

Spectrometer Solenoid Update

MICE Collaboration Meeting #28
Sofia, Bulgaria

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Topics

- Magnet overview and history
- Magnet technical assessment
- Design modification plan
- Manpower
- Schedule



MICE Cooling Channel Layout

Spectrometer Solenoid #1



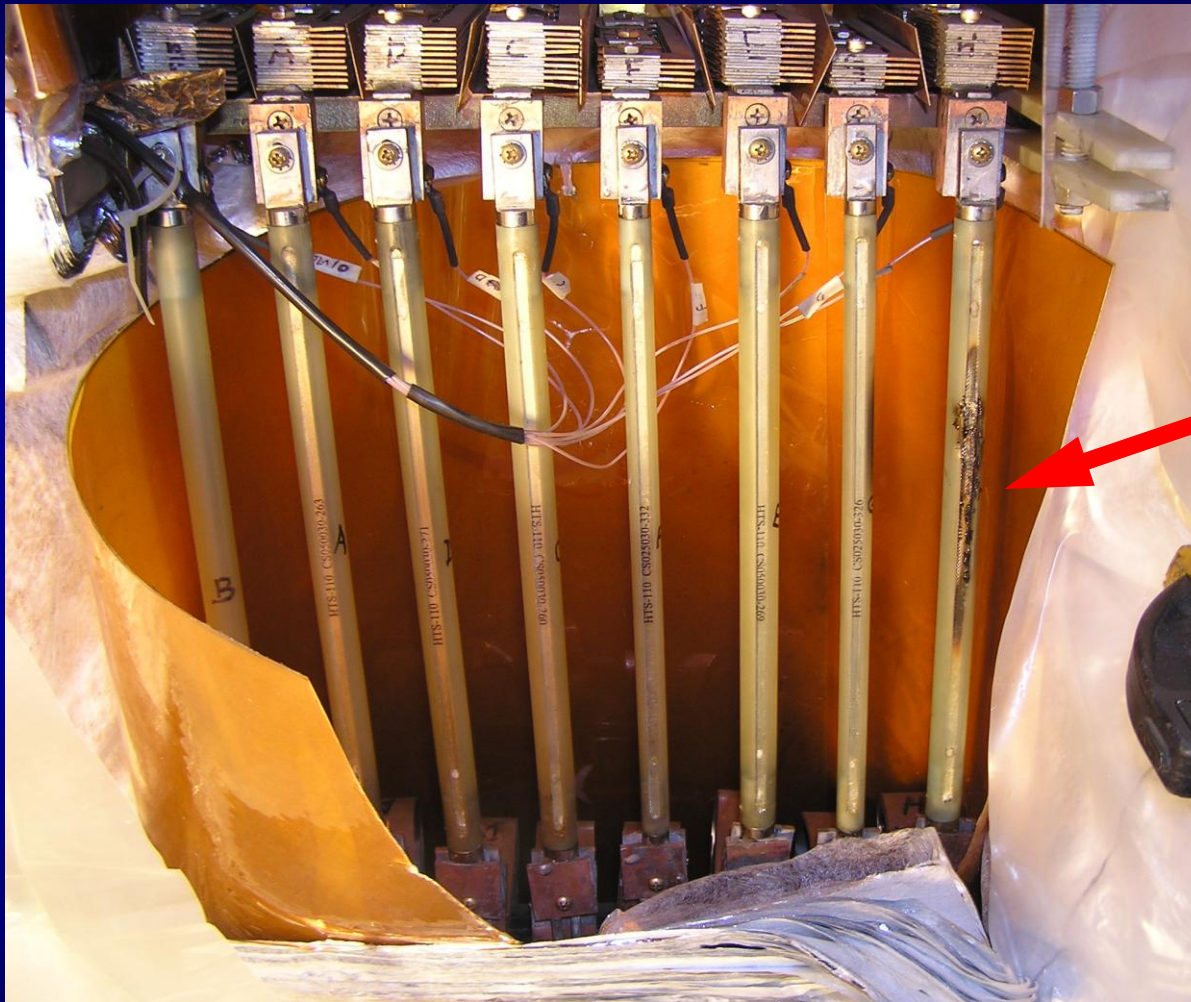
Spectrometer Solenoid #2

Spectrometer Solenoid Overview

- **Key magnet requirements:**
 - Each of the five coils must be trained to 275 amps
 - The cryocoolers must maintain the LHe in the cold mass (no boil-off)
- **Magnet history:**
 - Both magnets were previously fully assembled and tested
 - Magnet #1 trained to 196 amps before disassembly to modify the recondensing circuit, which was prone to blockage
 - Magnet #2 was assembled with a modified condensing circuit and several other design enhancements
 - The second magnet trained to 238 amps when an HTS lead burned out due to inadequate cooling of the upper lead ends



HTS Lead Burnout



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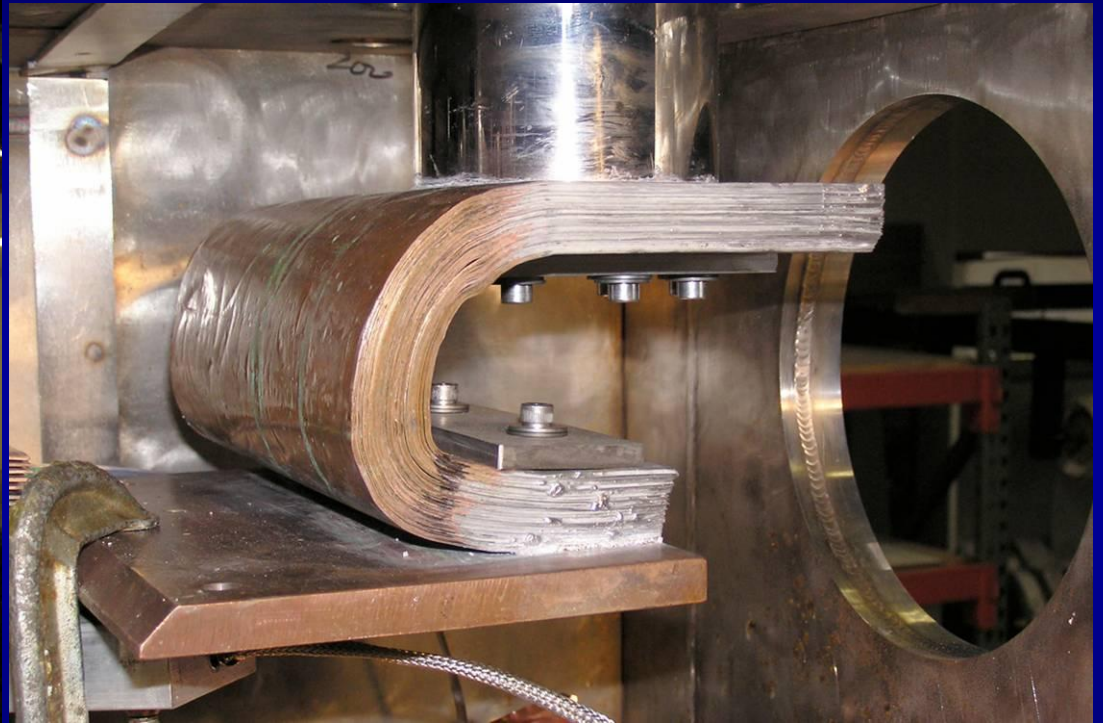
Spectrometer Solenoid Overview

- Magnet history (cont'd):

- An 11/09 MICE project committee developed recommendations before Magnet #2 was prepared for a 2nd round of testing
- Per the committee's recommendation, a single-stage cooler was added to increase the shield and HTS lead cooling
- With the HTS lead issue solved, Magnet #2 trained to 258 amps when a coil lead was found to contain an open circuit
- Also, the three 2-stage coolers + the 1-stage cooler could not maintain a closed LHe system (per boil-off measurements)
- Magnet #2 has been disassembled and the cold mass opened: the failed lead was just inside the cold mass feedthrough



Added Single Stage Cryocooler



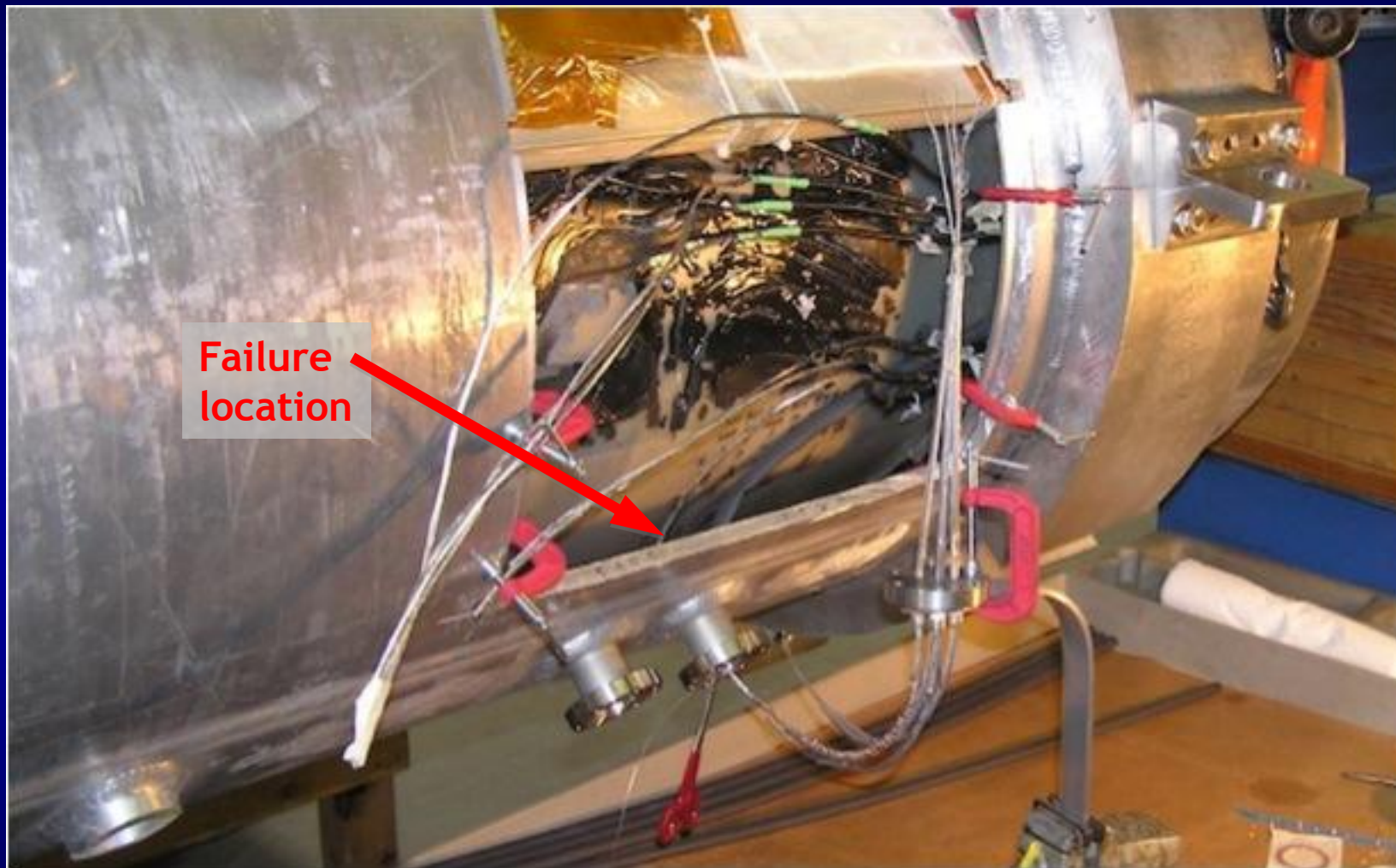
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Preliminary Repair of Leads



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FNAL Technical Assessment Committee

- An FNAL technical committee has assisted with the assessment of the magnet design and assembly
- Committee members: Jim Kerby (chair), Bob Sanders and Vladimir Kashikhin (all from FNAL)
- The committee's charge included the following:
 - assess the thermal design of the magnet
 - review the thermal performance of the magnet
 - recommend design changes to reduce heat leaks
 - determine the number and type of cryocoolers required



Preliminary Assessment & Plan

- LBNL is developing a plan to respond to the committee's 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
 - All **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



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
- The final plan will be reviewed later this month by a team assembled by MICE management



Design Modification Plan

- 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



Design Modification Plan (cont'd)

- **Radiation shield heat load reduction:**
 - 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



Design Modification Plan (cont'd)

- **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



Manpower

- **Magnet design consulting**
 - Tapio Niinikoski (Retired from CERN - Cryogenic/Magnet Engineer)
- **Thermal calculations & EM Analysis**
 - Soren Prestemon (LBNL Engineering Division - Cryogenic Engineer)
- **Mechanical analysis**
 - Steve Virostek (LBNL Engineering Division - Mechanical Engineer)
- **Drawings**
 - Steve Virostek, Sisi Shan (LBNL Mechanical Engineers), Wang NMR
- **Instrumentation plan**
 - Soren Prestemon, Mike Green (LBNL Cryogenic Engineers), Wang NMR
- **Fabrication oversight**
 - Nanyang Li (LBNL Engineering Division - Production Engineer)



Schedule (preliminary)

Task Description	2010			2011					
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1st Completed Spectrometer Solenoid									
Completion of magnet modification plan	■								
Cold mass modification		■							
Cold mass prep for assembly			■						
Thermal shield prep for assembly		■	■						
Cold mass/shield/cryostat assembly				■	■				
Tower area installation					■	■			
Magnet cool down and training							■		
2nd Completed Spectrometer Solenoid									
Component modification and assembly				■	■	■	■	■	■
Magnet cool down and training									■



Summary

- Magnet design assessment nearly complete
- Final modification plan being developed
- Committee review of plan to be conducted later this month

