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Low-Dose Total-Body Time-of-Flight PET Using High-Resolution Gamma Ray Multiplier Tubes (HGMTs)

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The high-resolution gamma ray multiplier tube (HGMT^{TM}) is a large-area gamma ray detector with high space and time resolution with applications in low-dose total-body time-of-flight positron emission tomography (TOF-PET). HGMTs are composed of a vacuum container containing laminar microchannel plates (LMCPs^{TM}) optimized for surface direct conversion (SDC) of a gamma ray into an electron cascade and LMCPs optimized for cascade amplification. SDC produces electrons from the gamma ray interacting in the LMCP substrate via Compton scattering or the photoelectric effect, bypassing the need for an intermediate step of converting the gamma ray into optical photons. HGMTs together with picosecond-precision electronics and strip-line pickup boards provide high-resolution time and space measurements of gamma ray interactions.

We will present simulation results of HGMTs for TOF-PET and summarize current progress towards building an HGMT. TOPAS and Geant4 simulations of HGMT-based whole-body PET scanners indicate possible dose reductions by a factor of 100. Line-of-response (LOR) reconstruction methods may differ for HGMTs built from low-atomic number (Z) and high-Z substrates in order to optimize accurate reconstruction to include time-ordering of Compton scatters. We are exploring manufacturing techniques and vendors as well as creating test stands.

Field

Detectors and electronics

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