Spectrometer Solenoid Update

MICE Collaboration Meeting #29
Rutherford Appleton Laboratory

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Topics

- MICE technical review
- Responses to committee report
- Magnet analyses
- Design modification plan
- MAP Tech Board
- Schedule, budget and manpower
- Current Status

MICE Cooling Channel Layout

MICE Technical Review

- An assessment and analyses of various aspects of the magnet design has been carried out by LBNL
- A preliminary design modification plan was presented to a MICE technical review committee on 10/27/10
- Preliminary comments were received from the committee on 11/22/10
- The committee's final report with recommendations was issued on 12/14/10

Responses to Committee Report

- The committee report includes a series of recommendations for the Spectrometer Solenoid team
- The LBNL team has reviewed the recommendations and has prepared preliminary responses that are detailed in a separate document
- The committee recommended that an active quench and lead protection system be implemented on the magnets
- LBNL is conducting a series of analyses to determine whether or not an active system will be necessary
- Other recommendations related to the heat load calculations are currently being undertaken at LBNL

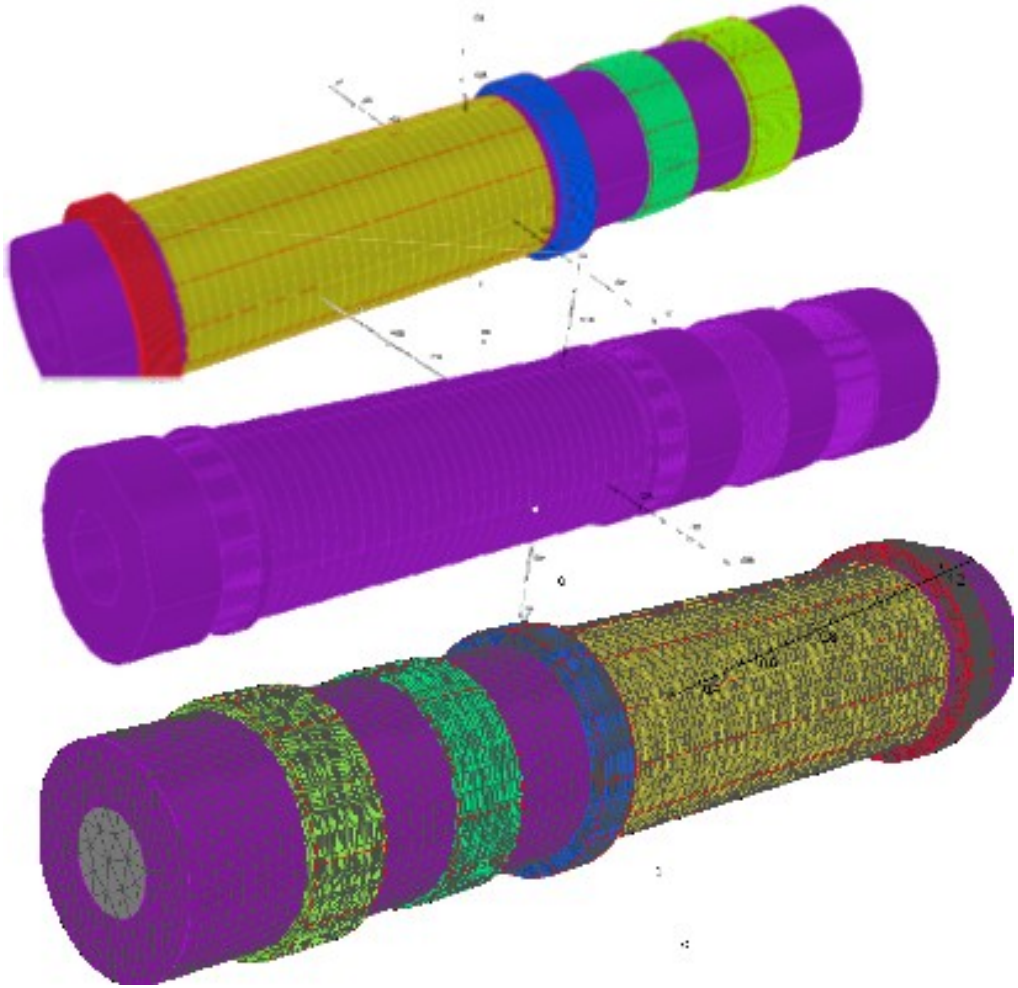
Heat Load Analysis

- 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

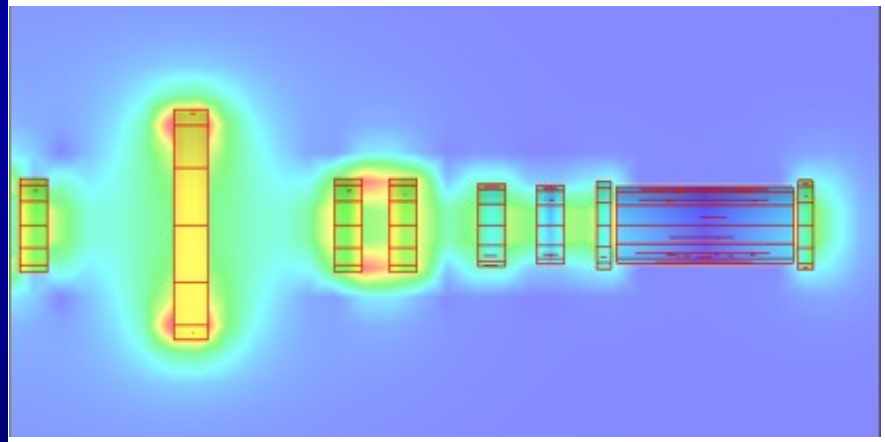
- The design of the passive magnet protection system is being reviewed and analyzed under the various operational regimes
- The areas covered include:
  - Peak voltages to ground and inter-layer
  - A more clear understanding of coupling between coils during various quench scenarios
  - A detailed estimate of the current decay and current seen by the shunt resistors, and feedback on possible improvements to the selected resistance values
  - An estimate of the role of quenchback from the Al mandrel
- The suitability of the existing passive quench protection system and the possible need for an active system is being assessed

Spectrometer Solenoid 3D EM Model



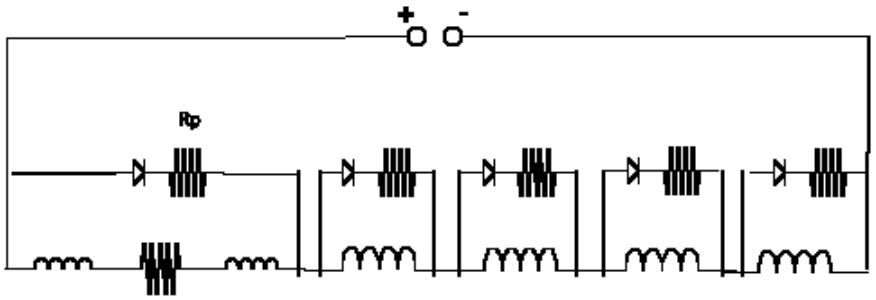
Quench Modeling

- VF quench code:
  - Allows simulation of…
    - Quenchback (e.g. from Al. mandrel)
    - Various circuit configurations
  - Provides access to…
    - Temperature and voltage evolution in time and space
    - Current distribution and decay

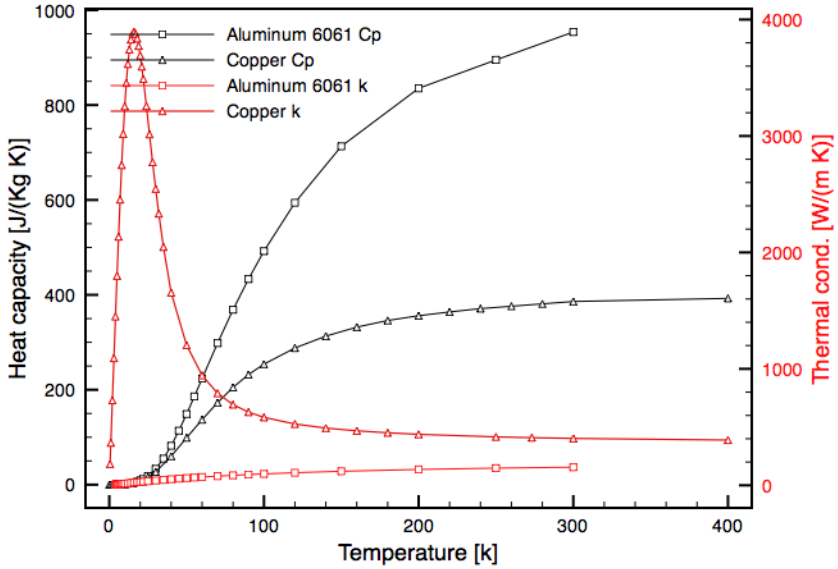


Distribution of field

Example circuit of spectrometer test sim.



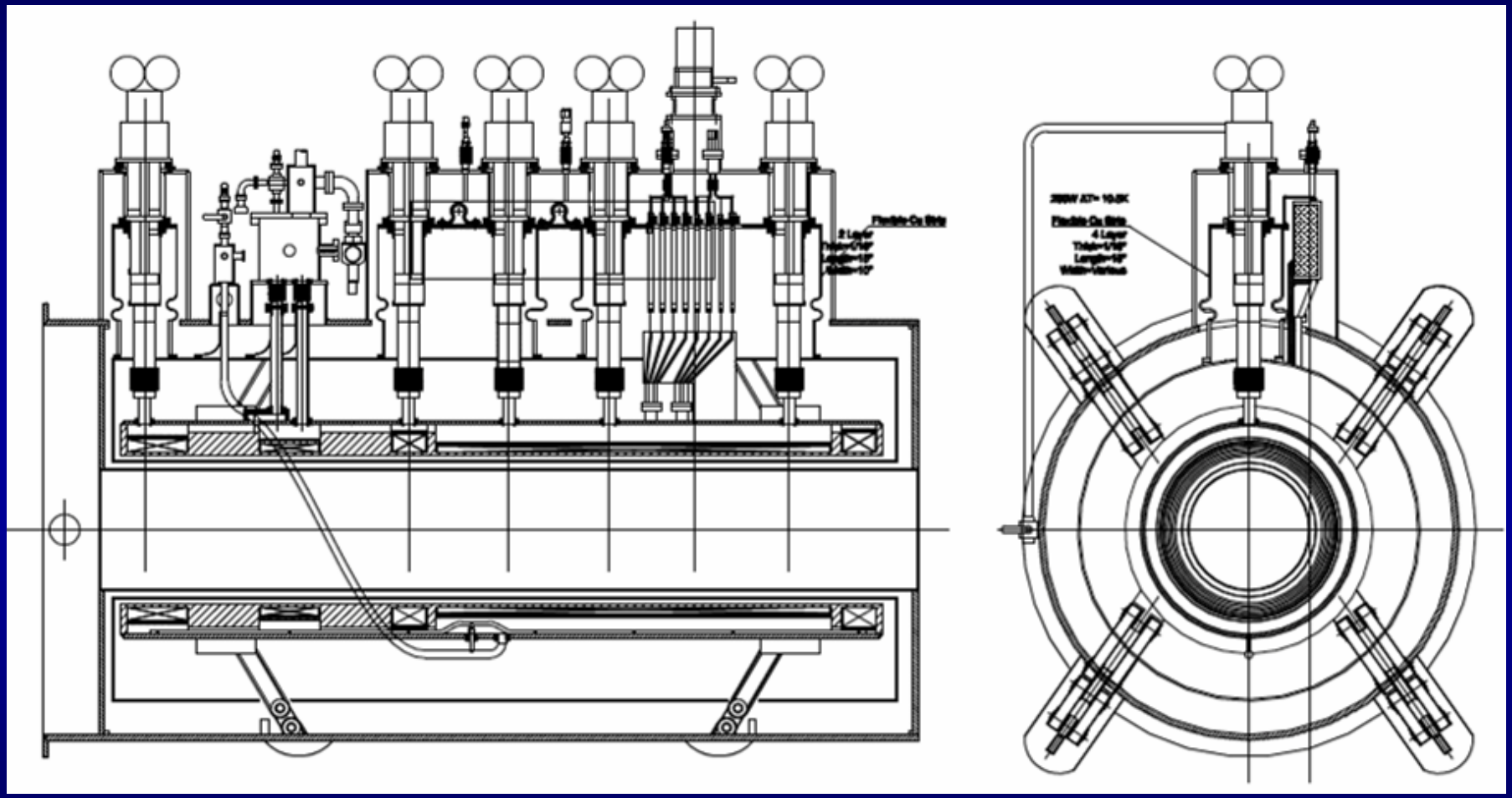
Quenching coil Superconducting coils



Design Modification Plan

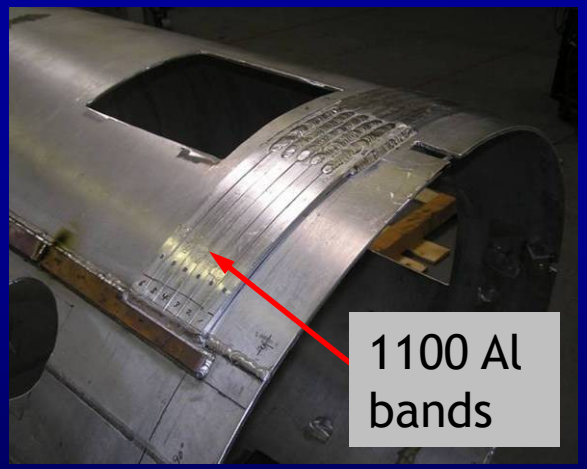
- A preliminary design modification plan has been developed by LBNL. The plan includes the following:
  - reduction of heat leaks to the cold mass
  - the addition of more cryo cooling power
  - assessment of the suitability of the passive quench protection system
  - modification of the LTS leads to prevent burn-out
- The plan has been detailed in a separate document
- The plan will be finalized once the quench analysis and design modification (if necessary) are complete

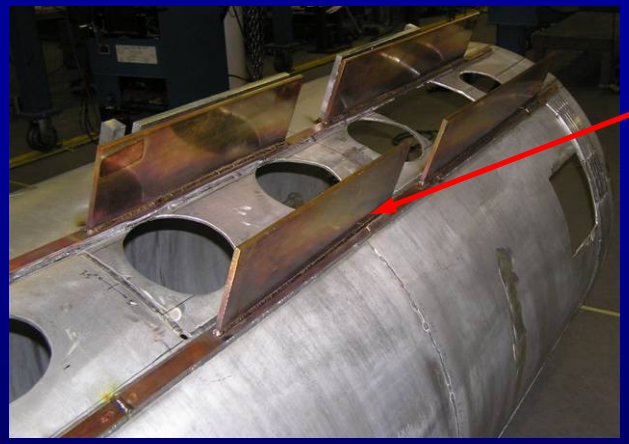
Proposed 5 + 1 Cryocooler Layout

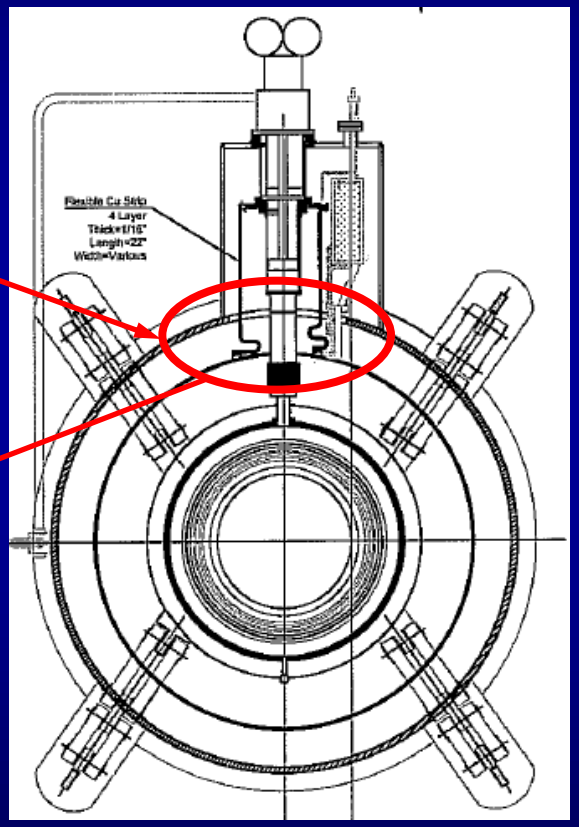


Radiation Shield Improvements

- The modification plan includes improvement of the connection between the 1st stage of the coolers and the shield as well as enhanced conduction to the cold mass support intercepts
  - Pure aluminum bands welded at either end of the shield reduce intercept temperature
  - Copper transition plates welded to the top of the shield increase the thermal conductivity from the coolers







MAP Tech Board

- Preliminary plan presented to MAP TB on Jan. 11
- Several comments arose from the meeting:
  - A coupled quench analysis should be carried out with all MICE magnets in place
  - The effects of stray fields on the coolers (particularly the 1-stage GM) and the need for local shielding needs to be assessed
  - The means for protecting the leads in a power outage needs to be established
- The possible concept for an active quench protection system was questioned
  - A system using heaters may be inadequate
  - A design study will be conducted if an active system is needed

Schedule, Budget and Manpower

- A detailed straw man schedule has been assembled based on LBNL experience that provides a compilation of the tasks with an estimate of the required durations
- A final, resource loaded schedule will be developed with the vendor once the repair plan is complete
- An estimate of the remaining costs to MAP to complete the Spectrometer Solenoids has been compiled, including both manpower and hardware
- Contingency was estimated to account for uncertainties, including the possible need for active quench protection
- Required manpower has been identified and is available

Budget Estimate (MAP cost)

Manpower	% Time*	Type	$/hr	Total (k$)
Analysis	25%	Cryo Engnr	160	53
Design Mods	25%	Cryo Engnr	160	53
Management	25%	Sr Mech Engnr	200	67
Fab Oversight	30%	Sr Cryo Engnr	140	56
Fab Oversight	30%	Mech Engnr	150	60
Quench prot/Pwr sup^	12%	Cryo Engnr	200	32
Controls+	20%	Elec Engnr	150	40
Testing/Training	12%	Sr Mech Engnr	200	32
Testing/Training	12%	Mech Engnr	150	24
Documentation	12%	Sr Mech Engnr	200	32
Documentation	12%	Mech Engnr	150	24
Travel FNAL-LBNL#				10
Fab/Procurement	**Qty**	**Unit**	**$k/ea**	**Total (k$)**
Cryocoolers (PT415)	1	ea	53	53
Contract Mods	2	magnets	25	50
Training Utilities	2	magnets	21	42
Training Cryogens	2	magnets	20	40
Shipping to RAL	2	ea	20	40
Spectrometer Solenoid Totals:				**708**
Contingency:				**254**

* average % time effort over the next 8 months
^ manpower help from FNAL
+ manpower help from RAL and Daresbury
# personnel from FNAL for testing/training

Manpower

The following individuals are part of the Spectrometer Solenoid team:

Steve Gourlay – LBNL AFRD Division Director
- LBNL technical contact for Spectrometer Solenoid and Coupling Coil magnets
- oversight of the LBNL Spectrometer Solenoid team
- contact for the DOE Office of High Energy Physics

Steve Virostek - Sr. Mechanical Engineer
- overall project management
- some oversight of magnet assembly
- magnet training oversight
- documentation

Tapio Niinikoski - Sr. Cryogenic Engineer
- CERN retiree, hired 1/2 time by LBNL
- magnet design analysis
- design modification recommendations
- some oversight of magnet assembly
- magnet training oversight

Roy Preece - Mechanical Engineer (RAL)
- oversight of magnet assembly
- magnet training oversight
- integration and documentation

Nanyang Li - Mechanical Engineer
- oversight of magnet assembly
- magnet training oversight
- documentation

Soren Prestemon - Cryogenic Engineer
- magnet design analysis
- design modification recommendations
- occasional oversight of magnet assy

Vladimir Kashikhin - Cryogenic Eng. (FNAL)
- quench analysis
- quench and lead protection design
- Power supply systems

Current Status

- The electromagnetic and heat load analyses are under way and expected to be completed in the coming days
- The quench and lead protection issue presents a major uncertainty in the completion of the plan
- Upon finalizing the modification plan, the Spectrometer Solenoid team will present the plan to MAP and subsequently the MICE tech board
- LBNL has been meeting with the vendor to begin preliminary work (approved by MICE) and to ensure the project restarts promptly when the plan is complete