A Measurement of Neutrino-Nucleus Scattering in a Narrow-Band Beam: SciNOvA

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The discovery of neutrino oscillations has instigated a world-wide experimental effort to use oscillations to measure the fundamental properties of the neutrino. Recent and near-future oscillation experiments in this program such as MiniBooNE, MINOS, T2K, CNGS, NOvA, LBNE, require detailed knowledge of neutrino-nucleus interactions to avoid being limited by uncertainties in the underlying neutrino-nucleus scattering process. Recent data from MiniBooNE and others indicate this knowledge currently eludes us. There currently exists an opportunity for large gains in understanding these interactions via a relatively modest upgrade to the planned NOvA near detector. The resulting measurements would provide crucial neutrino scattering data and would complement that from experiments in other neutrino beams, eg. the SciBooNE and MINERvA experiments.

These other experiments use beams with relatively large energy spread ("wide band") and hence have little a priori knowledge of the incident neutrino energy. NOvA, however, uses a narrow-band neutrino beam centered at 2 GeV. A fine-grained detector in this narrow-band beam would provide a unique opportunity to measure neutrino cross sections with a better constraint on the neutrino energy. In addition, the resulting measurements would provide important cross-checks of estimated backgrounds to oscillations in NOvA.

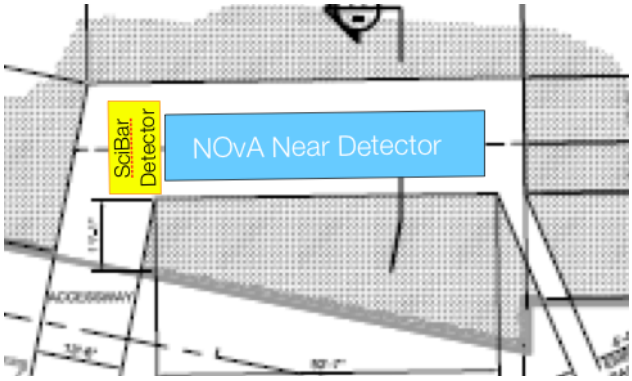

Figure 1: Schematic of the SciBar detector installed in the NOvA cavern just upstream of the NOvA near detector.

The upgrade, "SciNOvA" [1, 2] , requires construction of a SciBar detector as was used in the K2K and SciBooNE experiments, and installing it just upstream of the NOvA near detector underground at Fermilab in the NuMI neutrino beam (Fig. 1. The proposed detector consists of approximately 15,000 scintillator bars of dimensions approximately $1.2 \times 2.4 \times 300$ cm^3 for a total mass of 15tons. Light from the bars is collected with embedded wavelength-shifting optical fibers and routed to a multianode photomultiplier tube for digitization. The estimated cost for this upgrade is $2.4M.

In the region near 2 GeV, this detector would record a large sample of approximately 1 M neutrino events per year simultaneously with the NOvA experiment. This event sample will enable measurements of charged- and neutral-current elastic scattering as well as neutral-current production of pions and photons. These are all important processes in order to precisely measure neutrino oscillations.

References

[1] X. C. Tian [SciNOvA Collaboration], arXiv:1109.2552 [hep-ex].

[2] J. Paley *et al.*, FERMILAB-PROPOSAL-1003 (2010).