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Measurement of muon neutrino charged current interactions with the T2K near detector

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We present the T2K selection of muon neutrino charged current events using the near detector (ND280) data at J-PARC (Tokai) for flux and cross section fitting. An inclusive set of events were selected that contained a muon candidate, this data set was then divided into three categories according to the presence of additional pion and electron candidates. The categories resemble the event topologies of the three dominant cross sections at T2K's beam energy: charged current quasi-elastic, single-pion resonant production, and deep inelastic scattering. These selections are later used by the T2K flux and cross section fit to extract the muon neutrino beam flux and to re-weight and reduce the uncertainties in the neutrino-nucleus cross section at these energies. The selection of the data and its comparison with the Monte Carlo and cross section predictions are presented.

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The T2K (Tokai-to-Kamioka) experiment is a long-baseline neutrino oscillation experiment [1] whose primary goals are to make precise measurements of the appearance of electron neutrinos and the disappearance of muon neutrinos at a distance where the oscillation is maximal at the peak of the neutrino beam energy distribution. The data from the selection in the near detector (ND280) is fit to constrain the flux and neutrino cross section. All the data collected until April 2013, $5.9 \cdot 10^{20}$ protons on target, is analyzed.

1. Selection of ν_μ charged current interactions in ND280

For this analysis we measure the rate of ν_μ events in the ND280 tracker. The ND280 tracker is composed by two active Fine Grained Detectors (FGDs) [2] and three Time Projection Chambers (TPCs) [3].

We start with an inclusive charged current (CC) ν_μ selection of events, in the fiducial volume of the first FGD. This sample is then subdivided into "CCQE", "CC-1pion" and "CC-Others"-like samples. This splitting into three samples is done in order to better constrain the CC-1pion sample, is one of the main sources of background for the oscillation analysis. The CCQE-like sample consists of events without any pions, the CC-1 pion-like sample consists of events with one, and only one, positive pion, and the CC-Others contains all the other categories (a negative or neutral pion, or more than one pion). The neutral pion is identified by the presence of electron or positron in the event.

For the categorization in the Monte Carlo we define an event "topology" based upon the true particle types comming from the nucleus after the interaction and nucleus rescattering. Figure 1 shows the muon momentum distribution for the three samples before fitting.

Detector systematic uncertainties are estimated with several control samples and these systematics are propagated event by event. Then, a joint likelihood fit including the neutrino flux covariances predictions, cross sections uncertainties and ND280 spectrum analysis is constructed [4].

The output of this joint likelihood fit provides an updated spectrum prediction and cross section model, including a new covariance matrix for both the beam flux and cross sections, that is then used to predict the event distributions at the T2K far detector (Super-Kamiokande) for an oscillation analysis. Figure 2 shows the muon spectrum after the flux and cross section corrections are applied. A better agreement between data and Monte Carlo is showed.

References

[1] K. Abe et al. (T2K Collaboration), Nucl. Instrum. Methods A 659, 106 (2011), arXiv:1106.1238 [hep-ex].

[2] A. Amaudruz et al. (T2K ND280 FGD Collaboration), Nucl. Instrum. Methods A 696, 1 (2012), arXiv:1204.3666 [physics.ins-det].

[3] N. Abgrall et al. (T2K ND280 TPC Collaboration), Nucl. Instrum. Methods A 637, 25 (2011), arXiv:1012.0865 [physics.ins-det].

[4] M. Wilking, The latest results from T2K on the neutrino oscillation and interaction, in procedings of The European Physical Society Conference on High Energy Physics 2013, http://indico.cern.ch/contributionDisplay.py?contribId=92sessionId=21confId=218030

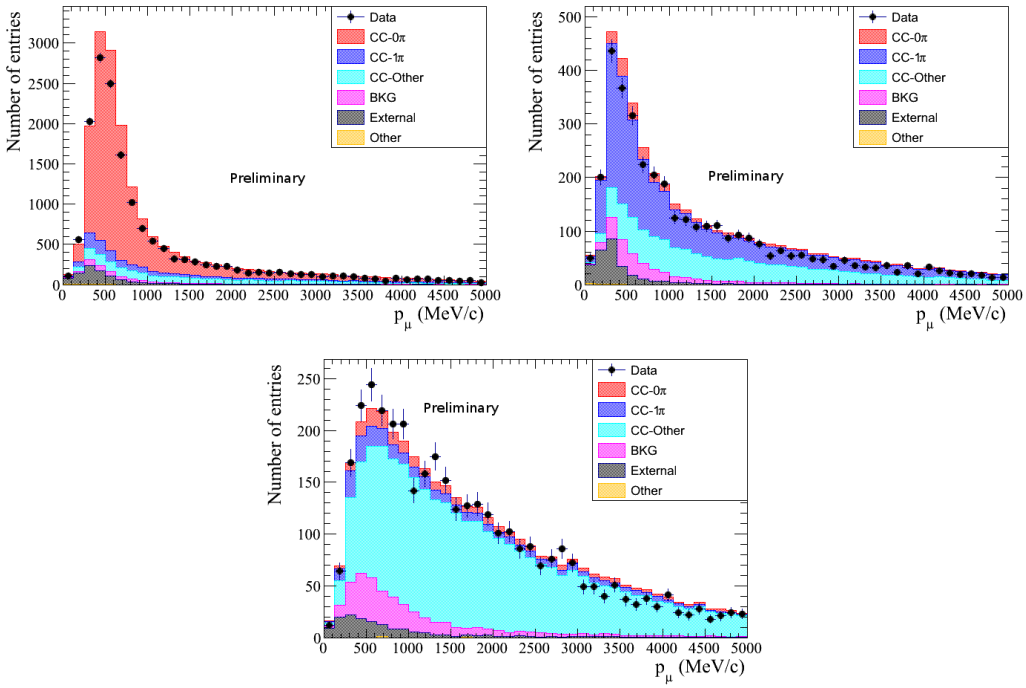

Figure 1: Muon momentum distribution for the CCQE (top-left), CC-1pion (top-right) and CCOthers (bottom) selected samples.

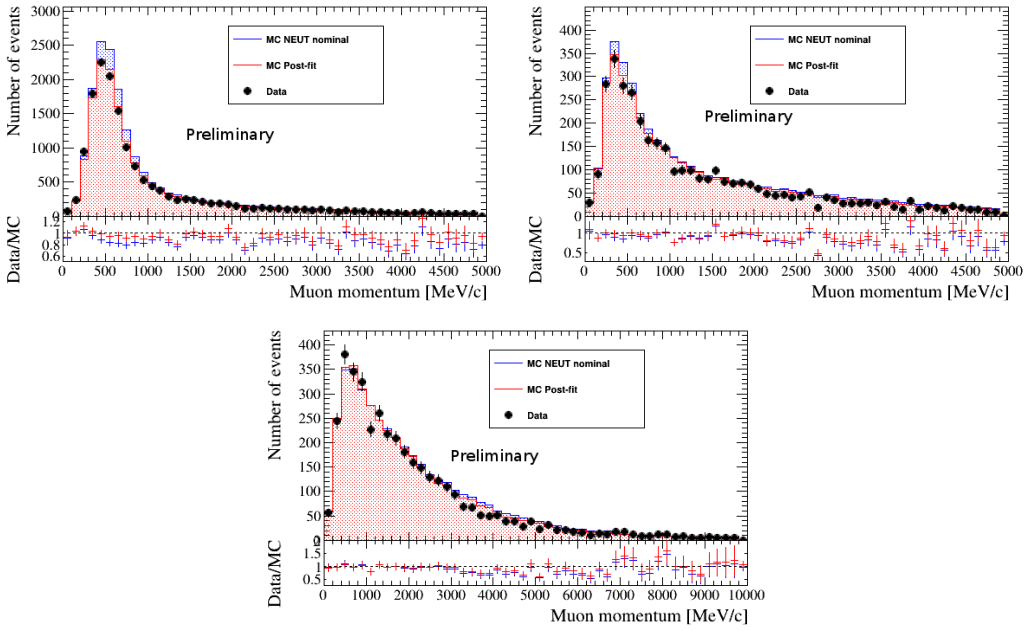

Figure 2: Muon momentum distribution for the CCQE (top-left), CC-1pion (top-right) and CCOthers (bottom) selected samples after the fit. Comparison between Nominal and post-fit MonteCarlo is showed.