

2.2. EXPERIMENTAL STUDIES OF PAIRWISE COMBINATION OF DETECTION METHODS FOR SOURCES OF IONIZING RADIATION

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Experimentally verified methodology of pairwise combination of detection methods for ionizing radiation sources is proposed for the first time. Detection methods are based on the recording of giveaway factors of ionizing radiation physical fields within radiometric mode of measurements. Experimental verification was performed using neutron source Cf^{252} and radiometer of neutron and gamma radiation. Used means are metrologically certified. New signal detection criterion is proposed, which is governed by the Poisson law on the basis of statistical check of the hypotheses of two-dimensional signal density and “signal+background” signal.

Dependences of probability of omission under one method P_1 and the combination of two methods P_2 in conditions of not correlated background are obtained, which demonstrate the advantage of combination of the pair of methods. Thus, probability of omission of not correlated signal $P_{22}(\Theta, r_1 = 0)$ exceeding in 5 times the root-mean-square error of background (“signal/background” ratio = 0.5) is by a factor of 100 lower the omission probability P_1 during detection under one method. Positive dynamics of the reduction of omission probability P_2 results in its decreasing by more than three orders of magnitude at $\Theta \geq 6$ («signal/background» ≥ 0.6) as compared with one method. Significant improvement of detection quality during combination of two methods is observed also at $\Theta \leq 4$ (weak signals during detection at the threshold level of detection). Thus, in the case of $\Theta = 4$, omission probability P_2 is in 50 times lower than probability P_1 . During detection of extremely weak signals equal to $\Theta = 2.36$ of the root-mean-square error of background, when probability P_1 is equal to 0.5 (omission of every second signal), joint processing of data of two methods reduces omission P_{22} to 0.2 (omission of every fifth signal); when signal is equal to $\Theta = 3$ of the root-mean-square error, $P_1 = 0.2$ (omission of every fifth signal), whereas P_{22} is less in four times ($P_{22} = 0.05$).

Availability of negative correlation ($r_1 = -0.5$, location of “signal+background” ellipse in parallel to the decisive border line $F(x, y) = 0$) decreases omission by more than three orders of magnitude event at $\Theta \geq 4$. Although positive correlation ($r_1 = +0.5$) deteriorates the dynamics of omission probability reduction, it preserves advantages over one-dimensional detector.

In the testing practice, situation can exist when one detection method plays the main role for some reasons. For example, it is adjusted for expected radiation source, possesses with high sensitivity, does not require participation of operator, while background component is favorable and stable. Herewith, second method performs supplementary function (is adjusted to radiation source of rarely realized type, possesses with low sensitivity, operates in conditions of instable background, etc.). This method is used in the mode of target indication.

Thus, with countability of background pulses per every channel $\lambda_{\Phi} = 1$ pulse/s, significantly steeper descent of omission probability is provided under two methods of not correlated signals as compared with detection under one method. With growth of detec-

tion time up to 100 s, reduction of omission probability by several orders of magnitude is observed.

Thus, relationship of omission probabilities of two-dimensional and one-dimensional detectors demonstrates advantage of two detection method combining in terms of the time index of testing.