AbstractID: 2709 Title: Monte Carlo investigation of scatter contribution to kilovoltage cone-beam computed tomography images

Purpose: In this work, we evaluate the scatter radiation present in projection images produced by kilovoltage (kV) cone-beam computed tomography (CBCT) using Monte Carlo (MC) calculations. We also demonstrate that MC simulations can be used to reduce scatter in kV CBCT reconstructed images.

Method and Materials: All images were acquired using a kV CBCT bench-top system composed of an x-ray tube, a rotation stage and a CsI flat-panel imager. The EGSnrc MC code was used to fully model the flat-panel imager and the x-ray source for energies of 80, 100, and 120 kVp. The x-ray source model was validated using first and second half-value layer (HVL) and profile measurements. MC simulations and measured images were obtained for a cylindrical water phantom and for the head of the anthropomorphic Rando phantom. A modified version of the DOSXYZnrc program was used to score phase space files with identified scattered and non-scattered particles after the phantoms. The cone angle and the source-to-detector distance (SDD) were varied during the simulations to determine their effect on scatter radiation in projection images. MC predictions of the scatter distribution were subtracted from the CBCT projection images prior to the reconstruction to improve the reconstructed image quality.

Results: The simulated and measured first and second HVL agree within 2% except for the 80 kVp beam where the agreement is within 9%. The measured and simulated profiles agree within 4%. Simulated and measured projection images are in good agreement. Decreasing the cone angle and increasing the SDD decrease the amount of scatter. On the other hand, the phantom geometry has little effect on the scatter radiation distribution.

Conclusion: MC simulations were used to characterize the scatter radiation from different geometries. It was shown that it is possible to use MC simulations to reduce the scatter in the reconstructed image.