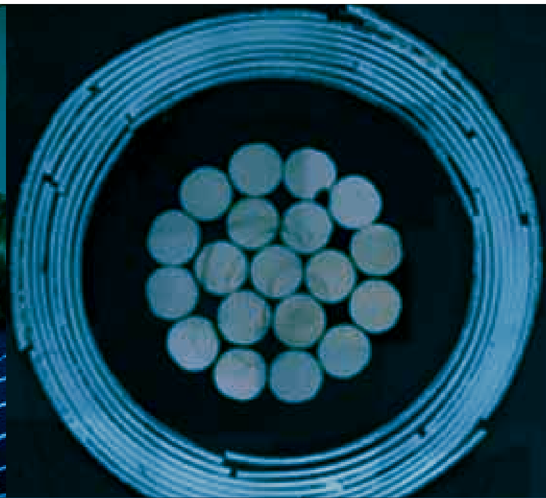



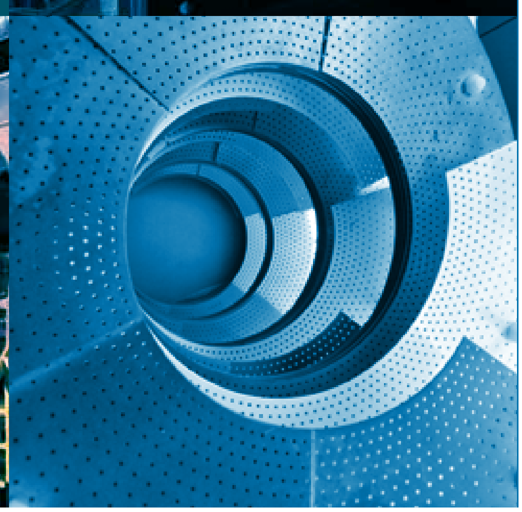

THE NATIONAL HIGH MAGNETIC FIELD LABORATORY

2013 ANNUAL REPORT

NATIONAL HIGH MAGNETIC FIELD LABORATORY
FSU • UF • LANL





2013 Annual Report

PUBLISHED BY

The National High Magnetic Field Laboratory

1800 East Paul Dirac Drive • Tallahassee, FL 32310-3706

PHONE NUMBER
(850) 644-0311

FAX NUMBER
(850) 644-8350

DIRECTOR
Greg Boebinger

DEPUTY LAB DIRECTOR
Eric Palm

USERS PROGRAM,
CHIEF OF STAFF
Anke Toth

GRAPHIC DESIGNERS
Liz Vernon & Caroline McNiel

This document is available in alternate formats upon request. Contact Anke Toth for assistance. If you would like to be added to our mailing list, please e-mail atoth@magnet.fsu.edu.

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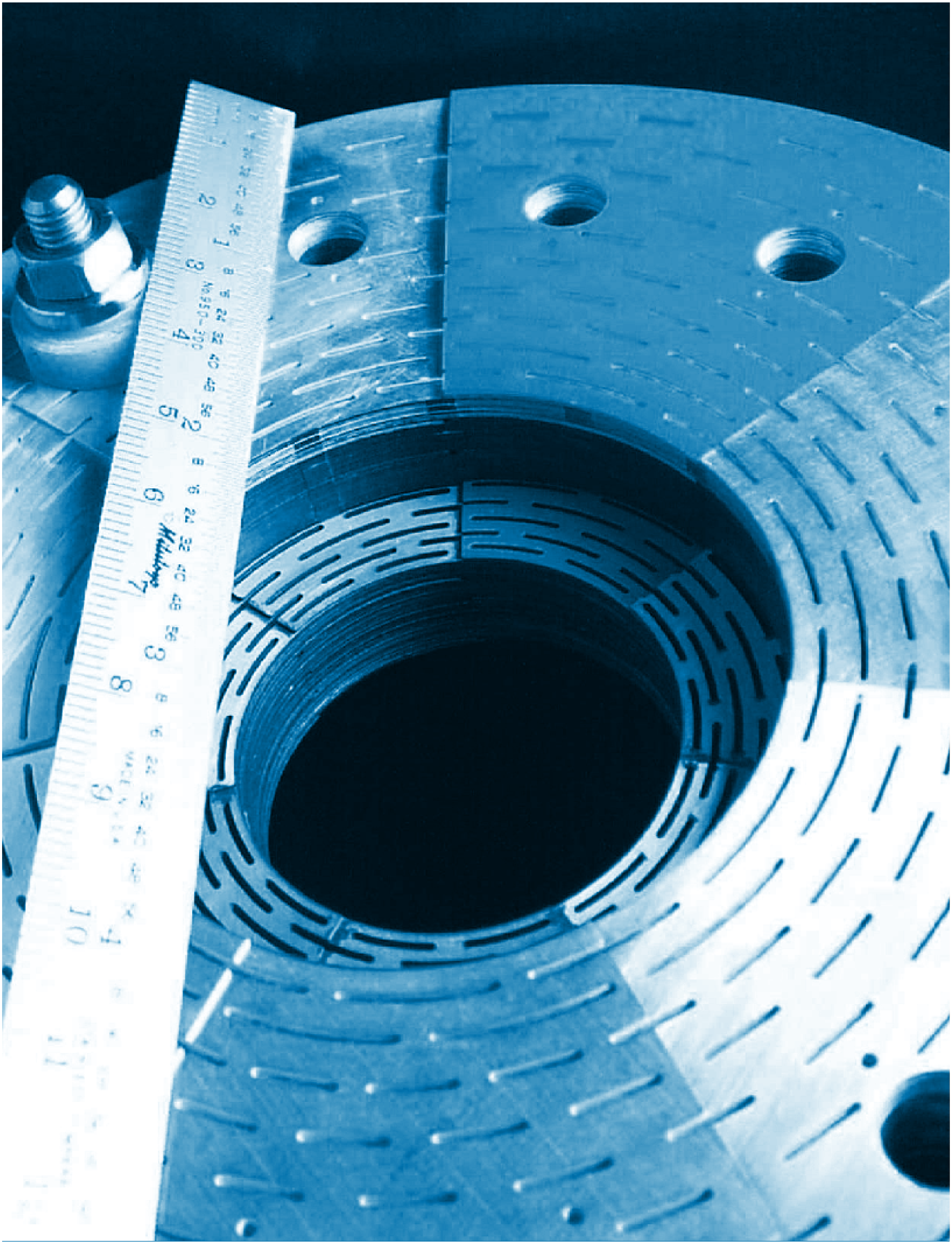

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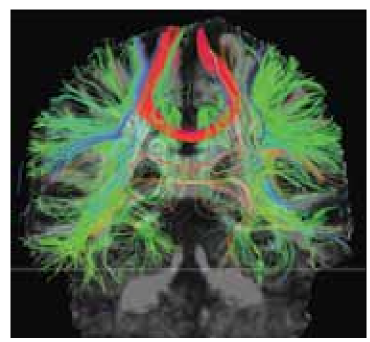


CHAPTER 1

2013 Year in Review

New funding… New discoveries

In 2013, the National High Magnetic Field Laboratory (MagLab) was awarded a $168 million renewal grant from the National Science Foundation (NSF). This renewal grant serves as a commitment to the lab and our users, ensuring that the MagLab will continue as a research hub for leading physicists, chemists, biologists and engineers during the 2013-2017 funding period.

Our renewal proposal sets the course for the next five years – an aggressive path to new discoveries in the areas of quantum matter, spin coherence and spin control, *in vitro* to *in vivo*, and energy and environment. These areas of science are as diverse as our interdisciplinary lab and worldwide user community, and in the first year of this new funding cycle, we have seen work in these areas flourish.

In the area of quantum matter, graphene was at the center of a big discovery at the MagLab in May 2013, when two teams of researchers published impressive findings revealing the elusive Hofstadter's butterfly. Theorized in 1976, Douglas Hofstadter showed that the full energy spectrum of an electron exposed to both a two-dimensional periodic lattice and a magnetic field is a complicated fractal that has come to be known as Hofstadter's butterfly. Combining boron nitride and graphene together with the low temperatures and high magnetic fields up to 45 T available at the lab, the two research teams were able to see clear experimental evidence of the butterfly fractal. Hofstadter's butterfly represents a new route to explore the role of topology in condensed matter systems and was recognized as a top ten physics breakthrough of the year by *Physics World* magazine. Additionally, Philip Kim, the head of one of research teams that made the Hofstadter discovery and a frequent MagLab user, was awarded the Oliver E. Buckley Condensed Matter Physics Prize for his discoveries of many unconventional electronic properties of graphene.

In late 2013, the National Academy of Sciences released a study on High Magnetic Field Science and its application in the United States. Known as the *MagSci Report*, the overall assessment is overwhelmingly supportive of the MagLab and its user community, stating that "owing in large measure to the NHMFL, high field magnet science in the United States is currently very strong." The Report also compliments the NHMFL as the "world leader in both advancing magnet technology and high-field science."

The *MagSci Report* also lays out a vision for the future of high magnetic field science — an ambitious plan that includes at least six new magnet systems of unprecedented size and performance. These recommended magnets include new high field (1.3-1.6 GHz) NMR magnets, a 150 T (msec) pulse magnet for thermal transport and optical experiments, a 60 T hybrid, and a 20 T large-animal and human MRI.
Many of these MagSci-proposed magnets require high-temperature superconductor materials and technology development, an ongoing MagLab R&D program that continued to be at the forefront of work in 2013. Two major breakthroughs were in testing and processing superconductors:

- a technique to test long lengths of tape made of the promising high-temperature superconductor YBCO, the conductor now being incorporated into our 32 T all-superconducting magnet project.
- a method to process high-temperature superconducting Bi-2122 round wire that significantly boosts its ability to carry large electrical currents to generate high magnetic fields.

Serving a Growing User Community

In 2013, a record-breaking 1,377 users from around the world conducted research at one of the MagLab's seven user facilities across its three campuses. In 2013, the MagLab also logged 77 new principal investigators and 49 new Ph.Ds. Users generated 440 research reports in 2013 and the laboratory continued its strong record of publishing, with 469 articles appearing in peer-reviewed scientific and engineering journals throughout the year.

But beyond the *quantity* of researchers who use the MagLab's facilities, our users were also overwhelmingly positive about the *quality* of their experience. Ninety-two percent of users were satisfied with the performance of the facilities and equipment and 96 percent were satisfied with the assistance they received by Magnet Lab technical staff. Users also report that they expect to disseminate their results as an outcome of their visit to the MagLab, 85 percent via publications and 74 percent through presentations. These numbers tell a complete story of the MagLab as a user-focused scientific facility.

Safety

In February 2013, the lab completed full implementation of Integrated Safety Management (ISM) to improve, codify and enforce enhanced safety practices at the MagLab. ISM requires employees and visiting scientists to **analyze their full scope of work, anticipate and analyze hazards, develop and implement hazard controls, perform their work within the hazard controls** and finally to **provide feedback for future**

improvement to the MagLab Safety Committee via the MagLab website. ISM steps and safety messages are emphasized in quarterly safety meetings hosted by the lab director, including the MagLab's "Stop Work Policy" whereby each employee has the responsibility and authority to stop work immediately, without fear of reprisal, when the employee believes that unsafe conditions exist. In addition, every new employee must complete job-specific online training before receiving a MagLab badge. New employees must also attend a face-to-face meeting with the MagLab Director. These New Employee Safety Meetings ensure that all new employees understand:

- The MagLab's commitment to Integrated Safety Management
- The MagLab's Stop Work Policy, Disciplinary Policy and all other MagLab resources available to help them work safely.

This training includes:

- A presentation by the MagLab Director
- A breakout session during which each new employee documents the ISM process for a task they regularly perform. Supervisors/ managers are required to attend the breakout session of this training to assist new employees with this process and to ensure reinforcement of the safety message.

Major Facility Upgrades

To meet the needs of our growing and evolving user community, the MagLab is in constant pursuit of improvements to our facility and capabilities. In 2013, the major upgrades across three sites included:

Helium conservation:

- The 45 T hybrid magnet was connected to the Linde L280 turbine liquefier through the cryogenic central distribution box. This change will result in more magnet time available for the 45 T hybrid magnet, as liquefier maintenance should no longer be an issue.
- 7,000 feet of polyethylene helium recovery piping was installed in the MagLab/FSU to return helium gas to the liquefier from throughout the facility.
- The rebuild of the University of Florida campus-wide helium recovery system was completed, serving the MagLab's High B/T Facility and the Advanced Magnetic Resonance Spectroscopy and Imaging (AMRIS) Facility. The new liquefier is based on a Linde Model L1610, which meets the projected needs of both large scale users like the MagLab and the widely distributed small scale users across campus for the next 15 years.
- The installation of a helium liquefaction system at the Pulsed Field Facility in Los Alamos was started, with plans to be fully operational in 2014.

New Probe Development:

- A compact, lightweight, automatic probe loader was developed, tested and implemented to help provide slow, precise and consistent cooling during sample loading into the top loading cryostats in DC Field Facility. The system mechanically lowers probes over the temperature range 300 K – 1.5 K at rates of 0.1 K/min. up to 10 K/min.
- Several fiber optic-based, high magnetic field Raman probes and associated optical setups were developed for DC Field Facility. These new probes allow for highly sensitive Raman scattering measurements at variable temperatures, 1.6K-300K, and high magnetic fields up to 45 T.
- Ultra-high mass-sensitivity solution NMR probes were successfully designed and engineered. A new 1.5-mm high-temperature superconducting probe designed to detect carbon 13 will significantly enhance studies in natural products and metabolomics.
- Radio frequency amplifiers using pseudomorphic field effect transistors were successfully developed and implemented for use as millikelvin temperatures at the High B/T Facility.

Dynamic Nuclear Polarization

- The AMRIS Facility installed a polarizer in 2013 for dissolution dynamic nuclear polarization (DNP). The custom design of the polarizer enables the use of dissolution DNP to study metabolic flux *in vivo* using a variety of NMR–active nuclei. This polarizer is now available to external users.
- The Electron Magnetic Resonance (EMR) Facility is working in partnership with the Nuclear Magnetic Resonance (NMR) Facility to develop a high-power, gyrotron-based 395 GHz/600 MHz DNP instrument targeted at small molecules in organic solutions. A separate DNP effort for solids is also underway.

Systems biology - Metabolomics

- The NMR/MRI Facility in at the MagLab/FSU teamed up with the AMRIS Program at the MagLab/UF to aid in a five-year, $9 million Metabolomics Initiative led by AMRIS researcher Art Edison that was recently funded by the National Institutes of Health. Metabolomics is an emerging field that studies the small molecules, called metabolites, which result from the metabolic processes that fuel and sustain life. It offers a new lens through which scientists can assess and understand the state of nutrition, infection, health or disease in an organism, whether human, animal, plant or microbe.

Pulsed Magnet upgrades:

- A second 100 T 10mm insert coil for the 100T multi-shot magnet system has been in use at the MagLab/LANL's Pulsed Field Facility throughout 2013 and a third 100T 10mm bore insert winding was completed and will be ready to install as needed in 2014. The demonstrated reliability of manufacturing a steady supply of these insert coils is key to the MagLab/ LANL's reliable provision of the highest non-destructive magnetic fields available to users anywhere in the world.
- A new electromagnetically screened room and heavy wall copper conduit was installed at the Pulsed Field Facility to enhance signal to noise for experiments using either the 100 T Multi-Shot magnet or the 60 T Controlled Waveform magnet. Signals with better than 5 $nV/(Hz)^{1/2}$ were collected on experiments in the 100 T magnet after installation in November of 2013.

Industry Collaborations & Partnerships

Nearly 90 unique MagLab partnerships and collaborations with industry, universities and other national laboratories are summarized in chapter 2. In addition to these important partnerships, the MagLab plays an important role in growing new businesses.

- The Future Fuels Institute completed its second full year in 2013, with three full share members ($250 k/yr for 4 years) to support research to address challenges associated with petroleum production and processing. In 2014, it will expand to four members.
- MagLab scientists Jeff Whalen and Theo Siegrist also founded a new company, Specialized Crystal Processing, based on their research into the development of synthetic crystals with immediate technological applications.

Engaging the Next Generation of Scientists

Throughout 2013, the MagLab's Center for Integrating Research and Learning (CIRL) continued its extensive outreach efforts that include classroom outreach, hands-on extended programs (e.g. internships and camps), tours, presentations and demonstrations, and web-based activities. These efforts reached over 10,000 K-12 students, undergraduates, graduate students, and more than 200 teachers in 2013.

- CIRL hosted 24 Research Experiences for Undergraduates and 14 Research Experiences for Teachers participants in 2013, exposing both groups to hands-on research projects with MagLab scientists.
- Another 89 students participated in the MagLab's summer camps.
- The annual MagLab Open House offered 5,500 visitors the opportunity to experience hands-on science at the MagLab/FSU. The MagLab/LANL Pulsed Field Facility hosted another 140 visitors on guided tours during Los Alamos National Laboratory's Family Day.

In 2013, the lab also hosted a Winter Theory School and Summer School to bring early career scientists to the Magnet Lab. The Winter Theory School was focused on *Unconventional Superconductivity* and attracted 50 participants while the Summer School on experimental techniques attracted 45 graduate students and post doc attendees, nearly double the number of participants in 2012..

Management Updates

There were a few major staff management updates in 2013:

- Tom Cordi was named Assistant Lab Director for Business Administration in March 2013.
- Kristin Roberts was named Director of Public Affairs in April 2013.
- Anke Toth was named the MagLab's User Program Chief of Staff in August 2013.

MagLab Researchers Honored and Awarded

Shermane Benjamin, a MagLab graduate research assistant in physics, was awarded a McKnight Doctoral Fellowship from the Florida Education Fund in June 2013. This fellowship seeks to improve the representation of minority faculty at Florida colleges and universities by recognizing quality of research and investing in African-Americans and Hispanics pursuing a Ph.D in a variety of areas, including physics.

Jeremy Weiss, a graduate student working at the Applied Superconductivity Center, was awarded a Florida State University Graduate Student Research and Creativity Award which recognizes students for their outstanding research and creative productivity within their programs.

Magnet Lab scientists Peter Lee and Dragana Popović have been recognized with 2013 Distinguished University Scholar awards from Florida State University — the only two recipients of the prestigious award this year.

MagLab-affiliated Professor Rufina Alamo received a 2013 Florida State University Distinguished Research Professor Award recognizing her pioneering chemical engineering research in the FSU-FAMU College of Engineering.

Peter Hirschfeld was selected as the University of Florida (UF) 2013 Teacher/Scholar of the Year. As UF's oldest faculty award, it is presented to a faculty member who demonstrates distinguished achievement in both teaching and scholarly activity.

Three MagLab researchers joined the fellowship ranks of the American Physical Society in 2013: Rufina Alamo, Luis Balicas and Dragana Popović. This fellowship is an honor reserved for those members who have made exceptional contributions to physics.

In June 2013, Lucio Frydman, Chief Scientist for Chem/Bio, received the Russel Varian Prize for innovation in NMR. This prize was awarded to Frydman's work on the acquisition of multidimensional NMR spectra within a single scan which was found to have important and broad impact on state-of-the-art NMR technology.

Alan G. Marshall, Director of the MagLab's Ion Cyclotron Resonance (ICR) Facility, was inducted as a fellow of the American Academy of Arts and Sciences in October 2013. The American Academy of Arts and Sciences was founded in 1780 and, as a new fellow, Marshall joins the company of George Washington, Ralph Waldo Emerson, Alexander Graham Bell, Ben Franklin and more than 250 Nobel laureates.

Final Remarks

And thus, 2013 has proven to be a successful first year of the 2013-2017 funding period: a year of launching new initiatives while continuing to support our world-leading efforts in high magnetic field research and technology.

CHAPTER 2

Laboratory Management

Strategic Plan

(Updated December 2013)

The MagLab strategic plan outlines eight institutional mission imperatives that describe our fundamental ongoing responsibilities as a national laboratory. Each imperative is followed by a prioritized set of supporting actions that the MagLab will undertake on behalf of its user program. Our plan also lays out a set of science drivers and technical frontiers – those opportunities that the MagLab and its user program intend to build out from and across existing programs and research activities. Together, the imperatives, science drivers and technical frontiers explain our highest-priority ongoing efforts and our aspirations for program development and enhancement. This is a five-year plan updated from the 2013-2017 renewal proposal submitted to the NSF in August 2011. It includes some activities that extend beyond the five-year horizon. This plan will be further updated following strategic planning meetings in 2014 that will thoughtfully consider 2013 MacSci Report and its recommendations.

This plan is not a comprehensive overview of the many valued activities conducted within the MagLab and its user program. Rather, it is intended as a concise, high-level explanation of institutional direction and priorities for growth. More detailed descriptions of the full sweep of MagLab activities can be found in the MagLab Annual Report, MagLab Science Highlights, and the MagLab periodicals: *MagLab Reports* and *Flux* magazine.

MagLab User Program Science Drivers

The specific MagLab research directions are ultimately determined by the most meritorious peer-reviewed proposals submitted by users. Input from the COHMAG report, the MagLab's user community, and advisory committees identifies the four most promising science drivers for the coming decade:

- **Quantum Matter**, the broadly challenging manifestations of quantum phenomena in materials, including • low-dimensional metals like graphene, where magnetic fields quench the kinetic energy to isolate correlation effects; • cuprate and Fe-based superconductivity, which despite many differences, both occur in proximity to magnetism; and • quantum phase transitions such as Bose-Einstein condensation in spin systems, where the density of spins is tuned by the applied magnetic field;

- **Spin Coherence and Spin Control**, the detection and manipulation of electron and nuclear spins, including • molecular magnets, where high fields enable study of systems with strong electron spin-orbit coupling; • quantum magnetism, which requires a very wide range of EPR frequencies; • spintronics and quantum computing, each requiring high fields and EPR frequencies; • high frequency pulsed EPR to resolve nanosecond dynamics; • highest-sensitivity NMR probes for both solution and solid-state NMR; • new contrast agents for single cell MRI; • novel NMR data processing; and high-magnetic-field dynamic nuclear polarization, which draws on MagLab EMR and NMR expertise.

- ***In Vitro* to *In Vivo***, the structure and dynamics of the molecular components of life using high magnetic fields for • structural studies of large heterogeneous membrane proteins using NMR; • hydrogen/deuterium exchange to probe molecular complex dynamics using ICR, • high frequency pulsed EPR to measure distance and dynamics in macromolecules; • large zero-field energy level splitting of metal ions in biological molecules using high-frequency EPR • organic radicals important to physiological processes using high-field EPR; • cellular MRI of individual neurons and subcellular structures; • the assay of hundreds to thousands of small molecule metabolites using highest-field NMR and ICR; and • in vivo biochemistry and physiology measurements of nuclei in living animals;

- **Energy and Environment,** the increase in user research at five of the MagLab's six user facilities that spans organic chemistry, solid-state physical chemistry, and materials physics at interfaces has required high magnetic fields where, for example • economic and environmental issues of energy production via molecular-level assaying of crude oil and candidate future fuels such as pine mulch and algae are revealed via the ICR sensitivity and resolution at the MagLab that launched the petroleomics research field; catalysis and the 'interface problem', where the highest magnetic fields change energy bands and local energy states sufficiently to provide reversible, quantitative tuning of nanostructured interfacial thermodynamics and kinetics • energy storage in batteries and chemicals, where the highest-sensitivity EMR and NMR determine local environment, location, and functionality.

Technical Goals resulting from the Science Drivers

The science drivers have determined the priorities for new initiatives and magnet technology articulated in this section. The highest priority technical goals are:

- **Increase Peak Magnetic Fields,** the primary demand of the user community and the primary enabler of the Science Drivers,

Vision

The MagLab will remain the most interdisciplinary and most scientifically productive magnet lab in the world.

MagLab Mission Imperatives

1. Promote magnet-related research to serve an interdisciplinary scientific user community spanning materials science, condensed matter physics, magnet technology, chemistry, and biology
2. Provide unique high-magnetic-field facilities through a competitive and transparent proposal review process.
3. Advance magnet and magnet-related technology via high-risk, high-reward projects
4. Partner with universities, other national laboratories and industry to enhance national competitiveness in magnet and related technologies.
5. Serve the NSF as a prominent example of its successful stewardship of large research facilities
6. Serve as a successful model as
   - **a.** a multi-site national laboratory
   - **b.** a collaboration among our three partner institutions: Florida State University (FSU), the University of Florida (UF) and Los Alamos National Laboratory (LANL)
   - **c.** a partnership of the federal and state government
   - **d.** a partnership of the National Science Foundation and the Department of Energy
7. Support science and technology education in the United States.
8. Increase diversity in the science, technology, engineering and mathematics workforce of today and tomorrow

by leveraging major investments by the MagLab's partner institutions, including
- ◦ Develop 28MW magnets to take advantage of the $7.5M State-of-Florida funded 56MW DC Magnet power supply upgrade at Florida State University,
- ◦ Steadily increase from 93 T to 100 T the peak field delivered to the Pulsed Magnet Users as experience is gained in the operation, the performance, and the experimental challenges of the 100 T Multi-Shot Magnet.
- ◦ Launch a user program that accesses the 200T microsecond-duration pulsed magnetic fields enabled by $4.2M LANL-funded infrastructure.
- ◦ Commission new $1.2M superconducting magnet at the High B/T facilities at the University of Florida.

- **Increase User Magnet Time** in response to the growing user demand evidenced by User Committee surveys and magnet oversubscription rates.

- **Further develop EMR, NMR and MRI capabilities** by investing in probes, gradient coils, upgraded electronics and new consoles.

- **Further develop cross-disciplinary utilization of MagLab facilities,** including for example the use of
  - ◦ the ultra-wide-bore 900 MHz magnet for temperature-dependent materials research of multi-ferroics and other quantum matter,
  - ◦ MagLab MRI capabilities for in-situ profiling of lithium and hydrogen in batteries and fuel cells, and
  - ◦ starting 2015, the 36T/1ppm-homogeneity Series Connected Hybrid to advance solid-state NMR to 1.5 GHz and multi-disciplinary Electron Magnetic Resonance to 1 terahertz.

- **Continue to develop MagLab high-Tc superconducting (HTS) materials and magnet technologies** to significantly advance the peak fields achievable from superconducting magnets.

- **Continue to develop MagLab superconducting Cable-in-Conduit Conductor (CICC) technology** for both Nb-based and HTS superconducting applications.

Education, Diversity and Outreach Goals

- Establish the MagLab's programs as national leaders in informal science education, and STEM diversity, including K-12 outreach in Florida and New Mexico, REU and RET programs, SciGirls summer camps, and two periodicals, *Flux* for the general public and *MagLab Reports* for scientists.

- Continued mentorships to young scientists from under-represented groups, tailored to strengthen and advance each individual's career aspirations. This is a very high priority reflected by the roughly $200K/yr budget devoted to support the MagLab Diversity Action Plan.

- Continue the MagLab summer school for graduate students and postdocs to learn experimental techniques of importance to high magnetic field research. The one-week curriculum will include basic electronics, noise suppression, and grounding techniques, as well as the details of NHMFL measurement techniques such as transport, magnetization, specific heat, and nuclear magnetic resonance.

- Continue the MagLab Winter Theory School for graduate students and postdocs. The theory school will host a half-dozen leading theorists to present a week-long series of lectures on topics in condensed matter physics and materials science relevant to high-magnetic-field research.

Science Enabling Technical Frontiers

The MagLab has world-leading magnet technology and unique capabilities to further advance a wide variety of technologies relevant next generation magnet and magnet materials. With the first priority listed first, MagLab technical priorities are listed below:

- **Series Connected Hybrid** – a pioneering MagLab magnet technology utilizing superconducting and resistive coils connected electrically in series. The system allows for multiple resistive insert coils to be positioned in the bore of a common superconducting outer coil.
    - to realize 36T fields of unprecedented homogeneity (1ppm) for powered magnets. This insert coil is under construction.
    - to realize 40T fields using only 14MW of power, half the amount required for an all-resistive magnet. Plans for this insert coil are under development.

- **28MW DC Magnets,** first developing a 41T/32mm magnet and then a 37T/50mm magnet, exploiting the capabilities of the new 56MW DC Power Supply to increase user DC magnetic fields by ~18%, the largest increase in 20 years and a two-fold increase in 40T fields worldwide.

- **Develop high-field dynamic nuclear polarization (DNP)** using existing MagLab strengths - NMR probes, high-frequency EMR, and NMR/MRI technique development – to enhance solid-state NMR and detection of critical biological molecules in living organisms, including *in vivo* metabolism and physiology.

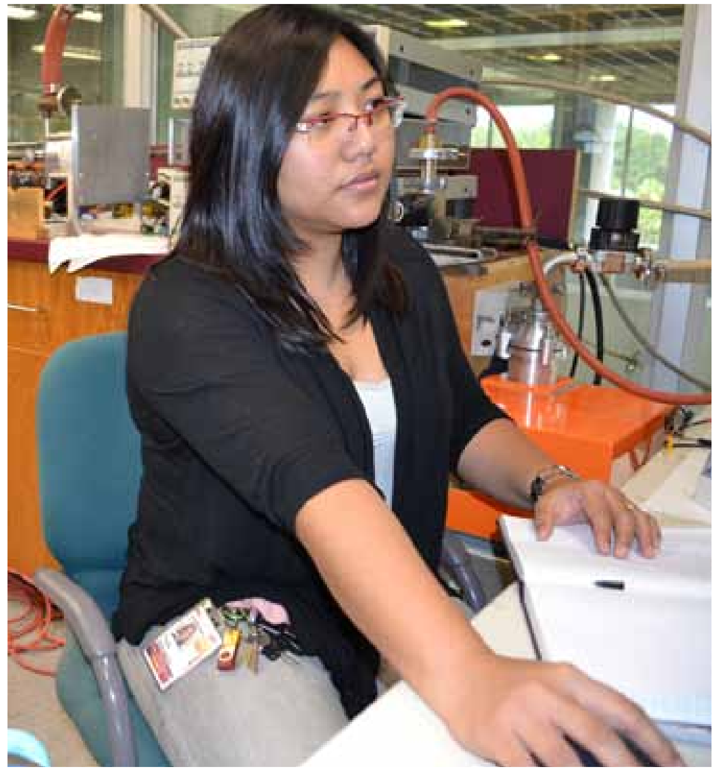
- **Continue to define the technical roadmaps** and provide impetus to the eventual realization of the two remaining COHMAG challenge magnets: the 30T NMR magnet and 60T Hybrid Magnet. Each of these magnets depends upon the development of new materials prior to the development of magnet construction proposals.

- **Magnets for Competing Magnet Labs** - four of the world's five leading magnet labs use MagLab Florida-Bitter technology. The MagLab will continue to assist and collaborate with other magnet labs in both magnet technology and experimental techniques, in particular:

- ◦ EuroMagNET, the unified European magnet laboratory: Grenoble and Nijmegen (DC magnetic fields), and Toulouse and Dresden (pulsed magnetic fields)
- ◦ Magnet Labs in Japan: Kashiwa (pulsed magnetic fields)
- ◦ Magnet Labs in China: Hefei (DC magnetic fields) and Wuhan (pulsed magnetic fields)

- **Magnets to the Neutrons** – commission a 25 T DC magnet for the neutron source at the HZB (Berlin, Germany); continue discussions with the Spallation Neutron Source at Oak Ridge National Laboratory

- **Magnets to the X-rays** – develop plans with the Advanced Light Source at Argonne National Lab for either pulsed or DC magnetic fields.



Strategic Plan Performance Metrics

The MagLab publishes an Annual Report that showcases the programs and activities at the MagLab and includes the metrics used by MagLab management, the MagLab External Advisory Committee, the MagLab User Committee and the NSF Site Visit committees to evaluate the MagLab's performance. Each Annual Report includes:

- The Year in Review, written by the Director
- Science & Engineering Highlights
- Reports and statistics from the lab's user facilities
- Summaries from the magnet engineering and materials groups
- Summaries of management, administration, education, and diversity programs
- Results of the User Collaboration Grants Program
- Summaries of MagLab industrial partnerships and collaborations
- Lists of publications, presentations, theses and other activities

The MagLab receives expert evaluation of its scientific program by other scientists, including but not limited to reports by the MagLab External Advisory Committee, the MagLab User Committee and the NSF Site Visit Committees. Numerical metrics that characterize the MagLab's performance are reported in the Annual Report including:

- MagLab User Committee's survey of user satisfaction with:
  - Equipment availability
  - Equipment performance
  - MagLab scientist assistance
  - MagLab administrative assistance
  - MagLab training and safety procedures
  - MagLab user proposal submission and evaluation process
- MagLab User Profile report containing the breakdown of the total number of MagLab users by:
  - Senior investigators, postdocs, students and technicians
  - Gender and minority status
  - Affiliation of users: NHMFL, university, industry, national lab, or overseas.
  - Facility utilized: DC, Pulsed, High B/T, NMR/MRI, EMR & ICR.
- MagLab Facility Usage Profile report containing the breakdown of magnet days allocated by scientific discipline, affiliation of users, and facility utilized.
- User Collaboration Grants Program (UCGP) report, including:
  - Number of proposals received
  - Proposal acceptance rates
  - Usage of facility enhancements reported from UCGP solicitations
  - Publications reported from UCGP solicitations
- Education Program report that includes the number of participants in:
  - Research Experiences for Teachers
  - Research Experiences for Undergraduates
  - Middle School Mentorships
  - High School Mentorships
  - MagLab classroom outreach and laboratory tours.
- Science and Research Productivity statistics, including:
  - Publications in Peer-Reviewed Journals
  - Publications in Prominent Peer-Reviewed Journals, such as *Nature*, *Science*, the *Proceedings of the National Academy of Sciences*, and prominent, discipline-specific journals such as *Physical Review Letters* and *Journal of the American Chemical Society*.
  - Ph.D. degrees awarded
  - Masters' degrees awarded

Annual Reports are posted on the MagLab website, www.magnet.fsu.edu at http://www.magnet.fsu.edu/mediacenter/publications/annualreport.aspx.

Organizational Chart

The Florida State University, the University of Florida and Los Alamos National Laboratory jointly operate the National High Magnetic Field Laboratory for the National Science Foundation under a cooperative agreement that establishes the lab's goals and objectives. FSU, as the signatory of the agreement, is responsible for establishing and maintaining administrative and financial oversight of the lab and ensuring that the operations are in line with the objectives outlined in the cooperative agreement.

The structure of the MagLab is shown in **Figure 1** and **Figure 2**. The first figure shows the external oversight and advisory committees, as well as the three internal committees that provide guidance to NHMFL leadership. The second figure shows the internal, operational structure of the laboratory.

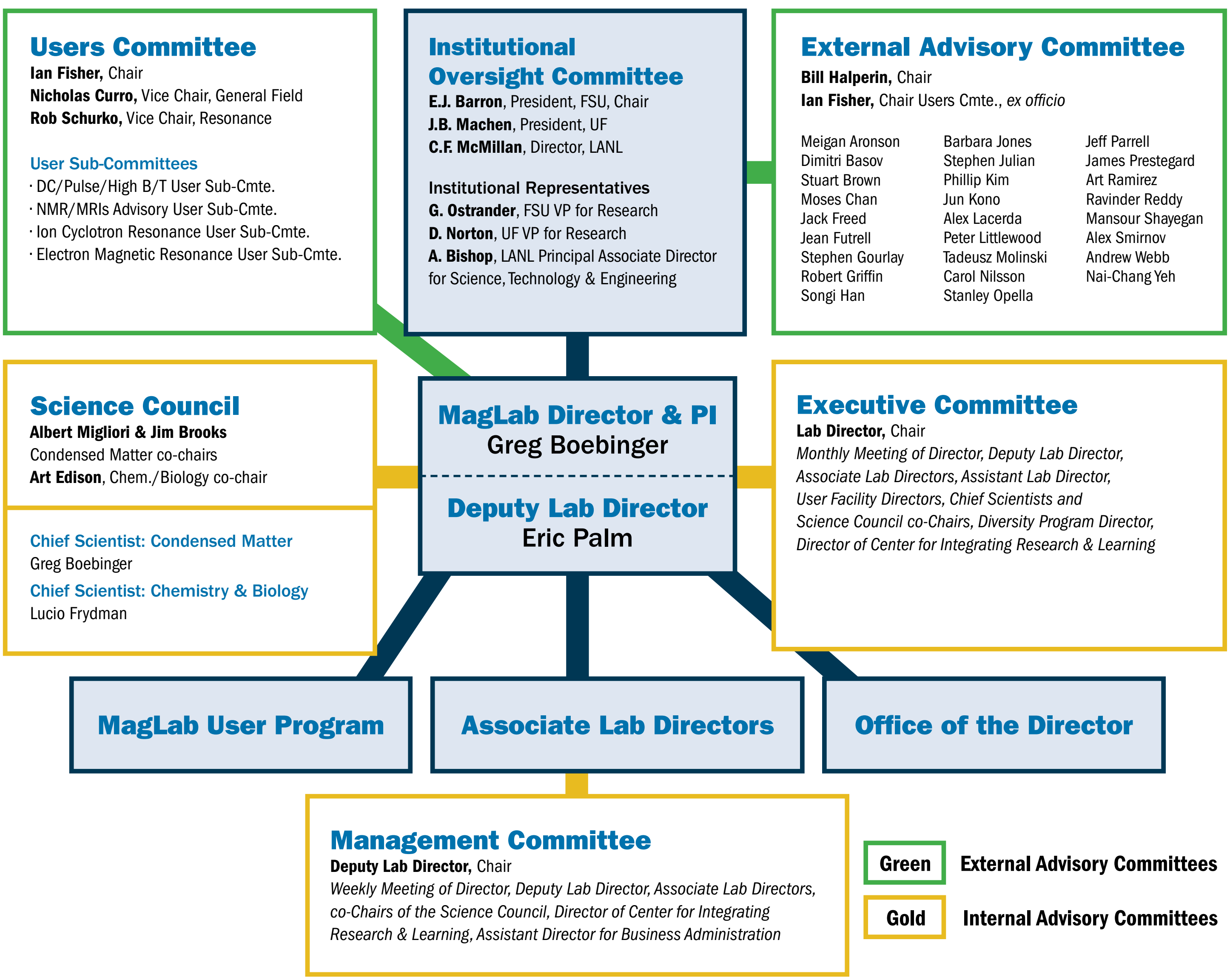


FIGURE 1. Advisory Committees of the MagLab, showing internal and external advisory committees.
Last Updated: January 30, 2014.

Greg Boebinger is the Director of the MagLab and PI of the cooperative agreement. Together the Director and Deputy Laboratory Director, **Eric Palm**, function as a team to provide management oversight for the laboratory. The management committee — consisting of the Associate Lab Directors, co-chairs of the science council, director of CIRL and the Assistant Director for Business Administration — meets on a weekly basis to discuss issues of importance across the MagLab. The Executive Committee meets on a monthly basis to discuss labwide issues as well as program-specific issues. Professor **Joanna Long**, Director of the NHMFL's AMRIS User Facility, was promoted to the position of Associate Laboratory Director for the MagLab/University of Florida Branch. In connection with this promotion, she replaced Professor **Art Edison** to become co-PI on the NHMFL's core NSF grant.

The lab's scientific direction is overseen by the **Science Council**, a multidisciplinary "think-tank" group of distinguished faculty from all three sites. Members are: Albert Migliori (co-chair), Jim Brooks (co-chair), Art Edison (co-chair), Gail Fanucci, Zhehong Gan, Lev Gor'kov, Stephen Hill, Jurek Krzystek, David Larbalestier, Dragana Popović, Ryan Rodgers, Theo Siegrist, Glenn Walter and Huub Weijers.

Two external committees meet regularly to provide critical advice on important issues. The **External Advisory Committee**, made up of representatives from academia, government, and industry, offers advice on matters critical to the successful management of the lab. The **Users Committee**, which reflects the broad range of scientists who conduct research at the lab, provides guidance on the development and use of facilities and services in support of the work of those scientists. These committees and their 2013 meetings are further described below.

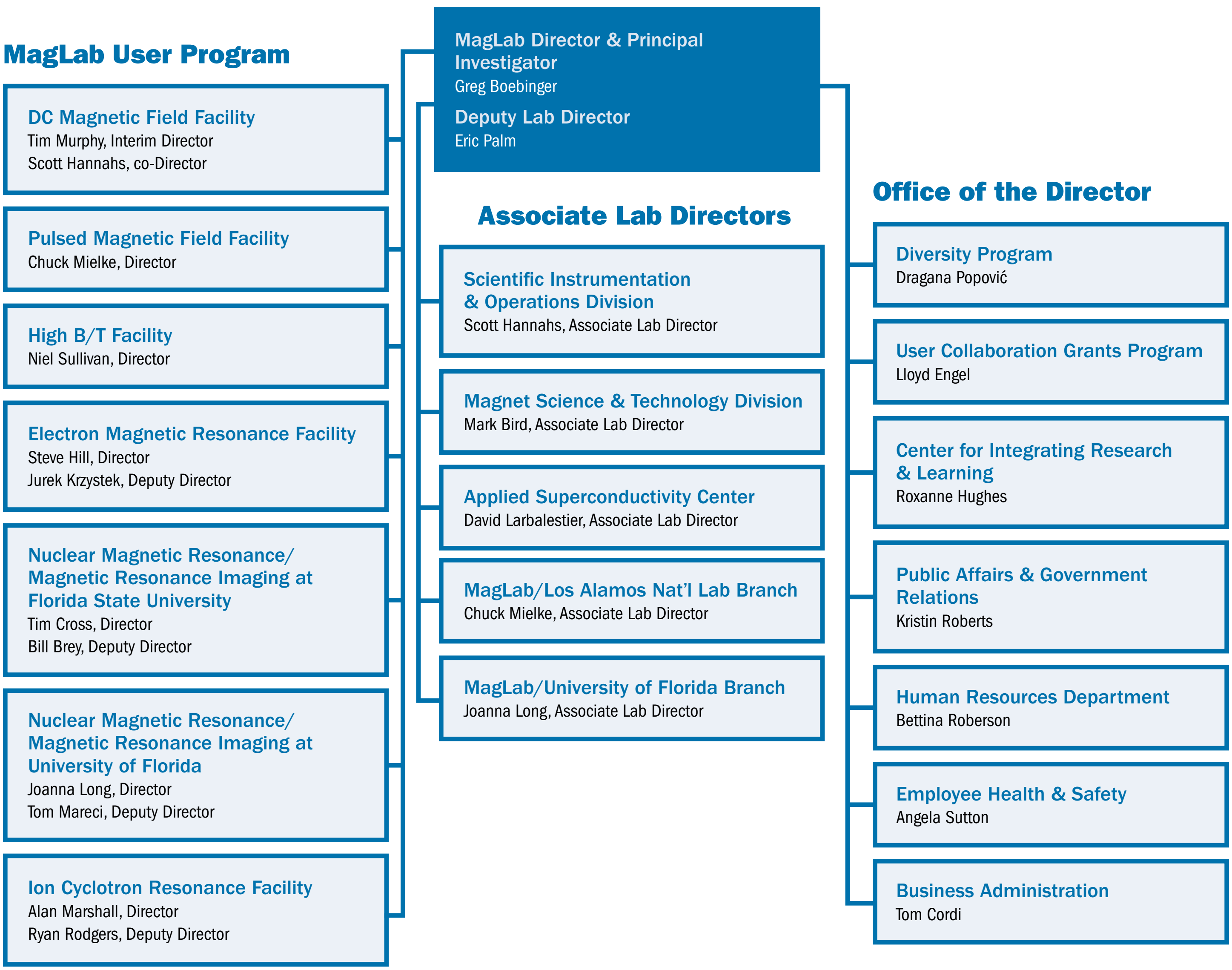


FIGURE 2. MagLab Organizational Chart

External Advisory Committee

The External Advisory Committee met July, 23–24, 2013, in Tallahassee and provided a report to Eric Barron, President of FSU; J. Bernard Machen, President of UF; and Charles F. McMillan, Director of Los Alamos National Laboratory. This report called out the success of the MagLab and provided advice in the form of recommended actions and priorities of the MagLab. This advice spanned challenges faced by budgetary constraints and the lab's expected recompetition in coming years.

External Advisory Committee Members & Affiliation

William Halperin, External Advisory Committee Chair, Northwestern University
Ian Fisher, User Committee Chair (*ex officio* member of EAC), Stanford University

Magnet Technology & Materials Subcommittee

Stephen Gourlay, Lawrence Berkeley National Lab
Jeff Parrell, Oxford Superconducting Technology

Biology & Chemistry Subcommittee

Jack Freed, Cornell University
Jean Futrell, Battelle, Pacific Northwest National Lab
Robert Griffin, Massachusetts Institute of Technology
Songi Han, University of California, Santa Barbara
Tadeusz F. Molinski, University of California, San Diego
Carol Nilsson, University of Texas Medical Branch
Stanley Opella, University of California, San Diego
James Prestegard, The University of Georgia
Ravinder Reddy, University of Pennsylvania
Alex Smirnov, North Carolina State University
Andrew Webb, Leiden University Medical Center

Condensed Matter Subcommittee

Meigan Aronson, Brookhaven National Lab
Dimitri Basov, University of California, San Diego
Stuart Brown, University of California, Los Angeles
Moses Chan, Penn State University
Barbara A. Jones, IBM Almaden Research Center
Stephen Julian, University of Toronto
Phillip Kim, Columbia University
Jun Kono, Rice University
Alex Lacerda, Los Alamos National Lab
Peter Littlewood, Argonne National Lab
Art Ramirez, University of California, Santa Cruz
Mansour Shayegan, Princeton University
Nai-Chang Yeh, California Institute of Technology

User Committees

The Magnet Lab's User Committees represents the MagLab's broad, multidisciplinary user community and advises the lab's leadership on all issues affecting users of our facilities. The Users Committee is elected from the user base of the NHMFL. Each facility has a subcommittee elected by its users to represent their interests to the NHMFL. Since the DC, Pulsed and High B/T facilities primarily deal with condensed matter physics, there is a single subcommittee representing the three user facilities. Likewise, the NMR facilities at UF and FSU have a single, combined subcommittee. Each subcommittee then elects members to represent it on the Users Executive Committee. This Users Executive Committee elects a chair and two vice chairs. The DC/Pulsed/High B/T Advisory Committee, the EMR Advisory Subcommittee, the NMR/MRI Advisory Committee, and the representative from the ICR Advisory Committee met October 18-19 at the University of Florida in Gainesville to discuss the state of the laboratory and provide feedback to the NSF and MagLab management. (Chapter 3, page 60)

User Committees Officers & Affiliation

DC/ Pulsed/ High B/T Advisory Committee

Kenneth Burch, University of Toronto
Nicholas Curro*, University of California Davis
Ian Fisher*, Stanford University
Paul Goddard, Clarendon Laboratory
Jeanie Lau, University of California, Riverside
Janice Musfeldt*, University of Tennessee-Knoxville
Cedomir Petrovic, Brookhaven National Lab
Oliver Portugall, CNRS, France
Makariy Tanatar, US DOE The Ames Lab

EMR Advisory Committee

Christos Lampropoulos, University of North Florida
Gavin Morley, University of Warwick
Stefan Stoll, University of Washington
Joshua Telser*, Roosevelt University
Kurt Warncke, Emory University
Sergei Zvyagin, Dresden High Magnetic Field Lab

ICR Advisory Committee

Jonathan Amster, University of Georgia
Steve Beu, S.C. Beu Consulting
Michael Greig, Pfizer Global R&D – LaJolla
David C. Muddiman, North Carolina State University
Alexandra Stenson*, University of South Alabama
Evan Williams, University of California

NMR/MRIs Advisory Committee

Dmitri Artemov, Johns Hopkins University
Ari Borthakur, University of Pennsylvania
Joanna Collingwood, University of Warwick
Linda Columbus, University of Virginia
Myriam Cotten, Hamilton College
Michael Harrington, Huntington Medical Research Institutes
Conggang Li, Wuhan Institute of Physics & Mathematics, Chinese Academy of Sciences
Manish Mehta, Oberlin College
Tatyana Polenova*, University of Delaware
Scott Prosser, University of Toronto
Marek Pruski, Ames Laboratory, Iowa State University
Mark Rance, University of Cincinnati
Rob Schurko*, University of Windsor
Fang Tian, Penn State University
Ivan Tkac, University of Minnesota

*Member of Users Executive Committee

Personnel

KEY FACULTY & STAFF

As of January 2, 2014, seven hundred and six people (706) worked for or were affiliated with the Magnet Lab at FSU, UF, and LANL in 2013 compared to 692 in 2012. A list of MagLab key facility faculty and staff is presented below. All information in the Personnel section is as of January 2, 2014.

PRINCIPLE INVESTIGATORS

Greg Boebinger – Director/Professor, Professor of Physics
Arthur Edison – Professor, Biochemistry & Molecular Biology, NHMFL Director for Chemistry & Biology
Timothy Cross – Nuclear Magnetic Resonance (FSU)
Alan Marshall – Ion Cyclotron Resonance
Neil Sullivan – High B/T Facility
Charles Mielke – Director, Pulsed Field Facility at LANL and Deputy Group Leader

USER FACILITY DIRECTORS

Scott Hannahs – DC Field Facility
Tim Murphy – (Interim) DC User Program
Chuck Mielke – Pulsed Field Facility
Neil Sullivan – High B/T Facility
Timothy Cross – Nuclear Magnetic Resonance (FSU)
Joanna Long – Nuclear Magnetic Resonance (UF)
Alan Marshall – Ion Cyclotron Resonance

KEY PERSONNEL

Management and Administration

Cordi, Thomas – Assistant Lab Director, Business Administration
Rea, Clyde – Assistant Director, Business & Financial / Auxiliary Services
Brooks, Richard – Facilities Superintendent
Kynoch, John – Assistant Director
Wood, Marshall – Facilities Electrical Supervisor
DC Instrumentation
Hannahs, Scott – Dir, DC Facilities and Instrumentation
Murphy, Timothy – Research Associate
Jensen, Peter – Network Administrator

Magnet Science & Technology

Bird, Mark – Scholar / Scientist
Zavion, Sheryl – Program Director
Bai, Hongyu – Assistant Scholar / Scientist
Dixon, Iain – Research Associate
Gavrilin, Andrey – Scholar / Scientist
Han, Ke – Scholar / Scientist
Hilton, David – Assistant Scholar / Scientist
Lu, Jun – Assistant Scholar / Scientist
Markiewicz, William – Scholar / Scientist
Marshall, William – Research Associate
Noyes, Patrick – Associate in Research
Painter, Thomas – Research Associate
Toth, Jack – Scholar / Scientist
Walsh, Robert – Research Associate
Weijers, Hubertus – Associate Scholar / Scientist
Xin, Yan – Associate Scholar / Scientist
Adkins, Todd – Research Engineer
Bole, Scott – Research Engineer
Cantrell, Kurtis – Research Engineer
Goddard, Robert – Scientific Research Specialist
Gundlach, Scott – Research Engineer
Johnson, Zachary – Research Engineer
Miller, George – Research Engineer
Viouchkov, Youri – Research Engineer
Voran, Adam – Research Engineer
Jarvis, Brent – Research Engineer
O'Reilly, James – Research Engineer

Condensed Matter Science

Bonesteel, Nicholas – Professor
Dobrosavljevic, Vladimir – Professor
Gor'kov, Lev – Professor
Rikvold, Per – Professor
Schlottmann, Pedro – Professor
Vafek, Oskar – Associate Professor
Yang, Kun – Professor
Albrecht-Schmitt, Thomas – Professor
Brooks, James – Professor

Cao, Jianming – Professor
Chiorescu, Irinel – Professor
Kovalev, Alexey – Assistant in Materials Instrumentation
Manousakis, Efstratios – Professor
Moulton, William – Professor
Oates, William – Assistant Professor
Ramakrishnan, Subramanian – Associate Professor
Shatruk, Mykhailo – Assistant Professor
Siegrist, Theo – Professor
Telotte, John – Associate Professor
Warusawithana, Maitri – Assistant Professor
Whalen, Jeffrey – Assistant Scholar / Scientist
Balicas, Luis – Scholar / Scientist
Engel, Lloyd – Scholar / Scientist
Graf, David – Assistant Scholar / Scientist
Hoch, Michael – Visiting Scientist/Researcher
Jaroszynski, Jan – Associate Scholar / Scientist
Knappenberger, Kenneth – Assistant Professor
Kuhns, Philip – Scholar / Scientist
Li, Zhiqiang – Assistant Scholar / Scientist
McGill, Stephen – Associate Scholar / Scientist
Park, Ju-Hyun – Associate Scholar / Scientist
Popovic, Dragana – Scholar / Scientist
Reyes, Arneil – Scholar / Scientist
Smirnov, Dmitry – Scholar / Scientist
Suslov, Alexey – Associate Scholar / Scientist
Tozer, Stanley – Scholar / Scientist

EMR

Dalal, Naresh – Professor
Fajer, Piotr – Professor
Hill, Stephen – Professor/EMR Director
Krzystek, Jerzy – Scholar / Scientist
Ozarowski, Andrzej – Assistant Scholar / Scientist
Song, Likai – Assistant Scholar / Scientist
van Tol, Johan – Scholar / Scientist

LANL

Balakirev, Fedor – Staff Member
Betts, Jonathan – Technical Staff Member
Crooker, Scott – Staff Member
Harrison, Neil – Staff Member
Hinrichs, Mark – Electrical Engineer
Jaime, Marcelo – Staff Member
McDonald, Ross – Staff Member
Mielke, Charles – Director, Pulsed Field Facility at LANL and Deputy Group Leader
Migliori, Albert – Staff Member and LANL Fellow
Rickel, Dwight – Staff Member
Singleton, John – Staff Member and LANL Fellow
Zapf, Vivien – Staff Member

NMR

Alamo, Rufina – Professor
Arora, Rajendra – Professor
Brey, William – Scholar / Scientist
Bruschweiler, Rafael – Professor
Cross, Timothy – Professor
Frydman, Lucio – Scholar / Scientist
Fu, Riqiang – Scholar / Scientist
Gaffney, Betty – Professor of Biology
Gan, Zhehong – Scholar / Scientist
Gor'kov, Peter – Research Associate
Grant, Samuel – Associate Professor
Hallinan, Daniel – Assistant Professor
Houpt, Thomas – Professor
Hung, Ivan – Assistant in
Kim, Jeong-su – Assistant Professor
Paravastu, Anant – Assistant Professor
Qin, Huajun – Assistant in Research
Schepkin, Victor – Associate Scholar / Scientist
Shekar, Srinivasan – Assistant Scholar / Scientist
Smith, James – Professor
Wi, Sungsool – Associate Scholar / Scientist
Zhang, Fengli – Assistant Scholar / Scientist
Zhou, Huan-Xiang – Associate Professor

ICR

Blakney, Gregory – Associate Scholar / Scientist
Kaiser, Nathan – Assistant Scholar / Scientist
Lu, Jie – Assistant in Research
Marshall, Alan – Professor
McKenna, Amy – Assistant Scholar / Scientist
Rodgers, Ryan – Scholar / Scientist
Young, Nicolas – Assistant Scholar / Scientist

UF

Andraka, Bohdan – Associate Scientist in Physics
Biswas, Amlan – Associate Professor of Physics
Cheng, Hai Ping – Professor of Physics
Hamlin, James – Assistant Professor
Hebard, Arthur – Distinguished Professor of Physics
Hershfield, Selman – Professor
Hirschfeld, Peter – Professor
Ingersent, Kevin – Chair of UF Physics Department & Professor
Kumar, Pradeep – Professor
Labbe, Greg – Senior Engineer
Lee, Yoonseok – Professor
Maslov, Dmitrii – Professor
Masuhara, Naoto – Senior Engineer, Microkelvin Laboratory
Meisel, Mark – Professor
Stanton, Christopher – Professor
Stewart, Gregory – Professor
Sullivan, Neil – Professor
Takano, Yasumasa – Professor
Tanner, David – Distinguished Professor of Physics
Yin, Liang – Assistant Scientist
Angerhofer, Alexander – Professor, Chemistry
Bowers, Clifford – Associate Professor, Chemistry
Brey, Wallace – Professor Emeritus, Chemistry
Butcher, Rebecca – Assistant Professor
Christou, George – Drago Professor

Eyler, John – Professor Emeritus, Chemistry
Fanucci, Gail – Associate Professor
Murray, Leslie – Assistant Professor
Polfer, Nicolas – Assistant Professor
Talham, Daniel – Professor
Abernathy, Cammy – Professor, Materials Science & Engineering
Douglas, Elliot – Associate Professor, Materials Science & Engineering
Pearton, Stephen – Distinguished Professor, Alumni Professor of Materials Science & Engineering

AMRIS

Ashizawa, Tetsuo – Melvin Greer Professor and Chairman, Department of Neurology, Executive Director McKnight Brain Institute
Blackband, Stephen – Professor, Neuroscience
Edison, Arthur – Professor, Biochemistry & Molecular Biology
Febo, Marcelo – Assistant Professor
Fitzsimmons, Jeffrey – Professor, Radiology
Forder, John – Associate Professor of Radiology
Lai, Song – Associate Professor
Long, Joanna – Associate Professor
Luesch, Hendrik – Associate Professor
Mareci, Thomas – Professor
Vaillancourt, David – Associate Professor
Vandenborne, Krista – Professor
Vasenkov, Sergey – Associate Professor
Walter, Glenn – Associate Professor
Zeng, Huadong – Specialist, Animal MRI/S Applications

ASC

Griffin, Van – Associate In Research
Hellstrom, Eric – Professor
Jiang, Jianyi – Associate Scholar / Scientist
Kametani, Fumitake – Assistant Scholar / Scientist
Larbalestier, David – Chief Materials Scientist
Lee, Peter – Scholar / Scientist
Liang, Zhiyong – Associate Professor
Pamidi, Sastry – Assistant Scholar / Scientist
Polyanskii, Anatolii – Associate Scholar / Scientist
Starch, William – Associate in Research
Tarantini, Chiara – Assistant Scholar / Scientist
Trociewitz, Ulf – Associate Scholar / Scientist
Dmytro Abraimov – Associate Scholar / Scientist

Director’s Office

Boebinger, Gregory – Director/Professor
Palm, Eric – Deputy Lab Director
Roberson, Bettina – Assistant Director, Administrative Services
Roberts, Kristin – Director of Public Affairs
Hughes, Roxanne – Assistant Scholar/Scientist
Sutton, Angela – Assistant Director, Environmental, Health, Safety and Security

Geochemistry

Chanton, Jeff – Professor
Cooper, William – Professor
Froelich, Philip – Scholar / Scientist
Hsieh, Ping – Professor
Humayun, Munir – Professor
Landing, William – Professor
Odom, Leroy – Professor
Sachi-Kocher, Afi – Scientific Research Specialist
Salters, Vincent – Professor
Wang, Yang – Professor
White, Gary – Scientific Research Specialist

Personnel

STAFFING AND DEMOGRAPHICS

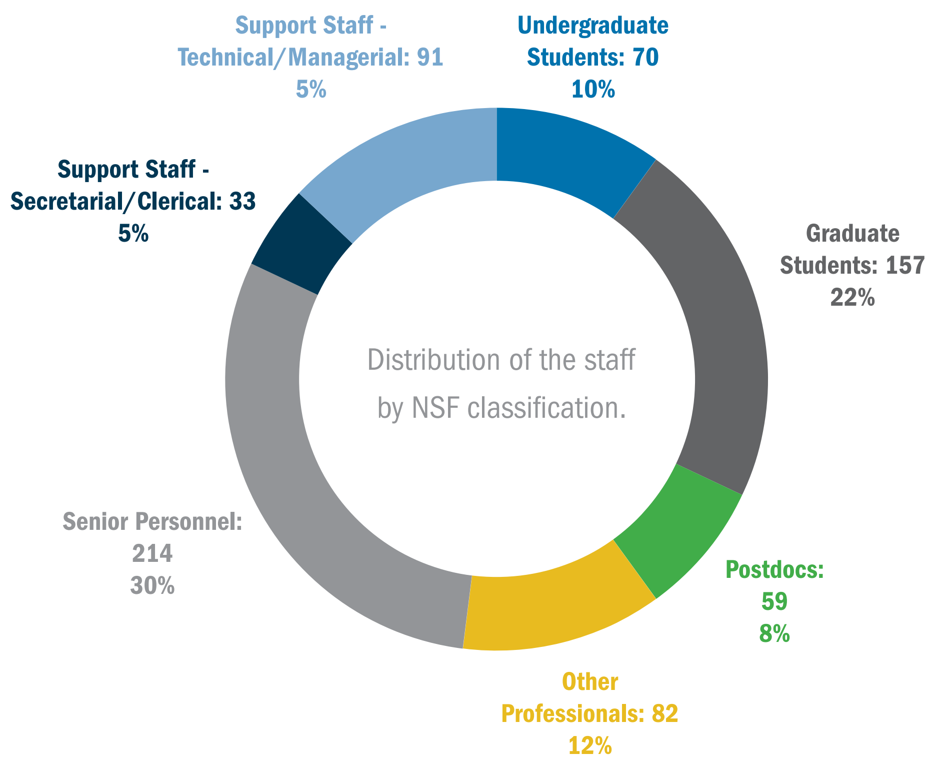
The MagLab comprises 706 people at its three sites, who are paid by NSF use grant, State of Florida Funding, individual investigator awards, as well as home institutions and other sources. Of that number, senior personnel represent the largest group at 30%, followed by graduate students at 22% and support staff technical/managerial at 13%. The total distribution by NSF classification appears in **Figure 1.**

FIGURE 1

MagLab Staffing

Personnel at FSU, UF, and LANL includes NHMFL Employees paid by the NSF Core Grant or State of Florida funding, plus all Affiliated Professors, Postdoctoral Researchers and Graduate Students.

Distribution by NSF Classification
January 2, 2014
Total Personnel: 706



The NHMFL is committed to expanding and maintaining a diverse and inclusive organization to ensure a broad pool of highly qualified applicants for open positions to enhance our diversity efforts. Search committees are strongly encouraged to recruit minorities from underrepresented groups. Positions are advertised in venues that target women and minorities, e.g., Association for Women in Science (AWIS), National Society of Black Physicists (NSBP), etc. Additional contact is made through special subgroups of professional organizations, focused conferences and workshops. The Director's letter to each search committee chair for Senior Personnel, provides guidelines for best practices to increase the recruitment of members of underrepresented groups.

New permanent hires in 2013 include four scientific senior personnel (white males), one non-scientific senior personnel (white female), nine STEM related staff personnel (1 black male, 1 white female, 1 American Indian and 6 white males). Additionally, fourteen (14) Postdoctoral Research Associates were hired (4 white females, 2 Asian females, 6 Asian males and 2 white males).

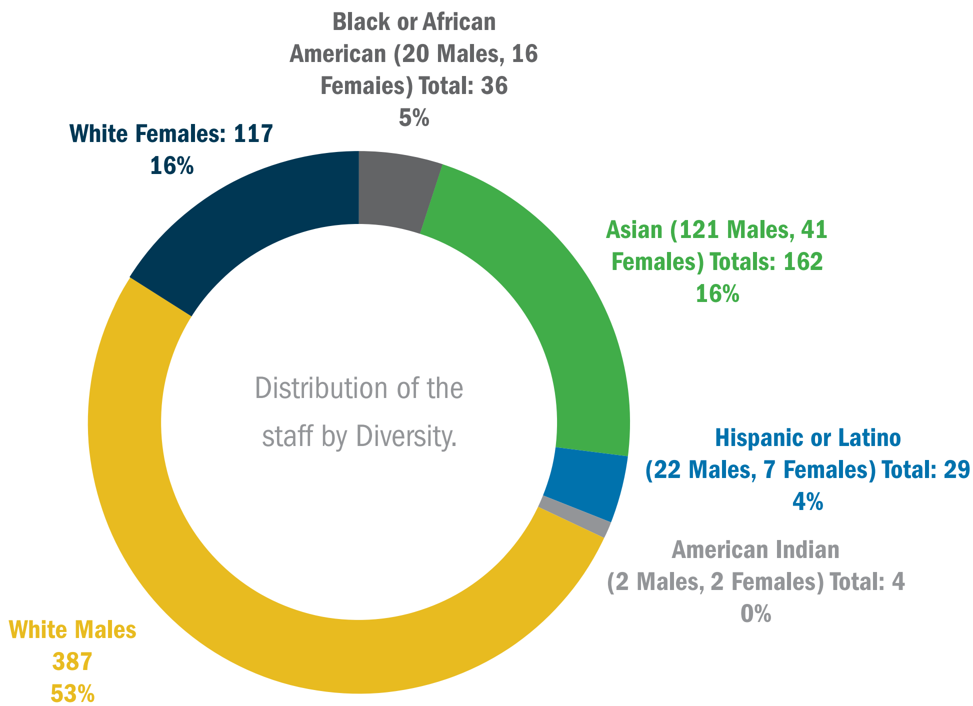
Overall distribution of diversity for all three sites of the MagLab includes 53% white males, 22% Asian males, 16% white females, 5% black or African American, 4% Hispanic and <1% American Indian. The total distribution by Diversity appears in **Figure 2.**

FIGURE 2

MagLab Demographics

Personnel at FSU, UF, and LANL includes NHMFL Employees paid by the NSF Core Grant or State of Florida funding, plus all Affiliated Professors, Postdoctoral Researchers and Graduate Students.

Distribution by Diversity
January 2, 2014
Total Personnel: 706



Diversity

The Magnet Lab has a goal to become a nationally recognized leader for its STEM diversity programs and the diversity of its scientific, technical and engineering staff, much the same way it is already recognized for its education and outreach programs. Since the adoption of the formal Diversity Action Plan (DAP) in 2004, the Magnet Lab has launched activities and efforts to increase the participation of underrepresented groups in science, engineering and mathematics.

The Diversity Action Plan, which is available online at http://magnet.fsu.edu/about/howwework/diversity/plan.html, was last updated in 2011. It includes lists of action items by which the Magnet Lab plans, implements, and assesses its Diversity activities. In 2013, the Lab conducted the following activities that focused on five main areas.

Building diversity permanence into the NHMFL scientific population:

- Professor Joanna Long, Director of the NHMFL's AMRIS User Facility, was promoted to the position of Associate Laboratory Director for the MagLab/University of Florida Branch. In connection with this promotion, she replaced Professor Art Edison to become co-PI on the NHMFL's core NSF grant.

- The Magnet Lab continued its policy that scientific search committees must include at least one NHMFL Diversity Committee member and that every committee member must have taken Faculty Recruitment for Excellence and Diversity (FRED) training. In addition, chairs of scientific search committees received Director's letter that outlines recruitment and hiring procedures based on best practices for increasing the recruitment of members of underrepresented groups. Three copies of the book Searching for excellence & diversity: A guide for search committees by E. Fine and J. Handelsman (WISELI: Women in Science and Engineering Leadership Institute, Madison, WI, 2012) were purchased, and each of the three NHMFL sites was given a copy to be used by search committees. Some positions were advertised in venues that target women and minorities, in particular in the Association for Women in Science and National Society of Black Physicists.

- In collaboration with "The Alliance for the Advancement of Florida's Academic Women in Chemistry and Engineering" (AAFAWCE), an NSF ADVANCE-PAID grant, a FRED training session was held at the NHMFL/LANL in March with 12 attendees. The presenter was AAFAWCE-FSU PI Prof. Penny Gilmer. The FRED webpage (http://magnet.fsu.edu/about/howwework/diversity/fred.html) was updated. This was the fifth FRED training session held at the NHMFL.

- AAFAWCE organized two workshops on Mentoring and Networking for FSU women faculty in STEM fields that were also attended by some NHMFL female faculty. (The grant expired at the end of August.) One of the workshops was held at the Magnet Lab.

Developing and cultivating individually crafted early career opportunities for members of underrepresented groups at the undergraduate level and above:

- NHMFL continued to offer the "College Outreach – Workforce Initiative Program" (CO-WIN). NHMFL scientists, engineers, and members of CIRL regularly traveled to publicize NHMFL science and recruit REU and graduate students from women's colleges, historically black and minority-serving colleges and universities. A list of past trips and lectures, which is available at http://www.magnet.fsu.edu/about/howwework/diversity/outreach.aspx, includes trips to the Society for Advancement of Chicanos and Native Americans in Science conference, Emerging Researchers National Conference in STEM, and Southeast Conference for Undergraduate Women in Physics.

- The NHMFL/UF continued to build a strong relationship with Claflin College, an HBCU in Orangeburg, SC. The relationship was initiated by a 2009 CO-WIN lecture. In 2013, Art Edison was a guest lecturer in two undergraduate classes; he also gave a research seminar and an overview on opportunities at the NHMFL for undergraduate students (REU), graduate students, and faculty collaborations. He also met informally with several students and faculty. Two African American undergraduates from Claflin worked as REU students in research labs at UF over the summer.

- Also at AMRIS (UF), Marcelo Febo mentored minority students via The Society for Neuroscience "Neuroscience Scholars Program" and University of Puerto Rico NIH grant called NeuroID.

- The NHMFL Diversity Program provided partial support to staff scientists to enable the hiring of three postdoctoral researchers and five graduate students. All of these early career scientists were from underrepresented groups and none would have been hired without the additional support.

- Support was provided to two female postdocs and two female graduate students for research-related travel.

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- Support was provided to two female postdocs and two female graduate students for research-related travel.

- Copies of books on mentoring were purchased and distributed to female postdocs who had participated in AAFAWCE mentoring events.

- The NHMFL continued to support a "MagLab Fellowship" award for one minority first-year graduate student in physics at Florida State University. This award, which provides $3,000/year for two years to a strong female or minority first-year graduate student in physics, was first established in 2012. The recipients are selected by the Department of Physics at FSU.

- NHMFL funds were provided to FAMU researchers to support 30 hours of NMR magnet time in the FSU Chemistry Department.

- NHMFL funds were provided to a female assistant professor in chemistry from the Univ. of West Florida to conduct research at the Magnet Lab, and ICR staff worked directly with her to help start an independent research program in her home laboratory.

- R. Hughes and D. Popović spoke at the 2013 Southeast Conference for Undergraduate Women in Physics (SCUWiP), held at the Univ. of Central Florida. Travel support was provided to a female physics graduate student (L. Winter) to attend and represent the Magnet Lab and the FSU physics graduate program. NHMFL provided partial financial support for the organization of the next SCUWiP to be held at FSU in January 2014. Winter, Hughes, Popović and several graduate and undergraduate physics students served on the organizing committee, in addition to others from the FSU Dept. of Physics led by Prof. S. Blessing. Blessing (PI), Popović and Hughes (co-PIs) submitted a proposal to the American Physical Society (APS) for conference funding.

- S. Hill, D. Popović and S. Capstick (FSU Physics Dept.) submitted a pre-proposal and, subsequently, a full proposal to the APS Bridge Program to establish a program to bridge students from underrepresented minorities (URMs) in Physics to a PhD program at FSU or elsewhere.

- A Magnet Lab graduate research assistant was awarded a McKnight Doctoral Fellowship, which seeks to add minority faculty to Florida universities by recognizing minority leaders in certain fields. A first-year physics graduate student who worked in Edison's lab at UF also received the prestigious McKnight Doctoral Fellowship.

- The annual NHMFL Summer School, held in May, attracted 46 graduate students and postdocs, including 11 females, 2 African Americans and 1 Hispanic.

- The REU program accepted 11 females (8 white, 3 African American – one of whom was also Hispanic) and 13 males (3 Hispanic and 1 African American) Three students came from Historically Black Colleges and Universities (HBCUs) and one from a Hispanic Serving Institution (HSI).

- Lab tours were given to undergraduate students from FSU Women in Math, Science and Engineering (WIMSE) and UROP (University Research Opportunities Program).

- CIRL, Diversity Program representatives and several other faculty worked with the FSU Dean of the Graduate School to discuss a proposal for the Alliances for Graduate Education and the Professoriate (AGEP) grant.

Aiming educational outreach for K-12 and the general public to broad and diverse groups:

- The Magnet Lab sponsored a portion of the MANYA: The Living History of Marie Curie event (a drama on the life of Marie Curie) held at FSU in November.

- Outreach and tours were provided to Title I or underserved schools, Boys and Girls Club, migrant workers' students and educators, school serving middle and high school students with emotional and behavioral problems, last chance students towards the pathway of becoming high school graduates, and a state-sponsored group of high-achieving minority high school students.

- In the two-week-long SciGirls summer camp for middle and high school girls, 35 girls participated (8 African American, 2 Hispanic). In May, R. Hughes conducted a SciGirls webinar for the SciGirls national organization.

- The Magnet Lab Summer camps had 19 of 36 middle school students registered as underrepresented.

- The School of Arts & Sciences middle school mentorship was held in the spring semester. Out of 13 students who participated, 3 were females and one male was African American.

- CIRL continued its partnership with the FSU-FAMU College of Engineering and the Center for Applied Power Systems as the director of the ERC-FREEDM's Pre-College effort, which has a strong representation of underrepresented minorities.

- In ERC FREEDM Summer Camp, 17 middle school students attended (7 came from Title I schools). Of the 11 girls, 4 were African Americans, 2 were Asians; of the 10 boys, 1 was African American and 7 Asians.

- During the summer of 2013, a total of 14 high school and college students participated in the internships run through CIRL: 3 Females (1 Hispanic), 11 Males (1 African American, 2 Asians).

- In ERC FREEDM Young Scholars program for high school students from title I schools, there were 7 students in attendance: 6 females (5 African Americans) and 1 male (African American).
- The RET program hosted 10 teachers. 5 Females (1 Hispanic) and 5 Males (1 African American and 2 Hispanics) participated. 7 of the teachers were from Title I schools.

- Four teachers - 2 Females and 2 Males (both African American) - participated in the ERC FREEDM RET program. All were from Title I schools.

- Science Café series was continued to translate science to the general public. New speakers were recruited to represent women in science.

- CIRL and Public Affairs conducted outreach for FSU's Day at the Capitol; NHMFL/LANL hosted tours as part of "Family Day" and the 70th anniversary of LANL, with 100 visitors.

- Public Affairs secured wide media coverage for the NHMFL's Annual Open House, utilizing radio, network television news, Facebook, Twitter, local Head Start programs, schools, and African-American churches. Open House was attended by 5,500 visitors. 2,660 pounds of food were collected for Second Harvest, a charitable organization.

Maintaining awareness among NHMFL staff and user programs that Diversity Matters:

- The Diversity Committee held regular, quarterly meetings. Its membership was expanded from 9 to 13, and it now includes a graduate student and a postdoctoral researcher.

- CIRL director, a member of the Diversity Committee, attended the Women in Engineering Proactive Network conference in Atlanta, GA, Research on Women and Education conference in Las Cruces, NM.

- The CIRL Director and Deputy Director of the NHMFL attended the North American Gender Summit on STEM in Washington, DC.

- The NHMFL demographic statistics were maintained on a monthly basis.

- The NHMFL diversity website was kept up to date.

- The first issue of the "Diversity Matters" newsletter was launched in September, the second one in December. Future issues will appear on a quarterly basis. This is an internal, electronic newsletter that was emailed to the entire NHMFL. All issues will be archived on the "MagLab Portal".

- All actions were catalogued in a Diversity Tracker, which was updated on a regular (quarterly) basis. This report was discussed at the meetings of the NHMFL Executive Committee. An update on the NHMFL Diversity Program activities was sent to NSF in October.

- All employees at all three branches were invited to participate in the minorities in physics survey conducted by the American Physical Society (APS) Committee on Minorities. This online survey was open for one month in October.

Maintaining frequent external guidance and review of NHMFL diversity issues:

- D. Popović, the NHMFL Diversity Program Director, gave a presentation on "Diversity Initiatives" at the meeting of the NHMFL External Advisory Committee.

- D. Popović attended a series of meetings of the FSU President's Diversity and Inclusion Council, and of its Recruitment and Retention (R & R) subcommittee, chaired by the FSU Provost. She prepared and presented an overview of the diversity program at the University of Michigan and of the 2012 Workshop on Ethnic Diversity in Materials Science and Engineering. D. Popović and B. Lamont (FSU College of Business) prepared a fourteen-page report containing the recommendations of the R & R committee for the university-wide implementation.

- Three newly elected members of the Executive User Committee for the DC, Pulsed and High B/T Facilities include one female. Their terms start in January 2014. They will replace four (two male, two female) outgoing members.

- The NHMFL invited the APS Committee on the Status of Women in Physics and the Committee on Minorities to conduct a Climate Survey. All FSU-based NHMFL employees were asked to complete a confidential, online survey, which was open for one month in September. The online survey was followed up with a two-day site visit in November. The site visit team report and recommendations will be sent in early 2014.

Safety

The MagLab's mission includes the provision of a safe and healthful working environment for all employees, visitors and users. The Safety Department directs a comprehensive set of safety programs directly related to the specific needs and operations of the laboratory. Great care, expertise and coordination are used to develop these programs in an effort to ensure the safest possible conditions for faculty, staff, users and visitors.

The MagLab maintains an active Safety Committee and several Safety Subcommittees that include the MagLab's upper management, members from each department across the laboratory, three full-time members of the MagLab's Safety Department and a representative from Florida State University Environmental, Health and Safety Department. Members of the Safety Committee review safety procedures, safety performance and propagate the MagLab's commitment to safety throughout the lab.

In February of 2013 the lab implemented Integrated Safety Management to enable the performance of cutting edge research while protecting our irreplaceable intellectual capital — our employees, as well as the public and the environment. Integrated Safety Management encompasses the five core functions shown in **Figure 4.**

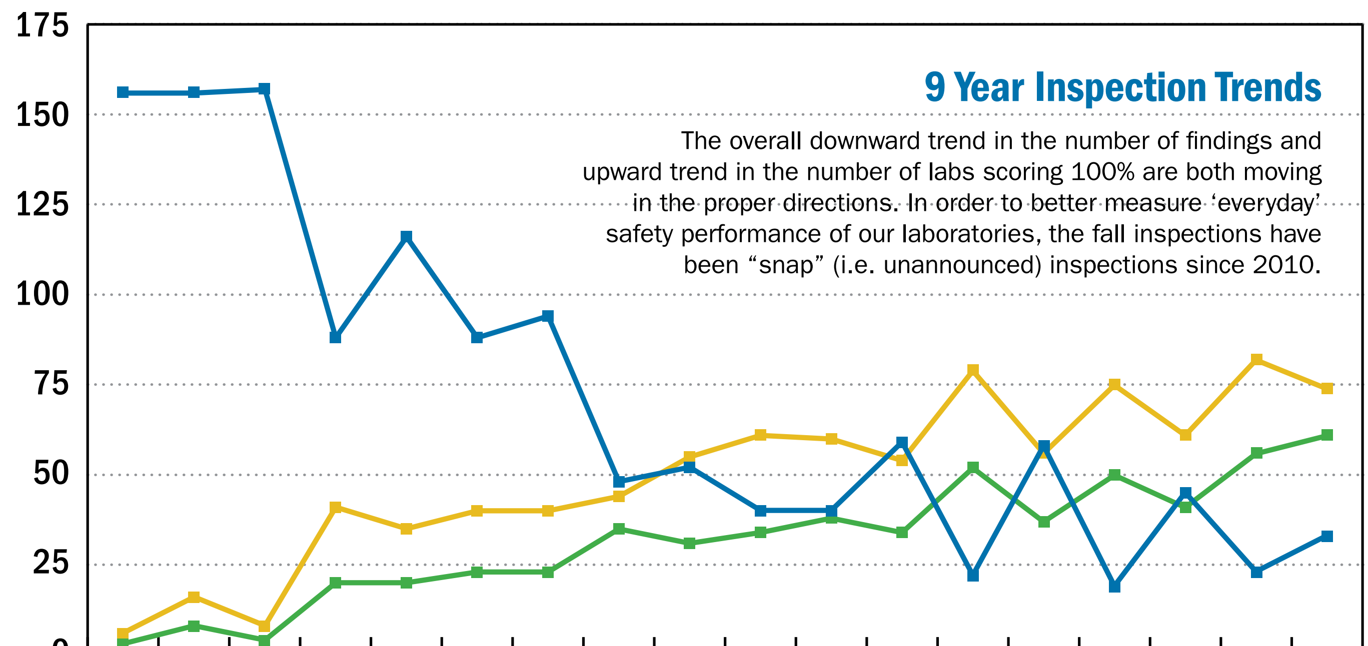
These steps are reemphasized in safety training, safety reviews and quarterly meetings.

The lab has also implemented a "Stop Work Policy". Every employee has the responsibility and authority to stop work immediately, without fear of reprisal, when the employee believes that conditions exits that:

- pose a danger to the health and safety of workers or the public
- could adversely affect the safe operation of the facility, or cause serious damage to the facility
- could result in a release of hazardous substances to the environment

Safety personnel and members of the Safety Committee conduct formal lab inspections every spring and fall for each of the MagLab's laboratories. These twice-annual lab inspections identify any unsafe conditions in the lab, using a compre-

FIGURE 3



	SPRING 2005	FALL 2005	SPRING 2006	FALL 2006	SPRING 2007	FALL 2007	SPRING 2008	FALL 2008	SPRING 2009	FALL 2009	SPRING 2010	FALL 2010	SPRING 2011	FALL 2011	SPRING 2012	FALL 2013	SPRING 2013	FALL 2013
No. Findings	156	156	157	88	116	88	94	48	52	40	40	59	22	58	19	45	23	33
Labs Scoring 100%	3	8	4	20	20	23	23	35	31	34	38	34	52	37	50	41	56	61
% Labs Scoring 100%	6	16	8	41	35	40	40	44	55	61	60	54	79	56	75	61	82	74

hensive checklist that includes chemical, electrical, compressed gas, magnetic field and housekeeping hazards. We require lab personnel to be present during the spring inspections to receive annual area-specific safety training from the safety department. Beginning in 2010, the fall inspection became 'snap' inspections, with inspectors showing up in each laboratory unannounced in order to gauge daily compliance with safety practices. Lab inspection reports are submitted to the PI/Supervisor of each lab and corrective actions are implemented for any infractions. **Figure 3** shows that the number of infraction findings has halved and the number of laboratories scoring 100 percent has doubled over the past five years.

In addition to our internal inspections, the MagLab hosts inspections from the following external agencies. We respond to all recommendations from the Fire Marshall to further improve fire safety at the lab. The MagLab received no violations from any of the other external agencies during the inspections listed in **Table 1**.

External safety reviews of MagLab facilities have convened at the Florida State University and University of Florida campuses of the MagLab on September 10th – 12th , and at the Los Alamos National Laboratory campus of the MagLab on September 17th – 18th. The External Safety Review Committee advised MagLab Management on the efficacy of the MagLab's Safety Program. This included observation of physical environments, as well as in-depth analyses of laboratory health and safety policies, oversight, and practices with an emphasis on chemical, electrical, and laser safety. A report has been generated that provided guidance to further strengthen the MagLab's comprehensive health and safety program. A few of the most noteworthy practices they cite:

- "The development of the safety culture at the research laboratories in Tallahassee could be used as a potential model for other research institutions."
- "Consistent implementation of Integrated Safety Management (ISM) throughout the centers …was demonstrated by all who addressed the panel from management to staff to users."
- "The Director is utilizing the Public Relations department to educate lab personnel on safety issues. Together they are developing interesting and appealing safety posters that are a strong visual indicator of the importance of safety at the lab."
- "The new employee orientation safety training program is notable. With this, the NHMFL director demonstrates his full support of safety by conducting a portion of this training for all [new employees] in the facility, outlining his expectations for safety integration with research."

MagLab safety personnel periodically facilitate safety tours for the Tallahassee Fire Department to educate first-response personnel on potential hazards at the lab. The Florida State University Biological and Radiation Safety departments support and assist the lab in maintaining compliance in these areas.

The MagLab is pleased that its recordable injury rate (.55 per 100 employees in 2013 and 0.8 per 100 employees in 2012) remains lower than the national averages from the U.S. Department of Labor for both "Scientific Research and Development" institutions (1.2 in 2012) as well as for "Colleges and Universities" (2.3 in 2012).

Detailed information on user safety training is available on page 54 of this report.

TABLE 1

Recent Safety Inspections *by the NHMFL external safety and security agencies*

External Agency	Frequency	Last Inspection Dates
State Fire Marshall	annually	10/2013, 10/2012, 12/2011
Florida Department of Environmental Protection - Waste Water Division	annually	4/2013, 4/2012, 12/2010
Florida Department of Environmental Protection - Hazardous Waste Division	biennial	3/2012, 5/2010
Federal Aviation Administration	periodically	6/2010
Department of Homeland Security	periodically	6/2012

FIGURE 4

Five Steps of Integrated Safety Management

1. Define scope of work
2. Analyze hazards
3. Develop/implement hazard controls
4. Perform work within controls
5. Feedback and improvement

Questions associated with each of the five steps

1. What will the work/job/experiment involve?
2. What are the hazards of this job?
3. What can be done to reduce the hazards?
4. Were all of the hazard reductions followed?
5. Was there anything that could have been changed to improve the quality and safety of the work?

Budget

Summary Proposal Budget

January - December 2013

TABLE 1

	NSF-Funded Person-months			Funds Requested By Proposer
	CAL	ACAD	SUMR	
A. (39) TOTAL SENIOR PERSONNEL (1-6)	300.71	0.00	0.00	2,299,148
B. OTHER PERSONNEL				
1. (10) POSTDOCTORAL ASSOCIATES	110.77	0.00	0.00	494,486
2. (67) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	680.91	0.00	0.00	3,239,756
3. (6) GRADUATE STUDENTS				120,567
4. (10) UNDERGRADUATE STUDENTS				159,318
5. (16) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				463,201
6. ( ) OTHER Temporary				0
TOTAL SALARIES AND WAGES (A + B)				6,776,476
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,913,819
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				8,690,295
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)				2,176,124
E. TRAVEL				
1. DOMESTIC (INCL. CAN, MEX & U.S. POSSESSIONS)				270,189
2. FOREIGN				30,122
F. PARTICIPANT SUPPORT				
1. STIPENDS 133,200				
2. TRAVEL 9,000				
3. SUBSISTENCE 15,000				
4. OTHER 2,158				
TOTAL NUMBER OF PARTICIPANTS (22)				
TOTAL PARTICIPANT COSTS				159,358
G. OTHER DIRECT COSTS				
1. MATERIALS AND SUPPLIES				3,301,008
2. PUBLICATION/DOCUMENTATION/DISSEMINATION				0
3. CONSULTANT SERVICES				0
4. COMPUTER SERVICES				0
5. SUBAWARDS				8,027,493
6. OTHER				2,523,772
TOTAL OTHER DIRECT COSTS				13,852,273
H. TOTAL DIRECT COSTS (A THROUGH G)				25,178,361
I. INDIRECT COSTS (F&A) Rate: 52% Base: $12,391,614				
TOTAL INDIRECT COSTS (F&A)				6,443,639
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				31,622,000

Budget Justification for FY 2013

The primary funding source for operation of the seven user programs of the National High Magnetic Field Laboratory (NHMFL) remains the National Science Foundation (NSF) and funds provided through the participating institutions: the Florida State University, the University of Florida, and the Los Alamos National Laboratory.

TABLE 2

The budgets approved by the National Science Board (NSB) for 2013-2017 are shown below and are compared to the amount funded in FY 2012.

	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	Total
DMR	31.300	30.002	30.908	31.833	32.782	33.772	159.297
CHE	1.500	1.620	1.740	1.840	1.880	1.920	9.000
TOTAL	32.800	31.622	32.648	33.673	34.662	35.692	168.380

The baseline budget for FY 2013 represents a reduction of $1,298,000 in DMR Division funding from funds received in FY 2012 while funding from the Chemistry Division increased by $120,000. The end result is a $1,178,000 reduction in funding for FY 2013 when compared to FY 2012. The total budget approved by the National Science Board for the next five years is $168,380,000.

According to the NSF Program Officer, funding for FY 2013 will be funded in two increments: an increment of $15,837,000 will be funded in January 2013 and the second increment of $15,785,000 in early July 2013. By reducing the number of funding increments, the operation of the NHMFL will be able to better maintain uninterrupted user program operations and efficient use of finite resources and staffing.

Optimal use and timing of expenditures will require careful planning for personnel, equipment, materials and supplies, travel, sub-awards and electricity. Specific rational for the 2013 budget follows:

BUDGET JUSTIFICATION

FSU - NHMFL

PERSONNEL

The staffing levels, when compared to 2012, level, show a slight decrease. The current level of staffing is required to maintain user support, technology development and science (NHMFL User Collaboration Grant Program) activities. Actual salary rates, plus a 3% increase, of existing NHMFL Staff, have been used in the cost calculations. Florida State University's fringe benefit rates for permanent staff fluctuate depending on the benefit package chosen by the staff member. Therefore, an average fringe benefit rate of 32.0% is used to calculate the cost of fringe benefits for permanent staff. FSU's fringe benefit rate for postdocs and non-students is 2.15% while the fringe rate for Graduate and Undergraduate Students is 0.70%. Postdoc's and Graduate Student's salaries includes a supplement for health insurance in accordance with FSU policy.

Since the NHMFL is a large, complex, multidisciplinary user facility, there is a requirement for a larger than normal level of non-research support staff. Due to the mission of the NHMFL, a higher level of administrative support is required to ensure successful operation of the facility. The primary responsibility of the NHMFL's administration is to ensure compliance with the terms and conditions of our sponsored project while facilitating the day-to-day work for users and scientific staff. Although formally, the NHMFL is an extension of Florida State University (FSU), the administrative staff offers direct, on-site services to the user and research community not provided by FSU. The administrative staff is responsible for a core set of activities including budget and finance; accounting; purchasing, shipping and receiving; human resources; facilities management and engineering; as well as safety, security and environmental protection. In addition to central departments and activities, the user divisions have a Program Associate to support and facilitate the non-science related tasks required to insure that the user program's operational needs are met. The services being provided by administrative staff are accrued solely for the benefit of the NHMFL, and exclusively support the three primary goals of the NHMFL: operate a user facility for all qualified researchers, develop future magnet technology, and provide educational and research opportunities for graduate and undergraduate students, postdoctoral associates and other scientist and engineers as well as education support for the REU/RET and K-12 outreach programs.

As of November 5, 2012, the total FTE required for administrative, secretarial, and clerical duties is twenty-nine of which 14 FTE are funded by the NSF award. These staff members support approximately 685 paid staff members and affiliated staff members as well as provide administrative support to over 1200 Users each year conducting research at the lab.

EQUIPMENT

Additional State of Florida funding is now covering a larger percentage of the payroll for user support scientists. As such, the 2013 budget includes an increase in the equipment budget when compared to 2012. Over $1,028,000 of equipment funds will be devoted to mitigating equipment failures and/or purchasing new and updated equipment for the User Program. Even with the increase in equipment funds, there will be very few new magnet technology initiatives funded within this reduced scope budget. Within the five years of this grant, the overwhelming majority of equipment funds represent essential expenditures to maintain existing User Support.

Anticipated major equipment purchases are listed below by MagLab division or user facility. Lists are in order of dollar amount not priority. Note the total for the equipment listed below is larger than our budget for equipment purchases. We will prioritize purchases as the year progresses based upon user's scientific needs and the progress that major projects make during the fiscal year. In addition, our highest priority is to maintain User Science. If major equipment fails, we will prioritize replacing that equipment. The inability to plan when major equipment will fail introduces additional uncertainty into our future purchasing plans. See **Table 3** for the specifically budgeted equipment of FY 2013.

TRAVEL

Travel budget levels are required to maintain a basic level of user support, technology development and science activities. The requested funds for foreign travel are for similar purposes. Total dollars of $270,189 are requested for domestic travel while funds of $30,122 are requested for foreign travel. Based on conference attendance and research performed in the past, the following expenditures are anticipated for travel to the following countries in 2013:

Scientific Conferences – United States, United Kingdom, Germany, France, Switzerland, Belgium, Italy, France, Brazil, Sweden, Japan, China and South Korea

Workshops – United States, France, United Kingdom and Belgium

Research – United States, Netherlands, France, Germany and Japan

NHMFL **Specifically Budgeted Equipment**

TABLE 3

MS&T	
YBCO HTS tape for experimental superconducting magnet	995,000
PVD equipment for High Strength Conductors Characterization	200,000
Cryostat and cryogenic equipment for experimental magnet	190,000
Keck Shims for Resistive Magnet Maintenance	100,000
Protection electronics for experimental magnet	78,000
5kN tensile machine for high strength conductor characterization	37,600
Capacitance Bridge for insulation testing	27,000
Variable temperature insert and controller for 15 T magnet	25,000
Computers for analysis, CAD, and fabrication	23,000
ASC	
Bi2212 Wire for experimental test coil	400,000
APT Ion Sputtering System	300,000
Overpressure furnace for small to medium samples	80,000
Insulation for Bi2212 wire	40,000
Continuous wire test machine upgrade	30,000
Small low pressure furnace	25,000
Ultrasonic mixer for insulation	10,000
Large coil insert for 16 T VSM	6,000
Quantum Design high resolution rotator	5,000
Stereomicroscope with CCD camera	3,000
DC Field Facility	
Active vibration isolation systems (2)	120,000
Lockin amplifiers (SRS830)	19,000
Lakeshore 370 resistance bridge	19,000
Keithley SMU	18,000
Lockin amplifiers (SRS124)	14,000
Lakeshore 350 temperature controller	5,000
NMR Facility (at FSU)	
Amplifiers for solid state NMR @ 720 MHz	60,000
Amplifiers for NMR @ 800 MHz	40,000
Preamplifiers, gradient amplifiers, test equipment	40,000
ICR	
Turbo-pumps (2)	40,000
New front end for 9.4 T magnet (turbo pump, rough pump, mass filter)	36,000
RF amplifiers for ion excitation (3)	30,000
EMR	
HiPER power upgrade	350,000
New probes for HiPER	100,000

PARTICIPANT SUPPORT – STIPENDS

Research for Undergraduates:

This item is an estimate of the budget required to support the Research Experience for Undergraduates (REU) Program. Although students are recruited from across the United States, the requested funding is an estimate. If students from FAMU or FSU (local students) are participants, housing and travel expense would not be incurred and, instead, more students than originally anticipated could be supported.

This summer internship program matches qualified undergraduate students with scientists and researchers at the NHMFL's three sites. The eight-week research experience offers unique opportunities to explore science at the extremes of magnetic field, pressure and temperature. Students explore contemporary science and engineering issues, working alongside some of the finest scientists, magnet designers and engineers in the world. Each student accepted by the program receives a stipend, and, if necessary, travel support and housing.

The NHMFL offers a wide range of science, math, engineering and interdisciplinary experiences in physics, chemistry, biological sciences, geochemistry, materials science and magnet science and engineering. Summer interns, working closely with their faculty mentors, are thoroughly integrated into these research and development activities. Students broaden their knowledge of the diverse research that takes place here by attending weekly seminars and colloquia.

In 2012, there were eighteen students consisting of ten males and eight females. Out of the eighteen participants, twelve were minorities. There were sixteen mentors, one from UF, two from LANL, and thirteen from FSU who participated in the program. Examples of student projects can be found at http://www.magnet.fsu.edu/education/reu. In 2013, the goal is to increase the number of students from underrepresented groups including women, African Americans, and Hispanic students. A special effort will be made to recruit students from HBCU, colleges and universities that serve a large percentage of African Americans, Hispanic, and other underrepresented students.

Costs: Approximately $6000 per student – incudes $3600 stipend; $1000 housing, non-local only; $600 travel, non-local only; and $800 per mentor for lab materials or travel associated with the REU program. The total amount of funds requested to support the REU program is $105,358.

Research for Teachers:

For the past five years, the Research for Teachers Program (RET) has been funded by a private PI award on which the past Director of CIRL was the Co-PI. Since this award end date was June 30, 2012, funding for the FY 2013 RET Program will be the responsibility of the NHMFL.

The RET Program is a six week summer residential program that gives K-12 teachers the chance to participate in the real-world science and cutting-edge magnetic field research. Through various program activities, the teachers develop strategies and resources to translate the experience into material for their classrooms.

The cost of the program is approximately $5400 per teacher, which includes a $3600 stipend, $1200 for housing, and $600 for travel. NSF funds of $54,000 will be utilized to pay stipends for the participants. All other obligations will be covered by funds from other sources.

OTHER DIRECT COSTS: MATERIALS AND SUPPLIES

Approximately 1100 scientists annually request, and are allocated, 'magnet time' for performing research and subsequently, publishing the results of their research in premier scientific journals. Other Direct expenses are necessary due to the complexity of operating and maintaining a large, international user facility while supporting the development of new magnet technology for the science community. In many cases these items may be charged to another source; however, since the NHMFL is a NSF funded user facility, these charges are directly related to the lab's mission as set forth in the Cooperative Agreement.

There is a significant ($1,513,000) reduction in this expense category when compared to the 2012 budget. Approximately $227,000 of the reduction is the reduced cost of helium due to the new helium recovery system. The remaining decrease is a result of across the board cuts and targeted reductions in specific projects that can be deferred. Through strategic planning and project management, the MagLab will be able to maintain the User Programs at the optimal level required for the Users.

Specific purchases in this category include but are not limited to:

- Computer equipment such as computers, servers for content management systems, storage arrays, networking equipment, software and software licenses, hardware maintenance agreements and audio visual equipment, hard drives, flash storage, office supplies. The NHMFL supports a variety of computing systems and services for international, academic, and government researchers. Due to the nature of the work and research conducted at the lab, various systems are required to protect various information technology assets, including physical resources (computers, peripherals, etc.), infrastructure (facilities and networks), intellectual property and confidential personal information. It is essential that the lab provide not only a secure computing environment but the required computers, related equipment, and office supplies that allow the staff, researchers, and users to perform their duties. These expenses are greater than those incurred in a normal academic unit due to the cost of operating and managing a large complex user facility and providing extraordinary dissemination of information to the scientific community. In addition, computers are required for experiment control, data acquisition and scientific analysis.

- Instrumentation and lab equipment such as voltmeters, current sources, thermometers, pumps, glassware, tape, etc. are required for the various labs used by researchers and users.

- Chemicals and raw materials such as acids and bases, reagents, metal, plastics, etc. are required for researchers and users to conduct their research.

- Safety equipment such as safety glasses, gloves, fall protection, harnesses, electrical safety gear, etc. These items are required to insure the safety of the staff.

- Postage expense used for functions directly affecting the performance of the NHMFL such as bulk mailings of NHMFL Research Reports to national and international users and prospective user community. All other postage expense is covered by other sources.

- Local telephone expenses for the divisions and departments directly supporting the functions of the NHMFL user facility. Other telephone expenses are covered by other sources.

SUB-AWARDS

Sub-award funding for each facility has remained basically the same over the past two years. This level of funding is required to maintain a basic level of operations for the AMRIS, High B/T and Pulsed Magnet User Programs. Detailed budgets and budget justifications for each individual division reflect their specific spending plan.

A subaward to Steven Beu, Consultant, will be funded from the Ion Cyclotron Resonance (ICR) User Program fund. As in the past five years, Dr. Beu will continue to consult with the ICR Program on the development of new ion transfer optics and techniques for improved ion transmission and decreased time-of-flight mass discrimination in FT-ICR mass spectra.

OTHER DIRECT COST

Electricity – The total electricity budget for FY 2013 is $2,645,000 of which $1,800,000 is funded from the NSF budget. This is a reduction of $845,000 in electricity for operations of the DC Magnets User Program when compared to FY 2012. This reduction was based on the average cost of electricity over the last year. Funds received from FSU in the amount of $845,000 will be used to subsidize the cost of electricity. At this time we do not expect an increase in the rates for electrical power from the City of Tallahassee.

Florida State University receives two power bills each month. One is the Electric Contract (Interruptible) and the other is the Electric Large Demand (Firm). These bills are generated from two different sets of meters. The electrical system is segregated into the power required to run the high power DC Field magnets (Interruptible) and power for the building (lighting, heating and cooling, computers and any scientific equipment (Firm). For the magnets (Interruptible) the NHMFL has a special rate since the City of Tallahassee can contact the lab and interrupt the power for magnets if the need occurs. Florida State University pays for the Electric Large Demand (Firm) while the Electric Contract (Interruptible) is paid with NSF funds since that electricity is directly used to operate the magnets for the users.

Tuition –The NHMFL mandates that only In-State tuition waivers may be paid and tuition rates do not include student related fees. For FY 2013-2014 the tuition rate per hour is $403.51. Graduate students are required to be enrolled nine hours each semester. The cost of tuition for nine hours per semester is $4,176. These costs, which are the standard tuition rates for FSU, were used to calculate the tuition for each Graduate Student based on the length of their appointment. The total cost of tuition for Graduate Students for FY 2013 is $73,772. Tuition rates and annual increases are set annually by the Florida Legislature and the Florida State University Board of Trustees. The current approved rate of increase is 15% per year.

User Collaboration Grant Program (UCGP) – The National Science Foundation has charged (through the Cooperative Agreement) the NHMFL with developing an in-house research program that utilizes the NHMFL facilities to carry out high quality high field research at the forefront of science and engineering; and advances the NHMFL facilities and their scientific and technical capabilities. To this end, the NHMFL's Users Collaboration Grants Program seeks to achieve these objectives through funded research projects, normally a two year award period, in the following categories:

- Collaborations between internal and/or external investigators that utilize their complementary expertise
- Bold but risky efforts which hold significant potential to extend the range and type of experiments
- Initial seed support for new faculty and research staff, targeted to magnet laboratory enhancements.

The UCGP strongly encourages collaboration between NHMFL scientists and external users of the NHMFL facilities.

Funds in the amount of $650,000 will support the first-year funding for the 2013-2014 UCGP proposal solicitation.

INDIRECT COST

Per the Florida State University's Indirect Cost Rate Agreement, the approved indirect cost rate for NSF funded awards is 55%. However, due to the size of the NSF Facilities award, a lower indirect cost rate was approved by the FSU Office of Vice President of Research. For the NHMFL's NSF Facilities award, the indirect cost rate is 52%. Indirect cost is calculated based on 52% of the modified total direct costs (MTDC). Modified Total Direct Costs consists of all salaries and wages, fringe benefits, materials, supplies, services, travel and subawards up to the first $25,000 of each subaward (regardless of the period covered by the subaward). Modified total direct costs excludes equipment, capital expenditures, participant support costs, electricity, tuition, and the amount of subawards greater than the first $25,000.

Note: The Indirect Cost Rate Agreements for Florida State University, University of Florida, and Los Alamos National Laboratory will be sent to the Grants Compliance Officer via email.

BUDGET JUSTIFICATION
UF - High B/T Facility

The University of Florida operates the HIGH B/T FACILITY for the National High Magnetic Field Laboratory (NHMFL). The facility is a User facility and is open to all qualified users. Users submit proposals that are reviewed by local and external scientists for scientific merit and feasibility. In the previous grant cycle the operations have been extended from Bay 3 of the Microkelvin Laboratory to include Bay 2 of the Microkelvin Laboratory and annex capabilities up to 10 T and 10 millikelvin in Williamson Hall. For the renewal period 2013-2017, we propose to meet the recent increases in user demand for magnet time at very low temperatures by opening Bay 1 of the Microkelvin Laboratory for external users.

PERSONNEL

Funds are requested to appoint an additional Assistant Scientist, Liang Yin, for 12 calendar months. Dr. Yin will be bringing Bay 1 into operation and also operating the additional facility for users. Funds are also requested for a postdoctoral associate (12 calendar months) who will be assisting users and a graduate student (12 calendar months) to assist with ultra-low temperature techniques.

EQUIPMENT

Equipment funds are also requested in years one and two to replace the 17-year old pumps that are used for the dilution refrigerator of Bay 1. Additional equipment funds are requested to meet costs of instrument acquisition for development of a high pressure capability. See **Table 4** for the specifically budgeted equipment of FY 2013.

TRAVEL

Support is requested to meet partial costs for attending meetings of the American Physical Society or equivalent meetings.

MATERIALS AND SUPPLIES

In addition, operating funds are sought to meet the costs of liquid helium and nitrogen supplied by the Department of Physics at $2.50 per liquid liter. The remaining funds will be used to purchase the following: specialized coaxial cables for cryogenic applications, low temperature thermometers, instruments for reading thermometer, digital multimeters for data acquisition, frequency counters, signal generators, silver stock for machining sample holders, electronic and mechanical tools, pressure gauges, computers for data acquisition, data acquisition cards for computers, and beryllium copper metal stick for high pressure cells.

TABLE 4

High B/T Facility **Specifically Budgeted Equipment**

High Pressure Generator and Measurement	15,110
Digital Storage Oscilloscope	12,700
Frequency Generator	12,044

TABLE 5

AMRIS **Specifically Budgeted Equipment**

400A/750 volt gradient amplifier rack for one of the MRS systems	85,000
Vacuum pump, replacing an aging pump	8,000
Chilled water recirculator, replacing an again recirculator	5,000
High voltage transformer to allow the installation of the gradient amplifier rack without costly electrical rewiring	2,000

BUDGET JUSTIFICATION
UF - AMRIS

PERSONNEL

Joanna Long is the AMRIS Director and is responsible for the overall operation of the AMRIS program and distributing the NHMFL supply money to pay for AMRIS fees. She also directs the dynamic nuclear polarization technology program to enhance the NHMFL external user program. She has 3 calendar months total effort, divided into 1.5 months for AMRIS and 1.5 months for new initiative development.

Arthur S. Edison is PI of the subcontract and Director of Chemistry & Biology (DCB) at the NHMFL. He also directs the high sensitivity NMR technology program to enhance the NHMFL external user program. He has 2.4 calendar months total effort, divided into 1.2 months for DCB and 1.2 months for the NMR core.

Glenn Walter leads the molecular imaging technology program to enhance the NHMFL external user program and serves on the science board for a total of 1.8 calendar months.

Steve Blackband leads the microimaging technology program to enhance the NHMFL external user program for a total of 1.2 calendar months.

Gail Fanucci, 1.2 calendar months, is a member of the Science Advisory board and develops technology.

Denise Mesa, 3.6 calendar months, is responsible for the administrative and secretarial activities necessary to run the NHMFL external user program.

RF engineer, 12 calendar months, is responsible for designing, constructing, testing, and maintaining unique RF coils for the horizontal animal imaging systems and the WB 750 system within the AMRIS facility as well as coordinating with new RF projects pursued by the NMR probe development group in Tallahassee.

EQUIPMENT

We have budgeted $100,000 each year for the purchase of new equipment in the AMRIS facility to support the NHMFL external user program. This includes equipment for 8 spectrometers, an RF engineering laboratory, and staff scientists. Typical items include new RF or gradient amplifiers, new NMR probes, RF frequency generators, computer workstations, network analyzers, and animal monitoring equipment. See **Table 5** for the specifically budgeted equipment of FY 2013.

TRAVEL

We have budgeted $31,000 each year for travel. This includes support for users on a limited basis, support for UF scientists to collect data in Tallahassee, travel to scientific meetings, and travel to NHMFL meetings.

MATERIALS & SUPPLIES

We have budgeted for $325,000 in materials and supplies. These funds will be used to pay for AMRIS instrument time and staff fees for the NHMFL external user program. The AMRIS facility operates under federal cost accounting standards (CAS) and is required to charge users fees for all users. These fees are billed hourly for each instrument and for each staff member that provides direct support to a project via consulting rates. Our fee structure is audited every year so that our facility runs cost neutral and hourly rates are publicized on our website. These funds also pay for development time on the instruments for NHMFL initiatives and an RF engineer, Malathy Elumalai, who is responsible for designing, constructing, testing, and maintaining unique RF coils for the external user program as well as coordinating with new RF projects pursued by the NMR probe development group at the NHMFL-Tallahassee.

BUDGET JUSTIFICATION
LOS ALAMOS NATIONAL LABORATORY

We will be using the funds to purchase materials and supplies and pay salaries for operation of the NHMFL-Pulsed Field Facility. The total budget of $6,737,000 will be used to pay salaries, purchase consumables and to travel to conferences and workshops for communication of the NHMFL-PPF user program capabilities and accomplishments. Consumables such as cryogenic liquids and pulsed magnet parts and components such as high strength wire and structural components must be purchased throughout the grant cycle to continue to develop our ability to create high magnetic fields for research for our user program.

BUDGET JUSTIFICATION
STEVEN BEU

Services will be billed quarterly at a rate of $100 per hour.

Total time billed for the 2013 calendar year will not exceed 550 hours for a total amount payable not to exceed $55,000 for the year.

TABLE 6

Statement of Expenses and Encumbrances As of 12/31/13

		2013	As of 12/31/13	
		EXPENSED	**ENCUMBERED**	**TOTAL COSTS**
A-C. TOTAL SALARIES, WAGES AND FRINGE BENEFITS		7,366,623	3,654,972	11,021,595
D. TOTAL EQUIPMENT		188,907	771,687	960,595
E. TRAVEL	1. DOMESTIC	187,581	18,957	206,539
	2. FOREIGN	41,145	5,664	46,809
F. PARTICIPANT SUPPORT	1. STIPENDS	101,426		
	2. TRAVEL	8,721		
	3. SUBSISTENCE	12,384		
	4. OTHER	–		
TOTAL PARTICIPANT COSTS		122,531	–	122,531
G. OTHER DIRECT COSTS	1. MATERIALS AND SUPPLIES	1,815,903	306,040	2,121,943
	2. PUBLICATION/DOCUMENTATION/ DISSEMINATION			–
	3. CONSULTANT SERVICES			–
	4. COMPUTER SERVICES			–
	5. SUBAWARDS	7,589,953	1,011,546	8,601,499
	6. OTHER	774,367	–	774,367
TOTAL OTHER DIRECT COSTS		10,180,223	1,317,586	11,497,809
H. TOTAL DIRECT COSTS (A THROUGH G)		18,087,011	5,768,867	23,855,878
I. INDIRECT COSTS (F&A)	Base	9,336,253	3,985,634	13,321,886
	Rate: %	52%	52%	52%
TOTAL INDIRECT COSTS (F&A)		4,929,211	2,072,529	7,001,740
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)		**23,016,222**	**7,841,396**	**30,857,618**

TABLE 7

Statement of Residual Funds

31,622,000	NSF Budget Allocation for FY 2013
(30,857,619)	Total Expenses and Encumbrances
RECONCILIATIONS	
5,555,567	Personnel and indirect costs encumbered in December 2013 for personnel expense from January 1, 2014 – June 30, 2014. These funds were encumbered in 2013 but will be paid with 2014 funds.
(845,323)	Magnet electricity invoices paid from the incorrect account and reconciled to the NSF budget in FY 2014.
OBLIGATIONS	
(894,384)	UCGP grants obligated to PI's to be expensed over the next 2-3 years.
(385,000)	Advanced cryogenic system for Series Connected Hybrid: purchase pending
(385,000)	Advanced cryogenics system for 28MW/41T: purchase pending
(700,000)	Superconducting magnet for infrared spectroscopy: purchase pending
(700,000)	Filter inductor replacement: purchase pending
(300,000)	Cooling water heat exchanger: purchase pending
(1,091,600)	Deferred annual magnet replacement parts: purchases underway ($881,000 resistive magnets, $210,000 100T upgrade wire plus applicable indirect cost)
RESIDUAL FUNDS	
1,018,641	

Line 3: Accounting policy dictates that all encumbered funds at the end of FY2013 are reported. Personnel expenses were encumbered in December 2013 for the period of January 1, 2014 through June 30, 2014. These expenses were part of the FY2014 budget and will be paid with 2014 funds.

Line 4: A portion of the electricity for the DC Facility magnets is paid from university funds, usually in the spring. Because the university's fiscal year is different than the NSF fiscal year, these were accidentally paid with university funds twice during FY2013. These funds will be recorded to the NSF budget in 2014.

Lines 5-10: Because of funding uncertainty in FY2013 and the late arrival of our last increment of funding (September 2013), several large purchases were initiated late in FY2013. Due to the lead time in procuring large items, the funds are obligated to these purchases but were not encumbered at the end of FY2013.

Line 11: Because of the uncertainty of the FY2013 funding described above, the purchase of spare parts and upgrades for magnets were not initiated until late FY2013. The funds were obligated for these purchases but not encumbered as of December 31, 2013.

Industrial Partners & Collaborations

Magnet Lab researchers and staff develop partnerships and collaborations with the private sector, federal agencies, and institutions and international organizations, resulting in a wide variety of magnet-related technologies and advancing other projects that bring technologies closer to the marketplace. Engaging in such research and development activities is part of the National Science Foundation's charge to the Magnet Lab.

Magnets, Magnet Technologies and Materials for Magnets

INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR (ITER INTERNATIONAL ORGANIZATION), Cadarache, France
US-ITER Project Office, Oak Ridge, TN
University of Twente, Enschede, the Netherlands

The Applied Superconductivity Center has for the last 5 years played a major role in helping ITER-IO understand the properties of the cables being wound into the Central Solenoid (CS) and the Tokamak Field (TF) coils. A central task has been the disassembly and metallographic analysis of the prototype Cable-in-Conduit-Conductors (CICCs) needed for TF and CS coils after testing in the SULTAN facility in conditions designed to simulate ITER operations. Many of these conductors Toroidal Field (ITER Organization) and Central Solenoid (US-ITER) CICCs typically suffered significant performance degradation during cyclic loading and occasional warm-up and cool-down cycles. The tests performed at the MagLab were able to identify many of the causes for this degradation and were instrumental in developing new cable patterns that resolved the degradation. This work was collaborative with groups at CEA-Cadarache, the University of Twente in the Netherlands and US-ITER
(Magnet Lab contacts: Peter J. Lee and David C Larbalestier, ASC)

LARGE ACCELERATOR PROJECT FOR THE HILUMI UPGRADE OF THE CERN LHC,
Brookhaven National Lab, Upton, NY

Accelerator magnets based on Nb3Sn wires are required to provide the increased magnetic fields for the next LHC upgrade. The Applied Superconductivity Center is collaborating with Brookhaven National Lab to understand the design and heat treatment optimization of accelerator magnet quality strand fabricated by the internal Sn process with a view to driving high current density strands to smaller filament sizes. Close collaboration with the R&D billets being manufactured for LARP under the Conductor Development Program of DOE High Energy Physics is a key part of the work.
(Magnet Lab contacts: Chiara Tarantini, Peter J. Lee and David C Larbalestier, ASC)

BRUKER EAS GMBH, Hanau, Germany

Bruker EAS is manufacturing accelerator quality Nb3Sn strands based on the powder-in-tube process that have the potential to provide the performance necessary for higher magnetic field upgrades to the Large Hadron Collider at CERN and the Applied Superconductivity Center is collaborating with Bruker and CERN to optimize the performance of the wire utilizing the electromagnetic testing and advanced microstructural and microchemical analysis facilities at the MagLab.
(Magnet Lab contacts: Chiara Tarantini, Peter J. Lee and David C Larbalestier, ASC)

CERN, Geneva, Switzerland

The Large Hadron Collider (LHC) at CERN uses a 27 km ring of superconducting magnets based on Nb-Ti to accelerate particles in the world's largest and most powerful collider but plans to increase the energy capability of LHC will require higher magnetic fields. The Applied Superconductivity Center is collaborating with CERN to characterize and optimize a new generation of accelerator quality Nb3Sn strands based on the powder-in-tube process that have the potential to provide the performance necessary for the next step in LHC upgrades.
(Magnet Lab contacts: David Larbalestier, Chiara Tarantini and Peter Lee, ASC)

EUCARD2 (European Collaboration for Accelerator R&D)

EUCARD2 is a European Framework collaboration of about 10 European labs aimed at developing kiloamp high temperature superconductor cables for future application to a high energy LHC. The European emphasis is on Roebel cables of REBCO coated conductors but an equally attractive cable for accelerator purposes is a round wire cable made in the Rutherford style out of Bi-2212 (Bi2Sr2CaCu2O8-x). This conductor has been developed at the MagLab under DOE-HEP support in the context of the Bismuth Strand and Cable Collaboration (BSCCo) that unites the MagLab, BNL, FNAL, LBNL and OST in a team developing this material for accelerator use. The MagLab is now the US point of contact for collaborations between EUCARD2 and the US program.
(Magnet Lab contacts: David Larbalestier, Eric Hellstrom and Jianyi Jiang, ASC)

FERMILAB, BATAVIA, IL

The shaping of Nb sheet to produce superconducting RF cavities introduces microstructural defects that may impact cavity performance; in collaboration with Fermilab the Applied Superconductivity Center is studying the surface and bulk superconductivity in deformed niobium wires. Controlled deformation is introduced into the Nb samples wire drawing and the resulting defects are quantified and compared to the measured superconducting properties.
(Magnet Lab contact: Peter J. Lee, ASC)

JEFFERSON LAB, Newport News, VA

Jefferson Lab are developing the next generation of Nb film coated Cu RF cavities and the Applied Superconductivity Center is assisting with the microstructural characterization of single-cell Cu cavities fabricated using a cathodic-arc-discharge (CAD) coating of Nb onto Cu.
(Magnet Lab contact: Peter J. Lee, ASC)

MICHIGAN STATE UNIVERSITY, Lansing, MI

The Applied Superconductivity Center is collaborating Michigan State University on a US-DOE funded project to study the impact of grain boundaries and associated microstructural defects on the performance of superconducting cavities using the advance microstructural, microchemical, and electromagnetic characterization techniques and expertise available in the MagLab. The new ultra-high resolution analytical TEM/STEM is particularly important for this work.
(Magnet Lab contact: Peter J. Lee, ASC)

SUPRAMAGNETICS, INC., Plantsville, CT

The Applied Superconductivity Center is participating in the development of a superconducting Nb3Sn wire that uses artificial flux-pinning centers to achieve high critical current densities. The MagLab provides microstructural and microchemical support for this work.
(Magnet Lab contact: Peter J. Lee, ASC)

TEXAS A&M UNIVERSITY, College Station, TX

Texas A&M University is fabricating Nb sheet and tubes with ultra-fine grain size and controlled textures for superconducting RF cavities by using the Equal Channel Angular Extrusion (ECAE) process; the Applied Superconductivity Center is providing microstructural characterization of the Nb primarily using the new fast-camera crystallographic orientation mapping system at the MagLab.
(Magnet Lab contact: Peter J. Lee, ASC)

UNIVERSITY OF COLORADO BOULDER, Boulder, CO

Nb3Sn is the primary superconductor for providing magnetic fields in the 11-22 T range but is brittle and there is the potential for filament fracture when subjected to the high Lorentz forces produced when the superconducting magnets are energized. The University of Colorado Boulder, (using the NIST-Boulder electromechanical testing facilities) has determined the strain sensitivity of a wide range of commercial Nb3Sn wires and has found a large variation in irreversibility strains (the limit in strain that the wire can be subjected to before unrecoverable degradation in performance), and the Applied Superconductivity Center has been working with UC-Boulder to try and the understand reasons for these variations so that future strands will be able to withstand the forces generated at high magnetic fields.
(Magnet Lab contact: Peter J. Lee, ASC)

SUPERPOWER INC, Schenectady NY

The Applied Superconductivity Center and the Magnet Science and Technology division of the Magnet Lab are collaborating with SuperPower Inc. on the characterization of YBCO coated conductors. This material has the potential to transform the field of high-field superconducting magnet technology and is in an early stage of commercialization. We work to improve our understanding of this product in support of the NHMFL 32 T project as well as to provide guidance to SuperPower on enhancing the quality of their product. We have also taken the lead in encouraging a Coated Conductor Round Table of users of coated conductors at which much information about the long length performance of coated conductors has been shared.
(Magnet Lab contacts: David C Larbalestier, Dmytro Abraimov and Jan Jaroszynski, ASC and Huub Weijers MS&T).

OXFORD SUPERCONDUCTING TECHNOLOGY (OST), Carteret, NJ.

Extensive collaborations exist between ASC and OST on both Nb3Sn and Bi-2212 conductor development, aided by direct support of R&D on these materials from DOE-High Energy Physics to ASC PIs and to OST through the Conductor Development Program managed out of Lawrence Berkeley National Laboratory. In this way OST has been able to develop the most advanced Nb3Sn and Bi-2212 conductors made.
(Magnet Lab contacts: David Larbalestier, Eric Hellstrom, Peter Lee, Chiara Tarantini, Jianyi Jiang, ASC)

ADVANCED CONDUCTOR TECHNOLOGIES, Boulder, CO

The Applied Superconductivity Center and the Magnet Science and Technology division of the Magnet Lab are collaborating with Advanced Conductor Technologies on the development and testing of Coated Conductor Stranded Cable (CCSC), using multi-layer spiraling tapes around a core, for magnet applications. Danko van der Laan, director of the company and associated with NIST/University of Colorado Boulder, is developing compact cables based on REBCO coated conductors, a high temperature superconductor. The ongoing collaboration on measurements of HTS cables at low temperature and high magnetic fields (4 K and 20 T in Cell 4) continues to set new benchmarks for peak current, current density, bend radius and ramp rates.
(Magnet Lab contact: Huub Weijers, MS&T)

OXFORD INSTRUMENTS, Abingdon, United Kingdom

Oxford Instruments is under contract to deliver a 15 T large-bore low temperature superconductor magnet to the NHMFL, to be combined with 17 T YBCO-coated conductor coils under development at the NHMFL to create the first 32 T all-superconductor magnet. In case of a quench, the LTS and HTS coils interact in a complex manager. To engineer a quench protection systm for the individual coil sets is require. This cannot be handled by routine specifications in a standard vendor relationship, therefore, Oxford Instruments and NHMFL Magnet Science and Technology are collaborating on quench protection to endure compatibility of the coil sets and are developing a numerical code to model quench in combined YBCO-LTS magnets.
(Magnet Lab contact: Huub Weijers, MS&T)

SUPERPOWER, INC., Schenectady, NY

The Applied Superconductivity Center and the Magnet Science and Technology division of the NHMFL are collaborating with SuperPower, Inc. on the characterization of YBCO-coated conductors. This material has the potential to transform the field of high-field superconducting magnet technology and is in an early stage of commercialization. We work to improve our understanding of this product in support of the NHMFL 32 T project, as well as to provide guidance to SuperPower, Inc. on enhancing the quality of their product.
(Magnet Lab contact: Huub Weijers, MS&T)

DANFOSS TURBOCOR INC., Tallahassee, FL

Danfoss Turbocor Inc. is a company specializing in compressors, particularly the totally oil-free compressors. The compressors are specifically designed for the heating, ventilation, air conditioning and refrigeration (HVACR) industry and need high performance soft and hard magnet materials. The company and the laboratory started a joint research project on selection, characterization, and development of permanent magnet materials for high performance and environmentally friendly compressors.
(Magnet Lab contact: Ke Han, MS&T)

HELMHOLTZ ZENTRUM BERLIN, Berlin, Germany

The MagLab has partnered with the Helmholtz Zentrum Berlin (HZB) to develop the highest field magnet worldwide for neutron scattering at HZB. In March 2007, HZB (formerly the Hahn-Meitner Institute) signed an agreement with Florida State University Magnet Research and Development Inc. The magnet is intended to provide 25 T on-axis using 4.4 megawatts of DC power and have upstream and downstream scattering angles of 30 degrees. The present record field for such a configuration is 17 T. Six external design reviews have been held with an international committee of reviewers. Fabrication of the magnet is nearing completion: The superconducting strand has been delivered and cabled and jacketed, the superconducting coil has been wound, reacted and impregnated, the cryostat has been fabricated. The superconducting coil has been shipped to Italy where the cryostat components are being assembled around it. Design of the resistive insert coils is complete and fabrication of them is well underway. In February 2014 the superconducting coil and cryostat should arrive in Berlin. We expect the system to be operational in 2014.
(Magnet Lab contact: Mark D. Bird, MS&T)

RADBOUD UNIVERSITY, NIJMEGEN, The Netherlands

The MagLab has partnered with the High Magnetic Field Lab in The Netherlands to develop a 45 T hybrid magnet using only 24 MW of power. The project was funded by the Dutch government in 2006 and in 2012 an agreement was signed for the MagLab to play a leading role in the development of the Nb3Sn cable-in-conduit superconducting coil for this magnet system. This will be the 4th hybrid outsert to be developed at the MagLab (MagLab 45 T, HZB, FSU SCH, Nijmegen) and the Dutch lab will benefit from our extensive experience. When complete should will be one of the two highest-field dc magnets in the world. Cable-in-conduit conductors are expected to arrive in Jan 2015 with winding to start thereafter, followed by jointing, reaction, impregnating and final assembly.
(Magnet Lab contact: Mark D. Bird, MS&T)

HIGH PERFORMANCE MAGNETICS (HPM), Tallahassee, FL

HPM is a spin-off from the Magnet Lab's Magnet Science & Technology Division and is involved in the USDOE ITER program. The Cable-in-Conduit-Conductor (CICC) technology used successfully in the NHMFL has led to the development of a state-of-the-art CICC jacketing production line. HMP collaborates with the Magnet Lab to develop test methods and processes that are mutually beneficial for the advancement of CICC technology.
(Magnet Lab contact: Bob Walsh, MS&T)

CALLAGHAN INNOVATIONS, Lower Hutt, New Zealand

The Applied Superconductivity Center and the Magnet Science and Technology division of the Magnet Lab are collaborating with researchers at New Zealand's Industrial Research Limited on the testing of Roebel-style cables based on REBCO coated conductors, a high temperature superconductor. Testing of a 15-strand cable with transposed 5 mm wide strands is in preparation. Roebel-style cables represent one of three viable concepts for REBCO coated conductor cables suitable for high field magnets.
(Magnet Lab contact: Bob Walsh, MS&T)

INSTITUTE OF METAL RESEARCH, CHINESE ACADEMY OF SCIENCES, Shenyang, China

The collaboration between the Institute of Metal Research and the Magnet Lab is related to the characterization of structural materials for high field magnets. The materials are mainly stainless steel 316LN and maraging steels with high mechanical strength.
(Magnet Lab contact: Ke Han, MS&T)

INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR (ITER), US-ITER PROJECT OFFICE, OAK RIDGE NATIONAL LABORATORY (ORNL), Oak Ridge, TN

The United States is part of an exciting international collaboration to demonstrate the feasibility of an experimental fusion reactor that is under construction in France. The MS&T's Mechanical Properties Lab is the US-ITER primary materials research and qualification laboratory supporting the US effort. The Topamak machine consists of three types of very large, complex superconducting magnets that all utilize Cable-in-Conduit Conductors (CICC) as the main structural components. Another important component for stress management of the Central Solenoid is a massive CS pre-compression structure (Tie Plates). The conduit and tie plate alloys, and their welds, are being studied and characterized here to ensure their performance and reliability. The funding for this research is provided by US-DOE, US-ITER Project Office at ORNL. *(Magnet Lab contact: Bob Walsh, MS&T)*

The quality assurance testing is critically important to the international thermonuclear fusion project, ITER. The collaboration between the Magnet Science and Technology division and the US-ITER focuses on the characterization of Nb3Sn wires used for ITER project. This involves large volume of quality assurance testing of superconducting properties of Nb3Sn wires. The Nb3Sn properties tested include the critical current, residual resistivity ratio, hysteresis loss, and room temperature metrology measurements.
(Magnet Lab contact: Jun Lu, MS&T)

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY, Newport News, VA

Large-grain Nb has become a viable alternative to fine-grain Nb for the fabrication of superconducting radio-frequency cavities. NHMFL collaborated with engineers at Jefferson Lab to evaluate the effect of thermal processing and grain size on the mechanical properties of Nb. The mechanical properties evaluation was carried out at MS&T's Mechanical Properties Lab.
(Magnet Lab contact: Bob Walsh, MS&T)

MEVION MEDICAL SYSTEMS, Littleton, MA

Mevion is a pioneer in the development of proton radiation therapy systems for the non-invasive treatment of cancer. The center of the systems is the proton accelerator that utilizes low temperature superconductors. NHMFL provides engineering support to Mevion by assisting in qualification testing of full-scale high current superconductors in background fields at low temperatures. The tests require NHMFL's unique test facitility designed for tests of large conductors in a 12 tesla split solenoid superconducting magnet system.
(Magnet Lab contact: Bob Walsh, MS&T)

KEY LABORATORY OF ELECTROMAGNETIC PROCESSING OF MATERIALS, NORTHEASTERN UNIVERSITY, Shenyang, China

The collaboration between the Northeastern University and the Magnet Lab is related to the magnetic field impact on fabrication of high strength conductors. A professor from Northeastern University joined the MagLab as a visiting scientist for one year to do the research. The collaboration is a continuous effort and a student arrived at the MagLab in 2013 and will stay for two years. A MagLab faculty visited Northeastern University in 2013 and will visit again in 2014.
(Magnet Lab contact: Ke Han, MS&T)

LAWRENCE BERKELEY LABORATORY, ACCELERATOR AND FUSION RESEARCH, Berkeley, CA

The Applied Superconductivity Center and the Magnet Science and Technology division of the Magnet Lab are collaborating with researchers at the Berkeley National Laboratory on the testing of Roebel-style cables based on REBCO coated conductors, a high temperature superconductor. Testing of a 10-strand cable with transposed 2 mm wide strands is in preparation. Roebel-style cables represent one of three viable concepts for REBCO coated conductor cables suitable for high field magnets.
(Magnet Lab contact: Huub Weijers, MS&T)

HYPER TECH RESEARCH INC, Columbus, OH

Hyper Tech Research Inc. develops and manufactures MgB2 superconducting wires for MRI applications. In this collaboration, the Magnet Science and Technology division measures critical current of MgB2 wires developed by Hyper Tech Research. The critical current measurements are performed at 4.2 K and in 0 – 10 tesla magnetic fields.
(Magnet Lab contact: Jun Lu, MS&T)

Materials Research

PRIME PHOTONICS, Blacksburg, VA

They ran tests on high speed fiber-optic magnetic field sensors in cell 7 in June 2013. This was not a collaborative effort. They came in as a user only. *(Magnet Lab contact: Tim Murphy, DC Field Facility)*

Electron Magnetic Resonance (EMR)

DANA-FARBER CANCER INSTITUTE, Boston, MA
Current collaboration between Dana-Farber Cancer Institute and the Magnetic Lab is aimed at determining the molecular details of HIV envelope protein gp41 using electron paramagnetic resonance methods. Other goals include characterization of antibody-induced structural changes of gp41, and developing optimized vaccine immunogens by structural approaches. *(Magnet Lab contact: Likai Song, EMR)*

ST. ANDREWS UNIVERSITY, United Kingdom
The EMR group has an ongoing partnership with St. Andrews University in the UK, involving the development of a high-power (1 kW) high-frequency (94 GHz) pulsed EPR spectrometer (HiPER) for its user program. *(Magnet Lab contact: Stephen Hill, EMR)*

THOMAS KEATING LTD, United Kingdom
The EMR group has entered into a partnership with Thomas Keating (TK) LtD in the UK as part of its program aimed at developing a new characterization tool, Dynamic Nuclear Polarization Nuclear Magnetic Resonance (DNP - NMR) at high fields (14.1 T / 600 MHz). TK draws on tool-making skills to design and develop quasi-optical Terahertz systems and subsystems. *(Magnet Lab contact: Stephen Hill, EMR)*

UNIVERSITY OF EDINBURGH, United Kingdom
The EMR group received funding through a joint program between the National Science Foundation and the Engineering and Physical Sciences Research Council in the UK, enabling an International Collaboration with the Chemistry Department at the University of Edinburgh, Scotland. This joint program involved the development of high-pressure/High-field EPR techniques. *(Magnet Lab contact: Stephen Hill, EMR)*

UNIVERSITY OF MODENA, Italy
The EMR group received joint funding with the University of Modena in Italy and Osaka City University in Japan through an International Program sponsored by the Air Force's Asian Office of Aerospace Research and Development (AOARD). This joint program focuses on quantum properties of molecular magnets. *(Magnet Lab contact: Stephen Hill, EMR)*

OSAKA CITY UNIVERSITY, Japan
The EMR group received joint funding with the University of Modena in Italy and Osaka City University in Japan through an International Program sponsored by the Air Force's Asian Office of Aerospace Research and Development (AOARD). This joint program focuses on quantum properties of molecular magnets. *(Magnet Lab contact: Stephen Hill, EMR)*

Ion Cyclotron Resonance

PFIZER, ANDOVER, Massachusetts
This collaboration is with Jason C. Rouse, who directs mass spectrometry research and development at Pfizer Andover. Current research focuses on identifying and locating the sites of post-translational chemical modifications of antibodies by top-down proteomics (i.e., direct analysis of intact gas-phase antibody molecules). *(Magnet Lab Contact: Alan Marshall, ICR)*

SIERRA ANALYTICS, Modesto, CA
The lab's ICR research team maintained a licensing agreement with Sierra, a company that provides mass spectrometry software to petroleum companies. The software contains high level algorithms for identification of thousands of compounds in petroleum mass spectra, obtained through the lab's pioneering Fourier transform ICR technique development. The agreement was terminated in Fall 2013. *(Magnet Lab contact: Ryan Rodgers, ICR)*

WOODS HOLE OCEANOGRAPHIC INSTITUTE
Woods Hole, MA
As part of FSU's Gulf Research Initiative Consortium, NHMFL collaborates with Christopher Reddy and Robert Nelson at WHOI in characterization of petroleum oil spills at the molecular level, by gas chromatography x gas chromatography and FT-ICR mass analysis. Characterization of the 2010 Macondo wellhead oil has been completed, and current research focuses on subsequent physical, chemical, and biological changes as the spill propagates into the environment. *(Magnet Lab Contact: Ryan Rodgers, ICR)*

SCRIPPS RESEARCH INSTITUTE
Jupiter, FL
We continue to collaborate with Dr. Ming Guo (Scripps Florida), for structural characterization of transfer RNA synthetases functioning in roles other than protein synthesis. Those functions result from complexation of a given synthetase with one or more other proteins. Synthetase mutations lead to various diseases. Scripps provides the mutants, and we use hydrogen/deuterium exchange monitored by FT-ICR mass spectrometry to map the protein:protein contact surfaces in the complexes to establish structure:function relationships. *(Magnet Lab Contact: Nicolas Young, ICR)*

UNIVERSITY OF TEXAS MEDICAL BRANCH
Galveston, TX
The ICR Program collaborates with Profs. Carol L. Nilssonand Mark R. Emmett. One current project is proteomics and glycomics of brain cancer-derived stem-like cells correlated to gene expression data and patient outcomes. A second project involves FT-ICR mapping of lipid alterations in spinal cord injury. *(Magnet Lab Contact: Nicolas Young, ICR)*

Nuclear Magnetic Resonance

AGILENT TECHNOLOGIES, LIFE SCIENCES/ CHEMICAL ANALYSIS DIVISION, Santa Clara, CA

Investigators from Magnet Lab facilities at UF and FSU collaborate with technical staff at Agilent on an NIH-funded project to develop improved superconductive cryogenic probes for solution NMR.
(Magnet Lab contacts: William Brey, NMR and Art Edison, AMRIS)

BRUKER BIOSPIN CORP., Billerica, MA

The Magnet Lab's NMR instrumentation program and Bruker Biospin collaborate on the development of Low-E probes for solid-state NMR in heat sensitive biological samples, such as proteins. Bruker Biospin manufactures a line of Efree probes based on the Low-E design developed at our lab.
(Magnet Lab contact: Peter Gor'kov, NMR)

REVOLUTION NMR, LLC, Fort Collins, CO

Revolution NMR has licensed from FSU the Low-E probe technology developed at Magnet Lab in order to fabricate static NMR probes for biological (protein) samples. Additionally, the Magnet Lab's NMR instrumentation program and Revolution NMR collaborate on the development of stators for magic angle spinning NMR.
(Magnet Lab contact: Peter Gor'kov, NMR)

SOUTHEAST CENTER FOR INTEGRATED METABOLOMICS, University of Florida

With a new $9 million grant from National Institutes for Health, the University of Florida created a Southeast Center for Integrated Metabolomics which joins a consortium of five other regional resource centers and a national coordinating center to spur metabolomics research in the United States by funding training, technology development, standards synthesis and data-sharing initiatives. Metabolomics draws from many scientific disciplines, including chemistry, physiology, statistics, genetics, computer science and systems design and, as such, has many partners: the National High Magnetic Field Laboratory at Florida State University, Sanford-Burnham Medical Research Institute, Ohio State University, the University of Georgia, Imperial College London, the University of Geneva and industry partners IROA Technologies and Thermo Fisher Scientific.
(Magnet Lab contact: Arthur Edison, AMRIS)

Education

CAISE - CENTER FOR THE ADVANCEMENT OF INFORMAL SCIENCE EDUCATION
Washington D.C.

The Center for the Advancement of Informal Science Education (CAISE) works in collaboration with the National Science Foundation (NSF) Advancing Informal STEM Learning (AISL) Program to strengthen and advance the field of professional informal science education and its infrastructure by providing resources for practitioners, researchers, evaluators and STEM-based professionals. CAISE also facilitates conversation, connection and collaboration across the ISE field — including in media (TV, radio, and film), science centers and museums, zoos and aquariums, botanical gardens and nature centers, cyberlearning and gaming, and youth, community, and out of school time programs. The Center for Integrating Research & Learning (CIRL) has worked with CAISE to provide advice for reaching Principal Investigators and improving the evaluation of broader impacts.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs)

CPALMS – COLLABORATE, PLAN, ALIGN, LEARN, MOTIVATE, AND SHARE
Tallahassee, FL

CPALMS is part of the Florida Center for Research in STEM and is the state of Florida's platform for educators to Collaborate, Plan, Align, Learn, Motivate, and Share through online lesson plans and activities. The Center for Integrating Research & Learning (CIRL) has partnered with CPALMS to facilitate scientist interviews as part of their video accessories for lessons. Carlos Villa also works closely with CPALMS to discuss the role of informal STEM outreach.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs)

COLUMBIA UNIVERSITY RET PROGRAM
New York, NY

The Center for Integrating Research & Learning continues its collaboration with other institutions that conduct educational outreach with teachers. Through the Research Experiences for Teachers (RET) Network, the Center maintains a national presence among other laboratories, centers, and universities that conduct RET and other teacher enhancement programs. Current projects include participating in a research project with Columbia University that will compare various RET programs from across the country.
(Magnet Lab contact: Jose Sanchez, Educational Programs)

COMMUNITY CLASSROOM CONSORTIUM, Tallahassee, FL

The Community Classroom Consortium (CCC) is a coalition of more than thirty cultural, scientific, natural history, and civic organizations in north Florida and south Georgia that provide educational experiences and resources to the public, especially K-12 teachers and students. Representatives from CIRL and Public Affairs represent the Lab on the board of this organization and as general members.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs or Kristen Coyne, Public Affairs)

FLORIDA AFTERSCHOOL NETWORK, Tallahassee, FL

The Florida Afterschool Network (FAN) is an organization that is working toward creating and sustaining a statewide infrastructure to establish collaborative public and private partnerships that connect local, state, and national resources supporting afterschool programs that are school-based or

school-linked; develop quality afterschool standards that are endorsed and promoted by statewide stakeholders and through Florida Afterschool Network; and promote public awareness and advocate for policy that expands funding, quality improvement initiatives, and accessibility of afterschool programs. The Center for Integrating Research & Learning is a member of the advisory council for this organization.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs)

FLORIDA STATE UNIVERSITY, COLLEGE OF EDUCATION, Tallahassee, FL

The Center for Integrating Research & Learning works closely with faculty from the FSU College of Education to network and strengthen programs on campus and at the lab. Currently, we utilize the expertise of FSU faculty for research projects. We also recruit graduate students from FSU departments to conduct research on CIRL programs.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs)

FUTURE PHYSICISTS OF FLORIDA

Future Physicists of Florida is an organization dedicated to recognizing talented middle school math and science students and providing educational guidance to these students to prepare them for careers in physics and engineering. CIRL is a partner in the organization.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs)

NORTH CAROLINA STATE UNIVERSITY, Raleigh, NC

In partnership with the Center for Advanced Power Systems and the FAMU-FSU College of Engineering, the Center for Integrating Research & Learning supports ERC FREEDM educational and assessment activities. Working with The Science House and the ERC FREEDM Center at North Carolina State University, CIRL facilitates the pre-college education program through summer camps, Young Scholars high school internship programs, and Research Experiences for Teachers. In addition, one full-time graduate student coordinates assessment at all locations participating in the FREEDM grant.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs)

PANHANDLE AREA EDUCATIONAL CONSORTIUM (PAEC)

The Panhandle Area Educational Consortium serves 13 school districts in the panhandle of Florida. PAEC provides leadership and support services to these districts, increases networking among members, and maximizes resources. Over the years, CIRL has provided teacher workshops and high school summer information sessions to students and teachers from these districts with PAEC's facilitation.
(Magnet Lab Contact: Roxanne Hughes, Educational Programs)

WFSU-TV, Tallahassee, FL

The Center for Integrating Research & Learning partners with WFSU-TV, the area's public television station, to administer SciGirls. The program is a 2-week camp for middle and high school girls with an interest in science. The collaboration between the Magnet Lab and WFSU-TV has resulted in a successful 6-year camp that has engaged the larger community. In addition, WFSU-TV and the Center partner to provide summer physics experiences for students entering high school.
(Magnet Lab contact: Roxanne Hughes, Educational Programs)

Optical Microscopy

89 NORTH, Burlington, VT

Scientists at the Magnet Lab are working with applications specialists at 89 North to develop light-emitting diode technology for fluorescence microscopy. This collaboration involves testing the power output and usability of new high power LED technology in the emission region between 490 and 590 nanometers, a spectral region that is central to microscopy investigations.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

AGILENT TECHNOLOGIES, Santa Clara, CA

Agilent Technologies is entering the imaging arena with a new "Monolithic" laser combiner featuring acousto-optic-tunable filter (AOTF) control. The Magnet Lab is collaborating with Agilent to prototype the laser system for use in super-resolution imaging.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

ALLELE BIOTECH, San Diego, CA

Allele is a manufacturer and distributor of fluorescent protein constructs made by Robert Campbell and Nathan Shaner. The Magnet Lab is collaborating with Allele to develop fusion vectors of selected fluorescent proteins.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

ANDOR-TECH, Belfast, Northern Ireland

Andor-Tech is an imaging specialist involved with development of CCD camera systems designed to produce images at extremely low light levels. The Magnet Lab is collaborating with Andor-Tech to produce interactive tutorials describing electron multiplying CCD (EMCCD) technology and will work with the company to test new camera products in live-cell imaging.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

B&B MICROSCOPES, Pittsburgh, PA

Scientists in the Optical Microscopy facility at the Magnet Lab are working with B&B engineers to develop new live-cell imaging techniques using the wide array of products offered by the company. Eventually, an educational website is planned.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

BIOPTECHS, Butler, PA

The Magnet Lab is involved with Bioptechs of Pennsylvania to develop live-cell imaging techniques using the company's advanced culture chambers. The collaboration involves

timelapse imaging of living cells over periods of 36-72 hours using techniques such as differential interference contrast, fluorescence, and phase contrast.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

CHROMA, Rockingham, VT

A major supplier of Interference filters for fluorescence microscopy and spectroscopy applications, Chroma is collaborating with the Magnet Lab to build educational tutorials targeted at fluorescence microscopy. Working in conjunction with Nikon, engineers from Chroma and scientists from the Magnet Lab are examining the characteristics of a variety of filter combinations.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

THE COOKE CORP., Romulus, MI

Scientists at the Magnet Lab are working with applications specialists at Cooke to field test the company's cooled and electron-multiplied scientific CCD camera systems. Demanding applications in quantitative image analysis and high-resolution images are being explored, as well as time-lapse fluorescence microscopy and resonance energy transfer imaging.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

COOLLED LTD., Andover, Hampshire, United Kingdom

Scientists at the Magnet Lab are working with applications specialists at CoolLed to develop light-emitting diode technology for fluorescence microscopy. This collaboration involves testing the power output and usability of new LED technology in the emission region between 490 and 590 nanometers, a spectral region that is central to microscopy investigations.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

COVANCE RESEARCH PRODUCTS, Berkeley, CA

Covance is a biopharmaceutical company involved with research and diagnostic antibody production. Magnet Lab scientists are working with Covance researchers to examine immunofluorescence staining patterns in rat and mouse brain thin and thick sections using a wide spectrum of antibodies.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

DIAGNOSTIC INSTRUMENTS, Sterling Heights, MI

Scientists at the Magnet Lab are working with applications specialists at Diagnostics to field test the company's new line of cooled scientific CCD systems. Demanding applications in quantitative image analysis and high-resolution images are being explored, as well as time-lapse fluorescence microscopy and resonance energy transfer imaging.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

EVROGEN, Moscow, Russia

Evrogen is a manufacturer and distributor of fluorescent protein constructs made by Dmitriy Chudakov and Vladislav Verkhusha. The Magnet Lab is collaborating with Evrogen to develop fusion vectors of selected fluorescent proteins.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

EXFO, Mississauga, Ontario, Canada

The Magnet Lab is collaborating with EXFO to examine the spectra and output power of various illumination sources for microscopy including metal halide lamps, light engines, LEDs, and the LiFi illumination system.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

HAMAMATSU PHOTONICS, Bridgewater, NJ

Scientists at the Magnet Lab are working with applications specialists at Hamamatsu to field test the company's cooled and electron-multiplied scientific CCD camera systems. Demanding applications in quantitative image analysis and high-resolution images are being explored, as well as time-lapse fluorescence microscopy and resonance energy transfer imaging.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

LINKAM, Surrey, United Kingdom

Scientists at the Magnet Lab collaborate with Linkam engineers to design heating and cooling stages for observation of liquid-crystalline phase transitions in the optical microscope. In addition, microscopists are assisting Linkam in introducing a new heating stage for livecell imaging in fluorescence microscopy.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

LUMENCOR INC., Beaverton, OR

The Magnet Lab is collaborating with Lumencor to examine the spectra and output power of various illumination sources for microscopy including metal halide lamps, light engines, LEDs, and the LiFi illumination system.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

MBL INTERNATIONAL, Woburn, MA

Scientists at the Magnet Lab are collaborating with MBL to develop new fluorescent proteins for live-cell imaging applications. These include both optical highlighters and fluorescence resonance energy transfer (FRET) biosensors.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

MEDIA CYBERNETICS, Silver Spring, MD

Programmers at the Magnet Lab are collaborating with Media Cybernetics to develop imaging software for timelapse optical microscopy. In addition, the Optical Microscopy group is working to add new interactive tutorials dealing with fundamental aspects of image processing and analysis of data obtained with the microscope.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

MOLECULAR PROBES/INVITROGEN, Eugene, OR

A major supplier of fluorophores for confocal and wide-field microscopy, Molecular Probes is collaborating with the Magnet Lab to develop educational tutorials on the use of fluorescent probes in optical microscopy.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

NIKON USA, Melville, NY

The Magnet Lab maintains close ties with Nikon on the development of an educational and technical support microscopy website, including the latest innovations in digital-imaging technology. As part of the collaboration, the Magnet Lab is field-testing new Nikon equipment and developing new methods of fluorescence microscopy.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

OLYMPUS AMERICA, Melville, NY

The Magnet Lab is developing an education/technical website centered on Olympus products and will be collaborating with the firm on the development of a new tissue culture facility at the Magnet Lab in Tallahassee. This activity will involve biologists at the Magnet Lab and will feature Total Internal Reflection Fluorescence microscopy.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

OLYMPUS CORP., Tokyo, Japan

Investigators at the Magnet Lab have been involved in collaboration with engineers at Olympus to develop and test new optical microscopy systems for education and research. In addition to pacing the microscope prototypes through basic protocols, the Optical Microscopy group is developing technical support and educational websites as part of the partnership.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

OMEGA OPTICAL, Brattleboro, VT

The Magnet Lab is involved in a collaboration with Omega to develop interactive tutorials targeted at education in fluorescence filter combinations for optical microscopy. Engineers at Omega work with Magnet Lab microscopists to write review articles about interference filter fabrication and the interrelationships between various filter characteristics and fluorophore excitation and emission.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

PHOTOMETRICS (ROPER SCIENTIFIC INC.), Tucson, AZ

The microscopy research team at the Magnet Lab is exploring single molecule fluorescence microscopy using electron-multiplying CCD camera systems developed by Photometrics. In addition, the team is conducting routine fixed-cell imaging with multiple fluorophores to gauge camera performance.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

PRIOR SCIENTIFIC INC., Rockland, MA

Prior is a major manufacturer of illumination sources and filter wheels for fluorescence microscopy. The Magnet Lab team is collaborating with Prior to develop new illumination sources and mechanical stages for all forms of microscopy.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

QIMAGING, BURNABY, British Columbia, Canada

High-resolution optical imaging is the focus of the Magnet Lab collaboration with Qimaging, a Canadian corporation that specializes in CCD digital cameras for applications in quantitative image analysis and high-resolution images for publication. Target applications are interactive tutorials and image galleries that will be displayed on the Internet.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

SEMROCK, Rochester, NY

The Magnet Lab Optical Microscopy group is collaborating with Semrock to develop interactive tutorials targeted at education in fluorescence filter combinations for optical microscopy. Engineers and support personnel at Semrock work with Magnet Lab microscopists to write review articles about interference filter fabrication and the interrelationships between various filter characteristics and fluorophore excitation and emission. In addition, Magnet Lab scientists produce images of living cells with Semrock filter combinations.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

SUTTER INSTRUMENT, Novato, CA

The Magnet Lab is collaborating with Sutter to examine the spectra and output power of various illumination sources for microscopy including metal halide lamps and the LiFi illumination system.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

ZEISS MICRO IMAGING, Thornwood, NY

The Optical Microscopy group at the Magnet Lab is negotiating a contract with Zeiss on the development of an educational and technical support microscopy website, including the latest innovations in digital imaging technology. As part of the collaboration, microscopists are field-testing new Zeiss equipment and developing new methods of fluorescence microscopy.
(Magnet Lab contact: Mike Davidson, Optical Microscopy)

Geochemistry

WOODS HOLE OCEANOGRAPHIC INSTITUTION (WHOI)
Woods Hole, MA

The collaboration between WHOI and the Magnet Lab is related to ocean crust formation. WHOI is providing samples and analyses of abyssal peridotites which are analyzed for Hf, Nd and Os-isotopic composition. We also participate in seagoing expeditions one has been to the mid-Atlantic Ridge, another is planned to the Marion Rise on the southwest Indian Ridge. Samples collected from these expeditions will be analalyzed at both the Magnet Lab and WHOI
(Magnet Lab contact: Vincent Salters, Geochemsitry Program)

INSTITUTE OF VERTEBRATE PALEONTOLOGY AND PALEOANTHROPOLOGY (IVPP) OF CHINESE ACADEMY OF SCIENCES, China

The collaboration between the IVPP and the Magnet Lab is related to the investigation of Late Cenozoic Vertebrate Paleontology and Paleoenvironments of the Tibetan Plateau

(China). Samples collected in this project are analyzed in the Geochemistry Laboratories in the Maglab.
(Magnet Lab contact: Yang Wang, Geochemistry Program)

LOS ANGELES COUNTY MUSEUM OF NATURAL HISTORY
Los Angeles, CA

The collaboration between the IVPP and the Magnet Lab is related to the investigation of Late Cenozoic Vertebrate Paleontology and Paleoenvironments of the Tibetan Plateau (China). Stable isotopic compositions of the samples collected in this project are analyzed in the Geochemistry Laboratories in the Maglab.
(Magnet Lab contact: Yang Wang, Geochemistry Program)

SOUTH FLORIDA WATER MANAGEMENT DISTRICT (SFWMD), West Palm, FL

The collaboration between the SFWMD and the Magnet Lab is related to the investigation of land-use and change on food web structure and mercury cycling in the Everglades. Isotopic compositions of the samples collected in this project were analyzed in the Geochemistry Laboratories in the Maglab.
(Magnet Lab contact: Yang Wang, Geochemistry Program)

Future Fuels Institute

The Future Fuels Institute (FFI) was established to enhance the existing Ion Cyclotron Resonance (ICR) Program at the NHMFL to deal specifically with biological and fossil fuels, particularly for heavy oils and synthetic crudes. Supported by sponsoring companies and collaborative entities (instrument companies, universities and research institutes), the FFI works to develop and advance novel techniques for research applications and problem solving. FFI is actively seeking up to 6 industrial collaborators as corporate MEMBERS to support core research programs. Each of these corporate members will be asked to provide $250,000/year for 4 years. The MEMBER may terminate the membership by giving the INSTITUTE 30 days written notice prior to the membership renewable date.

Current corporate members include:
ConocoPhillips
Petrobras
Reliance Industries

The institute also serves as a training center for fuel-related science and technology.
(MagLab contact/Director: Ryan Rodgers)

Private Businesses Spun Off From the MagLab

SPECIALIZED CRYSTAL PROCESSING, INC
Tallahassee, FL

Specialized Crystal Processing, Inc (SCPI) is an advanced materials processing, manufacturing and consultation spin-off of the National High Magnetic Field Laboratory. The SCPI home base facilities are in Innovation Park, Tallahassee, where a patent pending batch process is employed to produce specialized single crystalline materials like Europium (II) Oxide and Barium Oxytelluride. These crystals can be used for a variety of applications, including but not limited to high tech devices and sensors, advanced materials basic science research and crystalline additives for composite materials.
(MagLab contact: Jeffrey Whalen, Theo Siegrist)

HIGH PERFORMANCE MAGNETICS
Tallahassee, FL

High Performance Magnetics was founded in 2008 by Thomas Painter, an engineer at the National High Magnetic Field Laboratory. High Performance Magnetics designs, fabricates and tests advanced cable-in-conduit magnet components and has established a nearly half-mile long superconducting cable jacketing facility located at the Tallahassee Regional Airport. High Performance Magnetics is jacketing Toroidal Field Nb3Sn cable-in-conduit conductors for Oak Ridge National Laboratory as part of the United State's contribution to an international clean energy experiment, ITER, which is being built in France.
(MagLab contact: Tom Painter)

OMICS LLC
Tallahassee, FL

Omics LLC is a spinoff company that serves the data analysis and interpretation needs of the high resolution mass spectrometry market. It was formed 7 years ago and has grown over the years to address a wider analytical community.
(MagLab contact: Ryan Rodgers)

Data Management Plan
(Reprint of NHMFL Renewal Proposal 2013-2017)

The National High Magnetic Field Laboratory (NHMFL) user facilities serve a multi- and inter-disciplinary scientific research community. Users of NHMFL facilities are expected to promptly analyze and submit their data for publication, with authorship that accurately reflects the contributions of those involved, and including all scientific findings from experiments performed at the NHMFL.

The NHMFL Data Management Plan accommodates the specific environments and natures of data generated at each of its six user facilities: DC Magnets, Pulsed Magnets, High B/T, Ion Cyclotron Resonance, Electron Magnetic Resonance, and the Nuclear Magnetic Resonance/Magnetic Resonance Imaging (NMR/MRI) User Facilities located at three campuses: Florida State University, University of Florida and Los Alamos National Laboratory. The data management policy is driven by the needs of our user community and the standards of the relevant funding agencies. The policy is reviewed annually to stay current with user demands and changes in technology.

Data Types

NHMFL user data consists primarily of electronic records of measurements taken during a scheduled experiment. Data from a facility can be generated on either a facility computer system, a visiting user's laptop, or special data acquisition systems provided by a user. These electronic records may or may not exist on a facility computer during the course of an experiment.

All samples are considered to be under the control of the Principal Investigator (PI) and conforming to the requirements and standards under which the sample was generated. The NHMFL is able to temporarily store samples for experimenters at an NHMFL user facility as one of the services provided to the PI during an experimental project or for a period of time up to one year after the completion of an experiment. User samples are ultimately either returned to the PI or discarded with approval from the PI.

Data Standards

Standards for data vary as required by the experimental methods and equipment used: The most open standard for the DC Magnet facility is for ASCII text files in column format. High data rate experiments such as the Pulsed Field Facility necessitate the use of open-vendor-specified binary formats or custom file formats developed by NHMFL personnel. The ICR facility also stores data in an NHMFL-defined format as it develops new experimental protocols. For NMR experiments, data formats are dictated by the research equipment used, such as the vendor-specific format for NMR data collected by Bruker spectrometers. Data for the NMR/MRI imaging facility is in DICOM images for OSIRIX viewer. Data is made available to researchers through the use of the current picture archiving and communication systems (PACS) with dedicated computers on a local high speed network.

All NHMFL-developed formats are open. Specifications and software to read and analyze data in these formats is available to the scientific community for free or at nominal reproduction costs. These software tools are provided on laboratory web sites and software storage areas.

Meta data can be recorded with the raw data files at the option of the researchers. Other meta data is recorded in the users written notebooks, lap top files, or other media at the option of the PI. Management of the meta data associated with standard data files is exclusively the purview of the PI.

Data Access Policies

The laboratory will ensure that the NHMFL Data Management and Sharing Policy continues to be aligned with the policy applied to NSF single investigator grants, as the NHMFL user community consists primarily of researchers supported by traditional single investigator grants.

The control of raw data files and rights to the data are retained by the PI for the experiment. The PI has full control of the use of the data, including its publication in the refereed literature. The PI is responsible for adhering to the policies and procedures of their funding agency.

Data Archiving

Data collected and stored on an NHMFL facility computer system are backed-up to local hard drives, tape storage or other common backup media. Data archiving is primarily the responsibility of the PI at their home institutions, but archived user data are retained at the NHMFL facility for a period ranging from six months to two years after collection at the NHMFL. This retention policy is reviewed annually and may be revised at the request of our user community, or in response to the continually evolving capabilities and reduction in costs of data storage. Archived data will only be made available to individuals at the request of the PI of the project.

Data will be archived on CDs or other similarly permanent media and provided to the user. User data can be further transferred to any portable drive or computer deemed appropriate by the user. Users my request data transfer consistent local facility administration policies, e.g. via a hard copy, secure FTP or standard network protocols for copying files over a TCP-based network.

Data Re-use Policies

The NHMFL requires all NHMFL users to submit a one-page annual research report on each project for inclusion in the NHMFL Annual Report. These reports are available on the NHMFL web site and serve to illustrate the quantity, quality and breadth of research activities at the lab. Each year, thirty to forty of these reports are chosen as highlights to be published in a Special Issue of MagLab Reports, the NHMFL's quarterly magazine that is widely distributed to scientists, students, and granting agencies.

Data will not be reused nor any data-mining operations performed on past user data without permission of the PI. Once data are collected and provided to the user, it is solely the property of the PI. Any reuse of the data by the PI external to NHMFL is strictly at their discretion.

CHAPTER 3

User Facilities

User Program

Seven user facilities – DC Field, Pulsed Field, High B/T, NMR-MRI@FSU, NMR-MRI@UF (AMRIS), EMR, and ICR – each with exceptional instrumentation and highly qualified staff scientists and staff, comprise the Magnet Lab's User Program. In this chapter of the annual report, information is being presented about the proposal review process, user safety training, special user funding opportunities, and user committee report.

Proposal Review Process

Across all seven facilities, proposals for magnet time are submitted online (https://users.magnet.fsu.edu/) and reviewed in accordance with the NHMFL User Proposal Policy (https://users.magnet.fsu.edu/Documents/UserProposalPolicy.pdf).

In brief, each user facility has a User Proposal Review Committee (UPRC) comprising at least seven members, with more external members than internal. UPRC memberships are treated confidentially by the laboratory but are available for review by NSF and NHMFL advisory committees. Proposal reviews are conducted in strict confidence and are based on two criteria: (1) the scientific and/or technological merit of the proposed research and (2) the "broader impacts" of the proposed work. They are graded online according to a scale, ranging from "A" Proposal is high quality and magnet time must be given a high priority; to "C" Proposal is acceptable and magnet time should be granted at NHMFL discretion; to "F" – Proposal has little/no merit and magnet time should not be granted. The Facility Directors dovetail the UPRC recommendations with availability and scheduling of specific magnets, experimental instrumentation, and user support scientists and make recommendations for magnet time assignments to the NHMFL Director. The NHMFL Director is responsible for final decisions on scheduling of magnet time based on these recommendations.

TABLE 1

Magnet Lab Facility Usage Profile *for 2013*

	Total Days[1] Allocated (Utilized) /User Affil.	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Materials, Testing, Instruments	Biology, Biochemistry, Biophysics
NHMFL-Affiliated[2]	1768	387	418	22	199	742
Local[2]	1681	148	327	292	3	911
U.S. University	3465	1386	725	51	64	1239
U.S. Govt. Lab.	481	434	44	1	1	0
U.S. Industry	58	40	14	1	0	3
Non-U.S.	1129	740	214	35	35	105
Test, Calibration, Set-up, Maintenance[3]	1152	34	160	35	922	0
TOTAL	**9733**	**3169**	**1902**	**438**	**1224**	**3000**

1. User Units are defined as magnet days for four types of magnets. One magnet day is 7 hours in a water cooled resistive or hybrid magnet in Tallahassee. One magnet day is 12 hours in any pulsed magnet in Los Alamos and 24 hours in superconducting magnets in Tallahassee and the High B/T system in Gainesville. Magnet days for AMRIS instruments in Gainesville: Verticals (500, 600s, & 750 MHz), 1 magnet day = 24 hours (7 days/week); Horizontals (4.7, 11.1, and 3T), 1 magnet day = 8 hours (5 days/week).
2. Use by NHMFL-Affiliated and Local users as defined in Table 2, footnote 2.

In 2013, 1377 users from around the world conducted research at one of the seven user facilities. The Magnet Lab was extremely pleased to welcome requests for magnet time from 77 new principal investigators in 2013: 5 in the DC Field Facility; 10 in the Pulsed Field; 0 in the High B/T; 5 in NMR-MRI@FSU; 7 in NMR-MRI@UF (AMRIS); 19 in EMR; and 31 in ICR. 77 new PIs received magnet time during the year; 16 new PIs were scheduled for 2014 (see Appendix I, Table 7 for further information).

TABLE 2

Magnet Lab User Profile[1] *for 2013*

All Facilities	Users	Male	Female	Prefer not to respond to gender	Minority[1]	Non-Minority[1]	Prefer not to respond to race	NHMFL Affiliated Users[1]	Local Users[1]	University Users[2,4]	Industry Users[2,4]	National Lab Users[3,4]
Senior Personnel, U.S.	543	458	77	8	22	521	21	152	75	435	24	84
Senior Personnel, non-U.S.	206	181	21	4	22	184	13	5	4	154	6	46
Postdocs, U.S.	150	113	30	7	6	144	12	45	42	121	2	27
Postdocs, non-U.S.	39	31	8	0	6	33	3	4	4	32	0	7
Students[2], U.S.	311	228	78	5	19	292	21	44	91	307	0	4
Students[2], non-U.S.	99	75	21	3	6	93	7	0	20	93	0	6
Technician, U.S.	27	19	7	0	3	24	1	11	7	17	3	7
Technician, non-U.S.	2	2	1	0	1	2	0	1	0	1	0	1
TOTAL	**1377**	**1107**	**243**	**27**	**85**	**1293**	**78**	**262**	**243**	**1160**	**35**	**182**

1. The laboratory reports seven user facilities (DC Field, Pulsed Field, High B/T, NMR, AMRIS, ICR, EMR). A user is a member of a research group that is allocated magnet time. The user does not have to be "on site" for the experiment. Consequently, a researcher who sends samples for analysis; a scientist who uses new lab technologies to conduct experiments remotely; or a PI who sends students to the Magnet Lab, are all considered users.
2. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [*i.e.* on Web site/directory], even if they travel to another site.
Local users are defined as any non-NHMFL-affiliated researchers originating at any of the institutions in proximity to the MagLab sites (*i.e.* researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
· The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators."
3. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
4. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
5. Four columns of users (university, industry, national lab, non-U.S.) will equal the Total Number of Users.

At the end of each year, Magnet Lab users and faculty at FSU, UF and LANL submit brief abstracts of their experiments, research and scholarly endeavors. All reports are available online at: http://www.magnet.fsu.edu/usershub/publications/researchreportsonline.aspx
Users generated 440 research reports in 2013.

TABLE 3

2013 Research Reports *by Facility*

Facility	Number of Reports
DC Field Facility	127
Pulsed Field Facility	78
High B/T Facility	7
NMR-MRI@FSU	54
NMR-MRI@UF (AMRIS)	57
EMR Facility	45
ICR Facility	31
MagLab Departments & Related Groups	
Applied Superconductivity Center	12
Condensed Matter Theory /Experiment (FSU)	14
Magnet Science & Technology	13
UF Physics	2
TOTAL REPORTS	**440**

User Safety Training

Safety training, across all facilities, is an important component of the Lab's Integrated Safety Management.

DC Field Facility

Users of the DC Field Facility must complete the appropriate online safety training prior to being issued a badge and receiving access to the magnet cells. Since there are a wide variety of experiments performed at the MagLab, the online training system begins with an evaluation to determine the work the researcher is doing and what training modules are needed in order for the user to safely perform their work at the MagLab. When magnet time is awarded the safety training status of the researchers who are traveling to the MagLab is checked by the DC Field User Program Coordinator several weeks prior to their arrival. Any users who either have not taken the required training or whose training has expired are directed to the training website. (http://opswiki.magnet.fsu.edu/wiki/pages/u3k2v1W4/Safety.html) to take the appropriate training. Users who arrive at the lab without having completed the training are set up in one of our user offices so that they can complete the training and access the magnet cells.

During the user's magnet time they are assigned an in-house scientist as well as a technician in order to provide scientific and technical support as well as ensuring the experiment is performed in a safe manner. In addition, the control room operators monitor the magnet cells via cameras located in each cell. User operations on the 45 T hybrid magnet are also monitored directly by a hybrid operator who is present on the user platform while the hybrid magnet is in use.

Pulsed Field Facility

Users of the Pulsed Field Facility (PFF) are treated equally as full time employees at Los Alamos National Laboratory (LANL) with respect to hazardous work activities and authorization. All LANL workers are educated on a comprehensive approach towards safe work practices within the context of Integrated Safety Management at LANL before being authorized to perform hazardous work activities. The approach that LANL takes is based on "Human Performance Improvement" or HPI (available at: http://energy.gov/sites/prod/files/2013/06/f1/doe-hdbk-1028-2009_volume1.pdf). The use of engineering controls are preferred to keep workers safe and reduce the risk of a human based error whenever possible (example: door interlocks and "Kirk Keys" used to ensure safe equipment configuration in pulsed capacitor bank operations at the PFF). The knowledge of HPI practices and the approach to safety management is central to the safety aware work culture at the PFF and throughout LANL. All safety management is governed by LANL policies and procedures. All work performed at the PFF is categorized into one of three hazard classes (Low, Medium, or High). By default no Medium or High hazard work activities are permitted at the PFF unless needed and authorized.

All hazardous work that is categorized as Medium or High Hazard work activities (based on the LANL hazard categorization matrix found in the LANL Integrated Work Management policy P300 Hazard Grading Table Attachment B) require a written and approved work control process (called an Integrated Work Document or IWD) and documented work authorization by the Safety Responsible Line Manager (SRLM). All LANL workers (staff and users performing hazardous work) use an online system (called U-Train) to assign and track training and work authorization. All users are assigned one or two PFF Scientists to assist and support scheduled experiments. When users arrive they first complete a briefing by the assigned Scientist and the program specialist. The program specialist, based on the nature of the visit, then assigns any additional training to the user. Live training or on-line content is then completed by the user and tracked in U-Train. If hazardous work is to be performed by the user (e.g. operate the PFF User Capacitor Bank) the IWD is read, training is verified by the SRLM, and based on need and agreement with the Person In Charge of the IWD, the work authorization is granted by the SRLM (tracked in U-Train). At this time, PFF users may be authorized on work that is categorized as low or medium hazard work. All of the infrastructure and management support of the above work control process at LANL is provided by institutional support of programs.

High B/T Facility

When conducting an experiment, all members of the user group must observe all the safety precautions required by the National High Magnetic Field Laboratory and the University of Florida (see http://opswiki.magnet.fsu.edu/wiki/pages/u3k2v1W4/Safety.html).

After magnet time is scheduled and prior to carrying out an experiment, all members of the user group planning to participate in an experiment at the Facility must pass the safety training provided by the Tallahassee site of the National High Magnetic Field Laboratory. (see http://www.magnet.fsu.edu/usershub/safety/index.html).

Access to the High B/T Facility is limited to authorized personnel who will be provided with a key for entry. **All users must comply with the flowing safety instructions:**

1. No user may transfer cryogenic fluids.
2. No user may charge or discharge any magnets in the facility.
3. All undergraduate students must be accompanied by a supervising faculty or a staff member at all times.

NMR/MRI Facility at FSU

Internal Users

All of the NMR group members have become familiar with the ISM (Integrated Safety Management) principles. All of them attend the quarterly NHMFL Safety Meetings. A representative of the NMR group attends the monthly NHMFL Safety Committee meetings and reports on pertinent issues to the NMR group during its meetings.

NMR staff and faculty group meetings are conducted weekly. Every 6 weeks a meeting is dedicated to safety, safety issues and/or safety training. All members of the NMR group are required to complete and pass the NHMFL online safety training courses and, they are required to keep those trainings current.

External Users

Each external user prior to carrying out an experiment at the NMR Facility is required to pass the online safety training course(s) provided by the NHMFL (www.magnet.fsu.edu/usershub/safety/index.html). This is currently enforced by the NMR Administrative Assistant and/or CIMAR Coordinator, who will not issue a laboratory access card or any keys without all trainings being completed and passed.

Prior to an experiment, potential safety issues are discussed individually with each new user. During the actual experiments, users are accompanied/supervised by one of the NMR science staff. All non-routine or increased-risk operations, such as refilling the magnets with liquid helium, are performed by NMR staff rather than by the user.

NMR/MRI Facility at UF (AMRIS)

All internal and external users that will assist in data acquisition (*i.e.* anyone who will enter the facility without direct supervision of AMRIS personnel) are required to attend a one hour safety class as a first step to getting keyed access. In this class, safe operation in high magnetic fields, working with RF cables, and the principles of ISM are presented and discussed. Anyone working with animals is required to carry documentation of their IUCAC approved protocol when working with animals in the AMRIS facility. The UF IUCAC office oversees all animal related safety training and authorization of work with animals at UF, including for external users. Users wanting to work independently in the 11 T room (*i.e.* without an AMRIS staff person present) are required to demonstrate instrument proficiency to AMRIS personnel and to attend an additional hour of safety training specific to the 11 T system.

AMRIS personnel have weekly staff meetings and at each of these meetings we review whether there are any safety issues or training needing discussion. If so, time is dedicated to discussing any incidents or changes in training/operation and ensuring all AMRIS personnel are apprised of them. We also regularly update our web pages to reflect current safety policies. All AMRIS personnel are required to keep both the NHMFL and UF safety training current. Regular inspections of AMRIS facilities are performed by the UF office of Environmental Health & Safety as well as by the IUCAC. AMRIS personnel directly accompany all new users in the facility and regularly interact with experienced users to discuss any issues which might arise during their facility use. All non-routine, increased-risk operations, such as refilling the magnets with cryogens, are performed by trained AMRIS personnel. Any use of cryogens during experiments to cool samples requires additional training in safe handling of cryogens.

All access to the AMRIS facility is via RFID keys; these keys are monitored and regulated through the UF Police Department so we have a record of their use and can revoke access to an individual user at any point in time if needed.

Electron Magnetic Resonance Facility

Internal Users

All the EMR group members have become familiar with the ISM (Integrated Safety Management) principles. All of them also attend the quarterly NHMFL Safety Meetings. A representative of the EMR group attends the monthly NHMFL Safety Committee meetings and reports on pertinent issues to the EMR group during its meetings.

External Users

Each external user prior to carrying out an experiment at the EMR Facility is obliged to pass the on-line safety training course(s) provided by the NHMFL (www.magnet.fsu.edu/usershub/safety/index.html). This is currently enforced by the EMR Administrative Assistant, who will not issue a laboratory entrance card or any keys without proof of completion of the required course(s).

Prior to an experiment, potential safety issues are discussed individually with each new user. During the actual experiments, each user is accompanied/supervised by one of the EMR science staff. All non-routine or increased-risk operations such as refilling the magnets with liquid helium or sample changes are performed by the staff rather than the user.

Ion Cyclotron Resonance Facility

All internal ICR personnel and external users that will assist in data acquisition are required to select the labs that they will be working in prior to assignment of safety training. Safety training is assigned based on the working hazards that are within each lab space. For example, each person who will work in the ICR high bay is required to take the following safety training courses: cryogen safety, high magnetic field, general safety, laser safety and electrical safety. Additionally, no one is allowed to perform any cryogen fills or operate any instrument systems without extensive, supervised, hands-on safety training by an ICR staff member. All users that will be entering all ICR lab spaces are required to complete online safety training, but are assisted by an internal ICR group member for all sample preparation, instrument start up and shutdown, and data acquisition. All ICR magnet system usage is limited to trained ICR personnel. No external users are allowed to start up or shutdown ICR magnet systems. In addition, access to the ICR high bay is limited to only personnel that work within the NMR/ICR high bay area. All visitors are required to have an escort at all times, and everyone who enters any ICR lab space (C330, B239, B240, NM 113 and NM 117) are required to wear safety glasses with no exceptions. No food and drink is allowed in any ICR lab space except in designated areas that are marked with appropriate signs.

User Collaborations Grants Program

The National Science Foundation charged the National High Magnetic Field Laboratory with developing an internal grants program that utilizes the NHMFL facilities to carry out high quality research at the forefront of science and engineering and advances the facilities and their scientific and technical capabilities. User Collaboration Grants Program (UCGP), established in 1996, stimulates magnet and facility development and provides intellectual leadership for research in magnetic materials and phenomena.

The UCGP seeks to achieve these objectives by funding research projects of normally one- to two-year duration in the following categories:

- small, seeded collaborations between internal and/or external investigators that utilize their complementary expertise;
- bold but risky efforts that hold significant potential to extend the range and type of experiments; and
- initial seed support for new faculty and research staff, targeted to magnet laboratory enhancements.

The Program strongly encourages collaboration between NHMFL scientists and external users of NHMFL facilities. Projects are also encouraged to drive new or unique research, i.e., serve as seed money to develop initial data leading to external funding of a larger program. In accord with NSF policies, the NHMFL cannot fund clinical studies.

Seventeen (17) UCGP solicitations have now been completed with a total of 488 pre-proposals being submitted for review. Of the 488 proposals, 255 were selected to advance to the second phase of review, and 111 were funded (22.75% of the total number of submitted proposals).

TABLE 1

UCGP Proposal Solicitation Results *for 2012*

Research Area	Pre-Proposals Submitted	Pre-Proposals Proceeding to Full Proposal	Projects Funded
Condensed Matter Science	3	3	2
Biological & Chemical Sciences	10	8	2
Magnet & Magnet Materials Technology	1	1	0
TOTAL	**14**	**12**	**4**

2013 Solicitation and Awards

The 2013 solicitation was announced late in October, 2013. Owing to funding uncertainties, the solicitation was postponed from spring, which was when the solicitations of previous years were announced. We have now completed the pre-proposal phase. 24 proposals have been submitted, and as of this writing they are in the review/ranking stage. We expect to announce awards from the 2013 solicitation in June, 2014.

The NHMFL UCGP has been highly successful as a mechanism for supporting outstanding projects in the various areas of research pursued at the laboratory. Since 2001, the proposal submission and two-stage proposal review process has been handled by means of a web-based system.

Of the 14 pre-proposals received in 2012, the committee recommended that 12 pre-proposals be moved to the full proposal state. Of the 12 full proposals, 4 grants were awarded. A breakdown of the review results is presented in **Tables 1 and 2**.

2014 Solicitation

The 2014 Solicitation Announcement should be released on Oct 15, 2014. Awards will be announced by the middle of next year.

Results Reporting

To assess the success of the UCGP, reports were requested in December 2013, on grants issued from the solicitations held in the years 2007 through 2012, which had start dates respectively near the beginnings of years 2008 through 2013. At the time of the reporting, some of these grants were in progress, and some had been completed. For this "retrospective" reporting, PIs were asked to include external grants, NHMFL facilities enhancements, and publications that were generated by the UCGP. Since UCGP grants are intended to seed new research through high risk initial study or facility enhancements, principal investigators (PIs) were allowed and encouraged to report results that their UCGP grant had made possible, even if these were obtained after the term of the UCGP grant was complete.

The PIs reported:

- Lab enhancements which were used by 53 different external user groups.
- At least partial support for 7 undergraduate researchers, 34 grad students and 23 postdocs.
- 15 funded external grants which were seeded by results from UCGP awards. The total dollar value of the external grants was $9.3 M.
- 93 publications, many in high profile journals, as summarized in **Table 3**.

TABLE 2

UCGP Funded Projects *from 2012 Solicitation*

Principal Investigator	NHMFL Institution	Project Title	Funding
James Hamlin	UF	*In situ* Pressure Variation at Low Temperatures	$199,060
Dmitry Smirnov	NHMFL	High-field Raman Spectroscopy of Advanced Electronic Systems	$216,200
Stephen Hill	NHMFL	Integration of a Microwave Resonator and Diamond-Anvil Pressure Clamp for High-Field Cavity Perturbation Studies	$189,024
William Brey	NHMFL	High Temperature Superconductive NMR Probe for Metabolic Flux Studies in Single Animals	$200,710

TABLE 3

Publications Reported

2007-2012 UCGP Solicitations

Publication	Number of Articles
App. Phys. Lett.	2
Applied Supercond.	2
Biomacromolecules	1
Chem. Sci.	4
Chinese J. Magn. Resonance	1
Euro. Biophys. J.	1
Inorg. Chem.	2
Inst. of Phys. Conf. Series	8
J. Cryst. Growth	1
J. Low Temp. Phys.	5
J. Membrance Sci.	2
J. of American Chemical Society	4
J. of Materials Chemical	1
J. of Magnetic Resonance	7
J. Phys. Chem. Lett.	1
J. Phys. Condens. Mat.	2
Langmuir	1
Magnetic Reson. Imaging	1
Magnetic Reson. Med	7
Materials Science Forum	1
Nature	1
Nature Materials	1
Nature Physics	1
Nature Struct. Mol. Bio.	1
Neuro Image	3
Neurology	2
Phys. Rev. B	14
Phys. Rev. Lett	9
Physica C	1
PLOS1	2
PNAS	2
RSC Advances	1
Superconductor Sci. Technolgy	1
Proc,SPIE	1

Publications (including accepted for publication) as of December 2013, reported from UCGP grants.

Dependent Care Travel Grant Program

The Magnet Lab makes available small grants up to $800 per calendar year for qualified short-term, dependent-care expenses incurred by eligible recipients when traveling.

Eligible recipients are early career scientists, including undergraduate and graduate students, postdocs, and scientists with fewer than 10 years of active professional work since receiving a Ph.D. To be eligible, a scientist must be:

- An early career user traveling to a Magnet Lab facility in Tallahassee, Gainesville or Los Alamos to conduct an experiment as part of a user program (not including employees of Florida State University, the University of Florida or Los Alamos National Laboratory).
- A Magnet Lab early career scientist employed by any of the three Magnet Lab partner institutions who is selected to present results at scientific meetings, conferences or workshops.

A dependent is defined as 1) a child, newborn through 12 years of age (or any physically or mentally disabled child under the age of 18 who is unable to care for himself or herself), who resides with the applicant and for whom the applicant provides primary support, or 2) a disabled adult/elder (spouse, parent, parent-in-law, or grandparent) who spends at least eight hours per day in the applicant's home and for whom the applicant has responsibility.

The Dependent Care Travel Grant Program (DCTGP) is described in detail at http://magnet.fsu.edu/usershub/funding/travel.html.

There were no applications for the DCTGP awards in 2013.

First-Time User Support

The MagLab offers small grants for first-time users to provide travel support.

The MagLab is charged by the National Science Foundation with developing and maintaining facilities for magnet-related research that are open to all qualified scientists and engineers through a peer-reviewed proposal process. Facilities are generally available to users without cost. In an effort to encourage new research activities, first-time users are provided financial support for travel expenses. International users are provided $ 1,000 of support and domestic users are provided $500 of support for their travel costs. Support for this funding is provided by the State of Florida and is available for Tallahassee facilities only.

Visiting Scientist Program (VSP)

The National High Magnetic Field Laboratory provides researchers from academia, industry, and national laboratories the opportunity to utilize the unique, world-class facilities of the laboratory to conduct magnet-related research. In 2013, the Visiting Scientist Program provided a total of $112,881 financial support for 12 research projects on a competitive basis.

The primary intent of this program is to provide greater access to the unique facilities at the Magnet Lab and to seed research programs that help advance the laboratory. State funding is being used and principally intended to partially support travel and local expenses. Requests for stipends are considered but given a lower priority.

The amount of support generally ranges from a few thousand to $20,000. Beyond conducting the research as approved and maintaining fiscal integrity, the researcher has one additional responsibility, which is to provide the Magnet Lab with a progress report on request and a final report on their research to be included in the online version of the *NHMFL Annual Report*. **Participants in the NHMFL Visitors Program are expected to acknowledge support provided by the NHMFL in any publications coming from work during their visit or collaboration with the NHMFL.**

To apply for support from the Visiting Scientist Program, interested researchers are required to submit an application and a proposal that will be reviewed by appropriate facility directors and scientists at the NHMFL. All requests for support must be submitted online at https://vsp.magnet.fsu.edu/applications/submit/ at any time throughout the year.

User Advisory Committee Report

Report on the 2013 NHMFL User Advisory Committee meeting
Held in Gainesville from Thursday, Oct 17 – Saturday, Oct. 19, 2013

User committee members for 2014:

Chair
Ian Fisher, Department of Applied Physics, Stanford University

DC/Pulsed/High B/T Vice-Chair
Nicholas Curro, Department of Physics, UC Davis

NMR/MRI/ICR/EMR Vice-Chair
Robert Schurko, Departments of Chemistry and Biochemistry, University of Windsor

I. Jonathan Amster, University of Georgia
Dmitri Artemov, Johns Hopkins University
Steve Beu, S. C. Beu Consulting
Ari Borthakur, University of Pennsylvania
Kenneth Burch, University of Toronto
Joanna Collingwood, University of Warwick
Linda Columbus, University of Virginia
Myriam Cotton, Hamilton College
Nicholas Curro, University of California Davis
Ian Fisher, Stanford University
Nathanael Fortune, Smith College
Michael Greig, Pfizer Global R&D
Michael Harrington, Huntington Medical Research Institutes
Jeanie Lau, UC Riverside
Conggang Li, Wuhan Institute of Physics & Mathematics
Manish Mehta, Oberlin College
Gavin Morley, University of Warwick
David C. Muddiman, North Carolina State University
Cedomir Petrovic, Brookhaven National Laboratory
Tatyana Polenova, University of Delaware
Scott Prosser, University of Toronto
Marek Pruski, Ames Laboratory
Mark Rance, University of Cincinnati
Rob Schurko, University of Windsor
Stefan Stoll, University of Washington
Makariy Tanatar, Ames Lab
Joshua Telser, Roosevelt University
Fang Tian, Penn State University
Ivan Tkac, University of Minnesota
Evan Williams, UC Berkeley
Sergei Zvyagin, Dresden High Magnetic Field Laboratory

Committee members who served in 2013, and are now retiring:

Christoph Boehme, University of Utah
David Britt, UC Davis
Roy Goodrich, George Washington University
Janice Musfeldt, University of Tennessee-Knoxville
Oliver Portugall, Laboratoire National des Champs Magnétiques Intenses
Alexandra Stenson, University of South Alabama
(*Thank you for your service!*)

The User Committee thanks the NHMFL director, management, scientific staff and administrative assistants for their time, energy and hospitality in hosting the recent User Advisory Committee meeting in Gainesville. We also thank the lab management for accommodating the Committee's requests with respect to content and scheduling (both in advance of the meeting, and also on-the-fly during the meeting), which we felt lead to an especially productive meeting as a consequence.

The NHMFL continues to enable cutting edge, ground-breaking science with a user program that encompasses a truly impressive number of users. In 2012, the MagLab hosted experiments by more than 1350 users from 159 institutions across the United States, and a total of 277 institutions throughout the world. The statistics for 2013 are still accumulating, but look like they will equal or surpass those of 2012. On behalf of this enormous and vibrant user community, we sincerely thank the host institutions (UF, FSU & LANL), the NSF, and the State of Florida, for their continued support of the NHMFL.

1. Executive Summary

At the User Advisory Committee Meeting, several issues were discussed that affected the broad user base, as well as topics specific to individual labs or programs. The following bullet points summarize some of the major themes, which are discussed in greater detail in the remainder of the report.

Safety

The committee is entirely satisfied with the safety procedures and training at the NHMFL with respect to the user program. We discussed several additional ideas that we recommend be implemented to ensure that users have additional opportunities to ask safety questions while in their experimental cells and enhance feedback following the completion of their experiments.

Leadership for the CMP program / DC Director Search

Building on our recommendation from last year, the committee continues to strongly recommend that the lab partner with FSU to identify funds and a faculty line to attract a faculty scholar of international standing to fulfill the role of chief scientific officer for CMP. This is a different position to the ongoing search for a director/manager of the day-to-day running of the DC program.

Acknowledging user support in performance reviews

The committee felt very strongly that user support needs to be formally recognized and rewarded at the time of staff performance reviews and promotions uniformly across the lab, and that this be implemented by all of the host institutions.

NAS Report

In response to its specific charge, the NAS Committee to Assess the Current Status and Future Direction of High Magnetic Field Science in the United States recently published its findings and recommendations in a report entitled "High Magnetic Field Science and Its Application in the United States: Current Status and Future Directions". This comprehensive report provides a vision for the development of challenging magnet technologies far in to the future, and describes many of the associated scientific drivers. The charge of the NAS committee did not, however, include a determination of the user priorities for a national high field facility. In order to complement the vision expressed in the report, we provide a broad description of user priorities for a national high magnetic field facility. We emphasize that the current NHMFL meets all of these criteria. We also note that assessing the technical feasibility of any of the magnets proposed in the NAS report requires a deep appreciation of magnet technology, and we strongly recommend that experts on magnet technology/engineering be asked to participate in any future proposal review.

Housing in Tallahassee

The committee expressed the user priorities of access to safe, convenient and affordable accommodation. As a long term solution, we proposed working with FSU and Innovation Park to build the case for a guest house on the Innovation Park site at which University, Maglab, and Innovation Park visitors would be able to stay. As a short term solution, in so far as it is feasible, we recommend funds be allocated to partially offset the cost of users staying at local hotels (*i.e.* contributing towards the difference in cost between the condo, which has been let go, and local hotels).

Training

Finally, we commend the lab for continuing to run their highly successful summer school. We urge the lab to continue hosting this superb training event, which acts to draw new users to the lab, advertise the range of available experiments and facilities, and educate students and post-docs from a broad range of backgrounds.

2. Report on issues affecting the broad user community

The following (somewhat unpolished) bullet points are copied directly from the text used at the out-brief session at the end of the user meeting, in which the committee presented its suggestions to representatives from the host institutions as well as NHMFL management and program/facility directors.

2.1 Safety

- The User Committee expresses satisfaction with safety training & precautions for the user program. (In particular, we note that no major events have occurred that have involved the users.)
- We recommend the lab institutes the following minor measures in addition to the established safety training and protocols: (a) brief conversation with users in the cell on the first day of magnet time (does the user have any specific safety questions now that they are in the cell?) – in parallel with the usual technical questions at the start of magnet time; (b) brief conversation after magnet time finishes (does the user have any specific suggestions/recommendations for improving safety based on the week's experience); (c) explicitly include safety query as part of debrief email after magnet time, and link to safety comment website.

2.2 Intellectual leadership for the CMP program

- The CMP program broadly construed has historically been the flagship for the lab (largely within the DC program).
- It is crucial for the lab's success going in to the recompetition that there is a strong intellectual leader for the CMP program to articulate the scientific vision & opportunities.
- We strongly encourage the lab, in partnership with the host universities, to raise to the *highest priority* finding the resources and faculty line for a senior CMP faculty hire who would play the role of Chief Scientific Officer for CMP (defacto intellectual director for the DC/PFF programs). Should be widely publicized and made attractive to the very best in the field.
- This is a separate/different role to the current DC Director search, but just as important.

2.3 Housing in Tallahassee

- User priorities: access to convenient, safe and affordable accommodation.
- Many users have enjoyed access to the condo; at the same time, we understand the driving forces that have led to letting it go.
- No strong support for continued access to the Alumni Village (primary concern safety).
- **Long term**, a guest house in the Innovation Park could be an ideal solution (addressing both convenience and safety), and we strongly encourage any partnership between FSU and Innovation Park that might lead to such an outcome. We note that this is not a recommendation for the Maglab to have its own guesthouse, but rather to partner with the community in Innovation Park to attract a facility that serves a broader community, including MagLab users/visitors.

- **Short term**, the broad consensus is that it would be valuable to the user community if the lab could partially support/offset hotel costs (partially addressing the difference in cost between the old condo and more expensive hotels). Could be used as a method to encourage new users. We can help work out a sensible way to configure this depending on the level of support that is feasible (flat rate; scaled in some way with amount of magnet time received, etc).

2.4 Comment/discussion on the NAS "MagSci" Report

- We note, and add our voices to, the high level of praise voiced for the NHMFL in providing world-class facilities, enabling world-class science, and driving new magnet technologies.
- We strongly endorse the main finding and recommendation of the report; that the highest priority is to providing continued support for a centralized facility.
- The report clearly contains a vision of exciting but technologically challenging magnets, with a commensurate cost.
- Assessing the technical feasibility of any of these magnets requires a deep appreciation of magnet technology, and we strongly encourage that experts on magnet technology/engineering be asked to participate in any future proposal review.
- We also note that the committee that drafted the report were charged to address three specific questions:
  1. What is the current state of high-field magnet science, engineering, and technology in the United States, and are there any conspicuous needs to be addressed?
  2. What are the current science drivers and which scientific opportunities and challenges can be anticipated over the next ten years?
  3. What are the principal existing and planned high magnetic field facilities outside of the United States, what roles have U.S. high field magnet development efforts played in developing those facilities, and what potentials exist for further international collaboration in this area?
- We aim to provide in our report a balancing set of statements that convey <u>user priorities</u> for any national magnet facility. For our community these are perhaps statements of the obvious, but our concern is that if we don't make these statements we potentially risk having the bold vision of the Magsci report dominating any future conversation about perceived user needs. We note that the current NHMFL is delivering on *all* of these user priorities. Any national field facility should…

(1) Provide access to high-field magnets
– huge demand for continued access to existing magnet systems: "work horses" that enable cutting edge science (i.e. exciting new science is still being done on existing magnets)
– commensurate ongoing need for instrumentation, and instrument/technique development
– users require a transparent and fair proposal review procedure

(2) Provide a high level of user support and training
– provide expert technical advice for planning and implementing experiments.
– provide clear avenues for instrument development in collaboration with Maglab scientific staff & in cooperation with external grants.
– provide training for new users and our students/post-docs (summer/winter schools are excellent; repository for good low-temperature practices in a time of off-the-shelf cryogenics!)
– **user support needs to be formally recognized and rewarded at time of staff performance reviews and promotions** (See comment in Executive Summary)

(3) In house science
– beyond the implicit intellectual outcomes, a strong in-house science program drives a vibrant intellectual community (attractive to visitors), drives technique development (enables new tools and techniques for all users), and publicizes the sort of science that can be done at the lab (effectively reaching out to new users).
– needs to be balanced with user support.

(4) Develop new magnet technologies in consultation with the user community.
– new science is enabled by new technologies, as envisioned/articulated in the magsci report
– the report describes several very ambitious proposals for new magnet technologies, which could open new research avenues and/or vastly change the landscape of research in existing field regimes. To develop all of these systems simultaneously is likely infeasible, and we therefore strongly recommend that any decisions to invest in these directions be taken in consultation with the user community in order to maximize the research benefit associated with the initial investment.
– development of appropriate instrumentation in parallel with the new magnet technologies.

- In our considered opinion, the current NHMFL is delivering on all 4 of these requirements for a national high field user facility.

3. Report on DC, Pulsed Field & High B/T facilities:

Contributors to the DC – Pulsed Field – High B/T Report:
Nicholas Curro (UC Davis; UC; vice chair for DC/Pulsed/High B/T),
Kenneth Burch (University of Toronto),
Jason Cooley (Los Alamos National Laboratory),
Ian Fisher (Stanford University),
Nathanael Fortune (Smith College),
Jeanie Lau (UC Riverside),
Janice Musfeldt (UT Knoxville),
Makariy Tanatar (Ames Laboratory),
Chris Wiebe (University of Winnepeg),
Cedomir Petrovic (Brookhaven National Laboratory),
and Oliver Portugall (Laboratoire National des Champs Magnétiques Intenses, CNRS).

Overall the user committee for the DC/Pulse Field/High B/T facilities found that the NHMFL continues to do an excellent job to support the broad user base for these unique facilities. The upcoming commissioning of the series connected hybrid will enable a new generation of experiments beyond the current frontier, and the committee commends the leadership for their continued work bringing this new capability online. Furthermore, we enthusiastically support the development of the 32 T superconducting magnet scheduled for the third quarter of 2015, which will exploit new technology to achieve high fields at a fraction of the electrical cost of the traditional Bitter magnets. We also encourage the lab to continue planning for a 42 T 28 MW DC magnet, which would provide a second DC magnet above 40 T, with the added advantage over the existing hybrid magnet that it can easily go to zero field, and reverse field.

As discussed in earlier statements, the committee expressed satisfaction with the changes made to the safety training. The anonymous email server (*safemag*) for addressing safety concerns has clearly engaged the entire community of users, staff scientists, and technicians. The committee feels that the safety needs of the **users** are being adequately met. In fact, the safety training and practices that have been put in place at the magnet lab have provided inspiration for similar efforts at various users' home campuses.

A serious challenge that the magnet lab will be facing in coming years is the ever-decreasing supply of helium. The lab leadership continues to address this issue with commendable foresight. The upgrades to the recovery system at the DC field facility are a clear improvement and will provide security against the types of shortages that have been devastating to other institutions in recent years. We are also encouraged by the efforts underway at the pulsed field facility at Los Alamos to implement similar recovery systems, and express our recommendation that the LANL management team support these efforts via any necessary infrastructure upgrades.

The new developments at the High B/T facility include Mössbauer capabilities and new low-temperature preamplifiers. We recognize the need to utilize the remaining Bay 1 system in order to increase user access to these unique facilities and reduce the long wait times after proposal submission. **Future user committees should comprise an increased representation by high B/T users.**

We commend the lab leadership for their careful consideration of balancing the need to invest in new technologies *versus* maintenance of current facilities. The development of the 25 T superconducting magnet for the Helmholtz-Zentrum Berlin facility for neutron scattering is an excellent example of how new experiments will be enabled by the phenomenal magnet design team at the NHMFL. We encourage the lab leadership to continue to think as broadly as possible to not only continue to push the frontier of high magnetic fields, but also to enable new technologies at the currently available fields. This can be done by expanding the range of measurements — for example, pulsed-field NMR and high resolution optical scanning — and by upgrades to the facilities — such as the proposed Quantum Limit Lab — that would provide improvements in electrical, magnetic, and vibrational stability and signal to noise at these fields. The coupling of these high-risk/high-return investments with steady improvements in measurement performance and capability at existing fields will help the magnet lab to maintain its leadership role in the international scientific community.

Finally, one specific issue that emerged in conversations was the need for quality of user support by NHMFL staff members to be emphasized with *equal weight* by all of the NHMFL sites. The committee felt very strongly that strength of user support needs to be formally recognized, recorded, and rewarded at the time of staff performance reviews and promotions uniformly across the lab, and that this be implemented by *all of the host institutions.*

4. Report on the Magnetic Resonance Division

Sections: (I.) NMR, (II.) EPR and (III.) ICR

I. Nuclear Magnetic Resonance

Contributors to the NMR section of this report:

Robert Schurko (University of Windsor, UC Chair, MR division)
Linda Columbus (University of Virginia)
Michael Harrington (Huntington Medical Research Institute)
Manish Mehta (Oberlin College)

1. OVERVIEW

The NMR Users' Committee (NMRUC) is happy to report that we are pleased with progress at the NHMFL over the last year. There are significant advances in fundamental and applied research, continued development of new technologies, and expansion of the user base into an increasingly wider set of sub-disciplines. The promise of the launch of the 36 T Series-Connected Hybrid (SCH) NMR system in 2015 was the focus of a workshop prior to the meeting – this system has the potential to make enormous impacts in NMR research on biomolecules, materials and small molecules, as well as in magnetic resonance imaging. The continued development of the DNP research instrumentation and programs (dissolution, *in vivo* and solids) is impressive, and the impact of Lucio Frydman and co-workers is extraordinary. Older spectrometers have been repurposed for new applications, and construction of a plethora of different probes is enduring. A wide range of research areas are again being supported, including chemistry, biochemistry and materials science, and target research areas in biostructural characterization, pharmaceuticals, metabolomics, energy (batteries and fuel cells), and magnetic resonance imaging. Again, there are concerns about budget constraints and their influence on user programs, technical staff and support/acquisition of instrumentation. However, given the sustained improvements and advancements being made at the NHMFL facilities, it is still apparent that there is a bright future ahead for this facility, and that numerous scientific breakthroughs will continue to be made in the coming years.

2. PERSONNEL

Despite some turnover, the NMRUC notes that the overall stability in staffing in the NMR/EMR section of the lab has led to reliable operation for the external users. We are particularly delighted to see greater cooperation between the staff at UF and FSU, spurred by the DNP initiative. The efficient partitioning of resources and enhanced communication between these two sites strengthens the program and benefits the end user.

The appointment of Lucio Frydman as chief scientist has proven successful on several fronts. The departure of Rafael Brüschweiler from FSU, however, has created a vacancy that needs to be filled. The Committee encourages the NHMFL management team to work with FSU officials to appoint a replacement without delay.

The appointment of three staff scientists (Malathy Elumalai, Sungsool Wi and Srinivasan Shekar) is working out well. Two additional staff scientists (Ilya Litvak in probe engineering and another in DNP) are currently being supported by external grants (so-called soft money). These are important positions that complement existing expertise at the Mag Lab, and, as such, a way should be found to retain them in the long run. It is anticipated that the new Southeast Center for Integrated Metabolomics (SECIM), spearheaded by Arthur Edison, will result in a cluster of faculty hires. We note that Joanna Long has been appointed as a new co-PI at UF, while Art Edison will have more focus on activities at the SECIM. A new initiative in brain MRI is expected to result in a similar cluster of hires at UF. These additional faculty lines may place new demands on staffing at the AMRIS facility and other parts of the Mag Lab, to which careful thought should be given. It is our impression that growth areas (DNP, imaging, SCH, metabolomics) are creating new pressure points at the staffing level. This issue is compounded by aging instrumentation, as the MagLab is passing its second decade of operation: the staff is dividing their time between servicing existing and innovating new hardware. For example, the production queues for the probe development team have now lengthened to over a year. The NMRUC encourages the NHMFL management team to incorporate sustainable staffing into its overall growth model of the Mag Lab. In general, the NMRUC is pleased with the level and quality of support the staff are providing for the Lab's external users.

3. INFRASTRUCTURE & SAFETY

3.1 Current instruments and facility

The current instrumentation is serving the user community well with many instruments near 100% usage (*e.g.* 750 MHz). The space has accommodated the two new DNP (one at each site) magnets well. The low E and HST probes have facilitated exciting new research. The synergies between Tallahassee and Gainesville groups, as well as between the NMR and EMR groups) has significantly advanced the facilities and research conducted. The repurposing of equipment and purchasing of used equipment (*e.g.* magnets) to gain more capabilities was very successful for the 800 MHz instrument and the dissolution DNP and should be continued as a model.

3.2 Development/acquisition of new instrumentation.

User access for the dissolution DNP instrument will be on-line in the coming months for magnetic resonance experiments and within the year for imaging. The SCH development is promising and exciting with users already designing probes and collaborating with staff to begin test measurements as soon as the instrument is available. The HTS probe development is essential for the metabolomics work as well as many solution applications. The infrastructure needed for these developing technologies is in place to facilitate usage.

3.3 Facilitating future research and development

Staff needs support in focusing their expertise towards development and interactions with users rather than maintenance. In-house fabrication and outsourcing should be reassessed. For instance, reliable stator sources are lacking and the purchases of a mill would enable the facility to make their own. Alternatively, certain other fabrications can be outsourced if the manufacturer is reliable and the cost feasible. There should be a mechanism for recommendations and evaluation of current procedures (what should/can be home built and what can be standardized and outsourced) driven by staff and user input in order to have these operations assessed on a regular basis.

3.4 Access and expanding the user base

Remote access has been implemented for many of the spectrometers enabling even more user access and reducing costs for users. Remote access should continue to be a priority for increased access to the facility. Creative recruitment of users should be pursued; such as **organization of workshops** at society meetings profiling user results and low cost targeted public relations for the facility.

3.5 Facility management

There is a need to begin to think about satellite instruments to increase access and users. The remote capabilities on instruments do not need to be duplicated as satellite instruments; however, there may be synergies with existing laboratories that can handle the maintenance of non-commercial instruments (or probes) at other geographical locations. Planning and discussions about these possibilities should begin. The NMR and MRI staff has made significant efforts to obtain supplemental funds for the purchase of equipment and personnel support. These efforts and collaborations should be incentivized and continue with the user community and serve as a model for the other user groups.

3.6 Partnerships

Currently, there are productive active partnerships with Agilent, Bruker, Revolution, and JEOL. Industrial and academic partnerships are very important and should continue to be a priority.

3.7 Safety

The safety training and on-site training are sufficient and adequate for the safety of NMR/MRI users. The accessibility to materials online is improved from past years and will continue to bring awareness to the user community.

4. TECHNOLOGICAL ACCOMPLISHMENTS AND FUTURE DIRECTIONS

4.1 HTS Probes

The repair and continued development of the HTS probes is exciting and crucial for the solution NMR and specifically in supporting the new metabolomics center. The increase in sensitivity gained with the use of these probes is very important to the NMR community. These applications and probe development should be continued. The 2012 1.5 mm HTS probe optimized for ^{13}C detection is extremely important to the metabolomics and biomolecular user group. An area of development may be for a LC/MS/NMR flow probe for metabolomics.

4.2 900 MHz Imaging Spectrometer

Use of the unique 21.1 T, 900 MHz imaging spectrometer (Tallahassee) has continued to accomplish "firsts", such as ultrafast spatiotemporally encoded imaging sequences of a stroke rat model, and "functional" imaging *in vivo* of rat brain sodium-23 and chloride-35. Continued access to this imaging spectrometer is encouraged for the MRI field to take advantage of the increased SNR for protons and other biologically informative nuclei. The AMRIS group (Gainesville) is adapting the 17.6T, 750 MHz vertical system for rodent imaging. Initial experiments with an excised rat brain imaged overnight at 150, 150, 300 microns, interpolated to 75, 75, 75 microns, demonstrated the potential to examine white fiber tracts in the hippocampus, thalamus, and surrounding cortex. Coil development is underway for *in vivo* imaging.

4.3 Magnetic Resonance Imaging Probes

Probe development for both Tallahassee and Gainesville imaging spectrometers involves active collaboration with the expertise of the two centers. The AMRIS-centered group has utilized 3D printing technology, some in collaboration with the UF Architecture School, to produce rat and mouse birdcage coils based on the designs of the sliding ring volume birdcage probes designed originally in Tallahassee for the 21 T system. Proton linear, circular, and dual $^{1}H/^{13}C$ linear birdcage coils are in development and user access is predicted for the summer of 2014. Modifications for other nuclei for user projects, such as for ^{23}Na resonance, can be readily implemented on these probes

4.4 MAS and static probes

Further development of MAS and static probes are needed for the 830 and 900 MHz NMR spectrometers. The NMRUC recommends that (almost) all new probes should be double resonance (H/F-X) at a minimum, and tunable over a broad range of frequencies on the X channel, except for probes designed specifically for $^{13}C/^{15}N$ applications. In particular, probes with larger coil sizes should be able to access frequencies well below that of ^{15}N (*i.e.*, so-called low-gamma probe frequencies), to enable access to a wide range of low-gamma nuclides. The H/F channel is necessary for providing a source of decoupling, and to enable cross polarization experiments, both of which are crucial for most multinuclear SSNMR studies conducted at high field. Single-resonance probes (*i.e.*, X-channel only) are of limited use by comparison, since proton decoupling is necessary for most experiments involving CPMG echo trains; as well, new broadband CP techniques cannot be applied without a proton channel.

The NMRUC was happy to hear of the development and use of several new probes, and the proposal for future probes including:

- Low *E* 3.2 mm MAS probes, spinning speeds of 18-22 kHz, good for $^{13}C/^{15}N$ applications, available up to 900 MHz
- A fast MAS probe must be developed for the 36 T SCH; this will require even higher spinning speeds, which are important for J-based 2D correlation experiments, ^{1}H detection in HMQC-type experiments, and of course narrowing of lines in ^{1}H NMR spectra and increasing the efficiency of homonuclear dipolar coupling.
- Low *E*, 1.6-2.0 mm fast-MAS probe for $^{13}C/^{15}N$ applications; spinning speeds of 70-110 kHz for high-resolution ^{1}H NMR applications

5. SERIES CONNECTED HYBRID

The challenges surrounding the anticipated 36T Series Connected Hybrid magnet, as well as potential research innovations, were discussed at a one-day workshop on October 17, 2013. The 36 T SCH (40 mm bore, 1 ppm field inhomogeneity) should be operational in 2015. Continued innovations in stability, induction field regulation and water-cooled shims, continue to be developed. Major concerns were expressed over getting the field homogeneity of the magnet as low as possible, to permit studies of organic and biomolecules; high resolution is extremely important.

5.1 Applications to Materials Science and Unreceptive Nuclides

The SCH magnet is ideal for the development of ultra-wideline (UW) NMR techniques, and the study of a wide-range of unreceptive nuclides that were previously thought to be inaccessible to routine NMR experimentation. There are growing communities of NMR spectroscopists in the U.S., Canada and Europe who are increasingly using these techniques, and would certainly be interested in access to the 36 T SCH system for such experiments. Unreceptive nuclides constitute a large proportion of the periodic table, and are so-called due to their low gyromagnetic ratios, low natural abundances (or dilution in samples of interest), anisotropically broadened patterns, unfavourable relaxation characteristics, or some combination of all of these properties. UW NMR, which generally refers to acquisition of SSNMR powder patterns with breadths of 250 kHz or greater, is well suited for the 36 T SCH magnet, as there are no real concerns with resolution. Zhehong Gan and Ivan Hung have already demonstrated the usefulness of the 25 T resistive Keck magnet for the acquisition of broad powder patterns (*SSNMR* **2009**, 36,159–163).

The 36 T SCH magnet and spectrometer should enable acquisition of SSNMR spectra of nuclides that have either sparingly or never been observed before, including those with very large nuclear quadrupole moments and/or low gyromagnetic ratios, (*e.g.*, $^{79/81}Br$, ^{105}Pd, ^{127}I, ^{197}Au), and certain spin-1/2 nuclides with low n.a., low Larmor frequencies and broad patterns arising from CSA (*e.g.*, ^{57}Fe, ^{103}Rh, etc.). The 36 T SCH magnet also serves to narrow the central transitions of the SSNMR spectra of the half-integer quadrupolar nuclei, which leads to further enhancement of S/N. UW NMR techniques have permitted the study of many new NMR nuclides in solid materials – but the 36 T SCH will increase the rapidity with which spectra can be acquired, reduce experimental time frames, and enable the study of unreceptive nuclides which have been diluted (*e.g.*, molecules grafted to surfaces, metal centers in biomolecules, etc.).

The sheer variety of materials and nuclides that will be opened to study by the 36 T SCH spectrometer is stunning. This spectrometer will be of great interest to many of the NMR researchers who develop and apply UW NMR methods, and will be very attractive to materials, inorganic and organometallic chemists.

5.2 Applications to Biosolids

From the standpoint of the end user interested in conducting NMR experiments on biosolids, the main challenge will be to squeeze in full data collection in the approximately 8-10 hours the magnet will be in operation during a typical run. Given the magnet's design parameters and its hourly operational cost, the first round of experiments will necessarily be those that are relatively short and do not require high field homogeneity (1 ppm). Samples with short relaxation times may prove ideal for the first round of experiments. For bio-solids, samples that demand maximum spectral dispersion will be good candidates. A complement of six probes is in the design and planning stages, including four MAS probes, a static probe, and a dielectric resonator for MR microscopy. The NMRUC encourages the planners to assure that one of the MAS probes has a standard triple-resonance configuration, capable of spinning samples to at least 40 kHz. At the SCH workshop, the possibility of removing the DC insert was discussed. This would make available an approximately 80 mm bore within the 30 T outer magnet, which would allow RT shims to be inserted in its place, much as in a traditional 89 mm wide bore NMR magnet. Members of the NMRUC in attendance were encouraged by this prospect and thus encourage the magnet design team to keep this possibility on the table. The magnet design team has already done an impressive amount of work toward field stabilization, shimming, console, and safety.

With improvement of stability, the areas of 2D spectroscopy, heteronuclear experiments, analysis of complex solutions (*e.g.* metabolomics), and field-induced alignment should be explored to determine the feasibility and applications with biomolecules. Progress towards these applications is already in progress with groups designing probes, developing instrumentation to deal with temporal field fluctuations and other necessary technologies. These efforts should continue and develop along with user needs.

5.3 Applications to Imaging

The NMRUC was very excited with the progress made with the SCH and request that the MagLab consider feasibility and cost of adding a larger bore for the SCH than that currently envisaged to enable *in vivo* rodent imaging at higher field strengths than current in the 21 T system. Requirements would be to achieve 1 ppm homogeneity over a 35-mm diameter sphere in the SCH at 30 T. To achieve this, an additional resistive coil set may need an inner diameter of ~80mm and achieve 50 ppm at 30 T. Users have interest in working with the MagLab to generate additional funds towards costs for this development. Considering this SCH modification would add value for the recommended longer term design and feasibility study to construct a 20 T, wide-bore (65 cm diameter) magnet suitable for large animal and human subject research, for which the required homogeneity is 1 ppm or better over a 16 cm diameter sphere.

6. DYNAMIC NUCLEAR POLARIZATION (DNP) NMR

The NMRUC is very pleased with the continued commitment to the development of DNP NMR. This plan recognizes the great potential of DNP in enhancing NMR's sensitivity and the need of further foundational research in this area. The DNP effect was predicted theoretically, demonstrated experimentally and brought to recent prominence in the American universities by A. W. Overhauser, C. P. Slichter and R. G. Griffin, among others. However, as pointed out last year, the United States currently lags behind Europe in this area in view of significant investments made recently in Germany, Switzerland, France and the Netherlands. The increasing number of DNP NMR workshops in the US and Europe, and the growing number of publications describing applications of DNP NMR to wide range of materials, continue to illustrate the pressing demand for user access to DNP instrumentation. There must be a continued pledge for further development of DNP instrumentation and methodology in the United States – and the MagLab is the place that this should occur.

Last year, the future of developing DNP NMR looked bright, due to the hiring of Lucio Frydman, and the proposal of three new DNP initiatives: (i) shuttled DNP NMR at low temperature, (ii) DNP MAS NMR for solids, and (iii) pulse DNP NMR (Overhauser NMR) at room temperature.

6.1 Dissolution and *in vivo* DNP NMR

Interesting advances in dissolution and *in vivo* DNP are being made that really distinguishes the instrumentation at NHMFL from the commercial Hypersense DNP equipment.

The NHMFL dissolution DNP polarizer operates at 1.2 K, requires 1 to 2 L of liquid He, has a 140 GHz MW source, operates with a 5 T/89 mm bore magnet, and has a 2.8 GHz SW (considerably larger than the Hypersense). Importantly, the increased SW does not affect the choice of polarization radical; rather than using tritylOX063, which is expensive and proprietary, it is possible to use radicals like 4-oxo-TEMPO. The instrument also boasts a 92% liquid He recovery level, which is impressive. Transfer of samples can be made to any NMR or MRI spectrometer (though there are some problems with the stray fields of the latter that have to be resolved). The NMRUC is impressed by the versatility in terms of radical choice, higher S/N enhancements at higher fields (and lower temperatures), the absence of sample heating at optimal microwave powers, and the potential for ^{13}C MRI imaging. There is also much interested in future prospects involving optimization of polarization parameters for narrow line radicals, injection time minimization and the introduction of NMR and MRI animal studies.

6.2 MAS DNP NMR and Overhauser DNP NMR

As discussed last year, a single gyrotron source will service both the MAS DNP (solids) and Overhauser DNP (liquids) NMR spectrometers. An existing console was used to jump start this program, and progress has been made in developing both of these areas. The system will feature a 600 MHz magnet and a 395 GHz gyrotron source. An NIH application has been put in for a field-swept magnet, which is essential for the successful operation of these systems. In addition, a high-volume, liquid nitrogen MAS NMR system has been ordered for solids experimentation. The development of low-E, high power, 80-100 K DNP MAS probe and the necessary cryogenic system is an essential resource for many users with interests in studying low-gamma nuclei in materials science, battery materials, catalysts, etc.

The NMRUC was also interested to hear of new developments in the area of Overhauser DNP NMR, in particular, for observing molecules that are tumbling in super-critical fluids (*e.g.*, CO_2). The correlation times for such rotations are proportional to viscosity; hence, in the non-viscous SCFs, the correlation times can be very low, and accordingly, line widths very narrow. A high-pressure probe with a 5 mm ZrO_2 cell is currently under construction. This system will permit the studies of proteins in reverse micelles, a variety of large molecules in SCFs, and even the nature of the super-critical phases themselves.

Finally, the NMRUC is also impressed by the large number of collaborators that were involved in the proposal for the 600 MHz instrument; this list features a veritable "who's who" of biological solids NMR. The NMRUC was also impressed with the list of potential future projects, including applications in metabolomics, SCF chromatography, study of protein aggregation, and identification of natural products and active pharmaceutical ingredients. There is also great potential for collaborations with the materials and solid-state chemistry communities, especially for study of small molecules that are absorbed or adsorbed on porous support materials (*e.g.*, heterogeneous catalysts).

7. SUMMARY: DIVERSITY OF PROJECTS AND DISCIPLINES

The NMRUC is impressed with the wide range of projects covering numerous disciplines, including:
- Biosolids
- Structural characterization of biomolecules in solutions
- Materials science, inorganic chemistry, solids-state chemistry
- Energy-targeted research (batteries, fuel cells, etc.)
- Metabolomics
- Magnetic resonance imaging (MRI, fMRI, MRS, physiological/ medical studies, etc.)

Equally important are the developmental projects that will help make great strides in all of the aforementioned research areas:
- DNP NMR (dissolution, *in vivo* and MAS for solids)
- Development of the 36 T SCH magnet, console and probes
- 900 MHz MRI spectrometer
- HTS probes
- New probes for MAS and static solids experiments at ultra-high fields

It was also very impressive to see that major research proposals involving MagLab personnel have been submitted to or supported by federal granting agencies, including:
- High-end instrumentation for a rampable 600 MHz NMR spectrometer and associated cryogenics – $1.2 M
- Membrane proteins for mycobacteria tuberculosis (PI's: Cross and Opella) – $9.7 M
- R21 proposal for HTS/LTS demonstration (PI's: Trociewitz and Brey) - $657 K
- Establishment of the Southeast Center for Integrated Metabolomics (PI: Edison)

The NMRUC also notes that the record of peer-reviewed publications from the Magnetic Resonance group is again excellent, both in quality and number of papers (143 reported at the time of the meeting).

8. PRIORITIZED LIST OF RECOMMENDATIONS

8.1 Synopsis

The NMRUC is pleased to see all of the great progress that has been made over the past year, and the coherent set of future plans made for development of key project areas, and acquisition/ construction of instrumentation. We are aware of the financial constraints facing the MagLab, and make the following recommendations with this is mind:

8.2 General management (recommendations from 2011 and 2012 reports are still pertinent)

The NMRUC strongly recommends that the following recommendations be carried out:
- Management must continue to strive for infrastructure support, including maintenance and upgrades of existing equipment, along with support for future mid- to ultra-high field strength magnetic resonance spectrometers.
- The continued purchasing and repurposing of older NMR magnets and systems should continue to be supported (this year, an 800 MHz system from Minnesota was arriving on site). The MagLab is better equipped than anywhere in the world to give these systems second lives – which is a very cost effective way of ensuring NMR spectrometer availability to large use base with a wide array of interests.
- If budget constraints are not too tight, it would seem that the hiring of additional technical staff is a necessity – we hope that management can continue to push for this. Current staff seems occupied halfway between development of new projects, instruments, etc. and the maintenance and repair of older systems. The obligation of keeping older systems running can severely hamper progress on new systems, probes, etc.
- Ongoing collaboration between NMR and EMR areas should be continued, to ensure the success of the DNP research programs.
- Management must continue to improve outreach to attract a wide user base. Many of the meeting attendees (from all committees) were unaware of the great work that has been done in revising the MagLab web site. Regularly updated advertisements, mail outs, email lists and web site pages are essential for this. **This is key for attracting the best users to the MagLab to use the ultra-high field NMR instrumentation!** See also §8.4.

8.3 Budget

We did not have as detailed a budget discussion as that at the 2012 Users' Meeting, and specific line items and cuts were not examined in great detail. However, we understand that there are financial constraints on all areas. With this in mind, the NMRUC would like to make the following recommendations:
- As in the past, maintain funding for NMR/MRI experiments at close to previous levels.
- DNP NMR research is just getting off the ground – continued support of this area is essential.
- There has been past success in the development of HTS probes, and future developments and applications should be supported.
- As mentioned in §8.2, if possible, additional technical staff should be supported; certainly, no cuts to current technical staff should be made. See also §8.4 below.
- The SCH workshop demonstrated that the presence of the 36 T SCH system will have a major impact on many areas of NMR; support should be kept at a steady level to ensure the construction of probes, set-up of instrumentation and launch of first experiments in 2015.

8.4 User base and administrative issues:

Once again, the NMRUC is concerned that the total number of base users will be difficult to increase given the limited technical staff and scientist-scholars available on site. This staff is crucial for assisting users with experiment design and execution, as well as for the development of the new methods, instrumentation, etc.

discussed over the course of this report. We make the following recommendations:

- The SSNMR spectrometers are largely oversubscribed in terms of users time, the only exception being the 830 MHz spectrometer at Tallahassee. However, the continued construction of new probes (Peter Gorkov) for the 830 should see the usage increase on this spectrometer as well, and alleviate some of this strain. Once again, we mention the clever purchasing and repurposing of older spectrometers from other institutions as something that should continue.
- It is crucial that new users are recruited for the newer application areas like all three DNP areas, the 36 T SCH system (both materials and biosolids users), and the HTS probes.
- As in 2011 and 2012, we feel that the continued support for infrastructure, new spectrometers, development of new MR hardware and probes, repurposing of old spectrometers, along with the hiring and retention of scientific/technical personnel, are absolutely necessary for the continued development of a strong user base.

In addition:

The NMRUC would like to suggest that the MagLab host **annual workshops** (at least one per year) in several key areas of NMR, similar to the SCH workshop this year. This would include, but not be limited to (i) SSNMR applications to materials science; (ii) biosolids characterization; (iii) low-gamma/metal nuclides in SSNMR; and (iv) ultra-high field applications in MRI. This would be sure to attract a much wider user base into emerging areas of research interest.

The NMRUC also like to suggest that a set of governing rules be developed for the Users' committee to ensure that productive committee members are retained, and new and enthusiastic committee members are added on a regular basis. We note that on our committee contact list, there are members who have not attended a Users' meeting in years – this is certainly not optimal for obtaining useful input or broadening the user base. Ideas regarding term limits for committee members, development of new mailing lists, and how proposals should be reviewed have been tossed around, but perhaps should be treated with more gravity and formality at next year's meeting.

II. Electron Magnetic Resonance

Electron Magnetic Resonance (EMR) User Committee 2013 Meeting Report – Summary

ATTENDEES (18 October 2013)

- **User Committee:** Christos Lampropoulos (incoming, chem/bio area), Gavin Morley (in part, by Skype; outgoing, physics area), Stefan Stoll (continuing, chem/bio area), Josh Telser (Chair; outgoing, chem/bio area), Kurt Warncke (incoming, physics area; Chair-elect), Sergei Zvyagin (continuing, physics area), Alexandra Stenson (in part, ICR user committee).
- **FSU/NHMFL:** Steve Hill, Jurek Krzystek, Andrew Ozarowski, Likai Song, Hans van Tol, Sebastian Stoian
- **UF:** Alexander Angerhofer, Gail Fanucci

GENERAL/USER SUPPORT

The EMR program at the NHMFL with its outstanding instrumentation and staff is world-leading. The user committee is enthusiastic and congratulates the members of the EMR program on their continuing extraordinary success. Most impressive is the EMR program's high scientific productivity (46 papers already published or in press in 2013), relative to its small share of the NHMFL budget. The tremendous support given by EMR scientists to users, from start (or even pre-start in terms of assisting with magnet time proposal writing) to finish (publication) is especially noted. The user base is very broad, covering physics, materials science, chemistry, and biophysics/biochemistry.

INSTRUMENTATION

HiPER

The committee is impressed by the progress with the HiPER spectrometer over the past year, despite shipping damage. It has been operational since January 2013 and already outperforms the Bruker E680 in terms of signal to noise (S/N). The committee is especially pleased that last year's recommendation of securing funding for a 1 kW high-power amplifier was followed. Funding was provided by NHMFL, and the amplifier was already delivered in July 2013. However, the integration of this amplifier will require field service from the vendor of HiPER (University of St. Andrews, Scotland) and additional components (*e.g.*, a fast switch). The committee urges that funding be found for these and other improvements (*e.g.*, ENDOR accessory for HiPER, EMR improvements, see below). Once implemented, HiPER with the 1 kW amplifier will allow additional increases in sensitivity and smaller sample sizes that are critical for high-field biostructural studies (spin labeling, DEER). The HiPER spectrometer provides capabilities that are unique in the U.S., and will likely expand the EMR user base significantly.

EMR

The committee is supportive of proposed, relatively simple hardware improvements in the 120/240/336 GHz pulsed-EPR system that will make this equipment even more powerful for users, such as a new sample holder, a protection switch and a phase-stable reference source.

These developments will allow phase sensitive detection in pulsed-EPR experiments as well as increased S/N, faster repetition times, shorter pulse lengths, and improved phase stability. The phase sensitive detection will be particularly useful for quantum information work carried out with this spectrometer, which has produced papers in *Science*, *Nature*, *Nature Materials*, and *PRL* in the last four years. Access is also an important issue. Although EMR facilities are booked at or near capacity, no concerns were raised about user access. The proposal review process and magnet time allocation is smooth (see comment in first section above). However, due to this heavy utilization, any downtimes are potentially damaging. Therefore, the committee recommends that sufficient funds are provided to cover routine repair and maintenance of aging equipment.

In particular, the Oxford 15/17 T SC magnet power supply was down in 2013, but fortunately was able to be locally repaired.

The associated VDI source is approaching the end of its usable life: failure of this source would make the spectrometer unusable. Replacement of the VDI source (including a new set of multipliers) is estimated at $66,000.

Other improvements that would make the spectrometers more attractive to users include a crystal rotator on the SC system and the integration of laser excitation into the pulsed EPR system. The continued development of high pressure HFEPR is also a strong point. Another physical parameter that can be extended is temperature. There is interest in the condensed matter physics user community for EMR at temperatures below 1.5 K.

DNP

The committee is strongly supportive of the continued progress in DNP development, and the resulting close collaboration with the NMR facility. Recent hardware developments include purchases of a (no longer in service) 600 MHz NMR magnet from UF and a gyrotron (joint with NMR) from Bruker (demonstration model). Basic EMR-based research on organic radicals and solvent systems, that efficiently create and transfer polarization to the nuclei, thus enhancing DNP effect, is also strongly encouraged. This will bring aspects of the large organic chemistry community into EMR-related areas, from which they have been largely absent for the past several decades.

Mössbauer/Magnetic Mössbauer

The committee is supportive of the expansion of the EMR facility into the magnetic resonance technique of Mössbauer spectroscopy in magnetic fields (maximum 8 T). This has been achieved at low cost (including equipment donated from Emory Univ., Physics). The potential for supporting current users and attracting new ones, who may often become EMR users as well, is great, given the current dearth of Mössbauer facilities and expertise in the U.S. The committee also supports the extension of this technique to nuclei other than ^{57}Fe, *e.g.*, ^{151}Eu and ^{161}Dy, which have great relevance to the latest research in molecular magnetism as well as to materials/condensed matter physics.

DC

The committee is also supportive of EMR users taking advantage of the NHMFL's remarkable capabilities in resistive and hybrid magnets. EPR experiments are being done in the Keck, 31 T, and 35 T resistive magnets, and the 45 T hybrid. Therefore, EMR users share the concerns of other DC Field users regarding competition for magnet time on these oversubscribed systems. The EMR users join with others in urging that technological, staffing, and other measures be taken to ensure maximum DC magnet time availability. The committee is also very excited about the coming (2 - 3 years) low-power Series-Connected Hybrid (SCH) magnets, which will offer high-resolution – crucial for many EMR applications. Techniques to enhance the homogeneity of high-field resistive and hybrid magnets for NMR and EPR are encouraged (*e.g.*, P.J.M. van Bentum *et al.*, *Chem. Phys. Lett.* **376**, 338 (2003) and Z. Gan *et al.*, *J. Magn. Reson.* **191,** 135 (2008)).

FUNDING

The committee is impressed with EMR Director Hill's success in obtaining external funding, such as for DNP (NSF-MRI) and high pressure EMR (NSF-CHE), which helps keep the lab on its trajectory of technological advance in parallel with high scientific impact. The committee urges the EMR staff scientists to similarly leverage core grants by seeking external funding, especially in conjunction with collaborative projects with EMR users. For example, as suggested by G. Fanucci, the NIH-SIG program could provide a mechanism for obtaining funds that extend NHMFL EMR equipment to run experiments in biomedical research.

STAFFING

The committee is extremely pleased with the recent (September 2013) hiring of an EMR/NMR engineer (B. Trociewicz, funded 1:1 by Hill's NSF grant and NHMFL) whose presence will be crucial in DNP development, but will also help with EMR hardware improvements. This engineer will also be able to interact better with NHMFL machinists in terms of preparing technical plans to their exacting requirements. The addition of a postdoc (T. Dubroca, funded by Hill's NSF grant) with expertise in DNP and the presence of Crow postdoc S. Stoian, with respect to Mössbauer, are also very positive developments.

ADMINISTRATIVE

A broader issue that EMR users share with other users is the evolving management structure of NHMFL. There should not be an increase in unneeded layers of management; a direct line of communication should be maintained between the NHMFL Director and Deputy Director and the user programs. Such communication is crucial for maintaining and pushing a clear, strong and coherent scientific vision for the lab.

RECOMMENDATIONS (in Priority Order)

- Increase visibility and recognition of the contributions of EMR to magnet science overall. The MagSci report mentions EMR only in the context of NMR-related applications (DEER, greater *g* dispersion) and not in the context of (bio)inorganic and materials chemistry or solid-state qubits.
- Continue support for the operation and improvement of pulsed and CW EPR spectrometers at NHMFL/FSU (and supporting instrumentation such as magnetic Mössbauer) for the large number and wide scientific range of users. This includes ensuring that there are sufficient funds for routine maintenance, repairs, and consumables (*e.g.*, Mössbauer sources).
- Continue the already strong progress toward bringing the HiPER spectrometer online, and thus, to complete this high-field/high-sensitivity EPR user facility, to fully realize a unique user facility in the U.S. The recommended support includes funds that are necessary for integration of the the high-power amplifier (purchased, and on-site) and associated components,
- Make sure that the newly hired engineer is involved in projects that are directly related to EMR facility, in addition to projects related to DNP. This includes better interfacing with NHMFL machinists, who will now have someone who "speaks their language".

- Support the DC facility by contributing to the development and EPR applications of its existing magnets and the future high-resolution, low power SCH magnets. Make continued, and wider, use of the other DC facilities for EPR experiments.
- Support the DC facility in the hiring of a top-level condensed matter scientist (physicist, chemist, materials scientist, or engineer) as an FSU faculty member to lead the DC facility and provide direction in this core mission of the NMHFL that is also crucial for EMR, with its extensive research in materials areas.
- Support the NMR facility in the development of the DNP program.
- Encourage the EMR staff scientists to seek external funding, that comes to NHMFL, rather than simply providing support letters for external users' grant proposals.
- Continue supporting X-/Q-band EPR at UF for regional users.

III. Ion Cyclotron Resonance

21 T: Strongest FT-ICR MS magnet in the world

- The most exciting news this year is that the 21 T magnet has arrived and passed specs.
- The improvements in instrument design (from ions optics to cell configuration) that have taken place in the 14.5 T test-bed in preparation for bringing the new 21 T FT-ICR MS instrument online quickly and maximizing its potential are, once again, pushing the envelope in sensitivity, resolving power, and dynamic range.
- Use of the 14.5 T as the test-bed will therefore not only allow swift bringing online of the 21 T for user experiments, but will also enhance existing instruments.
- Thus, the acquisition of one new magnet resulted in far reaching improvements throughout the ICR facility from which all users will benefit.

Informatics Hires

- Previously, the user committee recommended the hiring of additional in-house informatics personnel.
- Acquisition of extremely complex and information rich datasets is only as valuable as the ability to process, evaluate, and present the data.
- Commercial software is largely incomplete, unsuited to specialized experiments, and unaffordable to most users.
- Therefore, the availability of powerful data processing technology alongside the world-leading data acquisition technology is important to both external and internal users.
- Therefore, the community welcomes the recent hiring of two in-house informatics specialists.

Hiring of World-Class Proteomics Expert

- Previously, the user committee recommended the hiring of a replacement for Mark Emmett to reinvigorate the bio-applications field of FT-ICR MS at the NHMFL.
- The hiring of Nick Young, a world-expert in histones, appears to be doing just that.
- Dr. Young's progress in attracting new users and enhancing visibility of FT-ICR MS in the proteomics field is impressive.
- Under his leadership, the bio-applications FT-ICR MS program at the NHMFL has joined two consortia (one on top-down proteomics and one on H/D exchange of proteins), which not only involve interesting and important science but also serve as an avenue to enhance visibility of the program in the proteomics community.
- Finally, the bio-applications community, in particular, will greatly benefit from the new 21 T FT-ICR MS technology soon to be available at the NHMFL. Getting the word out to this important base of users, maximizes the transformative potential of this powerful new tool.

Commitment to Users

- FT-ICR MS has shown true commitment to user support by not only meeting the previous year's number of external users but exceeding it despite high turnover in personnel and three months unavailability of the 14.5 T during its service as a test-bed for the 21 T magnet.
- The total number of users, number of new users, and diversity of external users illustrate unbiased commitment to serving the user community.

Innovation and Forward thinking

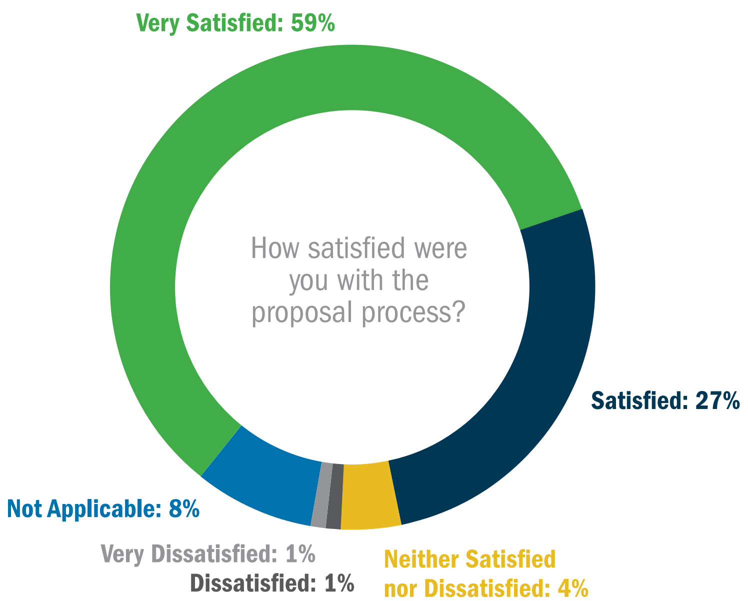
- Being the world-leader in FT-ICR MS and staying the world-leader require continual innovation and forward thinking.
- As mentioned above, the FT-ICR MS group continues to innovate and improve existing instrument design and software technology.
- In addition, the group is already thinking of ways to fund and implement the next big innovation - an 18 T wide bore FT-ICR MS.
- An 18 T wide bore instrument would be a powerful advancement for the characterization of extremely complex mixtures. As the current workhorse instrument, the 9.4 T has proven, a wider bore allows for more ions to be in the cell at the same time. In the characterization of extremely complex mixtures (as in the hugely successful petroleomic's work), it is an important advantage to look at millions of ions at the same time because each individual analyte is only a minor component in mixtures of thousands of components.
- The FT-ICR MS group at the NHMFL continues to impress with its creative and innovative ways to procure funding outside of the NHMFL core grant from a variety of sources (*e.g.*, NSF, BP, NIH, Skolkovo Tech, etc.)

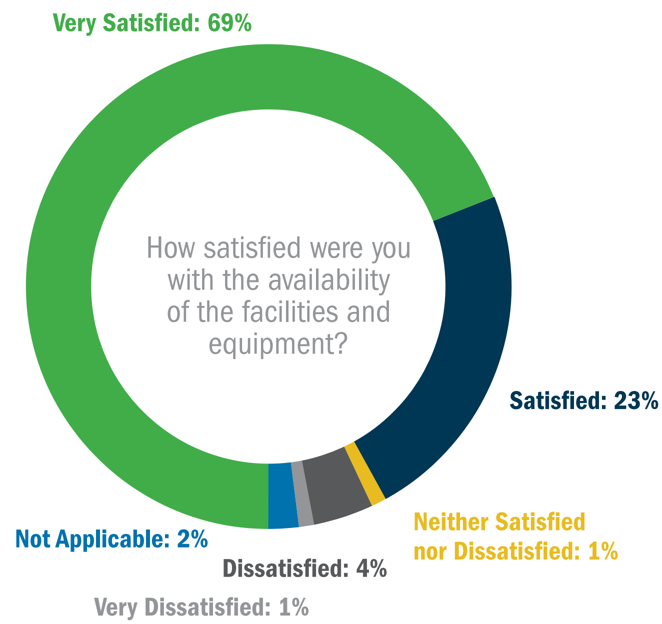
External Review

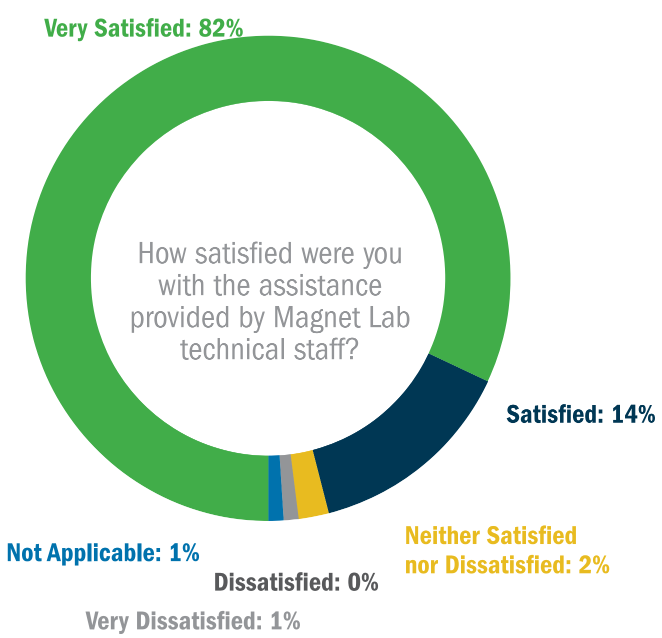
- Given that FT-ICR MS is such important and highly successful component of the NHMFL, the user committee would recommend that the NHMFL lobby for the inclusion of more ICR experts on external review committees evaluating the NHMFL and/or science drivers in the field of NHFL-related research.

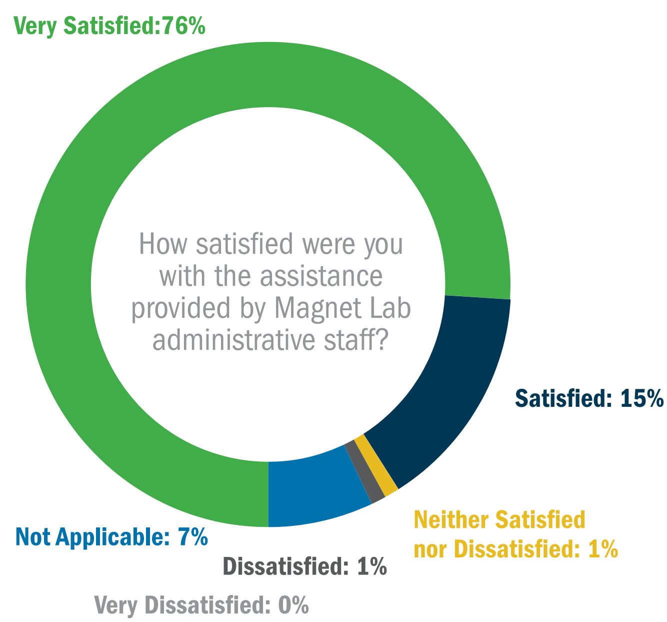
Annual User Program Survey

The National High Magnetic Field Laboratory conducted its fourth annual user survey between June 03, 2013 and July 01, 2013. User input assisted all seven facilities to respond to user needs, improve facilities and services, and guided the MagLab in setting priorities and planning for the future. This request was sent to all MagLab User Principal Investigators (PI) and to their collaborators who received magnet time between June 1, 2012 and May 31, 2013, including PIs who sent samples, where the experiment was performed by laboratory staff scientists.



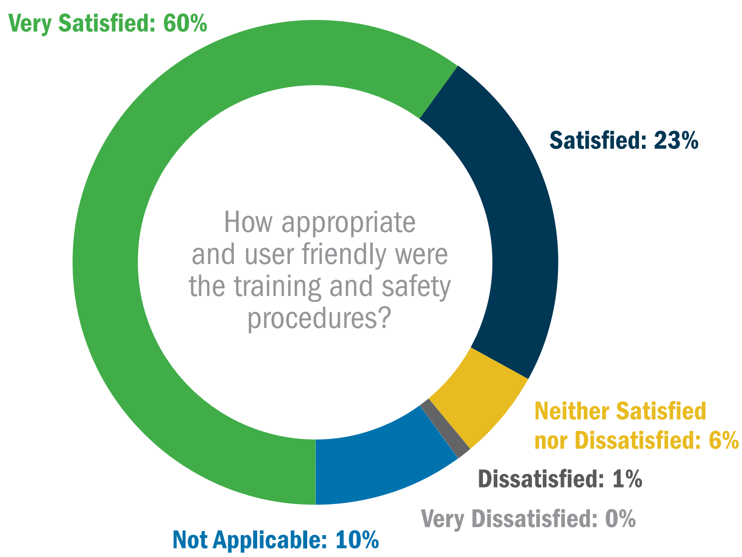


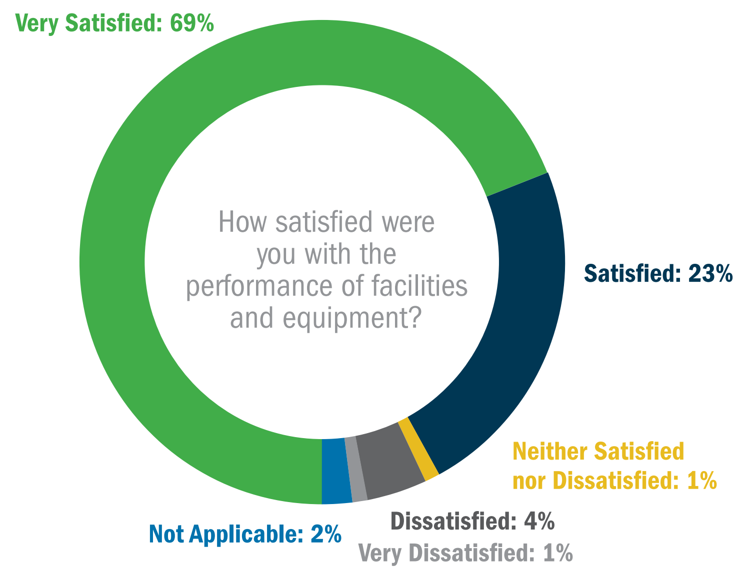


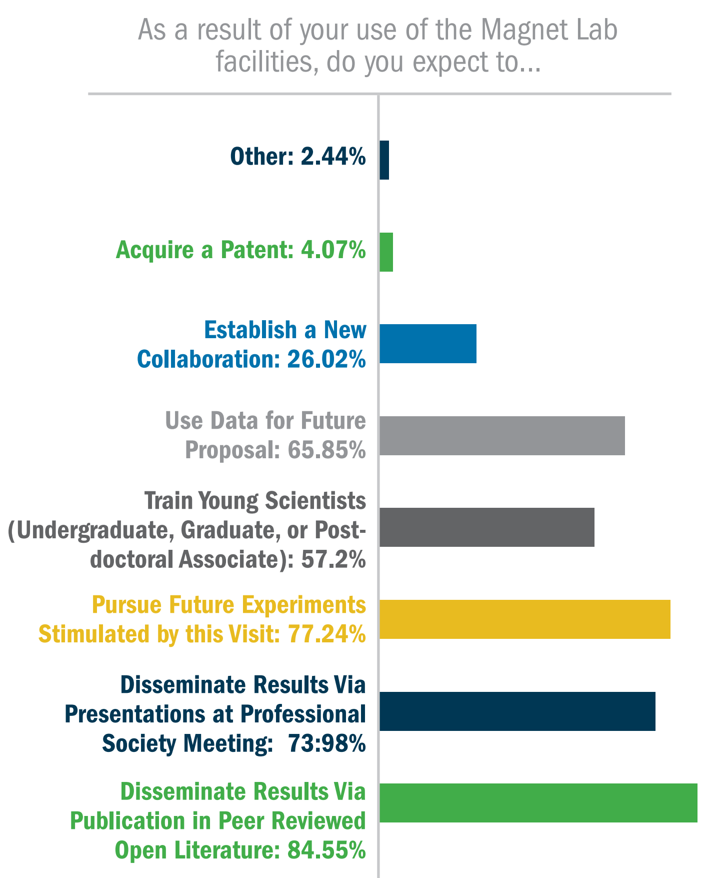


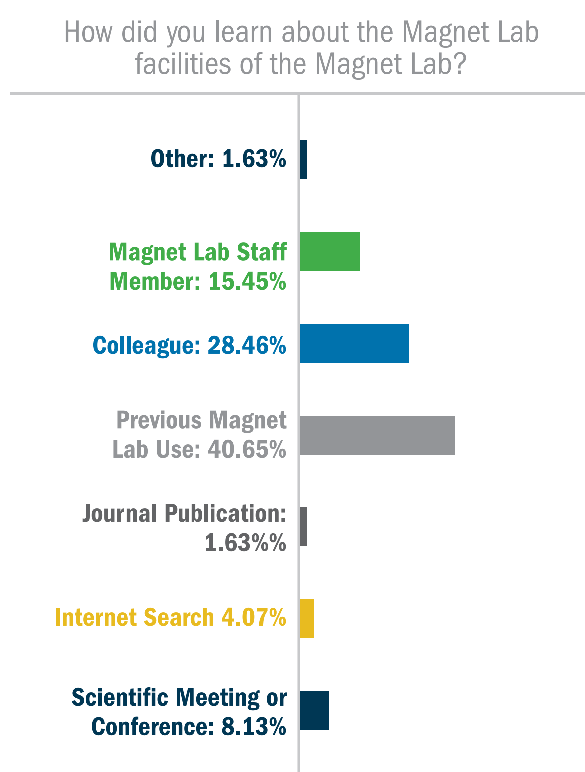
All user responses were treated anonymously.

*All presented figures exclude internal responders.


How appropriate and user friendly were the training and safety procedures?
Very Satisfied: 60%
Satisfied: 23%
Neither Satisfied nor Dissatisfied: 6%
Dissatisfied: 1%
Very Dissatisfied: 0%
Not Applicable: 10%


How satisfied were you with the performance of facilities and equipment?
Very Satisfied: 69%
Satisfied: 23%
Neither Satisfied nor Dissatisfied: 1%
Dissatisfied: 4%
Very Dissatisfied: 1%
Not Applicable: 2%


As a result of your use of the Magnet Lab facilities, do you expect to...
Other: 2.44%
Acquire a Patent: 4.07%
Establish a New Collaboration: 26.02%
Use Data for Future Proposal: 65.85%
Train Young Scientists (Undergraduate, Graduate, or Post-doctoral Associate): 57.2%
Pursue Future Experiments Stimulated by this Visit: 77.24%
Disseminate Results Via Presentations at Professional Society Meeting: 73:98%
Disseminate Results Via Publication in Peer Reviewed Open Literature: 84.55%


How did you learn about the Magnet Lab facilities of the Magnet Lab?
Other: 1.63%
Magnet Lab Staff Member: 15.45%
Colleague: 28.46%
Previous Magnet Lab Use: 40.65%
Journal Publication: 1.63%%
Internet Search 4.07%
Scientific Meeting or Conference: 8.13%

DC Field Facility

The DC Field Facility in Tallahassee continues to serve it's large and diverse user community by providing continuously variable magnetic fields in a range and quality unmatched anywhere in the world. The DC Field user community is made up of undergraduate students, graduate students, post docs and senior investigators from around the country and the world. State of the art instrumentation is developed and coupled to these magnets through the efforts of our expert scientific and technical staff. The users of the DC facility are supported throughout their visit by the scientific, technical and administrative staff to ensure that their visit is as productive as possible. The interaction between the NHMFL scientific and technical staff with the students, post docs and senior investigators who come to the DC Field Facility to perform their research results in a continuous mix of scientific ideas and state of the art techniques that are passed both to and from users.

Table 1 lists the DC Field Facility magnets. The MagLab leads the world in available continuous magnetic field strength, number of high field DC magnets available to users and accessibility for scientific research. The 45 T hybrid magnet is the highest field DC magnet in the world which is reflected in the number of proposals from PIs located overseas. The 35 T, 32 mm bore and 31 T, 50 mm bore magnets are coupled to top loading cryogenic systems that have impressive performance, flexibility and ease of use. The 25 T split helix magnet is the highest field direct optical access / scattering magnet in the world. With 4 optical ports located at field center each having a 11.4° vertical x 45° horizontal taken off of a 5mm opening the ability to perform ultrafast, time resolved and x-ray scattering experiments are now a reality at high magnetic fields.

TABLE 1

DC Field Facility Magnet Systems

Florida Bitter and Hybrid Magnets Field, Bore, (Homogeneity)	Power (MW)	Supported Research
45 T, 32 mm, (25 ppm/mm)	30.4	Magneto-optics – ultra-violet through far infrared; Magnetization; Specific heat; Transport – DC to microwaves; Magnetostriction; High Pressure; Temperatures from 30 mK to 1500 K; Dependence of optical and transport properties on field, orientation, etc.; Materials processing; Wire, cable, and coil testing. Low to medium resolution NMR, EMR, and sub/millimeter wave spectroscopy.
35 T, 32 mm (x2)	19.2	
31 T, 32 mm to 50 mm[1] (x2)	18.4	
30.5 T, 32 mm (~5 ppm/mm)[2]	18.3	
17 T, 195 mm	18.0	
25 T, 52 mm, (1 ppm/mm)[2]	18.6	
25 T, 32 mm bore (with optical access ports)[3]	27	

Superconducting Magnets Field (T), Bore (mm)	Sample Temperature	Supported Research
18/20 T, 52 mm	20 mK – 2 K	Magneto-optics – ultra-violet through far infrared, Magnetization, Specific heat, Transport – DC to microwaves, Magnetostriction; High pressure, Temperatures from 20 mK to 300 K, Dependence of optical and transport properties on field, orientation, etc. Low to medium resolution NMR, EMR, and sub/millimeter wave spectroscopy.
18/20 T, 52 mm	0.3 K – 300 K	
17.5 T, 47mm[3]	4 K – 300 K	
10 T, 34 mm, (50 ppm/cm)[3]	0.3 K – 300 K	

1. A coil for modulating the magnetic field and a coil for superimposing a gradient on the center portion of the main field are wound on 32 mm bore tubes.
2. Higher homogeneity magnet for magnetic resonance measurements.
3. Optical ports at field center with 4 ports each 11.4° vertical x 45° horizontal taken off of a 5mm sample space.

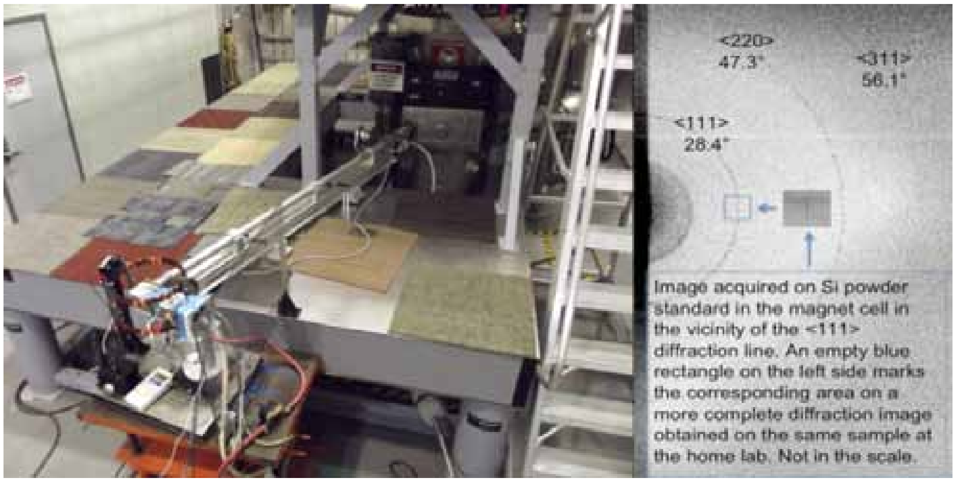


FIGURE 1. Assembled x-ray diffractometer source in cell 5. The image on the right is a diffraction image of powdered Si taken in the magnet overlayed on a much larger image obtained on a standard x-ray diffractometer.

Development/Enhancement

In 2013 an effort was undertaken to significantly expand the research possible in the DC Field Facility. Theo Siegrist and Alexey Suslov were awarded an NSF EAGER grant to develop **x-ray diffraction in the 25 T split helix magnet** located in cell 5. A diffractometer was designed to be compatible with the constraints placed on the experiment by the magnet, i.e. fringe field and geometry. Initial tests have been performed on Si powder standards and a diffraction image was successfully obtained. **Figure 1** shows a photo of the x-ray source coupled to the split helix magnet and a portion of the diffraction pattern of powdered Si. The portion of the diffraction image observed in the magnet is limited by the dimensions of the optical ports, windows and the image plate. Work is ongoing to improve the image quality and speed of acquisition.

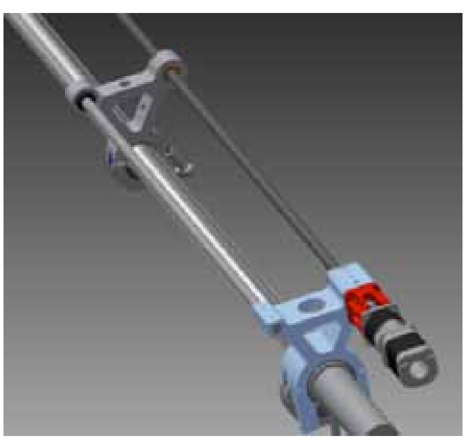


FIGURE 2. Automatic probe loading system for top loading cryostats.

A number of materials (organic conductors, topological insulators, graphene, semiconductors) which are studied at low temperatures by users at the MagLab can have very specialized requirements for the rate at which they are cooled from room temperature to low temperatures (below 4 K). It has been observed that specific cooling rates will allow subtle quantum states to be observed that would otherwise not be seen with a faster rate or different temperature profile during cooling. In order to provide slow, precise and consistent cooling during the loading of samples into the top loading cryostats at the MagLab a compact, lightweight, **automatic probe loader** was developed, tested and implemented by Ju-Hyun Park. The system mechanically lowers probes over the temperature range 300 K – 1.5 K at rates of 0.1 K/min. up to 10 K/min. A schematic of the probe loader is shown in **Figure 2**.

Recently, Dmitry Smirnov has developed several **fiber optic-based, high magnetic field Raman probes** and associated optical setups for highly sensitive Raman scattering measurements at variable temperatures, 1.6K-300K, and high magnetic fields up to 45T. The magneto-Raman probes were designed to fit inside the cryostats used with the NHMFL resistive magnets, typically 17 mm or 24 mm inner diameter. This was achieved through a combination of two principal design features as shown in **Figure 3**: (1) tight, quasi-monolithic assembly of all optical elements in the close vicinity of the sample to eliminate optical misalignment effects caused by thermal dilatation or magnetic forces; (2) delivery of light to/from the optical head assembly through optical fibers. While the use of optical fibers has drawbacks not present in traditional Raman spectroscopy, the newly accessible high magnetic field phase space has already delivered exciting results. This new experimental capability is being actively exploited by users to study electronic Raman scattering and electron-phonon coupling in graphite, magneto-phonon resonance in graphene, optical phonons in topological insulators, electron-phonon coupling in molecular magnets as well as low-intensity photoluminescence in GaAs/AlGaAs quantum Hall bilayers and in ZnSe quantum dots.

Following on the completion of the our multi year helium liquefaction and recovery system upgrade last year we have **connected the 45 T hybrid magnet to the Linde L280 turbine liquefier** through the cryogenic central distribution box. This change will result in more uptime for the 45 T hybrid magnet since the maintenance required for the 20 year old reciprocating liquefiers will no longer be an issue. In order to install the new cryogenic supply duct the superconducting outsert magnet needed to be brought to room temperature from 1.8 K. Warming up the 45 T hybrid magnet is a 6 week process that began in mid October at the start of our annual maintenance shutdown period. In early December the old reciprocating liquefiers were disconnected from the hybrid and the new cryogenic ductwork connecting the 45 T hybrid supply cryostat to the cryogenic central distribution box was installed and tested. Cooling of the hybrid is expected to begin in mid January with user operations restarting in mid March.

Outreach to Generate New Proposals-Progress on STEM and Building User Community

The DC Field Facility continued to be oversubscribed in 2013 as can be seen the usage tables in Appendix I. In spite of this oversubscription, however, the DC facility has continued to make bringing new investigators into the MagLab a priority. We are continuing our efforts to reach out wherever possible in order to expand our user program and enable principal investigators from backgrounds that are underrepresented in the scientific community. In particular, the NHMFL sponsored a booth at the APS March Meeting in Baltimore. In addition our DC Field Facility user support scientists regularly travel to conferences to present results and showcase the capabilities of the laboratory and recruit new users.

In 2013 the DC Field Facility continued to attract new researchers. Appendix I, Table 8 shows we attracted **11 new PIs who received time in 2013**. This is in addition to the 14 new PIs which we reported last year and 21 in 2011. These new PI's came from institutions as varied as ETH Zurich, Columbia, Bard College, and The National Institute for Materials Science (Japan) one of the new PIs was female.

The DC Field Facility also hosted the **2013 MagLab Summer School** that attracted 45 graduate students and post doc attendees which was almost double the 2012 number (24). The summer school is a five day series of lectures and practical exercises in experimental condensed matter physics techniques developed and put on by the MagLab scientific staff from the 3 sites. It has proven to be a great way to pass on valuable knowledge to the next generation of scientists from the enormous trove of experience encompassed by the MagLab scientific staff. The summer school is an annual event and will be presented again in 2014. Feedback from participants and their advisors has been overwhelmingly positive. Forty-two participants responded on the pre-survey and 43 on the post survey with the following rating:

- 100% rated the idea exchanges with lecturers and the idea exchanges with peers as good or better;
- 97% rated the lectures and the hands-on activities as good or better
- 92% rated the networking as good or better.
- 93% would attend another seminar hosted by NHMFL, and
- 68% indicated that the summer school was either better or much better than expected.

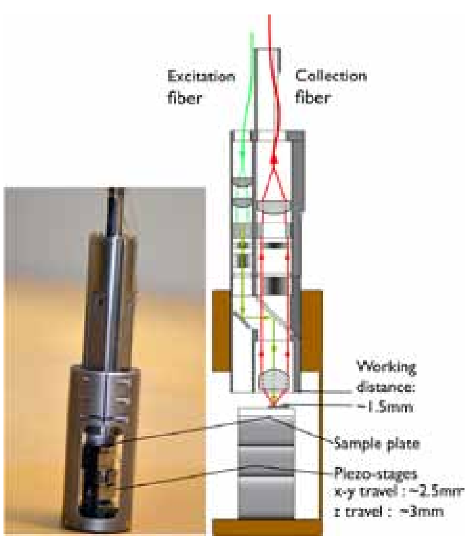


FIGURE 3. High field Raman spectroscopy experimental stage.

Facility Operations

At the heart of the DC Field Facility are four 14 MW, low noise, DC power supplies. Each resistive magnet requires 2 power supplies to run and the 45 T hybrid magnet requires three power supplies. Thus the DC Field Facility operates in the following manner; in a given week there can be 4 resistive magnets + 3 superconducting magnets operating or the 45 T hybrid, 2 resistive magnets and 3 superconducting magnets. The powered DC resistive and hybrid magnets operated for 45 weeks out of the year in 2013 with a 5 week shutdown for infrastructure maintenance from October 14 to November 18 and a 2 week shutdown period for the university mandated holiday break from December 23, 2013 to January 2, 2014. The three superconducting magnets operated for 48 weeks out of the year with staggered maintenance periods as required. The hourly operation schedule for the resistive and hybrid magnets is as follows:16 hours/day on Monday and 21 hours/day Tuesday-Friday. The superconducting magnets operate 24 hours/day.

Major Research Activities/ Discoveries

Research by the users of the DC Field Facility involved many areas of scientific endeavor in 2013. The categories that had the largest number of requests for facility time were magnetism and magnetic materials, superconductivity, semiconductors, graphene and topological matter. Innovative research by Bertram Batlogg and Phillip Moll from ETH Zurich on the motion of vortices in the pnictide superconductor SmFeAs revealed the unexpected observation of Josephson vortices in a material with low electronic anisotropy indicating strong order parameter modulations within the unit cell of the material.

Work done in the 25 T split helix magnet by Jim Gleeson and Sam Sprunt of Kent State University explored the effects of high magnetic fields on bent core liquid crystals that exhibit a wide temperature range amorphous blue phase. The high fields coupled with direct optical access allowed the Kent State group to observe dynamic molecular effects as the magnetic field was swept. These two examples and the two highlights that follow are just a small sampling of the work done in the DC Field Facility in 2013. The full breadth of the work done in the DC Field Facility can be found in the annual research reports submitted by users, which are published separately from this report.

Highlights

Work in graphene continued to produce very exciting results in 2013. Two user groups at the DC Field Facility simultaneously published manuscripts in *Science* and *Nature* detailing the observation of the Hofstadter Butterfly in a sheet graphene placed on top of a hexagonal boron nitride (h-BN) substrate. Douglas Hofstadter predicted in 1976 that the full energy spectrum of an electron experiencing a two dimensional periodic potential due to the lattice structure and a externally applied magnetic field would result in a complicated fractal pattern. Observation of the Hofstadter Butterfly had been long sought in semiconducting materials but the competition between magnetic length, lattice length constants and disorder meant that clean, atomic crystals with a lattice constant of less than 1 nm required magnetic fields of 10,000 T while lithographically produced lattices, on the order of 100 nm required magnetic fields of less than 1 T but suffered from disorder effects.

By placing graphene on top of h-BN at a small twist angle between the two periodic atomic structures, a moiré pattern appeared which provided the long periodic potential necessary for the electrons which was on the order of ~ 15 nm. This long periodic potential coupled with very low disorder allowed for the observation of the Hofstadter Butterfly in the range of fields produced at the DC Field Facility and utilized both the 45 T hybrid magnet and the 31 T resistive magnet located in Cell 9. The two science highlights show results from Phillip Kim and Cory Dean from Columbia that were published in *Nature* and Pablo Jarillo-Herrero and Ray Ashoori from MIT which were published in *Science*.

Plans/Directions

Work will begin in 2014 on the specification and development for the user instrumentation (cryostats, electronics, etc) needed for the 40 T-28 MW resistive magnet and the Series Connected Hybrid (SCH) in order to be ready for their anticipated deployment in 2015 as part of the DC Field Facility user program. Taking advantage of the wealth of experimental expertise available at the lab, world class sample environments and instrumentation will be developed to match the fields generated by these groundbreaking magnets.

The helium supply crisis in the fall of 2013 that affected helium users across the country and around the world served to add emphasis to our multi-year **helium recovery upgrade** effort. The first phase of installing new helium recovery lines linking the NMR, ICR and individual PI laboratories to the DC Magnet building was completed. 10 separate lines were installed, each with an individual length 700 ft. The type of tube used was underground conduit that is normally used for natural gas (NG) supply line. The lines are now in the process of being connected to our helium recovery system. The advantage of using NG tube is that it is helium leak tight, it is supplied in rolls of several hundred feet and it is very cost effective. The long lengths of tube minimize the number of joints where leaks could possibly occur.

In 2014 we plan to **upgrade our thermodynamic measurements portfolio** with the addition of a Scholar Scientist dedicated to more fully develop thermal measurements (heat capacity, thermal conductivity, thermoelectric effect) as fully supported measurement techniques for users of the DC Field Facility.

Improvements to our high magnetic field infrared (IR) measurement capabilities have begun and will continue through 2014. A new Bruker VERTEX 80v spectrometer has been purchased and will be installed on the SCM 3 platform. An improved transmittance probe for SCM 3 is being designed and built by MagLab scientists and technicians. Improvements to the dewar alignment and vibration isolation system for IR measurements in the resistive magnets are planned for 2014 as well.

Massive Dirac Fermions and Hofstadter Butterfly in a van der Waals Heterostructure

USERS B. Hunt, J.D. Sanchez-Yamagishi, A.F. Young, P. Jarillo-Herrero, and R.C. Ashoori (M.I.T.); M. Yankowitz and B.J. LeRoy (University of Arizona); K. Watanabe and T. Taniguchi (National Institute for Materials Science, Japan); P. Moon and M. Koshino (Tohoku University)

Van der Waals heterostructures are created by stacking two-dimensional crystals in a layered configuration. We placed graphene (which is normally a semimetal) on top of hexagonal boron nitride (hBN; normally a large-bandgap insulator) and found that graphene became a semiconductor. In other words, we opened a bandgap in the graphene electronic structure and imparted the normally massless Dirac fermions in graphene with a mass.

The bandgap only appeared in devices with a small twist angle between the graphene and hBN layers. When two periodic structures have a relative twist, a moiré pattern appears; in this case the moiré behaves as long-wavelength periodic potential for the graphene electrons. The problem of electrons in a periodic potential and a magnetic field was famously solved by Hofstadter in 1976 and resulted in a rare fractal structure in the available energy states, which resembled a butterfly shape. **The MagLab's 45T Hybrid magnet and the moiré potential provided us with just the right conditions to be able to observe the Hofstadter butterfly**.

The appearance of a bandgap in graphene is a technological breakthrough, and the study of small-twist-angle graphene-hBN structures in a large magnetic field provides fascinating physics related to the Hofstadter butterfly and probes the relationship between the bandgap and the moiré pattern.

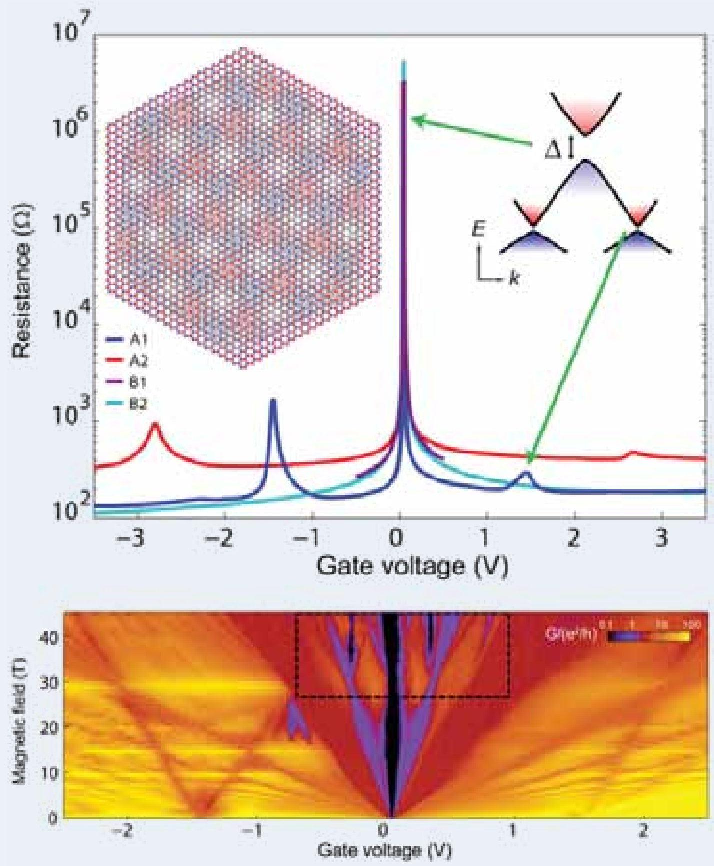


FIGURE 1. TOP: Moiré pattern of graphene (grey) on hBN (red/blue). Four graphene-hBN transistor devices (A1, A2, B1 and B2) show huge resistance and an associated band gap. The satellite peaks occur at full filling of the lowest "miniband" associated with the moiré potential.
BOTTOM: Conductance in the MagLab's 45T Hybrid magnet. When the magnetic-field-induced electron orbital motion is comparable to the moiré wavelength (above 29T), we observe striking features associated with the Hofstadter butterfly (black dashed box).

Facilities

DC Field Facility, 45T Hybrid magnet

Citation

Massive Dirac Fermions and Hofstadter Butterfly in a vander Waals Heterostructure. B. Hunt, J. D. Sanchez-Yamagishi, A. F. Young, M. Yankowitz, B. J. LeRoy, K. Watanabe, T. Taniguchi, P. Moon, M. Koshino, P. Jarillo-Herrero, and R. C. Ashoori. *Science*, Advance Online Publication, May 16th, 2013.

Hofstadter's Butterfly in Moiré Superlattices

USERS L. Wang, P. Maher, C. Forsythe, F. Ghahari, Y. Gao, K.L. Shepard, J. Hone and P. Kim (Columbia University); C.R. Dean (Columbia University & The City College of New York); J. Katoch and M. Ishigami (University of Central Florida); P. Moon and M. Koshino (Tohoku University); T. Taniguchi and K. Watanabe (National Institute for Materials Science, Japan)

In 1976, Douglas Hofstadter showed that the full energy spectrum of an electron subjected to both a twodimensional periodic lattice and a magnetic field is a complicated fractal that has come to be known as Hofstadter's butterfly. Later, theorists predicted that this spectrum should have dramatic signatures in the Hall voltage, including non-monotonic sequences of quantum Hall plateaus.

Though two-dimensional crystalline systems in a magnetic field are extremely well studied, observation of Hofstadter physics has proved challenging. In order to see the effect, the magnetic length must be comparable to the lattice constant of the periodic potential. Moiré patterns formed by graphene on hexagonal boron nitride (h-BN) provide an ideal sized lattice (~15 nm) for the MagLab's magnetic fields in the range of ~30 T. **These graphene on h-BN samples measured at the MagLab have recently provided unprecedented evidence of Hofstadter's butterfly.**

These results help enrich our understanding of the basic physics of electrons in a magnetic field. In addition, Hofstadter's butterfly represents a new route to explore the role of topology in condensed matter systems.

Facilities

DC Field Facility, 31 T resistive magnet and 45 T hybrid magnet

Citation

Hofstadter's butterfly and the fractal quantum Hall effect in moiré superlattices, C. R. Dean, L. Wang, P. Maher, C. Forsythe, F. Ghahari, Y. Gao, J. Katoch, M. Ishigami, P. Moon, M. Koshino, T. Taniguchi, K. Watanabe, K. L. Shepard, J. Hone & P. Kim. *Nature* (2013). doi:10.1038/nature12186

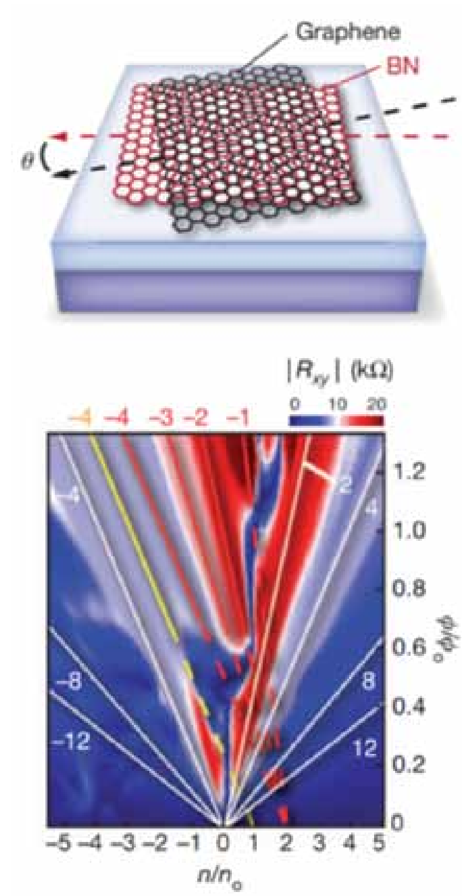


FIGURE 1. TOP: Cartoon of a moiré pattern in graphene on hBN, able to be verified in atomic force microscopy images of real devices.
BOTTOM: Color plot of Hall resistance showing Hofstadter features that display an unconventional Hall plateau sequence

Pulsed Field Facility

The National High Magnetic Field Laboratory - Pulsed Field Facility (NHMFL –PFF) is located in Los Alamos, New Mexico, at the Los Alamos National Laboratory (LANL) along with two other world class user programs. The center for Integrated Nano Technology (CINT) and the Los Alamos Neutron Science Center (LANSCE).

The NHMFL-PFF utilizes MagLab, NSF, LANL and DOE owned equipment and resources to provide world record pulsed magnetic fields to users from the scientific and engineering community worldwide.

The pulsed field users program is engineered to provide researchers with a balance of the highest research magnetic fields and robust scientific diagnostics specifically designed to operate in pulsed magnets. The connection with the DC Field Facility is strong and complementary in expertise.

Although achieving the highest research magnetic fields possible is a fundamental competency at the NHMFL-PFF, we also strive to create the very best high-field research environment possible and to provide users with support from the world's leading experts in pulsed magnet science. All of the user support scientists are active researchers and collaborate with multiple users per year.

A fully multiplexed and computer controlled, 6-position 4.0 mega-Joule (32 mF @ 16 kV) capacitor bank system is at the heart of the short pulse magnet activities. Many thousands of shots are fired for the users program, which accommodates approximately 150 different users each year.

The LANL/DOE owned 1.4GW generator is unique in the world and provides users with the highest non destructive magnetic fields available.

The magnets available for users at the NHMFL- PFF are listed in the table below.

Facility Developments

The second 10mm insert for the 100T multi-shot magnet system has been in use throughout 2013 delivering 92T on a routine basis, providing a sustainable high field science program.

TABLE 2

Pulsed Field Facility Magnet Systems

Capacitor Bank Driven Magnets — Field (T), Duration, Bore (mm)	Supported Research
Cell 1. 65 T Short Pulse, 25 msec, 15 mm Ultra low noise	Magneto-optics (IR through UV), magnetization, and magneto-transport from 350 mK to 300 K. Pressure from 10 kbar typical, up to 100 kbar. GHz conductivity, MHz conductivity, Pulse Echo Ultra-sound spectroscopy. IR & FIR transmission in the Single Turn Magnet. Specific heat capability in 60 T Long Pulse. Dilatometry up to 95T
Cell 2. 65 T Short Pulse, 25 msec, 15 mm Rapid cool	
Cell 4. 65 T Short Pulse, 25 msec, 15 mm Rapid cool	
Cell 4. 65 T Short Pulse, 25 msec, 15 mm Ultra low noise	
Cell 294. Development test cell	
60 T Long Pulse Magnet, ~3 sec, 32 mm	
95 T Multi-Shot, 10 msec, 10 mm / 85T Multi-Shot, 10 msec, 15 mm	
Single Turn (to 240 T so far), 0.06 msec, 10 mm	

Superconducting Magnets — Field (T), Bore (mm)	Supported Research
20 T magnet, 52 mm bore	Same as pulsed fields, plus thermal-expansion, specific heat, and 20 mK to 600 K temperatures. Heat Capacity, THz Resistivity, Heat Capacity, Magnetometry.
15/17 T magnet, 52 mm	
14 T-PPMS magnet	

A new electromagnetic screened room and heavy wall copper conduit was installed At the NHMFL-PFF to enhance signal to noise for both the 100 T multi-shot magnet and the 60 T Controlled waveform magnet. Signals with better than 5 nV/(Hz)1/2 were collected on experiments in the 100 T magnet after installation in November of 2013 **(Figure 1.)** Developments have been made on the science instrumentation for the generator driven magnet systems (100T MS & 60T LP).

The third 100T 10mm bore insert winding was completed by our in house magnet technology team. This insert will be ready to install as needed in 2014.

Facility Operations

The pulsed field facility uses 2 different power supply systems to operate its Large Scale User Pulsed Magnets. LANL's 1.4GW generator is used to run the 60T long pulse magnet and the outer coil set of the 100T multishot magnet. An 18KV 2.6 MJ capacitor bank is also used to energize the insert magnet for the 100T MS. The generator is scheduled to power one of the large scale magnets during a user run. The 60T LP or the 100T MS can be used during any given week. Hours of operation are from 8.00am – 5.00pmA 16KV 4MJ User accessible capacitor bank is used to drive the 65T short pulse magnets, 4 cells are equipped with these magnets and typically 3 are in use Monday – Friday 7.30am to 10.30pm.Preventative maintenance is scheduled each week (Monday. Morning 8 AM-10 AM) or performed on an as needed basis. During 2013 the PFF had 2 scheduled maintenance weeks where no user experiments were run One in April and one in July. The Pulsed Field Facility was closed for the Los Alamos National laboratories required Christmas break from December 25th 2013 – January 2nd 2104.

Facility Plans

In 2014 work will begin on the design and construction of the next generation of short pulse magnets. These magnets will utilize the Duplex design and are estimated to be able to provide users with 75T magnetic fields. Software and hardware modifications will need to be implemented on the 4MJ capacitor bank to allow the use of these duplex design magnets.

Science Productivity

To date 32 peer reviewed publications and 26 presentations and posters have been reported for 2013. 1 Ph.D dissertation has also been reported. Two examples of the pulsed Field Facilities productivity are given on the following pages.

Progress on STEM and Building the User Community

The NHMFL-PFF provided magnet time for 145 distinct experiments in 2013 with 54 unique PI's, of the unique PI's 10 were new users.

Several students from underrepresented groups were involved in the program this year providing mutual benefits to the students and the PFF mentors.

Travel support may be granted to the new users, which has been helpful in growing the new user base considering the relatively remote location of the PFF in Los Alamos.

The staff members of the PFF continue to make considerable efforts toward outreach, which included more than 10 facility tours for the public and scholar groups from US universities including HBCU students working at LANL. Visits to local Native American pueblo schools to get the word out about the excitement of high magnetic field science.

In 2013 the Los Alamos National Laboratory held a family day, The NHMFL – PFF was one of the sites where guided tours were held. The PFF hosted over 140 visitors during this event **(Figure 2.)**

FIGURE 1. A new electromagnetically screened room (shown above) and heavy wall copper conduit was installed.

FIGURE 2. Family Day at Los Alamos National Laboratory at the NHMFL-PFF. Over 140 visitors came to the NHMFL-PFF to see our 1.43 Billion Watt generator and record setting 100 T magnet amongst other high field systems.

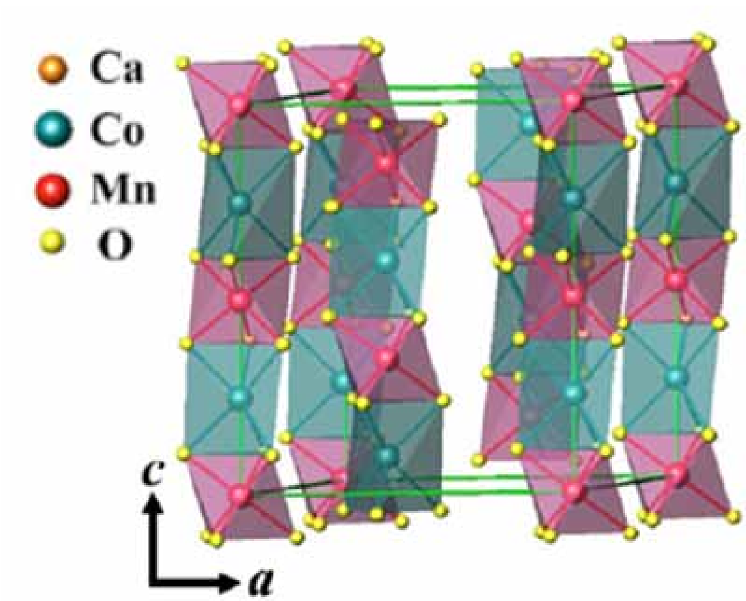
Magnetic Structure and Magneto-electric Coupling in Multiferroics

USERS V.S. Zapf, J.W. Kim, E.D. Mun, N. Harrison and M. Jaime (National High Magnetic Field Laboratory: Pulsed Field Facility & Los Alamos National Laboratory); Y. Kamiya and C. Batista (Los Alamos National Laboratory); H. Yi, Y.S. Oh and S.-W. Cheong (Rutgers University)

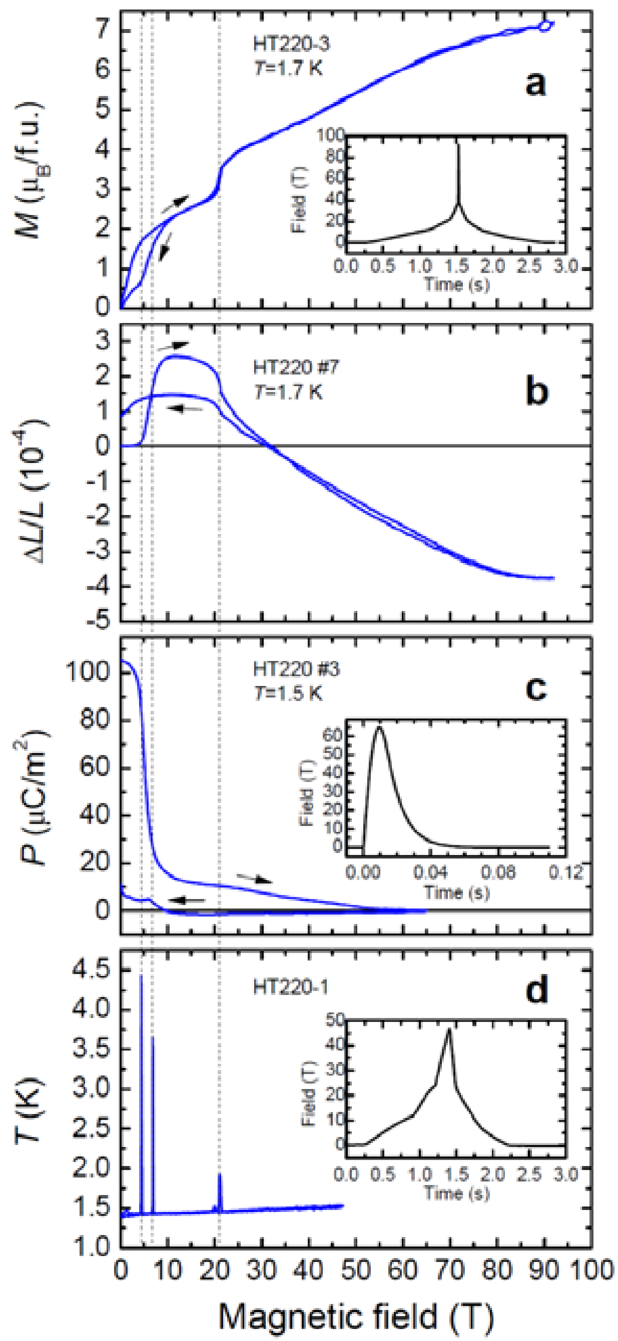
Multiferroics–"Spintronics without heat." Coupled ferromagnetism and ferroelectricity can provide a new class of functional materials for needed applications including magnetic sensing, data storage and manipulation, high-frequency and high-power electronics, and energy savings.

High magnetic fields exceeding 90 teslas are used to measure (a) magnetization, (b) magnetostriction, (c) electrical polarization and (d) magneto-caloric effects demonstrate the inter-related magnetic, electric, and structural properties that strongly constrain possible models for magnetic structure and multi-ferroic interactions.

In Ca_3CoMnO_6, hysteretic magnetism is coupled to ferroelectricity.



ABOVE: Choi *et al.*, PRL 100, 047601 (2008)



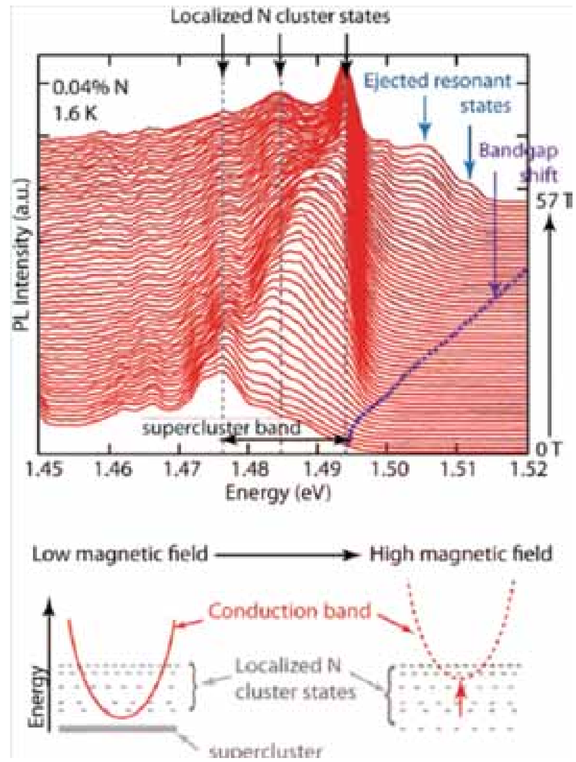
Magnetic Field-Induced Delocalized to Localized Transformation in GaAs:N

USERS K. Alberi, B. Fluegel, D.A. Beaton, A.J. Ptak and A. Mascarenhas (National Renewable Energy Laboratory, Golden, CO 80401); S.A. Crooker (National High Magnetic Field Laboratory, Los Alamos, NM 87545)

Formation and fragmentation of superclusters in semiconductors: The alloy properties of semiconductors are typically viewed as emerging from a smooth averaging of the constituent potentials. Dilute $GaAs_{1-x}N_x$ proved to be an anomaly in this regard, as nitrogen (N) atoms introduce strong potentials that can trap electrons and affect the overall material bandstructure. Thus, it was unclear whether this semiconductor should be considered as an isoelectronically-doped compound or as an alloy. Our research investigates how the percolation of localized N cluster states into **extended nitrogen superclusters** facilitates the evolution of GaAs1-xNx from the impurity-doped regime into a fully developed alloy.

The MagLab's unique 60 T Long-Pulse Magnet in Los Alamos enables the continuous tuning of the wave function overlap between N cluster states. These experiments allowed us to reverse the percolation and study how the optical properties evolve with supercluster formation and fragmentation.

Semiconductor alloys are important for a wide range of energy-related applications, including photovoltaics and solid state lighting. Understanding impurity state percolation and how it affects the overall properties of semiconductors is one key to advancing the performance of these materials.



ABOVE: Dozens of photoluminescence spectra of a GaAs:N sample (0.04% nitrogen) as a function of magnetic field, collected during a single pulse of the MagLab's 60 T Long-Pulse magnet. The schematic shows how the conduction band and nitrogen (N) cluster states evolve as the magnetic field is increased.

High B/T Facility

The High B/T Facility provides users with access to a unique combination of high magnetic fields (up to 16 T) and ultra-low temperatures (down to 0.04 mK) simultaneously.

Unique Instrumentation

In collaboration with a number of NHMFL Users the High B/T facility has developed unique instrumentation for high sensitivity measurements at ultra0low temperatures.

High frequency NMR techniques for pulsed NMR at sub-milliklevin temperatures. Users D. Candela (University of Massachusetts) and H. Akimoto (University of Tokyo) developed a re-entrant cavity (**Figure 1**) in which the sample is held in a cold finger thermally independent of the walls of the cavity that suffers from the RF heating of the NMR excitation pulse.

A **high sensitivity capacitance cell** (**Figure 2**) was developed by NHMFL staff members (J.S. Xia and L. Yin) in collaboration with M. Chan (Pennsylvania State University) for measurements of the dielectric constant of solid helium four at milliklevin temperatures.

A specially designed **RF amplifier** (**Figure 3**) using pseudomorphic field effect transistors was successfully developed by C. Huan and D. Candela to operate at temperatures from 0.1 to 1.2 K in the presence of a high magnetic field. The amplifier is broad band and matches a tuned NMR receiving coil to a 50-ohm transmission line connecting the system to a room temperature NMR detector. The device dissipation is held to less than 0.5 mW and the operating point and thus the impedance matching adjusted by changing the gate bias from an external voltage source.

Facility Developments

For high sensitivity RF conductivity measurements we are developing for Professor Bin Zhang, a user from the Institute of Chemistry of the Chinese Academy of Science a low powered tunnel diode oscillator that can be used in close proximity to a sample held at sub-milliKelvin temperatures.

Outreach to Generate New Proposals

Prof. Lee of the UF- NHMFL faculty has developed a formal agreement for collaboration between the NHMFL High B/T facility and the Korea Advanced Institute of Science and Technology (KAIST). Prof. Lee in collaboration with Prof. Hyoungsoon Choi of the Department of Physics at KAIST will develop a nuclear demagnetization refrigerator for KAIST similar to those used in his own laboratory and the NHMFL High B/T Facility. He will visit KAIST for 2 months in 2014 as part of his sabbatical. This activity and their common research interests in ultra-low temperature physics will lead to future research and grant proposals.

Dr. Liang Yin (NHMFL research scientist) has developed a collaboration with Professors Qiuju Li and Xuefeng Sun of the Hefei National Laboratory for Physical Science at the Microscale (University of Science and Technology of China). The collaboration will fabricate and characterize rare earth pyrochlores for studies of frustrated magnetism at very low temperatures. High temperature studies wil be carried out at the Hefei National Laboratory and low temperature studies at the NHMFL High B/T Facility.

Facility Plans and Directions

In order to reduce the length of the queue (currently 9 months) for assignment of magnet time to users whose research proposals have been approved, we propose to open Bay 1 of the University of Florida MicroKelvin laboratory to NHMFL Users. This bay was the first completed in 1988 and employs a copper nuclear demagnetization refrigerator and can study samples at temperatures down to 0.1 mK in applied magnetic fields up to 8 T. To operate this Bay successfully we will need an increase in base funding to increase the staff support, and to modernize the electronic instrumentation and upgrade helium-3 pumps for optimum refrigeration.

In addition we propose to take advantage of the rapid progress in realization of highly stable high temperature superconducting magnets to work with the Magnet

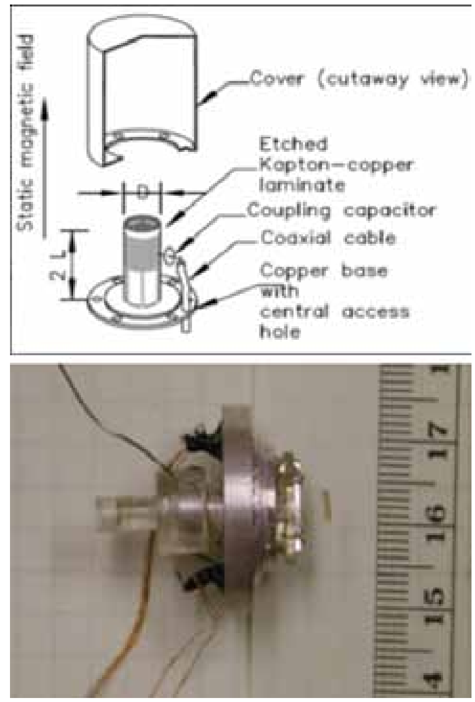


FIGURE 1.

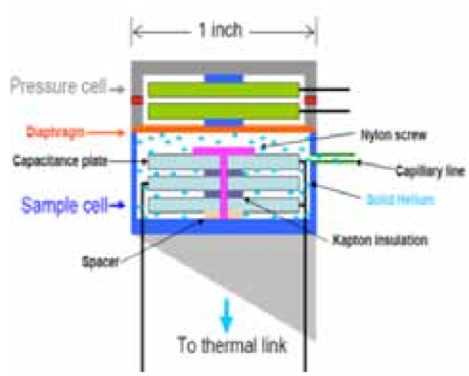


FIGURE 2.

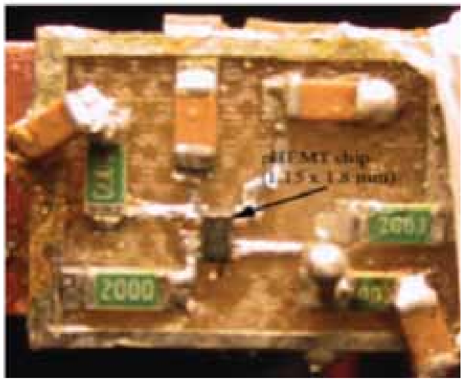


FIGURE 3.

Design and Development group to plan for a 25-30 T class magnet that would be sufficiently quiet and stable to be used in conjunction with one of the nuclear demagnetization cryostats in the High B/T Facility. If this is successful, the addition would access fields higher than the current maximum of 16.5 T.

Progress on STEM and Building the User Community

The NHMFL High B/T Facility offers all qualified users the opportunity to explore the fundamental properties of new and novel materials at the extremes of ultra-low temperature and high magnetic fields simultaneously. It is at these extremes of physical parameters that new phenomena can be discovered and fundamental theories tested. Highlights of these capabilities for users include (i) detecting exotic fractional quantum Hall states in 2D semiconductor heterostructures that can only be observed if you can reach electron temperatures below 10 mK, and (ii) exploring the low temperature ground states of frustrated pyrochlores using high sensitivity magnetic susceptibility measurements that require the ultra-quiet environment of this NHMFL facility.

The High B/T Facility provides unique training of graduate students working with users in the use and development of ultra-low temperature instrumentation. An example is the development of low temperature amplifiers for NMR detection to improve signal/noise ratios in critical applications. The facility also numerous hosts visits from teachers and students from local schools to enhance the awareness of students about the modern research environment and its relation to local communities.

ABOVE. Rock High School visits High B/T Facility in Fall 2013. (Prof. Lee and students)

Operating Schedule

Because most experiments carried out at the NHMFL High B/T Facility last from one to several months, this facility operates 24/7 for 365 days a year except for planned shutdowns for maintenance and servicing. In 2013 we scheduled shutdowns for the periods March 7 to March 21, and from October 15 to October 25. The first timeslot was selected to coincide with the major international meetings in our discipline, the March Meeting of the American Physical Society that is attended by a large number of our users. In addition to these planned shutdowns we also had short shutdowns for servicing Bay 2 from September 4 to September 11, and for Bay 3 and Bay 2 from October 25 to November 15 to make structural changes.

Discoveries and Achievements

Observation of a new intermediate phase between electron crystal ad liquid for a 2D quantum Wigner crystal.

Measurements of the transport of strongly interacting 2D holes in high mobility GaAs quantum wells at very

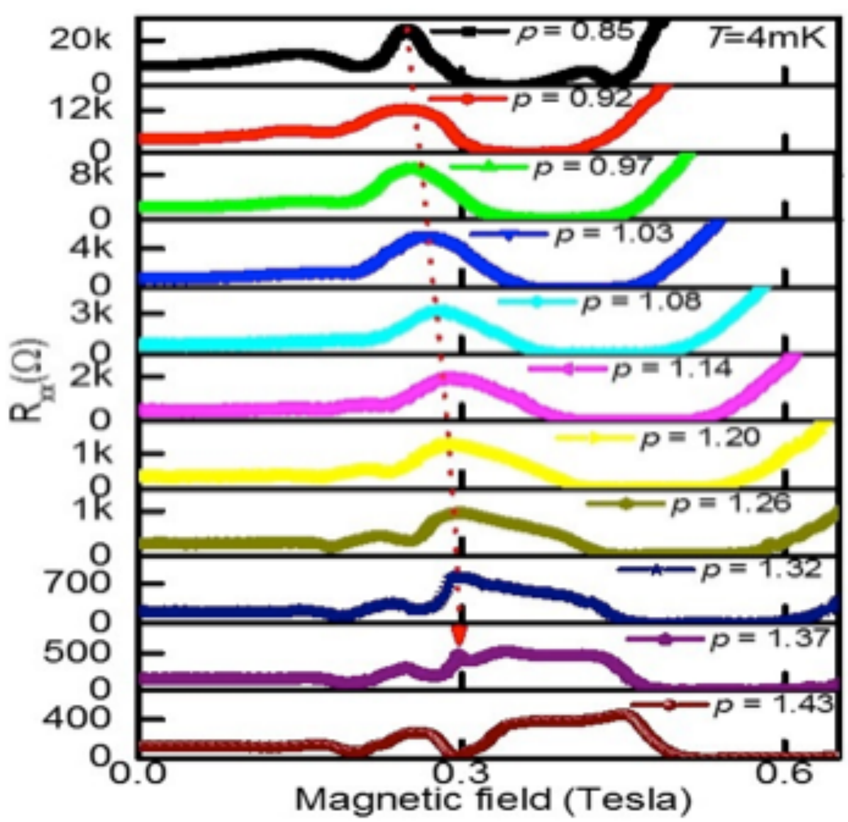


FIGURE 4. Variation of the magneto-resistivity of a 2D hole system at 4mK as a single function of density. The dash line illustrates the evolution/melting of the 2D Wigner solid.

low temperatures in the High B/T facility has shown strong evidence of a new intermediate phase between the clean 2D Wigner crystal phase and the liquid phase. The new phase had been predicted in the theory of micro-emulsions where the crystal and liquid co-exist. The new phase becomes washed out with increasing disorder in low mobility samples, confirming that it is due to Coulomb frustration and not a trivial disorder effect.

New quantum kagome ice for the pyrochlore $Tb_2Ti_2O_7$

Ultra-high sensitivity ac measurements of the magnetic susceptibility of the pyrochlore $Tb_2Ti_2O_7$ have revealed the existence of a new phase at low temperature, T<50 mK and for magnetic fields B< 700 gauss. In the titanate pyrochlores, $R_2Ti_2O_7$, the rare earth ions R^{3+} form a highly frustrated 3D lattice of corner sharing tetrahedra.

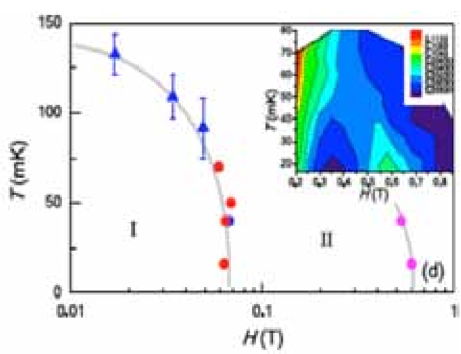


FIGURE 5. Phase diagram for $Tb_2Ti_2O_7$.

Completed rebuild of campus-wide helium recovery system, serving two NHMFL Facilities, (i) the High B/T Facility and (ii) the Advanced Magnetic Resonance Spectroscopy and Imaging facility (AMRIS) at the University of Florida. The new liquefier is based on a Linde Model L1610 and can produce liquid from pure helium gas at a rate of 80.7 liquid liters per hour and 73.4 liquid liters per hour from impure recovered helium gas, which exceeded the design capacity of 72 liquid liters per hour. This capability meets the projected needs of both large scale users and the widely distributed small scale users across campus for the next 15 years.

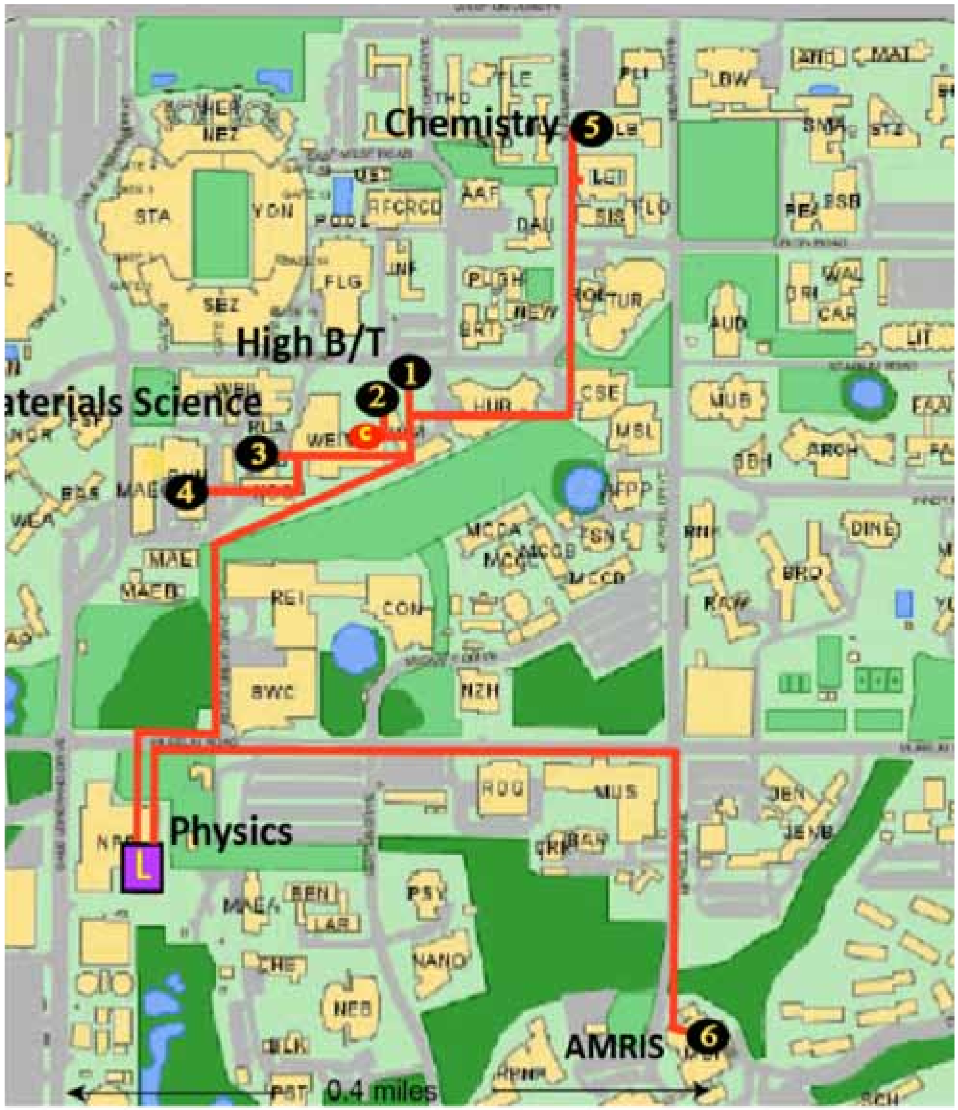
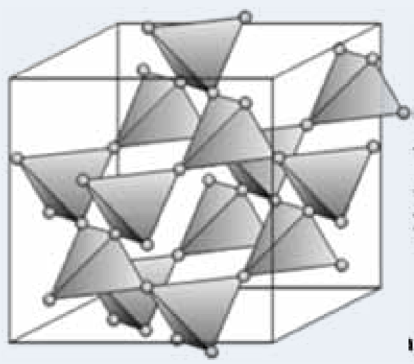
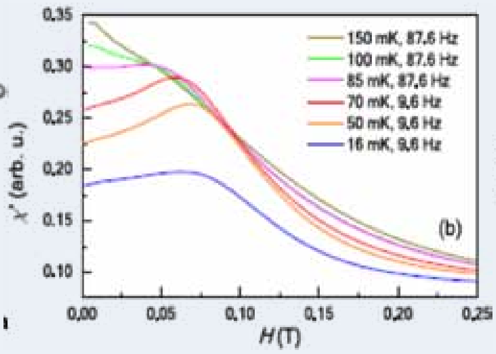


FIGURE 6. Aerial view of the helium gas recovery system with 1.4 miles of connections connecting recovery pods at the High B/T Facility (1), (2), AMRIS (6), Physics (L), Chemistry (5), Materials Sciences and Engineering (3,4) to the central purifier/liquefier in Physics. Typical annual production is 120,000 liquid liters.

Quantum Spin Ice: Pyrochlore Quantum Magnet $Tb_2Ti_2O_7$ at Ultra-Low Temperatures

USERS Q.J. Li and X.F. Sun (Hefei National Magnet Laboratory, China);
L. Yin, J.S. Xia, Y. Takano and N.S. Sullivan (University of Florida & National High Magnetic Field Laboratory)





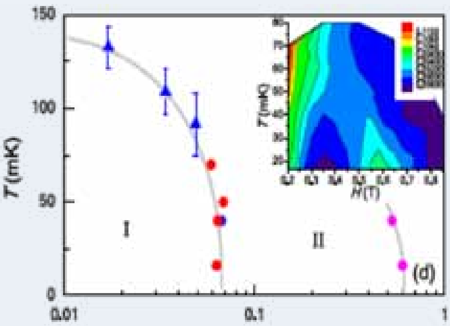


FIGURE 1. (LEFT) Corner-sharing tetrahedra of the pyrochlore structure.
FIGURE 2. (CENTER) Susceptibility as function of magnetic field and excitation frequency.
FIGURE 3. (RIGHT) Low temperature phase diagram of $Tb_2Ti_2O_7$

Frustrated quantum magnet – the pyrochlore structure consists of corner sharing tetrahedra (**Figure 1**). When this geometrical arrangement is realized for trivalent rare earth ions, as it is for R^{3+} ions in rare-earth titanates ($R_2Ti_2O_7$), the result is a high degree of frustration for nearest-neighbor magnetic interactions. The interplay of this geometrical frustration and magnetic anisotropy can lead to exotic magnetic ground states.

The most interesting of these rare-earth titanates is the terbium titanate, for which neutron scattering studies have suggested a crossover from a disordered paramagnet to a spin liquid at low temperatures. Researchers recently carried out ac susceptibility measurements at millikelvin temperatures to determine the nature of magnetic ordering -if any- as a function of applied magnetic field using the ultra-quiet low-temperature environment of the MagLab's High B/T Facility.

The results revealed a weak magnetization plateau below 50 mK (**Figure 2**), as predicted for a single-tetrahedron four -spin model. This new result supports the proposal that the disordered ground state of $Tb_2Ti_2O_7$ (Phase I in **Figure 3**) is a quantum spin ice.

Facilities

High B/T Facility, University of Florida, Gainesville, FL.

Citation

Low Temperature Phases of the Pyrochlore Quantum Magnet $Tb_2Ti_2O_7$, L. Yin, J.S. Xia, Y. Takano, N.S. Sullivan, Q.J. Li, and X.F. Sun, *Phys. Rev. Lett.* **110**(13), 137201 (2013)

NMR & MRI Facility at FSU

The NMR and MRI User Program in Tallahassee offers user scientists access to the highest magnetic fields along with the latest NMR techniques and unique probe technology. Our flagship 900 MHz ultra-wide bore spectrometer is the world's highest field instrument for *in vivo* imaging and also offers leading capabilities in materials and biological solid state NMR. Lower field instruments offer users additional unique capabilities in solution, solid state NMR and imaging, as well as, opportunities for additional experiment time.

Our technology efforts continue to be focused on the development of innovative probes for triple resonance solid state, high field *in vivo* imaging and very high mass sensitivity solution NMR probes. Associated with a new initiative funded through an NSF Major Research Instrumentation grant and the State of Florida, the NMR and EMR programs have teamed up to develop two new ultra-high sensitivity capabilities for the NHMFL, Overhauser solution Dynamic Nuclear Polarization (DNP) and Bio-solids DNP. The initial capabilities for these techniques will become available in the summer of 2014. An NIH High End Instrumentation proposal has been submitted for a rampable 14 T 89 mm bore magnet with the Bio-solids DNP. This proposal included research proposed from a dozen of the most highly respected NMR laboratories in the US. Efforts are also underway to develop *rf* probes and associated NMR instrumentation that will be needed for a ground-breaking new powered magnet, the 36 T series connected hybrid, which will have record-setting capabilities for NMR.

Facility Developments and Plans

2013 was a very productive year for the NMR/MRI Program in Tallahassee. A $10M renewal of an NIH Program Project Grant with a Technology Core for continued biological solid state NMR probe development was submitted. Indeed, the RF instrumentation group headed by Bill Brey hosted Bruker Instrument Engineers for a workshop on probe technology this year. The NMR/MRI in Tallahassee teamed up with the AMRIS Program in Gainesville to aid in a major Metabolomics initiative led by AMRIS researcher Art Edison that was recently funded by NIH. One of the tools for this initiative is the successful ultra-high mass-sensitivity solution NMR probes designed and engineered largely by Bill Brey.

Lucio Frydman was hired part time to be the NHMFL Chief Scientist for Chem/Bio in 2012. Lucio is one of world's leading spin physicists, who has pioneered novel high sensitivity NMR and MRI experiments. This past year he received the Russel Varian Prize for innovation in NMR. Lucio's enthusiasm, for higher fields, higher resolution and sensitivity in NMR and MRI is boundless. This past year Lucio facilitated in face to face meetings and many on-line meetings between the Applied Superconductivity Center, Magnet Science and Technology and the NMR/MRI program a strategy for the development of High Temperature Superconducting NMR magnets that will reach to much higher magnetic field strengths than the current low-temperature superconductors. Such a magnet will require 10s M$ and the

TABLE 3

NMR-MRI Facility at FSU Magnet Systems

NMR Frequency	Field (T)	Bore (mm)	Homogeneity	Measurements
1066 MHZ	25	52	1 PPM	Solid State / Solution NMR
900 MHZ	21.1	105	1 PPB	Solid State NMR, MRI
830 MHZ	19.6	31	100 PPB	Solid State NMR
800 MHZ	18.7	63	1PPB	Solid State NMR
800 MHZ	18.7	52	1 PPB	Solution NMR, Cryoprobe
720 MHZ	16.9	52	1 PPB	Solid State / Solution NMR
600 MHZ	14	89	1 PPB	MRI and Solid State NMR
600 MHZ	14	89	1 PPB	Solid State NMR
600 MHZ	14	52	1 PPB	Solution NMR
500 MHZ	11.75	89	1 PPB	Solid State NMR
500 MHZ	11.75	89	1 PPB	NMR Microscopy
400 MHZ	9.4	89	1 PPB	Solid State NMR
300 MHZ	7	52	1 PPB	Instrument Development
300 MHZ	7	89	1 PPB	Solid State NMR

primary scientific recipients of this technology with be biomedical applications. Consequently, a technology proposal was submitted to NIH for the development and testing to km length HTS coils for demonstrating and testing the HTS capabilities.

A year ago we received an 800/63 magnet from the University of Minnesota for the cost of extracting the magnet from a subterranean facility and shipping it to Tallahassee, where it has now been reassembled, energized and shimmed. A new Bruker console has recently been received and solution and solid state capabilities are being developed for this system including some of the unique high sensitivity pulse sequences developed by Lucio Frydman. With the latest Bruker console the NHMFL and Bruker are partnering for the development of a broadband lock system using the 800/63 as a test bed for the Series Connected Hybrid that is being constructed and will be energized in 2015 to a field strength of 36 T. This system and the HTS magnet systems will have significant temporal instabilities and hence a much more sophisticated field/frequency lock technology is under development. A pair of phase one activities for this project were implemented in 2013 with an integrated field-ramp/lock system on the 900 UWB bore magnet and a demonstrations of a unique capability for obtaining two dimensional solution NMR spectra from a resistive magnet were demonstrated.

Highlights from the Past Year

Dr. William Brey, head of the Radio Frequency Instrumentation and Technology Group teamed up with Prof. Jeff Schiano at Penn State to dramatically enhance the temporal stability of the Keck magnet, a 25 T resistive magnet. The demonstration shown in **Figure 1** used cascade field regulation of both high and low frequency fluctuations and permitted for the first time the recording of TOCSY 2D solution NMR spectrum of ethanol at 25 T and in a resistive magnet. The successful field regulation system was based on using an inductive pickup coil to detect high frequency fluctuations, and a pulsed NMR field sensor for low frequency fluctuations. A single cascade regulation system uses the signals from both sensors to regulate the field to a level where high resolution solid state and imaging experiments are possible. Remarkably, field regulation is sufficient to record the first 2D TOCSY spectrum with a powered magnet.

Prof. Y. Yang at Xiamen University has teamed up with R. Fu at the NHMFL to obtain high resolution images of a battery phantom by Stray Field Imaging (STRAFI) allow one to visualize *in situ* Li-ion transfer between the electrodes during charge/discharge cycling as well as the formation and changes of irreversible microstructures of the Li components in the interface between electrolyte and electrodes, and particularly reveal a non-uniform Li-ion distribution in the graphite for the first time. Determining how the electrochemical processes become irreversible, ultimately resulting in degraded battery performance, will aid in developing new battery materials and designing better batteries. This project was supported by the NHMFL's UCGP program (*Nature Sci. Rpts*, 2013).

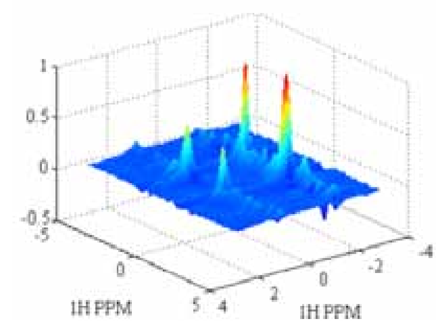


FIGURE 2. TOCSY spectrum of ethanol in the Keck magnet using cascade field regulation.

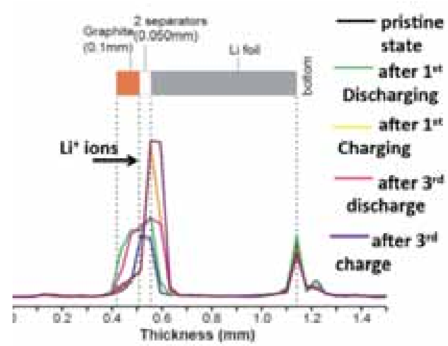


FIGURE 3. ^{7}Li Stray Field Imaging of prototype graphite||Li half-cell during charge-dicharge cycles.

Prof. S. Sen from UC Davis has been studying chalcogenide glasses which have found important and wide-ranging applications in photonics, electronics and telecommunication technologies owing to their unique optical properties including infrared transparency, large optical nonlinearity, and strong photosensitivity. Drs. Ivan Hung and Zhehong Gan of the NHMFL have developed a unique solid state NMR experiment called MATPASS to remove large chemical shift anisotropy broadening commonly seen in high-Z nuclei such as ^{77}Se in chalcogenide glasses. This experimental technique allows for

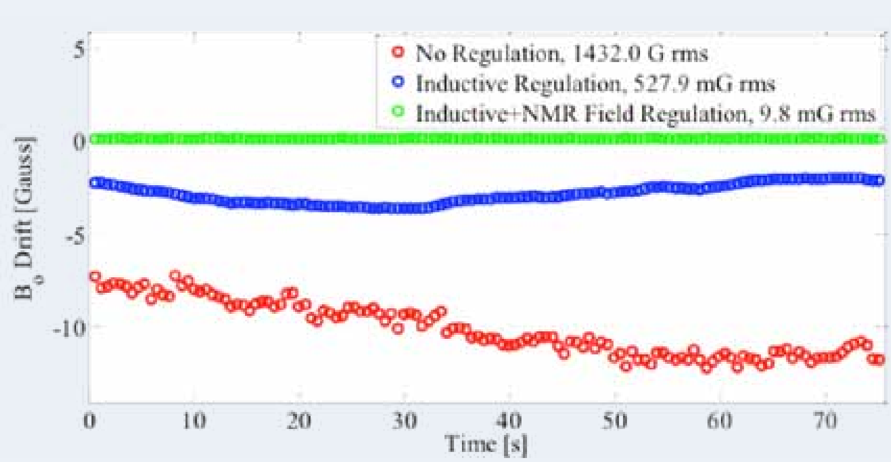


FIGURE 1. In the resistive Keck magnet, the time course of the magnetic field documenting more that two orders of magnitude enhancement in temporal stability.

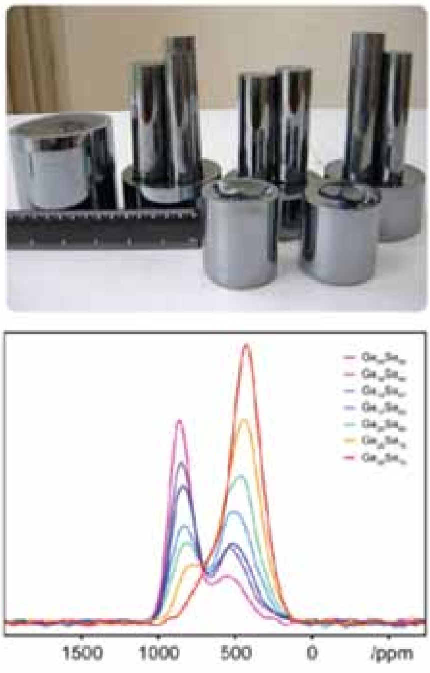


FIGURE 4. Chalcogenide glasses and a sample of the high resolution ^{77}Se MATPASS spectra that permit an examination of the electronic and bondingenvironment of nuclei in these important systems.

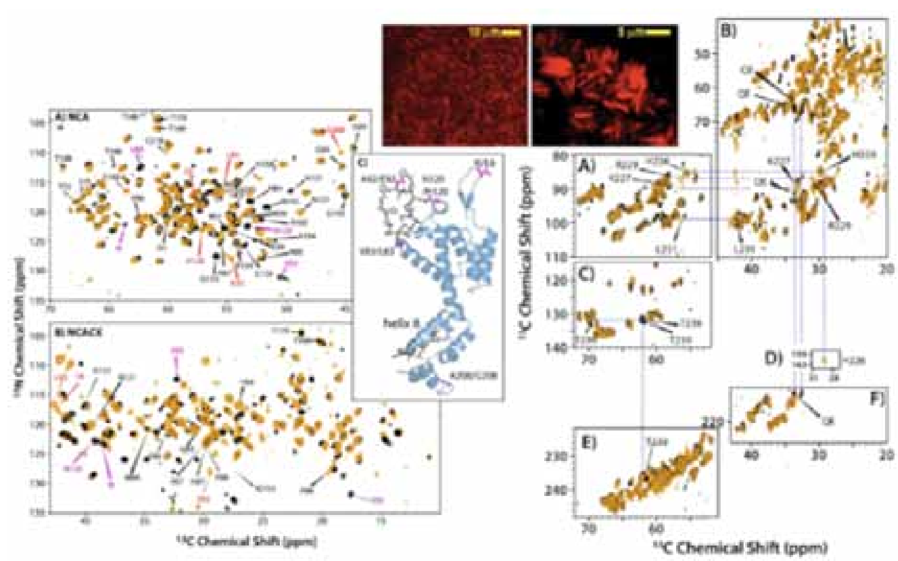


FIGURE 5. 1H, 13C, 15N triple resonance experiments on the Capsid protein, CA and CA-SP1 of HIV.

recording quantitative high-resolution NMR spectra of the chalcogenide glasses. The experimental results of Ge-Se glasses (**Figure 4**) and the data analysis with various Ge/Se mixtures indicate a randomly connected network of $GeSe_4$ tetrahedra and Se-Se chain fragments in these glasses (*J. Phys. Chem. B*, 2013).

T. Polenova (Univ. of Delaware) has been working with the CAPSID protein of the HIV virus in collaboration with an NHMFL team (P.Gor'kov, W.Brey, I. Hung, and Z. Gan) using enhanced magic-angle spinning spectroscopy capabilities on the 900. They have obtained high resolution $^{1}H/^{13}C/^{15}N$ correlation spectroscopy (**Figure 5**) which reveals detailed structural and dynamic information of the viral protein (selected as a highlight in *J. Am. Chem. Soc*, 2013).

Science Productivity

Work at the NMR-MRI Facility in Tallahassee led to 54 annual research reports and 43 peer-reviewed publications in 2013. These publications appeared in high-impact journals such as *Journal of the American Chemical Society* (3), *Angewante Chemie* (1), *ACS Nano* (1), *Nature Protocols* (1), *Chemical Science* (1), *Current Opinion in Structural Biology* (1), *Accounts in Chemical Research* (1), *Chemistry of Materials* (1), *Annual Review of Biophysics* (1) and *Nature Communications* (1), as well as in more specialized publications such as *Journal of Magnetic Resonance* (3), *Journal of Physical Chemistry B* (3), *Scientific Reports* (1), and *Analytical Chemistry* (1).

Progress on STEM and Building the User Community

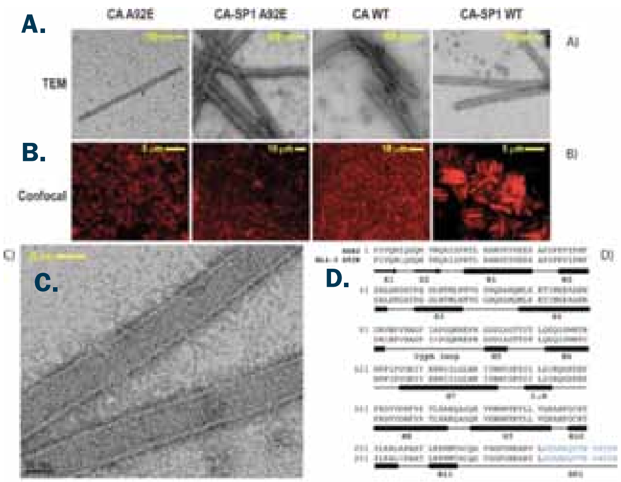
The NMR-MRI Facility in Tallahassee had 210 users during 2013: 48 were female and 18 were minorities. Of the 115 senior investigators in 2013, 34 were new to the NHMFL/NMR Program, of which 6 were **new principal investigators** leading research projects. To attract new users and projects we continue to add new capabilities such as the 63 mm bore 800 MHz magnet from the University of Minnesota.

Facility Operations Schedule

The NMR facility operates year round. Instrument time for non- *in vivo* samples are scheduled 24/7, including holidays and weekends. *In vivo* instrument time is scheduled for 10 hours a day including weekends. Since our goal in the NMR Facility is to develop new technology and new experiments there is typically 1-2 days per month that is allocated to testing equipment and testing new experiments. This is not true for the solution 800 and the 720 that are used for well tested experiments on the state of the art sample preparations. The 500 had somewhat more down time associated with the 50% of time that is dedicated to Prof. Anant Paravastu. Please note that Florida State University purchased this instrument in part for the start-up package of Prof. Paravastu.

Solid-State NMR Structural and Dynamics Studies of HIV-1 Protein Assemblies

USERS G. Hou, Y. Han, C. Suiter, H. Zhang and T. Polenova (U. of Delaware, Chemistry & Biochemistry); Z. Gan, W.W. Brey, I. Hung and P. Gor'kov (NHMFL)



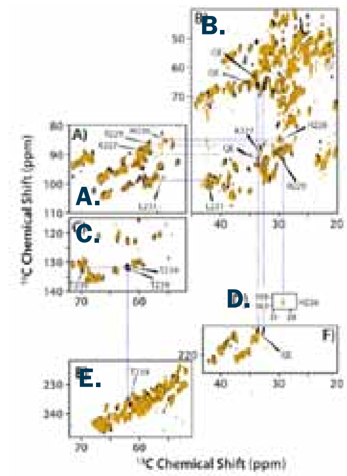


FIGURE 1. (LEFT) TEM **(A)** and confocal **(B)** images of CA A92E, CA-SP1 A92E, CA WT and CA-SP1 WT tubular assemblies. **C.** TEM image of the CA-SP1 WT tubular assemblies acquired at higher magnification and illustrating that highly regular hexameric lattice is clearly observed. **D.** Primary sequences of the HXB2 and NL4- 3 (A92E mutant) strains. **FIGURE 2. (RIGHT)** The superposition of the INADEQUATE spectra of the tubular assemblies of CA (orange) and CA-SP1 (black) HXB2 acquired at 21.1 T and 4 °C. **A., B. & C.** The aliphatic region. **D.** The Cβ–Cγ region of His residues. **E. & F.** The Cα-C' region.

Introduction

Gag polyprotein from HIV-1 virus is responsible for assembly of virions from infected cells. Gag and its two products, capsid CA protein and capsid-spacer peptide 1 (CA-SP1) are the focus of this research. CA organizes and protects the viral genome by assembling into conical capsids. Following the viral entry into the host, CA disassembles to allow release of the viral genetic material into the host cytoplasmic compartment (uncoating). CA and the Gag processing intermediate CA-SP1 have recently become attractive targets of HIV-1 uncoating and capsid maturation inhibitors. Despite the promise of targeting CA maturation and uncoating processes by novel inhibitors, the current research is hampered by lack of understanding of the molecular mechanisms of the maturation and uncoating and of their temporal regulation, and detailed atomic-resolution structural and dynamics information of the assembled Gag, CA, and CA-SP1 is still lacking. The objective of our ongoing work is to gain atomic-level insight on structure and dynamics of these HIV-1 protein assemblies and their interactions with host proteins and small-molecule inhibitors, through state-of-the-art solid-state NMR spectroscopy[1-3].

Experimental

MAS NMR spectra were acquired at 21.1 T (900 MHz) on the ultra-wide bore 105 mm NMR magnet, outfitted with a 3.2 mm Low-E triple- resonance HXY probe developed and built at NHMFL. 2D (DARR, INADEQUATE, NCA, and NCACX) spectra were acquired on U-^{13}C, ^{15}N-labeled CA and CA-SP1 assemblies of tubular morphology. All spectra were processed in NMRPipe and analyzed in Sparky.

Results and Discussion

We have analyzed the structure of HIV-1 CA and CA-SP1 assemblies of tubular morphologies from two sequence variants (**Figure 1**). These assemblies yield unprecedented high-resolution MAS NMR spectra at high magnetic fields, permitting resonance assignments of these systems. We have demonstrated that CA assemblies from two sequence variants exhibit surprisingly large conformational differences in two functionally important loops. Remarkably, we discovered that the SP1 peptide is dynamically disordered and exists in a random coil conformation in the assembled CA- SP1 from both constructs (**Figure 2**). Our results published in JACS[3] provide support for the hypothesis that capsid maturation proceed via *de novo* reassembly and that the role of SP1 cleavage is to mediate the disassembly of the immature lattice for maturation. Our data highlight the importance of conformational plasticity in HIV-1 capsid protein and call for atomic-level scrutiny of the structures and dynamics of the maturation intermediates.

Conclusions

The current work sets the stage for mechanisms of HIV-1 maturation and into evaluation the interactions of HIV-1 protein assemblies with maturation inhibitors at the detailed structural level. MAS NMR methods are envisioned to become a central tool in these studies as they offer unprecedented atomic-resolution insight into the structure and dynamics of the various HIV-1 protein complexes.

Acknowledgements

This work was supported by the National Institutes of General Medical Sciences (NIH 50GM082251) and is a contribution from the Pittsburgh Center for HIV Protein Interactions.

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Binding of MgtR, a Salmonella Transmembrane Regulatory Peptide, to MgtC, a Mycobacterium Tuberculosis Virulence Factor: A Structural Study

USERS F.L. Jean-Francois and L. Song (NHMFL); J. Dai and H.-X. Zhou (FSU, Physics, Inst. Molecular Biophysics); L. Yu (Univ. Science & Technology, China); A. Myrick, E. Rubin (Harvard School of Public Health); P.G. Fajer (FSU, Inst. Molecular Biophysics, NHMFL); T.A. Cross (FSU, Chemistry and Biochemistry, NHMFL)

Introduction

MgtC is a membrane protein and an important virulence factor for pathogens that replicate in human macrophages, such as *Mycobacterium tuberculosis* (*Mtb*), the causative agent for TB. MgtC has recently been shown to inhibit the all-important F_1F_0 ATPase that synthesizes ATP for the host. In *Salmonella* another small membrane protein, MgtR inhibits MgtC, but MgtR is not present in the genome of *Mtb*. Here, we describe the binding of Salmonella MgtR to a transmembrane helix of the Mtb MgtC using Oriented Sample Solid State NMR, Electron Paramagnetic Resonance and Restrained Molecular Dynamics, potentially opening a new approach for TB drug development[1].

Experiments

Peptides were chemically synthesized. Oriented Sample solid state NMR spectra were acquired on 400 MHz NMR spectrometer using an NHMFL Low-E triple-resonance biosolids probe. Native cysteines in MgtR and MgtC were spin labeled with MtSSL. All samples were prepared in DMPC lipid bilayers. Continuous wave EPR measurements were performed on a Bruker ELEXSYS E680 spectrometer at 150K and at the NHMFL.

Results and Discussion

Figure 1 shows the ssNMR spectra characterizing the MgtR structure, additional ssNMR data was obtained for MgtC and for the complex. **Figure 2** shows EPR spectra of the components and complex providing a distance restraint between the two peptides, while **Figure 3** shows the restrained molecular dynamics refined structure

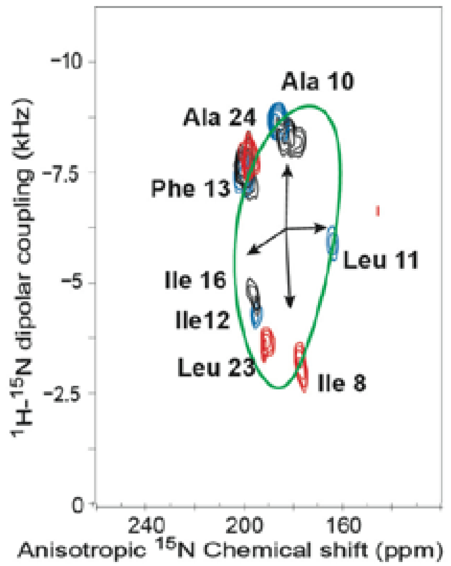

FIGURE 1. Superimposed OS ssNMR spectra of three specific site isotopically labeled MgtR samples in liquid crystalline lipid bilayers.

Conclusions

Salmonella MgtR binds to *Mtb* MgtC. The active site of MgtC is just a few residues from the N-terminus of the TM4 and therefore MgtR is in an ideal position to influence the function of MgtC raising the possibility that a peptide analog of MgtR could be developed as a new class of anti-TB drugs.

Acknowledgements

This work was supported by NIH AI-074805.

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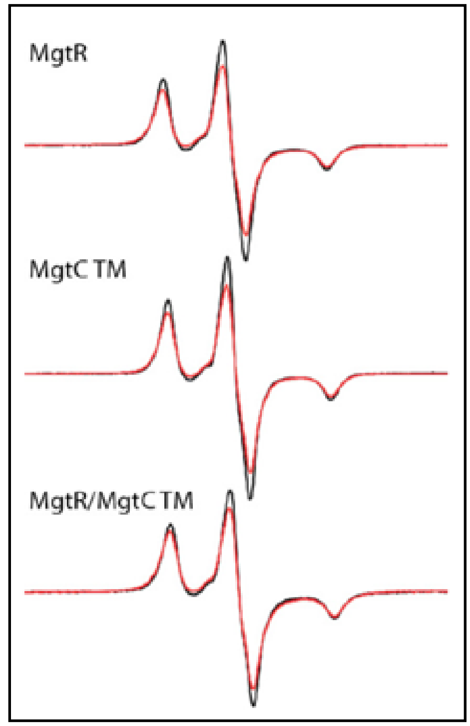

FIGURE 2. EPR spectra of MgtR, MgtC TM helix #4 and the combination of the two. Red curves – spin labeled; Black curves – 30% labeled peptides in (**A**) and (**B**) and the sum single labeled peptides.

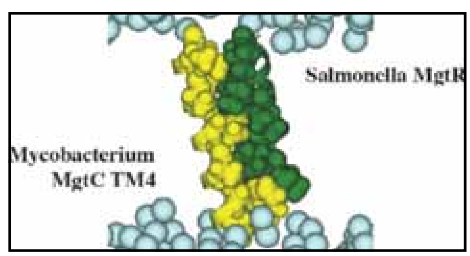

FIGURE 3. Molecular Dynamics refined complex in DMPC bilayers showing the inter-digitation of the sidechains

NMR & MRI Facility at UF (AMRIS)

The AMRIS facility at the University of Florida supports nuclear magnetic resonance studies of chemical compounds, biomolecular systems, tissues, small animals, large animals, and humans. We currently offer nine systems with different magnetic fields and configurations to users for magnetic resonance experiments. AMRIS has nine professional staff members to assist users, maintain instrumentation, build new coils and probes, and help with administration.

Several of the AMRIS instruments offer users unique capabilities: the 750 MHz wide bore provides outstanding high-field microimaging for excised tissues and small animals; the 11.1 T horizontal MRI is the largest field strength magnet in the world with a 400 mm bore; the 600 MHz 1 and 1.5 mm HTS cryoprobes are the most mass-sensitive NMR probes in the world for ^{1}H and ^{13}C detection, respectively, and are ideal for natural products research; the 3 T human whole body has 32 channels for rapid parallel imaging and is the only whole body instrument in the state of Florida dedicated to research. This year we added a 5 T DNP polarizer with helium cryostat. These systems support a broad range of users from natural product identification to solid-state membrane protein structure determination to cardiac studies in animals and humans to tracking stem cells and gene therapy *in vivo* to functional MRI in humans.

Facility Developments

With funding from the NHMFL, in 2013 we were able to accomplish two important goals within the AMRIS facility: upgrade our 750 MHz console and install a polarizer for dissolution dynamic nuclear polarization (DNP).

The upgrade of the 750 MHz system has enabled us to increase user throughput due to enhanced sensitivity, to streamline changes in modality between users (solids NMR vs. solution NMR vs. magnetic resonance imaging) and to increase the breadth of experimental configurations we can offer to users. It offers state of the art pulse programming and acquisition software and is our primary platform for offering new RF technologies to our users at the highest magnetic fields, in concert with the 18.8 T and 21.1 T systems sited in the NMR facility in Tallahassee. Through a UCGP award to Dr. Tom Mareci, we have developed a new probe for in vivo imaging on both rats and mice and are currently adding multi-resonance and quadrature detection capabilities to this platform. We also offer a state of the art triple resonance low-E magic angle spinning probe for solid state NMR studies, microimaging coils ranging in size from 50-500 µm and planar gradients for attaining micron resolution images, and a gradient with 30 T/m amplitude for diffusion studies.

The installation of a dissolution DNP polarizer realizes a major part of the DNP initiative, as outlined in our renewal proposal to the NSF for 2013-2017. In DNP, the higher polarization

TABLE 4

NMR & MRI Facility at UF Magnet Systems

^{1}H Frequency	Field (T)	Bore (mm)	Homogeneity	Measurements
750 MHZ	17.6	89	1 PPB	Solution/solid state NMR and MRI
600 MHZ	14.1	52	1 PPB	Solid state NMR and microimaging
600 MHZ	14.1	52	1 PPB	Solution NMR (HTS cryoprobe)
600 MHZ	14.1	54	1 PPB	Solution NMR (HTS cryoprobe)
500 MHZ	11.7	52	1 PPB	Solution/solid state NMR
470 MHZ	11.1	400 (290 mm useable bore)	0.1 PPM	MRI and NMR of animals
212 MHZ	5.0	89	1 PPM	DNP polarization
200 MHZ	4.7	330	0.1 PPM	DNP-MRI and NMR of animals
130 MHZ	3.0	900 (600 mm useable bore)	0.1 PPM	whole body MRI and NMR of humans and large animals

of an unpaired electron is transferred to a nucleus of interest to overcome the inherent insensitivity of nuclear magnetic resonance; dissolution DNP is a powerful technique for enhancing small molecule polarization by up to three orders of magnitude. Typically a metabolite of interest is hyperpolarized in one instrument (the DNP polarizer) and then transferred to a second instrument (either a conventional NMR spectrometer or an MRI scanner) where the hyperpolarized metabo-zlite can be injected to monitor metabolic flux *in vivo*. Our DNP polarizer utilizes a 5 T magnet in which samples are cooled to <1.1 K. With low power microwave irradiation (~140 GHz), at these temperatures we are able to achieve 70% polarization of ^{13}C nuclei in the polarizer; this translates to a >15,000 gain in SNR on dissolution and injection into our 4.7 T MRI/S scanner. The custom design of the polarizer enables the use of dissolution DNP to study metabolic flux in vivo using a variety of NMR –active nuclei as well as the study of fundamental mechanisms of polarization enhancement, including swept frequency and variable temperature studies of tailored stable radicals. This polarizer is available to external users through the MagLab. At present it is coupled to our 4.7 T MRI/S scanner with plans to extend automated injection to the 11 T MRI/S scanner and a 600 MHz NMR instrument in the near future.

Facility Plans and Major Research Activities

In spite of the continued challenging budgetary climate, our users have consistently successfully pursued federal funding to support their research programs and assisted the AMRIS facility in writing proposals to upgrade instrumentation. The successful partnership of the NHMFL user program with individual investigator research grants also provides constant scientific motivation for our technology development.

This year our continued efforts to develop high sensitivity MR technologies for small molecule analysis and in vivo spectroscopy coupled with our partnership with the NIH-funded Clinical Translational Science Institute at UF bore fruit in the successful funding of the newly created Southeast Center for Integrated Metabolomics (SECIM) through the metabolomics initiative supported by the NIH Common Fund. The goal of SECIM is to provide comprehensive and complementary resources for clinical and basic science metabolomics studies by developing an integrated metabolomics service to provide high-quality data, user-friendly statistical analysis tools, training and pilot funding to help users get the most out of a metabolomics study.

Facility Operations Schedule

The AMRIS facility operates year round, except for during the last week of December when the University of Florida is shut down. Vertical instruments for *ex vivo* samples are scheduled 24/7, including holidays and weekends. Horizontals operate primarily 8 hr/day, 5 days/week due to the difficulty in running animal or human studies overnight. In 2013, the 750 MHz NMR/MRI console was upgraded leading to an increase in time categorized as development or test, calibration, set-up, maintenance; full calibration of the RF console, new gradients, and new probes took approximately two months. A significant delay in the delivery of critical components for the new 500 console led to a decrease in magnet days on the 500 compared to other years; beginning in March it was back to full operation. The AMRIS facility operates as an auxiliary under federal cost accounting standards. Local and NHMFL-affiliated users pay for magnet time from federally funded projects (primarily individual investigator grants); the NHMFL funds magnet time for users from outside the UF system and development projects.

Outreach and Building the User Community

This year we hosted, in partnership with the NMR facility in Tallahassee, a highly successful planning workshop for the 36T SCH user program, which is scheduled to start in 2016. Over 45 scientists and engineers attended a series of presentations by leaders in the field of NMR/MRI on science drivers for the SCH in concert with technical presentations on the performance specifica-tions of the magnet and in depth discussions on console and probe requirements for successful commissioning of the SCH NMR program. A particular focus of this workshop was on identify-ing experiments that will produce significant, publishable results during the year-long SCH commissioning phase and enumerating the technical specifications needed for their success.

Art Edison visited Claflin University on March 18-19, 2013. During this visit he was a guest lecture in two undergraduate classes (advanced biochemistry and first semester organic chemistry), lecturing on nematode chemical ecology and presenting an overview of opportunities at the NHMFL for undergraduate students, graduate students, and faculty collaborations. He also met informally with several students and faculty. As a result of this visit, two under-represented (African American female) Claflin students worked at UF over the summer through the 2013 NHMFL REU program.

The 8-10 core faculty associated with the AMRIS facility are all active in recruiting and training undergraduate researchers as well as high school summer students. We consistently have 20-30 of these participants working on projects at any given time.

Science Productivity and Highlights

The AMRIS facility users reported 49 peer-reviewed publications and 8 theses for 2013. Some of the notable research highlights from 2013 include:

Development of a ^{13}C-optimized 1.5-mm high temperature superconducting (HTS) NMR probe and Detection of Natural Mechanisms of Chemical Detoxification

Art Edison, Bill Brey, Jerris Hooker, Vijay Ramaswamy, Gregg Stupp, Frank Schroeder, *et al.*

^{13}C is less sensitive and less abundant than ^{1}H and thus is not commonly used as a nucleus for biomolecular NMR studies. However, carbon is the basis of biological molecules, so improved methods for its detection would significantly enhance studies in natural products and metabolomics. We designed, built, and characterized a 1.5-mm HTS probe that is optimized for ^{13}C detec-tion. The probe

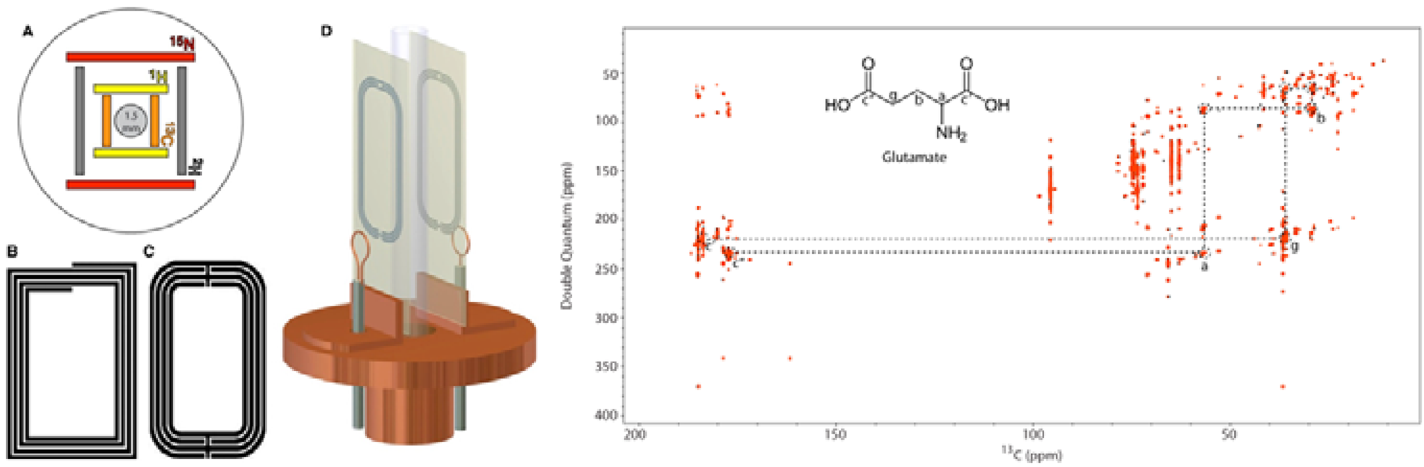

FIGURE 1. LEFT: Overall design of the 1.5-mm ^{13}C-optimized HTS probe. **A.** Schematic of coil layout. The sample chamber (light grey) accommodates a 1.5-mm tube and is regulated near room temperature. The coils are maintained near 20 K using a standard Agilent Cryogenic system (white background). The 4 Helmholtz pairs of coils are arranged around the sample as indicated. **B.** Schematic of a spiral resonator design, which is used for all non-^{1}H nuclei. **C.** Schematic of a racetrack design, which is used for the ^{1}H coils. **D.** The arrangement of one of the four pairs of HTS coils supported by a coldhead and surrounding the inner tube, into which the sample is loaded. The copper-colored coils on the outside are for inductive coupling and tuning (closest) and matching (in back). **RIGHT:** ^{13}C INADEQUATE spectrum of the exometabolome of 99% ^{13}C-labeled *C. elegans*. This spectrum took about 12 hours to collect and provides extremely rich information about the chemicals produced by the worm. A manual annotation of glutamate is shown, and we are developing new approaches to automate the spin system identification and database matching of 2D INADEQUATE spectra to allow for efficient identification of metabolites in ^{13}C-labeled samples

has a total sample volume of ~35 µL with an active volume of 20 µL. The resulting mass sensitivity ^{13}C S/N of this probe is more than twice the best currently available commercial ^{13}C-optimized probe. As a result, new applications are now possible that would not be feasible with existing commercial probes including (a) natural abundance ^{13}C-based metabolomics on compounds with as little material as 40 nanomoles and (b) experiments which allow direct tracing of the carbon backbone with as little as seven millimoles of sample.

We are currently developing many new applications using ^{13}C direct detection including metabolomics and mixture analysis for both natural abundance and ^{13}C-enriched samples, characterization of unknown natural products produced in fungi, and metabolic pathway analysis and proof-reading capabilities in cells. Many of these exciting new applications are only possible using high sensitivity ^{13}C detection.

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NMR data were collected using a the newly developed 1.5 mm HTS probe described in the first publication installed in a 600 MHz NMR spectrometer in the AMRIS facility.

Observation of Single-File Diffusion in Dipeptide Nanotubes by High Field ^{129}Xenon NMR Diffusometry

Sergey Vasenkov, C. Russ Bowers, Muslim Dvoyashkin, *et al.*

Diffusion studies of gaseous sorbates in systems of one-dimensional nanochannels are both fundamentally interesting and highly relevant for applications that include molecular separations and catalysis. Confinement to one-dimensional channels can lead to single-file diffusion, *i.e.* diffusion under conditions when sorbate molecules cannot pass one another in narrow channels (**Figure 1**). In this case, the mean square displacement (MSD) grows proportionally as the square root of the diffusion time for a broad range of diffusion times. This research uses pulsed field gradient (PFG) NMR to find clear evidence for molecular single file diffusion of xenon gas con-fined inside model nanotube systems, *i.e.* L-Ala-L-Val (AV) and L-Val-L-Ala (VA) dipeptide nanotubes. **Figure 2** shows the time dependences of the MSD of xenon measured by ^{129}Xe PFG NMR in dipeptide nanotubes at 298 K. The experimental data in the figure obey the time scaling of single-file diffusion. This observation is consistent with the expectation that xenon atoms are too large to pass one another in the channels of AV and VA nanotubes. The observation of single-file diffusion was independently confirmed by hyperpolarized tracer exchange ^{129}Xe NMR studies in the same materials. An example of PFG NMR observation of normal (*i.e.* Fickian) diffusion in nanotubes was also reported: the transport of tetrafluoro-

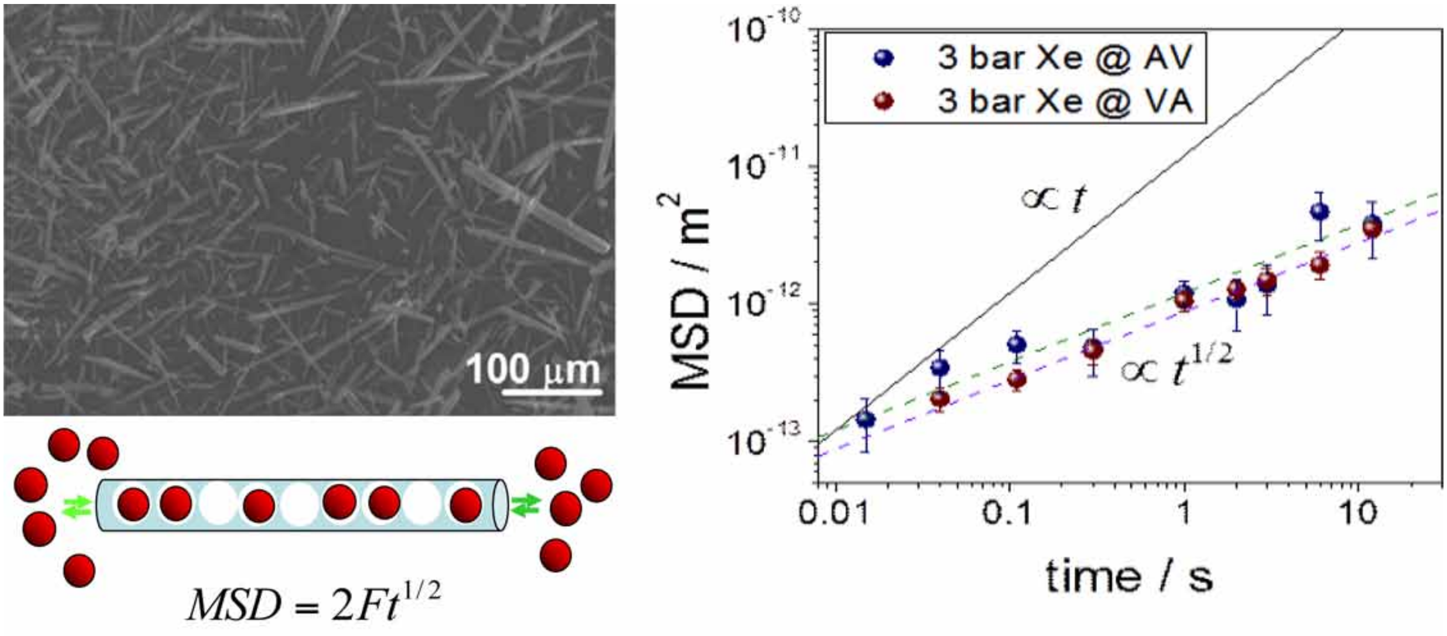

FIGURE 2. TOP LEFT: SEM micrograph of L-alanyl-L-valine dipeptide nanotubes.
BOTTOM LEFT: Schematic presentation of single-file diffusion in a nanotube.
RIGHT: Examples of the measured dependencies on diffusion time at 298 K of the mean square dis-placements (MSD) of xenon atoms inside AV and VA nanotubes.

methane in aluminosilicate nanotubes was found to follow the laws of normal diffusion in agreement with theoretical predictions.

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Diffusion data was collected using a Diff-60 gradient equipped probe on the 750 MHz NMR spectrometer in the AMRIS facility.

1.5-mm High Temperature Superconducting NMR Probe Optimized for ^{13}C

USERS Vijaykumar Ramaswamy and Arthur S. Edison (University of Florida/NHMFL); Jerris W. Hooker and William W. Brey (Florida State University/NHMFL); Richard S. Withers and Robert E. Nast (Agilent Technologies)

^{13}C is less sensitive and less abundant than ^{1}H and thus is not commonly used as a nucleus for biomolecular NMR studies. However, carbon is the basis of biological molecules, so improved methods for its detection would significantly enhance studies in natural products and metabolomics. We have designed, built, and characterized a 1.5-mm HTS probe that is optimized for ^{13}C detection. The ^{13}C coils required a counter-wound spiral design[1] to reduce the large E-field that would result with standard spiral coils. **The resulting mass sensitivity ^{13}C S/N of this probe is more than 2x greater than the best currently available commercial ^{13}C optimized probe.** As a result, new applications are now possible that would not be feasible with existing commercial probes including (a) natural abundance 13C-based metabolomics on compounds with as little material as 40 nanomols and (b) experiments which allow direct tracing of the carbon backbone with as little as 7 millimols of sample. **This probe is available to external users through the MagLab.**

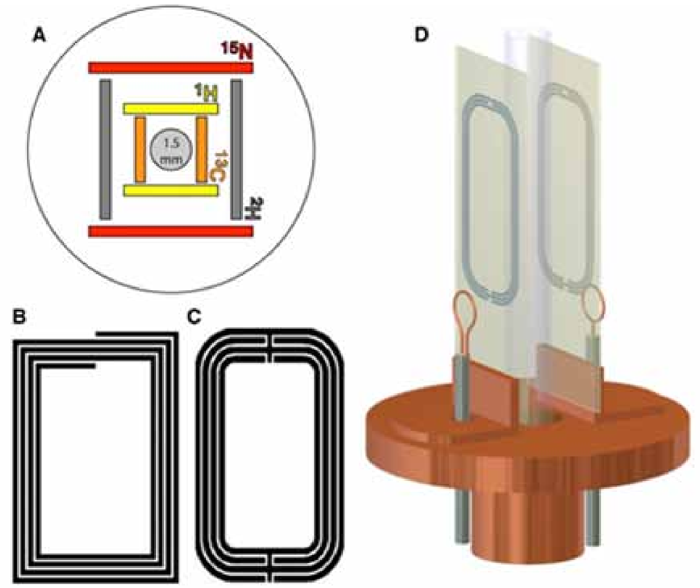


FIGURE 1. Overall design of the 1.5-mm ^{13}C-optimized HTS probe. **A.** Schematic of coil layout. The sample chamber (light grey) accommodates a 1.5-mm tube and is regulated near room temperature. The coils are maintained near 20 K using a standard Agilent Cryogenic system (white background). The 4 Helmholtz pairs of coils are arranged around the sample as indicated. **B.** Schematic of a spiral resonator design, which is used for all non-^{1}H nuclei. **C.** Schematic of a racetrack design, which is used for the ^{1}H coils. **D.** The arrangement of one of the four pairs of HTS coils supported by a coldhead and surrounding the inner tube, into which the sample is loaded. The copper-colored coils on the outside are for inductive coupling and tuning (closest) and matching (in back).

Facilities

MagLab's Advanced Magnetic Resonance Imaging and Spectroscopy Facility

1. Varian, Inc. (2010, April 20) NMR spiral RF probe coil pair with low external electric field (Withers, R. S., Nast, R. E., and Anderson, W. A., Eds.). US Patent Office.

Observation of Single-File Diffusion in Dipeptide Nanotubes by Xenon-129 High Field NMR Diffusometry

USERS M. Dvoyashkin, A. Katihar, C.R. Bowers and S. Vasenkov and A. Wang (University of Florida); J. Zang, G. Ipek Yucelen, Sankar Nair and David S. Sholl (Georgia Institute of Technology)

Diffusion studies of gaseous sorbates in systems of one-dimensional nanochannels are both fundamental interesting and highly relevant for applications that include molecular separations and catalysis. Confinement to one-dimensional channels can lead to single-file diffusion, *i.e.* diffusion under conditions when sorbate molecules cannot pass one another in narrow channels (**Figure 1**). In this case, the mean square displacement (MSD) grows proportionally to the square root of the diffusion time for a broad range of diffusion times.

This research uses pulsed field gradient (PFG) NMR to find clear evidence for **molecular single file diffusion of xenon gas confined inside model nanotube systems**, *i.e.* L-Ala-L-Val (AV) and L-Val-LAla (VA) dipeptide nanotubes. **Figure 2** shows the time dependences of the MSD of xenon measured by Xe-129 PFG NMR in dipeptide nanotubes at 298 K. The experimental data in the figure obey the time scaling of single-file diffusion. This observation is consistent with the expectation that xenon atoms are too large to pass one another in the channels of AV and VA nanotubes. The observation of single-file diffusion was independently confirmed by hyperpolarized tracer exchange Xe-129 NMR studies in the same materials. An example of PFG NMR observation of normal (*i.e.* Fickian) diffusion in nanotubes was also reported: the transport of tetrafluoromethane in aluminosilicate nanotubes was found to follow the laws of normal diffusion in agreement with theoretical predictions.

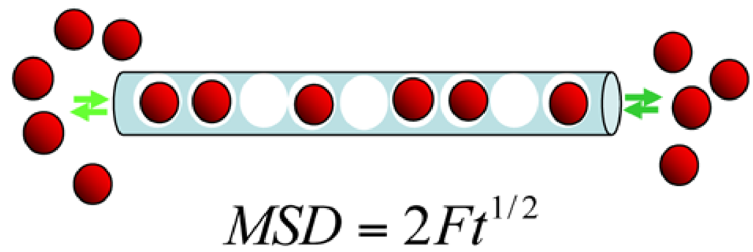


FIGURE 1. Schematic presentation of single-file diffusion in a nanotube.

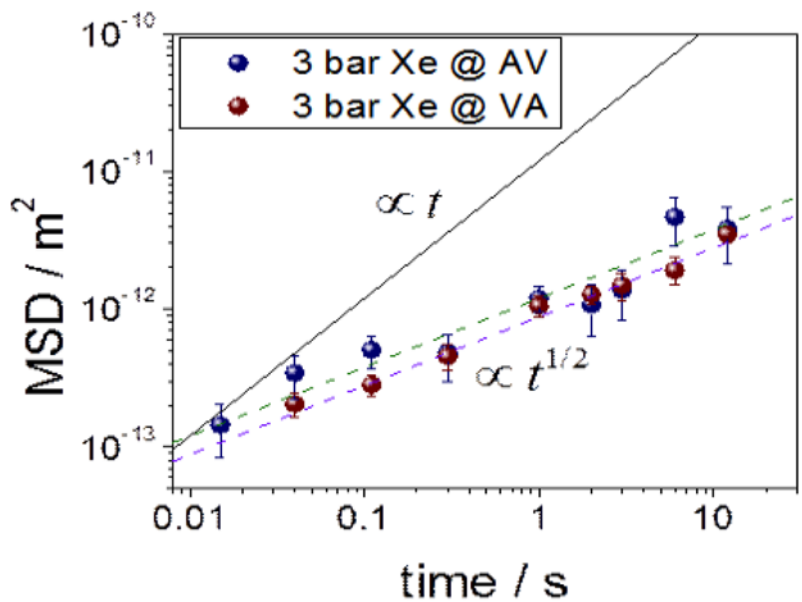


FIGURE 2. Examples of the measured dependencies on diffusion time at 298 K of the mean square displacements (MSD) of xenon atoms inside AV and VA nanotubes.

Facilities

AMRIS, University of Florida, wide bore 17.6 T Bruker Biospin spectrometer.

Citation

1. Dvoyashkin, M.; Wang, A.; Katihar, A.; Zang, J.; Yucelen, G.I.; Nair, S.; Sholl, D.S.; Bowers, C.R.; Vasenkov, S. Signatures of normal and anomalous diffusion in nanotube systems by NMR. *Microporous and Mesoporous Materials* **2013**, 178, 119-122.

Electron Magnetic Resonance

The Electron Magnetic Resonance (EMR) facilities at the NHMFL offer users several home built, high-field and high-frequency instruments providing continuous frequency coverage from 9 GHz to ~1 THz, with additional frequencies available up to 2.5 THz using a molecular gas laser. Several transmission probes are available for continuous-wave (c.w.) measurements, which are compatible with a range of magnets at the lab, including the highest field 45 T hybrid magnet. Some of the probes can be configured with resonant cavities, providing enhanced sensitivity as well as options for in-situ rotation of single-crystal samples in the magnetic field. Quasi-optical (QO) reflection spectrometers are also available in combination with dedicated high-resolution 12 & 17 T superconducting magnet systems; a simple QO spectrometer has also been developed for use in the resistive magnets (up to 45 T). EMR staff members can assist users in the DC field facility using broadband tunable homodyne and heterodyne spectrometers.

In addition to c.w. capabilities, the NHMFL EMR group boasts the highest frequency pulsed EPR spectrometer in the world, operating at 120, 240 and 336 GHz with 100 ns time resolution. A new quasi-optical 95 GHz spectrometer (HiPER) with 1 ns time resolution was delivered at the end of 2012 and has been undergoing testing and commissioning during 2013; this instrument will become available to users in a low-power mode in 2014, with high powers following later on. A commercial Bruker Elexsys 680 operating at 9/95 GHz (X-/W-band) is also available upon request. This combination of c.w. and pulsed instruments may be used for a large range of applications, including the study of optical conductivity, cyclotron resonance, paramagnetic impurities, molecular clusters, antiferromagnetic and ferromagnetic compounds and thin films, optically excited paramagnetic states, radicals, catalysts, model complexes and other biologically relevant species, etc.

Facility Operations

In principle, the EMR user facilities are available 365 days per year, 24 hours per day. Actual usage depends on user demand and the availability of support scientists. In many cases, the user can operate the instruments without EMR staff support. In many of these cases, users have been known to work long hours and for 7 days per week.

The most heavily used instrument in the EMR lab is the 17 T homodyne/transmission spectrometer. This instrument is reaching a point where it is over-subscribed during periods of high demand (at the time of writing, it is fully booked for the foreseeable future). This spectrometer was available for all of 2013, with the exception of 12 days due to the failure of the reference frequency generator. A replacement part was quickly ordered, thereby minimizing downtime. The usage (including maintenance) during 2013 was 293 days, implying that it was in use on EVERY SINGLE weekday, as well as on 46 weekend days and/or holidays.

The 12 T heterodyne/pulsed instrument was also available for most of 2013. About 1 week of time was lost for minor repairs. This spectrometer is not straightforward to use, requiring constant oversight by the EMR staff member (van Tol) responsible for the instrument. Consequently, users are not usually scheduled when this staff member is traveling. 181 days of usage were reported in 2013, constituting about 75% of the available working days (not including weekends and holidays).

The Bruker spectrometer was operational for the whole year in 2013. The instrument is shared between the FSU biology department and the NHMFL user program. 30% of the machine time was originally designated for the user program. In 2013, due to high demand from users, 68% of the usage time (161 days) was allocated for user operations. The high-field Mössbauer instrument was available throughout the year, with the exception of 63 days due to a major magnet cryostat repair. When it was available, it was used practically constantly, including at least 10 weekend days and holidays.

2013 Highlights: Events, Personnel and New Instruments/Projects

Workshops and conferences

The EMR group co-organized the 42nd Southeastern Magnetic Resonance Conference (SEMRC), which was held in Tallahassee from October 11 to 13, 2013. This conference attracts students, postdocs and faculty from across the region (and beyond). Keynote speakers were attracted from as far afield as St. Andrews University in Scotland.

The EMR group continued to sponsor the EPR Symposium at the Rocky Mountain Conference, which was held in Denver from July 28 to August 1, 2013. The sponsorship is used to support student travel to the conference.

EMR Engineer

Bianca Trociewitz joined the EMR group in 2013 as a permanent full-time engineer. She will assist the EMR scientists and students/postdocs in the development of new instrumentation, probes, sample-holders, etc., particularly as required for the new DNP initiative (see below) and as part of the effort to expand operations in the DC facility (Series Connected Hybrid and Split Resistive magnets).

DNP Postdoctoral Scientist

Thierry Dubroca (PhD from the University of Florida, followed by a postdoctoral position at UF) joined the EMR group in 2013. His position is funded through the National Science Foundation Major Research Instrumentation project focused on the development of an Overhauser DNP NMR capability operating at 395 GHz/600 MHz. Thierry has prior experience in the development of THz instrumentation as well as in the use of EPR.

Dynamic Nuclear Polarization (DNP)

Stephen Hill, Hans van Tol, Bianca Trociewitz and Thierry Dubroca are working closely with the NMR group (Bill Brey, Sungsool Wi, Joanna Long and Chief Scientist for Chemistry and Biology, Lucio Frydman) to develop a joint research program focused on high-field/frequency Dynamic Nuclear Polarization (DNP). As part of this effort, the National Science Foundation funded a separate $1.35M MRI project (with $250 k state match) to develop a high-power, gyrotron-based 395 GHz/600 MHz DNP instrument targeted at small molecules in organic solutions. A separate 395 GHz/600 MHz solids DNP effort is also under way, with support from the MagLab and the State of Florida. These joint EMR/DNP efforts represent a major new initiative that was laid out in the five-year renewal proposal to the NSF. The 395 GHz gyrotron source was ordered in 2013 and will be delivered in April 2014. In addition, many components of the solutions DNP setup were designed during 2013 and are now undergoing manufacture (delivery April 2014). A plan has been developed to run parallel 600 MHz solutions and solid-state DNP applications using 395 GHz microwave radiation from the same gyrotron source. The 600 MHz solution NMR magnet was delivered to the MagLab at the end of 2013, and the solids effort will initially take advantage of an existing magnet.

ABOVE: EMR users and students/postdocs working at: the 45 T hybrid magnet (top-left); the 25 T Keck magnet (lower-left); the 12 T heterodyne spectrometer (top-right); and the 15/17 T homodyne transmission spectrometer (lower-left).

HiPER

In August 2012, the 94 GHz HiPER spectrometer was delivered to the EMR lab from St. Andrews University in Scotland. The NHMFL system currently operates at low powers (<250 mW). However, an upgrade to 1 kW is planned within the next 6 – 12 months, which will enable $\pi/2$ pulses for S = ½ of just a few ns (shorter for larger spin values). HiPER features exceptional cross-polar isolation, enabling induction-mode detection while excitation pulses are incident on the sample. Thus, HiPER offers true nanosecond deadtime and the possibility to perform fourier-transform-type HFEPR measurements, akin to what is routinely achieved in NMR. Phase and frequency can be changed on nanosecond timescales, permitting highly complex spin manipulations (with sequences of up to 16 pulses of arbitrary phase) and repetition rates of up to 80 kHz. HiPER also offers excellent sensitivity.

HiPER is currently fully operational at low powers and will become part of the user program in 2014. A high-power (1 kW peak power) amplifier was delivered in the second half of 2013 and it is hoped that this will be integrated into HiPER in 2014 (pending further funding). Longer term plans involve extending capabilities to ~240 GHz. A workshop is planned either in 2014 or 2015 (pending the upgrade to 1 kW) in order to inform users of this new capability, and to grow a user program around HiPER.

Mössbauer Lab

A superconducting 8 T magnet was acquired in 2012 (donated to the MagLab from Emory University) and was installed as a part of a second, independent Mössbauer system in 2013. The magnet is specially designed for Mössbauer spectroscopy and is equipped with a bucking coil to reduce the magnetic field at the site of the gamma source below 100 Gauss. Both the old and the new instrument operate on ^{57}Fe nuclei. Mössbauer spectroscopy in magnetic field allows determination of the nuclear g parameters, the sign of the quadrupole splitting, etc. A Mössbauer specialist, Sebastian Stoian, was hired as a postdoctoral fellow at the end of 2012. He has been very active in attracting and supporting new users during 2013. There were 14 applications to use the Mössbauer facility in 2013. Interestingly, some of these applications generated new users for the EPR facility.

Plans for 2014

Magnetism Summer School

The EMR Director is part of a team of faculty from Florida State University (FSU physics and chemistry) that will organize the second Undergraduate School on Magnetism and Magnetic Materials (US-MMM). This event will be held in July, and will include lectures and practicals that focus on various topics in magnetism. The inaugural IS-MMM in 2012 was attended by 13 undergraduates selected from a diverse pool of US applicants. At least two of the participants have since joined graduate programs at FSU. We anticipate increasing the size of the 2014 School

HiPER

As noted above, it is hoped that the new 94 GHz HiPER spectrometer will be upgraded during 2014 (pending additional funding). A 1 kW 94 GHz amplifier with 1 GHz instantaneous bandwidth was delivered in 2013. Integration requires several modifications to the existing setup – work that will be performed by the University of St. Andrews. In the meantime, HiPER is fully functional at low power, offering exceptional concentration sensitivity in situations where the amount of sample is not limited. Extensive testing has been performed in 2013 demonstrating that HiPER outperforms the commercial W-band spectrometer in this regard, even at low powers. We plan to start accepting applications for time on HiPER during 2014.

HiPER Workshop

In response to recommendations from our users, a workshop is planned either in late 2014 or early 2015 that will focus on the technical capabilities and potential applications of the new HiPER spectrometer. The exact timing will depend on completion of the high-power upgrade (see above). The workshop will feature scientific presentations from experts, as well as hands-on demonstrations. Existing and new users will be invited to participate, particularly graduate students and postdocs. The workshop will be extensively advertised.

Dynamic Nuclear Polarization (DNP)

2014 is shaping up to be a big year for activities related to DNP. The 395 GHz, 50 W gyrotron source will be delivered in April, together with the quasioptical propagation system connecting the gyrotron output to the 600 MHz NMR magnet, as well as the DNP probe. The summer will therefore be devoted to assembling the system, and we hope to report results from initial tests at the end of 2014. Once assembled, a considerable amount of testing and optimization of this truly unique capability is necessary. Therefore, user activities are not anticipated before 2016 or even 2017.

Progress on STEM and Building the User Community

In 2013, the EMR group received 23 proposals from first time users out of a total of 66, *i.e.*, 35% of our applications were from first time users. These submission numbers represents significant increases over 2012 (42 proposals and 17 new users). This may be attributed to several new experimental capabilities that came online in 2013, including the 8 T Mössbauer spectrometer and HiPER. Interestingly, the Mössbauer facility has recently attracted new users who subsequently applied for time on the EPR spectrometers, *i.e.*, the Mössbauer facility seems to be attracting new users to the EPR facilities. The EMR program assisted 148 individual researchers in 2013, of which a quarter of those reporting were either female (19%) or minority (6.5%). In an effort to attract new users, the EMR group continues to provide up to $500 of financial support to first time visitors to the lab. The EMR group has also made progress in terms of the diversity of its staff, with the hiring of engineer Bianca Trociewitz. The majority of students and postdocs associated with the group are also female.

Members of the EMR group continue to make aggressive efforts to advertise the facility at international workshops and conferences. These efforts included attending and presenting at conferences outside of their own immediate research areas. The group also organized or participated in focused sessions/symposia at major conferences (*e.g.* APS and ACS) and provided financial support in the form of student travel grants for the two main EPR conferences in the US. The group will organize a student summer school during 2014 as a means of outreach to the international EPR community. Finally, the EMR group has participated in several outreach activities, including the mentorship of summer REU students, RETs and local high-school interns.

Science Productivity

In 2013 a large number of research groups and projects were accommodated by the EMR group, resulting in the submission of 45 research reports. In addition, 47 peer-reviewed journal articles were reported by our users (similar to 2012 where 48 were reported), as well as numerous presentations at conferences. Many publications appeared in high-impact journals including (in order of decreasing impact factor): *Angewandte Chemie* (4); *Journal of the American Chemical Society* (3); *PNAS* (1); *Physical Review Letters* (1); *Carbon* (1); *J. Biol. Chem* (1); *Inorganic Chemistry* (9); *Dalton Transactions in Chemistry* (2); Physical Review B (5); and *PLOS One* (1). Projects spanned a range of disciplines from applied materials research to studies of proteins. A few recent highlights are given below.

High-Frequency and -Field EPR Detection of a Di-radical Intermediate within the Context of Tryptophan Tryptophylquinone Biosynthesis

USERS E.T. Yukl, L.M.R. Jensen and C.M. Wilmot (U. of Minnesota); F. Liu and A. Liu (Georgia State U.); J. Krzystek (NHMFL); S. Shin and V.L. Davidson (U. of Central Florida)

One of the most important advantages of high-field electron paramagnetic resonance (**HFEPR**) over conventional EPR is its power of resolution: small differences in spectroscopic *g-factors* that go unnoticed in low fields can be observed in high fields. This advantage has been used in characterizing many radicals, including those occurring in biosynthetic reactions.

Despite the importance of tryptophan (Trp) radicals in biology, very few have been trapped and characterized in a physiologically meaningful context.

Previous biochemical and low-field EPR studies suggest that two protein-based radicals are important for the formation of the catalytic tryptophan tryptophylquinone (TTQ) cofactor in a precursor protein preMADH. However, **it is impossible to distinguish the two structurally different Trp-derived radicals by routine EPR as it is unable to resolve their g-tensors**. In this work, the power of HFEPR (~400 GHz, 14.5 tesla) played a vital role in demonstrating for the first time that a pair of two cation radicals, one on Trp108 and another on Trp57-OH (see the illustration on the right), has to be generated prior to the chemical crosslinking during catalysis.

This work defines a new mechanism for radical-mediated catalysis of a protein substrate, and has broad implications for applied biocatalysis and for understanding oxidative protein modification during oxidative stress.

Facilities

EMR Facility and 15/17 T superconducting magnet.

Citation

1. Di-radical Intermediate within the Context of Tryptophan Tryptophylquinone Biosynthesis, E.T. Yukl, F. Liu, J. Krzystek, S. Shin, L.M.R. Jensen, V.L. Davidson, C.M. Wilmot, A. Liu, *Proc. Natl. Acad. Sci. USA* **110**, 4569–4573 (2013).

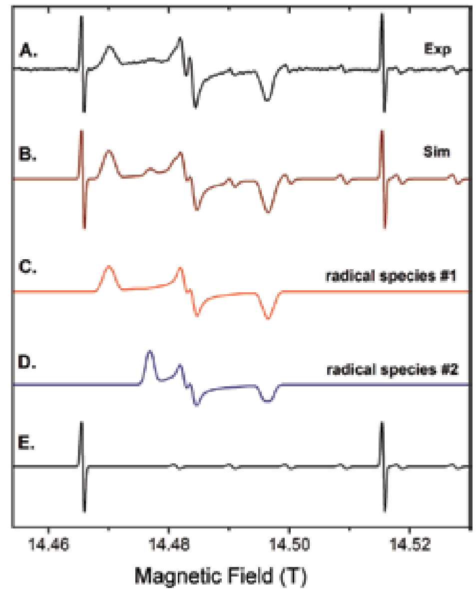


FIGURE 2. A 77 K HFEPR spectrum at 406.4 GHz of the preMADH di-radical intermediate 1 **A.** Spectral simulations show two free radical species, one with g tensor components of 2.00216, 2.00398, 2.00581 and Δg = 0.00365 (**C**) and the other 2.00216, 2.00402, 2.00486 and Δg = 0.00270 **D.** A hydrogen field standard and a Mn(II) impurity are also simulated (**E**) and added to an 85:15 concentration ratio combination of (**C**) and (**D**) to yield the final simulation (**B**).

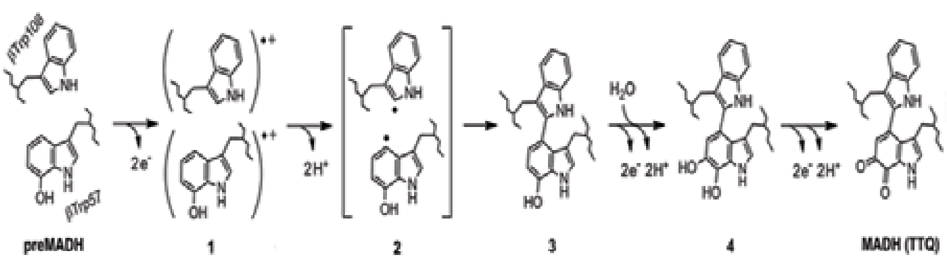


FIGURE 1. HFEPR was able to detect and characterize the intermediate species 1 in this proposed chemical reaction mechanism for the 6-electron oxidation of preMADH leading to formation of TTQ and mature MADH.

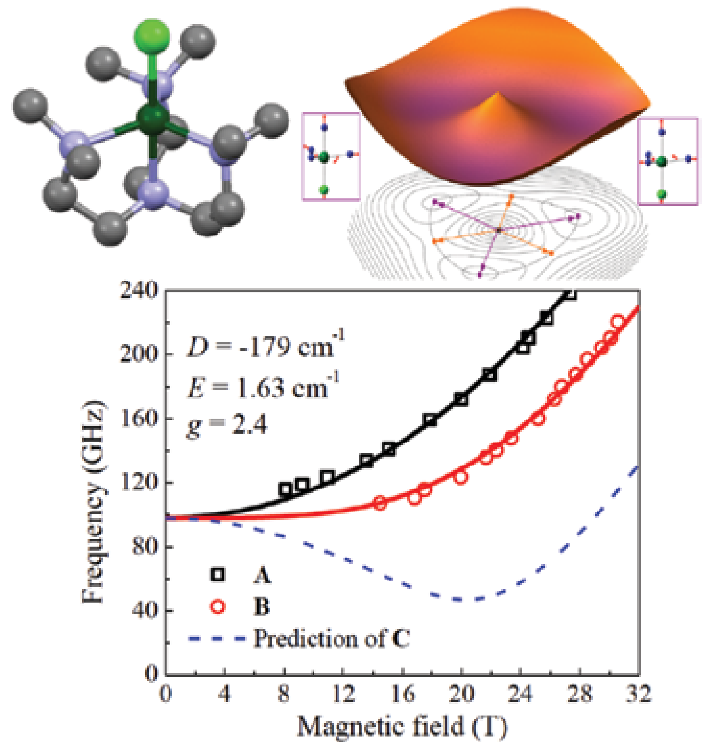
EMR

Giant Ising-Type Magnetic Anisotropy in Trigonal Bipyramidal Ni(II) Complexes

USERS R. Ruamps, R. Maurice, M. Boggio-Pasqua, N. Guihéry (U. Toulouse); L. Batchelor, R. Guillot and T. Mallah (U. Paris Sud); A.-L. Barra (LNCMI Grenoble); J. Liu and S. Hill (NHMFL); E.-E. Bendief, S. Pillet (U. de Lorraine)

Molecules that can be magnetized, so-called single-molecule magnets (SMMs), are of considerable interest in terms of their potential future use in molecular devices. Research has traditionally focused on large molecules with giant magnetic moments. However, recent studies show the importance of concentrating on maximizing magnetic anisotropy. One strategy involves using molecular building blocks with transition metals that reside in high-symmetry coordination environments, such as the trigonal bibyramidal Ni(II) complex seen in **Figure 1** (top left). If the correct symmetry is achieved, there may be a strong orbital contribution to the magnetic moment in addition to the spin moment. The combined ligand-orbital and spin-orbital interactions can then give rise to a giant magnetic anisotropy, as was predicted for this molecule.

EPR provides a direct measure of magnetic anisotropy and is, therefore, the method of choice to verify theoretical predictions. However, giant anisotropies require very high frequencies and giant magnetic fields. The molecule considered in this study is unstable to a small structural distortion away from the exact trigonal symmetry (top right), which is precisely quantifiable on the basis of the zero-field intercept (*2E*) of the EPR data (bottom). However, a very significant uniaxial anisotropy (D) remains, as determined from fits of the high-field EPR data. The results suggest that the anisotropy is an order of magnitude larger than in any previously known Ni(II) complex.



Facilities

EMR & DC field (31T, 50mm bore resistive magnet).

Citation

1. Giant Ising-Type Magnetic Anisotropy in Trigonal Bipyramidal Ni(II) Complexes: Experiment and Theory, R. Ruamps, R. Maurice, L. Batchelor, M. Boggio-Pasqua, R. Guillot, A.-L. Barra, J. Liu, E.-E. Bendief, S. Pillet, S. Hill, T. Mallah and N. Guihéry, *J. Am. Chem. Soc.* **135**, 3017–3026 (2013).

Ion Cyclotron Resonance Facility

During 2013, the Fourier Transform Ion Cyclotron Resonance (ICR) Mass Spectrometry program continued instrument and technique development as well as pursuing novel applications of FT-ICR mass spectrometry. These methods are made available to external users through the NSF National High-Field FT-ICR Mass Spectrometry Facility. The facility features six staff scientists who support instrumentation, software, biological applications, petrochemical and environmental applications, and user services as well as a machinist, technician, and several rotating postdocs who are available to collaborate and/or assist with projects.

TABLE 5

ICR Facility Magnet Systems

Field (T)	Bore (mm)	Homogeneity	Ionization Techniques
14.5	104	1 PPM	ESI, AP/LIAD-CI, APCI, DART
9.4	220	1 PPM	ESI, AP/LIAD-CI, APCI, APPI FT-ICR, Thermospray, DART, DAPPI
9.4	155	1 PPM	FD, LD FT-ICR

Facility Developments

An actively-shielded 14.5 T, 104 mm bore system offers the highest mass measurement accuracy (<300 parts-per-billion rms error) and highest combination of scan rate and mass resolving power available in the world (*Protein Sci.*, **19**, 703-715 (2010)). The spectrometer features electrospray, atmospheric pressure photoionization (APPI), atmospheric pressure chemical ionization sources (APCI), ; linear quadrupole trap for external ion storage, mass selection, and collisional dissociation (CAD); and automatic gain control (AGC) for accurate and precise control of charge delivered to the ICR cell. The combination of AGC and high magnetic field make sub-ppm mass accuracy routine without the need for an internal calibrant. Addition of new reagents enhances liquid chromatographic separation for intact proteins and increases the charge states of proteins up to 78 kDa (*Anal. Chem.*, **82**, 7515-7519 (2010). Mass resolving power > 200,000 at m/z 400 is achieved at one scan per second, which is ideal for LC-MS (*Int. J. Mass Spectrom.*, **305**, 116-119 (2011)) and facilitates automated data reduction for H/D exchange experiments (*J. Am. Soc. Mass Spectrom.*, **21**, 550-558 (2010)). Robotic sample handling allows unattended or remote operation. An additional pumping stage has been added to improve resolution of small molecules. Simultaneous infrared multiphoton (IRMPD) and front-end electron capture dissociation (ECD) are under development. Laser spray ionization inlet (LSII) and matrix assisted ionization inlet (MAII) coupled to high-field FT-ICR MS was applied to top-down protein analysis and characterization of metalloproteins (*J. Am. Soc. Mass Spectrom.*, **24**, 320-328 (2013).

The 9.4 T, passively-shielded, 220 mm bore system offers a unique combination of mass resolving power ($m/\Delta m$ = 8,000,000 at mass 9,000 Da) and dynamic range (>10,000:1), as well as high mass range, mass accuracy, dual-electrospray source for accurate internal mass calibration, efficient tandem mass spectrometry (as high as MS^8), and long ion storage period. (*Mass Spectrometry.*, **2**, S0009 (2013) A redesign to the custom-built mass spectrometer coupled to the 9.4T, 200 mm bore superconducting magnet designed around custom vacuum chambers has improved ion optical alignment, minimized distance from the external ion trap to magnetic field center and facilitates high conductance for effective differential pumping. (*J. Am. Soc. Mass Spectrom.* **22**, 1343-1351, (2011)) The length of the transfer optics is 30% shorter than the prior system, for reduced time-of-flight mass discrimination and increased ion transmission and trapping efficiency at the ICR cell. The ICR cell, electrical vacuum feed throughs, and cabling have been improved to reduce the detection circuit capacitance (and improve detection sensitivity) 2-fold (*Anal. Chem.* **85**, 265-272 (2013)). When applied to compositionally complex organic mixtures such as dissolved organic matter (*Org. Geochem.*, **65**, 19-28 (2013)) and petroleum (*Energy Fuels*, **27**, 1899-1908 (2013)), mass spectrometer performance improves significantly, because those mixtures are replete with mass "splits" that are readily separated and identified by FT-ICR MS. The magnet is passively shielded to allow proper function of all equipment and safety for users. The system features external mass selection prior to ion injection for further increase in dynamic range and rapid (~100 ms time scale) MS/MS (*Anal. Chem.*, **75**, 3256-3262 (2003)). Available dissociation techniques include collision-induced (CID), infrared multiphoton-induced (IRMPD) (*J. Am. Soc. Mass Spectrom.*, **23**, 644-654 (2012)), and electron capture-induced (ECD) (*J. Phys. Chem. A.*, **117**, 1189-1196 (2013). Development and design of an Atmospheric Pressure Laser-Induced Acoustic Desorption Chemical Ionization (AP/LIAD-CI) source enables facile and independent optimization of analyte desorption, ionization, and sampling events, and can be coupled to any mass analyzer with an atmospheric pressure interface (*Anal. Chem.* **84**, 7131-7137 (2012).

The 9.4 T actively shielded FT-ICR instrument is available for analysis of complex nonpolar mixtures and instrumentation development. The 9.4 T magnet is currently used for field desorption (*Anal. Chem.*, **80**, 7379-7382 (2008)) and elemental cluster analysis, and reported the formation of the smallest fullerene by stabilization through cage encapsulation of a metal by use of a pulsed laser vaporization cluster source (*J. Am. Chem. Soc.*, **134**, 9380-9389 (2012), and indicate that metallofullerences should be constituents of stellar/circumstellar and interstellar space as well as fullerenes (**Figure 2**, (*Proc. Natl. Acad. Sci. U.S.A.*, **110** (45), 18081-18086 (2013)). Boron-doped nanocarbon structures have important potential for use in materials science and electronics. Facile gas-phase formation of $C_{59}B$ from C_{60} by atom exchange reactions resulting from exposure of C_{60} to boron vapor elucidated by pulsed laser cluster source and analyzed by FT-ICR MS elucidates borafullerene formation (**Figure 3**, (*Angew. Chem. Int. Ed. Engl.*, **52**, 315-319 (2013)).

Science Productivity

Automated broadband phase correction of FT-ICR data can in principle produce and absorption-mode spectrum with mass resolving power as much as a factor of 2 higher than conventional magnitude-mode display, an improvement otherwise requiring a more expensive increase in magnetic field strength. We have developed and implemented a robust and rapid automated method to enable accurate broadband phase correction for all peaks in the mass spectrum and present experimental FT-ICR absorption-mode mass spectra with increased number of resolved peaks and higher mass accuracy relative to magnitude mode spectra, and produce more complete and more reliable elemental composition assignments for complex organic mixtures such as petroleum and asphaltenes (*Energy Fuels.*, **27**, 1899-1908 (2013)). Phase correction applied to complex petroleum fractions facilitates resolution and identification of ionic species that differ in mass by roughly the mass of an

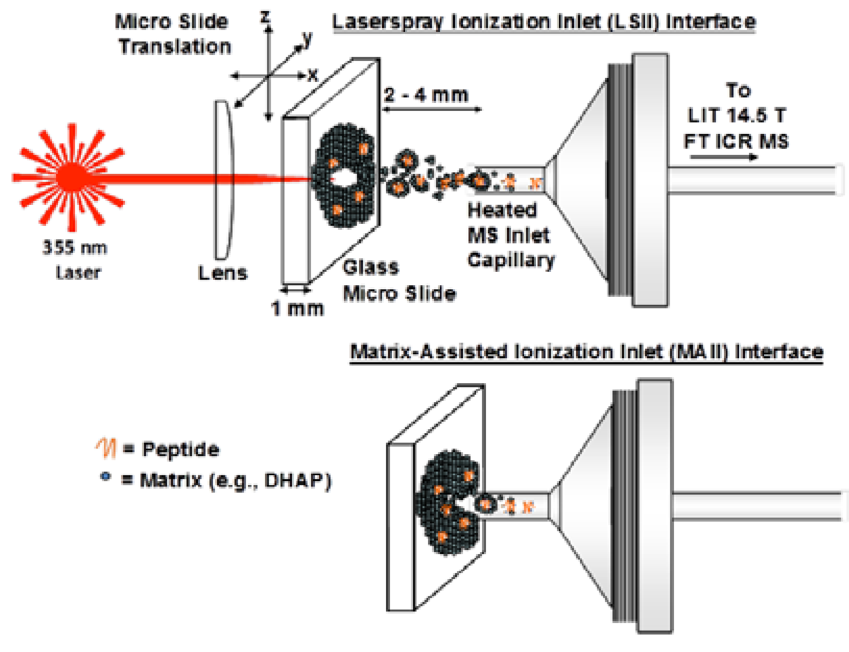


FIGURE 1. Schematic presentation of laserspray ionization inlet (top) and matrix-assisted ionization inlet source (bottom) interfaced to a hybrid linear quadrupole ion trap 14.5 T Fourier transform ion cyclotron resonance mass spectrometer.

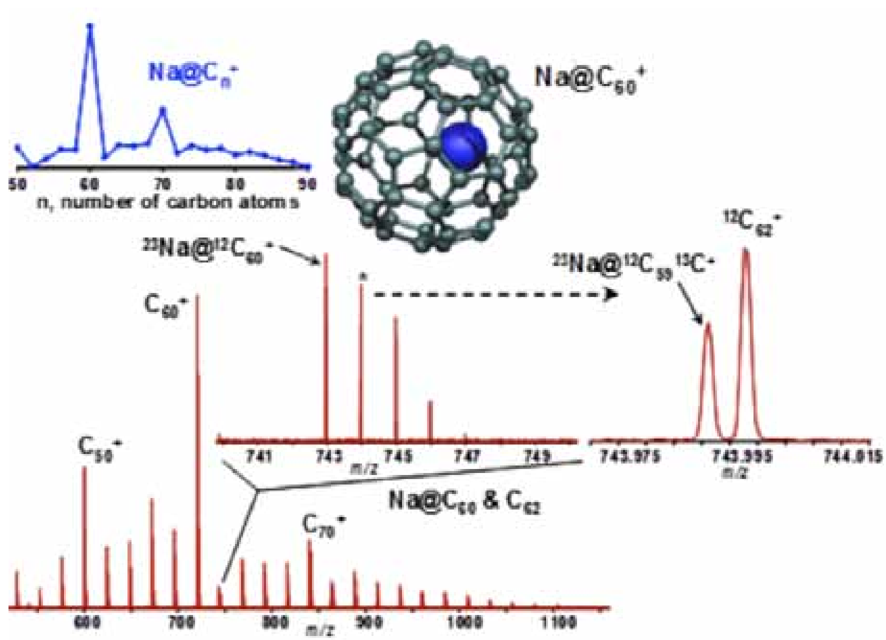


FIGURE 2. FT-ICR mass spectrum of cluster cations that spontaneously form in condensing carbon vapor seeded with Na (10 psi He gas flow, ~35 mJ·cm^{-2} fluence). The insets show Na@C_{60} clearly resolved from empty C_{62} and the relative abundance of Na@C_{2n} species.

electron (*J. Mass Spectrom.*, **46**, 337-343 (2011)). Development of a fast, robust, and automated algorithm that flattens the absorption-mode spectral baseline by defining baseline data minima, followed by linear interpolation to generate a complete baseline, followed by boxcar smoothing, and baseline subtraction increases the number of detected peaks for petroleum and proteins (*Int. J. Mass Spectrom.* **325-327**, 67-72 (2012)) (**Figure 4**).

Implementation of an **electrically compensated** Fourier transform ion cyclotron resonance cell for the 9.4 T instrument enables separation and identification of isobaric species in complex natural organic petroleum mixtures, and preserves ion cloud coherences for longer transient duration by a factor of 2 (*Anal. Chem.*, **83**, 6907-6910 (2011)). The improved performance of the compensated ICR cell provides more symmetric peak shape and better mass accuracy through tunable compensation electrodes, critical for optimal performance. FT-ICR MS typically uses an *m/z*-independent excitation magnitude to excite all ions to the same cyclotron radius, so that the detected signal magnitude is directly proportional to the relative ion abundance. However, deleterious space charge interaction between ion clouds is maximized for clouds of equal radius. To minimize ion cloud interactions, imposition of an *m/z*-dependent ion radius distribution (30-45% of the maximum cell radius) results in a 3-fold increase in mass spectral dynamic range for complex organic mixtures (*Anal. Chem.* **85**, 265-272 (2013)).

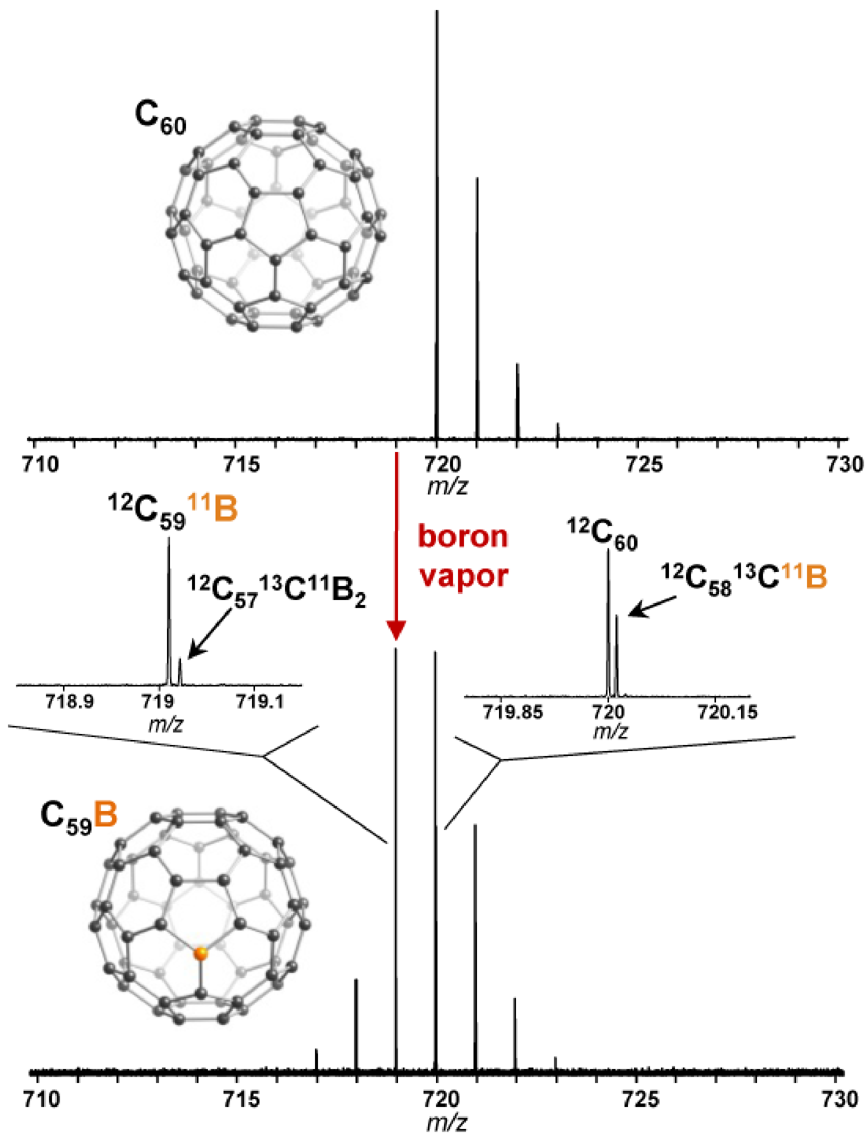


FIGURE 3. Negative-ion 9.4 T FT-ICR mass spectra of C_{60} without boron vapor (top), and after exposure to boron vapor (bottom). The heterofullerene, $C_{59}B$, was generated from pristine C_{60} by atom exchange reactions.

Development of novel ionization techniques such as Atmospheric Pressure Laser-Induced Acoustic Desorption Chemical Ionization (AP/LIAD-CI) decouples analyte desorption from subsequent ionization and enables rapid and independent optimization and generates analyte ions that are efficiently thermalized by collisions with atmospheric gases, thereby reducing fragmentation. Modification of the carrier/reagent gas for AP/LIAD-CI with O_2 reports the first molecular-level characterization of saturated hydrocarbons. Nonthermal sample vaporization with subsequent chemical ionization generates abundant ion signals for straight-chain, branched, and cycloalkanes with minimal or no fragmentation, and yields $[M-H]^+$ as the dominant molecular ionic species (*Anal. Chem.* **84**, 7131-7137 (2012))

Tertiary and quaternary structure can also be probed. Automated hydrogen/deuterium exchange improved by depletion of heavy isotopes ($^{13}C/^{15}N$) for protein subunits of a complex can greatly simplify the mass spectrum, increase the signal-to-noise ratio of depleted fragment ions, and remove the ambiguity in assignment of m/z values to the correct isomeric species. The potential epitopes of a recombinant food allergen protein, cashew Ana $_o$ 2, reactive to polyclonal antibodies, were mapped by solution-phase amide backbone H/D exchange (HDX) coupled to FT-ICR MS, and four regions were identified as potential epitoped and mapped onto a homologous model (**Figure 5**) (*J. Am. Soc. Mass Spectrom.*, **24**, 1016-1025 (2013)).

The detailed characterization of large

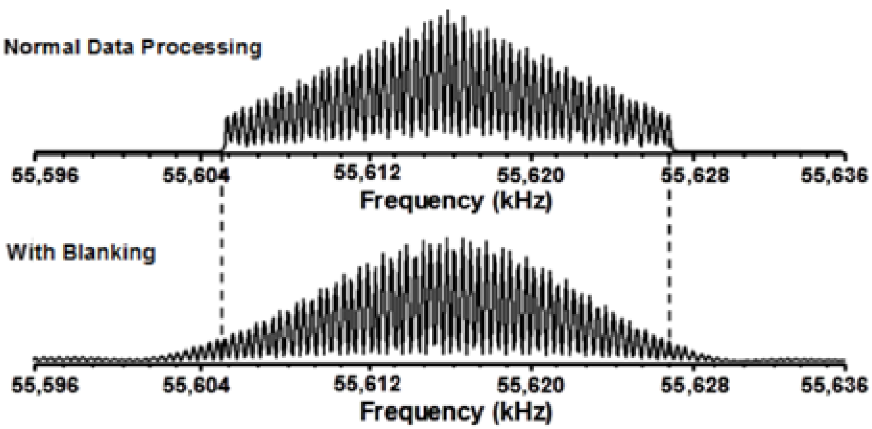


FIGURE 4. Simulated noiseless magnitude-mode FT-ICR mass spectra. Note the spurious signals at both ends of the bottom spectrum due to blanking of the time-domain segments between "beats."

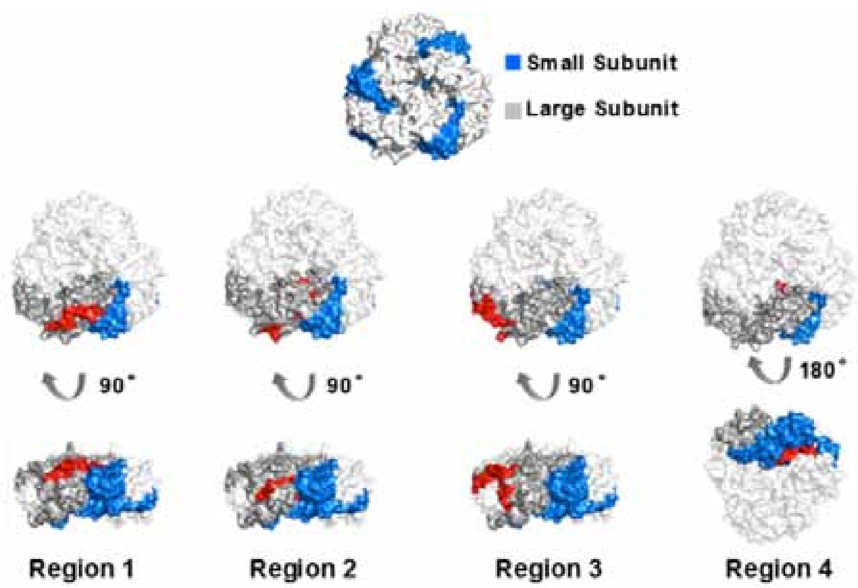


FIGURE 5. Four potential epitope regions mapped onto the X-ray structure generated by homology modeling (glycinin, pdb 1OD5).

protein assemblies in solution remains challenging to impossible. Nonetheless, these large complexes are common and often of exceptional importance. Hydrogen/deuterium exchange mass spectrometry (HDX-MS) applied to *E. coli* chaperonin GroEL conformation in solution. The ~800 kDa tetradecameric GroEL plays an essential role in the proper folding of many proteins via an ATP-driven cycle of conformational changes. Comparison of HDX-MS results for apo GroEL and GroEL-ATPγS enables the characterization of the nucleotide-regulated conformational changes throughout the entire protein with high sequence resolution. GroEL is by far the largest protein assembly yet mapped by HDX-MS, and the results achieved here establish the groundwork for further HDX-MS characterization of such large complexes (**Figure 6**)(**Scientific Reports**, **3**, 1247 (2013).

Current high-throughput **top-down proteomic** platforms provide routine identification of proteins less that 25 kDa with 4-D separations. Top-down electron capture dissociation (ECD) FT-ICR MS for structural analysis of an intact monoclonal antibody (IgG1-kappa ($_{\kappa}$) isotype, ~149 kDa, through simultaneous ECD for all charge states (42+ to 58+) generates more extensive cleavages than ECD for an isolated charge state, and provides more extensive sequence coverage than top-down collision induced dissociation (CID) and electron transfer dissociation (ETD) for time-of-flight and comparable sequence coverage for top-down ETC with orbitrap mass analyzers (**Figure 7**) (*Anal. Chem.* **85**, 4239-4246 (2013)). Multiple redox-active sites can be characterized simultaneously and unambiguously without the need for proteolysis or site-directed mutagenesis through isotope-coded cysteine alkylation coupled to top-down FT-ICR MS, and report the reliable determination of equilibrium protein disulfide bond reduction potentials ($E^{\circ\prime}$) (*Anal. Chem.* **85**, 9164-9172 (2013)).

The 7, 9.4, and 14.5 T instruments are primed for immediate impact in **environmental, petrochemical, and forensic analysis**, where previously intractably complex mixtures are common. The field of "petroleomics" has been developed largely due to the unique ability of high-field FT-ICR mass spectrometry to resolve and identify all of the components in petroleum samples. Further, fossil fuel samples can be analyzed and components resolved without chromatographic separation. However, resolution and detection of isotopologues can increase the confidence in elemental composition assignment through isotopic fine structure, particularly for compounds containing low numbers of nitrogen and oxygen (both ^{15}N and ^{18}O occur at less than 0.4% natural abundance). **Figure 8** demonstrates validation of the assignment of monoisotopic $^{12}C_{29}{}^{1}H_{43}{}^{16}O_{2}$ based on resolution and identification of the isotopologues, $^{12}C_{29}{}^{1}H_{43}{}^{16}O_{1}{}^{18}O_{1}$ (*J. Am. Soc. Mass Spectrom.*, **24**, 1608-1611 (2013)).

Solvent modification with tetramethylammonium hydroxide (TMAH)

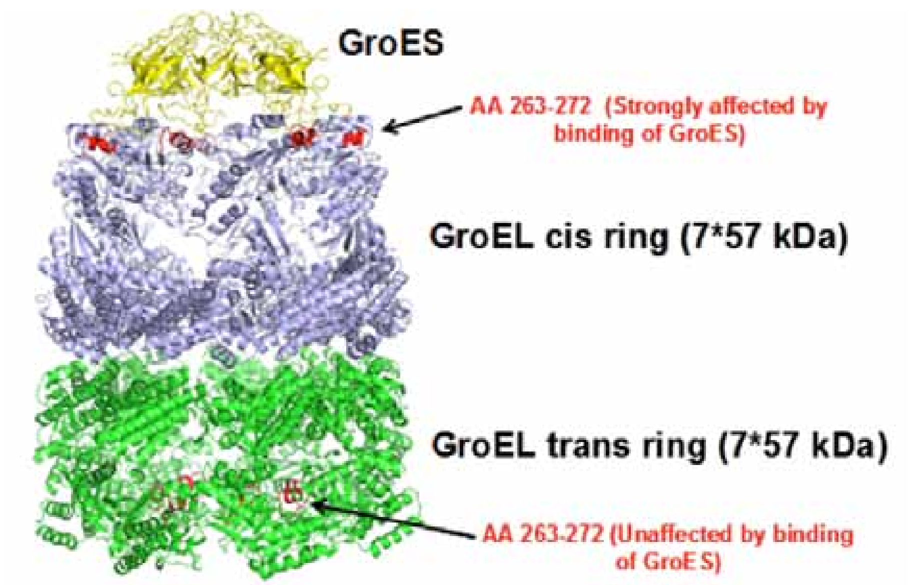


FIGURE 6. Structural models of the GroEL:GroES chaperone complex, showing changes in solvent accessibility for GroEL subunits on binding of the GroES "cap". Changes are seen in only one of the two GroEL heptamers.

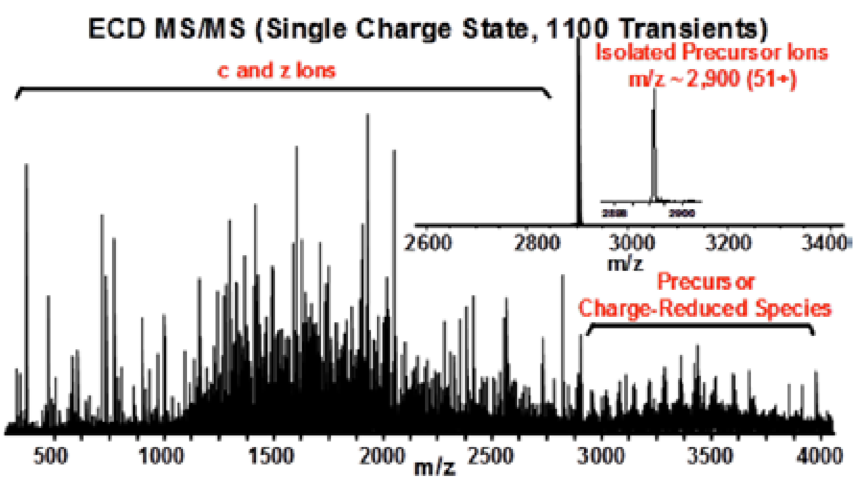


FIGURE 7. ECD product ion mass spectrum for the 51+ charge state ions from IgG1$_{\kappa}$ mAb. Inset: isolated precursor ions of *m/z*~2900.

enhances the compositional coverage to include less acidic crude oil components, such as pyrrolic nitrogen, and results three times the number of detected peaks compared with traditional ammonium hydroxide (*Anal. Chem.*, **85**, 7803-7808 (2013)). Negative-ion electrospray ionization FT-ICR MS of dissolved organic matter (DOM) combined with nuclear magnetic resonance (NMR) and fluorescence spectroscopy was applied to characterize the composition of surface and deep DOM derived from northern peatlands (*Geochim. Cosmochim. A.C.*, **112**, 116-129 (2013)). Characterization of water-soluble oil compounds from produced water by FT-ICR MS revealed that extraction with 70:30 cyclohexane/butyl acetate not only extracts more material from produced water compared to conventional *n*-hexane or cyclohexane, but is more efficient at extraction of polar species implicated in production deposit formation (*Energy Fuels*, **27**, 1846-1855 (2013)). Characterization of aqueous samples containing oil sands naphthenic acids fraction compounds following sorption with cyclodextrin-based copolymers revealed molecular selective sorption in copolymer materials containing β-cyclodextrin contributes toward the development of sorbent material to remove oil sands acids in aquatic environments (*Energy Fuels*, **27**, 1772-1778 (2013)).

Traditional tools for routine **environmental analysis and forensic chemistry of oil spills** have relied almost exclusively on gas chromatography-mass spectrometry (GC-MS), although many compounds in crude oil and its weathered transformation products are not amenable to GC-MS due to low volatility (**Figure 9**). Expansion of the analytical window for **oil spill characterization** provided 30,000 acidic, basic and nonpolar unique neutral elemental compositions for the Macondo well crude oil to provide an archive for future chemical analyses of the environmental impact of the 2010 *Deepwater Horizon* oil spill (*Env. Sci. Technol.*, **47**, 7530-7539 (2013)). Oil spill source identification by Principal Component Analysis (PCA) applied to thousands of elemental compositions obtained from ultrahigh resolution FT-ICR MS of neat samples from both tanks of the motor vessel (M/V) *Cosco* Busan identifies the source of environmental contamination caused by the unintended release of heavy fuel oil (HFO) in 2007 (*Anal. Chem.*, **85**, 9064-9069 (2013)).

Progress on STEM and Building the User Community

The ICR program had **36** new principal investigators in 2013. The ICR program also enhanced its undergraduate research and outreach program for 4 undergraduate scientists, (one female). The ICR program in 2013 supported the attendance of scholar-scientists, postdoctoral associates, graduate, undergraduate and high school students at numerous national conferences to present current results.

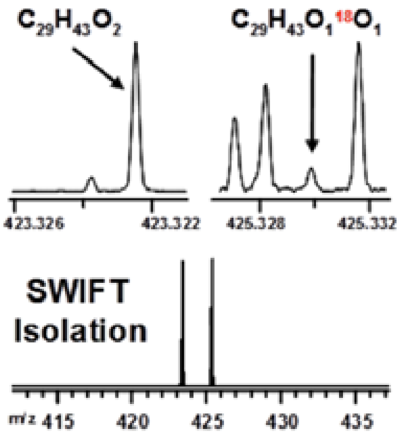


FIGURE 8. BOTTOM: Stored Waveform Inverse Fourier Transform (SWIFT)-isolated spectral segment, containing only ions of nominal mass 423 and 425 Da. **TOP LEFT:** Monoisotopic isotopologues at nominal *m/z* 423. **TOP RIGHT:** Corresponding $^{18}O_1$ isotopologue at nominal *m/z* 425.

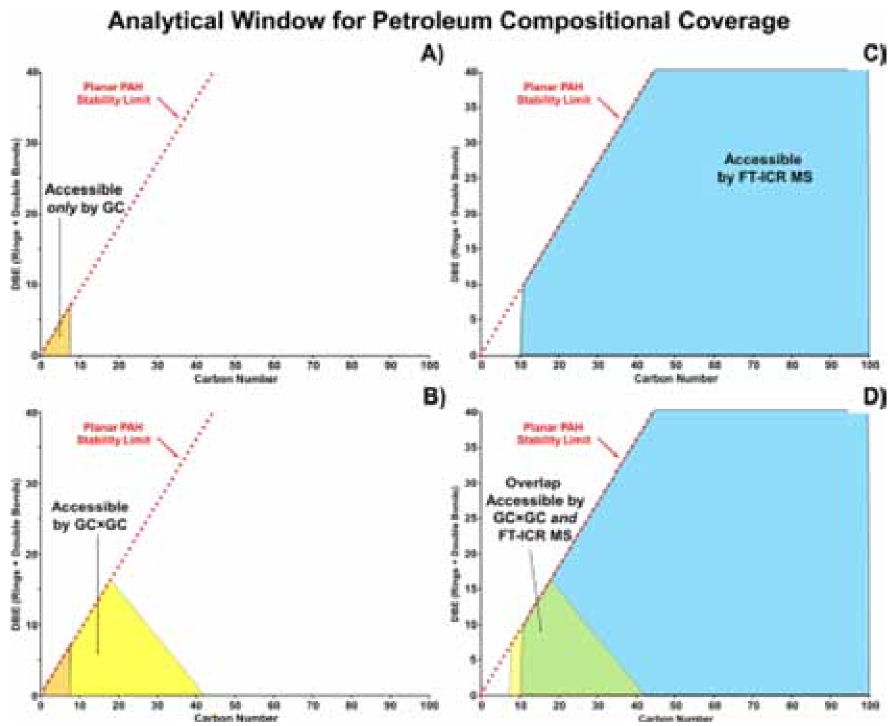


FIGURE 9. Schematic diagram of the compositional continuum of petroleum (the petroleome) reported as double bond equivalents (DBE, number of rings plus double bonds) versus carbon number. The analytical window accessible only by conventional gas chromatography (GC) is displayed in part a, with the upper boundary limit for all molecules known to exist in petroleum displayed as the PAH planar stability limit, as previously reported. Extension to hybrid analytical techniques (GC × GC) is displayed in **FIGURE 9B.** Part **C.** reports the extension to complete compositional coverage of petroleum molecules (up to C100) that have been observed in Macondo petroleum. Part d combines all three techniques in a single image to highlight the need for advanced analytical techniques beyond gas chromatography for oil spill science.

Future Fuels Institute

The Future Fuels Institute completed its second full year in 2013, with 3 full share members ($250 k/yr for 4 years) to support research to address challenges associated with petroleum production and processing. In 2014, it will expand to 4 members. The Future Fuels Institute currently supports 1 full time Research Associate and 3 Assistant Scholar Scientists to pursue analytical method development. 2012 industrial members are : Saudi Aramco and ConocoPhillips and current supported provided through partnerships with instrument manufacturers (Leco Instruments, Waters Instrument Company) for state-of-the-art instrumentation prior to release to the commercial market.

Facility Operations Schedule

The ICR facility operates year round, with no scheduled shutdowns. Holidays and weekend instrument time is scheduled annually. Usage of the 14.5 T FT-ICR mass spectrometer was lower than average during 2013 for three reasons: (a) We had a record 15 personnel departures during 2013 and 10 new arrivals. Thus, the new(and fewer) people were not able to hold the same pace as their predecessors on account of time needed for training. (b) The 14.5 T instrument is our primary resource for biological applications. However, we replaced our prior Director of Biological Applications by Dr. Nicolas Young, and it took a while to reorganize the "bio" projects. (c) The 14.5 T instrument serves as the "test bed" for development of the spectrometer for the 21 T system. Thus, with the impending installation of the 21 T magnet, we had to reduce user access to the 14.5 T instrument in order to complete various instrumentation developments.

Combining Cryogenic Electron Microscopy and Mass Spectrometry to Create a Pseudo-Atomic Model of the COPII Cage

USERS Alex J. Noble, Jason O'Donnell, Hanaa Hariri, Nilakshee Bhattacharya, and Scott M. Stagg (Florida State University); Qian Zhang (National High Magnetic Field Laboratory); Alan G. Marshall (Florida State University and National High Magnetic Field Laboratory)

The COPII protein is involved in transporting membrane proteins and other cargo from the endoplasmic reticulum (ER) to the Golgi apparatus. The 12 Å resolution cryo-electron microscopy structure of the COPII cage clearly defines the tertiary structure (see Figure 1), but is insufficient to identify the specific regions of subunits Sec13 and Sec31 that interact with each other.

Starting from the cryo-EM structure and a homology model for the Sec13/31 edge, we use flexible fitting methods to create a reliable pseudo-atomic model of the COPII cage. That model is then combined with data from hydrogen/deuterium exchange mass spectrometry monitored by the MagLab's capability to perform ultrahigh-resolution 14.5 tesla Fourier transform ion cyclotron resonance mass spectrometry. **The MagLab's ICR facility enables researchers to characterize four distinct contact regions at the vertices of each COPII cage.** Furthermore, researchers find that the 2-fold symmetry of the Sec31 dimeric region of Sec13/31 is broken on cage formation, and that the resulting hinge is an essential feature of Sec13/31 in the formation of edges into COPII cages.

These results were featured by E. Miller, "The COPII Cage Sharpens Its Image," *Nature Struct. Molec. Biol. News and Views*, **2013**, 20, 139-140.

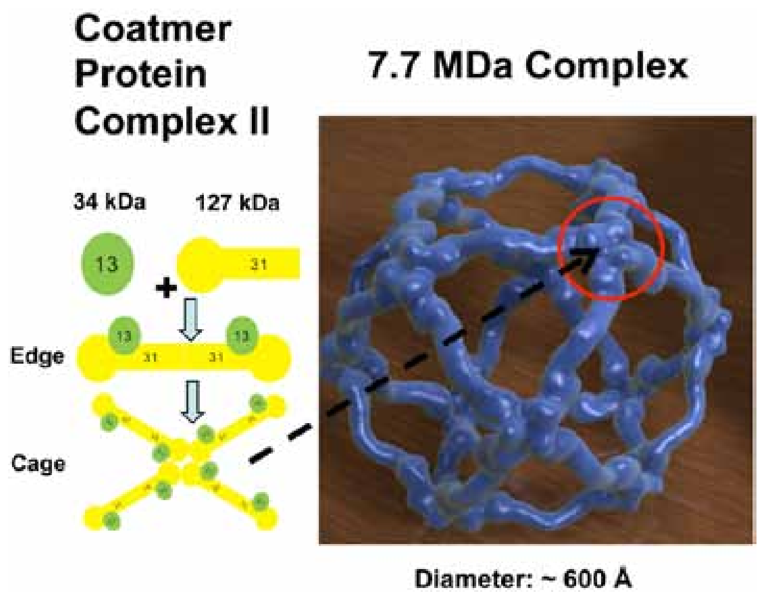


FIGURE 1. COP II protein complex (right), and its assembly from sec13 (34 kDa) and Sec31 (127 kDa) subunits into edges, which combine to form cages, which combine to form the full complex.

Facilities

NHMFL 14.5 Tesla Fourier Transform Ion Cyclotron Resonance Mass Spectrometer

Citation

A Pseudoatomic Model of the COPII Cage Obtained from Cryo-Electron Microscopy and Mass Spectrometry, Alex J. Noble, Qian Zhang, Jason O'Donnell, Hanaa Hariri, Nilakshee Bhattacharya, Alan G. Marshall, and Scott M. Stagg, *Nature Struc. Mol. Biol.* **2**, 167-174 (2013)

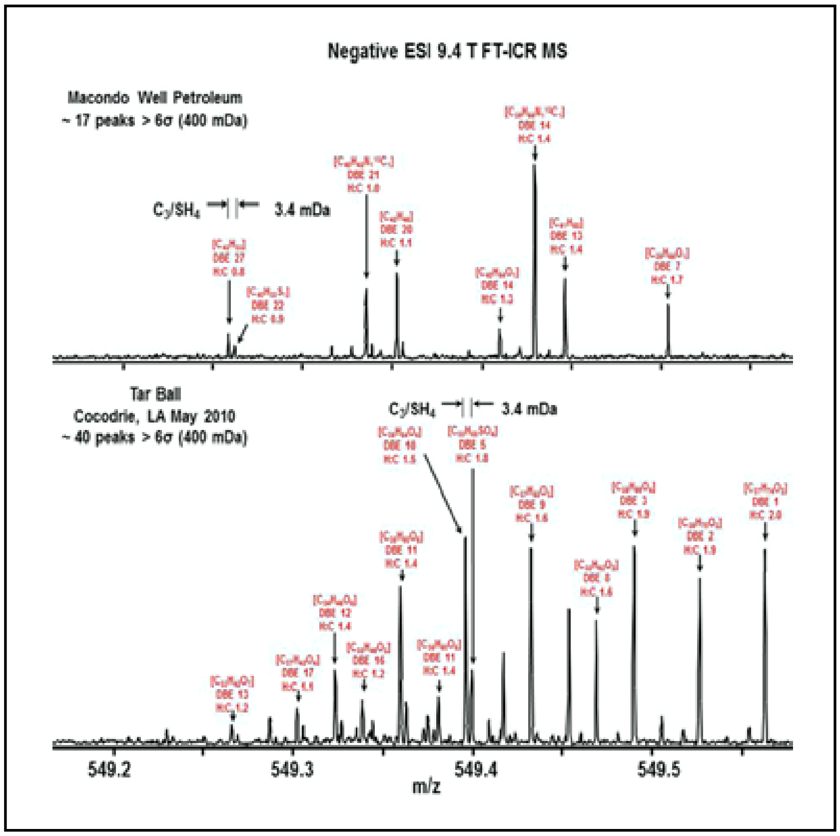
Beyond Gas Chromatography: Oil Spill Characterization by Ultrahigh Resolution Ion Cyclotron Resonance Mass Spectrometry

USERS A.M. McKenna, J.J. Savory, N.K. Kaiser, J.E. Fitzsimmons, A.G. Marshall, and R.P. Rodgers (National High Magnetic Field Laboratory); Robert K. Nelson and Christopher M. Reddy (Woods Hole Oceanographic Institute)

Traditional tools for routine environmental analysis and forensic chemistry of petroleum have relied almost exclusively on gas chromatography-mass spectrometry (GCMS), even though many compounds in crude oil (and its transformation products) are not chromatographically separated or amenable to GC-MS due to volatility. To enhance current and future studies on the fate, transport, and fingerprinting of the Macondo well oil released from the 2010 Deepwater Horizon disaster, researchers created an extensive molecular library of the unadulterated petroleum to compare to a tar ball collected on the beach of Louisiana.

We find that ultrahigh resolution Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometry identifies compositional changes at the molecular level between native and weathered crude oil samples, revealing enrichment in polar (i.e. oxidized) compounds inaccessible by GC-based characterization. High magnetic fields thus provide opportunities to enhance insight into: environmental fate of spilled oil, toxicology, molecular modeling of biotic/abiotic weathering, and comprehensive molecular characterization for petroleum-derived releases.

We characterize more than 30,000 acidic, basic, and nonpolar unique neutral elemental compositions for the Macondo well crude oil as an archive for future chemical analyses of the environmental consequences of the oil spill.



Facilities

NHMFL Ion Cyclotron Resonance Facility

Citation

Expansion of the Analytical Window for Oil Spill Characterization by Ultrahigh Resolution Mass Spectrometry: Beyond Gas Chromatography; McKenna, A.M.; Nelson, R.K.; Reddy, C.M.; Savory, J.J.; Kaiser, N.K.; Fitzsimmons, J.E.; Marshall, A.G. and Rodgers, R.P.; *Environmental Science & Technology*, **47**, 7530-7539 (2013)

CHAPTER 4

Education & Outreach

The Center for Integrating Research and Learning

In 2013, the Center for Integrating Research and Learning (CIRL) continued to expand and evaluate its programming.

In 2013, CIRL and Magnet Lab staff reached over 10,000 K-12 students, undergraduates, graduate students, and more than 200 teachers through a variety of outreach activities that included classroom outreach, hands-on extended programs (e.g. internships and camps), tours, presentations and demonstrations, Research Experiences for Teachers programs, and web-based activities. CIRL continued to run the Research Experience for Undergraduate program and the postdoctoral/graduate student mentoring program for the lab. Our mission to expand scientific literacy and to encourage interest in and the pursuit of scientific studies among educators and students of all ages has become more specifically targeted to encourage students – particularly students from underrepresented groups – to pursue STEM career paths. While this has always been a goal of CIRL programming, increasing the number of students entering the STEM pipeline has become a national imperative and one that is a mandate for informal science education.

TABLE 1

CIRL's 2013 Educational and Public Outreach Programs included:

K-12 STUDENTS

- **Classroom Outreach** – 7714 K-12 students; 63 schools (50% Title I)
- **Internships (High School and College) –** 21 (28% Female, 14% African American or Hispanic)
- **Middle School Mentoring (Leon County Schools) –** Fall - 6 students (50% Females) Spring – 13 students, 23%
- **Middle School Summer Camps** - These include the ERC FREEDM Engineering camp, the MagLab summer camp and the SciGirls Summer camp. 89 students participated: 64% female, 20% African American, 5% Hispanic and 33% from Title I schools.
- **ERC-FREEDM Young Scholars (High School)** - Seven students participated (85% were African American, 85% were Female, and 85% were from Title I schools)
- **Web Activities** – Facebook, Twitter, Blogs

K-12 TEACHERS

- **Classroom Outreach** – over 200 classrooms per year
- **Mag Lab Educators Club** – over 280 members
- **Teacher Workshops** – 1-2 school districts per year
- **Research Experiences for Teachers** – 10 teachers for the MagLab RET program and 4 teachers for the ERC FREEDM program. (50% female, 21% African American, 21% Hispanic, and 86% from Title I)
- **Social Media/Web, MagLab academy; CPALMS videos**
- **Leadership in teacher organizations** – BLAST (North Florida and South Georgia organization that promotes science instruction,) Participation in teacher organizations: National Science Teachers Association, Florida Association of Science Teachers

PUBLIC/COMMUNITY

- **Barnes and Nobles** – monthly
- **Science Nights and Science Fairs:** CIRL staff and MagLab scientists and staff presented/attended over 20 Science Fairs and Science nights at local schools in Tallahasse, Gainesville, and Los Alamos.
- **Science Café** – monthly opportunity for scientists to present research in informal setting - 50-100 participants at each café
- **Tours of the MagLab** According to the General Visitors statistics, 809 adults toured the lab and 1152 students. Open House: 5500 visitors came to the lab's big open
- **Social Media/Web -** 889,557 page views for MagLab education section – 61% of the lab's total page views.
  Facebook: 585 likes
  Twitter: 860 followers
  YouTube: 488 subscribers, 542,000 views for MagLab videos
- **Leadership in community organizations** – Community Classroom Consortium; Florida Afterschool Network
- **Leadership in National Organizations** - Center for Advancing Informal Science Education

UNDERGRADUATE & BEYOND

- **Research Experiences for Undergraduates** – 24 participants at all three sites.42% female, 16% from HBCUs and other Minority Serving Institutions (MSIs), 17% African American, 17% Hispanic
- **Graduate Student/Postdoc mentoring sessions** – professional development presentations monthly. Postdoc presentations weekly. Introduction of additional mentor program.
- **Outreach** – Provide opportunities to students, postdocs, and faculty to conduct outreach with K-12 students, teachers, and the public

As part of all of these programs, CIRL graduate students under the direction of Roxanne Hughes, Director of the Center for Integrating Research and Learning, conduct annual evaluations and research projects on all of the programming.

TABLE 2

CIRL Program Evaluations

Outreach	Form of Evaluation	CIRL Staff
Classroom outreach	· Post-survey sent after classroom outreach conducted – formative assessment	Smriti Jangra
RET/REU/ Summer camps	· Pre- and post-survey taken on first and final day of program to assess self-efficacy in STEM (and for teachers in teaching STEM); · Attitudes toward STEM and STEM careers; perceptions of STEM and STEM careers; · Annual tracking survey (where are they now) to measure STEM career persistence.	Brandon Nzekwe Smriti Jangra
Graduate Student/ Postdoc Mentoring	· Surveys given at opening session to determine academic sessions of interest; · Annual tracking survey (where are they now) to measure STEM career persistence.	Brandon Nzekwe Roxanne Hughes
NHMFL Winter Theory School and NHMFL Users Summer School	· Pre-survey measuring expectations; · Post survey measuring evaluations of program;	Brandon Nzekwe

New Evaluation/Research Initiatives: Results of Research

Our research – as well as leading science education researchers – indicates that reaching underrepresented minorities as early as elementary school and then providing continuous exposure to STEM research and careers, significantly increases persistence in STEM fields. CIRL helps students who participate in our programming at each of the crucial stages of their STEM career trajectories: middle school, high school, undergraduate, and graduate school.

The results of the research and evaluation that CIRL conducts demonstrates that our hands-on opportunities for students – internships, camps, and research experiences – provide the in-depth exposure that students need in order to maintain interest in STEM and develop positive attitudes toward and perceptions of STEM careers and professionals. All participants in our programs take a pre and post test that measures their interest in STEM, perception of STEM and STEM careers, expectations for the program (pre) and whether those expectations were met (post). In addition, we have started to send annual surveys to all past participants in our programs. This past year, CIRL staff reached out to past participants from two of our longest running programs: Middle school Mentorship and the SciGirls Summer camp. Both of these programs reach students at a crucial age and provide participants with hands-on opportunities to learn about scientific research and STEM careers. SciGirls participants provided the best return rates and the results of that research will be presented here.

The feedback from our SciGirls past participants indicated that the camp participants maintained an interest in STEM over time. The participants credited the camp with improving their interest in STEM, confidence in STEM abilities, understanding of STEM, and/or motivation to pursue a STEM career. We focused on identity trajectories and our qualitative methods helped to highlight that identity formation over time. Specifically we were able to see that all of our participants still had an interest in STEM, even if they did not necessarily want to pursue a STEM career. Since the camps inception, 46 campers are now in college (entering in 2013 or before). Of those, we have confirmation on college enrollment through social media and/or direct contact for 38 (all of whom are enrolled in college). Thirteen no longer have any working contact information and have not responded to social media inquiries. Thirty-three confirmed college majors with the researcher, 19 are in a STEM majors (57.6%), 3 are undecided (9.1%), 11 are non-STEM majors (33.3%).

The individuals who did not want to pursue a career in STEM still had an appreciation of STEM which is valuable since this appreciation may lead to a respect for STEM fields and the research they contribute to society. This demonstrates that the camp had a positive impact on the majority of our participants. It helped them to stay or become more interested in STEM and it maintained or increased their desire for STEM career. The participants cited that this increased desire was due to the role the camp played in their understanding of STEM, interactions with STEM professionals, and their recognition of the various possibilities in STEM. These all fit within our identity framework since these participants: saw the relevance of STEM to their lives; increased their confidence in their own abilities to succeed in STEM; and developed a desire to pursue STEM fields that fit with their goals and identity.

CIRL's Presentations, Publications, and Grant Applications

CIRL's Research staff published a number of studies at national conference and in peer-reviewed journals in 2013. CIRL continues to maintain a strong research agenda that allows it to add to the literature on informal science education. This knowledge gained from the research agenda allows CIRL to be a leader in Informal Science Education.

Resulting Presentations in 2013

Nzekwe, B. and Losh, S.C., *Occupational Identity Salience and Science Career Attitudes: Comparing undergraduate science majors participating in research programs*, American Educational Research Association, San Francisco, CA, April 27-May 1 (2013).

Nzekwe, B. and Losh, S.C., *Scientist Identity Salience and Career Attitudes: Comparing honors science majors with research internship participants,* Marvalene Hughes Research in Education Conf., FSU College of Education, Tallahassee, FL, March 29 (2013).

Nzekwe, B. and Losh, S.C., *How Gender, Ethnicity and Experience Influence Scientist Identity and Career Attitudes Among Research Program Students,* National Association for Research in Science Teaching, Rio Grande, Puerto Rico, April 6-9 (2013).

Nzekwe, B. and O'Shea, J., *Examining participation in Undergraduate Research,* Florida Statewide Symposium - Engagement in Undergraduate Research, University of Central Florida, Orlando FL, October 11-12 (2013).

Resulting Publications in 2013

Hughes, R. (In Press). *The Role of Access Policies: The Effects of a Single-Sex STEM Living and Learning Program on Female Undergraduates' Persistence.* International Journal of Gender, Science and Technology

Hughes, R., Nzekwe, B., & Molyneaux, K. (2013). *The single sex debate for girls in science: A comparison between two informal science programs on middle school students' STEM identity formation.* Research in Science Education Journal. 43(5), 1979-2007.

The research conducted by CIRL staff has also resulted in awards and recognition from National and International Organizations:

Roxanne Hughes, Winner of the Research on Women and Education Dissertation Award

Grant Submissions

CIRL recognizes the value of adding scholarship to the activities included under broader impacts. In accordance with the continued mission of the lab to foster research, proposals (see **Table 3.**) have been submitted to increase the research and development budget of CIRL programming. These proposals also fit within the diversity mission of the lab in that they seek to improve the representation of underrepresented minorities. Plans for 2014:

- Continue annual tracking of all participants from all programs
- Publication of validated survey instrument developed in 2012 and 2013
- Increase collaborations for educational outreach among three sites
- Find outside funding to improve research agenda

TABLE 3

Grant Submissions

Grant title and funding organization	**Submission date** (Hughes' role and names and affiliations of other PI/co-PIs)	**Title of Grant**	**Funded/ Not funded/ Announcement not made yet**	**Underrepresented Minority Group that was part of grant**
DuPont Foundation through FSU Foundation	April 12, 2013 (Hughes co-PI, co-PI Kim Kelling, WFSU)	SciGirls Afterschool Program	Feasibility study funded	Middle school girls in Title I schools
American Physical Society Group on Magnetism and its Application Magnetism Outreach Grant	December 13, 2013 (Hughes PI)	Magnetism Outreach: A Transportable Magnetic Induction Levitating Apparatus (TMILA)	Announcement not made yet.	
American Physical Society Public Outreach Grant	December 15, 2013 (Hughes PI, co-PI Zachary Leonard, LANL)	Side-by-Side: Teachers and Scientists working together to Increase Underrepresented Minority Physics Participation through Culturally Relevant Pedagogy	Announcement not made yet.	Native American and Hispanic teachers and students in New Mexico

Outreach

CIRL along with Public Affairs, help MagLab scientists and staff to communicate the research conducted here to the general public as well as K-12 students and teachers. Along with role, CIRL provides its expertise in making sure K-12, undergraduate, and graduate programs increase the representation of underrepresented groups including women, African Americans, Hispanics, and Native Americans. Our programs are aimed towards students and teachers from Title I schools and students/teachers who may not have access to the quality science outreach that we provide. In 2013 CIRL staff continued to work toward these efforts. Assistant Director Jose Sanchez continued his recruiting efforts for REU by attending the following conferences: Emerging Researchers National Conference and the Society for the Advancement of Chicanos and Native Americans in Science. CIRL Director Roxanne Hughes attended the Southeast Conference for Undergraduate Women in Physics and the Women's Engineering Proactive Network to discuss MagLab programs. Carlos Villa, CIRL's outreach coordinator, and Mr. Sanchez attended the Florida Association for Science Teachers to discuss outreach programs and the Research Experience for Teachers program. Mr. Villa also attended the National Science Teachers Association conference to promote outreach and the RET program as well.

CIRL is dedicated to reaching underrepresented populations, particularly Title I schools, students, and teachers. In 2013, almost 50% of our classroom outreach programs were provided to Title I schools. In addition, one-third of our summer camp participants came from Title I schools, 85% of our ERC FREEDM Young Scholar participants came from Title I schools and 86% of our RET teachers came from Title I schools. The results of our evaluation on all of these programs indicated that they are maintaining the high quality standards that the MagLab sets. About two-thirds of the teachers who received outreach responded to our survey. Of these, 100% percent rated the outreach program good or better, with 84.9% of these respondents rating the outreach as excellent. All of the teachers said they would definitely participate in the outreach again. The teachers that participated believed that: the CIRL representative was effective in employing instructional strategies that made the content understandable to students (84.9%), the CIRL representative encouraged and respected alternative explanations (82.2%), the outreach activity incorporated higher-order thinking processes (80.8%), there were connections made between the content presented and the real world (87.7%), the CIRL representative solicited students' prior knowledge (91.7%), students were encouraged to ask scientific questions to shape their understandings (84.7%), and after outreach, students were able to apply what they learned in other situations (75.3%).

Improvements to CIRL Classroom Outreach based on Evaluation

Evaluation comments from the previous school year highlighted that teachers wanted to have more programs on chemistry. CIRL's outreach coordinator, Carlos Villa worked during the summer with ICR Chemist Dr. Amy McKenna to develop two chemistry outreach programs that have been tested in classrooms this year in order to formalize them. These programs will be offered with our other outreach programs next school year.

Dr. McKenna is just one of many MagLab scientists and staff members who conduct outreach in our schools. In 2012, CIRL began tracking the outreach conducted by MagLab personnel at all three sites. CIRL also held the annual MagLab tour training at the Tallahassee site in August, 2013 and gave an information session about ways to get involved in outreach to all MagLab employees in the spring of 2013. The tracking of MagLab personnel outreach has resulted in a much better picture of the broader impact efforts of our lab, including: improving the STEM pipeline at the K-12 level, providing workforce development information to college students, providing mentoring to graduate students and postdoctoral researchers, and promoting scientific literacy to the general population.

MagLab personnel from all departments participate in outreach. CIRL oversees the longer term outreach wherein scientists serve as mentors (e.g. REU, RET, Internships, and Mentorship.) In 2012 and 2013, 54 scientists from all three sites participated in long term commitment outreach efforts. In 2012, these scientists mentored (11 RETs, 18 REUs, 11 mentorship students, and 18 interns. In 2013, these scientists mentored 10 RETs, 24 REUs, 17 mentorship students, and 21 interns.

CIRL has also tracked the shorter term outreach that MagLab scientists conduct. This includes activities such as: tours of MagLab facilities, presentations that are educationally related, mentoring, visiting K-12 classrooms, and judging science fairs. In 2013, 44 individual scientists (as far as reporting indicates) reaching 8000 people through the various outreach efforts (e.g. K-12 students, teachers, undergraduates, graduate students, early scientists, and the general public). These numbers demonstrate the extent of outreach that our MagLab staff does in addition to the outreach conducted by CIRL. The tremendous efforts of our MagLab scientists also highlight how passionate they are about their research and achieving the broader impacts of the lab.

TABLE 4

Outreach with a Long-Term Time Commitment *(e.g. REU, RET, Intern, Mentorship)*

	2013							2012					
Department (# of Scientists)	RET	RET	Fall Mentorship	Spring Mentorship	Fall Internship	Summer Internship	Spring Intern	Fall intern	RET	REU	Mentorship	Spring interns	Summer interns
ASC (3)	1	2							2	2			1
CIMAR/NMR (6)	4	2					1	2					1
CMS (17)	6	4	4	6	2	3	2	2	3	6	2		4
Other* (4)						2				1	2		1
Geochemistry (7)	2			2		3			2	1		2	3
ICR (2)						1				1			
LANL (3)	3								2	2			
MST (9)	3	2	2	3	1	5	1	1	2	3	7		1
UF (3)	5									2			

*Director, Public Affairs, Optical Microscopy

TABLE 5

Types of Outreach Conducted

	Tour of MagLab Facility		Presentation		Mentored undergraduates		Visit K-12 classroom		Judged Science Fair		Mentored Student K-12	
Department	Number of Scientists	Number of people reached	Number of Scientists	Number of people reached	Number of Scientists	Number of people reached	Number of Scientists	Number of people reached	Number of Scientists	Number of people reached	Number of Scientists	Number of people reached
AMRIS	1	40	2	91	1	2						
CMS	2	39	11	851			1	110				
DC			3	150					1	65		
Director's office			2	NA								
EMR	4	44	4	749	2	3			1	70	1	1
Geochem			1	60+			2	60 + (virtual)	1	20		
HBT (UF)	4	63			1	1						
ICR	2	77	2	747			1	395			1	60
NMR	1	8	1	338	2	14						
PFF (LANL)	1	273	3	3642			1	18			1	1

TABLE 6

Total Numbers of Individuals Reached

Department	Number of Scientists	Number of people reached
AMRIS (UF)	3 (17%)	139 (91 HS students, 48 undergraduates)
CMS	12 (23%)	1000 (885 graduate students and early scientists, 110 elementary school students, 5 undergraduates)
DC	3 (17%)	215 (150 Early scientists, 65 middle school students)
Director's office	2 (50%)	NA (Public, Early Career scientists, scholar scientists)
EMR	7 (70%)	867 (70 elementary students, 51 high school students, 24 undergraduates, 622 graduate students, 100 early career scientists)
Geochemistry	2 (18%)	150+ (60+ elementary school, 20 middle school, Science café)
HBT (UF)	4 (16%)	64 (37 high school, 5 graduate students and early career scientists, 15 undergraduate students, 7 senior scientists)
ICR	3 (23%)	1279 (645 elementary school, 130 middle school, 291 undergraduates, 100 early career scientists, 41 scholar scientists, 72 general public)
NMR	3 (12.5%)	360 (35 high school, 317 undergraduates, 8 senior scientists)
PFF (LANL)	5 (21%)	3934 (3775 general public, 120 undergraduate students, 39 4th through 12th grade)

Post Doc/Graduate Student Mentoring Plan.

The Magnet Lab housed 163 graduate students and 57 Postdoctoral Associates in 2013. The Postdoctoral/Graduate Student Mentoring Plan is moving forward under the leadership of Dr. Hughes (see Postdoctoral Mentoring Plan on p. 129.) In 2012, UF graduate students and postdocs came to Tallahassee to tour the lab. Then in the summer of 2013, Tallahassee graduate students and postdocs were invited to tour the Gainesville facilities. In addition to bridging the gap between the MagLab sites, CIRL staff members continue to schedule and plan professional development seminars with faculty from the MagLab and the Career Center at FSU. These sessions are video recorded and placed on the Graduate Student and Postdoc website for current and future MagLab students, postdocs, and staff to view – since we realize everyone's schedules cannot be accommodated. In addition each year, CIRL sends a survey asking graduate students and postdocs to submit topics that they would be interested in hearing about. In 2013 this survey was sent in August with monthly reminders in September, October, and November. Twenty graduate students/postdocs responded to the survey providing information for future topics.

TABLE 7

In 2013, the following Professional Development sessions were offered:

Session Title	Month	Presenter Affiliation	Number of Participants
Outreach Opportunities at the MagLab	January 2013	Jose Sanchez, NHMFL	9
Writing an Academic Cover Letter	January 2013	FSU Career Center	14
Developing a Curriculum Vitae	February 2013	FSU Career Center	11
Dissertation Writing Advice	February 2013	FSU English Faculty member	6
Preparing for Job Interviews	March 2013	FSU Career Center	18
Preparing for Faculty Positions	April 2013	Steve Hill, NHMFL	11
Negotiating Job Offers	April 2013	FSU Career Center	7
Funding Awards and Opportunities	September 2013	FSU Postdoctoral Affairs Director	2
Using Social Media in the Job Market	September 2013	FSU Career Center	8
Dual career: Research Scientist and Entrepreneur	October 2013	Jeff Whalen, NHMFL	3
Developing a Curriculum Vitae	October 2013	FSU Career Center	11
Entrepreneurship in STEM	November 2013	FSU Director of the FSU Jim Moran Institute for Global Entrepreneurship	3
Developing an E-Portfolio	November 2013	FSU Career Center	2

* Of the 220 total postdocs graduate students at the MagLab, 20% have attended at least one of the professional development sessions.

In addition to the seminars held at the lab. FSU and UF have strong graduate student information sessions. FSU just developed a Postdoctoral Affairs unit which is working hard to improve the Postdoc experience for Postdocs affiliated with the MagLab in Tallahassee. FSU emails a weekly information newsletter which includes career opportunities, professional development sessions on campus and on the web, as well as grant and funding opportunities. Dr. Hughes forwards this to postdocs and graduate students at the lab who are part of the MagLab email lists. In addition, Dr. Hughes copies the applicable information and emails that to postdocs and graduate students on the MagLab email lists at UF and LANL. One highlight to report from these email blasts was that physics graduate student Shermane Benjamin applied and was awarded the McKnight Doctoral Fellowship – this prestigious award is given to a select number of minority students annually by the Florida Education Fund. Graduate students from nine Florida universities who are majoring in STEM fields are eligible to apply. The grant provides funds for tuition and an annual stipend for three years.

Dr. Komalavalli Thirunavukkuarasu, a Postdoctoral Associate in the Condensed Matter Science/EMR group has taken the lead in planning bi-weekly postdoc sessions wherein one MagLab postdoc presents their research each week. The sessions started in June of 2013. On average, ten postdocs attend each week. Dr. Thirunavukkuarasu also plans social and networking sessions for the postdocs including a breakfast in the summer and a holiday party at the end of the year. Dr. Thirunavukkuarasu along with Dr. Audrey Grockowiak from the CMS/EMR group are the MagLab representatives on the FSU Postdoctoral Affairs Committee. FSU held its first annual postdoc symposium in September. Fifteen MagLab postdoctoral associates presented their research as posters. Deputy Director Eric Palm represented the lab leadership as one of the judges. And Dr. Liran Wang, a Postdoctoral Associate in the CMS group at the lab was the winner of the poster prize.

In 2013, we asked for MagLab scientists who would be willing to serve as mentors to postdoctoral associates who may need advice or have questions that cannot be answered by their Principal Investigator. We had 10 MagLab scientists volunteer. At the close of 2013, we had two Postdoctoral Associates request an additional mentor. CIRL has sent them the information on the mentor volunteers.

Graduate student and Postdoc Tracking

CIRL staff member, Brandon Nzekwe, spent a large portion of his time in the fall, tracking past MagLab graduate students and postdocs who are in the MagLab system. There were a total of 420 graduate students and postdoctoral associates formerly affiliated with the magnet lab from 2001 to 2013. The current educational and professional statuses of these former affiliates was collected and updated through internet searches. We were able to ascertain the current academic and profession statuses of 68% (286) of these former affiliates; the remaining 32% (134) are unknown. Of the 286 former magnet lab graduate students and postdoctoral associates, currently:

- 37 are graduate students (12.9%)
- 46 are postdoctoral researchers (16.1%)
- 66 are research scientist working at laboratories, institutes, and/or universities (23.1%)
- 54 are scientists or engineers working in the private sector (18.9%)
- 67 are professors at colleges or universit ies (23.4%)
- 7 are other science field professionals (e.g., science teacher) (2.4%)
- 9 are professionals in non-science fields (e.g., attorney) (3.1%)

TABLE 8

Overall Demographics (Graduate student and Postdoc Tracking)

Gender	Minority Status	Position Category while at Magnet Lab
(n=419) 73% - **Male** (306) 27% - **Female** (113)	**(n=419)** 89.7% - **Non-Minority** (i.e., White/Caucasian male or Asian male) 10.3% - **Minority** (i.e., female, American Indian, African American, Hispanic/Latino, or Pacific Islander)	**(n=417)** 61.2% - Graduate Students (256) 38.8% - Postdoctoral. (162)

TABLE 9

Tracking Information by Academic/Professional Position

Current Academic/Professional Position (ALL)
(n=286) 23.4% - Professors 23.1% - Research Scientists (i.e., research associate at a laboratory, institute, or university) 18.9% - Scientists/Engineers working in the private sector 16.1% - Postdoctoral Researchers 12.9% - Graduate students (i.e., masters and doctoral students) 3.1% - Professionals in non-science fields (e.g., attorney) 2.4% - Other professions in science fields (e.g., science teacher)

TABLE 9

Tracking and Demographics for Former Graduate Students Only

Current Academic/Professional Position (former Graduate students only)	
(n=158) 24.1% - Scientists/Engineers working in the private sector 23.4% - Graduate students (i.e., masters and doctoral students) 15.8% - Postdoctoral Researchers 15.2% - Research Scientists (i.e., research associate at a laboratory, institute, or university) 13.3% - Professors 4.4% - Professionals in non-science fields (e.g., attorney) 3.8% - Other professions in science fields (e.g., science teacher)	
Gender	**Minority Status**
(n=255) 68.6% - **Male** (175) 31.4% - **Female** (80)	**(n=255)** 89.4% - **Non-Minority** (i.e., White/Caucasian male or Asian male) 10.6% - **Minority** (i.e., female, American Indian, African American, Hispanic/Latino, or Pacific Islander)

TABLE 10

Tracking and Demographics for Former Postdoctoral Associates Only

Current Academic/Professional Position (former Postdoctoral Associates only)	
(n=126) 35.7% - Professors 32.5% - Research Scientists (i.e., research associate at a laboratory, institute, or university) 16.7% - Postdoctoral Researchers 12.7% - Scientists/Engineers working in the private sector 1.6% - Professionals in non-science fields (e.g., attorney) 0.8% - Other professions in science fields (e.g., science teacher)	
Gender	**Minority Status**
(n=162) 79.6% - **Male** (129) 20.4% - **Female** (33)	**(n=162)** 90.7% - **Non-Minority** (i.e., White/Caucasian male or Asian male) 9.3% - **Minority** (i.e., female, American Indian, African American, Hispanic/Latino, or Pacific Islander)

In 2014, CIRL will hire a full-time person to address the Postdoc and graduate student mentoring plan as well as evaluate all programs including tracking participants.

Other CIRL Programs

This year, CIRL expanded the Middle School Mentorship program, run by Outreach Coordinator **Carlos Villa,** to all Leon County Middle schools. (Since 2003 it was a partnership between the Magnet Lab and solely the School of Arts and Sciences.) Since 2003, over 156 students have participated in this semester long internship where students are paired with scientists at the lab: 56% of these students are female and 10% are African American, Hispanic, or Native American. In the spring of 2013, thirteen students from the School of Arts and Science participated in the final semester of mentorship provided solely to that school. Eight scientists from the lab served as mentors. Then in the fall of 2013 6 students from four local middle school participated in the expanded mentorship program that will be the new format. Four of the same scientists who worked in the spring came back to mentor in the fall: **Bob Walsh, Vince Toplosky, Dmitry Smirnov, and Lloyd Engel.** One-third of the students in the fall came from Title I schools and 50% were female. The results of our evaluation survey indicate that all of the middle school participants learned more about scientific research, with most indicating that they were able to see how science was relevant to their lives. All of the participants indicated that they would be interested in internships at the lab – four of these students are planning to return in the spring to work with their mentors.

TABLE 11

2013 Leon County Middle School Mentorship Participants

Participant	School	Research Area	Mentor
Sayeeda Aishee Devin McKenna	Cobb Middle School Fort Braden School	Strengthening of Parmax Through HIP Process	Bob Walsh Vince Toplosky
Omie Coyne Hana Kiros	Cobb Middle School Fairview Middle school	Spectral Analysis of Synthetic Diamonds	Dmitry Smirnov
Quinn Huckaba Grant Womble	Fairview Middle School Deerlake Middle School	Scanning Microwave Microscope	Lloyd Engel

In addition to the mentorship, our scientists also work each semester with interns from high school and college. Assistant Director, **Jose Sanchez** runs the internship program. In 2012 there were 18 students who participated (17% were African American, 17% were Hispanic, 5% were Native American, 33% were female, and 2 of the high school students came from local Title I schools. In 2012, 17 MagLab scientists participated as mentors. In 2013, 21 students participated (5% African American, 9% Hispanic, 29% female and four of the high school students came from Title I schools). In 2013, 18 MagLab scientists participated as mentors. To evaluate this program we have participants complete a pre and a post-survey. The results indicated that there was an increase in the number of students who were interested in pursuing a STEM career and becoming a STEM professional.

SUMMER PROGRAMS

CIRL's summer programs include three middle school camps, two of which are funded (fully or partially) through partnerships. The ERC Renewable energy camp (run by Smriti Jangra) is a one week camp for Title I middle school students and is fully supported through FSU/NHMFL's partnership with the ERC-FREEDM grant. ERC also funds a 5-week Young Scholars program for High School Students from Title I schools that is run through CIRL (by Smriti Jangra). In 2013, Carlos Villa became the Summer Camp Coordinator and oversaw both the Magnet Lab Camp and the SciGirls Summer camp. The SciGirls summer camps are two weeks and are supported partially through a partnership with WFSU. In 2013, the Magnet Lab Camp (Carlos Villa) maintained its two one-week camps allowing 36 students to attend (15 females, 2 Hispanic, 5 African American, and 7 from Title I schools). The SciGirls Camps reached 35 middle and high school girls (8 African American, 2 Hispanic, and 5 from Title I schools). The ERC FREEDM one-week Middle School camp included 18 middle school students all from Title I schools (7 females and 5 African Americans). The 5-week ERC FREEDM Young Scholars program included 7 high school students, 6 of which came from a Title I school (5 female, 6 African American). The results of our evaluations for these programs indicated that the participants would all recommend their respective program to a friend. In addition, the majority of the participants claimed that their respective program increased their interest in STEM and STEM careers – those who did not indicate an increase said that they already maintained a high interest in STEM before the summer program. Surveys with teachers indicate that the SciGirls program would like to infuse more computer science and technology into the camp and the MagLab program would like to incorporate more volunteers from past camps to serve as camp counselors.

K-12 TEACHER PROGRAMS

Since 1998, CIRL has run an RET program for K-12 teachers. Over 225 teachers have participated reaching more than 1,000 K-12 students annually. Since 2001, 30% of these teachers have come from Title I schools. In 2013, ten teachers and six Magnet Lab scientists participated in the Magnet Lab RET program (5 female; 1 African American, 3 Hispanic, and 8 of whom came from Title I schools).

TABLE 12

2013 RET Participants

Participant	School	Research Area	Mentor
Joy Breman	Preservice	Solid State NMR of designer peptides MAX8 & SAF	Anant Paravastu
Hilary Dennis	James A. Shanks Middle, Quincy, FL	Performance of Magnetometer Based Hall Sensor	Alexey Suslov
Lynn Emmerich	Chester Shell Elementary, Micanopy, FL	High Frequency/Field EPR Experiment & Analysis	Chris Beedle
Adreanna Gimenez	Crossroads Academy Charter, Quincy, FL	Nb-Sn Reactivity to form Superconducting Alloy	Bob Goddard
Mark Hall	Northeast Middle School, Clarksville, TN	Quantum Dot Analysis with Femtosecond Diffraction	Jim Cao
Alex Martinez	Charles Duval Elementary, Gainesville, FL	Quantum Dot Analysis with Femtosecond Diffraction	Jim Cao
Michael Myrga	Piedmont Lakes Middle, Apopka, FL	Nb-Sn Reactivity to form Superconducting Alloy	Bob Goddard
Katrina Roddenberry	Riversink Elementary School, Crawfordville, FL	Density of Bi-2212 in 85x7 Superconducting wire	Eric Hellstrom
Fabian Sanchez	Celebration High School, Celebration, FL	Solid State NMR of designer peptides MAX8 & SAF	Anant Paravastu
Erin Smidt	Deerlake Middle School, Tallahassee, FL	Density of Bi-2212 in 85x7 Superconducting wire	Eric Hellstrom

In addition to the MagLab RET, **Smriti Jangra** from CIRL runs the ERC FREEDM RET program in coordination with the FSU/FAMU College of Engineering. Four teachers participated in the program in 2013. All of these teachers came from a local Title I high school, half were female, and half were African American. CIRL (through Carlos Villa) maintains a monthly newsletter and an email list known as the MagLab Educators Club. The email newsletter highlights activities and opportunities for teachers at CIRL, the MagLab, and locally/nationally. There are currently more than 150 members. **Jose Sanchez** started an RET facebook page to engage past and present RET participants. CIRL also maintains a presence on Twitter, Facebook, and the web for teachers.

UNDERGRADUATE STUDENTS

The REU program is run by CIRL Assistant Director **Jose Sanchez**. It has been in existence since 1999. Since that time, 298 students have participated (44% have been female (132); 11% come from HBCUs and MSIs (33); 15% African American (46); 16% Hispanic (47); 2% Native American (6). In 2013, 24 students participated in the program, with 15 in Tallahassee, 5 at LANL, and 3 at UF. Seventeen scientists from all three sites worked with these REU participants. The 2013 cohort of students consisted of 12.5% freshmen, 12.5% sophomores, 29.2% juniors, and 45.8% seniors. The vast majority of students who participated in the 2013 Magnet Lab REU program were upper-classmen (75.0%). The mean grade point average (GPA) for these participants was 3.47 with a standard deviation of 0.42. Participants' academic fields of study were classified as physical sciences, life sciences, engineering, and mathematics/computer science: 48.8% were majoring in a physical science, 45.8% were majoring in an engineering discipline, 4.2% were majoring in a life science, and 4.2% were majoring in mathematics/computer science.

The 2013 REU participants came from 16 colleges and universities, with 2/3 of participants coming from publicly funded institutions and 1/3 from privately funded institutions. Of the 24 REU participants from the 2013 summer program, 33.3% were from non-research institutions, 4.2% were from Hispanic Serving Institutions, and 12.5% were from Historically Black Colleges and Universities. When participants were asked how they learned about or were recruited to the Magnet Lab REU program, 50.0% indicated from faculty at their home institution, 37.5% indicated through the Magnet Lab website, 33.3% indicated from a Magnet Lab REU mentor, 20.8% indicated through an internet search, 20.8% indicated from their peers or family members, and 16.7% indicated from their home institution .

Brandon Nzekwe runs the research and evaluation component for the REU program. His report indicated that 92% of the participants were likely to extremely likely to pursue another research experience. In the post-survey, the students were asked a number of questions regarding what they learned from their research experience. Most participants indicated that they learned: to have patience with research (79%), what it takes to be a successful graduate student (79%), and that they have the ability to be a competent researcher (79%). Participants also indicated a significant increase in their understanding of how science researchers work, which indicates that the goal of the REU program is being met.

[1] Some participants chose more than one recruitment method

TABLE 13

2013 REU Participants

Participant	School	Research Area	Mentor
Efrosini Artikis	Florida State University	Characterization of amyloid β-peptide self-association in presence of vitamin B12	Anant Paravastu
Joseph Andler	Marietta College, OH	Characterization of BeCu, MP35N, and WC:Ni6 to Enhance Pressure Cells	Stan Tozer
Chiara Beckner	Carleton College	Magnetodielectric Coupling in Multiferroics	Vivien Zapf
Breshawn Best	Harvard University	Insulation of Bi-2212 Superconducting Wire	Jun Lu
David Brickler	Morehouse College, GA	Analysis of the Properties of Superconducting Spiral Resonators	Bill Brey
Grace Chrzanowski	Florida State University	MR Electrical Impedance Tomography of Acetylcholine Induced Neural Activity	Sam Grant
Marcos Corchado	U. of Puerto Rico Mayaguez	Design of a pressure cell for 1 GPa heat treatments of ferropnictide (BaFe2As,2) superconductors	Eric Hellstrom
Steve Geller	University of Florida	Catalyst Preparation and Characterization for Use in Para-Hydrogen Induced Polarization of Propylene Hydrogenation Reactions	Russ Bowers
Amakia Gibson	Claflin University	Metabolism during Cold Exposure in Drosophila melanogaster	Art Edison
David Gonzalez	Florida State University	Tracing the Molecular Speciation of Neurotoxic Mercury in Grouper Fish Skeletal Muscle Tissue and Liver Tissue Using Isotopic Signatures	Vincet Perrot
Robyn Hall	College of Saint Benedict	EPR on Oxalate Decarboxylase	Alex Angerhofer
Justin Jensen	Florida State University	Growth and Characterization of Deuterated L-Alanine Doped Triglycine Sulfate (DLATGS)	Theo Siegrist
Sarah Marks	Arizona State University	Microstructural Analysis of Thick Section Austenitic Steel Weldments	Bob Walsh
Stefan McCarty	Rhodes College, TN	Regulating Magnetic Field Fluctuations While Pulsing Field Gradients	Bill Brey
Navid Mirnazari	University of Florida	Open Single-File Channel Persistence Length in Crystalline Dipeptide Nanochannels	Russ Bowers
Lauren Paladino	University of South Florida	Electron Paramagnetic Resonance Transmission Probe Design and Testing	Steve Hill
Emily Ralby See blog	Florida State University	Provenance of the Moon through the Comparison of Isotopic Abundances of 50 Ti IN Terrestrial, Lunar and Martian Samples	Munir Humayun
William Rieger	Rowan University	Effects of Rapidly Changing Applied Magnetic Fields on the Magnetic Ordering Characteristics of Metal-Organic Multiferroics	Vivien Zapf
Dennice Roberts	Florida State University	Photomechanical Responses in Polymerized Azobenzene	Jim Brooks
Kevin Rueswald	Florida State University	Effect of Temperature and Relative Air Humidity on the Electrical and Morphological Properties of Self-Assembling Peptide RADA16-I	Theo Siegrist
Louie Vegara	U. of California Santa Cruz	HTS Persistent Magnet for 30T?	Doan Nguyen
Brenda Villasenor	University of Washington	Effects on the Magnetic Properties and Nanostructure of Mn-Al Magnetic Material by Cryogenic Milling	Ke Han
Zachary Windom	Mississippi State University	Heat Machine Based on Differential Helical-Elastic Thermal Actuator with Mechanisms to Determine Degradation	Jim Brooks
Stephanie Wyche	Claflin University	Computational Method for Determining Peak Locations in an INADEQUATE	Art Edison

TABLE 14

Education Programs in Diversity Clarification

2013	Total	% Women	% African American	% Hispanic	% Native American	% Native Hawaiian and Pacific Islander
Research Experiences for Undergraduates REU (summer)	24 undergraduates	42%	17%	17%	NA	NA
Research Experiences for Teachers RET (summer)	10 K-12 teachers	50%	10%	NA	NA	NA
Middle school Mentorship (Spring)	13 middle school students	23%	8%	NA	NA	NA
Internship Spring	4 (high school/ college students)	50%	NA	25%	NA	NA
Internship Summer	14 (high school/college students)	21%	7%	7%	NA	NA
Internship Fall	3 (high school/ college students)	33%	NA	NA	NA	NA
MagLab Summer Camp (Two 1-week camps)	36 (middle school students)	42%	14%	6%	NA	NA
SciGirls Summer Camp (Two 2-week camps)	35 (middle school students)	100%	23%	6%	NA	NA
***ERC FREEDM Young Scholars summer**	7 (High School students)	86%	86%	NA	NA	NA
ERC FREEDM Research Experiences for Teachers (RET) summer	4 (high school teachers)	50%	50%	NA	NA	NA
ERC FREEDM Middle school camp (one week camp summer)	18 middle school students	29%	28%	NA	NA	NA

*Engineering Research Center – Future Renewable Electric Energy Delivery and Management
ERC FREEDM programs - (this is a series of program we facilitate through an NSF grant that is managed by the Center for Advanced Power Systems and the College of Engineering)

Public/Community

In collaboration with Public Affairs, the MagLab also expanded its outreach efforts to the public in 2013. The Public Affairs team, under the direction of Kristin Roberts, uses a wide variety of communications tools to share scientific news with general audiences. Several are summarized below:

WEBSITE:

The MagLab's website, overseen by Web Content Director Kristen Coyne and Webmaster Nilubon Tabtimtong, is a broad public tool communicating important information about the entire lab. Education, however, remains the most visited section of the MagLab website with 61 percent of the lab's total page views coming from the education section (889,557 pages out of 1,464,962 total). Within the education section, tutorials are the most viewed content with 86 percent (of the 889,557 page views in education section, 764,715 of them are for tutorials). These interactive tutorials enlighten audiences on scientific concepts such as alternating current, Hall effect, Lorenz force, and transformers. They also feature lessons on historical and modern scientific instruments like the Faraday motor, Van de Graaff generator, microwaves, guitar pickup and Fournier Transform Ion Cyclotron Resonance.

In addition, new general interest content was also added to the website in 2013:

- 20 news releases
- 6 feature stories
- 8 science "Show and Tell" audio slide shows showcasing MagLab scientists and highlighting the many paths to science as a career.
- "Scientist and the Sample" animation video that provides an introductory ex planation to what the MagLab is and what our scientists do here.

SOCIAL MEDIA:

In 2013, the MagLab's online presence was larger than just the website. Through social media networks, the MagLab expanded its reach to public audiences with daily information on the sites that they love most. According to the Pew Research Center, 73 percent of online adults used a social networking site of some kind in 2013 and 42 percent use multiple sites.

In 2013, the MagLab defined our Facebook presence by launching a "fan page" which is a profile type specific for businesses, brands and other organizations. It allows people to "like" a page and receive status updates, links, photos and videos from the organization. Our social media effort is run by Public Affairs Director, **Kristin Roberts.**

Due to the huge viral power of social media, however, many of our posts attained much larger reach than our total audience, with many reaching thousands of people. Posts generated by others on Facebook about MagLab science also yielded huge impacts in 2013. For example, an article on spider silk research at the MagLab was shared by a widely followed science page and received nearly 17,000 likes and over 3,000 shares.

Facebook has broad audience appeal with 73 percent of online Hispanic adults and 76 percent of online Black, non-Hispanic adults using the network. The MagLab's audience breakdown highlights the impact for 18-44 year olds and shows an almost even distribution between male and female fans. The MagLab's Facebook page also has fans from 35 countries including India, Brazil, Egypt, Iraq and Nepal.

The MagLab also continued to develop a social media presence on Twitter, expanding from 535 followers at the beginning of 2013 to 860 at the end – a 61% increase.

TABLE 15

Social Media Sites, 2012-2013

%of online adults who use the following social media websites, by year

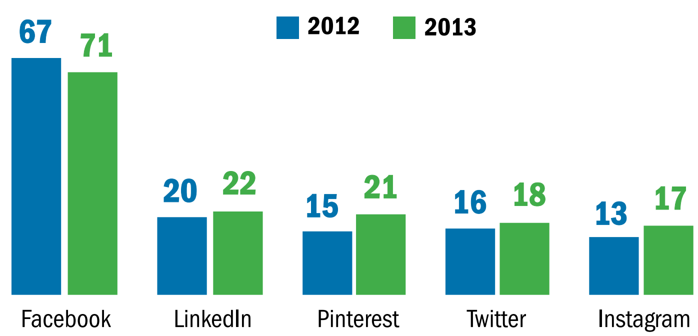


TABLE 16

Through 2013, this maglab facebook page (@nationalmaglab) saw a 701 percent growth in fans from 73 to 585:

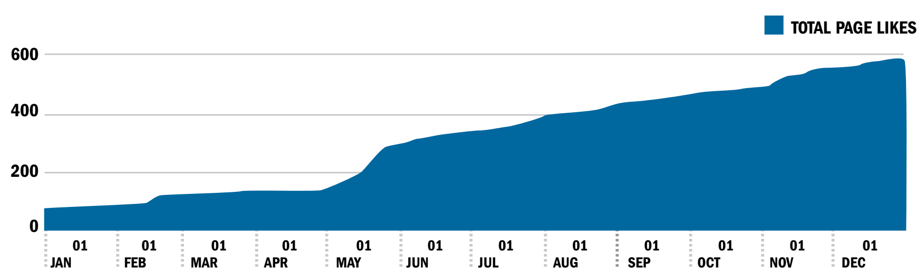


TABLE 17

People Who Liked the MagLab Facebook Page

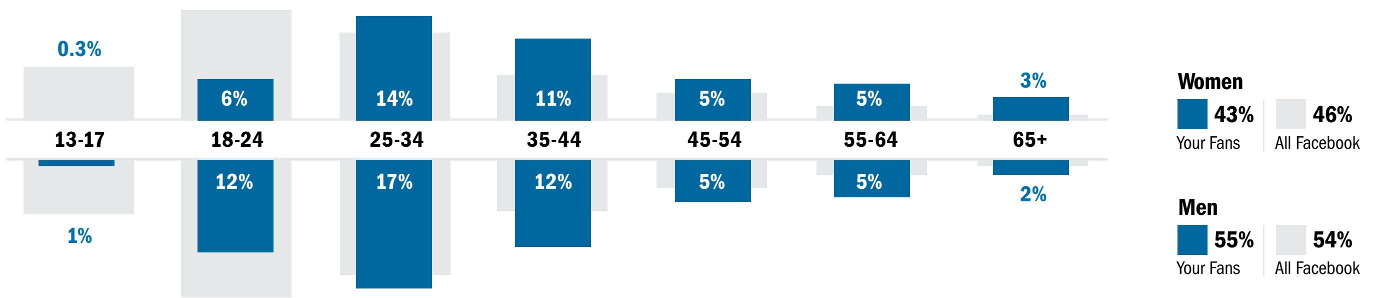
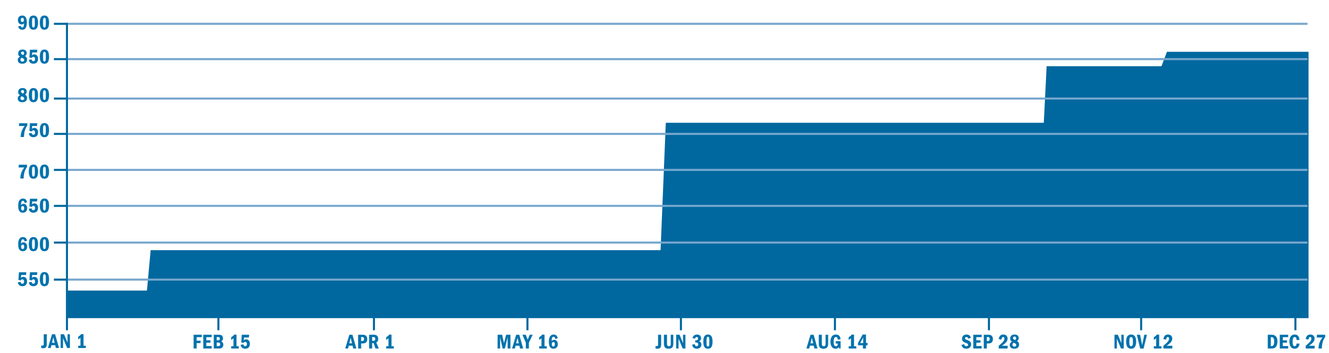


TABLE 18

Twitter Follower Growth



Twitter is a network known for its popularity in diverse, young audiences. Data shows that 29 percent of Black, non-Hispanic online adults use this social network. Analytics are not available on ethnic breakdown for the MagLab's Twitter account, however, the MagLab's gender breakdown is 79 percent male compared to 21percent female.

The MagLab has had an active YouTube page since 2008. In 2013 alone, this YouTube channel gained 100 new subscribers and had close to 129,000 views. New video content was added in 2013, including

- "Scientist and the Sample" animation video that provides an introductory ex planation to what the MagLab is and what scientists do here (462 views)
- 8 "Show and Tell" audio slideshows showcasing MagLab scientists and highlighting the many paths to science as a career (1,064 total views)
- 2 Science Café videos (see more information below)

This past year also saw large growth in the number of people using other social media networks including Instagram, Pinterest and LinkedIn. To ensure that MagLab science messaging capitalizes on where audiences are, the MagLab has launched accounts on Instagram, Pinterest and Tumblr with plans to launch a LinkedIn in early 2014. The lab's total number of followers in each new network is low (Instagram – 5 followers; Pinterest - 2 followers; Tumblr - 0), but we have not yet widely promoted these accounts to key audiences.

SCIENCE CAFÉ

The MagLab's Science Café series continued to grow in 2013 with a new year of programming and a change in venue. The combination of great food and interesting science drew an average of 50-100 guests to Science Café, which moved its venue to a locally owned restaurant in downtown Tallahassee, Backwoods Bistro, in September 2013. Science Café topics are selected to align cutting-edge science in our area. The presentation on 3D printing was a highlight of 2013, drawing an all-time-record crowd close to 200!

In 2013, the MagLab added an additional upgrade to the Science Café series by video recording the events and posting them on our YouTube channel. This allows our local Science Café series to have a broader impact than just the Tallahassee geographic area.

TABLE 19

2013 Science Café Series

Date	Topic	Speaker	Number of attendees/ Views online
Dec. 3	The Motion of the Ocean: How Scientists Measure the Sea	Nico Wiender, FSU Oceanographer.	About 75 in person
Oct. 1	Meteorites, Mars and the Moon	Munir Humayun, a professor of geochemistry at the MagLab.	About. 75 in person 93 views on YouTube
Sept. 3	3D Printing	David Brightbill and Mark Trombly, Making Awesome, Tallahassee's Makerspace	About. 200 in person 308 views on YouTube
May 7	Sharks, Cancer and Pseudoscience	Gary K. Ostrander, FSU vice president of research and shark scientistr.	About 60 people
April 4	Exploring Mars: What We've Learned	Jennifer Stern, NASA space scientist, geochemist, former MagLab researcher	About 85 people
March 5	Climate Sleuthing in Caves	Darrel Tremaine, graduate research assistant in geochemistry and cave detective	About 70 people
Feb. 5	The Secret Life of Fish	Felicia Coleman, Florida State University Coastal and Marine Lab	About 65 people

OPEN HOUSE:

Every February, the MagLab invites the public to spend the day at our world-class research laboratory, and in 2013, more than 5,500 people attended! The free event transforms our 370,000 square foot lab into an interactive science playground featuring hands-on demonstrations, self-guided tours, food, and the chance to meet and chat with MagLab scientists.

SENIOR CENTER WORKSHOP:

Nearly 30 seniors attended a MagLab educational event on September 24, 2013. The event featured an introductory presentation about high magnetic field research and the MagLab's role in creating world-record tools. The seniors toured the facility and then enjoyed lunch with two scientists who were available to answer questions and talk casually about their work at the lab.

MEDIA COVERAGE:

MagLab science writer, Kathleen Laufenberg, continues to maintain her high volume of quality media coverage on MagLab education and outreach. Newspaper articles of the lab's Science Cafés, Open House, REU students and REU teachers ran in the Tallahassee local paper as well as in publications from surrounding areas. Nearly every café speaker was also interviewed for radio spots that ran prior to the café event. Television coverage included spots on Open House and others.

TABLE 20

2013 Open House

Number of visitors	5,500
Pounds of food collected for America's Second Harvest of the Big Bend	2,660
Number of dill pickles used to transmit electricity in Electric Pickle demo	130
Quarts of dairy products used to make Einstein Ice Cream	66
Number of science demonstrations	83
Pounds of potatoes fired in Potato Cannon	200
Number of participating organizations	24

Postdoctoral Mentoring Plan

The goal of the Postdoctoral Mentoring Plan at the National High Magnetic Field Laboratory (NHMFL) is to provide NHMFL postdoctoral associates with a complete skill set that addresses the modern challenges of a career in science, technology, engineering and mathematics (STEM). A key component of the plan is full immersion in the interdisciplinary culture of the NHMFL and in the surrounding communities of one of the NHMFL's three partner institutions - the Florida State University (FSU), the University of Florida (UF), and Los Alamos National Laboratory (LANL). The Center for Integrating Research and Learning (CIRL) housed within the NHMFL will facilitate this Postdoctoral Mentoring Plan.

Currently, NHMFL postdoctoral researchers are required by their supervisors and research groups to participate in the preparation of publications, and to make presentations at group meetings and conferences. Postdoctoral researchers are also required to play active roles in STEM-strengthening programs, such as the NHMFL Diversity Action Plan, the Research Experiences for Undergraduates program, the Research Experiences for Teachers program, and other CIRL outreach programs, through which they can provide significant STEM mentorship to students, early career scientists and the teachers of the next generation of scientists. Finally, NHMFL postdoctoral associates are required to provide service to the laboratory through participation in the NHMFL Annual Open House or other events designed specifically to translate and communicate research in the NHMFL user community to members of the general public.

Key Components

Orientation: Each new postdoctoral associate will meet with the NHMFL Human Resources Director who can address questions they may have related to their new position. Orientation materials, including a "Welcome to the MagLab" document are available online to augment face-to-face orientation and best accommodate the different individual start dates of NHMFL postdoctoral associates. Orientation includes an overview of the three sites of the NHMFL, the breadth of scientific research in the NHMFL user program, particularly interdisciplinary research, and practical institutional information (including but not limited to performance expectations, salary information, the ordering and delivery of materials, as well as information about local housing, schools, health care resources, and links to special interest groups at the local partner institution).

Professional Development: Professional development classes, workshops, and online materials will cover grant writing, ethical conduct of research, organizing data, writing manuscripts, giving effective scientific presentations, mentoring other scientists and communicating scientific research to non-scientists. Workshops will be facilitated by CIRL and involve faculty from the NHMFL, the FSU Career Center and librarians from the FSU Dirac Science and Engineering.

Career Counseling: Sometimes postdoctoral associates may have career questions that their assigned mentor cannot speak to (e.g. careers in industry, networking opportunities for underrepresented minority students). Therefore, the NHMFL Postdoctoral Mentoring Plan includes a list of additional volunteer mentors who are willing to answer questions that postdoctoral associates may have. Postdoctoral associates may choose to contact volunteers from this list if they feel they need additional advice not exclusively from their direct supervisor. Possible forms of advice include: providing guidance, encouragement, and information on opportunities for networking, contributed and invited talks, and travel funds to attend conferences, including the NHMFL's Dependent Care Travel Grant Program [http://www.magnet.fsu.edu/usershub/funding/travel.html].

Assessment: Assessment will be conducted by the Center for Integrating Research & Learning through annual evaluation surveys to determine topics of interest to postdoctoral researchers and to ensure that postdoctoral researchers' mentoring needs are being met.

2013 Conferences and Workshops

Winter School on Biomolecular Solid-State NMR

January 5-11, 2013,
Stowe, Vermont

The third U.S.-Canada Winter School on Biomolecular Solid State NMR is a pedagogical meeting, aimed primarily at graduate students and postdocs, with the goals of training them in fundamental conceptual and experimental aspects of biomolecular solid-state NMR, promoting frank discussions of current trends and bottlenecks, and generally catalyzing future progress. The meeting is also open to more senior scientists who are interested in entering the field of biomolecular solid state NMR. This year's event drew around 75.

Theory Winter School

January 7-11, 2013
Tallahassee FL

The MagLab held its second Theory Winter School this year, with lectures focusing on Unconventional Superconductivity, a subject of continuing relevance in Condensed Matter and Materials Research Theory.

Ten leading experts in this active and exciting area of research presented tutorial lectures each during this five-day program. These lectures presented an overview of the most relevant concepts and mathematical techniques for understanding the mechanism and phenomenology of unconventional superconductors. Poster sessions were also planned for junior participants to have an opportunity for direct exchange of ideas with lecturers and each other. The Winter Theory School attracted 53 participants from across the globe.

9th North American FT MS Conference

April 28 – May 1, 2013
Key West, FL

The FT MS Conference is held every two years and is the premier conference of its kind in the field of Fourier Transform Mass Spectrometry and its applications. Presentations are varied with a focus on instrumentation, technique development in the biological/biomedical sciences ranging from pharmaceutical metabolism to proteomics, environmental analysis and petroleomics, with special emphasis on new developments. This year's conference featured 24 oral presentations, 2 vendor presentations, 3 student award presentations, and 19 poster presentations. Eleven student awards were given to promote and encourage young participants. The conference hosted 70 participants from around the world.

User Summer School

May 13-17, 2013
Tallahassee, FL

The fourth annual User Summer School once again introduced early-career users and potential users to the MagLab's infrastructure, experimental options, support staff. User Summer School focuses on helping attendees develop skills useful in both the home laboratory and in user facilities worldwide. MagLab User Summer School is designed to provide a "technique toolkit " to early career scientists that includes: noise types and theory, noise suppression techniques, transport techniques, magnetometry, heat capacity measurements, magneto-optics, infrared and terahertz spectroscopy, ultrasound spectroscopy, high-pressure methods, NMR techniques for chemistry, biology and condensed matter, electron paramagnetic resonance, cryogenic techniques, measurements at ultra-low temperatures, and the nuts and bolts of data acquisition.

16th US-Japan Workshop on Advanced Superconductors

July 10-12, 2013
Dayton, Ohio

Eric Hellstrom was a Co-Organizer This biannual workshop brings together leading research from the US and Japan and the venue rotates between the US and Japan. Topics at the workshop included LTS and HTS tapes and wires, large scale and novel applications, basic materials science of and search for new superconductors, and energy related applications and technologies. About 60 researchers participated in the workshop.

42nd Southeastern Magnetic Resonance Conference

October 11-13, 2013
Tallahassee, FL

The Southeastern Magnetic Resonance Conference (SEMRC) is held every year and rotates among various locations in the southeastern United States. With a long history of bringing together leading scientists to discuss the latest developments in NMR, EPR, and MRI, the focus of the conference is the exchange of ideas and recent magnetic resonance research highlights, including new applications and technique development. Particular emphasis is placed on activities in the region. This year's conference was attended by 129 participants from across the southeastern United States. SEMRC puts a special emphasis on the participation of young scientists (students and postdocs) and this year, 8 student awards were given to promote and encourage young participants.

Workshop on NMR in the Series Connected Hybrid Magnet

October 17, 2013
Gainesville, FL

The MagLab hosted this workshop in tandem with the 2013 User Committee Meeting to solicit user input on possible NMR and MRI user experiments during the commissioning phase of the 36 tesla Series Connected Hybrid user program. Fifty-three participants attended a series of presentations delivered by leaders in the field of NMR/MRI as well as technical presentations by NHMFL staff on the performance specifications of the magnet. A particular focus of this workshop was also on identifying experiments to produce significant, publishable results during the commissioning phase of the magnet and understanding the technical specifications that will be needed for their success. Ten external leaders in the fields of biomolecular NMR, high field MRI (both for biological and energy applications) were in attendance as well as potential commercial partners for the console and probe development to participate in the discussions.

Low Temperature Superconductivity Workshop (LTSW)

November 4-6, 2013
St. Petersburg, FL

The Low Temperature Superconductivity Workshop (LTSW) had its 30th anniversary in 2013. Established by Dave Sutter (DOE-HEP) and David Larbalestier (ASC, then at UW-Madison), this workshop was created to bring together government labs, industry, and academia in the US to advance the science of superconducting materials for high-energy physics accelerators. The primary material discussed in the early workshops was Nb(Ti), which is used in all of the superconducting accelerator magnets, NMRs and MRIs. However, Nb(Ti) is now a mature technology and instead, this workshop has a new focus and a new name - now the Low-Temperature, High-Field Superconductor Workshop (LTHFSW). on Nb3Sn and the high-temperature superconductors. The November 2013 meeting was attended my more than 80 participants with attention on Nb3Sn and other high-temperature materials as well as high-energy physics accelerators that are being proposed for high energy physics studies.

Contributions to Structure, Dynamics and Function of Membrane and Membrane Proteins, and to Developments of High Field NMR Technology and Methodology Symposium

December 14, 2013
Tallahassee, FL

The MagLab hosted this symposium celebrating the work done and inspired by Dr. Timothy A. Cross on the occasion of his 60th birthday. Five invited speakers presented on the influence that Tim Cross' work has made on them and their work. Additionally, 6-8 Cross alumni will also present. The evening will wrap up with a presentation by Dr. Cross. Expected attendance is 30-50 and will be held at the National High Magnetic Field Laboratory.

CHAPTER 5

In-House Research

Magnets & Materials

A central feature of the MagLab's mission is the provision of unique, high-performance magnet systems that exploit the latest materials and magnet design developments for our users.

Introduction

During 2013 the MagLab made significant progress on all fronts in 1) delivering new resistive and pulsed magnets to the user community, 2) making significant development in the construction of new superconducting and resistive-superconducting hybrid magnet projects, and 3) continued promising new demonstrations of the potential for High-Temperature Superconducting materials and coils. As we move forward, the maintaining a balance of development of new magnet systems with development of new technology is of critical importance to keep us at the forefront. Collaborations with other leading industrial, academic and government groups that develop these new magnet technologies is built in to many of these thrusts.

For several years the MagLab has been developing a 32-T all-superconducting magnet to be combined with a dilution refrigerator in the milli-kelvin facility aimed to replace an existing 20-T system. We expect that this magnet will be the first HTS coil-set to be put into routine operation, surpassing the present mark of 23.4 T for a superconducting coil provided by a Bruker NMR magnet in Lyon, France.

In March 2013 the MagLab tested the prototype of the innermost $REBa_2Cu_3O_{7-x}$ (REBCO) coil of the 32 T magnet (**Figure 1**). This coil used the same superconducting REBCO tape, insulation, joints, protection system, winding technology, clamping technology and was wound with the same inner and outer diameters as the real innermost coil of the 32 T magnet. While several previous REBCO coils have been tested, this was the first to incorporate all of these essential features for a real user magnet. The test was very successful and has allowed us to proceed to develop a two coil prototype of both outer and inner HTS coils which should be tested in Feb. 2014. Successful completion of these two milestones will allow us to proceed with winding and stacking of the full-scale REBCO coils for the 32-T magnet. These REBCO coils will then be mated to the outer Nb_3Sn and Nb-Ti coils being constructed by Oxford Instruments, which are due to arrive this year. We expect the 32 T superconducting magnet to be operational in 2015.

FIGURE 1. 32 T Inner prototype before testing in March 2013

The MagLab is developing a new resistive-superconducting hybrid magnet that will provide 36 T with 1-ppm uniformity and stability over a 10-mm-diameter spherical volume. This will not only be the 2nd highest-field dc magnet in the world, but its homogeneity will be ~200 times better than that of the present 45-T hybrid magnet enabling very high-field condensed-matter NMR experiments not possible elsewhere. In addition, we are developing a 25 T hybrid magnet for the Helmholtz Zentrum Berlin (HZB) to be used for neutron-scattering experiments. In 2013 we completed impregnating the HZB superconducting coil with epoxy as well as installing helium lines, cold structure and performing a Paschen test prior to shipping the coil to Europe in September **(Figure 2)**. Completing this 5.5-ton coil not only marks a major milestone in the HZB project, it also served as the final opportunity to refine the fabrication processes prior to performing the same tasks on the identical FSU coil which should be completed late in 2014, followed by operation in early 2016.

Attaining 1-ppm uniformity in the SCH requires development of a shim system capable of cancelling the inhomogeneity due to manufacturing tolerances in the resistive coils. In 2013 a novel shim system was successfully demonstrated in the Keck resistive magnet, culminating several years of development effort.

The HTS R&D program has continued, a major effort this year being to explore the capability of round-wire, multifilament Bi-2212 in coil applications, especially for high homogeneity NMR coils where there are real concerns about the ability to correct error fields due to the large magnetization of single-filament, wide-tape REBCO coated conductors. Designs for prototype NMR coils that can be tested in our 17 T, 110 mm bore superconducting magnets have been made and Bi-2212 conductor ordered for insert coil construction that is aimed to occur in 2014. DOE-High Energy Physics has made major investments at the lab in the conductor development, which has also been taken up by CERN. We have continued an extensive characterization of REBCO coated conductors so that their properties can be better understood and predicted, especially as manufacturers prefer to specify at 77 K and self-field, conditions that do not correlate well with 4.2 K, high field performance.

In addition to the highlights above,

FIGURE 2. Nb3Sn Cable-In-Conduit Coil (cold-mass) for Helmholtz Zentrum Berlin ready for packaging and shipping. The FSU CICC coil will be identical.

we completed improvements to the 65 T pulsed magnets, increasing the lifetime of the magnets while reducing the manufacturing costs and providing 80 pulses above 90 T at the pulsed-field facility. New pulsed magnet concepts are being developed as well as resistive coils for the FSU and HZB series-connected hybrid magnets and much, much more!

HTS Magnets & Materials

32 T Magnet

The goal of the 32 T project is to develop the technology for and to construct an all-superconducting magnet that generates 32 T in a 32 mm cold bore. Accomplishing this goal requires use of High-Temperature Superconductors (HTS), particularly REBCO tape. While numerous small HTS coils have been made by various groups over the years, those were all demonstration coils or test coils that were operated for only a few hours. We expect this magnet will be the first HTS coil-set to be put into routine operation, surpassing the present mark of 23.4 T provided by a Bruker NMR magnet in Lyon, France. The magnet is intended to be installed in the MilliKelvin facility at the NHMFL, replacing a 20 T system and is designed to have a dilution refrigerator installed at a later date. Completion of the magnet is projected by late 2015.

Prototype coils: A major part of the magnet technology development program was to make prototype coils of each of the two REBCO coils in the 32 T magnet. The first of the prototypes (inner prototype or IP, **Figure 1**, in introduction) was successfully tested in 2013, in a 19-T background field, demonstrating most of the features of the real 32 T inner coils for the first time and enabling us to proceed with the outer prototype (OP, **Figure 2**) and the real coils. These coils have all the essential features of the 32 T coils, except for a reduced height of six double-pancake modules each versus 20 and 34 respectively for the inner and outer coils of the 32 T **(Figure 3.)**

Outside the traditional test topics of current-density and stress-tolerance of conductor and joints, several 32 T-specific technology choices were realistically tested by the IP. First and foremost is the quench protection system that, given the very low normal-zone propagation-velocities in REBCO windings, relies on quench-protection heaters to initiate large enough normal zones. It was found that the quench-heaters performed well, generating fast quench-initiation times. Importantly, the coil was not degraded after many forced quenches while using only the heaters for protection. These are unique measurements for REBCO coils of this size and the results give confidence that the 32 T REBCO coils can also be protected within the proven operating parameters of the heaters.

While largely successful, the IP did demonstrate the need for improvements in the design of the terminals. These have now been re-designed and will be tested in the outer prototype coil. The detailed hardware design of the OP was also largely completed this year. After feedback from testing of the IP was incorporated, fabrication of the OP coil is underway **(Figure 2)**. In addition, the IP will be partially rebuilt, with a new 6th module and new terminals, and be nested inside the larger OP coil. This assembly will be tested in the 11 T background magnetic field provided by the superconducting coils of the 45 T Hybrid to conditions that match or exceed the 32 T design benchmark parameters for stress, current density, field*field-gradient product and ramp rate. The quench detection and protection electronics that will be used to operate the quench heaters for these prototypes will be re-used on the final 32 T coils.

Helium bubble: In relatively narrow-bore high-field magnets like the 32 T design, the field*field-gradient product in part of the bore and windings exceeds the threshold where magnetic forces exceed buoyancy forces. Helium-bubbles

FIGURE 3. YBCO coil-team & outer prototype of 32 T superconducting magnet.

then no longer rise to the surface but agglomerate into a large bubble. Cooling of the windings is poor in these regions, which can lead to thermal instability and reduced magnet performance. Measures to maintain thermal stability even in the presence of a significant helium-gas bubble were incorporated into the design and instrumentation was developed to measures the size and position of the gas bubble. We observed that the gas bubble formed as predicted and importantly that the temperature in the bubble and coil remained stable in operation. As the zone where the field*field-gradient product can trap helium gas is comparable to that in 32 T, we conclude that we have developed an adequate solution to this problem.

Insulation: Turn-to-turn insulation is vital to minimize magnetic field errors due to ramping and limit the AC (ramp-rate) losses, which are key parameters for a magnet that is expected to spend most of its projected 50,000 cycle operational life time ramping up and down. Insulating the conductor posed several challenges: since it must be applied to the winding, there is a risk of damage due to handling while commercial insulation tends to take up too much space and reduce the thermal conductivity of the windings. Accordingly we chose the alternate solution of insulating the co-wound stainless-steel reinforcement. The selected double-pancake approach with co-wound reinforcement lends itself well to this. Development of a sol-gel based process to apply a thin ceramic layer (from 3 to7 mm) on stainless steel tape was completed and a dedicated machine was built to perform long-length reel-reel insulation with a through-put of 1 m/minute and exceeding 220 m/day including setup. A non-provisional patent titled "Thin Composite Insulation Coatings" was filed in December 2013.

REBCO coated conductors are in a nascent commercial stage resulting in limited predictability of some properties of the REBCO coated conductor along its length. The 32 T project was the first to develop a comprehensive set of specifications, including a critical-current benchmark at 4.2 K at the limiting magnetic field and field-angle conditions. As the vendor did not have test capabilities at 4.2 K, the 32 T project has taken up that quality assurance task and a large amount of data has been collected, providing unique insights, on the 6 km of conductor received from the vendor in 2013.

Outer magnet: Oxford Instruments has completed the design of the 15 T, 250 mm bore LTS magnet in collaboration with the NHMFL, including three design reviews, and is now engaged in coil construction. The outer magnet, cryostat and leads are expected to arrive before the end of 2014.

REBCO Conductor Development

REBCO coated conductors (CC) with remarkably high critical currents are now available commercially. However, homogeneity of critical current and defect populations in long length conductors are still an issue. Thus, to assure the performance of CC, it is crucial to characterize them before coil-winding. Intensive and extensive studies of the REBCO conductors by many different techniques have been performed at the MagLab. These studies include transport investigations of the I_c dependence on temperature and external magnetic field and its orientation, study of the correlation between I_c at 77 K and 4.2 K, microscopic studies of morphology and defects, essential if tedious studies of conductor dimensions, internal delamination, contact resistance, quality of silver and copper plating, as well as the influence of substrate, and extensive magneto-optical studies. Nondestructive, continuous characterization of long (100-200 m) conductors by both transport and magnetization at 77 K was developed recently. Prototype continuous development of magnetization at 4.2 K in strong fields has also been performed. To accelerate and standardize measurements of I_c(B, 4.2K) we assembled versatile I_c transport-current measurement system based on modern nano-voltmeters and modular slaved power supplies using carefully designed probes. Using this system with home-written LabView-based software we are able to measure I_c(B, 4.2K) automatically

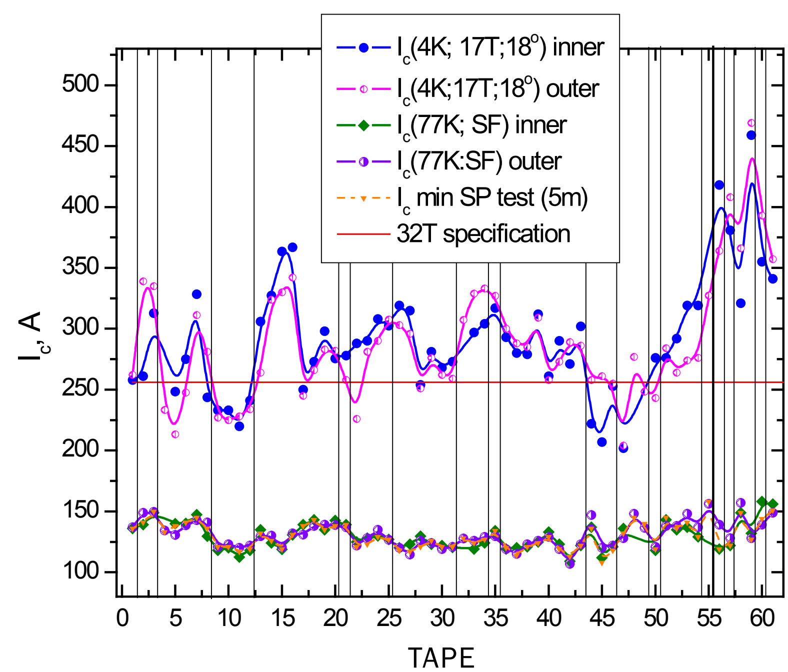


FIGURE 4. Extrapolated to 17T Ic (4K, 18o) data of short samples from each end of the piece length plotted with Ic(77K; SF). Data arranged by SuperPower's process number. Vertical lines separate SP processes. Ic(4K, 17T, 18o) values vary smoothly from process to process.

at currents up to 1.4kA in fields up to 13.5T. Our algorithm for current and field sweeping is insensitive to random voltage noise, but effective in preventing accidental burn up of the sample. We investigated short samples from all production deliveries of REBCO tapes manufactured by SuperPower Inc. I_c values routinely measured by transport technique for samples prepared from ends of 60-110 m long peace lengths correlate well (see **Figure 4**). At 4.2 K the I_c field-dependence follows very well a power law $I_c \sim B^{-a}$ even when measured up to 31T in a resistive magnet. We observe little variability of α value (<α>=0.82; σ_α =5.2%), which suggests good production uniformity. I_c(4K, 17T, 18°) extrapolated from data measured up to 13.5T for samples from different production runs has a significant spread with standard deviation σ_{4K} =17%, but I_c(77K, SF) measured on the same samples has half this spread: σ_{77K} =8.4%. The difference between I_c of different ends of tapes is small (σ_{ar77K}=4.8%) at 77K, SF, but is larger, σ_{r4K}=9.3%, for I_c(4K, 17T, 18°). A complication that we have discovered is that there is only a weak correlation between I_c (77K, SF) and I_c (4K, 17T, 18°). The highest I_c values and lowest spread of I_c(4K, 17T, 18°) values occurs for tapes with the smallest spread of T_c, larger α values, smaller angle between ab-planes and tape plane, and lower CuO grains density.

There are generally two ways to characterize long CCs: transport and magnetization measurement. Continuous transport measurement of I_c has been developed by Coulter, et al. at LANL. However, the time efficiency of this approach is low. A 10-m long tape usually takes more than 6 hours. In order to improve the speed by a factor of 100, remnant field measurement by a Hall sensor array has been adopted as an alternative.

Figure 5 compares results of both methods. It is seen that remnant field magnetization characterization is reliable; its spatial distribution along the conductor corresponds well to the I_c measurement. Moreover, its spatial resolution is much better: 1 mm vs 20 mm by transport. Indeed, as indicated by arrows, at the beginning of the tape the magnetization method reveals several crack-like defects across the tape and only the two biggest of them are observed in the transport measurement.

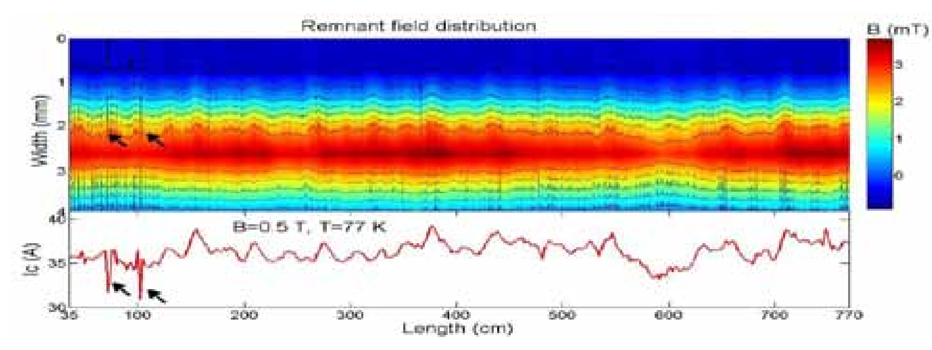


FIGURE 5. Top: Remnant field distribution after tape passed through the magnet in LN2. Bottom: Ic transport measurements in LN2 of the same ~7m of conductor.

Magnetic characterization with Hall sensors is faster and has better spatial resolution in finding defects. It possibly enables unique continuous measurements at 4.2 K. However, it does not measure absolute Ic value as accurately as the transport method. Thus, both methods are needed for evaluation of coated conductors.

Platypus (Towards a 30 T NMR User Magnet)

In 2005 the National Research Council Committee on Opportunities in High Magnetic Field Science (COHMAG) recommended the development of a 30 T NMR magnet, a major challenge that first of all required the development of appropriate HTS conductors not then available. The 32 T magnet project described above represents the first all-superconducting magnet venturing into this territory. It was initiated in 2009 partly to develop some of the technology that might be needed for the 30 T NMR magnet. In 2012 the 32 T project was far enough along that it became possible to start the next phase towards 30 T NMR, namely delivery of an HTS coil to operate in a background field with NMR-quality homogeneity. The effort has been two-pronged as it is not clear which is the preferred conductor for 30-T NMR: REBCO tape or Bi-2212 round-wire, a new conductor technology in which rapid strides were made in 2012.

REBCO for 30 T NMR: In 2009 REBCO conductor was clearly better for the 32 T project due to its high-strength, high current-density and availability in a factory-reacted and hermetically-sealed form [1]. Consequently, the 30-T NMR effort initially focused on this conductor. Being essentially a highly-aspected (4-mm wide by ~0.1 mm thick) single filament conductor, REBCO coated conductors sustain significant screening currents that are induced by the radial field components of the windings. These screening currents strongly affect the coil's field-profile and field-stability. As shown in **Figure 6**, a layer-wound, fully epoxy impregnated, REBCO insert test coil with one resistive electrical joint was made. To circumvent the issue of conductor delamination caused by transverse stresses our patented approach using thin polyester heat shrink tubing was used [2, 3].

FIGURE 6. View of the layer wound REBCO coil and coil terminals [4].

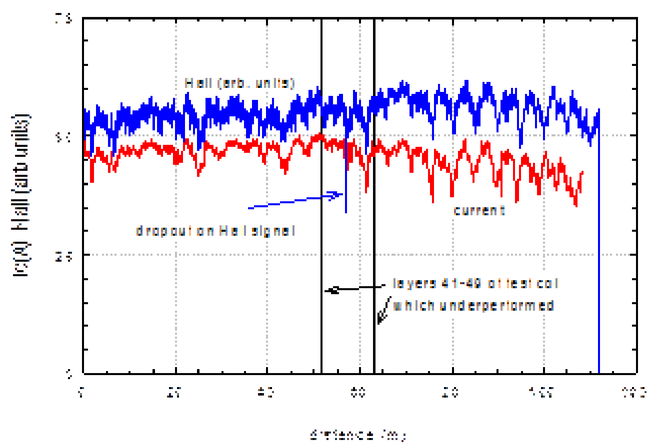


FIGURE 7. (right) Continuous critical current and Hall sensor data measured with our in-house test facility on one of the conductor piece lengths used in the coil.

Two major goals were pursued: 1) to develop and evaluate layer winding and joint making procedures, measure coil performance and 2) to study the effect of induced screening currents on the field stability. Before winding the coil, the Ic of the entire conductor was characterized in an in-house facility that combines Hall-sensor magnetometry and critical transport-current characterization **(Figure 7).**

Though the transport data did not indicate any conductor issue, the Hall data indicated a potential defect at about 55 m, which corresponds to a location within coil layers 41-49 (of a total number of 132 layers for the whole coil). The finished coil was tested at self-field and 12 T inside our 17.8 T Oxford Instruments superconducting magnet. Nine of the eleven coil-sections were superconducting. While the section around the resistive joint showed expected ohmic behavior (~0.57 μΩ for a bridge type joint of 8 cm length, extrapolated to a reference field of 20 T), coil layers 41-49 showed an unexpected resistive offset of about 22 μΩ (extrapolated to the same reference field) which corroborated the results of the conductor characterization done earlier. During the coil tests a Hall sensor located at field center was used to measure total field and field decay caused by the decaying shielding currents in the coil. During the measurement the operating current was cycled up and down to an increasing maximum with each cycle. The arrows indicate the directions of the operating currents with respect to time of the corresponding loop edges. A substantial magnetic hysteresis was measured. As shown in **Figure 8,** central magnetic field hysteresis and differences on the order of a percent or more were measured, which is substantial for NMR applications [5, 6].

Bi2212 for 30 T NMR: However, in recent years, tremendous progress (under leadership of the MagLab) has been made on reacting Bi2212 at elevated pressures

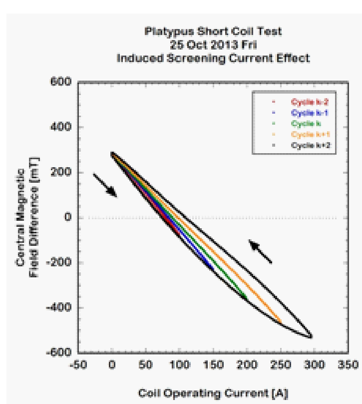


FIGURE 8. Central magnetic field difference measurements of a layer-wound tape test coil reaching about 5.1 T self-field at 300 A max.

resulting in increased current density and less sensitivity to heat-treatment temperature and duration. This, combined with the fact that the round-wire Bi2212 is essentially isotropic and should have smaller screening currents than REBCO, suggests that Bi2212 might be the better candidate for 30 T NMR. Consequently, the second prong of the Platypus project has been developing a Bi-2212 coil-design. Conductor insulation is one of the key components needed to make Bi-2212/Ag superconducting round wire successful for high field magnet applications as dielectric standoff and high winding current densities directly depend on it [7]. Besides good dielectric properties, the coating should be thin, since insulation space dilutes the overall winding current-density. Also, since coils are preferably made using the wind-and-react approach, the insulation has to be applied to the conductor before coil-winding and has to withstand high temperatures of about 890oC in a high pressure oxidizing environment.

These conditions pose several challenges for an effective insulation for Bi-2212/Ag, which must be chemically compatible with Bi-2212/Ag round wires. The insulation must be permeable to oxygen, to allow both for oxygen loss during the partial melting of the Bi-2212 and subsequent oxygen uptake during solidification and full development of the oxygen overdoped state during cooling. Lastly the insulation has to be abrasion resistant to allow for handling during coil winding and has to be sufficiently thin to permit a high winding current density Jw without sacrificing dielectric strength. A TiO_2/polymer insulation coating developed by nGimat LLC was applied to test samples and a high field test coil. The insulation was investigated by differential thermal analysis (DTA), thermo-gravimetric analysis (TGA), scanning electron microscopy (SEM), dielectric properties measurement, and transport critical current (Ic) characterization. TGA results indicate that about 29% of the insulation by weight is polymer. When the Bi-2212/Ag wire is full heat treated, the polymer decomposes with slow heating to 400°C. After the full reaction cycle, a 10 μμm thin porous layer of TiO_2

FIGURE 9. Insulated Bi-2212/Ag round wire wound superconducting coil, seen (a) after winding, (b) after insulation burn-off and (c) after complete reaction at 10 bar overpressure.

remains. We found that the presence of the TiO2 layer did not degrade the critical current properties. It adhered well to the conductor, and provided a breakdown voltage of >100 V. A provisional patent application based on this technology has been filed through FSU office of commercialization. A production insulation machine is operational and has been designed and constructed. It enables continuous reel-to-reel insulation of round Bi-2212 wire of hundreds of meters. A coil applied with this insulation was successfully tested [8] generating 33.8 T combined magnetic field in a 31.2 T background field at the NHMFL. **Figure 9** shows the pictures of the insulated test coil after three subsequent processing steps. Except for a little wear around the middle section of the coil that was due to conductor handling, the insulation stayed on the conductor and provided sufficient electric standoff for the subsequent successful coil test.

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2212 Conductor Development –

In 2012 we made a major breakthrough using overpressure (OP) processing to remove porosity in Bi-2212 round wire that strongly limited the current-density. OP processing, which can be done on wind-and-react coils, boosted Ic, Jc, and J_E by several times to levels high enough for Bi-2212 to be used in high-field magnets. Our work in 2013 has fully confirmed the conclusion of 2012 that eliminating bubbles using OP processing at 10-100 bar is what enables high I_c, J_c, and J_E in a controllable manner. We began using OP processing to reinvestigate prior processing studies that were done at 1 bar and used Jc as the response variable. Our studies are guided by a set of driving questions. Below we summarize some of our results.

We asked if there was clear evidence that one Bi-2212 powder was better than others. We used 100-bar OP processing on a series of wires that we had investigated with 1-bar processing. The data in **Figure 10** show that the Nexans granulate powder has the highest J_E. This is an important result because Nexans is currently the only major supplier of Bi-2212 powder in the world and they are making granulate powder. In addition, OST (Oxford Superconductor Technologies), who use Bi-2212 powder to fabricate the Bi-2212 wire, have the greatest success fabricating wire with Nexans granulate powder. **Figure 10** shows J_E values (I_c/wire area), but we need J_c data (I_c/filament area) to accurately measure improvements in the superconducting properties. The problem in the past was getting an accurate measure of the filament area. We found that we can use OP processing to fully densify the Bi-2212 filaments before they melt. We have begun measuring the cross sectional area of fully-densified filaments to get an accurate measure of J_c in the wires.

Two of the questions were related to the filaments. We first asked what the optimum filament diameter is for the highest J_c. We investigated a series of wires with different diameters and two different wire architectures. One was the standard architecture where the wires were densely packed in each bundle (85x7, 121x18), and the other architecture had a large spacing between the filaments in each bundle (27x7). **Figure 11** shows that there is essentially no effect of initial filament diameter for the two dense filament architectures, whereas

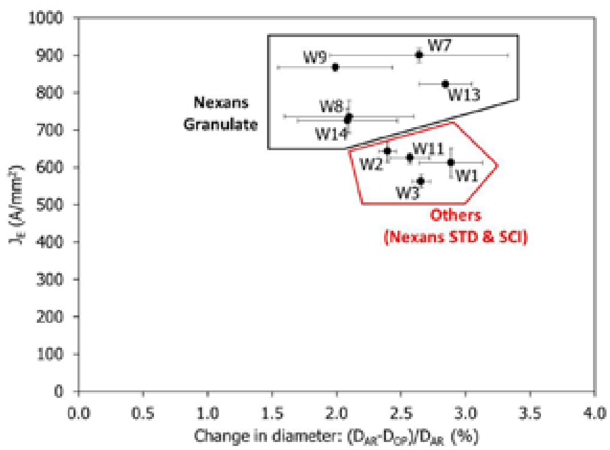

FIGURE 10. JE for Bi-2212 RW after 100 bar OP processing. The change in diameter is the % decrease in wire diameter after OP processing.

J_c increases with decreasing filament diameter in the wire with separated filaments. The SEM images show significant filament bridging in the two wires with the densely packed filaments and essentially no bridging in the wire with widely spaced filaments. Prior work with 1-bar processing indicated that increasing filament count increased J_c and that the optimum filament diameter was about 15 μm. These initial studies show that wire architecture needs to be restudied in detail with OP processing.

The second filament question asked what role filament bridging plays in determining transport J_c and magnetization hysteresis. We measured magnetization and transport properties in wires with the dense (37x18, 85x7, 121x18) and sparse (27x7) filament architectures mentioned above. The filament diameters in all the as-received wires ranged from 10 to 15 μm. We calculated J_c from the magnetization data and equated it to the transport J_c by adjusting the effective diameter used in the Bean model. In wires with densely-space filaments, the effective filament diameter was much larger than a single filament, ranging from about 80 to 90 % of the bundle diameter, which confirmed that the filament bridging couples filaments within a bundle. The filaments in the 27x7 wire were not completely decoupled, as we previously thought based on SEM images. The effective diameter was about 3x the individual filament diameter. These results are important to optimize the wire architecture.

We have installed three new OP furnaces, one has a 25 bar maximum pressure and the other two are 100 bar furnaces. These furnaces, which are just coming on line, include a 100-bar furnace with a working volume that is large enough to process high-field NMR coils.

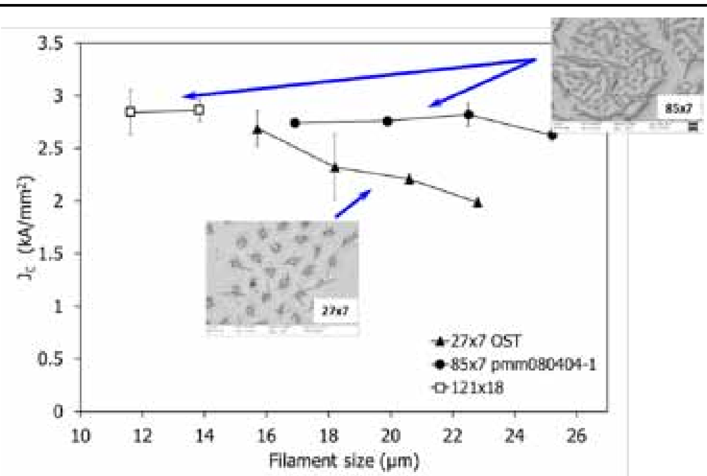

FIGURE 11. Jc as a function of as-drawn filament diameter for wires with different architectures. The 27x7 architecture has a sparse filament distribution with few bridges after heat treatment, as shown in the SEM image. The 85x7 and 121x18 wires have the standard architecture, which produces extensive filament bridging after heat treatment as shown in the SEM image.

HTS Cables testing

In 2004 the Committee on Opportunities at High Magnetic Fields (COHMAG) issued a report recommending development of a 60 T hybrid magnet. This challenge was re-iterated more recently in the MagSci report of 2013 along with a proposal to develop a design of a 20 T human head MRI system. Preliminary scaling studies have been performed for both these magnet systems. Both of them would require application of high-temperature superconductors in magnetic systems storing ~1 GJ of energy. Systems of this size are typically protected via an external dump-resistor system which requires that the magnet be constructed using cables carrying 10 kA or more. Similarly, the high-energy physics community needs HTS calbes for next-generation dipole magnets. During 2013 the MagLab continued to support testing of HTS cables made by third parties using a variety of concepts. All testing took place in the Large Bore resistive magnet in Cell 4, at currents generally between 5 and 10 kA in 15-17 T background magnetic field. One test employed a Roebel-style cable by Callaghan Innovation, formerly Industrial Research Limited, from New Zealand, followed by a test of a “Twisted Stack”-style cable by Dr. Makoto of the Massachusetts Institute of Technology, Plasma Science and Fusion Center. Several tests were performed on "Cable On Round Core" or CORC-style samples. Highlights include CORC cables with 75 strands, engineering current densities over the entire cable cross-section well exceeding 120 A/mm2 at 15 T and 6 cm bending diameter. These magnet cables are in an early stage of development and high-field high-current testing reveals the strength and weaknesses of each cable sample. Further improvements in current density are required and possible with improved cable terminals and refinement of each of the concepts.

In separate studies with CERN, Bi-2212 cables are being evaluated for application for the EUCARD2 dipole designs being used to consider a high field, high energy LHC upgrade.

Iron-based superconductors

We are studying the iron-based superconductors because they have properties that make them attractive for applications, which include high upper critical fields (>80 T) and high critical current density in single crystal form (> 1 MA·cm^2 Sf, 4.2 K). We have focused on $BaFe_2As_2$ (Ba-122) which shows promise as a bulk material. As reported in 2012, we developed a processing method that achieved critical current density in bulk samples of K-doped Ba-122 over 0.1 MA·cm^2 (SF, 4.2 K). This surprising result showed that the grain-boundaries in real, 3-D bulk materials are much less blocking than would be expected from the ideal, 2-D bi-crystal experiments. This high critical current density, which was achieved in round, untextured wires, is only about a factor of 5 lower than needed for practical applications. We have made multi-filamentary round wire **(Figure 12)** and its critical current density is the same as in bulk samples and monocore round wires. We are focusing our studies on round wire because it is the conductor geometry that magnet designers and builders prefer for high-field magnets. However, research at NIMS (National Institute for Materials Science) showed that making a flat tape of K-doped Ba-122 increased J_c above that in round wire to values just on the edge of being useful (>0.1 MA cm^2 in field) for applications. We are collaborating with the NIMS group to try increase J_c even further and to use knowledge gained from the flat tape studies to further improve J_c in round wire.

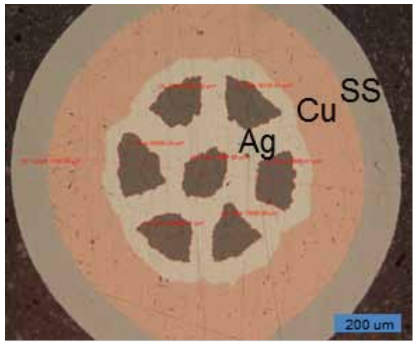

FIGURE 12. 7-filament wire made with K-doped Ba-122. The 122 is in contact with Ag and there is no reaction between the Ag and Ba-122. Jc in this multifilamentary is essentially the same as for mono-core wire and bulk samples.

Based on our very encouraging J_c results in round wire, we focused on improving J_c even further by varying the 122 doping and processing. We maintained the high J_c with a variety of different doping and processing schemes, but we did not increase J_c. This shows that the material is robust, maintaining high J_c over a wide processing and composition space. But it also shows that the grain boundaries are blocking current. We have started experiments to understand what causes blocking at grain boundaries and why the grain boundaries are different in Co- and K-doped Ba-122. To do this we have begun varying the grain boundaries in bulk material by synthesizing bulk samples that have different grain sizes. There are initial indications that decreasing the grain size increases J_c and we are working on methods to process samples at even lower temperatures and still form, dense, well- connected samples. We are also investigating whether chemical segregation occurs at grain boundaries, which could affect the superconducting properties. These grain boundary studies will lead to better understanding of supercurrent transport in bulk 122, which may ultimately lead to higher J_c and practical applications of iron-based superconductors.

LTS Magnets & Materials
Series-Connected Hybrid Outsert

The MagLab is developing two novel Series-Connected Hybrid (SCH) magnets, one to provide 36 T at MagLab for condensed-matter NMR and one to provide 25 T for neutron-scattering at the Helmholtz Zentrum Berlin. Both should be unique in the world when complete. Fabrication of the cold-mass (superconducting coil, helium lines, and cold structure) for the HZB SCH was completed in 2013 by the MagLab (**Figure 2**, introduction). It was subsequently transported to northern Italy **(Figure 13)** where the cryostat has been assembled around it and then transported to Berlin. It will soon be integrated with the resistive coils (also developed at the MagLab) and the power, cryogenic, cooling water, and control systems in Berlin. This concludes a rewarding conductor and coil development program from which the SCH for FSU/NSF will have a direct benefit. Much of the fabrication and quality control procedures, tooling, and lessons-learned from the HZB project will be applied to the remaining fabrication aspects of the NSF/FSU coil.

In 2013 the coil-winding and most of the lead and joint preparation for the FSU SCH was completed **(Figure 14)**. Sensitive impedance measurements through a wide frequency range conducted on this coil matches those from the HZB coil giving confidence that it is free of electrical shorts. With the completion of two more splice-joints the coil will enter the reaction (heat-treatment) phase of its production to form the Nb_3Sn compound. In addition, the SCH cryostat has made significant progress in its construction **(Figure 15)**. Delivery is anticipated in May of 2014. Several associated utilities and components have been installed in the SCH magnet cell or received. These include the iron for stray-field confinement, dump-resistor, diodes, breakers, and the cryogenic delivery system and infrastructure, to name a few.

FIGURE 13. HZB cold-mass leaving the MagLab by truck for Atlanta airport, then by air to Frankfurt, Germany, Oct. 2013.

FIGURE 15. SCH Cryostat Vacuum Vessel with LN2 Traced Bore Tube Thermal Shield in the Background.

FIGURE 16. Nijmegen HFML Design of a Cryostat for Testing of the HTS Binary Leads.

Development and testing of the HTS binary leads are partially funded through collaboration with the Radboud University Nijmegen High Field Magnet Lab (HFML) which has arisen from the success of the HZB and FSU hybrid magnet projects. The lead-fabrication will occur at the MagLab and testing will occur at the Nijmegen HFML. **Figure 16** shows a drawing of the cryostat at HFML to be used for testing the leads. All fabrication processes are being demonstrated on model components prior to kicking off the production lead construction. However, soldering of the HTS tapes into sub-units has been done and all have passed the critical-current qualification measurements.

FIGURE 14. Wound CICC coil for NSF/FSU Series-Connected Hybrid magnet.

Structural Materials for LTS Magnets

High field superconducting magnets require strong components as reinforcement to be suitable for use in the highest-field magnets. For example, cable-in-conduit-conductor (CICC) technology for superconducting magnets needs strong conduit materials. Years ago we developed a modified 316LN austenitic stainless steel for use as CICC material in the 45 T hybrid. This material has since been adopted by ITER for the conduit of the toroidal-field coils as well as by our own SCH projects. This material shows good mechanical properties and has been successful in the 45 T. However, the SCH uses a chrome-plating of the superconducting strand to reduce eddy-current-heating during ramping which was not used in the 45 T. To make the joints between pieces of 20-kA cable, it is necessary to remove the chrome-plating from a few meters. This is done via immersion in HCl. When the magnet later undergoes heat-treatment at sensitization-temperature range, conventional 316LN may lose its corrosion resistant characteristics if chlorine is present or result in reduced elongation-to-failure. We have conducted 4K tensile tests and microstructure examination on modified 316LN stainless steels that were exposed to chlorine compounds during heat treatment. The steels showed elongation-to-failure of 20%, which is comparable to steels treated without presence of chlorine-containing compounds. Therefore, our modified 316LN steels have resistance not only to conventional sensitization treatment but also to the sensitization treatment in chlorine containing environment.

The United States is part of an exciting international collaboration to demonstrate the feasibility of fusion reactor plasma confinement and eventual power generation: ITER. This Tokamak consists of very large, complex, superconducting magnets that utilize Cable-in-Conduit Conductors and a massive pre-compression structure (Tie Plates) for stress management in the Central Solenoid (CS). MS&T's Mechanical Properties Lab is US-ITER's primary materials research laboratory for the investigation and qualification of structural materials intended for cryogenic service in the CS. We have the cryogenic test facilities and experienced personnel necessary for measuring the tensile, fracture toughness and fatigue properties of structural materials at 4 K. The alloys and welds must be characterized to ensure their performance and reliability. Characterization includes mechanical properties-testing at room and cryogenic temperatures as well as microstructural investigations to understand the structure/property relationships. The collaboration provides critical data to ITER and a unique opportunity for NHMFL engineers, technicians, and undergraduate engineering students to gain experience in high field magnet research and development.

We have also worked on two Ni alloys [1] and stainless steels with alloy contents higher than 316LN. We have considered various fabrication conditions for superconducting materials, and have simulated selected conditions using these alloys in order to compare both mechanical properties and the microstructure generated under these conditions.

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Deconstruction of SULTAN-tested ITER CICCs

Prototype Cable-in-Conduit Conductors (CICC), using brittle Nb_3Sn-based superconducting strand, designed for the Toroidal Field (TF) and Central Solenoid (CS) coils of the ITER magnetic confinement fusion reactor, are tested in the SULTAN facility at CRPP in Switzerland, where they undergo a series of electromagnetic and warm-up/cool-down cycles to simulate ITER operation conditions. These tests have until recently shown degradation in performance during testing, but new prototypes have improved significantly, after a crash R&D program to determine the causes of this degradation [1]. An important part of this program has been a post-mortem deconstruction of these CICCs at the Applied Superconductivity Center at the MagLab. The different prototypes tested and studied here are shown in **Table 1** with their respective characteristics. **Figure 17** shows a transverse cross section of an ITER prototype that underwent 17,000 full Lorentz-load cycles. High resolution digital analysis of full cable cross-sections allows us to directly measure the displacement that the superconducting strands underwent during this cycling by tracking the coordinates of all the strands and comparing the average position to the center of the conductor. In addition we extracted short lengths of strand (~ 15 mm in length) from the cable to quantify any Nb_3Sn filament fracture. Figure 18 shows a strand that was severely damaged (blue dots are filamentary cracks).

All the CICCs showed movement of the wires in the direction of the Lorentz force but some move more than others depending on the CICC design and wire stiffness. CICCs with significant wire movement all have some degree of damage similar to that see in **Figure 18**. It was found that an initial short twist pitch locks the wires into position **(Figure 19)**, greatly reducing strand movement within the cable and eliminating filament fracture [2].

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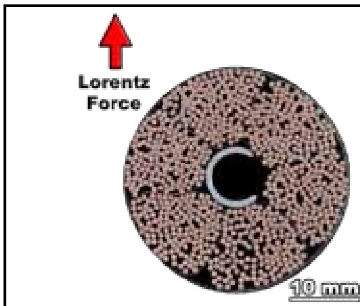

FIGURE 17. Transverse cross-section image of the CSJA2-2 prototype.

TABLE 1

Basic characteristics of the samples deconstructed.

	Characteristic	ΔT_{cs} (K)	Cycles	Triplet Configuration	Twist Pitch	Strand Type/ Manuf.
CSJA 2-2	Baseline Bronze	-1.36	17,000	2 x sc + 1 Cu	45/84/145/251/453	(BR) Jastec
CSIO 1-1	Baseline All SC	-0.32	11,200	3 x sc	45/83/141/252/423	(IT) OST
CSIO 1-2	Baseline Internal Tin	-0.42	11,200	2 x sc + 1 Cu	45/85/147/248/424	(IT) OST
CSIO 2-1	Pseudo Long IT	-0.29	6,100	2 x sc + 1 Cu	110/115/127/140/385	(IT) OST
CSIO 2-2	Short Internal Tin	0.20	6,100	2 x sc + 1 Cu	22/45/81/159/443	(IT) OST
CSJA 3-1	Short Bronze	0.29	8,650	2 x sc + 1 Cu	22/45/81/159/443	(BR) Jastec
TFRF	Baseline Bronze	0.20	1,000	2 x sc + 1 Cu + Cu core	80/140/190/300/420	(BR) Bruker
TFEU5	Baseline Bronze	-0.49	1,000	2 x sc + 1 Cu + Cu core	80/140/190/300/420	(BR) RF

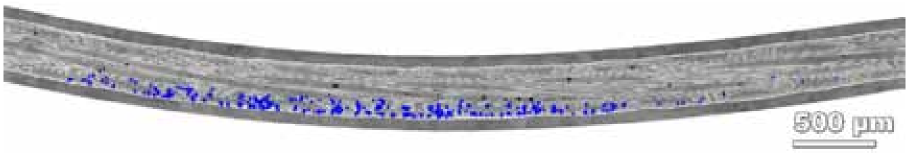

FIGURE. 18. Longitudinal cross-section of a strand extracted from the CSIO1-2 Prototype. Crack locations are shown in blue.

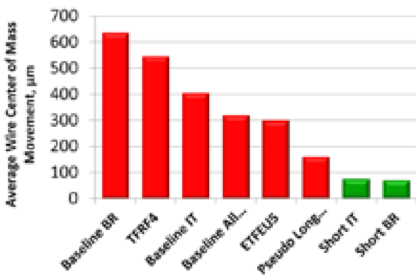

FIGURE. 19 Average displacement of strands in each prototype after cycling. Red indicates filament fracture.

ITER Wire Characterization

The ITER reactor is a multibillion dollar international collaborative effort to study the feasibility of nuclear fusion as a long term energy solution for the world. The US is one of seven participants of ITER. The key components of ITER include the superconducting magnet systems which consist of hundreds of tons of Nb_3Sn superconducting wires. Therefore the quality verification test of the production Nb_3Sn wires is very important and is on the critical path of the ITER project in year 2013.

The MagLab is the only US laboratory certified by ITER to perform Nb_3Sn quality verification tests. In 2012, we were awarded a two year contract by US-ITER (under management of the US Department of Energy) for testing Nb_3Sn wires used for ITER toroidal field (TF) magnets. In 2013, an additional contract is awarded for testing Nb_3Sn wires for ITER central solenoid (CS) magnets. Additional funds were also awarded for ITER CS Nb_3Sn wire heat treatment sensitivity study and the effect of weld heat simulation tests.

In 2013, we continue performing the TF wire verification tests **(Figure 20.)** During the course of the testing, we have found a few quality issues in the Nb_3Sn production wires coming from the vensor, including poor adhesion of Cr-plating and lower residual resistivity ratio then intended. We have been involved with ITER international organization and the US Nb_3Sn vendor resolving these issues. Our testing progresses smoothly, as of the end of 2013, the project is ahead of schedule and under budget.

This project will have many very positive long-term impacts on our technical capabilities. Through this work, we are establishing an international reputation as the superconducting materials testing reference lab in the US. We have trained/educated the young work force and students who later may be transferred to work on other NHMFL superconducting magnet projects. In addition, the equipment procured in this project will significantly enhance the capability of our materials testing laboratory. The equipment can serve other NHMFL projects such as the series-connected hybrid and the 32 T all superconducting magnet projects. It may also attract further funding on testing for similar large magnet projects for the next few years.

Optimization of Conductors for Accelerator-Magnet and Highest-Field Use.

The Nb3Sn conductor designs using the Rod-Restack-Process (RRP) made by OST (Oxford Superconducting Technologies) and Powder-In-Tube (PIT) designs made by Bruker Energy and Superconductor Technology (BEST) (compared in **Figure 21**) both combine Nb(Ta or Ti) and Sn in the presence of a small amount of Cu inside a diffusion barrier (DB) to produce a high Jc A15 filament array by reaction after winding (note that most Nb3Sn formed in reaction does not have the 25at.%Sn composition and thus loses full superconducting effectiveness). Broadly speaking one can say that, today, RRP conductor enjoys the advantage of higher non-Cu Jc, while PIT enjoys smaller effective filament diameter deff for RRR >100, leaving choice for the High Luminosity upgrade (HiLumi) still open. Multiple Nb3Sn conductor architectures are possible because there are multiple ways of assembling Sn, Nb and a small quantity of Cu inside the Diffusion Barrier (DB) (the so-called non-Cu fraction) that prevents poisoning of the stabilizing Cu and degradation of its Residual-Resistivity Ratio (RRR). This proposal takes as its primary challenge a comparative evaluation of these two leading designs so as to understand how industrial manufacture can expand the parameter space of highest possible non-Cu Jc while pushing to ever smaller filament sizes without DB degradation causing local RRR degradation due to cabling damage [1].

FIGURE 20. Testing of Nb3Sn wire for ITER at MagLab.

An important complication is that although the non-Cu package of Nb, Sn, Cu and DB is fixed at assembly, the details are generally ill-defined, either due to commercial confidentiality or because preferential draw-off of the softer components makes detailed makeup at final wire size uncertain. After several years of Conductor-Development Program (CDP) support of R&D at OST, it is clear that RRP conductors can yield 10-20% greater non-Cu Jc (~3000 A/mm2 at 12 T, 4.2 K, as opposed to ~2600 A/mm2 for PIT). Piece-length and price will also have a big impact on final selection but are not public at the present time. In their extensive review of the performance of 112 witness strands for the high-gradient quadrupole test coils for the LHC Accelerator Research Program (LARP), Godeke et al. [2] found very consistent wire performance for 54/61 and 108/127 stack RRP strands, suggesting that the 108/127 stack is now approaching the production maturity of the 54/61 stack, albeit with less RRR margin. The push of LARP and CDP is to make similar progress with 169 and 217 stack conductors of smaller deff. There is major doubt at the present time however as to whether these can be made industrially for LARP on the required project timescale.

Here follows a concise summary of the principal conclusions from our recent CDP RRP [3] and CERN PIT conductor evaluations. The RRP study builds on a close collaboration with Ghosh et al. at BNL and LARP on 54/61 stack RRP conductors and their detailed electromagnetic and heat treatment (HT) studies [4],[5] while the PIT strand is courtesy of our collaboration with CERN. A brief recapitulation of some of the more complex aspects of our work is presented later but for the purpose of moving rapidly to the ideas that motivate this proposal, we here summarize the principal findings of these coupled RRP and PIT studies:

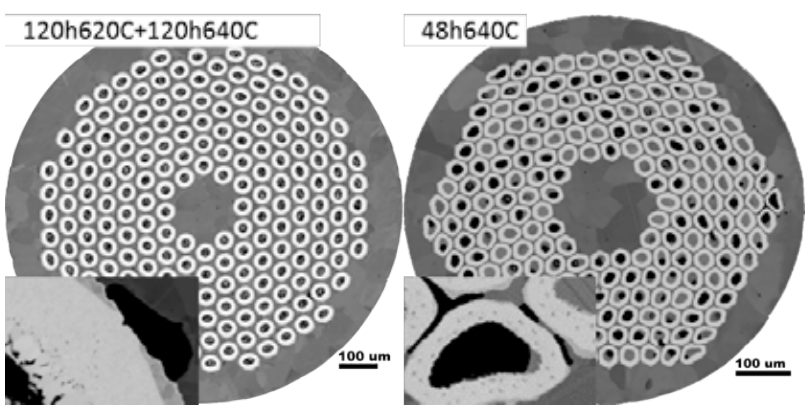

FIGURE 21. State of the art PIT and RRP wires being considered for Hi-Lumi. At left is a 192 filament PIT wire consisting of Nb7.5Ta diffusion barriers partially converted to A15 by reaction with its core of NbSn2 and Cu. Inset at lower left shows where the A15 has reacted through to the Cu matrix and the development of a major void as Sn dissolves from the A15 into the Cu. At right an RRP strand that uses 198 sub-bundles, each containing many Nb filaments inside a Nb diffusion barrier (DB); the Nb filaments react to form a single A15 tube inside each sub-bundle DB. The heavy deformation of the stack and its surrounding DB contributes to RRR degradation produced by non-uniform DB breakdown. Decreasing shape quality of filaments from inner to outer rings is evident in both designs and for this reason DB breakdown occurs preferentially in the outer filament rings.

1. *The maximum HT temperature is controlled both by the need to avoid diffusion barrier (DB) breakdown and by the need to maintain a high grain boundary (GB) density for high vortex pinning.* **Table 2** (see p. 159) shows that the RRR of the RRP conductor degrades from >200 to 109 while there is 5-6% still unreacted DB in the sub-element. If we analyze the DBs, by location, however, as shown in **Figure 22**, we see that degree to which A15 has reacted through to the Cu varies significantly across the wires. RRR degraded to ~170 in the PIT wires when only 2 or 3 of 192 filaments presented A15 to the Cu.
2. *The primary difference between the non-Cu Jc of PIT and RRP conductors is not in their GB pinning properties but in the quantities of fine-grain A15 that the two packages produce.* The GB pinning strength, as measured by QGB [6], in these Ta-doped RRP and PIT conductors is rather similar if we assert that only the small-grain A15 regions of the PIT conductors contribute to Jc. We believe this strongly because magnetization measurements show that the large grain A15 ring at the inside of the A15 layer does not support circumferential shielding currents, even though it has high Tc and superfluid density. Moreover our high resolution microscopy shows that many of the GBs in this large-grain A15 fraction are full of 2nd phase. With this assumption, the specific GB pinning force (QGB) values for PIT are very similar to those for Ta-doped RRP heat treated at similar temperature implying that the Jc superiority of RRP is not due to marked differences in GB pinning. Our RRP measurements cover a broader range of HT temperatures than the optimized PIT samples supplied to us by Bottura at CERN and they show that QGB (RRP) rises with increasing HT temperature. As our analytical microscopy of Ta- and Ti-doped Nb3Sn makes clear,

TABLE 2

Summary of the recent RRP and PIT measurements.

Ta-doped **RRP**, 0.7 mm, 54/61 design, d_{eff} ~70 µm, optimal non-Cu J_c(12 T, 4.2 K) = 3000 A/mm².

Heat Treatment ˚C/hours	J_c (12T) A/mm²	Q_{gb} N/m²	RRR	GB density 10^7 m^{-1}	A15 %	Diff. Barrier %	Core %	DB Perimeter React-through %	$T_{c,Onset}$	$T_{c,50\%}$	SC vol.%. 2 K, 16 T
620/192	4844	6606	377	2.64	58.8	8.1	33.1	7.6×10^{-3}	18.1	16.83	42%
650/96	5146	8382	233	2.21	59.7	7.2	33.1	0.17	18.09	17.06	40%
665/50	5037	8933	171	2.03	59.3	7.4	33.3	0.16	18.31	17.14	37%
680/48	5025	9090	109	1.99	60.9	5.6	33.5	2.0	18.40	17.24	42%
695/48	4889	10602	56	1.66	63.7	5.1	31.2	7.4	18.36	17.51	41%
750/96	3603	9266	15	1.40	65.8	3.7	30.5	23.1	18.34	17.57	53%

Ta-doped **PIT**, 1 mm, 192 filament, deff ~50 µm, optimal non-Cu Jc(12 T, 4.2 K) = 2500 A/mm2.

Heat Treatment ˚C/hours	J_c (12T) A/mm²	Q_{gb} (12T) N/m²	RRR	GB density 10^7 m^{-1}	A15 %*	Diff. Barrier %	Core %	Small grain / Total A15	Small grain J_c (12 T) A/mm²	Small grain Q_{gb} (12 T) N/m²	$T_{c,Onset}$	$T_{c,50\%}$	SC vol. % 2 K, 16 T
620/120+ 640/120	4554	5970	175	2.75	54.9	23.4	21.7	74.7	6068	7994	18.7	17.69	39.5%
625/280	4520	6248	166	2.60	54.2	23.4	22.4	73.9	6121	8460	18.6	17.59	40.0%

*= ~40% Small Grain + 14-15% Large Grain A15

however, substantial GB segregation of Ti or Cu (but not both together) occurs in Ti-doped RRP conductors,

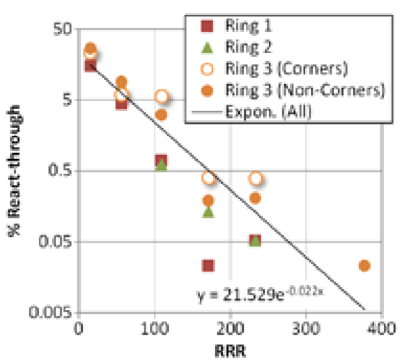

FIGURE 22. The percentage of the DB that is completely reacted through against RRR for each of the three rings of sub-elements in the 54/61 stack RRP Ta-doped strands (billet 8220) heat treated at BNL. The outer ring (3) is separated into corner and non-corner sub-elements.

while only Cu segregation is seen in this Ta-doped conductor. We should be open to the possibility that these segregations may change QGB.

3. *RRP is significantly more efficient in producing A15 phase from its starting sub-bundle components of Nb, Sn and Cu than PIT from its NbSn2-rich powder mixture.* The 54/61 RRP stack produces 50% more fine-grain A15 than PIT (~62% vs. ~40% - as noted by our conclusion that coarse grain A15 has a high Tc but does not contribute significantly to Jc), partly because it also has much less residual DB for RRR > 100 (5% vs. 23%, though this fraction rises to ~ 10% in smaller deff 144/169 and 192/217 RRP stacks), in spite of the fact that the shape quality of the PIT filament array appears better. Interestingly the residual core volume (unused Sn, residual Cu and void) is larger for RRP (~35%) than for PIT (~22%), which largely negates the DB advantage of the RRP conductor. Note that we calculate this residue by assuming that all of the filament pack is A15, a conclusion that we need to refine since not all the interfilamentary Cu present before reaction counter-diffuses out of the filament array[7] after reaction. Paying closer attention to this large residue could pay big dividends in allowing more of the non-Cu real estate to be used to thicken the DB.
4. *The optimization of intrinsic and extrinsic factors for 12-16 T use is complex and they are often uncertain and in conflict.* Specific heat allied with magnetization study has been critical to developing the ability to separate these two factors, as noted in our conclusion that the highest Tc fraction of A15 found in PIT conductors (~25%) plays little or no role in determining Jc because a) it has a very low GB density and b) is longitudinally disconnected by massive GB second (non-superconducting) phase. There are

clearly multiple subtleties which, for competitive reasons have not yet emerged into public view, and may not even be known to the manufacturers.

Resistive Magnets & Materials Pulsed Magnets

In 2013, the NHMFL's Pulsed Field Facility at Los Alamos continued making significant progress on development and production of pulsed magnets to support an ever-increasing number of users in the area of high field research.

Recent changes in designing and manufacturing of 65-T user magnets have been successfully tested and proven to deliver important advantages over the prior designs. The replacement of MP35N material by composite reinforcement shelves of Zylon fiber and S2-glass fabric for conductor winding layers 2 to 6 of the inner coil (coil A) is the most crucial change in the new design. This change has significantly reduced the manufacturing time (from 8 weeks to 5 weeks) and fabrication complexity. It also cuts down the magnet material cost (MP35N foil is the most expensive material in our magnets), and, most importantly, the design upgrade has proven to significantly increase the robustness and lifetime of the magnets. In 2013, we manufactured five 65-T magnets to fill all four available user cap-bank-driven magnet-stations for users. The improvements in magnet design in combination with the better quality-control in manufacturing processes brings us closer towards our goal of increasing a magnet's lifetime from a few hundred to 1,000 full energy shots.

The 100-T insert magnet installed in September 2012 has performed well through 2013 and is still in service **(Figure 23)**. This insert magnet has delivered a total of 182 shots with 83 full-field shots (> 90T). Comparing to the total of 880 shots (with 100 shots above 90 T) for the entire operational history of the 100 T magnet, these numbers indicated an increase of demand for ultrahigh-field research and our significantly improved capacity to deliver ultrahigh fields above 90 T for users. **Figure 24** presents the pulse history of the 100-T magnet. The experience and knowledge learned from the new design of 65-T magnets was applied to further optimize the design of 100-T insert magnet. A new insert (insert #5) with modified design was manufactured and is in the final assembly steps. This magnet will soon to be ready for replacement of the in-use insert magnet when we retire it. In 2013, Eveson Tesla completed the manufacture of coil-sets 5 and 6 for the 100-T outsert magnet. These coil-sets were successfully tested and delivered to the PFF. We also performed calculations to determine the optimized upgrading approaches for coil-sets 1 and 2 for the outsert magnet. The upgraded coil-sets 1 and 2 will require the use of large cross-section CuNb and the redesigned reinforcement shelve. Thus, we have worked closely with the material development group in the NHMFL's main campus in Tallahassee and our conductor vendor in Russia for R&D and manufacture of the required conductor for these coils. The wires are expected to be delivered in 2014 and 2015. The upgraded coils 1 and 2 are anticipated to be manufactured in 2015 and assembled

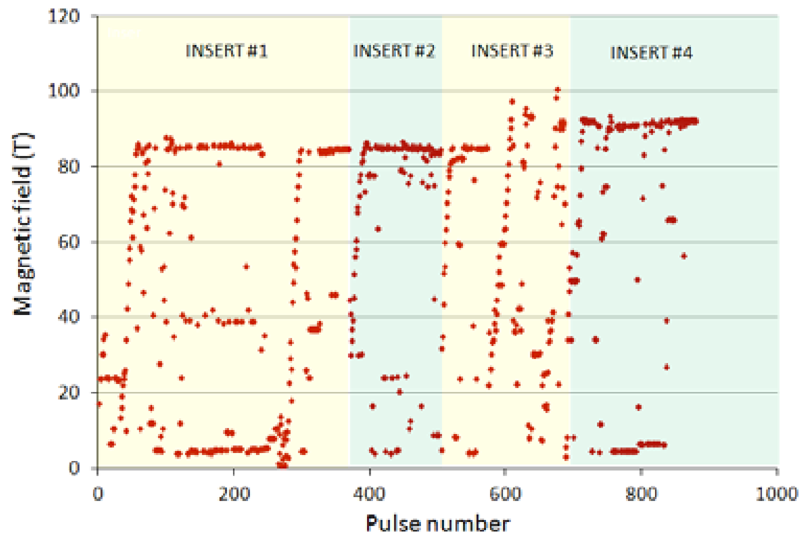

FIGURE 24. Pulse history of the 100-T magnet

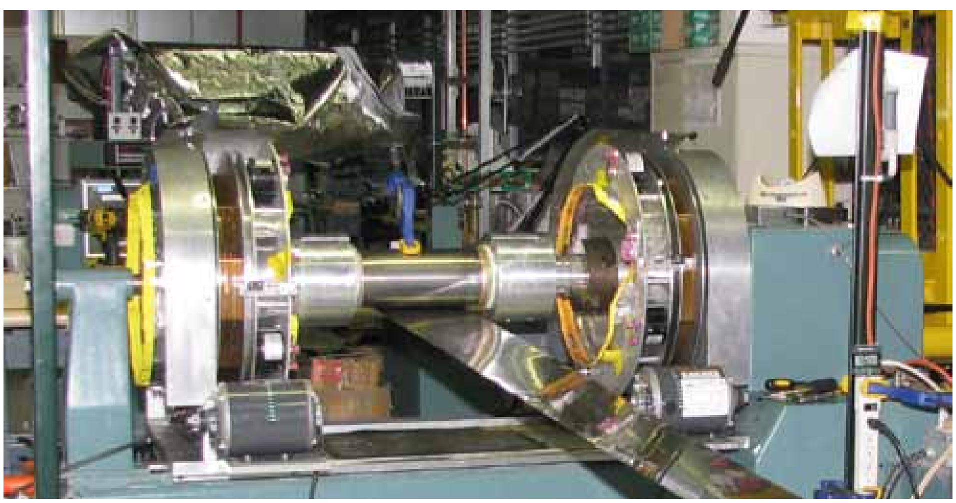

FIGURE 23. Winding MP35N sheet onto 100-T insert magnet

in 2016. This plan will allow us to achieve the goal of creating higher magnetic field level (B > 100.75 T in demonstration and 100T in operation) by 2017. The 60-T long pulse magnet also had a very busy year, delivered 322 pulses (or more than 30% of total shots in its operation history) of which 58 shots were at 60 T or higher.
In the effort to develop a new class of magnets that can produce higher field to upgrade our current 65-T pulsed magnets, several design-options were investigated but the duplex design was finally adopted for its potential to have longer magnet lifetime. The new duplex magnet design (which is very different from the design proposed previously) consists of two magnet coils, the inner coil made from CuNb wire and the outer coil made from hard copper wire (CDA-107). The duplex magnet is designed to produce 200 pulses of 80 T or 1000 pulses of 75 T. The structural design has been completed, and the CAD and design of tooling is in progress. A prototype duplex magnet is expected to be built and tested in 2014.
In 2013, we also performed preliminary research on the roadmap and requirements for the NSF's challenging goal of 150 T non-destructive magnets. The research provided us general ideas about the requirements of the magnet size, magnet energy, and power systems as well as material properties to achieve that goal. Many more R&D efforts on high-strength materials and magnet design will be needed in coming years to propose a more detailed plan and feasible steps to finally reach the proposed challenging goal.

DC Magnets

Conical-Bore for Neutron Scattering. In 2012, the MagLab finished the design of a novel resistive insert for the Series-Connected Hybrid (SCH) magnet to be delivered and installed at the Helmholtz Zentrum Berlin (HZB) in Germany. This magnet design includes a *unique conical bore with 30 degree opening angle at world record 25 T central field (US patent no. 7,825,760)*. The effective conical bore is created by stamping disks with different inner diameters and stacking them to form a series of steps.

In 2013, the NHMFL completed fabrication and assembly of the first inner coil for the HZB resistive insert. The outer coil is presently being fabricated and is expected to ship to Berlin in the first quarter of 2014. The system is expected to be operational in late 2014.

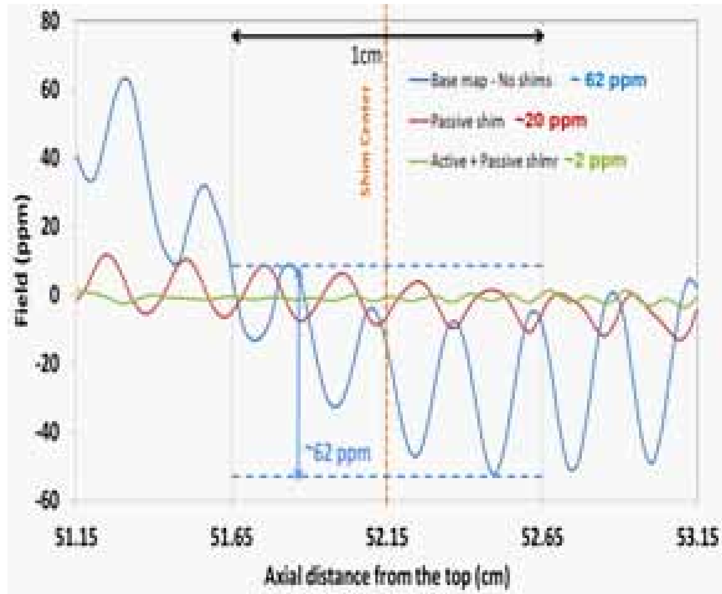

FIGURE 25. Keck Magnet with Shimming to World Record 2ppm Field Uniformity at 25T demonstrated in June 2013.

Resistive Shims: The Keck magnet serves as a test platform to demonstrate the new resistive-shim technology planned to be employed in the resistive insert of the 36T, 1ppm SCH suitable for condensed-matter NMR being developed for the MagLab. Towards that end, a new shim system that combines ferrous and electromagnetic shims has been developed by Oxford NMR and demonstrated in the MagLab's "Keck" magnet. In June 2013 we reached a homogeneity of 2 *ppm* over a 10-mm-diameter spherical volume at *25 T* (**Figure 25**), surpassing our previous *world record* of 5.6 ppm at this field. This technology will be installed in the 36 T series-connected hybrid magnet expected in 2015 and will likely be used in future 30 T NMR magnets as well.

High Homogeneity Resistive Insert: In 2013, the MagLab finished the design of the resistive coils for the resistive insert for the 36T, 1ppm SCH . This insert employs a combination of axial current-density grading in the A-Coil plus a ~22 mm gap in the B-Coil to meet the z2-term homogeneity requirements. The design of the SCH resistive housing is well underway and awaiting completion of final structural FEA (expected early 2014) evaluating compliance with the ASME BPVC.

High-Strength Conductors

High-field magnets depend on high-strength conductors, high-strength structural components, and high-quality insulation. In addition to independent research activities, we at the MagLab have been working with our current and new collaborators to meet the materials need. Our collaborators have been focused on providing us with large quantities of large-size materials for our magnets, while we have been studying how materials properties such as mechanical strength and microstructure are affected by sample size and fabrication methods. Our collaborators, in turn, use our results to improve their production processes. Our aim is to ensure the safe and reliable performance of high field magnets.

In 2013, we focused on metal-metal

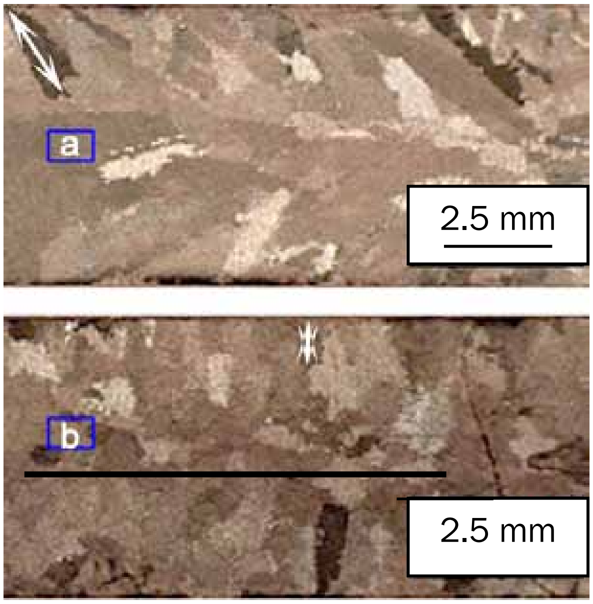

FIGURE 26. Macrostructure of Cu-Ag solidified without (a) and (b) with high magnetic field.

composites because of their potential for use as high strength conductors. One of these is Cu-Ag composite, in which Ag turns out to be the strengthening component even though it is softer than Cu in the annealed form. The present fabrication method starts with solidification, which provides a precursor for further cold deformation and heat-treatment. To improve the properties of the final product, it is necessary to study the materials formed during various stages of solidification. In collaboration with Northeastern University in China, we are studying the impact of high magnetic field (HMF) on solidification in the Cu-Ag system. **Figure 26** shows a comparison of the macrostructure in ingots solidified with and without 12 T HMF. **Figure 26a** shows that most of the columnar grains without HMF are elongated, as indicated by an arrow in the image. Application of HMF changed most of the columnar grains to nearly equiaxed grains, as shown in **Figure 26b**. This may enhance the ductility, and therefore the formability, of Cu-Ag composite, which facilitates their use in high-performance magnets. In addition to our studies of the solidification process, we investigated the impact of cold deformation and heat-treatment. Heavily-deformed Cu-Ag composite is known to have lattice distortion or internal stresses [1]. Large levels of lattice distortion may result in geometric distortion of Cu-Ag conductors and render them less than ideal for the manufacture of high-field magnets. Our tests indicated that the properties of heavily deformed Cu-Ag composite were stable at heat temperatures up to 200 °C. This indicates that we could reduce lattice distortion by heat treatment below 200 °C without significant loss of mechanical strength. We are working with Tanaka Kikinzoku Group, Japan to develop thermo-mechanical fabrication procedures that will allow us a partial reduction of lattice distortion. We expect this work will impact resistive magnets.

CuNb is the major high-strength metal-metal composite being used for pulsed magnets. The strengthening component of this conductor consists of ribbons of Nb with a cross-sectional area of about 100 nm^2 and a distance between ribbons of less than 100 nm. The cross-section of the conductor is usually greater than 15 mm^2 in the 100-T pulsed magnet. In next generation pulsed magnets beyond 100 T, we need high strength metal-metal composite conductors with a cross-section of about 35 mm^2 with continuous length greater than 25 meters. To achieve this goal, we need conductors with millions of Nb ribbons homogeneously distributed throughout the conductor materials, creating millions of interfaces that provide barriers to dislocation motion and therefore increase strength. We studied the homogeneity of ribbon shape and sizes, the density of the interface area, and the microstructure and the crystallographic texture of the Cu-Nb composites formed during fabrication. Our results indicate that severe curling and shape-changing of Nb set in at the size of Nb~400 nm[2]. Compared to the hexagonal-shaped Nb filaments, the curling of Nb in cross-section resulted in a surface area increase of 6.91 $\mu m^2/\mu m^3$ when Nb size is at 400 nm. Because the curling phenomenon occurred at Cu–Nb interfaces, we considered that it was related not only to the deformation mechanism of Nb but also to the presence of an interface. Increased interface areas due to curling provide further obstacles to dislocation motion and therefore increase the strength. Most of our research activities are in collaboration with Northwest Institute for Nonferrous Metal Research, China and Nanoelectro, Russia, who are our major partners in R&D of high-strength metal-metal composite conductors for pulsed magnets. These findings should have significant impact on the future manufacture of conductors for next generation pulsed magnets.

We continue our research on the fabrication of nanotwined (NT) Cu due to its potential to achieve both high strength and high electrical conductivity. Because coherent twin boundary (TB) has high strengthening effects and high stability[3], we are focusing on increasing the density of these boundaries. We have been able to make NT Cu foils with about 99% coherent TBs [4, 5]. These coherent TBs, with an average spacing of 25 nm, were engineered approximately parallel to foil surfaces. Our aging experiments reveal that such NT Cu in as-deposited form is stable for up to three years at ambient temperature. Low plane-strain deformation enhances hardness by refining microstructure and introducing dislocations.

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Materials Research

Discovery and growth of crystalline materials is one of the key areas in materials research. New materials, and engineering of their properties, have produced tremendous progress; and the search for new materials with novel properties remains an ongoing activity. These activities are funded, to a large extent, by the U.S. Department of Energy, Office of Basic Science, and the State of Florida.

$Nb_3Pd_{0.7}Se_7$

Superconductivity in $Nb_3Pd_{0.7}Se_7$ **(Figure 1)** was observed at low temperatures at 1.44K. $Nb_3Pd_{0.7}Se_7$ is low-dimensional system with quasi-one-dimensional ribbons running along the monoclinic b-axis. Despite this low transition temperature, the material has a large upper critical field H_{c2} of the order of 14T. Such a high H_{c2} is not expected, since the energy scale should be set by the superconducting transition temperature. Additionally, the upper critical field shows a large anisotropy of the order of 6. Band structure calculations show the Fermi surface in this system to be composed of quasi-one dimensional and quasi-two dimensional sheets with hole character, as well as three-dimensional sheets of both hole- and electron character. The superconductivity in this system is likely due to a strongly correlated electron gas, with an unconventional origin of the superconducting coupling that is reflected in the large ratio between H_{c2} and T_c. (Collaboration with L. Balicas, DOE-BES grant DE-SC0002613 (LB), and DE-SC0008832 (TS))
(Sci. Rep. 3, 1446(2013), Phys. Rev. B 88, 024508 (2013))

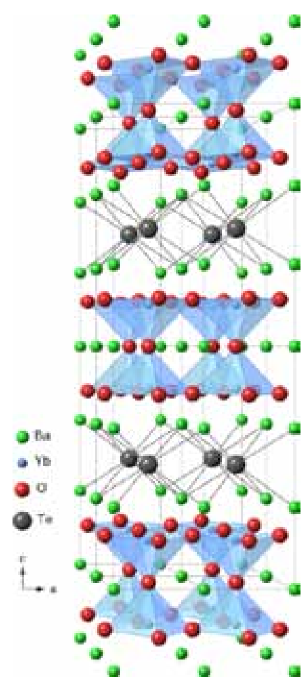


FIGURE 1.
$Nb_3Pd_{0.7}Se_7$

$Ba_3Yb_2O_5Te$

We synthesized the new oxy-telluride $Ba_3Yb_2O_5Te$ **(Figure 2,)** a system that combines two structural moieties: double pyramidal perovskite-type $Ba_2Yb_2O_5$ layers and BaTe CsCl-type layers (structure is shown in Fig. 3). This phase is grown as a single crystal from an alkaline earth metal flux, where simultaneously oxygen, tellurium as well as ytterbium are soluble, showing the versatility of the flux. This system is closely related to the well-known Ruddlesden-Popper phases, where perovskite-type layers are combined with rock salt (NaCl) layers. Structurally, the perovskite layers are highly strained, since perovskite-type systems with a lanthanide atom on the B site expand the lattice formed by oxygen. Therefore, ABO3 perovskite related phases with a lanthanide atom on the B-site are not common. We found that Ba3Yb2O5Te is antiferromagnetic, with a transition in the vicinity of 4K. However, the Weiss constant is larger than expected. Low temperature specific heat measurements showed that at the antiferromagnetic transition, the entropy release is Rln2, indicating that the ytterbium ion f-electrons require inclusion of the crystal electric field. The f-levels are split into three levels, with a Γ6 crystal field split ground state.
Ba3Yb2O5Te is the first demonstration that alkaline earth metal fluxes show sizable simultaneous solubility for two different

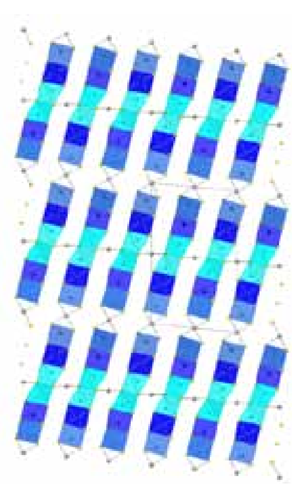


FIGURE 2.
Crystal structure of $Ba_3Yb_2O_5Te$.

anions, in this case oxygen and tellurium. This allows further exploration of lattices with two different kinds of anions. Based on DFT calculations, the valence band is formed by oxygen and tellurium orbitals, with mostly tellurium character at the valence band edge.
(J. Solid State Chem. 203, 204-211 (2013))

Molecular Quantum Dots

The structural and physical characterization of novel supramolecular assemblies comprising molecular quantum dots is studied in collaboration with the "Center for Re-Defining Photovoltaics: Efficiency through Molecular-Scale Control" located at Columbia University (EFRC, DE-SC0001085). Novel solid state materials that form the binary assemblies $[Co_6Se_8(PEt_3)_6][C_{60}]_2$ and $[Cr_6Te_8(PEt_3)_6][C_{60}]_2$ related to the CdI_2 structure type have been synthesized **(Figure 3.)** These systems can be considered as atomically precise solid-state compounds and form mono-disperse nano-particles of the order of 0.8nm. Co-crystallization assembles these building blocks into structures with substantial charge transfer, forming a supramolecular "ionic crystal" comprised of these clusters in a 1:2 ratio. The overall arrangement of the clusters is related to the CdI_2-type structure, where the iodine anion forms a hexagonal close packed lattice and the cadmium cation occupies half of the octahedral interstitial sites **(Figure 4.)** In the supramolecular assembly, the role of the cation is played by the $Co_6Se_8(PEt_3)_6$ clusters, while C_{60} plays the role of the anion, since C_{60} is an electron acceptor molecule. The same arrangement is observed for the supramolecular assembly of $[Cr_6Te_8(PEt_3)_6][C_{60}]_2$, where a also a charge transfer is observed. This charge transfer from the $Co_6Se_8(PEt_3)_6$ cluster to the C_{60} clusters is responsible for the enhanced electronic conductivity that results in a small band gap of the material.

The cluster assembly, $[Ni_9Te_6(PEt_3)_8][C_{60}]$ crystallizes in the rock-salt type structure, and also shows electron transfer from the $Ni_9Te_6(PEt_3)_8$ cluster to the C_{60} cluster. In this case, the charge transfer results in low temperature ferromagnetic order ($T_c \approx 4K$).
(Science 341, 157-160 (2013)).

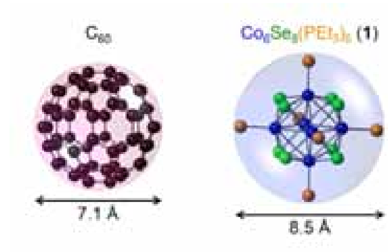


FIGURE 3.
C_{60} and $Co_6Se_8(PEt_3)_6$ cluster

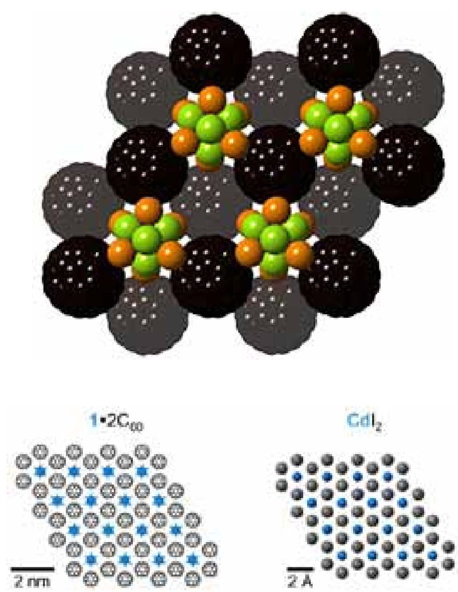


FIGURE 4. $[Co_6Se_8(PEt_3)_6][C_{60}]_2$ and CdI_2

Condensed Matter Science:

Experiment, Theory, and Techniques

The vibrancy and diversity of materials science (CMS) activities at the NHMFL at all locations represents roughly half of the total reported research at the NHMFL this year. Indeed, to review adequately and to give credit to all of the high quality reports submitted in this short over view is impossible. Hence to give the flavor of the exciting CMS science this year, a more general "Hot Topics" approach is used where the focus will be on innovative, new or novel aspects of selected work carried out by users and scientists at the NHMFL. This is with apologies to many whose work may not be cited due to space limitations.

Topological Matter

Topological matter, which one might consider the child of the physics of the quantum Hall effect and graphene , has clearly emerged as an area of intense current interest. Magnetic fields play the crucial role since they break the electronic time reversal symmetry, leading to new physics (i.e. Dirac fermions are the charge carriers). Remarkably, these effects are evident even in bulk materials such as "rocksalt", as the Princeton group (T. Liang, et al., Nat. Comm. 4, 3696 (2013)) show for the IV–VI semiconductor $Pb_{1-x}Sn_xSe$. In this case, high magnetic field thermoelectric measurements **(Figure 1)** show that the nature of electrical transport in this topological material are Dirac fermions rather than Schrödinger electrons. No less than 14 other investigations in this area, notably experimental and theoretical work on other materials (e.g. bismuth compounds, have appeared in this year alone.

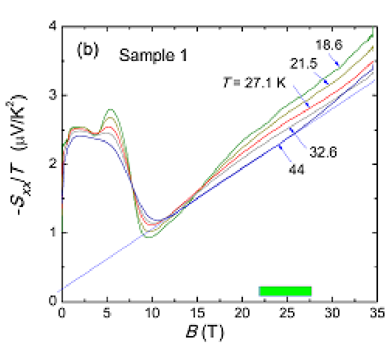


FIGURE 1. High magnetic field thermoelectric measurements show Dirac fermions.

Technique Development

Technique development continues to be an active area due to the many challenges of the high magnetic field, high pressure and low temperature environment that involves materials research "at the extremes", and this year's report contains over a dozen advances in instrumentation and sample environments. One area that is very new to the lab is the prospect of doing **x-ray diffraction in high magnetic fields (Figure 2,)** i.e. magnetic field dependent crystallography. Funded by an NSF EAGER Award, T. Siegrist and his group are pioneering this effort with a "proof of concept" project in the new NHMFL 25 T Split Helix magnet. Shown in **Figure 3** is the set-up of the x-ray source, spectrometer, and a "first light" diffraction pattern from the Split Helix magnet. When fully operational, DC high magnetic field studies involving the complex interplay of charge, spin, lattice and orbital degrees of freedom in transition metal oxide multiferroics will be possible for the first time.

FIGURE 2. X-ray diffractometer assembled in Call 5 of the NHMFL DC Field facility: the X-ray source side is shown.

FIGURE 3. Diffraction images obtainedon Si powder in our home laboratory and in the cell.

Magnetism and Magnetic Materials

Magnetism and magnetic materials, with almost 70 reports this year, is an important main stream activity at the NHMFL, particularly because of **newly synthesized compounds** that have become available due to a resurgence in materials synthesis. One example is the ternary compound $Ca_3NiNb_2O_9$ synthesized by H. Zhou (U.Tenn.) that is a manifestation of a spin-1 triangular lattice antiferromagnet. It has a complex multiferroic behavior including magnetic frustration, multiple magnetic phases, quantum plateaus in the magnetization, and ferroelectricity. In the study shown in the **Figure 4 & 5.)** Zhou and his collaborators at the NHMFL have studied the ferroelectric properties using dielectric and polarization methods. Another example of a novel material that NHMFL researchers are very fortunate to have access to **actinide compounds**, and in this case plutonium intermetallics. P. Tobash and co-workers (LANL & NHMFL) have investigated $PuRhIn_5$, which is in the "115" family of quantum-critical point materials such as $CeCoIn_5$. Here 5f electrons are on the A-site cation, giving rise to both localized and itinerant electronic behavior **(Figure 6.)** The material may be classified also as a "heavy fermion superconductor" (T_c (P=0) ~ 1.1 K) since the effective mass of the carriers is 230 times the bare electron mass. In the present work the authors have used a new fiber Bragg grating (FBG) optical technique to measure the physical strain DL/L of a single crystal sample of $PuRhIn_5$ vs temperature and magnetic field. This is very useful since by using the Ehrenfest relation $dT_c/dP = TVDa/DC_p$, the pressure dependence of the superconducting transition temperature may be obtained, thus giving information on which direction pressure will move the system with respect to a possible quantum critical point.

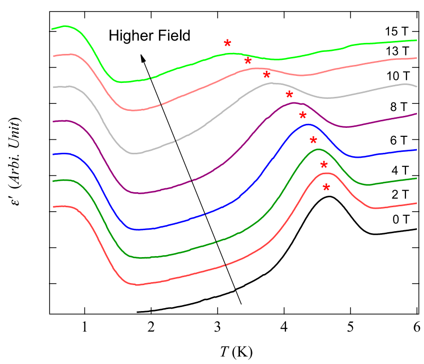


FIGURE 4. Temperature-dependent dielectric constant at different fields. The red asterisk indicates the dielectric constant anomaly associated with a magnetic phase transition.

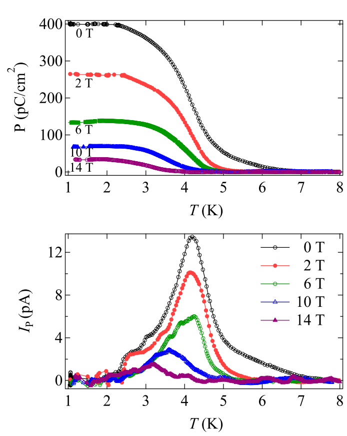


FIGURE 5. 2 Pyroelectric current data (top) and polarization curves (bottom) calculated from the pyroelectric current data.

Soft Matter

Soft matter is gaining a foothold in the research programs at the NHMFL due in part to the unique and diverse nature of the experimental capabilities that are available. In the area of **liquid crystals and complex fluids,** Gleeson et al. (Kent state) have recently used the 25 T Split Helix magnet to explore optically the properties of a new twist-bend nematic liquid crystal structure by optical birefringence as a function of temperature and magnetic field. Their results are shown in **Figure 7.** They made several new discoveries. First, the temperature dependence of the birefringence is highly magnetic field dependent, and the insets of the figure show the expectation that the high magnetic field suppresses the twist-bend (TB) morphology of the nematic structure. Secondly, the temperature dependent changes in morphology that show a second order type behavior at zero magnetic field clearly evolve into a first order transition by 25 T. The group has also recently obtained results in several unusual complex fluid systems.

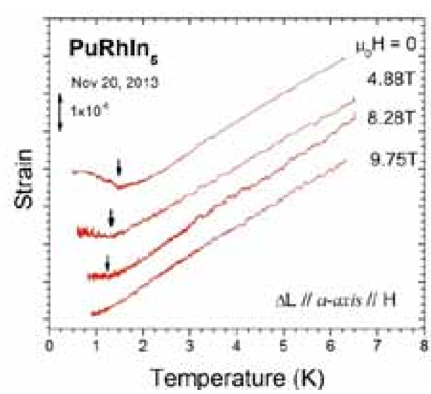


FIGURE 6. Linear thermal expansion DL/L (Strain) , plotted vs temperature for PuRhIn5 when the magnetic field and the strain are along the crystallographic a-axis.

Organic Conductor Bilayer Thin Film Structures

Recent progress has been made in producing **organic conductor bilayer thin film structures** produced by an oxidation process on polycarbonate thin films. E. Steven (NHMFL) in collaboration with the Barcelona ICAMB group has successfully transferred the organic conductor thin films to a natural silk thin film substrate, and has explored the dependence of the resistivity of the films on strain and humidity **(Figure 8.)** Remarkably, the electrical properties of the organic conductor films appear to be due to strain on their crystalline structure, and not on grain boundary or

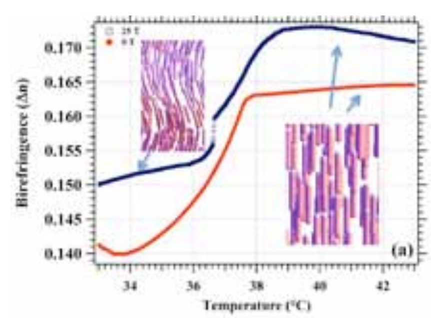


FIGURE 7. Effective optical anisotropy vs temperature at two different fields. The transition to TB phase goes from second order at zero field to first order at 25T. Insets are proposed structures for the TB morphology in the two cases.

other percolation type effects. Likewise, the transport properties of the thin bilayer films are similar to the bulk properties of the materials (in this case a-(BEDT-TTF)$_2$I$_3$, a semiconductor, and b-(BEDT-TTF)$_2$I$_3$, a metal). Hence their sensor properties are very uniform and consistent, as shown in the figures below. Plans are now underway to explore the electronic junction properties of the semiconductor-metal interface, and also to determine the high magnetic field transport properties, since applications of the bilayer structures as strain and thermometer sensors are possible in high fields.

Quantum Fluids and Solid

Quantum fluids and solids are in the domain of very low temperatures, pressure and magnetic fields. Recent **theoretical and experimental work** on the nature of the transport of ^{3}He atoms (a fermion) in solid ^{4}He (a boson) has been carried out by Candela (UMass) with co-workers at Georgia Tech and UF. Their theoretical model involves the tunneling of the ^{3}He atom in the ^{4}He lattice, where the interaction with other ^{3}He impurities and the "wake" produced in the ^{4}He soft-solid lattice are taken into account. Experimentally, the authors use NMR on the ^{3}He nucleus to measure the spin-lattice relaxation time, which can then be directly related to the ^{3}He tunneling dynamics. A comparison of the calculated and observed dynamical behavior is shown in **Figure 9.** The authors conclude the results show an unusual quantum plastic property of the ^{4}He lattice through which the ^{3}He atoms tunnel.

Unconventional Superconductivity

Unconventional superconductivity has been an important theme at the NHMFL, especially with the emergence of new types of materials with unusual properties, and theoretical predictions and interpretations play a crucial role in this area. Vafek's group (NHMFL) has recently considered the possibility of **superconductivity in bilayer graphene structures.** Motivated in part by the experimental observation of excitonic order in bilayer structures, his group has explored possible electron attractive paring scenarios such as the pair density wave (PDW), f-wave and d-wave. The physical and electronic structure is shown in **Figure 10**, and the possible phase diagrams based on theory are shown in **Figure 11**. The authors conclude that a robust superconducting phase is possible in these bilayer structures.

Summary

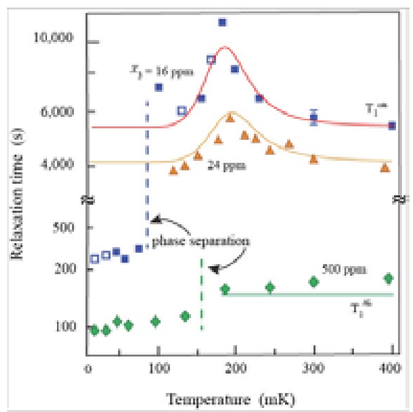


FIGURE 9. Comaprison of the calculated temperature dependence of the nuclear spin-lattice relaxation for 3He impurities in solid 4He with the observed values.

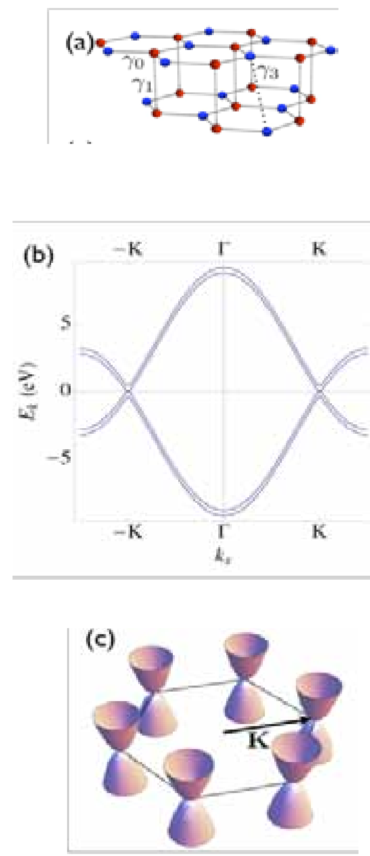
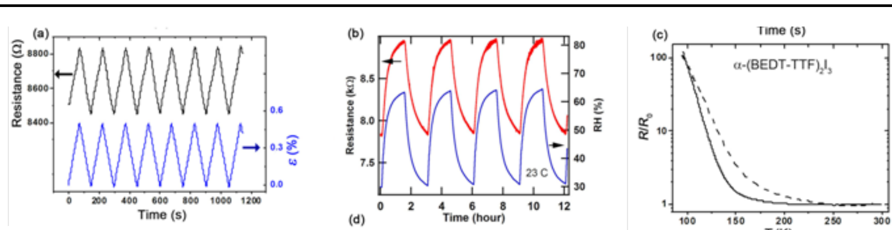


FIGURE 10. Features parabolicly touching energy bands at the corners of the Brillouin zone, known to be unstable to multiple types of excitonic ordering near half filling.



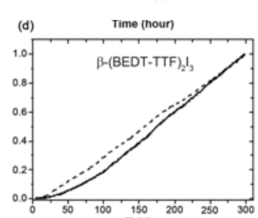


FIGURE 8. Electrical properties of (BEDT-TTF)2I3 / silk bilayer films. (a) Strain- and (b) humidity- dependent resistance of silk bilayer films. The humidity dependence is not observed in the pristine polycarbonate bilayer films. Temperature dependent resistance of α- and β- phased (BEDT-TTF)2I3 / silk bilayer films, showing a semiconducting and metallic behavior, respectively.

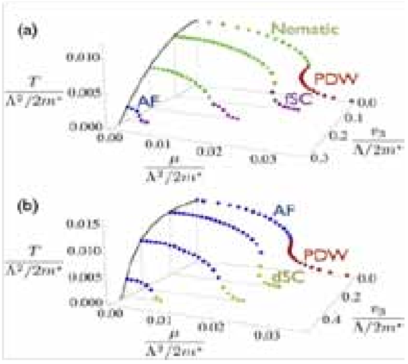


FIGURE 11. Shows the characteristic temperatures for ordering in various channels as a function of chemical potential and v3, which characterizes the strength of trigonal warping. The most likely ordered phases at half filling are nematic, realized for longer-ranged interactions and shown in Figure 2(a), and antiferromagnetic, realized for shorter-ranged interactions and shown in Figure 2(b). Upon doping, these give way to various types of superconducting order.

It has been an eye opener to review the many reports in materials science that have come in this year, as the result of what is clearly an international effort by first rate scientists and facilities. Naming the topics, they include techniques, graphene, Kondo/heavy fermion systems, magnetism and magnetic materials, molecular conductors, quantum materials, semiconductors, superconductivity, soft matter and topological matter. The types and quality of the materials has been impressive, matched with equally remarkable methods – methods that are directed at making precision measurements of sometimes very small signals under the extreme conditions of high field, low temperature, and high pressure. In some cases, theory is driving experiment, and in other cases, it is the reverse. Clearly both are active and interactive areas of activity. Looking to the future, it is clear that with materials science on the move, new materials coupled with advanced engineering will continue to push the limits of magnetic fields and pressure to higher limits and in parallel, new synthetic routes will provide materials that will surprise us with new physics and new function.

Geochemistry

The geochemistry facility has six mass spectrometers of which four are available to outside users.

Introduction

Three instruments are single collector inductively coupled plasma mass spectrometers each with there own niche. One instrument is dedicated to *in-situ* trace element analyses on solid materials using laser ablation. The other two are for elemental analyses of solutions. One instrument is a quadrupole ICP-MS with a collision cell. The quadrupole allows for very fats switching between isotopes and the collision cell removes major interferences created by the Ar-plasma. The second instrument is a high resolution instrument. The high resolution allows separation of molecular interferences on atomic ions. The facility has two instruments dedicated to determination of isotopic compositions. One is a multi collector inductively coupled plasma mass spectrometer (NEPTUNE) used for determination of isotopic abundances of metals. The other is a mass spectrometer designed for the measurement of the light stable isotope compositions (C, N O, S). The facility is run with the support of external grants and in the last year individual principal investigators had funding from NSF (five divisions of the GEO directorate), NASA, NOAA, EPRI (Electrical Power Research Institute), as well as BP oil spill funding.

Publications and Outreach

In 2013, the six principle faculty in the program authored or co-authored 37 peer-reviewed publications and made even more presentations at international meetings. Most publications were in first-tier journals and included a paper in Science and two in Nature. The Geochemistry program contributed to three Science Café presentations: "Caving for Climate Clues" on proxies of climate in Florida caves; "Exploring Mars: What we have learned" by a Geochemistry program alum now member of the Mars Curiosity team, and Meteorites, Mars and the Moon on the recent discovery of an ancient Martian meteorite (see Science highlight)

Science Highlight

The martian meteorite NWA 7533, found by Bedouins in the Saharan dessert, made its way to the Geochemistry labs and Humayun and collaborators examined this rock and reported on in the journal Nature (Humayun et al. Nature, 503, 473-474, 2013) They found this rock to be regolith breccia: a soil compacted into rocks by impact driven melts. Some of the fragments in the breccia have a chemical composition unique to Mars. Radioactive age dating of zircons in the fragments reveals an oldest age 4,428 Myr, about 2 billion years older than the previously oldest Martian rock. This sample is evidence of very early crust formation on Mars, within the first 100 Myr of its existence, which is similar to the Earth and the Moon. The composition of the crustal fragments also allows the calculation of the extent of melting and by extension the average thickness of the Martian crust. These type of samples are important pieces of information on the evolution of Mars.

Progress on STEM and Building the User Community

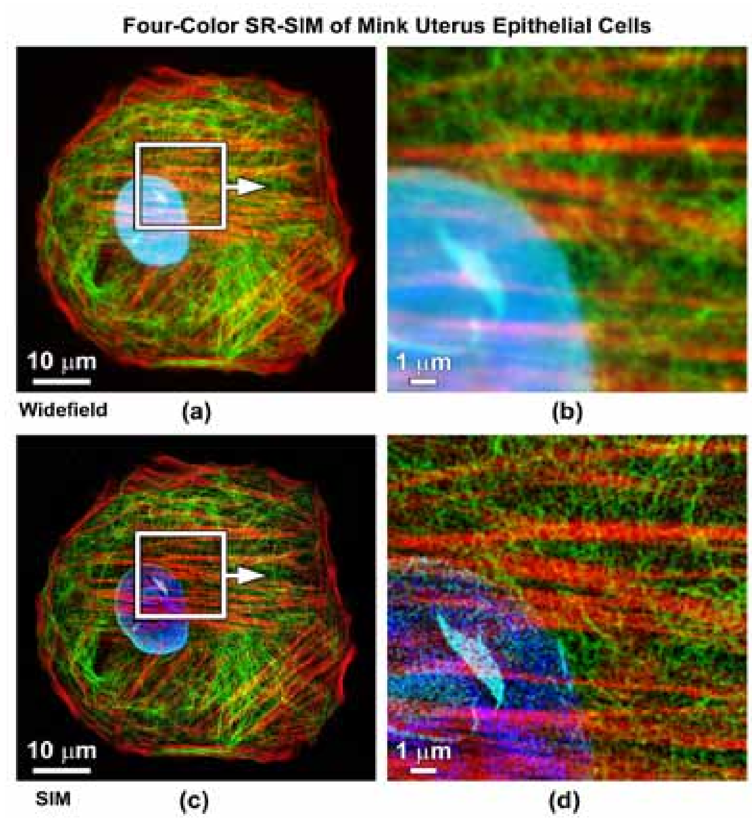
The facility is open to users of all disciplines, and we have a long-time collaboration with the USGS Volcano Monitoring Program and the South Florida Water Management District. During the summer we hosted one undergraduate students from the REU program. We participated in the annual open house. As our facilities are mainly supported through external grants, external users have to be able to contribute to the cost of the lab use, but we continue to help people get preliminary data for use in proposals etc., free of charge. Also, training of new users on the instruments is done free of charge.

Microscopy

Research at the Davidson laboratory is primarily concerned with the development and characterization of novel Fluorescent Proteins (FPs) and FP fusion chimeras, and their use as tools for a variety of biomedical research applications.

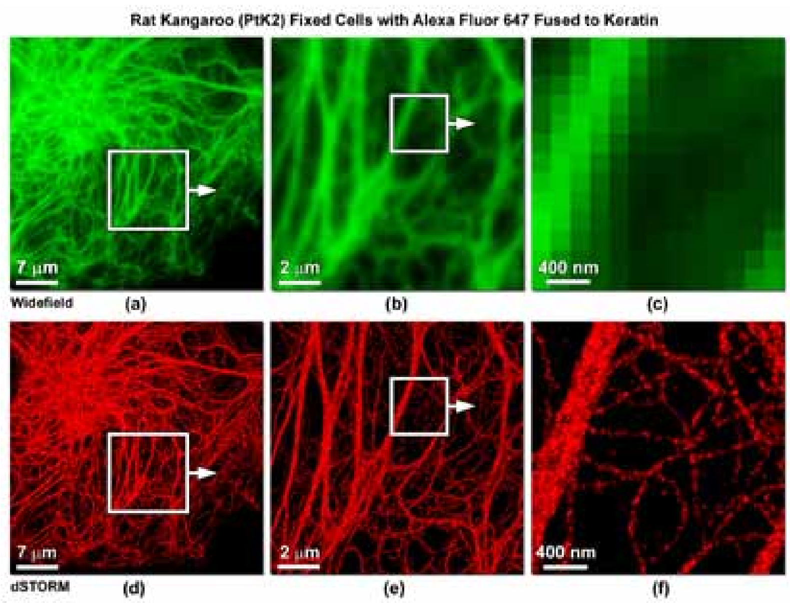
The Davidson lab is also very active in the field of high resolution optical microscopy, developing and implementing state-of-the-art imaging techniques to help elucidate a number of biological questions. However, perhaps the most important work performed at the lab is the continuous development of educational websites focused on all aspects of optical microscopy. These websites are developed in conjunction with our corporate partners, including Nikon, Zeiss, Olympus, and Hamamatsu. The included material was developed with both the amateur and seasoned microscopist in mind, thus it is of little surprise that these websites host approximately 15,000 unique visitors daily.

FPs have revolutionized live-cell imaging, allowing one to view a number of biological processes with great specificity, minimal invasiveness, and high spatial and temporal resolution. In 2013 the Davidson lab was key in the development and characterization of the new FPs mNeonGreen[1] and mPapaya[2]. mNeonGreen is the brightest FP ever engineered and mPapaya is the most robust true yellow FP ever developed, expanding the useful emission spectral range for multicolor fluorescence imaging with FP probes. Additionally, FP fusions developed at the Davidson lab have been key in recent research of focal adhesion-actin dynamics[3], the relationship between focal adhesions and cellular tension[4], the mechanism of initial neurite extension[5], the identification of key proteins for axonal outgrowth[6], the role of CD81 in influenza infection[7], the structure and role of nonmuscle myosin II in epithelial cell apical junctions[8], and the trafficking of caveolin-1[9], a protein implicated in both oncogenesis and tumor suppression. As one of the greatest authorities on fluorescent probes for biological imaging, the lab has helped to create a number of specialized reviews on their applications[10-13].



Another focus of the Davidson lab is high resolution optical microscopy. In addition to regular use of 'standard' fluorescence microscopy techniques, including TIRF, confocal and widefield, the lab has been heavily involved with the burgeoning field of diffraction-unlimited 'superresolution' optical fluorescence microscopy. Specifically, the lab uses single molecule localization microscopy (SMLM) and structured illumination microscopy (SIM); the former was awarded 'method of the year' by Nature in 2008. Our superresolution involvement includes a key role in the application of sCMOS detectors for single molecule localization microscopy (SMLM)[14], significantly improving imaging speed, as well as its use for visualizing CD81 in viral uncoating and infection[7]. The lab is also considered an authority on SMLM, and has published reviews designed to increase the accessibility of cutting-edge superresolution techniques to researchers[15, 16].

The Davidson lab is also involved with collaborative research at NHMFL and FSU, making the wealth of equipment and knowledge at the lab available for our colleagues. This includes work in the development and characterization of novel fluorescent Zinc(II) indicators for in vivo imaging[17], the use of superparamagnetic iron oxide to for long-term visualization of human mesenchymal stem cells by



MRI in ischemic stroke models[18], and the visualization of the new oxytelluride compound $Ba_3Yb_2O_5Te$[19]. The greatest strength of our lab is the wealth and diversity of our research efforts, a quality that will continue into future.

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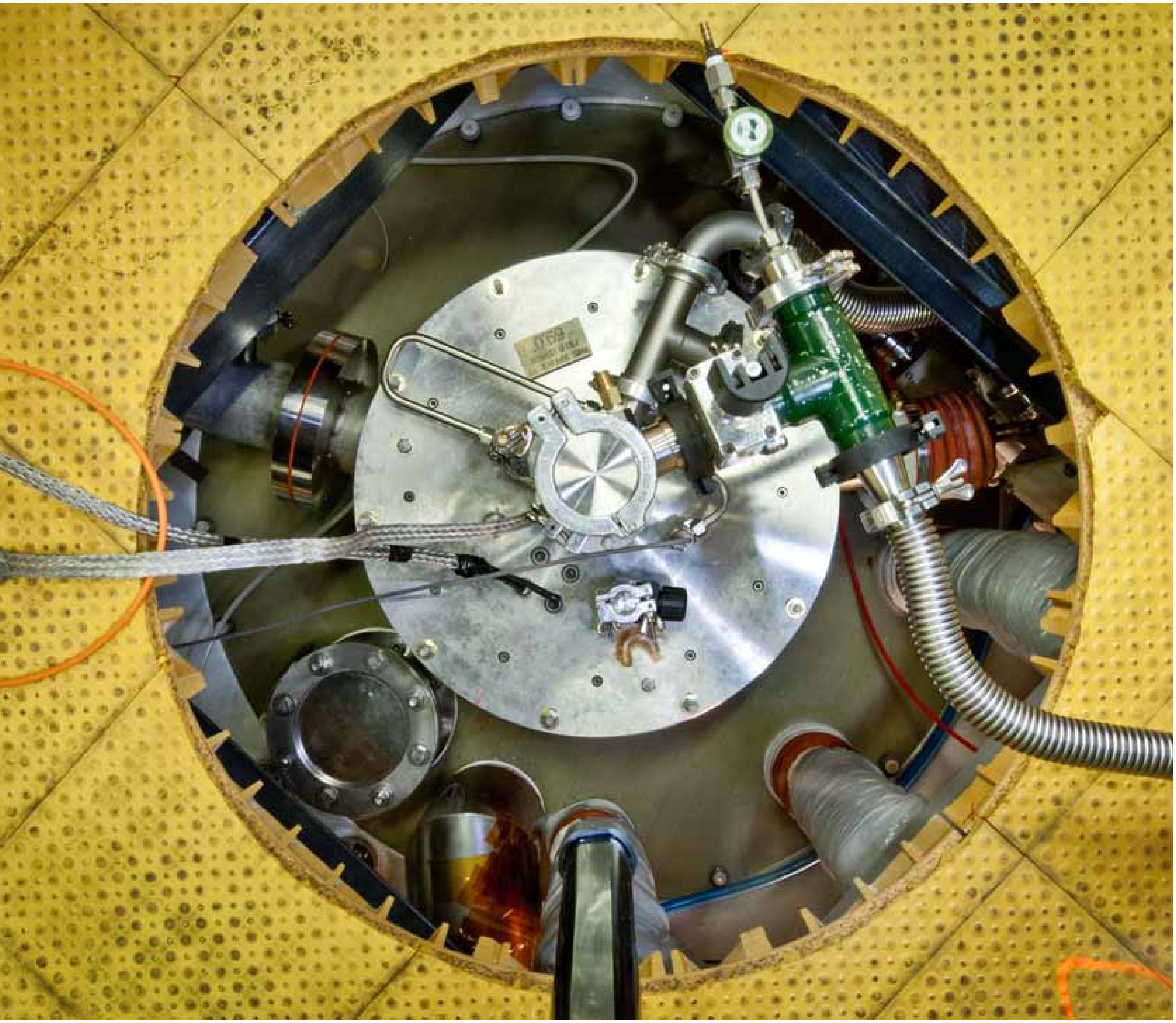
CHAPTER 6

Accomplishments & Discoveries



Products of MagLab Users & Faculty

(as of 2-20-2014)

The laboratory continued its strong record of publishing, with 469 articles appearing in peer-reviewed scientific and engineering journals in 2013. The full listing, along with citations for over 417 presentations, is available on the Magnet Lab's Web site http://www.magnet.fsu.edu/search/publications/search.aspx

This chapter lists publications by user facility, followed by publications attributed to Magnet Science & Technology, the NHMFL Applied Superconductivity Center, UF Physics, the Condensed Matter Theory/Experiment group, the Center for Integrating Research & Learning Geochemistry, and Optical Microscopy. Please note that publications may be listed with more than one facility or group, as the research may have resulted from e.g., using both DC and Pulsed Field Facilities, or from a collaboration that involves both user/ experimentalists and theorists.

Of the 417 publications, 213 (51%) appeared in significant journals.

Presented on the remaining pages of this chapter are lists of one-time publications, internet disseminations, patents, awards, PhD dissertations, and Master theses.

TABLE 1

Submitted Peer-Reviewed Publications

From the OPMS live database. The point-in-time snapshot was on February 20, 2014.

Facility	**2013**
DC Field Facility	90
Pulsed Field Facility at LANL	31
High B/T Facility at UF	9
NMR Facility	44
MBI-UF AMRIS	49
EMR Facility	48
ICR Facility	31
MS & T	29
Applied Superconductivity Center	15
UF Physics	24
CMT/E	54
Education (NHMFL only)	1
Subtotal	**425**
Geochemistry Facility	26
Optical Microscopy	18
Total	**469**

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Books, Chapters, Reviews and Other One-Time Publications (4)

Eckstein, J.N.; Zheng, M.; Zhai, X.; Davidson, B.; Warusawithana, M.P. and Oh, S., “Chapter 21 - Atomic layer-by-layer molecular beam epitaxy of complex oxide films and heterostructures”, *Molecular Beam Epitaxy*, 509-528, 2013.

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Patents & Other Products (3)

Hilton, D.K.; Dalban-Canassy, M.; Weijers, H.W.; Trociewitz, U.P. and Larbalestier, D.C., *“Mechanical Decoupling in High-Temperature Superconducting Tapes”,* Patent US 8,530,390 B2 (2013)

Marshall, W.S. (William), *“System For Quick Disconnect Termination Or Connection For Cryogenic Transfer Lines With Simultaneous Electrical Connection And Method Thereof”,* US Patent No. 8,517,749 (2013)

Park, Y.W. and Baek, S.J., *“Temperature Sensors Using Material with Charge Density Wave Property”,* Korean patent application No.: 10-2013-0104864About temperature sensors using materials with charge density wave property that operatate in the presence of magnetic field utilizing their magneto-insensitive resistivity (2013)

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Trociewitz, U.P.; Hilton, D.K.; Viouchkov, Y.L. and Dalban-Canassy, M, *“An Electric Joint Design to Be Used in Electromagnetic Coils Made with High Temperature Superconducting Tape”,* Patent US 8,588,876 B1 (2013)

Whittington, A.D.; Dalban-Canassy, M.; Hilton, D.K.; Trociewitz, U.P.; Starch, W.L.; Sheppard, W.R.; Mankin, A. and Whittington J.W., *“Shrink Tube Insulation Apparatus (STIA)”,* U.S. patent application, FSU 14-056 (2013)

Awards, Honors & Service (11)

Alamo, R. (Rufina),
FSU Distinguished Research Professor (2013)

Crooker, S. A.,
Fellow, Optical Society of America (2013-present)

Grant, S. (Samuel),
FSU Planning Grant Award for 2012-2013: Delayed Human Mesenchymal Stem Cell Injections for Stroke Treatment as Evaluated by High Field MRI (2013)

Guo, W. (Wei),
FSU First Year Assistant Professor Award for 2012-2013: Producing a Line of Excimer Helium Molecules for Visualization Study of Turbulence in Superfluid Helium-4 (2013)

Hirschfeld, P. (Peter),
University of Florida -- University Teacher/Scholar of the Year Award (2013)

Hughes, R. (Roxanne),
Research on Women and Education Selma Greenberg Outstanding Dissertation Award (2013)

Lee, P.J. (Peter),
Distinguished University Scholar, Florida State University (2013)

Marshall, A.G. (Alan),
Fellow, American Academy of Arts and Sciences (2013)

Popovic, D. (Dragana),
Distinguished University Scholar, Florida State University (2013)

Rodgers, R. (and co-authors: Podgorski, D.; Corilo, Y.; Nyadong, L.; Lobodin, V.; Robbins, W.; McKenna, A. and Marshall, A.G.),
Glenn Award from the Energy and Fuels Division of the American Chemical Society (2013)

Sebastian, S.,
L'Oréal-UNESCO Fellowship for women in science (2013-present)

Vanderlaan, M.H. and Van Sciver, S.W.,
CEC Student Paper Award (2013)

Weiss, J. (Jeremy),
FSU Graduate Student Research and Creativity Award (2013)

Weiss, J.D.,
IEEE CSC Graduate Study Fellowship in Applied Superconductivity (2013)

Ph.D. Dissertations (49)

Fourty-nine (49) Ph.Ds. were reported for 2013:15 were awarded to users/ students at FSU or UF; 34 were awarded to users at other academic institutions.

Ph.Ds. awarded to users/students at FSU or UF (15):

Colon-Perez, L.M., *"Weighted Networks and the Topology of Brain Networks"*, University of Florida, Biochemistry & Molecular Biology, advisor: Mareci, Thomas (2013)

Ford, A.A., *"Broca's Area--Thalamocortical Circuitry: Effects of Anterior and Posterior Thalamic Lesions Investigated Using Diffusion-Weighted Tractgraphy"*, University of Florida, advisor: Keith D. White (2013)

Huang, X., *"Monitoring Polymorphism-Induced Conformational And Dynamics Changes In Hiv-1 Protease Via Pulsed Electron Paramagnetic Resonance And Nuclear Magnetic Resonance Spectroscopy"*, University of Florida, Department of Chemistry, advisor: Gail Fanucci (2013)

Jarvis, Jacqueline M., *"Complex Mixture Analysis by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry: Applications for the Fuel Industry"*, Florida State University, Department of Chemistry & Biochemistry, advisor: Alan G. Marshall (2013)

Knowles, E.S., *"Strain-Mediated Photomagnetic Effects in Heterostructured Nanoparticles of Prussian Blue Analogues"*, University of Florida and Department of Physics, advisor: Mark W. Meisel (2013)

Kuhn, T.P., *"Structural and Functional Correlates of Adjacent Temporal Lobe Circuits: Associations with Memory Performance and Structural Neuroimaging in Temporal Lobe Epilepsy"*, University of Florida, advisor: Russell M. Bauer (2013)
Kuznetsova, A., *"Structural Analysis Of The C-Terminus Of Lung Surfactant Protein B (SP-B)"*, University of Florida, Chrmistry Department, advisor: Joanna Long (2013)

Lomasney, Anna, *"Development Of Analytical Tools To Study The Signaling Mechanisms Of Glucose Homeostasis Regulation In Islets Of Langerhans"*, Florida State University, Department of Chemistry & Biochemistry, advisor: Roper, Michael (2013)

Mao, Yuan, *"Application of FT-ICR Mass Spectrometry in Study of Proteomics, Petroleomics, and Fragmentomics"*, Florida State University, Department of Chemistry & Biochemistry, advisor: Alan G. Marshall (2013)

Montaser, R., *"Structural Characterization, Biological Evaluation and Synthesis of Novel Secondary Metabolites from Guamanian Marine Cyanobacteria Lyngbya SPP"*, University of Florida, Medicinal Chemistry, advisor: Luesch, H. (2013)

Ruddy, Brian, *"A Forensic Investigation into Deepwater Horizon Heavy End Environmental Transformation by High Resolution Detection and Isolation FT-ICR Mass Spectrometry"*, Florida State University, Department of Chemistry & Biochemistry, advisor: Alan G. Marshall (2013)
Salvador, L., *"Drug Discovery from Marine Cyanobacteria Symploca spp. and Phormidium spp.: Novel Structures and Bioactivities of Secondary Metabolites"*, University of Florida, Medicinal Chemistry, advisor: Luesch, H. (2013)
Valeja, Santosh G., *"Hydrogen/Deuterium Exchange, Supercharging, and Top-Down FT-ICR Mass Spectrometry of Biomolecules--Method Development, Optimization, and Application"*, Florida State University, Department of Chemistry & Biochemistry, advisor: Alan G. Marshall (2013)

Wang, J., *"Magnetic Studies on Trimetal Chain Complexes and Their Derivatives"*, Florida State University, Department of Chemistry and Biochemistry, advisor: Dalal, N.S. (2013)
Zhang, Qian, *"Protein-Protein and Protein Ligand Interactions Monitored by Hydrogen/Deuterium Exchange Coupled with FT-ICR MS"*, Florida State University, Department of Chemistry & Biochemistry, advisor: Alan G. Marshall (2013)

Ph.Ds awarded by other academic institutions to external users/students (34):

Amjad, Asma, *"Exchange Coupling In Molecular Magnets: Zero, One And Three Dimensions",* University of Central Florida, Dept. of Physics, advisor: Enrique del Barco (2013)

Ben Shalom Moshe, *"Srtio3 Based Interfaces: Tuning Through Multiple Ground States.",* Tel Aviv University, advisor: Yoram Dagan (2013)

Brinzari, T., *"Electron-Phonon And Magnetoelastic Coupling In Molecular Quantum Magnets",* University of Tennessee, Department of Chemistry, advisor: Janice L Musfeldt (2013)

Carson, Ingo, *"Magnetic Resonance Imaging of Anomalous Diffusion and Entropy in Neural Tissue",* University of Illinois at Chicago, Department of Bioengineering, advisor: Richard L. Magin (2013)

Chen, P., *"Field-Induced Color Changes in Transition Metal Oxides",* University of Tennessee, Department of Chemistry, advisor: Janice L Musfeldt (2013)

Chen, Yan, *"The Structural And Function Study Of Three Metalloenzymes That Utilize Three Histidines As Metal Ligands",* Georgia State University, Dept. of Chemistry, advisor: Dr. Aimin Lu (2013)

Dugar, Sneha, *"NMR and Imaging Studies on Energy Materials",* Chemistry and Biochemistry, Florida State University, advisor: Naresh Dalal (2013)

Fan, C., *"Crystal Growth And Low-Temperature Physical Properties Of Magnetically Frustrated Rmno3 And Dy2Ti2O7",* University of Science and Technology of China, advisor: Sun, X.F. (2013)

Garcia-Ricard, O.J., *"Pillar-Layered Structured Nanoporous Coordination Polymers for Carbon Dioxide Adsorption-based Applications",* University of Puerto Rico at Mayaguez, Department of Chemical Engineering, advisor: Hernandez-Maldonado, A.J. (2013)

He, Weiwei, *"Aminoacyl-tRNA Synthetases and Charcot-Marie-Tooth Disease",* The Scripps Research Institute, Department of Cell and Molecular Biology, advisor: Yang, Xiang-Lei (2013)

Idesicova, Monika, *"Magnetostructural D-Correlations In Tetrahedrally Coordinated Co(II) Complexes",* University of SS. Cyril and Methodius, Trnava, Slovakia, Dept. of Inorganic Chemistry, advisor: Dr. Ing. Roman Boca (2013)

Kamenskyi, Dmitro, *"High-Field ESR Studies Of Frustrated Spin Systems",* Technical University Dresden, advisor: Sergei Zvyagin (2013)

Khim, S., *"Crystal Growth And Upper Critical Field Properties Of Iron-Based Superconductors And A Chalcogenide Superconductor",* Seoul National University, Department of Physics and Astronomy, advisor: Kee Hoon Kim (2013)

Li, Pei, *"Grain Boundaries In Superconducting Ca-Doped Ybbco Thin Films",* FSU, Department of Physics, advisor: David Larbalestier (2013)

Li, Q.J., *"Low-Temperature Heat Transport Of Spin-Liquid Material",* University of Science and Technology of China, advisor: Sun, X.F. (2013)

Merritt, Travis, *"Optoperforation of Intact Plant Cells, Spectral Characterization ofAlloy Disorder in InAsP Alloys, and Bimetallic Concentric Surfacesfor Metal-Enhanced Fluorescence in Upconverting Nanocrystals",* Virginia Tech, Physics Department, advisor: Giti Khodaparast (2013)

Moeller, J.S., *"Muon-Spin Relaxation And Its Application In The Study Of Molecular Quantum Magnets",* University of Oxford, Department of Physics, advisor: Prof S. J. Blundell (2013)

Mohammady, M. H., *"Nuclear-Electronic Spin Systems, Magnetic Resonance, And Quantum Information Processing",* Department of Physics, University College London, advisors: Prof Tania S Monteiro and Dr Gavin W Morley (2013)

Moll, P.J.W., *"The Role Of Anisotropy In The Iron-Pnictides Addressed By Focused Ion Beam Preparation",* ETH Zurich, advisor: Prof. Bertram Batlogg (2013)

Mounce, Andrew M., *"Nuclear Magnetic Resonance Study of High Temperature Superconductivity",* Northwestern University, Department of Physics and Astronomy, advisor: W.P. Halperin (2013)
Oh, Sangwon, *"Nuclear Magnetic Resonance Study On The Pnictide Superconductors In High Magnetic Fields",* Northwestern University, Department of Physics and Astronomy, advisor: W.P. Halperin (2013)

Pascui, Andrea Eva, *"Synthesis, Structural Variations and Trends in the Properties of Unique Dinuclear and Polynuclear Complexes of Bis(pyrazolyl)methane Ligands in Solid State and in Solution",* University of South Carolina, Dept. of Chemistry, advisor: Prof. D. L. Reger (2013)

Pouya Moetakef, *"Emergent Phenomena In Mott/ Band Insulator Heterostructures",* University of California, Santa Barbara; Materials Department, advisor: Susanne Stemmer (2013)

Primera-Pedrozo, J.N., *"Flexible Titanium Silicate Porous Materials for Selective Carbon Dioxide Adsorption",* University of Puerto Rico at Mayaguez, Department of Chemical Engineering, advisor: Hernandez-Maldonado, A.J. (2013)

Qu, Lei, *"Microstructure and Properties of Cu-Fe Composite Wires Controlled by Magnetic Field",* Northeastern University, Shenyang, China, advisor: Wang, E.G.; Han, K. (2013)

Roy, B., *"Optical and Magneto-Optical Properties of type-II Excitons in ZnTe/ZnSe Stacked Submonolayer Quantum Dots",* Queens College and Graduate Center of The City University of New York, advisor: Igor L. Kuskovsky (2013)

Saber, Mohamed, *"Enhancing Magnetic Properties of Molecular Magnetic Materials: The Role of Single-Ion Anisotropy",* Texas A&M University, Dept. of Chemistry, advisor: Kim R. Dunbar (2013)
Schweinfurth, David, *"3d Metal Complexes with 1,2,3-Triazole and Quinone Ligands: Magnetic Bistability, Single-Ion Magnets and Small Molecule Activation",* Freie Universitat Berlin, Dept. of Chemistry and Biochemistry, advisor: Prof. Dr. B. Sarkar (2013)

Senchyk, Ganna A., *"Metal-Organic Frameworks Based On 1,2,4-Triazolyl Functionalized Adamantanes And Diamantanes",* Taras Shevchenko National University of Kyiv, Dept. of Inorganic Chemistry, advisor: Andriy Lysenko (2013)

Smith, B., *"Influences of Organic-Inorganic Surface Interactions on Crystallization in Liquid-Solid Systems",* University of California, Santa Barbara, Chemical Engineering, advisor: Chmelka, B. (2013)

Stillwell, R.L., *"Fermi Surface Reconstruction in Chromium At High Pressure and High Magnetic Fields",* The Florida State University, Department of Physics, advisor: Stanley W. Tozer (2013)

Thomson, B.F., *"Estimation and Reduction of Temporal Magnetic Field Fluctuations in Powered Magnets Using Inductive and NMR Feedback Control",* The Pennsylvania State University, Department of Electrical Engineering, advisor: J.L. Schiano (2013)

Zadrozny, Joe, *"Slow Magnetic Relaxation in Multinuclear Coordination Clusters and Low-Coordinate Transition Metal Complexes",* University of California at Berkeley, Dept. of Chemistry, advisor: Jeffrey Long (2013)

Zhong, Guiming, *"The Application of Solid State NMR in the Study of Electrochemical Energy Materials",* Chemistry Department, Xiamen University, advisor: Yong, Yang (2013)

Master Theses (14)

Allen, N., *"Pure Bending Characterization of Nb3Sn Superconducting Strands Using Experimentation and FEA Modeling",* Tufts University, Mechanical Engineering Department, advisor: Luisa Chiesa (2013)

Dial, Angela, *"Accurate And Precise Determination Of Low Concentration Iron, Arsenic, Selenium, Cadmium, And Other Trace Elements In Natural Samples By Octopole Collision/Reaction Cell (Crc) Equipped Quadrupole-Icp-Ms",* Florida State University; Earth, Ocean, and Atmospheric Science, advisor: William M. Landing (2013)

Holland, S. (Stephen), *"Conductivity Measurements in Activated Abdominal Ganglia from Aplysia Californica Using MREIT at 11.75 T",* Flordia State University, Chemical & Biomedical Engineering, advisor: Grant, S. (Samuel) (2013)

Hurd, Joseph, *"Multilayer Insulation Testing At Variable Boundary Temperatures",* ME Department, FSU, advisor: Dr. Van Sciver (2013)

Hwang, Jaewon, *"Synthesis and Magnetic Characterizations of the Decorated Shastry-Sutherland system Cd(Cu1-xZnx)2(BO3)2",* Chung-Ang University, Dept. of Physics, advisor: Kwang-yong Choi (2013)

Lewis, Adam, *"Evaluation of Extraction Method and Characterization of Water Soluble Organics from Produced Water by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry",* Florida State University, Department of Chemistry & Biochemistry, advisor: Alan G. Marshall (2013)

Mudela, S. (Sai), *"New RF Electronics for NMR Field Mapping of Powered Magnets and High Power Solid State NMR",* Florida State University, Electrical and Computer Engineering, advisor: Foo, S. (Simon) (2013)

Mudela, S.K., *"2-Channel Low Power Broadband Transmit/Receive Switch and 720 MHz High Power Narrow Pass Band Filter",* Florida State University, Department of Electrical and Computer Engineering, advisor: Foo, Simon (2013)

Murphy, Jason, *"The Effects Of Heavy-Ion And Electron Irradiation On Bafe2as2 Basedpnictide Superconductors",* Department of Physics and Astronomy, Iowa State University, advisor: Ruslan Prozorov (2013)

Sagaram, S. (Smriti), *"Single and Multiple Coaxial Inputs to a Cylindrical Waveguide for Far Field MRI at 21.1 T",* Florida State University, Electrical & Computer Engineering, advisor: Grant, S. (Samuel) (2013)

Stangl, Alex, *"In Situ Comparison Between Direct and Magnetization Reel-to-Reel Critical Current Measurements in REBCO Coated Conductors",* FSU, advisor: Jan Jaroszynski, David Larbalestier, Harold Weber (2013)

Wang, A., *"Single-File Diffusion in Dipeptide Nanotubes: Experimental Study by Xe-129 PFG NMR",* University of Florida, Chemical Engineering Department, advisor: Vasenkov, S. (2013)

Wang, H., *"NMR Study of Diffusion in Mixtures of Carbon Dioxide and Functionalized Ionic Liquid",* University of Florida, Chemical Engineering Department, advisor: Vasenkov, S. (2013)

Zhang, S., *"Self-Diffusion of Carbon Dioxide in Samaria/Alumina Aerogel Catalyst Using High Field NMR Diffusometry",* University of Florida, Chemical Engineering Department, advisor: Vasenkov, S. (2013)

APPENDIX I

User Facility Statistics

Including List of Proposals

Seven user facilities — DC Field, Pulsed Field, High B/T, NMR-MRI@FSU, NMR-MRI@UF (AMRIS), EMR, and ICR — each with exceptional instrumentation and highly qualified staff scientists and staff, comprise the Magnet Lab's User Program. In this appendix, each facility presents detailed information about its user demographics, operations statistics and requests for magnet time.

A user is an individual or a member of a research group that is allocated magnet time. The user does not have to be "on site" for the experiment. A researcher who sends samples for analysis; a scientist who uses new lab technologies to conduct experiments remotely; or a PI who sends students to the Magnet Lab, are all considered users. All user numbers reflect distinct individuals, i.e. if a user has multiple proposals (different scientific thrusts) or is allocated magnet time more than once during the year, he/she is counted only once.

DC FIELD FACILITY

TABLE 1

User Demographic

DC Field Facility	Users	Male	Female	Prefer Not to Respond to Gender	Minority[1]	Non-Minority[1]	Prefer Not to Respond to Race	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	166	146	15	5	8	158	8	101	0	22	43
Senior Personnel, non-U.S.	91	82	8	1	3	88	5	35	0	8	48
Postdocs, U.S.	53	45	5	3	0	53	5	46	0	3	4
Postdocs, non-U.S.	17	14	3	0	2	15	3	14	0	0	3
Students, U.S.	148	122	23	3	8	140	17	126	0	13	9
Students, non-U.S.	41	36	3	2	3	38	6	34	0	1	6
Technician, U.S.	1	1	0	0	0	1	0	1	0	0	0
Technician, non-U.S.	1	1	0	0	0	1	0	1	0	0	0
Total:	**518**	**447**	**57**	**14**	**24**	**494**	**44**	**358**	**0**	**47**	**113**

1. NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin
2. "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
3. "Users Sending Sample" refers to users who send the sample to the facility and the experiment is conducted by in-house user support personnel. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
4. "Off-Site Collaborators" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

TABLE 2

User Affiliations

DC Field Facility Users	NHMFL-Affiliated Users[1]	Local	Users[1]	University Users[2,4]	Industry Users[4]	National Lab Users[3,4]
Senior Personnel, U.S.	166	53	9	128	5	33
Senior Personnel, non-U.S.	91	1	0	55	0	36
Postdocs, U.S.	53	13	10	45	1	7
Postdocs, non-U.S.	17	1	0	12	0	5
Students, U.S.	148	12	19	145	0	3
Students, non-U.S.	41	0	0	35	0	6
Technician, U.S.	1	1	0	1	0	0
Technician, non-U.S.	1	0	0	1	0	0
Total:	**518**	**81**	**38**	**422**	**6**	**90**

1. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [i.e. on our Web site/directory], even if they travel to another site.
   Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e. researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
   The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators".
2. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
3. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
4. The total of university, industry, and national lab users will equal the total number of users.

TABLE 3

Users by Discipline

DC Field Facility	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Senior Personnel, U.S.	166	113	6	19	13	5
Senior Personnel, non-U.S.	91	80	1	4	4	2
Postdocs, U.S.	53	46	2	2	2	1
Postdocs, non-U.S.	17	15	0	1	0	1
Students, U.S.	148	109	15	18	5	1
Students, non-U.S.	41	40	1	0	0	0
Technician, U.S.	1	0	0	0	1	0
Technician, non-U.S.	1	0	0	1	0	0
Total:	**518**	**403**	**35**	**45**	**25**	**10**

TABLE 4

User Facility Operations

	Resistive Magnets & Hybrid	Superconducting Magnets	Total Days[1] Allocated / User Affil.	Percentage Allocated / User Affil.
NHMFL-Affiliated	96.51	191	287.51	16.23%
Local	41.50	97	138.50	7.82%
U.S. University	351.63	449	800.63	45.19%
U.S. Govt. Lab.	41.53	71	112.53	6.35%
U.S. Industry	6.07	35	41.07	2.32%
Non-U.S.	207.08	145	352.08	19.87%
Test, Calibration, Set-up, Maintenance, Inst. Dev.	1.37	38	39.37	2.22%
Total:	**745.69**	**1026**	**1771.69**	**100%**

1. User Units are defined as magnet days. For the DC Field Facility, one magnet day is defined as 7 hours in a water-cooled resistive or hybrid magnet. Using this definition, a typical 24-hour day in the DC Field Facility contains three or four "magnet days". For experiments in the superconducting magnets, one "magnet day" is defined as 24 hours of use.

TABLE 5

Operations by Discipline

	Total Days Allocated / User Affil.	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
NHMFL-Affiliated	287.51	230.45	0	10.25	46.80	0
Local	138.50	105.63	32.88	0	0	0
U.S. University	800.63	738.71	52.07	2.59	4.06	3.20
U.S. Govt. Lab.	112.53	110.25	0	1.34	0.94	0
U.S. Industry	41.07	39.69	0	1.38	0	0
Non-U.S.	352.08	339.42	0	7.00	5.65	0
Test, Calibration, Set-up, Maintenance, Inst. Dev.	39.37	10	0	0	29.37	0
Total:	**1771.69**	**1574.15**	**84.94**	**22.56**	**86.83**	**3.20**

TABLE 6

User Program Experiment Pressure

Experiment Requests Received	Experiment Requests Deferred from Prev. Year	Experiment Requests Granted	Experiment Requests Declined/Deferred	Experiment Requests Reviewed	Oversubscription
365	29	282 (71.57%)	112 (28.43%)	394	139.72%

TABLE 7

New User PIs

Name	Organization	Proposal	Year of Magnet Time
Kominsky, Daniel	Prime Photonics	P02355	2013
Osada, Toshihito	Institute for Solid State Physics, University of Tokyo	P02361	2013
Ott, Hans Rudolf	ETH Zuerich	P02362	2013
Cadden-Zimansky, Paul	Bard College	P02377	2013
Han, Tian-Heng	University of Chicago	P02458	2013
Deemyad, Shanti	University of Utah	P02464	2014
Henriksen, Erik	Washington University in St. Louis	P02466	2014
Myronov, Oleh	The University of Warwick	P02472	2014
Eremin, Alexey	Otto von Guericke University	P02517	2014
Heinz, Tony	Columbia University	P07177	2014
Kikugawa, Naoki	National Institute for Materials Science	P07189	2014
Total:			**2013 – 5** **2014 - 6**

TABLE 8

Research Proposals[1] Profile, with magnet time

	Total	Minority[2]	Female[3]	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Number of Proposals	161	4	15	129	5	5	20	2

1. A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
2. The number of proposals satisfying one of the following two conditions: (a) the PI is a minority OR (b) the PI is a non-minority working at a minority-serving college or university AND the proposal includes minority participants.
3. The number of proposals satisfying one of the following two conditions: (a) the PI is a female OR (b) the PI is a male working at a college or university for women AND the proposal includes female participants.

TABLE 9

User Proposals

PI	Organization	Funding Source(s)			Proposal Title & ID#	Number of Days Awarded/ Scheduled
Scott Hannahs (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)	Operations		DC Field Facility Magnet and Power Supply testing P00501	1.22
Yury Pusep (S) New PI 2010	**Institute of Physics, University of Sao Paulo**	Other - Brazilian agency FAPESP			Quantum Hall effect in multi-component electron systems formed in weakly coupled layers and in hetero-structured nano-wires P01472	7
Scott Hannahs (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Power & Protection System Testing For the Series Connected Hybrid P01855	0.19
Janice Musfeldt (S)	**University of Tennessee, Knoxville**	Department of Energy	Materials Science Division	DE-FG02-01ER45885	Spectroscopic investigations of complex electronic and magnetic materials P01291	26.21
Thomas Herrmannsdoerfer (S) New PI 2012	**Helmholtz-Zentrum Dresden-Rossendorf**	Other - Helmholtz-Zentrum Dresden-Rossendorf	Dresden High Magnetic Field Laboratory		High-field study of the electrical transport of nanostructured Bi3Ni at very low temperatures P02053	5.92
David Tanner (S)	**University of Florida**	Department of Energy		DE-FG02-02ER45984	Searching for quantum oscillations in new candidates for topological insulators 2 P02102	11.21

TABLE 9

User Proposals (Continued)

Sergey Obukhov (S)	**The Ioffe Physical Technical Institute of the Russian Academy of Sciences**	Other - A.F.Ioffee Physical Technical Institute St.-Petersburg, Russia	Department of Solid State Electronics		Magnetotransport studies of p-InSb(Mn) crystals under hydrostatic pressure in high magnetic field. P02139	7
Kenneth Knappenberger (S)	**Florida State University**	Other - Department of Defense			Magnetophotoluminescence Studies of Tunable Nanocrystals P01742	21
Clifford Bowers (S)	**University of Florida**	NHMFL User Collaboration Grants Program	Condensed Matter Physics	FSU# 227000-520-022742/ NSF# DMR-0654118	A New Probe for NMR Signal Detection of Optically Addressable Samples P02073	35
Zhiqiang Li (S)	**National High Magnetic Field Laboratory**	National Science Foundation		654118	Magneto-optical Spectroscopy of Graphene and Few-layer Graphene P01901	52.67
		NHMFL User Collaboration Grants Program	DC field			
Philip Kim (S)	**Columbia University**	Department of Energy		DEFG02-05ER46215	Quantum Hall States in Graphene at High Magnetic Fields P01275	11.15
Chang-Beom Eom (S) New PI 2010	**University of Wisconsin**	National Science Foundation		27586	Studies of critical current, upper critical field and irreversibility field in doped BaFe_2As_2 thin films with strong vortex pinning P01286	5.7
Igor Kuskovsky (S)	**Queens College of CUNY**	National Science Foundation		40A94-0001	Temperature studies of Aharonov Bohm oscillations in type-II magneto-excitons P02083	18.48
		National Science Foundation		DMR-1006050		
Xiaodong Xu (S)	**University of Washington**	National Science Foundation		DMR-1150719	Cooling of Hot-Carriers with Landau Levels in Graphene P02040	35
Jun Sung Kim (S) New PI 2011	**POSTECH**	Other - National Research Foundation Korea			Magnetotransport properties of layered transition-metal pnictide single crystals P01719	12.14
Bertram Batlogg (S)	**ETH**	NHMFL User Collaboration Grants Program			High Field Vortex Dynamics in SmFeAs(O,F)	5.55
Luis Balicas (S)	**NHMFL**				P01735	

TABLE 9

User Proposals (Continued)

YounJung Jo (S)	**Kyungpook National University**	Other - Korea government		2012-0006377	High magnetic field effects on the magnetoelectric properties of multiferroics P01941	17.99
Sheena Murphy (S)	**University of Oklahoma**	National Science Foundation Other - Microsoft		1207537	Magneto-Transport of Quantum Confined Sb P01833	21
Hailin Wang (S)	**University of Oregon**	National Science Foundation		1104718	Optical Studies of Manybody-Correlated Tunneling in Mixed-Type Quantum Wells P02182	3.22
Denis Markiewicz (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Development of YBCO coil technology for 32 T superconducting magnet P01508	3.92
Jason Cooley (S)	**Alloy Design and Development Team, MST-6**	National Science Foundation NHMFL User Collaboration Grants Program		FIA-08-025-A015 FIA-08-025-A015	Magnetic Field dependence of the latent heat, melting and freezing points during solidification P02184	7.48
Kang Wang (S)	**UCLA**	Other - Department of Defense Other - DARPA	DARPA	N66001-12-1-4034 N66001-11-1-4105	Investigation of magnetic-field effect on topological insulator surface states P01920	25.84
Jeremy Levy (S)	**University of Pittsburgh**	National Science Foundation		NSF-DMR-0602846	Magnetotransport Experiments with Oxide Nanostructures P01304	7
Maitri Warusawithana (S)	**Dept of Physics, Florida State University / NHMFL**	Other - Start-up funds			Quantum Transport at Complex Oxide Interfaces P01945	2
Gil Lonzarich (S)	**Cambridge University**	Other - Royal society			Mapping the Charge Density Wave in underdoped YBCO P02189	4.3
Wei Pan (S)	**Sandia National Labatories**	Department of Energy		K0202020	Optical and Electronic Properties in Ferromagnetic Oxide Nanostructures	
Quanxi Jia (S)	**Mpa-cint: center for integrated nanotechnologies**	Department of Energy		N/a	P02072	14
James Brooks (S)	**Florida State University**	National Science Foundation		1005293	Proton NMR investigation of the coupling of the spin Peierls and CDW chains in Per2[Pt(mnt)2]: High magnetic field phases P01480	3.61

TABLE 9

User Proposals (Continued)

Tom Rosenbaum (S)	**Univ. of Chicago**	Department of Energy	DE-AC02-06CH11357	Investigating the magnetic structure of 2-dimensional quantum magnet SrCu(2-x) Mgx(BO3)2, as a function of magnetic field and pressure	9.21
New PI 2012		National Science Foundation	DMR-0907025	P02044	
Mingliang Tian (S)	**Hefei Institute for Physical Science**	Other - China Natural Science Foundation		Detection of surface Dirac states in ultrathin cylindrical topological insulator Bi2Te3 nanowires fabricated by electrodeposition	4.81
New PI 2012				P02162	
Ray Ashoori (S)	**Massachusetts Institute of Technology**	Department of Energy	DE-FG02-08ER46514	Magnetocapacitance of Dirac Materials P01844	5.21
Tim Murphy (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Maintenance and testing of hybrid, resistive magnets and their associated infrastructure P02230	0.95
Yuji Matsuda (S)	**Kyoto University**	Other - Kakenhi foundation - Japan	N/A	Thermal Hall effect and quantum oscillations of spin-liquids: detecting spinon related Fermi surface P02231	2.77
Michael Zudov (S)	**University of Minnesota**	Department of Energy	USDOE/DE-SC002567	Nonequilibrium magnetotransport in quantum Hall systems	14
		National Science Foundation	548014	P01496	
Taichi Terashima (S)	**National Institute for Materials Science**	Other - MEXT, Japan		de Haas-van Alphen measurements of iron-pnictide superconductors and other novel superconductors P01694	6.77
Pascoal Pagliuso (S)	**UNICAMP**	Other - FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo)		Quantum Oscillations in AFe2As2 (A = Eu, Ba): a comparative study of reconstructed Fermi surface geometries P02238	12.37
Bruce Brandt (S)	**Hefei High Magnetic Field Lab**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Magneto-Resistance of Cernox and RuOx Temperature Sensors in DC Magnetic Fields to 45 T P02145	4.36

DC FIELD

TABLE 9

User Proposals (Continued)

Rui-Rui Du (S)	**Rice University**	Department of Energy		DE-FG02-06ER46274	Topological States Based on InAs/GaSb Quantum Wells	19.88
		National Science Foundation		DMR1207562	P01831	
		Other - Welch Foundation		C-1682		
David Cardwell (S)	**University of Cambridge**	Other - Boeing Corporation	Boeing Reseach and Technology		To demonstrate the extremely high flux pinning force in single grain RE-Ba-Cu-O bulk superconductors containing nano-scale pinning centres.	7
New PI 2010		Other - University of Cambridge	Engineering	Funding Extension Competition (REF)	P01570	
Kenneth Burch (S)	**University of Toronto**	Other - Natural Sciences and Engineering Research Council of Canada			Optical Studies of the Lattice and Electronic Excitations of Topological Insulators	12.16
					P01911	
Chun Ning (Jeanie) Lau (S)	**University of California, Riverside**	National Science Foundation		7,489,101, 106,358	Magnetotransport and Magnetooptical Studies of Gated Graphene Devices	26.85
		National Science Foundation		748910	P01282	
Martin Greven (S)	**University of Minnesota**	National Science Foundation		NSF DMR-1006617	Temperature and field dependence of the ab-plane and c-axis resistivity in the electron-doped superconductor ND2-xCexCuO4+d	5.55
					P02242	
Phaedon Avouris (S)	**IBM T. J. Watson Research Center**	Other - IBM			Magneto-optical Spectroscopy of Plasmons in Graphene	39.69
New PI 2012					P02079	
Guillaume Gervais (S)	**McGill University**	Other - NSERC, FQRNT, CIFAR, MDEIE,			High-Magnetic Field Measurement of Hydrogenated Graphene	33.15
					P01934	
Tao Hong (S)	**Oak Ridge National Laboratory**	Department of Energy		11111	Quantum magnetism of low dimensional spin-1/2 antiferromagnets in high magnetic fields	21
New PI 2010					P01464	

TABLE 9

User Proposals (Continued)

Hironori Sakai (S)	**Japan Atomic Energy Agency**	Other - Japan Atomic Energy Agency (JAEA) Other - Grant-in-Aid for Scientific Research of MEXT, Japan Other - "REIMEI" International Research Project, funded by JAEA	Advanced Science Research Center (ASRC) on Innovative Areas "Heavy Electrons"		Investigation of the quantum criticality of URu2Si2 and its novel emergent phases around 40 T: a high field 29Si-NMR study (Following up the Project ID: P01917) P02173	5.54
Giti Khodaparast (S)	**Virginia Tech.**	National Science Foundation		NSF-Career Award DMR-0846834	Magnetic Circular Dichroism Spectroscopy of III-V Ferromagnetic Semiconductors P02245	3.89
Peide Ye (S)	**Purdue University**	Other - IBM Faculty Award Other - Semiconductor Research Corporation			Study of graphene physics coupled with metallic nanostructures P01711	28
William Brey (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Attenuation of Temporal Variations in Magnetic Field Strength using Digital Feedback Control P01543	9.26
Luis Balicas (S)	**NHMFL**	Department of Energy Department of Energy		DE-SC0002613 SC0002613	de Haas van Alphen in LiFeAs P02247	10.21
Yasu Takano (S)	**University of Florida**	NHMFL User Collaboration Grants Program Other - JSPS			High field studies of novel low-dimensional quantum magnets P01830	23.34
Guo-Qing Zheng (S)	**Okayama University**	Other - Japan Society for Promotion of Science Other - Ministry of Education, Sports, Science and Technology of Japan			High-field NMR study of the pseudogap state in high-Tc copper-oxides P01559	13.29
Carlo Ferdeghini (S)	**CNR-SPIN**	Other - CNR ITALY			Characterization in high fields of FeSe0.5Te0.5 thin films with enhanced pinning properties P01814	3.77
Kresimir Rupnik (S)	**Louisiana State University**	NHMFL User Collaboration Grants Program	Physics/ materials	227000-520-022742	Polarization Phase Selective Spectroscopy (PPS) Studies P01838	3.2

TABLE 9

User Proposals (Continued)

Nadya Mason (S) New PI 2012	**University of Illinois**	National Science Foundation	1124696	Measurements of Shubnikov-de Haas Oscillations in LaAlO3/SrTiO3 Heterointerfaces to Determine a Possible 2D to 3D Conductivity Crossover P02255	14
Haidong Zhou (S)	**University of Tennessee**	Other - start up for haidong zhou in UTK		The study of the magnetic monopole transition and phase diagram of the pyrochlore spin ice P01278	7
David Hilton (S)	**University of Alabama-Birmingham**	National Science Foundation	1056827	Development of Ultrafast Terahertz Spectroscopy Experiments for SCM3 P02175	0.8
Mikhail Yakunin (S)	**Institute of Metal Physics**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Quantum Hall Ferromagnetism in HgTe/HgCdTe quantum wells P01847	11.95
Yejun Feng (S) New PI 2012	**Argonne National Laboratory**	Department of Energy Department of Energy	NE-AC02-06CH11357 NEAC02-06CH11357	Investigating the crossover from linear to quadratic field dependence in magneto-resistance of GdSi P02036	22
Yan Xin (S)	**NHMFL**	Other - Chian Scholarship Council, National Natural Science Foundation of China (Grant No.51031002) Other - National Natural Science Foundation of China (Grant No.51031002)		Impacts of High Magnetic Field and Strain on the Resistance of Cu-Nb Composite Wires P02258	7.01
Sergei Zvyagin (S)	**Dresden High Magnetic Field Laboratory**	Other - DFG grant		Spin dynamics and high-field properties of low-dimensional and frustrated spin systems P01581	5.6
Hans-Joachim Grafe (S)	**IFW Dresden**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		The role of spin fluctuations in underdoped LaO1-xFxFeAs probed by high-field 75As NMR P02260	5.57

TABLE 9

User Proposals (Continued)

Qiang Li (S) New PI 2010	**Brookhaven National Lab**	Department of Energy		DOE-BES FWP-Superconducting Materials (KC0201030).	Jc and Hc2 under high magnetic field of Fe(Se,Te) and FeTe:O_x films and grain boundaries on single crystal and coated metal conductor substrates P01283	11.45
Hans-Henning Klauss (S)	**Technical University Dresden**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Unconventional superconductivity in hexagonal pnictides P02252	7
Huiqiu Yuan (S) New PI 2011	**Zhejiang University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Field induced quantum critical behavior in CeRhIn5 P01840	4.94
William Halperin (S)	**Northwestern University**	Department of Energy		DE-FG02-05ER46248	Vortex Structures in BSCCO P01277	5.87
Junichiro Kono (S)	**Rice University**	National Science Foundation		DMR-1006663	Intense superradiant generation of coherent femtosecond bursts from quantum wells in strong magnetic fields P01332	28
Wei Pan (S)	**Sandia National Labatories**	Department of Energy		No. DE-AC04-94AL85000	Search for novel fractional quantum Hall states in the second Landau level in ultra-high mobility two-dimensional electron systems P02005	14
Chenglin Zhang (S)	**The University of Tennessee**	National Science Foundation National Science Foundation Department of Energy		DMR-0454672 654118 DE-FG02-05ER46202	Magneto-optical Spectroscopy of Iron-based Superconductors P02263	26.16
Nicholas Long (S)	**Industrial Research Ltd**	Other - New Zealand Government: Ministry of Science and Innovation	CRI Core Capability Funding		Performance of high current capacity 2G HTS Roebel cable at fields up to 20T. P01898	1.3
Venkat Selvamanickam (S) New PI 2012	**University of Houston**	Department of Energy	Advanced Research Projects Agency-Energy	DE-AR0000141	Critical current characterization of Zr-doped REBa2Cu3Ox coated conductors at 4 K for high field magnet applications above 25 T P02261	4.06

TABLE 9

User Proposals (Continued)

Paul Goddard (S)	**Oxford University**	Other - EPSRC UK		EP/H00324X/1	Fermi surface topology of under-doped cuprate superconductors using angle-dependent magnetoresistance P02265	4.78
Kim Dunbar (S)	**Texas A&M University**	Department of Energy		DE-FG02-02ER45999	EPR Spectroscopy Studies to Investigate the Role of Spin-Orbit Coupling/Zero-field Splitting Effects on The Properties of Vandium(III) Compounds P02155	12.49
Louis Taillefer (S)	**University of Sherbrooke**	Other - NSERC, CFI, CIFAR (all in Canada)			Thermoelectric studies on high-temperature superconductors P01572	17.67
Ivan Bozovic (S)	**Brookhaven National Lab**	Department of Energy		MA-509-MACA	Determination of the upper critical field of cuprates by electrical transport under high magnetic field P02266	16.68
James Brooks (S)	**Florida State University**	National Science Foundation		1005293	Exploratory dielectric probes of charge, spin, and lattice degrees of freedom in complex materials P01246	12.6
Thomas Howarth (S) New PI 2011	**NAVSEA Division Newport**	U.S. Navy	NAVSEA Division Newport	N0001411-WX30050	Acoustic Characterization of Magnetorheological Fluids P01702	1.34
Lu Li (S) New PI 2011	**University of Michigan**	Other - University of Michigan Department of Energy		DE-SC0008110	Exploration of novel magnetism in interfacial strongly correlated materials P01822	35.09
Mansour Shayegan (S)	**Princeton University**	National Science Foundation Department of Energy Department of Energy		904117 DE-FG02-00-ER45841 DE-FG0200-ER45841	Magnetotransport measurements of 2D electrons in strained AlAs quantum wells P01265	40.02
Stan Tozer (S)	**NHMFL**	Department of Energy		DE-FG52-10NA29659	High pressure magnetostriction studies of actinides and related materials P02128	20.6
Ian Fisher (S)	**Stanford University**	Department of Energy		I don't know	High field study of pyrocholore materials P02077	4.7

TABLE 9

User Proposals (Continued)

Greg Boebinger (S)	**NHMFL**	Other - Florida State University Other - Canadian Institute of advanced study	NHMFL		High Field Heat Capacity of YBCO P01554	5.56
Marc-Henri JULIEN (S)	**CNRS Grenoble**	Other - LNCMI-CNRS			NMR study of the field-induced charge-stripe order in high temperature superconductors P01939	5.54
Zhigang Jiang (S)	**Georgia Institute of Technology**	Department of Energy		DE-FG02-07ER46451	Quantum Transport and Infrared Spectroscopy of Graphene P01311	7
Lloyd Engel (S)	**NHMFL**	Department of Energy		DE-FG02-05ER46212	Microwave spectroscopy of electron solids: fractional quantum Hall effect and controlled disorder P01841	18.17
James Gleeson (S)	**Kent State University**	National Science Foundation		964765	High field magneto-optics on complex fluids P01492	33.37
N. Phuan Ong (S)	**Princeton University**	National Science Foundation		819860	The thermal Hall conductivity of Dirac quasiparticles in YBa2Cu3O6+y in high fields P02268	9.6
Dmitry Smirnov (S)	**NHMFL**	Department of Energy		DE-FG02-07ER46451	Electron Phonon Coupling in graphite-related systems P01553	21
Dmitry Smirnov (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Magneto-Raman Spectroscopy of Graphite and Graphene P01738	54
James Analytis (S)	**University of California, Berkeley**	Other - University of California, Berkeley	Physics		High field magnetometry of strong spin-orbit coupled oxides P02271	4.86
Ryan Baumbach (P)	**MPA-CMMS**	Department of Energy		E415	High magnetic fields, applied pressure, and materials science: A toolbox to understand Quantum Criticality P02269	5.39
David Goldhaber-Gordon (S)	**Stanford University**	Other - Office of Naval Research Other - Center for Probing the Nanoscale Other - FENA		1134229	Spin and Valley Effects and Fractional Quantum Hall Effect in Graphene p-n Junctions P02275	12.25

DC FIELD

TABLE 9

User Proposals (Continued)

Cory Dean (S)	**The City College of New York**	Other - New Faculty Start Up Funds Other - Start up funds for new faculty hire Other - City College of New York Other - The City College of New York	 Physics Physics	 New Faculty Hire Start Up Funds New Hire Startup Funds	Resistively detected NMR study of spin polarization in 13C graphene P02272	27.01
Yuko Hosokoshi (S)	**Osaka Prefecture University**	Other - MEXT of Japan NHMFL User Collaboration Grants Program			Thermodynamic studies of geometrically frustrated spin systems made of organic radicals P01737	15
Yong Chen (S)	**Purdue University**	National Science Foundation		847638	Magnetotransport in Graphene Nanostructures: Disorder and Interaction physics for Dirac fermions P01320	7
Andrey Chabanov (S)	**University of Texas at San Antonio**	Other - UTSA	Physics		Induced Microwave Transmission and Giant Faraday Effect in Co Thin Films Applied to Wide-Aperture, Wide-Angle Isolator Design P02187	2.59
Eun Sang Choi (S)	**NHMFL**	NHMFL User Collaboration Grants Program			Study of magnetoelectric and magnetic properties of new multiferroic materials P01731	9
Chris Palmstrom (S) New PI 2012	**UC Santa Barbara**	Other - IARPA, Microsoft station Q National Science Foundation National Science Foundation		02-12032 1121053	Magneto transport measurements in narrow band gap semicondcutors P02254	21
Dmitry Semenov (T)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			SCM3 maintanence P02281	14
Martin Greven (S) New PI 2011	**University of Minnesota**	Other - Florida State University Department of Energy		227000 110 ER46823	High Field Heat Capacity of the cuprate Hg 1201 P01725	7.33
Eric Palm (S)	**NHMFL-FSU**	NHMFL User Collaboration Grants Program			General proposal for the development and testing of instrumentation P02194	14

TABLE 9

User Proposals (Continued)

Joshua Telser (S)	**Roosevelt University**	National Institutes of Health	GM38767	HFEPR on Macrocyclic Complexes of Transition Metals in High Oxidation States	5.59
		Other - Deutsche Forschungsgem-einschaft (DFG)	Sonderforschu-ngsbereich (SFB) 583	P01522	
		Department of Energy	DE-FG02-07ER15893		
Jens Hanisch (S) New PI 2011	**Leibniz Institute for Solid State and Materials Research IFD Dresden**	Other - IFW Dresden		Study the pinning and transport properties of Ba-122 superconductor thin films P01938	5.74
Madalina Furis (S)	**University of Vermont**	National Science Foundation	1056589	Excitons and Spin Coupling in Crystalline Organic Semiconductors: Bridging Quantum Chemistry to Solid State Physics P01759	4.42
Yung Woo Park (S)	**Seoul National University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Investigation on Zero Magneto Conductance Phenomena in Low Dimensional Systems: Polymer Nanofibers and Charge Density Wave Materials P02331	5.39
Tom Painter (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Installation and Testing of Shims Keck III Prototype using Combined Active and Ferroshims for Correciton at 25 T. P02337	3.27
Danko van der Laan (S)	**National Institute of Standards and Technology**	Department of Energy	DE-FG02-12ER41801	Critical current measurement at 4.2 K up to 20 T of REBa2Cu3O7-delta coated conductor cables designed for high-field magnet applications	0.94
New PI 2011		Department of Energy	DE-SC0009545	P01693	
		Department of Energy	DE-SC0007660		
Haidong Zhou (S)	**University of Tennessee**	Other - start up from haidong zhou in UTK Other - start up for haidong zhou from university of tennessee		Probing the ground sates of new quantum magnets by using AC susceptibility P02341	14
Philip Kim (S)	**Columbia University**	Department of Energy	DEFG02-05ER46215	Tunable Quantum Hall in Graphene Heterostructures P02330	11.41

TABLE 9

User Proposals (Continued)

Hannes Kuehne (P)	**Helmholtz-Zentrum Dresden-Rossendorf**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Interplay of spin fluctuations and superconductivity in Co doped Ba122 superconductors probed by high-field NMR P02256	4.85
Nicholas Curro (S)	**University of California**	National Science Foundation		1005393	NMR Investigation of Spin Fluctuations near Hc2 in Ba(Fe1-xCox)2As2 P02344	6.12
James Analytis (S)	**University of California, Berkeley**	Other - UC Berkeley	Physics		High field magnetoresistance of Sr3Ru2O7 P02346	5.72
Zhiqiang Li (S)	**National High Magnetic Field Laboratory**	National Science Foundation		654118	Magneto-transport Measurements of Topological Insulators P02349	7
Susanne Stemmer (S)	**UC Santa Barbara**	National Science Foundation		DMR-1121053	High-Field Magnetotransport in Oxide Heterostructures P02350	5.71
Mitsuhiko Maesato (S)	**Kyoto University**	Other - KAKENHI			Quantum effect on the p–d hybrid molecular conductor P02352	5.6
Luis Balicas (S)	**NHMFL**	U.S. Army	ARO	W911NF-11-1-0362	Hall mobility and Shubnikov de Haas Oscillations in WSe2 based Field-effect transistors P02353	7
Daniel Kominsky (S) New PI 2013	**Prime Photonics**	U.S. Navy	ONR	N00014-12-C-0569	High Field Strength Testing of Optical Magnetic Field Sensors P02355	1.38
Yoram Dagan (S)	**Tel Aviv University**	Other - US- Israel bi national science foundation			Oxide-interface-based quantum wire P02354	7
Eun Sang Choi (S)	**NHMFL**	NHMFL User Collaboration Grants Program			Low temperature piezo-VSM instrumentation P02276	7
Yong Chen (S)	**Purdue University**	Other - DARPA, MESO program Other - DARPA			Quantum Oscillations in Topological Insulators and Related Materials P02358	10.67
Luis Balicas (S)	**NHMFL**	Department of Energy		DE-SC0002613	New multi-band transition-metal chalcogenide superconductors displaying extremely high upper critical fields P02251	7

TABLE 9

User Proposals (Continued)

Paul M Chaikin (S)	**Princeton University**	National Science Foundation		DMR-0820341	Studying the mysterious metal in coexistence regime of the organic superconductor (TMTSF)2PF6 P02048	7
Kwang Yong Choi (S)	**Chung Ang University**	Other - Korea NSF			Exotic Ground State in 2D Frustrated Quantum Spins P02360	7
Toshihito Osada (S) New PI 2013	**Institute for Solid State Physics, University of Tokyo**	Other - KAKENHI (Grant-in-Aid from JSPS)			Helical Edge State in Organic Dirac Fermion System: Quantum Hall Ferromagnet vs. Quantum Hall Insulator P02361	7.46
Hans Rudolf Ott (S) New PI 2013	**ETH Zuerich**	Other - Swiss National Science Foundation (SNF)			Field-controlled soliton-soliton interactions in a frustrated low-dimensional quantum magnet P02362	5.34
Dmitry Shulyatev (S)	**National University of Science and Technology "MISIS"**	Other - Russian Foundation for Basic Research			Weak localisation in decogonal qusicrystal Al-Cu-Co. P02363	21
Thomas Herrmannsdoerfer (S)	**Helmholtz-Zentrum Dresden-Rossendorf**	Other - Helmholtz-Zentrum Dresden-Rossendorf			Investigations of a possible field-induced ordering in the pyrochlore Pr2Sn2O7 P02365	5.45
Eun Sang Choi (S)	**NHMFL**	NHMFL User Collaboration Grants Program			Study of Magnetic Phase transitions and Multiferroicity of Triangular Lattice Antiferromagnets P02366	15
Nathanael Fortune (S)	**Smith College**	Other - Smith College NHMFL Visiting Scientist Program		173	Calorimetric studies of magnetic-field-induced phase transitions in strongly correlated systems P02364	12.35
Dmytro Abraimov (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)	ASC		Critical current densities of MOCVD ReBCO coated conductor in wide range of temperatures, magnetic fields and field orientations P01850	3.78
David Mandrus (S)	**Oak Ridge National Laboratory**	Other - Florida State University	NHMFL		High Field Measurements of the Heat Capacity of LSCO P02369	6.78
David Hilton (S)	**University of Alabama-Birmingham**	National Science Foundation National Science Foundation		1229217 1056827	Development of a Broadband Ultrafast THz Spectrometer for High Magnetic Field Research P02198	1.74

DC FIELD

TABLE 9

User Proposals (Continued)

Martin Greven (S)	**University of Minnesota**	Department of Energy		SC0006858	High-magnetic-field torque measurements of the model cuprate HgBa2CuO4+d P02371	4.83
Kevin Storr (S)	**Prairie View A&M University**	U.S. Army	ARO		Torque Measurements of Nd(1-x)CexCoIn5 P02348	7
Lloyd Engel (S)	**NHMFL**	Department of Energy		DE-FG02-05ER46212	Broadband microwave studies of high quality graphene in high magnetic field P02375	8.25
Jan Jaroszynski (S)	**NHMFL**	NHMFL User Collaboration Grants Program			Comparative study of usual and contact-free methods of the angular critical current measurement in YBCO coated conductors by means of Vector Vibrating Sample Magnetometer under development P02376	5.89
Yunwei Charles Cao (S)	**University of Florida**	U.S. Navy	Code 30	N000141310325	Optical Spectroscopy of Colloidal Superparticles in High Magnetic Fields P02378	11.88
Paul Cadden-Zimansky (S) New PI 2013	**Bard College**	Other - Bard College	Internal Support		The Quantum Hall Effect in Hybrid Graphene P02377	8.76
R. Ramesh (S)	**University of California, Berkeley**	Department of Energy		DE-AC02-76SF00515	High field transport studies of pyrochlore iridates P02264	12.27
Janice Musfeldt (S)	**University of Tennessee, Knoxville**	National Science Foundation		DMR-1233118	High field spectroscopy of materials P02415	12.50
Zhigang Jiang (S)	**Georgia Institute of Technology**	Department of Energy National Science Foundation		DE-FG02-07ER46451 DMR-0820382	Quantum Transport and Infrared Spectroscopy of Graphene P02425	14
Liang Yin (P) New PI 2012	**University of Florida**	NHMFL User Collaboration Grants Program Other - the National Basic Research Program of China			Magnetic Susceptibility of the Pyrochlore Magnet Tb2Ti2O7 at High Fields P02114	7
Theo Siegrist (S)	**NHMFL**	National Science Foundation		1257649	Test of an X-ray diffractometer for the Florida Split Coil 25T Magnet	2.27

TABLE 9

User Proposals (Continued)

Ke Han (S)	**NHMFL**	Other - National Science Fundation in China		51071099	Improvement of Permanent Magnetic Material Properties by High Magnetic Field Annealing P02241	3.25
Irina Drichko (S)	**A.F.Ioffe PTI**	Other - Russian Foundation for Basic Research			High Frequency Magnetotransport in High-Mobility n-AlGaAs/GaAs/AlGaAs Heterostructures in the Fractional Quantum Hall Regime. Acoustic Studies. P02442	13
David Goldhaber-Gordon (S)	**Stanford University**	U.S. Army	Army Research Office	W911- NF-09-1-0398	High Field Magneto-Transport in Two-Dimensional Electron Liquids in SrTiO3 P01699	4.4
Jun Lu (S)	**NHMFL**	National Science Foundation		DMR-0923070	Hysteresis loss of YBCO pancake coils by calorimetry P02444	3.28
Satoru Nakatsuji (S)	**University of Tokyo**	Other - University of Tokyo	Institute for Solid State Physics		Exotic metallic states in rare-earth based compounds P02445	6.07
Keizo Murata (S)	**Osaka City University**	Other - Osaka City University funding	Dep of Science		Clarification of Field Induced CDW in HMTSF-TCNQ P01569	5.91
N. Phuan Ong (S)	**Princeton University**	U.S. Army	Army Research Office (ARO W911NF-11- 1-0379)	DMR 0819860	High-field experiments on the Topological Crystalline Insulator Pb1-xSnxSe/Pb1-xSnxTe P02446	8.24
Ian Fisher (S)	**Stanford University**	U.S. Army	Air Force - Multidiscip-linary University Research Initiative (MURI)	TXARN	High-field study of Superconducting thallium doped lead telluride (Pb1-xTlxTe) P02297	5.97
Xiaodong Xu (S)	**University of Washington**	Department of Energy		DE-SC0008145	Magneto-optical Spectroscopy of 2D transition metal dichalcogenides P02450	14
Nathanael Fortune (S)	**Smith College**	NHMFL Visiting Scientist Program		173	Field-Rotatable Low-Temperature Calorimeters: 0 - 45 T, 0.1 - 10 K P02447	7
Chun Ning (Jeanie) Lau (S)	**University of California, Riverside**	Department of Energy National Science Foundation			Magneto-transport and Symmetry-broken Quantum Hall States in Few Layer Graphene P02457	19.2

TABLE 9

User Proposals (Continued)

Feng Wang (S)	**University of California, Berkeley**	Department of Energy	DE-AC02-05CH11231	Magneto-optical Spectroscopy of Graphene on Boron Nitride substrate	7.53
		Department of Energy	DE-AC03-76SF0098	P02456	
Tian-Heng Han (P) New PI 2013	**University of Chicago**	Department of Energy	DE-AC02-06CH11357	Quantum Spin Liquids in High Fields P02458	7
Kwang Yong Choi (S)	**Chung Ang University**	Other - Korea NRF		Quantum Criticality in S=1/2 Frustrated Spin Chains P02188	7
Cagliyan Kurdak (S)	**University of Michigan**	National Science Foundation	1006500	Study of Two-Dimensional Electron Systems on the Surface of a Topological Kondo Insulator SmB6 P02461	4.55
Stuart Brown (S)	**UCLA**	National Science Foundation	1105531	NMR study of the field-induced phases of the triangular lattice antiferromagnet Ba3CoSb2O9 P02469	6.05
Sara Haravifard (S)	**Argonne National Lab / University of Chicago**	Department of Energy	DE-AC02-06CH11357	High Magnetic Field Studies of Pure and Doped Model 2D Quantum Magnet Under Pressure	4.34
		National Science Foundation	DMR-0907025	P02465	
Stephen McGill (S)	**NHMFL**	National Science Foundation	1229217	Split-Helix Magnet Ultrafast Laser Installation P02471	0.14
Tim Murphy (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Maintenance and Testing of SCM 1 and SCM 2 P01892	3
Total Proposals:				**161**	**1771.69**

PULSED FIELD FACILITY

TABLE 1

User Demographic

Pulsed Field Facility	Users	Male	Female	Prefer Not to Respond to Gender	Minority[1]	Non-Minority[1]	Prefer Not to Respond to Race	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	55	50	5	0	3	52	2	31	0	10	14
Senior Personnel, non-U.S.	20	18	2	0	2	18	1	2	0	8	10
Postdocs, U.S.	24	20	4	0	1	23	2	19	0	1	4
Postdocs, non-U.S.	2	2	0	0	0	2	0	1	0	0	1
Students, U.S.	15	13	2	0	0	15	1	12	0	1	2
Students, non-U.S.	10	9	0	1	0	10	1	5	0	2	3
Technician, U.S.	2	1	1	0	1	1	1	2	0	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0	0	0	0
Total:	**128**	**113**	**14**	**1**	**7**	**121**	**8**	**72**	**0**	**22**	**34**

1. NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin
2. "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
3. "Users Sending Sample" refers to users who send the sample to the facility and the experiment is conducted by in-house user support personnel. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
4. "Off-Site Collaborators" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

PULSED FIELD

TABLE 2

User Affiliations

	Users	NHMFL-Affiliated Users[1]	Local Users[1]	University Users[2,4]	Industry Users[4]	National Lab Users[3,4]
Senior Personnel, U.S.	55	18	10	24	0	31
Senior Personnel, non-U.S.	20	0	0	16	1	3
Postdocs, U.S.	24	7	8	9	0	15
Postdocs, non-U.S.	2	0	0	1	0	1
Students, U.S.	15	3	2	14	0	1
Students, non-U.S.	10	0	0	10	0	0
Technician, U.S.	2	1	0	0	0	2
Technician, non-U.S.	0	0	0	0	0	0
Total:	**128**	**29**	**20**	**74**	**1**	**53**

1. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [i.e. on our Web site/directory], even if they travel to another site.
   Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e. researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
   The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators".
2. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
3. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
4. The total of university, industry, and national lab users will equal the total number of users.

TABLE 3

Users by Discipline

Pulsed Field Facility	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Senior Personnel, U.S.	55	44	5	1	2	3
Senior Personnel, non-U.S.	20	19	1	0	0	0
Postdocs, U.S.	24	23	1	0	0	0
Postdocs, non-U.S.	2	2	0	0	0	0
Students, U.S.	15	15	0	0	0	0
Students, non-U.S.	10	9	0	0	0	1
Technician, U.S.	2	1	0	1	0	0
Technician, non-U.S.	0	0	0	0	0	0
Total:	**128**	**113**	**7**	**2**	**2**	**4**

TABLE 4

User Facility Operations

	Short/ Mid Pulse	Long Pulse	100T	Single Turn	Total Days[1] Allocated/ User Affil.	Percentage Allocated/ User Affil.
NHMFL-Affiliated	104	12	11	0	127	18
Local	40	5	5	0	50	7
U.S. University	171	24	6	0	201	29
U.S. Govt. Lab.	2	5	9	0	16	3
U.S. Industry	0	0	0	0	0	0
Non-U.S.	191	0	12	0	203	29
Test, Calibration, Set-up, Maintenance, Inst. Dev.	35	15	14	33	97	14
Total:	**543**	**61**	**57**	**33**	**694**	**100**

1. User Units are defined as magnet days. For the Pulsed Field Facility, one magnet day is defined as 12 hours in any pulsed magnet system.

TABLE 5

Operations by Discipline

	Total Days Allocated / User Affil.	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
NHMFL-Affiliated	127	124	0	0	3	0
Local	50	40	10	0	0	0
U.S. University	201	181	12	0	8	0
U.S. Govt. Lab.	16	16	0	0	0	0
U.S. Industry	0	0	0	0	0	0
Non-U.S.	203	186	0	0	17	0
Test, Calibration, Set-up, Maintenance, Inst. Dev.	97	24	0	0	73	0
Total:	**694**	**571**	**22**	**0**	**101**	**0**

TABLE 6

User Program Experiment Pressure

Experiment Requests Received	Experiment Requests Deferred from Prev. Year	Experiment Requests Granted	Experiment Requests Declined/Deferred	Experiment Requests Reviewed	Oversubscription
158	29	86 (45.99%)	101 (54.01%)	187	217.44%

TABLE 7

New User PIs

Name	Organization	Proposal	Year of Magnet Time
Ni, Ni	Los Alamos National Lab	P02290	2013
Brechin, Euan	UniVersity of Edinburgh	P02296	2013
Smythe, Nathan	Chemistry Division	P02380	2013
Gordon, John	Los Alamos National Laboratory	P02407	2013
Janoschek, Marc	LANL	P02420	2013
Hill, John	Brookhaven National Laboratory	P02486	2013
Ramshaw, Brad	National High Magnetic Field Lab - Los Alamos	P02488	2013
Schaller, Richard	Argonne National Laboratory	P02502	2013
Rice, William	NHMFL	P07162	2013
Yang, Luyi	NHMFL-LANL	P07164	2013
Total:			**10**

TABLE 8

Research Proposals[1] Profile, with magnet time

	Total	Minority[2]	Female[3]	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum	Biology, Biochem., Biophys.
Number of Proposals	54	2	11	42	4	0	8	0

1. A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
2. The number of proposals satisfying one of the following two conditions: (a) the PI is a minority OR (b) the PI is a non-minority working at a minority-serving college or university AND the proposal includes minority participants.
3. The number of proposals satisfying one of the following two conditions: (a) the PI is a female OR (b) the PI is a male working at a college or university for women AND the proposal includes female participants.

TABLE 9

User Proposals

PI	Organization	Funding Source(s)		Proposal Title & ID#	Number of Days Awarded/ Scheduled
Sang Wook Cheong (S)	**Rutgers University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant) NHMFL User Collaboration Grants Program Department of Energy	Vivien Zapf, PI 2011 User collaboration Grant LDRD 20160601ER	Multiferroic behavior and slow dynamics in Ca3CoMnO6 and Sr3NiIrO6 P02092	36
Neil Harrison (S)	**NHMFL-LANL**	Department of Energy	F100	Suppression of the spin moment in underdoped YBa2Cu3O6+x P01611	5
Michael McHenry (S) New PI 2012	**Carnegie Mellon University**	National Science Foundation	1121672	Spin-Flip Transitions in the Titanomagnetites P02222	5
Martin Greven (S)	**University of Minnesota**	Department of Energy	SC0006858	Temperature and field dependence of the resistivity in the model cuprate superconductor HgBa2CuO4+d P02191	5
Vivien Zapf (S)	**NHMFL-LANL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Magneto-electric coupling in metal-organic frameworks P02232	5
Martin Greven (S) New PI 2012	**University of Minnesota**	Department of Energy	SC0006858	High-magnetic-field torque measurements of the model cuprate HgBa2CuO4+d P02193	12
Stan Tozer (S)	**NHMFL**	Department of Energy	DE-FG52-10NA29659	High pressure magnetostriction studies of actinides and related materials P02128	51
Suchitra Sebastian (S)	**Cambridge University**	Other - Royal society		Search for exotic phases in the parameter space of a Kitaev Heisenberg model realized in iridates using magnetic field P01856	11
Bertram Batlogg (S)	**ETH**	NHMFL User Collaboration Grants Program		Doping dependence of Fermi Surface Reconstruction in the pnictide superconductor SmFeAs(O,F) P01360	5

PULSED FIELD

TABLE 9

User Proposals (Continued)

Jamie Manson (S)	**Eastern Washington University**	National Science Foundation		1005825	Magnetization studies of Ni(II)-based molecular and polymeric magnets P01531	42
Ram Seshadri (S) New PI 2012	**UCSB**	National Science Foundation		909180	Understanding the magnetism of Co10Ge3O16 P02195	5
Ni Ni (P) New PI 2013	**Los Alamos National Lab**	NHMFL User Collaboration Grants Program			Anisotropic Hc2 measurement on the new (Ca0.855La0.145) 10(Pt3As8)(Fe2As2)5 high temperature superconductor P02290	5
Raphael Raptis (S)	**Florida International University**	National Science Foundation		822600	Mapping of Spin States in Mixed-Valent [Fe8]n– Complexes by 95 T Pulsed Field Magnetization Measurements P01965	3
Oscar Ayala Valenzuela (P)	**Los Alamos National High Magntic Field Laboratory**	Department of Energy		20130285ER	Hc2 Measurement and Vortex Physics Dynamics in Ca10(Pt4As8)((Fe1-xPtx)2As2)5 P02305	5
Kirstin Alberi (T) New PI 2012	**National Renewable Energy Lab**	Department of Energy		?	Magneto-Photoluminescence Measurements of AlxGa1-xAs Superlattices P02283	5
Euan Brechin (S) New PI 2013	**UniVersity of Edinburgh**	Other - EPSRC	Condensed Matter Physics		Single-Molecule Magnets in Pulsed Fields P02296	3
Jonathon Kemper (G)	**Florida State University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant) No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)	Director's office Director's Office	227000 110	Thermometry calibrations for specific heat experiments P01654	12
Vivien Zapf (S)	**NHMFL-LANL**	Department of Energy No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		201300601ER	Quenched 2nd order phase transitions P01761	23

TABLE 9

User Proposals (Continued)

Fedor Balakirev (S)	**NHMFL - LANL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Vortex dissipation in SmFeAs(O,F) in ultra-high magnetic fields: Emerging isotropy in the layered '1111' Fe pnictides ? P01623	5
Paul Goddard (S)	**Oxford University**	Other - EPSRC (UK) Other - EPSRC UK			Determining the Fermi surface of colossal magnetoresistive materials P02111	22
Chun Ning (Jeanie) Lau (S) New PI 2012	**University of California, Riverside**	Other - UC Fees proposal			High field studies of topological insulators P02113	19
Filip Ronning (S)	**Los Alamos National Laboratory**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Pulsed Field Measurements of CaFe4As3 P02299	3
Ian Fisher (S)	**Stanford University**	U.S. Army	Air Force - Multidisciplinary University Research Initiative (MURI)	TXARN	High-field study of Superconducting thallium doped lead telluride (Pb1-xTlxTe) P02297	31
Huiqiu Yuan (S)	**Zhejiang University**	Other - National Science Foundation of China			Measurements of magnetization and dHvA effect in heavy fermion compound Yb2Pt2Pb P02335	12
Vivien Zapf (S)	**NHMFL-LANL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Understanding and Controlling Complex States Emerging from Frustration P01345	5
Neil Harrison (S)	**NHMFL-LANL**	NHMFL Visiting Scientist Program No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Pulsed field magnetization measurements on rare earth kagome systems P02287	8
Suchitra Sebastian (S)	**Cambridge University**	Other - Royal Society			Magnetisation and angular torque magnetometry on a Kitaev Heisenberg model P02382	12

TABLE 9

User Proposals (Continued)

Pei-Chun Ho (S)	**California State University, Fresno**	National Science Foundation	1104544	Investigation of Fermi surface properties of NdOs4Sb12, CeOs4Sb12, and SmOs4Sb12 along the high symmetry axes [001], [011], and [111] P01388	9
Paul Goddard (S)	**Oxford University**	Other - EPSRC (UK)	EP/ H00324X/1	Fermi surface topology of under-doped cuprate superconductors using angle-dependent magnetoresistance P02265	3
Raphael Raptis (S)	**Florida International University**	National Science Foundation	822600	Mapping of S > 1/2 Spin States of Mixed-Valent [Fe8]n– by Pulsed Field Magnetization Measurements P01481	12
Yayu Wang (S)	**Tsinghua University**	NHMFL User Collaboration Grants Program Other - Tsinghua University		Transport measurement on (Bi1-xSbx)2Te3 thin films in 100T pulsed magnet P02327	31
Philip Moll (G)	**ETH Zurich**	NHMFL User Collaboration Grants Program		technique development proposal P01456	36
Eric Bauer (S)	**Los Alamos National Laboratory**	Department of Energy	Science at 100T	Pulsed Fied Magnetostriction of URu2Si2 P02332	5
Marc Janoschek (S) New PI 2013	**LANL**	Department of Energy	Seaborg Fellowship	Investigation of the high-field magnetic phase diagram of URu2-xFexSi2 P02420	12
Yoshihiro Iwasa (S)	**The University of Tokyo**	Other - Japan Science and Technology Agency		Upper critical field measurements in fullerene superconductors using 65 T and 100 T magnets P02066	12
Eun Deok Mun (P)	**Los Alamos National Laboratory**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Test and calibrate new probe for 65 T Pulsed-Field P02474	3
Matthias Frontzek (P)	**Oak Ridge National Laboratory**	Department of Energy	N/A	Critical magnetic field(s) of the spin driven multiferroic CuCrO2 P01899	3

TABLE 9

User Proposals (Continued)

John Hill (S) New PI 2013	**Brookhaven National Laboratory**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		High-magnetic field properties of Sr3CuIrO6 P02486	8
Brad Ramshaw (P) New PI 2013	**National High Magnetic Field Lab - Los Alamos**	Department of Energy	DOE-BES	Crossing the Dome: YBa2Cu3O6+delta Fermi Surface Measurements at 100 Tesla P02488	27
Huiqiu Yuan (S)	**Zhejiang University**	Other - National Science Foundation of China		Angle dependence of the dHvA effect in CeRhIn5 P02334	15
Lu Li (S) New PI 2012	**University of Michigan**	Department of Energy	DE-SC0008110	Magnetic property of high temperature superconductors in ultrahigh magnetic fields P02065	10
Franziska Weickert (P)	**Los Alamos National Laboratory**	Department of Energy	LANL Director funded postdoc	Double Dome Structure in the H-T Phase Diagram of AgVOAsO4 P02381	5
Kee Hoon Kim (S)	**Seoul National University**	Other - Institute for Complex Adaptive Matter		Quantum ocsillation of transparent perovskite oxides (Ba,La)SnO3 under High Magnetic Fields P02395	12
Francisco Rivadulla (S)	**Universidade de Santiago de Compostela**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		High Field low temperature specific heat in spin-liquid ACr2O4 (A=Zn2+, Mg2+) P02075	5
Suchitra Sebastian (S)	**Cambridge University**	Other - European Research Council		Quantum Oscillations in strongly correlated topological insulators P02495	24
Neil Harrison (S)	**NHMFL-LANL**	Other - Royal Society		Doping-dependent Quantum Oscillations in High Temperature Superconductors P01955	7
Gil Lonzarich (S)	**Cambridge University**	Other - Royal Society		Angular-dependent quantum oscillations in YBCO in search of the origin of Fermi surface reconstruction P01975	19

PULSED FIELD

TABLE 9

User Proposals (Continued)

James Analytis (S)	**University of California, Berkeley**	Other - University of California Berkeley	Physics		High field magneto-transport in a magnetically tuned quantum critical point : Sr3Ru2O7 P02228	12
Filip Ronning (S)	**Los Alamos National Laboratory**	NHMFL User Collaboration Grants Program			Pulsed field transport measurements of nano-machined Ce-based compounds P02510	5
Nathan Smythe (S) New PI 2013	**Chemistry Division**	Department of Energy		20140177ER	Magnetic Study of a Dinitrogen Bridged Fe Dimer P02380	10
Zengwei Zhu (P)	**Los Alamos National lab**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Calibrating pick-up Coilds P02514	4
Doan Nguyen (S)	**NHMFL - PFF**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Testing and Training of pulsed magnets P07288	31
Jonathan Betts (S)	**LANL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Maintenance of 1.4GW Generator system P02322	5
Dwight Rickel (S)	**NHMFL @ LANL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Maintenance, diagnostics and testing of single turn magnet system P07290	14
Total Proposals:					**54**	**694**

HIGH B/T

TABLE 1

User Demographic

High B/T Facility	Users	Male	Female	Prefer Not to Respond to Gender	Minority[1]	Non-Minority[1]	Prefer Not to Respond to Race[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	14	13	0	1	0	14	2	7	0	7	0
Senior Personnel, non-U.S.	2	1	0	1	0	2	1	0	0	1	1
Postdocs, U.S.	1	1	0	0	0	1	0	1	0	0	0
Postdocs, non-U.S.	0	0	0	0	0	0	0	0	0	0	0
Students, U.S.	0	0	0	0	0	0	0	0	0	0	0
Students, non-U.S.	1	0	1	0	0	1	0	0	0	0	1
Technician, U.S.	0	0	0	0	0	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0	0	0	0
Total:	**18**	**15**	**1**	**2**	**0**	**18**	**3**	**8**	**0**	**8**	**2**

1. NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin
2. "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
3. "Users Sending Sample" refers to users who send the sample to the facility and the experiment is conducted by in-house user support personnel. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
4. "Off-Site Collaborators" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

TABLE 2

User Affiliations

High B/T Facility	Users	NHMFL-Affiliated Users[1]	Local Users[1]	University Users[2,4]	Industry Users[4]	National Lab Users[3,4]
Senior Personnel, U.S.	14	5	0	11	0	3
Senior Personnel, non-U.S.	2	0	0	1	0	1
Postdocs, U.S.	1	1	0	1	0	0
Postdocs, non-U.S.	0	0	0	0	0	0
Students, U.S.	0	0	0	0	0	0
Students, non-U.S.	1	0	0	1	0	0
Technician, U.S.	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	
Total:	**18**	**6**	**0**	**14**	**0**	**4**

1. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [i.e. on our Web site/directory], even if they travel to another site.
   Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e. researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
   The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators".
2. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
3. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
4. The total of university, industry, and national lab users will equal the total number of users.

TABLE 3

Users by Discipline

High B/T Facility	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Senior Personnel, U.S.	14	11	0	3	0	0
Senior Personnel, non-U.S.	2	2	0	0	0	0
Postdocs, U.S.	1	1	0	0	0	0
Postdocs, non-U.S.	0	0	0	0	0	0
Students, U.S.	0	0	0	0	0	0
Students, non-U.S.	1	1	0	0	0	0
Technician, U.S.	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0
Total:	**18**	**15**	**0**	**3**	**0**	**0**

TABLE 4

User Facility Operations

	16T Bay 3	8T Bay 2	10T Williamson Hall	4T Williamson Hall	Total Days[1] Allocated / User Affil.	Percentage Allocated / User Affil.
NHMFL-Affiliated	0	0	0	0	0	0%
Local	0	0	0	0	0	0%
U.S. University	154	0	247	0	401	48.08%
U.S. Govt. Lab.	0	308	0	0	308	36.93%
U.S. Industry	0	0	0	0	0%	
Non-U.S.	125	0	0	0	125	14.99%
Test, Calibration, Set-up, Maintenance, Inst. Dev.	0	0	0	0	0	0%
Total:	**279**	**308**	**247**	**0**	**834**	**100%**

1. User Units are defined as magnet days. For the High B/T Facility, one magnet day is defined 24 hours in the superconducting magnets.

TABLE 5

Operations by Discipline

	Total Days Allocated / User Affil.	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
NHMFL-Affiliated	0	0	0	0	0	0
Local	0	0	0	0	0	0
U.S. University	401	401	0	0	0	0
U.S. Govt. Lab.	308	308	0	0	0	0
U.S. Industry	0	0	0	0	0	0
Non-U.S.	125	125	0	0	0	0
Test, Calibration, Set-up, Maintenance, Inst. Dev.	0	0	0	0	0	0
Total:	**834**	**834**	**0**	**0**	**0**	**0**

TABLE 6

User Program Experiment Pressure

Experiment Requests Received	Experiment Requests Deferred from Prev. Year	Experiment Requests Granted	Experiment Requests Declined/Deferred	Experiment Requests Reviewed	Oversubscription
5	7	9 (75.00%)	3 (25.00%)	12	133.33%

TABLE 7

New User PIs

Name	Organization	Proposal	Year of Magnet Time
Gervais, Guillaume	McGill University	P02503	2014
Total:			**1**

TABLE 8

Research Proposals[1] Profile, with magnet time

	Total	Minority2	Female3	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Number of Proposals	6	0	0	6	0	0	0	0

1. A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
2. The number of proposals satisfying one of the following two conditions: (a) the PI is a minority OR (b) the PI is a non-minority working at a minority-serving college or university AND the proposal includes minority participants.
3. The number of proposals satisfying one of the following two conditions: (a) the PI is a female OR (b) the PI is a male working at a college or university for women AND the proposal includes female participants.

TABLE 9

User Proposals

PI	Organization	Funding Source(s)		Proposal Title & ID#	Number of Days Awarded/Scheduled
Jian Huang (S)	**Wayne State University**	Other - Wayne State University National Science Foundation	1105183	Preliminary Exploration of Wigner Crystallization Effects in HIGFET Devices P02007	247
Xuefeng Sun (S) New PI 2011	**Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China**	Other - Chinese Academy of Science Other - Chinese Academy of Sciences		Magnetic Susceptibility of the Pyrochlore Tb2Ti2O7 at Ultralow Temperatures P01895	56
Xuan Gao (S)	**Case Western Reserve University**	National Science Foundation Department of Energy	906415	Magnetic Field Induced Insulating Phases in a Strongly Correlated Two-Dimensional Hole System near the Metal-Insulator Transition P02210	154
Xuefeng Sun (S)	**Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China**	Other - Chimnese Academy of Sciences		Magnetic Susceptibility of the Pyrochlore Magnet Yb2Ti2O7 at Magnetic High Fields P02280	69
Wei Pan (S)	**Sandia National Labatories**	Department of Energy		Search for novel fractional quantum Hall states in the second Landau level in ultra-high mobility two-dimensional electron systems P02005	154
Wei Pan (S)	**Sandia National Labatories**	Department of Energy		Two-Dimensional Conduction near the Metal-Insulator Transition in a Si/SiGe Quantum Well under In-Plane Magnetic Field P07151	154
Total Proposals:				**6**	**834**

NMR

TABLE 1

User Demographic

NMR Facility	Users	Male	Female	Prefer Not to Respond to Gender	Minority[1]	Non-Minority[1]	Prefer Not to Respond to Race	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	97	81	16	0	4	93	1	46	3	18	30
Senior Personnel, non-U.S.	18	18	0	0	2	16	0	4	1	2	11
Postdocs, U.S.	20	17	3	0	2	18	0	14	2	1	3
Postdocs, non-U.S.	9	6	3	0	2	7	0	0	3	0	6
Students, U.S.	53	31	21	1	7	46	1	37	3	3	10
Students, non-U.S.	8	5	3	0	0	8	0	1	3	0	4
Technician, U.S.	5	3	2	0	1	4	0	5	0	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0	0	0	0
Total:	**210**	**161**	**48**	**1**	**18**	**192**	**2**	**107**	**15**	**24**	**64**

1. NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin
2. "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
3. "Users Sending Sample" refers to users who send the sample to the facility and the experiment is conducted by in-house user support personnel. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
4. "Off-Site Collaborators" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

TABLE 2

User Affiliations

NMR Facility	Users	NHMFL-Affiliated Users[1]	Local Users[1]	University Users[2,4]	Industry Users[4]	National Lab Users[3,4]
Senior Personnel, U.S.	97	33	9	88	9	0
Senior Personnel, non-U.S.	18	2	0	16	1	1
Postdocs, U.S.	20	8	5	19	0	1
Postdocs, non-U.S.	9	0	0	9	0	0
Students, U.S.	53	15	15	53	0	0
Students, non-U.S.	8	0	0	8	0	0
Technician, U.S.	5	4	1	5	0	0
Technician, non-U.S.	0	0	0	0	0	0
Total:	**210**	**62**	**30**	**198**	**10**	**2**

1. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [i.e. on our Web site/directory], even if they travel to another site.
Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e. researchers at FSU, UF, FAMU, or LANL), even if they travel to another site. The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators".
2. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
3. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
4. The total of university, industry, and national lab users will equal the total number of users.

TABLE 3

Users by Discipline

NMR Facility	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Senior Personnel, U.S.	97	3	17	21	9	47
Senior Personnel, non-U.S.	18	0	6	3	0	9
Postdocs, U.S.	20	1	1	3	1	14
Postdocs, non-U.S.	9	0	5	2	0	2
Students, U.S.	53	0	6	13	3	31
Students, non-U.S.	8	0	4	0	0	4
Technician, U.S.	5	0	0	1	1	3
Technician, non-U.S.	0	0	0	0	0	0
Total:	**210**	**4**	**39**	**43**	**14**	**110**

TABLE 4

User Facility Operations

	900	830	800	720	600	600WB	600WB2	500	500E	Total Days1 Allocated / User Affil.	Percentage Allocated / User Affil.
NHMFL-Affiliated	96	53	181	0	0	23	34	0	99	486	17.51%
Local	93	89	50	124	0	186	82	288	0	912	32.86%
U.S. University	52	88	56	186	270	154	227	0	55	1088	39.21%
U.S. Govt. Lab.	0	0	0	0	0	0	0	0	0	0	0%
U.S. Industry	3	0	0	0	0	0	0	0	0	3	0.11%
Non-U.S.	103	18	0	0	0	0	14	0	0	135	4.86%
Test, Calibration, Set-up, Maintenance, Inst. Dev.	18	21	0	14	5	17	13	42	21	151	5.44%
Total:	**365**	**269**	**287**	**324**	**275**	**380**	**370**	**330**	**175**	**2775**	**100%**

1. User Units are defined as magnet days. For the NMR Facility in Tallahassee, one magnet day is 24 hours in the superconducting magnets

TABLE 5

Operations by Discipline

	Total Days Allocated / User Affil.	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
NHMFL-Affiliated	486	0	108	0	62	316
Local	912	0	61	292	0	559
U.S. University	1088	33	191	6	7	851
U.S. Govt. Lab.	0	0	0	0	0	0
U.S. Industry	3	0	0	0	0	3
Non-U.S.	135	0	44	4	0	87
Test, Calibration, Set-up, Maintenance, Inst. Dev.	151	0	4	35	112	0
Total:	**2775**	**33**	**408**	**337**	**181**	**1816**

TABLE 6

User Program Experiment Pressure

Experiment Requests Received	Experiment Requests Deferred from Prev. Year	Experiment Requests Granted	Experiment Requests Declined/Deferred	Experiment Requests Reviewed	Oversubscription
417	23	379 (86.14%)	61 (13.86%)	440	116.09%

TABLE 7

New User PIs

Name	Organization	Proposal	Year of Magnet Time
Chen, Bo	University of Central Florida	P02368	2013
Harper, James	University of Central Florida	P02383	2013
Davis, Mark	California Institute of Technology	P07137	2013
Lee, Chang Hyun	Dankook University	P07138	2013
Freeman, Benny	The University of Texas at Austin	P07224	2013
Total:			**5**

TABLE 8

Research Proposals[1] Profile, with magnet time

	Total	Minority[2]	Female[3]	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Number of Proposals	76	4	10	3	19	5	7	42

1. A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
2. The number of proposals satisfying one of the following two conditions: (a) the PI is a minority OR (b) the PI is a non-minority working at a minority-serving college or university AND the proposal includes minority participants.
3. The number of proposals satisfying one of the following two conditions: (a) the PI is a female OR (b) the PI is a male working at a college or university for women AND the proposal includes female participants.

TABLE 9

User Proposals

PI	Organization	Funding Source(s)			Proposal Title & ID#	Number of Days Awarded/ Scheduled
Tatyana Polenova (S)	**University of Delaware**	National Institutes of Health		P50GM082251	Solid-State NMR Structural and Dynamics Studies of HIV-1 Protein Assemblies P01798	8
Tim Cross (S)	**Florida State University**	National Institutes of Health		227000-520-015450	Structure Determination of LspA Using NMR P01751	140
Tim Cross (S)	**Florida State University**	National Institutes of Health		227000-520-015450	Rv0011c a Mtb Membrane Protein Structure Determination by NMR Spectroscopy P01746	23
Tim Cross (S)	**Florida State University**	National Institutes of Health		227000-520-015450	Full length M2 Protein Structural Characterization P01752	93
David Doty (S) New PI 2012	**Doty Scientific, Inc**	National Institutes of Health		NIH SBIR 5R44 GM079888-03	Testing Of A 900 Mhz H/C/N Nmr Pisema Probe For Use With Membrane Proteins In Bicelles P02209	3
Zhehong Gan (S)	**Florida State University**	Other - NSERC No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant) National Science Foundation		NSF DMR 1104869	Development of high-field solid-state NMR methods P02217	90
Naresh Dalal (S)	**Florida St. University**	National Science Foundation		701462	Probing the origin of unexpected splitting in 31P CP-MAS of hydrogen-bonded ferroelectrics at 21.1 T P01786	11
Fang Tian (S) New PI 2010	**Penn State University**	Other - Penn State College of Medicine National Institutes of Health		5R01GM081793	"In Cell" Characterization of the Transmembrane Domain of the Human Amyloid Precursor Protein Binding Receptor LR11 (sorLA) with Solid State NMR P01407	27
Cathy Levenson (S)	**FSU College of Medicine**	U.S. Army	MRMC	W81XWH-11-2-0121	Use of zinc to improve outcomes after traumatic brain injury P02282	12

TABLE 9

User Proposals (Continued)

Samuel Grant (S)	**Florida State University & The National High Magnetic Field Laboratory**	Other - American Heart Association	Southeastern USA		In vivo tracking of exogenous and endogenous stem cells associated with stroke P01906	42
Tim Cross (S)	**Florida State University**	National Institutes of Health		227000-520-022846	Structure-Function Studies of Nucleotide Hydrolysis in a Membrane Environment P01754	233
Conggang Li (S)	**Wuhan Institute of Physics & Mathematics, Chinese Academy of Sciences**	Other - National Science Foundation of China			Orientation and Dynamics of Uniaxially Rotating Membrane Proteins Probed with Multidimensional Solid-State MAS NMR in Unoriented Samples P01695	2
Lucio Frydman (S)	**Weizmann Institute of Science**	National Science Foundation	NMR	1064075	Ultrafast High Field Functional Magnetic Resonance Imaging and Spectroscopy P02112	59
		Other - Minerva Foundation				
		Other - Metafulx				
		No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)				
		National Science Foundation		OISE 1064075		
		Other - Fulbright Foundation				
		Other - Feinberg Graduate School				
		Other - Metaflux(EU-FP7)				
		NHMFL User Collaboration Grants Program				
		Other - Fulbright				
		Other - Metaflux (EU-FP7)				
Linan An (S)	**University of Central Florida**	Department of Energy		DE-FOA-0000408	NMR Studies on Structures of Polymer-Derived Amorphous Ceramics P01741	7

TABLE 9

User Proposals (Continued)

Myriam Cotten (S)	**Hamilton College**	National Science Foundation National Science Foundation		CHE 0832571 832571	Membrane Interaction and Atomic-Level Structures of Membrane-Active Peptides by 15N and 2H Solid-State NMR P02289	11
Annadanesh Shellikeri (G)	**FAMU-FSU College of Engineering**	Department of Energy		31054	Solid State in-situ NMR Studies of Li-ion Capacitors P02124	32
Hans Jakobsen (S)	**University of Aarhus**	Other - Aarhus University	Department of Chemistry		Dynamics in KMnO4 from low-temperature 17O VT MAS NMR at 21.1T: A collaboration between Aarhus University and NHMFL (FSU) P02233	9
Fengli Zhang (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			MRI Tests, Development, and Maintenance P01859	11
Victor Schepkin (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)	NMR/MRI		IN VIVO CHLORINE-35 MRI IN RODENT BRAIN P01779	15
Sabyasachi Sen (S)	**University of California at Davis**	National Science Foundation National Science Foundation National Science Foundation		DMR 1104869 NSF DMR 1104869 DMR1104869	Structure and connectivity in Ge-Se glasses: 77Se NMR MAS-CSA correlation spectroscopy P01915	50
Sungsool Wi (S) New PI 2012	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Development and implementation of the state-of-the-art solid-state NMR pulse techniques 1) at ultrahigh magnetic fields and 2) for utilizing 14N overtone transition P02137	32

TABLE 9

User Proposals (Continued)

Jan Rainey (S)	**Dalhousie University**	Other - Natural Sciences and Engineering Research Council of Canada (NSERC)	Discovery Grant	432034-2012	Solid-state NMR characterization of recombinant spider wrapping silk.	5
New PI 2012		Other - Canadian Institutes of Health Research	New Investigator Award	261507	P02277	
		Other - Natural Sciences and Engineering Research Council of Canada (NSERC)	Postgraduate Scholarship			
Tim Cross (S)	**Florida State University**	National Institutes of Health		1PO1A1074805-01	Structural Characterization of FtsX P02213	81
Tim Cross (S)	**Florida State University**	National Institutes of Health		AI 074805	31P and 15N solid-state NMR study for the development of a membrane protein drug-screening methodology P01780	140
Nate Traaseth (S) New PI 2012	**New York University**	National Institutes of Health		5 K22 AI083745 02	Structure and Orientation of Efflux Pumps P02009	10
Glenn Walter (S)	**College of Medicine**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Evaluation of glycogen accumulation in a mouse model of Pompe disease using carbon magnetic resonance spectroscopy (13C-MRS) at ultra high field P02153	2
Tim Cross (S)	**Florida State University**	National Institutes of Health		5R01AI073891	Dynamics of M2 – Understanding the dynamics of the transmembrane segment of the influenza A M2 proton channel P01885	155
Camille Jones (S)	**Columbia University**	Department of Energy		DE-FG02-05ER46243	F-19 MAS NMR Studes of Hydrate Compounds P01671	2
Bo Chen (S)	**University of Central Florida**	U.S. Army	Air Force Office of Scientific Research	BAA-AFOSR-2012-0005	Structure and dynamics study of Rous Sarcoma Virus capsid assembly	28
New PI 2013		Other - University of Central Florida		Inhouse award	P02368	
		U.S. Army	Air Force Office of Scientific Research	FA9550-13-1-0150		

NMR

TABLE 9

User Proposals (Continued)

Manish Mehta (S)	**Oberlin College**	National Science Foundation		1012813	Solid State 13C NMR characterization of an Incommensurately Modulated Structure P01696	5
Riqiang Fu (S)	**NHMFL**	NHMFL User Collaboration Grants Program			In Situ Imaging of Lithium Ion Pathway in Lithium Rechargeable Batteries by STRAFI P01770	37
James Harper (S)	**University of Central Florida**	Other - University of Central Florida - start up funds			Using 13C/14N distance measurements in NMR crystallography	33
New PI 2013		No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			P02383	
		Other - University of Central Florida				
		Other - Univeristy of Central Florida start-up funds	Chemistry			
Srinivasan Chandrashekar (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Battery MRI	57
		U.S. Army	Army CERDEC	Army CERDEC	P02140	
		National Science Foundation	Future Renewable Electric Energy Delivery and Management	FREEDM		
Karunya Kandimalla (S)	**Florida A&M University**	Other - Alzheimer's Association			Development of Theranostic Nanovehicle to Target Toxic Amyloid Deposits in Cerebral Amyloid Angiopathy and Alzheimer's Disease P01747	38
Elan Eisenmesser (S)	**University of Colorado Health Sciences Center**	National Institutes of Health		1R01GM096019-01A1	Determining the Conformational Changes within Active Enzyme-Substrate Systems on both Sides of the Reactions. P02387	242

TABLE 9

User Proposals (Continued)

Sungsool Wi (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Investigation of dynamics-transport correlations in polymeric membranes of fuel cell and reverse osmosis applications P02138	40
Zhehong Gan (S)	**Florida State University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Development of methods and probes for solid-state NMR of biological samples P01530	12
Dorothee Kern (S) New PI 2012	**HHMI/Brandeis University**	Other - HHMI			Unravelling the molecular mechanism by which Pin1 recognizes tau and its role in Alzheimer's disease P02085	13
Peizhi Zhu (S)	**University of Michigan**	National Institutes of Health		1R01AR056657	Chemical Structure Effects on Bone Response to Mechanical Load Studied by Solid State NMR P01534	5
Victor Schepkin (S)	**NHMFL**	Other - Grant from FSU Council on Research& Creativity (CRC) FSU: Multidisciplinary Support Award 2013			Sodium-Diffusion MRI and Rodent Glioma Resistance to Therapy P02404	6
Gang Wu (S)	**Queen's University**	Other - NSERC of Canada			Characterization of a low-barrier hydrogen bond in nicotinic acid crystals P02432	16
Fang Tian (S)	**Penn State University**	Other - Penn State University National Institutes of Health	College of Medicine	GM 094526-01	Spherical Nanoparticle Supported Lipid Bilayers for the Study of Membrane Architecture P02428	24
Ayyalusamy Ramamoorthy (S)	**University of Michigan**	National Institutes of Health		GM084018	Solution NMR studies on protein-protein interaction P02485	14
Ayyalusamy Ramamoorthy (S)	**University of Michigan**	National Institutes of Health		GM084018 and GM095640 GM095640 GM084018	Solid-state NMR studies on membrane-bound cytochrome-b5 P02484	25

TABLE 9

User Proposals (Continued)

Naresh Dalal (S)	**Florida St. University**	NHMFL User Collaboration Grants Program			High resolution MAS NMR study on ion dynamics in superionic conductor LiH2PO4 P02479	18
Peizhi Zhu (S)	**University of Michigan**	Other - Mary Lou Fundation			Effects of Glycation on Diabetic Bone Studied by Solid State NMR P01709	7
Robert Schurko (S)	**University of Windsor**	Other - NSERC, Canada			Multinuclear SSNMR of Unreceptive Nuclides Using Adiabatic Pulses	16
		Other - NSERC (Canada)	Chemistry - Discovery Grant	n/a (Discovery Grant)	P02490	
Vladimir Ladizhansky (S)	**University of Guelph**	Other - Natural Sciences and Engineering Research Council of Canada			Resolution and sensitivity of magic angle spinning solid-state NMR spectra of membrane proteins at ultra high magnetic fields	21
New PI 2012		Other - Natural Science and Engineering Research Council of Canada			P02088	
Tim Cross (S)	**Florida State University**	National Institutes of Health		227000-520-015450	In situ study of M2 protein P01810	36
Anant Paravastu (S)	**FSU/FAMU College of Engineering**	Other - DARPA grant			Solid State 19F NMR Light-Induced Isomerization of Azobenzene Glassy Polymer Networks P01961	4
Peizhi Zhu (S)	**University of Michigan**	Other - Mary Lou Fundation for Science			Early Biominearalization of Mice Bone Studied at Different Stage of Age by 43Ca Solid State NMR P01515	2
Mark Davis (S) New PI 2013	**California Institute of Technology**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Solid-state 67Zn NMR Characterization of Zincosilicates (CIT-6) P07137	21
Chang Hyun Lee (S) New PI 2013	**Dankook University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Characterization of water/gas separation and energy generation membrane materials by solid-state NMR spectroscopy P07138	7

TABLE 9

User Proposals (Continued)

Kwang Hun Lim (S)	**East Carolina University**	National Institutes of Health	NINDS-NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS AND STROKE	1R15NS084138-01	Biofuels from Biomass: Characterization of Biomass using Solid State NMR Spectroscopy P01794	12
Tatyana Polenova (S)	**University of Delaware**	National Institutes of Health		P50GM082251	Solid-State NMR Structural and Dynamics Studies of HIV-1 Protein Assemblies P01758	6
Gail Fanucci (S)	**University of Florida**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			NMR Backbone Dynamics Study of HIV-1 Protease Subtypes and Drug-resistant Mutants P02082	7
Brian Miller (S) New PI 2012	**Florida State University**	National Institutes of Health Other - American Heart Association Other - NIDKK	NATIONAL INSTITUTE OF DIABETES AND DIGESTIVE AND KIDNEY DISEASES NIDDK	1R01DK081358 12POST12040344	Quantification of Side Chain Dynamics Responsible for Allosteric Activation of Human Glucokinase P02216	11
Sabyasachi Sen (S)	**University of California at Davis**	National Science Foundation		DMR1104869	High Field 73Ge NMR Spectroscopic Investigation of The Structural Nature of Transitions in GeTe-Sb2Te3 Phase Change Materials P01640	4
Benny Freeman (S) New PI 2013	**The University of Texas at Austin**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Investigation of the structure of thermally rearranged polymers using solid-state nuclear magnetic resonance P07224	4
Samuel Grant (S)	**Florida State University & The National High Magnetic Field Laboratory**	Other - NIH Other - Korea Science and Engineering Foundation UF McKnight Brain Institute			Active Membrane Bidomain model for planning MREIT studies of neural tissue P01683	41
Samuel Grant (S)	**Florida State University & The National High Magnetic Field Laboratory**	NHMFL User Collaboration Grants Program			High Field Magnetic Resonance Microscopy P01682	15

TABLE 9

User Proposals (Continued)

Samuel Grant (S)	**Florida State University & The National High Magnetic Field Laboratory**	National Science Foundation		654118	Maintenance on the 500 MHz at Engineering School P02012	21
Samuel Grant (S)	**Florida State University & The National High Magnetic Field Laboratory**	Other - Planning Grant Award	FSU		MR Electrical Impedance Tomography at Ultra High Magnetic Fields P01684	14
Rafael Bruschweiler (S)	**NHMFL**	Other - NIH			Arginine Kinase: Joint Crystallographic and NMR RDC Analyses Link Substrate-Associated Motions to Intrinsic Flexibility P01686	59
Rafael Bruschweiler (S)	**NHMFL**	Other - NSF			NMR Based Protein Force Field P01685	61
Rafael Bruschweiler (S)	**NHMFL**	Other - NIH Other - The American Heart Association			Higher-Rank Correlation NMR spectra with Spectral moment filtering P01688	61
Rafael Bruschweiler (S)	**NHMFL**	Other - NIH			Simultaneous de Novo identification of Molecules in Chemical Mixtures by Doubly Indirect Covariance NMR spectroscopy P01689	49
William Brey (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Development of a static double-resonance probe for the studies of oriented biological samples P01449	2
William Brey (S)	**NHMFL**	National Science Foundation		412169	Attenuation of Temporal Variations in Magnetic Field Strength using Digital Feedback Control P01543	2
Samuel Grant (S)	**Florida State University & The National High Magnetic Field Laboratory**	NHMFL User Collaboration Grants Program	Chem/Bio		Quadrature Surface and Array Coils for In Vivo Imaging and Relaxometry in Vertical High Field Magnets P01905	20

TABLE 9

User Proposals (Continued)

Samuel Grant (S)	**Florida State University & The National High Magnetic Field Laboratory**	NHMFL User Collaboration Grants Program			HIGH-FIELD 1H/23NA MAGNETIC RESONANCE MICROSCOPY OF NEURONAL GANGLIA UNDER PERTURBATION P01904	19
Liliya Vugmeyster (S)	**University of Alaska Anchorage**	Other - University of Alaska ENRI			Characterization of unfrozen water in soils of Dry Valleys of Antarctica P01744	2
Arturo Hernandez-Maldonado (S)	**University of Puerto Rico - Mayaguez**	NASA	University Research Centers	NNX08BA48A	Solid State NMR Characterization of Nanoporous Materials for Carbon Dioxide Removal: Porous Coordination Polymers and Alkaline Earth Metal Exchanged Silicoaluminophosphates P01785	2
Stephen Melville (S) New PI 2012	**Virginia Tech**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Determination of the conformation and geometry of bacterial pilin proteins in an artificial membrane P02219	1
Anant Paravastu (S) New PI 2011	**FSU/FAMU College of Engineering**	National Science Foundation		NSF DMR-1055215	Solid State NMR Structural Characterization of Designer a-helical Peptide Nanofibers P01874	288
Anant Paravastu (S)	**FSU/FAMU College of Engineering**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Maintenance, Repairs, Testing on 500 MHz, Paravastu Magnet	42
		National Science Foundation		654118	P02013	
Total Proposals:					**76**	2775

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TABLE 1

User Demographic

	Users	Male	Female	Prefer not to Response Regarding Gender	Minority[1]	Non-Minority	Prefer not to Response Regarding Race	Users Present	Users Operating Remotely [2]	Users Sending Sample [3]	Off-Site Collaborators [4]
Number of Senior Investigators, U.S.	75	60	15	0	6	69	0	46	0	29	0
Number of Senior Investigators, non-U.S.	9	6	3	0	1	8	0	1	0	8	0
Number of Postdocs, U.S.	18	11	7	0	3	15	0	16	0	2	0
Number of Postdocs, non-U.S.	8	6	2	0	1	7	0	7	0	1	0
Number of Students, U.S.	34	22	12	0	1	33	0	28	0	6	0
Number of Students, non-U.S.	24	16	8	0	0	24	0	22	0	2	0
Technicians, U.S.	15	13	2	0	0	15	0	9	0	6	0
Technicians, non-U.S.	1	1	1	0	1	1	0	1	0	0	0
Total	**184**	**135**	**50**	**0**	**13**	**172**	**0**	**130**	**0**	**54**	**0**

1. NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin
2. "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
3. "Users Sending Sample" refers to users who send the sample to the facility and the experiment is conducted by in-house user support personnel. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
4. "Off-Site Collaborators" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

TABLE 2

User Affiliations

	Users	NHMFL-Affiliated Users[1]	Local Users[1]	University Users[2,4]	Industry Users[4]	National Lab Users[3,4]
Number of Senior Investigators, U.S.	75	14	34	71	0	4
Number of Senior Investigators, non-U.S.	9	1	0	9	0	0
Number of Postdocs, U.S.	18	2	13	15	0	3
Number of Postdocs, non-U.S.	8	3	4	8	0	0
Number of Students, U.S.	34	0	29	34	0	0
Number of Students, non-U.S.	24	0	20	24	0	0
Technicians, U.S.	15	4	5	7	3	5
Technicians, non-U.S.	1	1	0	0	0	1
Total	**184**	**25**	**105**	**168**	**3**	**13**

1. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [i.e. on our Web site/directory], even if they travel to another site.
   Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e. researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
   The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators".
2. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
3. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
4. The total of university, industry, and national lab users will equal the total number of users.

TABLE 3

Users by Discipline

	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Number of Senior Investigators, U.S.	75	0	14	5	1	55
Number of Senior Investigators, non-U.S.	9	0	4	2	1	2
Number of Postdocs, U.S.	18	0	4	2	2	10
Number of Postdocs, non-U.S.	8	0	5	0	0	3
Number of Students, U.S.	34	0	8	0	3	23
Number of Students, non-U.S.	24	0	12	1	2	9
Technicians, U.S.	15	0	2	2	2	9
Technicians, non-U.S.	1	0	0	0	1	0
Total	**184**	**0**	**49**	**12**	**12**	**111**

TABLE 4

User Demographic

	500 MHz NMR	600 MHz NMR / MRI	600 MHz cryo	600 MHz cryo[2]	750 MHz wb	4.7 T / 33 cm	11.1 T / 40 cm	3T whole body	Total Days[1] Allocated / User Affil.	Percentage Allocated / User Affil.
NHMFL-Affiliated	0	69	66	98	96	176	59	50	614	32%
Local	10	11	6	5	26	50	41	124	272	14%
U.S. University	86	80	49	28	62	10	7	0	323	17%
U.S. Govt. Lab.	1	0	17	0	0	0	0	0	18	1%
U.S. Industry	0	0	0	0	0	0	0	0	0	0%
Non-U.S.	0	0	27	9	22	0	11	0	69	4%
Development	34	61	21	60	48	25	45	13	305	16%
Test, Calibration, Set-up, Maintenance	27	30	32	40	70	25	55	25	304	16%
Total	**158**	**250**	**218**	**240**	**324**	**286**	**217**	**212**	**1905**	**100%**

1. User Units are defined as magnet days. Magnet-day definitions for AMRIS instruments:
Verticals (500, 600s, & 750 MHz), 1 magnet day = 24 hours (7 days/week).
Horizontals (4.7, 11.1, and 3T), 1 magnet day = 8 hours (5 days/week). This accounts for the difficulty in running animal or human studies overnight.
Magnet days were calculated by adding the total number of real hours used for each instrument and dividing by 24 (vertical) or 8 (horizontal).

TABLE 5

Operations by Discipline

	Total Days Allocated / User Affil.	Condensed Matter Physics	Chemistry, Geochem.	Engineering	Magnets, Matls, Testing, Instrum.	Biology, Biochem., Biophys.
			Number of Magnet Days			
NHMFL-Affiliated	614	0	152	12	34	416
Local	272	0	1	0	0	271
U.S. University	323	0	134	42	18	129
U.S. Govt. Lab.	18	0	18	0	0	0
U.S. Industry	0	0	0	0	0	0
Non-U.S.	69	0	35	24	10	
Development	305	0	0	0	305	0
Test, Calibration, Set-up, Maintenance	304	0	0	0	304	0
Total	**1905**	**0**	**340**	**78**	**671**	**816**

TABLE 6

User Program Experiment Pressure

Experiment Requests Received	Experiment Requests Deferred from Prev. Year	Experiment Requests Granted	Experiment Requests Declined/Deferred	Experiment Requests Reviewed	Oversubscription
1601	0	1601	200	1801	112%

TABLE 7

New User PIs

Name	Organization	Proposal	Year of Magnet Time
Shepherd, Timothy	New York University Langone Medical Center	P02244	2013
Morgan, Theodore	Kansas State University	P02313	2013
Pochi, Subbarayan	University of Miami	P02328	2013
Lathrop, Hillary	University of Florida	P02329	2013
Cusi, Kenneth	University of Florida	P02340	2013
Foote, Kelly	College of Medicine	P02393	2013
Uy, Mylene	Mindanao State University-Iligan Institute of Technology	P02418	2014
Agbandje-McKenna, Mavis	University of Florida	P02429	2013
Total			**2013 - 7** **2014 - 1**

TABLE 8

Research Proposals[1] Profile, with magnet time

	Total	Minority[2]	Female[3]	Condensed Matter Physics	Chemistry, Geochem.	Engineering	Magnets, Matls, Testing, Instrum.	Biology, Biochem., Biophys.
Number of Proposals	57	17	3	0	15	2	10	30

1. A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
2. The number of proposals satisfying one of the following two conditions: (a) the PI is a minority OR (b) the PI is a non-minority working at a minority-serving college or university AND the proposal includes minority participants.
3. The number of proposals satisfying one of the following two conditions: (a) the PI is a female OR (b) the PI is a male working at a college or university for women AND the proposal includes female participants.

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TABLE 9

User Proposals (Continued)

PI name	Affiliation	Funding Source(s)	Proposal Title and Proposal #	Number of Days Awarded/ Scheduled
Agbandje-McKenna, M. (S)	**Univ. of Fl**	NIH GMS	NMR Studies of the AAV Capsid Minor Viral Protein 1 Unique Region (VP1)	0.2
Baumer, M. (S)	**Bremen Univ.**	NSF Division of Chemical, Bioengineering, Environmental, and Transport Systems	Carbon Dioxide Transport in a Samaria Aerogel Catalyst by High Field Diffusion NMR	24.2
Best, M. (S)	**Univ. of Tenn**	NIH GMS	Solid State 2H NMR Characterization of BMP Membranes	27.5
Brady, L.J. (S)	**Univ. of Fl**	NIH NIDCR	Structural Studies of Adhesion Protein P1	11.0
Brodersen, C.R (S)	**Univ. of Fl**	NHMFL Maglab Users services	NMR Imaging of Drought-Induced Vessel Blockage and Restoration Of Hydraulic Conductivity in Citrus and Blueberry Plants	1.1
Butcher, R.A. (S)	**Univ. of Fl**	NIH NIGMS	Identification of Pheromones from Entomopathogenic Nematodes	6.3
Butcher, R.A. (S)	**Univ. of Fl**	Human Frontier Science Program	Identification of Novel Pheromones from Caenorhabditis Elegans Using Comparative Metabolomics and Multi-dimensional NMR Spectroscopy	6.5
Castro-Gamboa, I. (S)	**Sao Paulo Univ.**	NHMFL	Metabolomic Analyses of Associated Endophytic Fungi from Senna Spectabilis Using NMR and Computational Dereplication Models”	30.2
Deacon, T.W. (S)	**UC Berkeley**	NSF	Determining the Embryonic Origin of Primate Encephalization via High Resolution MRI	30.0
Edison, A.S. (S)	**Univ. of Fl**	NHMFL	Structure Identification of Compounds Promising Anticancer and Antinematode Extracted From Chinese Traditional Herbs Using NMR	24.1
Edison, A.S. (S)	**Univ. of Fl**	NIH NIBIB	^{13}C-optimized 1.5-mm NMR Probe Based on High Temperature Superconductors	90.0
Edison, A.S. (S)	**Univ. of Fl**	NIH NIGMS	^{13}C-Enriched Global Metabolomics Approach Using 2D 13C NMR	23.8
Edison, A.S. (S)	**Univ. of Fl**	NIH NIBIB	A Natural Abundance 13C NMR Approach for Metabolomic Studies of Complex Mixtures	17.4
Edison, A.S. (S)	**Univ. of Fl**	NIH NBIB	Natural Abundance Applications to 13C Metabolomics	5.7
Erickson, M. (S)	**VA Hospital**	NHMFL	Augmented Tune/Match Circuits for High Performance Duel Nuclear Transmission Line Resonators	3.0
Fernandez-Funez, P. (S)	**Univ. of Fl**	NIH NIBIB	Three-Dimensional MRM of the Drosophila Brain at High Resolution	30.0
Fisher, A. (S)	**UPenn**	NIH NHLBI	Structural Study Of Human Peroxiredoxin 6	1.0
Flotte, T.R. (S)	**Univ. Mass**	NIH NHLMI	A Metabolomic Analysis of Very-Long Chain Acyl-CoA Dehydrogenase Deficient and Corrected Mice	25.4
Foote, K.D. (S) (S)	**Univ. of Fl**	UCGP	17.6T MR Microscopy of Movement Disorders as a Guide for Deep Brain Stimulation	22.3
Hamilton, T.D. (S)	**Barry U**	Research Corporation for Science Advancement	NMR Characterization of Tetra-meso-substituted Porphyrins Synthesized by Mechanochemistry	2.0
Hanson, A.D. (S)	**Univ. of Fl**	NHMFL	Study of the Enzymatic Activity of COG3236 Protein on Riboflavin Intermediates	22.0

TABLE 9

User Proposals (Continued)

Heldermon, C (S)	**Univ. of Fl**	NHMFL	Characterization of Brain Morphology in Mucopolysaccharidosis Type IIIB Affected Mice Using Magnetic Resonance Imaging	3.9
Koros, W. (S)	**Georgia Inst**.	NSF Division of Chemical, Bioengineering, Environmental, and Transport Systems	Self-Diffusion of Ethane and Ethylene in Carbon Molecular Sieve Membranes by Pulsed Field Gradient NMR	11.8
Long, J.R. (S)	**Univ. of Fl**	NHMFL	Development of a Dissolution DNP Instrument: For Applications and Technique Development	11.0
Long, J.R. (S)	**Univ. of Fl**	NHMFL	Characterizing DNP Mechanisms at High Magnetic Fields to Enable Membrane Protein NMR Studies	14.6
Long, J.R. (S)	**Univ. of Fl**	NHMFL	Development of MRI Sequences Optimized for Use with Dissolution DNP	14.6
Long, J.R. (S)	**Univ. of Fl**	NHMFL	Study of DNP Polarization of Acetate and Butyrate at 1.11 K	33.0
Long, J.R. (S)	**Univ. of Fl**	Gates Foundation	Structural Analysis of the C-Terminus of Lung Surfactant Protein B (SP-B)	20.0
Long, J.R. (S)	**Univ. of Fl**	Gates Foundation	Characterization of Hydrogen Bonding In Amphiphilic Peptide Helices via REDOR	15.0
Long, J.R. (S)	**Univ. of Fl**	Gates Foundation	Solution NMR Structural Studies of a Surfactant Peptide, SP-B1-25	15.0
Long, J.R. (S)	**Univ. of Fl**	NHMFL	Developing DNP Mixtures with Long T1s for In Vivo Metabolomics	15.0
Luesch, H (S)	**Univ. of Fl**	NIH NCI, NIGMS	Modular Strategies for Structure and Function Employed by Marine Cyanobacteria: Characterization and Synthesis of Pitinoic Acids	6.6
Luesch, H. (S)	**Univ. of Fl**	NIH NIGMS	Potent Elastase Inhibitors from Cyanobacteria: Structural Basis and Mechanisms Mediating Cytoprotective and Anti-Inflammatory Effects in Bronchial Epithelial Cells	6.6
Magin, R.L. (S)	**Univ. of Illinois**	NIH NIBIB	Entropy as a Measure of Non-Gaussian Diffusion in Fixed Rat Brain Tissues	10.8
Maginn, E.J. (S)	**U. of Notre Dame**	NSF Division of Chemical, Bioengineering, Environmental, and Transport Systems	Diffusion and Chemical Exchange in Mixtures of Carbon Dioxide and an Amine-Functionalized Ionic Liquid by High Field NMR	30.4
Mareci, T.H. (S)	**Univ. of Fl**	MBI	Quantitative Susceptibility Mapping Using MRI Phase Image	31.4
Mareci, T.H. (S)	**Univ. of Fl**	UCGP	Design of an MR Probe for In Vivo Studies in a 17.6 T, 89 mm Vertical Magnet	22.0
Mareci, T.H.(S)	**Univ. of Fl**	NIH NINDS	Mapping Phase Changes in MR Signal Due to Current Injection into Hydrogel Phantoms	6.0
Mehta, Manish (S)	Oberlin College	NSF Chemistry	Solid-State NMR Characterization of Two Tripeptides	2.0
Montie, E. (S)	**USCB**	NOAA University Corporation of Atmospheric Research	Cortical Connectivity in Excised Rat Brain with Thyroid Hormone Deficiency	7.0
Pan, X.J. (S)	**Univ. of Wisconsin-Madison**	NHMFL	Dynamic Visualization of Cell Wall Deconstruction during Pretreatment and Enzymatic Hydrolysis Using MRI	30.0

TABLE 9

User Proposals (Continued)

Pochi, S.R. (S)	**Univ. of Miami**	NHMFL USERS SERVICES	Structural Determination of the Active Anti Cancer Molecule in Achyranthes Aspera	7.7
Prosser, R.S (S)	**Univ. Toronto**	NHMFL	Towards the Direct in vivo Detection of Proteins, Macromolecules, and Drug Delivery Systems by 13C-edited 1H MRI and MRIS	10.5
Reddy, K.R. (S)	**Univ. of Fl**	NSF GRFP	Comparison of Organic Matter Composition from Shifting Vegetation Communities Due to Increased Inundation of a Subarctic Mire in Abisko, Sweden	12.3
Sarntinoranont, M. (s)	**Univ. of Fl**	NIH Neurological Disorders and Stroke	Measurement of Point Infusion Fluid Flow in Hydrogel Using Phase Contrast MRI	4.8
Schmelz, E.A. (S)	**USDA**	NSF IOS at NSF	Characterization of Novel Sequiterpenoid Phytoalexins in Zea Mays	18.0
Shepherd, T.M. (S)	**NYU**	NHMFL	Quantitative MR Microscopy of Ex Vivo Normal and Diseased Human Cortex	13.8
Tari, A.M (S)	**Univ.of Fl**	UF Opportunity Fund	Magnetic Resonance Imaging of Gadolinium-Filled Neurophilic Lipid Nanoparticles	1.6
Turner, B.L. (S)	**Smithsonian Tropical Research Institute**	NHMFL User Collaboration Grants Program	31P NMR Analysis of African Tropical Savanna Herbivore Manure	5.6
Turner, B.L.(S)	**Smithsonia**	NSF	Influence of Termites on Stability and Reactivity of Phosphorus in East African Savanna	5.0
Vaillancourt, D.E. (S)	**Univ. of Fl**	NIH NINDS	Brain Activation Differences in Tremor and Non-Tremor Dominant Parkinson's Disease	44.6
Vandenborne, K. (S)	**Univ. of Fl**	NIH NIAMS	Myocardial and Skeletal Muscle T2 is Reduced in γ-Sarcoglycan Deficient Mice at 7 Months of Age	12.5
Vandenborne, K. (S)	**Univ. of Fl**	NHMFL	Structural Integrity Changes Following Severe Contusion Injury	71.0
Vandenborne, K.(S)	**Univ. of Fl**	Wellstone Muscular Dystrophy Cooperative Center Grant	Monitoring Skeletal Muscle Changes in Dystrophin and Laminin-α2 Deficient Mice	13.0
Vasenkov, S (S)	**Univ. of Fl**	NSF Chemistry	Observation of Single-File Diffusion of Xe in One-Dimensional Nanochannels by Diffusion NMR	7.8
Walter, G. (S)	**Univ. of Fl**	NIH NIAMS	Biomarker Discovery in Duchenne Muscular Dystrophy Through Global Metabolomic Analysis	71.0
Walter, G.A. (S)	**Univ. of Fl**	DOD	Magnetic Resonance and Optical Imaging as Biomarkers for Muscle Injury	71.0
Total Proposals:			**57**	**1080.4**

EMR

TABLE 1

User Demographic

EMR Facility	Users	Male	Female	Prefer Not to Respond to Gender	Minority[1]	Non-Minority[1]	Prefer Not to Respond to Race	Users Present	Users Operating Remotely [2]	Users Sending Sample [3]	Off-Site Collaborators [4]
Senior Personnel, U.S.	52	43	8	1	0	52	6	25	0	14	13
Senior Personnel, non-U.S.	40	34	4	2	8	32	6	10	0	13	17
Postdocs, U.S.	17	11	2	4	0	17	5	11	0	3	3
Postdocs, non-U.S.	2	2	0	0	0	2	0	2	0	0	0
Students, U.S.	25	16	8	1	0	25	1	15	0	4	6
Students, non-U.S.	12	8	4	0	1	11	0	5	0	2	5
Technician, U.S.	0	0	0	0	0	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0	0	0	0
Total:	**148**	**114**	**26**	**8**	**9**	**139**	**18**	**68**	**0**	**36**	**44**

1. NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin
2. "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
3. "Users Sending Sample" refers to users who send the sample to the facility and the experiment is conducted by in-house user support personnel. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
4. "Off-Site Collaborators" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

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TABLE 2

User Affiliations

EMR Facility	Users	NHMFL-Affiliated Users1	Local Users[1]	University Users[2,4]	Industry Users[4]	National Lab Users[3,4]
Senior Personnel, U.S.	52	19	6	49	2	1
Senior Personnel, non-U.S.	40	0	0	38	0	2
Postdocs, U.S.	17	6	4	15	1	1
Postdocs, non-U.S.	2	0	0	2	0	0
Students, U.S.	25	5	9	25	0	0
Students, non-U.S.	12	0	0	12	0	0
Technician, U.S.	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0
Total:	**148**	**30**	**19**	**141**	**3**	**4**

1. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [i.e. on our Web site/directory], even if they travel to another site.
   Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e. researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
   The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators".
2. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
3. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
4. The total of university, industry, and national lab users will equal the total number of users.

TABLE 3

Users by Discipline

EMR Facility	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Senior Personnel, U.S	52	10	27	1	2	12
Senior Personnel, non-U.S.	40	8	27	0	0	5
Postdocs, U.S.	17	8	8	0	0	1
Postdocs, non-U.S.	2	1	1	0	0	0
Students, U.S.	25	7	15	0	2	1
Students, non-U.S.	12	2	9	0	1	0
Technician, U.S.	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0
Total:	**148**	**36**	**87**	**1**	**5**	**19**

TABLE 4

User Facility Operations

	17T	12T	Mossbauer	Bruker	Total Days[1] Allocated / User Affil.	Percentage Allocated / User Affil.
NHMFL-Affiliated	43	33	66	0	142	15.74%
Local	19	29	5	49	102	11.31%
U.S. University	102	52	111	82	347	38.47%
U.S. Govt. Lab.	0	0	16	0	16	1.77%
U.S. Industry	0	0	0	0	0	0%
Non-U.S.	117	56	6	26	205	22.73%
Test, Calibration, Set-up, Maintenance, Inst. Dev.	12	11	63	4	90	9.98%
Total:	**293**	**181**	**267**	**161**	**902**	**100%**

1. User Units are defined as magnet days. For the EMR Facility, one magnet day is defined as 24 hours in superconducting magnets.

TABLE 5

Operations by Discipline

	Total Days Allocated / User Affil.	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
NHMFL-Affiliated	142	33	91	0	16	2
Local	102	2	42	0	3	55
U.S. University	347	32	223	0	3	89
U.S. Govt. Lab.	16	0	16	0	0	0
U.S. Industry	0	0	0	0	0	0
Non-U.S.	205	90	97	0	0	18
Test, Calibration, Set-up, Maintenance, Inst. Dev.	90	0	75	0	15	0
Total:	**902**	**157**	**544**	**0**	**37**	**164**

TABLE 6

User Program Experiment Pressure

Experiment Requests Received	Experiment Requests Deferred from Prev. Year	Experiment Requests Granted	Experiment Requests Declined/Deferred	Experiment Requests Reviewed	Oversubscription
51	26	68 (88.31%)	9 (11.69%)	77	113.24%

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TABLE 7

New User PIs

Name	Organization	Proposal	Year of Magnet Time
Morgan, Grace	University College Dublin	P02315	2014
Freedman, Danna	Northwestern University	P02333	2013
Dinca, Mircea	Massachusetts Institute of Technology	P02384	2013
Preuss, Kathryn	University of Guelph	P02400	2013
Schulz, Charles	Knox College	P02401	2013
Shanmugam, Maheswaran	Indian Institute of Technology-Bombay	P02402	2013
Stiegman, Albert	FSU	P02403	2013
Stagg, Scott	Florida State University	P02437	2013
Raja, Muthukrishna	Claflin University	P02487	2013
Haddon, Robert	University of California Riverside	P02491	2013
Girolami, Gregory	University of Illinois at Urbana-Champaign	P02493	2013
Thomas, Christine	Brandeis University	P02508	2013
Bakac, Andreja	Ames Laboratory, Iowa State University	P02513	2013
Manson, Jamie	Eastern Washington University	P07136	2013
Sharma, Ral	Panjab University	P07146	2013
Albrecht-Schmitt, Thomas	Florida State University	P07153	2013
Tupitsyn, Igor	University of British Columbia	P07163	2014
Colacio, Enrique	Universidad de Granada	P07181	2013
Magliozzo, Richard	Brooklyn College CUNY	P07195	2013
Cano, Joan	Universita de Valencia	P07202	2013
zur Loye, Hans-Conrad	University of South Carolina	P07235	2014
Pombeiro, Armando	Instituto Superior Tecnico	P07238	2013
Chen, Ping-Yu	National Chung-Hsing University	P07239	2014
Total:			**2013 – 19** **2014 - 4**

TABLE 8

Research Proposals[1] Profile, with magnet time

	Total	Minority[2]	Female[3]	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Number of Proposals	66	3	9	17	34	0	6	9

1. A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
2. The number of proposals satisfying one of the following two conditions: (a) the PI is a minority OR (b) the PI is a non-minority working at a minority-serving college or university AND the proposal includes minority participants.
3. The number of proposals satisfying one of the following two conditions: (a) the PI is a female OR (b) the PI is a male working at a college or university for women AND the proposal includes female participants.

TABLE 9

User Proposals

PI	Organization	Funding Source(s)			Proposal Title & ID#	Number of Days Awarded/ Scheduled
Ellis Reinherz (S) New PI 2010	**Dana-Farber Cancer Institute**	Other - Gates Foundation			Structural analysis of HIV-1 MPER segment from clade C viruses using EPR P01518	61
Andriy Lysenko (S) New PI 2011	**Taras Shevchenko National University of Kyiv**	Other - Research Foundation of National Taras Shevchenko University			Metal-Organic Frameworks Based upon Multifunctional 1,2,4-Triazole Bridges Towards Development of Novel Magnetic and Microporous Materials. P01893	9
Changlin Tian (S) New PI 2010	**University of Science and Technology of China**	Other - National Key Basic Science Research Plan--Protein Science, China			Interaction and Dynamics Studies of Potassium Channel and its Modulation Subunit using Pulsed EPR P01583	18
Richard Oakley (S) New PI 2010	**University of Waterloo**	Other - NSERC Canada Operating Grant	University of Waterloo		EPR Studies on High Tc Ferromagnetic Radicals P01429	13
Joshua Telser (S)	**Roosevelt University**	National Science Foundation		804167	HFEPR on Macrocyclic Complexes of Transition Metals in High Oxidation States P01522	8
Jurek Krzystek (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Electron Paramagnetic Resonance at Very High Fields P01587	15
Mark Meisel (S)	**University of Florida**	Other - UF Research Opportunity Fund	UF Division of Sponsored Research		EPR study of Mn(III) Linear-Chain Materials P01909	2
Michael Shatruk (S)	**Florida State University**	National Science Foundation		955353	Study of Magnetic Ordering in AlFe2-xMnxB2 by Mössbauer Spectroscopy P02021	66
Srinivasa Rao Singamaneni (P)	**North Carolina State University**	U.S. Army	ARO		High frequency EMR investigations on graphene nanoribbons P01513	3

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TABLE 9

User Proposals (Continued)

Ulrich Kortz (S)	**Jacobs University**	Other - NSF-NIRT		High Field and High Frequency EPR Study on Novel Heteropolyoxopalladates P01525	5
Likai Song (S)	**NHMFL**	NHMFL User Collaboration Grants Program		HIV-1 membrane analysis by multi-frequency EPR at 9, 95 and 240 GHz P02094	2
Matthew Merritt (S) New PI 2010	**University of Texas Southwestern Medical Center**	National Institutes of Health	R21EB009147	Electron spin resonance investigation of dynamic nuclear polarization (DNP) samples P01453	12
Gavin Morley (S)	**University of Warwick**	Other - Australian Research Council		High-field electrically-detected magnetic resonance for readout of donor based spin qubits P01250	4
Daniel Reger (S) New PI 2010	**University of South Carolina**	National Science Foundation National Science Foundation	1011736 CHE–1011736 (Reger)	Ligand Design for Molecular and Supramolecular Control of the Structures of Metal Complexes: Investigations of Unusual Magnetic and EPR Properties P01548	28
Linan An (S)	**University of Central Florida**	Department of Energy	DE-FOA-0000408	EMR Studies on Defects of Polymer-Derived Amorphous Ceramics P01740	1
Evgeny Dikarev (S)	**University at Albany, SUNY**	National Science Foundation	1152441	Investigation of Low-Coordinate Fe(II) beta-Diketonates by High-Frequency EPR Spectroscopy P02022	2
Nuria Aliaga-Alcalde (S) New PI 2011	**ICREA & UB**	Other - Ministerio de Educación y Ciencia/ Generalitat de Catalunya/ Goverment of India through Dept. of Science and Technology	CTQ2009-06959/ CTQ2008-06670-C02-01/ 2009SGR-1459/ SR/S1/IC-12/2008	Characterization of Ni3 Isomer Species with Different Magnetic Answers: Strict Analysis on their Inherent Magnetic Parameters by HFEPR P01817	11
Darrin Richeson (S)	**University of Ottawa**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		Rational Design of Switchable Nano-Magnetic Materials P02100	2

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TABLE 9

User Proposals (Continued)

Alex Angerhofer (S)	**University of Florida**	National Science Foundation		809725	High Field EPR of Oxalate Decarboxylase P01641	19
Johan van Tol (S)	**Florida State University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			High Frequency Pulsed EPR/ ENDOR instrumentation testing P00082	11
Roman Boca (S)	**Slovak Technical University**	Other - Slovak Information Agency			Magnetostructural correlations in transition metal coordination complexes P02146	2
Geoffrey Strouse (S) New PI 2010	**FSU**	National Science Foundation		701462	High Frequency and High Field EPR Characterization on a Serial of Dilute Magnetic Semiconductor Quantum Dots P01259	7
Maheswaran Shanmugam (S) New PI 2013	**Indian Institute of Technology-Bombay**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Probing the electronic and magnetic properties of lanthanide Schiff base complexes through EPR spectroscopy P02402	7
Mircea Dinca (S) New PI 2013	**Massachusetts Institute of Technology**	Department of Energy		DE-SC0006937	Using 57Fe Mössbauer Spectroscopy and High-Field EPR to Establish the Electronic Structure of Fe Sites in Lacunary Zn4O Clusters of MOF-5 P02384	82
Kenneth Burch (S)	**University of Toronto**	Other - National Science and Engineering Research Council of Canada			Uncovering the Interplay Between the Magnetic, Lattice and Electronic Excitations in Strong Spin-Orbit Materials P02356	19
Andrej Zorko (S)	**"Jozef Stefan" Institute**	Other - Slovenian Research Agency			Local ESR Insight into Geometrically Frustrated Antiferromagnets P02399	24
Irinel Chiorescu (S)	**NHMFL & Florida State University**	National Science Foundation		1206267	Coherent manipulation of spin states of the molecular cluster V15 P02149	8
Zhiqiang Li (S)	**National High Magnetic Field Laboratory**	NHMFL User Collaboration Grants Program	DC field, CMS	P01901	Magneto-optical Spectroscopy of Graphene and Few-layer Graphene	16

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TABLE 9

User Proposals (Continued)

Scott Stagg (S) New PI 2013	**Florida State University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Measuring the displacement of the N-terminal amphipathic helix of Sar1b on GTP binding. P02437	12
Patrick Lenahan (S)	**Penn State University**	U.S. Army			Electrically Detected Magnetic Resonance at High Field Using Novel Approaches P02409	5
Likai Song (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Instrument testing P02439	4
Charles Schulz (S) New PI 2013	**Knox College**	National Institutes of Health		GM062211	Mechanistic Investigation of the Reduction of Nitric Oxide to Nitrous Oxide by Biosynthetic Protein Models P02401	13
Stephen Holmes (S) New PI 2011	**University of Missouri-St. Louis**	National Science Foundation Other - Missouri Research Board		CHE 0914935	High-Field EPR Studies of Low-Spin Iron(III) Complexes and Clusters. P01979	3
Kathryn Preuss (S) New PI 2013	**University of Guelph**	Other - NSERC of Canada discovery grant			Study of magnetic exchange interaction in thiazyl-based molecular materials using electron paramagnetic resonance P02400	3
Susan Latturner (S) New PI 2011	**Florida State University**	National Science Foundation		DMR-05-47791	Characterization of Ce rich intermetallics containing Fe using Mossbauer spectroscopy P01638	5
Dmitry Smirnov (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		DE-FG02-07ER46451	Electron Phonon Coupling in graphite-related systems P01553	9
Danna Freedman (S) New PI 2013	**Northwestern University**	Other - Northwestern University Start-up Fund	Chemistry		Systematic analysis of decoherence sources for spin-based quantum computation P02333	35

TABLE 9

User Proposals (Continued)

Stephen Hill (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Development of new microwave sources P02509	16
Kim Dunbar (S)	**Texas A&M University**	Department of Energy		DE-FG02-02ER45999	EPR Spectroscopy Studies to Investigate the Role of Spin-Orbit Coupling/Zero-field Splitting Effects on The Properties of Vandium(III) Compounds P02155	9
Naresh Dalal (S)	**Florida St. University**	Future Fuels Institute Future Fuels Institute		To be supplied	High-field EPR and ENDOR Studies of Fossil-Fuel and Related Materials P02481	20
Ewa Bienkiewicz (S) New PI 2012	**FSU**	Other - FSU/ COM seed grant			EPR analysis of an intrinsically disordered amino-proximal domain of Prion protein P01982	21
Mary Ellen Zvanut (S)	**University of Alabama at Birmingham**	National Science Foundation National Science Foundation		1006163 654118	Electron Nuclear Double Resonance and field dependent spin-lattice relaxation of nitrogen substitutional defects in 4H- and 6H-SiC P01973	3
Christine Thomas (S) New PI 2013	**Brandeis University**	Department of Energy		DE-SC0004019	Variable temperature and variable field 57Fe Mossbauer and high field EPR studies of Fe-containing homo- and heterobimetallic complexes P02508	11
Richard Oakley (S)	**University of Waterloo**	Other - NSERC, Canada	Discovery Grant - Individual, Richard Oakley		Magnetic Resonance in Antiferromagnetic Organic Radicals P02460	1
Robert Haddon (S) New PI 2013	**University of California Riverside**	Department of Energy		DE-FG02-04ER46138	Solid State Electronic Structure and Properties of Neutral Iron (Fe3+) Complexed Phenalenyl Radicals P02491	2

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TABLE 9

User Proposals (Continued)

Srinivasa Rao Singamaneni (P)	**North Carolina State University**	Other - Home Institution			Temperature Dependent High Frequency EMR investigations on Nd1-xYxMnO3: Probing Competing Magnetic Interactions P02421	11
Gregory Girolami (S) New PI 2013	**University of Illinois at Urbana-Champaign**	National Science Foundation		11-12360	Zero- and applied-field Mössbauer studies of a nearly linear two-coordinate iron(II) amide P02493	32
Jamie Manson (S) New PI 2013	**Eastern Washington University**	National Science Foundation		1005825	High-field ESR of novel S=1 molecular and polymeric magnets P07136	13
Panayotis Kyritsis (S)	**University of Athens**	Other - University of Athens Other - Empirikion Foundation, Greece			Electronic properties of (i) synthetic analogues of metalloproteins' active sites and (ii) single-ion molecular magnet metal complexes, probed by HFEPR spectroscopy. P07143	29
Muthukrishna Raja (S) New PI 2013	**Claflin University**	U.S. Army	ARO	W911NF-09-1-0058	DESIGN, SYNTHESIS, AND STUDY OF NEW METALLOSUPRAMOLECULAR HELICATES P02487	13
Albert Stiegman (S) New PI 2013	**FSU**	National Science Foundation		911080	Electron Spin Resonance (ESR) Studies of the Phillip's Ethylene Polymerization Catalyst. P02403	6
Sylvain Bertaina (S)	**IM2NP - CNRS**	Other - CNRS			High Frequencies EPR in 1D organic (TMTTF)2X P02025	7
Richard Magliozzo (S) New PI 2013	**Brooklyn College CUNY**	Other - Brooklyn College			High-field EPR of the Met-Tyr-Trp radical cofactor in M. tuberculosis catalase-peroxidase (KatG) P07195	3
Ral Sharma (S) New PI 2013	**Panjab University**	Other - Panjab University	Department of Chemistry		Magnetic and EPR Properties of Supramolecular Copper (II) Complexes P07146	10

TABLE 9

User Proposals (Continued)

Enrique Colacio (S) New PI 2013	**Universidad de Granada**	Other - MINECO (Spain) (Project CTQ2011-24478) Other - , the Junta de Andaluca (FQM-195 and Project of excellence P08-FQM-03705), and the University of Granada.			Co(II)-Based Single-Ion Magnets P07181	2
Joan Cano (S) New PI 2013	**Universita de Valencia**	Other - Universitat de Valencia			Building arrays from mononuclear single-molecule magnets based on Mn(III) and other 3d transition metal ions. In pursuit of new physics in spintronics. P07202	5
Hiroshi Sakiyama (S) New PI 2011	**Yamagata University**	Other - Yamagata University			HFEPR study of dinuclear cobalt(II) and nickel(II) complexes P01642	4
Thomas Albrecht-Schmitt (S) New PI 2013	**Florida State University**	Department of Energy	Heavy Elements Chemistry	will be provided	High Field and High Frequency EPR Study of Novel Heterobimetallics P07153	3
Euan Brechin (S)	**UniVersity of Edinburgh**	National Science Foundation Other - Engineering and Physical Sciences Research Council		CHE 0924374 EP/H004106/1	EPR characterization of molecular magneto-structural correlations under pressure P07168	3
Andrew Ozarowski (S)	**National High Magnetic Field Laboratory**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			CALIBRATION AND MAINTENANCE OF THE MÖSSBAUER INSTRUMENTS P02498	75
En-Che Yang (S)	**Fu-Jen Catholic University**	National Science Foundation		DMR0924374	High Field Electron Paramagnetic Resonance Characterization of Mn, Fe and Ln Based Metal Clusters P01627	2
Kwang Yong Choi (S)	**Chung Ang University**	Other - Korea NRF			ESR Studies on Novel Quantum States of Matter P02423	27

EMR

TABLE 9

User Proposals (Continued)

Andreja Bakac (S) New PI 2013	**Ames Laboratory, Iowa State University**	Department of Energy	DE-AC02-07CH11358	Mossbauer spectroscopy of Fe(IV) species in acetonitrile. P02513	16
Naresh Dalal (S)	**Florida St. University**	National Science Foundation	701462	High Frequency EPR of Fe doped CdSe Quantum Dots P07221	4
Armando Pombeiro (S) New PI 2013	**Instituto Superior Tecnico**	Other - The Foundation for Science and Technology (Portugal)		Magnetic Properties and EPR spectroscopy of High-Nuclear Copper complexes P07238	5
Joanna Long (S)	**NHMFL/UF Mcknight Brain Institute**	Other - UF Matching Support to the NHMFL for the DNP Program		Characterizing DNP mechanisms at high magnetic fields to enable membrane protein NMR studies P07148	3
Total Proposals:				**66**	902

ICR

TABLE 1

User Demographic

ICR Facility	Users	Male	Female	Prefer Not to Respond to Gender	Minority[1]	Non-Minority[1]	Prefer Not to Respond to Race	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S	90	70	19	1	3	87	2	28	0	35	27
Senior Personnel, non-U.S.	20	17	3	0	4	16	0	4	0	5	11
Postdocs, U.S.	17	8	9	0	0	17	0	11	0	3	3
Postdocs, non-U.S.	1	1	0	0	1	0	0	0	0	0	1
Students, U.S.	36	24	12	0	3	33	1	31	0	2	3
Students, non-U.S.	3	1	2	0	2	1	0	1	0	0	2
Technician, U.S.	4	2	2	0	1	3	0	2	0	1	1
Technician, non-U.S.	0	0	0	0	0	0	0	0	0	0	0
Total:	**171**	**123**	**47**	**1**	**14**	**157**	**3**	**77**	**0**	**46**	**48**

1. NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin
2. "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
3. "Users Sending Sample" refers to users who send the sample to the facility and the experiment is conducted by in-house user support personnel. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
4. "Off-Site Collaborators" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

TABLE 2

User Affiliations

ICR Facility	Users	NHMFL-Affiliated Users[1]	Local Users[1]	University Users[2,4]	Industry Users[4]	National Lab Users[3,4]
Senior Personnel, U.S.	90	11	11	70	8	12
Senior Personnel, non-U.S.	20	0	0	13	4	3
Postdocs, U.S.	17	8	2	17	0	0
Postdocs, non-U.S.	1	0	0	0	0	1
Students, U.S.	36	9	17	36	0	0
Students, non-U.S.	3	0	0	3	0	0
Technician, U.S.	4	1	1	4	0	0
Technician, non-U.S.	0	0	0	0	0	0
Total:	**171**	**29**	**31**	**143**	**12**	**16**

1. NHMFL-Affiliated users are defined as anyone in the lab's personnel system [i.e. on our Web site/directory], even if they travel to another site.
   Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e. researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
   The sum of NHMFL-Affiliated and Local users equals what was formerly referred to as "Internal Investigators".
2. In addition to external users, all users with primary affiliations at FSU, UF, or FAMU are reported in this category, even if they are also NHMFL associates.
3. In addition to external users, users with primary affiliations at NHMFL/LANL are reported in this category.
4. The total of university, industry, and national lab users will equal the total number of users.

TABLE 3

Users by Discipline

ICR Facility	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Senior Personnel, U.S.	90	0	43	3	5	39
Senior Personnel, non-U.S.	20	0	15	1	1	3
Postdocs, U.S.	17	0	9	0	1	7
Postdocs, non-U.S.	1	0	1	0	0	0
Students, U.S.	36	0	18	2	2	14
Students, non-U.S.	3	0	1	1	0	1
Technician, U.S.	4	0	2	0	1	1
Technician, non-U.S.	0	0	0	0	0	0
Total:	**171**	**0**	**89**	**7**	**10**	**65**

TABLE 4

User Facility Operations

	14.5 T Hybrid	9.4. T Passive	9.4. T Active	Total Days[1] Allocated / User Affil.	Percentage Allocated / User Affil.
NHMFL-Affiliated	47	65	0	112	13.16%
Local	20	34	152	206	24.21%
U.S. University	145	159	0	304	35.72%
U.S. Govt. Lab.	0	10	0	10	1.18%
U.S. Industry	0	14	0	14	1.65%
Non-U.S.	1	39	0	40	4.70%
Test, Calibration, Set-up, Maintenance, Inst. Dev.	73	38	54	165	19.39%
Total:	**286**	**359**	**206**	**851**	**100%**

1.For the ICR Facility, one magnet day is defined as 24 hours of use.

TABLE 5

Operations by Discipline

	Total Days Allocated / User Affil.	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
NHMFL-Affiliated	112	0	67	0	37	8
Local	206	0	180	0	0	26
U.S. University	304	0	113	0	24	167
U.S. Govt. Lab.	10	0	10	0	0	0
U.S. Industry	14	0	14	0	0	0
Non-U.S.	40	0	38	0	2	0
Test, Calibration, Set-up, Maintenance, Inst. Dev.	165	0	81	0	84	0
Total:	**851**	**0**	**503**	**0**	**147**	**201**

TABLE 6

User Program Experiment Pressure

Experiment Requests Received	Experiment Requests Deferred from Prev. Year	Experiment Requests Granted	Experiment Requests Declined/Deferred	Experiment Requests Reviewed	Oversubscription
69	28	81 (83.51%)	16 (16.49%)	97	119.75%

TABLE 7

New User PIs

Name	Organization	Proposal	Year of Magnet Time
Isaacs, Jennifer	Medical University of South Carolina	P02291	2013
Grubbs, Dean	Florida State University Coastal and Marine Laboratory	P02303	2013
Valentine, Dave	University of California Santa Barbara	P02304	2013
Murray, Kermit	Louisiana State University	P02306	2013
Schaub, Tanner	New Mexico State University	P02307	2013
Stiegman, Albert	FSU	P02309	2014
Moens, Luc	National Renewable Energy Laboratory	P02312	2013
Aeppli, Christoph	Woods Hole Oceanographic Institute	P02314	2013
Meyer, Buffy	Louisiana State University	P02321	2013
Gryko, Jan	Jacksonville State University	P02325	2013
MacDonald, Ian	Florida State University	P02339	2014
Star, Alexander	University of Pittsburgh	P02342	2013
Hou, Aixin	Louisiana State University	P02345	2013
Lubkowitz, Joaquin	Separation Systems	P02370	2013
Stroupe, Elizabeth	Florida State University	P02385	2013
Kilpatrick, Peter	Notre Dame University	P02396	2013
Vaughan, Pamela	University of West Florida	P02406	2013
Tarr, Matthew	University of New Orleans	P02408	2013

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TABLE 7

New User PIs (Continued)

Crane, David	CA Dept of Fish and Wildlife	P02410	2013
Coon, Joshua	University of Wisconsin-Madison	P02412	2013
Dalton, Stephen	University of Georgia	P02422	2014
Lewis, Zackary	University of Georgia	P02424	2013
Bota, Gheorghe	Institute for Corrosion and Multiphase Technology at Ohio Univerisy	P02436	2013
Savage, Phillip	University of Michigan	P02440	2013
Kaplan, Louis	Stroud Water Research Center	P02443	2013
Xu, Wei	Beijing Institute of Technology	P02492	2013
Gilbert, David	Florida State University	P02494	2013
Saravanan, Chandra	Reliance Oil	P02497	2013
Duncan, Michael	University of Georgia	P02506	2014
Yan, Beizhan	Columbia University	P02511	2013
Humayun, Munir	NHMFL	P02519	2013
Mortazavi, Behzad	University of Alabama	P07147	2013
McCafferty, Dewey	Duke University	P07159	2013
Hunt, Donald	University of Virginia	P07160	2013
Dennis, Jonathan	Florida State University	P07166	2013
Knapp, Angela	Florida State University	P07236	2014
Total:			**2013 – 31** **2014 - 5**

TABLE 8

Research Proposals[1] Profile, with magnet time

	Total	Minority[2]	Female[3]	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Matls., Testing, Instrum.	Biology, Biochem., Biophys.
Number of Proposals	79	3	15	0	50	0	8	21

1. A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
2. The number of proposals satisfying one of the following two conditions: (a) the PI is a minority OR (b) the PI is a non-minority working at a minority-serving college or university AND the proposal includes minority participants.
3. The number of proposals satisfying one of the following two conditions: (a) the PI is a female OR (b) the PI is a male working at a college or university for women AND the proposal includes female participants.

TABLE 9

User Proposals

PI	Organization	Funding Source(s)			Proposal Title & ID#	Number of Days Awarded/ Scheduled
Michael Freitas (S) New PI 2012	**Ohio University Medical Center**	National Institutes of Health		5 R01 CA107106 07	Top-down characterization of H1 phosphorylation isoforms P02204	10
Min Guo (S)		Other - Sydney Kimmel Cancer Scholar Award Other - Sydney Kimmel Cancer Scholar Award		SKF-11-003 (Guo)	HDX FT-ICR MS to Study the conformations of tRNA synthetases P02118	8
Micheal Trakselis (S) New PI 2012	**University of Pittsburgh**	Other - American Cancer Society		RSG-11-049-01-DMC	Individual DNA Strand Interactions with Hexameric Helicase Investigated by High Resolution Hydrogen/Deuterium Exchange Mass Spectrometry P02202	8
Jarrod Marto (S) New PI 2012	**Harvard Medical School**	Other - Harvard University	Dana Farber Cancer Insitute	Interal Funding	Isotopologue Chemical Labels for Quantitative Proteomics Applications P02215	6
Carol Nilsson (S)	**University of Texas Medical Branch**	National Institutes of Health	Neuroscience	NS39161, NS 11255	Spinal cord injury and novel lipid markers of chronic pain P02104	22
Brian Silliman (S)	**University of Florida**	National Science Foundation	OCE	1044939 and 1057417	Biodegradation of the Deepwater Horizon oil in marsh ecosystems and exploration of novel passive remediation strategies P02108	3
Henry Williams (S) New PI 2012	**Florida Agricultural & Mechanical University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Characterization of DOM generated by bacteriophage and bdellovibrio and like organisms (Balos) by FT-ICR MS P01964	1
Ryan Rodgers (S)	**NHMFL**	National Science Foundation Future Fuels Institute		06-54118	Isolation of Interfacial Material from Oil/Water Emulsions P02235	27

TABLE 9

User Proposals (Continued)

Ryan Rodgers (S)	**NHMFL**	National Science Foundation Other - Future Fuels Institute Other - BP-Gulf of Mexico Research Initiative		DMR-06-54118	An Efficient Method for Extraction of Water-Soluble Organics from Produced Water P02122	4
Markus Huettel (S)	**Florida State University**	Other - GRI grant Other - Future Fuels Institute			Degradation of buried crude oil from the MC252 spill in Gulf of Mexico beach sand P02106	14
Nate Kaiser (S)	**NHMFL**	National Science Foundation National Science Foundation National Science Foundation		DMR-0654118 CHE 1016942 CHE-1019193	Novel Fourier Transform Ion Cyclotron Resonance Cell design and performance P01987	14
Alexandra Stenson (S)	**University of South Alabama**	National Science Foundation		EAR-0848635	In-cell Ion Molecule Reactions to Probe Structural Features of Humic Substances P02126	6
Thomas Manning (S)	**Valdosta State University**	Other - VSU-QEP; EPA-P3			Bryostatin P02243	3
Amala Dass (S) New PI 2012	**University of Mississippi**	National Science Foundation	EPS	903787	High Resolution FTICR Mass spectrometry on atomically precise Au and Au-alloy nanoparticles P02130	4
Dean Grubbs (S) New PI 2013	**Florida State University Coastal and Marine Laboratory**	Other - Deep C Consortia Other - National Ocean and Atmospheric Sciences Other - Florida Fish and Wildlife Conservation Commission through the NOAA	NMFS Endangered Species Branch through the Northern Gulf Institute Agreement #10088	Contract WC-133F-12-SE-2310 Office of Protected Resources: ESA Section 6 Grant Program	Molecular level characterization of seafloor sediments potentially affected by the Deepwater Horizon blowout of 2010 P02303	2
Dave Valentine (S) New PI 2013	**University of California Santa Barbara**	Other - BP/Gulf of Mexico Resrarch Initiative	Deep-C Consortia		MOLECULAR-LEVEL CHARACTERIZATION OF PETROLEUM SEEPS AND ASPHALT VOLCANOES FROM SANTA BARBARA BASIN BY FT-ICR MASS SPECTROMETRY P02304	9

TABLE 9

User Proposals (Continued)

Nate Kaiser (S)	**NHMFL**	National Science Foundation		CHE-1016942 1019193	21 Tesla Fourier Transform Ion Cyclotron Resonance Instrumentation design and development P01998	81
Kermit Murray (S) New PI 2013	**Louisiana State University**	Other - American Refining Group		LSU 39654	Petroleomic Analysis of Crude Feedstocks P02306	2
Ulrich Kortz (S)	**Jacobs University**	Other - German Science Foundation Other - German Science Foundation		DFG-KO-2288/9-1 DFG-IZ-60/1-1	Mass spectrometry study of first discrete palladium(II)-gold(III) oxoanion P02320	3
Nate Kaiser (S)	**NHMFL**	National Science Foundation		227000-550-003597	Redesign of Ion Source, Ion Transfer, and Ion Accumulation for 9.4 Tesla FT-ICR Mass Spectrometer P02205	30
Neil Kelleher (S)	**Northwestern University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			The Consortium for Top-down Proteomics Pilot Project #1: Complete Characterization of Histone H4 P02123	67
Buffy Meyer (S) New PI 2013	**Louisiana State University**	Other - BP Gulf of Mexico Research Initiative			Characterization of in situ burn residues from the Deepwater Horizon oil spill P02321	3
Christoph Aeppli (P) New PI 2013	**Woods Hole Oceanographic Institute**	Other - BP/Gulf of Mexico Research Initiative	Deep-C Consortia		Molecular level characterization fo Carpinteria terrestrial tar pits by comprehensive GC X GC and FT-ICR MS P02314	5
Luc Moens (S) New PI 2013	**National Renewable Energy Laboratory**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Renewable Hydrocarbon Production through Hydrodeoxygenation of Lignocellulosic Bio-Oil P02312	2
Jennifer Isaacs (S) New PI 2013	**Medical University of South Carolina**	Other - DOD		PC110235	How secreted Hsp90 modulates histone modifications in prostate epithelial cells P02291	15
Karen Molek (S)	**University of West Florida**	National Science Foundation		227000-550-003597	SimION Simulations for A Time-of-Flight Mass Spectrometer P02302	3

TABLE 9

User Proposals (Continued)

Daniel Pierce (U)	**Florida State University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			A Comparison of Naphthenic Acid Extraction Techniques by FT-ICR MS P02336	1
Parviz Rahimi (S)	**National Centre for Upgrading Technology (NCUT)**	Future Fuels Institute			Comprehensive Simulation/ Projection of Heavy Crude Oil Distillation and Detailed Molecular Composition Prediction by Direct-Infusion Fourier Transform Ion Cyclotron Mass Spectrometry. P02294	9
John Headley (S)	**Environment Canada**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Analysis of Naphthenic Acid extracts and treated water samples by negative- ion and positive-ion ESI FT-ICR MS P02338	6
Aixin Hou (S) New PI 2013	**Louisiana State University**	Other - BP/Gulf of Mexico Research Initiative			Characterization of the BP petroleum residuals in the sediment of the Salt Marshes in the Northern Gulf of Mexico P02345	10
Amy Qing-xiang Sang (S)	**Florida State University**	Other - Susan G Komen for the Cure Breast Cancer Foundation Other - Florida Breast Cancer Coalition Research Foundation Other - Elsa U Pardee Foundation			Understanding Cancer Disparity via Investigation of Human Cancer Phosphoproteome and Signal Networks by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry P02093	15
Peter Kilpatrick (S) New PI 2013	**Notre Dame University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Characterization of Interfacial Material by FT-ICR MS P02396	2
Christine Foreman (S)	**Montana State University**	National Science Foundation	ANT - Antarctic Science	11141936 Molecular level characterization of dissolved organic carbon and microbial diversity in the WAIS Divide replicate core	WAIS Divide Rep Core P02416	2

TABLE 9

User Proposals (Continued)

Jan Gryko (S) New PI 2013	**Jacksonville State University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Development of pyrolysis method to study disintegration of heavy oil residue in the environment P02325	2
Alexander Star (S) New PI 2013	**University of Pittsburgh**	National Institutes of Health	NIEHS	RO1ES019304	Investigation and Mitigation of Carbon Nanomaterial Toxicity P02342	5
Joshua Coon (S) New PI 2013	**University of Wisconsin-Madison**	National Institutes of Health		R01 GM080148	Neutron-encoded Signatures for Ultra-plexed Protein Quantification P02412	8
Tanner Schaub (S) New PI 2013	**New Mexico State University**	Other - New Mexico State Internal Funding			Elucidation of lipid and/or metabolite indicators of M. Bovis infection by monitoring serum extract composition by FT-ICR mass spectrometry P02307	4
David Crane (S) New PI 2013	**CA Dept of Fish and Wildlife**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Characterization of Tar Balls Collected from Beaches in Central California and newly discovered Piedras Blancas Seep by FT-ICR MS P02410	2
Chris Reddy (S)	**Woods Hole Oceanographic Institute**	National Science Foundation	RAPID CHE-1049753	BMS 227000-520-028953	Molecular Level Characteriztion and Archive for the 2010 BP Oil Spill P01533	4
Pamela Vaughan (S) New PI 2013	**University of West Florida**	Other - Gulf of Mexico Research Consortia Deep-C			Development of Water Accommodated Fractions from MC252 Surrogate Oil:The role of photochemistry P02406	11
Matthew Tarr (S) New PI 2013	**University of New Orleans**	National Science Foundation National Science Foundation		1111525 1004869	High Resolution MS of Phototreated Crude Oil P02408	18
Harvey Yarranton (S) Jackie Jarvis (P) New PI 2013	**University of Calgary** **NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			CHARACTERIZATION OF BOILING FRACTIONS BY FT-ICR MS OBTAINED FROM DEEP VACUUM DISTILLATION P02224	12

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TABLE 9

User Proposals (Continued)

Ryan Rodgers (S)	**NHMFL**	Other - Future Fuels Institute			Characterization of Exploratory Crudes (Future Fuels Institute) P02414	1
Joaquin Lubkowitz (S)	**Separation Systems**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)	Separation Systems Inc. of Gulf Breeze, Florida		PROPOSAL TO OBTAIN TIME AT THE NATIONAL HIGH MAGNETIC FIELD LABORATORY FOR THE ANALYSIS OF THE ASTM REFERENCE OIL 5010 P02370	1
Zackary Lewis (S) New PI 2013	**University of Georgia**	Other - University of Georgia			Analysis of combinatorial H1 modifications in a simple eukaryotic system P02424	7
Mark Johnson (S)	**Yale University**	Department of Energy	DE-FG	DE-FG02-00ER15066 DE-FG02-06ER15800	Ultrahigh resolution mass spectrometric characterization of an activated iridum-based hydrogenation catalyst	2
New PI 2012		Department of Energy	DE-FG		P02144	
Elizabeth Stroupe (S) New PI 2013	**Florida State University**	National Science Foundation	MES	1149763	HDX FT-ICR MS to Study the conformations of electron transfer complex in sulfite reductase P02385	5
Jeff Chanton (S)	**Florida State University**	Department of Energy		DE-SC0007144	Investigating dissolved organic matter decomposition pathways with depth along a natural permafrost thaw gradient in Northern Sweden	1
		Department of Energy		DE-SC0004632	P02435	
Ryan Rodgers (S)	**NHMFL**	National Science Foundation		DMR-11-57490	Characterization of Petroleum using Spectral Stitching by High Resolution FT-ICR MS P02452	8
Phillip Savage (S)	**University of Michigan**	National Science Foundation		1157490	Characterization of Biocrudes from Fast and Conventional Hydrothermal Liquefaction of Microalgae Nannochloropsis sp.	2
New PI 2013		National Science Foundation	DGE	1256260	P02440	
Louis Kaplan (S) New PI 2013	**Stroud Water Research Center**	National Science Foundation	Division of Environmental Biology	1120717	Negative Ion ESI FT-ICR MS of Water Stream Samples from White Clay Creek in Eastern, PA and Rio Tempisquito in the Cordillera de Guanacaste, Costa Rica P02443	2

TABLE 9

User Proposals (Continued)

Friedemann Freund (S)	**NASA Ames Research Center**	NASA	Ames Research Center	227000-524-030259	Characterization of Stereochemically Constrained Complex Organic Molecules Extracted from Olivine Crystal Matrix P01878	4
Ryan Rodgers (S)	**NHMFL**	National Science Foundation		DMR-06-54118	Characterization of HVGO Sulfide Ring Type Distribution by FT-ICR MS (Future Fuels Institute) P02391	4
Amy McKenna (S)	**NHMFL**	National Science Foundation		DMR-06-54118	Optimization of instrument parameters for APPI P01753	1
Chandra Saravanan (S) New PI 2013	**Reliance Oil**	Future Fuels Institute			Educational Training and Evaluation of FT-ICR MS Facilities and Future Fuels Institute at Florida State University (Future Fuels Institue) P02497	8
Gheorghe Bota (S) New PI 2013	**Institute for Corrosion and Multiphase Technology at Ohio Univerisy**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Characterization of Corrosive Naphthenic Acids by FT-ICR MS P02436	9
Beizhan Yan (S) New PI 2013	**Columbia University**	National Science Foundation Other - GoMRI National Science Foundation Other - Deep C	OCE ECOGIG	10-58233 1157490	Characterization of Gulf of Mexico sediment cores from the Deepwater Horizon well head location P02511	3
Amy McKenna (S)	**NHMFL**	National Science Foundation		11-57490	Molecular Characterization of Petroporphyrins in Crude Oil by Atmospheric Pressure Photoionization Fourier Transform Ion Cyclotron Resonance Mass Spectrometry P02504	1
Thomas Manning (S)	**Valdosta State University**	Other - Valdosta State, NIH	NIH doing micro testing		High Resolution, High Mass Accuracy of a Copper-Albumin Complex P02496	5

TABLE 9

User Proposals (Continued)

Wei Xu (S) New PI 2013	**Beijing Institute of Technology**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Towards ion mobility measurements within FT-ICR cells P02492	2
Nate Kaiser (S)	**NHMFL**	National Science Foundation National Science Foundation		1019193 06-54118	Hardware and Software Development Toward 21 Tesla : The Use of the 14.5 Tesla FT-ICR as a Test Bed for the Future P01988	5
Amy Paller (S)	**Northwestern University**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Ganglioside Manipulation As a New Tool to Modify Skin Disease P01656	7
Nate Kaiser (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Maintenance and Cleaning of the FT-ICR MS instrumentation P07172	25
Behzad Mortazavi (S) New PI 2013	**University of Alabama**	National Science Foundation	RAPID GRANT	1042743	Characterization of oil degradation in sandy sediments with choline P07147	1
Andrew Yen (S)	**Nalco Energy Service**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			The Separation and Characterization of Oxygenated Species from Petroleum P02105	5
Priyanka Juyal (S)	**Nalco Energy Services**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)		1157490	Characterization of Interfacial Material from Crude Oil by FT-ICR MS P07156	8
Munir Humayun (S) New PI 2013	**NHMFL**	NASA	NASA	0	Molecular Analysis of Extraterrestrial Compounds in the Murchison Meteorite by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry P02519	1

TABLE 9

User Proposals (Continued)

Donald Hunt (S)	**University of Virginia**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			Front End ETD coupled to 14.5T FTICR	21
New PI 2013					P07160	
Brian Silliman (S)	**University of Florida**	National Science Foundation		DMR-11-57490	Separation-Enhanced Characterization of Environmentally Weathered Crude Oil by Fourier Transform Ion Cyclotron Mass Spectrometry (FT-ICR MS)	8
					P07192	
Harold Kroto (S)	**Florida State Unversity**	National Science Foundation		NSF CHE-1019193	Elucidation of fullerene, heterofullerene, and endohedral heterofullerene formation by high resolution FT-ICR mass spectrometry	158
		Other - Agence Nationale de la Recherche (ANR) Grant		ANR-2010-BLAN-0819-04	P02160	
Nicolas Young (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)			COMPLEMENTRAY LYS-N/LYS-C DIGESTION COMBINED WITH ULTRAHIGH RESOLUTION FT-ICR MS AND MS/MS FOR PEPTIDE DE NOVO SEQUENCING	8
					P07176	
Fraydoon Rastinejad (S)	**Sanford-Burnham Medical Research Institute**	National Institutes of Health	NIDDK	R01 DK094147	Structural characterization of estrogen related receptors (ERRs) ERRa and ERRg by HDX coupled with FT-ICR MS	6
New PI 2012					P02166	
Jeff Chanton (S)	**Florida State University**	Department of Energy		DE-SC0007144 and DE-SC0004632	Influence of Phosphorus on Soil Organic Nitrogen Pools in Subtropical Wetlands	1
		National Science Foundation	DEB	DEB-0841596	P07179	
		National Science Foundation		DMR-06-54118		
Harold Kroto (S)	**Florida State Unversity**	National Science Foundation		DMR-1157490	Study of encapsulation of clusters and metals in carbon cages by high resolution FT-ICR mass spectrometry	48
		National Science Foundation		CHE-1019193	P07175	

TABLE 9

User Proposals (Continued)

Christine Foreman (S)	**Montana State University**	National Science Foundation	Antarctic Sciences Section	11141936	Molecular level characterization of carbon and microbial diversity from the WAIS Divide replicate core P07223	2
Jonathan Dennis (S) New PI 2013	**Florida State University**	National Institutes of Health	NIDA - National Institute on Drug Abuse	R01 DA033775	Dynamic Changes in Histone Sequence Variants and Post-Translational Modifications During HIV activation P07166	2
Dewey McCafferty (S) New PI 2013	**Duke University**	U.S. Army	U.S. ARMY MEDICAL RESEARCH AND MATERIEL COMMAND (USAMRMC)	W81XWH-13-1-0400	Determination of the Substrate Specificity and Interfaces of Interaction of Lysine-Specific Demethylase 1 in Biologically Relevant Samples P07159	1
Nicolas Young (S)	**NHMFL**	No other support (i.e. this experiment is entirely supported by NHMFL users services via its core grant)	ICR		Determination of Site-Specific Proteins Disulfide Bond Redox Potentials by Top Down FTICR Mass Spectrometry P07237	13
David Gilbert (S) New PI 2013	**Florida State University**	National Institutes of Health		GM085354	Dynamic Changes in Histone Post-Translational Modifications During the Cell Cycle by Top-Down MS/MS Analysis P02494	2
Total Proposals:					**79**	**851**

APPENDIX II

Geographic Distribution

US geographic distribution of PIs and senior investigators by home institution by facility

National Distribution

Magnet Usage Start Date: 1/1/2013 Magnet Usage End Date: 12/31/2013 User Type And Country: Senior Personnel, U.S.

TABLE 1

DC Field

Name	Organization	Country
Dmytro Abraimov (S/PI)	NHMFL	FL
Charles Agosta (S/PI)	Clark University	MA
James Analytis (S/PI)	University of California, Berkeley	CA
Ray Ashoori (S/PI)	Massachusetts Institute of Technology	MA
Phaedon Avouris (S/PI)	BM T. J. Watson Research Center	NY
Hongyu Bai (S/PI)	Magnet Science and Technology, NHMFL	FL
Luis Balicas (S/PI)	NHMFL	FL
Eric Bauer (S/PI)	Los Alamos National Laboratory	NM
Greg Boebinger (S/PI)	NHMFL	FL
Scott Bole (S)	NHMFL	FL
Clifford Bowers (S/PI)	University of Florida	FL
Ivan Bozovic (S/PI)	Brookhaven National Lab	NY
William Brey (S/PI)	NHMFL	FL
James Brooks (S/PI)	Florida State University	FL
Stuart Brown (S/PI)	UCLA	CA
Paul Cadden-Zimansky (S/PI)	Bard College	NY
Yunwei Charles Cao (S/PI)	University of Florida	FL
Bob Cava (S/PI)	Princeton University	NJ
Andrey Chabanov (S/PI)	University of Texas at San Antonio	TX
Paul M Chaikin (S/PI)	Princeton University	NJ
Yong Chen (S/PI)	Purdue University	IN
Sang Wook Cheong (S/PI)	Rutgers University	NJ
Eun Sang Choi (S/PI)	NHMFL	FL
C. W. (Paul) Chu (S)	University of Houston	TX
Anthony Coley (S)	Sandia National Labs	NM
Jason Cooley (S/PI)	Alloy Design and Development Team, MST-6	NM
Nicholas Curro (S/PI)	University of California	CA
Anne de Jager (S)	University of Colorado	CO
Cory Dean (S/PI)	The City College of New York	NY
Fraser Douglas (S)	Advanced Conductor Technologies	CO
Rui-Rui Du (S/PI)	Rice University	TX
Kim Dunbar (S/PI)	Texas A&M University	TX
Lloyd Engel (S/PI)	NHMFL	FL
Chang-Beom Eom (S/PI)	University of Wisconsin	WI
Yejun Feng (S/PI)	Argonne National Laboratory	IL
Ian Fisher (S/PI)	Stanford University	CA
Nathanael Fortune (S/PI)	Smith College	MA
Frank Fratantonio (S)	NAVSEA Div Newport	RI
Madalina Furis (S/PI)	University of Vermont	VT

TABLE 1

DC Field (Continued)

Zhehong Gan (S/PI)	Florida State University	FL
James Gleeson (S/PI)	Kent State University	OH
David Goldhaber-Gordon (S/PI)	Stanford University	CA
David Graf (S/PI)	Florida State University	FL
Martin Greven (S/PI)	University of Minnesota	MN
Genda Gu (S)	Brookhaven national lab	NY
William Halperin (S/PI)	Northwestern University	IL
Ke Han (S/PI)	NHMFL	FL
Scott Hannahs (S/PI)	NHMFL	FL
Sara Haravifard (S/PI)	Argonne National Lab / University of Chicago	IL
Neil Harrison (S/PI)	NHMFL-LANL	NM
Sophia Hayes (S)	Washington University	MO
Tony Heinz (S/PI)	Columbia University	NY
Eric Hellstrom (S)	NHMFL	FL
Stephen Hill (S/PI)	NHMFL	FL
David Hilton (S/PI)	University of Alabama-Birmingham	AL
Tao Hong (S/PI)	Oak Ridge National Laboratory	TN
Yew Hor (S)	Missouri University of Science and Technology	MO
Thomas Howarth (S/PI)	NAVSEA Division Newport	RI
Eric Isaacs (S)	Argonne National Laboratory	IL
Marcelo Jaime (S/PI)	MPA-CMMS	NM
Antal Jakli (S)	Kent State University	OH
Pablo Jarillo-Herrero (S/PI)	MIT	MA
Jan Jaroszynski (S/PI)	NHMFL	FL
Quanxi Jia (S)	Mpa-cint: center for integrated nanotechnologies	NM
Jianyi Jiang (S/PI)	ASC-NHMFL	FL
Zhigang Jiang (S/PI)	Georgia Institute of Technology	GA
Glover Jones (S)	NHMFL	FL
Giti Khodaparast (S/PI)	Virginia Tech.	VA
Philip Kim (S/PI)	Columbia University	NY
Kenneth Knappenberger (S/PI)	Florida State University	FL
Daniel Kominsky (S/PI)	Prime Photonics	VA
Junichiro Kono (S/PI)	Rice University	TX
Jurek Krzystek (S/PI)	NHMFL	FL
Philip Kuhns (S)	NHMFL	FL
Cagliyan Kurdak (S/PI)	University of Michigan	MI
Igor Kuskovsky (S/PI)	Queens College of CUNY	NY
Chris Landee (S/PI)	Clark University	MA
Jonathan Lang (S)	Argonne National Lab	IL
Chun Ning (Jeanie) Lau (S/PI)	University of California, Riverside	CA
Jeremy Levy (S/PI)	University of Pittsburgh	PA
Lu Li (S/PI)	University of Michigan	MA
Qiang Li (S/PI)	Brookhaven National Lab	NY

TABLE 1

DC Field (Continued)

Qing'an Li (S)	Argonne National Laboratory	IL
Zhiqiang Li (S/PI)	National High Magnetic Field Laboratory	FL
Jun Lu (S/PI)	NHMFL	FL
David Mandrus (S/PI)	Oak Ridge National Laboratory	TN
Michael Manfra (S)	Bell Labs	NJ
Denis Markiewicz (S/PI)	NHMFL	FL
Ivar Martin (S)	Argonne National Laboratory	IL
Lane Martin (S)	University of Illinois	IL
Nadya Mason (S/PI)	University of Illinois	IL
Ross McDonald (S/PI)	NHMFL - LANL	NM
Stephen McGill (S/PI)	NHMFL	FL
Charles Mielke (S/PI)	NHMFL - LANL	NM
George Miller (S)	NHMFL	FL
Daniel Mindiola (S)	Indiana University	IN
Ireneusz Miotkowski (S)	Purdue University	IN
John Mitchell (S)	Argonne National Laboratory	IL
Sheena Murphy (S/PI)	University of Oklahoma	OK
Tim Murphy (S/PI)	NHMFL	FL
Janice Musfeldt (S/PI)	University of Tennessee, Knoxville	TN
Patrick Noyes (S/PI)	NHMFL	FL
N. Phuan Ong (S/PI)	Princeton University	NJ
Andrew Ozarowski (S/PI)	National High Magnetic Field Laboratory	FL
Tom Painter (S/PI)	NHMFL	FL
Eric Palm (S/PI)	NHMFL-FSU	FL
Chris Palmstrom (S/PI)	UC Santa Barbara	CA
Wei Pan (S/PI)	Sandia National Labatories	NM
Ju-Hyun Park (S)	NHMFL	FL
Loren Pfeiffer (S)	Princeton University	NJ
Andy Powell (S/PI)	NHMFL	FL
Kenneth Purcell (S/PI)	University of Southern Indiana	IN
Lawrence Que (S)	University of Minnesota	MN
R. Ramesh (S/PI)	University of California, Berkeley	CA
Arneil Reyes (S/PI)	NHMFL	FL
Filip Ronning (S/PI)	Los Alamos National Laboratory	NM
Tom Rosenbaum (S/PI)	Univ. of Chicago	IL
Kresimir Rupnik (S/PI)	Louisiana State University	LA
Michael Santos (S/PI)	University of Oklahoma	OK
Jeffrey Schiano (S)	Penn State University	PA
John Schlueter (S/PI)	Argonne National Laboratory	IL
S n Seestrom (S)	Los Alamos National Laboratory	NM
Venkat Selvamanickam (S/PI)	University of Houston	TX
Sung Seok Seo (S)	University of Kentucky	KY
Mansour Shayegan (S/PI)	Princeton University	NJ

TABLE 1

DC Field (Continued)

Kiran Shetty (S)	NHMFL	FL
Weidong Si (S)	Brookhaven National Laboratory	NY
Theo Siegrist (S/PI)	NHMFL	FL
Daniel Silevitch (S)	University of Chicago	IL
Dmitry Smirnov (S/PI)	NHMFL	FL
Sam Sprunt (S/PI)	Kent State University	OH
George Srajer (S)	Argonne National Lab	IL
Christopher Stanton	(S/PI) University of Florida	FL
S. Stemmer	(S/PI) UC Santa Barbara	CA
Kevin Storr (S/PI)	Prairie View A&M University	TX
Alexey Suslov (S/PI)	NHMFL	FL
Yasu Takano (S/PI)	University of Florida	FL
David Tanner (S/PI)	University of Florida	FL
Chiara Tarantini (S)	Florida State University	FL
Antoniette Taylor (S/PI)	Los Alamos National Laboratory	NM
Joshua Telser (S/PI)	Roosevelt University	IL
Joe Thompson (S/PI)	Los Alamos National Laboratory	NM
Stan Tozer (S/PI)	NHMFL	FL
Ulf Trociewitz (S/PI)	NHMFL	FL
Daniel Tsui (S/PI)	Princeton University	NJ
Li-Chun Tung (S/PI)	University of North Dakota	ND
Mark Turnbull (S/PI)	Clark University	MA
Danko van der Laan (S/PI)	National Institute of Standards and Technology	CO
Feng Wang (S/PI)	University of California, Berkeley	CA
Hailin Wang (S/PI)	University of Oregon	OR
Kang Wang (S/PI)	UCLA	CA
Maitri Warsawithana (S/PI)	Dept of Physics, Florida State University / NHMFL	FL
Hubertus Weijers (S/PI)	NHMFL	FL
Ken West (S)	Princeton University	NJ
Chris Westcott (S)	Prime Photonics	VA
James Willit (S)	Argonne National Laboratory	IL
Stanislaus Wong (S)	Stony Brook/BNL	NY
Jie Wu (S)	Brookhaven National Laboratory	NY
Yan Xin (S/PI)	NHMFL	FL
Aixia Xu (S)	University of Houston	TX
Xiaodong Xu (S/PI)	University of Washington	WA
Peide Ye (S/PI)	Purdue University	IN
Chenglin Zhang (S/PI)	The University of Tennessee	TN
Haidong Zhou (S/PI)	University of Tennessee	TN
Michael Zudov (S/PI)	University of Minnesota	MN
Xiaowei Zuo (S/PI)	MST	FL
166 Users		

TABLE 2

Pulsed Field

Name	Organization	Country
James Analytis (S/PI)	University of California, Berkeley	CA
Meigan Aronson (S/PI)	Brookhaven National Laboratory	NY
Fedor Balakirev (S/PI)	NHMFL - LANL	NM
Cristian Batista (S)	Los Alamos National Laboratory	NM
Eric Bauer (S/PI)	Los Alamos National Laboratory	NM
Jonathan Betts (S/PI)	LANL	NM
Gang Cao (S/PI)	University of Kentucky	KY
Sang Wook Cheong (S/PI)	Rutgers University	NJ
Jason Cooley (S/PI)	Alloy Design and Development Team, MST-6	NM
Scott Crooker (S/PI)	Los Alamos National Lab	NM
Georg Ehlers (S)	Oak Ridge National Laboratory	TN
Ian Fisher (S/PI)	Stanford University	CA
Brian Fluegel (S)	National Renewable Energy Lab	CO
Franz Freibert (S)	LANL	NM
David Graf (S/PI)	Florida State University	FL
Martin Greven (S/PI)	University of Minnesota	MN
Genda Gu (S)	Brookhaven national lab	NY
Neil Harrison (S/PI)	NHMFL-LANL	NM
John Hill (S/PI)	Brookhaven National Laboratory	NY
Pei-Chun Ho (S/PI)	California State University, Fresno	CA
Marcelo Jaime (S/PI)	MPA-CMMS	NM
Marc Janoschek (S/PI)	LANL	NM
Rongying Jin (S)	Louisiana State University	LA
Valery Kiryukhin (S)	Rutgers University	NJ
Chun Ning (Jeanie) Lau (S/PI)	University of California, Riverside	CA
Lu Li (S/PI)	University of Michigan	MA
Jamie Manson (S/PI)	Eastern Washington University	WA
Brian Maple (S/PI)	Univ. of California at San Diego	CA
Angelo Mascarenhas (S/PI)	National Renewable Energy Lab	CO
Ross McDonald (S/PI)	NHMFL - LANL	NM
Michael McHenry (S/PI)	Carnegie Mellon University	PA
Charles Mielke (S/PI)	NHMFL - LANL	NM
Albert Migliori (S/PI)	Los Alamos National Laboratory	NM
Jeremy Mitchell (S)	LANL	NM
Tim Murphy (S/PI)	NHMFL	FL
Doan Nguyen (S/PI)	NHMFL - PFF	NM
N. Phuan Ong (S/PI)	Princeton University	NJ
Eric Palm (S/PI)	NHMFL-FSU	FL
Ju-Hyun Park (S)	NHMFL	FL
Ward Plummer (S)	Louisiana State University	LA

TABLE 2

Pulsed Field (Continued)

Andrey Podlesnyak (S)	Oak Ridge National Laboratory	TN
Raphael Raptis (S/PI)	Florida International University	FL
Dwight Rickel (S/PI)	NHMFL @ LANL	NM
Efrain Rodriguez (S)	UMD	MD
Filip Ronning (S/PI)	Los Alamos National Laboratory	NM
John Schlueter (S/PI)	Argonne National Laboratory	IL
Ram Seshadri (S/PI)	UCSB	CA
John Singleton (S)	NHMFL - LANL	NM
Nathan Smythe (S/PI)	Chemistry Division	NM
Joe Thompson (S/PI)	Los Alamos National Laboratory	NM
Stan Tozer (S/PI)	NHMFL	FL
James Willit (S)	Argonne National Laboratory	IL
Vivien Zapf (S/PI)	NHMFL-LANL	NM
Haidong Zhou (S/PI)	University of Tennessee	TN
Wojciech Zurek (S)	Los Alamos National Lab	NM
55 Users		

TABLE 3

High B/T

Name	Organization	Country
Greg Boebinger (S/PI)	NHMFL	FL
Xuan Gao (S/PI)	Case Western Reserve University	OH
Jian Huang (S/PI)	Wayne State University	MI
Michael Lilly (S)	Sandia National Labs	NM
Naoto Masuhara (S)	University of Florida	FL
Wei Pan (S/PI)	Sandia National Labatories	NM
Loren Pfeiffer (S)	Princeton University	NJ
John Reno (S)	Sandia National Laboratories	NM
James Sturm (S)	Princeton University	NJ
Neil Sullivan (S)	University of Florida	FL
Yasu Takano (S/PI)	University of Florida	FL
Daniel Tsui (S/PI)	Princeton University	NJ
Ken West (S)	Princeton University	NJ
Jian-sheng Xia (S)	University of Florida	FL
14 Users		

TABLE 4

NMR

Name	Organization	Country
Edward Agyare (S)	Florida A & M	FL
Linan An (S/PI)	University of Central Florida	FL
Rajendra Arora (S)	FAMU-FSU College of Engineering	FL
Nitash Balsara (S)	University of California Berkeley	CA
William Brey (S/PI)	NHMFL	FL
Rafael Bruschweiler (S/PI)	Ohio State University	OH
Lei Bruschweiler-Li (S)	Ohio State University	OH
David Bth (S/PI)	Brigham Young University,	UT
Barry Byrne (S)	UF	FL
Srinivasan Chandrashekar (S/PI)	NHMFL	FL
Bo Chen (S/PI)	University of Central Florida	FL
Hailong Chen (S/PI)	Georgia Institute of Technology	GA
Alexander Cole (S)	University of Central Florida	FL
Amy Cole (S)	University of Central Florida	FL
Myriam Cotten (S/PI)	Hamilton College	NY
Tim Cross (S/PI)	Florida State University	FL
Geoffrey Curran (S)	Mayo Clinic	MN
Naresh Dalal (S/PI)	Florida St. University	FL
Mark Davis (S/PI)	California Institute of Technology	CA
David Doty (S/PI)	Doty Scientific, Inc	SC
Ben Dunn (S)	UF	FL
Arthur Edison (S)	University of Florida	FL
Elan Eisenmesser (S/PI)	University of Colorado Health Sciences Center	CO
Paul Ellis (S)	Doty Scientific Inc	SC
George Entzmiger (S)	Doty Scientific, Inc	SC
Piotr Fajer (S/PI)	FSU	FL
Gail Fanucci (S/PI)	University of Florida	FL
Benny Freeman (S/PI)	The University of Texas at Austin	TX
Riqiang Fu (S/PI)	NHMFL	FL
Zhehong Gan (S/PI)	Florida State University	FL
Barjor Gimi (S/PI)	Dartmouth Medical School	NH
Petr Gor'kov (S/PI)	NHMFL	FL
Samuel Grant (S/PI)	FSU & The National High Magnetic Field Laboratory	FL
Clare Grey (S/PI)	State University of New York at Stony Brook	NY
Lisa Hall (S)	Ohio State University	OH
Daniel Hallinan (S)	Florida State University	FL
James Harper (S/PI)	University of Central Florida	FL
Michael Harrington (S/PI)	Huntington Medical Research Institutes	CA
Arturo Hernandez-Maldonado (S/PI)	University of Puerto Rico - Mayaguez	PR
David Hilton (S)	NHMFL	FL
Sonjong Hwang (S)	Caltech	CA

TABLE 4

NMR (Continued)

Camille Jones (S/PI)	Columbia University	NY
Karunya Kandimalla (S/PI)	Florida A&M University	FL
Dorothee Kern (S/PI)	HHMI/Brandeis University	MA
David Larbalestier (S/PI)	National High Magnetic Field Lab	FL
Cathy Levenson (S/PI)	FSU College of Medicine	FL
Kwang Hun Lim (S/PI)	East Carolina University	NC
Joanna Long (S/PI)	NHMFL/UF Mcknight Brain Institute	FL
Val Lowe (S)	Mayo Clinic	MN
Teng Ma (S)	Florida State university	FL
Richard Magin (S/PI)	University of Illinois at Chicago	IL
Denis Markiewicz (S/PI)	NHMFL	FL
James McGrath (S/PI)	Virginia Tech	VA
Manish Mehta (S/PI)	Oberlin College	OH
Stephen Melville (S/PI)	Virginia Tech	VA
Brian Miller (S/PI)	Florida State University	FL
George Miller (S)	NHMFL	FL
Robert Nast (S)	Out of the Fog Research	CA
Patrick Noyes (S/PI)	NHMFL	FL
William Oates (S/PI)	FAMU-FSU College of Engineering	FL
Dmitry Ostrovsky (S)	University of Alaska Anchorage	AK
Anant Paravastu (S/PI)	FSU/FAMU College of Engineering	FL
Sunkyu Park (S)	North Carolina State University	NC
Gary Pielak (S/PI)	University of North Carolina-Chapel Hill	NC
Joseph Poduslo (S)	Mayo Clinic College of Medicine	MN
Tatyana Polenova (S/PI)	University of Delaware	DE
Malini Rajagopalan (S)	University of Texas Health and Science Center	TX
Subramanian Ramakrishnan (S)	FSU	FL
Ayyal my Ramamoorthy (S/PI)	University of Michigan	MI
Simone Raoux (S)	IBM	NY
James Rocca (S)	NHMFL-UF	FL
Eric Rubin (S/PI)	Harvard University	MA
Rosalind Sadleir (S/PI)	Arizona State University	AZ
Victor Schepkin (S/PI)	NHMFL	FL
Jeffrey Schiano (S)	Penn State University	PA
Sabyasachi Sen (S/PI)	University of California at Davis	CA
Kiran Shetty (S)	NHMFL	FL
Carlos Simmerling (S)	Stony Brook University	NY
Likai Song (S/PI)	NHMFL	FL
Geoffrey Strouse (S/PI)	FSU	FL
Suresh Swaminathan (S)	University of Minnesota	MN
Suren Tatulian (S)	University of Central Florida	FL
Fang Tian (S/PI)	Penn State University	PA
Nate Traaseth (S/PI)	New York University	NY

TABLE 4

NMR (Continued)

Ulf Trociewitz (S/PI)	NHMFL	FL
Vitali Tugarinov (S)	University of Maryland	MD
Liliya Vugmeyster (S/PI)	University of Alaska Anchorage	AK
Glenn Walter (S/PI)	College of Medicine	FL
Hubertus Weijers (S/PI)	NHMFL	FL
Sungsool Wi (S/PI)	NHMFL	FL
Richard Withers (S)	Maxim Integrated	CA
Fengli Zhang (S/PI)	NHMFL	FL
Huilan Zhang (S)	University of Delaware	DE
Jianping Zheng (S)	FSU	FL
Jim Zheng (S)	Florida State University - FAMU-FSU College of Engineering	FL
Huan-Xiang Zhou (S)	Florida State University	FL
Peizhi Zhu (S/PI)	University of Michigan	MI
97 Users		

TABLE 5

AMRIS

Name	Organization	State
Mavis Agbandge-McKenna	UF	FL
Tetsuo Ashizawa	UF	FL
Michael D. Best	Tennessee	TN
Stephen Blackband	UF	FL
Prodip Bose	UF	FL
Clifford Bowers	UF	FL
L. Jeanine Brady	UF	FL
William Brey	NHMFL	FL
Richard Briggs	Georgia State	GA
Craig Brodersen	UF	FL
Rebecca Butcher	UF	FL
Christopher Butson	Medical College Of Wisconsin	WI
Paul Carney	UF	FL
M.W. Clark	UF	FL
Thomas Conlon	UF	FL
Terrence Deacon	UC Berkeley	CA
Warren Dixon	UF	FL
Vonetta Dotson	UF	FL
Art Edison	UF	FL
Matthew Erickson	UF	FL
Gail Fanucci	UF	FL
Marcelo Febo	UF	FL

TABLE 5

AMRIS (Continued)

Pedro Fernandez-Funez	UF	FL
Aron Fisher	Univ Of Pennsylvania	PA
David Fizgerald	UF	FL
Terence Flotte	Univ Of Massachusetts	MA
Kelly D. Foote	UF	FL
John Forder	UF	FL
Joe Gibney	UF	FL
Tamara Hamilton	Barry Univ.	FL
Andrew Hanson	UF	FL
Coy Heldermon	UF	FL
Alisa Huffaker	USDA	FL
Patrick W. Inglett	UF	FL
Huabei Jiang	UF	FL
James Keener	UF	FL
William Koros	Georgia Inst. Of Technology	GA
Sooyeon Lee	UF	FL
Joanna Long	UF	FL
Donovan Lott	UF	FL
Hendrik Luesch	UF	FL
Richard Magin	Illinois Chicago	IL
Edward Maginn	Notredame	IN
Thomas Mareci	UF	FL
Glenroy Martin	The University Of Tampa	FL
Elizabeth McNally	Univ Of Chicago	IL
Manish Mehta	Oberlin	OH
Eric Montie	Univ Of South Carolina	SC
Lucia Notterpek	UF	FL
Michael Okun	UF	FL
David Ostrov	UF	FL
Xuejun Pan	Univ Of Wisconsin	WI
Valerie Paul	Smithsonian	FL
Subbarayan Pochi	Univ Of Miami	FL
Dave Powell	UF	FL
Justin Ragains	Louisiana State	LA
K. Ramesh Reddy	UF	FL
Adrian Roitberg	UF	FL
Rosalind Sadleir	Arizona State	AZ
Mark Sands	Washington Univ	MO
Malisa Sarntinoranont	UF	FL
Eric Schmelz	USDA	FL
W.W. Seeley	Uc San Francisco	CA
Jindal Shah	Notredame	IN

TABLE 5

AMRIS (Continued)

William Shain	Univ Of Washington	WA
Tim Shepherd	New York University	NY
Nishanth Sunny	UF	FL
Ana Tari	UF	FL
Fred Thompson	UF	FL
Zhaohui Tong	UF	FL
David Vaillancourt	UF	FL
Krista Vandenborne	UF	FL
Sergey Vasenkov	UF	FL
Glenn Walter	UF	FL
Adam Woods	UF	FL
75 Users		

TABLE 6

EMR

Name	Organization	Country
Thomas Albrecht-Schmitt (S/PI)	Florida State University	FL
Linan An (S/PI)	University of Central Florida	FL
Alex Angerhofer (S/PI)	University of Florida	FL
Phaedon Avouris (S/PI)	IBM T. J. Watson Research Center	NY
Andreja Bakac (S/PI)	Ames Laboratory, Iowa State University	IA
Ewa Bienkiewicz (S/PI)	FSU	FL
Christoph Boehme (S)	University of Utah	UT
Marc Caporini (S)	Bruker Biospin	MA
Irinel Chiorescu (S/PI)	NHMFL & Florida State University	FL
Naresh Dalal (S/PI)	Florida St. University	FL
Evgeny Dikarev (S/PI)	University at Albany, SUNY	NY
Mircea Dinca (S/PI)	Massachusetts Institute of Technology	MA
Kim Dunbar (S/PI)	Texas A&M University	TX
Piotr Fajer (S/PI)	FSU	FL
Danna Freedman (S/PI)	Northwestern University	IL
Gregory Girolami (S/PI)	University of Illinois at Urbana-Champaign	IL
David Goldberg (S/PI)	Johns Hopkins University	MD
Robert Haddon (S/PI)	University of California Riverside	CA
Stephen Hill (S/PI)	NHMFL	FL
Stephen Holmes (S/PI)	University of Missouri-St. Louis	MO
Jurek Krzystek (S/PI)	NHMFL	FL
San Latturner (S/PI)	Florida State University	FL

TABLE 6

EMR (Continued)

Patrick Lenahan (S/PI)	Penn State University	PA
Zhiqiang Li (S/PI)	National High Magnetic Field Laboratory	FL
Joanna Long (S/PI)	NHMFL/UF Mcknight Brain Institute	FL
James M.Tour (S)	Rice University	TX
Richard Magliozzo (S/PI)	Brooklyn College CUNY	NY
Jamie Manson (S/PI)	Eastern Washington University	WA
Alan Marshall (S)	NHMFL	FL
Amy McKenna (S/PI)	NHMFL	FL
Mark Meisel (S/PI)	University of Florida	FL
Matthew Merritt (S/PI)	University of Texas Southwestern Medical Center	TX
Andrew Ozarowski (S/PI)	National High Magnetic Field Laboratory	FL
Muthukrishna Raja (S/PI)	Claflin University	SC
Raphael Raptis (S/PI)	Florida International University	FL
Daniel Reger (S/PI)	University of South Carolina	SC
William Reiff (S/PI)	Northeastern University	MA
Ellis Reinherz (S/PI)	Dana-Farber Cancer Institute	MA
Ryan Rodgers (S/PI)	NHMFL	FL
Charles Schulz (S/PI)	Knox College	IL
Michael Shatruk (S/PI)	Florida State University	FL
Dmitry Smirnov (S/PI)	NHMFL	FL
Likai Song (S/PI)	NHMFL	FL
Scott Stagg (S/PI)	Florida State University	FL
Albert Stiegman (S/PI)	FSU	FL
Geoffrey Strouse (S/PI)	FSU	FL
Mas Subramanian (S/PI)	Oregon State University	OR
Daniel R. Talham (S)	University of Florida	FL
Joshua Telser (S/PI)	Roosevelt University	IL
Christine Thomas (S/PI)	Brandeis University	MA
Johan van Tol (S/PI)	Florida State University	FL
Mary Ellen Zvanut (S/PI)	University of Alabama at Birmingham	AL
52 Users		

TABLE 7

ICR

Name	Organization	Country
Jennifer Isaacs (S/PI)	Medical University of South Carolina	SC
Jeffrey Agar (S)	Brandeis University	MA
Gordon Anderson (S)	PNNL	WA
Greg Blakney (S)	NHMFL	FL
Gheorghe Bota (S/PI)	Institute for Corrosion and Multiphase Technology at Ohio University	OH
Jennifer Brodbelt (S)	University of Texas at Austin	TX
Benjamin Bythell (S)	University of Missouri-St Louis	MO
Jeff Chanton (S/PI)	Florida State University	FL
Joshua Coon (S/PI)	University of Wisconsin-Madison	WI
William Cooper (S/PI)	Florida State University	FL
David Crane (S/PI)	CA Dept of Fish and Wildlife	CA
Amala Dass (S/PI)	University of Mississippi	MS
Jonathan Dennis (S/PI)	Florida State University	FL
Mark Emmett (S/PI)	University of Texas Medical Branch	TX
Christine Foreman (S/PI)	Montana State University	MT
Michael Freitas (S/PI)	Ohio University Medical Center	OH
Friedemann Freund (S/PI)	NASA Ames Research Center	CA
David Gilbert (S/PI)	Florida State University	FL
David Goodlett (S)	University of Washington	WA
Dean Grubbs (S/PI)	Florida State University Coastal and Marine Laboratory	FL
Jan Gryko (S/PI)	Jacksonville State University	AL
Min Guo (S/PI)	The Scripps Research Institute - Florida	FL
Young Gwak (S)	University of Texas Medical Branch	TX
Chris Hendrickson (S/PI)	NHMFL	FL
Laird Henkel (S)	California Dept of Fish and Game	CA
Aixin Hou (S/PI)	Louisiana State University	LA
Markus Huettel (S/PI)	Florida State University	FL
Claire Hulsebosch (S)	University of Texas Medical Branch	TX
Munir Humayun (S/PI)	NHMFL	FL
Donald Hunt (S/PI)	University of Virginia	VA
Wade Jeffrey (S)	University of West Florida	FL
Mark Johnson (S/PI)	Yale University	CT
Priyanka Juyal (S/PI)	Nalco Energy Services	TX
Nate Kaiser (S/PI)	NHMFL	FL
Louis Kaplan (S/PI)	Stroud Water Research Center	PA
Neil Kelleher (S/PI)	Northwestern University	IL
Peter Kilpatrick (S/PI)	Notre Dame University	IN
Joel Kostka (S)	Florida State University	FL
Harold Kroto (S/PI)	Florida State University	FL
Franklin Leach (S)	PNNL	WA
Zackary Lewis (S/PI)	University of Georgia	GA

TABLE 7

ICR (Continued)

Joaquin Lubkowitz (S/PI)	Separation Systems	FL
Thomas Manning (S/PI)	Valdosta State University	GA
Alan Marshall (S)	NHMFL	FL
Marida Martin (S)	California Dept of Fish and Game	CA
Jarrod Marto (S/PI)	Harvard Medical School	MA
Dewey McCafferty (S/PI)	Duke University	NC
Amy McKenna (S/PI)	NHMFL	FL
Roberto Meneghini (S)	Separation Systems	FL
Buffy Meyer (S/PI)	Louisiana State University	LA
Luc Moens (S/PI)	National Renewable Energy Laboratory	CO
Karen Molek (S/PI)	University of West Florida	FL
Behzad Mortazavi (S/PI)	University of Alabama	AL
Jennifer Mosher (S/PI)	Stroud Water Research Center	PA
Kermit Murray (S/PI)	Louisiana State University	LA
Robert Nelson (S)	Woods Hole Oceanographic Institute	MA
Carol Nilsson (S/PI)	University of Texas Medical Branch	TX
Edward Overton (S)	Louisiana State University	LA
Amy Paller (S/PI)	Northwestern University	IL
Ljiljana Pasa-Tolic (S)	Battelle Pacific Northwest Laboratory	WA
John Peterson (S)	American Refining Group	PA
Fraydoon Rastinejad (S/PI)	Sanford-Burnham Medical Research Institute	FL
Chris Reddy (S/PI)	Woods Hole Oceanographic Institute	MA
K. Ramesh Reddy (S)	University of Florida	FL
Rob Ricker (S)	NOAA	CA
Ryan Rodgers (S/PI)	NHMFL	FL
Brian Ruddy (S/PI)	Taxon Biosciences	CA
Amy Qing-xiang Sang (S/PI)	Florida State University	FL
Phillip Savage (S/PI)	University of Michigan	MI
Tanner Schaub (S/PI)	New Mexico State University	NM
Jeffrey Shabanowitz (S)	University of Virginia	VA
Brian Silliman (S/PI)	University of Florida	FL
Alexander Star (S/PI)	University of Pittsburgh	PA
Alexandra Stenson (S/PI)	University of South Alabama	AL
Elizabeth Stroupe (S/PI)	Florida State University	FL
Eric Swindell (S)	University of Texas-Houston Medical School	TX
John Syka (S)	Thermo Fisher Scientific	VA
Matthew Tarr (S/PI)	University of New Orleans	LA
Tyler Thacker (S)	USDA-Agricultural Research Service	NM
Micheal Trakselis (S/PI)	University of Pittsburgh	PA
Dave Valentine (S/PI)	University of California Santa Barbara	CA
Pamela Vaughan (S/PI)	University of West Florida	FL
Xiaoqi Wang (S)	Northwestern University	IL

TABLE 7

ICR (Continued)

Chad Weisbrod (S)	NHMFL	FL
Henry Williams (S/PI)	Florida Agricultural & Mechanical University	FL
Beizhan Yan (S/PI)	Columbia University	NY
Andrew Yen (S/PI)	Nalco Energy Service	TX
Nicolas Young (S/PI)	NHMFL	FL
Huimin Zhang (S)	Merck Research Laboratories, Merck & Co., Inc	NJ
Andrew Zimmerman (S/PI)	University of Florida	FL
90 Users		

International Distribution

Magnet Usage Start Date: 1/1/2013 Magnet Usage End Date: 12/31/2013 User Type And Country: Senior Personnel, U.S.

TABLE 8

DC Field

Name	Organization	Country
Manuel Almeida (S)	ITN, Sacavém	Portugal
Rod Badcock (S)	Industrial Research Ltd	New Zealand
Bertram Batlogg (S/PI)	ETH	Switzerland
Jonathan Baugh (S)	University of Waterloo	Canada
Emilio Bellingeri (S)	CNR-SPIN	Italy
Doug Bonn (S/PI)	University of British Columbia	Canada
Valeria Braccini (S)	CRN	Italy
Bruce Brandt (S/PI)	Hefei High Magnetic Field Lab	China
Chris Bumby (S)	IRL, New Zealand	New Zealand
Kenneth Burch (S/PI)	University of Toronto	Canada
David Cardwell (S/PI)	University of Cambridge	United Kingdom
Kwang Yong Choi (S/PI)	Chung Ang University	South Korea
Young Jai Choi (S)	Yonsei University	South Korea
Hanna Dabkowska (S)	McMaster	Canada
Yoram Dagan (S/PI)	Tel Aviv University	Israel
Nicolas Doiron-Leyraud (S)	University of Sherbrooke	Canada
Irina Drichko (S/PI)	A.F.Ioffe PTI	Russia
Haifeng Du (S)	Chinese Academy of Science	China
Cheng Fan (S)	Hefei National Laboratory	China
Carlo Ferdeghini (S/PI)	CNR-SPIN	Italy
Andrea Ferrari (S)	Cambridge University	United Kingdom
Bruce Gaulin (S)	McMaster University	Canada
Guillaume Gervais (S/PI)	McGill University	Canada
Paul Goddard (S/PI)	Oxford University	United Kingdom

TABLE 8

DC Field (Continued)

Hans-Joachim Grafe (S/PI)	IFW Dresden	Germany
Guennadi Gusev (S)	University of Sao Paulo	Brazil
Jens Hanisch (S/PI)	Leibniz Institute for Solid State and Materials Research IFD Dresden	Germany
Walter Hardy (S)	University of British Columbia	Canada
Thomas Herrmannsdoerfer (S/PI)	Helmholtz-Zentrum Dresden-Rossendorf	Germany
Yuko Hosokoshi (S/PI)	Osaka Prefecture University	Japan
Kazumasa Iida (S)	IFW Dresden	Germany
YounJung Jo (S/PI)	Kyungpook National University	South Korea
Marc-Henri JULIEN (S/PI)	CNRS Grenoble	France
Shinsaku Kambe (S)	Advanced Science Research Center	Japan
Woun Kang (S/PI)	Ewha Womans University	South Korea
Janusz Karpinski (S/PI)	ETH-Zurich	Switzerland
Shinji Kawasaki (S)	Okayama University	Japan
Naoki Kikugawa (S/PI)	National Institute for Materials Science	Japan
Jun Sung Kim (S/PI)	POSTECH	Korea
Hans-Henning Klauss (S/PI)	Technical University Dresden	Germany
Yoshimitsu Kohama (S/PI)	Tokyo University	Japan
Ray LaPierre (S)	McMaster University	Canada
Zheng Li (S)	Institute of Physics	China
Ruixing Liang (S)	University of British Columbia	Canada
Nicholas Long (S/PI)	Industrial Research Ltd	New Zealand
Gil Lonzarich (S/PI)	Cambridge University	United Kingdom
Hubertus Luetkens (S)	Paul Scherrer Institute	Switzerland
Mitsuhiko Maesato (S/PI)	Kyoto University	Japan
Jochen Mannhart (S)	Max Planck Institute	Germany
Yuji Matsuda (S/PI)	Kyoto University	Japan
Joel Mesot (S)	Paul Scherrer Institute	Switzerland
Karsten Meyer (S)	Friedrich-Alexander-University Erlangen-Nuremberg	Germany
Keizo Murata (S/PI)	Osaka City University	Japan
Satoru Nakatsuji (S/PI)	University of Tokyo	Japan
Sergey Obukhov (S/PI)	The Ioffe Physical Technical Institute of the Russian Academy of Sciences	Russia
Toshio Ono (S)	Osaka Prefecture University	Japan
Toshihito Osada (S/PI)	Institute for Solid State Physics, University of Tokyo	Japan
Hans Rudolf Ott (S/PI)	ETH Zuerich	Switzerland
Pascoal Pagliuso (S/PI)	UNICAMP	Brazil
Je-Geun Park (S)	Seoul National University	Korea
Yung Woo Park (S/PI)	Seoul National University	South Korea
Yury Pusep (S/PI)	Institute of Physics, University of Sao Paulo	Brazil
Henrik Ronnow (S)	EPFL	Switzerland
Christian Ruegg (S/PI)	Paul Scherrer Institute	Switzerland
Florence Rullier-Albenque (S)	Commissariat à l'Energie Atomique	France
Hironori Sakai (S/PI)	Japan Atomic Energy Agency	Japan

TABLE 8

DC Field (Continued)

Suchitra Sebastian (S/PI)	Cambridge University	United Kingdom
Takasada Shibauchi (S)	Kyoto University	Japan
Toni Shiroka (S)	ETH Zurich	Switzerland
Dmitry Shulyatev (S/PI)	National University of Science and Technology “MISIS”	Russia
Ivan Smirnov (S)	A.F.Ioffe PTI	Russia
Xuefeng Sun (S/PI)	Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China	China
Thomas Szkopek (S)	McGill University	Canada
Louis Taillefer (S/PI)	University of Sherbrooke	Canada
Cherry Tan (S)	Shanghai University	China
Hidekazu Tanaka (S/PI)	Tokyo Institute of Technology	Japan
Taichi Terashima (S/PI)	National Institute for Materials Science	Japan
Mingliang Tian (S/PI)	Hefei Institute for Physical Science	China
Yo Tokunaga (S)	Advanced Science Research Center	Japan
Alexander Toropov (S)	Institute of Semiconductors	Russia
XiaoCheng Wang (S)	Beijing National Laboratory for Condensed Matter Physics, Institute of Physics, Chinese Academy of Sciences	China
Ning Wei (S)	Chinese Academy of Sciences	China
Tao Wu (S)	University of Science and Technology of China	China
Chuanying Xi (S)	Chinese Academy of Sciences	China
Mikhail Yakunin (S/PI)	Institute of Metal Physics	Russia
Minoru Yamashita (S)	ISSP, University of Tokyo	Japan
Huiqiu Yuan (S/PI)	Zhejiang University	China
Changjin Zhang (S/PI)	Chinese Academy of Sciences	China
Guo-Qing Zheng (S/PI)	Okayama University	Japan
Nikolai Zhigadlo (S)	ETH-Zurich	Switzerland
Sergei Zvyagin (S/PI)	Dresden High Magnetic Field Laboratory	Germany
91 Users		

TABLE 9

Pulsed Field

Name	Organization	Country
Bertram Batlogg (S/PI)	ETH	Switzerland
Doug Bonn (S/PI)	University of British Columbia	Canada
Euan Brechin (S/PI)	University of Edinburgh	United Kingdom
Paul Goddard (S/PI)	Oxford University	United Kingdom
Walter Hardy (S)	University of British Columbia	Canada
Yoshihiro Iwasa (S/PI)	The University of Tokyo	Japan
Janusz Karpinski (S/PI)	ETH-Zurich	Switzerland
Kee Hoon Kim (S/PI)	Seoul National University	South Korea
Ruixing Liang (S)	University of British Columbia	Canada

TABLE 9

Pulsed Field (Continued)

Gil Lonzarich (S/PI)	Cambridge University	United Kingdom
Gwilherm Nénert (S/PI)	ILL	France
Shimpei Ono (S)	Central Research Institute of Electric Power Industry (CRIEPI)	Japan
Armando Paduan-Filho (S)	Universidade de Sao Paulo	Brazil
Francisco Rivadulla (S/PI)	Universidade de Santiago de Compostela	Spain
Helge Rosner (S)	Max-Planck-Institute Chemical Physics of Solids Dresden	Germany
Florence Rullier-Albenque (S)	Commissariat à l'Energie Atomique	France
Suchitra Sebastian (S/PI)	Cambridge University	United Kingdom
Yayu Wang (S/PI)	Tsinghua University	China
Huiqiu Yuan (S/PI)	Zhejiang University	China
Nikolai Zhigadlo (S)	ETH-Zurich	Switzerland
20 Users		

TABLE 10

High B/T

Name	Organization	Country
Cheng Fan (S)	Hefei National Laboratory	China
Xuefeng Sun (S/PI)	Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China	China
2 Users		

TABLE 11

NMR

Name	Organization	Country
Jean-Paul Amoureux (S/PI)	Université des Sciences et Technologies de Lille	France
Henrik Bildsoe (S)	Aarhus University	Denmark
Michael Brorson (S)	Haldor Topsoe	Denmark
Lucio Frydman (S/PI)	Weizmann Institute of Science	Israel
Hans Jakobsen (S/PI)	University of Aarhus	Denmark
Antonios Kolocouris (S)	National and Kapodistrian University of Athens	Greece
Vladimir Ladizhansky (S/PI)	University of Guelph	Canada
Chang Hyun Lee (S/PI)	Dankook University	Republic of Korea
Cheoi Lee (S)	Korea University	Korea
Conggang Li (S/PI)	Wuhan Institute of Physics & Mathematics, Chinese Academy of Sciences	China
Ho Bum Park (S)	Hanyang University	Republic of Korea
Jan Rainey (S/PI)	Dalhousie University	Canada
Roberto Salinas (S)	University of Sao Paulo	Brazil
Robert Schurko (S/PI)	University of Windsor	Canada

TABLE 11

NMR (Continued)

Victor Terskikh (S)	University of Ottawa	Canada
Eung Je Woo (S)	Kyung Hee University	South Korea
Gang Wu (S/PI)	Queen's University	Canada
Yong Yang (S)	Xiamen University	China
18 Users		

TABLE 12

AMRIS

Name	Organization	Country
Ian Castro-Gamboa	Univ Of Sao Paulo	Brazil
Helena Nader	Universidade Federal de São Paulo	Brazil
R. Scott Prosser	Univ Of Toronto	Canada
Ting Liu	Beijing Acad Of Ag & Forestry	China
Lina Wang	SMMU	China
Brian Hansen	Aarhus Univ.	Denmark
Joanna Collingwood	Univ Of Warwick	England
Marcus Baumer	Bremen Univ.	Germany
Ben Turner	Smithsonian	Panama
9 Users		

TABLE 13

EMR

Name	Organization	Country
Nuria Aliaga-Alcalde (S/PI)	ICREA & UB	Spain
Bernard Barbara (S)	CNRS	France
Fabrice Bert (S)	Laboratoire de Physique des Solides	France
Sylvain Bertaina (S/PI)	IM2NP - CNRS	France
Roman Boca (S/PI)	Slovak Technical University	Slovakia
Euan Brechin (S/PI)	University of Edinburgh	United Kingdom
Kenneth Burch (S/PI)	University of Toronto	Canada
Joan Cano (S/PI)	Universita de Valencia	Spain
Isabel Castro (S)	Universitat de València	Spain
Kwang Yong Choi (S/PI)	Chung Ang University	South Korea
Enrique Colacio (S/PI)	Universidad de Granada	Spain
Konstantin Domasevitch (S)	Taras Shevchenko National University of Kyiv	Ukraine
Julia Jezierska (S/PI)	Wroclaw University	Poland
Miguel Julve (S)	Universitat de Valencia	Spain
Ulrich Kortz (S/PI)	Jacobs University	Germany

TABLE 13

EMR (Continued)

Harald Krautscheid (S)	Universität Leipzig	Germany
Panayotis Kyritsis (S/PI)	University of Athens	Greece
Francesc Lloret (S)	Universitat de València	Spain
Andriy Lysenko (S/PI)	Taras Shevchenko National University of Kyiv	Ukraine
Boris Malkin (S)	Kazan State University	Russia
Philippe Mendels (S)	Laboratoire de Physique des Solides	France
Sasankasekhar Mohanta (S)	University of Calcutta	India
Gavin Morley (S/PI)	University of Warwick	United Kingdom
Achim Mueller (S)	Bielefeld University	Germany
Muralee Murugesu (S/PI)	U. of Ottawa	Canada
Richard Oakley (S/PI)	University of Waterloo	Canada
Emilio Pardo (S)	Universitat de València	Spain
Paul Plieger (S)	Massey University/ University of New Zealand	New Zealand
Armando Pombeiro (S/PI)	Instituto Superior Tecnico	Portugal
Kathryn Preuss (S/PI)	University of Guelph	Canada
Darrin Richeson (S/PI)	University of Ottawa	Canada
Eliseo Ruiz (S)	University of Barcelona (UB)	Spain
Eduard Rusanov (S)	Institute of Organic Chemistry National academy of sciences of Ukraine	Ukraine
Hiroshi Sakiyama (S/PI)	Yamagata University	Japan
Maheswaran Shanmugam (S/PI)	Indian Institute of Technology-Bombay	India
Ral Sharma (S/PI)	Panjab University	India
Andre Stesmans (S)	K U Leuven	Belgium
Changlin Tian (S/PI)	University of Science and Technology of China	P. R. China
En-Che Yang (S/PI)	Fu-Jen Catholic University	Republic of China
Andrej Zorko (S/PI)	"Jozef Stefan" Institute	Slovenia
40 Users		

TABLE 14

ICR

Name	Organization	Country
Jean-Joseph Adjizian (S)	Université de Nantes	France
Christoph Borchers (S)	University of Victoria-Genome British Columbia	Canada
Ramachandra Chakravarthy (S)	Reliance	India
Julia Chamot-Rooke (S)	Ecole Polytechnique, Centre national de la recherche scientifique	France
Christopher Ewels (S)	Universite de Nantes	France
John Headley (S/PI)	Environment Canada	Canada
Natalya Izarova (S)	Jacobs University	Germany
Ulrich Kortz (S/PI)	Jacobs University	Germany
Anu Krishnan (S)	Reliance	India
Pat Langridge-Smith (S)	University of Edinburgh	United Kingdom

TABLE 14

ICR (Continued)

Josep Poblet (S/PI)	Universitat Rovira i Virgili	Spain
Parviz Rahimi (S/PI)	National Centre for Upgrading Technology (NCUT)	Canada
Antonio Rodriguez-Fortea (S)	Universitat Rovira i Virgili	Spain
Chandra Saravanan (S/PI)	Reliance Oil	India
Hisanori Shinohara (S)	Nagoya University	Japan
Hisanori Shinohara (S)	Nagoya University	Japan
Biswajit Shown (S)	Reliance	India
Yury Tsybin (S/PI)	Ecole Polytechnique Federale de Lausanne EPFL	Switzerland
Wei Xu (S/PI)	Beijing Institute of Technology	China
Harvey Yarranton (S/PI)	University of Calgary	Canada
20 Users		

APPENDIX III

Personnel

Personnel

SENIOR PERSONNEL AT FSU, UF & LANL (214)

Name	Job Title
100 – Management and Administration	
Cordi, Thomas	Assistant Lab Director, Business Administration
Davidson, Michael	Assistant Scholar / Scientist
Rea, Clyde	Assistant Director, Business & Financial / Auxiliary Services
Zhu, Lei	Assistant Professor
300 – DC Instrumentation	
Bangura, Ali	Visiting Professor
Hannahs, Scott	Dir, DC Facilities and Instrumentation
Murphy, Timothy	Research Associate
400 – Magnet Science and Technology	
Bai, Hongyu	Assistant Scholar / Scientist
Bird, Mark	Scholar / Scientist
Crooks, Roy	Visiting Assistant Scholar / Scientist
Dixon, Iain	Research Associate
Gavrilin, Andrey	Scholar / Scientist
Guo, Wei	Professor
Han, Ke	Scholar / Scientist
Hilton, David	Assistant Scholar / Scientist
Kalu, Peter	Professor
Li, Tianlei	Visiting Assistant Scholar / Scientist
Lu, Jun	Assistant Scholar / Scientist
Marakov, Alex	Visiting Scientist/Researcher
Markiewicz, William	Scholar / Scientist
Marshall, William	Research Associate
Painter, Thomas	Research Associate
Toth, Jack	Scholar / Scientist
Van Sciver, Steven	Professor
Walsh, Robert	Research Associate
Weijers, Hubertus	Associate Scholar / Scientist
Xin, Yan	Associate Scholar / Scientist
Zavion, Sheryl	Program Director

400 – Magnet Science and Technology (continued)	
Zheng, Jianping	Professor
Zuo, Xiaowei	Visiting Assistant Scholar / Scientist
500 – Condensed Matter Science	
Albrecht-Schmitt, Thomas	Professor
Balicas, Luis	Scholar / Scientist
Baumbach, Ryan	Research Faculty I
Bonesteel, Nicholas	Professor
Brooks, James	Professor
Cao, Jianming	Professor
Chiorescu, Irinel	Professor
Choi, Eun Sang	Associate Scholar / Scientist
Dalal, Naresh	Professor
Dobrosavljevic, Vladimir	Professor
Engel, Lloyd	Scholar / Scientist
Fajer, Piotr	Professor
Gao, Hanwei	Assistant Professor
Gilmer, Penny	Adjunct Professor
Gor'kov, Lev	Professor
Graf, David	Assistant Scholar / Scientist
Hill, Stephen	Professor/EMR Director
Hoch, Michael	Visiting Scientist/Researcher
Jaroszynski, Jan	Associate Scholar / Scientist
Kikugawa, Naoki	Visiting Associate Scholar / Scientist
Knappenberger, Kenneth	Assistant Professor
Kovalev, Alexey	Assistant in Materials Instrumentation
Krzystek, Jerzy	Scholar / Scientist
Kuhns, Philip	Scholar / Scientist
Li, Zhiqiang	Assistant Scholar / Scientist
Ma, Biwu	Associate Professor
Manousakis, Efstratios	Professor
McGill, Stephen	Associate Scholar / Scientist
Moulton, William	Professor
Oates, William	Assistant Professor
Ozarowski, Andrzej	Assistant Scholar / Scientist

500 – Condensed Matter Science (continued)	
Park, Ju-Hyun	Associate Scholar / Scientist
Popovic, Dragana	Scholar / Scientist
Ramakrishnan, Subramanian	Associate Professor
Reiff, William	Visiting Associate Scholar / Scientist
Reyes, Arneil	Scholar / Scientist
Rikvold, Per	Professor
Schlottmann, Pedro	Professor
Schneemeyer, Lynn	Visiting Associate in
Shatruk, Mykhailo	Assistant Professor
Siegrist, Theo	Professor
Smirnov, Dmitry	Scholar / Scientist
Song, Likai	Assistant Scholar / Scientist
Suslov, Alexey	Associate Scholar / Scientist
Telotte, John	Associate Professor
Tozer, Stanley	Scholar / Scientist
Vafek, Oskar	Associate Professor
van Tol, Johan	Scholar / Scientist
Warusawithana, Maitri	Assistant Professor
Whalen, Jeffrey	Assistant Scholar / Scientist
Winger, Ian	Associate in
Yang, Kun	Professor
Zhang, Mei	Associate Professor
Zhou, Haidong	Adjunct Assistant Scholar/Scientist

600 – LANL	
Balakirev, Fedor	Staff Member
Betts, Jonathan	Technical Staff Member
Crooker, Scott	Staff Member
Harrison, Neil	Staff Member
Hinrichs, Mark	Electrical Engineer
Hundley, Mike	CMMS Group Leader
Jaime, Marcelo	Staff Member
McDonald, Ross	Staff Member
Mielke, Charles	Director, Pulsed Field Facility at LANL and Deputy Group Leader
Migliori, Albert	Staff Member and LANL Fellow

600 – LANL (continued)	
Nguyen, Doan	Magnet Scientist
Rickel, Dwight	Staff Member
Singleton, John	Staff Member and LANL Fellow
Zapf, Vivien	Staff Member
700 – CIMAR	
Alamo, Rufina	Professor
Arora, Rajendra	Professor
Blakney, Gregory	Associate Scholar / Scientist
Brey, William	Scholar / Scientist
Bruschweiler, Rafael	Professor
Cross, Timothy	Professor
Eberlim de Corilo, Yuri	Visiting Assistant Scholar / Scientist
Frydman, Lucio	Scholar / Scientist
Fu, Riqiang	Scholar / Scientist
Gaffney, Betty	Professor of Biology
Gan, Zhehong	Scholar / Scientist
Gor'kov, Peter	Research Associate
Grant, Samuel	Associate Professor
Hallinan, Daniel	Assistant Professor
Houpt, Thomas	Professor
Hung, Ivan	Assistant in
Jakobsen, Hans	Visiting Professor
Kaiser, Nathan	Assistant Scholar / Scientist
Kim, Jeong-su	Assistant Professor
Litvak, Ilya	Visiting Assistant in
Lobodin, Vladislav	Visiting Assistant Scholar / Scientist
Lu, Jie	Assistant in Research
Marshall, Alan	Professor
McKenna, Amy	Assistant Scholar / Scientist
Paravastu, Anant	Assistant Professor
Podgorski, David	Visiting Assistant Scholar / Scientist
Qin, Huajun	Assistant in Research
Rodgers, Ryan	Scholar / Scientist
Schepkin, Victor	Associate Scholar / Scientist

700 – CIMAR (continued)	
Weisbrod, Chad	Visiting Assistant Scholar / Scientist
Wi, Sungsool	Associate Scholar / Scientist
Young, Nicolas	Assistant Scholar / Scientist
Zhang, Fengli	Assistant Scholar / Scientist
Zhou, Huan-Xiang	Associate Professor
800 – UF	
Abernathy, Cammy	Professor, Materials Science & Engineering
Andraka, Bohdan	Associate Scientist in Physics
Angerhofer, Alexander	Professor, Chemistry
Ashizawa, Tetsuo	Melvin Greer Professor and Chairman, Department of Neurology, Executive Director McKnight Brain Institute
Biswas, Amlan	Associate Professor of Physics
Blackband, Stephen	Professor, Neuroscience
Bowers, Clifford	Associate Professor, Chemistry
Brey, Wallace	Professor Emeritus, Chemistry
Butcher, Rebecca	Assistant Professor
Cheng, Hai Ping	Professor of Physics
Christou, George	Drago Professor
Douglas, Elliot	Associate Professor, Materials Science & Engineering
Edison, Arthur	Professor, Biochemistry & Molecular Biology
Eyler, John	Professor Emeritus, Chemistry
Fanucci, Gail	Associate Professor
Febo, Marcelo	Assistant Professor
Fitzsimmons, Jeffrey	Professor, Radiology
Forder, John	Associate Professor of Radiology
Hagen, Stephen	Professor
Hamlin, James	Assistant Professor
Hebard, Arthur	Distinguished Professor of Physics
Hershfield, Selman	Professor
Hirschfeld, Peter	Professor
Ingersent, Kevin	Chair of UF Physics Department & Professor
Kumar, Pradeep	Professor
Labbe, Greg	Senior Engineer
Lai, Song	Associate Professor
Lee, Yoonseok	Professor

800 – UF (continued)	
Labbe, Greg	Senior Engineer
Lai, Song	Associate Professor
Lee, Yoonseok	Professor
Long, Joanna	Associate Professor
Luesch, Hendrik	Associate Professor
Mareci, Thomas	Professor
Maslov, Dmitrii	Professor
Masuhara, Naoto	Senior Engineer, Microkelvin Laboratory
Meisel, Mark	Professor
Murray, Leslie	Assistant Professor
Muttalib, Khandker	Professor
Pearton, Stephen	Distinguished Professor, Alumni Professor of Materials Science & Engineering
Polfer, Nicolas	Assistant Professor
Rinzler, Andrew	Professor
Stanton, Christopher	Professor
Stewart, Gregory	Professor
Sullivan, Neil	Professor
Takano, Yasumasa	Professor
Talham, Daniel	Professor
Tanner, David	Distinguished Professor of Physics
Vaillancourt, David	Associate Professor
Vandenborne, Krista	Professor
Vasenkov, Sergey	Associate Professor
Walter, Glenn	Associate Professor
Xia, Jian-Sheng	Associate Scientist
Yin, Liang	Assistant Scientist
Zeng, Huadong	Specialist, Animal MRI/S Applications

1100 – ASC	
Abraimov, Dmytro	Associate Scholar / Scientist
Griffin, Van	Associate In Research
Hellstrom, Eric	Professor
Jiang, Jianyi	Associate Scholar / Scientist
Kametani, Fumitake	Assistant Scholar / Scientist
Larbalestier, David	Chief Materials Scientist

1100 – ASC (continued)	
Lee, Peter	Scholar / Scientist
Liang, Zhiyong	Associate Professor
Pamidi, Sastry	Assistant Scholar / Scientist
Polyanskii, Anatolii	Associate Scholar / Scientist
Starch, William	Associate in Research
Sung, Zu Hawn	Visiting Assistant Scholar / Scientist
Tarantini, Chiara	Assistant Scholar / Scientist
Trociewitz, Ulf	Associate Scholar / Scientist
1200 – Director's Office	
Boebinger, Gregory	Director/Professor
Hughes, Roxanne	Assistant Scholar/Scientist
Palm, Eric	Deputy Lab Director
Roberts, Kristin	Director of Public Affairs
1300 – Geochemistry	
Chanton, Jeff	Professor
Cooper, William	Professor
Froelich, Philip	Scholar / Scientist
Hsieh, Ping	Professor
Humayun, Munir	Professor
Landing, William	Professor
Odom, Leroy	Professor
Salters, Vincent	Professor
Wang, Yang	Professor

Personnel

POSTDOCTORAL ASSOCIATES AT FSU, UF & LANL (59)

Name	Job Title
400 – Magnet Science and Technology	
Chagovets, Tymofiy	Postdoctoral Associate
Niu, Rongmei	Postdoctoral Associate
500 – Condensed Matter Science	
Beedle, Christopher	Postdoctoral Associate
Besara, Tiglet	Postdoctoral Associate
Chen, Zhiguo	Postdoctoral Associate
Coniglio, William	Postdoctoral Associate
Cvetkovic, Vladimir	Postdoctoral Associate
Dubroca, Thierry	Postdoctoral Associate
Goswami, Pallab	Postdoctoral Associate
Grockowiak, Audrey	Postdoctoral Associate
Hatke, Anthony	Postdoctoral Associate
Lai, Hsin-Hua	Postdoctoral Associate
Maiti, Saurabh	Postdoctoral Associate
Moon, Byoung Hee	Postdoctoral Associate
Murray, James	Postdoctoral Associate
Park, Jin Gyu	Postdoctoral Associate
Poumirol, Jean-Marie	Postdoctoral Associate
Pradhan, Nihar	Postdoctoral Associate
Shi, Zhenzhong	Postdoctoral Associate
Steven, Eden	Postdoctoral Associate
Stoian, Sebastian	Postdoctoral Associate
Thirunavukkuarasu, Komalavalli	Postdoctoral Associate
Wang, Liran	Postdoctoral Associate
Wang, Shengyu	Postdoctoral Associate
Wildeboer, Julia	Postdoctoral Associate
Yasuyuki, Shimura	Visiting Scientist/Researcher
Zeng, Bin	Postdoctoral Associate
600 – LANL	
Jain, Prashant	

600 – LANL (continued)	
Kim, Jae Wook	
Mun, Eun-Deok	Postdoctoral Research Associate
Ramshaw, Brad	Postdoctoral Research Associate
Rice, Bill	Postdoctoral Research Associate
Shehter, Arkady	Postdoctoral Research Associate
Zhu, Zengwei	Postdoctoral Research Associate
700 – CIMAR	
Brownstein, Naomi	Postdoctoral Associate
Chen, Huan	Postdoctoral Associate
Chen, Yu	Postdoctoral Associate
Dai, Jian	Postdoctoral Associate
Dunk, Paul	Postdoctoral Associate
Guan, Xiaoyan	Postdoctoral Associate
He, Huan	Postdoctoral Associate
Hooker, Jerris	Postdoctoral Associate
Jarvis, Jacqueline	Postdoctoral Associate
Kweon, Jin Jung	Postdoctoral Associate
Lalli, Priscila	Postdoctoral Associate
Larion, Mioara	Postdoctoral Associate
Ramachandran, Vasanth	Postdoctoral Associate
Rosenberg, Jens	Postdoctoral Associate
Tang, Tzu-chun	Postdoctoral Associate
800 – UF	
Serafin, Alessandro	Postdoctoral Associate
1100 – ASC	
Constantinescu, Anca-Monia	Postdoctoral Associate
Craig, Natanette	Postdoctoral Associate
Kandel, Hom	Postdoctoral Associate
Zhang, Zili	Postdoctoral Associate
1300 – Geochemistry	
Mayer, Bernhard	Postdoctoral Associate
Morton, Pete	Postdoctoral Associate
Perrot, Vincent	Postdoctoral Associate
Shelley, Rachel	Postdoctoral Associate
Waeselmann, Naemi	Postdoctoral Associate

Personnel

OTHER PROFESSIONALS AT FSU, UF & LANL (82)

Name	Job Title
100 – Management and Administration	
Brooks, Richard	Facilities Superintendent
Clark, Eric	Application Developer/Designer
Kynoch, John	Assistant Director
McCrory, Marcia	Budget Analyst
McEachern, Judy	Assistant Director, Business Systems
Payne, Jimmy	Scientific Research Specialist
Thomas, Carey	Budget Analyst
Wood, Marshall	Facilities Electrical Supervisor
300 – DC Instrumentation	
Barrios, Matthew	Research Engineer
Berhalter, James	Technology Specialist
Billings, Jonathan	Scientific Research Specialist
Boenig, Heinrich	Engineer
Dalton, Bryon	Scientific Research Specialist
Jensen, Peter	Network Administrator
Jones, Glover	Scientific Research Specialist
Maier, Scott	Scientific Research Specialist
Powell, James	Research Engineer
Rubes, Edward	Scientific Research Specialist
Schwartz, Robert	Scientific Research Specialist
Schwerin, John	Technology Specialist
Semenov, Dmitry	Scientific Research Specialist
Stiers, Eric	Research Engineer
Williams, Vaughan	Research Engineer
400 – Magnet Science & Technology	
Adkins, Todd	Research Engineer
Bole, Scott	Research Engineer
Cantrell, Kurtis	Research Engineer
Goddard, Robert	Scientific Research Specialist
Gundlach, Scott	Research Engineer

400 – Magnet Science & Technology (continued)	
Jarvis, Brent	Research Engineer
Johnson, Zachary	Research Engineer
Lucia, Joseph	Welder/Technician
Marks, Emsley	Research Engineer
McRae, Dustin	Research Engineer
Mellow, Amy	Adminstrative Specialist
Miller, George	Research Engineer
Noyes, Patrick	Associate in Research
O'Reilly, James	Research Engineer
Richardson, Donald	Research Engineer
Sheppard, William	Research Engineer
Stanton, Robert	Research Engineer
Su, Yi-Feng	Research Specialist
Toplosky, Vince	Scientific Research Specialist
Viouchkov, Youri	Research Engineer
Voran, Adam	Research Engineer
White, James	Research Engineer
500 – Condensed Matter Science	
Javed, Arshad	Grants Compliance Analyst
Ling, Shenglong	Research Assistant
Luallen, Renee	Program Coordinator
Stillwell, Ryan	Research Assistant
Sun, Liang	Visiting Scientist/Researcher
Trociewitz, Bianca	Research Engineer
Wood, Ryan	Visiting Scientist/Researcher
700 – CIMAR	
Beu, Steven	Visiting Scientist/Researcher
Bickett, Karol	Administrative Specialist
Hodges, Kurt	Coordinator, Animal Welfare Compliance
Kitchen, Jason	NMR Engineer
McIntosh, Daniel	Scientific Research Specialist
Quinn, John	Research Engineer
Ranner, Steven	Research Engineer
Schiano, Jeffrey	Visiting Scientist/Researcher

800 – UF	
Elumalai, Malathy	RF Engineer
Jenkins, Kelly	RF Coil Engineer
Nicholson, Tammy	Certified Radiology Technology Mgr. (3T Imaging Applications)
Plant, Daniel	Coordinator
Rocca, James	Senior Chemist & NMR Applications Specialist
1100 – ASC	
Hanawa, Masafumi	Visiting Scientist/Researcher
Higashikawa, Kohei	Visiting Scientist/Researcher
Linville, Connie	Administrative Specialist
1200 – Director's Office	
Coyne, Kristen	Media Specialist
DeBoer, Diana	Administrative Specialist
Laufenberg, Kathleen	Media Specialist
Orth, William	Industrial Safety & Health Engineer
Roberson, Bettina	Assistant Director, Administrative Services
Rodman, Christopher	Industrial Safety & Health Eng.
Sanchez, Jose	Associate in Research
Sutton, Angela	Assistant Director, Environmental, Health, Safety and Security
Tabtimtong, Nilubon	Media Specialist
Toth, Anke	Program Coordinator
Vernon, Lizette	Media Specialist
Villa, Carlos	Training Specialist
1300 – Geochemistry	
Sachi-Kocher, Afi	Scientific Research Specialist
White, Gary	Scientific Research Specialist

Personnel

GRADUATE STUDENTS AT FSU, UF & LANL (157)

Name	Job Title
100 – Management and Administration	
Daykin, Kirsten	Microscopist
Wilson, Korey	Microscopist
400 – Magnet Science and Technology	
Allampalli, Surya Prakash	Graduate Research Assistant
Becker, Lee	Graduate Research Assistant
Bosque, Ernesto	Graduate Research Assistant
Brown, Daniel	Graduate Research Assistant
Deng, Liping	Research Assistant
Dhuley, Ram	Graduate Research Assistant
Gao, Jian	Research Assistant
Gordon, Renee	Research Assistant
Harwood, Parker	Graduate Research Assistant
Mastracci, Brian	Graduate Research Assistant
Scott, Valesha	Graduate Research Assistant
Vanderlaan, Mark	Graduate Research Assistant
Zhao, Congcong	Research Assistant
500 – Condensed Matter Science	
Akinfaderin, Adewale Abiodun	Graduate Research Assistant
Baity, Paul	Graduate Research Assistant
Barrett, Ryan	Graduate Research Assistant
Benjamin, Shermane	Graduate Research Assistant
Chakraborty, Shantanu	Graduate Research Assistant
Chen, Kuan-Wen	Graduate Research Assistant
Cherian, Judy	Graduate Research Assistant
Christian, Jonathan	Graduate Research Assistant
Cipri, Robert	Graduate Research Assistant
Coulter, John	Graduate Research Assistant
Das, Suvadip	Graduate Research Assistant
Dong, Lianyang	Graduate Research Assistant
Ellanson, Garrett	Graduate Research Assistant

500 – Condensed Matter Science (continued)	
Feng, Weibo	Graduate Research Assistant
Gallagher, Andrew	Graduate Research Assistant
Ghosh, Soham	Graduate Research Assistant
Gorfien, Matthew	Graduate Research Assistant
Greer, Samuel	Graduate Research Assistant
Javan Mard, Hossein	Graduate Research Assistant
Kinyon, Jared	Graduate Research Assistant
Kiswandhi, Andhika	Graduate Research Assistant
Komijani, Dorsa	Graduate Research Assistant
Kreth, Phillip	Graduate Research Assistant
Lai, You	Graduate Research Assistant
Lakshmi Bhaskaran, FNU	Graduate Research Assistant
Lee, Minseong	Graduate Research Assistant
Lee, Tsung-Han	Graduate Research Assistant
Li, Dong	Graduate Research Assistant
Liou, Shiuan-Fan	Graduate Research Assistant
Liu, Teng	Graduate Research Assistant
Ludwig, Jonathan	Graduate Research Assistant
Lundberg, Matthew	Graduate Research Assistant
Mahmoudian, Samiyeh	Graduate Research Assistant
Martens, Mathew	Graduate Research Assistant
Memaran, Shahriar	Graduate Research Assistant
Mendez, Joshua	Graduate Research Assistant
Moench, Michael	Research Assistant
Muhammed, Faheem	Graduate Research Assistant
Muhandis, Muhandis	Graduate Research Assistant
Pavanjeet Kaur, FNU	Graduate Research Assistant
Pouranvari, Mohammad	Graduate Research Assistant
Pramudya, Yohanes	Graduate Research Assistant
Ramirez, Daniel	Graduate Research Assistant
Rhodes, Daniel	Graduate Research Assistant
Riner, Lauren	Research Assistant
Simmons, Danielle	Graduate Research Assistant
Stanley, Lily	Graduate Research Assistant
Suarez, Daniel	Graduate Research Assistant

500 – Condensed Matter Science (continued)	
Sun, Jifeng	Graduate Research Assistant
Tang, Shao	Graduate Research Assistant
Wang, Luyang	Graduate Research Assistant
Wang, Xi	Graduate Research Assistant
Wilson, Douglas	Graduate Research Assistant
Winter, Laurel	Graduate Research Assistant
Yuan, Shaojie	Graduate Research Assistant
Yue, Guang	Graduate Research Assistant
Zeuch, Daniel	Graduate Research Assistant
Zhang, Qiu	Graduate Research Assistant
Zhang, Yuhui	Graduate Research Assistant
Zhou, Jun	Graduate Research Assistant
Zhou, Qiong	Graduate Research Assistant

600 – LANL	
Martinez, Nicholas	Graduate Research Assistant
Modic, Kimberly	Graduate Student

700 – CIMAR	
Abrahams, Carl	Graduate Research Assistant
Beasley, Rebecca	Graduate Research Assistant
Bradshaw, Miles	Graduate Research Assistant
Chen, Tong	Graduate Research Assistant
Clingenpeel, Amy	Graduate Research Assistant
Dang, Xibei	Graduate Research Assistant
Das, Nabanita	Graduate Research Assistant
Ekanayake, E	Graduate Research Assistant
Escobar, Cristian	Graduate Research Assistant
Griffin, James (Jay)	Graduate Research Assistant
Huang, Danting	Graduate Research Assistant
Hudson, Benjamin	Graduate Research Assistant
Khamoui, Andy	Graduate Research Assistant
Krajewski, Logan	Graduate Research Assistant
Leonard, Sarah	Graduate Research Assistant
Liu, Peilu	Graduate Research Assistant
Longo, Liam	Graduate Research Assistant
Meng, Dan	Graduate Research Assistant

700 – CIMAR (continued)	
Miao, Yimin	Graduate Research Assistant
Morris, Debbie	Graduate Research Assistant
Muniz, Jose	Graduate Research Assistant
Murray, Dylan	Graduate Research Assistant
Oparaji, Onyekachi	Graduate Research Assistant
Paulino, Joana	Graduate Research Assistant
Poornan, Avinash	Graduate Research Assistant
Ramaswamy, Vijaykumar	Graduate Research Assistant
Rowland, Steven	Graduate Research Assistant
Sahanggamu, Paula	Graduate Research Assistant
Shellikeri, Annadanesh	Graduate Research Assistant
Shin, Yiseul	Graduate Research Assistant
Shomo, Alan	Graduate Research Assistant
Tao, Yeqing	Graduate Research Assistant
Tingting, Jiang	Graduate Research Assistant
Worden, Matthew	Graduate Research Assistant
Wright, Anna	Graduate Research Assistant
Wu, Xianfang	Graduate Research Assistant
Yang, Guang	Graduate Research Assistant
Zimmerman, Maxwell	Graduate Research Assistant
1100 – ASC	
Brown, Michael	Graduate Research Assistant
Chen, Peng	Graduate Research Assistant
Collins, Justin	Graduate Research Assistant
Davis, Daniel	Graduate Research Assistant
Hu, Xinbo	Graduate Research Assistant
Matras, Maxime	Graduate Research Assistant
Sanabria, Carlos	Graduate Research Assistant
Segal, Christopher	Graduate Research Assistant
Weiss, Jeremy	Graduate Research Assistant
Whittington, Andrew	Graduate Research Assistant
1200 – Director's Office	
Jangra, Smriti	Graduate Research Assistant
Kemper, Jonathon	Graduate Research Assistant
Moir, Camilla	Graduate Research Assistant

1200 – Director's Office (continued)	
Nzekwe, Brandon	Graduate Research Assistant
Stegen, Zachary	Graduate Research Assistant
Wartenbe, Mark	Graduate Research Assistant
1300 – Geochemistry	
Aljahdali, Mohammed	Graduate Research Assistant
Bosman, Samantha	Graduate Research Assistant
Bowman, Chelsie	Research Assistant
Dial, Angela	Graduate Research Assistant
Ebling, Alina	Graduate Research Assistant
Edwards, Amy	Graduate Research Assistant
Eller, Virginia	Technician
Harper, Alexandra	Graduate Research Assistant
Henrick, Stevie	Graduate Research Assistant
Hodgkins, Suzanne	Graduate Research Assistant
Imhoff, Johanna	Graduate Research Assistant
Krishnamurthy, Nishanth	Graduate Research Assistant
Landing, Alexandra	Laboratory Assistant / Technician
Liu, Rui	Graduate Research Assistant
Mauney, Michael	Graduate Research Assistant
Mickle, Alejandra	Graduate Research Assistant
Pan, Ruiguang	Graduate Research Assistant
Rogers, Kelsey	Graduate Research Assistant
Roy, Rupsa	Graduate Research Assistant
Stacklyn, Shannon	Graduate Research Assistant
Tazaz, Amanda	Graduate Research Assistant
Tremaine, Darrel	Graduate Research Assistant
Wang, Zong	Graduate Research Assistant
Yang, Shuying	Graduate Research Assistant
Yokum, Evan	Graduate Research Assistant

Personnel

UNDERGRADUATES AT FSU, UF & LANL (70)

Name	Job Title
100 – Management and Administration	
Kohn, Jonathan	Web Designer/Programmer
400 – Magnet Science & Technology	
Arroyo, Erick	Technician
Dellinger, Kegan	Laboratory Assistant / Technician
Flynn, Daniel	Technician
Nwodu, Arriana	Clerk
Sloan, Timothy	Research Assistant
Walsh, Nicole	Technician
Wickery, Ryne	Technician
400 – Magnet Science & Technology	
Adkins, Todd	Research Engineer
Bole, Scott	Research Engineer
Cantrell, Kurtis	Research Engineer
Goddard, Robert	Scientific Research Specialist
Bernheisel, Ashley	Laboratory Assistant / Technician
Bernstein, Michael	Laboratory Assistant / Technician
Bjeren, Nils	Research Assistant
Chown, Amanda	Research Assistant
Coffman, Christopher	Research Assistant
Colbert, Ashlee	Research Assistant
Daniel, Alden	Graduate Research Assistant
deTorres, Fernando	Laboratory Assistant / Technician
Ellis, Andrew	Research Assistant
Ferrari, Anthony	Research Assistant
Gray, Matthew	Research Assistant
Hwang, Christine	Research Assistant
Jarrett, Jeremy	Laboratory Assistant / Technician
Jensen, Justin	Research Assistant
Jerdi, Bourna	Research Assistant
Jeter, Emily	Research Assistant

400 – Magnet Science & Technology (continued)	
Johansen, Cody	Research Assistant
Johnson, Hayden	Research Assistant
Jordan, Cody	Research Assistant
Krehl, Jessey	Laboratory Assistant / Technician
Lipscomb, Crystal	Research Assistant
Mckay, Zara	Research Assistant
Porter, Amber	Research Assistant
Redmon, Carissa	Research Assistant
Sanchez, Lorena	Research Assistant
Silverman, Isaiah	Research Assistant
Trujillo Jr, Francisco	Research Assistant
Velasquez, Ever	Research Assistant
Vetter, Colleen	Research Assistant
Woods, Michael	Laboratory Assistant / Technician
600 – LANL	
Schneider, Kim	Undergraduate Student
700 – CIMAR	
Abad, Nastaren	Research Assistant
Bartges, Tessa	Research Assistant
Beskid, Nicholas	Research Assistant
Chrzanowski, Grace	Research Assistant
Dang, Khoa	Research Assistant
Franklin, Robert	Undergraduate Research Assistant
Hampe, Alexander	Undergraduate Research Assistant
Rausch, Alexander	Research Assistant
Sokoll, Michelle	Research Assistant
1100 – ASC	
Atchison, Alexander	Laboratory Assistant - Level 1
Blum, Timothy	Laboratory Assistant- Level 2
Boebinger, Matthew	Laboratory Assistant-Level 2
Chew, Brandon	Laboratory Assistant - Level 3
Collantes, Yesusa	Laboratory Assistant
Dillman, Markus	Laboratory Assistant - Level 2

1300 – ASC (continued)	
Flagler, Erin	Laboratory Assistant-Level 2
Francis, Ashleigh	Laboratory Assistant - Level 3
Hainsey, Benjamin	Laboratory Assistant-Level 2
Mankin, Alexander	Laboratory Assistant-Level 2
McCallister, Jeremiah	Laboratory Assistant - Level 2
Nabulsi, Wael	Laboratory Assistant - Level 1
Thakker, Niraj	Laboratory Assistant-Level 1
Velasquez, Julian	Laboratory Assistant - Level 1

1300 – Geochemistry	
Anderson, Anthony	Research Assistant
Leverone, Randy	Undergraduate Research Assistant
McColaugh, Stephanie	Research Assistant
Oulton, Jonathan	Research Assistant
Prince-Ralby, Emily	Undergrad Research Assistant
Verbeke, Brittany	Research Assistant
Westberry, Shelby	Research Assistant
Williams, Jeffrey	Research Assistant

FACILITY PARTICIPANTS & STAFF IN DIVERSITY CLASIFICATION

Parameter/ Category	Senior Personnel	Postdoc	Other Professional	Graduate Student	Undergraduate Student	Support Staff - Technical/ Managerial	Support Staff - Secretarial/ Clerical	Total	%
Gender									
Male	193	42	62	104	45	78	6	**530**	**75.10%**
Female	21	17	20	53	25	13	27	**176**	**24.90%**
Race									
White	157	29	70	86	62	74	26	**504**	**71.40%**
Male	141	20	54	58	44	66	4	**387**	**54.80%**
Female	16	9	16	28	18	8	22	**117**	**16.60%**
Black or African American	2	2	4	9	5	12	2	**36**	**5.10%**
Male	2	1	2	5	0	10	0	**20**	**2.80%**
Female	0	1	2	4	5	2	2	**16**	**2.30%**
Native Hawaiian or Pacific Islander	0	0	0	0	0	0	0	**0**	**0.00%**
Male	0	0	0	0	0	0	0	**0**	**0.00%**
Female	0	0	0	0	0	0	0	**0**	**0.00%**
Asian	55	28	8	62	3	3	3	**162**	**22.90%**
Male	50	21	6	41	1	1	1	**121**	**17.10%**
Female	5	7	2	21	2	2	2	**41**	**5.80%**
American Indian or Alaska Native	0	0	0	0	0	2	2	**4**	**0.60%**
Male	0	0	0	0	0	1	1	**2**	**0.30%**
Female	0	0	0	0	0	1	1	**2**	**0.30%**
Ethnicity									
Hispanic or Latino	4	1	2	9	3	8	2	**29**	**4.10%**
Male	3	1	2	7	1	8	0	**22**	**3.10%**
Female	1	0	0	2	2	0	2	**7**	**1.00%**
Not Hispanic or Latino	210	58	80	148	67	83	31	**677**	**95.90%**
Male	190	41	60	97	44	70	6	**508**	**72.00%**
Female	20	17	20	51	23	13	25	**169**	**23.90%**
Total:	**214**	**59**	**82**	**157**	**70**	**91**	**33**	**706**	**100.00%**
%	**30.30%**	**8.40%**	**11.60%**	**22.20%**	**9.90%**	**12.90%**	**4.70%**	**100.00%**	


GROUND

1800 E. Paul Dirac Drive
Tallahassee, FL 32301-8350

www.magnet.fsu.edu

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1800 E. Paul Dirac Drive
Tallahassee, FL 32301-8350

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