FERMILAB-POSTER-23-202-STUDENT

Neutral Pion Interactions in MicroBooNE

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MicroBooNE Experiment

The analysis conducted in MicrBooNE will aid experiments, like DUNE, that sit in other energy ranges.

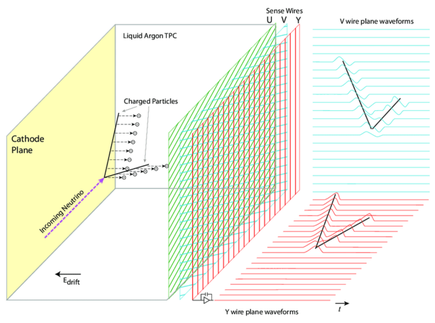


Fig. 1: Liquid Argon Time Projection Chamber (LArTPC) has a cathode and anode plane to create an electric field in the liquid argon. Ionized electrons are generated when charged particles pass through the LAr volume of the detector.

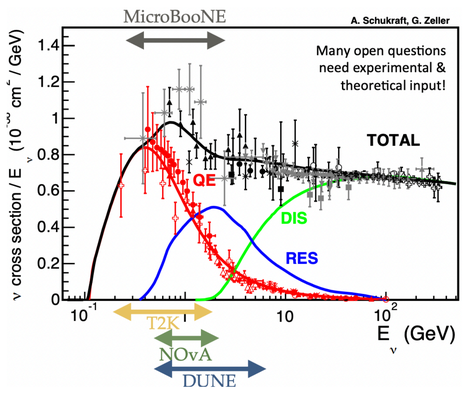


Fig. 2: MicroBooNE sits in the quasi-elastic and resonance region for neutrino interactions, overlapping with DUNE's lower energy area.

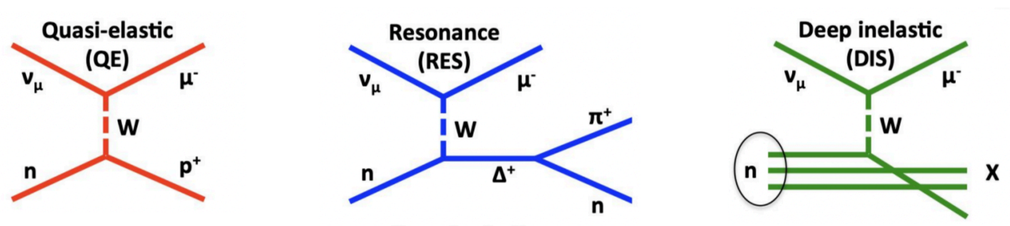


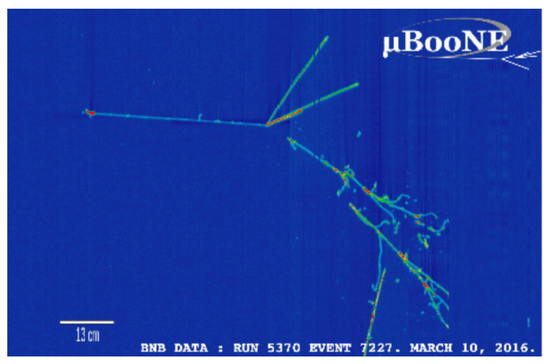
Fig. 3: These Feynman diagrams explain the different kinds of neutrino interaction and the particles found in the final stage.

Types of Neutrino-Nucleus Interactions

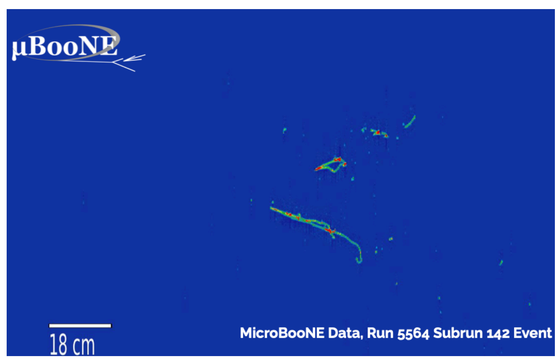
Two types of interactions are produced in the fiducial volume; Charged Current Events (CC) and Neutral Current Events (NC).

CC Signal: $\nu\mu + Ar \rightarrow \mu + 1\ \pi0 + 0\ \pi\pm + X$ (nucleons)

NC Signal: $\nu + Ar \rightarrow 1\ \pi0 + 0\ \pi \pm + X$



Charged Current Event



Neutral Current Event

Fig. 4: Two event displays showcasing the difference between CC (left) and NC (right) events in the detector. Unlike CC, NC does not contain a muon track.

Event Selection

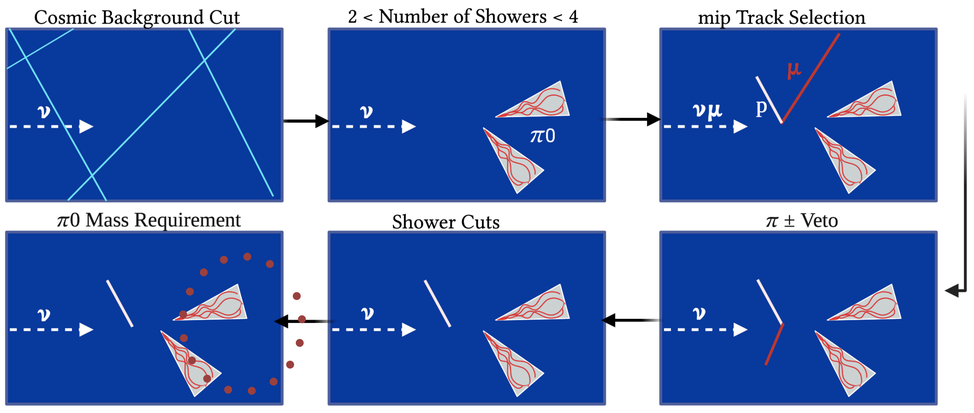


Fig. 5: When sifting through the data, cuts are placed to reduce cosmic background, misidentified neutrino interactions and to differentiate between the CC and NC events.

Cosmic Background

Original Cut-off:
Topological Score > 0.1

New Cut-off:
Topological Score > 0.15

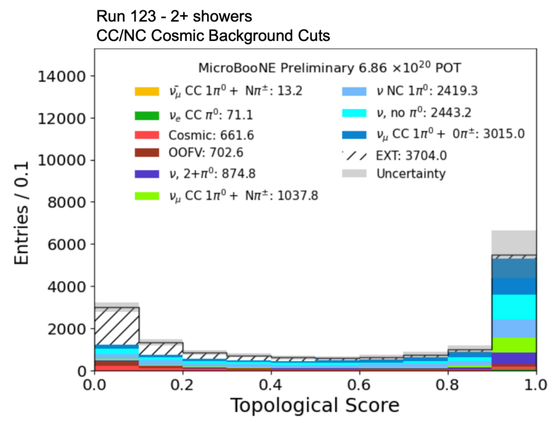


Fig. 6: The Topological Score variable classifies events as either neutrino-like event (1) or cosmic-like event (0).

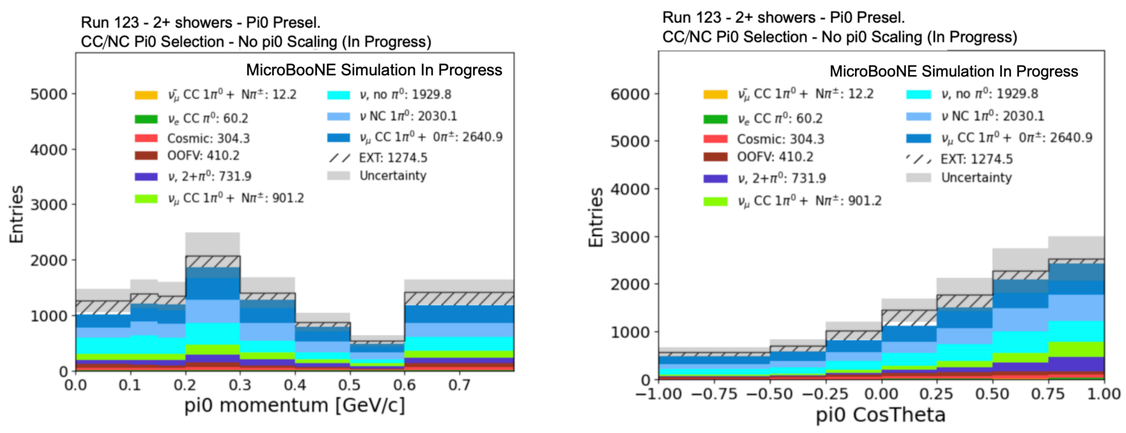


Fig. 7: Basic cosmic background rejection and shower selection requirements (2 or 3 showers) are placed on CC and NC events. Our minimal CC/NC $\pi0$ selection leads to ~50% $\pi0$ purity, with large contribution from both processes.

Neutral Current Event Selection

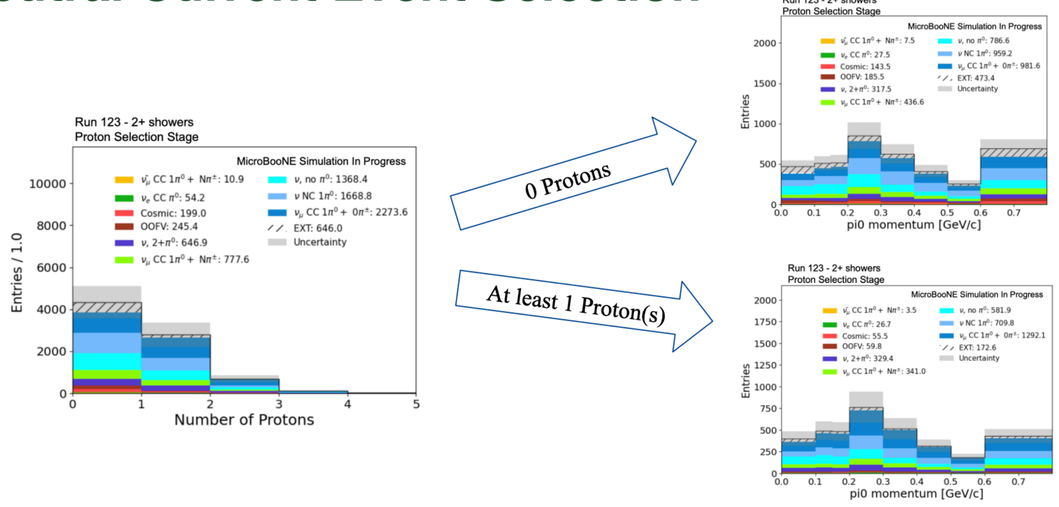


Fig. 8: If a neutral current event has no proton track, the vertex is unclear. Since there are a significant number of NC events with no proton track, these events will need to be included into the signal definition for NC.

Reconstructing the Vertex for NC Events

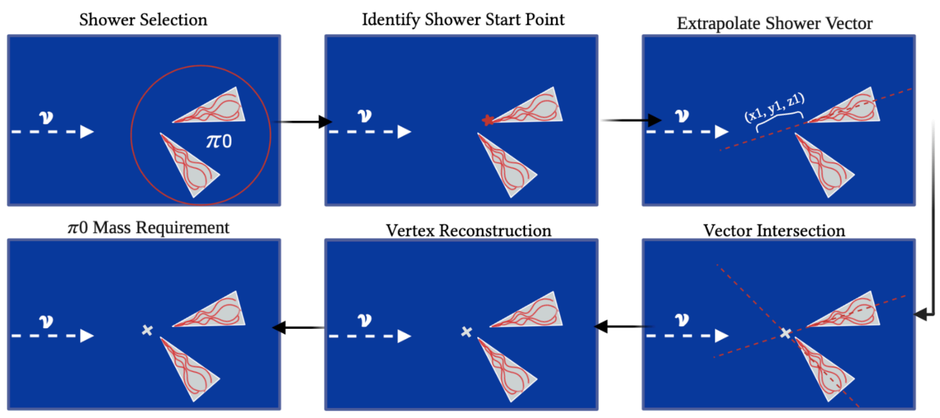


Fig. 9: To reconstruct the vertex, the shower's 3D positions are used to construct unique lines.

Conclusion

- The neutral current signal definition will include events with no proton track
- Improvement in the purity through a new cut on the topological score
- The method of finding the start of the $\pi0$ decay will be extrapolation
- Next Steps: **Calculate the CC/NC ratio for the MicroBooNE experiment**