**Neutrino Tridents**

The type of interaction we are focused on is called neutrino trident production: a weak process in which a neutrino scatters off a nucleus, generating a pair of charged leptons. Specifically, we are interested in trident events that produce two muons in the final state, or “dimuon” events.

Trident production is a Standard Model process, possibly enhanced by new physics!

NOvA’s measurement will be the lowest energy measurement of trident production to date, having a neutrino energy spectrum with peaks at 2GeV and 12GeV.

\[
\frac{\sigma(\nu_\mu \rightarrow \mu^+ \mu^-)}{\sigma(\nu_\mu \rightarrow \mu^+ \mu^-)}_{\text{SM}} = \frac{1.58 \pm 0.64}{(\text{CHARM-II})} \approx 20\text{GeV} \quad [2] \\
0.82 \pm 0.28 \quad (\text{CCFR}) \quad (E_\nu) \approx 160\text{GeV} \quad [3] \\
0.72^{+0.73}_{-0.72} \quad (\text{NuTeV}) \quad (E_\nu) \approx 50 - 300\text{GeV} \quad [4]
\]

**The NOvA Experiment**

NOvA uses the NuMI beam from Fermilab to detect neutrinos at a near detector on site, and a far detector located 810 km away.

The detectors are made of alternating planes of PVC filled with liquid scintillator and optical fibers to collect three-dimensional information about interactions.

**Tridents in NOvA**

Because the near detector is close to the beam, it has very high statistics. With our current dataset we expect to see about 10-20 $\nu_\mu$ events and 10-20 $\bar{\nu}_\mu$ events in NOvA. [5]

Simulated events in the near detector typically have the following topology: [1]

- Two high energy tracks with a signature muon-like dE/dx.
- A very narrow opening angle between the tracks.
- Very low hadronic energy.

**Reconstruction**

Existing reconstruction struggles to resolve between the two tracks because of the narrow opening angles. About 60% of our simulated events have two well-reconstructed tracks.

**Summary**

Neutrino tridents produce a distinctive topology of two long tracks in the near detector, distinguishing them from other $\nu_\mu$ interactions.

NOvA has the potential for a ~30% measurement of neutrino trident production below 20GeV using existing data.

**References**