

AbstractID: 13552 Title: Interplay between Prostate Intra-fraction Motion and Proton Uniform Scanning Treatment: A Dosimetry Study

Purpose: To investigate dosimetric impact of prostate intra-fraction motion to proton uniform scanning (US) treatment using Calypso prostate tracking data and a validated in-house dosimetry analysis software.

Method and Materials: Uniform scanning (energy stacking) delivers energy layers from distal to proximal temporally, which interplays with prostate intra-fraction motion. In-house software was developed to simulate the interplay and evaluate its dosimetry impact. It imports patient contour structures and dose matrix from treatment planning system (TPS) and de-convolved it into temporal-spatial dose matrix that indexed by energy layers. CTV was rigidly moved through the temporal-spatial dose matrix according to prostate motion traces. Validation of the software was performed against Eclipse Proton TPS. 17 patient prostate intra-fraction motion traces were used to evaluate prostate CTV dosimetry. For comparison, double scattering (DS) treatment was also simulated using the same prostate motion traces. Furthermore, higher dose rate was simulated for both US and DS treatments to evaluate its effect.

Results: Software validation indicated that its difference to TPS calculation is minimum. For patient treatment simulation, the results indicated that CTV dose degradation depends on magnitude and direction of prostate intra-fraction motion and is patient specific. In fractions with significant motion, 100% dose coverage can reduce to 66% and 78% of CTV for US and DS treatments, respectively. DVH and isodose graphs revealed significant CTV cold/hot spots in US and only CTV underdose in DS treatment. Higher dose rate caused more dose degradation.

Conclusion: Intra-fraction prostate motion causes dose uncertainty in proton treatment. The interplays between temporal delivery of energy layers and prostate motion in US treatment further degrade planned dosimetry and cause hot and cold spots inside CTV compared to DS treatment. This study indicated that such significant CTV dose inhomogeneity may exist for some patients with severe prostate intra-fraction motion during US treatments.