**Abstract**

NuWro Monte Carlo event generator is described and then used in investigation of MEC events.

**NuWro**

NuWro is a Monte Carlo neutrino event generator under development at Wroclaw University since ∼ 2006 [1].

- Open source code, repository at https://github.com/NuWro/nuwro
- Covers energy range from ∼ 100 MeV to TeV region.
- Flux and detector interfaces allow for a use in neutrino experiments.

**NuWro physics models**

The basic picture is that of impulse approximation. Neutrino-nucleus scattering is a two-step process. Primary interaction on quasifree nucleons is followed by hadron rescatterings.

- **QEL:** ν̄μ n → l− p
- **RES:** W < 1.6 GeV; mostly single pion production via ν̄μ N → l− Δ N′, Δ → π N″
- **DIS:** W > 1.6 GeV
- **COH:** coherent pion production

**NuWro FSI model**

How pion cascade may change final state particles.

- A critical ingredient to compare to experimental data.
- NuWro includes FSI effects for pions and nucleons.
  - a) Pion rescatterings (and absorption) described by Oset et al model [2]
  - b) Nucleon rescatterings described by Pandharipande-Pieper model [3]. Nucleon-nucleon correlations effects will be included.

**MEC mechanism**

In case of neutrino nucleus scattering interaction can occur on nucleon-nucleon pairs via two body current mechanism. Ab initio computations for electron scattering show that the mechanism must be include to describe quasielastic peak region.

**NuWro MEC model**

Contribution to lepton inclusive cross section taken from Valencia model [4] Hadronic part described by "phase space" model [5].

**A search for MEC events**

MEC events are supposed to be a significant fraction of CCν̄μ events with a signal defined as no pions and arbitrary number of nucleons in the final state. Example: MINERvA experiment results [6].

One may try to learn about MEC contribution from CCν̄μ data from MINERvA, T2K, ν̄μ, and Pν̄, measurements, but there is a lot of ambiguity.

**Proton observables**

It seems necessary to study proton observables. Example: T2K measurement of CCν̄μ without a proton in an acceptance region [7].

In this data there is a small contribution from MEC and it can be used to constrain nucleon FSI effects.

**Final remarks**

- A lot of interest in MEC contribution to overall cross section
- Theoretical models predictions are quite different.
- There is a lot of new neutrino scattering data, also with proton detection, one must use MC generator to analyze results and learn about the MEC contribution.

**References**