Radiant Detector Technologies, LLC
19355 Business Center Drive, Suite #9
Northridge, CA 91324
Phone (818) 280-0745
Fax (818) 709-2463

Vortex®
Vortex®-EX

Silicon Multi-Cathode X-Ray Spectrometer

User's Manual
(Revision 0011)

June 1, 2004

This manual and the data herein are subject to change at any time without notification.

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1. General Instructions

- The system can be stored at room temperature without any special care, but it is recommended that it be stored in a location with low humidity.

- The beryllium (Be) window in the front of the probe is only < 25μm thick, thus great care must be taken to ensure that nothing comes in contact with it. Cover the Be window with the plastic protective cover when not in use.

- The silicon multi-cathode detector (SMCD) package must be placed with the fan side up (solid side with no openings down) during operation, to ensure proper cooling.

- List of delivered items:

  - SMCD package
  - Electronics box
  - Main biasing cable
  - Output signal BNC cable
  - User's Manual
  - Software Installation CD

2. Safety and Precautions

2.1 Detector Beryllium Window

- The Be window at the front of the detector probe is extremely thin and fragile. Never touch, jar, or subject the detector window to thermal shock. Do not allow corrosive substances or water to be in contact with the window.

- Never allow any object to come in contact with the Be window!

- Beryllium particles are highly toxic. If breakage of a Be window does occur, be sure not to inhale, swallow, or allow such particles to come in contact with skin, open cuts, or eyes. In case of cuts or ingestion, seek medical assistance immediately. In case of window breakage, return the product to Radiant for repair.

2.2 Detector Biases

Be sure that the detector biases are correctly set (see bias specifications pertaining to individual units). Excessively high bias might damage the detector crystal and/or the field effect transistor (FET). **The detector is supplied with the electronics box (which includes the power supply and/or digital pulse processor (DPP)), the biases were set at Radiant and they should not be altered. However, measure them to ensure the correct values are maintained.**

2.3 Mechanical Shock

The system is a relatively rugged device. However, traumatic handling, such as falling onto the floor from a bench height, can definitely cause damage. Keep the detector in a safe place during operation and storage to prevent accidental mistreatment.

3. System Description

The system is comprised of three main parts, as shown in Figure 1: the SMCD package, the electronics box and cables.

Figure 1. The Vortex® and Vortex® -EX system. Left to right: the electronics box, the signal power cables, and the SMCD package.

3.1 SMCD package

The SMCD package includes the vacuum chamber, which is sealed with a Be window, and the preamplifier box. Inside the vacuum chamber are the SMCD chip, the thermoelectric cooler (TEC) and the first amplification stage FET. The SMCD package weighs 0.8 kg. The SMCD package is shown in Figures 2 and 3, with external dimensions shown in Figure 4. The preamplifier box includes the preamplifier, the temperature controller unit, the electrical connectors and the fan.

Figure 2. SMCD Vortex® window side.

Figure 3. SMCD Vortex® -EX back panel.

Figure 4. SMCD Vortex® -EX package window side

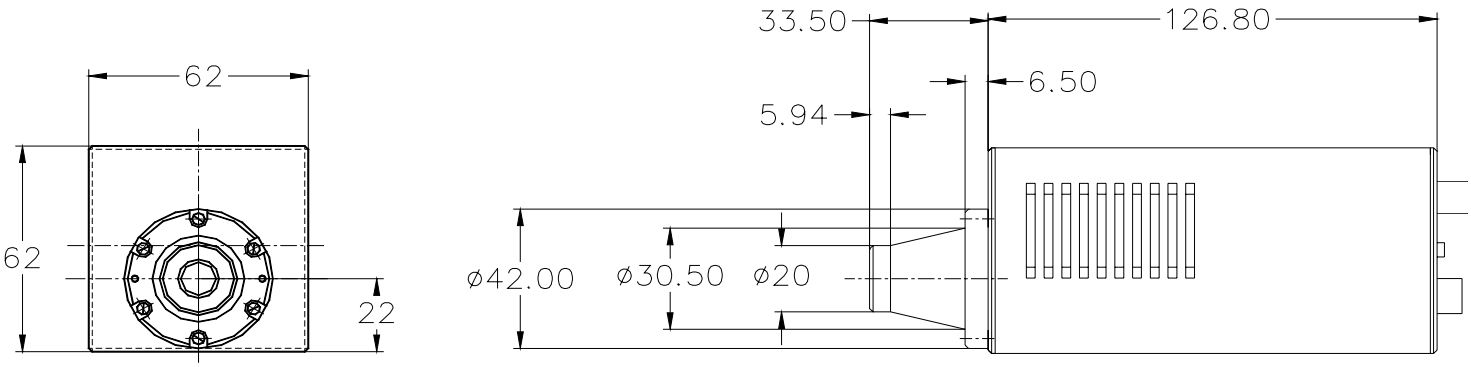

Figure 5. Vortex® SMCD package external dimensions (in mm).

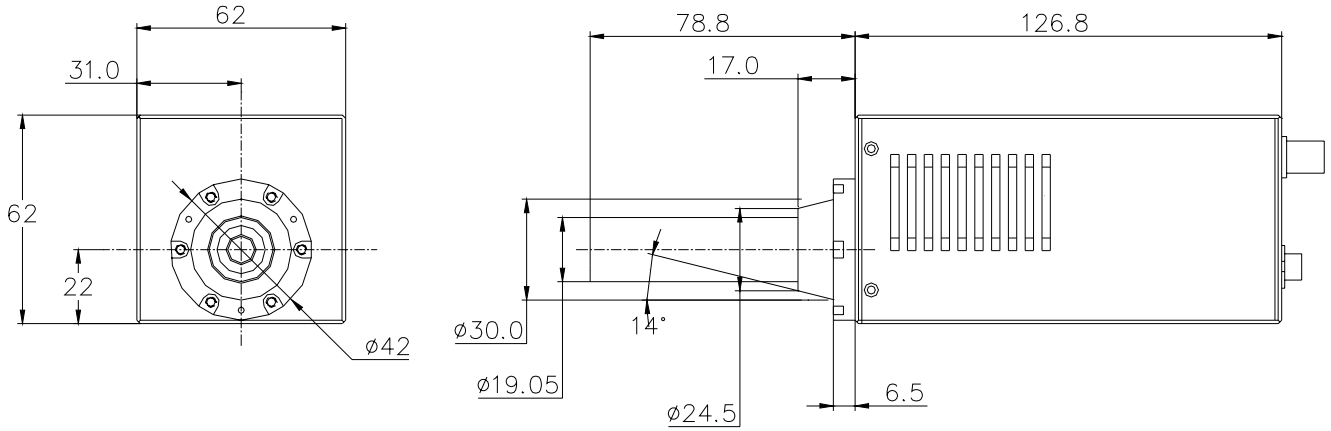

Figure 6. Vortex® -EX SMCD package external dimensions (in mm).

3.2 Electronics Box

The electronics box includes four separate voltage power supplies and one dual low voltage linear regulated power supply. The detector power supply provides biases to the SMCD. The linear power supply provides power to the TEC and to the rest of the electronics. A digital pulse processor (DPP) is also enclosed in the electronics box, if purchased by the customer. The front and the back panels of the electronics box are shown in Figures 5 and 6, respectively.

Figure 7. Electronics box front panel.

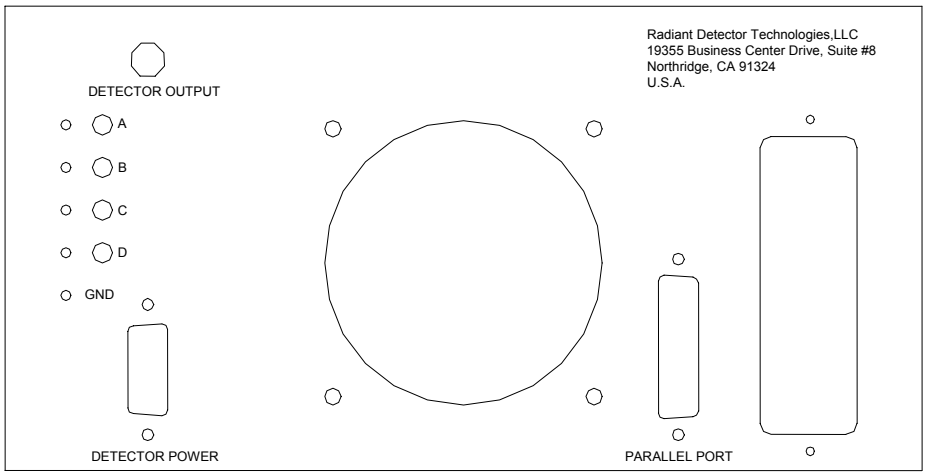

Figure 8. Electronics box back panel.

On the front panel of the electronics box (Figure 7) there are HV (high voltage) and TEC (Thermo-Electric Cooler) LEDs (light-emitting diode). There are another three LED status lights on the front panel:

- **Status** (**Red LED)**: This LED is lit when the Digital Signal Processor (DSP) has detected sometimes, an error condition. This LED also flashes briefly when DPP operating parameters are changed.

- **I/O (Yellow LED)**: Flashes for data transfers.

- **Rate (Bicolor (Green/Red) LED)**: This LED flashes in a 5 ms duration whenever a reset is detected. If the reset rate exceeds 200 Hz, the LED will be "ON" continuously. The color of the LED indicates the relative throughput of the system, as follows:

    - If the Output Count Rate (OCR) is greater than 50% of the Input Count Rate (ICR), then the LED is green.

    - If $1/e < OCR/ICR < 0.5$, then the LED is orange (green + red), where e is the exponential base.

    - If $OCR/ICR < 1/e$, then the LED is red. It is roughly the point of maximum throughput.

On the back panel of the electronics box (Figure 8) are the ON/OFF switch, the detector power connector, the detector bias regulating points (adjusting biases by customers could void warranty!), the parallel port and "Detector Output" connectors.

The electronics box dimensions are 250 x 130 x 200 mm^3, and the weight is 5.5 kg.

3.3 Cables

The cables are shown in Figure 9, with the cable edges physically labeled as "main biasing cable" and "out BNC" cable, respectively.

Figure 9. Signal and power cables.

3.4 Preamplifier

The Radiant Detector Technologies preamplifier model AA-1212 is a charge-sensitive preamplifier, which is optimized to work with a transistor-reset FET. The output signal from the preamplifier is a step wave with its height proportional to the energy of the incident photon

(~1.7mV per 1 keV photon energy), as is shown in Figure 10. The mV/keV ratio can be modified per customer's request, if required.

With an x-ray source applied, the preamplifier output signal consists of positive steps superimposed on an irregularly spaced ramp of positive slope, as is shown in Figure 11. The negative reset duration is about 1 μs. The ramp voltage range is from ~ -2 V to ~ +2 V.

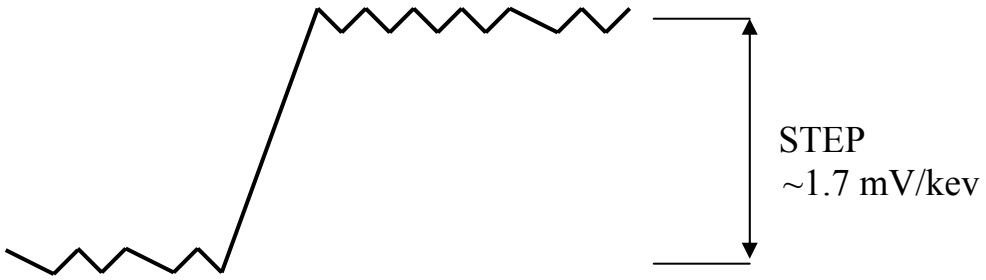

Figure 10. Schematic of preamplifier output step pulse, including noise. Height of the step is proportional to the x-ray energy.

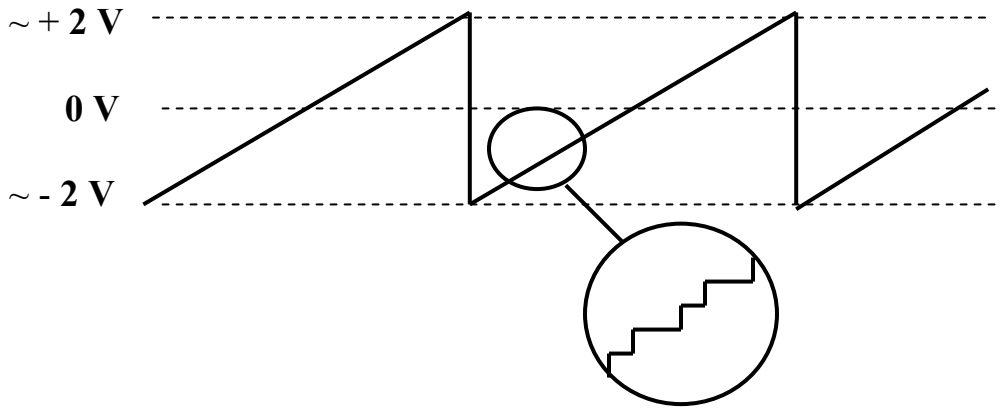

Figure 11. Preamplifier output signal when x-ray source is applied.

The preamplifier connectors' panel includes two connectors and one test point, as shown in Figure 12. The DB-15 connector is for detector power supply and the BNC connector is for signal output. The test point "T" is for temperature testing.

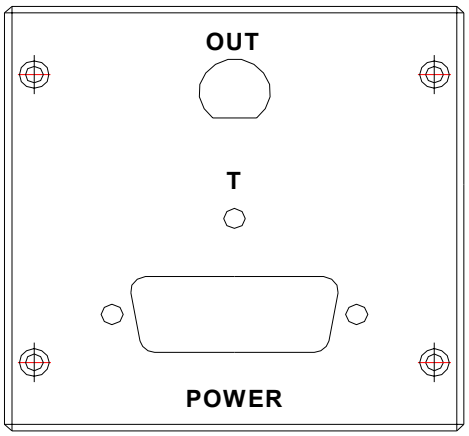

Figure 12. Schematic of the preamplifier back panel.

3.5 Software

The -DPP electronics box comes with the PI-Spec software especially designed to work with the Radiant detector and DPP electronics. Using this software, the user can acquire, open/save, export/import spectra or manipulate a spectrum to view its details, evaluate peak resolutions, etc.

To run this software, the computer must be a Pentium III or higher, with at least 64 MB RAM and at least 100 MB hard drive free space. The operating system could be Windows 98/ME, NT/2000 or Windows XP.

To meet certain customers' needs, we offer another type of software – VTXDLL (Dynamic Link Library) which, in the form of a Dynamic-Link Library, serves as an intermediate layer between the host software and the DPP driver. The objectives are to encapsulate, or wrap up, the otherwise complicated DPP setup procedures and also to optimize the DPP performance under widely varying conditions. The host software can use it as a shortcut to interface with the DPP without even knowing anything about the latter. This software is available under a specific License Agreement.

The software (PI-Spec and VTXDLL) comes with an automated installer. The PI-Spec/VTXDLL User's Manuals and detailed instructions are provided in the form of Microsoft Word documents, which can be found in the program folder created by the installer. For further information the reader is referred to the PI-Spec/VTXDLL User's Manuals.

4. Operation

4.1 Setting up the for Operation

- Connect the appropriate ends of the cables to the connectors shown in Figure 12:

  - Main biasing cable connects to the D-Sub 15 pin connector including: detector Bias, TEC and preamplifier Power.
  - Output cable to Preamp Out.

- Connect the other end of the cables to the back of the electronics box:

  - D-Sub 15 pin connector to Detector Power.

- Connect to a computer:

  - One end of the "male to male" parallel port cable to the Parallel Port of the electronics box
  - Other end of this cable to the Parallel Port on the computer.

- Plug the power cable of the electronics box into the wall outlet.

- Turn the electronics box switch ON.

- Turn the electronics box ON/OFF switch OFF.

4.2 Collecting X-Ray Spectra

Refer to the "PI-Spec User's Manual", which can be found in the PI-Spec program folder, for instructions.

4.3 Powering Down the System

When the biases to the detector are turned off, the Peltier cooler is also turned off. The detector can be turned back on at any time.

5. Trouble shooting

5.1 The spectrum cannot be acquired:

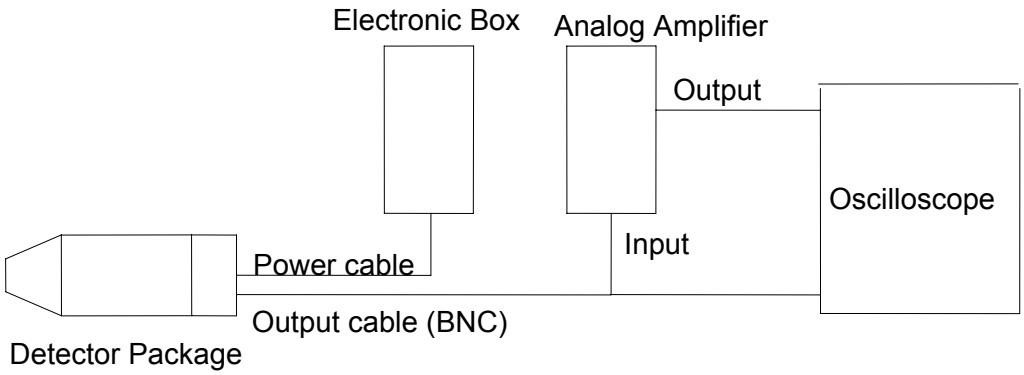

Figure 13. Schematic of detector connections for trouble-shooting.

Connect the system to an oscilloscope as shown in Figure 13. Use the electronics box for supplying the biases, and disconnect the input cable (BNC) from the box and connect it to an analog amplifier (APP) as shown in Figure 11. Turn on the system as described in section 4.1. Monitor the output of the preamplifier with the oscilloscope.

5.1.1 Preamplifier does not ramp up in voltage:

If the preamplifier does not ramp up (as shown in Figure 9), but stays at the ~ 0 V or < 0 V, check the electronics box cable connections to the preamplifier. If the cable is connected properly, but still the preamplifier does not ramp up in voltage, then the FET or preamplifier may be defective. (If this is the case, please contact Radiant to arrange returning the detector for repair).

5.1.2 Preamplifier output is always positive:

If the preamplifier output is always positive, and is not resetting as shown in Figure 9, check all cable connections to ensure proper connection and proper bias conditions. If the cables

are connected properly, but still the preamp output stays positive, the detector may not be cold enough. Contact Radiant staff to arrange returning the detector to Radiant for temperature adjustment. Another reason for this problem may be that the FET and/or preamplifier may be defective and, again, contact Radiant to arrange returning the detector.

5.2 Bad resolution and/or noisy:

If the energy resolution is poor, or the spectum is otherwise noisy, ensure that all the cables are properly and tightly connected. If the cables are connected properly, but the energy resolution does not improve, detector may not be cold enough. Contact Radiant staff to arrange to return the detector to Radiant for temperature adjustment. This problem may also occur if the correct biases are not being supplied to the detector, in which case you should contact Radiant staff for a consultation.

6. Technical Support

Please contact Radiant Detector Technologies for technical support or additional information:
(818)-280-0745

7. Inspection & Acceptance

Purchaser shall inspect all products immediately upon delivery and shall, within seven (7) calendar days, give written notice to the common carrier and RDT of any claim for damages or shortages. Purchaser shall give written notice to RDT within thirty (30) calendar days of delivery in the event that any products do not conform with or meet RDT's Product Specifications. If Purchaser gives the aforementioned thirty day notice, then at RDT's option it may at its own expense either repair the product at Purchaser's facility, or require Purchaser to freight prepaid, promptly return the defective products to RDT. RDT will at its option either repair or replace the properly rejected products that are returned and ship it freight prepaid back to Purchaser, or credit Purchaser for any products so returned, but will have no other liability in respect thereof. RDT shall not be liable to Purchaser for amounts representing loss of profits, loss of business or indirect, incidental, consequential or punitive damages of Purchaser. If Purchaser fails to give any such notice, the products shall be deemed accepted for all purposes.

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