

# Vortex

## Description

The Vortex is a large (50mm<sup>2</sup>) silicon drift diode detector for synchrotron radiation applications (Figure 1). Typical applications include x-ray fluorescence spectroscopy and x-ray diffraction. Manufacturer specified energy resolution is <136eV FWHM at Mn K $\alpha$ ; input count rate is >1 Mcps. At a peaking time of 0.25 $\mu$ s, an output count rate of 600 kcps is specified.



Figure 1: Vortex 1001 (MCD Package)

The Vortex-EX, shown in Figure 2, has an extended probe (60mm).



Figure 2: Vortex-EX

The Vortex and Vortex-EX consist of three main parts: the multi-cathode detector (MCD) package, the Electronics Box, and the cables. The MCD package, shown in Figure 1, includes the vacuum chamber, which is sealed with a Beryllium window, and the preamplifier box. The MCD crystal, the thermoelectric cooler (TEC) and the first amplification stage (FET) are contained inside the vacuum chamber. Inside the preamplifier box itself is the preamplifier, the temperature controller unit, the electrical connectors, and the fan.

## Safety and Handling

The beryllium window on the snout of the Vortex is very thin and fragile (50 microns thick for the Vortex, 25 microns thick for the Vortex-EX). Therefore it is important to ensure that nothing comes into contact with it. Also, Beryllium particles are extremely toxic. If breakage of a Be window does occur it is important not to inhale, swallow, or allow the particles to come into contact with skin, open cuts, or eyes. If contact occurs seek medical attention immediately.

The detector biases were factory set and should not be altered. If you have questions, please contact Detector Pool staff (2-9490).

If you need to turn the system off, the manufacturer recommends waiting a few minutes before turning the system back on. Likewise, once the detector is turned on, it is best to avoid turning it off until it has remained at a stable operating temperature for a few minutes.

## Operation

Typical connections are shown in the photo below.



**Figure 3:** Basic connections. On the left is the DXPx PC.

On the right is the Vortex detector with DXP-Saturn power supply (blue box).

1. Make connections as shown in Figure 3. Connect the Vortex detector to the DXP-Saturn power supply (blue box), and use a parallel port cable to connect a DXPx PC to the DXP-Saturn power supply. Connect the DXPx PC to the network via Ethernet cable.

2. Power ON the DXP-Saturn power supply. The Vortex power supply in most cases also contains Digital X-ray Processor electronics (aka DXP-Saturn). If not, an external DXP-Saturn unit will be provided (connect as shown in Figure 4).



Figure 4: Vortex detector with external DXP-Saturn unit. On the right is the DXPx PC.

3. Turn on the DXPx PC with front panel button (note that the DXP-Saturn clicks). The DXPx PC functions as an ioc, broadcasting information over the subnet to which it is connected.
4. Start MEDM screen from beamline Linux (or Windows) PC:  
`/APShare/DetectorPool/start_dxpVortexSDD`.
5. You can also access the DXP MEDM screens from the DXPx PC
  - a. Connect a monitor, mouse, and keyboard, and go to [www.whatismyip.com](http://www.whatismyip.com)
  - b. IP address should be 164.54.xxx.190-199
  - c. ssh into DXPx from beamline PC (user = dxp; *call Detector Pool at 2-9490 for password*).
  - d. Run `start_epics_medm` from `/home/dxp`

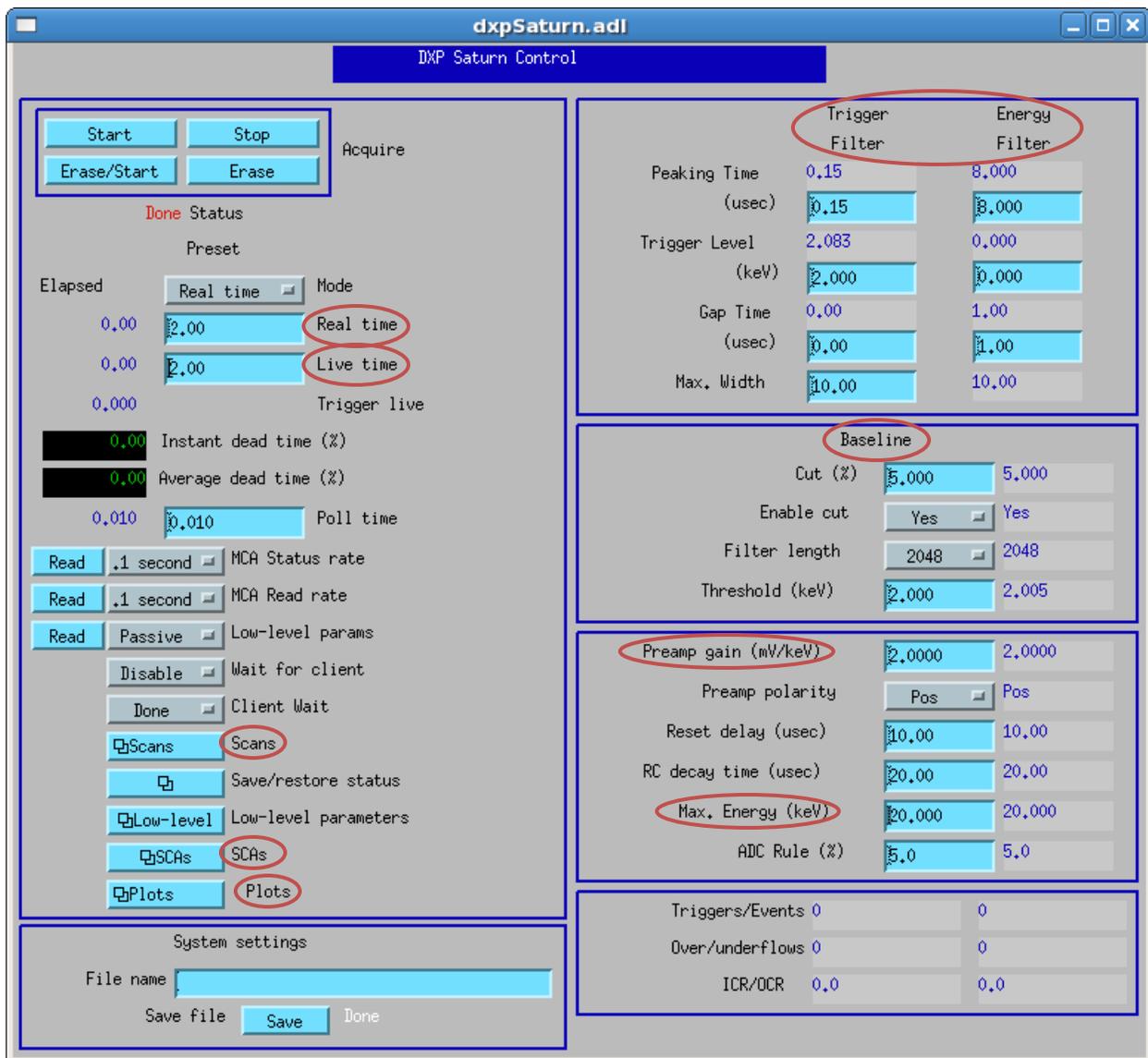


Figure 5: MEDM control screen for Vortex

MEDM Screen, left side:

- In figure 5, **Real Time** is equivalent to “clock time.”
- **Live Time** corrects for deadtime, when the electronics are shut off during readout.
- **Scans** specifies the epics scan record.
- The **SCA** (single channel analyzer) provides counts per window of energy on the spectrum.
- **Plots** can be used to access the MCA (multi-channel analyzer) plot.

## MEDM Screen, right side:

The DXP implements two filters, each with a specific purpose (Figure 5, upper right).

- The **Trigger Filter** lacks energy resolution but efficiently counts hits with minimal pile-up or downtime.
- The **Energy Filter** is slower but has better resolution at lower energies. If the count rate is too high, downtime will rise. The Vortex counts well up to a few hundred kHz; beyond that, energy resolution worsens.
- Recommended settings are as follows:
  1. Trigger Filter:
    - a. Do not change Peaking Time and Gap Time (gap time should be 0).
    - b. Raise Threshold if counts appear in the 0 energy bin of the MCA plot.
  2. Energy Filter:
    - a. Long Peaking Times improve energy resolution (~130 eV) but increase pile-up. Watch the downtime if you lengthen this parameter.
    - b. Keep Trigger Level low.

DXP samples the background between hits to measure dark response of the detector. **Baseline** (Figure 5, middle right) sets the reference voltage used to determine the energy of an x-ray hit. In general:

1. Short filter length is better for low-frequency noise (drift)
2. Long filter length is better for higher frequency noise

**Preamp Gain** and **Max Energy** (Figure 5, lower right) tend to move around features (peaks) within the MCA spectrum. They should be adjusted carefully.

1. Max Energy
  - a. Proper adjustment will determine how many MCA bins map across a specific feature. It is good practice to set this as low as you can, but high enough to span the energy range you want to study.
  - b. Bear in mind that the Vortex detector efficiency drops rapidly around 20 KeV so this should typically be <20 KeV.
  - c. Setting this higher will move features closer to 0 on the horizontal scale, and setting this lower will move features further from 0.
2. Preamp Gain
  - a. Changing this will move features around. A lower value will move peaks closer to 0 on the horizontal scale, and a higher value will move peaks further from 0.
  - b. A reasonable value is somewhere around 1.5-3, with a good starting value being around 2.
3. Do not change the preamp polarity (it should be positive for the Vortex detector).

**IDL MCA** can be used for energy calibration (optional, Figure 6).

1. Take a spectrum.
2. start\_idl\_mca
  - a. IDL does not display well over ssh. Start it from the beamline control PC, and input the Vortex base PV.
3. Choose ROIs (Figure 6, middle left)
  - a. Click Clear All
  - b. Click Add, and specify Mn K $\alpha$ , for example.
  - c. Use the mouse to designate the lower boundary, upper boundary, and top of the K $\alpha$  peak.
    - i. Middle mouse button identifies left edge
    - ii. Right mouse button identifies right edge
    - iii. Left mouse button identifies the top of the peak
  - d. Repeat for K $\beta$ .

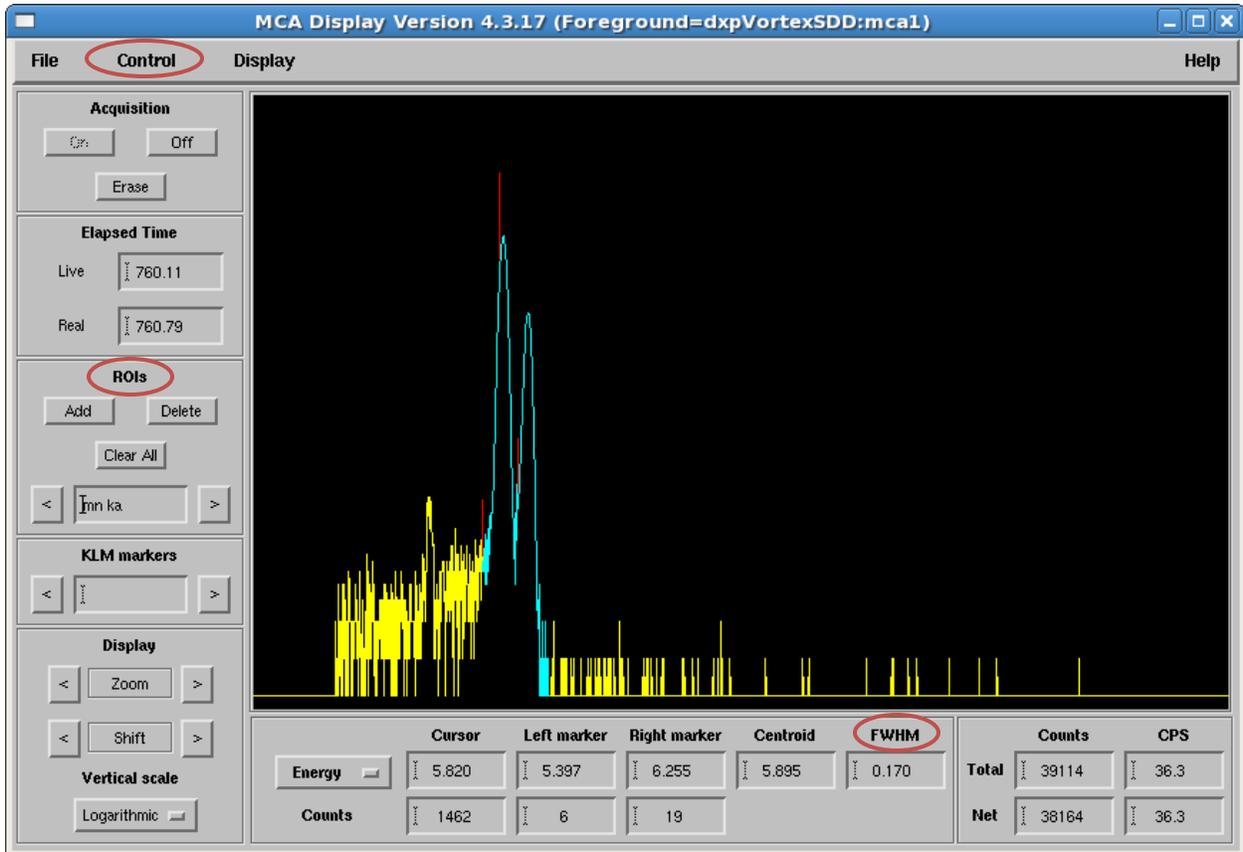


Figure 6: MCA display screen

4. Under the *Control* menu (Figure 6), select *Calibrate Energy*.
5. Click *Compute calibration*, (Figure 7) then *OK*.
  - a. The FWHM is shown on both the MCA Display and Calibrate Energy screens.

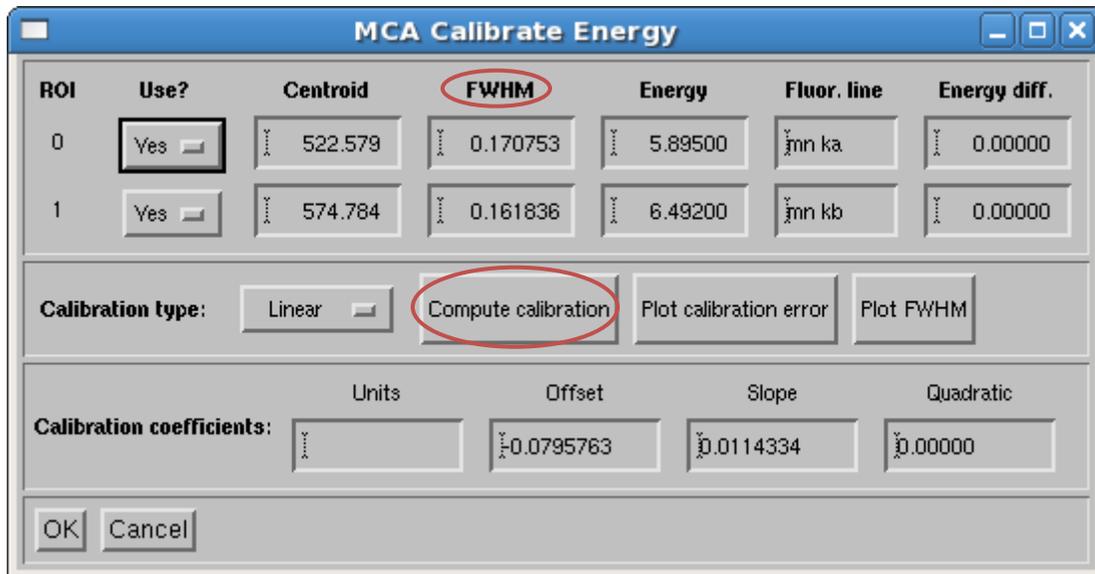


Figure 7: MCA “Calibrate Energy” screen

## Alternative Connections

Alternatively, the Vortex can be connected to a shaping amplifier (e.g. Canberra 2016A)



Figure 8: Alternative connections, using a Canberra shaping amplifier

1. Connect the Vortex detector to the DXP-Saturn power supply (blue box), and use a BNC cable to connect the detector output to a shaping amplifier (e.g. Canberra 2016A).
2. Power ON the DXP-Saturn power supply.
3. Note that the vortex output consists of positive pulses; the input polarity of the shaping amplifier needs to be set to positive. This can be done by positioning jumpers inside the shaping amplifier, as shown in Figure 8 (for assistance, please contact Detector Pool staff at 2-9490).

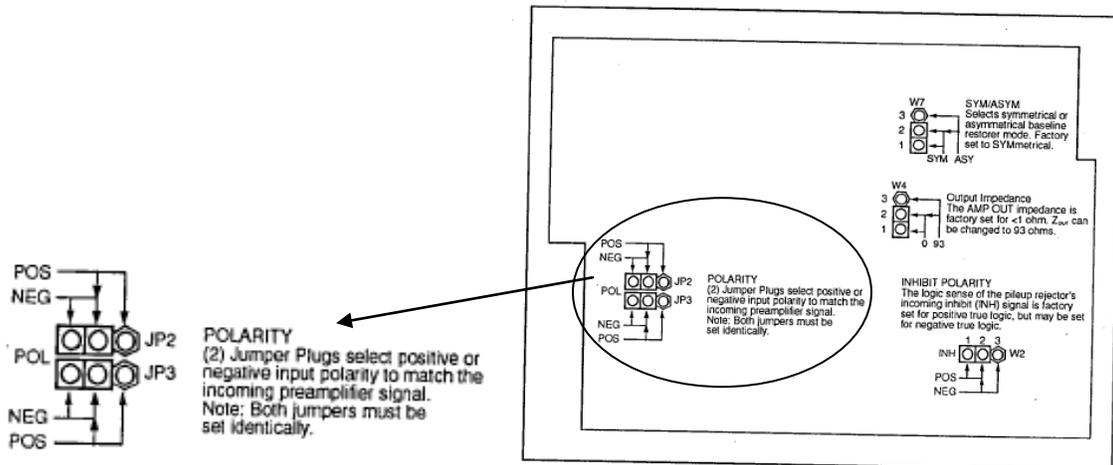


Figure 9: Canberra 2016A shaping amplifier jumper controls

## Software

A software user's manual and instructions are provided in the form of a Microsoft Word Document, which can be found in the program folder created by the automated software installer.

**More Information:** [www.radiantdetectors.com](http://www.radiantdetectors.com)

## Appendix

The Electronics Box, shown in Figure 9, includes four separate voltage power supplies and one dual low voltage linear regulated power supply. The detector power supplies provide biases to the MCD. The linear power supply provides power to the TEC and the rest of the electronics. A digital pulse processor (DPP), if purchased, is also included in the Electronics Box.



Figure 9: Electronics Box

High voltage (HV) and Temperature Controller (TEC) LEDs are located on the front panel of the Electronics Box along with three LED status lights. A brief description of these three LED status lights is given below.

### Descriptions of LED Status Lights on Electronics Box

#### **HV LED** (color = red)

This LED will be lit when the system is on and the detector is normally biased.

#### **Status LED** (color = red)

This LED will be lit when the Digital Signal Processor (DSP) has detected an error condition. It will also illuminate briefly when switching the Field Programmable Gate Array (FPGA) firmware configurations.

#### **I/O LED** (color = yellow)

This LED will flash during data transfers.

#### **Rate LED** (color = green / red)

When running with a reset preamplifier, this LED flashes with a 5ms duration whenever a reset is detected. If the reset rate exceeds 200 Hz, the LED will stay on continuously. The color of the LED, green / red, indicates the relative throughput of the system.

- If the Output Count Rate (OCR) is greater than 50% of the Input Count Rate (ICR) then the LED will be green.
- If  $(1/e) < (OCR/ICR) < 0.5$  then the LED will be orange (green + red).
- If  $(OCR/ICR) < (1/e)$  then the LED will be red. This is roughly the point of maximum throughput.

#### **TEC LED (opt.)** (color = green / red)

This LED will be red when the detector is cooling down. The LED will be green when the cooling process is finished, and the detector has reached normal operating conditions.