AbstractID: 8841 Title: Photon Detection Efficiency of TomoTherapy® Array Detectors and Impact on MVCT Image Quality

Purpose: To quantify the photon detection efficiency of the TomoTherapy® X-ray detector and assess its impact on megavolt CT image quality.

Method and Materials: The signal to noise ratio of two similar X-ray detector arrays available on TomoTherapy® Hi·Art® systems was measured during exposure to the megavolt X-ray imaging beam. These measurements are compared to calculations of the ideal signal-to-noise ratio if all incident photons were detected to determine the detective quantum efficiency (DQE). Similarly, the signal-to-noise ratio is measured in CT images reconstructed from data collected by these detector arrays and compared to theoretical predictions.

Results: The detection efficiency of the out-of-focus detector cells are 11% and 18% for the two types of detector arrays studied. The efficiency drops for the central detector cells that are aligned toward the source. The signal-to-noise ratio in the resulting CT images is 19.7 and 28.4 using a dose of 1 cGy to the center of the 30 cm diameter solid-water phantom. These image signal-to-noise ratios are in good agreement with previous theoretical predictions at this dose level, beam energy, and detector efficiency.

Conclusion: Compared with conventional flat-panel detectors that can have detection efficiencies of only 1 – 2% at megavolt energies, the TomoTherapy® detector arrays are an order of magnitude more efficient, resulting in better signal-to-noise ratios in the resulting CT images or a lower dose (or a combination of both).

Conflict of Interest (only if applicable):