2000 NHMFL Annual Programs Report

National High Magnetic Field Laboratory

2000 Annual Programs Report

of the

National High Magnetic Field Laboratory

1. INTRODUCTION

The National High Magnetic Field Laboratory (NHMFL) entered its second decade of operations and exploration in year 2000. Much of the year was spent preparing for the next five-year renewal proposal review, 2001-2005, for the National Science Foundation. A renewal site review was held at the laboratory in Tallahassee on April 16-18. The NHMFL was extremely pleased to have several distinguished scientists, users, and collaborators speak to the review committee, including:

- Horst Störmer, Columbia University and Lucent Technologies, who spoke on high magnetic field science opportunities in semiconductors and quantum wells;
- Warren Warren, Princeton University, who discussed his perspectives on the next very exciting frontiers in high field NMR science;
- Dante Gatteschi, University of Florence, who talked about research opportunities in high field EMR;
- Jan Kees Mann, Director, High Field Magnet Laboratory, University at Nijmegen, The Netherlands, who addressed magnet technology collaborations with NHMFL;
- William J. Simonsick, Jr., Director, Mass Spectrometry, DuPont Performance Coatings, Marshall R&D Laboratory who commented on interactions in the field of ion cyclotron resonance;
- George Srajer, Experimental Facilities Division, Advanced Photon Source, Argonne National Laboratory who discussed joint magnet development activities for a unique research magnet;
- Steve McQuillan, Managing Director, Oxford Instruments Research Instruments who commented on joint R&D efforts on high temperature superconductors; and
- Phil Ingram, President, Training Solutions Interactive who addressed joint collaborations on science curriculum development for K-12 grades.

In addition, the chairs of the NHMFL's two principal advisory boards met with review officials: External Advisory Committee Chair George Crabtree of Argonne National Laboratory and Users Committee Chair Chuck Agosta of Clark University. Florida Lieutenant Governor Frank Brogan and Vice Chancellor James Mau of the State University System spoke to the continued support and commitment of the NHMFL.

Leaders of the three participating institutions—representing Florida State University, President Sandy D'Alemberte; the University of

> *Many achievements justify the view that the Lab is now the premier high magnetic field laboratory world wide...This ranking is based on achievements in several areas, first of all in its construction of magnets having significantly high fields than are available elsewhere. The NHMFL has constructed the highest purely resistive DC field (33 T), the highest DC field (44 T in a hybrid magnet), the highest long pulse field (60 T), and the highest short pulse field (79 T) magnets...The user program is developing well in many areas. The education outreach program is exceptionally strong, reaching out very effectively to K-12, to teachers, to the public, and to diverse undergraduate and graduate students. An in-house research program that takes strong advantage of the NHMFL facilities, helps Laboratory staff be responsive to new opportunities and give flexible support for new faculty and high-payoff ideas is also operating well.*
>
> NSF site review committee report

Florida, Vice President for Research Win Phillips; and Los Alamos National Laboratory, Program Director Allen Hartford—also spoke to the NSF site review panel about their respective commitments to the multidisciplinary laboratory.

Later in the year, the National Science Board approved a $117.5 million grant for the NHMFL through 2005. The award represents a 35 percent increase over the last five-year grant period of $87.5 million. NSF Director, Dr. Rita Colwell, praised the laboratory in her funding recommendation to the NSB: *The NHMFL requires this level of investment to maintain and consolidate its position of innovation and world leadership for research in high magnetic fields and magnet technology.*

User activity at the NHMFL for the year 2000 has produced 295 research reports. The research is broadly distributed across sixteen disciplines, with the largest number of projects being biology (47), magnetism and magnetic materials (38), chemistry (28), semiconductors (27), basic superconductivity (26), Kondo/heavy fermions (19), molecular conductors (19), and magnetic resonance techniques (19). International users continue to constitute almost 40 percent of all users at the DC and Pulsed Field Facilities.

Magnets are complex systems of engineering and materials technology, and these state-of-the-art magnet systems are operated on the edge of their ultimate design limits as the laboratory tries to offer the extremes of magnetic fields to its diverse user community. An aspect of the design and operation of these systems includes a risk and lifetime assessment. Regrettably in the commissioning and operation of these systems unanticipated mishaps and failures do occur.

The commissioning and testing of the 45 T Hybrid magnet began early in the year and the Hybrid reached 45.1 T in late June. Unfortunately, the quench protection system failed during a routine testing run. The Hybrid magnet experienced some damage to one of the superconducting coils and therefore can now be operated safely at lower fields. It ran at 37 T through the early fall, and at 42 T for the last half of December. New discoveries and interesting physics have already emerged from this system supporting the contention that if you expand parameter space new science will be found. Improvements in the resistive insert were already contemplated and when implemented in early 2001 should bring the central field back to its design specifications of 45 T. (note added in proof: The insert field was boosted still further in late January as a test. The total field was 45.1 T, and the insert's behavior during a day and half of

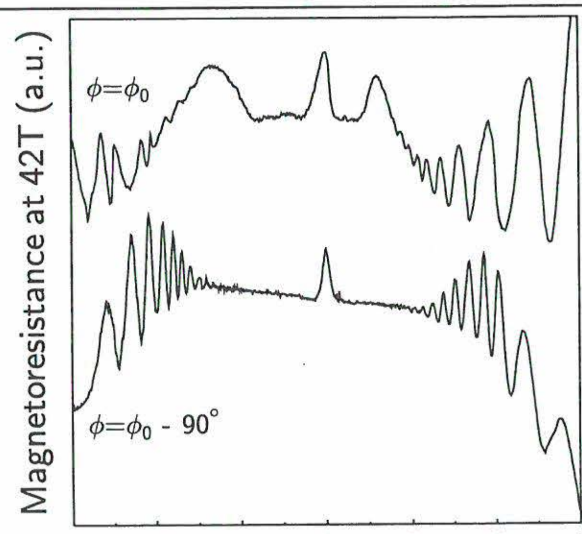


Figure 1. κ-(BEDT-TTF)$_2$Cu(NCS)$_2$ as a function of the applied magnetic field orientation. The peaks around θ=0 degrees in the two graphs demonstrate that the electron wave functions are coherent in all directions.
–A. Ardavan, J. Singleton, et al., personal communication.

normal use at 45 T leads to the expectation that users can count on 45 T throughout 2001.) Rebuild and eventual replacement of the innermost superconducting coils for the Hybrid superconducting magnet will be undertaken in 2001 so the Hybrid outsert can operate at its design field of 14 T, rather than the present operational restrictions, which allow only 11.2 T. With repair of the innermost superconducting coil and the implementation of modifications to the resistive insert, the laboratory will be able to provide fields beyond 45 T. This magnet had been designed with the eventual target of 50 T and moving to this target is one of the goals of the laboratory for the next five years. One of the unanticipated surprises of the 45 T Hybrid system recently pointed out by condensed matter science NMR users of the magnet is the high homogeneity of the magnet, which has accelerated interest in the system for such measurements.

From September 1999 through April 2000, the NHMFL Pulsed Field Facility worked very hard to move into a new and much improved experimental hall. This relocation doubles the capacity over the old building and provides magnet stations for the many magnet design strategies and experimental techniques currently under development. The long-pulse and short-pulse user programs are now located in separate buildings and, for the first time, short-pulse experiments can operate completely independently of one another. The new facilities greatly enhance the laboratory effectiveness in responding to the challenges of a growing demand for these facilities.

At the NHMFL Pulsed Field Facility at Los Alamos, the unique 60 T Long-Pulse magnet has proven to be a unique tool for experimentalists. During its one and a half year of operations, a *Nature*, *Science*, and six *PRL* reports have been published utilizing the unique system. Unfortunately, the magnet failed during otherwise normal operations. Analysis of the magnet debris is ongoing and we believe the precise cause of the failure can be determined. The emerging theory is that the magnet failure nucleated as a stress-induced failure of the Nitronic-40 reinforcing shells in the middle layers of the magnet due to a recently discovered embrittled phase which can arise during thermal aging of Nitronic-40. The 60 T Long-Pulse magnet will be rebuilt during the next two years. User activity is being directed to other pulsed magnets including the newly-designed 50 T Mid-Pulse magnet, which will address many of the needs of the NHMFL Optics Program, which had constituted much of the research on the 60 T Long-Pulse. In addition, the 50 T Mid-Pulse magnet will also provide a platform for developing new experimental capabilities, such as AC specific heat and thermal conductivity measurements, as well as new low-noise magnetotransport measurements.

The Advanced Magnetic Resonance Imaging and Spectroscopy (AMRIS) facility at the University of Florida McKnight Brain Institute has experienced a very active and productive year. The Bruker 750 MHz wide bore NMR/MRI system was delivered and installed. This is the first 750 MHz wide bore NMR system installed by Bruker in the United States and the second in the world. This new system has imaging capabilities and has been producing high quality images. AMRIS has been busy getting the state-of-the-art 11.7 T, 40 cm wide bore MRI magnet tested and operational. At this time, the magnet is operating safely at 9.4 T and will soon be brought to its design field of 11.7 T. The first *in vivo* images of a rat are quite impressive. During 2000, ARMIS group submitted an NIH Resource proposal and was site visited at the end of the year. The site visit report was extremely positive and ARMIS is awaiting the official NIH response.

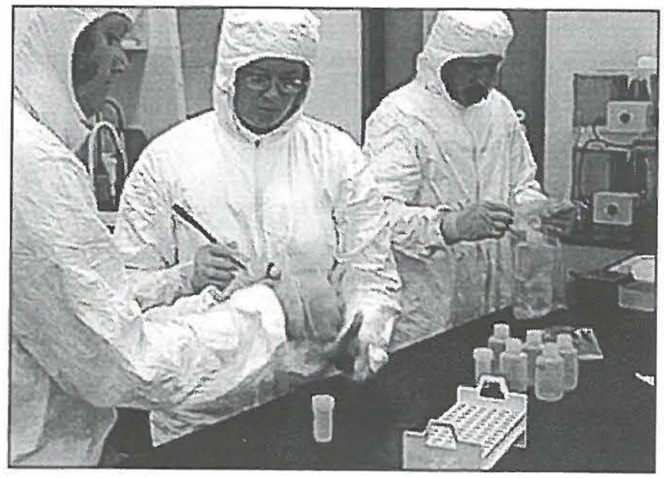
The NSF renewed its support for the NHMFL's National High-Field Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS) Facility for a second five-year period, 2000-2004. The NSF chose to fund the proposal at its full requested budget of $5.76 million. **The ICR program has been one of the shining successes of the NHMFL both in terms of instrumentation and technique development and in applications for a worldwide user base.** As the end of this funding approaches, the continued support of this unique facility will be transferred to the NSF core grant and funding for this facility in year 2004 and 2005 has already been incorporated into the $117.5 million funding of the core activities of the laboratory.

A consortium of scientists from NHMFL, FSU, FAMU, and UF under the leadership of Professor Peter Fajer has received a $1.1 million grant from the NSF to acquire a high field EPR spectrometer. This state-of-the-art spectrometer is the first instrument of its kind in the United States and is capable of high field/frequency (9 and 94 GHz) operation, pulsed (Fourier Transform) operation, and pulsed Electron-Electron Double Resonance (ELDOR) and Electron Nuclear Double Resonance (ENDOR). The spectrometer will support a wide range of important research topics and is consistent with the laboratory's commitment to multi- and cross-disciplinary activities.

The 900 MHz, 100 mm wide bore NMR magnet system is a major part of the long-term program to provide user access to high resolution NMR at and beyond 25 T. The program is a collaboration between the NHMFL and the principal industrial partner Intermagnetics General Corporation (IGC). Additional industrial suppliers include Supercon, Vacuumschmelze, and Ability Engineering and Technology. The main components of the 900 MHz have all been fabricated at three locations simultaneously. IGC fabricated all of the NbTi coils at its main facility located in Latham, New York, and Ability Engineering built the cryostat in South Holland, Illinois. The NHMFL fabricated and impregnated all the Nb_3Sn coils as well as coordinating the overall assembly logistics and final assembly design. **Commissioning of the 900 MHz wide bore is expected in the fall of 2001.**

The In-House Research Program completed its fifth year of competitive solicitations. The program is designed to encourage collaborations between internal and external investigators, and supports bold and often risky efforts that have the potential to expand the realm of high magnetic field research or open new frontiers. The program provides seed money to explore new opportunities or develop new capabilities for the user programs at the laboratory. Funding from this program is limited to two years and extensions beyond this two-year limit require external funding. The leadership of this program rotates among the three institutions and this year Dr. Al Migliori, NHMFL of Los Alamos National Laboratory, assumed these duties. The 2000 solicitation moved to a pre-proposal process that was reviewed by the Research Program Committee augmented by members of the NHMFL Users Committee, which is elected by NHMFL external users. Pre-proposals deemed to hold the highest merit were then passed on to the second review step as full proposals. This year forty-six pre-proposals were submitted, eighteen proceeded to full proposal status, and six proposals were ultimately funded for a period of two years.

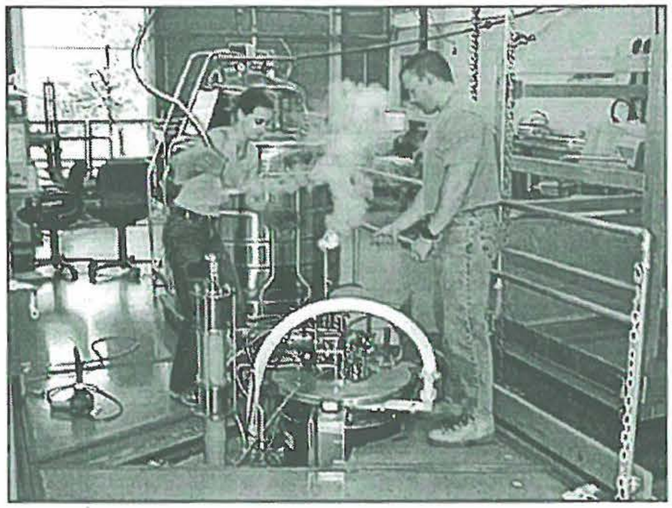
The U.S. Office of Naval Research awarded Florida State University $10.9 million over three years to establish a program in advanced power systems that will support the Navy's all-electric ship program. In announcing the award at the NHMFL, Admiral Jay Cohen, Chief of Naval Research, compared the switch to the all-electric ship to the historic transition from sails to steam powered ships. **The program will be conducted by FSU's Center for Advanced Power System (CAPS), which is focused on research and development of advanced electrical power systems for transportation and utilities.** The center builds on the expertise of the NHMFL in high field electromagnetics, materials, and superconductivity, FSU, and FAMU-FSU College of Engineering. All three have unique resources for the development of new equipment and systems for electrical power applications and for training the next generation of electrical power system engineers. The center is dedicated to developing a multidisciplinary research program with a strong partnership between government, industry, and the academic research community. "Recent developments in superconductivity, magnetics, solid state power switching and control give power system engineering a whole new range of options to work with," said James Ferner, interim director of CAPS. "We are on the edge of a revolution in electrical power engineering."



In support of the ongoing educational mission of the NHMFL, the Center for Integrating Research and Learning (CIRL) continued its expansion of educational programs, creating new classroom resources, extending further its education opportunities for students and teachers, and developing new programs. CIRL saw an increase in national interest with the *Science, Tobacco & You* curriculum program now adopted in two states outside of Florida—Connecticut and Illinois. As many as a 1,000 Connecticut fourth and fifth grade teachers returned to their classrooms this fall with digital cameras, CD-ROMS, stethoscopes, lungs bags with mouthpieces, stopwatches, and other tools and knowledge to teach students how the body works and the effects of tobacco on the body.

The CIRL once again hosted talented teachers and undergraduates in the Research Experiences for Teachers program and the Research Experiences for Undergraduates summer internship program. An essential part of both programs is combining research with presentation skills and events that encourage communication and collaboration among groups. Sixteen participating teachers presented their work in a public showcase of materials they created to translate their research experiences into classroom activities. The showcase, combined with written reports, gave teachers a opportunity to articulate what they had learned about the process of science, magnets and related content material, and science education. One elementary teacher said, "My vision of science has been enhanced through the work I did with my mentor and sharing of experiences we had with other groups." Another teacher remarked, "Due to my experience here at the NHMFL, I really want to turn my students on to science."

The NHMFL hosted the seventh Research Experiences for Undergraduates and 21 students selected from across the country spent eight weeks in research mentorships at all three sites. In addition, CIRL was asked to incorporate ten other interns from FSU into the program. The breakdown of participants was 76 percent women and 24 percent men. The students' research experiences were in biology, chemistry, geochemistry, engineering, and physics.



The National Science Foundation challenged the NHMFL from its inception to reach out to other organizations in order to support and develop a wide range of new magnet technologies. To this end, the NHMFL has worked aggressively to engage private industry, other federal agencies and institutions, and international organizations. These outreach activities have gained momentum each year and have had a profound effect on the NHMFL's ability to maintain worldwide leadership in high magnetic field research and technology. This year, collaborations with the private sector grew about 30 percent. The laboratory is also engaged in significant collaborations with almost all of the Department of Energy national laboratories and is working with the Office of Naval Research on a long-term research and development program for the electrification of naval ships. Bilateral science and technology collaborations are among the most unifying forces between national and international organizations and the number of these affiliations is rising as well.

2. USER PROGRAMS

HIGHLIGHTS

The 45 T Hybrid Magnet was completed and set a new world's record for DC fields of 45.1 T in June, 2000. Although an unprotected quench of the outsert magnet in July resulted in damage to the innermost coils of the outsert magnet, the system was operated for several users at 37 T. The insert was modified to allow user operation at 42 T starting December 7. Figure 1 shows some exciting results that required the 42 T. Work aimed at bringing the total field back up to and beyond the design field has begun. (note added in proof: The insert field was boosted still further in later January as a test. The total field was 45.1 T, and the insert's behavior during a day and half of normal use at 45 T leads to the expectation that users can look forward to 45 T throughout 2001.)

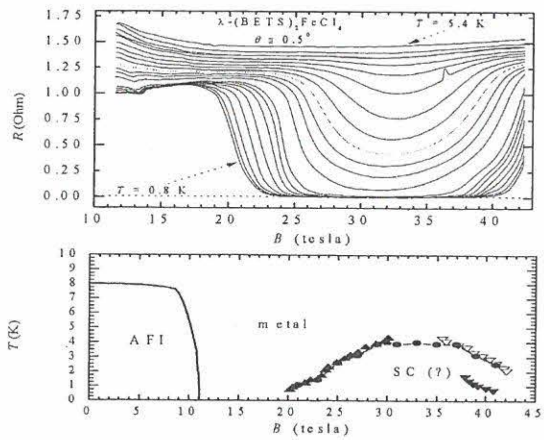


Figure 1. First high field investigation of the new Field Induced Supercondutor State (FISC) in a Magnetic Molecular Conductor. The Hybrid experiment has answered an important question regarding the possible high field reentrance toward the metallic state from the exotic FISC phase in the magnetic organic conductor λ-$(BEDTS)_2FeCl_4$. The Hybrid allowed us to carefully determine, for the first time, the phase diagram in a quite broad range of fields and several temperatures (lower panel). Further work is planned in the Hybrid magnet in order to explore the FISC by thermodynamic and spectroscopic means with the objective of achieving a complete understanding of this phenomenon.
–L. Balicas, J.S. Brooks, et al., personal communication, December 2000

Specific heat measurements to 60 T (**60 T Long-Pulse Magnet**) show the collapse of the correlation energy gap above 40 T in a Kondo insulator. These are the first specific heat measurements above 35 T and the first ever taken in a pulsed magnet article [M. Jaime *et al.*, *Nature*, **405** (#6783), 160-163, 2000].

In-plane magnetotransport measurements utilizing the **60 T Short Pulse Magnet** of $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$, reveal a crossover from insulating to metallic behavior in the under doped regime, the regime with fewer charge carriers than at optimum doping [S. Ono, *et al.*, *Phys. Rev. Lett.*, **85** (#3), 2000].

A newly-developed 1 GPa pressure clamp was used to investigate the suppression of antiferromagnetism in intermetallic UNiAl through pressure [O. Mikulina, *et al. J. of Appl. Phys.*, **87**, 5152 (2000)]. From the data, it is estimated that the critical pressure necessary to suppress the antiferromagnetic transition is about 10 GPa.

NHMFL Mass Spectrometer Sets Two More World Records. Postdoctoral fellow, Fei He, working with Christopher Hendrickson and Alan Marshall at the NSF National High-Field FT-ICR Mass Spectrometry Facility at Florida State University, has baseline-resolved two peptides, RVMRGMR and RSHRGHR, differing in mass by only 0.00045 Da, by electrospray ionization 9.4 T Fourier transform ion cyclotron resonance mass spectrometry (*Anal. Chem.*, **73**, 000-000, 2001). That is less than the mass of an electron (0.00055 Da), and it establishes a new record for the smallest resolved mass difference between any two molecules. Such capability promises to eliminate one or more wet chemical separation steps currently required for mass spectrometric identification of peptides and proteins.

Secondly, over a wide mass range (200-1250 Da), Kuangnan Qian from ExxonMobil Research Engineering in New Jersey, working with NHMFL's Ryan Rodgers, Mark Emmett, Hendrickson, and Marshall, has resolved and identified over 5,000 distinct elemental compositions (at 2% threshold) in one of nature's most complex mixtures, namely heavy petroleum crude oil (*Energy & Fuels*, **15**, 000-000, 2001). Up to 10 mass peaks were resolved within a 0.2 Da mass window. Elemental compositions in turn yield heteroatom content, number of rings plus double bonds, and extent of alkylation of each molecular type. That result represents the most extensive chemical characterization ever achieved for such a complex mixture by a single measurement.

A 750 MHz 89 mm bore NMR instrument (the second of its kind in the world) was installed early in 2000 and is in full working order with both high resolution spectroscopy and imaging capability in the AMRIS facility at the University of Florida McKnight Brain Institute. Our first data have been submitted to the ISMRM in 2001 (see research reports in the *2000 NHMFL Annual Research Review*) and the instrument at this early stage in its deployment is nearly fully booked. At the same time the world's first 11.7 T/40 cm magnet was also installed. The magnet made field on the first attempt and limited data on rf coils was obtained with the unshimmed magnet. Since then cryogenic leaks have caused delays in its operation and it is now expected that this system will be fully functional in the spring of 2001.

World record resolution of an NMR signal has been achieved in resistive magnets at the DC High Field Facility in Tallahassee by two complementary approaches. Drs. William Brey and Nagarajan Murali of the NHMFL in collaboration with Prof. Warren Warren at Princeton University and his postdoc, Dr. Yung-Ya Lin have applied an intermolecular zero-quantum detection approach (Lin *et al.*, *Phys. Rev. Lett* 85:3732 (2000)). Dr. Zhehong Gan in the NHMFL has developed a HeteroNuclear PhasE Correction method to compensate for phase fluctuations in the time-domain signals. Resonance linewidths in signal averaged spectra approaching two orders of magnitude narrower than would be implied by the magnetic field temporal stability have been achieved (<0.04 ppm). Since resistive magnets reach field strengths far in excess of the stable and homogeneous superconducting magnets, these novel approaches to resolution enhancement open unique opportunities to observe solution NMR phenomena at very high magnetic field strengths that may not be available in superconducting magnets for decades to come.

Junfeng Wang, Sanguk Kim and Frank Kovacs working with Tim Cross have developed a **unique approach for three dimensional structure determinations of membrane proteins** having the potential for high through-put characterizations. This solid state NMR method utilizes two dimensional correlation spectra of uniformly aligned lipid bilayer samples. Resonance patterns are observed that directly reflect the structure of the protein, obviating for the first time the need for resonance assignments before structural conclusions can be achieved. This work, featured on the cover of the *Journal of Magnetic Resonance* (Wang *et al.*, 144:162 (2000)), was issued as a press release from the National Science Foundation and was featured in *Physics Today*.

EMR for Observation of Fast Transients. The inherent time scale of an EMR experiment is inversely proportional to the frequency in use, thus higher frequencies allow for faster measurements. In time-resolved EMR this enables the study of systems with very short lifetimes and/or fast relaxation rates, and this prompted J. van Tol and L.C. Brunel to develop a new high-field spectrometer with both fast detection as well as optical access for excitation of paramagnetic excited states and/or creation of paramagnetic reaction intermediates. The spectrometer operates at 120, 240, and 360 GHz, this later frequency of 360 GHz is 4 times higher than what is available outside the NHMFL. J. van Tol and A. Angerhofer from the University of Florida used that machine to study the lowest excited triplet state in free base porphyrin. Their results will enable a better interpretation of the measurements obtained in porphyrin-based biological systems.

High Frequency CW Electron Nuclear Double Resonance (ENDOR). The double resonance character of the ENDOR technique has important advantages. The nuclear resonance is detected through the absorption changes of the electron magnetic resonance. Currently ENDOR measurements are limited to about 100 GHz. C. Saylor and J. van Tol developed a spectrometer that works between 110 and 330 GHz. High Field ENDOR will permit us to use the increase in g-factor resolution of high frequency EPR to map the angular dependence of the hyperfine interactions in a randomly oriented sample with a small g-value anisotropy. Added advantage will be to probe distances well over 10 Å, and to be able to study such low-γ nuclei as ^{13}C, ^{1}H, ^{15}N, and ^{31}P.

Together with Al Maniero and G. Maresch, Van Tol and Saylor have studied a nitroxide radical with delocalized spin density. The simulations we performed allow for a much better accuracy in the determination of the g and A tensors components than single crystal work at lower frequency. For instance we can distinguish the contributions from two protons that appeared identical at X band.

GENERAL PURPOSE DC FIELD FACILITIES—TALLAHASSEE

The general purpose DC magnetic field facility at the NHMFL's headquarters in Tallahassee exists to provide to the user community the strongest, quietest, steady and slowly varying magnetic fields in the world coupled with state of the art instrumentation and experimental expertise.

Several major systems provide a broad magnetic field-temperature-pressure-angle "parameter space" to researchers. Two dilution refrigerators offer 40 mK sample temperatures in fields to 33 T. Diamond anvil high pressure cells permit optical and transport measurements to 14 GPa at temperatures from 40 mK to 300 K. Magneto-optical measurements can cover wavelengths from the near ultraviolet to far infrared. Non-optical measurements of transport properties can be done at DC through audio frequency AC to millimeter and microwave frequencies. Magnetic properties of materials can be measured optically, by AC susceptibility, cantilever force and torque, and vibrating sample magnetometry. Nuclear magnetic resonance and electron magnetic resonance (both spin and cyclotron resonance) provide unique insights into materials, including many of interest to biologists and chemists. Sample rotators allow researchers to vary not only the amplitude of the applied magnetic field but also its angle with respect to the sample. NHMFL staff often help visitors develop new instruments for unique experiments not possible with the general purpose instrumentation that is kept on hand for everyone.

The research in the DC general purpose facility is supported by eight magnet plant and cryogenic system operators and mechanical, electronic, and computer engineers and technicians. Eight scientists and an engineer, whose specialties cover the kinds of measurements required for much of the science commonly done at the NHMFL, work directly with users. Other members of the NHMFL's scientific staff also support the user program by developing instrumentation and collaborating with visitors.

We continue to support remote collaborators with hardware and software that allow any member of a research group to connect directly to the experimental areas at all three NHMFL sites. Remote collaborators can view data and modify experimental strategies "live" during the magnet runs.

Further information on the facilities and services available to users of the continuous field, general purpose magnets can be obtained by contacting Bruce Brandt at *brandt@nhmfl.gov* or 850-644-4068 or by viewing *http://www.magnet.fsu.edu/users/facilities/dcfield/*.

Continuous Field, General Purpose Magnets, Changes since January 1, 2000

Commissioning of the 45 T Hybrid continued with full field operation demonstrated June 26, 2000. Unfortunately, an unprotected quench of the outsert magnet on July 10 resulted in damage to the innermost coils of the outsert magnet. The system was operated for several users at 37 T, after which the insert was modified to allow user operation at 42 T starting December 7. Improvements to the insert are aimed at meeting the original goal of 45 T. (This goal was met while this Report was in production.) Plans are being developed to restore the outsert to its original field (see Chapter 3).

The **field modulation bore tube for the 27 T, 32 mm bore magnet was completed** and tested successfully.

Table 1. Magnet systems available to users at the Continuous Field Facility, Tallahassee, as of January, 2001, and the kinds of experiments that can be done in them.

SUPERCONDUCTING MAGNETS		
FIELD (T), BORE (mm)	TEMPERATURE	SUPPORTED RESEARCH
18/20, 52	20 mK - 2 K	Magneto-optics–ultra-violet through far infrared, Magnetization, Specific heat, Transport, High pressure, dependence of optical and transport properties on field orientation, etc.
17.5/19.5, 52	0.4 - 300 K	
15, 45	10 mK - 1 K	
RESISTIVE and HYBRID MAGNETS		
FIELD (T), BORE (mm)	POWER (MW)	SUPPORTED RESEARCH
20, 195	20	Magneto-optics–ultra-violet through far infrared, Magnetization, Specific heat, Transport, High Pressure, low to medium resolution NMR, temperatures from 40 mK to 800 K, dependence of optical and transport properties on field orientation, etc.
24.5, 32[1]	15	
25, 52[1]	19	
27, 32 to 50[2]	15	
30, 32	20	
33, 32	30	
42, 32	27	

1 Higher homogeneity magnet.
2 32 mm bore tube supports a coil for modulating the magnetic field.

Magnet Power Supply & Cooling System Update

One power supply input transformer failed on October 24, 2000. A spare coil was installed quickly and full operation resumed on November 27.

New Instrumentation for Users of the Continuous Field General Purpose Magnets

The Condensed Matter NMR Group has developed a versatile NMR spectrometer capable of operating from 2 MHz to 2 GHz. Their all-in-one design integrates all the I/O and data acquisition functions into a computer by using commercially available hardware modules and software they wrote. This concept allows unlimited flexibility in spectrometer functionality by placing control of key components completely in software. The spectrometer uses a graphical user interface for both pulse programming and data acquisition. Complicated pulse sequences can be programmed, including delay and phase tables, and real-time frequency shifting. In an effort to improve efficiency of data taking and maximize the productivity during precious magnet time, the software also includes full automation of temperature, frequency and field sweeps as well as user flexibility in programming arduous and time consuming tasks through the use of scripts. Other capabilities include sophisticated data reduction and analysis, e.g. digital filtering, baseline correction, Fourier transform, apodization, windowing, phase shifting, integration, moment analysis, FFT series-sum, and non-linear squares fit. Figure 2 shows data taken to 42 T on the Hybrid magnet with the new spectrometer.

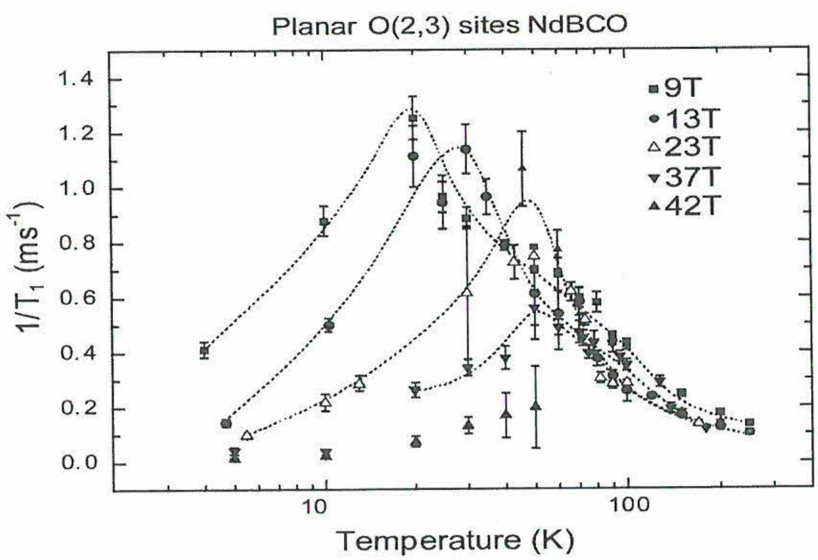


Figure 2. These data show an unexpected field dependent slowing of the Nd spin fluctuations measured by ^{17}O NMR in $NdBa_2Cu_3O_7$ far above the Nd ordering at 0.5 K. The relaxation rate is more than an order of magntitude faster than in $YBa_2Cu_3O_7$, which shows that the relaxation is due to the Nd spins. The peak in $1/T_1$ moves up in temperature and is reduced in amplitude with increasing field, nearly disappearing at 42 T, so the effect saturates at high field. This behavior is not presently understood.
–W. Moulton, et al., personal communication.

DC Field Facility User Statistics 1/1/00 through 12/31/00

	Total	Minority	Female
Number of Research Projects	106		
Number of Senior Investigators, U.S.	73	1	4
Number of Senior Investigators, non-U.S.	16	NA	0
Number of Students, U.S.	63	2	9
Number of Students, non-U.S.	12	NA	2
Number of Post Docs, U.S.	6	0	1
Number of Post Docs, non-U.S.	1	NA	1

DC Field Facility Magnet Day Statistics 1/1/00 through 12/31/00

	Resistive	Superconductor	Percent
User Affiliations	Number of Magnet Days		
NHMFL, UF, FSU, FAMU, LANL	165	258	33.5%
U. S. University	186	179	29%
U. S. Govt. Lab.	7	0	0.6%
Industry	18	0	1.4%
Non-U.S.	154	64	17%
Test, Calibration, and Maintenance	27	163	15%
Idle	10	34	3.5%
Total: 1265	**567**	**698**	**100.00%**

PULSED FIELD FACILITY—LOS ALAMOS

The Pulsed Field Facility in Los Alamos is the pulsed magnet user facility of the NHMFL. Its mission is to establish magnet technologies and the experimental infrastructure to support in-house research and an international user program. To those ends, the facility offers a 20 T superconducting magnet, as well as a series of capacitor-bank-driven magnets: 50 T and 60 T short-pulse magnets (25-100 ms pulses) and a 40 T Mid-Pulse magnet (600 ms pulses). A 50 T mid-pulse magnet is under development to help mitigate the scientific impact of the loss in July 2000 of the 60 T Long-Pulse magnet.

Late in 1999 and early 2000, the NHMFL–Los Alamos Pulsed Field Facility moved to a new building and extensively redesigned its user support infrastructure for increased functionality. In the New Experimental Hall (Figure 3), the laboratory is configured for future growth by fully exploiting the possibility to time-multiplex pulsed magnet experiments. The long-pulse and short-pulse user programs are located in separate buildings and all experiments operate independently of one another. The new Experimental Hall opened to users in April 2000.

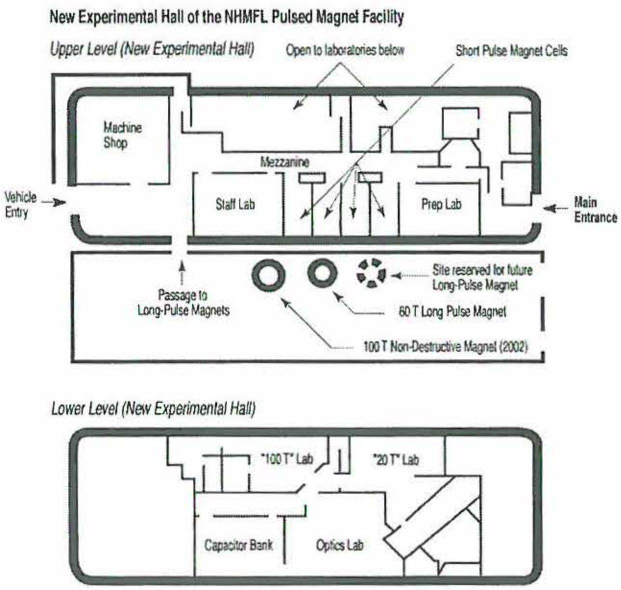


Figure 3. New Experimental Hall of the NHMFL Pulsed Field Facility: (a) upper level, showing the short pulse magnet cells and, in the adjoining Long Pulse Magnet Building, the generator-driven long-pulse magnets (b) lower level contains the optics lab and the capacitor bank that powers the short-pulse and mid-pulse magnets.

The NHMFL–Los Alamos research staff and collaborators have developed a wide variety of experimental capabilities utilizing the short-pulse and long-pulse magnets, which are summarized in Table 2. Research proposals to utilize the facility should be submitted through the laboratory's web page (*http://www.lanl.gov/mst/nhmfl*). Magnet time is scheduled following successful review of submitted proposals. Most commonly, users visit for one to two weeks of magnet time, although longer visits and sabbatical stays are also welcome. Additional information on magnets, instrumentation, and personnel, as well as a Research Proposal Form may be obtained by contacting Alex H. Lacerda at *lacerda@lanl.gov* or 505-665-6504.

Table 2. Summary of scientific capabilities at NHMFL–Los Alamos.

FIELD, DURATION, BORE	SUPPORTED RESEARCH
Capacitor-bank-driven	Magneto-optics (IR through UV), magnetization, and magneto-transport *from 350 mK to 300 K*
40 T–Mid-Pulse, 400 ms, 24 mm	Dilution refrigerator *with 50 T, 24 mm*
50 T–Mid-Pulse, 400 ms, 15 mm	Pressure from 10 kbar typical, up to100 kbar
50 T–Short Pulse, 25 ms, 24 mm	
60 T–Short Pulse, 25 ms, 15 mm	
60T–Long Pulse, 2000msec, 32mm	*magnet to return to service in early 2003*
Superconducting magnet 20 T magnet, 52 mm	Same as pulsed fields, plus thermal-expansion, specific heat, and 20 mK to 600 K temperatures.

Capabilities of the Facility, Illustrated by Scientific Highlights

The 60 T Long-Pulse Users Program. During the life time of the 60 T Long-Pulse magnet (approximately 900 pulses) data were collected for 22 submitted publications, of which 18 are already in print. Among these articles are six *Physical Review B*, three *Physical Review B Rapid Communications*, a *Physical Review Letter*, and an article in *Nature*. The *Nature* article [M. Jaime *et al.*, *Nature*, **405** (#6783), 160-163, (May 11, 2000)] presents specific heat measurements showing the collapse of the correlation energy gap above 40 T in a Kondo insulator. These are the first specific heat measurements above 35 T and the first ever taken in a pulsed magnet.

On Friday, July 28, the 60 T Long-Pulse magnet failed at peak magnetic field. The full 90 MJ of peak magnetic field energy contributed to the total destruction of the magnet. The NHMFL and NSF are committed to rebuild the 60 T LP magnet and a detailed recovery plan is in place (more details on the recovery plan can be found in the *NHMFL Reports*, October 2000 Issue).

The Short-Pulse and Mid-Pulse Users' Program. NHMFL Pulsed Facility operations were suspended during the move into the New Experimental Hall from July 1999 to April 2000. The New Experimental Hall allows simultaneous short-pulse experiments. One experimental highlight recently appeared in Physical Review Letters: the in-plane resistivity of $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$ (in which the carrier concentration is controlled by La and O) reveals a crossover from insulating to metallic behavior in the under doped regime, the regime with fewer charge carriers than at optimum doping [S. Ono, *et al. Phys. Rev. Lett.*, **85** (#3), 638-641 (July 17, 2000)].

The 20 T Superconducting Users Program. The 20 T superconducting magnet is commonly utilized to stage experiments for later measurements in pulsed magnetic fields. It also offers wider temperature and pressure ranges than are currently available in pulsed magnets. As an example, a newly-developed 1 GPa pressure clamp was used to investigate the suppression of antiferromagnetism in intermetallic UNiAl through pressure [O.Mikulina, *et al.*, *J. of Appl.. Phys*., **87,** 5152 (2000)]. From the data, it is estimated that the critical pressure necessary to suppress the antiferromagnetic transition is about 10 GPa.

The 100 T Multi-Shot Magnet Project. A joint U.S. Department of Energy and National Science Foundation project is designing a 100 T, 15 mm bore, non-destructive magnet that marries two pulsed magnet technologies: an approximately 50 T generator-driven outsert with about a 50 T capacitor-driven insert. Construction of the power supplies and infrastructure will continue through 2001, with the magnet commissioning scheduled to begin in late in 2002.

Pulsed Field Facility User Statistics, 1/1/00 through 12/31/00

	Total	Minority	Female
Number of Research Projects	51		
Number of Research Groups	45		
Number of Senior Investigators, U.S.	29	2	2
Number of Senior Investigators, non-U.S.	8	NA	0
Number of Students, U.S.	18	4	3
Number of Students, non-U.S.	4	NA	3
Number of Post Docs, U.S.	8	0	0
Number of Post Docs, non-U.S.	3	NA	0

Pulsed Field Facility Magnet Day Statistics 1/1/00 through 12/31/00

	20 T-SC	40 T-SC	50 T-SP	60 T-SP	60 T-LP	Total
User Affiliations	Number of Magnet Days					
NHMFL	82	27	32	17	9	167
LANL	11	0	0	12	22	45
U.S. University	79	0	27	26	17	149
Industry	0	0	0	5	4	9
Non-U.S.	33	0	16	48	14	111
Total	**205**	**27**	**75**	**108**	**66**	**481**

HIGH B/T FACILITY—GAINESVILLE

The High B/T Facility operated for the NHMFL at the University of Florida provides users with the capability for conducting experiments in high magnetic fields (up to 16.5 T) and at very low temperatures (down to 0.4 mK) simultaneously. Instrumentation for studies of magnetization, thermodynamic quantities, transport measurements, magnetic resonance and pressure are available. In addition, the facility is housed in an ultra-quiet environment with "tempest" quality electromagnetic shielding and vibration isolation of the experimental station to permit high sensitivity measurements.

Applications for the use of the facility follow the procedures as for all NHMFL facilities. The use is restricted to experiments that need the special low temperature and high field configurations available at the facility. Many of the experiments require special assemblies and direct interaction with personnel on site, as well as having need for long running times. Prospective users should contact the facility manager and resident research scientist, Dr J.S. Xia (352-392-8871, *jsxia@phys.ufl.edu*), or the facility director, E. Dwight Adams (*adams@phys.ufl.edu*) well in advance.

Magnet, Instrumentation and Services Update

The current high field superconducting magnet designed for 20 T is limited to 15.5 T (operating at 4 K) and 16.5 T (if operated at 1.5 K). Attempts by the manufacturer to repair the failed fourth Nb_3Sn coil have not been successful. The highest priority for the Gainesville NHMFL facility is to replace this magnet with a new one capable of reaching 25 T. This will be accomplished in two stages: first a 21 T conventional superconducting magnet with a 25 mm ID experimental volume, and second, a high T_c insert capable of bringing full field above 25 T with a 12.5 mm experimental access.

In order to meet user demand for experimentation at very low temperatures but in modest or quasi-zero magnetic fields, a new experimental volume has been made available above the nuclear refrigerator (Figure 4). We plan to construct a small 5 T magnet that will operate in vacuum to make this experimental volume available for transport and thermodynamic measurements in low fields but at temperatures down to 0.45 mK.

A special feature of the new experimental cells constructed for measurements in both the high field and low field experimental volumes has been the use of sintered silver heat exchangers for cooling samples and electrical leads. The sintered silver is held in contact with liquid ^3He that in turn has a high contact area to the nuclear cooling stage through large areas of sintered metal. This heat exchange technique has proven critical for both recent experiments on the quantum Hall effect in $GaAs/Ga_{1-x}Al_xAs$ heterostructures, and more recently for electrical conductivity measurements of the non-Fermi liquid $CeNi_2Ge_2$.

An additional new capability has been introduced in collaboration with the low temperature group of Don Candela at the University of Massachusetts to provide pulsed NMR capabilities for this extreme low temperature environment. A bird cage resonant circuit has been successfully tested and used to carry out measurements of the spin diffusion in highly polarized dilute Fermi liquids: ^3He in ^4He. The NMR system can be operated up to 650 MHz and with minor changes eventually to 1500 MHz for broadband physics applications.

Table 3. New instrumentation available at the High B/T Facility.

EQUIPMENT	FEATURE	USAGE
Network Analyzer	300 to 1300 MHz	RF signal analysis
NMR Spectrometer	650 MHz	Broadband NMR applications
Vibrating Wire Thermometer	Low Noise, High Resolution	Thermometry in high magnetic fields

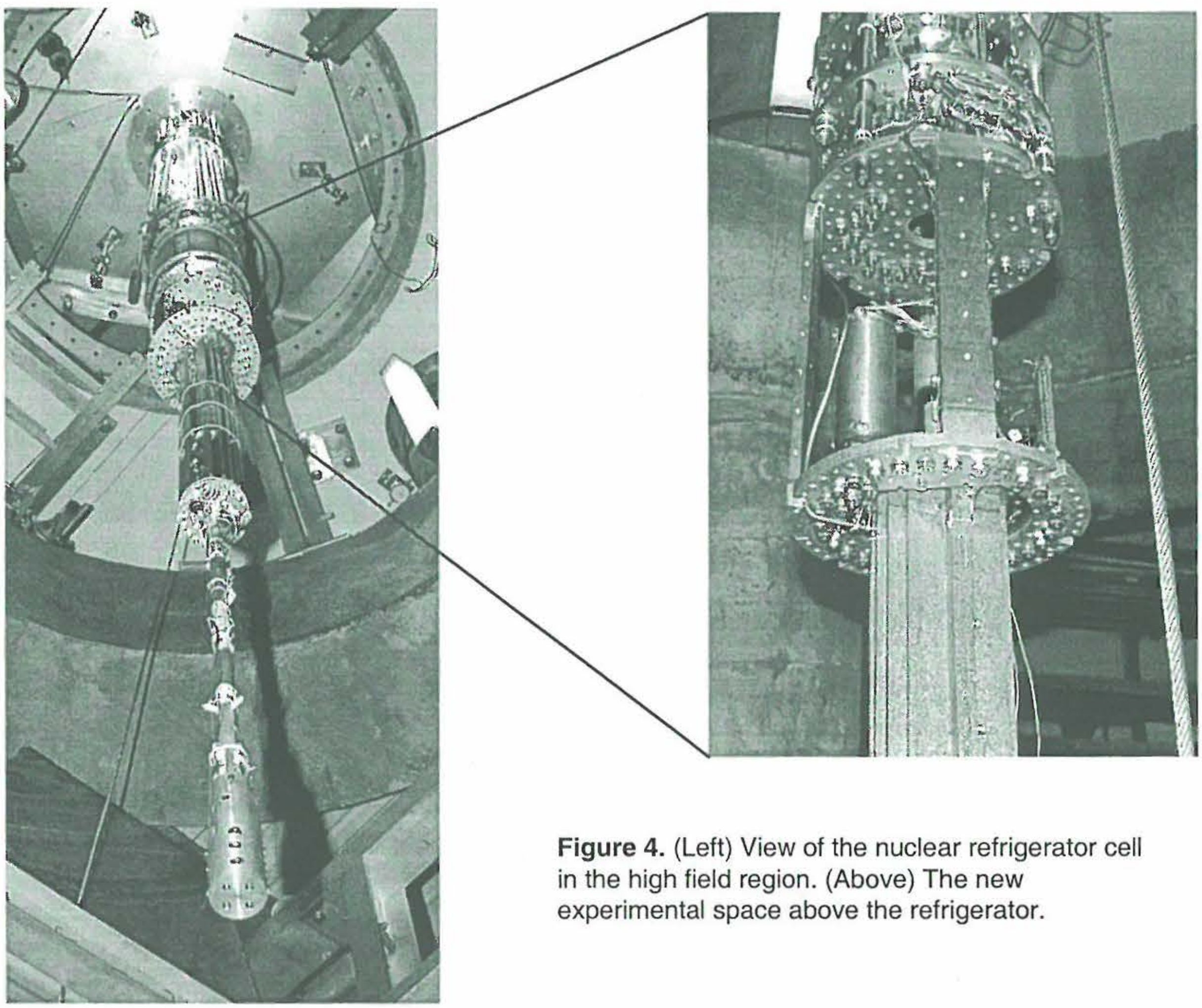


Figure 4. (Left) View of the nuclear refrigerator cell in the high field region. (Above) The new experimental space above the refrigerator.

HIGH B/T FACILITY USER STATISTICS 1/1/00 THROUGH 12/31/00

	Total	Minority	Female
Number of Research Projects	4		
Number of Senior Investigators, U.S.	11	1	
Number of Senior Investigators, Non-U.S.	1		
Number of Students, U.S.	5	1	1
Number of Students, Non-U.S.			
Number of Post Docs, U.S.	4	2	
Number of Post Docs, Non-U.S.			

HIGH B/T FACILITY MAGNET DAY STATISTICS 1/1/00 THROUGH 12/31/00

	Number of Magnet Days	Percent
User Affiliations		
NHMFL, UF, FSU, FAMU, LANL	93	25%
U.S. University	211	57%
U.S. Govt. Lab.		
Industry		
Non-U.S.		
Test, Calibration, and Maintenance	61	16%
Idle		
Total	**365**	

CENTER FOR INTERDISCIPLINARY MAGNETIC RESONANCE (CIMAR)

The NHMFL's Center for Interdisciplinary Magnetic Resonance supports a broad range of research in the biological, chemical, and physical sciences, as well as cross-disciplinary programs in areas like environmental science. The techniques available to users include nuclear magnetic resonance (NMR), magnetic resonance imaging and spectroscopy (MRI/S), electron magnetic resonance (EMR), and Fourier transform ion cyclotron resonance mass spectrometry (ICR). Cross fertilization among the four fields is a unique feature of the Center that is facilitated by broadly based external and internal users programs.

Table 3. CIMAR facilities in Tallahassee, as of January, 2001.

MAGNETIC RESONANCE SYSTEMS			
Frequency	**Field (T), Bore (mm)**	**Homogeneity**	**Measurements**
1066 MHz+	25, 52	1 ppm	Solid state NMR
830 MHz	19.6, 31	100 ppb	Solid state NMR
720 MHz	16.9, 50	1 ppb	Solution state NMR
600 MHz	14, 89	1 ppb	MRI and solid state NMR
600 MHz	14, 52	1 ppb	Solution state NMR
500 MHz	11.75, 50	1 ppb	Solution state NMR
400 MHz	11.75, 89	1 ppb	Solid State NMR
400 MHz	9.3, 50	1 ppb	Solution state NMR with high T_c probe
300 MHz	7, 50	1 ppb	Solution state NMR
300 MHz	7, 89	1 ppb	Solid state NMR
Up to 7 THz	30, 32	100 ppm	ECR
700 GHz+	25, 52	1 ppm	Multifrequency EMR
470 GHz	17, 61	3 ppm	Multifrequency EMR
400 GHz+	14, 88	3 ppm	Transient EMR
9 GHz			X-band EPR
	25, 52+	1ppm	ICR
	11, 220+	1 ppm	ICR
	9.4, 220	1 ppm	ICR
	7, 150	1 ppm	ICR
	6, 150	1 ppm	ICR
	3, 150	10 ppm	ICR

\+ Under development

Table 4. CIMAR facilities at the University of Florida, as of January, 2001.

MAGNETIC RESONANCE SYSTEMS			
Frequency	**Field (T), Bore (mm)**	**Homogeneity**	**Measurements**
750 MHz	17.5, 89	1 ppb	Solution state NMR & MRI
600 MHz	14, 50	1 ppb	Solution state NMR & MRI
500 MHz	11.75, 50	1 ppb	Solution state NMR
500 MHz+	11.7, 400	0.1 ppm	MRI & NMR of animals
200 MHz	4.7, 330	0.1 ppm	MRI & NMR of animals
125 MHz	3, 800	0.1 ppm	Whole body MRI & NMR

\+ Under development

NMR Spectroscopy and Imaging Program

The NMR spectroscopy and imaging program continues development of NMR instrumentation and technology for high magnetic fields and applications of NMR spectroscopy and imaging to chemistry, biology and material science. The development of unique NMR capabilities and high field magnets at NHMFL continue to attract scientists from around the world to use the high field NMR facility. Details on instrumentation capabilities and how to apply for instrument time can be found at *http://nmr.magnet.fsu.edu/*

NMR Instrumentation Update

750 MHz wide bore spectrometer/imager. The world's second 750 MHz wide bore (first in the United States) was installed in the AMRIS facility at UF. The instrument has a range of conventional spectroscopy capabilities including a 2.5 mm TXI probe, and a complete Bruker microimaging capability with several imaging coil inserts. At 89 mm bore, live mice can be accommodated.

11.7 T/40 cm imager/spectrometer. The world's first 11.7 T, 40 cm instrument has been installed at the AMRIS facility at UF and made field. Some teething problems have kept the magnet at 9.4 T for the time being but it is expected to be at full field in early 2001. The instrument has two sets of gradients and compliments our 4.7 T/33 cm instrument.

833 MHz three-channel Bruker console. The new NMR console enhances experimental capabilities with the 19.6 T magnet, which is still the highest NMR-grade superconducting magnet in a user facility.

Double rotation (DOR) NMR probe. The double axial (6 kHz and 1.5 kHz for inner and outer rotations) averages both the first and the second-order spin interactions for high resolution NMR spectroscopy of quadrupolar nuclei. The probe is compatible with the 25 T Keck, 720 MHz narrow bore (NB) and 600 wide bore (WB) magnets.

Triple-resonance NMR probes. 1H/19F/X and 1H/X/Y three-channel probes are now available on the 600 MHz WB magnet. Triple-resonance capability permits distance measurement among nuclei with different resonance frequencies.

An ultra-fast magic-angle spinning NMR probe has been built recently at the NHMFL in collaboration with Ago Samoson of the National Institute of Chemical and Biophysics of Estonia. 40 kHz magic-angle spinning can average the strong ^{1}H-homonuclear dipolar coupling and large quadrupolar couplings for high resolution NMR spectroscopy of solids.

Triple resonance cryoprobe. A Bruker 600 MHz cryoprobe will soon be installed on the UF-McKnight Brain Institute AMRIS 600 MHz spectrometer. This probe should provide up to 4 times the sensitivity of a conventional probe.

Microcoils for solution NMR. In collaboration with Prof. Webb at the University of Illinois at Champaign-Urbana, the NHMFL has been developing microcoil technology that can minimize the amount of protein required for structural characterization.

Phased array hardware. Both the 4.7 T, 33 m and 11.7 T, 40 cm have four channel phased array hardware installed (the first in the United States on animal imaging systems). Research is underway to develop the phased array rf coils required (not provided by the vendor).

Stray field imaging. A STRAFI imaging probe has been built for the 19.6 T superconducting magnet at the NHMFL in collaboration with Andrey Samoilenko of Chemical Physics Institute, Russian Academy of Sciences. The magnet has a stray field gradient about 75 T/m at 11.7 T and can achieve spatial resolution in the order of 10μm.

Microimaging probe. A 25 mm clear access probe body is available for use with the 500 and 600 MHz microimaging spectrometers. The clear access to the active volume is essential for some small animal and flow measurements.

NMR Technology Development

Intermolecular zero-quantum NMR spectroscopy. Prof. Warren of Princeton University has been improving the intermolecular zero-quantum approach to obtain high-resolution NMR spectra using the Keck resistive magnet at the NHMFL since first demonstration last year.

Improving magnetic field homogeneity and stability for high resolution NMR spectroscopy using resistive magnets. Flux stabilization, ferromagnetic and active shims have been improved and optimized. Using the newly developed HENPEC method, residual magnetic field fluctuations have been corrected and 40ppb ^{1}H line widths have been achieved on the Keck resistive magnet. Such line width is approaching the minimum requirement for high-resolution NMR spectroscopy of solutions.

Hyperpolarized ^{129}Xe and ^{3}He. The construction of a spin exchange optical pumping system for the generation of hyperpolarized ^{129}Xe and ^{3}He is nearing completion. It is expected to be available as an NHMFL user resource in spring 2001. The new polarized noble gas generator incorporates the highest power fiber coupled diode array laser system ever used for spin exchange optical pumping. The system has been designed to be self-contained for maximum functionality and portability to support a wide variety of hyperpolarized ^{129}Xe and ^{3}He NMR and MRI experiments at NHMFL sites. NMR applications already underway include studies of surfaces, binding sites in proteins, phase transitions and gas clathrate hydrates.

Imaging/spectroscopy rf coil development. The new 11.7 T, 40 cm imager/spectrometer offers new challenges in rf coil design at high frequency over relatively large volumes, since conventional coil designs are inefficient. To this end novel volume coils (the ReCav coil) have been developed and tested at 200 and 400 MHz, and phased array coils have been constructed at 200 MHz. These designs are being extended to 500 MHz.

Satellite-transition magic-angle spinning. The newly developed STMAS NMR experiment achieves high-resolution isotropic NMR spectra of quadrupolar nuclei. The experiment improves spectral sensitivity by an order of magnitude over the well-known multiple-quantum MAS experiment.

NMR Application Development

PISA wheel. A resonance pattern named PISA wheel was discovered recently in 2D NMR spectra of uniaxially oriented membrane proteins. The resonance pattern reveals directly information on the orientation of helices and has potential for spectral assignment for uniformly labeled proteins.

Molecular alignment using high magnetic fields. Alignment of membrane proteins by magnetic fields avoids the need of glass plates for shear alignment and can dramatically improve the sample-filling factor. This ongoing project takes advantage of high magnetic fields that increase quadratically the alignment force from anisotropic magnetic susceptibility.

^{19}F solid state NMR of membrane proteins. The high gyro-magnetic ratio of ^{19}F increases the spectral sensitivity and the range of internuclear distances measurable by NMR spectroscopy. Static H/F and H/F/X MAS probes are available now on the 19.6 T 31 mm and 14 T 89 mm magnets. These probes are being used for structural characterization of selectively ^{19}F labeled proteins.

Solid state NMR of low-gamma nuclei. Many important materials such as glasses, zeolites, catalysts and semiconductors contain low-gamma nuclei that are inherently difficult to observe. High magnetic fields can reduce the second-order quadrupolar effects and the resonance ring-down time and in addition to the well-known increase in sensitivity and resolution for detection of low-gamma nuclei. Special probes are available for low-gamma nuclei using the 19.6 T superconducting magnet.

GAMMA This important NMR simulation platform has now been expanded to electron spin resonance (ESR). Many new features have been added to this popular software in the magnetic resonance community.

MRI velocimetry. Pulse sequences and analysis software are implemented on the 500 and 600 MHz MRI systems for pulsed field gradient velocimetry. These methods are being used to understand fluid transport in complex media.

Single cell microimaging. Single cells have been imaged on the 14 T magnet. Dynamic studies of perturbed single cells provide information on the characteristics and dynamics of MR signals in single cells (T2, T1, diffusion). Such information is being used to aid in the interaction of signal changes in macroscopic assembles of cells (i.e. tissues) Single cell spectra offer similar potential for macroscopic studies at the single cell level.

NMR User Statistics, 1/1/00 through 12/31/00

	Total	Minority	Female
Number of Research Projects	98		
Number of Research Groups	55		
Number of Users	140		
Number of Senior Investigators, U.S.	37	1	6
Number of Senior Investigators, non-U.S.	5	NA	1
Number of Students, U.S.	45	1	15
Number of Students, non-U.S.	5	NA	
Number of Post Docs, U.S.	20	1	5
Number of Post Docs, non-U.S.	4	NA	0

116

NMR Magnet Day Statistics 1/1/00 through 12/31/00

	25 T Keck	833 NB	750 WB*	720 SB	11.7 T/ 40 cm*#	600 WB
User Affiliations	Number of Magnet Days					
NHMFL	3	123	0	253	NA	282
U.S. University	9	58	91	84	NA	36
U.S. Govt. Labs	0	0	0	0	NA	0
Industry	0	21	0	0	NA	0
Non-U.S.	0	28	0	14	NA	12
Test, Calibration, and Maintenance	6	95	18	6	NA	26
Idle	NA	40	0	8	NA	9

* - instruments at AMRIS, Brain Institute, UF

\# - not yet fully installed

FOURIER TRANSFORM ION CYCLOTRON RESONANCE MASS SPECTROSCOPY

During the past year the ICR program continued instrument and technique development as well as outgrowth of 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. An instrumentation director and a biological applications director were added to the machinist, technician, and three rotating postdocs who are available to collaborate and/or assist with projects.

During the past year the ICR 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 directors for instrumentation, biological applications and environmental applications as well as a machinist, technician, and five rotating postdocs who are available to collaborate and/or assist with projects.

FT-ICR Magnet and Instrumentation Update

The **9.4 T, 220 mm bore system** continues to be the highest performance electrospray FT-ICR mass spectrometer in the world. It offers unrivaled mass resolving power ($m/\Delta m$ = 10,000,000 at mass 9,000 Da) and dynamic range (>10,000:1), as well as high mass range, mass accuracy, efficient tandem mass spectrometry (MS^n as high as MS^8), and long ion storage period. The magnet is passively shielded to allow proper function of all equipment and safety for users. This system has recently been upgraded with external mass selection prior to ion injection for further increase in dynamic range.

A **7 T electrospray FT-ICR instrument** has been dedicated to high sensitivity biological analysis. HPLC and CE interfaces are available. Picomolar concentration detection limit has been demonstrated. Sample amounts as low as 300 amol loaded (in biological matrix) have been detected. The instrument is currently available for use.

9.4 and 7 T magnets have been installed. The 9.4 T magnet is currently used for ICR instrumentation development. The 7 T magnet will be optimized for volatile mixture analysis. Samples will be volatilized in a heated glass inlet system (at 200-300 °C) and ionized by an electron beam (0-100 eV, 0.1-10 μA). The ions will be collected in a linear multipole trap and injected into the FTICR cell. Mass resolving power ($m/\Delta m$) greater than 10^5 and mass accuracy within 1 ppm have been achieved routinely in a similar (lower field) instrument. Hundreds of components in a complex mixture (e.g., petroleum distillates) can thus be resolved and identified. This instrument should be available June 1, 2001.

ICR Applications

Biomolecular sequence verification continues to be in high demand. Protein and oligonucleotide masses can be determined with ppm accuracy. Molecules can be fragmented (by collisions, photons, or electron capture by multiply-charged positive ions) to yield sequence-specific products. In-house software has been developed for rapid data analysis.

Tertiary structure can also be probed. **Hydrogen/deuterium exchange** can be carried out (in solution or gas phase) and monitored with the mass spectrometer. Details of biomolecular conformation and surface contact between molecules in a noncovalent complex can be deduced. For example, conformational changes in *Yersinia* tyrosine phosphatase were induced by point mutation and inhibitor binding and monitored by H/D exchange and FT-ICR [*Biochemistry*, **37**, 15289-15299 (1998)].

The 7 T instrument is primed for immediate impact in **environmental analysis**, where intractably complex mixtures are common. Several environmental applications of FT-ICR MS are underway. For example, diesel fuel is analyzed to evaluate removal of sulfur-containing organics that contribute to air pollution [*Anal. Chem.*, **70**, 4743-4750 (1998)]. Initial characterization of a jet fuel (JP-8) contaminated site has been completed. The site is now targeted for remediation, and FT-ICR will be used to monitor progress.

ICR Facility User Statistics 1/1/00 through 12/31/00

	Total
Number of Research Projects	63
Number of Research Groups	49
Number of Students, visiting	14
Number of Post Docs, visiting	7

49 // 28

ICR Facility Magnet Day Statistics 1/1/00 through 12/31/00

	9.4 T, 200 mm	9.5 T, 155 mm
User Affiliations	Number of Magnet Days	
NHMFL, UF, FSU, FAMU, LANL	230	
U. S. University	24	180
U. S. Govt. Lab.	0	0
Industry	4	0
Non-U.S.	7	0
Maintenance	2	0
Idle	85	0
Total	**352**	**180**

Electron Magnetic Resonance Program

The continuing trend in the development of Electron Magnetic Resonance spectroscopy towards higher field and frequency ranges is providing the advantages that can be gained from the increase in both these parameters for a broad variety of applications. The applications of high-field/high-frequency EMR can be roughly classified into two categories: The first one includes studies of highly concentrated spin systems, typical for material sciences. The second category of applications mainly concerns chemical, biochemical, and biological paramagnetic spin systems that are usually characterized by low spin concentrations. Low spin density systems require high spectrometer sensitivity. The high-field, multi-frequency spectrometers at the NHMFL were originally developed for investigations of highly concentrated spin systems. The EMR users program spans biology, chemistry, and condensed matter physics, with an emphasis on chemistry and a clear trend toward more biological science.

There are two different regimes in the frequency domain for Electron Magnetic Resonance spectroscopy, (a) from 1 to about 150 GHz, and (b) above 150 GHz. From 1 GHz up to about 150 GHz, the electromagnetic waves propagate in single-moded or over-moded waveguides, and one can use single mode cavities. Above 150 GHz, one can not use single mode cavities because they become impracticable, one has to use Fabry-Perot type cavities. In EMR spectroscopy, increasing the frequency increases the sensitivity, but there is a drop when one changes from the low frequency regime to the high frequency regime, because the technologies are different. Also it should be noted that pulsed techniques are only available up to 140 GHz, there are no pulse switches available for higher frequencies.

Very High Field EMR Spectrometers

The development of EMR spectrometers at the NHMFL has focused on very high field/very high frequency machines. Presently there are two high field EMR spectrometers; the first one is the 17 T superconducting magnet based spectrometer, the second one uses the 25 T resistive "Keck" magnet.

The **17 T spectrometer spectrometer** has been built around a 17 T Teslatron magnet made by Oxford Instruments Inc. It consists of a main 17 T coil with a +/- 0.1 T sweep coil. We use different sources in the 23 GHz to 3 THz range. The detector is either a Schottky diode or a "hot electron" InSb bolometer. The system performance specifications are:

Frequency range: < 95 GHz up to 475 GHz for a g = 2 system, optimized at 220 and 330 GHz.
Sensitivity with a Fabry-Perot cavity: 10^{11} spins/gauss second at room temperature and 10^{9} spins/gauss second at 4 K.
Averaging: up to about 100 spectra.
Field calibration: g determination error: +/- 3.10^{-5}.
Resolution: 1 to 10 ppm.
Sample temperature: 1.6 to 300 K.

The **25 T "Keck" magnet spectrometer** is built around the 25 T, high homogeneity Keck magnet. The "Keck" magnet is perfectly poised for EMR - fast ramping to the magnetic field of interest, very convenient sweepability, homogeneity better than 10 ppm over a typical sample size (a few mm^3), good field stability. It uses a far infrared laser for its source and an InSb "fast electron" bolometer detector with a magnetically extended response. A Fabry-Perot cavity is under development. The system performance specifications are:

Frequency range: up to 700 GHz for a g=2 system.
Sensitivity: 10^{12} spins/gauss second at room temperature
Field calibration: g determination error: +/- 3.10^{-5}.
Resolution: better than 10 ppm.
Sample temperature: 1.6 - 400 K.

EMR User Statistics, 1/1/00 through 12/31/00

Research Projects/Groups	Total	U.S.	Non-U.S.
Number of Research Projects	34	28	6
Number of Research Groups	36	26	10
Users	Total	Minority	Female
Numbers of Users	68	2	13
Number of Senior Investigators, U.S.	26	1	2
Number of Senior Investigators, non-U.S.	12		3
Number of Students, U.S.	18	1	4
Number of Students, non-U.S.	6		2
Number of Post Docs, U.S.	5		1
Number of Post Docs, non-U.S.	1		1

EMR Magnet Day Statistics 1/1/00 through 12/31/00

	17 T	14 T	X-band
User Affiliations	Number of Magnet Days		
NHMFL, UF, FSU, FAMU, LANL	88	63	
U. S. University	127	50	
U. S. Govt. Lab.	9		
Industry	10	25	10
Non-U.S.	72	30	
Development	20	70	
Maintenance	10		
Idle	29	36	
Total	**365**	**274**	**10**

Geochemistry Program

The majority of the funding for the Geochemistry program comes from the Earth Science Directorate at NSF. Presently there are three active research grants from either earth or ocean sciences to either Salters or Zindler. The research funded through these programs mostly concerns the study of the chemical evolution of the Earth through trace element and isotope analyses and the lab has a major program on mid-ocean ridge basalt (MORB) genesis.

The Geochemistry program continued this year its expansion of activities in the environmental science area. The program receives funding from both the South Florida Water Management District (Salters) for research on the sources, speciation and bioavailability of phosphorous in the Everglades as well as the Department of Energy (Wang) for research on the global carbon cycle. Salters is also heading a group of faculty from both the NHMFL and FSU that is actively pursuing the application of high magnetic field analytical techniques to environmental sciences. This group is concentrating on metal speciation, including organic-metal complexation, in natural waters. In addition to the geochemistry facilities at the NHMFL the "environmental scientists" use both FT-ICR-MS and EPR instrumentation.

The Geochemistry Division houses a mass spectrometry facility that includes a chemistry clean lab which approaches a Class 100 clean lab. This lab is used for the separation and purification of all elements which are analyzed by mass spectrometry. The facility has three mass spectrometers: the Lamont Isolab, a mass spectrometer with secondary ionization capability, used mainly for difficult to ionize elements like Hf, Th and Hg. The Lamont Isolab, outfitted with a Daly detection system and 5 faraday cups, has TIMS, SIMS capability. Furthermore, the facility includes a fully automated 9 collector Finnegan mass spectrometer equipped with a RPQ-system for increased abundance sensitivity and a 13 sample turret. This second mass spectrometer is used for Sr, Nd, Pb and U isotope analyses by positive thermal ionization and Re and Os by negative ionization, as well most isotope dilution analyses. The facility also includes an ICP-MS Finnegan "Element" for elemental analyses. Furthermore, all the peripheral equipment as mineral picking stations, atomic absorption and decay counting systems are present.

Instrumentation improvements are concentrated on developing novel analytical techniques for the High Resolution Inductive Plasma Mass Spectrometer. Considerable time has been spent on integrating capillary electrophoresis with the ICP-MS. This combination of techniques potentially allows determination of metal speciation in natural waters. The initial tests have been promising, but further measurements are needed to assess the applicability to environmental samples. Furthermore we designed and acquired the components for an Electric Pulse Disaggregator. This instrument disaggregates materials through discharge of a high potential (greater than 100 kV) through the material. Our instrument is designed for discharges of 120 kV to 150 kV. One advantage of Electric Pulse Disaggregation is that the material preferentially breaks up material along grain boundaries. This allows for an easier separation of the different phases. Final assembly and testing of the instrument awaits appropriate housing.

Table 4. Types and configuration of mass spectrometers.

Name	Type of ionization	Mass analyzer configuration	Detection systems	Measurements	Sample introduction
Isolab	Thermal and Sputtering	E-M-D1-E-D2	4 faraday cups after M Daly Ion counting and faraday cup	Isotope ratios: Th, Hf and Hg	Solids and chemical separates
262/RPQ	Thermal	M-D1-E-D2	7 faraday cups, 1 electron multiplier Electron multiplier	Isotope ratios: Pb, Sr, Nd, Os	Chemical separates
ICP-MS	Thermal-Plasma	M-E-D	Electron multiplier	Concentrations and isotope ratios	Solutions

E = energy filter
M= magnetic mass filter

Geochemistry Facility User Statistics 1/1/00 through 12/31/00

	Total	Minority	Female
Number of Research Projects	22		
Number of Senior Investigators, U.S.	11	1	2
Number of Senior Investigators, Non-U.S.	1	0	1
Number of Students, U.S.	10	0	2
Number of Students, Non-U.S.	0	0	0
Number of Post Docs, U.S.	0	0	0
Number of Post Docs, Non-U.S.	0	0	0

Geochemistry Magnet Day Statistics 1/1/00 through 12/31/00

	Isolab	262/RPQ	ICP-MS	Total
User Affiliations	Number of Magnet Days			
NHMFL	120	215	200	535
U.S. University	20	50	40	110
U.S. Govt. Labs	0	0	NA	0
Industry	0	0	NA	0
Non-U.S.	20	0	0	20
Maintenance	80	20	40	140
Total	**240**	**285**	**280**	**805**

Large Magnet Component Test Laboratory

To support the continued development of a variety of cryogenic/electrical components for large superconducting magnet systems, the Large Magnet Component Test Laboratory (LMCTL) was established in Cell 16 of the DC Field Facility in Tallahassee. These facilities have been essential in recent years to programs within the Magnet Science and Technology Group at NHMFL as well as to external groups from both the government and commercial sectors. In the past year, the facilities were completed, tested, and approved for regular use. In addition, the following improvements were made.

Table 5. Magnets presently available for use in the LMCTL.

Identifier	Type	Max. Field (T)	Bore (m)	Special Features
Oxford Split	Nb_3Sn/NbTi split solenoid, high-J, impregnated winding	14	0.150	30 x 70 mm^2 radial access
CWTX	NbTi split solenoid, low-J, ventilated winding	8	0.380	67-mm dia. radial access
TACL	NbTi cos θ dipole, high-J, ventilated winding	7	0.040	1-m long uniform field region
SMES CTA	NbTi simple solenoid, low-J, ventilated winding	4	2.0	Separate cryogenic test volume in bore

LMCTL Usage

Lawrence Berkeley National Laboratory: High-current, transverse load testing of model conductors for high-field accelerator dipoles.

EURUS Technologies/General Atomics: Test of high-current HTS busbars (J-Bars) for a superconducting fault-current limiter.

EURUS Technologies: Test of high-current HTS components for cryogenic current leads being developed for the CERN Large Hadron Collider.

Access to NHMFL Facilities

User access to the NSF-funded NHMFL facilities is controlled by a two-step proposal and review process that is administered by the Directors of the Continuous and Pulsed Field User Programs. A brief initial proposal is reviewed by NHMFL staff and approved or denied by the Director of the NHMFL. Then, once a year, a summary listing of all user programs is compiled and ranked in order of magnet use.

Users who have consumed a consumed a significant portion of resources (about 1% to 2%) within the previous twelve months are required to submit a more extensive proposal based on their present and future work in high fields. Users in this category are the largest users and collectively account for at least 80% of the annual total facility use. In addition, all users of the 45 T Hybrid and 60 T Long Pulse magnets are required to submit such a proposal. Each major proposal is reviewed by a panel of scientists chosen for their familiarity with the fields of research commonly done at the NHMFL. The panel may also seek input in the form of mail reviews. A grade from A to C is given to each proposal with an A being required for heavy use of facilities, and especially, use of "expensive" or high demand facilities. A "C" grade means the user has access only after other demands are met. (Work that would merit a failing grade is blocked or stopped before it reaches the major proposal process.) The final decision for use of the High Field Facility rests with the Director of the NHMFL.

The ICR mass spectrometer facilities, isotope geochemistry facilities, and many of the magnetic resonance spectroscopy and imaging facilities are supported by grants other than the NHMFL Cooperative Agreement with the NSF. The fraction of time on these systems available to general users equals the fraction of the facility cost paid by the NHMFL. Collaborative access to them is governed by the terms of the grants and the principal investigators. General access is by the same process as for the general purpose resistive and pulsed magnets.

3. MAGNET SCIENCE AND TECHNOLOGY

The Magnet Science and Technology group has three main responsibilities within the NHMFL:

- Major magnet development projects supported by the NHMFL
- Research and development programs
- External activities such as magnet design and development in collaboration with other organizations.

The first and largest of these activities are major magnet development projects, which include both in-house magnet systems and those funded by external organizations. MS&T has developed this dual role to best utilize the human capital developed through the many magnet projects for the NHMFL. As major projects such as the Hybrid, 900 MHz and many of the resistive magnets are completed, external activities are expected to increase as a fraction of our workload.

MS&T continues to work on a number of external programs and projects with outside agencies. This is part of the natural evolution of the organization and exemplifies the high regard the MS&T group has worldwide. A few examples of major external project activities are:

- Magnet and cryogenic design for the DuPont ore separation magnet
- Magnet design and construction for the Michigan State University, National Cyclotron Laboratory
- Design and construction of a radiography pulsed magnet system for Sandia National Laboratory
- Magnet design for the Muon collider collaboration
- Testing of a large superconducting magnetic energy storage device for the Navy
- Design of HTS current leads for the W7-X plasma physics experiment.

A significant amount of work was accomplished during 2000. Highlights of achievements are listed below:

MAJOR PROJECTS HIGHLIGHTS

The **60 T Long-Pulse** magnet at LANL that was first operated as a user facility in November 1998 suffered a destructive failure in June 2000. A recovery plan is now in place, which combines the increased use of short pulse magnets and a rapid schedule for rebuilding the 60 T Long-Pulse magnet.

The **45 T Hybrid** magnet system achieved its design goal by exceeding 45 T in June 2000. Subsequently, the superconducting outsert experienced an unprotected quench that resulted in damage to the coil. The facility now runs at a reduced field of 42 T, while planning is in progress to repair the superconducting magnet and bring the facility back to 45 T.

The **900 MHz project** is progressing toward the ultimate goal of achieving 21 T in a 100 mm bore NMR spectrometer. Most of the coils have been fabricated and the coil set is in preparation for assembly. A test of the coil in a temporary cryostat is scheduled for July 2001. The design of the cryostat is complete and Ability Engineering and Technology has begun fabrication of the components. The final test of the fully assembled magnet system is scheduled for fall 2001.

The pulsed magnet group continues to deliver **capacitively driven magnets** for the LANL user facility. A recent development is a 50 T, 15 mm bore 400 ms long pulse magnet.

The **100 T project** achieved significant progress over the last year. A self-consistent design exists for 100 T on 15 mm bore. All materials are in house. A duplex magnet test is planned to simulate the performance of the 100 T insert.

DEVELOPMENT PROGRAMS HIGHLIGHTS

A detailed scoping study has been performed on a new hybrid consisting of a series connection of a resistive insert and superconducting outsert magnet. The goal is production of 35 T with one 10 MW power supply.

The HTS magnets and materials group, in collaboration with Oxford Superconductor Technologies, is designing and building a 5 T high field insert coil for the 20 T, 200 mm bore resistive magnet.

The Cryogenics group recently began an effort to use particle imaging techniques to study the detailed flow structure in superfluid helium.

The High Strength/Conductivity materials group is investigating strengthening of pure copper by cryogenic deformation. Yield strengths in the range of 500 to 600 MPa have been achieved by this process.

EXTERNAL ACTIVITIES HIGHLIGHTS

MS&T staff have performed a number of scoping studies for different magnet systems. The main effort in this area involves **design of superconducting magnets for the Muon Collider**.

MS&T is working with Sandia National Laboratory to build a Radiography pulsed magnet.

In collaboration with Michigan State University, MS&T is building **a sweeper magnet** for particle control at the National Superconducting Cyclotron Laboratory.

The NHMFL is developing a **split pulsed magnet** for the Los Alamos Neutron Science Experiment (LANSCE). A preliminary prototype of this magnet is scheduled for delivery by mid 2001.

More details on these and other MS&T projects are described herein. The reporting period is January through December 2000.

MAJOR PROJECTS

PROJECT TITLE: 45 T HYBRID

REPORT DATE: DECEMBER 31, 2000

STATUS

Following initial tests during December 1999, Operations and Instrumentation assumed responsibility for operation of the 45 T Hybrid System. Minor redesign and repairs made to the resistive insert early in 2000 and the combined system was operated to a new record field of 45.2 T on June 26, 2000. After several weeks of operation—including one 8-hour run with the outsert at full field—the outsert suffered an unprotected quench. That is to say, the quench detection computer did not command the breakers to open and discharge the magnet's energy into the dump resistor.

Tests of the outsert following the unprotected quench disclosed significant DC heating as current was increased slowly above 8 kA, with an eventual thermal runaway and quench as the current reached 9.5 kA. Further testing confirmed that the outsert could be operated quite reliably at 8 kA.

Analysis of data from the unprotected quench event, indicate that essentially all the magnet's stored energy (approximately 100 MJ at 10 kA) was absorbed by the first several layers of Coil A, the innermost Nb_3Sn coil. This appears to have raised conductor temperatures in that portion of the coil to levels in the neighborhood of 500 K within a matter of seconds. It is quite reasonable to believe that, during this process, the temperature of the Nb_3Sn cable strands differed substantially from that of the surrounding conduit, resulting in the imposition of substantial stresses on the fragile and strain-sensitive superconductor by differential expansion. The net result is that the superconducting transition has become very broad in the sense that there is now a small, but non-negligible, steady-state dissipation in the conductor of Coil A, beginning at current levels significantly below the design current. The dissipation increases non-ohmically with current, but at a power much smaller than typically observed in undamaged superconductors.

There is no evidence that any section of the outsert magnet other than Coil A quenched during the unprotected quench. Nor is there any reason to believe there is any damage other than to the higher-field regions of Coil A.

Prior to the unprotected quench, there was at least one other confirmed quench, which occurred when the resistive insert was ramped in field-opposing direction. Such an action causes a field increase at the highest-field region of the superconducting windings. An emergency discharge occurred on the day prior to the unprotected quench, but because data for this event was lost by the quench-detection computer, it could not be absolutely confirmed that this was a quench and not instrumentation fault. This event was preceded by a ramp of the outsert to full current within half the "guaranteed" ramp time of one hour. The unprotected quench also occurred at the end of a half-hour ramp, but there were prior half-hour ramps that did not result in a quench.

Since the unprotected quench, we have performed very careful and detailed analyses of the outsert operation, and we have correlated these analyses with what is presently a quite sound database for the AC-loss and critical-current characteristics of both the superconducting coils and the conductors from which they are constructed. Our understanding of the observed quenchs is as follows: During ramp up, AC heating in the conductor (predominantly by hysteresis losses) competes with the limited cooling afforded by the static He II. Hysteresis losses are greater in Coil A, primarily because of the larger volume of superconductor necessary to carry the current at the higher fields. If the ramp time is too short, the temperature inside the cable-in-conduit conductor (CICC) exceeds the lambda temperature and cooling is even further reduced. With He I in the CICC, even "index" heating may be sufficient to overwhelm the cooling and quench the magnet. Such quenches are easily avoided, however, by simply ramping to full current more slowly.

Plans for Outsert Repair

We are now in the planning stages for repairing the outsert magnet, which will require rebuilding and replacing Coil A. Rebuilding Coil A requires procurement of approximately 500 kg of high-performance Cu/Nb_3Sn composite wire, cabling that wire, jacketing the cable, winding the coil, heat treating it, vacuum-pressure impregnating it, and finally fitting it for connection to the other coils. Coil-A fabrication will require approximately two years. As the new Coil A nears completion, the old outsert will have to be removed from the cryostat, extracted from its steel housing, and disassembled, a process that will require at least six months. Reassembly of the outsert with the new Coil A and reinstallation of the assembly into the cryostat will require another six months. In summary, complete repair of the outsert will require between 2.5 and 3 years from start of the project.

PROJECT TITLE: **HIGH FIELD MAGNETIC RESONANCE MAGNET SYSTEMS**
REPORT DATE: **DECEMBER 31, 2000**

OBJECTIVE

The 900 MHz magnet is a major part of the long term program to achieve high resolution at 25 T, corresponding to a proton resonance frequency of 1.066 GHz. The future 25 T magnet will consist of an HTS inner coil operating in the field of a large LTS outer magnet. The requirements of this LTS magnet have been formulated as the wide bore 900 MHz program. Activities toward development of the HTS inner coil are carried out in the High Field HTS Insert Coils and Coil Technology (formerly Delta B) program.

The 900 MHz magnet is a very wide bore high resolution NMR magnet, with a central field of 21.1 T, a room temperature bore of 110 mm, and a temporal and spatial homogeneity objective of less than 1 part per billion in a 4 cm DSV. The magnet will operate in the persistent current mode at a reduced temperature of 1.8 K. The magnet employs epoxy impregnated coil technology, with coils fabricated from NbTi and Nb_3Sn metallic superconductors. The magnet system includes magnet, superconducting and room temperature shims, cryostat with JT refrigerator, and power supply.

The program is a collaboration between the NHMFL and the principle industrial partner Intermagnetics General Corporation. Additional industrial suppliers include Supercon and Vacuumschmelze.

STATUS

Fabrication of the main components of the 900 MHz project was conducted in three locations simultaneously. Intermagnetics General Corporation (IGC) has completed fabrication of the NbTi coils in Latham, NY. Ability Engineering is currently fabricating the cryostat in South Holland, IL. The NHMFL has completed fabrication of the Nb_3Sn coils and is beginning the overall assembly and testing process. The major work elements to complete are: (1) assembly of the magnet, (2) bucket test of the magnet, (3) fabrication of the permanent cryostat and (4) installation of the magnet in the permanent cryostat.

IGC was responsible for the engineering design and fabrication of the five NbTi coils (Production Coils 6 through 10) and the superconducting shim set comprising an axial and redial shim assembly. All of the coils have been completed and delivered to the NHMFL.

Ability Engineering is responsible for the engineering design and fabrication of the cryostat. The final engineering design details have been completed and are undergoing final review. Fabrication will start after review and approval of the design by the NHMFL. Long lead material procurement has been released and the fabrication of the bottom head of the 1.8 K vessel is nearly complete. The head is needed as the base for assembly of the magnet.. The fabrication process has been structured so that the cryostat components will arrive in priority order to support assembly of the magnet. The cryostat is not on the critical path.

The NHMFL is responsible for the overall magnetic design, the engineering design and fabrication of the Nb_3Sn coils, and the overall assembly of the magnet including the auxiliary systems. The Nb_3Sn coil set includes one model coil (Model Coil 3) and five production coils (Production Coils 1 through 5). The engineering design of the Nb_3Sn coils and the final assembly design are complete.

The Nb_3Sn coil fabrication process has the following sequence: wind, prepare joints, heat treat, solder joints, vacuum pressure impregnate, and breakout and mandrel removal. Coils 1 through 5 have been through the epoxy process. Mandrel removal is required for coils 3 through 5 and coils 4 and 5 are yet to be broken out after epoxy impregnation.

The final assembly design is complete and parts are being fabricated. Assembly should begin in mid-January 2001. The bucket test apparatus design is complete and parts are in fabrication. The magnet is scheduled to be ready for bucket test by July 2001. This will require at least a month, depending on the number of training quenches, etc. The bucket test program will include NMR mapping of the field homogeneity and potentially an NMR experiment at 900 MHz.

Cost and Schedule Issues

Extended efforts on joint development and longer than anticipated times for preparation and execution of heat treatment and epoxy impregnation of the tin coils have been the main causes of schedule changes in the past year.

900 MHz Magnet Project—Milestone Schedule Summary

	7/31/96 Schedule	Actual (A) or Current (C) Schedule
Issue Engineering Design (NHMFL)		
Engineering Design	8/30/96	9/12/96(A)
Even/Integer Design		3/26/97(A)
Conductor Procurement (NHMFL)		
Nb_3Sn Specification	8/30/96	8/30/96(A)
Nb_3Sn Order	10/1/96	10/1/96(A)
Nb_3Sn Delivery Complete		
Coils 1,2,3	10/1/97	3/30/98(A)
Coils 4,5		12/30/98(A)
NbTi Specification		5/6/97(A)
NbTi Order		6/30/97(A)
NbTi Delivery		3/30/99(A)
900 MHz Research & Development (NHMFL)		
Nb_3Sn Jc (B,T) Development	6/30/96	6/30/96(A)
Nb_3Sn Mechanical Properties	11/30/96	11/30/96(A)
Epoxy-Fibers Composites Development	1/31/97	1/31/97(A)
Winding composites	3/31/97	3/31/97(A)
Persistent Joint Development	5/31/97	12/15/99(A)
Persistent Switch Development	6/15/97	12/30/99(A)
Model/Test Coils Fabrication		1/30/99(A)
Mechanical Configuration and Structural Design (NHMFL)		
Initial Concepts Review		5/15/97(A)
Design Initial Inputs Complete	8/15/97	9/15/97(A)
Configuration Design Complete		4/30/99(A)

900 MHz Magnet Project—Milestone Schedule Summary (cont.)

	7/31/96 Schedule	Actual (A) or Current (C) Schedule
IGC Design and Fabrication		
Prepare Manufacturing Drawings		
Start Manufacturing Design	12/16/96	9/22/97(A)
Manufacturing Design Complete	11/15/97	7/31/99(A)
Fabricate NbTi Coils		
Ti Coil Forms and Tooling Delivered	2/2/98	
Coils 6 & 7		2/15/99(A)
Coils 8, 9 & 10		7/15/99(A)
Start Winding of Ti Coils	2/2/98	3/1/99(A)
Ship Ti Coils to NHMFL	9/30/98	8/30/00(A)
Fabricate Shim Coils		
Shim Tooling Received	1/10/98	7/1/99(A)
Complete Winding of Shim Coils	2/15/98	3/15/00(A)
Assemble Shim Coil Set	7/10/98	5/15/00(A)
Ship Shim Coil Set to NHMFL	9/30/98	5/30/00(A)
NHMFL Fabrication Program		
Fabricate Nb_3Sn Coils		
Nb_3Sn Coil forms & Tooling Delivered	11/20/97	9/1/99(A)
Start Winding Nb_3Sn Coils	11/21/97	5/1/99(A)
Complete Nb_3Sn Coil Assembly	9/30/98	4/30/01(C)
Cryostat and Cryogenic System		
Start Cryogenic System Design	3/1/98	3/1/98(A)
Receive Cryostat & Components	4/15/98	5/30/01(C)
Power Supply and Protection Controls		
Start Electronic Components Design	5/1/99	5/1/99(A)
Complete System Assembly and Test	8/30/99	4/30/01(C)
Magnet Assembly and Test		
Start Final Assembly of Magnet	10/1/98	12/30/00(A)
Installation of Magnet in Bucket Cryostat	12/23/98	5/30/01(C)
Magnet Bucket Testing		7/30/01(C)
Installation of Magnet in Cryostat		9/30/01(C)
Magnet Testing	12/26/98	11/30/01(C)

MAJOR PROJECTS

PROJECT TITLE: **50 MM BORE MULTIPURPOSE MAGNET**
REPORT DATE: **DECEMBER 31, 2000**

OBJECTIVE

This magnet can be operated in four different configurations for different purposes: (1) standard high field, (2) high field plus moderate uniformity for condensed matter NMR, (3) high field plus high modulation for de Haas van Alphen, (4) high field plus high gradient for force magnetometry.

STATUS

The magnet was constructed by taking the inner coil of an old 30 T, 32 mm bore magnet and enlarging the inner diameter of the Florida-Bitter disks. In the high field configuration the magnet provides 27 T in a 50 mm bore. In the moderate homogeneity configuration a piece of 1018 steel of rather intricate shape can be installed in the bore to provide uniformity of roughly 50 ppm over 1 cm DSV in a 36 mm bore. In the modulation configuration, the 50 mm bore tube is replaced with a 32 mm version with a small wire-wound coil on the outer diameter. This provides approximately 0.4 T peak to peak of AC modulation (roughly four times what other facilities provide) and can be operated at frequencies varying from 10 to 1000 Hz. The high gradient configuration should provide 0.05 T/cm either AC or DC in a 32 mm bore. An improved version of the modulation system is being developed to reduce the falloff at higher frequencies.

MAJOR PROJECTS

PROJECT TITLE: **30 T HIGH HOMOGENEITY MAGNET**

REPORT DATE: **DECEMBER 31, 2000**

OBJECTIVE

This magnet is an upgrade of our old 24.5 T, 32 mm bore, 50 ppm magnet. The new magnet will provide at least 30 T in a 32 mm bore with similar field homogeneity as our existing 24.5 T magnet. It will support the condensed matter NMR activities at the NHMFL and permit the study of magnetically-driven phenomenon at high fields.

STATUS

The coil design work for this project is essentially complete. It will be based on our 33 T Florida-Bitter magnets but will have a longer "A" coil to reduce the field inhomogeneity and a gap in the "B" coil for compensation. The project is on hold awaiting manpower.

MAJOR PROJECTS

PROJECT TITLE: **PULSED MAGNETS FOR USER FACILITY**
REPORT DATE: **DECEMBER 31, 2000**

OBJECTIVE

The objective of this activity is to provide the magnets necessary to sustain the NHMFL Pulsed Field Facility at Los Alamos. Magnet performance is upgraded as technology becomes available.

STATUS

Pulse magnet coils are, by the necessity for higher magnetic fields, operating with extreme mechanical stress. Conductor and reinforcement materials are in the plastic deformation range. Technical improvement entails the exploration of the design space compromises availed by high strength materials. A new coil design reflects this understanding. Ultimately the design is driven by the operational and physics requirements of the user community.

Traditionally, 24 mm bore, 50 T magnets and 15 mm bore, 60 T magnets are provided on an as-needed basis for the user facility. The 50 T magnets have a lifetime in the range of 1000 full field pulses without destruction. Earlier 60 T magnet designs have had a lifetime in the range of 250 full field pulses. Research has focused on the development and refinement of longer lived and higher field magnets.

We have developed and are refining a 15 mm bore 60 T ZM design. The achieved lifetime is now over 500 full field shots. The ZM coil is wound with a larger cross-section Glidcop Al-15 conductor and internally reinforced by Zylon fiber composites and MP35N. MP35N is a cobalt based multiphase superalloy. The ZM design reduces both the deformation and the heating in the magnets, which enables better performance and reliability. Development tasks entail the understanding of the Zylon and MP35N macro composite's mechanics in a winding. The ZM represents the first successful implementation of this technology in a user magnet. We have delivered four 60 T ZM coils to the NHMFL Los Alamos facility as user magnets. We will continue production of the 60 T ZM magnets in 2001.

Future plans for monolithic ZM coil development entail the application of a higher strength conductor, Glidcop AL-60, together with the now developed Zylon and MP35N reinforcement strategy. The ultimate goal is the production of reliable higher field pulse coils for the user facility. We have completed two new coil designs, and we anticipate prototype testing of these coils in the first half of 2001.

A prototype 15 mm bore, 50 T mid-pulse magnet was delivered to the NHMFL Los Alamos user facility in March 2000. The magnet was energized with the full capacitor bank to generate a magnetic field of 50 T with 400 ms pulse duration. The magnet failed prematurely after 38 full field shots. The fault was due to a layer-to-layer transition short in the windings. The design, although quite conservative and low in stress, allowed excessive conductor motion. We believe this motion was due to Zylon's low transverse modulus. A redesign of the magnet was completed using a Finite Element Analysis to understand and control conductor motion in the windings. We learned that Zylon reinforcement lacks axial stiffness. We also learned that subdividing the Zylon with stiff MP35N sheet enhances the axial stiffness of the reinforcement scheme. A second "improved" prototype was delivered to the NHMFL Los Alamos facility in November 2000. This prototype is now trained and operating as a user magnet with more than 70 full field shots. We plan to deliver three 50 T more mid-pulse coils to the user facility in 2001.

Major Project

Project Title: 60 Long-Pulse Magnet, "Mark II"

Report Date: December 31, 2000

Objective

The objectives of this activity are (a) to analyze the failure of the 60 T Long-Pulse magnet; (b) to determine if design or fabrication changes are likely to increase the operating life of the next 60 T Long-Pulse magnet; and (c) to build and commission a new 60 T Long-Pulse magnet, the "Mark II," for the User Program at the Pulsed Field Facility of the NHMFL.

Background

The 60 T Long-Pulse (60T LP) magnet was commissioned in August 1998. During its lifetime, the magnet was pulsed approximately 900 times, during which data was collected for 22 submitted manuscripts, of which sixteen were in print as of early August 2000. Among these articles are six *Physical Review B* articles, three *Phys. Rev. B Rapid Communications*, a *Physical Review Letter* and an article in *Nature* magazine. Research on the 60T LP magnet has led to at least eighteen invited talks at international conferences.

Summary of the Failure Event and the Subsequent Engineering Recovery Plan

At approximately 9:15am on Friday, July 28, 2000, the 60T LP magnet failed during normal operations at the NHMFL Pulsed Field Facility. The resulting explosion caused the destruction of the magnet assembly and minor damage within building, which housed the magnet.

The **Engineering Recovery Plan** in place will lead to a second-generation 60 T Long-Pulse magnet (the 60T LP-II) available to users in two-and-a-half years (currently estimated at April 2003 in the magnet rebuild schedule). A magnet review underway has analyzed all aspects of the 60T LP failure, seeking to determine the cause of failure and reduce the likelihood of a similar failure in the 60T LP-II. The summary report from this review is due in March 2001. An independent safety review panel commissioned by the Los Alamos National Laboratory has indicated that existing NHMFL safety procedures worked well and confirmed our own assessment that no personnel were put at risk during the magnet failure.

Status

A formal laboratory review of the incident plus a laboratory technical review of the magnet have been performed and are nearly complete. Evidence is mounting that the 60T LP failure was caused by a reduced fracture toughness in the Nitronic-40 reinforcing shells in layers five through eight. Preliminary conclusions therefore suggest that the 60T LP-II will follow the design of the 60T LP with altered specifications, anneal schedules, and quality assurance tests for the Nitronic-40 shells. These steps should eliminate this particular materials weakness at the outset of the shell fabrication process and, furthermore, verify the required fracture toughness before the shells are built into the magnet. Stronger conductor and reinforcing materials developed by the 100 T magnet project since the construction of the 60T LP magnet might also be incorporated in the 60T LP-II magnet to increase the design margin, but a definitive decision need not be taken until Spring 2001, according to the magnet rebuild schedule. The new materials under consideration are (a) the conductor Glidcop AL-60, fabricated using a newly-developed manufacturing protocol (which is 1.3 times stronger than traditional Glidcop AL-60 used in the 60T LP magnet) and (b) reinforcing shells made by winding sheets of cold-rolled 301 Stainless Steel (which is 2.0 times stronger than the solid Nitronic-40 shells in the 60T LP).

The magnet rebuild schedule is based upon past experience with the 60T LP magnet and is scheduled to dovetail with the 100 T magnet project schedule. Relevant lessons learned from the 60T LP failure are being incorporated into the 100 T assembly, quality assurance tests, and operational procedures. At the present time, the 100T magnet is anticipated to be available for users in February 2003 and the 60T LP-II is anticipated to be available for users in April 2003. The final schedule depends, among other factors, upon the outcome of the 60T LP failure analysis, as well as the ability and willingness of vendors to adopt the proposed schedule.

MAJOR PROJECT

PROJECT TITLE: 100 T INSERT MAGNET PROJECT

REPORT DATE: DECEMBER 31, 2000

OBJECTIVE

The objective of this activity is to design, construct, and test a 15 mm bore capacitor powered insert coil for use with an outer coil set operated in a long-pulse mode. Together, the two systems will be capable of producing a total field of 100 T.

STATUS

Three different insert coil designs based on different materials (CuNb, CuAg, and CuSS) were developed. The coil geometry, conductor dimensions, and reinforcing materials have been determined for each coil design.

We selected CuNb as our initial design material and the CuNb was delivered from the Bochvar Institute in December 2000.

The internal reinforcements for all the designs are the cobalt-based multiphase alloy MP35N combined with Zylon fibers and epoxy resin. The magnetic field reduction due to eddy currents in the MP35N reinforcement has been modeled by computer simulation. A series of coils has been designed to analyze the eddy current effect of MP35N reinforcement.

A duplex test magnet system has been designed for early testing of the 100 T insert magnet prototypes. The objective of this duplex system is to simulate the performance of the 100 T insert coil under stress loading, which mimics that experienced during full 100 T pulses. The duplex test magnet system will allow more rapid and complete testing of 100T magnet inserts: It will come available well before the generator-driven outsert coil system is available, and it removes all risk to the outsert magnet during initial 100 T insert magnet testing.

RESEARCH & DEVELOPMENT ACTIVITIES

PROJECT TITLE: CRYOGENIC COMPONENT DEVELOPMENT
REPORT DATE: DECEMBER 31, 2000

OBJECTIVE

The objectives of this program are to develop and better understand cryogenic systems in order to improve our ability to support superconducting magnet technology. To this end, the Cryogenic Component Development program has three main objectives:

- To develop cryogenic technology in support of large scale superconducting magnet systems
- To conduct R&D to advance cryogenic technology for improved application
- To collaborate with industry and other laboratories in development of cryogenic technology.

STATUS

Over the last year the Cryogenic Component Development (CCD) group has concentrated its efforts in two main projects, which are as follows.

Design and development of the 900 MHz NMR magnet cryostat. The design of this system is complete and fabrication is underway at Ability Engineering and Technology. Installation of the completed 900 MHz magnet is scheduled to begin in fall 2001.

Design and development of the cryogenic system for a DOE funded high temperature superconducting magnetic ore separator. This is a Industrial/Laboratory program supported by the Superconducting Partnership Initiative. The resulting 3 T HTS coil will be tested in 2001.

In addition, the CCD group is pursuing several R&D activities. These are mostly funded by outside grants as indicated:

Liquid Helium Flow Visualization Studies. This program is supported by a grant from the National Science Foundation. The work involves experimental application of modern particle imaging techniques to flow states in liquid He II. Current activities include establishing the facility for particle imaging and generating neutral density particles in liquid helium.

Liquid Helium Fluid Dynamics Studies. This program is supported by a grant from the Department of Energy. The work focuses on cryogenics issues of future particle accelerators. Current studies include: (1) propagation of intense thermal shock and second sound attenuation; and (2) High Reynold's number forced flow He II and instrumentation development using the Cryogenic Helium Experimental Facility.

Collaborations

DESY-Hamburg. We are working together on a He II two phase flow experiment to confirm the operating characteristics of the cooling system for the TESLA electron accelerator. We are also performing Kapitza resistance measurements in support of RF cavity development.

University of Oregon. We are collaborating with researchers in the Physics Department on an experiment to measure drag on a spherical body at high Reynold's numbers in liquid helium.

Research & Development Activities

Project Title: High Strength Materials

Report Date: December 31, 2000

Objectives

The effort in material research and development programs related to the high field magnets at MST/NHMFL has been concentrated on (a) development of various fabrication routes for different conductors and reinforcement materials in collaboration with industrial partners, (b) investigation of the physical properties, atomic structure and microstructure of both kinds of materials, and (c) exploration of new materials that have the potential for fabrication of next generation magnets. The program emphasizes the requirement to develop fabrication routes capable of producing the conductors and reinforcement materials with desired and homogeneous properties and with appropriate sizes.

Activities

The study of fabrication routes and properties of the conductors took an approach to relate the properties both to design requirements and to the service life of the magnets. Fabrication of Cu, Cu-Ag, Cu-Nb, and Cu+Al_2O_3 aims to make high strength conductors with the appropriate cross-section required for the magnets. Considerations have been given to the role of atomic structure distortion on both the elastic-plastic transition and the mechanical instability of heavily deformed conductors. The assessments were also made on Young's modulus, yield stress, and conductivity of the materials at room temperature and 77 K. In both Cu-Ag and Cu-Nb conductors, the strain hardening introduces crystallographic lattice distortion and consequently no sharp elastic-plastic transition can be observed. Cyclic deformations, such as mechanical fatigue, reduce the effect of the lattice distortion on the mechanical properties of the materials. More severe lattice distortions were found in Cu-Nb than Cu-Ag conductors and resulted in more rounded stress-strain curves. The deformed Cu+Al_2O_3 materials have the most abrupt elastic-plastic transition among all the conductors investigated, because the reinforcement particles essentially are not shear-susceptible at the stresses applied and little lattice distortion occurs. Because the lattice distortion is related to the fatigue behavior of the conductors, it affects the service life of the pulse magnets.

The exploration of new conductors is concentrated on cryogenic deformation of Cu and Cu+Al_2O_3 and fabrication of various macro-composite. The assessment of the microstructure and properties of cryogenic deformed pure Cu indicates that the structure and strength formed by 77 K deformation need to be stabilized. Therefore, low temperature rolling and drawing have been undertaken on Cu+Al_2O_3 conductors. The preliminary results indicate that the low temperature deformation indeed introduces more strain hardening in Cu+Al_2O_3 conductors at low strain levels.

Currently, macro-composites made of stainless steel jacked Cu, Cu+0.3wt%Al_2O_3, and Cu+1.1wt%Al_2O_3 have been fabricated. The preliminary results indicate that the conductors have the potential to achieve high strength with large cross-sections.

The reinforcement materials investigated are cobalt-nickel alloys and high purity maraging steels. The cobalt-nickel alloys are reinforced mainly by dislocations and coherent defects or precipitates which are only a few atomic layers thick. The high purity maraging steels have a low interstitial level and thus a high fracture toughness value than conventional maraging steels. Both materials have a higher Young's modulus than other currently available reinforcement materials, e.g. stainless steels. The lack of available data on the heat treatment and cold work conditions, however, resulted in inconsistent and lower than optimized mechanical properties of cobalt-nickel alloys. A systematic investigation has been undertaken on the thermo-mechanical processing variables and their effect on the strength, ductility and fatigue life of cobalt-nickel alloys. The properties are related to the structure of the materials from the microscopic scale to atomistic scale. Currently, the optimized fabrication routes supply an MP35N alloys in a repeatable manner with an ultimate tensile strength of 2500 MPa at 77 K. The materials can survive more than 2000 cycles at a maximum stress level of 2300 MPa at 77 K. These properties meet the aggressive requirements of the current pulse magnet designs.

PROJECT TITLE: **HIGH FIELD HTS INSERT COILS AND COIL TECHNOLOGY**

REPORT DATE: **DECEMBER 31, 2000**

OBJECTIVES

The goal of this activity (formerly referred to as Delta B) is the development of high field insert coils using high temperature superconductor (HTS) materials. The generation of 5 T in a 20 T background corresponds to a 1.1 GHz NMR system. Toward this end, the immediate objectives are:

- conductor development and characterization for improved electrical and mechanical behavior
- coil winding studies for the development of suitable techniques for layer wound coils with co-wound reinforcement and improved packing factor
- testing of double-pancake coils and prototypical inserts to better understand coil performance, leading to improved coil design
- development of a 5 T pre-prototype insert for testing in the large bore resistive magnet in 2001
- development of insulation for layer-wound coils.

ACCOMPLISHMENTS

In the past year we have begun qualifying conductors for the pre-prototype 5 T insert. This project builds upon the successful testing in 1999 of a 3 T insert coil within the 19 T large bore resistive magnet. Both the previous 3 T and the present 5 T inserts are collaborative projects with Oxford Superconducting Technology (OST), Inc., and required the heat treatment of long-lengths of Bi-2212 conductor. Significant increases in the critical current density of this superconductor have been obtained. The preliminary design of the 5 T coil has been completed, and the first few double pancake coils have been wound.

Internal conductor development has investigated the effects of Ba additions on the heat treatment, microstructure, and critical current density (J_c) of Bi-2212 conductor. We have found that for a narrow Ba-added stoichiometry, significant improvements are obtained.

We have also developed a unique methodology for measuring the effects of axial compressive strain on short-samples of BSCCO conductor.

ACTIVITIES

With OST, we are studying the effects of varying the Bi-2212 conductor geometry on conductor performance. Further increases in J_c may be obtained for the 5 T coil. With OST, we are also studying conductors for wind-and-react double pancake coils and for react-and-wind double pancake and layer wound coils. Lastly, with American Superconductor Corporation, Nordic Superconductor Technologies (NST), and the Korean Institute of Machinery and Materials (KIMM) we are evaluating Bi-2223 conductors for react-and-wind coils.

Also important for high field insert coils is the mechanical behavior of the HTS conductor. We are evaluating the stress-strain behavior at room temperature and low temperature, the effects of strain on J_c, and the effects of fatigue on J_c, of the various conductors under development. Furthermore, we are studying pancake coils of small radial build to determine the mechanical performance of coils under Lorentz forces. By using coils with large diameter and small radial build, Lorentz forces are maximized while maintaining a fairly uniform distribution of stress within the coil. This approach allows functional performance limits to be determined in realistic model coils.

Building upon the success of the 3 T coil and the improvements in conductor performance, we are now developing a 5 T insert coil for the 19 T large bore resistive magnet. Design scoping studies indicate that, by reinforcing some of the coil, 5 T can be achieved with Bi-2212 conductor from OST. It is envisioned that this coil will be comprised of a wind-and-react stack of double pancake coils for the smallest diameter section, a react-and-wind stack of double pancake coils for the middle section, and a react-and-wind layer wound coil for the outermost section. In support of this effort, we are developing techniques for co-winding reinforcement and for winding layer-wound coils, including turn-to-turn insulation. Results from these smaller test coils will allow further optimization of the 5 T insert coil design.

HTS Reciprocating Magnetic Ore Separator

The magnetic ore separator project is being conducted in collaboration with DuPont Superconductivity and Outokumpu-Carpco and is funded by the Department of Energy. When complete, the system will be a quarter-scale, working prototype in operation at one of DuPont's demonstration facilities. The magnet system consists of a 2^{+} T, 200 mm warm bore Ag/BSCCO conductor HTS magnet with a room temperature iron shield. The magnet, which is being built by American Superconductor, will be conductively cooled and operate at approximately 30 K. The goal is to provide a robust, industrial unit that is competitive with existing LTS superconducting separators. During Phase I of this project (until December 1999), the NHMFL conducted a magnet and cryogenic system design. The magnet will have a 250 mm cold bore and an overall length of 300 mm. During Phase II in 2000, the NHMFL began fabrication of the cryogenic system. The cryostat is now under test after which we will install the magnet and test the entire system at DuPont.

Pulsed Magnets for the Advanced Hydrodynamic Radiography Program at Sandia National Laboratory

In the spirit of cooperation the pulse group at NHMFL has collaborated with groups at Dresden, the Korean Research Institute of Standards & Science, the Ruppin Institute, and the radiographic physics department of the Sandia National Laboratory. The NHMFL pulse group provided coils for use in the physics research facilities at Dresden and the Korean Research Institute of Standards & Science. We also started an ongoing technical cooperation with the Physics and Engineering Research Institute (PERI) at the Ruppin Institute in Emek Hefer, Israel. The Sandia collaboration involves the development of pulse coils for electron beam experiments.

Institute of Solid State and Materials Research Dresden

The NHMFL delivered one 15 mm bore, 60 T ZM pulse magnet for physics research to the Institut für Festkörper und Werkstofforschung in Dresden Germany. This magnet has expanded the user magnet capability at the Dresden facility.

Navy SMES

The NHMFL has contracted with the Office of Naval Research for a demonstration of major components being developed for future electrified ships. Components to be tested initially include a 19 ton, 2 meter bore, 4 T Superconducting Magnetic Energy Storage (SMES) magnet provided by the Naval Surface Warfare Center-Annapolis and a Power Electronics Building Block (PEBB) module provided by Virginia Polytechnic Institute and State University. The SMES magnet is being assembled in its cryostat (delivered separately) and installed in the Large Magnet Component Test Laboratory (LMCTL) at the NHMFL. The test program involves operations of the SMES magnet and PEBB both together and separately, supported by other utility and power/protection systems available in the LMCTL.

Muon Collider Design Study

The Fermi National Accelerator Laboratory is conducting a conceptual design of a future muon collider and has contracted the NHMFL to address magnet design issues. To date, our contributions have dealt with two superconducting magnet systems important to cooling a muon beam created by pion capture and decay. These systems include a "bent" solenoid/dipole system and an alternating-field solenoid system. The bent solenoid/dipole system requires modest fields (approximately 3 T from the solenoids and < 0.6 T from the dipole), but high homogeneity over a significant volume along the path of the beam. On the other hand, the alternating-field solenoid system requires quite high fields (approximately 15 T in the present system) and a precisely defined field profile along the beam path that includes field reversal with a gradient at the zero crossing of nearly 50 T/m. Sizes of the coils are moderate. The bent solenoid/dipole system must fit around a 300 mm diameter beam tube. A liquid hydrogen adsorber (150 mm outer diameter) sets the bore of the high-field coils for the alternating-field solenoid system, while a 400 mm outer diameter. RF cavity defines the bore of the coils in the zero-crossing region. The field profile for the alternating-field system is cyclic with a period of 1.5 m. Challenges of this system include the production of high fields over large volumes, handling the high forces of repulsion, and integration of the magnet cryogenic system with that of the liquid hydrogen adsorber.

NSCL: Sweeper Magnet

The National Superconducting Cyclotron Laboratory at Michigan State University has contracted with the NHMFL to build a 4 T superconducting sweeper magnet. The magnet is referred to as a sweeper because it "sweeps" charged particles out of a neutron beam and into a mass spectrometer. It is required to bend beams of 4 T/m rigidity though 40° on a one meter radius. The magnet consists of 2 D shaped coils with a split of 140 mm. The conductor is epoxy impregnated niobium titanium operating at 4.2 K. There is a yoke of approximately 16 tons to enhance the peak field and reduce the fringe field.

Although 4 T is not a tremendously high field, attaining 4 T in a gap of 140 mm with a D-shaped magnet leads to high stresses and requires substantial analytical work in the design process to ensure reliable operation. The design of this magnet system is underway and fabrication is scheduled to begin in early 2001.

EURUS/NRIM: High Field Florida-Bitter Magnets

We are presently working through EURUS Technologies to provide magnets to the National Research Institute for Metals of Tsukuba, Japan. In late 1998 a contract was signed for a replacement A coil, for the 30 T Florida Bitter coil that the NHMFL delivered in 1997. The replacement A coil was delivered. Replacement B coil is currently under construction. A contract has been signed for a replacement C coil to be delivered early 2001.

High Field Magnet Laboratory, University of Nijmegen, The Netherlands

The NHMFL has signed a contract to deliver a 30 T, DC resistive Florida Bitter magnet to the High Field Laboratory at Nijmegen. The magnet, which is similar to NHMFL user magnets, will be delivered during 2001.

4. NHMFL In-House Research Program

The National Science Foundation charged the National High Magnetic Field Laboratory (NHMFL) with developing an in-house research program that *utilizes* the NHMFL facilities to carry out high quality research at the forefront of science and engineering and *advances* the NHMFL facilities and their scientific and technical capabilities.

To this end, the NHMFL established in 1996 an in-house research program that stimulates magnet and facility development and provides intellectual leadership for experimental and theoretical research in magnetic materials and phenomena. The NHMFL In-House Research Program (IHRP) 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 NHMFL In-House Research Program (IHRP) strongly encourages collaboration across host-institutional boundaries; between internal and external investigators in academia, national laboratories and industry; and interaction between theory and experiment. Some projects are also supported to drive new or unique research, that is, to 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.

The IHRP is now five years old. Five solicitations have been completed with a total of 214 proposals being submitted for review. Of the 214 proposals, 110 were selected to advance to the second phase of review, and 45 were funded (21% of the total number of submitted proposals). The results from the funded projects have materialized and are reported in the *2000 NHMFL Annual Research Review to be published in spring 2000.*

2000 Solicitation and Awards

Beginning with the 2000 Solicitation, the IHRP moved to a pre-proposal process that was reviewed by the Research Program Committee augmented by members of the User Committee, who are elected by the laboratory's external users. The Committee selected the pre-proposals that met the review criteria, keeping in mind that funded projects had to meet the highest quality. The NHMFL reserved the right to turn down pre-proposals that did not fully meet the solicitation guidelines. Pre-proposals deemed to hold the highest merit were then passed on to the second review step as full proposals.

The Research Program Committee augmented by members of the User Committee provided the review of the full proposals. The proposals were evaluated based upon the goals and criteria stated in the solicitation.

A final determination of project funding was made by the NHMFL Chief Scientist.

Of the 46 pre-proposals received, the committee recommended that 18 pre-proposals be moved to the full proposal stage. Of the 18 full proposals, 6 proposals were funded. A breakdown of the review results is presented in the following tables.

IHRP Overview

Research Area	# Pre-Proposals Submitted	# Proceeding to Full Proposal Status	# of Projects Funded
Magnetic Resonance	17	3	0
Condensed Matter Physics	16	9	5
Materials Science & Engineering	13	6	1
TOTAL	**46**	**18**	**6**

Funded Projects

Lead P.I.	NHMFL Institution	Project Title	Project Duration	Total Funding
Jack Crow	NHMFL	*Development of low mass specific heat capacity in high magnetic fields*	2 years	$224,971
Lloyd Engel	NHMFL	*Complex rf conductivity measurements of 2D electron systems in high magnetic fields*	2 years	$136,365
Neil Harrison	LANL	*Millimeter-wave spectroscopy in pulsed magnetic fields*	2 years	$196,629
Art Hebard	UF	*Luttinger liquid phase induced by ultraquantum magnetic fields*	2 years	$148,199
Albert Migliori	LANL	*Development of advanced instrumentation for static and pulsed fields*	2 years	$200,478
Arneil Reyes	NHMFL	*Studies of the vortex dynamics and spin fluctuations in high temperature superconductors by NMR at fields to 45 T*	2 years	$193,402

2001 Solicitation

The 2001 Solicitation Announcement will be released March 9, 2001, with a pre-proposal deadline of April 6, 2001. Awards will be announced in the summer of 2001.

5. EDUCATION PROGRAMS

In support of the ongoing educational mission of the NHMFL, the *Center for Integrating Research and Learning* continued its expansion of educational programs, creating new classroom resources, extending further its educational opportunities for students and teachers, and developing new programs. This year saw an increase in national interest in Center programs and the solidifying of the NHMFL's educational programs as an important resource for educators.

NHMFL educational activities are created in consultation with scientists, engineers, and technicians who provide valuable input that helps translate the real-world science activities of the laboratory for students, teachers, and the general public. The Center continued its active partnerships with the university, the local, state, and national education community, as well as with other NHMFL sites at the University of Florida and Los Alamos National Laboratory.

The Center's seven major areas of focus continue to provide an infrastructure and the continuity necessary to provide ongoing quality educational programs.

- Student Education
- Teacher Education
- General Public Awareness
- Curriculum Materials Development
- Educational Research
- Educational Resource Laboratory
- Partnerships

These seven areas allow the Center to enhance the learning and understanding of science, research, and technology in both formal settings (e.g., schools) and informal settings (e.g., at home, on a laboratory tour, or at our Open House). Particular care is taken to incorporate strategies that encourage and involve underrepresented student populations, supporting the vision promoted by the National Science Foundation, state agencies, and other reform advocates. As National Science Board (NSB) Chair Eamon Kelly highlighted in his release of the report, *Preparing Our Children: Math and Science Education in the National Interest*, "Believing that education is simultaneously a local responsibility and a national priority, the NSB asserts that scientists, engineers, and their institutions must have a key responsibility to assist K-12 schools, teachers, and students to improve the nation's math and science achievement."

This report summarizes our efforts toward these goals and is organized around the seven Center focus areas. Each area is complementary to the others, however, and the interaction among them is the key to their success. For example, our work with Training Solutions Interactive (TSI) is listed under "Partnerships," but this partnership has spawned several programs, such as *Science, Tobacco & You* and its recent extension, the *Best Practices Program*. *Science, Tobacco & You* is a multidisciplinary science curriculum resource that engages students in developing skills in language arts, mathematics, social studies and many other subjects. The goal of *Science, Tobacco & You* is to encourage students to use *science* to ask and answer questions to promote scientific literacy; in this case, the platform used is the issue of tobacco use and prevention. Through training and distribution, the Center and its partner, TSI, have delivered over 1,000 curriculum packages in Connecticut, over 4,200 in Florida, and over 350 in Illinois. Expansion continues as educators realize the benefits of a science curriculum that addresses current issues of concern.

Highlights of the current reporting period (January 1, 2000-December 31, 2000) are presented below, followed by expanded descriptions of each program.

STUDENT EDUCATION HIGHLIGHTS

As part of our *Science, Tobacco & You* program, we engaged students across Florida, Connecticut, and Illinois. Since its inception, the Web site (*http://scienceu.fsu.edu*) has continued to be a valuable resource for students and teachers. The Florida Department of Health projects that **400,000** students will be reached each year through this program.

Our outreach efforts emphasized experiences for the students that were more hands-on and substantive by working with smaller groups for longer periods. These multifaceted and interdisciplinary programs reached **4,241** students during the period.

The NHMFL provides mentorship and internship experiences for students from the middle grades level (grades 6-8) through graduate level. This year we hosted over **30** middle or high school students and numerous undergraduate students, including students in our Research Experience for Undergraduates Program.

We continued to maintain the large number of visitors to the laboratory while enhancing their educational experience. Approximately **1800** grades 4-12 students and **860** adults toured the NHMFL during the reporting period.

TEACHER EDUCATION HIGHLIGHTS

We continued our expansion of workshops and training providing statewide and regional workshops for **a total of 60 workshops**, reaching **1800** elementary, middle grades, high school, and community college teachers during the period.

Our Ambassador program continues to flourish with active participation from over **75** regional K-12 teachers representing **70** schools and **15** community organizations.

Drawing upon the success of the Research Experience for Undergraduates, the Center conducted its Second Annual Research Experiences for Teachers, attracting 16 educators from across the United States. Teachers work in teams comprised of experienced teachers, pre-service teachers, new teachers, and undergraduate science majors, and with scientists and researchers at the Tallahassee site of the NHMFL on research projects.

NHMFL educators offered undergraduate level courses for prospective teachers through the Florida State University College of Education and continued to provide experiences for Elementary Education and Science Education students as part of their formal course of study.

General Public Awareness Highlights

Approximately **2,600** members of the general public experienced guided tours of the lab during the reporting period. Based on numbers from previous years, we anticipate an additional **3,000** visitors to the 6th Annual NHMFL Open House to be held in March 2001.

Curriculum Materials Development Highlights

Science, Tobacco & You—an integrated science, standards-based program that is designed to encourage students to use science to ask and answer questions to promote scientific literacy continues to be distributed and enhanced. We have distributed **5,550** packages to Florida, Connecticut, and Illinois schools.

MagLab: Alpha—our first commercially available curriculum product continues to be marketed nationally through Sempco Incorporated and Sargent Welch. *MagLab: Alpha* is an integrated science, standards-based program that is designed to enhance the teaching and learning of magnet-related science in middle grades (grades 6-8).

Other proposed curriculum products include elementary science activities that focus on light, color, and optics; elementary magnets and magnetism activities; and other activities that support workshop and institute development.

Educational Research Highlights

Conference papers and presentations were curtailed during this reporting period due to a shift in resources to accommodate the continued development and dissemination of the *Science, Tobacco & You* program, although Center faculty continue to be invited to participate in national and international conference activities. Requests for papers presented in 1999 were received from researchers and established educational experts.

Education Resource Laboratory Highlights

This state-of-the-art laboratory houses multimedia development equipment, manipulative development equipment, curriculum materials, and instructional resources, and is used by teachers, students, and NHMFL personnel.

Partnerships & Community Support Highlights

The NHMFL continues to work closely with Florida Agricultural and Mechanical University and the Alliance for Minority Participation to promote the laboratory's Research Experience for Undergraduates (REU) Program.

Training Solutions Interactive (TSI), a private business headquartered in Atlanta, Georgia and the laboratory have formed a partnership to develop and market NHMFL curriculum materials.

We have continued our active role serving on the Board of the Community Classroom Consortium and establishing stronger links with regional schools through our Ambassador program.

STUDENT EDUCATION

Through our expanded curriculum resources and comprehensive programs the Center continues to support educational experiences and opportunities that reach well over half a million students each year. Each program is designed to enhance the students' understanding of science, while encouraging them to become scientifically literate citizens and consider careers in science or science-related fields. All of our programs reflect research and practice at the cutting-edge in both education and science. We are continuing to develop this comprehensive program, which affords opportunities for students at all levels and abilities to engage in science and to experience the excitement of learning. These experiences are engaging, fun, and promote high standards. As one teacher wrote, "This is definitely an A+ project!"

K-12 Student Education. At the K-12 level, our student education programs comprise "in-house" programs that bring the students to the NHMFL and "outreach" programs that send NHMFL educators or resources to the students. In-house efforts include tours of the facility, mentorship, internship and externship experiences, and classes taught in our resource lab or seminar rooms. Outreach efforts engage students through presentations and classes taught at schools across Florida and through our Web site resources. Some highlights from these programs follow.

- **Outreach.** Our outreach program sends NHMFL educators directly to the schools with presentations and workshops on science. These multifaceted and interdisciplinary programs reached approximately **4,241** students between January 2000 and December 2000. In all of these programs, we encourage students from all backgrounds to see themselves as potential scientists, engineers, and/or end-users of science and technology. We have shifted our programs to provide more interactive, small-group learning experiences rather than large group "shows." Other outreach efforts included school fund raising events, assistance with science fairs, mentoring science projects, providing equipment to teachers for special activities, and participating in Barnes and Noble's Young Scientists Club for middle school students.

- **Mentorships and Internships.** The NHMFL provides mentorship and internship experiences for students from the middle grades level (grades 6-8) through graduate level. Every third semester we host over **25** middle school students, pairing students with scientists at the laboratory designing and implementing real-world science research projects. Past research projects have spanned topics ranging from studying the engineering design of structures, to JAVA programming development, to the design and construction of a superconducting magnet system. The success of this program was evidenced by researchers requesting that the students stay on for further research and by researchers' continued commitment to the program. During the reporting period, the NHMFL provided externship experiences for 5 high school students who worked at the laboratory on a regular basis for one semester, earning high school credit.

- **Young Scholars Program.** The NHMFL continues its support of the Young Scholars Program by providing research mentorships and speakers for the summer program.

- **Web site.** The lab maintains and continues to develop extensive Web-based resources for students. Please visit our sites:

http://k12.magnet.fsu.edu

http://ret.magnet.fsu.edu

http://reu.magnet.fsu.edu

http://scienceu.fsu.edu

http://arts.magnet.fsu.edu

http://micro.magnet.fsu.edu/primer/index.html

http://www.magnet.fsu.edu.

- **Tours.** We have enhanced the tour experience by expanding the overview portion of the program as well as through extended tours, which include mini-classes. For example, students and teachers have been encouraged to attend a "build an electromagnet" class as part of their tour experience. Approximately **1,720** grades 4-12 students toured the NHMFL during the reporting period.

- **Afterschool Programs.** During this reporting period, the NHMFL conducted classes in cooperation with two afterschool programs for high-achieving, at-risk students. The middle school group of 12 students worked with Center staff one day per week for a semester and included 3 high school students as participants/mentors. The elementary school group comprised 20 students and worked with Center staff one day per week learning new ways to use technology to enhance their schoolwork.

- **Earth Day Contest.** During this reporting period, the Center initiated an Earth Day Contest that attracted over 75 entries statewide. The theme, **Earth Day 2000: Inventions and Innovations for a Brighter Tomorrow,** was addressed by K-12 students with projects ranging from a solar powered cooling hat to a table that cleans itself!

Future plans include seminars and courses available through distance learning strategies (such as telecasts and Web-based resources), new curriculum resource materials, a "women and girls in science" day at the laboratory, science fair workshops for students and parents, and a resource library for teachers, students and parents..

Undergraduate Student Education. The NHMFL provides a variety of opportunities for undergraduate students. NHMFL faculty advise numerous undergraduates and teach over 20 undergraduate courses. At the University of Florida, over 60 percent of all graduating students enroll in at least one physics course. In addition to advising and coursework, undergraduates also have opportunities for internship, research, and work experiences throughout the laboratory.

In 2000 we hosted the seventh NHMFL Research Experiences for Undergraduates Program. The selected undergraduate students were placed for 8 weeks in research experiences with mentors in Tallahassee, Gainesville, and Los Alamos. Table 1 provides details about the "NHMFL Internship Class of '00."

Table 1. NHMFL REU Class of 2000.

Name	Home Institution	Scientist	Area of Research
Andreae Arey	Florida State University	Peter Fajer	The Biochemistry of Muscle Contraction
Carolyn Boyce	South Carolina State	Alex Angerhofer	Biochemistry EPR Spectroscopy
Karen Davis	Florida State University	Peter Kalu	Analysis of the Microstructure of Copper Niobium
Arnett Flowers	Florida State University	Louis-Claude Brunel	Amplifier Designs: Studies in Interdisciplinary Projects
Stephanie Howse	Florida Agricultural & Mechanical University	Roy Odom	Contribution of Land Management Methods to Soil Respiration of CO_2
Vinima Kerof	College of Notre Dame of Maryland	Alex Angerhofer	Calculating the g-factor Anisotropy of Paramagnetic Radicals in Photosynthesis
James Maloney	University of Florida	Mark Meisel	Low Temperature Measurements of Novel Low Dimensional Systems
Shanna McCord	Northwestern University	Justin Schwartz	Research on High Temperature Superconductors
Eliza Miller-Ricci	Middlebury College	Stan Tozer	The de Haas-van Alphen Effect in 115s: The Cantilever Method
Lydia Peabody	Smith College	Stan Tozer	The de Haas-van Alphen Effect in 115s: The Cantilever Method
Charis Quay	Mount Holyoke College	Stan Tozer	The de Haas-van Alphen Effect in 115s: The Cantilever Method
Megan Raymond	Michigan State University	James Brooks	Probe Development for Testing Inorganic and Organic Semi-conductors in the Hybrid Magnet
Melissa Romero	Florida State University	Roy Odom	Contribution of Land Management Methods to Soil Respiration of CO2
Salvador Santolucito	University of Texas at Austin	Heinrich J. Boenig	Assembling and Commissioning of a 2.4 MJ, 24 kV Capacitor Bank
Nicole Tibbetts	Florida State University	Roy Odom	Geochemistry Studies
Sharon Touton	Occidental College	Alex Lacerda	Transport Properties of Correlated Electron System
Kirstin Walther	Mount Holyoke College	Dragana Popovic	Magnetoconductance of 2D Silicon MOSFETs in Parallel Magnetic Fields
Nicholas West	College of William & Mary	Jack Crow	Magnetic Ordering of R3RuO7 (R=Eu, Gd, Sm, Tb)
Brandi Wilcox	Smith College	Justin Schwartz	Preparing and Analyzing Superconducting Tapes
Joel Wilson	University of Colorado at Boulder	James Sims	Design related to NHMFL 30T / LANSCE Magnet
June Yowtak	University of Dallas	Mark Meisel	Transgenic Arabidopsis Plants as the Subject of Magnetic Field Effects

Summer 2000 saw an increase in the number of interns applying to and being accepted into the annual Research Experiences for Undergraduates program. In all, 21 students served in mentorships at the three NHMFL sites. In addition to the 21 students "officially" in the program, the Center was asked to incorporate other interns at the laboratory into REU activities (lectures, seminars, colloquia, etc.). In all, 31 students participated in the program. The breakdown of participants is as follows:

Gender		Ethnicity	
Women	16 (76%)	African American	2 (10%)
Men	5 (24%)	Asian	4 (19%)
		Caucasian	13 (62%)
		Hispanic	2 (10%)

Both Summer 1999 and Summer 2000 student presentations and papers can be found at *http://k12.magnet.fsu.edu*.

Graduate Student Education. The graduate student education program at the NHMFL continues to provide strong learning experiences for students both in formal class settings and through productive "workplace" and research-based learning. NHMFL faculty taught graduate courses and advised students through the site universities (Florida State University and University of Florida) and Florida Agricultural and Mechanical University.

Through these efforts, NHMFL graduate students continue to learn while contributing to the work and educational efforts of others at the laboratory.

Postdoctoral Fellows at the NHMFL. Postdoctoral opportunities for independent research provide scientists with skills and expertise that enhance their already considerable talents. Additionally, postdocs provide the laboratory with a base of energetic "new thinkers" who provide different insights and facilitate the development of new programs and the enhancement of existing programs. By incorporating postdocs into our research and development activities, we are developing our future users and the next generation of significant drivers of science and technology in high magnetic fields. Even a cursory review of their activities reveals the remarkable breadth of their contributions and educational experiences, and the bright future ahead for magnet-related science and technology.

Vocational Coop Programs at the NHMFL. The NHMFL cooperative programs with two regional vocational and technical schools have continued during the period, with students from Lively Technical Center and Thomas Technical Institute continuing to work closely with senior staff members in our Facilities and Electronics Instrumentation programs. The purpose of the externship programs is to give students experience in a real-world workplace so they gain hands-on experience and be involved in the day-to-day activities of the laboratory. All of the students were very appreciative of the opportunity and report their experience was valuable. Through the job training partnership act the Center provided the opportunity to encourage school completion or enrollment for youth ages 14-21.

TEACHER EDUCATION

The Center's teacher education efforts have continued to mature and expand. In collaboration with the FSU College of Education, science education centers and museums, and local school districts, the NHMFL has a rich teacher education program that involves educators from K-12 through the university level. The teacher education program comprises a wide array of activities that are summarized briefly below.

- **Statewide and regional workshops** for elementary, middle level, high school, and community college teachers are offered to translate the practice and excitement of science into classrooms. Over **120** teachers attended workshops ranging in subject from the use of the new standards-based curriculum products developed at the NHMFL to integrating science and mathematics in the primary classroom using literature and hands-on activities. By request of a south Florida district, Center staff conducted a weeklong summer institute for 20 teachers who continue to maintain communication that indicates the continued effect that the institute had upon science instruction in classrooms.

As part of a regional mini-conference, Beyond the Blackboard, Center personnel were asked to present two workshops, "Literature in the Science Classroom" and "Integrating Technology in the Science Classroom," which were among the best attended sessions at the event.

- **Statewide training** for the *Science, Tobacco & You* program was conducted for **923** of Florida's elementary school teachers at sites across the State. Thirteen workshops were conducted in Connecticut and 4 in Illinois. Participants attended a one-day training session where they learned ways to incorporate technology into classroom instruction and had opportunities to work with the *Science, Tobacco & You* science curriculum. Participants also received training in how to conduct inservice sessions at their schools or districts in order to facilitate dissemination of the *Science, Tobacco & You* materials. Comments at the end of the training indicated that the sessions accomplished far more than their original goals. For example:

> "This was more exciting than I was expecting! I never expected to receive this many tools to work with. This program should spark every child's interest...I'm pumped." (5th grade teacher)

> "There are so many wonderful lessons and help that I would be foolish not to *use Science, Tobacco & You* with my students." (4th/5th grade teacher)

> "It is very exciting to see <u>science</u> promoted as a means to teach required Sunshine State Standards and to teach health issues." (5th grade teacher)

> "It is one of the most innovative curriculum I have ever seen and I have been around a while. I love it all—I'm excited and I know the kids will be too." (4th grade teacher).

> "It went beyond (my expectations)—GREAT use of tobacco settlement funds!! Bravo." (4th grade teacher).

• **RET.** Drawing upon the success of the Research Experience for Undergraduates, the Center conducted the second Research Experience for Teachers program in summer 2000, targeting elementary, middle and high school teachers as well as preservice teachers. Experienced educators were paired with preservice and new (3-5 years' experience) elementary and secondary teachers to work with scientists and researchers at the Tallahassee site of the NHMFL on research projects. Participants spent a portion of their day translating what they had learned and experienced in their research mentorships into classroom materials and activities. Sixteen teachers participated, working on research projects such as instrumentation and operations; making, preparing, and analyzing superconducting tapes; and granular physics. One project developed during the summer 2000 program has been expanded into the school year and now involves over 300 classrooms across the state of Florida. Working with the Geochemistry Department, teachers continue to develop the Spanish Moss Project, with plans to analyze the over 200 samples collected and then to post results of the analysis on a Web site. The Web site will not only provide information on individual samples, but will have additional activities for intermediate teachers and classrooms to use the information to learn about the local environment. In addition to the Spanish Moss Project, a second Web-based program is being developed in cooperation with a group from high-pressure instrumentation and operations to provide real-world real-time science experiences to classrooms.

• **The NHMFL Ambassador Program** involves teachers from public and private elementary, middle, and high schools, magnet schools, charter schools, and community organizations from North Florida and South Georgia. Teachers work to improve science and mathematics teaching and learning by becoming actively engaged in determining needs for and applications of curriculum products and teacher workshops. Ambassadors serve as conduits through which communication is maintained with all science and mathematics teachers in the three-county area. Input is provided to NHMFL educators from this network of **76** regional K-12 teachers representing over **68** schools, **16** community members, and school board personnel that influences the development and modification of our education programs.

• **Conference presentations** by NHMFL educators serve to inform teachers nationwide about the laboratory's scientific and educational activities and opportunities and also to introduce them to new strategies for implementing national and local standards in the science classroom. Although conference participation was curtailed due to the increased number of workshops being facilitated, Dr. Sam Spiegel was invited to serve as Keynote Speaker at the National Science Teachers' Association national meeting. An increased conference participation is anticipated and Center staff have been invited to participate and present at the Educational Workshop on Research Programs for Science Teachers being held at the Spring MRS meeting in San Francisco.

• **Undergraduate level courses** continued to be offered through the FSU College of Education. This year, Center faculty taught courses in Educational Foundations and Policy Studies. The Center's involvement in teaching undergraduate courses provides a foundation for future research efforts.

- **Supporting graduate students and prospective teachers** through work and assistantships provides the students with models and experience in education. These students also contribute to the Center through their enthusiasm and energy.

- **Web-based resources** have been established to serve several purposes:

  - A teacher discussion room allows teachers to share lesson plans, discuss questions related to current issues in science teaching and learning, share successes and failures of classroom activities, and offer ideas for discussions. We also engage in conversation with teachers about curriculum, teaching science, and answering student questions through e-mail and other means.

  - Activities appropriate for classroom, home, and individual use are provided to enhance classroom teaching and learning. Teachers are encouraged to add to the repertoire of activities on the Web and provide comments about the activities that they try.

In the *Science, Tobacco & You* Web site, for example, the teacher resource sector allows teachers to share ideas (journals), share curriculum (lesson plans), and ask questions (bulletin boards). The sector includes six (6) areas, including the "Student and Teacher Guidebook." Teachers (and students) continue to highlight their papers and presentations found on the Web site as evidence for credit and as an enhancement to resumes.

Future teacher education plans include expanded technology workshops for teachers, seminars and courses offered through distance learning strategies, more Web-based resources for teachers to use in classrooms, and expanded summer institute offerings.

General Public Awareness

In addition to our efforts to educate students and teachers through formal settings, we also strive to educate the general public about the NHMFL and to be contributing members of the community and region. Our general public awareness program seeks to promote general scientific literacy, to inform the public about the research at the laboratory, and to communicate the importance of research facilities—to regional economic development, to national competitiveness, and to the advancement of our quality of life. These activities mirror the other educational programs of the laboratory and include special events, such as our annual Open House.

- **Tours**. Each year we attract approximately **2,600** members of the general public for tours of the lab. Each tour consists of a general overview of the laboratory, as well as a walking tour of the main research areas of the Tallahassee facility.

- **Open House**. Every year since the laboratory's dedication in 1994, the NHMFL has held an open house in the fall, and each year finding a "free" weekend has proved increasingly difficult. Conflicts with Tallahassee's busy fall 2000 calendar—football games, religious holidays, election events—prompted the laboratory to move the event to spring. Consequently, no open house was held in 2000, but we are actively planning the 7th Annual NHMFL Open House to be held on March 3, 2001. We anticipate attracting about **3,000** people. The 2001 Open House will include a greeting by senior faculty and staff, an orientation video, and self-guided tours of the facility, as well as booths by many local community organizations with an interest in science education. Throughout the laboratory, guests experience a wide range of demonstrations, hands-on activities, and informational videos. For example, visitors see magnetic levitation demonstrations, learn about the latest research efforts in our various laboratories, and learn how contaminants get into well water as they dissipate through the soil.

- **Community Service**. The laboratory and its staff contribute to the community in a myriad of ways, and in doing so, educate the community about the laboratory. Through community service events and personal involvement in civic organizations and activities, the NHMFL faculty and staff work to overcome commonly held misconceptions about scientists and science and demonstrate that science facilities are very beneficial to their host communities. For example, numerous members of the laboratory volunteer at annual "fix-up" days where they help build or repair homes; others promote the lab through their efforts in groups such as the Rotary Club; many judge science fairs and/or mentor students; while others teach community information courses, such as safety training.

CURRICULUM MATERIALS DEVELOPMENT

The Center has established itself as a leader in creating innovative curriculum materials.

Through funding from the Florida Department of Health, we developed and launched a *Science, Tobacco & You.*

- **Science, Tobacco & You** is a multidisciplinary science curriculum resource that engages students in developing skills in language arts, mathematics, social studies, and many other subjects. All of the materials reflect the Sunshine State Standards and the activities are cross referenced to the Standards as well as Florida's assessments (such as FCAT, Florida Writes!, and Terra Nova). The goal of *Science, Tobacco & You* is to encourage students to use science to ask and answer questions to promote scientific literacy; in this case, the medium used is the issue of tobacco use and prevention.

Beginning with a knowledge of human body structures and function, students are encouraged to learn more about how the use of tobacco products affects their lives. *Science, Tobacco & You* provides multi-sensory experiences, through which students explore the harmful effects of tobacco on their bodies, strategies for handling peer pressure to use tobacco products, and how they can use a scientific perspective to make decisions. Each package contains:

- a **box of manipulatives**. The box of manipulatives contains all the equipment necessary for up to 250 students to conduct over 22 activities (presented in the guidebook). The equipment is selected to provide hands-on opportunities, which allow students to quantify their observations, explore related questions, and experience the process of data generation
- an **electronically published student/teacher Guidebook** Teacher/Student Guidebook, which is located on the Web site and in CD-ROM format. Consisting of 9 modules and 22

activities, the Guidebook is set up so that each module and activity is consistent with the others, so you will know exactly where to look for the features that you need.

- a "**big book**", *How Your Body Works*. It provides a nicely illustrated overview of the human body and the major functions. It works well for whole class instruction as well as individual and group review. We are pleased to be able to include this resource in the package. (1997, Henderson Publishing LTD: Woodbridge, England. ISBN 1-890409-43-x).

- an interactive **CD-ROM**—another resource for teachers and students that provides a number of science inquiry activities and tools with which to collect and present data and formulate and communicate ideas. Composed of three main areas, Virtual Body Lab, Community Research Lab, and Teacher's Lab, these resources further support *Science, Tobacco & You* activities. They also encourage individual research and further exploration of issues identified while implementing *the Science, Tobacco & You* science curriculum materials.

The CD-ROM includes opportunities for students to write, draw, graph, and enter on a spreadsheet data gathered through the activities, use of the Web site, and exploration of the CD- ROM itself.

Virtual Body Lab: This section provides an opportunity for students to assemble their "virtual you" through which they will explore the human body's nervous, circulatory, and respiratory systems. Students are encouraged to "see" changes in their own bodies. Teachers can chart student progress through the Virtual Body Lab by accessing the Teacher's Lab.

Community Research Lab: Students explore their feelings about the use of tobacco products to compare them with the attitudes of friends, teachers, community members, and health and science experts. A Lab Notebook, Data Entry and Analysis Tools, and ways of presenting student research are provided.

Teacher's Lab: This section contains resources for the teacher. Instructions for taking digital pictures and entering them into the computer so that students can work with the Virtual You are found here. Also in this section is the opportunity to check student lab notebooks and to chart student progress as they move through the activities on the CD-ROM. The *Science, Tobacco & You* Guidebook can be downloaded and printed as can the Nutrition Database that supports several activities found in the Guidebook.

- a **training/promotional videotape**.

- The *Science, Tobacco & You* **Web site** provides a comprehensive resource for students and teachers to as questions about how tobacco impacts their lives. It also facilitates communication through the Asking and Sharing sector. This outline provides you with a brief description of the Web site, its features, and suggested uses. Although the best way to learn about a Web site is to explore it yourself, this outline will serve as a quick and easy resource for finding specific features. The Web site has five major sectors: Navigation Help, Looking and Thinking, Asking and Sharing, Bulletin Boards, and Teacher Resources. Within each category there are subdivisions that each have links to each other and to other sites.

• **MagLab: Alpha** is commercially available nationwide. It was developed for use in middle grades classrooms and is being used in over **240** classrooms. An integrated, standards-based curricular resource package, *MagLab: Alpha* was designed to promote hands-on, collaborative, interdisciplinary learning based on science concepts. *MagLab: Alpha* has three components—The Alpha Guide, The Alpha Pack, and The Alpha Interface—takes students in grades 5-8 on a journey toward discovering magnets, magnetism, and related concepts. A series of "Excursions" and "Explorations" goes beyond the original 20 hands-on collaborative activities and leads students to additional study that incorporates mathematics, history, geography, language arts, literature, art, and music.

The **Alpha Guidebook** contains (1) instructions on how to use the materials presented and (2) discussions of issues that enhance teaching and learning in the science classroom, such as cooperative learning, interdisciplinary approaches, assessment, learning styles, Florida's Sunshine State Standards, National Science Education Standards, accurate and insightful record keeping in the form of a science notebook, and management techniques in the science classroom. Posters provided with the guidebook emphasize the team metaphor used to create a collaborative classroom atmosphere.

The **Alpha Pack** contains all the equipment ("gear") necessary for a class of 36 students in groups of 4 to complete all activities. Materials in the Alpha Pack are nonconsumable and can be used year after year without refurbishing. For example, rechargeable batteries and battery chargers are included to eliminate the recurring need to buy batteries.

The **Alpha Interface** is a CD-ROM and Web-based resource closely aligned with the Alpha Guidebook to provide support for both teachers and students. Teachers and students can use the interface resources to directly support learning in the expeditions and explorations of MagLab: Alpha, or they can use the CD to launch deeper probes into areas of interest. The Alpha Team, a group of characters that guide students beyond the scope of the Alpha Guidebook, provides the link between the Guidebook and the Interface. Features include graphics and animations of complex concepts, an interactive interpreter that helps students choose the correct path, and in-depth information that both informs and leads students to further study.

• **Pre/Post Tour Packages** are sent to every student group that tours the NHMFL. A new feature of the pre-visit materials is a videotape introducing students and teachers to the kinds of research done at the laboratory. Prior to their arriving, teachers are encouraged to engage students in a variety of activities that will enhance their visit to the laboratory. Activities are also provided to be used *after* their tour to further extend their experience. Resources are suggested for teachers to expand the experience to classroom research and exploration. In addition to print and video resources, students and teachers are encouraged to visit the Web site and to e-mail questions, pictures, photographs, and student work. The Center continues to enhance pre- and post-visit materials to further extend the tour experience.

• **Open House Curriculum Resources** were developed to enhance the experience for learners in grades K-14. These materials will be expanded for the 2001 Open House to include more activities for preschool and early elementary students. Resources for parents to use at home with children to extend the Open House experience are currently in development.

Future curriculum development efforts will build on our existing programs and experiences. We anticipate expanding the *Science & You* series as well as the *MagLab* series.

Educational Research

Conference papers and presentations were curtailed during this reporting period due to a shift in resources to accommodate the development and delivery of the *Science, Tobacco & You* program. Center faculty were, however, invited to participate in national and international conference activities.

An important aspect of the concept behind the Center for Integrating Research and Learning is research, not only science research but science education research. We have continued our research efforts to evaluate our education program overall, as well as specific features of the program. The curriculum products that the NHMFL developed are the subjects of ongoing research as is the connection between a science research facility and educational reform. The results of these research activities will provide valuable information for Center educators and drive the development of new curriculum projects and professional development. The curriculum development process has become an area of intense interest for the program making the NHMFL's affect on science teaching and learning fertile ground for our research efforts.

The following article was published during the reporting period:
Dixon, P. (2000). Some Thoughts on Authority and Discourse: Dialogue between Scientists and Science Teachers. *Gazing into the Future: Proceedings of the Gender and Science Education (GASE) Colloquium*, Boston. 1999.

The following conference presentation was given during the reporting period:
Spiegel, S. (2000). National Science Teachers Association (NSTA). Keynote speech: "Enhancing Science and Use of Technology in the Classroom."

Educational Resource Laboratory

In support of our vision to create a unique learning center for students of all ages (including K-12 students, teachers, undergraduates, and graduate students), the NHMFL maintains an Educational Resource Laboratory that was developed in conjunction with the State of Florida. The state-of-the-art laboratory houses multimedia development equipment, manipulative development equipment, curriculum materials, and instructional resources. It is intended for use by educators, students, and NHMFL personnel, and it is a popular instructional and development resource for regional schools. The Educational Resource Laboratory is used to support teacher groups who request technical support and instruction as well as after school groups.

During open hours, teachers and students can come to the Resource Laboratory to develop a new interactive multimedia program; to desktop publish student materials; to create QuickTime movies and video clips; to preview a variety of curriculum products such as those produced by other classroom teachers. Additionally, teachers can schedule classes for small groups of teachers or students to learn about the development or integration of multimedia into their classrooms. This laboratory is also used as an instructional technology classroom for our teacher education efforts.

Partnerships & Community Support

The Center has been actively developing partnerships to pursue new ways to promote science learning, develop new opportunities for our various target groups (e.g., students, teachers, parents, etc.), and extend the resources of the NHMFL. Partnerships with the private sector have helped to support new curriculum products, promote the mission of the Center, and generate some revenue for future programs. The partnerships with schools and other learning agencies extend our resources and tap into a pool of expertise on various education issues. Some of our recent partnerships are described briefly below.

- **Training Solutions Interactive (TSI)** has joined us as a partner this year in our curriculum development efforts. TSI is an internationally recognized leader in the development of innovative interactive programs for education and training. TSI specializes in the implementation of programs, systems and strategies to improve efficiency and productivity for a wide variety of applications, businesses and industries. Together TSI and the NHMFL create a strong partnership to create innovative curriculum resources.

- **Sempco, Incorporated.** This private business located in Nashua, NH, has been working with us to develop and mass-produce our curriculum materials projects. Sempco has assisted by providing sample materials to test new activities and in the creation and production of new equipment, specifically designed to meet the needs of our programs.

- **Schools and Other Student Groups** (e.g. home school groups). Through our Ambassador Program and various other efforts, we have developed close relationships with most of the regional schools, as well as some in other regions (i.e., schools in Alabama and Georgia). These partnerships facilitate the development of our education programs and engage a variety of stakeholders in education (students, parents, teachers, etc.) by providing links that allow them to take ownership and see that what is accomplished in a science research institution is "do-able."

- **Florida Agricultural and Mechanical University, Alliance for Minority Participation (FAMU/AMP) Programs**. The NHMFL has been working closely with FAMU/AMP in the development and promotion of our Minority/Women Summer Research Internship Program.

- **Science Museums.** The NHMFL has partnerships with the ODYSSEY Science Center of Tallahassee, and the Orlando Science Center to design and develop interactive Web-based exhibits and resources, as well as, traveling and permanent exhibits for science museums and centers. We are exploring new programs to extend the impact of our outreach programs across Florida, and possibly nationally.

- **Community Classroom Consortium (CCC).** The CCC is an ideal partnership joining the north Florida/south Georgia community with cultural, natural, and educational resources. The purpose of this liaison as described in the CCC mission statement is "to inspire a sense of community; to provide educational enrichment by offering authentic experiences through collaborative projects, programs, and publications; and to support and strengthen the educational missions of the members of the community." The CCC will continue its participation in NHMFL open house events (next one scheduled for March 3, 2001) by proving hands-on activities and displays.

- **Leon Association for Science Teachers (LAST).** As part of our continuing commitment to enhancing science teaching and learning in the region surrounding the NHMFL, Center personnel continue to serve as Board Members and advisors to LAST.

6. COLLABORATIONS

The technological expertise and the critical mass of human scientific capital that exists at the NHMFL are attracting an increasing number of collaborators each year and at all levels. The list of collaborations for 2000 that follows is a striking illustration of the breath and scope of activities undertaken by the researchers and staff of the laboratory. Collaborations are an excellent means of fulfilling the laboratory's mission to advance magnet related technologies and to promote U.S. economic competitiveness while advancing the user facilities.

While collaborations with the private sector have increased by nearly 30 percent, it is important to note how frequently the NHMFL is being sought to advise and work with industry to advance new technologies and test prototypes. Hardly a week goes by that the NHMFL is not meeting with corporations and other research institutions to explore common interests and problems. The laboratory is engaged in significant collaborations with almost all of the Department of Energy national laboratories and is working with the Office of Naval Research on a long-term research and development program for the electrification of naval ships. Likewise, with regard to international collaborations, the NHMFL has interactions with every active magnet laboratory. Since the NHMFL has set the benchmark for advanced research magnets, European and Asian laboratories have entered into agreements with us to procure our state-of-the-art resistive and pulsed magnet systems.

PRIVATE SECTOR ACTIVITIES

ABB, Raleigh, NC, American Superconductor, Westborough, MA. At the Pulsed Field Facility at Los Alamos, NHMFL researchers are collaborating on a DOE Superconductivity Partnership Initiative for transformer projects. The teams are designing and setting up experimental equipment for measuring current limiting characteristics of high temperature superconducting tapes for high currents under variable conduction times. A background field coil is being designed to do the measurements in a background field, thus simulating short circuit behavior of a HTS transformer.

American Superconductor Corporation (AMSC), Westborough, MA. As part of the Office of Naval Research-supported HTS motor program, the NHMFL has characterized AMSC conductors. In particular, the NHMFL has focused on the effects of mechanical stress and strain (both tensile and compressive), one the current-carrying capabilities of AMSC conductors.

Big Horn Valve, Sheridan, WY. The NHMFL and Big Horn Valve recently received a NSF STTR grant to develop a magnetic actuated fluid handling valve that could have wide applications in the fluid processing industry. The potential outcome from this project is a valve that is completely sealed and thus will not leak to the environment. Applications in space-based systems are also envisioned.

Biospace International, College Park, MD. Researchers at the NHMFL and Biospace are in the second phase SBIR from NASA to look at protein crystal growth in a high magnetic field force/gradient environment. This environment allows a variation of the effective gravity on materials to vary from zero to several times the Earth's gravitational force in the presence of high magnetic fields. Efforts are underway to secure funding to design and build a specialty magnet for high field crystal growth.

Bruker Instruments, Billerica, MA. The NHMFL is partnering with Bruker Instruments on the development of a high temperature superconducting probe for the NHMFL's 750 MHz wide bore magnet at the McKnight Brain Institute at the University of Florida. This collaboration has successfully completed a NSF Phase I SBIR grant with the characterization of HTS probe coils in the 25 T Keck magnet. These coils were made from thin films of $YBa_2Cu_3O_7$. Q values dropped by less than 12% between zero field and 21.1 T and only an additional 12% in going up to 25 T. These numbers demonstrate the feasibility of using YBCO coils at very high fields for high sensitivity NMR probes.

DuPont Superconductivity, Wilmington, DE, and Outokumpu-Carpco, Jacksonville, FL. The NHMFL is working with DuPont Superconductivity and Outokumpu-Carpco, and the NHMFL to develop a quarter-scale high temperature superconducting magnetic ore separation system. The NHMFL has responsibility for the magnet design and building the cryogenic system. Carpco is building the ore separator equipment. The working prototype system will be assembled and tested at the NHMFL and then shipped to DuPont for process engineering studies. This $6 million project is funded under the Department of Energy's Superconductivity Partnership Initiative (SPI) program.

EURUS Technologies, Inc., Tallahassee, FL. The close proximity of the NHMFL and EURUS helps to foster many collaborative projects, such as the following.

- The design and development of the SX Series power lead, the world's first bipolar YBCO current lead engineered to power superconducting and hybrid magnet systems while minimizing the influence of head load from room temperature into the cryogen system.

- The enhancement of the SL Series YBCO current leads, where redesign has reduced joint resistance by an order of magnitude while significantly enhancing the reliability, ruggedness, and cost effectiveness of these state-of-the-art power leads.

- The improvement of Power Plus BSCCO 2223 Ag tape, where technical consulting has enabled EURUS to commence development of insulation and coating techniques essential to providing this commodity for HTS coil windings.

- The development of a long-length HTS power transmission cable as a mutual venture to illustrate the cost effectiveness and problem solving capacity of HTS materials.

- The commencement of development of second generation YBCO tape that will reshape the cost of HTS materials while offering significant HTS coil design and fabrication advantages. The improvements achieved in AC losses of the HTS conductors in power applications by using the NHMFL's proprietary sol-gel insulation show the AC loss reduction is improved by three-fold. This particular activity was supported by a Phase I SBIR proposal and the Phase II proposal is pending reviews.

- In the development of high-current leads, the principal focus of this collaboration is a pair of 20 kA HTS current leads for the proposed Series-Connected Hybrid (SCH). A design code for these leads has been constructed, including a detailed design database for the various materials and components used in the lead system. The latter continues to be tested and improved as part of the collaboration. While work is underway to build and test major components and a pair of 20 kA prototype leads for the SCH, the design tools and fabrication processes are also being tested through participation in a EURUS project to produce 13 kA prototype leads for the CERN Large Hadron Collider.

Everson Electric Company, Bethlehem, PA. This continuing collaboration between Everson and the NHMFL Pulsed Field program at Los Alamos has the goal of further developing the methods of fabricating large, high strength, high field long pulse magnet coils. This work is essential to the 100 T Multi-Shot (MS) magnet project and helpful to the 60 T Long-Pulse Mark II magnet rebuild project.

General Atomics, San Diego, CA. General Atomics is involved in the DOE-funded Accelerator Production of Tritium (APT) Project at Los Alamos. They must design structural components for the linear accelerator that operate at liquid helium temperature and utilize specialty construction materials (pure Niobium, pure Titanium, and Austenitic steel). Structural materials problems (such as the welding of dissimilar metals) and the lack of available data in the literature has necessitated the development of a mechanical properties database. The NHMFL's Materials Development and Characterization Group is conducting a mechanical properties test program to provide design data. Measurements of tensile and fracture toughness are made on base metals and welds over a temperature range from 295 K to 4 K.

Honeywell, Kansas City, MO. This collaboration of the NHMFL Pulsed Field program at Los Alamos and Tallahassee and Honeywell is based on common interest in development and evaluation of the stainless-steel-clad copper conductors produced the A.A. Bochvar Institute in Moscow, Russia. The collaboration has consisted of sharing conductor fabrication specifications and conductor testing results. This type of conductor is of importance to the 100 T Multi-Shot magnet project (outsert coils) and other high field user magnet systems with long decay times.

Intermagnetics General Corporation (IGC), Latham, NY. The IGC-NHMFL collaboration on the cutting edge, wide bore, 900 MHz NMR magnet system was completed in 2000. IGC delivered five NbTi coils and a NbTi shim set in summer and the coils are now at the NHMFL in preparation for installation in the final magnet assembly. The collaboration was an excellent example of industry-laboratory partnership leading to a significant technical breakthrough.

LGK Corporation, Albuquerque, NM. Researchers at the Pulsed Field Facility in Los Alamos are working on a contract to develop the PC boards for the basic building blocks of the Digital Lock-In system. The collaboration is an outgrowth of some of the very specialized instrumentation developed for users of the Pulsed Field Laboratory.

Magnetic Resonance Microsensors (MRM), Savoy, IL. The NHMFL is collaborating with MRM to extend the high field limits of NMR spectroscopy using high sensitivity microcoils in very narrow bore magnets. At the NHMFL this technology will be adapted for the 32 mm bore, 19.6 T superconducting magnet. This unique magnet and probe technology will not only lead to increased NMR sensitivity, but also to inherent cost advantages associated with narrow bore magnets.

Minnesota Mining and Manufacturing Company (3M), Saint Paul, MN. This collaboration of the NHMFL Pulsed Field program at Los Alamos and Tallahassee with 3M attempted to produce a ultra high strength conductor with a tensile strength 50% higher than previously achieved with any high conductivity (greater than 70% IACS) conductor. This material would have potential application to very high field pulsed magnets and high repetition rate pulsed magnets. A proprietary 3M process was used and over one hundred meters of composite conductor were produced. While very strong, the conductor did not achieve the expected strength levels; this combined with fabrication difficulties and other technical problems prompted this work to be discontinued.

Molecular Probes, Inc., Eugene Oregon. This company is assisting NHMFL researchers in determining a new method to relate excitation and emission wavelength spectral ranges of fluorophores with commercially available interference filter combinations that are available from microscope manufacturers. The collaboration is an important contributor to the new tissue culture laboratory that is being established at the NHMFL.

Nikon USA, Melville, NY. The NHMFL maintains close ties with Nikon on the development of educational and technical support microscopy Web site, including the latest innovations in digital imaging technology. As part of the collaboration, the NHMFL is field-testing new Nikon equipment and developing new methods of fluorescence microscopy.

Nordic Superconductor Technologies (NST), Denmark. The NHMFL is collaborating with NST on the development of wind-and-react double pancake coils that could ultimately play a role in a 1 GHz NMR magnet system. NST has provided fully-processed Bi-2223 Ag-alloy clad superconducting tape to the NHMFL. The NHMFL has evaluated the conductor in terms of the effects of high magnetic fields and mechanical strain on the critical current density. Furthermore, double pancake coils have been wound and tested in self-field and validate the NHMFL's capability to form wind-and-react coils. This double pancake was subsequently tested in the 19 T large-bore resistive magnet.

Olympic Metal Cutting Co., Montebello, CA. The NHMFL Pulsed Field Facility at Los Alamos has worked with this vendor to test the processing and handling of heavily cold worked, high strength stainless steel strip. This strip will have application to high field magnets, especially the large coils required for long pulse magnets as it is a low cost, very high strength material. This stainless strip is essential to the 100 T Multi-Shot magnet project and helpful to the 60 T Long-Pulse Mark II magnet rebuild project

Olympus America, Melville, NY. The NHMFL is also developing an education/technical Web site centered around Olympus products and will be collaborating with the firm on the development of a new tissue culture facility here at the NHMFL that features Total Internal Reflection Fluorescence microscopy, a project that will involve biologists at the NHMFL.

OMG Americas, Research Triangle Park, NC and IGC-Advanced Superconductors, Waterbury, CT. The NHMFL Pulsed Field program at Los Alamos and Tallahassee continues development of high performance magnet conductors in collaboration with these companies. This work includes developing methods to increase the strength, length and size of production quantities of high performance aluminum oxide strengthened copper and micro-composite copper silver conductors. These conductors are essential to the 100 T Multi-Shot magnet project and the 60 T Long-Pulse Mark II magnet rebuild project.

Oxford Superconductor Technologies (OST), Carteret, NJ. The NHMFL and OST successfully developed an HTS insert coil that generated 3 T in the 19 T large bore resistive magnet, generating 22 T in total. This insert coil, which required approximately 1.5 kilometer of HTS conductor, is an important development on the path toward a 1 GHz NMR magnet system. OST is providing all of the powder-in-tube BSCCO 2212 conductor for the program. After OST fabricated the unreacted conductor, the NHMFL insulates it using an internally developed sol-gel approach and subsequently wound the double pancake coils. Approximately half of the coils are stacked at the NHMFL and electrically joined. Building upon this success, the NHMFL and OST are now collaborating on a 5 T insert coil that will include wind-and-react and react-and-wind coils. It will also include both layer wound and double-pancake wound coils. Testing of this coil is planned for summer 2001.

Physical Sciences Inc., Alexandria, VA. A Phase 1 SBIR proposal has been funded by NIH for the development of a gyrotron to provide radiation for an instrument for pulsed and continuous wave electron magnetic resonance (EMR) spectroscopy. A pulsed system allows determination of the response spectrum of a sample over the bandwidth of the pulse. Higher carrier frequencies allow both the production of shorter pulses and the matching of the resonance frequency of stronger magnetic field. The required frequency of the radiation scales with the magnetic field, so the frequency for EMR can substantially exceed 100 GHz. For short pulse EMR, there are no sources, other than fixed frequency FIR lasers, above 140 GHz. For the instrument we propose to build, the desired pulse widths are from 1 ns to 10 ns, with a power of about 10 watts (at the sample) at frequencies to at least 600 GHz. The gyrotron we propose to develop will be perfectly poised for use in the Keck magnet with its unique capabilities.

Pirelli Cable, Lexington, SC, American Superconductor, Westborough, MA, Detroit Edison, Detroit, MI. Researchers at the Pulsed Field Facility are designing and setting up experimental equipment for measuring the AC losses in a high temperature superconducting cable at variable frequencies under external field conditions. This collaboration is being conducted under the auspices of a DOE Superconductivity Partnership Initiative.

PPG Industries, Inc., Allison Park, PA. A collaboration with the Research Center of PPG Industries has been established for the improvement of the protection of automotive paints against photooxidation. Automotive paints contain hindered-amin light stabilizers as inhibitors of polymer photooxidation. These leads and the process of polymer exposure to the formation of free radicals are conveniently detected by EPR spectroscopy. Clear coat microtomed slices are studied to obtain the depth distribution of the radical concentration.

Resonance Research Inc., Billerica, MA. The NHMFL is partnering with Resonance Research on the development of shim systems for the 25 T Keck magnet. The present goal is to achieve 1 ppm homogeneity over a spherical volume of 1 cm in this 52 mm bore resistive magnet. Without shims the peak to peak homogeneity is approximately 50 ppm. The approach that has been taken is to use a combination of ferroshims and resistive coils. The first attempt with ferroshims mounted on the outside of the bore tube improved the homogeneity by a factor of 4. Currently, the next generation of ferroshims is being developed as well as the first generation of resistive shims.

Southern California Edison, General Atomics, Intermagnetics General Corporation, San Diego, CA. NHMFL researchers at the Pulsed Field Facility at Los Alamos are participating in a DOE Superconductivity Partnership Initiative to design and build a state-of-the-art fault current limiter to reduce short circuit currents in a medium voltage utility system. The fault current limiter uses large high temperature superconducting magnets. The collaboration includes fault analysis of a HTS 12.5 kV three phase fault current limiter, evaluation of high voltage breakdown of lead in vacuum at low temperatures, and preliminary design of a high voltage lead.

Spalding Worldwide Sports: The NHMFL Material Development and Characterization Group is currently involved in a materials research program with Spalding R&D. The NHMFL scientists and FAMU-FSU College of Engineering students will conduct experiments to measure the dynamic impact properties of elastomeric materials proposed for use in golf ball construction. The project will expand our experience with sensitive measurement techniques and unique materials. Spalding's design engineers will utilize the dynamic materials properties data that was previously unavailable.

Stereotaxis, St. Louis, MO. The NHMFL has developed a collaboration with Stereotaxis for the design of a superconducting magnet system for catheter guidance through the body. The requirements for this magnet system include a variable direction and amplitude magnetic vector that can be positioned near the body for steering a magnetic device. The ultimate goal is a low cost system that can be installed in hospitals to assist with diagnosis and delivery of medical treatment.

Stonehenge, Ltd., New York, NY. Stonehenge is a commercial partner that licenses photomicrographs generated by a NHMFL researcher for men's neckware. This collection of neckties continues to be one of the leading sellers at the national level. The long-term collaboration with Stonehenge is in its eighth year and has generated over a $1.5 million dollars to equip the NHMFL's unique and state-of-the-art optical microscopy facility.

Supercon Inc., Shrewsbury, MA. The development of high strength/high conductivity, composite conductors requires evaluation of the mechanical and electrical properties by the NHMFL's Materials Development and Characterization Group. By evaluating the properties we can help assess manufacturing process variables (thermal or mechanical) and their influence on properties.

Training Solutions Interactive, Inc., (TSI) Atlanta, GA, Washington, D.C., Tallahassee, FL. TSI is an international recognized leader in the development of innovative interactive programs for education and training. TSI specializes in the implementation of programs, systems, and strategies to improve efficiency and productivity for a wide variety of applications, businesses, and industries. TSI continues to be a key partner to the NHMFL's Center for Integrating Research and Learning in the *Science, Tobacco & You* curriculum program. NHMFL educators and TSI are conducting special workshops and training sessions for teachers using the *Science,* *Tobacco & You* in Connecticut, and Illinois (as well as Florida) who have purchased the program this year.

Vacuumschmelze, Hanau, Germany. In the framework of the 900 MHz ultrawide bore NMR magnet, the NHMFL has initiated a cooperation with Vacuumschmelze to evaluate different approaches to high strength Nb_3Sn conductors. Vacuumschmelze has further offered to send some lengths of HTS conductors to the NHMFL to be characterized and wound into high field insert coils.

Inter-Agency & Inter-Institutional Activities

Department of the Navy, Office of Naval Research (ONR). The NHMFL is working on a feasibility study and investigative program that will lead to a research and development program in support of the electric ship concept for the Navy. The initial program will identify power distribution and power management issues with a primary focus on the next generation of aircraft carriers. The feasibility study will identify new research activities that will most likely produce both near-term and long-term benefits for the ultimate Navy objective of the all-electric ship. As an initial step, a productive workshop was held at the NHMFL to outline the numerous R&D issues that need to be addressed in these studies. The workshop included representatives from ONR, academia, shipbuilding, power engineering, utility, and superconductor industries.

Department of the Navy, Office of Naval Research. The NHMFL is cooperating with the Navy to test a superconducting magnetic energy storage (SMES) system. Virginia Polytechnic Institute and State University (VA Tech) is providing the power electronic equipment for the test. All components of the large-scale SMES system are on-site at the NHMFL. The project is part of the Navy's power electronic building blocks program for the electrification of ship drives and related systems.

Fermi National Accelerator Laboratory, Batavia, IL. The Magnet Science and Technology group at the NHMFL is participating in a broad collaboration to study the feasibility of building and operating a muon-muon collider. Our primary contact in this collaboration is the Fermi National Accelerator Laboratory, to which we provide design support for specific magnet systems. In actuality, however, we work in close cooperation with all the major high-energy physics laboratories—Fermi, Brookhaven, and Lawrence Berkeley—as well as with other university collaborators. Our primary focus is presently a set of large, high-alternating-field solenoids required in a system proposed for cooling the muon beam. This is a large magnet system with technical similarities to both the NHMFL 900 MHz system and the 45 T hybrid solenoid system.

Gulf Coast Alliance for Technology Transfer (GCATT). As a founding member of GCATT, the laboratory continues to be an active participant with nine federal and defense laboratories, five universities, and one community college. GCATT provides an important vehicle to network and exchange technologies and support among its members. Its principle mission, however, is to promote technology transfer among the laboratories and universities and to look for shelf technologies that are good candidates for commercialization.

Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA. The Superconducting Magnet Group at LBNL collaborates with the NHMFL's Magnet Science and Technology Group to measure the current transport characteristics of Rutherford-style superconducting cables for dipole magnet development. The NHMFL Large Magnet Component Test Laboratory, with its unique capabilities, is used to simultaneously apply high magnetic field, transverse compressive loading, and high current to the LBNL conductors.

Lawrence Berkeley National Laboratory, Berkeley, CA. The laboratory continues to support LBNL's high field, dipole development program through operation of a specially designed facility that allows simultaneous application of high field, high current, and high transverse load to large test conductors. The facility is based on our superconducting split-pair solenoid, produced by Oxford Instruments, Inc., that is located in the NHMFL's Large Magnet Component Test Laboratory. At present, the facility is capable of applying up to 13 T, 19.5 kA, and 250 kN to a test conductor fitting into the 30 x 70 mm^2 radial-access port of the Oxford magnet. A variety of large Rutherford-style cables based on multifilamentary Nb_3Sn/copper composite wires have been tested already and have provided insight to the performance of an experimental model dipole magnet tested at LBNL. Future test plans include cables fabricated with high temperature superconductor wires based on Ag-matrix Bi-2212.

Los Alamos National Laboratory, Los Alamos, NM. The object of the Los Alamos Neutron Science Experiment (LANSCE) high frequency split-pair pulsed magnet, funded by the Department of Energy and the NHMFL, is to supply the LANSCE with the highest field repeating pulsed magnet for neutron scattering experiments in the world. The present target is 30 T for 10 million cycles. The design of the magnet system is well underway with construction of the first prototype scheduled to begin shortly. These high frequency magnets will be pulsed at 1 Hz in the LANSCE facility to provide a high magnetic field and neutron beam scattering capability unique in the world. This magnet is being designed and fabricated by the NHMFL's Magnet Science and Technology group.

MAGLEV 2000, Brevard County, FL. The NHMFL is a contributing partner to this project in east central Florida. MAGLEV 2000 is supported by Florida industry, academia, and the state Department of Transportation. For several years the State of Florida has had an ongoing interest in maglev technology as the next-generation alternative to high-speed rail in congested central and south Florida. A recently adopted state constitutional amendment mandates that the state develop a high-speed rail project.

National Museum of American History, Smithsonian Institution, Washington, D.C. The NHMFL has been working with this Smithsonian museum for some time on a special Information Age Exhibit that opened in November 2000. The laboratory contributed a collection of computer chips that features microscopic graffiti placed on the surface of computer chips by their designers. The collection uncovered a once-hidden practice of etching art on integrated circuit development. The exhibition features contributions from chip designers at Intel, Hewlett-Packard, MIPS, Analog Devices, Dallas Semiconductor, VLSI, Texas Instruments, Advance Micro Devices, Cyix, National Semiconductor, and NCR.

National Superconducting Cyclotron Laboratory (NSCL), Michigan State University, East Lansing, MI. The Magnet Science and Technology Group of the NHMFL were contacted by the NSCL to build a 4 T superconducting sweeper magnet. The magnet is referred to as a sweeper because it "sweeps" charged particles out of a neutron beam and into a mass spectrometer. It is required to bend beams of high rigidity 40° on a 1 meter radius. The magnet consists of 2 D shaped coils with a split of 140 mm. The conductor is epoxy-impregnated niobium titanium operating at 4.5 K. There is a yoke of approximately 20 tons to enhance the peak field and reduce the fringe field. Although 4 T is not a tremendously high field, attaining 4 T in a gap of 140 mm with a D-shaped magnet leads to high stresses and requires substantial analytical work in the design process to ensure reliable operation. Design of the magnet nears completion and fabrication is beginning.

New York University and Brookhaven National Laboratory, Upton, NY. The NHMFL is designing the magnets for a muon and electron number violation experiment (MECO) searching for muons converting to electrons in the field of the nucleus. The magnets consist of a series of moderate field superconducting solenoids for controlling beam dynamics in the experiment. The MECO experiment will be performed in a new pulsed muon beam to be constructed in the experimental hall of the Alternating Gradient Sychrotron at Brookhaven.

Ohio State University, Columbus, OH. The NHMFL is collaborating with Ohio State University to measure the magnetic field dependence of the critical current density of "jelly rolled" Nb_3Al conductors at 4.2 K and up to 26 T. Ohio State, IGC, and NRIM have developed the conductors by Ohmic heating and quenching. The aim of this collaboration is to evaluate the capacity of conductors as possible candidate conductor for high field NMR applications due to the high B_{c2} of a-15 Nb_3Al.

Pacific Northwest National Laboratory, Richland, WA. The pulsed field group at Los Alamos received a contract from Pacific Northwest National Laboratory to construct a capacitor bank for a metal forming research project, or otherwise known as the C4 Initiative. The initiative is part of a larger collaboration among DOE national laboratories and the automotive industry to develop lightweight fuel efficient vehicles. There is potential for follow-on work for the pulsed field group to design magnetic field coil sets for different metal forming configurations.

Princeton Plasma Physics Laboratory, Princeton, NJ. One of the future options for the next generation of fusion experiments will involve resistive field coils. The NHMFL is participating in a cooperation with the Princeton Laboratory on optimizing the choice of conductor materials, insulators, and magnet design for the Fusion Ignition Research Experiment (FIRE). With the limitations on energy sources, the utilization of high strength, high conductivity materials, combined with a magnet design that reduces stress concentrations, will allow FIRE to extend the pulse length of plasma experiments.

Sandia National Laboratories, Albuquerque, NM. The pulsed field group of the MS&T is developing a pulsed high magnetic field system for the advanced hydrodynamic radiography program at Sandia National Laboratories to generate intensive electron beams. The magnetic field profile along the axis of the system is required to be a gradient from 30 T at the center of a 110 mm bore pulsed magnet to 60 T at the center of a 45 mm bore pulse magnet. The two magnets will be energized with independent banks. The total energy of the system will be about 5 MJ. The preliminary design has been completed. The materials required for construction are on order. We developed the coil designs based on the properties of the CuNb and Glidcop AL15. Coil geometry, dimensions, and the reinforcing materials have been determined. We have completed the prototyping of the initial lead designs for these coils. We are now engaged in coil production for this project. In a separate collaboration with Sandia, work is underway to develop new instrumentation packages for the NHMFL Pulsed Field Facility using Sandia's special MEMS capabilities.

Sandia National Laboratories, Albuquerque, NM. The Pulsed Field Facility at Los Alamos is providing information on pulsed magnet coil materials to the Electromagnetic Coil Gun program at Sandia. The goal of this collaboration is to evaluate high field pulsed magnet and coil gun materials, plus fabrication and engineering experience for possible use in improving the performance of high field magnets and coil gun systems. This results of this collaboration could have potential application to very high field pulsed magnets and high repetition rate pulsed magnets.

U.S. Army Research Laboratory, Aberdeen, MD and Air Force Research Laboratory, Kirkland, NM. The NHMFL Pulsed Field program at Los Alamos is sharing information on pulsed magnet coil materials with and providing material samples to these laboratories. The goals of these collaborations are to provide useful material information to both parties; the defense laboratory applications are related to the use of high field magnetics for military purposes while the NHMFL applications relate to high field short pulse and repetitively pulsed magnets for basic research purposes.

University of Illinois, Champaign-Urbana, IL. The NHMFL' s National High-Field Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS) Facility is collaborating on the design, construction, and applications of a 9.4 T electrospray ionization FT-ICR mass spectrometer. The entire system will reside at the University of Illinois.

Westinghouse Savannah River Laboratory, Aiken, SC. The Non-Proliferation Technologies Section of the Savannah River Technology Center (SRTC), in collaboration with Prof. John Eyler at the University of Florida, has been modernizing a Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometer for use in various high mass resolving power elemental analysis projects. One aspect of this modernization was replacement of an obsolete data system with a state-of-the-art MIDAS (modular ICR data acquisition system), developed and supported by the National High Field FT-ICR Facility at the NHMFL. Staff and postdoctoral associates in the FT-ICR Facility assisted SRTC scientists in the selection and specification of MIDAS components and provided two custom-built interfaces between the MIDAS and the FT-ICR system at the SRTC. The modern data system allowed mass spectra to be obtained again for the first time in several years on the SRTC FT-ICR instrument.

INTERNATIONAL ACTIVITIES

A.A. Bochvar Institute, Moscow, Russia. Researchers at the NHMFL's Pulsed Field Facility at Los Alamos and Tallahassee have maintained a long-standing relationship with the Bochvar Institute. As a result, high quality Cu-Nb micro-composite wires with outstanding characteristics (strength, conductivity, and resistive ratio) were developed and are now available for the construction of high field coils. Another activity concerns the development of stainless-steel-clad cooper conductors in long lengths and large cross sections. Both types of conductors are of great importance to the 100 T development project (outsert and inner coils) and other high field user magnet systems with long decay times.

ALCATEL, France. The NHMFL is collaborating with ALCATEL to measure the magnetic field dependence of the critical current density of ALCATEL Bi-2212/AgPd short samples at 4.2 K up to 30 T. A 1-T class, layer wound, wind & react HTS insert coil is being built. This layer wound coil will use the NHMFL sol-gel insulation and high J_c ALCATEL Bi-2212/AgPd tape conductor, and it will be more compact than what was achieved with nickel oxide insulation. The coil (1 T at 20 T background and 4.2 K) will be tested at the NHMFL in the cold bore of the 20 T superconducting magnet.

Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany. The NHMFL is collaborating with the DESY laboratory on cryogenic problems relating to the future of the TESLA electron accelerator. DESY is developing the TESLA Test Facility for He II cooling of RF cavities The NHMFL is providing components to study the flow characteristics of two-phase He II for the test facility and measurements of the Kapitza conductance of the niobium cavity material.

Grenoble High Magnetic Field Laboratory, Grenoble, France. Since the start of the NHMFL, the cooperation between the two high field laboratories has been very successful and productive. Accomplishments include the 20 T, 50 mm bore magnets at the NHMFL and the joint development of the 20 T, 20 cm bore magnet at the NHMFL along with a similar magnet in Grenoble. Plans have been developed to repeat this cost saving approach for the design of two split-coil magnets for the two laboratories.

High Field Magnet Laboratory, University of Nijmegen, The Netherlands. A contract has been signed for the NHMFL to construct a 33 T Florida-Bitter magnet for the University of Nijmegen and construction is underway. We have developed a plan to develop 30 T magnets suitable for condensed matter NMR in the near future. We have discussed collaboration on split pairs of high field resistive coils over the next few years.

Institut für Experimentalphysik, Technische Universität, Wien, Austria. The NHMFL Pulsed Magnet Group made the first design of a magnet that will match the new quasistationary energy source (10 MW, 1 s) of the Institut für Experimentalphysik. Magnets to generate a 100 ms flat top at 35 T and a peak field of 35 T for a triangular 1 second pulse shape are feasible. The two partners are identifying funding sources for this new and exciting facility. The development of ultra-low noise magnets for magnetization measurements also will be further pursued.

Institut für Plasmaphysik, Greifwald, Germany. The NHMFL Magnet Science and Technology group has recently begun a study of the high current leads to supply the superconducting magnets for the Wendelstein 7-X plasma physics experiment. The study compares conventional leads with HTS leads for reliability, cost and availability. The NHMFL also will define the recommended acquisition and testing program for the final lead design.

Institute of Chemical Physics, Russian Academy of Sciences, Moscow, Russia. The NMR program has an agreement with Dr. Andrei Samoilenko to develop Stray Field Imaging (STRAFI) capability for the 19.6 T, 32mm superconductive NMR magnet. Initial demonstrations of the system obtained a resolution of approximately 10 µm. This represents the highest field and highest field gradient stray field imaging achieved in the world.

Institute of Low Temperature Physics, University of Sao Paulo, Brazil. The NHMFL Pulsed Field Facility has an ongoing collaboration with the group at the University of Sao Paulo to investigate colossal magnetoresistance materials at very high magnetic fields.

Institute of Materials Research, Charles University, Prague, Czech Republic. Researchers at Charles University and the Pulsed Field Facility at Los Alamos are collaborating on the investigation of correlated metals at the facility's sophisticated low temperature and very high pressure instrumentation.

Institute of Solid State and Materials Research Dresden (IFW Dresden)/Research Centre Rossendorf (FZ Rossendorf), Germany. The NHMFL has an Agreement of Cooperation with IFW Dresden and FZ Rossendorf for the design and construction of pulse magnets for the non-destructive generation of the highest magnetic fields possible. Among other contributions, the German partner will develop and provide high-strength micro- and macro-composite conductors, their characterization, and offers the use of their facilities. The NHMFL delivered one 15 mm bore, 60 T pulse magnet for physics research to the Institut für Festkörper-und Werkstofforschung in Dresden Germany. This magnet has expanded the user magnet capability at the Dresden facility.

Laboratoire National des Champs Magnétiques Pulsés, Toulouse, France. Extending the successful cooperation with the pulsed high field laboratory of Toulouse, the Pulsed Magnet Group has agreed to wind a 150 kg magnet for use as an external coil of a duplex 80 T system. It will generate 48 T in a bore of 70 mm with an energy of 8 MJ. As a first step, the NHMFL has received copper-stainless steel conductor to develop and produce a long-pulse 50 T coil for physics research. In addition, the NHMFL Pulsed Field program at Los Alamos has been providing advice and information to assist CNRS in Toulouse in ensuring that their high energy, high field magnet systems are configured and operated in a safe manner. The goals of this aspect of the collaboration are safer high field magnet systems.

Korean Institute of Machinery and Materials (KIMM), (Changwan, South Korea). The NHMFL and KIMM are collaborating on the development of Bi-2223-based high temperature superconducting insert coils. KIMM has provided conductor for the winding of a double pancake coil that was successfully tested in the 19 T large bore resistive magnet.

Korean Research Institute of Standards & Science (KRISS), Taedok Science Town, Korea. The NHMFL pulse magnet group delivered a unique 20 mm bore, 40 T magnet for physics research at Korean Research Institute of Standards & Science. This was our first technical collaboration in this part of Asia.

Ministry of Science and Technology of Korea. The Multinational Cooperation Project on Quantum Transport in Synthetic Metals is funded by the Ministry of Science and Technology of Korea. Overall direction of the project is by Professor Yung Woo Park at the Seoul National University. The NHMFL portion is directed by Prof. James Brooks. Its aim is to investigate the effects of high magnetic fields on quantum transport in conducting polymers, charge transfer salts, and high T_c materials. Two of Prof. Brooks' students have worked at the Seoul National University in Korea; Prof. Park and several of his students have used the NHMFL's DC High Field Facility. Research results were presented at a conference in Seoul in August, 2000, and have been submitted for publication.

National Institute of Chemical Physics and Biophysics, Tallinn, Estonia. High-resolution solids NMR in high magnetic fields requires fast magic angle spinning (MAS), and Dr. Ago Samosan makes the fastest MAS bearings in the world. In the NMR instrumentation workshop at the NHMFL, NMR probes for the highest field NMR magnets in the world are built around his precision-machined ceramic air bearings. Dr. Samosan is also a world leader in the development of Double Rotation (DOR) spectroscopy in which samples spin about two independent axes simultaneously. He also collaborates with Dr. Zhehong Gan on solids NMR applications.

National Research Institute for Metals (NRIM), Tsukuba, Japan. The Japanese NRIM purchased a 30 T resistive magnet from the NHMFL in 1996 that was delivered in 1997. We are presently working on a long-term collaboration to provide magnets to the NRIM. In late 1998, a contract was signed for a replacement "A" coil that was delivered in 2000. A contract for a replacement "B" coil has been signed and construction is underway. We expect to sign a contract for a replacement "C" coil within the next few months. Preliminary discussions have begun regarding a new insert for their 40 T class hybrid magnet.

Physics and Engineering Research Institute (PERI), Ruppin Institute for Solid State Physics Applications, Ruppin, Israel. A Memorandum of Understanding has been signed with the PERI of the Ruppin Institute for Solid State Physics Applications. It is planning to install a pulsed magnetic field facility in cooperation with the NHMFL. Scientific applications of high pulsed magnetic fields, the development of new technologies using magnetic fields, and the development of new and advanced methods for the generation of high fields will be part of the program.

Physikalisches Institut, Johann-Wolfgang-Goethe Universität, Frankfurt, Germany. In the spirit of cooperation with the Physikalisches Institut of the Johann-Wolfgang-Goethe Universität, the Pulsed Magnet Group has delivered one 50 T, 24 mm bore pulse magnets for its pulse field facility.

Ruppin Institute, Emek Hefer, Israel. The NHMFL started a joint project with the group at Ruppin by hosting a graduate student at the Tallahassee facility for two months. The purpose of the visit was training in the theory and details of pulse magnet fabrication. The visiting student produced two 27 T coils that initiate pulse magnet work at Ruppin.

Uppsala University, Sweden. The NHMFL's ICR program is collaborating with researchers at Uppsala University in a project jointly funded by the Swedish Foundation for International Cooperation in Research and Higher Education and the laboratory. The groups are cooperatively investigating the detection, identification, and quantification of neuropeptides in biological tissues, to elucidate the effects of drugs on neurotransmission pathways in the brain. A special emphasis of this project is the study of the role of neuropeptides in movement disorders such as Parkinson's disease and Tardive diskinesia.

The Versaille Project on Advanced Materials and Standards (VAMAS). VAMAS is an international collaboration of laboratories that is organized into Technical Working Areas. The NHMFL's Materials Development and Characterization Group participates in pre-standards measurement research to foster the development of internationally acceptable standards for advanced materials. This year's research was related to the development of a new low-temperature, fracture-toughness test method for structural alloys used in cryogenic and magnet applications.

Van der Waals-Zeeman Instituut, Amsterdam, The Netherlands. The NHMFL Pulsed Field program at Los Alamos and Tallahassee and the Van der Waals-Zeeman Instituut have shared information on pulsed magnet coil materials. The NHMFL has provided material specimens for evaluation and testing by the Institute. In addition, the NHMFL Pulsed Field program at Los Alamos has been providing advice and information to assist the Institute in ensuring their high energy, high field magnet systems are configured and operated in a safe manner. The goals of this collaboration are better characterization of materials for high field magnets and safer high field magnet systems.

7. CONFERENCES AND WORKSHOPS

International Workshop on Latest Developments in Low-Density and Low-Dimensional Electronic Systems

March 4-7, 2000
University of Florida, Gainesville, FL

This three-day workshop was planned by several members of the UF Physics department. The conference sponsors included the Center for Ultra-Low Temperature Physics, the College of Liberal Arts and Sciences, the Department of Physics, the Institute for Fundamental Theory, and the NHMFL.

The program was organized with ascending dimensionalities in mind: 0D and 1D (dots, wires, nanotubes, etc.), followed by 2D (Hall, stripes, planar interfaces and surfaces, etc.), followed by quasi 3D and 3D (hexaborides, bismuth, graphite, etc.). An underlying theme in all of these topics was the relationship between low carrier density, low dimensionality, and the magnetic, metallic and/or insulating properties of novel materials. Some attention was also focused on the use of high magnetic fields at the NHMFL to induce transitions to new states of matter. Examples in this category included transitions from Kondo insulators to metals, B-induced spin-density waves in organics, and B-induced transitions into charge-density wave and excitonic insulator states in low-density semimetals.

More than 60 scientists (professors, postdocs, and students) participated in a program that comprised 22 invited talks together with a well-attended poster session. The scientific exchanges were energetic and wide-ranging and there was general agreement that the workshop was a success.

Center for Advanced Power Systems (CAPS)

July 25-26, 2000
Tallahassee, Florida

On July 25 and 26, seventy representatives from industry, the U.S. Navy, academia, and government laboratories attended the CAPS Naval Power Systems Issues workshop at the NHMFL in Tallahassee. The workshop established significant collaborative interactions and generated input from the participants that will assist CAPS in developing its research program in support of the Navy's all-electric ship and related dual-use technologies.

Presentations and focused panel discussions at the workshop prompted an exceptional dialogue on dual-use strategies, economic drivers, technology insertion, simulations, and new equipment applications. One of the objectives of CAPS will be to provide technical leadership at the power engineering systems level and to bring ship builders, equipment vendors, and the Navy together on the same development path.

At a press conference on Tuesday morning, Raymond Bye, FSU vice president for research, announced a $10.9 million, three-year contract with the U.S. Office of Naval Research for R&D of the Navy's next-generation, all-electric ship. Adm. Jay Cohen, director of the Office of Naval Research, explained the Navy's historic decision to move to the all-electric ship and the implications of such a move—enhanced wartime survivability, reduction of manpower, improved living conditions, applications to industry, etc. He also commended FSU and the NHMFL for seeing the opportunities of new magnet-related materials and control technologies and for "seizing the moment" to drive new applications by working with the Navy and industry. Other speakers included FSU President Talbot "Sandy" D'Alemberte; James Ferner, CAPS interim director and former NHMFL Chief Administrative Officer; and Al Tucker, program officer at ONR.

US-Japan Joint Seminar on Innovative Measurement Techniques in Cryogenics

December 3-6, 2000
NHMFL, Tallahassee, Florida

The US-Japan seminar on Innovative Measurement Techniques in Cryogenics was held at the NHMFL at Florida State University, December 3-6, 2000. The seminar was sponsored by the National Science Foundation and the Japanese Society for the Promotion of Science, with additional funding provided by the NHMFL. LakeShore Cryotronics and Scientific Instruments also participated in the seminar and contributed to the cost of the event. The program was organized by Dr. Steven Van Sciver of the NHMFL and Dr. Tom Haruyama of the KEK, High Energy Accelerator Research Organization.

The purpose of the seminar was to bring together researchers involved in making measurements and developing instrumentation to discuss new techniques, devices and their use in cryogenic measurements and applications. The small workshop environment was established to allow more focused exchange than normally occurs at major national and international conferences. There were a total of 34 attendees, 12 from Japan, 5 from Europe and the remainder from U.S. institutions including the NHMFL. Topics discussed included instrumentation and sensors, applications and new techniques. Papers submitted as part of the seminar will be published in a special issue of the journal, *Cryogenics*.

8. BUDGET AND STAFFING

INTRODUCTION

The National High Magnetic Field Laboratory (NHMFL) operates with funding provided by federal, state, institution, and industry sources. The lab staff has been successful in securing individual research grant funding for specific areas of research from federal, state, and local agencies. The additional awards offset the operating costs by shifting costs during the periods of time in which staff is engaged in individual research activities. The lab has also actively pursued opportunities for industry support through collaborative efforts. While the lab receives funding from numerous sources, the primary funding source for operation of the NHMFL remains the National Science Foundation (NSF).

NSF CORE BUDGET

In 1996, The National Science Foundation (NSF) awarded the second five-year research grant to the National High Magnetic Field Laboratory (NHMFL) in the total amount of $87,500,000. The funding provided a level annual budget of $17,500,000 per year for the five-year period. In the early years of the grant, the actual dollars expended was less than the budget provided. In the last two years of the NSF grant, however, the budgetary requirements exceeded the annual NSF funding. The NHMFL utilized institutional funds and prior year surplus to offset this funding deficit. The non-recurring institutional support provided during FY 2000 is explicitly indicated on the individual budgets and was provided to help cover budget deficits. Table 1 provides the cumulative NSF budget and expenses by expense classification through 12/31/00.

Table 1. NSF Budget and Expenses*

Expense Classification	Total Budget Dollars	*Dollars Expended	*Dollars Encumbered	*Total Dollars Expended & Encumbered
Salaries, Wages, & Benefits	26,656,350	23,536,300	15,690	23,551,990
Permanent Expenses	12,724,300	7,249,880	144,000	7,393,880
Other Direct Expenses	34,394,810	40,099,175	1,669,280	41,768,455
Total Direct Cost	73,775,460	70,885,355	1,828,970	72,714,325
Indirect Cost	13,724,540	14,755,410	30,265	14,785,675
Total Cost	87,500,000	85,640,765	1,859,235	87,500,000
Program Income	1,352,960	1,352,960		1,352,960

** Data was compiled from NHMFL internal financial records and represent unaudited financial estimates*

NHMFL Matching Commitment

The NSF grant includes a matching commitment by the State of Florida. The state commitment to provide matching for the NSF funding is based on the original commitment of recurring funds in the amount of $4,200,000. This requirement is increased annually based on the legislatively approved increases for personnel costs.

For FY2000, the State of Florida again elected to provide additional funds for the operation of the lab programs. The NHMFL utilizes the additional state resources as available cost sharing funds for additional funding opportunities. Table 2 presents the current State of Florida matching requirements for FY2000.

Table 2. State of Florida Matching Requirements

	FY 2000 Matching ($)
State of Florida recurring funds cost sharing	$4,667,250
Indirect cost (46.5%)	$2,170,270
Total State Commitment	$6,837,520
Overhead rate adjustment for negotiated rate of 48%	$70,000
Total State & Institutional Cost Sharing	$6,907,520

Additionally, the Los Alamos National Laboratory makes a contribution to the costs of the NHMFL Pulsed Field Facility. In FY2000, the contribution included $500,000 toward facility expenses and $290,000 in support of center management. Additional non-quantified support was provided in the form of the waiving of demand charges for electricity used by the NHMFL facility.

NSF Renewal Funding for FY 2001-2005

The National Science Board approved the NHMFL renewal award, in the amount of $117,500,000, at its meeting on October 19, 2000. The renewal period will be from January 1, 2001 through December 31, 2005. Table 3 presents the NSF funding comparison for the current fiscal year and fiscal year 2001. It also details the current five-year grant period funding with the renewal funding levels for each program. The most significant increase to the budget included a reserve that will be used for currently planned equipment purchases.

Table 3. NSF Budget Comparison, FY2000 and FY2001

Division/Program	FY2000 Budget *	%	FY2001 Budget *	%	FY 1996 - 2000 5 Yr NSF Summary	%	FY 2001 - 2005 5 Yr NSF Summary	%
Director	186,500	1.00%	636,160	2.99%	3,110,550	3.39%	3,353,010	2.75%
CIRL	94,870	0.51%	244,970	1.15%	479,691	0.52%	1,293,600	1.06%
Reserve (2)	0	0.00%	-952,002	-4.48%		0.00%	6,671,960	5.47%
Facilities & Admin	1,059,180	5.65%	1,785,800	8.40%	7,799,663	8.51%	9,425,500	7.72%
Instruments & Operations	6,057,645	32.33%	6,673,380	31.38%	25,315,912	27.61%	35,277,500	28.90%
Magnet Science & Technology (4)	4,660,040	24.87%	4,388,730	20.64%	22,007,181	24.00%	19,147,600	15.69%
Science (3)	490,855	2.62%	1,575,830	7.41%	7,273,389	7.93%	8,360,050	6.85%
LANL	4,232,650	22.59%	4,572,650	21.50%	19,098,427	20.83%	26,476,850	21.69%
CIMAR	302,260	1.61%	588,845	2.77%	889,361	0.97%	4,828,070	3.96%
ICR Facilities**	1,236,496	6.60%	1,266,064	5.95%	4,200,000	4.58%	4,554,220	3.73%
UF	416,000	2.22%	485,637	2.28%	1,525,825	1.66%	2,665,860	2.18%
Total	18,736,496		21,266,064		91,700,000		122,054,220	

* *Budget amounts are inclusive of overhead distribution by program.*
** *CIMAR is inclusive of NSF Chemistry Division award in the amount of $1,206,338 (FY2000), $1,266,064 (FY2001), $1,056,779 (FY2002), and $994,881 (FY2003).*

PROGRAM BUDGET DISCUSSION

FY2000 was the final year of the current grant award for funding from the National Science Foundation. The total NSF budgetary allocation for FY2000 was $17,500,000. The NHMFL also receives an annual operating budget from the State of Florida. In FY2000, the state budget was $6,235,500. State revenue offsets of royalties and work for others provided an additional spending amount of $200,000. Additionally, $886,000 was provided from institutional funds to offset the initial FY2000 NSF budget deficit. The NHMFL internally allocates the annual budgets by program area.

For FY2000, Table 4 details the budget allocations and actual expenditures by program for both NSF and state E & G funding.

Table 4. NSF and State Budget Allocations and Actual Expenditures, FY2000*

(Dollars in 000's)

Program	NSF Budget	State Budget	Total Budget	NSF Actual**	State Actual**	Total Actual
Director	125.6	1,837.0	1,962.6	197.6	1,187.3	1,384.9
CIRL	63.2	372.9	436.1	61.3	128.5	189.8
Facilities & Admin	771.7	522.7	1,294.4	910.0	699.8	1,609.8
Instruments & Operations	4,766.9	236.3	5,003.2	4,459.4	352.8	4,812.2
MS & T	3,583.7	945.7	4,529.4	3,847.1	772.9	4,620.0
Science	444.9	1,178.8	1,623.7	1,601.9	1,107.7	2,709.6
LANL	4,232.7	52.7	4,285.4	4,396.8	83.5	4,480.3
CIMAR	203.5	883.6	1,087.1	256.8	1,074	1,566.4
ICR Facilities***	1,236.5	297.9	1,534.4	1,299.9	295.6	1,595.5
UF	296.3	110.6	406.9	1,072.7	60.8	1,133.5
Overhead/Unallocated****	3,011.5		3,011.5	3,597.8	275.1	3,872.9
Total	18,736.5	6,438.2	25,174.7	21,701.3	6,038	27,974.9

** Data was compiled from NHMFL internal financial records and represent unaudited financial estimates. State funding includes State of Florida E & G budget allocation only.*

*** Includes actual expenditures and encumbrance balances at the end of FY2000. NSF Actual exceeded the FY2000 budgetary allocations. The NHMFL utilized institutional funds and prior year surplus to offset this funding deficit.*

**** The ICR facilities is supported primarily by a NSF Chemistry Division award.*

*****Overhead budget is not distributed to programs. State Unallocated includes encumbered salaries and start-up expenses funded from the state budget.*

Director's Office

The Director's Office includes the Director, Deputy Director and their administrative assistants. In addition, the Office of Government and Public Relations is included in the Director's Office. Government and Public Relations has been realigned for FY2001 to include a new Laboratory Information Management group that is a consolidation of the functions of publications, web master, graphics and publication support that were carried out in other units. The Visiting Scientist's program provides funding for scientists to conduct research utilizing the NHMFL facilities. Proposals are internally peer reviewed and awards are made on a first-come basis based on input provided through the internal review process.

DIRECTOR'S OFFICE FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Director	32,000	476,980
Deputy Director	10,000	301,750
Government & Public Relations	83,500	518,500
Visitor's Program		300,000
Director's Research		126,650
Reserve		249,340
Total	125,500	1,973,220
* Institutional funding provided		136,220

Center for Integrating Research and Learning (CIRL)

This unit was formerly included in the Director's Office, but as the program has expanded, it has been set up as a separate cost center. CIRL supports programs in curriculum development, distance learning and teacher education with the primary focus on enhancing science education at all levels and promoting public awareness. CIRL administers the Research Experience for Undergraduates (REU) program that has been extremely successful over eight years. The Research Experience for Teachers (RET) is also coordinated and run by the Center. The RET program has fit very effectively with the summer REU students. All mentorships are organized by CIRL for middle school students. CIRL is also the focal point for organization of the NHMFL Annual Open House and other tour activities for K-12 groups and the public. The Optical Microscopy Resource Center (OMRC) is another program operated as part of the NHMFL research and learning efforts. The OMRC has been hugely successful and received national recognition. The costs associated with the microscopy research program are offset with funding from other sources.

CENTER FOR INTEGRATING OF RESEARCH AND LEARNING FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Education	63,150	173,890
REU Program	0	65,000
Optical Microscopy		210,900
Total	63,150	449,790
*Institutional funding provided		76,890

Facilities and Administration

Facilities and Administration includes general administrative functions for the lab including personnel, budget, accounting, payroll, procurement, accounts payable, grant administration, and media activities. Facilities include maintenance of the magnet power supplies and cooling systems, helium system, and the remainder of the facilities with the exception of the grounds, janitorial, and some HVAC and plumbing preventative maintenance. The Facilities group also handles small interior renovations and modifications needed to support research activities. Funding for the Facilities group is split between NSF, state and institutional funds. NSF funding is used for core-related activities while state and institutional funds are used for general facility maintenance and modifications.

FACILITIES AND ADMINISTRATION FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Administration	98,580	1,215,470
Facilities	508,800	706,600
Safety	164,270	
Total	771,650	1,922,070
* Institutional funding provided		1,399,370

In FY2001, all of the budget, accounting, and financial analysis functions are being consolidated in the Director's Office with the Chief Administrative Officer and Chief Budget Officer. These two positions provide the Director with greater cost accounting and budget control over the many different funding sources and programs. In addition, the Chief Administrative Officer is responsible for purchasing, travel, disbursements, and capital equipment inventory.

Instrumentation and Operations

This unit, headed by the Director of DC Fields Operations, is responsible for the operation of the DC magnet systems at Tallahassee, as well as, the Millikelvin facility. This unit also provides operational machine shop, electronics, and computer networking support for the entire laboratory. Most of the staff is dedicated to supporting user activities from the technical level to assistance from instrumentation scientists. This group focuses on keeping abreast of the cutting edge instrumentation specialties and improving the performance level of user instrumentation through the development of new approaches to measurements. The Instrumentation and Operations group also helps coordinate annual meetings of the NHMFL Users' Committee and other interface activities with the user community.

INSTRUMENTATION AND OPERATIONS FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Administration	121,930	319,750
Computer Services	268,225	
Cryogenics	572,480	
Electronics	245,365	
Magnet Operations	2,117,560	
Mechanical Instruments	507,620	
User Services	933,770	71,040
Total	4,766,950	390,790
* Institutional funding provided		154,490

Magnet Science and Technology

MAGNET SCIENCE & TECHNOLOGY FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Administration	685,740	470,600
Resistive Magnets	855,260	
High Field Systems	1,315,120	280,460
Materials Development	245,270	263,360
Pulsed Magnets	131,630	
Cryogenics	113,770	22,550
HTS Magnets	114,780	79,280
Analysis	122,030	154,080
Total	3,583,600	1,270,330
* Institutional funding provided		324,630

The Magnet Science and Technology (MS&T) group is responsible for the design and engineering of the DC, pulsed, and advanced superconducting magnets, such as the wide-bore 900 MHz NMR magnet. This group has brought together some of the best and brightest talent ever assembled to advance magnet technology and magnet materials. MS&T has broad interactions with the private sector, other national laboratories, and international institutions involved in high field magnet research and development. Future advances in magnet technology will be heavily dependent on advances in materials, specifically high strength, high conductivity normal conductors and high strength, high performance superconductors; high transition temperature superconducting conductors and reinforcement materials that are critical to overcome the enormous forces reflected in high field magnet design. The specific programs in MS&T include Administration, which includes general management, administrative, and some engineering staff and supplies; Resistive Magnets; High Field Systems, which includes NMR systems; Materials Development and Characterization; Pulsed Magnets; Cryogenics Operations and In-house Research and Development; HTS Magnets and Materials Development; and MS&T analysis.

Science Program

SCIENCE FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Administration	10,000	376,870
In-House Research Program	379,700	56,000
Condensed Matter Theory		253,760
Condensed Matter Experimental		412,150
Geochemistry	55,090	151,020
Total	444,790	1,249,800
* Institutional funding provided		71,000

The NSF funding for the science and facilities development program are primarily distributed through the In-House Research Program (IHRP). A small amount of funding is utilized to cover the administration of the program and to provide assistance for the Director of the IHRP. The Director of the IHRP serves a two-year term, and the position rotates among the three institutions. During the current period, the program is headed by Dr. Al Migliori from the NHMFL Pulsed Field Facility at Los Alamos National Laboratory. The Condensed Matter & Theory group in Tallahassee assists and provides administrative support with proposal solicitations and reviews. IHRP proposals must include an internal investigator from one of the three participating institutions as Principal

Investigator but participation from external users as Co-Principal Investigators is strongly encouraged by the NSF and NHMFL. The proposed research work must utilize and advance facilities and support is restricted to two years or less. Proposals that support young scientists and/or support bold new research areas that have the possibility of opening new frontiers are strongly encouraged.

Pulsed Field Facility – Los Alamos

PULSED FIELD FACILITY LOS ALAMOS FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Facilities & Admin	2,316,350	
User Operations	1,402,440	52,700
60 T Pulsed Magnet	513,861	
Total	4,232,651	52,700
* Institutional funding provided		0

The NHMFL Pulsed Field Facility is sited at Los Alamos National Laboratory (LANL) and operated under a subcontract agreement between Florida State University and the Department of Energy. Funding for the NHMFL Pulsed Field Facilities and Administration includes the facility overhead charges. The Pulsed Field Facility provides technical and instrumentation support for the user community. The staff of the NHMFL Pulsed Field Facility, in cooperation with the user community, also devotes considerable attention to the development of new research capabilities and instrumentation responding to the unique requirements imposed by the rapidly changing magnetic fields and vibrations characteristic of these systems. The NHMFL Pulsed Field Facility staff works closely with members of the NHMFL Magnet Science and Technology group in Tallahassee to advance pulsed magnet technology and materials for these unique systems. Special staffing is also required to maintain the 4.0 MJ capacitor bank and the 1.4 GVA generator used to power the magnets available at this facility.

High B/T Facility

The High B/T Facility is located at the University of Florida and is housed in the existing Microkelvin facility. A special bay has been retrofitted in the Microkelvin laboratory with a 15/18 T magnet designed for ultra-low temperature research, i.e. research at a few hundred microkelvin.

HIGH B/T FACILITY UNIVERSITY OF FLORIDA FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Administration		110,650
High B/T User Support	71,925	
Total	71,925	110,650
* Institutional funding provided		0

Center for Interdisciplinary Magnetic Resonance

CENTER FOR INTERDISCIPLINARY MAGNETIC RESONANCE FY2000		
Program	NSF Budget $	State & *Institutional Budget $
Administration	26,510	116,380
NMR program	126,895	427,270
ICR Program*	1,266,064	297,900
ESR Program	50,000	339,970
AMRIS	224,385	
Total	1,693,854	1,181,520
* Institutional funding provided		0

*The ICR-MS facilities are primarily supported by a separate award from the Chemistry Division of NSF.

CIMAR represents all areas of magnetic resonance techniques and has made significant advances in building a user program that involves interdisciplinary activities with Physics, Geochemistry, Chemistry, and Biology. The program focuses on nuclear magnetic resonance (NMR), electron magnetic resonance (EMR), ion cyclotron resonance mass spectroscopy (ICR-MS), and magnetic resonance imaging and spectroscopy (MRI/S). The facilities within CIMAR provide unique instrumentation and capabilities to support a wide variety of research areas and are open to all qualified users. CIMAR has received only modest support from the NSF core grant. Most of the program activities have been supported with state and institutional funds. A portion of the NMR spectroscopy and imaging activities are pursued at the Advanced Magnetic Resonance Imaging and Spectroscopy Facility (AMRIS) located at the McKnight Brain Institute at the University of Florida.

BASIS OF ESTIMATE OF PROGRAM BUDGET

The program budgets were prepared in accordance with the following criteria:

Budget Units: The NSF and state budgets are allocated to the NHMFL programs. There is one sub-contract for facilities and activities at Los Alamos National Laboratory, Los Alamos, NM. The overall operations of the NHMFL are governed by the Executive Committee which is responsible for developing recommendations to the Director for allocation of budget dollars to programs.

Wage and Salary Rates: Where possible, actual salary rates have been used in the cost calculation. In some instances, the average salary rate may have been used for vacant and Ops (temporary) positions.

Overhead Rates: The Florida State University current approved overhead rate of 46.5% has been used for all costs at Tallahassee. Current approved institutional overhead rates have been used for costs at University of Florida (44.5%) and Los Alamos (49.4%).

Overhead Base: At FSU and UF, overhead is applied to all costs except the following:

- Permanent Equipment
- Undergraduate, Graduate, and Ph.D. Programs (CIRL)
- Electric Power for magnet operations
- Subcontracts (excluding the first $25,000 of each subcontract).

At LANL, full overhead is applied to all costs except for projects designated as capital projects where a reduced overhead (10%) is applied to all costs.

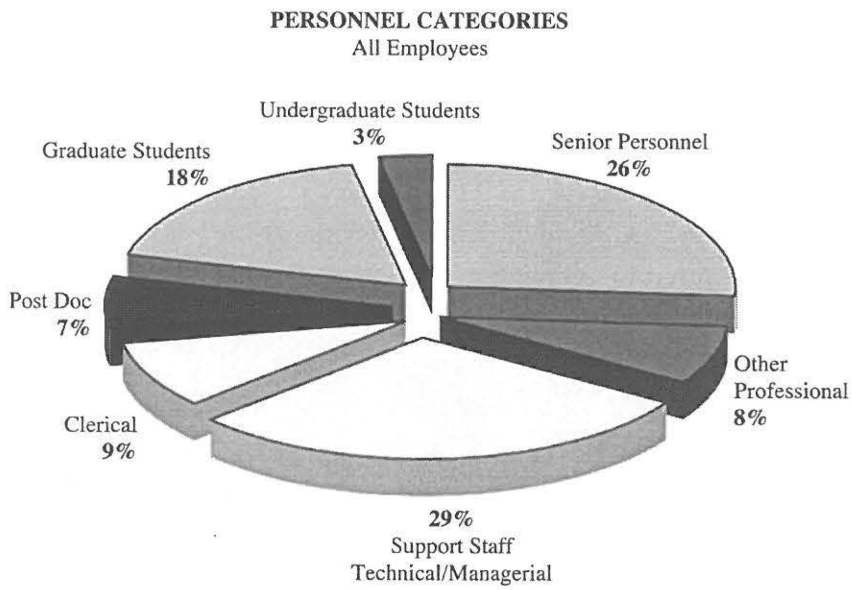
Fringe Benefits: Fringe benefits for Florida personnel are based on average actual costs of fringe benefits for permanent employees (31%) and temporary employees (10%). Fringe benefit costs for LANL employees are included in the average salary rates for each class.

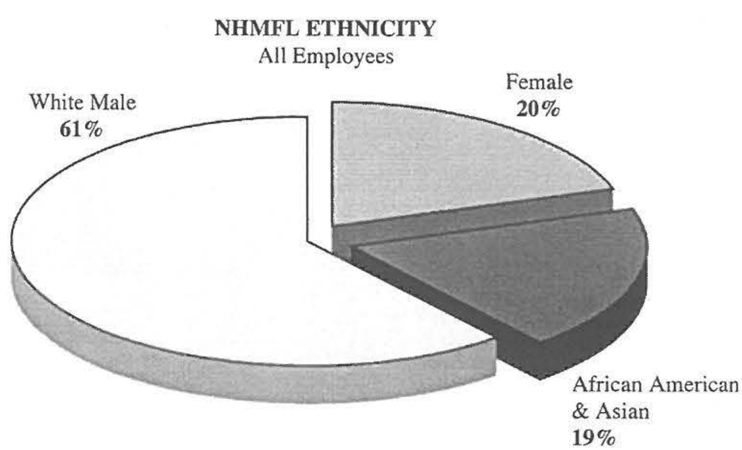
Administrative and Facility Maintenance Costs: Certain administrative and facility maintenance costs are accrued solely for the benefit and function of the NHMFL. These costs are included as direct costs in the budget estimates as allowed by the OMB regulations.

In-House Research Program Awards: The designated budget for the IHRP is inclusive of institution overhead. Since the actual overheads vary depending on the nature of the program and the institution involved, actual overheads are determined at the time of award within the total IHRP budget.

PERSONNEL STAFFING

During this year, the Information Management Services group developed a Web-based personnel tracking system that can provide a demographic profile of the NHMFL staff. The statistics reflected below include all personnel supported on the NSF grant, State of Florida funds, and support from individual faculty grants. These figures include all three sites—Tallahassee, Gainesville, and Los Alamos. The definitions for personnel categories and ethnicity are the same definitions used by NSF for proposal and budget submissions. It is important to note at both Florida sites, Florida State University and the University of Florida, there are affiliated faculty who work closely with NHMFL Senior Personnel. If affiliated faculty at both campuses were included in the analyses, Senior Personnel would increase to 33% of the total. The following graphs provide the overall NHMFL employee allocations as indicated.





APPENDIX A: USERS & PROJECTS

DC FIELD FACILITIES

+ POSTDOC   * STUDENT

USER	INSTITUTION	FUNDING	PROJECT
Agosta, Charles Coffey, Tom*	Clark U. Clark U.	NSF	Tunnel Diode Oscillator Experiments
Aldissi, Matt	Fractal Systems, Inc.	DASG60-99M-0062	Magnetization of Magnetic Powders
Balicas, Luis Brooks, James Pappavasiliou, George Kayoshima, K Ward, Brian+	Venezuelan Institute for Scientific Research FSU Institute for Chemistry - Greece IMS- Japan NHMFL	NSF	Transport Studies of t-Phase and BETS-Type Organic Conductors
Barilo, Sergei Tozer, Stan Hall, Donavan	ISSSP NHMFL NHMFL	INTAS, Belgium	Magnetization - Specifically CL Suspectiblity of BKBO
Basov, Dimitri Dordevic, Sasa* Ando, Yoichi	UC, San Diego UC, San Diego Lucent Technology/Bell Labs Innovations	NSF	FIR Spectroscopy of $La_{2-x}Sr_xCuO_4$ for x-0.08, 0.125, 0.17
Bauer, Pierre Dietderich, Dan	Fermilab Lawrence Berkeley Lab	DOE	Ic Measurements of Nb_3Sn Superconducting Cables
Bergemann, Christoph* Brooks, James Mackenzie, Andy Maeno, Yoshiteru Julian, Steven	U. of Cambridge FSU Birmingham U. Kyoto U. Cambridge U.	NSF	Transport and Magnetism of Sr_2RuO_4
Brey, William Warren, Warren Murali, Nagarajan Gan, Zhehang	NHMFL Princeton NHMFL NHMFL	NSF	Improvements to 25 T Resistive Magnet for NMR
Brooks, James Cothern, J.* Summerlin, D.* Rutel, I.* Marsceill, Alex*	FSU NHMFL Mt. Dora High School NHMFL Pine Crest High School	NSF/IHRP	Many Body Effects During Diamagnetic Levitation
Brooks, James Terashima, Taichi Pappavasiliou, George Storr, Kevin	FSU NRIM Institute for Chemistry - Greece FSU	NSF	Electrical Transport in CeNiSn, Organic t - Phase and dHvA in κ-(BEDT-TTF)^2 I3 and λ-(BETS)^2 FeC_{l4}

Brooks, James Balicas, Luis Qualls, Jeremy* Ward, Brian+	FSU Venezuelan Institute for Scientific Research FSU FSU	NSF	In-Plane and Inter-Plane Angular Dependent Magnetoresistance Anisotropy of Quasi-Dimensional and Two-Dimensional Organic Conductors
Brunel, Louis-Claude Zvyagin, Sergei* Saylor, Charles+ Luthi, Bruno Wang, Yong-Jie VanTol, Hans Karmerner, Konstantin	NHMFL NHMFL NHMFL U. of Frankfurt NHMFL NHMFL Edinburg U.	NHMFL	FIR-Investigation of the Insulator-Metal Phase Transition in $Nd_{0.5}Sr_{0.5}MnO_3$
Butler, Les	Louisiana State U.	NSF	Field Swept NMR Experiment
Cao, Gang Crow, Jack	NHMFL NHMFL	NHMFL	Magnetoresistance of CaRuO
Cheikh-Ali, Askar	FAMU-FSU College of Engineering	FAMU-FSU	Annealing at High Magnetic Field. of Zn-1.1%Al
Chen, Ching Haik, Yusef	FAMU-FSU College of Engineering FAMU-FSU College of Engineering	NSF	Effects of Magnetic Fields on Biological Fluids
Chien, Chia-Ling Xiong, Peng Strikers, Gustav Yang, Fengshaun* Parker, Jeff*	Johns Hopkins U. FSU Johns Hopkins U. Johns Hopkins U. FSU	NSF	Anisotropic Magnetoresistance in Electromechanical Deposited Bi Anti-Dots
Clark, Gilbert Moulton, Bill VonLanthen, Patrik Kuhns, Phil Reyes, Arneil Kriza, George Tanaka, Kenji*	UCLA NHMFL UCLA NHMFL NHMFL Control Research Inst. for Physics, Budapest UCLA	NSF	• Phase Fluctuations of the Charge Density Wave in $Rb_{0.3}MoO_3$ • Excitation Gap of the 1-D Anti-Ferromagnetic $LiVGe_2O_6$
Clayhold, Jeffrey A. Whangbo, Mike Ulutuguy, Mutlu*	Clemson U. NC State U. Clemson U.	NSF Hun, Shiou-Jyh	Studies of Magnetism in $CsNa_5Cu_4As_4O_{16}\bar{C}_{12}$: A Two-dimensional Square Planar yet Frustrated Antiferromagnet
Cross, Tim Gan, Zhehong Massiot, Dominique	FSU NHMFL Cours	NHMFL	High Field 27 A NMR of Some Solid Samples
Crow, Jack McCall, Scott*	NHMFL NHMFL	NSF	Transport Studies of Itinerant Systems at High Magnetic Fields

Datta, Timir Mahan, Gerry Lugu, Anea Igbal, Zafar Estrada, Javier Woolam, John Bleiweiss, Michael*	U. of South Carolina U. of Nebraska U. of MN Honeywell Corp. Grand Valley U. of Nebraska U. of South Carolina	NSF	Magnetoresistance, SdH and Hall Measurements
Douglas, Elliot Cho, Seunghyun* Kim, Dongsik* Castell, Pere*	UF UF UF UF	NSF	Materials Processing in Magnetic Fields: High Strength Polymers
Du, Rui-Rui Zhang, Jian* Simmons, Jerry Reno, J. L. Zudov, Michael+ Yang, Chang-li*	U. of Utah U. of Utah Sandia National Laboratory Sandia National Laboratory U, of Utah U. of Utah	NSF	High Magnetic Field Transport of Two-Dimensional Electrons in Semiconductors
Dynes, Robert Hellman, Frances Teizer, Winfred*	UC, San Diego UC, San Diego UC, San Diego	NSF	Electron Tunneling, Transport, and Hall Measurements in Amorphous Materials at the Metal Insulator Transition
Ebihara, Takao Lawrence, Jon M. Sarrao, John	UC Irvine UC Irvine LANL		Cantilever dHvA Measurements
Engel, Lloyd Yeh, Peide* Tsui, Daniel C.	NHMFL NHMFL Princeton U.	NHMFL	QHE with Microwaves
Epstein, Arthur J. Kmety-Stephenson, Carmen*	Ohio State U. Ohio State U.	NSF	Field Induced Magnetic Properties of $Fe[N(CN)_2]^2$ and $Mn[N(CN)_2]^2$
Fisk, Zachary Hall, Donavan Petrovic, Cedomir*	FSU NHMFL FSU	NSF	AC Suspectibility Measurement of Tc of $CeIrCoLu_5$
Fortune, Nathanael Aoki, H. Uji, Shinya Gossett, Gayle* Peabody, Lydia*	Smith College NRIM - Tsukuba NRIM - Tsukuba Smith College Smith College	Smith College	Magnetic Field Dependence of the Specific Heat of α-(BEDT-$TTF)^2KHg(SCN)^4$
Garmestani, Hamid Meda, Lamartine* Bacaltchuk, Cristiane*	FSU FAMU-FSU College of Engineering FAMU-FSU College of Engineering	NSF	Magnetic Texturing of $Nd_2Fe_{14}B$ at High Temperatures
Goodrich, Roy G.	Louisiana State U.	NHMFL	Magnetoresistance of Large Aluminum Coils
Hall, Donavan Murphy, Tim Palm, Eric Sarrao, John Tozer, Stan Goodrich, Roy Alver, Ulmet	NHMFL NHMFL NHMFL LANL NHMFL Louisiana State U. Louisiana State U.	NSF	Electronic Structure of $RMIn_5$ (R=Ce,La,Y; M=Co, Ir, Rh)

Hall, Donavan Goodrich, Roy Fisk, Zachary	NHMFL LSU NHMFL	NHMFL	Quadrupolar to Paramagnetic Phase Transition in CeB_6
Halperin, William Moulton, Bill Kuhns, Phil Mitrovic, Vesna* Reyes, Arneil Calder, Ned* Thomas, Will*	Northwestern U. FSU NHMFL Northwestern U. NHMFL Northwestern U. Northwestern U.	NSF	• Fringe Field Gradient NMR Diffusion Measurements • Induction Shielding for NMR (Applied Field Stability)
Halperin, William Moulton, Bill Kuhns, Phil Mitrovic, Vesna* Reyes, Arneil Calder, Ned* Thomas, Will*	Northwestern U. FSU NHMFL Northwestern U. NHMFL Northwestern U. Northwestern U.	NSF	Vortex Microscopy By NMR
Harrison, Neil Biskup, Neven* Brooks, James Balicas, Luis Molinuevo	NHMFL-LANL NHMFL FSU Venezuelan Institute for Scientific Research.	NSF & DOE	Thermodynamics of the Phase Diagram of an Organic CDN
Harrison, Neil Wosnitza, Jochen Brooks, James Balicas, Luis Molinuevo	NHMFL-LANL Karlsruhe U. FSU Venezuelan Institute for Scientific Research.	NSF & DOE	Persistent Currents in an Organic Metal in Strong Magnetic Fields
Hebard, Arthur F. Liu, Ying Maslov, Dmitri Bompadre, Silvia+ Ganesh, Omjoy*	UF Pennsylvania State U. UF UF UF	NSF	Three Dimensional Low-Density Metals in Ultraquantum Magnetic Fields: Search for Instabilities
Hellman, Frances Teizer, Winfried* Hall, Donovan	UC, San Diego UC, San Diego NHMFL	NSF	Magnetization of Amorphous Gd-Si on Si Substrates
Hentges, Rob Parrel, Jeff Field, Mike Zhang, Youzhu Hong, Seung	Oxford Superconducting Technology OST OST OST OST	Oxford Superconducting Technology	Low Temperature, High Field Current Density of Nb_3Sn and NbTi Superconducting Wires
Hill, Steve Mola, Monty* Maeno, Yoshi Brooks, James	Montana State U. Montana State U. Fyoto, Japan FSU	NSF	Millimeter-wave Spectroscopy of Novel Electronic Systems in High Magnetic Fields
Houpt, Thomas Smith, James Barranco, Jan Pittman, Dave*	FSU FSU FSU FSU	National Institute of Health	Behavioral and Neural Effects of Magnetic Fields
Ishiguro, Takehiko Maeno, Yoshiteru Ohmichi, Eiji*	Kyoto U. Kyoto U. Kyoto U.	CREST/ JST	Search for Reentrant Superconductivity in Sr_2RuO_4

Kang, Woun Brooks, James Balicas, Luis Kang, Hae Yong*	EWHA U. NHMFL Venezuelan Institute for Scientific Research EWHA U.	Korean Research Foundation	Magnetoresistance and Hall Effect Measurements of $(TMTSF)_2ReO_4$
Kang, Woowon Young, Joseph* Nelson, Jeffery	U. of Chicago U. of Chicago U. of Chicago	Packard Foundation	Sonoluminescence at High Magnetic Fields
Karczewski, Grzegorz Wang, Yong-Jie Wei, Xing	Polish Academy of Sciences NHMFL NHMFL	NHMFL	Resonant Coupling of Cyclotron and Spin Resonance in Modulation - Doped CdMnTc/CdMgTc Quantum Well Structures
Knap, Wojiech Karczewski, Gregory Grangjean, Nicolas Grzegory, Isabella Shur, Michael Khan, M. Asit	Rensselaer Polytechnic Institute NHMFL CNRS UNIPRESS RPI U. of South Carolina	NSF	Quantum Transport in 2D Electron Gas in GaN/AlGaN Heterojunctions
Krasovitsky, Vitaly Hannahs, Scott	Institute for Low Temperature Physics, Krakow NHMFL		"High–Temperature" Oscillations of Bismuth Conductivity
Kuhns, Phil Reyes, Arneil Caldwell, Tod* Abdelrazek, Margie*	NHMFL NHMFL FSU FSU	NSF	Metal Insulator Transition in BEDT
Landee, Christopher Turnbull, Mark Jensen, Bill Albrecht, Andy Woodward, Matt*	Clark U. Clark U. Clark U. Clark U. Clark U.	NSF	Magnetization of Low Exchange Strength, Heisenberg Antiferromagnets in 2D
Liu, Ying Nelson, Karl*	Penn State U. Penn State U.	NSF	Magnetoresistance of Sr_2RuO_4
Maley, Martin Krusin-Elbaum, Lia Coulter, James Morozov, Nikolai+ Bulaevskii, Lev	LANL IBM LANL LANL LANL	NHMFL/IHRP	Vortex Physics and C-Axis Transport Properties of High Temperature Superconductors at High Magnetic Fields
Markiewicz, Denis Swenson, Chuck Hall, Donavan	NHMFL NHMFL NHMFL	NSF	Magnetic Permeability on 900 MHz Support Tubes
McCombe, Bruce Wang, Yong-Jie Wei, Xing Jones, Eric	SUNY at Buffalo NHMFL NHMFL Sandia National Laboratory	NSF & ONR	Optical Study of Exitonic Transition in GaAs/AlGaAs Quantum Wells

Meisel, Mark Brooks, James Paul, Anna- Lisa Watson, Brian* Ferl, Robert Morgan, Nicole* Maloney, James*	UF FSU UF UF UF UF UF	NSF	Magnetic Field Effects and Levitation of Transgenic Plants
Mohammed, Osama Minev, Daniel* Walsh, Robert	Florida International U. Florida International U. NHMFL	NSF	Magnetostrictive Effects on Electrical Steel
Molodov, Dmitry Konijnenberg, Peter	Institut fuer Metallkunde und Metallphysik, RWTH Institut fuer Metallkunde und Metallphysik,	Aachen University of Technology	Grain Boundary Motion in Zinc Bicrystals Driven by High Magnetic Field (>25T)
Moulton, Bill Reyes, Arneil Kuhns, Phil Caldwell, Tod* Abdelrazek, Margie*	FSU NHMFL NHMFL FSU FSU	NSF	NMR Studies of Nd Fluctuations and Psuedogap in NdBCu T1and Knightshift at High Field
Murata, Keizo Brooks, James Balicas, Luis Ward, Brian+ Storr, Kevin* Graf, David*	Osaka City U. FSU Venezuelan Institute for Scientific Research FSU FSU FSU	NSF	Modification of the Tight Binding Parameters of $(TMTSF)_2PF_6$ and Their Influence on Superconductivity and Spin Density Wave Formation in High Magnetic Fields
Musfeldt, Janice L. Wang, Yong-Jie	SUNY at Binghamton NHMFL	NSF	Spectroscopic Studies of Magnetically Driven Phase Transitions in Organic and Inorganic Solids
Naughton, Mike Sushko, Yuri+ Ren, Zhifeng	Boston College Boston College Boston College	NSF	Accurately Aligned Critical Fields in Superconductors
Ng, Hon-Kie Samarth, Nitin Leem, Young-Ahn*	FSU Penn State U. FSU	NSF	Cyclotron Resonance in a ZeSe Heterostructure
Noh, Tae W. Choi, Eun Sang Moritomo, Y. Jung, Jong* Lee, HaeJa* Wang, Yong-Jie	Seoul National U. Seoul National U. Nagoya U. Seoul National U. Seoul National U. NHMFL	Korea - MS & T	Melting of Charge Ordering in Manganese Oxides
Palm, Eric Murphy, Tim Pekola, Jukka*	NHMFL NHMFL U. of Jyvaskyla	NHMFL	High Field Tests of Coulomb Blockade Thermometer
Palm, Eric Murphy, Tim	NHMFL NHMFL	NHMFL	Studies of Kapton and Copper Jellyroll Capacitors

Park, Yung Woo Brooks, James Shirakawa, H. Akagi, K. Kim, Taek Jung* Suh, Dong-Seok* Kim, Dong Chul*	Seoul National U. FSU U. of Tsukuba U. of Tsukuba Seoul National U. Seoul National U. Seoul National U.	Korea Science & Engineering Foundation	Magnetoresistance of Polyacetylene Doped with Iodine and $FeCl_3$
Pekarek, Thomas	U. of North Florida	NSF	Magnetic and Calorimetric Measurements of III-VI and II-VI Diluted Magnetic Semiconductors
Petrou, Athos Wang, Yong-Jie Wei, Xing	SUNY at Buffalo NHMFL NHMFL	NSF	Magneto Luminescence of n-type AlGaAs/AlAs Quantum Wells
Popovic, Dragana Eng, Kevin* Feng, Xiang Guang* Washburn, Sean	FSU UNC Chapel Hill UNC Chapel Hill UNC Chapel Hill	NHMFL	Magnetoconductivity and Temperature Dependence of 2 DEG in Parallel and Perpendicular Magnetic Fields
Pourrahimi, Shahin Williams, John	Superconducting Systems, Inc. Superconducting Systems, Inc.	NSF	Testing of New Nb_3Al Wire
Reyes, Arneil Moulton, Bill Caldwell, Tod* Kuhns, Phil Abdelrazek, Margie*	FSU NHMFL FSU NHMFL FSU	NSF	Studies of SmB_6 Conduction Mechanism (Magnetic Impurities) by NMR Techniques
Reyes, Arneil Kuhns, Phil Moulton, Bill	FSU NHMFL NHMFL	NSF	^{17}O and $^{63.65}Cu$ NMR Study of Spin-lattice Relaxation Rates in NdBCO
Rosenbaum, Ralph Pullum, Bobby Joe Hannahs, Scott	Tel Aviv U. NHMFL NHMFL	NSF	Magnetoresistance Measurements in Insulating Thin Films Exhibiting Variable-Range Hopping Resistivities
Rosenbaum, Ralph Murphy, Tim Habekern, Roland Palm, Eric Hannahs, Scott	Tel Aviv U. NHMFL Tel Aviv U. NHMFL NHMFL		Metal-Insulator Transition in Quasicrystalline Films
Sarachik, Myriam P. Vitkalov, Sergey Hairong, Zheng*	City College City College of New York City College of New York		Sh-dH Measurements on Si MOSFET
Sarma, Bimal Ketterson, John B. Feller, Jeff* Suslov, Alexei Dasgupla, Debashi	U. of Wisconsin Northwestern U. U. of Wisconsin U. of Wisconsin U. of Wisconsin	NSF	High Field Ultrasonic and Magnetometric Studies in the Heavy Fermion Systems
Schmiedeshoff, George M. Murphy, Tim Palm, Eric	Occidental College NHMFL NHMFL	NHMFL	Critical Field vs, Temp. and Angular Dependent Magnetoresistance

Barbosa-Canovas, Gustavo Harte, Federico * San Martin, Fermando * Bennett, Marcus Lacerda, Alex	Wash. State U. Wash. State U. Wash. State U. NHMFL-Los Alamos NHMFL-Los Alamos	University	Effect of 50T Pulsed Magnetic Field on Inactivation of *Esherichia Coli*
Karczewski, Grzegorz Crooker, Scott	Poland NHMFL-Los Alamos	Other	Unconventional Semiconductors at High Magnetic Fields
Jones, Eric Tozer, Stan Crooker, Scott Allerman, A. Kurtz, S. White, R. Sieg, R.	Sandia Natl. Labs NHMFL-Tallahassee NHMFL-Los Alamos Sandia Natl. Labs Sandia Natl. Labs Sandia Natl. Labs Sandia Natl. Labs	DOE	Semiconductor Alloy Band Crossing Studies
Movshovich, Roman Jaime, Marcelo + Sarrao, John	LANL-MST-10 NHMFL-Los Alamos LANL-MST-10	DOE	Specific Heat of Plutonium in High Magnetic Field
Tozer, Stan Mielke, Chuck Hall, Donovan Palm, Eric Murphy, Tim Pacheco, Mike Sarrao, John Goodrich, Roy	NHMFL-Tallahassee NHMFL-Los Alamos NHMFL-Tallahassee NHMFL-Tallahassee NHMFL-Tallahassee NHMFL-Los Alamos LANL-MST-10 Louisiana State U.	NSF	High Pressure Fermiology of Quasi-2D Compounds
Rickel, Dwight	NHMFL-Los Alamos	NSF	Diagnose of System Noise
Jones, Eric Crooker, Scott	Sandia Natl. Labs NHMFL-Los Alamos	DOE	High-Field Photoluminescence Linewidth of InGaAsN
Crooker, Scott Negre, Nicolas Samarth, Nitin	NHMFL-Los Alamos NHMFL-Los Alamos Penn State U.	NSF	Charged Excitons in Doped II-VI Heterostructure
Guertin, Robert Mielke, Chuck McCall, Scott Cao, Gang Xhou, Z. * Crow, Jack	Tufts U. NHMFL-Los Alamos Tufts U. NHMFL-Tallahassee Florida State U. NHMFL-Tallahassee	NSF	Field-Induced Transitions in Rare-Earth Ru Coupled Systems
Canfield, Paul Jaime, Marcelo Bud'ko, Sergey	Iowa State U-Ames Lab NHMFL-Los Alamos Iowa State U-Ames Lab	NSF	Low Temperature Magnetization Process of $Ce_3Bi_4Pt_3$
Bud'ko, Sergey Canfield, Paul Christianson, Andy * Touton, Sharon * Lacerda, Alex	Iowa State U-Ames Lab Iowa State U-Ames Lab Colorado State U. Occidental College NHMFL-Los Alamos	University	Fermi Surface Investigation of TmSb Single-Crystal
Crooker, Scott Negre, Nicolas Rickel, Dwight Perry, Clive Karczewski, Grzegorz Wojtowicz, Tomasz	NHMFL-Los Alamos NHMFL-Los Alamos NHMFL-Los Alamos Northeastern U. Poland Poland	NSF	Time-Resolved Luminescence Decays of Charged Excitons in 60 T

Crooker, Scott Negre, Nicolas Karczewski, Grzegorz Wojtowicz, Tomasz	NHMFL-Los Alamos NHMFL-Los Alamos Poland Poland	NSF	Reflectivity of High-Mobility II-VI 2D Electron Gases
Betts, Jon Balakirev, Fedor Barrick, Todd	NHMFL-Los Alamos NHMFL-Los Alamos TVI-Albuquerque	DOE	Cryogenics and Electronics to Prepare Cell 4
Perry, Clive Munteanu, Florin * Crooker, Scott Rickel, Dwight Simmons, Jerry Reno, J. Pffeifer, L. West, K.	Northeastern U. Northeastern U. NHMFL-Los Alamos NHMFL-Los Alamos Sandia Natl. Labs Sandia Natl. Labs Bell Labs Bell Labs	NSF	MPL Measurements in GAAs/AlGaAs SHJs in High Magnetic Field
Rickel, Dwight Migliori, Albert	NHMFL-Los Alamos NHMFL-Los Alamos	NSF	Preamp Noise Test
Beyermann, Ward Kelley, T. * Christianson, Andrew * Cooley, Jason	UC-Riverside UC-Riverside Colorado State U LANL-MST-8	NSF	Low Temperature Transport Measurements: $CeNi_2Ge_2$
Sarrao, John Christianson, Andrew * Lacerda, Alex	LANL-MST-10 Colorado State U NHMFL-Los Alamos	DOE	Magnetotransport Measurements of New Heavy Fermion Compounds: $CeRhIn_5$, $CeCoIn_5$
Landee, Christopher Woodward, Matthew * Galeriu, Calin * Harrison, Neil Turnbull, M. Giantsidis, John	Clark U. Clark U. Clark U. NHMFL-Los Alamos Clark U. Clark U.	NSF	Magnetization Studies of Quantum Antiferromagnets
Li, Liang Lesch, Benny Stanton, Robert Rickel, Dwight Mielke, Chuck	NHMFL-Tallahassee NHMFL-Tallahassee NHMFL-Tallahassee NHMFL-Los Alamos NHMFL-Los Alamos	NSF	50 T-LP Magnet Test
Maple, Brian Freeman, Eric * Zapf, Vivien Lacerda, Alex Li, Shi * Dickey, Robert * Bauer, Eric	UC-San Diego UC-San Diego UC-San Diego NHMFL-Los Alamos UC-San Diego UC-San Diego UC-San Diego	NSF	Non-Fermi Liquid Compounds at High Magnetic Fields: $Sc_{1-x}U_xPd_3$
Crooker, Scott Negre, Nicolas Karczewski, G. Wojtowicz, Tomasz	NHMFL-Los Alamos NHMFL-Los Alamos Poland Poland	NSF	Time Resolved Photoluminescence from Charged Excitons in High Magnetic Fields
Onellion, Marshall Hirai, Yoshinao * Schneider, Michael * Balakirev, Fedor Boebinger, Gregory	U. of Wisconsin-Madison U. of Wisconsin-Madison U. of Wisconsin-Madison NHMFL-Los Alamos NHMFL-Los Alamos	NSF	High Field-Ground State Properties of Cuprates

Ando, Yoichi Ono, Shimpei * Balakirev, Fedor Betts, Jon Boebinger, Gregory Murayama, Takashi	CRIEPI-Japan CRIEPI-Japan NHMFL-Los Alamos NHMFL-Los Alamos NHMFL-Los Alamos CRIEPI-Japan	Other	High Field Transport Properties in the Normal Phase of High Tc
Singleton, John Mielke, Chuck Ardavan, Arzhang Blundell, Stephen Symington, Jane * Schlueter, John	U. of Oxford, UK NHMFL-Los Alamos U. of Oxford, UK U. of Oxford, UK U. of Oxford, UK Argonne Natl. Lab	Other	Localization Mechanisms in Quasi-Dimensional Bands
Lacerda, Alex Christianson, Andrew * Lacerda, Alex Sarrao John Pagliuso, Pascoal Hundley, Michael	NHMFL-Los Alamos Colorado State U. NHMFL-Los Alamos LANL-MST-10 LANL-MST-10 LANL-MST-10	DOE	High Field Fermi Surface Investigation of 115 Compounds
Singleton, John Harrison, Neil Ward, Roger Wells, Mike Lyons, Eleanore *	U. of Oxford, UK NHMFL-Los Alamos U. of Oxford, UK U. of Oxford, UK U. of Oxford, UK	Other	Quantum Critical Behavior in $LiHoF_4$
Torikachvili, Milton Nakotte, Heinz Chang, S.	San Diego State U. New Mexico Tech New Mexico Tech	NSF	Magnetoresistance Measurements: CePtSn
Singleton, John Mielke, Chuck Symington, Jane * Schlueter, John	U. of Oxford, UK NHMFL-Los Alamos U. of Oxford, UK Argonne Natl. Lab	Other	Isotope Effect in Organic Superconductors
Sarma, Bimal Suslov, Alexei Dasgupta, Debashis Jaime, Marcelo Feller, Jeff Ketterson, John	U. of Wisc.-Milwaukee U. of Wisc.-Milwaukee U. of Wisc.-Milwaukee NHMFL-Los Alamos U. of Wisc.-Milwaukee Northwestern U.	NSF	Ultrasonic Measurements in Heavy Fermions at High Magnetic Fields
Ando, Yoichi Balakirev, Fedor Betts, Jon Ono, Shimpei * Boebinger, Gregory	CRIEPI-Japan NHMFL-Los Alamos NHMFL-Los Alamos CRIEPI-Japan NHMFL-Los Alamos	Other	Normal State Transport of BiSrLaCuO Superconductors
Rickel, Dwight Crooker, Scott Perry, Clive	NHMFL-Los Alamos NHMFL-Los Alamos Northeastern U.	NSF	Time Resolved Photoluminescence
Lawrence, Jon Ebihara, Takao Harrison, Neil Sarrao, John	UC-Irvine Shizuoka Univ.-Japan NHMFL-Los Alamos LANL-MST-10	NSF	dHvA Measurements in $CeIn_3$

Bushweller, J.H. Lukasik, S.M.	U. Virginia	U. Virginia	Towards the Solution Structure of CBFB-SMMHC
Quine, J.R. Denny, J.K. Wang, J. Cross, T.A.	Mercer U./ NHMFL/FSU	NSF	PISEMA Powder Patterns and PISAA Wheels
Logan, T.M. Wylie, G.W. Fortune, M.	FSU/NHMFL	NSF/American Cancer Society	Solution Structure of a Prokyarotic SH3 Domain From the Diphtheria Toxin Repressor
Cross, T.A. Mo, Y. Tian, C,	NHMFL/FSU	NIH	The Structural Studies of Gramicidin A in Long Lipid Bilayers by Solid State NMR
Halperin, W.P. Sigmund, E.E. Mitrovic, V.F. Calder, E.S. Thomas, G.W. Reyes, A.P. Kuhns, P.L. Moulton, W.G.	Northwestern U./NHMFL	NSF	Inductive Shield Magnetic Field Stabilization for NMR in Bitter Magnets
Warren, W.S. Lin, Y.Y. Brey, W. Murali, N.	Princeton U./ NHMFL	NIH	Resolution Enhancement in Solution NMR on the Keck Magnet by Intermolecular Zero-Quantum Detection and Matrix Pencil Estimation
Logan, T.M. Twigg, P.D. Parthasarathy, G. Guerrero, L. Caspar, D.L.	FSU/NHMFL	NIH	A Disorder-To-Order Transition in the Regulation Diphtheria Toxin Repressor Activity
Logan, T.M. Korepanova, A. Palmer, A.	FSU/NHMFL	NIH	Initial Steps in the Folding of the FK506 Binding Protein
Webb, A.U. Li, Y. Logan, T.M. Marin, V.	Illinois Electrical Engineering/ NHMFL	NHMFL/IHRP/FSU	Triple-Resonance Microcoils for Biological NMR
West, J. Smith, T. Dunn, B.M.	FAMU/FSU	FAMU/FSU	An NMR Investigation of Peptide Inhibitors for HIV-1 Protease
Luck, L. Sondi, B. Johnson, B.	Clarkson U.	DOE	Unique Ligands of the Leucine Binding Proteins: A 19F NMR Study
Bowers, C.R. Storhaug, V.	UF	NHMFL/ IHRP	Monitoring Formation of the Type II Mixed Hydrate Clathrate by Spin-Exchange Enhanced Xenon-129 NMR

Newby, M.I. Greenbaum, N.L.	NHMFL/FSU	NIH	Role of a Conserved Paeudourdine in Eukaryotic Branch Site Structure
Greenbaum, N.L. Epperson, J.	NHMFL/CIMAR/FSU	FSU Council on Research & Creativity	1H NMR Studies of a Zn(II)-Dependent Deoxyribozyme Following Replacement With Paramagnetic Ion Replacement
Greenbaum, N.L. Schroeder, K.T. Newby, M.I.	NHMFL/CIMAR/FSU	NIH	Structural Features of the Branch Site From the Group II Self-Splicing Intron Studied by 1H NMR
Drobny, G.P. Cotton, M. Stayton, P.S.	U. Washington	NIH	Preliminary Orientational and Structural Studies of Antimicrobial Salivary Histatin-5 in Oriented Lipid Bilayers
King, B.F. Gan, Z. Cross, T.A.	NHMFL	NSF	Using Nuclear Magnetic Resonance Spectroscopy to Study the Structure of Humic Acid
Dalal, N.S. Pierce, K.L. Fu, R.	FSU/NHMFL	NHMFL	17O Isotropic Chemical Shift Probing of Phase Transitions in Hydrogen-bonded Solids: Squaric Acid
Nageswara, R. Ray, B.	Indiana U. Purdue U. Indianapolis	NIH	Active-Site Structures of ATP-Utilizing Enzymes
Van Doren, S.R. Gao, G. Arumugam, S. Murali, N	U. Missouri-Columbia/ NHMFL		NMR Studies of Two Proteins Which Affect Tissue Remodeling in Human Health and Disease
Edison, A.S. Smith,, L. Hillman, J. Novak, J.	UF/U. Alabama	NIH/UFBI/NHMFL	Structural Studies of Mutacin 1140
Edison, A.S. Zachariah, C. Thomas, S. Espinoza, E.,	UF/NHMFL	NSF/UFBI/NHMFL	Structure/Function Relations of Neuropeptides and Neuropeptide Precursor Proteins
Edison, A.S. Bubb, M.R. Lenox, R.H.	UF/U. Pennsylvania/ NHMFL	NHMFL/ UFBI	Structural and Dynamical Studies of IA-3, a Potent Yeast Proteinase A Inhibitor
Edison, A.S. Green, T. Dunn, B. Kay, J. Wlodawer, A.	UF/Cardiff U./ National Cancer Institute/NHMFL/NCI	NHMFL/NIH/UFBI	Biophysical Studies of Marcks: Implications for Neuroplasticity

Busath, D.D. Markham, J.C. Merrell, J.D. Cross, T.A. Busath, D.D.	Brigham Young U./ NHMFL/FSU	NIH	Comparison of Gramicidin A and Gramicidin M Channel Conductance Dispersion Properties
Cross, T.A. Wang, J. Kim, S. Kovacs, F.	FSU/NHMFL	NSF	Membrane Protein Structure Determination Using PISA Wheels
Gao, F Fu, R. Wang, J. Kaback, H.R. Cross, T.A.	NHMFL/ U. California-Los Angeles/FSU	NHMFL/Visitor	Structural Mapping of *Escherichia coli* Lactose Permease Using 19F Solid State NMR Spectroscopy
Gan, Z. Cross, T.A. Samoson, A.	NHMFL/NICBP/ Estonia/ U. Warwick/England/ Polish Academy of Sciences	NSF	Double Rotation (DOR) NMR at High Fields
Gao, F. Cross, T.A.	NHMFL/CIMAR/FSU		Prediction of Alpha-Helical Transmembrane Protein in Mycobacterium Tuberculosis Genome
Blackband, S.J. Grant, S Thelwall, P. Webb, A. Gibbs, S. Plant, D. Mareci, T.	UFBI/UF, NHMFL/ U. Chicago/U. Illinois/ FAMU/FSU	IHRP/NIH/UFBI	NMR Microscopy and Spectroscopy of Single Cells
Thelwall, P. Blackband, S.J.	UFBI/UF/NHMFL	NIH/NHMFL/UFBI	NMR Studies of Red Blood Cell Ghosts
Blackband, S.J. Bui, J.D. Roper, S. Thelwall,, P. Phillips, M.I.	UFBI/UF/ NHMFL	NIH/UFBI	NMR Microscopy of Isolated Perfused Brain Slices
Beck, B. Blackband, S. Fitzsimmons, J. Crozier, S.	UF/NHMFL/ UFBI/U. Queensland	NHMFL/ UFBI	Development of Large Volume High Frequency RF Coils
Silver, X.S. Inglis, B.A. Bossart, E.L. Vemuri, B. Anderson, D.K. Reier, P.J. Beck, B.L. Mareci, T.H.	UF/UFBI/ NHMFL	NHMFL/ NIH/State of Florida/ Brain and Spinal Cord Injury Research Trust Fund	NMR Studies of Spinal Cords *In Vivo* and *In Vitro*
Beck, B. Duensing, R. Fitzsimmons, J. Inglis, B. Blackband, S.	UF/NHMFL/MRI Devices Corporation	NHMFL/ UFBI	Development of High Frequency Phased Array rf Coils

Benveniste, H. Plant, D. Hedges, K. Blackband, S.	Duke U./ UFBI/UF/NHMFL	NIH/NHMFL/UFBI	MR Microimaging Studies of Mouse Brains for Generation of a Web Based Atlas
Forder, J. Hus, E. Buckley, D.L. Bui, J.D. Blackband, S.	Birmingham, Alabama/ Duke U./U. Manchester/ UF/UFBI/NHMFL	NIH/UFBI/ NHMFL	MR Biexponential Diffusion Tensor Imaging of Isolated Rat Hearts
Peterson, D. Beck, B. Duensing, R.	UF/MRI Devices Corporation/ NHMFL	NHMFL/ UFBI	Reduction of Cable Shield Currents Generated by External Volume Coils
Edison, A.S. Smith, L. Hillman, J. Novak, J.	UF/NHMFL/ U. Alabama	NIH/ NHMFL	Structural Studies of Mutacin 1140
Edison, A.S. Zachariah, C. Thomas, S. Espinoza, E.	UF/NHMFL	NSF/ NHMFL	Structure/Function Relations of Neuropeptides and Neuropeptide Precursor Proteins
Edison, A.D. Green, T. Dunn, B. Jay, J. Wlodawer, A.	UF/NHMFL/NCI/ U. Wales	NIH/ NHMFL	Structural and Dynamical Studies of IA-3, a Potent Yeast Proteinase A Inhibitor
Edison, A.S. Bubb, M.R. Lenox, R.H.	UF/NHMFL/ U. Pennsylvania	NSF/ NHMFL	Biophysical Studies of MARCKS: Implications for Neuroplasticity

ICR FACILITIES

V.P.I = A PRINCIPAL INVESTIGATOR THAT CAME TO THE FACILITY
V.G.S. = A GRADUATE STUDENT THAT CAME TO THE FACILITY
V.P.D. = A POSTDOC THAT CAME TO THE FACILITY
USER = SENT SAMPLES FOR ICR ANALYSIS
COLLABORATOR = GRANTS ARE EITHER ACTIVE OR IN PROGRESS FOR THESE PROJECTS

USER	INSTITUTION	FUNDING	PROJECT
Andren, Per (collaborator)	Uppsala U.	NSF ICR Facility	Drug Analysis, Endogenous Release of Dynorphins
Baxter, Helen (User)	U. of Edinburgh (Scotland)	NSF ICR Facility	Analysis of Prion Proteins Isolated from Sheep
Ben, Rob (User)	SUNY Binghamton	NSF ICR Facility	Antifreeze Glycoproteins
Besuden, Tim (User)	Cirent Semiconductors	NSF ICR Facility	ESI of Organic Contaminant
Bitler, Cathy (Collaborator)	Elan Pharmaceuticals	NSF ICR Facility	H/D Exchange of NGF Receptor and NGF
Blaber, Mike (User)	FSU	NSF ICR Facility	ESI of Myelin Basic Protein Enzyme
Brenner, Steve (v.P.I.)	DuPont Pharmaceuticals	NSF ICR Facility	TNF-a and TNF-R1 (2000)
Conrad, Charles (collaborator)	Kansas City Cancer Center	NSF ICR Facility	Cytokines Associated with Gliablastoma Brain Tumors
Cooper, Bill (P.I.)	FSU	NSF ICR Facility	ESI of Humic Substances
Costello, Kathy (P.I.)	Boston U. Medical School	NSF ICR Facility	ESI of Glycosylated Peptides
Cross, Tim (User)	FSU	NSF ICR Facility	Peptide Sequence Analysis
Damoc, Eugene (v.G.S.)	U. of Konstanz	NSF ICR Facility	Analysis of Peptide Multimers
Domaille, Peter (v.P.I.)	DuPont Pharmaceuticals	NSF ICR Facility	H/D Exchange on P19 and CDK6, TNF-a and TNF-R1 (2000)
Eyler, John (v.P.I.)	UF	NSF ICR Facility	ICP/ICR, Ion Solvation
Farrow, Neil (v.P.I.)	DuPont Pharmaceuticals	NSF ICR Facility	TNF-a and TNF-R1 (2000)
Fredrickson, Herbert (User)	Army Corps of Engineers	NSF ICR Facility	Environmental Analysis
Freitas, Michael (P.I.)	Ohio State U.	NSF ICR Facility	H/D Exchange of Peptide/Protein
Gaskell, Simon (P.I.)	UMIST (United Kingdom)	NSF ICR Facility	ESI of Peptide and Protein
Glass, John (User)	Dow Chemicals	NSF ICR Facility	ESI of Polymers
Goli, Omesh (User)	FSU	NSF ICR Facility	Peptide Lab, Verification of Peptide Structure
Greenbaum, Nancy (User)	FSU	NSF ICR Facility	FT-ICR of RNA

Hare, Joan (Collaborator)	FSU	NSF ICR Facility	Magnetic Assisted Transformation, Gliablastoma and Microglia
Hendricks, Hank (User)	FSU	NSF ICR Facility	Peptide Lab, Verification of Peptide Structure
Hongbin, Liu (User)	U. of California, Los Angeles	NSF ICR Facility	ESI of Metalloproteins
Hubalek, Frank (User)	Emory U.	NSF ICR Facility	Xanthine Dehydrogenase, Monoamine Oxidase
Hyson, Richard (User)	FSU	NSF ICR Facility	Endogenous Release of Dynorphin B from Chick Brain
Karpinski, Matthew (v.g.s.)	U. of Texas (Laude)	NSF ICR Facility	H/D Exchange, Dissociation of 16 kDa Protein
Kelleher, Neil (v.p.d.)	U. of Illinois	NSF ICR Facility	Construction of High Performance ESI 9.4T FT-ICR
Kelly, Peter (User)	Novartis Pharmaceuticals (Switzerland)	NSF ICR Facility	Analysis of Vasotocin at Bio-Concentrations
Kim, Hie-Joon (User)	Seoul National U. (Korea)	NSF ICR Facility	Analysis of Oligomeric Silsesquixanes
Koch, Matt (User)	Maine Research Inc.	NSF ICR Facility	Proposed Mini-FT-ICR MS
Laue, Ernest (v.P.I.)	Cambridge U.	NSF ICR Facility	H/D Exchange on P19 and CDK6
Li, Hong (User)	FSU	NSF ICR Facility	Verification of Protein RNA Complex
Limbach, Pat (v.P.I.)	Louisiana State U.	NSF ICR Facility	MALDI of Nucleic Acids
Llewellyn, Jennifer (User)	FSU (Cooper)	NSF ICR Facility	ESI of Humic Substances
Logan, Tim (User)	FSU	NSF ICR Facility	Di-sulfide Bonding and Verification of Peptide Sequence
Manning, Thomas (User)	Valdosta State U.	NSF ICR Facility	Analysis of Peptide Mixtures
Marzluff, Elaine (v.P.I.)	Grinnell U.	NSF ICR Facility	Gas Phase H/D Exchange
McIntosh, Michael (User)	U. of Utah	NSF ICR Facility	MS/MS of Unique Conotoxin
Muddiman, Dave (User)	Virginia Commonwealth U.	NSF ICR Facility	ESI of Nucleic Acids
Nilsson, Carol (v.P.I.)	Goteborg U., Sweden	NSF ICR Facility	MS/MS of Glycosylated Peptides
Plew, Larry (User)	Cirent Semiconductors	NSF ICR Facility	ESI of Organic Contaminant
Przybylski, Michael (v.P.I.)	U. of Konstanz	NSF ICR Facility	Analysis of Peptide Multimers
Pulido, Silvia (v.p.d.)	FSU	NSF ICR Facility	ESI of Troponin and Oxidized Troponin
Qian, Kuangnan (v.P.I.)	Exxon/Mobil Inc.	NSF ICR Facility	ESI of Crude Oil

Roberts, Ronald (User)	Cirent Semiconductors	NSF ICR Facility	ESI of Organic Contaminant
Rodgers, Ryan (v.p.d.)	Oak Ridge Laboratories	NSF ICR Facility	ESI of Environmental Particulates
Schanze, Kirk	UF	NSF ICR Facility	ESI of Square, Triangle and Pentomer Compounds
Seavy, Margaret (User)	FSU	NSF ICR Facility	Maldi of Proteins
Simonsick, William (User)	DuPont, Inc.	NSF ICR Facility	ESI of Synthetic Polymers
Thurow, Kerstin (v.P.I.)	Universität Rostok	NSF ICR Facility	ESI of Triphenyl Arsine
Watson, Brant (User)	U. of Miami Medical School	NSF ICR Facility	Analysis of Fluorescent Dyes
Wood, Paul (collaborator)	Centaur Pharmaceuticals	NSF ICR Facility	Effects of Gliablastoma on Growth of Microglia
Wood, Troy (v.P.I.)	SUNY at Buffalo	NSF ICR Facility	Glucokinase (32,441 da) Analysis

EMR FACILITIES

Users	Institution	Funding	Project
Angerhofer, A. Zvyagin, S. Kamenev, K Paul, D.McK. Balakrishnan, D.G. Brunel, L.-C.	NHMFL/UF NHMFL/UF-FSU U. Edinburgh U. Warwick U. Warwick NHMFL/FSU	NSF	Microwave Properties of $Nd_{0.5}Sr_{0.5}MnO_3$: the Key Role of Orbital Effects
Zvyagin, S. Cao, G. Brunel, L.-C. Crow, J.	NHMFL/UF-FSU NHMFL NHMFL NHMFL	NHMFL	Electron-Spin Resonance Investigation of the Spin-Chain System $LiCu_2O_2$
Krzystek, J. Sienkiewicz, A. Weber, R.T. Brunel, L.-C. von Schütz, J.U.	NHMFL Polish Academy of Sciences Bruker Instruments, Inc. NHMFL Phys. Institute, Stuttgart	NSF	The Role of Molecular *g* Anisotropy in Determining EPR Linewidth in Radical-Ion Salts of Me(2,5-Dimethyldicyanoquin-onediimine)$_2$ Class
Telser, J. Krzystek, J. Brunel, L.-C.	Roosevelt U. NHMFL NHMFL	NHMFL	EPR from "EPR-Silent" Species: High Frequency and Field EPR Spectroscopy of a Catalytically Relevant Cobalt (I) Molecular Complex
Krzystek, J. Brunel, L.-C. Cao, G.	NHMFL NHMFL NHMFL	NHMFL	EPR from "EPR-Silent" Species: High Frequency and Field EPR and Magnetic Studies of Nickel(II) Molecular Complexes
Telser, J. Krzystek, J. van Tol, J. Brunel, L.-C.	Roosevelt U. NHMFL NHMFL NHMFL	NHMFL	EPR from "EPR-Silent" Species: High Frequency and Field EPR Spectroscopy of Vanadium(III) Molecular Complexes
Hoffman, B.M. Krzystek, J. Telser, J. Brunel, L.-C. Licoccia, S.	Northwestern U. NHMFL Roosevelt U. NHMFL U. Rome, Italy	NSF	Investigations of Manganese(III) Corrole Complexes as Solids and in Glasses
Krzystek, J. Telser, J. Saylor, C. Brunel, L.-C.	NHMFL Roosevelt U. NHMFL NHMFL	NHMFL	HFEPR Concentration Sensitivity Study of Frozen Mn(III) Solutions
Hoffman, B.M. Telser, J. Smoukov, S. Bernat, B.A. Armstrong, R.N. Krzystek, J. Brunel, L.-C.	Northwestern U. Roosevelt U. Northwestern U. Vanderbilt U. Vanderbilt U. NHMFL NHMFL	NSF	High Frequency and Field EPR Spectroscopy of a Mononuclear Manganese(II) Enzyme, FosA, Involved in Bacterial Drug Resistance

Maresch, G.G. Bauman, B. Fajer, P. Saylor, C.A. Brunel, L.-C.	NHMFL NHMFL NHMFL NHMFL NHMFL	NHMFL	Detection of Spin Labels in Aqueous Solutions by HFEPR
Shatlock, M. Maresch, G.G. Brunel, L.-C.	PPG Industries NHMFL NHMFL	Private	Automotive Paint Stabilization Study by EPR
Shatlock, M. Brunel, L.-C. Maresch, G.G.	PPG Industries NHMFL NHMFL	Private	HFEPR Spectroscopy of Metal Centers in Silicon Oxide Glasses
Saylor, C.A. Maresch, G.G. Brunel, L.-C.	NHMFL NHMFL NHMFL	NSF	High-Frequency Source Stabilization and Control for EPR Spectroscopy
Angerhofer, A. Zvyagin, S. Brunel, L.-C. Von Schütz, J.	NHMFL/UF NHMFL NHMFL U. Stuttgart, Germany	NSF	Microwave Evidences of the Metal-Insulator Phase Transition in Cu(DMe-DCNQI)$_2$ System with Partial Deuteration
Fajer, P. Li, H.	NHMFL/FSU NHMFL	NSF & American Heart Association	Domain Dynamics of Smooth Muscle Myosin
Hambly, B. Baumann, B. Fajer, P. Hideg, K.	U. of Sydney, Australia NHMFL NHMFL/FSU U. of Pecs, Hungary	NSF	The Regulatory Domain of the Myosin Head Behaves as a Rigid Lever
Fajer, P. Brown, L. Klonis, N. Sawyer, W. Hambly, B.	NHMFL/FSU U. of Sydney, Aust. U. of Melbourne, Aust. U. of Melbourne, Aust. U. of Sydney, Aust.	NSF	Independent Movement of Regulatory and Catalytic Domains of Myosin Heads revealed by Phosphorescence Anisotropy
Hambly, B. Brown, L. Singh, L. Sale, K. Yu, B. Trent, R. Fajer, P.	U. of Sydney, NSW, Aust. U. of Sydney, NSW, Aust. U. of Sydney, NSW, Aust. NHMFL U. of Sydney, NSW, Aust. U. of Sydney, NSW, Aust. NHMFL/FSU	NSF	Functional and Spectroscopic Studies of an FHC Mutation in Motif X of Cardiac Myosin Binding Protein-C
Maniero, A. Saylor, C. Maresch, G. van Tol, J. Brunel, L-C.	U. of Padova, Italy NHMFL NHMFL NHMFL NHMFL	NHMFL & CNR, Italy	High Frequency, 220 GHz, CW ENDOR of a Nitroxide Radical with Delocalized Spin Density
Thurnauer, M. Poluektov, O. Brunel, L.-C. Zvyagin, S. Boyce, C. Walker, L. Angerhofer, A.	Argonne Nat. Lab. Argonne Nat. Lab. NHMFL NHMFL U. of South Carolina NHMFL/UF NHMFL/UF	DoE	The *G*-Factor Anisotropy of Bacteriochlorophyll $a^{\bullet+}$

Feher, G. Isaacson, R. Calvo, R. Abresch, E. Paddock, M. Maniero, A. Saylor, C. Brunel, L.-C.	UC-San Diego UC-San Diego FBCB & INTEC UC-San Diego UC-San Diego U. of Padova, Italy NHMFL NHMFL	NSF/NIH	A 330 GHz EPR Study of the Semiquinone Biradical $Q_A^{-\bullet}Q_B^{-\bullet}$ in Photosynthetic Reaction Centers of *Rb. sphaeroides*
van Tol, J. Brunel, L.-C.	NHMFL NHMFL	NSF	A High-Field Transient Electron Magnetic Resonance Spectrometer
van Tol, J. Angerhofer, A. Brunel, L.	NHMFL UF NHMFL	NSF	The Lowest Excited Triplet State in Porphyrins Studied by High Field Transient EMR
Pasimeni, L. van Tol, J. Maniero, A-.L. Brunel, L.-C.	U. of Padova NHMFL U. of Padova NHMFL	NHMFL & CNR Italy	High-Field Transient EPR of Bisadducts of Fullerene C60
Shur, M. Knap, W. Deng, Y. Saylor, C.	Rensselaer Polytech. Inst. Rensselaer Polytech. Inst. Rensselaer Polytech. Inst. NHMFL	NSF & CNRS France	Plasma Waves Detection and Generation in Sub Micron High Electron Mobility Transistors
Wood, K. Araujo, M. Van Tol, J.	QMC Inst. London Queen Mary & Westfield NHMFL	Private	Application of a Nb Hot-Electron Bolometer for Time-Resolved Electron Magnetic Resonance
McCombe, B. van Tol, J.	SUNY-Buffalo NHMFL	NSF	Transient Effects in the Cyclotron Resonance of a 2D Quantum Well
Sharma, V. Burnett, C. Smith, T. Saylor, C. van Tol, J.	FL Inst. of Technology FL Inst. of Technology FL Inst. of Technology NHMFL NHMFL	NHMFL	High Frequency and High Field Electron Paramagnetic Resonance Studies of Ferrate Species
Budil, D. Smith, S. Khairy, K. Fajer, P.	Northeastern U. NHMFL NHMFL/Northeastern U NHMFL/FSU	NSF	The Stochastic Liouville Equation in Magnetic Resonance. An Object Oriented Implementation.
Pogni, R. Maniero, A. Brunel, L.	U. of Siena, Italy U. of Padova, Italy NHMFL	CNR Italy	High Field EPR Study of *Heme* Proteins Radical Intermediates
Kispert, L. Konovalova, T. Saylor, C.	U. of Alabama U. of Alabama NHMFL	DoE	High-Field EPR Study of Carotenoid Radical Cations in Mesoporous Metal-Silicate MCM-41 Molecular Sieves
Hendrickson, D. Christou, G. Nakano, M. Yoo, J. Saylor, C.	UC, San Diego U. of Indiana U. of Osaka, Japan UC, San Diego NHMFL	NSF	High Frequency Electron Paramagnetic Resonance Spectroscopy Study of a Series of Polynuclear Transition Metal Complexes

Bakker, M. Blackstock, S. Nikles, D. van Tol, J.	U. of Alabama U. of Alabama U. of Alabama NHMFL	NSF	Electron Transfer Reactions for Data Storage: Using (1) Redox Gradient Dendrimers and (2) Novel Metallophorpyrin Chromophores
Meisel, M. Ward, B. Jolicoeur, Th. Talham, D. van Tol, J.	UF UF CEN Saclay, France UF NHMFL	NSF	High Frequency EMR of Mn 3+ Low Dimensional Organic Complexes

GEOCHEMISTRY FACILITIES

USER	INSTITUTION	FUNDING	PROJECT
Marcantontio, F.	Tulane U.	State of Louisiana	Sr-Isotopes in the Mixing Zone in the Mississippi River
Jacob, D.	U. Göttingen	DFG, Germany	Studies of the Hafnium Isotopic Composition of Eclogites in Diamondiferous Kimberlite
Udin, A.	Auburn U.	American Chemical Society	Isotopic Constraints on Provenance of Miocene Sediments from the Bengal Basin, Bangladesh
Hames, W.E.	Auburn U.	NSF	Trace Element Characteristics of Clubhouse Crossroads Basalts
Hsieh, Y.P.	Florida Agricultural and Mechanical U.	DOE	Marine Biotechnology and Marine Estuarine Environmental Science Project
Choppin, G.	FSU	DOE	Stability of Uranium-Thorium Complexes in Aqueous Solutions
Hickey, R.	Florida International U.	NSF	Isotopic Investigation of Island-Arc Basalts
Macfarlane, A.	Florida International U.	NSF	Pb-Isotope Investigations of Ore Deposits
Landing, W.M.	FSU		Trace Elements in Atmospheric Dust
Landing, W.M.	FSU	NSF	Fe by Isotope Dilution ICP-MS

Appendix B: Seminars

Seminars at the NHMFL in Tallahassee

January 11, 2000
J. R. Quine
Florida State University
Mathematical Biophysics Seminar

January 14, 2000
Sang Cheong
Rutgers University
Recent Results in Manganites

January 17, 2000
Kristina Hakansson
University of Uppsala (Sweden)
Electron Capture Dissociation for Tandem Mass Spectrometry of Peptides

January 20, 2000
Juha Kauppinen
Nanoway Oy, Finland
Coulomb Blockade Thermometers: Nanoscale Devices as Field Independent Primary Thermometers

January 21, 2000
Dan Dahlberg
University of Minnesota
Exchange Anisotropy: The Wrong and the Right

January 24, 2000
Yoon-Bae Kim
Korea Research Institute of Standards and Science
Magnetocrystalline Anisotropy of $R_2Fe_{14}B$ Compounds

January 28, 2000
Doug Scalapino
University of California, Santa Barbara
N-leg Ladders and the High Tc Puzzle

January 29, 2000
J. R. Quine
Florida State University
Mathematical Biophysics Seminar

February 4, 2000
Art Ramirez
Bell Labs/Lucent Technology
Geometrical Frustration and Complexity in Materials Physics

February 7, 2000
Andy Gavrilin
NHMFL
On the Normal Zone and Quench Propagation and Protection Analysis of the ATLAS Toroids

February 11, 2000
T. Imai
Massachusetts Institute of Technology
NMR Study of Stripe Phase in High Tc Superconductor $La_{2-x}Sr_xCuO_4$

February 11, 2000
Peter Katalinic
University of Muenster (Germany), Institute for Medical Physics and Biophysics
Mass Spectrometry in Structural Glycobiology

February 15, 2000
Mike Walker
Intermagnetics General Corp.
Waukasha - IGC HTS Transformer

February 17, 2000
Tae Kuk Ko
Yonsei University
Large Scale Applications of High Tc Superconductivity at Yonsei University

February 18, 2000
Gabriel Kotliar
Rutgers University
The Mott Transition: Recent Theoretical and Experimental Development

February 21, 2000
Peter Kalu
NHMFL
Application of Orientation Imaging Microscopy in the Study of Highly Deformed Cu-Based Materials

February 28, 2000
Agusti Sin
Laboratoire de Cristallographie-CNRS
Ceramics, Films and Nanoparticles of Mercury Cuprates Superconductors

February 28, 2000
M. A. Sadovskii
Institute for Electrophysics, Russian Academy of Sciences
Solvable Models of Pseudogap State?

March 2, 2000
Wei Guo Wang
Nordic Superconductor Technologies
Bi-2223 Tape Development and Manufacture in Nordic Superconductor Technologies

March 6, 2000
Shinji Matsumoto
Tsukuba Magnet Laboratory, National Research Institute for Metals
Magnet Developments at Tsukubu Magnet Laboratory

March 8, 2000
David Embury
Los Alamos National Laboratory
Potential Forming Methods for High Strength Conductors

March 9, 2000
Wolfgang Sigmund
University of Florida
Colloidal Ceramic Forming Methods: Overview and Fundamentals

March 20, 2000
Steven M. Durbin
Florida A&M University & Florida State University
Pulsed Laser Deposition of Thin Films for Microelectronic Applications

March 31, 2000
Christopher Ford
Cavendish Laboratory, Cambridge, UK
Coulomb Blockade of Tunneling Through Compressible Rings Formed Around an Antidot: An Explanation for h/2e Aharonov-Bohm Oscillations

April 2, 2000
Hongbin Liu
University of California, Los Angeles
Metalloprotein Structure

April 3, 2000
David Hilton
NHMFL
Second Sound Shock Pulse and Induced Quantum Turbulence Interaction in Helium II

April 7, 2000
Steve Girvin
Indiana University
Tunneling Between 2D Electron Gases and Interlayer Phase Coherence

April 7, 2000
Victor Fleurov
Tel Aviv University
Plasticity and Dislocation Paths in a Magnetic Field

April 13, 2000
Troy Wood
State University of New York, Buffalo
Technological Developments in and Analytical Applications of Nanospray Mass Spectrometry

April 14, 2000
D. Cox
University of California, Davis
Long Range Electron Transfer in DNA Mediated by Magnetic Bound States

April 18, 2000
J. R. Quine
Florida State University
Mathematical Biophysics Seminar

April 21, 2000
John Hill
Brookhaven National Laboratory
Resonant X-Ray Scattering: A New Probe of Charge and Orbital Order in Transition Metal Oxides

May 1, 2000
Ke Han
NHMFL
Lattice Distortion and Mechanical Properties of Cu-Ag Conductors

May 1, 2000
Leslie Bromberg
Massachusetts Institute of Technology
Bulk Monolithic High Tc Superconducting Magnets

May 2, 2000
Carolus Boekema
San Jose State University
How the Muon Spies in Condensed Matter: A Magnetic Spy Novel

May 3, 2000
Zlatko Tesanovic
Johns Hopkins University
Vortices, Quasiparticles and Criticality in Cuprates

May 15, 2000
Yusuf Hascicek
NHMFL
NHMFL Sol-Gel Process: High Temperature Insulation, YBCO Coated Conductors for Magnet Technology

May 15, 2000
Kurt Wüthrich
Swiss Federal Institute of Technology (ETH)
Recent Advances of Solution NMR in Structural Biology Using TROSY and CRINEPT

May 18, 2000
Takao Kohara
Unisversity of California, San Diego
NMR/NQR Studies of f-Electron Systems under High Pressure on $CeIn_3$, $CeRhIn_5$ and URu_2Si_2

May 26, 2000
Stephen Kuznetsov
Power Superconductor Applications Corp.
Advanced Superconductivity Projects for the Electric Power Industry
and Magnetic Levitation Program

May 31, 2000
Sang-Soo Oh
Korea Electrotechnology Research Institute
Status of HTS Development at KERI

June 1, 2000
Steve Schmid and Sibley Burnett
DSM Desotech
UV Coatings as Potential Insulators for Conductors: Normal, LTS and HTS

June 6, 2000
Andrei Sirenko
Pennsylvania State University
Spin-Flip Raman Scattering in Low-Dimensional Semiconductors

June 9, 2000
Dominique Massiot
CRMHT-CNRS
Solid State and High Temperature NMR: Tools for Solid State Chemistry

June 9, 2000
Donald Pooke
Industrial Research Ltd, Lower Hutt, New Zealand
BSCCO HTS Materials Research and Applications in New Zealand

June 13, 2000
Virender Sharma
Florida Institute of Technology
Ferrate(VI) and Ferrate(V) Oxidations of Cyanide and Thiocyanate

June 19, 2000
Helen Cooper
NHMFL
Mass Spectrometry at the University of Warwick

June 20, 2000
Michael Przybylski
University of Konstanz (Germany)
Protein:Protein Interactions from Mass Spectrometry

June 28, 2000
M. D. Bird, *et al.*
NHMFL
Some Recent Developments in High Magnetic Fields: Hybrid Insert High Homogeneity, Large Bore, Sweeper, Repeating Pulsed

July 5, 2000
George Martins
NHMFL
Half-Doped Stripes in Models for the Cuprates Emerging from the One-Hole Properties of the Insulator

July 10, 2000
Steven W. Van Sciver
NHMFL
Cryogenic Systems for Superconducting Devices

July 17, 2000
Rainer Soika
Texas A&M University
Development of a Strain-Resistent Bi2212 Cable in Conduit

July 24, 2000
Michael Steurer
Swiss Federal Institute of Technology (ETH)
A Novel Hybrid Current Limiting Circuit Breaker for Medium Voltage: Principle and Test Results

July 26, 2000
Michael De Marco
Buffalo State College, SUNY at Buffalo
^{99}Ru Mossbauer Effect Studies of the Ruthenates

August 7, 2000
Yan Xin
NHMFL
Transmission Electron Microscopy and Perovskites Structure Related Transitional Metal Oxides

August 7, 2000
Al Migliori
NHMFL-LANL
NHMFL Short Course in Electronic Measurement

August 10, 2000
Kerstin Thurow
University of Rostock (Germany)
Analysis of Arsenicals from Contaminated Soils

August 14, 2000
Timothy Cross
NHMFL, Florida State University
NMR Spectroscopy at High Fields: An NMR Collaboratorium

August 22, 2000
Dwight Viehland
U.S. Department of the Navy, Newport, RI
A Random-Field Model for Ferroelectric Domain Dynamics and Polarization Reversal

August 30, 2000
Anatolii Polyanskii
University of Wisconsin
Magneto-Optical Imaging, Magnetic and Superconducting Materials

September 12, 2000
Jeffrey Long
University of California at Berkeley
Toward Molecular Data Storage: Directed Assembly of High-Spin Metal-Cyanide Clusters

September 18, 2000
Bruce Wilcox
University of New Mexico
Advances in Time-of-Flight Mass Spectrometry

September 22, 2000
Victor Barzykin
NHMFL
New Superconducting States from BCS?

September 25, 2000
Bertrand Baudouy
CEA Saclay
Heat and Mass Transfer in He I Thermosiphon Flow

September 25, 2000
Nobuya Banno
NRIM
Coil Performance of Stabilized RHQT-Processed Nb_3Al Conductors and the Enhancement of Jc by TRUQ process

September 25, 2000
Timothy Cross
NHMFL, Florida State University
From Topology to High Resolution Membrane Protein Structures

September 28, 2000
Robert Cotter
Johns Hopkins University
Development of Time-of-Flight Mass Spectrometers for Chemical and Biological Structure Analysis

September 29, 2000
Steve von Molnár
Florida State University, MARTECH
Static and Dynamic Properties of the Insulator Metal Transition in Magnetic Semiconductors, Including the Perovskites

September 29, 2000
Catherine Fenselau
University of Maryland
Structures and Reactions of Zinc-Binding Proteins Studied by Mass Spectrometry

September 29, 2000
M. Paranthaman
Oak Ridge National Laboratory
High Jc YBCO Coated Conductor Development by Solution Based Approaches

October 3, 2000
David DiVincenzo
IBM, Yorktown Heights
Physical Implementation of Quantum Computation

October 6, 2000
David Huse
Princeton University
Quantum Phase Transitions in Spin and Hopping Model with Strong Randomness

October 6, 2000
Dan Dahlberg
University of Minnesota
Exchange Anisotropy: The Wrong and the Right

October 10, 2000
Israel Vagner
Grenoble High Magnetic Field Laboratory
High Field Magnetic Resonances and Solid State Quantum Computation

October 16, 2000
John Miller
NHMFL
Hybrid Outsert Test Results and Their Interpretation

October 16, 2000
Timothy Cross
NHMFL
From Topology to High Resolution Membrane Protein Structures

October 20, 2000
John Sarrao
Los Alamos National Laboratory
Unconventional Magnetism

October 27, 2000
Bruce Kane
University of Maryland
Silicon-based Quantum Computation

October 30, 2000
Thomas Baldwin
NHMFL and Center for Advanced Power Systems
Fault Locating in Ungrounded and High-Resistance Grounded Systems

November 3, 2000
Philip Adams
Louisiana State University
Bridging the Gap: Quantum Metallicity in a 2D Correlated Insulator

November 5, 2000
Z.X. Shen
Stanford University
Observation of Collective Excitations in High-Tc Superconductors

November 6, 2000
Peter S. Riseborough
Temple University
Magnetic Bound States in SmB_6

November 13, 2000
Peter G. McLaren
University of Manitoba
Electrical Power—Then and Now

November 14, 2000
F. Schauer
W7X
Technology of the Stellarator Fusion Experiment Wendelstein 7-X

November 16, 2000
John Miller
NHMFL
American Society of Mechanical Engineers Seminar

November 17, 2000
Daniel Arovas
University of California, San Diego
Josephson Coupling Through an Anderson Impurity

November 27, 2000
Warren Warren
Princeton University
Understanding and Exploiting Intermolecular Coherences in Solution NMR and MRI: How Everything We Tell Organic Students Can Be Wrong

November 29, 2000
Vasili Perebeinos
State University of New York at Stony Brook
Manganites

November 30, 2000
Cyril Krolick
Syntek
The Navy All-Electric Ship Program

December 1, 2000
Robert Hudgins
University of Basel (Switzerland)
Peptide Conformation from Ion Mobility Spectrometry

December 1, 2000
Ali Yazdani
University of Illinois at Urbana-Champaign
Nanoscale Investigations of Superconductors & Other Correlated Electronic Systems

December 7, 2000
John Eyler
University of Florida
IR Multiphoton Dissociation Spectroscopy of Gaseous Ions—Past Experiments and Future Promise

December 8, 2000
Asle Sudbo
California Institute of Technology
Fractal Dimension of Critical Fluctuations in 3D Extreme Type-II Superconductors

December 11, 2000
Greg Lehmann
GE Medical Systems
Cryopackage and Physical Design for a 12 Channel PCS Receive Front End

December 15, 2000
Matthias Mann
University of Odense (Denmark)
The Impact of Mass Spectrometry Based Proteomics on Functional Genomics

December 15, 2000
David J. Singh
Navel Research Laboratory
Unexpected Phenomena in Transition Metal Oxides: Sr_2RuO_4 and LiV_2O_4

December 18
Mark Bird
NHMFL
Design of a Repeating Pulse Magnet for Neutron Scattering

NHMFL Seminars at Los Alamos National Laboratory

January 7, 2000
Benedetta Camarotta
CRTBT, Grenoble
One-Dimensional Plasma Modes in Superconducting Wires

January 14, 2000
George Schmeideshoff
Occidental
UBe_{13}: Selected Histories and Recent Results

January 28, 2000
Bob Heffner
Los Alamos National Laboratory
Muon Spin Relaxation and Neutron Spin Echo Measurements of the Spin Dynamics in the Colossal Magnetoresistive Manganites $La_{1-x}Ca_xMnO_3$: Evidence for Microscopic Phase Separation in the Transition to the Ferromagnetic State

February 4, 2000
Scott Greenfield
Los Alamos National Laboratory
Nanosecond Interferrometric Studies of Surface Deformation Induced by Laser Irradiation

February 11, 2000
Neil Harrison
NHMFL-LANL
Could α-$(BEDT\text{-}TTF)^2KHg(SCN)^4$ be a Field-Induced Superconductor?

March 3, 2000
Sasha Balatsky
Los Alamos National Laboratory
d + id_xy Superconductivity in Cuprates and Clapping Collective Modes

March 10, 2000
Jeremy O'Brien
Centre for Quantum Computer Technology, University of New South Wales
Experimental Evidence for Paramagnetic Limiting of In-Plane Critical Fields in YBCO

March 17, 2000
Bob Clark
Australian National Magnet Laboratory and Semiconductor Nanofabrication Facility
Development of Nanofabricated Magnetometers for Sensitive M, Xac and dHvA Measurements in Intense Pulsed Fields: Objectives—NHMFL User Probe, YBCO Fermi Surface in Megagauss Fields

April 14, 2000
Albert Migliori
NHMFL-LANL
Use of the Third Harmonic Response of Combined Heater/Thermometers to Measure Thermal Conductivity and Specific Heat in Pulsed Magnets

April 21, 2000
Denis Pelekhov
Los Alamos National Laboratory
High Resolution Scanned Probe Magnetic Resonance Microscopy

April 28, 2000
Aoki Dai
Osaka University
Fermi Surface Properties of Uranium Compounds, Including UX_2 (X=Bi,Sb,As,P), UX_3 (X=Al,Ga,In)

June 2, 2000
Eric Jones
Sandia National Laboratories
Strange Physics in the Semiconductor Alloy System InGaAsN

June 16, 2000
Zachary Fisk
NHMFL
Ferromagnetism in the Alkaline Earth Hexaboride

June 23, 2000
Laurent Devoille
Laboratoire de Cryophysique, Grenoble
AC-Calorimetry Measurements Under Hydrostatic Pressure on Spin-Peierls System $CuGeO_3$

June 30, 2000
Fiorenzo Omenetto
Los Alamos National Laboratory
Ultrashort Pulse Propagation in Optical Fibers

July 14, 2000
Jan Musfeldt
SUNY at Binghamton
Low Energy Excitations in Doped Spin Peierls Materials

July 21, 2000
Steven Watts
Florida State University
Magnetoresistance in Half-Metallic Chromium Dioxide Films

July 28, 2000
John Sarrao
Los Alamos National Laboratory
Unconventional Magnetism and Superconductivity in Heavy Fermions $CeRhIn_5$, $CeIrIn_5$, $CeCoIn_5$ and Related Compounds

August 11, 2000
Feri Mezei
LANSCE
Spin Correlations in Paramagnets

August 10, 2000
Ralph Rosenbaum
Tel Aviv University
The Metal-Insulator Transition in Quasicrystalline Films of AlPdRe

August 18, 2000
Matt Woodward
Clark University
Two Dimensional S=1/2 Heisenberg Antiferromagnets

September 8, 2000
Zlatko Tesanovich
Johns Hopkins University
Topology and Fermiology in Cuprates

October 27, 2000
Alexy Suslov
University of Wisconsin, Milwaukee (A.F. Ioffe PTI, St.-Petersburg, Russia)
Ultrasonic Methods in the Study of Heavy-Fermion Compounds

December 1, 2000
Monty Mola
University of Montana
Flux Jumps and Dynamics in κ-$(ET)^2Cu(NCS)^2$

NHMFL SEMINARS AT THE UNIVERSITY OF FLORIDA

September 8, 2000
Sajeev John
University of Toronto
A Microscopic Model for Non-Fermi-Liquid Behavior and d-Wave Pairing in the Cuprates

September 14, 2000
Dmitri Maslov
University of Florida
Correlated Electrons in Strong Magnetic Fields: "Magnetic Nanotechnology"

September 18, 2000
V.M. Pudalov
Lebedev Institute and Rutgers University
Metal-Insulator Transition in 2D Carrier Systems: General Overview

October 16, 2000
Nick Bonesteel
Florida State University
A Quantum Computing Primer

November 6, 2000
Alexander Balatsky
Los Alamos National Laboratory
Impurity States in Unconventional Superconductors

November 13, 2000
Doug Bonn
University of British Columbia
Getting the Dirt Out: Long-Lived Quasiparticles in Clean Crystals of YBCO

December 4, 2000
Valeri Kotov
University of Florida
The Novel Quasi-One-Dimensional Spin-Ladder Material $(C_5H_{12}N)_2CuBr_4$*: Behavior in High Magnetic Field and Universal Quantum Critical Scaling*

December 7, 2000
Christopher Landee
Clark University
Molecular-Based Quantum Antiferromagnets

Appendix C: Key Personnel & Committees

NHMFL Key Personnel

Principal Investigator
Jack E. Crow, Director

Co-Principal Investigators
Greg Boebinger, LANL
Alan Marshall, FSU
J. Robert Schrieffer, Chief Scientist
Neil Sullivan, UF

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NHMFL COMMITTEES

EXTERNAL ADVISORY COMMITTEE

The External Advisory Committee reviews and evaluates overall NHMFL performance and provides advice and guidance to the NHMFL Oversight Committee on matters critical to the success and management of the laboratory. Members of the NHMFL External Advisory Committee represent academic, government, and industrial organizations, as well as the NHMFL user community. Committee members are appointed by the Chair of the NHMFL Oversight Committee, with the concurrence of the Oversight Committee.

George W. Crabtree, Chair
  Argonne National Laboratory
Chuck Agosta
  Clark University
  Chair, NHMFL Users' Committee
  (through mid-2000)
W. Gilbert Clark
  University of California at Los Angeles
Donald U. Gubser
  Naval Research Laboratory
Lynn W. Jelinski
  Louisiana State University
Eric Jones
  Sandia National Laboratories
Brian Maple
  University of California at San Diego
Eric Oldfield
  University of Illinois at Urbana-Champaign
Raymond Orbach
  University of California at Riverside
Charles Reed
  California State University
Carl H. Rosner
  Intermagnetics General Corporation
Ray Shaw
  Varian Associates, Inc.

Users' Committee

Members of the NHMFL Users' Committee are nominated and elected by the user community. The committee provides guidance on the equipment and policies needed for the development and utilization of the laboratory's facilities.

Meigan Aronson
University of Michigan, Department of Physics

Ward P. Beyermann
University of California at Riverside, Department of Physics

Stuart Brown
University of California at Los Angeles, Department of Physics

Michelle Buchanan
Oak Ridge National Laboratory, Analytical Chemistry Division

Bill Halperin, Chair
Northwestern University, Department of Physics and Astronomy

Steve Hill, Secretary
Montana State University, Department of Physics

Martin Kushmerick
University of Washington, Radiology, Physiology & Biophysics, Bioengineering

Martin Maley
Los Alamos National Laboratory, MST Superconductivity Technology Center

Janice Musfeldt
State University of New York at Binghamton, Department of Chemistry

Jim Prestegard
University of Georgia, Complex Carbohydrate Research Center

Larry Rubin
Massachusetts Institute of Technology, Magnet Laboratory

George Schmiedeshoff
Occidental College, Department of Physics

Marion Thurnauer
Argonne National Laboratory, Chemistry Division

RESEARCH PROGRAM COMMITTEE

The NHMFL Research Program Committee is charged with promoting the laboratory's In-House Research Program (IHRP) and with ensuring the development of the highest quality facilities for the laboratory's research communities. The committee evaluates research opportunities and facilities enhancements available to the NHMFL and recommends programs for the use and enhancement of NHMFL facilities and resources. It oversees the IHRP, encourages the formation of collaborative research efforts, establishes worldwide channels for communication, and identifies cutting-edge high magnetic field research programs. The committee, through its chair, administers the funding of the IHRP. Members of the RPC also participate in the Users' Program proposal review and evaluation.

NHMFL/FSU

Bruce Brandt
James Brooks
Zachary Fisk
Lev Gor'kov
Alan Marshall
Stan Tozer
Stephan von Molnár

NHMFL/UF

Kevin Ingersent
Neil Sullivan

NHMFL/LANL

Alex Lacerda
Dwight Rickle
Al Migliori, Chair

User Committee Members

Stuart Brown
Martin Maley

EXECUTIVE COMMITTEE

The NHMFL Executive Committee reviews and advises on a broad range of issues including organization, staffing, resource allocation, budgeting, and interactions with external agencies and private organizations. Members take into account the objectives and mission of the laboratory, external reviews, and internal evaluations of the overall program.

Jack E. Crow
: Director and Co-Principal Investigator, FSU

Greg Boebinger
: Co-Principal Investigator, LANL

Alan Marshall
: Co-Principal Investigator, FSU, and Director, ICR Program

J. Robert Schrieffer
: Co-Principal Investigator, FSU, and Chief Scientist

Neil Sullivan
: Co-Principal Investigator, UF

Reza Abbaschian
: NHMFL-University of Florida Representative

Bruce Brandt
: Director, Continuous Fields Facility

Tim Cross
: Center for Interdisciplinary Magnetic Resonance Representative

Alex Lacerda
: Director, Pulsed Field User Programs

William G. Luttge
: Director, University of Florida McKnight Brain Institute

Albert Migliori
: Chair, Research Program Committee

Janet Patten
: Director, Public and Governmental Relations

Dwight Rickel
: NHMFL-Los Alamos National Laboratory Representative

Hans Schneider-Muntau
: Deputy Director

Steven Van Sciver
: Director, Magnet Science and Technology