ST 9: Radiation Monitoring and Dosimetry

Time: Thursday 15:00–16:15 Location: PC 203

ST 9.1 Thu 15:00 PC 203

Neutron Dosimetry with Diamond Sensors — Claus Maximilian Bäcker[2], Christian Bäumer[2], Kevin Kröninger[1], Alina Landmann[1], •Jennifer Schlüss[1], Holger Stevens[1], and Jens Weingarten[1] — [1]TU Dortmund University — [2]West German Proton Therapy Center Essen

Neutron dosimetry is becoming increasingly relevant in proton therapy. From the neutrons released, conclusions can be drawn about the deposited energy in the body. However, the dosimetry is complicated because of their physical characteristics. One way to convert neutrons is using diamond sensors. The natural carbon isotope ^{12}C captures fast neutrons ($E_{kin} > 5$ MeV). ^{12}C produces alpha particles which can be detected in the diamond detector itself. The detection spectrum of diamond sensors is limited to fast neutrons. The goal is to make the detector sensitive to fast and thermal neutrons. To make the detector sensitive to thermal neutrons, an attempt is made to coat the detector with a converter material such as ^{6}LiF. ^{6}LiF has a large neutron absorption cross-section for thermal neutrons. The simulation platform Geant4 is used to test carbon capture reactions as a tool for further detector development. The results of the Geant4 simulation show that a diamond sensor coated with ^{6}LiF is suitable for measuring thermal and fast neutrons. A first prototype of a diamond sensor is ready to measure energy spectrums in proton therapy. To characterize the detection of the whole spectrum, the diamond sensor will be tested in a later step with a converter.

ST 9.2 Thu 15:15 PC 203

Neutron Detection With Coated Semiconductors — Kevin Alexander Kröninger, •Alina Johanna Landmann, and Jens Weingarten — TU Dortmund University, Department of Physics, Otto-Hahn-Str.4a, 44227 Dortmund

3He is a popular element in neutron detection. However, the world is suffering from an extreme 3He shortage which increases the need for alternative neutron detection methods. Coated semiconductors represent a promising alternative for 3He gas-filled detectors in high flux particle fields. Typical environments with high particle fluxes are represented by (research) reactors. To make use of semiconductor detectors in lower particle flux environments, the detection efficiency has to be increased significantly. In Geant4 simulations, we investigated various neutron-converting materials and possible detector layouts capable of increasing the detection efficiency of neutron-detecting silicon detectors. Based on the simulation results, a first prototype with a single converter layer on top of a silicon sensor was built to investigate the detection principle. This prototype additionally allows the investigation of more complex detector layouts which will be presented in this talk.

ST 9.3 Thu 15:30 PC 203

Dose gradients for calibration of planar dosimeters in modern radiotherapy — •Stevan Pecic[1], Strahinja Stojadinovic[2], Ivan Belca[1], Ljubomir Kurij[3], Borko Nidzovic[4], and Slobodan Devic[5] — [1]Faculty of Physics, University of Belgrade, Belgrade, Serbia — [2]Department of Radiation Oncology, University of Texas Southwestern Medical Center, Dallas TX, USA — [3]University Clinical Center, Belgrade, Serbia — [4]Institute of Oncology and Radiology of Serbia, Belgrade, Serbia — [5]Medical Physics Unit, McGill University, Montreal, Canada

This investigation explores the importance of dose gradients in achieving accurate calibration for modern planar dosimeters. The focus was on the advantages of using dose gradients while identifying novel methodologies for gradient-based calibration. Radiochromic films were subjected to both conventional and cutting-edge gradient-based calibration techniques, including an in-depth examination of physical wedge calibration. The study investigated the problem of achieving the desired calibration dose range by identifying optimal gradient placement and the required number of exposures. The insights gained from physical wedge calibration demonstrated promising outcomes in terms of reliability and useability. Optimization studies on wedge gradient positioning indicated the potential for achieving uniformity with just a few exposures. Additionally, valuable insights were obtained regarding the measurement resolution. In summary, the presented method proves the synergistic interplay of using gradients and optimization, holding promise for broader application in contemporary medical physics.

ST 9.4 Thu 15:45 PC 203

A Two Plane Proton Imaging System Using ATLAS IBL Pixel Detectors — •Hendrik Speiser[1], Claus Maximilian Bäcker[2], Christian Bäumer[2], Jana Hohmann[3], Kevin Kröninger[1], Isabelle Schilling[3], Helen Thews[1], and Jens Weingarten[1] — [1]TU Dortmund — [2]West German Proton Therapy Center Essen — [3]Formerly TU Dortmund

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 the residual energy distribution of protons after going through the patient is measured.

Former studies showed the feasibility of proton radiography using a single radiation hard ATLAS IBL pixel detector. In order to improve the energy 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 a so-called Two-Plane-System showed promising results. Thus, the aim of the project is to realize such a system and investigate the yielded energy resolution. To this purpose, first measurements were conducted at the West German Proton Therapy Centre in Essen.

This talk will briefly introduce the Two-Plane-System. Subsequently, first results concerning its realization with the ATLAS IBL pixel detector and future steps of the project are presented.

ST 9.5 Thu 16:00 PC 203

Optimizing the Energy Resolution of the ATLAS IBL Pixel Detector for Proton Imaging — Dennis Hermelyn, Kevin Kröninger, Hendrik Speiser, •Helen Thews, and Jens Weingarten — TU Dortmund, department of physics

In radiotherapy for cancer treatment, proton therapy is an important method because of the steep dose gradient which allows a conformale dose distribution in the tumour while protecting the healthy tissue. However, patient misalignment and the uncertainties of the calculated stopping power using the conversion of Houndsfield units lead to larger safety margins around the tumour.

One opportunity to decrease the uncertainties is the usage of proton radiography imaging. Investigations in the past showed the feasibility of proton range measurement with ATLAS IBL pixel detectors despite their limitations in energy resolution.

As part of a master thesis, the concept of superpixel tuning is studied to improve the energy resolution of the detector. A superpixel includes multiple pixel that have different fine tunings to measure adjacent small energy ranges. With that, besides the higher energy resolution a broader range of deposited energy in the detector can be measured. In addition a spatial resolution is maintained to obtain two dimensional images.

This talk will introduce the concept of superpixel tuning and discuss its technical realization. Subsequently, first results of the study about arising challenges in data post-processing are discussed. Finally, the achieved change of the energy resolution is shown.