Measuring Transverse Momentum Imbalance in MINERvA's Nuclear Targets

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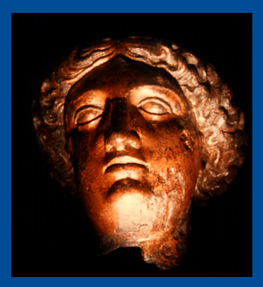
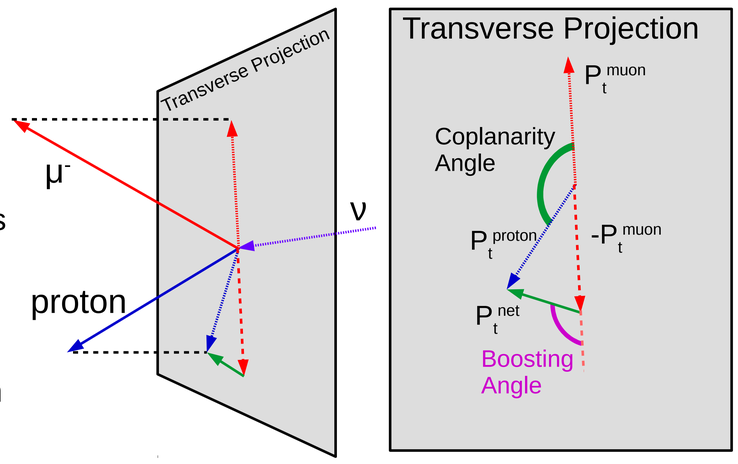
On Behalf of the MINERvA Collaboration



Introduction

- Neutrino-nucleus interaction is complex convolution of many nuclear effects
  - Fermi motion
  - Final State Interactions: proton interacts with nucleus before leaving
- Separate out nuclear effects using transverse momentum projection and muon + proton final state [1][2]
- MINERvA's Medium Energy run → study nuclear targets with high statistics

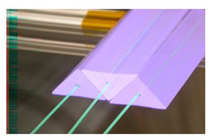


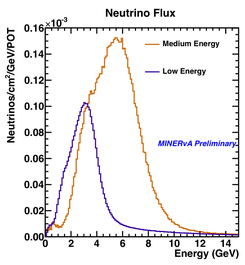
Muon doesn't interact with interaction nucleus.

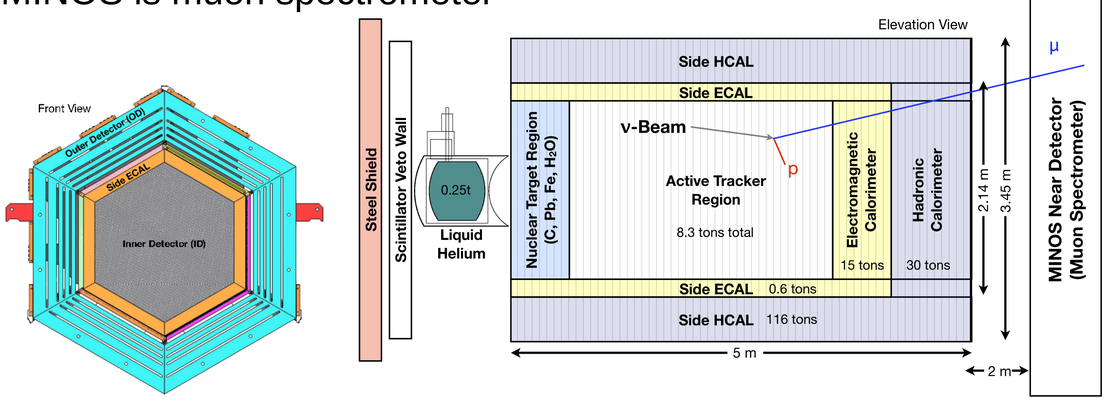
Coplanarity angle → proton deflection
Boosting angle → other FSI effects

MINERvA Detector

- Fine-grain scintillator strip detector
- Inside NuMI Beam
- MINOS is muon spectrometer

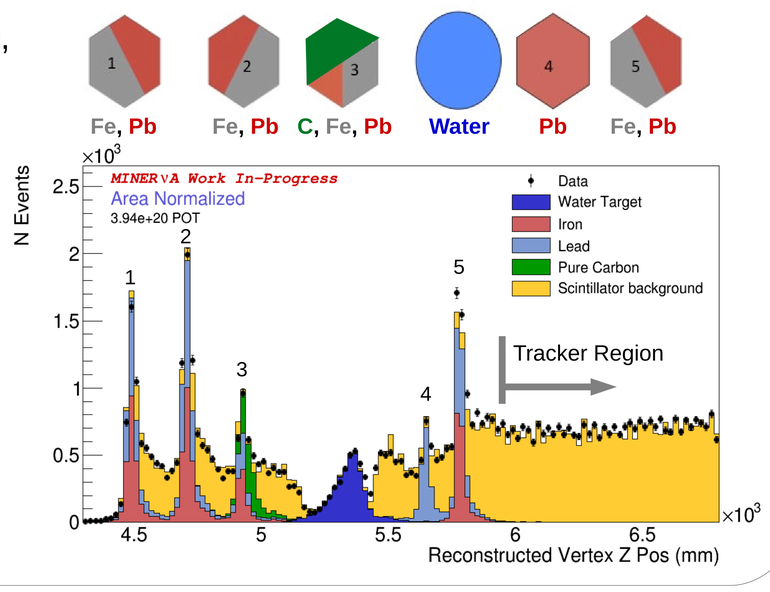






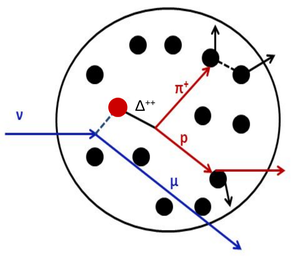
Nuclear Targets

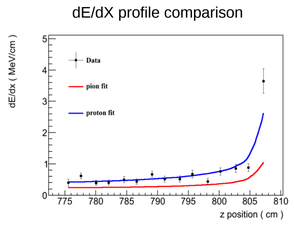
- Pure carbon, water, iron, and lead
- Separate events based on reconstructed vertex position
- Understand scaling of nuclear effects as function of target nucleus

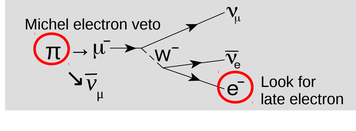


Signal Selection

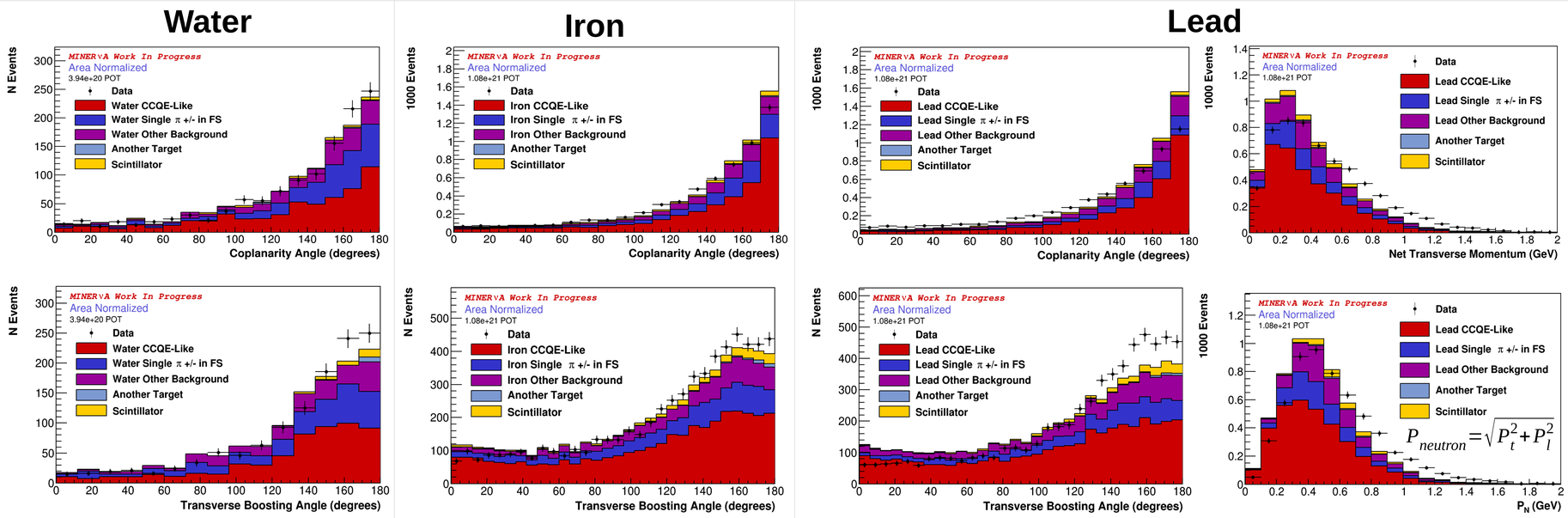
- Final state is Charged Current 0 Pion (CC0Pi):
  1 Muon
  no mesons
  no gammas > 10 MeV (usually from Pi^0)
  1 or more protons
- Final State Interactions (FSI) make differentiating pure muon + proton events from CC0Pi events difficult
- More closely matches capabilities of proton-blind detectors
- Proton/pion seperation using michel electron veto and dE/dX
  - Proton momentum reconstructed via dE/dX
- Remove events with 2+ pockets of isolated energy
  - Photons from pi^0s
- Backgrounds tuned via sideband procedure







Results



- Trend: Simulation and data discrepancy gets greater as nucleus gets heavier
- Lead's transverse boosting angle suggests the modeling of FSI in lead needs work

Summary

- Transverse variables separate nuclear effects
- Able to measure per-nucleus
  - See trend as function of nucleus size
- High statistics measurement
- Statistically significant differences to simulation
- Results coming soon

References:
[1] A. P. Furmanski and J. T. Sobczyk, Phys. Rev. C **95**, 065501 (2017).
[2] X. Lu, et al. [MINERvA Collaboration], arXiv:1805.05486 [hep-ex]