Cryomodule Assembly Facility (CAF) at Fermilab

Current Status Report

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Tesla Technology Collaboration Meeting
October 20-23, 2008

Outline

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- Cryomodule Assembly Workflow at CAF
- CAF-MP9 & CAF-ICB Infrastructure
- Cryomodule Transportation
- Helium Vessel Development for CM2 cavities
- Summary

Assembly Workflow @ CAF-MP9

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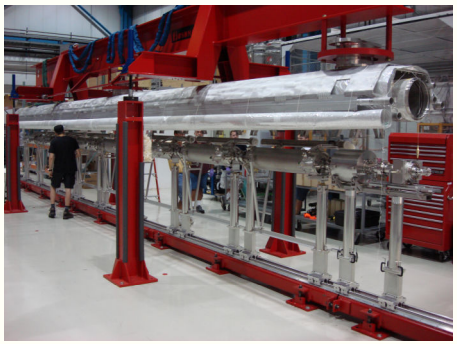
Receive dressed Cavities



Receive peripheral parts

Assemble dressed Cavities to form a String in the **Cavity String Assembly Area** (Clean Room)

Install String Assembly to Cold Mass in the **Cold Mass Assembly Area**

Transport the Cold Mass to **CAF-ICB**

Assembly Workflow @ CAF-ICB

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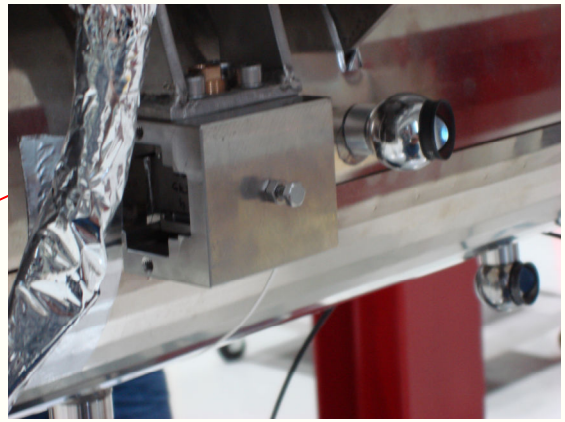
Install the Cold Mass back to the Cold Mass Assembly Fixture in **Cold Mass Assembly Area**

Align Cavity String to the Cold Mass Support



Install the String assembly with the cold mass into the Vacuum vessel in the **Vacuum Vessel Assembly** area

Ship Completed Cryomodule to **ILCTA-NML** for testing

CAF-MP9

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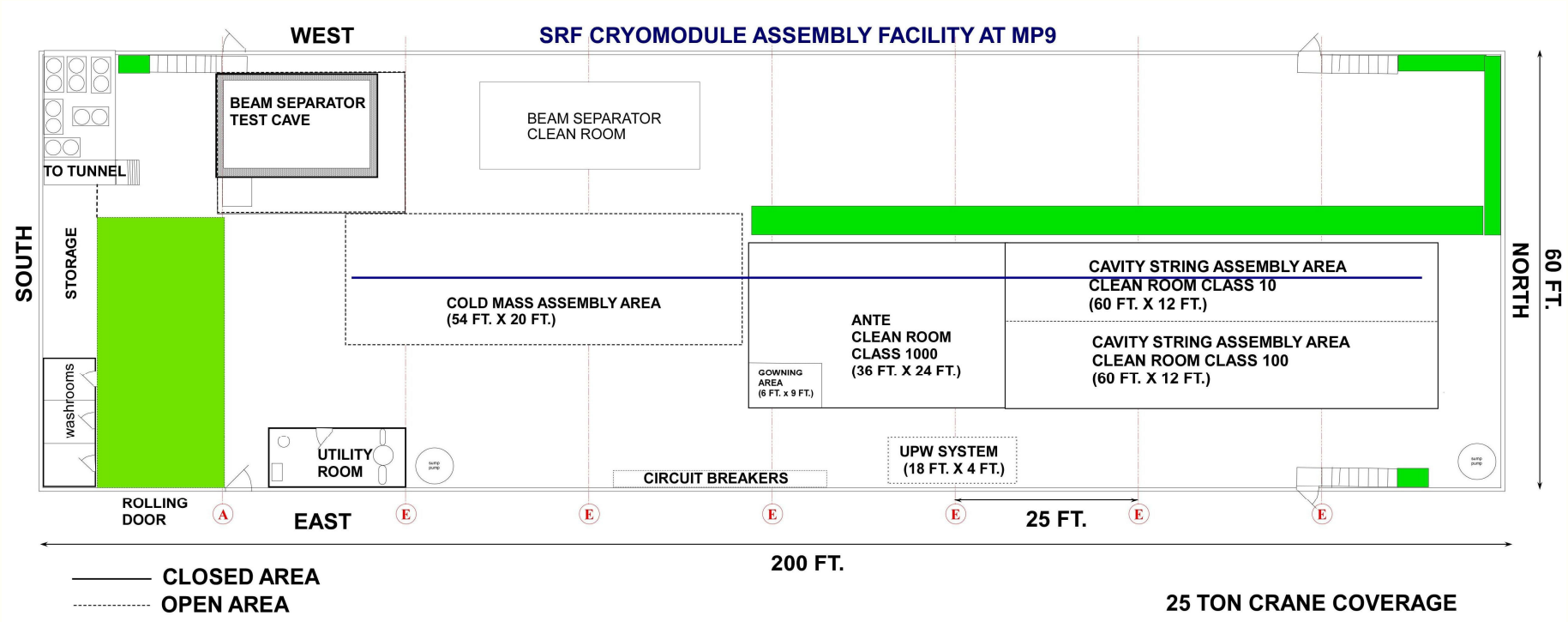
CAF-MP9 houses the string assembly clean rooms, the rail for string assembly under the clean room extending to the cold mass assembly area and the cold mass assembly fixture adjacent to the clean room.



CAF-MP9

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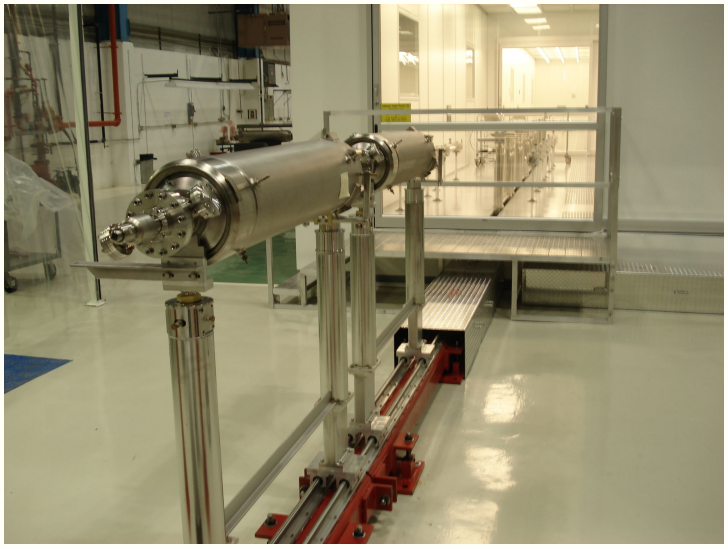

CAF-MP9 Infrastructure

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- Cavity String Assembly Clean Room: ~250 square meter
- The cavity string assembly clean rooms infrastructure consists of:
  - Class 1000 area: (~90 square meter)
    - Ante clean room for parts / hardware / fixtures preparation to enter the Class 10/100 area
  - Class 100 area: (~75 square meter)
    - Parts / Hardware / Fixtures final preparation for assembly
  - Class 10 area: (~75 square meter)
    - Where the cavities vacuum is vented to interconnect them with bellows:
      - Cavity flanges / couplers installation for vertical and horizontal test
      - Cavity string assembly

CAF-MP9 Infrastructure (cont.)

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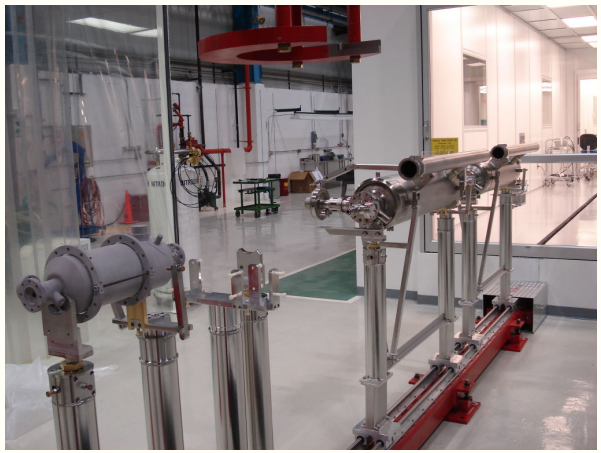
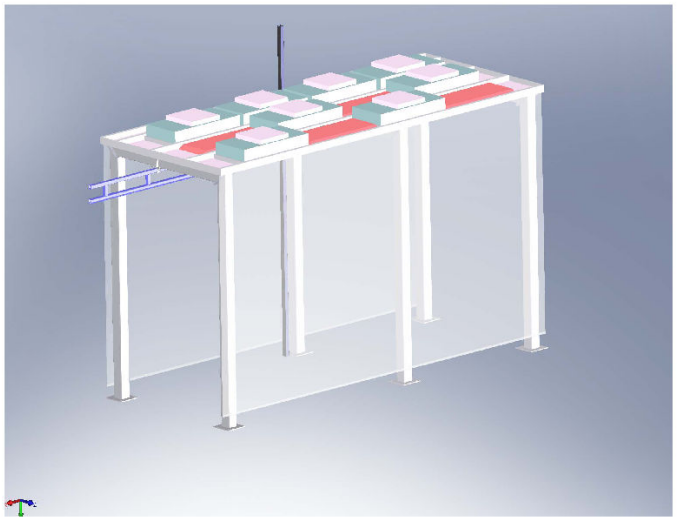
Other infrastructure:

- String Assembly Fixtures
- Vacuum / Ultra Pure Gas Flow Equipment/ Hardware
- Ultrasonic Cleaner
- Ultra pure DI water
- Cavity Handling Cart / Fixtures
- Cold Mass Assembly Fixture
- Soft wall clean room with a crane





Cavity preparation for VTS, HTS

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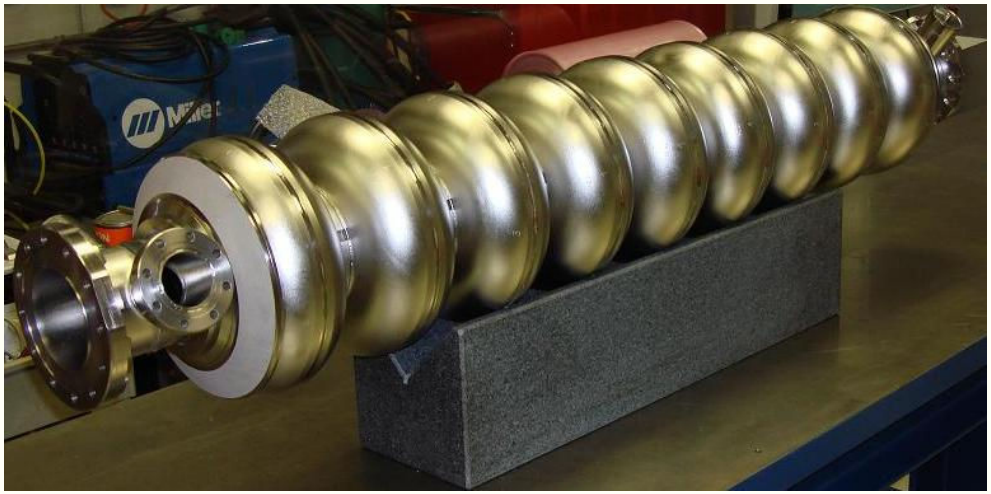
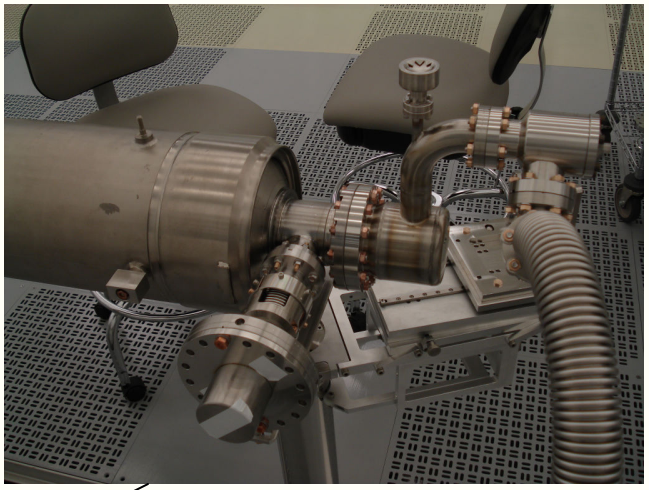


1.3GHz equal length end bare cavity



1.3GHz dressed cavity

Fixed or variable coupler, field probe, misc. flanges installation at CAF-MP9 clean room

325 MHz Single Spoke Cavity

CAF-ICB

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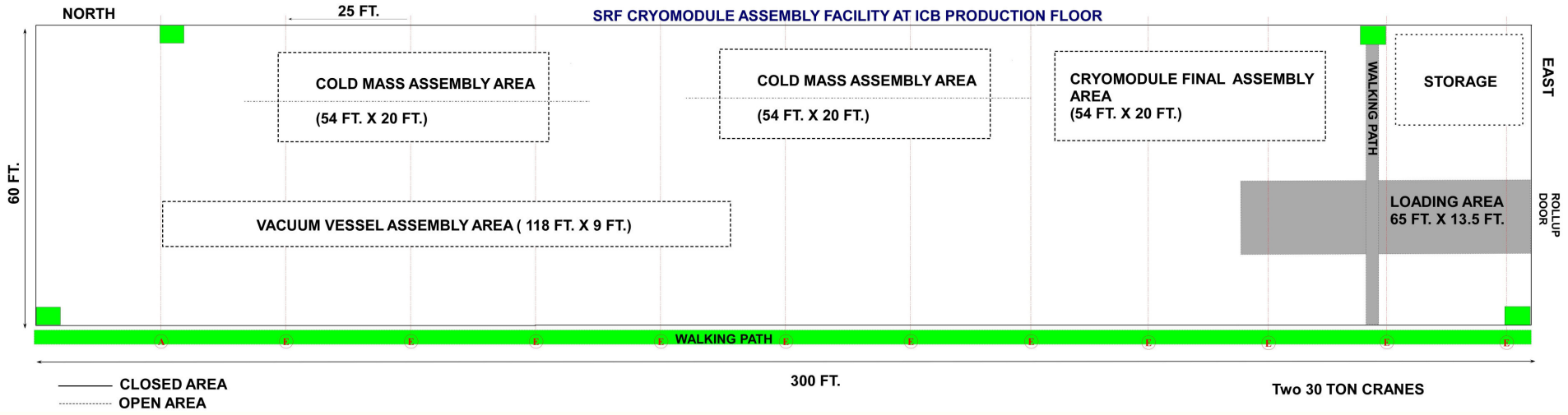
CAF-ICB houses the Vacuum Vessel Assembly area and Final Assembly area including the Cantilever fixture. (Big Bertha)



CAF-ICB

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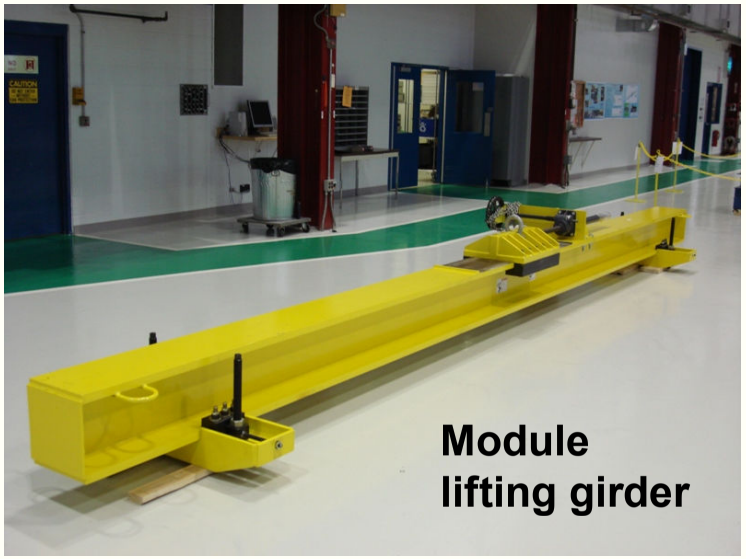

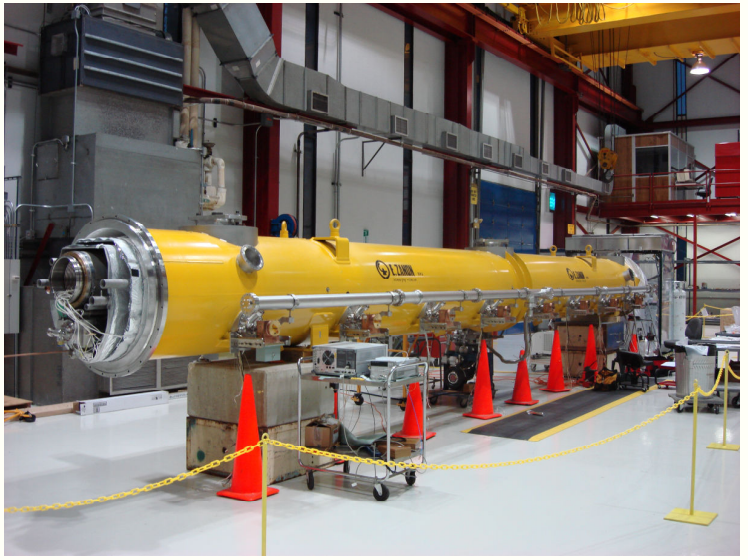

Pictures from CM1 String Assembly at CAF-MP9

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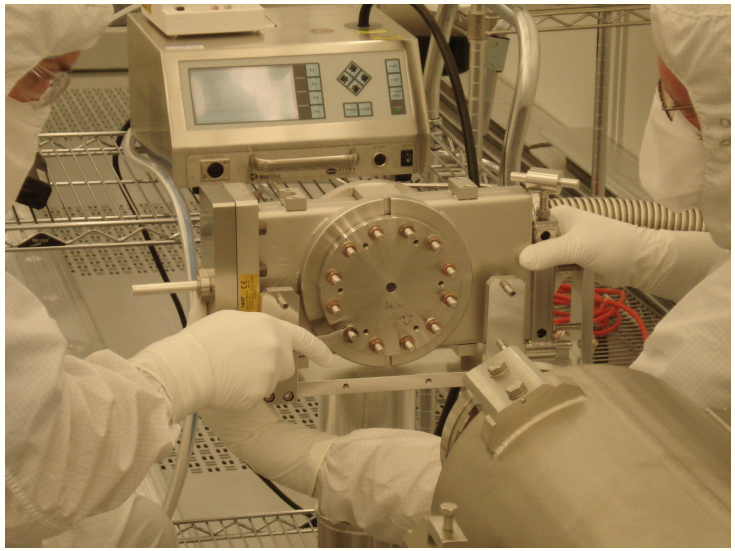

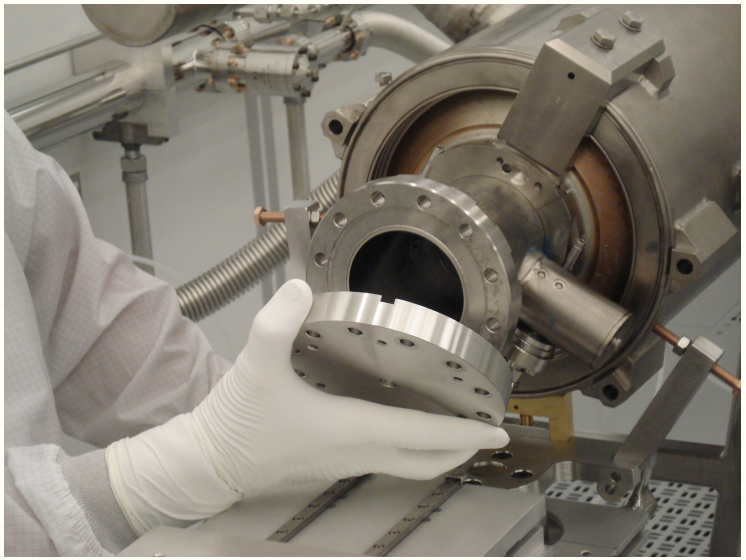

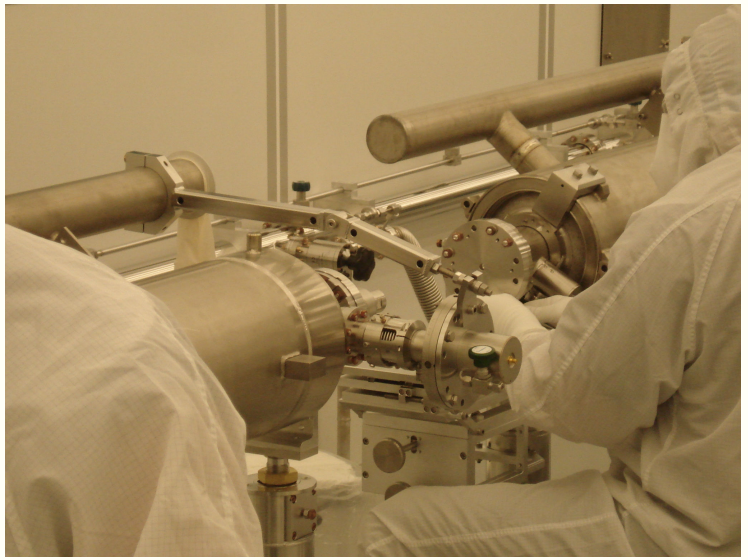

Pictures from CM1 Assembly at CAF-ICB

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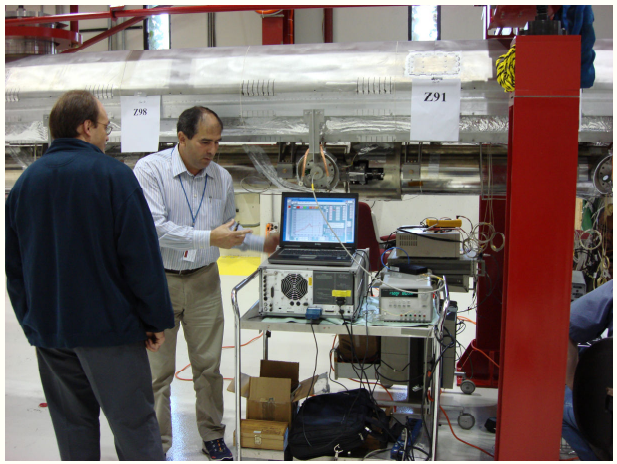



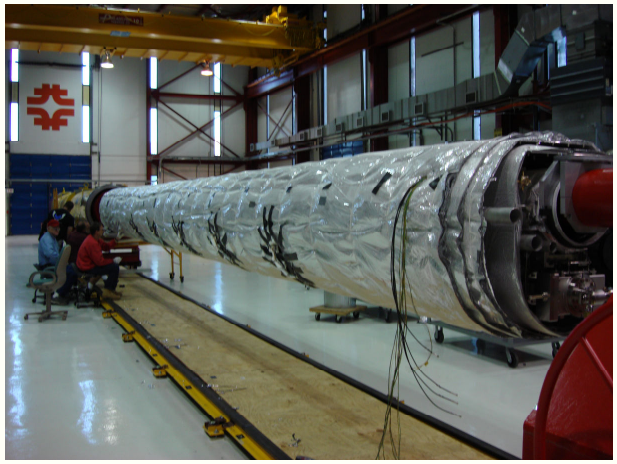


Cold Mass Transport

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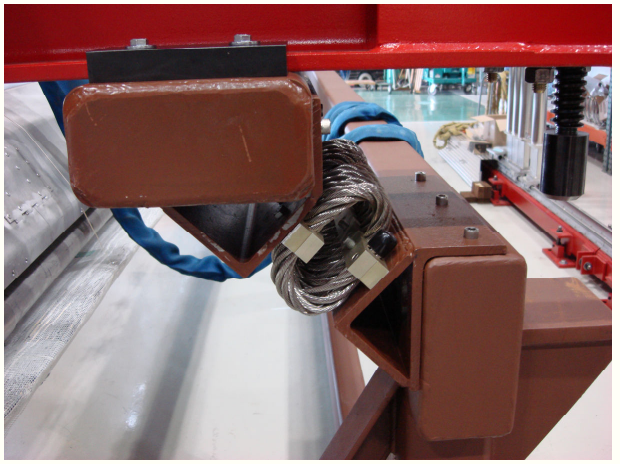
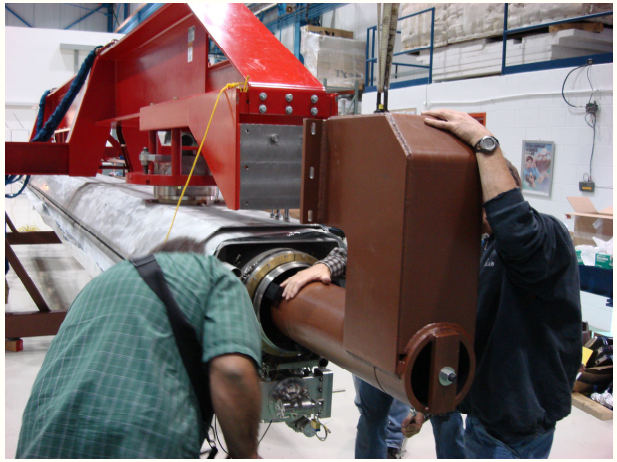
- After the cavity string is picked up off the rail and partially assembled to the cold mass support, the cold mass assembly is transported to the Vacuum Vessel Assembly Area at CAF-ICB.
- The maximum coldmass accelerations measured were 0.25 g (vertical), 0.13 g (transverse) and 0.05 g (longitudinal).





Cold Mass Transport Fixture

Cryomodule Transport

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- Module weight: ~8000kg, Girder Weight: ~2250 kg, 5 cross members: ~1000 kg each
- Fixture to transport completed Cryomodule from CAF-ICB to the ILCTA-NML
- Ten helical cable isolators (shock absorbers) were used to protect the cavities from extreme acceleration
- The goal was to limit maximum acceleration experienced by the coldmass to 0.5 g during the CM1 assembly transport from CAF-ICB to NML

CM1 Transport

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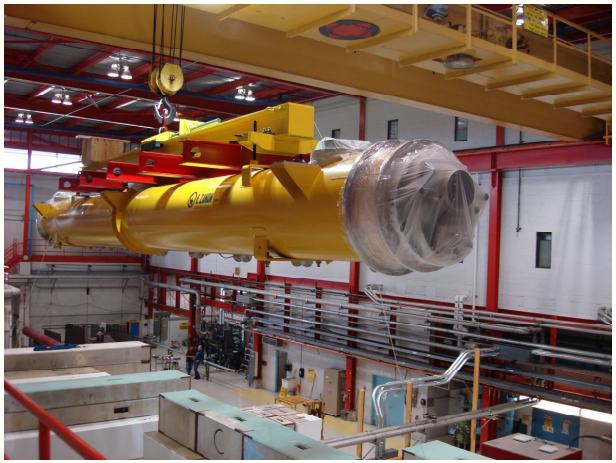
- The CM1 assembly traveled 2.1 miles in 50 minutes with an average speed of 2.6 mph
- The maximum acceleration on cold the cold mass was: vertically=0.4 g, transverse=0.36 g and longitudinal=0.13g



3.9GHz Module Transport

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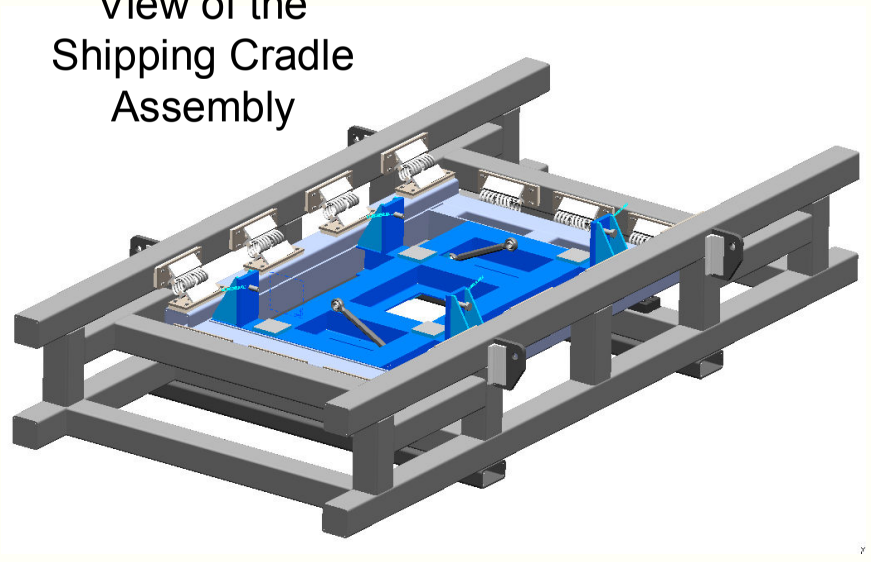
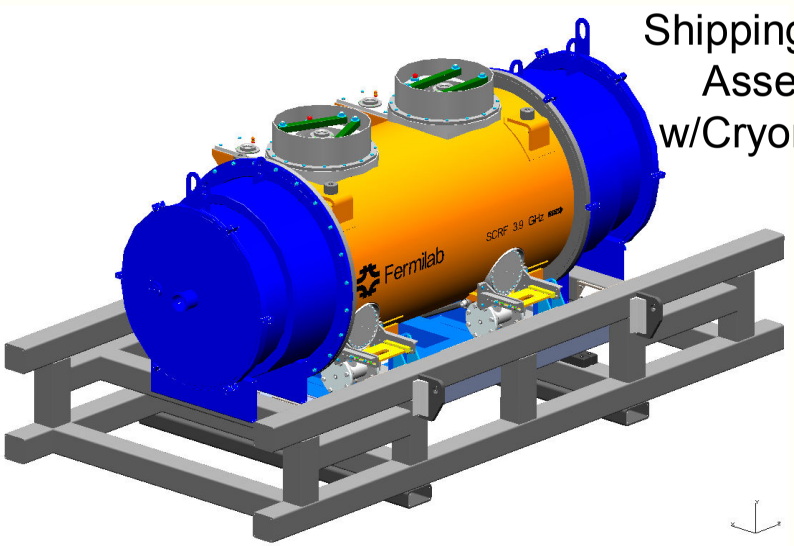
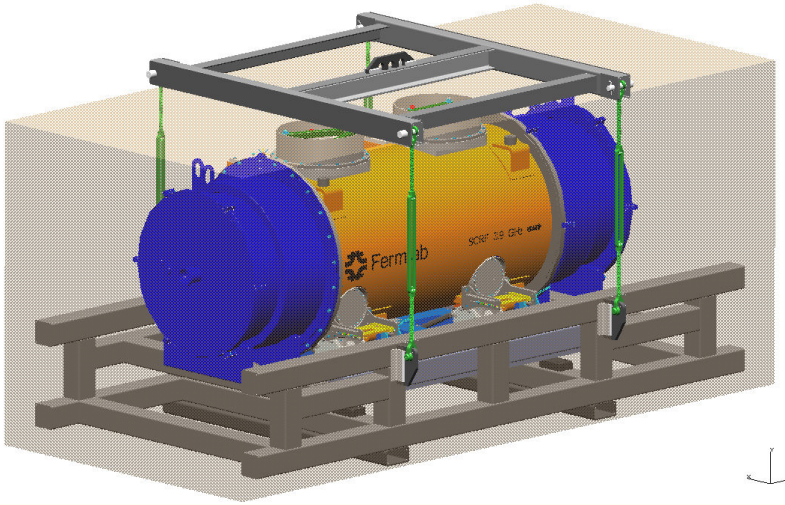
View of the Shipping Cradle Assembly



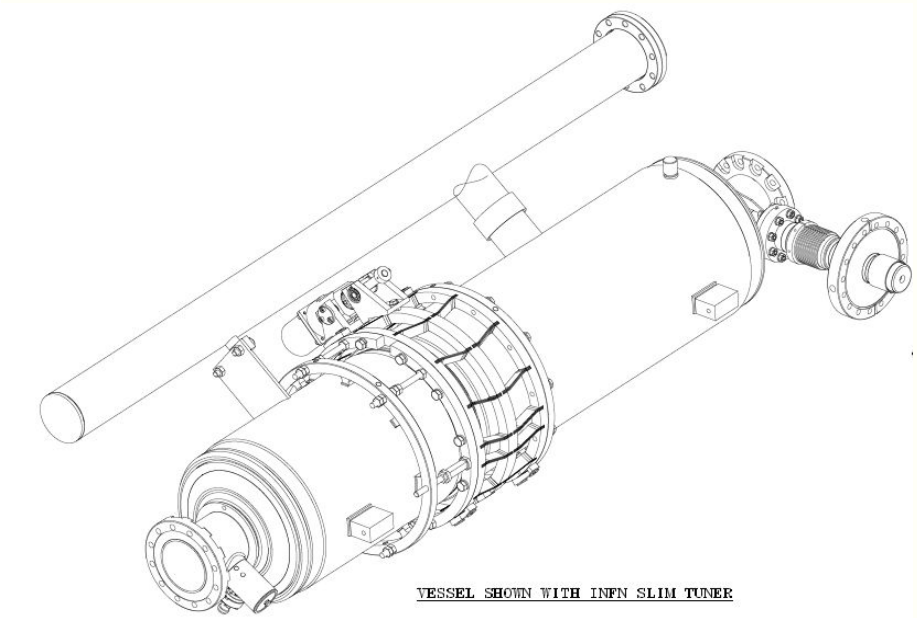
View of the Shipping Cradle Assembly w/Cryomodule

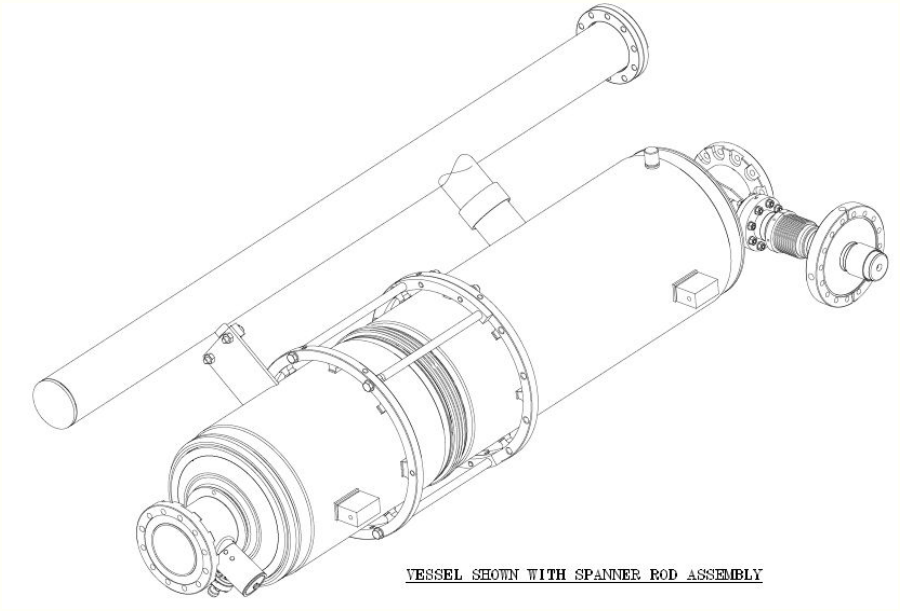




View of the Complete Shipping Package. Wood crate is shown as a transparent box. Lifting spreader bar is shown on the top of the crate, with turnbuckle lifting arms

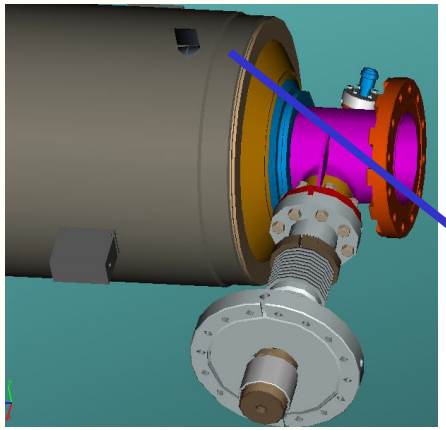
Helium Vessel Development

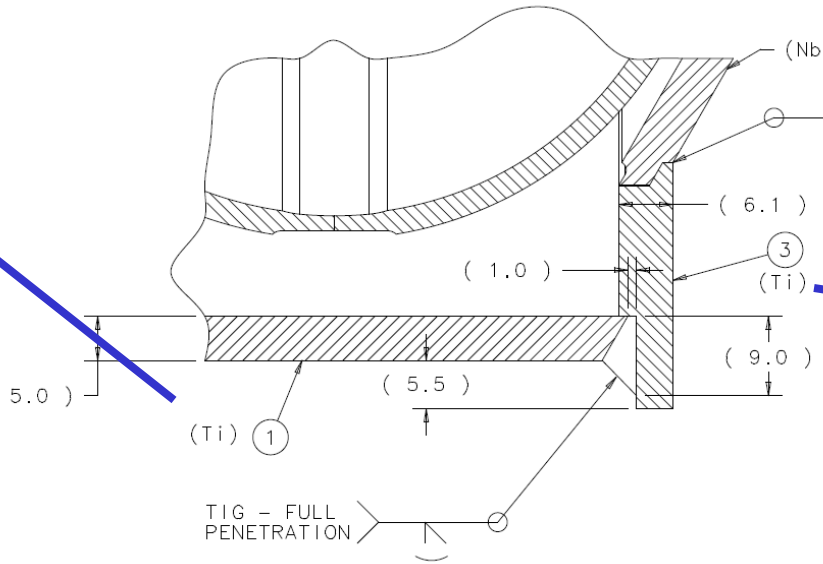


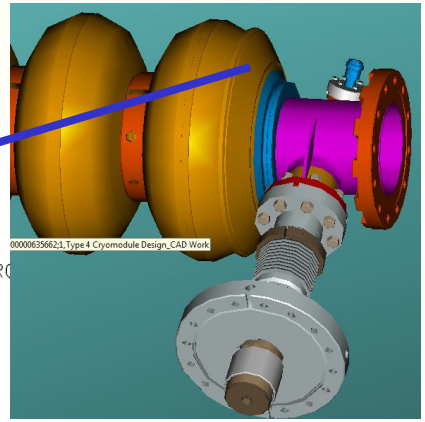


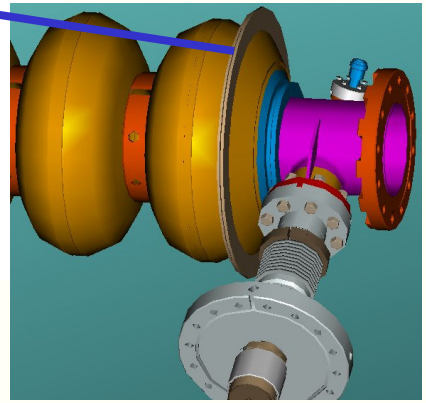
- Eight bare 1.3GHz cavities (>30 MV/m gradient) need to be dressed and qualified for CM2.
- Mechanical Design:
  - Blade tuner compatible Helium Vessel
    - Titanium vessel, 2-phase pipe; INFN Slim Tuner
  - Transition parts were designed, weld tests are under progress

Input Coupler End

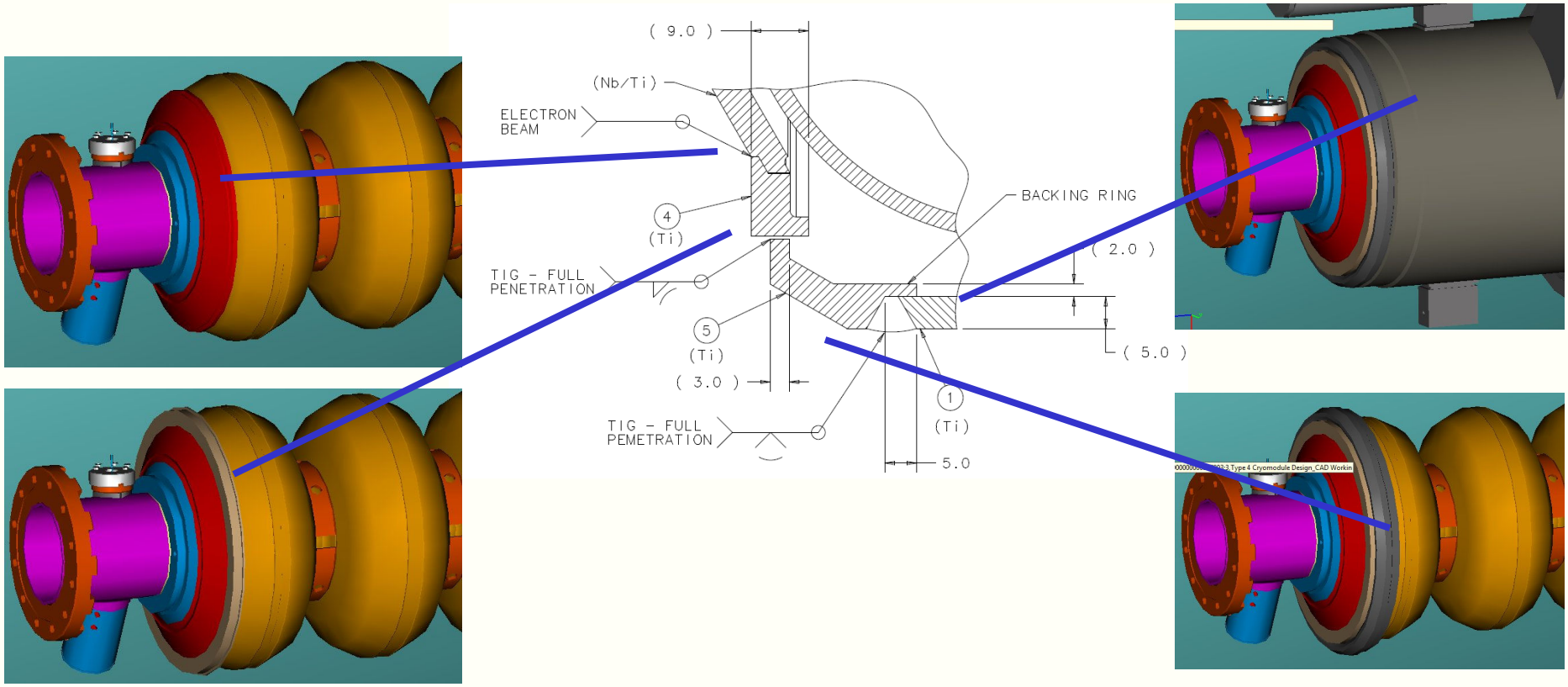








Field Probe End



CAF-MP9 Infrastructure for Cavity Dressing

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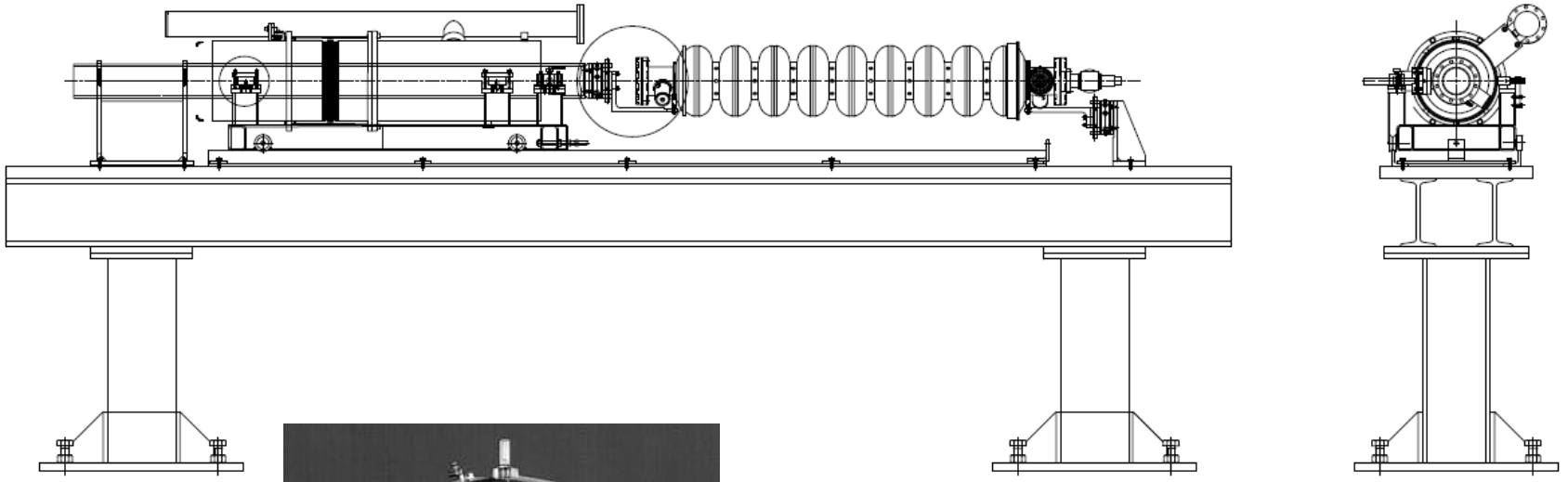
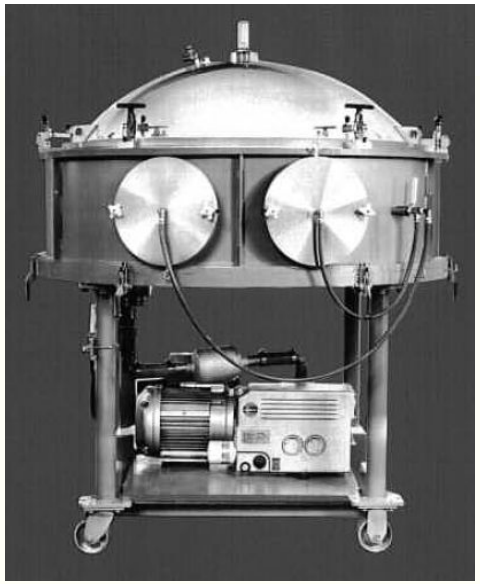
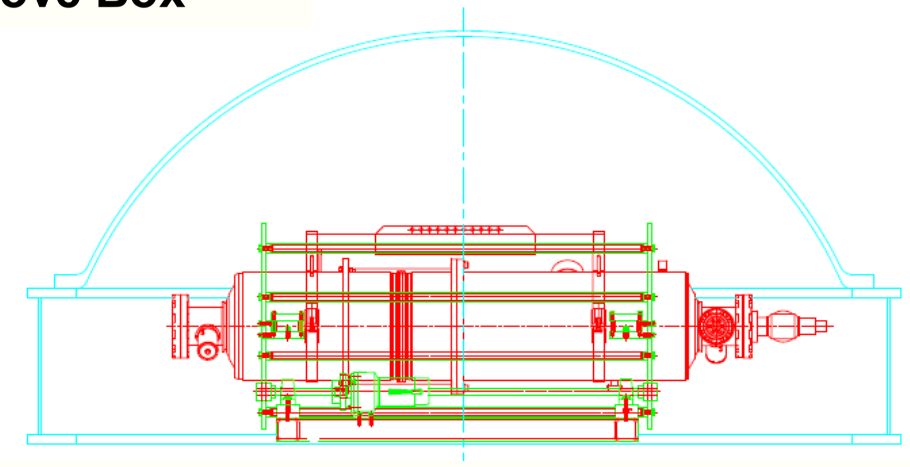
Alignment & Insertion Fixture





Glove Box



CM2 Components

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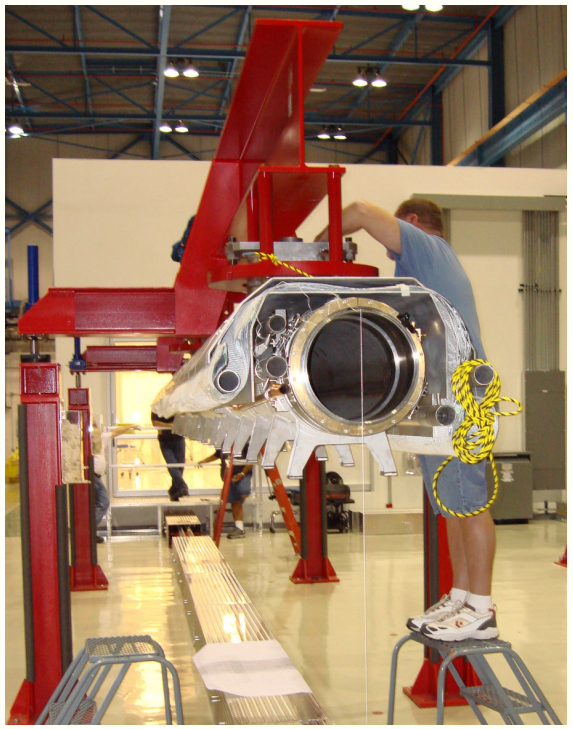
- Vacuum Vessel & Cold Mass, Cold Mass Posts (3), Blade Tuners (8) will be provided by INFN as a kit



Delivery: December 2008

CM2 Components (FNAL)

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- 8 Qualified & Dressed Cavities:
  - Bare Cavities: Procured by FNAL from Accel & AES (received)
  - Processing & Vertical Test: FNAL & U.S. collaborators
  - As of September 2008, the 5 Cavities out of 8 needed for CM2 are: A6, A8, A11, A12, AES2. The average gradient based on last measurement is ~34 MV/m.
  - Dressing of Cavities: at CAF-MP9 in FNAL
  - Horizontal Test: at HTS in FNAL
- Helium Vessels
- Cavity Interconnecting Bellows
- Gate valves
- Tuner motors, harmonic drives
- Magnetic Shielding
- Dipole Corrector Package, BPM
- Couplers (processed at SLAC)

Summary

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- CAF infrastructure is fully operational for R&D rate module assembly and cavity preparation for VTS & HTS. We need to assess the upgrades necessary for Project X assembly throughput requirements (1 module / month)
- 3.9GHz module assembly will likely start in January 2009:
  - Cavities are currently being dressed and tested in HTS
  - All the components (except the cavities) are ready for module assembly (stored at CAF)
  - Assembly travelers are ready
  - Module engineering documentation is complete and waiting for review & approval process
  - Expected shipping time frame to DESY: February-March 2009
- CM2 parts will be sent by INFN as a kit except dressed cavities and string related components:
  - Cavities are currently being tested at VTS
  - Helium Vessel welding & dressing will start in January 2009
  - CM2 assembly is planned to start late summer to early Fall 2009