Cryomodule Assembly Facility (CAF)

Tug Arkan

Outline

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- Progress/accomplishments in past two years
  - CAF Infrastructure development – installation - qualification
  - Personnel training, assembly procedures & travelers development
  - 1.3 GHz module (CM1) assembly
  - 3.9 GHz module assembly
- Plan for next two to three years
  - Dressing cavities for CM2 and CM3
  - CM2, CM3 assembly
- Technical Milestones
- Conclusion

Technical Progress

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- CAF infrastructure development, installation & qualification were successfully done in FY07-08
- SRF components handling, cleaning, assembly procedures are well developed & travelers were implemented
- CAF personnel are fully trained to work on SRF R&D
- First 1.3GHz cryomodule (CM1) was successfully assembled at CAF with the collaboration of FNAL-DESY personnel. Module was delivered to ILCTA-NML in August 2008
- 3.9GHz cryomodule was assembled at CAF. Module was delivered to DESY in April 2009

Assembly Workflow @ CAF-MP9

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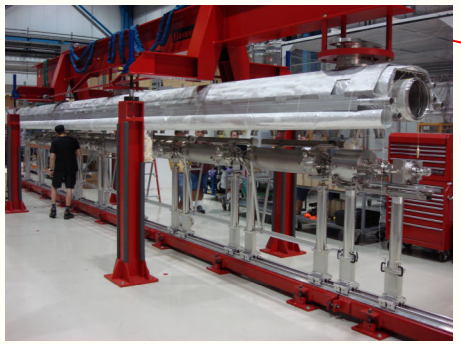
Receive dressed Cavities



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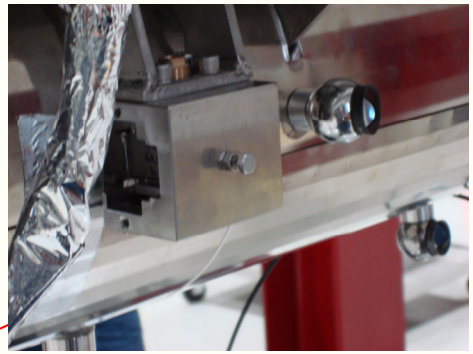
Install the Cold Mass back to the Cold Mass Assembly Fixture in **Cold Mass Assembly Area**



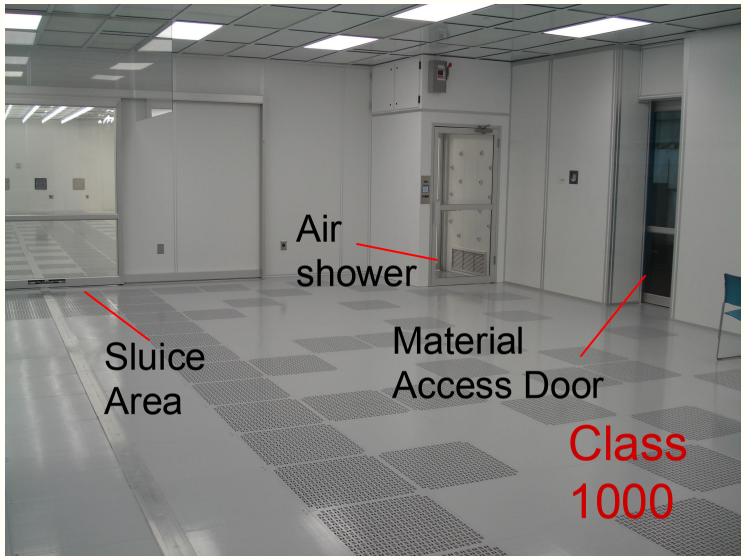
Align Cavity String to the Cold Mass Support

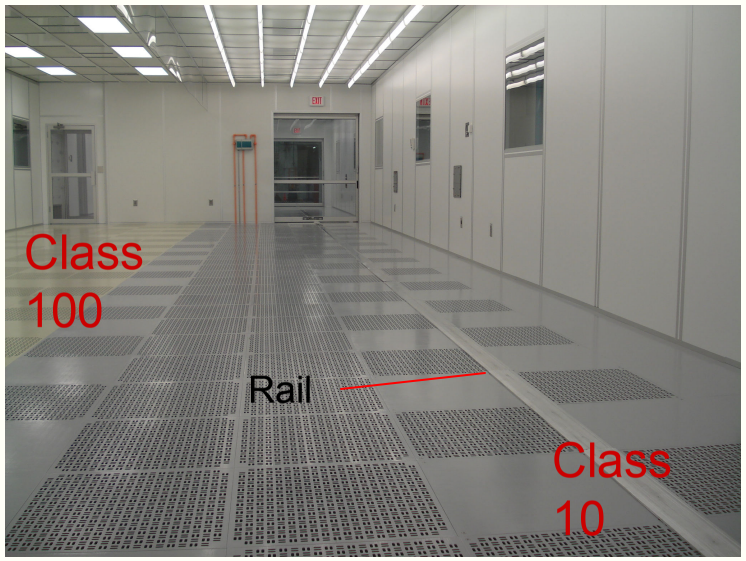
Install the String assembly with the cold mass into the Vacuum vessel in the **Vacuum Vessel Assembly** area

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

CAF-MP9 Clean Room

- Cavity String Assembly Clean Room
- A ~250 square-meter clean room:
  - Class 1000 ante clean room area:
    - Preparation of the dressed cavities for transportation into the assembly clean room.
  - Class 10/100 sluice area
    - Parts and Fixtures final preparation to enter the Class 10 assembly area
  - Class 100 area
    - Parts and Fixtures preparation for assembly
  - Class 10 assembly clean room area:
    - Where the cavity vacuum is vented for assembly





CAF-MP9 Infrastructure

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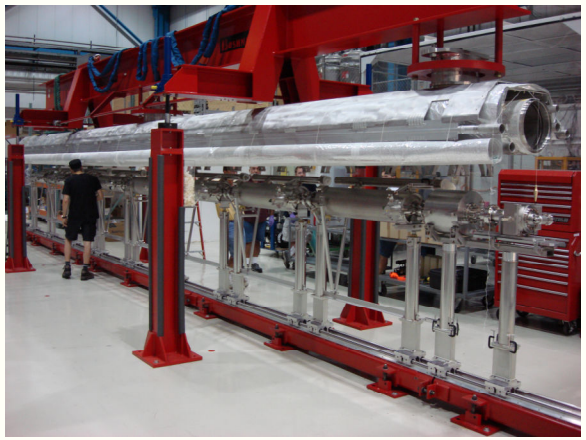
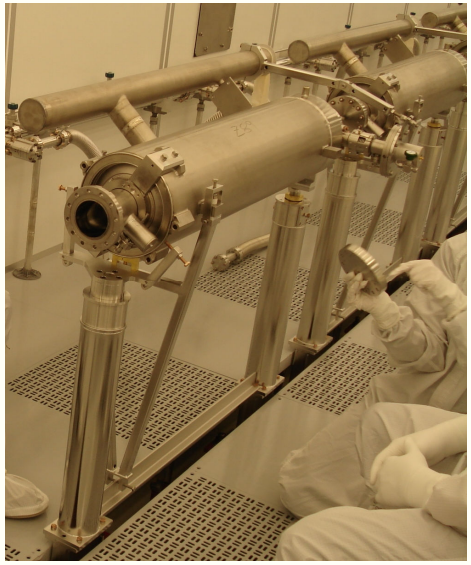
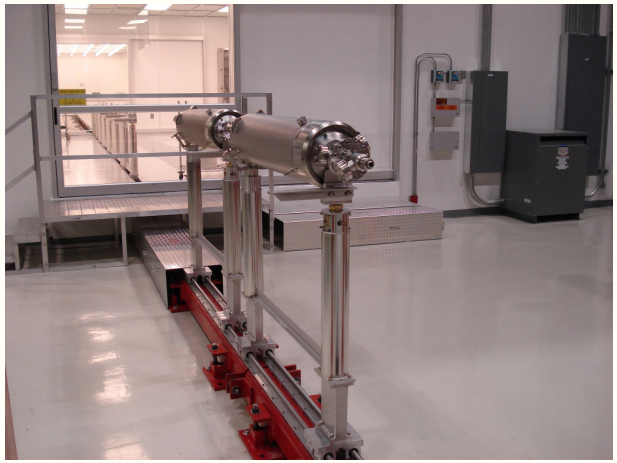


Cold Mass Assembly Area

Softwall clean room





Cavity Assembly Fixtures

UHV Equipment

CAF-ICB Infrastructure

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Production Floor

Big Bertha Cantilever Fixture

Module Alignment

Cold Mass on Big Bertha

Completed CM1 at CAF

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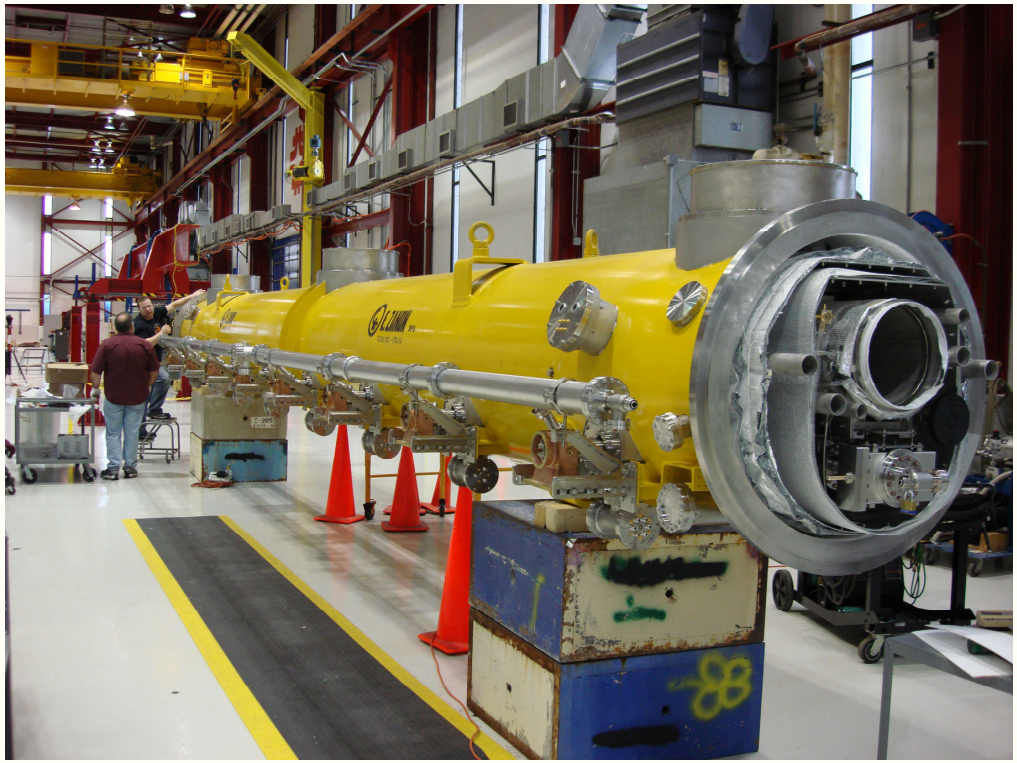
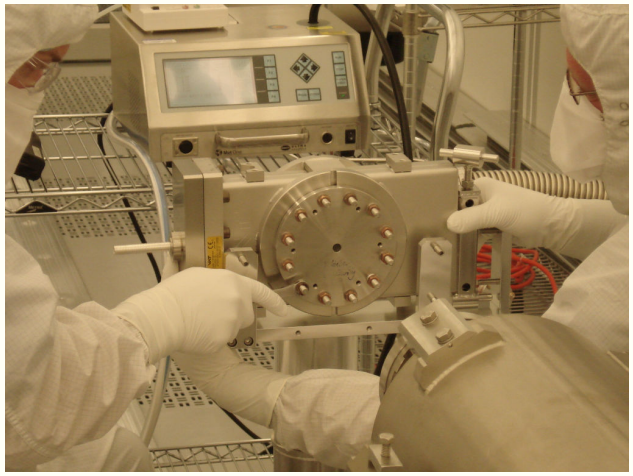


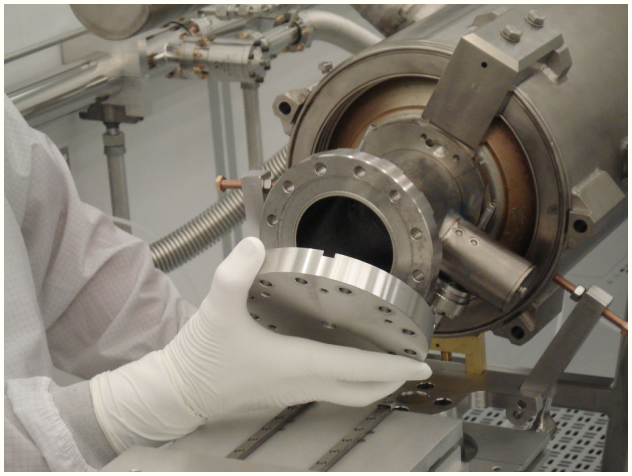
CM1 was assembled at CAF from parts provided by DESY as a kit. The assembly was done by FNAL personnel with the assistance of DESY colleagues.

Pictures of CM1 String Assembly

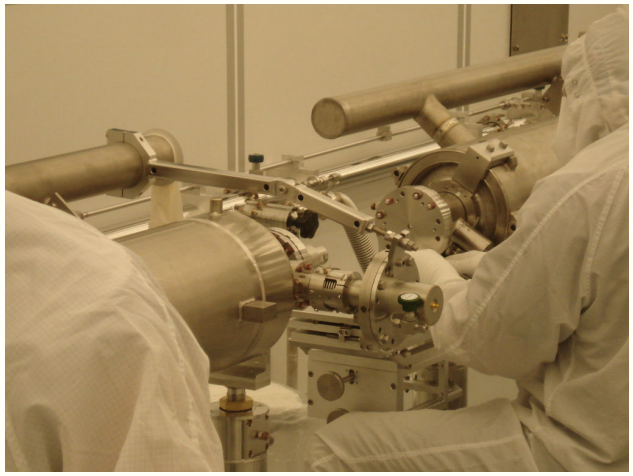
FNAL-DESY personnel at CAF-MP9 clean room



Gate valve sub-assembly



Cavity blank off flange being opened



Cavity being prepared to be interconnected with bellows

Pictures of CM1 Cold Mass Assembly

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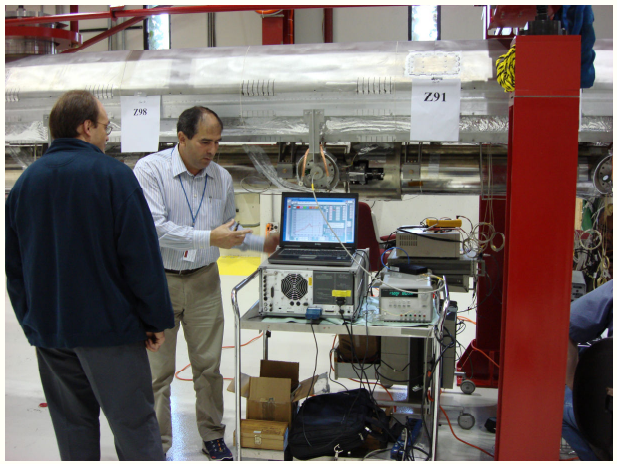
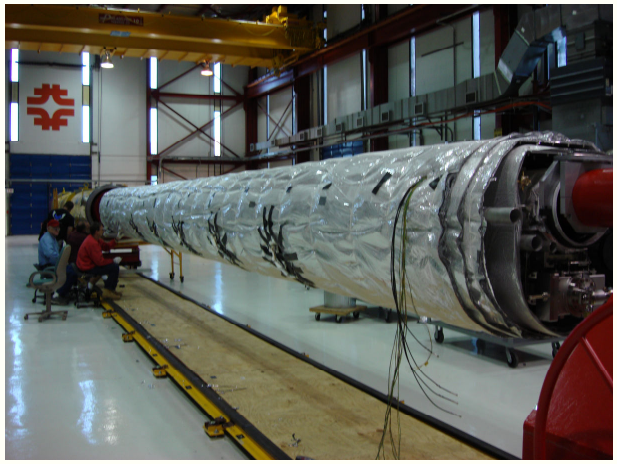
Cold Mass Transportation



RF Measurements

Cold Mass move to Big Bertha

Cold Mass at Big Bertha



Cold Mass fully assembled

Cold Mass in the vacuum vessel

3.9GHz Module Assembly at CAF

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3.9GHz module components were designed at FNAL. Cavities were processed and qualified at FNAL / ANL. Module was assembled at CAF by FNAL personnel. DESY colleagues collaborated to the assembly as consultants.

3.9GHz Module Assembly

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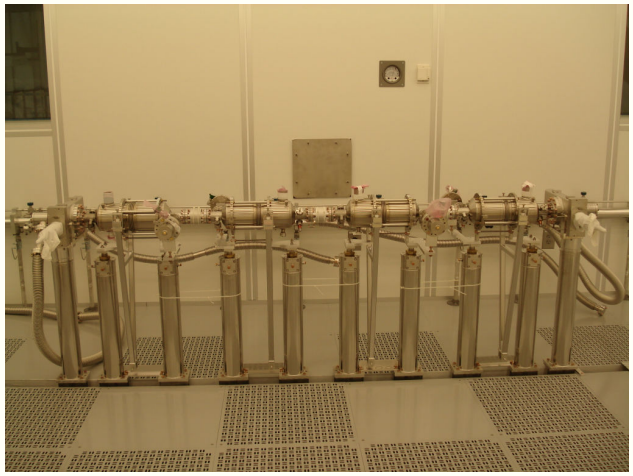

Assembled cavity string

Various group working on the cold mass assembly

Cold Mass being prepared for transport

Cold Mass transport

3.9GHz Module Assembly

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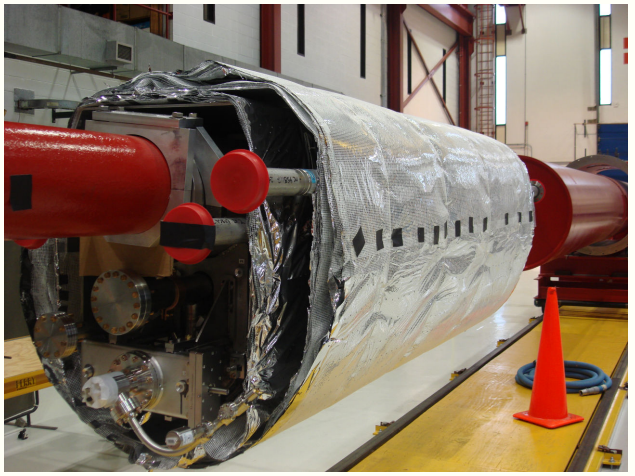
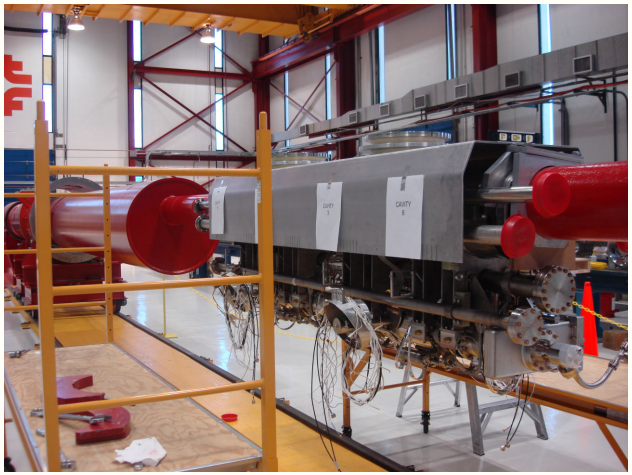
Cold mass to Big Bertha



Completed Cold Mass



Cold Mass at Big Bertha

Cold Mass to the Vacuum Vessel assembly

Plan for next 2-3 yrs

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- Cavity to the helium vessel welding
  - Cavity to helium vessel assembly & welding infrastructure was recently setup at CAF-MP9
- Cavity dressing for horizontal testing
- CM2 assembly
- CM3 assembly

CAF-MP9 Infrastructure for Cavity Dressing

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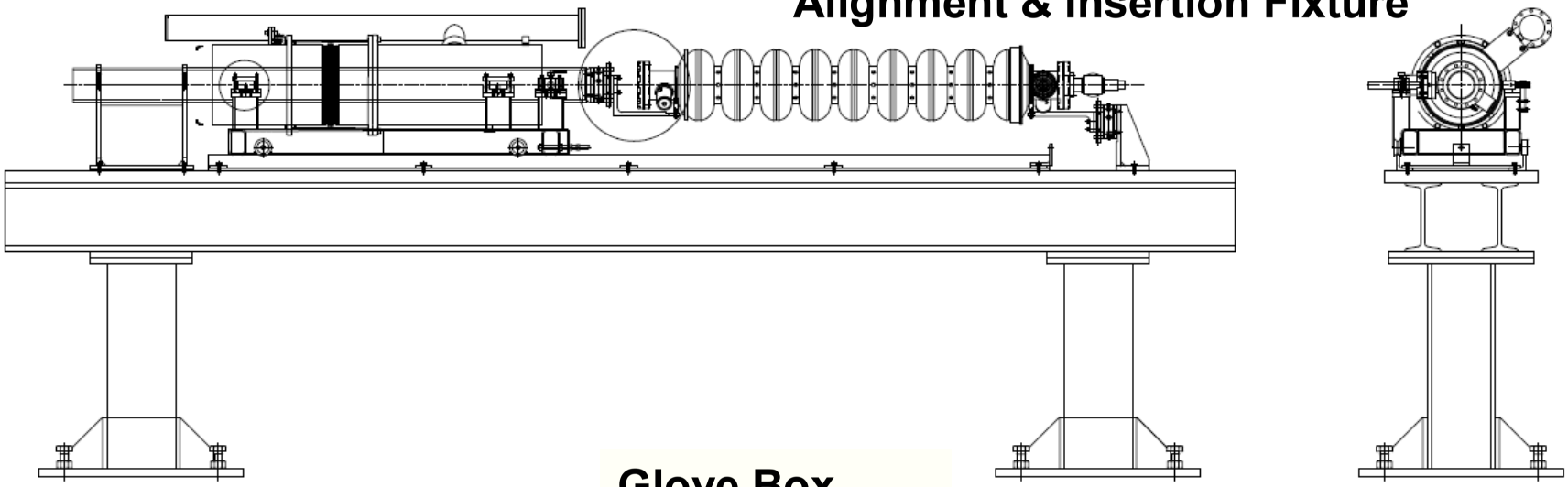
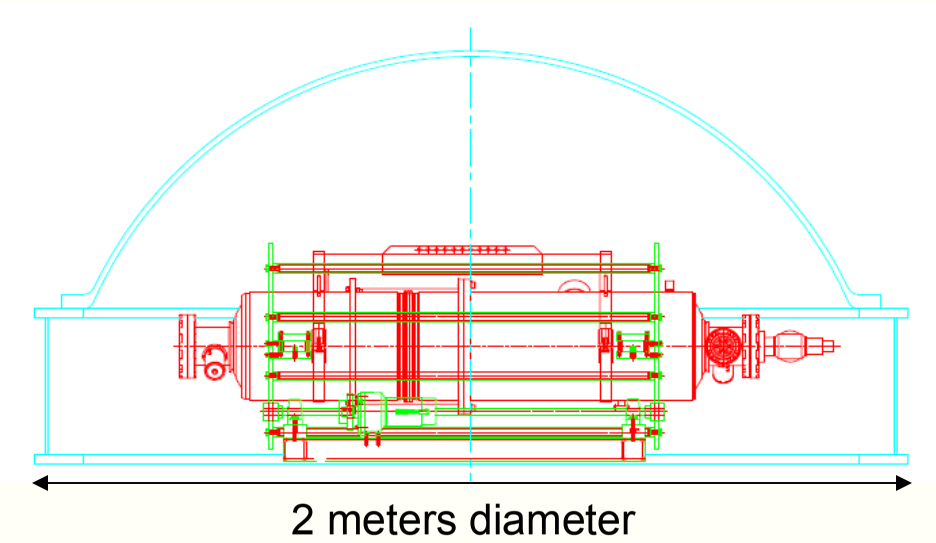
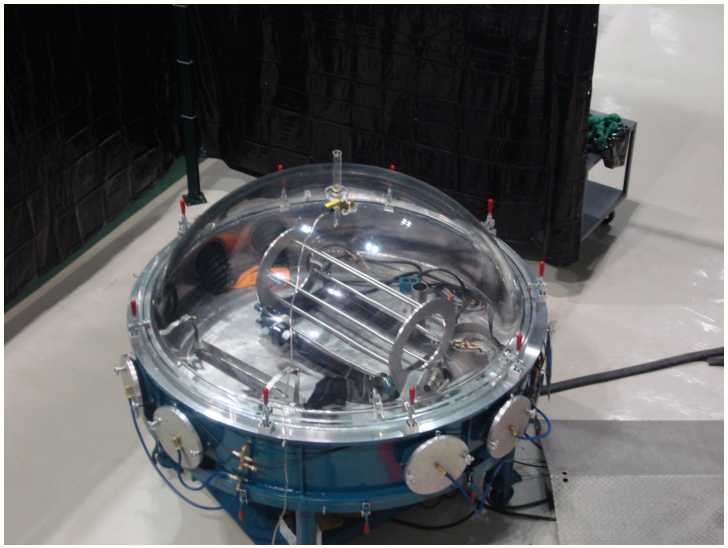
Alignment & Insertion Fixture



Glove Box





Cavity Dressing

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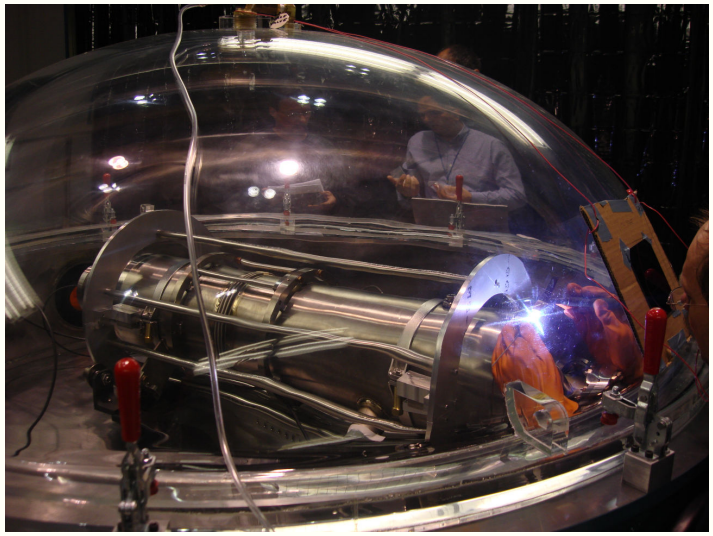
- Assembly & welding procedures are developed and will be fined tuned during AES-1 & AES-4 cavities (prototype cavities) welding to their helium vessels
- After the prototype cavities, we will start welding cavities to helium vessel for CM2
- Dressing Workflow:
  - Ti transition rings welding at Sciaky (e-beam welding)
  - Ti helium vessel welding to the cavity at CAF-MP9 (TIG welding)
  - Field flatness measurements
  - High pressure rinse at ANL/FNAL clean room
  - Input coupler assembly at CAF-MP9 clean room
  - Magnetic shielding & tuner assembly
  - Horizontal test



CM2 components delivered from Zanon

Vacuum Vessel

Cold Mass Assembly Components

Components are being inspected for Quality Assurance

Cavities and string related components will be provided by FNAL

Milestones at CAF

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- Assemble CM2 (type III+) in early 2010
- Assemble CM3 (type IV) in late 2010
- Assemble CM4 (type IV) in mid 2011
- Assemble CM5 (type IV) in late 2011
- Update CAF infrastructure for Project X modules assembly in early 2012:
  - 1 module per month assembly throughput
- Assemble CM6 (type IV+) in late 2012

Project X Throughput Assumptions

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- The current CAF infrastructure has a throughput for the R&D quantities cryomodule fabrication.
- The ultimate throughput is to assemble 1 cryomodule per month at CAF facilities.
- Module assembly R&D rate: (40 work days)
  - String Assembly (Clean Room): 10 work days, 3 techs
  - Cold Mass Assembly: 12 work days
  - Final & Vacuum Vessel Assembly: 10 work days
  - Warm Part Coupler Assembly: 5 days
  - Coupler Pump Lines Assembly: 1 days

  (3 techs)

  (3 techs)
  - Cables/Wires Termination: 2 days, 2 techs
- 3 clean room techs, 3 cold mass assembly techs, 2 electrical techs, total = 8 technicians

Throughput Assumptions (cont.)

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In order to achieve a throughput of 1 cryomodule per month:

- 2 shifts in the Cavity String Assembly Clean Room to assemble cavity string: (currently one assembly rail in the clean room, a second rail will be beneficial to assure the throughput requirements)
  - This will assure 1 assembled string every 5 work days
- Transport the assembled string from CAF-MP9 to CAF-ICB. (preferably right after the string is rolled out of the clean room)
- 2 parallel Cold Mass Assembly Lines at CAF-ICB to receive assembled cavity strings. 1 shift:
  - This will assure 1 cold mass assembly every 7 work days
- 1 Big Bertha fixture in the Vacuum Vessel Assembly Area at CAF-ICB. 2 shifts:
  - This will assure 1 final cryomodule assembly every 5 work days
- Coupler Assembly. 2 shifts:
  - This will assure 8 couplers are assembled in 3 days

With the above assumptions, One cryomodule can be assembled in 20 work days. (This throughput assumes that the trained personnel (15 technicians) are available as needed and CAF infrastructures upgrades are done)

Conclusions

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- CAF is fully operational for SRF R&D. The feasibility of the current infrastructure was proven with the assembly of the CM1 and 3.9GHz modules.
- CAF personnel are fully trained to work on SRF R&D. Travelers are developed & implemented.
- Cavity dressing infrastructure was recently setup at CAF-MP9. The first prototype cavity was welded to its helium vessel last week. Cavity dressing is a critical path task for the assembly of CM2.
- CM2 assembly will be a reassurance for the feasibility of CAF infrastructure and the expertise of the CAF personnel
- Project X module assembly throughput requirements are well understood. Facility and personnel upgrades are planned for the coming fiscal years.