AbstractID: 5564 Title: Performance Assessment of a Deterministic Method Incorporating Coupled Photon-Electron Transport for Photon Beam Dose Calculations on Acquired CT Data

Purpose: To evaluate the performance of a neutral and charged particle deterministic solution method for external photon beam dose calculations using acquired CT data.

Methods and Materials: The Attila® radiation transport code, which solves the differential form of the linear Boltzmann transport equation for neutral particles and the Boltzmann-Fokker-Planck transport equation for charged particles, has been adapted for calculating dose distributions from acquired CT images. Comparisons were made with the Monte Carlo code EGSnrc (DOSXYZnrc) for a sample prostate treatment consisting of 8 10x10 cm^2 open beams with a realistic 6 MV photon spectrum. The Attila computational mesh consisted of 125,000 arbitrary tetrahedral elements, of approximately uniform size, which encompassed an imaged torso region. CT numbers were mapped to the Attila tetrahedral elements using one of four materials: air, tissue, adipose tissue, and bone, each having four discrete densities. Attila dose was determined at the image resolution by extracting the energy dependent particle flux at each 1x1x2.5 mm^3 pixel from Attila's calculated linear discontinuous finite element spatial representation, and multiplying by the energy dependent dose deposition response for that pixel material and density.

The DOSXYZnrc calculation used 2.5x2.5x2.5 mm^3 voxels, and was run until an average statistical uncertainty of 0.4% was achieved for voxels in the target region.

Results: Computational times Attila and DOSXYZnrc were 36 CPU minutes (2.4 GHz Opteron processor) and approximately 8,500 CPU minutes, respectively. Employing a deterministic electron cut-off below 300 keV reduced the Attila computational time to 22 CPU minutes. Agreement between both codes was excellent in both high and low dose regions, with differences less than 2%/2mm for greater than 95% of points on a 2-D plane through the entire torso.

Conclusions: A general purpose deterministic solver was successfully applied for dose calculations using CT image data.

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