ST 12: High-LET Radiation Therapy 2

Time: Thursday 11:00–12:40 Location: H41

ST 12.1 Thu 11:00 H41

Three Dimensional Biological Dose Distribution of Antiprotons — •Sara Tegami[1], Rebecca Boll[1], Stefan Sellner[1], Carsten P. Welsch[1,2], and Michael H. Holzscheiter[1,3] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland — [2]Cockcroft Institute and University of Liverpool, UK — [3]University of New Mexico, Albuquerque, USA

The goal of external beam cancer therapy is to destroy the tumour while sparing the healthy tissue around it. In hadron therapy, the dose profile of heavy charged particles satisfies this request, because most of the energy is deposited at the end of the particle path, in the Bragg peak. Antiprotons are even more promising, thanks to the extra energy released by annihilation when captured in a normal atom at the end of range.

The aim of the AD-4/ACE experiment at CERN is to determine the increase in biological dose near the Bragg peak due to densely ionizing particles emanating from the annihilation of antiprotons. Initial experiments showed the damage to cells inflicted at the end of the beam for identical damage at the skin level to be four times higher for antiprotons than for protons. The radiation field in a spread-out Bragg peak produced with antiprotons is highly mixed and for proper dose planning knowledge of linear energy transfer (LET) and relative biological efficiency (RBE) at any point in the target is needed.

We are studying a number of detection methods for their response to mixed radiation fields with the goal to obtain a direct measurement of the 3D LET distribution and will report on first results.

ST 12.2 Thu 11:20 H41

Real Time Imaging of Stopping Distributions in Biological Targets for Antiprotons — •Stefan Sellner[1], Rebecca Boll[1], Sara Tegami[1], Carsten P. Welsch[1,2], and Michael H. Holzscheiter[1,3] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland — [2]Cockcroft Institute and University of Liverpool, UK — [3]University of New Mexico, Albuquerque, USA

Antiprotons are interesting particles that have special properties when used in possible cancer particle therapy. They behave almost the same as protons in the entrance channel but deposit additional annihilation energy when they come to rest in the Bragg peak region. Thus, the number of antiprotons can be reduced while still delivering the same target dose to the tumor. Healthy tissue in the entrance channel is finally less harmed compared to protons which is a ultimate goal for good cancer treatment.

Additionally, annihilation energy partially goes into the creation of new particles, especially pions. They exit the body mostly non-interacting and can be detected with an external detector, enabling a real time supervision of the irradiation process. This is currently not possible in any particle treatment method.

In our contribution we will present model calculations for a low-cost real time detector setup and compare these to results from the recent experiment carried out with the Antiproton Cell Experiment (ACE) Collaboration at the Antiproton Decelerator (AD) at CERN as well as develop improved set-ups for future experiments.

ST 12.3 Thu 11:40 H41

Beam Monitor for Hadron Therapy using a Crystalline Pixel Detector — •Rebecca Boll[1], Stefan Sellner[1], Sara Tegami[1], Carsten P. Welsch[1,2], and Michael H. Holzscheiter[1,3] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland — [2]Cockcroft Institute and University of Liverpool, UK — [3]University of New Mexico, Albuquerque, USA

The unique dose deposition properties of hadron beams allow delivery of high dose to deep seated tumors while sparing surrounding normal tissue. Spot scanning techniques can achieve very high precision in targeting complex geometric shapes. In order to be able to distribute the dose exactly as planned, exact information about the incoming particle beam during the course of treatment is mandatory. Therefore a high resolution and high-speed beam monitor is needed.

Silicon pixel detectors are very promising candidates for this task. They have a high spatial resolution and can be built very thin, in order to not disturb the beam. In the AD-4/ACE experiment at CERN, we test a new crystalline silicon pixel detector called MIMOTERA, applying a pulsed antiproton beam (3×10^7 particles per 500 ns every 90 seconds). We will show results of first measurements, examining sensitivity, temporal and spatial resolution, and linearity of the detector response with beam intensity. Next steps will include investigations of the detector response to beam energy and linear energy transfer for antiprotons, protons, and carbon ions.

ST 12.4 Thu 12:00 H41

Modellierung des Sauerstoffeffekts für die Bestrahlungsplanung in Hoch-LET-Strahlentherapie — •Tatiana Dorsch und Jan Wilkens — Klinik für Strahlentherapie, Technische Universität München, Klinikum rechts der Isar, München, Germany

Die schlechte Behandlungsprognose für Patienten mit hypoxischen, d.h. sauerstoffarmen, Tumoren hängt in der Regel mit der verminderten Empfindlichkeit der hypoxischen Zellen gegenüber ionisierender Strahlung zusammen. Dieser Sauerstoffeffekt wird quantitativ durch den Sauerstoffverstärkungsfaktor (OER) ausgedrückt, der das Verhältnis zwischen den Strahlendosen beschreibt, die benötigt werden, um das gleiche Maß an Tumorkontrolle unter hypoxischen und normoxischen Bedingungen zu erreichen. Da der OER mit zunehmendem linearen Energietransfer (LET) abnimmt, könnte das einen klinischen Vorteil von Hoch-LET-Strahlentherapie darstellen. Das Ziel dieser Arbeit ist es, unterstützt von Literaturdaten zum Zellüberleben, einen einfachen voxelbasierten Algorithmus zu entwickeln, der die Reaktion von Tumorregionen mit unterschiedlichen Hypoxiegraden in Abhängigkeit vom LET, der lokalen Dosis, dem Sauerstoffpartialdruck und dem Gewebetyp beschreibt und zukünftig in die Therapieplanung integriert werden könnte. Unsere Rechnungen verwenden sowohl das Linear-Quadratische als auch das Alper-Howard-Flanders Modell und ermöglichen eine Diskussion der Dosisabhängigkeit des Sauerstoffverstärkungsfaktors und der klinischen Konsequenzen für verschiedene Fraktionierungsschemata. Gefördert durch das DFG Exzellenzcluster: Munich-Centre for Advanced Photonics.

ST 12.5 Thu 12:20 H41

Distribution of DNA lesions in amorphous track structure — •Thomas Friedrich[1], Thilo Elsässer[1], Marco Durante[1,2], and Michael Scholz[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt — [2]Technische Universität Darmstadt, Institut für Festkörperphysik, Hochschulstraße 6-8, 64289 Darmstadt

There is evidence that the effect of radiation to cells is mediated predominantly by lesion induction to the DNA. Whereas for radiation qualities with low linear energy transfer (LET) the dose and therefore the induced lesions can be assumed to be distributed homogeneously over the cell nuclei, in the case of ion irradiation the dose is deposited within a narrow peaked track structure profile around the ion trajectory. In the latest version of the Local Effect Model (LEM), spatial distributions of DNA lesions simulated within an amorphous track structure form the starting point to quantify the enhanced effectiveness of high LET radiation qualities compared to photon radiation. We discuss the implementation into the local effect model and present comparisons of model calculations with experimental data.