

Pulse shape studies of various scintillators with waveform digitizing techniques

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In this study we used a waveform digitizer to record, store and analyse individual scintillation pulses from the following scintillators: CeBr₃, LaBr₃:Ce, LaBr₃:Ce,Sr, NaI:Tl, CsI:Tl, and BaF₂. With off-line analysis software we sorted the pulses according to their charge integrals. Then we obtained the pulse shape as a function of energy deposited within a scintillator. The result on pulse shape change with density of excitation can be used to verify currently investigated scintillation mechanisms and the postulated excitation track structure [1]. By exploiting a time correlation of nuclear decay events we separated ²¹⁹Rn and ²¹⁵Po alpha peaks from an internal alpha contamination spectrum in LaBr₃:Ce, CeBr₃, and LaBr₃:Ce,Sr. We found that the alpha peaks are not symmetric in lanthanum-based scintillators. The origin of this phenomenon is unknown, but it may indicate a presence of domains in the crystal structure or a directional anisotropy [2]. This type of analysis can be used for collecting data on an intrinsic alpha excitation in scintillators, while avoiding surface effects [3]. We will show that by using a waveform digitizer all experimental data can be recorded and then analysed off-line, giving not only high flexibility, but also exceeding what is possible with classical nuclear electronics. For example, it is possible with a ¹³⁷Cs source to collect within one hour multiple scintillation decay curves for different deposited energies ranging from 10 to 662 keV. The same may take a few weeks using a classical start-stop method.

[1] X. Lu et al. "Energy-Dependent Scintillation Pulse Shape and Proportionality of Decay Components for CsI:Tl: Modeling with Transport and Rate Equations", Phys. Rev. Applied, Vol. 7, Iss. 1, 2017.

[2] W. Wolszczak, P. Dorenbos, "Shape of intrinsic alpha pulse height spectra in lanthanide halide scintillators", NIM A, <http://dx.doi.org/10.1016/j.nima.2017.02.041>, 2017.

[3] W. Wolszczak, P. Dorenbos, "Non-proportional response of scintillators to alpha particle excitation", submitted to IEEE TNS, 2017.

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