

CEBAF Wien filters HV system: overview and operational guidelines  
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Ver. April 11, 2022

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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.

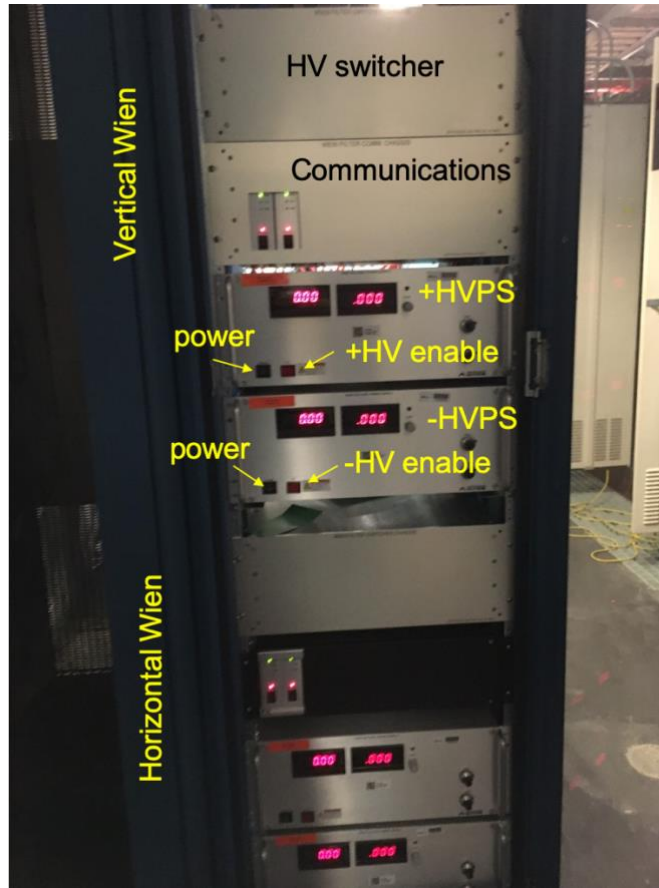


Figure 1: Photo of the rack housing the supplies, switch boxes, and control components.

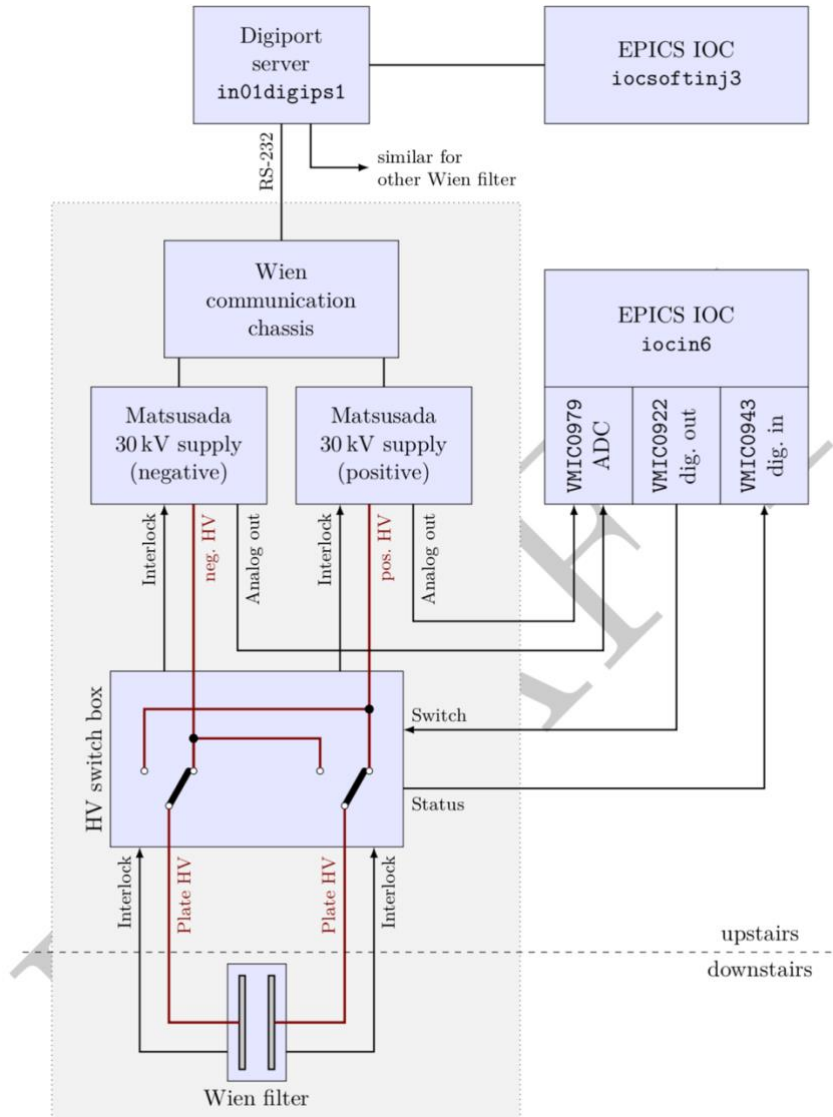


Figure 2: Schematic layout of the Wien filter control circuitry. The components inside the gray box exist separately for each Wien filter.

## 2 Control screens

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

JMenu -> Injector -> Spin

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

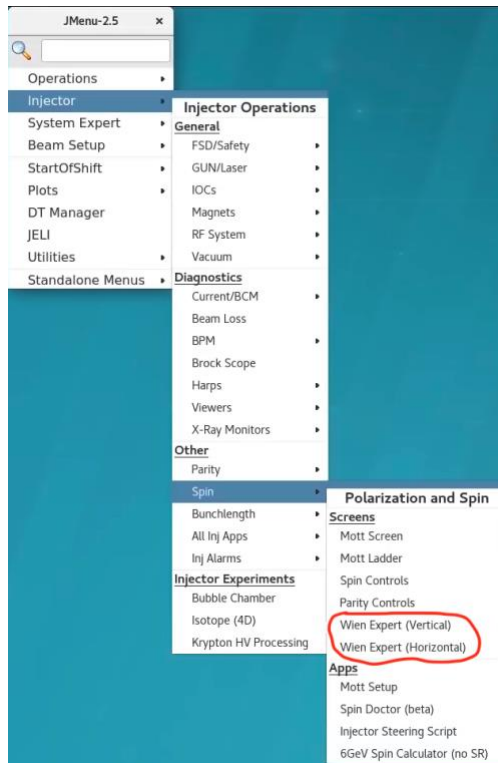


Figure 3: JMenu entries for the Wien expert screens.

## 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.

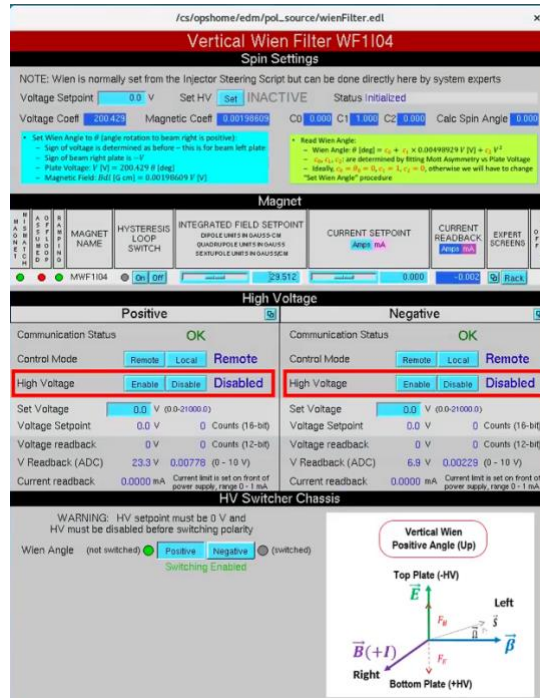


Figure 4: Wien filter expert screen. In this example, both HV supplies are disabled, and the polarity switch is set to positive.

## 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.

## 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  $1 \text{ kV s}^{-1}$  rate (software-controlled) upon hitting the “return” key. The voltage range in volts is shown in parenthesis 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. 4,096 counts = 30,000 volts.
- V Readback (ADC): reports the voltage in volts read from the ADC output in the power supply (0 -10 volts)
- Current readback: reports the current read from the power supply in mA. The current limit is set on front of the power supply, range 0 – 1 mA dialing the grey knob (Figure 2). The knob has been 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. This section displays a Warning: HV setpoint must be 0 AND HV must be disabled before switching polarity.

Figure 4 shows the V-Wien in the positive Wien angle configuration. Because both positive and negative HV are disabled, the green lettered “Switching Enabled” 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.

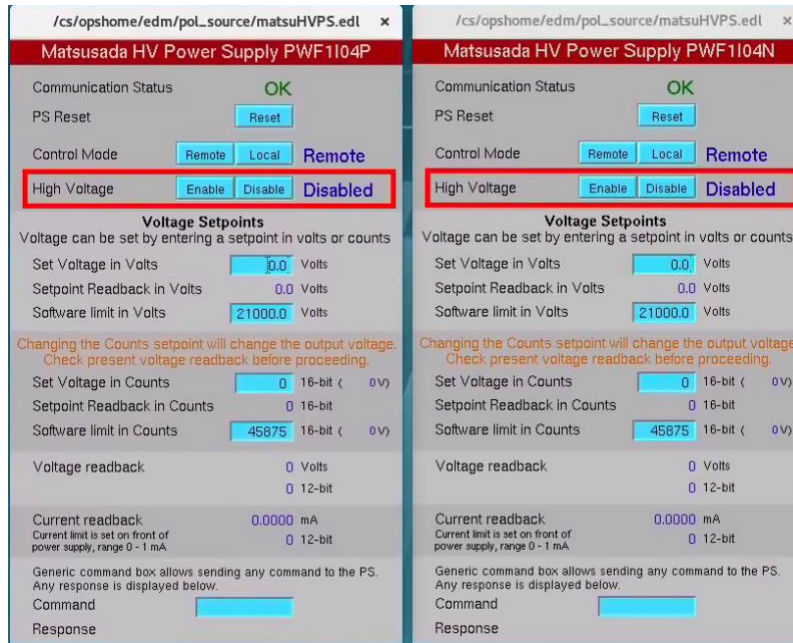


Figure 5: High-voltage power supply expert screen.

### 3 Procedures

#### 3.1 Powering system on and Hot Check Out (HCO)

System preconditions for both, Vertical and Horizontal Wien HV systems:

- Communications chassis powered off
- Matsusada HV power supplies powered off
- HV switcher chassis may be powered off, or on. Power switch is located in the back of this chassis.

1. Proceed to a computer terminal and open the Vertical and the Horizontal Wien Controls screen (Fig. 4). Ensure 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 Negative control screen sections.
2. Ensure Set Voltage is set to 0 volts in both Positive and Negative in the controls screen section.
3. Ensure the High Voltage is DISABLED in the controls screen sections. If not, click DISABLE.
4. Proceed to the Wien HV systems rack front (Fig. 1). Starting with the Vertical Wien HV system (top stack):
5. Locate the communications chassis, and turn the power button of each of the two boxes located to the left of the chassis. One box is the ethernet connection for the positive, and the other one for the negative Matsusada high voltage power supplies. When the communications are operating properly, the TLK green LEDs will intermittently blink.

6. Ensure the HV enable/disable toggle switch is OFF (depressed) in each Matsusada HV power supply.
7. Turn the upper power supply power switch on. This should illuminate the red LED displays (left for voltage 0-30,000 V, and right for current 0-1 mA). Repeat for the lower power supply.
8. Ensure that the current limit turning gray knob is turned all the way to the right in each of the power supplies.
9. Press the HV enable toggle switch. The switch will not illuminate because the High Voltage is still DISABLED in the controls screen (Fig. 4).
10. Proceed to the back of the rack and located the HV switcher chassis. Turn its power button on. NOTE: There is no pilot light (yet) indicating this chassis is powered on.
11. Repeat from #5 -#10 for the Horizontal Wien filter.
12. Proceed back to the computer terminal.
13. Ensure the set Voltage is set to 0 volts in both Positive and Negative in the controls screen section for both the Vertical and the Horizontal Wien filter controls screen.
14. Click on HV ENABLE for each Positive and Negative in both the Vertical and Horizontal Wien HV systems controls screen. The red box around the HV Enable section should disappear.
15. Proceed to the HV controls rack (Fig. 1) and verify that now the HV enable/disable toggle switch is illuminated red for all of the four power supplies. The display in all four supplies should still be 0 V.
16. Proceed back to the computer terminal and enter Set Voltage 500 V in each of the controls section and for both Vertical and Horizontal Wien HV controls.
17. Proceed back to the front of the rack (Fig. 1). And ensure the LED displays are reporting  $\sim 0.5$  kV for the upper (Positive) HV power supply, and  $\sim -0.5$  kV for the lower (Negative) HV power supply, and for both the Vertical (top stack) and the Horizontal (bottom stack) HV power supplies. See Fig. 6.
18. Proceed back to the computer terminal and set all voltages back to 0 V.
19. Click HV DISABLE.
20. Procedures for powering ON and HCO COMPLETE.





Figure 6. LEFT: Vertical Wien filter HV system (top stack). RIGHT: Horizontal Wien filter HV system. The pictures show how the systems should look like when powered, high voltage enabled (toggle switch illuminated in red), and 500 V Set point. Notice the lower power supplies display negative values, these correspond to the negative power supplies.

### 3.2 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 (Figure 5). If the polarity is the one desired, proceed. If not, go the “changing polarity” section below.
2. Ensure 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 Negative.
3. Ensure Set Voltage is set to 0 volts in both Positive and Negative.
4. Click HV enable in both Positive and Negative. A warning in red letters will be displayed: “Switching Disabled” see figure 7.

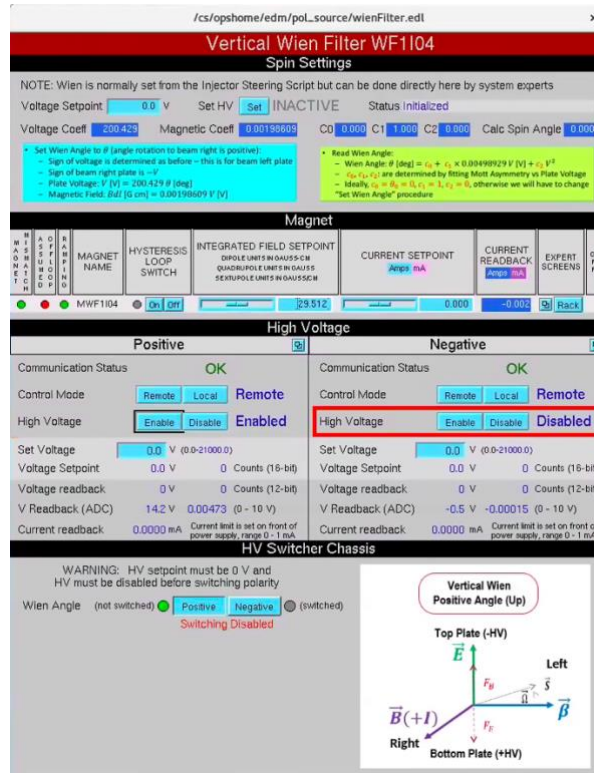


Figure 7. Wien filter expert screen with one of the HV supplies enabled, preventing the user from switching the polarity. Irrelevant areas are desaturated

5. Entered 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.
6. Repeat #5 for the Negative HV.

Figure 8 shows an example of voltage ramp up and down for both Wien filters.

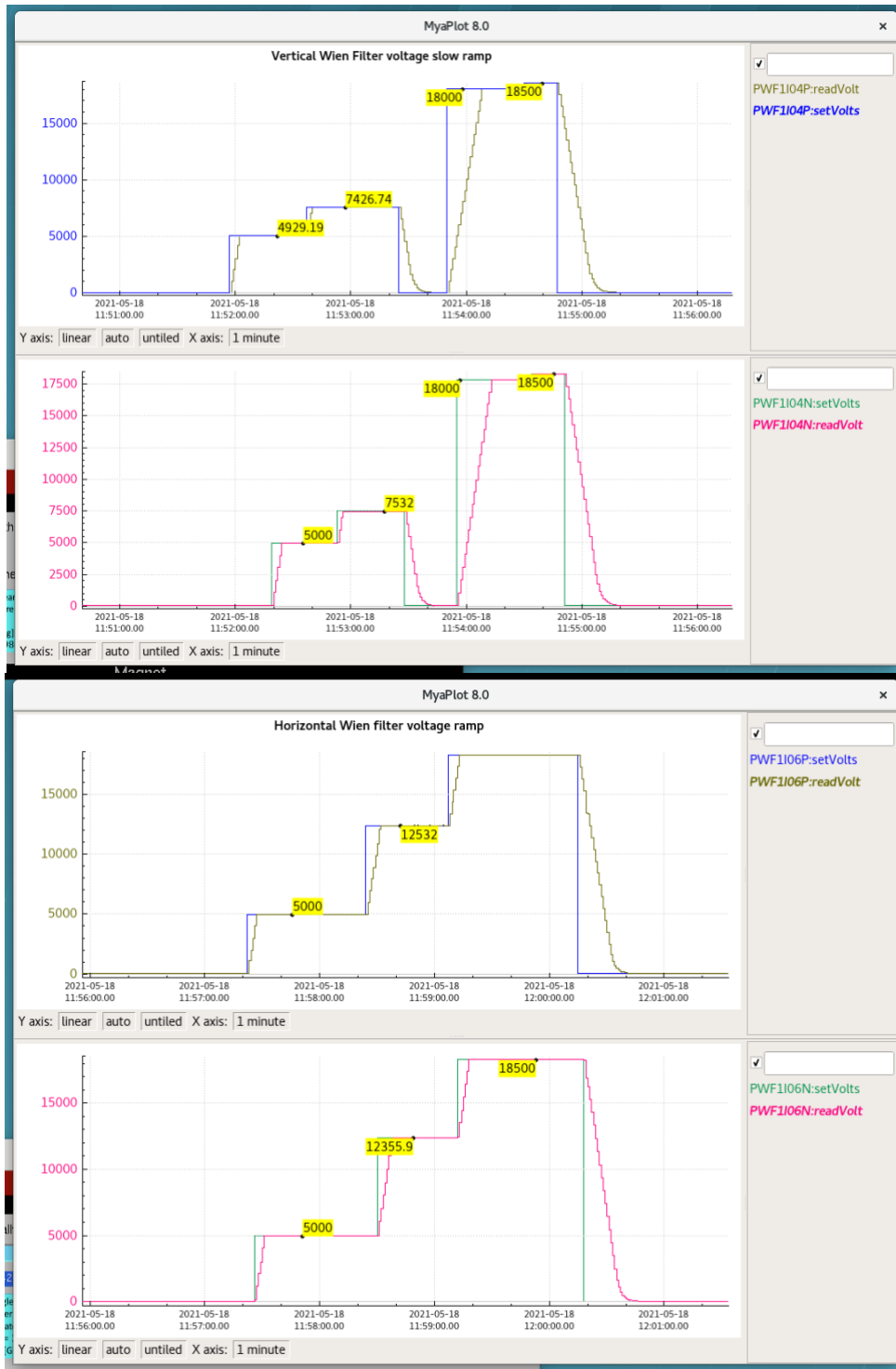


Figure 8. Example of the voltage ramp of both Wien filters

### 3.3 Changing the voltage setpoint

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.

2. Repeat for the Negative HV.

### 3.4 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.

NOTE: Nominally the HV will be left ENABLED for both Positive and Negative.

### 3.5 Changing the polarity

1. Set the voltage to 0 Volts 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 lettering “Switching Disabled” will turn into green lettering “Switching Enabled” when BOTH Positive and Negative HV are disabled.
3. Click on the desired Polarity. Figure 9 shows an example with the Positive polarity chosen (left) and with the Negative polarity option (right)

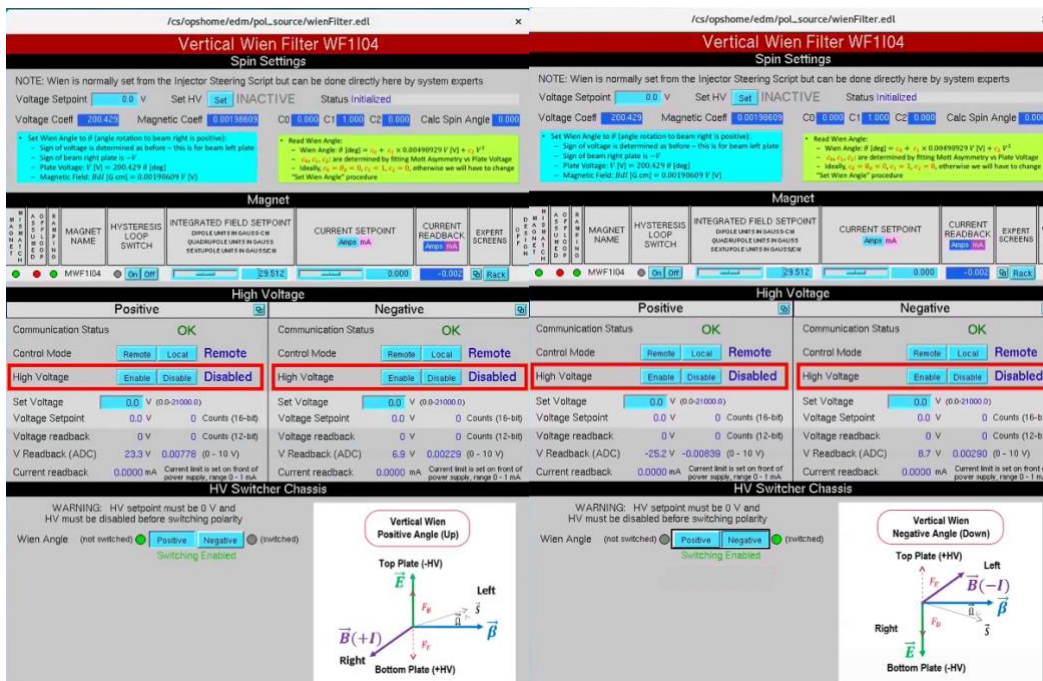


Figure 9. Wien filter expert screen with both HV supplies disabled, allowing the user to switch the polarity. Irrelevant areas are desaturated. Left: positive. Right: negative.

4. Ensure voltage set point is 0 Volts for both Positive and Negative HV.
5. Enable HV Positive and then HV Negative.
6. Wien HV is now in the new chosen polarity configuration and HV can be ramped up per the procedure described above.

## 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 are operating properly, the TLK green LEDs will intermittently blink. If they do not, proceed. If they do: contact S. Windham for diagnosing communications to the IOC. If they don't, proceed.
6. Starting with the Vertical Wien system (top), turn the communication chassis power switches (2) off. The TLK green 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. If not, find out why they were disconnected. Contact K. Cole.
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 under 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.