APPLICATION OF LITHIUM-DOPED CRYSTALS IN TASKS OF SEPARATE DETECTION OF GAMMA-RAYS AND NEUTRONS

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Modern trends of radiation control instruments development require creation of highly efficient high autonomy detection devices with minimal dimensions, which allows radiation safety services to perform inspection of various objects in the most efficient way.

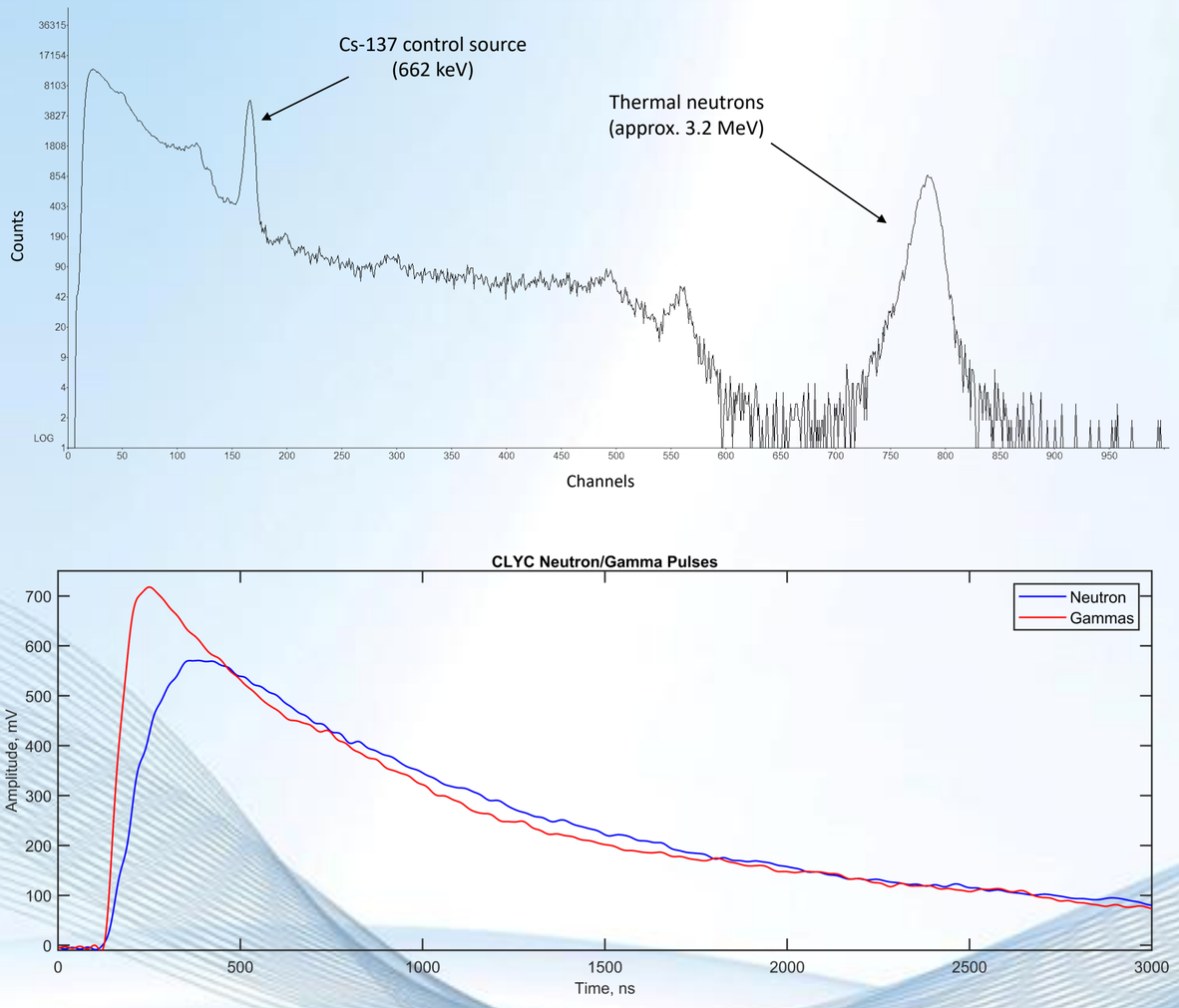
Currently, ^{3}He counters are used in most of the neutron detection devices. An alternative is the use of lithium-doped crystal scintillators, which combine the functions of gamma spectrometry and neutron detection. The main representatives of detectors of this class are CLYC [$Cs_2LiYCl_6(Ce)$], NaIL [NaI(Li+Tl)] and CLLB [$Cs_2LiLaBr_6(Ce)$].

Specifications	CLYC	NaIL	CLLB
Density, g/cm^3	3,3	3,66	4,2
Light yield, photons/MeV	20 000	35 000	45 000
Primary decay time, ns	1 000	240	190
Wavelength of emission maximum, nm	370	419	420
Typical energy resolution at 662 keV, %	4,5	6,5-7,0	3,1
Total lithium content, %	~1,2	Up to 8	~0,78
Thermal neutron sensitivity (⌀50x50 mm), A*ε (cm^2)	20	13 (1% of ^{6}Li)	22
FOM	2,6	2,8	1,9

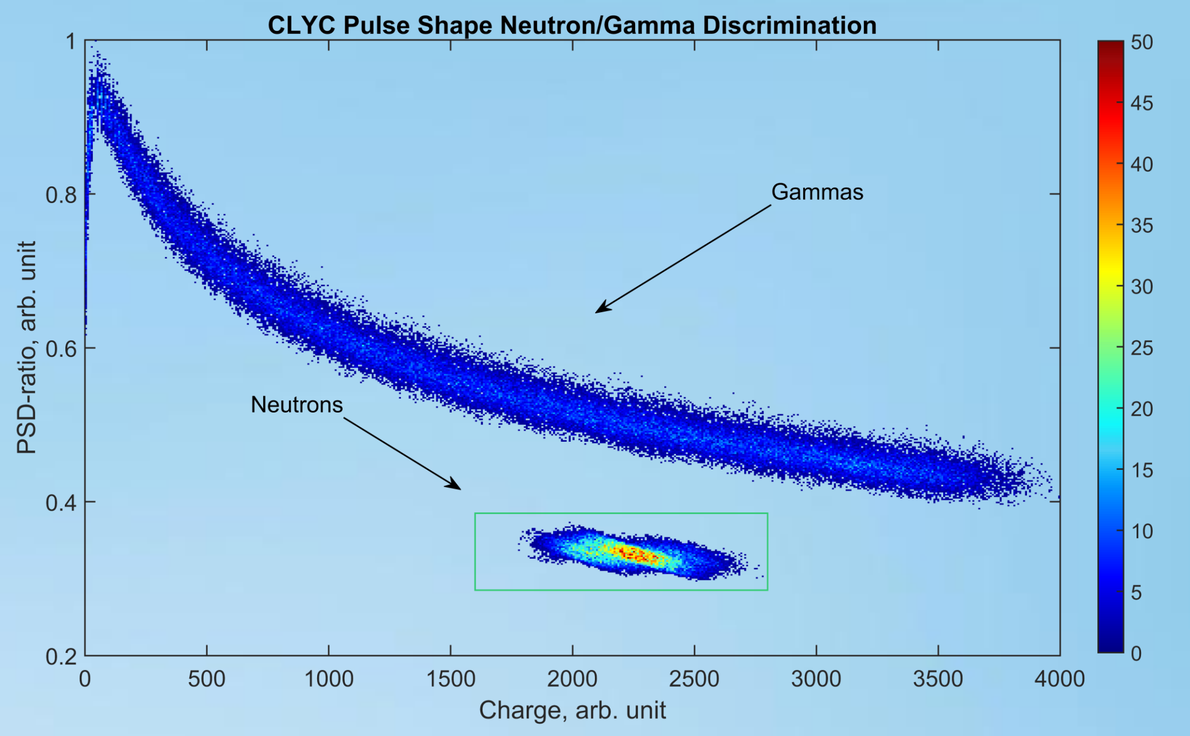
CLYC application

The advantage of the CLYC crystal is the presence of lithium, which provides neutron sensitivity without the need for enrichment. Neutrons are registered due to the (n,α) reaction on ^{6}Li atoms, which allows for both detection and separation of gamma rays and neutrons.

CLYC spectrum from moderated Cf-252 source



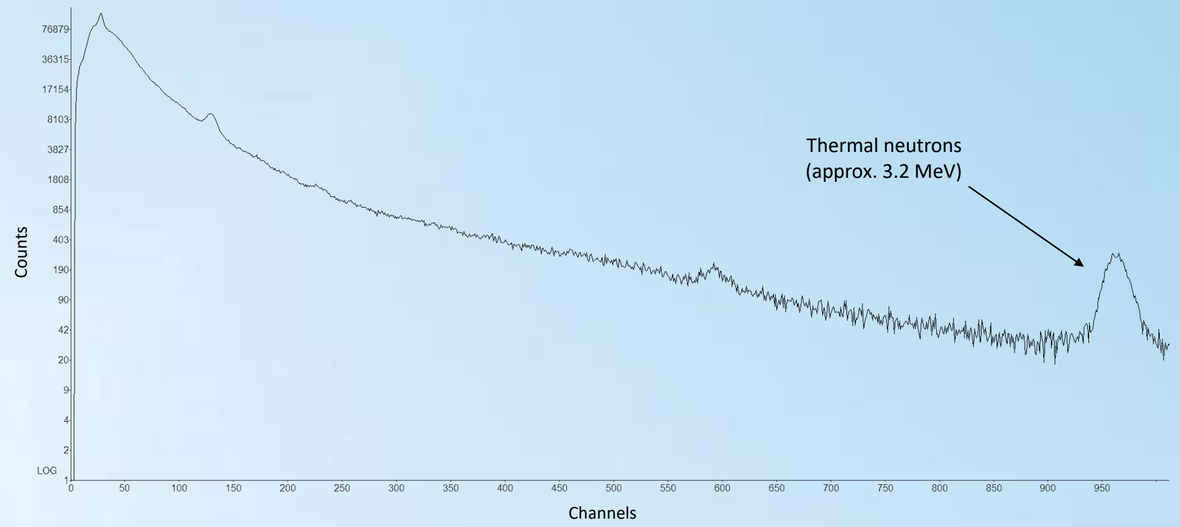
The pulse discrimination is based on the difference of the pulse rise time, which is due to the absence of the fast component of neutron scintillation. PSD factor is used to determine the difference in shape, which is defined as the ratio of the head to total charge.



NaIL application

Distinctive feature of NaIL scintillator is that lithium is artificially added to NaI structure, which allows to inject up to 8% of lithium without significant deterioration of initial crystal parameters.

NaIL spectrum from moderated Cf-252 source



In contrast to CLYC, the fast scintillation component of NaIL crystal is more pronounced for neutrons. Due to this feature the pulse separation in NaIL crystal can be carried out without using PSD-ratio, because at the same value of the total charge the neutron pulse amplitude is much higher than from gamma-quantum.