AbstractID: 9290 Title: Aperture Design of Two-Dimensional MLC Motion for Dose-Rate-Regulated Tracking

Purpose: Real-time adaptive tumor tracking called Dose-Rate-Regulated Tracking (DRRT) is based on a preprogrammed MLC sequence and real-time dose-rate modulation. We have developed an algorithm for designing the MLC sequence reflecting 2-D MLC motion. MLC apertures were designed from 4D-CT images, and the algorithm was tested in the 3-D phantom.

Method and Materials: The 2-D MLC motion and the corresponding tumor shape are derived from ten-breathing bins of 4D-CT. The closed MLC leaves that are not participating in the beam aperture are programmed to remain in motion to minimize leaf-end leakage. This feathering motion is intended to spread the leakage dose to the normal tissue beneath the closed MLC leaves. We performed phantom studies with a 3-D Phantom (Washington Univ.) for two cases: (1) a circular moving target (2) a patient's lung tumor in the lower lobe. The results of these two measurements were compared with those for the case of a static beam aperture and a static phantom (static-static case). The accuracy of the 2-D MLC sequence was determined by γ analysis with those for the static-static case. The effectiveness of the feathering motion was quantified with the leakage dose normalized to the maximum dose measured by the film.

Results and Conclusions: For both of the above cases, the γ analysis showed that 95% of the pixels are less than 1 for 3 % and 3 mm criteria. The feathering motion reduced the leaf-end-leakage dose from ~15% to ~7%. A careful design of the MLC-leaf sequence done in advance can not only facilitate real-time tumor tracking, but also reduce the dose to healthy tissue, and thus can lead to improved results using DRRT.