AbstractID: 11435 Title: A method for intra-fractional beam range control in proton therapy treatment

Purpose: Range uncertainty in proton therapy is a recognized concern. For some treatment sites, e.g., prostate, liver/pancreas, beam range in patient may change daily due to variations in patient setup and anatomical configurations. We propose a strategy for intra-fractional range control based on in-vivo range verification and retroactive correction.
Method and Materials: A proton treatment field contains a series of spread-out Bragg peaks (SOBP) weighted to produce a dose distribution uniform in depth over the target volume. While the convention is to deliver all the peaks with their full weights in a single sequence, we want to split the delivery into two or more subsequences each containing only part of the weight for each peak. The first one or two subsequences can be used to detect the beam range in patient, and the remaining subsequences will be delivered with, if necessary, adjusted beam energies and weights to retroactively correct the overall beam range so that the total dose distribution for the treatment session is as prescribed for the target volume and critical organs nearby. Range detection can be achieved by point dose measurements and by manipulating the partial weights of the subsequences to "encode" the beam range information into the dose distributions. Specifically, "sloped" SOBP depth dose distributions were created and dose ratios between oppositely "sloped" subsequences were used to determine the water equivalent pathlengths to the dosimeter locations.
Results: "Sloped" SOBP distributions were produced with sufficient accuracy in a passive-scattering beam delivery system. Phantom tests with ion chamber showed millimeter accuracy in range determination. Treatment planning exercises were performed for prostate cases to illustrate the range control strategy.
Conclusion: A method for intra-fractional beam range control in proton treatment has been explored with encouraging results.