4.4 ELECTRON CURRENT CONTROL (ECC)

This power supply offers the option of feedback stabilized Electron Current Control (ECC), which is especially useful in maintaining ion beam current with Ion Guns. Under normal circumstances, when a constant voltage source drives the ionization cathode heating, electron emission current varies over time. The electron emission current changes are due to variations in the cathode heater's resistance as its temperature varies and physical changes such as evaporation and contamination. To provide a stable and constant electron emission current, the ECC option can be used. The ECC circuit maintains a constant electron emission current by using feedback control to adjust the source voltage.

Note that while the electron emission current is held constant, both the ion emission and the final ion beam current may still vary. The electrons emitted from the cathode bombard the gas present in the region of the ion chamber and ionize that gas to produce the ion emission. This ionization process is very dependent on the type of gas and on the pressure of the gas introduced. The gas inlet is controlled manually or automatically. Thus, although the electron emission is constant, the resulting ion emission may vary considerably. Many further factors can cause the ratio of final ion beam current to electron emission current to vary such as, but not limited to: Grid and Focus values, chamber pressure, Ion Gun and target contamination, and outgassing.

Although protection against excessive source current is built into the ECC circuitry, it is best to employ the ECC mode **after** the approximate operating parameters have been determined in Source mode. For example, if the Electron Energy is too low, the ECC feedback may call for more source current in order to maintain the chosen electron emission current value. This increased source current will raise the filament's temperature, thus reducing filament lifetime. **Ensure that the Electron Energy is at least 50 V when operating in ECC mode.**

Do not switch from ECC Mode to Source Mode while the Ion Gun is running.

When operating in ECC mode, turning the encoder wheel with **SOURCE** selected determines the desired electron emission current level. Turning the control to full scale will yield the maximum electron emission current. This is read on the **e- CURRENT** meter on the display screen. The specific values for the ECC range vary with the gun model and cathode type.
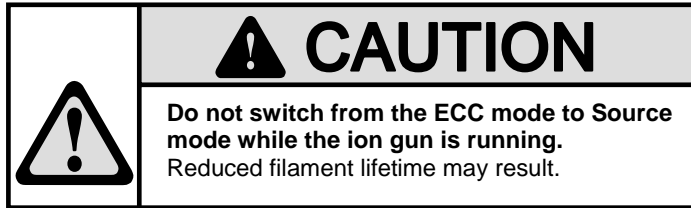
When operating in Source mode, turning the encoder wheel with **SOURCE** selected determines the source voltage directly. Turning the control to full scale will yield the maximum source voltage. Such a high source current will result in short filament lifetime. If the **SOURCE** control has been turned to full scale while operating in ECC mode and then the power supply is switched to Source mode, source current will immediately be switched to its maximum level, reducing filament lifetime.

CAUTION: If the **SOURCE** voltage and current values on the display screen become highlighted (or if the **Overcurrent** button on the computer turns yellow), this is a warning that indicates that the Source Current has reached or exceeds the recommended maximum operating current. Running the Source current this high greatly reduces the cathode lifetime.

The Zener limit, which controls the maximum source voltage and the maximum electron emission current, has been preset at the factory for the Source/ECC board. If, under normal operating conditions, the desired ion beam current range cannot be achieved while the ECC circuit is in use, please call the Engineering Department at Kimball Physics at (603) 878-1616. Note that the Zener limit is meant to protect the filament from high, life shortening, current. Achieving the full electron emission current range under all operating conditions will not be possible.

CAUTION: The Zener limit is calibrated for a particular gun and a particular ion source. When the ion source is replaced by the user or the gun is rebuilt, the Zener limit may need to be recalibrated. Call Kimball Physics at (603) 878-1616.

4 OPERATION

4.4 ELECTRON CURRENT CONTROL cont.

⚠ **CAUTION**

⚠ **Do not switch from the ECC mode to Source mode while the ion gun is running.** Reduced filament lifetime may result.

OPERATING PROCEDURE FOR ECC MODE WITH FLEXPANEL CONTROLS

1. Set-up:
   a. To assure low cathode heater temperatures, determine initial operating parameters and **ensure that the Electron Energy is at least 50 V** before operating in ECC mode. Once operating in the ECC mode, the ion beam may be optimized by further adjusting the bias voltages (keeping Electron Energy at 50 V or more), while maintaining source current. Excessive source current will reduce filament lifetime.
   b. Using the **SOURCE** control (encoder wheel or computer control), decrease the Source Voltage to zero.
   c. On the IGPS, switch the amber **ECC ON/OFF** rocker switch on (**I** position) to enable the ECC feedback circuitry for ECC mode.
      i. Alternatively with the LabVIEW™ program, set **Source/ECC** toggle switch on the computer to **ECC**. On the computer the Source control is relabeled **ECC** when in ECC mode.

2. Adjusting Electron Current Control:
   a. Slowly increase the **SOURCE** control (encoder wheel or computer **ECC** control) up to one tenth of the range or about one turn with the encoder wheel. Then wait.
   b. After a delay, the Source voltage and Source current will start to rise. It may take a few minutes to rise to the emitting range.
   c. GRADUALLY, turn up the **SOURCE** control until the desired electron emission current is achieved. Monitor the effect on **SOURCE** voltage and current meters. Make only small changes, and wait several minutes for oscillations to stop before adjusting again.
   d. **CAUTION: With FlexPanel Controls, care must be taken not to increase the Source voltage too rapidly with the encoder wheel.** Due to capacitance in the cathode system, there is a delay in the response to voltage changes. Make small changes, and then wait until the Emission current has stopped drifting up, before continuing. Because the encoder wheel has a variable rate of increase/decrease, it is possible to turn the ECC up higher than is intended.

(Adjusting Emission Current Control cont.)
   e. **CAUTION:** If the **SOURCE** voltage and current values on the display screen become highlighted (or if the **Overcurrent** button on the computer turns yellow), this is a warning that indicates that the Source current has reached or exceeds the recommended maximum operating current. Running the Source current this high greatly reduces the cathode lifetime.

3. **For Remote Programming**: On a power supply with a 50-pin **EXTERNAL INTERFACE** rear panel connector, the ECC option can also be controlled by a 0 V to +10 V programming signal (such as might be provided by a D/A supply). A +10 V signal will yield the full-scale emission current value. (For example, with a 0 to 500 µA ECC range, +10 V will yield 500 µA, while +5 V will yield half the ECC range or 250 µA, etc.) See the following section on remote/ computer control.

4. Turning off the ECC option:
   a. Using the **SOURCE** control (encoder wheel or computer **ECC** control) turn down the emission completely, so that the Source voltage and current meters read zero. Failure to do so could severely damage the filament and greatly shorten the filament lifetime.
   b. On the IGPS, switch the amber **ECC ON/OFF** rocker switch off (**O** position) for Source mode. Alternatively, set **Source/ECC** toggle switch on the computer to **Source**.

This completes the ECC Instructions.