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Time response simulation of a “shashlyk”-type calorimeter as applied to ECAL MPD / NICA

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Sampling calorimeters of the “shashlyk” type are widely used in high-energy physics due to the low cost of construction materials and good energy resolution. Using this technology, within the framework of the NICA / MPD project, a cylindrical electromagnetic calorimeter (ECAL) with a diameter of 4 m and a length of 6 m is being created. It contains 38400 towers of the “shashlyk” type with a total weight of about 60 tons. The towers represent a truncated pyramid with a base of 4x4 cm2, containing 200 alternating 1.5 mm thick polystyrene scintillator and 0.3 mm thick lead plates pierced with 16 Kuraray Y11 wavelength shifting (WLS) fibers 1.2 mm in diameter for collecting light on an avalanche silicon multipixel photon counter (MPPC) Hamamatsu S13360-6025PE (˜ 64000 cells) with an area of 6x6 mm2. In this configuration, one can hope to obtain subnanosecond time resolution for ECAL towers. This will expand the capabilities of ECAL in particle identification, background rejection and clustering in high multiplicity events. .This report is devoted to modeling the time response of ECAL. In full, this task is reduced to obtaining the distribution of energy release in scintillators, converting it into blue light, collecting these photons on the WLS fibers, converting blue to green light and capture it in fibers, transportation to the MPPC, shaping its output signal and registration by digital electronics. Results are given for a part of this common task. GEANT4 environment has unique possibilities of Monte Carlo simulation, which has been repeatedly tested for calculations in the areas of high energy density of matter, astrophysics, accelerator physics, and radiation medicine, in which most of the well-studied processes of interaction of particles and radiation with matter are taken into account, including optical processes, scintillation, Cherenkov radiation, interaction of photons with the boundaries of media, wavelengths shifting in fibers and others. Within the framework of the GEANT4 package, a numerical simulation of the light collection from the ECAL tower was carried out. The influence of reflective coatings of the scintillator surface, the propagation of light in fibers, taking into account their multilayer structure and light reflection from their ends, as well as the effects of joining a fiber bundle with an MPPC are considered. The time shapes of the light signal at the MPPPC input were obtained, both taking into account only geometric effects and with the scintillation and WLS reemission decay times. This work was supported by the Russian Foundation for Basic Research, Grant No. 18-02-40054

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