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^{234}Am ACTIVATED NaI(T) AS A STABLE LIGHT SOURCE

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In spectrometers consisting of a photomultiplier and a scintillator or Cherenkov radiator, the stability of the spectrometer channel is controlled by pulsed constant-intensity light sources. Scintillation crystals of CsI(Tℓ) or NaI(Tℓ) with a radioactive alpha source are normally used for this purpose.

This report describes a miniature pulsed light source consisting essentially of a NaI(Tℓ) crystal and a ^{241}Am alpha source. The light source is located in a hermetic cylindrical Dural container 10 mm in diameter and 5 mm high (fig. 1). Light passes from the Na I(Tℓ) crystal through a glass window at one end of the cylinder. Inside the container is the ^{241}Am alpha source which is deposited on the polished surface of a stainless steel disc 5 mm in diameter and 0.2 mm thick. The active zone is 4.5 mm in diameter. The alpha source produces about 100 decays per second in a 2π solid angle. A NaI(Tℓ) crystal 2 mm thick and 6 mm in diameter is attached to the radioactive side of the disc and is in optical contact with the glass window. The container is hermetically sealed by means of epoxy resin. Ninety-six light sources were built. Fig. 2 shows the distributions of the FEU-49 photomultiplier's mean pulse height and of the pulse-height resolution for 70 sources when the light sources' outlet windows were in optical contact with the input window of the same FEU-49 photomultiplier. The most probable pulse-height does not deviate by more than 20% from the mean value. The mean value of the pulse-height resolution (full width on the half-height) is 5.2%. For purposes of comparison, we should point out that a light source of similar design, which was described in paper /2/, had a pulse-height resolution of about 16%.

The light sources are intended to control the stability of the gain co-efficients of photomultipliers used in a gamma spectrometer, and also the stability of electronic equipment. The individual modules of the gamma spectrometer are described in paper /3/.

The gamma spectrometer has 90 modules. The layout of the module is shown in fig. 3. Epoxy glue was used to fasten the light sources centrally to the front ends of the lead glass opposite the FEU-photomultipliers. Fig. 4 shows the distributions of the FEU-49 photomultiplier's mean pulse height and the pulse-height resolution for 90 light sources. The most probable pulse-height does not deviate by more than 20% from the mean value. The mean value of the pulse-height resolution is 6.5%. The slight worsening in the pulse-height resolution is mainly due to the absorption of light as it passes through the 35 cm of lead glass.

Fig. 5a shows the shapes of pulses from the anode of the FEU-49 photomultiplier "looking through" the lead glass radiator. Curve 1 represents the pulse from the electron shower generated in the radiator by an electron; curves 2 and 3 represent the pulses generated by the NaI(Tℓ) and CsI(Tℓ) light sources respectively. It is obviously better to use a light source with a NaI(Tℓ) crystal in a shower detector because the shape of its pulse is closer to the shape of the pulse from the electron shower. Fig. 5b shows the shape of the pulse from a NaI + α source taken from the anode of a fast FEU-30 photomultiplier. The pulse front is approximately 5 nsec., and the decay time constant 250 nsec.

Fig. 6 shows the pulse-height spectra from the NaI + α light source (curve 1) and from the showers generated in the radiator by electrons of 2.0 and 4.0 GeV (curves 2 and 3). The scintillation from the NaI + α source is on average equivalent to the light from Cherenkov radiation from 1.2 GeV electrons.

The time stability of the light source's parameters was checked selectively for groups of 5 sources. The mean values of the pulse heights and the pulse-height resolution did not vary over a period of 4 months.

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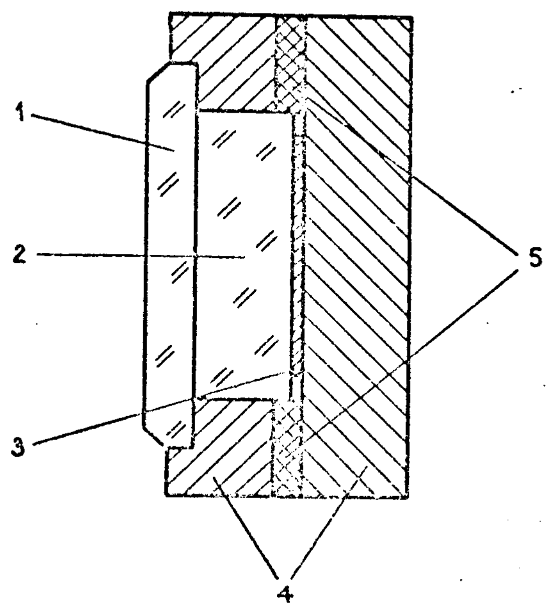


Fig. 1 Design of a pulsed light source based on a NaI(Tl) crystal and a ^{241}Am alpha source.

1 - glass window
2 - NaI(Tl) crystal
3 - disc with ^{241}Am alpha source
4 - container
5 - epoxy resin

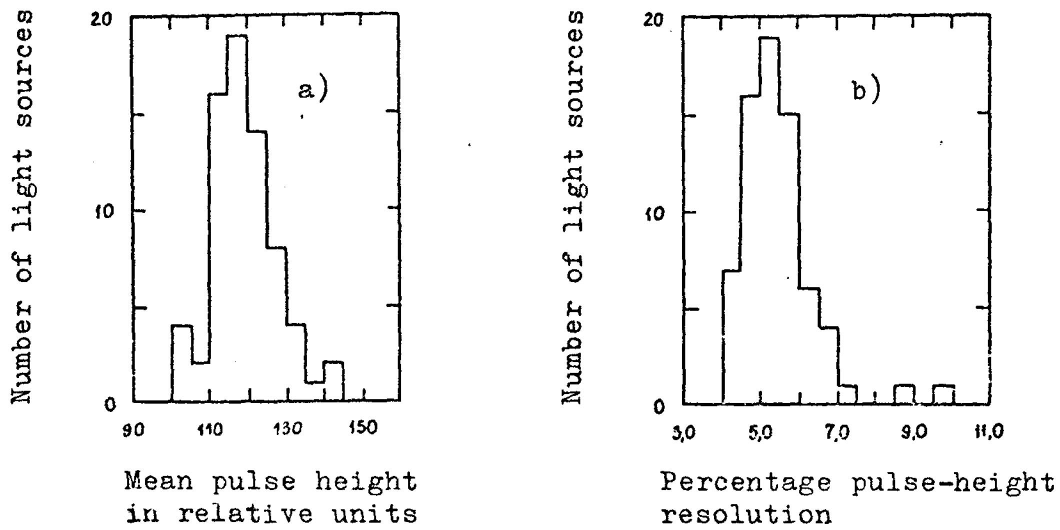
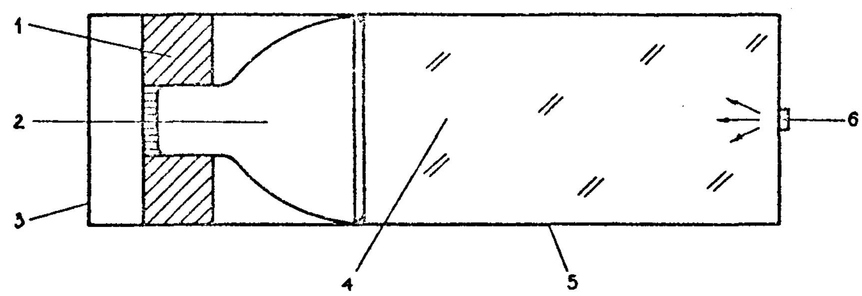


Fig. 2 Distribution of the mean pulse-height and resolutions for 70 light sources, when the sources are in direct contact with a FEU-49 photomultiplier.



<u>Fig. 3</u> Cherenkov gamma spectrometer module.

1 - light-tight ring
2 - FEU-49 photomultiplier
3 - magnetic screen
4 - TF-1 lead glass
5 - wrapping
6 - pulsed light source

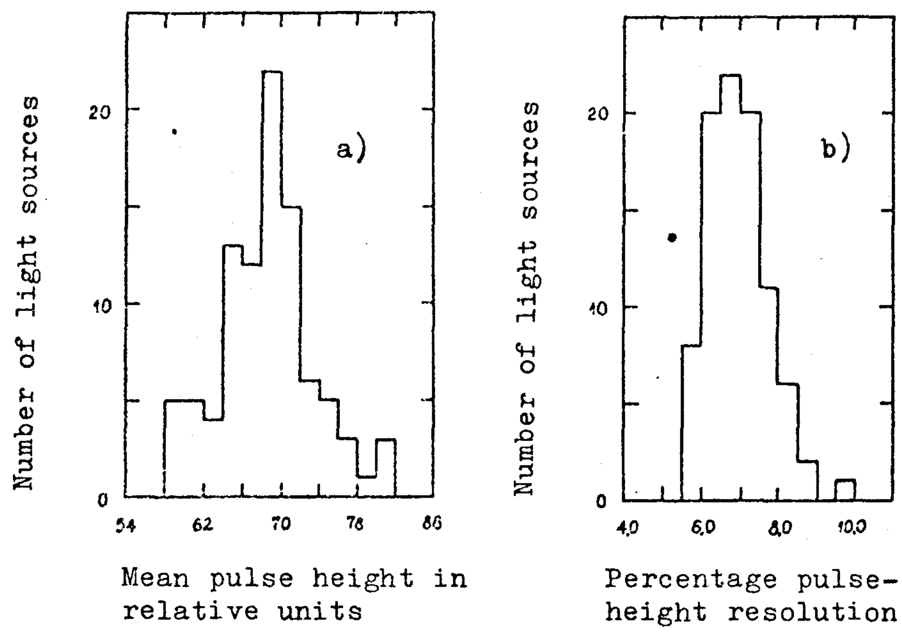
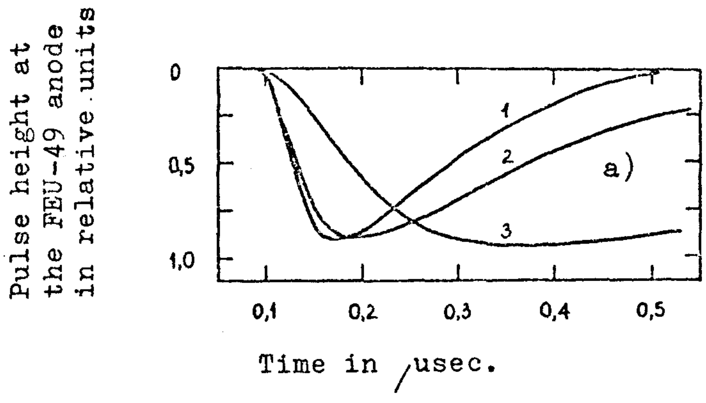
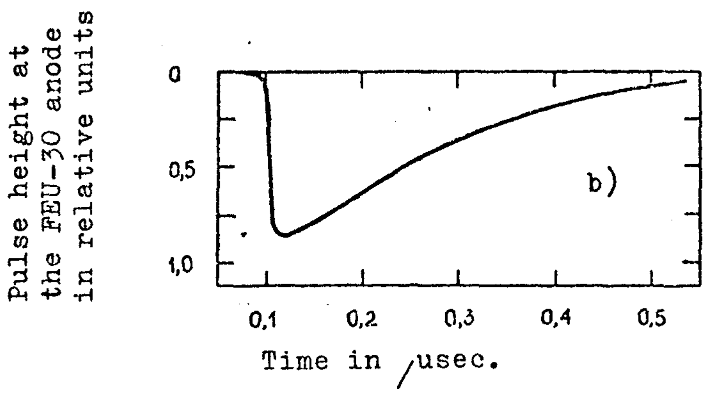


Fig. 4 Distribution of mean pulse height and resolutions for 90 light sources when the sources are attached to a Cherenkov gamma spectrometer module.





<u>Fig. 5</u> Pulse shapes:

a - for the electrons' Cherenkov light (1), for the NaI + α source (2) and for CsI(Tl) (3), taken using an FEU-49 photomultiplier;

b - for the NaI + α source, taken from the anode of an FEU-30 photomultiplier.

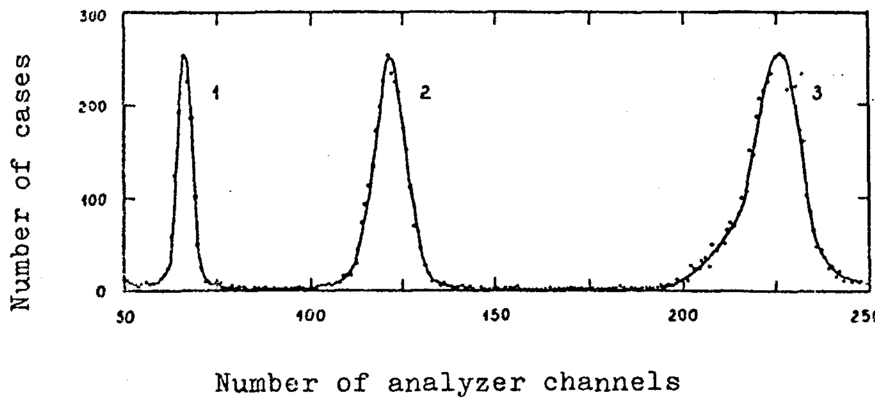


Fig. 6 Pulse-height spectrs from the NaI + α light source (1) and from the showers generated by 2.0 and 4.0 GeV electrons (2 and 3 respectively).