Contribution ID: **249** Type: **Poster**

Development of Single-Photon Avalanche Diode Array for Particle Physics and Medical Imaging

Monday, 23 May 2022 15:44 (1 minute)

Due to their single-photon sensitivity and timing resolution, SiPMs are now the baseline solution for a large fraction of noble liquid experiments and medical imaging such as positron emission tomography, among others. Following this trend, digital SiPMs, or Photon-to-Digital Converters (PDC), are foreseen like the next generation of photon sensors. PDCs and SiPMs are both based on an array of Single-Photon Avalanche Diodes (SPAD) with the major difference that CMOS circuit is used to quench and read out the SPAD in the former compared to a passive resistor and an analog sum of each SPAD in the latter. PDCs offer major advantages over SiPMs due to the one-to-one SPAD-CMOS readout coupling. It enables control of the afterpulsing, improved timing resolution, disabling noisy SPADs, a single photon counting on a dynamic range equal to the number of SPAD in the array, to name a few.

Our team and collaborators are working to develop 3D PDCs, where a SPAD array is vertically integrated on a CMOS readout circuit with digital signal processing. In this contribution, the SPAD array developed by U. of Sherbrooke and Teledyne DALSA Semiconductor Inc (Bromont, Canada) will be presented in public for the first time. The structure of the SPAD array will be detailed. Measurements and wafer-level test setups will be presented and discussed.

Collaboration

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Session Classification: Photo Detectors and Particle ID - Poster session