HK 63: Combined Instrumentation Session: Semiconductor Detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: H-HS XV

HK 63.1 Fri 11:00 H-HS XV

Investigation of light enhanced annealing of irradiated silicon strip detectors and pad diodes — •Mägdefessel Sven, Parzefall Ulrich, and Mori Riccardo — Uni Freiburg, Germany

Thermally induced annealing of irradiated silicon devices has been widely studied. Latest results indicate that charge carriers being generated during the annealing procedure can change charge states of the defect centers and therefore influence the annealing behaviour. Therefore, we irradiated silicon strip detectors and pad diodes during the annealing process with IR and green light to achieve different penetration depths and performed CV based impedance spectroscopy to investigate differences in defect behaviour compared to annealing in the dark.

HK 63.2 Fri 11:15 H-HS XV

Temperature Scaling of Leakage Current in Irradiated Silicon Sensors — •Felix Wizemann, Kevin Kröninger, and Jens Weingarten — TU Dortmund, Experimentelle Physik IV

The leakage current of silicon sensors increases with radiation damage, which can be used to monitor fluence. For this, the bulk leakage current needs to be scaled with temperature using the parameter E_{eff}. In previous studies, this parameter was determined to be 1.21 eV for samples irradiated to fluences up to $1 \times 10^{15}\,\mathrm{n_{eq}cm^{-2}}$. Sensors irradiated to higher fluences have shown lower values of E_{eff}.

To investigate this change in scaling behaviour, E_{eff} was determined as a function of the applied bias voltage for irradiated samples with fluences from $1 \times 10^{14}\,\mathrm{n_{eq}cm^{-2}}$ to $3 \times 10^{15}\,\mathrm{n_{eq}cm^{-2}}$. Results of this study are presented in this talk.

HK 63.3 Fri 11:30 H-HS XV

Studie zur Auswirkung von Strahlenschäden auf die Zwischenstreifenisolation von n-in-p Siliziumstreifensensoren — Felix Bögelspacher, Alexander Dierlamm, Thomas Müller, •Jan-Ole Müller-Gosewisch, Andreas Nürnberg, Hans Jürgen Simonis und Pia Steck — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Der Gebrauch von n-in-p Siliziumstreifensensoren erfordert eine spezifische Zwischenstreifenisolation. Ohne diese kommt es insbesondere nach Bestrahlung durch Akkumulation von Ladungsträgern an der Oberfläche zu einem Kurzschluss der Streifen und einer Verringerung der Ortsauflösung. Ein Maß für die Güte der Isolation ist der Zwischenstreifenwiderstand. Entgegen den Erwartungen wurde bei Sensoren ohne spezifische Isolation ein ausreichend hoher Widerstand zwischen den Streifen nach Protonenbestrahlung mit einer Fluenz von $10^{15}\mathrm{n_{eq}/cm^2}$ beobachtet. Für ein genaueres Verständnis der beitragenden Effekte auf die Streifenisolation wurden Sensoren ohne Zwischenstreifenimplantat mit Röntgenstrahlen, Protonen und Neutronen bestrahlt. In diesem Vortrag werden Messungen und Simulationen der Zwischenstreifenwiderstände für unterschiedlichen Bestrahlungszusammensetzungen gezeigt und bewertet.

HK 63.4 Fri 11:45 H-HS XV

Study of thermal runaway of hadron-irradiated silicon sensors — Ingo Bloch[1], Heiko Lacker[2], •Felix Riemer[2], and Christian Scharf[2] — [1]Deutsches Elektronen-Synchrotron DESY — [2]Humboldt-Universität zu Berlin

Silicon sensors are widely used in the several parts of the ATLAS detector at the LHC. Low leakage current is desirable since the leakage current generates heat. At the same time the leakage current increases with increasing sensor temperature. Thermal runaway will occur if the heat removed from the sensor is lower than the heat generated by the sensor. During operation the silicon sensors at hadron colliders are exposed to high fluences of highly energetic particles which introduce defects in the crystal lattice strongly increasing the leakage current. The cooling infrastructure of the detector has to be adapted order to prevent thermal runaway during operation until the end-of-life. Therefore, the capacitance and current of irradiated silicon diodes have been measured as a function of the particle fluence, temperature, bias voltage, heating power, and for different pad areas. The diodes were irradiated with 70 MeV/c protons and 1 MeV/c neutrons to equivalent fluences between $1 \cdot 10^{13}$ cm^{-2} and $5 \cdot 10^{16}$ cm^{-2}. The goal of the study is to develop models for the capacity and reverse current of highly irradiated silicon sensors which can be used to estimate the cooling power needed to prevent thermal runaway while fully depleting the sensors after high particle fluences.

HK 63.5 Fri 12:00 H-HS XV

R&D for the Cooling Demonstrator of the CBM Silicon Tracking System (STS) — •Kshitij Agarwal for the CBM-Collaboration — Physikalisches Institut der Universität Tübingen

As the core detector of the CBM experiment, the Silicon Tracking System (STS) located in the dipole magnet aims to reconstruct charged-particle tracks & momentum from beam-target interactions.

Due to the expected non-ionising irradiation damage (fluence - 10^{14} n_{eq}(1MeV)/cm^2), the silicon microstrip sensors will dissipate < 6 mW/cm^2 at -10°C. Thus it is imperative to keep the sensors at or below -10°C at all times to avoid thermal runaway and reverse annealing by forced N_2 cooling. The corresponding electronics connected via ultra-thin microcables are placed outside detector acceptance with a dedicated cooling system used to remove $\sim$ 40kW power dissipated.

To experimentally verify the aforementioned concepts under realistic mechanical constraints, a thermal demonstrator comprising a half-layer of STS is under development. This contribution will describe the electronics cooling system design and respective cooling performance simulations. Experimental proof-of-principle tests/simulations with 3M™ Novec™ 649 for electronics cooling and air cooling for silicon sensor cooling will be shown. Lastly, future plans on the demonstrator integration and design will be also presented.

This work is supported by GSI/FAIR.

HK 63.6 Fri 12:15 H-HS XV

Ultra Fast Silicon Detectors for timing applications in HADES — •Wilhelm Krueger[1], Nicolo Cartiglia[2], Marco Ferrero[2,3], Tetyana Galatyuk[1,4], Mladen Kis[4], Wolfgang Koenig[4], Michal Koziel[5], Sergey Linev[4], Jan Michel[5], Stefano Moneta[6], Jerzy Pietraszko[4], Adrian Rost[1], Arnaud Schemm[7], Valentina Sola[2], Konrad Sumara[8], Michael Traeger[4], Michael Traxler[4], and Christian Wendisch[4] — [1]TU Darmstadt, Germany — [2]INFN, Sezione di Torino, Italy — [3]Università del Piemonte Orientale, Novara, Italy — [4]GSI, Darmstadt, Germany — [5]Goethe-Universität Frankfurt, Germany — [6]Universita di Pisa, Italy — [7]IMT Atlantique, Campus de Nantes, France — [8]Jagiellonian University in Kraków, Poland

In order to measure a precise time zero (T0) for particle identification produced in nucleon-nucleon or nucleus-nucleus collisions a time precision of 50 ps or better is required. Ultra fast silicon detectors (UFSD) enable such precision. In addition the combination of high spatial resolution, high time precision and high radiation hardness makes them an excellent alternative to the scCVD diamond detectors used so far by HADES for T0 measurements and for beam monitoring.

In this contribution we present the results of test measurements conducted at COSY in Juelich. Particular emphasis is put on achieving the desired precision for MIPs and on comparison of two different discriminator boards, one based on the NINO chip and the other, called PaDiWa, which is based on discrete components. This work has been supported by BMBF under ErUM -FSP C.B.M. and GSI.

HK 63.7 Fri 12:30 H-HS XV

A precision floating, high-voltage picoamperemeter — •Florian Rössing, Tobias Rudolph, Dimitri Schaab, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Many modern tracking detectors, e.g. the Time Projection Chambers for ALICE and CBELSA, are based on Micropattern Gaseous Detector (MPGD) technology. In the examples given above, Gas Electron Multipliers (GEM) will be used for the amplification of primary charges. The optimization of MPGD often requires current measurements at the level of picoamperes on the high-voltage lines. Therefore, currentmeters with a complete electrical insulation from ground are needed, requiring wireless data transmission and floating power supply. Previous versions of devices custom-made at TU München and further developed at Bonn University showed problems with the overvoltage-protection, a residual non-linearity and a non-negligible temperature dependence. In order to overcome these issues the analog signal processing was completely revised. The shunt resistor configuration in use was replaced by a zero burden transimpedance amplifier, with high input impedance. A precise temperature sensor and a photovoltaic powering were added. In the talk design characteristics and the performance of the devices will be discussed.

HK 63.8 Fri 12:45 H-HS XV

Automatized dark current measurement system for irradiated SiPM detectors in COSY — •Anoop Nagesh Koushik for the JEDI-Collaboration — Forschungszentrum Jülich GmbH — III. Physikalisches Institut B, RWTH Aachen University

The JEDI (Jülich Electric Dipole moment Investigations) collaboration performs Electric Dipole Moments (EDM) experiments with deuteron beams at COSY (COoler Synchrotron) accelerator in Forschungszentrum Jülich. The beam is polarized and the determination of the polarization is based on a polarimeter using LYSO scintillators coupled to SiPM (Silicon Photo-Multiplier) modules. SiPM are preferred over traditional PMT's because of absence of high electric fields near the beam which affects the EDM measurements.

SiPMs near the beam pipe were accidentally exposed to intense radiation and were damaged. This radiation damage adds noise to the signal and hence decreases the resolution of the detector. The dark current of the irradiated SiPM was characterized and was found to be orders of magnitude higher.

An automatized system of dark current measurement for different SiPM reverse bias voltages was developed. 8x8 array mapping of the SiPM was designed to analyze the extent of the damage of the irradiated SiPM. Few SiPM arrays were annealed several times at different temperatures and was compared to the previous annealed results to determine the reduction of the damage. Extent of damage, the results of annealing and the comparison between them for the irradiated SiPM will be presented and discussed in the talk.