

AbstractID: 10857 Title: A simulation of position and volume errors in 4D-CT caused by irregular breathing

**Purpose:** To simulate the position and volume errors in 4D-CT caused by irregular breathing.

**Methods and Materials:** A 4D-CT simulator was designed to reproduce axial mode scans with retrospective resorting. This simulator creates an artificial spherical tumor based on specifications of the user, and recreates the image produced by a 4D-CT scanner using a patient breathing waveform. 155 respiratory waveforms of patients were used to test the margins of 4D-CT scans. Each breathing waveform was normalized and scaled to 1cm, 2cm, and 3cm peak-to-peak motion. Then, artificial tumors with 2 cm and 4 cm radius were simulated to follow the trajectory of each patient breathing waveform with each scaling. The center of mass and volume of each CT image was calculated and compared to the expected values of center of mass and volume for the artificial tumor. Intra-subject variability was investigated by running the simulator over different sub-intervals of the breathing waveform.

**Results:** The average error in the center of mass location of an artificial tumor was less than 2 mm standard deviation for 2 cm motion. The corresponding average error in volume was less than 4%. In the worst-case scenarios, we found a center of mass error of 1.0 cm standard deviation, and volume errors of 30-60% at inhale. Systematic errors are observed in a subset of patients due to irregular breathing, and these errors are more pronounced when the tumor volume is smaller.

**Conclusion:** Irregular breathing during 4D-CT simulation causes systematic errors in volume and center of mass measurements. These errors are small, but depend on the tumor size, motion amplitude, and degree of breathing irregularity.