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Implementation of QED radiative corrections theory for photon emission prediction in the NEUT event generator

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The accelerator-based neutrino oscillation experiment T2K aims to investigate neutrino CP violation by measuring differences in oscillation probabilities between neutrinos and antineutrinos. One of the dominant sources of systematic uncertainty in T2K arises from neutrino–nucleus interaction modeling. In particular, tree-level photon-emission contributions to the neutrino–nucleus cross section are currently implemented in the event generator NEUT via an empirical model, which may introduce uncertainties in the predicted event rates and thereby affect the precision of oscillation measurements. To estimate these uncertainties, a recently developed theoretical model for radiative corrections to the neutrino–nucleus cross section has been implemented into NEUT. This is the first microscopic theory-based implementation of radiative photon emission in NEUT. Preliminary NEUT predictions based on this implementation will be presented, focusing on radiative photon production in the accelerator-neutrino energy region and its impact on electron- and muon-neutrino interaction predictions. To study the impact of radiative photon production on detector simulation, the energy and angular distributions of radiative photons were generated. Several comparisons between the theoretical predictions and NEUT simulations were also performed to validate the implemented theoretical model.

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