LARGE-SIZED COMBINED BLOCKS OF DETECTION A BETA AND GAMMA OF RADIATION

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Characteristics are presented for a combined detection block (CDB) of gamma- and beta-radiation based on a four-crystal detector using CsI(Tl) and ZnSe(Te) scintillator crystals and Si-PIN-PD. Four CsI(Tl) crystals (total volume 53 cm^3) form a clover-type arrangement - a cylinder 45 mm in diameter and 40 mm high subdivided into four light-protected quadrants along the rotation axis. Space between the crystals and container walls are filled with a light reflecting composite. Light is collected by a S3590 Hamamatsu Si-PIN-PD through square-shaped diaphragmed openings at lower sides of the crystals. CDB characteristics in the counting mode of digital summation: sensitivity to gamma-radiation of ^{137}Cs and ^{60}Co is 10 and 5 pulses·s^{-1}/mcR·h^{-1}, respectively. Sensitivity to beta-radiation is 0,031 pulses·s^{-1}/particles·cm^{-2}·min^{-1}. Sensitivity was calculated as function of energy for detectors with crystals CsI(Tl) and ZnSe(Te) both without and with filters, accounting for electromagnetic shielding [1]. Results are presented for statistical characteristics of output signals, which confirm statistical independence of signals coming from the segments of CDB. The stand allows to measure the duration of time intervals between consequently coming pulse signals. Statistical properties of time interval sets between subsequent pulse signals can be studied more efficiently if logarithms of the measured data are considered. If the time histogram for initial data is a monotonous function smoothly decreasing from the minimum time of instrumental resolution, histograms for logarithms are of characteristic shape with a maximum. In the double logarithmic scale the shape of the hystogram is close to an inclined parabola. Studies of histograms of signals from detection blocks with scintillator volume 1 cm^3, 10 cm^3, 40 cm^3 have proved universal character of their shape, independence of shape upon scintillator volume, counting rate and gamma-quanta flux density. Analysis of statistical sequences by the normalized range method has shown high degree of self-similarity of the process under change of the time scale by 4-5 decimal orders of magnitude [2]. The calculated Hurst exponent value (0.53) proves high degree of statistical independence of the process; however, the obtained accuracy is not sufficient to calculate the fractal dimensionality.

[1] V.D. Ryzhikov, V.P. Sokhin. Pribory i tekhnika eksperimenta 5, 177 (1988).

[2] J. Feder. Fractals, Plenum Press, New York-London, 1996.