

CEBAF Wien filter HV system: Overview and operational guidelines

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1 High-voltage system layout

For each Wien filter, there is a separate pair of unipolar high-voltage power supplies: one positive, one negative. These supplies are controlled individually by vendor-specific control devices that communicate with an EPICS soft IOC. Because the supplies lack an internal polarity reversal option, the connections to the Wien filter plates can be swapped by external high-voltage relays controlled directly by EPICS.

In case any part of the wiring needs to be interrupted for maintenance, interlock cables between all devices ensure that the supplies stay deenergized while any connections are unsafe. This interlock must be broken manually by disconnecting the respective cable prior to exposing any high-voltage wiring.

Figure 1 shows the corresponding rack in the Injector Service Building. A schematic overview of the high-voltage wiring and controls is shown in Fig. 2.

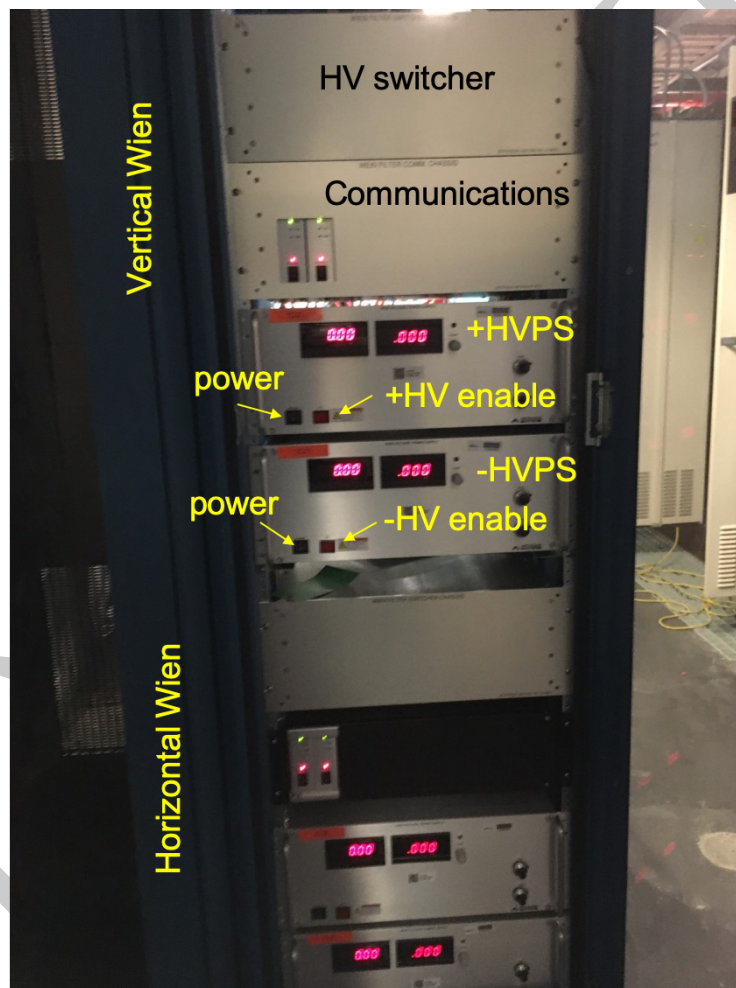


Figure 1: Photo of the rack housing the supplies, switch boxes, and control components.

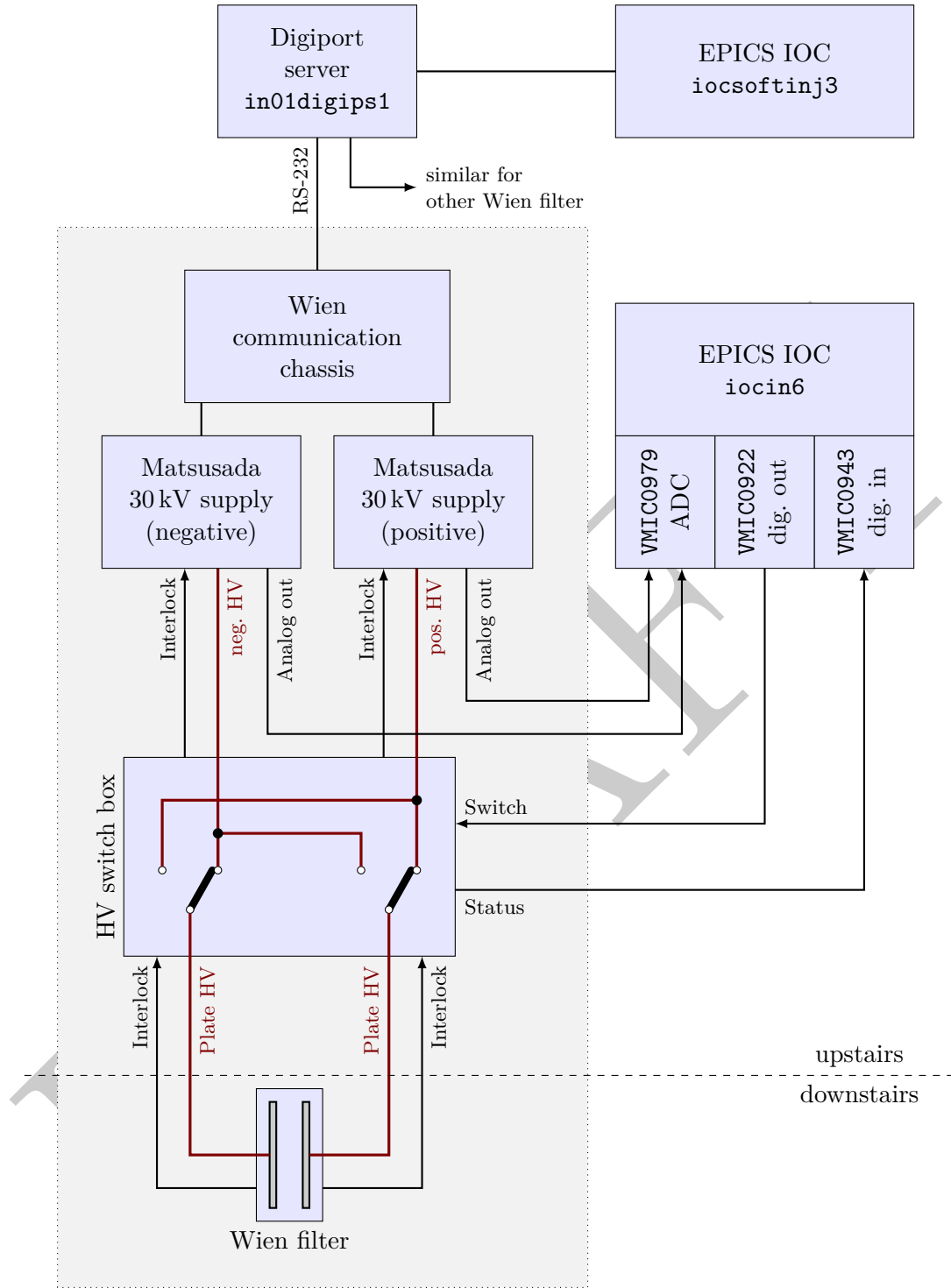


Figure 2: Schematic layout of the Wien filter control circuitry. The components inside the gray box exist separately for each Wien filter.

2 Control screens

Each Wien filter has its own control screen. The screens are accessed from

JMenu → Injector → Spin

as shown in Fig. 3. Figure 4 shows the V-Wien expert screen as an example.

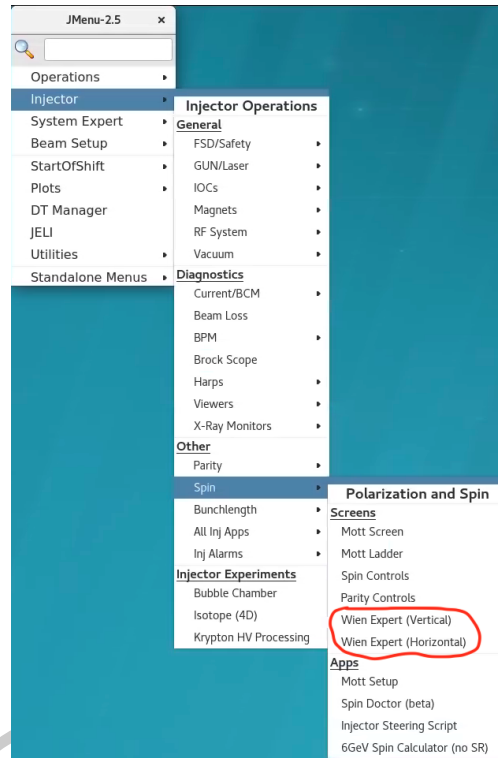


Figure 3: JMenu entries for the Wien expert screens.

2.1 Spin settings

The Wien filter high-voltage value is defined by the desired spin angle and by the electron beam energy. It is normally set by the injector steering script, but it can also be done directly in this screen by system experts.

Ask G. Croke to remove voltage set point and Set HV input boxes from this screen section.

2.2 Magnet

The integrated field setpoint of the Wien filter magnet is defined by the desired spin angle and by the electron beam energy. It is normally set by the injector steering script, but it can also be done directly in this screen by system experts.

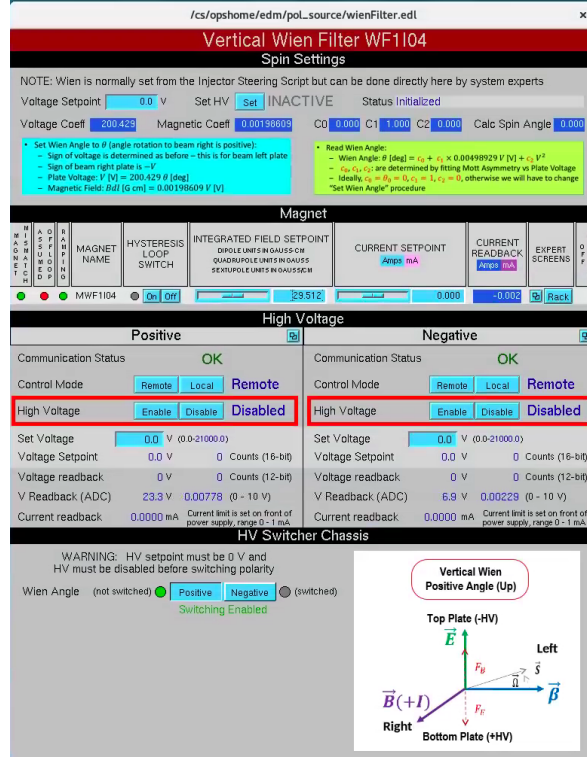


Figure 4: Wien filter expert screen. In this example, both HV supplies are disabled, and the polarity switch is set to positive.

2.3 High voltage

The positive (on the left-hand side of the screen) and negative (on the right-hand side of the screen) power supplies are controlled individually. The button on the upper right corner of the Positive and Negative controls opens a “secondary” expert screen described later. The elements on the screen have the following meaning:

- **Control Mode:** Nominally, the Remote control mode is Enabled. This can be toggled here using the Remote and Local buttons.
- **High Voltage:** Similarly, the High Voltage is nominally Enabled and can be toggled using the buttons. The example in Fig. 4 shows both positive and negative HV Disabled.
- **Set Voltage:** This is the box where the desired voltage is entered in volts. The power supply voltage will ramp up or down to the typed-in set point at a rate of 1 kV s^{-1} rate (software-controlled) upon hitting the “return” key. The voltage range in volts is shown in parentheses to the right of the input box. The high limit is manually entered in the secondary expert screen.

- Voltage Setpoint: reports the entered set voltage in volts and in 16-bit counts. 65 536 counts = 30 000 V, corresponding to the maximum output voltage of the power supply.
- Voltage readback: reports the voltage read from the high voltage power supply GPIB (12-bit) in volts and also in counts. 4096 counts = 30 000 V.
- V Readback (ADC): reports the voltage in volts read from the ADC output in the power supply (0 V to 10 V)
- Current readback: reports the current read from the power supply in mA. The current limit is set on the front of the power supply in the range 0 mA to 1 mA by dialing the grey knob (see photo in Fig. 1). The knob should be turned all the way clockwise, thus setting the limit to 1 mA. There is no remote-control option to set the current limit. There is no expected current draw during normal Wien operations.

2.4 HV switcher chassis

This section is utilized to change the polarity of the Wien filter electrodes through the HV switcher chassis. There is only one toggle control in this section: Positive or Negative, according to the desired Wien angle. Again, this is normally controlled by the Injector Steering Script, but experts can control it in this screen. Prior to switching the polarity, the HV setpoint must be 0 *and* both HV supplies must be disabled. Otherwise, a red message “Switching Disabled” is displayed underneath the buttons.

Figure 4 shows the V-Wien in the positive Wien angle configuration. Because both positive and negative HV are disabled, the green “Switching Enabled” message is displayed. A diagram made by R. Suleiman depicts the fields, forces, beam, and Wien angle configuration according to the set polarity. If the polarity is changed, the diagram changes accordingly.

2.5 Secondary expert screens

The secondary expert screen shown in Fig. 5 is launched by clicking the top right button in the positive or negative high voltage section of the Wien filter expert screen (Fig. 4), respectively. This screen has the same high-voltage controls functions found in the Wien Expert screen, but additionally:

- Has a power supply (PS) Reset button (more on this in the troubleshooting section)
- Allows for entering a software limit in volts. This value can be changed but for now has been set to 21 000 V and will be restored upon IOC reboot.
- Allows for entering a set voltage in 16-bit counts. **Warning:** Changing the Counts setpoint will change the output voltage. Check present voltage readback and compare with counts readback before proceeding.

- Has a generic command box allowing to send any command to the power supply. Any response is displayed below the command input box.

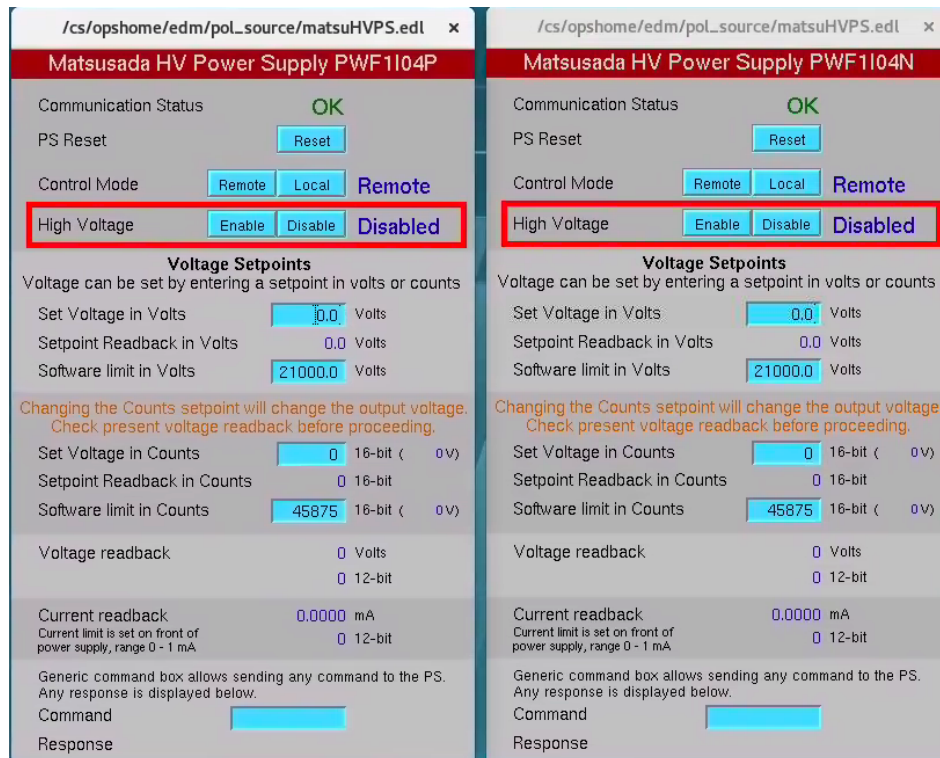


Figure 5: High-voltage power supply expert screen.

3 Procedures

3.1 Turning HV on to a desired set point

1. Check the Wien Angle polarity in the HV Switcher section of the desired Wien filter expert screen (Fig. 4). If the polarity is the one desired, proceed. If not, go to section 3.4.
2. Ensure the Control Mode is set to REMOTE in both the Positive and Negative High Voltage control screen sections. If not, click the Remote button in both the Positive and the Negative section.
3. Ensure the Set Voltage is set to 0 V in both the the Positive and the Negative section.
4. Click HV enable in both Positive and Negative. A warning in red letters will be displayed: “Switching Disabled”, see Fig. 6.
5. Enter the desired voltage set point in volts in the Positive section and hit enter. The voltage will start ramping up to the set point at 1 kV s^{-1} .
6. Repeat #5 for the Negative HV.

Figure 7 shows an example of the voltage ramping up and down for both Wien filters.

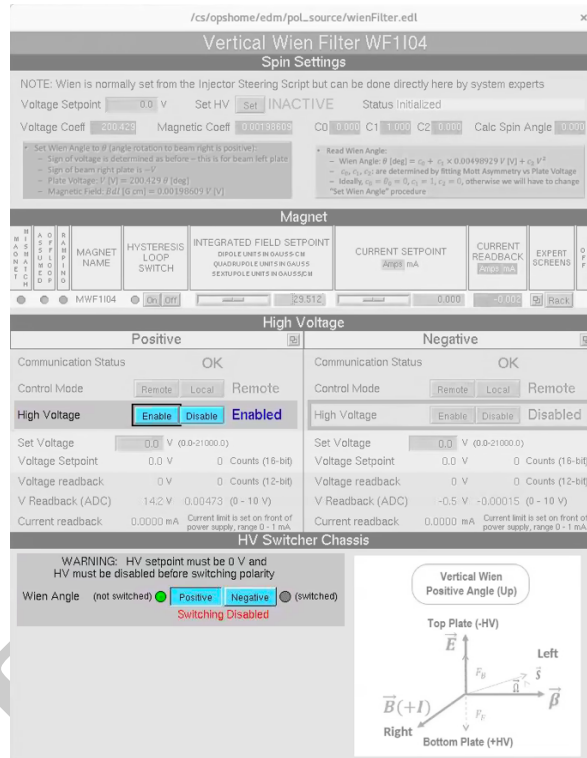


Figure 6: Wien filter expert screen with one of the HV supplies enabled, preventing the user from switching the polarity. Irrelevant areas are desaturated.

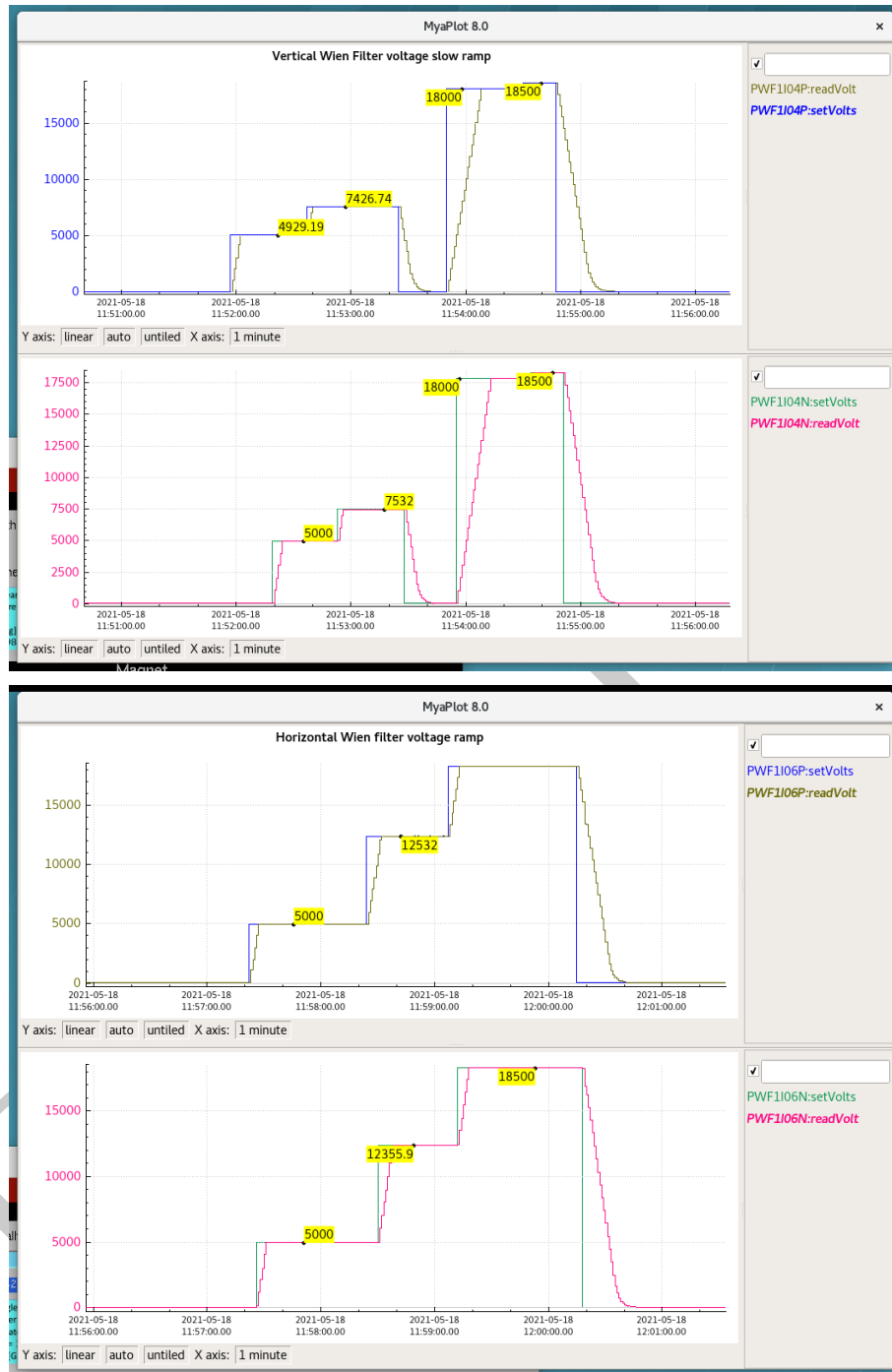


Figure 7: Example of the voltage ramp of both Wien filters.

3.2 Changing the voltage set point

1. Enter the new voltage set point in the Positive HV and hit enter. The HV will ramp to the new set point at 1 kV s^{-1} .
2. Repeat for the Negative HV.

3.3 Turning HV off

1. Enter 0 in the Set Voltage input box and hit enter. The HV will ramp to 0 V at 1 kV s^{-1} .

Note: Nominally, the HV will be left enabled for both Positive and Negative.

3.4 Changing the polarity

1. Set the voltage to 0 V and hit enter for the Positive HV. Repeat for the Negative HV.
2. Click Disable in the Positive HV and then in the Negative HV. The red message “Switching Disabled” will turn green and read “Switching Enabled” when *both* Positive and Negative HV are disabled.
3. Click on the desired polarity. Figure 8 shows an example with the Positive polarity chosen (left) and with the Negative polarity chosen (right).
4. Ensure the voltage set point is 0 V for both Positive and Negative HV.
5. Enable HV Positive and then HV Negative.
6. The Wien HV is now in the new chosen polarity configuration, and HV can be ramped up per the procedure described above.

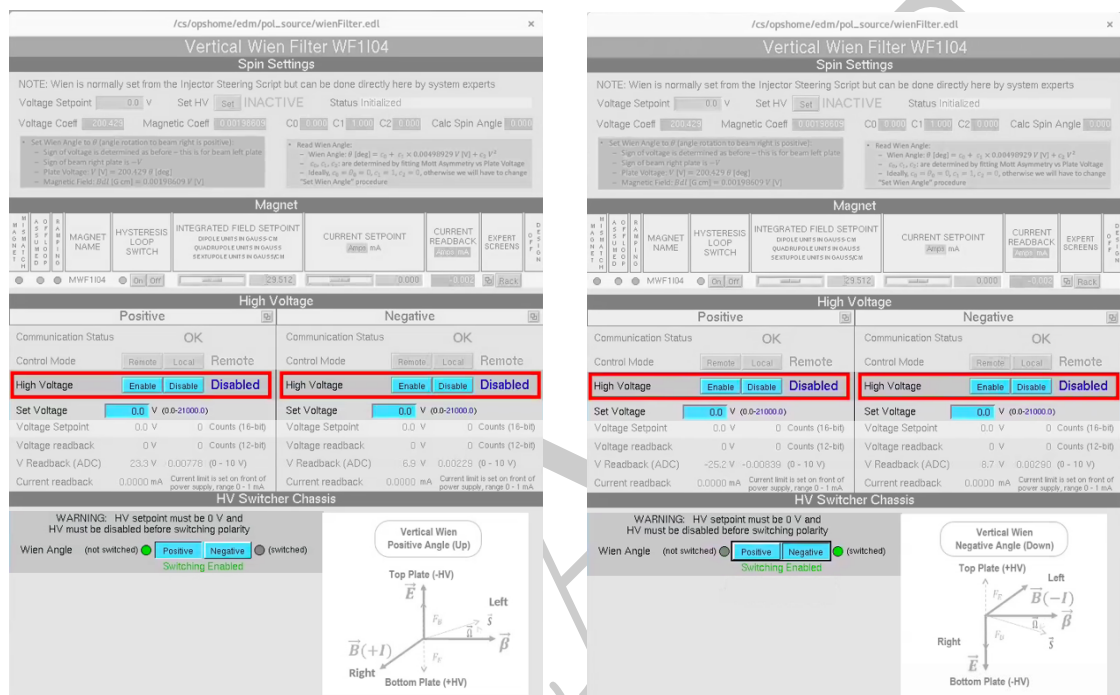


Figure 8: Wien filter expert screen with both HV supplies disabled, allowing the user to switch the polarity. Irrelevant areas are desaturated. Left: positive. Right: negative.

4 Troubleshooting

4.1 Communication error

1. Proceed to the Wien Filter HV rack located in the injector service building (shown in Fig. 1).
2. Open the back door.
3. Ensure the GPIB IEEE toggle switch is flipped up to REMOTE communications.
4. Open the front door.
5. Locate the communications chassis. There are two 1x4 in boxes with LEDs. When the communications chassis is operating correctly, the green TLK LEDs will flash intermittently. If they are flashing but the communication error persists, contact S. Windham for diagnosing communications to the IOC. Otherwise, proceed.
6. Starting with the Vertical Wien system (top), turn the communication chassis power switches (2) off. The green TLK LEDs will be off now.
7. Depress the HV enable red push button in each of the two Matsusada high voltage power supplies.
8. Turn the power off in each of the two Matsusada high voltage power supplies.
9. Repeat #5–#8 for the Horizontal Wien system (bottom)
10. Turn back on the two power switches of the communications chassis in the Vertical Wien system. The green TLK LEDs should be blinking now. If they do not, contact K. Cole.
11. Turn back on each of the two Matsusada high voltage power supplies.
12. Press the HV enable red push button in each of the two Matsusada high voltage power supplies.
13. Proceed to a computer terminal and check in the Wien Expert Controls for the Communication Status to show OK.

4.2 Lost HV Enable

1. Identify which HV Enable was lost (Vertical or Horizontal Wien, and corresponding positive or negative HV enable)
2. Open the secondary expert screen for the corresponding HV Enable lost. Press PS Reset.
3. Click on HV enable. If this does not resolve the problem, proceed to the Wien HV system rack in the injector service building.

4. Open the rack front door.
5. Cycle the HV enable push button.
6. Proceed to a computer terminal, and Enable HV. If this does not solve the problem, open the back door of the Wien HV system rack.
7. Ensure that each of the interlock cables are connected to the back end of the HV switcher chassis.

I would suggest adding something like: If not, find out why they were disconnected...

8. If they are connected, proceed to the injector in the tunnel and identify the corresponding Wien with the HV enable problem. The interlock box is located underneath each of the Wien filters attached to the wire rack.
9. Ensure each of the interlock cables are connected to the interlock box.
10. If the above steps do not solve the problem, contact I&C and software.