AbstractID: 4649 Title: Accurate and efficient Monte Carlo dose calculation for electron beams

Purpose: To develop a Monte Carlo dose calculation engine for electron beams that is feasible for routine clinical treatment planning.
Method and Materials: The dose calculation engine consists of a description of the clinical beams and a dose calculation module. A 12-component multi-source model was used to characterize the phase-space of clinical beams. There are 6 components each for electrons and photons, corresponding to the 3 scrapers, x-jaws, y-jaws, and the direct component respectively. In addition, we have developed a method to account for the presence of an arbitrary shaped cutout by modifying the last component of the standard beam model. For the dose calculation module, implementation of the Super-Monte Carlo method accelerates the calculation by using electron and photon tracks pre-calculated in water to avoid the computationally intensive sampling processes. These tracks are replayed in the patient computer model as defined by CT. To account for inhomogeneities, the step size and scattering angle were adjusted according to the CT voxel values and material indexes. The dose calculation engine was verified by comparing with film measurements in several different geometries.
Results: The results agreed with film measurements to within 2-5% percent both in homogeneous and heterogeneous phantoms. Our method is faster than the analog Monte Carlo calculation by a factor of 6 to 10 and is comparable in performance to a commercial system. The modified beam models for arbitrary cutouts can be derived in a few seconds. The disk storage for pre-calculated tracks is about 5.5 GB and 125 MB for the standard beam models.
Conclusion: The developed Monte Carlo calculation engine is accurate and efficient. The disk space and computational time required are well within clinical acceptability. It is a highly promising dose calculation tool for routine clinical applications.

This work supported in part by NCI grant P01-CA59017.