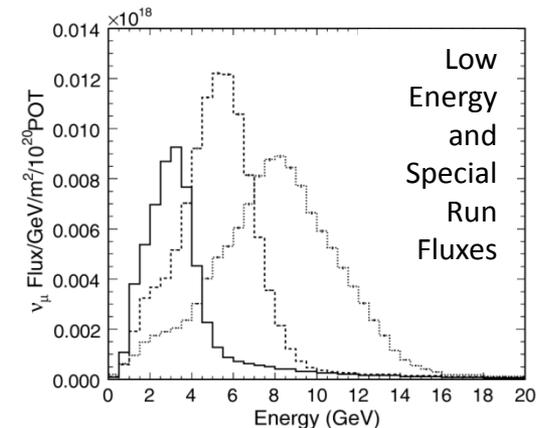


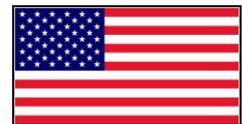
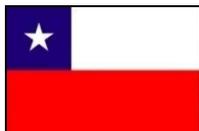
MINERvA Overview



- MINERvA is studying neutrino interactions in unprecedented detail on a variety of different nuclei
- Low Energy (LE) Beam Goals:
 - Study both signal and background reactions relevant to oscillation experiments (current and future)
 - Measure nuclear effects on exclusive final states
 - as function of a measured neutrino energy
 - Study differences between neutrinos and anti-neutrinos
 - Precise understanding important for oscillation expt's
- Medium Energy (ME) Beam (NOvA) Goals:
 - Structure Functions on various nuclei
 - Study high energy feed-down backgrounds to LBNE
- NuMI Beamline Provides
 - High intensity, Wide range of available energies
- MINERvA detector Provides
 - Reconstruction in different nuclei, broad range of final states



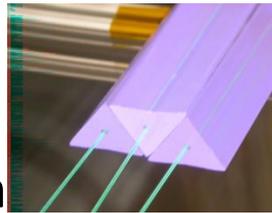
~100 Particle, Nuclear, and Theoretical physicists from 22 Institutions



MINERvA Detector Basics



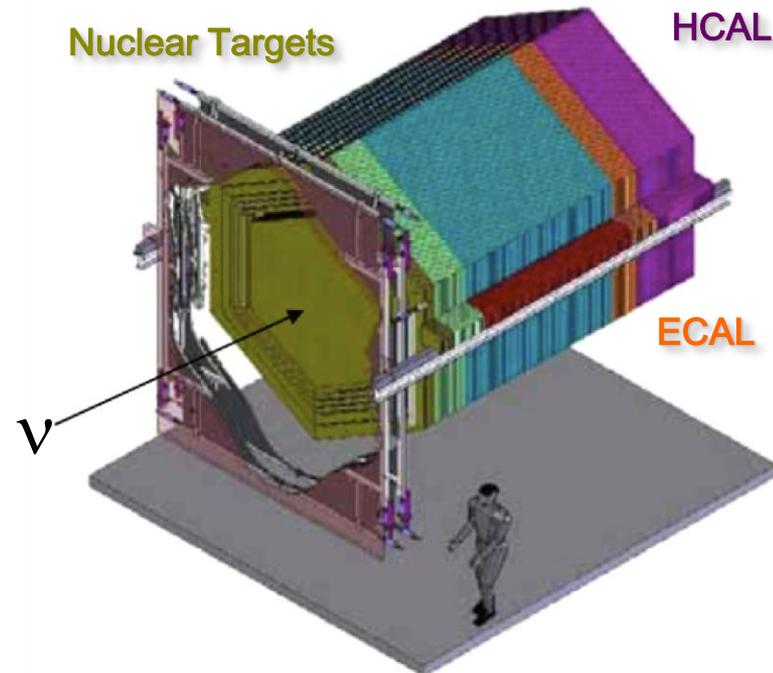
- Nuclear Targets
 - Allows side by side comparisons between different nuclei
 - Solid C, Fe, Pb, He, water
- Solid scintillator tracker
 - Tracking, particle ID, calorimetric energy measurements
 - Low visible energy thresholds
- Side and downstream Electromagnetic and Hadronic Calorimetry
 - Allow for event energy containment
- MINOS Near Detector
 - Provides muon charge and momentum



Nuclear Targets



cryogenic target

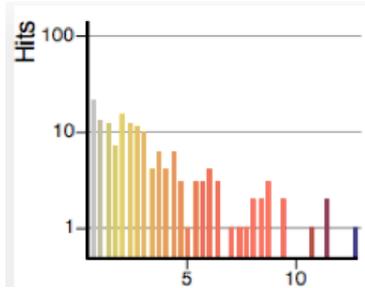




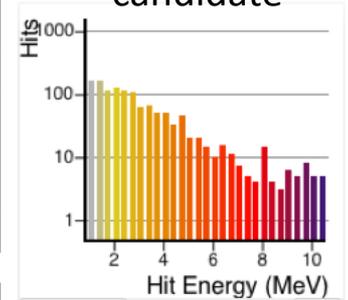
MINERvA Data

- One out of three views shown, color=energy

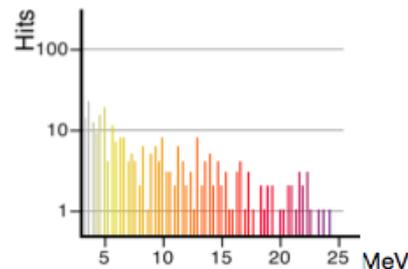
Quasi-elastic candidate



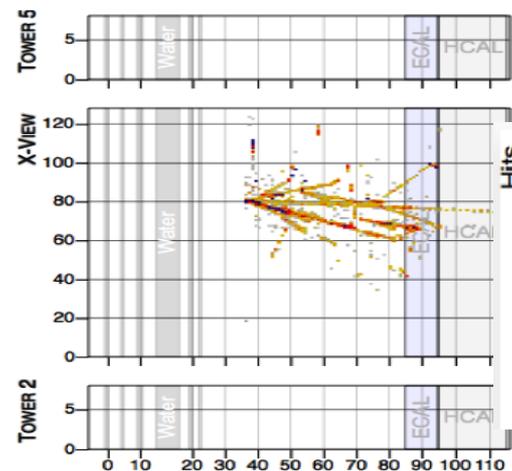
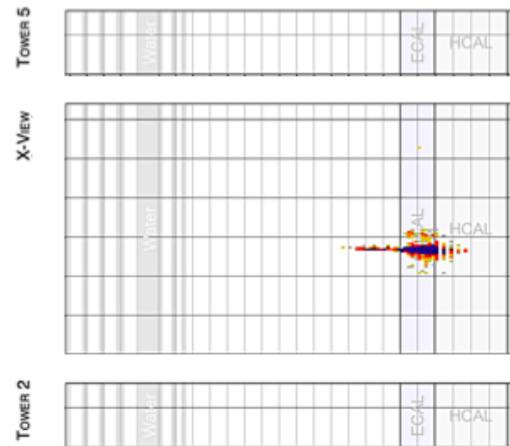
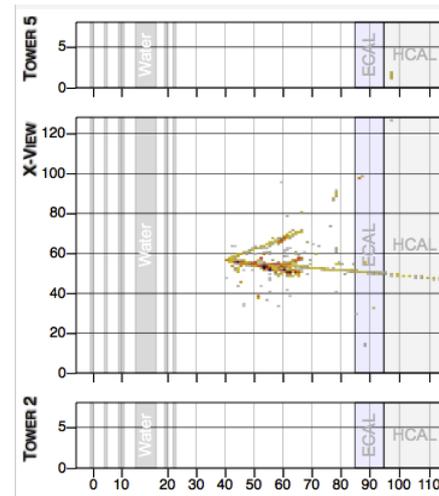
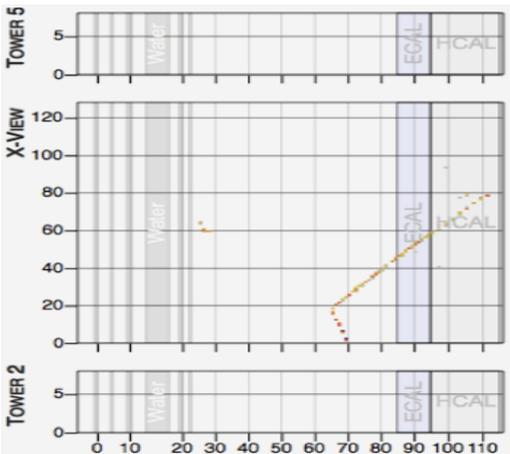
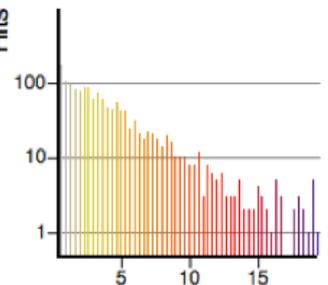
Resonant candidate



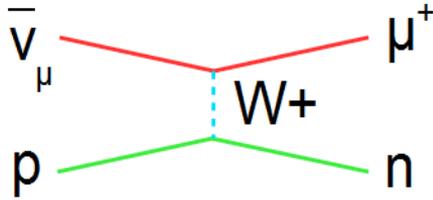
Single Electron candidate



Deep Inelastic Scatter candidate

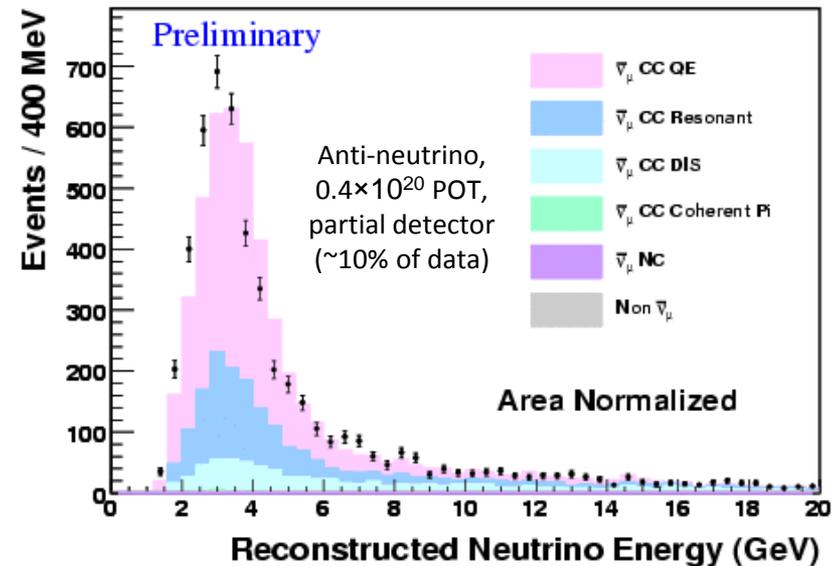
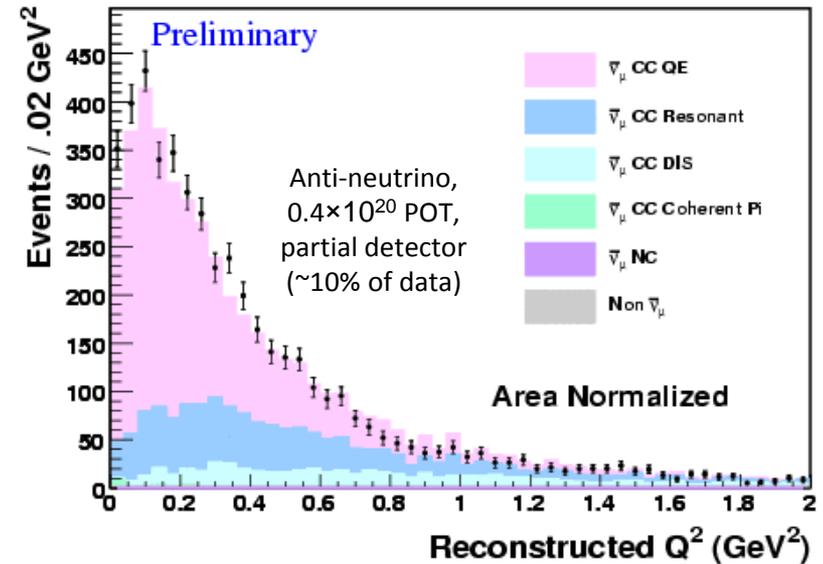


MINERvA: Quasi-Elastic Analysis



- Relatively Simple Final state
 - Require Muon, plus little or no extra energy
- Primary interaction type for neutrino oscillation experiments
- Measuring muon energy and angle (with respect to the beam) reconstructs a quasi-elastic interaction:
 - neutrino energy
 - momentum transfer to nucleon (Q^2)
- Preliminary analysis of first half of anti-neutrino data taken during final detector construction period, represents about 1/10 of current data set.
 - Statistical errors only

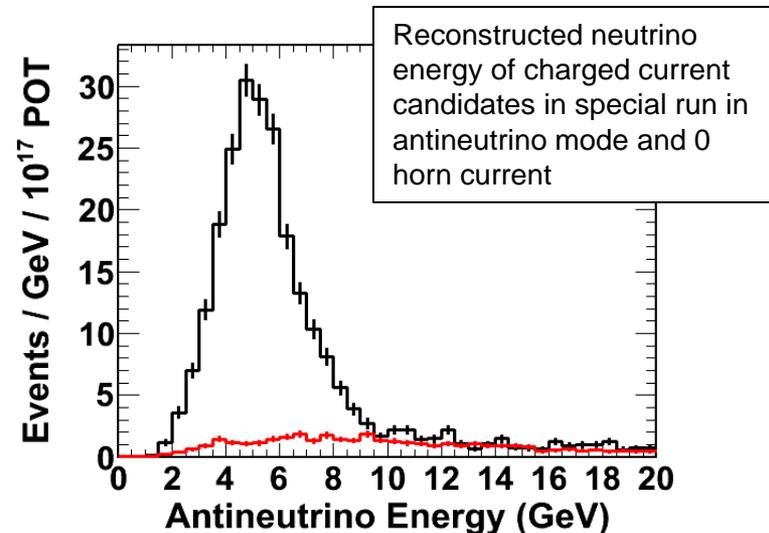
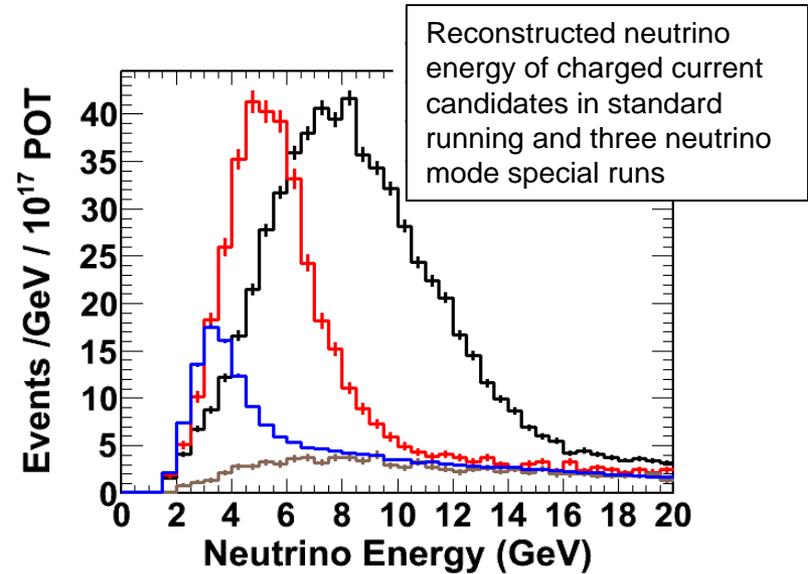
$$Q^2 = 2 E_{\bar{\nu}_\mu}^{QE} (E_\mu - p_\mu \cos(\theta_\mu)) - m_\mu^2$$



MINERvA: Special Runs to understand Neutrino Flux



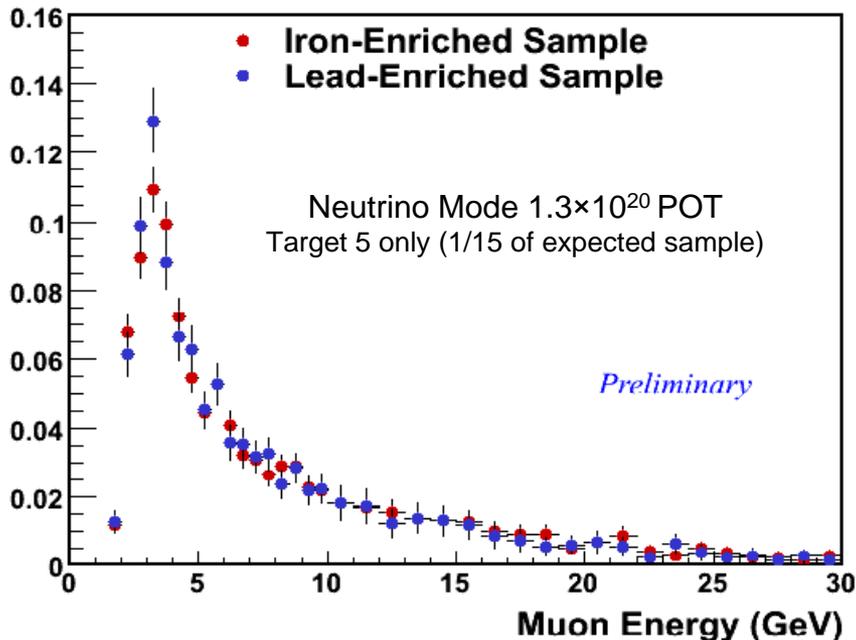
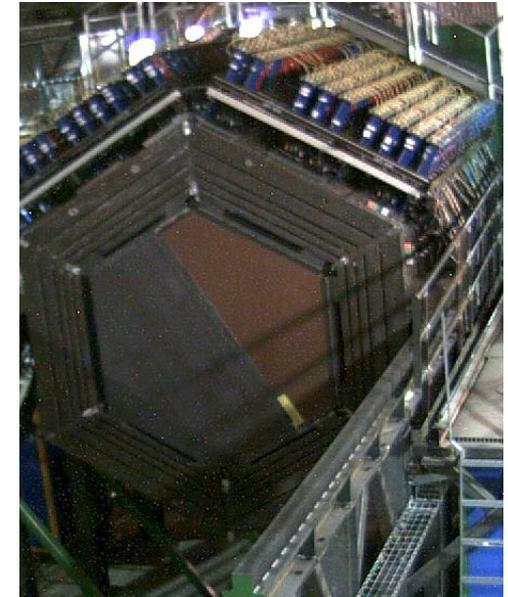
- Goal: to test flux model by taking neutrino data in several different configurations
 - Map through pion production spectrum
 - Change transverse and longitudinal focusing
 - Standard candle cross sections should be independent of incident neutrino flux
- Capability unique to NuMI beamline
- Standard candles available:
 - Inclusive Charged Current events
 - Quasi-Elastic Events
- Have taken 4 special run configurations
 - Medium, High energy target positions
 - Horn off data (no focusing)
- Developing Data Reconstruction and Flux Tuning Infrastructure in parallel



MINERvA: Nuclear Target Analysis



- MINERvA has 5 solid nuclear targets
 - Different thicknesses good for different analyses: most downstream target best for exclusive final state analyses
- First look at inclusive Charged Current (CC) events from Fe and Pb



First shown at NuINT'11, Dehradun India

Target	Fiducial Mass	ν_{μ} CC Events in 4×10^{20} POT
Plastic	6.43 tons	1363k
Helium	0.25 tons	56k
Carbon	0.17 tons	36k
Water	0.39 tons	81k
Iron	0.97 tons	215k
Lead	0.98 tons	228k