Status of MiniBooNE

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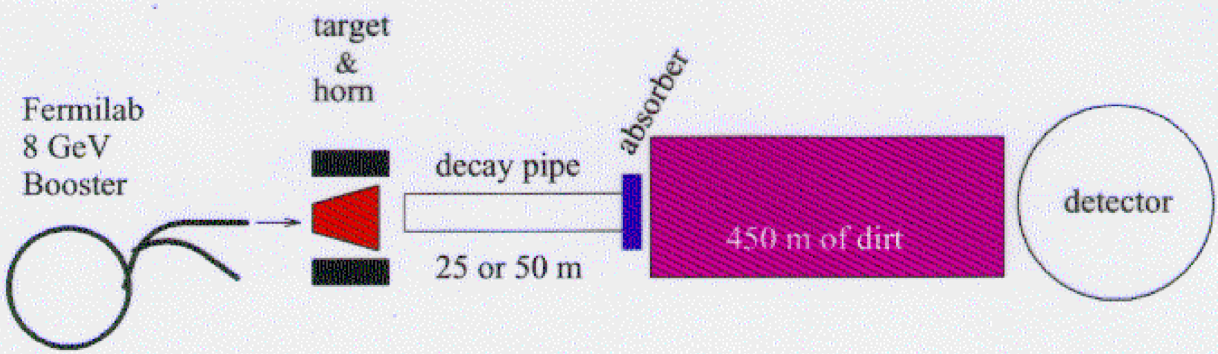
Neutrino 2000

Booster Neutrino Experiment at Fermilab:

An experiment to measure $\nu_\mu \rightarrow \nu_e$ appearance,
ν_μ disappearance,
and to probe the LSND region.



Bucknell, Cincinnati, Columbia, Embry Riddle, Fermilab,
Los Alamos, Louisiana State, Michigan, Princeton, Riverside

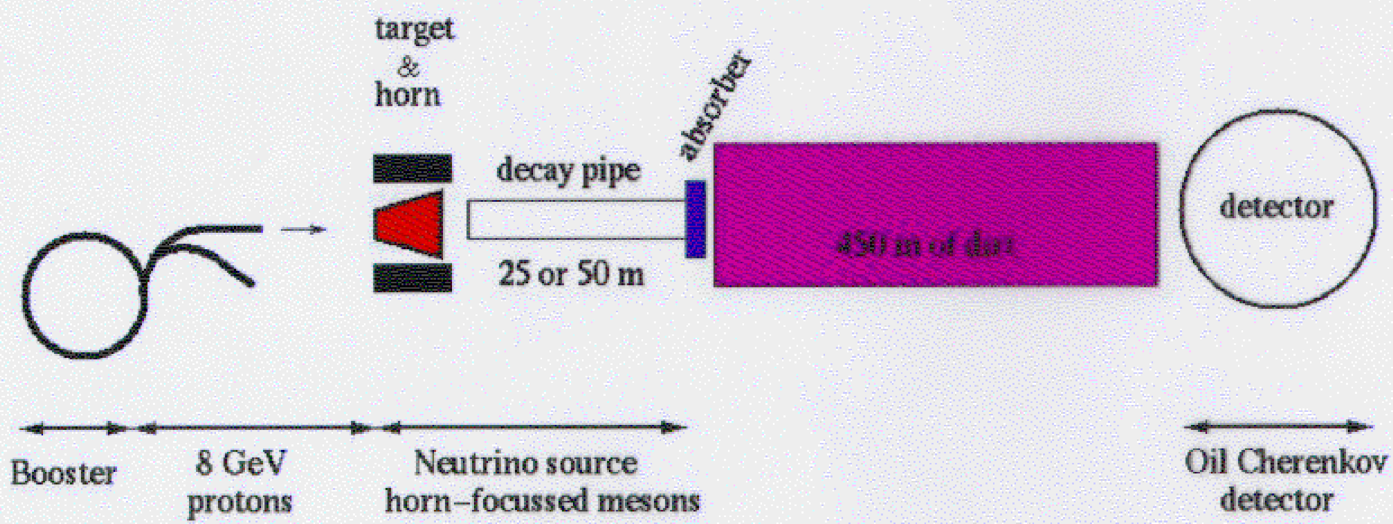
MiniBooNE design goals

- to check the LSND signal
- Keep L/E ~ 1
  - like LSND, but with different systematics (different signature and backgrounds)
- Use a high flux ν_μ beam
  - with well-understood ν_e content
  - 1 GeV: ten times higher E than LSND
- Large fiducial volume detector
  - with good particle id capability
  - to observe ν_e quasi-elastic scattering

MiniBooNE —

Booster Neutrino Experiment, Phase One

to begin running Dec 2001 — all parts now under construction



BooNE, Phase Two

add a second detector, the position of which is determined by MiniBooNE

BooNE Detectors and Site Layout

The Booster

8 GeV proton accelerator
built to supply beam to the Main Ring,
it now supplies the Main Injector.

Booster must now run at record intensity

MiniBooNE will run simultaneously with other programs:

Dec 2001 to Dec 2002 Run II + BooNE
5×10^{12} ppp at a rate of 7.5 Hz
(5 Hz for BooNE)

BooNE: 5×10^{20} protons on target in one year

Challenges are in radiation issues:
limit losses at extraction and
during acceleration

The 8 GeV Project

Development of a new low-energy hadron experimental area.

New beamline
MiniBooNE target hall

Future users are foreseen,
e.g. Muon collider R&D experiments

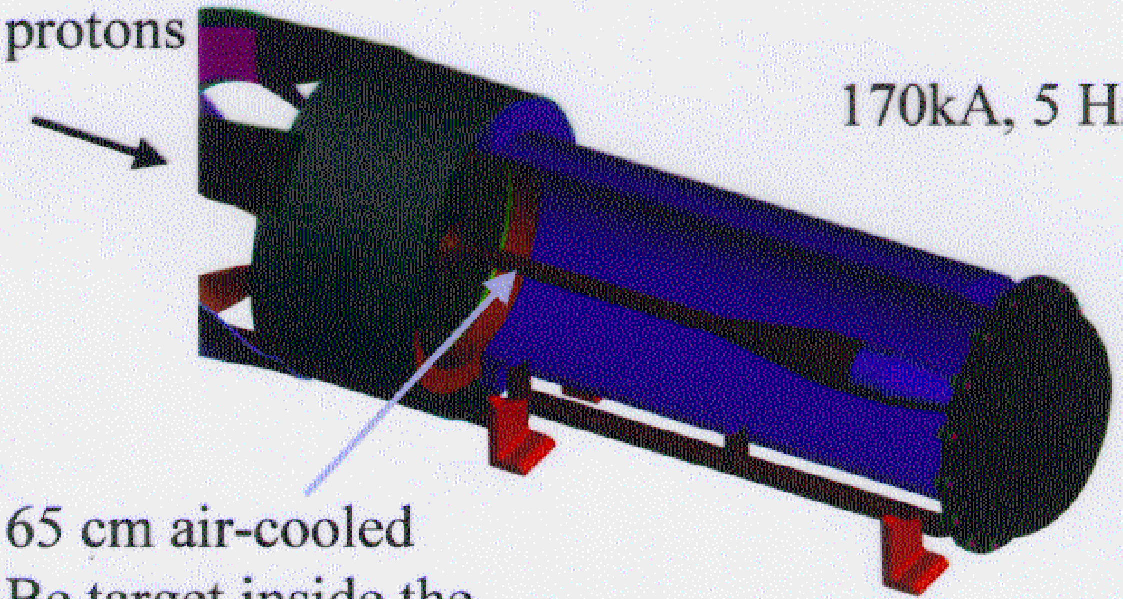
Contractor started work last week.

Target and Horn

The charged pions and kaons are focussed toward the detector with a magnetic horn

8 GeV protons

170kA, 5 Hz



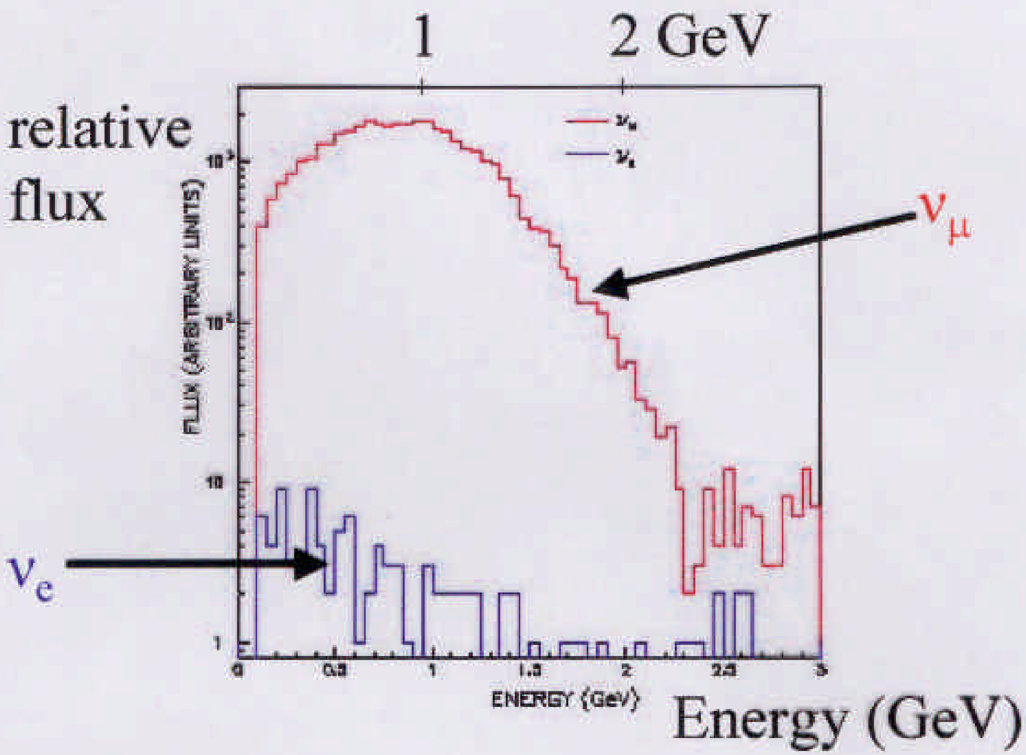
65 cm air-cooled Be target inside the inner conductor

High Rep Rate — 6-7 times higher than any other horn. To run one year this horn must survive 100 M pulses

Pre-prototype testing going well: corona, water-cooling, welds

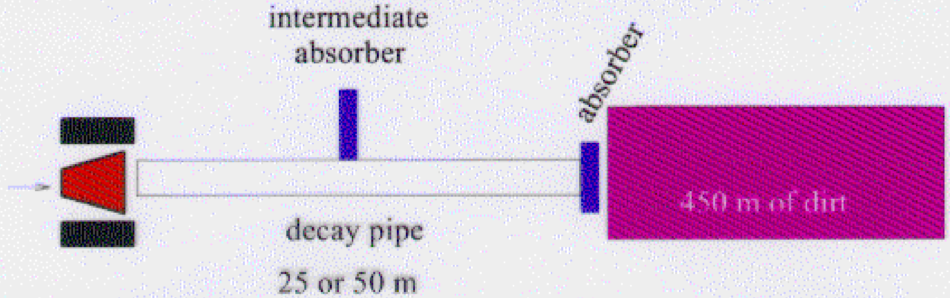
A prototype horn will be tested in October and allowed to run for >10 M pulses

Neutrino Beam



50 m decay length
flux in detector located at 500 m

Design of the Decay region



- The decay region will have two absorber positions: 25 and 50 m
- Varying the length provides a crosscheck on the background:

For example, assume a 600 event excess is observed

Is it signal?

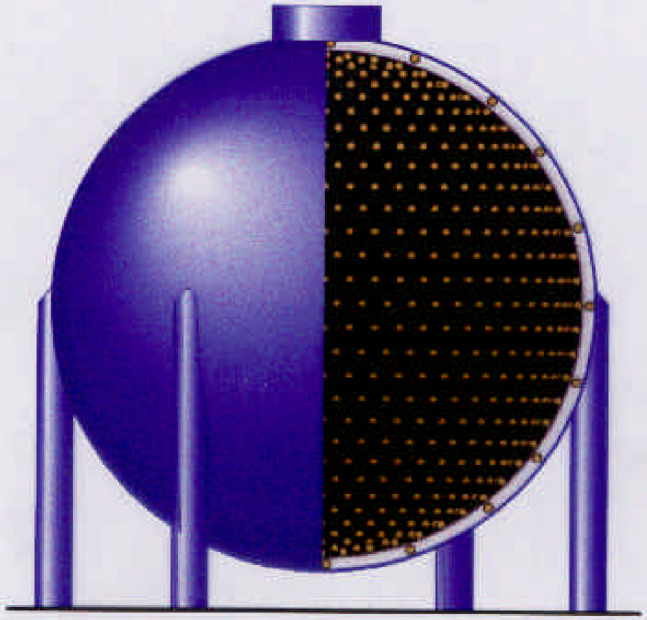
or

is it an underestimate of the ν_e background?

Check by changing the decay length,
which has a strong effect on the $\pi \to \mu \to \nu_e$ bkgd:

Decay pipe length	ν_μ events	$\nu_\mu \to \nu_e$ (oscillation events) $\propto L_{\text{decay}}$	if due to ν_e bkgd: $\pi \to \mu \to \nu_e \propto L^2_{\text{decay}}$ K decays constant
50 m	700 000	600 ± 50	600 ± 50
25 m	390 000	334 ± 35	174 ± 32

MiniBooNE detector



Pure mineral oil

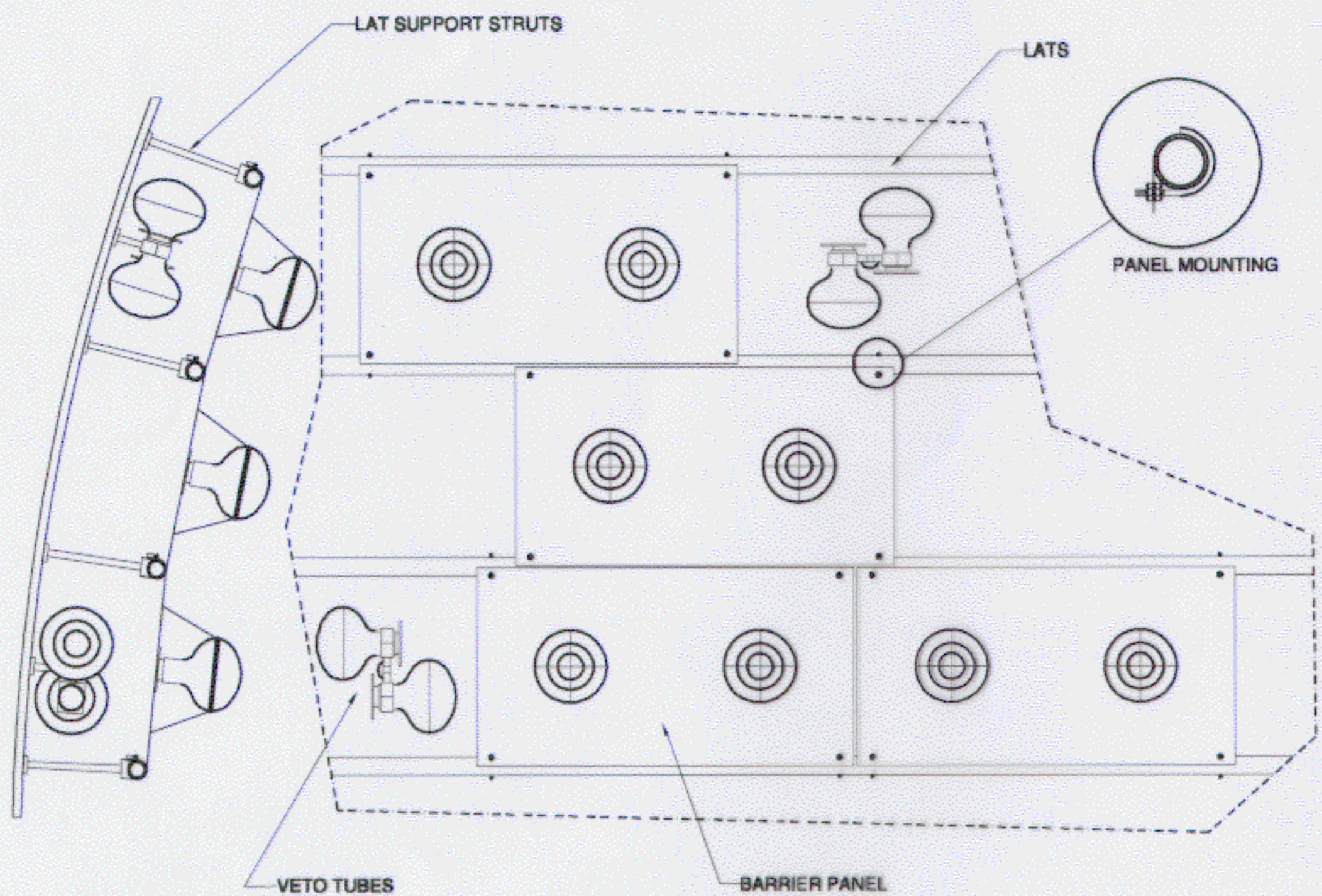
total volume: 800 tons (20 foot radius)
fiducial volume: 445 tons (5 m radius)

1280 PMTs in detector at 5.5 m radius
$\rightarrow$ 10% photocathode coverage

240 PMTs in veto

Phototube support structure provides an opaque barrier between veto and main volumes

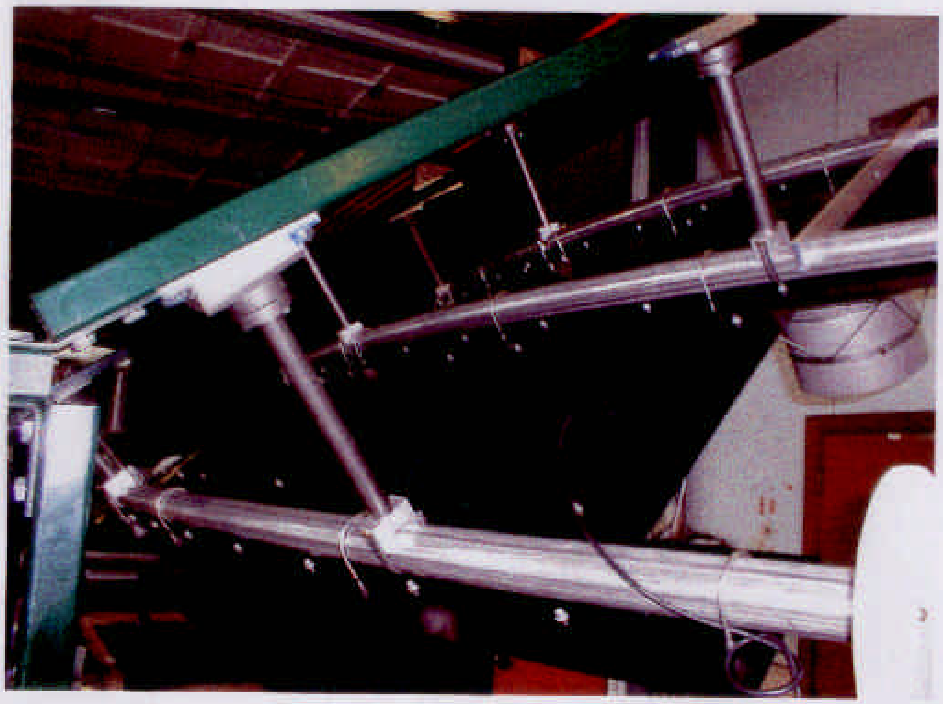
main volume black
veto volume white


LAT SUPPORT STRUTS
LATS
PANEL MOUNTING
VETO TUBES
BARRIER PANEL

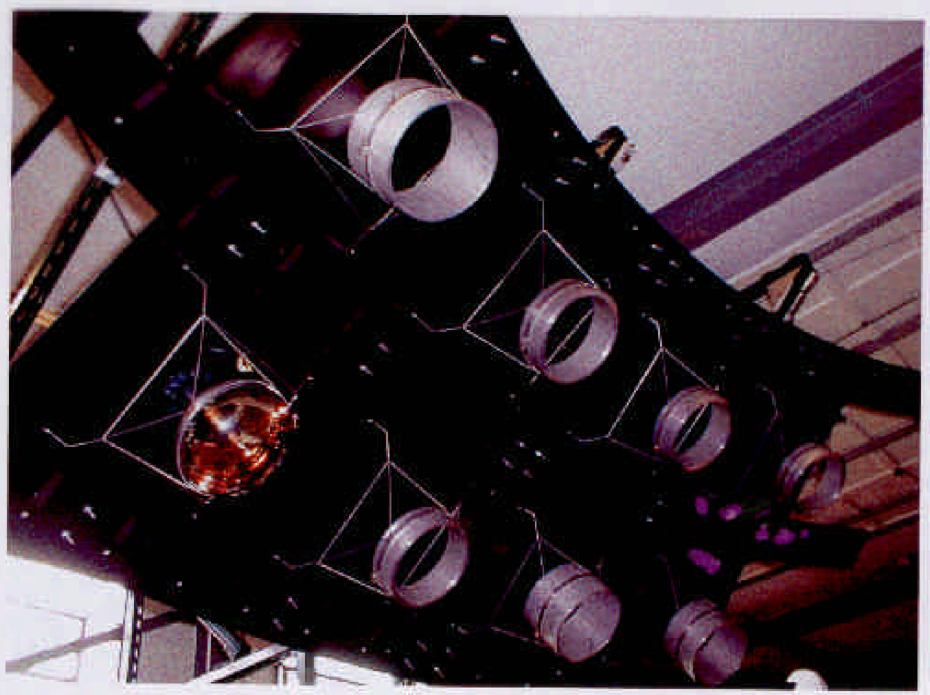
Prototype PMT Support Structure

Final pieces now being fabricated

Struts hold lat pipes



Panels attached to lats carry the PMTs



MiniBooNE detector

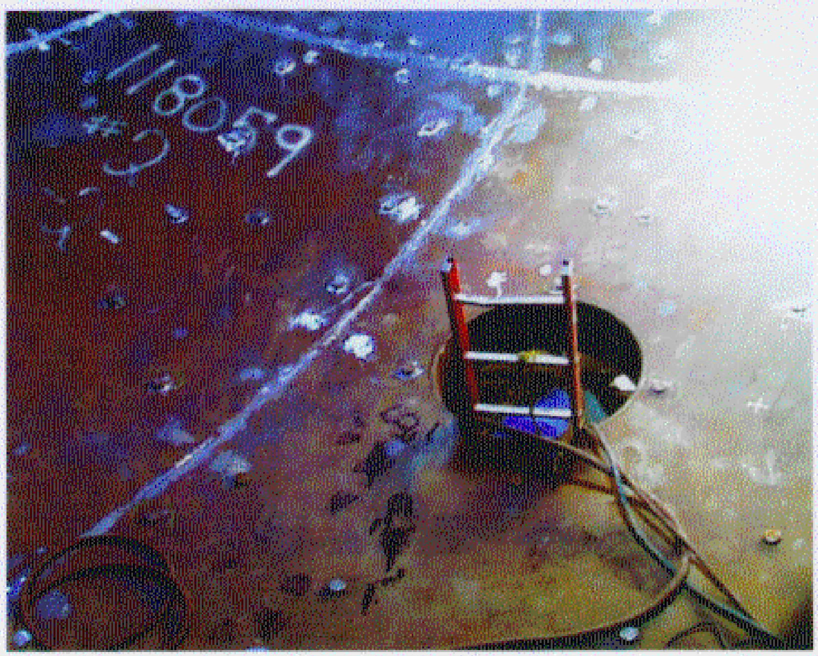
8 foot diameter tophat access with cable ports

5 Jun 2000

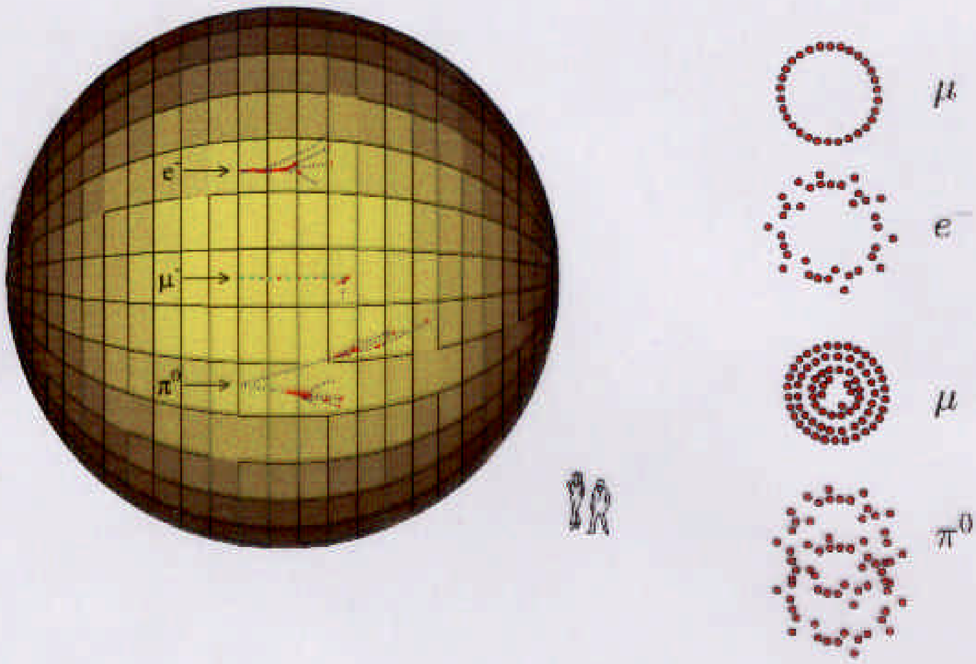
Manhole access from bottom

Bosses for mounting PMT structure

2 May 2000



Analysis: e, μ, π^0 discrimination



PID based on ring id, track extent, ratio of prompt/late light

Signatures substantially different from LSND due to

- $\times 10$ higher energy
- very little scintillation light in QE event (pure oil)
  Cherenkov to scintillation light ratio 4:1
- neutron capture is not part of the signature

if LSND correct: ~ 500 events or more (1 year)

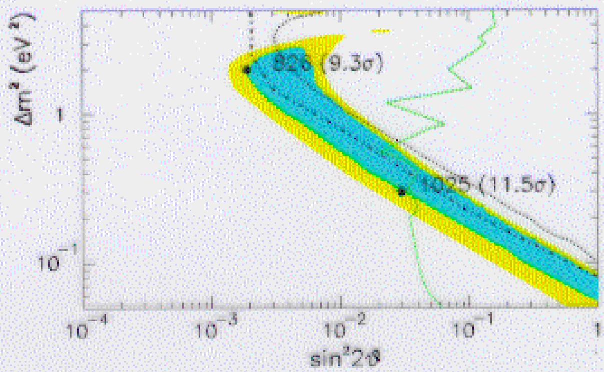
backgrounds are mis-id of μ's and π^0's, and intrinsic ν_e in the beam

What MiniBooNE can do

Consider the total signal; excess expected based on LSND:

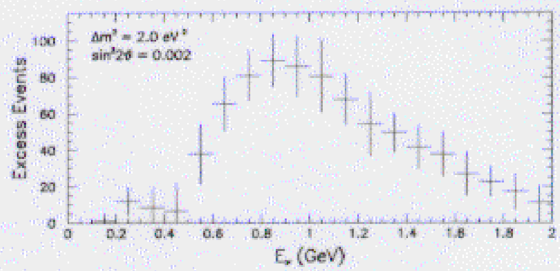
For a given ν beam:
$\mu \to \nu_e$ component (known to 5%)
$K \to \nu_e$ component (10%)

μ misid (5%)
π^0 misid (5%)

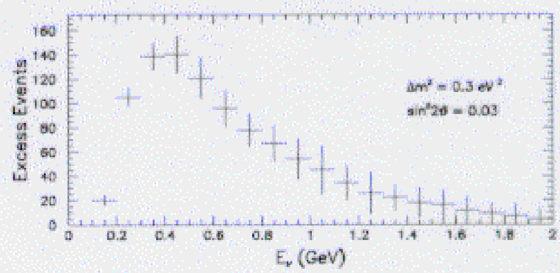


Consider the energy dependence:
Signal for two possible sets of oscillation parameters:

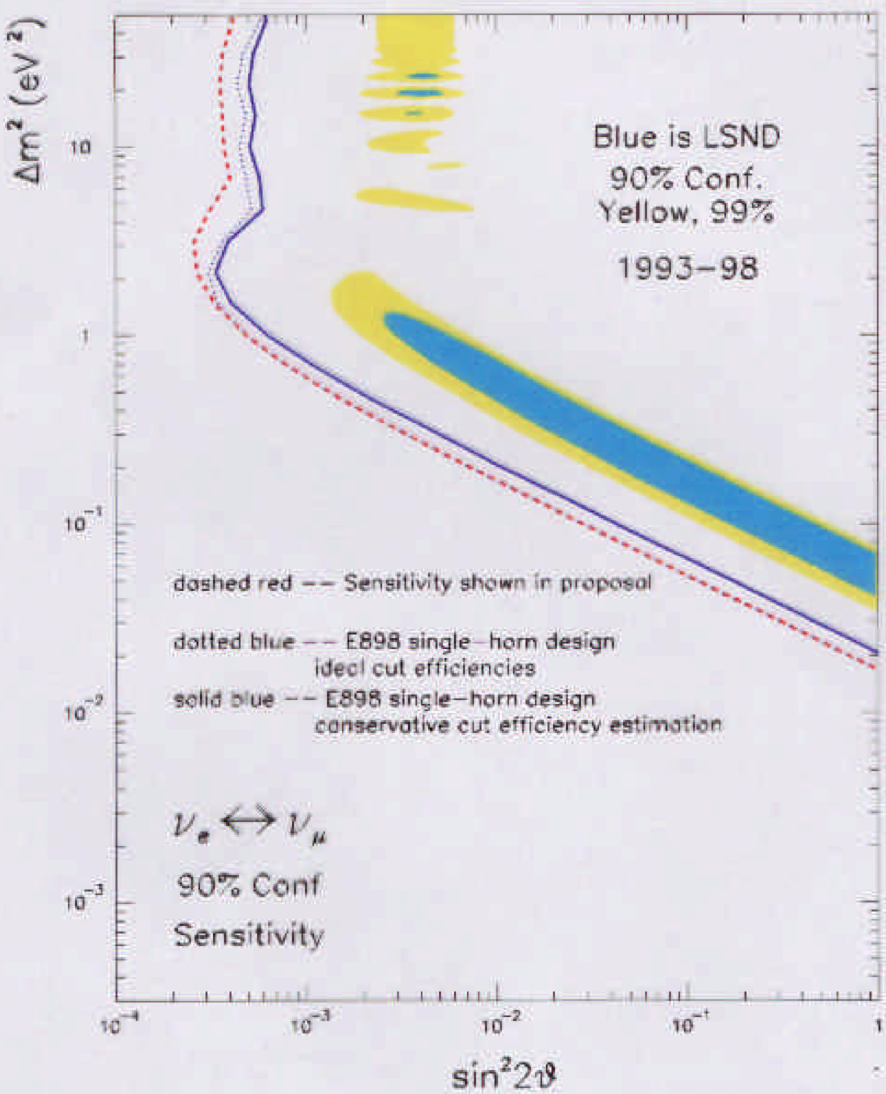
$\Delta m^2 = 2$ eV^2, $\sin^2 2\theta = 0.002$:



$\Delta m^2 = 0.3$ eV^2, $\sin^2 2\theta = 0.03$:

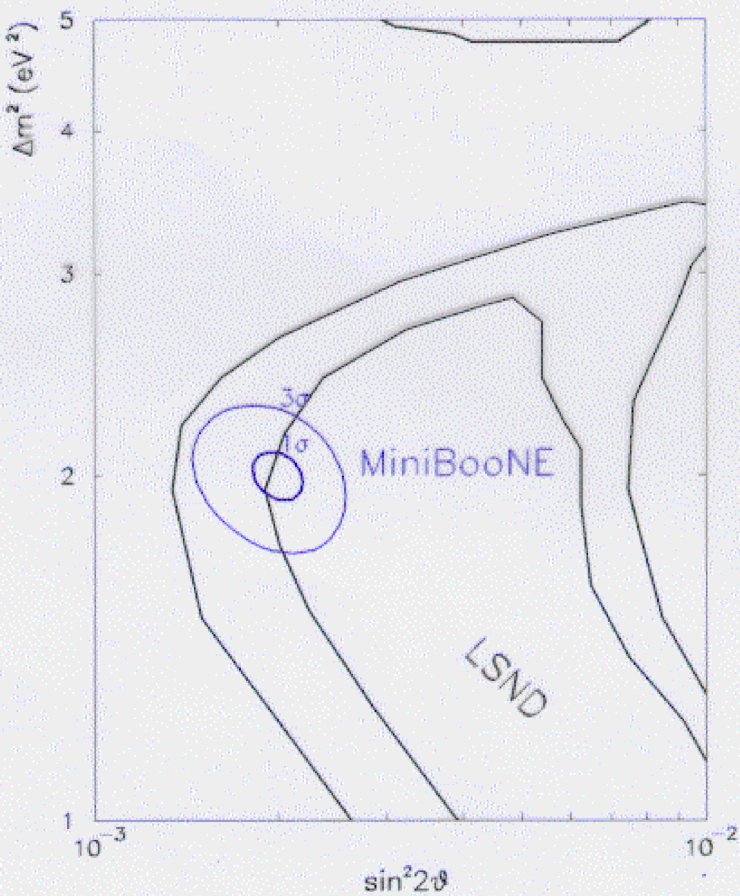


MiniBooNE expected sensitivity

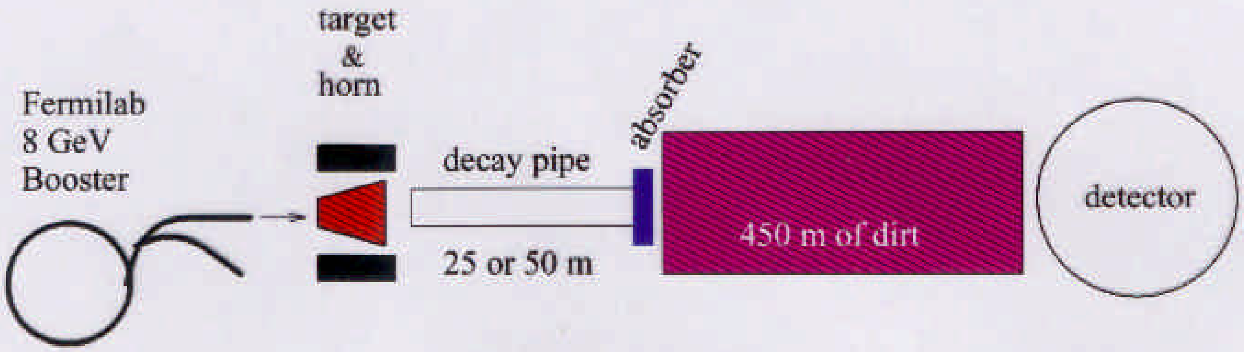


Final horn design, most conservative mis-id estimate, one calendar year of running

Expected Measurement for
$\Delta m^2 = 2\ \text{eV}^2$
$\sin^2 2\theta = 0.002$



In summary, MiniBooNE



is under construction!

- civil design is essentially finished
- detector construction well underway
- Booster testing is underway
- detector internal components are being fabricated
- horn and target elements are being procured
- 8 GeV line and Target hall construction began last week.

We are on schedule!

Start running December 2001.
Sensitivity based on one year of running.