AbstractID: 8645 Title: Quantitative Analysis of a Compact On-board SPECT Detector for ROI Reconstruction

Purpose: Single photon emission computed tomography (SPECT) imaging on-board radiation therapy machines may enhance radiation therapy. Use of a light-weight, compact detector would be desirable because of maneuverability, yet is challenged by truncation and consequently reconstruction artifacts. We hypothesize that, for a sizeable volume surrounding the tumor target, and with properly chosen detector trajectories, compact detectors can provide image quality that is comparable to that of full-size SPECT detectors.

Methods and Materials: On-board SPECT imaging was computer simulated for detectors with active surface widths of 21.2 and 40.0 cm. Detector trajectories were selected such that the common volume encompassed an 8-cm-diameter ROI surrounding each tumor in the torso of a NCAT phantom. For deep tumors, two common volumes – interior and partially exterior – were investigated. Radiotracer distribution was modeled for ^{99m}Tc-Sestamibi. Noise-free and noisy projection images were generated with an analytical simulator that models non-uniform attenuation, collimator & detector efficiency, and spatially-varying spatial resolution. Images were reconstructed by OSEM. In reconstructed images, root mean square error and recovered tumor activity were analyzed as a function of detector width and detector trajectory.

Results: Image truncation reduced overall image quality. For example, RMS error over an entire noise-free image slice was 18 – 35% worse with the 21-cm-wide detector versus the larger detector. However, for regions within the common volume for both detector widths, RMS errors differed by less that 2%. Similar results were observed for noisy images. Moreover, the recovered fraction of tumor activity was comparable, except for when the smaller-detector common volume was interior – the recovered activity was reduced by 11%.

Conclusions: Preliminary results show that an 8-cm-diameter ROI can be reconstructed using 21 or 40-cm-wide detectors with comparable RMS errors and recovered tumor activities, supporting the proposal that on-board target localization could be accomplished using compact SPECT detectors.