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Test of LYSO and LFS PET prototypes with micropixel APD readout

A few results on measurements of LYSO and LFS crystals with MAPD readout have been reported. These MAPDs were produced by Zecotek Co. and have 3x3 mm2 sensitive area. Due to the specific micro-wells structure such MAPDs have high pixel density up to 40000/mm2 that results in large dynamical range and linearity of MAPD response to intensive light pulses. The experimental set-up includes two sets of the scintillators: LYSO with the 4x4x22 mm3 sizes and 3x3x10 mm3 LFS crystals. Pairs of crystals with MAPD readout were carefully aligned together with 22Na -source placed between the crystals. The measured energy and time resolutions for LYSO photopeak events are 10.9% and 340 ps, respectively. LFS crystals revealed slightly better time resolution of about 325 ps and energy resolution ˜13%. A few approaches for the further improvements of time and amplitude parameters are discussed.

Summary (Additional text describing your work. Can be pasted here or give an URL to a PDF document):

A few results on measurements of LYSO and LFS crystals with new micropixel APD (MAPD) readout have been reported. MAPDs Used in this work were produced by Zecotek Co. (Singapore) and have 3x3 mm2 sensitive area. These MAPDs have a specific structure, where the matrix of avalanche regions and passive/quenching elements are placed inside the silicon substrate together with the individual micro-wells for charge collection. Such micro-wells structure advantages in high density of avalanche regions (or cells) that might achieve 40000/mm2 and exceeds for a few tens times the corresponding parameter of other types of solid state photomultipliers (SSPMs). High cell density and, hence, the linearity of MAPD response to intensive light pulses already found the application in the calorimetry for high energy physics. At the same time, similar performance is requested in PET applications too.

In our work the type MAPD-3N with pixel density 15000/mm2 was used. Its relatively low gain of ˜5x104 results in negligible cross-talk and after-pulses effects observed for other types of SSPMs with higher gain. The MAPD-3N measured PDE value for blue (410 nm) is about 25%, i.e. rather similar to existing PMTs.

The experimental set-up includes two scintillator detectors (pairs of LYSO (or LFS) crystals with MAPD readout) carefully aligned together with 22Na -source placed between these two crystals. The MAPD signals were amplified by specially designed preamplifiers with the gain of about 120 and bandwidth ˜300 MHz. Time and amplitude spectra were recorded with CAMAC based data acquisition system. In this test the energy resolution of 0.511 MeV photopeak and coincidence time resolution between two crystals were measured. Two sets of the crystals are used: 1) LYSO with the 4x4x22 mm3 sizes and 2) LFS with 3x3x10 mm3 dimensions. The following results were obtained. The energy and time resolutions for LYSO photopeak events are 10.9% and 340 ps, respectively. LFS crystals revealed slightly better time resolution of about 325 ps and energy resolution ˜13%. A few approaches for the further improvements of time and amplitude parameters are discussed.

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