NSLS-II SRX Documentation

SRX

Jun 16, 2021

CONTENTS:

CHAPTER

ONE

INTRODUCTION TO SRX

The Sub-micron Resolution X-ray Spectroscopy (SRX) beamline at the NSLS-II supports a wide variety of scientific use-cases, ranging from geoscience through energy materials. Facilities include state-of-the-art, sub-micron focusing X-ray optics and a flexible sample environment.

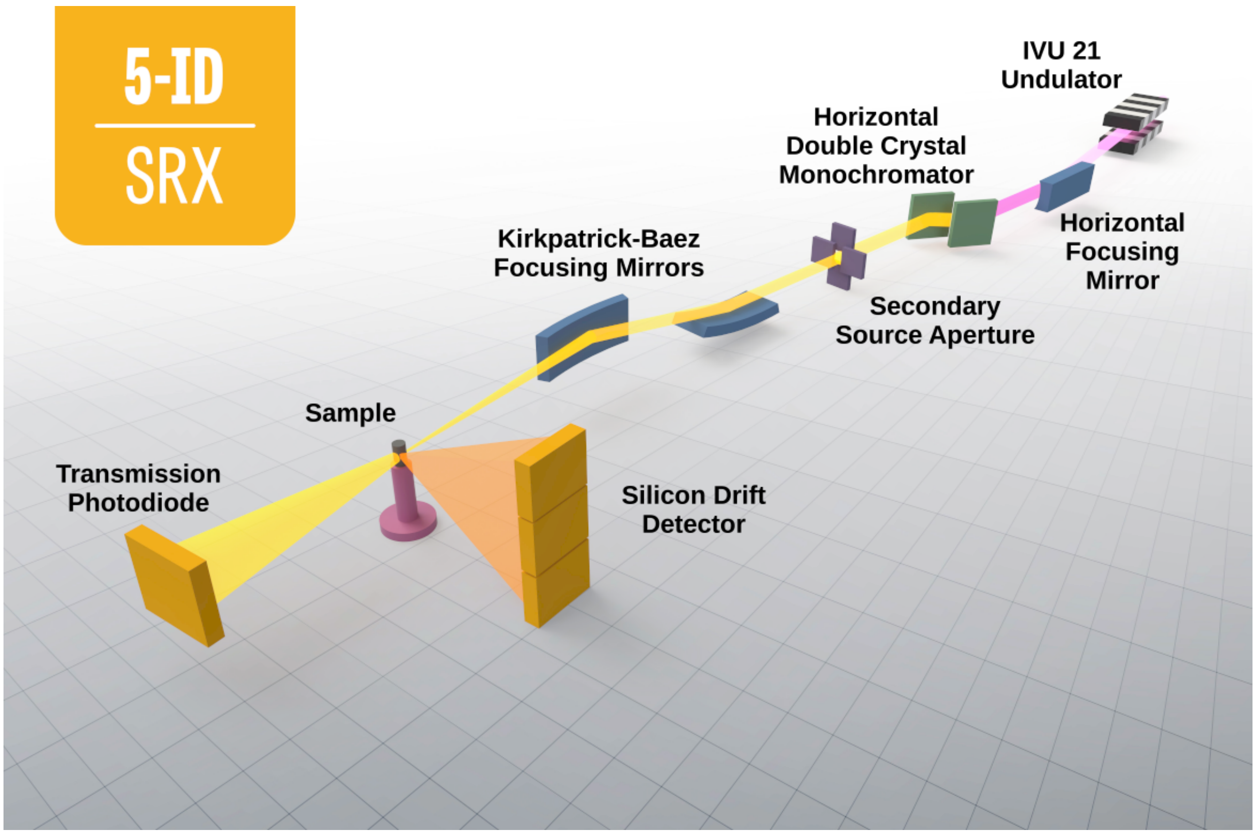

Fig. 1: A schematic of the SRX beamline at the NSLS-II.

CHAPTER

TWO

USEFUL COMMANDS

Below is a list of useful commands for running the SRX beamline. Previous commands can be seen by hitting the up arrow in Bluesky. To search through them, you can start typing a command before hitting the up arrow to filter your history.

2.1 Starting Bluesky

Start Bluesky - *Start Bluesky from the terminal.*

```
$ bsui
```

2.2 General Functions

Change X-ray energy - *Either command can be used below. The energy can be entered in units of eV or keV.*

```
Bluesky@SRX [1] energy.move(7.2)
Bluesky@SRX [2] %mov energy 7.2
```

Optimize the beam - *Maximize the X-ray flux.*

```
RE(peakup_fine())
```

Setting a region of interest - *Set the ROI on the detector. The specific edge is optional.*

```
Bluesky@SRX [1] setroi(1, 'Fe')
Bluesky@SRX [2] setroi(1, 'Fe', 'ka1')
```

2.3 XRF Imaging

Fly scan - *Perform a fly scan. Return an image with dimensions (numX, numY)*

```
Bluesky@SRX [1] RE(nano_scan_and_fly(startX, stopX, numX,
                                     startY, stopY, numY, dwell))
Bluesky@SRX [2] RE(nano_y_scan_and_fly(startY, stopY, numY,
                                       startX, stopX, numX, dwell))
```

Step scan - *Perform a step scan. Note: these arguments take a step size, not the number of points.*

```
Bluesky@SRX [1] RE(nano_xrf(startX, stopX, stepX,
                            startY, stopY, stepY, dwell))
```

2.4 XAS Spectroscopy

Print element binding energies - *Print the binding energies for the element of interest. The "best" edge can be returned as available.*

```
Bluesky@SRX [1] Fe_k = getbindingE('Fe')
```

Print element emission energies - *Print the emission energies for the element of interest.*

```
Bluesky@SRX [1] getemissionE('Fe')
```

XANES scan - *Run a XANES scan. This scan has 3 regions with different steps spanning the iron K-edge.*

```
Bluesky@SRX [1] RE(xanes_plan(erange=[Fe_k-50, Fe_k-10, Fe_k+50, Fe_k+150],
                              estep=[2.0, 1.0, 2.0],
                              acqtime=1.0,
                              samplename='Fe foil',
                              filename='Fe_foil']))
```

2.5 Troubleshooting

Pause a scan - *The scan will pause at the next checkpoint.*

```
CTRL+C
```

Urgently stop a scan - *With each CTRL-C, Bluesky raisens the urgency of stopping the scan.*

```
CTRL+C x20
```

Resume a scan - *A scan can be resumed after pausing.*

```
Bluesky@SRX [1] RE.resume()
```

Stop a scan - *Stop a scan and label the scan as a success or failure.*

```
Bluesky@SRX [1] RE.stop()   # Label scan as success
Bluesky@SRX [2] RE.abort()  # Label scan as failure
```

CHAPTER

THREE

BEAMLINE STAFF PAGES [STAFF ONLY]

The information provided on this page is directed towards helping beamline staff.

3.1 Quick Links

1. Analog camera web server
2. Ceiling camera web server
3. Trac ticket system
4. Jira ticket system
5. SRX Posted SAFs
6. SRX Olog
7. SRX Radiation Safety Component Checklist
8. NSLS-II Controls Documentation
9. NSLS-II IP Address Management
10. NSLS-II Sharepoint Documentation
11. Former SRX Wiki Staff Page

Todo:

- Fix IOCs reference

3.2 Setting up Users

1. Post SAF to PASS
2. **Update user-specific metadata**
    - Open /nsls2/users/xf05id1/.ipython/profile_collection/startup/90-userdata.py
    - Update proposal dictionary with information from posted SAF. Save.
    - Restart bluesky.
3. Perform beamline specific training. 5-ID BST Form

3.3 Beamline Setup

These tasks are typically done once a cycle

Todo:

- Beamline alignment
- Setting up the Merlin
- Setting up the Dexela
- Setting up the Xspress3

3.3.1 Preparing for a new cycle

This is a comprehensive list of things to consider before the start of a cycle.

1. Close all system safety work permits.
2. Check cryocooler pressure and load.
3. Check all vacuum, temperature, water systems.
4. Check and top-off the PPS burn-through.
5. Confirm the RGA in the A-hutch is connected and scanning.
6. Perform a Radiation Safety Component Checklist.
7. Post a valid SAF and ESR.
8. Test and deploy the latest bluesky environment.
9. Setup lsyncd.

3.3.2 Aligning the Beamline

Historically, the beamline and storage ring take about a day to stabilize. Therefore, on day 1 of operations, it makes sense to ope

1. Previous motor positions should be captured at the end of each cycle. As a precaution, capture the current motor positions.
2. **Check front-end (FE) slits, white-beam (WB) slits, and mirror (HFM) position.**
   - Open the gap of the undulator to 18 000 m. Insert the camera in the HFM tank.
   - Open the FE shutter. Open the WB slits all the way (4 mm x 4 mm). Turn off mirror pitch feedback and reset the voltage to 30 V. Remove the HFM by dropping the pitch to 0.0 mrad and translating in the positive direction by 3 mm.
   - Tweak the FE slits so the slits are just protecting the mask.
   - Tweak the WB slits so the slits are centered. Return the WB slit gaps to their previous values (0.5 mm V x 2.0 mm H).
   - Bring the HFM back in. Center the mirror on the incoming beam and confirm the mirror is parallel to the beam. Pitch to the nominal 2.5 mrad. Enable the mirror pitch feedback.
   - Close the FE shutter and retract the camera.

3. **Align the monochromator to allow light through.**
    - With the FE shutter closed, insert the BPM 1 camera (*this can be slow*).
    - In bluesky, set the energy to the last used value. If starting from scratch, choose a higher energy such as 12 keV. By using bluesky, this will set the undulator gap, and monochomator positions to a reasonably close value.
    - Open the pink-beam (PB) slits to a 4.0 mm gap to make sure they are fully open.
    - Open the FE shutter and hopefully light will come through onto the camera.
    - If not, set the exposure time on the camera to something large, like 0.1 s. This will help you see the light come through while you scan the motors. There are 4 motors that can be off: Bragg, crystal offset, roll, and pitch. Hopefully, by starting with Bragg you can start to see some light and then optimize by tweaking pitch and roll. Finally, the position of the beam can be translated with the crystal offset.
    - The PB slits can be centered and closed so they are just intercepting the beam.
    - Once the light is through the monochromator, the FE shutter can be closed, the camera removed, and alignment downstream can continue.
4. Tweak monochromator and mirror alignment to center secondary source aperture (SSA).

3.3.3 Focusing the K-B Mirrors

- **These are the complete instructions for focusing the K-B mirrors. Some steps can be skipped if the optics are already align**

1. Check that the local bump is at the nominal values.
2. Open the slits: JJ Slits (2.0 x 2.0 mm), SSA (1.0 x 0.05 mm).
3. Move the K-B mirrors out of the beam. They should return to 0 pitch and translate out of the beam path.
4. Make sure the X-ray beam goes through the system. Check the X-ray eye. The ion chambers should see X-rays. The X-rays should pass through the nanoKB chamber. The X-ray beam should be about 1.5 x 1.2 mm (HxV) on the Merlin detector. Be sure to keep the total counts below 100k.
5. Check that the JJ slits are centered on the X-ray beam. Close down the JJ slits to 0.3 x 0.6 mm (HxV).
6. **Move in and roughly align the K-B mirrors:**
    - Start with the fine pitch motors for both K-B mirrors at 15 m (the middle of their range).
    - Move in the vertical mirror. Check that the mirror is flat and set to zero. Move to the middle of the X-ray beam.
    - Move in the horizontal mirror. Check that the mirror is flat and set to zero. Move to middle of the X-ray beam.
    - Pitch the vertical mirror to 3 mrad. Translate the mirror down by 0.63 mm.
    - Pitch the horizontal mirror to 3 mrad. Translate the mirror outboard by 0.15 mm.
    - Check that the focused beam can be seen by the Merlin and the VLM is not blocking the focused beam. VLM positions June 2021 (X, Y, Z) = (-0.090, -0.380, -1.357)
7. Put in the diving board. Look for the fiducial marker patterns (Pt/Cr, 50 nm) with 5 m wide horizontal and vertical features on the very edge.
8. Use the VLM and fluorescence signal to roughly align the X-ray position cross-hair.

9. **Start with the vertical focus alignment:**
   - Run a knife-edge scan across a line to get an initial beam size. `RE(nano_knife_edge(nano_stage.sy, -10, 10, 0.2, 0.1))`
   - If the beam size is greater than 1 m, move the coarse Z by 500 m and look for a smaller beam size. Be aware line features will move horizontally when changing coarse Z.
   - Repeat until the beam size is smaller than 1 m.
   - Run the slit-scan script. Here we as scanning the sample from -8 to 8 m to move across the Pt line. The JJ slits are set to a gap of 0.1 mm and scanned a total of 1 mm centered around the beam center. Some of the knife-edge scans will not hit the mirror, so these scans will need to be excluded from the final analysis. `RE(slit_nanoflyscan(nano_stage.sy, -8, 8, 0.1, 0.05, jjslits.v_trans, 3.01, 4.01, 0.1, jjslits.v_gap, 0.1))`
   - Run the calculation for alignment. `slit_nanoflyscan(scan_id_list=np.linspace(startid, stopid, numscans), slit_range=np.linspace(jjslit_start, jjslit_stop, numscans), interp_range=[2, 3, 4, 5, 6, 7, 8, 9, 10], orthogonality=False)`
   - The script will show a plot of the Pt line center and report some values. In particular, pay attention to the defocus amount. Move the sample by the defocus amount using the coarse Z stage.
   - Run another knife-edge scan to make sure the focus improved.
   - Run the slit-scan script and calculation again. Hopefully upon calculation, the defocus amount is small (< 100 m) and the curve is relatively flat. In that case, change the orthogonality flag to True and run the calculation again. Otherwise, repeat until the defocus amount is small.
   - With orthogonality True, the fine vertical pitch is adjusted. Move the fine pitch actuator for the vertical pitch. Move the coarse Z stage as well.
   - Run a knife-edge scan to check the focus improved.
   - Repeat the slit-scan and knife-edge scans with orthogonality True until the focus is acceptable.
10. **Focus the horizontal K-B mirror**
   - Attenion! For horizontal mirror alignment, only horizontal mirror pitch should be moved to prevent astigmatism in the two focal planes.
   - Find a line for scanning and run a knife-edge scan to get the initial beam size.
   - Run the slit-scan to scan the JJ slits across the mirror.
   - Perform the slit-scan calculations with orthogonality False.
   - The calculation will output an amount to move the horizontal K-B mirror in mrad. To translate this to a linear distance for the fine actuator, multiply by 100 mm. Move the horizontal fine pitch actuator by this amount.
   - Similar to the vertical mirror, run a knife-edge scan to make sure the actuator was moved the correct direction and measure the new focus.
   - Repeat the slit-scans until the focus is acceptable.
   - Check the horizontal focus as a function of SSA width.

3.3.4 Calibrating the monochromator

Calibrating the monochromator is done by collecting XANES spectra across several element absorption edges. A least-squares fitting

1. Collect XANES scans at 3-5 different energies. For the best fit, a wide range of energies is best. Typically, scans are performed using V, Cr, Fe, Cu, Se, Zr foils. *It is a good idea to record the C1 Roll and C2 Pitch values for each energy. These can be used for a lookup table to improve the peakup function.*:

```
Bluesky@SRX [1] X = getbindingE('Fe')
Bluesky@SRX [2] %mov energy X
Bluesky@SRX [3] RE(peakup_fine())
Bluesky@SRX [4] RE(xanes_plan([X-50, X+50], [1], 0.1))
```

2. Define a dictionary in bluesky with element symbols mapped to scan IDs.:

```
Bluesky@SRX [5] scanlogDic = {'V' : 1000,
                              'Cr': 1001,
                              'Fe': 1002,
                              'Cu': 1003,
                              'Se': 1004,
                              'Zr': 1005}
```

3. Run the *braggcalib()* function with the dictionary as input. The function will go through each scan and display a plot marking where the edge was found. Finally, this will output the new HDCM parameters.:

```
Bluesky@SRX [6] braggcalib(scanlogDic=scanlogDic, use_xrf=True)
```

4. Update the values in the bluesky profile (10-machine.py). Save and restart bluesky.

3.4 Beamline Maintenance

Todo:

- Calibrating the Xspress3
- Power loss preparation and recovery

3.4.1 Cryocooler

The manual for the cryocooler can be found here.

Todo:

- Upload cryocooler manual

Warming the cryocooler

1. Connect a turbo-pump station to the monochromator tank. Pump the turbo so that it reads a pressure in the 10^{-8} Torr range.
2. Close the beamline gate valves to isolate the monochromator.
3. Open the manual valve between the monochromator and turbo-pump.
4. Turn off the ion pump. This should automatically put the cryocooler in "Stop" mode.
5. The cryocooler will warm up over several days.

Cooling the cryocooler

1. Verify the monochromator cold cathode gauge is on and the cryocooler is not inhibitted. This typically means a pressure reading better than 10^{-7} Torr.
2. **Purge the system according to the cryocooler manual, section 3.3.1, on page 28.** ***Note: V10 and V11 are variable values, 0%***
   - Verify N_2 gas source is at a pressure between 1.5 and 3.0 bar.
   - Verify the monochromator ion pump and cold cathode gauge are on.
   - Close all the valves.
   - Open V9, V10, V20, and V21 fully. Purge for 30 min.
   - Close V9 and open V11. Purge for 15 min.
   - Close V11. Open V17 and purge for 15 min.
   - Close all the valves.
3. **Following the cryocooler manual, section 4.2.1.1, fill the sub-cooler to 15% and fill the heater vessel to 20%.**
   - Verify the liquid N_2 source valve is open.
   - Open V19 to start filling the sub-cooler.
   - Close V19 when the sub-cooler reaches 15%.
   - Open heater vessel valve to start filling the heater vessel.
   - Close heater vessel valve when level reaches 20%.
4. **Follow the automatic cool down proceedure from the manual, section 4.3.**
   - Verify the liquid N_2 source valve is open.
   - From the cryocooler CSS page, click "Cool Down".
   - Once full, in CSS click on the "A" to enable automatic filling of the cryocooler.

3.5 Controls

3.5.1 IOC Monitoring

On a Debian server, the manage-iocs tool can be used to monitor the IOC status. SSH into the server that hosts the IOC (*e.g.* xf0

- List all IOCs

```
$ manage-iocs report
```

- Show IOC status

```
$ manage-iocs status
```

- Start IOC, *softioc-example*. The path to the IOC can be found using `manage-iocs`.

```
$ sudo /etc/init.d/softioc-example start
```

- Stop IOC, *softioc-example*. The path to the IOC can be found using `manage-iocs`.

```
$ sudo /etc/init.d/softioc-example stop
```

On a CentOS server, the IOCs are managed using procServ. This is typically a simple executable script that will start them.

- SSH into the camera server, xf05idd-ioc2.
- To start the IOC for the Blackfly camera

```
$ cd /epics/iocs/cam-bfly1
$ ./start_cam_bfly1
```

- Using these commands, the IOC will start and you will be in a telnet of the IOC.
- To exit the telnet, type `Ctrl+]` and then `q`.
- To stop the IOC, the process for procServ must be stopped. The process ID is the second column.

```
$ ps aux | grep procServ
akiss      820  0.0  0.0  27448   976 ?        Ss    2020  29:07 procServ --
↪logstamp -n cam-bfly1 -i ^D -L /epics/iocs/cam-bfly1/log/cam-bfly1.log 20001 .
↪/st.cmd
$ sudo kill -9 820
```

3.5.2 Motion Controls

Todo:

- Insert table with: Motor controller, IOC, Motor, PV, Bluesky object
- Rearrange table to be motor, bluesky, IOC, controller, PV?
- List of all IOCs on each server

Table 1: xf05ida-ioc1 motors

Motor Controller	IOC	Motor	PV	Bluesky Object
mc01	softioc-mc01	testmotor	XF:	bs.motor

Table 2: xf05idd-ioc1 motors

Motor Controller	IOC	Motor	PV	Bluesky Object
mc01	softioc-mc01	testmotor	XF:	bs.motor

Table 3: xf05idd-ioc3 motors

Motor	Bluesky Object	Motor Controller	IOC	PV
nanoKBv angle calc	bs.motor	none	softioc-anglecalc	XF:05IDD-ES:1{nKB:vert-Ax:PC}Mtr
nanoKBh angle calc	bs.motor	none	softioc-anglecalc	XF:05IDD-ES:1{nKB:horz-Ax:PC}Mtr
testmotor	bs.motor	fpsensor1	softioc-fpsensor	XF:05IDD-ES:1{FPS:1-Chan0}Pos-I
testmotor	bs.motor	fpsensor1	softioc-fpsensor	XF:05IDD-ES:1{FPS:1-Chan1}Pos-I
testmotor	bs.motor	fpsensor1	softioc-fpsensor	XF:05IDD-ES:1{FPS:1-Chan2}Pos-I
nanoKBv Fine Pitch	bs.motor	PI E518	softioc-mcd19	XF:05IDD-ES:1{nKB:vert-Ax:PFPI}Mtr
nanoKBh Fine Pitch	bs.motor	PI E518	softioc-mcd19	XF:05IDD-ES:1{nKB:horz-Ax:PFPI}Mtr
nanoKBh Coarse Pitch	bs.motor	PI E712	softioc-mcd20	XF:05IDD-ES:1{nKB:horz-Ax:PC}Mtr
nanoKBv Coarse Pitch	bs.motor	PI E712	softioc-mcd24	XF:05IDD-ES:1{nKB:vert-Ax:PC}Mtr
Sample Coarse Z	nano_stage.z	Smaract	softioc-mcd26	XF:05IDD-ES:1{nKB:Smpl-Ax:sz}Mtr
Sample Coarse X	nano_stage.x	Smaract	softioc-mcd26	XF:05IDD-ES:1{nKB:Smpl-Ax:sx}Mtr
Sample Coarse Y	nano_stage.y	Smaract	softioc-mcd26	XF:05IDD-ES:1{nKB:Smpl-Ax:sy}Mtr
Sample Theta	nano_stage.th	Smaract	softioc-mcd26	XF:05IDD-ES:1{nKB:Smpl-Ax:th}Mtr
Sample Top Z	nano_stage.topx	Smaract	softioc-mcd26	XF:05IDD-ES:1{nKB:Smpl-Ax:zth}Mtr
Sample Top X	nano_stage.topz	Smaract	softioc-mcd26	XF:05IDD-ES:1{nKB:Smpl-Ax:xth}Mtr
Sample Scanner X	nano_stage.sx	nPoint	softioc-nPoint	XF:05IDD-ES:1{nKB:Smpl-Ax:ssx}Mtr
Sample Scanner Y	nano_stage.sy	nPoint	softioc-nPoint	XF:05IDD-ES:1{nKB:Smpl-Ax:ssy}Mtr
Sample Scanner Z	nano_stage.sz	nPoint	softioc-nPoint	XF:05IDD-ES:1{nKB:Smpl-Ax:ssz}Mtr
testmotor	bs.motor	picoscale	softioc-picoscale	XF:
nanoZebra	nanoZebra	none	softioc-zebra	XF:05IDD-ES:1{Dev:Zebra2}

Table 4: xf05idd-det1

Motor Controller	IOC	Motor	PV	Bluesky Object
mc01	softioc-mc01	testmotor	XF:	bs.motor

Table 5: xf05idd-det2

Motor Controller	IOC	Motor	PV	Bluesky Object
mc01	softioc-mc01	testmotor	XF:	bs.motor

Table 6: xf05idd-ioc2

Motor Controller	IOC	Motor	PV	Bluesky Object
mc01	softioc-mc01	testmotor	XF:	bs.motor

3.5.3 EPS

Todo:

- Upload wiring diagrams

CHAPTER

FOUR

INDICES AND TABLES

- genindex
- modindex
- search