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Positron emission tomography imaging with measurements of the polarization-correlated Compton events with single-layer gamma-ray polarimeters

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During the positron emission tomography (PET) scan, decaying radionuclide emits a positron, which annihilates with an electron from the surrounding tissue. In this process, two photons are emitted back-to-back, with 511 keV energies, and are subsequently detected by the scanner detectors. These two photons also have orthogonal polarizations, a fundamental property that has not yet been utilized in conventional PET imaging. Polarization correlation offers an opportunity to improve the reconstructed image quality by reducing the random background noise, which lacks this property. To test this possibility, a novel type of PET scanner with four single-layer Compton polarimeters, has been developed and commissioned. Four detector modules are mounted on the sturdy rotating annular construction, which enables them to precisely rotate around the source at different diameters. The detector modules consist of four 8 x 8 crystal (GAGG:Ce and/or LYSO:Ce) matrices, with either 2.2 mm or 3.2 mm pitch. The identically pitched modules, mounted on opposite sides of the ring, could be used to determine and reconstruct the polarization correlations of the emitted annihilation quanta by measuring the azimuthal angles of the Compton scattered photons in the modules. The scanner was tested with various sources, such as Ge-68 line sources and the NEMA phantom filled with Ga-68, at the University Hospital Centre Zagreb. Data acquisition and processing are performed with TOFPET2 ASIC readout system and analyzed with different event selection criteria. Images are reconstructed with OMEGA software using the Ordered Subsets Expectation Maximization (OSEM) algorithm, with image analysis conducted in MATLAB. We will report on the scanner's properties, as well as show for the first time images of the clinically relevant sources using polarization-correlated Compton events. We will compare them with the images obtained using photoelectric events and discuss the imaging's background reduction potential.

Collaboration

Role of Submitter

I am the presenter

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