AbstractID: 9421 Title: High Temporal Resolution and Streak-Free Four-Dimensional Cone-Beam Computed Tomography

Purpose: Respiratory gated CBCT (e.g. 4D CBCT) with an on-board imager has been introduced to track tumor motion for lung cancer patients. However, the image quality is comprised by aliasing artifacts and lower CNR, due to the limited number of projections. The temporal resolution of 4D CBCT is often chosen to be around 500~1000ms to increase the sampling at each phase. In this paper, we present a method to simultaneously achieve high temporal resolution and streaking artifacts-free images in 4D CBCT.

Method and Materials: The enabling technique is an image reconstruction method called Prior Image Constrained Compressed Sensing (PICCS). By incorporating a prior image into the reconstruction, PICCS enables accurate image reconstruction from few projections. Home made physical motion phantoms were scanned on a Varian Trilogy system. Projection data were retrospectively gated based on the phase information obtained by synchronizing the 'x-ray on' signal and the motion signal.

Results: The gating window was chosen so that only one projection was selected in each respiratory cycle. Streak artifacts free 4D CBCT images were achieved using PICCS from these 11-14 selected projections, while other reconstruction algorithms like FDK and conventional Compressed Sensing failed to generate meaningful images. Temporal information was well preserved in these images and the temporal resolution in these images was primarily limited by the detector read out speed which was about 100ms. Moving objects were segmented out from images at each phase and the motion trajectory was extracted. Agreement was observed between the extracted motion profile and the programmed motion profile.

Conclusions: A new algorithm, PICCS, was proposed to mitigate undersampling streaking artifacts in 4D CBCT. High temporal resolution was achievable by using fewer projections. The trajectory of moving objects could be extracted from the high quality 4D CBCT images.