Measurement of Neutrino-Electron Scattering In The NOvA Near Detector

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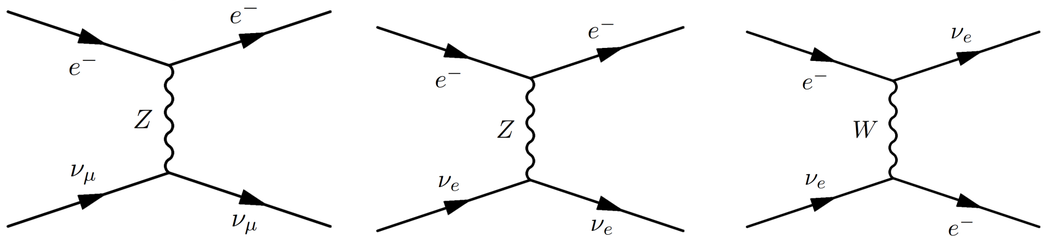
Introduction

Neutrinos can elastically scatter off electrons via neutral current or charge current exchange.



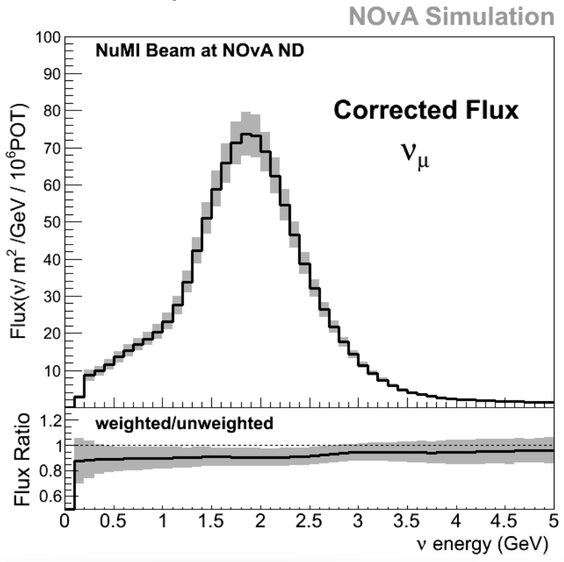
- Pure leptonic process.
- Small but very well-known cross section.
- Great for constraining neutrino flux for neutrino experiments.

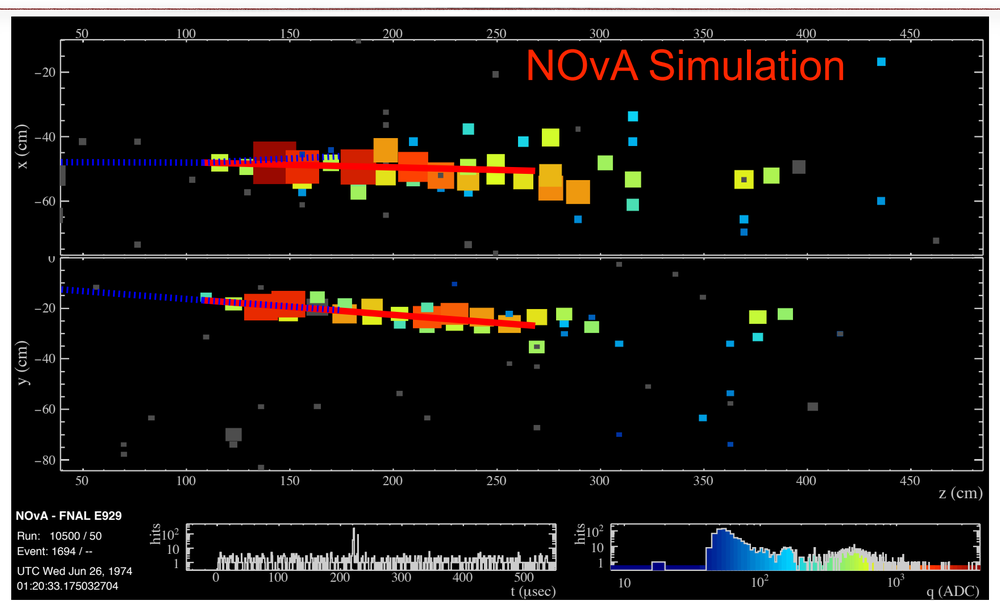
The NOvA Near Detector and Neutrino Flux

The NOvA ND is a 300-ton tracking calorimeter with liquid scintillator, located at Fermilab,1 km away from the NuMI target, at 14.6 mrad off the beam axis.

- Fine-grained, low-Z, highly active.
- **X_0 = 38cm** (6 cell depths, 10 cell widths), optimized for EM shower measurement.
- Narrow band neutrino flux between **1~3 GeV** with peak at **~2 GeV**

NOvA Simulation



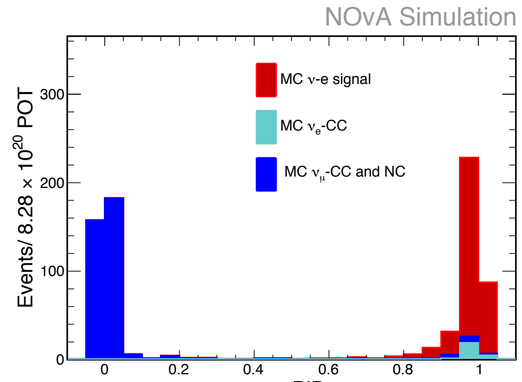


The neutrino-electron scattering topology we look for is one shower induced by electron in the NOvA ND collinear with the beam direction.

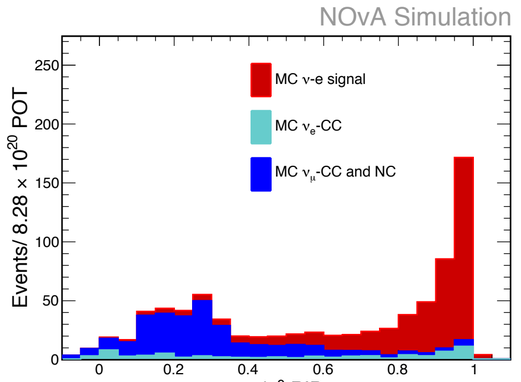
Signal Electron Selection

- The signal events are required to have one EM shower with no other particles or vertex activity.
- Two PID algorithms are developed to further select signal events from background using plane dE/dx information.
  - ν-e PID selects EM showers against background particles.
  - e-π^0 PID further rejects π^0

NOvA Simulation

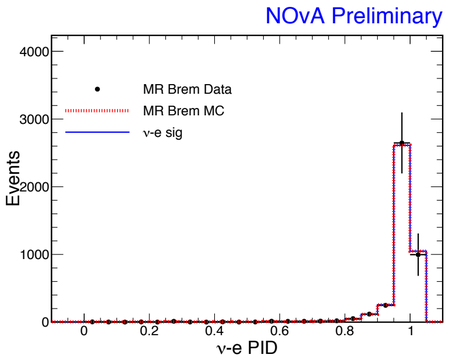


NOvA Simulation

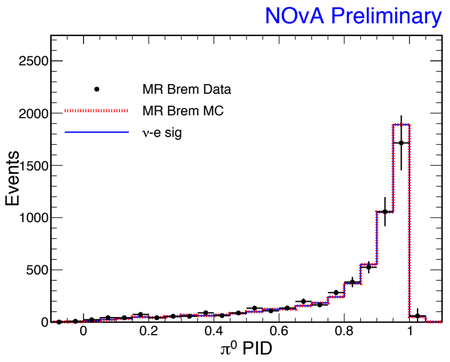


Muon-Removed Bremsstrahlung Shower

NOvA Preliminary



NOvA Preliminary

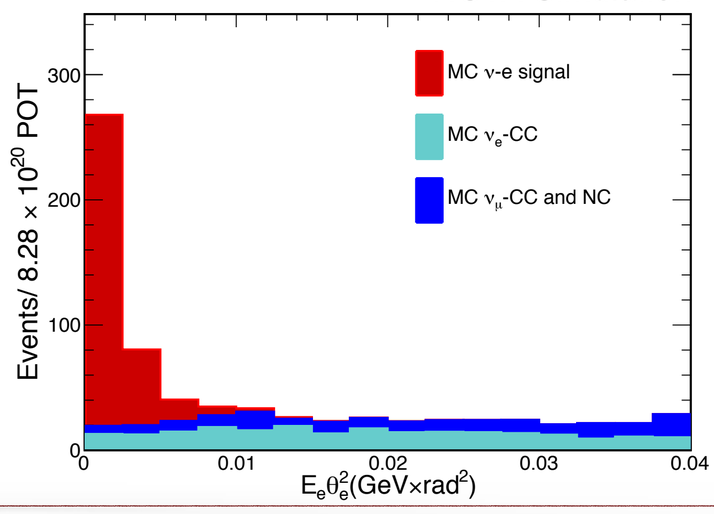


- Rock muons induces brem showers in the NOvA ND
- A muon-removal algorithm is developed to remove the muon tracks to get pure brem showers from data and MC.
- It provides a data-driven tool to check the simulation of EM showers and performance of PIDs.
- Also studying electrons from decay-in-flight muons in the NOvA ND.

ν-e Signal Selection and Background Normalization

- The electrons from ν-e are distinctly forward going
- Best described by small values of $E_e\theta_e^2 = 2m_e(1-y)$
- Background can be normalized using the sideband region to reduce background systematic uncertainty.

NOvA Simulation



Looking Forward

- This analysis uses 8.3E20 POT of FHC data in NOvA ND.
- MC simulation predicts ~290 neutrino-electron scattering events after background subtraction, good for a flux measurement with low statistical uncertainty.
- Data-driven tools are developed to constrain the systematic uncertainty.
- Absolute flux measurement very soon!

Uncertainty Source	Estimated Uncertainty
Signal Efficiency	4.6%
Background Normalization	1.3%
Reconstruction	4.2%
Detector and Beam Simulation	1.4%
Total Systematics	6.5%
Statistic Uncertainty	6.3%
Total Uncertainty	9.1%

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