Final Remarks

Michael S. Zisman
Center for Beam Physics
Accelerator & Fusion Research Division
Lawrence Berkeley National Laboratory

Muon Accelerator Program Review-Fermilab
August 25, 2010

Outline

- Introduction
- Responses to selected review topics
- Charge topics
  - Scientific and technical merit
  - Appropriateness of approach
  - Competency of personnel and resources
  - Reasonableness of budget
  - Critical technical issues
  - Milestones
  - Management structure
- Summary

Introduction

- In past two days the MAP R&D plan has been presented
  - design and simulation
  - technology development
  - system tests
- Natural and seamless extension of predecessor programs
  - NFMCC + MCTF
- Development of intense muon beam facilities offers potential of unique and powerful scientific program, in line with P5 recommendations

Review Comments (1)

- "Go/No-Go" risk list
  - 6D cooling
- Performance risk list
  - proton driver intensity
  - final cooling
  - final focus (detector backgrounds)

Review Comments (2)

- Total power consumption
  - estimated (Study 2) for NF at ~50-60 MW (at 15 Hz)
  - no detailed estimate for MC yet, as design incomplete
    - range expected to be ~120-200 MW
      - design choices (especially *E*) will affect this
      - advantage of MC over other lepton colliders
- Muon polarization
  - "if we had it, theorists would find clever ways to use it; if not theorists will find clever ways around it"
    - E. Eichten, this review

Review Comments (3)

- MICE magnets
  - recognized as critical and getting attention
    - plans being formulated and resources to carry them out have been identified
- Pre-installation test of MICE RF
  - such a test anticipated, either at MTA or RAL
    - FY10 supplemental funds will permit test vacuum vessel
      - can also test LN-temperature operation

Review Comments (4)

- Magnet program
  - involves participants (and expertise) from many institutions
    - BNL, LBNL, Fermilab, U.-Miss.
    - leveraged by
      - funded SBIR projects
      - work of core programs and LARP

Review Comments (5)

- HTS contributions
  - MAP becoming involved in broad effort to develop and explore HTS technology
    - VHFSMC, NHMFL, SBIR companies
  - MAP is both a contributor and a customer
    - as contributor, we take responsibility for specific aspects of the development program
    - as customer, we provide a concrete focus and incentive for sustained development effort
    - it is important for MAP to play both these roles

Review Comments (6)

- Organizational structure
  - based on discussions with FNAL director and DOE
    - balance between R&D task and oversight will likely be discussed further
  - structures within MAP are believed to be helpful to Program Director
    - “collaboration” aspects have proven in the past to benefit our efficiency and ability to get buy-in on priority and technical decisions

Scientific and Technical Merit

- Design & Simulations will:
  - deliver first end-to-end MC design (and cost range)
  - participate in NF RDR (under IDS-NF auspices)
- Technology Development will:
  - develop high-gradient RF cavities
    - better understanding of NCRF breakdown phenomena
    - more effective methods for SRF fabrication
  - push limits of magnet technology
    - high field solenoids with HTS, open mid-plane dipoles
- Systems Tests will:
  - demonstrate 4D (and maybe 6D) cooling in MICE
  - define and prepare for 6D cooling test (if needed)

Appropriateness of Approach (1)

- Design & Simulations
  - continuing development of required simulation tools (ICOOL, G4beamline)
    - testing against each other and experimental results
  - developing cost-effective acceleration schemes
    - dog-bone RLAs; non-scaling FFAGs
  - developing plausible 4D and 6D muon cooling channels
  - contributing to high-power proton driver design

Appropriateness of Approach (2)

- Technology Development
  - developing promising approaches for high-gradient NCRF cavities
    - Be windows; magnetic insulation, ALD, HPRF,...
    - created MTA as dedicated test facility
  - exploring cost-effective fabrication methods for low-frequency SRF (~201 MHz) [NSF contribution]
  - exploring limits of HTS magnet technology
  - continuing development of free Hg-jet target facility
- Systems Tests
  - participating in MICE [includes NSF contribution]
  - iterating with D&S and TD ⇒ bench test

Competency of Personnel & Resources

- Core group of NFMCC and MCTF scientists and engineers involved since 1996
  - augmented by experienced design and operations effort from Tevatron, B factory, and RHIC
  - significant accomplishments already
    - MERIT, NF design studies,…
- Broad participation
  - labs, universities, SBIR companies
    - brings particle physicists into the accelerator game
- MAP provides excellent opportunity for training
  - hands on participation; guidance from senior physicists and engineers

Reasonableness of Budget

- Effort needs and corresponding budgets based on experience in similar tasks
  - SWF dominates the funding request
    - Feasibility Studies 1, 2, 2a serve as good models
    - effort needed for major hardware tasks well calibrated
- M&S needs based on scaling from ongoing FY10 development activities
  - milestones, and procedures for choosing, in place
    - need discipline to avoid following too many parallel paths for too long (built into our plan)
- Inevitable adjustments to R&D plan will be accommodated within MAP budget envelope

Critical Technical Issues

- Identified several critical issues
  - Design & Simulation
    - designing and simulating *all* portions of MC facility
      - need complete description to permit end-to-end simulations
    - RF breakdown simulations
  - Technology Development
    - producing high-gradient NCRF in strong magnetic field
    - producing very high field solenoids for final cooling
      - within reason, neither of these represents a potentially fatal flaw
        - partial mitigation should be possible as limits understood
  - System Tests
    - timely and successful completion of MICE
      - delays we face not intrinsically related to MICE or MC design
        - mainly thermal issues due to the choice in cooling

Milestones

- Milestones identified down to Level 2
  - these will enable MAP to deliver on its primary goals
    - MC-DFS; NF-RDR; MICE; 6D bench test
  - "down-selection" explicitly called out
    - Project Director will ensure that this happens
    - will define criteria well in advance
- Milestones will be monitored and updated as appropriate depending on outcome of initial R&D
  - we cannot predict in advance all R&D results
    - must (and will) stay "light on our feet"

Management Structure

- MAP management structure in place and functioning
  - Program Director has authority to make decisions on technical directions and budget allocations
    - mechanisms for obtaining advice on both are in place
      - Technical Board; Institutional Board
  - roles for all high-level functions defined in Management Plan
- Strong oversight roles defined
  - Fermilab Director; MCOG+MUTAC; PMG; DOE PM; DOE program reviews

Timing

- International decisions on what the next big project(s) will be are expected in a 2014 time frame
  - if the MC is to have a “seat at the table” the proposed R&D effort is urgent
    - at the nominal funding level, we must stay very focused to be ready in time
      - augmented funding and more community involvement would therefore be of great benefit

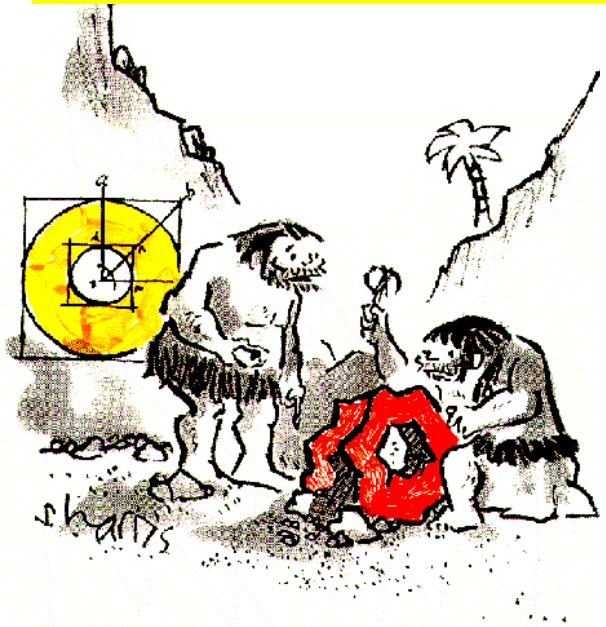
Summary

- MAP explores a possible scientific future for Fermilab and U.S. particle physics
  - innovative and cost-effective lepton collider
    - would bring energy frontier back to U.S.
- MAP participants well-motivated to succeed
  - accelerator and particle physicists working together toward common goal
    - support from DOE, NSF and Fermilab management
      - these are strengths of our program
- Benefits of a Muon Collider facility easily justify the proposed MAP plan as the appropriate next step to assess its feasibility and cost

Final Thought

- Challenges of a muon accelerator complex go well beyond those of standard beams
  - developing solutions requires substantial R&D effort to specify
    - expected performance, technical feasibility/risk, cost (matters!)

Critical to do experiments and build components. Paper studies are not enough!



"I guess there'll always be a gap between science and technology."