AbstractID: 14099 Title: Validation of a Novel Dose Calculation Approach for Heterogeneous Voxelized Phantoms in a Parallel Computation Environment using Electron Dose Kernels for Radiotherapy

Purpose

Here we present a rapid *whole body* dose estimation approach applied to a clinical water phantom and whole body CT-voxelized phantom, using electron dose kernels coupled with deterministic photon transport. This method yields fast, accurate whole body doses.

Method and Materials

A novel dose calculation methodology called EDK-S_N, or "Electron Dose Kernel-Discrete Ordinates" rapidly estimates organ doses in a voxelized human phantom, accounts for in- and out-of-field doses using external photon beam therapy. We begin by solving the complete photon transport problem using parallel computing with the 3-D discrete ordinates (S_N) photon transport code PENTRAN. We then project pre-computed (via Monte Carlo) voxel-based Electron Dose Kernels (EDKs), mapping them to surrounding voxels via quaternion rotation, scaled by the magnitude of photon fluence from the S_N calculation. An 8 MV flat-weighted beam is incident on an 11×11×11 cm^3 water phantom, and on a 15 year old human phantom, down-sampled to 1×1×1 cm^3 (60×27×167 voxels); a 6 MV Philips Elekta Linac photon spectrum has also been simulated. The percent depth dose was compared to clinical CC04 chamber measurement results; comparison of doses using the EDK-Sn method and clinical treatment planning system (in field dose) will also be presented.

Results

The EDK-S_N technique has demonstrated independent agreement with Monte Carlo photon-electron transport calculations for whole body dose. The EDK-S_N method yields a speedup of ~8 (30 minutes versus 4+ hours) over the traditional parallel Monte Carlo, with <7% difference in different organs (smaller given stochastic uncertainties). The Monte Carlo simulated percent depth dose and clinical chamber PDD measurement agree within 10% among different field sizes.

Conclusion

The EDK-S_N method for high energy photon external beam dose calculations has been validated based on clinical external therapy beam calculations. This method will help to determine both in-field and out-of-field radiation dose for radiotherapy.