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Class II simulation of electron and proton transport: PENELOPE and PENH

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Content

The interaction physics and the transport algorithm of the electron-photon Monte Carlo code system PENE-LOPE have been introduced as an option in the Geant4 toolkit. PENELOPE implements a strict class II (mixed) algorithm for the simulation of electrons and positrons in matter. The algorithm is defined by cutoff values of the energy loss for inelastic interactions and bremsstrahlung emission, and by a pair of energy-independent parameters that determine the cutoff scattering angle of elastic collisions as a function of the energy of the transported particle. Hard interactions, with energy transfer and/or angular deflection larger than the corresponding cutoff, are described from the corresponding restricted differential cross sections. The effect of soft interactions (with sub-cutoff energy loss and/or scattering angle) that occur along a trajectory step between hard interactions is simulated by means of the random-hinge method; the accumulated angular deflection is applied at the hinge and the total energy loss is described by means of a continuous slowing down process with constant stopping power.

Class II simulation algorithms present clear advantages in from of the more conventional class I (complete grouping) algorithms used in many high-energy Monte Carlo codes, at the expense of a certain complication of the simulation program. We shall comment on practical aspects of the coding of strict class II schemes for the simulation of the transport of charged particles, as implemented in PENELOPE for electrons and positrons, and in the recently developed code PENH for protons. The stability of simulation results under variations of user-defined parameters will be demonstrated.

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