

# Measurement of the Energy Dependent Numu Charged Current Inclusive Cross Section on Iron with the T2K INGRID Detector

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The Tokai-to-Kamioka (T2K) experiment [1] is designed to measure neutrino oscillation parameters. It uses an almost pure muon neutrino ( $\nu_\mu$ ) beam that originates at J-PARC. INGRID [2] (Fig. 1) is installed 280 m downstream from the T2K target to monitor the direction and intensity of the neutrino beam. It has 14 independent modules which are composed of iron plates and scintillator planes. The modules make up a cross-shape with center on beam-axis.

The  $\nu_\mu$ -Fe charged-current (CC) inclusive cross section had been measured by T2K and the MINOS experiment [3]. However, data in the energy range 2-3 GeV have not yet been measured. The purpose of this analysis is to measure the energy range 1-3 GeV to cover the non-measured region.

In order to extract the energy dependent CC inclusive cross section with INGRID, following information is employed: 1) INGRID covers different off-axis angles of the neutrino beam. As a result, the neutrino energy spectra are different at different modules as shown in Fig. 2. 2) The neutrino candidate events are categorized according to proper event topologies. Details of these analysis methods and the result with T2K data taken from 2010 to 2013 will be presented.

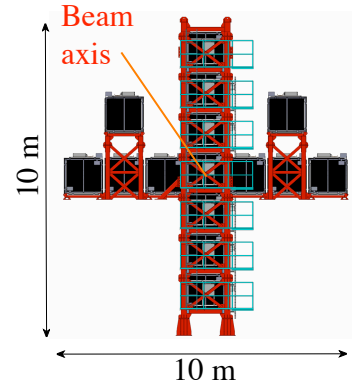


Fig. 1. The INGRID detector

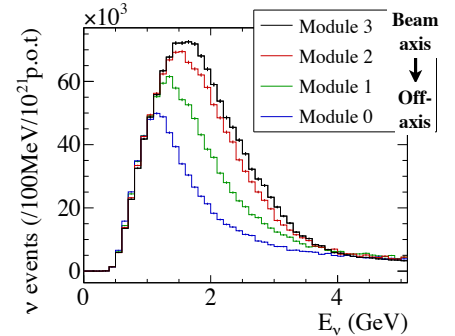


Fig. 2. Predicted neutrino energy spectra for the different INGRID modules

## References

- [1] K. Abe *et al.* (T2K Collaboration), Nucl. Instrum. Meth. **A659**, 106 (2011)
- [2] K. Abe *et al.* (T2K Collaboration), Nucl. Instrum. Meth. **A694**, 211 (2012).
- [3] P. Adamson *et al.* (MINOS Collaboration), Phys. Rev. D **81**, 072002 (2010)