T 123: Pixel/Belle II, Si/Other

Time: Thursday 15:50–17:20 Location: WIL/A317

T 123.1 Thu 15:50 WIL/A317

Investigation of high backside currents in DEPFET pixel sensors for the Belle II experiment using dedicated test structures — Florian Bernlochner, Jochen Dingfelder, •Georgios Giakoustidis, and Botho Paschen — University of Bonn, Germany

For the Belle II experiment at KEK (Tsukuba, Japan) the KEKB accelerator was upgraded to deliver e^+e^- collisions at a center-of-mass energy of $E_{CM} = 10.58\ GeV$ with an instantaneous luminosity of up to $8 \cdot 10^{35}\ cm^{-2}s^{-1}$. As the innermost part of the Belle II detector, the PiXel Detector (PXD), based on DEpleted P-channel Field Effect Transistor (DEPFET) technology, is most exposed to radiation from the accelerator. An unexpected steady increase of backside current with time and thus accumulated irradiation dose was observed in several modules during detector operation. Doping profile measurements and electric field simulations show that this is a consequence of (partially) shorted guard rings at the backside leading to high electric fields and avalanche current multiplication. Irradiation results of dedicated test structures to further investigate the mechanism will be presented.

T 123.2 Thu 16:05 WIL/A317

Development of the BDAQ-PXD laboratory readout system for the characterization of DEPFET pixel detector modules — Patrick Ahlburg, Florian Bernlochner, Jochen Dingfelder, Tomasz Hemperek, Hans Krüger, Botho Paschen, and •Jannes Schmitz for the Belle II-Collaboration — University of Bonn, Germany

The DEPFET PiXel Detector (PXD) is successfully operated in the innermost layers of the Belle II experiment at the SuperKEKB e^+e^-collider in Japan. The PXD data acquisition is optimized for the requirements of the full-scale pixel detector in Belle II. In this talk, the development of a laboratory readout system (BDAQ-PXD) for single PXD modules is presented. BDAQ-PXD provides a simple, flexible and expandable readout for measurements in laboratory, irradiation and test-beam environments. It thus facilitates studies to gain further insights into the behavior of the pixel detector modules and the DEPFET technology. The setup of the system and measurements for the characterization of PXD modules under laboratory conditions are presented in this talk.

T 123.3 Thu 16:20 WIL/A317

Simulation of power lines for the Investigation of the Emergency Shutdown system of the DEPFET pixel detector — •Paula Scholz[1], Florian Bernlochner[1], Jochen Dingfelder[1], Hans Krüger[1], Botho Paschen[1], Matthias Hoek[2], Jannes Schmitz[1], and Patrick Ahlburg[1] for the Belle II-Collaboration — [1]University of Bonn, Germany — [2]Institut für Kernphysik JGU Mainz, Germany

The Belle II Pixel Detector (PXD) is based on DEpleted P-channel Field Effect Transistor (DEPFET) matrices. To control the sensors, voltage levels have to be switched by 20 V within a few nanoseconds per readout cycle (50 kHz). The voltage switching is implemented in Application Specific Integrated Circuits (ASICs), the so-called switchers, on the detector modules. These switchers have been observed to be vulnerable to sudden irradiation bursts, which can occur during beam loss events in the SuperKEKB accelerator. To safeguard the modules from damage caused by beam loss events, the modules have to be switched off as fast as possible when a loss of beam control is imminent. Several beam monitoring systems are employed in the experiment to detect these situations. On PXD hardware side it is investigated how the vulnerable channels can be switched off fast and securely. Therefore, an electronics circuit simulation of the complex PXD power system is being set up to understand the limitations and conduct studies of possible hardware modifications. This talk will concentrate on the necessary steps for creating such a simulation.

T 123.4 Thu 16:35 WIL/A317

Investigation of high resistivity p-type FZ silicon diodes after ^{60}Co - γ irradiation — •Chuan Liao[1], Eckhart Fretwurst[1], Erika Garutti[1], Joern Schwandt[1], Anja Himmerlich[2], Yana Gurimskaya[2], Michael Moll[2], and Ioana Pintilie[3] — [1]Institute of Experimental Physics University of Hamburg, Hamburg, Germany — [2]European Organization for Nuclear Research (CERN), Geneva, Switzerland — [3]National Institute of Materials Physics, Bucharest, Romania

In this work, the macroscopic (I-V, C-V) and microscopic Thermally Stimulated Current (TSC) measurements were used to investigate the radiation effects in high resistivity p-type FZ silicon diodes induced by ^{60}Co γ-rays with dose values between $1{\times}10^5$ and $2{\times}10^6$ Gy. Two different types of diodes were manufactured using either p-stop or p-spray isolation between the pad and the guard-ring. The leakage current density development with dose was investigated and compared to standard float zone (FZ) n-type diodes. Frequency dependence of capacitance-voltage characteristics was only observed for p-stop diodes and showed a strong dose dependence. In the microscopic measurements, the development of radiation-induced defects (B_iO_i, C_iO_i, VO, I_P) with dose will be presented. To understand the thermal stability of these defects, isochronal annealing experiments from 80 ^oC up to 300 ^oC for 15 min were performed. The corresponding macroscopic and microscopic measurements will be presented and discussed.

T 123.5 Thu 16:50 WIL/A317

Compton imaging of undepleted regions of germanium detectors — •Felix Hagemann, Iris Abt, Chris Gooch, Lukas Hauertmann, David Hervas Aguilar, Xiang Liu, Oliver Schulz, and Martin Schuster — Max-Planck-Institut für Physik, München

Over the past three years, a novel experimental setup has been built, commissioned and operated at the Max-Planck-Institute for Physics in Munich to characterize the bulk of germanium detectors: the Compton Scanner. In this fully automated setup, a detector is irradiated with a collimated beam of 661.66 keV gammas from a ^{137}Cs source. A part of these gammas Compton scatter in the germanium detector and are detected by pixelated cameras placed nearby, allowing to reconstruct their interaction point in the detector.

If the germanium detector is operated below the depletion voltage, the undepleted volume of the detector cannot be used to register the energy left behind by the Compton scattered photon. By comparing regions with almost no reconstructed events, i.e. measured undepleted volumes for different bias voltages, to predictions based on different assumed impurity density profiles, an estimate of the real impurity density profile of the detector becomes possible.

In this talk, the Compton Scanner setup and its working principle will be presented. Images of the undepleted regions of a germanium detector will be shown and compared to predictions obtained with the open-source julia software package *SolidStateDetectors.jl.*

T 123.6 Thu 17:05 WIL/A317

Angle-selective electron detection with a silicon-based active Transverse Energy Filter (aTEF) — •Kevin Gauda[1,4], Sonja Schneidewind[1,4], Kyrill Blümer[1,4], Christian Gönner[1,4], Volker Hannen[1,4], Hans-Werner Ortjohann[1,4], Wolfram Pernice[2,3], Lukas Pöllitsch[1,4], Richard Wilhelm Julius Salomon[1,4], Maik Stappers[2], and Christian Weinheimer[1,4] — [1]Institute for Nuclear Physics, University of Münster — [2]CeNTech and Physics Institute, University of Münster — [3]Kirchhoff-Institute for Physics, University of Heidelberg — [4]KATRIN Collaboration

The active Transverse Energy Filter (aTEF) is a concept to discriminate electrons in a large magnetic field based on their pitch angle (EPJ-C 82, 922 (2022)). It is investigated as a background reduction measure in the KATRIN experiment, where low-energy electrons from ionisation of atoms in highly excited (Rydberg or autionising) states within the spectrometer impede the design sensitivity of $0.2\,\mathrm{eV\,c^{-2}}$ (90% C.L.). These electrons are practically indistinguishable from desired tritium beta electrons via kinetic energy, while their pitch angle distribution differs significantly. The aTEF for KATRIN may be realized as a microstructured detector – e.g., based on Si-PIN diodes – tailored to exclusively detect electrons with large pitch angles. Fabrication of prototypes is carried out via semiconductor processing technologies, for instance deep inductively coupled plasma etch (ICP-RIE). Production and performance of aTEF prototypes will be presented.

The work of the speaker for KATRIN is supported by BMBF under contract number 05A20PMA.