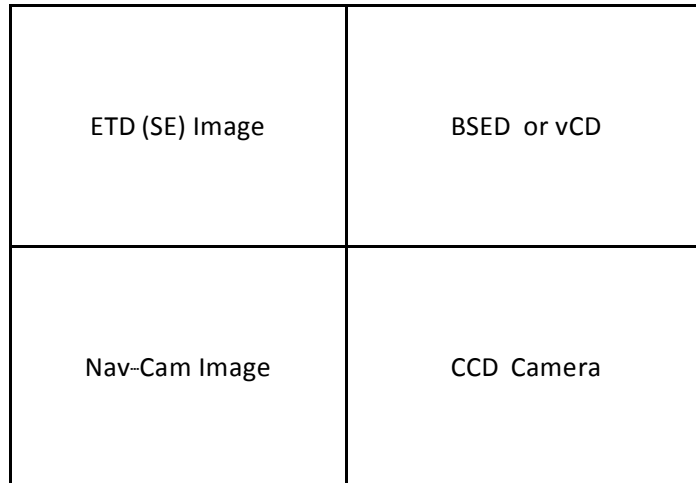


# FEI Quanta FEG 450 ESEM Manual

## ESEM Terminology

**Quad** –Computer screen has 4 independent windows. The bottom two quads are designated for the NavCam still image and the live video feed of the CCD camera. The top two quads may be used for imaging the sample. Clicking on a quad can activate it. The data bar at the bottom will be blue if the quad is active. F5 key can toggle between the quad view and enlarged active window view. Ctrl+F5 will show the active quadrant in the second monitor.



Default Quadrant Orientation

**Z-Link** –The link adjusts the z coordinate such that it corresponds to the distance from the pole piece to an in-focus scanning area on a sample. Once linked, (under the Navigation tab) z=0 corresponds to the end of the pole piece. Without link, z=0 corresponds to the lowest point of the stage motion. The up or down of the red arrow in the stage z coordinate indicates the direction of increasing z. Always focus on the highest part of your sample and link. The generated WD is approximately your clearance. When tilting the sample extreme care must be taken to ensure the highest point of your sample does not contact the pole piece, even at a large working distance.

**Stigmation** –Stigmation is a procedure that adjusts the beam until it is circular. When a beam is not circular, the image will have sharp edges in one direction and fuzzy edges in the other. One sure way to see if your beam needs stigmation is to go through focusing on a small feature. Stigmation needs to be adjusted if the feature stretches in one direction when it is under focused and in the orthogonal direction when it is over focused.

## Startup

Start xT Microscope Server found on the desktop. Click on the Start button. Login using your login information. Click to hide the Status window. Right click the top of the server window, and choose Show Tiny View. If needed, you may click and move the server bar to the top.

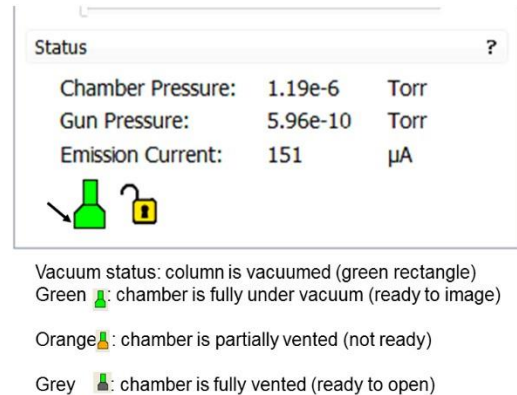
## Precautions during stage movement

When making stage movements, the live video feed must be observed and your hand must be ready to hit the **ESC** key to stop stage movements. Pressing **ESC** will immediately stop all stage movement to prevent anything from touching the pole piece and other detectors.




**The z-axis should only be adjusted with the mouse controls while observing the live video feed.** The z-direction speed can be adjusted by click and hold the scrolling wheel on the mouse.

## Status Display

The bottom right corner of the xT Microscope Control window contains information about the status of the vacuum, stage, gun, and HV. The pressure of the chamber and the column are displayed. Green color indicates the system is functioning properly. Grey indicates that the system is off and orange indicates that the system is in transition between off and ready. When the chamber pressure is below  $2.48 \times 10^{-4}$  Torr, the chamber icon will turn green. When the icon turns green, the electron beam can be turned on.



Status		
Chamber Pressure:	1.19e-6	Torr
Gun Pressure:	5.96e-10	Torr
Emission Current:	151	µA

Vacuum status: column is vacuumed (green rectangle)  
Green : chamber is fully under vacuum (ready to image)  
Orange : chamber is partially vented (not ready)  
Grey : chamber is fully vented (ready to open)

## Vent and load sample

Click 'Vent' on vacuum mode on the beam control Panel to open the SEM chamber. You will be asked to confirm this action. The color of the chamber icon changes from green to orange. Slowly pull the chamber door open when hear air hissing out the chamber or when it lets you pull it open (takes a little over a minute). **Caution** must be taken when open/closing the chamber door. If there is a sample in the sample holder, you must ensure that the sample will not hit the pole piece or any detector prior to pull the chamber door.

Make sure that there is not a pause icon on quad IV, so you can see the live video feed of the pole piece in this quad (if there is a pause icon, click on it to un-pause the video). Insert your sample stub onto the sample holder.

**Taking a NavCam picture:** swing the NavCam 90 degrees to activate it. Wait for the stage to move under the NavCam and for the lower-left quad to go live. Take a picture with the NavCam by pressing the round silver button located at the base the NavCam arm. An image of your sample on the stage will appear in quad III. Wait for the light to blink off two times. Swing the NavCam back to its home position.

**Slowly push** the door into the close position. Before initializing pump down, ensure the door is completely closed. Click the radio button to select necessary vacuum mode (high vacuum, low vacuum, or ESEM). For the Low Vacuum and ESEM mode select the target **Chamber Pressure and aperture cone choice** before clicking the **Pump** button. Press the chamber door handle firmly for a few seconds to help seal the chamber at the beginning of pump-down.

## Imaging a sample

While pumping, double click where you want to move the stage to on the NavCam image.

Use Ctrl+F5 to utilize the right monitor with a workable area of whatever quadrant is active.

Wait until chamber pressure reaches vacuum.

Click on **Beam On**. Either quad I or quad II can be used to perform SEM imaging but only quad I can be fed into EDS. Click on the pause button (or F6) to make that quad go live. Click on the **Auto Contrast/Brightness** (half black/half white circle) button on the software toolbar.

Navigate around to find a distinguishable feature on the sample surface. Focus on your sample by either holding down the right mouse button and dragging the mouse to the left or right or by using the Coarse and Fine knobs on the MUI. You can use the **Reduced Area** icon (or F7) to assist. Focusing at 2x to 3x the magnification needed for the final result will make the lower magnification sharper, e.g. photo mag = 2000x, therefore focus at mag = 4000x-8000x.

To change the magnification, use the + and – buttons on the numpad. This will double and halve the magnification, respectively and will always be a rounded number. You may also use the magnification dial on the MUI. This will change the magnification in smaller increments, but will not be a rounded number. You may use the asterisk (\*) button on the numpad to round the number.

Link Z by clicking on the icon that looks like a pyramid and a halo with a red question mark in the middle. Working distance can be reduced if necessary by going to the navigation tab on the right and selecting the desired working distance. Usually you want to be at least at 10mm working distance, if not shorter. This is the easiest way to get better resolution.

You can move around the sample by double clicking on the point of interest to center it within the quad, or using arrows on the keyboard, or pressing the scroll wheel on the mouse and dragging the mouse in the direction you want to move.

**Aperture Centering:** If the image moves when changing focus, the aperture needs centering. Next, take the magnification to at least 20,000x and ensure that you are in focus. Select a 100ns dwell time. Select the Direct Adjustments icon from the toolbar and click the Lens Modulator button. The image will appear to go in and out of focus, and will shift if the aperture is not centered. Center the aperture using the mouse and clicking the middle of the Lens Alignment square. As you hold the left mouse button down, adjust the green crossed lines (the Lens Shift) in the direction the beam is swinging until the swaying/swinging of the image is minimized. What you want to reach is a position in the Lens Alignment in which the image is not swaying or swinging but is gently pulsing in and out of the screen – the image will appear to be “breathing.” Close the window to stop.

**Astigmatism Correction** (shift + right mouse button, or using the X and Y knobs on the MUI): Astigmatism usually needs to be corrected initially for most specimens, and then again after changing kV, spot size or working distance. The astigmatism in the image is usually only visible at higher magnifications (as a guide 3000x or greater).

Focus as well as possible at the focus magnification. Now move the focus control through focus to the other side of focus to observe any astigmatic distortion. If astigmatism is present, the result observed is a directional distortion change of 90° between the two out of focus conditions.

To correct the astigmatism, hold the shift key and the right mouse button, or use the X and Y knobs on the MUI.

**Scanning and Saving an Image:** Scanning and databar settings are found under the Tools menu and by selecting Preferences... The Scanning tab will allow you to change the dwell time for the single (F2) image.

Set the databar label to what you need. Save the desired image by clicking the Image Acquisition button on upper menu banner, or by selecting F2. The scan will pause after one frame scanned and a save dialog will open. You can also save by going to the File menu and selecting Save As...

An image can be saved in TIF, JPG or BMP format. We usually choose 16bit Grayscale TIF or 24bit Image TIF.

### **Vent chamber and unload sample**

Turn the beam off by pressing the **Beam On** button. The button should turn from yellow to grey.

Vent the chamber by clicking **Vent** button under the **Beam Control** work page. It takes a little over a minute until the chamber is vented enough to pull open the door.

Slowly pull the chamber door open while monitoring the live video feed of the chamber. Ensure that the sample and stage path is clear.

Slowly push the chamber door closed and click the **Pump** button under the Beam Control menu on the right to pump the chamber back to high vacuum.

Wait for the vacuum icon to turn green. Hit the **Stop** button on the server window, and wait for the server to fully unload (the green bar will empty out). Then you may log off.