Abstract

The thesis presents the measurement of the double differential cross section for single π^- production in $\bar{\nu}_\mu$ interaction on scintillating material. The results are reported in muon kinematical variables i.e. momentum and cosine of the muon emission polar angle $(p_\mu, \cos\theta_\mu)$. Data for this measurement were collected in T2K near detector ND280 during $\bar{\nu}_\mu$ beam mode runs from 2014 to 2018. Collected data statistics correspond to about 8.46×10^{20} protons on target.

T2K is a long-baseline neutrino oscillation experiment. Cross section measurements of neutrino interaction in sub-GeV to few GeV energy range allow to constrain the systematic uncertainties in the oscillation analysis. Single charged pion production is a relevant interaction mode at this energy scale.

The signal selection is based on the reconstruction of μ^+ and π^- tracks in ND280 with the interaction vertex in scintillator subdetector FGD1. Selection optimisation and estimation of the systematic errors are done with Monte Carlo simulations based on NEUT v5.4.0 generator. The cross section is measured as integrated over the energy spectrum of the incident neutrino beam. The final result is reported in the restricted phase-space for muon and pion kinematics. The double differential cross section is used to obtain the differential cross section in p_μ (integrated over angle), the differential cross section in $\cos\theta_\mu$ (integrated over momentum) and the total cross section (integrated over the restricted phase-space), which is found to be:

$$\sigma_{total} = \left(1.002 \pm 0.277[\text{stat+syst}] \pm 0.123[\text{stat}]\right) \times 10^{-40} \text{ cm}^2 \text{ per nucleon}$$

for muon with 200 MeV/c $< p_\mu <$ 30000 MeV/c, $\cos\theta_\mu > 0.74$
and pion with 100 MeV/c $< p_\pi <$ 3000 MeV/c, $\cos\theta_\pi > 0.32$.

This result on single π^- production is in agreement with the nominal NEUT v5.4.0 predictions, which are based on Rein-Sehgal model of resonant interaction and Rein-Sehgal model of coherent interaction with Berger-Sehgal corrections. The measurement is however smaller than GENIE v2.8.0 predictions, were Rein-Sehgal coherent model is used without Berger-Sehgal corrections.