T 115: Detectors 10 (semiconductors)

Time: Friday 9:00–10:30 Location: Geb. 30.23: 2/1

T 115.1 Fri 9:00 Geb. 30.23: 2/1

Simulation of HV-CMOS sensor arrays intended for beam monitoring at ion beam therapy facilities — •Pietro Marchesi[1], Alexander Dierlamm[1,2], Ulrich Husemann[1], Markus Klute[1], and Bogdan Topko[1] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT) — [2]Institute for Data Processing and Electronics (IPE), KIT

The use of ion beams for cancer therapy has been proven to be an advantageous alternative to conventional photon therapy due to the ability to deliver the dose more precisely to the malignant tumor and spare healthy tissue thanks to the depth control that the Bragg peak of ions allows.

To operate such a therapeutic system safely, precise monitoring of the beam characteristics (specially position and width) is required. To this end, KIT has been developing HV-CMOS detectors intended for the Heidelberg Ion-Beam Therapy Center consisting of an array of individual sensor chips.

To assist in the development efforts, simulations using the Allpix Squared software have been made. The use of individual chips arranged into an array implies the presence of gaps between them, which can induce biases in the reconstruction of the beam characteristics. An interpolation algorithm is presented that bridges these gaps to avoid such effects. Simulated data and real data from beam tests are compared.

T 115.2 Fri 9:15 Geb. 30.23: 2/1

Simulation of Hexagonal Pixel Configurations in Monolithic Active Pixel Sensors — •Larissa Mendes[1], Simon Spannagel[1], Manuel Alejandro del Rio Viera[1], Lennart Huth[1], Ingrid-Maria Gregor[1,2], Håkan Wennlöf[1], Anastasiia Velyka[1], and Adriana Simancas[1] — [1]Deutsches Elektronen-Synchrotron DESY, Germany — [2]Universität Bonn, Germany

The Tangerine Project is investigating monolithic active pixel sensors (MAPS) fabricated using the 65 nm CMOS imaging process with a small collection electrode. The complex interplay between different doping regions in the silicon sensor and the resulting non-linear electric field configuration makes it challenging to predict sensor behavior accurately. Therefore, precise simulations are essential for describing and predicting the key performance parameters of the sensor, thereby contributing to an optimized performance.

A simulation approach for achieving this type of characterization may involve a combination of electrostatic field simulations and Monte Carlo techniques. This study explores a hexagonal pixel grid to enhance sensor performance as an alternative to conventional square or rectangular pixel layouts. The layouts are evaluated based on efficiency, cluster size, and spatial resolution, and a comparison is made between square and hexagonal pixel geometries. Transient simulations in detectors were also executed to model the time-dependent behavior of detectors in response to incident particles of hexagonal pixels. These investigations underscore the potential of the hexagonal pixel grid to improve the performance of MAPS in high-energy physics experiments.

T 115.3 Fri 9:30 Geb. 30.23: 2/1

Developing a simulation chain for synthetic single and polycrystalline diamonds using Allpix-squared — •faiz ur rahman ishaqzai[1,2], Tobias Bisanz[1], and Jens Weingarten[1] — [1]TU Dortmund, Germany — [2]DEU Izmir Turkey

Diamond, known for its exceptional properties, such as radiation hardness and a larger radiation length, stands out as a promising material for tracking detectors in high-energy physics experiments. A simulation chain has been developed to assess the validity of implementing diamond as a sensor material in Allpix-squared, a widely used software framework in the high-energy physics community, based on GEANT4. It was started to simulate testbeam setups with silicon detectors but has garnered interest from a wider community by now. It is shown that the currently implemented physics models for charge career drift are ineffective when applied to diamond. The charge carrier drift properties of diamond are influenced by very low acceptor concentrations, which resulted in the implementation of diamond-specific parameter values for mobility models in Allpix-squared. Additionally, a model representing the polycrystalline nature of diamond was introduced. I will present the simulation results of charge carrier properties of single-crystal chemical vapor deposition (scCVD) and polycrystalline chemical vapor deposition (pcCVD). These results are systematically compared with experimental and literature data to further validate the effectiveness of the implemented models in Allpix-squared.

T 115.4 Fri 9:45 Geb. 30.23: 2/1

Sensor Performance of the ATLAS High Granularity Timing Detector — •Theodoros Manoussos[1,2], Xiao Yang[1], Guilherme Saito[3], Xiangxuan Zheng[4], Dominik Dannheim[1], Gregor Kramberger[5], Stefan Guindon[1], Stefano Manzoni[1], Giulia Di Gregorio[1], and Lucia Masetti[2] — [1]CERN — [2]Johannes Gutenberg-Universität Mainz, Deutschland — [3]Universitade de São Paulo, Brasil — [4]University of Science and Technology of China, Hefei, China — [5]Institut Jožef Stefan, Ljubljana, Slovenia

The increase of the instantaneous luminosity at the HL-LHC will be a challenge for the ATLAS detector. The pile-up is expected to increase on average to 200 interactions per bunch crossing. To mitigate these effects a High Granularity Timing Detector (HGTD) will be integrated in the end-cap regions of ATLAS, covering a pseudo-rapidity range of $2.4 < |\eta| < 4.0$. HGTD, which also serves as a luminosity monitor, aims for a single track time resolution for MIPs of 30 ps at the beginning of the lifetime, up to 50 ps after a maximum fluence of $2.5 \times 10^{15} \frac{\mathrm{neq}}{\mathrm{cm}^2}$. The high precision timing information improves the assignment of tracks the correct vertex. HGTD sensors are based on the Low Gain Avalanche Detector (LGAD) technology. Each sensor is a 15×15 array of 1.3×1.3 mm LGAD pads. Along with the sensors, an equal amount of Quality Control-Test Structures is produced, to monitor the quality and uniformity of the sensors and extract technology parameters during the production. This contribution presents the status of the sensor quality control and the non-irradiated and irradiated LGAD performance obtained in a series of test-beam campaigns.

T 115.5 Fri 10:00 Geb. 30.23: 2/1

Timing Performance of a Digital SiPM Prototype with a Fast Laser — Inge Diehl[1], Finn Feindt[1], Karsten Hansen[1], Stephan Lachnit[1,2], Frauke Poblotzki[1], •Daniil Rastorguev[1,3], Tomas Vanat[1], and Gianpiero Vignola[1,4] — [1]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [2]Universität Hamburg, Germany — [3]Bergische Universität Wuppertal, Germany — [4]Universität Bonn, Germany

Recent advances in CMOS technologies open up possibilities for new types of monolithic silicon detectors. DESY has designed a prototype of a silicon photomultipier integrated with a digital readout ASIC. This device, combining features of a pixelated chip, such as a high granularity readout, with an intrinsically high temporal resolution of a SiPM, is an interesting candidate for 4D tracking in future particle physics experiments. This work presents the characterization of the timing performance of the dSiPM by means of a fast pulsed laser, as well as comparison with the results, obtained via direct detection of charged particles at the DESY II testbeam facility. The study showcases temporal resolution of the device as a function of charge injection position. The results can be correlated to intrinsic properties of the single photon avalanche diodes and to the design of the digital circuitry.

T 115.6 Fri 10:15 Geb. 30.23: 2/1

Module assembly for the ATLAS High Granularity timing detector — •Hendrik Smitmanns[1], Maria Soledad Robles Manzano[1], Doğa Elitez[1], Jan Ehrecke[1], Theodorus Manoussos[1], Lucia Masetti[1], Andrea Brogna[2], Atila Kurt[2], Fabian Piermaier[2], Steffen Schoenfelder[2], Antonin Zeeman[2], and Quirin Weitzel[2] — [1]Institut für Physik, Johannes-Gutenberg Universität Mainz — [2]PRISMA+ Detector Lab, Johannes-Gutenberg Universität Mainz

To meet the challenges of the High Luminosity Large Hadron Collider (HL-LHC), especially the increase of pile-up interactions, the ATLAS detector will need to be upgraded. One of the foreseen upgrades will be the installation of the High-Granularity Timing Detector (HGTD). The HGTD will mitigate the effects of pile-up in the ATLAS forward region, providing a time resolution of about 30-50 ps per track. The active area consists of 2-double-sided disks per end-cap. Two 2x2 cm* Low Gain Avalanche Detectors bump-bonded to two ASICs and glued to a flexible PCB form the HGTD basic unit, the so-called module.

Multiple modules are then glued onto a support unit to form a detector unit. Each module is tested before and after being glued to a support unit. Prototype modules and detector units are being assembled at Johannes Gutenberg University Mainz in preparation for the production of around 1000 modules for the final detector over the next few years. The assembly procedure, performance and test results are presented.