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Large area tiles of position-sensitive Silicon photomultipliers

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Silicon Photomultipliers (SiPMs) are solid-state single photon sensitive detectors that show excellent performance in a wide range of applications. In FBK (Trento, Italy), we developed a position sensitive SiPM technology, called "linearly-graded"(LG-SiPM), which is based on an avalanche-current weighted-partitioning approach. It shows position reconstruction resolution below 250 μm on an 8x8 mm² device area with four readout channels and minimal distortions. This technology was proven effective in the readout of segmented and monolithic LYSO crystals for PET application.

At FBK we recently developed a new version of LG-SiPM, with a larger chip active area (10x10 mm²) and based on NUV-HD technology, having a peak photon detection efficiency at 420 nm, as opposed to the previous ones centered at 550 nm. Such large area detector coupled with position sensitivity is very interesting in applications like MR-compatible PET, high-energy physics experiments, readout of time-projection chambers, readout of scintillating fibers for X ray spectroscopy, compact gamma and beta cameras with a reduced number of channels.

These SiPMs have been characterized in terms of noise, detection efficiency and position resolution. We also developed tiles of 2x2 and 3x3 elements with such SiPMs, reaching very large sensitive areas of 20x20 mm2 and 30x30 mm2. In such large area tiles, we implemented a smart channel connection configuration, being able to have just 6 output channels for the 2x2 elements and 8 channels for the 3x3 element tiles, with a position resolution below 0.5mm. We characterized the position resolution of such tiles, finding a small pincushion effect and some distortions, which will be studied and detailed. Still, these detectors and readout provide great advantages: a similar detector configuration with single elements would require hundreds of channels for the same spatial resolution. LG-SiPMs can be used to build larger arrays in a completely scalable approach.

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