FACILITY FOR RARE ISOTOPE BEAMS

Spring 2022

Overview

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.

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 heart of FRIB is a high-power superconducting linear accelerator (linac) that accelerates all ions from hydrogen to uranium to at least 200 MeV/nucleon and produces rare isotopes by in-beam fragmentation. FRIB enables scientific research with fast, stopped, and reaccelerated rare isotope beams, supporting a community of 1,600 scientists from around the world.

Science

Particle accelerators, including the superconducting linear accelerator at the core of FRIB, enable the production and study of rare isotopes no longer found on Earth that have a host of basic and applied uses. Each element has a specific number of protons, its atomic number. Most elements are stable and can be found on Earth, like oxygen (8 protons), carbon (6 protons) or calcium (20 protons). When neutrons are added to or removed from the stable nucleus of an element, it becomes more unstable and will decay. While we are not sure exactly how many new isotopes remain to

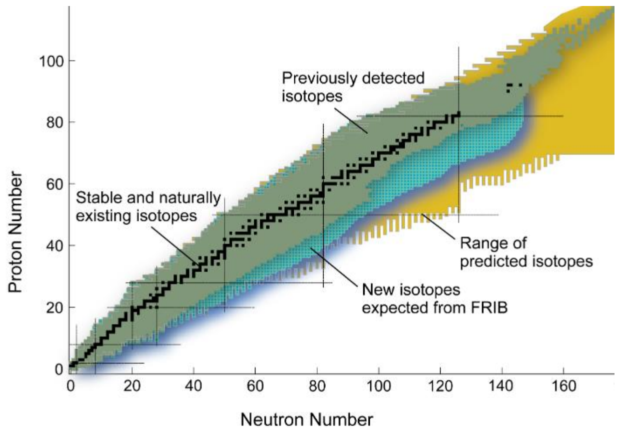
How It Works

A beam of stable atomic nuclei is accelerated to half the speed of light and impinges on a thin target material. When the beam impacts the target, the resulting collision creates a number of reaction products, most with fewer protons and neutrons than the stable beam. (On occasion, a beam nucleus picks up a proton or neutron from the target material.) Among those products are the rare isotopes requested by experimenters. This mixture continues to speed through the fragment separator, where a series of magnets selects the desired isotopes for study and sends them to the experimental area. Scientists use detectors to measure their unique properties or interaction with other nuclei.

Why It's Important

With FRIB we will, for the first time, have the capability to produce most of the same rare isotopes that are created in the cosmos, which then decay into the elements found on Earth. This will help us understand the origins of the elements. The same isotopes are needed to develop a predictive model of atomic nuclei and how they interact. Researchers using FRIB will be able to improve our understanding of how atomic nuclei may be used to diagnose and cure diseases. Improved nuclear models and precision data will allow optimization of the next generation of nuclear reactors and evaluation of techniques to destroy nuclear waste. They will probe advanced materials to examine the processes involved on the nano- and micro-scale, providing insights into how materials are affected by radiation and other forces. Modeling atomic nuclei and their interactions—a challenging problem in science—can also help lead to breakthroughs in energy, security, medicine, the environment, and more.

be discovered, it is pretty certain that a majority of isotopes have not been discovered. Many isotopes exist for only fractions of seconds before they decay towards stability. Rare isotopes are not normally found on Earth. Instead, they are forged in some of the most spectacular processes in the cosmos, including exploding stars known as supernovae.



FRIB Users Organization

Approximately 1,600 scientific users are engaged and ready for science at FRIB. They organized themselves in an independent FRIB Users Organization, with 21 working groups specializing in instruments and scientific topics. Members are from 124 U.S. colleges and universities, 13 national laboratories, and 52 countries. In August 2021, the FRIB Program Advisory Committee (PAC) peer-reviewed the first set of science proposals for experiments. User experiments are anticipated to begin 9 May. The PAC-recommended experiments align with national science priorities and span FRIB's four science areas and technical capabilities.

Workforce Development

Training the next generation of scientists at a world-unique campus-based DOE-SC user facility is a unique experience and top priority at FRIB. FRIB expands on MSU's practice to involve undergraduate and graduate students in research. MSU's nuclear physics graduate program is ranked No. 1 in the nation, according to *U.S. News and World Report*'s rankings of graduate schools. 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. In collaboration with the MSU colleges of Natural Science and Engineering, FRIB helps train the next-generation accelerator science and engineering workforce, critical to U.S. economic competitiveness, energy security, nuclear security, and nonproliferation efforts.

U.S. Department of Energy Office of Science

FRIB is supported by the Office of Science of the U.S. Department of Energy (science.energy.gov). The Office of Science is the single largest supporter of basic research in the physical sciences in the United States and is working to address some of the most pressing challenges of our time.

For more Information

Visit frib.msu.edu

Visit FRIB Users Organization website at fribusers.org

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