New generations of detectors of ionizing radiation and elementary particles

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- Introduction
- At the present time, one of most actual problems of science and technology is improvement of methods of registration of ionising radiation, as the utilized working phenomena don't allow to reach speed of registration more than 10^8 particles per second, or the dead time less than 0.1 nsec.. The next actual problem is to reach coordinate sensitivity up to 10 microns. For example, the proportional counters have limitation in speed due to drift and diffusion of carriers of current, in scintillation counters – lighting time of the scintillator, light propagation through the scintillator and the electron's flight time in photoelectronic multiplying system. Therefore along with improvement of traditional methods of registration, more actual is development of essentially new methods of the registration based on rather new physical phenomena.
- Taking account all above mentioned facts, the phenomena of birth, drift and multiplication of secondary electrons are of practically big interest. Investigations of these processes show that under certain conditions it is possible to control the cross section of these processes, otherwise the coefficient of secondary electron emission. Characteristic time of this phenomenon ~10^{-10}sec., and area of localization of secondary electron around the point of passage of the ionizing radiation ~10^{-6}cm, so it is possible to create detectors with low dead time and high co-ordinate resolution. Also, the ability of the detector to proceed in the vacuum, which is necessary to registrate the highly ionizing component of radiation, in order to reduce the contribution of repeated dispersion and radiation absorption. Such detectors can be used for registration of any type of ionizing radiation and elementary particles, as it is possible to synthesized corresponding porous media, so the urgency of carrying out such investigation is dictated.
- In our institute several laboratory samples of detectors working on the basis of the phenomenon of birth, drift and multiplication of secondary electrons in porous media are created by us are created, some of which have coordinate sensitivity.
- The present report is devoted theoretical and experimental researches in the field of development of new detectors of ionizing radiation and elementary particles, based on the investigations of the phenomenon of birth, drift and multiplication of secondary electrons in synthesized by us new porous

Development and synthesis of new porous media

- With the aim to develop new technologies of creation of new generation of detectors of ionising radiation composite media CsI [SiO] [Ag] and CsI [AlO_2] [Ag] with deferent relative density and persents of consisting composite materials.
- These composite new materials were synthesized with the aim to increase the coefficient of secondary electron emmision, to reduce the influence of polyrization on the properties of the porouse layer, to decrease the dead time and to increase the sensitve energy range. Layers have been received in vacuum by thermal, electric and magnetic evaporation of base elements. In figures (1,2) porous layers CsI [SiO] [Ag] and CsI [AlO_2] [Ag] are presented at the beginning of growth process. Similar pictures have been received during the growth process of other porous layers.
- During our investigations we also synthesized composite medias CsI [SiO] [Ag] and CsI [AlO_2] [Ag] with some periodical structure. In the figure 3 CsI [AlO_2] [Ag] composite media with periodical structure is presented.
- Now we are developing new technologies of synthesis of layers with different relative densities and degree of periodical structure including heavier atoms as teylur and others.

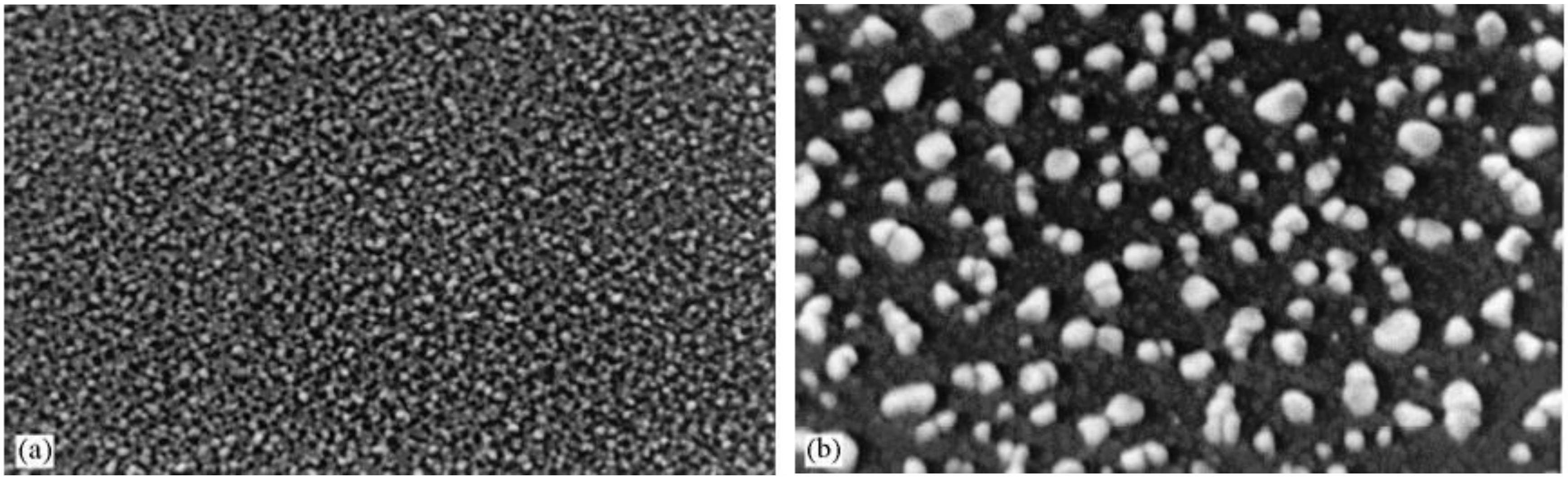

Figure 1

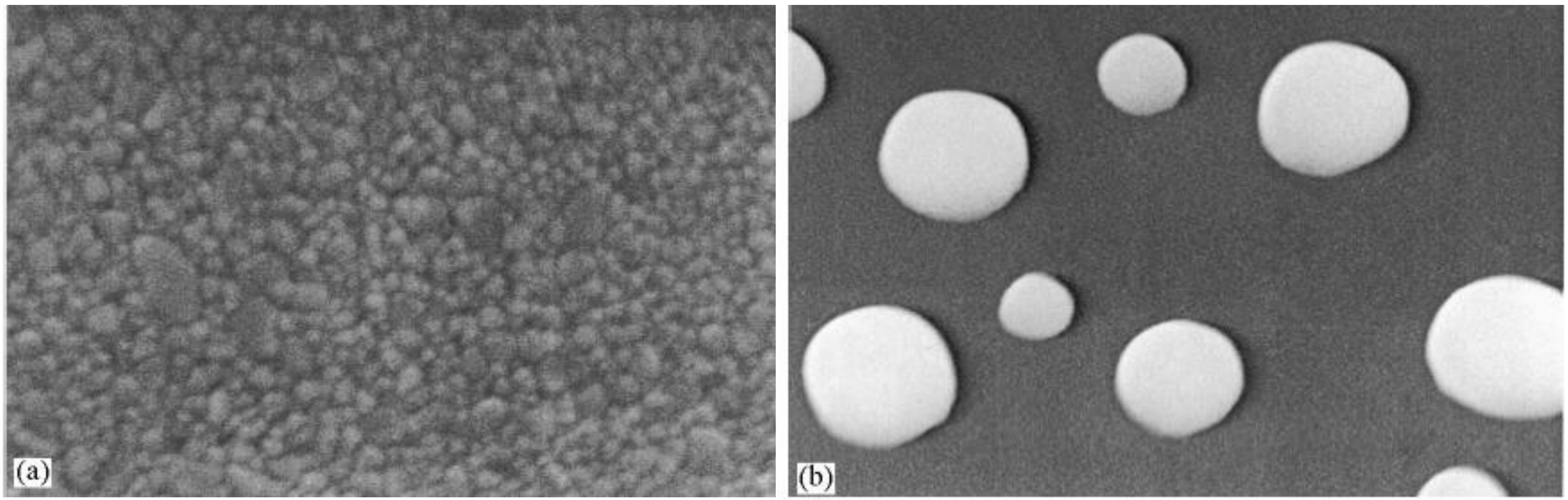

Figure 2

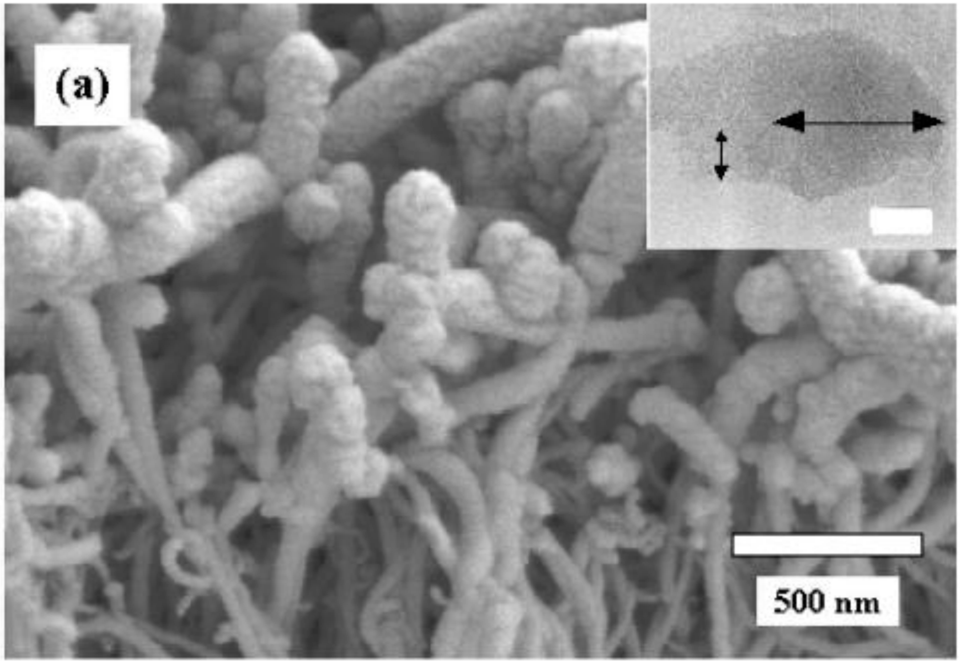

Figure 3

The main working priciples of the detector

- The detectors works on the basis of the phenomena of birth, drift and multiplication of delta electrons arising during the interaction of elementary particles and gamma quanta with the radiator-layers. In our case as radiator porous materials with the porous ~30μ were utilized. Delta electrons under the influence of an external accelerating field are accelerating in the porous of the radiator and start avalanche reproduction process.
- To descripe these processes within the limits of the gas-discharge and solid state physics theory a mathematical model has been developed. In the Figures 4 and 5 the process of delta electrons reproduction, propagation through the radiator and resulting output from the radiator calculated by the developed model is presented.

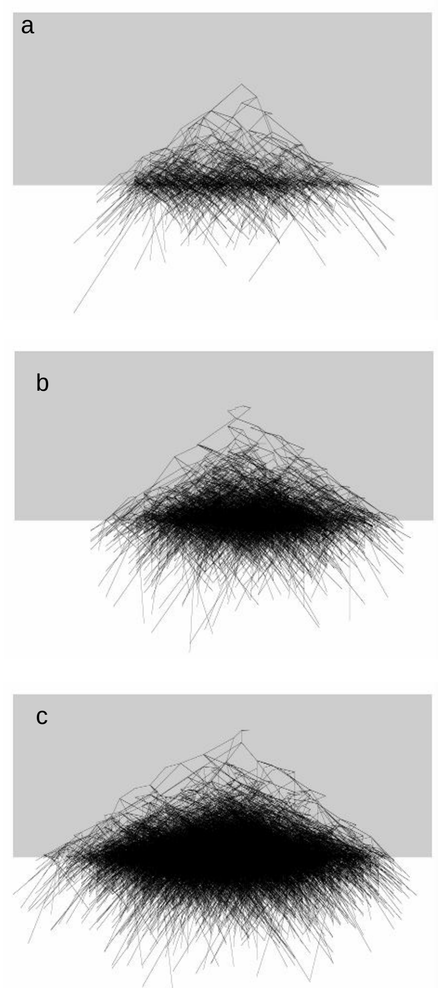

Figure.4. The trajectories of avalanche multiplied delta electrons within porous composite layers of 0.35mm thickness and relative density 2 % in the presence of external accelerating field 1200V originated due to interaction with gamma quanta with energies 1keV, 2keV and 5keV correspondingly, and.

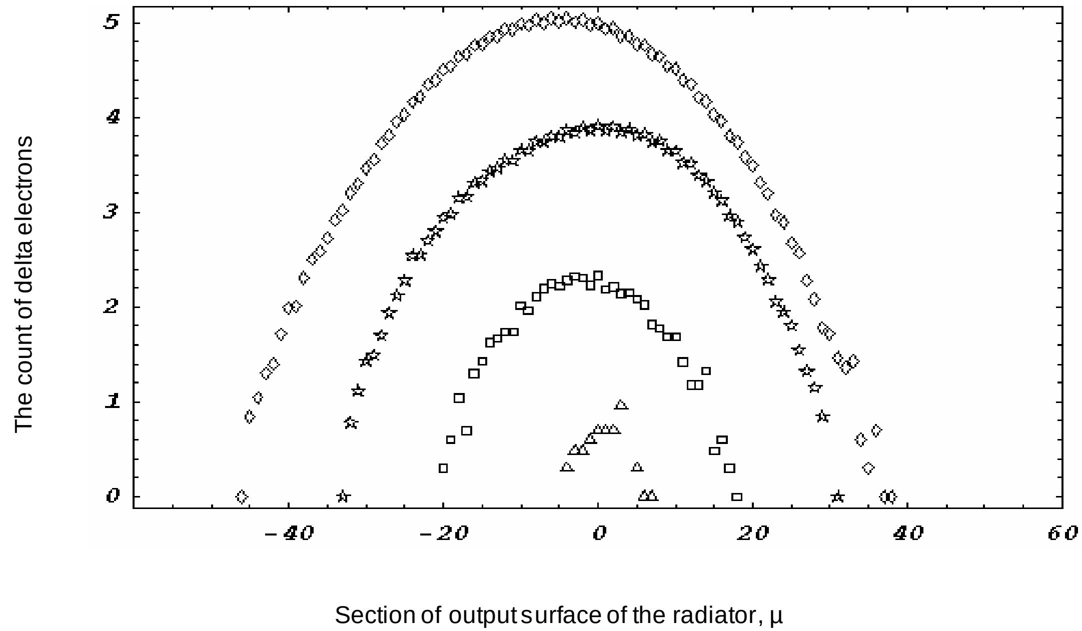

Figure. 5. Distributions of avalanche multiplied delta-electrons on the output surface of the radiator originated due to interaction of composite porous radiator of differenet thickness with standard gamma quanta source ^{57}Co. (Δ – d =50 μ; □ – d =150 μ; ☆– d =300 μ; ◊ – d =500 μ)

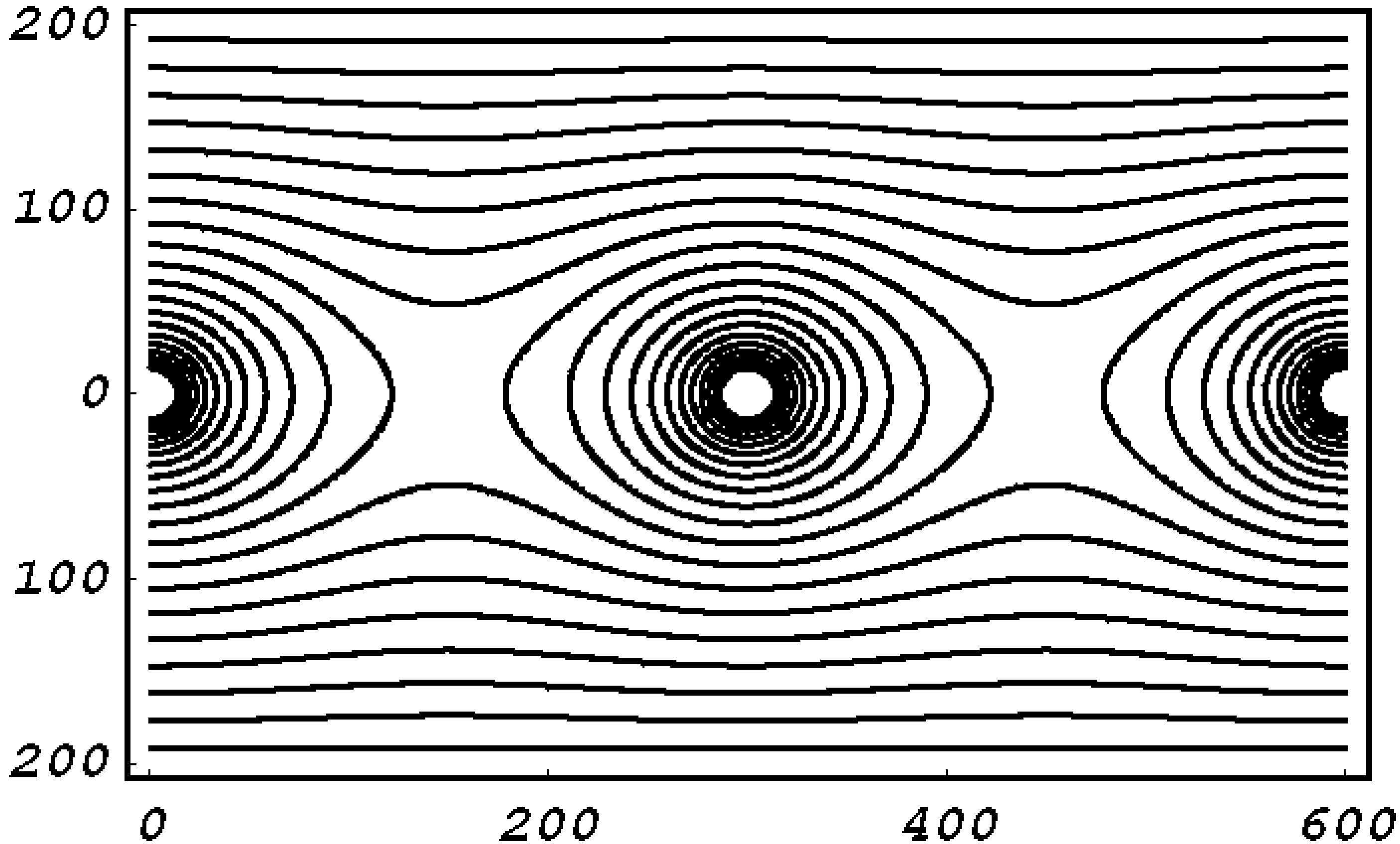

Figure 6

$$\varphi(x,y)=V\left[2\ln\frac{sh\frac{\pi d}{l}}{sh\frac{\pi r}{l}}\right]^{-1}\sum_{k=-\infty}^{k=\infty}(-1)^k\ln\frac{sh^2\frac{\pi d}{l}(2k+1)+\sin^2\frac{\pi x}{l}}{sh^2\frac{\pi d}{l}(2k+\frac{y}{d})+\sin^2\frac{\pi x}{l}}$$

Equa potential lines of accelerating field, calculated by the formula developed for multiwire detector, thickness of the working radiator 400 μ, diameter of the wires 28 μ, distance between the wires 300 μ.

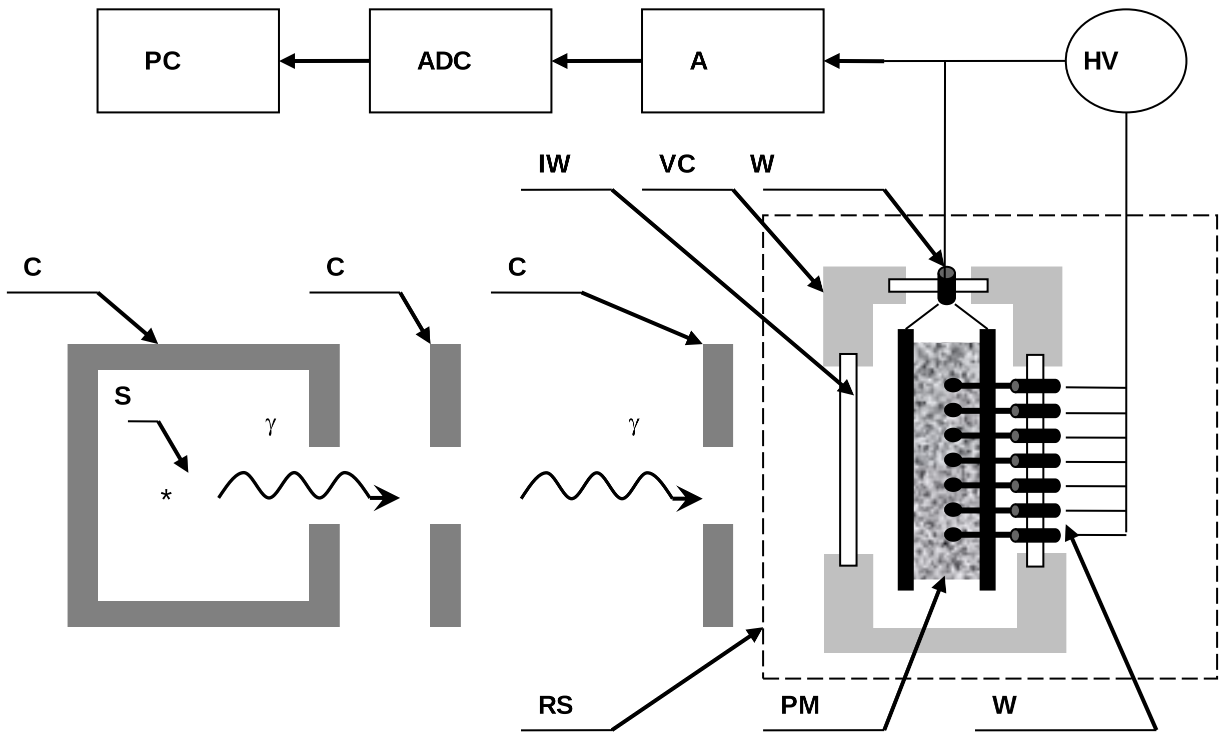

Figure. 7. Schematic view of the experimental setup: S – gamma quanta source; C – collimator; HV – High voltage suply; A – amplifier; ADC – analog to digital convertor; PC – personal computer; RS – registering system; IW – input window; PM – porous material; W-wires; VC – vacuum chamber

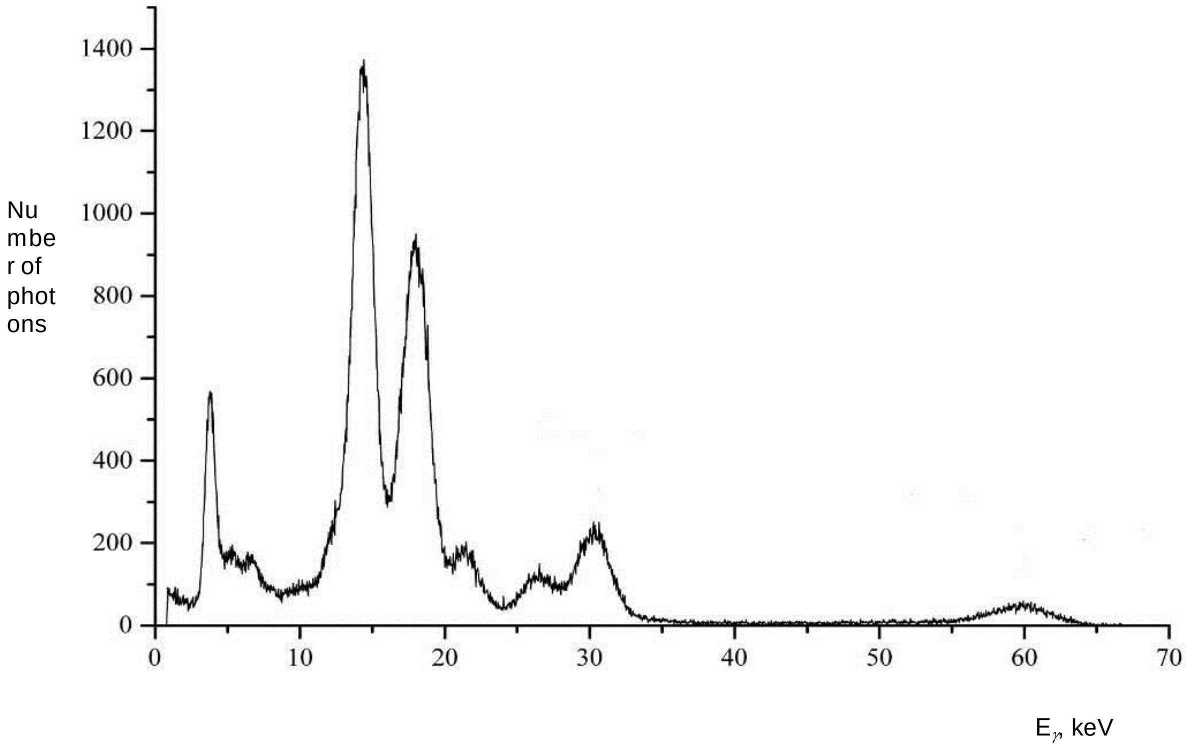

Figure 8 Characteristic energy distribution of standard gamma quanta source ^{241}Am registrated with porous detector.

Similar energy distribution were registrated for other gamma quanta souces.

- **At the present time we are developing new approach to increase coordinate sensitivity in order to receive accurate forms of the beams' spatial distribution and to increase the energy efficiency.**
- **We are looking for any type of collaboration in this area of reserach**

Thank you for attention!