ST 3: Radiation Therapy II

Time: Tuesday 11:00–12:00 Location: PC 203

ST 3.1 Tue 11:00 PC 203

A High-Performance Particle Tracker Based on CBM Silicon Strip Detectors for Range Verification in Heavy-Ion Therapy — •Devin Hymers[1], Sebastian Schroeder[1], Olga Bertini[2], Johann Heuser[2], Joerg Lehnert[2], Christian Joachim Schmidt[2], and Dennis Mucher[1] — [1]Institut für Kernphysik, Universität zu Köln, Köln, Germany — [2]GSI GmbH, Darmstadt, Germany

The growing societal burden of cancer necessitates improvement in safety and efficacy of radiation therapy. Scanned heavy-ion therapy provides precise and highly conformal dose delivery, but inherent uncertainties make it difficult to ensure accuracy. Filtered Interaction Vertex Imaging (fIVI) has been demonstrated to have potential as a relative range verification method with sub-millimeter accuracy, to ensure full and consistent tumour coverage in treatment [1]. A high-performance system, based on modern strip-segmented silicon detectors originally developed for the Compressed Baryonic Matter (CBM) experiment at GSI, is being adapted for use in fIVI. These sensors have a segment pitch of 58 microns, cover a large sensitive area of up to 72 cm^2, and are capable of count rates up to 250 kHz on each segment, in line with the expected requirements for fIVI under clinical conditions. These detectors are coupled to a parallel, pipeline-based analysis system, for high-efficiency data processing. Results of initial tests on detector and analysis software performance will be presented, along with the expected precision of the setup.

[1] Hymers *et al* 2021 Phys. Med. Biol. **66** 245022

ST 3.2 Tue 11:15 PC 203

Geant4 Simulation of the CBM Silicon Strip Detector for Interaction Vertex Imaging — •Sebastian Schroeder, Devin Hymers, and Dennis Mücher — Institut für Kernphysik, Universität zu Köln, Germany

Interaction vertex imaging (IVI) is a method which can be used to determine relative range differences in Bragg peaks in heavy-ion therapy. Current treatment plans must account for uncertainties in Bragg peak position on the order of millimeters. The sub-millimeter precision of IVI reduces the overall treatment uncertainty and allows further reduction of dose to healthy tissue. Previous studies suggest that to achieve IVI under clinical conditions, large sensitive detectors will be required to operate at high event rates of order MHz [1]. One possible detection system uses the double sided silicon strip detectors and fast readout electronics developed for the Compressed Baryonic Matter (CBM) experiment at GSI (Gesellschaft für Schwerionenforschung). To evaluate the suitability of this system, an IVI setup was simulated using the Geant4 Monte Carlo toolkit. The resultant event rates and cluster sizes, when compared to the capability of various readout configurations, are an order of magnitude lower than the limit of the CBM detection system. When energy cuts relevant for IVI are applied, the simulation shows that 98% of detected events correspond to particle species of interest, further demonstrating the suitability of this system for range monitoring in heavy-ion therapy under clinical conditions.

[1] Hymers *et al* 2021 Phys. Med. Biol. **66** 245022

ST 3.3 Tue 11:30 PC 203

A coded mask setup for on-line beam range monitoring in proton therapy — •Monika Kercz[1,2,3], Alexander Fenger[3], Ronja Hetzel[3], Jonas Kasper[3], Magdalena Kołodziej[1,2], Linn Mielke[3], Magdalena Rafecas[4], Katarzyna Rusiecka[1], Achim Stahl[3], Ming Liang Wong[1], and Aleksandra Wrońska[1] — [1]M. Smoluchowski Institute of Physics, Jagiellonian University, Kraków, Poland — [2]Doctoral School of Exact and Natural Sciences, Jagiellonian University, Kraków, Poland — [3]III. Physikalisches Institut B, RWTH Aachen University — [4]Institute of Medical Engineering, University of Lübeck

The full potential of proton therapy cannot be reached without an on-line method for beam range verification. One technique for dose monitoring involves the analysis of spatial distribution of prompt gamma radiation emitted during the treatment and its translation to the distribution of deposited dose.

The SiFi-CC project focuses on developing a setup operating in two imaging modes: a Compton camera and a coded mask camera. A Compton camera comprises two detector modules: a scatterer and an absorber, while a coded mask camera uses a single detection module combined with a structured passive collimator. In our approach, both modules are made of elongated LYSO:Ce crystals coupled to SiPMs.

After the prototyping phase, the first full-scale module has been constructed. First measurements in the coded mask setup were performed at HIT using a proton beam and a PMMA phantom. Preliminary results will be presented.

ST 3.4 Tue 11:45 PC 203

Progress of a Geant4 Simulation for the SiFi-CC Compton camera project in proton therapy — •Linn Mielke[1], Achim Stahl[1], Ronja Hetzel[1], Alexander Fenger[1], Jonas Kasper[1], Monika Kercz[1,2], Magdalena Kołodziej[2], Magdalena Rafecas[3], Katarzyna Rusiecka[2], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland — [3]Institute of Medical Engineering, University of Lübeck

Proton therapy is a clinically established cancer treatment characterized by its precise dose deposition. However, a prerequisite to this advantage is that there are no discrepancies between what is foreseen by the treatment plan and the actual deposition. One approach to monitor such shifts is to detect the prompt gamma radiation from the proton interactions inside a patient. The SiPM and scintillating Fiber-based Compton Camera (SiFi-CC) project is an example of this approach. The full camera consists of a scatterer and an absorber, both of which are constructed by layering LYSO fibers read out in SiPMs. Ideally, the origin of each detected prompt gamma lies somewhere on the surface of its associated Compton cone. With enough cones, the position of the Bragg peak can be inferred. The concept is tested in a multi-step Geant4 simulation, where a beam shift can be artificially generated and retrieved. This talk will focus on the simulation side of the project, its structure and results as well as recent developments.