Fermilab

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Director's Office

June 29, 2012

Alan Bross
MS 231

Dear Alan:

Thank you very much for your presentation on the νSTORM letter of intent at the June meeting of the Fermilab Physics Advisory Committee (PAC). The Committee explicitly mentioned its appreciation of the time and effort required of the proponents and presenters to prepare the reports for this PAC meeting.

Short-baseline neutrino developments and experiment options were a major consideration at this meeting, and your efforts were important for the informed discussions which followed. Attached are the νSTORM-relevant parts of the Comments and Recommendations document which the PAC has sent to me.

As you see, the Committee was quite intrigued by the possibility of the νSTORM approach to resolving the short-baseline neutrino anomalies and its being a stepping stone toward use of neutrino-factory technology. While the PAC did not write about the commitment of personnel needed for the next steps, they did discuss your presentation of manpower needed to get to a proposal. They understood that this effort would have to come largely from outside Fermilab. I would like to know more explicitly what work could be done by non-Fermilab collaborators, and what could only be done by Fermilab staff.

Please send me your estimates of the resources needed from Fermilab (both scientist and engineering effort, as well as any other costs) and what can be expected from outside collaborators to get to a full proposal. Also, please keep me informed as you consider your next steps; and good luck.

Sincerely,

Piermaria Oddone

cc:
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Excerpt from Physics Advisory Committee Comments and Recommendations, June 2012

Overview

Another significant topic under discussion centered on short-baseline neutrino oscillation experiments and other related indications of possible anomalies at odds with the current three-neutrino mixing picture. The PAC received and discussed a report from a focus group established by Fermilab which examined the short-baseline neutrino-oscillation situation and recommended possible paths leading to resolution of the anomalies. Two LOIs, LAr1 and νSTORM, aimed at addressing the apparent anomalies, were presented and discussed by the Committee.

Short Baseline Neutrino Experiments

The PAC heard a presentation and received a report from the Short-Baseline Neutrino Focus Group established by Fermilab. Following a suggestion in the December 2011 PAC report, Fermilab responded rapidly to define a strategic plan for short-baseline neutrino physics. The report outlined that several neutrino oscillation experiments have produced hints that do not seem to fit within the simple three-flavor mixing framework. These tensions might be purely statistical in origin, or might arise from one or more unidentified systematic effects or from new physics. The Focus Group report established a valuable baseline for evaluating the extent to which ongoing and planned neutrino experiments will be able to determine the origin of these anomalies. The report also addresses competing facilities and future capabilities at Fermilab for supporting a short-baseline neutrino program to definitively resolve these questions, and suggests what the criteria for an optimal short-baseline neutrino program might be beyond the presently approved and running experiments.

The Focus Group made a number of recommendations promoting new experiments to deal definitively with the short-baseline neutrino-oscillation issue. Among them is the compelling statement that any new short-baseline proposal should clearly demonstrate in detail the ability to discover, or exclude (with at least 5σ significance), sterile neutrinos over the entire parameter space indicated by the LSND and recent MiniBooNE results. The PAC considers that any new experiment should address appearance and disappearance phenomena. In addition a new experiment would be better justified if the physics case for sterile neutrinos is further enhanced by new measurements from MicroBooNE, MINOS+, reactor, or radioactive sources.

The PAC received two LOIs dealing with possible new short-baseline neutrino-oscillation experiments: LAr1 and νSTORM.

νSTORM LOI (P-1028)

The PAC heard and discussed the νSTORM letter of intent. The experiment would consist of a muon storage ring to produce a neutrino beam from 3.8 GeV-muon decays, and of a 1000-ton-scale magnetized-iron far detector located approximately 1.5 km away from the ring. This configuration, based on an old, but never implemented idea, would provide an ideal setup to study eV-scale oscillation physics in appearance and disappearance modes, and to measure electron and muon neutrino cross sections with an unprecedented precision. The envisioned facility offers opportunities for extensions, such as adding a cooling channel and opening the path towards neutrino factory technologies. The presented baseline design envisions a new 60 GeV, 100 kW target station, followed by a collection/transport channel and a decay ring. A cost estimate was presented, and the required investments are significant.

A clear set of parameters for the various accelerator components and schemes, backed up by beam-transport simulations, and the corresponding achievable performances were presented. Assuming $1x10^{21}$ protons on target are achievable in 5 years, the neutrino event rates are impressive, even in a 1000-ton detector. Each accessible-flavor neutrino (ν_e and anti-ν_μ, or anti-ν_e and ν_μ) would produce several hundred thousand events in the far detector and several million events in a near detector approximately 50 m from the decay ring. The baseline magnetized-iron detector (SuperBIND) offers a reasonable approach for studying muon final states.

The event reconstruction efficiency of the SuperBIND depends sharply on the energy in the region of interest and drops significantly at the lower range. A further optimization of the detector and of the reconstruction method might help to recover lower-energy events. A low probability of muon-charge misidentification and a high event rate would provide a clean environment to probe electron-to-muon neutrino oscillations.

The combination of a clear resolution of the short-baseline neutrino anomalies, the precise measurements of the neutrino cross sections, and the synergy with neutrino-factory technology makes this a potentially attractive project.