AbstractID: 13221 Title: How accurately can the internal target volume (ITV) from a free-breathing cone beam computed tomography (FB-CBCT) scan be used for target verification?

Purpose: An internal target volume (ITV) is often identified by acquiring a free-breathing cone-beam computed tomography scan (FB-CBCT) to verify patient setup of tumors affected by respiratory motion. However, its accuracy is not well understood. The purpose of this study is to characterize the potential underestimation of the ITV when a FB-CBCT is acquired with irregular respiratory cycles.
Methods & Materials: Five patient respiratory profiles were programmed into a 4D Dynamic Thorax (CIRS Model 008) phantom containing a spherical target, 2cm in diameter. The superior-inferior motion was 3cm with respiratory cycles approximately 5 seconds in length. Five 360^{o} CBCT scans of each profile were acquired using a gantry mounted kV imaging system. A FB-CBCT, as well as a 4DCBCT of 10 phase bins with 10% phase windows were reconstructed for each profile. Inspiration (0%) and expiration (50%) phase images were compared to FB-CBCT images. The ITV of each FB-CBCT displayed a sharp and a smeared region. The percent reduction in contrast-to-noise ratio (CNR) between these regions was calculated, as well as the ratio of the average time spent in inspiration versus expiration. The relationship between contrast reduction and the ratio of time spent per phase was investigated.
Results: For the five profiles studied, the CNR reductions ranged from 37% to 70%, corresponding to ratios of average time spent in inspiration versus expiration that ranged from 0.42 to 0.12, respectively. As the difference between time spent in expiration versus inspiration increased, the reduction in contrast also generally increased (r^2=0.873).
Conclusions: The observed loss of contrast in the ITV for irregular respiratory cycles may lead to the potential underestimation of this volume obtained from a FB-CBCT. Extra caution is required when using an ITV for on-board target localization when respiratory cycles exhibit large time differences between inspiration and expiration periods.