ν_e CC Analysis Using Neural Network at NuMI Off-Axis ν_e Appearance Experiment (NOνA)

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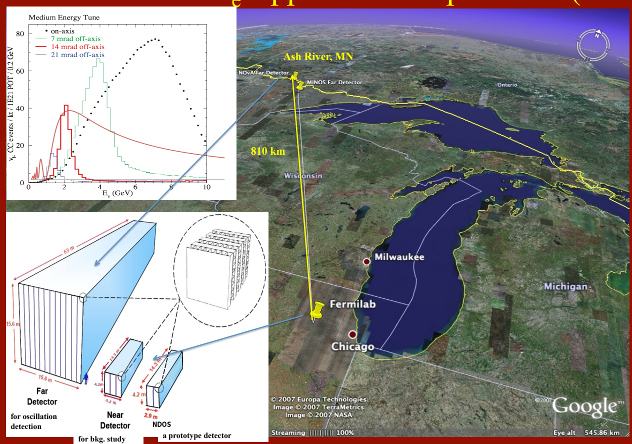
NuMI Off-Axis ν_e Appearance Experiment (NOνA)



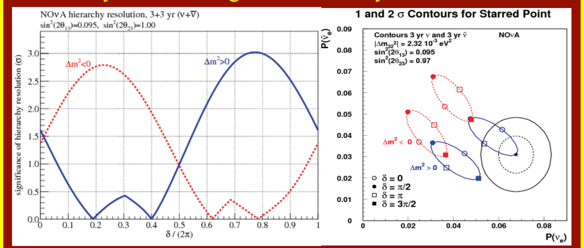
Main features of NOνA:

- An upgrade of the NuMI beam intensity from 400 kW to 700 kW.
- Detectors consist of plastic (PVC) extrusions filled with liquid-scintillator, with WLS fibers connected to APDs. They are high resolution electro-magnetic calorimeters. Near and Far detectors are functionally identical, and are assembled in alternating layers of vertical and horizontal extrusions to provide reliable tracking.
- A 15 kt far detector located 14 mrad off the NuMI beam axis at a distance of 810 km from fermilab at Ash River, MN.
- A 220 ton near detector located 14 mrad off the NuMI beam axis at a distance of 1 km.

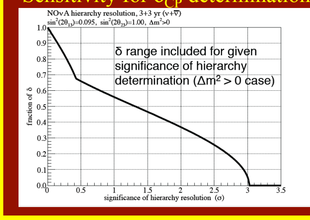
NOνA Physics Goals

Measure θ_{13} — ν_e appearance
Determine neutrino mass hierarchy
Constrain CP violation phase (δ_{CP})
Precise measurements of Δm_{23}^2, θ_{23} — ν_μ disappearance

Sensitivity for Resolving Mass Hierarchy



Sensitivity for δ_{CP} determination



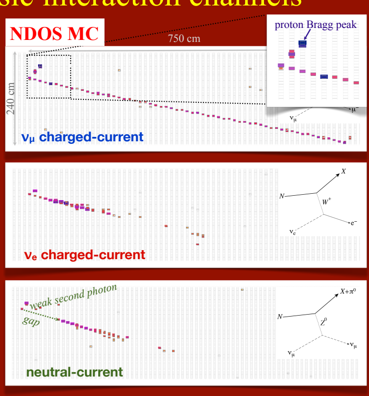
Because of its long baseline and the recently measured large θ_{13}, NOνA may resolve the mass hierarchy with 3 years neutrino beam running and 3 years antineutrino beam running.

Topologies of basic interaction channels

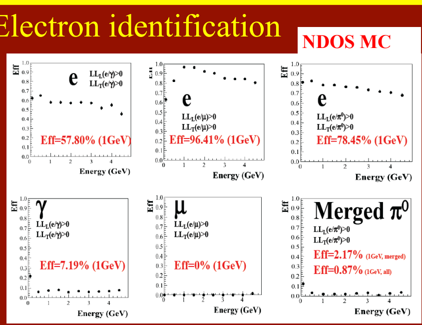
Each "pixel" is a single 4 cm x 6 cm x 15 m cell of liquid scintillator.

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

NOνA achieves 35% efficiency for ν_e CC while limiting NC→ν_e CC fake rate to 0.1%.

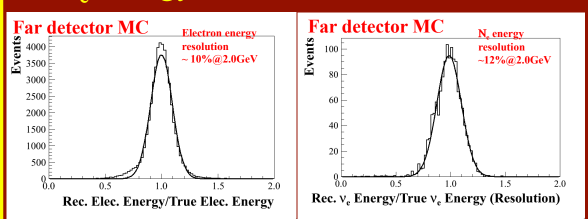


Electron identification



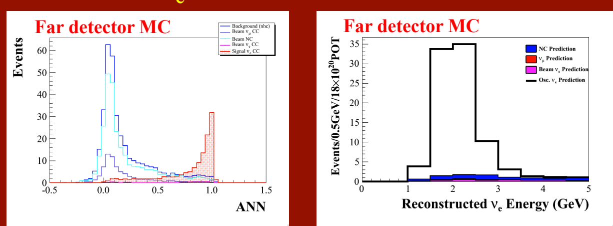
We identify electrons using shower energy profiles. Longitudinal and transverse log likelihoods (LL_L/LL_T) for each particle hypothesis are defined based on dE/dx. Single particle Monte Carlo shows excellent particle identification performance.

ν_e energy reconstruction



Preliminary electron resolution is about 10% at 2.0GeV. We calibrate electron and hadron energy scales for ν_e CC energy reconstruction. Comparing with true ν_e energy we know that the neutrino reconstruction energy resolution is about 12% at 2.0GeV.

ν_eCC event selection



An artificial neural network (ANN) has been applied in the ν_e CC selection. Likelihoods for each particles hypothesis are used for training this ANN. Performance can reach the designed PID requirements.

The NOνA Collaboration (*www-nova.fnal.gov*)

ANL, Athens, Caltech, Institute of Physics of the Czech Republic, Charles University, Czech Technical University, FNAL, Harvard, Indiana, Iowa State, Lebedev, Michigan State, Minnesota/Duluth, Minnesota/Twin Cities, INR Moscow, South Carolina, SMU, Stanford, Tennessee, Texas/Austin, Tufts, Virginia, WSU, William and Mary