35ton Deliverables

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Recent SciOp document (#8087, pp91)

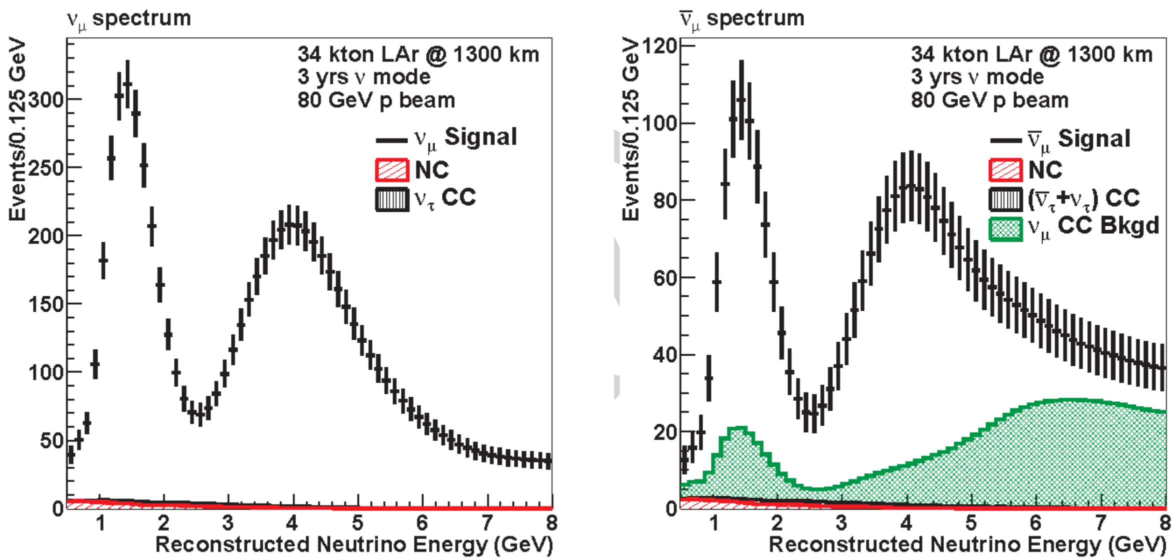

Figure 4.2: The expected spectrum of ν_μ or $\overline{\nu}_\mu$ events in a 34-kt LArTPC for 3 years of neutrino (left) and antineutrino (right) running with a 1.2-MW beam.

	Signal Events	Background Events				
	ν_e	ν_μ NC	ν_μ CC	ν_e Beam	ν_τ CC	Total
Neutrino Normal Hierarchy	222	19	24	42	14	99
Neutrino Inverted Hierarchy	98	19	23	44	15	100
Antineutrino Normal Hierarchy	54	11	11	23	9	54
Antineutrino Inverted Hierarchy	80	11	11	23	9	54

Where did the numbers come from?

"The GLoBES package was used to simulate the detector response using simple smearing and detector efficiency values based on results from ICARUS and earlier simulation efforts." (reference CDRvol1 docdb5235, might be wrong volume)

- page 88 of SciOpDoc, detailed explanation follows

Table 4.2: Estimated range of the LArTPC detector performance parameters for the primary oscillation physics. Signal efficiencies, background levels, and resolutions are obtained from the studies described in this chapter (middle column) and the value chosen for the baseline LBNE neutrino oscillation sensitivity calculations (right column).

Parameter	Range of Values	Value Used for LBNE Sensitivities
For ν_e CC appearance studies		
ν_e CC efficiency	70-95%	80%
ν_μ NC mis-identification rate	0.4-2.0%	1%
ν_μ CC mis-identification rate	0.5-2.0%	1%
Other background	0%	0%
Signal normalization error	1-5%	1-5%
Background normalization error	2-15%	5-15%
For ν_μ CC disappearance studies		
ν_μ CC efficiency	80-95%	85%
ν_μ NC mis-identification rate	0.5–10%	1%
Other background	0%	0%
Signal normalization error	1-10%	5–10%
Background normalization error	2-20%	10-20%
For ν NC disappearance studies		
ν NC efficiency	70-95%	90%
ν_μ CC mis-identification rate	2-10%	10%
ν_e CC mis-identification rate	1-10%	10%
Other background	0%	0%
Signal normalization error	1-5%	under study
Background normalization error	2-10%	under study
Neutrino energy resolutions		
ν_e CC energy resolution	$15\%/\sqrt{E(GeV)}$	$15\%/\sqrt{E(GeV)}$
ν_μ CC energy resolution	$20\%/\sqrt{E(GeV)}$	$20\%/\sqrt{E(GeV)}$
E_{ν_e} scale uncertainty	under study	under study
E_{ν_μ} scale uncertainty	1-5%	2%

Where did the numbers come from?

Hand scans?!

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DRAFT

Same resolution uniformly across the detector ?

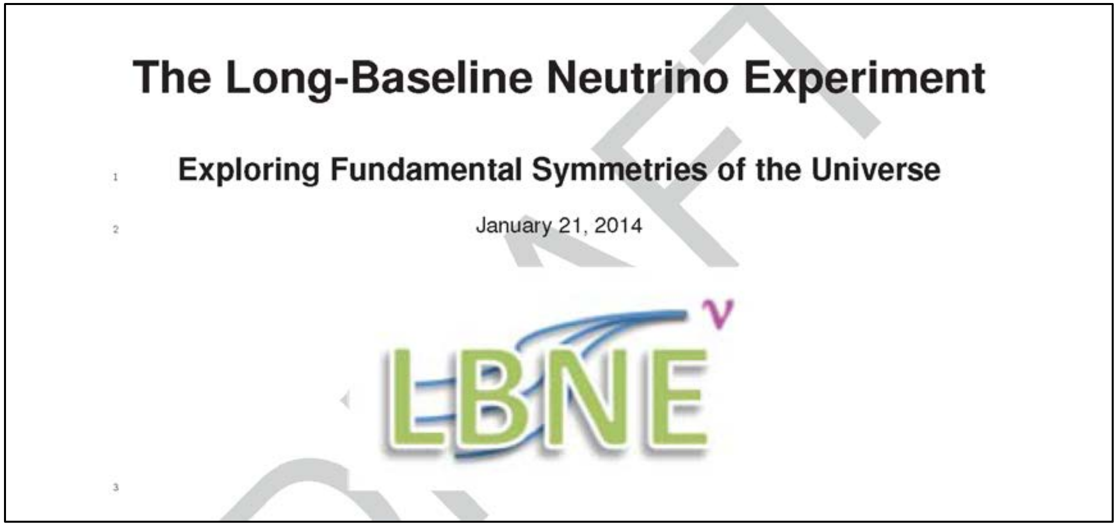
Natural questions . . .

- What happens to this number when the electron shower is split across two different TPCs (drift volumes/wire plane sets)?
- Did the extrapolation to 34 ton include FV cuts around individual TPC edges?
- What was the wire spacing in ICARUS and how does wire spacing affect position resolution for electron showers?
- The event time comes from PMTs in ICARUS ? How does their time resolution compare with LBNE PDs? How does the event time resolution affect the neutrino energy resolution?

LBNE GOAL: sensitivities calculated with "Full simulation and reconstruction" – a huge task!

Comparison of data and simulation in the 35ton is an important part of pursing this goal.

Homework – read it!



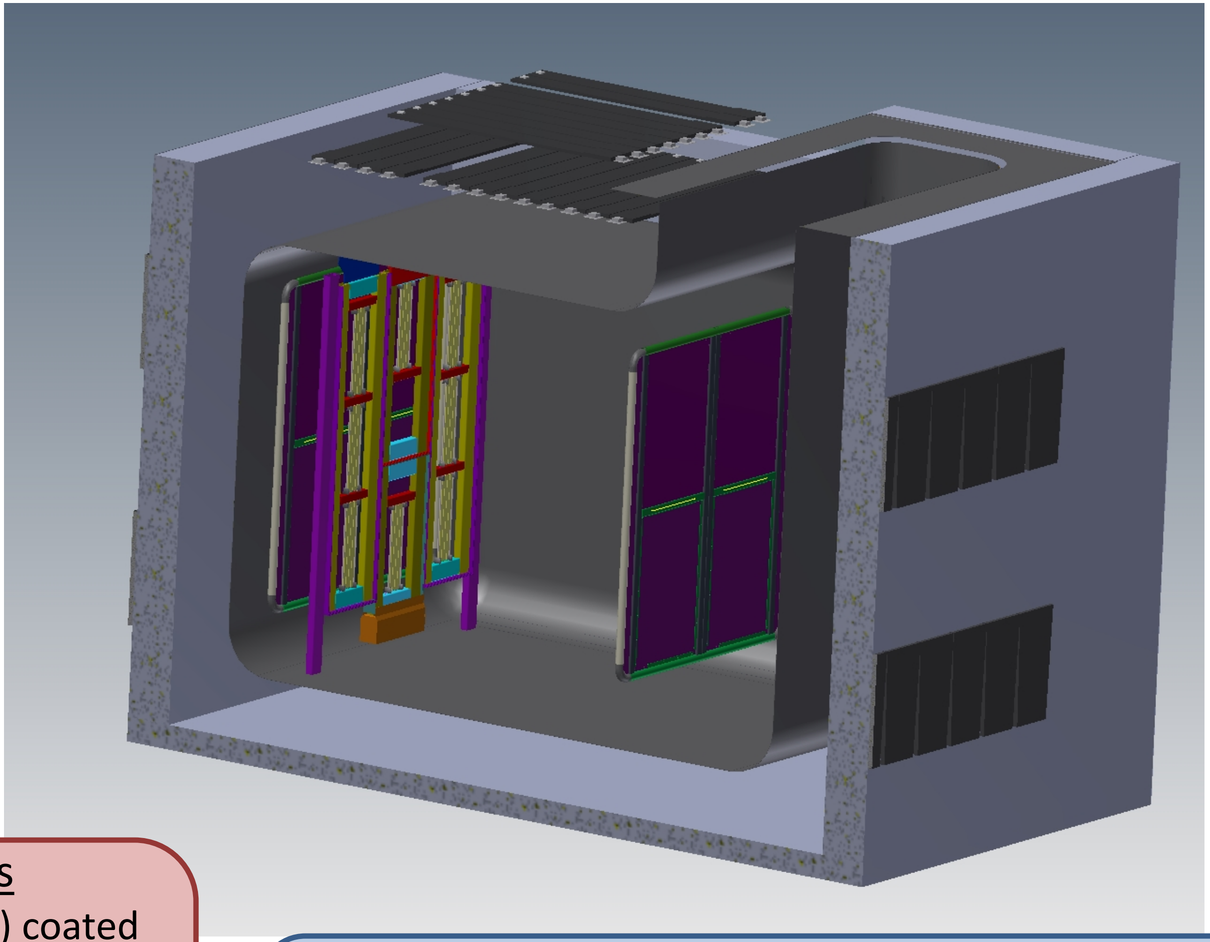
The Long-Baseline Neutrino Experiment

Exploring Fundamental Symmetries of the Universe

January 21, 2014

- Pick your favorite physics topic
  - Look up the internal references (and their internal references) to understand where the resolution numbers come from
  - Think about how we can improve the estimate of resolution, and the resolution itself.
  - If the numbers came from a different detector, what is different and how would that affect the precision?
  - Discuss with colleagues
- Pick your second favorite physics topic . . . .

LBNE 35-ton prototype
(what makes it special)



Cryostat
Membrane cryostat technology from LNG industry

Cold Electronics
Amplify and digitize signals inside cryostat

DAQ
Continuous readout of TPC and Photon Detectors

Photon Detectors
- TPB (wavelength shifter) coated light guides with SiPMs
- Absolute SiPM calibration being developed
- Simulation of light production and collection

TPC
- Cathode HV up to 200 kV, 2.2 m electron drift
- Wrapped wire planes (ambiguity associating induction plane hits to drift volume)
- 8 sets of wire planes, 8 drift volumes, 2 drift directions

35ton deliverables

"Integrated system test that incorporates as many features of the far detector as possible"

- Measure dE/dx vs residual range for muons (MIPs), electrons (Michel), protons? and compare with simulation ***
- Measure tracking performance for muons and electrons and compare with simulation ***
- Measure tracking performance for through-going muons as a function of cos(theta) (angle between track and wire plane)
- Determine event time with photon detectors, cross check with external scintillators
- Simulate light production and collection, tune to match data
- Electron/photon separation - needs to be explored

*** with special attention to gaps between APAs and edge effects near field cage/APA

35ton deliverables

- Use APA crossing tracks to verify event time and drift velocity
- Look for distortions in through-going muon tracks and compare with space charge models. Vary drift field to isolate space charge effects
- Characterize electronics performance:
  - Fine tune wire calibration inputs (electronics response function) with data.
  - Measure S/N for MIPs (noise as function of wire length and temperature)
  - Study signal shape as a function of wire plane bias voltages
- Use TPC data to study purity profile inside the TPC
- Incorporate photon detector information into energy determination

Physics Tools Needed

- Calibration – implement measured electronics response function into code. Modify FFT code for 35 ton (zero suppression)
- Hit finding and Disambiguation
- Straight track reconstruction
- General track reconstruction
- Shower reconstruction
- Algorithm to determine event time from external counters
- Algorithm to determine event time from photon detectors
- Event display
- Generate MC samples

Be warned that many of these things either do not exist, or have not yet been adapted to the 35ton.