Status of the MINERvA Experiment

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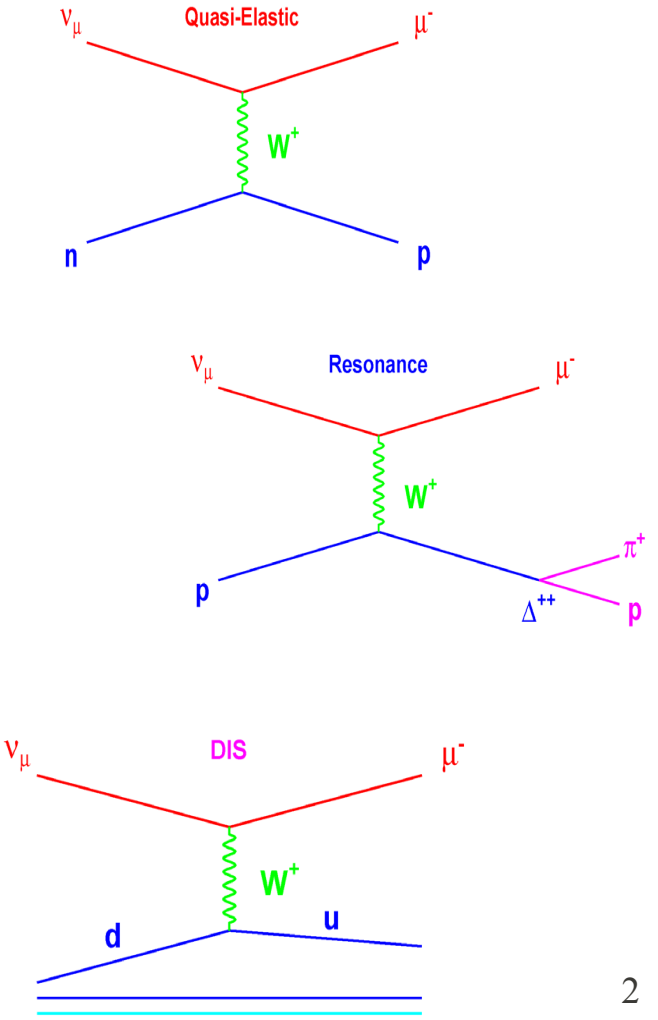
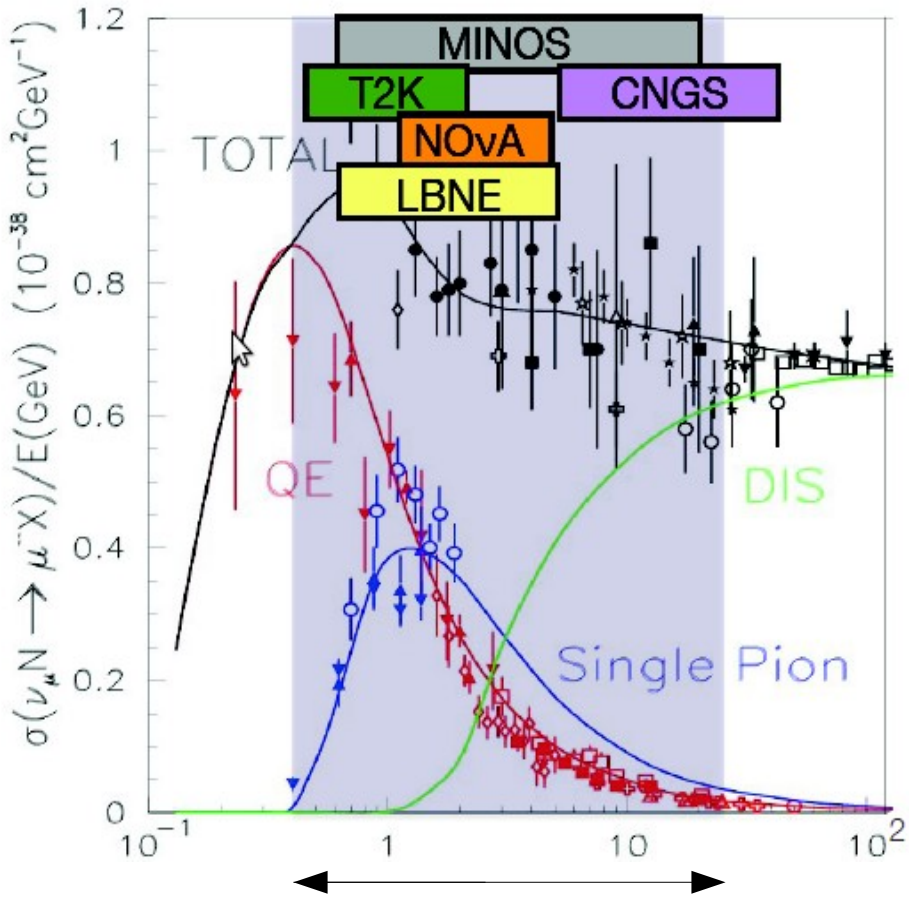
MINERvA Goal

- MINERvA is a neutrino-nucleus interaction experiment in the NuMI beamline at Fermilab
- Purpose: Measure cross section precisely in 1-10 GeV region for:
  - Charged and neutral current quasi-elastic
  - Resonance production, Δ(1232)
  - Resonance↔deep inelastic scatter, (quark-hadron duality)
  - Deep Inelastic Scattering
- Study A dependence of ν interactions for various nuclei



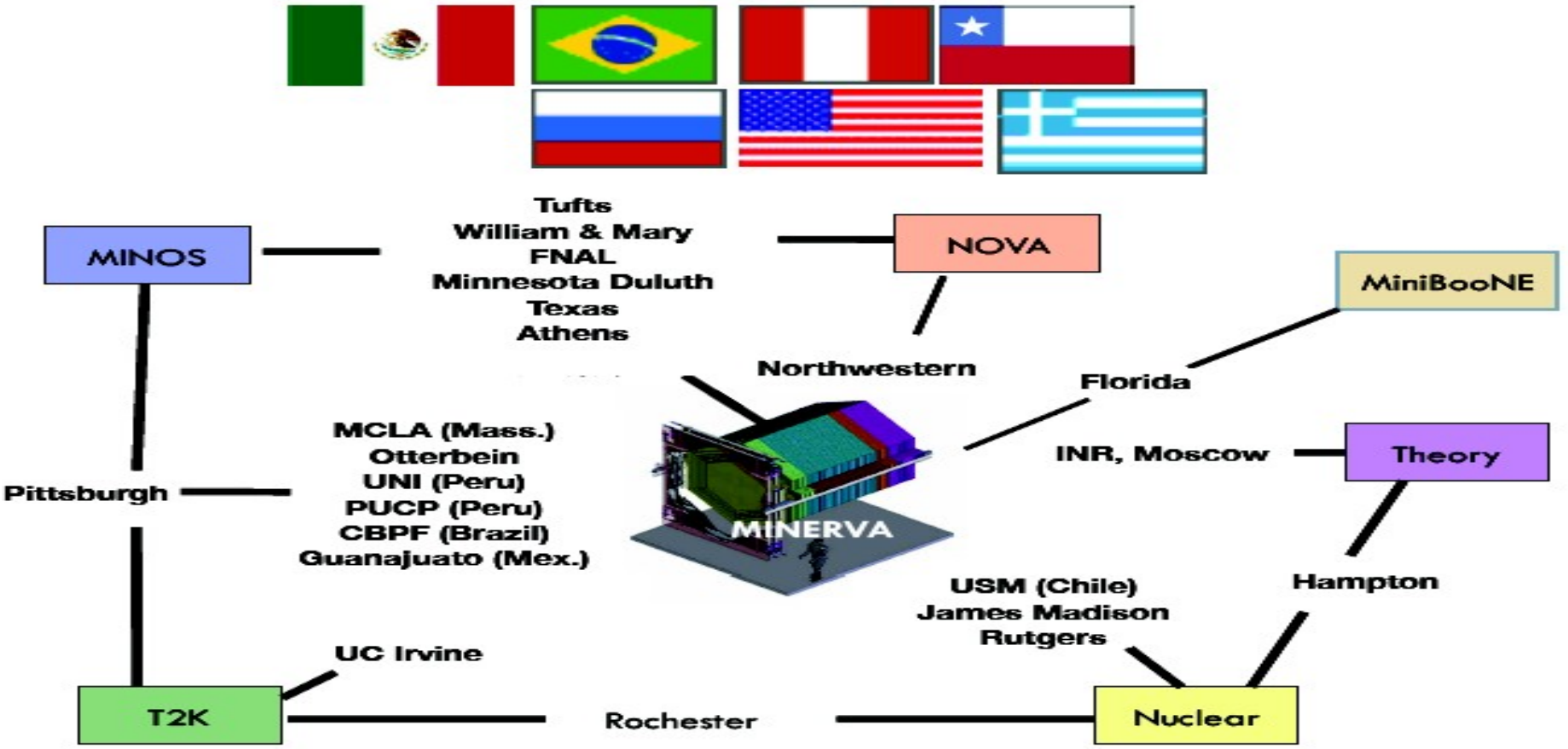
MINERvA Motivation

- Low energy (<10 GeV) cross sections not well understood, and many current and future neutrino oscillation experiments depend on these parameters
- Many current measurements and uncertainties are based on bubble chamber experiments or wide band neutrino beams at low energy
- These suffer from low statistics, poorly understood flux and high A material nuclear effects



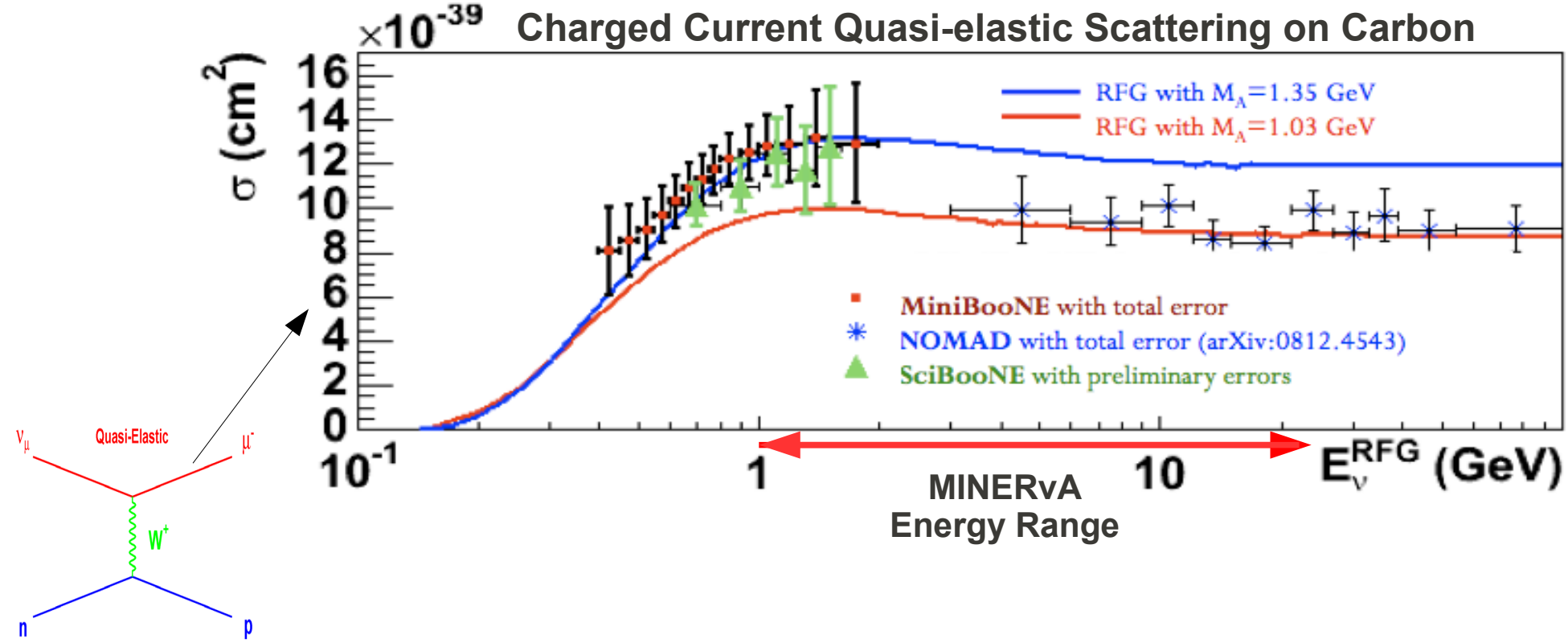
MINERvA Collaboration

The MINERvA collaboration currently constitutes about 80 nuclear and particle physicists from 21 institutions and 7 countries



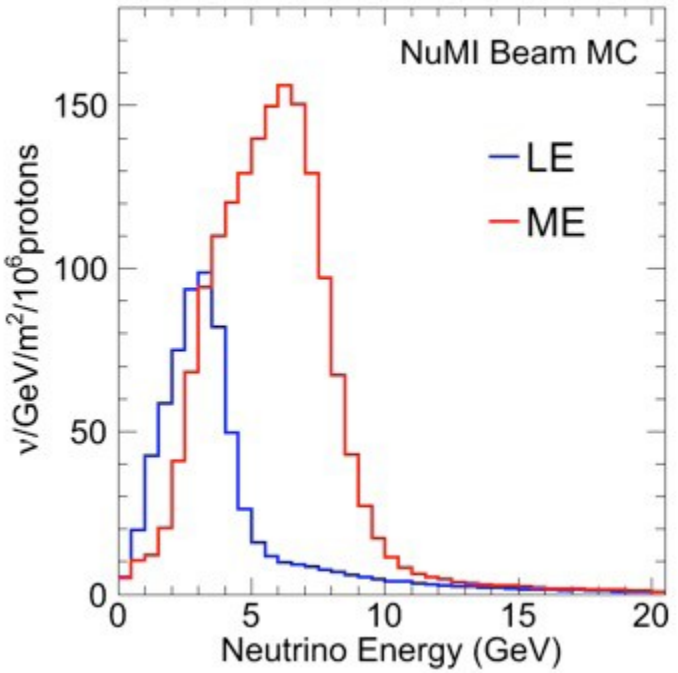
MINERvA Motivation cont.

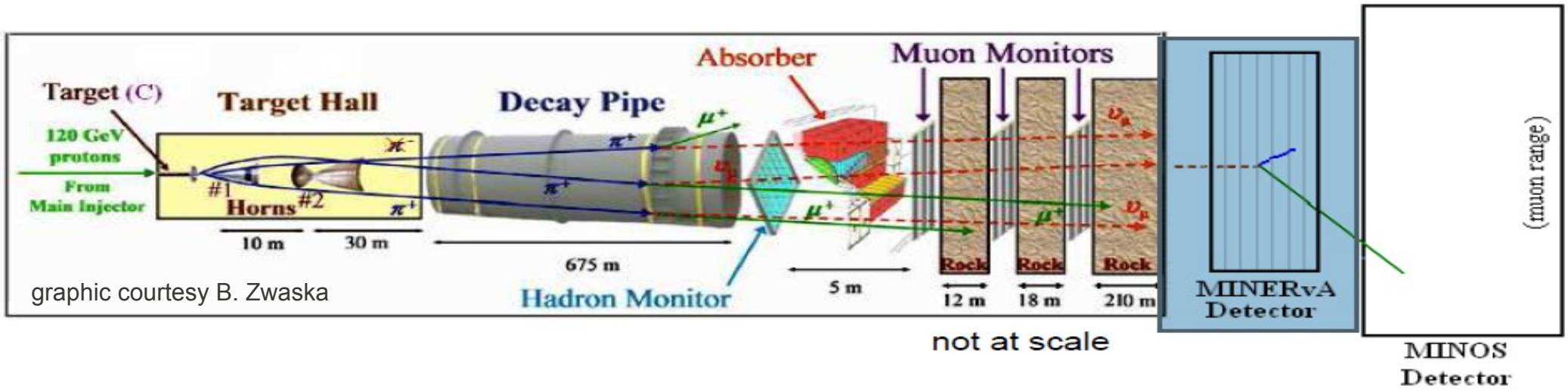
- Even more recent measurements do not always agree!
- MiniBooNE and SciBooNE data agree with each other but conflict with NOMAD results at higher energy
- MINERvA is in a good position to examine this discrepancy



NuMI Beam

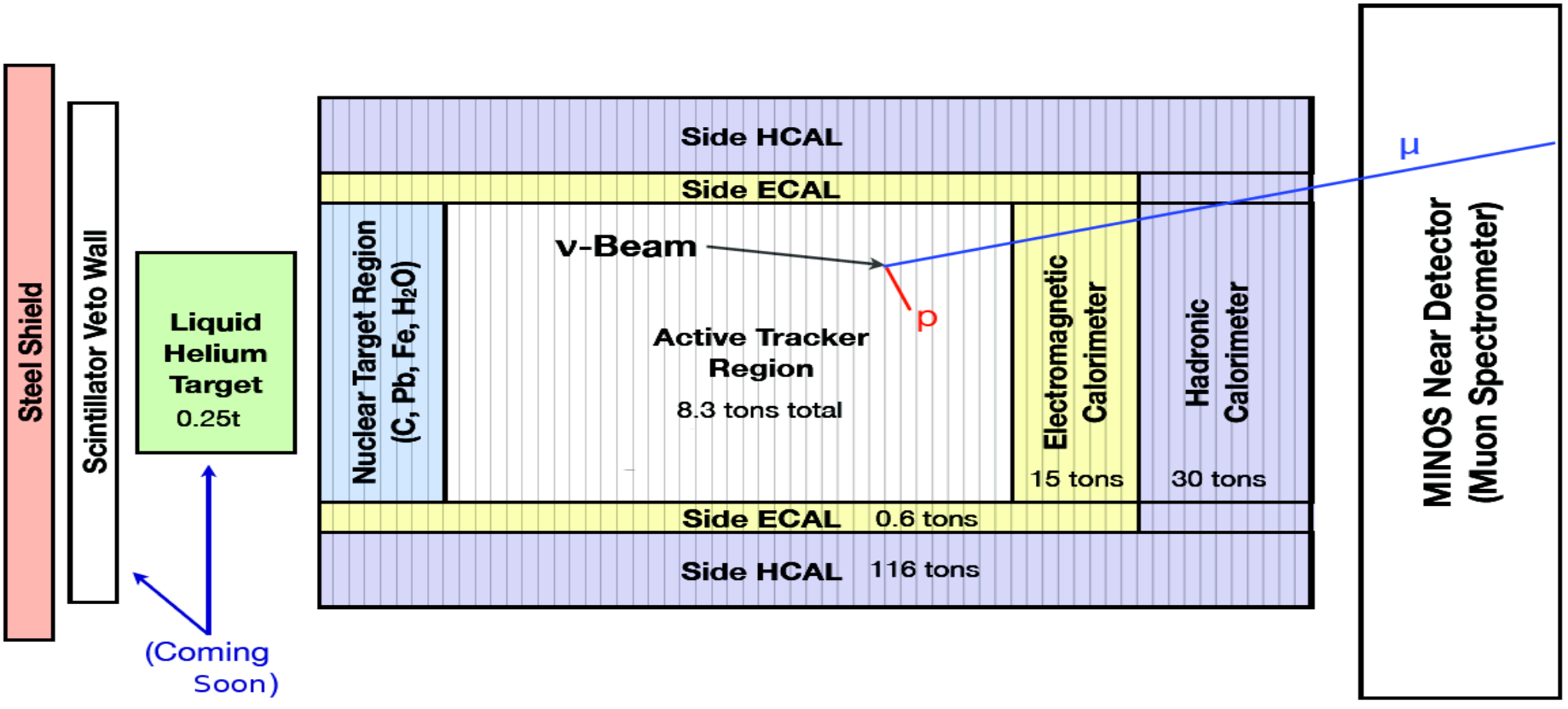
- The MINERvA detector sits in the NuMI beamline between the muon monitors and the MINOS detector
- NuMI provides either ν_μ or anti-ν_μ beam by sign selecting with magnetic horn
- Have 35e12 protons on target(POT) per spill at 120 GeV with a beam power of 300-350 kW at ~.5 Hz





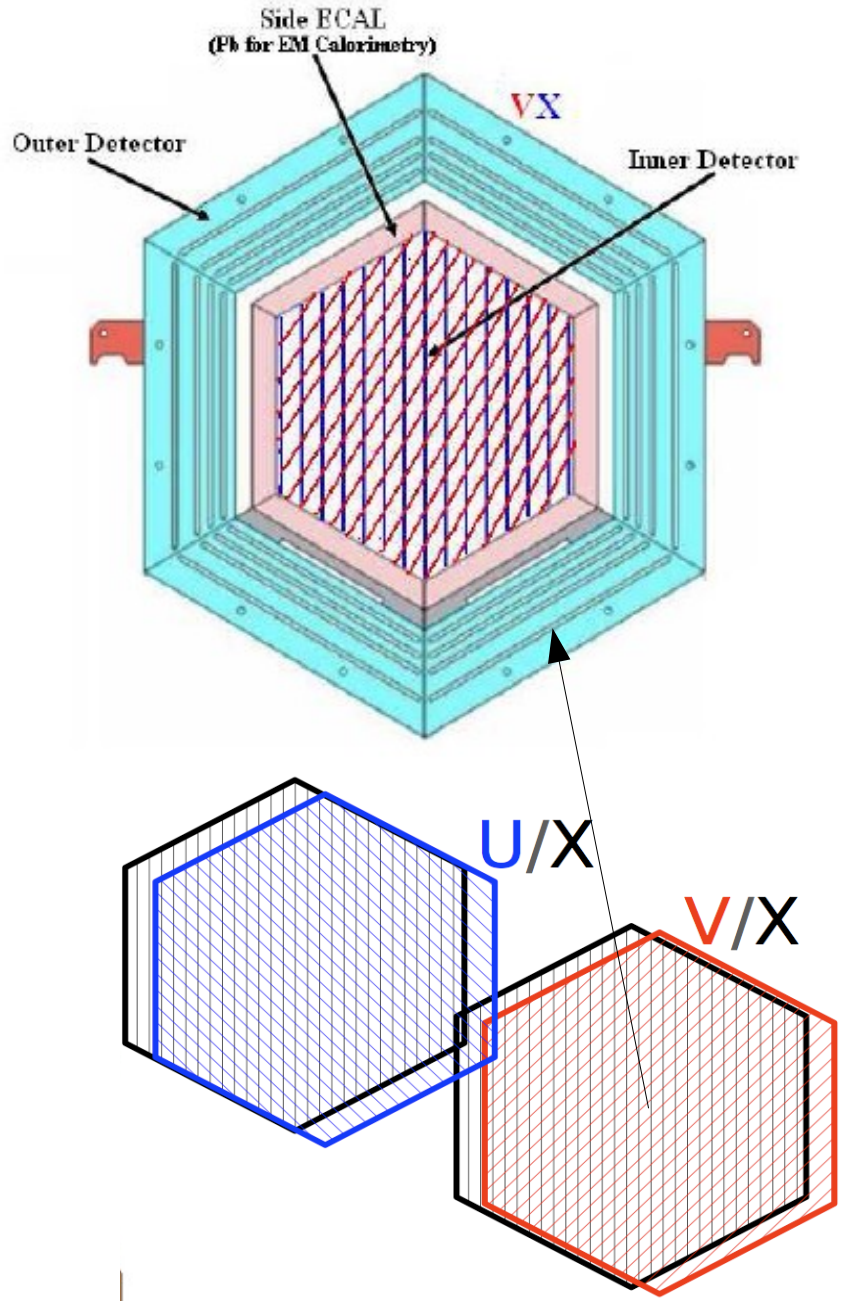
MINERvA Detector

- MINERvA is an active segmented scintillator detector with nuclear targets of C, Fe, and Pb (H_2O and He coming soon)
- Having all targets in same detector reduces systematic errors between nuclei
- Have 120 modules of four types: nuclear target, tracker, ECal and HCal

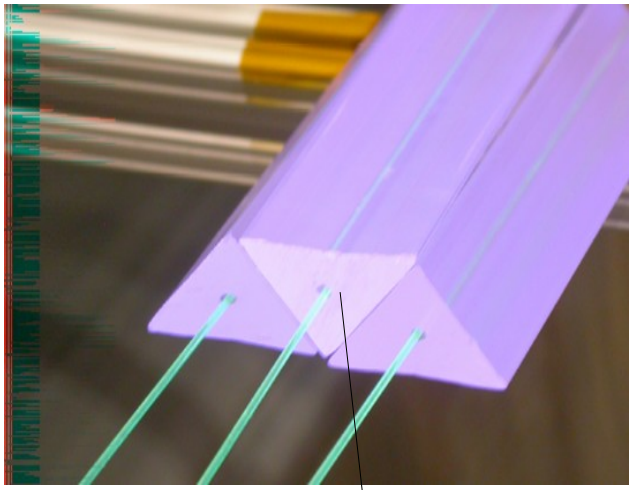


MINERvA Detector cont.

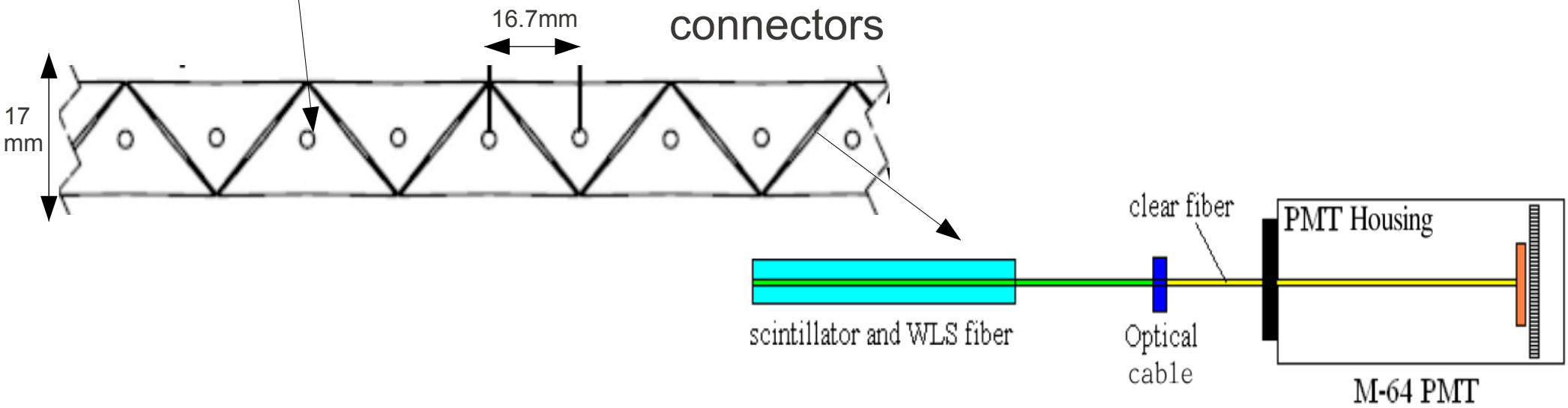
- Each module is composed of:
- A lead collar which acts as a side ECal
- An outer detector for hadron calorimetry made of iron and permeated with scintillator bars to detect exiting particles
- An inner detector made of layers of scintillator bars in either a UX or VX configuration
- X layers are vertical and U and V layers are rotated 60 degrees in either clockwise or counterclockwise direction



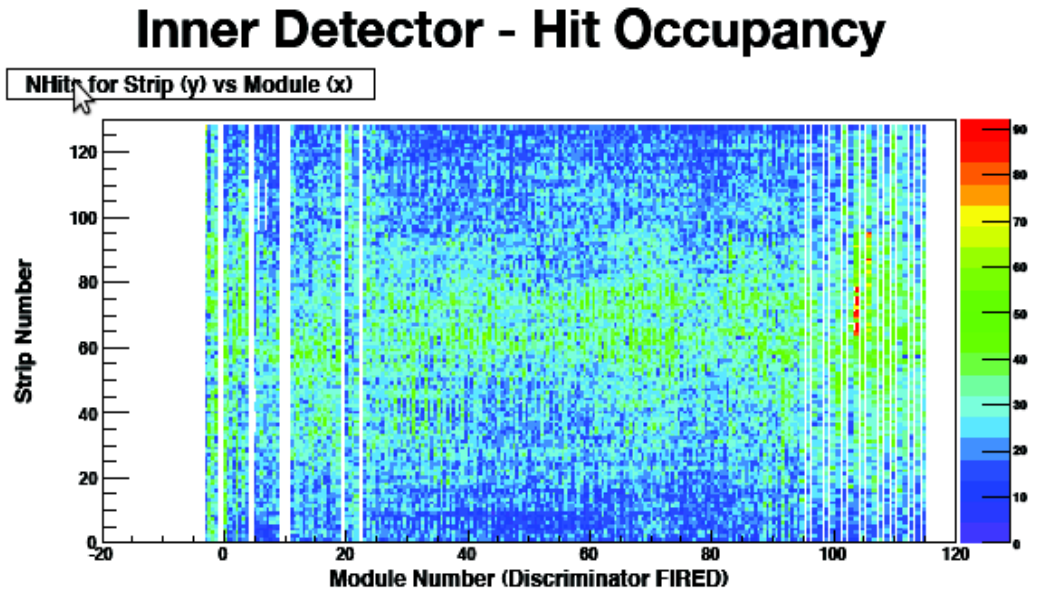
MINERvA Detector cont.

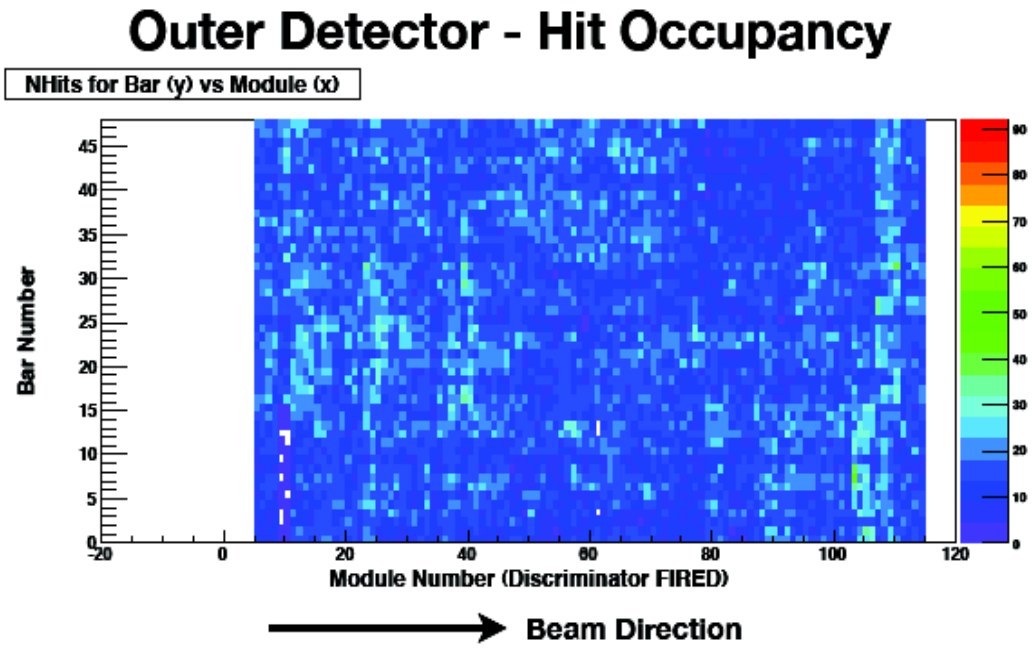


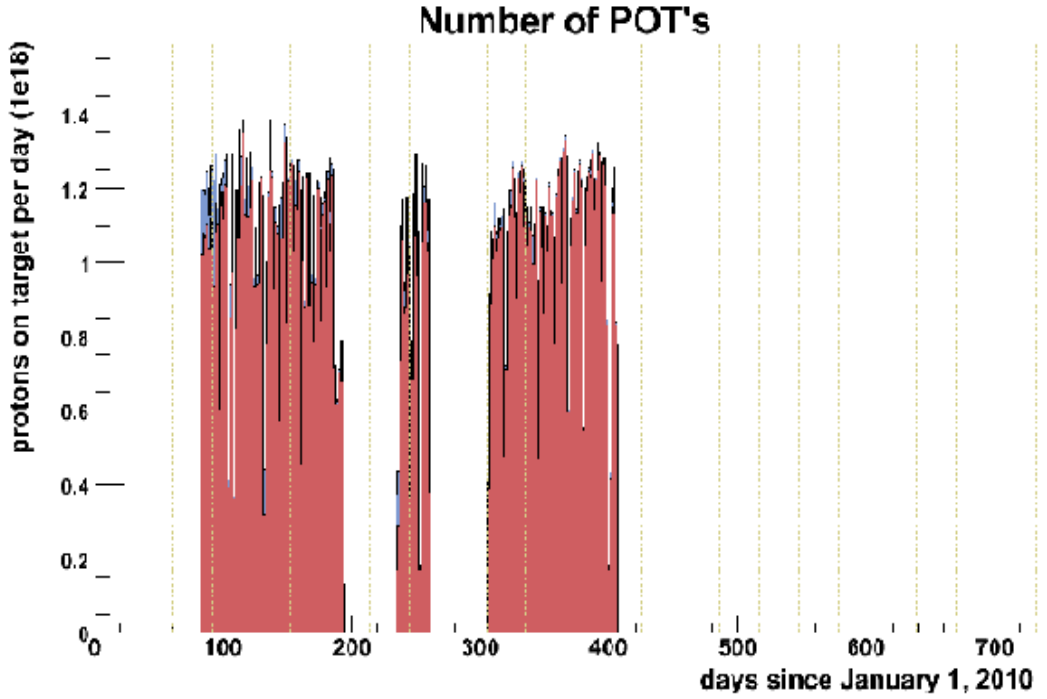
- MINERvA uses doped polystyrene triangular scintillator bars with embedded wavelength shifting fibers
- Triangular shape allows greater position resolution via charge sharing(transverse position resolution of ~3mm)
- 127 strips per plane
- WLS fiber connects to PMT box via optical connectors



Data Quality







- >98% livetime since November
- Check live channels and occupancy
- ~20(inner) and ~10(outer) dead channels of ~32,000 total

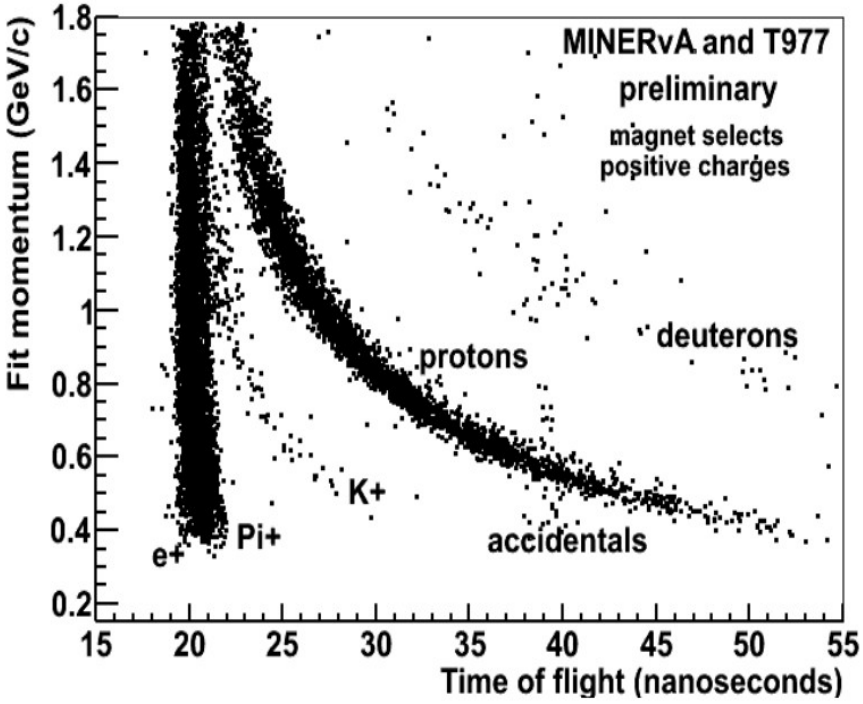
MINERvA Test Beam

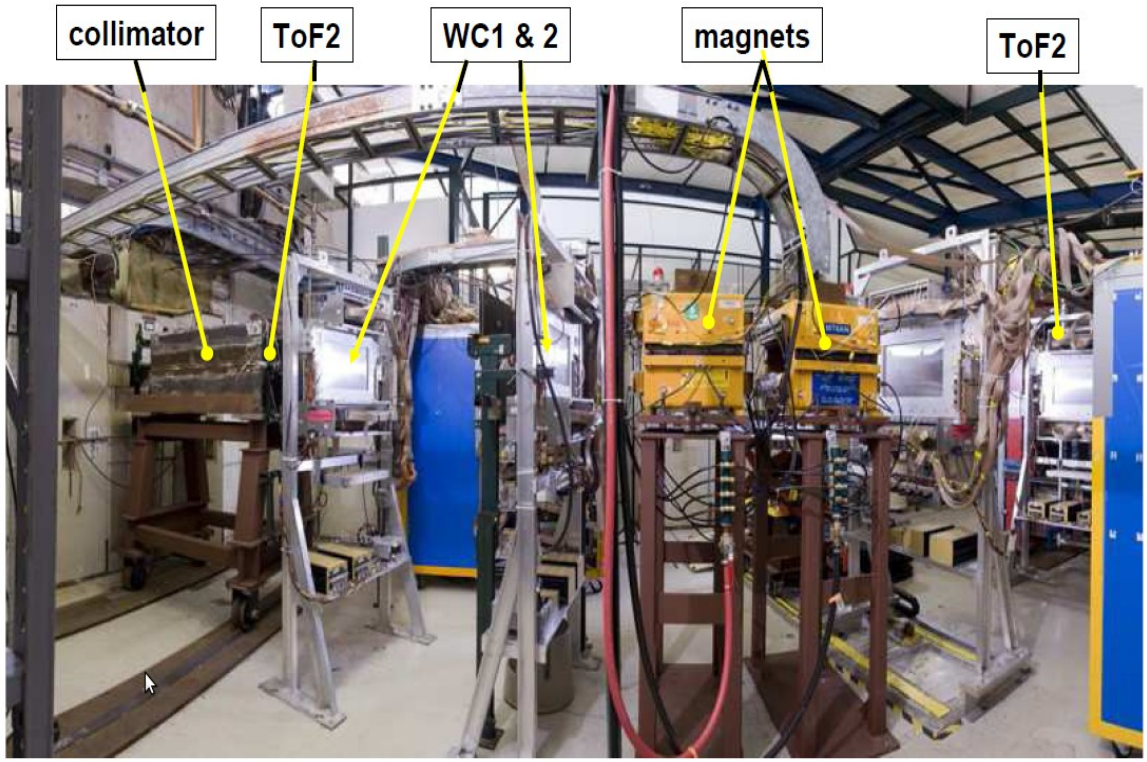
- Ran at FNAL Test Beam Facility
- 40 planes in XUXV stereoscopic orientation using the same scintillator and absorber geometry.
- Reconfigurable - can shuffle absorber configuration to mimic any part of the detector.
- Finished first physics run June 10 - July 17, 2010.

The Test Beam detector, with scintillator modules and absorbers visible.

MINERvA Test Beam cont.

-16 GeV pion beam on a Cu target produces tertiary pion beam from 400 MeV to 1.2 GeV.
- Four wire chambers, two dipole magnets, and time of flight system for triggering
•-Provide hadronic response calibration(ratio of π/μ, p/μ).



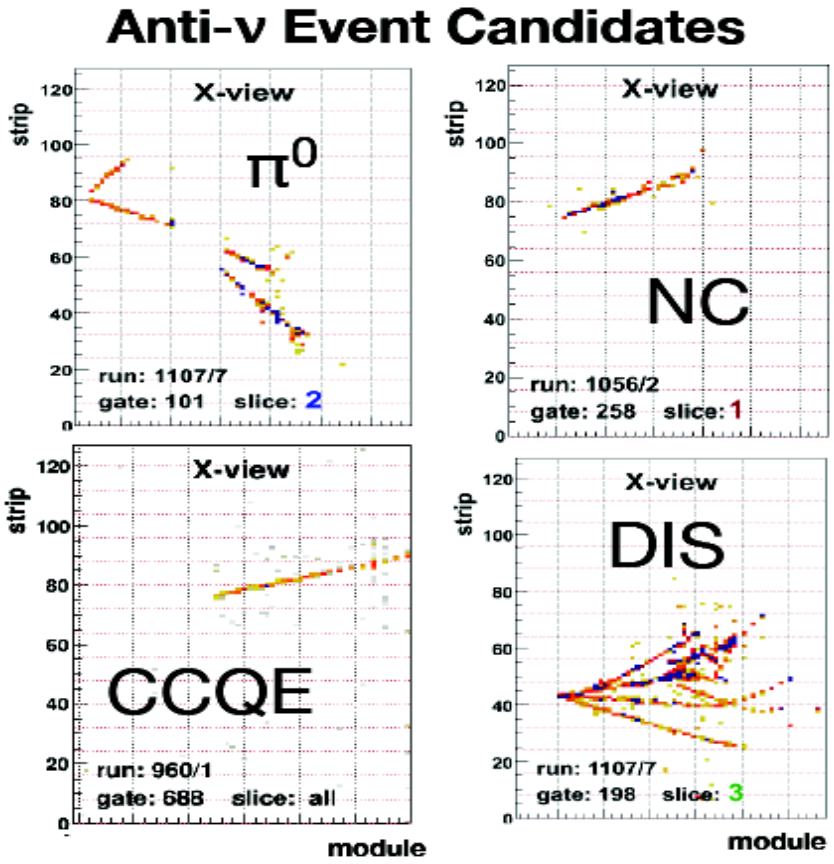


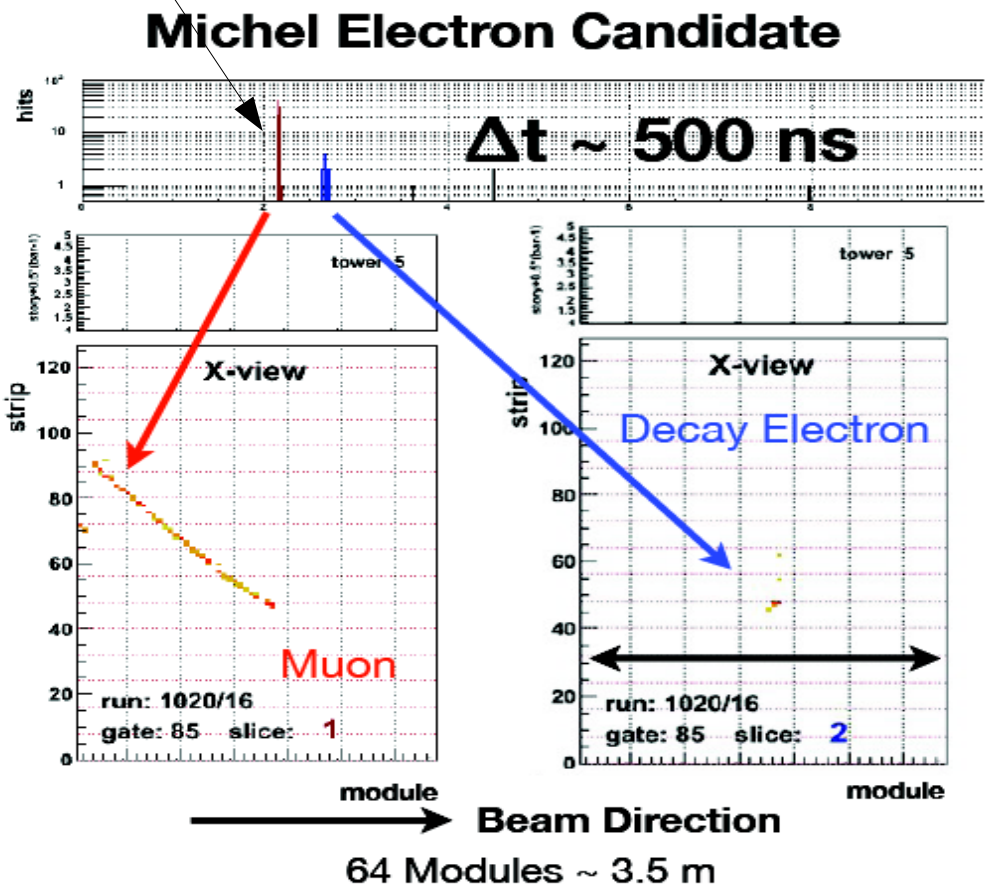
MINERvA Timeline

- **11/2009**: ~0.8e20 POT of low energy (LE) anti-v beam with 55% of detector.
- **2/2010**: Installed remaining 45% of detector. Ran LE v beam from 3/2010-9/2010.
- **11/2010-Spring 2012:** Approved for 4.9e20 POT in LE anti-v beam, with about 1.3e20 POT already taken
- **3/2012**: Fermilab accelerator shutdown, switch to ME. More than 12e20 POT with NOvA.
- Currently in process of analyzing anti-v dataset using GAUDI based framework (LHCb, ATLAS) with GRID production (300 slots)
- Expect ~9 million CC events in the active scintillator over the course of full Run Plan (LE+ME, NEUGEN prediction).

MINERvA Event Display

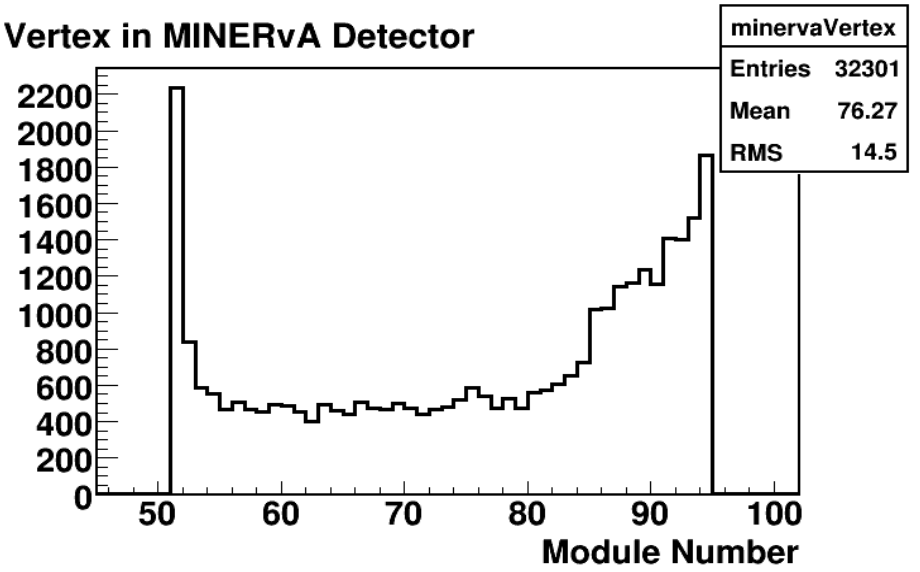
- Event displays typically show only one view(X,U or V)
- X view is essentially looking at detector from above
- Timing is displayed above track plots
- Tracking resolution is ~3.3mm, timing resolution is ~4.5ns

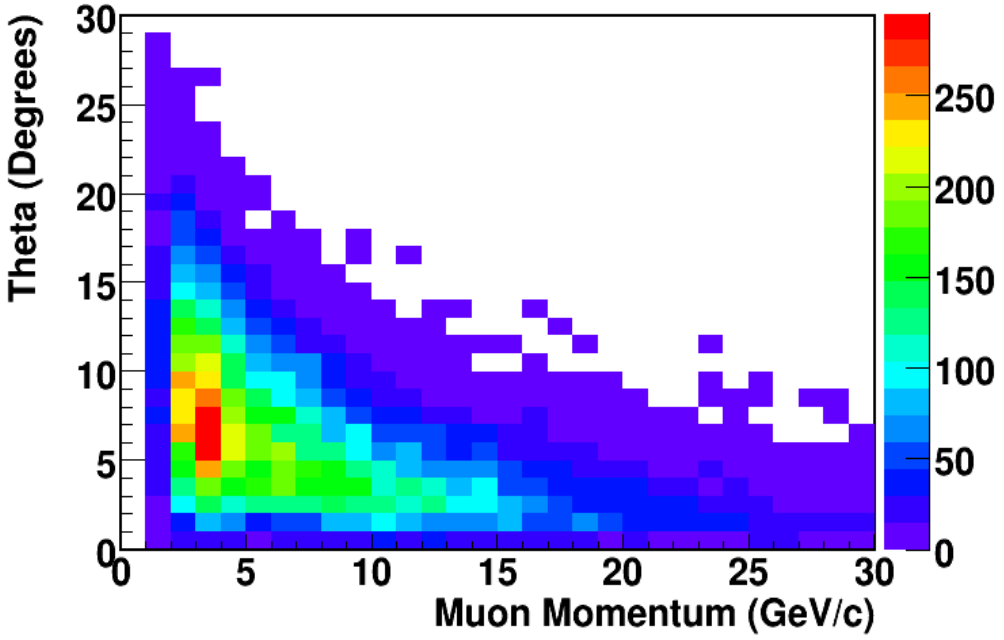


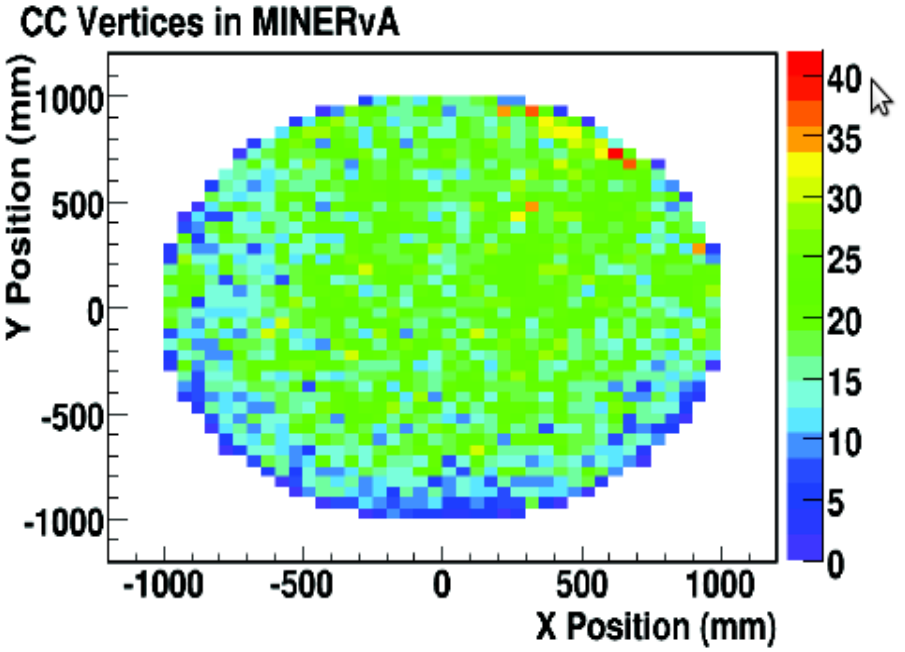


Anti-v Kinematic Distributions

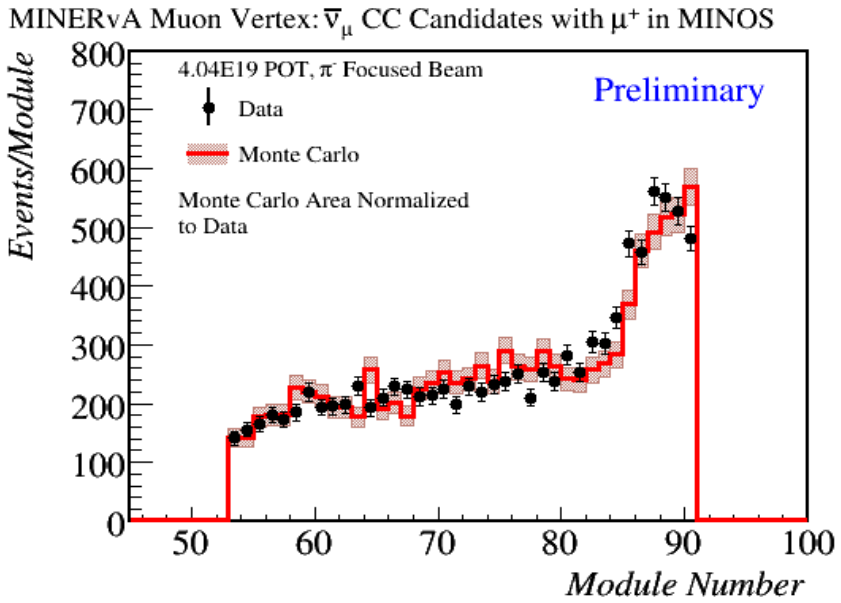
- Charged current analysis
- Get momentum at vertex from curvature of muons in MINOS
- Cut on high quality tracks and clean vertices-Work in Progress

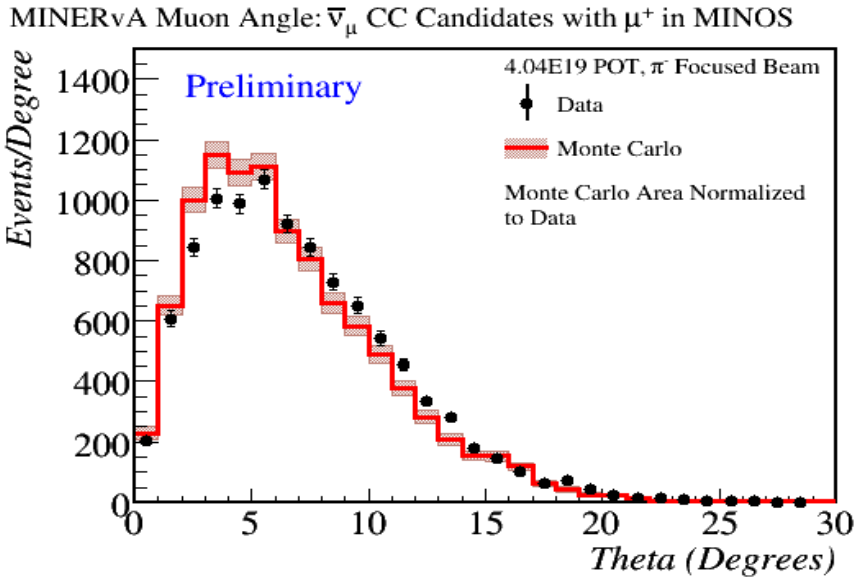


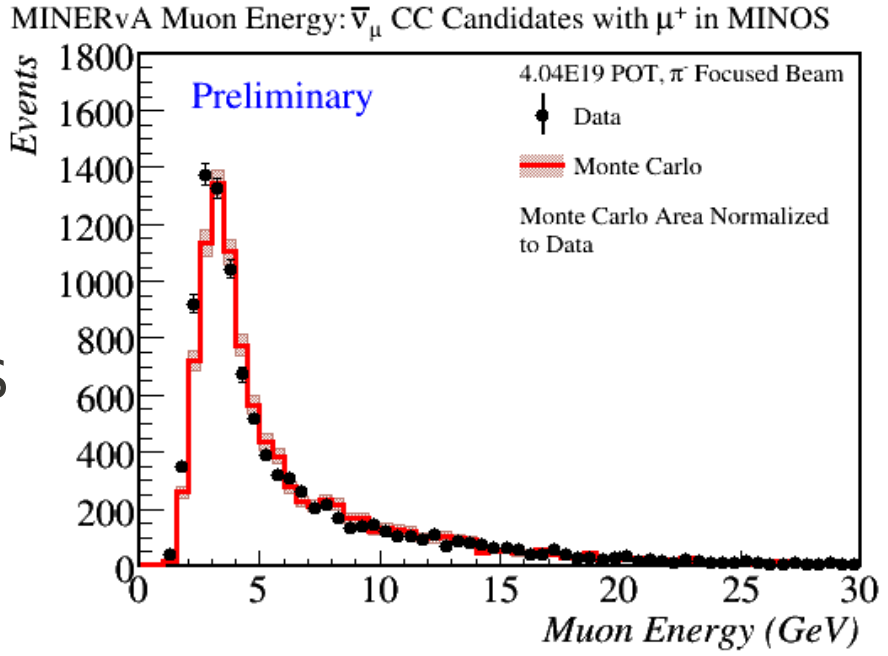




Data/Monte Carlo Comparison







- MC generator is GENIE v2.6.0 with a full GEANT4 detector simulation.
- 4.04e19 P.O.T. in anti-ν mode (RHC)
- Studying inclusive anti-ν QE events - require single reconstructed muon in MINOS
- Cut off in momentum is not full kinematic range! Current absolute flux uncertainty on the (untuned anti-nu) MC is ~30-40%.

Summary

- MINERvA is an experiment in the NuMI beamline looking to improve cross section measurements
- Will be able to improve uncertainties and provide data to current and future experiments
- Currently in early stages of analyzing data from the anti-v run and beginning to analyze ”low energy” v data
- Will have preliminary results in the near future

Backup

Charged Current Event Rate

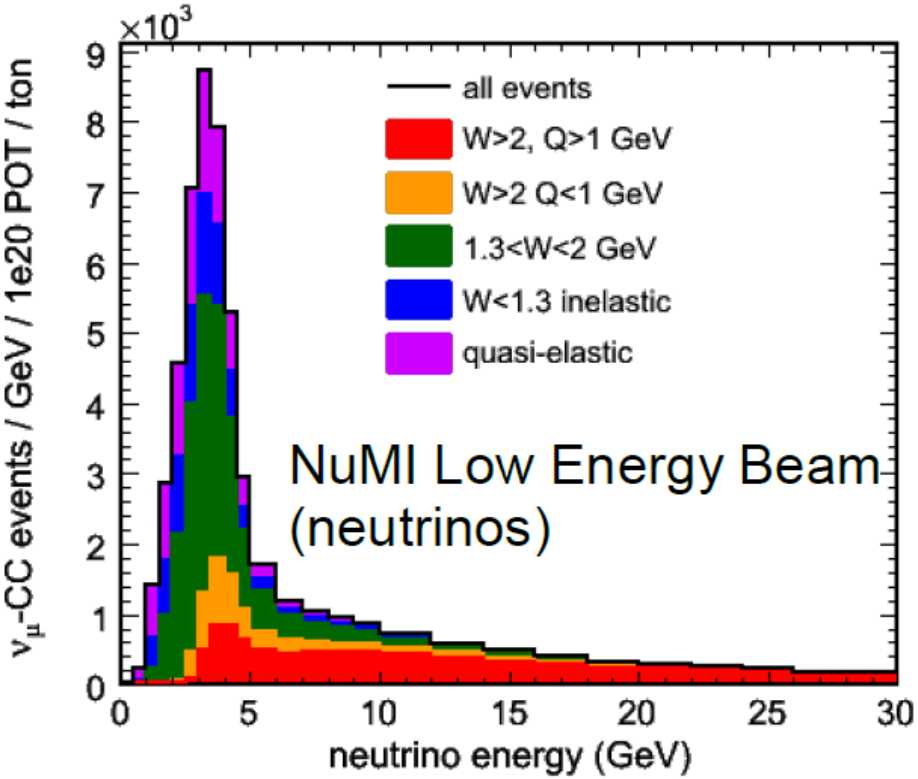
- Calculate with Run Play 4x10e20 POT plus

  0.9x10e20 POT special run LE beam and 12x10e20 POT ME beam
- Expected Yield: ~14M CC events with 9M in scintillator
- Quasi-elastic - 0.8 M
- Resonance production - 1.7 M
- Resonance to DIS

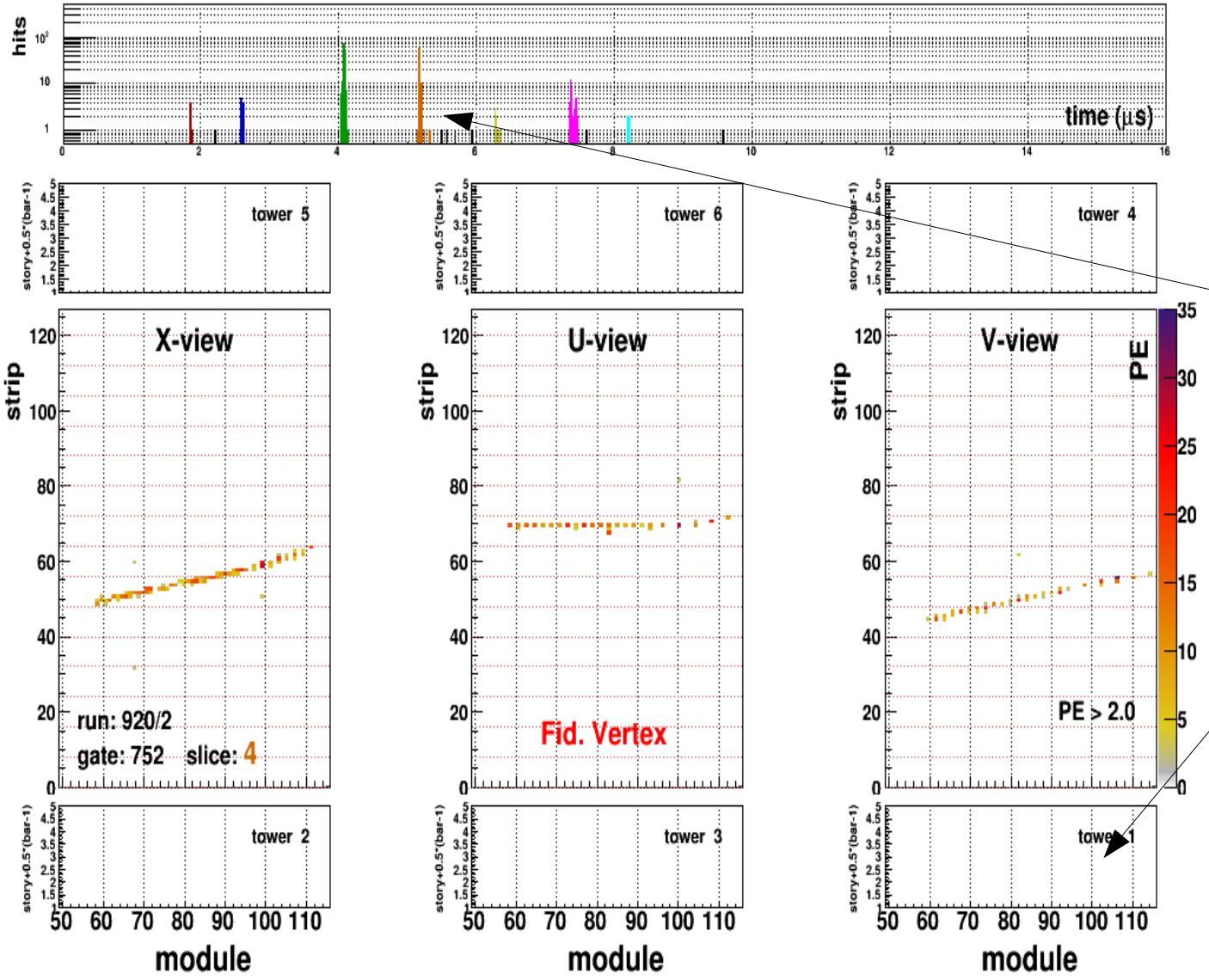
  Transition Region - 2.1 M
- DIS Low Q2region and

  Structure Functions - 4.3 M
- Coherent Pion

  Production - CC 89k, NC 44k
- Charm / Strange Production >240 k



Sample Anti-v Event



- CCQE anti-v event
- Timing for different events(time ”slices”)
- 4th slice is this event
- Outer calorimeter