Silicon Drift Detector (SDD)

XR-100SDD
X-123SDD

The Amptek Silicon Drift Detectors (SDD) represent a breakthrough in x-ray detector technology by providing "off-the-shelf" performance previously available only from expensive cryogenically cooled systems.

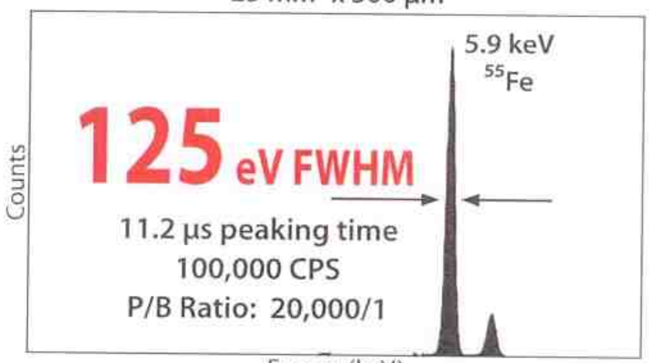
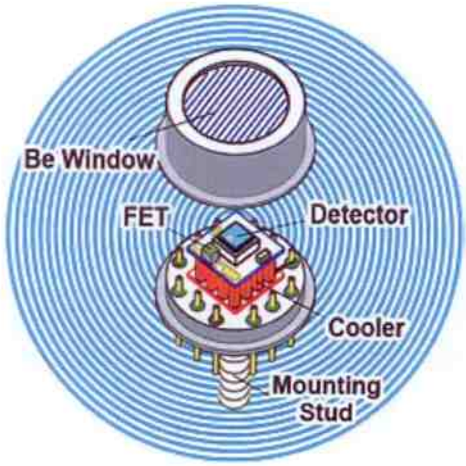


Figure 1. ^{55}Fe Spectrum with Silicon Drift Detector (SDD).



Features

- 125 eV FWHM Resolution @ 5.9 keV
- High Peak-to-Background Ratio - 20,000:1
- 25 mm^2 x 500 µm
- 11.2 µs Peaking Time
- 100,000 CPS
- USB Controlled
- No Liquid Nitrogen

Applications

- X-Ray Fluorescence
- RoHS / WEEE Compliance XRF
- OEM & Special Applications
- Process Control
- Research

The XR-100SDD and X-123SDD Silicon Drift Detectors (SDD) are the latest additions to Amptek's line of x-ray detectors that revolutionized the industry.

Their high performance, small size, and low cost make them the ideal detector for OEM hand-held applications to bench-top analyzers.

The SDD enables extremely high count rate applications with excellent energy resolution. The detector is housed inside the same TO-8 package as Amptek's other detectors, so its form-factor is a direct replacement for current systems and is compatible with all Amptek accessories and options.

XR-100SDD

X-Ray Detector and Digital Pulse Processor with MCA

X-123SDD

Complete X-Ray Spectrometer Includes:

1 Silicon Drift Detector and Preamplifier
2 Digital Pulse Processor and MCA
3 Power Supply

OEM's #1 Choice

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Specifications

General	
Detector Type	Silicon Drift Detector (SDD)
Detector Size	25 mm^2
Silicon Thickness	500 µm. See Figure 5
Energy Resolution @ 5.9 keV (55Fe)	125 - 140 eV FWHM at 11.2 µs peaking time
Peak to Background	20000:1 (ratio of counts from 5.9 keV to 1 keV)
Background Counts	<3 x 10^{-3}/s, 2 keV to 150 keV
Detector Be Window Thickness	0.5 mil (12.5 µm). See Figure 5
Collimator	Internal MultiLayer Collimator (ML)
Charge Sensitive Preamplifier	Amptek custom design with reset
Gain Stability	<20 ppm/°C (typical)
Case Size XR-100SDD X-123SDD	 3.00 x 1.75 x 1.13 in (7.6 x 4.4 x 2.9 cm) 3.94 x 2.67 x 1.0 in (10.0 x 6.78 x 2.54 cm)
Weight XR-100SDD X-123SDD	 4.4 ounces (125 g) 6.7 ounces (190 g)
Total Power XR-100SDD X-123SDD	 <1 Watt 2.5 Watt (typical)
Warranty Period	1 Year
Device Lifetime	Typical 5 to 10 years, depending on use
Storage & Shipping	Long-term Storage: 10+ years in dry environment Typical Storage & Shipping: -20°C to +50°C, 10 to 90% humidity noncondensing
Operation conditions	0°C to +50°C
OEM	Compatible with all Amptek OEM configurations

XR-100SDD Inputs	
Preamp Power	±8 to 9 V @ 15 mA with no more than 50 mV peak-to-peak noise
Detector Power XR-100SDD X-123SDD	 -95 to -150 V @ 25 µA, very stable <0.1% variation -95 to -1500 V (typical -120 V)
Cooler Power Current Voltage	 350 mA maximum 3.5 V maximum with <100 mV peak-to-peak noise

Note: The XR-100SDD includes its own temperature controller

XR-100SDD Outputs	
Preamplifier Sensitivity Polarity Feedback	 1 mV/keV typical (may vary for different detectors) Positive signal output (1 kΩ max. load) Reset
Temperature Monitor Sensitivity	PX5/X-123: direct reading in Kelvin through software.

Note

The SDD requires negative high voltage and produces a positive preamplifier output. This is the opposite of the standard Si-PIN which requires positive high voltage and produces a negative preamplifier output.

When ordered in an XR100SDD/PX5 configuration, the PX5 is equipped with a negative high voltage supply. The new PX5 is also equipped with a positive high voltage supply. It can be used with all Amptek detector types, as well as, with many other radiation detectors and preamplifiers, including HPGe detectors and scintillators.

Use of Collimators

Most of Amptek's detectors contain internal collimators to improve spectral quality. X-rays interacting near the edges of the active volume of the detector may produce small pulses due to partial charge collection. These pulses result in artifacts in the spectrum which, for some applications, obscure the signal of interest. The internal collimator restricts X-rays to the active volume, where clean signals are produced.

Depending on the type of detector, collimators can improve peak to background (P/B); eliminate edge effects; and/or eliminate false peaks.

For more information please see: http://www.amptek.com/xrspectr.html#edge

Vacuum Operation

The XR-100SDD can be operated in air or in vacuum down to 10-8 Torr. There are two ways the XR-100SDD can be operated in vacuum:

1) The entire XR-100SDD detector and preamplifier box can be placed inside the chamber. In order to avoid overheating and dissipate the 1 Watt of power needed to operate the XR-100SDD, good heat conduction to the chamber walls should be provided by using the four mounting holes. An optional Model 9DVF 9-Pin D vacuum feedthrough connector on a Conflat is available to connect the XR-100SDD to a PX5 outside the vacuum chamber.

2) The XR-100SDD or X-123SDD can be located outside the vacuum chamber to detect X-Rays inside the chamber through a standard Conflat compression O-ring port. Optional Model EXV9 (9 inch) vacuum detector extender is available for this application. Click here for more information on vacuum applications and options.

For more information see: http://www.amptek.com/exv.html

Additional System Information and Performance

The XR-100SDD and X-123SDD are new high performance x-ray detector, preamplifier, and cooler system using a thermoelectrically cooled silicon drift detector (SDD). Also mounted on the 2-stage cooler are the input FET and a novel feedback circuit. These components are kept at approximately -55 °C, and are monitored by an internal temperature sensor. The hermetic TO-8 package of the detector has a light tight, vacuum tight thin Beryllium window to enable soft x-ray detection.

A SDD is a type of photodiode, functionally similar to a PIN photodiode, but with a unique electrode structure to improve performance. Amptek's SDDs are optimized for X-ray spectroscopy. The key advantage of the SDD is that it has much lower capacitance than a conventional diode of the same area, therefore reducing electronic noise at short shaping times. For X-ray spectroscopy, an SDD has better energy resolution while operating at much higher count rates than a conventional diode. The SDD uses a special electrode structure to guide the electrons to a very small, low capacitance anode.

Resolution for Different Peaking Times

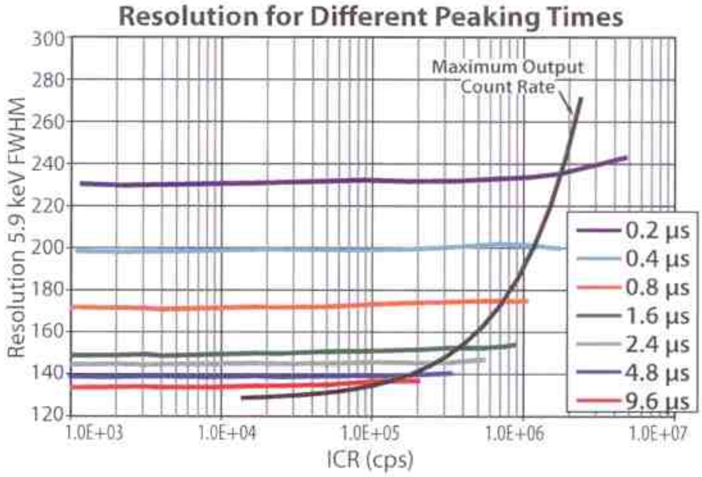


Figure 2. Resolution vs. Input Count Rate for different peaking times for the SDD with the DP5. The plot also shows the curve of maximum output count rate. Operating to the right of that curve results in less throughput than the maximum despite a higher input rate. See Figure 3.

Throughput

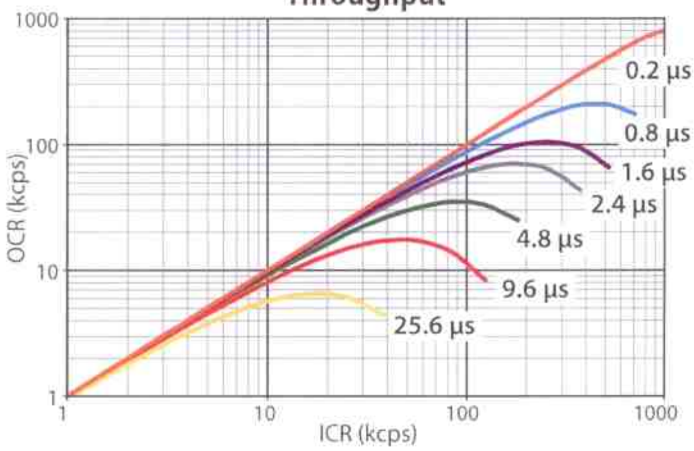


Figure 3. Throughput with the SDD. Due to the detector's smaller capacitance, a much shorter peaking time is used in the shaping amplifier without sacrificing resolution. Typically 9.6 µs or less is used. This dramatically increases the throughput of the system.

Resolution vs Peaking Time

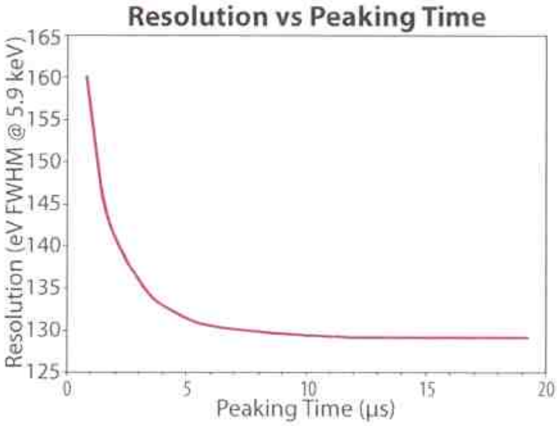


Figure 4. Resolution vs. Peaking Time for the SDD.

Efficiency and Transmission

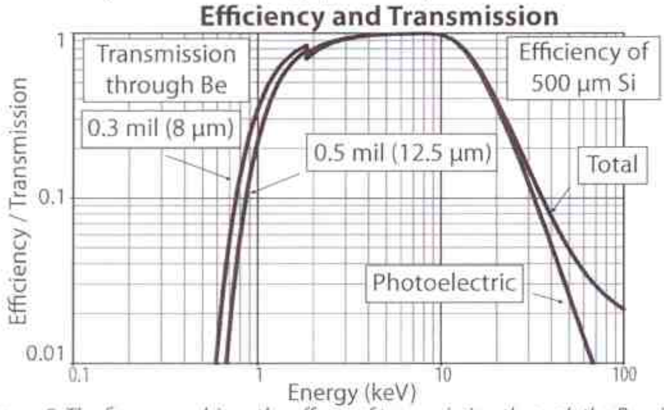


Figure 5. The figure combines the effects of transmission through the Be window (including the protective coating), and interaction in the SDD. The low energy portion of the curve is dominated by the thickness of the Be window - either 0.3 mil (8 µm) or 0.5 mil (12.5 µm), while the high energy portion is dominated by the thickness of the active depth of the SDD - 500 µm.

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

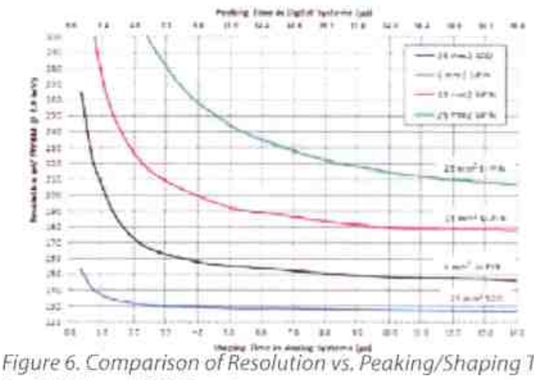


Figure 6. Comparison of Resolution vs. Peaking/Shaping Time for Si-PIN and SDD Detectors

Resolution vs. Energy for Different Peaking Time

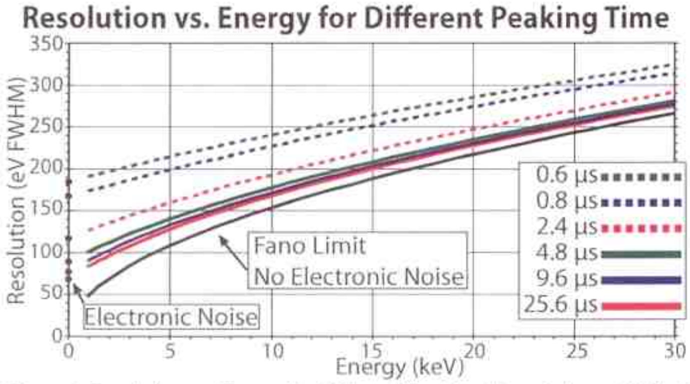
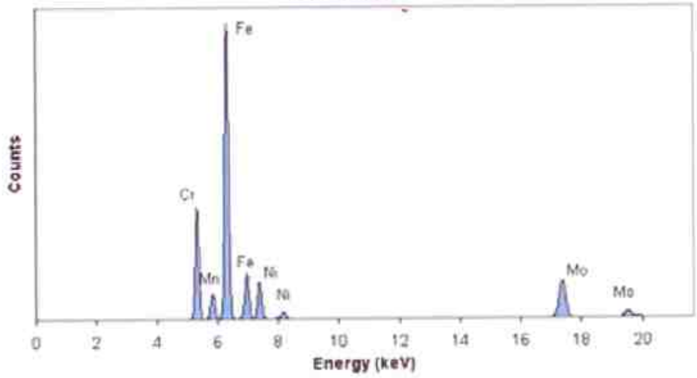


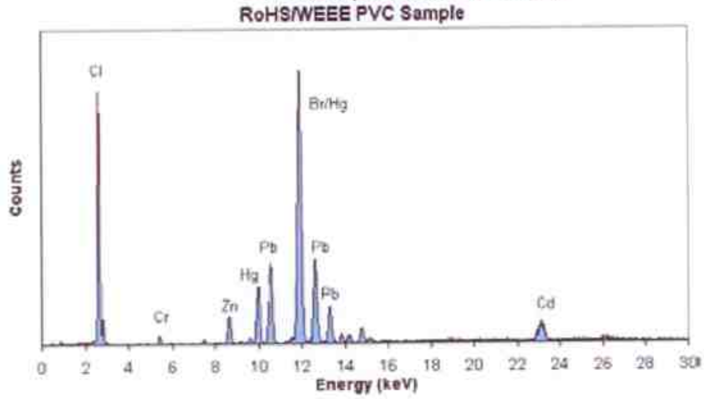
Figure 7. Resolution vs. Energy for Different Peaking Times taken with the SDD.

Application Spectra

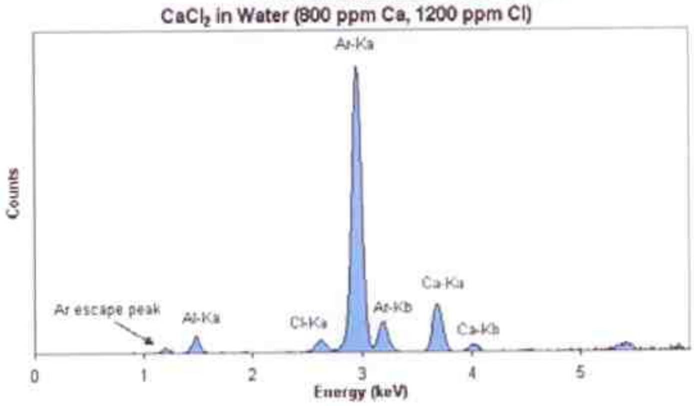
25 mm²/500 µm Silicon Drift Detector
XRF of SS316



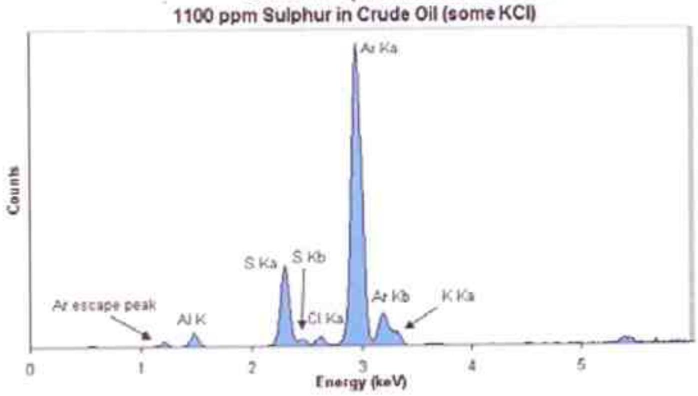
25 mm²/500 µm Silicon Drift Detector
RoHS/WEEE PVC Sample



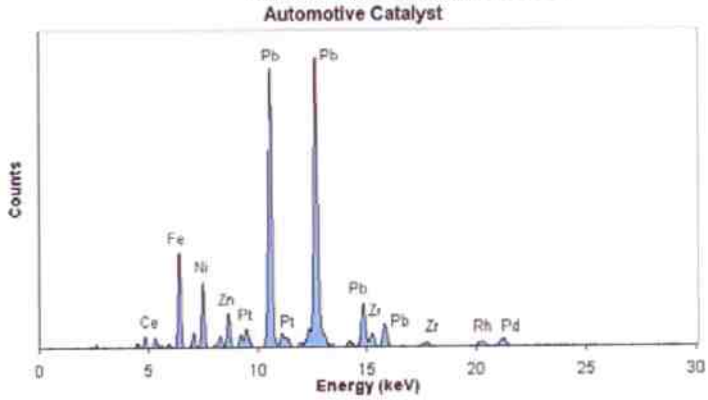
25 mm²/500 µm Silicon Drift Detector
$CaCl_2$ in Water (800 ppm Ca, 1200 ppm Cl)



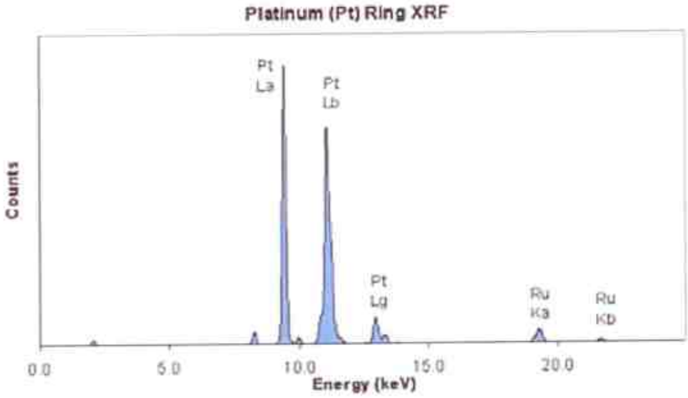
25 mm²/500 µm Silicon Drift Detector
1100 ppm Sulphur in Crude Oil (some KCl)



25 mm²/500 µm Silicon Drift Detector
Automotive Catalyst



25 mm²/500 µm Silicon Drift Detector
Platinum (Pt) Ring XRF



Experimenter's XRF Kit with SDD

Complete XRF System Includes:

X-123SDD Complete Spectrometer

Mini-X USB Controlled X-Ray Tube

XRF-FP Quantitative Analysis Software

MP1 XRF Mounting Plate

The X-123SDD and Mini-X on the MP1 mounting plate.

See Experimenter's XRF Kit: http://www.amptek.com/xrfkit.html

OEM Components

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