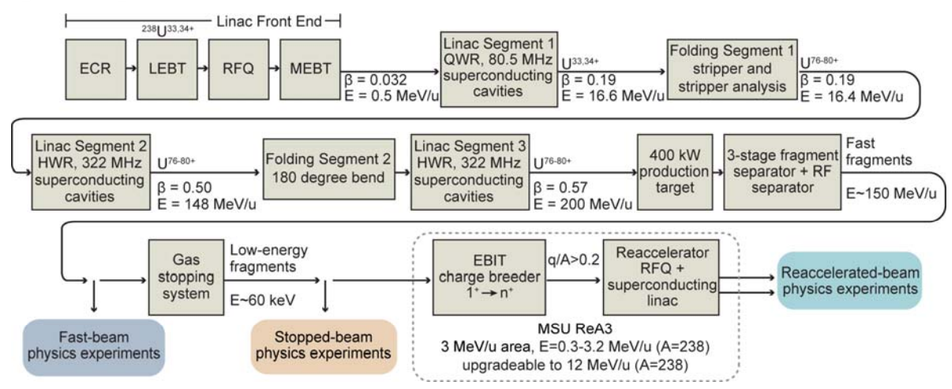
Design Status of the SRF Linac Systems for the Facility for Rare Isotope Beams

M. Leitner, J. Bierwagen, J. Binkowski, S. Bricker, C. Compton, J. Crisp, L. Dubbs, K. Elliot, A. Facco, A. Fila, R. Fontus, A. Fox, P. Gibson, P. Guetschow, L. Harle, M. Hodek, M. Johnson, S. Jones, B. Lang, D. Leitner, I. Malloch, F. Marti, D. Miller, S. Miller, T. Nellis, D. Norton, R. Oweiss, J. Popielarski, L. Popielarski, X. Rao, G. Velianoff, N. Verhanovitz, J. Wei, J. Weisend, M. Williams, K. Witgen, J. Wlodarczak, Y. Xu, Y. Zhang

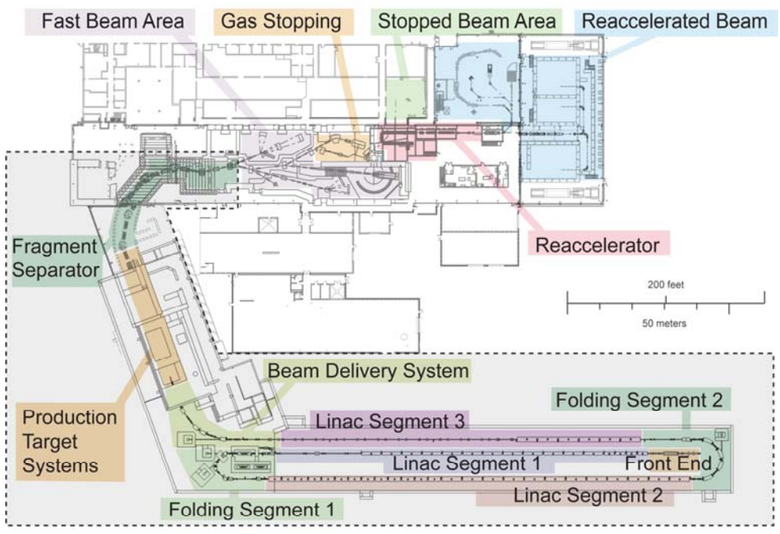
Facility for Rare Isotope Beams (FRIB), Michigan State University, East Lansing, MI 48824 USA

Summary

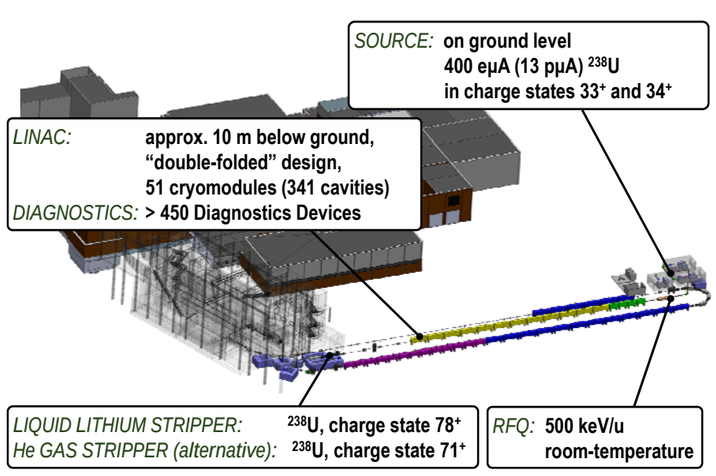
The Facility for Rare Isotope Beams (FRIB) will utilize a powerful, superconducting heavy-ion driver linac to provide stable ion beams from protons to uranium, at energies of > 200 MeV/u at a beam power of up to 400 kW. ECR ion sources installed above ground will be used to provide highly charged ions, that will be transported into the linac tunnel approx. 10 m below ground. For the heaviest ions, two charge states will be accelerated to about 0.5 MeV/u using a room-temperature 80.5 MHz RFQ and injected into a superconducting cw linac, consisting of 112 quarter-wave (80.5 MHz) and 229 half-wavelength (322 MHz) cavities, installed inside 51 cryomodules operating at 2K. A single stripper section will be located at about 17 MeV/u (for uranium). Transverse focusing along the linac will be achieved by 9 T superconducting solenoids within the same cryostat as the superconducting rf accelerating structures. The project is currently progressing towards a Department of Energy performance baseline definition in spring 2012. Pending DOE approval for CD-3a (Start of Construction for Conventional Facilities), the project plans to start target building and linac tunnel construction in 2012.

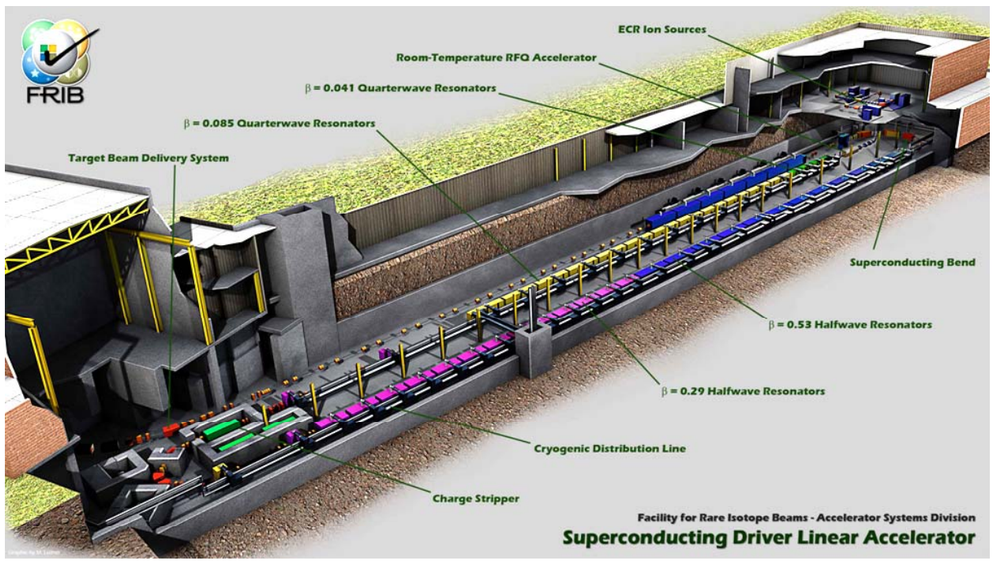


Functional System Diagram of the FRIB Facility

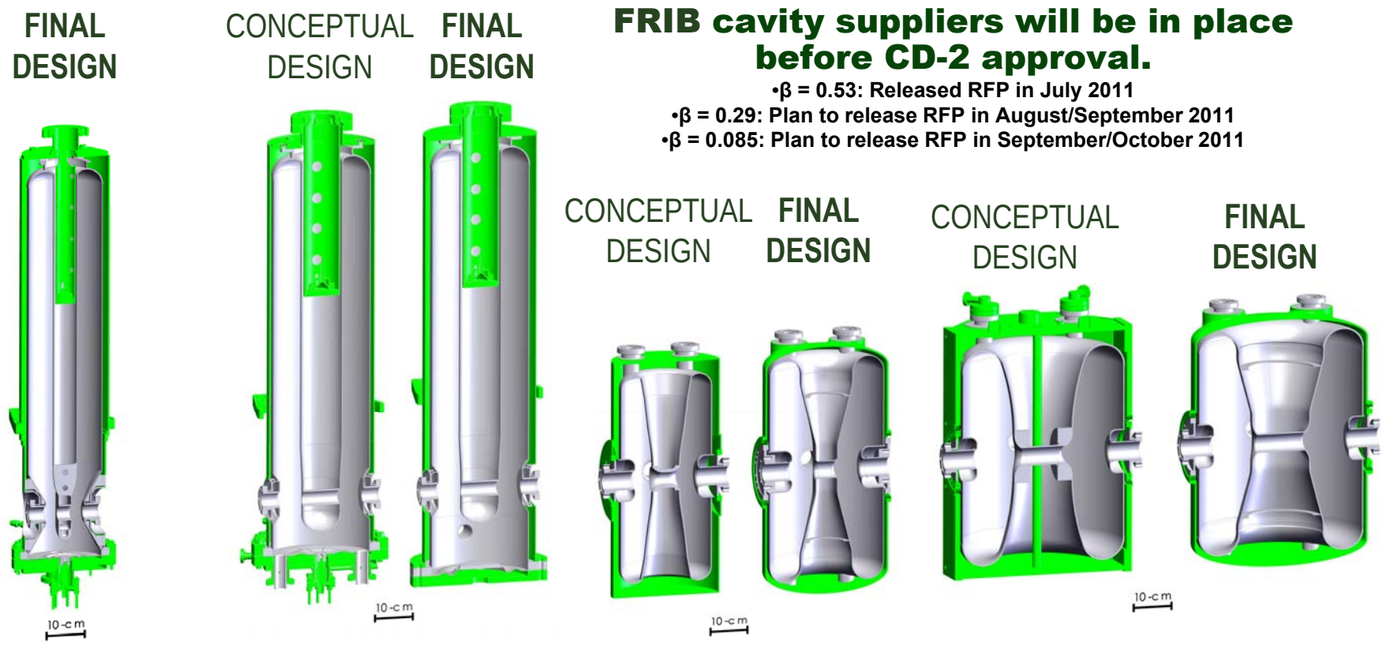


FRIB Project at MSU
Project of $614.5M ($520M DOE, $94.5M MSU)





Layout of the FRIB facility displaying the folded linac design, 400 kW CW production target, fragment separator, as well as nuclear science experimental facilities for fast, stopped, and re-accelerated radioactive beams.



β = 0.041 cavity
(12 cavities in FRIB linac)

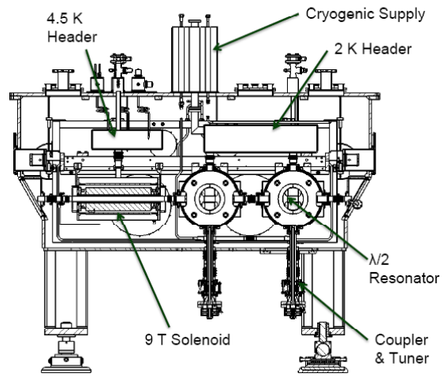
β = 0.085 cavity
(100 cavities in FRIB linac)

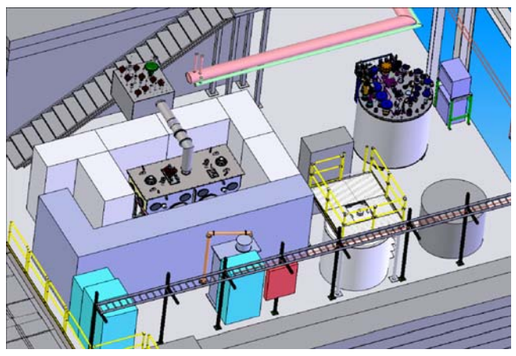
β = 0.29 cavity
(82 cavities in FRIB linac)

β = 0.53 cavity
(147 cavities in FRIB linac)

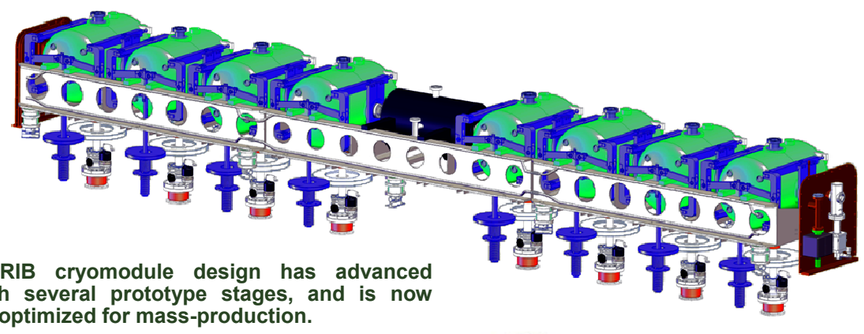
FRIB cavity suppliers will be in place before CD-2 approval.

- **β = 0.53: Released RFP in July 2011**
- **β = 0.29: Plan to release RFP in August/September 2011**
- **β = 0.085: Plan to release RFP in September/October 2011**

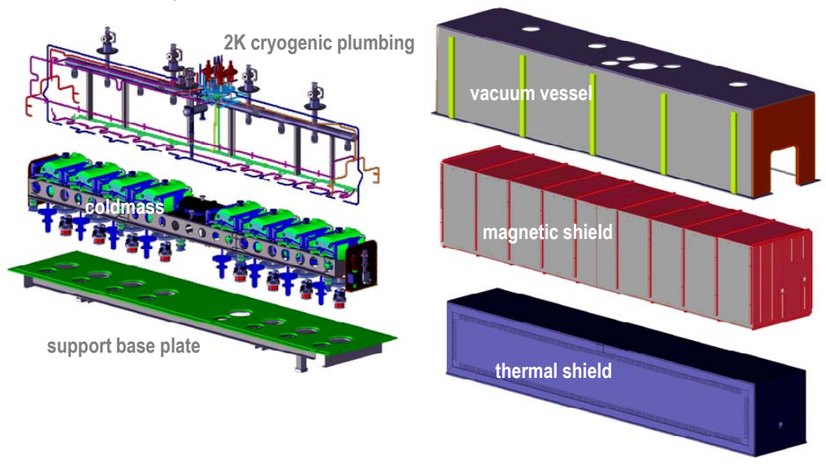




FRIB is currently assembling a Technology Demonstration Cryomodule (TDCM) with two β = 0.53 half wave resonators and one 9 T solenoid. The TDCM serves as half-wave cryomodule prototype as well as 2K systems test.



The FRIB cryomodule design has advanced through several prototype stages, and is now highly optimized for mass-production.



FRIB Cavity and Coldmass Acquisition Scope

Quarter Wave Resonators:

Type	Development Run (no helium vessel)	Pre-Production Run (with helium vessel)	FRIB LINAC	10% excess	TOTAL
	FY2011 - FY2012	FY 2012 - FY2013	FY2014 - FY2017		
β = 0.041	-	-	12	1	13
β = 0.085	2	10	100	10	122

Half Wave Resonators:

Type	Development Run (no helium vessel)	Pre-Production Run (with helium vessel)	FRIB LINAC	10% excess	TOTAL
	FY2011 - FY2012	FY 2012 - FY2013	FY2014 - FY2017		
β = 0.29	2	10	82	8	102
β = 0.53	2	10	147	14	173
TOTAL:			341		410

Quarter Wave Coldmasses:

		Number of Cryomodules	Number of Cavities	Number of Solenoids
β = 0.041	Accelerating Cryomodules:	3	12	6
	Matching Cryomodules:	-	-	-
β = 0.085	Accelerating Cryomodules:	12	96	36
	Matching Cryomodules:	2	4	0

Half Wave Coldmasses:

		Number of Cryomodules	Number of Cavities	Number of Solenoids
β = 0.29	Accelerating Cryomodules:	13	78	13
	Matching Cryomodules:	2	4	0
β = 0.53	Accelerating Cryomodules:	18	144	18
	Matching Cryomodules:	1	3	0
TOTAL:		51	341	73

FRIB Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

This material is based upon work supported by the U.S. Department of Energy Office of Science under Cooperative Agreement DE-SC0000661.
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.