AbstractID: 7398 Title: Investigation of the Beam Penumbra Effect on IMRT Dose Conformity and Uniformity

Purpose: To investigate the effect of beam penumbra and intensity variation on IMRT dose distributions and to determine an optimal beam penumbra for IMRT dose delivery.

Method and Materials: Differences in accelerator/MLC geometry may have a significant effect on IMRT dose conformity and uniformity. The beam penumbra is affected by photon energy, source size and the distance from the collimator to the patient. In this work, we have investigated the beam penumbral effect on IMRT dose distributions based on ten real IMRT cases (6 prostate, 2 breast and 2 head and neck) originally planned with the Corvus inverse planning system. Monte-Carlo dose calculations were performed with different penumbra settings, which correspond to three accelerator models, Siemen-Primus, Primart and Varian-21Ex. A variety of beam penumbra settings were considered, including the primary and extrafocal source size and the distance from the MLC to the patient. Film measurements were performed to verify a penumbra effect model and the Monte Carlo calculations.

Results: The results show that the dose for 95% of the target volume is not significantly affected by the difference in the beam penumbra. Siemen-Primus and Primart have slightly larger geometrical beam penumbra and result in slightly larger doses to nearby critical structures. The Varian-21Ex has smaller MLC leaves (5mm) and smaller beam penumbra but gives more heterogeneous target dose distributions (hot and cold spots). A beam overlapping model is used to explain these results.

Conclusions: Smaller MLC leaves may improve dose conformity but introduce more target dose heterogeneity. The hot spots can be partially explained by the overlapping of MLC segments while larger beam penumbra can smear out the overlapping effect. An optimal beam penumbra can lead to the best target dose uniformity.