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Optimizing the Performance of a Total-Body PET scanner based on a new crystal design: A Monte Carlo Study

PET is a vital molecular imaging modality using positron-emitting radionuclides to assess organ metabolism. Cherry et al. introduced an extended AFOV scanner in 2006 to overcome W-B PET limitations, yet designing an efficient crystal for T-B PET remains challenging. This study aims to optimize T-B PET with a new crystal design combining pixelated and monolithic advantages. Our simulated T-B PET scanner has 16 heads (32×105 cm), forming a 41 cm diameter cylindrical scanner, each with 1×1×2 cm crystals. Using GATE, we evaluated sensitivity, spatial resolution, and scatter fraction based on NEMA NU-2 2018. Common scintillator crystals (BGO, LYSO, LaBr3(Ce)) were simulated, and analytical sensitivity was compared with simulation. Analytical vs. simulated sensitivity showed ~8% error. GATE results showed BGO with lower scatter fraction than LYSO and LaBr3(Ce) (5% and 7%, respectively) and higher sensitivity (27% and 41% more than LYSO and LaBr3(Ce)), due to its density and stopping power. LYSO had superior spatial resolution from high stopping power and light yield, while LaBr3(Ce) had lower resolution despite high light yield. Conversely, BGO had degraded spatial resolution due to low light yield. Compared to walk-through PET, our design had slightly weaker spatial resolution but higher sensitivity across all crystals. The designed T-B PET scanner shows promising sensitivity and spatial resolution, outperforming conventional PET scanners.
keywords:PET, total Body- NEMA

Field

Systems and applications

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