Office of High Energy Physics
Report on the

Muon Accelerator Program Review

August 2010

Fermi National Accelerator Laboratory

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Table of Contents

Table of Contents 3
Executive Summary 5
Introduction 7
Beam Physics and Simulation 8
  Findings 8
  Comments 8
  Recommendations 9
Accelerator Systems 10
  Findings 10
  Comments 10
  Recommendations 11
Magnets 12
  Findings 12
  Comments 12
  Recommendations 14
RF Systems 15
  Findings 15
  Comments 15
  Recommendations 17
Management 18
  Findings 18
  Comments 18
  Recommendations 19
Answers to the Charge Questions 21
Appendix A 22
Appendix B 24

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Executive Summary

The review of the proposed Muon Accelerator Program (MAP) was held at the Fermi National Accelerator Laboratory on August 24–26, 2010. The review charge, which is included in Appendix A, covered the standard required criteria for all DOE merit reviews. In addition, the charge asked the peer reviewers to consider the following questions:

- Does the proposal devote appropriate effort towards demonstrating that the most critical technical issues to building a muon collider or neutrino factory can be solved?
- Are there clear milestones that can be used to track progress of the R&D?
- Is there a management structure in place capable of evaluating progress, setting priorities, and making changes in response to unexpected results and new discoveries?

The reviewers observed that the national Neutrino Factory and Muon Collider Collaboration (NFMCC) under the direction of Michael Zisman of LBNL and the Fermilab Muon Collider Task Force (MCTF) under the direction of Steven Geer had effectively merged to make the proposal. The proposed work was called very important to the field of high energy physics by the review committee, and the committee found that significant progress had been made by the collaborations.

The reviewers found the management structure had met the basic requirements for a directed R&D program, but that it was cumbersome and it reflected the history of the preceding organizations rather than just the elements needed to manage the proposed program. The management structure was more like that of a experimental particle physics collaboration than that of a focused R&D program.

The reviewers noted that there were several unresolved technical challenges that will prevent the program from achieving a credible final design. It was strongly suggested by all individual members of the review committee that MAP management focus on the resolution of the technical issues before significant time is allocated to specific machine design.

The committee found that significant progress had been made by the collaborations in their previous research on the physics of muon colliders, but that the completion of the MICE experiment was vitally important to the program in demonstrating the feasibility of 4D cooling. Delays in delivering superconducting magnets to the MICE experiment by the U. S. collaboration were troubling in this regard. The committee also concluded that there were significant technical challenges to be addressed before detailed design of a collider should be attempted. Further, the committee strongly recommended that a strong project manager be recruited as quickly as possible.

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Introduction

A DOE review of the proposed Muon Accelerator Program (MAP) was held at Fermi National Accelerator Laboratory August 24-26, 2010. The eight peer reviewers were Thomas Markiewicz (SLAC), Steven Peggs (BNL), Erk Jensen (CERN), Chris Adolphsen (SLAC), John Cary (Colorado), Yunhai Cai (SLAC), Peter McIntyre (TAMU), Al Zeller (MSU/FRIB), and John Wormersley (STFC/UK). Michael Procario, the director of the Facilities Division in the Office of High Energy Physics (OHEP), chaired the review. Funding agency representatives included L.K. Len (DOE), Bruce Strauss (DOE), and James Whitmore (NSF).

The reviewers were charged to generally evaluate the structure and content of the proposal with regard to appropriateness of the effort to demonstrate the most critical technical issues required to build a muon collider. In addition, were clear milestones proposed that could track progress of the research and development? Finally, had a strong management structure been established? The complete charge can be found in Appendix A.

The committee heard a series of thirty talks divided into seven sessions. The review began with an introductory session including talks by laboratory management and the leaders of the collaboration making the proposal. This was followed by an introductory technical session covering design, simulations, technology development, systems tests and management plans. Over the next two days there were nine separate breakout sessions covering specific topics and areas. The review concluded with an executive session and a closeout. Mike Zisman (LBNL), NFMCC Director and Steve Geer (FNAL), MCTF director, coordinated the presentations. The agenda for the review with speakers and an URL hosting the talks can be found in Appendix B.

The reviewers submitted individual written evaluations, and this report is based on those written comments. Each reviewer was free to comment on any aspect of the program or the charge. The report is structured around the following sections: Beam Physics, Accelerator Systems, RF Systems, Magnets, and Management. These sections begin with findings, and then present comments, followed by recommendations. A final section contains summary answers to the questions from the charge.

Beam Physics and Simulation

Findings

Much progress has been made in over the past decade in understanding beam physics in the process of ionization cooling. In particular, two different codes (ICOOL and G4beamline) have been developed for simulation. In general, they agree well with each other. They have become essential tools for the design of a muon collider.

There are two aspects to demonstrating the usefulness of a simulation. Verification is ensuring that the code is solving the equations correctly. Validation is ensuring that the correct equations are being solved.

Many new ideas and innovations, such as three schemes of six-dimensional (6D) cooling, were presented: Guggenheim, Helical Cooling Channel (HCC), and Helical FOFO-snake.

A fast ramping synchrotron from 25 to 750 GeV has a synchrotron tune larger than a unit, which enters a new operation region where strong coupling between betatron and synchrotron can occur.

Comments

- Because of the many technical tasks proposed for completion in the next five years it may be impossible to provide a rational design of a muon collider.
- While much excellent simulation has been done, there is also a need for global optimizations, which require simple analytic models. A clear picture of major tradeoffs in the entire preliminary design was not presented.
- The committee saw little verification, little comparison between codes and no validation of simulation codes against experiments. More validation would alleviate concern that the codes might be missing some physics. This is especially critical for four-dimensional ionization cooling, which is a key for success of a muon collider.
- It appears that there could be plasma effects arising through the beam matter interactions. We did not see estimates of the plasma effects (wake fields, inductive current ionization).
- The area wherein strong coupling between betatron and synchrotron oscillations could occur should be studied using a strawman lattice.
- The preliminary design of a collider lattice with a center-mass energy of 1.5 TeV presented here seems adequate for both single-particle dynamics and control of radiation damage. However, several collective effects should be studied. First, an extremely small momentum compaction factor (10^{-5}) combined with huge charge (10^{12}) in a single bunch might lead to a microwave instability, such as one driven by coherent synchrotron radiation. Second, a very small synchrotron tune might lead to a head-tail instability. Finally, to reach a beam-beam parameter of 0.09 without any radiation damping may not

be as easy as described in the proposal. A design of an interaction region for a center-mass energy of 3.0 TeV might be difficult due to the large aperture required for avoiding radiation damage.

Recommendations

1. Focus on the new issues in muon system, ionization cooling, huge beam loss, radiation damage, plasma creation, magnetic loss of accelerating gradient, and other intense beam effects.
2. Estimate intense beam, plasma, other collective effects, and if they are possibly important, establishes a simulation program for helping to understand them.
3. Defer a detailed muon collider design until the technical issues have been solved.
4. Validate the simulation codes using experimental results from MICE as early as possible, so that they can be confidently used in the design process.
5. Host a workshop to engage the accelerator community in solving these tough problems.

Accelerator Systems

Findings

The "Milestones & Deliverables" recorded in four tables of the MAP proposal are intended to be used to track the progress of the R&D. The proposal describes a plan spanning a six year "Phase I" period. If successful, Phase I could be followed by a "Phase II" that would include a number of technology demonstrators.

If the Muon Ionization Cooling Experiment (MICE) at the Rutherford Appleton Lab (RAL) in the United Kingdom is successful, it will demonstrate that 4D cooling is possible and performs as expected. This systems test is the first step towards a demonstration of 6D ionization cooling that the MAP team is contemplating for Phase II. MICE must be successful in order to proceed to 6D cooling. Therefore the significance of successfully completing and operating MICE cannot be overstated. The MAP collaboration stated that "We are fully committed to the success of MICE." However, the MICE experiment has experienced very significant (multi-year) delays, perhaps with more to come.

The most critical delays are connected with the fabrication and delivery of the Spectrometer Solenoid and Coupling Coil superconducting magnets. The contract for the Spectrometer Solenoids is held by LBNL who are responsible for its execution. LBNL had the magnets designed and built by a local vendor. A review of design modifications for these magnets will occur in October 2010 and it is expected that the first unit will be ready at the manufacturer no earlier than January 2011 with the second following around April 2011.

The coupling coils and cryomodules are being designed and built in collaboration with the Institute for Cryogenics and Superconducting Technology in Harbin, China. The first cold mass is scheduled to be tested in December 2010. Magnets 1, 2, and 3 are scheduled to be completed by Q3-2011, Q1-2012 and Q2-2012. The first magnet will be shipped to Fermilab and the remainder to RAL.

At Fermilab the first magnet will be used to immerse the existing 201 MHz RF cavity in a full solenoidal field. This will not happen until at least 2012. RF cavities for MICE will be tested later. The MAP collaboration plans to down-select between 201 MHz and 805 MHz cavities in 2012 before the MICE cavity is operational. This decision is needed to help choose a 6D cooling approach.

Comments

The value of a neutrino factory to the High Energy Physics program will depend on the value of the neutrino mixing angle, θ_{13}. Nonetheless, from a pure accelerator systems point of view, it is absolutely clear that the value of a neutrino factory as the first stage in a staged approach towards a muon collider cannot be overstated. The proposers should embrace this perspective, as far as

possible. Current resources should be spent on technology demonstrations needed to convince the community that a neutrino factory is feasible.

MICE is a high-profile international activity that is crucial for the advancement of the neutrino factory and muon collider plans. Successes with 4D ionization cooling in MICE in the middle of MAP Phase 1 would greatly boost the knowledge, morale and prestige of the collaboration and would pave the way towards plans for a 6D cooling demonstration. On the other hand, failure—or even just further extensive delays—could be disastrous for MAP. The MAP Program Director should have no higher priority than to honor its commitment

> *"to ensuring that the US contributions [MICE magnets] work as specified…"*

Beyond honoring inherited hardware commitments, the Program Director should also ensure that the collaboration joins enthusiastically with the rest of the MICE collaboration in data taking and analysis, to ensure the overall physics success of the experiment.

It is presently assumed that all problems in the MICE magnets are associated with insufficient cooling. Additional cryocoolers, or in the extreme case, a small liquid helium plant are presented as solutions. It's not a foregone conclusion that a large solenoid with 12 MJ stored energy (coupling solenoids) can be effectively cooled by indirect means. The success of MICE is vital to the program on a number of fronts.

Recommendations

1. Prepare a brief and direct MAP Mission Statement by December 1, 2010.
2. Prepare a list and a schedule of technical down-selections that will be made by the end of Phase 1 for presentation at the next review.
3. Articulate to DOE management a detailed plan to deliver on the commitment to MICE by November 30, 2010.

Magnets

Findings

The fast cooling of muons remain a primary challenge for the viability of a muon collider. Several scenarios have been conceived that appear capable of achieving the necessary cooling. They all require extreme performance from high-field superconducting solenoids, well beyond anything ever achieved.

There are many difficult magnet systems to be eventually developed: 20 T capture solenoid that has to operate in a high-radiation environment; many meters of high field solenoids (>20 T); 30–50 T solenoids for the 6-D cooling helical cooling channel (HCC) option; and ring and accelerator magnets with fields beyond what is being developed under the LARP program. There are additional significant radiation problems associated with these magnets.

The high-field magnet R&D proposed within MAP has three components: conductor R&D, coil technology development, and an insert winding with self-field of 20T in an 8 T background field by FY 13.

Coil technology for Bi-2212 is being developed by National High Magnetic Field Laboratory (NHMFL), Very High Field Superconducting Magnet Collaboration (VHFSMC), and others. Note however that the solenoids being developed by others are generally for applications such as NMR spectroscopy, where the winding lengths taper from longest on the outer layers to shortest on the inner layers. This is a significant issue, because for those magnets the high-field insert windings operate in a nearly axial field, and hence tape conductor can be used effectively and the windings experience ~purely radial forces.

Comments

- No high temperature superconducting (HTS) magnet has ever been built with stored energy as high as a muon collider will need. The proposed work will not break this barrier, nor will that at NHMFL or VHFSMC.
- The large-bore magnets for fast cooling have very high stored energy. This will require high-current cable conductor rather than wire or tape if the magnets are to operate safely.
- MAP faces a significant dilemma: the scale of expense and effort to actually build an HTS solenoid with the field and aperture needed for the fast cooling scenarios would be an effort beyond the scope of the proposed budget. On the other hand, the existing efforts at NHMFL and elsewhere are typically focused upon NMR-type winding geometries and cannot be expected to resolve the above challenges for MAP requirements.

- All the inserts that have been built are for vertical magnets. Converting to a working horizontal solenoid with other solenoids in close proximity that are exerting forces on the insert is not straight forward.
- The high radiation environment of many of the magnets will put further stress on the HTS inserts. Few insert coils have much operating margin and while the quench energy for HTS may be high, the specific heat of them at 4 K is no higher than any other material. Cooling issues may also be a challenge.
- The high radiation environment in the capture solenoid and the collider ring magnets, both storage ring and IR will require significant study. Since ring magnets are similar to those being developed under the LARP program, MAP can greatly benefit from their construction. Building ring magnets and capture solenoid models is beyond the scope of MAP, in its initial configuration, but MAP can focus on design issue related to their specific application.
- The capture solenoid problem can probably be solved by brute force: Make the superconducting outsert large enough that sufficient shielding can be placed inside. A HTS insert is probably not a viable option, because, while the mass can be reduced, the superconductor is in a higher radiation environment. This not the direction one normally wants to go. Large cable in conduit (CICC)-magnets have been built for detector magnets, so the intrinsic technology needs to be adapted for the specific MAP application. While large aperture resistive solenoids are significant power drains, they will likely give less trouble than replacing a failed superconducting one.
- The collider ring magnets are likely to be more difficult than anticipated because their development is at the tail end of requirements that LARP must address: They need to reach very high conductor fields, the fields must be accelerator-quality, and must work in a high radiation environment. While LARP is the appropriate avenue for study of the first two requirements, the last one is more than just keeping the deposited energy below the quench limit. Cooling and refrigeration power are two of the more obvious problems that will need to be addressed.
- The high-field solenoids specified in the fast muon cooling scenarios require high-performance superconductor, either YBCO or Bi-2212.
- YBCO tape has now been developed to reproducible performance in pre-reacted tape, high engineering current density, and excellent strain tolerance. Piece length is only ~50 m, and with the de-funding of its development for AC power it cannot be assumed that YBCO piece-length will improve in the foreseeable future.
- Bi-2212 round wire is commercially available in km piece-length. Issues remain for core leakage and action diffusion during heat treatment, temperature control during heat treatment of large coils, and strain sensitivity under Lorentz stress. Presently achieved current density for long wires is not adequate as a basis for the magnets required for fast cooling. Recent tests of model windings and development of large coils for 30 T NMR are driving steady improvement in wire performance. There is reason to expect ongoing

improvement in Bi-2212 wire performance because manufacturing is not capital-intensive.

- In contrast to the work on HTS inserts being done at NHFML, the solenoids needed for fast muon cooling require that the high-field inner windings extend essentially to the end of the magnet body so that the winding ends operate in a strongly divergent field. This produces large end forces and turning fields and is a big deal for HTS windings: YBCO current capacity is much less when there is significant field component perpendicular to the tape face. Although Bi-2212 performance is not orientation-dependent, wire fabricated by the powder in tube (PIT) method is not capable of supporting large Lorentz loading in the axial and radial directions.
- Given resource limitations, care should be taken to limit insert winding development to specific issues that are needed to inform the selection of cooling options. The program to develop 4-coil HCC segments is a good example. There, however, the proposed scope for the first 3 years is ambitious and resource-intensive. Attention should focus from the outset on the most challenging element– the HTS segment.
- The success of MAP will critically depend upon DOE's continuing support of high magnetic field development. In light of this and similar R&D from other funding sources MAP management should avoid duplicating work being done elsewhere.

Recommendations

1. MAP should focus on the aspects of its magnets that are unique to MAP and on demonstrating critical technical elements that can make or break the proposed muon collider.
2. Establish intermediate milestones that accomplish the most important or significant tasks pertinent to strategic down-selects.

RF Systems

Findings

RF is of central importance for the neutrino factory (NF) and in particular for the muon collider (MC); the highest gradients are required, primarily to minimize the muon decay losses. MAP presented a multipronged approach consisting of:

- An 805 MHz cavity with an all Be interior is planned, but the effects of Be on breakdown are not known—nose tests will be done first.
- An 805 MHz cavity made with an ALD coating will be evaluated but breakdown will remove the coating—SC cavity ALD results are probably not relevant—nose tests will be done first.
- The existing 201 MHz cavity will not be immersed in a full solenoidal field until at least 2012. Cavities for MICE will be tested later.
- The magnetic insulated cavity approach is only being evaluated indirectly with a waveguide cavity—also the effect of the lower shunt impedance and smaller packing fraction for such a cavity has not yet been evaluated.
- Early open cavity results were promising but the required power is higher, and it appears the window damage is higher.
- The existing high pressure cavity will be tested with beam to study RF loading effects of ionization electrons. The practicality of having a large high pressure hydrogen gas-filled chamber with multiple RF feeds has not been evaluated.

There has not been a systematic study of the impact on machine performance of operating at a lower-than-design gradient for the various cavity systems. Additionally, there has not been any serious study of the cost tradeoffs of the various approaches to high gradient. The group plans to down select a cavity approach in 2012 before the MICE cavity operation, in order to help choose a 6D cooling approach.

RF systems for muon acceleration are more conventional, but the large voltages in the Rapid Cycling Synchrotron lead to unconventionally large synchrotron tunes (ν= 1…2!)

Comments

- The past 805 MHz results are suspect due to what appears to be coupler pulse-heating related damage—fortunately, the cavity has been refurbished and will be tested again soon.
- Pressurized gas filled cavities may give distinct advantages for the performance of ionization cooling.

- The full impact of "beam loading" by ionization is a serious concern for absorber filled cavities and needs continued study.

- The cavity findings have been based on very limited statistics – there are many ways of degrading cavity performance, so one should be wary of generalizing the results from any one test. More and better data are required to understand the dependence of E_{max} on B. Too few relevant test data do not allow conclusion or down selection.

- Relevant R&D on high gradients and the physics of breakdown has been done by the normal conducting Linear Collider community (CLIC & US High Gradient Collaboration) – there is a reservoir of knowledge in these areas in other R&D programs and collaboration/co-ordination is strongly encouraged to assure that R&D effort is not unnecessarily repeated (ALD, different materials, surface preparation methods, tricks of the trade …).

- There was no table giving an overview of all of the RF systems required for the muon collider. The reason given to the committee was that this required the down selection first. The committee believes on the other hand that such an overview should be tried for every single scenario – it may add an element necessary for the down selection process.

- The RF systems of the MC cooling channels are in a very early stage; some initial technical design/costing is necessary to imagine possible implementations at least conceptually.

- The down-selections of the RF systems cannot be done independently of the other efforts.

- Having beryllium windows between the cavities will suppress the continued acceleration of dark current, but may generate a large, low energy, electron current due to the cascading of showering electrons.

- Beryllium has its issues; due to its toxicity, its handling and manufacturing, but maybe also cavity failure modes, raise safety concerns.

- Even though the RF systems for muon acceleration are conceptually conventional, the numbers involved for both the overall voltages and the bunch charge are frightening. To accelerate to 400 GeV in 24 turns requires an installed RF voltage of well above 16 GV (depending on the synchrotron phase angle), which will require long straight sections. The bunch charge of 2E12 is equally very large. The extremely large synchrotron tune was already mentioned.

While the R&D is aimed at demonstrating a viable approach is multipronged, it is fraught with many uncertainties.

Recommendations

1. Focus on key issues: 1) High gradient in the presence of *B*, 2) absorber filled cavities and their issues (pressure, "beam loading"), 3) large synchrotron tune RCS.
2. Rough cost-benefit studies of the various rf cavity approaches should be used in order to prioritize the test program for the next few years. In particular, revisit the use of open cavities and the associated cost.
3. Do more tests of the existing 201 MHz cavity and build more of the 805 MHz cavities to improve statistics.
4. Delay the cavity down select for at least another year – **tie it to test milestones, not calendar dates.**
5. Engage other communities working on RF breakdown such as CLIC or the US High Gradient Collaboration, to minimize duplication of effort.

Management

Findings

The former MCTF and NFMCC organizations have been combined to create an interim MAP organization. The interim organization is in place and functioning.

A clear reporting line to the Fermilab director and to DOE is in place.

A permanent MAP program director has not yet been appointed.

Interim Management has successfully developed the project plan that was evaluated by the review committee.

The team presented a process for making technology down-selects in a structured way.

It is clear that MAP is very dependent on small fractions of staff effort: while there are 214 participants in MAP, this only contributes 31 FTE, from 14 institutions.

The MAP proposal is to carry a directed R&D program with clear deliverables.

Comments

- A directed R&D program with clear deliverables like MAP has more in common with construction project than a scientific collaboration. The MAP program director should evolve the team away from the consensual, collaboration-style mode in which they have been working towards more of a focused approach with concrete deliverables, while making sure not to alienate the participants and maintaining their innovative spirit. As an example, when a scientific collaboration moves from carrying out R&D to delivering an approved detector construction project it must go through a similar transition, and there are many examples where this has been carried out successfully.

- Even though MAP is a directed R&D program and includes a lot of simulation work, full use should be made of project management and project control tools. Appropriate milestones and contingency are necessary. What was shown at the review did not seem very detailed in this regard.

- The ability of management to focus effort on the highest priorities is a key attribute of a successful directed R&D program. It was not clear to what extent this is actually true of MAP, and this is a potential problem.

- The MAP Program Director should ensure that technology down-selects are made as soon as possible, to allow resources to be focused.

- Ideally, in any successful directed R&D program the internal management structure should reflect the program deliverables and milestones.

- The current (interim) organization is very much a superposition of the previous organizations. There is not much evidence yet of re-organization or that the sum-is-greater-than-the-parts from combining NFMCC and MCTF. A further evolution of the management structure would better serve a national program, supporting the potential construction of a US NF or MC at Fermilab.

- The MAP organization combines the attributes of a scientific collaboration (like the Institutional Board described by Don Hartill) and a project. This means the management has lots of boards and committees whose distinct roles aren't immediately apparent and which potentially waste the already limited time and effort of the participants. (There are also parallel overlapping structures for the MICE experiment and the Neutrino Factory – International Design Study).

- International inputs and advice have in the past come through international members on MUTAC. The MAP PM should take steps to improve the international connections of/into the program as it becomes more project-like. This may mean reviewing the membership of MUTAC and/or considering whether MUTAC is the best way to deliver these connections.

- The effort is not very focused, and the program is spreading itself very thin - lots of activities have their own advocates and sometimes even their own independent funding (SBIR, NSF grants…). There is a need for more people working on MAP at the 100% level; ten people at 10% effort do not contribute as much as one person at 100%. Being able to call on national lab effort is essential, but does mean that the program can be at the mercy of internal lab priorities.

- The very large number of technical challenges has resulted in an effort to address all of them equally. The MAP Program Director should ensure that the program plan focuses effort on the highest priorities. Solving the current MICE magnet problems and demonstrating muon cooling in MICE should be the highest short term priority for MAP.

Recommendations

1. The Fermilab Director should appoint and fully empower a MAP Program Director who is able to move resources as needed within the program and who can concentrate effort on the highest priorities. This person would ideally be a highly respected scientist of international stature and should be able to attract and inspire additional effort to join the program, acting not just as a program director but in some sense as an evangelist for it. The committee believes that it is necessary to look outside the current management of the program for such a director.

2. The program's oversight group should ensure that MAP is adequately resourced with staff of the appropriate skills to deliver the program, and that MAP receives sufficient priority within the various national laboratories.

3. The MAP Program Director should take steps to streamline and reduce the various advisory and oversight bodies inherited from NFMCC and MCTF, and to ensure that the appropriate international connections are in place.

4. A revised R&D plan addressing the technical issues highlighted in the review closeout must be submitted by December 30, 2010.

Answers to the Charge Questions

Does the proposal devote appropriate effort to demonstrating that the most critical technical issues to building a muon collider or neutrino factory can be solved?

The proposal describes a thoughtful and detailed plan that evolved from previous activities under NFMCC & MCTF. The proposal matches the resources that could made available, in the context of an international program. However, the proposed activities are spread too thinly over too many topics. Consistent with the overarching need

> "*…to* ***permit an informed choice*** *when the lepton collider energy is established." By "****demonstrating****…****the most critical technical issues*** *to building a muon collider or neutrino factory can be solved*"

the priority of performing and planning for technology demonstrations should be raised, and the priority of performing detailed design tasks should be lowered.

Are there clear milestones that can be used to track progress of the R&D?

There are "milestones and deliverables" in 4 tables in the proposal, but they are not clearly linked to each other, nor to decision trees. Successful technical demonstration of 4D ionization cooling in MICE is nowhere included as a milestone or deliverable. RF technology down-selects are not fully coordinated with the MICE schedule. More clarity is required, with linkages between tasks. Even though planning for MAP Phase 2 is premature, nonetheless a tentative list of potential demonstrators that could be considered for implementation in MAP Phase 2 should be generated.

Is there a management structure in place capable of evaluating progress, setting priorities, and making changes in response to unexpected results and new discoveries?

Such a structure is only loosely in place within MAP, with many overlaps inherited from merging NFMCC & MCTF. There is also a complicated and loose structure within MICE, with MAP being only one actor.

Appendix A

Appendix B

DRAFT MAP DOE-OHEP REVIEW AGENDA – V11b

TUESDAY 24 August

Executive Session (8:30-9:00)

Session 1: Introduction and Physics Case (9:00-10:25)

09:00-09:10	Importance to Fermilab	Oddone	10
09:10-09:20	MCOG Perspective	Vigdor	5+5
09:20-09:55	MAP Introduction and Overview	Geer	25+10
09:55-10:25	Physics motivation (NF and MC)	Eichten	20+10
10:25-10:45	Coffee		

Session 2: Overviews: past, present & future (10:45-12:45)

10:45-11:25	Design & Simulations: Overview & Resources	Fernow	30+10
11:25-12:05	Technology Development: Overview & Resources	Bross	30+10
12:05-12:45	Systems tests: Overview & Resources	Kaplan	30+10
12:45-13:45	Lunch (+ Exec. Session if needed)		
13:45-14:15	Management Plan	Zisman	20+10

Session 3a: Design & Simulations (14:25-15:35)

For each of the following cover what needs to get done, why it needs to get done, and what is the plan to do it (timeline, milestones, down-selection strategy), and why we think the plan will succeed:

14:25-15:00	Front-End (target, decay channel, bunching, phase rotation, initial cooling)	Kirk	25+10
15:00-15:35	6D cooling	Roberts	25+10

Session 3b: Systems Tests (14:25-15:35)

For each of the following cover what needs to get done, why it needs to get done, and what is the plan to do it (timeline, milestones, down-selection strategy), and why we think the plan will succeed:

14:25-15:05	MICE Overview, Status and Facility	Coney	30+10
15:05-15:35	MICE magnets	Virostek	20+10
15:35-15:55	Coffee		

Session 4a: Design & Simulations (15:55-17:30)

15:55-16:20	Final cooling	Palmer	20+5
16:20-16:40	Proton source (interface with Pr. X) & site layout	Gollwitzer	15+5
16:40-17:00	Acceleration	Berg	15+5
17:00-17:30	Rings	Alexahin	25+5

Session 4b: Systems Tests (15:55-17:20)

15:55-16:15	6D Cooling with MICE	Snopok	10+5
16:15-16:45	MERIT & Target Plans	McDonald	25+10
16:45-17:20	6D Cooling Section Bench Test & 6D Experiment Planning	Shiltsev	25+10

Executive Session (17:30-18:30)

DRAFT

WEDNESDAY 25 August
Executive Session (8:30-9:00)

Session 5a: RF (9:00-10:40)

For each of the following cover what needs to get done, why it needs to get done, and what is the plan to do it (timeline, milestones, down-selection strategy), and why we think the plan will succeed:

09:00-09:55	RF Strategy & MTA	Bross	45+10
09:55-10:40	NCRF R&D Plan	Li	35+10

Session 5b: Magnets (9:00-10:40)

For each of the following cover what needs to get done, why it needs to get done, and what is the plan to do it (timeline, milestones, down-selection strategy), and why we think the plan will succeed:

09:00-09:55	Magnet Strategy	Lamm	45+10
09:55-10:40	VHFSMC High Field R&D Status & Relationship with MAP	Larbalestier	35+10
10:40-11:00	Coffee		

Session 6a: RF (11:00-12:00)

11:00-11:20	HPRF R&D	Yonehara	15+10
11:20-12:00	SCRF	Hartill (or designee)	25+10

Session 6b: Magnets (11:00-12:00)

11:00-12:00	Magnet R&D (HCC, HTS, Collider Ring & SBIR R&D)	Tompkins	45+15
12:00-13:00	Lunch		

Session 7: Partnerships (13:00-14:30)

13:00-13:40	International partnerships in muon accelerator R&D	Blondel	30+10
13:40-14:10	MAP Participation	Hartill	20+10
14:10-14:30	Tour Logistics	Torun	10

14:30-15:30 MTA TOUR

15:30-16:00 Coffee

Session 8: Wrap-up (16:00-16:30)

16:00-16:30	Final Remarks	Zisman	30

Executive Session (16:30-18:30)

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THURSDAY 26 August

Executive Session / Responses: (8:30-11:00)

Responses to questions (if needed)
and Executive Session

CLOSE-OUT (11:00-12:00)

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