



Cryomodule Development at Fermilab



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Representing the SRF engineering community at Fermilab

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TILC09



Today's focus: Fermilab's Cryomodule development



Overall FNAL Cryomodule Effort

- 2008: CM1 built at FNAL with ALL components provided by DESY and INFN (Zanon) – Type III+
- 3rd Harmonic Cryomodule to ship to DESY in April 2009. Completely built at FNAL.
- 2009: Summer – building CM2 at FNAL Type III+ design, FNAL providing cavities. Coldmass and Cryostat provided by INFN (Zanon)



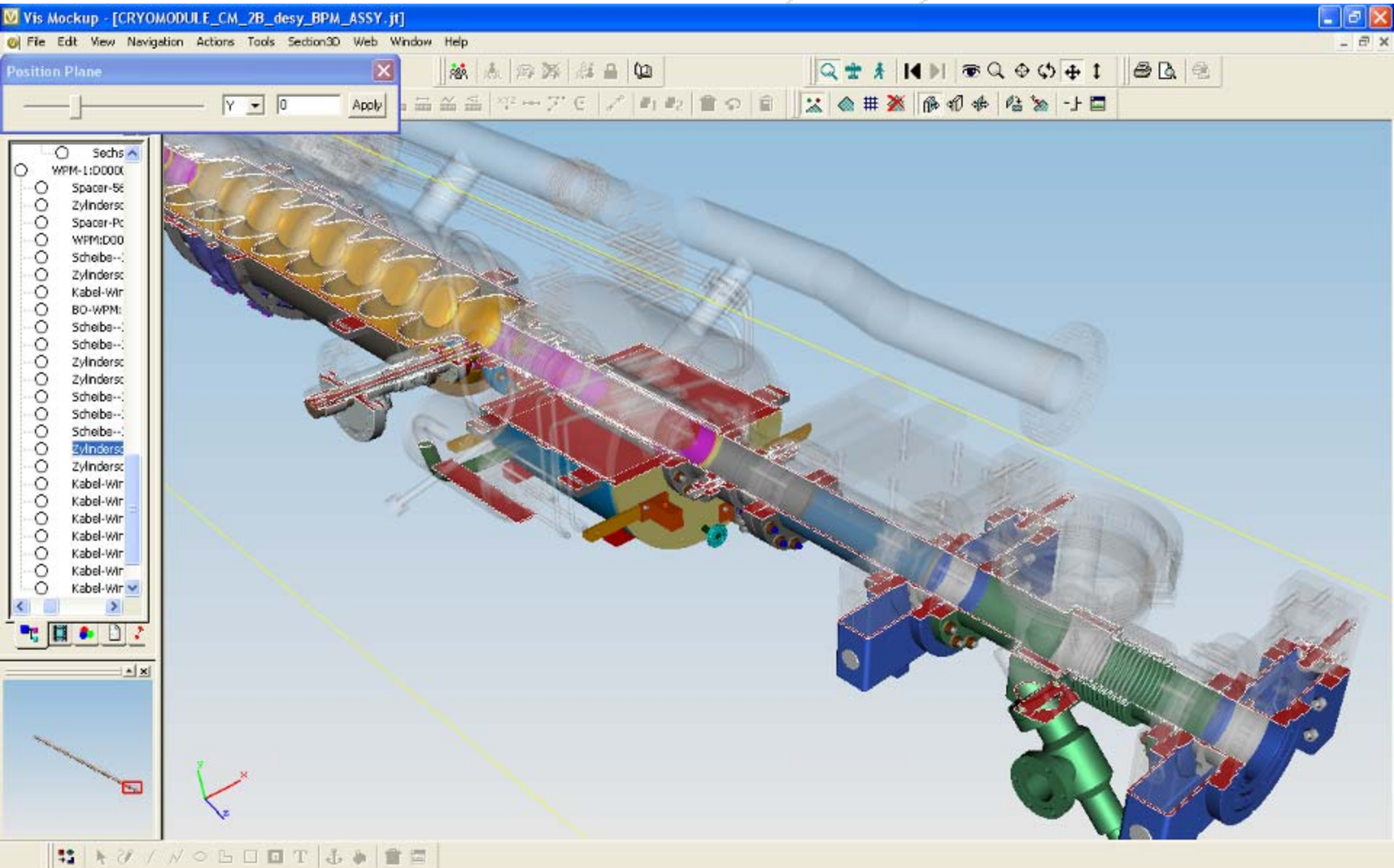
Cryomodule Effort, cont.

- Order T4CM components by August 2009. Design currently in final stages.
 - FNAL procurement
 - FNAL built
- 2009: Begin working with US industry to procure 2 more T4CMs. Deliver in 2010.
 - Cost reduction
 - Help develop US industry capabilities
 - Utilize FNAL facilities for cryomodule assembly
 - Develop at least 2 suppliers



Cryomodule Design Effort

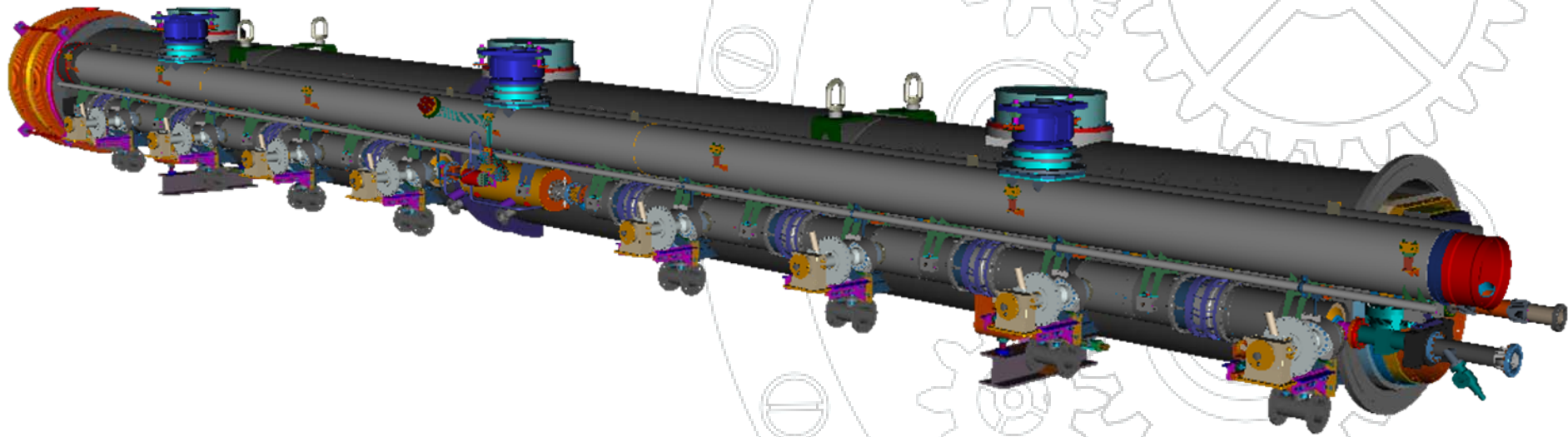
- In December, 2007, the design of the Type IV Cryomodule was halted due to funding constraints.
 - 95% of the 3-D model was complete.
 - 90% of the drawings are complete but need checking
- Design effort re-focused on CM2
 - Magnet package was designed to fit into CM2 (TTF III+)
 - Compatible with Fermilab's test facility requirements
 - To be fabricated and assembled in 2009
- Now with renewed funding, the T4CM will be completed
 - All US fabrication of cryomodule components
 - Magnet centered on cryostat
 - Not the final ILC or Project X cryomodule



Courtesy of Youri Orlov, FNAL

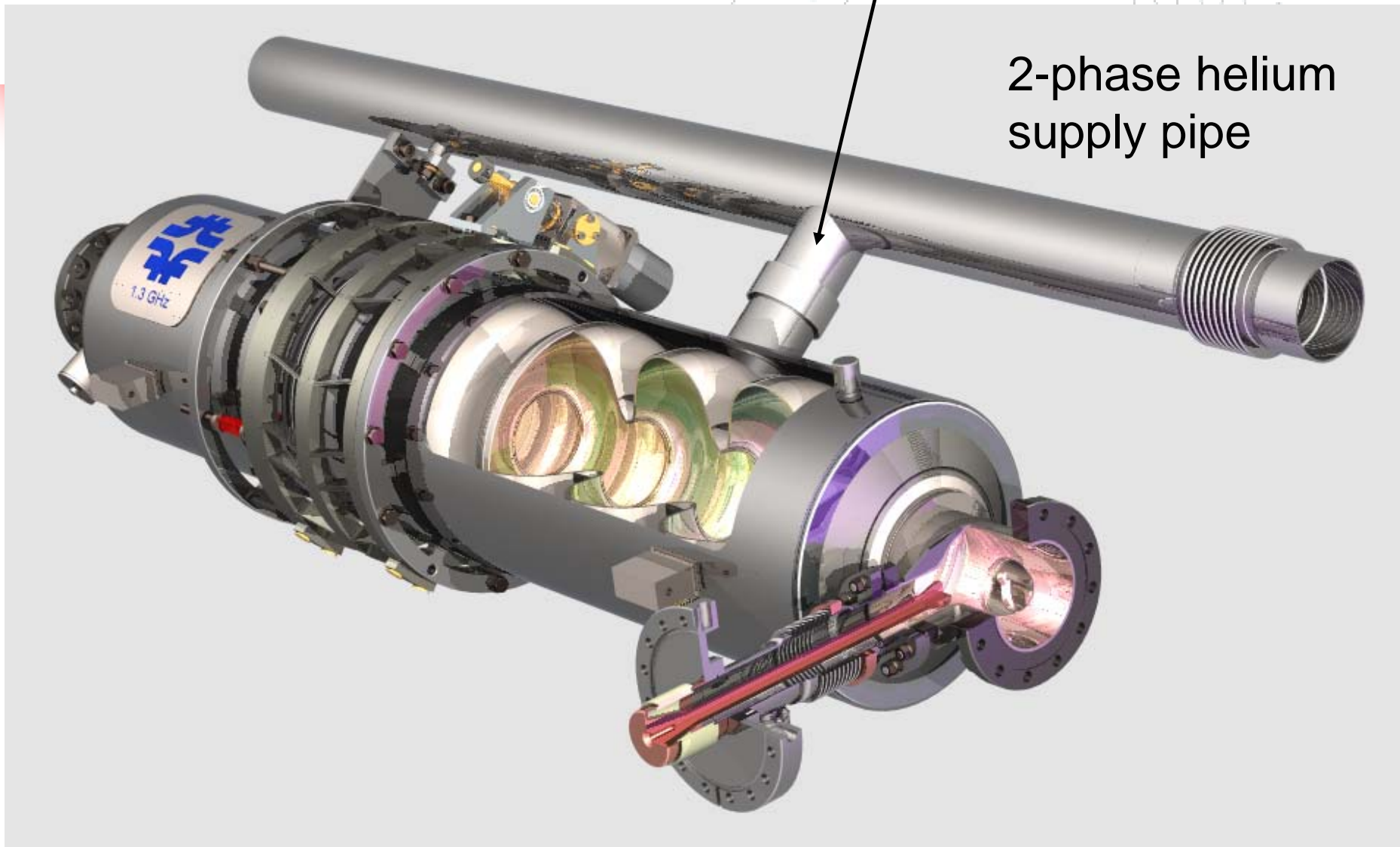


Type IV Cryomodule (T4CM)



**Magnet Package located
under center post**

Investigated Nb, stainless steel, niobium with tabular transition



INFN Bladetuner, FNAL procured cavity and He vessel

Fermilab's Cleanroom at MP9



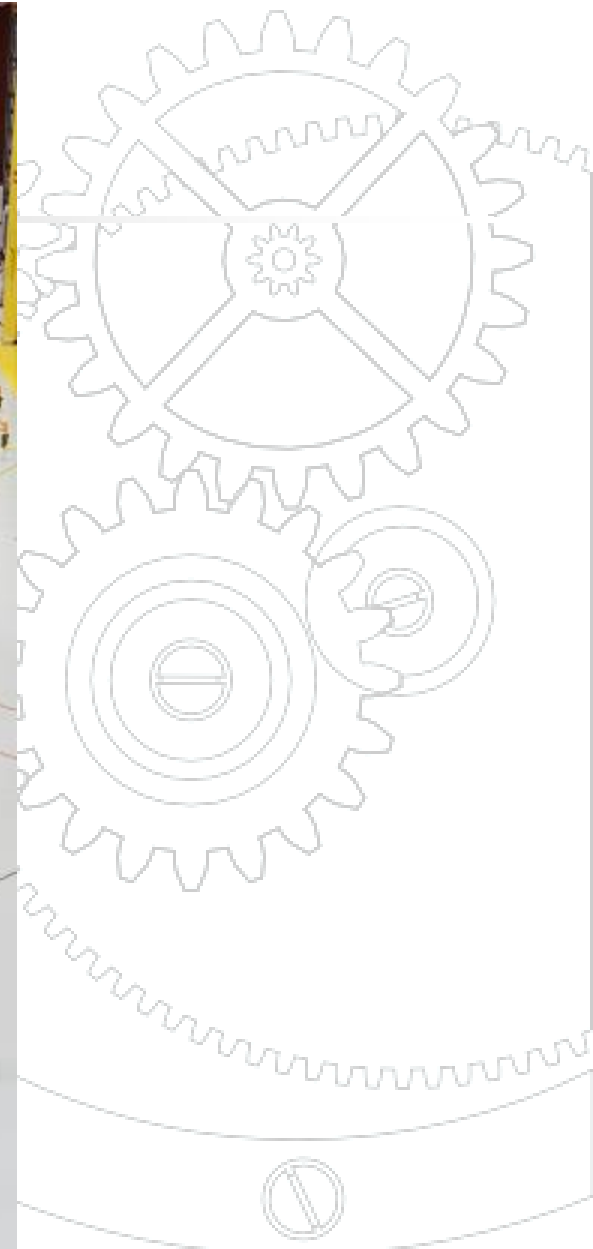
Cryomodule Assembly



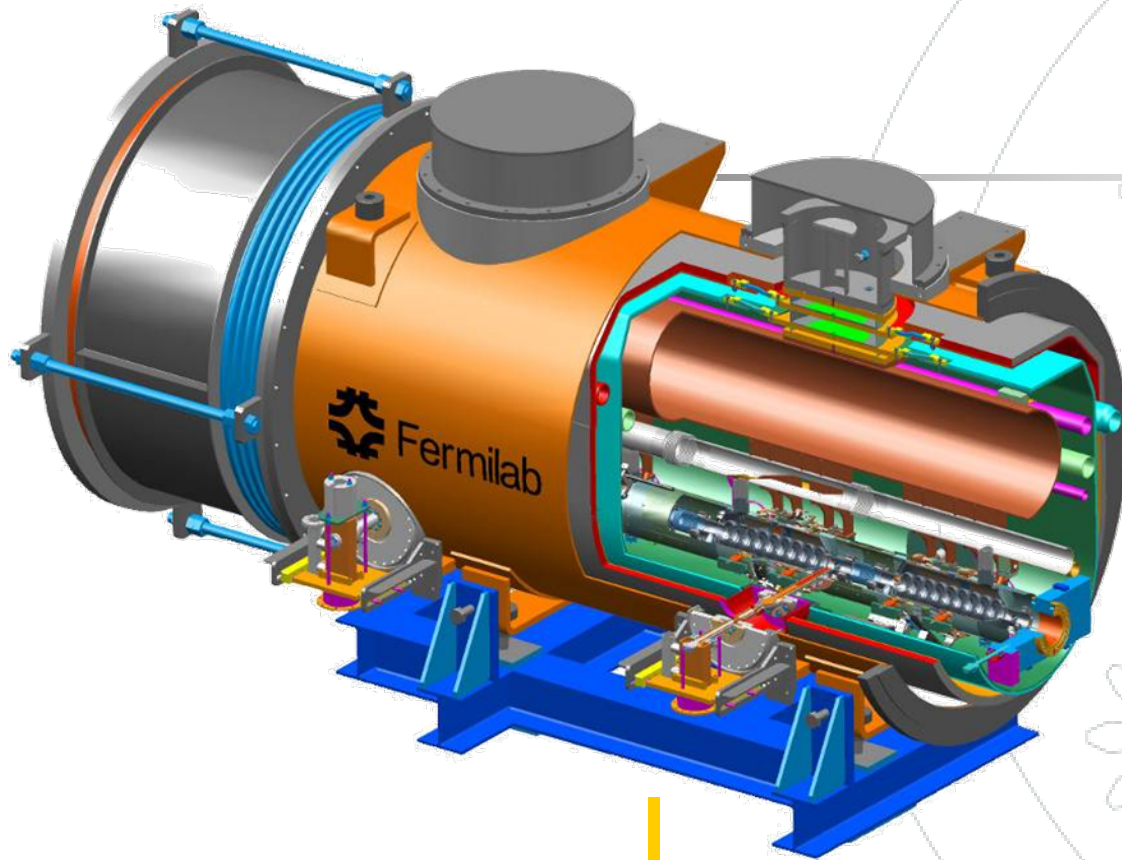
Cryomodule Assembly, ICB



Cryomodule Assembly



3rd Harmonic Ships to DESY!



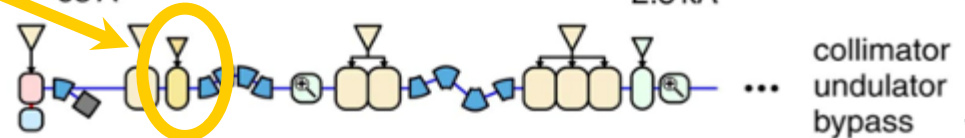
FLASH linac with 3rd harmonic rf

4 MeV
3.3 mm
65 A

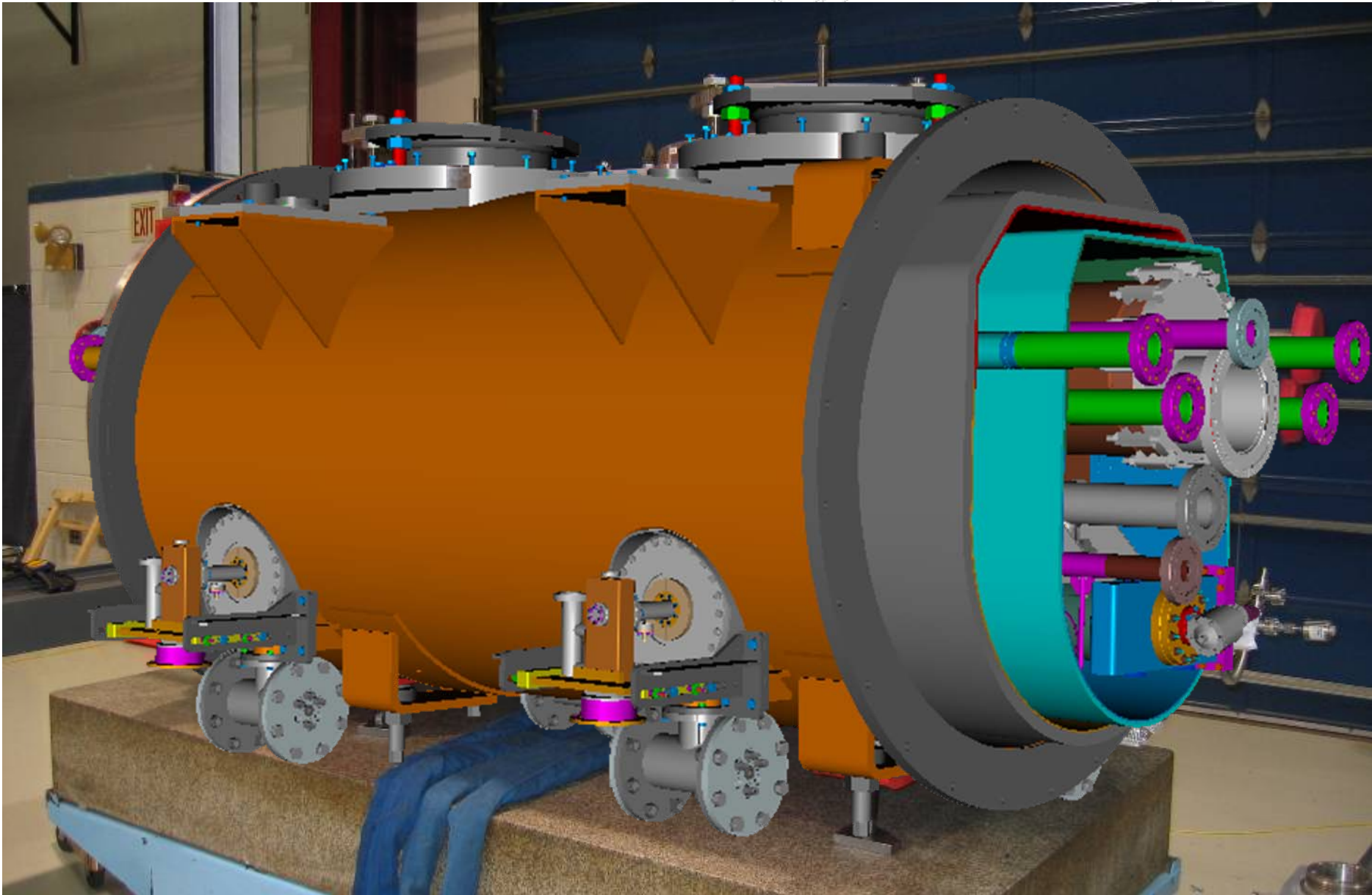
130 MeV

380 MeV
μm

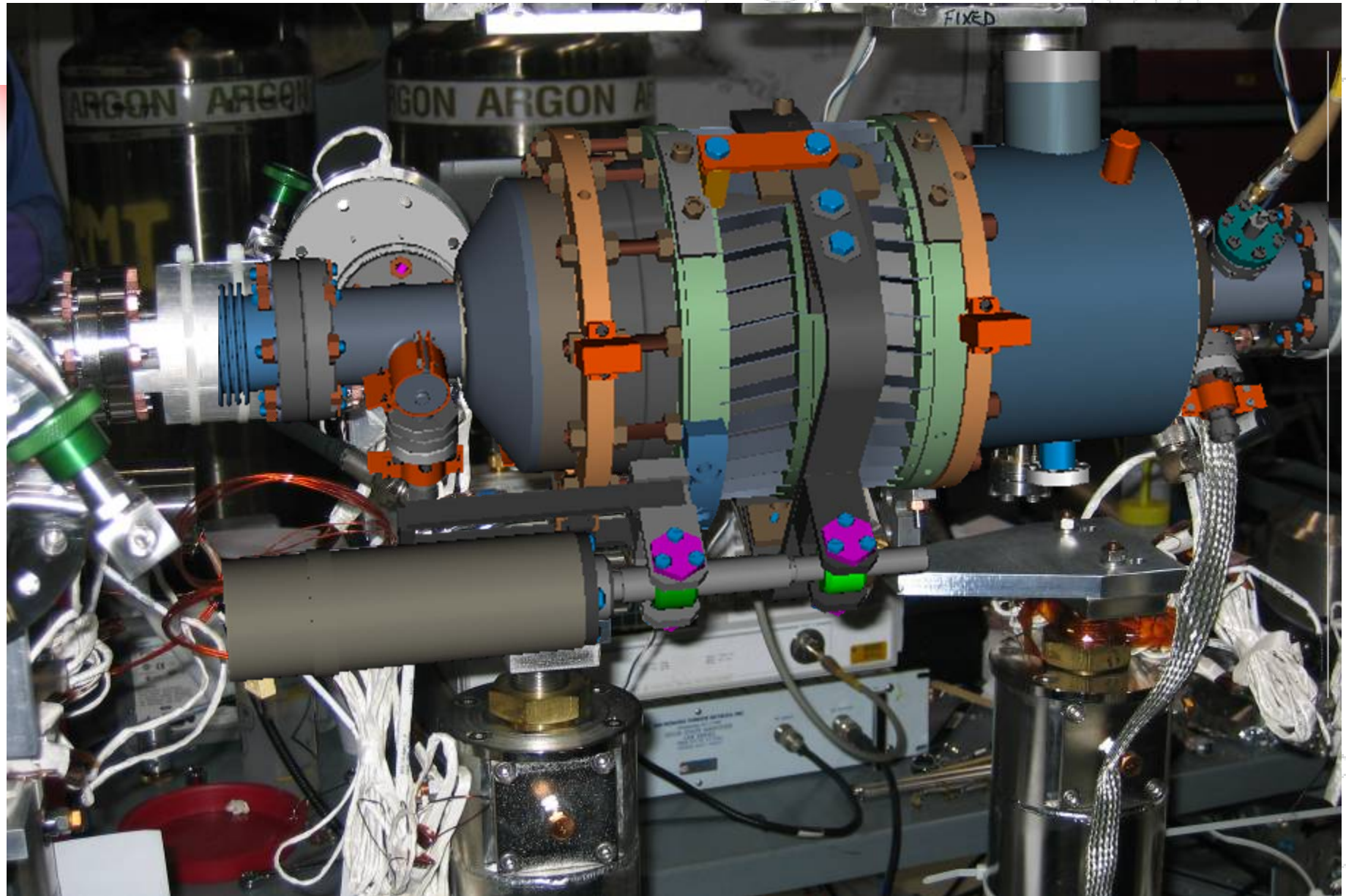
1000 MeV
10 μ m
2.5 kA



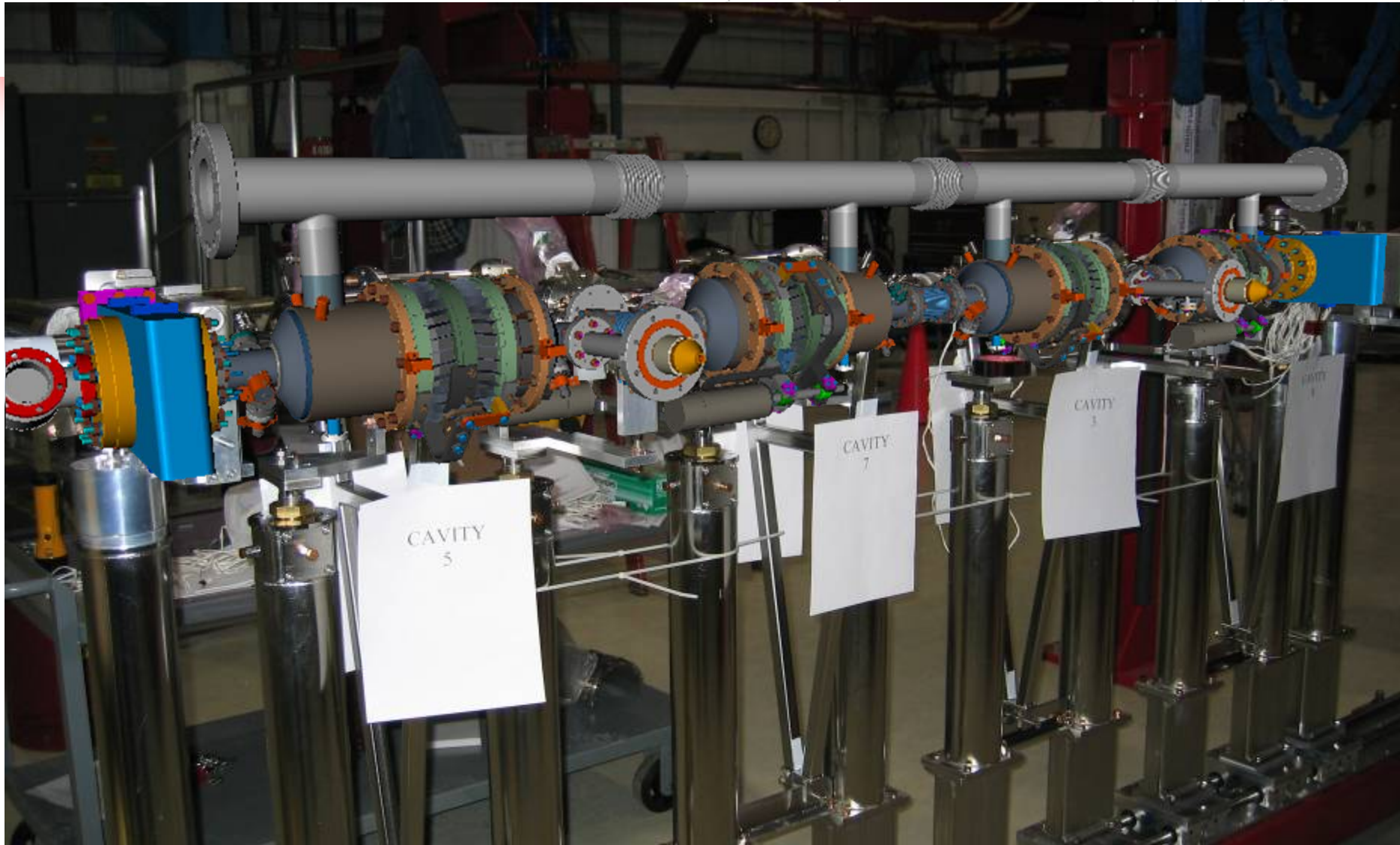
3rd Harmonic: Design to Reality



Cavity Design



Cavity String Assembly



Coldmass Assembly



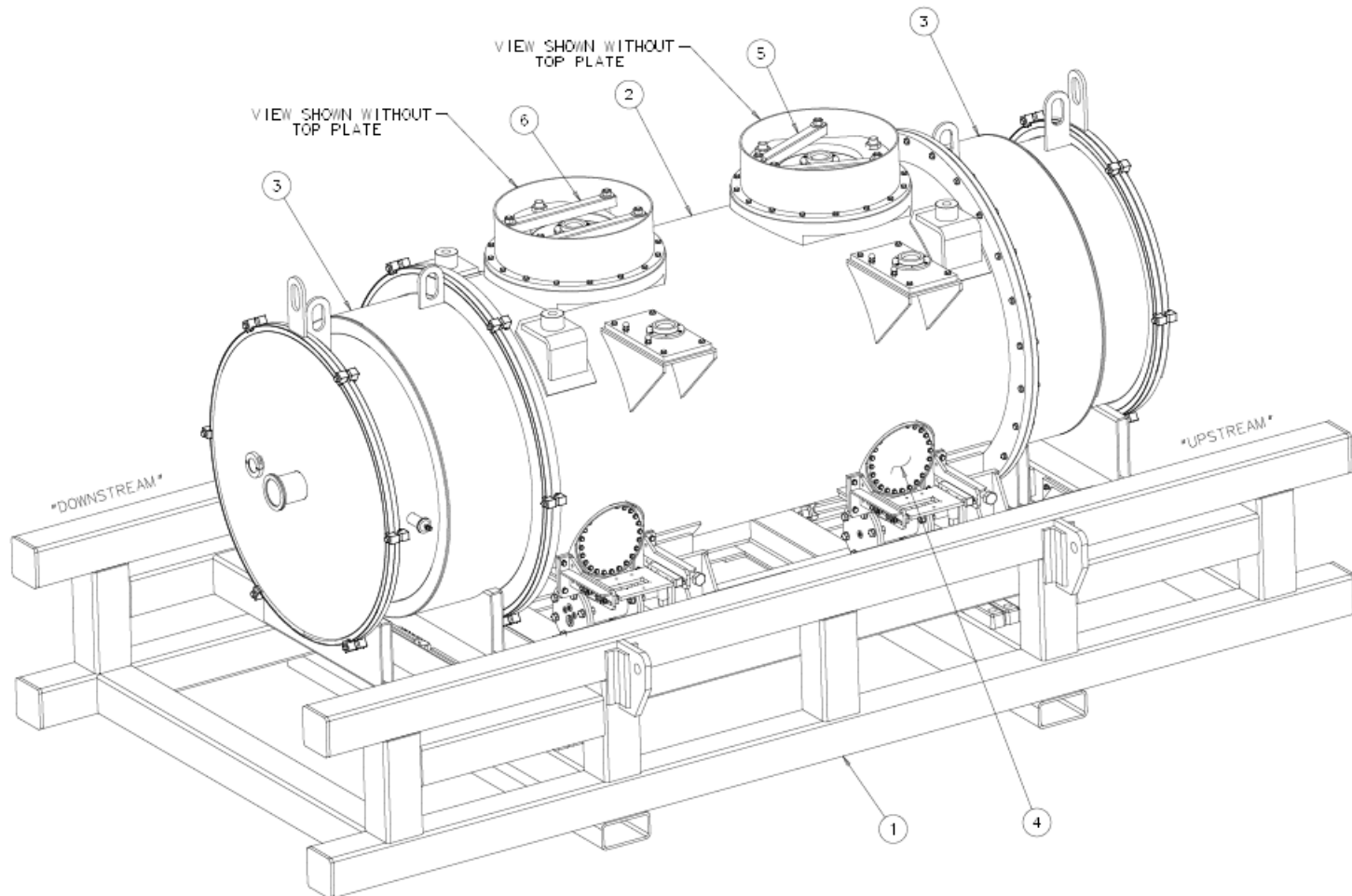
Coldmass Assembly



Shipping to DESY



3rd Harmonic on Shipping Fixture



Indian Collaboration

- Helium Gas Return Pipe (HGRP) redesign
 - Uses standard pipe with lower tolerances
 - Lower cost
 - Laser welded components
- Explosion bonded Nb-to-SS joint development
- Needle bearing redesign
- Scissor tuner
- Wedge tuner
- Thermal blanket design rather than single sheets
- Two-phase pipe redesign
 - Single pipe
 - Bellows connection down to each cavity
- β .81 cryomodule design and deliverable to Fermilab

RF Unit Test Facility at NML



New Muon Lab



NML Project Overview

- Overall Plan
 - Build an RF Unit Test Facility at New Muon Lab Building (NML)
 - One RF Unit (3 ILC-like Cryomodules)
 - 10-MW RF System
 - Beam with ILC/Project-X parameters (3.2 nC/bunch @3 MHz, Up to 3000 bunches @ 5Hz, 300- μ m rms bunch length)
- Phase-1 (FY07 - FY09)
 - Prepare Facility for Testing First Cryomodule (CM1) without Beam
 - Infrastructure, RF Power, Cryogenics (Refrigerator #1)
 - Install First Cryomodule (CM1), Cooldown, and RF Test
- Phase-2 (FY10 - FY11)
 - Prepare for First Beam
 - Install Gun, Injector, Test Beamlines, Second Cryomodule (CM2)
 - Generate First Beam
- Phase-3 (FY11 - FY13)
 - Complete RF Unit
 - Upgrade RF System to 10 MW, Install Third Cryomodule (CM3)
 - Operate Full RF Unit with Beam

NML Infrastructure (FY07-08)



NML During Removal of Chicago Cyclotron Magnet (CCM) (September, 2006)



NML Facility after CCM Removal and Floor Painting (February, 2007)

SRF Test Facility at NML

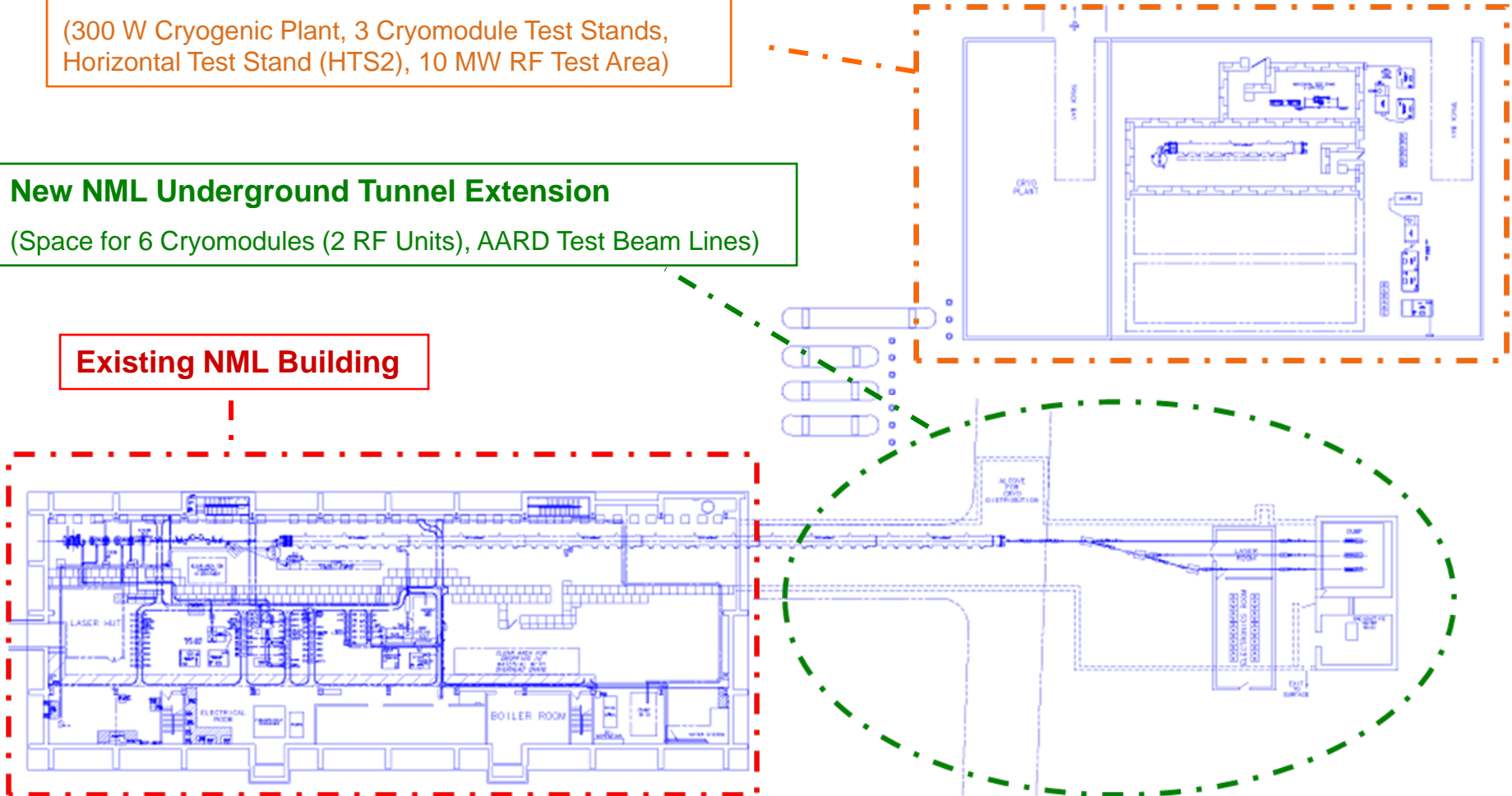
New Cryoplant Building

(300 W Cryogenic Plant, 3 Cryomodule Test Stands, Horizontal Test Stand (HTS2), 10 MW RF Test Area)

New NML Underground Tunnel Extension

(Space for 6 Cryomodules (2 RF Units), AARD Test Beam Lines)

Existing NML Building



Current Picture of NML Facility



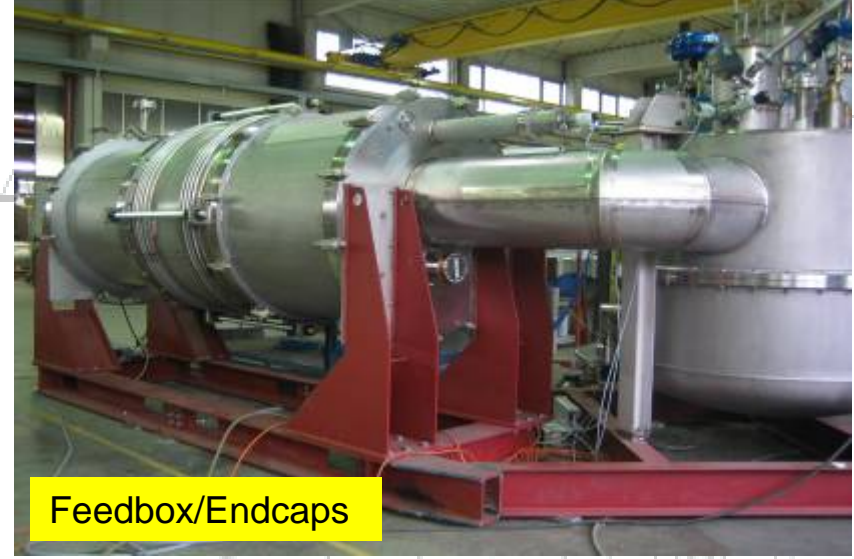
Viewed From North end



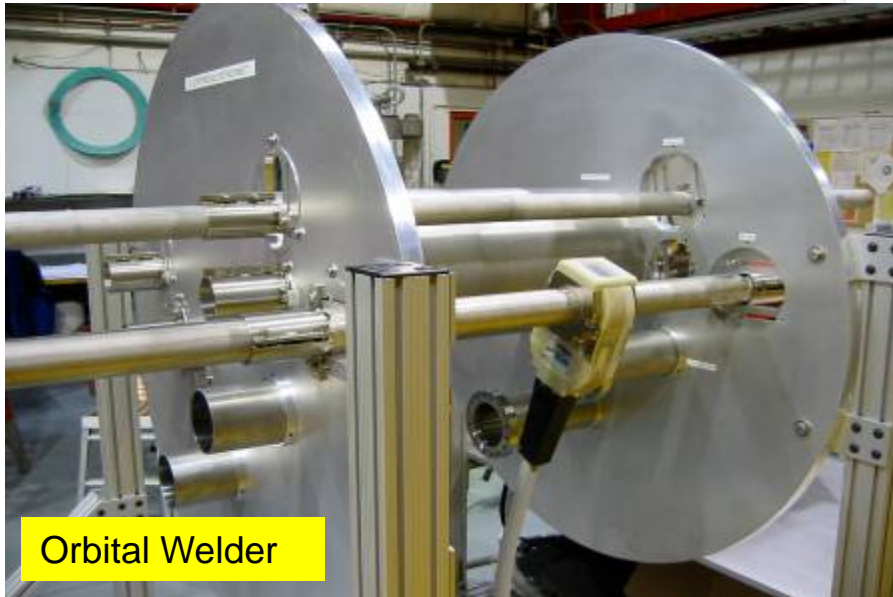
NML Cryogenic System



Cryo. Room



Feedbox/Endcaps



Orbital Welder



Cryo Vac. Pump

NML RF System

■ RF System

- 5 MW for CM1
 - Ready for Commissioning
- 300 KW for CC2
 - Ready for Commissioning
- Distribution
 - CM1 Distribution from SLAC
 - 1st Section at NML, Remaining due 2/09

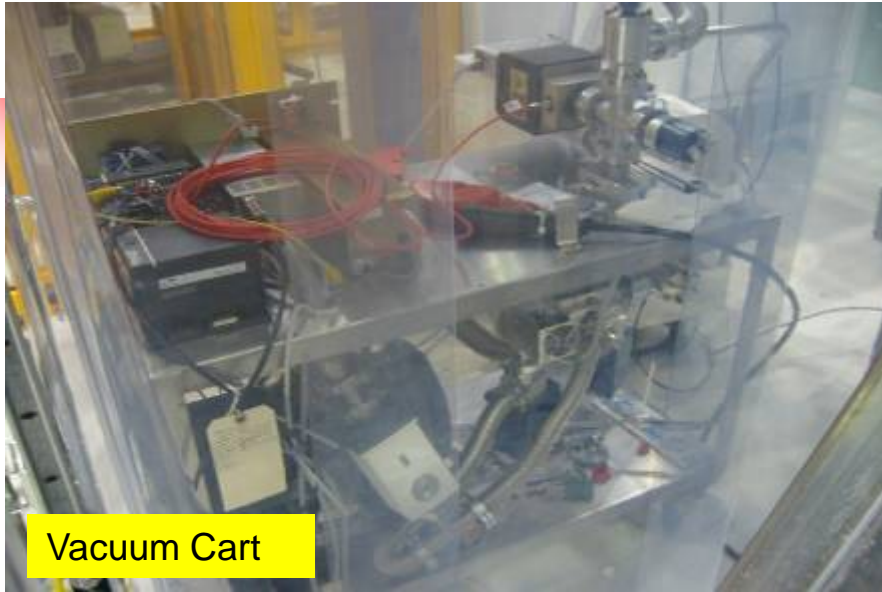


NML Accelerator (CM1)

- Injector
 - Lattice is Designed
 - New Gun Being Built (Will be Tested at A0)
 - CC2 Installation Scheduled for 2/09
- Accelerator
 - Cryo. Girder/CM Support Installed & Aligned
 - First Cryomodule Initially Installed (8/08)
- Test Beamline
 - Lattice Designed
 - Beam Absorber Analysis Complete



NML Auxiliary Systems



Vacuum Cart



Portable Cleanrooms



Water System



Inside Cave

NML Controls/Instrumentation

- Controls
 - Control Room Finished and Operational
 - Wireless Network Installed Throughout Building
- Instrumentation
 - Wire Position Monitors for CM1 Tested and Installed in Endcaps
 - Faraday Cup Assembled
 - RF Protection/Interlock System Complete





Special thanks to...

- Chuck Grimm: Component design
 - Yuri Orlov: Cryomodule design
 - Tug Arkan: Cryomodule Assembly
 - Jerry Leibfritz: New Muon Lab coordination
 - And many other designers, engineers, and physicists who have participated on SRF development at Fermilab both locally and internationally.
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