Review of MICE Spectrometer Solenoid repair plan

First meeting – Phone call of October 27th 2010

Conveners: Pasquale Fabbricatore (INFN), Andy Nichols (STFC Rutherford labs)

Documents and and presentations at WEB site
http://indico.cern.ch/conferenceDisplay.py?confId=110250

Agenda

1)	Introduction and goal of the review	Andy Nichols
2)	The review committee and charge	Andy Nichols
3)	Review plan and organization	Pasquale Fabbricatore
4)	Status of the magnets	Steve Virostek
5)	Summary of design modifications and analyses	Steve Virostek
6)	Instrumentation plan	Tapio Niinikoski
7)	Analysis of the Lead Failure	Steve Virostek
8)	Heat leak calculations	Tapio Niinikoski
9)	Magnet quench analysis	Soren Prestemon
10)	Drawings, schedule and manpower	Steve Virostek
11)	Concluding remarks and next steps	Pasquale Fabbricatore

General comments, remarks and questions

The following comments reflect the discussions held during the meeting. Waiting for a more deep study of the documentation the spectrometer solenoid team is invited to address the remarks and answers to the questions below by November 17th; or in any case, if the questions cannot be answered by that date, indicate when they can be answered keeping in mind that we aim at completing the review by early December.

It will be seen that, for the understanding of the critical issues, the reviewers need to have access to as-built drawings of the magnet as soon as possible. In particular, it would be highly desirable to the reviewers to have access to the final vendor report of 6 September 2006, LBL P.O. 6806258.

1. The overall impression is good. The spectrometer solenoid team appears to have a good grasp of the repair problems and how to solve them. Previously weaker areas are being reinforced and we applaud the measured, step-by-step approach that is being cultivated.

2. The instrumentation plan and control system specification are still under construction so cannot be assessed in detail, but the methodology presented is very clear. It is essential that the Daresbury Lab. Controls and Power System staffs are involved for their technical input when making these documents. Areas such as the level of on-magnet instrumentation, hardwiring or software control, interfaces with EPICS and compatibility with the rest of the cooling channel must be addressed.

3. It is very encouraging to hear that additional project staffs have been employed, as this is fundamental to fixing the technical problems. We need to be made aware of the percentage commitment of the staff, as the one FTE quoted in the talk appears too light for the size of the task.

4. Priority should be given to the assembly drawings of the magnets, as it is only by doing this that critical points in the assembly, such as thermal loads and joints between cold heads and thermal links can be properly specified, understood and identified in the relevant QA process.

5. There is not enough detail in the project schedule as presented to form a realistic idea of the magnet delivery dates, important milestones or critically risky tasks. It is understood that some input from the vendor is required before this is done, but some important dates can be set earlier, for example:
   - Delivery of additional cryocoolers
   - Fabrication changes to cryostats, which can be based on the time taken for the single stage cooler
   - Completion of drawings and sign-off
   - Review & sign off of instrumentation plan
   - Review & sign off of control system specification
   - On site magnetic mapping exercise

6. Fitting additional cryocooler(s) would be a major task, and should only be undertaken upon conclusion of the review process. The need for them appears to be predicated on the revised heat load assessment of approximately 6 watts at 4.2K; but there first needs to be (a) satisfactory agreement between the thermal analyses and diagnostic information for the whole cryogenic system (NB: presently one can not exclude that an additional cool-down might be required to obtain missing data), (b) sufficiently high confidence in the revised heat load assessment, and (c) sufficient margin in the cooling power provided by the proposed solution, based on normal cryogenic conventional practice

7. The schedule start point should be 15 December, 2010 and staged delivery of magnet #1 before magnet #2 should not be taken as an essential MICE requirement.

If it makes more practical sense to work on both magnets in parallel, this route should be taken

8. Critical points:

a) Heat loads to the shield. The test 2B seems to demonstrate that 277 W of cooling power were available at the first stage of the cryocoolers. On the contrary the computed heat loads were much lower (about half).
b) Heat loads at 4.2 K.
c) Passive and active protection of the current leads and cold leads. It appears possible that the instrumentation and control systems would not be ready when testing the magnets at the vendor site. This is strongly not recommended after two severe fails (current lead and cold lead).
d) The quench analyses showed very high internal voltages. In facts these values might be over evaluated by a large factor. Some more refined computations are required for a better understanding of the issue.

Some specific requests to the solenoid team for further documents/information:

1) Quench protection and electrical circuits

1.1) An electrical scheme of each individual circuit - a sketch is indicated on slide 5 of the presentation given by Soren Prestemon. But together with the characteristics of the circuits (nominal and maximum current, time constants) we should get information on the type of superconductor used in the bus and in the magnets (cross section, filling factor, type and possibly characteristics of the stabilizer), on the exact location and configuration of all electrical joints, on the exact location of all voltage taps already available or envisaged to be added in the system, on the type of cooling of all superconducting elements. (We possibly understood that the current leads are in vacuum, and somewhere there is a leak-tight electrical transition to the liquid helium environment, where all the other superconducting parts are located).

1.2) A scheme indicating which signals were used in the past for protection of the leads, of the bus and of the magnets, and what is planned to be done in the future - monitoring is a separate issue;

1.3) The proposal, if it exists, for the quench detection voltages;

1.4) Information on which actions are taken in case of resistive transition of the bus and of the HTS part of the lead (fast or slow discharge);

1.5) Information on the characteristics of the HTS part of the lead (number of tapes, electrical characteristics, amount of stabilizer).

2) CERNOX and other low-temperature sensors

2.1) There was considerable doubt in March about the usefulness of existing CERNOX and other low-temperature sensors fitted to the cold mass, due to confused or missing calibration data, and faulty sensors. Which of the existing low-temperature sensors on each of the magnets are reliable? What can be done about the others?

2.2) Full details are required regarding the instrumentation planned for the HTS and LTS leads and their heat-intercepts, which require comprehensive monitoring prior to and during powering of the magnet.

2.3) A complete set of the temperature logged data during the test in March is required.

3) Thermal model

(3.1) Are there current plans or ideas for a low impedance path for vacuum pumping the volume between the shield and the cold mass? Of course, the radiation heat load on the cold mass through this path must be considered.

(3.2) Please revise the table on page 4 of the heat load review talk to have a column for the expected heat loads on the new revised design. It is expected that some entries may have ranges or question marks.

(3.3) Please prepare another table similar to the table on page 4 of the heat load review talk for the heat loads on the shield. Include a column the expected heat loads on the new revised design. It is expected that some entries may have ranges or question marks. It is important however to identify all shield heat load sources in one table.

(3.4) Please provide enough information on the 2B magnet for the connections between the copper plate and the shield to calculate the heat flow using the measured temperatures. We wish to calculate the heat flow similar to what was done for magnet 2A in Mice note 285 , page 3, item i. If drawings do not exist please provide sketches or descriptions of the material and dimensions.

(3.5) Are there any noticeable defects in the magnet 2B connections between the copper plate and the shield, such as a cracked weld, that may have impeded heat flow?

(3.6) Does anyone recall if there any noticeable defects in the magnet 2A connections between the copper plate and the shield, such as a cracked weld, that may have impeded heat flow?

4) Cryocoolers

4.1) What are the dimensions of the Cryomech 415 cryocooler condenser? What is its outside diameter and height? How many vertical holes are there and what is the diameter? Please confirm that these holes are not blind, that they go completely through the copper.

(4.2) What is the internal diameter of the tube the Cryomech 415 cryocooler condenser was inserted into?

(4.3) How many of the cryocoolers used in the 2B test, had been tested individually by Wang NMR or LBNL? Did any of them have prior extensive operation? The review panel will be in contact with Cryomech and will confirm that they performance test all cryocoolers before shipping.

(4.4) What is the maximum temperature of the liquid helium that is acceptable for operation of the solenoid. The cooling capacity of a cryocooler (in Watts) increases with temperature.

(4.5) Based on the experiences of the 2B test, will there be a minimum required helium level for operation of the solenoid? This determines if the cryocoolers will be condensing superheated vapor or saturated vapor.

(4.6) In the 2B magnet test, how many holes (through which the helium had to flow) were between the plenum below the cryocoolers and the top of the helium space of the cold mass and what was the hole diameter? The review panel is aware of the plan to open up the flow path.

(4.7) Are you aware of any realistic modes of cryocooler failures where the cryocooler 2nd stage degrades in performance but the 1st stage doesn't? Hypothetically If this event did occur would it be possible through the installed instrumentation to determine which of the five PT415 cryocooler's 2nd stage is not working properly?

5) Drawings

5.1 Drawings of vacuum chamber, thermal shield, supports and turret. There is a high priority on these drawings, which could help understanding the mis-matching between effective and computed heat load at the first stage.

5.2 Drawing of cold mass cross-section with all dimensions, including ground, G10 spacers, interlayer electrical insulation, outer Al bobbin, bandage ring, LHe vessel, feed through, etc..

5.3 Drawing of cold leads position inside and outside the coil sections, electrical insulation;

5.4 Drawing of shunt resistors and cold diodes with corresponding insulation and space positions in the cold mass;

5.5 All leads cross-sections inside the coil, in space between coil-shunt, shunt-cold feed through, feed through-bottom HTS lead, and shunt resistor cross-section.

6) Schedule and Organization

6.1 Please provide more information on the %FTE commitment of the people nominated for the various repair tasks. Please also indicate which tasks are most at risk from insufficient manpower.