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Geant4 simulations applied to analysis of the Po-210 and Pb-210 content in the components of the DarkSide-20k dark matter detector

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The DarkSide-20k (DS-20k) experiment is located in the Gran Sasso underground laboratory in Italy. Its main goal is to search for direct interactions of cold dark matter particles with argon nuclei. The detector is based on a two-phase time projection chamber (TPC) and because the expected signal from dark matter is very low, a strong background suppression is needed in order to maximize the detectors sensitivity. As a consequence there are strong requirements for the construction components/material with respect to contamination with radioactive isotopes.
In searches for dark matter one of the most important background sources are neutrons, especially those produced in the (alpha, n) reactions. It is impossible to distinguish between the signal coming from dark matter particles and that induced by neutrons. Alpha particles can be produced in the Po-210 (daughter of the long-lived Pb-210) decays. In my research Po-210 content in samples to be used in the DS detector, is determined by application of alpha spectrometry. A large-surface, low-background alpha spectrometer XIA UltraLo-1800 was used. Registered spectra contain contributions from the bulk and from the surface Po-210 contamination. Monte Carlo simulations are crucial to deconvolute these contributions and to obtain the surface and bulk Po-210 activity concentrations. The alpha-spectrometer and the samples geometry were implemented in the Geant4 package including appropriate physical processes. A few millions of the Po-210 decays were generated from the samples'bulk (entire volume) and surface (a few nanometers of the layer). The combined spectra from the simulations were fitted to real data by the $\chi 2$ method due to the deconvolute the bulk and surface activity. The obtained values are compared to the DarkSide requirements.

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