CZT Quasi-Hemispherical Detectors with Improved Spectrometric Characteristics

V. Ivanov, L. Alekseeva, P. Dorogov, A. Luchanskii

ZRF RITEC SIA, 23 Aizkraukles St. office 407, Riga, LV-1006, Latvia
Tel./Fax: +371-67543304, E-mail: ritec@ritec.lv

Text

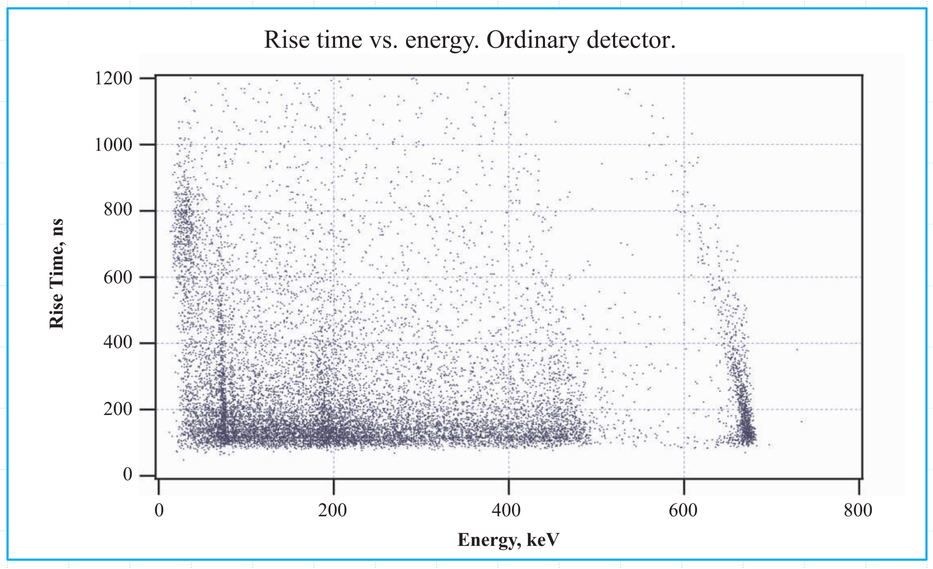
At present time serial miniature Spectrometric Detection Probes [1] with CZT quasi-hemispherical detectors [2] of various sensitive volumes from 1 mm^3 to 500 mm^3 are available. These probes are widely and successfully used for different applications, but there are some disadvantages that limits application capabilities. It are asymmetric peaks shapes, insufficient for many application energy resolution and peak-to-Compton ratio. Yield of high quality detectors is rather low, that increases theirs cost. These disadvantages are connected with charge losses during a charge carriers collection. Charge carrier trapping, different material defects and distortions of electric field distribution define charge losses and its nonuniformity per detector volume. Applying of sufficiently high operation voltage may reduce charge losses, but many detectors do not allow it because of increased noise level defined by a high leakage current or/and high electric field effects influence.

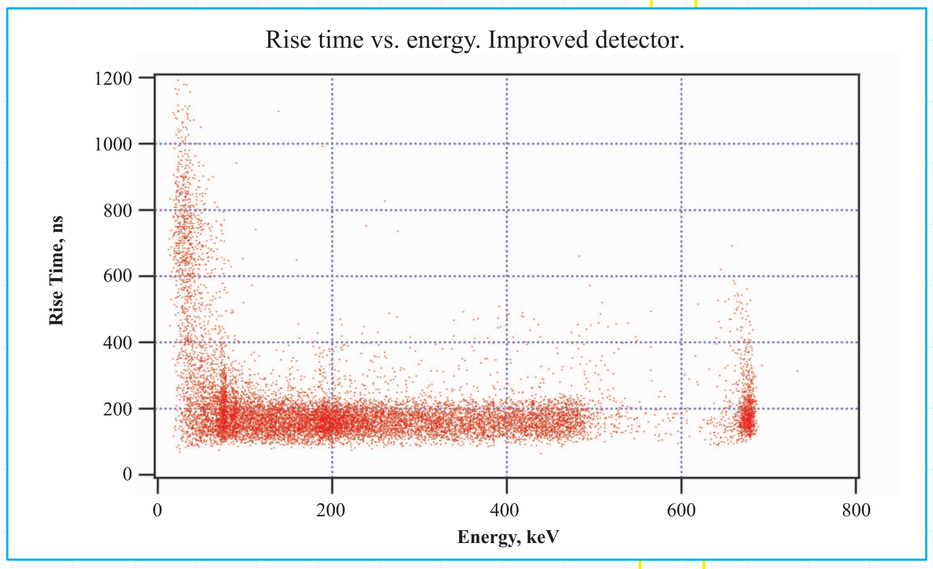
Development of the CZT quasi-hemispherical detectors fabrication method, optimisation of contacts structure and probes design allowed noticeable improve probes spectrometric capability. Optimised contact structure maximizes charge collection efficiency and its uniformity per detector volume.

Spectrometric Detection Probes

Scatter contour of Cs-137 events (event rise time vs. energy) for ordinary and improved detectors. Detector volume 60 mm^3. Operation voltage 150 V.

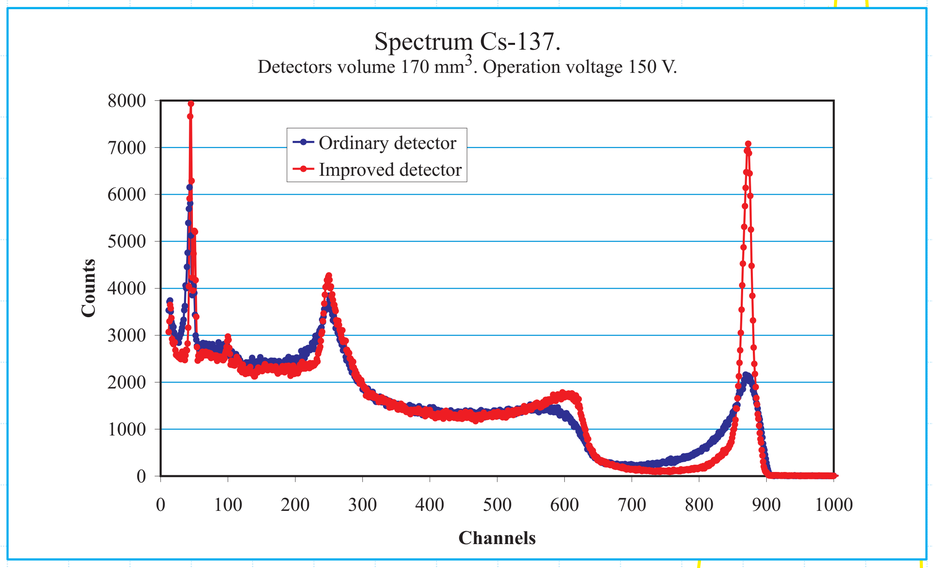
Measurements were done with XIA digital spectrometer DGF POLARIS and associated software [3].



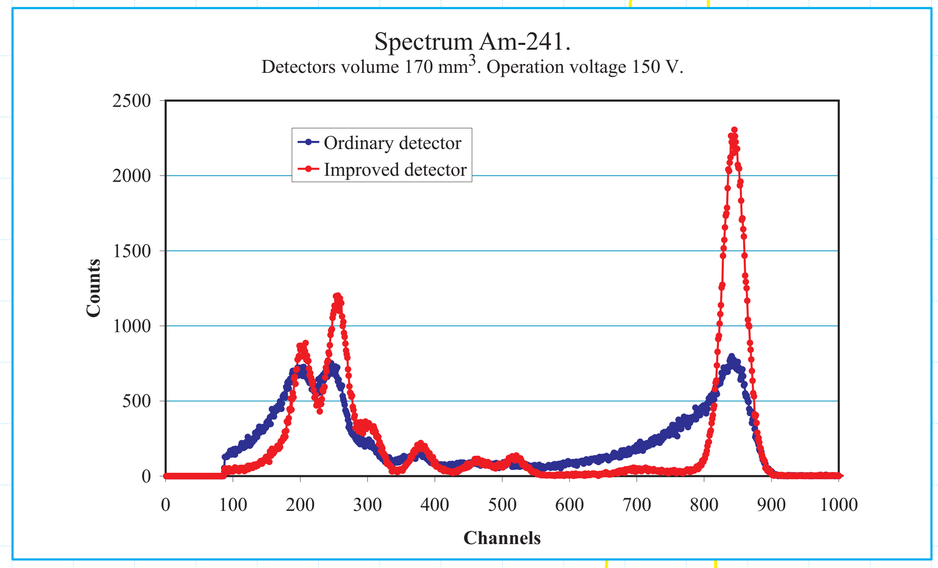


New improved CZT quasi-hemispherical detectors have much better performance in comparison with ordinary detectors fabricated of the same initial crystal.

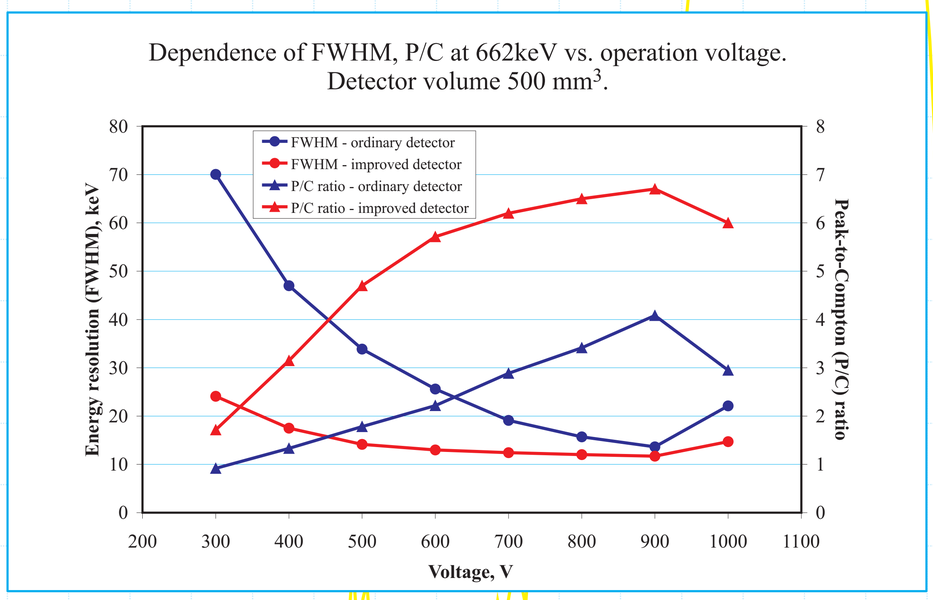
New detectors of all tested sizes have improved energy resolution and peak-to-Compton ratio. Improvement is obtained without decreasing of a total absorption peak efficiency.



Improvement of spectrometric capabilities is obtained in a wide energy range. Shape of total absorption peaks become more symmetrical and approximate to Gaussian.



Improvement of spectrometric capabilities is obtained without increasing of detector operation voltages. Perfect energy resolution as well as peak-to Compton ratio for high-quality detectors can be obtained at low operation voltages.



Degree of improvement is various for different detectors and depends on a quality of used initial CZT crystal.

Table

Some results obtained with ordinary and improved CZT quasi-hemispherical detectors of different volumes.

No.	Detector volume, mm^3	Operation voltage, V	Energy resolution (FWHM), keV		Peak-to-Compton ratio	
			Ordinary detector	Improved detector	Ordinary detector	Improved detector
1	15	50	17.3	6.7	2.2	5.4
		250	6.9	5.5	5.4	6.3
2	60	100	29.8	10.1	10.1	4.3
		400	7.3	6.8	6.8	7.7
3	170	150	36.3	12.7	1.6	5.5
		800	6.4	5.1	9.4	12.6
4	500	500	33.9	14.2	1.8	4.7
		1000	13.2	11.2	4.5	7.2
Low-quality detector, witch were rejected before improvement						
5	60	500	22.4	11.7	1.8	5.3
6	500	1000	23.1	12.8	2.9	6.8

Application of the new fabrication method allows fabricate miniature CZT probes with energy resolution about and even less then 1% at 662 keV line at room temperature and noticeable increases the yield of high quality probes with energy resolution 2-3%. All improvements are obtained without application of any pulse shape correction/selection electronics or/and special software support.

References:
1. Spectrometric Detection Probe SDP310, RITEC Data Sheet, http://www.ritec.lv
2. V. Ivanov, P. Popov, A. Loutchansky, L. Aleksejeva, E. Mozchaev, "Further Development of Hemispherical CdZnTe Detectors for Safeguards Applications", Proc. 21th Annual ESARDA Symp. on Safeguards and Nuclear Material Management, Seville, Spain, pp. 479-484, 1999.
3. Digital Gamma Finder POLARIS, XIA Data Sheet, http:// www.xia.com

NUCLEAR RADIATION
SEMICONDUCTOR DETECTORS
AND ASSOCIATED ELECTRONICS

Ritec