The MiniBooNE-II Proposal
A 5σ Test of MiniBooNE's Neutrino Mode Excess

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MiniBooNE has enjoyed 10 years of smooth operation, during which an astounding 6.46×10^{20} protons on target (POT) have been delivered in neutrino mode, and an even more astounding 1.14×10^{21} POT have been delivered in anti-neutrino mode. The neutrino mode data has yielded a excess of $162.0 \pm 28.1(stat) \pm 38.7(sys)$ events at reconstructed neutrino energies below 475 MeV. That excess is not described well by a simple two-neutrino model, but can be accommodated by an extended 3 active + 2 sterile neutrino model, fit to the worlds relevant neutrino data. While the statistical significance of the excess is 6σ, the overall significance is limited to 3.4σ by the systematic error in the estimation of the background. That systematic error is related to the error in the detector acceptance or efficiency for π^0 background events, and to a lessor extent, the flux of neutrinos, and the neutrino-nucleus cross sections. Similarly, an excess of is observed in anti-neutrino mode of $78.4\pm20.0(stat)\pm 20.3(sys)$ events events, consistent with the neutrino-mode data.

We now believe that nearly all the possible avenues for explaining the excess events by conventional processes have been explored. We believe that constructing a MiniBooNE detector (reusing the mineral oil, electronics, and PMTs from MiniBooNE if necessary) at a new location $\sim$ 200 meters from the Booster Neutrino Beam proton target, will be the most expedient way understand whether or not the excess events observed by MiniBooNE are caused by an oscillation process. The primary motivation for a near detector, rather than a detector further away, is that the neutrino interaction rate will be over 7 times larger, and the measurement will precisely determine the neutrino-related backgrounds within 6 months of running. The combination of the present MiniBooNE neutrino-mode data, plus a 4-month (1×10^{20} POT or $\sim$ 700,000 neutrino events) neutrino-mode run with the MiniBooNE-II detector, would result in a 5σ sensitivity to whether or not the excess is an oscillation effect.

Furthermore, the MiniBooNE-lI detector at 200 meters, in conjunction with the ultra-fine-grained MicroBooNE liquid argon TPC, would be a tremendously powerful, oscillation-hunting combination with a price tag of less than $10M. They would provide a timely, conclusive 5σ test on whether or not the MiniBooNE excess was an oscillation phenomena by the year 2017, well in advance of the CERN short baseline program. While MicroBooNE does not anticipate any antineutrino-mode operation, the operation of MiniBooNE-II during the MicroBooNE neutrino-mode run would double the statistics of the present MiniBooNE neutrino data to 1.2×10^{21} POT.

For detailed information on the MiniBooNE-II sensitivities see the BooNE proposal see:

http://www.fnal.gov/directorate/program_planning/Dec2011PACPublic/BooNE_Proposal.pdf.