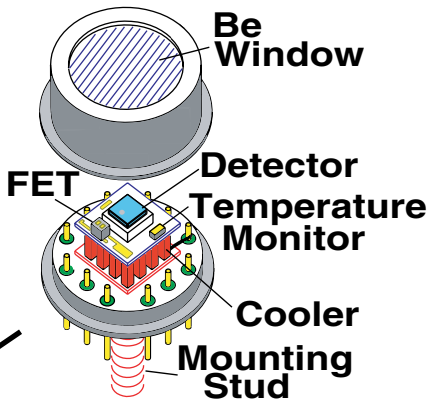
X-RAY and GAMMA RAY DETECTOR HIGH RESOLUTION CdTe CADMIUM TELLURIDE

XR-100T-CdTe

DETECTOR TECHNOLOGY ADVANCEMENT - The XR-100T-CdTe 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

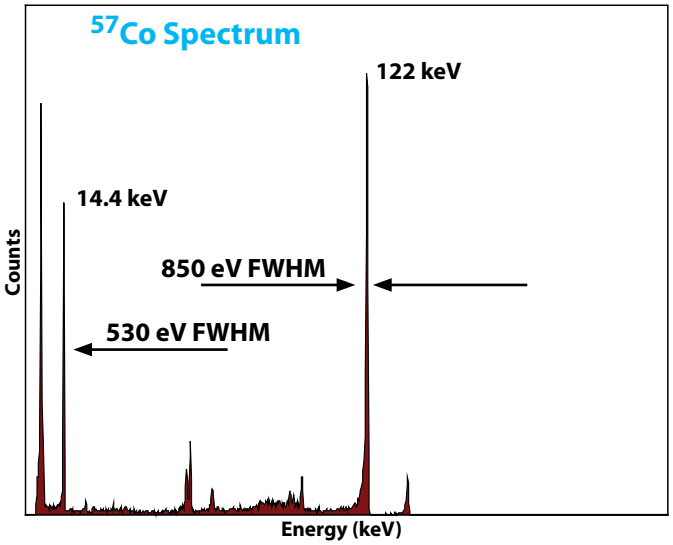
FEATURES:

- CdTe-Diode Detector
- Thermoelectric (Peltier) Cooler
- Cooled FET
- Beryllium Window
- Temperature Monitor
- Hermetic Detector Package (TO-8)
- Wide Detection Range

Model ***XR-100T-CdTe*** is a high performance X-Ray and Gamma Ray Detector, Preamplifier, and Cooler system using a 3 x 3 x 1 mm^3 (or 5 x 5 x 1 mm^3) Cadmium Telluride (CdTe) diode detector mounted on a two-stage thermoelectric cooler. Also mounted on the cooler are the input FET and feedback components to the charge sensitive preamplifier. 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 4 mil (100 µm) Beryllium window.

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

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



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SPECIFICATIONS

MODEL XR-100T-CdTe X-RAY and GAMMA RAY DETECTOR	
GENERAL	
Detector Type	Cadmium Telluride (CdTe) Diode
Detector Areas	3 x 3 mm (9 mm^2) 5 x 5 mm (25 mm^2)
Detector Thickness	1 mm
Energy Resolution @ 122 keV, ^{57}Co	9 mm^2: <1.2 keV FWHM, typical 25 mm^2: <1.5 keV FWHM, typical
Dark Counts	<5 x 10^{-3} counts/sec @ 10 keV <E <1 MeV
Be Window	4 mil thick (100 µm)
Preamplifier	Charge Sensitive, with Current Divider Feedback
Case Size	3.00 x 1.75 x 1.13 in 7.7 x 4.4 x 2.9 cm
Case Weight	4.4 ounces / 125 g
Total Power	Less than 1 Watt
UL Certified	Certificate #: CU 72072412 01 Tested to: UL 61010-1: 2004 R7 .05 CAN/CSA-C22.2 61010-1: 2004
INPUTS	
Preamp Power	± 8 Volts @ 25 mA
Detector Power	+ 500 Volts @ 1 µA
Cooler Power	Current = 350 mA maximum Voltage = 4 V maximum
OUTPUTS	
Preamplifier Sensitivity Polarity	 0.82 mV/keV Negative signal out 1 kΩ max. load
Temperature Monitor Sensitivity	 PX4: direct reading in K through software
CONNECTORS	
Preamp Output	BNC coaxial connector
Power and Signal	6-Pin LEMO connector (Part# ERA.1S.306.CLL)
Interconnect Cable	6-Pin, LEMO (Part# FFA.1S.306. CLAC57) to 6-Pin D (5 ft length)
6-PIN LEMO CONNECTOR ON THE XR-100T-CdTe	
Pin 1	Temperature monitor diode
Pin 2	+ H.V. detector bias, +500 V
Pin 3:	-8 Volt preamp power
Pin 4	+8 Volt preamp power
Pin 5	Cooler power return
Pin 6	Cooler power (0 to +4 Volt @ 0.350 A max.)
CASE	Ground and shield

OPTIONS
Other detector sizes available on special orders.
Other Be window thicknesses available on special orders.
Components for vacuum applications.
Collimator kit for high flux applications.
See also XR-100CR specifications using Si-PIN for detection of low energy X-Rays with high resolution (149 eV FWHM @ 5.9 keV, ^{55}Fe).
Available in X-123CdTe configuration.

MODEL PX4 DIGITAL PULSE PROCESSOR, MCA and POWER SUPPLY

Power to the XR-100T-CdTe is provided by the PX4. The PX4 is DC powered by an AC adaptor and provides both a variable Digital Pulse Shaping Amplifier (0.8 µs to 100 µs shaping time), the MCA function, and all necessary power supplies for the detector and preamplifier. The PX4 connects via USB to a PC. Please PX4 specifications at http://www.amptek.com/px4.html.

VACUUM OPERATION

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

1) The entire XR-100T-CdTe 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-100T-CdTe, 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-100T-CdTe to the PX4 outside the vacuum chamber.

2) The XR-100T-CdTe 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.

FIGURE 1. The CdTe detector in the X-123CdTe configuration

THEORY OF OPERATION

X-Rays and Gamma Rays interact with CdTe atoms to create an average of one electron/hole pair for every 4.43 eV of energy lost in the CdTe. 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 CdTe. See Figure 2.

In order to facilitate the electron/hole collection process in the CdTe detector, a +500 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-CdTe is cooled, the leakage current is reduced considerably, thus permitting the high bias voltage.

The thermoelectric cooler cools both the CdTe detector and the input FET transistor to the 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 preamplifier are also placed on the same substrate as the detector and FET. This minimizes parasitic capacitance at the input.

A temperature monitoring sensor 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-CdTe will not change with a temperature variation of a few degrees. Hence, accurate temperature control is not necessary when using the XR-100T-CdTe inside the laboratory.

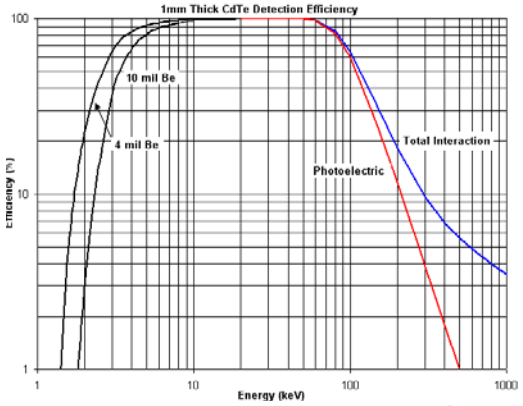


FIGURE 2. 1 mm Thick CdTe Detection Efficiency

FIGURE 3. XR-100T-CdTe Gamma ray detector; PX4 digital pulse processor, power supply, shaping amplifier and MCA; and EXVC Collimator

MEDICAL APPLICATIONS

MEDICAL X-RAY TUBE SPECTRA for MAMMOGRAPHY and RADIOLOGY

- Direct Measurement Spectra
- End Point Energy (kVp)
- See what the patient gets
- No Compton corrections
- Self-Calibrating System
- Escape peaks adjustment with XRF-FP software
- Look straight at the X-Ray tube and record simultaneously the spectrum and the peak potential (kVp)
- For Quality Assurance in Radiographic and Fluoroscopic Systems

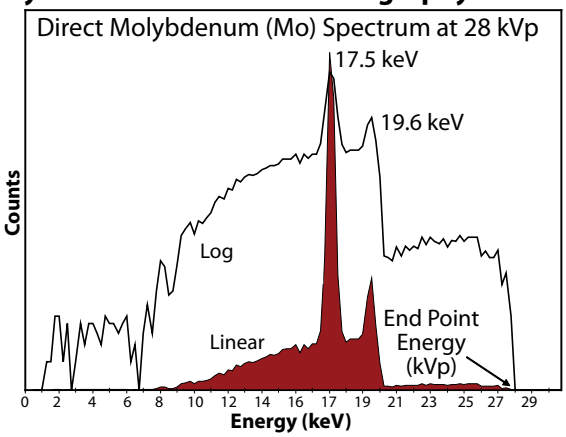
Design Objective

This detector system was designed with the objective of simultaneously measuring the X-Ray tube peak potential (kVp), and to characterize the mammography X-Ray tube spectrum.

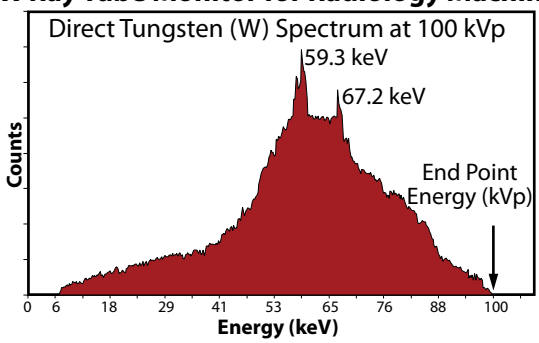
Significance of the Measurement

* Both the tube spectrum and the peak potential (kVp) are important parameters affecting the image quality in film-screen and digital mammography.
* Automatic selection of proper target/filter combination in modern mammography systems maybe affected by improper kVp.
* In conventional devices, the user depends on central laboratory calibration and has no easy way to calibrate the instrument during use.

X-Ray Tube Monitor for Mammography Machines



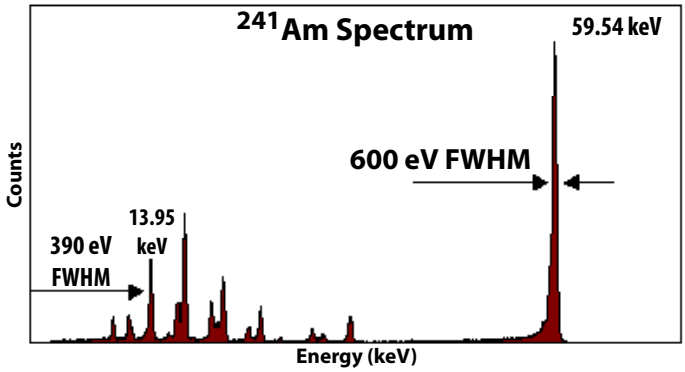
X-Ray Tube Monitor for Radiology Machines

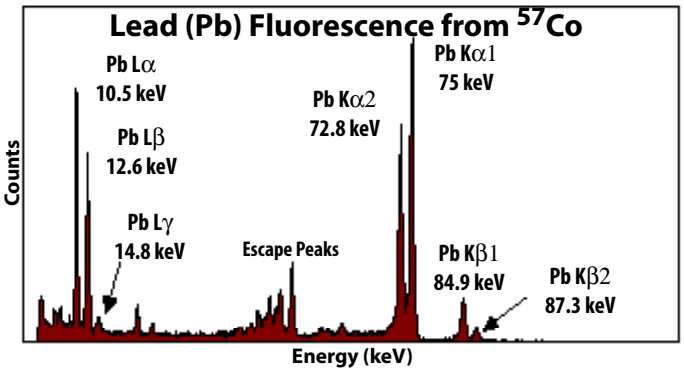


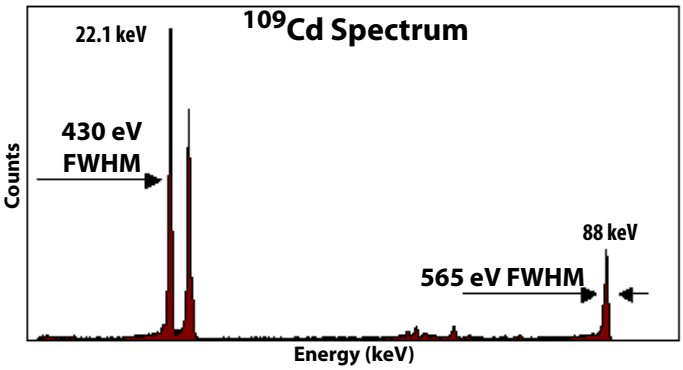
Spectra courtesy of Andrew Karellas, Ph.D., University of Massachusetts Medical School, Worcester, MA 01655

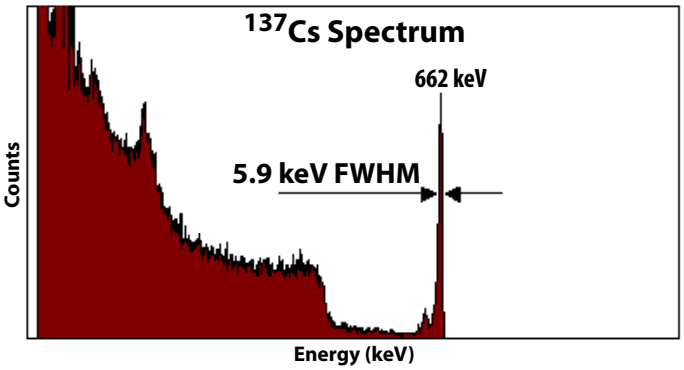
XR-100T-CdTe TYPICAL PERFORMANCE

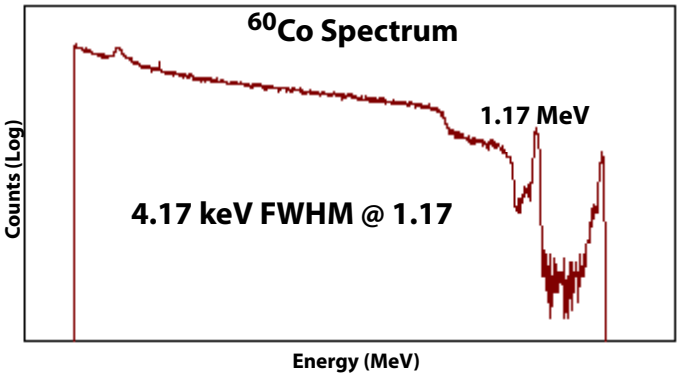
All spectra below were taken with a 3 x 3 x 1 mm thick CdTe-diode detector *with* the use of RTD.
All the spectra are taken with the Amptek MCA8000A multichannel analyzer.

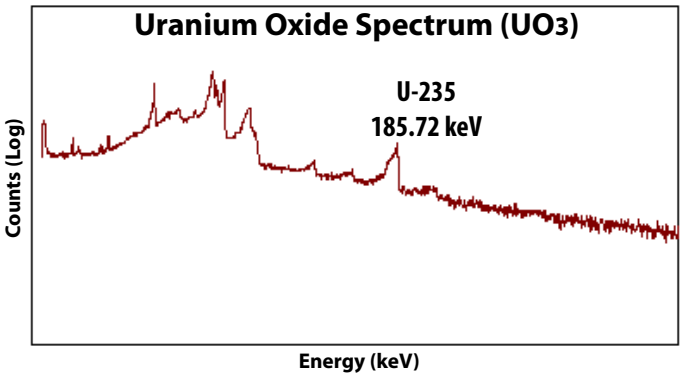


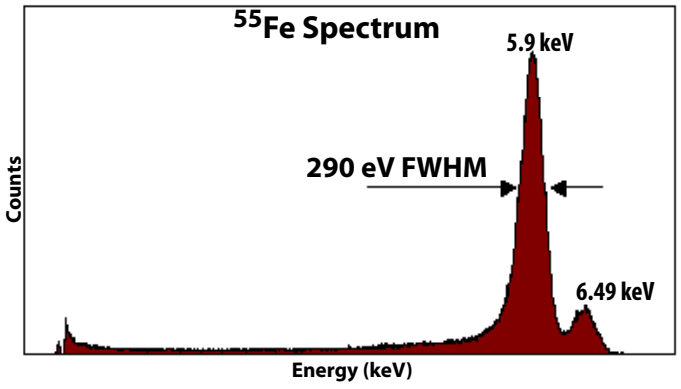


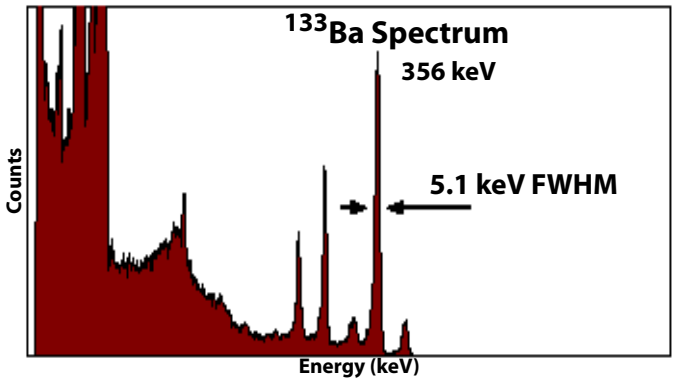












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