Overview of Review

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MICE Spectrometer Solenoid Review
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Magnet 1

- **Original design based on Genoa effort**
  - updated by LBNL team after INFN could not fund the fabrication
- **Problems with Spectrometer Solenoid first arose in 2008**
  - magnet 1 was assembled and tested, but did not reach full current
    - 196 A (need 270 A)
  - several problems were uncovered
    - alignment of cold mass to end flanges was poor
    - blockage of the siphon pipe prevented the stage 2 cold heads from delivering LHe to the cold mass
    - thermal shield temperature was too high (~93 K)
    - pressure rise during a quench was deemed too high
  - fixing these problems necessitated disassembly of magnet 1

See MG slides for more detail

- **To reduce the schedule impact, installing fixes on magnet 2 while magnet 1 is being repaired**

Magnet 2

- Fixes were made to magnet 2 to avoid the previous problems
  - not all of these were successful
- Fixes included
  - using portable CMM to align cold mass to end flanges ✓
    - achieved fraction of mm accuracy
  - eliminated siphon tubes in favor of recondensation from the top ✓
    - less effective, but robust against possible blockage
  - replaced thermal connection from Stage 1 to thermal shield with larger area version
  - added LN_2 reservoir to improve cooling of shield and provide some protection for HTS leads
  - added second vent line
- Result was that shield temperature still too high and Stage 2 cold heads cannot fully maintain LHe level

Magnet 2 Findings

- **Initial attempt to cool down met with problems**
  - fill line blockage developed
  - attempt to bypass fill line and use vent line to fill led to vacuum leak
    - vent line repair delayed further testing
    - with Fermilab help, developed improved cool-down procedure
- **Cool-down with new procedure was trouble free**
  - took ~4 days to reach operating temperature
- **Shield temperature even higher than before (~105 K), as was temperature at top of HTS leads (~80 K)** ☹
  - magnet was training successfully until HTS lead burned out at 238 A
  - some top-up needed, LHe loss of ~1% overnight
  - no external cold spots found
- **Details will come in SV talk**

Magnet 2 Plans

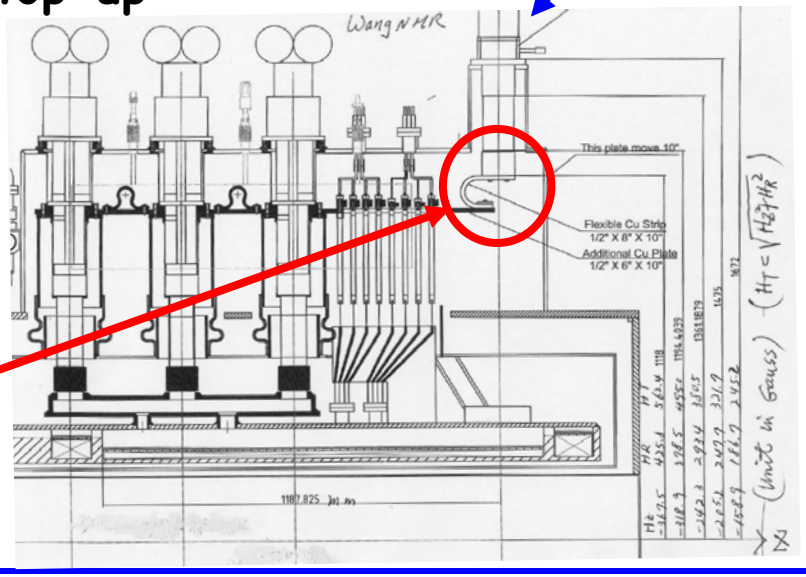
- **Goal: solve problems with minimal schedule impact**
  - **in other words, wish to avoid disassembly of magnet (if possible)**

- **Plan is to add fourth, single-stage cryocooler outboard of HTS leads**
  - **should solve problem of HTS temperature being too high**
  - **not likely to have much effect on shield temperature**
    - **may or may not avoid need for top-up**

Treats symptom but not a real cure

Testing heat leak on leads during refurbishment effort

This is critical interface



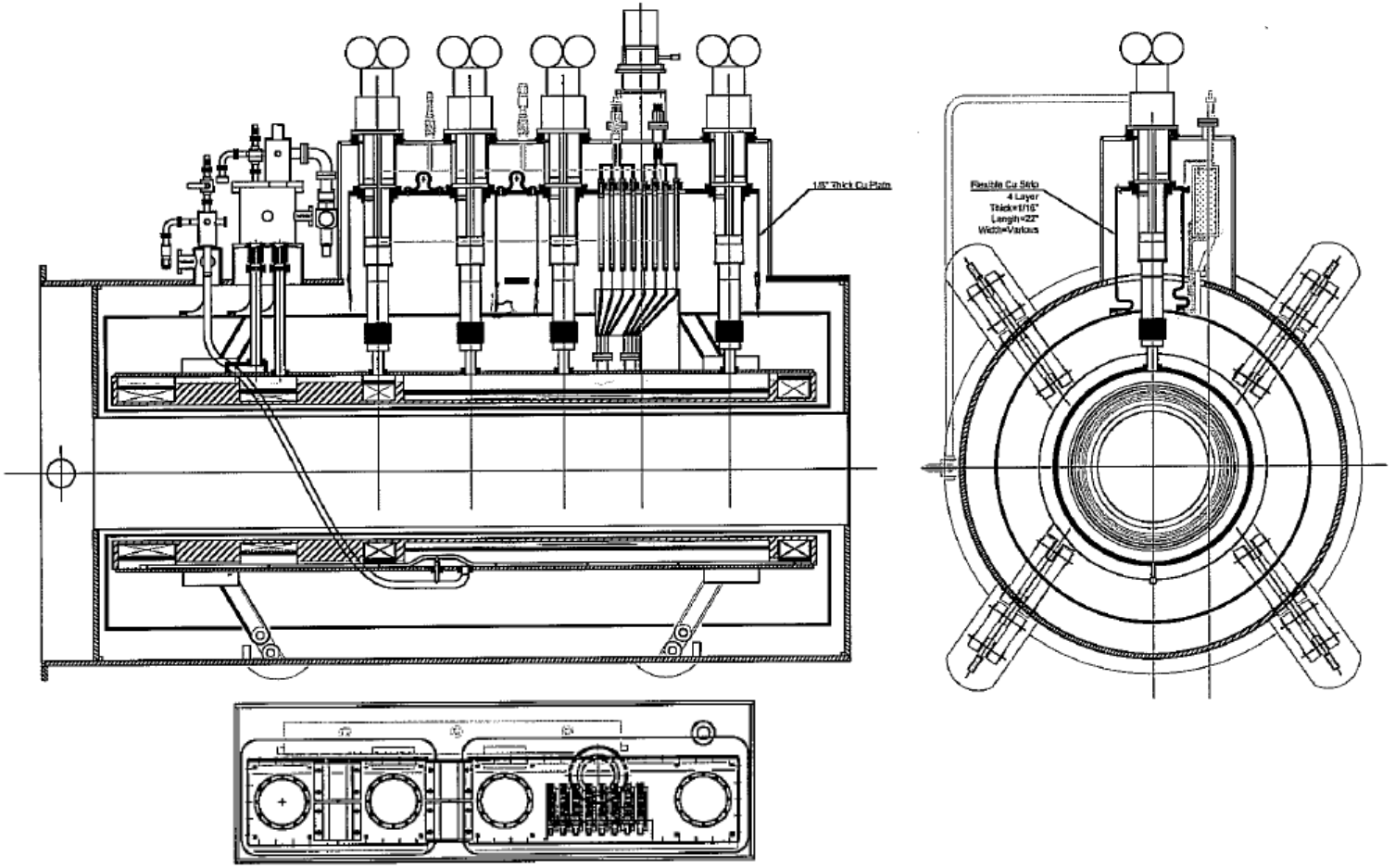
Magnet 1 Plans

- **Present plans include**
  - implement ideas to improve thermal connection between coolers and shield
    - use copper sheets rather than Al cylinder
    - use Al-1100 strips on outside of shield to improve heat conductivity
      - thus lowering cold mass support intercept temperature
  - make preparations for using additional 2-stage cooler
    - either augmenting or in place of single-stage cooler
      - one or the other (or both) will likely solve both thermal problems
    - decision to do this will depend on outcome of present magnet 2 tests
  - modify fill pipe to facilitate clearing a blockage should one occur
  - add voltage taps across HTS leads

2-Stage Cooler Modification

- **We could add a fourth 2-stage cooler as shown below**
  - **still leaves room for single-stage cooler, if it is needed**

Side view:



Top view:

LBNL Team

- LBNL team comprises
  - Steve Virostek (mech. engineer)
    - lead engineer and technical contact
  - Mike Green (cryogenics and SC magnet engineer, ret.)
    - technical expert
  - Frederic Trillaud (mech. engineer) [recent addition to team; appendicitis!]
    - thermal calculations
  - Mike Zisman (accel. physicist)
    - team leader

- Partnering with experts at vendor (Wang NMR)
  - despite problems, vendor support has been solid
    - collaborative approach has helped us make progress in difficult situation

Charge

- **Charge for reviewers is as follows**

1. Review and comment on the construction, cooling and testing of the MICE Spectrometer Solenoids under construction at Wang NMR. In particular, comment on:
    a. Original thermal model for magnet including analysis and assumptions.
    b. Interpretation of the existing results on the cooling of the magnet using cryocoolers and powering of the magnet.
    c. Updated thermal analysis based on the recent testing
2. Review the proposed modifications aiming at assuring successful and reliable powering of the magnet to full current. Comment on
    a. Updated thermal model, operating margin and ability to maintain the LHe with cryocoolers.
    b. New cryo-cooler implementation and mechanical modifications to the assembly
    c. Thermal and vacuum instrumentation and diagnostics
3. Review the power supplies and the operational abilities of the magnet in relation to the expected operating modes, and the magnet power supplies.
4. Review the presented schedule for implementing changes and the overall magnet successful delivery schedule. Evaluate possible risks and sources of delays.

Logistics

- Lunch will be available in this room at noon
- Refreshments will be available at 10:30 and 15:30 today
  - and 10:30 tomorrow
- Dinner (no host) will be at 7 p.m. tonight
  - please let me know by lunchtime whether you wish to attend
- Network access use LBL-VIS (unsecured)
  - for printing, see Wes Tabler or me
- For any problems during your visit, I can be contacted at 1-650-515-0651

Schedule

- **Schedule intentionally left with lots of time for discussion**

Wednesday, November 18, 2009

Time	Topic	Speaker	Duration	Comments
08:30 - 09:30	**Executive Session**	Committee	60	
09:30 - 09:45	Overview of Review	Zisman	15	History and meeting logistics
09:45 - 10:30	Spectrometer Solenoid Design & Test Results	Virostek	30+15	incl. design, cryogenics mods, quench history, thermometry
10:30 - 10:45	**B R E A K**		15	
10:45 - 11:15	Cryocooler and Leads Test Program	Green	20+10	Setup, results
11:15 - 12:00	Discussion	all	45	
12:00 - 13:00	**W O R K I N G L U N C H**		60	
13:00 - 14:00	Interpretation of Thermometry	Trillaud	45+15	
14:00 - 14:30	Plans to Fix Magnet 2	Virostek	20+10	Additional cooler, thermal estimates
14:30 - 15:30	Discussion	all	60	
15:30 - 15:45	**B R E A K**		15	
15:45 - 16:15	Plans to Fix Magnet 1	Zisman	15+15	Additional coolers, shield improvements, thermal calculations
16:15 - 16:45	Wrap-up and Outstanding issues	Zisman	15+15	Do we take it apart, schedule if we do this
16:45 - 18:30	**Executive Session**	Committee	105	Homework for next day, if any
19:00	**D I N N E R**	all		

Thursday, November 19, 2009

09:00 - 09:30	Response to Homework (if needed)	tbd		
09:30 - 11:30	**Executive Session - Report Preparation**	Committee		
11:30 - 12:00	**C L O S E O U T**	tbd		

Note: Visit to Wang NMR being arranged for Thursday afternoon for those interested.