T 64: Halbleiterdetektoren: Forschung und Entwicklung 2

Zeit: Dienstag 16:45–19:00 Raum: ZHG 001

T 64.1 Di 16:45 ZHG 001

Optical test stand for SiPM characterisation — •Benjamin Glauss, Thomas Hebbeker, Carsten Heidemann, and Markus Merschmeyer — III. Physikalisches Institut A, RWTH Aachen University

Silicon photomultipliers (SiPMs) are versatile and hence interesting semiconductor based detectors for detection of single photons. This makes SiPMs ideal detectors for particle and astroparticle physics experiments. The SiPM characteristics include absolute and relative photon detection efficiency (PDE) and furthermore noise phenomena such as after pulsing and optical crosstalk as well as thermal noise. We have developed a test device, capable of measuring the above in a compact setup featuring devices for pulsing single wavelength LEDs and for providing constant white light that are designed especially for these testing purposes. Readout is carried out via QDC and FADC hardware and all testing mentioned above is integrated in one single setup, running fully automated. One main focus is on the resolution of the optical monochromator for studying the SiPM properties as a function of wavelength. The optical test stand for precision measurements on SiPM characteristics as well as results of these measurements are presented.

T 64.2 Di 17:00 ZHG 001

Studies on afterpulses and saturation of SiPM with fast UV light pulses — •Marco Szalay for the CALICE-Germany-Collaboration — Max-Planck-Institut für Physik, München — Technische Universität München

Arrays of novel avalance photodiodes operated in geiger mode called Silicon Photo Multipliers (SiPM) are capable of detecting light with single photon detection efficiency. Their smaller form factor and insensitivity to magnetic fields make them an interesting alternative to photomultiplier tubes (PMT) in fields ranging from medical imaging to high energy physics.

In this talk, the time structure of signals from a SiPM device, standalone and coupled to a plastic scintillator, is investigated. The time distribution of single photons created by short-pulsed intensity-controlled UV light sources and detected by the SiPM device is reconstructed on a per event basis. By decomposing the recorded waveforms into individual geiger discharges one can obtain the time of arrival with nanosecond precision. This way late components of the signal shape like afterpulses and instantaneous and delayed contributions from the scintillator can be disentangled. The precision of the measurement of the SiPM saturation was optimized and can be used for calibration in order to recover the linearity of such devices on a broader intensity range.

T 64.3 Di 17:15 ZHG 001

Study of detection efficiency distribution and areal homogeneity of SiPMs — •Michal Tesař, Christian Jendrysik, Frank Simon, Jelena Ninković, Hans-Günther Moser, and Rainer Richter — Max Planck Institut for Physics, Munich, Germany

Silicon photomultipliers (SiPM) are a very attractive option for light detection in highly granular scintillator-based sampling calorimeters in future high energy physics experiments at Linear Colliders (ILC, CLIC). The CALICE collaboration has already successfully operated a 1 m^3 physics prototype with about 8 000 small scintillator tiles, each read out by a SiPM, demonstrating the power of this new technology. We have developed a setup for the measurement of relative photon detection efficiency (PDE), crosstalk probability and other important characteristics of SiPMs to study the performance of different devices. The precise positioning system of the setup together with excellent focusing of the light source provides scanning capabilities that allow a study of the spatial distributions of PDE, crosstalk etc. over large sensor areas with sub-pixel resolution. A brief description of the setup, final results of a study of two types of Hamamatsu MPPCs and first scans of SiMPl devices, developed at MPI Semiconductor Lab, will be presented.

T 64.4 Di 17:30 ZHG 001

Charakterisierung von HV-MAPS — •Ann-Kathrin Perrevoort[1], Ivan Peric[2] und Dirk Wiedner[1] — [1]Physikalisches Institut, Heidelberg — [2]ZITI, Mannheim

Im MU3E-Experiment soll der leptonzahlverletzende Zerfall des Muons in drei Elektronen mit einer um vier Größenordnungen verbesserten Sensitivität gegenüber dem Vorgängerexperiment gemessen werden.

Hierfür wird ein Detektor mit hoher Impuls- und Vertexauflösung benötigt. Wesentlicher Bestandteil des Spurdetektors bilden HV-MAPS (high voltage monolithic active pixel sensors). Diese Silizium-Pixel-Sensoren besitzen integrierte Elektronik und Null-Unterdrückung. Durch Anlegen einer Hochspannung ($\sim$60 V) bildet sich eine Verarmungszone aus. Ein einfallendes Teilchen erzeugt durch Ionisation Elektron-Loch-Paare. Diese Ladungen werden in der Verarmungszone durch Drift aufgesammelt. Dieser Prozess ist relativ schnell (O(μs)) und erlaubt somit einen Detektorbetrieb bei hohen Raten. Da sich die Verarmungszonen zweier benachbarter Pixel berühren, haben die HV-MAPS einen Füllfaktor von nahezu 100%. Zudem ist es möglich, das Substrat der HV-MAPS zu dünnen, da die aktive Region des Sensors weniger als 30 μm dick ist. Somit kann die Menge an Material im Detektor und dadurch die Vielfachstreuung verringert werden.

Es werden hier Messungen an einem im neuen 180nm-HV-CMOS-Prozess hergestellten Prototypen vorgestellt sowie Studien zu Signal-zu-Untergrundverhältnis, Energie- und Doppelpulsauflösung und Pixel-zu-Pixel-Variationen gezeigt.

T 64.5 Di 17:45 ZHG 001

Track Fitting based on Broken Lines for the MU3E Experiment — •Moritz Kiehn, Niklaus Berger, and Andre Schöning — Physikalisches Institut, Universität Heidelberg, Germany

The MU3E project is a recently proposed experiment to search for the lepton flavour changing decay $\mu \rightarrow eee$. In the Standard Model this decay can occur on the loop-level via neutrino mixing. However, it is highly suppressed with an unobservable branching ratio of $< 10^{-50}$. An observation would be a clear sign of new physics. In many models for physics beyond the Standard Model the branching ratio is greatly enhanced (up to 10^{-12}).

The current MU3E detector design consists of a electron spectrometer build with four cylindrical layers of thin silicon pixel sensors in a solenoidal magnetic field. The low electron momentum (up to about 53 MeV) makes multiple scattering the biggest source of measurement uncertainty. To reach the required sensitivity, a very high track resolution is required. We investigate a new track fitting algorithm based on broken lines [1], that directly takes scattering angles into account. Results of simulation studies for the fit performance in the MU3E experiment are presented.

[1] V.Blobel, NIM A, 566 (2006), 14-17

T 64.6 Di 18:00 ZHG 001

Pixel sensors capacitance determination with PixCap chip — •Miroslav Havranek, Fabian Hügging, Hans Krüger, and Norbert Wermes — Physikalisches Institut, Universität Bonn

The innermost layers of the ATLAS experiment are occupied by a pixel detector, which plays an essential role in the ATLAS tracking system. After years of operation, the sensors and the read-out electronics of the pixel detector will degrade due to the radiation damage. Also, due to the planned LHC luminosity upgrades, the pixel detector will have to cope with higher hit rates and therefore will need an upgrade. Currently three competing sensor technologies exist: silicon planar, silicon 3D and diamond sensors. One of the key parameters of a sensor is the capacitance it couples to the read-out electronics, which determines the noise performance. Knowledge of the pixel capacitance for each sensor type allows a direct comparison of the various sensor technologies. Since the expected pixel capacitance is in order of hundreds femtofarads, a precise capacitance measurement of the fine pitch ATLAS pixel sensors can not be easily achieved by conventional methods. To resolve this problem, we developed the PixCap chip which directly interfaces with sensor pixels and thus performs precise on-sensor capacitance measurement with an accuracy of a few femtofarads. In this presentation, the PixCap design will be introduced and capacitance measurement results with various ATLAS sensor types will be discussed.

T 64.7 Di 18:15 ZHG 001

Der Galatea Teststand - Analyse von Oberflächeneffekten

in koaxialen n-Typ Germanium Detektoren — •Sabine Irlbeck für die GeDET-Kollaboration — Max-Planck-Institut für Physik, München, Deutschland

Messungen mit einem speziell entwickelten 19-fach segmentierten n-Typ High-Purity Germanium Detektor unter Verwendung eines eigens dafür entwickelten Teststands dienen der Untersuchung von oberflächennahen Ereignissen. Ziel ist es, solche Ereignisse in diesem Detektor zu charakterisieren, um damit Ereignisse in Experimenten zu identifizieren, in denen sie als Untergrundereignisse auftreten. Der experimentelle Aufbau sowie erste Messungen mit einer Sr90 Quelle werden präsentiert.

T 64.8 Di 18:30 ZHG 001

Determination of the crystal axes in segmented germanium detectors — Iris Abt, Allen Caldwell, Bela Majorovits, and •Oleksandr Volynets — Max-Planck-Institut für Physik, München, Germany

High-purity germanium detectors are used in a variety of applications in particle and nuclear physics. For some applications, the shapes of the electric pulses collected on the electrodes are of interest. A comparison between measured and simulated pulses may reveal interesting intrinsic properties of the germanium detectors. However, the pulses are sensitive to detector parameters such as the position of the crystallographic axes. The $\langle 001 \rangle$ axis is usually aligned with the z axis of the detector, the position of the $\langle 110 \rangle$ and $\langle 100 \rangle$ axes are unknown upon delivery.

A new method to determine the crystallographic axes in an n-type ϕ-segmented germanium detector is presented. The method is based on comparing measured to simulated event rates in the segments. The full absorption peaks for gammas originating from ^{60}Co or ^{228}Th sources were used for the analysis presented here. The accuracy of this method is best for the symmetric case when the source is aligned with the geometrical axis of the crystal. However, good results are also obtained for other source positions, if the position is well known.

T 64.9 Di 18:45 ZHG 001

Ladungssammlung an der Si-SiO$_2$-Grenzschicht in Silizium Streifensensoren vor und nach 1 MGy Gammastrahlung — •Thomas Pöhlsen, Robert Klanner, Sergej Schuwalow, Jörn Schwandt und Jiaguo Zhang — Institut für Experimentalphysik, Universität Hamburg

Bei segmentierten p+-n-Siliziumzählern kann sich an der Si-SiO$_2$ Grenzfläche eine Elektron-Akkumulationsschicht ausbilden, die die Feldverteilung und die Ladungssammlung maßgeblich beeinflussen kann. Die Größe der Akkumulationsschicht hängt von den elektrischen Randbedingungen an der SiO$_2$ Oberfläche, den Oxidladungen und den geladenen Zuständen an der Si-SiO$_2$ Grenzschicht ab. Röntgenstrahlen erzeugen Oxid- und Grenzschichtladungen. Nach Bestrahlung mit einer Dosis von 1 MGy überdeckt die Akkumulationsschicht fast vollständig den Bereich zwischen den p+ Bereichen.

Mit Hilfe der Transient Current Technique (TCT) werden die Pulsformen an den einzelnen Streifen, die durch fokussiertes Laserlicht der Wellenlänge 660 nm erzeugt werden, untersucht.

Es wird festgestellt, dass es nahe der Oberfläche zu Ladungsverlusten kommen kann, die nicht nur von der Strahlendosis abhängen, sondern auch von der angelegten Spannung, der Vorgeschichte (Spannung von tieferen oder höheren Werten angefahren) aber auch von der Luftfeuchtigkeit. Die Messungen erlauben es auch Rückschlüsse auf das "weighting potential"nahe der Si-SiO$_2$ Grenzfläche und die Größe der Akkumulationsschicht zu ziehen. Eine qualitative Erklärung für das Auftreten der Ladungsverluste wird gegeben.