Single Pion Production in Neutrino Interactions

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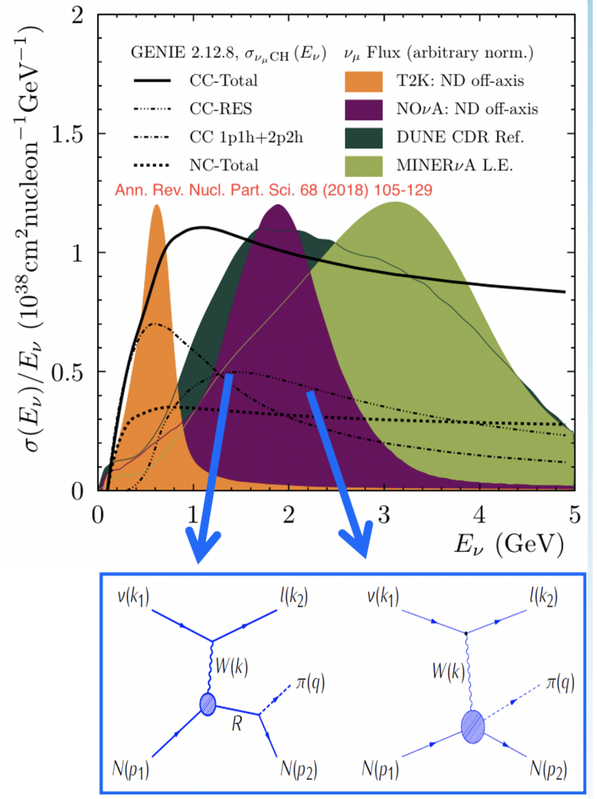
Introduction

– Single pion production (SPP) is the most important process in the long baseline neutrino experiment.



– Single pion can be produced via decay of resonance excitations or non-resonant interactions.

References

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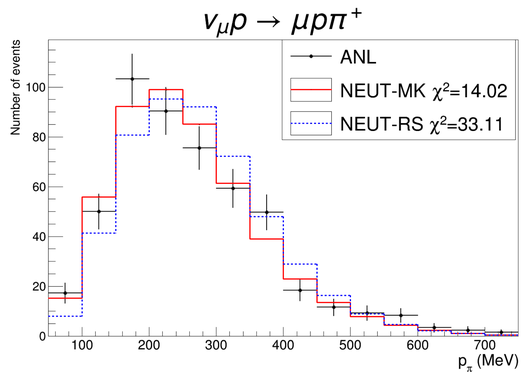
MK model

The MK model [1] provides a full kinematic description of SPP in neutrino-nucleon interactions, including the resonant and the nonresonant interactions in the helicity basis. This allows for calculations of the interference terms. Resonance production in the MK model follows the formalisms of the RS model [2] while the nonresonant interactions follow the HNV model [3].

The long-standing Rein and Sehgal (RS) model in NEUT [5] and GENIE [4] does not include a reliable model for nonresonant processes and related interference terms. It is not a full kinematic model and the output of this model does not include the pion angles. The MK model is developed to be a substitution for RS model in neutrino generators.



Updated MK model

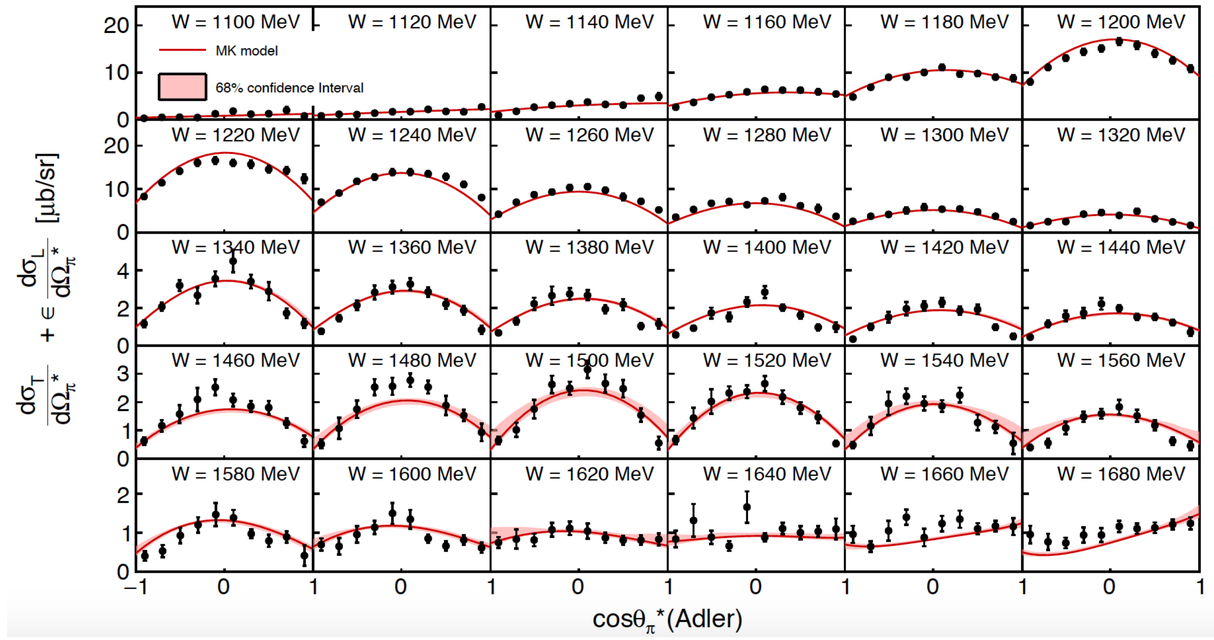
In the updated approach the vector helicity amplitudes from the RS model are changed to the helicity amplitudes of the Rarita-Schwinger formalism [6].

Fits were used to determine the Q^2 dependence of transition form-factors for resonance production and nonresonant SPP. Measurements of single pion differential cross section of electron scattering on a Hydrogen target from the CLAS Collaboration analysis is used in the fits. Data was limited to the kinematic region most important for accelerator-based neutrino experiments.

Channel	E_e (GeV)	Q^2 (GeV/c)^2	W (GeV)
$ep \to ep\pi^0$	1.6, 2.4	0.4 - 0.9	1.1 - 1.68
$ep \to en\pi^+$	1.5	0.3 - 0.6	1.1 - 1.57

Analysis of electron-induced exclusive data: Fit results

Fit results from MK model at $Q^2 = 0.65$ (GeV/c)^2 and $E_e = 2.445$ GeV for $ep \to ep\pi^0$ channel. Data is from [7].

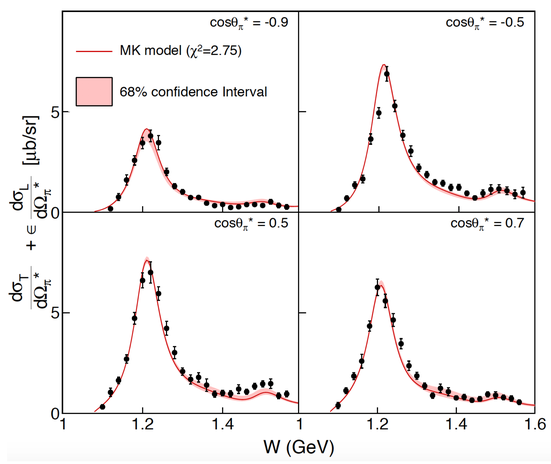


Results for electron-induced data (Validation)

To validate our fit result we compare the updated MK model with electron-induced pion production data that is not included in this analysis.

Exclusive data

Measurements of single π^0 at $E = 2445$ MeV and $Q^2 = 1.15$ (GeV/c)^2. Data is from [7].



Inclusive data

Inclusive electron-proton differential cross section in terms of energy transferred at $E_e = 0.73$ GeV. DCC model [8] prediction with πN in the final state are also presented for comparison with the updated MK model. Data is from [9].