AbstractID: 7714 Title: A practical Monte Carlo method for modeling dose deposition in intensity modulated radiation treatment planning

Purpose: To determine dose deposition coefficients for a beamlet with improved accuracy using a limited Monte Carlo method that will be practical for use in a clinical setting, as well as in IMRT optimization techniques, which require smooth dose models.

Method and Materials: To model the depth dose curve and lateral penumbra, smoothing functions are applied to the data from Monte Carlo experiments with histories ranging from one million to one billion. The quality of each approximation is determined by comparison to the approximation obtained from the one-billion history experiment. The depth dose curve is approximated by the most accurate polynomial fit from polynomials with degrees ranging from 10 to 45. Such high-degree polynomials are able to capture the behavior of the depth dose curve, even in the presence of heterogeneous tissues. The lateral penumbra can be modeled as the average of several error function pairs. A Levenberg-Marquardt quasi-Newton minimization method is employed to determine the parameters of each error function, as well as the number of error functions required. This method is applicable to both homogeneous and heterogeneous mediums.

Results: Examination of the models obtained for both the depth dose curve and the lateral penumbra show that for both homogeneous and heterogeneous mediums, the models obtained provide satisfactorily accurate approximations using as few as 100 million Monte Carlo histories.

Conclusion: This work indicates that it is possible to obtain very accurate dose deposition coefficients using Monte Carlo techniques in a reasonable amount of time using the smoothing functions methods presented. Because the resulting dose model is smooth, in contrast to the inherently noisy Monte Carlo data, the dose model is suitable for optimization techniques. Further testing and refinement could lead to even fewer required Monte Carlo histories.

Conflict of Interest (only if applicable):