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GEANT4 Modelling of Light Collection in PWO Scintillator Crystal Wrapped by a Retro-reflective Film

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Scintillation light transport and collection at the entrance window of a photodetector in a great extent have effect on the energy and time resolutions of a scintillation detector, especially in the case of high value of the scintillator refraction index and its large size at least on one of dimensions. Now various wrappings are applying to improve light collection and in some cases, its linearity. To control photon capture in oblong scintillator sensors some variants of the photonic crystals are proposed [1]. As was showed [2], retro-reflector also can be successfully used for the effective control of photon transport within a detector.

In the contribution we consider distributions of scintillation photons and evaluations of energy and time resolutions in the CMS type PWO element wrapped by specular reflector (aluminum foil mirror), diffuse reflector (Tyvek), and retro-reflector (3M Scotchlite Reflective Material) irradiated by electrons and gamma-quanta with energy of 1, 10, and 100 GeV. Simulations were performed using Monte-Carlo GEANT4 toolkit supplemented by implementation of the retro-reflector into its optical simulations.

[1] M. Salomoni et al. Enhancing light extraction of inorganic scintillators using photonic crystals // Crystals 8 (2018) 78.

[2] J.W.T. Heemskerk et al. A micro-machined retro-reflector for improving light yield in ultra-high-resolution gamma cameras // Phys. Med. Biol. 54 (2009) 3003.

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