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The search for neutrinoless double beta decay using the nEXO experiment: Simulation needs and challenges

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The nEXO experiment aims to explore beyond standard model physics in the neutrino sector, particularly through the search for neutrinoless double beta decay (0vBB) of Xenon-136. This decay, if observed, is a lepton-number violating process and would shed light on the fundamental properties of neutrinos. nEXO will employ a 5-tonne xenon target enriched to 90% of the 2vBB isotope, Xenon-136, and utilizes a liquid xenon time projection chamber (TPC) detector design. The nEXO experiment will probe 0vBB half-lives up to 10ˆ28 years, 2 orders of magnitude past the current experimental limits.

nEXO employs a thorough radiopurity screening campaign, with multi-mode screening for all forms of radiogenic backgrounds. Combining these screening measurements with simulations of full decay chains for the measured uranium and thorium of all detector materials, we can estimate the background contributions to our expected signal. To this end, efficient simulation methods are crucial due to the low efficiency of external background simulations, low levels of radioactive contamination, and the 10-year lifetime of the experiment. To further optimize simulation time, nEXO GEANT4 simulations use light-maps to produce the expected photodetector response for energy depositions within the TPC. This light-map is built using the GPU accelerated photon transport simulation framework, Chroma. The role of Chroma in nEXO simulations and plans, including direct GEANT4 integration will be discussed, alongside the current challenges, and strategies that are being explored for GEANT4 simulations.

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