Cosmic backgrounds on surface

Milind Diwan filling in for Bob Svoboda

6/13/2012

- This is only a progress report.
- There are no hard numbers yet, and unlikely to have hard numbers for a while.
- Some strategies can be discussed. And examination of other experiments performed.
- The team is in place: Vitaly Kudryavtsev, Jeff DeJong, Bob Svoboda, Dongming Mei, Cara Nichole Maesano, Stan Siebert, Maury Goodman, ...

My reason for optimism. (but not necessarily happiness !).

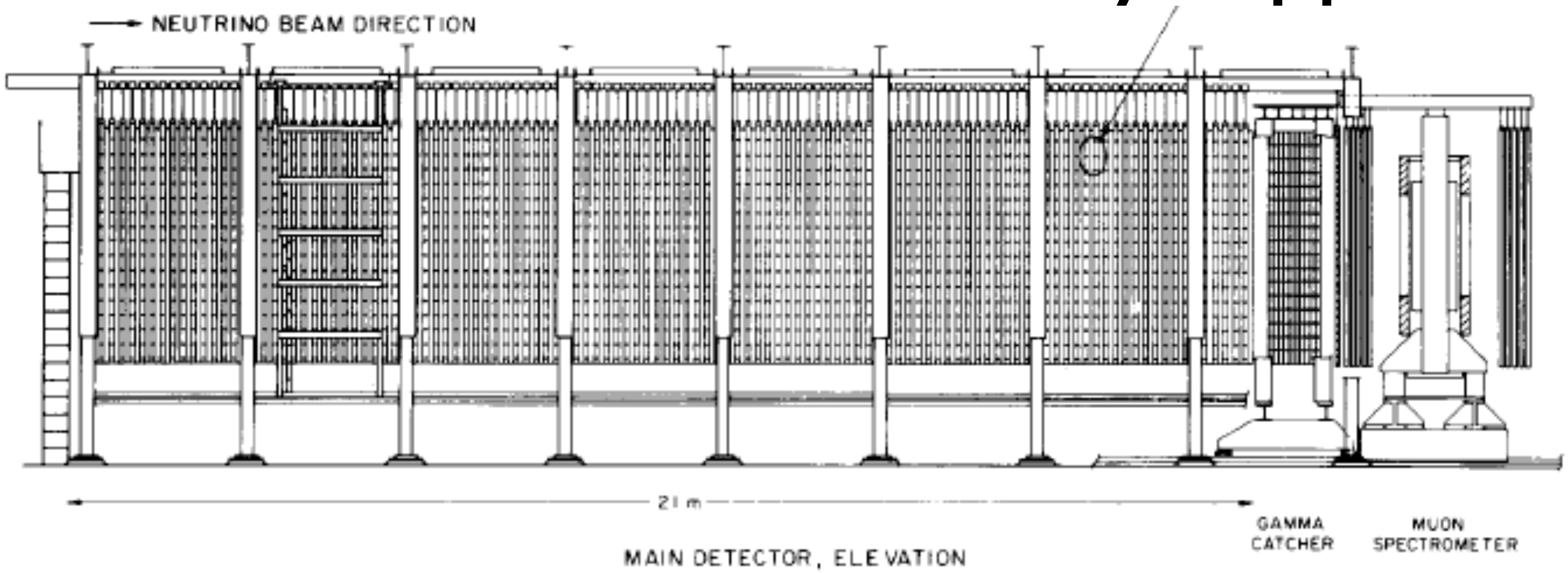

Fig. 2. Schematic drawing of the complete BNL–Brown–KEK–Osaka–Pennsylvania–Stony Brook neutrino detector.

There was ~1m of concrete on top

- For BNL-E734 (and E776), pattern recognition was used to find event vertices. The corrected time of the vertex was plotted to confirm there are no cosmic backgrounds, but the time cut was not used to actually cut the background.
- LAr is extremely fine grained (~5 mm) allowing strategies that we have not yet thought of.

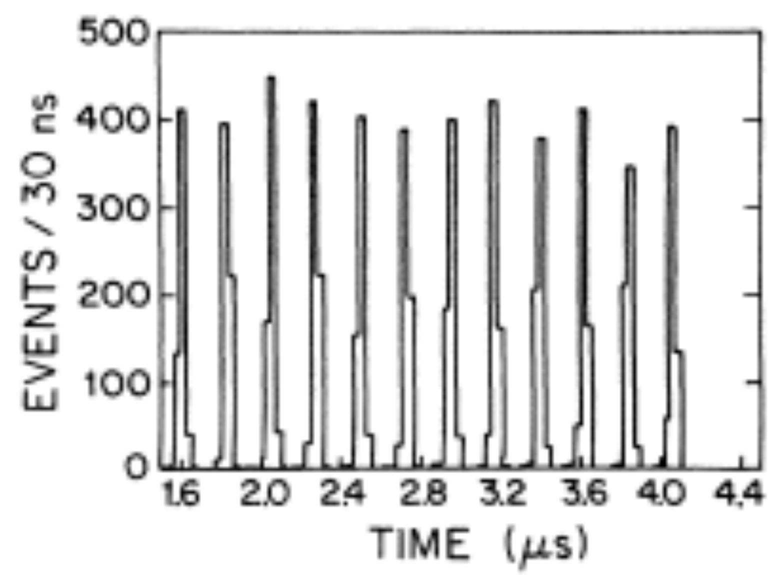

FIG. 2. The AGS has 12 proton bunches circulating, and extraction is accomplished in a single revolution. The time structure of the proton beam is preserved through extraction and transport to the target; the bunch structure is shown here as measured by charged-current neutrino interactions in the detector.

Problems from cosmic μs

for an LBNE liquid Argon Drift Chamber on the Surface

See docdb 5950 (Pordes & Gerstle, 2006)

i. Saturate DAQ
ii. they might obscure such a large fraction of the volume of the detector that they overlap the events of interest to the point where the events cannot be reconstructed accurately (confusion)
iii. prohibitive computing time
iv. They generate interactions in the argon which mimic the neutrino events of interest (background)

Follow Docdb 5958

Goodenough, Goodman, Paley, Learned, Davies, Sanchez
16 May 2012
Some changes to parameters below based on latest design numbers

- Assumptions
  - 1.7e7 seconds/year
  - 1.33 s repetition rate
    - 1.31e7 spills per year, each 10 microseconds
    - This is 131 seconds/year
  - 34 kT surface detector has 1.4 ms (2.3m) drift & 24x49x16 m^3
  - Area at top is 1176; calculate 16% more μ flux in sides
  - use 100 Hz/m^2 giving 136 kHz of muon rate in the full detector. (~200 mus over the detector per drft)
  - electron neutrino signal is 100 to 270 events/yr

DAQ, computing, etc.

- Focus only on accelerator physics. Set the DAQ window to be 0.1 ms before the spill to 1.5 ms after the spill to capture all tracks.
- Above acquisition is easily achieved with current design. But the cosmic muons will dominate the event rate. Raw rate is ~300Mb/sec per Anode Plane.
- We will assume that computing challenge will be handled.

Event Obscuring

- Consider 200 muons in any one spill.
- Assume track length of 15 m and square tube of 1 cm side.
- only 0.3 m^3 volume will be obscured out of 19000 m^3. This is not a big issue.
- The probability of the neutrino vertex (~4cm^3) falling on top of a muon is < 10^{-4}.
- The computing challenge to track 200 track events and remove them from the data is not difficult.

How can a μ make background, and then what to do about it?

- You can see the μ, and it can cause something which looks like a beam ν_e. You need to choose a cut strategy, and you cannot cut on every μ.
- You can miss the μ, and it causes a neutral particle which enters the detector. Cuts are fiducial volume related or related to large veto counters (& gaps if any).

Background mitigation

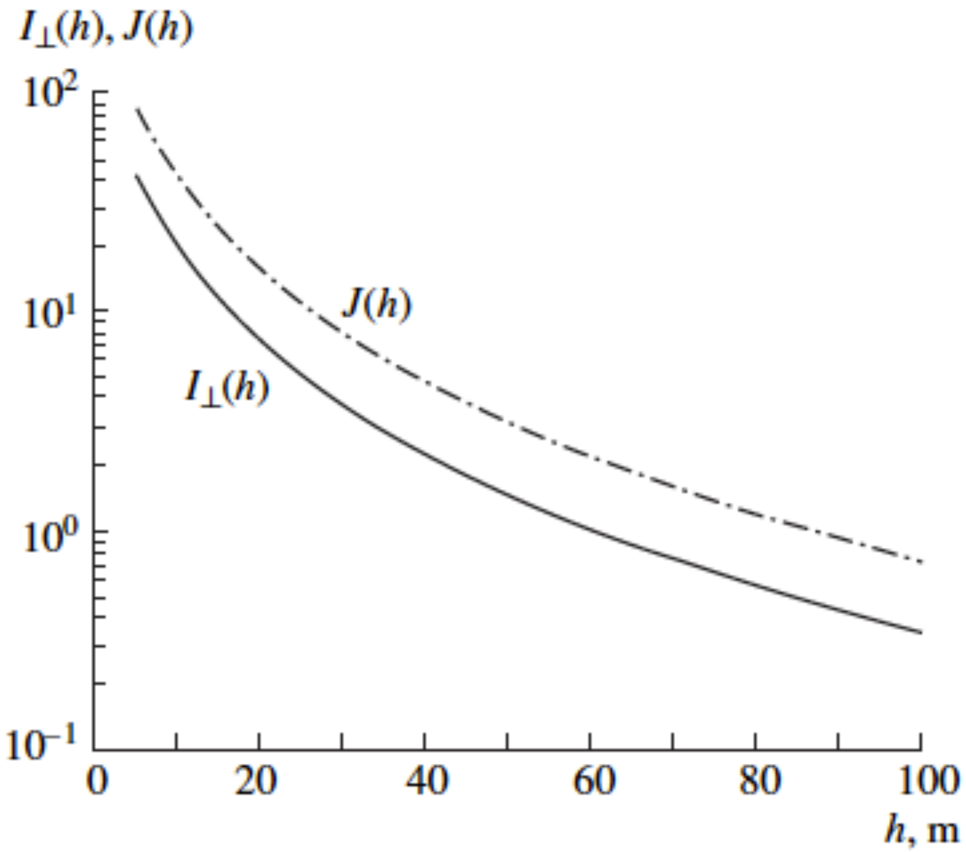

Fig. 2. Vertical muon intensity $I_\perp(h)$ [m^{-2} s^{-1} sr^{-1}] and the integral muon flux $J(h)$ [m^{-2} s^{-1}] vs. the standard rock overburden thickness h.

Bogdanova, et al., Physics of Atomic nuclei, 2006

- Detailed calculations in progress
- Overburden: for rejection of soft component and neutrons we need ~4 m of rock.
- Muon veto to be investigated.
- Photon system
- compartmentalization in space and time.
- Vertex activity. Nuclear fragments to detect the vertex.

How to know what the background rate is?

- Single particle Monte Carlos can be useful, but cannot be definitive
- Complete Monte Carlos to predict rejection at the 10^{-8} level are daunting (unrealistic)
- ICARUS data?
- MicroBooNE data. (cosmic data, not beam data)

↳ Note that if you are relying on detailed pattern recognition algorithms to identify beam ne events, you have to have developed those algorithms to test them.