MINERνA Charged Current Inclusive Analysis

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Abstract. MINERνA is a few-GeV neutrino scattering experiment that has been taking data in the NuMI beam line at Fermilab since November 2009. The experiment will provide important inputs, both in support of neutrino oscillation searches and as a pure weak probe of the nuclear medium. For this, MINERvA employs a fine-grained detector, with an eight ton active target region composed of plastic scintillator and a suite of nuclear targets composed of helium, carbon, iron, lead and water placed upstream of the active region. We will describe the current status of the charged current inclusive analysis in plastic scintillator.

Keywords: Neutrino, Kinematics, Inclusive

INTRODUCTION

MINERνA is a few-GeV neutrino scattering experiment that has been taking data in the NuMI beam line at Fermilab since November 2009. The experiment will provide important inputs, both in support of neutrino oscillation searches and as a pure weak probe of the nuclear medium. MINERνA has been approved for 4.0e20 protons on target (POT) in low energy mode. The data collected at the time of the this analysis was 3.98e20 (POT) for neutrino and 1.7e20 (POT) for antineutrino. The MINERνA charged current inclusive analysis preliminary results that are presented in this document uses $\frac{1}{4}$ for neutrinos and $\frac{4}{5}$ for antineutrinos of the total data collected.

CHARGED CURRENT INCLUSIVE ANALYSIS

EVENT TOPOLOGY

We are interested in reconstructing ν events where a muon is present[3] in both the MINERνA detector[1] and MINOS near detector[2][1]. In the Figure 1 is presented the common event topology to be analyzed. We can see from the event vertex[2] one long track due to the μ^- and the extra activity related to the recoil energy[4].

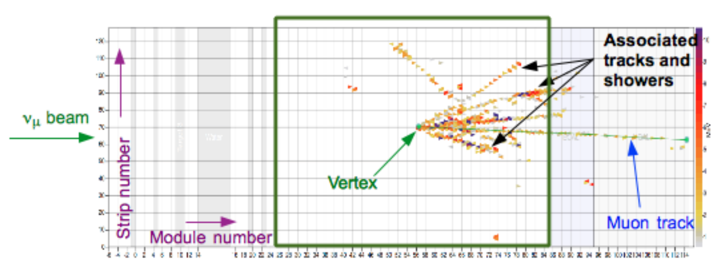

FIGURE 1. A candidate event for a charged current inclusive in the tracker region. The nuclear targets are upstream of the tracker region and calorimeters to contain additional particles coming from the neutrino interaction are downstream of the tracker region.

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[1] MINOS near detector contains magnets to complete the muon reconstruction
[2] The muon vertex defines the event vertex

EVENT SELECTION

The requirements for an event to be classified like a charged current inclusive are:

- One muon track matched to a track in MINOS.
- Hits to be used in the reconstruction must be within $[-20, 35]ns$ of the vertex time. Crosstalk hits are excluded.
- The muon vertex must be inside the fiducial volume defined in the tracker region between modules 27-78 and 85 cm of apothem.
- The recoil energy will be computed calorimetrically[4].
- Neutrinos are defined by a negative track curvature while for anti-neutrinos, anti-muons are defined by the positive track curvature (curvature $\rightarrow \frac{q}{p}$).

KINEMATIC QUANTITIES AND NEUTRINO ENERGY RESOLUTION

Neutrino energy, muon energy and recoil energy reconstructed kinematic quantities are presented (Figures 2 and 4). Figures 3 and 5 show the systematic uncertainties for the different energy distributions, the purple line is the fractional uncertainty on the GENIE[5] cross section. The major fractional uncertainties for the energy distributions are related to the modeling of the neutrino flux.

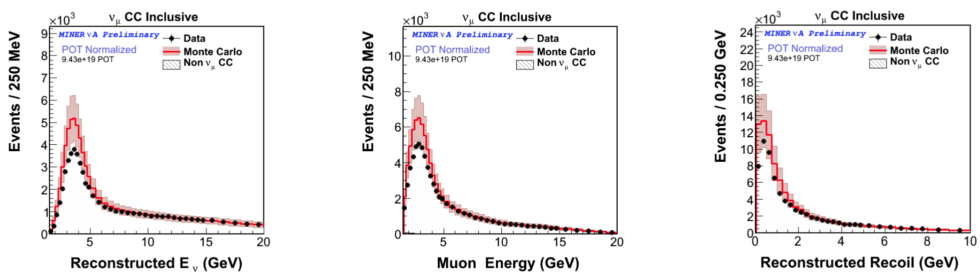

FIGURE 2. Neutrino Kinematic Distributions

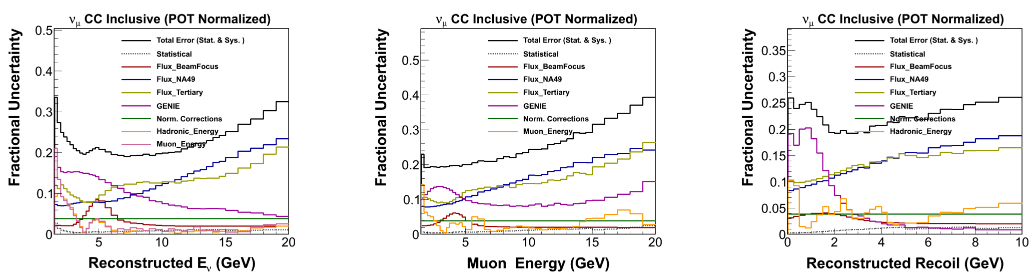

FIGURE 3. Fractional uncertainties on montecarlo for charged current inclusive neutrino events

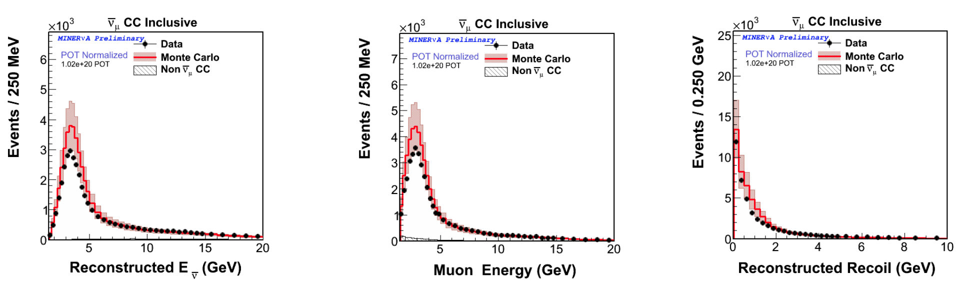

FIGURE 4. Antineutrino Kinematic Distributions

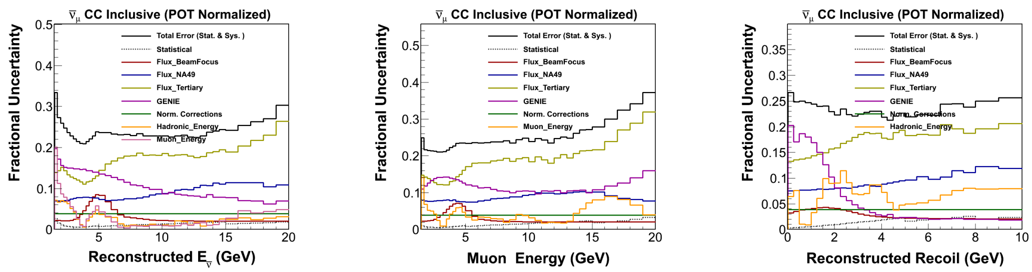

FIGURE 5. Fractional uncertainties on montecarlo for charged current inclusive antineutrino events

Figure 6 show the neutrino and antineutrino energy resolutions defined as:

Resolution E_ν = Generated E_ν (GENIE Neutrino event generator [5]) - Reconstructed E_ν

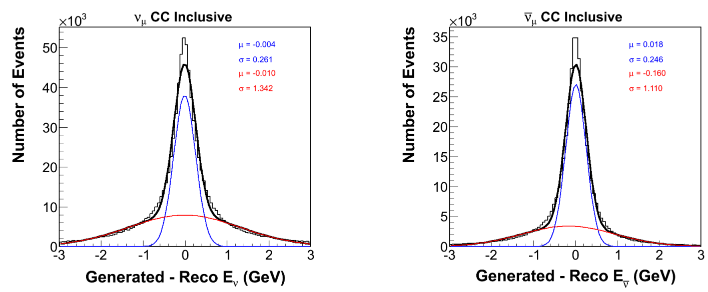

FIGURE 6. Left: Neutrino Energy Resolution, Right: Antineutrino Energy Resolution

CONCLUSIONS

- MINERνA has demonstrated the capability to make accurate measurements of the charged current inclusive cross section for both neutrinos and antineutrinos in the few GeV region. A brief description of the event selection and kinematic distributions for neutrino and antineutrino data for the charged current inclusive analysis were presented.
- The infrastructure and machinery for the first preliminary cross sections it is being actively developed.

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