AbstractID: 6663 Title: Monte Carlo based superposition dose calculaiton for proton beam radiotherapy

An accurate and fast dose calculation algorithm has been developed for proton beam radiotherapy. The algorithm has been implemented in the MCDOSE code to calculate dose deposition in a 3D rectilinear phantom built from patient CT data by superposition of pre-generated Monte Carlo proton tracks. Monoenergetic protons of 250 MeV kinetic energy were simulated in an infinite water phantom using the GEANT3 Monte Carlo code. The changes in position, angle and energy for every step and the energy deposition along the step were recorded for the primary protons and all the secondary particles. When calculating the dose for a particular patient geometry, the pre-generated particle tracks are used with the step lengths adjusted based on the density and the stopping power for the local material while keeping the energy deposition unchanged in each step. The tracks are rotated based on the direction of the incident proton and the scattering angles adjusted if the phantom materials are different from water. If the incident proton energy is below 250 MeV the simulation will start at a transportation step with corresponding energy. We have validated the algorithm by comparing the dose distributions for 120, 150, 180 and 250 MeV proton beams. The difference between the results of the Monte-Carlo based superposition method and the GEANT3 Monte Carlo simulation is within 1%. The superposition Monte Carlo algorithm is about 13 times faster than GEANT3 for uniform phantom geometry and over 700 times faster for heterogeneous phantom geometry.