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Photo-Trap: a low-cost, low-noise, large-area SiPM pixel

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The small sensitive area of commercial silicon photomultipliers (SiPMs) is the main limitation for their use in many experiments and applications where large detection areas, low cost and power consumption are needed. Since capacitance, dark count rate and cost increase with the SiPM size, they are rarely found in sizes larger than 6 mm $\times$ 6 mm. Photo-Trap offers a low-cost solution to build SiPM pixels of a few cm^2 by combining a wavelength-shifter plastic (WLS), a dichroic filter and a standard commercial SiPM (not larger than 6 mm $\times$ 6 mm). Photo-Trap collects light over an area that can be $\sim 10-100$ times larger than the area of a commercial SiPM, while keeping the noise, single-photoelectron resolution, power consumption and likely the cost of a single, small SiPM. We developed and characterized through laboratory measurements and simulations, four different proof-of concept pixels, the largest one being of 40 mm $\times$ 40 mm. These pixels are sensitive in the near UV and achieve an optical gain that goes from ~5 to ~15, depending on the areas if the WLS and the SiPM employed. In all pixels we measured a time resolution of ~3 ns or better. Photo-Trap could provide a solution to use SiPM technology in applications in which large collection areas, low cost and low noise are needed (e.g., optical wireless communication, free space quantum key distribution, Cherenkov detectors). Here we present the results of our laboratory measurements, Geant4 simulations of the pixel and we briefly discuss the some of the potential applications of Photo-Trap.

Collaboration

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