DESIGN OF A FRIB HALF-WAVE PRE-PRODUCTION CRYOMODULE

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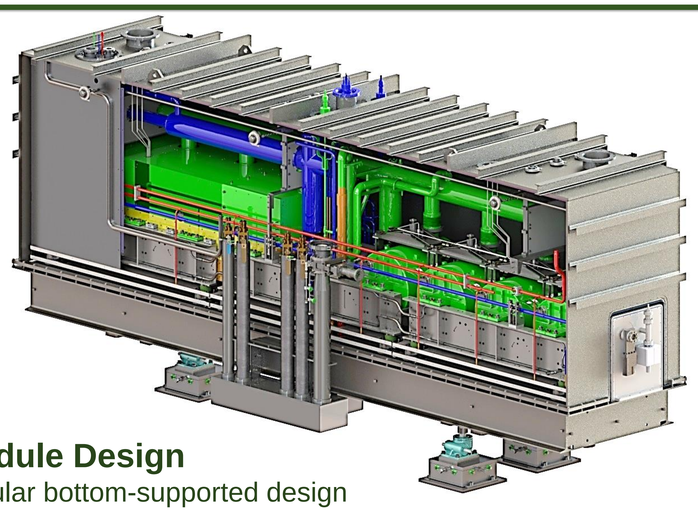
Abstract

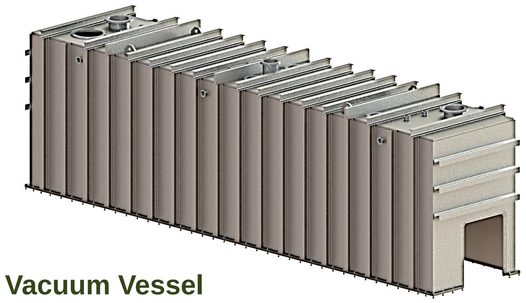
The driver linac for the Facility for Rare Isotope Beams (FRIB) will require the production of 48 cryomodules. FRIB has completed the design of a β=0.53 half-wave cryomodule as a pre-production prototype. This cryomodule will qualify the performance of the resonators, fundamental power couplers, tuners, and cryogenic systems of the β=0.53 half-wave design. In addition to the successful systems qualification; the β=0.53 cryomodule build will also verify the FRIB bottom up assembly and alignment method on a half-wave cryomodule type. The lessons learned from the β=0.085 pre-production cryomodule build including valuable fabrication, sourcing, and assembly experience have been applied to the design of β=0.53 half-wave cryomodule. This paper will report the design of the β=0.53 half-wave cryomodule as well as the cryomodule interfaces within the linac tunnel.



Cryomodule Design

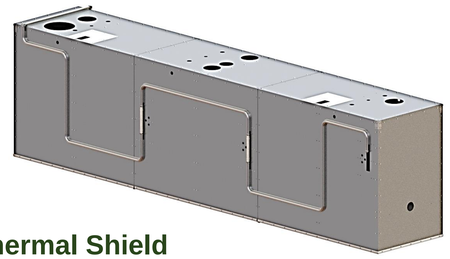
- Modular bottom-supported design
- Optimized for mass-production and efficient precision-assembly
- Designed with a focus on commonality between the cryomodules
- Incorporated robust manufacturing methods
- Minimized material usage and assembly time

Type	Cryomodule Quantity	Resonator Quantity	Solenoid Quantity
β=0.041	3	12 (4)	6 (2)
β=0.085	11	88 (8)	33 (3)
β=0.29	12	72 (6)	12 (1)
β=0.53	18	144 (8)	18 (1)
Matching Modules	3 (β=0.085) 1 (β=0.53)	12 (4) 4 (4)	0 0
Total	**48**	**332**	**69**



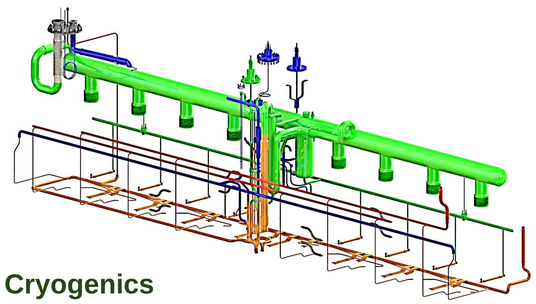
Vacuum Vessel

- Insulating vacuum space is sealed by an O-ring gasket
- Allows for simultaneous horizontal and vertical sealing
- Constructed primarily from A36 (UNS K02600)



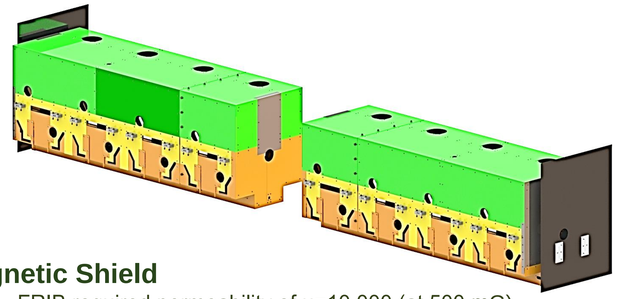
Thermal Shield

- Segmented construction which simplifies assembly
- Allows for differential contraction
- Constructed from 1100-H14 Aluminium (UNS A911000)
- Cooled via a custom extrusion to distribute 38 K helium



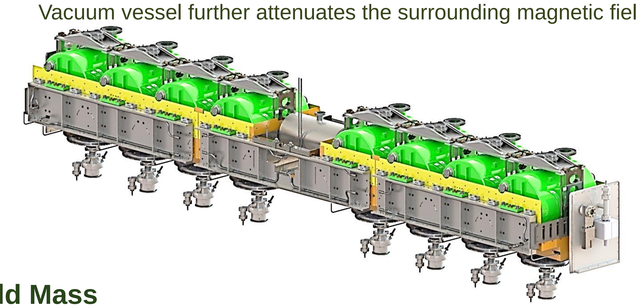
Cryogenics

- Separate helium circuit for the resonators (2 K) and solenoids (4.5 K)
  - Allow for magnetic degaussing cycles
- Gaseous helium thermal shield circuit, operating at 38 K



Magnetic Shield

- FRIB required permeability of μ=10,000 (at 500 mG)
- 2 mm thick mu-metal local shield for the two sets of four resonators
- Vacuum vessel further attenuates the surrounding magnetic field.



Cold Mass

- Precision machined rails set the resonator and solenoid alignment
- 3 piece 316L stainless steel (UNS S31603) welded alignment rail
  - Annealed to relieve residual stress and restore permeability

Baseplate

- Provides rigid support for cold mass alignment
- Precision machined bearings allow for differential contraction
- Constructed primarily from A36 (UNS K02600)

Conclusion

The β=0.53 pre-production cryomodule design is complete. Procurement of components for this cryomodule is complete and assembly is taking place at FRIB. Continuous vendor interaction is essential to ensure critical features for alignment, performance, and functionality are maintained. The testing of the cryomodule is planned before the end of 2016 and will validate the HWR subsystems, alignment, and system level performance in the cryomodule. Design effort is now underway on design for the Beta=0.085 and Beta=0.53 matching cryomodules for the FRIB linac. The Beta=0.29 cryomodule design is being developed in collaboration with JLAB and is expected to complete in early 2017.

FRIB Facility for Rare Isotope Beams
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