AbstractID: 5167 Title: A Method to Reduce the Dose Uncertainty Caused by High Energy Cutoffs for Monte Carlo Treatment Planning

Purpose: A method to reduce the statistical uncertainty of dose caused by high energy cutoffs for electron transport was implemented in our home-grown Monte Carlo treatment planning system.

Method and Materials: In Monte Carlo radiation transport, an electron is discarded and its energy is deposited locally when its total energy is below a cutoff energy. The deposited energy is significantly higher than that calculated using the CSDA model with the corresponding restricted stopping powers. This will create a higher statistical uncertainty on dose and generate a confusing dose distribution, especially when low-density voxel exists. In this work, a new technique was developed by continuously transporting a discarded electron without considering electron multiple scattering or secondary particle generation. It has a continuous energy loss based on its mass collision stopping power in the local medium with an additional energy loss (about 70%) to account for the effect of approximations made in transporting the electron in a straight line rather than a curved path.

Results: After the new method was applied, the statistical uncertainties of the doses in air cavities of a head-and-neck patient was reduced from up to 39% to the same level of that in the surrounding tissue which is only about 2%. The dose statistical uncertainties of the tissue voxels were also reduced by 9% of their initial values. The simulation time with the new method was increased by 9%. And thus, the simulation efficiency was increased by 9% when the energy cutoff is 0.7MeV. When a cutoff of 1.5MeV was used, the new method increased the simulation efficiency by a factor of 3.

Conclusion: A new technique was developed to reduce the statistical uncertainty of doses in low-density voxels caused by high energy cutoffs for electron transport. The calculation efficiency and the dose distributions were improved significantly.