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Case Study of Digital SiPMs

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Single-photon timing resolution (SPTR) is a key parameter for SiPM that influences the system-level timing performance, e.g. in applications such as positron emission tomography (PET), correlated photon detection or ranging (LiDAR). Appropriate standardization of SPTR in digital silicon photomultipliers (D-SiPMs) encounters a challenge as it is dependent of the electronic readout architecture, which is inherently different for individual D-SiPMs. Additionally, comparing analog SiPMs (A-SiPMs) to D-SiPMs in a meaningful way is limited by their different intrinsic device natures.

In this presentation, we start from the basic definition of SPTR and apply it to the characterization of several D-SiPMs cases, such as multichannel digital silicon photomultipliers (MD-SiPMs), 3D digital SiPM (3DdSiPM) and the digital photon counter (DPC). We compare the D-SiPMs' architectures and their impact on the timing performance including a description of on-chip testing circuits that has been used for characterization. Architecture independent and dependent parameters are identified and discussed in order to build a standardization flow. We specify the measurement conditions and system settings in order to obtain a fair comparison between architecture-independent parameters, and a recommendation for a standardized measurement procedure. In addition, we will outline the main differences in SPTR measurements between D-SiPMs and A-SiPMs and present a subset of conditions and standardized parameters that could enable a comparison between them.

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