AbstractID: 13357 Title: Dose Simulation in Random Media for Radiotherapy Planning with Proton Beams

Purpose: To develop a technique for proton beam dose simulation in a random medium where geometry or density may change stochastically. An example of such a random medium can be found in a rectum during fractionated proton therapy for prostate cancer because of air bubbles of random size and location.

Method and Materials: The proton range in a random medium can be considered as a random parameter. The distribution of random proton ranges is given by the probability density function (PDF). The total dose distribution during fractionated radiotherapy may be described by a sample range PDF if we assume that the each fractional radiotherapy treatment is a single statistical trial. To verify this hypothesis we have computed the range PDFs in the random medium which simulates the proton beam transport through the rectum. The rectum was simulated as a cylindrical region with an air bubble randomly placed in the upper semicircle. A random number generator was utilized to simulate the random bubble location and radius. The range of a 200 MeV monoenegetic proton beam was computed using continuous slowing down approximation.

Results: We have computed the proton range PDF in the model rectum problem using different number of histories. The range PDF consists of two major parts describing the total probability to hit the bubble and total probability not to hit the bubble. The convergence of the range PDF in the "hit bubble" region was seen at 1000 histories; however, even with 40 histories the PDF shape can be predicted. The depth-dose distributions in the "hit bubble" region agree within 10% for converged PDF and sample PDFs with 40 histories.

Conclusions: The proton range PDF in a random medium as rectum with air bubbles can be potentially used for evaluation of total dose distributions in fractionated proton therapy.