FACILITY FOR
RARE ISOTOPE BEAMS

Spring 2022

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 to discover, explore, and understand all forms of nuclear matter.
- The establishment of FRIB was funded by DOE-SC, MSU, and the State of Michigan, and user facility operation is supported by the DOE-SC Office of Nuclear Physics.

For Scientists

- Approximately 1,600 scientists from around the world organized in existing, independent FRIB Users Organization
- Unique discovery potential with fast, stopped, and reaccelerated beams
- FRIB's peer-reviewed experiments, slated to begin 9 May 2022, align with key national science priorities and comprise exciting new research that was not possible prior to FRIB.
- High demand exists for research opportunities. First call for proposals to do experiments garnered 82 proposals from:
    - 597 individual scientists—354 from U.S.
    - 130 institutions in 26 U.S. states and 30 countries.
- Given the high demand, approximately 30 percent of the requested beam time was recommended.
    - 34 (of 82 requested) experiments
    - 4,122 hours (out of 12,412 hours) facility-use hours

Building

- Facility consists of four buildings
- Underground tunnel: 570 feet long, 70 feet wide, 13 feet high; floor: 32 feet underground
- Architect/Engineer: SmithGroup, Detroit, Michigan
- Construction Manager: Barton Malow, Southfield, Michigan

Total Project Cost and Funding

- Total Project Cost: $730 million
- The State of Michigan contributed $94.5 million of that cost

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.
- Hosting what will be the most powerful heavy-ion accelerator, FRIB will enable 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.

Significant Dates

- December 2008 – DOE-SC selects MSU to establish FRIB
- May 2009 – Project started
- September 2010 – DOE-SC approved Critical Decision 1
- August 2013 – DOE-SC approved Critical Decision 2/3a (project baseline and start of civil construction)
- March 2014 – Groundbreaking
- August 2014 – DOE-SC approved Critical Decision 3b (start of technical construction)
- October 2014 – Technical construction began
- March 2017 – Civil-construction beneficial occupancy achieved
- October 2017 – FRIB accelerated argon and krypton beams in the front end to the Key Performance Parameters (KPP) required at project completion
- November 2017 – The FRIB 4 kelvin (K) cryogenic plant made its first liquid helium at 4.5 K
- July 2018 – FRIB accelerated argon and krypton beams in the first three of 46 superconducting cryomodules to KPP
- August 2018 – FRIB circulated liquid lithium and established lithium film in its charge stripper
- December 2018 – The cryogenic plant cooled liquid helium to 2 K, making FRIB's accelerator the first superconducting heavy-ion linear accelerator to operate at 2 K
- February 2019 – FRIB accelerated beams through the first 15 (of 46 total) cryomodules to 10% of FRIB's final beam energy
- March 2020 – FRIB accelerated argon-36 beam through 37 of 46 superconducting cryomodules to 204 million electron-volts per nucleon (MeV/u) or 57% of the speed of light, to KPP
- June 2020 – FRIB completed assembly and testing of all 46 baseline cryomodules
- September 2020 – DOE designated FRIB as a DOE-SC user facility at an outdoor ceremony at MSU
- November 2020 – FRIB issued first call for proposals
- February 2021 – FRIB scientific users worldwide submitted 82 experiment proposals and 6 letters of intent in response to FRIB's first call for proposals, representing 597 scientists
- April 2021 – The liquid lithium charge stripper installed in the FRIB linac functioned properly upon first attempt in stripping a 17-MeV/u-accelerated $^{124}Xe^{26+}$ beam
- April 2021 – FRIB commissioned the entire linac. The FRIB team commissioned a krypton-86 beam to 212 MeV/u using all 46 cryomodules, achieving 100% beam transmission in less than three hours on the first attempt.
- August 2021 – FRIB Program Advisory Committee peer-reviewed and recommended first FRIB experiments
- December 2021 – The FRIB Project team produced and identified the first rare isotopes in FRIB, marking the demonstration of the last required KPP
- January 2022 – The FRIB Project team delivered the first beam to the focal plane of the FRIB fragment separator, demonstrating that the technical scope supported by the FRIB Project is functional and complete
- May 2022 – Ribbon cutting marking the start of FRIB's scientific mission and start of user experiments
- June 2022 – Critical Decision 4 (project completion). FRIB was technically completed in January 2022, on budget and ahead of Critical Decision 4

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 ranked No. 1 in the nation according to *U.S. News and World Report*.
- Each year, about 10 percent of the nation's nuclear science PhD holders are educated at MSU.
- The median time to a physics PhD at MSU is 5.2 years; the national median time is 6.2 years.
- FRIB helps train the next generation accelerator science and engineering workforce, critical to U.S. economic competitiveness, energy security, nuclear security, and nonproliferation efforts.
- Located on the campus of MSU and in collaboration with the College of Natural Science and the College of Engineering, FRIB attracts the best and brightest students into accelerator science and engineering.

For More Information

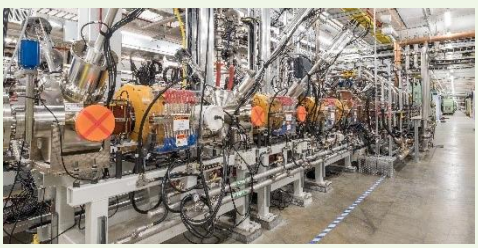
- FRIB Laboratory: frib.msu.edu
- Tour information: 517-355-9672
- FRIB Users Organization: fribusers.org

Media Contact

FRIB Senior Communications Manager: Karen King
kingk@frib.msu.edu
517-908-7262

Leadership

- Thomas Glasmacher, Laboratory Director



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