4.9 FARADAY CUP ASSEMBLY OPTION

The Faraday cup assembly, mounted on the front end of the Ion Gun, is positioned by either a rotary feedthrough or a pneumatic actuator assembly, located on one of the 1⅓ inch (34 mm) conflat flanges on the Flange Multiplexer. The two types of gun-mounted Faraday cup are shown below in Figures 4.9-1 and 4.9-2. The Faraday cup assembly is UHV compatible, and can be heated to 350°C; however, the optional pneumatic cylinder and its external plastic tubing should be removed for bakeout. Some guns which were purchased without a Faraday cup can be modified for the addition of a Faraday cup assembly at the factory.

The Faraday cup assembly consists of three basic parts: the electrically-isolated stainless steel collector cup / aperture, the grounded external shield cup, and the hinge / link assembly. The collector cup is mounted coaxially inside the shield cup on an Al_2O_3 insulator. The cup assembly rotates around the hinge pin mounted on the rim of the shield cup. The hinge / link assembly is connected to either the rotary feedthrough via a rod which turns the cup to one side of the beam, or to the pneumatic actuator assembly via a push / pull slide rod. The beam current signal is transmitted by a stainless steel wire isolated in Al_2O_3 tubing to a BNC feedthrough located on one of the 1⅓ CF flanges on the Flange Multiplexer. The Faraday cup can be biased at a non-ground potential to increase collection efficiency.

The rotary feedthrough consists of a calibrated knob and a locking screw. The zero position on the knob indicates that the Faraday cup is in position in the beam line; turning the knob rotates the cup into and out of the beam line. The rotary feedthrough is operated manually.

The pneumatic actuator assembly consists of two basic parts: the removable dual-action pneumatic cylinder, and the 1⅓ CF flange / welded metal bellows feedthrough sub-assembly. The cylinder can be actuated either with air pressure or optionally with a manual knob. A sliding lock button provides positive positioning of the cup assembly when operating the Faraday cup in the manual mode.

POWER INPUT CAUTIONS

The maximum recommended beam power into the standard gun-mounted Faraday cup is 2 watts. The Faraday cup temperature should not be raised above 350ºC due to outgassing. The overall power input is of concern mainly with high power guns; there is usually not a problem with Ion Guns as they usually produce lower currents at lower acceleration energies. The focused beam power density is of concern with any focusable gun.

The power input can be calculated by multiplying the beam current times the ion acceleration voltage; for example, 1 mA at 20 keV gives 20 W, much too high for continuous measurement. The temperature of the Faraday cup increases approximately linearly with the power input. A 2 W input results in approximately 150ºC, and a 4 W input in 300ºC.

To use the Faraday cup at high power, measure currents briefly and then let the Faraday cup cool down before repeating the measurement. For a large Faraday cup (such as on the EGG-3103, EFG-11, or EMG-12), a 20 W input for 20 sec will raise the cup temperature by approximately 100ºC, due to the heat capacity of the cup. The cup will then dissipate this heat and cool to the initial gun temperature in 10 to 15 min. For a small Faraday cup (such as on the IGL-2101 or IGL-6), the lower heat capacity of the smaller cup is compensated for by the low maximum power output of the gun. For non-standard applications, the acceptable power into the cup and the heat dissipation should be verified.

Care must always be exercised when using a highly focused beam, as a high power density can bring the Faraday cup to melting temperature in the impact region of the beam. For example, an ion gun with an output of 1 mA at 10 keV focused to a 1 mm spot size has a power density of approximately 13 kW/cm^2. Assuming no heat flow, this would bring the Faraday cup stainless steel at the spot to its melting point in only 11 μsec.

4.9 FARADAY CUP ASSEMBLY OPTION cont.

4.9.1 FARADAY CUP with PNEUMATIC ACTUATOR

⚠ CAUTION

High beam power can melt Faraday cup components.
Maximum recommended beam power into the Faraday cup is 2 WATTS.

INSTALLATION OF ION GUN AND FARADAY CUP WITH PNEUMATIC ACTUATOR

1. Ensure that there is proper clearance in the host vacuum system for the Faraday cup to rotate out of the beam line when in the retracted position.

2. Manually position the Faraday cup to the measuring position (in-line position) and lock in position using the sliding lock button. Note: The red indicator on the sliding lock button is visible when the pneumatic cylinder is locked. (If there is no manual knob and lock button, use the shipping bracket at the end of the actuator to lock the Faraday cup in position.)

3. Install the Ion Gun according to the instructions in Section 2.3.

4. Connect the pneumatic cylinder to a 4-way electro-pneumatic valve (not supplied) using 1/8 inch plastic tubing.

5. Connect the valve via an air regulator to a clean dry air supply. Adjust the air regulator to 40 - 60 psi.

6. Connect a suitable ammeter or pico-ammeter to the Faraday cup output BNC located on the Flange Multiplexer.

7. **Remove pneumatic unit for bakeout**: Remove plastic tubing. Remove the two 6-32 socket head cap screws. Press the pin on tube toward the actuator, and slide unit sideways to remove.

CAUTION: The maximum temperature allowed for the pneumatic cylinder is 65ºC.

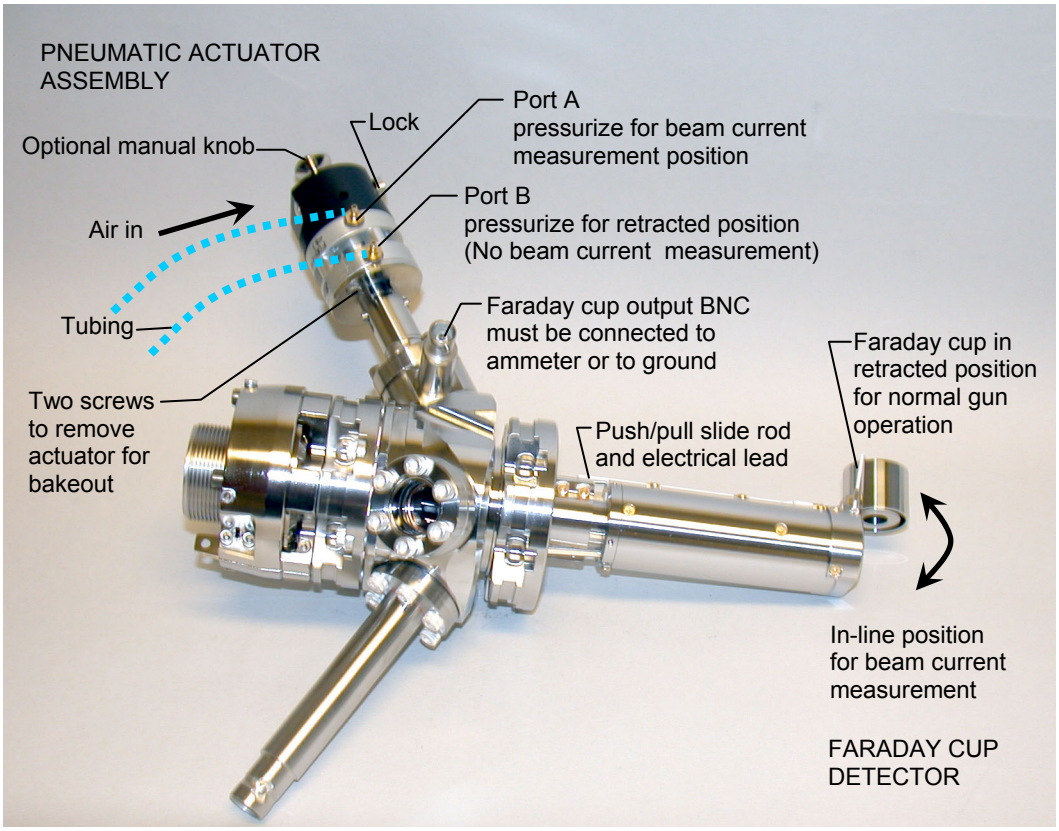

Fig. 4.9-1 Faraday Cup Assembly with Pneumatic Actuator

4.9 FARADAY CUP ASSEMBLY OPTION cont.

NORMAL OPERATION OF FARADAY CUP WITH PNEUMATIC ACTUATOR

1. Ensure that an ammeter is connected to the Faraday cup BNC located on the Flange Multiplexer. ***NEVER* collect beam current in the Faraday cup without proper termination of this BNC** (connected to an ammeter or grounded using a "shorting" BNC connector). Without proper termination the Faraday cup, the BNC center terminal will charge up to full beam acceleration voltage and electrical discharging will result.

2. Check the actuator:
   a. With the optional manual controls: Unlock the actuator by positioning the sliding lock button so that the red indicator is not visible. Check the actuator for free movement by cycling with the manual actuator knob at the end of the actuator cylinder.
   b. Without optional manual controls: Remove the shipping bracket from the end of the actuator to unlock it. Check the actuator for free movement by alternately applying air pressure and venting the ports.

3. Calculate the expected power input into the Faraday cup and check that it is within the acceptable range. See the discussion of power input cautions.

4. To measure beam current:
   a. Apply air pressure to Port “A” and vent Port “B” to position the Faraday cup in the measuring position (in-line position); see Fig 4.9-1
   b. Read beam current on the ammeter.
   c. Check beam power (beam current x ion acceleration voltage). If power exceeds 2 Watts, measure briefly, then move Faraday cup off line to cool down before repeating.

5. To operate the Ion Gun so the beam current is delivered to the target.
   a. Apply air pressure to Port “B” and vent Port “A” to position the Faraday cup to the non-measuring position (retracted position).

OPTIONAL MANUAL OPERATION OF FARADAY CUP WITH PNEUMATIC ACTUATOR

1. Ensure that an ammeter is connected to the Faraday cup BNC located on the Flange Multiplexer. ***NEVER* collect beam current in the Faraday cup without proper termination of this BNC** (connected to an ammeter or grounded using a "shorting" BNC connector). Without proper termination the Faraday cup, the BNC center terminal will charge up to full beam acceleration voltage and electrical discharging will result.

2. Calculate the expected power input into the Faraday cup and check that it is within the acceptable range. See the discussion of power input cautions.

3. To measure beam current:
   a. Unlock the actuator by positioning the sliding lock button so that the red indicator is not visible.
   b. Push in the manual actuator knob at the end of the actuator cylinder.
   c. Lock the Faraday cup in position by pushing the sliding lock button so that the red indicator is visible.
   d. Read the beam current on the ammeter.
   e. Check beam power (beam current x ion acceleration voltage). If power exceeds 2 Watts, measure briefly, then move Faraday cup off line to cool down before repeating.

4. To operate the Ion Gun so the beam current is delivered to the target:
   a. Unlock the actuator.
   b. Pull the manual actuator knob out.
   c. Lock the Faraday cup in the retracted position by pushing the sliding lock button so that the red indicator is visible.

This completes the Faraday Cup with Pneumatic Actuator Instructions.

4.9 FARADAY CUP ASSEMBLY OPTION cont.

4.9.2 FARADAY CUP with ROTARY FEEDTHROUGH

⚠ CAUTION

High beam power can melt Faraday cup components.
Maximum recommended beam power into the Faraday cup is 2 WATTS.

INSTALLATION OF ION GUN AND FARADAY CUP WITH ROTARY FEEDTHROUGH

1. Ensure that there is proper clearance in the host vacuum system for the Faraday cup to rotate into and out of the beam line.

2. Manually position the Faraday cup to the centered measuring position by turning the black calibrated knob to zero, and lock in position using locking screw (the large screw on top of the black knob, not visible in photo).

3. When the gun is built, the degree of rotation is set so that the Faraday cup rotates between the centered in-beam position and an out-of-beam position which does not interfere with gun operation. The rotational stop can be adjusted with its adjustment screw, but this should not be necessary unless the Faraday cup is disassembled.

4. Install the Ion Gun according to the instructions in Section 2.3.

5. Connect a suitable ammeter or pico-ammeter to the Faraday cup output BNC located on the Flange Multiplexer. If there are two BNCs, the Faraday cup one will be stamped with an **F.**

CAUTION: The maximum bake out temperature of the Rotary Feedthrough is 300ºC, which is less than that for the Faraday cup, its feedthroughs and the rest of the gun (usually 350ºC).

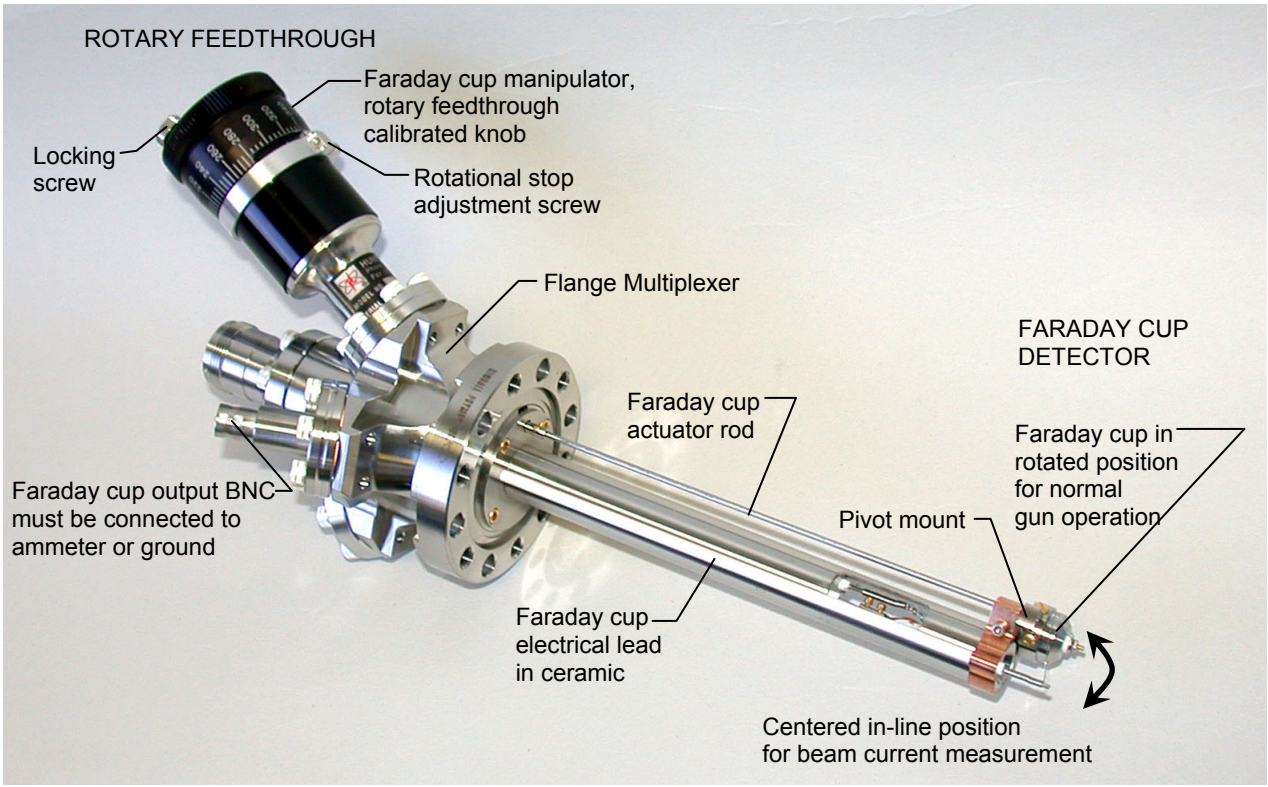

Fig. 4.9-2 Faraday cup assembly with manual Rotary Feedthrough (cup size and style may vary)

4.9 FARADAY CUP ASSEMBLY OPTION cont.

OPERATION OF FARADAY CUP WITH ROTARY FEEDTHROUGH

1. Ensure that an ammeter is connected to the Faraday cup BNC located on the Flange Multiplexer. ***NEVER* collect beam current in the Faraday cup without proper termination of this BNC** (connected to an ammeter or grounded using a "shorting" BNC connector). Without proper termination the Faraday cup, the BNC center terminal will charge up to full beam acceleration voltage and electrical discharging will result.

2. Calculate the expected power input into the Faraday cup and check that it is within the acceptable range. See the discussion of power input cautions.

3. To measure beam current:
   a. Unlock the locking screw.
   b. Turn the black, rotary feedthrough knob to **0** indicating the Faraday cup is centered in the beam line.
   c. Lock the Faraday cup in position by tightening the locking screw on the top of the black knob.
   d. Read the beam current on the ammeter.
   e. Check beam power (beam current x ion acceleration voltage). If power exceeds 2 Watts, measure briefly, then move Faraday cup off line to cool down before repeating.

4. To operate the Ion Gun so the beam current is delivered to the target:
   a. Unlock the locking screw.
   b. Turn the black, rotary feedthrough knob, rotating fully to the stop, to move the Faraday cup out of the beam line.
   c. Lock the Faraday cup in the off-line position with the locking screw.

This completes the Faraday Cup Instructions.