Investigation of the Ion Feedback Afterpulse Spectra by Autocorrelation Method (II)

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Autocorrelation method for investigation of delayed coincidences which was used for half-life measurements may also be applicable for investigation of the charge-time distributions of afterpulses (AP) due to ion feedback pulses in the photomultipliers. Necessity to decrease: the number of registered AP's plays an essential role at delayed coincidence experiments in order to register low energy radiation on background of high energy radiation. That is a reason for detailed investigation of the creation process of AP in the vacuum photodetectors. The ion feedback afterpulse spectra were investigated with the autocorrelation time spectrometer. Aim of the investigation was to study of the time and charge distributions for the different types of photomultipliers and to establish the criteria for selection of the PMTs with low intensity of the afterpulses. It was also established the time dependence of the afterpulse distribution from the spectral light composition illuminating the photocathode.

**Principle of operation**
Measurements of the afterpulse time distribution is based on autocorrelation principle - Fig.1 where FA-fast amplifier, DL-delay line for excluding self-coincidences, LIN-linear integrator of nanosecond pulses, D-disriminator, TR-trigger, CC-coincidence circuit, TAC-time-to-amplitude converter. Fig.2 presents the time sequences of pulse. Pulse duration from TR is equal to the time range of interest. In our case a time range was chosen up to 8 ms. Photocathodes were illuminated by blue or red LED.

**Main results**
1. It was investigated the time distributions of the first coming AP (FAP) for different types of PMTs (XP2020, FEU130 - first doped GeP, H6780-metal package PMT) - Fig.3, 4.

2. It was shown that optimization of potential in focusing chamber of PMT plays essential role at the AP registration process - Fig. 5, 6.

3. Demonstration of equality the AP’s change independently from the time range and the amplitude of output signal quite clearly seen on Fig.7-9.

4. Two stage autocorrelation spectrometer - Fig.10 allows to register the second coming afterpulse (SAP) in the time range chosen for registration of first coming APs (FAP). Their appearance is due to consecutive creation by one photoelectron or by other photoelectrons emitted in the same registration process. Intensity of SAP is considerably less than FAP.

5. It was established a different delay in the time distributions of APs at illumination of PMT by the red or blue LED - Fig.12. Shorter delay in the time distributions for the blue light in comparison with the red light is evidently connected with different speed of emitted photoelectron at illumination by photon of higher energy. The same effect is seen at the measurement of the time flight of electrons. In this case the signal START is taken from a generator and signal STOP for TAC is taken from the PMT’s output.

**Conclusion**
Autocorrelation method has proven that it is the most suitable for investigation of the ion feedback pulses created at the radiation registration process by the PMTs. These investigations have allowed to formulate some recommendation for reducing registration of APs:

a. It is desirable to choose of PMT with different focusing properties at registration of photoelectrons and ions (similar XP2020).

b. It is necessary to choose the proper interelectrode potentials in focusing camera of PMT.

c. It is necessary to use the PMT with a high quantum efficiency.

d. It is necessary to choose a scintillator with the high light output.

e. It is necessary to select PMT and scintillator which must have similar spectral sensitivity and spectral luminescence distributions.