

AbstractID: 5612 Title: Verification of a proton treatment-planning pencil-beam dose algorithm with Monte Carlo

Purpose: To verify the accuracy of a pencil beam superposition dose algorithm in heterogeneous media for proton therapy treatment planning system using Monte Carlo simulations.

Method and Materials: A proton treatment planning system (ECLIPSE, Varian) was validated using dose distributions predicted with Monte Carlo (MC) simulations. The accuracy of the MC physics models was established in previous studies and the model of the therapy unit is described elsewhere (Newhauser et al, Zheng et al., separate contributions to this conference). MC simulations of proton beams with different range, field sizes and modulation widths into various phantom geometries, comprising cubic water phantoms with lung and bone equivalent material slabs, cylindrical inhomogeneities and non-flat upstream surfaces, were carried out to compare depth dose profiles, lateral profiles, penumbral widths and field size values to predictions from the treatment planning system.

Results: More than 30 different beam configurations have been investigated. Range differences, and differences in the 80%-20% penumbras larger than 2 mm were observed twice, while differences in the 50%-50% field size were smaller than 1 mm. The range differences were not related to the inhomogeneities, but are due to differences in the proton stopping powers used in the MC and TPS systems. The deviations in the penumbras were mostly seen in the 90%-10% penumbra comparisons of profiles at large depths, where contributions from multiple Coulomb scattering started to become more visible in the MC simulations, but less in the TPS predictions.

Conclusions: Monte Carlo simulations proved to be a valuable tool to verify the dose predictions in heterogeneous phantoms from a commercial treatment planning system. The treatment planning software performed well in most cases considered. This investigation helped to substantially reduce the time required for testing and the treatment planning software package and provided valuable feedback to the TPS developer.