T 148: Si/SiPM, Pixel/Other

Time: Thursday 17:30–19:00 Location: WIL/A124

T 148.1 Thu 17:30 WIL/A124

Study of the self-heating in SiPMs — •Carmen Victoria Villalba Petro, Erika Garutti, Robert Klanner, Stephan Martens, and Jörn Schwandt — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland.

The main effect of radiation damage in a Silicon-Photomultiplier (SiPM) is a significant increase in the dark current. For SiPMs irradiated at $\Phi_{eq} = 10^{13}$ cm^{-2} and operated at 2 V above breakdown voltage, V_{bd}, the leakage current leads to a power of 50 mW. Such power produces an instantaneous increase in the SIPM temperature, which needs to be cooled down by proper thermal contact to a cooling system. The performance of the SiPM changes with temperature (T). The V_{bd} increases with T. For a fixed bias voltage, this leads to a decrease in gain and PDE. A method has been developed to determine the SiPM temperature increase induced by the power dissipated in the SiPM multiplication layer. Heating studies were performed with a KETEK SiPM, glued on an Al_2O_3 substrate, which is either directly connected to the T-controlled chuck of a probe station, or through layers of material with well-known thermal resistance. The SiPM is illuminated by a LED operated in DC-mode. The SiPM current is measured and used to determine the steady-state temperature as a function of power dissipated in its multiplication region and of the thermal resistance, as well as the time constants for heating and cooling. The method is applied to MPPC samples before and after irradiation. The knowledge of the multiplication region temperature can be used to properly determine the working parameters of irradiated SiPMs.

T 148.2 Thu 17:45 WIL/A124

Integration time dependence of sipm performance parameters — •Katjana Neumann, Erika Garutti, Jörn Schwandt, and Jack Rolph — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland

The research on Silicon Photomultipliers (SiPMs) and their characteristic parameters has increased strongly due to their advantages as photon detectors. The standard way to obtain these parameters from the charge spectra of SiPMs is to fit a model based on (generalized) Poisson distributed Gaussian functions to the low light intensity response spectra. However, this method has the disadvantage that it only describes the photo-electron peaks but not the regions between them, which means that a large amount of information is lost, for example about the dark-count rate (DCR) or after-pulsing. Thus a description of the whole spectrum in a single model is practical. The Python program PeakOTron is based on a model, that describes the entire spectrum. This program has been tested on the low light intensity spectra obtained by integrating the charge at various gate lengths, for two SiPM types operated at various overvoltage. The parameters and fitted spectra determined with this method are discussed and compared to those obtained with standard methods.

T 148.3 Thu 18:00 WIL/A124

Design and Production of Pixel Strips for the P2 Tracking Detector Modules — •Lucas Sebastian Binn for the P2-Collaboration — Institute of Nuclear Physics, Johannes Gutenberg-University Mainz, Germany

The P2 Experiment will make use of the new Mainz Energy-Recovering Superconducting Accelerator (MESA), currently under construction in Mainz, to measure the weak mixing angle in electron-proton scattering at low momentum transfer with unprecedented precision.

A key parameter for the analysis, the momentum transfer Q^2, is measured by a tracking detector consisting of 8 identical modules. Each module consists of two sensor planes, with pixel sensors glued and wire-bonded on rigid-flex strips. Commercially available and custom solutions for the production of the strip module design are currently being evaluated. With a total production of 260 strips, processes are semi-automated, with dedicated glue and bonding machines.

An overview of the P2 experiment with focus on the tracking detector will be given in this talk, as well as the current state of the development of the strip modules.

T 148.4 Thu 18:15 WIL/A124

Characterization of a Digital Silicon Photomultiplier — •Gianpiero Vignola[1,2], Inge Diehl[1], Doris Eckstein[1], Finn Feindt[1], Ingrid-Maria Gregor[1,2], Karsten Hansen[1], Stephan Lachnit[1], Frauke Poblotzki[1], Simon Spannagel[1], and Tomas Vanat[1] — [1]DESY, Hamburg, Germany — [2]Universität Bonn, Bonn, Germany

Silicon photomultipliers (SiPM) are increasingly used in high-energy physics, medical and commercial applications. Until now, most SiPMs are implemented as large arrays of Single Photon Avalanche Diodes (SPAD) in a parallel circuit, serving as photon counters. Recently, the possibility of using SPADs produced in commercial Complementary Metal-Oxide Semiconductor (CMOS) processes has opened up the possibility of combining their excellent performance in single photon detection and timing, with the possibilities offered by monolithic circuitry at a relatively low cost. The digital SiPMs, thanks to the per-pixel CMOS circuitry, extend the properties of standard SiPMs with features such as detailed event hit map, masking of noisy SPADs and in-chip trigger logic and digitalisation.

A prototype of a SPAD array with per-pixel CMOS circuitry was fully developed at DESY in a 150 nm CMOS technology offered by LFoundry. This talk will report the results of characterisations performed on the prototype in the laboratory and in the DESY II Test Beam facility. Studies on Dark Count Rate, MIPs detection efficiency and time resolution will be presented; along with an overview of planned future studies with a laser setup and scintillator coupling.

T 148.5 Thu 18:30 WIL/A124

Simulation of laser-TCT experiments with Allpix^2 — •Daniil Rastorguev for the Tangerine-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany — Bergische Universität Wuppertal, Wuppertal, Germany

The Transient Current Technique (TCT) is a powerful yet flexible laboratory characterization technique for silicon sensors. By precisely injecting charges with laser pulses and analyzing waveforms, produced as deposited charge drifts in the sensor bulk, one may experimentally study different charge collection features of the sensor under test.

With the development of novel types of silicon sensors with complex internal structures, experimental results can be challenging to interpret. To investigate possible outcomes of such experiments and understand these in detail, computer simulations are often used.

This work focuses on Monte-Carlo simulations of TCT experiments, performed with the Allpix^2 framework. A dedicated Allpix^2 module, modeling absorption of laser light in silicon sensors, was developed to build a full pipeline that simulates processes occurring in a real experiment. An overview of the simulation technique is presented, as well as first simulation results and its comparison to experimental data.

T 148.6 Thu 18:45 WIL/A124

Simulations for High-Granularity LGAD Sensors using Commercial CMOS Technologies — •Saqlain Khan[1], Sinuo Zhang[1], Tomasz Hemperek[2], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn — [2]Dectris, Switzerland

Low-Gain Avalanche Diode (LGAD) detectors can provide a time resolution an order of magnitude better than traditional silicon detectors. This enhancement is enabled by the implementation of controlled low gain in the detector response. One of the challenges in LGAD design is to achieve a high granularity. The granularity is constrained due to the design of an inter-channel protection structure referred to as "Junction Termination Extension" (JTE). This structure avoids breakdown between channels but also creates regions where charge collection is severely limited. An approach in the direction of improving the granularity is to have the gain layer of LGAD buried deep inside and below the readout surface. In this way, inter-channel breakdown is avoided and a high granularity could be achieved.

CMOS pixel sensors utilizing commercial processes are promising methods to be used in high energy particle physics experiments for high-precision charged particle tracking. In this talk, TCAD simulations to investigate the feasibility of the aforementioned approach using a commercial CMOS process will be presented.