ST 6: Ion Radiation Therapy 1: Radiation fields and effects

Chair: Gerhard Kraft

Zeit: Mittwoch 14:00–15:30 Raum: A021

ST 6.1 Mi 14:00 A021

Relevance of light and low energy particles in heavy ion therapy — •Thomas Friedrich, Alexander Schmidt, Thilo Elsässer, and Michael Scholz — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Biophysics, Planckstr. 1, 64291 Darmstadt

When heavy ions penetrate water or biological tissue lighter fragments are produced. We show that under conditions typical for tumor therapy with carbon ions light particles do contribute to the photon equivalent dose in the order of some percent. Hence an uncertainty in the estimate of their contribution does hardly alter the predicted relative biological effectiveness of the radiation field within the target volume. Likewise it is discussed that in particular very low energetic carbon ions (< 500 keV/amu) could be significantly more effective than estimated by the approach currently implemented in treatment planning. In contrast we demonstrate that their contribution to the photon equivalent dose is negligibly small even under extreme model assumptions. Though a more precise mechanistic understanding of low energetic particles is of general interest, it will have only minor impact on treatment planning systems for carbon ion therapy.

ST 6.2 Mi 14:30 A021

Multiple scattering in TRiP — •Gheorghe Iancu, Michael Kraemer, and Dieter Schardt — GSI Helmholtzzentrum für Schwerionenforschung

One of the main goals of any therapy treatment planning is the delivery of a conformal dose distribution in the target tissue while sparing the near seated critical ones. The multiple scattering is one of the important aspects that play a role in the modelling of the beam parameters especially for deep seated tumours. For calculating the multiple scattering the Moliere[3] formula, with Fano improvement for scattering by atomic electrons, is used. This is known to give good agreement within 4% with measured data [Gottschalk]. The nuclear part of scattered angle is calculated using the modified formula of Goldhaber [Goldhaber], [Morrisey] which, for some projectile and target combinations, underestimates the data by a factor of 2 [Heinrich et all, *]. Recent measurements [Schardt] of angular distribution of incident C ions on water are used to calibrate for the uncertain factor in Morrisey theory. The calculated results are compared with measurements of water phantom experiments performed in therapy conditions.

ST 6.3 Mi 14:50 A021

Microdosimetry measurements for 300 MeV/u C-12 pencil beams stopping in water — •Giovanna Martino, Oksana Kavatsyuk, Marco Durante, and Dieter Schardt — GSI Biophysik, Darmstadt

Microdosimetry measurements have been carried out at GSI to investigate the radiation field produced by a 300 MeV/u C-12 pencil-like beam stopping in water and to study the dose fall-off as a function of distance from the beam axis. For this purpose, microdosimetric spectra were recorded moving a Tissue-Equivalent-Proportional-Chamber (TEPC) to 50 different positions inside a water phantom. As the lateral spread of heavy ions is very small the main contribution to the lateral dose comes from secondary fragments which are produced in nuclear reactions. The corresponding LET spectra are characterized by peaks around 10 keV/μm in a range extended up to around 50 keV/μm. Absorbed doses were obtained by integration of the microdosimetric spectra. Along lines parallel to the beam axis the dose curves, as a function of depth, show a typical grow-in part due to the build-up of secondary fragments, including neutrons. The dose characteristics along lines perpendicular to the beam axis show a steep exponential fall-off. At larger distances from beam axis the fall-off is slower. Here the main contribution comes from light secondary fragments, such as protons and neutrons, which have much broader angular distributions than the heavier fragments. These results confirm that the lateral dose characteristics of carbon ion beams used in radiotherapy shows an extremely steep decrease with distance from the beam axis.

ST 6.4 Mi 15:10 A021

Optimierung von Fraktionierungseffekten in der Bestrahlungsplanung — •Stefan Schell[1], Jan J. Wilkens[1] und Uwe Oelfke[2] — [1]Klinik und Poliklinik für Strahlentherapie und Radiologische Onkologie, Technische Universität München, Klinikum rechts der Isar — [2]Abteilung Medizinische Physik in der Strahlentherapie, Deutsches Krebsforschungszentrum Heidelberg

Der Erfolg der Strahlentherapie in der Tumorbehandlung beruht darauf, dass durch technische Weiterentwicklungen das Verhältnis der physikalischen Dosen von Normalgewebe zu Tumorgewebe gesenkt werden konnte. Dennoch ist ein Therapieplan immer ein Kompromiss zwischen Schaden in Normalgewebe und Tumor. Daher ist es wichtig Methoden zu entwickeln, die dabei helfen, den biologisch besten Kompromiss zu finden. Die in dieser Arbeit verwendete biologische Therapieplanung benutzt anstelle der physikalischen Dosis ein erweitertes Linear-Quadratisches Modell zur Beschreibung des Gewebeschadens in Abhängigkeit von der Dosis, dem Fraktionierungsschema und Gewebeparametern (z.B. Radiosensitivität, Reparaturzeitskalen). Dieses Modell wurde in ein voxelbasiertes Planungsprogramm integriert und ermöglicht die Untersuchung von Fraktionierungseffekten an dreidimensionalen Patientenfällen. Zur Visualisierung werden effektive Dosis-Volumen-Histogramme verwendet. Damit können Chancen und Risiken von alternativen Fraktionierungsschemata (z.B. Hypo-, Hyperfraktionierung) betrachtet werden. Es zeigt sich, dass aufgrund von Modell- und Parameterunsicherheiten eine konservative Herangehensweise an alternative Fraktionierungsschemata zu empfehlen ist.