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Design and characteristics of a novel single plane Compton gamma camera based on GAGG scintillators readout by SiPMs

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Radiation detection in the environment is of great importance and suitable instruments are highly needed. One possibility for the detection of gamma-ray sources is a Compton gamma camera (CGC) which uses electronic collimation based on the kinematics of the Compton scattering. Most realizations comprise two separate detector planes, a scatterer and an absorber, with some recent attempts to make a single plane CGC in order to enhance compactness and reduce costs. We have designed a novel single plane CGC based on pixelated GaGG scintillators read out by silicon photomultipliers (SiPM). The CGC comprises the scatterer and the absorber layers consisting of 8x8 arrays of 3 mm x 3 mm x 3 mm GaGG scintillator pixels. In the introduced concept, the individual pixels in the scatterer layer are optically coupled to the corresponding pixels in the absorber by the matching 3 mm x 3 mm plexiglass lightguides, and hence both the scatterer and the absorber pixel in one column are readout by the same SiPM. The single-pixel energy resolution is measured to be 12.3% for 662 keV gammas. GEANT4 simulations have been done to estimate the intrinsic efficiency of various detector configurations in dependence on the lightguide length. The angular resolution is estimated from the point-source image reconstructed by the simple back-projection method. The length of 20 mm is chosen for the final design, with an estimated intrinsic efficiency of 0.11% and angular resolution of about 10.5o (FWHM). The first results of the measured characteristics of the detector will be shown. A successful realization of the described detector may be a significant step in the realization of a compact, efficient, cost-effective and easily transportable Compton gamma camera, also with the realistic potential for upgrading to application-specific larger systems comprising more identical modules.

Collaboration

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