AbstractID: 11553 Title: A Quantitative Evaluation of Four Dimensional Computed Tomography

Purpose: Four dimensional computed tomography (4DCT) is a clinically emerging imaging modality capable of creating time resolved images of mobile anatomy. A quantitative assessment of its accuracy is a necessary prerequisite to clinical implementation for radiation treatment planning.

Method and Materials: A mechanical motion phantom was used in conjunction with PMMA spheres of 1, 3, and 5 cm diameters. 4DCT images where acquired using a Phillip's Big Bore CT Scanner using both the Philip's Bellows respiratory monitoring device and Varian's Real-time Position Management system. Images acquired were segmented in Matlab. Imaged motions and sphere sizes were compared to their true physical values. Volume, centroid position, eccentricity, as well as mean and standard deviation of CT numbers within the mobile spheres were determined as a function of segmentation threshold. An assessment of 4DCT image quality was also performed.

Results: Maximum discrepancies between physical and imaged tumor volumes, for all sphere sizes and motion ranges, did not exceed 2.2 mm (mean = 1.3 mm, standard deviation = 0.3 mm). Differences between true and segmented volumes for the 1cm sphere did not exceed 9.2%, (mean = 2.5%, standard deviation = 2.3%). Maximum volumetric differences of 0.78% were observed for the 5cm sphere (mean = 0.26%, standard deviation = 0.22%). Noise was increased by 365%, and SNR's were reduced by 80% in 4DCT images in comparison to standard clinical protocol values. MTF's of both standard clinical and 4DCT acquisitions showed no significant difference at frequencies below 0.4 lp/mm. 4DCT acquisition caused shifts in median CT number for stationary objects, and in both mean and median CT number for mobile objects under 4DCT acquisition.

Conclusion: 4DCT reproduces target volumes and motion paths with reasonable accuracy but image quality can be significantly degraded.