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The NOvA Experiment

A. Habig for the NOvA collaboration

[a] *University of Minnesota Physics Dept., 10 University Dr., Duluth, MN, 55812*

Abstract

NOvA is an off-axis long-baseline neutrino experiment, looking for ν_e appearance in an upgraded NuMI beam of ν_μ to search for θ_{13} acting in subdominant $\nu_\mu \rightarrow \nu_e$ transitions. As an appearance experiment, NOvA might also be sensitive to CP-violating δ and the neutrino mass hierarchy. To maximize sensitivity to the resulting ~GeV electromagnetic showers, the 14 kton Far Detector is "totally active", comprised of liquid scintillator contained in 15.7 m long extruded PVC cells, with the scintillation light piped out in wavelength shifting fibers then digitized by avalanche photodiodes. Civil construction at the far detector site is underway, and the smaller near detector is being assembled at Fermilab.

Keywords: neutrino oscillation, long baseline, detector, electron neutrino appearance

The NOvA experiment [1] will observe an upgraded (700 kW) NuMI [2] ν_μ beam looking for the ν_e appearance signature of a non-zero θ_{13}. See [3] for the physics goals and sensitivities of this experiment, while this poster describes the detectors used.

For maximal cancellation of potential systematic errors, the NuMI beam is observed both soon after creation at Fermilab with a "near detector" and again 810 km to the northwest with a "far detector" installed in a greenfield site near Ash River Falls, MN. These detectors are functionally identical, of a "totally active" design utilizing liquid scintillator contained in 15.7 m long extruded PVC cells layered in alternating horizontal and vertical planes. The 14 kton far detector is being constructed on the surface starting when civil construction of the building finishes in the spring of 2011, and the 225ton near detector is undergoing commissioning in the summer of 2010 on the surface at Fermilab. It will serve as a prototyping exercise and beam test on the surface, and will be moved 100 m underground in 2012 to match the 14 mrad off-axis position of the far detector with respect to the beam.

Charged particles resulting from neutrino interactions in the detectors will create scintillation light in the mineral oil and pseudocumene, which will be carried out of each highly reflective (15% TiO_2) PVC cell with a loop of wavelength-shifting optical fiber to be collected using Avalanche Photodiodes (APDs). These low-gain devices coupled with low-noise preamps provide an affordable readout system for the 357,120 channels in the far detector. The $\sim 4 \times 6$ cm cell cross-section provides the spatial resolution needed to resolve electromagnetic showers. Since the large far detector is on the surface, the beam neutrinos are selected from the 700 MB/s cosmic ray data rate by means of GPS timestamps created by the NuMI beam spills and sent to the detectors via the internet. Data is kept in a circular buffer for ~30 s, and saved for later analysis if triggered by these timestamps or a periodic signal to save a small sample of cosmic rays for calibration purposes.

The near detector on the surface (NDOS) is taking data now. Using this experience, the far detector will take data as it is assembled, with a complete detector ready to take physics data in the upgraded NuMI beam starting in late 2012.

[1] D. S. Ayres, et al., The NOvA technical design report, Tech. Rep. FERMILAB-DESIGN-2007-01, Fermilab (2007).

[2] K. Anderson, et al., NuMI facility technical design report, Tech. Rep. FERMILAB-DESIGN-1998-01, Fermilab (1998).

[3] G. Pawloski, et al., Physics goals and sensitivity of NOvA, Nucl. Phys. B (Proc. Suppl.)This issue.