AbstractID: 13278 Title: Fast and accurate Monte Carlo-based simulation of dynamic jaw helical TomoTherapy

Purpose: Design an accurate and efficient Monte Carlo (MC)-based model for the future dynamic jaws feature of TomoTherapy, which involves very small fields (< 1cm). In a previous study, it was shown that one can simulate any field size from the 5 cm phase-space file (PSF) using pre-calculated intensity and angular longitudinal distributions. The present work extends TomoPen, a MC model of TomoTherapy based on Penelope, to dynamic jaw motion through two steps: (1) design a simplified and efficient MC model to calculate longitudinal and angular distributions and (2) interpolate and incorporate those distributions during an actual dynamic delivery.

Material and methods: In the simplified MC model, a full-MC PSF is stored just above the jaws, keeping future changes in target position accountable. The particles are duplicated according to cylindrical symmetry and only photon interactions are simulated through the jaws. Longitudinal intensity and angular distributions are then computed and stored for future interpolation and dynamic simulation. The integration over other dimensions (energy, transverse direction…) ensures good statistics.

Results: Using simple analytical modifiers of the 5 cm PSF, it is straightforward to extend TomoPen to dynamic jaw simulation with similar accuracy as compared to full MC generated PSFs. Distributions computed with full MC or the simplified model showed no significant difference, the quality of the interpolation being the only remaining potential source of discrepancies.

Conclusions: A fast and comprehensive approach for efficient dynamic jaw simulation was devised. After building a database of intensity and angular distributions, one can simulate dynamic jaws motion for all the field sizes with a single PSF, keeping the same speed of TomoPen, i.e. around 6 hours per treatment plan on a single CPU.

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