REIXS Beamline
Reference Manual

(Work in Progress)

Feizhou He

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1.0 Introduction

The Resonant Elastic and Inelastic Soft X-ray Scattering (REIXS) Beamline is a soft X-ray beamline dedicated to soft X-ray scattering and soft X-ray spectroscopy experiments. The beamline is located at 10ID-2 port of Canadian Light Source.

This document describes the setups and calibration of REIXS Beamline.

2.0 Advanced Controls

2.1 Starting the Beamline from Scratch

All valves closed

2.1.1 Beamline Pump Down

If one vacuum section has been vented, use turbo cart to pump down to below 10^{-6} Torr. Bakeout the section.

Pumps, pump down individual vacuum sections, bakeout

Before a power outage, close all gate valves to isolate each vacuum section. If the power outage is less than 2-3 days, usually the vacuum can be recovered by turning on the ion pumps in each section. Otherwise, use turbo cart to pump down each section to below 10^{-6} Torr before turning on the ion pump.

2.1.2 RSXS Endstation Pump Down

Turbo pump for scattering chamber and load lock.

Pump down the Cryo pump by either chamber turbo pump or through the roughing port on the cryo pump. Then start cryo pump.

Pump down the Thermionics 2L/s ion pump for the rotary feedthrough differential pumping. Close the valve to turbo roughing line. Connect a turbo cart, open both valves on the differential pumping line. Pump the differential pumping line to $<10^{-6}$ Torr, then start the ion pump. Current < 5mA?? Close the valve besides the 2L/s ion pump. Close the valve to turbo cart. Open the valve to 700L/s turbo roughing line.

2.1.3 Turn on the Electronics

IOC1610-201

OPI1610-201

OPI1610-202

IOC1610-403

Start VME crates

Start NIM crate

Start control software for the beamline

3.0 Beamline Setup

Power ready

Air ready

Cooling ready

Vacuum ready.

3.1 Calibrating the Beamline Components

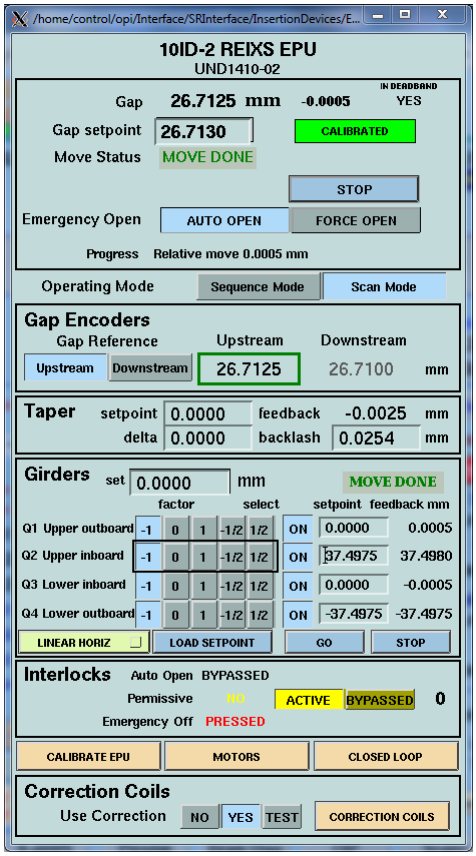
3.1.1 EPU Calibration

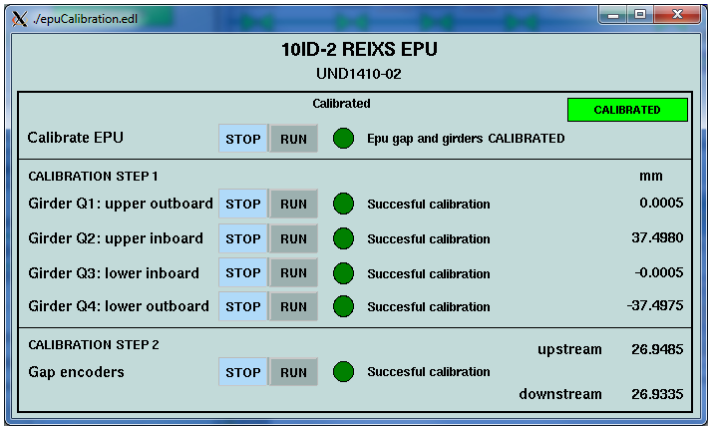
For qualified beamline staff only.

The REIXS EPU Control can be accessed by typing: `runREIXS_Epu &` from a command line window (xterm), or click the [R-EPU] button in the REIXS Advanced Control Interface.

Clicking the [Calibrate EPU] button will bring up the EPU Calibration panel. Clicking [Run] button in the "Calibrate EPU" line will automatically calibrate all five motors on the REIXS EPU. Clicking other [Run] buttons will calibrate individual motors. When all the motors are calibrated, the calibration status shows Calibrated with green beackground.

Other details of the REIXS EPU could also be accessed from this interface. **DO NOT** make adjustments without comprehensive knowledge of EPU control.



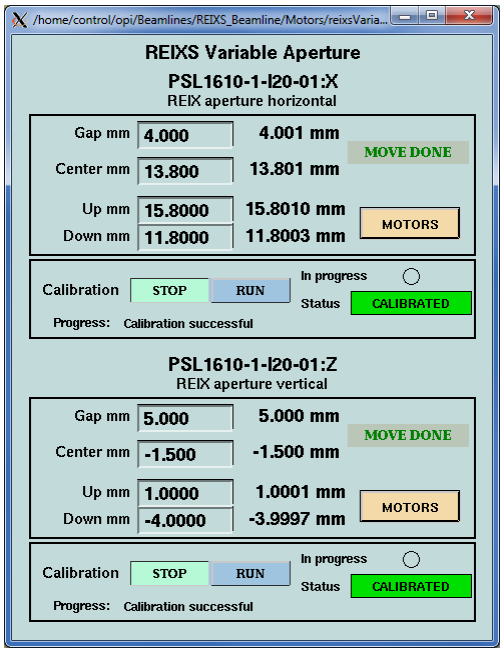


3.1.2 Calibrating Apertures and Slits

REIXS Beamline has several apertures / slits.

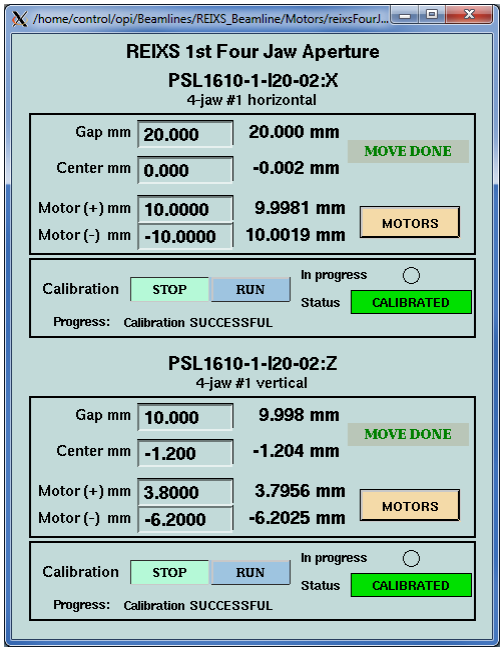
3.1.2.1 *Variable Aperture*

Variable Aperture



3.1.2.2 *4-Jaw #1 and 4-Jaw #2*

4-Jaw #1 and 4-Jaw #2



3.1.2.3 *Exit Slit*

Exit Slit has four motors.

Vertical gap: beam based calibration

Inboard and outboard blade motors are the same as 4-Jaw motors.

Roll motor

3.1.3 Calibrating Mirror positions

For qualified beamline staff only.

It is not necessary to move the mirrors for encoder calibration. Use procedure below for every motor / encoder pair for each mirror:

1. Open motor control interface for one motor.
2. Verify the settings for motor velocity, base velocity and acceleration. Make corrections if needed.
3. On Power/Backlash tab, turn off the Motor Power.
4. Go to Calibration tab, verify the values of Step Slope, Encoder Slope and Calib Position. Make corrections if needed.
5. Click the Home CW button. The motor feedback value should be changing.
6. Go to the corresponding motor, push the encoder tip back. Once the reference mark is detected, the motor feedback value will stop. The encoder is calibrated now.
7. Go back to Power/Backlash tab and turn on the motor power (or Auto Hardware for some motors).

Other details of the motor could also be accessed from this interface. **DO NOT** make adjustments without comprehensive knowledge of motor control.

3.1.4 Calibrating Chopper

Chopper must rotate in the positive direction for correct operation. If the chopper has moved in negative direction, it must rotate in positive direction for one revolution, so that the encoder can pass the home position reference mark and establish the correct angle readout.

LED indicators on the Chopper Controller in the NIM Crate show the status of the chopper system.

Once chopper is stopped, use "Move Relative" to adjust chpper position.

[SYNCD] – Chopper calibrated

[DS1] – Data stream 1 (REIXS EPU Beam)

[DS2] – Data stream 1 (SM EPU Beam)

3.1.5 Monochromator Calibration

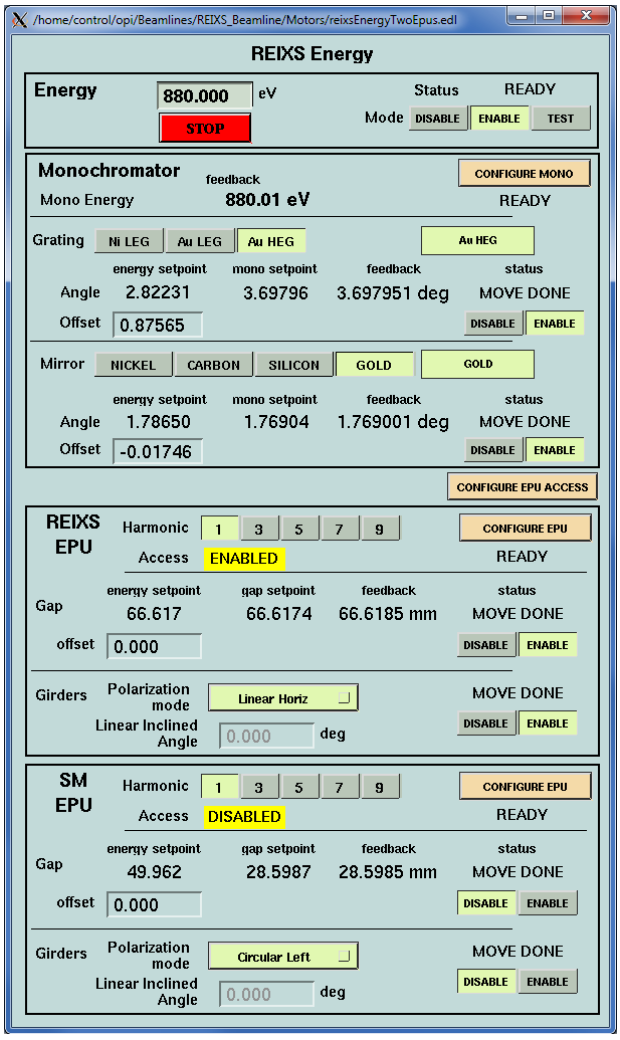
For qualified beamline staff only. DO NOT make adjustments without comprehensive knowledge of monochromator control.

Verify motor parameters: velocity, base velocity, accelaration

Translation motors calibration

In the "REIXS Energy" panel, click [ENABLE] button to activate the energy control. Use the input box to set the energy for monochromator and EPU. Click [Stop] button to stop all motors of monochromator and of EPU immediately. "Status" shows if the monochromator and EPU have reached correct setpoints.

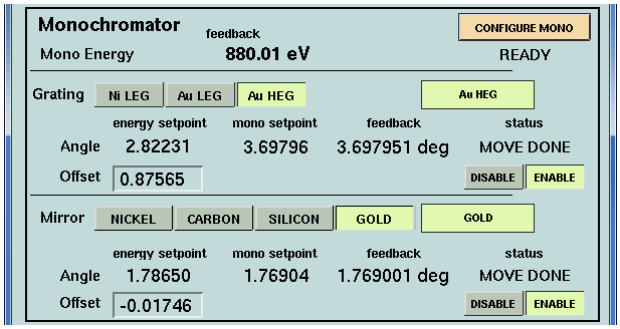
The [Disable/Enable] buttons are used to activate/deactivate individual components.



1.1.1.1 *Selecting Gratings and M2 Coatings*

The REIXS monochromator has three gratings. There are four coatings the M2 mirror.

In the "Monochromator" panel, user can select which grating and coating are used. The setpoint and feedback values are also displayed.

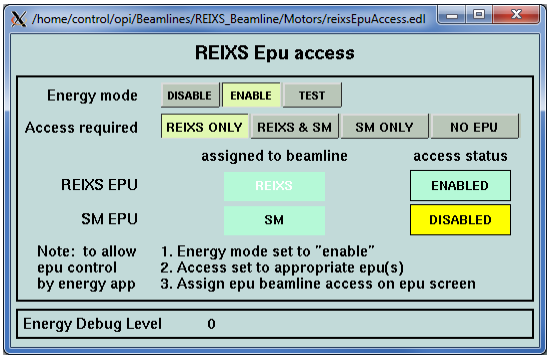


3.1.5.1 *Configure EPU Access*

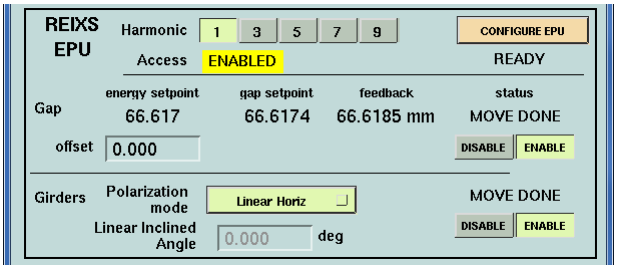
This panel is used to switch EPU access.

Normal mode: [REIXS Only]

2-in-1 mode: [REIXS & SM]



1.1.1.2 *Selecting EPU Harmonics*



Depending on the desired photon energy range, appropriate EPU harmonics shall be selected for optimum flux.

For circular polarization, only the first harmonics can be used.

For linear polarization, use the first harmonics for energy between 80 eV and 1000 eV. Use the third harmonics for energy between 800 eV to 2000 eV. Use the fifth harmonics for energy above 1500 eV.

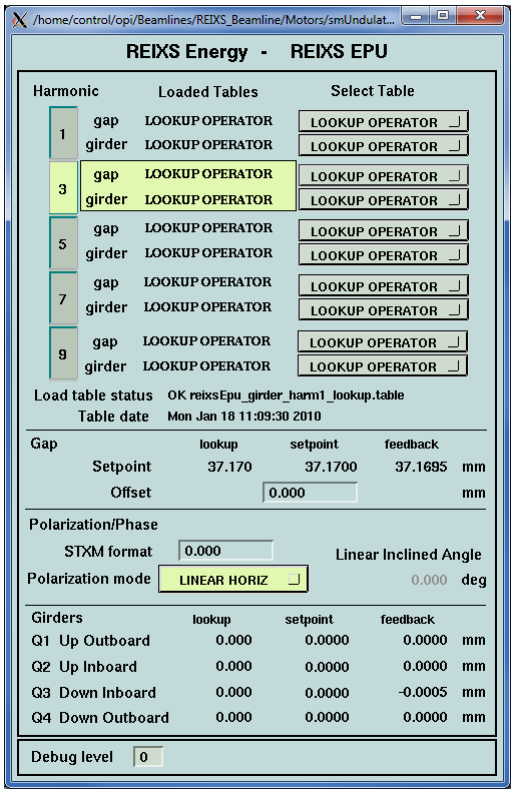
After executing the command to change EPU harmonics, the EPU does not respond immediately. The EPU harmonics will change the next time energy or polarization is changed.

When the EPU control is established, the "Access" field shows "ENABLED"

3.1.5.2 *Setup EPU Lookup Tables*

The [Configure EPU] button will bring up the panel for loading EPU lookup tables for gap and girder phase control.

Polynomial



1.1.1.3 *Monochromator Parameters*

Clicking [Configure Mono] button will bring up the following panel. In this panel, various monochromator parameters can be configured. This is to be used by beamline staff only.

Grating parameters

Line Density

Position

b2

Grating offset

Mirror Offset

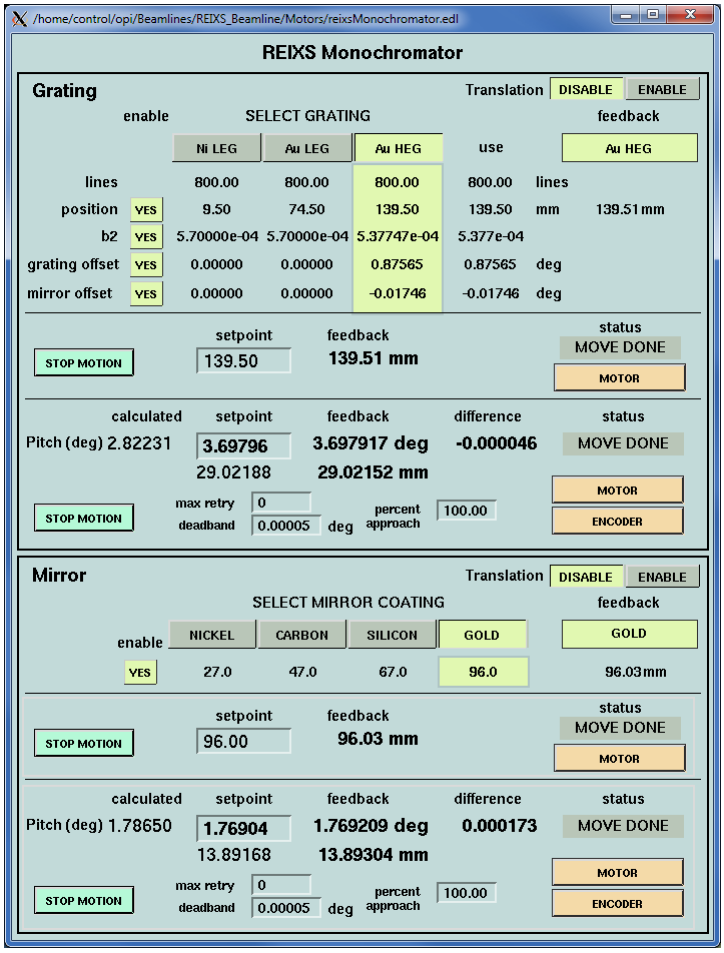
Mirror position

For both grating and mirror

Max retry: 0

Deadband: 0.00005

Percent approach: 100%



3.1.5.3 *IK320 Encoder interface*

For qualified beamline staff only. DO NOT make adjustments without comprehensive knowledge of monochromator control.

For both M2 mirror and Gratings

Sample rate 0.04sec 50Hz

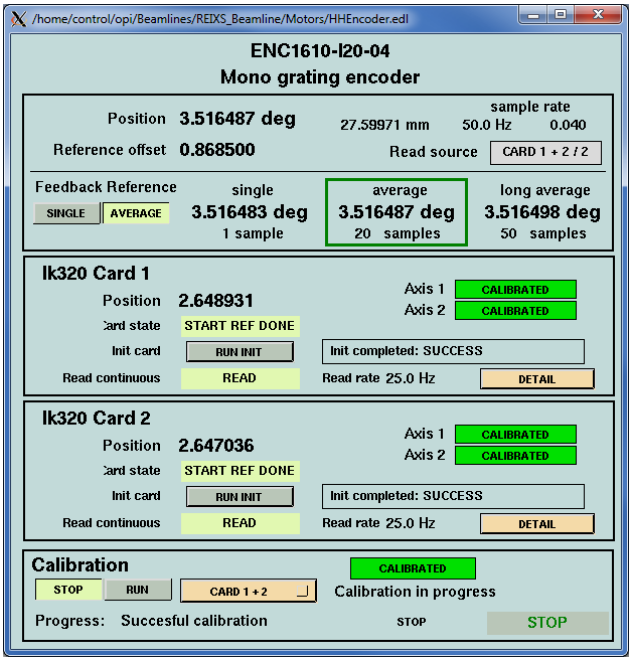
Initialization [Run Init]

"Init completed: SUCCESS"

Calibration

[Card 1 + 2] and [RUN]

"Calibrated" with green background



3.2 Calibrating the Photon Energy

3.2.1 Calibration References

3.2.1.1 *Using Gas cell*

X-ray Photoionization of gas phase

Nitrogen, Neon, Argon, Carbon monoxide or Carbon Dioxide, Oxygen

3.2.1.2 *Solid references*

Through X-ray Absorption Spectroscopy (XAS) of well-defined absorption edges

Metal, Ni, Stainless Steel

Oxides: La edge, Ni edge,

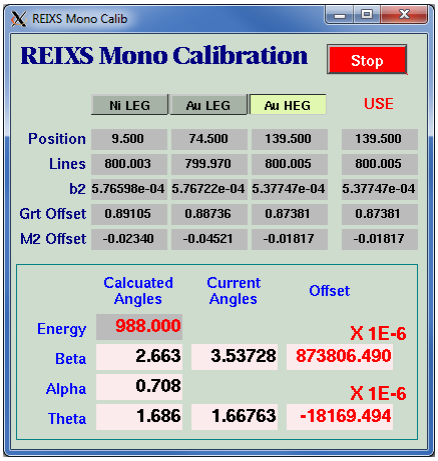
Si, graphite

3.2.2 Tuning the Monochromator Energy Scale

The REIXS Mono Calibration panel is used to fine tune the monochromator calibration.

The calibration needs to be carried out for each grating.

Using a calibration reference with known energy, optimize the flux by adjusting monochromator M2 mirror and grating pitch. Input the known energy into the red "Energy" box. Then input the two red "Offset" values into the corresponding "Grt Offset" and "M2 Offset" boxes. Click the Grating button above this column. The "USE" column will show the current used values. The monochromator is now calibrated to this reference energy.



1.1.2 Tuning the EPU Calibration

To be done only after monochromator calibration.

Needs to be done for each type of polarization.

Scan EPU gap at each energy point.

Using polynomial equations to calculate EPU gap.

4.0 RSXS Endstation Setup

Need to reach UHV. Setup motors. Setup detectors.

4.1 RSXS Endstation Pump Down

RSXS Endstation has several chambers.

4.1.1 Scattering chamber Pump Down

The main scattering chamber has a Pfeiffer Turbo pump and a CTI cryo pump.

Two gate valves

1. Open the gate valve to the turbo pump. If cryo pump is at room temperature, open the gate valve to the cryo pump.
2. Turn on roughing pump.
3. Turn on turbo pump.
4. Turn on ion gauge when the Convection gauge shows 0
5. Turn on cryo pump. The Lakeshore 211 Temperature Monitor shows the cryo pump temperature, ~15K during the normal operation.

RGA on the Scattering Chamber.

4.1.2 Rotary Feedthrough Pump Down

The 2L ion pump on rotary feedthrough needs to be pumped down before start.

1. Close the valve to the main chamber roughing line.
2. Connect a turbo cart to the pumping port for the rotary feedthrough.
3. Open the valve between the first and second stage of the rotary feedthrough.
4. Turn on the turbo cart.
5. When the turbo cart reaches base pressure, turn on the small ion pump. Green light
6. Close the valve between the first and second stage of the rotary feedthrough.
7. Open the valve to the main chamber roughing line.
8. Close the valve to the pumping port for the rotary feedthrough.
9. Stop the turbo cart.

4.1.3 Loadlock Pump Down

Pfeiffer Turbo pump:

1. Close loadlock door. Close gate valve.
2. Turn on roughing pump
3. Turn on turbo pump. The venting valve will close automatically.
4. Turn on ion gauge when the Convection gauge shows 0

4.1.4 Transfer chamber Pump Down

4.2 Setup RSXS Endstation Electronics

Turn on power to the NIM Crate and VME Crate in the endstation electronics rack.

4.2.1 Detectors

Photodiode: connected to Electrometer through a Triax cable

TEY: SR-570 Current Amplifier

Channeltron: Ortec

Micro-Channelplate (MCP):

4.2.2 Scaler Setup

SIS3820

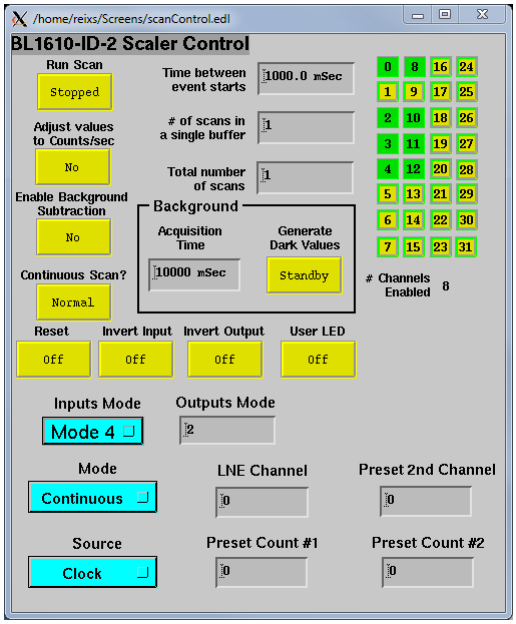
Scaler Setup

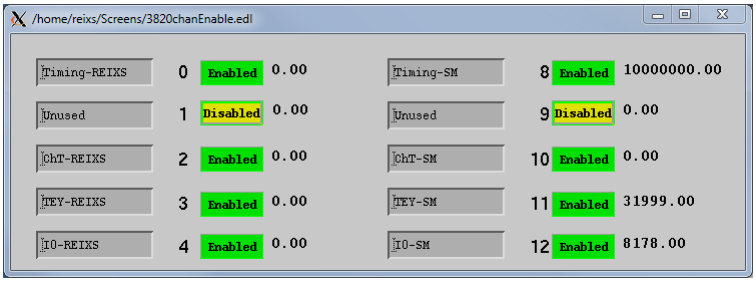
Input Mode: Mode 4

Output Mode: 2

Mode: Continuous

Source: Clock





4.2.3 Temperature Control Setup

Lakeshore 325 Temperature control

Temperature Sensor: Si Diode DT-670

Heater: 25 Ω, 25W max

PID setting

4.3 Setup Motors and SPEC

There are nine AML UHV motors and two Attocube piezo motors in the Scattering chamber.

4.3.1 AML UHV Motors

The AML UHV motors are controlled by SPEC as epics motors. The APS motor record connects to CLS motor record through a wrapper software.

Motor parameters:

TTH, tth, …

Motor temperature: Omron Temperature monitor, keep temperature below 65°C.

4.3.2 Attocube ANC350 Controller

The two piezo motors inside the polarization analyzer are controlled by the Attocube ANC350 Controller.

Initial setup

To setup the Attocube controller and motors, quit FOURC first. After power on the ANC350, from Windows computer, open the Attocube folder on the desktop.

The software "dgdiscvr.exe" is used to setup the IP address for the ANC350 controller.

The ANC350 is connected to the REIXS VLAN (642)

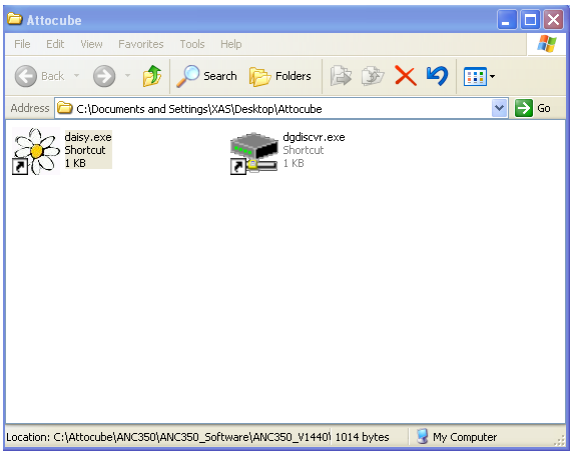
Host name: MC2E1610-401

Domain: clsi.ca

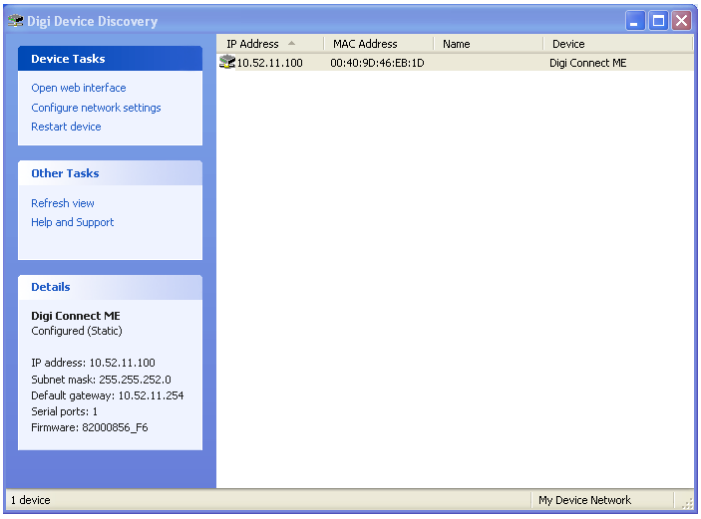
Static IP address: 10.52.11.100

Subnet mask: 255.255.252.0

Default Gateway (routers): 10.52.11.254

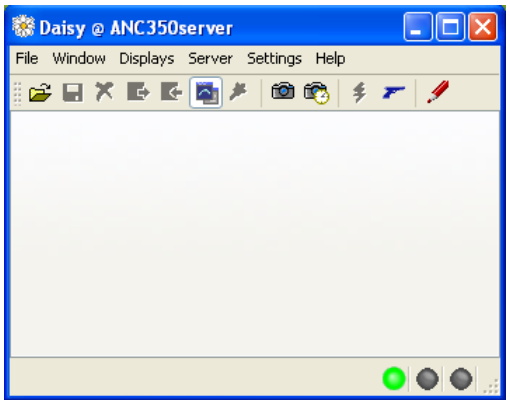


Confirm the network connection is established.

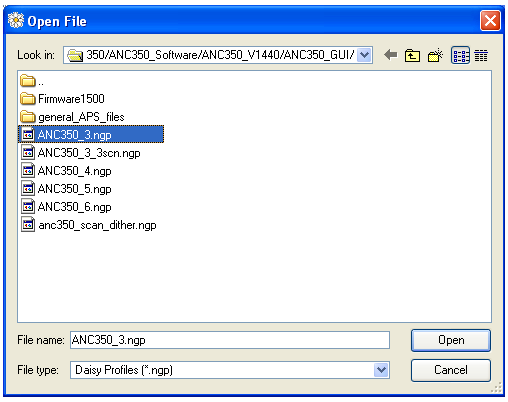


Software "daisy.exe" is used to setup the motor parameters.

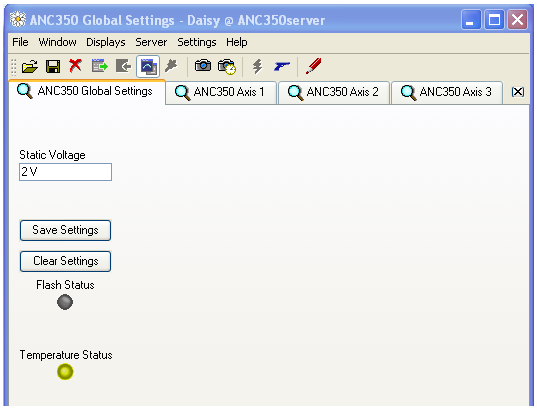
Open the "daisy" software. It will try to connect to the ANC350 server. Once connected, the left indicator at the bottom will be green. If it failed to connect to ANC350, click the "start" icon (like a thunderbolt) to try again.



Once connected to the ANC350, click "Open File" icon, and select "ANC350_3.ngp" profile. There will be four tabs opened in "Daisy" interface.

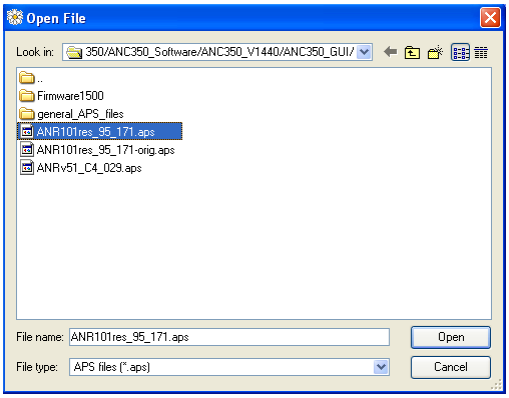


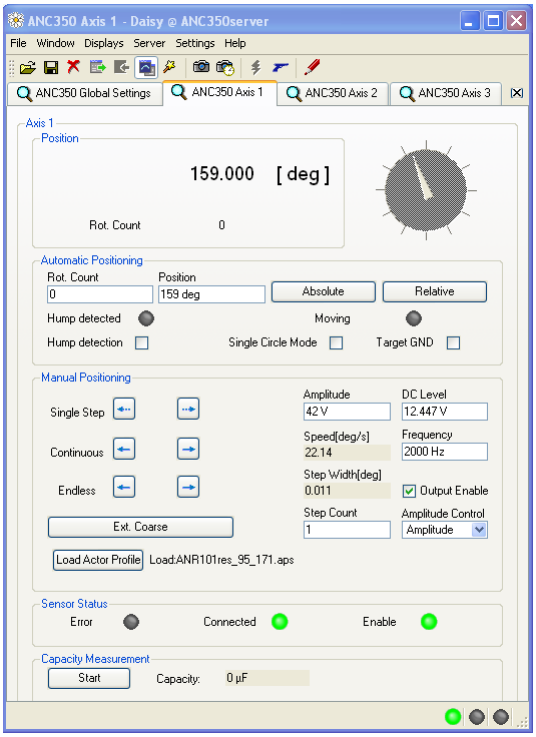
The first tab is Global Settings. Keep the default values.



The second tab is for ANR101/RES Motor. This motor is used to position the multilayers for either horizontal polarization or vertical polarization.

The default motor profile can be loaded using "Load Actor profile" button and then choose "ANR101res_95_171.aps" file.



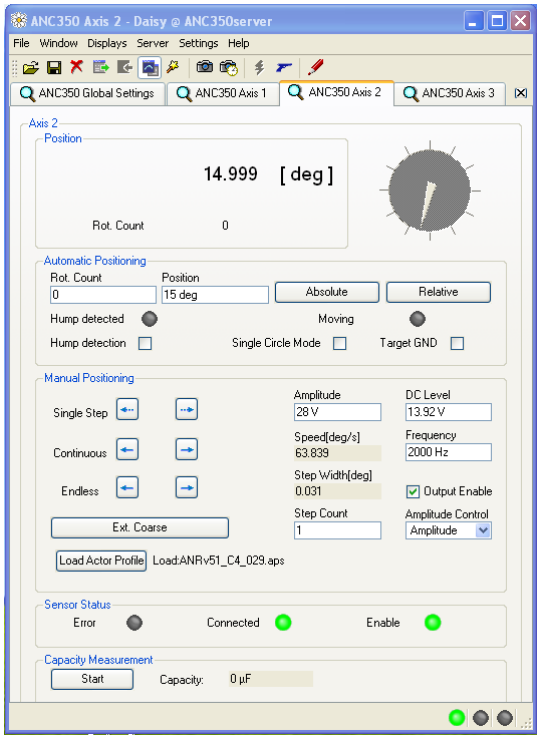


Uncheck the "Target Ground" checkbox. This parameter could not be changed within FOURC.

The third tab is for ANRv51/RES Motor. This motor is used to change the multilayers and also to scan the analyzer theta angle.

The default motor profile can be loaded using "Load Actor profile" button and then choose "ANRv51_C4_029.aps" file.

Also uncheck the "Target Ground" checkbox.



The fourth tab (ANC350 Axis 3) is not used.

Now close all tabs by clicking the "close" icon (red cross). And then disconnect the ANC350 server by clicking the "shutdown" icon (blue handgun).

The ANC350 front panel is shown above. The first slot is the master module, and shows the driving voltage of the module in focus. The second and third modules are for the Analyzer and ATH motors, respectively. The current angular position or holding voltage is shown. Refer to Attocube User Manual for more information.

Setup in FOURC

Start SPEC using "runFOURC". If you see startup message as following, quit SPEC and try again (or use "reconfig"):

```
Getting configuration parameters from "SPECD/fourc/config".
Bad packet from Attocube.
Purported Attocube ANC350 on "MC2E1610-401.clsi.ca" is unusable.
ANC350 motor "ana" (unit 0, ch 0) unusable:  controller unresponsive.
ANC350 motor "ath" (unit 0, ch 1) unusable:  controller unresponsive.
```

The following startup message means communication with ANC350 has been established:

```
Getting configuration parameters from "SPECD/fourc/config".
Using Attocube ANC350 (fw 0.0.2.1 new) on "MC2E1610-401.clsi.ca".
Found ANC350 chan 0 for "ana", resistive, 0.011 deg/step
Found ANC350 chan 1 for "ath", resistive, 0.031 deg/step
```

The two motors are:

Analyzer	ana	ANR101/RES
ATH	ath	ANRv51/RES

Both ana and ath motors have resistive encoders. The real time position is displayed on the ANC350 front panel.

From SPEC, use `motor_par()` function to change the motor parameters. Refer to SPEC help page "Attocube" for more information. Be careful the unit of the parameters.

If FOURC reports discrepancy between the setpoint and feedback, answer "no" to keep using the encoder (feedback) value as the true motor position.

`motor_par(ana,"dump")` and `motor_par(ath,"dump")` commands can be used to list all the parameters for Attocube motors. See Appendix C for typical parameters.

4.3.3 Macro Motors

The photo energy is a macro motor in SPEC – engy

Voltage Source?

Linear Inclined Polarization angle – lian

4.4 Setup SPEC Control

SPEC control

Config: Motors, Devices, Scalers

Macros: Macro Motors, Macro Hardware, Pre and Post

Polarization, harmonics

Energy

Sample Temperature

5.0 XES Endstation Setup

5.1 XES Endstation Pump Down

Sample Chamber

Grating Chamber

Detector Chamber

5.2 Setup XES Endstation Electronics

Motion control

Gratings

Microchannel Plate (MCP)

Appendix A: REIXS Beamline Motor Settings

Motor Settings

Appendix B: REIXS Information

[telnet]
telnet ioc1610-201 10000

application	ioc	port	
variableAperture	IOC1610-201	10000	variable aperture for SM and REIXS
reixsMotors	IOC1610-201	10001	motors on REIXS beamline
reixsChopper	IOC1610-201	10002	chopper on REIXS beamline
HHEncoder	IOC1610-201	10003	encoders for REIXS mono
reixsEnergy	IOC1610-201	10004	set up energy on beamline
uofsMotors	IOC1610-201	10011	motors for U of S endstation
apsMotors	IOC1610-201	10021	motors for UBC endstation
picoammeter	IOC1610-108	10000	picoammeters in POE
picoammeter	IOC1610-022	10000	picoammeters along beamline
keithleyMeter	IOC1610-401	10000	REIXS Keithley Meters for RSXS
LakeShore325	IOC1610-401	10001	REIXS Lakeshore Controller for RSXS
SIS3820	IOC1610-403		SIS3820 Scaler for RSXS

[Example]
control@OPI2031-001:181 >telnet ioc1610-201 10002
Trying 10.52.8.2...
Connected to ioc1610-201.cs.clsi.ca (10.52.8.2).
Escape character is '^]'.
@@@ Welcome to the procServ process server (procServ Version 2.4.0)
@@@ Use ^X to kill the child, auto restart is OFF, use ^T to toggle auto restart
@@@ procServ server PID: 29993
@@@ Server startup directory: /etc/rc.d/init.d
@@@ Child startup directory: /iocApps/REIXS_Beamline/IOC1610-201/REIXS_IK320_Encoders
@@@ Child started as: /bin/sh
@@@ Child "/bin/sh" PID: 30749
@@@ procServ server started at: Jul 02, 2009 11:00:56 AM
@@@ Child "/bin/sh" started at: Jul 02, 2009 11:14:15 AM
@@@ 2 user(s) and 0 logger(s) connected (plus you)

^C	Kill
^R	restart
^]	talk to telnet
quit	exit telnet

[Restart Sub-Process]
[Example] Fix mono mirror angle glitch:

telnet IOC1610-201 10003	telnet into the IOCApp ProcServe:
seqShow	list processes:
seqStop monoAngle	stop unresponsive process (monoAngle for mono glitch)

To lookup the restart command, find iocApp in directory /iocApps/REIXS_Beamline, eg:
/iocApps/REIXS_Beamline/IOC1610-201/REIXS_IK320_Encoders (for mono glitch)

st.cmd contains the seq commands with the required parameters (there are two for the mono glitch):

seq monoAngle "deviceLabel=GRATING, monoDevice=MONO1610-I20-01:grating, unit=deg, motor=SMTR1610-I20-04, encoder=ENC1610-I20-04, motorUnit=mm"

seq monoAngle "deviceLabel=MIRROR, monoDevice=MONO1610-I20-01:mirror, unit=deg, motor=SMTR1610-I20-02, encoder=ENC1610-I20-02, motorUnit=mm"

Run these command from the procServe telnet session to restart the process.

[Clear Registers]

Start up application with VME could run out of registers. Use
/iocApps/vme-commands/clearMaps

Need to logon to IOC1610-201

/iocApps/1100_drv/clearMaps /dev/sis1100_1 0	will clear register (0) for VA application
/iocApps/1100_drv/clearMaps /dev/sis1100_1 1 5	will clear registers (1-5) for reixsMotors application
/iocApps/1100_drv/clearMaps /dev/sis1100_1 6	will clear register (6) for reixsChopper application
/iocApps/1100_drv/clearMaps /dev/sis1100_1	will clear all registers
/iocApps/1100_drv/clearMaps /dev/sis1100_2	will clear all registers for IK320

[Computer ID]

REIXS Main IOC:	IOC1610-201
REIXS OPI:	OPI1610-203, OPI1610-204
RSXS IOC:	IOC1610-403
RSXS Temp:	IOC0000-045

Tony's computer: OPI2031-001
/home/wilsont/Epics/Sandbox/epics_local/cs-apps/Beamlines/REIXS_Beamline

Appendix C: Attocube Motor Settings

Typical Attocube motors parameters. Some parameters will be updated during operation. Some parameters are read-only (ro). Refer to SPEC help page "Attocube" for more information.

ana motor

```
296.FOURC> motor_par(ana,"dump")
                    Direction:  forward (0)                         "actordir"
                    Loop gain = 0.00041 deg/V (410)                "actorgain"
                  Loop offset = 15000 mV                          "actoroffset"
                Approach speed:  disabled (0)                    "adaptsetpctrl"
   Setpoint for speed feedback:  amplitude (1)                        "amplctrl"
         Speed feedback factor = 1                                "amplctrlavg"
    Speed feedback sensitivity = 10 (10000)               "amplctrlsensitivity"
                    Amplitude = 42000 mV                             "amplitude"
             Capacitance (ro) = 1684                               "capacitance"
                     DC level = 12447 mV                              "dclevel"
                    Frequency = 2000 Hz                             "frequency"
               Hump detection:  enabled (1)                        "humpenable"
            Maximum amplitude = 70000 mV                             "maxampl"
            Maximum frequency = 2000 Hz                             "maxfrequ"
Max position for actuator (ro) = -272000 deg (-271999936)              "maxpos"
Min position for actuator (ro) = -272000 deg (-271999936)              "minpos"
        Optical sensor periods = 1000 per deg                          "period"
                 Position (ro) = 159.002 deg (159002)                 "position"
    Minimum position of sensor = 0 deg                              "positionmin"
    Maximum position of sensor = 320 deg (320000)                   "positionmax"
          Position loop time = 0.0005 ms (500)                      "poslooptime"
            Reference offset = 0 deg                                  "refoffset"
       Reference position (ro) = 1.129 deg (1129)                        "refpos"
    Reference voltage (global) = 2000 mV                              "refvolt"
                Output relays = 1                                      "relays"
                Movement type:  rotary (1)                             "rotary"
        Sensor-average factor = 6                                    "sensoravg"
             Sensor direction:  forward (0)                          "sensordir"
     Internal signal averaging = 6                                   "sensorres"
                 Sensor units = 20 deg                              "sensorunit"
       Shortest way algorithm:  disabled (0)                     "singlecircle"
        Target approach speed = 0.01 deg/sec (10000)                 "slowspeed"
                    Speed (ro) = 22.14 deg/sec (22140)                   "speed"
          Approach speed gain = 1 Hz (1000)                         "speedgain"
              Step width (ro) = 0.011 deg (11)                     "step_width"
                  Sticky hump:  enabled (1)                       "stickyhump"
              Hump sensitivity = 200 deg                       "humpsensitivity"
       Minimum steps for hump = 10 steps                          "humpstepsmin"
   Minimum time frame for hump = 500 msec                             "humptime"
      Position feedback factor = 6                                "targetctrlavg"
 Position feedback sensitivity = 8000 (8000000)           "targetctrlsensitivity"
          Positioning accuracy = 0.002 deg (2)                     "targetrange"
 Minimum hold-time for success = 300 msec                           "targettime"
       Resistive transfer gain = 332.03 deg/V (332030)            "transfergain"
                    Sensor type:  resistive (1)                   "transfertype"
```

ath motor

```
297.FOURC> motor_par(ath,"dump")
                    Direction:  forward (0)                         "actordir"
                    Loop gain = 0.0014 deg/V (1400)                "actorgain"
                  Loop offset = 5200 mV                           "actoroffset"
                Approach speed:  disabled (0)                    "adaptsetpctrl"
   Setpoint for speed feedback:  amplitude (1)                        "amplctrl"
         Speed feedback factor = 1                                "amplctrlavg"
    Speed feedback sensitivity = 10 (10000)               "amplctrlsensitivity"
                    Amplitude = 28000 mV                             "amplitude"
```

```
             Capacitance (ro) = 2077                                "capacitance"
                    DC level = 16224 mV                                 "dclevel"
                   Frequency = 2000 Hz                                 "frequency"
              Hump detection:  enabled (1)                            "humpenable"
            Maximum amplitude = 70000 mV                                "maxampl"
            Maximum frequency = 2000 Hz                                 "maxfrequ"
Max position for actuator (ro) = 88.123 deg (88123)                     "maxpos"
Min position for actuator (ro) = 83.217 deg (83217)                     "minpos"
        Optical sensor periods = 1000 per deg                           "period"
              Position (ro) = 15.002 deg (15002)                        "position"
    Minimum position of sensor = 0 deg                                  "positionmin"
    Maximum position of sensor = 325 deg (325000)                       "positionmax"
         Position loop time = 0.0001 ms (100)                           "poslooptime"
           Reference offset = 0 deg                                     "refoffset"
       Reference position (ro) = 4.098 deg (4098)                       "refpos"
    Reference voltage (global) = 2000 mV                                "refvolt"
              Output relays = 1                                         "relays"
              Movement type:  rotary (1)                                "rotary"
        Sensor-average factor = 6                                       "sensoravg"
             Sensor direction:  forward (0)                             "sensordir"
     Internal signal averaging = 6                                      "sensorres"
              Sensor units = 20 deg                                     "sensorunit"
       Shortest way algorithm:  disabled (0)                          "singlecircle"
        Target approach speed = 0.01 deg/sec (10000)                    "slowspeed"
                  Speed (ro) = 63.839 deg/sec (63839)                       "speed"
          Approach speed gain = 1 Hz (1000)                             "speedgain"
              Step width (ro) = 0.031 deg (31)                          "step_width"
                   Sticky hump:  enabled (1)                            "stickyhump"
             Hump sensitivity = 200 deg                              "humpsensitivity"
       Minimum steps for hump = 10 steps                                "humpstepsmin"
   Minimum time frame for hump = 500 msec                                   "humptime"
      Position feedback factor = 6                                    "targetctrlavg"
 Position feedback sensitivity = 1000 (1000000)                "targetctrlsensitivity"
          Positioning accuracy = 0.002 deg (2)                          "targetrange"
 Minimum hold-time for success = 300 msec                               "targettime"
       Resistive transfer gain = 341.483 deg/V (341483)                 "transfergain"
                  Sensor type:  resistive (1)                           "transfertype"
```