ST 2: Detector Physics

Zeit: Dienstag 16:30–18:45 Raum: Phys-HS P

ST 2.1 Di 16:30 Phys-HS P

Geant4 simulation: Beam characterization by using a veto detector — •Christina Stergianou, Max Emde, Ronja Hetzel, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen University

Our working group develops a time-of-flight spectrometer to calculate the cross sections of nuclear reactions to identify the fragments that occur in ion therapy. For this purpose we measure the time of flight, the energy loss and the kinetic energy. We use a carbon beam on a plastic target. In front of the target is a movable veto detector which consists of four scintillator plates forming the sides of a square.
Therefore, this geometry allows gradual change of its diameter. At every diameter position we measure the particle ratios and calculate the differences. In this way the veto detector can be used additionally to measure the beam profile prior to the actual run. In this talk the simulation of the setup in Geant4 is presented. The results show that this detector can determine the origin of the beam centre with sufficient precision.

ST 2.2 Di 16:45 Phys-HS P

Test measurements of Scintillation Fibres for a Compton Camera — •Jonas Kasper[1], Achim Stahl[1], Kasia Rusiecka[2], and Aleksandra Wronska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Institute of Physics, Jagiellonian University, Cracow, Poland

Online monitoring of the Bragg-Peak position is one of the main challenges in hadron therapy. One of the most promising approaches to achieve an online monitoring is the detection of prompt gamma radiation. For this purpose a Compton Camera based on heavy scintillating fibres is developed.

The performance of the Compton Camera is strongly influenced by the properties of the fibres. Therefore different candidates for the fibre materials are tested and the properties of these candidates are evaluated. Further the quality of different fibres of the same material is tested.

The general concept of the Compton Camera and first results of fibre tests are presented.

ST 2.3 Di 17:00 Phys-HS P

Detection of Cherenkov Light from Compton-Scattered Electrons for Medical Applications — •Reimund Bayerlein, Ayesha Ali, Ivor Fleck, Waleed Khalid, Ayman Salman, Albert Walenta, and Ulrich Werthenbach — Universität Siegen

Modern nuclear medicine and radiation therapy require imaging systems for higher energy gamma rays up to several MeV. Especially monitoring dose delivery in radionuclide or proton/ion therapy would benefit from the ability to image high-energetic gamma rays.

Since Compton-scattering dominates in this energy-region, the momentum information of the gamma is lost. However, using a two-layer detection system (Compton Camera) where the high-energetic Compton-electron is detected in coincidence with the scattered gamma, the origin of the photon can be narrowed down to the surface of a cone. In order to perform this challanging measurement, a new concept is introduced using Cherenkov light from Compton-electrons in the optically transparent scattering layer. Coincident detection of Cherenkov photons on an array of Silicon Photomultipliers (SiPM) enables a reconstruction of the characteristic Cherenkov cone and allows to draw conclusions on the momentum information of the incident gamma.

Results of coincident Cherenkov light detection on a 4x4 SiPM-array with sub-nanosecond timing resolution will be presented. The spatial distribution of Cherenkov photons from collimated electrons in PMMA on the detector-array was investigated. The distribution of the number of photons per incident electron was studied using pulse-integral spectra.

ST 2.4 Di 17:15 Phys-HS P

A x-ray pinhole camera based on Timepix3 — •Michael Thiel[1], Gisela Anton[1], Christoph Bert[2], Thilo Michel[1], Jürgen Hössl[1], Karoline Kallis[2], Patrick Hufschmidt[1], and Sebastian Schmidt[1] — [1]Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg, Erwin-Rommel-Str. 1, 91058 Erlangen — [2]Universitätsklinikum Erlangen, Strahlenklinik, Medizinische Strahlenphysik, Universitätsstr.27, 91054 Erlangen

In this contribution we present results of first measurements with a Timepix3 detector positioned behind a pinhole in order to image radioactive sources for example to control brachytherapy treatments.

Interstitial brachytherapy of breast cancer requires catheters implanted into the breast. In these catheters a radioactive source is inserted and moved to certain dwell positions for an optimized dwell time in order to irradiate the tumor bed. The Timepix3 detector is a time-, energy- and position resolving active pixel detector. The pixel matrix consists of 256 x 256 square pixel with 55 micrometer pixel pitch. In contrast to the previous version of the Timepix detector, the Timepix3 does not work in camera mode but transfers the deposited energy (as time-over-threshold) and a timestamp to the readout almost instantaneously after a pixel has been triggered. The dead time is reduced to negligible amounts for the count rates expected in HDR-brachytherapy. During HDR-brachytherapy, an image of the radioactive source can be obtained with a pinhole placed in front of the Timepix3 detector.

15 min. break

ST 2.5 Di 17:45 Phys-HS P

Photon Dose Equivalent Measurements with Timepix3 Detector — •Jürgen Roth[1], Oliver Hupe[1], Hayo Zutz[1], Annette Röttger[1], Thilo Michel[2], and Patrick Hufschmidt[2] — [1]Physikalisch-Technische Bundesanstalt (PTB); Bundesallee 100; 38116 Braunschweig — [2]Erlangen Centre for Astroparticle Physics ECAP Friedrich-Alexander-Universität Erlangen-Nürnberg Erwin-Rommel-Str. 1 91058 Erlangen

The use of pixel detectors is a very promising approach for dosimetry in pulsed photon radiation fields. In these challenging fields, the pulse duration and the pulse dose rate range over several orders of magnitude. The scalable sensor area of active pixel detectors has the great advantage that each pixel acts as a separate detector. At low dose rates, aggregating the signals from all individual pixels improves counting statistics, thus also improving the uncertainty of dose measurement. At high dose rates, due to the small sensor area of a single pixel, the count rate is kept low and therefore the dead time and the likelihood of pile-ups is reduced. This contribution presents the first measurements in terms of ambient dose equivalent $H^*(10)$ performed using a TIMEPIX 3 detector with 256 x 256 pixels in PTB's reference fields. The comparability of the results with the DOSEPIX detector, which uses the same sensor material of 300 μm thick silicon semiconductor but a different pixel layout, are discussed as well.

ST 2.6 Di 18:00 Phys-HS P

Development of a scintillation and light transport simulator — •José Ricardo Avelar-Rivas and Jürgen Henniger — ASP, IKTP, TU Dresden, Zellescher Weg 19, 01069 Dresden, Germany

Accurate modeling and simulation of radiation detectors, among other benefits, lead to improvements in efficiency, increase reliability and sensitivity of the measuring technique, allows easy testing and decrease costs related to the experimental design and set up. In scintillation detectors is known that the link between the scintillator material, the light detector and the analyzer electronics is crucial for the development, improvement and optimization of scintillator-based detection systems. To simulate radiation detectors there are available several well-known Monte Carlo general purpose codes. Most of them were initially developed for individual or coupled particle-photon transport and do not allow the simulation of light generation and transport of optical photons through scintillation materials, perform an incomplete light transport simulation or the light transport simulation is inexistent. Therefore, a precise and fast scintillation and light transport simulator is being developed.

In its first stage, this work focuses on the simulation of light generation in scintillation materials and light photon transport through the material. In contrast with other existing Monte Carlo codes, this code will follow each light photon through all interactions within the scintillation material until it goes out of the crystal, it is absorbed or it reaches a selected surface. The results of the implementation will be shown in this presentation.

ST 2.7 Di 18:15 Phys-HS P

An Integrated System for 3D Energy Deposition Measurements in Hadron Therapy with the GEMPix Detector: First Results — •Johannes Leidner[1,2], Fabrizio Murtas[1,3], and Marco Silari[1] — [1]CERN, Geneva, Switzerland — [2]RWTH Aachen University, Aachen, Germany — [3]INFN-LNF, Frascati, Italy

The GEMPix detector is a gaseous detector with 2.8x2.8x0.3 cm^3 sensitive volume and three Gas Electron Multiplier (GEM) layers read out by a 55 μm pitch pixelated ASIC with 512 x 512 pixels (four naked Timepix readout chips). An integrated system consisting of a water phantom, the GEMPix detector and a reference ionization chamber has been developed to measure the 3D energy deposition in hadron therapy. This presentation reports on first measurements with the new system performed at the Italian National Center of Oncological Hadrontherapy (CNAO).

ST 2.8 Di 18:30 Phys-HS P

Ionization Quenching of Plastic Scintillators — •Thomas Pöschl, Martin Losekamm, Daniel Greenwald, and Stephan Paul — Technische Universität München

Plastic scintillators have a long tradition as radiation detectors in high-energy and medical physics. For high-ionizing radiation, however, their light output is not linearly dependent on the particle's energy deposition. To correctly reconstruct the deposited energy, the scintillator's response including this saturation effect—commonly called ionization quenching—must be known. We measured the response of two commonly used plastic scintillators to protons with energies of 30 MeV to 100 MeV and compared the data to different empirical quenching models. We calculated the evidence for each model and compared them using Bayes' factor. We also explored the empirical shape of the quenching response with a model-independent Markov-Chain Monte Carlo fit. This research was supported by the DFG cluster of excellence 'Origin and Structure of the Universe' (www.universe-cluster.de).