

Cryomodule Assembly at CAF in Fermilab

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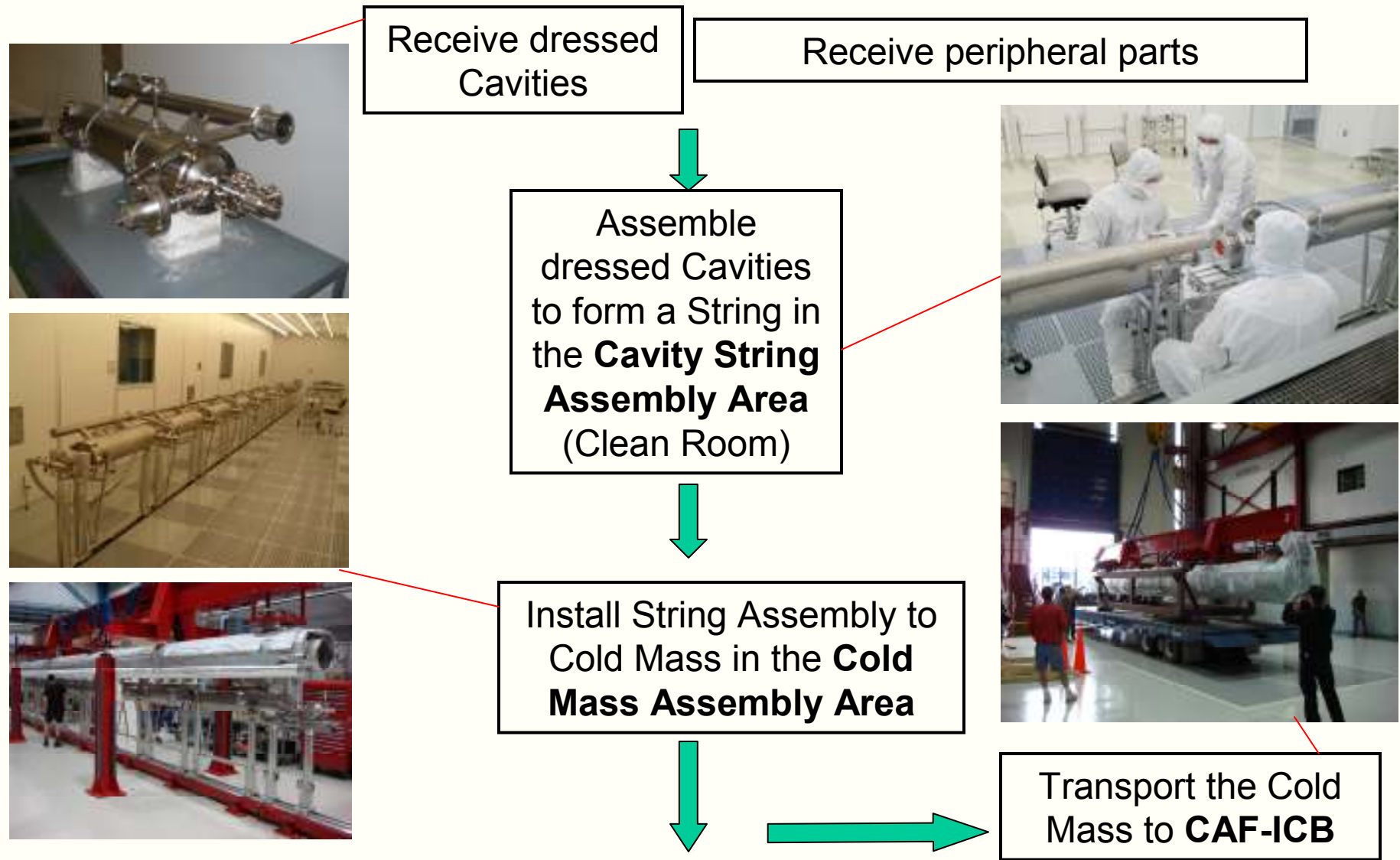
Parallel session of
Cryomodule(S1-G)/Cryogenics groups in TILC09

Outline



- Cryomodule Assembly Workflow at Cryomodule Assembly Facility (CAF):
 - Cavity String Assembly (detailed)
 - Cold Mass Assembly
 - Vacuum Vessel Assembly
- Summary

Assembly Workflow @ CAF-MP9



Assembly Workflow @ CAF-ICB

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**

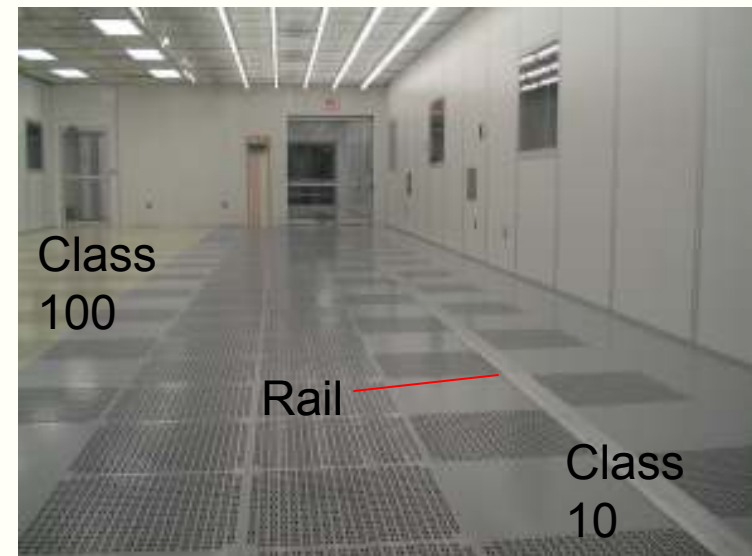
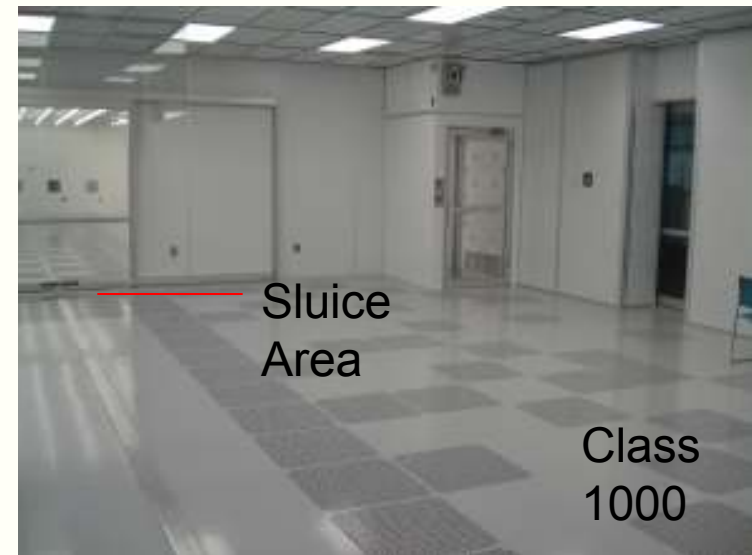


Ship Completed Cryomodule to **ILCTA-NML** for testing



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 cavities vacuum is vented to interconnect them with bellows.



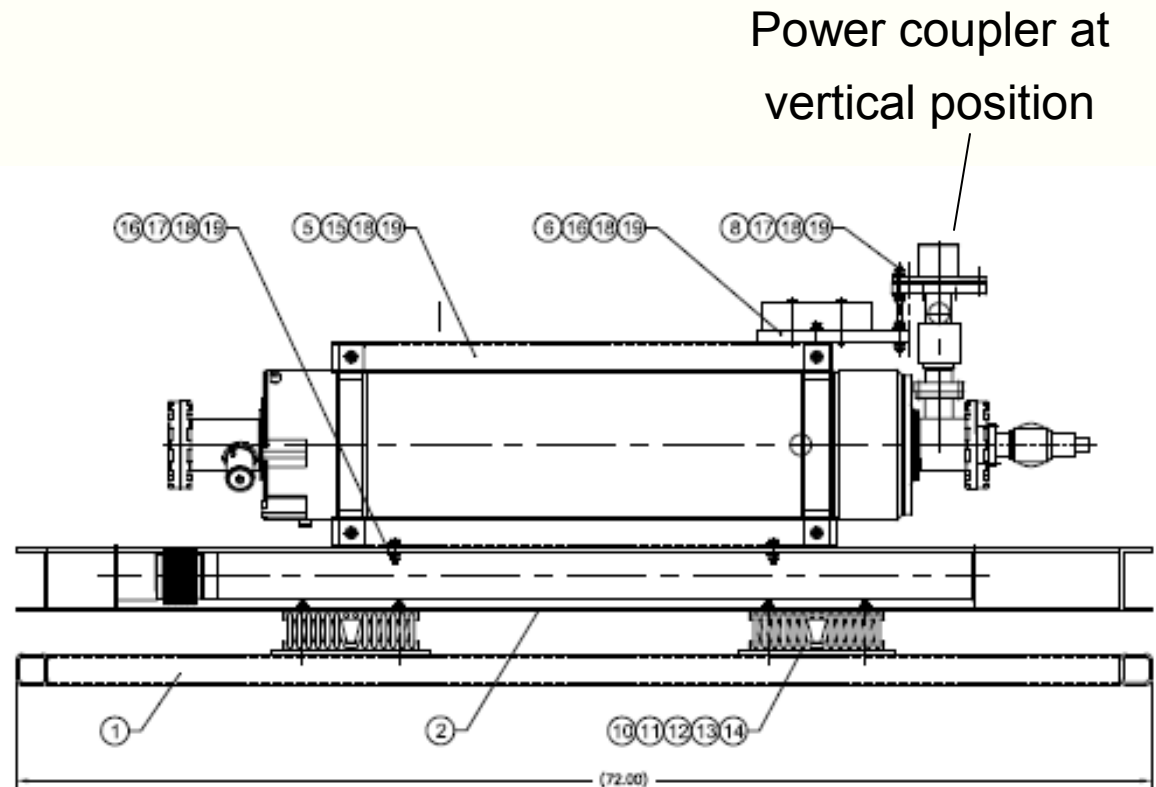
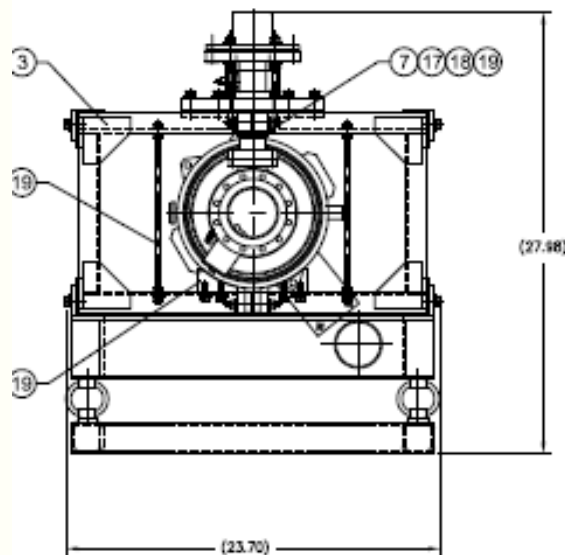
Cavity String Assembly Workflow



1. Receive dressed, qualified (horizontal tested) cavities at CAF-MP9
2. Prepare cavities exterior surfaces to enter the clean room
3. Prepare peripheral cavity string assembly parts, assembly hardware and fixtures to enter the clean room
4. Cavity alignment in Class 10 clean room
5. String assembly:
 1. Acceptance Vacuum Leak Check
 2. Gate Valve to Cavity Assembly
 3. Cavity to Cavity Assembly
 4. Final Vacuum Leak Check

1- Receive Dressed Cavities

The dressed cavity transport fixture is used to transport dressed cavities with main coupler (cold end) installed



2- Cavity preparation to enter the clean room

- Cavity exterior surfaces are wiped with lint free cloth soaked in isopropyl alcohol in the Class 1000 soft wall clean room. (not washed in in the ultrasonic bath)
- Cavities are then transported in the Class 1000 ante clean room where they are installed on the support posts fixture.
- Slide the cavities in the Class 10/100 Sluice area for further cleaning to enter the Class 10 assembly clean room:
 - Wipe with lint free cloth
 - Blow clean with ionized nitrogen while monitoring the airborne particulates with a particle counter
 - Continue to clean until acceptable counts are reached

Class 1000 soft wall clean room

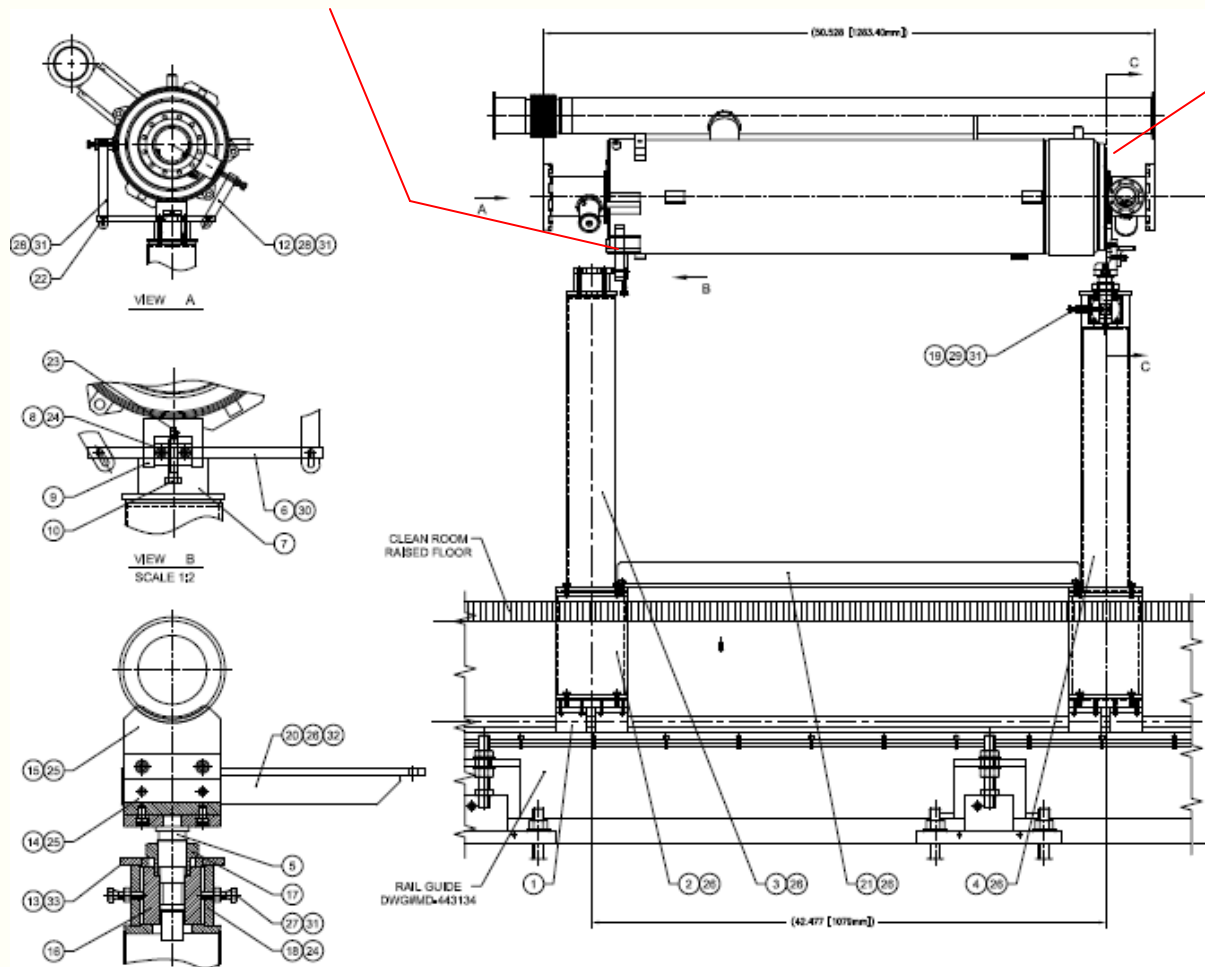


Class 1000 ante clean room material access door

Cavity Support Posts Fixture

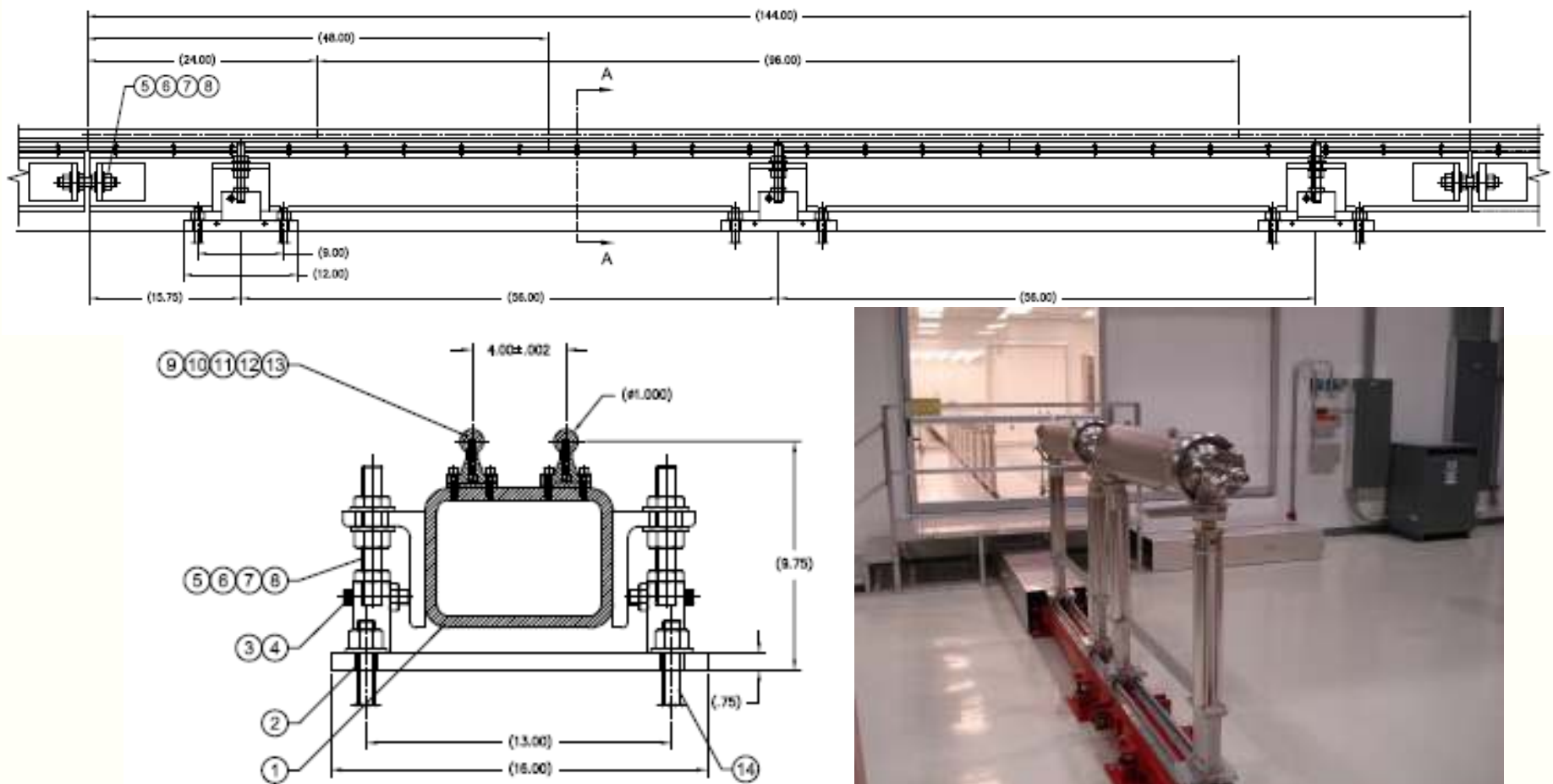
Cavity is supported with two clamps around the helium vessel at the field probe end

Cavity is supported through the alignment ring on the beam pipe flange at the coupler end



Rail for Cavity String Assembly

Rail length: 3.65 m, 12 rails aligned to each other to 0.1 mm



3- Parts / Fixture / Hardware Preparation

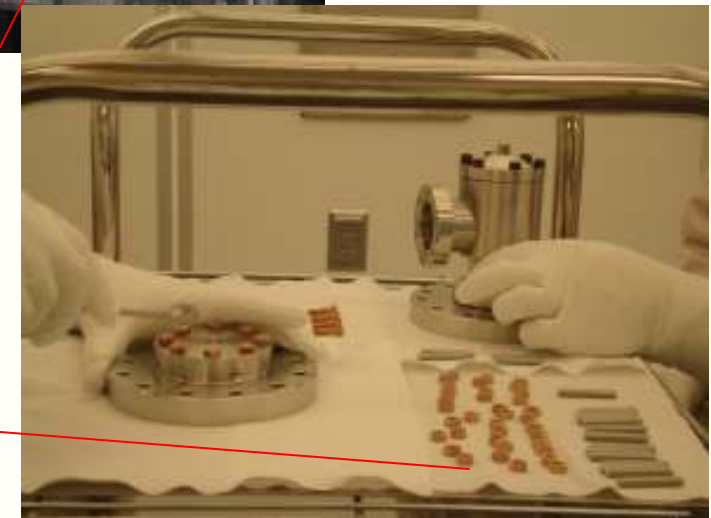
- Assembly hardware:
 - Wash in the ultrasonic bath
 - Blow clean with ionized nitrogen under the Class 10 hood
 - Bag and transport in the Class 1000 ante clean room
 - Blow clean with ionized nitrogen while monitoring the particulates count in the sluice area
 - Transport into the Class 10 assembly

Electro-polished, rolled thread stainless steel studs; silicon bronze nuts

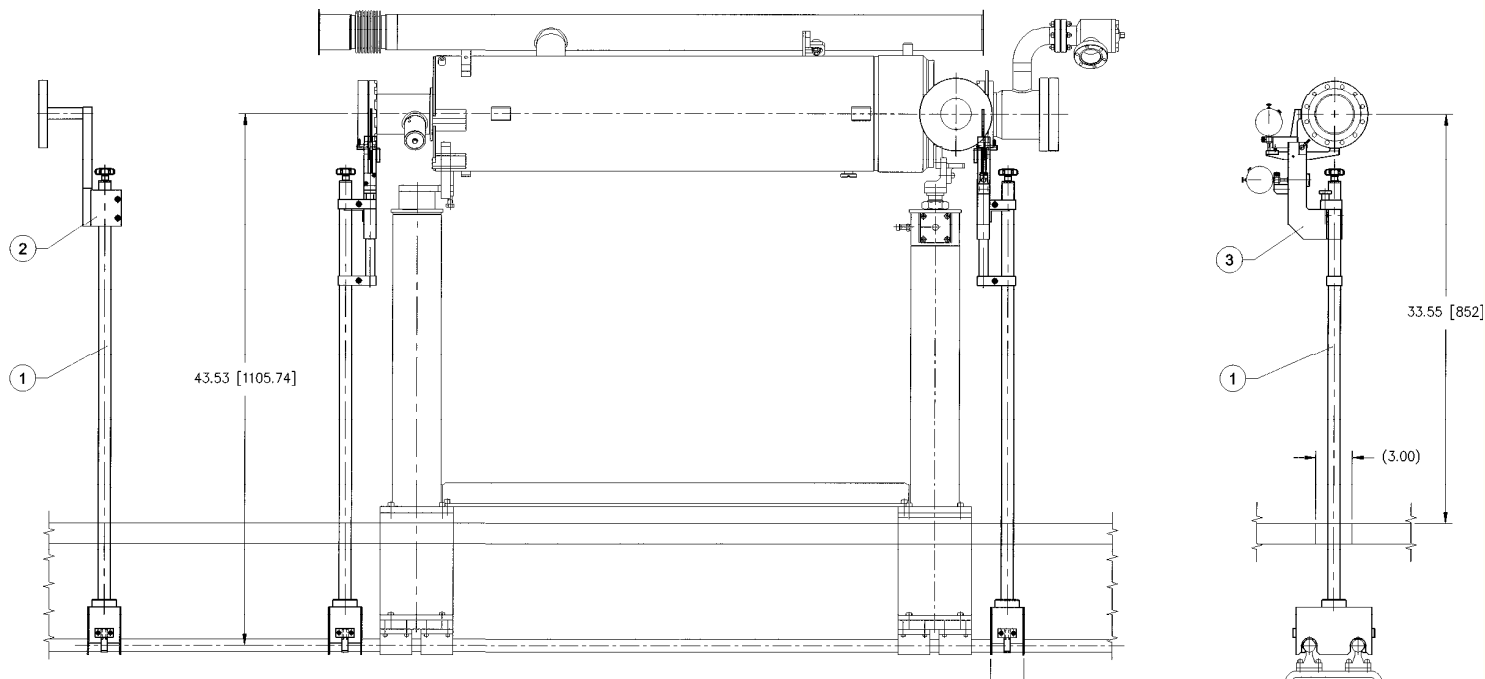


Class 10 Hood

US cleaner



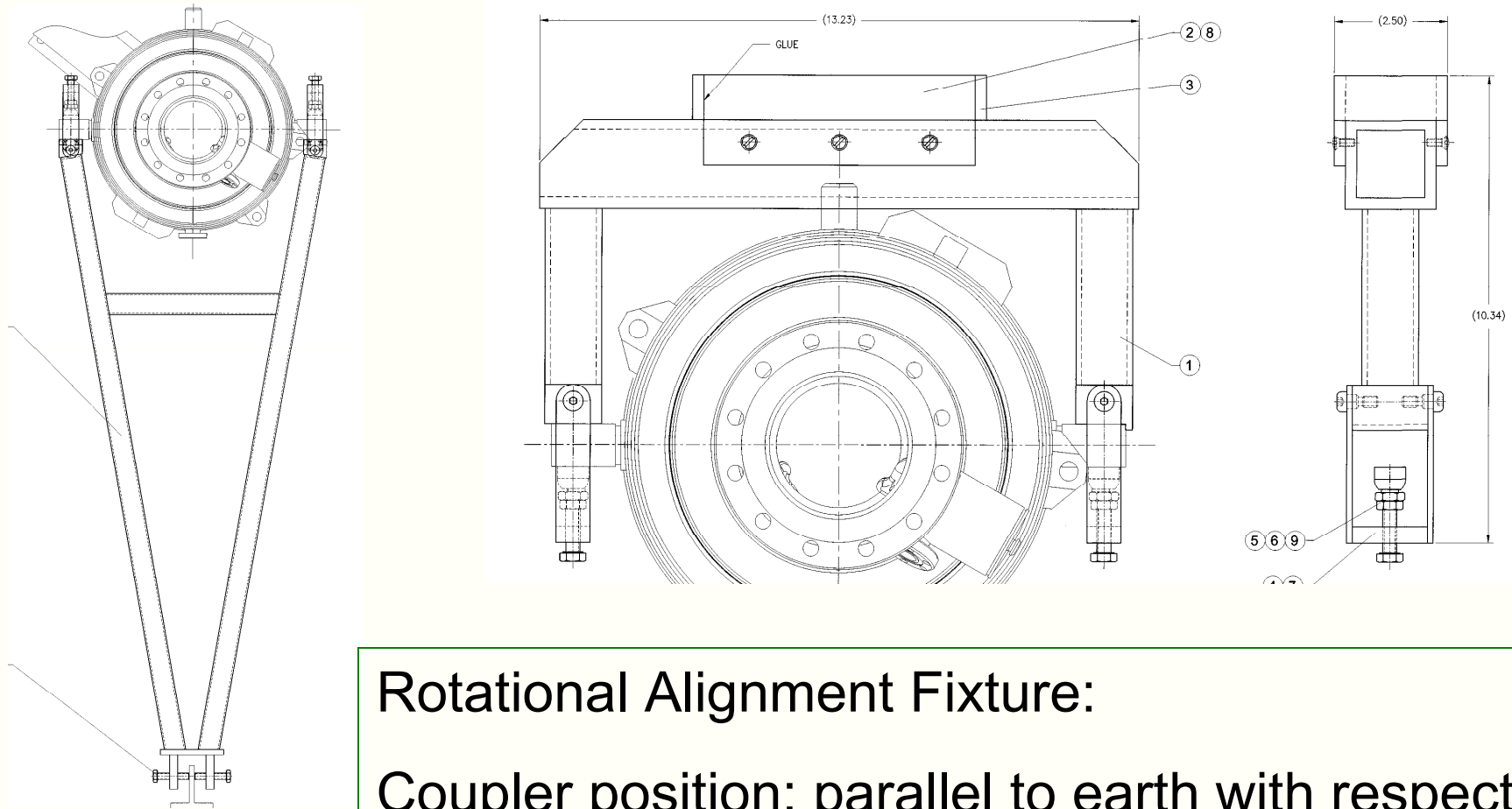
4 – Cavity Alignment in the clean room



X-Y Alignment Fixture:

Cavities beam line flanges are aligned to
~0.1mm for the interconnect bellows
assembly in the clean room

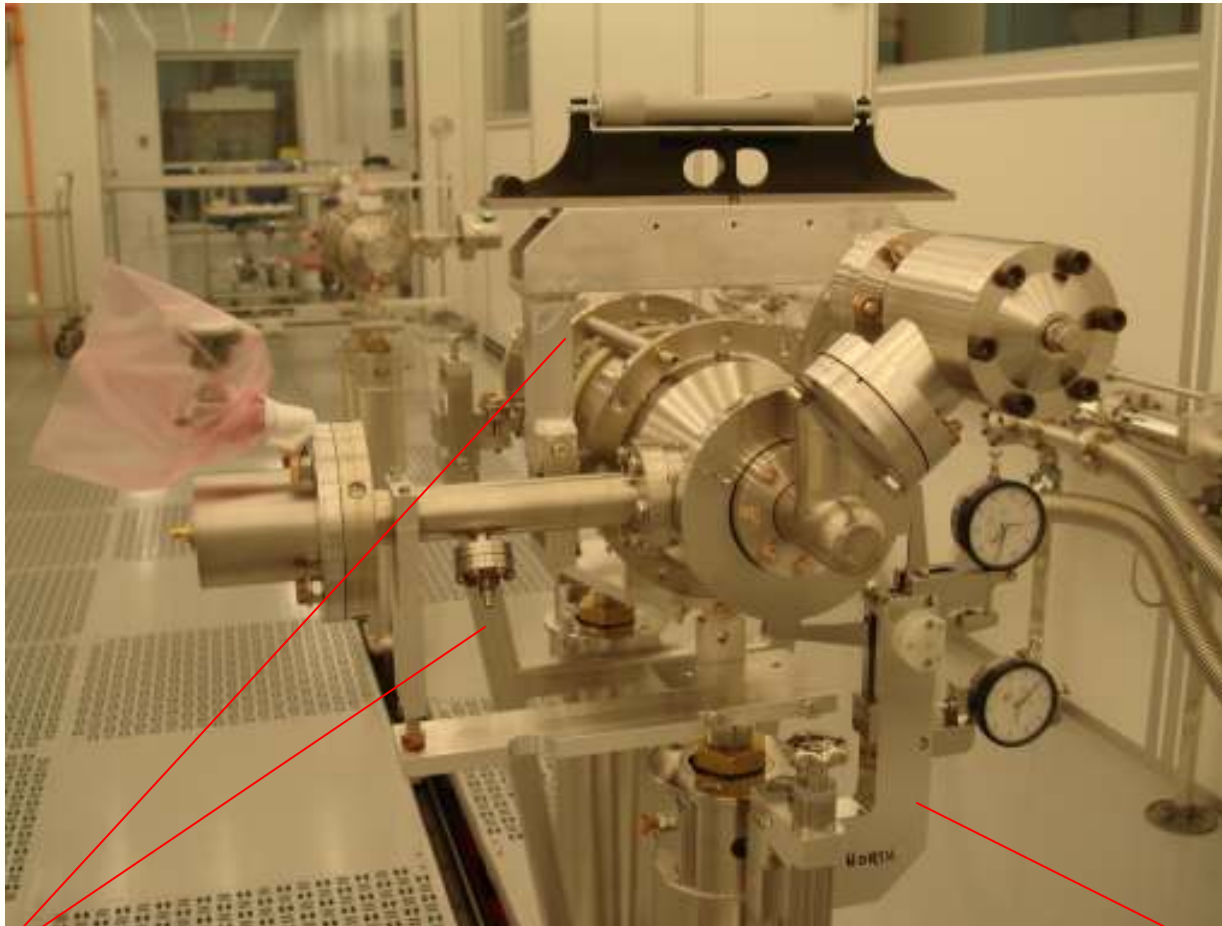
4 – Cavity Alignment in the clean room (cont)



Rotational Alignment Fixture:

Coupler position: parallel to earth with respect to the cavity helium vessel lugs

3.9GHz cavity alignment



Rotational Alignment
fixture

X-Y
Alignment
fixture

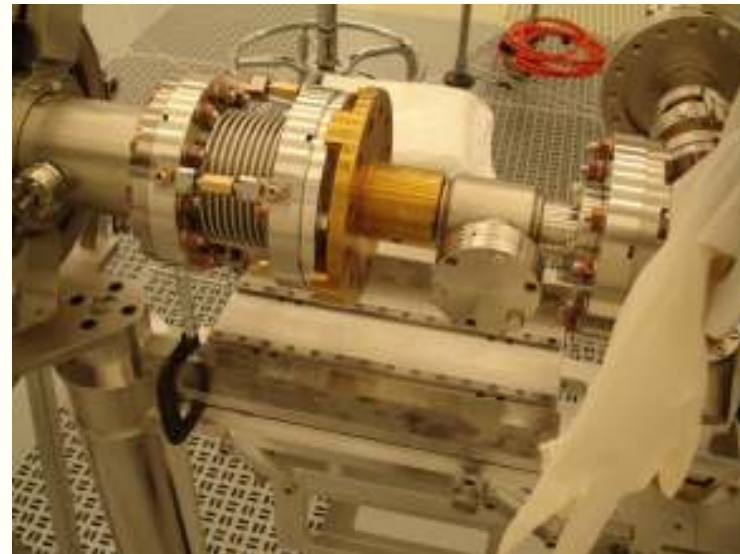
5- String Assembly

- **Gate Valve to Cavity Assembly:**
 - Sub-assembly of the right angle valve
 - Installation to the support post and vacuum hose assembly
 - Leak check
 - Alignment to the cavity beam line flange
 - Particulate free flange assembly (PFFA) procedures
 - Assemble the gate valve to the cavity

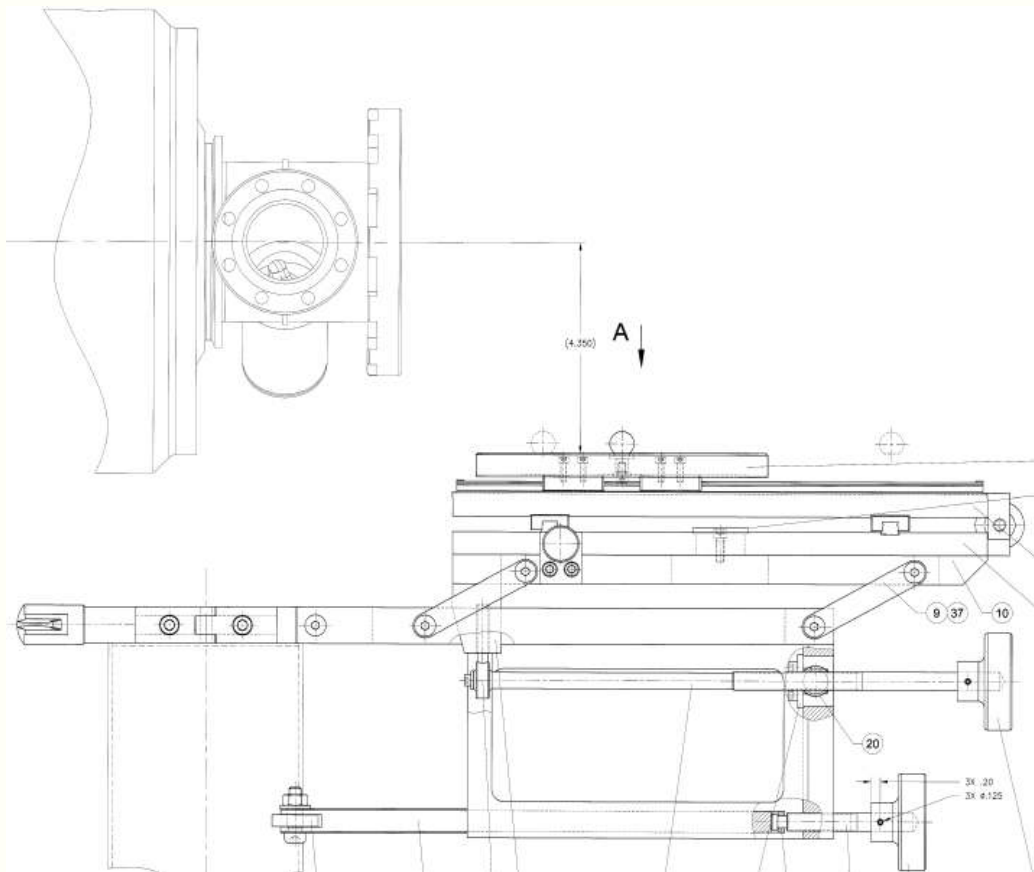


5- String Assembly (cont.)

- **Cavity to Cavity Assembly with the interconnect bellows:**
 - Assemble vacuum hose to the cavity. Pump down and Leak check. Backfill
 - Align the interconnect bellows to the cavity field probe end beam line flange
 - Assemble with PFFA
 - Align the bellows to the other cavity coupler end beam line flange
 - Assemble with PFFA

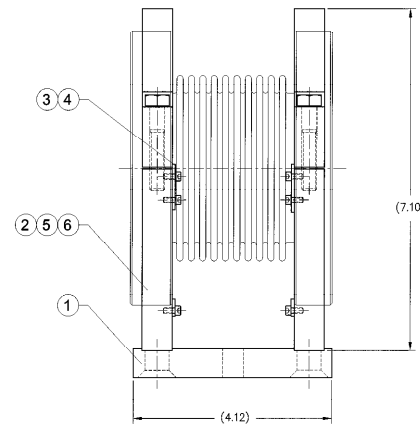
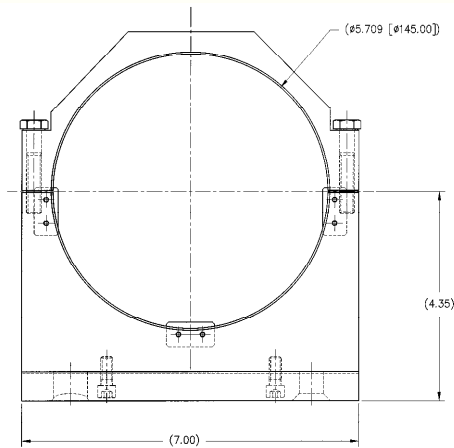


Adjustable Table Fixture

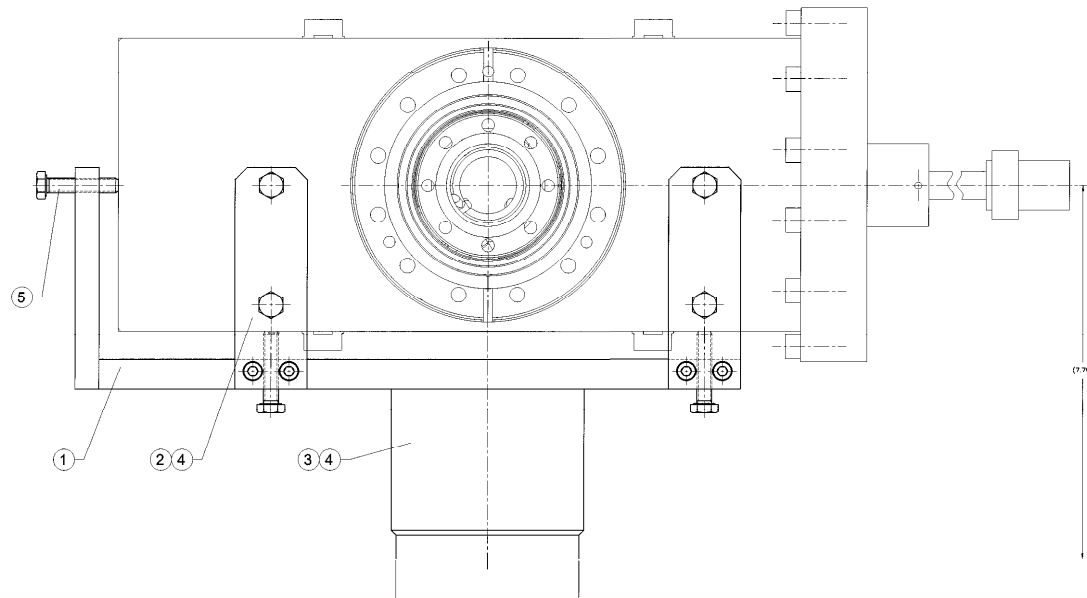
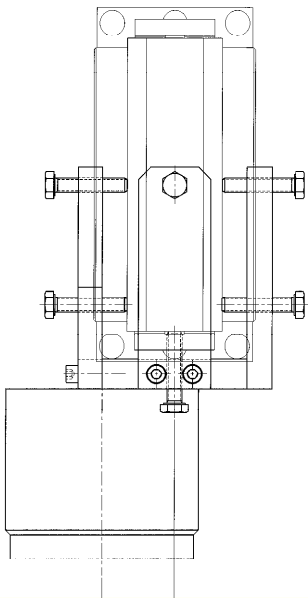


This fixture is used to align the flanges of the parts that will be assembled

Miscellaneous Fixtures



Interconnecting
Bellows Holder
Fixture



Gate Valve
Holder &
Alignment
Fixture

Cold Mass Assembly Fixture



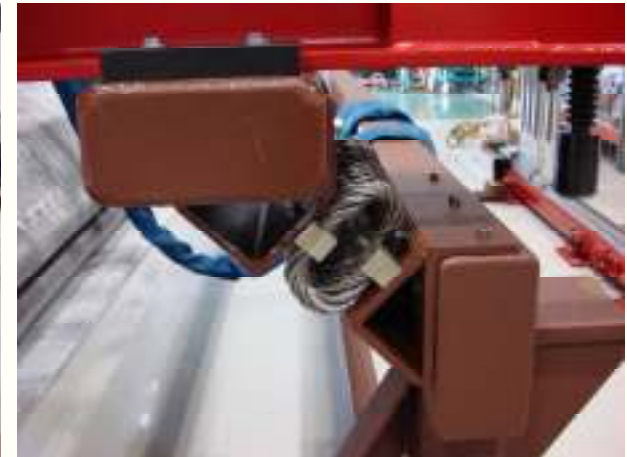
String assembly rail is aligned to the center of the spreader bar fixture

Spreader bar fixture is used to support, lower and raise the GRHP



Cold Mass Transport Fixture

- 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 (~5km from CAF-MP9).



Cold Mass Transport
Fixture

Vacuum Vessel Assembly Fixture

- The assembly fixture used in CAF-ICB is the Vacuum Vessel Assembly fixture aka “Big Bertha”
 - a cantilever fixture used to support the cold mass for the remainder of the insulation and power coupler assembly and then slide the vacuum



Cryomodule Transport Fixture

- Fixture to transport completed Cryomodule from CAF-ICB to the ILCTA-NML



Summary



- FNAL Cavities:
 - Symmetrical beam tube length
 - Standard flanges with aluminum hex shape seals
 - Blade Tuner, helium vessel bellows in the middle of the tank
 - FNAL design magnetic shielding
- DESY Cavities:
 - Non symmetrical beam tube length
 - Standard flanges with aluminum hex shape seals
 - End tuner, helium vessel bellows at the end of the tank
 - DESY design magnetic shielding
- Interconnecting bellows:
 - In order to assemble the 2 FNAL cavities, standard DESY design interconnecting bellows will not work. Symmetrical end cavities are shorter. FNAL should provide two modified bellows with the two cavities accordingly. (No copper coating inside the bellows)