Contribution ID: **52** Type: **Oral**

4D-Tracking with Digital SiPM-IC

Tuesday, 28 May 2024 11:00 (20 minutes)

Silicon Photomultipliers are the state-of-the-art technology in single-photon detection with solid-state detectors. Single Photon Avalanche Diodes (SPADs), the key element of SiPMs, have been introduced by CMOS foundries into process design kits, facilitating the development of monolithic SiPMs with custom ASICs. This allows implementing features such as signal digitization, masking, full-hitmap readout, noise suppression, and photon counting on the same monolithic CMOS chip alongside avalanche diodes. The complexity of the readout chain is then reduced. Cost-effective multi-project wafer iterations and access to large-volume production are also other advantages of commercial CMOS nodes.

These new features allow to think of new applications for digital SiPM, such as 4D-tracking of charged particles, where spatial resolutions of the order of SPAD pitch and timestamping with time resolutions of a few tens of ps are required.

A prototype of a digital SiPM was designed at DESY using LFoundry 150 nm CMOS technology. Various studies were carried out in the laboratory and at the DESY II Test Beam Facility to evaluate the sensor's spatial and timing performance in MIP detection. The direct detection of charged particles was investigated for bare prototypes and assemblies coupling the dSiPM and a thin LYSO crystal.

In this contribution, the concept of monolithic SiPMs, capable of detecting single photons and MIPs with high spatial and timing performance will be presented. DESY digital SiPM designs and characterizations will be reported as examples to illustrate the R&D potential. Perspectives and possible applications of CMOS SPAD arrays will be discussed.

Collaboration

Role of Submitter

I am the presenter

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Session Classification: Solid State Detectors - Oral session

Track Classification: T3 - Solid State Detectors