Contribution ID: **10** Type: **poster**

A GEANT4 Simulation Framework for the Optimization of a CCD-based Diagnostics for Next Generation MeV Photon Sources

Laser plasma accelerators generate GeV electrons with acceleration distances of a few centimeters. This technology enables compact Thomson scattering photon sources at energies of 1-10 MeV, which have applications in radiography, photo-fission and nuclear resonance fluorescence for nuclear nonproliferation and homeland security. Knowledge of the energy-angle distribution of the photon bunch is crucial to source development as well as to enabling new applications. However, diagnosing Thomson sources is challenging due to the high intensity, ~108 photons per shot, and milli-radian angular divergence. We develop a simulation framework in Geant4 for a diagnostic system composed of a thin scatterer and a scientific CCD electron tracker. The uncertainties introduced by the scatter and the tracker in reconstructing a 1.73 MeV mono-energetic photon sources are evaluated, which determine the intrinsic limit of the current design on measuring the energy-angle distribution. With the flexibility the framework provides, an optimal diagnostic system will be designed.

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