T 92: Strahlenschäden (gemeinsam mit HK)

Zeit: Mittwoch 16:45–19:00 Raum: F 234

T 92.1 Mi 16:45 F 234

Proton-energy dependent damage to Si sensors — •Elena Donegani, Eckhart Fretwurst, and Erika Garutti — University of Hamburg

Silicon bulk damage is the limiting factor of detector lifetime for future HL-LHC experiments. Nowadays, the knowledge of radiation-induced bulk defects and their effects on the sensor properties are especially limited after proton irradiation. Therefore, 200μm silicon pad-sensors (n- and p-type bulk materials: FTH, MC and dd-FZ) were irradiated with 23 MeV, 188 MeV and 23 GeV protons (with $\Phi_{neq} \leq 3{\cdot}10^{14}$cm^{-2}). I-V, C-V-f and TSC measurements were performed at subsequent annealing steps at 353K. In particular, the main experimental challenges will be addressed regarding the TSC filling temperature (at T=10K) and filling forward current (I≈1mA). The TSC spectra are analyzed with a revisited SRH statistics, modified to account for defect clusters after hadron irradiation.
A proton-energy dependent introduction of defects is found, except for deep cluster-related defects. Shallow defects are present in different concentrations according to the material type. A correlation is notable between the leakage current and the concentrations of three deep defects (the V2, E5 and H(220K) defects). Other defects affect the space charge, with positive contributions from e.g. the E(30K) and BiOi defects, or negative contributions from deep acceptors (namely the H(116K), H(140K) and the H(152K)).
This information will be exploited as input for a physics-based and measurement-driven radiation damage model.

T 92.2 Mi 17:00 F 234

X-ray dose and electric field dependence of oxide charges at the Si-SiO$_2$ interface of high-ohmic Si — •Ioannis Kopsalis, Eckhart Fretwurst, Erika Garutti, Robert Klanner, and Joern Schwandt — Institute for Experimental Physics, Hamburg University, Luruper Chaussee 149, D-22761 Hamburg, Germany

The surface radiation damage of the Si-SiO$_2$ system on high-ohmic Si has been investigated. Circular p- and n-MOSFETs biased to an electric field of about 500 kV/cm at the Si-SiO$_2$ interface, have been irradiated up to an X-ray dose of about 17 kGy(SiO$_2$). From the measured drain-source current the change of oxide charge density during irradiation has been determined. Cycling the gate voltage before and after irradiation the oxide charge density N$_{ox}$, the interface traps N$_{it}$ and the charging and discharging of border traps as function of X-ray dose and field direction has been determined. The study has been performed for two field directions at an electric field of 500 kV/cm, which according to TCAD simulations is the maximum field at the Si-SiO$_2$ interface in segmented sensors under normal operation.
The N$_{ox}$ increases and decreases as function of dose depending on the field direction in the SiO$_2$. An increase of N$_{it}$ has been observed for all the conditions. The observations predict that the position dependence of the electric field at the Si-SiO$_2$ interface in segmented silicon sensors will result in a non-uniform oxide charge density due to surface damage. The results presented can be used to improve simulations of the surface radiation damage of silicon sensors.

T 92.3 Mi 17:15 F 234

Studies of radiation field impact on microstrip sensors for the CBM Silicon Tracking System — •Ievgeniia Momot[1,2,3], Olga Bertini[2], Maksym Teklishyn[3,4], Anton Lymanets[2,3], Hanna Malygina[1,2,3], Johann Heuser[2], and Christian Sturm[2] for the CBM-Collaboration — [1]Goethe-Universität, Frankfurt — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [3]KINR, Kyiv Institute for Nuclear Research, Kyiv, Ukraine — [4]FAIR, Facility for Antiproton and Ion Research, Darmstadt, Germany

The Silicon Tracking System (STS) is the main tracking detector of CBM experiment. Located in the dipole magnet, reconstructs tracks and determines momentum of charged particles originating from beam-target interactions. The response of double-sided silicon micro-strip sensors to hits is very depended on the radiation load on the detector, which is expected to reach 10^{14} 1 MeV n$_{eq}$/cm^2. It is vital to maintain signal-to-noise ratio at the level of ≈ 10 to keep 98% hit reconstruction efficiency after irradiation up to the CBM lifetime dose. Results of testing newest prototypes of sensors from two different vendors to fluences between 10^{13} and $2{\times}10^{14}$ n$_{eq}$/cm^2 will be reviewed. Thus the total effect of the different radiation doses on the signal-to-noise ratio will be presented.
Supported by HIC for FAIR and HGS-HIRe.

T 92.4 Mi 17:30 F 234

Characterization and calibration of radiation-damaged double-sided silicon strip detectors — •Levent Kaya[1], Andreas Vogt[1], Peter Reiter[1], Benedikt Birkenbach[1], Rouven Hirsch[1], Christian Stahl[2], and Norbert Pietralla[2] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Kernphysik, Technische Universität Darmstadt

Double-sided silicon strip detectors (DSSSD) are commonly used for event-by-event identification of charged particles as well as the reconstruction of particle trajectories in nuclear physics experiments with stable and radioactive beams. Individual pixel segments are given by intersecting areas of both p- and n-doped front- and backside segments resulting in a high detector granularity. Typically, charged particles do not homogeneously illuminate the detector surface during in-beam experiments. Consequently, radiation damages of the detector are distributed non-uniformly. Position-dependent incomplete charge collection due to radiation damage limits the performance and lifetime of the detectors; the response of different channels may vary drastically. Position-resolved charge-collection losses for front- and back-side segments were investigated for an in-beam experiment and by performing radioactive source measurements. A novel position-resolved calibration method for radiation-damaged DSSSDs, based on mutual consistency of p-side and n-side charges, was developed. It yields a significant enhancement of the energy resolution and the performance of radiation-damaged parts of the detector. Supported by Bonn-Cologne Graduate School for Physics and Astronomy (BCGS).

T 92.5 Mi 17:45 F 234

Applikations- und Bestrahlungsstudien für die Wire-Bond-Enkapsulierung in zukünftigen Siliziumsensormodulen des CMS Spurdetektors — Tobias Barvich, Felix Boegelsbacher, Alexander Dierlamm, •Stefan Maier und Pia Steck — Institut für Experimentelle Kernphysik (IEKP), KIT

Für das Phase-II-Upgrade des CMS-Spurdetektors werden sowohl Siliziumpixel-, als auch Streifensensoren in einer Modulbauweise eingesetzt. Die Wire-Bond-Verbindungen zwischen Siliziumsensoren und Auslesechips sollen hierbei durch eine Enkapsulierung geschüzt werden. Neben den herkömmlichen Voraussetzungen wie Temperaturbeständigkeit, hohe Strahlungslänge und Strahlenhärte muss das verwendete Material die richtige Viskosität besitzen. Diese muss in einem Bereich liegen der einerseits ein leichtes Benetzen der Bonddrähte ermöglicht, andererseits aber ein Verlaufen auf darunter liegende Modulkomponenten verhindert. Am Karlsruher Institut für Technologie wird mit Hilfe eines selbst entwickelten halbautomatischen Roboters die Applikation und Eigenschaften der Materialien untersucht. Der Vortrag gibt Einblicke in eine Auswahl an Materialien, deren Eigenschaften und Applikationsmöglichkeiten.

T 92.6 Mi 18:00 F 234

Dark Current of Neutron Irradiated SiPMs — •Svenja Nadine Sonder[1], Matteo Centis Vignali[1,2], Erika Garutti[1], Robert Klanner[1], and Jörn Schwandt[1] — [1]Institut für Experimentalphysik, Universität Hamburg, Germany — [2]CERN, Geneva, Switzerland

Silicon photomultipliers (SiPMs) have become popular as photon detectors in high-energy physics and many other fields due to their excellent performance. One major limitation, especially for the use in colliders, is the radiation damage by hadrons. In this talk, SiPMs with 3484 pixels of 15x15 μm^2 produced by the company KETEK have been irradiated with reactor neutrons to different fluences up to 10^{12} n$_{\mathrm{eq}}$/cm^2 (1 MeV equivalent neutrons). Current-voltage measurements have been performed at different temperatures between -30°C and +30°C. To better understand the generation of the dark current, parameters like the breakdown voltage and the activation energy given by the Arrhenius model have been investigated. A parameterization, which describes the temperature and dose dependence of the current-voltage results within 5%, is presented.

T 92.7 Mi 18:15 F 234

Study of GEM ageing effects for the ALICE TPC Upgrade
— •Michael Jung[1], Harald Appelshäuser[1], Chilo Garabados[2], and Renato Negrao de Oliveira[3] for the ALICE-Collaboration — [1]IKF - Goethe-Universistät Frankfurt — [2]GSI - Helmholtzzentrum für Schwerionenforschung — [3]Universidade de Sao Paulo

Long-term measurements with a quadruple stack of Gas Electron Multipliers (GEMs) at relatively high gain (about 15,000) were performed to invesitgate the ageing effects of GEMs in Ar-CO_2 (70-30). The GEM stack was irradiated with a high-rate ^{55}Fe source to simulate the dose of the upgraded ALICE Time Projection Chamber (TPC) at the LHC during RUN3 with a Pb–Pb interaction rate of about 50 kHz. Also the outgassing effects of different materials, such as Vetronite, Araldite 2011 and Polyamide on the energy resolution and the gain were studied. During all measurements the temperature and the ambient pressure were measured to discriminate between a change of the environment conditions and a degradation of the detector properties. One phenomenon observed was that the kapton in the GEM holes was etched, so that the double conical shape of the holes got lost.

T 92.8 Mi 18:30 F 234

Radiation Tolerance of a Fully Depleted CMOS Monolithic Active Pixel Sensor
— •Tobias Bus, Michael Deveaux, and Benjamin Linnik for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

CMOS Monolithic Active Pixel Sensors (MAPS) are considered as the technology of choice for the micro vertex detector (MVD) of the CBM experiment. We aim to adapt the radiation tolerance of the technology to the needs of CBM.
The tolerance of MAPS to non-ionizing radiation damage can be improved by means of depleting the active volume of the sensors. This technologically difficult approach could be realized with a novel sensor prototype named Pipper-2. The tolerance of this prototype to non-ionizing radiation hardness of the sensors was tested for doses of up to $5 \cdot 10^{14} \frac{n_{eq}}{cm^2}$. First results of the test will be shown and discussed.
*This work has been supported by BMBF (05P15RFFC1), GSI and HIC for FAIR.

T 92.9 Mi 18:45 F 234

Einsatzmöglichkeiten von synthetischem Graphit in zukünftigen Spurdetektoren
— Tobias Barvich, Conny Beskidt, Wim de Boer, Alexander Dierlamm und •Stefan Maier — Institut für Experimentelle Kernphysik (IEKP), KIT

Die Anforderungen an die verwendeten Materialien in zukünftige Spurdetektoren wie dem des CMS Phase-II-Upgrades sind sehr hoch. Die Verwendung von synthetischem Graphit in Form von Klebefolien hätten in solchen Experimenten viele Vorteile. Es ermöglicht einen präzisen und leichten Bau während es gleichzeitig mit seiner hohen Wärmeleitfähigkeit für die Kühlung der Komponenten sorgt. Mit einer PET Schutzschicht ist es zusätzlich als elektrische Isolation zwischen Hochspannungspotentialen geeignet. Am Karlsruher Institut für Technologie werden die Eigenschaften und Einsatzmöglichkeiten des Materials untersucht. Der Vortrag gibt Einblicke in Simulationen und Tests mit synthetischem Graphit.