Isotope Harvesting

Broadening FRIB's Scientific Impact

Michigan State University operates the Facility for Rare Isotope Beams (FRIB) as a user facility for the U.S. Department of Energy (DOE) Office of Science, supporting the mission of the 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.

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 Isotope Program in the U.S. Department of Energy Office of Science funds $13.2M/5 years for isotope harvesting project, covering base operations and core research.
- $12.4M for renovations to MSU's Chemistry Building, including new radiochemistry laboratories and supporting spaces
- FRIB's isotope harvesting is expected to be operating in 2024.

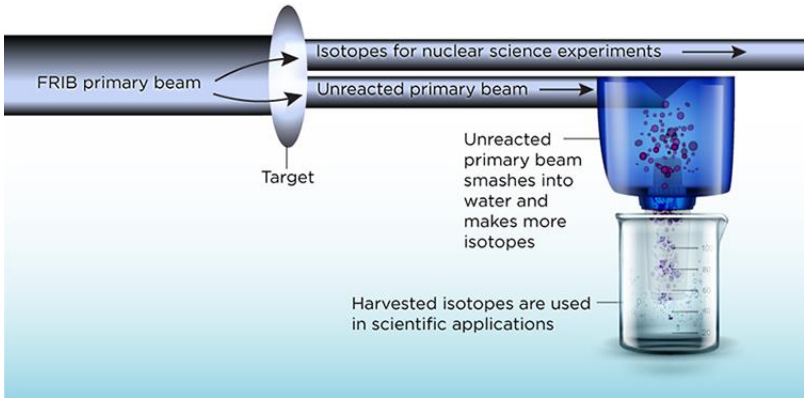
Sponsors

- 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 from 126 U.S. colleges and universities, 13 U.S. national laboratories and 53 countries.
- 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.

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.



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 the U.S. Department of Energy.

NSACI recommended it in its 2015 NSAC Isotope Long Range Plan: *"Research quantities of many of these isotopes, which are of interest to various applications including medicine, stockpile stewardship and astrophysics, are currently in short supply or have no source other than FRIB operation."*

About FRIB (cont.)

- FRIB has delivered more than 270 rare isotope beams to experiments.
- FRIB will make the United States the world leader in rare isotope nuclear science research.
- U.S. companies in fields, such as homeland security and nuclear medicine, would have an advantage in commercializing FRIB's discoveries in the United States.
- FRIB is a critical component in training the next generation of nuclear physics researchers.
- FRIB was delivered on budget and a few months early.

For More Information

- frib.msu.edu