Motion management in radiation therapy — Christoph Bert — GSI Helmholtzzentrum für Schwerionenforschung, Abteilung Biophysik, Darmstadt, Germany

Radiotherapy of tumors that move during irradiation requires dedicated means to ensure target coverage despite the motion influence. Motion can occur inter-fractionally (e.g. position of the prostate) or intra-fractionally; the most dominant reason for intra-fractional motion is respiration. The standard procedure to reduce the influence of target motion is the use of margins encompassing the clinical target volume (CTV) to form a planning target volume (PTV) that covers all uncertainties. This approach ensures CTV coverage for most treatment modalities but results in therapeutic dose to normal tissue.

With the opportunities given by improved imaging techniques such as time-resolved computed tomography (CT) or (cone-beam) CT in treatment position as well as motion mitigation techniques such as gating or tracking the dosimetric influence of target motion could be reduced. Especially for conformal techniques such as intensity modulated radiotherapy (IMRT) or particle therapy only advanced motion mitigation techniques and/or adaptive therapy concepts lead to preservation of the target conformation established for stationary targets in treatments of moving targets.

In the scope of the talk an introduction to motion management will be given with an emphasis on application in scanned particle beam therapy.

Compensation of dose changes due to intrafractional tumor motion — Robert Lichtenborg1, Nami Saito1, Naved Chaudhri1, Marco Durante1, Eike Rietzel1,2, and Christoph Bert1

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Treating tumors that are subject to intrafractional motion with scanned ion beams leads to deterioration of the deposited dose pattern. Thus techniques to mitigate motion effects are currently investigated. The most favorable among them in terms of target conformity and sparing of organs at risk is tracking, i.e. individually adapting Bragg peak positions to the changing tumor position.

While the main part of dose delivered by an ion pencil beam is deposited at the Bragg peak position some dose is delivered in the plateau before the Bragg peak. These dose contributions can be considered in treatment planning for stationary tumors but are subject to unpredictable changes in case of intrafractional tumor motion.

When tracking is used motion induced changes in dose deposition to the plateau region have to be considered. That means not only the position but also the particle number of each ion beamlet has to be adapted. Because the adaptation values depend on the a priori not exactly known trajectory (e.g. breathing period of patient changes) they have to be determined during treatment delivery.

Functionality to compensate for motion induced dose changes has been implemented to the beam tracking system at GSI and first experimental results will be presented.