Generators for the SIS/DIS Region

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We describe how the main neutrino interaction generators (GENIE, NEUT and NuWro) used by current neutrino oscillation experiments treat the shallow and deep inelastic region. We then compare their predictions for charged current events in this region, in terms of transferred momentum as well as multiplicities for different types of hadrons. We present additional comparisons in the low hadronic invariant mass region, where the generators use different custom models.

KEYWORDS: Neutrino interaction generator, deep-inelastic, shallow-inelastic, generator comparisons

1. Introduction

Neutrino oscillation experiments rely on predictions obtained by Monte Carlo simulations to analyze their data. A crucial requirement for those simulations is the ability to properly simulate the interactions of neutrinos and anti-neutrinos with the nuclei of the elements constituting the detectors, to generate the particles which will then be propagated through a simulation of the detector to produce the final observables. This step is handled by neutrino interaction generators, and in this article we look at how the generators most commonly used by the current experiments handle the shallow and deep inelastic (SIS-DIS) region. We will focus on the case of the charged current (CC) interactions, and define this region as comprising all the events for which the invariant mass of the hadronic system W is larger than 1.7 GeV/c^2, for reasons which will be detailed in the next section.

We considered the following three neutrino interaction generators:

- NEUT [1] version 5.3.4
- GENIE [2] version 2.10, comparing the predictions of the two models for final state interactions (FSI) hA and hN when relevant
- NuWro [3] version 11q

Additionally, predictions of the GiBUU generator taken from [4] will be shown on comparisons when possible. When comparing the output of different generators, all the simulated events will be interactions of muon neutrinos and anti-neutrinos.

2. Modelling of the shadow and deep inelastic region in the generators

Above the pion production threshold, the three generators use different models depending on the value of the invariant mass of the hadronic system for the event to generate. The general picture is that at low W a combination of exclusive resonance channels and of a continuous DIS background is used, while at high W the predictions of the PYTHIA [5, 6] generator are used. The number of resonances considered, as well as how the transition between those two regimes is done differ from