



# Spectrometer Solenoid Modification Plan

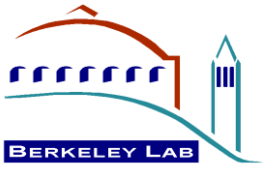
MICE Schedule Review

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# Topics



- Magnet analyses
- Design modification plan
  - Heat reduction to 4.2K
  - Radiation shield improvements
  - Cryocooling power
  - Other improvements



# Analysis and Design Assessment



- LBNL has undertaken a series of tasks to respond to the recommendations of the MICE review committee before incorporating design changes
- The initial steps carried out are shown below:
  - A complete set of the latest as-built drawings (w/future changes where possible) has been compiled
  - All heat loads have been reassessed to ensure that the LHe in the cold mass can be maintained with the final number of cryocoolers
  - EM calculations have been redone for testing and operation (ongoing)
  - The instrumentation plan has been modified to allow confirmation of the thermal and EM calculations during testing
  - The mechanical supports of the magnet, leads, piping and other internal components have been reassessed (ongoing)



# Heat Load Analysis



- The heat leaks due to the dominant static sources have been re-evaluated
- The focus of the calculations was the heat leaks into the 4.2K cold mass as these directly relate to the issue of LHe boil-off during operation
- Other aspects of magnet thermal performance including heat loads on the shield and vacuum insulation have also been considered
- The dynamic heat loads that occur during cooldown or current ramp-up when the magnet system is not in equilibrium have been ignored as they are negligible during long-term operation



# Electromagnetic Calculations



- The design of the passive magnet protection system has been reviewed and analyzed under the various operational regimes
- The areas covered include
  - calculation of the magnet self and mutual inductance parameters
  - determination of the coil current decay versus time during a quench
  - calculation of the hot spot temperature in the magnet for different scenarios
  - analysis of coil voltage versus time during a quench
- Final assessment expected in coming days



# Fabrication Drawings



- Nearly 200 detail fabrication drawings representing the latest assembly of the Spectrometer Solenoid (Magnet 2B) collected from Wang NMR
- Drawings have been organized in the form of a drawing tree list
- The drawings are a fairly complete representation of the previously as-built magnet
- Wang NMR has completed the update of the fabrication drawings to reflect the latest design changes
- In parallel with the effort to organize the drawings, LBNL has developed a preliminary 3D CAD model of the magnets
- The CAD model will be updated to reflect the as-built magnets



# Instrumentation Plan



- The current configuration of the instrumentation on the spectrometer solenoid magnets has been revised
- The instrumentation under consideration includes temperature sensors, voltage taps, helium level gages, and pressure gages
- In most cases, the proposed changes to the instrumentation scheme came about due to shortcomings that were identified during the previous rounds of magnet training and testing
- Another prime consideration is the ability to record data relevant to the confirmation of our heat load analyses
- Feedthroughs have been reconfigured to separate the various types of instrumentation



# Mechanical Support Assessment



- The internal mechanical support of the various magnet components has been reviewed (ongoing)
- The primary issues are:
  - the mechanical stresses caused by thermal contraction during cooldown and by electromagnetic forces during operation
  - the relative movement of components caused by cooldown and operation that could cause a thermal short between components at different temperatures
  - The ability of the magnets to survive accelerations that will occur during shipping
- The components under review are the cold mass supports, the thermal shield and its supports, and the support of the 1st stage copper plate and its relative movement with respect to the cryocoolers and the HTS leads





# Design Modification Plan



- The design and assembly modification plan has been developed based on the following:
  - reduction of heat leaks to the cold mass
  - the addition of more cryo cooling power
  - modification of the cold leads near the feedthroughs to prevent burn-out
- Some of the details of the magnet modification plan is provided on the following slides



## 4.2K Heat Load Reduction



- Improved vacuum pumping and instrumentation will be implemented to ensure adequate cold mass insulation
- All 4K areas will be covered with actively cooled shield where possible - partially covered areas will be analyzed
- Baffles will be added to the vent lines to prevent direct radiation shine to 4.2K
- Possible thermal acoustic oscillations in vent lines will be addressed by monitoring with fast pressure gauges
- Application of MLI on cold mass bore will be improved
- Sensor wires will be optimized & w/proper heat sinking



# Radiation Shield Improvements



- The radiation shield for both magnets will be remade using 6.35 mm thick 1100 series aluminum to replace the existing 60601 aluminum shields
- The thermal connection between the cooler first stage and the radiation shield will be improved by using sheets of copper rather than tubes of aluminum
- Application of MLI on shield bore tube will be improved to reduce compression
- The heat loads from the following will be decreased as possible: shield pass-through holes for the cold mass supports, intermediate cold mass support heat intercepts, and shielding of the warm end of the supports



# Other Design Modifications



- Other key improvements:

- The total cooling power will be increased by using five 2-stage pulsed tube coolers and one single-stage cooler
- The thermal/mechanical stabilities of the cold leads will be improved by adding extra copper/superconductor near the cold mass feedthroughs

- Other improvements/additions:

- LBNL/MICE personnel will be present to document and oversee all aspects of magnet reassembly
- Detailed MLI inspection will be carried out during ass'y
- A fast DAQ system will continuously monitor voltage taps
- Additional temperature sensors will be added to the logging system

# 5 + 1 Cryocooler Layout

