AbstractID: 9150 Title: Real-Time Motion-Adapted-Optimization (MAO) guided TomoTherapy Delivery

Purpose: IMRT delivery follows planned leaf sequences, which are optimized before treatment delivery. Real-time variations, such as respirations, are hardly to be modeled in planning procedure. We developed a real-time Motion-Adapted-Optimization (MAO)-guided delivery technique in TomoTherapy[SM] treatments. This technique models the radiation delivery with the real-time motion as a negative feedback system. It updates the motion-encoded cumulative dose and optimizes the leaf sequence in real-time, right before the delivery of each projection.

Method and Materials: TomoTherapy[SM] treatment delivery consists of thousands of projections with projection time around 200-500 ms. The leaf latency plus transition of TomoTherapy® binary MLC takes less than 50 ms. Real-time MAO is to optimize leaf sequence of the coming projection right before its execution. It consists of several real-time procedures including "motion detection and prediction", "motion-encoded dose accumulation" and "leaf sequence optimization" for the coming projection. To update leaf sequence in real-time, all above procedures must be executed within 150 ms. We developed ultra-fast algorithms and codes to approach such critical goal.

We implemented and tested this technique with the TomoTherapy® research system. The integrated system includes a real time camera system and a programmable motor-driven phantom. We tested different TomoTherapy[SM] plans with various simulated and real respiration traces. We used film dosimetry to verify and validate the final results.

Results: MAO-guided delivery runs smoothly in the integrated TomoTherapy® system. The whole MAO procedure takes less 100 ms per projection. Both simulated motion and real respiration of ~2cm amplitude, the real-time MAO-guided delivery doses matched with the planning dose within 3% and 3mm criteria, for a typical TomoTherapy[SM] treatment configuration. No hot and cold spots are noticeable.

Conclusions: We present a novel technique for real-time MAO-guided delivery within current TomoTherapy® hardware. Simulations and experiments conceptually proved this technique. Further validation and clinical implementation are underway.