

July 1, 2008

To: Dennis Kovar, Department of Energy/Division of High Energy Physics

From: Piermaria Oddone, Director, Fermilab, and on behalf of,
Sam Aronson, Director, Brookhaven National Laboratory, and
Steven Chu, Director, Lawrence Berkeley National Laboratory

SUBJECT: REPORT OF THE MUON COLLABORATION TECHNICAL ADVISORY COMMITTEE 2008 MEETING AND
COMMENTS/RECOMMENDATIONS OF THE MUON COLLIDER OVERSIGHT GROUP.

Attached please find the report from the meeting of the Muon Collaboration Technical Advisory Committee (MUTAC), held at Lawrence Berkeley National Laboratory on April 8-10, 2008. The MUTAC report is based on presentations, and accompanying discussion, of the R&D programs and plans of the Neutrino Factory and Muon Collider Collaboration (NFMCC) and the Muon Collider Task Force (MCTF). The report has been reviewed by the Muon Collider Oversight Group (MCOG) who have provided the following commentary on the report and their specific recommendations:

In 2005 the NFMCC prepared a 5-year plan based on the then-current view of realistic funding levels (which were considerably below prior expectations). The plan was reviewed, accepted and endorsed by MUTAC and MCOG at the 2005 meeting. Since then this plan has provided the basis of the NFMCC program and accompanying MUTAC reviews.

A new element within the national program was the establishment, by Fermilab, of a Muon Collider Task Force in late 2006. This group is supported by Fermilab for the specific purpose of developing design concepts and technologies directly applicable to a Muon Collider operating at energies above 1 TeV. The MCTF is an integral part of Fermilab's long term energy frontier strategy and, while formally independent of the NFMCC, overlaps in goals and in participants. Activities of the MCTF are reviewed as part of the MUTAC meeting and fostering a constructive integration of NFMCC and MCTF is a goal of MCOG. Following last year's MCOG request, the two organizations have established a Steering Group consisting of the NFMCC and MCTF leadership. It is the judgment of MUTAC and MCOG that the Steering Group is being effective in its efforts to move the two efforts forward in an efficient and coordinated manner.

The MCOG views the NFMCC as operating effectively under the leadership of its two spokespersons and the R&D Project Manager. All parties recognize that the NFMCC continues to pursue a forefront R&D program under very constraining fiscal conditions. The NFMCC effort remains aligned with the 5 year plan and has made substantial progress towards primary goals: 1) development and testing of hardware required for ionization

cooling (MuCool), accompanied by significant participation in the effort to mount the international Muon Ionization Cooling Experiment (MICE); 2) execution of the targetry experiment (MERIT) at CERN; and 3) continuing development of design concepts for a Neutrino Factory and a Muon Collider guided by simulations and cost optimization models. This effort has been expanded by the inclusion of MCTF activities focusing on: 4) pursuit of cooling hardware and system designs of the 6-D cooling that will be required for a Muon Collider; and 5) simulations support for cooling system configurations and Muon Collider accelerator systems conceptual designs. MUTAC and MCOG endorse the high priority assigned to the first two goals over the short term. We note that the MICE experiment, which will provide the critical ionization cooling measurements, is now being prepared at the Rutherford Appleton Lab (RAL). The U.S. is playing a leading role in this effort both intellectually and in terms of component development, but is in danger of not delivering on commitments in a timely manner.

The MUTAC has judged these activities as well focused on the critical R&D areas for determining and demonstrating feasibility of muon storage ring based facilities. Significant progress has been made in the last year with the successful completion of the MERIT at CERN, and in operations at the MuCool Test Area (MTA) at Fermilab. MICE is making good progress, with a major ongoing concern relating to the fabrication of the coupling coils addressed through the incorporation of ICST-Harbin (China) into NFMCC. However the completion of the first coupling coil (required to verify performance of the 201 MHz cavity at MTA) remains on the critical path. MCTF has made substantial progress in developing design concepts for 6-D cooling that appear to provide the requisite performance for a Muon Collider. These concepts require solenoids with fields beyond current state of the art.

As we come to the end of the 5-year period it is clear that the time is right to start thinking beyond the 2005-2009 period. The year 2012 is identified as a critical time for decisions on future facilities, representing the confluence of a number of anticipated events: interpretation of initial physics results from the LHC, the completion of a more detailed design of ILC and a conceptual design for CLIC, and the next indications of the magnitude of the neutrino mixing parameter $\sin^2 2\theta_{13}$. The collaborations have proposed two high level goals for 2012, namely the completion of a Neutrino Factory Reference Design Report (developed by the international community and known as the International Design Study), and a Muon Collider feasibility study. While these goals appear well motivated to both the MUTAC and MCOG, we note that achievement will require a higher level of resources than currently available.

The current DOE funding level for the NFMCC and MCTF are approximately \$3.8M and \$4.1M respectively. The NFMCC funding level has been stable to $\pm 10\%$ over the last several years, while the MCTF level represents new effort. In addition significant funding is being received from the NSF, including ongoing support of \$0.13M/year and an MRI grant of \$0.8M in FY08 to support the MICE coupling coil.

In summary, the MCOG accepts and endorses the MUTAC Report attached here and offers the following specific recommendations:

1. MCOG recommends that the highest priority effort is to deliver assigned components to the MICE program and to support associated developments within the MuCool

program: this is the most ambitious program for demonstrating a practical implementation of muon cooling in a full experimental context.

2. MCOG strongly urges the creation of a new 5 year plan, integrating NFMCC and MCTF activities, with a goal to completing a Neutrino Factory Reference Design Report and Muon Collider feasibility study in the 2012 time frame. Such a plan should identify the next round of experimentation and technology demonstrations required to support these goals. It is recognized that such a plan will require an increase in resources over current levels.
3. MCOG recommends that NFMCC and MCTF proceed as parallel, but coordinated, efforts for the immediate future, but that the two organizations start exploring options for establishment of an integrated organization once the activities start acquiring the characteristics of a more formalized project.

In our judgment, the MUTAC did an excellent job of responding to the difficult charge they were provided. We believe that their report, and the MCOG response, represent very helpful advice in setting the future directions of muon based facilities. We would suggest that a joint meeting involving the NFMCC, MCTF, MCOG, and the DOE/HEP Division in the near future could be helpful in resolving issues relating to the future evolution of the muon program. We note that the NFMCC and MCTF efforts are developing concepts for one of the very few elementary particle physics accelerator ideas on the horizon, and R&D in support of a complete design in the foreseeable future will take a consistent effort.

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