Monte Carlo Simulations of Detectors Background and Analysis of Background Characteristics of the SuperNEMO Experiment in the Modane Underground Laboratory

Abstract

Presented dissertation thesis is focused on Monte Carlo simulations of background induced by high energy gamma rays in the SuperNEMO experiment.

The discovery of neutrino masses through the observation of neutrino oscillations renewed the interest in neutrinoless double beta decay searches. They can probe lepton number conservation and investigate the nature of the neutrinos - Dirac or Majorana - and also probe their absolute mass scale. SuperNEMO experiment aims to search for the signal of neutrinoless double beta decay. It utilizes a tracking approach by separating the source isotope from the detector, while combining tracker and calorimetry techniques to detect emitted electrons independently. The first module of the experiment, the Demonstrator, is located in Modane underground laboratory. Its background suppression technique is based on rejection method by reconstructing the topology of events and on background suppression by selecting radiopure materials used in detector construction and passive shielding.

Part of the thesis is dedicated to evaluation of different sources of background, namely ambient background sources in the Modane underground laboratory that are unavoidable to all experiments operating here, and radiogenic sources of neutrons produced in fission processes of uranium and thorium, and in (α,n) reactions. This part represents an important component of inputs used for Monte Carlo simulation of the background induced by high energy gamma rays. A problem with simulation of gamma cascades emitted after thermal neutron capture in the software package along with the solution of this problem is discussed.

Another part is dedicated to simulations of attenuation of radiation passing through different shielding configurations and geometries. This study helps to optimize the final design of passive shielding used for the Demonstrator module.

All these parts are then used as inputs for the final Monte Carlo simulations of external background in the SuperNEMO experiment.

The main goal of this task is to study and to identify events that mimic the 2 electron topology of neutrinoless double beta decay.

Keywords: Neutrino, SuperNEMO, Neutrinoless double beta decay, Monte Carlo simulations