AbstractID: 5043 Title: Quantification of image alignment differences for tomotherapy prostate patients

Purpose: Accurate registration of MVCT to planning kVCT images is required for daily positioning of patients treated on helical tomotherapy. Due to prostate motion, overlaying the prostate, overlaying the pelvic bones, and finding the best overall image overlap can result in three different alignments for prostate treatments. The objective is to quantify these alignment differences for research patients treated on the TomoTherapy Hi*Art system and determine the suitability of using the latter two alignments to correct for inter-fraction prostate motion.

Method and Materials: Daily MVCT images have been retrospectively registered to planning images using three different mutual information based algorithms. Each algorithm is designed to produce one of the alignments and does so by using selective planning CT pixels when calculating the mutual information parameter. Depending on the alignment, only prostate pixels (including small margin), bony pixels, or all image pixels are used. To reduce registration uncertainty and eliminate gross miss-registrations, a multi-start optimization procedure with random initial alignments was employed. Offsets between each alignment were calculated for ten prostate patients, each typically having twenty-five fractions.

Results: Maximum offsets of 6.7mm and 4.9° were observed between the pelvic bone and overall image alignments. Mean translational and rotational deviations were 2.3mm and 1.5° with standard deviations of 1.4mm and 0.7°. Registration resulting in pelvic bone overlap better accounts for prostate motion than using the entire image for alignment purposes. Maximum, mean and standard deviation translational offsets between overlaying the prostate and overlaying pelvic bones are 7.8mm, 2.8mm, and 1.6mm. The respective values for prostate and overall image overlap are 9.3mm, 4.4mm, and 2.1mm.

Conclusion: Clinically significant offsets between the three image alignments have been observed for tomotherapy prostate patients. Mutual information registration using only bone pixels better accounts for inter-fraction prostate motion than using all image pixels.