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# The role of excitation distribution in the intrinsic resolution

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Non proportionality (NP) of scintillation response is usually used as an explanation of intrinsic resolution change, nevertheless there are no direct links between definitions of these scintillation parameters. At [1] the wide spread between LY and energy resolution (ER) was pointed for the same scintillator (NaI:Tl). The literature data are between 5 and 12% resolution that is out of the LY spread! It is important to note that NP significantly depends on crystal purity, co-doping, integration time and so on [2, 3]. In other words it is necessary to assume that ER depends on the scintillator structure as well nevertheless there are no any "structure parameters"in ER definition (only statistical parameters).

These experimental data allows to assume that not all scintillation events have the same contribution to the PMT registered statistics, and it is necessary to find the core for such difference. Moreover, the decay kinetics also fluctuate significantly. These two factors approve the supposition that the main reason for such effects is the fluctuation of spatial distribution of electrons, holes and activators in the track region. In order to demonstrate this link we analyze electron-hole, electron-electron, hole-hole, electron-activator and hole-activator correlation functions just after the production of themalized excitations. This approach could also estimate the role of electric fields created due to the separation of electrons and holes. Fractal correlation dimensions of these functions shows the change of the track structure for different scales (e.g. 3D spherical for small distances where the clusters of excitations do not overlap, 1D cylindrical one for the case of overlapped clusters (intermediate distances) and 0D for distances comparable with the track length). The account for energetic Auger- and delta-electrons result in the change of this fractal correlation dimensions. The structure of these correlation functions determines different scintillation decay kinetics and corresponding yield at different stages of the scintillation and from different parts of the track.

It is important that "scale factor"based on the e-h separation and later thermalization for alkali halide scintillators is more significant than of alkali earth halides that explains the better ER for the latter materials. This is an additional (to the activator uniformity) factor at the predictable energy resolution description that has to looks like the new step to conventional NP and ER models.

References

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