

LBL MICE Project Status

Spectrometer Solenoids, Coupling Coils and RFCC Modules

Steve Gourlay

MICE Project Board

March 8, 2012



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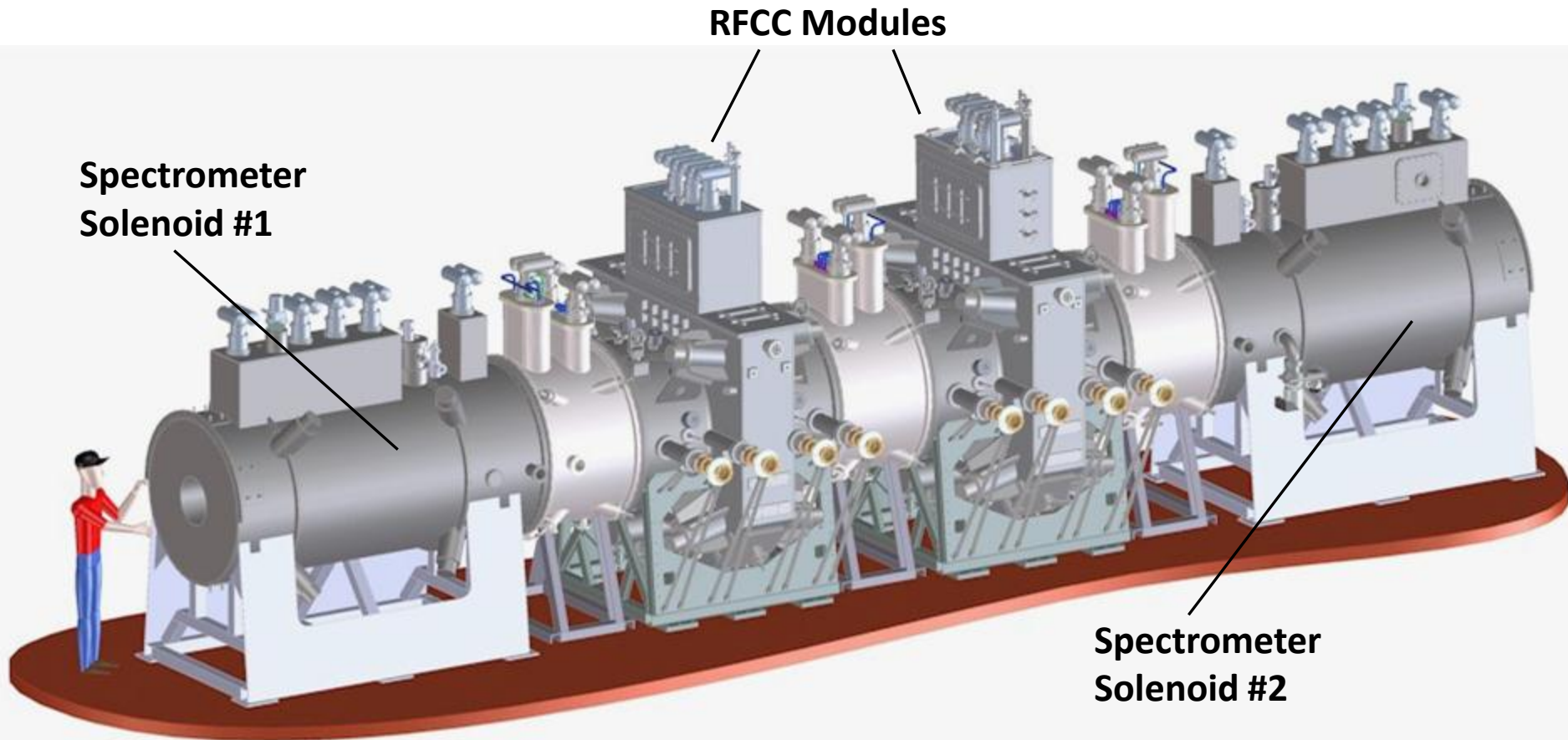
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LBNL Responsibilities



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Spectrometer Solenoids

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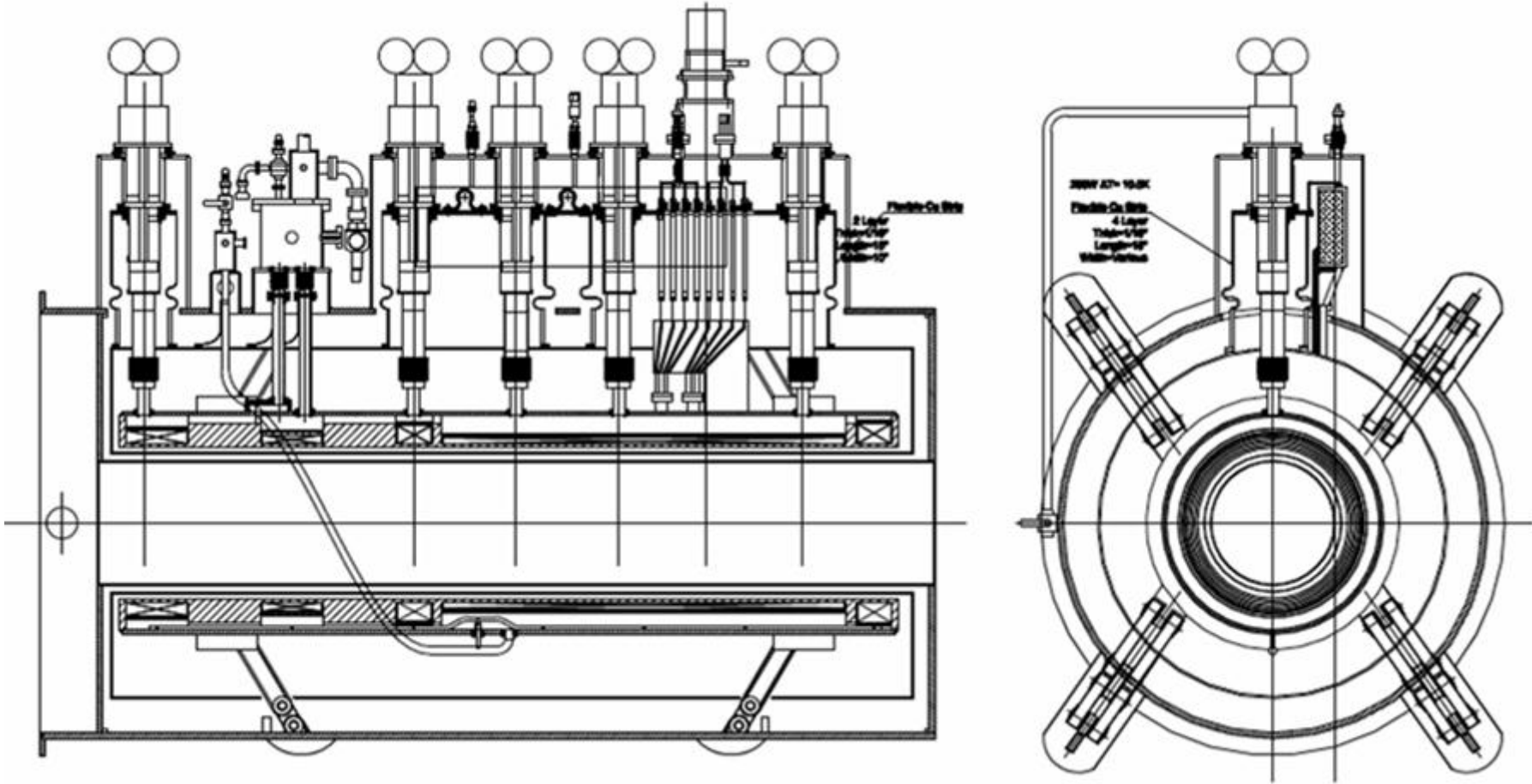
Spectrometer Solenoid Overview

Magnet design modifications focused on several key deficiencies identified through prior testing:

- Reduce cold mass heat leak and increase cryocooling power to prevent LHe boil-off
- Stabilize the LTS leads with copper and superconductor to prevent burnout
- Make improvements to enhance the reliability and effectiveness of the passive quench protection system



Current 5 + 1 Cryocooler Layout



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Reviews and Workshops

- Spectrometer Solenoid Review Workshop
 - May 10 & 11, 2011 at LBNL
 - Attended by magnet/cryo experts and MICE collaborators
 - Focus was on assessing heat leak to cold mass, developing modified designs, and validating quench protection system
- MAP Tech Board Meeting
 - September 13, 2011 at FNAL
 - Presented magnet modification and reassembly plan to board
- Spectrometer Solenoid Test Plan Workshop
 - February 17, 2012 at LBNL
 - Included discussions on: system layout, run plans, safety, power supplies, instrumentation and control, magnetic measurements

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Resources and Responsibilities

- Wang – core assembly team, design implementation
 - Machinist
 - ME, EE, Eng/Phys
 - Techs (x2)
 - Welder – SLAC
- LBNL/MICE
 - Steve Virostek – Lead Engineer - Overall coordination, fill in the gaps
 - Roy Preece – Continuous onsite supervision/coordination
 - Dennis Calais – onsite mech tech
 - Junior mech techs onsite part time (x2)



Resources cont'd

- LBNL Support team
 - Soren Prestemon – QP, assembly
 - Heng Pan – QP/Cryo
 - Jon Joseph – Power supplies/interlocks
 - Mike Zisman – Project management/technical assistance
 - Allan DeMello – Engineering/CAD
 - Steve Gourlay – Technical assistance, resources, overall responsibility
- Fermilab
 - Vladimir Kashikhin + others
 - Sensor calibration
 - Improved vacuum system
 - Fast data acquisition system
 - Testing support
- Others
 - Daresbury Lab: control system and data logging system
 - MIT: Coupling Coils and QP calcs for Spectrometer Solenoids

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Progress on First Magnet

- Cold mass modifications and MLI wrap done
- Shield assembled around cold mass
- Cold mass/shield installed and aligned in vacuum vessel
- Shield assembly complete and MLI wrapped
- Tower installed on vacuum vessel with cooler and shield connections; leads installed
- Instrumentation feedthroughs wired
- Cold mass leak check complete
- Final vacuum vessel welding this week prior to leak check

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MLI Wrapped Cold Mass



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Shield over Cold Mass



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Assembly into Vacuum Vessel



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Ready for End Plate Installation



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Cryocooler Tower



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Ready for Final MLI Wrap & Welding



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Second Magnet Cold Mass



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Other items

- Second cold mass is on assembly stand and has been opened to expose QP resistors and diodes – no damage
- Heat sink design for QP resistors has been modified for use on the 2nd magnet – parts in fabrication now
- Power supply rack reconfiguration and rewiring completed at LBNL – one rack to go to Wang, one to RAL.
- Support stand redesign complete – attachment adapters are fabricated and to be welded to vessels at Wang, support bases to be fabricated at RAL.
- LBNL techs have designed and are assembling a water supply system at Wang for the cryocooler compressors.

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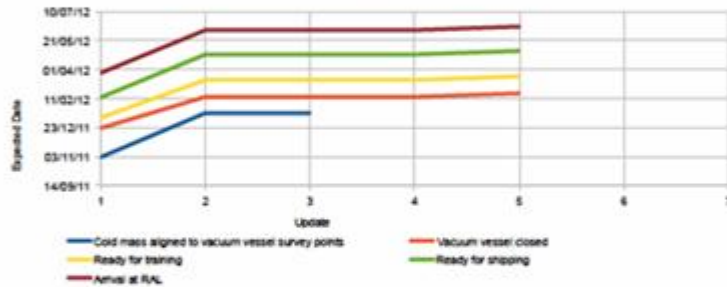
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Milestone Tracker

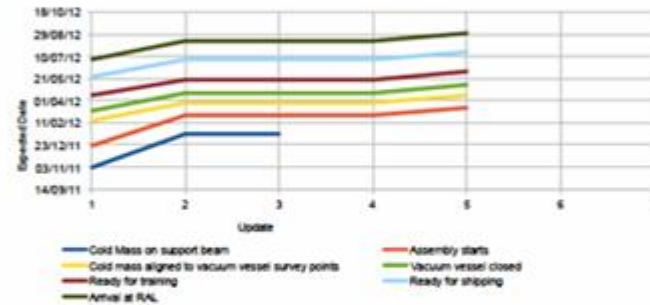
	11/10/11	11/01/12	10/01/12	09/01/12	01/02/12	06/02/12	12/02/12
Upstream							
Cold mass aligned to vacuum vessel survey points	02/11/11	17/01/12	17/01/12				
Vacuum vessel closed	22/12/11	14/01/12	14/02/12	14/02/12	20/02/12		
Ready for training	09/01/12	14/03/12	14/03/12	14/03/12	20/03/12		
Ready for shipping	13/02/12	27/04/12	27/04/12	27/04/12	03/05/12		
Arrival at RAL	24/03/12	06/06/12	06/06/12	06/06/12	14/06/12		
Downstream							
Cold Mass on support beam	02/11/11	17/01/12	17/01/12				
Assembly starts	21/12/11	26/02/12	26/02/12	26/02/12	14/03/12		
Cold mass aligned to vacuum vessel survey points	14/02/12	27/03/12	27/03/12	27/03/12	13/04/12		
Vacuum vessel closed	09/01/12	18/04/12	18/04/12	18/04/12	07/05/12		
Ready for training	13/04/12	18/05/12	18/05/12	18/05/12	04/06/12		
Ready for shipping	23/05/12	03/07/12	03/07/12	03/07/12	20/07/12		
Arrival at RAL	03/07/12	14/08/12	14/08/12	14/08/12	31/08/12		

Change since last update	
Reduction	Dark Green
No Change	Light Green
1 - 3 week extension	Yellow
2 - 4 weeks extension	Orange
1 - 2 month extension	Red
2+ months extension	Dark Red
Baseline	Grey
Complete	Dark Grey

Upstream Milestone Tracker



Downstream Milestone Tracker



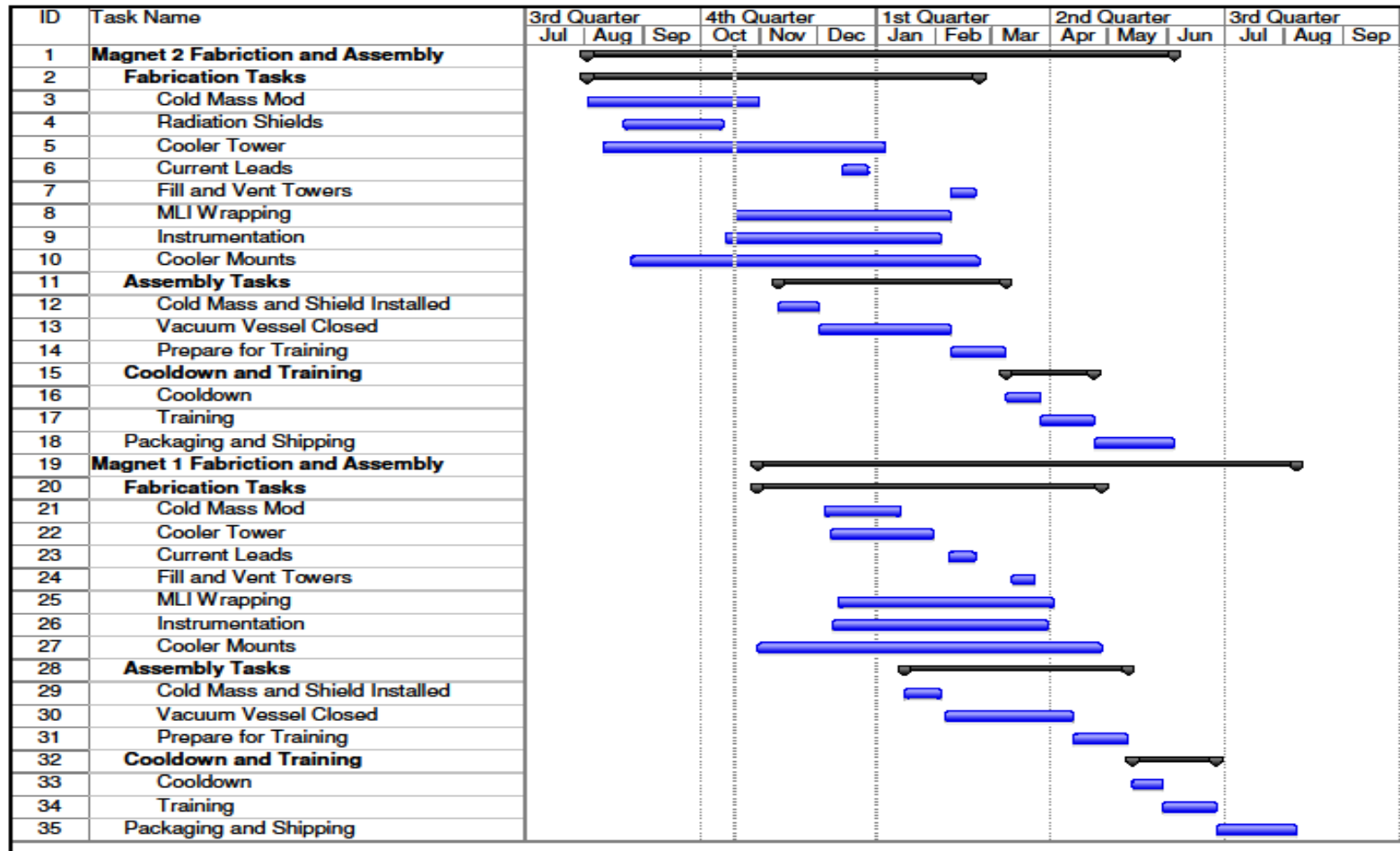
Work Completed	
Cold Mass bore covered with Aluminized Mylar to give added thermal efficiency	
Radiation Shield bore installed, end plates of the Radiation shield fitted and welded into place	
Cooler tower placed into position and tack welded. Cooler stub tubes welded to the main cooler inlet tubes on the cold mass	
Instrumentation from the radiation shield, cold mass supports, cold mass wired to the feedthrough	
All radiation shield penetration holes for the cold mass supports have been covered to prevent stray thermal radiation transfer	
Vacuum Vessel end plates have been aligned to the cold mass bore and fixtures welded	
ToDo in next 2 week period	
Fit the end plate MIU to the radiation shield	Scheduled: 01/02/2012, Days: 2, Resource: LBNL
Fit the warm bore	Scheduled: 13/02/2012, Days: 1, Resource: WANG
Weld the Virostek plate bracket pads to the outside of the vacuum vessel. Pads are to be surveyed into position using the tooling cell positions on the outside of the vacuum vessel	Scheduled: 06/02/2012, Days: 2, Resource: LBNL Survey / WANG Welding
Weld the Support feet into position on the outside lower section of the vacuum vessel	Scheduled: 10/02/2012, Days: 2, Resource: LBNL Survey / WANG Welding
Weld the vacuum chamber end plates	Scheduled: 16/02/2012, Days: 3, Resource: WANG Welding
Fit MIU to the upper and lower sections of the cooler tubes, outside of the first stage copper plates	Scheduled: 07/02/2012, Days: 2, Resource: LBNL
Weld side to the cooler towers	Scheduled: 14/02/2012, Days: 2, Resource: WANG Welding
Finalise all instrumentation	Scheduled: 16/02/2012, Days: 2, Resource: LBNL

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Schedule



First magnet to ship in May 2012, second in July 2012

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Coupling Coils

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Coupling Coil Test Prep

- First Coupling Coil cold mass:
 - Work continuing at LBNL to prepare the 1st CC cold mass for testing at FNAL



Cover plate welding at HIT in early August 2011

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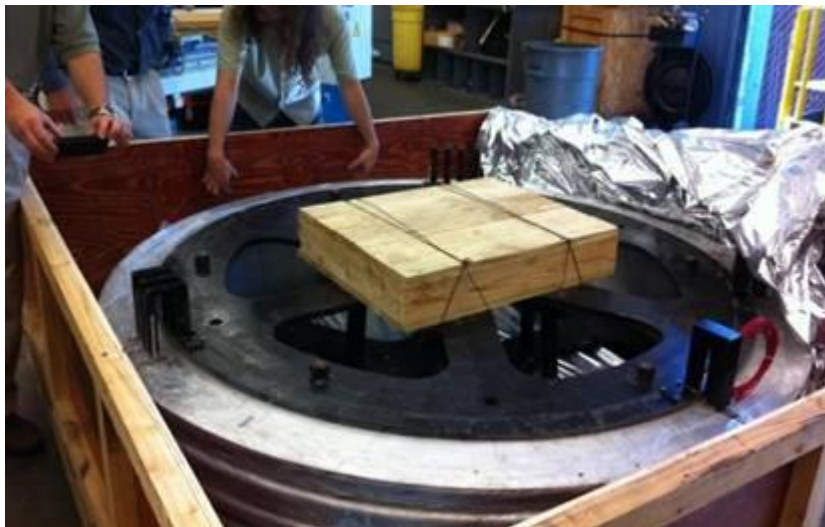


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Coupling Coil Test Prep

- External physical measurements completed
- Cooling pipes are ready for welding to cold mass
- Resistance measurement of each segment completed
- Epoxy for potting has been procured
- Cold mass support brackets being fabricated



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Design Work

- Work has continued to finalize the Coupling Coil detailed design
- Nearing completion of drawing modifications and conversion to US standard
- Modifications to the cooling circuit design being finalized
- A tentative plan for forced cooling during the FNAL testing has been developed
- MIT has completed the quench system analysis and is designing the quench protection assembly
- Analysis of the coil leads completed by MIT; design of the lead stabilization scheme is under way

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Cooling Circuit Design

- Original lower LHe reservoir removed from the bottom of the magnet
- Liquid supply and vapor return through same cooling tubes deemed high risk
- Implemented a dedicated, insulated liquid supply line from the upper reservoir to the bottom of the magnet
- New scheme is a traditional thermal siphon cooling circuit
- A second parallel line to the bottom of the coil to be used for cool down



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Coil Testing at FNAL

- FNAL and LBNL participated in a 1/25/12 meeting (at Fermilab) to discuss interfaces and a test plan review on 1/22/12
- Forced-flow cooling scheme developed by FNAL
- New cover designed for FSU cryostat
- Facility for testing identified (CHL)
- Test requirements and test plan are currently under development
- Project has strong support of FNAL management



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Pre-production Review

- Review held at LBNL on February 29 and March 1
- Fabrication drawings were assessed for readiness to start cryostat parts fabrication at QiHuan Co. (China)
- The overall cooling circuit design assessed including: re-condensing power vs. heat leaks, coil temperature margin, radiation shield design
- The instrumentation plan was presented and reviewed
- MIT group presented their designs for the quench protection system and lead stabilization
- Other topics included coil testing at FNAL and plans for assembling the cryostats and installing the coils

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Major Sub-Assemblies



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Plan Going Forward

- All three cold masses to be tested and trained to full current at Fermilab prior to magnet assembly
- All parts for the magnet cryostats will be fabricated in China by the QiHuan Company and shipped to the US
- QiHuan is to wind the 2nd and 3rd coupling coils using conductor currently being procured by Fermilab
- Plans call for the cryostats to be assembled by an outside vendor (preliminary quote from Meyer Tool)
- Assembly of the first unit likely to occur at FNAL
- Different options being explored for assembly of 2nd and 3rd coupling coils

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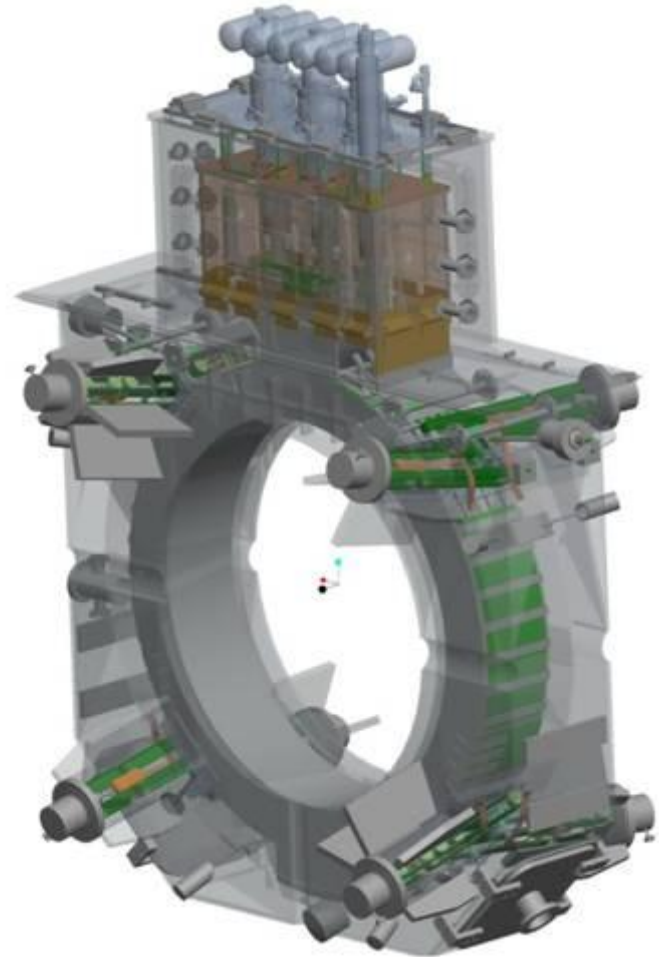
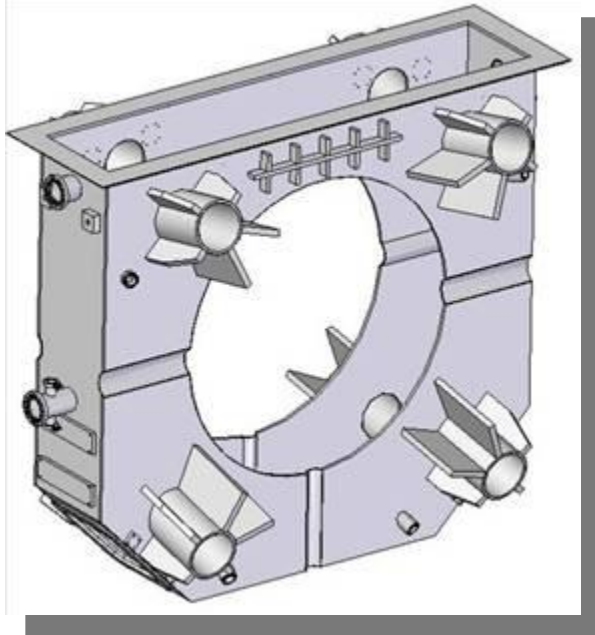
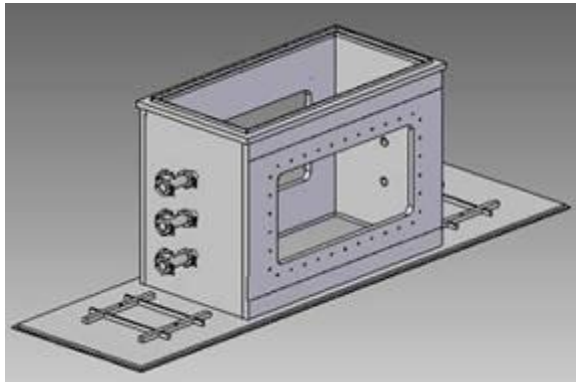
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3D Cryostat Model



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Cryostating Elements

- Parts fabrication – Qi Huan
- Fabrication of sub-assemblies
- CC cryostat assembly
- Testing
- RFCC integration
- Shipment to RAL

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CC Cryostating Status

- Budgetary estimate for sub-assembly from Meyer Tool based on preliminary drawings
- ~\$1.5M and 1.5 years for three cryostats
- Discussions at Fermilab on their possible role in final magnet assembly
 - Advantages
 - Meyer Tool is close, and allows monitoring
 - First coil to be installed and operated in MuCool at FNAL
 - No commitment yet

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Next Steps

- Sub-assemblies
 - Following completion of drawing package . . .
 - Follow-up with Meyer on details
 - Expand set of vendors
 - Assembly dialog with vendor(s)
 - Resource needs
 - Up to 1 FTE to interface with vendor
 - Update and feedback on parts modifications – incorporate into drawings (~ 0.25 FTE?)

In any case, we also need another “Roy” for Coupling Coils

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Next Steps

- CC assembly
 - Much prefer to do this at one of the labs but can explore other options (experience with SS shows the importance of this)
 - Estimates from FNAL and LBNL
 - CERN for 2nd and/or 3rd?
- Test
 - First CC test would ideally be done at FNAL

Schedule Milestones

- Delivery of 1st coil to FNAL from LBNL with cooling tubes, potting, QP system, support brackets, and instrumentation: **end April '12**
- Perform testing and training of first coil at Fermilab: **Sept '12**
- Complete assembly of 1st cryostat vessel: **April '13**
- Delivery of 2nd and 3rd coils from QiHuan Company to LBNL: **Jan. '13, May '13**



RFCC Modules

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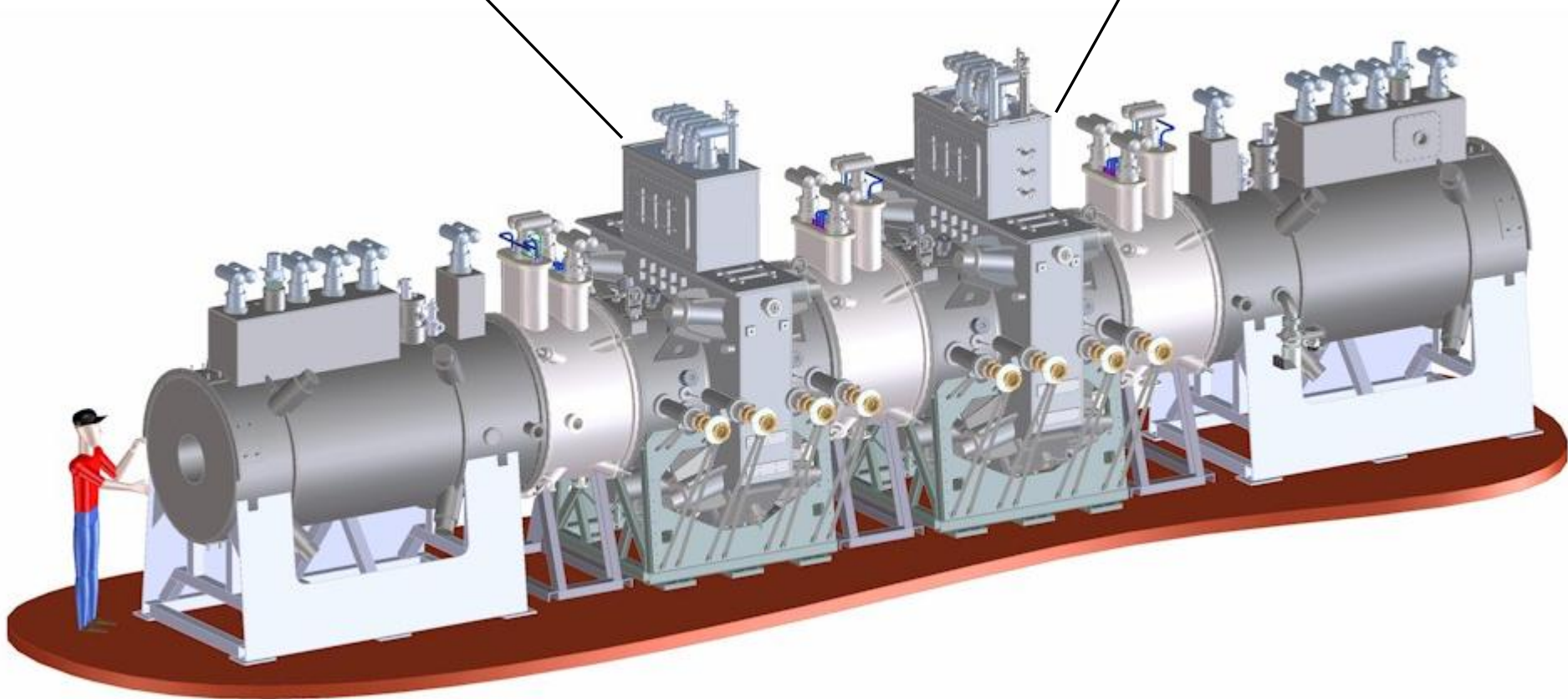
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2 RFCC Modules in MICE Channel

RFCC Module #1

RFCC Module #2



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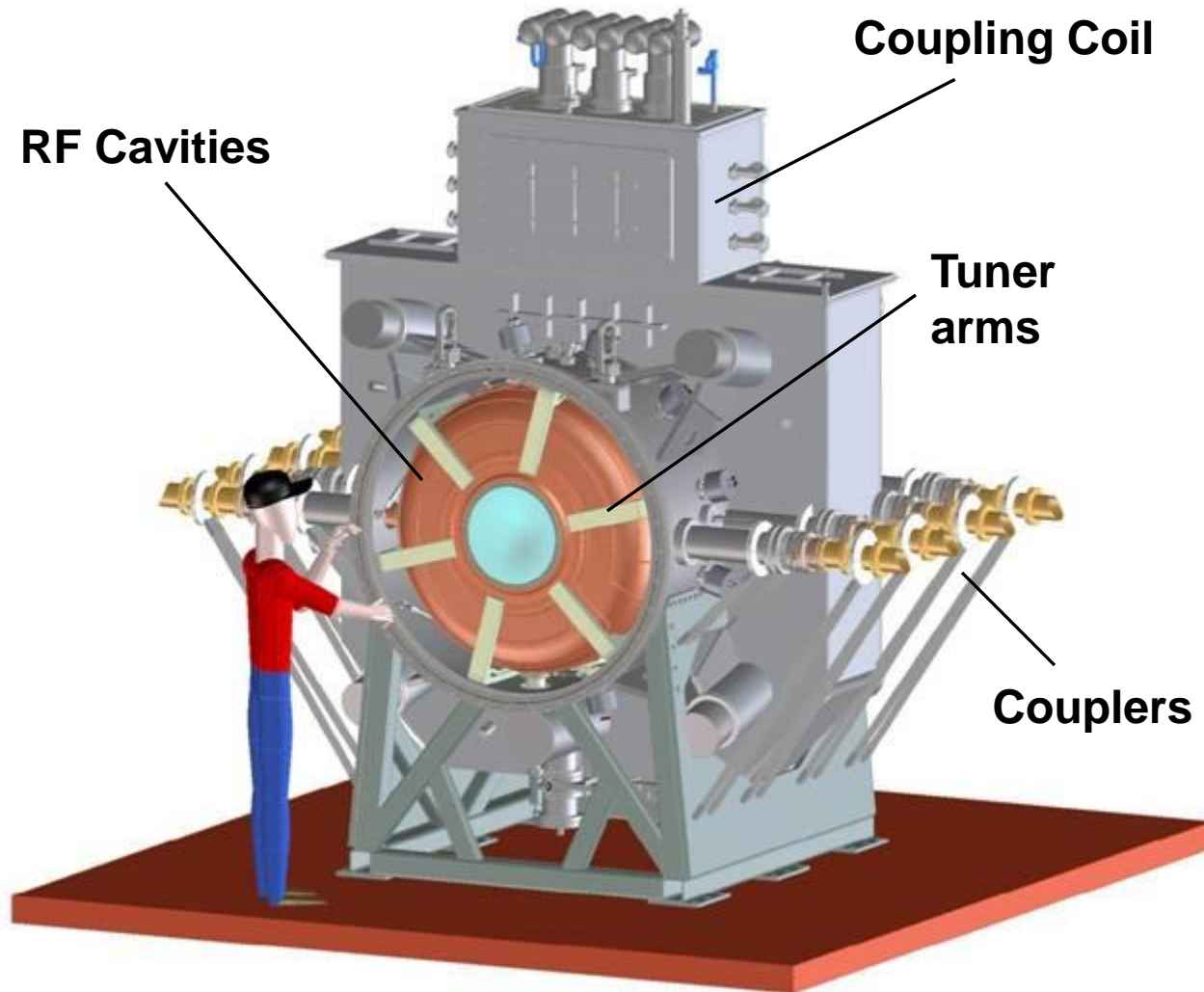
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RFCC Module Overview

- The MICE cooling channel incorporates two RFCC modules
- Each module consists of a Coupling Coil integrated with four 201 MHz normal conducting RF cavities and a vacuum vessel
- Integration of the CC with the vacuum vessel to be done at LBNL
- A third Coupling Coil (first delivered) for MuCool will be sited in the MTA at Fermilab
- The 201 MHz cavity design is based on the prototype developed by LBNL and J-Lab and has been operated in the MTA



RFCC Module Overview



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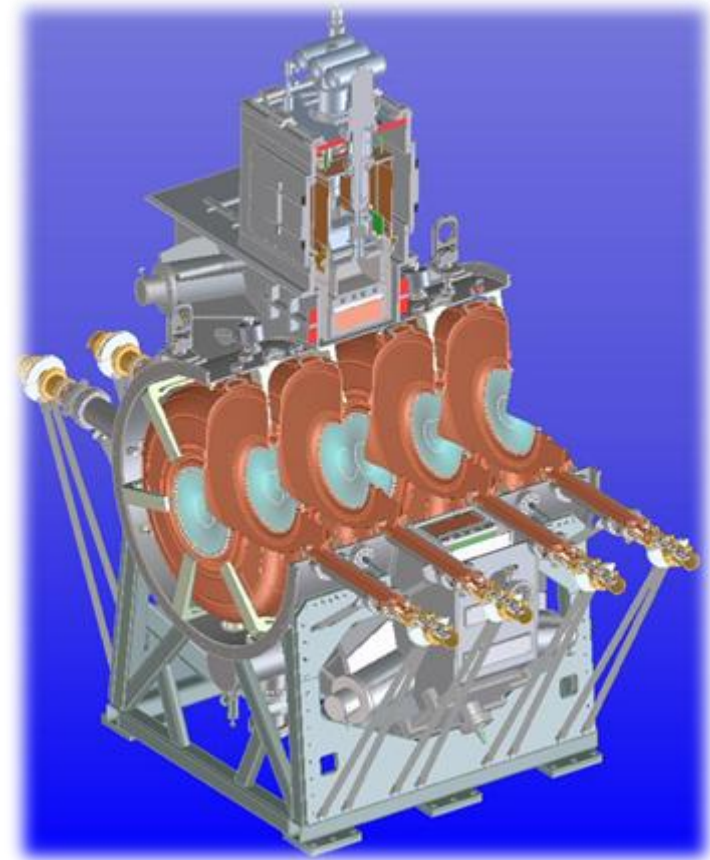


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Status of RF Cavities

- Ten RF cavities (two spares) now at LBNL
- All 11 beryllium windows received at LBNL
- Ten ceramic RF windows on hand
- Six tuner flexures in fabrication at FNAL
- LBNL procuring components for 6 actuators
- RF loop coupler design updated to eliminate gap between the outer coax and the RF loop
- Cavity EP preparation in progress at LBNL:
 - Fabrication of fixturing complete
 - ES &H approval for EP in progress at LBNL
 - Preparation of the cavity surface: mechanical smoothing
 - EP to start after the ES & H approval.
- Measurements of the remaining six cavities to start after EP
- Each cavity will be tuned to a center frequency after EP



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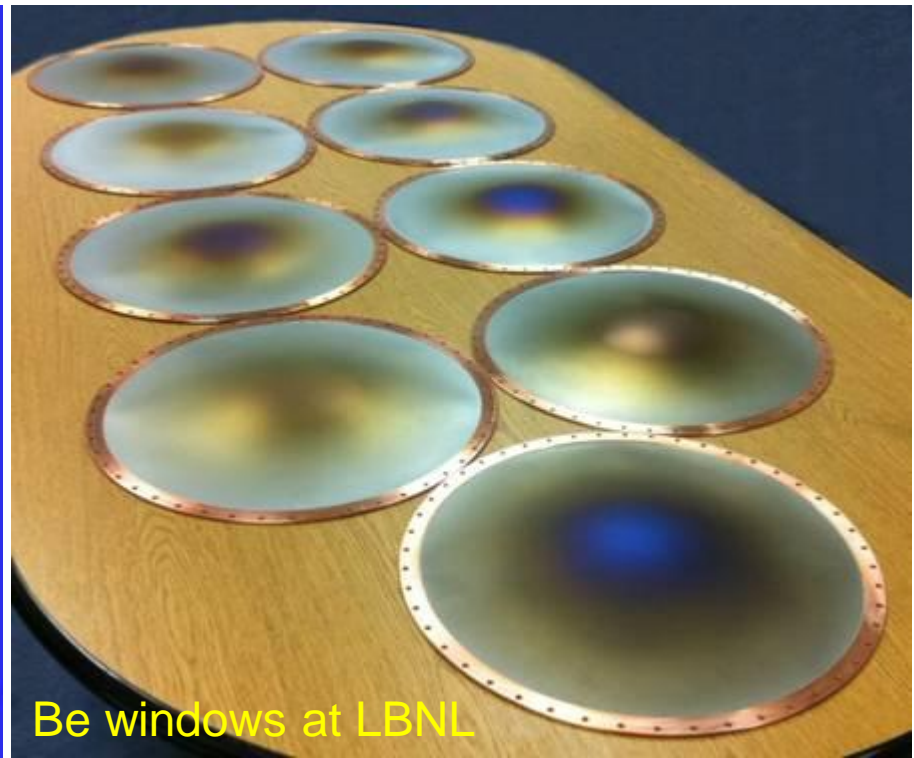




EP setup at LBNL



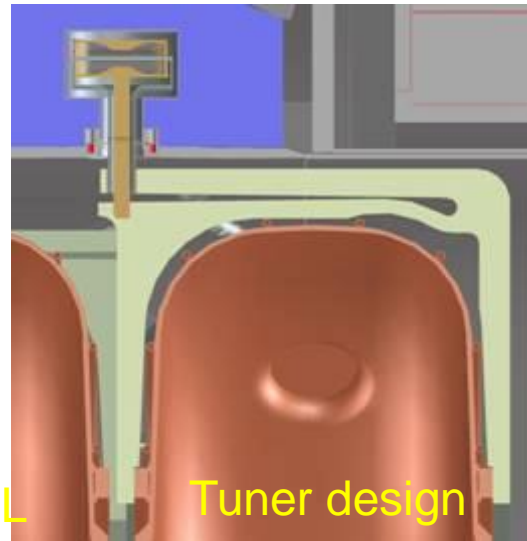
Coupler design



Be windows at LBNL



Tuner arms fabricated at FNAL



Tuner design



Wire EDM at FNAL

Summary

- Spectrometer Solenoids
 - Modification and assembly plan has been carried out
 - Testing of first magnet to begin shortly
- Coupling Coil
 - First coil test is critical
 - Plan is in place to complete test at FNAL
 - 2nd and 3rd coil winding at QiHuan after 1st coil test
 - Cryostat fabrication
 - Parts drawings for fabrication at QiHuan being finalized
 - Exploring in house and outside vendor options for assembly
 - Final magnet assembly
 - Fermilab is the most likely candidate
- RF cavities
 - LBNL proceeding with cavity preparation and tuner fabrication

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