SBN Progress – December 2015

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I. SBND Photon Detection System Design

As the L2 manager, Richard Van de Water has completed the conceptual design for the SBND Photon Detection System (PDS). The design has a total of 112 8” Hamamatsu R5912 cryogenic phototubes positioned behind the four APA planes, corresponding to 28 phototubes per plane. The phototubes will be the same as the ICARUS phototubes and will have 10 dynode stages and a gain of 10^7. The PDS will collect ~30 photoelectrons/MeV with ~ns timing, which will be used to correlate events in the SBND TPC with the beam spill. A schematic drawing of the PDS support structure for one of the sub-modules is shown in Figure 1, where there are 6 sub-modules per APA plane and 24 sub-modules in total. Two CAEN modules are being considered for the electronics: (i 1725 module with 250 MHz and 14 bits,16 channels/board, ~$700/channel; (ii) 1730 module with 500 MHz and 14 bits, 16 channels/board, ~$1000/channel.

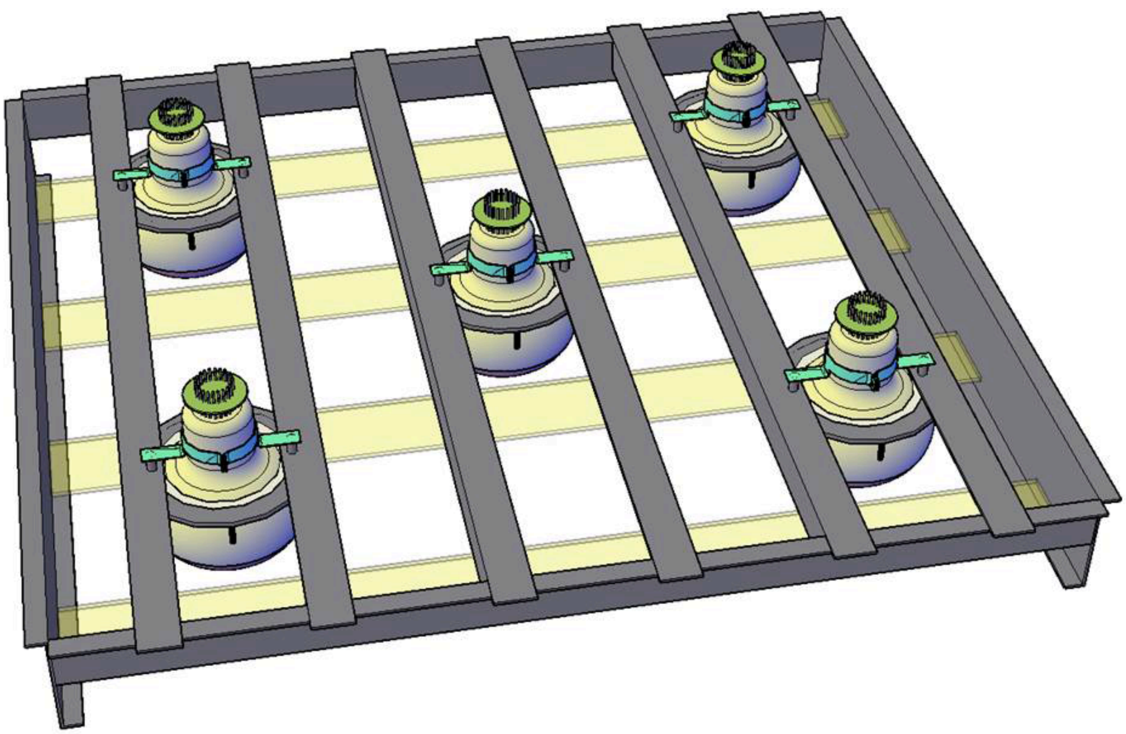

Figure 1: A schematic drawing of the PDS support structure for one of the sub-modules.

II. BNB Neutrino Flux & Timing

As part of the MicroBooNE experiment, the MiniBooNE detector has been taking data in order to check that the BNB neutrino flux has not changed since the magnetic focusing horn was replaced earlier this year. Figure 2 is a histogram of events in MiniBooNE as a function of beam time and clearly shows the collection of clean neutrino events during the 1.6 μs beam spill. Figure 3 shows the raw (unprocessed) rate of neutrino events per proton on target (POT) as a function of calendar time. More statistics will be collected; however, the figure demonstrates that the neutrino event rate with the new focusing horn is consistent with previous running. Therefore, the neutrino beam conditions for MicroBooNE appear to be the same as they were for MiniBooNE. Figure 4 shows a comparison between the absolute timing of MiniBooNE muon-neutrino charged-current quasielastic (CCQE) data events relative to the beam (black histogram) and the Monte Carlo expectation (red curve). The absolute timing resolution is ~1.5 ns, showing an improvement in the timing resolution compared to previous running.

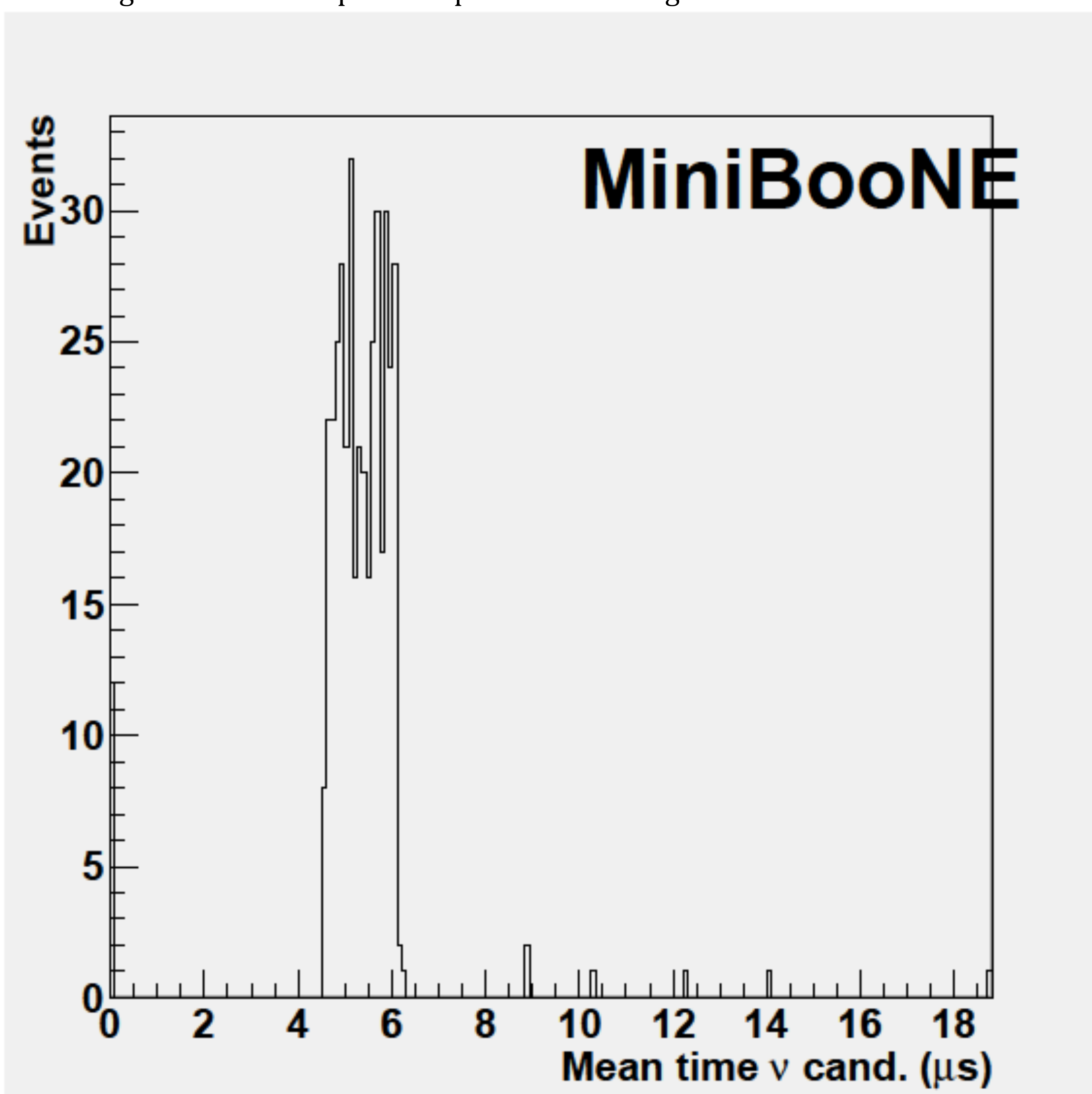

Figure 2: A histogram of events in MiniBooNE as a function of beam time.

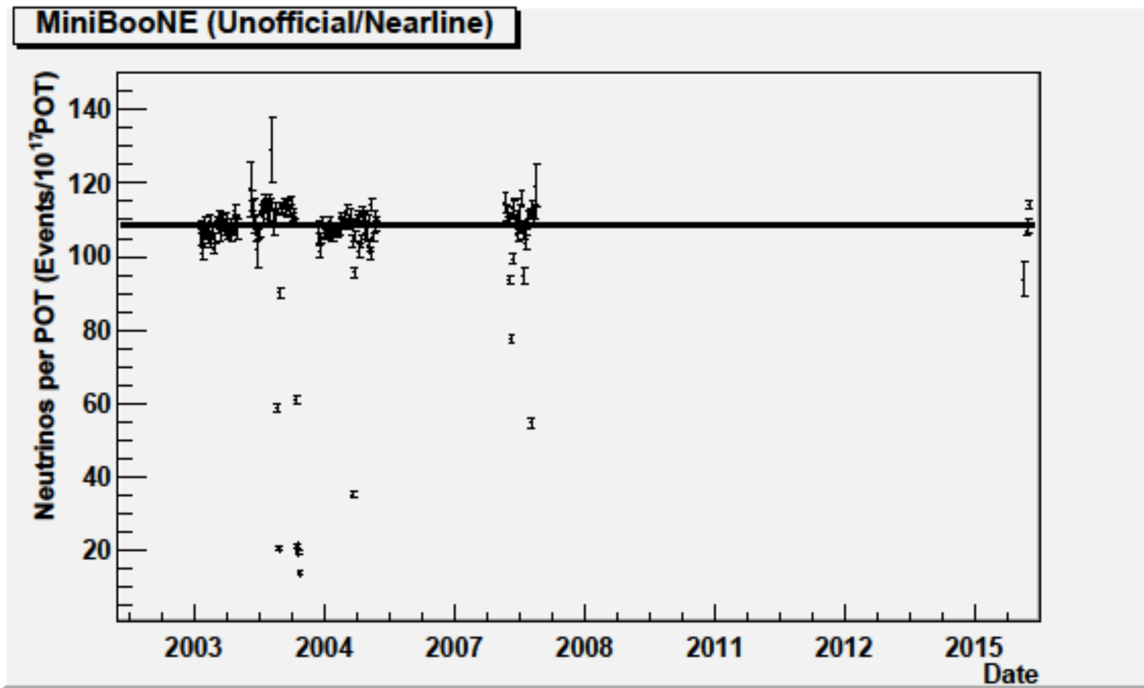

Figure 3: The raw (unprocessed) rate of neutrino events per proton on target (POT) as a function of calendar time.

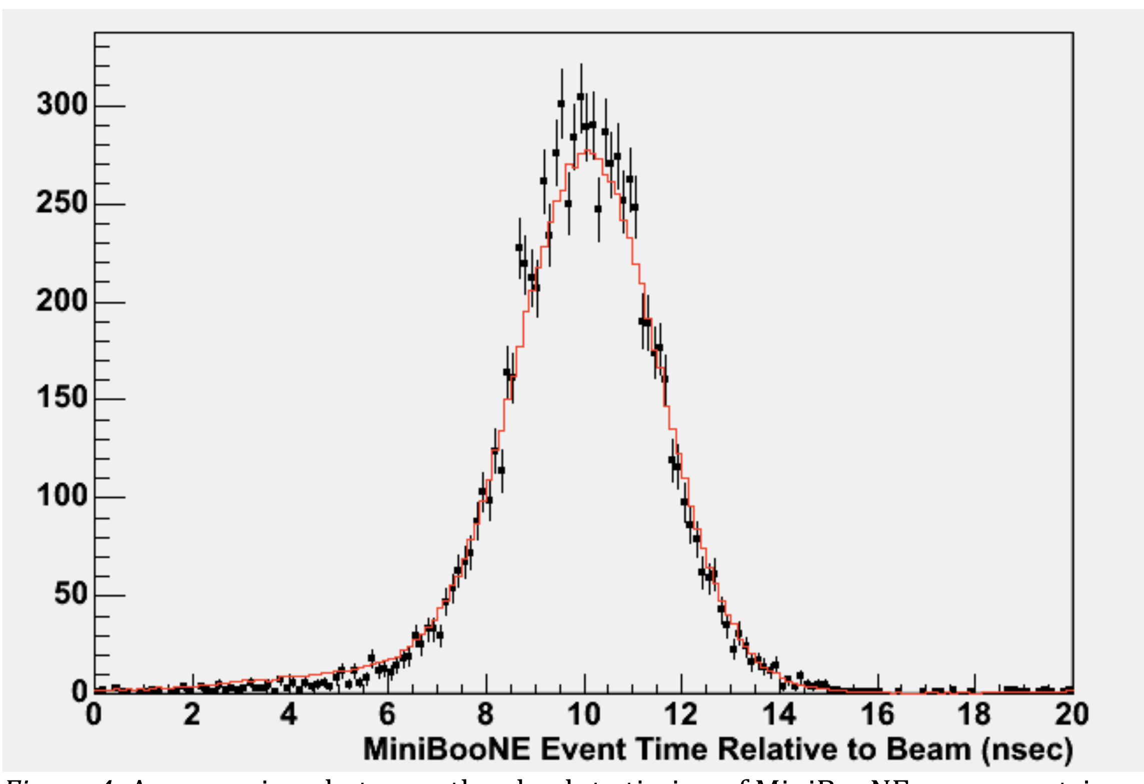

Figure 4: A comparison between the absolute timing of MiniBooNE muon-neutrino charged-current quasielastic (CCQE) data events relative to the beam (black histogram) and the Monte Carlo expectation (red curve).

III. MicroBooNE PMT Hit Rate

We are working with the Columbia and Fermilab groups on MicroBooNE to understand the PMT hit rate of ~200-300 KHz, which is an order of magnitude higher than expected. The Columbia group has identified radon from the liquid argon circulation filter as a possible contribution, while our LANL group has estimated the rates due to cosmic-ray neutrons and radioactivity in the cryostat. The rates due to these latter two sources are estimated to be <10 kHz. As a next step, we are working with the Columbia group on a proposal to take data for two weeks by bypassing the filter to understand the source of radon contamination.

IV. MicroBooNE Electronics Noise

The MiniCAPTAIN liquid argon (LAr) detector at LANL is being commissioned to run in the LANSCE neutron beam in early 2016. We are using the same electronics and DAQ system as MicroBooNE, and so MiniCAPTAIN serves as a test bed for understanding electronics/DAQ performance. Much work was required (grounding, filtering, etc.) to reduce the electronic noise to acceptable levels for data analysis. Many of these lessons learned were communicated to MicroBooNE experts to help in their efforts to reduce noise.