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Angular distributions in Monte Carlo event generation of weak single-pion production

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One of the substantial sources of systematic errors in neutrino oscillation experiments that utilize neutrinos from accelerator sources stems from a lack of precision in modeling single-pion production (SPP). Oscillation analyses rely on Monte Carlo event generators (MC), providing theoretical predictions of neutrino interactions on nuclear targets. Pions produced in these processes provide a significant fraction of oscillation signal and background on both elementary scattering and detector simulation levels. Thus, it is of critical importance to develop techniques that will allow us to accommodate state-of-the-art theoretical models describing SPP into MCs.

In this work, we investigate various algorithms to implement single-pion production models in Monte Carlo event generators. Based on comparison studies, we propose a novel implementation strategy that combines satisfactory efficiency with high precision in reproducing details of theoretical models predictions, including pion angular distributions. The proposed implementation is model-independent, thereby providing a framework that can include any model for SPP. We have tested the new algorithm with the Ghent Low Energy Model for single-pion production implemented in the NuWro Monte Carlo event generator.

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