T 41: Halbleiterdetektoren / Strahlenhärte I

Zeit: Dienstag 16:30–19:00 Raum: Z6 - SR 2.010

T 41.1 Di 16:30 Z6 - SR 2.010

Direct Measurement of Optical Cross-Talk in SiPMs Using Light Emission Microscopy — •Derek Strom, Razmik Mirzoyan, and Jürgen Besenrieder — Max-Planck-Institut für Physik, München

Silicon Photomultipliers (SiPMs) are attractive light detectors for high energy and astroparticle physics experiments. They are compact in size, have fast (few ns) response time, operate at lower voltage compared to classical photomultiplier tubes, are insensitive to magnetic fields, and offer photon detection efficiencies of $> 40\%$. The optical cross-talk effect, whereby light emitted during the initial avalanche breakdown process may be absorbed by neighboring cells causing additional breakdowns, can degrade the measurement sensitivity of SiPMs. We describe ongoing work at the Max Planck Institute for Physics in Munich where we constructed a light emission microscopy setup to directly measure the emission due to optical cross-talk in SiPMs. We present an overview of our setup and measurements performed.

T 41.2 Di 16:45 Z6 - SR 2.010

Direct temperature measurement of SiPMs via IV diode characteristics — •Naomi Vogel, Michael Wagenpfeil, Sebastian Schmidt, Tobias Ziegler, and Thilo Michel — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg, Erwin-Rommel-Str. 1, 91058 Erlangen

Silicon photomultipliers (SiPMs) are semiconductor photo-detectors with single-photon resolution consisting of a pixel matrix of single avalanche photodiodes operated in Geiger-mode. Several characteristic parameters of the detector, e.g. the breakdown voltage, are temperature-dependent. Therefore, knowing the precise temperature at which a SiPM is operated is crucial for all characterization efforts. We present a method using a SiPM as a thermometer by deriving its temperature directly from the diode IV-characteristics which need to be calibrated in advance in a climate chamber under controlled ambient conditions.

T 41.3 Di 17:00 Z6 - SR 2.010

Characterization of SiPMs after radiation damage — •Sara Cerioli, Erika Garutti, Robert Klanner, David Lomidze, Joern Schwandt, and Milan Zvolsky — University of Hamburg, Hamburg, Germany

Silicon PhotoMultipliers (SiPMs) are light detectors with sensitivity to single photons. Thanks to their excellent performance (high gain and low noise), their robustness and insensitivity to magnetic fields, they find many applications in high energy physics experiments and many other fields. For applications in collider experiments one of the major limitation is due to radiation damage.

This talk present characterization procedures for SiPMs irradiated with reactor neutrons to fluences up to 10^{14} cm^{-2}. The measurements are performed in a controlled climate chamber, which can reach a temperature of 50° C. Blue pulsed laser light is used to illuminate the SiPM and the waveform recorded using a 2.5 GHz oscilloscope to investigate the signal response and the gain.

The increase of dark count rate and noise, and the decrease of signal of the irradiated SiPMs, as a function of the fluence, operational temperature and voltage are determined, and compared with results obtained by an analysis of the current-voltage characteristics of the same SiPMs. Moreover, it has been made also a detailed simulation of the SiPM, allowing a further comparison and comprehension of the results.

T 41.4 Di 17:15 Z6 - SR 2.010

Annealingverhalten von bestrahlten p-Typ Streifendetektoren — •Leena Diehl, Riccardo Mori, Ines Messmer, Marc Hauser, Ulrich Parzefall und Karl Jakobs — Universität Freiburg

Hochenergetische Teilchen verursachen Schäden in Siliziumdetektoren, was zu Defektbildung und dadurch zu einer steigenden effektiven Dotierungskonzentration in p-Typ Detektoren führt. Dies resultiert einerseits in schlechterem Ladungstransport und Ladungssammlung und andererseits in einer steigenden Verarmungsspannung und einem größerem Leckstrom. Die entstandenen Gitterdefekte sind beweglich, wobei die Beweglichkeit stark von der Temperatur abhängig ist.

In diesem Vortrag werden Langzeitstudien zu verschiedenen Schadensparametern in Abhängigkeit der Ausheilungszeit bei Raumtemperatur und 60° C in p-Typ Streifendetektoren, die mit bis zu $3e14\,\frac{n_{eq}}{cm^2}$ bestrahlt wurden, präsentiert. Die Messungen beinhalten das Verhalten der Ladungssammlung, des Leckstrom und der effektiven Dotierungskonzentration sowie den Vergleich der Parameter bei den unterschiedlichen Temperaturen. Insbesondere liegt der Fokus auf der Suche nach Erklärungen zu stark abweichenden Werten von vorherig bekannten Werten in ähnlichen Sensoren.

T 41.5 Di 17:30 Z6 - SR 2.010

Labormessungen von bestrahlten und unbestrahlten Reinerstrukturen — Silke Altenheiner[1], Sascha Dungs[1,2], Andreas Gisen[1], Claus Gössling[1], Valerie Hohm[1], Reiner Klingenberg[1], Kevin Kröninger[1], •Anna-Katharina Raytarowski[1] und Mareike Weers[1] — [1]TU Dortmund, Lehrstuhl für Experimentelle Physik IV — [2]CERN

Aufgrund der erhöhten Luminosität des High Luminosity LHC wird ein neuer Spurdetektor, der sogenannte Inner Tracker (ITk), für das ATLAS-Experiment benötigt.

Der aktuelle Spurdetektor besteht unter anderem aus planaren n^+-in-n-Silizium-Pixelsensoren. Für eine mögliche Effizienzsteigerung beim Nachweis von Teilchen wurden verschiedene Pixelimplantationen entwickelt und auf Testsensoren angeordnet. Diese werden als Reinerstrukturen bezeichnet.

Mit Protonen bzw. Neutronen bestrahlte sowie unbestrahlte Reinerstrukturen wurden mit IV- , CV- und Quellenmessungen untersucht.

In diesem Vortrag werden die Ergebnisse dieser Messungen vorgestellt.

T 41.6 Di 17:45 Z6 - SR 2.010

The GeMSE Low-Background Facility for Meteorite and Material Screening — •Diego Ramírez García — Albert-Ludwigs-Universität Freiburg, Freiburg im Breisgau, Germany

Low-background gamma-ray spectrometry is a widely used method in different scientific disciplines. It serves for, e.g., the assessment of the radiopurity of materials for rare event search experiments, while in the field of Geology it is crucial to characterize meteorite samples. GeMSE (Germanium Material and meteorite Screening Experiment) is an interdisciplinary project addressing both of these topics. Using a p-type high-purity germanium (HPGe) detector installed in the Vue-des-Alpes underground laboratory ($\sim$ 620 m.w.e. depth), the GeMSE facility features several layers of shielding, a permanent N_2-flushing in a closed glove-box and an active muon veto. As a result, the background levels are highly competitive: $<$ 240 counts/day in the 100 - 2700 keV energy range.
GeMSE is ideally suited for the ongoing material selection campaign for the upcoming XENONnT dark matter detector. This talk will describe the facility, the calibration methods and the data analysis, and will present some results of recently measured samples.

T 41.7 Di 18:00 Z6 - SR 2.010

Shallow angle measurements on prototypes for the CMS Phase II pixel sensors — •Caroline Niemeyer[1], Aliakbar Ebrahimi[1], Finn Feindt[1], Erika Garutti[1], Daniel Pitzl[2], Jörn Schwandt[1], Georg Steinbrück[1], and Irene Zoi[1] — [1]Institute for Experimental Physics, Hamburg University, Luruper Chaussee 149, D-22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, D-22607 Hamburg

For the High-Luminosity LHC the irradiation level that the detectors will have to withstand will be reaching a 1 MeV neutron equivalent fluence of 2.3×10^{16} neq/cm^2 and a total ionizing dose of 10 MGy at the innermost part of the CMS pixel detector. The upgraded Phase-2 Inner Tracker is designed to maintain or improve the tracking and vertexing capabilities under these high pileup and radiation conditions. Various pixel sensor designs with pixel sizes of 50×50 μm^2 and 100×25 μm^2 have been manufactured on silicon wavers with an active thickness of 150 μm. They have been bump bonded to ROC4Sens read-out chips and are evaluated at the DESY test beam facilities. The shallow angle method is used to measure the depletion depth and the charge collection efficiency as a function of the distance from the readout pixels. The edge-on method, in which the beam transverses the sensor parallel to its surface, allows for in-silicon tracking and thus to obtain

the intrinsic position resolution of the silicon sensors and to study the influence of δ-electrons on the position resolution without using an external reference tracking detector. The results of these measurement methods for the new pixel sensor designs will be presented.

T 41.8 Di 18:15 Z6 - SR 2.010

Modulbauentwicklung für das Phase-II-Upgrade des äußeren CMS-Spurdetektors — Tobias Barvich, Alexander Dierlamm, Ulrich Husemann, •Stefan Maier und Marius Neufeld — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Für den äußeren Bereich des zukünftigen CMS-Spurdetektors werden im Rahmen des Phase-II-Upgrades sowohl Siliziumpixel-, als auch -streifensensoren in Detektormodulen eingesetzt. Diese Module bestehen aus zwei dicht übereinander liegenden Sensoren und sind damit in der Lage Teilchen mit hohem Transversalimpuls bereits im Auslesechip zu identifizieren. Dies ist Startpunkt für einen neuartigen spurbasierten Trigger, mit dem interessante Ereignisse angereichert werden können.

Dieses Konzept erfordert eine präzise Positionierung der Sensoren sowie eine verlässliche Qualitätskontrolle während des Modulbaus. Der Vortrag gibt eine Übersicht über die einzelnen Montageschritte sowie Qualitätskontrollen während dieser Fertigung anhand von Prototypen. Es werden die Klebeschritte mit einer halb-automatisierten Auftragestation sowie eine optische und lasergestützte Vermessung der relativen Sensorpositionen innerhalb eines Moduls näher erläutert.

T 41.9 Di 18:30 Z6 - SR 2.010

Enhanced lateral drift sensors: concept and development — •Anastasiia Velyka and Hendrik Jansen — DESY, Hamburg

Future experiments in particle physics require few-micrometer position resolution in their tracking detectors. Silicon is today's material of choice for high-precision detectors and offers a high grade of engineering possibilities. Instead of scaling down pitch sizes, which comes at a high price for increased number of channels, our new sensor concept seeks to improve the position resolution by increasing the lateral size of the charge distribution already during the drift in the sensor material. To this end, it is necessary to carefully engineer the electric field in the bulk of this so-called enhanced lateral drift (ELAD) sensor. This is achieved by implants with different values of doping concentration deep inside the bulk which allows for modification of the drift path of the charge carriers in the sensor.

In order to find an optimal sensor design, detailed simulation studies have been conducted using SYNOPSYS TCAD. Process simulations are used to provide the production-determined shapes of the implants in order to allow for a realistic modelling.

Results of a geometry optimisation are shown realising an optimal charge sharing and hence position resolution. A position resolution of a few micrometer is expected by using deep implants without relying on a Lorentz drift or tilted incident angle. Additionally, a description of the multi-layer production process is presented, which represents a new production technique allowing for deep bulk engineering.

T 41.10 Di 18:45 Z6 - SR 2.010

Optimization of bias rail implementations for segmented silicon sensors — Marta Baselga, Alexander Dierlamm, Thomas Müller und •Daniel Schell — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Bias rails are fundamental design features of segmented strip as well as pixelated silicon sensors that are necessary to distribute the ground potential from the bias ring to the implants. However, adding these rails is usually accompanied with a certain degree of efficiency loss and modification of the electric field which could result in an early breakdown of the sensor.

TCAD simulations provide a deeper insight into the process of how the electric field evolves and how charge is collected. By simulating various sensor layouts with different parameter settings an optimized design can be obtained.

This contribution summarizes an extensive simulation study looking for an optimal set of design parameters to maximize the breakdown voltage and the charge collection efficiency of the sensor. The results are complemented by measurements performed at the DESY test beam facility in Hamburg, Germany.