AbstractID: 1718 Title: A Hybrid Superposition Monte Carlo (HSMC) dose calculation algorithm optimized for radiotherapy treatment planning

Treatment management decisions in 3DCRT/IMRT are usually made based on the computed dose distributions. These decisions may include, for example, the choice of one treatment plan over another and the level of tumor dose escalation. The ability to accurately calculate dose distributions is therefore of basic importance. In this work, a Hybrid Superposition Monte Carlo (HSMC) model for photon dose calculations is developed. The model integrates both the stochastic MC method and the deterministic Superposition method for the computation of primary and scatter dose, respectively, utilizing the accuracy and speed properties of each technique. Unlike MC algorithms, which require significant computation-time, a substantial time-saving is achieved by performing two separate calculations. The Voxel Monte Carlo (VMC++) algorithm for primary dose where the calculation is performed over a small region, and the collapsed cone Superposition algorithm for scatter dose, where the calculation is performed over a larger area. This accurate and faster approach is possible since (i) the primary dose has extremely large gradients close to the interaction-point, but make no contributions beyond a few centimeters from the interaction-point, whereas the scatter dose has smaller gradients but contribute dose over a much larger range, and (ii) a fraction of the computation time in MC algorithms is spent tracking scattered photons and electrons that are set in motion by scattered photons. Results show that the HSMC algorithm is within 1% of measurements and VMC++ in homogeneous and heterogeneous phantoms, respectively, for 6 and 10 MV beams, and is 25% faster than VMC++.