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Cherenkov Light Simulations with Chroma for nEXO's Muon Veto

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nEXO is a proposed neutrinoless double beta decay experiment currently in the design stage. nEXO is expected to reach a half-life sensitivity of approximately 10^{28} years, which requires ultra-low backgrounds. To achieve this, the plan is to build the detector 2 km underground at SNOLAB to reduce backgrounds from cosmic radiation, as well as use a water-Cherenkov muon veto, the focus of this summer project. The muon veto, also known as the outer detector (OD), is a large tank of ultra pure water. When high energy cosmic muons pass through the outer detector, they produce UV photons in a process called Cherenkov radiation. These photons are detected by photomultiplier tubes (PMTs) inside the water tank and let us tag the muons passing by. The muons'energy signals can then be removed from the total data recorded from nEXO's main inner detector to get cleaner results.

Before finalizing the design of the outer detector, simulations need to be run to optimize the placement of the PMTs that will detect the Cherenkov light. This summer, we are adapting Chroma, a ray tracing program already being used for nEXO's inner detector, to simulate the light propagation in the outer detector. Chroma, along with being easily editable for new detector set ups, also aims to be faster than most comparable Geant4 simulations, which is the C++ Monte Carlo software used for most of nEXO's current simulations. This summer work has mainly focused on implementing the required theory to generate Cherenkov photons with the correct properties for Chroma to then propagate. The outer detector geometries and material optical properties have also been added into Choma. The final work of the summer will be running large simulations and further developing the analysis pipeline.

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