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Particle Monte Carlo codes in SEM

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Monte Carlo particle transport codes are usually used to simulate the processes energies beyond the SEM range of few tens of KeV. The functionality of some of these codes is however broader and they can be successfully used to simulate the physics in the range corresponding to SEM. This contribution demonstrates the usage of two closely related codes for the simulation of the SEM detector systems.
Geant4 is the toolkit written in C++ which simulates the passage of the particles through the matter and is mainly used in high energy, nuclear and accelerator physics. It incorporates several models for the interactions of the electrons/photons with matter and proved to provide very good predictions of BSE yields (Figure 1), response functions for semiconductor detectors or optical photon transport from scintillators to PMT. Geant4 was also used for several smaller tasks like the simulation of electron/X-ray passage through thin layers (eg. CNT membranes), the spectra of the transmitted particles, etc. As such, the toolkit provides an important step between the analytical calculations and costly experimental validation.
Allpix2 extends the Geant4 ability with the simulation of the transport of electron-hole pairs in the semiconductor materials. The tracked particles (X-rays, electrons) are transported using the Geant4 code in the detector geometry (detector housing, dead layers, etc.). The energy deposited in the sensitive part of the semiconductor detector is converted to electron-hole pairs, Allpix2 code takes over their transport in the user defined electrical/magnetic fields using a rich set of models describing charge carrier mobility, recombination, trapping, etc.
Both codes have greatly deepened our understanding of the complex processes within detectors, paving the way for leveraging this knowledge in the creation of a new simulation framework designed specifically for detector systems.

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