AbstractID: 7475 Title: A simulation study of intra-fraction motion effects on the proton discrete scanning treatment

Purpose: Spot scanned beam delivery can be used to implement intensity modulated proton therapy (IMPT) to better conform dose distributions to the target volume. Unlike passive scattering beam delivery techniques, the interplay of the infra-fraction organ motion and the discrete spots scanning can introduce ‘hot’ and ‘cold’ spots. We investigated the variation of computer simulated delivered dose, and the improvements for motion effects by scanning with multiple beam widths so that regions that needed higher resolution had smaller beam widths.

Method and Materials: The simulation was done for one-dimensional spots scanned with target motion. The motion pattern was recorded from an actual patient breathing normally. The analysis was made for a range of beam widths and number of repaintings. The beam widths were chosen to be narrow at the edge and wider in the center of the target in order to provide the best efficiency.

Results: The variation in delivered dose can be 100% more than planned when there is no repainting. After 10 repaintings, the variation of dose distribution is reduced to 5% or 20% depending on beam width. Beam width modulation approaches high uniformity faster as the number of repaintings increases without the compensation of conformity.

Conclusion: The dosimetric effect of the intra-fraction target motion is a function of the beam width and number of repaintings. The simulation showed that the interplay produces large inhomogeneities. A wider beam can improve the uniformity, with the side effect of a larger penumbra. Multiple repainting and fractionation also smooth out these variations, with the cost of increased total treatment time. Beam width modulation has shown a good balance of these two factors and is expected to be a delivery technique to achieve both high uniformity and conformity as long as sufficient numbers of fractions or repainting.