National Research Nuclear University «Moscow Engineering Physics Institute»

Optimization of the gamma - locator characteristics based on the SiPM

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Radiopharmacological γ - diagnostics

- One of the main problems - localization of the γ-rays sources in a biological object.

- γ-diagnostics used in the search of local tumor formations (seal). RFP (γ-source) is introduced into the body and concentrates in malignant tumors. γ-ray detector allows us to localize the place formation.

- One such possible devices can be designed as a detector for γ-rays.

- For these tasks a γ-ray detector in the energy range 60 ~ 600 keV is required.

Abstract.

The results of studies on the optimal scintillator - photodetector (SiPM) pair for gamma - locator device are presented.

The criterion is the maximum ratio of the signal / background for gamma - rays with energies in the range 60 ÷ 660 keV. The optimal pair consists of a scintillator LaBr3: Ce and SiPM firm HAMAMATSU.

The experimentally obtained signal / background ratio ~ 1000.

^{137}Cs & ^{241}Am sources activity is ~ 10^5 Bk.

Gamma - Locator - a medical device based on the SiPM for operative cancer diagnostics

SiPM - Silicon photomultipliers

We were investigating and made:

- choice of the optimal pair of scintillator + photodetector
- electronics assembly for the gamma - rays detection in the energy range from 60 to 660 keV
- processing of the physical experiments data
- testing and debugging of the detector prototype

Experimental setup

Fig.1. shows a diagram of the experimental setup the measurements were taken on.

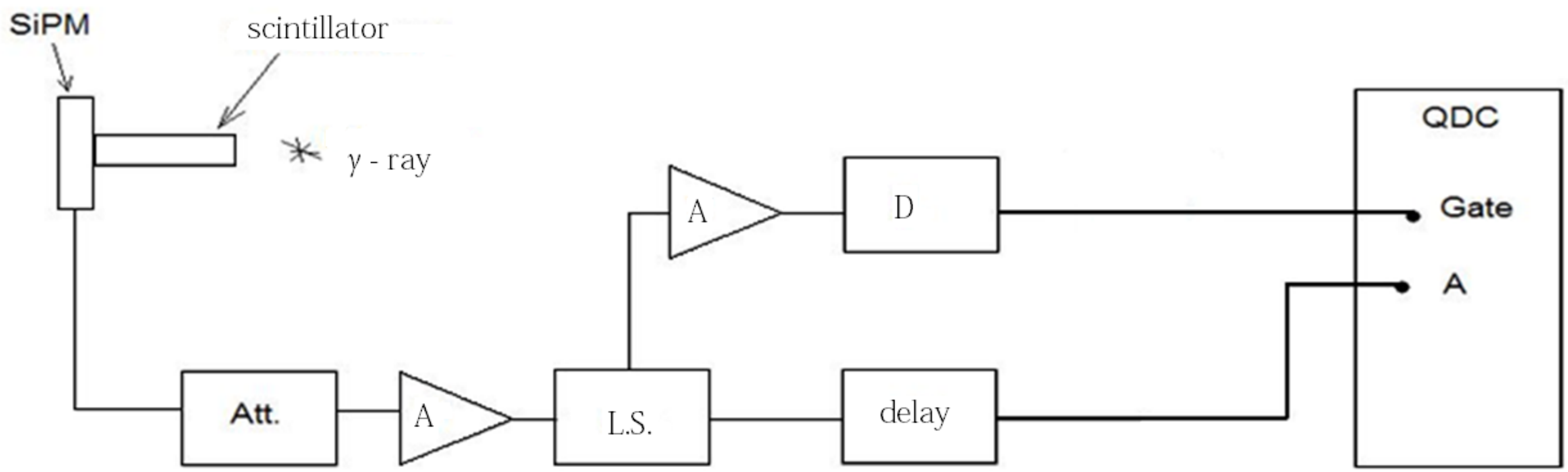


Fig.1. SiPM- photodetector; scintillator– LYSO, LaBr3Ce; Att.- attenuator; A.- amplifier; L.S.- linear splitter; D.- discriminator; QDC (Lecroy2249).

Achieved experimental results

SiPM MPPC Hamamatsu 3x3 spectra;

$LaBr_3$:Ce scintillator; LYSO scintillator;

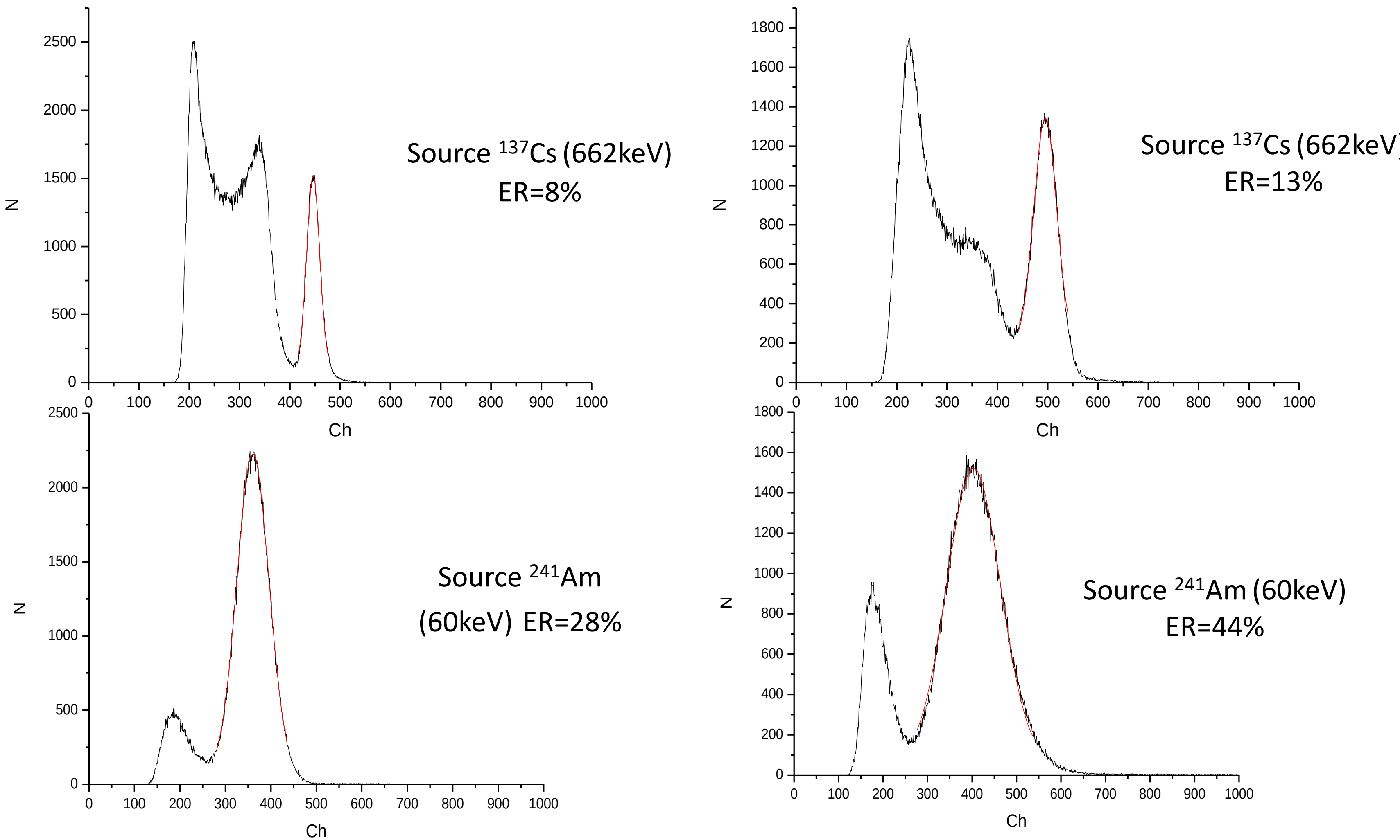
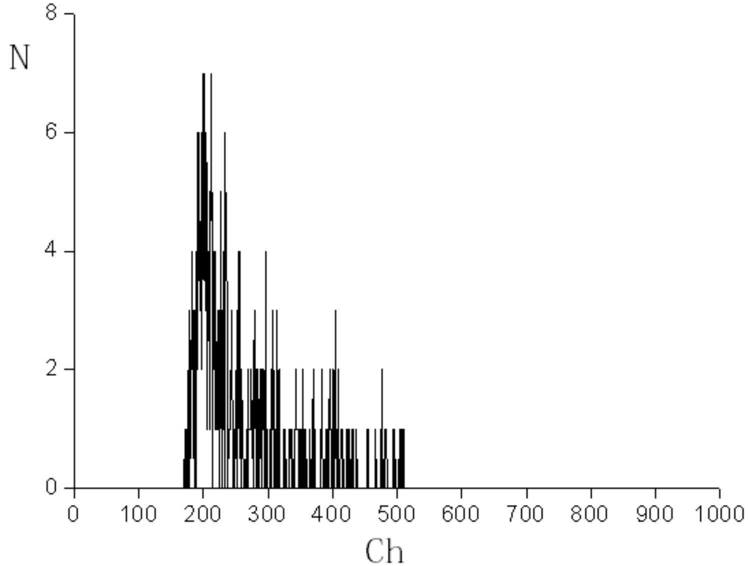
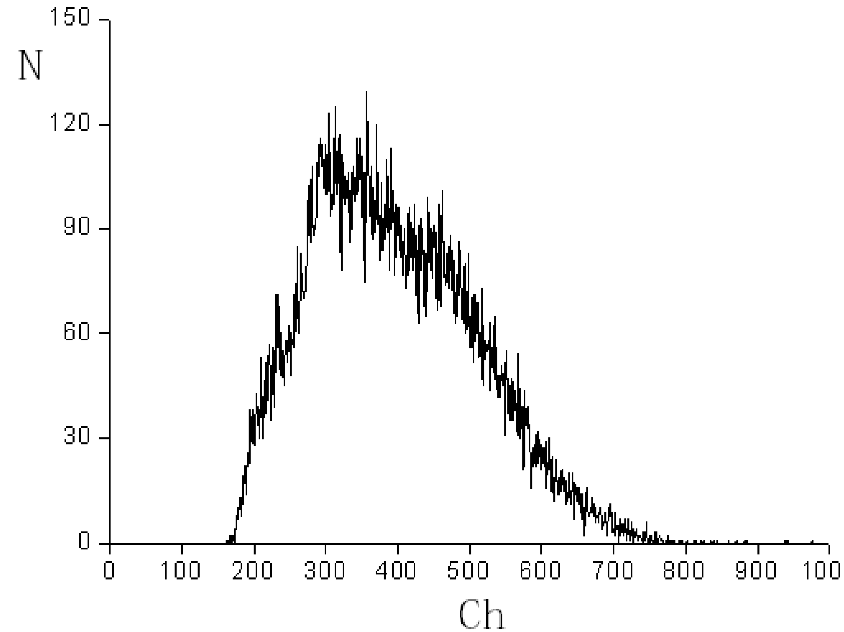


Fig.2. **Experimental spectra**.

Background for $LaBr_3$:Ce and LYSO scintillators.



Background for $LaBr_3$:Ce scintillator



Background for LYSO scintillator

Table 2. Experimental mesurement results

Photodetector	crystal $LaBr_3$:Ce			
	^{137}Cs		^{241}Am	
	ER,%	N1/N2(photopeak)	ER,%	N1/N2(photopeak)
SiPM MPPC Hamamatsu	***8***	***3700***	**28**	**770**
SiPM MAPD-3 (Zecotek)	16	1070	45	414
SiPM MEPhI	13	2803	44	2718

Photodetector	crystal LYSO			
	^{137}Cs		^{241}Am	
	ER,%	N1/N2(photopeak)	ER, %	N1/N2(photopeak)
SiPM MPPC Hamamatsu	**13**	**13**	**44**	**977**
SiPM MAPD-3 (Zecotek)	16	16	52	605
SiPM MEPhI	17	11	56	1023

GAMMA-LOCATOR PRACTICAL IMPLEMENTATION

A prototype of a compact device was designed and manufactured to work with the real short half life sources (Fig. 3); the detector itself (Fig. 4)

The measurement results shown on Fig. 5.6 allow us to estimate the accuracy of the γ - quanta source coordinates measurement.

Measurements duration is 5 seconds. Collimator with 2 mm diameter was used.

Fig.3. Detector

Fig.4. Gamma-locator prototype

Fig.5. The counting rate dependence of the source (^{137}Cs) - detector distance; **a –** air, **b** – using absorber(water), **c** - noise

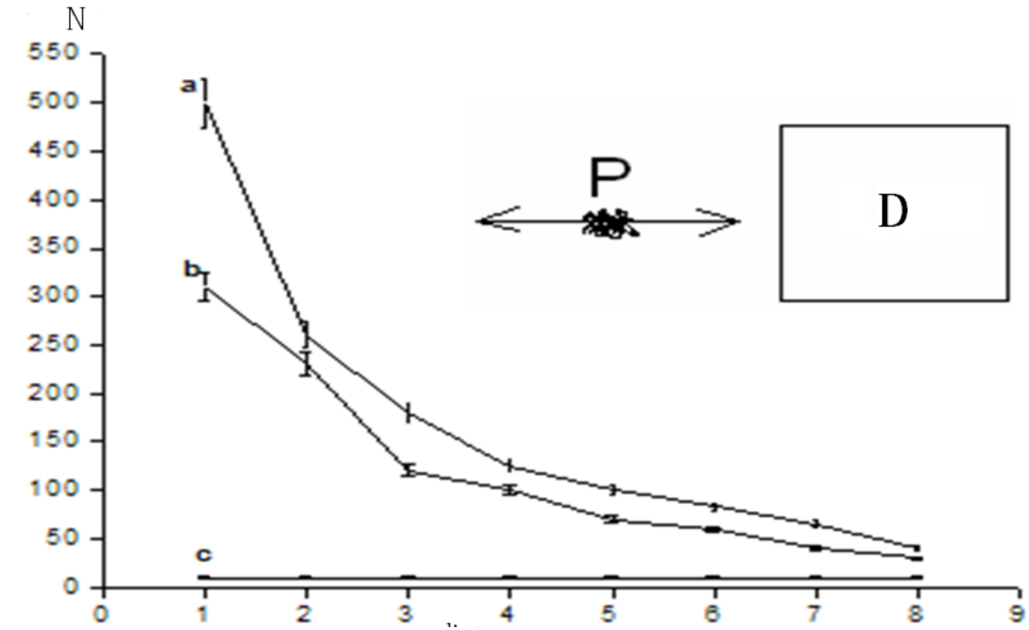
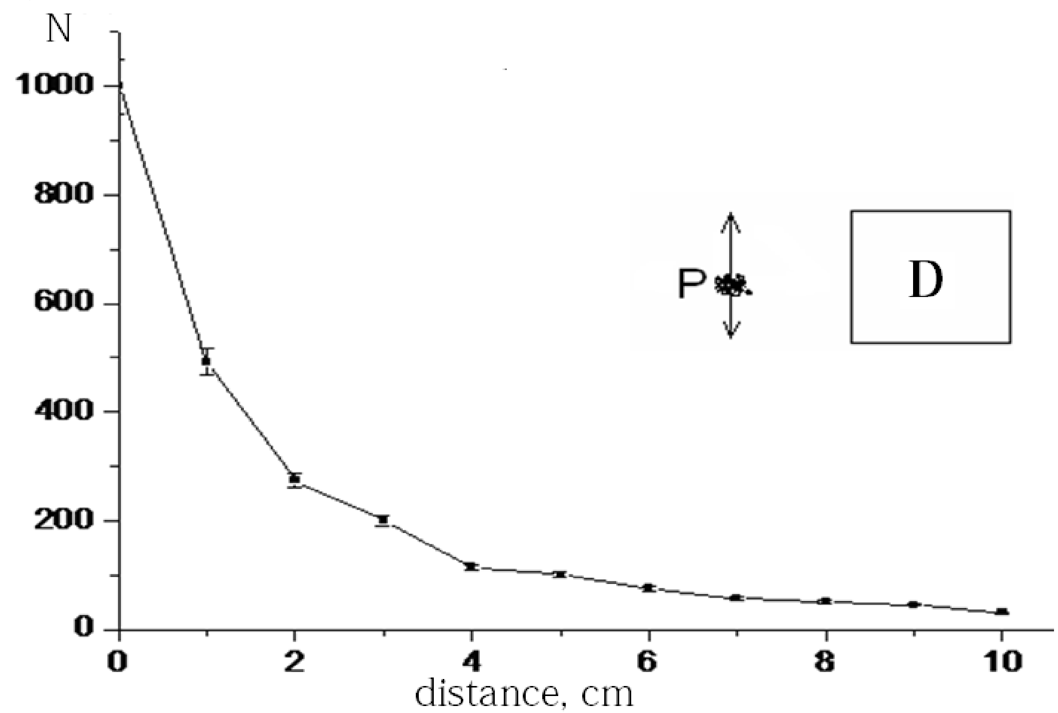


Fig.6. The counting rate dependence of the γ - source (^{137}Cs) displacement from the center of the detector.



Conclusions :

Scintillator replacement on $LaBr_3$:Ce and using SiPM of HAMAMATSU firm allowed to improve the energetic resolution for γ-locator from 22% to 8%.

Source ^{137}Cs (662keV) ER=8% for LaBr3:Ce scintillator and Source ^{137}Cs (662keV) ER=13% LYSO scintillator.

Source ^{241}Am (60keV) ER=28% for LaBr3:Ce scintillator and Source 241Am (60keV) ER=44% LYSO scintillator.

Experimental data show that the noise level is much lower than the instruments useful signal. Signal / background (noise) ratio ~ 1000.

This research results achieved using sources with the activity much lesser than the ninety nine Technetium activity used in clinical practic. It is hoped that the signal / background ratio is much higher when dealing with the real short half-life source.

Thanks for you time.