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Dual-panel geometry for PET-guided therapy to be enabled by super-fast detector: simulation study

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TOF information is essential to the improvement of image quality in PET reconstruction. However, the fastest TOF resolution currently available commercially, at around 200 ps, is not good enough to realize reconstruction-free imaging, and therefore, PET systems still require a ring geometry to satisfy the completeness condition in image reconstruction. On the other hand, a 30 ps TOF resolution has been achieved with Cherenkov-radiator-integrated microchannel-plate photomultiplier tubes (CRI-MCP-PMTs). In other words, a conventional ring geometry will not be necessary in future PET systems, and any other geometry like a dual-panel open geometry, which may enable PET imaging during cancer therapy, will be possible. Therefore, the aim of this work was to investigate the feasibility of a novel panel PET system with CRI-MCP-PMTs. A 5.75 mm-pitch position-sensitive CRI-MCP-PMT with a BGO window (5.0 mm thick) was simulated by GEANT4, as a future possible extension from the current devices that use a lead-glass Cherenkov radiator. A panel PET (142 mm x 142 mm, 300 mm panel separation) was modeled. A rod phantom was simulated, and the ML-EM reconstruction was applied. As a figure of merit, the peak-to-valley (P2V) ratio was measured for 4 mm diameter rods. The P2V ratio of the 30-ps panel PET was 15.9, which was higher than the 14.7 ratio of the 210-ps ring PET. The simulation results supported the feasibility of the proposed dual-panel geometry.

Field

Systems and applications

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