Constraining High Energy Intrinsic Beam Background of the NOvA Experiment

Ishwar Singh, Brajesh Choudhary, University of Delhi, Delhi
Prabhjot Singh, Queen Mary University of London, London
On behalf of the NOvA Collaboration
Invisibles’22 Workshop, ICJLab, Orsay, France

The NOvA Experiment

- NuMI Off-axis $\nu_e$ Appearance Experiment (NOvA)
- A long-baseline Neutrino Oscillation Experiment
- $\nu_\mu$ beam is provided by Fermilab’s NuMI beam line
- Two Detectors - functionally identical
  - Situated 809 km apart
  - 14.6 milli-radians Off-axis
- Primary Goal: To constraint parameters of 3-flavor neutrino oscillations
- Oscillation Channels:
  - $\nu_\mu$ ($\bar{\nu}_\mu$) Disappearance
  - $\nu_e$ ($\bar{\nu}_e$) Appearance

High Energy $\nu_e$ Events

- NOvA uses $\nu_e$ ($\bar{\nu}_e$) events with $1 < E_e < 4$ GeV for constraining the oscillation parameters
- FD predictions included $\nu_e$ ($\bar{\nu}_e$) events with energies up to 12 GeV
- Impact of these high-energy $\nu_e$ ($\bar{\nu}_e$) events on oscillation sensitivity was investigated

FD $\nu_e$ Predictions

- A joint fit to FD $\nu_\mu$, $\bar{\nu}_\mu$, $\nu_e$, and $\bar{\nu}_e$ predictions was performed, with various samples included
- Additional high energy $\nu_e$ ($\bar{\nu}_e$) events were added to FD predictions to try to constrain large beam $\nu_e$ ($\bar{\nu}_e$) background

Beam Background - Sources

- $\nu_e$ appearance signal in the FD is mimicked by intrinsic beam $\nu_e$ events
- The majority of low-energy $\nu_e$s arise from $\mu^\pm$ decay
- Most of the high energy $\nu_e$s come from $K^\pm$ and $K^0$ decay
- Aimed to constrain high energy beam $\nu_e$ background

Conclusions

- Minimal gain in signal events from high energy sideband sample
- Beam background dominates the high energy sample
- Impact on NOvA standard 3-flavor oscillation sensitivities is minimal