AbstractID: 8027 Title: Energy modulation of laser accelerated proton beams for radiation therapy

This work investigates dose optimization of energy modulated proton beams using Monte Carlo simulations. Polyenergetic protons are assumed to be produced as a result of laser-plasma acceleration. A Monte Carlo code, PROTONDOSE, based on GEANT3 was developed for the pre- and post-optimization dose calculation. PROTONDOSE was designed for particle transport in a 3D rectilinear voxel geometry, suitable for patient dose calculations using CT data. Monoenergetic proton beams of different cross-sections were studied and their Bragg peak characteristics were determined. Monoenergetic proton beams within a given range of energies were weighted to produce spread out Bragg peaks (SOBP) to achieve conformal dose distributions for target coverage and normal tissue sparing. An optimization scheme based on least-squares minimization following the method of Powell was employed. An iterative process was developed to obtain optimal weights for beamlets of different energies. The energy spectral distributions computed by the optimization process were used to simulate SOBPs by sampling from these spectra in PROTONDOSE. We compared the least-squares method with a conjugate gradient method used to minimize an augmented objective function. Results yielding SOBP having different widths showed that our method can produce comparable uniformity as the gradient methods with fewer beamlets of different energies and faster execution. We conclude that generating SOBP holds significant potential for radiation therapy by improving local control and reducing normal tissue toxicity over therapy using intensity-modulated x-ray beams.