Commissioning of the MiniBooNE detector at Fermilab

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The MiniBooNE experiment [1], designed to search for $\nu_\mu \to \nu_e$ oscillations with enhanced sensitivity to the same mass-squared difference range where the LSND experiment previously reported a positive signal [2], was approved in 1998 and built between 1998 and 2002. Data collection with a ν_μ beam began in September 2002. The MiniBooNE detector and neutrino source are now working very well and the neutrino intensity is approaching the proposal goal. The neutrinos are produced for MiniBooNE by the Fermilab Booster Neutrino source. 8-GeV protons are delivered from the Booster synchrotron onto a 1.7 interaction-length beryllium target located within a magnetic horn. The horn focuses secondary mesons toward the detector so that their decay results in a large neutrino flux at the detector. The horn, which has performed as designed, is pulsed with 170 kA during the 1.6 μs beam spill, at an average rate of 5 Hz.

The MiniBooNE detector consists of a 12.2-m diameter spherical tank filled with 800 tons of (undoped) mineral oil. This tank is divided into a central "main" region, viewed by 1280 8-inch phototubes (PMTs) and a "veto" region viewed by 240 8-inch PMTs. The oil, carefully selected based on attenuation length and scintillation light yield (measured at IUCF), was transferred into the detector during Spring 2002. A nitrogen gas bubbling system was installed to purge any residual water and oxygen from the oil. The detector calibration systems, consisting of a pulsed laser (397 and 438 nm) system, an overhead muon tracker, and muon scintillation cubes, allow monitoring of the PMT charge and time response. The health of the detector is constantly checked with a "slow-monitoring" system that measures temperatures, pressures, and humidity levels of the detector oil and surrounding environment.

The MiniBooNE data acquisition (DAQ) system uses the front-end electronics from the LSND experiment [3] with new readout computers and software. The main trigger is an accelerator signal indicating beam spill to the neutrino target. This trigger opens a window in which all PMT data are recorded, regardless of the amount of light in the detector, for 19.2 μs around the beam spill. Other triggers, implemented to allow calibrations and additional physics investigations, include a supernova trigger, a random strobe trigger, multiple calibration triggers, and a minimum bias trigger. The distribution of number of hit PMTs from minimum bias triggers taken during commissioning is shown with annotations in Fig. 1. This system has proved to be extremely reliable, averaging 98% live time while beam is on.

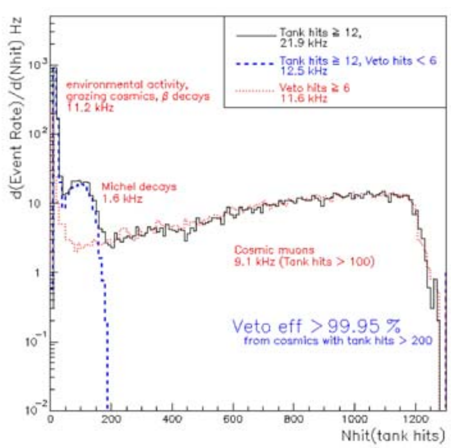

Figure 1. *Tank PMT multiplicity distribution for a minimum bias trigger in the MiniBooNE detector. The components of this distribution are understood and are labeled.*

The IUCF neutrino group has played an important role in the construction and commissioning of the MiniBooNE detector, with responsibility for management of detector components installation, DAQ and trigger software, the slow-monitoring and nitrogen systems.

1. E. Church *et al.*, (BooNE Collaboration), *A proposal for an experiment to measure muon-neutrino to electron-neutrino oscillations and muon-neutrino disappearance at the Fermilab Booster: BooNE,* FERMILAB-PROPOSAL-0898.
2. A. Aguilar *et al.*, Phys. Rev. D **64**, 112007 (2001).
3. C. Athanassopoulos *et al.*, (LSND Collaboration), Nucl. Instrum. Methods A **388**, 149 (1997).