Abstract ID: 16436 Title: Variations in Tumor Motion Trajectory Due to Breathing Irregularity in 4D Cone Beam CT Using Prior Image Constrained Compressed Sensing (PICCS-4DCBCT)

Purpose: As breathing motion varies from cycle to cycle, the extracted motion profile from 4D Cone Beam CT represents an averaged motion over a number of breathing cycles. It is important to evaluate how the motion profiles extracted from 4DCBCT change with breathing cycle irregularity. In this study, we aimed to evaluate the robustness of 4D Cone Beam CT using the Prior Image Constrained Compressed Sensing method (PICCS-4DCBCT).

Methods: Numerical simulation studies were performed using a hybrid phantom. The phantom consists of in vivo human subject data and simulated lung cancer tumors with motion. Different types of breathing irregularity were simulated in this study, including irregular amplitudes, irregular periods, baseline drifts and the combinations of the above. These simulated cases represent realistic scenarios commonly observed in clinical practice. Because of the random nature of breathing irregularity, 10 experiments were conducted for each irregular case to achieve statistically meaningful results. After image reconstruction, a free-form deformable registration method was applied to extract the motion trajectory of the sphere. With the regular motion trajectory as reference, the normalized root mean square error (nRMSE) is used to characterize the variation in the extracted average motion trajectory.

Results: As the irregularity in breathing amplitude increases and more types of breathing irregularity are included, the variation in the extracted average tumor motion trajectory becomes larger. However, the normalized root mean square error is below 11% for all studied irregular cases.

Conclusions: The study demonstrates that tumor motion profiles are robust against breathing cycle irregularity when the PICCS-4DCBCT method is used.