MICE Spectrometer Solenoid FY12 Plans

MAP L1 + L2 Management Meeting

October 20, 2011

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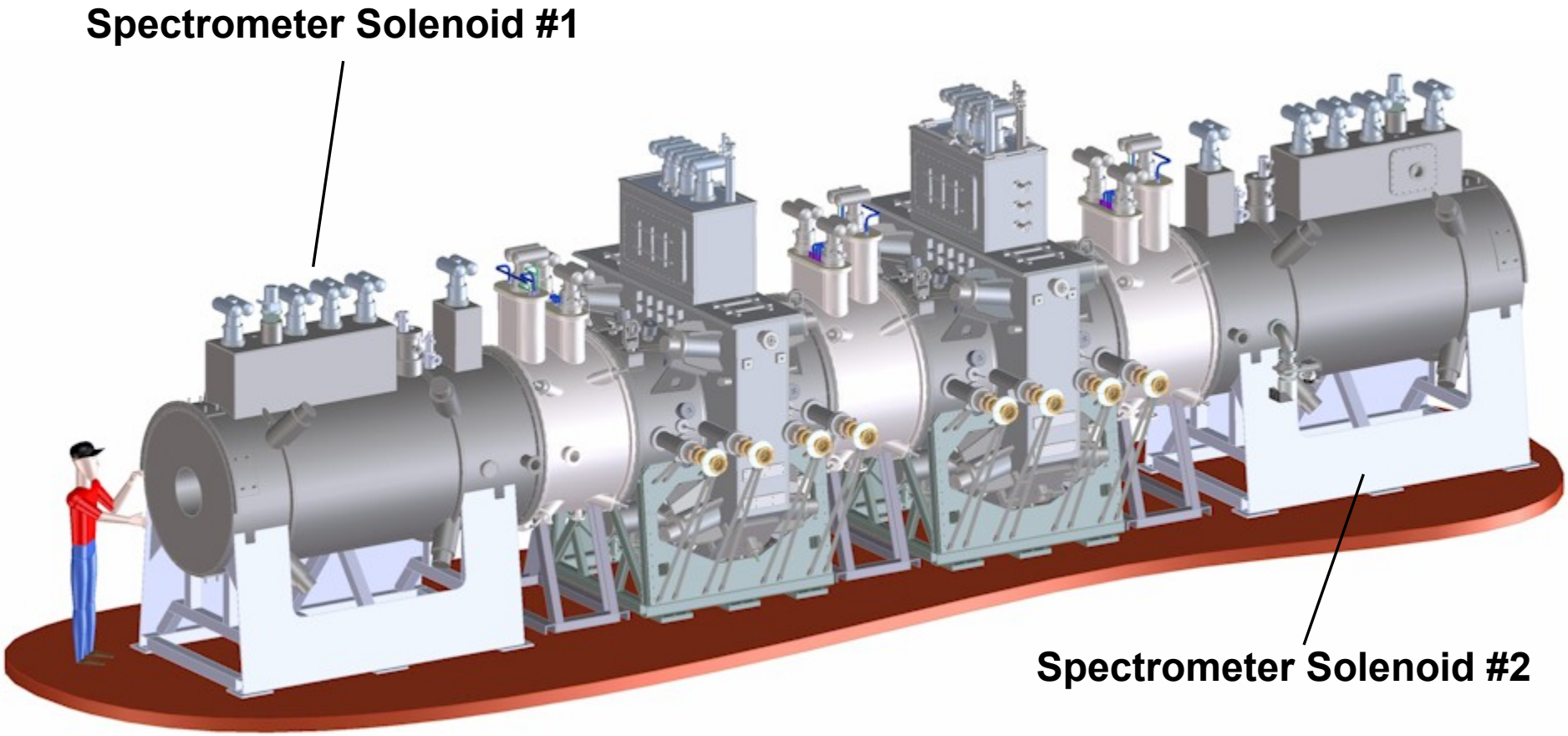
Topics

- Overview of the Spectrometer Solenoids
- Modification plans
- Current status
- Schedule
- FY12 Budget

MICE Cooling Channel Layout



Spectrometer Solenoid Overview

- **Key requirements:** coils must be trained to 275 amps, and the cryocoolers must maintain the LHe in the cold mass (no boil-off) **Not yet achieved for either magnet**
- Both magnets have previously been assembled and tested
- Various design issues and test failures have necessitated disassembly of both of the magnets
  - Magnet 1: blockages in the helium recondensing circuit prevented operation of the thermal siphon
  - Magnet 2: Failed HTS lead due to inadequate cooling of the upper end of the leads
  - Magnet 2B: Failed LTS lead in the cold mass and overheated quench resistors
- All design issues being addressed with recent modifications

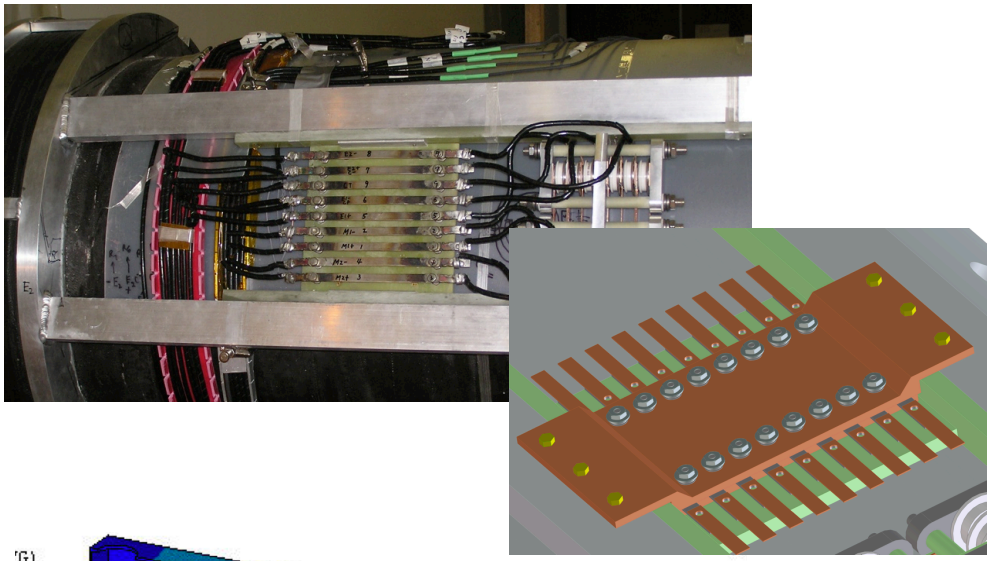
Design and Analysis Work

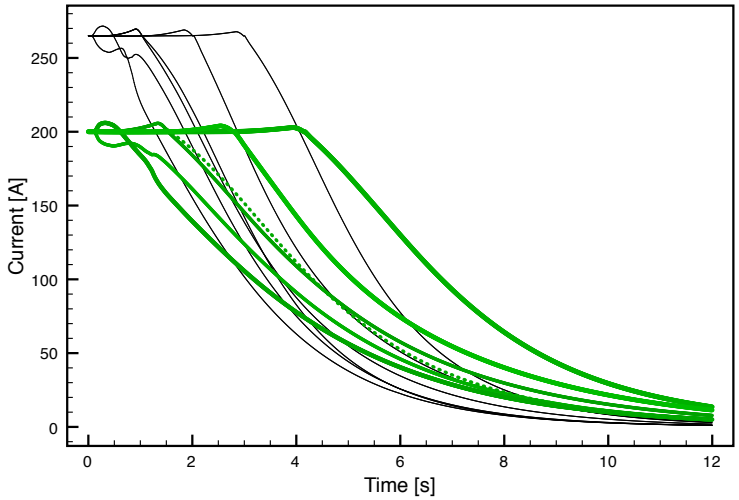
- Based on the results of the previous testing and the recommendations of several review committees, LBNL has carried out an extensive series of analyses
- A variety of design improvements are being implemented based on the results of the analyses
- The focus of the analyses included:
  - Quench protection system including the suitability of the existing passive system instead of an active system
  - Heat leaks to the 4.2K cold mass
  - Thermal/mechanical performance of the radiation shield
  - Overall shield and cold mass cooling power available

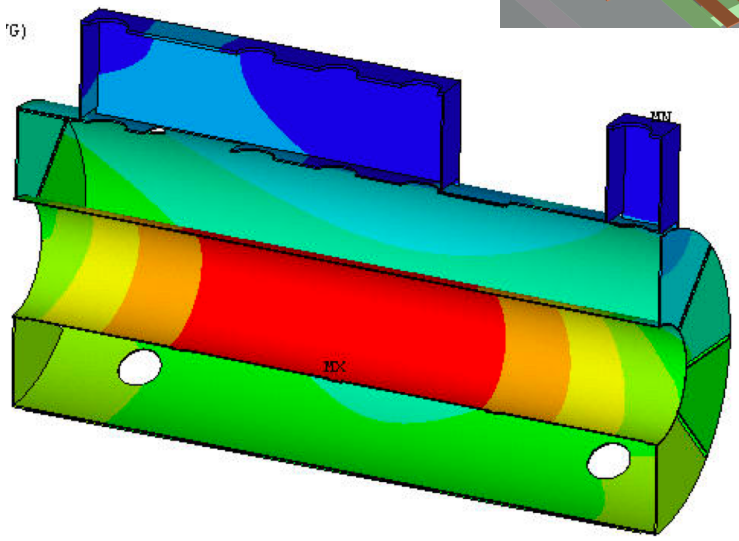
Design Modification Plan

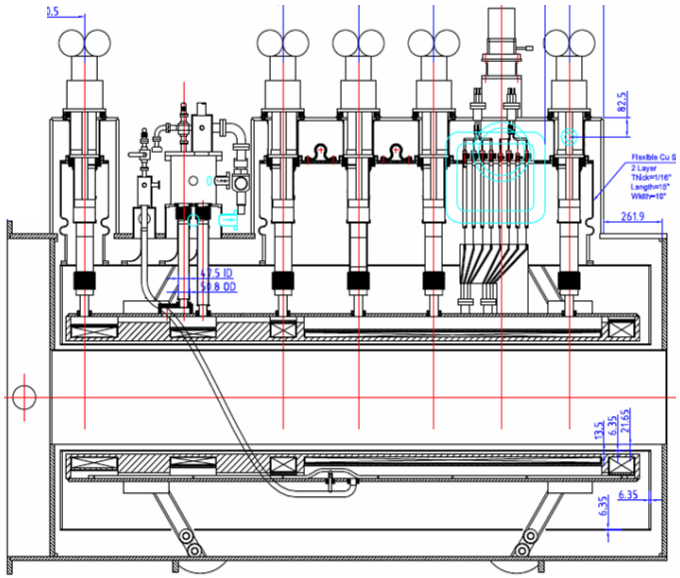
- Reduction of cold mass heat leaks:
  - Improve MLI application and QC
  - Improve vacuum insulation and measurement
  - Eliminate radiation shine in vent/fill lines
  - Implement provisions to damp thermo-acoustic oscillations
  - Reduce cold mass support intercept temperatures
- Improvement of the passive quench protection system :
  - Analyses indicate passive system will work
  - Divert current from quenched HTS leads with an active, external circuit
  - Conductively cool the quench resistors to prevent overheating
- Addition of two 2-stage cryocoolers to the system
- Stabilize the cold leads w/extra copper to prevent burnout
- Improve the radiation shield performance:
  - Reconstruct the majority of the shield with pure aluminum
  - Improve the thermal connection from the cryocoolers to the shield

Analyses and Design Modifications









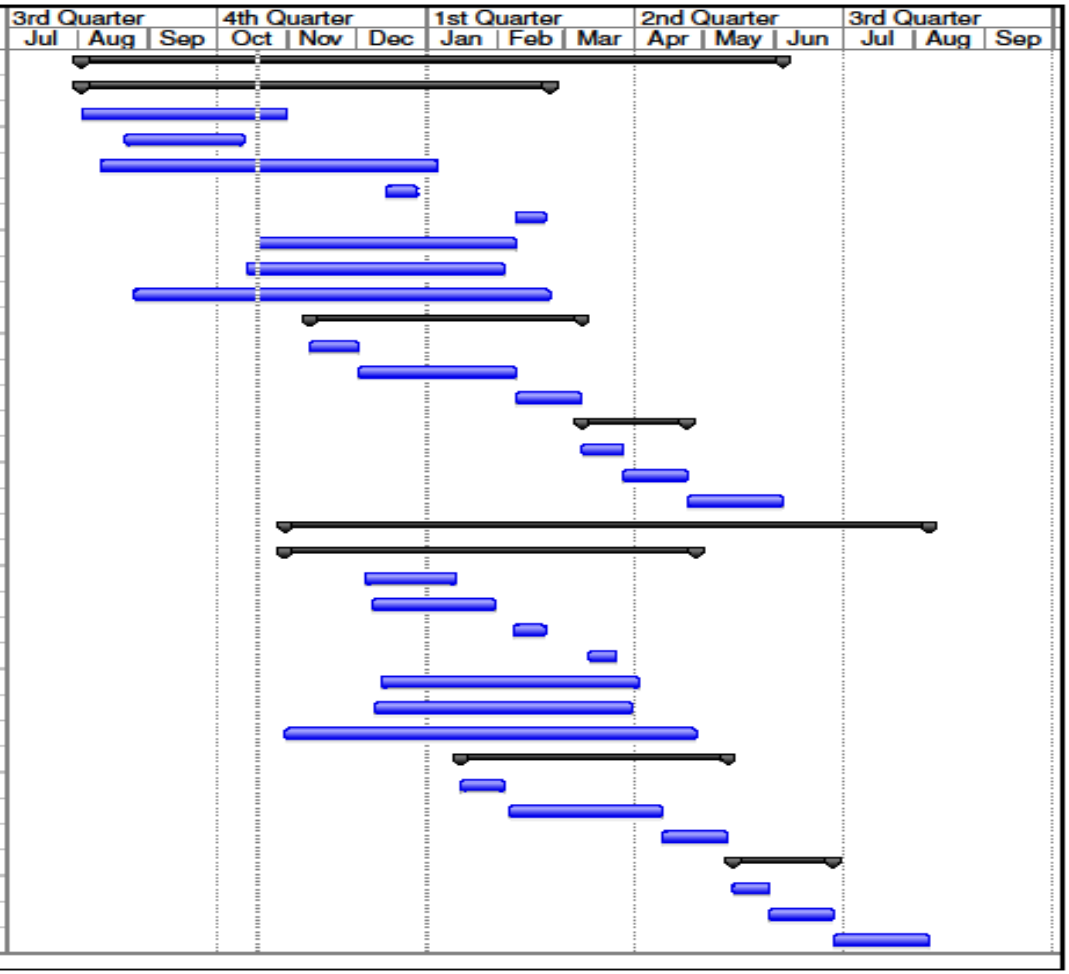
Current Magnet Status

- The completed modification plan has been presented to the MAP TB
- A contract mod was made to the Wang PO for the completion of detailed design work for the system modifications (now complete)
- A 2nd contract mod was made to the Wang PO for completing the physical magnet modifications (now under way)
- The Magnet 2 cold mass has been opened to allow modification
- The radiation shields have been remade with 1100 aluminum
- Custom MLI blankets for the cold mass have been procured
- A conductively cooled quench resistor assembly has been fabricated
- Modifications to the magnet vacuum vessels for added cryocoolers have been completed
- The Magnet 2 cold mass will be ready for leak check in ~2 weeks
- Magnet 1 to follow Magnet 2 by ~ 3 months in the schedule

FY12 Schedule

Spectrometer Solenoid FY12 Schedule

ID	Task Name
1	**Magnet 2 Fabriction and Assembly**
2	**Fabrication Tasks**
3	Cold Mass Mod
4	Radiation Shields
5	Cooler Tower
6	Current Leads
7	Fill and Vent Towers
8	MLI Wrapping
9	Instrumentation
10	Cooler Mounts
11	**Assembly Tasks**
12	Cold Mass and Shield Installed
13	Vacuum Vessel Closed
14	Prepare for Training
15	**Cooldown and Training**
16	Cooldown
17	Training
18	Packaging and Shipping
19	**Magnet 1 Fabriction and Assembly**
20	**Fabrication Tasks**
21	Cold Mass Mod
22	Cooler Tower
23	Current Leads
24	Fill and Vent Towers
25	MLI Wrapping
26	Instrumentation
27	Cooler Mounts
28	**Assembly Tasks**
29	Cold Mass and Shield Installed
30	Vacuum Vessel Closed
31	Prepare for Training
32	**Cooldown and Training**
33	Cooldown
34	Training
35	Packaging and Shipping



FY12 Budget

Description	Labor ($k)	M&S ($k)
Design and analysis at LBNL	19	
Management and fab oversight	108	
Assembly tech work at vendor	164	
PS/quench system modifications	16	24
LBNL supplied hardware	20	15
Control system design and fab	40	
Vendor contract modifications		0*
Training utilities and cryogens		88
Magnet testing and training		49
System documentation		34
Shipping to RAL		40
Totals	**368**	**250**

+ $173k contingency = $791k

*all Wang NMR contract mods have been either paid or liened – no add'l mods are anticipated

LBNL effort is ~2.7 FTE over 10 months (includes no cost manpower help from RAL)

- No FY13 costs are anticipated as both magnets are scheduled to be completed during FY12

Budget Scenarios (+/-20%)

- A budget variation of +/-20% is not likely to have any effect on the Spectrometer Solenoid completion during FY12
- The same source of equipment money is bring used by LBNL for the MICE RFCC modules (including the coupling coils)
- A budget variation will have an impact on the RFCC FY12 work (see next talk)

MICE RFCC Module
FY12 Plans

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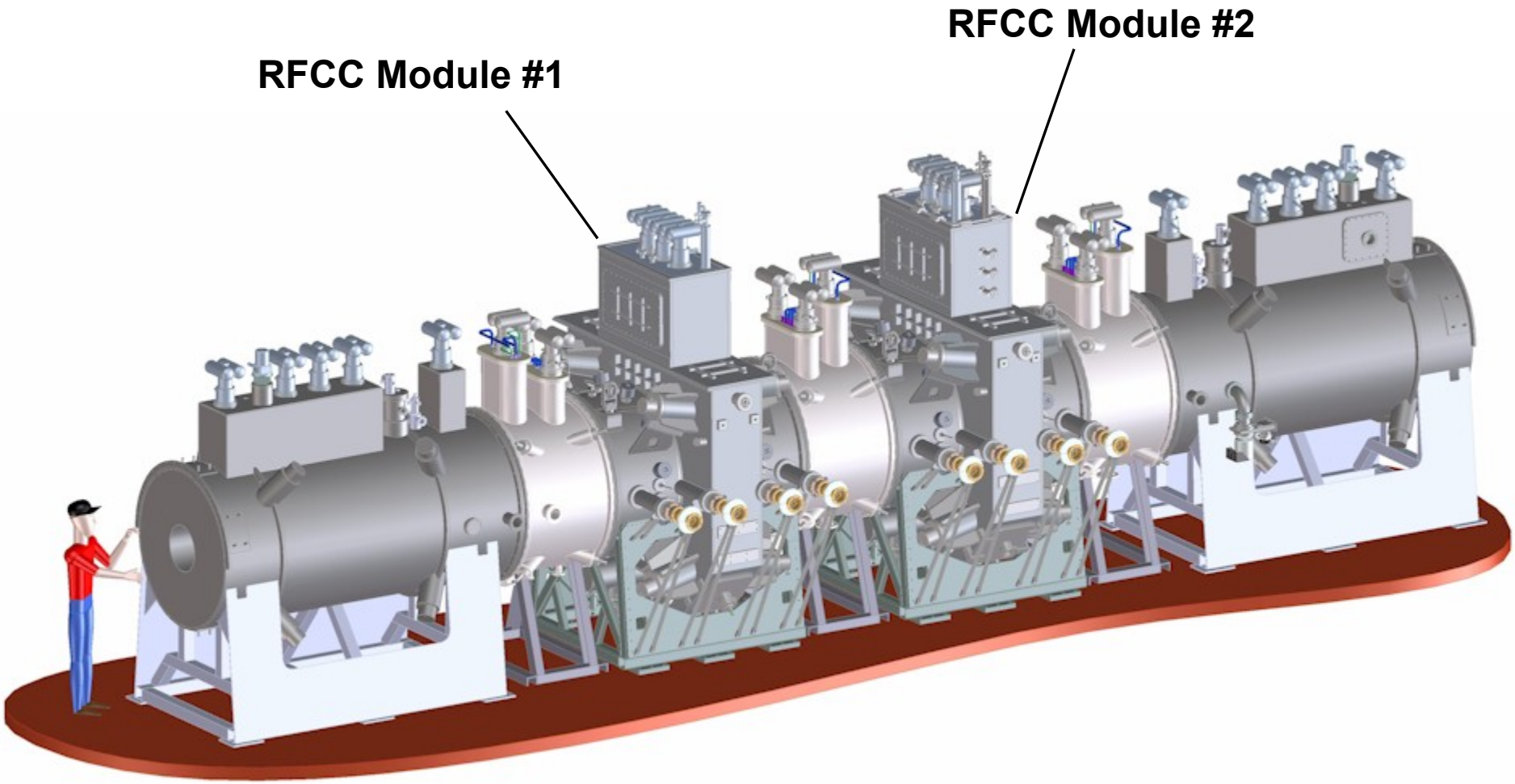
Topics

- Overview of the RFCC Modules
- Coupling Coil status
- Coupling Coil plans
- RFCC Module status and plans
- Schedule
- FY12 Budget

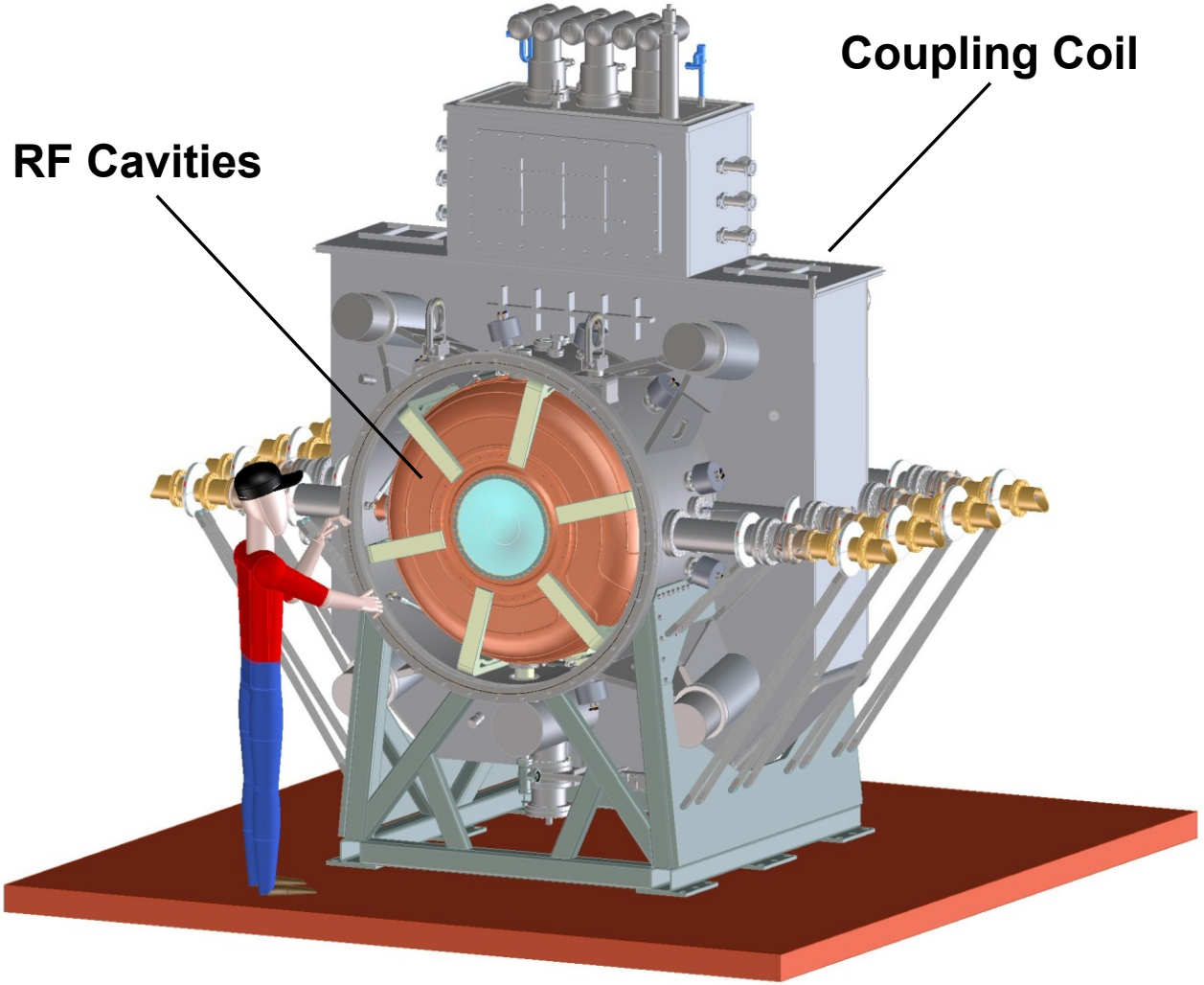
MICE Cooling Channel Layout



RFCC Module Overview

- The MICE RF and Coupling Coil Module has been designed by LBNL and our collaborators
- MICE incorporates two RFCC modules to be provided by LBNL
- Each module consists of a single superconducting Coupling Coil integrated with four tunable 201 MHz normal conducting RF cavities and a vacuum vessel
- The Coupling Coil design was developed by the Harbin Institute of Technology in China (a MICE collaborator)
- 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 cavity developed by LBNL and J-Lab and now operating in the MTA

RFCC Module Overview



Coupling Coil Status

- The detailed design of the Coupling Coils is complete with the exception of the quench protection system and the lead stabilization detailed designs (to be undertaken by MIT)
- LBNL is currently carrying out changes to the fabrication drawings as well as translation from Chinese to English
- Winding and fabrication of the first Coupling Coil cold mass was completed at the QiHuan Company in Beijing, China
- The coil arrived at LBNL last week where cooling tube welding and epoxy potting will be completed
- Additional superconductor for the two MICE coils is currently being procured

Coupling Coil Plans

- Current plans call for all three cold masses to be tested and trained to full current at Fermilab prior to magnet assembly
- A suitable test cryostat obtained from FSU is now at Fermilab being prepared for coil testing
- All parts for the magnet cryostats will be fabricated in China by the QiHuan Company and shipped to the US
- Current plan is for QiHuan to also wind the 2nd and 3rd coils
- Various options for cryostat assembly and welding being explored: outside vendor (Meyer Tool or other), FNAL, LBNL
- Assembly of the first unit likely to occur at FNAL or LBNL
- Assembly of 2nd and 3rd units still in planning: options include QiHuan, FNAL, LBNL, RAL, outside vendor

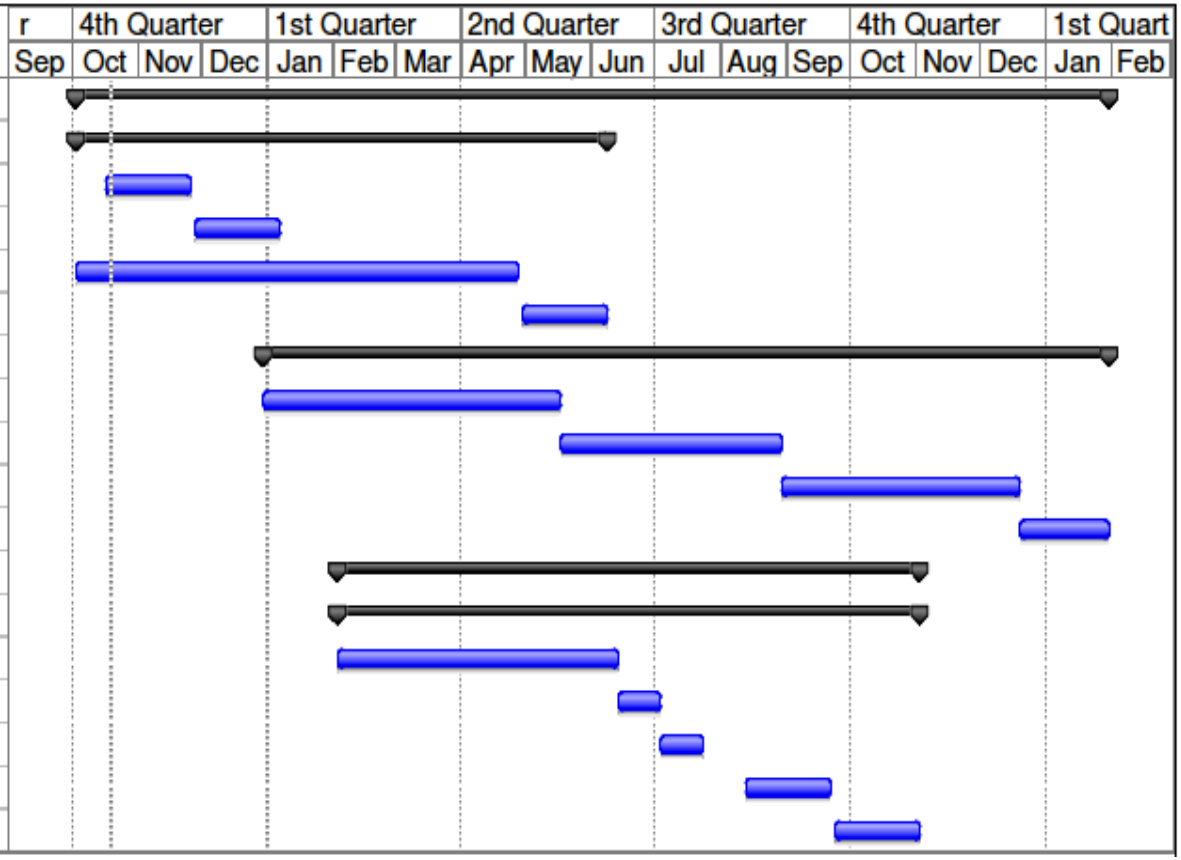
RFCC Module Status and Plans

- Work on other RFCC components has continued at LBNL at a slower pace due to Coupling Coil delays and limited funding
- All associated design work has been completed
- Ten copper RF cavities are complete and at LBNL
- Cavity tuner prototype has been fabricated and tested
- RF and beryllium windows for first module are now on hand
- Activities at LBNL for FY12 include: surface prep and electropolishing of cavities, fabrication of tuner actuators
- FNAL FY12 activities: fabrication of RF couplers for prototype and single MICE cavities, fabrication of tuner arms for a single cavity test

FY12 Schedule

Coupling Coil FY12 Schedule

ID	Task Name
1	**First Coupling Coil**
2	**Cold Mass Tasks**
3	Tube weld at LBNL
4	Epoxy impregnation at LBNL
5	Test dewar setup at FNAL
6	Coil test and training
7	**Magnet Assembly**
8	Parts fabrication (all cryostats)
9	Cryostat vessel assembly
10	Magnet system assembly
11	Cold testing
12	**2nd Coupling Coil**
13	**Cold Mass Tasks**
14	Coil winding and ship to LBNL
15	Tube weld at LBNL
16	Epoxy impregnation at LBNL
17	Test prep at FNAL
18	Coil test and training



- Schedule of FY12 RFCC cavity related tasks at LBNL are not shown here

FY12 Budget

RFCC Tasks (cavities)

Description	Labor ($k)	M&S ($k)
Ongoing design at LBNL	15	
Management and fab oversight	72	
First cavity tuner actuators		30
Cavity prep for electropolish	22	3
Cavity electropolish	25	12
Totals	134	45

Total RFCC costs: $876k + $210k contingency
= $1086k

Coupling Coil Tasks (LBNL only)

Description	Labor ($k)	M&S ($k)
Fab drawings and design issues	55	
Management and fab oversight	109	
Quench protection/lead design (MIT)	198	
Control system design and fab	40	
Cooling tube weld at LBNL (2 coils)	28	4
Epoxy potting at LBNL	9	3
Cryocoolers (3 each)		159
Sensor procurement		40
Shipping to FNAL (coils and parts)		16
Shipping to LBNL (from China)		36
Totals	439	258

- Costs shown are LBNL costs only and do not include FNAL testing efforts or possible magnet assembly effort

Budget and Planning Issues

- There are still many uncertainties in the RFCC completion plan, particularly associated with the assembly of the Coupling Coil cryostats and final assembly and testing
- Not included in the budget presented here:
  - test cryostat setup/cold mass testing at FNAL (1st coil test in FY12)
  - cryostat assembly for at least 1st unit ($200k - $400k each)
  - 1st magnet final assembly and testing
- Further uncertainties for the assembly of the 2nd and 3rd magnets in FY13 and beyond
- The possibility of winding one or two extra coils has been discussed as a contingency, but not yet planned or budgeted

Budget Scenarios (+/-20%)

- A decrease in the LBNL budgeted work would likely result in: reduced contingency, delay of RF cavity surface processing, deferment of cryocooler purchase
- Budget increase: any additional funding would likely be used to move forward earlier with the work on the 2nd and 3rd coupling coils (primarily cryostat assembly)
- There are still big unknowns in the cost and budget for the assembly and testing of the first magnet since the plan is not yet established