AbstractID: 5022 Title: Monte Carlo simulation of Tomotherapy: derivation of a dual source model for treatment planning

Purpose: To simulate a commercial Tomotherapy unit using Monte Carlo methods and to derive a dual-sources model for the treatment planning.

Method and Materials: The EGSnrc/BEAMnrc codes were used to simulate the linac head geometry of a Tomotherapy unit (HiArt, Tomotherapy Inc.). Various component modules were used to consider the head design including the target, primary collimator and multi-leaf collimators (MLC). The percentage depth dose (PDD) and beam profile in a water phantom were generated using the phase-space data below MLC and then compared to measurements. Using tools from the BEAMnrc package, the phase-space data above MLC were used to extract a dual source model, consisting of a ring photon source located at the target and another ring source located at the primary collimator. The source model was verified in the following steps: (1) the source model was used to reconstruct the phase-space data below MLC, which, in turn, was used to calculate PDD and beam profiles, (2) the PDD and beam profiles generated by (1) were compared to those generated by the original phase-space data.

Results: It was found that the PDD and beam profiles using Monte Carlo methods (the phase-space data) agreed well (within 2%) with the measurements. The dose distributions using the source model were found to agree with (within 2%) the Monte Carlo and measurement data, indicating the source model is suitable to replace the Monte Carlo simulation for dose calculations in routine treatment planning.

Conclusion: Monte Carlo simulation of a Tomotherapy unit has been carried out and a source model suitable for dose calculations in treatment planning has been derived. This model is useful for better understanding linac head design and for improving the accuracy and efficiency in dose calculations for Tomotherapy.

Conflict of Interest (only if applicable): Research sponsored in part by TomoTherapy Inc.