AbstractID: 9062 Title: Using EGSnrc within GATE to improve the efficiency of positron emission tomography simulations

Purpose: GATE, a Geant4 based application for use in emission tomography, is a powerful package that permits realistic Monte Carlo simulations of both, the scanner geometry and the digitization chain. The main problem when using GATE in practice is its slow simulation speed. The purpose of this investigation is to improve the efficiency of PET related simulations.

Method and Materials: An EGSnrc based radiation transport tool, referred to as egs_pet, is developed. egs_pet can be used together with GATE in two modes: In mode 1, egs_pet performs the simulation of radiation transport in the phantom and passes exiting particles to GATE for further transport through the scanner geometry and for digitization. In mode 2, egs_pet performs the entire simulation and writes energy depositions in the detectors to a file. GATE is modified to be able to read this file when performing the digitization.

Results: The correct operation of egs_pet within GATE is validated using benchmark calculations of a source within a water phantom and a detailed model of the GE Advance PET scanner. In mode 1, the number of singles and coincidences are found to agree with GATE within the statistical uncertainties (0.2% for singles). Differences of about 0.5% are observed in mode 2, which can be attributed to differences between Geant4 and EGSnrc when modeling binding effects for photon interactions in BGO. For a 4 mm voxel phantom, the simulation efficiency is increased by a factor of 4 in mode 1, and by a factor of 130 or 44 with digitization excluded or included in mode 2.

Conclusion: A new Monte Carlo tool for PET simulations based on EGSnrc is developed and incorporated into GATE. Significant gains in simulation efficiency are achieved. Results from egs_pet simulations agree with GATE at the 1% level.