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METHODS FOR DETERMINING THE AMOUNT OF MULTI-ELECTRONIC SCINTILLATIONS ON THE SCREEN OF ELECTRO – OPTIC TRANSFORMER OF IMAGES

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ABSTRACT: *One of the basic requirements when using electro – optical transformer (EOT) of images in space research is the low level of bright light flashes on the screen, called multi – electronic scintillations.*

The experimental research of number and brightness of scintillations show that the distribution of the multi – electronic scintillations' number across the screen's diameter could be approximated by a normal law.

The analysis of multi – electronic scintillations amplitude spectrum shows, that in the center of the EOT's screen, the number of scintillations with greater amplitude is significantly greater in comparison with those at the end of the active surface of the screen.

KEY WORDS: *electro – optical transformer , multi – electronic scintillations.*

One of the basic requirements when using electro – optical transformer (EOT) of images in space research [1, 2, 5, 7, 8] is the low level of bright light flashes on the screen, called multi – electronic scintillations. The existence of multi – electronic scintillations leads to significant expansion of the possibility for diminishing the utmost sensitivity of the EOT [4, 6, 9, and 10]. The definition of the amount of scintillations per definite time could be done with the help of the method for scintillations' calculation while using photo – electronic multiplier [3]. If the number of scintillations' distribution over the active surface of the screen is determined and experimentally are evaluated the distribution parameters for a certain EOT, it is a matter of simpler methods required for the scintillation evaluation without the need for development of complex scanning devices. The current research is about evaluating the law of scintillations' amount distribution over the active surface of the screen, evaluation of their amplitude spectrum and development of method for defining the amount of multi – electronic scintillations over the active surface of the EOT's screen.

METHOD FOR DEFINING THE DISTRIBUTION OF SCINTILLATIONS NUMBER OVER THE ACTIVE SURFACE OF THE EOT.

A certain device [3] is used in order to define the distribution of the scintillations number over the screen. The measurement of scintillations is made as in [3], from the surface o the EOT's screen, with the help of mobile diaphragm, 2 mm in diameter, and optic system for transferring the image to the photo – electronic multiplier. The light source secures monochromatic adjustable infrared radiation, hitting the photo cathode of the EOT. The method for measurement is based on evaluation of average amplitude of scintillations, invoked by single electrons, hitting the EOT's photo cathode, the amplitude distribution of scintillations and their integral number. The measurements are taken in dark, in light, on background 10^{-7} cd/m^2, in adjustable shine of EOT's photo cathode by the light source. A consecutive account is being taken after every diaphragm's movement on every 2 mm from the center across the EOT's screen radius toward the periphery. The received experimental data serves for setting up a dependency between scintillations' amplitude spectrum and their integral number across the screen's diameter. The measurements show that the distribution is asymmetric, which allows simplification of the method and evaluation of the scintillations' distribution only in dependence with the screen's radius.

MEASUREMENT – RESULTS AND ANALYSIS

Figure 1 shows experimental data for the distribution number of dark scintillations on the EOT's screen with background brightness 10^{-7} cd/m^2.

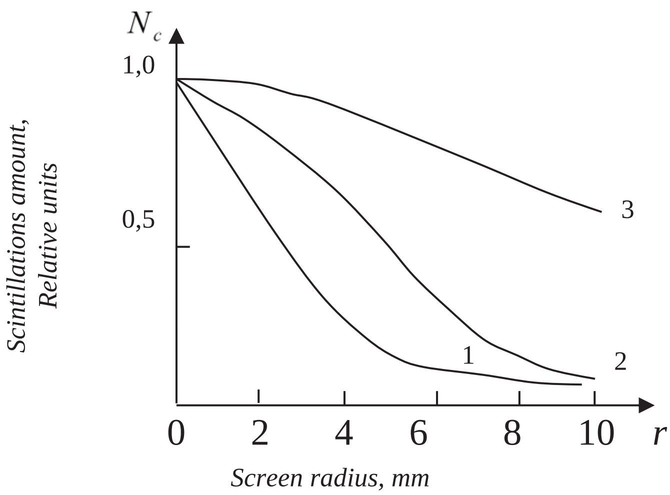

Figure 1. Distribution of dark scintillations number across the EOT's screen radius: 1 – when σ = 2,5; 2 – when σ = 4 and 3 – when σ = 10.

Figure 2 shows the distribution of background scintillations across the EOT's screen radius with background brightness 10^{-4} cd/m^2.

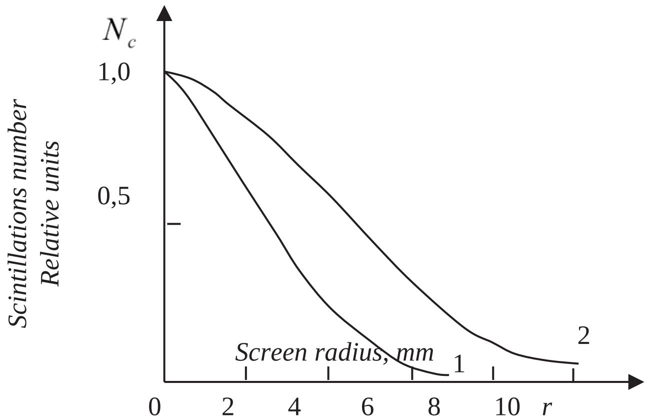

Figure 2. Distribution of background scintillations number across the EOT's screen radius: 1 – when σ = 2,3 and 2 – when σ = 4.

The experimental data is compared to a normal distribution law. The values of mean quadratic aberration σ are shown in the figures. The values show, that the scintillations are concentrated mainly in the center of the screen. As it is observed in the figures, the comparison of experimental data with normal distribution law shows good coordination. It could be considered that the possibility for appearance of scintillations across the EOT's screen diameter is similar to the normal distribution law (Figure 1, Figure 2), describable with the formulae:

$$y = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{r^2}{2\sigma^2}}, \tag{1}$$

where: *r* – EOT's screen radius.

The definition of scintillations' number over the active surface of the EOT's screen could be done in the following sequence. By following that method could be defined the scintillations' number N_c across the co-ordinate r_n. The mean quadratic aberration σ in normal distribution could be defined by the formulae:

$$\sigma = \frac{r_n}{1{,}18}. \tag{2}$$

Having in mind the values of σ and N_c, we could define the scintillations number *N* for the entire active surface of the screen:

$$N = N_c \frac{V}{V_c},$$ (3)

where: V_c - the volume of a body, restricted by the surface in rotation of the curve $y_2 = f(r)$ across the analyzed surface of the screen *S*, definable by $V_c = S.y_2$, where $y_2 = \frac{1}{\sqrt{2\pi\sigma}}$;

V - the volume of a body, restricted by the surface in rotation of the curve $y_1 = f(r)$ across the working surface of the screen:

$$V = S + \pi \int_{y_1}^{y_2} r^2 dy,$$ (4)

$$y_1 = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{r_k^2}{2\sigma^2}};$$

r_k - radius of the screen working surface.

The value of r^2 could be defined by the equation (1):

$$r^2 = \left(\ln \frac{1}{\sqrt{2\pi\sigma}} - \ln y \right) 2\sigma^2.$$ (5)

By replacing equation (5) in equation (4), after integration we get:

$$V = 2\pi\sigma^2 \left[(y_2 - y_1)(\ln y_2 + 1) - y_2 \ln y_2 + y_1 \ln y_1 \right] + Sy_1.$$ (6)

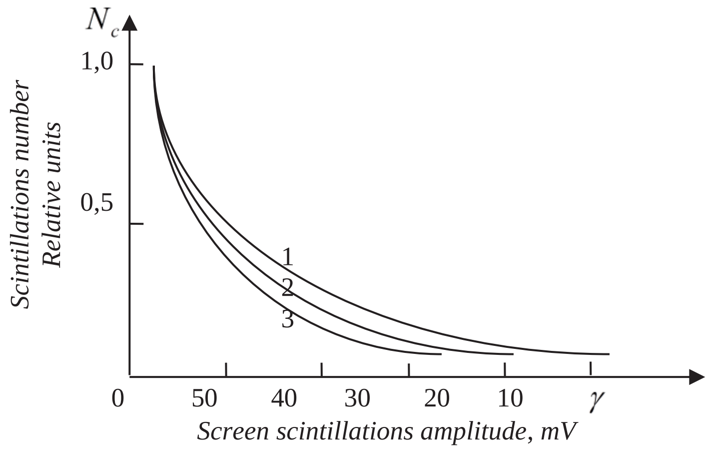

Figure 3. Amplitude distribution of dark scintillations: 1 – measured in the center of EOT's screen; 2 – measured at distance of 3 mm from the center of the screen; 3 – measured at distance of 7 mm from the center of the EOT' screen.

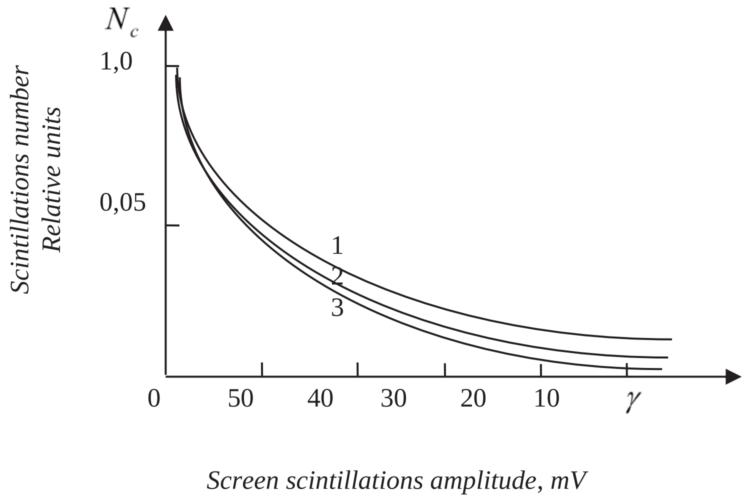

Figure 4. Amplitude distribution of background scintillations: 1 – measured in the center of EOT's screen; 2 – measured at distance of 3 mm from the center of the screen; 3 – measured at distance of 7 mm from the center of the EOT' screen.

The definition of the scintillations number across the working surface of the EOT's screen is made with the help of measurement of scintillations number in circular areas of the screen and calculation of their whole number with the suggested method for approximation of scintillations number distribution across the screen surface with a normal distribution law. Figure 3 and figure 4 show amplitude distributions of scintillations, measured in the center (scheme 1) and in distance of 3 mm (scheme 2), 7 mm (scheme 3) and 10 mm (scheme 4) from the center with background brightness – full darkness - 10^{-7} cd/m^2, created in front of the EOT's photo cathode, and at background brightness 10^{-4} cd/m^2.

Variations in amplitude distribution are observed. A significant contribution to the amplitude distribution in the screen center brings the scintillations with greater amplitude.

CONCLUSION

The experimental research of number and brightness of scintillations show that the distribution of the multi – electronic scintillations' number across the screen's diameter could be approximated by a normal law. This allows the application of the suggested method for measuring of scintillations number across the active surface of the EOT's screen.

The analysis of multi – electronic scintillations amplitude spectrum shows, that in the center of the EOT's screen, the number of scintillations with greater amplitude is significantly greater in comparison with those at the end of the active surface of the screen.

These multi – electronic scintillations could invoke the registration of non – existing signal, because of which along with the enumeration of multi – electronic scintillations number across the active surface of the screen is necessary to be made measurement and accounting of the amplitude spectrum of scintillations across the EOT's screen.

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