AbstractID: 11450 Title: Technical and practical considerations in implementing proton pencil beam scanning

Purpose: Magnetically scanned proton beams (PBS) have lateral position, energy, spot size, and flux degrees of freedom that allow for optimal target dose distributions and tissue sparing. PBS requires fast and accurate control of the degrees of freedom during the treatment to deliver the desired dose. We describe how a PBS field is delivered and verified in the technology we developed.

Methods and Materials: Treatment plan beam parameters are converted to equipment settings, sorted in energy layers, and sent to various measurement and control devices that check the parameters every 0.25 ms. The on-line dosimetry system was adapted to support this speed and characterized over a range of beam positions and dose rates. These data were calibrated against measurements at isocenter using a variety of instrumentation techniques. Sources of potential error and noise were identified and reduced to a level which enabled accurate clinical treatment.

Results: The scanning system produces pencil beams smaller than 6-8 mm lateral width (1σ) with focusing magnets and 9-14 mm without. Dose accuracy is +/-0.2 cGy in the Bragg peak for a single pencil-beam and +/-0.75% for our reference irradiation geometry. Measured 3-dimensional dose distributions satisfy the (3 mm, 3%) gamma index criterion with 97% of points below 1.

Conclusion: Our current system has proven to be accurate and safe. We developed the capability for treating large tumors, a purpose not usually considered for proton beam scanning but which we see as an important opportunity. We achieved clinically useful dose distributions with our beam and system parameters (including dose and position accuracy and spot size). Further refinements are planned.