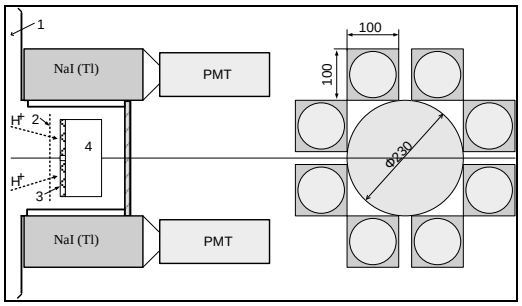
ADJUSTMENT AND MONITORING OF PARAMETERS OF THE GAMMA-RAY DETECORS USED IN THE EXPERIMENTS WITH THE IMPULSE ACCELERATOR IDM-20

Valiyarova A.R.
Scientific adviser: V.N. Padalko, Senior Researcher
Linguistic advisor: Ya.V. Ermakova., Senior Lecturer
National Research Tomsk Polytechnic University 634050, Tomsk, Lenin Avenue, 30
E-mail: adel_chik92@mail.ru

The impulse accelerator IDM-20 is aimed for the generation of powerful ion beams of hydrogen, deuterium, helium with the purpose of research of thermonuclear reactions with small section in astrophysical range of energies (5 – 25 keV). The system of NaI(Tl) scintillation detectors was used in the experiments of detecting gamma-rays [1].

In this work method of the adjustment of detectors and result of basic parameters measurement are presented.

The system of detectors in work configuration (Pic. 1) has geometric efficiency ε_g equal to 0.6. Tektronix Digital Oscilloscopes were used in the experiment of detecting detectors signals. Adjustment and monitoring of energy characteristics of detectors were experimented with the special-purpose amplitude analyzer.



Picture 1 – detectors arrangement.
1 – ionic source; 2 – net; 3 – target; 4 – multigrid energy spectrometer

The range of gamma-ray detecting 0.5 ÷ 7 MeV demanded special selection of the PMT divisors for the ensuring of linearity in the dynamic stated range. For the following data handling (off-line) knowledge of the energy calibration, detector energy resolution and dependence on location of gamma-ray in the crystal scintillators are needed.

It is necessary to pair detectors because equipment is intended for the detecting of rare events.

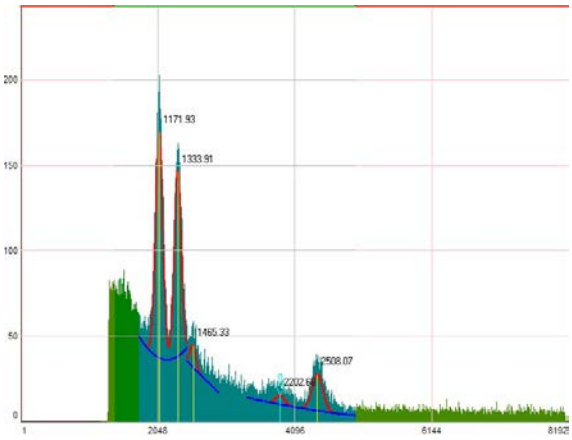
The main task is to achieve the identity of energy characteristics in all detectors.

CAEN high-voltage system was used in this work. The accuracy of high-voltage system equals 1V, that guarantees the adjustment of energy calibration of detectors to the accuracy 10 keV. After the first energy calibration with the source of ^{60}Co the detector, which had the best energy resolution, was taken as a model. The individual adjustment of characteristics of other detectors was carried out with the help of exemplary detector.

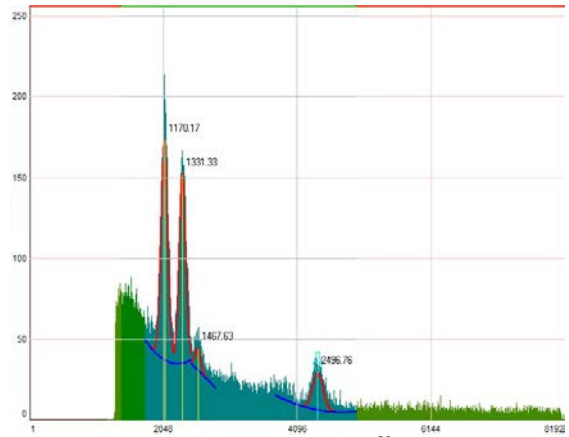
Set and analysis of the spectrum were realized in the program SpectraLine with the height analyser "ASPEKT". Energy calibration of the scale of analyzer was executed with isotope ^{60}Co, that emits two gamma rays with energies of 1.17 and 1.33 MeV. The summary energy of radiation equals 2,5005 MeV.

The individual spectrums of detectors are shown in Pictures 1 and 2 and spectrum of pair is shown in Picture 3.

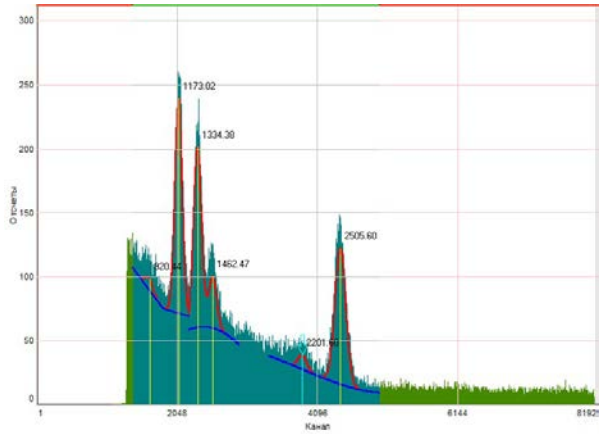
The energy resolution of pair of detectors isn't worse than the energy resolution of separate detectors that were put together. This fact shows the satisfactory quality of adjustment of detectors. The energy resolution of all detectors for the line 1.17 MeV is $\Delta E(½) \leq 6\%$ and for the line 2.5 MeV is $\Delta E(½) \leq 4\%$. The result of the adjustment of parameters of the gamma-ray detectors are vales of the determinate voltages.



Picture 1 – Energy spectrum ^{60}Co taken on the seventh detector D7



Picture 2 – Energy spectrum ^{60}Co taken on the eighth detector D8

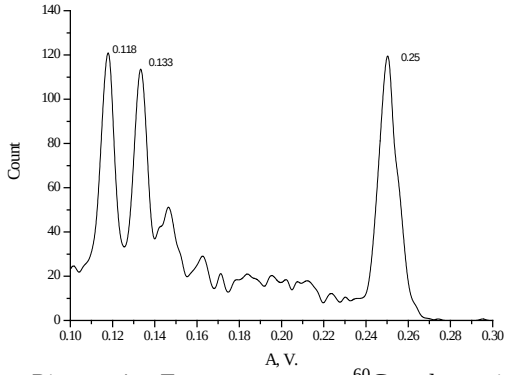


Picture 3 – Total energy spectrum ^{60}Co, taken on the fourth pair of detectors

Table 1 – Results of energy calibration of the 4th pair of detectors

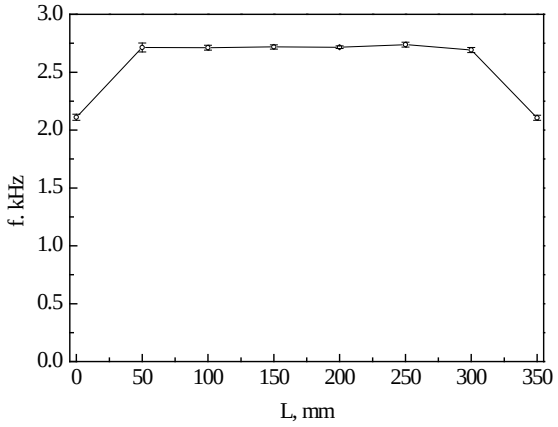
Channel	Energy, keV	HWHH, keV	Nuclide
2072,07	1173,02	74,66	^{60}Co
2347,73	1334,38	80,96	^{60}Co
2568,33	1462,47	79,77	^{40}K
4428,25	2505,60	101,04	^{60}Co

The final quality control of detectors adjustment was realized with the help of analyzer which is a part of the IDM-20 software. The multiplication factor of PMT was chosen in such way that the signal amplitude of oscilloscope 0,1 V corresponds with 1 MeV (Picture 4).



Picture 4 – Energy spectrum ^{60}Co taken with the help of the oscilloscope

One of the important characteristics of large detectors is position sensibility. The frequency of detecting gamma rays depending on the source position was measured on one of the detectors. The collimated source ^{60}Co moved along the long side of the crystal. The result of measurements is shown in Picture 5. Approximation of the position sensibility curve is used in Monte Carlo data handling.



Picture 5 – Position sensibility of the gamma ray detector

References:

1. G. N. Dudkin, B. A. Nechaev, V. N. Padalko, Vit. M. Bystritskii, S. S. Parzhitskii, J. Wozniak. Fast scintillatorneutron detectors for measurement pulsed neutron flux// Proceedings of the institute of higher education. Physics. – 2010. – № 10/2