

## Performance of the Latest MPPCs with Reduced Dark Counts and Improved Photon Detection Efficiency

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We have tested the performance of two types of the latest Multi-Pixel Photon Counters (MPPCs; measuring  $3 \times 3 \text{ mm}^2$  in size) developed by Hamamatsu Photonics K.K. The new S12572-050C is a successor to the S10362-33-050C (i.e., conventional  $3 \times 3\text{-mm}^2$  pixel MPPC of  $50\text{-}\mu\text{m}$  pitch), comprises 3,600 Geiger mode avalanche photodiodes (APDs), and also features high gain ( $\sim 1.25 \times 10^6$ ), a low dark count ( $\sim 10^6$  cps), and improved photon detection efficiency (PDE) of  $\sim 35\%$ . The S12572-015C is a new type of fine-pitch ( $15 \mu\text{m}$ ) MPPC featuring a wide dynamic range and fast timing response. This paper first presents the detailed performance of these latest MPPCs as photon counting devices. It then describes our fabrication of a prototype detector consisting of a MPPC optically coupled with a Ce:GAGG scintillator. We obtained average FWHM energy resolutions of 9.0% (S12572-015C) and 10.9% (S12572-050C), as compared to 11.7% (S10362-33-050) for 662-keV gamma rays from the  $^{137}\text{Cs}$  source, as measured at  $20^\circ\text{C}$ . Moreover, the number of fired pixels for 662-keV gamma rays increased by 14.2% for S12572-050C (as compared to S10362-33-050), thus indicating more than a 10% improvement in PDE around the light emission peak of Ce:GAGG at 480 nm. We also confirmed that the low energy threshold improved from 10 keV to 4 keV, when using the latest MPPC device (S12572-050C). The results thus confirm that these new types of MPPCs are promising for various applications as scintillation detectors.

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