AbstractID: 14192 Title: Monte Carlo Simulations of Beam Characteristics for a Compact Plasma Proton Accelerator

Purpose: To (1) develop Monte Carlo applications for the geometry and particle transport in the treatment head of a compact coaxial plasma proton accelerator and (2) quantify the sensitivity of the output particle flux and dose distributions on the energy and angular spread of the input proton phase space.

Method and Materials: Geant4 v4.9.3 was employed to simulate a plasma proton treatment head geometry, including the beam collimator, the magnetic field region, and the energy selector. The energy spectrum assumed a Gaussian distribution centered at E_{max}=200MeV, and the full width at half maximum (FWHM) was 0%, 12.5%, 25%, 37.5% and 50% of E_{max}. The angular spread of the input proton beam was considered to be 0^0, 15^0, and 20^0, respectively. Flux and dose calculations were performed using a phase space implemented at the energy selector exit plane and a voxelized water phantom, respectively.

Results: For a fixed angular spread, the output particle flux is fairly constant as the energy spectrum becomes broader, while for a fixed energy spread the flux decreases significantly with increasing angular spread. The decrease is 10 times for 15^0 and 40 times for 20^0 angular spread. Dose measurements show that 200MeV protons, even with a broad energy spectrum, are preferable to photons when low entrance dose and conformal distal edge falloff are desired. The energy spread translates into a spread out Bragg peak used clinically, without the introduction of any scattering devices in the beam path.

Conclusions: This study shows that the delivered proton flux is highly sensitive to the angular spectrum of the input plasma accelerated protons and dose is sensitive to the spread of the energy spectrum. Monte Carlo simulations of beam characteristics for compact plasma proton accelerators provide important design parameters for the development of the next generation proton therapy units.