T 6: Silicon Detectors II (Belle II, Tristan)

Time: Monday 16:45–18:15 Location: VG 1.101

T 6.1 Mon 16:45 VG 1.101

Performance study of the proposed Belle II vertex detector upgrade — •Lukas Herzberg[1], Benjamin Schwenker[1], Thibaud Humier[1,2], and Ariane Frey[1] — [1]Georg August-Universität Göttingen, Göttingen — [2]DESY, Hamburg

The proposed Belle II vertex detector upgrade intends to replace the current vertex detector (VXD), consisting of pixel and strip subdetectors with a unified silicon pixel detector (VTX). This upgrade is scheduled to take place during long shutdown 2 in 2032. The main purpose of the vertex detector in Belle II is to improve the analyses of time dependent CP violation. To quantify the impact of the upgrade on performance, we investigated three variables.
The *effective flavor tagging efficiency* is a measure of how good the detector can differentiate between B^0 and $\overline{B}^0$ which directly affects the statistical power of any CP violation analyses in the B^0 system. The *reconstruction efficiency* is the fraction of correctly reconstructed events. The *vertex resolution* is the accuracy of the decay positions. It is measured separately for the two B mesons in the event. These three performance variables can be measured in simulation for both the VXD and the VTX. Finally a fit of the unitary triangle parameter β was performed as an example of a full time dependent CP violation analyses.

T 6.2 Mon 17:00 VG 1.101

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 $E_{CM} = 10.58\ GeV$ and it has reached a record-breaking instantaneous luminosity of $4.7 \cdot 10^{34}\ cm^{-2}s^{-1}$. During the so-called Long Shutdown 1 (LS1) the innermost part of the Belle II detector, the initially descoped PiXel Detector (PXD1) with 20 modules, based on Depleted P-channel Field Effect Transistor (DePFET) technology, was replaced by a fully-populated, two-layer PXD with 40 modules. As the detector closest to the experiment's interaction region, the PXD is most exposed to radiation from the accelerator. Throughout the operation of the PXD1 a steady increase of backside current with irradiation was observed in several modules. 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 6.3 Mon 17:15 VG 1.101

Characterization of new BELLE-type DePFET pixel test-structures — •Erik Büchau, Florian Bernlochner, Jochen Dingfelder, Georgios Giakoustidis, and Jannes Schmitz — University of Bonn, Physikalisches Institut, Nußallee 12, 53115 Bonn, Germany

Silicon-based detectors are a fundamental component of particle tracking systems in modern High Energy Physics (HEP) experiments. The BELLE II experiment in Japan employs the Depleted P-channel Field Effect Transistor (DePFET) technology in its PiXel Detector (PXD), taking advantage of its low material budget while keeping low intrinsic noise at high signal-to-noise ratio. DePFET pixel technology is subject to extensive research and development, leading to the production of a new technology variation, PXD13. Due to its similarity to the existing PXD9 design, the PXD13 mini-matrices can be tested using the same infrastructure. Dedicated full system demonstrators (Hybrid5), containing the minimum amounts of all necessary components, are used for laboratory tests and characterization. First characterization results on transistor level, as well as signal response studies on Belle-type PXD13 mini matrices will be covered in this talk.

T 6.4 Mon 17:30 VG 1.101

Investigation of TID damage in the Drain Current Digitizer chip of the Belle II Pixel Detector — •Nikolas Pässler, Jannes Schmitz, Georgios Giakoustidis, Jochen Dingfelder, and Florian Bernlochner — University of Bonn, Physikalisches Institut, Nußallee 12, 53115 Bonn, Germany

The Belle II experiment at the SuperKEKB collider in Tsukuba, Japan, explores e^+e^- collisions at a center-of-mass energy of 10.58 GeV and achieved a record luminosity of $4.7 \cdot 10^{34}\,\mathrm{cm^{-2}s^{-1}}$. During the Long Shutdown 1 (LS1) from 2022 to 2023, the initial partially installed PiXel Detector (PXD1) was upgraded to a fully-populated two-layer PXD with 40 modules. These modules consist of a 250×768 pixel matrix, based on Depleted P-channel Field Effect Transistor (DePFET) technology and 3 types of row control and readout ASICs. As the PXD is positioned closest to the interaction region, it has to withstand the highest radiation levels.

Radiation damage leads to increasing levels of noise in the Drain Current Digitizer (DCD) ASIC. Since the exact nature and manifestation of this noise are not yet well understood, further investigation and the development of enhanced calibration routines are required.

In this talk, results from a dedicated X-ray irradiation campaign for the DCD will be presented, focusing on identifying and disentangling the noise effects from the rest of the system. Strategies for mitigating these issues will also be discussed.

T 6.5 Mon 17:45 VG 1.101

Towards Sterile Neutrino Detection: TRISTAN Detector Characterization with a UV-Light-Induced Electron Source — •Daniela Spreng for the KATRIN-Collaboration — TUM School of Natural Sciences - Physics Department, Garching, Germany

The search for keV-scale sterile neutrinos, a potential dark matter candidate, is a major goal in neutrino physics. These neutrinos, if they exist, create subtle distortions in the beta-decay spectrum due to their mixing with active flavors. The KATRIN experiment aims to detect these effects using TRISTAN, a modular multi-pixel silicon drift detector.

This talk focuses on the operation of three TRISTAN detector modules integrated into a KATRIN-like setup. We present characterization measurements of the detector's electron response, emphasizing tests with a UV-light-induced electron source. This partial implementation is a crucial step toward validating the system's performance and readiness to detect sterile neutrino signatures.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2 and 05A23WO6).

T 6.6 Mon 18:00 VG 1.101

Characterization of TRISTAN Detector Modules in a KATRIN-like Detector Section with 83mKr — •Christian Forstner for the KATRIN-Collaboration — TUM School of Natural Sciences - Physics Department, Garching, Germany

Sterile neutrinos, a minimal extension of the Standard Model of particle physics, are a promising dark matter candidate if their mass is in the keV-range. The Karlsruhe Tritium Neutrino experiment (KATRIN) will be equipped with a multi-pixel silicon drift detector array, the TRISTAN detector, to search for a keV-scale sterile neutrino signature in the tritium β-decay spectrum. This measurement will follow the completion of KATRIN's neutrino mass measurement campaign. In this work, we report on the first simultaneous operation of three TRISTAN detector modules. The detector system has been installed in a KATRIN-like detector section and is characterized using a 83mKr source. This talk will focus on the first light observed with the detectors to validate the progress of the system and its readiness for the sterile neutrino operation.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2 and 05A23WO6).