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Detection module based on position-sensitive large-area Silicon photomultipliers

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Silicon Photomultipliers are compact single-photon-sensitive detectors, widely used in many applications. In FBK (Trento, Italy) we developed large area SiPMs (up to 10x10mm^2), based on different technologies and we are also focusing on the position-sensitive SiPM (PS-SiPM) technology based on charge-sharing approach. These are based on the so called "linearly-graded, LG"technology, exploiting a weighted current dividers on vertical and horizontal axis, to obtain signals (left, right, top and bottom signals) with amplitude and charge proportional to the light-absorption position.
Such large area detector with position sensitivity is very interesting in applications like ultra-high spatial resolution, MR-compatible PET and in the creation of a compact gamma and beta cameras with a reduced number of channels, for radio-guided surgery or other clinical decision support tool for diagnostic imaging.
In this contribution, we illustrate the project developed in collaboration with the University of Geneva for a detection module based on a 2×2 tile of large-area PS-SiPMs, including front-end amplifiers and shaped like a "handable"probe. Total area is 1.6x1.6 cm^2. The PS-SiPMs are connected in a smart configuration, maintaining a very low number of channels. Indeed, while for a single LG-SiPM there are 4 output, for a 2×2 tile, we have just 6 outputs. The measured position resolution (measured with a pulsed LED, scanned over active area) is better than 0.5 mm.
Finally, we performed an estimation of the performance of such module when used as a gamma camera for tumor detection. With OpenGate simulation, we proved that for a radio-tracer emitting gamma of lower energy, as 99mTc, the gamma camera could achieve an excellent performance. Superficial tumors, of about 2 mm, could be well reconstructed in less than 20 seconds. Tumors bigger than 6 mm in radius could be detected at 30 mm deep within about 10 seconds.

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