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Characterisation of Cherenkov Optimised Silicon Photomultipliers Following Long Duration Operation

Silicon photomultipliers (SiPMs) specifically designed with a high photon detection efficiency (PDE) at the UV end of the visible spectrum are now competing with traditional photomultiplier tubes (PMTs). Typical applications where UV sensitive photosensors play a key role include Cherenkov and scintillation light detection in particle, astroparticle, nuclear physics, and medical physics.

PMTs have held prime place in UV photosensor applications owing to their photon counting capability, low dark count rate, high radiation-hardness, and large format. However, they are fragile both mechanically and to high illumination, have a finite lifetime and require high operating voltages. SiPMs on the other hand, are robust, operate at much lower voltages and have much longer potential lifetime. SiPM technology has developed considerably over the last decade resulting in lower dark count rate, reduced optical crosstalk, and PDE optimised for Cherenkov imaging, with increased sensitivity in the UV region and suppression at longer wavelengths, and they are now replacing PMTs in applications requiring UV photosensors. Being a solid-state device, they should operate indefinitely however external factors can degrade performance and inevitably lifetime.

In this research we describe results from a 64-pixel tile of Hamamatsu MPPC (SiPM) (peak sensitivity 465 nm) which has been operating continuously since January 2021 while gathering data from air shower events. The SiPM tile was temperature stabilised to 11° C in air, with the relative humidity maintained at <70%. All 64 pixels have been active during this period and we have collected continuous event data for four of these pixels. Accounting for some instrument downtime, we have currently (April 2022) accumulated >10,900 hours of live operation.

We present results characterizing the 64-pixel tile at start and end of the period of operation, including identification of failed and faulty pixels. The SiPM characteristics of the four pixels were monitored across the whole period of study and we assess the results for degradation in performance.

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