AbstractID: 7705 Title: Monte Carlo in the optimization of Intensity Modulated Proton Therapy

Purpose: Analytical algorithms with unavoidable intrinsic accuracy limits are currently used for the dose computation in Intensity Modulated Proton Therapy (IMPT). These limits result in not achieving the optimum dose distribution and to overcome them, Monte Carlo algorithms (MC) have to be applied. We report on the implementation of a fast MC into a treatment planning system for IMPT and the achieved gains of MC in optimisation.

Methods and Materials: We use the MC VMCpro and an analytical pencil beam algorithm, both implemented into the treatment planning system Hyperion. To quantify the gain of using MC in IMPT, treatment plans for six patients (three head and neck, one breast case and two prostate cases) were calculated with both algorithms. The analytical calculated plans were recalculated with MC without reoptimization to obtain the convergence errors. In case of the analytical algorithm, the highest accuracy settings (high spot decomposition, nuclear scattering lateral correction, multiple-scattering model) were applied. In case of MC, the dose uncertainty of better than 3% in each voxel for each proton spot was guaranteed by the chosen number of primary protons.

Results: The convergence error in the target is for all cases besides the prostate cases negligible (below 0.4%). However, MC shows large impact on the standard deviation of the convergence error for cases with high lateral heterogeneity levels leading up to 2.1% in the target (breast case). For prostate cases with high initial proton energies, the convergence error reaches up to 1% in the target and is caused mainly by the nuclear interactions. The calculation times were 25-50 times higher for MC.

Conclusions: MC in the optimisation of IMPT significantly improves the optimum dose distribution for specific patient cases.