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RGB-HD SiPMs for fast readout of GAGG scintillation crystals in medical imaging

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In this work, we present the characterization of energy and coincidence time resolution of scintillation detectors obtained by the optical coupling of gadolinium-aluminum-gallium garnet (GAGG) crystals with RGB-HD silicon photomultipliers (SiPMs) with active area of 4×4 mm2 and cell pitch of 25 μm, developed at Fondazione Bruno Kessler (FBK). The emission spectrum of GAGG:Ce, peaked at 525 nm suggests RGB-HD SiPMs as the best candidates for the scintillation light readout, with peak photodetection efficiency (PDE) around 550 nm. Moreover, the recently improved production process of RGB-HD SiPMs resulted in a substantial reduction of both dark count rate and correlated noise probability. This fact, together with an optimized electronics for leading edge discrimination allows an accurate triggering capability at low thresholds. Crystal samples with a size of 3×3×5 mm3 with different dopants were characterized for application in time-of-flight positron emission tomography (TOF-PET). Ce-activated GAGG was compared to samples codoped with Mg and to multidoped crystals containing Ce, Mg and Ti. The scintillation detectors featured an energy resolution of 6% at 511 keV at +20℃. The timing performance of the GAGG crystals was found to be improved by the presence of Mg and Ti dopants. The best coincidence resolving time of 160 ps was obtained with GAGG:Ce,Mg at +20℃.

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