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#11-183 Large Area SiPM Pixels for SPECT: from high energy astrophysics to medical imaging

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The gamma camera is still employed in most Single Photon Emission Computed Tomography (SPECT) clinical scanners. In particular for large cameras it provides a balance between cost, reliability and performance that is hard to obtain for instance with modern CZT cameras. A standard gamma camera for full-body SPECT features a large area 50×40~cm^2) scintillator coupled to an array of 50-100 photomultiplier tubes (PMTs) of 4-8 cm diameter. The camera is shielded by a thick layer of lead, turning it into a heavy and bulky system that can weight a few hundred kilograms. The volume, weight and cost of a camera could be significantly reduced if the PMTs are replaced by silicon photomultipliers (SiPMs). The main obstacle to use SiPMs in full-body SPECT is their limited physical size. A few thousand channels would be needed to fill a camera if using the largest commercially-available SiPMs of of 6×6~mm^2. We propose to reduce the number of readout channels by using Large-Area SiPM Pixels (LASiPs), built by summing individual currents of several SiPMs into a single output. Our LASiPs employ the MUSIC, an ASIC designed for high-energy astrophysics, to perform the sum of the SiPM individual currents. We built a LASiP prototype with a sensitive area 8 times larger than a 6×6~mm^2 SiPM and evaluated its performance in a proof-of-concept detector consisting of a $40\times40\times8$~mm^3 NaI(Tl) crystal coupled to 4 LASiPs. We were able to reconstruct simple images with an intrinsic spatial resolution of $\sim$ 2~mm, achieving an energy resolution of $\sim$ 11.6\% at 140 keV. We also performed a detailed study on the SiPM noise and its impact on the performance of a SPECT camera, focusing on the additional noise introduced by the summing stage. We simulated the proof-of-concept detector with Geant4 and validated it with experimental data. Once validated, we simulated a larger camera with more and larger pixels, which we used to study how to optimize the pixel size, geometry and trigger settings of a full-body SPECT camera equipped with LASiPs. We present the results of such optimization, which sets the basis for a first compact full-body SPECT camera based on LASiPs.

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