AbstractID: 11476 Title: Boundary study of Bragg peak shift and Bragg peak degradation in proton dose calculation

Purpose: The purpose of this work is to study the Bragg peak shifts and degradation caused by density and boundary changes in proton beam dose calculation

Method and Material: Proton beam delivery provides promising dose characteristics as radiation dose can conform tightly to tumor while sparing surrounding healthy tissues. Proton particles deposit energy in a narrow range around the Bragg peak and as such the dose calculation is more challenging for that the Bragg peak is sensitive to tissue density, tissue composition and organ boundaries along the proton track path. We simulated a few scenarios to study the proton Bragg peak shift due to density and Bragg peak degradation due to change and boundary changes. The calculation of the three dimension dose matrix was performed using a 2 x 2 x 1 mm^3 voxels in the depth peak dose range in water phantom after some rough simulation for the dose peak estimation.

Results: Bragg peak shift at the iso-center slice were found to follow a linear relationship with the density of heterogeneity insert based on our simulations with density ranging [0.4 2.0] g/cm^3 which we studied. Bragg peak degradation and proton dose changed significantly due to low density and small beams size. Proton dose degraded when high energy proton beam irradiated to low density material. Proton dose degraded also when small beam with beam radius at several mm range.

Conclusion: Proton dose calculation depends on many factors as Bragg peak is sensitive to tissue density and composition. Besides that, there exist several scenarios causing Bragg peak shift due to density change, causing Bragg peak degradation due to low density and small proton beam. The Monte Carlo simulation is a very accurate solution to provide precise dose distribution in inhomogeneous structures by simulating transport and energy deposition.