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Single layer Compton detectors for measurement of polarization correlations of annihilation quanta

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Measurement of gamma ray polarization can provide valuable insight in different areas of physics research: nuclear, particle and astrophysics. Also, since the polarizations of gamma quanta from positron annihilation are perpendicular, there have been studies to use these polarization correlations in Positron Emission Tomography (PET). The polarization of gammas can be determined from Compton scattering. We have set up two compact, position and energy-sensitive Compton scattering detectors in coincidence mode. Each consists of a single-layer array of Lutetium Fine Silicate scintillation pixels (3x3x20 mm3) in a 4x4 matrix read out on one side by SiPM array with matching elements size. Signals from all elements are acquired and processed by fast pulse digitizers. The coincidence time resolution of typically <0.5 ns (FWHM) allows a clear identification of coincident events, while the energy resolution of 11% (at 511 keV) and the detector granularity allow the reconstruction of the polar and the azimuthal scattering angles. We will present the evidence of the observed polarization correlations of the gamma quanta from positron annihilation and discuss the possible applications of this feature in PET and other experiments where measurement of gamma polarization is of interest. A system of such single-layer Compton detectors would significantly reduce the number of electronic channels compared to typical two layer (scatter-absorber) systems used for Compton scattering detection.

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