## SM beamline control window

X SM Beamline Control System	
10ID-1 SM Beamline - STXM Branch C	Control RingStatus: 184.100 mA Normal Operations 250mA 2.9 GeV
PSH1 F.Val. PSH SSH F.Val. VA 1 2 3 4 5 6 7	M1 M3PEH 4J1 PGM M3PEEM M3STXM STXM-ES 8 9 10 11 12 13 14 15 16
Branch&GratingSelection     Note: To change branch or grating, the SM photon     shutter (SM-PSH) has to be closed. Refer step#2     SelectBranch PEEM BRANCH 1: PEEM	5         EPU/Monochromator           EPU         Sec.1           Gap         35.5918           35.5918         35.5840           Gat         1.567e-10           Gat         1.163e-09
SelectGrating LEG 250	Q2         0.0000         0.0010         Sec.6         Sec.7         1.000e-11
SSH-OPEN OPEN/CLOSE OpenBM PSH-OPEN SM-PSH-OPEN BSH-CLOSED	Q4         0.0000         0.0005         Sec.8         Image: Constraint of the sec.9         0           Q4         0.0000         0.0005         Sec.9         Image: Constraint of the sec.9         0
Copen/close beam OPEN TOTAL CLOSE CloseBeamline SM-PSH-OPEN BSH-CLOSED CloseBM	Taper         0.0000         -3.0373         Sec.10         5.248e-09         •••           MONOCHROMATOR         Sec.11         C         6.255e-09         •••           Minror         38120.60         38120.52         Sec.12         C         2.672e-09         •••
	Status       Status       7.110e-10 •••         Status       Status       7.110e-10 •••         Status       Status       1.514e-09 •••         Gap 100.0135       Sec.14       Image: Total status         Q1       0.0010       Sec.15       Total status         Q2       0.0020       Pressure should be < 5E-9 before empire status value
1         Linklor         0.000         0.000           Cff         2.150         2.150         Epu- offse         0.000         0.000           Energy (eV)         292.000         292.002         292.002	Q4     0.0030       Taper     0.0175       Scan     Picoanmeter       StripTool

# STXM control window

STXM Control Program -24 Jan 2009			X
File Setup Window Help			
Storage Ring Current E:\Data\STXM-data\2009\200	09_03\Temp\090325_101	- Chart	Chart 🗾 Scan
-0 mA On Off Focus Scan 50x40 pts 1	49.992 eV 6 ms Dwell	🗃 🖬 🚭 💡 Clear 🛛 👔	nterval (ms) 500 🔻 Signals
ဆံးမြားဆြားနိုင်ငံ ကြောက်ခြားနိုင်ငံ 🗘 😋	unter0	1	
	<b>1</b> 0		
-3975 -		0.8	
-3980 -			
		0.6	
-3985 -			
-3990 -		0.4	
- 3992 -		0.2	
-4000 —		0	
4005			
- cuu+-		-0.2	
-4010 -			
-4015		-0.4	
4013			
-4020 -		-0.6	
-4025 -			
1020	<b>•</b> ••	-0.8	
-4030 - 1	<u>6 9 </u>	-1	
Length 0 ZonePlate	0 Data No Data	11:22:34 11:24:00 11:2	25:26 11:26:53
Focus To Cursor	10 Ser	rial port configured and initialized.	PMT /10
Focus To Cursor +	- 8 Eth	nernet Connection to server #6* established	- Churter
Set for autofocus	- 6 Res	setting boards.	Shutter
	-4 Ag	ilent Interferometer controllers initialized	
Set Ao for autofocus	-2 en	ror from XPS position read -2	
0 0.2 0.4 0.6 0.8 1	1.2 1.4		V Undates On
	1		Microscope Status
Energy Reading Destination	Current Scan Status	Scan Controls	SampleX • 5345.100 • •
(eV) 0 149.993 0 149.996 Go 5	Focus Scan Im	hage 1 of 1 Start Sample Scan	SampleY • -34.730 • •
Hori Defl (mrad) 9 2.5 9 2.682 Go 5	Estimated Time: 12s Reg	gion 1 of 1	CoarseX 9 5340.50 9 9
	Elapsed Time: 3s	Line 0 of 40 Abort Pause	CoarseY • -50.3 • •
Dispersive (µm) • 35 • 34.9 Go 5	increation of the		CoarseZ O 5005.9 O
View + Beam NonDispersive(um) 34 @ 34.5 Co 5	Microscope Control	Destination ( los	OSAX 0 0.0 0
	Motor Curren	Setup Motors	OSAY • 0.1 • •
EPU Gap [mm] 24.997 30.005 Go	Coarsex • 5340	0.50 O S340.5 GO D Stop S All OFF	DetectorX 0 1.8 0 0
EPU Polarization 0.00 0.00 0 Go	CoarseZ • • 500	05.9 O 5005.2 Go D Stop S det Off	DetectorZ O 2003.9 O
EPU Folowing   On EPU Harmonic   1st	Static - C Reset Sa	mple OSA IN Zone Plate IN Sample IN Stop	Cff • 2.2 • •
Scan Crd BL Feedback 1 On EPU Offset 0.000 0 set	Interfero M	over OSA OUT Zone Plate OUT Sample OUT All	EPUGap Q 24,995 Q
Slit Curr 0.000 0.000	A0 554.7 meter		EPUPhase O -0 O O



#### 1. Getting started and Loading sample

- 1.1 Close SM-PSH and BSH SM beamline control, if they are open.
- 1.2 Close pump valve and turn off pump, if they are open.
- 1.3 Open the vent valve on STXM tank to break the vacuum.
- 1.4 Turn off Detector.
- 1.5 Move coarseZ to 5000 um.
- 1.6 Open the STXM tank. Check there is no sample inside. If there is a sample, remove it by gently lifting it straight up. Be careful not to touch OSA or any other components inside STXM.
- 1.7 Load your sample. Write down the sample information, sample position and the empty hole position in own logbook.
- 1.8 Change ZP to static mode.
- 1.9 Select the right polarization (if your sample is not polarization sensitive, use Circular Right/Left), grating, harmonic number.

Energy Range (ev)	Grating	Harmonic	Polarization
<320 up to 390	LEG 250 l/mm	1 <sup>st</sup> (use it for only C 1s & below)	LH, CR, CL
330 to 1000	MEG 500 l/mm	1st	LH, CR, CL
1000 to 1800	MEG 500 l/mm	3rd	Only LH
1800 to 2500	MEG 500 l/mm	5th	Only LH
>2200	HEG 1250 l/mm	5 <sup>th</sup> or 7 <sup>th</sup> (not well characterized)	Only LH

LH: Linear Horizontal; CR: Circular Right; CL: Circular Left

- 1.10 Change to the desired energy. Choose a proper A0 as recommended by the software (click the "S" above A0 line (1.10).
- 1.11 Set ZP to auto mode, and click 'Go' besides energy again.
- 1.12 Check the gap between ZP and OSA to make sure they do not touch each other.
- 1.13 Move Coarse Z to 3000 um.
- 1.14 Change energy to 395 ev with Harmonic = 1.
- 1.15 Close STXM tank.
- 1.16 Close vent valve.
- 1.17 Start pump and open pump valve slowly until it is completely open.

- 1.18 IF NOT A WET CELL, pump until Presure ~0.1 torr (~5 minutes), close the valve, and stop pump.
- 1.19 Backfill with He to 1/3rd atmosphere or 20inch.Hg in the analog gauge.

## 2. Optimizing signal and collecting data

- 2.1 Turn on Detector.
- 2.2 Open SM-PSH and BSH. Open SM-PSH and BSH SM beamline control, if they are close). Note: after storage ring is refilled, one should manually open the safety shutter on ACIS panel and PSH SM beamline control as well.
- 2.3 Move to an empty hole on sample holder by changing Coarse X and Coarse Y.
- 2.4 Open shutter and some level of counts should be observed.
- 2.5 Optimize the Hori\_Defl\_(mrad) for maxium photon counts by clicking the "S" besides "Go" and jogging by 1 unit Hori\_Defl\_(mrad) ● 2.5 ● 2.682 Go 5
- 2.6 Optimize EPU offset for maximum photon counts by input a value (starting with 0) into the blank space besides the "set" EPU Offset 0.000 0 set.
- 2.7 Adjust dispersive and non-dispersive slit size to have counts lower than  $2 \times 10^6$  (PMT/10).
- 2.8 Table with recommended slit sizes :

	C 1s	N 1s	O 1s	Fe 2p
Dispersive	35	30	25	10
Non-Dispersive	35	30	25	10

- 2.9 Close shutter to avoid unnecessary photo exposure to detector.
- 2.10 Perform an OSA scan to find OSA center, set OSA (0,0) to center of the ZP.

05A Scan -	SA Scan - Estimated Time: 63s 🔀									
(	Centre Pos (µm)	Range (µm)	# Points	Step (µm)	-nergy (eV) 204,273	ZP in Focus	Begin	Save Scan	Recorded	
OSA X	0	80	30	2.667	Dwell Time (ms) 20		Juan	Definition	Chaimeis	
OSA Y	0	80	30	2.667	Dwen Time (ins)   20	ZP to	Cancel	Load Scan		
						In-locus		Definition		

2.11 Perform an OSA focus scan and set the ZP scale.

$\mathbf{r}$	1	0
<i>∠</i> .	T	4

Centre Pos (µm)	Length (µm) Theta (*)	# Points St	ep (µm)	Energy (eV)	204.273	Begin Scan
-30.025	10.0	40	0.25	Dwell (ms)	4	Cancel
1.730	0.00	L				
ne Plate Centre Pos (μm)	Range (µm)	# Points	Step (µm)			Save Scan Definition
7 1000.0	200.0	20	15		Becorded	Load Scan

- 2.13 Move to your sample by changing coarse X and coarse Y.
- 2.14 Repeat steps 1.9, 1.10 and 1.11 to set the desired energy.
- 2.15 Move the coarse Z towards the expected position (Ao+sample thickness) CAUTIOUSLY while checking the sample does not make contact with the OSA. The following is the recommendation. Move first Coarse Z to the expected +300 um and after checking move to the desired position.

		C 1s			N 1s	5		O 1s		
		Sample coarse Z			Sample co	oarse Z		Sample	coarse Z	
	A0	grids	200 um window	A0	grids	200 um window	A0	grids	200 um window	
25 nm ZP	320	450	600	400	530	680	500	630	780	

# 2.16 Perform a sample scan with a big scan range (coarse scan), for example 300 um $\times$ 300 um, to find the sample.

Image Scan - Estimated Time: 106s						2
Scan Type Image (Line – unidirectior 💌	Energies Current Energy 204 273	Total Points	Single R	legions	1 🗧 🔽 Same dwell	Begin Scan
Stage Automatic	Energy (eV)		- Linered t	(	Dwell Time (ms)	Cancel
Dichroism	204.289				2	Save Scan Definition
2 Reg						Load Scan Definition
Defocus Focus (nm) 49						Load Energy Definition
Auto Defocus Accel. Dist. (µm) 70.40	Scan Velocity: 0.721 mm/s	Coarse Stage				Recorded Channels
Point Delay (ms) 0.08 Auto Parameters	Multiple Regions	Centre Pos (µn	n) Range (µm)	# Points	Step (µm)	Charle Vale situ
Line Delay (ms) 100	Regions	x 5346.247 Y -32.023	300.000	60	5.0000	Move To First
time EPWT (ms) Wait Time Between 300						Energy Point
Regions Additional Wait Time 0 WT=EPWT+dE * AWT						
Scripted Scan 🗖						Record Position
Remote Start Sample/Scan Annotation (save	d in .hdr file)					

2.17 Choose a sample region or an object with good white/black contrast. Perform a focus scan with the line drawn on this region to cover sufficient white/black contrast. The ZP scan range can't be too big, usually smaller than 300 μm, otherwise ZP might hit OSA. After focus scan, select the focal point or most close to the focal point region, set 'Focus to cursor + set for autofocus'.

Sample Centre Pos (µm) X 5344.199	Length (µm) Theta (*) 10.0	# Points	Step (µm) 0.25	Energy ( Dwell	eV) 204.274 (ms) 3	Begin Scan
Y -34.707 Zone Plate Centre Pos (μm) Z -1047.9	0.00 Range (µm) 300.0	# Points 40	Step (μm) - 7.5	Acc Dist (um) Line wait time	0.708 200 Recorded	Save Scan Definition Load Scan Definition

- 2.18 When an interested small area is chosen, focus scan should be performed again. If the scan range is within 30 um, use 'set Ao for focus'.
- 2.19 Perform necessary point scan, line scan, or image scan.

## Point scan:

Point Scan - Estimated Time: 5m 33	s							
Scan Type Point	Energies Curre	ent Energy 04.274	Total P	oints 5	Regi	ons 3	÷ 🛛 Same dwel	e Begin Scan
Stage	Region	Start Energy (eV)	End Energy (eV)	Range (eV)	# Points	Step (eV)	Dwell Time (ms)	Cancel
	1	695	706	11	29	0.393	600	Save Scan
Pol EPU Offset	2	706.2	730	23.8	120	0.2	600	Definition
🗖 2 Reg	3	731	745	14	36	0.4	600	Load Scan Definition
Defocus Focus (nm) 49								Load Energy Definition
Auto Defocus Accel. Dist. (µm) 3.568	Scan Velocity	: 0.017 mm/s	Fine Sta	ge (um)				Recorded Channels
Auto Parameters  Line Delay (ms)	Multiple Regions	Regions 1	X 419 Y 4478	.196 3.902				Check Velocity Move To First
time EPWT (ms) Wait Time Between Regions		2	Pos X 0.0	(μm) 000				Energy Point
WT=EPWT+dE * AWT			Y 0.0	000				
Scripted Scan	d in hdr filo)							Record Position
Sample/Scan Annotation (Save	a in hur me)							

#### Line scan:

Line Scan - Estimated Time: 5m 17s									2
Scan Type Line (Full Horiz, Line)	Energies Curren 20	nt Energy 4.273	Total Po 136	oints	Regi	ons 3	÷ 🔽 Sa	ume well	Begin Scan
Stage Automatic	Region	Start Energy (eV)	End Energy (eV)	Range (eV)	# Points	Step (eV)	Dwell Time (ms)		Cancel
Dichroism	1	524	528	4	11	0.4	11.211		Save Scan Definition
2 En Pol EPU Offset	2	528.2	546	17.8	90	0.2	11.211		Load Scan
2 Reg	Ŭ	1							Definition
Focus (nm) 49									Load Energy Definition
Auto Defocus	Scan Velocity:	0.017 mm/s	Fine Stag	je					Recorded
Point Delay (ms) 0.44	– Spatial Regio	ns	Centre F	os (µm) Len	gth (µm)	# Points	Step (µm)		Chamers
Auto Parameters	Regions		X 419.	185 2	0.000	100	0.2000		Check Velocity
Energy point wait 300	1 -		Y 4478	.943	0.00				Move To First Energy Point
time EPWT (ms) Wait Time Between 300									
Additional Wait Time 0									
writer writer Awr									
Remote Start								R	ecord Position
Sample/Scan Annotation (save	d in .hdr file)								

# Fine image:

Image Scan - Estimated Time: 234s						×
Scan Type Image (Point by Point)	Energies Current Energy 204.273	Total Points	Single Energy Reg	gions 1	Same dwell	Begin Scan
Stage Automatic Dichroism C 2 En Pol EPU Offset C 2 Reg	Energy (eV)			I	Dwell Time (ms) 1	Cancel Save Scan Definition Load Scan Definition
Defocus Focus (nm) 49 × Auto Defocus	Scan Velocity: 0.004 mm/s	Fine Stage				Load Energy Definition Recorded
Accel. Dist. (µm) 0.454 Point Delay (ms) 1 Auto Parameters Line Delay (ms) 100 Energy point wait time EPWT (ms) 300	Spatial Regions Multiple Regions Regions	Centre Pos (µm) X 5346.247 Y -32.023	Range (µm) 2.000 2.000	# Points 200 200	Step (μm) 0.0100 0.0100	Channels Check Velocity Move To First Energy Point
Additional Wait Time 0 WT=EPWT+dE * AWT Scripted Scan Remote Start Sample/Scan Annotation (save	d in .hdr file)					Record Position

# Stack:

Image Scan - Estimated Time: 26m 3	s							2
Scan Type	-Energies Current 204.	Energy 275	Total Po 81	oints 🗆 Si	ingle Regi	ons 3	÷ □ Sam dwe	e Begin Scan
Stage Automatic	Si Region	tart Energy (eV)	End Energy (eV)	Range (eV)	# Points	Step (eV)	Dwell Time (ms)	Cancel
Dichroism	1	281	284	3	10	0.333	1	Save Scan Definition
2 Reg	3	292.3	298	5.7	17	0.356	1	Load Scan Definition
Defocus Focus (nm) 49								Load Energy Definition
Accel. Dist. (µm) 1.181	Scan Velocity: 0. Spatial Regions	048 mm/s	Fine Stag	je	iae (um)			Recorded Channels
Auto Parameters	Multiple Reg	gions	Centre P X -498	'os (μm) 8.990 5	.000	# Points	Step (µm) 0.0500	Check Velocity
Energy point wait time EPWT (ms)			Y   142.	180 5		100	0.0500	Move To First Energy Point
Wait Time Between 300 Regions Additional Wait Time 0 WT=EPWT+dE * AWT								
Scripted Scan 🗖 Remote Start 🗖								Record Position
Sample/Scan Annotation (save	d in .hdr file)							

#### 3. Moving between samples on the same sample holder

- 3.1. Write down the current Coarse Z reading (for example, 400 um).
- 3.2. Move Coarse Z by 1000 um from the current position (400 + 1000 = 1400 um).
- 3.3. Move to your next sample by changing coarse X and coarse Y.
- 3.4. If you are going to use the same energy, move coarse Z to 500 um (400 + 100 = 500 um). If you are going to use a different energy, refer to step 4.
- 3.5. Repeat steps from 2.12 to 2.15.

## 4. Change to a different energy

- 4.1 Write down the current coarse Z reading (for example, 400 um).
- 4.2 Write down the current A0 reading (for example, 390 um).
- 4.3 Change ZP to static mode.
- 4.4 Select the right polarization (if your sample is not polarization sensitive, use Circular Right/Left), grating, harmonic number.

Energy Range (ev)	Grating	Harmonic	Polarization
<320 up to 390	LEG 250 l/mm	1 <sup>st</sup> (use it for only C 1s & below)	LH, CR, CL
330 to 1000	MEG 500 l/mm	1st	LH, CR, CL
1000 to 1800	MEG 500 l/mm	3rd	Only LH
1800 to 2500	MEG 500 l/mm	5th	Only LH
>2200	HEG 1250 l/mm	5 <sup>th</sup> or 7 <sup>th</sup> (not well characterized)	Only LH

4.5 Change to the desired energy. Choose a proper A0 (for example, 690 um) as

recommended by the software (click the "S" above A0 line

- 4.6 Calculate the difference of the two A0 ( $\Delta$ : 690 um 390 um = 300 um).
- 4.7 Move coarse Z to the position of the current reading plus the difference of A0 (in this case, the new position is 700 um = 400 um + 300 um).
- 4.8 Set ZP to auto mode, and click 'Go' besides energy again.
- 4.9 Repeat steps from 2.12 to 2.15.

# 5. Unloading Sample

- 5.1 Close SM-PSH and BSH SM beamline control.
- 5.2 Move coarse Z to 5000 um.
- 5.3 Detector off.
- 5.4 Pump valve closed and pump off and (if you were pumping).
- 5.5 Vent the STXM tank.
- 5.6 Remove top flange to access sample.
- 5.7 Take sample out, being careful NOT to touch the OSA lift straight up.
- 5.8 If no more sample to run during the shift, click 'Close BM'.
- 5.9 Pump STXM tank and fill with He if it is the end of your beam time and there is no user after you (if instructed by the beamline staff).