AbstractID: 3149 Title: Clinical implementation of proton Monte Carlo dose calculation

Purpose: Clinical use of Monte Carlo dose calculation to support routine treatment planning and delivery at the Northeast Proton Therapy Center.

Method and Materials: The Monte Carlo code GEANT4 was used to model the treatment heads. More than 1000 objects were considered in the geometry. This includes a time dependent simulation of the modulator wheel (broad beam modulation) and the magnetic field settings (beam scanning). The code was benchmarked against phantom measurements. Further, the capability of using CT data information was implemented in GEANT4. Different Hounsfield unit to material conversion methods were tested. The standard GEANT4 tracking algorithm was modified to allow time-efficient dose calculation. A software link of the Monte Carlo dose engine to the patient database and the commercial planning system was established.

Results: The setup for Monte Carlo dose calculation is automated via a user interface. Information from the commercial treatment planning system and the treatment machine control software is imported to generate Monte Carlo input files. Dose calculations have been performed for radiosurgery and for breast, paranasal sinus, spine, and lung malignancies. Monte Carlo dose distributions can be imported into the planning system for analysis. Differences to the planning program could be identified. Due to the detailed model of the treatment head, Monte Carlo is also being used for absolute dosimetry. The reading of the segmented parallel plate ionization chamber in the treatment head was simulated with 1.4 % accuracy. Output factors can thus be simulated using the patient geometry.

Conclusion: Proton Monte Carlo dose calculation for treatment planning support can be efficiently done using GEANT4 based software. Re-calculated plans can be used for decision making in the planning process. Simulated output factors allow the use of Monte Carlo for absolute dosimetry. This is the first clinically implemented complete Monte Carlo for proton therapy.