Close-out Report of the MICE Spectrometer Solenoid Review
3-4 Dec 2015 @FNAL

DRAFT!!

Reporting days:
Closeout report delivered on 4 December 2015
Preliminary report delivered on x December 2015
Final report delivered on x December 2015

Review Committee:
Herman ten Kate - CERN (chair), Jim Kerby – ANL, Mike Anerella – BNL, Peter Wanderer – BNL, Tom Taylor – CERN, Cesar Luongo – JLAB, Peter McIntyre – TAMU, Luigi Muzzi – ENEA.

Observers:
Bruce Strauss – DOE, Josef Boehm – RAL, Oleg Kiricheck – ISIS.

Client:
Review requested by Mark Palmer, director US Muon Accelerator Program.

1. Overview

The review committee met with the Mice Spectrometer Project team on 3-4 December 2015 at FNAL on request of Mark Palmer following the electrical breakdown of the M1 and M2 internal electrical circuitry in the so-called SSD magnet system and attempting to move forward with an approach for repair and/or replacement of the magnets. The agenda is in Annex 1.

The committee would like to commend the Mice-SSU&D team for the professional set of presentations. The presentations provided, as far as known, a clear status of the magnet damage, concerns, and thoughts about options for the projected repairs and move-forward plans for the magnet system. The committee is impressed with the ….

The review committee expresses its status issues, concerns and observations immediately below and under the specific charge in each case. Provided the resulting issues are suitably addressed, the review committee endorses acceptance of the talks as the basis for continuing the work for repair of the solenoid.

The project's Review Committee charges and their responses follow, enriched with additional observations, concerns and recommendations.

2. Response to the Charge to Review Committee

1.1. Evaluate the existing SS magnet power supply and quench protection scheme in light of the failure event.

The existing QP system based on cold diodes and resistors is not sufficiently robust. The margins are so small that when operating the system in different way, without M2, caused the system to break down.

1.2. Examine modifications to the power and quench protection systems being proposed by the SS magnet group and assess the ability of the MICE experiment to safely operate the magnets in the Step IV configuration as well as the Cooling Demonstration configuration.

The plans for adaptations of the QP systems are generally endorsed though the designs need to be further detailed.

The proposed new QP for the SS with adding external dump is well conceived as the best plan to deal with the present system in step IV.

When building the new cold mass for SSD, the QP shall be based on using quench heaters and proper voltage taps in the center of each coil section.

The resistors in series of the diodes shall be suppressed. When charging/discharging time/voltage is a problem, a better solution is to add diodes to the stack.

Also the dimensioning of all internal leads and busses have to be reviewed and made more robust, i.e. have a larger cross section, properly insulated and fixed by locking bolts throughout the entire system.

It is recommended to position the internal QP leads in the bottom part of the cryostat and the diodes geometrically above them, all to warrant that the parts are properly operating in liquid helium under all circumstances.

2.1. Evaluate the technical details of the magnet recovery plan as presented by the SS magnet team.

The level of details is not the same for all options presented. Regarding the most likely options, opening/repair and new cold mass, the following can be said.

For the option new cold mass: it is considered essential to find an engineering and construction team with experience in fabricating large bore solenoids rather than to start in in-house manufacturing at the bottom of the learning curve.

The design of the previous cold mass should be followed as closely as possible, though, it is recommended to increase the operational margins of the coils.

Some coils, in particular E2, are at about 60% of critical current which is a too high level. Typically such solenoids can run at about 30% of critical current. More NbTi in the present SS design greatly helps. It is recommended, as proposed, to increase the margins by resizing the coils, resulting in significantly lower peak fields, and allow some 30% more turns, which looks very well possible.

In the opening and repair option the problems with training and its consequences will remain. In that option it would be important to explore options for adding quench heaters attached to coil entries or outer surface.

It is noted that the problems are mitigated if the user field is reduced to 3 T which seems sufficient for spectrometer requirements, though quench protection consequences have to be checked.

2.2. In particular, please address the robustness of each of the presented modifications and repair steps.

We only consider the open & repair and the new cold mass options.

A new cold mass with heater driven quench protection system will have to be tested and fully qualified for operation in the SS, and the entire cold mass can then be considered a robust core for integration in the magnet system.

The same level of robustness can probably not be achieved for the open & repair option.

2.3. Also consider the degree of operational safety that will be provided by executing the recovery option as presented.

Considering operational safety of the existing machinery while the repair is prepared, the cold mass construction parallel to Step IV provides the best chance that Step IV can be performed gaining physics results unaltered, not disturbed by repair works.

3.1. Evaluate the balance of costs, schedule impact and risks associated with the recovery option based on the initial cost, schedule and risk analysis provided by the SS magnet team.

The risk table presented was developed by the Mice management and is consistent with their assumptions…..

The manufacturing time for the cold mass shown to start in December 2015 and lasting 9 months only including a 40% margin is not credible in view of the foreseen design, analysis, engineering and model coil work proposed by the team. Even for a full industrial supply starting tomorrow this time is far too short. To come close it is recommended, as said before, to stay close to the existing design and find an industrial supplier with experience in construction of such solenoids as soon as possible and be creative in shortening the placement of the contract.

The cost table provided shows full overhead and includes 40% contingency, still leading to on over run of some 250k$ to be covered.

The cost model is based on in-house manufacturing which is not recommended. A cost model based on industrial production should be developed. It is noted that industrial production may look more expensive at start but the integrated cost at the conclusion of the project can be expected to be less.

3.2. Identify any elements of the plan that require further attention by the SS magnet group before finalizing the proposed recovery option.

-see above.

4.1. Based on the overview and analysis presented by the SS magnet team, confirm whether the recovery option presented will provide a viable path forward for the MICE Experiment.

Make sure Step IV can be executed. The importance of running Step IV program to get physics output is greatly acknowledged and has to be respected. It is a strong argument in favor of making a new cold mass even when not the most cost and time efficient solution.

The option to recommend also depends on the experience of the team as well as schedule and cost constraints. Given this the committee recommends to proceed with the new cold mass option in full speed, but built in industry.

As said before, the new cold mass has to be made according the present design but eliminating some production flaws and including adjustments for increasing operational margins of the coils.

A full development program at the lab should be avoided if qualified manufacturers are present in the market.

A detailed make/buy analysis is highly recommended. Thus the next step is a thorough survey of feasible manufacturing partners.

Mice will retain the technical risk associated with the production of a new cold mass.

4.2. Also, please identify any other magnet recovery options that should be evaluated prior to presenting the magnet recovery proposal to the MICE Collaboration and the funding agencies.

-none.

EOF today.

More in the final full report!