AbstractID: 6993 Title: Use of the 4D Phantom to Test Real-Time Targeted Radiation Therapy Device Accuracy

Purpose: To create a motion fixture capable of testing real-time targeted radiation therapy delivery systems.

Method and Materials: The 4D Phantom is a custom positioning system with stages for accurate reproduction of 3D internal tumor motion and 1D external surrogate motion. A standard film box filled with solid water was sent through two 3D lung tissue trajectories, one from 4DCT and spirometry data and the other measured from a fiducial marker that had been bronchoscopically implanted in a canine lung. An external trigger synchronized motion with the beginning of therapy, and the 4D Phantom gated the linear accelerator via a reed relay based on the real-time longitudinal position of treatment isocenter. The gating windows, 3mm and 4mm long, encompassed end-expiration for each motion trajectory. A four-field, 6MV, 3DCRT plan from a randomly chosen lung cancer patient was delivered and measured for static and for gated and ungated treatments with each motion trajectory. The distance from the edge of the film to the edge of the treatment field was used to align pairs of films for analysis in RIT.

Results: The dose distributions' relative positions varied within 2-6mm. Post-alignment comparisons between static and motion films revealed large misdosed regions. The gated films had fewer areas and smaller magnitudes of dosimetric error than did the ungated films, but hot spots of 10% error were present even in the gated films.

Conclusion: The experiment revealed a systematic shift in that the dose was centered at an average phantom position rather than the planned treatment isocenter. Additionally, although gating reduces dosimetric errors due to tissue motion, they can occur during gated radiation delivery. Further work is needed to determine if static film dosimetry is sufficient for QA of gated therapy. The 4D Phantom is capable of improved real-time targeted radiation therapy QA.