T 21: Si-Strips/CMS, Pixel/Sensor

Time: Monday 16:30–18:00 Location: WIL/A124

T 21.1 Mon 16:30 WIL/A124

Stress testing optical readout components for CMS 2S modules — Max Beckers[2], •Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Martin Lipinski[1], Vanessa Oppenländer[1], Felix Thurn[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]III. Physikalisches Institut B, RWTH Aachen University

New detector modules will be installed for the upcoming CMS Phase-2 Outer Tracker upgrade. There are two general types of modules, one consisting of two co-planar silicon strip sensors (2S) and one of a macro pixel and a strip sensor (PS). The communication and the auxiliary support are supplied by a so-called SErvice Hybrid (SEH) in the case of a 2S module. It houses a two-stage DC-DC converter and a Low-Power Gigabit Transceiver (lpGBT). At the RWTH Aachen University, the SEHs are qualified regarding power and communication stability in a so-called test board setup, where the SEHs will undergo additional thermal cycling while being tested. A Field-Programmable Gate Array (FPGA) firmware was developed for the integrated testing routines, like a Bit Error Rate Testing (BERT) of the lpGBT's connections. This talk will focus on the data tests of this setup.

T 21.2 Mon 16:45 WIL/A124

Thermal Measurements of 2S Modules with an evaporative CO_2 Cooling System for the CMS Phase-2 Outer Tracker Upgrade — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], •Vanessa Oppenländer[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The new operating conditions of the future HL-LHC require a replacement of the complete silicon tracking system of the CMS experiment as part of the CMS Phase-2 Upgrade. For the Phase-2 Outer Tracker new silicon strip modules, so-called 2S modules, are being developed that consist of two silicon sensors stacked on top of each other. The high radiation conditions of the HL-LHC lead to a higher leakage current in the silicon sensors, which is exponentially dependent on the sensor temperature. An evaporative CO_2 cooling system will be used to cool the modules and ensure a successful operation. In an unstable cooling scenario it is possible that the module enters an uncontrolled self-heating loop called thermal runaway. Therefore it is crucial that the thermal properties and performance of the 2S modules and the cooling structure are tested and characterized. In this talk measurements with a test setup of 2S modules on a cooling structure using a custom CO_2 cooling system will be presented.

T 21.3 Mon 17:00 WIL/A124

Integration Tests with 2S Module Prototypes for the Phase-2 Upgrade of the CMS Outer Tracker — •Lea Stockmeier, Bernd Berger, Alexander Dierlamm, Ulrich Husemann, Markus Klute, Roland Koppenhöfer, Stefan Maier, Hans Jürgen Simonis, and Pia Steck — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

To deal with the increased luminosity of the HL-LHC, the CMS experiment will be upgraded until 2028. During this Phase-2 Upgrade, the CMS Outer Tracker will be equipped with modules each assembled with two silicon sensors. Depending on the position in the tracker, these silicon sensors are pixel or strip sensors. The modules with two strip sensors are called 2S modules. In the barrel region, they are placed on mechanical structures called ladders. A fully equipped ladder contains twelve modules.

During the prototyping phase of the modules, integration tests are performed with the purpose to test the module functionality on the final detector structures. Investigations focus on the cooling performance as well as on electrical performance of the modules on the supporting structures.

This talk summarizes integration tests with 2S modules on ladders performed at CERN and Institut Pluridisciplinaire Hubert Curien (Strasbourg) in cooperation with other CMS working groups.

T 21.4 Mon 17:15 WIL/A124

Investigations of a BiCOMS Pixel Sensor — André Schöning[1], Heiko Augustin[1], Ivan Peric[2], and •Benjamin Weinläder[1] — [1]Physikalisches Institut, Universität Heidelberg — [2]IPE, Karlsruher Institut für Technologie

In the field of particle physics, High Voltage Monolithic Active Pixel Sensors (HV-MAPS) are promising candidates to fulfil the high demands on spatial and time resolution of modern detectors. A new generation of sensors, which combines the HV-MAPS architecture with a BiCMOS technology, opens new possibilities for faster timing in the sub-nanosecond regime.

The BeBiPix is a small test chip to investigate the aforementioned potentials. It is a fully analog sensor featuring two 3×3 pixel matrices with pixel sizes of $41 \times 41\,\mu m^2$ and $81 \times 81\,\mu m^2$. During the ongoing testing phase several problems occurred, making an in-depth characterisation difficult. Identified problems such as an early break down at $\sim 10\,V$ and a weak amplifier feedback are isolated and reproduced in simulations.

T 21.5 Mon 17:30 WIL/A124

Study of diffusion in small pixel sensors — •Amala Augusthy[1], Daniel Pitzl[2], Erika Garutti[1], Jörn Schwandt[1], and Tilman Rohe[3] — [1]Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, 22607 Hamburg, Deutschland — [3]Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

Pixel sensors are widely used in the CMS experiment for tracking. From 2025 to 2027, the LHC will undergo the high luminosity upgrade where the beam luminosity will be increased to about 7.5 x $10^{34} cm^{-2} s^{-1}$. To maintain high tracking efficiencies under such an extreme radiation environment, pixel sensors of smaller pitches will be used for tracking. However, as the pixel pitch is reduced, charge sharing effects like diffusion start to play an important role in determining the resolution of these sensors.

To investigate the effects of diffusion, measurements were performed on non-irradiated pixel sensors of sizes 50 x 50 μm^2 , 25 x 100 μm^2 and 17 x 150 μm^2 using 5.2 GeV electron beam at the DESY test beam facility. These sensors have a thickness of 285 μm and are bump bonded to low noise read-out chip ROC4SENS. From these measurements, the spatial resolution, cluster size and efficiency as a function of sensor bias and incidence angle of the beam were extracted. These results are then compared to simulation. The simulations were performed using PIXELAV and Synopsys TCAD. In this talk, the results of these measurements will be presented.

T 21.6 Mon 17:45 WIL/A124

guard ring optimisation for passive-CMOS pixel sensors — •Sinuo Zhang[1], Tomasz Hemperek[2], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn, Germany — [2]Dectris, Switzerland

In high energy physics, the silicon pixel sensors manufactured in commercial CMOS chip fabrication lines have been proven to have good radiation hardness and spatial resolution. Along with the mature manufacturing techniques and the potential of large throughput provided by the foundries, the so-called “passive CMOS” sensor has become an interesting alternative to standard planer sensors.

High and predictable breakdown behaviour is a major design goal for sensors and the guard-ring structure is one factor to optimise. This is especially important for applications that require higher voltages.

In this talk we discuss the influence of the guard ring design on the breakdown voltage based on measurements and TCAD simulations. Results has shown that a more uniform potential distribution across the guard rings can be achieved by implementing deep n-well for guard ring structures, and reveals a higher breakdown voltage. Simulations has provided a potential way to reduce the size of the guard ring structures without limiting the breakdown performance.