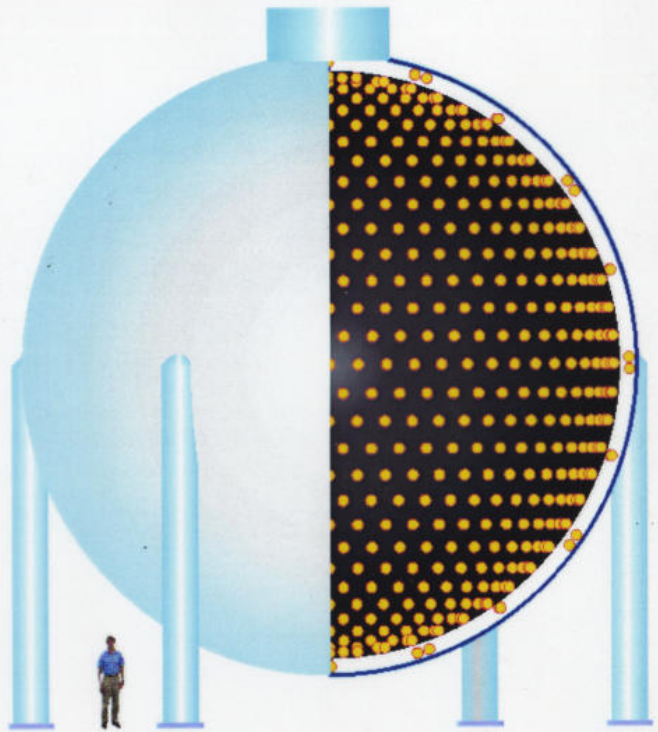


# miniBooNE: Status and Plans

- final LSND results
- miniBooNE experiment  
and status:
  - $\nu$  beam
  - detector
- summary



Rex Tayloe, Indiana U.  
Neutrino 2002, 5/02

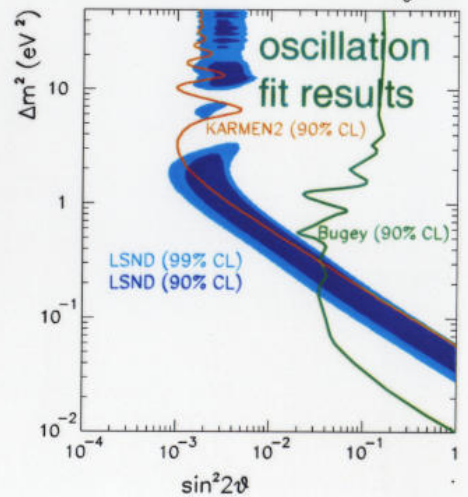
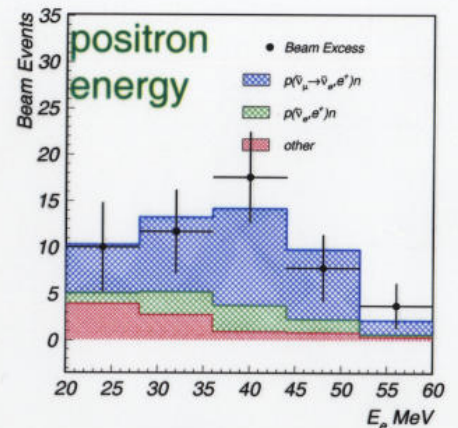
## Final LSND Results:

- $\nu_e$  -electron elastic scattering:  
PRD 63, 112001
- $\nu_e$  -Carbon Charged Current scattering:  
PRC 64, 065501
- $\nu_\mu$  -Carbon Charged Current scattering:  
Accepted to PRC

-  $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$  Oscillations:  
PRD 64, 112007

Signal above background:  
 $87.9 \pm 22.4 \pm 6.0$  events

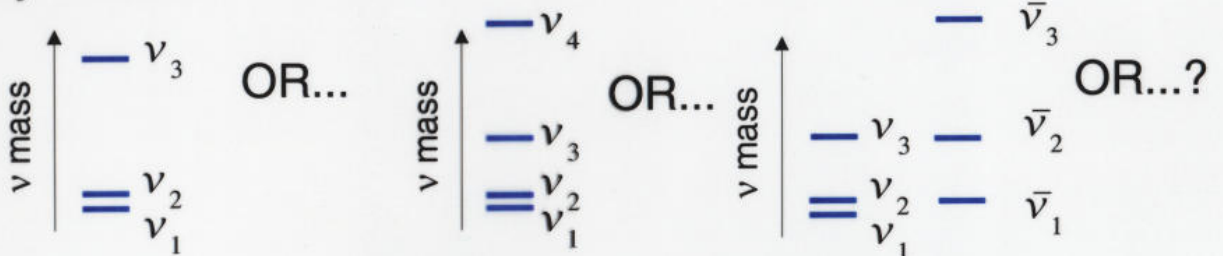
Oscillation Probability:  
 $(0.264 \pm 0.067 \pm 0.045)\%$



## $\nu$ Oscillation Scenarios:

With the latest results on solar, atmospheric, and accelerator  $\nu$ -oscillation searches ( $3 \Delta m^2 s$ ), we have an interesting situation:

Only 3 active  $\nu$ :    3 active+1 sterile  $\nu$ :    CPT violation:



*solar:*  $\nu_e \rightarrow \nu_\mu$

*atmos:*  $\nu_\mu \rightarrow \nu_e, \nu_\tau$

*LSND:*  $\bar{\nu}_\mu \rightarrow \bar{\nu}_\tau \rightarrow \bar{\nu}_e$

- not a good fit to data

*solar:*  $\nu_e \rightarrow \nu_\mu, \nu_\tau$

*atmos:*  $\nu_\mu \rightarrow \nu_\tau$

*LSND:*  $\bar{\nu}_\mu \rightarrow \bar{\nu}_s \rightarrow \bar{\nu}_\mu$

- possible(?)

*solar:*  $\nu_e \rightarrow \nu_\mu$

*atmos:*  $\nu_\mu \rightarrow \nu_\tau$

*LSND:*  $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$

- possible(?)

Need to definitively check the LSND result!

## miniBooNE:

**Goal:** to definitively test the LSND signal.

First, with a

$\nu_{\mu} \rightarrow \nu_e$  appearance search.

Then, with a

$\bar{\nu}_{\mu} \rightarrow \bar{\nu}_e$  appearance search.

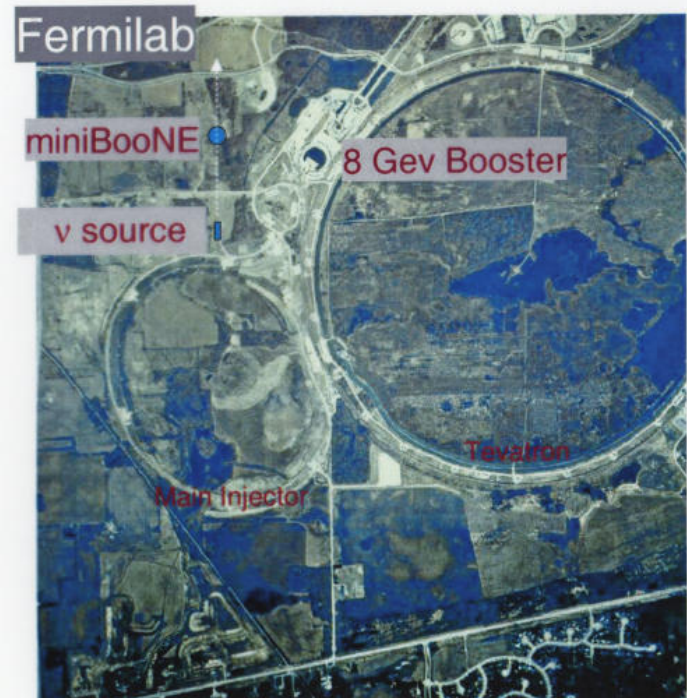
Then, if a signal is seen, with a 2nd detector.

Dec. 1997:

Proposal submitted

June 2002:

experiment begins





## The miniBooNE Collaboration:

- 64 scientists from  
14 institutions:  
– 3 undergrad universities  
– 9 graduate universities  
– 2 national laboratories

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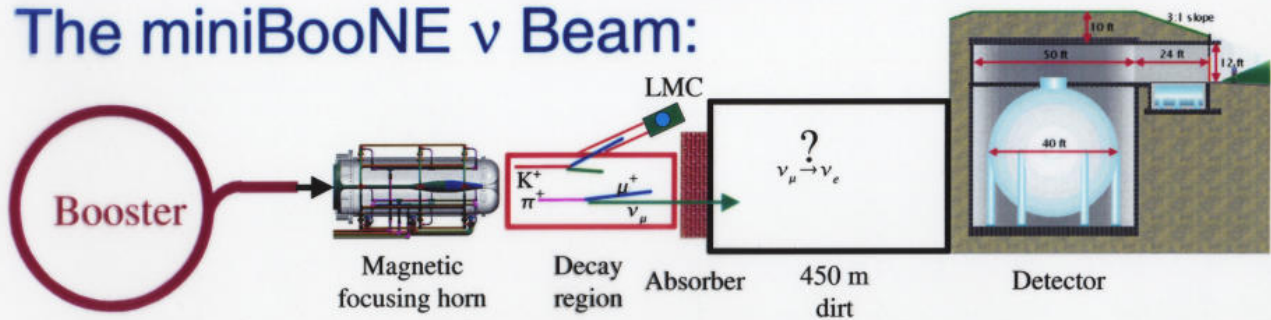
*J. Cao, Y. Liu, B. P. Roe*

*University of Michigan, Ann Arbor, MI 48109*

*A. O. Bazarko, P. D. Meyers, R. B. Patterson, F. C. Shoemaker*

*Princeton University, Princeton, NJ 08544*

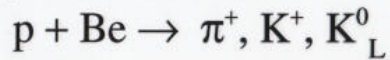
## The miniBooNE $\nu$ Beam:



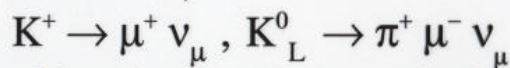
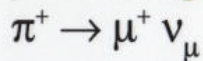
- 8 GeV protons from the FNAL booster...
- on a Be target, produce  $\pi^+$  ...
- $\pi^+$  are focused via the neutrino "horn"...
- $\pi^+$  decay ( $\pi^+ \rightarrow \mu \nu_\mu$ ) in 50m pipe...
- yielding intense source of  $\nu_\mu$

## The miniBooNE $\nu$ Flux:

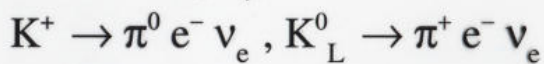
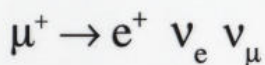
-protons on Be:



-yield a high flux of  $\nu_\mu$  :



-with a low background of  $\nu_e$  :



We need to know the flux!

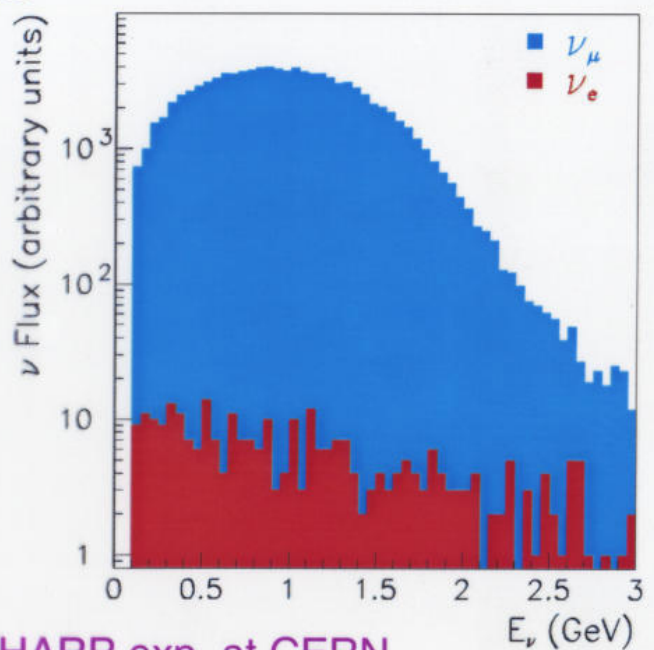
-Detailed simulations

-Actual measurements with the HARP exp. at CERN

-Measuring  $\nu_\mu$  C charged current cross section

-A secondary absorber at 25m (checks  $\mu$  background)

-Little Muon Counters (LMC) (checks K background)



## miniBooNE 8 GeV Beamline and Target Hall:

– 8 GeV line commissioned

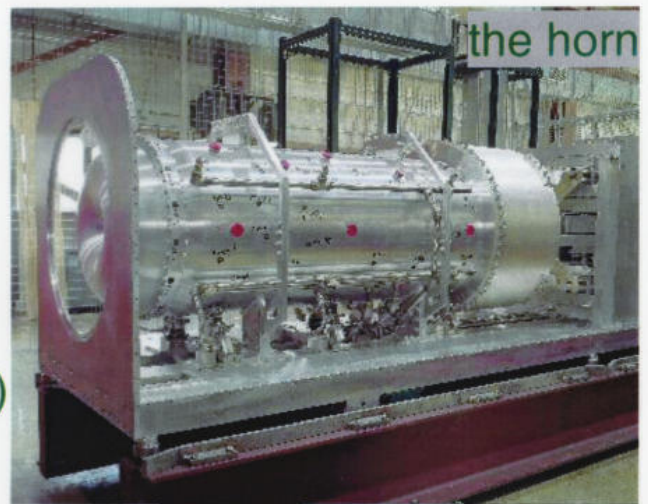


– Target hall complete



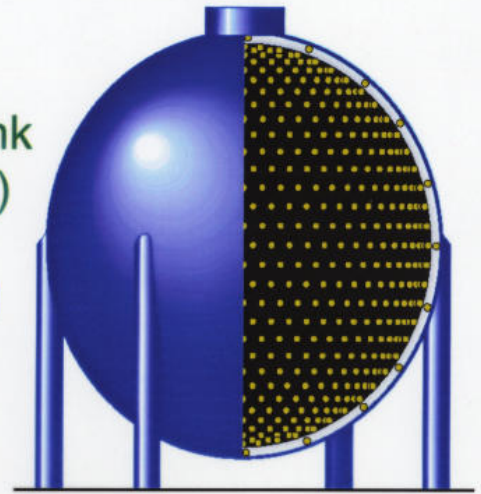
## The miniBooNE $\nu$ Horn:

- 170 kA, 140 $\mu$ s current pulse at average rate of 5Hz
- Horn has been tested with 11M pulses at full current – behaves as expected (vibration, temperature, etc.)
- Be target tested
- installation (into target hall) underway
- Neutrino beam will be delivered in June!



## The miniBooNE $\nu$ Detector:

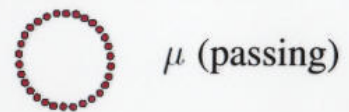
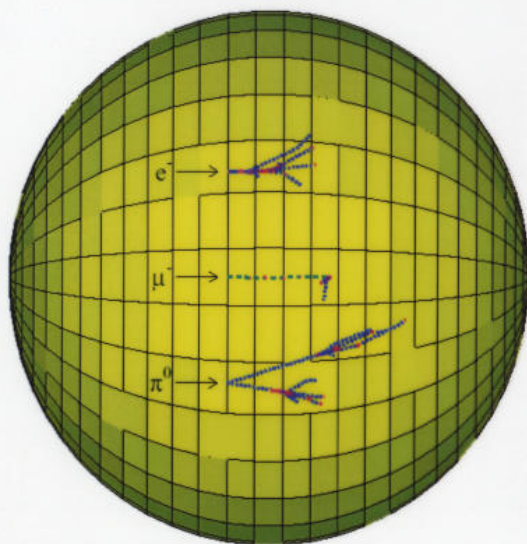
- 12 meter (40') diameter spherical tank
- 807 tons (250kgal, 445 tons fiducial) of mineral oil
- Optically isolated inner region lined with 1280 8" PMTs (10% coverage)



- Veto region with 240 PMTs
- Extensive calibration system: laser flasks, muon tracker, stopping muon cubes

## Particle ID with miniBooNE:

The pattern of hit tubes (with energy and time info) allows for the separation of different event types.



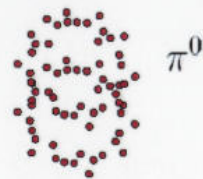
$\mu$  (passing)



$e^-$



$\mu$  (stopping)

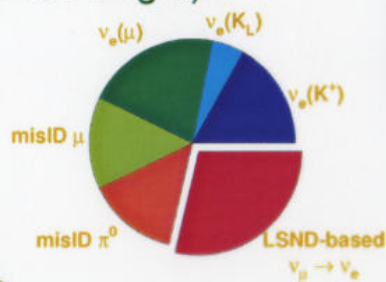


$\pi^0$

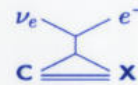
# miniBooNE Expected Signal:

In 2 years  
 ( $10^{21}$  protons on target):

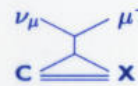
Also:  
 ~500k  $\nu_\mu$ C charged current events  
 ~70k  $\nu_\mu$ C neutral current events



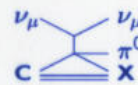
Intrinsic  $\nu_e$  background: 1,500 events



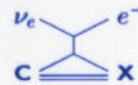
$\mu$  mis-ID background: 500 events



$\pi^0$  mis-ID background: 500 events



LSND-based  $\nu_\mu \rightarrow \nu_e$ : 1,000 events





## miniBooNE Expected Signal:

In 2 years  
( $10^{21}$  protons on target):

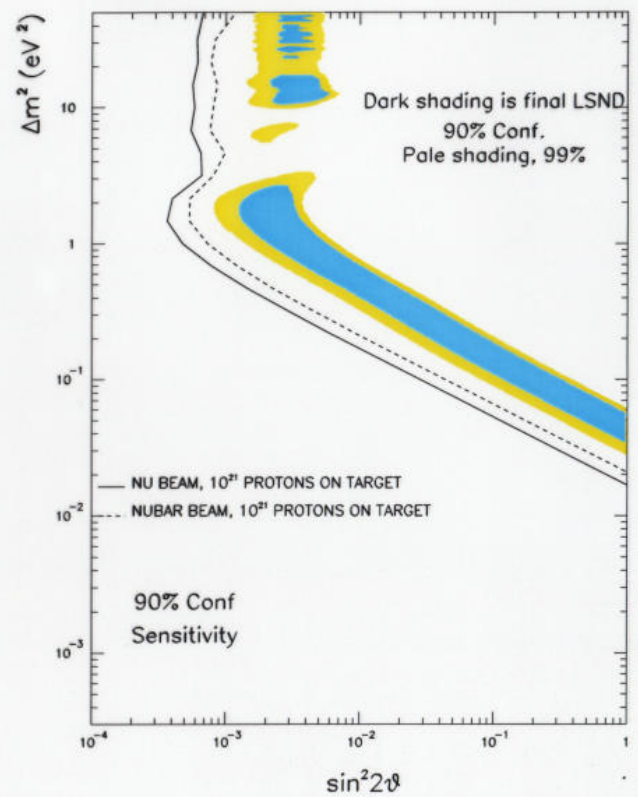
- miniBooNE will confirm or  
refute the LSND signal

and then...

-Antineutrino running...

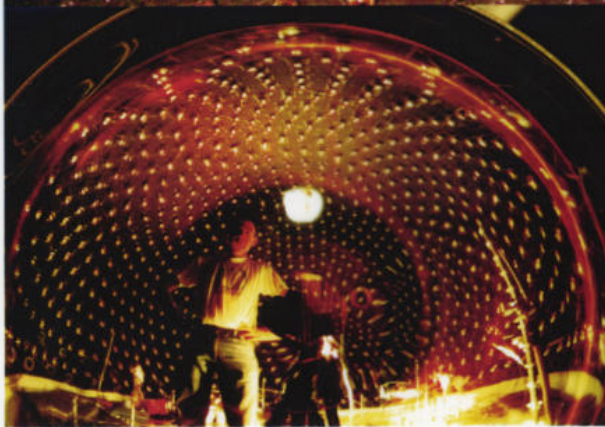
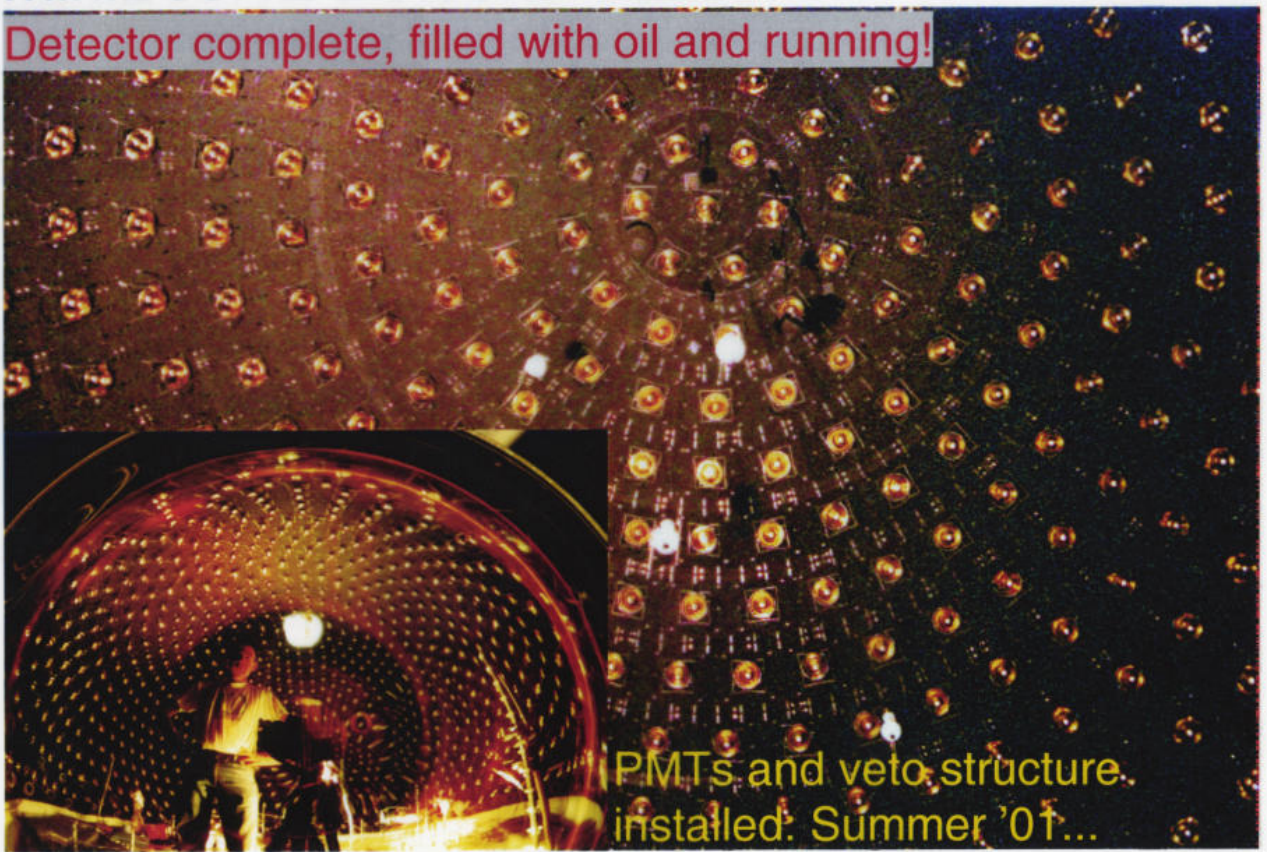
and then if a signal is confirmed..

-2nd detector



## miniBooNE Detector Status:

Detector complete, filled with oil and running!



PMTs and veto structure installed. Summer '01...

## miniBooNE Detector Status:

Detector Full of Oil: May 2...

- mineral oil:  
Exxon/Mobil Marcol 7,  
 $\rho = .836 \text{ g/cm}^3$  ,  $n = 1.46$





## miniBooNE Detector Status:

Electronics and data acquisition up and running...

"QT" electronics



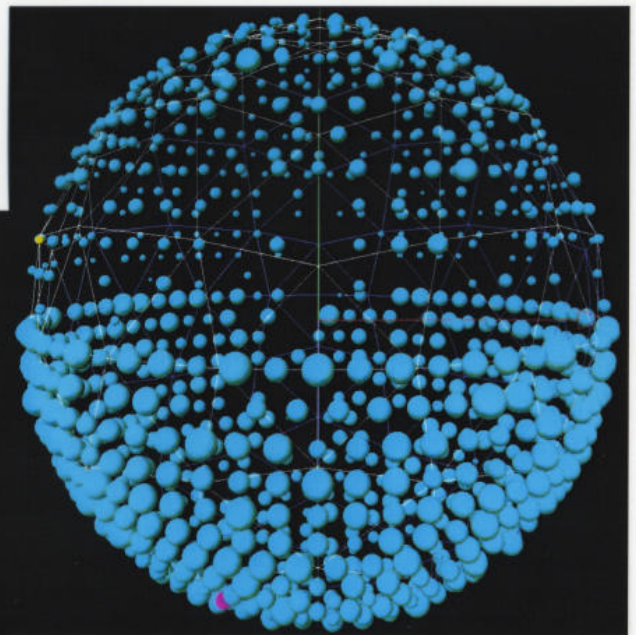
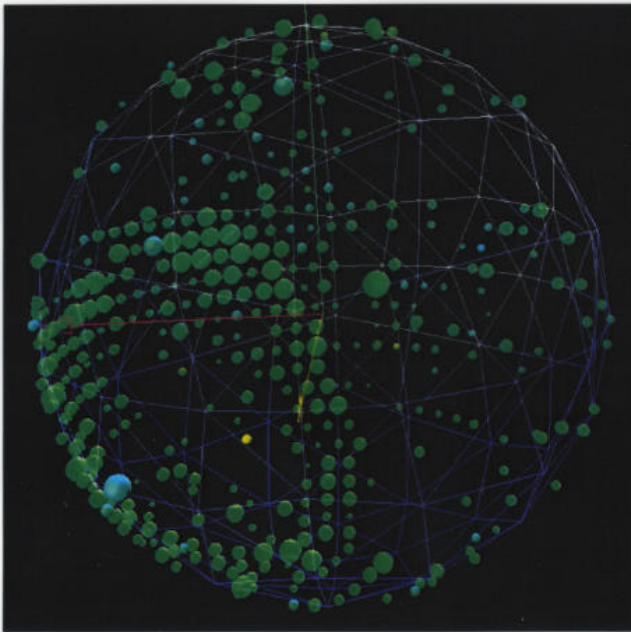
Electronics Area and muon tracker



## miniBooNE Detector Status:

Calibration events  
are being collected...

cosmic muon

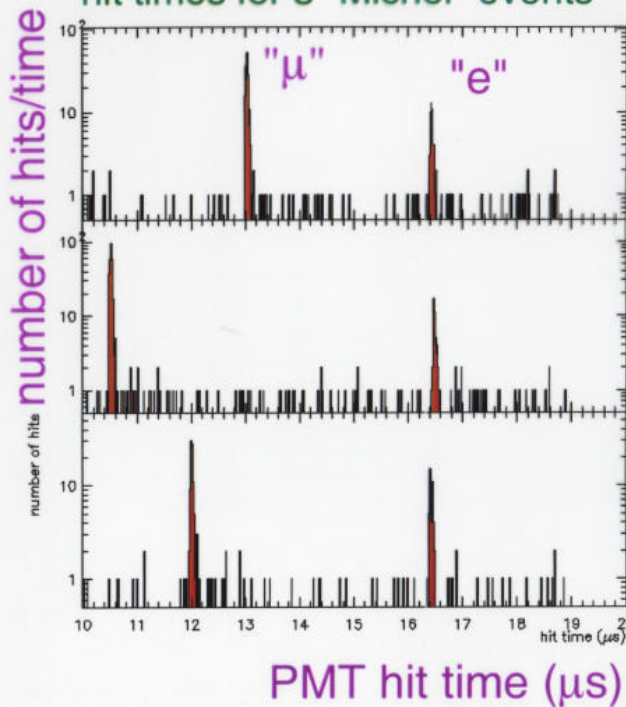


laser event, tank ~1/2 full

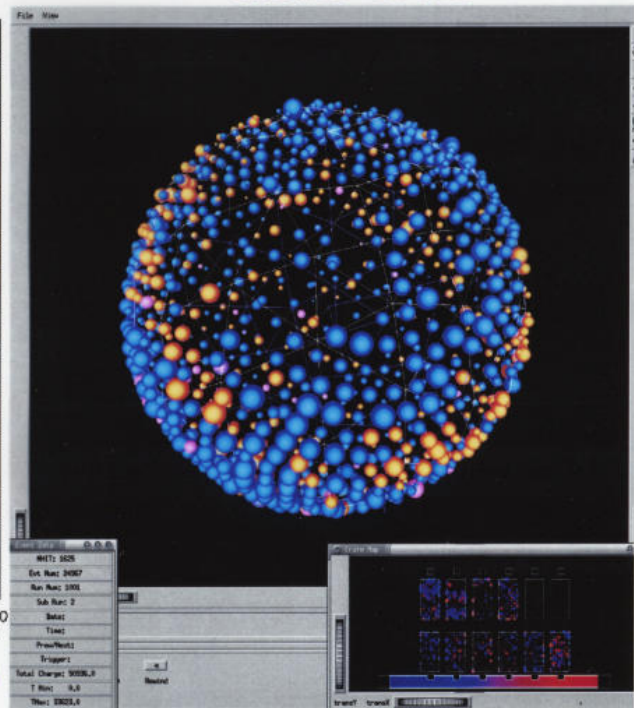
# miniBooNE Detector Status:

"Michel" (cosmic  $\mu \rightarrow e$ ) trigger working...

hit times for 3 "Michel" events



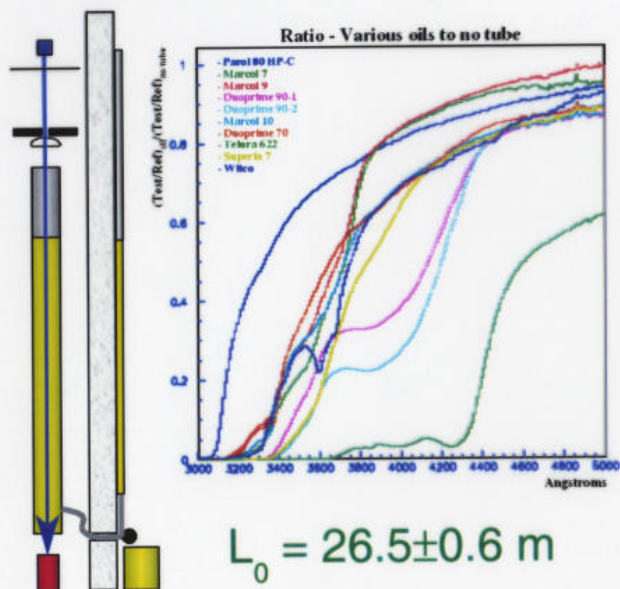
"Michel" event



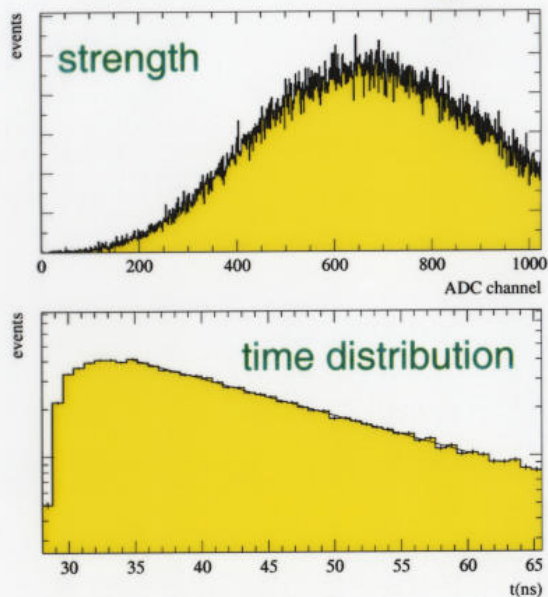
# miniBooNE Detector Status:

Calibration work continuing... in the lab...

oil attenuation length



emitted scintillation light



... to have a well understood and working detector ready for  $\nu$  beam in June 2002!

## Summary:

The miniBooNE experiment will definitively test the LSND oscillation result.

The beam and target components have been tested. Final installation underway. Will deliver neutrinos in June.

The detector is complete, running, and full of oil.

The experiment commences in June 2002.

