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Large-Area SiPM Pixels (LASiPs) in SPECT

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A typical gamma camera for full-body Single Photon Emission Computed Tomography (SPECT) employs a lead collimator and a scintillator crystal (~ 50 x 40 x 10) cm^3. The crystal is coupled to an array of 50-100 photomultiplier tubes (PMTs). The camera is shielded by a thick layer of lead, making it heavy and bulky. Its weight and size could be significantly reduced if replacing the PMTs by silicon photomultipliers (SiPMs). However, one would need a few thousands channels to fill a camera with SiPMs even with the largest commercially-available SiPMs of 6 x 6 mm^2. As a solution we propose using Large-Area SiPM Pixels (LASiPs) in SPECT, which are built by summing individual currents of several SiPMs into a single output. We developed a LASiP prototype that sums 8 SiPMs of 6 x 6 mm^2 (pixel area ~2.9 cm^2) and built a proof-of-concept micro-camera holding 4 of those prototypes coupled to a NaI(Tl) crystal. We measured an energy resolution of ~ 11.6 % at 140 keV and were able to reconstruct simple images of a ^{99m}Tc capillary of 0.5 mm diameter with an intrinsic spatial resolution of ~2 mm. The micro-camera was also simulated with Geant4 and validated with experimental measurements. To study the possibility of using (eventually larger) LASiPs in a full-body SPECT camera, we extended the simulations to a camera of 50 x 40 cm^2. We optimized the trigger and reconstruction settings for LASiPs summing 9, 16, 25 and 36 SiPMs (pixel area up to ~13 cm^2). We found an intrinsic spatial resolution going from ~2 to ~6 mm depending on the pixel size and the simulated LASiP noise (dark counts, crosstalk) and were able to reconstruct images of phantoms. In the conference we will present the results of this study.

Collaboration

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