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A METHOD FOR IMPROVEMENT OF SIGNAL-TO-BACKGROUND RATIO OF AIRBORNE SCINTILLATION GAMMA-DETECTOR

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The paper describes a new method for improving sensitivity of scintillation-type gamma-detectors, whose pickup elements include a measuring crystal and a protective alkali-halogen one with different times of gamma-luminescence relaxation. Processing of the luminescence signal after photoelectric multiplier is performed by a magnetoacoustic correlator with memory or differentiating devices.

The scintillation detectors of gamma-radiation using alkali-halogen crystals belong to the most sensitive devices for measurement of radiation background [1]. Apart from the fact that alkali-halogen crystals are characterized with a very high quantum output of gamma-luminescence, the advanced technology of their growing permits to fabricate rather cheap and large specimens of such crystals. It should be added that Ukraine (the Institute of Monocrystals, city of Kharkov) is the world leader in the growing of these crystals.

The structural features of a scintillation detector are dictated by concrete tasks of radiation recording. When checking the contamination of vast areas by radionuclides, there arises the problem of prompt collection of information, and the high-sensitive airborne detector of gamma-radiation is best suited for its handling. Installation of such detector on a flying vehicle makes it possible to control quickly and efficiently the contamination over large areas of the earth's surface at a minimum of cost and with low factor of risk for human operator.

The efficiency of operation and time resolution of scintillation detectors depend not only on characteristics of the scintillation materials employed, but also on design features of the detector and its elements. The main goal of optimization of scintillation detectors is to raise their sensitivity and to lower the scattered radiation background. The sensitivity of scintillation detectors depends on efficiency of conversion of gamma-radiation into light, and also on the coefficient of collection of the light radiated in the process of gamma-luminescence. The conversion efficiency is defined by such characteristics of the scintillator as its density, mean atomic number, shape and geometric dimensions of the specimen. As for the coefficient of light collection, it depends on specimen's size and shape, on the type of the reflecting coating, and on the size of the photomultiplier cathode.

The basic method of optimization of these characteristics of scintillation detection is computer-aided simulation [2], which does not require fabrication of a large number of experimental specimens. However, for any airborne detector of radiation, because of application of heavy and awkward protective screens, there arises a problem of separation of a weak measured signal from intensive noise created by natural cosmic radiation. Accordingly, this work is devoted to development of methods permitting to raise the signal-to-noise ratio when measuring the gamma-radiation by a scintillation detector.

REFERENCES

1. N. A. Vartanov and P. S. Samoilov, Practical Methods of Scintillation Gamma-Spectrometry [in Russian], Atomizdat, Moscow, 1964.

2. Yu. A. Tsirlin, M. Ye. Globus, and M. Ye. Sysoyeva, Optimization of Gamma-Radiation Detection by Scintillation Crystals [in Russian], Energoatomizdat, Moscow, 1991.

3. Yu. A. Tsirlin, Collection of Light in Scintillation Counters [in Russian], Atomizdat, Moscow, 1975.

4. M. Ye. Globus and B. V. Grinyov, Inorganic Scintillators — New and Traditional Materials [in Russian], Akta, Kharkov, 2000.

5. P. Schotanus, R. Kamermans, and P. Dorenbos, IEEE Trans. Nucl. Sci. Vol. 37, No. 2, pp. 177–181, 1990.

6. N. M. Naumenko and A. N. Panova, Kinetics of luminescence of crystals CsI(Na), in coll.: Monocrystals, Scintillators and Organic Luminophores, VNII of Monocrystals, Kharkov, Iss. 5, pp. 309–312, 1969.

7. N. N. Krupa, Izv. VUZ. Radiofizika, No. 10, pp. 1–6, 2001.

8. A. N. Panova and R. Kh. Mustafina, Impact of activator concentration on optical and scintillation properties of crystals NaI(Tl) [in Russian], in coll.: Monocrystals and Engineering, VNII of Monocrystals, Kharkov, Iss. 1, pp. 81–87, 1970.

9. K. V. Shakhova, L. V. Kovalyova, and T. B. Grinyova, Funct Mater., Vol. 5, No. 1, pp. 36–39, 1998.

10. V. A. Tarasov, E. V. Sysoeva, E. P. Sysoyeva, and O. V. Zelenskaya, Modeling of detection systems on the base of scintillation materials, Inorg. Scint. and Their Appl. — Proc. of the Fifth Intern. Conf. "SCINT-99", August 16–20, 1999, Moscow, pp. 288–292.

11. V. S. Bondarenko, V. V. Krinochkin, M. V. Manuilov, and V. V. Sobolev, Pis'ma v ZhTF, Vol. 13, No. 7, pp. 598–601, 1987.

12. D. Morgan, Signal Processing Devices in Surface Acoustic Waves [Russian translation], Radio i Svyaz', Moscow, 1990.

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