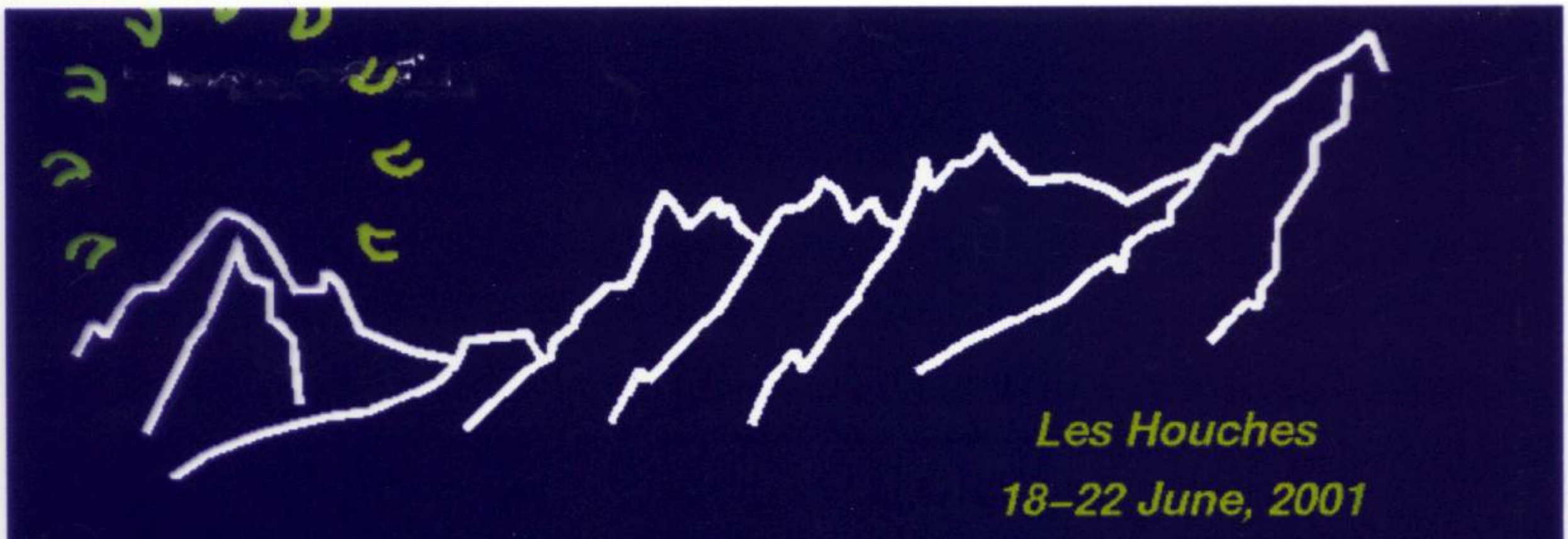


Les Houches

18–22 June, 2001

Current Status of BooNE
Phase I - MiniBooNE

Fernanda Gallinucci Garcia

FNAL

Brief introduction to oscillations

Design of MiniBooNE

The 8 GeV beamline

The detector

Summary

The LSND experiment

- LAMPF 800 MeV proton beam on targets and beam stop
- Detector 30 m from beam stop
- 167 tons of liquid scintillator, surrounded by phototubes

Decay-at-rest Analysis

($\nu's$ from beamstop)

stopped $\pi^+ \to \nu_\mu \, \mu^+$

$\hookrightarrow e^+ \, \overline{\nu}_\mu \, \nu_e$

$\overline{\nu_\mu} \to \overline{\nu_e}$

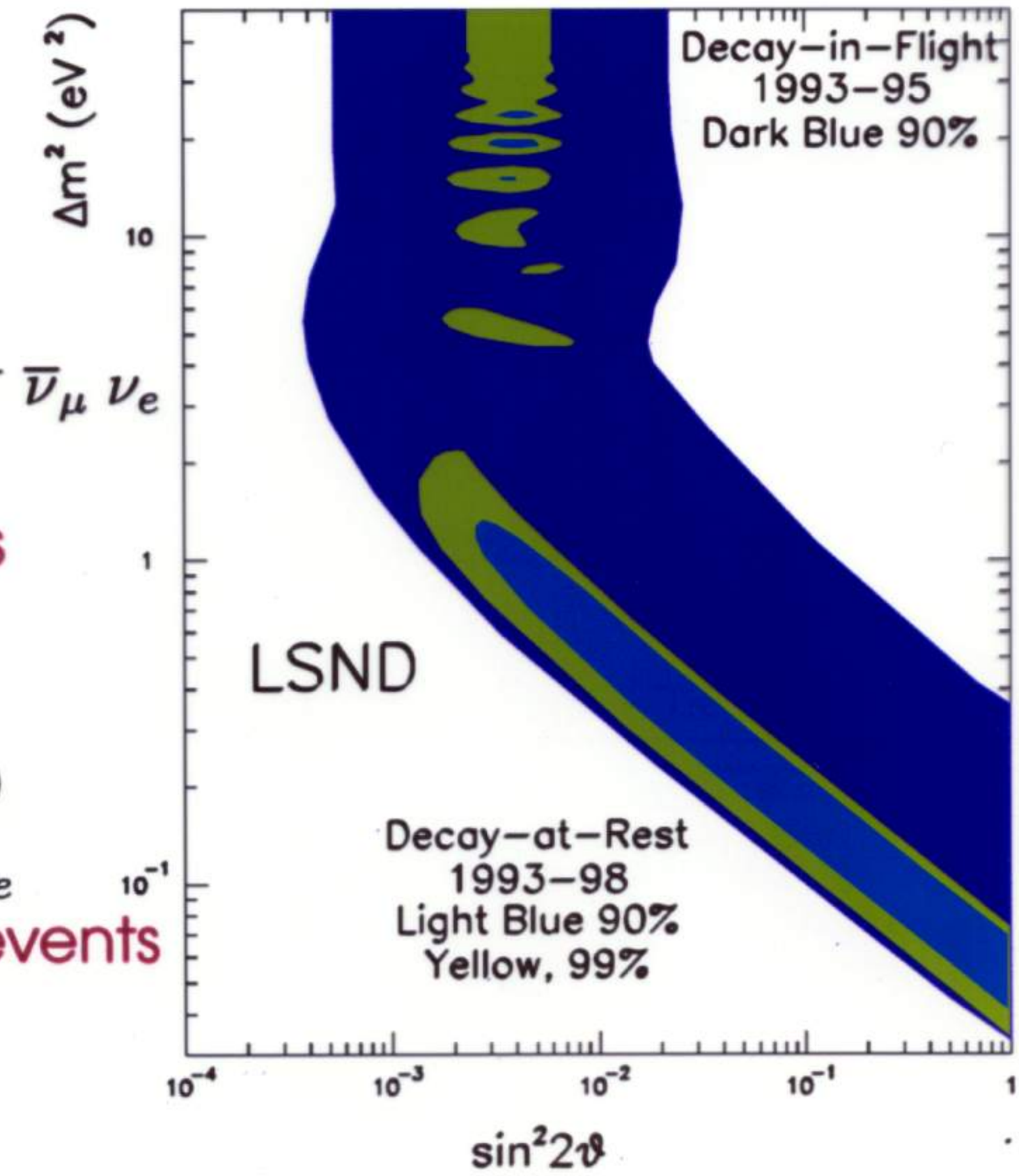
Excess: 39.5 ± 8.8 events

Decay-in-flight Analysis

(stop+upstream targets)

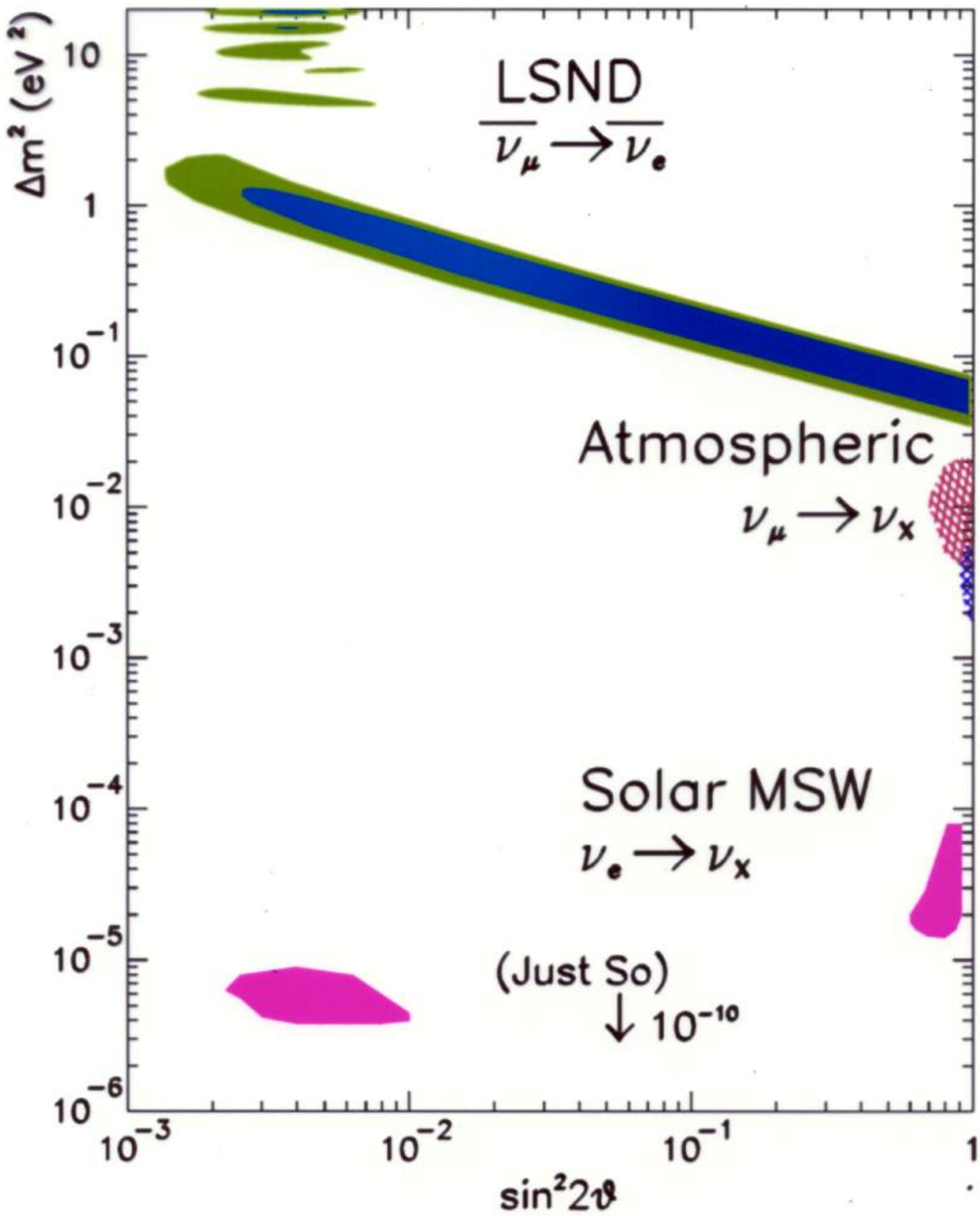
$\pi^+ \to \nu_\mu \, \mu^+$ $\qquad$ $\nu_\mu \to \nu_e$

Excess: $18.1 \pm 6.6 \pm 4.0$ events



Different analysis but consistent signal

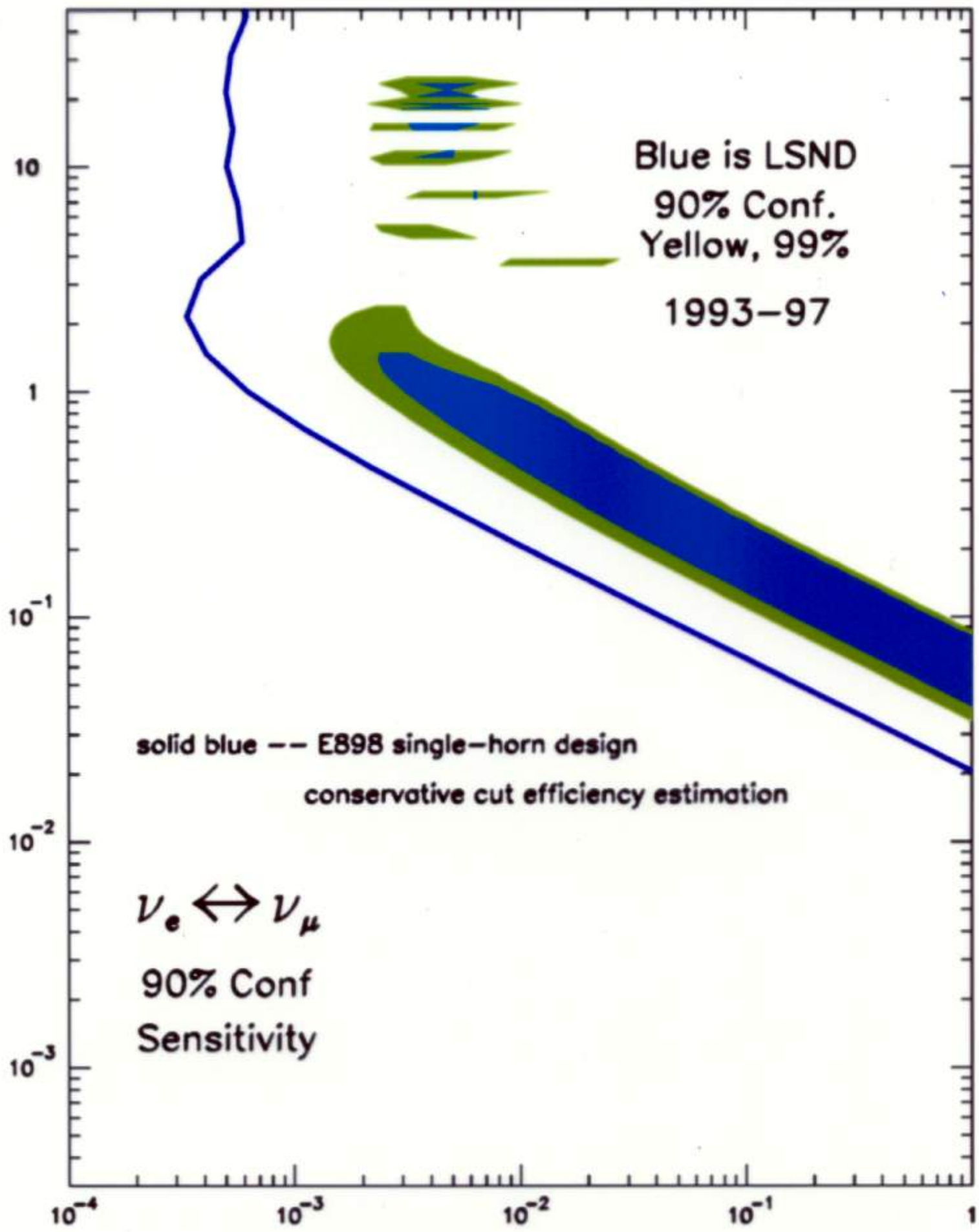
Summary of the hints



Although the oscillation scenario looks possible for each case...

- So many Δm^2!
- So many mixing angles!

Sensitivity of MiniBooNE



The only experiment with sensitivity fully covering the LSND allowed region

Design of MiniBooNE

★ We want to check the LSND signal ($\nu_\mu \rightarrow \nu_e$)

★ Keep L/E $\approx$ 1

→ $E_\nu \approx 0.5GeV$ and $L \approx 500m$

→ different event signatures and backgrounds

★ High flux ν_μ beam

→ with well understood ν_e component

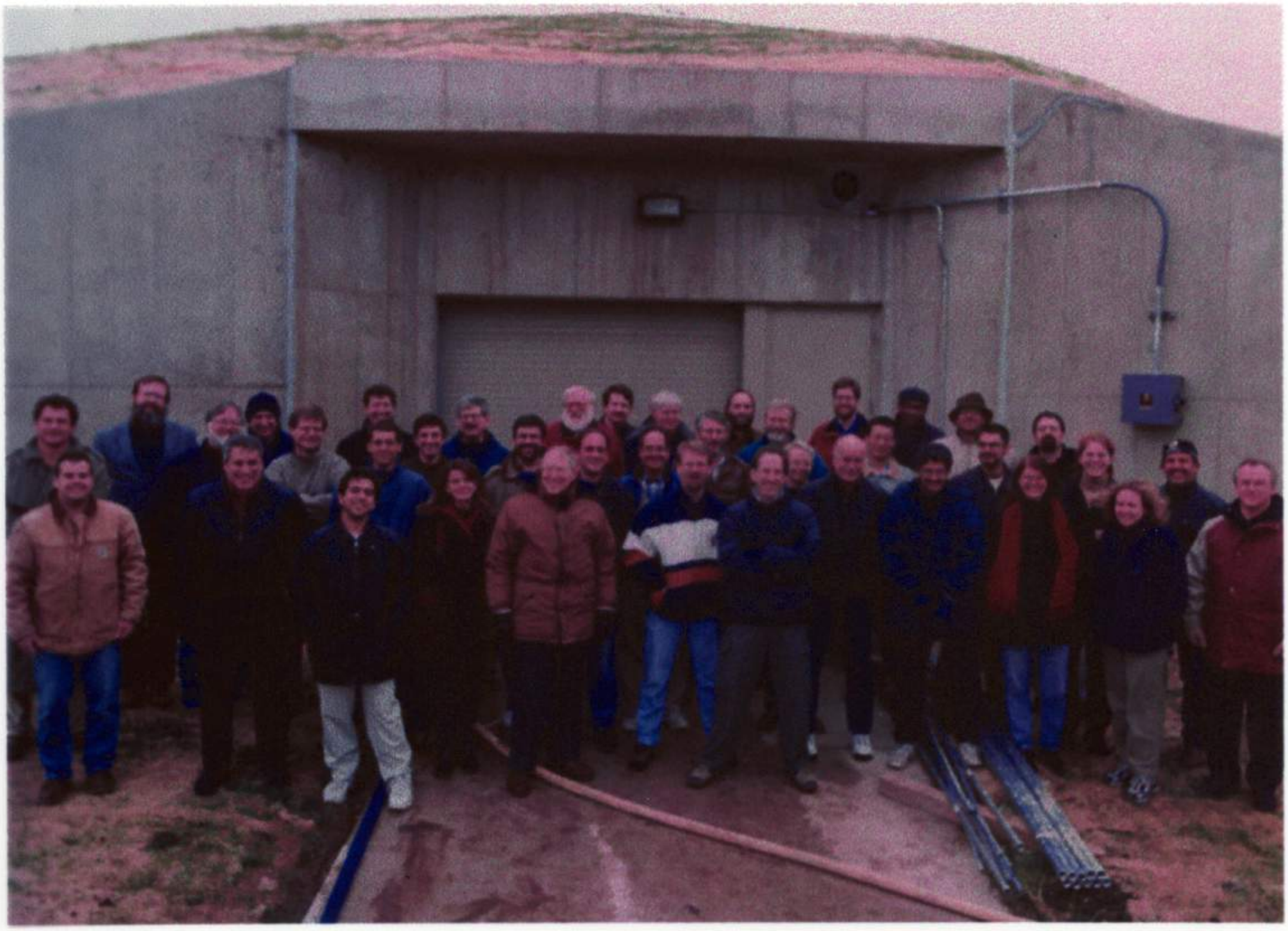
★ Large fiducial volume detector

→ with good particle id capability

★ With the goal of observing:

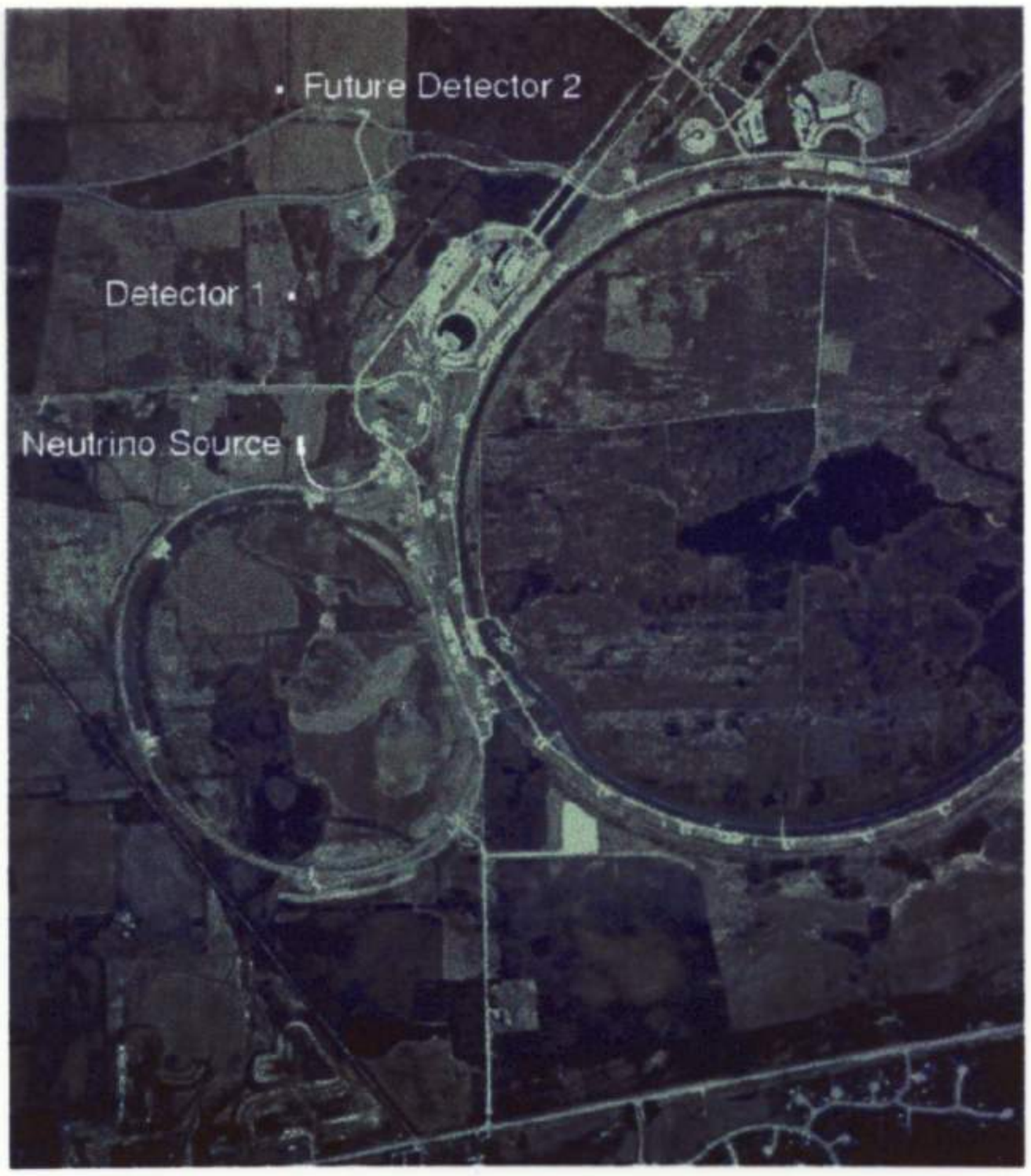
→ $\nu_e N \rightarrow e^- N'$

The collaboration



Alabama - Bucknell - Cincinnati - Columbia
Embry-Riddle - Indiana - Louisiana
Michigan - Princeton - Riverside
FNAL - LANL

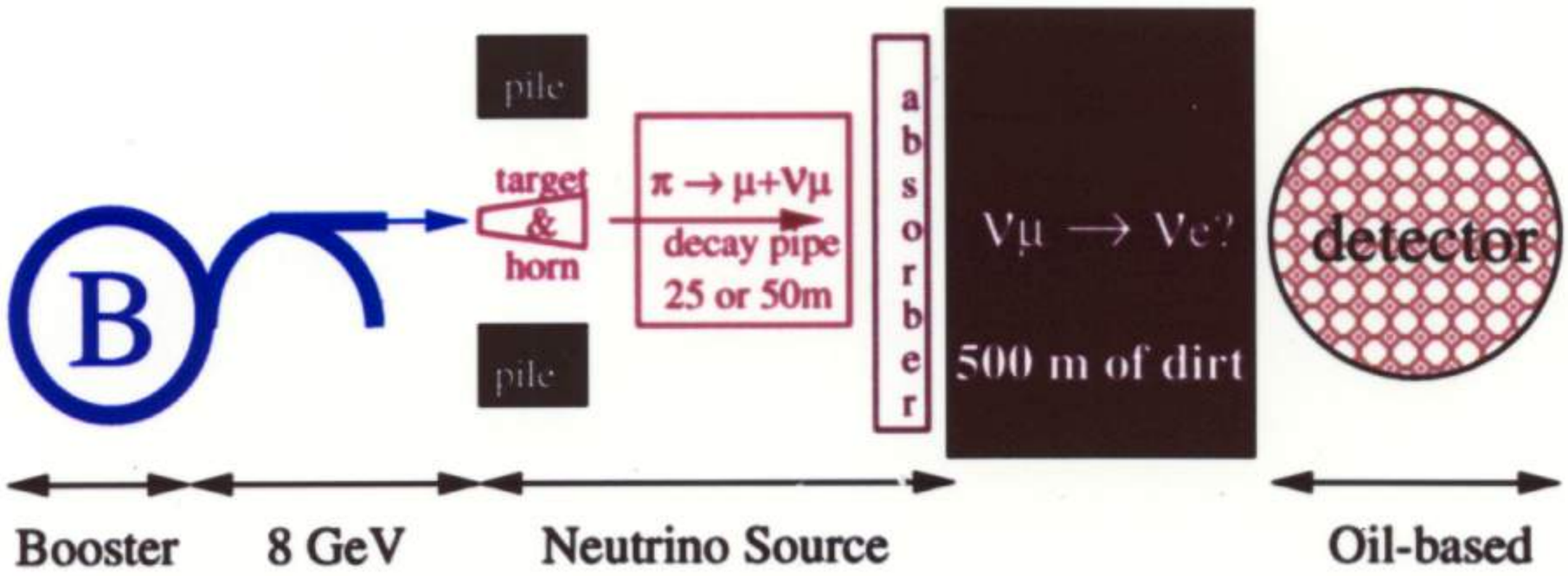
Where are we at FNAL?



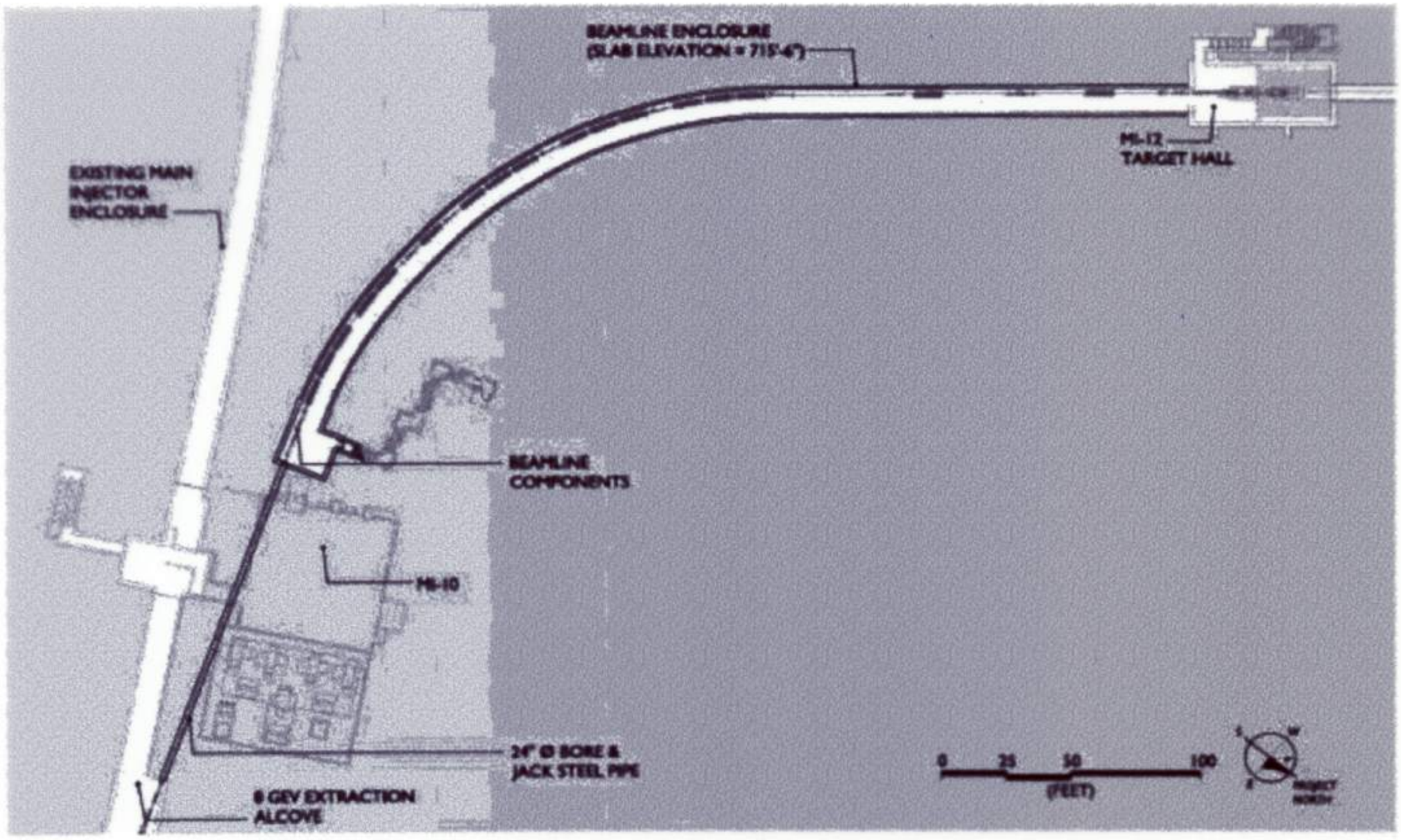
A 2-phase experiment:

Phase 1: *MiniBooNE* - single detector

Goal: Confirm or refute LSND signal at $\geq 5\sigma$



8 GeV beamline



The 8 GeV beamline consists of a tunnel that curves into roughly a quarter circle.

The tunnel is tied to the Main Injector by a 24" pipe that is pushed beneath the MI-10 service building.

At the north end, the beam tunnel ties into the target hall.

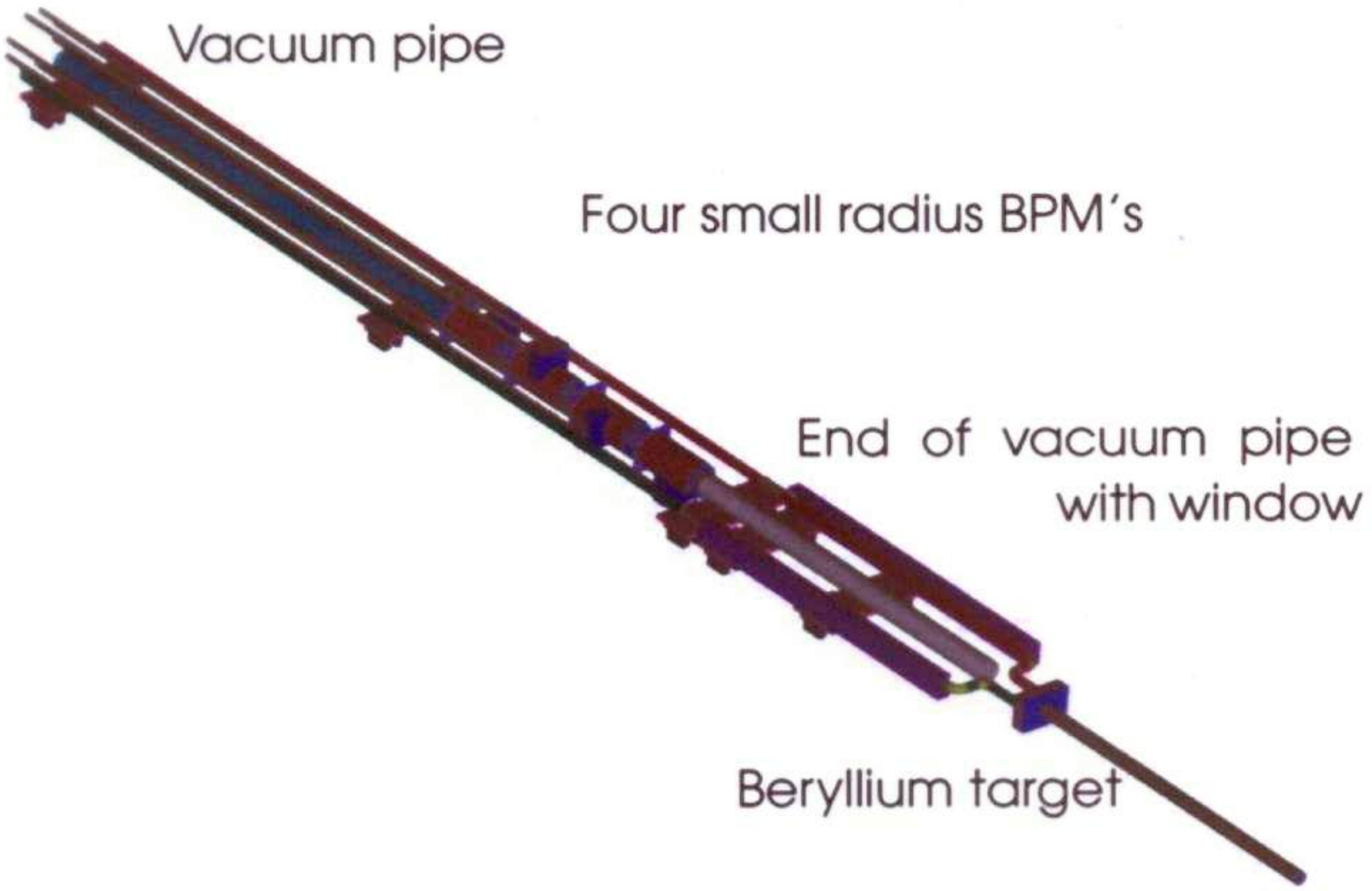
Further downstream, the target hall leads to the decay pipe and the beam absorbers.

8 GeV beamline

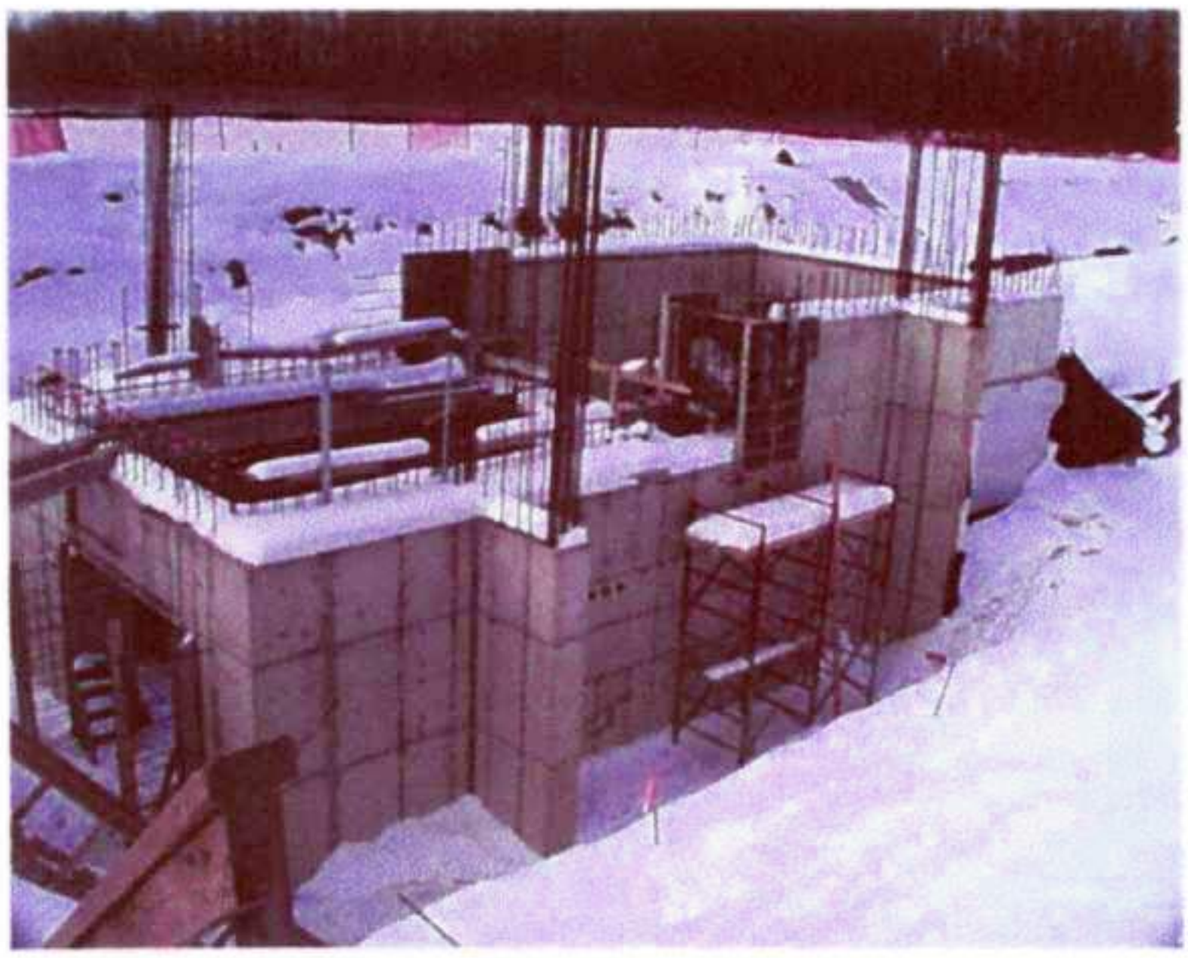
The Booster:

- 8 GeV → low energy neutrino beam
- MiniBooNE + RunII (7.5 Hz total)
- 5×10^{12} protons per pulse
- Challenge: radiation
  - Losses at extraction
    - Shielding was installed under the West Booster Tower
    - The experiment will run with a "notched beam"
  - Losses during acceleration
    - 2-year study to reduce radiation losses

The target



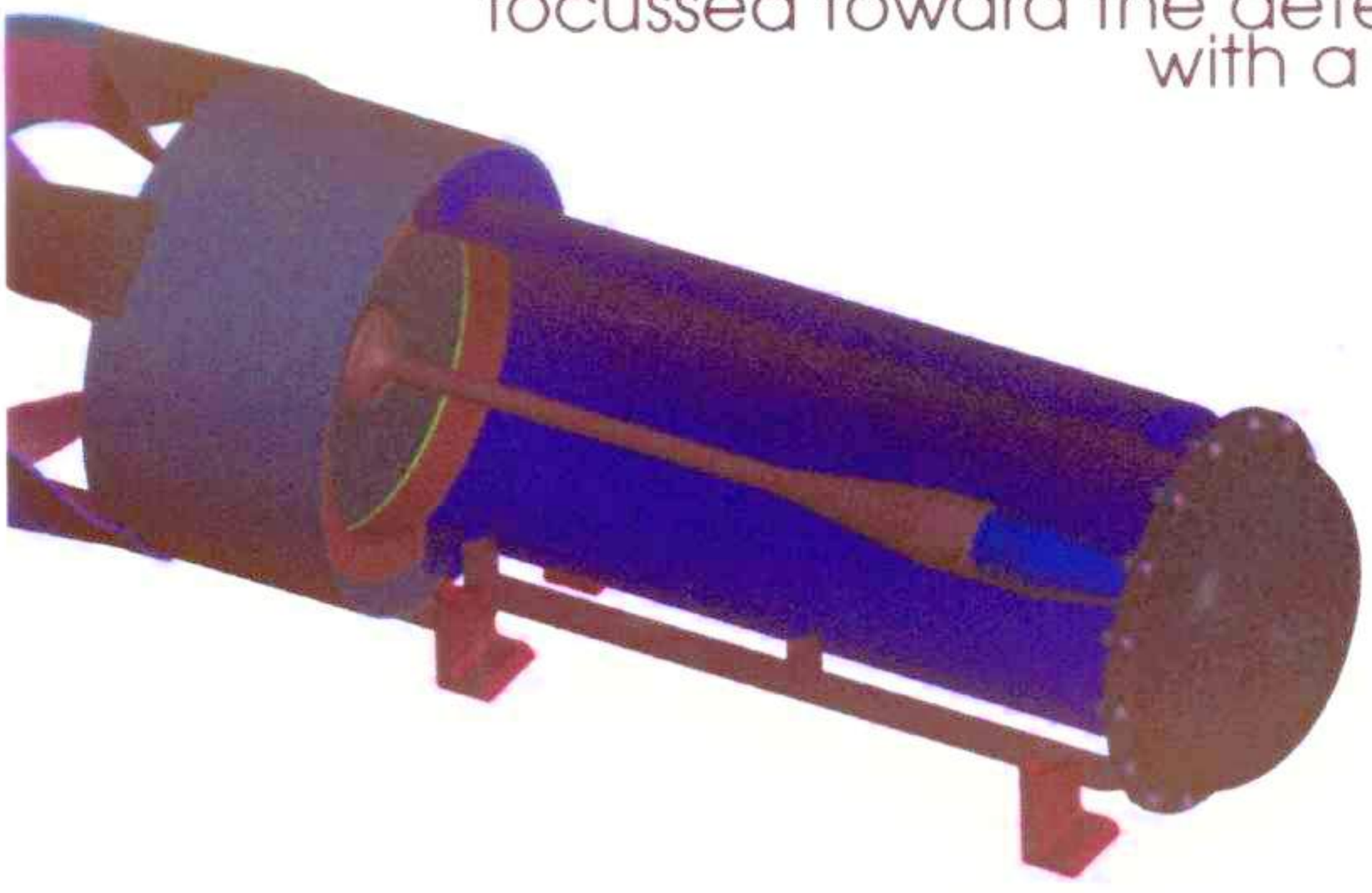
- 71 cm beryllium target with helium cooling
- Assembly begins soon



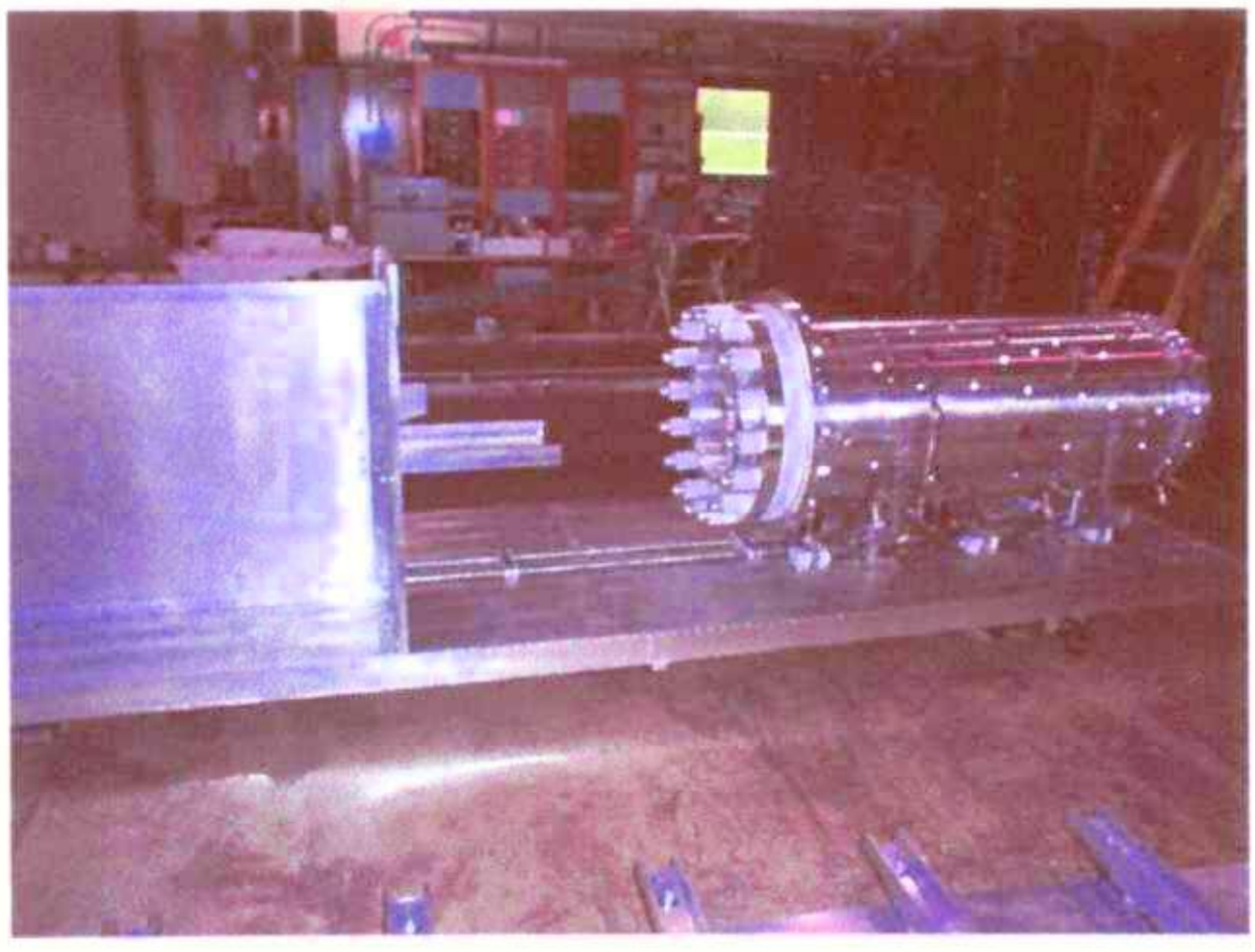
The Target Hall (01/08/01)

The horn

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



- 170 kA, 5Hz, 200M pulses/year
- Prototype horn just about to be tested
- We will have 1 horn installed and 1 spare



MiniBooNE horn

courtesy of L. Bartoszek

The decay region

The decay region has
2 absorber positions:
25 and 50 meters

Varying the length provides one example of our crosschecks on backgrounds

(oscillation events $\propto L_{decay}$, bkgnd events $\propto L^2_{decay}$)

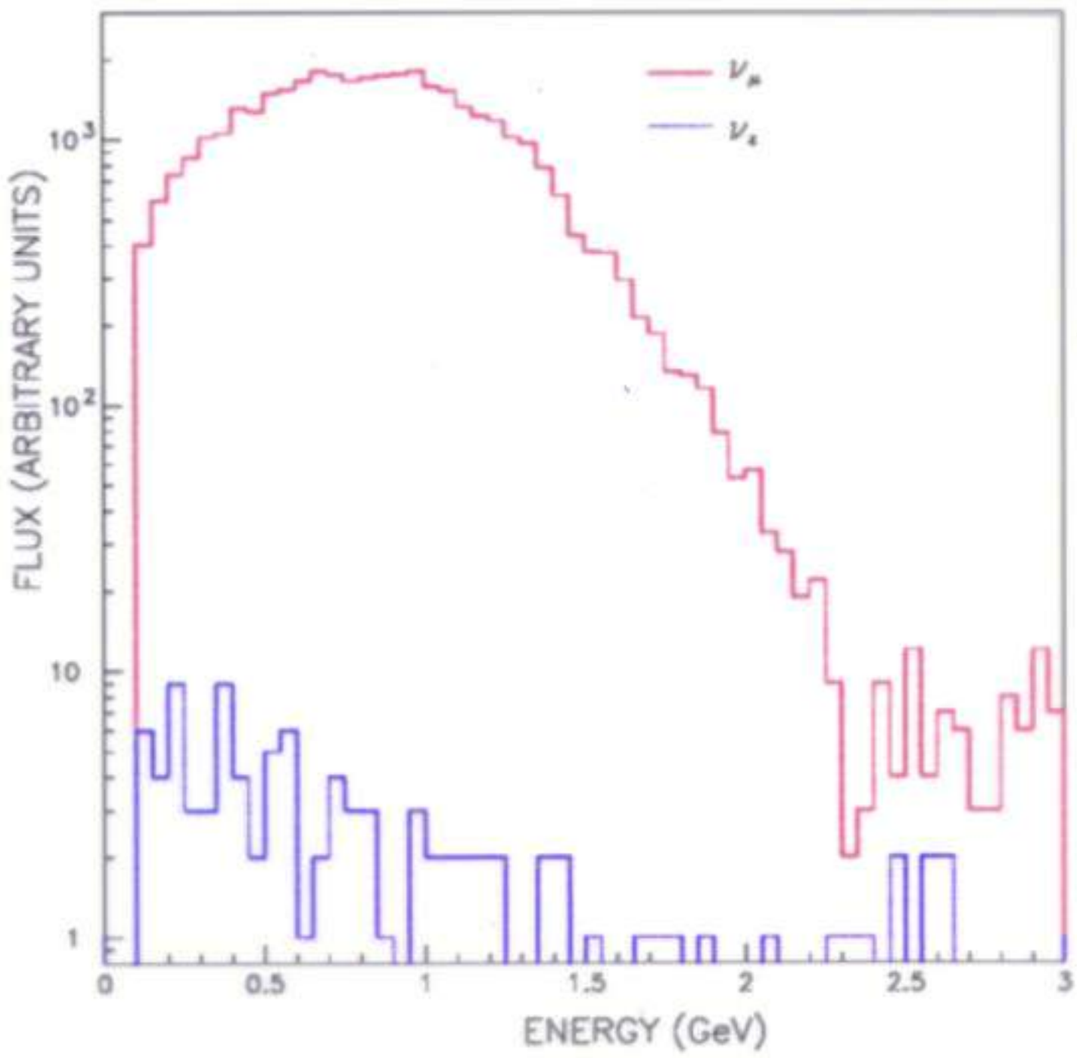
South view along the decay region

The beam and ν interactions

Nominal ν beam

$\nu_\mu(\mathrm{cm}^{-2}/\mathrm{pot})$	8.0×10^{-10}
$< E >_\nu$	1.0 GeV
$(\nu_e + \overline{\nu_e})/\nu_\mu$	0.4%

2 years of running
5×10^{20} pot/year



→ Interactions

with beryllium target per 2 years

$\sim$ .5 - 1 million ν NC+CC

$\sim$ 520 $\overline{\nu_\mu} \rightarrow \overline{\nu_e}$

⇑

for LSND allowed region:

$sin^2(2\theta) = 0.03$

$\Delta m^2 = 0.3 eV^2$

Events in the detector

Measurements

- PMT hits
- Time of the first pe
- Total charge deposited
- Veto hits in the event

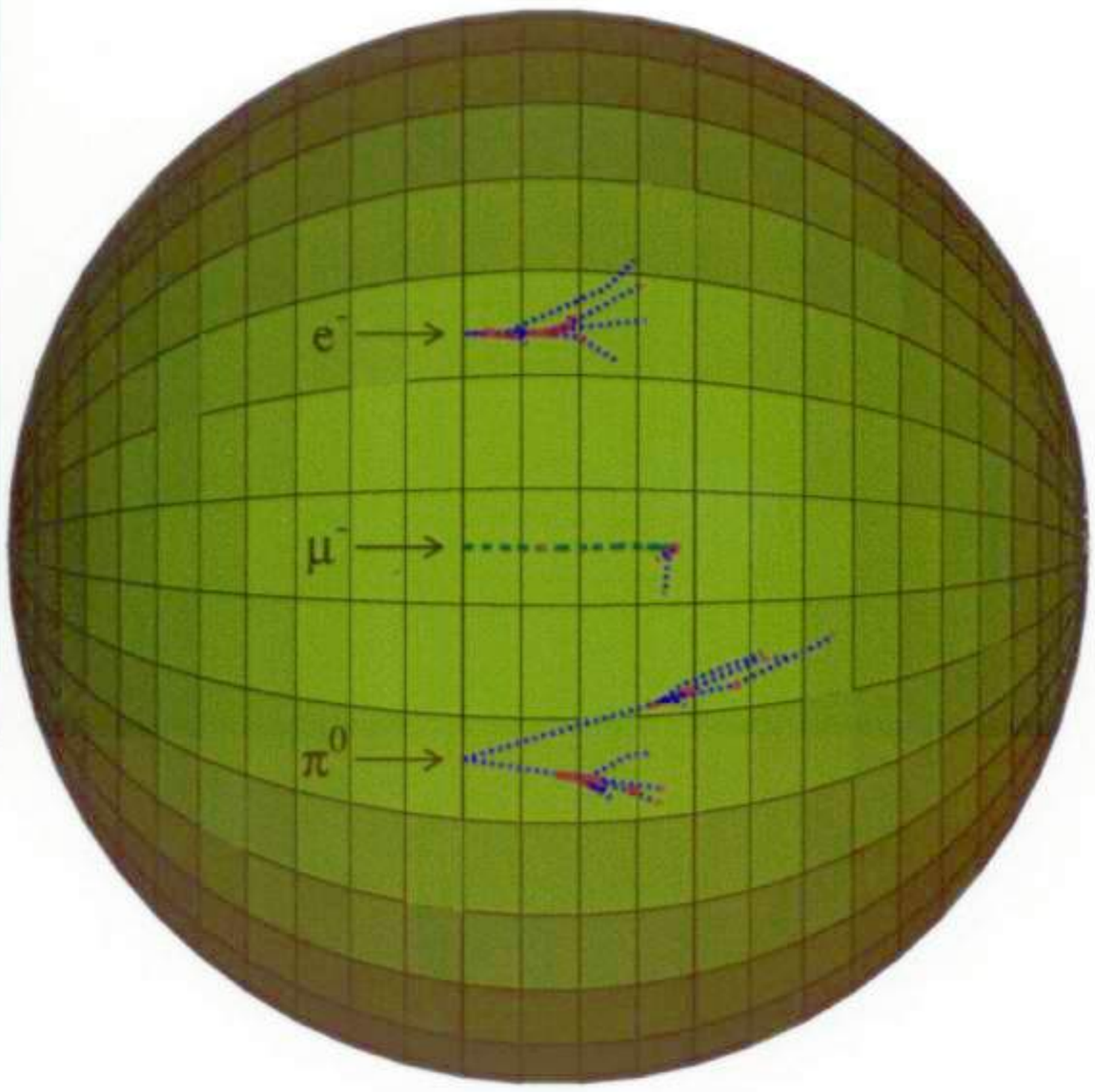
Event Analysis

- Mean track

  position and direction

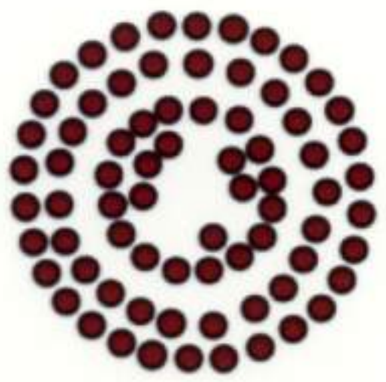
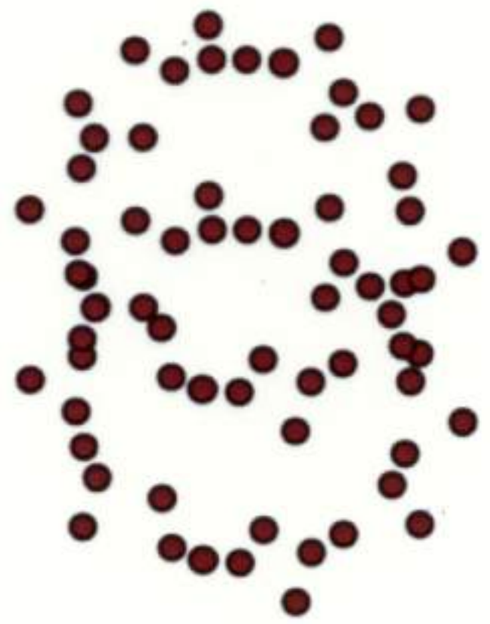
- PID - Cerenkov and scintillation light

e^-, μ and π^0 have different topologies in the tank



Particle ID in a Cerenkov detector

Cerenkov Light...

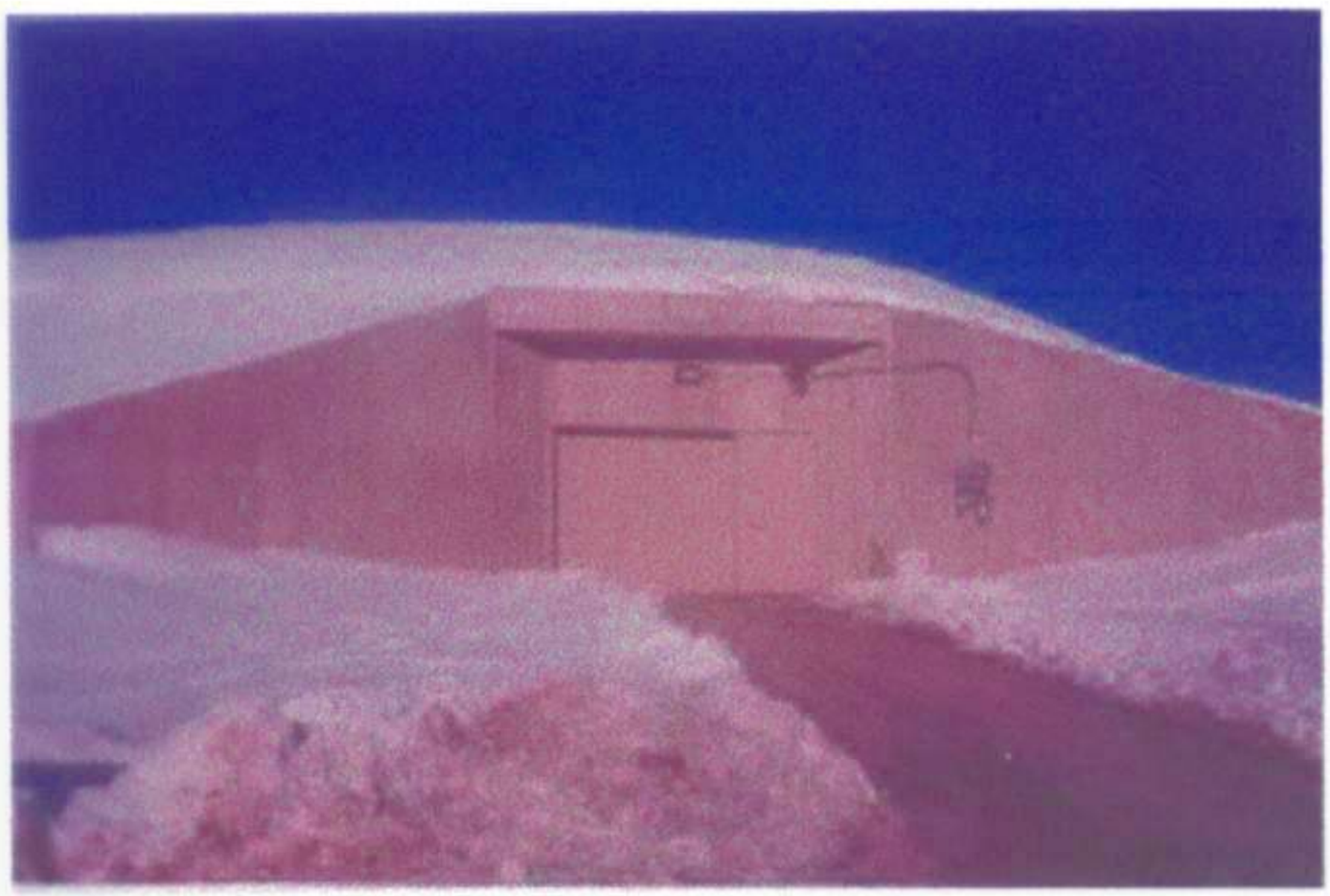
	From side	Ring	
short track, no multiple scattering			Sharp Ring
electrons: short track, mult. scat., brems.			Fuzzy Ring
muons: long track, slows down			Sharp Outer Ring with Fuzzy Inner Region
neutral pions: 2 electron-like tracks			Two Fuzzy Rings

Expected background

(2 years of running)

Main backgrounds	# events
$K^+ \nu_e$	~ 350
$K^0_L \nu_e$	~ 100
$\mu \nu_e$	~ 450
Intrinsic ν_e contamination	~ 900
Mis-identified μ	~ 150
Mis-identified π^0	~ 500
Total	1550

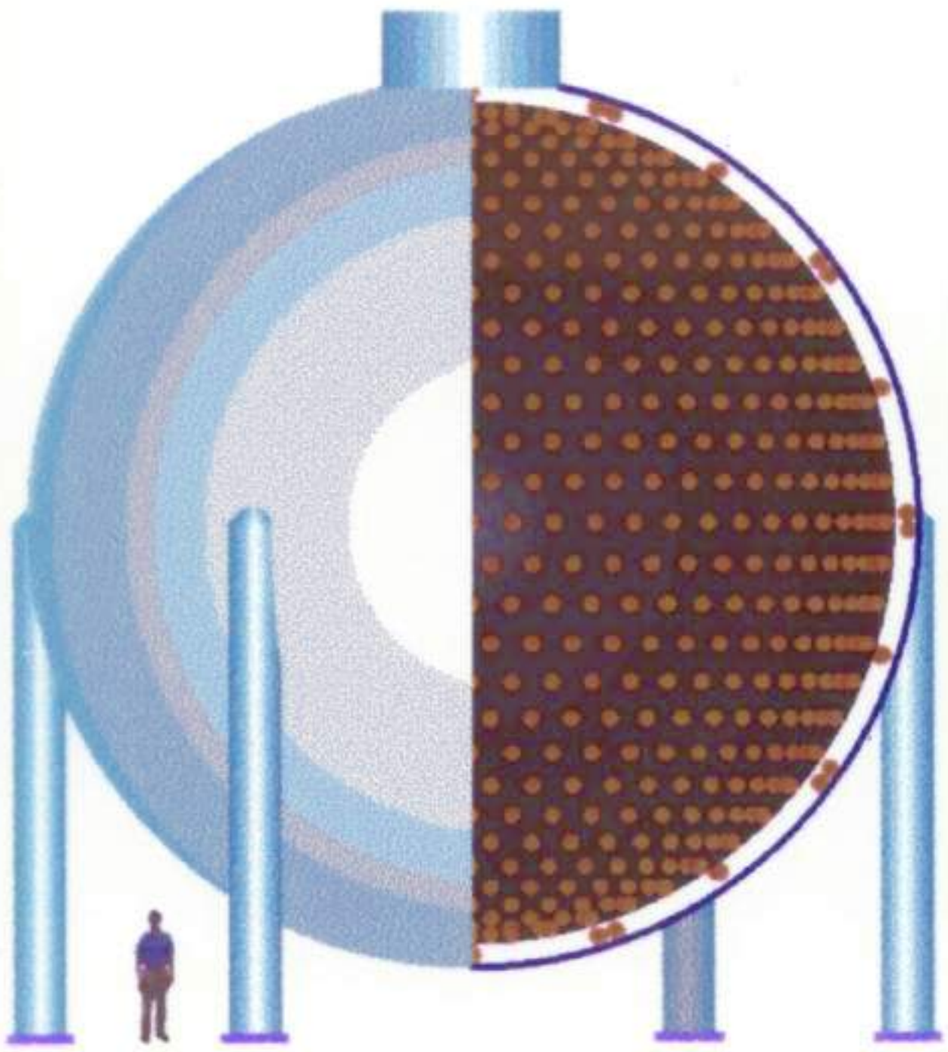
The detector



Beneficial Occupancy:
December 11, 2000

Beginning construction of the detector

The tank



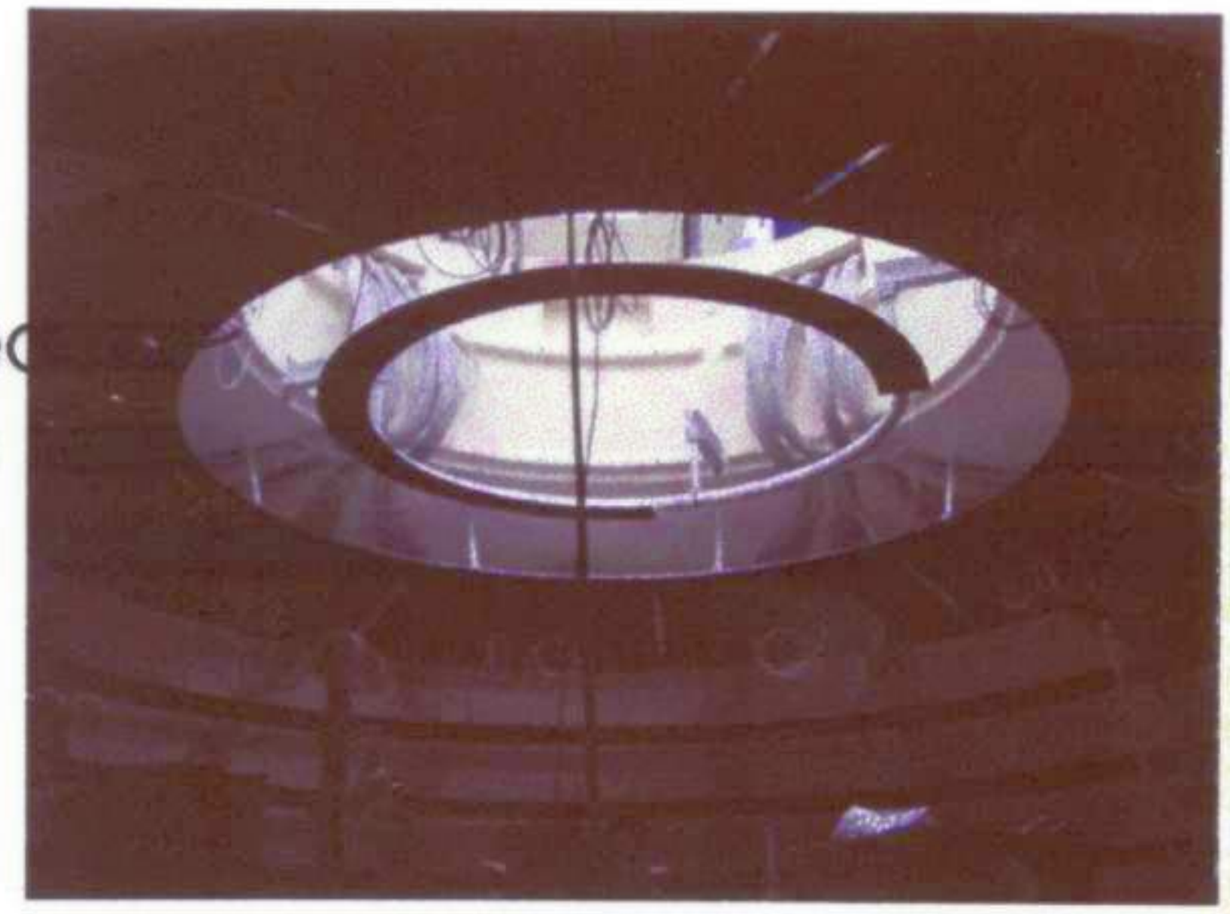
The Detector

40 ft diameter spherical steel tank
250,000 gallons of pure mineral oil
807 tons total, 445 tons fiducial
1280 phototubes in detector regio
240 phototubes in veto region

Hardware installation

Various mechanical parts involved (boss/strut/clamps)

)ptical barrier panels installe
his separates the veto PMT's
om the main PMT's



PhotoMultiplier Tubes

MiniBooNE will use

1520 8" Hamamatsu PMT's

1280 signal region 240 veto region

The majority of the tubes were inherited from the LSND experiment

Source	Specifications Qt.	Dynode	Model (Hamamatsu)
LSND	1250	9 stages	R1408
New	330	10 stages	R5912

Test objectives

- Guarantee they are operational
- Establish their operating voltage
- Measure figures of merit

Prepping the tubes before installation

Prepping phototubes

Step 1: Wash

Initial cleaning of the tubes to remove scintillator oil

Step 2: Coating the base

It seals the electrical parts of the base to isolate them from the mineral oil

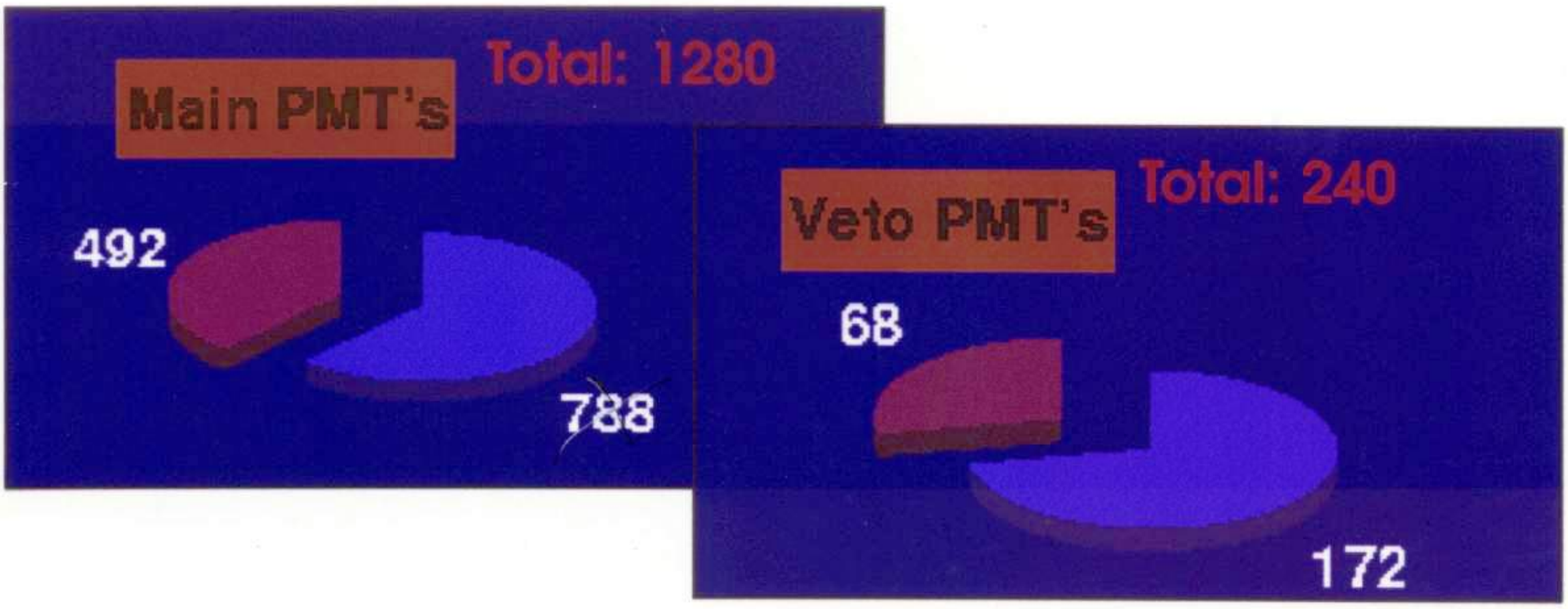
Step 3: Alignment

Inspect tubes in wire frames. Reposition if needed

PMT installation

Main Tubes 1^{st} 17 rows installed

Current status of installation



In summary...

MiniBooNe is progressing smoothly

- The LSND question needs to be addressed
- MiniBooNE is decisive:
  - ★ If LSND signal is disproved, that will be interesting
  - ★ If LSND signal is confirmed, that will open a very exciting neutrino physics program
- MiniBooNE will use
  - ★ Low energy neutrino beam
  - ★ Cerenkov detector

We are looking forward to start running in Spring 2002!