Achievement of 1 Mcps Output Rate from a Large Area Silicon Drift Detector

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We are reporting here for the first time the achievement of one million counts per second (1 Mcps) output count rate (OCR) from our large area (~50 mm^2) single element silicon drift detectors (the Vortex®) using a commercially available digital pulse processor, the Mercury Digital X-ray Processor from XIA (X-ray Instrumentation Associates, LLC).

The advantages and high performance of the Vortex® silicon drift detectors have been extensively reported. However, their highest achievable OCR has been limited to 500 - 600 Kcps in the past, due to limitations of the previous generation of pulse processors. Old processors offer a minimum processing peaking time of only 0.25 μs, with a limited capability in pile-up rejection (PUR). This made it impractical to break through the 500-600 Kcps OCR limit, although the Vortex® detectors feature a very short rise time (< 100 ns) which is suitable for a much shorter processing peaking time. Recent advances in digital pulse processing technology has led to a new generation of pulse processors which typically run at much higher clock speed (>= 50 MHz) and offer much shorter processing peaking times (<= 0.1μs) with improved PUR performance, making it possible to exceed the previous OCR limit. Using XIA's Mercury processor, for example, we achieved 1 Mcps output rate with 0.1 μs processing peaking time. This is a significant improvement, especially for applications where OCR performance is critical, such as in fast X-ray mapping, ultra-trace elemental analysis, EXAFS, etc. Figure 1 shows a series of Mn K spectra acquired for 0.1 μs peaking time at various OCR from a Mn sample excited with a Rh X-ray tube using 40 kV voltage. For up to ~3 Mcps input count rate (ICR), both peak position and resolution are reasonably stable: the peak position change is less than 1% while the Mn K_α resolution varies within the range of 345 - 386 eV. The acquisitions were set to have a moderate PUR performance as exhibited in Figure 1.

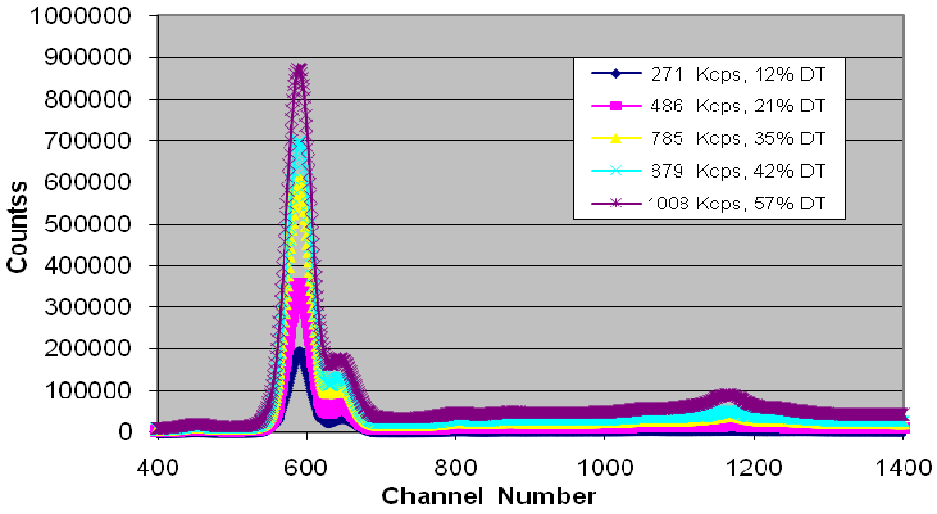

Figure 1. Mn spectra acquired using 0.1 μs preaking time at various OCR