AbstractID: 5045 Title: A deformable phantom for dynamic modeling in Radiation Therapy

Purpose: The vast array of research projects aimed at measuring and managing intra-fraction motion in treatment planning and delivery demand sufficient quantitative means of verification. While analytic models and patient data are useful, a reproducible, compartmented, mechanical phantom is critical to proper commissioning and use of new systems for physiological motion management. In this study we evaluated the reproducibility of a deformable lung phantom for various simulated breathing states.

Methods and Materials: A diagnostic thoracic phantom was modified for this purpose. The abdominal cavity insert was removed, and an extension of the existing lung insert was created using high density foam. To mimic lung density, the foam insert was infused with iodine. Tumor-simulating inserts of varying density and size were inserted and fixed to the foam at different positions. A programmable actuator-driven diaphragm was created to compress/decompress the foam according to an arbitrary breathing profile. Repeat CT scans of the phantom at different diaphragm positions were acquired and the locations of the tumor-simulating inserts were measured.

Results: The phantom has been demonstrated to produce compression as well as reproducible breathing states. All tumor positions are reproducible to within 1.5mm (with a maximum of 3.5mm deviation for the most inferior large tumor) over multiple repeat scans at the same simulated breathing state. Compressions of over 60% of the foam insert have been demonstrated, with propagation of motion ranging from 95% of the actuator motion at the diaphragm to about 20% near the “apex” (the interface with the existing lung insert). Hounsfield units equivalent to the relative attenuation of lung (~20% of water) were achieved in the uncompressed foam.

Conclusion: This phantom is simple, efficient, and viable. Experiments in quantitative dynamic modeling of breathing-induced deformations are underway using this system.