Muon Collaboration

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Neutrino Factory and Muon Collider Collaboration
FY05 Supplemental Funding Request

DOE budget guidance for FY05 indicates a budget for the MC of only $1.4M. At this reduced funding level, it will be impossible to complete some of the critical hardware development intended for this year. This request for supplemental funds, prepared in consultation with MC Co-spokespersons Stephen Geer and Robert Palmer, outlines the key areas where additional funds would permit us to make more rapid technical progress during FY05. The total request for supplemental funds is $1025K; *the ordering of the items listed reflects our view of their importance to the MC R&D program*. In all cases, partial funding would still advance the program. Thus, in the event that we do not get the entire amount requested, we would plan to use the funds to optimize the R&D program based on the budget available. We note that MUTAC and MCOG have both strongly endorsed our R&D program directions, verified that we are using our funds efficiently, and indicated to DOE that we are sorely in need of additional funding to make progress in a timely way.

1) *Targetry Magnet Cryogenics System* ($525K)

Validating the target design for a Neutrino Factory requires that we perform beam tests—at realistic intensities and with realistic target parameters—in a high-field solenoid. In the absence of beam time in the A3 line at BNL, we have proposed an international Targetry experiment to be carried out at CERN, most likely during 2007. During FY04, fabrication of a pulsed magnet capable of operating at field levels between 5 and 15 T was nearly completed. In order to test the magnet, two things are needed—a 4.5 MW power supply and a cryogenics system that will permit magnet operation at about 70 K. We anticipate having sufficient MC funds to purchase the power supply in FY05, but would require supplemental funding in order to fabricate the cryogenics system. With supplemental funding, the magnet, along with its power supply and cryogenics system, would be available for initial testing in less than two years[1]; without incremental funds, we anticipate a 1–2 year delay in operating the magnet. This would seriously delay, and potentially jeopardize, the proposed CERN Targetry experiment.

2) *Coupling Coil Design and Construction* ($400K)

To fully test the recently fabricated 201-MHz RF cavity in the MUCOOL Test area, a large solenoid ("coupling coil") surrounding the cavity is needed. These funds would permit developing a full engineering design for the coil and ordering

[1]MC funding at about the $500K level will still be needed in FY06 and FY07 to install the magnet and its ancillary mercury-jet target system at CERN, in preparation for the Targetry beam experiment at the SPS.

the requisite superconducting cable. We anticipate that magnet fabrication could then be completed in FY06, permitting us to begin to address what is likely to be the most critical issue for a Neutrino Factory—behavior of a high-gradient 201-MHz RF cavity in a strong solenoidal field. We have already demonstrated in tests at 805 MHz that the influence of a superimposed solenoidal field on an RF cavity drastically changes the cavity behavior, lowering the achievable gradient by roughly a factor of two. Lack of supplemental funds will delay the beginning of coupling coil fabrication by at least one year, making it impossible to proceed in a timely way with RF testing in the presence of a realistic cooling channel magnetic field configuration. Such a delay may also lead to some slowdown in preparations for the Muon Ionization Cooling Experiment (MICE).

3) *Tests of RF Surface Modification Techniques* ($100K)

A critical issue for any muon cooling system is the performance of the RF cavities. Failure to understand, and learn to mitigate, the performance limitations of RF cavities in a strong magnetic field could compromise the success of the muon cooling program. A program for such studies will be getting under way this year in the MUCOOL Test Area at Fermilab. Based on our current understanding, development of high-gradient RF cavities for muon cooling is constrained by two effects:

1. newly discovered limits on the gradient associated with high magnetic fields
2. field emission, which appears to be a precursor to voltage breakdown in the cavity[2]

In addition to the planned "button" tests at 805 MHz, we intend to demonstrate experimentally that *in-situ* coatings can help with both effects. Both electrical and mechanical issues are important. To study these, we have developed a bench-top experimental program that can systematically and quickly evaporate metals and alloys onto substrates, and then measure the field emission and bonding at the atomic level. The program will examine a variety of substrates and cleaning techniques. We have access to a field-ion microscope and some existing hardware that can be used for this R&D, but we need additional support for assembly and operation of the complete system along with an experienced materials science post-doc to carry out and analyze the measurement program. Due to limited Muon Collaboration funds, this effort cannot be launched this year without supplemental funds. Insofar as the techniques we develop could be used to good advantage in MICE, it is very valuable to carry out the study as soon as possible. We could avoid a year's delay if supplemental funding is forthcoming in FY05.

[2]Reducing field emission should reduce the $\boldsymbol{j} \times \boldsymbol{B}$ forces within emitters that we believe give rise to breakdown events.