Distortion of pulse-height spectra of neutron capture gamma rays

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The precise neutron capture cross-section measurement in wide neutron energy range is required for the study of nuclear transmutation. Neutron capture has been investigated at many neutron facilities in the world with a large amount of data having been already measured and published. Under measurement at pulse neutron source in TOF mode, any used gamma-ray detector was significantly affected by strong gamma-flash pulse of the accelerator. The strong detector overload causes baseline distortion, which leads to distortion of the measured pulse height and therefore to distortion of obtained capture cross-section value, based on gamma-ray yield, at using traditional analog-to-digital converters with fixed pulse height bias. Recently, the flash-ADC has found wide applications in neutron cross-section measurements. It gives an opportunity to study, quantitatively, the baseline shift effect on the measured capture cross section and to investigate the magnitude of possible systematic error of many previous experiments. The result of this investigation is presented.

The baseline distortion study has been done using the data obtained in the course of the neutron capture cross section measurement of ^{nat}Zr and separated Zr isotopes that was carried out at the TOF facility of 46-MeV electron linac at the KURRI. The C_6D_6 liquid scintillate detectors were used for gamma-ray registration. The data acquisition system of this experiment is based on a 40 MHz flash-ADC. To estimate the magnitude of the baseline distortion, the baseline reconstruction has been done using the pre-histories of the accumulated pulse waveforms. To evaluate the magnitude of the correction, taking into account the baseline distortion, the reconstruction of the pulse height spectra has been done. For spectra reconstruction, two methods, based on the operational principle of both conventional analog-to-digital converter and flash-ADC, have been used. For both modes of calculation, the definite bias, corresponding to gamma-ray energy of about 100 keV, was applied. The obtained correction factor, reflecting the difference of both calculated gamma-ray yields, has complicated energy dependence with sign changes and reaches magnitude of 20% at the beginning of time dependence of detector baseline distortion and more than 10% at the first positive maximum at time about 75 μs after neutron burst. The baseline distortion continues up to the time of about 600 μs. The obtained results give us insight into the possible systematic errors due to gamma-flash of cross sections measured in the past in the world.

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