MiniBooNE Status

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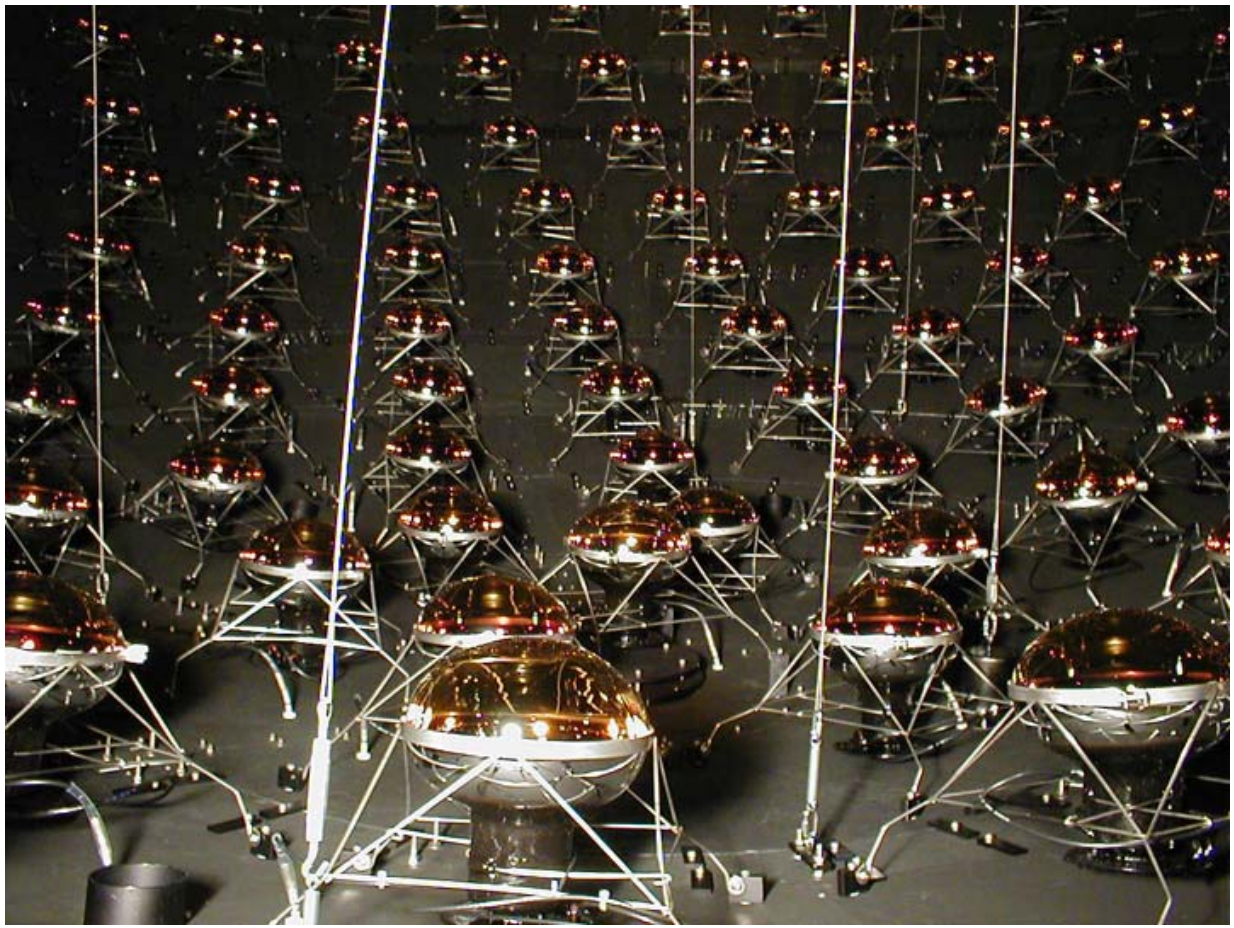


Overview

Beam

- Primary Beam
- Secondary Beam

Detector

- Calibration
- Triggering
- Neutrinos

Summary

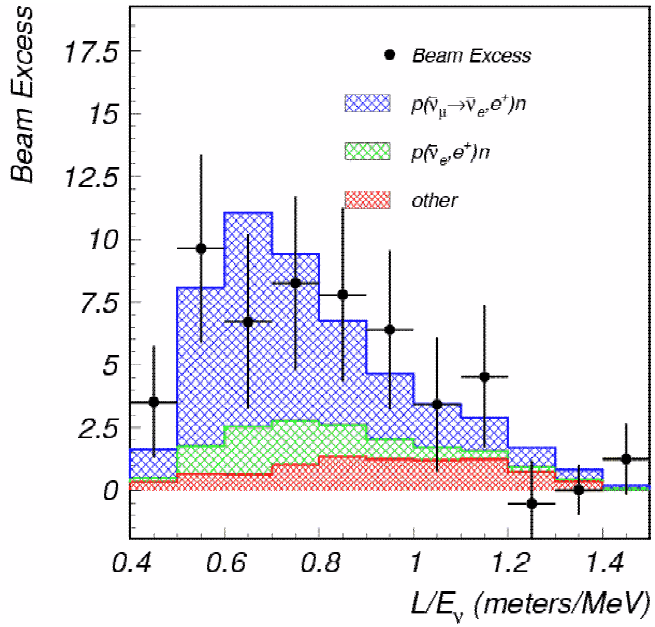
The Collaboration

Small experiment

- ~60 scientists
- 13 institutions

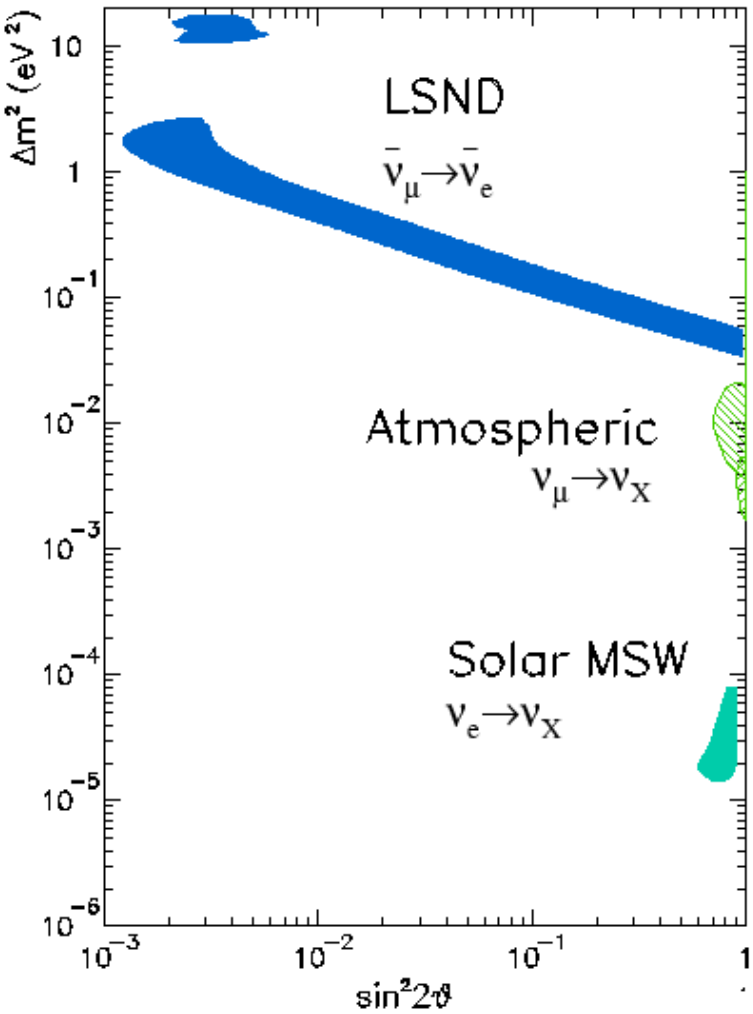
Investigating LSND Result

- LSND:
  - Excess of ν_e events in a ν_μ beam
  - $87.9 \pm 22.4 \pm 6.0$ over background
  - 4σ evidence for ν oscillation



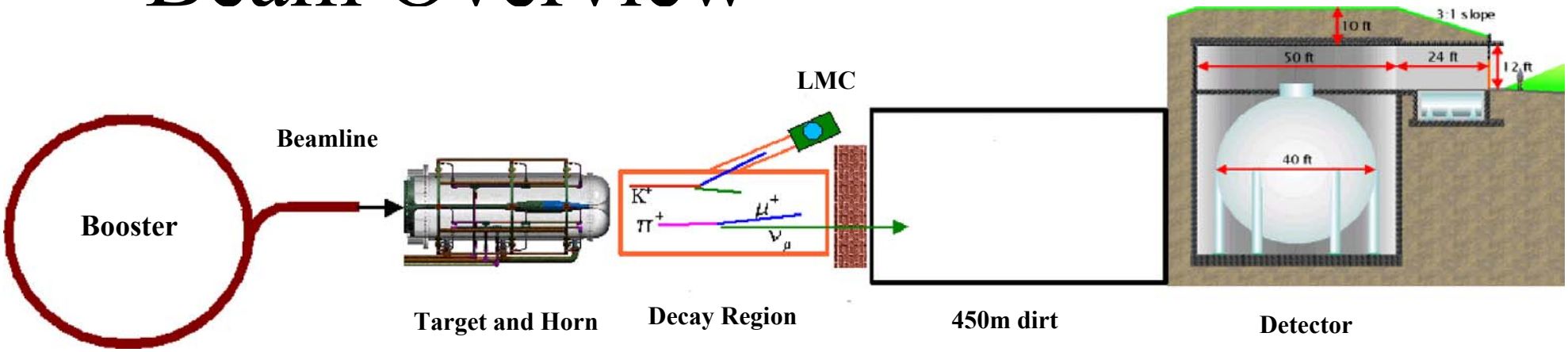
- To Check LSND you want
  - Experiment with
    - different systematics
    - higher statistics
    - similar L/E
- ⟶MiniBooNE

Why is the LSND Result Interesting?



- LEP measurement of Z width says...
  - 3 light, active neutrinos
- Solar, atmospheric, and LSND neutrino measurements indicate...
  - 3 different Δm^2 scales
- Cannot get 3 Δm^2 scales from 3 masses
- Some possible ways out...
  - one or more results not due to oscillations
  - add sterile neutrino(s)
  - violate CPT

Beam Overview



Primary Beam

- *8 GeV protons from Booster*
- *Into MiniBooNE beamline*

Secondary Beam

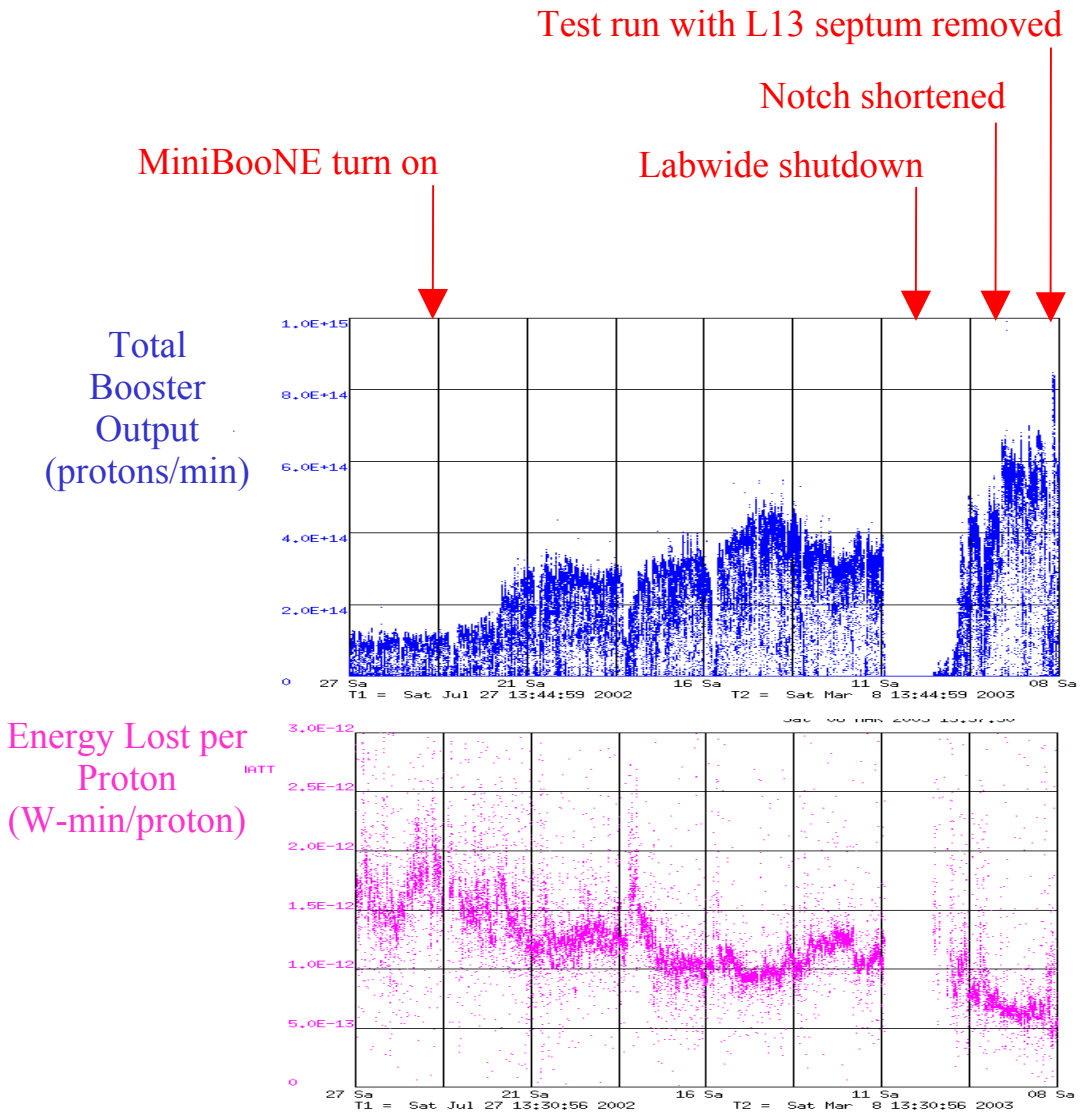
- *Mesons from protons striking Be target*
- *Focused by magnetic horn and monitored by LMC*

Tertiary Beam

- Neutrinos from meson decay in 50m pipe
- Pass through 450m dirt (and oscillate?) to reach detector

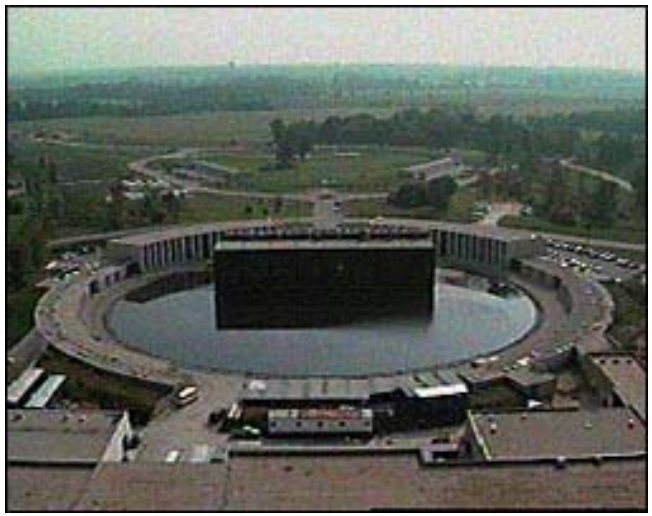
Booster Performance

- Booster has never worked this hard
- Steady increase in rate of delivered protons via ...
  - Careful tuning
  - Optimising rep rate and charge per pulse
- On 6 March set all time Booster record ...
  - 5.7×10^{16} protons/hour
- Currently average ...
  - $3\text{-}4 \times 10^{16}$ protons/hour
- Need ~2-3 times higher rate to get to 10^{21} protons on target



Future Booster Improvements

- Booster studies
  - Recent physics staff increases and dramatic increase in involvement of Beam Physics Department
  - Already paying off (e.g. septum dogleg beam losses)
- Collimation system
  - Design almost complete
  - Installation ~ June 1
- Large Aperture RF Cavities
  - Increase aperture from 2¼" to 5"
  - Powered prototype tested
  - 2 vacuum prototypes being built for summer shutdown
  - Propose to build whole new system (18 cavities + power supplies)



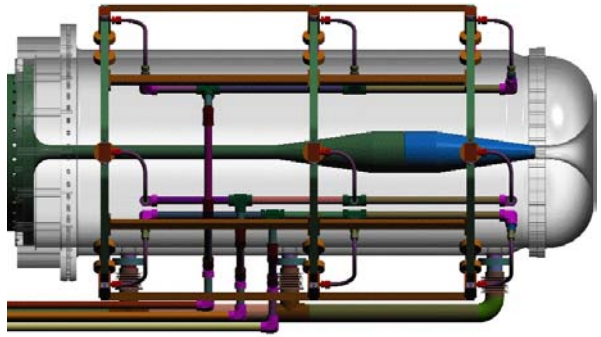
MiniBooNE Beamline

- Beamline works well
- Beamline modelling works well

- Phase I beam (intermediate dump)
  - April 29 2002
- Phase II beam (multiwire instead of target)
  - June 26 2002
- Phase III beam (final configuration)
  - August 24 2002

Horn and Target Performance

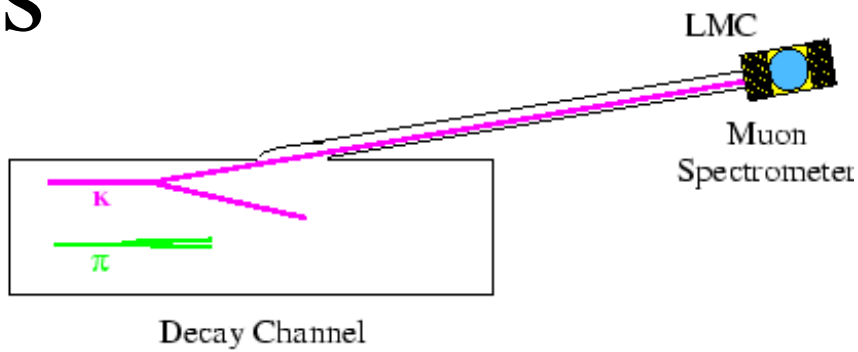
- Protons impinge on 71cm long, air cooled Beryllium target
- Horn focusing of secondary beam increases ν flux by factor of ~7
- 170 kA pulses, 143μs long at ~5 Hz
- 200 million pulse design lifetime



- Horn stress tested with 10 million pulses in Nov-Dec 2001
- Installation completed June 2002
- Has performed flawlessly with ~11 million pulses in situ to date

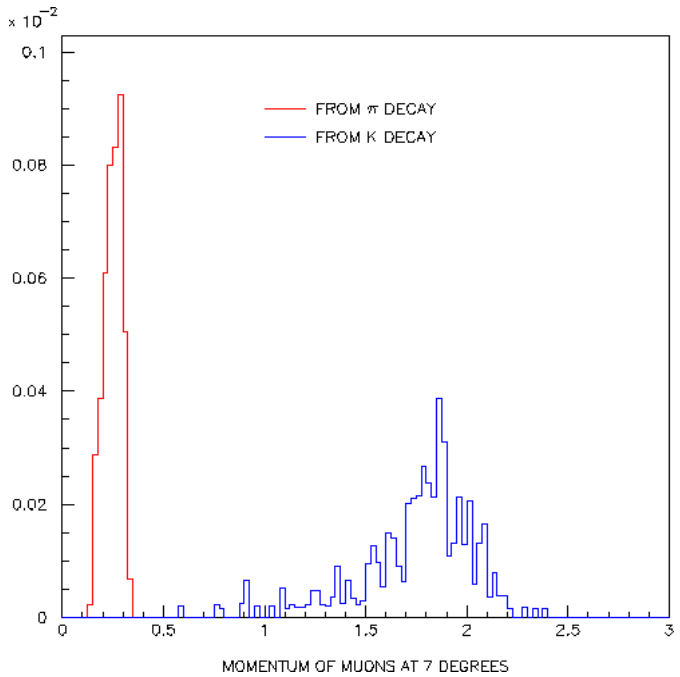
Little Muon Counters

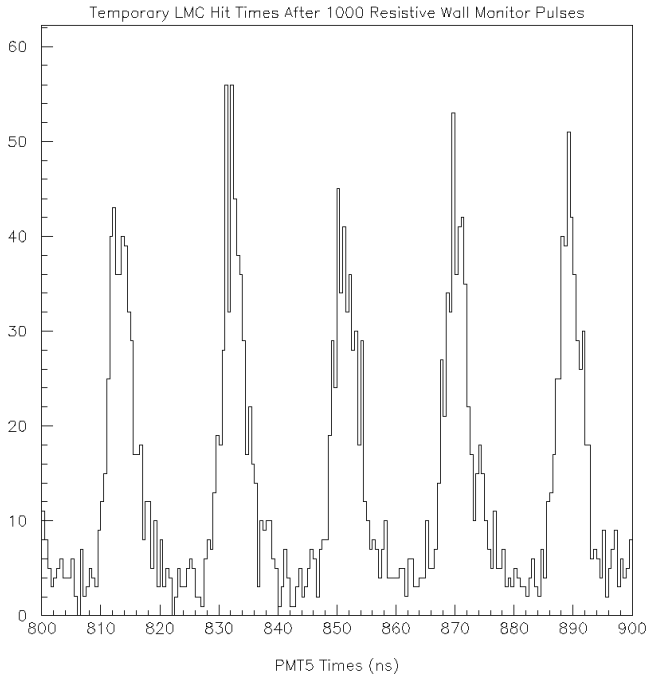
- ν_es from K decay are a major background
- K decays produce wider angle muons than π decays



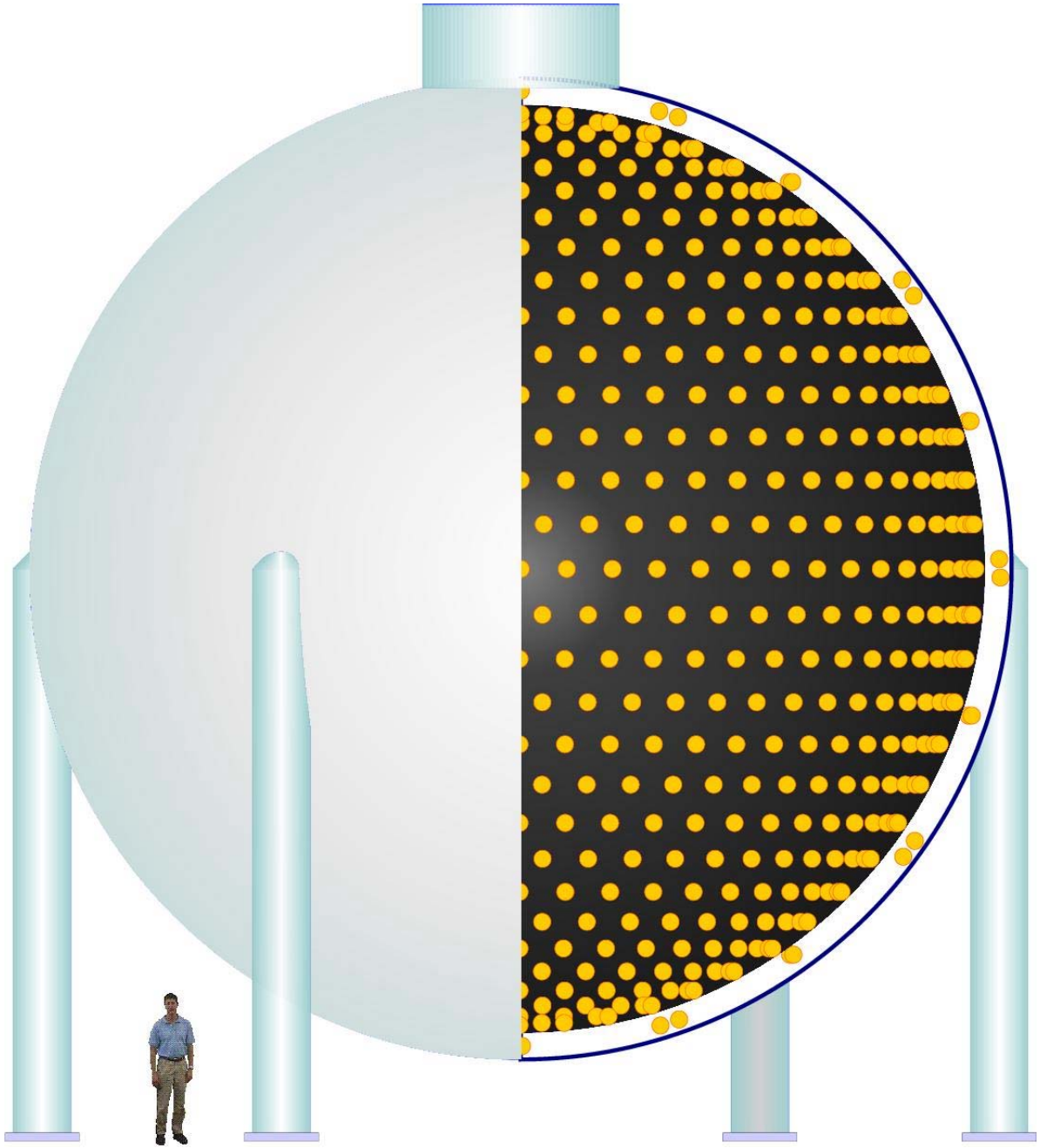
- LMC muon spectrometer
- 7 degrees off axis
- Scintillating fibre tracker
- Currently scintillator paddles

- LMC triggered off beam-on-target signal
- Can see 53MHz beam microstructure





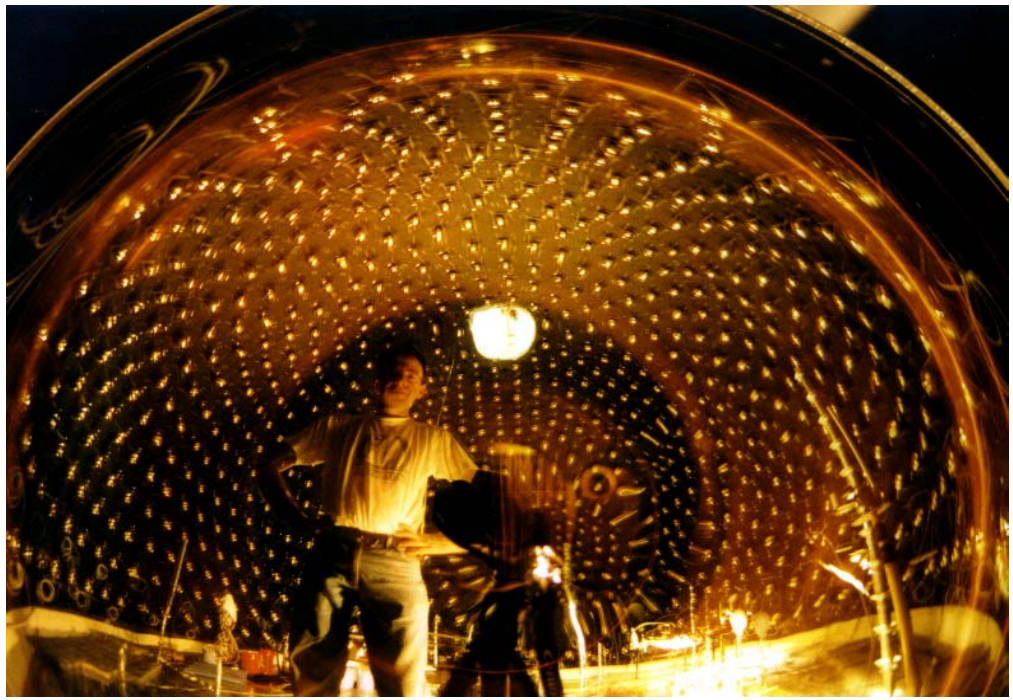
Detector Overview



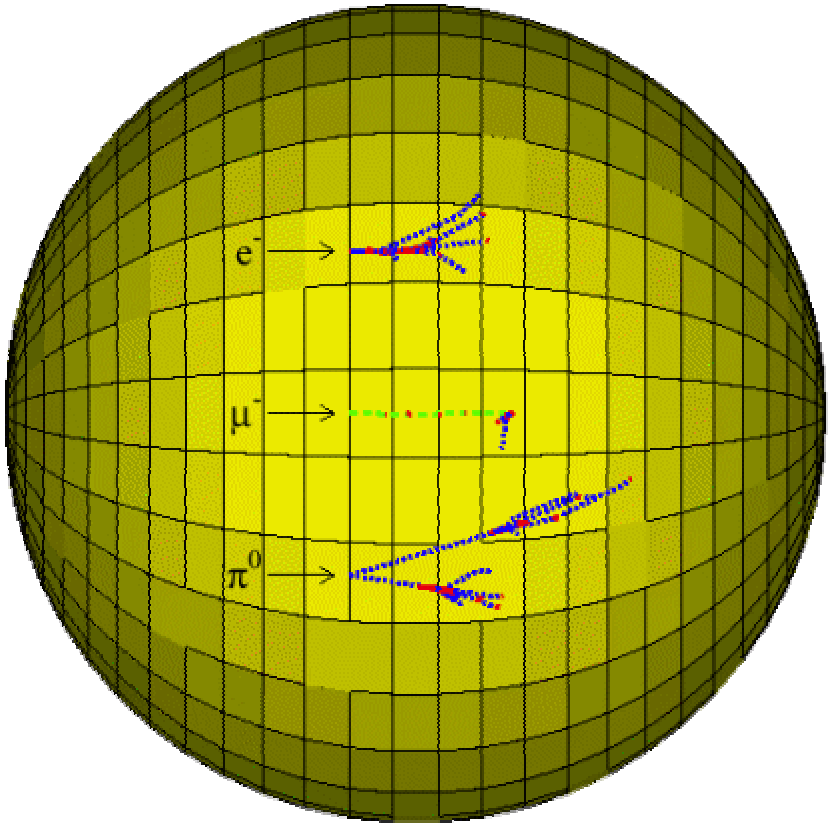
- 12m diameter sphere
- Filled with 950,000 litres of pure mineral oil
- Light tight inner region with 1280 8” PMTs (10% coverage)
- 240 PMTs in outer veto region
- Neutrino Interactions in oil produce
  - Prompt Čerenkov light
  - Delayed scintillation light

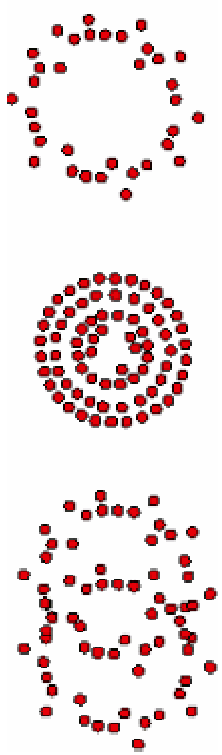
Detector Construction

- Fully Complete April 2002
- Several months of shakedown and calibration prior to first beam

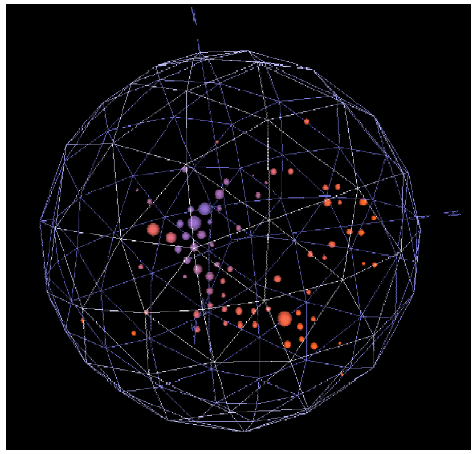


MiniBooNE Particle ID

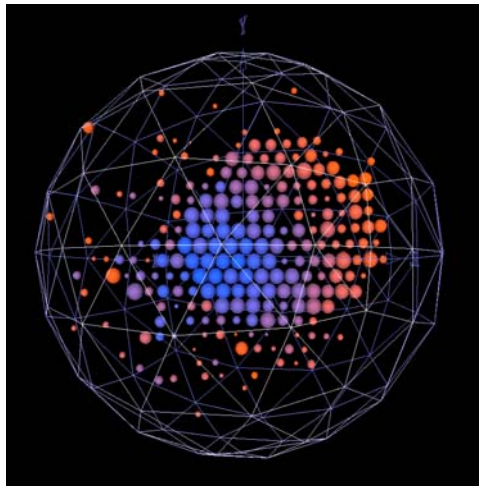




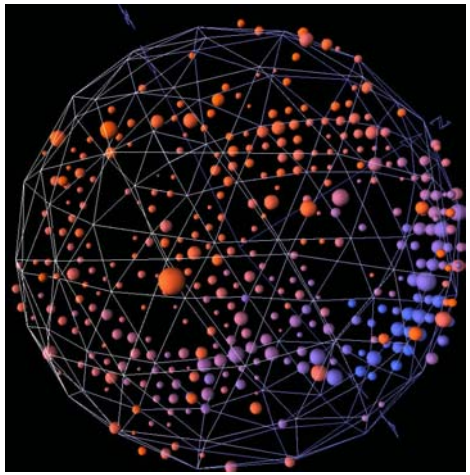
Michel e candidate



Beam μ candidate



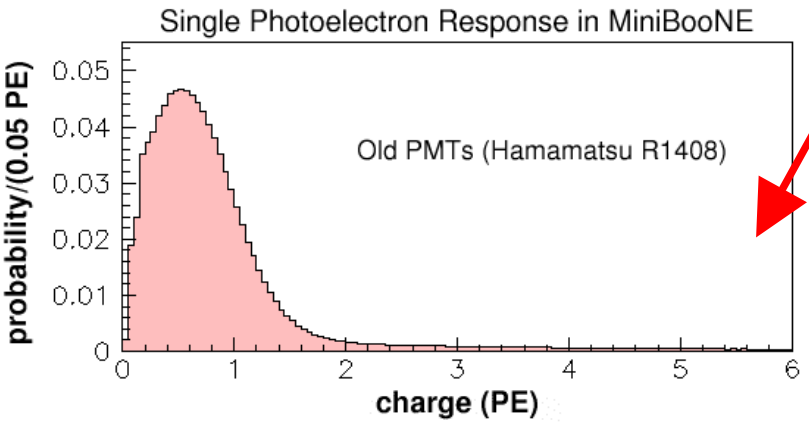
Beam π^0 candidate

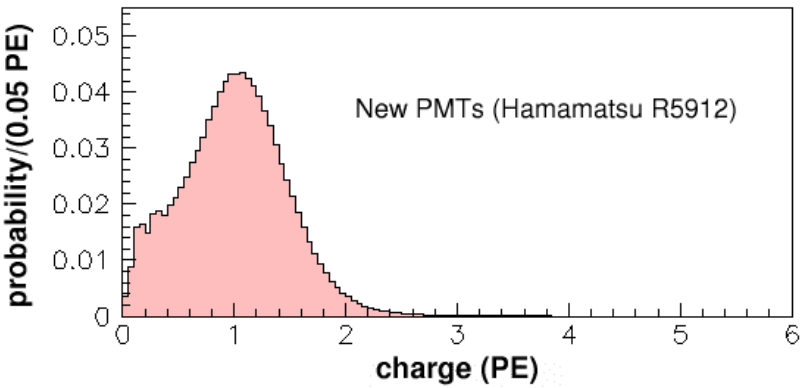


- Identify electrons (and thus candidate ν_e events) from characteristic hit topology

Laser Flask System

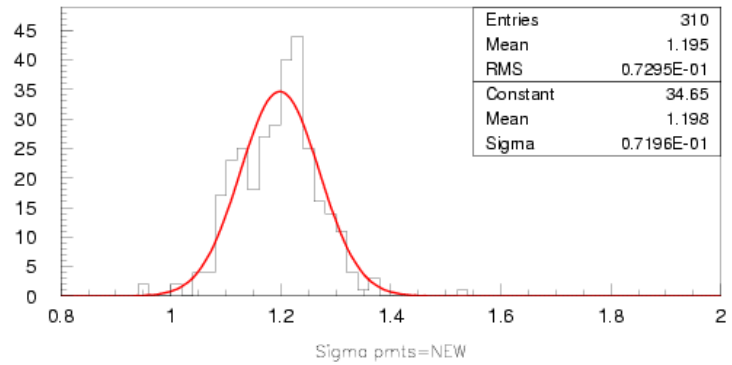
- Measure tube charge response (needed for energy measurement)

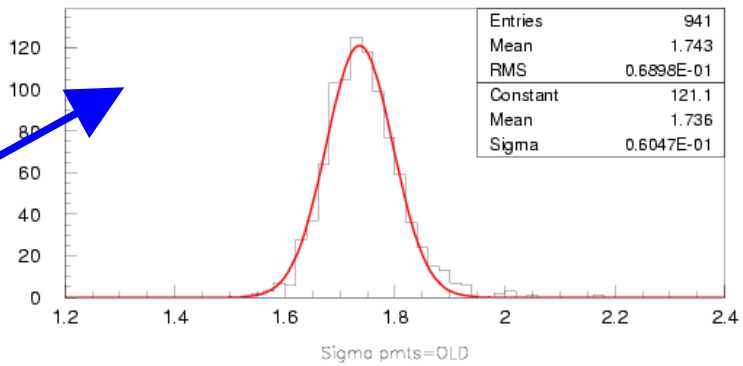




- Measure tube timing response (needed for event reconstruction)

- 4 Flasks distributed about the tank

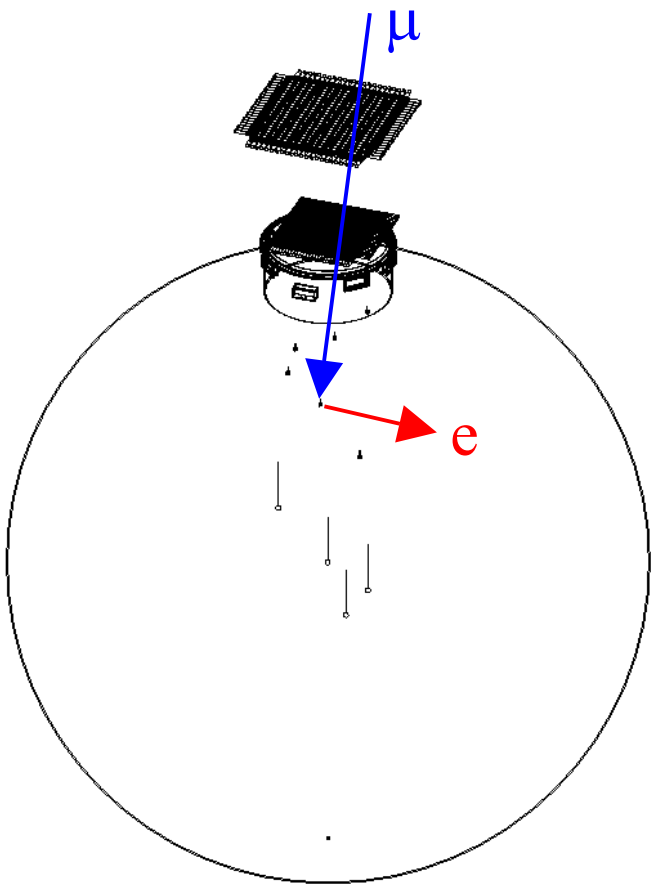




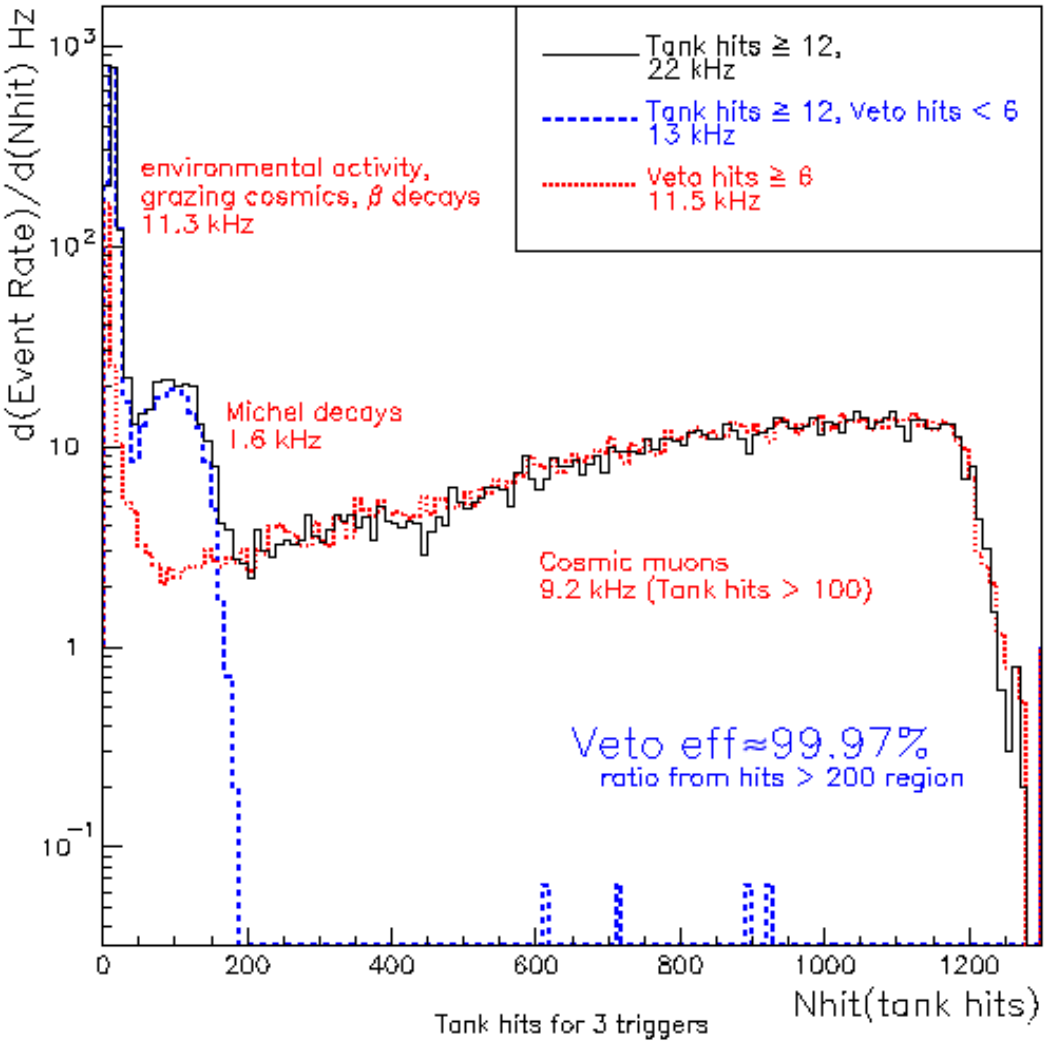
Muon Tracker and Cubes

- Scintillator cubes
- 7 throughout the tank
- Provides muons and Michel electrons of known position

- Muon tracker system
- Provides muons of known direction in the tank
- Key to understanding energy and reconstruction



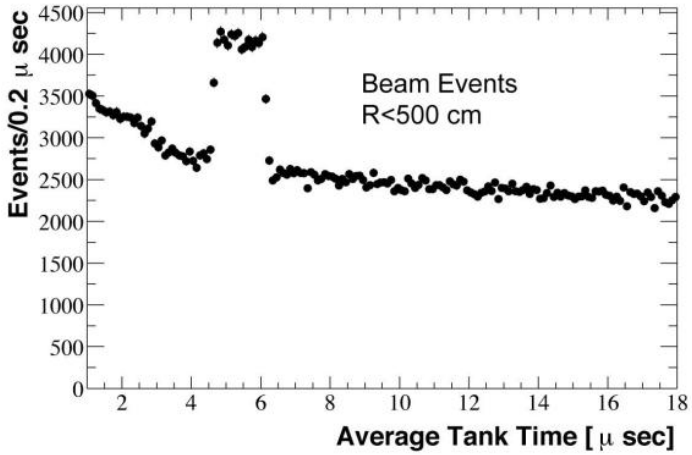
DAQ and Triggering

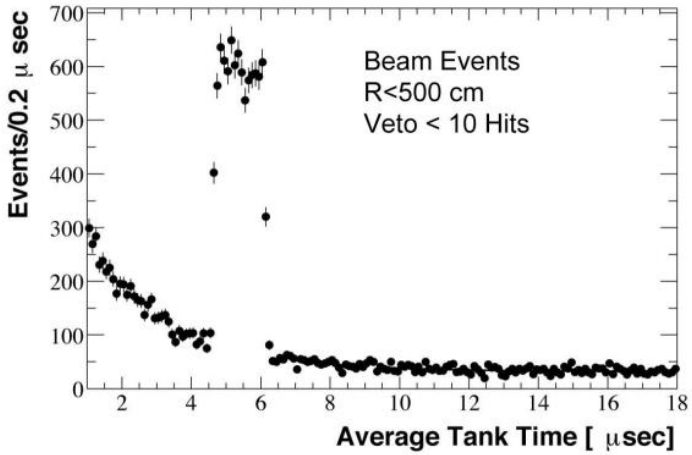


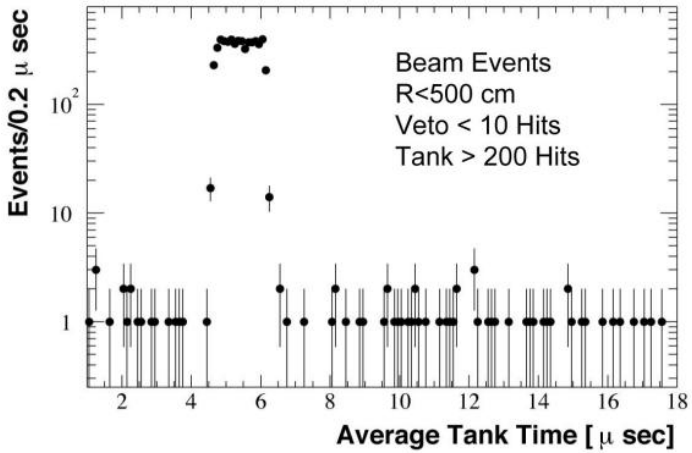
- Variety of triggers
  - Laser
  - Tracker and cube
  - Strobe
  - Beam
  - Tank activity
- Understand detector response down to a few MeV

Coarse Beam Event Timing

- DAQ triggered on beam from Booster
- Detector read out for 19.2 μs
- Neutrino pulse through detector lasts 1.6 μs
- With a few very simple cuts non-neutrino/neutrino rate is $\sim 10^{-3}$

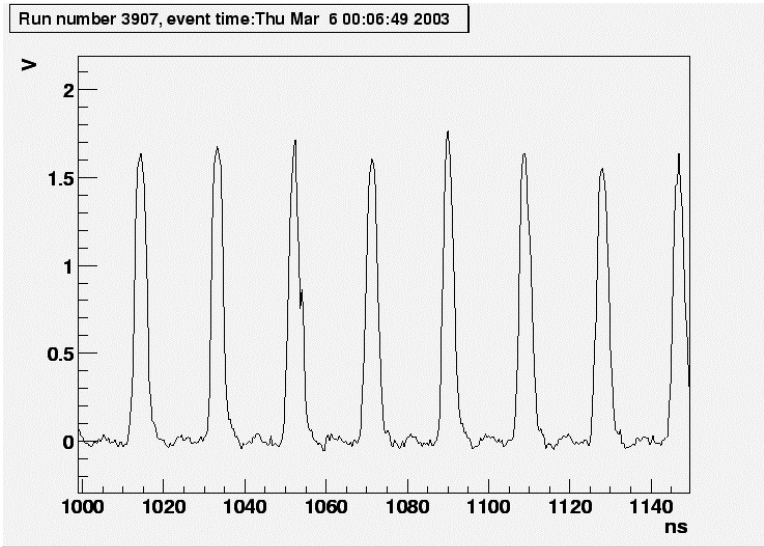


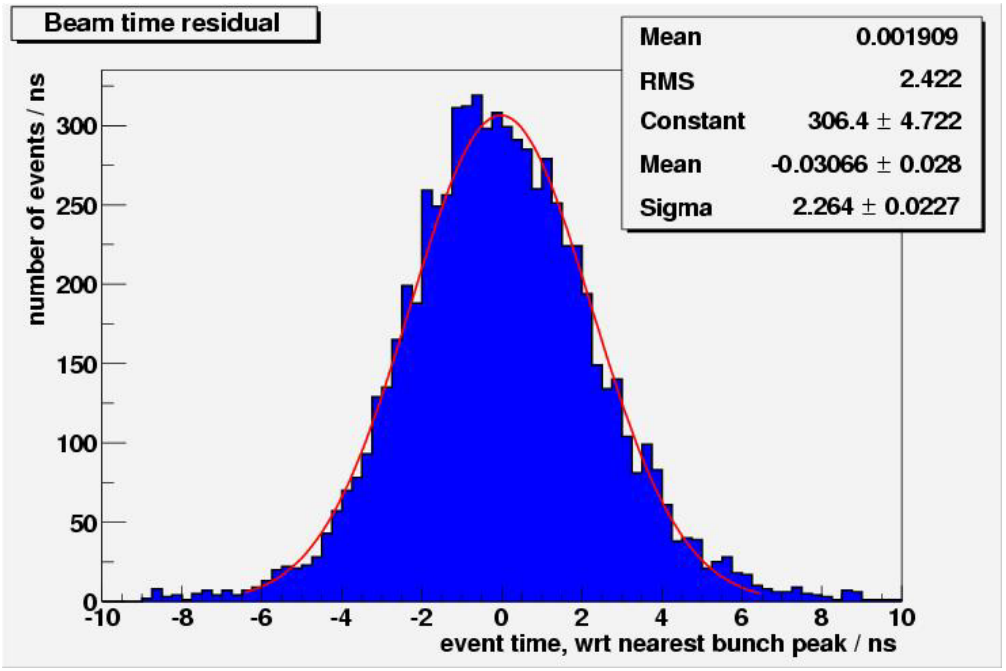




Fine Beam Event Timing

- A resistive wall monitor measures the beam time profile just before the target
- Discriminated signal sent to DAQ for fine timing





With ...

- Fitted event position
- Fitted event time
- RWM timing pulse

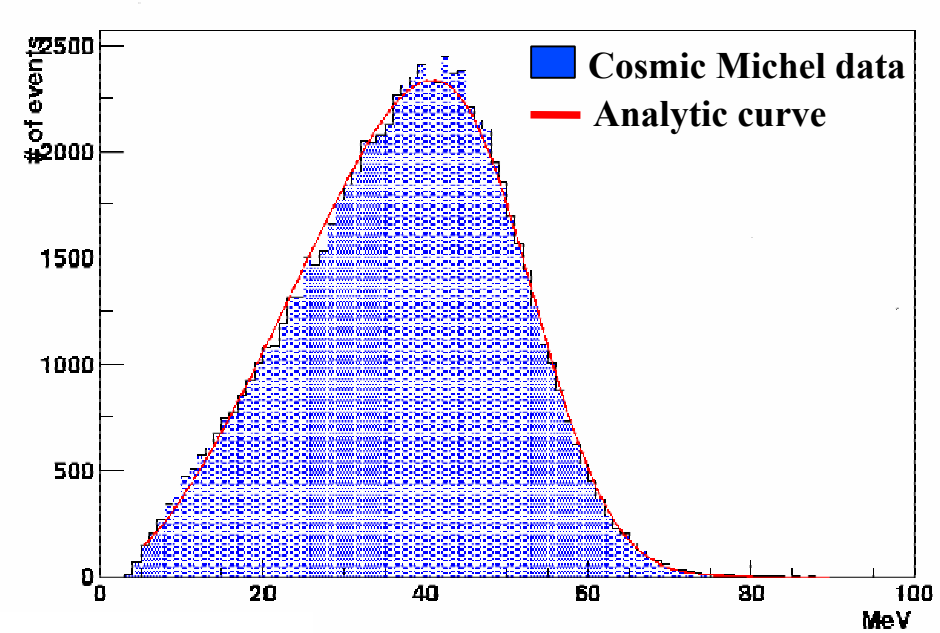
we measure the booster bunch timing....

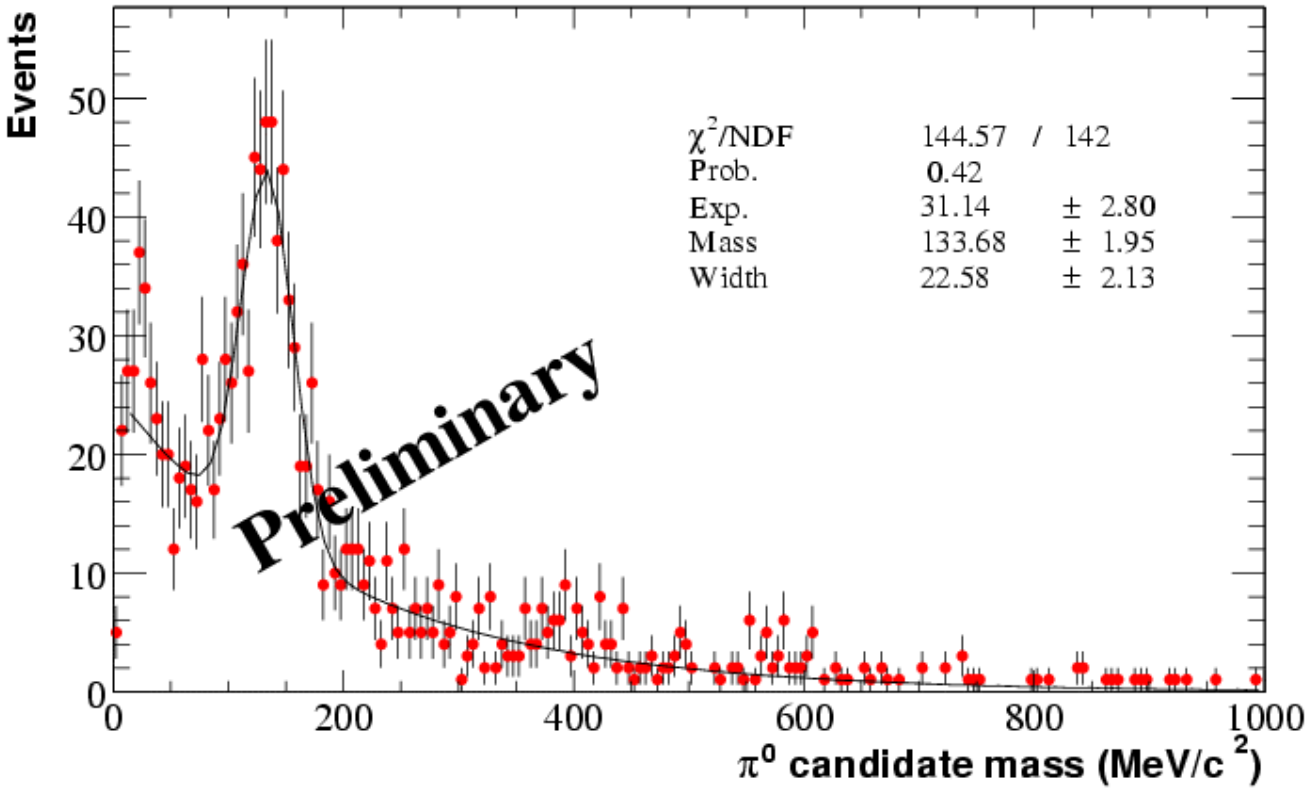
in neutrinos!

Energy Response

Cosmic Michel Decays

- Used to set energy scale

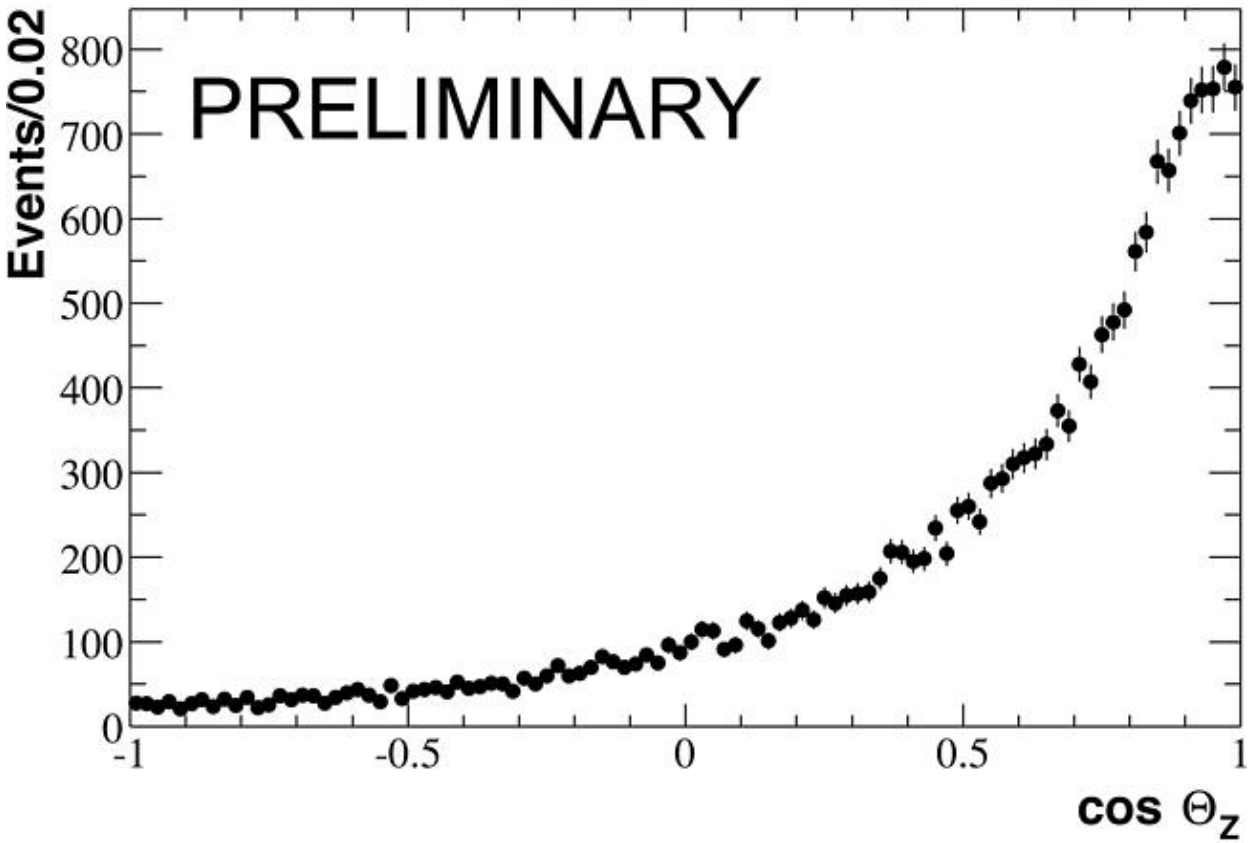




π^0 mass reconstruction

- In Beam Time window
- Tank hits > 200
- Veto hits < 6
- Both rings > ~60MeV

Reconstruction: Charged Lepton Direction

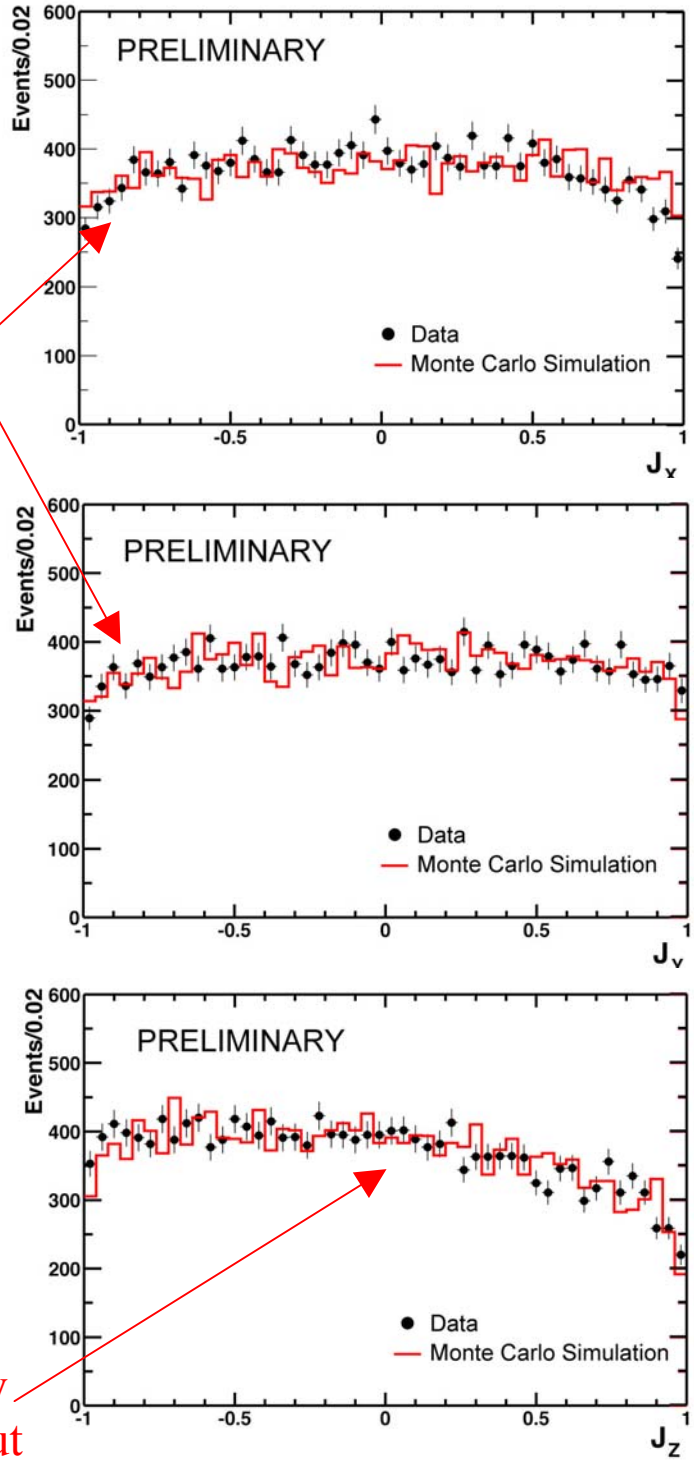


Fitted direction with respect to beam

- Tank hits > 200
- Veto hits < 6
- Fit radius < 500cm

Reconstruction: Event Position

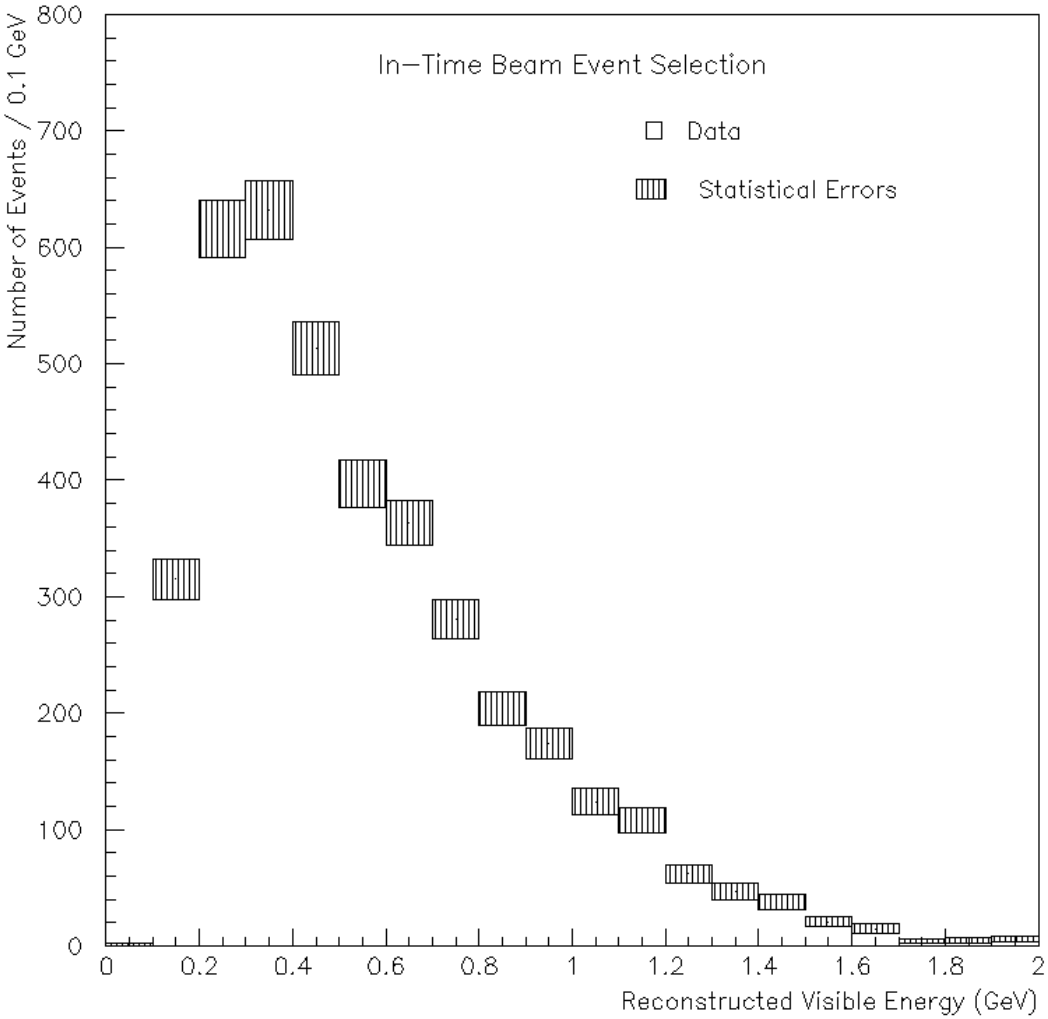
- Fitted position of the centre of the event track
- Cuts:-
  - Tank hits > 200
  - Veto hits < 6
  - Fit radius < 500cm
- Cartesian coordinates scaled to give equal volume slices in a sphere



Rolloff at edges from veto cut

Asymmetry from anisotropy of event directions + veto cut

Reconstruction: Energy



Preliminary Visible Energy

CUTS:-

- In beam time window
- Tank hits > 200
- Veto hits < 6
- Fitted radius < 450

Flux falls in range of MC predictions

HARP and E910 analyses will tighten prediction

Summary

- All systems working well
- We're at 4% of 10^{21} protons on target
- Just need to continue improvement in beam.