VORTEX – A HIGH PERFORMANCE SILICON DRIFT DETECTOR FOR X-RAY DIFFRACTION

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A new class of silicon drift detectors (SDD) has been developed for XRF spectrometry applications having large active area (~ 0.5 cm^2), high-energy resolution (< 150 eV FWHM) and high count rate capability (>1 Mcps). The advantage of the drift detector design is that, unlike with traditional planar detectors, it allows for relatively large active area while still maintaining a very low anode capacitance (~ 60 fF). This very small detector capacitance results in a reduction of the series-noise component and hence also a reduction of the overall inherent electronic noise. Additionally, the reduction of the series noise leads to faster optimal shaping time, which provides for extremely high count rate operation. When the overall system capacitance is kept low, it is possible to reach extremely low noise at very short shaping times.

The Photon Imaging SDD utilizes novel structures that have produced very low dark current (both bulk silicon dark current and surface dark current), high electric field, uniform charge collection, low noise and high-sensitivity to low energy x-rays and is thus ideally suited for high-resolution x-ray spectroscopy applications. Energy resolution of 143 eV FWHM at 5.9 KeV was measured with a 50 mm^2 SDD, with a corresponding electronic noise level of 70 eV FWHM (< 10 e^- RMS). At a very short peaking time (250 ns) an energy resolution of less than 250 eV is easily achieved with commensurate output count rates of greater than 400 Kcps.

These new detectors are interesting for a new class of instruments combining affordability, small mass, and low power consumption that will enable new x-ray analytical systems, or for replacing many existing detectors based on cryogenic Si(Li) and high purity germanium, used in many commercial applications (e.g. microanalysis, x-ray fluorescence, x-ray diffraction, and medical imaging) as well as scientific applications (e.g. nuclear science, high energy physics, and synchrotron radiation experiments). Other new applications are possible for use in hand-held, portable field instrumentation.

In this paper we present a description of the large-area SDD, specifically as it is being introduced as a new product for x-ray diffraction applications. Spectra from different samples that were collected with a 50 mm^2 SDD under high count rate x-ray flux conditions are presented. We also present results comparing the 50 mm^2 SDD with a 50 mm^2 Si(Li) detector, in which both detectors were operated under the same geometry and x-ray conditions.