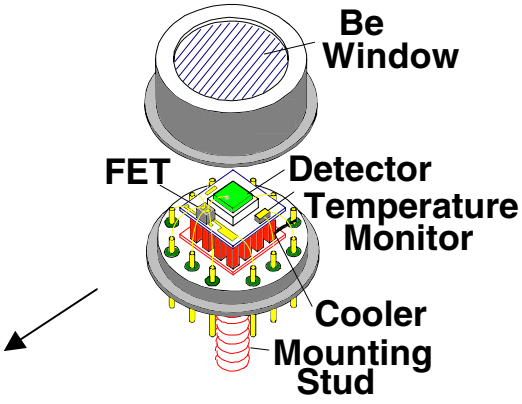
X-RAY AND GAMMA RAY DETECTOR
HIGH RESOLUTION CZT
CADMIUM ZINC TELLURIDE

XR-100T-CZT

DETECTOR TECHNOLOGY ADVANCEMENT - The XR-100T-CZT provides "off the shelf" performance previously available only from expensive cryogenically cooled systems.



APPLICATIONS:

- Medical X-Ray & Gamma Ray Detection
- Mammography, Radiology & Conventional X-Ray
- Uranium & Plutonium Detection
- Portable X-Ray & Gamma Ray Instruments
- Research & Teaching
- Nuclear Plant Monitoring
- X-Ray Fluorescence
- Art & Archaeology

FEATURES:

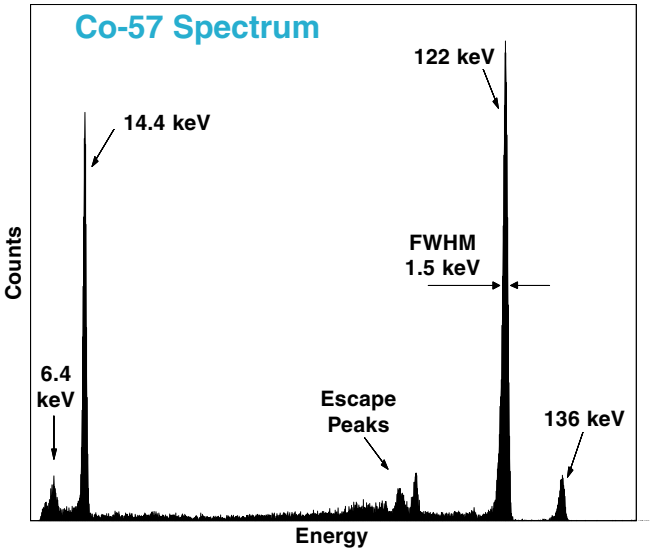
- CZT Detector
- Peltier Cooler
- Cooled FET
- Beryllium Window
- Temperature Monitor
- Hermetic Detector Package
- Wide Detection Range
- Amptek A250 Preamp

Model ***XR-100T-CZT*** is a new high performance X-Ray and Gamma Ray Detector, Preamplifier, and Cooler system using a 3 x 3 x 2mm^3 Cadmium Zinc Telluride (CZT) detector mounted on a thermoelectric cooler. On the cooler are also mounted the input FET and feedback components to the Amptek A250 charge sensitive preamp. The internal components are kept at approximately -30°C, and can be monitored by a temperature sensitive integrated circuit. The hermetic TO-8 package of the detector has a light tight, vacuum tight 10 mils (250 µm) Beryllium window.

All the critical connections between detector and preamplifier have been made internally to the XR-100T-CZT to ensure quick, first time operation by the user. The XR-100T-CZT is provided complete with BNC connectors and power cable.

In order to facilitate the use of the CZT detector, Model PX2T-CZT was developed to provide the DC Voltages needed to operate the XR-100T-CZT, and the signal processing through the Shaping Amplifier and Rise Time Discrimination (RTD) circuits. The signal output from the PX2T-CZT can be connected directly to a Multichannel Analyzer (MCA).

The XR-100T-CZT is capable of detecting energies from a few keV to several hundreds of keV.



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MODEL XR-100T-CZT SPECIFICATIONS

GENERAL

Detector Type:	Cadmium Zinc Telluride $Cd_{0.9}Zn_{0.1}Te$ (CZT)
Detector Size:	3 x 3 mm (9 mm^2)
Detector Thickness:	2 mm
Energy Resolution @ 122 keV, ^{57}Co:	1.5 keV FWHM, typical
Dark Counts:	$<5 \times 10^{-3}$ counts/sec @ 10 keV < E < 1 MeV
Detector Window:	Be, 10 mil thick (250 µm)
Preamplifier:	Amptek Model A250, with Current Divider Feedback
Case Size:	3.75 x 1.75 x 1.13 in (9.5 x 4.4 x 2.9 cm)
Case Weight:	4.4 ounces (125 g)
Total Power:	Less than 1 Watt

INPUTS

Test Input:	20 mV test pulse ~ 30 keV
Preamp Power:	± 8 Volts @ 25 mA
Detector Power:	+ 400 Volts @ 1 mA
Cooler Power:	Current = 0.7 A maximum Voltage = 2.1 Volt maximum

OUTPUTS

1) Preamplifier

Sensitivity:	0.73 mV/keV
Polarity:	Negative Signal Out (1 kΩ max. load)

2) Temperature Monitor

Sensitivity:	1 µA corresponds to 1 °K

CONNECTIONS

Preamp Output:	BNC coaxial connector
Test Input:	BNC coaxial connector
Other connections:	6-Pin, LEMO connector with 5 ft cable

OPTIONS

Other detector sizes (5 x 5 x 2 mm^3 or 5 x 5 x 5 mm^3) are available on special orders.

Components for vacuum applications.

Collimator kit for high flux applications.

See also XR-100T specifications using Si-PIN for detection of low energy X-Rays with high resolution (186 eV FWHM @ 5.9 keV, ^{55}Fe).

6-PIN LEMO CONNECTOR ON THE XR-100T-CZT

Pin 1: +8 Volt Temperature Monitor Power
Pin 2: + H.V. Detector Bias, +400 Volt max.
Pin 3: -8 Volt Preamp Power
Pin 4: +8 Volt Preamp Power
Pin 5: Cooler Power Return
Pin 6: Cooler Power (0 to +2.1 Volt @ 0.7 A max.)
CASE: Ground and Shield

MODEL PX2T-CZT POWER SUPPLY + SHAPING AMPLIFIER

GENERAL

Size:	6 X 6 X 3.5 inches (15.3 X 15.3 X 8.9 cm)
Weight:	2.5 lbs (1.15 kg)

Input AC power to the PX2T-CZT is provided through a Standard IEC 320 plug (110/250 VAC, 50/60 Hz). See Figure 1.

The four (4) DC Voltages needed to operate the XR-100T-CZT are supplied through a female 9-Pin D-Connector on the PX2T-CZT. The Pin list to this connector is given below. The multiconductor cable which connects the PX2T-CZT to the XR-100T-CZT is provided with the system.

9-PIN D-CONNECTOR ON THE PX2T-CZT

Pin 1: +8 Volt Preamp Power
Pin 2: -8 Volt Preamp Power
Pin 3: 0 to +3 Volt Cooler Power @ 0.7 A max.
Pin 4: +8 Volt Temperature Monitor Power
Pin 5: + H.V. Detector Bias, +400 Volt max.
Pin 6: Ground and Case
Pin 7: Cooler Power Return
Pin 8: Ground and Case
Pin 9: Ground and Case

PX2T-CZT SHAPING AMPLIFIER

Polarity:	Positive Unipolar
Shaping Time:	3 µs
Pulse Width:	7.2 µs FWHM. See Figure 2
Shaping Type:	7 pole "Triangular" with Base Line Restoration, Pileup Rejection, and Rise Time Discrimination (RTD).
Sensitivity with XR-100T-CZT:	6 to 60 mV/keV
Output Range:	+6.0 Volts into 500 Ω load
Output Impedance:	50 Ω

The output pulse produced by the PX2T-CZT Shaping Amp-lifier is optimum for most applications using cooled CZT detectors, and can be connected directly to the input of a Multichannel Analyzer (MCA). If different shaping time constants or gains are needed, an external NIM type shaping amplifier with base line restoration can be used.

PX2T-CZT SIGNAL CONNECTIONS

Input from XR-100T-CZT:	Front panel BNC
Output to MCA:	Front panel BNC
Pileup Rejection (PU):	Rear panel BNC, Positive TTL For the duration of this output gate, any detected pulse must be rejected by the MCA.
Input Count Rate (ICR):	Rear panel BNC, Positive TTL <2 µs When connected to a counter, the ICR countrate corresponds to the total number of X-Rays events that strike the detector.

THEORY OF OPERATION

X-Rays / Gamma Rays interact with CZT atoms to create an average of one electron/hole pair for every 5.0 eV of energy lost in the CZT. Depending on the energy of the incoming radiation, this energy loss is dominated by either the Photoelectric Effect or Compton Scattering. The probability or efficiency of the detector to "stop" the incoming radiation and create electron/hole pairs increases with the thickness of CZT. See last page.

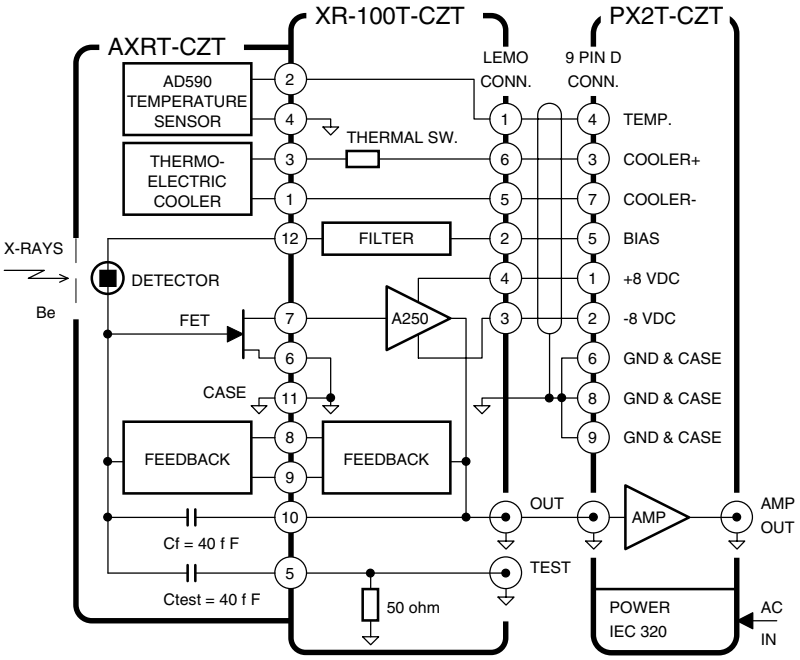
In order to facilitate the electron/hole collection process in the CZT detector, a 400 Volt potential is applied. This voltage is too high for operation at room temperature, as it will cause excessive leakage, and eventually a breakdown. Since the detector in the XR-100T-CZT is cooled, the leakage current is reduced considerably, thus permitting the high bias voltage.

Electron/hole pairs created by radiation, which interacts with the CZT near the back contact of the detector, result in fluctuations of charge collection times. These fluctuations are observed as rise time variations of the voltage step at the output of the charge sensitive preamplifier. As a result, the acquired spectra suffer from increase background counts and degraded energy resolution. To reduce these effects a Rise Time Discrimination (RTD) circuit has been developed for the PX2T-CZT amplifier. When the RTD is active, the shaped pulses are internally gated and only pulses corresponding to "full charge collection" events are allowed to be sent to the Multichannel Analyzer (MCA) for analysis.

The thermoelectric cooler cools both the CZT detector and the input FET transistor to the A250 Charge Sensitive Preamplifier. Cooling the FET reduces its leakage current and increases the transconductance which in turn reduce the electronic noise of the system.

In order to further reduce the electronic noise, the feedback capacitor and part of the current feedback network to the A250 preamp are also placed on the same substrate as the detector and FET. This minimizes parasitic capacitance at the input.

A temperature monitoring integrated circuit is placed on the cooled substrate to provide a direct reading of the temperature of the internal components, which will vary with room temperature. Once the internal temperature gets below minus 10°C the performance of the XR-100T-CZT will not change with a temperature variation of a few degrees. Hence, accurate temperature control is not necessary when using the XR-100T-CZT inside the laboratory.



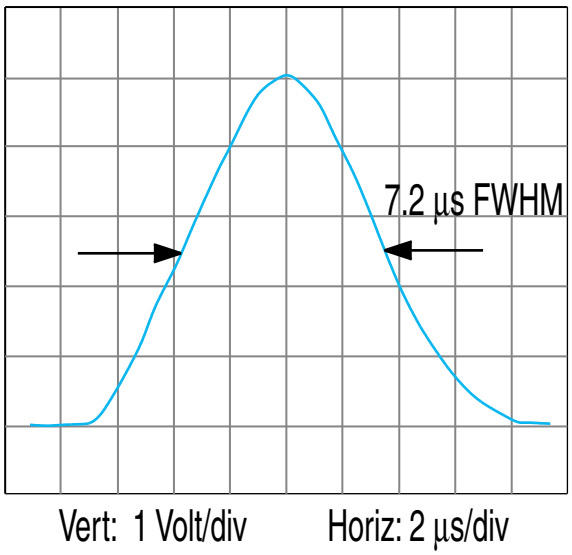
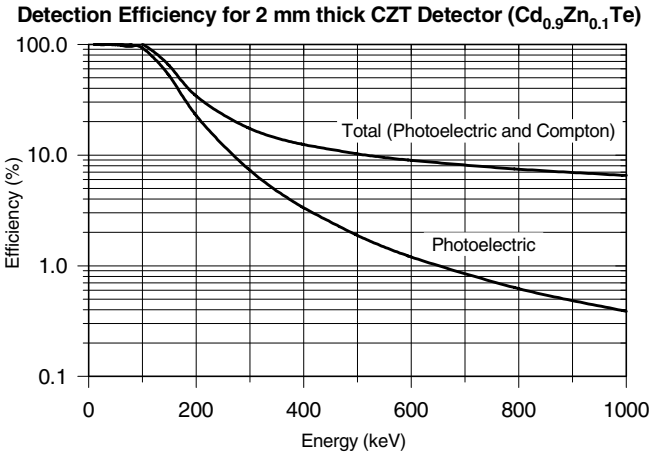


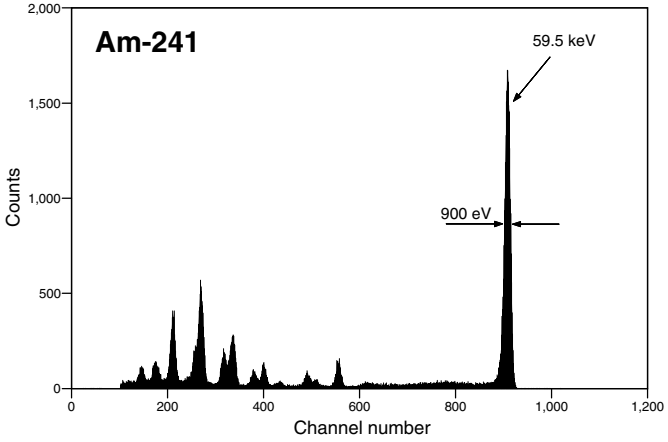
FIGURE 1. XR-100T-CZT CONNECTION DIAGRAM

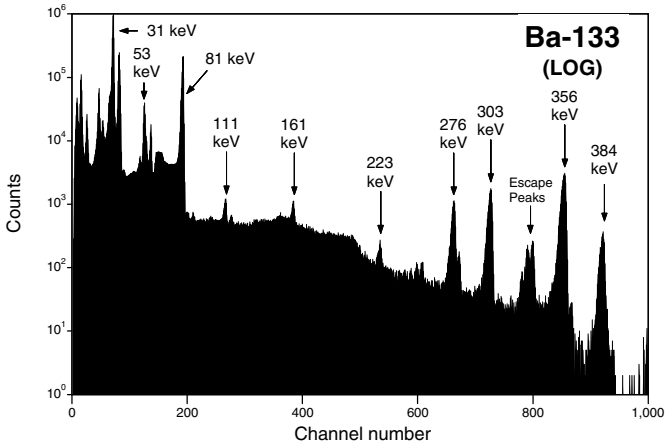
This diagram shows the internal connections between the AXRT-CZT hybrid sensor and the electronics with the case, as well as the external connections to the PX2T-CZT.

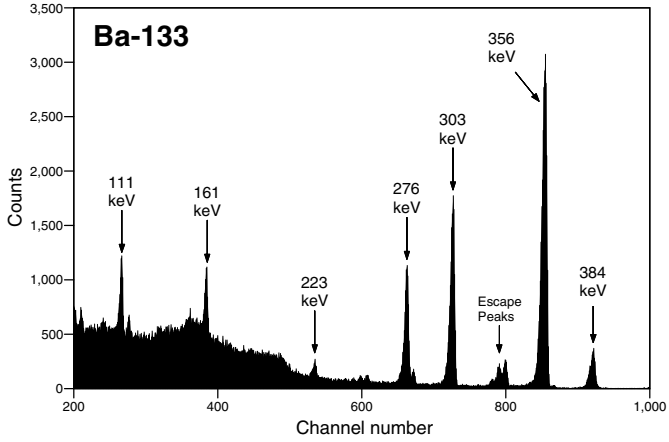
FIGURE 2. PX2T-CZT AMPLIFIER OUTPUT

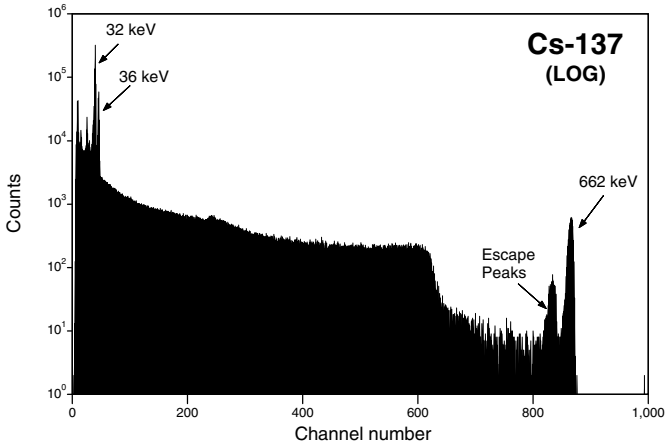
XR-100T-CZT TYPICAL PERFORMANCE

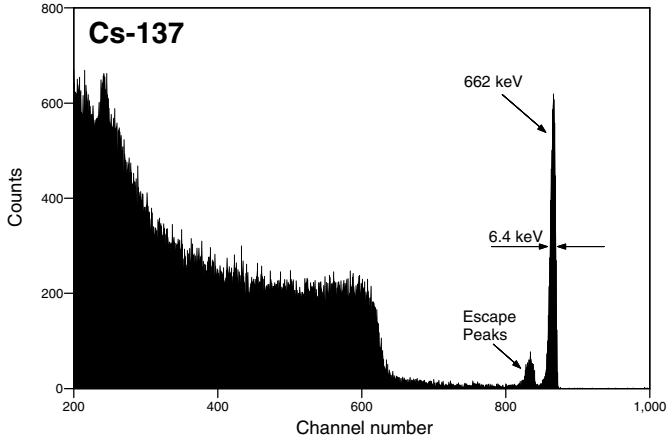


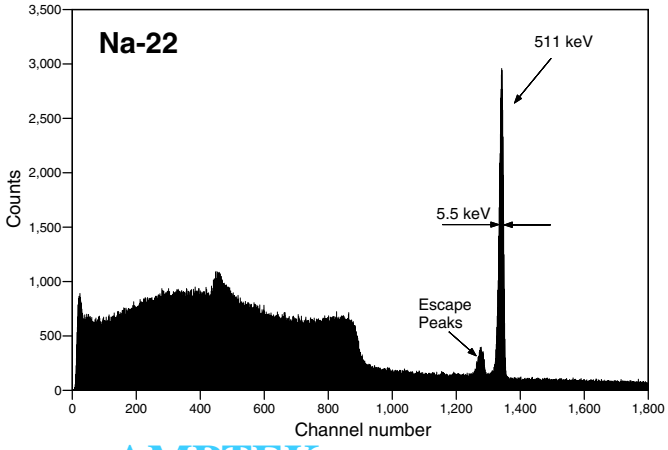


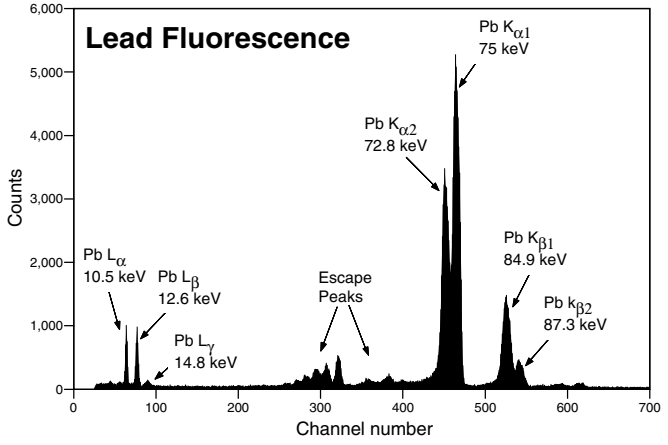












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