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(POS-48) Improving the efficiency of SuperCDMS background simulations with Geant4's Importance Biasing

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SuperCDMS is a direct detection dark matter (DM) experiment which is currently being built at the SNOLAB underground laboratory in Sudbury, Canada. It will operate cryogenically cooled Ge and Si crystals with different sensor designs to perform a broadband DM search for particles with masses $\leq$ 10 GeV/c^2, thus exploring new regions of interest.

Among the key requirements to reach this sensitivity are 1) to provide a sufficiently low background environment, and 2) to understand the background composition of the measured energy spectra. The former is achieved by several layers of lead and hydrogen-rich materials to shield the detectors from external radiation. For the latter, Geant4 simulations are performed taking into account the measured radioactive impurities from screening materials. As the shielding is designed to be very effective, the simulations that propagate particles through the thick shielding lack in statistics in terms of number of detector hits, which leads to large uncertainties in the background composition.

Geant4 provides a mechanism called Importance Biasing which can significantly increase the number of particles that travel into the direction of the sensitive detectors.
Effectively, Importance Biasing has the potential to increase the number of detectors hits by orders of magnitude while at the same time consuming less CPU time on a per-event basis.

This talk will discuss the working principle of Importance Biasing and its implementation in the SuperCDMS simulation framework, explain how to distinguish different event topologies to reconstruct the simulated energy spectra and show the achieved efficiency boost in the respective background simulations.

Keyword-1

SuperCDMS

Keyword-2

Geant4 background simulations

Keyword-3

Importance biasing

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