T 43: Halbleiter: Belle, Germanium, Diamant

Zeit: Dienstag 16:45–18:45 Raum: G.10.05 (HS 7)

T 43.1 Di 16:45 G.10.05 (HS 7)

Test of Electrical Multi-Chip Module for Belle II Pixel Detector — •Felix Müller for the Belle II-Collaboration — Max-Planck-Institut für Physik, München

DEPFET pixel detectors offer excellent signal to noise ratio, resolution and low power consumption with few material. They will be used at Belle II and are a candidate for an ILC vertex detector. The Electrical Multi-Chip Module (EMCM) has been designed to study the back end of line (BEOL) and the metal layer interconnectivity of the DEPFET matrix production for Belle II. The electrical characterization of the EMCM allows studying the signal and control line routings. Having verified the integrity of the electrical network three different types of ASICs are flip-chipped on the EMCM. The electrical characterization of the assembled module allows the analysis and optimization of the ASICs in terms of data integrity. The EMCM serves also as a mechanical test structure to exercise flip-chip and wire bonding. Finally a small DEPFET prototype matrix is mounted on the module which acts as silicon PCB. Consequently, the full study of the complete readout chain can be done.

An overview of the EMCM concept and first characterization results with the latest ASIC generation will be presented.

T 43.2 Di 17:00 G.10.05 (HS 7)

Test of the metallization of the EMCM for Belle II Pixel Detector — •Daniel Klose[1], Ladislav Andricek[1], Christian Koffmane[1], Jelena Ninkovic[1], Rainer Richter[1], Florian Schopper[1], Andreas Wassatsch[1], Paola Avella[2], Christian Kiesling[2], Hans-Günther Moser[2], Felix Müller[2], and Manfred Valentan[2] for the Belle II-Collaboration — [1]Halbleiterlabor der Max-Planck-Gesellschaft, München, Deutschland — [2]Max-Planck-Institut für Physik, München, Deutschland

In order to achieve excellent single point resolution and to keep multiple scattering at a minimum with low material budget, DEPFET sensors were chosen as inner two layers of the VXD (Vertex Detector) for the Belle II experiment. DEPFET sensors also offer a low power consumption and a high signal to noise ratio, even for thin sensors. The Electrical Multi-Chip Module (EMCM) was designed in the interest of studying especially the metal layer interconnectivity for the steering and regulation of the DEPFET matrix of the detectors for Belle II. The main goal of this study of the metal system is to get insights on the feasibility and reliability of the technology and collect information on its production yield. This study is done on wafer level. Specially designed test structures and testing strategies, developed to be able to identify all possible causes of reduction of the yield, will be presented. Finally results obtained from the optimized metallization technology will be shown.

T 43.3 Di 17:15 G.10.05 (HS 7)

The Belle II VXD production database — •Manfred Valentan[1], Benedikt Würkner[2], Federico Pilo[3], Martin Ritter[1], and Bernhard Leitl[2] for the Belle II-Collaboration — [1]Max-Planck-Institut für Physik, München — [2]Institut für Hochenergiephysik, Wien — [3]Istituto Nazionale di Fisica Nucleare, Pisa

The construction and commissioning of the Belle II Vertex Detector (VXD) is a huge endeavor involving a large number of valuable components. Both subsystems PXD (Pixel Detector) and SVD (Silicon Vertex Detector) deploy a large number of sensors, readout electronic parts and mechanical elements. These items are scattered around the world at many institutes, where they are built, measured and assembled. One has to keep track of measurement configurations and results, know at any time the location of the sensors, their processing state, quality, where they end up in an assembly, and who is responsible. These requirements call for a flexible and extensive database which is able to reflect the processes in the laboratories and the logistics between the institutes.

This talk introduces the database requirements of a physics experiment using the PXD construction workflow as a showcase, and presents an overview of the database “HephyDb”, which is used by the groups constructing the Belle II VXD.

T 43.4 Di 17:30 G.10.05 (HS 7)

Comprehensive studies on irradiated single-crystal diamond sensors — •Martin Stegler — DESY, Zeuthen, Germany

Single-crystal diamond sensors are used as part of the Beam and Radiation Instrumentation and Luminosity (BRIL) projects of the CMS experiment. Due to an upgrade of the Fast Beam Conditions Monitor (BCM1F) these diamond sensors are exchanged and the irradiated ones are now used for comprehensive studies. Current over voltage (IV), current over time (CT) and charge collection efficiency (CCE) measurements were performed for a better understanding of the radiation damage incurred during operation and to compensate in the future. The effect of illumination with various light sources on the charge collection efficiency was investigated and led to interesting results. Intensity and wavelength of the light were varied for deeper insight of polarization effects.

T 43.5 Di 17:45 G.10.05 (HS 7)

Messungen zur Ladungssammlung in pCVD-Diamanten mit der *transient-current technique* (TCT) — Arnulf Quadt, Jens Weingarten, Lars Graber und •Helge Christoph Beck — II. Physikalisches Institut, Georg-August-Universität Göttingen

Für zukünftige Hochenergieteilchenexperimente mit höherer Luminosität werden strahlenharte Detektormaterialien für Spurdetektoren benötigt. Industriell mit dem *chemical vapour deposition* (CVD) Verfahren hergestellte Diamanten könnten dafür in Frage kommen. Diese werden je nach Wachstumsverfahren in einkristalline (scCVD) oder polykristalline (pCVD) Diamanten unterschieden. Bei der Herstellung entstehen besonders bei pCVD Diamanten viele Korngrenzen, an denen driftende Ladungen eingefangen werden können. Um die Eignung als Sensormaterial bestimmen zu können, muss daher das Ladungssammlungsverhalten studiert werden, z.B. mit TCT Messungen: Mit einer α-Quelle werden dazu Elektron-Loch Paare nahe einer Elektrode im Material erzeugt. Durch die Nähe zur Elektrode wird eine Sorte Ladungsträger beinahe sofort gesammelt, sodass mit einem angelegten elektrischen Feld der durch die andere Ladungsträgersorte induzierte Strom gemessen werden kann. Aus der Form des Signals kann auf viele Eigenschaften des Materials, z.B. auf die Mobilität der Ladungsträger und die *charge collection distance* (mittlere Strecke, die von Ladungsträgern zurück gelegt wird, bevor sie eingefangen werden), geschlossen werden.

In diesem Vortrag werden Ergebnisse von TCT Messungen mit pCVD Diamanten präsentiert.

T 43.6 Di 18:00 G.10.05 (HS 7)

Graphitsäulen als Elektroden für 3D Diamantsensoren — •Lars Graber, Jörn Grosse-Knetter, Arnulf Quadt und Jens Weingarten — II. Physikalisches Institut, Georg-August-Universität Göttingen

Diamant ist wegen seiner Strahlenhärte ein Sensorkandidat für zukünftige Spurdetektoren, z.B. am HL-LHC am CERN. Durch seine große Bandlücke ist er relativ rauscharm, allerdings ist auch die deponierte Ladung im Vergleich zu Silizium deutlich geringer. Zusätzlich kommt es besonders in polykristallinen künstlichen Diamanten (pCVD) zu Ladungsverlusten durch Ladungsfallen. Daher ist eine wichtige Kenngröße von Diamant die „charge collection distance“ (CCD). Diese gibt die mittlere Distanz an, um welche sich das Elektron-Loch-Paar voneinander entfernen kann, bevor sie z.B. durch Ladungsfallen eingefangen werden. Für eine möglichst vollständige Ladungssammlung sollte der Abstand der Elektroden nicht wesentlich größer sein als die CCD.

pCVD Diamanten weisen im Allgemeinen eine deutlich kleinere CCD als ihre Dicke auf. Daher bietet sich an, die Elektroden nicht auf der Oberfläche aufzubringen (2D), sondern im Sensormaterial wachsen zu lassen (3D). Hierfür eignen sich Elektroden aus Graphit, welche mittels eines Femtosekundenlasers im Diamanten erzeugt werden. Untersuchungen dieser unter verschiedenen Bedingungen selbst erzeugten Strukturen mittels Raman-Spektroskopie werden präsentiert.

T 43.7 Di 18:15 G.10.05 (HS 7)

Investigation of sapphire detector designed for single particle detection — •Olena Karacheban[1,2], Konstantin Afanaciev[3], Maria Hempel[1,2], Hans Henschel[1], Wolfgang Lange[1], Jessica Leonard[1], Itamar Levy[4], Wolfgang Lohmann[2,5], Olga Novgorodova[6], and Sergej Schuwalow[7] — [1]DESY, Zeuthen, Germany — [2]Brandenburg University of Technology, Cottbus, Germany

— [3]NCPHEP, Minsk, Belarus — [4]Tel Aviv University, Tel Aviv, Israel — [5]CERN, Geneva, Switzerland — [6]Technical University, Dresden, Germany — [7]DESY, Hamburg, Germany

For beam halo and beam loss monitoring systems at accelerators extremely radiation hard sensors are needed. Single crystal sapphire is a promising material. Industrially grown sapphire wafers are available in large sizes, are low in cost and can be operated at room temperature. Currently sapphire sensors are used for a beam-loss monitor at FLASH,detecting bunches of particles crossing the sensors simultaneously. Here we present a multichannel detector designed for single minimum ionising particle detection using a stack of sapphire plates. The performance of the detector was studied in a 5 GeV electron beam at DESY-II. The detector was operated together with the EUDET beam telescope, which allowed the reconstruction of the position of the hits at the detector. For each sapphire plate the charge collection efficiency was measured as a function of the bias voltage and the signal size as a function of the hit position with respect to the metal electrodes. The data confirms that mainly electrons contribute to the signal. Based on these results the next generation sapphire detector will be designed.

T 43.8 Di 18:30 G.10.05 (HS 7)

Optimization of the geometry of broad energy germanium detectors — •Marco Salathe — Max Planck Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

Broad energy germanium (BEGe) detectors are employed in many different scientific experiments and widely used in industrial applications. A circular contact is implanted on a base of the cylindrical shaped detector. This circular contact is used as a read out electrode and is surrounded by a passivated groove that separates it from the high voltage electrode, which spans over the remaining surface. The size of the read out electrode and the groove geometry are assumed to have a major impact onto the energy resolution, pulse shape discrimination and energy threshold.

To quantify the impact of the detectors geometry on its performance, the read out contacts size of two BEGe detectors was modified several times. The geometry of the detector was optimized prior to each reprocessing step through the use of simulations. For each configuration, the detectors performance was analysed through distinct measurements.

Some general consideration about analysis tools, simulation libraries and first results of this study will be presented in this talk.