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Underlying physics properties for identifying 511 keV gammas in high-Z crystal PET

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Due to the need to correctly determine the first interaction location of each of the two gamma rays to measure the line-of-response, Positron Emission Tomography (PET) scanner sensitivity changes rapidly with small changes in the efficiency at 511 keV. Current PET scanner designs use high atomic number (high-Z) scintillating crystals to detect photoelectric interactions in the detector. Due to photoelectric interactions having a lower cross-section than Compton scattering at 511 keV for high-Z materials, large losses in detector sensitivity occur. This loss in sensitivity can be countered by the inclusion of Compton scattering in the detection of the gamma rays.

Determination of the first scatter in a chain of Compton scatters requires precise measurement of the geometry of the scatter chain, requiring uncertainty in scattering locations to be substantially smaller than the distance between scatters. In typical high-Z detectors the crystal segmentation is on the same scale as the distance between scatters, making determination of the first scatter so difficult it is typically not done. TOPAS simulations show that sensitivity for lines-of-response can be increased by a factor of 3 with the inclusion of Compton scatters.

Early Career

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