AbstractID: 10456 Title: Optimization of Internal Target Margins for Dynamic IMRT and RapidARC

Purpose: To determine the optimal Internal Margin (IM) for targets undergoing respiratory motion during treatment with dynamic IMRT and RapidARC.

Methods and Materials: Dynamic IMRT and RapidArc plans were created for two targets (3 cm and 5 cm diameter) in the exhale phase with 6 different IM expansions (0,2,4,6,8,10 mm). The plans were delivered to a stationary two-dimensional ion chamber array (Matrixx, IBA) using a 0.2 second sampling rate. Breathing motions of sin, $\sin^2$, $\sin^4$, and $\sin^6$, with amplitudes of 0 to 4 cm, were simulated by shifting the dose frames by the respiration trace. The resulting simulated motion-blurred dose planes were randomly sampled from ten starting breathing phases and summed for 30 fractions. The summed dose planes were then compared to the dose delivered to a stationary target with a 0 mm. The optimal IM was calculated as that which resulted in the Equivalent Uniform Dose (EUD) or minimum dose to 95% of the target (D95) closest to that of the stationary case. The optimal margins were fit to the following linear equation: $IM = C_1*Amp + C_2$ using a least-squares fit.

Results: The value of C1 ranged from 0.55 to 0.98, depending on the target size, type of target motion, and treatment plan. The optimal IM was ~2mm larger for sin motion compared with sin6 motion. In all cases the optimal IM calculated using the two different criteria (EUD and D95) agreed within 1mm.

Conclusion: Optimal Internal Margins are a function of target size and target motion. In many cases the IM is smaller than the peak-to-peak motion. We have developed formulae that correlate motion with the necessary IM.