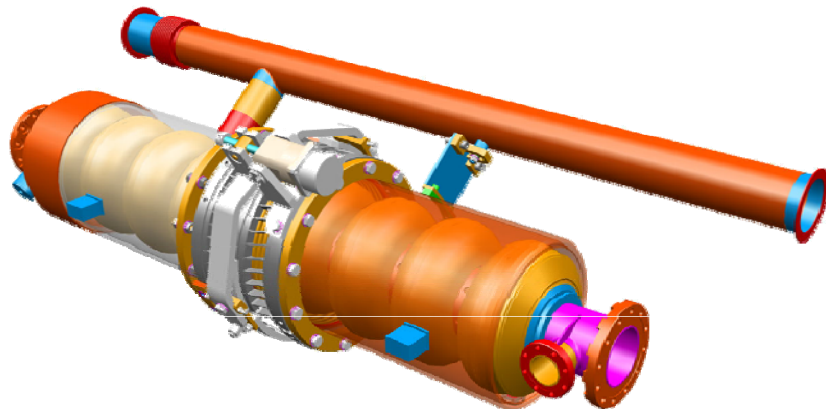


# **Cavity Dressing and CM2 Assembly Mini-Reviews Report**

**(a.k.a. Summary of the Cavity Dressing and CM2 Fabrication Plan)**



**H. Carter  
2/9/2009**

# **Cavity Dressing and CM2 Mini-Reviews: Review Panel Members**

**Phil Pfund, Chairman**

**Elvin Harms**

**Jerry Leibfritz**

**Tom Nicol**

**Rich Stanek**

**Bob Webber**

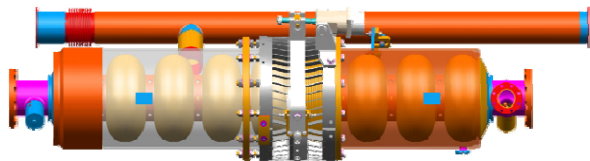
# **Cavity Dressing and CM2 Mini-Reviews: Items in Charge to the Review Panel**

- 1) Project organization chart that spells out the responsibilities of people.**
- 2) Project execution plan**
- 3) Project resources both SWF and M&S that would allow for schedule described in 4)**
- 4) Cavity Dressing and CM2 schedules with milestones**
- 5) Travelers for Cavity Dressing and CM2 assembly**
- 6) Plan and schedule for safety and engineering notes that would allow to meet the schedule detailed in 4)**

# Cavity Dressing Mini-Review Agenda

Thursday, Jan. 22, 2009

- **Introduction** 5 min.
- **Cavity Dressing Organization** 15 min.
- **Cavity Dressing Flow Chart** 10 min.
- **Cavity Dressing Plan & Schedule** 20 min.
- **Cavity Dressing Detailed Schedule** 20 min.
- **Cavity Dressing Procedure** 20 min.
- **General Discussion and Q&A** 15 min.
- **Closed Session for Reviewers** 15 min.



**Total: 2 hours**

# CM2 Mini-Review Agenda

Thursday, Jan. 29, 2009

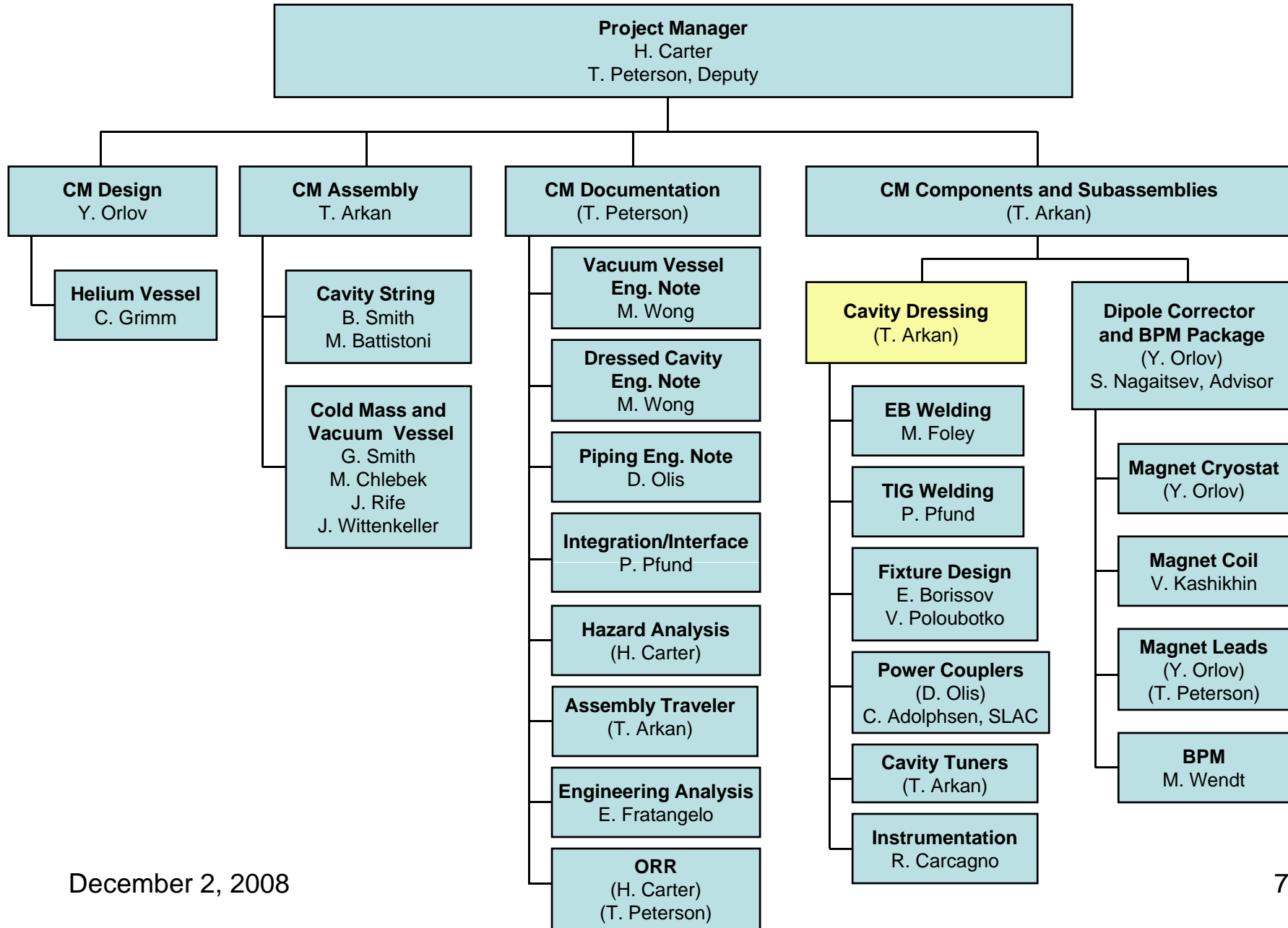
Comitium, WH2SE

- **Introduction & Charge** 5 min.
- **Project Organization** 15 min.
- **Project Plan & Schedule** 20 min.
- **BOM** 10 min.
- **Assembly Plan** 10 min.
- **Assembly Schedule** 20 min.
- **ORC Documentation Status** 20 min.
- **General Discussion and Q&A** 20 min.

**Total: 2 hours**

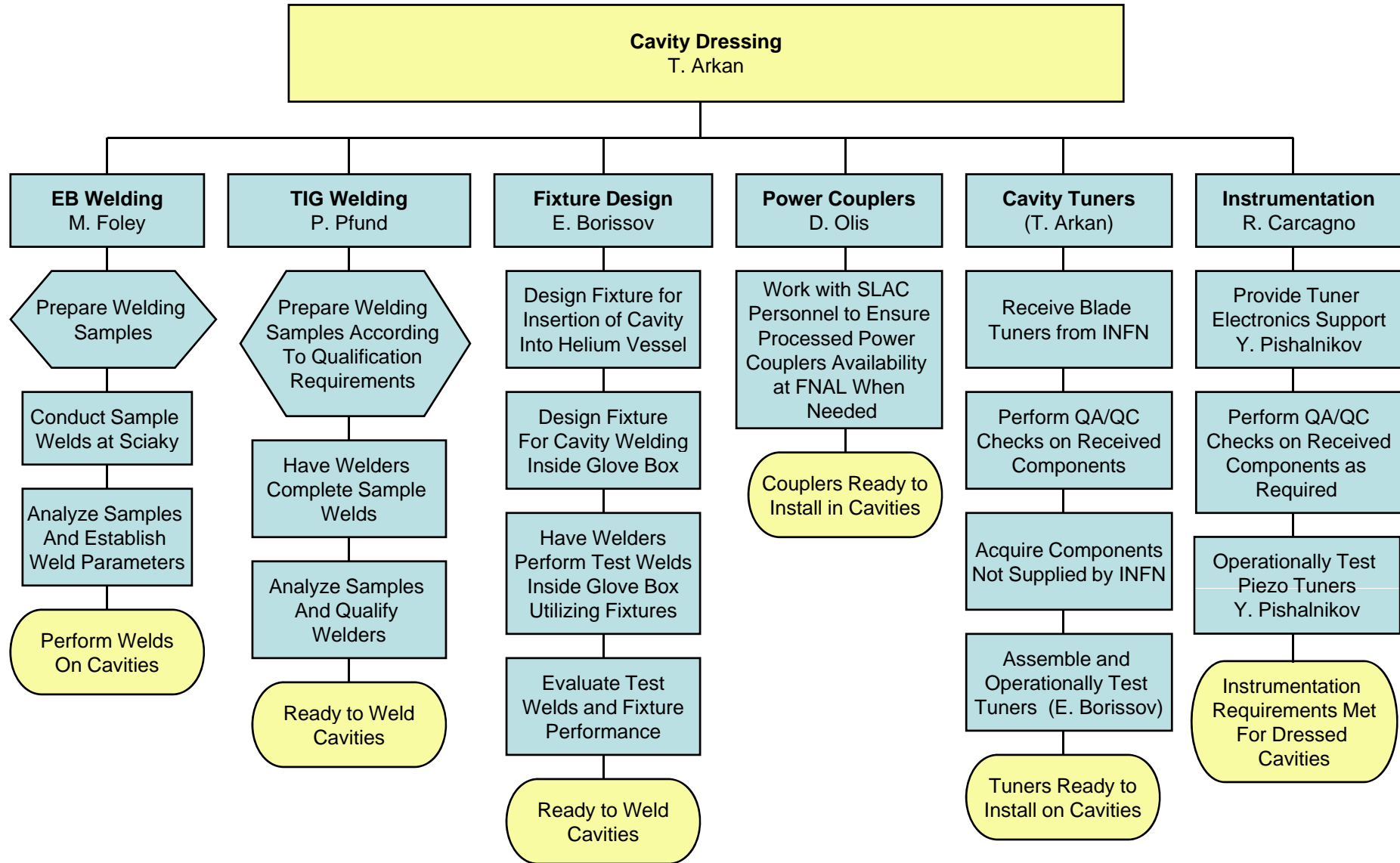
# **1) CM2 Project Organization**

# Cryomodule 2 Project Organizational Chart



December 2, 2008

## CM Components and Subassemblies: Tasks





## **2) Project Execution Plan**

The Project Execution Plan (PEP) is a formal, written description of the project including the overall scope, resource requirements, technical objectives, and the schedule for achieving the plan.

A formal PEP has not yet been prepared for the CM2 project, but it will be soon.

**3) Project resources both SWF and M&S that would allow for schedule described in 4)**

## Item #3: Resources Snapshot

- ~\$600K M&S needed to procure components that FNAL will provide
  - Of this, \$250K planned to be spent in FY08
  - Remaining \$350K will be needed early in FY09 in order to meet desired assembly schedule
    - Cavity dressing:
      - \$355K M&S available in FY09
        - » Orders totaling \$289K + \$115K – \$404K already written (but split between CM2 and CM3), so ~\$150K remains available
      - SWF of \$367K available in FY09
    - CM2 assembly funds
      - \$75K M&S in FY09
      - \$459K SWF in FY09
- Major long lead items have been ordered (the \$404K above)
  - Some components required qualified vendor development:
    - Cavity helium vessel tubes and assemblies (ended up with Hi Tech)
  - Exception is the external waveguide for supplying power to cavities
- Infrastructure requirements (\$120K)
  - Glove box for titanium welding has been received and is being installed
  - Various in-house fixtures to support cavity dressing have been procured and are being assembled

## **4) Cavity Dressing and CM2 schedules with milestones**

# Item #4: Cavity Dressing Schedule

<b>Dress first 1.3GHz cavity with Ti Helium Vessel</b>	<b>254d</b>	<b>Mon 6/9/08</b>	<b>Fri 6/12/09</b>
• Mechanical Design	150d	Mon 6/9/08	Fri 1/16/09
• <b>Design and Drawings Release Complete</b>	<b>0d</b>	<b>Fri 1/16/09</b>	<b>Fri 1/16/09</b>
• Welding Tests	144d	Tue 6/10/08	Fri 1/9/09
• <b>Welding Tests Complete</b>	<b>0d</b>	<b>Fri 1/9/09</b>	<b>Fri 1/9/09</b>
• Procurement	202d	Mon 6/30/08	Wed 4/22/09
• <b>Procurements Complete</b>	<b>0d</b>	<b>Wed 4/22/09</b>	<b>Wed 4/22/09</b>
• Assemble Tooling and Welding Fixtures at CAF-MP9	5d	Thu 1/15/09	Thu 1/22/09
• Assemble Helium Vessel to AES1 at CAF-MP9	10d	Mon 3/9/09	Fri 3/20/09
• <b>1st Dressed Cavity (AES1) Complete</b>	<b>0d</b>	<b>Fri 3/20/09</b>	<b>Fri 3/20/09</b>
<b>2nd Dressed Cavity Complete</b>	<b>10d</b>	<b>Mon 3/23/09</b>	<b>Fri 4/3/09</b>
<b>3rd Dressed Cavity Complete</b>	<b>10d</b>	<b>Mon 4/6/09</b>	<b>Fri 4/17/09</b>
<b>4th &amp; 5th Dressed Cavities Complete</b>	<b>10d</b>	<b>Mon 4/20/09</b>	<b>Fri 5/1/09</b>
<b>6th &amp; 7th Dressed Cavities Complete</b>	<b>10d</b>	<b>Mon 5/4/09</b>	<b>Fri 5/15/09</b>
<b>8th &amp; 9th Dressed Cavities Complete</b>	<b>10d</b>	<b>Mon 5/18/09</b>	<b>Fri 5/29/09</b>
<b>10th &amp; 11th Dressed Cavities Complete</b>	<b>10d</b>	<b>Mon 6/1/09</b>	<b>Fri 6/12/09</b>
•			
• In-house Titanium Welding Infrastructure Development	166d	Mon 7/7/08	Mon 3/9/09
•			
•			
<b>Test Cycle for AES1</b>	<b>23d</b>	<b>Mon 3/23/09</b>	<b>Wed 4/22/09</b>
• <b>Test Cycle complete for AES1</b>	<b>0d</b>	<b>Wed 4/22/09</b>	<b>Wed 4/22/09</b>

# Item #4: CM2 Assembly Schedule

• Cryomodule 2 Engineering Design Work	115d	Mon 9/22/08	Fri 2/27/09
• Cryomodule 2 Component Parts	341d	Mon 6/9/08	Mon 9/28/09
• Cavities	10d	Mon 9/22/08	Fri 10/3/08
• Power Couplers	30d	Mon 1/26/09	Fri 3/6/09
• Blade Tuners	118d	Mon 12/15/08	Wed 5/27/09
• Magnetic Shielding	80d	Tue 2/3/09	Mon 5/25/09
• Dressed Cavities	341d	Mon 6/9/08	Mon 9/28/09
• Dress first 1.3GHz cavity with Ti He Vessel	215d	Mon 6/9/08	Fri 4/3/09
• Dress 10 cavities for CM2 and S1 Global	162d	Fri 2/13/09	Mon 9/28/09
• Quadrupole doublet	23d	Wed 4/15/09	Fri 5/15/09
• Cavity BPM	1d	Mon 4/13/09	Mon 4/13/09
• <b>Cold Mass Assembly</b>	<b>0d</b>	<b>Fri 2/27/09</b>	<b>Fri 2/27/09</b>
• <b>Vacuum Vessel</b>	<b>0d</b>	<b>Fri 2/27/09</b>	<b>Fri 2/27/09</b>
• <b>Thermal Shields</b>	<b>0d</b>	<b>Fri 2/27/09</b>	<b>Fri 2/27/09</b>
• Instrumentation	71d	Fri 2/27/09	Fri 6/5/09
• Hardware	80d	Fri 2/27/09	Thu 6/18/09
• <b>All components for CM2 in house</b>	<b>0d</b>	<b>Mon 9/28/09</b>	<b>Mon 9/28/09</b>
• Cryomodule 2 Assembly	51d	Tue 9/29/09	Tue 12/8/09
• Cavity String Assembly	12d	Tue 9/29/09	Wed 10/14/09
• "Cold Mass Assembly (Phase-I, 2 weeks)"	10d	Wed 10/14/09	Tue 10/27/09
• "Cold Mass Assembly (Phase-II, 2 weeks)"	10d	Wed 10/28/09	Tue 11/10/09
• "Cold Mass Assembly (Phase-III, 1 week)"	5d	Wed 11/11/09	Tue 11/17/09
• Warm Part Coupler Assembly	8d	Wed 11/18/09	Fri 11/27/09
• Terminate and Connect Cables	4d	Mon 11/30/09	Thu 12/3/09
• Install coupler pumping lines & leak check	3d	Fri 12/4/09	Tue 12/8/09
• <b>CM2 Assembly Complete</b>	<b>0d</b>	<b>Tue 12/8/09</b>	<b>Tue 12/8/09</b>
• Beamline vacuum leak check	1d	Wed 12/9/09	Wed 12/9/09
• Insulating vacuum leak check	2d	Thu 12/10/09	Fri 12/11/09
• Prepare for transport from CAF-ICB to NML	2d	Mon 12/14/09	Tue 12/15/09
• Deliver CM2 to NML	1d	Wed 12/16/09	Wed 12/16/09



## **5) Travelers for Cavity Dressing and CM2 assembly**

Travelers for cavity dressing and for CM2 assembly do not exist at this time.

For cavity dressing, the plan is to develop a traveler during the initial cavity dressing learning period (on AES1, et.al.), then implement the use of the traveler during routine dressing operations. The DESY cavity dressing Procedure will be the reference for development of the dressing process here at FNAL.

For CM2 assembly, a cryomodule assembly procedure was developed during CM1 assembly which will be used as the basis for development of a traveler during the assembly of CM2.

**6) Plan and schedule for safety and engineering notes that would allow to meet the schedule detailed in 4)**



# Item #6: CM2 Documentation Schedule

## 1.3GHz CM2 Documentation Schedule

- ORC Documentation
- Vacuum Vessel
- Helium Vessel
- Pressure Piping (FNAL ES&HM 5031.1)
- Cryomodule Assembly
- CM Interface Documentation
- Hazard Analysis
- Cryomodule Shipping Plan (same as CM1)
- ORC Supporting Appendicies
- **ORC Documentation complete**
- "ORC Review Process (Per TD-1140, v2)"
- **ORC Review Process Complete**

## Supporting Technical Documentation

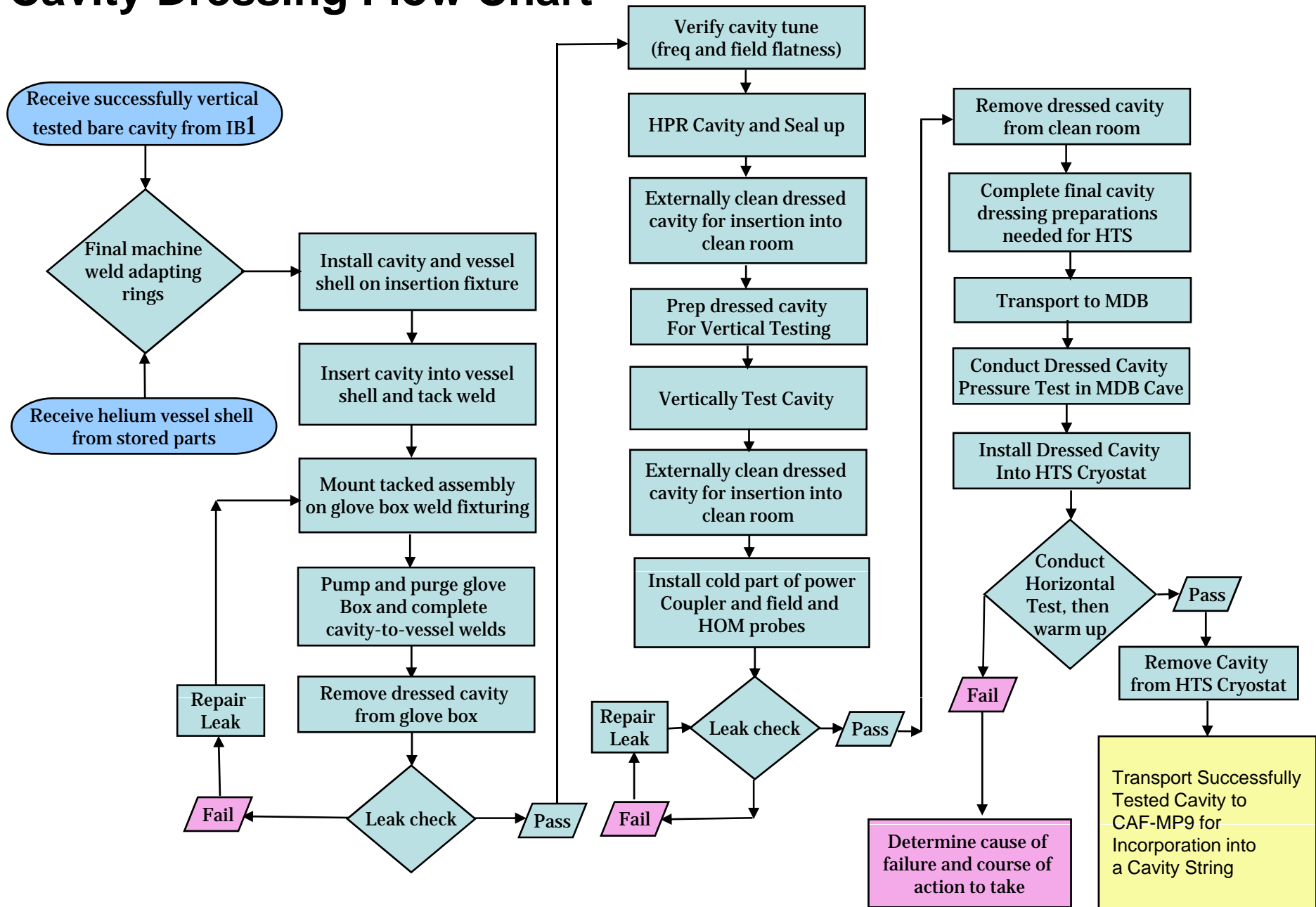
- Cavity Fabrication Documentation
- Cavity Processing Documentation
- Cavity RF Performance Documentation
- Vertical Test Documentation
- Horizontal Test Documentation
- **Supporting Technical Documentation complete**

583d	Wed 9/5/07	Fri 12/18/09
547d	Mon 10/1/07	Fri 11/20/09
79d	Tue 1/27/09	Fri 5/15/09
249d	Mon 9/8/08	Fri 8/28/09
51d	Tue 9/8/09	Tue 11/17/09
40d	Mon 9/28/09	Fri 11/20/09
45d	Mon 2/16/09	Fri 4/17/09
35d	Mon 6/8/09	Fri 7/24/09
110d	Mon 2/11/08	Mon 7/14/08
368d	Mon 10/1/07	Fri 3/13/09
0d	Fri 11/20/09	Fri 11/20/09
48d	Mon 10/12/09	Fri 12/18/09
0d	Fri 12/18/09	Fri 12/18/09
528d	Wed 9/5/07	Wed 9/30/09
100d	Wed 9/5/07	Mon 1/28/08
80d	Tue 1/22/08	Mon 5/12/08
100d	Tue 2/5/08	Mon 6/23/08
257d	Mon 5/5/08	Fri 5/8/09
120d	Wed 4/15/09	Wed 9/30/09
0d	Wed 9/30/09	Wed 9/30/09

# Supplemental Slides

# Cavity Dressing

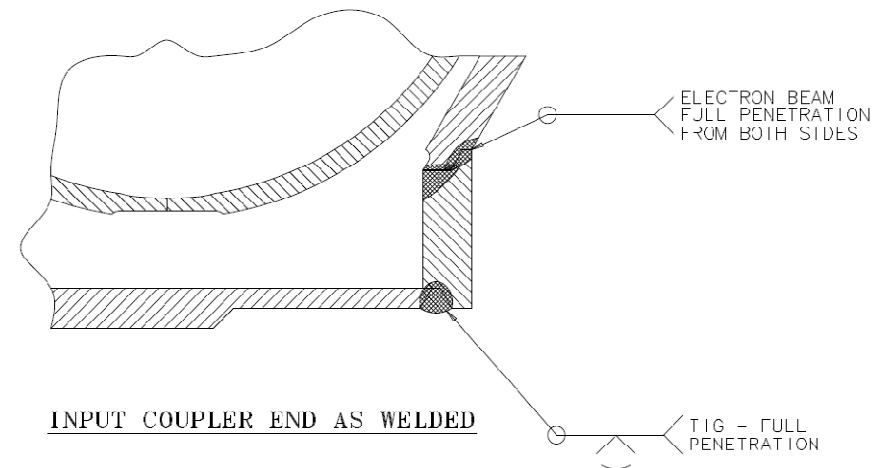
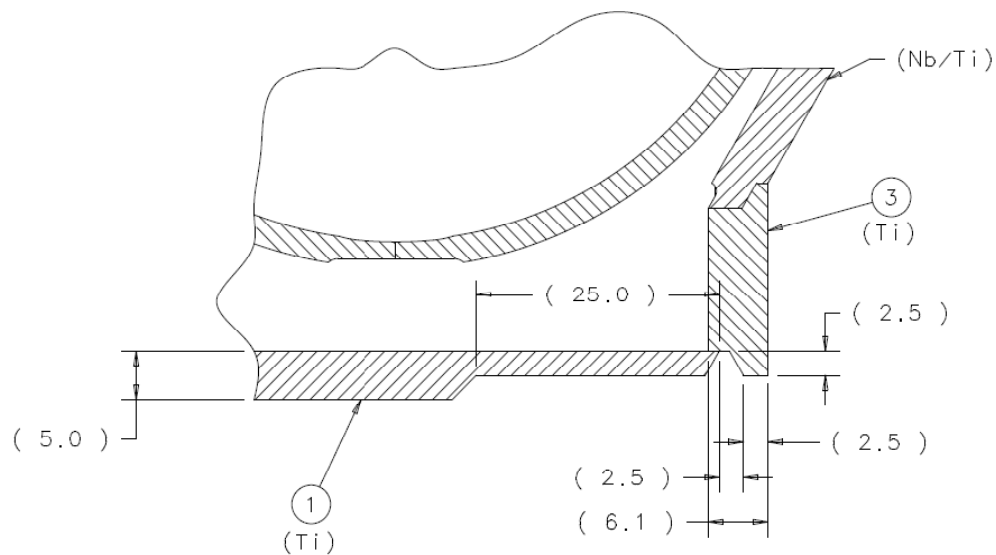
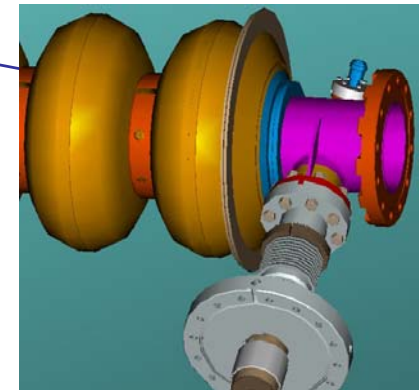
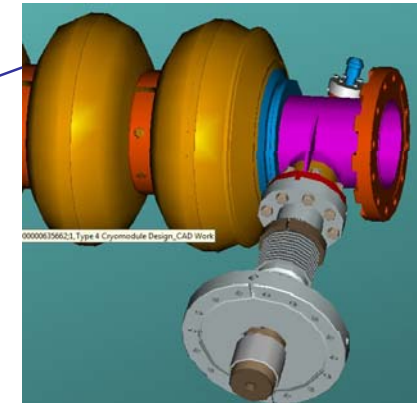
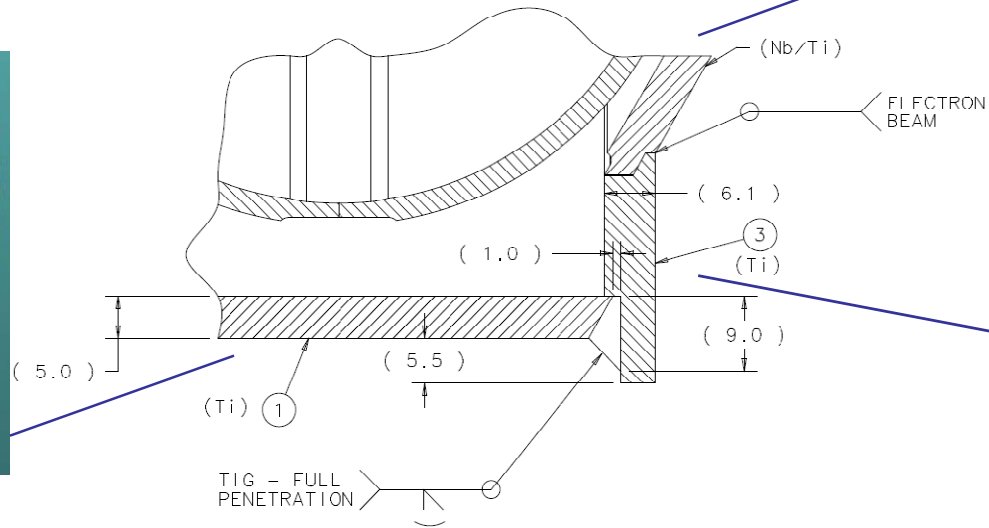
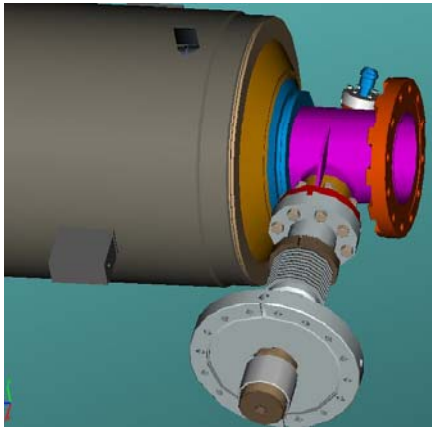
# Cavity Dressing Flow Chart



# Cavity Dressing Requirements

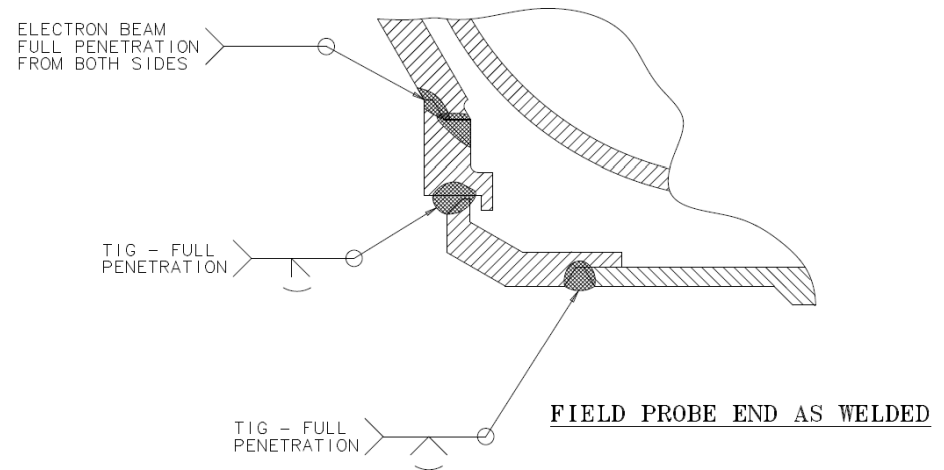
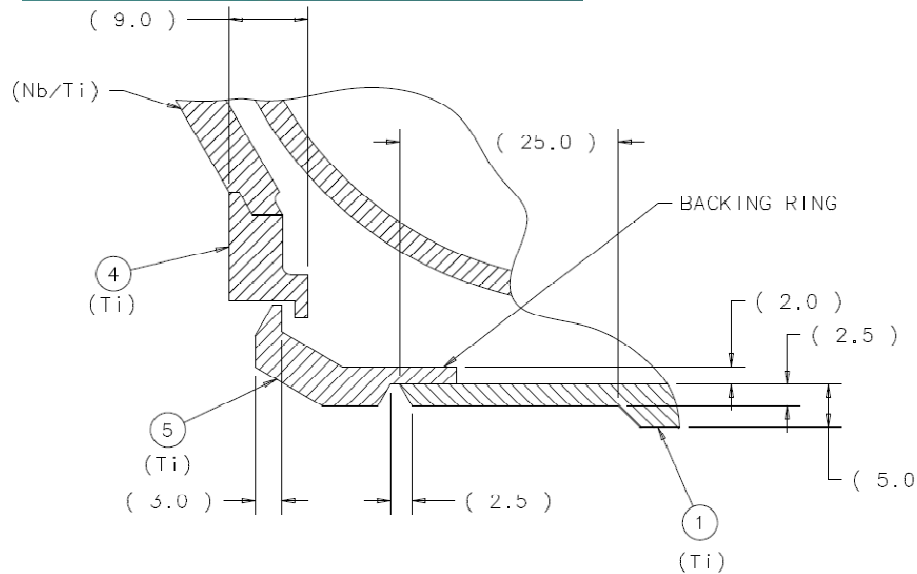
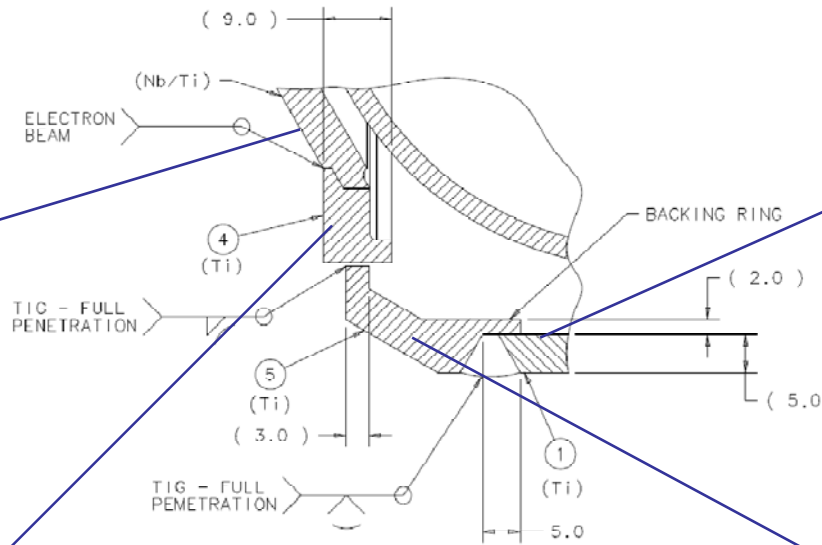
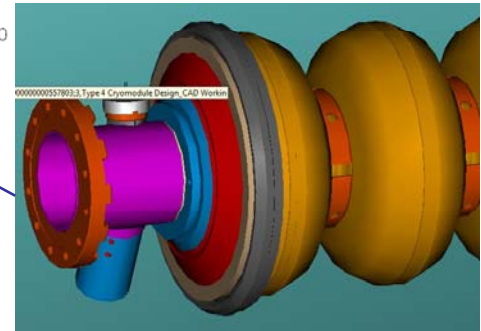
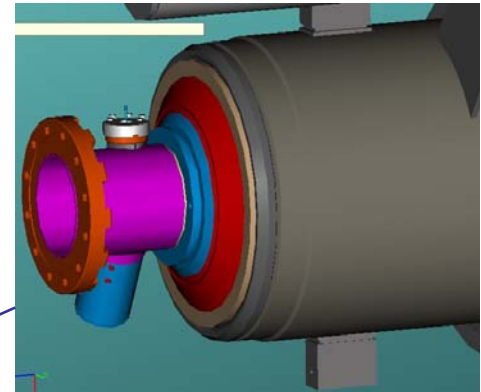
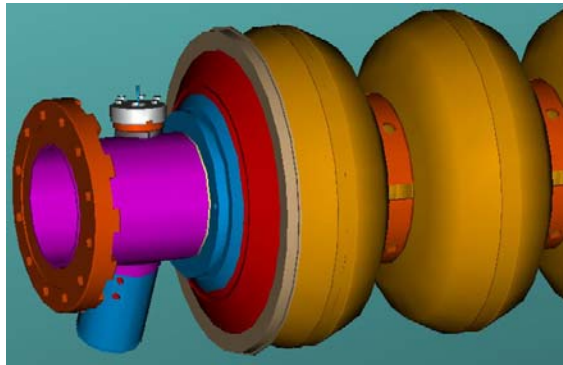
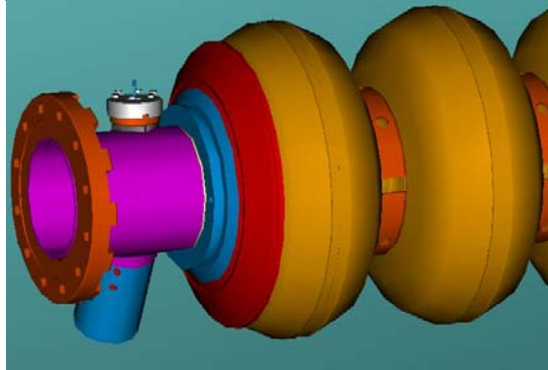
- **AES1 Bare Cavity**
  - **Standard Tesla Design with unequal length beam tubes**
- **EBW Titanium Rings to Nb-Ti Cones of Cavity End Groups**
- **G3 Design Titanium Helium Vessel Subassembly**
- **TIG welding infrastructure at CAF-MP9 Completed**
- **Processed power coupler from SLAC**
- **1.3 GHz Cavity Magnetic Shielding**
- **One Slim Blade Tuner with Piezos from INFN-Milano**
- **All Cavity seals, hardware, and RF components**

# Weld Joint Details: Input Coupler End

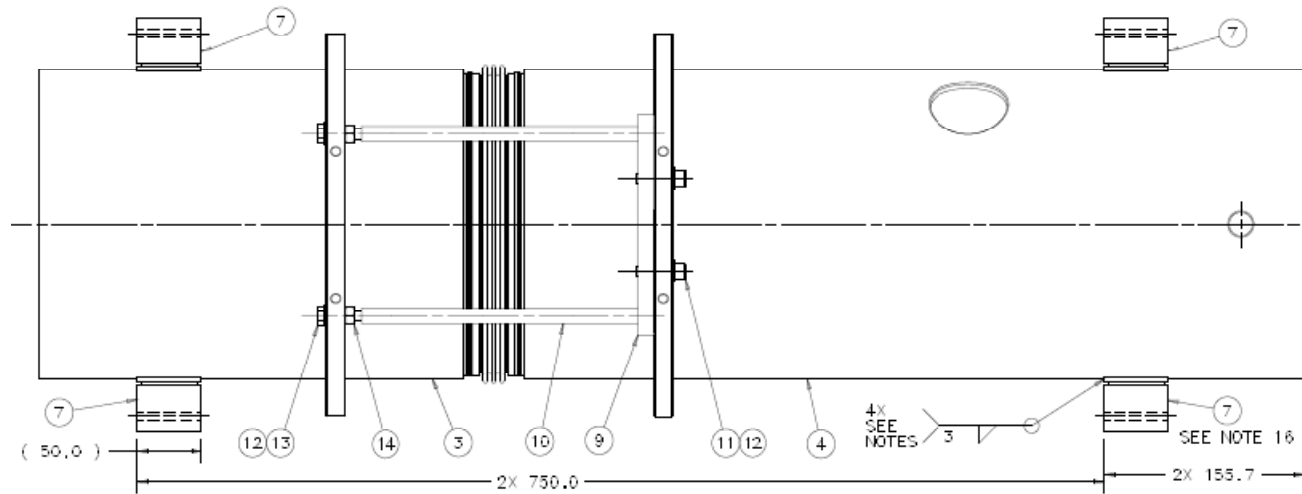


INPUT COUPLER END AS WELDED

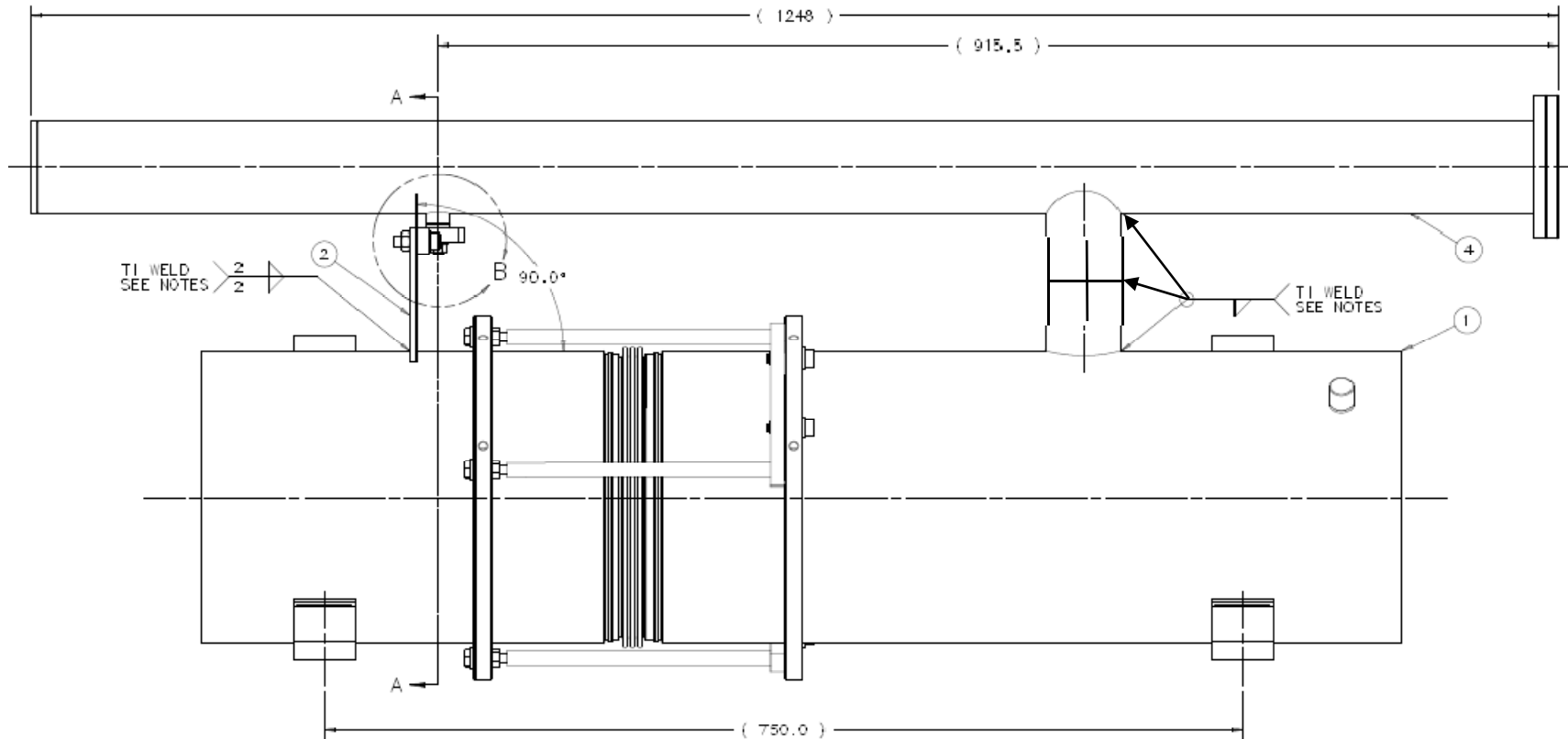
# Weld Joint Details: Field Probe End



# G3 VESSEL SUB-ASSEMBLY (FABRICATION AT HI-TECH)



- Local machine shop
- Adequate size glove box
- Certified welders for titanium TIG welding





# **CM2 Assembly**

# CM2 Components

- **Vacuum Vessel & Cold Mass, Cold Mass Posts (3):** from Zanon through MOU with INFN



Delivery: Originally planned for end of CY2008

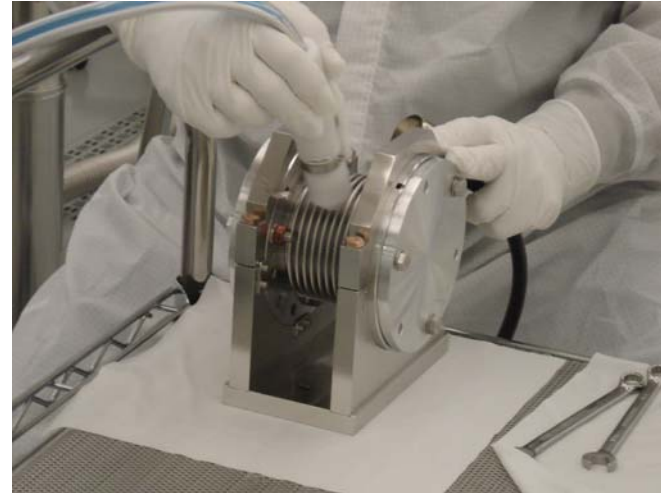
Now expected by end of Jan 2009

# CM2 Components-II

- **8 Qualified & Dressed Cavities:**
  - Bare Cavities: Procured by FNAL from Accel & AES (received)
  - Processing & Vertical Test: FNAL & U.S. collaborators
  - Dressing of Cavities: at CAF-MP9 in FNAL
    - Cavity Helium vessel design & development
    - TIG welding infrastructure development at FNAL
  - Horizontal Test: at HTS in FNAL

# CM2 Components-III

- **Cavity Interconnecting Bellows: (8)**
  - DESY Design
  - Stainless steel, convolutions are copper plated
  - FNAL will procure
  - Guesstimate:  $\sim \$2.5\text{K} \times 8 = \$20\text{K}$



- **String Gate Valves: (2)**
  - From VAT
  - Cleaning procedures need to be learned from DESY vacuum group
  - FNAL will procure 5 valves in FY08 (meets CM3 & CM3 reqmts.)
  - $\sim \$26.3\text{K} \times 5 = \$131.5\text{K}$



Sub total = \$151.5K

# CM2 Components-IV

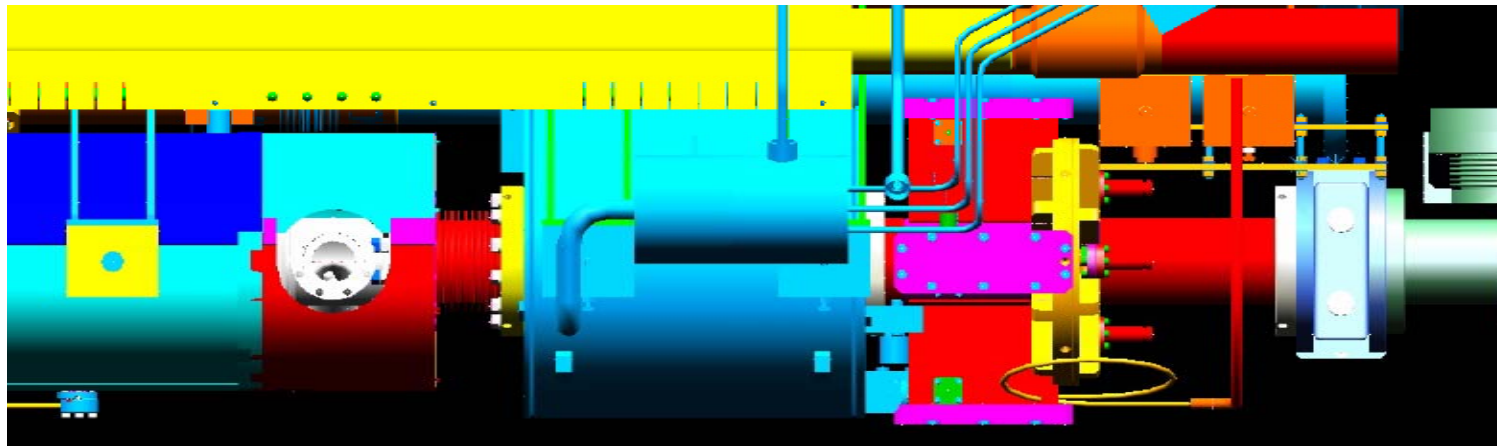
- **Blade Tuner – Piezo Tuner – Motor/Drive: (8)**
  - 8 light design blade tuners will be provided by INFN ← 2 have arrived at FNAL
  - Piezo tuners will be provided by INFN
  - Stepping Motors & gear drives to be provided by FNAL
  - Guesstimate: ~ \$8K x 10 = \$80K
- **Blade Tuner compatible Helium Tank: (8)**
  - Designed and Supplied by Fermilab
  - Cost: ~\$7.2K x 16 = \$115K + 4 prototypes = \$145K
- **2-phase pipe: (8)**
  - Titanium ← Now plan to use titanium for CM2
  - Guesstimate: ~\$1K x 8 + development costs = \$8K
- **Titanium bellows: (20)**
  - Have been procured
  - Cost: ~\$2.75K x 20 = \$55K
- **Blade Tuner compatible Magnetic Shields: (8)**
  - FNAL will procure
  - Guesstimate: ~\$10K x 10 = \$100K

Sub total = \$388K

# CM2 Components-V

- **Dipole Corrector Package:** (V. Kashikhin)
  - FNAL design, construction and testing
  - Test at MTF
  - Estimated cost? (guesstimate: ~ \$20K)
- **Cryostat Design:** (Y. Orlov)
- **Cavity BPM:** (Manfred Wendt)
  - FNAL design (RF-BPM) or **XFEL Button BPM**
  - Will be fabricated in industry
  - Estimated Cost? (guesstimate: ~ \$10K)

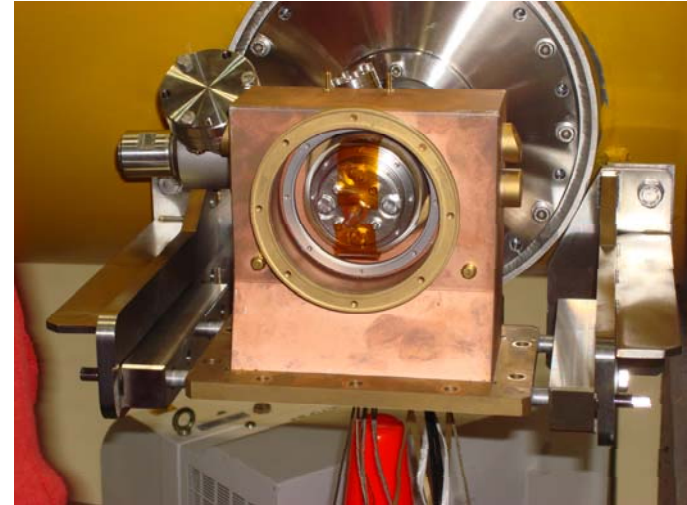
Coordination and  
Integration into  
the CM2 design  
by Y. Orlov





# CM2 Components-VI

- **Power Couplers:** (8 required)
  - 12 purchased From CPI in FY06
  - 8 are currently being processed at SLAC
  - To be delivered to FNAL from SLAC upon request
- **Waveguides, Tuner Motors**
  - To be procured by FNAL
  - Guesstimate:  $\sim 2K \times 8 = \$16K$
- **Coupler Pumping Lines & Pumps**
  - To be procured by FNAL
  - Guesstimate: \$15K



Sub total = \$31K

# CM2 Components-VII

- Cavity String Assembly Hardware, Seals (available at CAF)
- Cold Mass And Vacuum Vessel Assembly Hardware: (provided by INFN---due 1/09)
- Assembly Fixtures (available at CAF)

CAF infrastructure is complete and tested (during CM1 assembly) and ready for CM2 assembly CAF