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Investigating the Effect of Depth of Interaction on Coincidence Timing Resolution

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Coincidence timing measurement has a wide range of applications in the detection of high energy physics, material science, and medical device. A scintillator detector is commonly used for the aforementioned applications due to its favorable physical properties including high energy resolution and brilliant timing resolution.

Unlike positron emission tomography (PET), which measures annihilation quanta having identical energy, measurement of particle momentum (in a large ion collider experiment) or positron annihilation lifetime spectroscopy (PALS) treat quanta having non-identical energy. This research aims to study the effect of the coincidence timing resolution due to the above discrepancy. Since the energy of the radiation to be measured could represent a different distribution of depth of interaction within the scintillator and it could affect the resolution as a factor of uncertainty To this end, we utilized 'order statistics'-based photon statistics for the purpose of reflecting the scintillator properties, and particle tracking in the Monte Carlo simulation to only designate the distribution of photoelectric interaction.

As a result of this study, we found significant differences in coincidence timing resolution depending on radiation energy. In addition, the correlation and degree of contribution to the timing uncertainty between photon statistics and depth of interaction regarding incident radiation energy were studied.

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