Electron Neutrino Identification in the NOvA Detectors

Tian Xin, Gavin S. Davies, Iowa State University
On behalf of the NOvA Collaboration

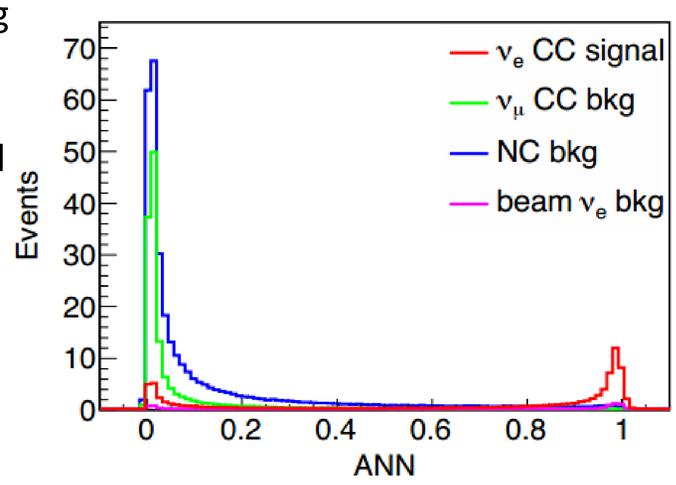
06/12/2013 – FNAL User's Meeting

NuMI Off-Axis ν_e Appearance

The main objective of the NOvA experiment is to observe electron neutrino appearance from the off-axis NuMI muon neutrino beam. The NOvA collaboration has developed three independent algorithms to select electron-neutrino charged current events in the NOvA detectors. The main background to this selection are neutrino neutral current events dominated by π^0's.

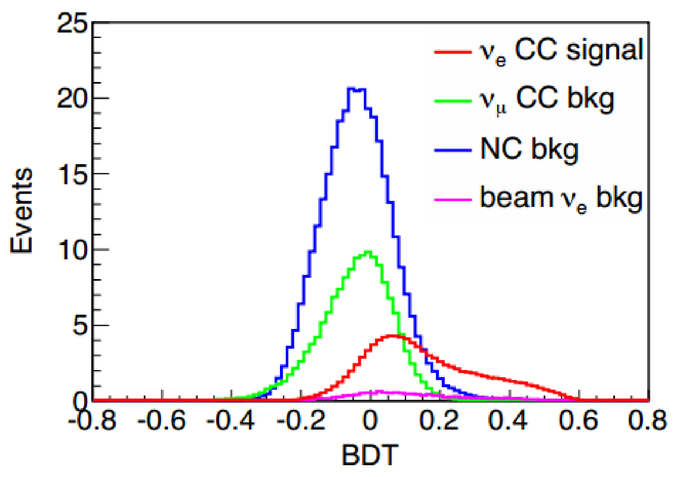
Artificial Neural Network (ANN)

Electrons are identified using their shower energy profile. Longitudinal and transverse log likelihoods are calculated for each particle hypothesis based on dE/dx information. Electron energy resolution is ~10% at 2.0 GeV. We select 56 ν_e CC signal for 28 background for 6.1 figure of merit.



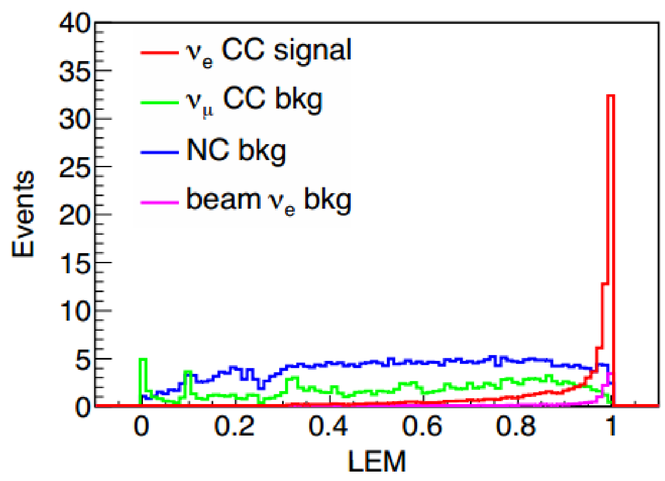
Boosted Decision Tree (BDT)

A boosted decision tree has been developed using reconstructed variables like energy, length of the track, maximal energy density in the longitudinal direction and transverse energy shower width as well as the energy balance of the clusters. A figure of merit of 5.4 is obtained.



Library Event Matching (LEM)

The LEM method compares each data event to a large library of Monte Carlo events. The fraction of best matches that are signal, plus other properties of the matched events are fed into a decision tree. A figure of merit of 6.1 is obtained.



Event Selection rates

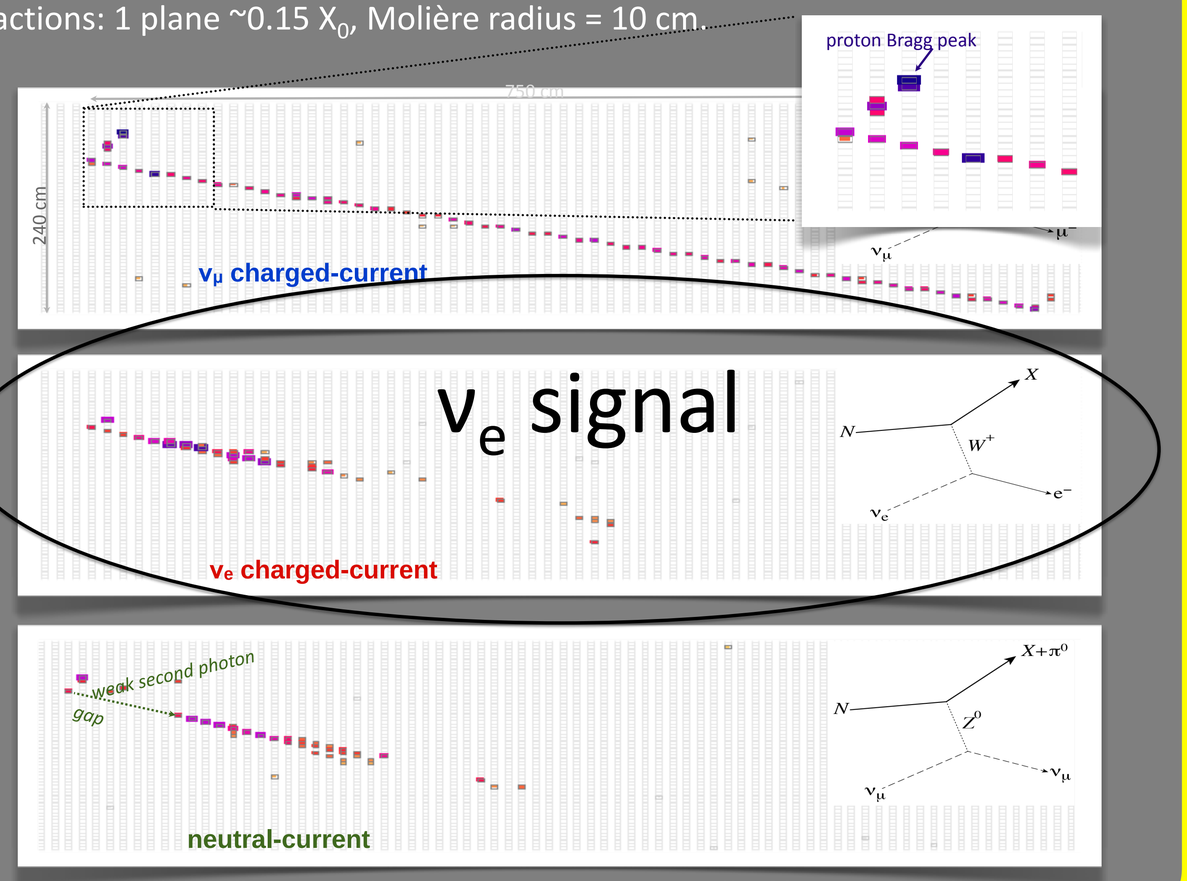
ANN	signal	total bkgd	NC bkgd	ν_μ CC bkgd	ν_e CC bkgd
ν (3 yrs)	56	28	17	4	7
$\overline{\nu}$ (3 yrs)	26	14	9	1	4

Expected signal and background event rates for 3 years neutrino and anti-neutrino running each.

The NOvA Collaboration: ANL, Athens, Banaras Hindu, Caltech, Delhi, Charles University, Cincinnati, Czech Technical, FNAL, Harvard, Hyderabad, IIT Guwahati, IIT Hyderabad, Indiana, INR Moscow, IoP of Czech Republic, Iowa State, Jammu, Lebedev, Michigan State, Minnesota/Crookston, Minnesota/Duluth, Minnesota/Twin Cities, Panjab, South Carolina, SMU, Stanford, Sussex, Tennessee/Knoxville, Texas/Austin, Tufts, Virginia, WSU, William and Mary.

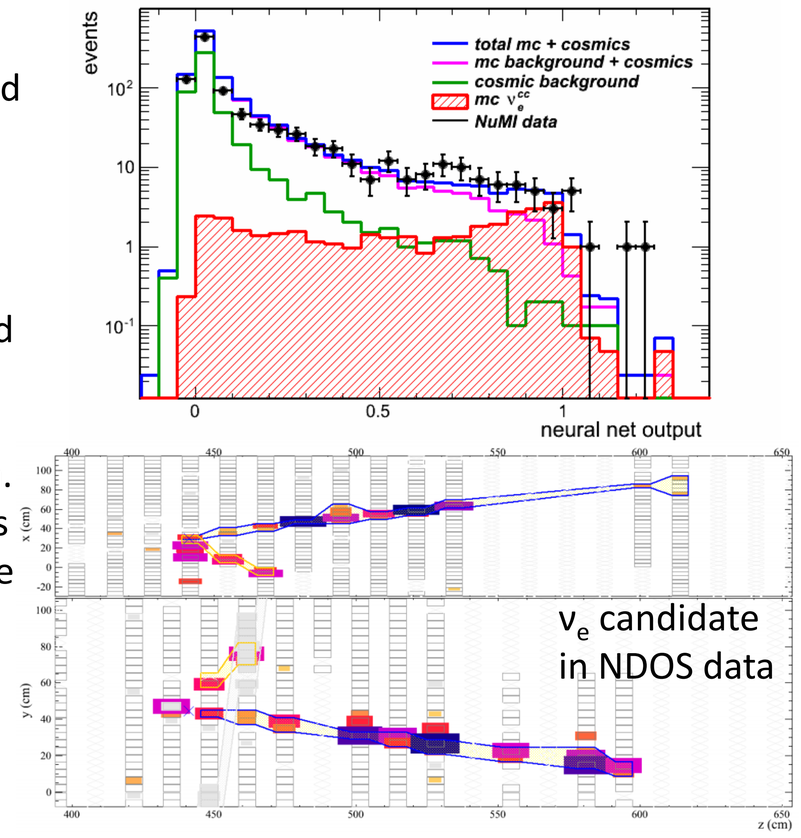
Topologies of basic interaction channels

The NOvA detectors are optimized for detection of ν_e charged-current interactions: 1 plane ~0.15 X_0, Molière radius = 10 cm.



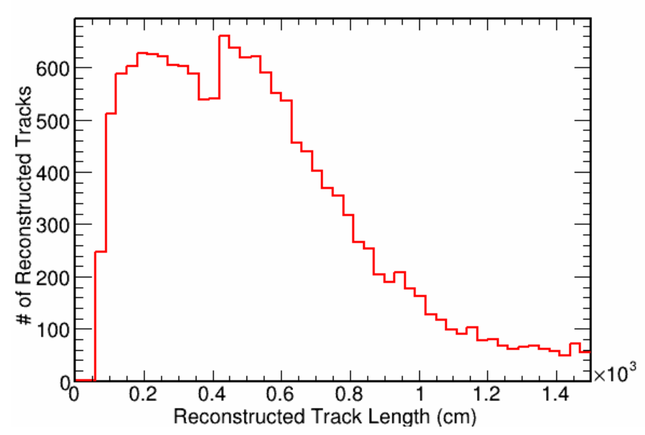
Electron Neutrinos in NDOS

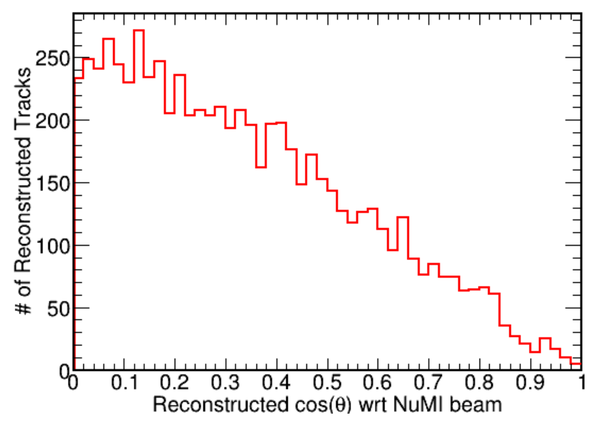
We ran the analysis chain on the NuMI data recorded at the Near Detector On Surface (NDOS). This prototype detector was sparsely instrumented with no overburden. It had a large surface area to volume ratio and a lower energy neutrino spectrum. The situation at NDOS was thus much harder than the Far Detector will be. Even so, we successfully found an electron neutrino component of the beam.



Early Far Detector Cosmic Data!

NOvA has begun collecting Far Detector cosmic ray data. Detector commissioning began on March 12th. We have successfully processed these early data through NOvA reconstruction and particle identification algorithms.
The reconstructed track length and the distribution for the track angle with respect to the direction of the beam for these data are shown.





www.twitter.com/NOvANuz
www.facebook.com/novaexperiment