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Dynamic Range Characterization of SiPM with a Double Light Superposition Method

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We present a new method, Double Light Superposition (DLS) to characterize the dynamic range (DR) of silicon photomultipliers (SiPMs). This self-calibrated technique does not need the calibration procedures for the intensity of the light source from single photon to the level of SiPM saturation, makes the measurement easy and robust, thus can be a candidate of standard for DR measurement of SiPM. It is also benefit to be compatible to characterize the recovery time of SiPM, thus deducing the maximum photon-counting rate for the device operation. The setup of the DLS method includes two identical LEDs, coupled to an optical integrator with fly-eye lens; two short-pulse drivers, with the same frequency and phase, to drive the two LEDs and adjust their light intensity independently. The SiPM functions as both a device under test and a photon meter that is illuminated by the uniform pulsed light in a light tight box. The pulsed signal outputted from the SiPM is inputted to an oscilloscope, to which a synchronous signal correlated to the dual pulsed signals is fed as a trigger to reject the dark counts. The procedure steps of DLS method are as follow: (1) Adjust the intensity of each pulsed light from the dual LED to achieve an output of ~ 1 MFPN (mean fired pixel number) from the SiPM respectively. It is set as N_{init} and is equal to the MPEN (mean photoelectron number) under few photons level, and an initial point (photoelectron number, fired pixel number) $= (N_{init}, N_{init})$ is thus obtained. Then, the two pulse light are superposed (i.e., doubled) and re-measure the MFPN from the SiPM, the second point of ($2N_{init}$, MFPN) is obtained. (2) Increase the light intensity of each light pulse to achieve the same MFPN as the previous superposed one, respectively, and then superpose the two light beams and re-measure the outputted MFPN. (3) Follow this alternative, double increasing and self-calibrated measurement procedure, the dependence of the fired pixel number on photoelectron number can be obtained. We will report DLS method in detail in this conference, and present the results and discussion on the dynamic range of NDL latest C series EQR-SiPM with high density of micro cell ($10^4/mm^2$).

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