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Time Resolution Measurement with Analog SiPMs: Measurements and Setup Examples

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Silicon Photomultipliers (SiPM) are multi-cell photodetectors that have been studied and improved over the last few years. They are used in several applications ranging from the detection of single photons to multiple photons. Among others properties, the single-photon time resolution (SPTR) is an important characteristic of the SiPMs which has been studied in depth over the last few years by different groups employing different setups and techniques. The single-photon time resolution has been considered one possible limiting factor for the coincidence time resolution (CTR), where SiPMs are coupled with scintillators in applications like positron emission tomography (PET). It is also becoming increasingly important in low-light applications such as Cherenkov-light detection, and in SiPM-based light-detection and ranging (LIDAR).

In this contribution we will discuss different measurements setups and readout methodologies used by various groups to characterize the SPTR of analog SiPMs with a critical view of the possible sources of error and with an overview of the practical aspects. In addition we will discuss the measurement related aspects such as the type of laser, attenuation of light and the identification of single photon events. The two commonly used techniques to measure timing are waveform acquisition and ASIC readout. In waveform acquisition, the SiPM output is amplified and acquired directly using an oscilloscope for the signal to be then analyzed to extract the timing histogram and SPTR. In ASIC readout the output is either a time stamp or a discriminated signal that can further be digitized by an external TDC. Irrespective of the readout technique, only the single photon events are selected for measuring the signal time delay against a reference. The SPTR is affected by the choice of the excess bias and by the discriminating threshold: they both have always to be specified. By examining the SPTR measurement techniques for analog SiPM, we intend to have comparable parameters for the measurements performed by groups across several fields and institutions.

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