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Photodetection Module Technologies for Particle Physics and Medical Imaging

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Single-photon detectors are a corner stone of many scientific experiments. While some require precise timing resolution under 100 ps, others need components to be radiopure and operational at noble liquid temperatures. To this end, the team at Université de Sherbrooke and their collaborators have been working on the development of a photodetection module. This module is comprised of Photon-to-Digital Converters (PDC) –an array of Single-Photon Avalanche Diodes (SPAD) vertically integrated on a CMOS readout circuit with digital signal processing where photon-to-bit conversion is performed. To match the coefficient of thermal expansion of silicon-based PDCs in cryogenic experiments, a silicon interposer was implemented. To manage and read out the PDCs, a tile controller was implemented and tested with an FPGA, and we are now designing a custom integrated circuit to fulfill this purpose to be radiopure. Finally, to provide low power and radiopure communication, R&D on a silicon photonic-based interface is ongoing with devices currently being characterized. In this contribution, an overview of these key components with their most recent results will be presented. This includes SPAD array characterization, a demonstration of a photodetection module prototype converting a pulse of light into a digital signal, interposer DC and RF characterizations and the silicon photonic communication interface modulation and performances at cryogenic temperature.

Collaboration

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