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Logical Muon Generation for Monte Carlo Simulations (Underground)

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The main purpose of building a particle detector underground is to minimize cosmic ray induced backgrounds, however, even the low flux of residual cosmic rays can constitute an appreciable source. The high sensitivity required to detect rare nuclear decay events or other sought after interactions can exaggerate these effects. Through-going cosmogenic muons contribute to background sources for many underground detection experiments including nEXO. There are possible muonic interactions from which erroneous signals arise. Muons may also cause delayed interactions within the detector from their interactions in surrounding rock. One way to mitigate this problem is to build a secondary (auxiliary) detector to tag muons in order to discard unwanted signals in the main detector.

One of such detectors is being designed to work with the nEXO time projection chamber (TPC) tagging muons that pass through the water tank where the TPC is installed. This introduces new work in optimization through simulations and design alterations of an entirely distinct system. This presentation seeks to briefly mention the mechanisms by which muons affect nEXO detector operations and the rudimentary functioning of the water-Cerenkov detector. On this basis, an approach to logically generate such muons will be shown. Many of the relations to be presented have been used in Monte Carlo simulations previously for underground experiments, some of them at SNOLAB. While the underground energy spectra and zenith angle intensity are normally addressed in muon veto simulations, there is a lack of clarity with regard to the zenith angle dependence of the muon energy. This will be featured with an example of how to implement this in code. While the focus will be held on SNOLAB, particularly with its flat overburden, topics discussed can be applicable to other underground laboratories.

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