Measurement of Single Electron Events in MicroBooNE

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MicroBooNE and the Low Energy Excess

- MicroBooNE is a Liquid Argon Time Projection Chamber (LArTPC) neutrino detector located along the Booster Neutrino Beam at Fermilab.
- Primary physics goals:
  - LArTPC R&D
  - \( \nu \rightarrow \mu \) Cross sections
- Investigate and characterize the nature of the MicroBooNE excess.
- MicroBooNE is exploring two hypotheses for the excess of EM events:
  - \( \nu_e \) excess
  - Excess of photons

Single Electron Channel

- The \( \nu_e \) excess is studied by relying on two exclusive and orthogonal channels:
  \[ \nu_e + Ar \rightarrow 1eNp0\pi \quad \nu_e + Ar \rightarrow 1e0p0\pi \]

Single Shower Topology

- Single shower topology: one contained shower within the fiducial volume with zero contained tracks.
- Prompt scintillation light is coincident in time with beam.

Single Shower Selection Performance

- Data unblinded for energy above 0.9 GeV.
- Expected purity of = 47% for electron neutrinos in the 0-2 GeV reconstructed energy range.
- Scaling to the full dataset (1.25E21 POT), we expect 19 1e0p0\pi selected events.

BDT Training

- A single Boosted Decision Tree (BDT) is trained on a dedicated true low energy \( \nu_e \) sample and a \( \pi^0 \) cosmic enhanced sample for background events.
- 28 BDT training variables:
  - shower \( dE/dx \) most important training variable.

Towards the Low Energy Excess

- Sideband strategy: opened events having a reconstructed visible energy \( > 0.9 \) GeV or a BDT score \( < 0.4 \), away from signal region.
- Useful for validation studies:
  - Validate BDT input variables and BDT score at high energies.
  - Validate BDT response over energy spectrum.

Summary

- Presented ongoing measurement of \( \nu_e \) single shower events in the Booster Neutrino Beamline with the MicroBooNE detector.
- First measurement of single shower events in a LArTPC.
- 19 single shower events are expected in the full open dataset with a purity \( = 47\% \) and efficiency \( = 10\% \) at selecting \( \nu_e \) events.
- Framework good at selecting truth 1e0p0\pi events in the high energy sideband region.
- Validation of analysis on sideband shows good performance.
- Looking forward towards a full dataset unblinding.

References:

[1] Search for Electron Neutrinos in Multiple Topologies with the MicroBooNE Experiment (Public Note) MICROBOONE-NOTE-1085-PUB