Beamline Manual

Version 1.0

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1 Contacts

Beamline cell phone (xxx) xxx-xxxx

The people listed in Table 1 should be called whenever there is a problem beyond the on-hand expertise. The beam line expert is the main source for help.

Who	Expertise	Cell Phone	Office
MCC	Beam tune, vacuum		x7048 & x7043
Stepan Stepanyan	Beamline devices and applications	(757) 303-0499	x7196
Francois-Xavie Girod	Beamline devices and applications		x6002
Engineering on call	General beamline		

Table 1: The beamline call list.

2 What to Monitor along the Beamline

2.1 Beam conditions

During data taking it is important to monitor the electron beam to insure that changes in beam parameters do not effect data quality. For example, changes in the beam halo can dramatically increase background rates making the data worthless, or a change in the electron beam direction can cause unwanted beam losses leading detector damage or beam trip. There are automatic controls and alarms on beam conditions that will prevent beam damage to equipment and will terminate beam delivery in an event of beam excursion. Nevertheless, the shift taker must continuously monitor the beam parameters and act accordingly.

2.1.1 Beam Current

A consistent reading between the Faraday Cup (see Section 3.2) current and the "nA" BPMs is one way to check that the electron beam is cleanly transported to the beam dump (Faraday Cup). (Note: in some experiments, when beam current exceeds allowed limit for Faraday cup, ~ 50 nA, beam stopper will be inserted in front of the Faraday cup. During high current runs, consistency in measured beam currents with "nA" and "stripline" BPMs must be monitored). In addition to the inconsistency of beam current readings, the halo counters (see Section 3.4) should show an increased activity if the beam is scraping the beam pipe upstream or downstream of the target. Also higher then normal rates in the detectors would be indicative of scraping immediately downstream of the target. After the initial beam tuneup reference numbers for the scalers will be posted in the log book and are to be used as reference.

In the event that there appears to be unacceptable beam losses the following course of action is recommended:

1. Stop taking data, and make an E-log entry flagging any data runs that may be contaminated.
2. Call MCC and explain to the operator what has been observed and explain why the tune is unacceptable.
3. Work with the MCC operator to come up with a game plan to fix the problem.
4. Document the solution and start taking data again.

2.1.2 Beam Halo

The presence of a beam halo is usually observed by an increase count rate in the beam halo counters (see Section 3.4). Typically the upstream counters are very quiet and any count rate above $\sim$ 200Hz (after initial gain adjustments for a well tuned beam) is indicative of a problem. Note that an increase count rate in the upstream beam halo counters can also indicate an obstruction in the beam pipe or just a bad beam tune. To further investigate the source of a large count rate in the upstream beam halo counters a harp scan (see the "electron beam profile scan" procedure in Section 3.6) should be performed.

If the beam halo is unacceptable, take the following steps:

1. Stop taking data, make an E-log entry.
2. Call MCC and explain to the operator what has been observed and why this tune is unacceptable.
3. Work with MCC to solve the problem.
4. Document the solution and start taking data again.

2.1.3 Beam Position

The beam position before HPS is available from three "nA" cavities, 2C21, 2C24, and 2H01 and two stripline BPMs, 2H00 and 2H02. They measure the beam position as well as the current. From these five measurements the beam angle can be determined. Drifts more the $\pm$0.1mm should be brought to the attention of MCC. Feedback system is used to keep the beam position stable. It uses BPM information to drive horizontal and vertical correctors. Before data taking, shift worker must confirm that the feedback system is active. Note, that at beam currents below 50 nA only "nA" cavities are reliable.

2.2 Beamline Vacuum

The beamline vacuum is monitored from the vacuum screen available from the MCC on EPICS screens. The vacuum tends to be of order 10^{-6} torr upstream of the shield wall (upstream tunnel), and of order 10^{-5} torr near the tagger and the throughout the downstream beam line. Vacuum is tightly monitored and interlocked to the beam delivery.

2.2.1 Catastrophic Loss of Vacuum

There are two thin windows that are components of the HPS beamline, the Hall-B tagger vacuum chamber window and the photon exit window at the downstream end of the last Frascati dipole vacuum chamber. If either of these two windows fail under vacuum load there are fast valves interlocked to pressure gauges which will close automatically. These valves will limit the loss of vacuum to the small region of the Hall B beamline. Valves are interlocked to the beam Fast Shutdown System (FSD) and beam will be shutoff in an event of vacuum loss.

If any of the valves close due to poor vacuum:

1. notify MCC immediately, turn off the beam (if it is not already OFF)

2. call the engineering on call

2.3 Magnet Power Supplies

The Hall-B beamline and HPS have magnets for beam transport, and momentum analysis. In Table 2 list of the magnets, their power supplies and point of control (POC) are shown. The items listed with B as the point of control will be controlled by staff in the counting house. The vertical and horizontal correctors, and the tagger magnet are controlled by MCC, but the shift taker should monitor their settings. The tagger magnet power supply is interlocked to the machine Fast Shutdown System (FSD). Interlocks are activated if run requires dumping the beam in the tagger beam dump, e,g during the initial beam tune. When the tagger trips off the beam will be automatically shut off. This interlock must be masked out when electron beam is put through the hall for the experiment. The HPS chicane dipoles, Frascati-1, HPS-dipole, and Frascati-2, are controlled by the shift personal. Two "frascatis" share the same power supply, so called the Hall-B mini-torus power supply. The HPS-dipole uses the Hall-B pair spectrometer power supply. Both power supplies are interlocked with FSD system. Beam delivery will be terminated if any if these power supplies will trip.

magnet	power supply	POC	Function	Status
MB2C21V		MCC	vertical kick	Active
MB2C21H		MCC	horizontal kick	Active
møller A	Dyna-B	B	Møller polarimeter	Not used
møller B	Dyna-C	B	Møller polarimeter	Not used
MB2C22H		MCC	horizontal kick	Active
MB2C23V		MCC	vertical kick	Active
raster_h1	Danfysik	B	first horizontal target raster	Not used
raster_v1	Danfysik	B	first vertical target raster	Not used
tagger	Danfysik	MCC	bend beam to tagger dump	Active
MBD2H00H		MCC	horizontal kick	Active
MBD2H00V		MCC	vertical kick	Active
MBD2H02H		MCC	horizontal kick	Active
MBD2H02V		MCC	vertical kick	Active
Frascati-1	Dyna-A	B	bend beam by 30 mrad	Active
HPS-dipole	Danfysik	B	spectrometer magnet	Active
Frascati-2	Dyna-A	B	bend beam by 30 mrad	Active

Table 2: List of the magnets along the Hall B beamline and their functionality.

If the tagger or the HPS chicane dipoles do trip off or is set incorrectly take the following action:

1. Call MCC immediately, tell them to shut off the beam.
2. Make an E-log entry.
3. Restore magnets (have MCC restore the tagger) to the proper setting.
4. Restore beam, verify that the beam is incident on the viewer (at the tagger dump if the tagger is energized or at the downstream tunnel if electron run is in progress)

2.4 Magnet and Power Supply Beacons

Near every magnet in Hall B there are red flashing beacons that indicate status of the magnets. If beacon is flashing then the magnet **is powered** or **can be powered** at any time. If you need to work near or on a magnet and the red light is flashing you must turn off the supply. The dangers of working near a magnet are limited to those associated with stray magnetic fields. All the high current bus work is enclosed in protective shields so there is no shock hazard. Of course the supply needs to be shut off and lock and tagged before any of the protective shield is removed.

After any work that required the power supply to be lock and tagged a through sweep of the magnet area for magnetic debris is required before the lock and tag can be removed.

3 Hall B Epics Control Screens

3.1 EPICS GUI Launcher

The *"hps_epics"* (see Fig.1) is a *medm* screen that serves as an icon manager of *medm* screens. From this screen, the bulk of the epics applications can be started. It is recommended that when finished with a particular *medm* screen, that application be terminated (**not iconized**). If the screen is needed in the future, just launch it again from the *"hps_epics"*. In this manner searching through all the degenerate icons is eliminated.

To start the *"hps_epics"*:

- log onto **clon01**
- type: **hps_epics**

3.2 Faraday Cup (classc4)

The instantaneous beam current reading from the Faraday cup is available on the **Main Scaler** screen as shown in Figure 4. This GUI can be launched via the *"hps_epics"* by selecting the **Beam** pull down menu. The update rate is the same as for the beam halo scalers and is controlled from that GUI, see Section 3.4. An important consideration is that the Faraday Cup current integrater rate is 10 counts/sec when the current is 1 nA. This means that if the count time on the scaler is less than 1 sec you will observe large statistical flucations.

3.2.1 Beam blocker

The Hall-B Faraday cup is not cooled and cannot operate at high currents (especially at high energies). If run requires use of beam currents above 50 nA, beam blocker, cooled copper absorber, must be position in front of the Faraday cup. The beam blocker control GUI is shown in Figure 2. Push "Go beam" button in order to put the blocker on the beam and "Go Home" to retract if from the beamline.

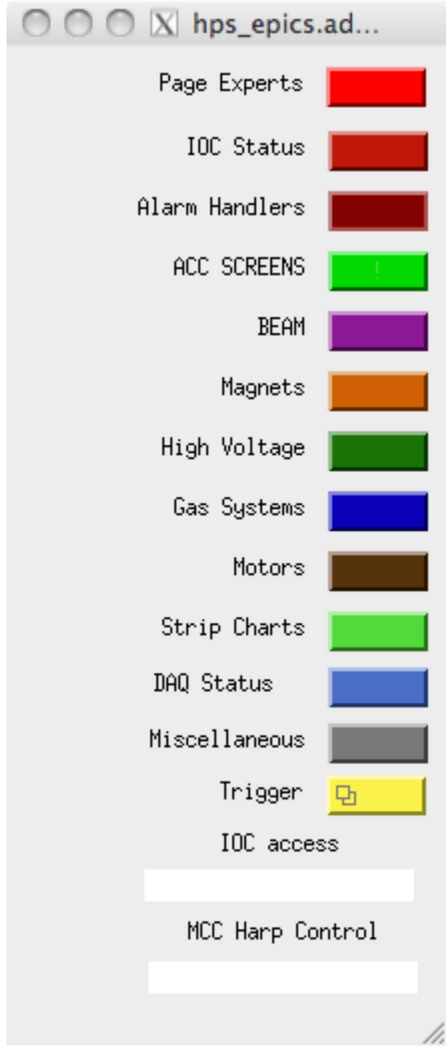

Figure 1: HPS EPICS GUI launcher.

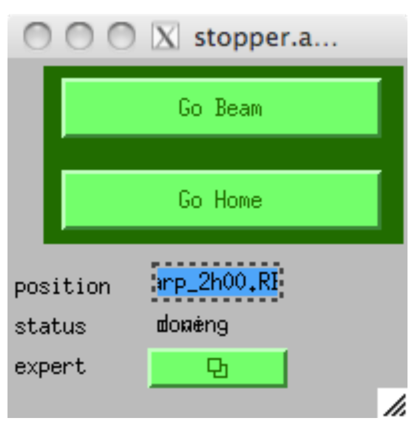

Figure 2: The beam blocker GUI.

3.3 nA BPM Displays

The readout of na BPMs are displayed on the main scaler GUI as well as on BPM GUI, Fig. 3. The BPM screen can be launched via the *"hps_ epics"* by selecting the **Beam** pull down menu.

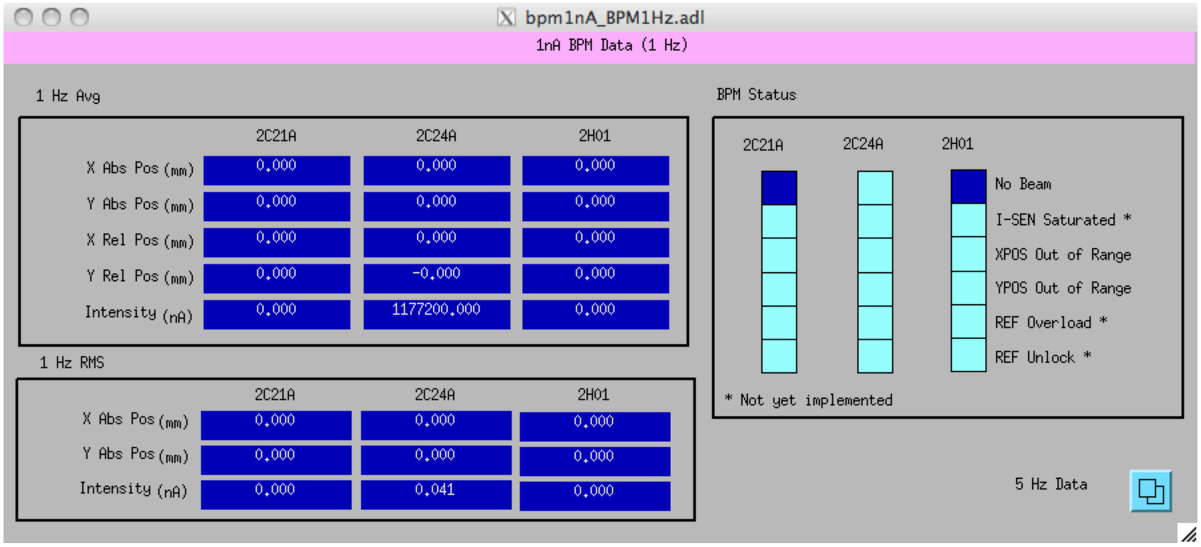

Figure 3: The Hall B current screen. The current reading, in nAmps. The Faraday Cup current reading is updated at the same rate as the beam halo scalers.

3.4 Beam Halo Counters (classc1/classc4)

The beam halo counters consist of photomultiplier tubes strapped to the beampipe along the beam line. There are two halo counters upstream of the Hall-B tagger magnet, two are installed on top of the tagger magnet vacuum box, four counters located in the apex of the forward carriage, two counters downstream of the Frascati-1 and one counter downstream of the target, between HPS dipole and the Frascati-2. The beam halo counter scalers are displayed on the main scaler GUI. The GUI also displays the Faraday Cup beam current, information from BPMs, rates in detectors (e.g. calorimeter), magnet settings, motor position (e.g. target). This display is launched via the Beam menu on the *"hps_ epics"*.

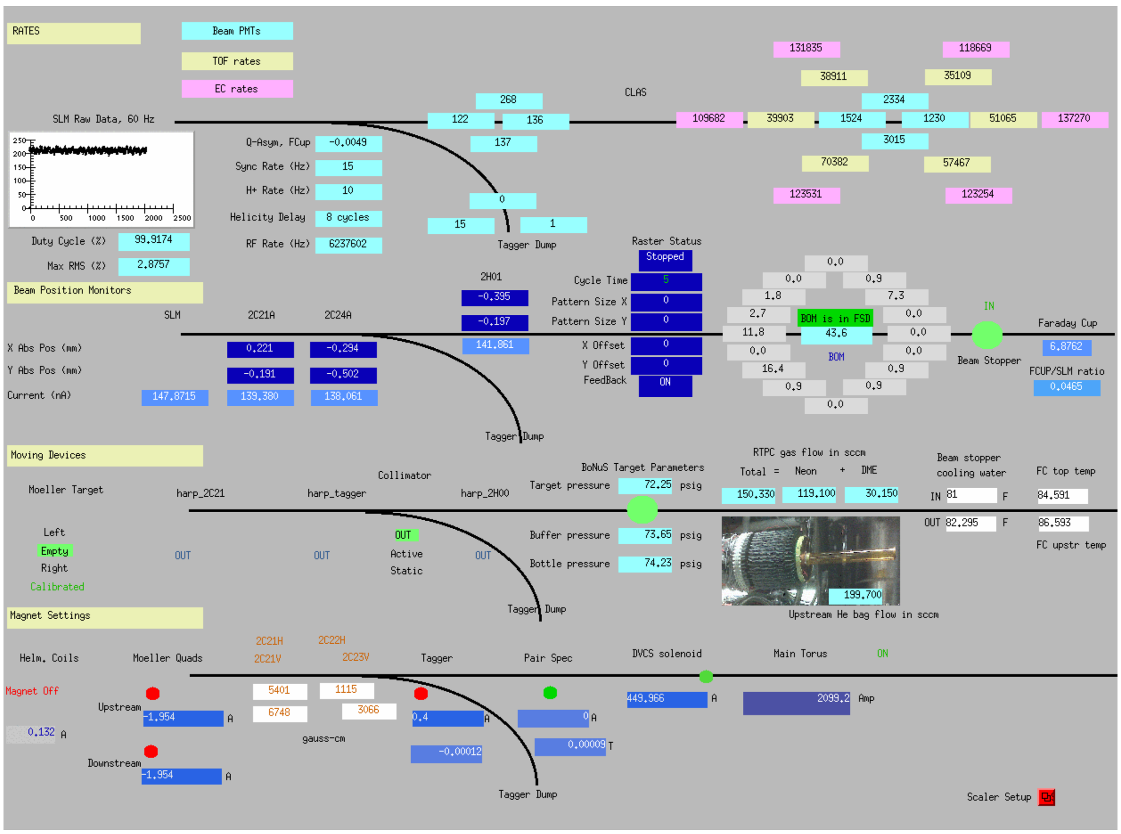

Figure 4: The main scaler GUI.

3.5 Target

Figure 5 shows the HPS target. The 4μm-thick tungsten is used for 1.1 GeV and 2.2 GeV data taking, and the 8μm-thick tungsten is for 4.4 GeV and 6.6 GeV. The graphite and CH_2 targets are for calibration.

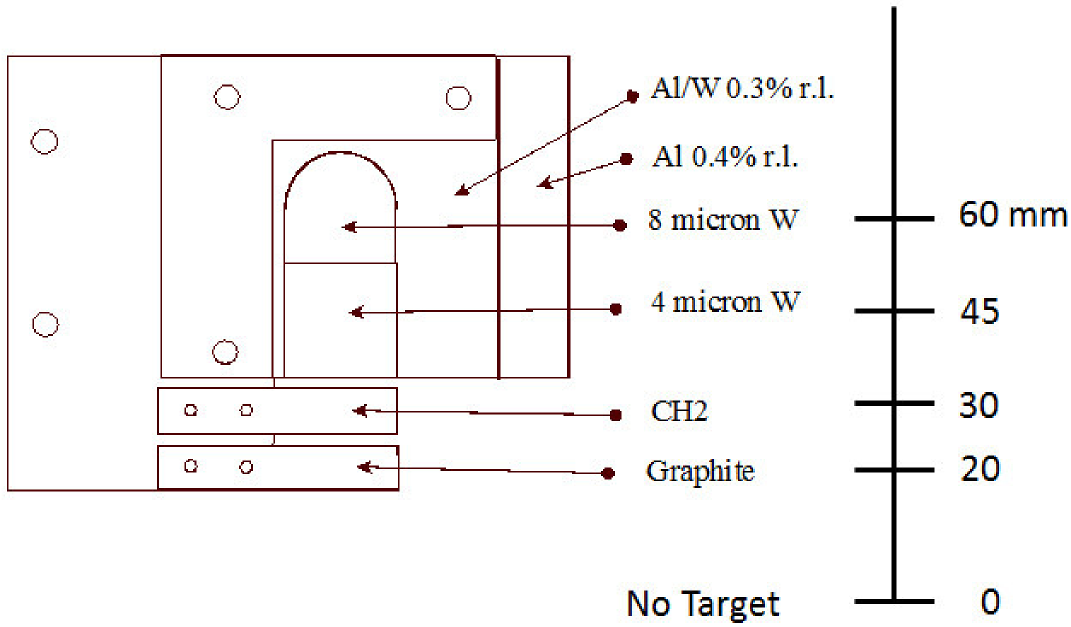

Figure 5: HPS target.

3.5.1 Setting the target

Target can be set by running the target GUI (Figure 6).

- Type in who you are.
- Call MCC to turn off the beam and click "Have you called MCC to turn off the beam?".
- Hit appropriate target button.
- Hit "Remove Target" button to remove the target.

Your name and Date and Time will be logged. The target will be placed at the nominal beam position. By providing an offset value, the target position can be adjusted vertically.

3.6 Hall-B Harps (classc3)

There are three wire harps on the Hall B beamline, 2C21, "tagger" or 2C24, and 2H03 (will be renamed to 2H00 for CLAS running). The harp launch GUI, Figure 7, enables operator to open control GUI for the desired harp. A stepper motor in conjunction with the beam halo scalers is used to perform a beam profile measurements. The harp operation is controlled from the Harp GUI, see Figure 8. During a scan the beam halo scaler GUI is controlled by the scan application (see Section 3.4).

In order to perform a harp scan one should push "SCAN" button. After the scan finished (motor position has been restored at 0.0 position) use "Analyze Scan Data" to see beam profile and fit results to the scaler distributions.

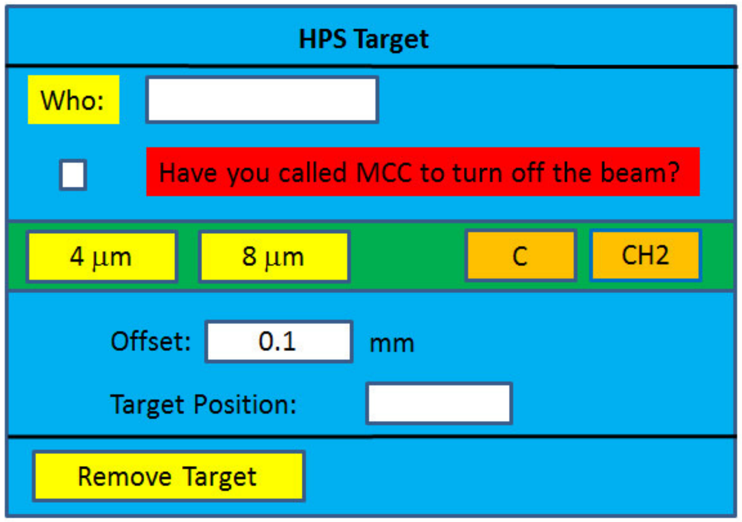

Figure 6: Target GUI

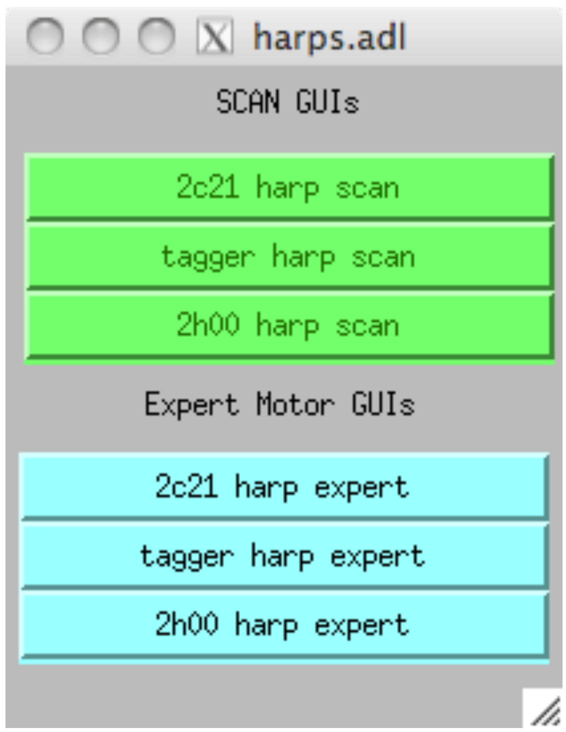

Figure 7: The main Harp medm screen. The green buttons on the top are for opening individual harp control. Cyan buttons below for expert GUIs.

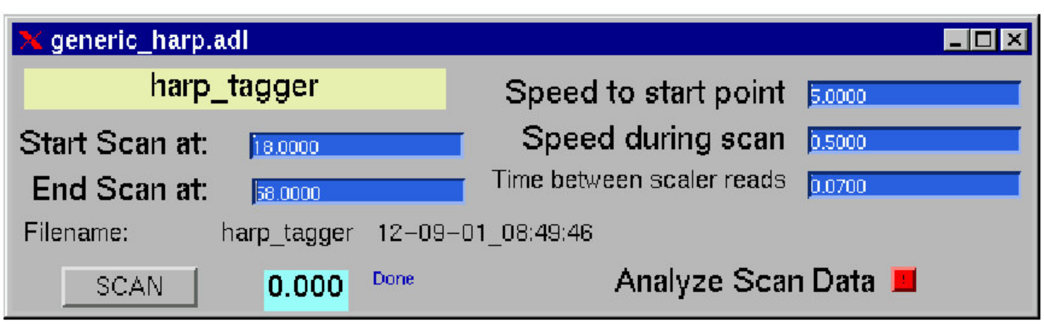

Figure 8: The tagger harp medm screen. This GUI controls a stepper motor and the halo counter scaler settings.

3.7 SVT Protection Collimator

Figure 9 shows the SVT protection collimator. “3 mm gap” and “2 mm gap” are 1cm-thick Tungsten collimator with a 3 mm gap and 2 mm gap, respectively. “3 mm gap + Foil” has a 10^{-4} r.l. Gold foil at the downstream surface. The nominal positions in the collimator coordinate are,

- Collimator out: 0 mm
- Wire: 20 mm
- Middle of 3 mm gap : 50 mm
- Middle of 3 mm gap + 10^{-4} r.l. Gold Foil: 80 mm
- Middle of 2 mm gap: 110 mm
- 10^{-4} r.l. Gold Foil: 140 mm

3.7.1 Wire Scan

Setup

- MCC is not moving the beam or changing beam conditions
- Ask MCC to mask Halo Counters in FSD as we are doing Collimator Wire Scan.
- SVT is fully retracted and the power is off.
- ECal is operational.
- Downstream Halo Counter is operational.

Scan

A wire scan can be performed from the wire scan GUI (Figure 8) which is launchable from *clas epics*. Once the scan is completed, the collimator will move to “out” position.

- Click “scan” using default values.
- When the motor is “Done”, click the red button to the right of “Analyze Scan Data”.
- Choose either ECal or Halo Counter as the detector.
- Find the beam offset (Δy) from the nominal beam position (y=20 mm).

3.7.2 Setting the collimator

Once the beam offset is measured, the collimator can be set by running the collimator GUI shown in Figure 10.

- Call MCC to turn off the beam
- Type in the beam offset value.
- Hit “3 mm + Foil”, “3 mm gap”, or “2 mm gap” button.

If you don’t provide the beam offset, the collimator will be set at the nominal position. If you provide the beam offset and hit “Reset”, the collimator nominal position will be reset by this value. The collimator position can be fine tuned by providing an arbitrary offset value. However, maximum offset value is limited to 1 mm for the 3-mm gap and 0.5 mm for the 2-mm gap.

Hitting “Rettract’ moves the collimator to y=0 mm.

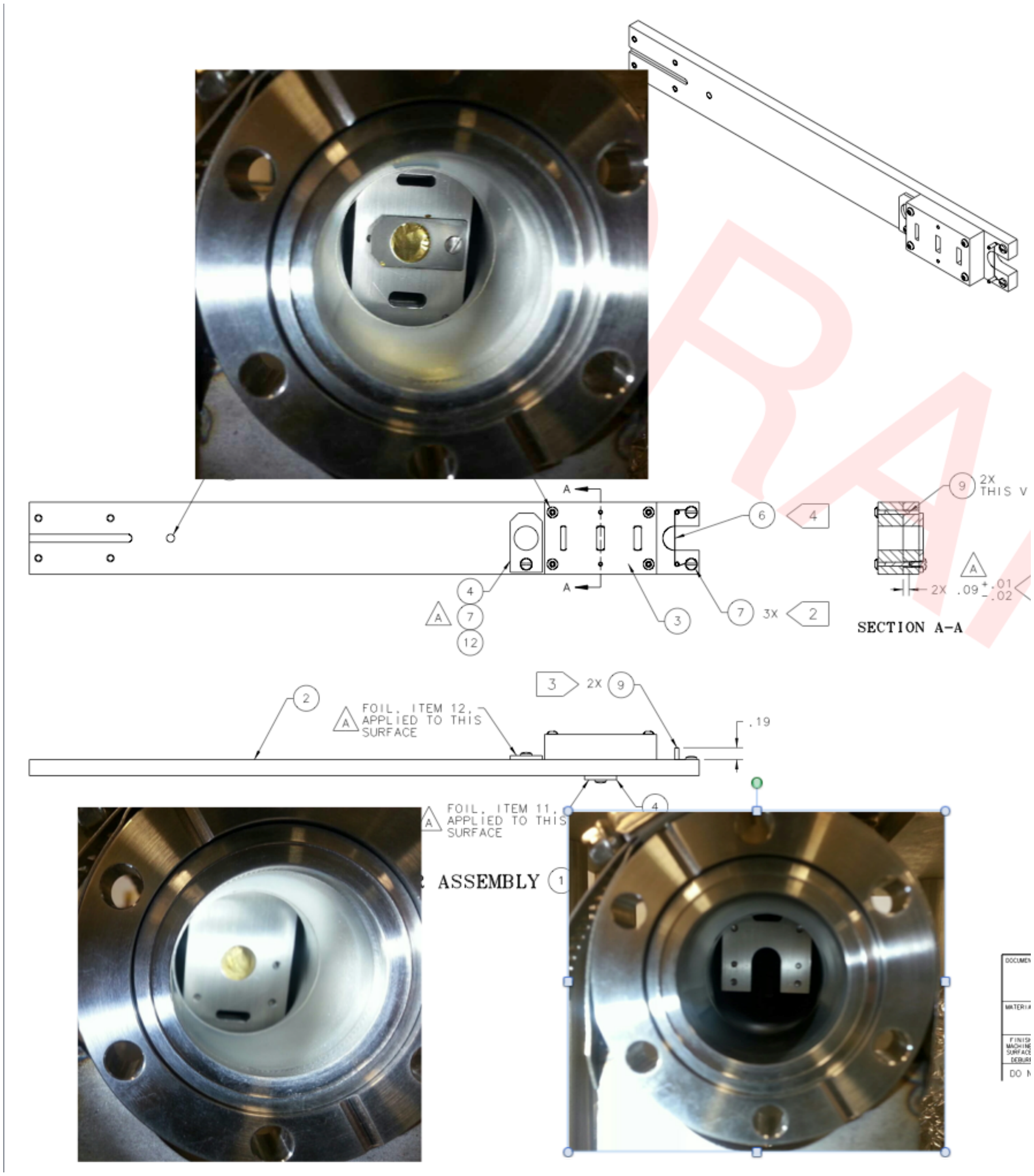

Figure 9: SVT Protection Collimator

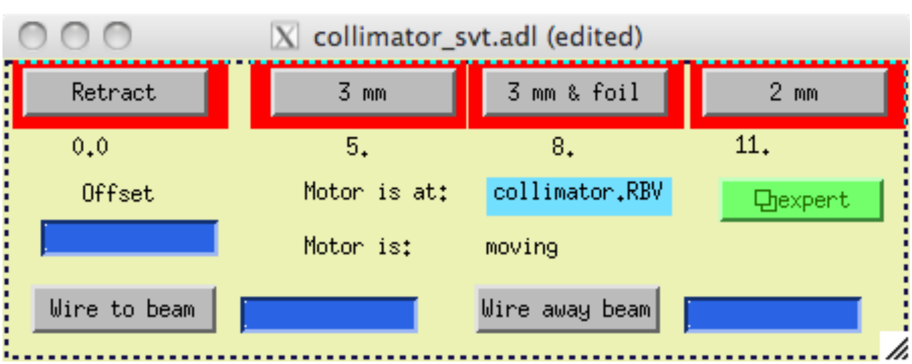

Figure 10: SVT protection collimator control GUI.

3.8 Magnets

3.8.1 Mini-Torus Magnet(classc3)

The "Frascati-1 and Frascati-2 dipoles are controlled by the Hall-B mini-torus magnet GUI (see Figure 11) launchable from "Magnets" of the *"hps_epics"*. The magnet current settings vary depending on the run conditions, check with the shift leader, Run Coordinator or PDL if you are unsure of the appropriate current setting. The power supply is 10000 A/30 V supply. In EPICS control system of this power supply the max current to the magnets will be limited to 1200 A.

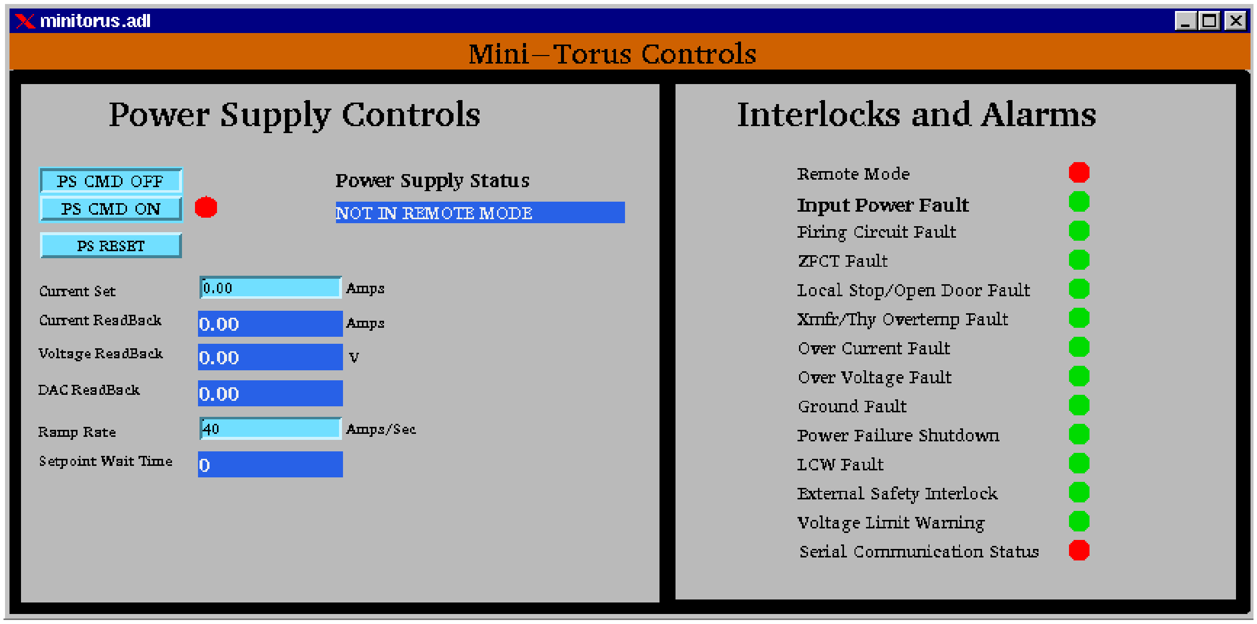

Figure 11: The mini torus power supply control GUI.

3.8.2 HPS-dipole Magnet(classc3)

The HPS-dipole magnet is fed from the Hall-B pair spectrometer magnet power supply. The power supply is controlled by a GUI (see Figure 12) launchable from "Magnet" of the *"hps_epics"*. The magnet current settings vary depending on the primary electron beam energy, check with the shift leader, Run Coordinator or PDL if you are unsure of the appropriate current setting. The magnet and power supply can operate up to ~3600Amps.

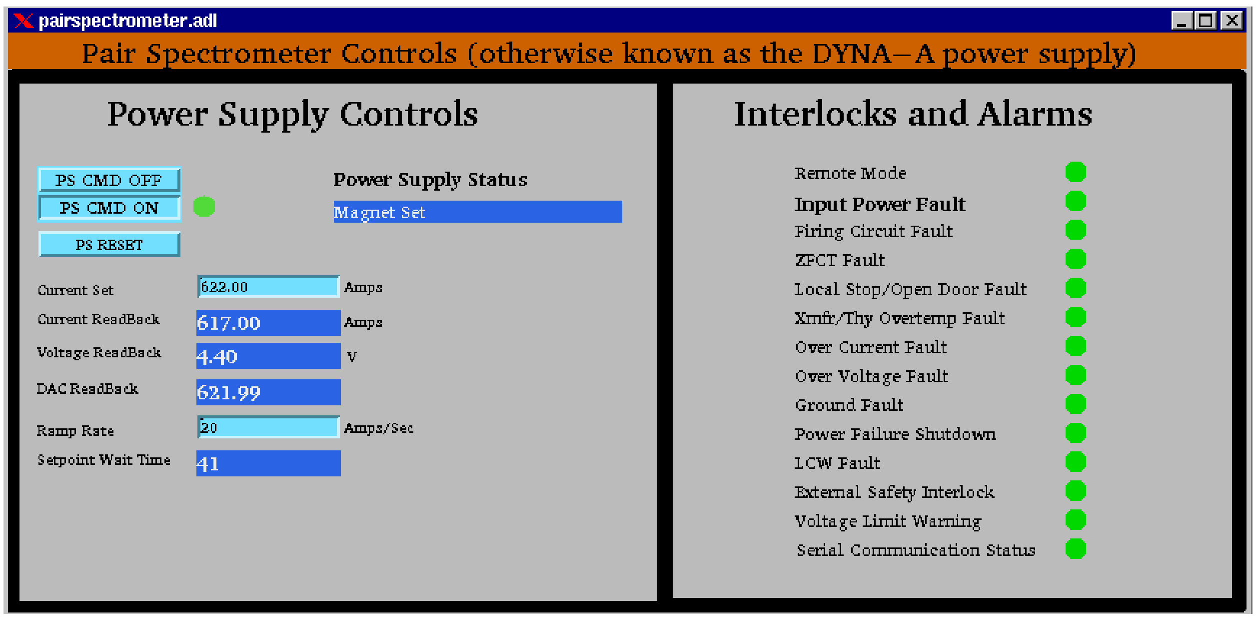

Figure 12: The mini torus power supply control GUI.