Abstract ID: 15650 Title: Construction of Digital Phantoms for X-Ray Image-Guided Radiotherapy (IGRT)

Purpose:To construct digital phantoms for testing x-ray-based IGRT software using anatomic CT images and NIST mass attenuation coefficients table of different tissue types for photon energies ranging from 1keV to 20MeV .

Methods:CT images of the interested sites are first segmented into different tissue types based on the CT numbers, and converted to a three-dimensional (3D) attenuation phantom by linking each voxel to a lookup table of that voxel's tissue type containing the energies and corresponding mass attenuation coefficients from the NIST table. The x-ray source can be a radio isotope or an x-ray generator with known spectrum data consisting of the weight w(n) for each energy bin E(n). Siddon's method was used to compute the x-ray transmission line integral for detector m and energy E(n) by ray tracing through the attenuation phantom from the x-ray source to detector m and summing up the interpolated attenuation coefficient for E(n) along the ray. The x-ray fluence at detector m is then the weighted sum of the exponential of line integral for all energy bins with added Poisson noise.

Results:We built a digital phantom using the CT scan of a Rando head phantom segmented into three (air, grey/white matter and bone) regions and simulated poly-energetic projection images for Mohan 4MV energy spectrum. The projection images are similar to typical portal images obtained with 4 or 6 MV x-ray source. The CBCT reconstructed from the simulated projection images showed similar but noisier and blurrier geometric features in comparison to the segmented CT scan, which is expected for a 4 MV source.

Conclusions:We have successfully built digital phantoms using anatomic CT images and NIST mass attenuation coefficients table. The constructed digital phantoms can be used to generate 2D projection images and 3D CBCT images for testing x-ray-based IGRT algorithms/systems.