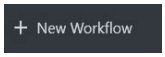
ZEISS Xradia 630 Versa

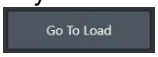
ZEN navx Control System Quick Reference Guide

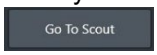
Overview of the procedure:

- **Sample** - Set the Sample's directory and data folder.
- **Load** - Load the sample and roughly align the ROI (Region-Of-Interest) using the Visual Light Camera.
- **Scout** - Scout the sample to find the desired ROI and determine imaging parameters using X-Rays.
- **Scan** - Set up 3D scan parameters for the recipe.
- **Run** - Run the recipe and acquire the tomographies

Detailed Steps: *(Assume no sample is currently in the system)*

1. Open **ZEN navx** Control System. If the application is already opened, start a new tomography by pressing 

button in the left lower corner. You will start at the **Sample** step.
2. Select the directory where data will be saved and input a sample name. At IAC, the data is saved to **D:\PW Data\{Your Name}** directory. You will see suggestions for sample mounting on this page.
3. Go to the **Load** step by clicking 

at the bottom right.
4. Move the Source and Detector away from the sample stage by clicking 
5. Set sample stage to X = 0, Y = 0, Z = 0, θ = 0°.
6. Load sample and position it roughly to the cyan crosshairs of the Live Camera, using the sample stage controls at both at 0° and -90° (use Rotation buttons on the left).
7. SmartShield (optional). To protect the system from collisions between the Sample and the Source/Detector, you can use SmartShield procedures on the right. It creates a 3D model of your sample that is used to automatically avoid collisions. The result can be viewed by pressing System Model View button. Note: if you want to use "3D Volume Scout" or "2D Projection Scout" options below then you *must use* SmartShield procedure.
8. Click 

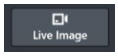
button to go to the **Scout** step.
9. You will see three Scout options: 3D Volume Scout, 2D Projection Scout, and Manual Scout.
   a. **3D Volume Scout.** This is a guided procedure, in which first you will take a quick (e.g. 15 min) 3D tomography of your sample. Using this 3D image, you will be able to select an internal volume for final tomography, also called Region-of-Interest (ROI). Then the system will give you a choice of optimal imaging parameters (objective, filter, beam energy, etc.). Please, follow step-by-step instructions on the screen. When finished - **go to step 22**.
   b. **2D Projection Scout**. This is another guided procedure, in which you will take two (0° and -90°) 2D images of your sample. Using these two projections, you will be able to select a ROI for tomography. Then the system will give you a choice of optimal imaging parameters (objective, filter, beam energy, etc.). Please, follow step-by-step instructions. When finished - **go to step 22**.
   c. **Manual Scout.** In this procedure you have full control over selecting imaging parameters. It is the fastest option for experienced users. The necessary steps are described below (steps 10 to 22).
10. In the Scout (Manual) screen, first open a recipe point in the lower left panel either by pressing 

button in 3D RECIPE POINTS field for a generic recipe or "Import" button to open an existing recipe.

11. Under the Acquisition tab, set source to **80kV** 

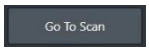
(for low density samples such as biologicals or polymers) or **140kV** (for high density samples such as semiconductors or metals, also for large samples), Power = max (as shown), Filter = **Air**, Objective = 0.4x or FPX (Flat Panel eXtension) to match sample size, Exposure = 1 sec for 0.4x objective or 0.04 for FPX (frames = 5), Bin = 2 and click Apply. Wait for X-ray source to stabilize.
12. Use 

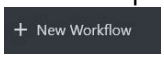
to turn the sample to θ = 0° and click button to start the continuous imaging.
13. Using the mouse, double click at the center of ROI to move it to the center of the screen. ROI is roughly centered for sample Z and Y axes. Stop continuous scan by pressing the same button.
14. Rotate sample to -90° by clicking on 

and then 

button to start the continuous imaging.
15. Center ROI along X and Y axes in the same way as in step 13.
16. Set a desired magnification by switching to an appropriate objective and changing sample-objective distance. If 20x or 40x, switch to Bin = 4 for less noisy image. (Change back to Bin 2 before step 18)
17. Fine tune ROI position at 0° and -90° (repeat steps 12 to 15 as necessary).

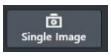
For steps 18-20 please use the VLC to verify sample, source, and detector positions. It is important to observe the relative positions of these components throughout the set-up to avoid collisions, especially if you did not use SmartShield feature (step 7).

18. Rotate sample between -180° and +180° to find the angle where sample is closest to source. Position source as close as possible to the sample at the angle determined.
19. Position detector at a collision free distance, to achieve the desired magnification/voxel resolution.
20. Rotate sample between -180° and +180° to verify collision free rotation.
21. Determine the optimal Filter, Voltage, and Exposure settings. Follow the instructions on the **next page**. Alternatively, you may choose “Parameter Guidance” option on the left of the screen. Then you will see step-by-step instructions, walking you through the process of taking test images. At the end you will be given a selection of 3 automatically determined Parameter sets, optimized for scan time, image quality, and a balanced option.
22. Click 

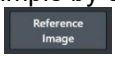
button to go to **Scan** step
23. Change the number of projections to 1601 (for FPX: 2401, # of frames = 5) for samples fitting in the FOV, for high image quality. For interior tomographies, use >2001 (for FPX > 3501, # of frames = 5). Use default values for the other parameters.
24. Click “Go to Run” button and go to the **Run** step. Click the Start button to start the tomography. The progress and the estimated remaining time will be shown on the screen.
25. When finished, leave the **ZEN navx** window opened.
26. To start a new tomography, press 

button in the left bottom corner of the window.

Manual Determination of Optimal Scan Parameters

a) Take an image of the sample by clicking 

button, use Exposure that gives >1000 counts.

b) Click on the reference 

button. Make sure the reference is collected on air. If the sample is too tall, go to the "Reference for Scouts" tab and change the reference axis to +X and try again.

c) Select a filter based on the typical Transmittance values from the newly created image using the tables below. Set the suggested filter in Acquisition tab, click Apply. This is **final** filter.

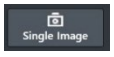
Table 1: FPX[3], 0.4X and 4X Filter Selection

Transmission (%) @ 80 kV For Thin samples and/or Low Z Materials[4]	**Transmission (%) @ 140kV** For Thick samples and/or High Z Materials[5]	**Filter**
>74	Re-Check at 80 kV	No Filter
74 - 58		*LE #1*
58 - 46		*LE #2*
46 - 36		*LE #3*
36 - 28		*LE #4*
28 - 20		*LE #5*
20 - 12		*LE #6*
Re-Check at 140 kV (if possible)	32 - 20	**HE #1**
	20 - 12	**HE #2**
	12 - 8	**HE #3**
	8 - 5	**HE #4**
	5 - 3	**HE #5**
	< 3	**HE #6**

Table 2: 20X and 40X[6] Filter Selection

Transmission (%) @ 80 kV For Thin samples and/or Low Z Materials[4]	**Transmission (%) @ 140kV** For Thick samples and/or High Z Materials[5]	**Filter**
> 63	Re-Check at 80 kV	No Filter
63 - 44		*LE #1*
44 - 34		*LE #2*
34 - 28		*LE #3*
28 - 21		*LE #4*[d]
21 - 14		*LE #5*
14 - 8		*LE #6*
Re-Check at 140 kV (if possible)	30 - 18	**HE #1**
	18 - 8	**HE #2**
	8 - 6	**HE #3**
	6 - 4	**HE #4**
	4 - 3	**HE #5**
	< 3	**HE #6**

d) With the filter in place, take another sequence of Single - Reference images. Adjust Voltage (kV) to obtain an ideal transmittance in the range of **20% - 35%**. Increase or lower Voltage (by steps of 10) to increase or lower the transmission respectively. Note: ideal transmittance may not be obtainable. In this case, please image using a transmission closest to the ideal range.

e) Determine Exposure observing average Intensity in the image, taken with 

button. Best image quality is obtained with average counts >5000. (Counts scale linearly with exposure time).

---

[3] For FPX scans only: if the required filter is HE#5 or higher, the sample should be scanned with HE#18.

[4] Low Z samples are typically biological or polymeric

[5] High Z Samples are typically metallic or contain metallic structures (i.e. semiconductor samples)

[6] For 40X only: If the required filter is LE#4 or higher; the sample should be scanned with the 20X instead. This indicates a relatively high absorption for the sample and the 40X will not provide any better resolution than the 20X.

Appendix

Table 3: Objective recommendations for typical user scan conditions

Objective	Sample Size (Maximum*) (mm)	Maximum 3D FOV (WFM[7]) (mm)	Voxel Size Bin1 (µm)	Voxel Size Bin2 (µm)
FPX	15 - 140 (200*)	140	6 - 57	12 - 115
0.4X	6 - 50 (100*)	50 (90)	3 - 30	6 - 60
4X	2 - 20 (50*)	6 (10)	0.7 - 3	0.7 - 6
20X	0.5 - 4.0 (10*)	1.1	0.3 - 0.6	0.5 - 1.2
40X	0.3 - 2.0 (5*)	0.5	0.2 - 0.3	0.3 - 0.6

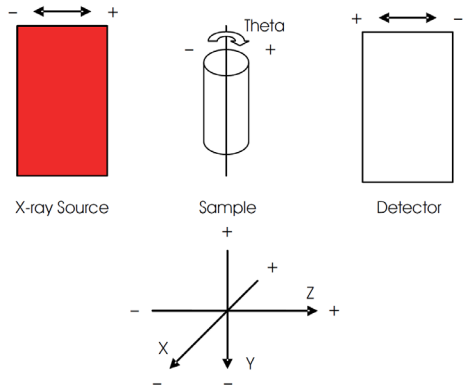


Figure 1. Axis Definitions of X-ray Source, Sample, and Detector

Emergency Information:

Medical Emergencies: Contact 911 and Public Safety (609) 258-1000
Room / facility emergencies: Contact Public Safety (609) 258-1000
Issues related to the instrument:

1. Contact IAC Staff.
2. Leave system as is.
3. Try to shut down the X-ray source.

Audible/Siren Emergency Alerts:
Follow previous steps 2 & 3 and leave the building.

Emergency Contact Information:

Nan Yao: Office (609)258-6394; Cell (908) 922-2236 Email: nyao@princeton.edu
Denis Potapenko (609) 258-7956; Cell (718) 551-6810 Email: denisp@princeton.edu
John Schreiber: Office (609)258-0034; Cell (215) 431-4670 Email: js51@princeton.edu
Paul Shao: Office (609)258-3851; Cell (847) 721-0861 Email: pshao@princeton.edu