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Data processing and event selection for measuring polarization correlations of annihilation photons at large Compton scattering angles

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We describe the experimental setup and data analysis procedure developed for measuring polarization correlations of 511 keV annihilation photons after Compton scattering at angles from 60° to 120°. The setup consists of two arms of Compton polarimeters with intermediate pre-scatterers placed in front of the main scatterers. Each arm is equipped with a ring of 16 scintillation counters covering the full azimuthal range. The upgrade of the setup for large-angle measurements and the corresponding changes in the data acquisition are discussed. The data processing pipeline includes energy calibration of all detectors with temperature drift correction, time-based selection of coincidence events, identification of pre-scattering interactions in the intermediate scatterer, and reconstruction of the scattering angle from the measured energy deposit. The classification of events into bins by scattering angle and the extraction of the visibility parameter from azimuthal angular distributions are described in detail. The entire procedure is validated against Monte Carlo simulations performed with the Geant4 toolkit. The resulting data set provides the input for the physics analysis of entanglement evolution during Compton scattering.

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