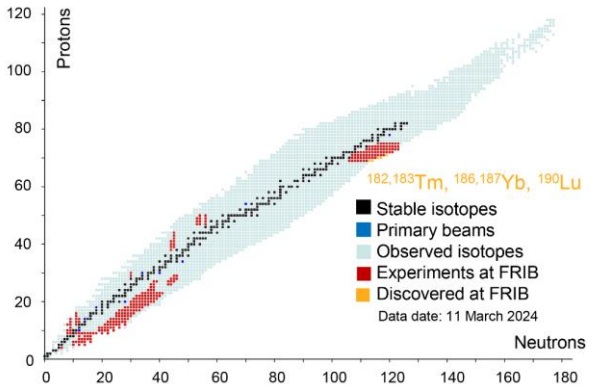
FACILITY FOR
RARE ISOTOPE BEAMS

April 2024

Quick Facts for Media

A U.S. Department of Energy Office of Science User Facility

- 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), supporting the mission of the DOE-SC Office of Nuclear Physics.
- FRIB is the only accelerator-based user facility on a university campus. User facility operation is supported by the DOE-SC Office of Nuclear Physics as one of 28 DOE-SC user facilities.



Status

- Since the start of user operation in May 2022, FRIB has:
  - delivered more than 260 rare isotope beams to experiments and
  - supported 1,263 participants, including 340 students, across 89 experiments, 101 countries, and 354 institutions (including U.S. national laboratories, colleges, and universities: Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Lawrence Livermore National Laboratory, Argonne National Laboratory, Los Alamos National Laboratory, Mississippi State University, University of Tennessee Knoxville, Florida State University, Rutgers University, Ursinus College, and more; and the Institute for Basic Science (Korea), RIKEN (Japan), Gesellschaft für Schwerionenforschung (Germany); universities in the United Kingdom, Italy, France, Spain, Sweden, Canada, and many others).
- Published results available at frib.msu.edu/publications.
- Given the high demand for FRIB, about 35% of the requested beam time following the second Program Advisory Committee was allocated by the FRIB Laboratory director.
- In 2024, FRIB provides a broad scientific program, serving more than 450 scientific users from about 125 institutions, and continuing technical developments to further enhance user discovery opportunities.
- Currently, FRIB employs 553 employees, 144 graduate students, and 140 undergraduate students.

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.
- 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

- Approximately 1,800 scientists from 125 U.S. colleges and universities, 13 national laboratories, and 53 countries are organized in existing, independent FRIB Users Organization (fribusers.org).
- FRIB is enhancing capability based on scientific needs in a safe manner and consistent with available resources. Capabilities are listed on the website, including the beam list. at frib.msu.edu/beams.

FRIB Adds Value to Nation

Leveraging FRIB for Chip Testing

- The FRIB Single Event Effects (FSEE) Facility (frib.msu.edu/fsee) uses energetic and penetrating heavy-ion beams to measure the response of electronic components to such ions. This simulates in a few minutes the effect of cosmic rays on electronics over decades.
    - Existing facilities are oversubscribed; FSEE facility will provide up to 2,000 hours/year to users.
- MSU obtained a $14M federal contract to refurbish FRIB's K500 cyclotron (frib.msu.edu/k500) to test electronics for space flight.

Isotope Harvesting Benefits Society

- An area of discovery opportunity for researchers is rare isotope harvesting. 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.
- Isotope harvesting at FRIB is recommended by the Nuclear Science Advisory Committee Isotopes, a federally chartered advisory committee to DOE.
- The DOE Isotope Program (energy.gov/science/ip) is providing $13.2M over five years for FRIB's isotope harvesting project, covering base operations and core research.
- Operational end of 2024

Enhancements to Optimize FRIB Potential

"A New Era of Discovery: The 2023 Long Range Plan for Nuclear Science" recommends both of the following enhancements to optimize FRIB potential.

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 FRIB's beam energy to 400 MeV/nucleon and expand 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 of the next generation of scientists at a world-unique campus-based DOE-SC user facility is a unique experience and a top priority at FRIB.
- MSU's nuclear physics graduate program is a top-ranked program nationally, according to *U.S. News & World Report*.
- Each year, MSU awards 10 percent of nuclear physics doctorate degrees.
- The median time to a physics PhD at MSU is 5.4 years; the national median time is 6.2 years.
- FRIB is the only accelerator-based 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.

Significant Dates

- 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

For More Information

- FRIB Laboratory: frib.msu.edu
- Tour information: 517-355-9672
- FRIB Users Organization: fribusers.org

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