AbstractID: 9157 Title: Target motion tracking with a scanned particle beam: calculation and experimental validation of biologically effective doses in the presence of motion

Purpose:
A beam tracking system for scanned ion beams was developed to compensate intrafractional motion. A novel method to calculate biologically effective doses for charged particles (especially carbon ions) in the presence of motion was implemented and experimentally validated.

Method and Materials:
The tracking system adapts pencil beam positions according to target motion in quasi real time. Lateral position adaptation is performed with the beam scanning system, longitudinal range compensation with a dedicated energy modulation system that includes absorber material of adjustable thickness. To validate the calculation of biologically effective dose distributions in the presence of motion, a medium-filled container with Chinese hamster ovary cells was irradiated on a sliding table (3D biological dosimetry). Cell survival was measured for three irradiation schemes: 1. stationary target, 2.moving target without tracking, 3. moving target with tracking. Measured cell survival was converted to biologically effective doses and compared to calculations. Furthermore, measurements of the stationary setup and tracking irradiation under motion were compared directly to validate the functionality of the beam tracking system.

Results:
The average relative differences between measured and calculated biologically effective doses D (D_{calc}/D_{meas}-1) in the target area were -5%±9%, 5%±9% and -6%±8% for the stationary, moving target and tracking irradiation, respectively. Differences between calculations and measurements were comparable to relative variations in biologically effective doses of the experimental data of 11% (individual measurements). The difference between stationary and tracking irradiation (1-D_{comp}/D_{stat}) was 6%±9%.

Conclusion:
The performance of the beam tracking system was succesfully validated with 3D biological dosimetry by cell survival measurements. Results of the novel method to calculate biologcially effective dose distributions are in good agreement with measured data.

Conflict of Interest:
Research sponsored in part by Siemens Healthcare.