Large-Scale High-Efficiency Helium Liquefaction

To meet its need for liquid helium to operate the superconducting radio frequency linear accelerator, FRIB built and operates its own helium cryogenic plant, which has operated without interruption since 2018 and is highly energy-efficient.

FRIB's vertically integrated approach—with on-site helium liquefaction, cryoplant operation, and end-to-end design capabilities—enables seamless transition from concept to execution. The approach supports rapid innovation and implementation in helium liquefaction, distribution, recycling, and purification.

State-of-the-Art Cryogenic Plant

To meet the stringent cooling requirements of its superconducting components, FRIB built and operates a state-of-the-art helium cryogenic plant—one of the most reliable and energy-efficient in the nation. Operating at 4 kelvin (K), which can be further cooled to 2 K, the plant distributes liquid helium through large cryogenic lines to cool superconducting radio frequency resonators and superconducting solenoid magnets that cannot function without this ultra-cold environment.

The helium cryogenic plant utilizes the patented Ganni Floating-Pressure Process Cycle, which automatically optimizes system performance. It provides the highest efficiency and reliability for a wide range of capacities and operating modes.

FRIB's integrated design and controls are central to its success. With on-site helium liquefaction, cryoplant operation, and full-spectrum design capabilities, FRIB streamlines every step—from concept to implementation. This vertically integrated structure not only ensures operational efficiency but also accelerates innovation in cryogenic systems, enabling rapid testing and deployment of advanced solutions.

FRIB's cryogenic expertise has become a magnet for collaboration. As a user facility for the U.S. Department of Energy Office of Science, FRIB hosts engineers and researchers from industry, government laboratories, and academia who work together to advance cryogenic technologies. Its advanced infrastructure and expert leadership support a growing knowledge base essential to sustaining and evolving this critical field.

Enhancing American Competitiveness

FRIB's helium liquefaction capabilities enhance American competitiveness by advancing domestic production of critical cryogenic systems and fostering innovation in the design and fabrication of essential components for emerging industries.

Learn more at frib.msu.edu

Michigan State University (MSU) operates the Facility for Rare Isotope Beams (FRIB) as a user facility for the U.S. Department of Energy Office of Science (DOE-SC), with financial support from and furthering the mission of the DOE-SC Office of Nuclear Physics.

- In-house design and fabrication: FRIB has the in-house capability to design and fabricate small to large-scale cryogenic system components including transfer lines and distribution systems.
- System integration: FRIB's vertically integrated cryogenic system—spanning on-site helium liquefaction, purification, distribution, and full-spectrum design and controls—enables seamless system integration from concept to execution.

Training Successful Students

At FRIB, students receive hands-on training with world-leading experts on world-unique systems, gaining critical skills and real-world experience. This training helps them win prestigious awards and contribute to a skilled workforce, lead in emerging industries, and drive national competitiveness.

Cryogenic engineers are responsible for the design of these low-temperature refrigeration systems. The demand for cryogenic engineers has increased in the last decade. Having FRIB at MSU offers a unique opportunity to attract and train the next generation of cryogenic system innovators to prepare them for opportunities in cryogenic engineering and related fields.

A partnership between FRIB and MSU's College of Engineering, the MSU Cryogenic Initiative combines classroom education with training on the nation's largest helium liquefaction plant at FRIB. It is the focal point for the investigation of efficient cryogenic process designs and the research and development (R&D) of equipment for these processes.

FRIB staff teach undergraduate and graduate cryogenic engineering courses offered through MSU's Mechanical Engineering Department. These courses teach both the therma-process and mechanical design aspects involved in cryogenic engineering.

In addition to student research on the FRIB cryoplant, the Cryogenic Assembly Building at FRIB is planned for cryogenic system R&D activities. Such activities include helium-compressor efficiency investigations, the development and investigation of freeze-out purification for the conservation of helium, and the development of small 2 K process and refrigeration system.