AbstractID: 8609 Title: Accurate simulation for therapeutic protons range-energy and range-density tables

Purpose

The purpose of this work is to generate accurate range-energy and range-density tables for therapeutic protons using Monte Carlo simulation in water phantom.

Method and Material

The percentage depth dose and the depth peak dose was calculated using Monte Carlo simulation for protons. The simulation was based on Monte Carlo code, MCNPX in water phantom with protons energy ranging from 40 MeV increasing by 10 to 250 MeV. The calculation of the three dimension dose matrix was performed using a 2 x 2 x 1 mm^3 voxels in the depth peak range in water phantom. The pencil beam was used and the source was uniformly distributed in area with beam diameter as 20 mm. A 3,000,000 history was used in each individual simulation with uncertainty controlled less than 1.0%.

Results

The total 22 data points of simulated depth peak were compared to two widely used proton range-energy tables from International Commission on Radiological Units and Measurements (ICRU) Report 49 and from Data Nuclear Data Tables (DNDT). The simulated range-energy curve matches very well with ICRU and DNDT with coefficient of determination equal to 1. The difference of the simulation and measurements is 1.17% at maximum and 0.70% at average compared to ICRU, 1.15% and 0.37% compared to DNDT respectively. The relation of range-density was determined with water density ranging from 0.4 to 2.0 g/cm^3.The exponential relation of range-density gives very closely matched estimation to the simulated value with the coefficient of determination as 0.9999.

Conclusion

The simulated proton range-energy matches very well to two widely used measurements. The accurate Monte Carlo simulation provides a close benchmark for existed measurements. The simulation offers the chance to replace the infinite experiments for each detailed energy and density. The simulation also expands the feasibility of accurate simulation in heterogeneity.