

AbstractID: 2996 Title: Systematic Uncertainties in a Commercial Monte Carlo Electron Treatment Planning Algorithm

Purpose: To evaluate the reproducibility of a commercial Monte Carlo dose calculation algorithm for electron beams. The Varian electron Monte Carlo (eMC) dose calculation algorithm allows the user to specify the “accuracy” of the dose calculation. Because of the stochastic nature of the algorithm, one expects that correlations between successive calculations should be minimal.

Method and Materials: The dose distribution (per monitor unit) in a flat water phantom was calculated for multiple field sizes, with and without inserts, for multiple energies. The dose grid voxel size was 2.5 mm in all directions, and smoothing of the dose distribution was turned off. The depth dose profile was extracted by averaging the dose matrix voxels in variably-sized rectangular regions centered on or near the beam axis. Depth dose distributions were compared for different regions in the same calculation and for the same region in different calculations.

Results: The depth doses in adjacent CT slices showed significant correlations, as expected. An unexpected result was that the depth doses in slices with up to 2.5-cm separation also showed significant correlations. Also unexpected for higher energies was that the depth dose exhibited a systematic oscillatory behavior in the region near dose maximum that was not reduced even by averaging over a large area. Comparing the depth doses for different field sizes, the same correlations were seen. In addition, averaging the dose over multiple calculations of the same beam did not smooth out the apparent noise in the depth dose.

Conclusion: The systematic uncertainties are approximately 1% and are most visible for higher energies because of the flat dose maximum region. The correlations seen in this work are most likely a result of complex interactions between the Monte Carlo step size and the dose grid, as well as possible reuse of particle histories.