

AbstractID: 3703 Title: Analysis of response time delays in an adaptive feedback system: considerations for a real-time intra-fraction motion tracking couch

Purpose: To assess the impact of response time delays in an adaptive feedback couch-based respiration-induced motion tracking system.

Method and Materials: We employed a convolution/superposition based Monte Carlo dose calculation to determine the impact of response delays between the tumor or surrogate respiration markers and the couch on planned dose distributions. The isocenter was randomly sampled from the distribution of the residual tumor/marker/couch trajectory. With this calculation we obtained the ensemble average over all possibilities of the dose distribution (assuming each fraction starts with a random respiration phase). Two test motion trajectories were used: 1) sinusoidal and 2) a published diaphragm motion description. For motion periods of 3 and 4 s and a motion amplitude of 1 cm, we simulated response delays ranging from 100-500 ms. Calculations were validated with measurement for one case.

Results: For a motion period of 3 s, the penumbra width increased by 1-11.5 mm when superior-inferior motion with an amplitude of 1 cm was considered for response delays ranging from 100-500 ms with slightly worse results observed for the published motion trajectory. The decrease in the width of the 90% isodose line was 1.2-16.7 mm. The degradation in the penumbra and 90% isodose line width in the direction of motion were less severe when the motion period was 4 s. Phase delay film measurements agreed with our calculations to < 2 mm agreement of the corresponding isodose lines.

Conclusion: For both sinusoidal and a published diaphragm motion trajectory, a response time of < 300 ms within the feedback loop is desirable to deliver highly conformal plans reliably. Response times of 500 ms or higher are equivalent to applying no real-time motion compensation and in some cases can degrade the plan much worse than no corrective action.

Conflict of Interest (only if applicable): N/A