Electron Neutrino Selection for Neutrino Oscillation Searches in the SBN Program

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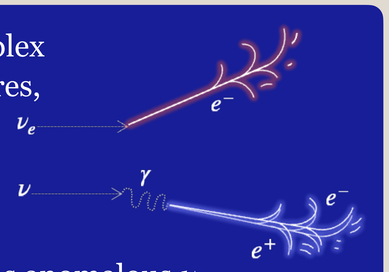
ν_e CC interactions produce complex electromagnetic shower signatures, **similar to photon-induced signatures, yet still distinguishable** in LArTPCs



A sterile neutrino can manifest as anomalous ν_e appearance and/or disappearance along the beamline making a **robust ν_e selection essential**

SBN is well-positioned, with two LArTPC detectors (same technology and same beam) SBND at 110 m and ICARUS at 600 m, to make a **precision measurement that constrains correlated systematics** [1]

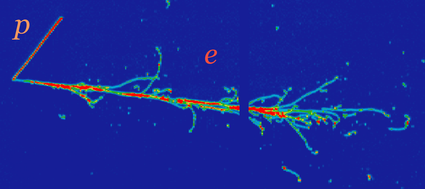
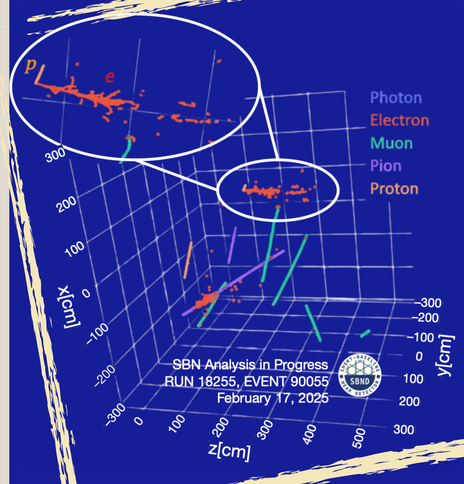


Figure 1: ν_e CC 1e1p candidate event in raw SBND data (above) and reconstructed by SPINE (below)



A ν_e excess and/or deficit at either or both detectors beyond systematic uncertainties would be a **strong indication of physics beyond the Standard Model**

ν_e selection makes use of an end-to-end trainable LArTPC reconstruction framework (SPINE) [2] that uses convolutional and graph neural networks to aggregate particle hits, assign particle IDs, and categorize interactions

We target ν_e **CC 1eNp0π interactions**: a cleanly reconstructible topology less affected by interaction model uncertainties

	ICARUS	SBND
Efficiency	71 %	70 %
Purity	70 %	68 %

Table 1: Selection performance with respect to target 1eNp0π topology

The goal is to **retain high ν_e statistics**, while **reducing systematic uncertainties**

Shower start dE/dx distributions shows the photon peak around 4 MeV/cm **well suppressed**

The **dominant background is NC events** (~10%), driven by photon/electron confusion, particularly at reconstructed visible energies <0.75 GeV

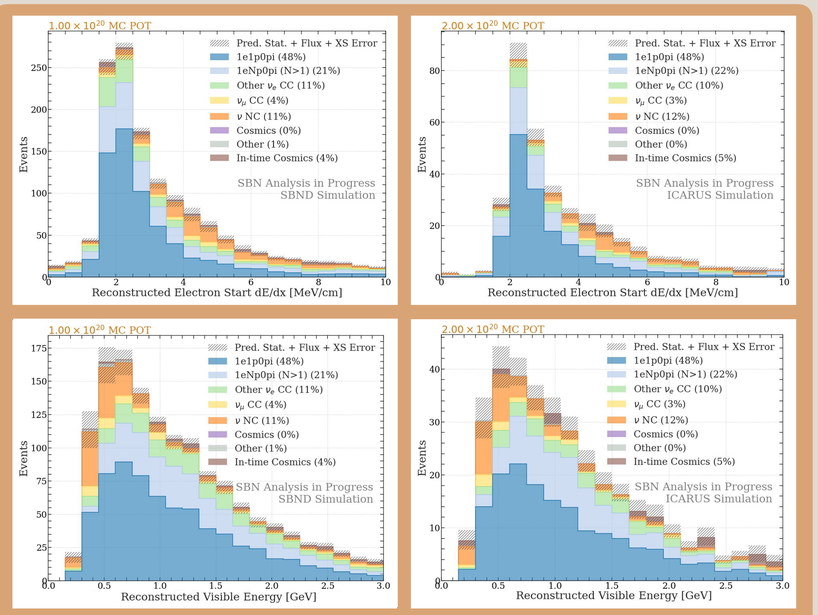


Figure 2: Reconstructed electron start dE/dx (top) and reconstructed visible energy (bottom) distributions for selected events in SBND (left) and ICARUS (right)

Good resolution on the electron kinetic energy (KE) and total visible energy ~3% for target topology

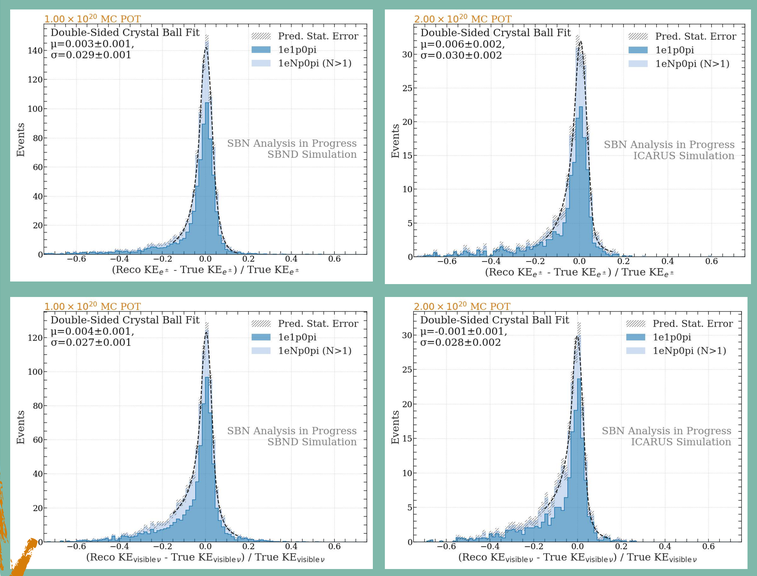


Figure 3: Energy resolution for electron KE (top) and total visible energy (bottom) for SBND (left) and ICARUS (right), extracted by a double-sided crystal ball fit bounded at ± 0.15

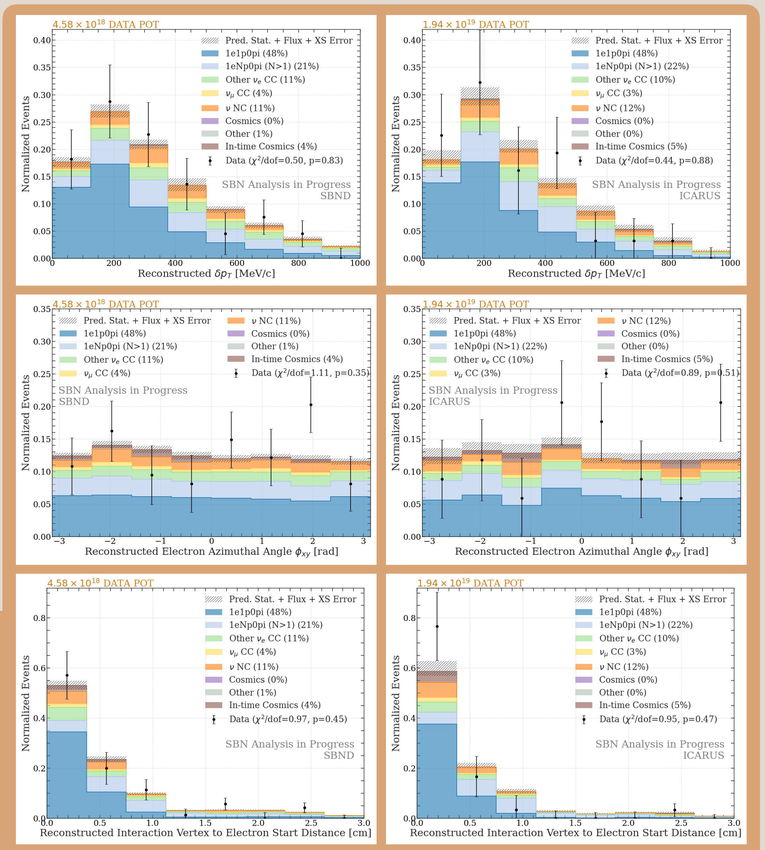


Figure 4: Reconstructed δp_T (top), azimuthal angle ϕ_{xy} (middle) and interaction vertex to electron start distance (bottom) distributions for SBND (left) and ICARUS (right)

Fairly pure preliminary selection developed for SBN, preserving high efficiency and showing consistency between SBND and ICARUS. Future selection optimization will focus on maximizing sensitivity to '3+1' sterile neutrino oscillations

Good data/MC shape agreement using (limited) open data. Provides confidence in SPINE reconstruction on on-beam data

References: [1] R. Acciarri et al. A Proposal for a Three Detector Short-Baseline Neutrino Oscillation Program in the Fermilab Booster Neutrino Beam. 2015. arXiv: 1503.01520 **[2]** Francois Drielsma et al. Scalable, End-to-End, Deep-Learning-Based Data Reconstruction Chain for Particle Imaging Detectors. 2021. arXiv: 2102.01033

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