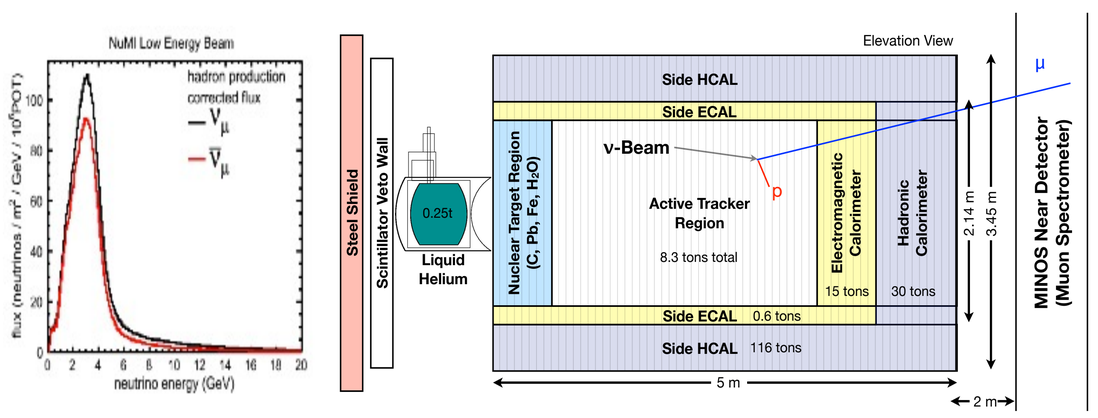
Charged Current Coherent Pion Production and Charged Current Charged Pion in MINERvA

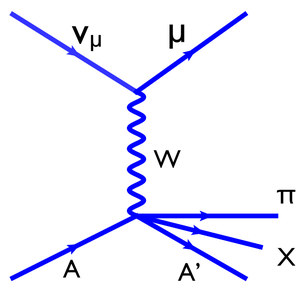
Aaron Higuera
Universidad de Guanajuato
(on behalf of the MINERvA collaboration)

MINERvA is a dedicated neutrino cross section experiment

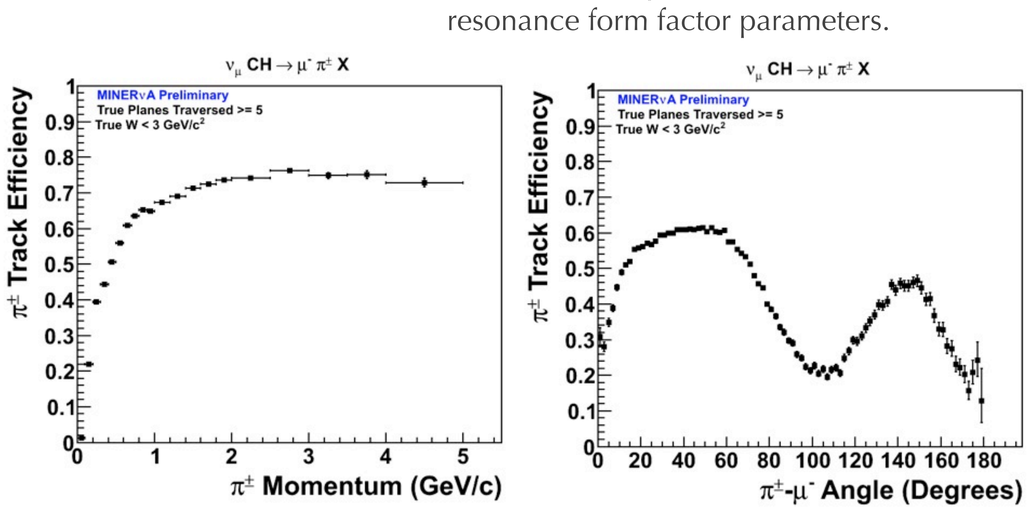
- MINERvA makes use of the configurable NuMI beam at Fermilab. At right the low energy (LE) distribution for neutrinos and antineutrinos
- Single detector with multiple targets (He, C, H_2O, Fe and Pb) allows study of nuclear effects and A-dependence in neutrino interactions.
- Compact, fully-active detector design provides excellent detail in complex final states.
- MINERvA can provide an important input to present and future neutrino oscillation experiments.



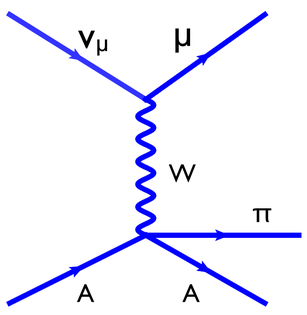
Charged Current Charged Pion Production



- Predominantly resonances and deep inelastic scattering and also due to final state interactions.
- Resonance component responsible for an important background systematic in neutrino oscillation experiment.
- Δ-rich sub-sample could be used to measure resonance form factor parameters.

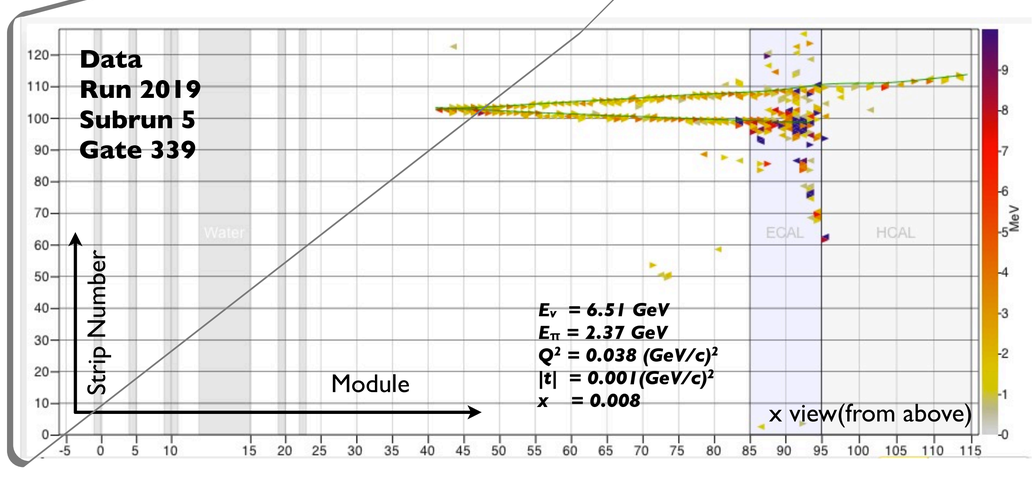


Charged Current Coherent Pion Production



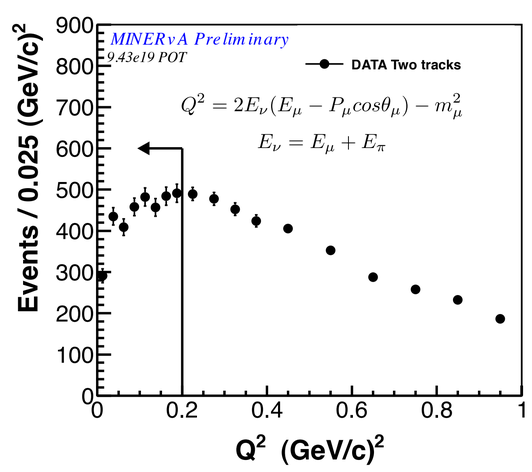
- The defining feature of the interaction is that the hadronic final state contains a single pion and a residual nucleus is in its ground state.
- Coherent interactions have a great practical application to neutrino experiments because NC coherent pion production is part of the background to the ν_e appearance measurement.
- The cross sections are low and backgrounds (usually from resonance pion production processes) are large.
- Measurements have been made for CC, however the latest measurements could not find evidence at the very lowest energies. NC coherent has only been estimated from the sum of signal plus background.

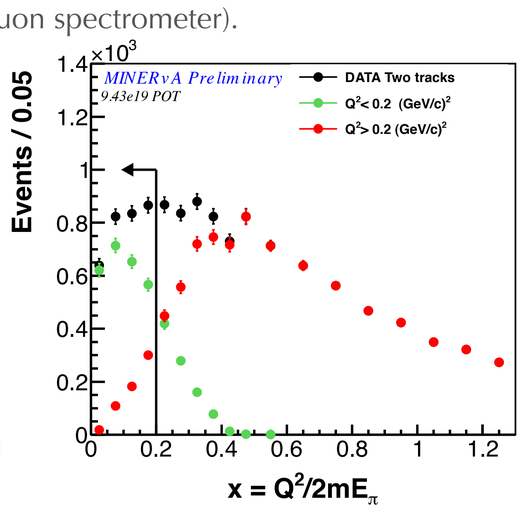
Charged Current Coherent Pion Candidate



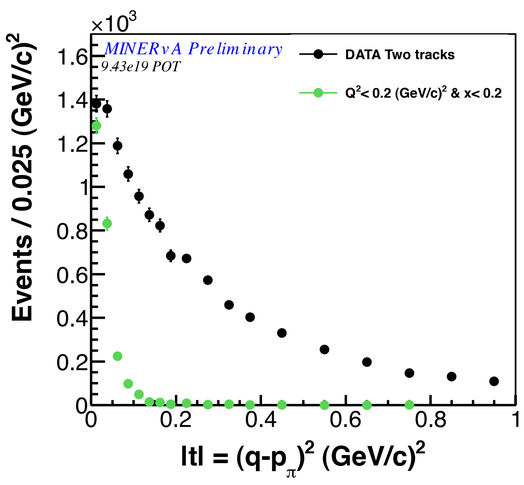
Towards a Data-Driven Analysis

- For CC pion production (coherent and non-coherent process) almost all Monte Carlo neutrino event generators rely in Rein-Sehgal model with small modifications. Nevertheless this model has been shown to have problems. Until the MC models are fixed, use the data to isolate the sample of CC coherent candidates.
- According to Partially Conserved Axial vector Current models (PCAC) CC coherent pion production must be produced at very low Q^2 ($Q^2 < m^2_\pi$) in order to be in the PCAC regime.
- MINERvA will take that assumption as a start point in its effort to isolate CC coherent pion production. This analysis requests two tracks coming out of a common vertex in the tracker and one of them identified as a muon using MINOS near detector (MINERvA muon spectrometer).

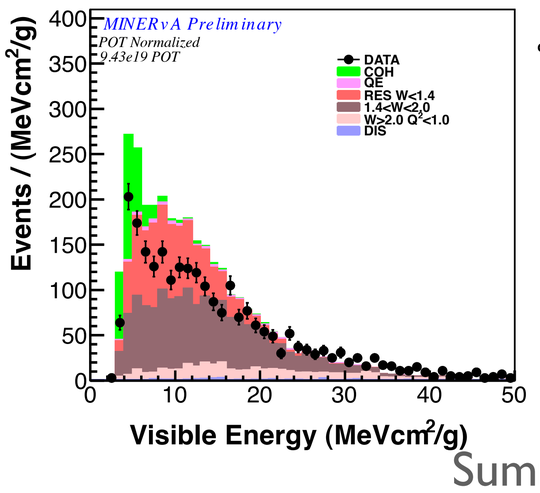




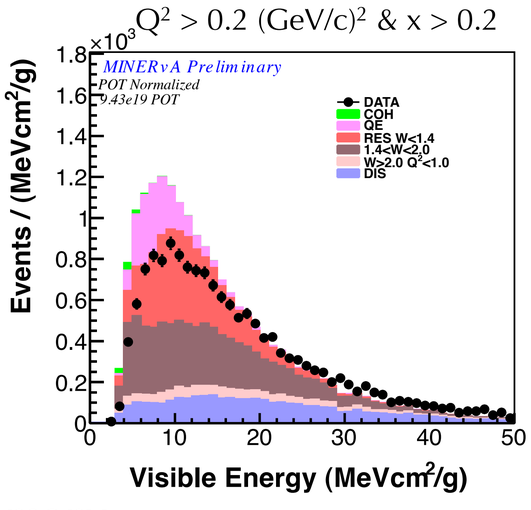
- A $Q^2 < 0.2$ (GeV/c)² cut emphasize small x for coherent pion production, since $\langle E_\pi \rangle$ for coherent is larger than $\langle E_\pi \rangle$ for resonances, a $x < 0.2$ cut enriches the coherent sample
- Since the 4-momentum transfer to the nucleus $|t| = (q\text{-}p_\pi)^2$ must be small the energy at the vertex should be consistent with two minimum ionizing particles.



$Q^2 < 0.2$ (GeV/c)² & $x < 0.2$



$Q^2 > 0.2$ (GeV/c)² & $x > 0.2$



Summary

- MINERvA's fully active detector allow us to study vertex activity.
- With high statistics and better tracking capabilities MINERvA will provide a precision measurement of the coherent pion production cross section.