Isotope Harvesting

Broadening FRIB's Scientific Impact

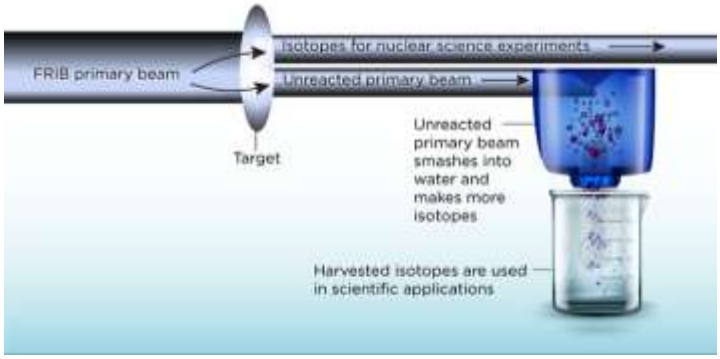
Michigan State University (MSU) operates the Facility for Rare Isotope Beams (FRIB) as a user facility for the U.S. Department of Energy Office of Science (DOE-SC), with financial support from and furthering the mission of the DOE-SC Office of Nuclear Physics. An area of discovery opportunity for researchers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

Science Isotope Harvesting Will Enable

Rare isotopes have a role in multiple fields of study, such as medicine, biochemistry, materials science, horticulture, and astrophysics. In medicine, they could help researchers develop cancer treatments and diagnostics. One of the most direct examples is in positron emission tomography scans, or PET scans, Before a PET scan, a doctor injects a patient with a tracer that contains isotopes that emit a small amount of radiation. A scanner then detects the radiation emitted by the tracer, which helps doctors diagnose and treat disease, such as cancer tumors, inside patients. Radionuclides are important tools for tracing biological, chemical, and physical processes. FRIB has the potential to supply unique radioisotopes that are otherwise difficult to produce.

FRIB will allow researchers to parse and purify the stock of co-produced radionuclides to obtain both high radionuclidic purity and high specific activity for application in basic science, medical, chemical and biological research. Of particular interest are transition and rare-earth radiometals for use in the development of new diagnostics and therapeutics against invasive disease.

How It Works



FRIB accelerates stable nuclei to half the speed of light. Stable, in this context, means the nuclei do not decay. FRIB creates a beam from these really fast nuclei and sends that barreling through a target made of carbon or beryllium atoms. Nuclei in the beam smash into the target's nuclei, leading to all sorts of nuclear reactions that create unusual and unstable isotopes.

A new beam filled with rare and unstable isotopes exits the target. FRIB then filters this beam using magnets to extract the rarest of the rare isotopes for FRIB's primary experiments. Not all of the stable beam reacts with the target. The unreacted portion of the beam continues into a beam dump made of water. Here, the unreacted primary beam smashes into water to make more rare isotopes. Then researchers extract the isotopes using technology similar to what households use to remove hard minerals from water.

Learn more at frib.msu.edu

Collaborations

- Lawrence Livermore National Laboratory
- Los Alamos National Laboratory
- University of Alabama
- Hope College
- FRIB Users Organization Isotopes and Applications Working Group

Cost and Status

- The DOE Isotope Program (energy.gov/science/ip) funded FRIB's isotope harvesting project to establish the capability and now supports operations and research.
- Project completed December 2024.

Sponsor

- U.S. Department of Energy Office of Science Isotope Program

About FRIB

- FRIB started scientific user operation in May 2022, and published results are available at frib.msu.edu/publications.
- FRIB supports a community of 1,800 scientific users.
- FRIB provides researchers with a vast unexplored terrain of more than 1,000 new rare isotopes never before produced on Earth—more than double what was previously possible.
- U.S. companies in fields, such as homeland security and nuclear medicine, would have an advantage in commercializing FRIB's discoveries in the U.S.
- FRIB is a critical component in training the next generation of nuclear physics researchers.

Nuclear Science Community Support

- Isotope harvesting at FRIB was recommended by the Nuclear Science Advisory Committee Isotopes (NSACI) Subcommittee, a federally chartered advisory committee to DOE.