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Beams Division
Muon Collider

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Proposal to the Muon Collider Collaboration for Financial Support of Neutrino Source Study based on the Fermi Lab site

Introduction

During the first six month of the FY 00 the Muon Collider working group at Fermi Lab was asked by the directorate to prepare a feasibility study for a Neutrino source based on a muon storage ring. Together with the parallel effort going on within the collaboration and with site specific studies at CERN and maybe Brookhaven this would give a valuable overview of different scenarios. The work being done in the collaboration forms the basis for the study. Deviations from the collaboration effort would only be implemented if necessary, for example because of special geological circumstances, or if useful because certain technologies are available. Therefore most of the subsystems being investigated are of interest for the collaboration as well as for the colleagues at CERN. While the collaboration has a longer perspective for the application of high intensity muon sources, the working group at Fermi Lab as well as at CERN has a specific mandate to perform such a study and deliver a report by march 1st, 2000. This very aggressive schedule has forced us to go ahead with the definition of a set of parameters which will be the basis of the study of the muon storage ring complex. The choice is preliminary and will be redefined (or reinforced) by the time the physics study, driven by S. Geer and H. Schellmann, will have produced their report on what the first Neutrino source should provide. It forced us also to establish contacts with experts in certain fields, which we considered necessary in order to fulfill our task over the given time scale. This attempt to integrate other laboratories to in order to find solutions for specific subsystems has been very successful so far. For a comparatively short period of time these laboratories can identify their specific task and will help, without making any further commitment. On the other hand, once being involved, the natural attraction to the Neutrino Source and Muon Collider program is much higher.

Many (not all) of these laboratories will need financial support for at least part of their work (e.g. Russian institutes). Most of the other laboratories are willing to spent at least 50% of the costs from their own funds. Nevertheless it will be necessary to

contribute a certain amount of money to these institutes from either Fermi Lab or the collaboration. While the muon collider group at Fermi Lab is driving this study, the results will be of general interest and therefore it is natural to propose to the collaboration, that the studies which are not site specific receive some support. The money will be used to fund mainly people (or infrastructure) in order to establish technical feasibility. The required R&D program and schedules are other main topics. Following the advise from the first MUTAC report, all this is very valuable input for our future program.

The Different Programs

A number of contacts to different laboratories have been established and in most of the cases the scope of the work has been defined already.

The Target Station

The Fermi Lab study will be based on a 16 GeV (or lower) 1 MW proton driver, plus the assumption that for the proposed muon intensity a solid graphite target will work. Questions which remain to be answered concern the feasibility of a 20 T solenoid tapered down to 1.25 T over 4 meters, the facility surrounding the target and the extraction of the proton beam through the solenoid.

For the solenoid we have been in contact with the National High Magnetic Field Laboratory (John Miller). The proposal is to involve this lab in the solenoid design for the target station. Different from the target experiment a DC solenoid (most probably super-conducting) will have to be designed. Radiation and power deposition in the super conducting coil have to be controlled. The work will be done in collaboration with FERMI, the Target Experiment group as a subset of the Neutrino Source/Muon Collider Collaboration, and people from Oak Ridge National Laboratory. We propose to fund John Miller with at least k$ 25 (may be k$ 50) over the next fiscal year.

For the target station and all the supporting systems, like cooling, remote handling, shielding, civil construction etc, people from the Oak Ridge National Laboratory have been approached. The primary contact is Tony Gabriel, who took part in many Muon Collider and Target workshops. Oak Ridge has a unique expertise because of the ongoing design work for the 2 MW target station for the Neutron Spallation source. We propose to fund Tony Gabriel with k$ 100 (including G&A). We have a proposal from him showing his funding and indicating that he will contribute with more than that from his own funds because of his specific long term interest in this program.

Solenoid Channels

Most recently Fermi Lab asked the Inst. of High Energy Physics in Protvino to develop and build a high field super-conducting solenoid for the Beam-Beam compensation experiment at Fermi Lab. We are convinced that the required expertise to optimize, develop and (preliminary) engineer long solenoidal channels is available there. These channels are required in the decay, the drift, the induction linac and the cooling. Given the parameters for the Neutrino Source, all these channels are large aperture but not very high field which makes a conventional approach more feasible. In addition, we know that the schedule will fit the available man power and that for a given amount of money we will receive a large amount of engineering support. It also will give us a different perspective optimizing stored energy (B^2r^2) and acceptance (Br^2). The required funding is approximately k$ 75 An offer from IHEP is not available as of now, but at this moment it has been considered reasonable. Deviations will have to be adjusted later on.

The Induction Linac

The induction linac is one of the most crucial components in the present design of the neutrino source. The total acceleration which has to be provided by such an induction linac is of the order of 200-300 MV, which is clearly beyond anything being build so far. The enormous aperture as well as the required focussing field inside are additional complications. Nevertheless, we have been convinced that such a device is a feasible, although expensive, approach to perform the type of phase rotation required here. Preliminary contacts have been established with the help of Andy Sessler at LBNL. Simon Yu , who has worked in this field for many years, is the primary contact so far and would be willing to lead the effort of doing the study at LBNL. The proposal is to conceptually design a 200 (± 100) MeV induction linac, which later on can be scaled to higher or lower energy depending on the scenario finally picked for the phase rotation. We propose to fund this study with k$ 100. A final offer does not exist as of now, but is under preparation.

The Acceleration

Accelerating the Muons from 200 MeV to 50 GeV, which is the proposed energy of the muon storage ring, will require low frequency high gradient super conducting cavities. Recirculating linacs can make much better use of this very expensive equipment by increasing the number of passes through each cavity and therefore decreasing

the total length of the rf installation. The real expertise in this field is at Jefferson Laboratory where a 5 turn recirculating electron machine has been built. We approached the people at Jefferson Lab for the reason, that the experts in beam dynamics for beam separations in the arcs are available and sufficient knowledge about super conducting rf is around. The goal is the have them supply a preliminary design for the recirculating linacs and have an optimized layout which balances the cost of the arcs with the cost of the required rf. Jefferson Lab so far has promised to support the study on a comparatively small basis and has not asked for any support. Ohowever, we consider this to come up and believe that the required funding will be of the order of 50 k$.

Proposal for Funding

Institute	*Funding*
Target	
Oak Ridge	**100**
National High Magnetic Field Lab	**50**
Solenoids	
Inst. of High Energy Physics IHEP	**75**
Induction linac	
LBNL	**100**
Acceleration	
Jefferson Lab	**50**
sum:	**375**