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Background simulation of the SABRE experiment

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The SABRE experiment (Sodium-iodide with Active Background REjection) will search for dark matter through the annual modulation in the rate of ultra-pure NaI(Tl) crystals. Dark matter signal is expected to modulate yearly because of the rotation of Earth around Sun, and thus the change of the relative velocity of the detector with respect to the dark matter halo.

The first phase of the experiment is the SABRE Proof-of-Principle (PoP), a single 5 kg crystal operated inside a liquid scintillator veto at the Laboratori Nazionali del Gran Sasso (LNGS) in Italy.
The final experiment will consist of twin NaI(Tl) crystal arrays of about 50 kg, located in the north and south hemisphere: respectively at the LNGS in Italy, and at the Stawell Underground Physics Laboratories (SUPL) in Australia. The double location is a key feature in order to understand site related backgrounds, and to discriminate a modulation signal of seasonal origin, with opposite phase in the two sites, from a signal of galactic origin with the same phase.

The signal region for dark matter interactions is in the range 1-20 keV, and the background for this experiment is mainly due to the contamination of radioactive isotopes and cosmogenic activation in the detector material and surroundings.
A detailed GEANT4 simulation has been developed to estimate the background of the PoP, based on radiopurity measurements of the detector components.
This simulation will be compared with the PoP data and used as a tool to quantify the most important backgrounds.
Simulation of the full scale geometry is now under development, in parallel with the finalization of the design of the final experiment. In addition to the radioactivity, we have added the optical physics and the propagation of scintillation light in the crystals and in the liquid scintillator veto, in order to study and optimize the light collection efficiency.

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