

The Short-Baseline Anomalies

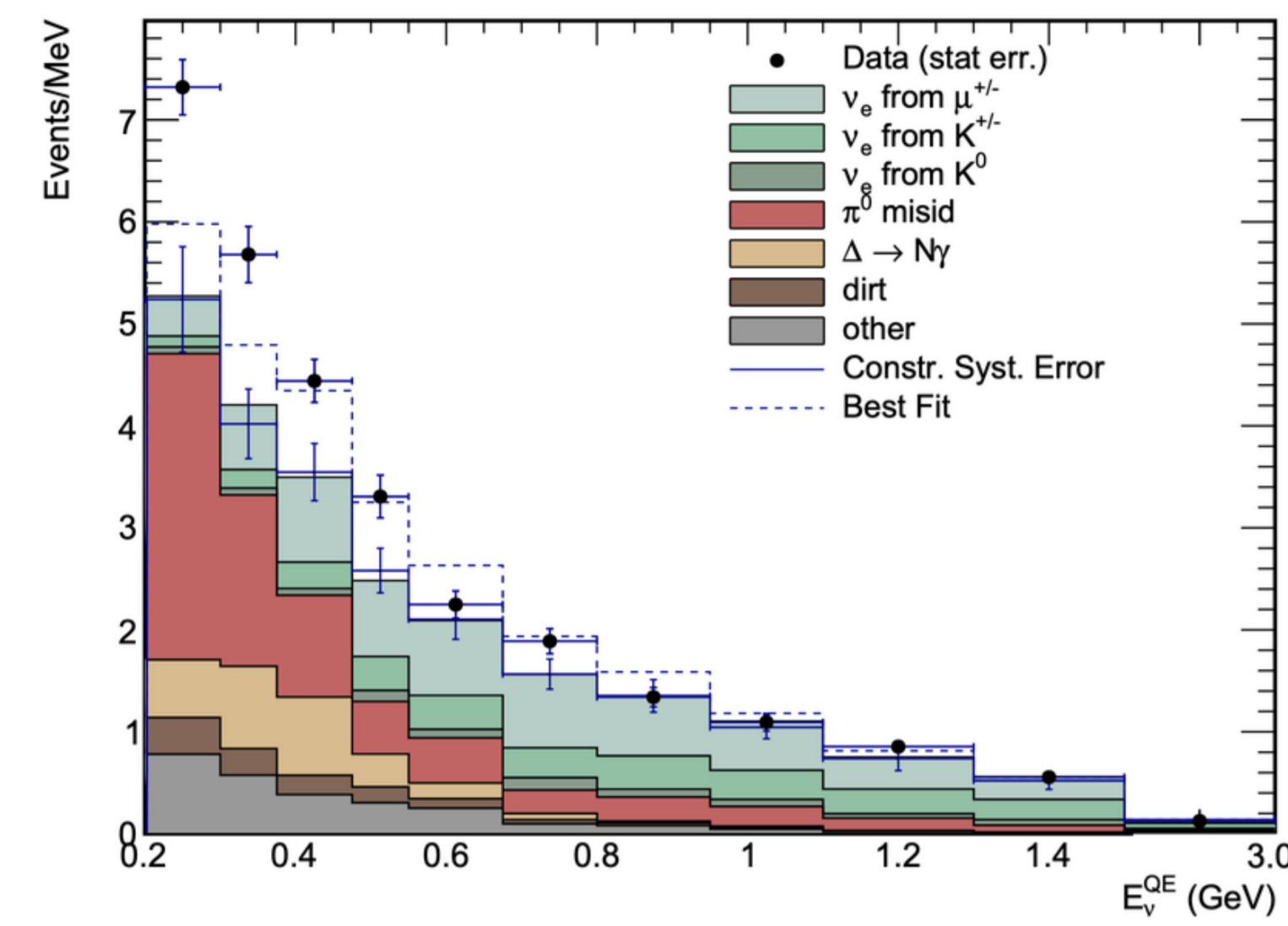
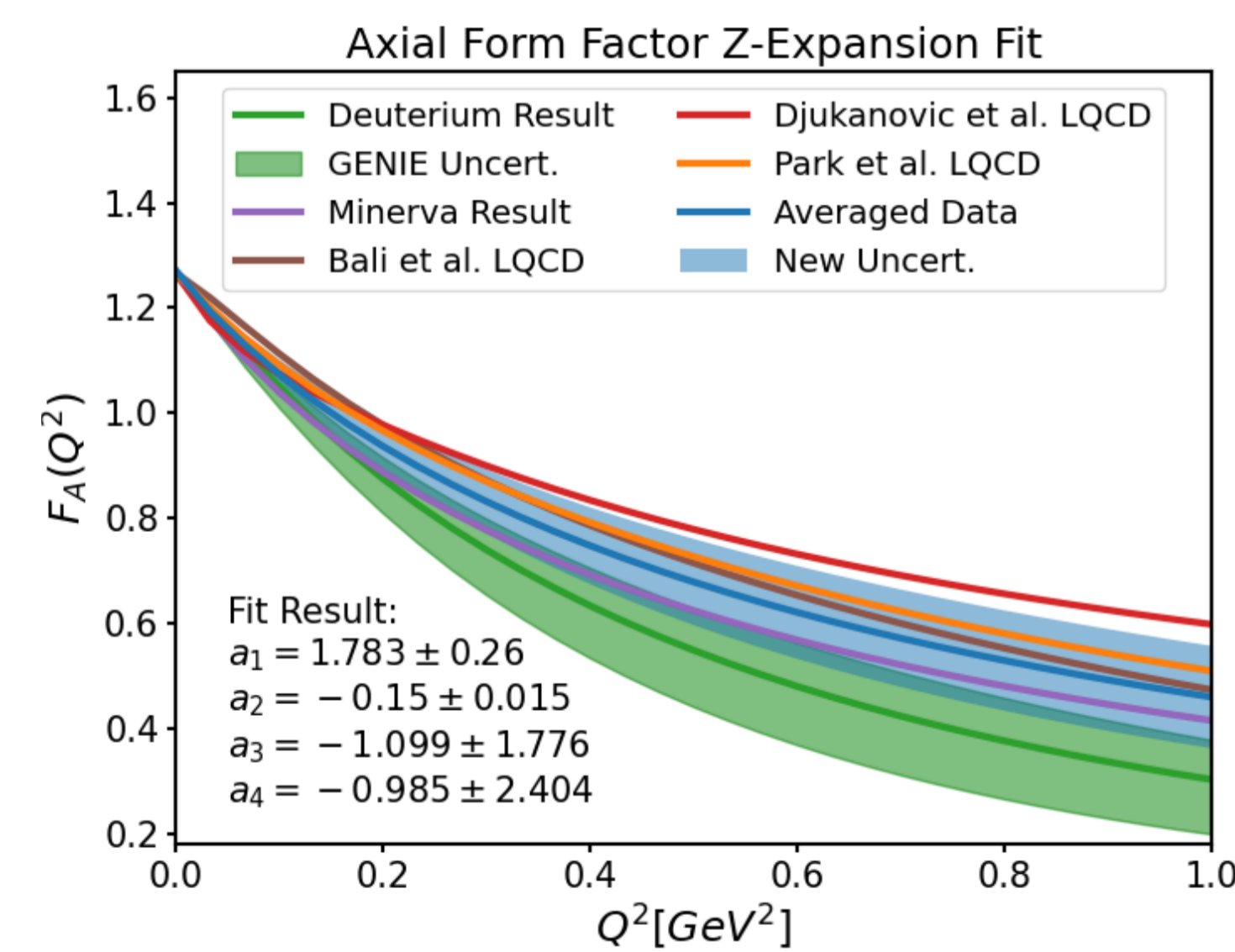


Figure 1. Excess of electron neutrino-like events found in the MiniBooNE detector [3].

- Several short-baseline experiments reported results which deviate from the 3-neutrino oscillation model.
- One possible explanation is the existence of a sterile neutrino which would most easily be detected via oscillations.

Developing Well-Informed Systematic Uncertainties

When considering an exclusive sample, having well-informed systematic uncertainties on the neutrino interaction model becomes especially important.



(a) An updated axial form factor model which is more consistent (blue) with recent results [2, 4, 5, 7, 8] than the prior model (green).

(b) A more accurate ground state model using the argon spectral function using results from [6].

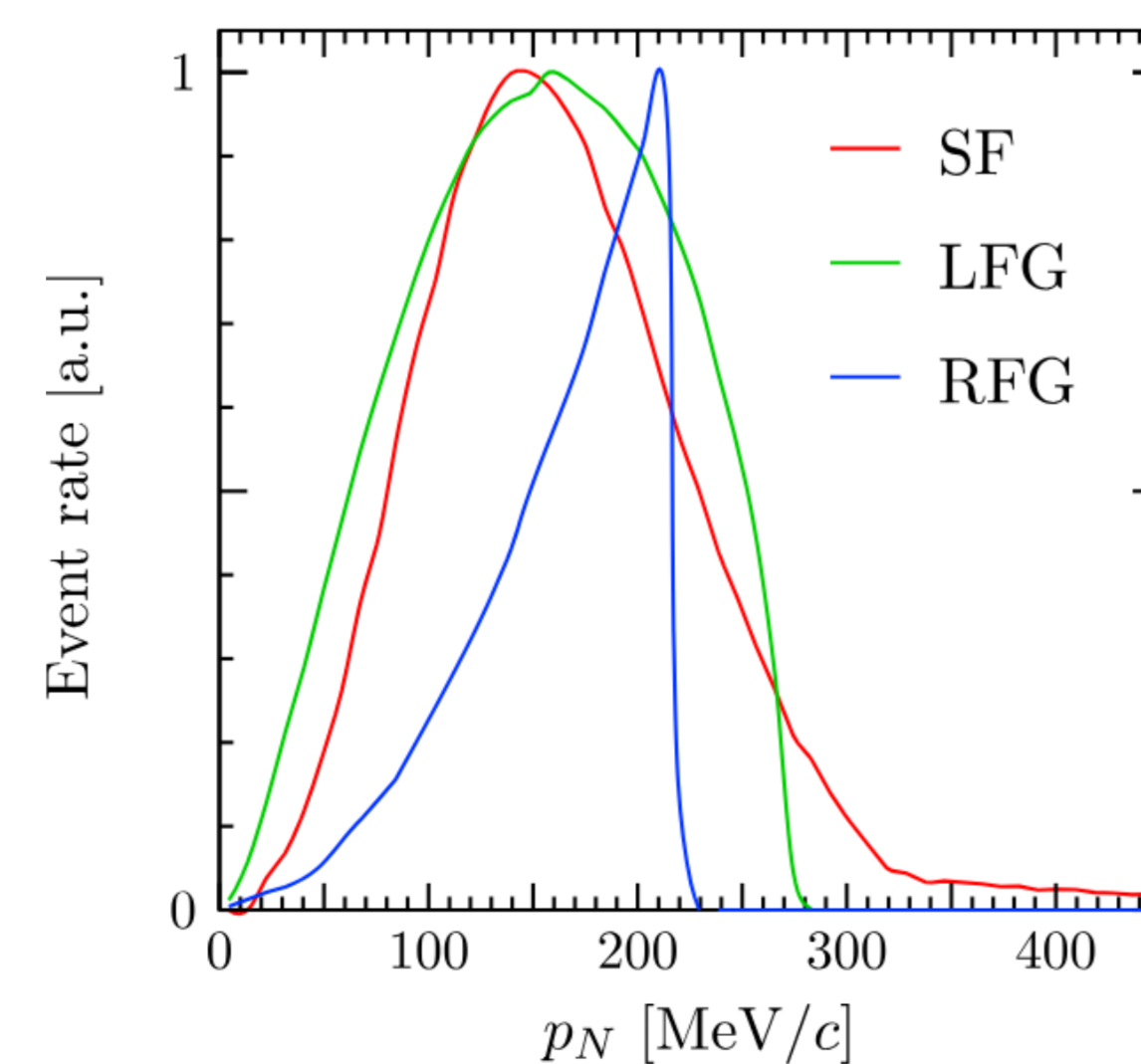


Figure 2. An improved cross section model can reduce a priori systematics and improve post-fit uncertainties.

The SBN Program at Fermilab

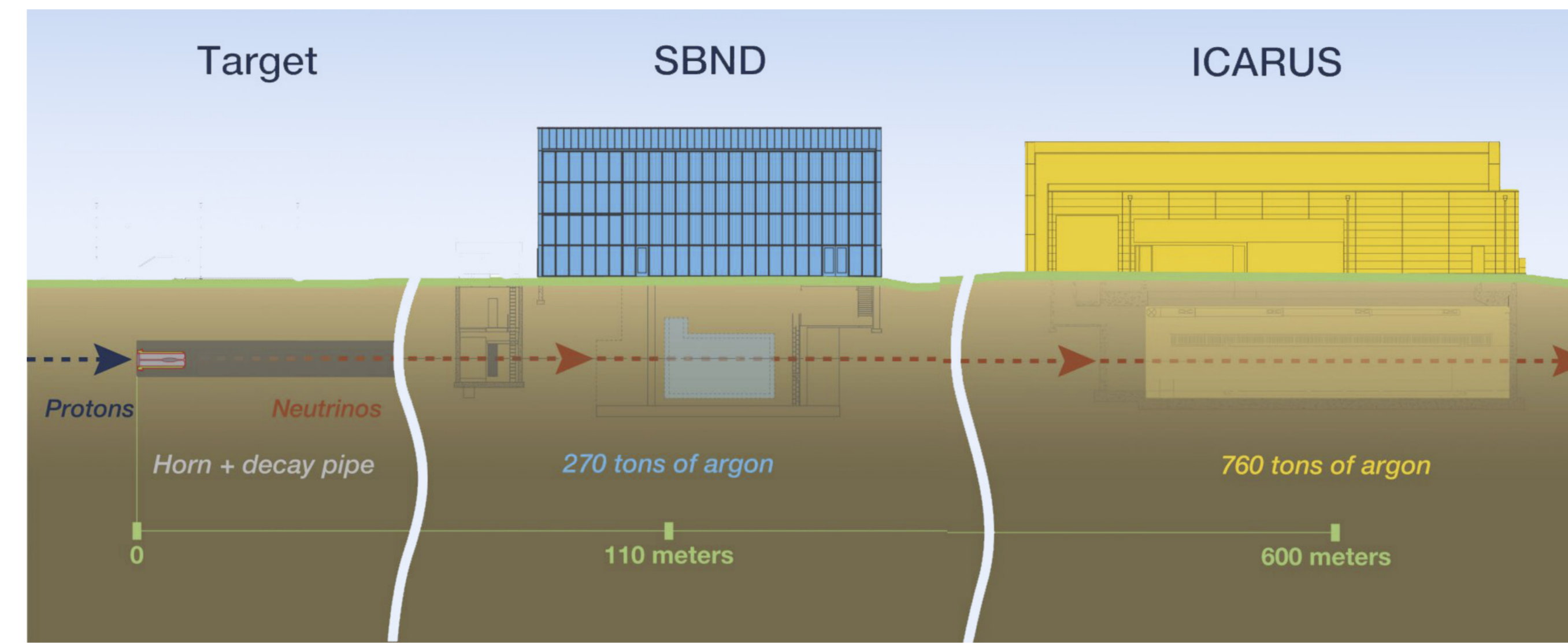
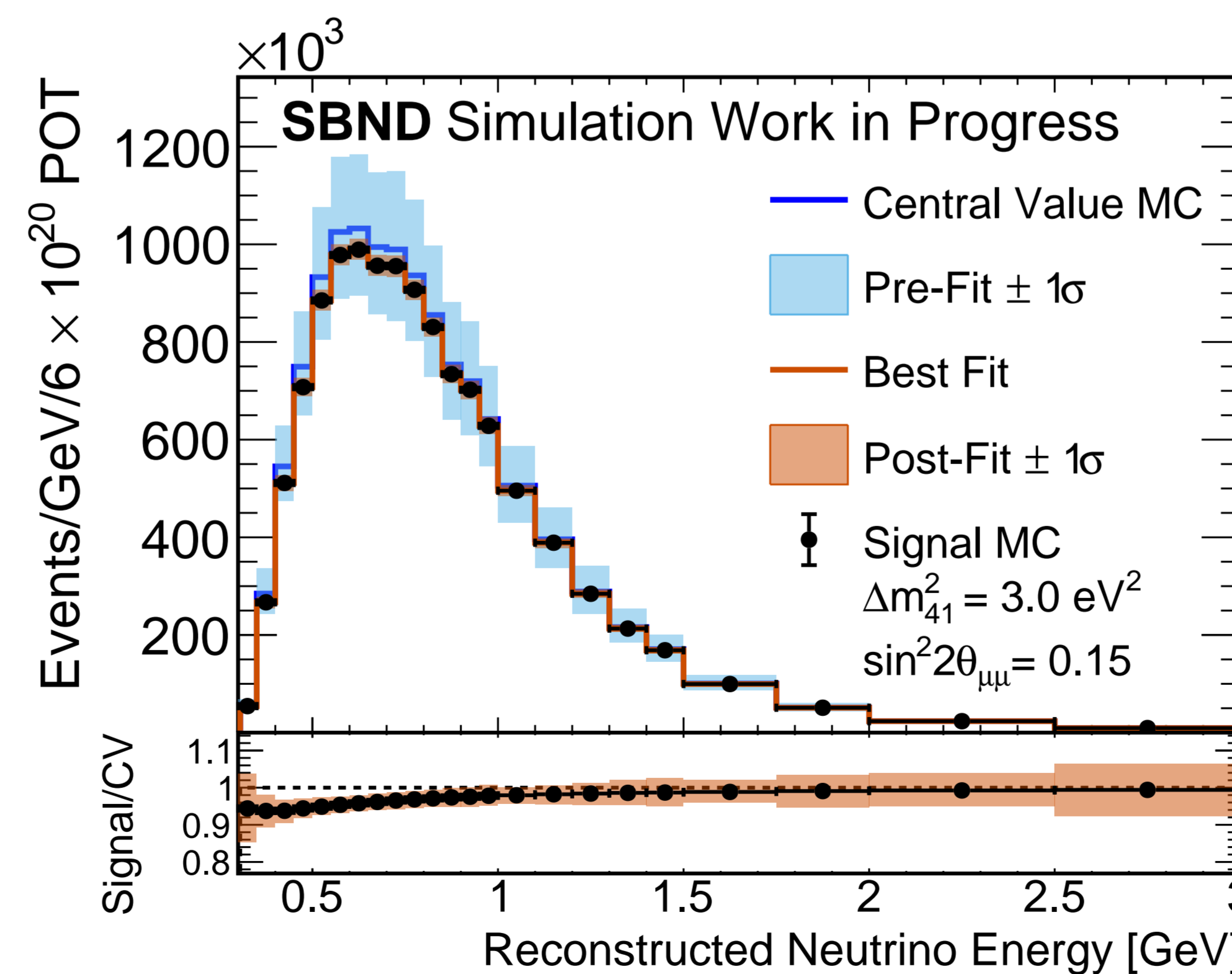


Figure 3. The two-detector configuration of Fermilab's Short-Baseline Neutrino (SBN) program enables an exploration of short-baseline oscillations through muon neutrino disappearance with unprecedented sensitivity.

Utilizing the PROfit Framework

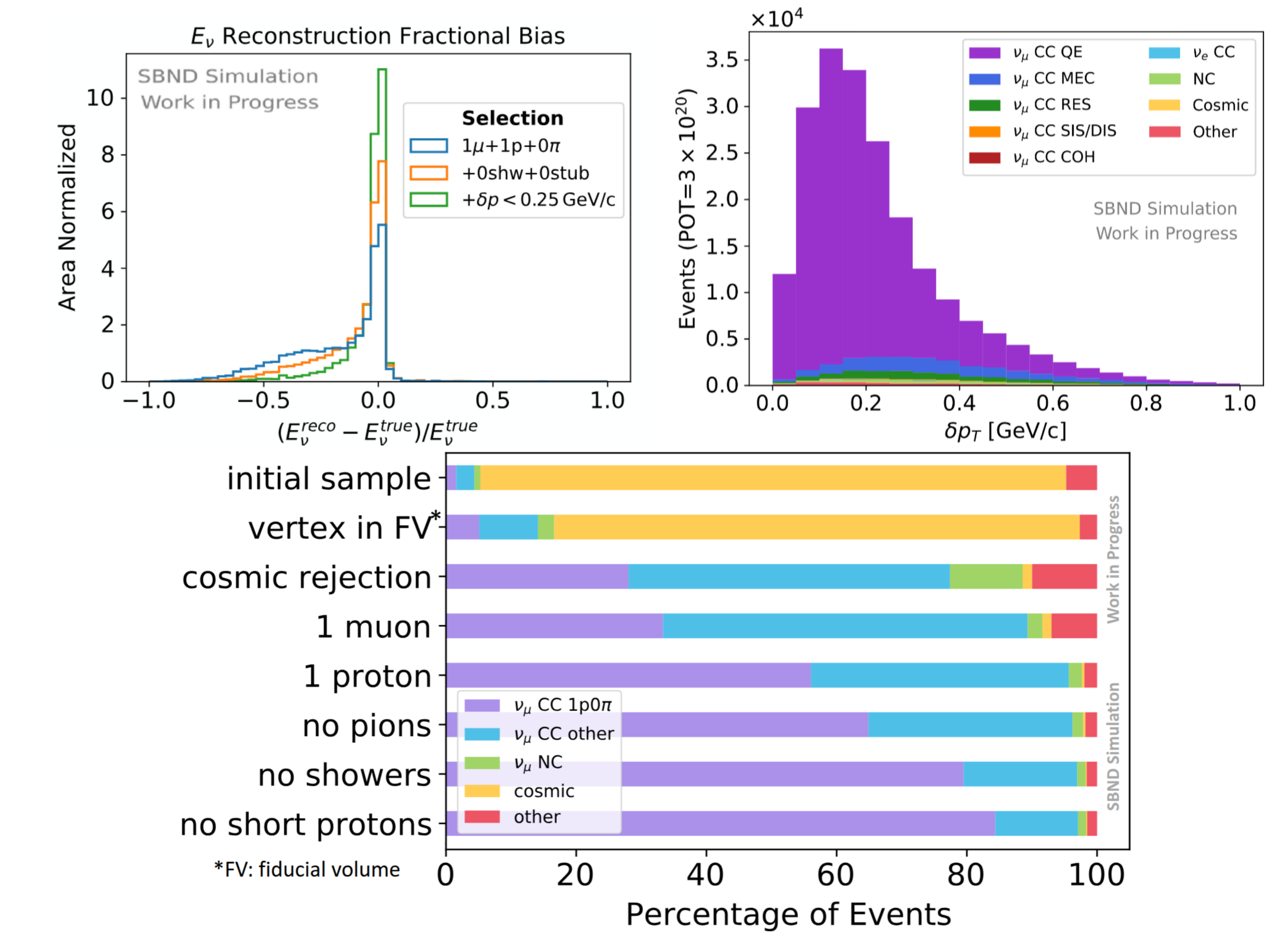
The PROfit fitting framework [1] is leveraged for both physics parameters (Δm_{41}^2 , $\sin^2 2\theta_{\mu\mu}$) and pull terms for systematics. This allows us to be robust against inaccuracies in our Monte Carlo simulations.



PROfit uses a three step algorithm of latin hypercube sampling, particle swarm optimization, and L-BFGS-B minimization.

The $1\mu 1p$ selection

Our cuts on PID and reconstructed variables allow us to achieve a purity of $\approx 85\%$ and efficiency of $\approx 40\%$ in the SBND detector. This grants us an improved energy resolution, which is a critical component in the search for neutrino oscillations.



References & Acknowledgements

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- [2] MINERvA Collaboration. *Nature*, February 2023.
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