Search for scaling properties of electromagnetic cascades produced by 100-3500 MeV gamma quanta in heavy amorphous media

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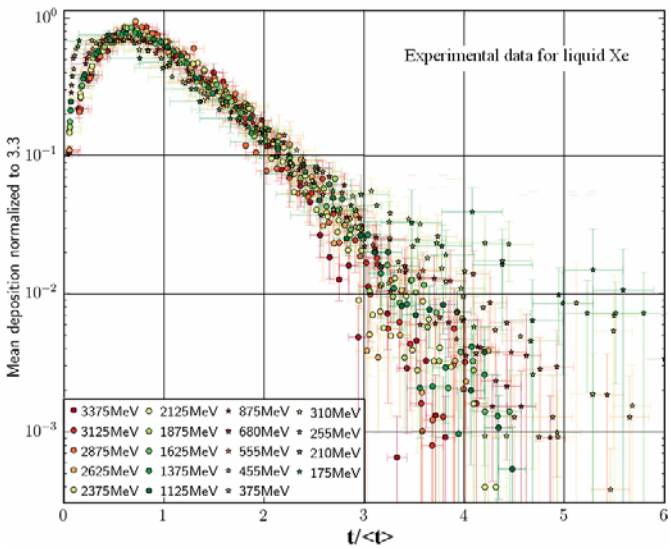
The process of electromagnetic cascade (EC) produced by high enough energy gamma quanta (GQ) or electrons (≳100 MeV) and developing in dense amorphous materials (DAMs) consists of succession and superposition of mainly four elementary electromagnetic phenomena: pair production, gamma radiation (bremsstrahlung), ionization and multiple Coulomb scattering. The knowledge of this process is necessary, in particular, for detectors and shielding construction, energy reconstruction of primary GQ and electrons, estimation and prognosis of radiation degradation of materials etc. Presently in use is practically the simplest and rough description of the main features of ECs created in dense materials by high energy GQ: longitudinal profiles (LPs) and several integral formulas describing the longitudinal energy deposition in ECs (for example, [1,2]). Nevertheless, such a simple model is not too adequate, especially at large depths *t* and at the very beginning of the cascade [2].



In the work we study the average longitudinal profiles of ECs created in eight most popular dense amorphous media: liquid xenon, PWO, $CdWO_4$, GaAs, NaI, Pb, lead glass and BGO by gamma quanta of energy E_γ = 100÷3500 MeV at two different cut-off energies E_{co} of electrons (1.2 and 3.0MeV). Moreover, to compress such a copious experimental information about EC it is quite reasonable to find some scaling description of LPs making them at least energy independent and we found that the average cascade depth $\langle t \rangle$ is quite good candidate. In addition, this parameter reveals a simple dependence of E_γ: $\langle t \rangle \sim ln\, E_\gamma$.

The work has been performed using GEANT4 modeling codes [3] and experimental data from Xe bubble chamber of ITEF (Moscow) [2]. For every set of parameters: E_γ, E_{co} and material we modeled 20000 events (histories). The ultimate objective of this investigation is to obtain simple formulas describing average profiles of ECs suitable for practical applications.

References

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