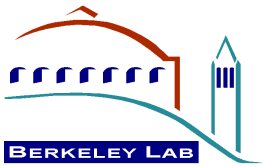

Summary of Design Modifications

Spectrometer Solenoid Review

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Steve Virostek

Lawrence Berkeley National Lab

Topics

- Magnet analyses
- Design modification plan
  - -4.2K heat load reduction
  - -Radiation shield improvement
  - -Other key improvements
- Cryocooler layout

Analysis and Design Assessment

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

Heat Load Analysis

- The heat leaks due to the dominant static sources have been re-evaluated
- The focus of the calculations was the heat leak 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

Fabrication Drawings

- Nearly 200 detail fabrication drawings representing the latest assembly of the Spectrometer Solenoid (Magnet 2B) collected from Wang NMR
- Drawings are being organized in the form of a drawing tree list
- The drawings appear to be a fairly complete representation of the previously as-built magnet
- Some recent drawings represent improvements to the thermal shield as proposed by Wang NMR which have been included in our proposed magnet modifications
- In parallel with the effort to organize the drawings, LBNL is developing a detailed 3D CAD model of the magnets

Instrumentation Plan

- The current configuration of the instrumentation on the spectrometer solenoid magnets has been reviewed, and a series of changes and additions to the system have been proposed
- The instrumentation under consideration includes temperature sensors, voltage taps, helium level gages, and pressure gages
- The wire type used to connect the instrumentation has also been reviewed
- 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

Mechanical Support Assessment

- The internal mechanical support of the various magnet components is being reviewed
- The primary issues are:
  - the mechanical stresses imposed on the components and supports 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 components reviewed 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

- In parallel to the analysis effort, a modification and assembly plan is being developed and will include:
  - 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
- The preliminary plan (pending the final results of analyses) is shown 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

- Portions of the shield will be reinforced with copper and pure aluminum to improve thermal conductivity
- The thermal connection between the cooler first stage and the radiation shield will be improved
- Application of MLI on shield bore tube will be improved
- 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

Proposed 5 + 1 Cryocooler Layout