AbstractID: 10552 Title: A track repeating algorithm for carbon therapy dose calculation

Purpose: In radiation therapy, the use of heavy charged particles offers numerous advantages (narrow Bragg peak and sharp penumbra) over electron and X-ray beams. Conventional dose algorithms are fast but less accurate for heterogeneous patient anatomy for small fields and beam scanning. Accurate dose calculations based Monte Carlo simulations are time consuming. Our goal is to develop a fast Monte Carlo dose calculation algorithm using a track repeating method for carbon therapy treatment planning and dose verification.

Method and Materials: Using the GEANT 4 Monte Carlo code we recorded the tracks of mono-energetic (300MeV/nuclon) carbon ions in a homogeneous water phantom. For every carbon history, the incident carbon ion and all secondary particles are transported in discrete steps and all parameters for each step are recorded in a database. A program is developed to adjust the step length and energy deposition in different materials along the particle path in a heterogeneous phantom. Based on the energy and angle of an incident carbon either the whole history or parts of tracks will be repeated with proper angular rotation.

Results: We first demonstrated the applicability of the track repeating method for mono-energetic carbon beams (100-300 MeV/nucleon) by comparing the calculated dose distributions in homogeneous and heterogeneous phantoms with those simulated by two established Monte Carlo codes (GEANT 4 and FLUKA). As a second step we confirmed that the Bragg peak shift and energy deposition changes in bone and soft tissue are accurately reproduced. As a final test we applied the algorithm to calculate the dose distribution in patient geometry built from CT data.

Conclusion: Our track repeating technique for carbon ions is extremely efficient (11-100 times faster than FLUKA) opening the possibility for both fast and clinically accurate dose calculations for advanced carbon therapy using beam scanning and intensity modulation.