SUPER HIGH THROUGHPUT WITH A SILICON DRIFT DETECTOR AND ADVANCED PULSE PROCESSING TECHNOLOGY

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An advanced Vortex® detector (from SII NanoTechnology USA) using a 50 mm^2 silicon drift detector (SDD) has been successfully combined with the new FalconX™ processor (from XIA LLC) and the SI-TORO™ pulse processing technology (from Southern Innovation) to achieve extremely high throughput, while maintaining excellent energy resolution.

Using an ^{55}Fe radioisotope source and an analog pulse processor (Canberra 2026x), a common un-collimated 50 mm^2 Vortex® SDD achieves an energy resolution of 126 eV FWHM at 5.9 keV at a time constant of 3 µs, as is shown in Figure 1. The energy resolution, as well as the throughput and dead time performance of the Vortex® SDD with the FalconX™ processor with SI-TORO™ technology, are shown in Table 1. The data in Table 1 was collected using an X-ray tube and a Mn foil sample.

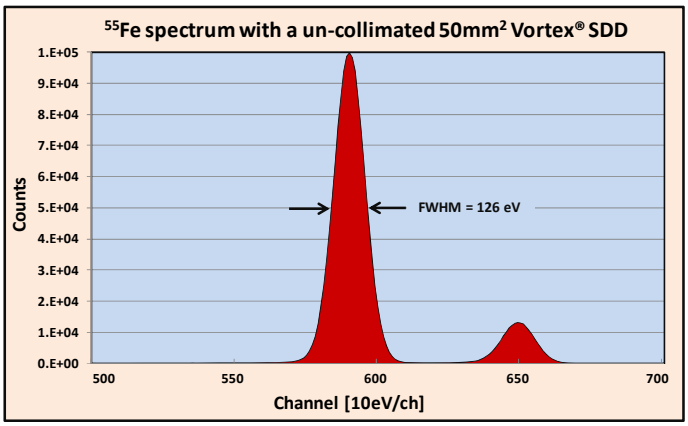

Fig. 1 – An ^{55}Fe spectrum with an un-collimated 50mm^2 collected with Canberra 2026x analog pulse processor

ICR [kcps]	OCR [kcps]	DT [%]	FWHM [eV]
21.80	21.77	0.1	146.7
104.50	103.60	0.9	152.7
209.8	205.4	2.1	163.6
416.0	397.9	4.4	176.4
619.2	579.1	6.5	189.0
820.9	750.0	8.6	203.1
1017.9	909.4	10.7	210.8
1208.7	1059.8	12.3	223.4

Table 1 – Throughput and DT performance of the 50mm^2 Vortex® SDD with the FalconX™ processor with SI-TORO™ technology

As can be seen from Table 1, the Vortex® SDD with the FalconX™ processor achieves just over 10% dead time and an energy resolution of 211 eV FWHM (at 5.9 keV) at an input rate exceeding 1 Mcps! It is possible to give up some throughput and achieve even better resolution with the SITORO™ algorithms by tuning the event rejection and timing parameters.

The SI-TORO™ technology uses advance signal processing algorithms, based on Maximum Likelihood Estimation, to recover information from pile-up events. After shaping the preamplifier step reset data into a nuclear decay tail pulse, the system digitizes the detector signal at 120 MHz and 16-bit resolution.

The digitized detector data is then modeled as the sum of an unknown number of events (n), each with random arrival time (t) and unknown energy (e). It is assumed the detector response function to a single event is determined a priori via an online calibration routine. By solving for each of the unknown parameters n, t, and e (on-line and in real-time), it is possible to accurately recover information from piled-up pulses.

The combination of the Vortex® SDD, the FalconX™ digital pulse processor, and the SI-TORO™ technology, enables super high throughput, and low dead-time pulse processing by recovering, rather than discarding, detector data corrupted by pulse pile-up.