Constraining the Neutral Current $\pi^0$ Background for MicroBooNE’s Single-Photon Low-Energy Excess Search

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1. NC $\Delta$ Radiative Decay

- Possible source of low-energy excess (LEE) events in MiniBooNE
- Dominant source of single-photon events in MicroBooNE
- ~80% of single-photon backgrounds are neutral current (NC) $\pi^0$'s

2. Analysis Flow

1. Select Signal Topology
   - Take Pandora [3] reconstructed tracks and showers
   - Select events with two shower (2$\gamma$) and either one or zero tracks (sp or op)

2. Background Rejection
   - Use tailored Boosted Decision Tree (BDT) trained on background events
   - Result is the world's highest-stats NC $\pi^0$ selection on Argon

3. High-Stats NC $\pi^0$ Selection
   - Constrain single-photon NC $\pi^0$ background
   - See poster by G. Yarbrough

4. Initial Selection

5. BDT Training
   - Train BDT on 10 various kinematic and calorimetric variables in simulation
   - Choose variables with high separation power between signal and background
   - Example: track $dE/dx$ Energy deposition per unit length
   - Isolates events with proton tracks (higher $dE/dx$) for 2$\gamma$0p selection
   - Peak at 2 MeV/cm mostly from minimally-ionizing muon tracks

6. BDT Response

   - Cut on BDT response to maximize efficiency times purity in final selection

7. Final Selection

8. Summary

- Demonstrated world's highest-stats NC $\pi^0$ selection on Argon
- Still more data to process!
- Provides excellent background constraint for single-photon LEE search

References