AbstractID: 14120 Title: The impact of monitor unit constraints on plan quality of IMPT planning using single-field optimization

Purpose: To investigate the effect of monitor unit (MU) constraints on the dose distribution created by intensity modulated proton therapy (IMPT) treatment planning using single-field optimization (SFO).
Methods and Materials: Ninety-four energies between 72.5 and 221.8 MeV are available for scanning-beam IMPT delivery at our institution. The minimum and maximum MUs for delivering each pencil beam (spot) are 0.005 and 0.04, respectively. These MU constraints are not considered during optimization by the treatment planning system; spots are converted to deliverable MUs during post-processing. Treatment plans for delivering uniform doses to rectangular volumes with and without MU constraints were generated for different target doses, spot spacings, spread-out Bragg peak (SOBP) widths, and ranges in a homogenous phantom. Four prostate cancer patients were planned with and without MU constraints using different spot spacings. Rounding errors were analyzed using an in-house software tool.
Results: From the phantom study, we have found that both the number of spots that have rounding errors and the magnitude of the distortion of the dose distribution from the ideally optimized distribution increases as the field dose, spot spacing, and range decrease and as the SOBP width increases. From our study of patient plans, it is clear that as the spot spacing decreases the rounding error increases, and the dose coverage of the target volume becomes unacceptable for very small spot spacings.
Conclusions: Constraints on deliverable MU for each spot could create a significant distortion from the ideally optimized dose distributions for IMPT fields using SFO. To eliminate this problem, the treatment planning system should incorporate the MU constraints in the optimization process and the delivery system should reliably delivery smaller minimum MUs.