Simulating Electron Impact Ionization using a General Particle Tracer (GPT) Custom Element

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A new C++ custom element has been developed with the framework of General Particle Tracer (GPT) to simulate electron impact ionization of residual gas molecules in particle accelerators. However, it is readily extensible to other applications. The custom element uses Monte-Carlo routines to determine both the ion production rate and the secondary electron kinetic energy based on user-defined gas densities and theoretical values for the ionization cross section and the secondary electron differential cross section. It then uses relativistic kinematics to track the secondary electron, the scattered electron, and the newly formed ion after ionization. The ion production rate and the secondary electron energy distribution determined by the custom element have been benchmarked against theoretical calculations and against simulations made using the simulation package IBSimu. The custom element will be described in detail and examples of applications at the Thomas Jefferson National Accelerator Facility will be presented for ion production in a DC high voltage photo-gun and for ion trapping with magnetic confinement.

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