Contribution ID: **1156** Type: **Oral**

Simulation of the setup for studying the kinematics of Compton scattering of annihilation photons in entangled and decoherent states

Tuesday, 25 October 2022 16:35 (5 minutes)

Currently, positron emission tomography (PET) is one of the most effective tools for medical diagnostics. The basic principle of PET is the detection of gamma pairs with an energy of 511 keV generated by the annihilation of a positron with an electron in organic tissue. According to the theory, annihilation photons have mutually perpendicular linear polarizations, and their quantum states are entangled. This feature is proposed to be used in the future generation of PET tomographs, in which different angular correlations of scattered annihilation photons in entangled and decoherent states can be applied to suppress the background and improve image quality. However, these differences have not been confirmed experimentally.
We have constructed a setup to identify the quantum state and observe the angular correlations of scattered annihilation photons. The results of Monte Carlo simulation of the setup in Geant4 toolkit are presented in the comparison with experimental data. Detailed study of systematic errors is shown.

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Session Classification: High Energy Physics

Track Classification: High Energy Physics