ST 9: Detectors and Applications II

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

ST 9.1 Thu 14:00 ST-H4

Polyethylene naphthalate as alpha and heavy nucleus detection material — •Kim Tabea Giebenhain, Hans-Georg Zaunick, Roman Bergert, and Kai-Thomas Brinkmann — Justus-Liebig Universität, Gießen, Germany

Polyethylene naphthalate (PEN) is a material with intrinsic scintillation capabilities. Using a thin film of PEN read out by SiPM photo sensors has shown to be an excellent detector for alpha particles with potential applications for alpha spectroscopy. Measurements with alpha sources were conducted to determine the achievable energy resolution. Furthermore, optimization of the detector by means of optical surface coating was studied and results will be discussed.

ST 9.2 Thu 14:15 ST-H4

Technical aspects of simulation-based scatter correction in total-body Positron Emission Tomography (PET) imaging using the uEXPLORER PET scanner — •Reimund Bayerlein, Edwin K. Leung, Zhaoheng Xie, Eric Berg, Benjamin A. Spencer, Negar Omidvari, Qian Wang, Lorenzo Nardo, Simon R. Cherry, and Ramsey D. Badawi — University of California Davis

Positron Emission Tomography (PET) is a powerful tool for molecular imaging and has brought enhancements to biological research with widespread oncological and clinical adoption. The limited sensitivity of conventional PET scanners with a short axial field of view (AFOV) has been overcome by the uEXPLORER total-body PET scanner with a total AFOV of 194 cm. With a 15-68-fold increase in sensitivity and a spatial resolution of 3.0 mm the uEXPLORER can provide improved image quality, or reduced scan duration, or reduced radioactivity in the subject, or late time point imaging, or some combination of these. This state-of-the-art PET scanner constitutes a paradigm shift in nuclear medicine with the ability to address open questions in medicine and biology. However, the large number of detectors and the widened acceptance angle dramatically increase the data sizes, setting higher demands on the image reconstruction algorithms. Specifically, quantitative techniques for the correction of scattered events become more complex and computationally expensive. Due to the high number of lines of response (92×10^9) scatter correction by direct computation using the Klein-Nishina formula is challenging in total-body PET and Monte-Carlo (MC) methods are preferred. In the spirit of a technical note, this contribution will describe the procedure of scatter correction in total-body PET using MC simulations embedded in a framework using a list-mode ordered subset expectation maximization image reconstruction. The method was developed and validated using phantom studies conducted at the EXPLORER Molecular Imaging Center at UC Davis. In the presentation, mathematical, physical, and computational aspects will be highlighted.

ST 9.3 Thu 14:30 ST-H4

Two Photon Absorption - TCT: Characterisation of LGAD and other silicon sensors with a newly developed table-top TPA-TCT system — •Sebastian Pape[1,5], Esteban Currás[1], Marcos Fernández[1,2], Michael Moll[1], Raúl Montero[3], F. Rogelio Palomo[4], Christian Quintana[2], Ivan Vila[2], and Moritz Wiehe[1,6] — [1]CERN — [2]Instituto de Física de Cantabria — [3]Universidad del Pais Vasco (UPV-EHU) — [4]Universidad de Sevilla — [5]TU Dortmund University — [6]Universität Freiburg

The Two Photon Absorption – Transient Current Technique (TPA-TCT) uses fs-pulsed infrared lasers, with photon energies below the silicon band gap to only generate excess charge carriers in a small volume (approximately $1\mu m \times 1\mu m \times 20\mu m$) around the focal point of the laser beam. Therefore, a resolution in all three spatial directions is achieved to characterise silicon devices. Following the initial success of the method, a compact TPA-TCT setup was developed at CERN and first measurements were performed. The setup, measurements on non-irradiated and irradiated PIN diodes, and measurements on LGAD sensors with focus on the gain suppression mechanism will be presented.

ST 9.4 Thu 14:45 ST-H4

Studies towards a Time-of-Flight system equipped with LGADs — •Valerie Hohm[1], Kevin Kröninger[1], Sebastian Pape[1,2], and Jens Weingarten[1] — [1]TU Dortmund, Department of Physics — [2]CERN

Treatment planning is a crucial part in particle therapy of cancer in order to prevent healthy tissue from being irradiated falsely. One approach to improve the precision in proton therapy is the usage of proton computed tomography (pCT) for imaging. In such a system the paths of the protons as well as their energy loss in a phantom are measured to create an image of the phantom.

To measure the energy loss of protons, a Time-of-Flight (ToF) system can be used. The time an ionising particle needs to traverse two detectors in a given distance depends on its energy. For a precise energy measurement, the time resolution of the used detectors needs to be as small as possible.

In high-energy physics so called Low Gain Avalanche Detectors (LGADs) were developed for the ATLAS and CMS experiment upgrades. These *n*-in-*p* silicon sensors with an additional gain layer are designed for a typical charge amplification in the range of 10 to 30 for unirradiated LGADs which results in a time resolution up to 30 ps.

This talk focuses on the usage of LGADs in a ToF system. The feasibility of the system for the energy measurement in a proton tomography system will be presented as well as first measurements with a prototype.

ST 9.5 Thu 15:00 ST-H4

Single Photon Avalanche Diodes with an on-chip integrated preamplifier to improve single photon time resolution — •Jonathan Preitnacher[1], Wolfgang Schmailzl[1], Sergei Ageev[2], and Walter Hansch[1] — [1]Bundeswehr University Munich, Neubiberg, Germany — [2]The Moscow Engineering Physics Institute-Kashira Hwy, 31, Moscow, Russland, 115409

Silicon photomultiplier (SiPM) are solid-state detectors used for applications requiring high timing resolution and single photon sensitivity and play an important role in various measurement methods in high energy physics or in fields of medical imaging. To further improve the measurements in such applications, an enhanced single photon time resolution (SPTR) on the SiPM is required. For this we designed and implemented a small array of 4x4 single photon avalanche diodes (SPAD) in CMOS 350 nm technology and combined it with an on-chip integrated amplifier. The amplifier is a modified Regulated Common Gate (RCG) circuit and consists of an n-MOS based current follower with additional amplification stages that provides a stable signal and a fast slew rate, which are necessary conditions for a good SPTR. The standard characterization of the SiPM using parameters such as IV-curves, breakdown voltage, dark count rate, crosstalk, gain and afterpulsing shows acceptable results. Furthermore, first measurements of SPTR with a femtosecond laser and an oscilloscope with 10 GHz bandwidth show that it is possible to measure SPTR down to 42 ps FWHM. The results and different contributions to the SPTR are also discussed.

ST 9.6 Thu 15:15 ST-H4

Space applications - Measuring the effect of total ionization dose on field-effect transistors — •Erik Jozsef[1], Andreas Reeh[2], Hans-Georg Zaunick[2], Kai-Thomas Brinkmann[2], and Uwe Probst[1] — [1]Technische Hochschule Mittelhessen, Gießen, Germany — [2]Justus-Liebig University, Gießen, Germany

Compared to terrestrial applications the utilization of electronics in space environment meets several additional requirements to ensure functional reliability. One of the key requirements is the radiation hardness of the electronic components. Field-effect transistors are vital for modern electronics and are commonly used in power electronics. This presentation shows a method how radiation hardness of switching transistors can be investigated qualitatively. Parameters relevant to operation, such as threshold voltage, parasitic capacitances and leakage currents are to be measured. Measuring methods, process and equipment are presented. EU regional development funding via the EFRE scheme of the State of Hesse is gratefully acknowledged.