Influence of Infrared Stimulation on Spectroscopy Characteristics of Different CdZnTe detectors

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IT was previously found that illumination with monochromatic infrared (IR) light with wavelengths close to the absorption edge of the CdZnTe exert significant positive influence on the spectrometric characteristics of quasi-hemispherical CdZnTe detectors at room temperature [1]. In this paper, results of IR stimulation on the spectrometric characteristics of planar detectors of size 10 mm × 10 mm × 5 mm and co-planar grid detectors of size 10 mm × 10 mm × 10 mm are presented. Results of further studies of IR stimulation on the spectrometric characteristics of quasi-hemispherical detectors of size 10 mm × 10 mm × 5 mm are shown too. Were suggested and tested a new design of CdZnTe detector - Capacitive Frish Single Pixel Detector of of size 15 mm × 15 mm × 1.1 mm.

Analysis of transient current and transient charge pulses waveforms from alpha particles measured with different detectors and spectroscopy measurements with various gamma-radiation sources at different intensity of IR illumination were performed.

All detectors were fabricated of CdZnTe crystals produced by REDLEN TECHNOLOGIES. $(\mu\tau)_e$ value of used CdZnTe crystals were more then 10^{-2} cm^2/V. Planar and co-planar grid detectors were fabricated and supplied by REDLEN, quasi-hemispherical and capacitive Frish single pixel detectors were fabricated by RITEC.

Was found that spectrometric characteristics of planar detectors under IR illumination practically did not improved.

Unlike planar detectors spectrometric characteristics of quasi-hemispherical detectors can be noticeably improved by a low intensity IR illumination using wavelengths of approximately 900 to 1000 nm at room temperature, Fig. 1. IR illumination decreases total collecting time and improves charge collection first of all from the corner regions of the detector.

Obtained improvement of energy resolution of co-planar grid detectors under IR illumination was considerably smaller, Fig. 2. then in quasi-hemispherical detectors.

Spectrometric characteristics of suggested capacitive Frish single pixel detectors were noticeably improved under IR illumination too, Fig. 3.

The mechanism of impact of IR radiation on the CdZnTe detectors of all tested types is similar. IR light with a wavelength below the fundamental absorption edge penetrates deeply into the detector and influences charge carriers trapping and detrapping processes, thus changing the balance between trapped and free charge carriers.

Our investigations showed that IR illumination considerably affects the electric field distribution in CdZnTe detectors increasing it near the cathode. In the case of the planar and co-planar detectors redistribution of the electric field leads to increasing of charge time collection and to some improvement of charge collection uniformity. In case of the quasi-hemispherical and capacitive Frish single pixel detectors redistribution of the electric field leads to reduction of charge collection time and improvement of charge collection uniformity especially from the corner areas of the detector. IR illumination can be successfully applied to improve detectors where the geometric weighting effect is implemented.

REFERENCES

[1] V. Ivanov, P. Dorogov, A. Loutchansky, L. Grigorjeva, D. Millers, "Improving the Performance of Quasi–Hemispherical CdZnTe Detectors Using Infrared Stimulation", IEEE Trans. Nucl. Sci., vol. 59, no. 5. pp. 2375–2382, 2012.

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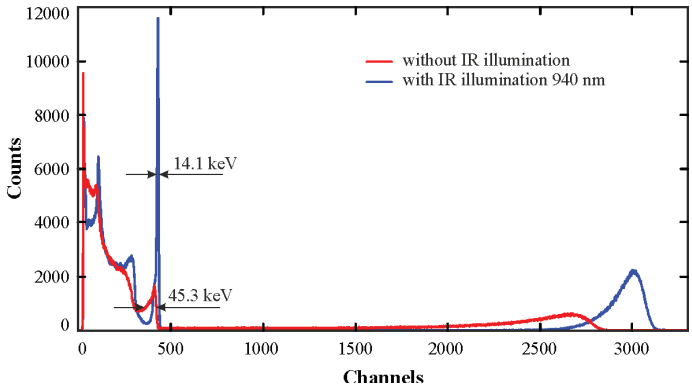

Fig. 1. Alpha and gamma–radiation spectra of ^{137}Cs measured by quasi-hemispherical detector of 10 mm × 10 mm × 5 mm size without and with IR illumination.

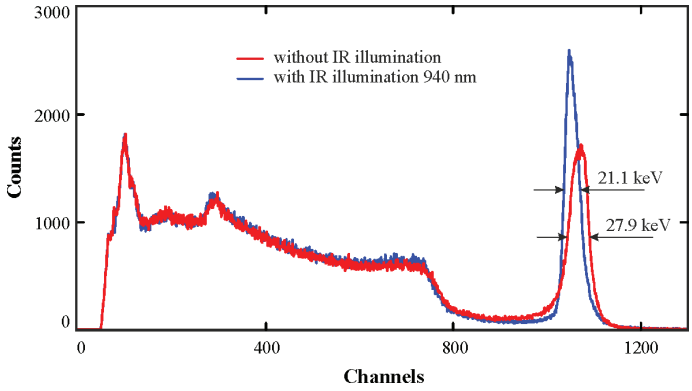

Fig. 2. Spectra of ^{137}Cs measured by co-planar grid detector of 10 mm × 10 mm × 10 mm size without and with IR illumination.

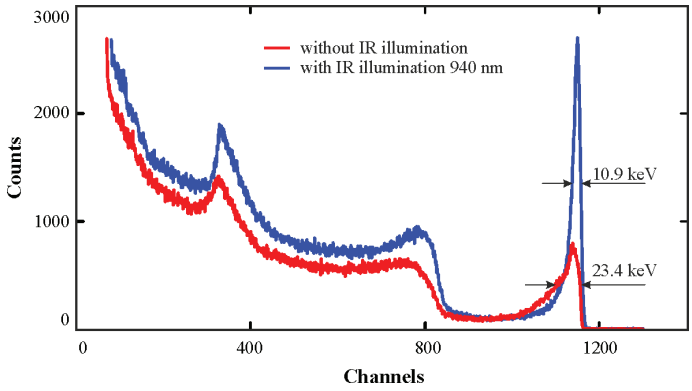

Fig. 3. Spectra of ^{137}Cs measured by capacitive Frish single pixel detector of 15 mm × 15 mm × 1.1 mm size without and with IR illumination.