AbstractID: 13247 Title: Range Adaptive Proton Therapy for Prostate Cancer

Purpose: The rapid distal falloff of a proton beam allows for sparing of normal tissues distal to target organs. However proton beams that aim directly towards critical structures are avoided due to concerns of range uncertainties, such as CT number conversion and anatomy variations. We propose to eliminate range uncertainty and enable prostate treatment with a single anterior beam by detecting the proton's range at the prostate-rectal interface and adaptively adjusting the range in vivo and in real-time.

Materials and Methods: A prototype device, consisting of an endorectal liquid scintillation detector and dual-inverted lucite wedges for range compensation, was designed to test the feasibility and accuracy of the technique. Liquid scintillation filled volume was fitted with optical fiber and placed inside the rectum of an anthropomorphic pelvic phantom. Photodiode-generated current signal was generated as a function of proton beam depth, and the spatial resolution of this technique was calculated by relating the variance in detecting proton spills to the penetration depth. The relative water-equivalent thickness of the wedges was measured in a water phantom and prospectively tested to determine the accuracy of range corrections. Treatment simulation studies were performed to test the potential dosimetric benefit in sparing the rectum.

Results: The spatial resolution of the detector in phantom measurement was 0.5 mm. The precision of the range correction was 0.04 mm. The residual margin to ensure CTV coverage was 1.1 mm. The composite distal margin for 95% treatment confidence was 2.4 mm. Planning studies based on a previously estimated 2mm margin on 27 patients showed a rectal sparing up to 51% at 70Gy and 57% at 40Gy relative to IMRT and bilateral proton treatment.

Conclusion: We demonstrated the feasibility of our design. Use of this technique allows for proton treatment using a single anterior beam, significantly reducing the rectal dose.