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Geant4 simulations for the NEXT experiment and applications

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NEXT is an experiment searching for neutrinoless double beta decay with high-pressure gaseous xenon enriched in the Xe-136 isotope. It is situated in the Canfranc Underground Laboratory, in the Spanish Pyrenees. Neutrinoless double beta decay represents an extremely rare hypothetical mode of beta decay. Its confirmation would provide critical insights into the nature of neutrinos, demonstrating that neutrinos are Majorana particles, meaning that the neutrino is its own antiparticle.

An accurate modelling of both the expected signal and the background affecting the detector is essential in all rare event searches. To address this, the NEXT Collaboration has developed the NEXUS software, built upon the Geant4 toolkit. This software incorporates the specific geometry of the NEXT detectors, enabling simulations of the interaction of both radiogenic and cosmogenic backgrounds with xenon, as well as of xenon nuclear decay.

In this talk I will describe the NEXUS software and discuss the challenges of the simulation, which include the computational effort required by the propagation of a large amount of photons, the precise modelling of the optical properties of materials or the vertex generation.

I will also mention the application of Geant4 to a spin-off project of the NEXT experiment, called PETALO, which employs liquid xenon for Positron Emission Tomography technology.

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