Spectrometer Solenoid Update

MICE Collaboration Meeting #28
Sofia, Bulgaria

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Topics

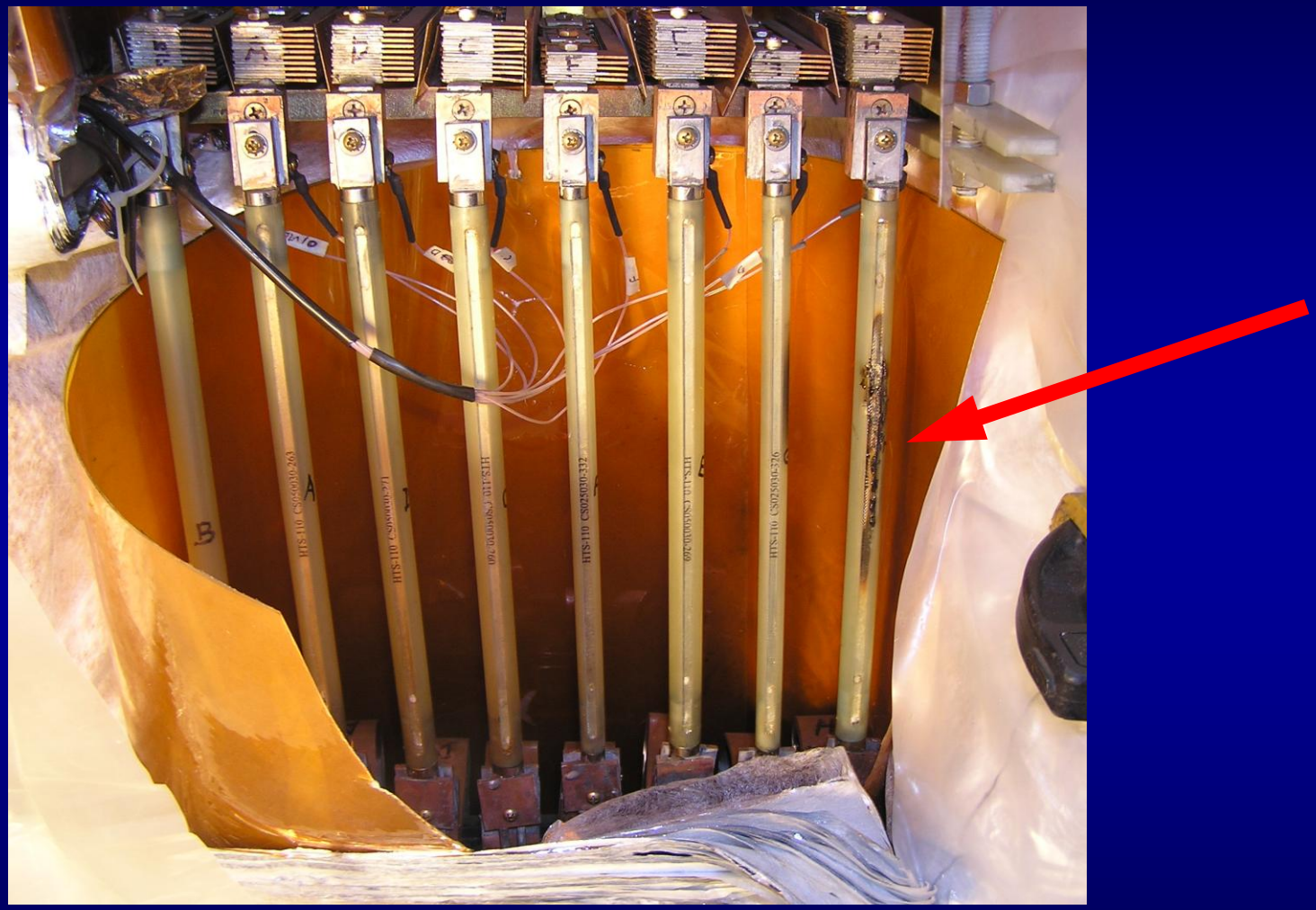
- Magnet overview and history
- Magnet technical assessment
- Design modification plan
- Manpower
- Schedule

MICE Cooling Channel Layout

Spectrometer Solenoid 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

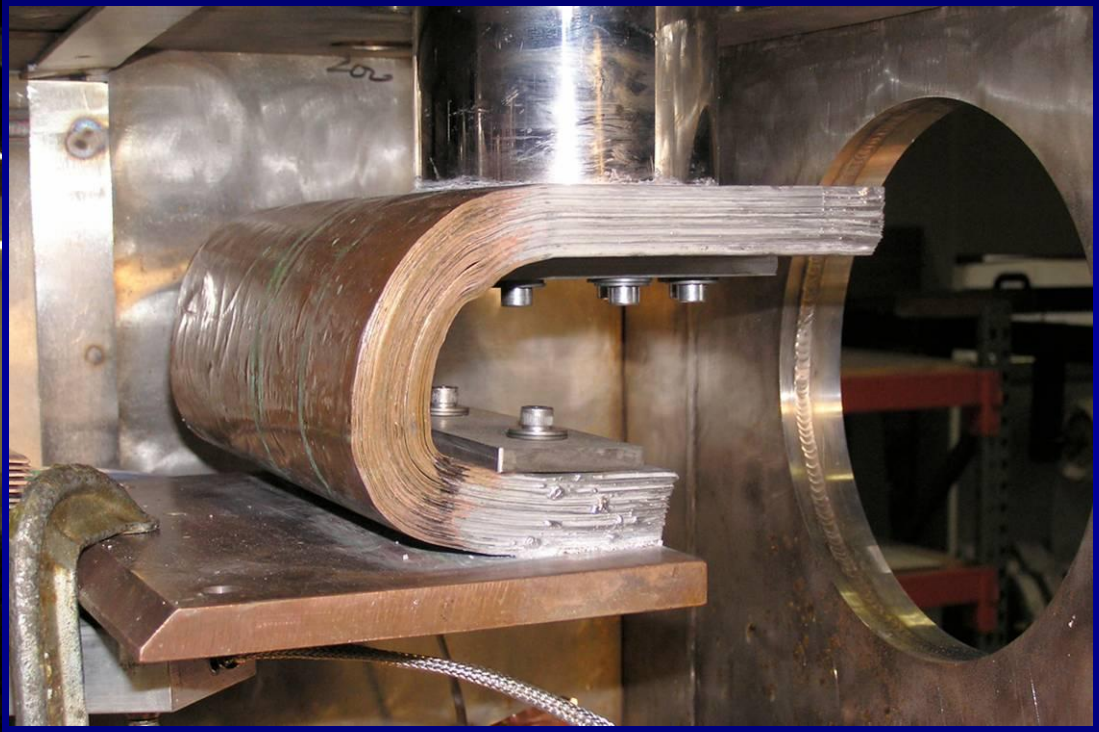
HTS Lead Burnout



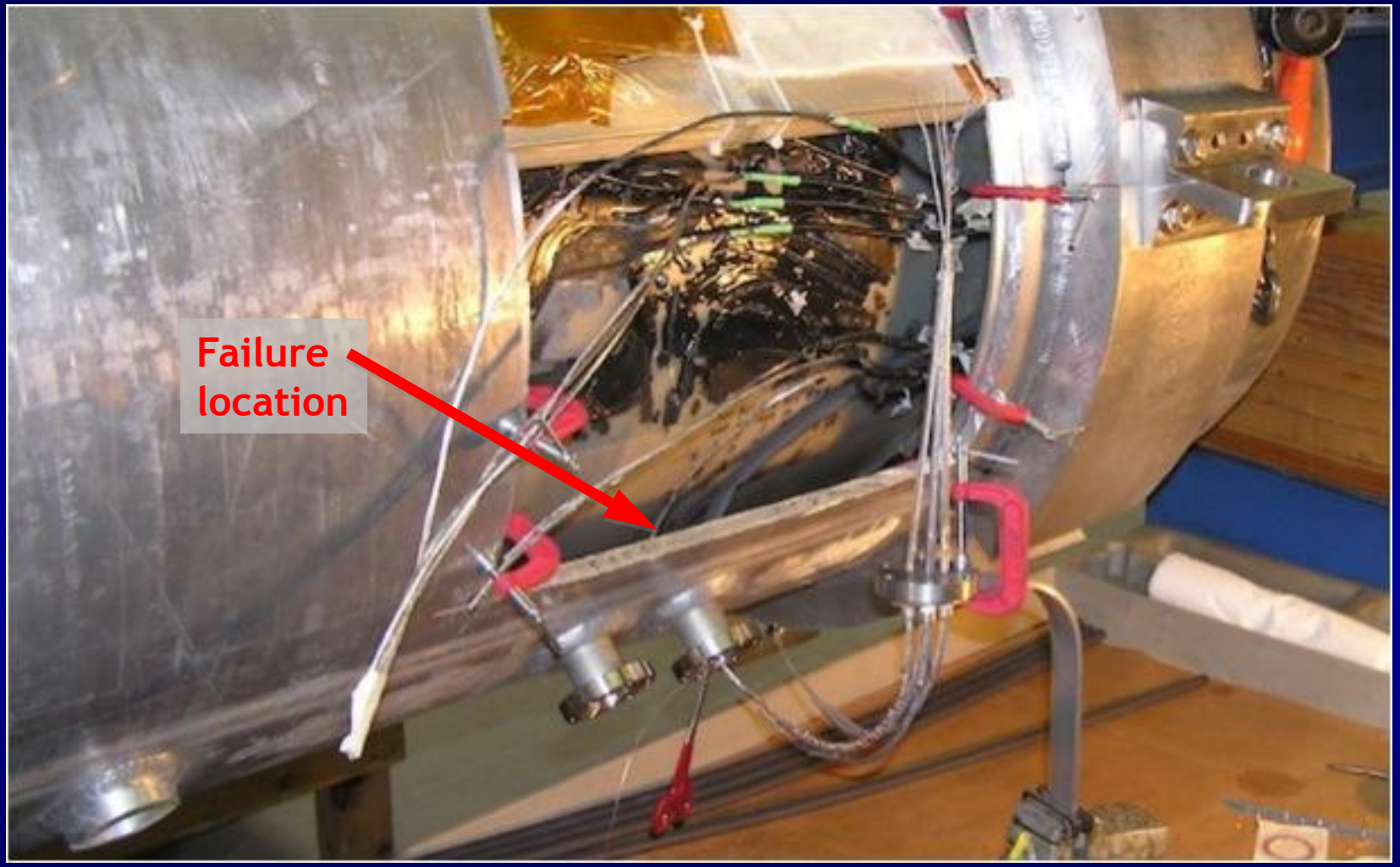
Spectrometer Solenoid Overview

- 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



Preliminary Repair of Leads



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

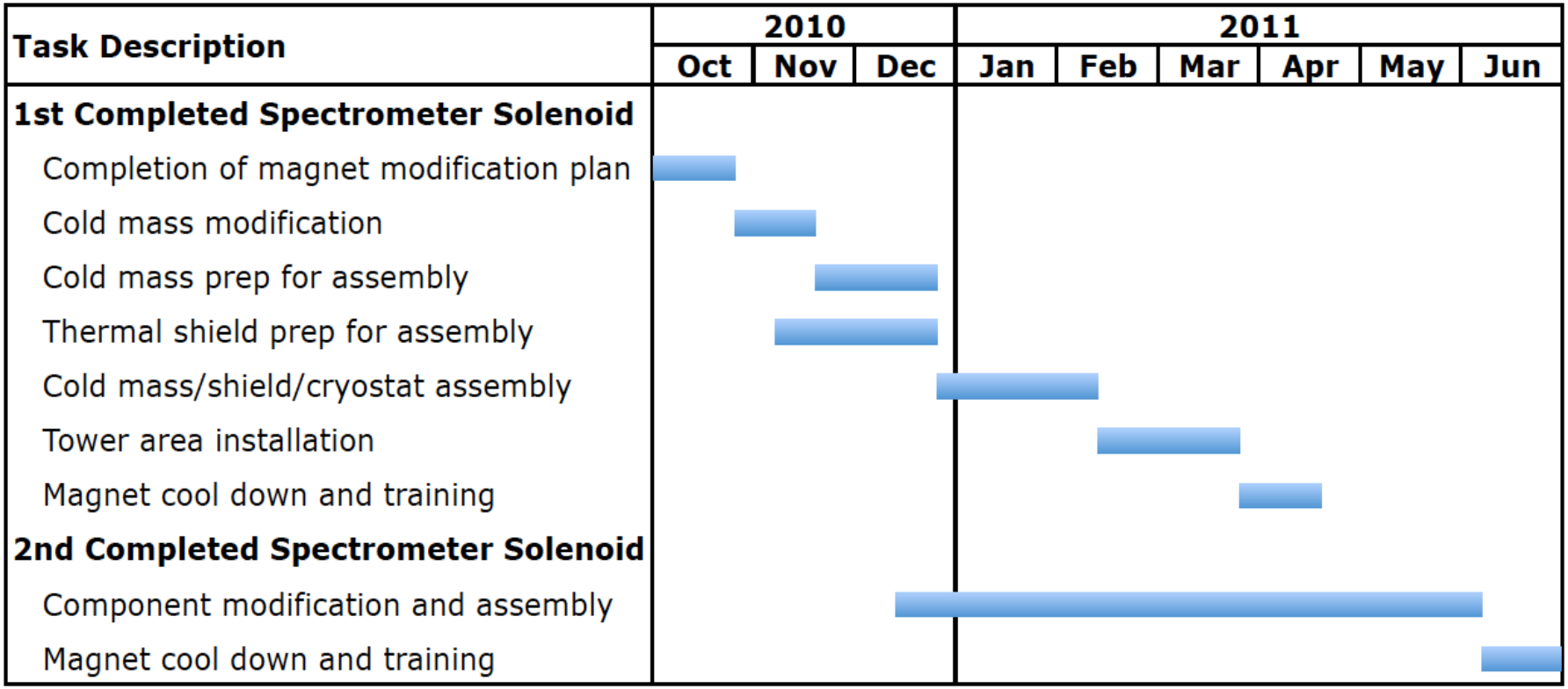
Design Modification Plan (cont'd)

- 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)



Summary

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