AbstractID: 3721 Title: An Efficient Adjoint Monte Carlo Method for Radiation Treatment Planning

Purpose: Adjoint Monte Carlo methods were originally developed for optimizing nuclear reactor designs, but have recently shown to be useful in radiation treatment planning. This study evaluates the efficiency of the AMC method and addresses several issues on implementing it into the MCNP code for potential IMRT treatment planning.

Method and Materials:
We compare the difference between an adjoint and a forward Monte Carlo calculations for computing time and dose. By exploring a tally feature (FT card) of MCNP, we then describe a source sampling scheme for multiple ROIs of the patient body in a single adjoint simulation. Two methods are used in this study to speedup the Monte Carlo simulations, which includes a mesh tally speedup and a variant reduction technique (VRT) using importance functions from the adjoint Monte Carlo calculations.

Results and Discussions: The doses calculated by the forward and the adjoint MC are in a good agreement within statistical uncertainties. After normalized to the same statistical uncertainties, the computing time of the forward run is about 9 times of that of the adjoint run, which clearly demonstrates the computing efficiency of an adjoint simulation over a forward run. We also successfully implemented a source sampling scheme for different ROIs in only one simulation. This facilitates future implementation of an automatic AMC-based radiation treatment planning system. The VRT reduces the forward MC calculation time by approximately 26.7% for the prostate case. The reduction for the urinary bladder and the rectum is 24.8% and 13.6%, respectively.

Conclusion: The efficacy and efficiency of the AMC method in achieving optimized dose objective have been demonstrated. The potential for the AMC method to be useful in treatment planning of IMRT procedures is particularly attractive because the large number of beam parameters involved.