ST 8: Particle Radiography

Time: Thursday 16:15–17:15 Location: ZHG003

ST 8.1 Thu 16:15 ZHG003

Online Adaptive Radiotherapy with Silicon Detectors — Kevin Kröninger, Hendrik Speiser, •Annsofie Tappe, Helen Thews, and Jens Weingarten — TU Dortmund

Proton therapy is a relevant modality of radiation therapy used to treat cancer, offering the main advantage of a well-defined proton range. Knowing the exact range is crucial in proton therapy to minimize radiation exposure to healthy tissues and ensure the correct tumor dose. Anatomical changes in the patient between treatments significantly impact proton range. Therefore, an imaging technique is required to monitor these changes. One potential solution is a proton radiography system that can be used behind the patient in the beam axis.
We currently study the realization of a two-plane imaging system, consisting of two silicon pixel detectors and an intermediate absorber. This setup measures a two dimensional image of the water equivalent thickness (WET) of the patient along the beam axis during the treatment. A trigger for plan adaption could be given when the measured WET deviates from the expected value.
As part of a master thesis, this system is being implemented in the Monte Carlo simulation tool Allpix^2, to optimize the prototype and the post processing of the measured data. With simulations, we aim to improve data analysis and make first predictions of the feasibility in online adaptive proton therapy. To evaluate this, we want to determine the WET accuracy and precision with this system.
The talk will provide a short introduction of proton radiography, introduce the two-plane system and showcase simulated WET images.

ST 8.2 Thu 16:30 ZHG003

A Two Plane Proton Imaging System Using ATLAS FE-I4 Pixel Detectors — •Hendrik Speiser[1], Claus Maximilian Bäcker[2], Christian Bäumer[2], Johannes Esser[2], Kevin Kröninger[1], Annsofie Tappe[1], Helen Thews[1], and Jens Weingarten[1] — [1]TU Dortmund — [2]West German Proton Therapy Center Essen

For years, proton therapy is increasingly being used to treat cancer because of its well-known advantages, such as the high dose precision of protons. However, exploiting this precision requires improved imaging techniques to ensure accurate patient positioning and dose delivery. One such technique is proton radiography, where an image of the water equivalent thickness (WET) distribution of the patient is taken measuring the residual proton energy.

Former studies showed the feasibility of proton radiography using a single radiation hard ATLAS FE-I4 pixel detector. To improve the WET resolution of the resulting images, a second pixel detector of the same kind and a water equivalent absorber between both detectors are used. Proof-of-concept simulation studies of the so-called Two-Plane-System showed promising results. Thus, the aim of the project is to realize such a system and investigate the yielded WET resolution. To this purpose, prototype measurements were conducted at the West German Proton Therapy Centre in Essen.

This talk will briefly introduce the Two-Plane-System. Subsequently, the first results of the prototype measurement using ATLAS FE-I4 pixel detectors and future steps of the project are presented.

ST 8.3 Thu 16:45 ZHG003

Simulations of detector setups for Helium Radiography and CT — Alexander Dierlamm[1], Tim Gehrke[2], Ulrich Husemann[1], Oliver Jäkel[2], Maria Martisikova[2], and •Linus Schlee[1] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT) — [2]Medical Physics in Radiation Oncology, German Cancer Research Center (DKFZ), Heidelberg

For the precise irradiation treatment of cancers that are located near critical tissues, ion beam therapy has been developed as an efficient and highly conformal treatment compared to x-ray therapy. Compared to the established methods with proton or carbon beams, helium provides a higher linear energy transfer than protons while causing less secondary radiation than heavier nuclei like carbon. To obtain higher precision with helium therapy, precise knowledge of the integrated stopping power of the affected region is needed. In future, the imaging for the treatment planning could be performed by the same He ions but at higher energies compared to the therapeutic range. In this talk, research on detector setups involving helium beams is presented. With the Allpix^2-Framework, the path of ions through a plexiglass-phantom (PMMA) and the resulting hits and signals of different detector setups are simulated. With subsequent analysis of simulated detector data on the positions and deposited energies of tracked particles, the goal is to optimise the setups to achieve higher measurement accuracy. The simulations are based on and compared to existing setups at the German Cancer Research Center (DKFZ).

ST 8.4 Thu 17:00 ZHG003

First experimental time-of-flight-based helium radiography of a mouse phantom — •Felix Ulrich-Pur[1], Ashish Bisht[2], Thomas Bergauer[3], Tetyana Galatyuk[1,4,5], Albert Hirtl[6], Matthias Kausel[6,7], Mladen Kis[1], Barbara Knäusl[8], Yevhen Kozymka[4], Wilhelm Krüger[4], Sergey Linev[1], Jan Michel[1], Jerzy Pietraszko[1], Christian Joachim Schmidt[1], Michael Träger[1], Michael Traxler[1], and Matteo Centis Vignali[8] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [2]Fondazione Bruno Kessler — [3]Austrian Academy of Sciences, Institute of High Energy Physics — [4]Technische Universität Darmstadt — [5]Helmholtz Forschungsakademie Hessen für FAIR — [6]TU Wien, Atominstitut — [7]EBG MedAustron — [8]Medical University of Vienna, Department of Radiation Oncology

Ion computed tomography (iCT) is an imaging modality for the direct measurement of the relative stopping power (RSP) distribution inside the patient. To reconstruct the RSP map, the traversed path and corresponding energy loss of ions passing through the patient have to be estimated. While this is usually done via a tracking system and a separate calorimeter, we present a so-called time-of-flight (TOF) iCT system that uses only one detector technology, namely Low Gain Avalance Diodes (LGADs), for both tracking and the energy loss measurement. In this contribution, first ion images, recorded with the TOF-iCT system, will be shown, including a proton radiograph of an aluminium stair phantom and a helium radiograph of a mouse phantom.