DIGITAL SIGNAL PROCESSING FOR CDTE PHOTON-COUNTING X-RAY SENSOR

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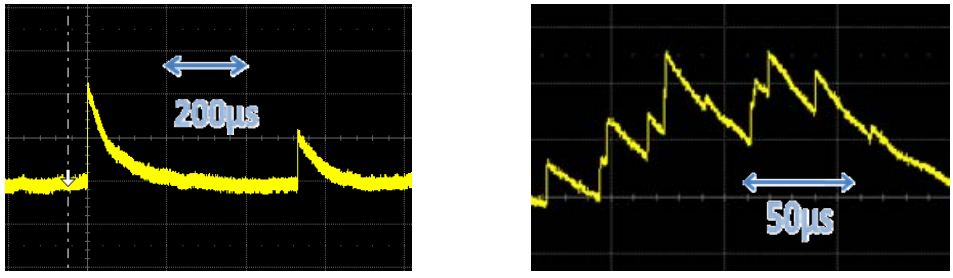
Recently the practical X-ray measurement system is demanded photon-counting X-ray sensor with the high count rate and the high energy resolution. Photon-counting CdTe semiconductor detector has a high energy resolution in low count rate at room temperature. However, the energy resolution is decreased by pile-up phenomenon as shown in Fig 1b in high count rate. Because of the photon counting sensor was used the signal-processing algorithm that the digital energy value was estimated by integration of the output waveform from the CdTe detector. Moreover, the photon counting sensor is required to maintain the high energy resolution even if the pile-up occurred.

This paper purposes to maintain the high energy resolution by changing the signal-processing algorithm which derived the digital energy value from the pulse rise height of the output waveform generated the pile-up from the CdTe detector. The experiment system was used the CdTe pin diode detector (2mm x 2mm x 0.5mm-thick), the preamplifier (Clear Pulse-5102B) and Am-241 radioisotope as a checking source. The output of preamplifier was connected to high speed signal storage oscilloscope, and the output date was analyzed by MATLAB R2008a, as shown in Fig 2. As a result, the pulse rise time required to estimate the pulse rise size was shorter than 500ns. Result of calculating energy spectrum by using this data, the FWHM was about 4keV (at 60keV) when the count rate of 3counts/60us in the pulse attenuation constant of 60us (with the pile-up is occurred in this condition). This result is indicated the possibility that the photon counting sensor has application for the high count rate without decrease of the high energy resolution.



(a) (b)

Fig.1. The output waveform from the CdTe detector.
(a) No pile-up phenomenon. (b) Pile-up phenomenon

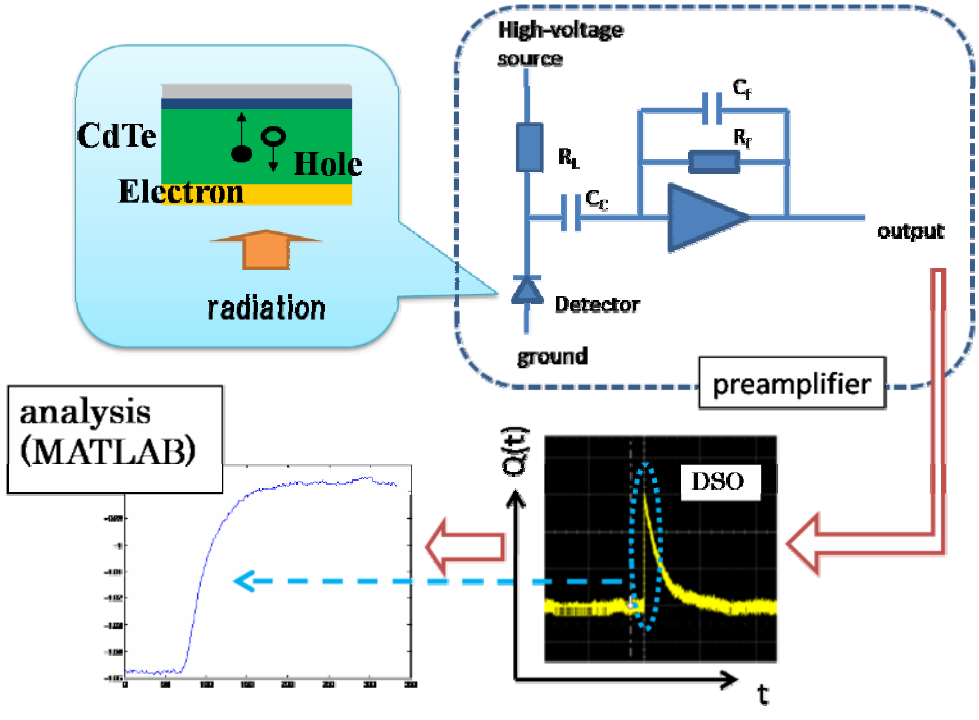


Fig.2. Block diagram of the experiment system