

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

This document provides a response to the points raised in the feedback from the Resource Loaded Schedule Review committee and the MICE Project Board following their meetings in April 2014.

### **Resource Loaded Schedule Review**

**1. The project is required to undertake a full cost-risk-benefit analysis of the proposed expedited STEP V schedule for the next meeting.**

The Step V schedule is being analysed in terms of the costs and the risks that will accrue from delivering the benefits of the expedited Step V schedule. In parallel, looking at the problem along a complementary axis, an analysis in which the costs and benefits that will accrue from a programme based on the mitigation of the risks in the Step V programme is being carried out. Initial results from these analyses will be documented in preparation for the DOE review of MAP and MICE that will take place in August 2014. Development of the analyses will continue and the results will be presented to the RLSR panel at its meeting in October 2014.

**2. It is vitally important that the level 1 milestone, the completion of the installation for STEP IV that is currently scheduled for March 4th 2015 is met and the project team must ensure that everything is done to ensure this is achieved.**

The project team agree with the RLSR panel's statement. The development of the sub-projects that must be completed successfully for the level-1 milestone to be delivered are continuously monitored through the processes that have been presented to the RLSR panel. The project dash-board (<http://micewww.pp.rl.ac.uk/dashboard/>) gives a top-level view of progress towards the goal of completing the Step IV construction project by the end of Q1 2014.

**3. The UK project management should redo the schedule projection taking into account the 35% contingency for concurrent tasks (the green line) by the end of May.**

The UK PMO made a revision of the schedule projection including a consistent implementation of contingency at 35%. The schedule analysis was communicated to the chair of the RLSR panel on the 31<sup>st</sup> May 2014 and may be found at:

- <http://www.eng.dl.ac.uk/secure/mice/RLSR/2014-04%20RLSR/Schedules/Step%20IV%20Critical%20Path.pdf>

**4. The project should produce a coherent plan for the commissioning and the running of MICE for STEP IV for the next meeting.**

Work to prepare a coherent commissioning and operations plan for Step IV is underway. An initial study will be completed and documented in preparation for the DOE review of MAP and MICE in August 2014. The initial study will continue to be developed and will be presented to the RLSR panel and to the MPB at their meetings in October 2014.

**5. The committee reviewed the revised project planning methodology and agrees it is appropriate and gives a more representative value for future use in comparing the baseline to the optimistic and risk dates.**

The project team notes the panel's comment and refers the panel to the project dash-board (<http://micewww.pp.rl.ac.uk/dashboard/>) for an update on the status of the Step IV construction project.

**6. The dashboard and slip charts should be included in future reports.**

The project team notes the panel's comment and will continue to use the dashboard and slip charts as a means of monitoring and presenting the progress of the project.

**7. The project should provide an optimum revised project plan for the completion and operation of STEP V within the financial constraints for the next meeting.**

A number of scenarios are being used to evaluate the Step V construction-project schedule. In response to DOE-OHEP guidelines to MAP, the US construction project is being analysed based on:

- (a) A funding profile that will allow the US deliverables to Step V to be completed early in US fiscal year 2017; and
- (b) A funding profile that corresponds to "Scenario A" presented to the RLSR and MPB in April 2014. In this scenario the US deliverables to Step V are completed by late spring 2017.

At present, the UK planning assumption is that the funding profile will be "flat cash" ("flat/flat"). Therefore, the schedule for the implementation of Step V is being analysed separately:

- (a) To derive the funding profile necessary to realise the benefits of the early delivery of components from the US; and
- (b) To determine the integration schedule that will result should it prove not to be possible to deviate from the flat-cash allocation in the UK.

Initial results from these analyses will be documented in preparation for the DOE review of MAP and MICE in August 2014. The results will be discussed with STFC and DOE and further developed in order that an optimised revised project plan can be presented to the RLSR and MPB meetings in October 2014.

## **MICE Project Board**

**1. The director of the MAP program should ask the DOE office of HEP to intervene to expedite the remaining procurement for the Partial Return Yoke fabrication. The timely delivery and installation of the PRY is critical to meeting the Step IV schedule.**

The MAP Director pursued this issue with both DOE-OHEP and Brookhaven senior management with the result that all Purchase Orders for procurement of the PRY were in place on the 27<sup>th</sup> June 2014.

**2. Complete a risk/benefit analysis of the switch from the baseline program to an expedited delivery of Step V, for all components, by the next meeting.**

The risk/benefit analysis of the switch from the baseline programme to that by which the implementation of Step IV is expedited will be carried out as described in response to RLSR recommendation number 1.

**3. Begin a series of independent Machine Protection and Personnel Protection reviews of the integrated commissioning activities and early operation stages, and report back on progress at the next MPB meeting.**

Safety issues related to the MICE experiment are dealt with through the regular MICE/ISIS Safety Committee meetings. The meetings occur every six weeks or as necessary. Reviews of the Machine Protection System (MPS) and Personnel Protection System (PPS) will be carried out within the MICE/ISIS Safety Committee framework. The first of the meetings dedicated to a review of the MPS and PPS will take place on the 10<sup>th</sup> or 12<sup>th</sup> of October 2014. Independent personnel with appropriate expertise will be invited to take part in these dedicated meetings. Should unforeseen issues arise, further meetings will be scheduled.

**4. Scientific output in refereed scientific and technical journals should be enhanced and made more visible, publishing in the worlds of both experimental physics and accelerator physics.**

The project team agrees with the MPB. Steps are being taken to expedite the two remaining publications using the Step I data and the collaboration plans to engage enthusiastically with JINST which has proposed a special issue on muon accelerators for particle physics.

The collaboration recognises the need to make its scientific output more readily accessible. A list of publications and (separately) conference contributions is maintained on the collaboration's WWW site. The WWW site is being refurbished (see <http://mice.iit.edu/refit>). Navigation to the publications and conference proceedings has been made much easier on the new MICE site. The "Documents" drop-down menu contains a link to both publications and conference contributions. The new WWW page will under-go a "beta-testing" phase starting on the 17<sup>th</sup> July 2014. The new pages will go into production at the next collaboration meeting (CM40, Rome, 26–29 October 2014).

### Superconducting magnets

- 5. Prepare to choose between FC1 and FC2 immediately after the FC2 test. In parallel with FC2 testing, complete the analysis that shows that FC1 is (or is not) adequate for Step IV and V. (There is probably not enough time after the test to rework FC2 if needed and still hold the Step IV schedule.)**

On the 20<sup>th</sup> May 2014 it was decided that FC1 will be used in Step IV since it is capable of supporting an excellent programme at Step IV.

It was recognised that FC2 might be shown to outperform FC1. Should this prove to be the case, the timescale on which FC2 could be integrated into the experiment would be evaluated. The option to use FC2 rather than FC1 would then be considered taking into account the potential benefit to Step IV and the risk to the cost and schedule.

FC1 has now been mapped in both solenoid and flip mode and has been shown not to require retraining when going from flip to solenoid or from solenoid to flip mode. In addition, the magnet has been shown to be stable in operation at the nominal current in solenoid mode and at 180 A in flip mode.

- 6. Present at least one paper on the spectrometer magnet experience at upcoming conferences. Though potentially painful and difficult, these lessons apply to many others in the field, and even to other vendors working for MICE.**

A paper will be prepared for the International Conference on Magnet Technology that will take place in Korea in October 2015 (Seoul, 18–23 October 2015). S. Prestemon (LBNL) will coordinate the effort and H. Pang (LBNL) will initiate ANSYS studies on the thermal stability of the cold-mass bobbin used in the spectrometer solenoid. This analysis will be included in the submission.

- 7. Pay special attention to risks that are shifting from other collaborators to RAL. Look for ways to encourage and/or enforce continued responsibility for those components by the home institution after delivery has occurred.**

The project team is aware that the implementation of the expedited schedule for Step V implies a redistribution of risk across the collaboration. These risks will form part of the cost/risk/benefit analysis being carried out as described in response to RLSR recommendation number 1.

### RF systems and controls

- 8. Generate an integrated RF system testing plan, including both the alternative of using an early delivered RFCC module and also the present option of using a single cavity, so that valuable practical operation experience can be gained in a timely fashion and in parallel to operating Step IV.**

**Promised for after RF meeting on Wednesday 09Jul14**

**Lead author:** Preece

- 9. Prepare and present at the next meeting a plan for how the controls and sub-system teams will train and share information with the operations and maintenance crews, within both the collaboration and ISIS.**

The mechanisms by which the controls and sub-system teams will train and share information is in preparation. Initial proposals for these mechanisms will be presented in the commissioning and operations-planning documents that are being drafted. First drafts of these documents will be produced in preparation for the DOE review of MAP and MICE that will take place in August 2014. The commissioning and operations plans, including the training and information-sharing aspects, will continue to be developed and will be presented to the MPB at its meeting in October 2014.

**10. Implement a prioritised plan towards making the essential components of a control system operational for Step IV.**

The necessary controls systems for MICE have been reviewed and the priority of each system has been identified. In line with MPB recommendation 13, the schedule for the development of the software and computing (S/w&C) project, of which the development of control and monitoring systems is part, is being integrated into the overall schedule for the implementation of Step IV. The first-pass integration of the S/W&C project into the overall schedule has been completed making it possible to analyse the resource implications. The status of the planning and resource analysis will be presented to the MPB at its meeting in October 2014.

**Data taking, simulation and reconstruction**

**11. Present a combined physics/operations plan for Step IV data taking and analysis, clearly describing the critical early measurements to be made, and the plan towards first Step IV publications.**

The work and documentation referred to in the response to RLSR recommendation 4 will also address the physics data taking and the planning of the physics analysis. The status of the planning will be presented to the Board at its meeting in October.

**12. Develop a plan for on-site support of online systems during Step IV running, ensuring that the experiment can run smoothly during this critical period.**

A plan for on-site support of online systems is under development. It will include extensions to the on-call systems that have already been established successfully to support operations of the MICE Muon Beam, the online reconstruction system and the tracker.

In the case of online systems, redundancy is essential to ensure that the system overall is resilient. Therefore, an analysis of the redundancy of all appropriate systems (such as the DAQ) is being carried out. In parallel, the maintenance schedule for the online systems is being re-evaluated and a careful review of the spares requirements of the experiment is underway. The procurement of some of the most critical spares is already underway.

The cost of the on-site support, redundancy and maintenance programmes will be incorporated into the experiment's overall plan to make sure that the resources can be applied effectively. The plans prepared for the DOE review of MAP and MICE that in August 2014 will contain an initial evaluation of the resource implications. The plans will be updated and presented to the MPB at its meeting in October 2014.

**13. Fully integrate the online and offline development schedules into the overall experiment planning, showing where shortfalls in resources occur, and their effects on the overall schedule up to publications.**

A first pass at integrating the schedule for the S/w&C project into the overall schedule for MICE has been completed. The resource implications and issues related to the levelling of resources are being addressed. The documentation which is in preparation for the DOE review of MAP and MICE in August 2014 will contain the first-pass integration. The integration of the S/w&C schedule will continue to be updated/improved and will be presented to the MPB at its meeting in October 2015.

**14. Present the methodology for track reconstruction and explain how it is being used to achieve the best possible resolution, at the next meeting.**

At the time of the last MPB meeting a small bug in the reconstruction programme caused a bias in the emittance reconstruction. This has now been resolved. Figure 1 shows the single-particle emittance distribution upstream and downstream of the liquid-hydrogen absorber in a simulation of Step IV using a nominal muon beam (emittance  $6 \pi$  mm, momentum 200 MeV/c). The distribution obtained using tracks reconstructed by MAUS is shown together with the distribution obtained using the generated tracks. The agreement between the generated and reconstructed distributions is excellent.

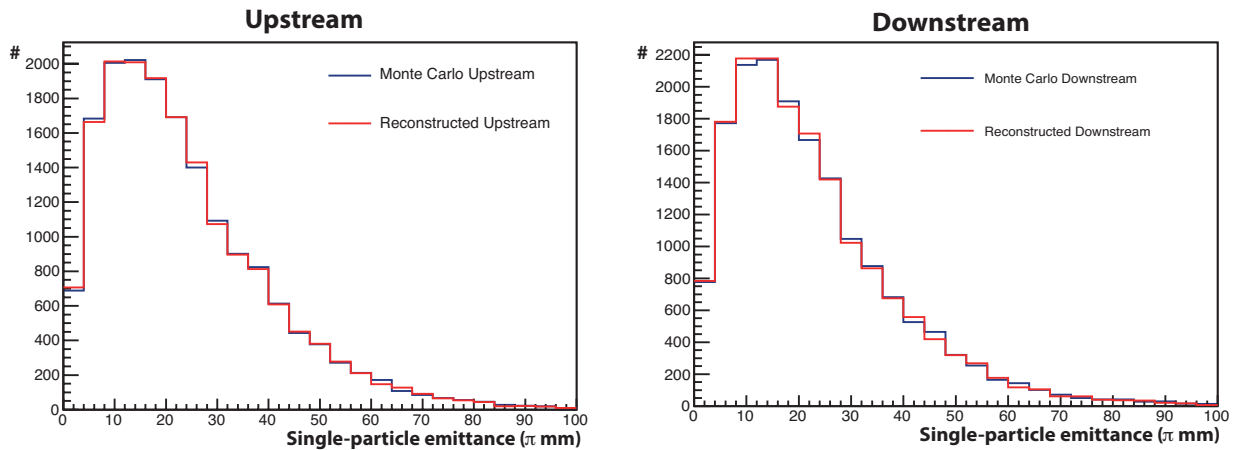


Figure 1: Single-particle emittance. The blue histogram shows the generated single-particle emittance in the upstream tracker (left) and downstream tracker (right). The red histogram shows the distribution obtained using tracks reconstructed in the scintillating-fibre trackers using the MAUS s/w.

Documentation of the track reconstruction algorithms used to calculate track positions and momenta is described in [1]. A refereed paper based on this conference contribution is in preparation. The status of the track reconstruction software will be presented to the MPB at its meeting.

Global track reconstruction routines, which tie the momentum and position information determined by the scintillating-fibre tracker, into the timing information provided by the ToFs, are under development. These routines will provide enhanced particle identification capabilities and the ability, at Step V, to determine particle time at the tracker with respect to the RF phase.

A refereed paper describing the MAUS framework, including the global reconstruction algorithm, is in preparation. The status of the publication will be presented to the MPB at its next meeting.

### Commissioning and operations

15. **Develop and present at the next meeting a more detailed plan of Step IV commissioning and early operational activities in 2015, indicating the anticipated progress on each major component and sub-system, possible problem areas/delays and how these may affect timescales.**

**Lead author:** Blackmore/Boyd

16. **Assure adequate participation of the operational team in Step IV installation and commissioning activities, in order for them to gain “hands-on” knowledge of the hardware, and of typical and possible issues of relevance to operation.**

The operational team is made up of experts responsible for their individual subsystems. These responsibilities will be defined in the assumptions document referred to in the response to MPB recommendation 18. It is expected that these experts will have detailed knowledge of the construction, installation and operation of the systems for which they are responsible. Knowledge exchange between the subsystem experts will be maintained through bi-weekly Operations Meetings as well as the day-to-day interactions of the experts with those working on the individual systems.

17. **Develop a policy and a corresponding plan for the active participation of non-UK and non-US collaborators in the installation and commissioning activities, and on operational shifts.**

**Lead author:** Long

18. **Fully define the expected contributions of the collaborating groups towards the commissioning, operation and maintenance efforts.**

The project team has initiated the drafting of an “assumptions document” that will list the assumptions it has made in the preparation of the construction, commissioning and operations schedules. The contributions and responsibilities of the collaborating groups towards the commissioning, operations and maintenance efforts will be documented in the assumptions document. A first draft of the assumptions document will be produced in preparation for the DOE review of MAP and MICE that will take place in August 2014. The document will be refined and presented to the MPB at its meeting in October 2014.

19. **Continue communications with ISIS on operational staffing and rebuilding the MICE liquid hydrogen team.**

Discussions continue with respect to the staffing of the MICE operations activity. With regard to the rebuilding of the liquid-hydrogen team, the MICE/ISIS Safety Committee has constituted a small working group to oversee the preparation of the system for operation at Step IV. The working-group activity will follow that by which the system was successfully commissioning into the test absorber. Progress on the development of the liquid-hydrogen activity, and the operations-project staffing in general, will be presented to the MPB at its meeting in October.

20. **Identify means of presenting the ISIS team with full system drawings and specifications of the equipment that they will be involved in running.**

The first step to providing ISIS personnel with all relevant material on the equipment they will be using is the identification of the relevant components. With the aid of the Hall Manager and in conjunction with ISIS, the Operations Coordinator (S. Boyd) has started to construct a list of the relevant equipment. Once the list is complete, all documentation on specification and operating details will be compiled into an operations dossier and made available to the ISIS personnel. The dossier will be ready well in advance of the commissioning of Step IV.

## References

- [1] A. Dobbs, K. Long, E. Santos, D. Adey, P. Hanlet, *et al.*, “The Reconstruction Software for the Muon Ionization Cooling Experiment Trackers,” *J.Phys.Conf.Ser.* **513** (2014) 022008.