Overview of Short-Baseline Neutrino Program

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Introduction

Consisting of three large liquid argon time projection chambers (LArTPCs) located along Fermilab's Booster Neutrino Beam (BNB), the Short-Baseline Neutrino (SBN) Program is a neutrino oscillation experiment that seeks to address anomalous results from the LSND and MiniBooNE experiments, where excesses of electron-like events could possibly be interpreted as originating from light sterile neutrinos.

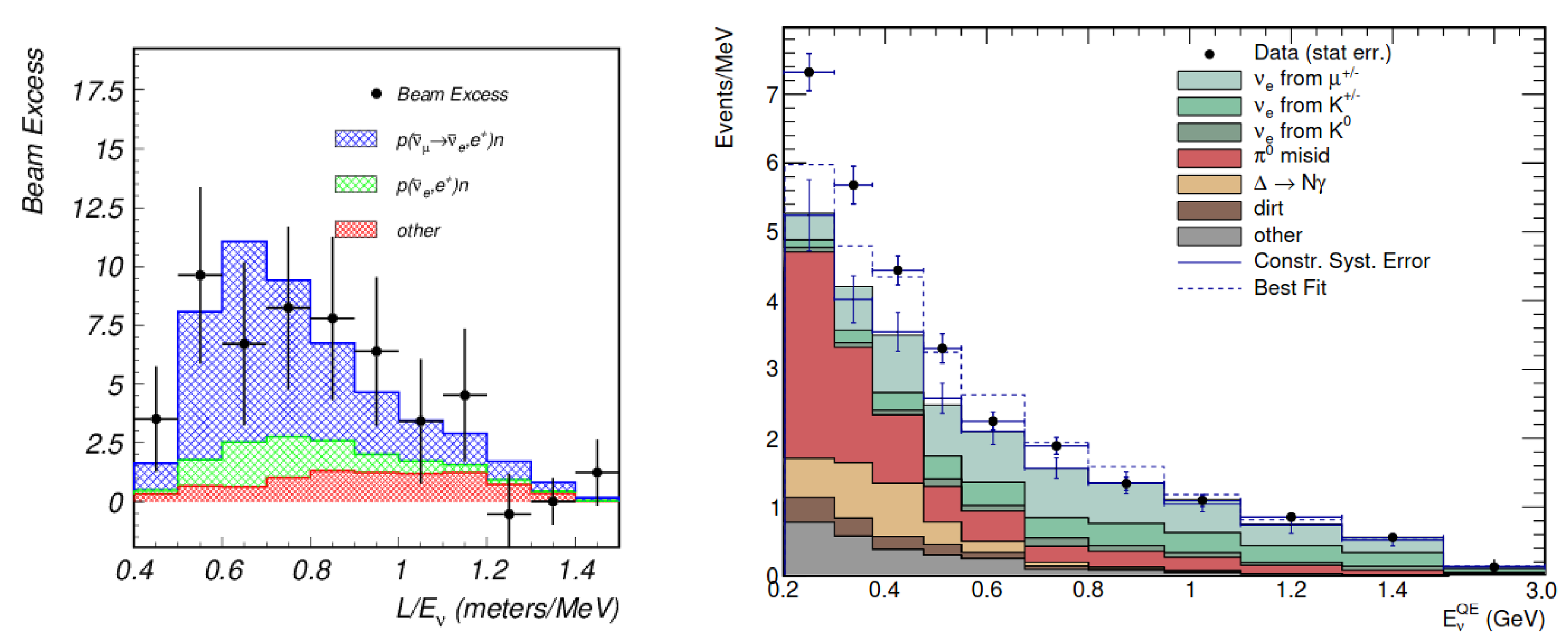

Figure 1. Left: Electron antineutrino excess seen at LSND [1]; Right: Electron neutrino excess seen at MiniBooNE [2]

SBN features the 112-ton short-baseline near detector (SBND), the intermediate 89-ton MicroBooNE detector, and the 470-ton far detector (ICARUS). These detectors will be subject to neutrinos from the BNB. It is also worth noting that MicroBooNE and ICARUS will be subject to the off-axis NuMI beam, though beam references in this poster are referring to the BNB.

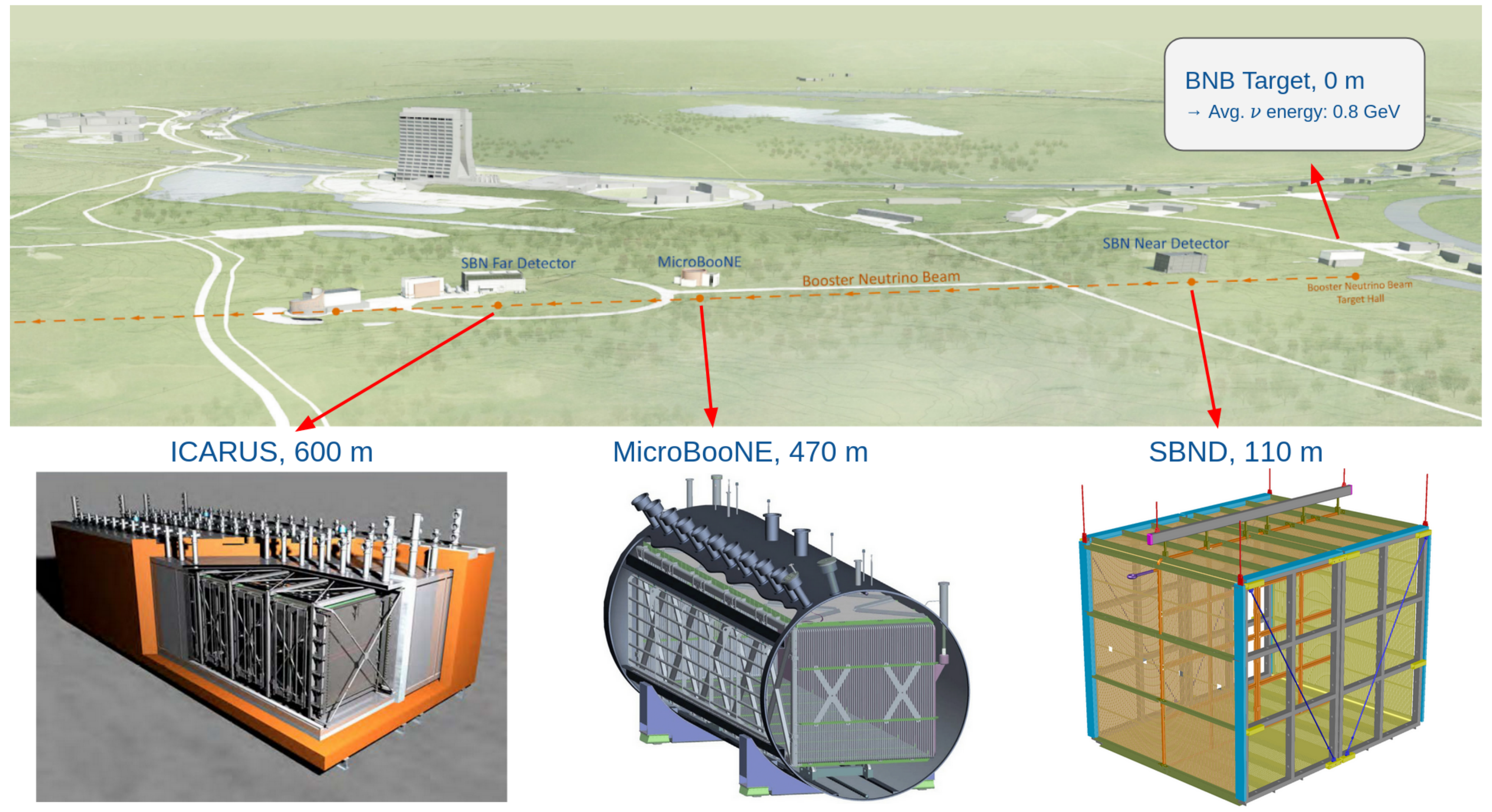

Figure 2. Detectors of the SBN Program at Fermilab

SBN Detectors

It is an exciting time for the SBN Program, with first results from MicroBooNE recently reported, assembly of SBND in progress, and ICARUS physics data collection slated to begin soon.

SBND

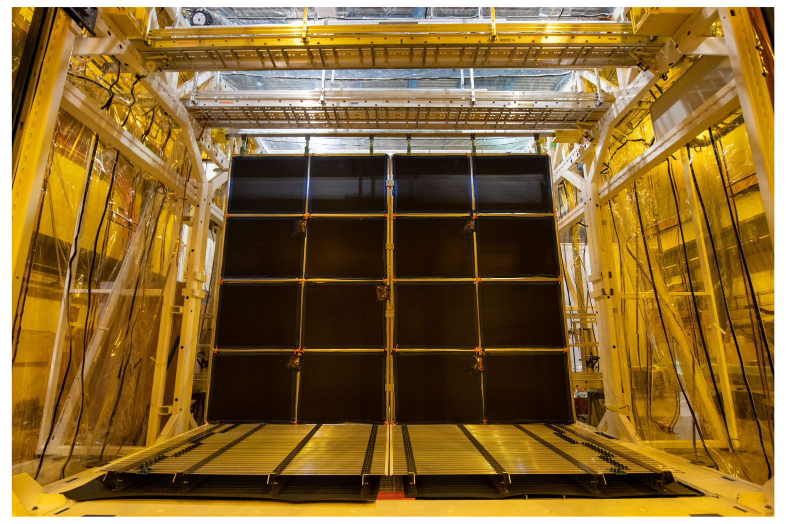

Figure 3. SBND in assembly phase; cathode plane and bottom field cage modules are pictured.

SBND is the closest SBN detector to the beam source and will measure the unoscillated neutrino (antineutrino) flux.

- More than 2 million neutrino events per year
- Reduce neutrino flux and cross section systematic uncertainties
- Detector assembly in progress
- Commissioning to take place in 2023

ICARUS

The ICARUS T600 detector is the farthest SBN detector from the beam source and will measure the oscillated neutrino spectrum.

- Largest LArTPC built to date to record neutrino interactions
- Originally operated at Gran Sasso National Laboratory
- Commissioning at Fermilab complete, physics run beginning in 2022

Figure 4. Top of ICARUS detector at Fermilab

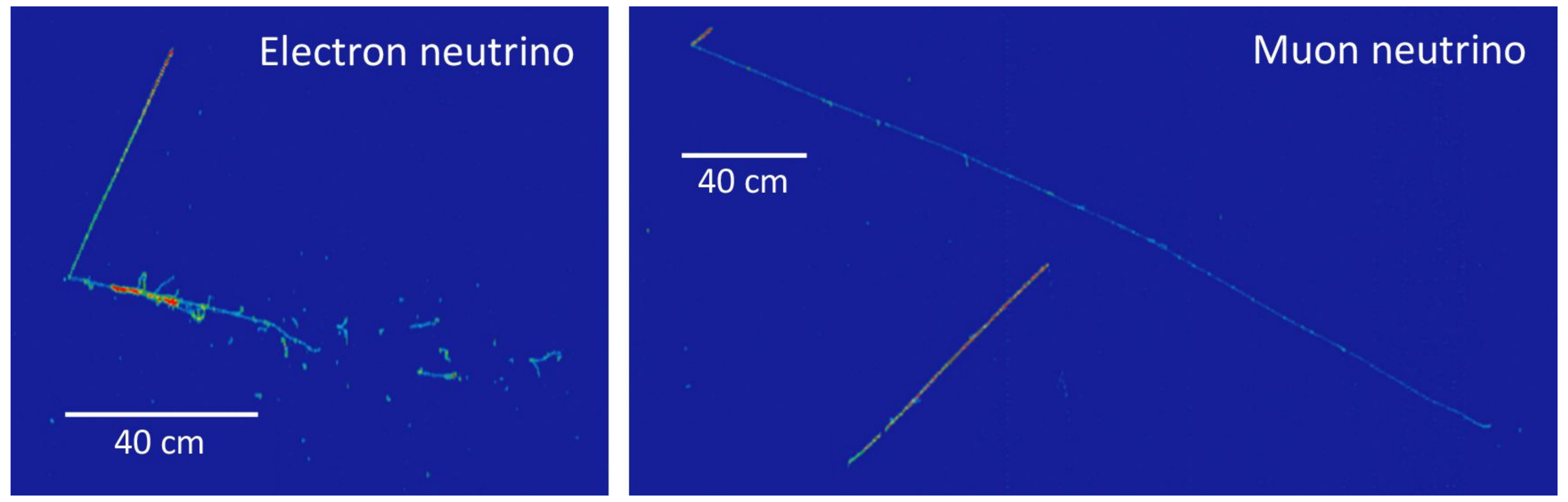

Figure 5. Event displays from ICARUS commissioning. An electron neutrino event is shown at left, and a muon neutrino event is shown at right.

For information regarding the MicroBooNE detector, including recent results from the low energy excess analysis, visit https://microboone.fnal.gov/.

Physics Program

By using multiple, functionally identical detectors subject to the same neutrino beam, the SBN Program seeks to definitely answer the question of whether or not the LSND and MiniBooNE anomalies can be attributed to sterile neutrinos. In fact, SBN is designed to cover the LSND-favored oscillation parameter region at 5σ sensitivity.

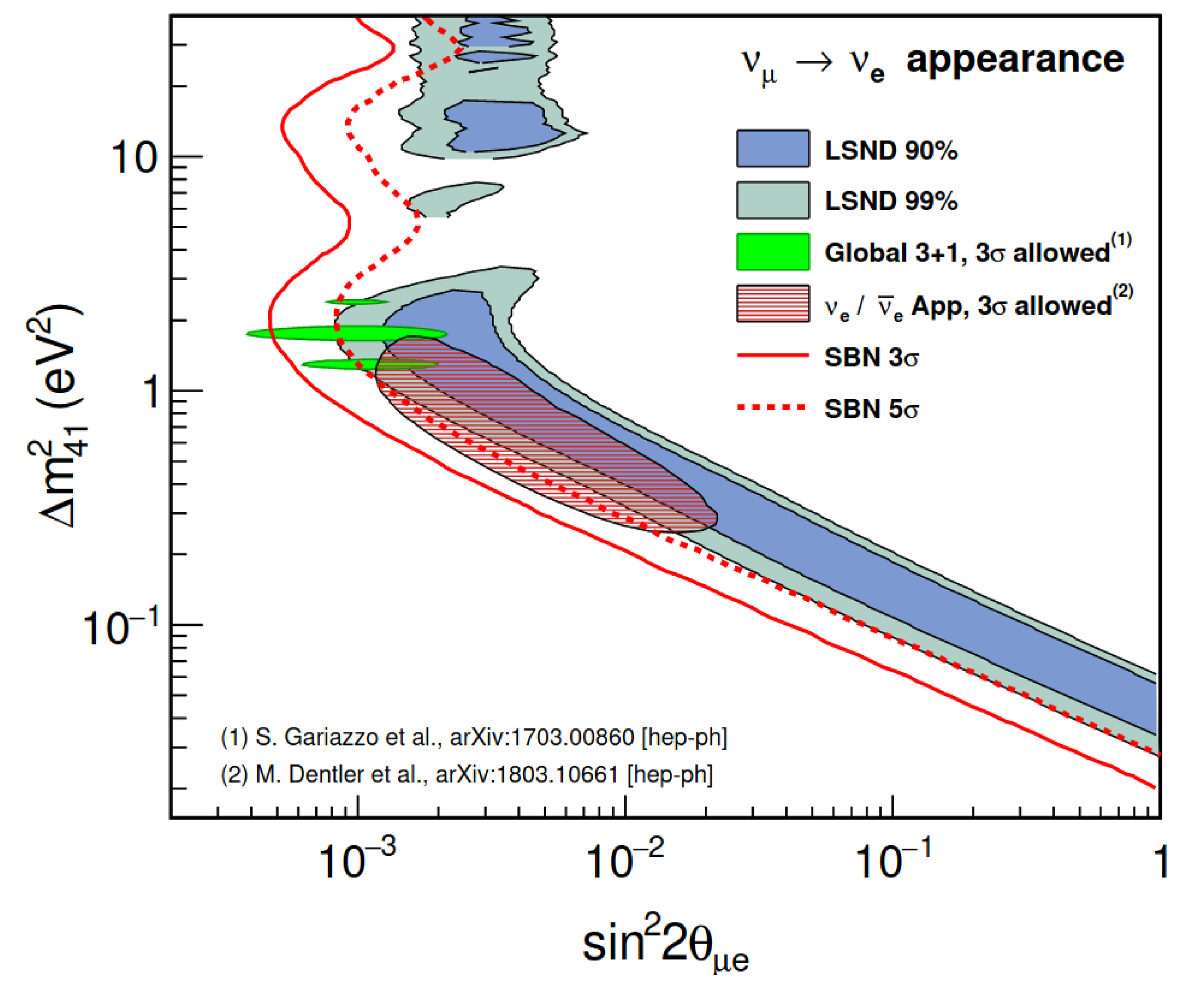

Figure 6. 3σ (solid red line) and 5σ (dotted red line) sensitivities to a light sterile neutrino in the $\nu_\mu \rightarrow \nu_e$ appearance channel [3]

The SBN Program has broad science goals that extend beyond oscillation searches. Excellent LArTPC reconstruction and high statistics at SBN pave the way for exploration of beyond the Standard Model (BSM) physics and precision studies of neutrino-argon interactions.

References

[1] LSND Collaboration, Evidence for Neutrino Oscillations from the Observation of $\bar{\nu}_e$ Appearance in a $\bar{\nu}_\mu$ Beam, arXiv:hep-ex/0104049

[2] MiniBooNE Collaboration, Updated MiniBooNE Neutrino Oscillation Results with Increased Data and New Background Studies, arXiv:2006.16883

[3] Pedro A. N. Machado, Ornella Palamara, and David W. Schmitz, The Short-Baseline Neutrino Program at Fermilab, arXiv:1903.04608

Acknowledgements

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