Purpose: Cone beam computed tomography (CBCT) provides wide scan coverage per rotation; however, its image quality is compromised due to large amounts of scatter. In this study, we performed detailed Monte Carlo (MC) simulations of a CBCT flat panel detector to characterize scatter for the purposes of scatter correction.
Methods: An amorphous silicon (aSi) flat panel detector (Varian Medical Systems) of an On-Board Imager (Varian Medical Systems) was modeled using BEAMnrc/EGSnrc code system based on detailed geometric information provided by the manufacturer. Layers from the proximal Al cover to the light reflector encompassing the 10:1 anti-scatter grid were simulated using the block component module (BLOCK_CM) in BEAMnrc. Layers from the cesium iodide (CsI) detector to the proximal Pb electronics protection cover were modeled in DOSXYZnrc to create a voxelized representation of the detector layer. Various scatter properties were elicited from phase space files within the grid and detector layers. A two-dimensional (2-D) cone-beam image “in-air” (without the phantom) was acquired (125 kVp, 80 mAs). 2-D and 1-D pixel intensities were compared to the simulated projection to verify the accuracy of MC simulation of the entire detector system.
Results: 2-D pixel intensities of the computed image agreed well to the measured image as the difference map showed values within +-10%. However, given the large number of histories required for detector simulation, the MC uncertainty was quite high, up to 10% in some regions. The central axis profile also showed good agreement between simulation and measurement within 3% on average, except in the regions where the statistical uncertainty was larger (1sigma=7.5%).
Conclusions: A CBCT imager has been modeled in detail using the BEAMrnc/EGSnrc code system. Additional verification of the MC-based modeling is warranted to for the purposes of scatter characterization.