T 97: Silicon Detectors VIII

Time: Friday 9:00–10:15 Location: KH 01.022

T 97.1 Fri 9:00 KH 01.022

MIP detection on a plastic scintillator and SiPM system in very noisy environments — •Katjana Neumann, Massimiliano Antonello, Lukas Brinkmann, Erika Garutti, and Jörn Schwandt — Universität Hamburg, Hamburg, Deutschland

Radiation damage to a silicon photomultiplier (SiPM), as occurs during the lifetime of the planned CMS HGCAL detector, increases the dark current and degrades the signal to noise (S/N) separation and thus the minimum ionizing particles (MIP) detection efficiency. To investigate this, a system consisting of a plastic scintillator tile directly coupled to a SiPM is used to detect the MIP from a ^{90}Sr source. The aim of this thesis was to compare the effects of true radiation-induced damage with a method that increases the dark-count rate (DCR) exclusively through DC light illumination. This second approach does not induce any physical structural damage. This allows the isolation of the effect of increased DCR as the primary factor degrading the SiPM response. The results show that an increase in the DCR, regardless of whether it was induced by irradiation or DC illumination, leads to a comparable reduction in the MIP-response and the S/N ratio. This confirms that the dominant factor for the performance degradation is the increased DCR itself and not additional damage or defects introduced in the silicon. This study highlights a significant insight: the primary consequence of radiation damage on SiPMs can be effectively mimicked under laboratory settings using optical illumination to increase the DCR.

T 97.2 Fri 9:15 KH 01.022

A digital SiPM in liquid xenon — •Tiffany Luce — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

Silicon PhotoMultipliers (SiPMs) are photosensors commonly used in many experiments. However, achieving single-photon sensitivity in the experiments is limited by the high dark count rate (DCR) of these devices. Digital SiPMS, where the digitization happens directly on the chip, can show DCRs competitive to that of traditional photomultiplier tubes (PMTs) with the added benefit of not needing analog to digital converters and greatly reducing the data rate. This would open up to cheaper and thus larger systems. We present results of the test of a digital SiPM in cryogenic liquid xenon, one of the most important detector target for dark matter searches.

T 97.3 Fri 9:30 KH 01.022

Characterisation of commercially available SiPMs — Theodoros Avgitas[1], Zoe Balmforth[1], Ioannis Manthos[1], Konstantinos Nikolopoulos[1,2], and •Christos Toukmenidis[1] — [1]University of Hamburg (UHH) — [2]University of Birmingham (UoB)

Silicon Photomultipliers (SiPMs) are increasingly employed in particle physics experiments thanks to a number of desirable properties such as single-photon sensitivity, high intrinsic gain, and compact design. Nevertheless, their performance depends strongly on the operating conditions such as the applied voltage and temperature. In this talk, a detailed characterisation of commercially available SiPMs is presented over an extended range of temperatures and SiPM bias. Key performance parameters are studied including breakdown voltage, gain, dark count rate (DCR), afterpulsing probability, and optical crosstalk.

T 97.4 Fri 9:45 KH 01.022

Radiation damage of red sensitive SiPMs — •Momo Scharf, Massimiliano Antonello, Lukas Brinkmann, Erika Garutti, Katjana Neumann, and Joern Schwandt — Universität Hamburg

A new generation of red sensitive Silicon Photomultipliers (SiPMs) are being developed by Broadcom. These feature a high Photo Detection Effiency (PDE) for near infrared light with a peak PDE of 38 % at 700 nm and a wide dynamic range due to the small pixel pitch with 6216 SPADs per mm^2. The influence of radiation damage on the performance of this new SiPM design is investigated. Sets of samples have been neutron irradiated in the TRIGA reactor facility at JSI (Ljubljana) at four different fluences up to $1 \times 10^{13}\,\mathrm{cm}^{-2}$. The characterization of the SiPMs includes performance parameters such as breakdown voltage, gain, correlated noise, dark count rate and non-linear response. The correction function is obtained with the single-step method on non-irradiated samples and the applicability to irradiated samples tested. This presentation shows first results of the comparison for irradiated and non-irradiated samples.

T 97.5 Fri 10:00 KH 01.022

On the temperature, voltage, gate-length, and pixel-pitch dependence of the SiPM non-linear response — •Lukas Brinkmann, Massimiliano Antonello, Erika Garutti, Katjana Neumann, Momo Scharf, and Jörn Schwandt — Universität Hamburg, Hamburg, Germany

The finite number of pixels in a silicon photomultiplier (SiPM) limits its dynamic range to light pulses up to typically 80 % of the total number of pixels in a device. Correcting the non-linear response is essential to extend the SiPM's dynamic range. One challenge in determining the non-linear response correction is providing a reference linear light source. Instead, the single-step method used to calibrate PMTs is applied, based on the difference in responses to two light sources.

A systematic study of the SiPM's response dependence on the operating voltage, temperature and gate length is performed for a KETEK SiPM design with different pixel sizes. The correction function, determined at reference conditions ($T = 20\,^\circ\mathrm{C}$, $\Delta V = 5\,\mathrm{V}$), is applied to data spanning a temperature range of $-20\,^\circ\mathrm{C}$ to $+20\,^\circ\mathrm{C}$ and an overvoltage range of 3 V to 5 V.

The method successfully corrects the non-linearity of the SiPM response across this parameter space for sub-nanosecond illumination with light intensities up to a mean number of Geiger discharges equal to the number of pixels, with an average deviation from linearity below 3 %. No significant dependence of the correction function on temperature, overvoltage, gate length or pixel size is observed for the tested devices.