The National High Magnetic Field Laboratory (National MagLab) remains the world's largest and highest-powered magnet lab. A multi-disciplinary user facility, the National MagLab provided high magnetic fields to 9,240+ researchers between 2018 and 2022. Scientists used the National MagLab's powerful magnets - instruments more than a million times stronger than Earth's magnetic field - to investigate new materials, find energy solutions, protect the environment, understand diseases to improve health, and answer other important interdisciplinary research questions, generating more than 2,000 peer-reviewed publications.

Magnets Explore New Materials

Magnets help explore electronic properties of new materials, unlocking technologically-important behaviors for new products and devices. Researchers made important foundational discoveries on materials:

- Hydrogen-packed compound squeezed to ultra-high pressures superconducts close to room temperature.
- Uranium compound exhibited reentrant superconductivity in high magnetic fields.
- Explored graphene's electrical conductivity and electron interaction and the first direct evidence of the nature of superconductivity in magic-angle twisted bilayer graphene.
- Method to bond together atomically-thin semiconductors that yields high-quality structures for new nanotechnologies.
- Behavior in cuprates suggests different current carrying method from conventional metals.
- Found promising thermoelectric properties in a class of *1-2-20s* materials.
- Discovered evidence of a quantum spin liquid in ruthenium trichloride, findings with applications in quantum computing.
- Modified critical current of Nb_3SN and boosted performance by 50%.
- Used far-infared magnetospectroscopy to probe coupled electronic and vibrational modes in a molecular magnet with quantum information applications.

Magnets Fuel Energy Discoveries

Researchers used high magnetic fields to fuel discoveries about existing energy sources and explore new ones:

- Work to understand how carbohydrates interact to form plant biomass which can be used for energy.
- Internal structure of corn revealed as different than previously thought, aiding in conversion into ethanol.
- A new method to stabilize the light emitted from a class of next-generation materials could yield cost-effective technology that can turn light into electricity.
- Showed that batteries built from inexpensive components can deliver three to four times the punch of batteries built with lithium-ion technology.
- New characterization method showed that crude oil corrosion is dependent on acid molecule structures, information that can help improve oil refining.

Magnets Protect the Environment

MagLab magnets analyze exceptionally complex mixtures with amazing precision and facilitate discoveries on the makeup of our world:

- Pinpointed pink pigments that are the oldest on record.
- Showed that sun and water exposure causes thousands of chemicals to leach from road asphalt binder into the environment.
- Discovered that older dissolved organics from deforested areas were more energy-rich and potentially more harmful to the planet.
- Found that sunlight can chemically transform consumer plastic bags into complex chemical mixtures that leach into the ocean.
- Analysis on peat wetland soils' organic composition that has implications for climate models.

Magnets Understand Disease to Improve Health

Customized magnet systems - including a 21T MRI - allow scientists to study everything from whole, living animals to individual cells to tiny disease proteins, leading to exciting health-related discoveries:

- A link between migraines and sodium distribution through the brain that could yield future treatments.
- Possible pathway for metabolic waste removal from the brain found suggesting that waste clearance may be why we sleep.
- Polarized protons of hydrogen atoms in water, boosting its magnetic properties and making water that is more sensitive to MRI detection.
- Found new potential disease markers for brain tumors using chemical exchange saturation transfer.
- Contributed to creation of a **Blood Proteoform Atlas** that maps 30,000 unique proteoforms as they appear in 21 cell types found in human blood.

Magnet Technology

Home to more than a dozen world-record magnet systems, MagLab engineers work to advance magnet technology, pushing research magnets to new heights:

- A **2022 R&D 100 Award** for the design and construction of the 32 tesla superconducting magnet.
- A mini no-insulation magnet test coil achieved 45.5 tesla, a world-record field that could inspire magnets for biomedical research, nuclear fusion reactors and other applications.
- Tested a CORC cable magnet that could be used in particle accelerators and compact fusion.
- Found that adding Hafnium can lead to 60% more electrical current carrying ability in a Nb_3Sn wire.
- Showed how processing methods can influence Bi-2212 performance.

Education, Outreach & Broadening Participation

The National MagLab grows new generations of diverse scientists and from 2018 to 2022:

- Facilitated educational outreach to 7,400+ K-12 students.
- Offered long-term mentorship, camp or research program for 600 students.
- Engaged 29,000+ visitors at MagLab Open Houses.
- Contributed to 100 PhD and masters' theses.
- User Summer and Winter Theory School had 600+ attendees.
- Hosted users from 23 EPSCOR states with 5.5% of all MagLab users from Minority Serving Institutions.