Response to feedback from the Resource Loaded Schedule Review panel and the MICE Project Board

The project team welcomes the reports from the Resource Loaded Schedule Review panel and the MICE Project Board following their meetings in April 2016. This document provides the project team's response to each of the RLSR panel's and the MPB's recommendations.

Resource Loaded Schedule Review

Actions

1. **The US to confirm formally that with a US-led procurement there is no way forward to a satisfactory spectrometer solenoid repair within the financial framework set by the DOE.**
   The MICE team in the US continues to develop an updated engineering-and-technical-requirements package that will be used to inform the procurement process for the repair of the downstream spectrometer solenoid. This package will include a summary of lessons learned with the existing magnet. It will also identify a set of technical issues that must adequately be addressed by any bid and that the project team will use in the evaluation of the bids prior to placing a contract.
   The project team notes the MPB's finding:
   > *It is found that the total estimated cost (including contingency) of procuring a new magnet to replace SSD exceeds the funds available in the U.S.*

   While a final cost estimate will not be available until a formal set of bids have been obtained and evaluated, the US DOE has opened discussions with the UK STFC to explore the possibility that the UK project team will lead the magnet-recovery effort. Accordingly, RAL personnel are making the necessary preparations to take over the procurement process for the magnet recovery.
2. **The US needs to inform the STFC how much funding and when it is prepared to transfer to them (see below).**
   The project team understands that discussions are underway between the DOE and the STFC with a view to agreeing a transfer of funds to support a UK procurement effort. The project team notes that the degree to which the US is able to follow through with support for its hardware as well as its involvement in commissioning, operations and analysis is likely to depend on the agreement that is eventually reached.
3. **The STFC needs to determine whether it is prepared to take on the responsibility of the procurement for the spectrometer solenoid repair and to wait and see the outcome of the initial UK procurement process (expected by October 2016 at the earliest), or, whether to terminate MICE at STEP IV and to stop all work immediately on the Cooling Demonstration.**
   The STFC is in contact with the DOE with a view to determining the level of resource that can be transferred from the US to the UK to support a RAL-led procurement by which the functionality of the downstream solenoid may be recovered. The project team is committed to work with both the STFC and the DOE in this process and to provide all necessary clarifications in a timely manner.
4. **If the STFC decides to proceed with the solenoid procurement, the US must inform the project of the support it can give, from any remaining funds in the MICE/MAP budget.**
   As noted in our response to action 2, the resources that remain to the MICE-US team, assuming that agreement is reached on a transfer of funds to the UK, will determine the level of future support that can be provided by the US team. The principal remaining components of the US effort are: delivery

and commissioning of the RF modules for the cooling demonstration; delivery of the partial return yoke required for the cooling demonstration; provision of experimental support for MICE Step IV. While we anticipate that delivery of all hardware required for the cooling demonstration will be completed this (US) fiscal year, the level of involvement of the US team beyond the end of fiscal-year 2016 will necessarily be reduced. The collaboration notes the importance of the US contributions to the MICE programme and will therefore seek to maximise the continuing contribution of US personnel to the experiment.

MICE Project Board

Actions

1. **Ensure that all measures are taken for protection of the solenoids during Step IV runs.**
   The modifications to the quench-detection and quench-protection systems for the spectrometer solenoids and modifications to the powering circuitry have been documented and approved. The design and implementation has been assessed by the DL Electrical Engineering Group and an electrical-integration plan has been generated and agreed. The main focus of the modifications to the system are to prevent further failures of the coils, feedthroughs, high- and low-temperature superconductor leads and internal protection components. This is achieved by minimising the use of the internal energy-discharge circuitry and minimising the possibility of internal damage to the magnet if a failure should occur.
   The implementation of the electrical integration plan commenced in January 2016, with key milestones agreed, including the design and procurement being complete by early April 2016, the equipment installed by mid-May 2016 and handover to the operations team after a thorough commissioning period, including system-performance checks and interlock verifications, by the beginning of June 2016. These modifications are progressing on schedule with the electrical drawings complete and all major components procured and delivered. The DCCTs for precision monitoring of output current and additional DC contactors for improved reliability are now installed. As these modifications include major system changes an extended period of commissioning has been scheduled, with verification of the quench-detection and quench-protection system essential before operation the magnets in Step IV.
2. **STFC (RAL) should plan for the procurement of a new cold mass with an option for the supply of the enveloping cryostat. The vendor should be required to make the coil according to a detailed specification based on the knowledge of the previous magnets supplemented by any intervening studies. Report to STFC as soon as possible—about 6 months—in order to decide the course of action.**
   The MICE-UK project team has started the procurement process at RAL. Initial informal meetings have been followed by more in depth discussions with the procurement staff within UK SBS to understand the steps required in the process for a procurement of this size. There has been substantial progress. Preparation of the required tender specification documentation is with the magnet team in readiness for posting in the relevant European journal. The "bid package", in preparation at BNL, will be considered in the preparation of the tender specification. In parallel, the project team have canvassed opinion within the community to identify further possible suppliers that may be able to bid to supply. An emphasis has been placed on "low risk" suppliers. Several potential new suppliers with good supply track records have been identified and are being actively pursued. The magnet team plans to make a series of trips to potential suppliers in the next few months.

Recommendations

1. **Seek the advice of external experts on the proposed methods and hardware for the muon transit phase detection and trigger clock synchronization systems.**

The project team welcomes the comments made by the MPB in its report and in further informal discussions. The overall phase-measurement process will require the synchronous operation of devices monitoring the RF waveform, the particle transit through the hodoscopes and "global" track reconstruction. The calibration of the phase measurement will be achieved by a difference measurement of the particle momentum upstream and downstream of the cooling cell as a function of the measured phase. The RF team have been using wave-forms measured using the 201 MHz cavity in the MTA to test aspects of their approach. The cavity tests at in the MICE Hall will allow the commissioning and test of the relevant hardware before the start of the cooling demonstration.

Due to the number of systems involved in the phase measurement, development has involved discussion between the RF, TOF, analysis and data-acquisition teams. Elements of the proposed hardware are now being subjected to bench tests. A detailed description of the diagnostic hardware and proposed operation and calibration method will be prepared (and subjected to critical review) by these internal experts. This will provide a platform and a resource for discussion with external experts over the coming six months. The collaboration has started to consider suitable external experts who could be approached to advise on the finalisation of the phase-measurement system.

2. **Ensure sufficient documentation of the "final" software suite such that MICE code can be maintained in the long term, and across any future personnel changes.**

   The project team understands the importance of maintaining up-to-date documentation of the software.

   Documentation for the Monte Carlo and the reconstruction software is maintained as part of the official MAUS software package and is provided as part of each release of MAUS. The relevant documentation is updated whenever there is a change to the software and it is made available to the collaboration in html and PDF formats. Documentation of the actual code source is made available using Doxygen. In addition, the software group provides a "workbook" intended to help new developers get up to speed with the software suite. There are also MICE technical notes detailing some of the individual detector reconstructions, for e.g., the track-reconstruction software (see [1]), which is now being finalised for publication. Finally, a "shifter's guide"—documentation for running the online reconstruction framework—is provided as part of the standard shift documentation.

3. **Carry on with Step IV, and good luck with data taking and analysis!**

   We thank the Board for their encouragement to continue the Step IV measurement programme. The Operations and Analysis teams will continue to work closely together in order to take the data necessary to deliver the Step IV programme over the coming ISIS User cycles.

4. **Conduct comprehensive and systematic transfer line optimization, in order to ensure the maximum possible return on the available ISIS beam time.**

   Following on from the preliminary studies that indicate that significant gains can be achieved and which were presented to the MBP, the collaboration has already instigated a new optimisation of the MICE beam-line. The collaboration will continue with this optimisation effort and report results at the MPB's next meeting.

5. **Fully quantify the expected performance of the emittance measurement in the absence of the SSD M2 coil, including an analysis of the systematic uncertainties in the measurement caused by possible acceptance effects.**

   The collaboration will continue to study the performance in this configuration, including the possible acceptance effects.

References

[1] A. Dobbs *et al.*, "The Reconstruction Software for the MICE Scintillating Fibre Trackers." http://mice.iit.edu/micenotes/public/pdf/MICE451/MICE451.pdf, 2014.