

AbstractID: 13639 Title: Biological effects of variable RBE in different proton therapy delivery modalities

Purpose: To evaluate and compare dosimetric effects of variable Relative Biological Effectiveness (RBE) in scanning and passive scattering proton therapy treatments.

Method and Materials: Three prostate treatment plans for an actual patient treated in our clinic were simulated using a Monte Carlo code MCNPX. Two Intensity Modulated Proton Therapy (IMPT) and one passive scattering (PSPT) treatment plan in a typical, two-field, lateral, parallel-opposed configuration were created using a computed tomography (CT) scan of the patient and a commercial treatment planning system (Varian Eclipse). The plans were simulated using the Monte Carlo code MCNPX scoring the total energy deposition and the fluence inside the patient volume using a three-dimensional mesh tally. The energy deposition and the fluence were used to compute the total unrestricted stopping power, or LET. A space-variable RBE as a function of LET, dose, and tissue type was calculated using a phenomenological model developed by Wilkens and Oelfke.

Results: The RBE-weighted dose was compared for three treatment plans for constant and variable RBE and significant differences were observed inside the treatment volume. While the three-dimensional LET distribution in PSPT is relatively easy to predict with simple models, the LET distribution in IMPT can be much more complex and may require a detailed MC simulation in order to be estimated accurately.

Conclusion: This example illustrates how very similar physical doses may have significantly different biological effects depending on the modality and the beam configuration of the treatment plan. This approach can be used for biologically based treatment planning and to explain some unexpected treatment toxicities in proton therapy patients.