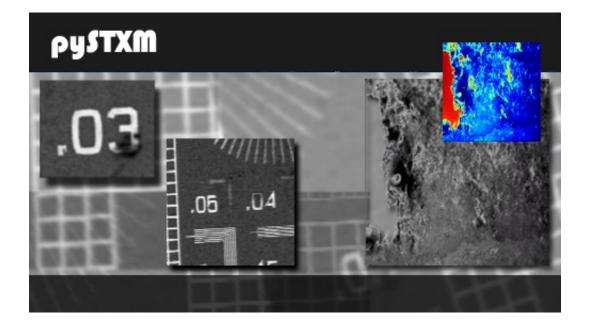


Canadian Centre canadien Light de rayonnement Source synchrotron

pySTXM

Scanning microscope data collection with Python , Qt and BlueSky





Epics Collaboration Meeting July 2021

Russ Berg: russ.berg@lightsource.ca

THE BRIGHTEST LIGHT IN CANADA 📔 lightsource.ca



Scanning microscope data collection with Python, Qt and BlueSky

The goal of this talk is to present some ideas on facilitating user "experience and efficiency" that is not 100% dependent on the experience level of the user on an Epics beamline end station, hopefully some of these idea's translate and are of some value to data collection software others are working.

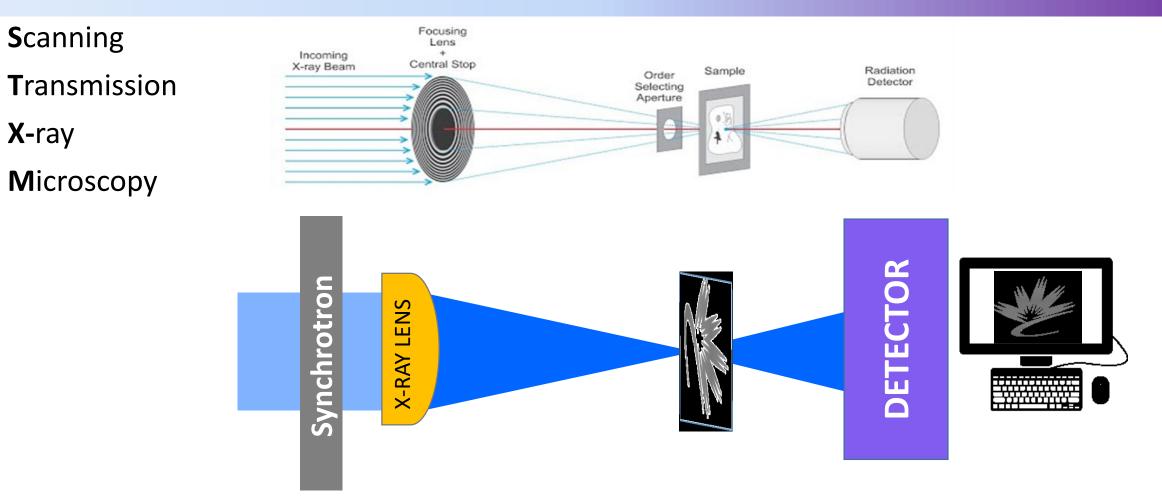
I will cover:

- What is STXM?
- High level overview of the software architecture
- UI idea's that were implemented focusing on streamlining the "User Experience"





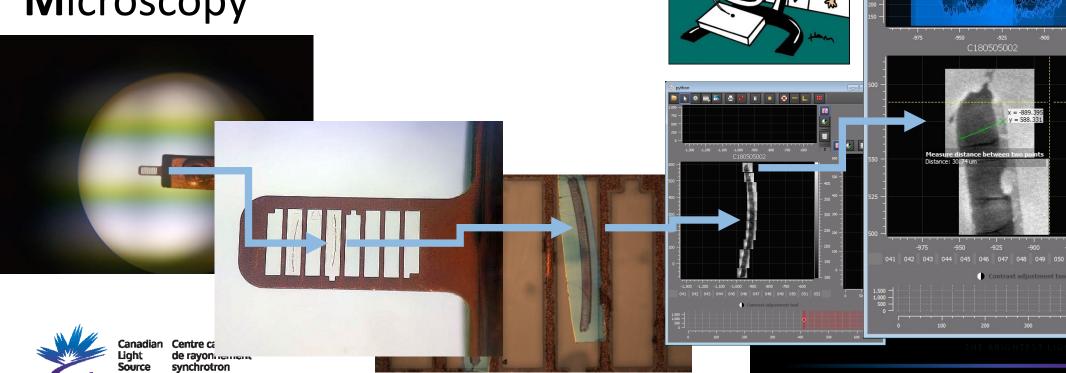
what is STXM?





What is STXM?

ScanningTransmissionX-rayIt's a microscopeMicroscopy



LIFE ON EARTH

YOU

LOOKIN

AT ME?

by Ham

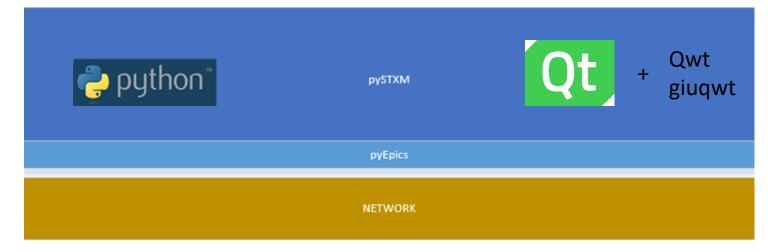
⁹ python

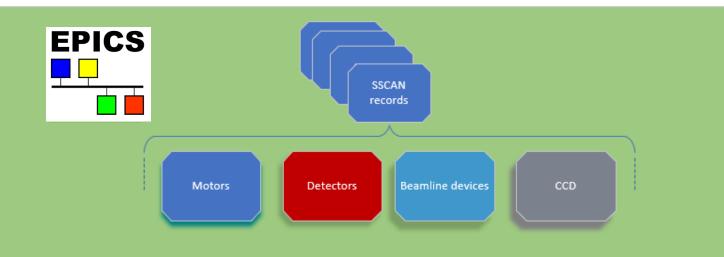
8

III 🗶 🗌 🔛

 \odot

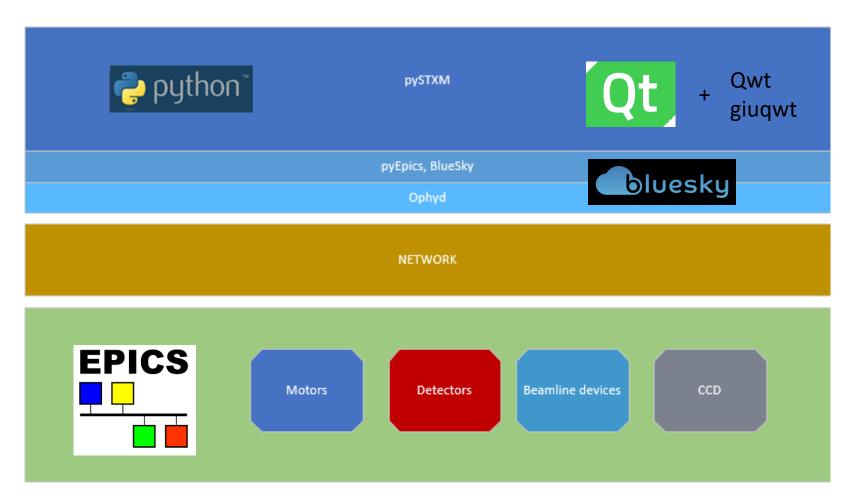
pySTXM: General software structure, initial implementation







pySTXM: General software structure, ported to use BlueSky





GUI layout Philosophy: How to avoid clutter as app scales?

- Wanted to be intentional • grow
- Needs to display complex • as new capabilities are ad
- Didn't want GUI that look • "the present" in terms of display with no sense of v
- Some examples of what I •

Centre canadien

synchrotron

de ravonnement

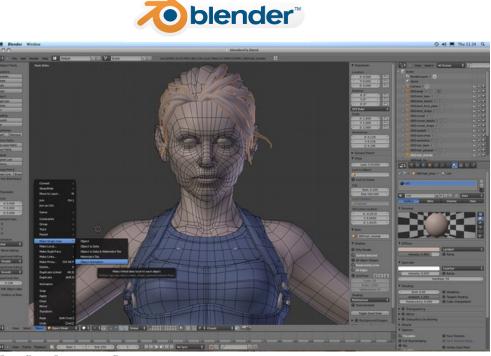
anadian

Source

	File Spectrum			
about the GUI not just let it	Magellanic Cloud Select	LMC Positional Data	LMC Position Display	Time Control
data in a way that can scale	Large Magellanic Cloud Small Magellanic Cloud	RA: 5.3333 DEC: -69.0000 Current Hour Angle: 0.218		-Year +Year -North +Year
ded	Local Date/Fime Mon 18 Apr 2016 - 15:42:59	Bours to Next Transit: 23.72 Bext Transition Minutes File Action Set		-Day +Day Hour +Hour
s like it is only thinking of the amount of data to	UTC Date/Time Mon 18 Apr 2016 - 05:42:59	Data Rur Stors + (1990) uw) Curren Curren Curren	bies balances & Filter Jup. Use 3	-Min ○ +Min -Sec +Sec
vorkflow	Greenwich Sidereal Time 19:30:05	AZ/EL Barth V Observer N/S V O	Down-1000 Sachara 2010 DT DT<	Stereal Day Steps
wanted to try and avoid	Local Sidereal Time	Sun V () == 20 -= 20 - 20 - 20 - 20 - 20 - 20 -	Dyset=1398 District Class Charm MA2000 Dyset=1308 MSE3121.0 CF MI MI MI Solution Dyset=1308 MSE3121.0 CF MI MI MI Solution Dyset=1308 MSE3121.0 CF MI MI Solution Solution Dyset=1308 MSE3120.0 CF Minute Solution Solution Dyset=1308 MSE3120.0 CF Minute Solution Solution Solution Solution Dyset=1308 Minute CF CF Minute Solution	Mode Picol Time Time Lapse Manual
sferona your :		Topo D	Company and a set of the set of t	
Partonia M Image: Constraint of the second sec		P or P or <th< td=""><td>Data Acquisition Control Par Input Device RE Centrol</td><td>t Frequency 75 MHz Vels Acquisiton Mode e Frequency 173750 * MHz Reset</td></th<>	Data Acquisition Control Par Input Device RE Centrol	t Frequency 75 MHz Vels Acquisiton Mode e Frequency 173750 * MHz Reset
000 000 000 000 Acq Finish S_OK 100032 2 For 4 = 0 **********************************	NB CH Freq Amp(m) App R Err(ii) 22 001 CH2 0.40625 0.000 39023168 124.491 23 001 CH2 0.6055 0.000 39023168 124.491 24 001 CH2 0.6055 0.000 28164.828 12.509 25 001 CH3 0.40525 0.000 28164.828 12.509 26 001 CH3 0.40525 0.000 56805.570 63.239 27 001 CH3 0.6555 0.000 12011.215 64.446 28 001 CH3 0.5625 0.000 12011.215 64.446 29 001 CH4 0.5625 0.000 12012.25 1292 29 001 CH4 0.40625 0.000 54975.434 94.475 30 001 CH4 0.40625 0.000 54975.434 94.475	F5(%) En(%) CP(mead) En(mond) Antenna 39.323 65.355 363.81.66 4136.916 1 39.323 65.355 363.81.66 4136.916 1 39.323 65.355 361.81.66 4136.916 1 39.323 65.355 315.367 570.766 Antenna 124.465 77.140 -402.005 1152.803 Antenna 124.465 37.140 -472.281 4684.492 Antenna 124.465 37.140 -172.281 4684.492 Antenna 124.465 37.140 -172.281 4684.822 Antenna 124.465 37.140 -172.184 481.928 Antenna 126.84 39.300 408.922 699.521 Antenna 108.014 29.330 -71.486 851.502 Antenna	An 195.0 + deg Mumber of Samples 5,625,5	Velocity Cted Cloud SMC Middle Control 0 = Data File Size: 10.48 Gb
255 27 28 Arcq Freich S.C.K. 10.5439 040 28 649 Arcq Freich S.C.K. 10.5435 267 26 267 Arcq Freich S.C.K. 10.7599 177 27 Arcq Freich S.C.K. 11.3451 233 28 233 Arcq Freich S.C.K. 11.3452 265 26 64 Reinh S.C.K. 11.3452 244 27 64 Arcq Freich S.C.K. 10.9779	31 001 C+4 0.65625 0.000 12665149 11.980 32 001 C+4 0.90625 0.000 15814658 5.639 33 004 C+1 0.95625 0.000 15814658 5.649 34 004 C+1 0.46625 0.000 24591.00 35.815 35 004 C+1 0.46625 0.000 21597.678 48.448 36 004 C+1 0.5005 0.000 33800.297 28.015 37 004 C+2 0.5625 0.000 23697.233 34.265 38 004 C+2 0.4525 0.000 2809.387 1.968 38 004 C+2 0.4525 0.000 2697.87 1.978	100,014 29.300 5.556 118.4.08 100,014 29.300 755.655 2972.4.34 101,356 129.204 1401.344 202.4.4 101,356 129.204 1401.344 225.4.17 101,356 129.204 4309.271 2072.633 103,356 129.204 4309.271 2072.633 103,356 129.204 4309.271 2072.633 103,356 129.204 4309.271 2072.633 103,356 129.204 4309.271 2072.633 103,356 129.204 4305.271 2072.633 104,304 2.261 266.065 1350.244	Record Now Record	ng Off

GUI layout and goals: take inspiration from successful software

- Layout that facilitates workflow
- "like typed" information organized into panel areas on the screen
- Minimal color pallet used to express as few different types of information as possible
- Open as few new screens as possible to get at the data
- Inspiration from:









adian Centre canadien nt de rayonnement rce synchrotron

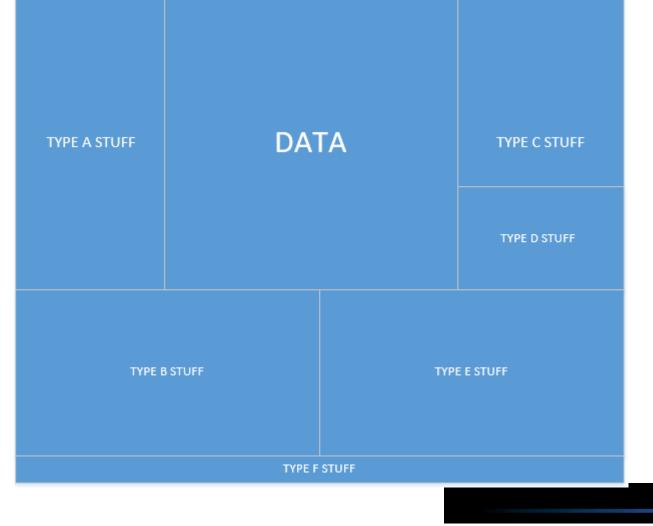
GUI layout and goals: what I did want

• wanted a structure that would scale as new features and capabilities were realized

- Type A Stuff:
 - Scan definition
 - User Preferences

- Type B Stuff:
 - Scan control

synchrotror



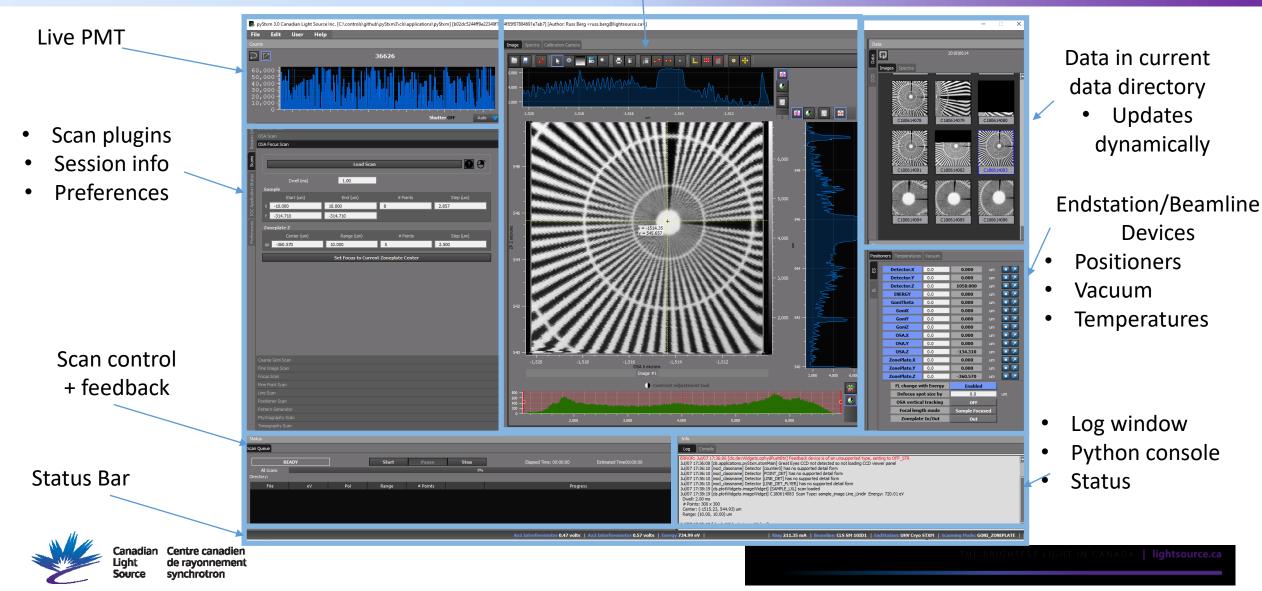
- Type C Stuff:
 Data that has been collected
- Type D Stuff:

٠

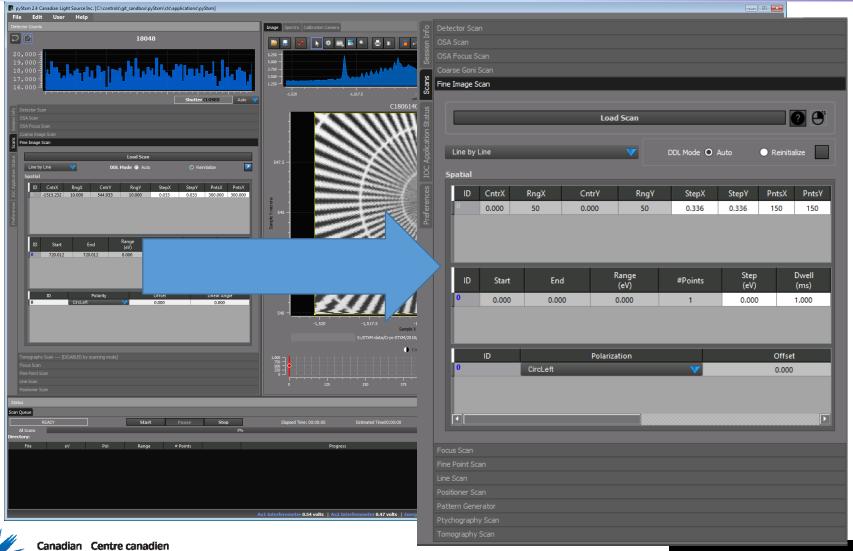
- Device Control
- Type E Stuff:
 Log, Info
- Type F Stuff:
 - Status bar



- Image data
- Spectra data
- Calibration Camera



Scan plugin layout -> workflow



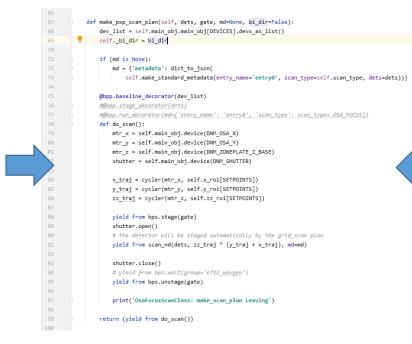
Scans vertical tab with each individual scan using a horizontal toolbar.

Scan plugins ordered from top to bottom in usual order a user needs to work to collect data.

Top -> alignment/focus scans Down -> data collect/refine scans

BlueSky plans combined to create higher level STXM scans

	OSA Focus Scan						
Scans		Load Scan					
	Dwell (ms)	1.00					
	Sample						
	Start (um)	End (um)	# Points	Step (um)			
	X -10.000	10.000	8	2.857			
	Y -314.710	-314.710					
	Zoneplate Z						
	Center (um)	Range (um)	# Points	Step (um)			
	zp -360.570	10.000	5	2.500			
	Set Focus to Current Zoneplate Center						



One or more base level pre-assembled plans used to create whatever scan is needed

Pre-assembled Plans

Below this summary table, we break the down the plans by category and show examples with figures. Summary Notice that the names in the left column are links to detailed API documentation. count Take one or more readings from detectors. Scan over one multi-motor trajectory. scan rel_scan Scan over one multi-motor trajectory relative to current position. list scan Scan over one or more variables in steps simultaneously (inner product). rel_list_scan Scan over one variable in steps relative to current position. Scan over a mesh; each motor is on an independent trajectory. list_grid_scan Scan over a mesh; each motor is on an independent trajectory. rel list grid scan Scan over one variable in log-spaced steps. log_scan

rel_log_scan Scan over one variable in log-spaced steps relative to current position.

scan_nd	Scan over an arbitrary N-dimensional trajectory.
rel_grid_scan	Scan over a mesh relative to current position.
grid_scan	Scan over a mesh; each motor is on an independent trajectory.

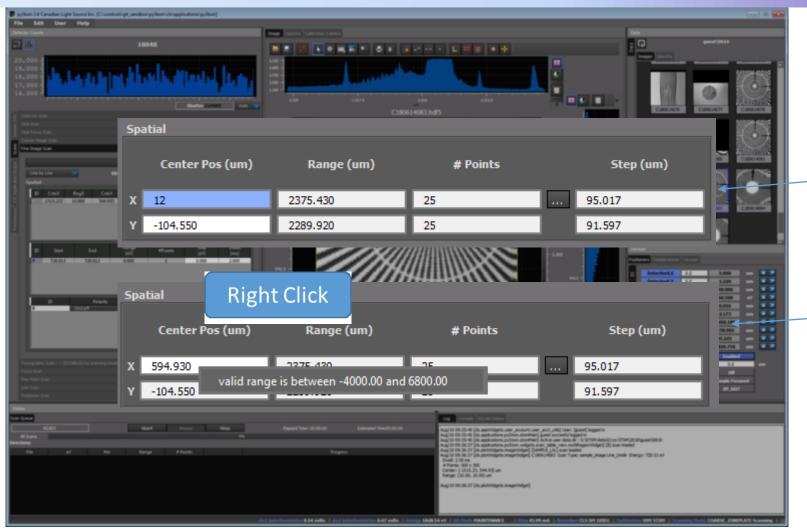
spiral Spiral scan, centered around (x_start, y_start)

Alexandrian Alexandrian and a second second second loss and loss a



nadian Centre canadien ght de rayonnement wrce synchrotron

Knowledgeable text edit fields



Smart text edit fields:

- Color

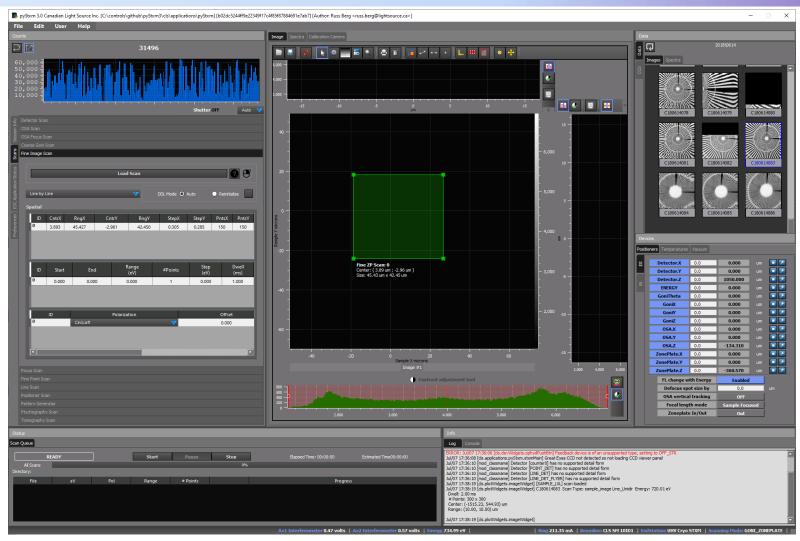
- Snap back to initial value if focus changed

- Int/Float validation

Limit values entered to the soft limits of that positioner

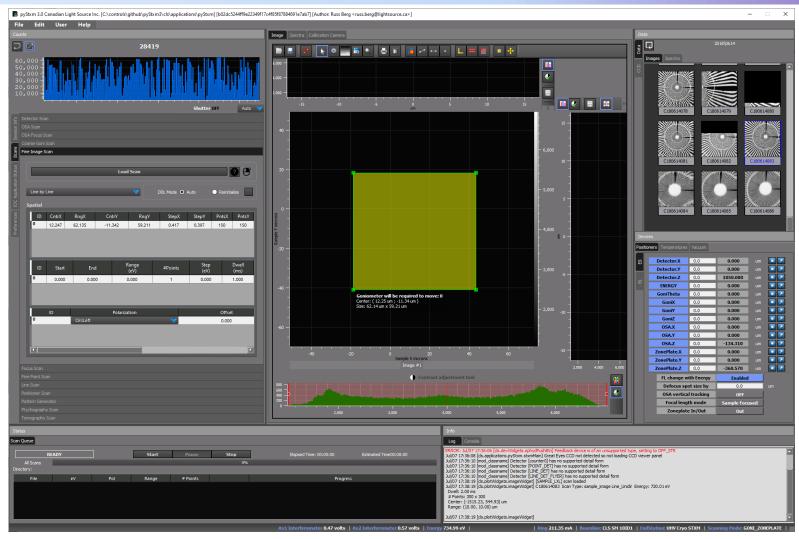


Only allow valid scans to be configured/executed



Visual cues to indicate an impossible scan

Only allow valid scans to be configured/executed

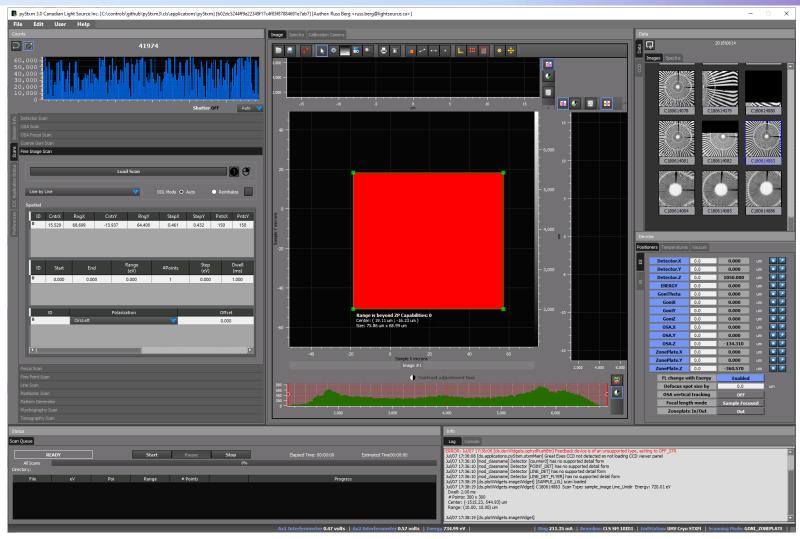


Visual cues to indicate an impossible scan

- When nearing the max range of the positioner the selection area background changes to solid yellow indicating the situation



Only allow valid scans to be configured/executed

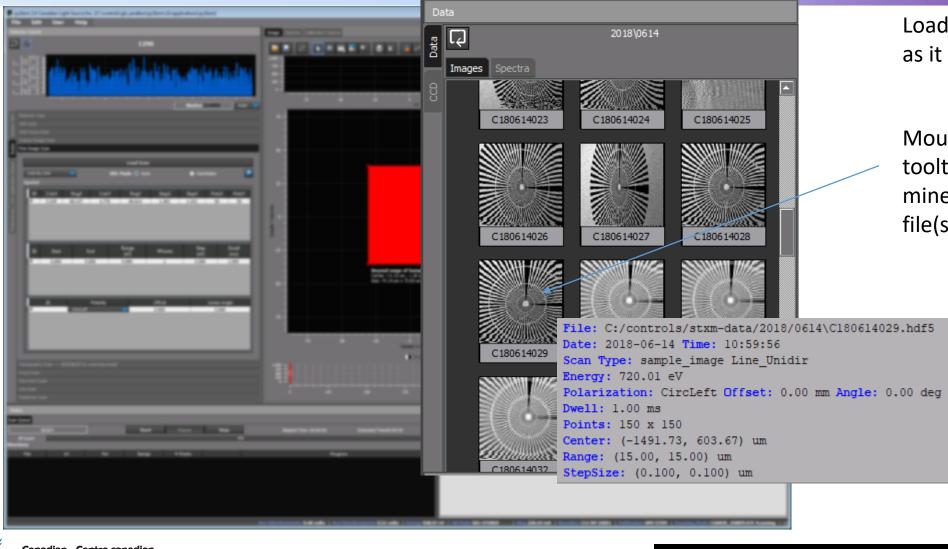


Visual cues to indicate an impossible scan

- When the max range of the positioner would be exceeded the selection area background changes to solid red and the scan range fields are no updated until scan range is valid again



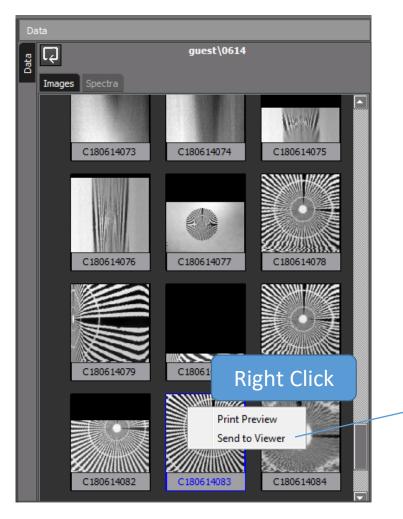
Easy access to data, Thumbnail viewer

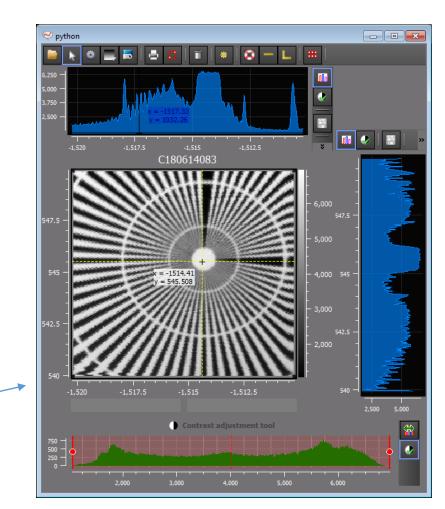


Loads data from disk as it becomes available

Mouse over brings up tooltip of metadata mined from the hdf5 file(s)

Easy access to data, print or load into a viewer



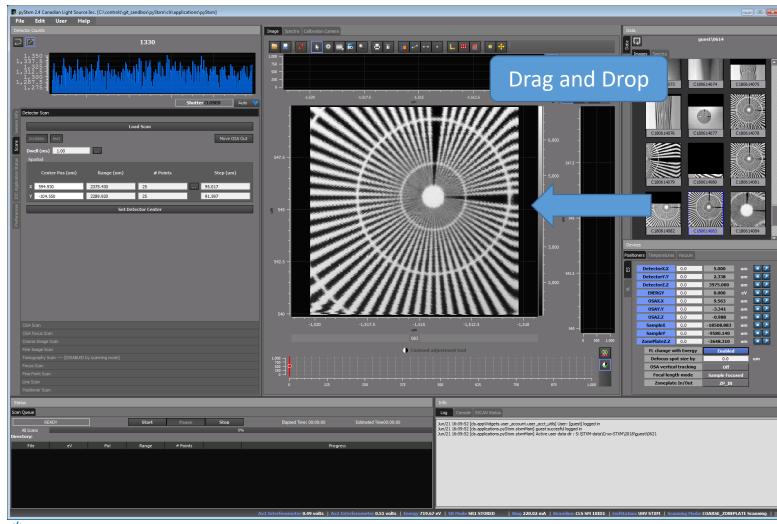


Right click menu:

- "print" data small enough to fit in log book
- "send to Viewer" to load data into separate viewer



Easy access to data, quickly load a previous scan

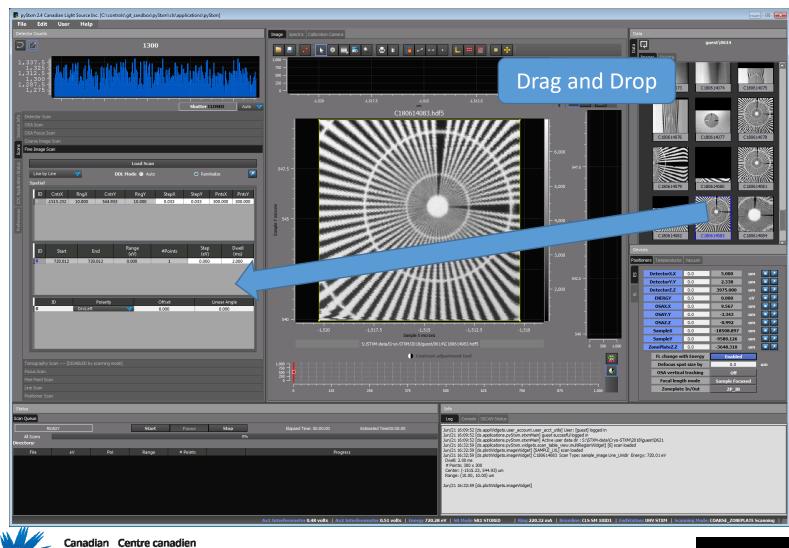


Load previous scan and use to select scan area

Drag and drop data from Thumbnail viewer to central plot to be used to select ROI for a different scan



Easy access to data, Load previous scan for re-execution



Drag and drop data from Thumbnail viewer to central plotter

Or

Onto the scan plugins pane to be reloaded

de rayonnement

synchrotron

Light Source

Interactively build larger view from smaller images

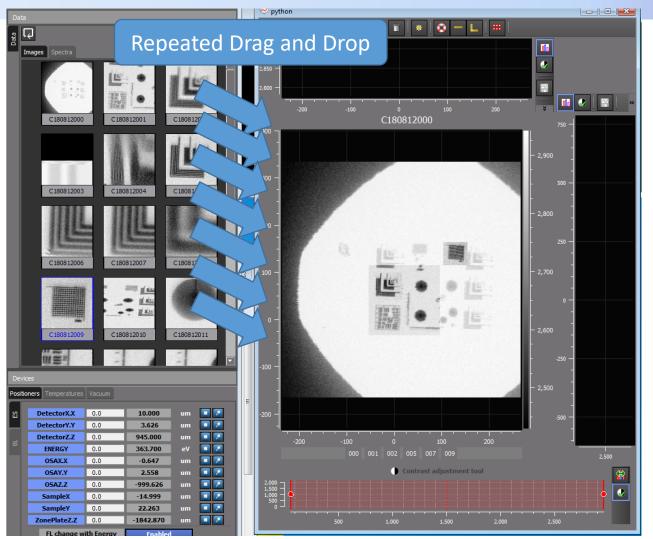


Drag and drop multiple images from thumbnail viewer onto another viewer building up a mosaic of a number of scans

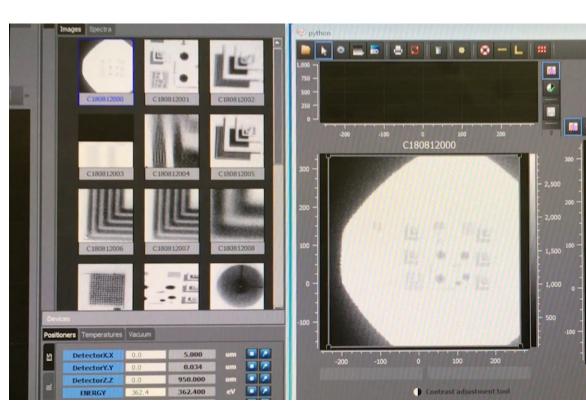
Or select and load multiple files from disk



combine coarse and fine images



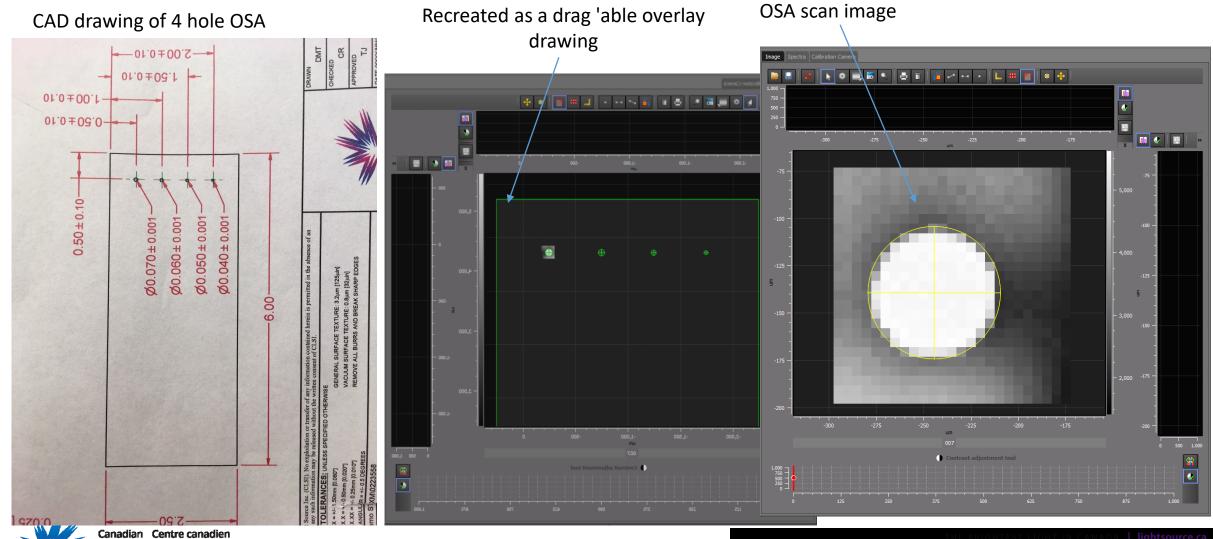
Images are placed on top of each other based on scan resolution and scan range





Canadian Centre canadien Light de rayonnement Source synchrotron

pySTXM visual tools - Overlay images of OSA, Sample Holder



de rayonnement iaht Source synchrotron

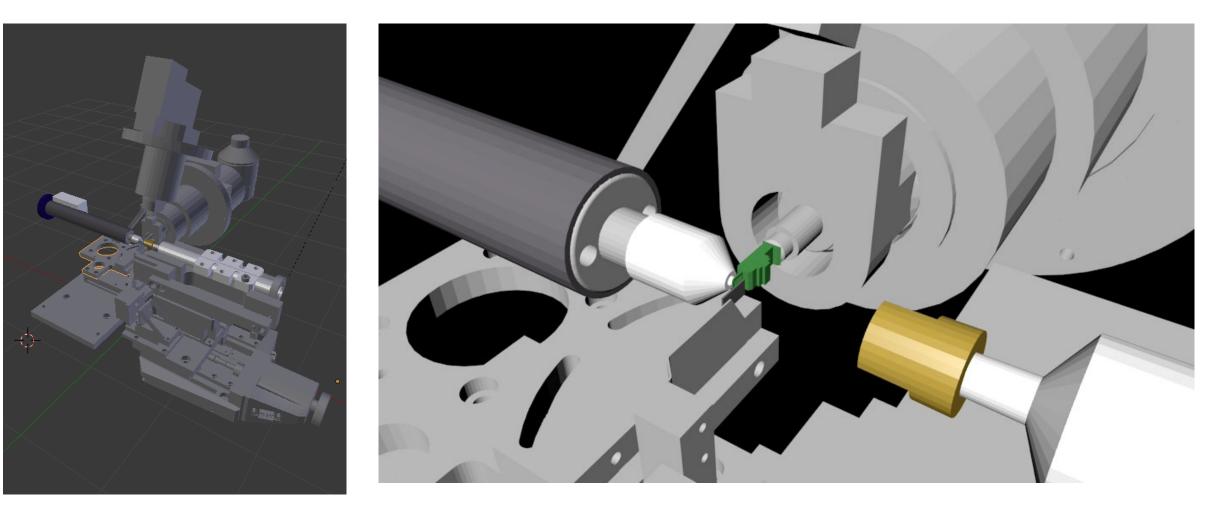
pySTXM Interactive tools – Drag the beam

Image Spectra Calibration 🖪 🗼 🛎 💷 🗟 🔍 🛎 🗉 🗯 🗠 🚥 🕒 Image Spectra Calibration Camera k • 🔜 🖬 🔍 8 T 🗿 2 - - - L = 📰 🔹 🕂 • Shutter CLOSED Auto 🔻 Drag beam to new location x = 20.2254 y = 10.4802Auto N Shutter CLOSED rag beam to new x = 20.2254 PntsX PntsY 150,000 150,000 Load Scan e 🛛 Auto Reinitializ Dwell (ms) 1 000 StepX PntsY 0.000 0.400 0.400 150.000 150.000 Linear Angl Step (eV) Dwell (ms) #Points Contrast adjustment too 0.000

Target shows current position of beam, then use tool to drag it to desired location, ex: I0 optimization



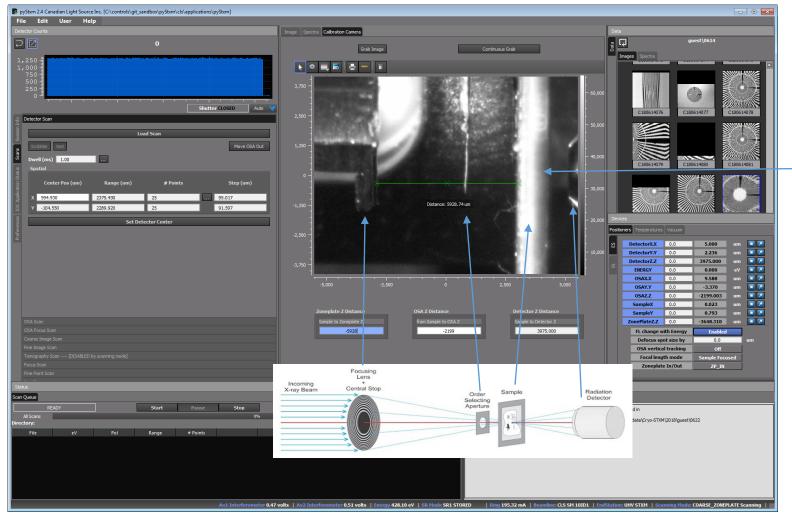
To prevent collisions, typically requires an expert to calibrate the system





adian Centre canadien nt de rayonnement prce synchrotron

Make use of CCD camera that was there for a different purpose



Calibration Camera, roughly calibrate 3 devices in seconds

Frame of video taken from fire wire camera looking inside the UHV STXM tank. Used to set the initial distance of: - Zoneplate Z - OSA Z

- Detector Z



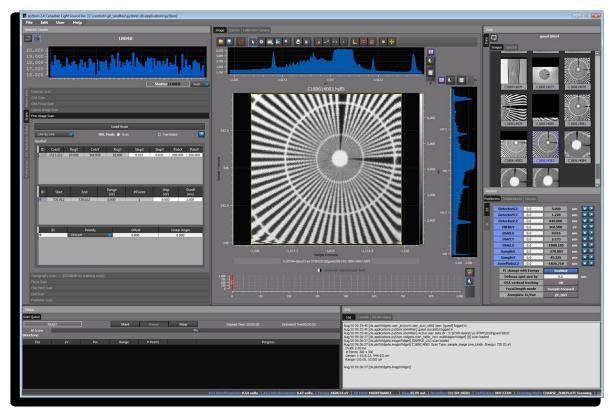
Canadian Centre canadien Light de rayonnement Source synchrotron



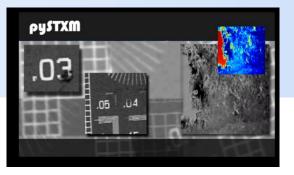
Future for the project

- Install as part of a current beamline upgrade 10ID1
- Extend to include Ptychography (started)
- Automate Tomography
- Have interest from other labs, no simple way **yet** for people to install/configure without my help
- Goal of making this an inter lab collaboration

https://github.com/RussBerg/pyStxm3.git







Acknowledgments

- 10ID1 Beamline: Jian wang, Chithra Karunakaran, Charan Kupili
- Canadian Light Source: Adam Leontowich, Jan Geilhufe, Michel Fodje
- BlueSky/Ophyd: Daniel Allan, Tom Caswell, Maksim Rakitin

Thank you very much for listening!

