T 113: Silicon trackers 6

Time: Friday 9:00–10:30 Location: Geb. 30.22: kl. HS B

T 113.1 Fri 9:00 Geb. 30.22: kl. HS B

Slow pion identification at the Belle II PXD with machine learning — •Johannes Bilk and Sören Lange — II. Physikalisches Institut (Subatomare Physik), Justus-Liebig- Universität Giessen

The identification of slow pions in Belle II experiments presents a notable challenge, arising from their high dE/dx energy loss and their short flight path in the tracking detectors. This study introduces a method employing advanced machine learning algorithms to accurately detect pions with momentum p<100 MeV/c exclusively with the Belle II pixeldetector (PXD). By analyzing detector signals (in particular a 9x9 pixel matrix) with image processing and pattern recognition methods, this approach significantly boosts the efficiency and accuracy. Offline and online (FPGA) implemenation will be discussed.

T 113.2 Fri 9:15 Geb. 30.22: kl. HS B

Characterization of Sensor Properties of Large DEPFET Modules for the Belle II Pixel Detector — Patrick Ahlburg, Florian Bernlochner, Jochen Dingfelder, Georgios Giakoustidis, Munira Khan, Hans Krüger, •Botho Paschen, Jannes Schmitz, and Paula Scholz — University of Bonn

The Belle II PiXel Detector (PXD) is composed of large (1.5×8.5 cm^2) all-silicon modules with integrated sensor and bump-bonded Application Specific Integrated Circuits (ASICs). Pixel matrices of DEpleted P-channel Field Effect Transistors (DEPFETs) with pixel pitches down to 55×50 μm^2 constitute their active area. The DEPFET technology is employed for the first time in High Energy Physics in the Belle II experiment that has recorded data from $e^+ - e^-$ collisions since 2019.

Variations in the DEPFET drain currents form the detection signal for ionizing radiation. To achieve a high resolution, an online dark current subtraction is implemented in the digitizer ASIC. Process and wafer bulk property fluctuations lead to variations of the FET properties and their dark currents over the sensor area.

The PXD pixel design and results of sensor current characterizations will be presented in this talk.

T 113.3 Fri 9:30 Geb. 30.22: kl. HS B

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, 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 113.4 Fri 9:45 Geb. 30.22: kl. HS B

Upgrade of Belle II Vertex Detector with CMOS Pixel Technology — •Marike Schwickardi[1], Ariane Frey[1], Yannik Buch[1], Benjamin Schwenker[1], Maximilian Babeluk[2], Ajit Kumar[4], Ludovico Massaccesi[3], Christian Finck[4], Jerome Baudot[4], Bernhard Pilsl[2], and Christian Irmler[2] — [1]Georg-August Universität, 37077 Göttingen, Germany — [2]Institute of High Energy Physics, Austrian Academy of Sciences, 1050 Vienna, Austria — [3]Dipartimento di Fisica, Università di Pisa, I-56127 Pisa, Italy — [4]Université de Strasbourg, CNRS, IPHC, UMR 7178, 67037 Strasbourg, France

The Belle II experiment at KEK in Japan considers upgrading its vertex detector system to address the challenges posed by high background levels caused by the increased luminosity of the SuperKEKB collider. One proposal for upgrading the vertex detector aims to install a 5-layer all monolithic pixel vertex detector based on fully depleted CMOS sensors in 2027. The new system will use the OBELIX MAPS chips to improve background robustness and reduce occupancy levels through small and fast pixels. This causes better track finding, especially for low transverse momenta tracks elow 100 MeV. During the summer of 2023, electron-beam tests at DESY were conducted on the TJ-Monopix2, which served as the precursor to the OBELIX sensor. Initial measurements on irradiated modules, subjected to Protons at 5×10^{14} n_{eq}/cm^2, were performed. Results from the laboratory and test beam evaluations, focusing on pixel response, efficiency, and spatial resolution, will be presented.

T 113.5 Fri 10:00 Geb. 30.22: kl. HS B

Comissioning and Characterization of the Belle II PXD Power System — •Jannes Schmitz, Florian Bernlochner, Jochen Dingfelder, and Botho Paschen — University of Bonn

The Belle II experiment at the SuperKEKB collider in Tsukuba, Japan, collected e^+e^- collision data between 2019 and 2022, and after reaching a record-breaking instantaneous luminosity of $4.7 * 10^{34} cm^{-2}s^{-1}$ and a dataset corresponding to $424 fb^{-1}$, it is currently in its first planned long shutdown phase (LS1) until December 2023. Aside from upgrades of the collider, the shutdown is used for the installation of the new two-layer Pixel Vertex Detector (PXD), which together with four layers of double-sided silicon strips (SVD) forms the Belle II Vertex Detector (VXD). The previous single-layer PXD was replaced by the new fully-populated PXD2, doubling the amount of required detector services. One key component are the custom-made power supplies (PS). For each of the 40 modules a dedicated PS provides voltages for 24 channels. Due to the 14m-long power lines, remote sensing is needed and electronic components need to be calibrated for accurate supply and monitoring of voltages and currents. This talk will cover the commissioning of the PXD power system as well as studies of calibration data to examine aging effects of the electronics.

T 113.6 Fri 10:15 Geb. 30.22: kl. HS B

Pixel Vertex Detector background generation using Generative Adversarial Networks — •Fabio Novissimo, Thomas Kuhr, and Nikolai Hartmann — Ludwig-Maximilians-Universität München

The Pixel Vertex Detector (PXD) is the innermost detector of the Belle II experiment. Information from the PXD, together with data from other detectors, allows to have a very precise vertex reconstruction. The effect of beam background on reconstruction is studied by adding measured or simulated background hit patterns to hits produced by simulated signal particles. This requires a huge sample of statistically independent PXD background noise hit patterns to avoid systematic biases, resulting in a huge amount of storage due to the high granularity of the PXD sensors. As an efficient way of producing background noise, we explore the idea of an on-demand PXD background generator realised using Generative Adversarial Networks (GANs). In order to evaluate the quality of generated background we measure physical quantities which are sensitive to the background in the PXD.