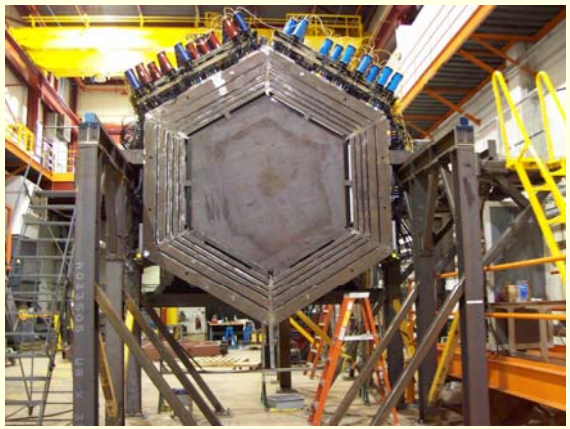
Recent headlines from MINERνA



Robert Bradford
University of Rochester
For the MINERνA Collaboration

Fermilab Users' Meeting
3 June, 2009

Question:

What's the difference between MINERνA and a news report?

Answer:

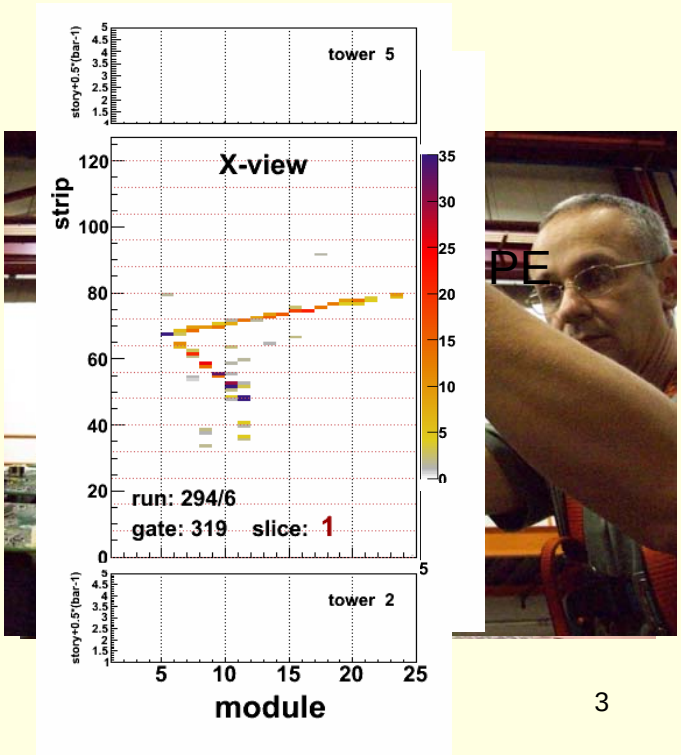
The news is always breaking…

but our detector isn't!

Much recent progress on:

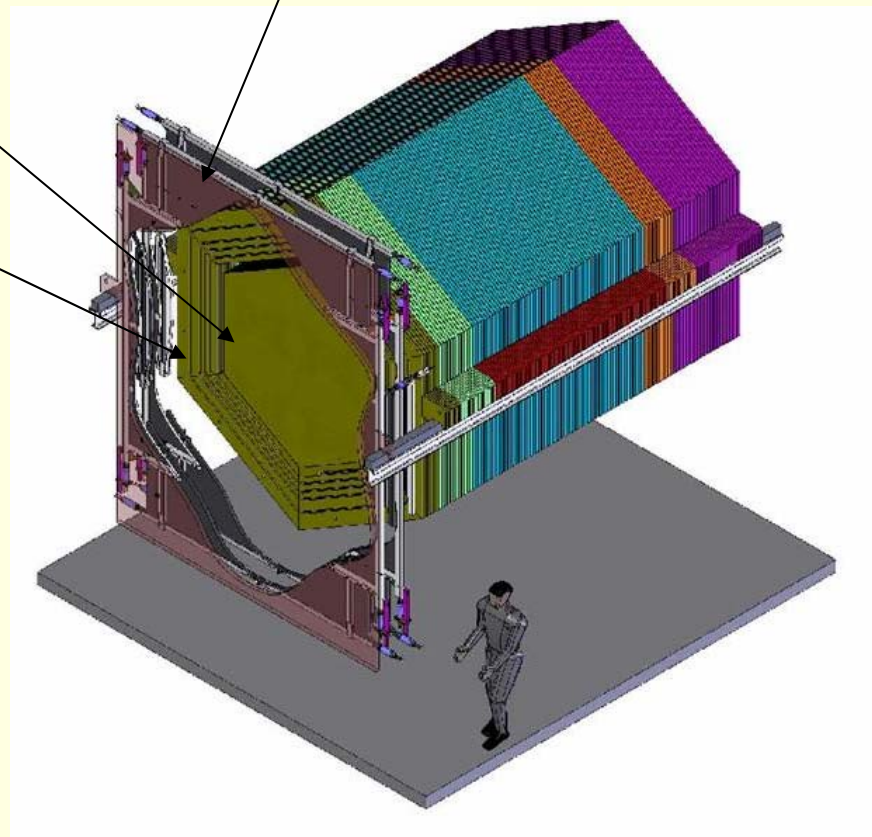
- Construction
- Installation of first modules
- First data taking

Proud to report that the detector is working, and working quite well!



MINERνA

- Few-GeV ν scattering experiment to run at Fermilab
  - Active scintillator tracking volume
  - Outer calorimeter
  - Variety of nuclear targets (He, C, Fe, Pb)
- Optimized to study interaction physics across variety of scattering regimes.
  - Precision cross sections
  - Nuclear (A) dependence



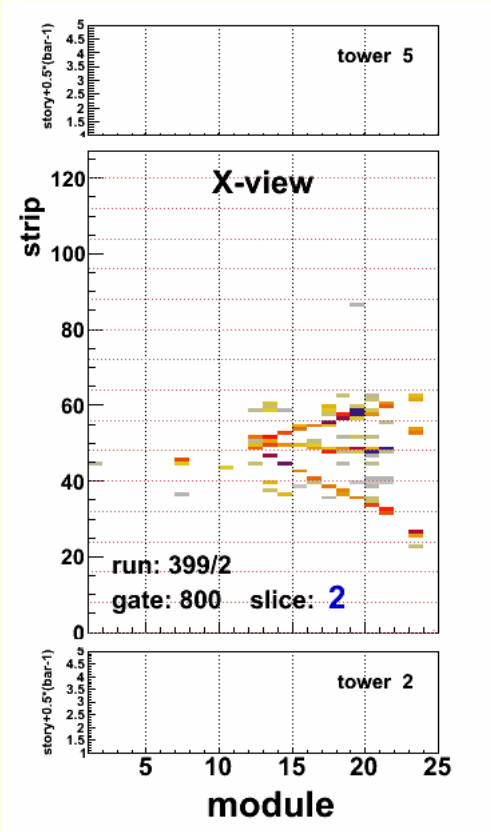
Detector Performance

- Fine-gained detector optimized to study details of events.
  - 3mm position resolution
- Particle ID by dE/dx

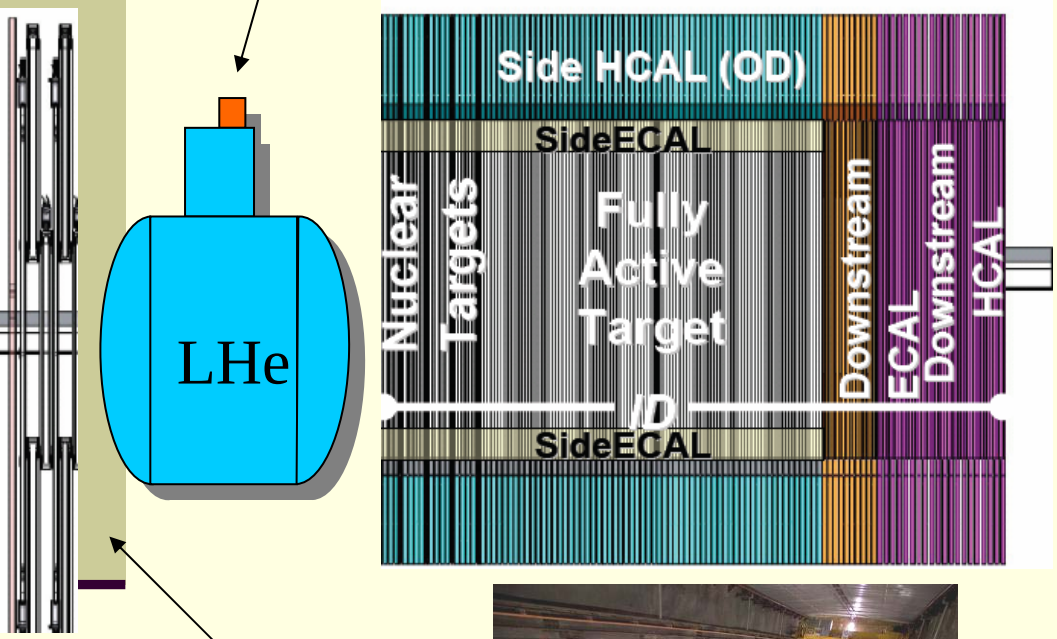
Particle	Reconstruction Threshold	% ID
π	85 MeV	90
P	175 MeV	95

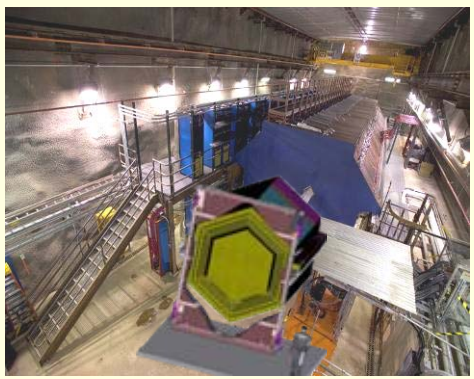
- μ id:
  - Threshold: 70 MeV
  - 85-90% stop in MINERνA or caught by MINOS

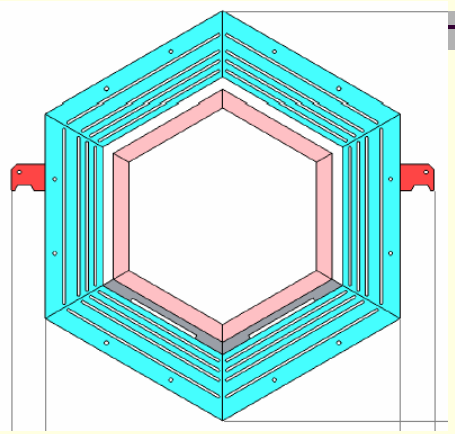
DIS Candidate Event



Detector Geometry



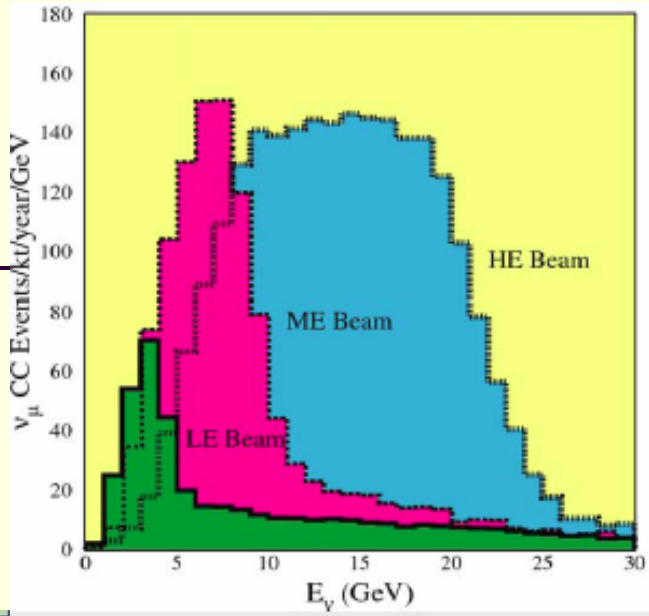


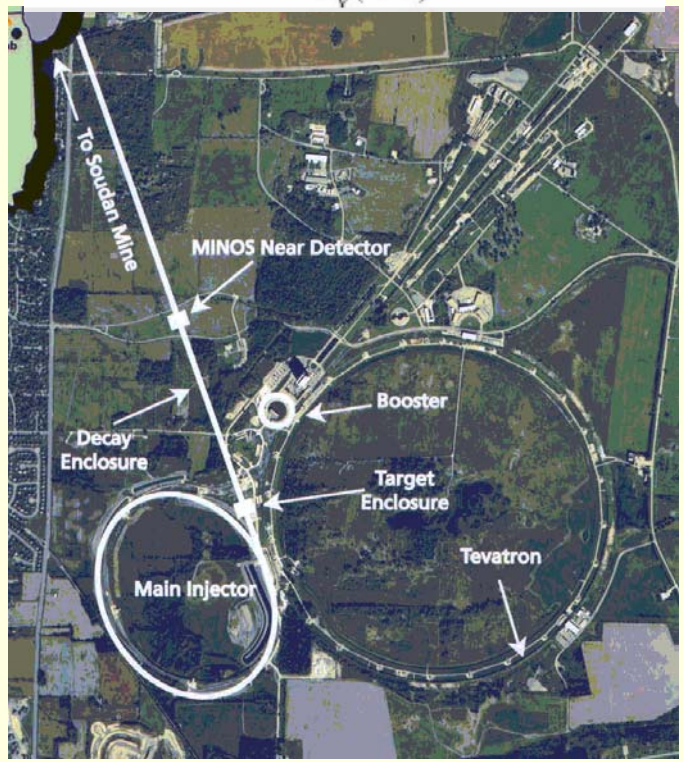


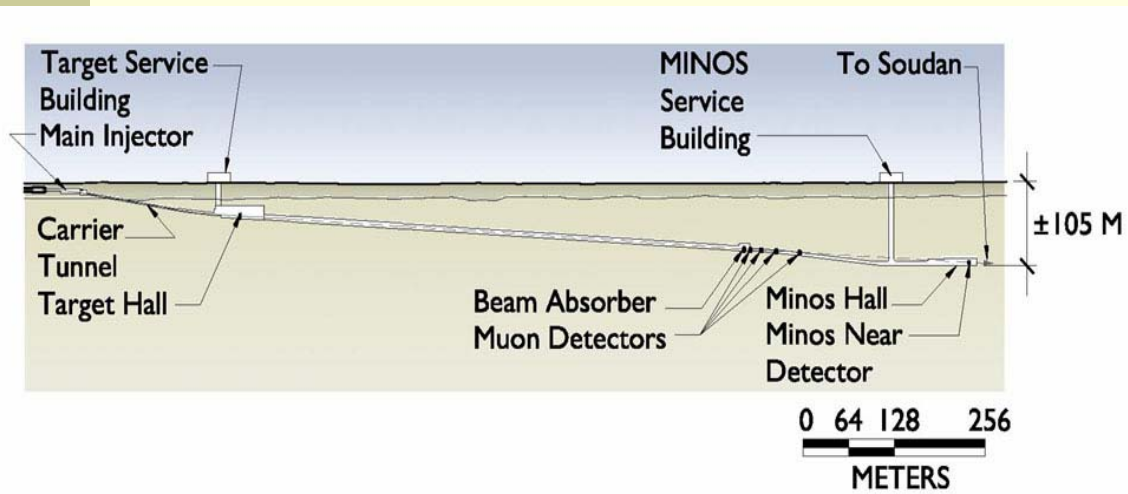
- Made of 108 planar “modules”.
- By the numbers:
  - Total Mass: 200 tons
  - Fiducial mass: 3-5 tons (in active target)
  - Total channels: ~31K
- Uses MINOS Near Detector as muon spectrometer.

NUMI Beamline

- Currently, world's most powerful ν beamline.
  - $3X10^{20}$ protons/year
- Configurable beam
  - Wide range of ν energies
- World's best cross section beamline!





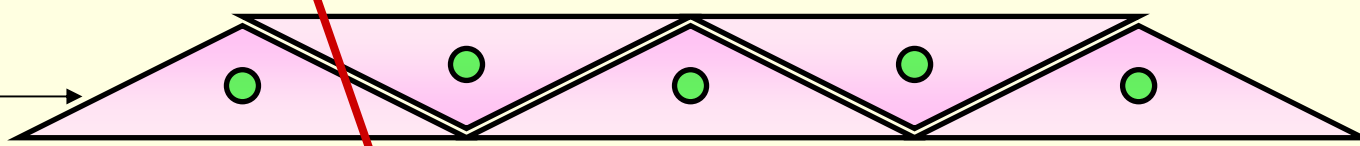


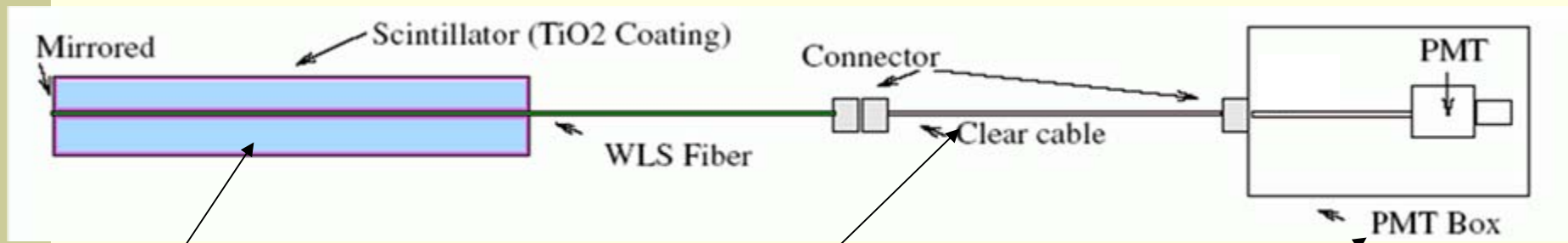
MINERvA Optics

Particle

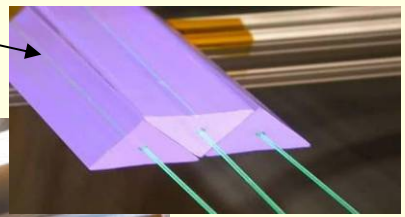
Position determined by charge sharing

Extrusions built into planar structures.

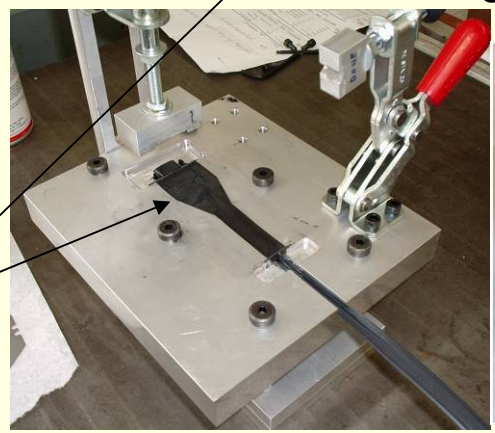




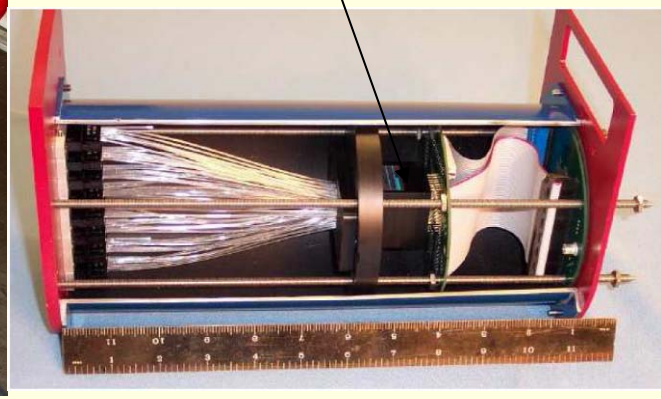
Extruded Scintillator



Clear Fiber Cable

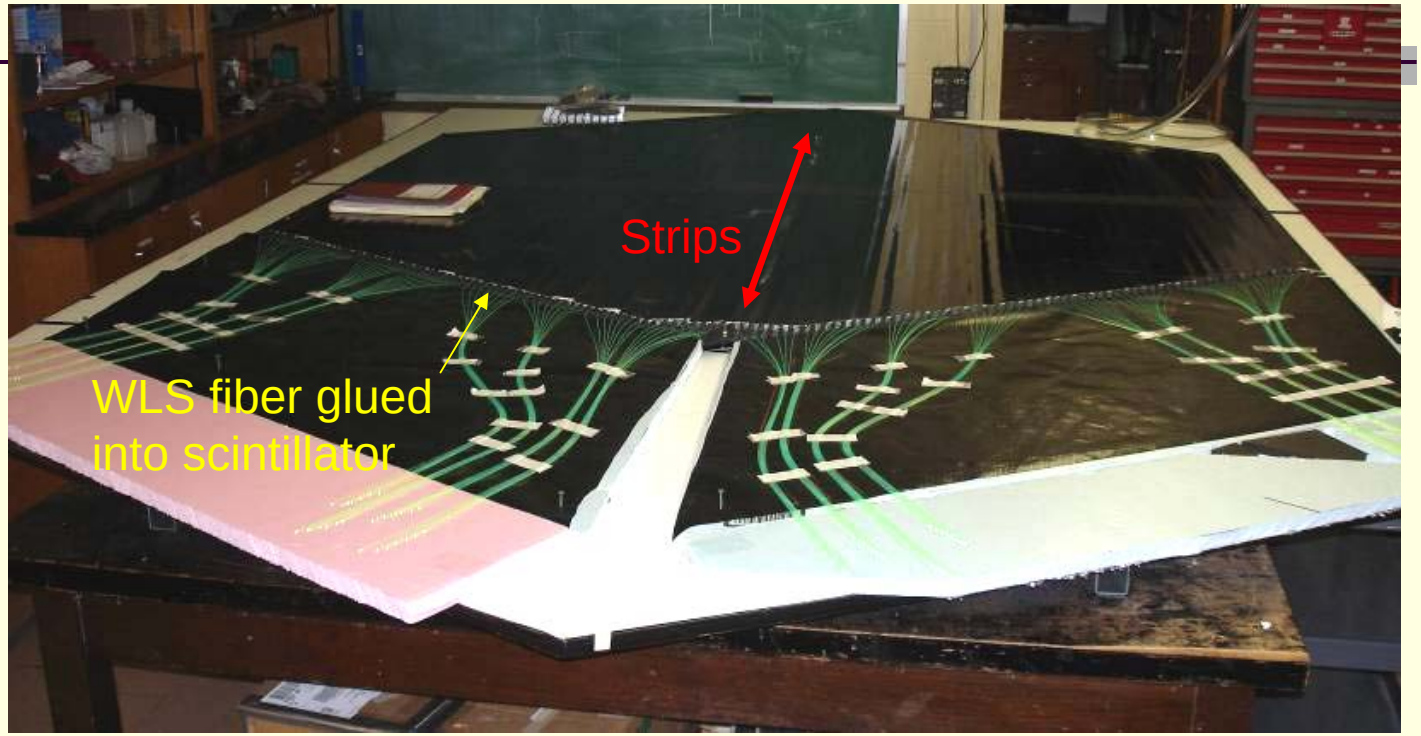


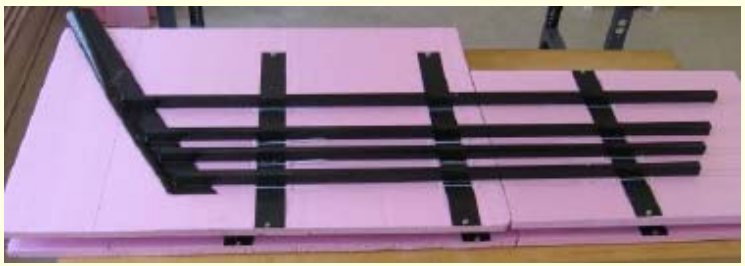
64-Anode PMT



Scintillator

Bulk of scintillator packaged into planes.

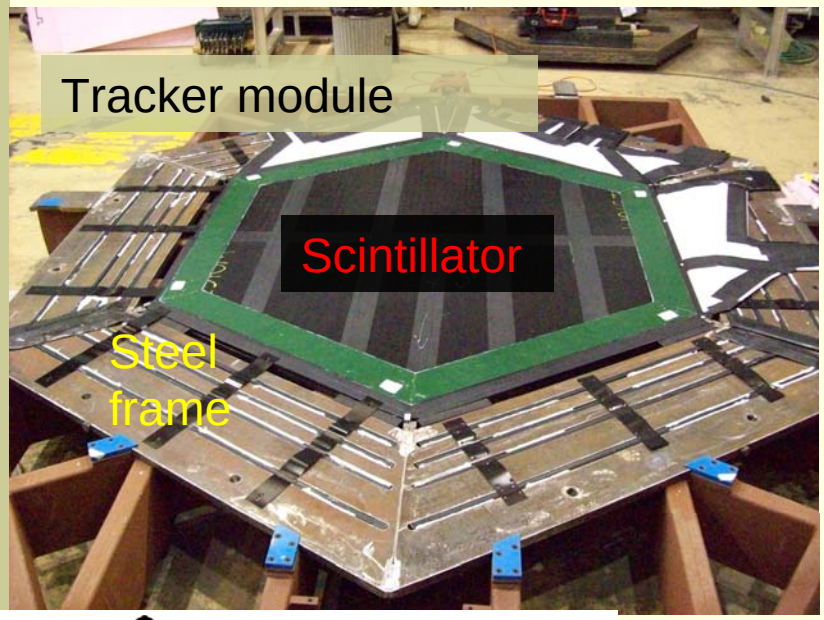




Outer Detector Scintillator Assembly

Fibers mirrored on far end. Near end will be terminated in optical connector, polished, and light-tightened.

Module Construction



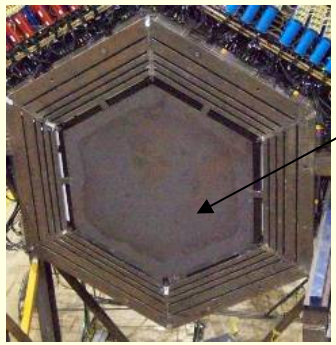
Steel + scintillator = module

Typical module:

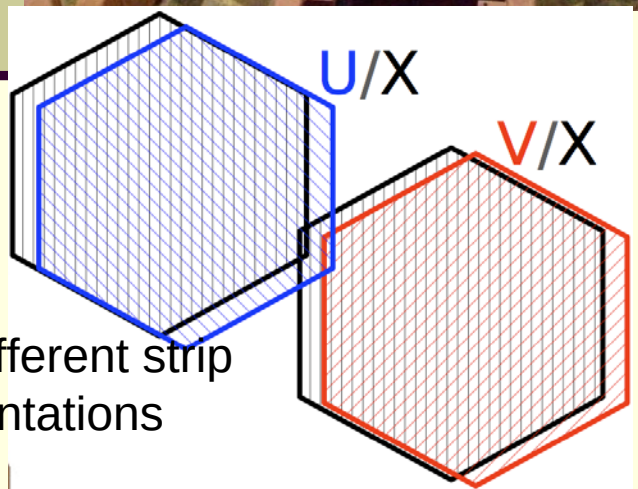
- has 302 scintillator channels
- weighs 3,000 lbs
- 3 types of modules

Full detector:

- 108 modules; ~30K channels.



HCAL modules include 1” steel absorber

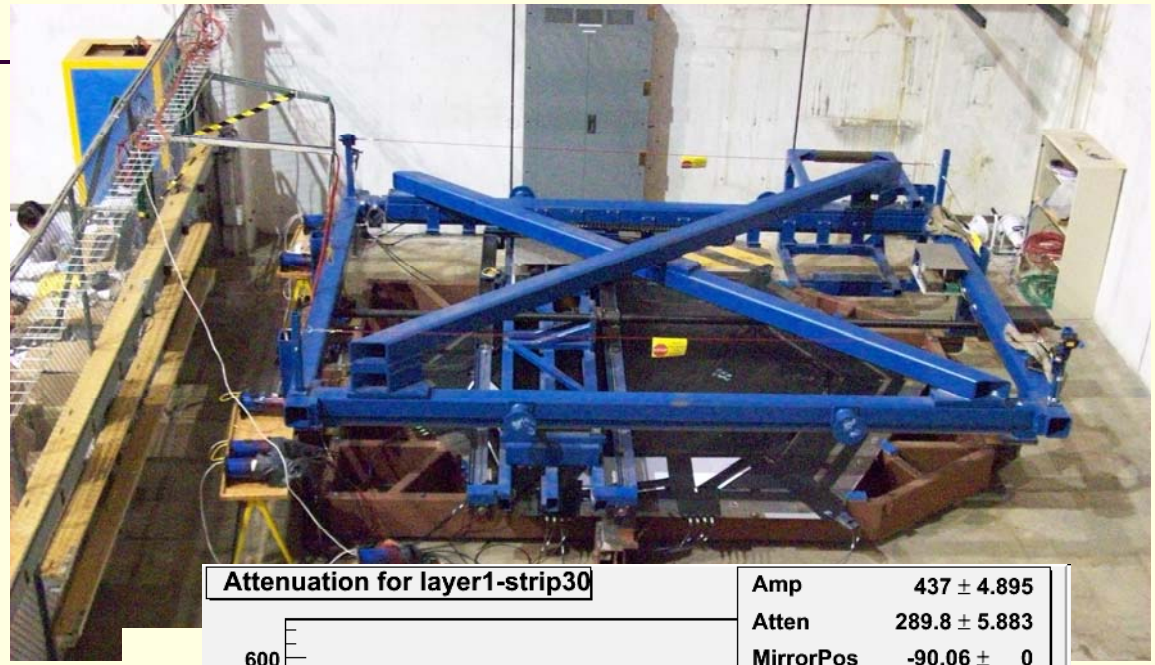


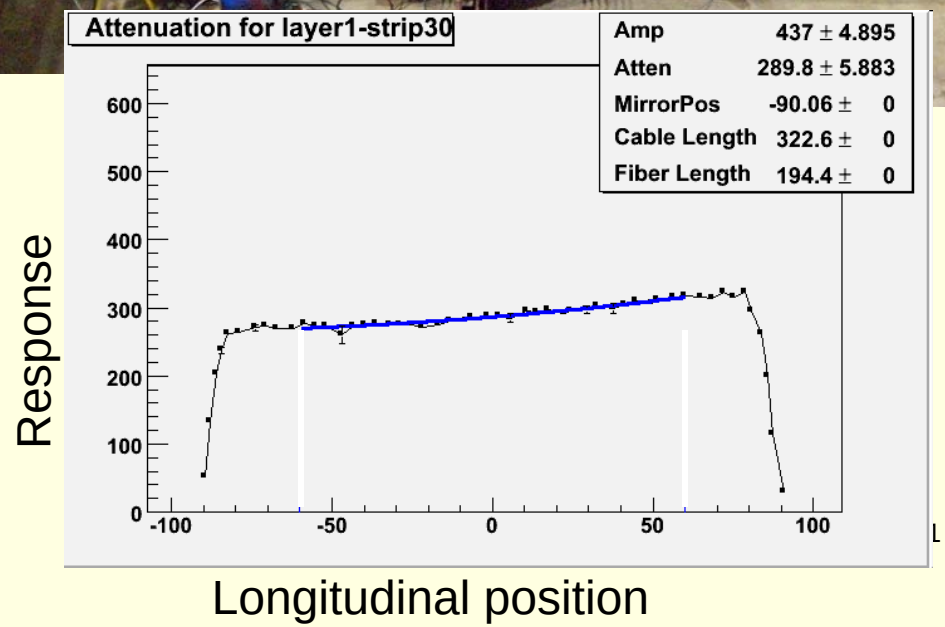
3 different strip orientations

ECAL modules incorporate 2mm-thick Pb absorber

Mapping

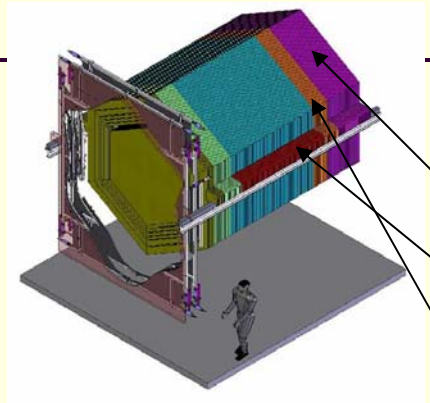
- Comprehensive source test of all modules after assembly.
- Scintillator scanned with Cs-137 source; read out scintillator response.
- Test:
  - Maps attenuation curve of each channel
  - Location of each chanel
  - Localizes anomalies in scintillator or optics



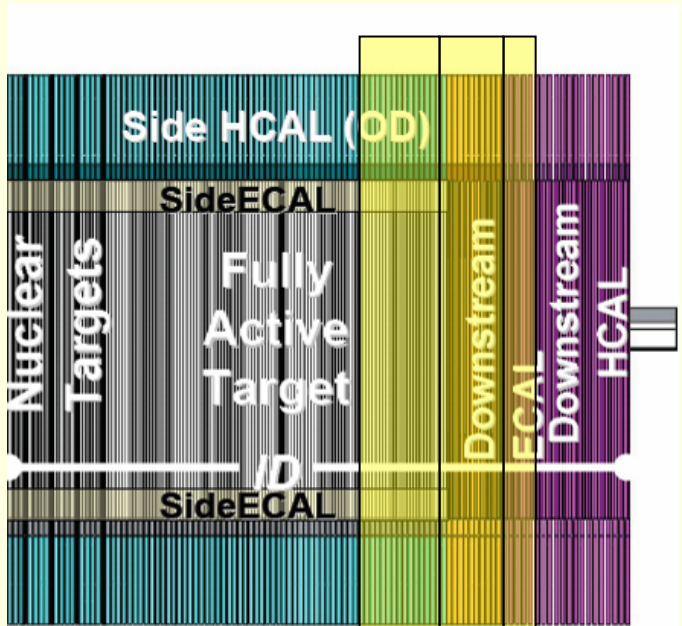


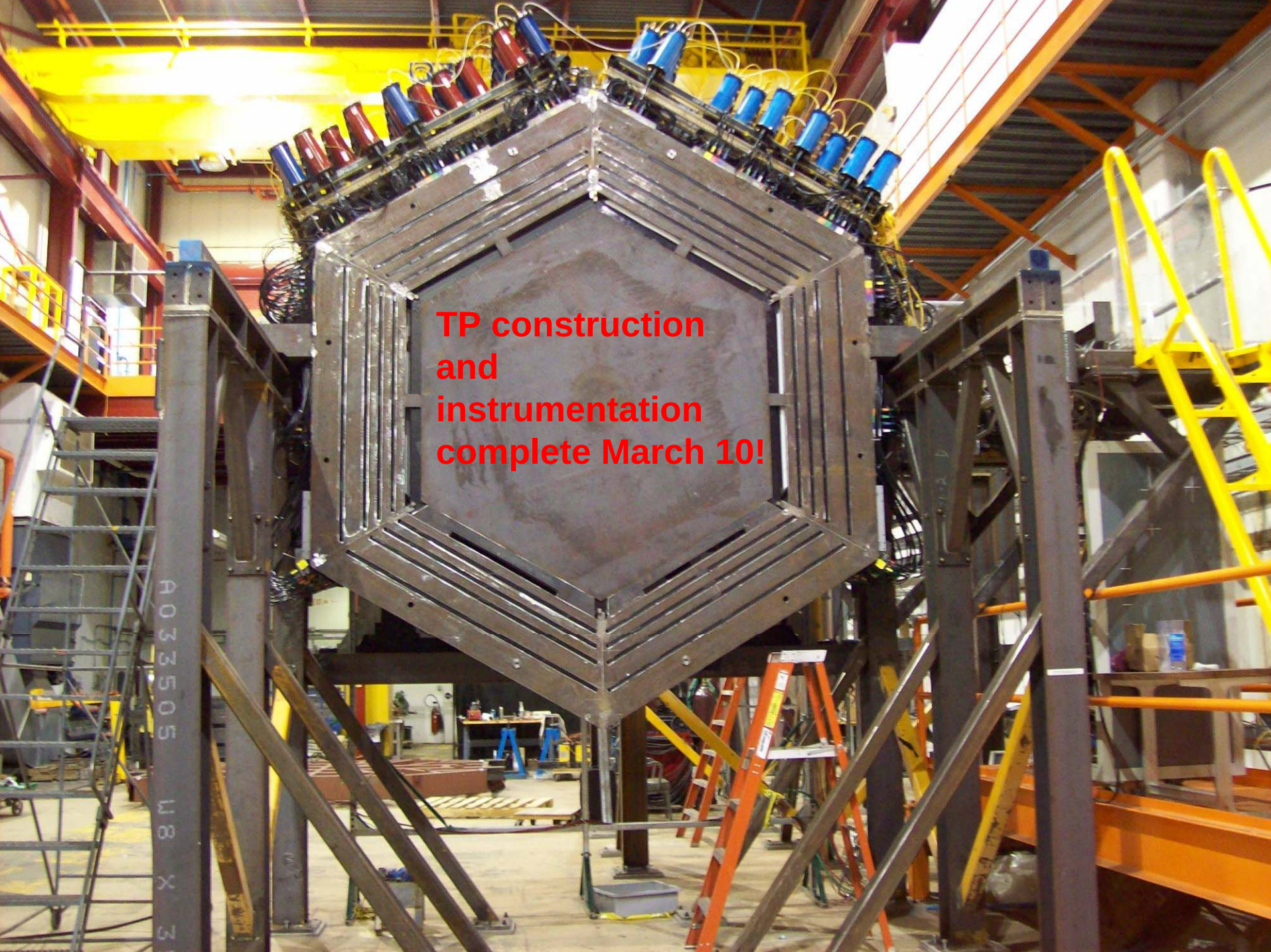
Tracking Prototype

- 24 module sub-assembly:
  - 10 tracker modules
  - 10 ECAL modules
  - 4 HCAL modules
- Full sized modules
- Used to test:
  - Construction techniques
  - Installation
  - Commissioning
  - Calibration
  - Reconstruction



Effectively, last bit of tracker region, DS ECAL, 4 HCAL modules



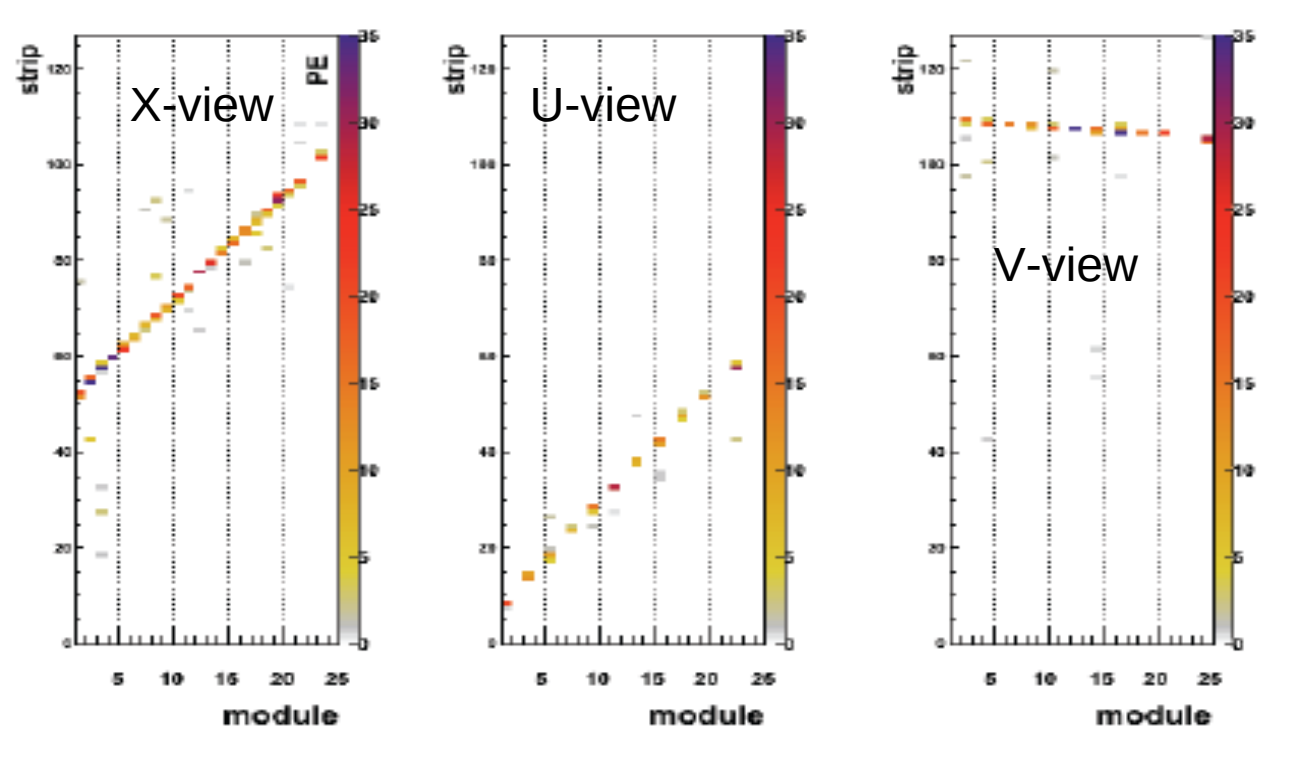

TP construction
and
instrumentation
complete March 10!

Wideband running….

- Took comic ray data with subsets of TP for several months as we built.
- Took extended cosmic run with entire detector weekend of March 14-16.
  - Kicked it off with special trombone performance…

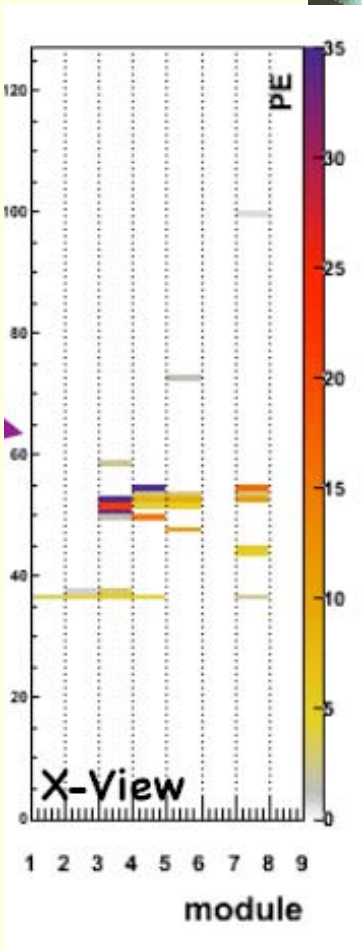
It’s working…

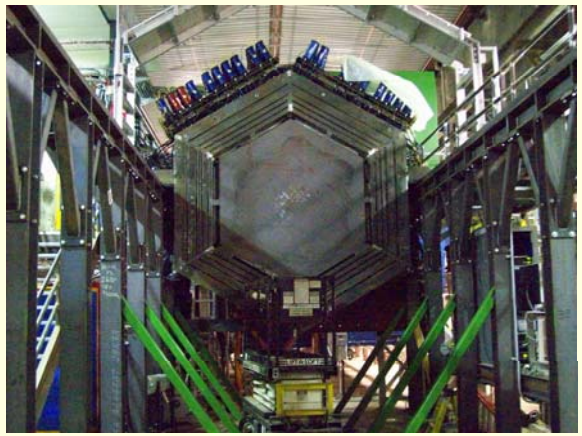
- Long cosmic run yielded 32.6K single track events



Mobile Detector

- Moved prototype detector from Wideband to MINOS Near Hall.
  - All modules moved and re-instrumented
- First beamline neutrinos – April 1, 2009





Taking Data…

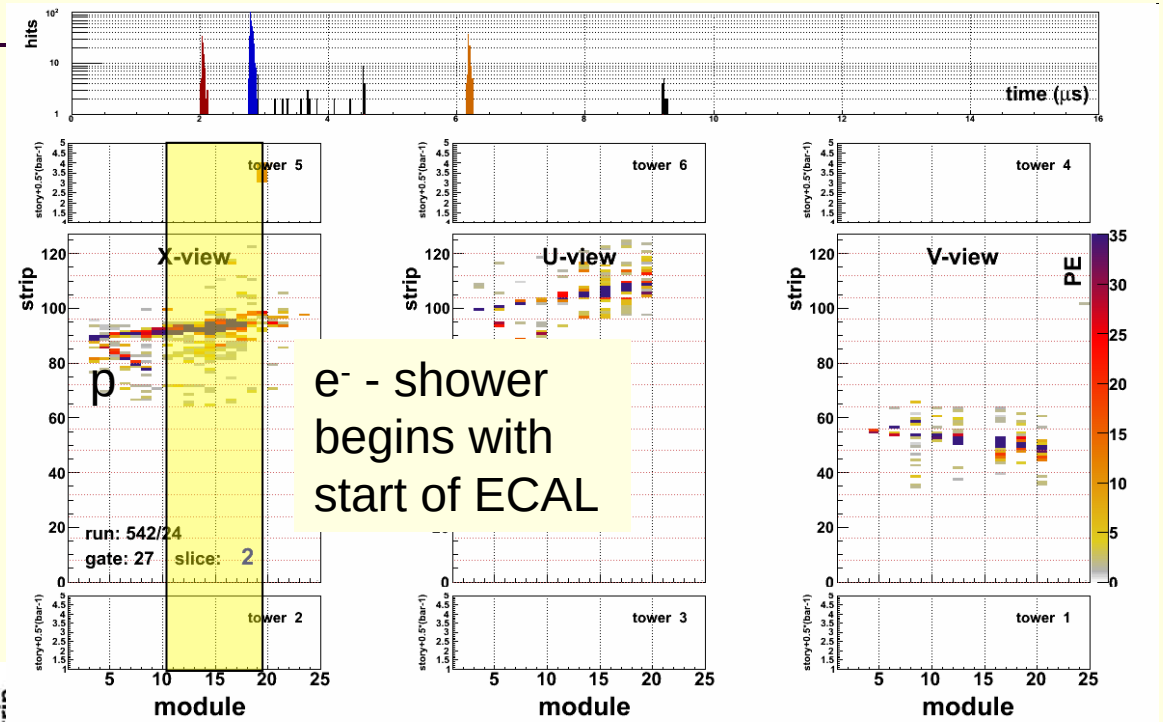
- Running remotely from control room since mid-April.
  - Have started operator shifts
- 60-day run ending on June 13 (shutdown) will produce ~22k CC ν_μ events

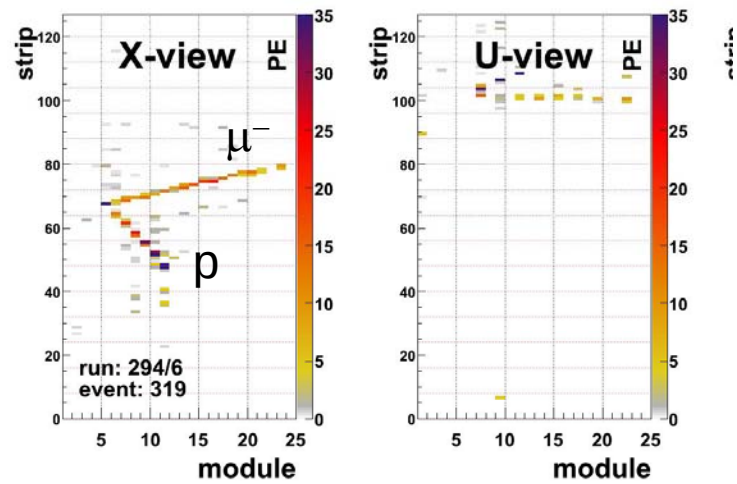
Process	K Events	% of total
Safe DIS	7.01	31.9
Low Q DIS	2.09	9.5
Transition	6.86	31.2
Delta	2.66	12.1
Quasi-elastic	3.26	14.8
Coh. π prod.	0.11	0.5

Events

ν_e Charged-Current Quasi-Elastic candidate event

$\nu_e + n \rightarrow e^- + p$



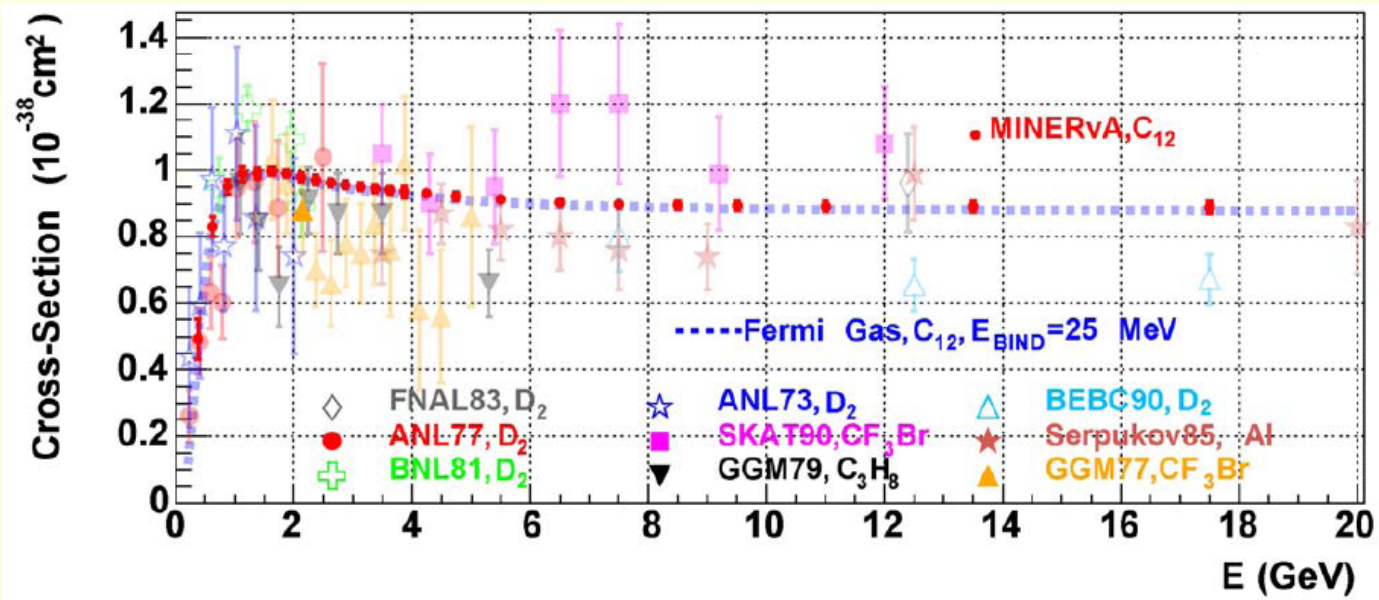


Charged-Current Quasi-Elastic

$\nu_\mu + n \rightarrow \mu^- + p$

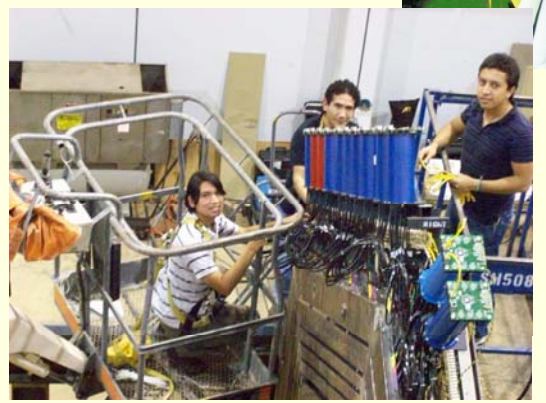
Coming soon…

- Will collect 14 million CC events
- Broad physics program:
  - Total and differential cross sections for exclusive states
  - Nucleon structure - axial form factor
  - Structure functions, PDF's
  - Studies of nuclear dependence



Detector is working well and…

- Producing beautiful neutrino interaction events.
- Remaining construction is underway:
  - 36 modules complete; ~1/3 of detector
  - Installation continues during summer shutdown
- Build complete early 2010



Backup Slides

Event Sample:
Assume: 4**.0 x** 10^{20} POT LE and
12**.0 x** 10^{20} POT ME beam

14.5 Million total CC events

Fiducial Volume = 3 tons CH, 0.2t He, 0.15t C, 0.7t Fe and 0.85t Pb
Expected CC event samples:
9.0 M ν events in 3 tons of CH (totally active central detector)
0.6 M ν events in He
0.4 M ν events in C
2.0 M ν events in Fe
2.5 M ν events in Pb

Main CC Physics Topics (Statistics in CH only)

Quasi-elastic	0.8 M events
Resonance Production	1.7 M total
Transition: Resonance to DIS	2.1 M events
DIS, Structure Funcs. and high-x PDFs	4.3 M DIS events
Coherent Pion Production	89 K CC / 44 K NC
Strange and Charm Particle Production	> 240 K fully reconstructed events