Amptek X-Ray Detector Selection Guide

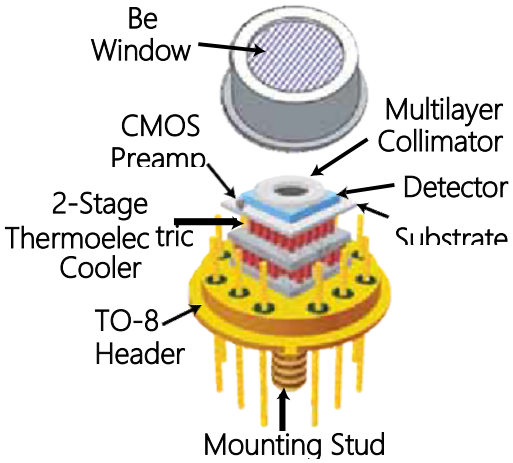
Overview

Amptek provides a family of high performance, compact X-ray detectors and associated signal processing electronics. The radiation detectors are custom photodiodes, including the traditional Si-PIN diodes, Silicon Drift Detectors (SDDs), and CdTe Schottky diodes. The detector is mounted on a two-stage thermoelectric cooler along with the preamplifier's input transistor. The cooler keeps the detector and transistor at -25 ^{o}C or below, reducing electronic noise without cryogenic liquid nitrogen and drawing <1W. This cooling permits high performance in a compact, convenient package, and has been critical to the development of portable XRF analyzers and of high performance, bench top XRF and EDS systems.

Amptek's detectors represent the state-of-the-art in X-ray spectroscopy, delivering the best energy resolution, best efficiency at low energies, highest count rates, highest peak to background ratios, all at low cost and suitable for portable systems, vacuum systems, etc. They are used by OEMs and by laboratory researchers. The core enabling technologies include the detectors themselves (which are designed and manufactured by Amptek), CMOS technology, and the packaging which enables good cooling in a robust system. Amptek has several different basic detectors in this family, sharing the core technology but optimized for different applications.

The sketch above illustrates a detector mounted on a thermoelectric cooler, on a TO-8 header. The input FET and other components are also mounted on the cooler. A nickel cover (also shown) is welded to the TO-8 header with vacuum inside the enclosure for optimum cooling. In the cover is a window (shown green above) to enable soft X-ray detection. This is typically beryllium for energies > 2 keV, with Si3N4 available for lower energies. The detectors use reset-style preamplifiers.

The Detector Element



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Detector Selection

FAST SDD®: This is Amptek's highest performance detector. The FAST SDD® is recommended for users needing the best performance. It can provide the best energy resolution (down to 122 eV FWHM at 5.895 keV), can measure the lowest energy X-rays (down to the Li Ka line at 52 eV), has the best peak to background ratios, can run at the highest count rates (> 1 Mcps), and is available at the largest areas (up to 70 mm^2). The FAST SDD® is widely used in the most demanding XRF applications, in EDS and SEMs/TEMs, in synchrotrons, and other research systems.

Si-PIN: Recommended for applications requiring moderate energy resolution and count rate, where cost is most important. Si-PIN devices have a conventional planar structure, yielding more electronic noise than an SDD but are easier to fabricate. There are three different Si-PIN variations currently available, with areas of 6 mm^2, 13 mm^2, and 25 mm^2. The 6 mm^2 detectors provide an energy resolution of 140 eV FWHM at the 5.9 keV Mn Ka line at count rates up to 50k cps. The 13 mm^2 and 25 mm^2 detectors typically offer energy resolutions of 180 and 210 eV FWHM for the same count rates.

CdTe: Recommended for applications above 20-30 keV. CdTe has much higher stopping power than Si and can be made much thicker, so has high efficiency for all characteristic X-rays, even up to the K lines of U. The electronic noise of CdTe is worse than that of either Si detector (resolution typically 450 eV FWHM at the 5.9 keV Mn Ka line), making a Si detector a better choice for energies below 20 keV. But above 20 to 30 keV, the resolution is dominated by Fano broadening anyway so the difference becomes small, the characteristic X-ray lines are more widely spaced, and the efficiency of the Si detector falls off, making CdTe a better choice. The CdTe detectors is very well suited to measuring the spectrum from an X-ray tube, where efficiency is very important and energy resolution is less critical. CdTe is also the best choice for Gamma- Ray applications.

FAST SDD with Be Window

FAST SDD with C Series Window

Configurations

All Amptek x-ray detector elements are available in the XR-100, X-123, or OEM configurations.

The XR-100 configuration includes the detector and preamplifier only and must be paired with the PX5 Digital Pulse Processor, MCA, and Power Supply to be a complete system (or the DP5/PC5 OEM processor and power supply). The XR-100/PX5 combination is the most flexible and is designed for laboratory and research use. The PX5 can be used with other detectors, including from other manufacturers.

The X-123 includes the detector, digital pulse processor, MCA, and power supply all in one box, and is a complete system. The X-123 configuration is ideal for OEM bench-top and custom applications where size, portability, and speed to market are considerations.

For hand-held and custom OEM applications, other configurations are available.

X-123SDD X-Ray Spectrometer

XR-100CR and PX5 Digital Pulse Processor

A sample of OEM configurations

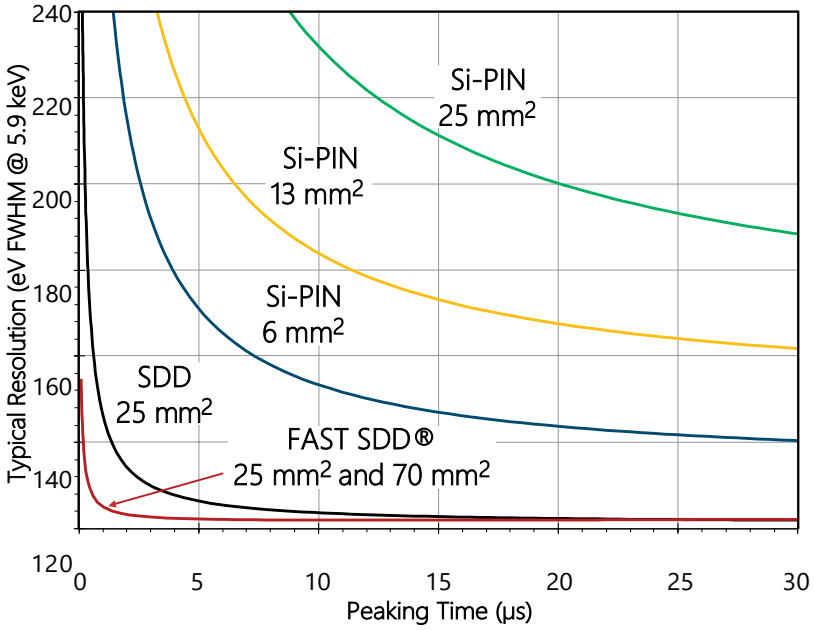
XRF Experimenter's Kit

Si-PIN & FAST SDD® Selection Table

Detector Type Area / Thickness Window Options	Guaranteed Energy Resolution eV FWHM @ 5.9 keV* Peak to Background Ratio*	XR-100 Part Number	X-123 Part Number
Si-PIN 6 mm^2 / 500 µm 0.5 or 1.0 mil Be	139 - 159 eV 32 µs Peaking Time P/B Ratio: 19000/1 (typical)	XY-FSG32MD-G3SP (1 mil Be) XY-FSG32MD-G2SP (0.5 mil Be)	ZY-FSG32MD-G3SP (1 mil Be) ZY-FSG32MD-G2SP (0.5 mil Be)
Si-PIN 13 mm^2 / 500 µm 1.0 mil Be	180 - 205 eV 32 µs Peaking Time P/B Ratio: 4100/1 (typical)	XY-FS432MD-G3SP (1 mil Be)	ZY-FS432MD-G3SP (1 mil Be)
Si-PIN 25 mm^2 / 500 µm 1.0 mil Be	190 - 225 eV 32 µs Peaking Time P/B Ratio: 2000/1 (typical)	XY-FSJ32MD-G3SP (1 mil Be)	ZY-FSJ32MD-G3SP (1 mil Be)
FAST SDD® 25 mm^2 / 500 µm 0.5 mil Be, C1, or C2 Si3N4	122 - 129 eV 4 µs Peaking Time P/B Ratio: >20000/1 (typical)	XY-HSH3AMD-G2SP (0.5 mil Be) XY-HSH3AMD-U0EA (C1) XY-HSH3AMD-E6EA (C2)	ZY-HSH3AMD-G2SP (0.5 mil Be) ZY-HSH3AMD-U0EA (C1) ZY-HSH3AMD-E6EA (C2)
FAST SDD®-70 70 mm^2 / 500 µm 0.5 mil Be or C2 Si3N4	123 - 135 eV 4 µs Peaking Time P/B Ratio: >20000/1 (typical)	XY-HS63AMD-Y2SP (0.5 mil Be) XY-HS63AMD-W6EA (C2)	ZY-HS63AMD-Y2SP (0.5 mil Be) ZY-HS63AMD-W6EA (C2)

*All results are under full detector cooling; please Contact Us to discuss guaranteed performance under different operating conditions. The Peak to Background (P/B) Ratio is the ratio of counts from 5.9 keV to 2 keV for 13 and 25mm^2 Si-PIN, and 5.9 keV to 1 keV for all SDDs and 6 mm^2 Si-PIN.

Resolution vs. Peaking Time for Amptek Si-PIN and SDD Detectors



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