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Exploration of the physical limits for Cherenkov PET using tiny crystals and a large cube

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This study is performed within the scope of the SwissPix project, which aims at developing a new photo-sensor for Positron Emission Tomography with ~10 ps FHWM timing resolution, capable of exploiting the prompt nature of Cherenkov radiation. Using Monte Carlo simulations, we estimated the physical limits of timing resolution for two possible detector geometries: a radiator of 3x3x3 mm^3 with one photo-sensor attached opposite to the side the gamma enters, and a 25x25x25 mm^3 cube with photo-sensors fully covering all six sides. The 25x25x25 mm^3 cube required reconstruction of the gamma interaction position that it performed using arrival times and the Cherenkov photons detection positions, minimizing a cost function for the gamma interaction position. Monte Carlo information confirmed the reconstruction of the gamma interaction position inside the cube. We simulated a whole-body PET system with GATE (Geant4 Application for Tomographic Emission). As a result, the spatial resolution in three directions of the point source was obtained reconstruction-less.

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