

The committee wishes to thank the proponents of MICE for their clear and enthusiastic presentations, and also for some useful clarifications of issues which were raised during the exchanges in the closed session. The committee appreciates the timeliness of MICE and its importance as a necessary step towards a serious proposal for the construction of a Neutrino Factory. The proponents and RAL are encouraged to proceed towards the difficult but essential step of achieving adequate funding and resources. This document represents a distillation of the questions, doubts and uncertainties which remain with the committee members concerning the MICE proposal. It should not be regarded in a negative sense, rather, clarification of the issues raised, should lead to a much more effective report, which can serve as a basis for achieving approval.

Experimental detector issues

Fibre tracker

It seems essential to perform a full simulation of a tracker with five planes, including nominal inefficiency and assessment of the redundancy by simulation of the loss of readout—dead fibres. The impact of noise and misalignment should also be assessed. What is the status of this simulation?

Because of the cost saving by multiplexing, it is important to repeat the simulation in a realistically multiplexed arrangement.

Will the main alignment be derived from “straight through” muons?

Some documented information on the performance of the fibre tracker in the MUSCAT experiment would be useful.

TPG detector

It is important to test a full drift length using the triple GEM technique, hexaboard pads, coupled to narrow strips, using a final electronics chain. These results should be used to simulate the performance of the TPG in the experiment, and appear to be crucial in making the decision on the tracker type.

Is the uniformity of “better than 1%”, assumed for the 1000 mm by 300 mm diameter solenoid good enough for the imaging performance of the TPG?

Has an estimate been made of the effect of RF noise and X-rays on the GEMs?

Timescales for the tracker

The timescale set for MICE appears very aggressive—both spectrometers in place for testing and commissioning by winter 2005. Realistically what tests will the tracker decision be

based upon? What performance criteria can be examined in the short time? After the decision it is important to see the proposed timescales for production, tests, construction of components including coils, and assembly, followed by installation.

Safety factor

What is the loss performance in the spectrometers which will compromise the measurement? How large is the safety factor?

Particle ID

It is good design to have two detector systems for each question of ID. The redundancy allows a cross check of the individual detector performance, and the ability to demonstrate the complementarity. The particle ID detectors do not represent innovative technology, but achieving the required performance will require good quality assurance and sound engineering. The proposed detectors are “state of the art”.

Concerns are the homogeneity of response over the required surface area, and how this can be proved, and the risk of bias (in terms of phase space population) through loss of muons by unwanted rejection in the particle ID systems (e.g. position, incident angle, and energy dependence of “over-vetoing” of electrons in the calorimeter or Cerenkov).

General experimental questions

Is there a plausible general argument to support the claim that the correlation of the measurement of the emittance of the incoming and outgoing muons improves the statistical precision of the difference measurement?

There is a statement, “it is believed that the systematic errors on the ratio of the output to input emittance can be kept at the level of $\pm 10^{-3}$ or better”, is this merely a pious hope, or is there evidence to justify it?

The re-weighing of the particle density is used as an argument to allow the experiment to make many studies with one data taking setting. However this comes at a price in terms of statistics. What would be the real statistics needed to reach the required effective statistics for the worst case?

Is it possible to provide a plan of the envisaged experimental program, indicating which configurations will be explored, and what kind of changeover times are anticipated? This question has a bearing on the different magnetic forces which will be experienced. It also impacts the question of how essential the decay solenoid is for the beam line.

This question concerns the MICE proponents with input from expert committee members. Because of costs, etc., might it not be necessary to quantify the gains which may follow from exploring set-up VI, beyond set-up V, in figure 3.13. Is this step a luxury or prudent insurance against a situation where cooling is less than expected?

Software

Successful software simulation of the MICE results appears to be an important ingredient for extending the measurement to future cooling configurations. What steps are being taken within the MICE collaboration to set-up the appropriate software team?

RF systems

This is perhaps the most challenging accelerator system in MICE, and the proposed 201 MHz cavity structure includes several new and novel aspects, which will need intense R and D effort before moving to construction. The introduction of cavity windows and the operation in a magnetic field are untried innovations. Several questions arise:-

- e-beam welds or braze joints
- best method to clean and bake cavities
- lifetimes of windows
- use of copper or copperclad steel
- microphonic issues will be an important aspect of cavity timing—the cavity frequency bandwidth corresponds to a 30 μm window displacement
- cavity conditioning and multipactoring in the magnetic field—is there a gain from TiN coating
- effects at field reversal point

Is it possible to indicate a timescale and funding required to cover this R and D? Can it happen within the MUCOOL R & D program of MUTAC at FNAL? Have the proponents considered a small advisory group of recognized RF experts?

Liquid hydrogen absorbers

The R and D on this system is widely dispersed. What are the plans for assembling and testing the completed system, liquid hydrogen container, vacuum, and focusing coils? Where will it occur? Who supplies the infrastructure and safety needs? While liquid hydrogen is the baseline absorber in MICE, to what extent can other absorbers be explored?

Beam line

The committee heard that the proposed work plan for the ISIS division in the long shutdown projected to commence in Spring 2004, already stretches resources to the limit. This would appear to make the installation of the new MICE beamline practically impossible without increased effort. The committee would like to hear whether simply enlarging the hole in the shielding wall in the next long shutdown is a possible way forward for MICE. When would the beamline be subsequently completed? Would this step preclude the use of the PSI solenoid? What delay might be envisaged for the MICE program? How would this step impact the required funding and resource profile for MICE? The committee understands that this is not the

preferred schedule of MICE, but it may prove to be a realistic one. What is the timescale for a decision on the possible use of the PSI solenoid?

Funding

The committee realizes that the cost estimates as presented are “physicists’” estimates. This is always a necessary first step. However these estimates must be firmed up with adequate documentation, before funding agencies will give serious attention to a funding request. What steps are envisaged to move forward? Is there a clear view of what amounts are expected from the various agencies involved? Some funds seem to be assumed from MUCOOL R&D, will this continue? What funds, if any, does MICE have already, a piece of MUTAC? It would seem sensible to consider two funding scenarios. One profile which is front loaded to make maximum use of the 2004 shutdown—the preferred profile. A second which makes minimum use of the 2004 shutdown.

Timescales

The committee understands that the preferred MICE timescale as outlined in figure 3.13 is driven by the feeling that a result is needed by 2007. If minimal use is made of the 2004 shutdown how would the dates be modified?

The committee would like to see some milestones which would allow the steps of figure 3.13 to be realized as presented in the proposal, or possibly a modified set of steps from figure 3.13. The most obvious milestones are,

- date of beamline completion for step I.
- date of decision on trackers for steps II and III.
- length of time remaining for R and D on the liquid hydrogen absorbers in order to go into production, achieve a sub-system test, and be ready for step IV.
- length of time remaining for RF R and D to produce cavities in time for steps V and VI.
- start dates for coil production – focusing, coupling, matching, spectrometer, to mesh into the above steps.

Management issues

The Rutherford Laboratory is proposing to host MICE. This role will bring significant international visibility to RAL, but it will also demand considerable responsibilities if the project is to proceed successfully. The following observations are made. There is a need for an overall, fairly senior, Project Leader. The RAL team should contain sufficient expertise in sub-systems (RF, magnets, absorbers, etc.) to play a leading role in helping to define them, so that there are no surprises in the “in kind” equipment which arrives at the laboratory for installation. In addition the laboratory will need to supply appropriate engineering coordination to provide the beamline, the infrastructure for the installation of subsystems and spectrometers, plus define, implement and manage safety systems. There will also be a need for an experienced UK physicist to assist in the liaison with the physics groups providing the detector components.

The funding for MICE will include international contributions. It would seem prudent to envisage some form of “agency committee” which monitors the funding during the provision of the MICE equipment. There has been no mention of MICE operating funds—a common fund? RAL?

The committee feels that it is not too early for the laboratory to begin to formulate and present a management plan for hosting MICE at RAL.