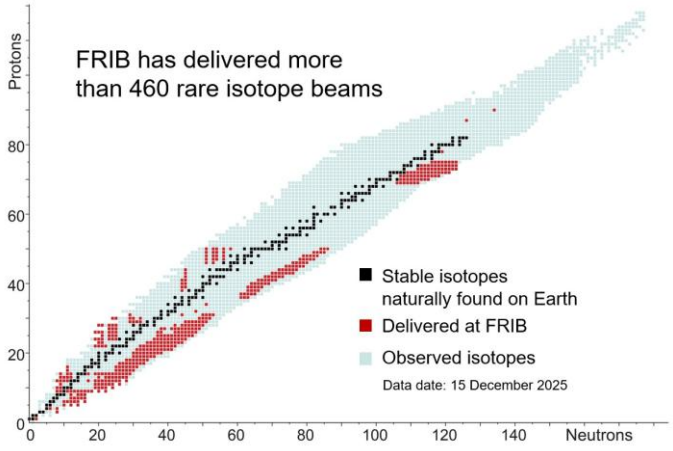
FACILITY FOR
RARE ISOTOPE BEAMS

January 2026

FRIB Quick Facts

Operating Most Powerful Heavy-Ion Accelerator

- Michigan State University 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.
- User facility operation is supported by the DOE-SC Office of Nuclear Physics as one of 28 DOE-SC user facilities.



FRIB Operates Reliably

- FRIB operates with 93% availability for scientific user experiments.
- FRIB's automation control system uses 22,000 input/output points to send and receive information for various machine functions.
- The controls network connects over 3,000 devices and tracks 1.3 million control values as fast as every few milliseconds, which are backed up every second for operators and experts to manage FRIB.
- FRIB uses artificial intelligence and machine learning's power to process immense data sets for experiments, theoretical studies, and the science and engineering to operate the instruments.

ISO Programs Keep Public Trust

- FRIB maintains management systems externally registered by NSF International Strategic Registrations (NSF-ISR) to the ISO 9001 (since 2008), ISO 14001 (since 2006), ISO 27001 (since 2018), and ISO 45001 (since 2007) standards. ISO registration ensures compliance and quality to external international standards.

Enabling Scientific Discoveries

- Since the start of user operation in May 2022, FRIB has:
  - delivered more than 460 rare isotope beams to experiments,
  - supported 957 participants, including 282 students, from 174 institutions and 24 countries.
- Published results available at frib.msu.edu/publications.
- FRIB is oversubscribed and can only accommodate a third of all requested time. Since 2022, FRIB has received 251 proposals for beam time use.

Learn more at frib.msu.edu

The Science

- Most elements are stable and naturally occurring on Earth.
- When neutrons are removed from or added to the nucleus of a stable atom it becomes more unstable, thus rare.
- Many rare isotopes exist only for fractions of seconds before they decay into a more stable form.
- Rare isotopes are not normally found in nature; most likely a majority of possible isotopes have not been discovered.
- Rare isotopes are forged in spectacular cosmic processes and in rare isotope accelerators.
- Operating the most powerful heavy-ion accelerator, FRIB enables scientists to make discoveries about the properties of rare isotopes, nuclear astrophysics, fundamental interactions, and applications for society, including in medicine, homeland security, and industry.

The Process

- At the beginning of the process, the ion sources heat the element to be studied, knock off electrons, and push the ionized atoms around with electric and magnetic fields to create beams that are injected into the linear accelerator.
- The 400 kW superconducting radio-frequency linear accelerator drives these charged particles down the track at ever-increasing speed, providing the highest intensity beams at half the speed of light.
- The beams arrive at the rare isotope production area where they strike a target and, when their nuclei collide, produce the rare isotopes.
- The isotopes advance to the experimental area where scientists conduct experiments with fast, stopped, and reaccelerated beams to measure the rare properties and give us unprecedented understanding of these rare isotopes.

Building

- Facility consists of 536,000 gross square feet, which includes 229,800 gross square feet of new construction
- Underground tunnel: 570 feet long, 70 feet wide, 13 feet high; floor: 32 feet underground

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.

- Currently, FRIB employs 467 employees, 136 graduate students, and 98 undergraduate students.
- Approximately 1,800 scientific users are engaged in FRIB science and instrumentation. They organized themselves in an independent FRIB Users Organization (fribusers.org).
- FRIB enhances capability based on scientific needs in a safe manner and consistent with available resources. Capabilities, including the beam list, are online at frib.msu.edu/beams.

FRIB Adds Value to Nation

FRIB Expertise Applied to National Need for Chip Testing

- FRIB supports U.S. industry by addressing the national shortage of microelectronics testing. Its heavy-ion facilities—FRIB Single Event Effects Facility (FSEE) and K500 Chip Testing Facility (KSEE)—test chips used in spaceflight, wireless tech, and autonomous vehicles. These facilities use energetic, penetrating heavy-ion beams to simulate in minutes the decades-long effects of cosmic rays on electronics.
- With existing facilities oversubscribed, FSEE offers up to 2,000 user hours per year, and KSEE offers up to 6,000 user hours per year.
- The federal government funded MSU to establish KSEE by repurposing the world's first superconducting cyclotron, built at MSU in the 1980s.
- Student opportunities through the MSU Space Electronics Initiative, launched by FRIB and the MSU College of Engineering, position MSU as a national leader in chip design and testing and help develop the U.S. workforce in these fields.

Isotope Harvesting Benefits Society

- Rare isotope harvesting provides additional discovery opportunity. During routine operation for its nuclear physics mission—without interfering with FRIB's primary users—extra, unused isotopes can be "harvested."
- Rare isotopes have a role in multiple fields of study, such as medicine, biochemistry, materials science, horticulture, and astrophysics.
- The DOE Isotope Program (energy.gov/science/ip) provided funding for FRIB's isotope harvesting project to establish the capability and now supports operations and research.

Enhancements to Optimize FRIB Potential

"A New Era of Discovery: The 2023 Long Range Plan for Nuclear Science" (nuclearsciencefuture.org) recommends the following:

High Rigidity Spectrometer (HRS)

- HRS (hrs.lbl.gov) will have a significant benefit for FRIB's scientific program, extending the scientific reach to neutron-rich isotopes by a combined production-rate and luminosity increase of up to a factor of more than 100.The project is underway, and a user community of over 500 scientists supports HRS.

FRIB400 Energy Upgrade

- The FRIB400 energy upgrade (frib.msu.edu/frib400) will double its beam energy to 400 MeV/nucleon, expanding the scientific impact by increasing the yield of many rare isotopes tenfold. The science community laid out the opportunities in the FRIB400 whitepaper (frib.msu.edu/frib400paper).

Workforce Development

- Training the next generation of scientists at a world-unique campus-based DOE-SC user facility is a unique experience and a top priority.
- MSU's nuclear physics graduate program is a top-ranked program nationally, according to *U.S. News & World Report*.
- MSU awards 15 percent of nuclear physics doctorate degrees*.
- The median time to a physics PhD at MSU is 5.5 years; the national median time is 6 years.
- FRIB is the only accelerator-based DOE-SC user facility on a university campus for students studying accelerator science, cryogenic engineering and radiochemistry, all areas identified in federal advisory panel reports as in short supply for the nation, and critical to U.S. economic competitiveness, energy security, nuclear security, and nonproliferation efforts.
- FRIB collaborates with the MSU College of Natural Science and the MSU College of Engineering to attract the best and brightest students into accelerator science and engineering.

** Based on National Science Foundation National Center for Science and Engineering Statistics (NCSES) Survey of Earned Doctorates between 2018 and 2023*

Significant Dates

- December 2024 – Isotope harvesting project completed
- May 2022 – FRIB's first experiment commenced
- May 2022 – DOE officially opened FRIB with ribbon cutting
- January 2022 – FRIB completed on budget, ahead of schedule
- May 2009 – Project started
- December 2008 – DOE-SC selects MSU to establish FRIB

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