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Monte Carlo simulation of external background in the SuperNEMO experiment

Investigation of neutrino properties is one of the most essential interests for particle physics and for better understanding the evolution of our Universe. Crucial missing information could be provided by the observation of neutrinoless double beta-decay ($0\nu\beta\beta$), a rare decay that violates total lepton number by two units which makes it forbidden in the Standard Model of particle physics. If observed, it would prove neutrinos are their own antiparticles - Majorana particles - and they could be the key to the matter-antimatter asymmetry problem.

SuperNEMO is a one-of-a-kind experiment searching for neutrinoless double beta decay in the Modane Underground Laboratory (LSM). It utilizes a tracking approach by separating the source isotope from the detector, while combining tracker and calorimetry techniques to detect emitted electrons independently. This approach provides the means to discriminate different underlying mechanisms for the $0\nu\beta\beta$ decay by measuring the decay half-life and the electron angular and energy distributions.

The modular design of SuperNEMO consists of modules containing approximately 5-7 kg of enriched and purified $\beta\beta$ emitting isotope in the form of a thin layer deposited on a foil placed between 2 tracker detectors and 2 plastic scintillator blocks with photo-multiplier tubes. The baseline isotope currently used in the first module, the Demonstrator, is ^{82}Se. This unique approach offers extremely good background rejection based on reconstructing the topology of measured events.

Backgrounds to SuperNEMO's double beta-decay measurements arise from events that mimic the topology of two electrons emitted from a common vertex in the source foil at energies up to the $Q_{\beta\beta}$ value of ^{82}Se, 2995 keV. In order to design a system with the lowest possible background, there is a need for understanding individual background sources and estimation of each component.
High energy γ-rays originating from de-excitations of radionuclides in ^{238}U and ^{232}Th decay chains and from neutron capture reactions can mimic $2e^-$ events through their interaction in the source foil.
The aim of this work is to estimate the background contributions from high energy gamma rays coming from the underground environment and (n,γ) reactions that constitute a major source of background to almost all underground experiments.

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