



FRIB Overview with Recent Instrumentation Developments

S.N. Liddick

FRIB/MSU

2/12/2026



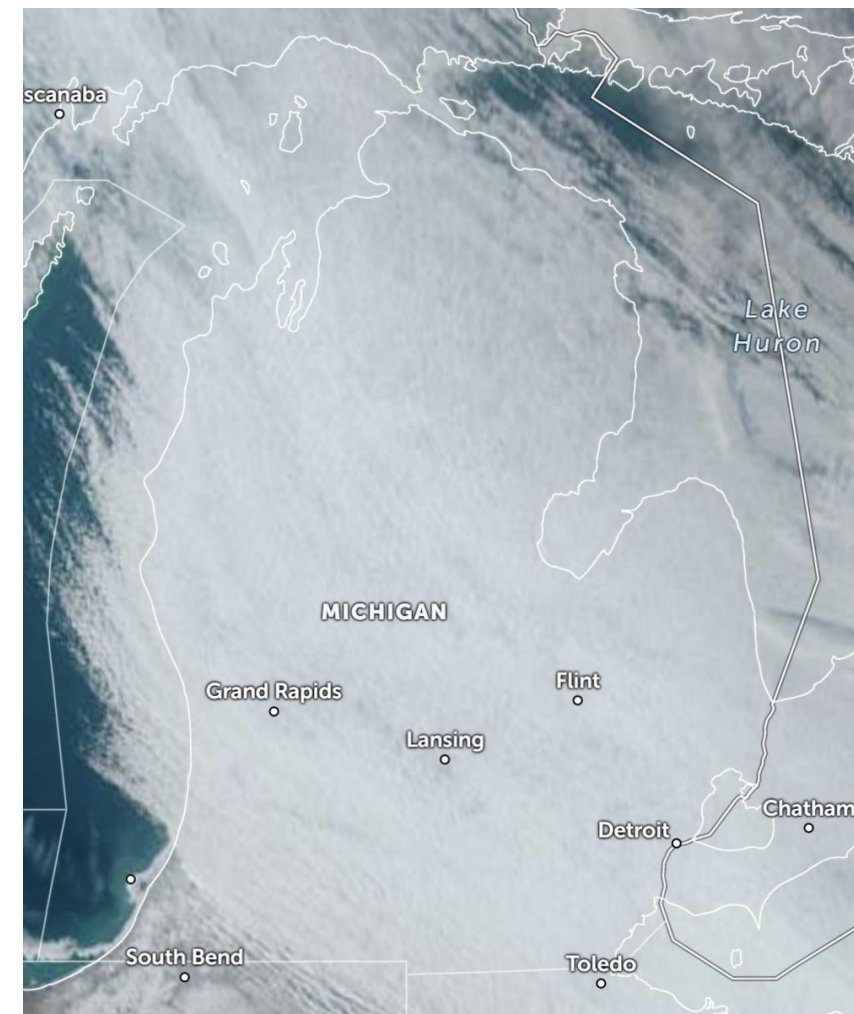
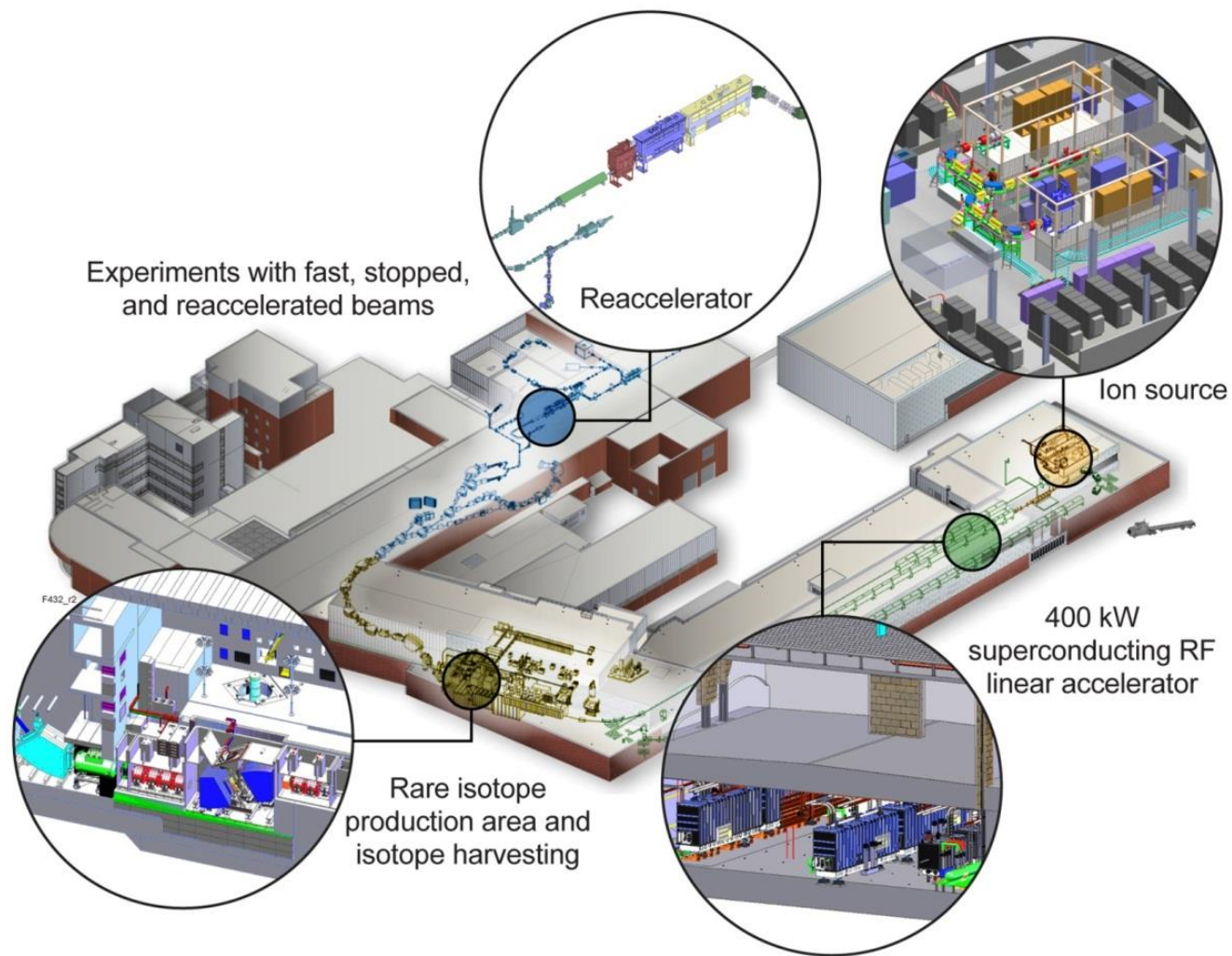
MICHIGAN STATE
UNIVERSITY



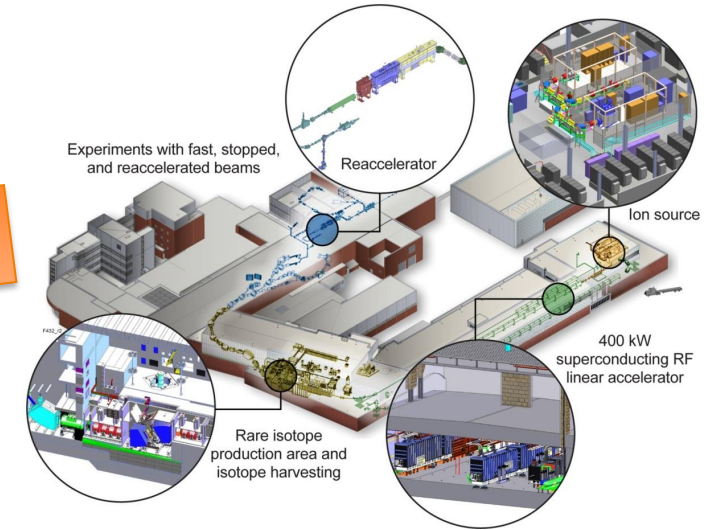
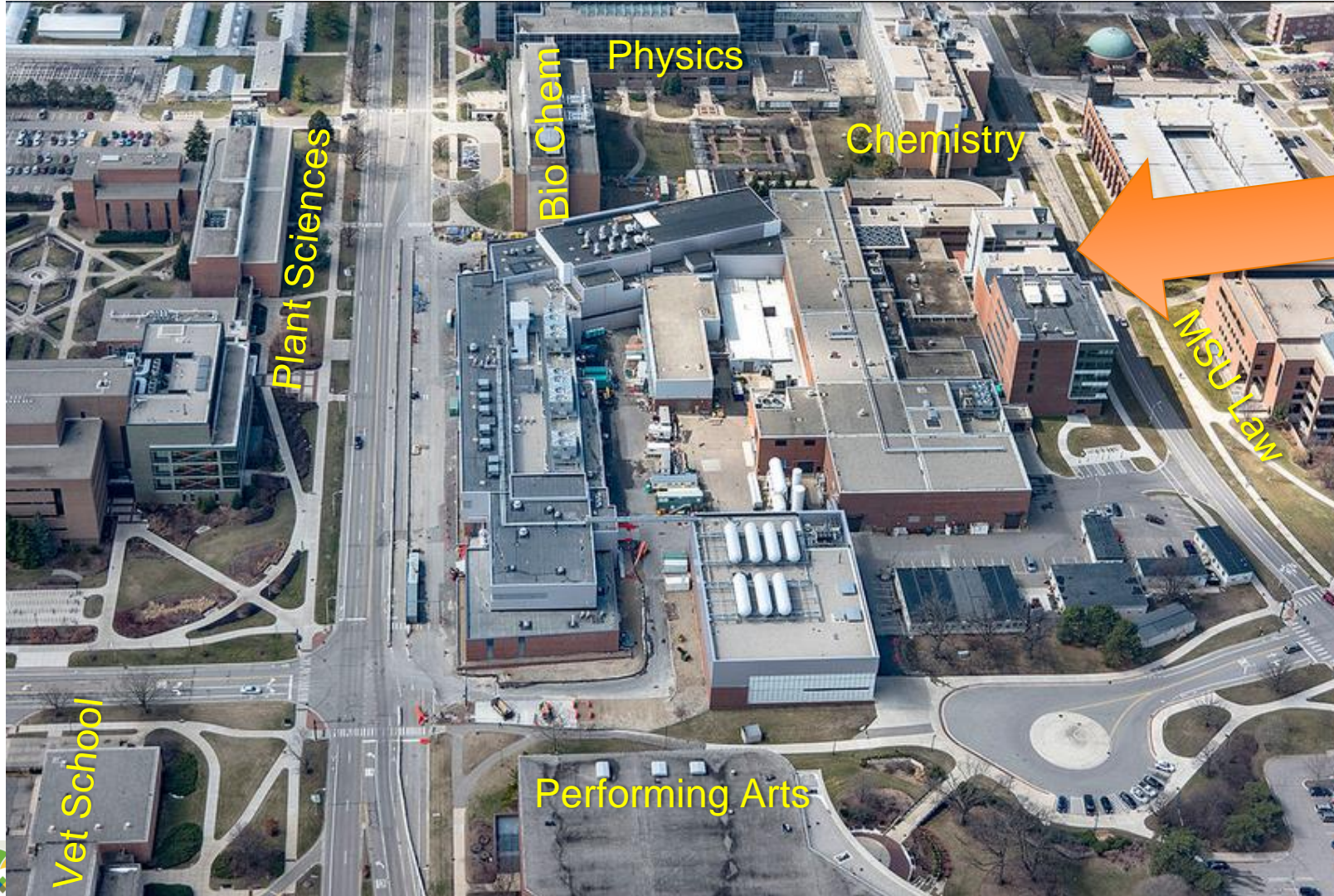
U.S. DEPARTMENT OF
ENERGY

Office of
Science

Facility for Rare Isotope Beams (FRIB)



located in the middle of the Michigan State University Campus



Combining education and research experiences for students and faculty

Who we are – Facility for Rare Isotope Beams



~800 employees

Including:

>45 faculty

>20 postdocs

>140 graduate

>90 undergraduate
students

National User
Facility

>1800 Users

Who we are – Facility for Rare Isotope Beams

- Michigan State University has a long history in nuclear science: First beam in 1965
- Operated the National Superconducting Cyclotron Lab (NSCL)
- FRIB is the next generation facility for rare isotope production.
- Timeline:**

Groundbreaking 03/2014



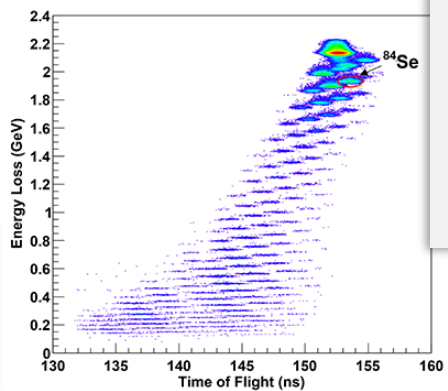
Beneficial occupancy 03/2017



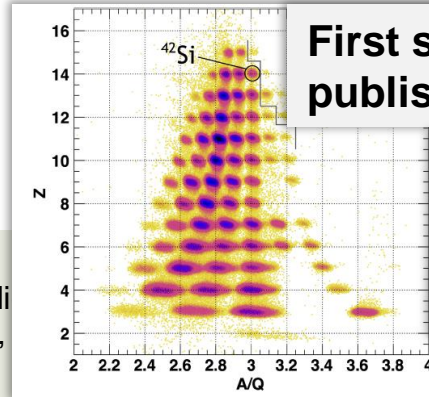
Designated as DOE-SC User Facility 09/2020

First rare isotopes produced and identified 12/2021

Isotope Beams
of Energy Office of Science | Michigan State University
East Lansing, MI 48824,



First science results published 11/2022



Featured in Physics Editors' Suggestion

Access by Michigan State University Go Mobile >

Crossing $N = 28$ Toward the Neutron Drip Line: First Measurement of Half-Lives at FRIB

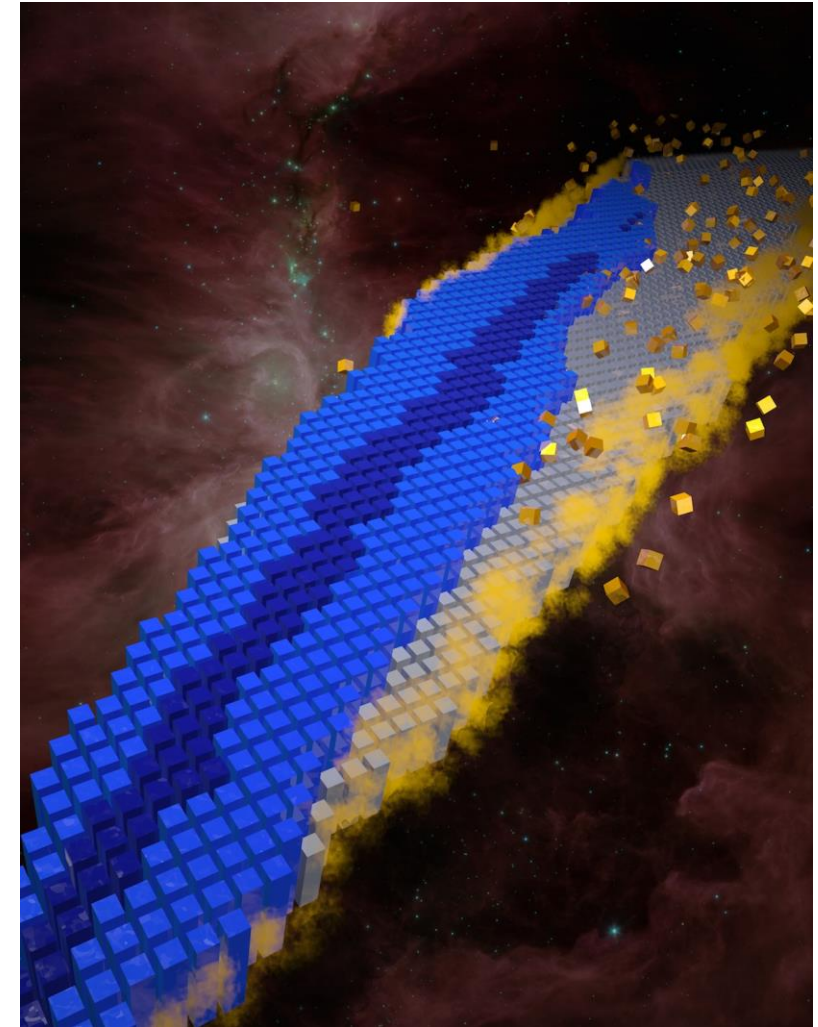
H.L. Crawford *et al.*
Phys. Rev. Lett. **129**, 212501 – Published 14 November 2022

PhysiCS See Viewpoint: Probing the Limits of Nuclear Existence



FRIB Science

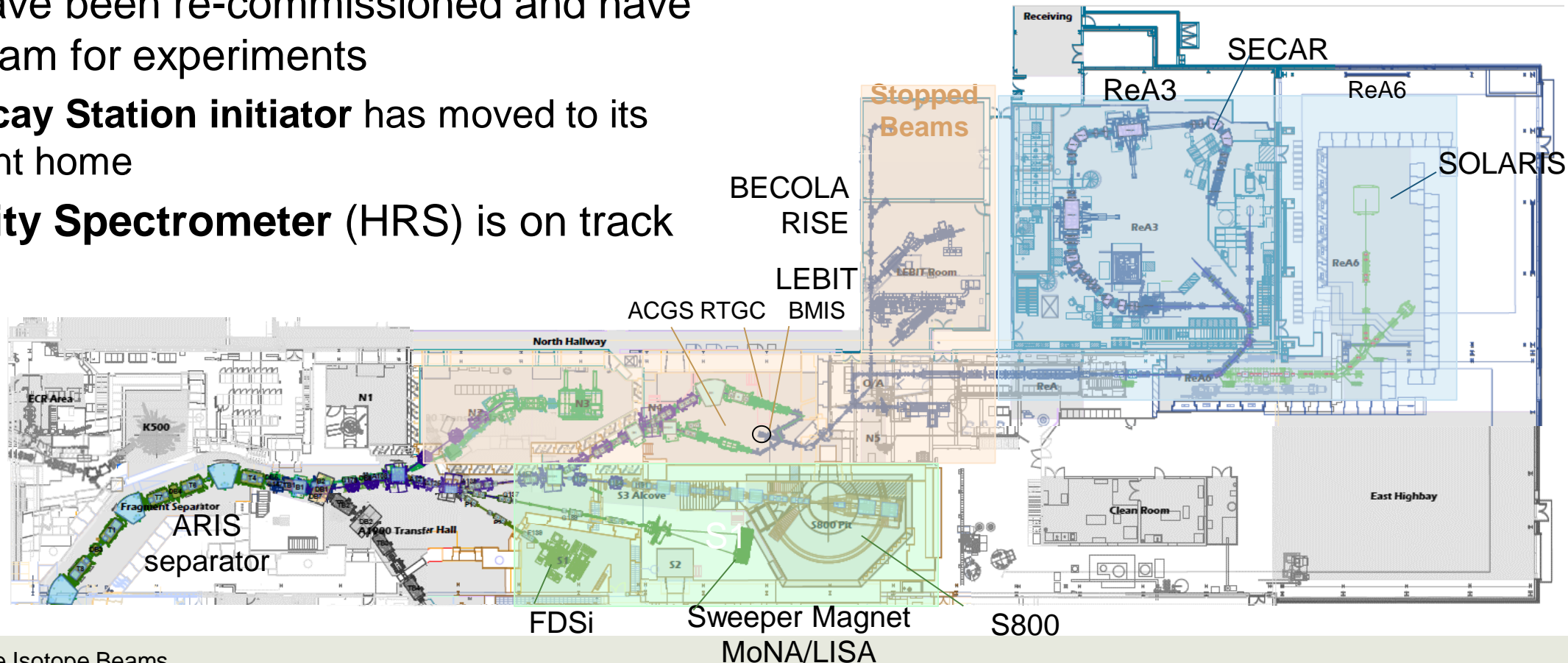
- **Nuclear Structure**
 - How do the rich patterns observed in the structure and reactions of nuclei emerge from the interactions between neutrons and protons
 - Limits of nuclear existence and new phenomena
- **Nuclear Astrophysics**
 - Origin of the elements, r process
 - Explosive environments: novae, supernovae, X-ray bursts
 - Properties of neutron stars
- **Fundamental Symmetries**
 - High Precision Measurements
 - Electric Dipole Moments
- **Isotopes for Society**
 - Isotope Harvesting
 - Medicine, energy, material sciences, national security



A. Sproles, Oak Ridge National Laboratory

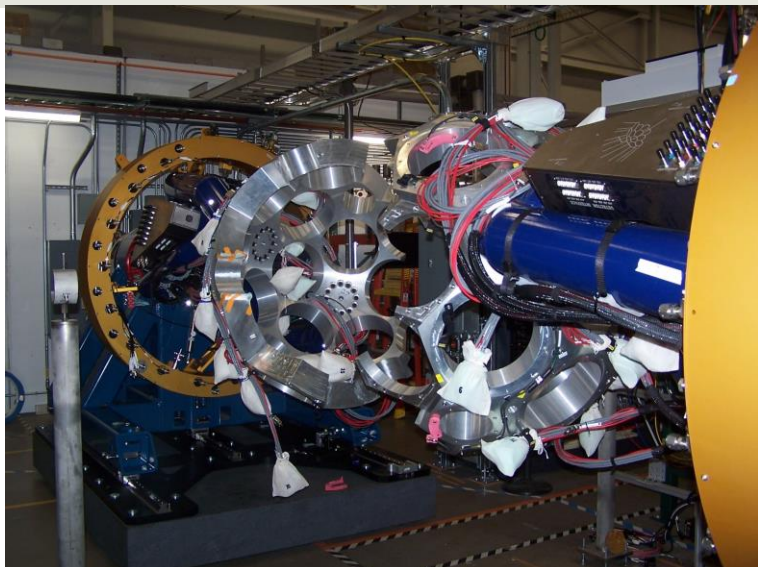
All experimental areas for user experiments ready

- FRIB offers **fast, stopped, and reaccelerated** experiments with rare isotopes
- All vaults have been re-commissioned and have received beam for experiments
 - **FRIB Decay Station initiator** has moved to its permanent home
- **High Rigidity Spectrometer (HRS)** is on track



Status of GRETA at FRIB

- GRETA frame is installed for offline commissioning in ReA6
- All GRETA detectors returned from ANL and joined the GRETA detectors already at MSU
- Electronics is fully cabled, filling system is tested, and the first detector is planned to be mounted in the week of 02/09



Dirk Weisshaar, Stephen Gillespie



Competing Nuclear Shapes in ^{62}Cr

nature physics

Article


<https://doi.org/10.1038/s41567-024-02680-0>

In-beam spectroscopy reveals competing nuclear shapes in the rare isotope ^{62}Cr

Received: 17 March 2024

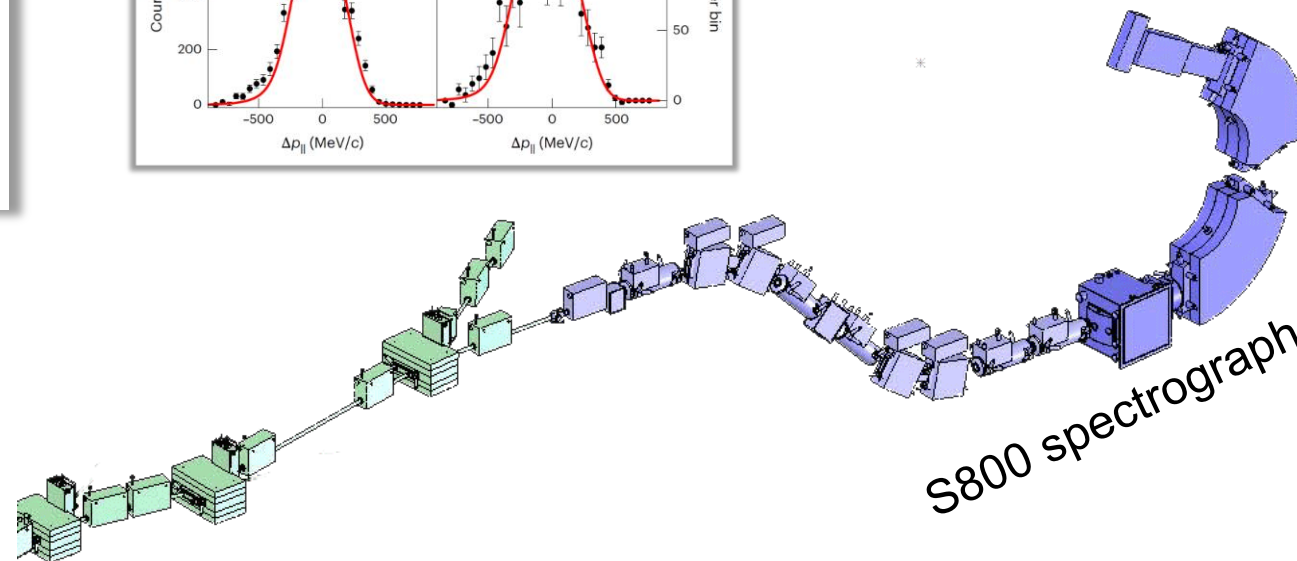
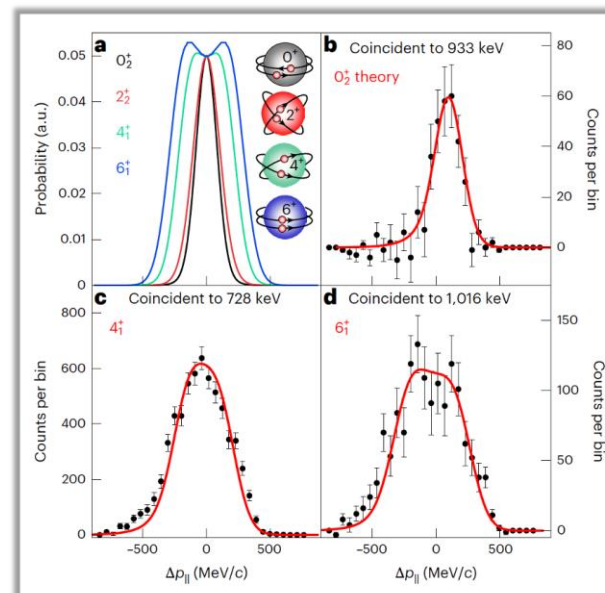
Accepted: 24 September 2024

Published online: 18 October 2024

 Check for updates

Alexandra Gade^{1,2}✉, Brenden Longfellow³, Robert V. F. Janssens^{4,5},
Duc D. Dao⁶, Frédéric Nowacki⁶, Jeffrey A. Tostevin⁷,
Akaa D. Ayangeakaa^{4,5}, Marshall J. Basson^{1,2}, Christopher M. Campbell⁸,
Michael P. Carpenter⁹, Joseph Chung-Jung^{1,2}, Heather L. Crawford⁸,
Benjamin P. Crider¹⁰, Peter Farris^{1,2}, Stephen Gillespie¹, Ava M. Hill^{1,2},
Silvia M. Lenzi¹¹, Shumpei Noji¹, Jorge Pereira¹, Carlotta Porzio⁸,
Alfredo Poves¹², Elizabeth Rubino¹ & Dirk Weisshaar¹

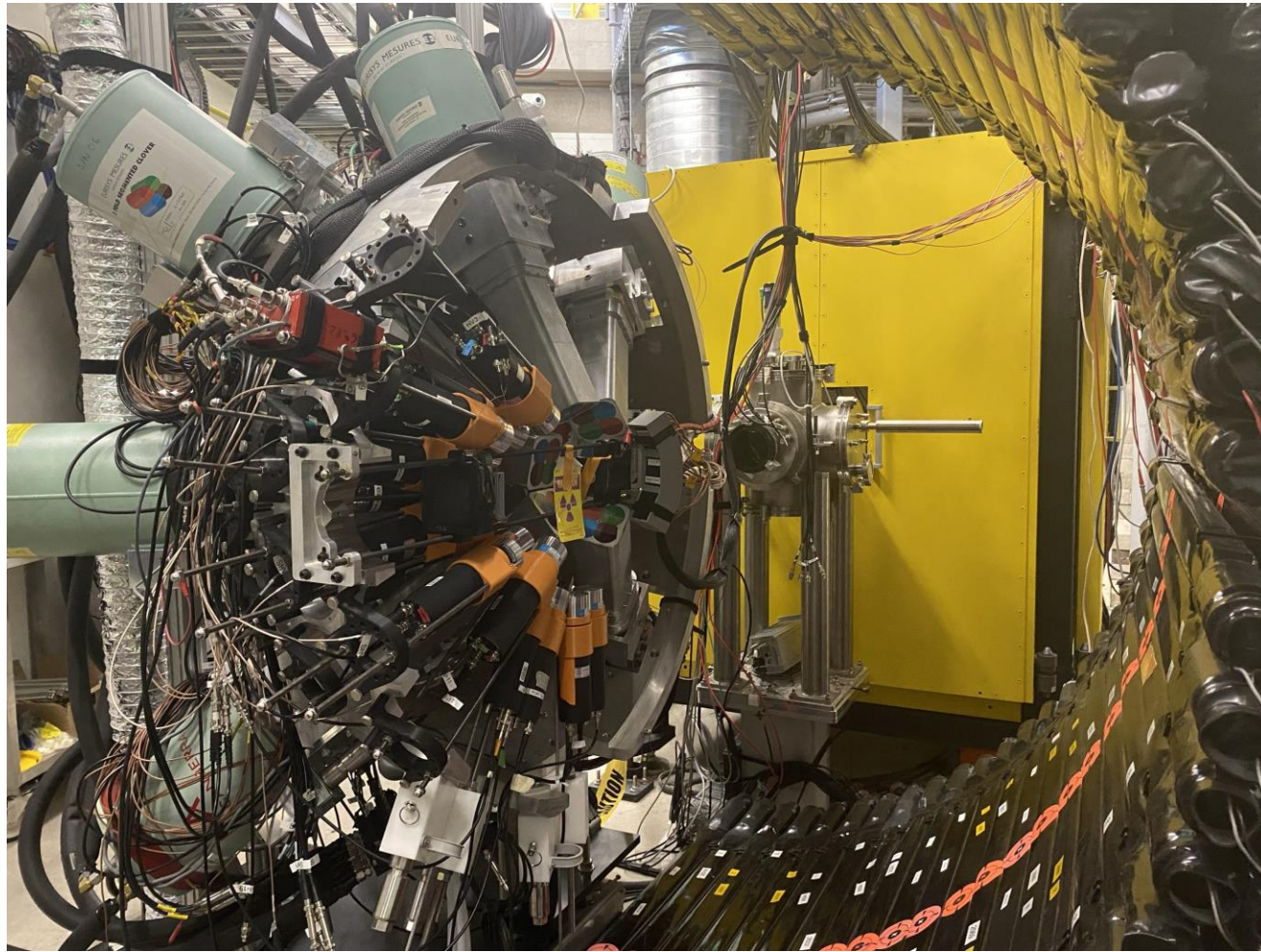
- ^{62}Cr : member of the island of inversion
- 2p knockout from ^{64}Fe to populate ^{62}Cr
- Shape coexistence
- Rich ground for state-of-the-art theoretical models



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First GRETINA experiment at FRIB

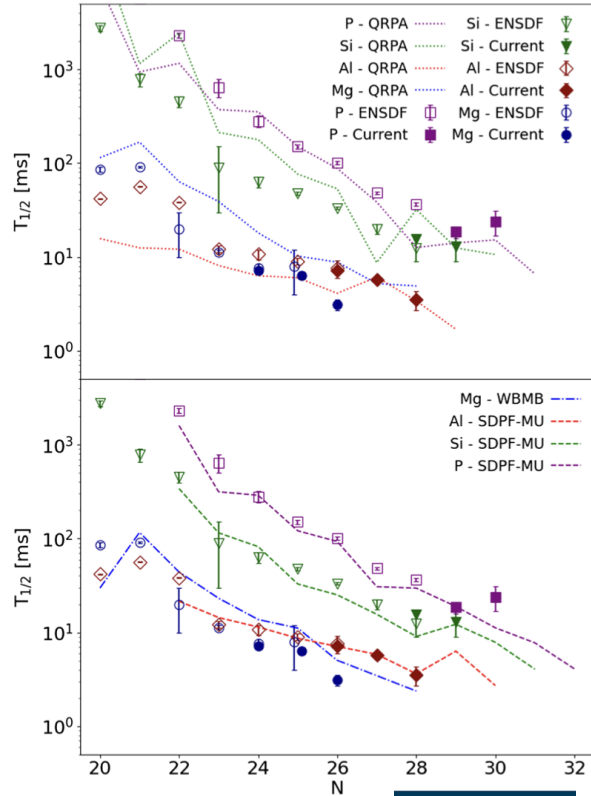
β decay studies at FRIB: Decay Station initiator (FDSi)



- Large community effort to put together a diverse set of detectors.
- Community driven effort for assembling FDSi from ORNL, UTK, MSU, ANL
- FDSi includes detectors for
 - Charged particles
 - Neutrons
 - » Thermal
 - » Time-of-flight
 - Photons
 - » High energy resolution
 - » High time resolution
 - » Calorimetry
- Branching ratios above and below S_n .

First results from the FDSi at FRIB

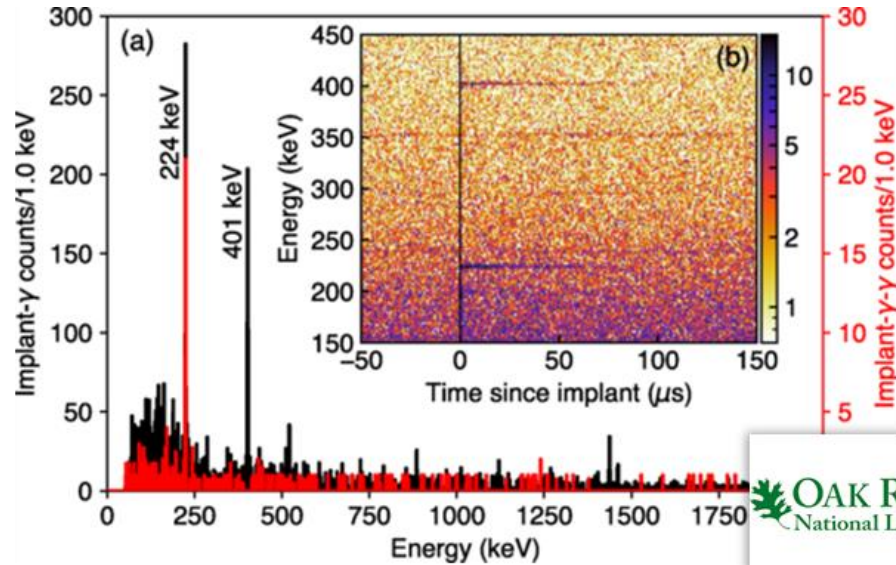
First FRIB experiment:
New half lives



Crawford et al. PRL
129, 212501 (2022)



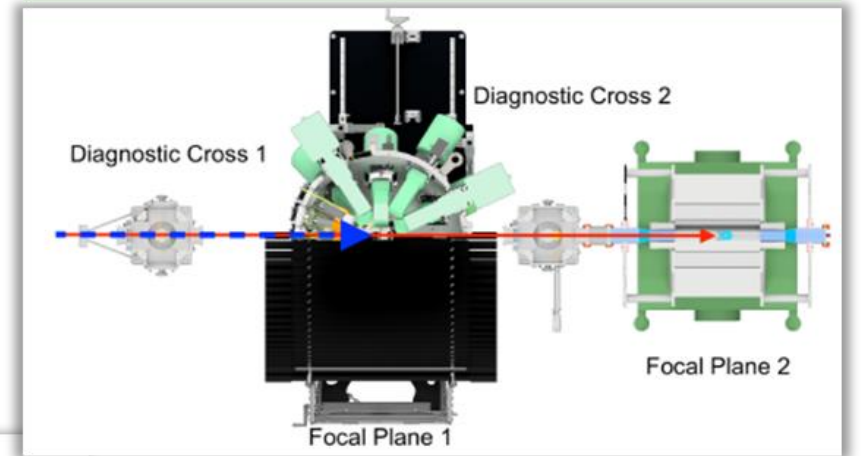
Discovery of unusually long-lived isomer in ^{32}Na (24 μs) indicates onset of spherical-to-deformed shape inversion.



Gray et al. PRL 130, 242501 (2023)



First complete spectroscopy of ^{45}Cl β -decay strength distribution – a new approach to probe proton shell structure in neutron-rich nuclei



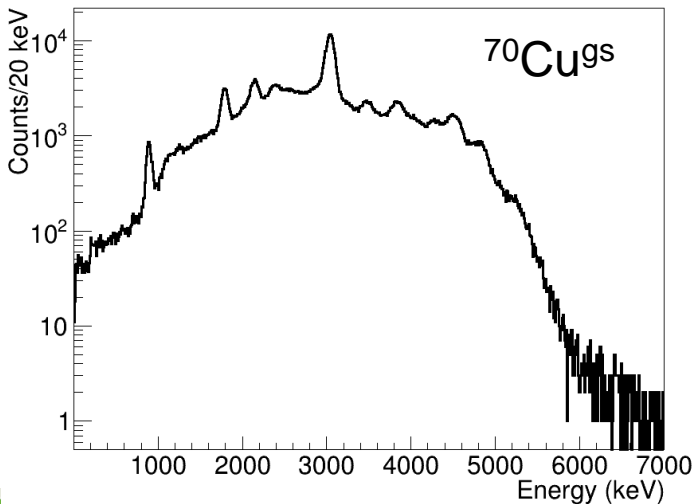
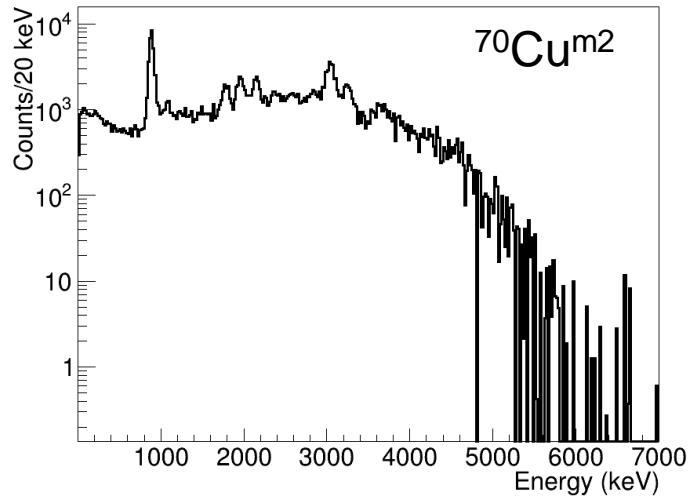
Cox et al. PRL 132, 152503 (2024)

- Half-lives
- High-resolution γ -ray spectroscopy
- Total Absorption Spectroscopy
- β -delayed neutron emission
- Isomers

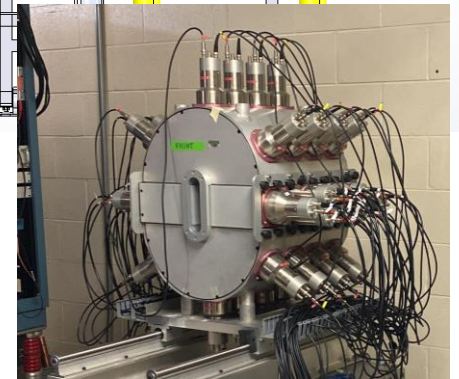
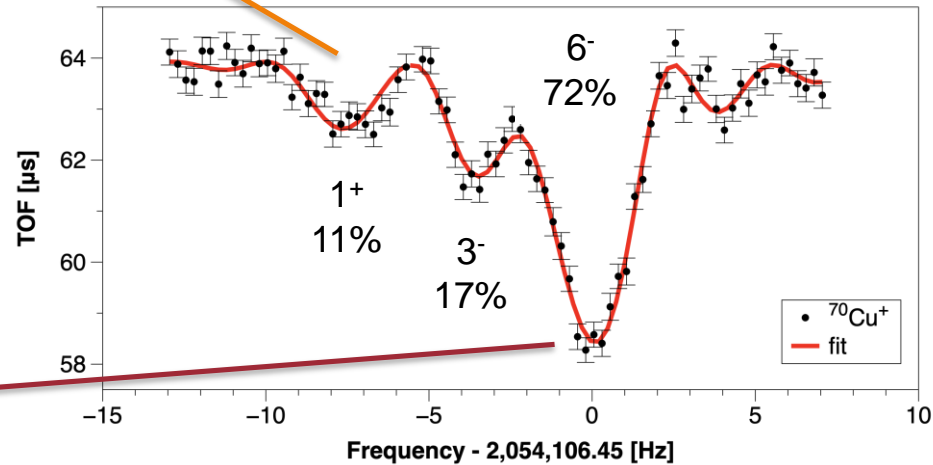
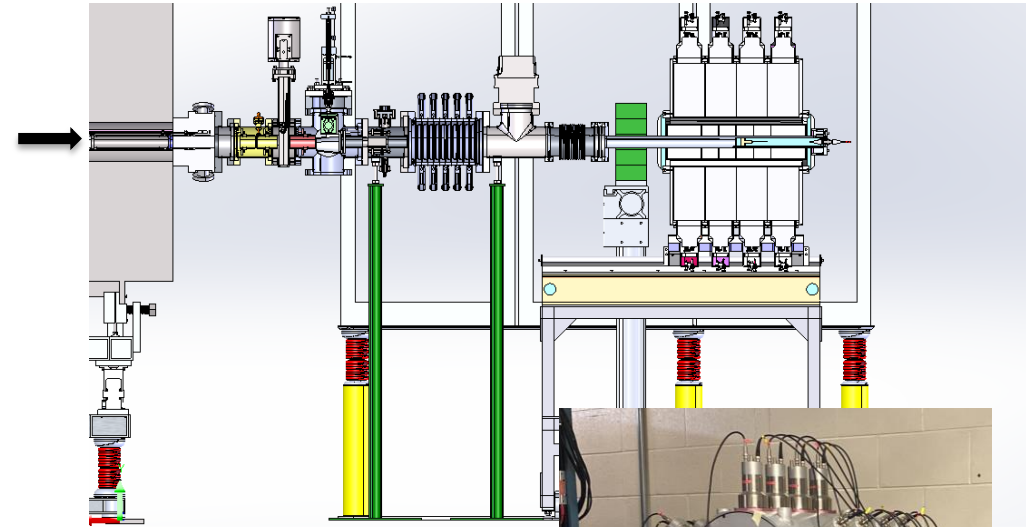


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Capability to Produce, Isolate, and Deliver Purified Isomeric States Demonstrated



Beam containing ^{70}Cu ions produced, separated (ARIS), thermalized (Gas Cell) and isomers isolated and delivered (LEBIT) to experimental end-station



SuN also used for indirect constraints on n,γ reactions.



The MoNA Collaboration @ FRIB



Summer 2025 Campaign @ FRIB



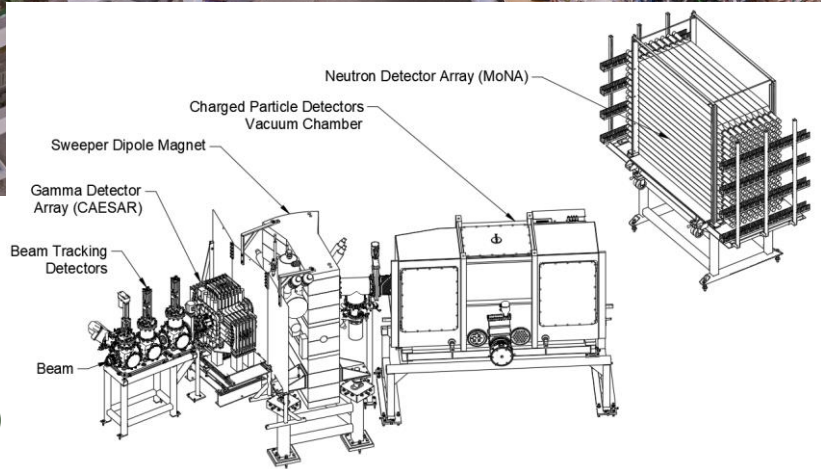
S. Noji

Modular Neutron Array

Charged Particle Detectors

Sweeper Magnet

in front of sweeper



target chamber

CAESAR

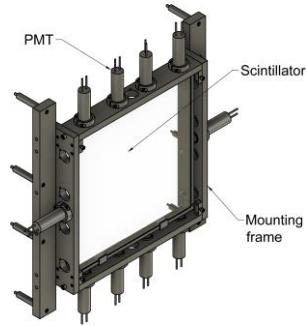
Investigation of neutron dripline phenomena using invariant-mass measurement

2025
 e23033, Coulomb dissociation of ^{37}Mg (A. Revel)
 e23068, Coulomb dissociation of ^{34}Na (A. Revel)

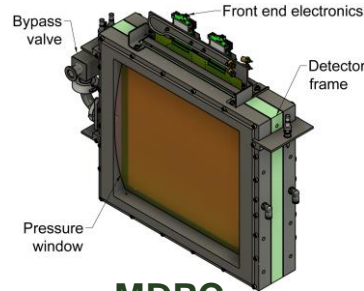
2026
 e21066, neutron-unbound excited states in $^{53,55}\text{Ca}$ (T. Baumann)



New/Upgraded Detectors



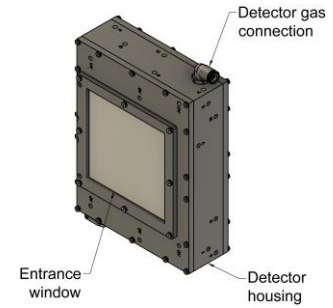
Stop
scintillator



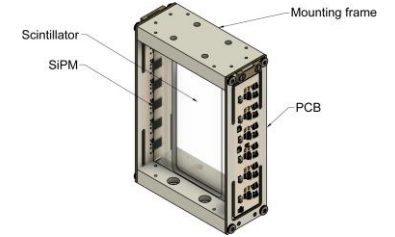
MDPC
fragments
tracking



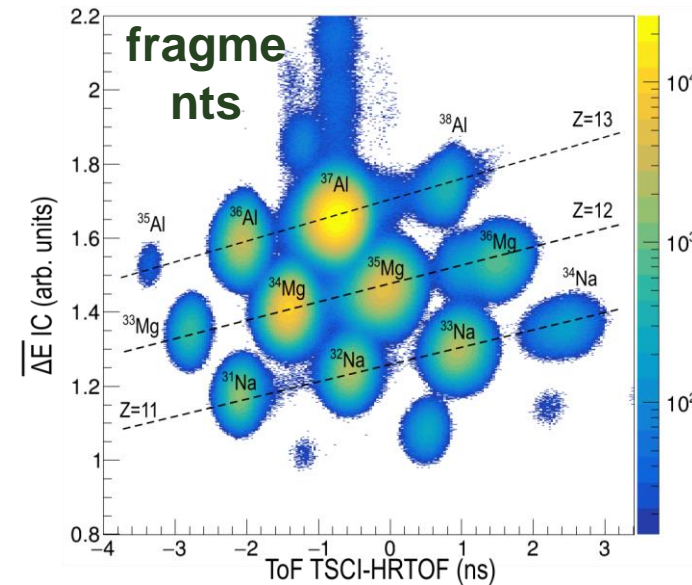
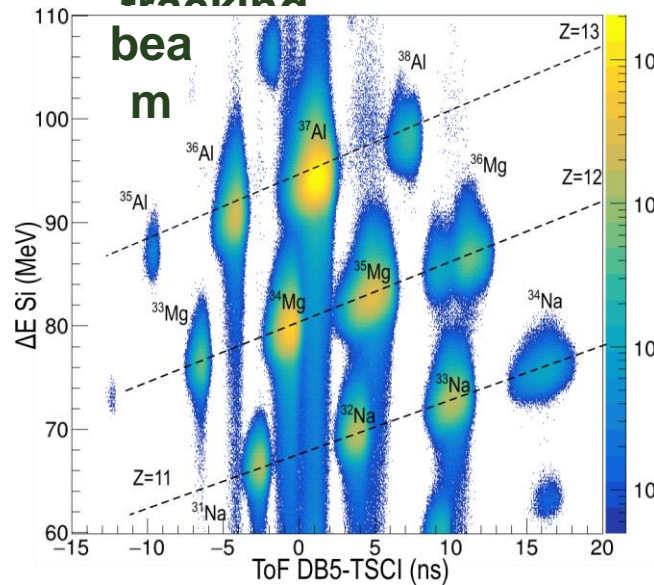
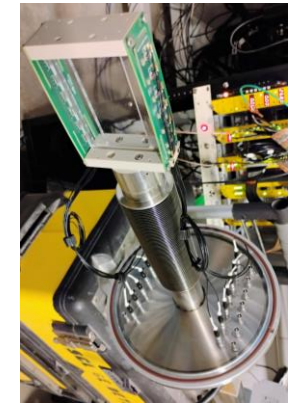
Targets
Segmented target



delay line PPACs
beam tracking



Start
scintillator



Rare Isotope Production at FRIB and Isotope Harvesting

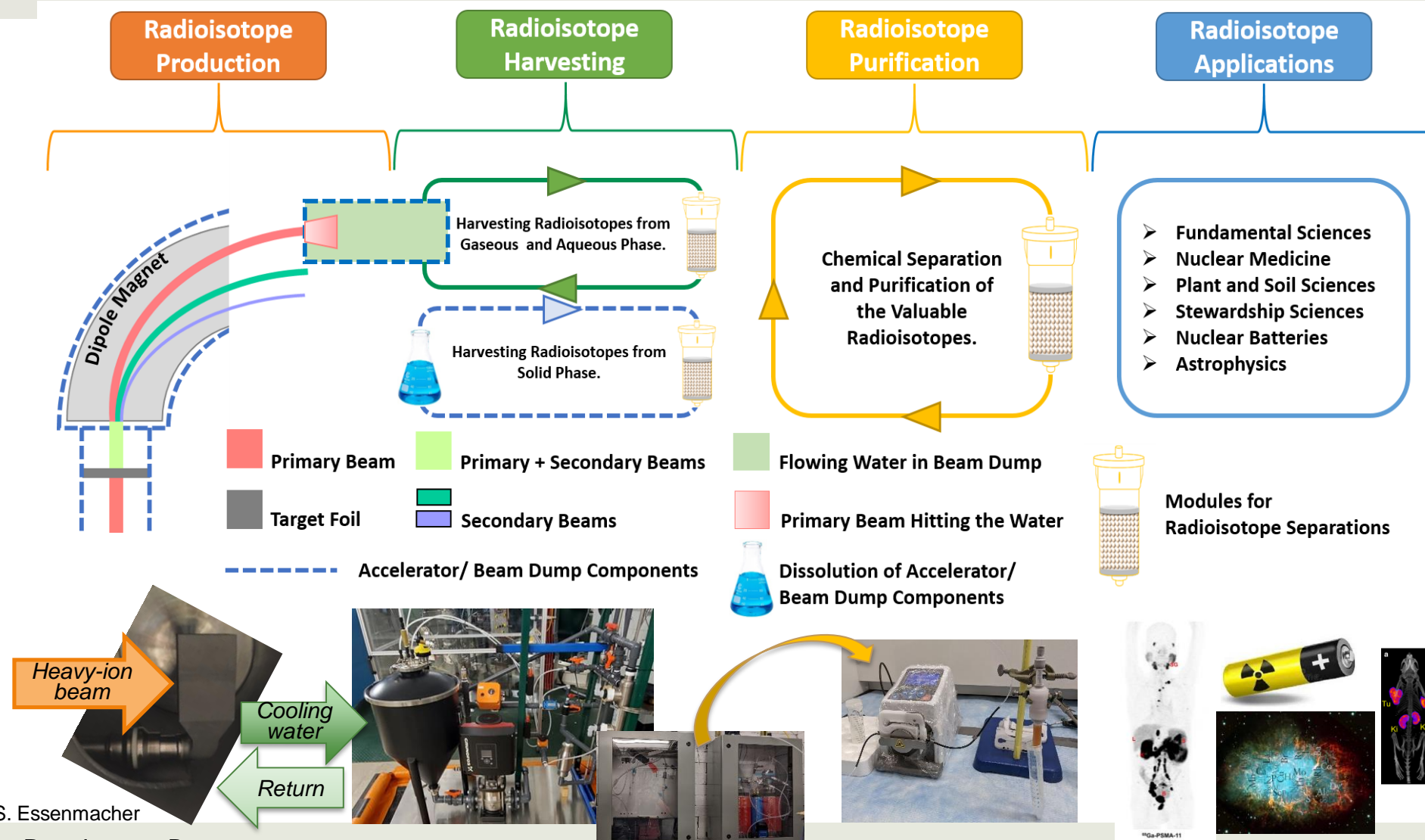


Image kindly provided by S. Essenmacher

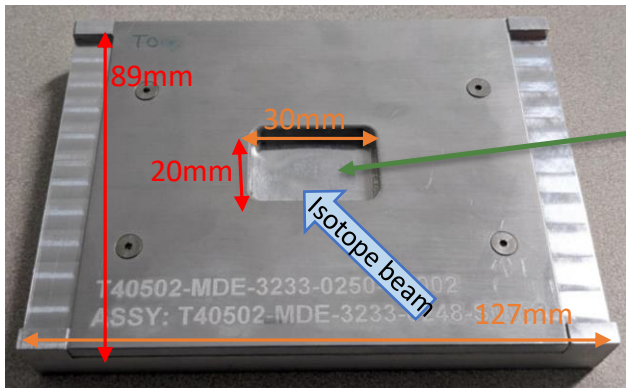


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Solid Isotope Harvesting

- Capturing of rare isotopes in a solid matrix
 - Ideal method to harvest radionuclides with challenging aqueous chemistry

■ Design of Solid Harvesting Collector (SHC)

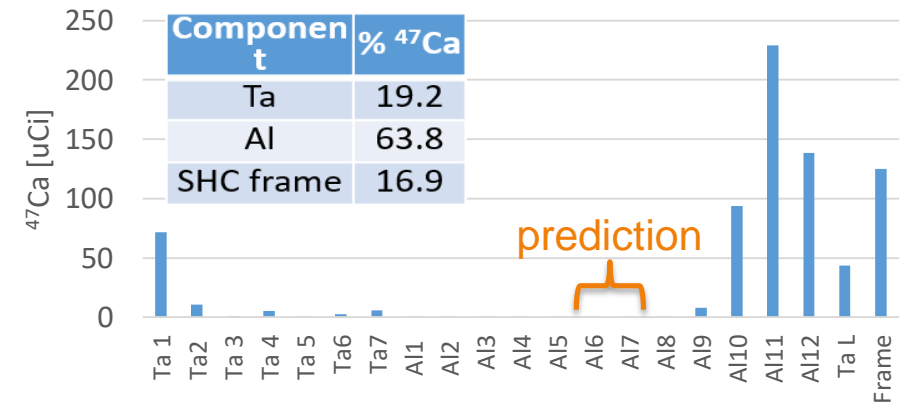


Stack of Ta & Al foils:

- Variable thickness of Ta and Al foils
- Tailored to fully stop the high-power secondary isotope beams (beam energies of several GeV)

- ^{47}Ca in parent isotope of ^{47}Sc
 - ^{47}Sc is β^- emitter for radiotherapy
 - True 'matched pair' with $^{43}/^{44}\text{Sc}$ for theragnostic applications

Measured ^{47}Ca distribution of 1st irradiation

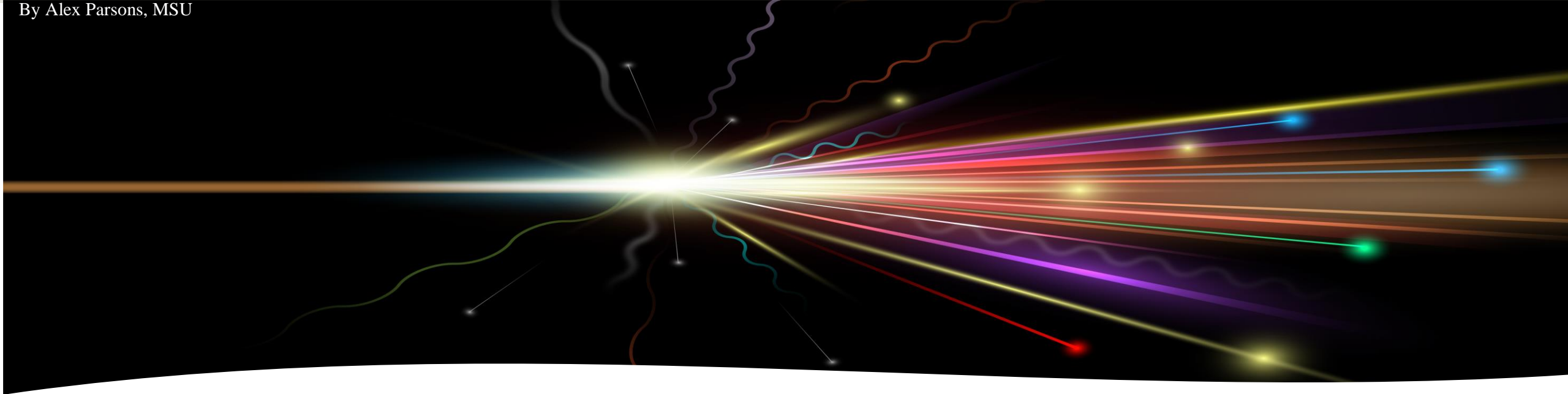


- Capturing of ^{197}Pt and ^{47}Ca in solid matrix

Isotope	Decay	$t_{1/2}$	Application
^{197}Pt	β^- / Auger electron	19.9 h	therapeutic, as radio-cisplatin
^{47}Ca	$^{47}\text{Ca}/^{47}\text{Sc}$ generator	4.5d/ 3.4d	Repeated elution of ^{47}Sc for radio therapy

Summary

By Alex Parsons, MSU



- FRIB is up and running, providing beam to all areas, and ramping up capabilities
- Broad science program including
 - nuclear structure
 - nuclear astrophysics
 - fundamental symmetries
 - isotope for society



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Questions



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