AbstractID: 1712 Title: 4D treatment planning for organ motion compensated heavy-ion therapy

Since 1997 we have treated more than 200 patients with carbon ions. Treatments are delivered with the rasterscanner-system by scanning the target volume fully active, intensity-controlled in 3D with pencil beams[1]. Currently only static targets are treated to guarantee the extreme conformity between target and irradiated volume. The in-house treatment planning system TRiP biologically optimizes the number of particles per raster-point[2]. The active beam delivery offers the feedback capability to tune the beam position online during treatments. To irradiate moving targets with high precision we have built and commissioned a prototype system for 3D online motion compensation. Given offsets according to the measured target motion, the system adjusts the lateral beam position to follow the current raster-point. Density variations due to motion are compensated in real-time with a fast absorber wedge-system. Next, a fluoroscopy system will be integrated for online motion tracking. New software modules have been added to TRiP to facilitate treatment planning for moving targets. Dose calculations as well as correction parameter optimization for moving targets have been implemented and successfully tested against data from phantom measurements. Furthermore, to benchmark dose calculations, moving detectors were irradiated without motion compensation. The resulting motion artefacts in dose patterns were accurately reproduced with the new modules of the treatment planning system. All basic treatment planning requirements for motion compensated heavy-ion therapy have successfully been implemented and tested.

[1] Haberer et al, Nucl. Instr. Meth. Phys. Res. **A330** (1993) 296-305
[2] Krämer et al, Phys. Med. Biol. **45** (2000) 3319-3330