AbstractID: 5870 Title: 4D CT Using Retrospective Velocity-Based Amplitude Sorting

Purpose: To present a technique, velocity-based amplitude sorting (VBAS), which addresses current shortcomings of 4D CT, which is conventionally performed using phase-based retrospective sorting of CT images. The phase of the breathing signal contains little information about the tumor's displacement. When the breathing signal is irregular, blurring artifacts can result. Amplitude-based sorting has the disadvantage that fewer images are acquired when the tumor velocity is large, and therefore may reduce spatial resolution. VBAS analyzes the breathing signal to determine the average tumor velocity, and resizes the amplitude-based sorting bins accordingly.

Method and Materials: An infrared marker was placed on the patient's chest and tracked by a camera to record the breathing signal. Each CT image was correlated with the breathing signal and sorted into the appropriate bin using one of three methods: (i) phase sorting, (ii) amplitude sorting, and (iii) VBAS. The 8 resulting image sets for each method were interpolated when necessary. Methods (i), (ii), and (iii) were evaluated by comparing target volumes in reconstructed motion-phantom images. Volumes of 3 patient tumors were also analyzed to determine their reproducibility over every bin for each method.

Results: The volumes of the targets of the motion phantom were compared to those of a static phantom. The respective errors in the methods were (i) 27%, (ii) 34%, and (iii) 11%. The VBAS technique also resulted in the lowest variability in patient tumor volumes: these were (i) 18%, (ii) 32%, and (iii) 12%, respectively. Qualitatively, the spatial resolution of the VBAS images was greatest.

Conclusions: Sorting by amplitude rather than phase is advantageous when the breathing signal is irregular. However, to maintain spatial resolution, bin size must be adjusted for tumor velocity, which can be accomplished with VBAS. This method proved to be the most effective in terms of volumetric analysis and reproducibility.