ST 1: Radiation therapy I

Time: Monday 14:00–15:30 Location: ST-H4

ST 1.1 Mon 14:00 ST-H4

Usage of the track reconstruction framework Corryvreckan in proton therapy — •Christopher Krause, Valerie Hohm, Kevin Kröninger, Jens Weingarten, and Florian Mentzel — TU Dortmund, Dortmund, Germany

The Inner Tracker of the ATLAS experiment requires the optimal performance of its pixel sensors. To test their efficiency, a reliable track reconstruction and analysis for testbeam data is necessary to ensure the precise detection of particles. In the last years, track reconstruction was mostly done with the EUTelescope software, a generic and versatile framework.
In 2017, the new track reconstruction software Corryvreckan was published with the intention to reduce external dependencies without reducing the quality and versatility of track reconstruction in complex environments.
Efforts are made in TU Dortmund to use pixel sensors and track reconstruction software for proton computed tomography. The usage of Corryvreckan for low energy high density proton beams is investigated. This talk presents the performance tests of Corryvreckan with simulated data. The simulated data is generated with Allpix^2 and serves to test the usability of Corryvreckan with beam properties used in proton therapy. Results are further improved through the use of machine learning algorithms to separate true and false reconstructed tracks.

ST 1.2 Mon 14:15 ST-H4

Simulationen zur Ortsauflösung in der Protonenradiographie unter Verwendung eines ATLAS Pixeldetektors — •Jacqueline Schlingmann, Marius Hötting, Kevin Kröninger und Jens Weingarten — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

Bei der Protonentherapie muss eine Sicherheitsspanne um den zu bestrahlenden Bereich eingehalten werden um sicherzustellen, dass das gesamte zu bestrahlende Gewebe behandelt wird. Unsicherheiten durch Lagerungsveränderungen und durch die Bildgebung mit Elektronen sind ausschlaggebend für die Sicherheitsspanne.

Um die Protonentherapie zu optimieren, soll zur Verifizierung der Position des zu bestrahlenden Bereiches eine Bildgebung mit Protonen am Ort der Bestrahlung stattfinden. Desweiteren kann der Patient vor und während der Bestrahlung überwacht werden. Für die Bildgebung wird zunächst die Auflösung über ein edge Phantom mit Hilfe der Modulation transfer function (MTF) untersucht. Außerdem werden Methoden zur Bildverarbeitung und Objektextraktion getestet.

In diesem Vortrag werden die Ergebnisse und die Methode zur Auflösungsbestimmung präsentiert. Desweiteren werden Bildverarbeitungsmethoden mit den verwendeten Filtern in Hinblick auf die Möglichkeit zur Positionsfindung von Objekten im Phantom diskutiert.

ST 1.3 Mon 14:30 ST-H4

Study of prompt gamma emission in c^{12}(p, p*γ)c^{12} nuclear reactions close to a bragg peak — •Mariam Abuladze[1,2], Ronja Hetzel[3], Jonas Kasper[3], Revaz Shanidze[1,2], and Achim Stahl[3] — [1]Tbilisi State Univerity, Tbilisi, Georgia — [2]Kutaisi International University, Kutaisi, Georgia — [3]RWTH Aachen University, Aachen, Germany

Proton therapy is a high-quality radiation therapy which uses a proton beam to irradiate human tissue. The advantage of this type of treatment is a highly conformal dose deposition due to the presence of the Bragg peak. Though it is often required to irradiate the tumor volume with a precision better than 1 - 2 mm, which means that proton therapy needs not only precise treatment planning but also monitoring and proton range verification during the treatment. One of the ways to monitor the proton range is Prompt Gamma Imaging (PGI) which means to detect gamma rays produced by the excitation of the target nuclei by incident protons.

In this work, a results of the Geant4 simulation (version 10.6.3.) of interactions of 17.56 MeV protons with a carbon target are shown. This includes the study of 4.4 MeV and 9.6 MeV line properties, as multiple differences were observed between simulation and experiment, one of which is a double peak for the C^{12}(p, p*γ)C^{12} spectral line. The shortcomings of the current physical models in Geant4 in describing the shape and intensity of the 4.4 MeV and 9.6 MeV gamma lines will be discussed.

ST 1.4 Mon 14:45 ST-H4

Granularity and Photomultiplier studies for Prompt Gamma Spectra in Proton Therapy — •Olga Novgorodova and Arno Straessner — IKTP TU Dresden, Dresden, Germany

Prompt gammas (PG) in proton therapy are one of the promising techniques for non-invasive measurements of in-vivo proton range and it is already in implementation in clinical research. It can be based on time or spectral measurements. We concentrate on the spectral properties by developing systems measuring PG in the range 2-8 MeV, which already were shown to provide a time resolution of about 100 ns. A big problem in the recording prompt gammas during the irradiation of patients is the data load due to the size of the crystal. By decreasing the size of the crystals and forming them into the matrices the load to each channel can be reduced and more PGs can be detected. We are investigating different sizes and types of crystals to find an optimum. Availability on the market and the choice of photomultipliers also plays an important role for the granularity of crystals. Three different types of photomultipliers were used: a regular PMT, MAPMT and several SiPMs, which have high photon detection efficiency, good time resolution, low bias voltage and can operate in magnetic fields. For the SiPMs, PETsys readout electronics was used. In the presentation we present effects due to crystal types and sizes, and compare different photomultipliers and read out systems.

ST 1.5 Mon 15:00 ST-H4

Use of PET Readout Electronics for a Scintillating Fiber-Based Compton Camera — •Sara Müller[1,3], Ronja Hetzel[1,3], Mareike Profe[1], Achim Stahl[1], Aleksandra Wronska[2], Ming Liang Wong[2], Magdalena Kołodziej[2], Katarzyna Rusiecka[2], David Schug[3], Björn Weissler[3], and Volkmar Schulz[1,3] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland — [3]RWTH Aachen University, Physics of Molecular Imaging Systems, Aachen, Germany

A powerful tool in cancer treatment is hadron therapy. Its precision can be optimised by online-monitoring the Bragg peak position by using prompt gamma radiation emitted in the process. A Compton camera is a promising setup for this task as it provides the possibility to reconstruct the shape and the location of the deposited dose.

The SiFi-CC (SiPM and scintillating Fiber-based Compton Camera) is developed by researchers of the RWTH Aachen University, the Jagiellonian University in Kraków and the University of Lübeck. The two parts of the SiFi-CC, the scatterer and the absorber, both consist of closely packed LYSO:Ce fibres and are read out by digital SiPMs. The SiPMs are arranged in a sensor tile which was originally developed for PET systems and which consists of 36 Digital Photon Counters containing four readout channels each. Thus, the light produced in the scintillating fibers is spread over several SiPMs. A small-scale prototype of the camera has been assembled and was tested under laboratory conditions. First results of these measurements will be presented.

ST 1.6 Mon 15:15 ST-H4

Proton field verification by implant activation — •Claus Maximilian Bäcker[1,2,3], Christian Bäumer[1,2,3], Walter Jentzen[5], Sandra Laura Kazek[5], Kevin Kröninger[1], Fleur Spiecker[1], Nico Verbeek[2,3], Jens Weingarten[1], Jörg Wulff[2,3], and Beate Timmermann[2,3,4,6] — [1]TU Dortmund University, Department of Physics, D-44221 Dortmund — [2]West German Proton Therapy Centre Essen, D-45122 Essen — [3]University Hospital Essen, West German Cancer Center, D-45122 Essen — [4]University Hospital Essen, Department for Particle Therapy, D-45122 Essen — [5]University Hospital Essen, Clinic for Nuclear Medicine, D-45122 Essen — [6]University Duisburg/Essen, Faculty of Medicine, D-45147 Essen

The delivered dose in particle therapy is sensitive to the correctly predicted range. Uncertainties arise e.g. from estimation of tissue stopping powers. In order to identify range uncertainties of the treatment fields, multiple techniques have been developed in the past. However, these techniques come with several limitations for the clinical applicability. In this study, the potential use of implant activation for field verification is investigated. Therefore, a method validation is performed focusing on the activation of titanium implants during proton therapy treatments and subsequent PET imaging. The parameters delivered dose and variations in the beam range are investigated to estimate the detectability of these changes during fractional treatment. While first pre-clinical studies demonstrated the general potential of implant activation for range verification, the current limitations and necessary developments in PET imaging will be presented in this talk.