FTD-TT-65-1139

AD 625157

TT66-60018

TRANSLATION

EFFECT OF GAMMA-RAYS CO^{60} ON F. E. U. PARAMETERS

By

A. N. Pertsev, A. N. Pisarevskiy, and L. D. Soshin

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

WRIGHT-PATTERSON AIR FORCE BASE

OHIO

FTD-TT- 65-1139/1+2+4

UNEDITED ROUGH DRAFT TRANSLATION

EFFECT OF GAMMA-RAYS CO^{60} ON F. E. U. PARAMETERS

BY: A. N. Pertsev, A. N. Pisarevskiy, and L. D. Soshin

English pages: 10

SOURCE: Pribory i Tekhnika Eksperimenta. (Russian), No. 2, 1965, pp. 146-149.

S/0120-065-000-002 TP5002443

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

This translation was made to provide the users with the basic essentials of the original document in the shortest possible time. It has not been edited to refine or improve the grammatical accuracy, syntax or technical terminology.

EFFECT OF GAMMA-RAYS Co^{60} ON F. E. U. PARAMETERS

A. N. Pertsev, A. N. Pisarevskiy and L. D. Soshin

Discussed is the effect of radiating f. e. u. (photomultiplier with Co^{60} gamma rays on the subsequent operation of f. e. u. It is shown that here take place reverse sensitivity changes of the photocathode and of the amplification coefficient of f. e. u.

At present time the effect of penetrating radiation on the performance of f. e. u. (photo multiplier) appears to be, evidently, a little investigated problem. In report (1) the authors found, that in dependence upon the form of gamma-radiation source and its energy is observed an increase as well as a decrease in the total sensitivity of f. e. u. type 6292 (RCA), while for f. e. u. 5819 a similar effect was absent.

In connection with various applications of f. e. u. in scientific investigations and in industry data about the effects of greater dosages of radiation on f. e. u. become necessary. Successes in the study of natural f. e. u. noise (2-5) allow in a more simple way to make a more thorough investigations of the effect of gamma-rays on the performance of f. e. u.

Method and Technique of the Experiment

Ordinarily investigations of f. e. u. are carried under a condition of a scintillating spectrometer, and the basic attention is directed to the stability of the photopeak in the spectrum on the energy axis of the spectrometer: in this case is determined the change in total f. e. u. sensitivity and the role of the photocathode and dinode system can not be explained separately at a change in position of the photopeak. Natural noise of f. e. u. in this case are considered only to a point, since they carry in distortions in the measurement results and are characterized by the number of pulses at selected discrimination level. Separation in the amplitude spectrum of noise pulses of a "monoelectron" peak (corresponding to the arrival on the first dynode of one electron from the photocathode) offers the possibility of dividing the radiation effect on the photocathode and dynode system when studying the gamma-radiation effect on f. e. u. The single electrode peak in amplitude spectrum of noise of a "good" f. e. u. is due basically to thermoemission from the photocathode and is described by Poisson distribution with determined $\bar{k}$ (4-6) for each f. e. u. example: the value k characterizes the coefficient of secondary emission of the first dynode. A comparison of the average amplitude of the monoelectron pulse with the average amplitude of the pulse in the photopeak allows to characterize the effectiveness of the photocathode with the number of photo electrons per unit of lost in the scintillator energy at other conditions being equal (one and the same crystal, identical light assembly conditions etc) which does not depend upon the amplification coefficient of f. e. u. On the other hand, the change in position of the maximum distribution on the amplitude axis offers data about the change of the amplification coefficient of f. e. u. In this way, by the way of noncomplicated measurements is possible to obtain data about the change of working parameters of basic f e. u elements.

Investigated was the effect of gamma-radiation on the performance of FEU-13 (2 examples), FEU-1S (3 examples) and thirteen cascade f. e. u. with working photocathode ϕ 15 mm, similar to FEU-1S and FEU-1A, on a metal layer in FEU-13 dynodes from Cu + Al + Mg alloy for FEU-13 and from AMGK alloy for all the remaining f. e. u. All selected f. e. u. gave a noticeable monoelectron peak, they were stable in time and had a small setting time. Before the radiation was measured the number of noise pulses and their amplitude spectrum, the effectiveness of the photocathode was determined in the number of phot electrons at 1 mev with NaI (TI) crystal. After the radiation, in addition to these values was taken down the dependence of the monoelectron peak position upon time. The monoelectron peak was identified with the aid of a weak light source with known number of quanta (51.103 quanta

	Type of f.e.u.	FEU-13			FEU-1S (a)		FEU-1S (b)				FEU-1B	
	Radiation dosage, r.	N_o	50000	50000	N_o	50000	N_o	5000	5000	5000	N_o	50000
1	Conversion effectiveness of photoelectrons, mev	5550	1420	530	2500	540	2100	1360	1320	1130	3680	390
2	Position of electron peak	5	21	42	11	36	20	30	30	33	10	17
3	Number of noise pulses in 1 sec	1620	13670		450	8770	88	14200			19	3100
4	Number of light quanta	2280			2360	1410	3800	300			1700	
5	$\bar{k}$	~1.5	~ 2	3	3	5	3	4	4	4	4	5

sec. light mass of constant action). Before radiation the f. e. u. was held for a period of two weeks in darkness and during radiation it was packed in a light nonpenetrating shell.

F. e. u. was irradiated with Co^{60} gamma-rays on two installations with dosages of 1 and 130 r/sec, whereby FEU-13 was subjected to repeated radiation, and one of the FEU-IS - to triple radiation. For measurements were used multichannel analyzers AI-100 and AMA-4S.

Experimental Results and Evaluation

Data of the experiment are presented in table and in figure 1 and 2; in table are given results, obtained for one of the f. e. u. of each type: for the remaining investigated samples the data are analogous. In first line are given values of photocathode effectiveness for the radiated and nonradiated f. e. u. with respect to the scintillation spectrum of NaJ(Tl) (crystal NaJ (Tl) was placed directly on the photocathode, to improve the optical contact was used silicone grease); on the other side is given the position of the monoelectron peak on the axis of the amplitudes; in the third 0 number of noise impulses; in the fourth number of pulses, corresponding to 51 10 quanta/sec of the light source; in the fifth - the value $\bar{k}$ Poisson distribution of monelectron pulses.

In figure 1 are shown: noise spectrum and distribution of monoelectron pulses prior and after radiation of FEU-1S, in Figure 2 restoration of the amplification coefficient FEU-1S and FEU-13 after radiation.

From the listed data is evident, that the effect of gamma rays Co^{60} on the f.e.u. parameters of the investigated types bears an identical nature. In all instances the amplification coefficient f. e. u. increases (1.5 - 4.2 times), the number of noise pulses increases sharply (19.4 - 162 times) and their amplitude distribution changes in direction of greater $\bar{k}$ (which indicates an increase in the coefficient of secondary emission of the first dynode), it remained basically monoelectron, with noticeable admixture or dielectron- for FEU-1S and FEU-1A (figure 1, b) and monoelectron - for FEU-13. The effectiveness of the photo cathode to the scintillation spectrum of NaI (Tl) decreases noticeably (1.5 - 9.5) times.

In the FEU-13 and FEU-1S within diurnal periods after the first radiation was restored the initial amplification coefficient and the effectiveness of the photocathode; FEU-13 after repeated radiation within two diurnal periods has not fully restored the effectiveness of the photocathode (4850 instead of 5550 photoelectrons/mev), which may be connected with the darkening of the photocathode glass under the effect of gamma-rays. Measurements show a reduction in transparency of the glass at a dosage of 10^5 r in 1.1 times at a wave length $\lambda = 4200$ Å. FEU-1A experienced irreversible changes: within a month after radiation it possessed as before a low sensitivity of the photocathode and increased amplification coefficient.

The f. e. u. noise increase after radiation, they drop slowly and not one of the f. e. u. has not returned within a month to initial noise level.

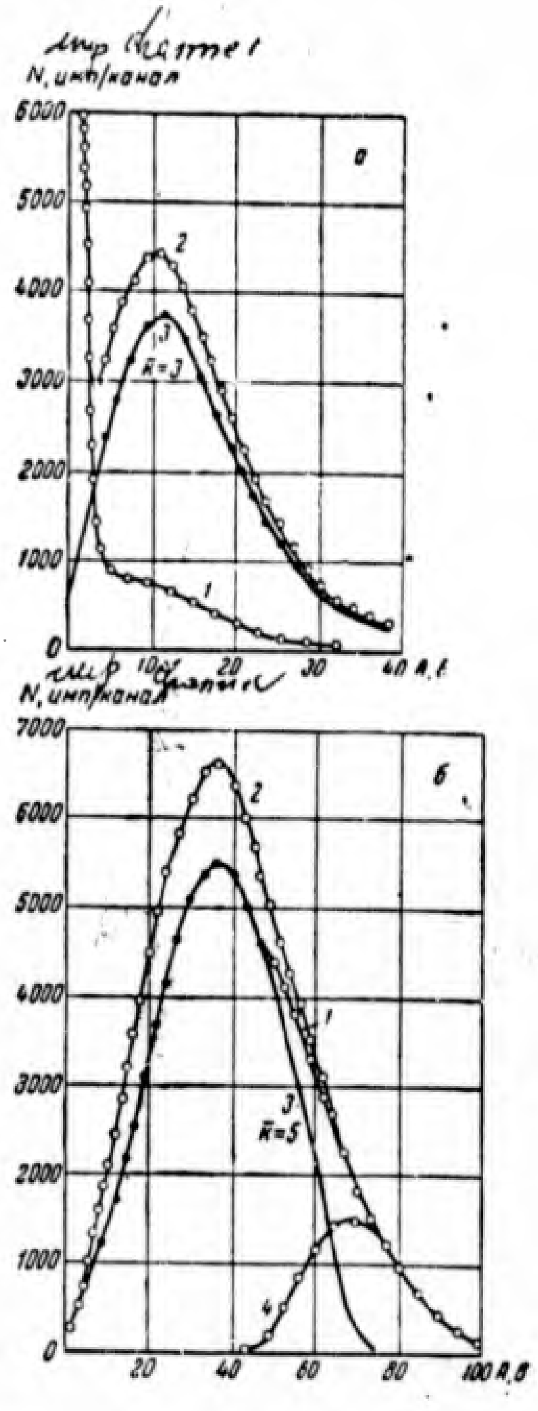

Figure 1. a - FEU-1S prior to radiation: 1 - amplitude distribution of noise; 2 - amplitude distribution of noise with bias lighting; 3 - difference in curves 2 and 1, solid curve-poisson distribution at k = 3. b-FEU-1S after radiation with a dosage of 40000 r; 1 - amplitude distribution of noise; 2 - amplitude distribution of noise with bias lighting; 3 - Poisson distribution with k = 5; 4 - from curve 1 was read curve 3; peak corresponds to dielectron pulses.

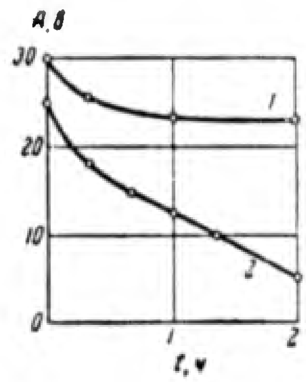

Fig. 2. Change in coefficient of amplification FEU-13 (curve 2) and FEU-1S (curve 1) after irradiation with dosages of 50000 and 5000 r respectively.

In order to check, whether the increase in f. e. u. noise is connected with thermo emission from the cathode, the last one from the FEU-1S was cooled to 0^{0}, which led to a reduction in the number of noise pulses by 5.5 times.

Repeated radiation of FEU leads to an interesting affect in spite of all this, that after the first dosage f. e. u. return into initial state, the change in amplification coefficient of FEU-1S (figure 1, b) are connected, apparently with the characteristics of its radiation: a dosage of 1 r/sec has obtained the cathode, while the dynode system obtained a smaller dosage in conformity with the square of the distance from the source. Also characteristic is the thing that for a sharp increase in f. e. u. noises is sufficient a relatively small dosage of 5000 r.

From the obtained facts are evident two tendencies in the behavior of f. e. u. elements during the radiation: deterioration of photocathode activity (sensitivity) and an increase in coefficient of secondary dynodes; the resulting effect of such, that in the f. e. u. as a whole can be an inconsiderable displacement of the photo peak into the greater or smaller side, and here may originate the impression, that gamma-radiation shows no effect on f. e. u.

Explanation of these phenomena is difficult, since very little was investigated in the phenomenon of penetrating radiation. The photo effect and the phenomenon of secondary electron emission are connected with processes, taking place on the surface of the material, and radiation just by the force of penetrating nature, no doubt, affects the entire volume of the photocathode and dynodes.

Conclusions

As results of bombarding FEU-13, FEU-1S with gamma-rays Co^{60} with a dosage of 50000 r took place:

a) an increase in amplification coefficient by 3.5 times;

b) reduction in sensitivity of photocathode relative to the scintillation spectrum NaI (Tl) by 4 times;

c) increase in $\overline{k}$ in Poisson distribution of output "monoelectron" impulses;

d) increase in the amount of noise of f. e. u. by more than an order.

The amplification coefficient and sensitivity of the cathode return within diurnal periods into initial state.

F. e. u. possess a property of "summating" the dosage with respect to a change in amplification coefficient and photo cathode sensitivity at repeated radiation.

The metallic photocathode liner FEU-13 exerts no noticeable effect on the time of restoring the f. e. u. parameters after radiation.

Literature

1. R. Cardwell, S. Turner: Nucleonics, 1954, 12, 47.

2. N. S. Khlebnikov, A. Ye. Melamid, T. A. Kovaleva: Radiotekhnika i Elektronika, 1962, No. 3, 518.

3. D. G. Fleyshman, PTE, 1962, No. 5, 08.

4. F. Tusting Robert, A. Kerus Queutin, K. Knudsen Harold; IRE, Trans. Nucl. Sci., 1962, 9, 118.

5. A. N. Pertsev, A. N. Pisarevskiy, L. D. Soshin; PTE, 1963, No. 5, 173.

6. A. N. Pertsev, A. N. Pisarevskiy, L. D. Soshin, PTE, 1964, No. 3, 132.