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Determination of lutetium density in LYSO crystals: methodology and PET detector applications

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Lutetium yttrium oxyorthosilicate (LYSO) scintillation crystals are favored in positron emission tomography (PET) imaging for their high gamma-ray attenuation, satisfactory energy resolution, and rapid scintillation decay rates. The natural 176Lu isotope, with a half-life of 37.9 billion years, contributes a steady background radiation (BG) profile influenced by the crystals' geometry and composition. This study introduces a method for determining the composition of LYSO crystals when the precise Lutetium content is unknown. By exploiting the relationship between BG spectrum intensity and intrinsic radioactivity, we can accurately estimate the Lutetium concentration within LYSO crystal samples. Initially tested on a well-documented LYSO sample, our method closely matched the sample's known composition. This estimation technique was applied to various unidentified LYSO samples, including both individual crystals and arrays, finding remarkable consistency in Lutetium content across samples of the same material, with discrepancies under 1%. Additionally, the background spectrum for LYSO-based arrays representing a PET detector is generated by simulations using the Geant4 library. Our approach, combined with simulation, effectively predicts the background radiation spectra for different LYSO detector designs. This research has provided implications for enhancing the predictive capabilities and autonomous adjustment of system settings in LYSO-based PET detectors.

Field

Detectors and electronics

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