Welcome and FRIB Project Status

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U.S. DEPARTMENT OF ENERGY | Office of Science

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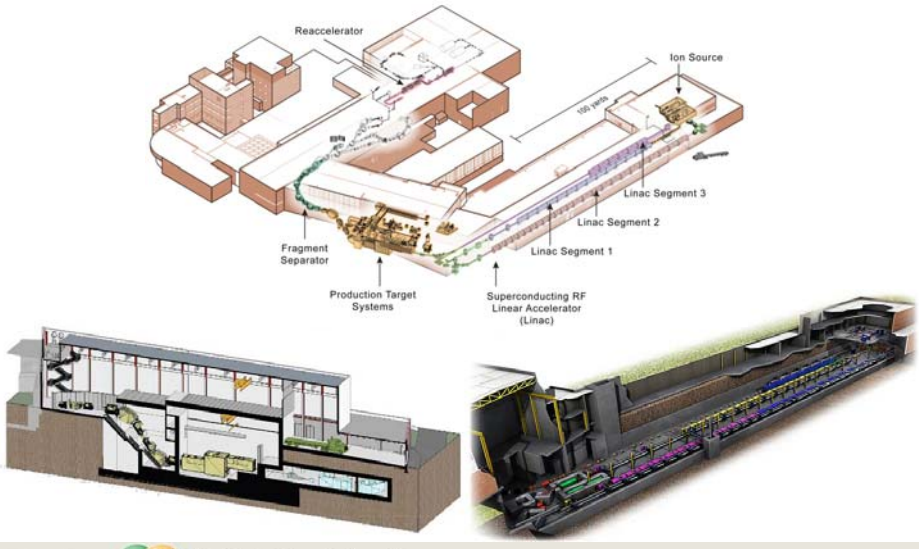
Michigan State University designs and establishes FRIB as a DOE Office of Science National User Facility in support of the mission of the Office of Nuclear Physics.

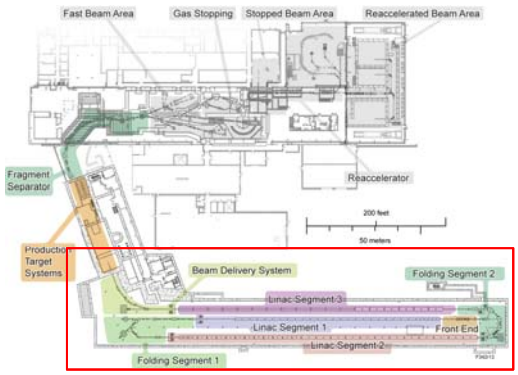
FRIB Highlights and Plan Ahead

- 8 June 2009 – DOE-SC and MSU sign Cooperative Agreement
- September 2010 – Critical Decision 1 approved, DOE issues NEPA FONSI
- October 2010 – DOE Office of Science Director Brinkman visits
- March 2011 – Lehman mini-review
- September 2011 – Lehman review
- March 2012 – Independent CD-2/3A Readiness and Cost Review
- April 2012 – Lehman Review, readiness to baseline and start civil construction
- August 2012 – Doctor Dehmer approves placement of pilings as long-lead procurement
- October 2012 – Lehman mini-review
- January 2013 – NSAC report on LRP implementation
- 4-5 June 2013 – Lehman review, Plan for CD-2/3A ESAAB
- Spring 2014 – Plan for CD-3B review
- October 2020 – Manage to early completion
- March 2022 – Plan for CD-4

FRIB Scope Unchanged Since April 2012



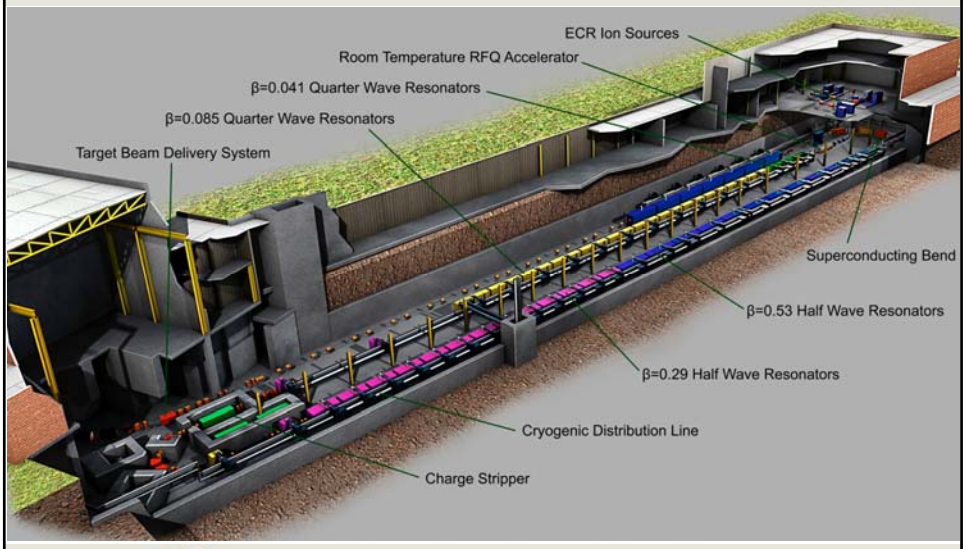
Accelerator Systems Scope Defined and Unchanged since April 2012



- Delivers FRIB accelerator as part of a DOE-SC national user facility with high reliability & availability
- Accelerate ion species up to ^{238}U with energies of no less than 200 MeV/u
- Provide beam power up to 400 kW
- Satisfy beam-on-target requirements
- Energy upgrade by filling vacant slots with 12 SRF cryomodules
- Maintain ISOL option
- Upgradable to multiuser simultaneous operation of light/heavy ions with addition of a light-ion injector

FRIB Driver Accelerator Layout Mature

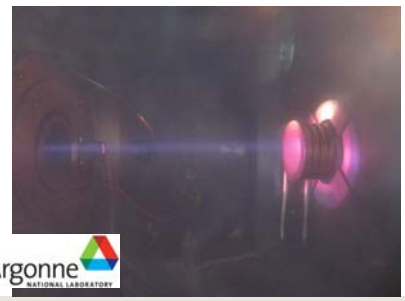
Accelerator Footprint Has Been Frozen Since June 2011



Liquid Lithium Charge Stripper Demonstrated

LANL Ion Source Commissioned at MSU & ANL Tests Successful

- Liquid lithium film established with controllable thickness and uniformity
- LEDA source beam commissioned at MSU, moved to ANL
  - Beam commissioned at MSU after restoring with new cooling and power supply system after more than 10 years of storage.
- ANL demonstrates integrity of liquid lithium film at required power density

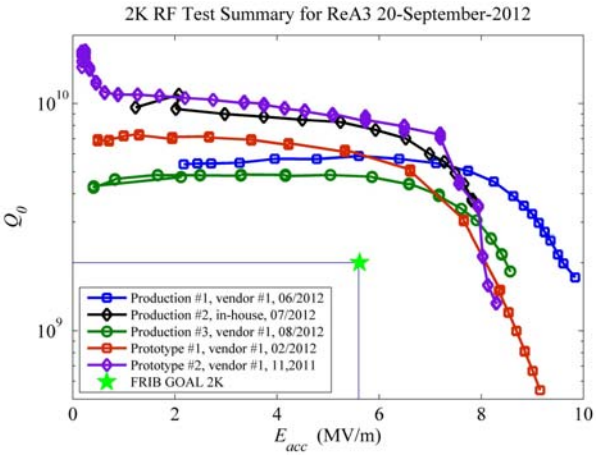


Los Alamos NATIONAL LABORATORY

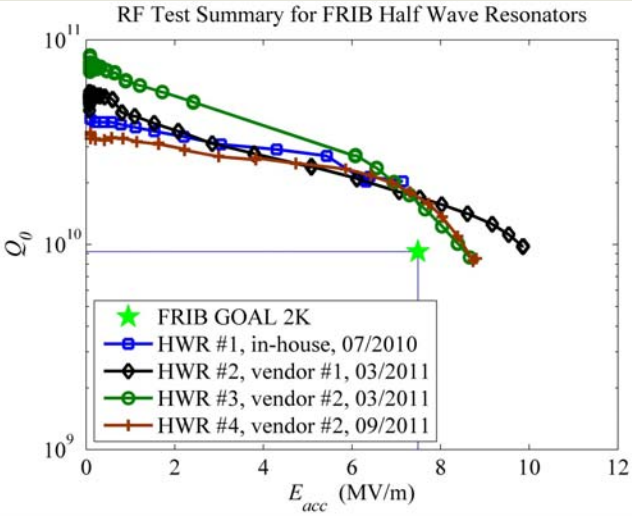
Argonne NATIONAL LABORATORY

β=0.085 Production QWR Test Results Excel
Margin Allowed Gradient Increase & Operational Reliability

- 2 prototype and 3 production cavities tested at 100% success rate since 2011



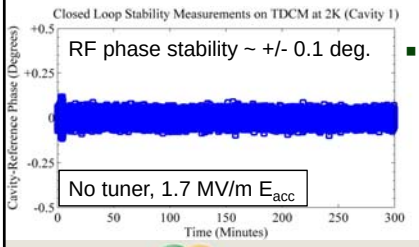
β=0.53 HWR Test/Processing Verified by JLab
All Vendor-Fabricated Cavities Meet Performance Goals



Test results independently verified at JLab

β=0.53 Prototype Cryomodule Test Met Goals

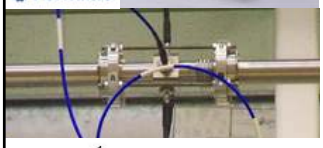
Successfully Meeting R&D Milestones in SRF Tests

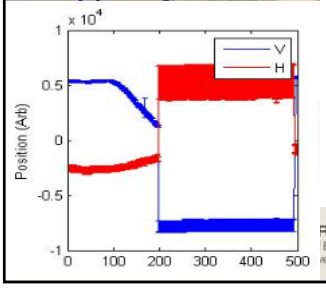


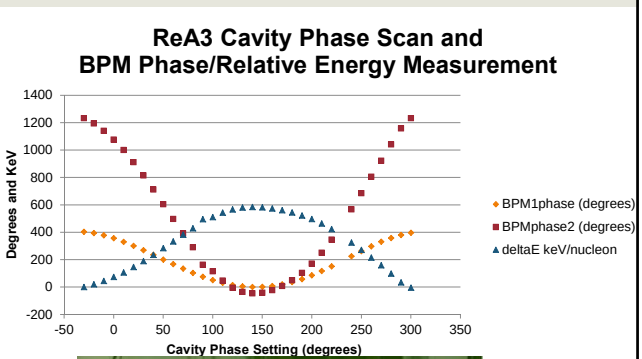
- FRIB Technology Demonstration Cryomodule R&D milestones completed
  - TDCM operates stably at 2 K temperature with excellent cryogenic stability
  - Cavities continually locked to design frequency; excellent low-level RF control
  - Coupler operated at full CW power (4.5 kW) in full reflection within specified cryogenic load
  - Magnetic shielding efficiency demonstrated
  - Ancillary components (cavity, low-level control, coupler, tuner) operating
- Lessons learned to benefit the design of FRIB preproduction cryomodules
  - Team coordination, engineering culture enforcement, magnetic material management, tuner noise, coupler/cavity multipacting, solenoid lead heat load/pressure drop, NSCL cryogenics issues

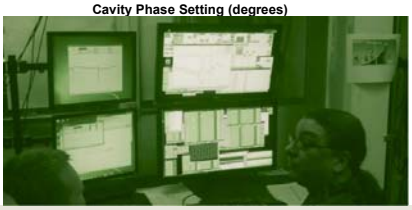
Beam Position Monitor Successfully Tested

Beam Test in ReA3 Met FRIB Specifications



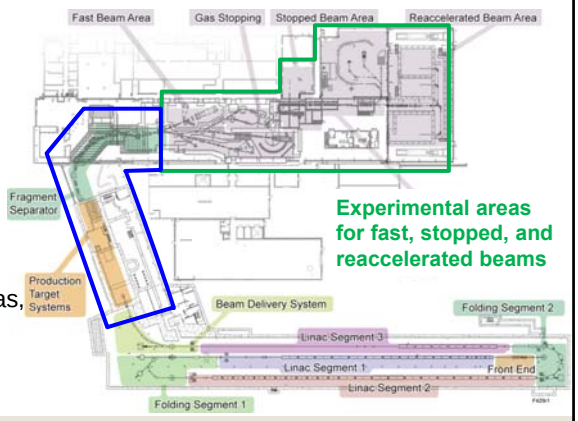






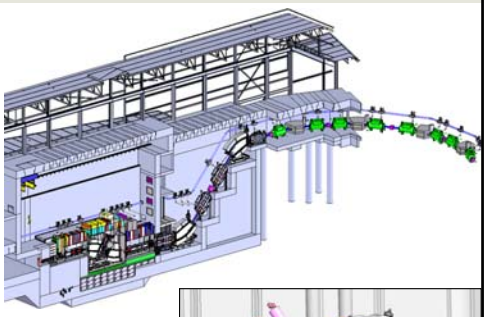
Experimental Systems Scope Defined and Unchanged since April 2012

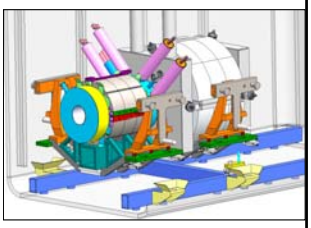
- Facility performance expectations
  - Rare isotope production with primary beams up to 400 kW, 200 MeV/u uranium
  - Fast, stopped and reaccelerated beam capability
  - Experimental areas and scientific instrumentation for fast, stopped, and reaccelerated beams
  - World-class science on day one
- Experimental Systems project scope
  - Production target facility
  - Fragment separator
- Non-TPC contributions to Experimental Systems
  - Beam stopping systems, reaccelerator, experimental areas, experimental equipment



Fragment Separator Engineering/Design
Detailed Design on Track

- Optics design unchanged and optimized
  - Detailed fields being implemented
  - Detailed imperfection sensitivity study started
  - Beam delivery to three experimental end-stations developed
- Mechanical detailed design on track
  - Vacuum vessel design optimized
  - Component mounts and alignment optimized
  - Remote-handling integrated in component design
- Magnet design on track
  - Design compatible with different super-conducting magnet technologies
  - Detailed magnet mapping supports magnet design and beam optics
- Target and Beam Dump design verification
  - Successful 50 kW target prototype test
  - Full-scale beam dump prototype built – tests at ORNL next





Ready for Civil Construction to Begin

- Site preparation and placement of pilings for earth retention complete
- Ready for start of civil construction upon approval from DOE-SC

Photo from 25 February 2013; live and time lapse images at frib.msu.edu

FRIB Users Organization
Over 1350 Users Ready for Science

FRIB Users Organization
FACILITY FOR RARE ISOTOPE BEAMS

- Users are organized as part of the independent FRIB Users Organization
  - FRIBUO has 1350 members (92 U.S. colleges and universities, 10 national laboratories, 53 countries) as of January 2013
  - Chartered organization with an elected executive committee (Chair is Michael Smith, Oak Ridge National Laboratory (ORNL))
  - FRIBUO has 20 working groups on experimental equipment
- Science Advisory Committee
  - Review of equipment initiatives (February 2011)
  - Review of FRIB integrated design (March 2012)

August 2011
Joint Users Meeting
284 participants

fribusers.org

Summary

- We are executing as planned; no significant changes or risks affecting cost, schedule, and scope since the April 2012 DOE-SC review
- Motivated team in place ready to deliver FRIB
- FRIB users ready for science
- Very constructive and result-oriented working relationship with DOE-NP, DOE-SC and DOE Chicago
- DOE review 4-5 June 2013, CD-2/3A ESAAB planned afterwards