Current state of the art semiconductor detectors for very high count rate x-ray applications

J. Flamanc, J. Douwen, V. Marian, M. Morelle, P. Quirin, M.-O. Lampert
jflamanc@mirion.com

Most fluorescence and diffraction beamlines uses semiconductor detectors for high resolution x-ray spectrometry. These detectors need to face high count rate (from few thousands to several million counts per seconds), provide large sensitive area but compact footprint, and the highest reliability.

This paper presents the performances of latest generation of silicon and high purity germanium x-ray detectors, exhibiting precedent defying energy resolutions and throughput characteristics. These detectors consist of multichannel sensors (array of individual elements or monolithic pixelated detector slab) cooled using a state-of-the-art electrical cryocooler with active vibration cancellation in compact, multi attitude and customizable designs. Measurement from laboratories point sources (ranging from 6keV to 122keV) as well as from actual synchrotron beams will be presented.

More precisely, a new state-of-the-art 7 element silicon drift diode (SDD) array, electrically cooled (either with Peltier or electrical cooler) will be introduced. An energy resolution (FWHM) of 156 eV at 6keV is achieved for an input count rate of 1.1 Mcps.

Single or multichannel HPGe systems will also be described, which are now capable of resolving up to several million counts per second and per channel, with reasonable dead-times (<20% at 1Mcps), good linearity (<5% after correction), and excellent energy resolutions (typically < 175eV at 1Mcps, and <200eV at 2.6Mcps). Measurement at higher energies (60keV) will also be presented.
Thus, performances similar to SDD are now possible with HPGe detectors, while covering a much broader energy range compared to silicon.

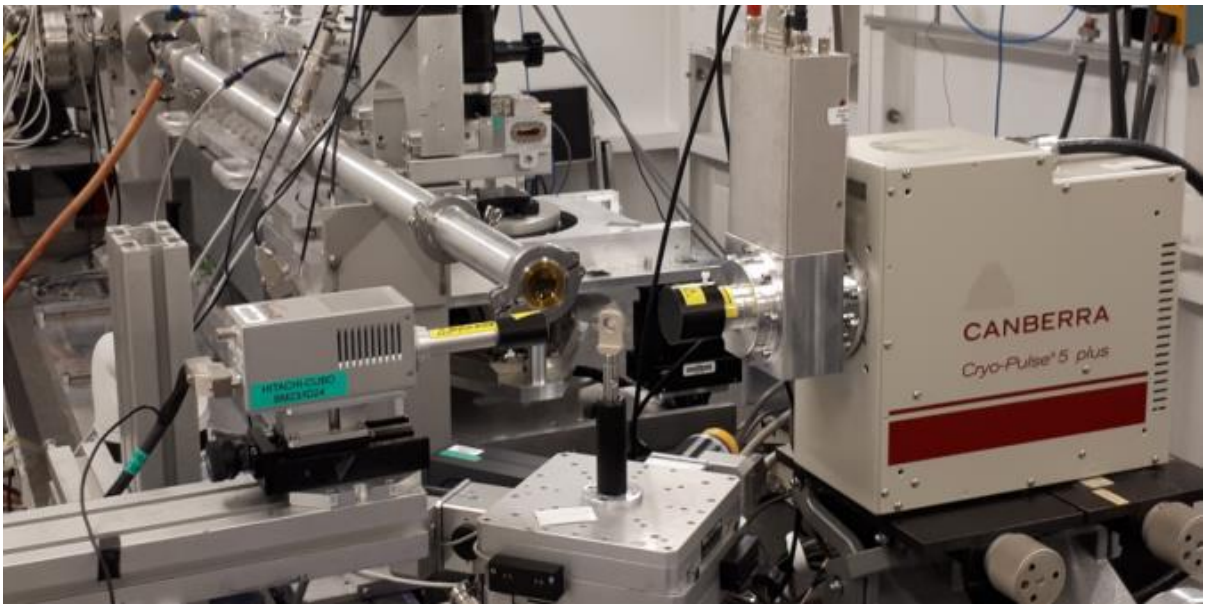

Figure 1 - Picture of a single channel detector prototype under beamline test on BM23 at ESRF

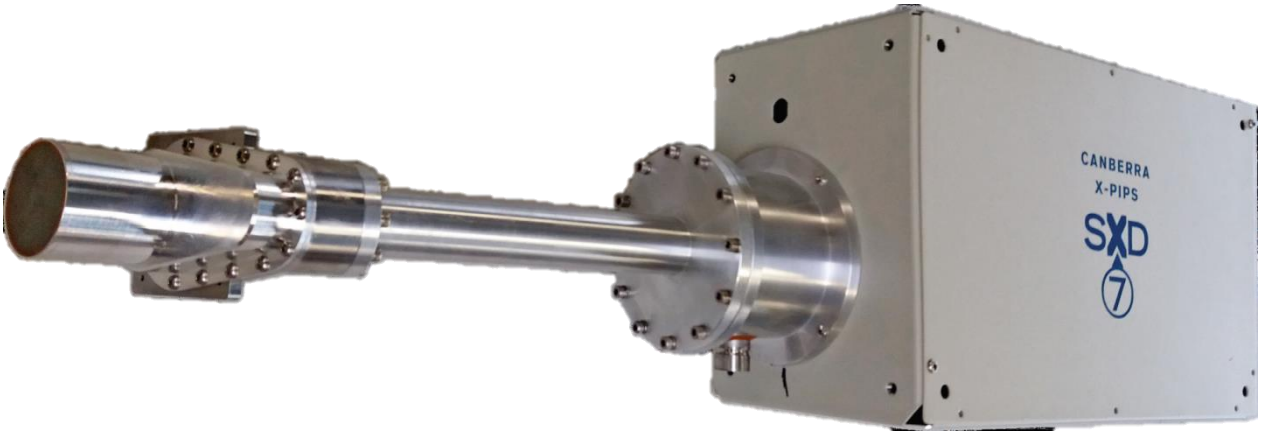

Figure 2 – 7x 50 mm² SDD array in close packed configuration with 1.4W Cryo-Pulse electrically refrigerated cryostat