

FEI Tecnai F20 S/TEM: imaging in STEM mode

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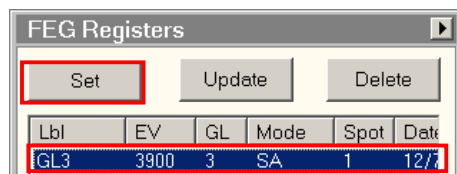
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This document assumes the user is already familiar with basic operation of the instrument in TEM mode and use of the Microscope Control interface.

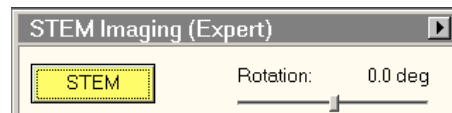
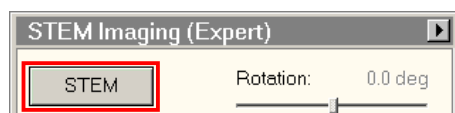
1. Load your specimen into the selected holder, plasma clean the specimen and holder (this is particularly important if you wish to perform EDS and/or high-resolution STEM imaging) and load the holder into the column as described previously.
2. Before entering STEM mode
 - 2.1. Find a region of interest and bring it to eucentric height.
 - 2.2. Select and apply the “GL3” FEG register; this can be used equally well for analytical work (EDS) or high-resolution work.



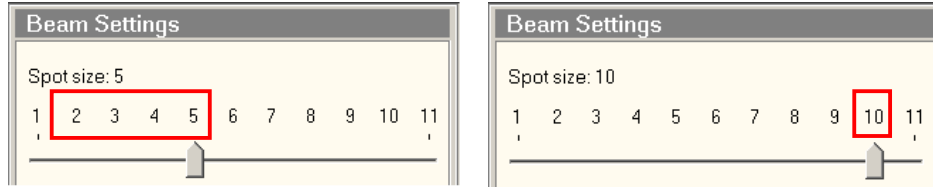
- 2.3. Make sure the objective and SA apertures are both *retracted*.

3. Entering STEM mode

- 3.1. In Microscope Control, select the **STEM** tab; navigate to the “STEM Imaging” control panel and select “STEM” to enter STEM mode (the button will turn yellow); a stationary CBED pattern (Ronchigram) should be visible on the viewing screen.

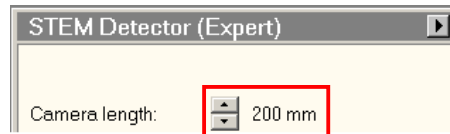


- 3.2. In Microscope Control, select the **Beam** tab; navigate to the “Beam Settings” control panel and select an appropriate spot size (you must do this *after* entering STEM mode); spot size = 2 – 5 is recommended for analytical work while spot size = 10 is recommended for high-resolution work.

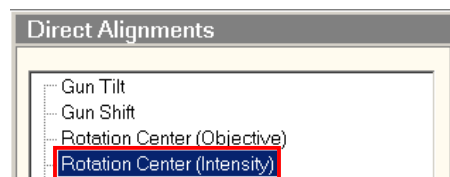


4. Alignment

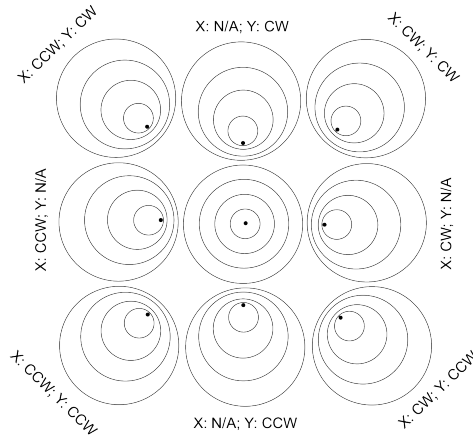
- 4.1. In the “STEM Detector” control panel, set “Camera length” to 200 mm (this will be changed later after alignment is complete).



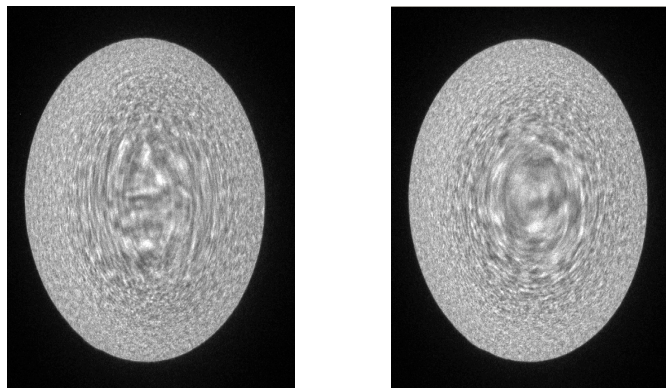
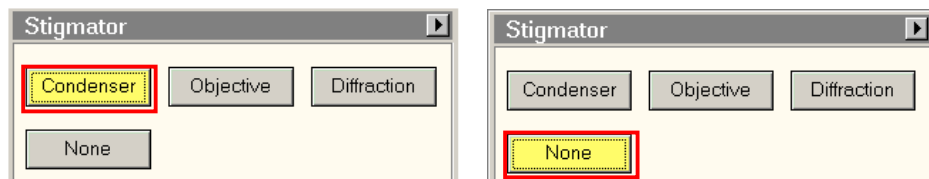
- 4.2. Insert the #4 C2 aperture (largest available); then wobble the “Focus” knob (use a large step size) to determine the approximate center position of the Ronchigram (000 CBED disc) and roughly center the aperture on it.
- 4.3. Alignment should be performed on a region of the specimen that is amorphous or partially amorphous (evaporated C or FIB Pt, for example). If you are not over such a region, use the “Focus” knob to defocus the Ronchigram to the point where the specimen can be observed and use the joystick to move to an appropriate region; once finished, roughly focus the Ronchigram.
- 4.4. In Microscope Control, select the **Tune** tab; navigate to the “Direct Alignments” control panel and select “Rotation Center (Intensity)”.



- 4.5. Use the “Focus” knob to expand and contract the Ronchigram. Adjust the “Multifunction” knobs until the expansion and contraction of the Ronchigram is straight into and out of the page. The Ronchigram may move close to the edge of the C2 aperture while doing this; if this occurs, simply roughly re-center the C2 aperture around the Ronchigram. When the rotation center is finished, select .

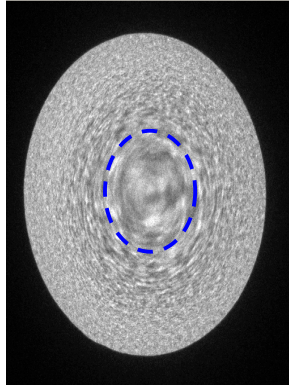


- 4.6. Use the “Focus” knob to slightly under focus until rings are clearly evident in the Ronchigram. If the rings do not have the same elliptical shape as the C2 aperture edge (as viewed using the focusing screen), the probe is astigmatic. Navigate to the “Stigmator” control panel and select “Condenser”; use the “Multifunction” knobs to adjust the Ronchigram so the rings have the same shape as the C2 aperture edge; select “None” when finished.

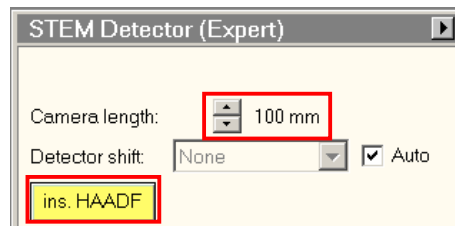


Astigmatism in the Ronchigram: uncorrected (left) and corrected (right)
(As observed on the focusing screen)

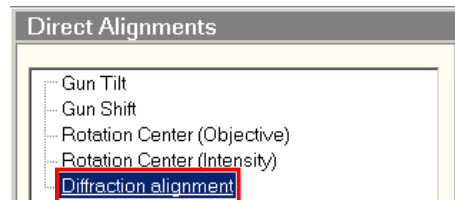
4.7. Insert and finely center the #1 C2 aperture on the Ronchigram (see below).



4.8. In Microscope Control, select the **STEM** tab; navigate to the “STEM Detector” control panel and set “Camera length” = 100 mm (for a HAADF-STEM image); then select the “ins. HAADF” button to insert the STEM detector.

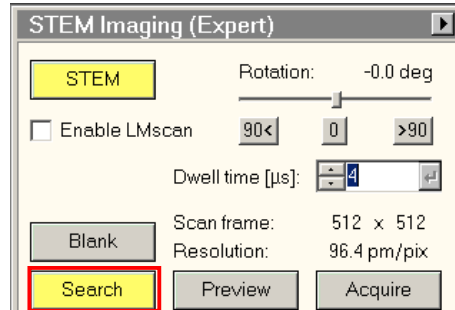


4.9. The default position of the Ronchigram should result in it being centered reasonably well inside the inner rim of the STEM detector. If the Ronchigram is not positioned appropriately, this will need to be done manually. In Microscope Control, select the **Tune** tab; navigate to the “Direct Alignments” control panel and select “Diffraction alignment”; use the “Multifunction” knobs to center the Ronchigram inside the inner rim of the STEM detector; select **Done** when finished.

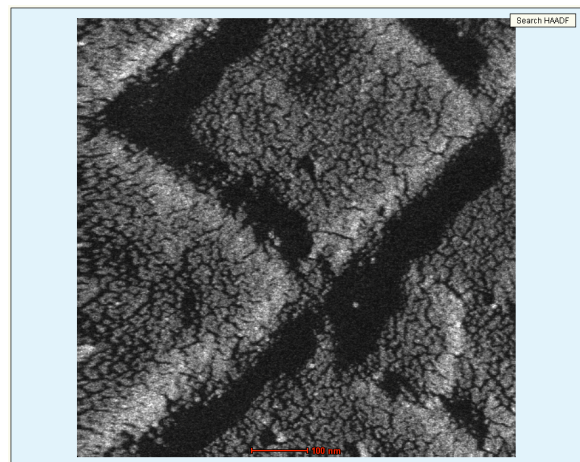
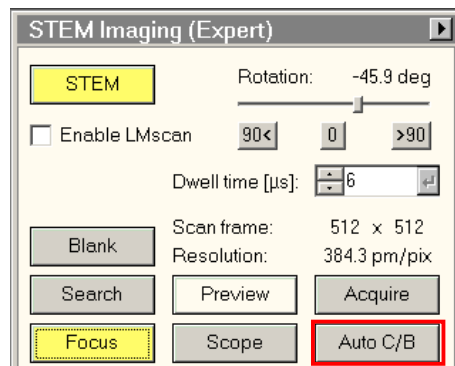


5. Live imaging in STEM mode

- 5.1. In Microscope Control, select the **STEM** tab; navigate to the “STEM Imaging” control panel and select “Search” to start acquiring a live STEM image in TIA.



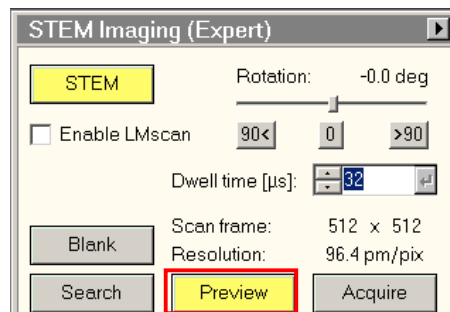
- 5.2. Set the “Dwell time” to 4 μs (this is the default value and is usually sufficient for live imaging); if the contrast in the image is difficult to observe, select “Auto C/B” to automatically adjust the contrast and brightness to make the image easier to observe.



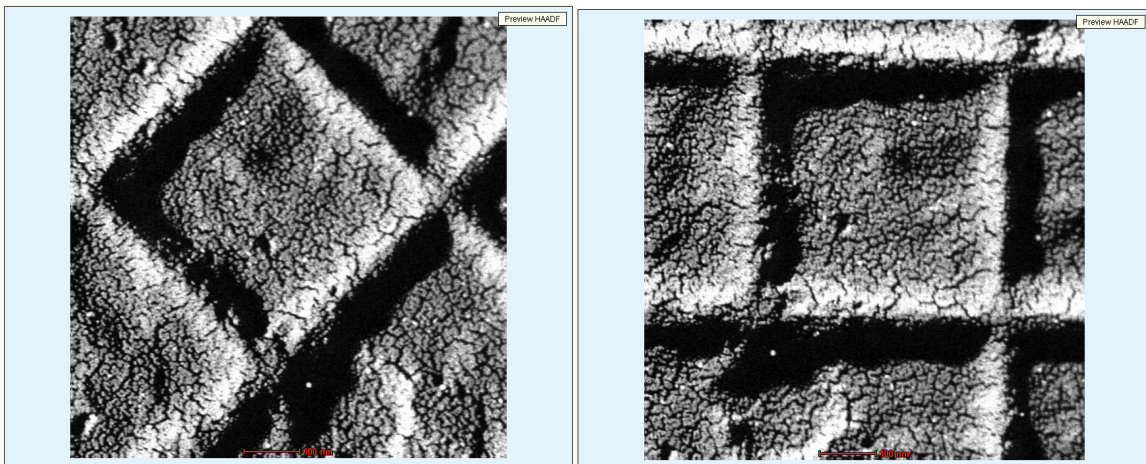
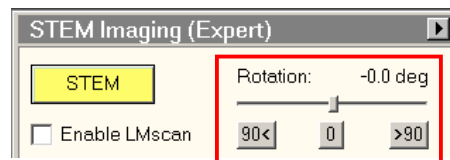
- 5.3. Adjust the “Magnification” knob to change the field of view; use the joystick to move around as needed to find an area of interest.

6. Fine tuning and acquiring the STEM image

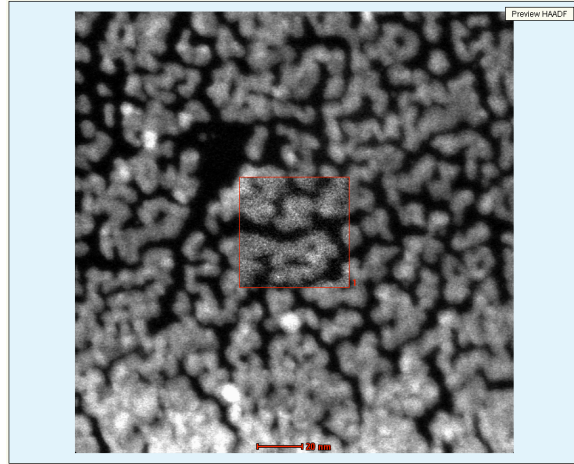
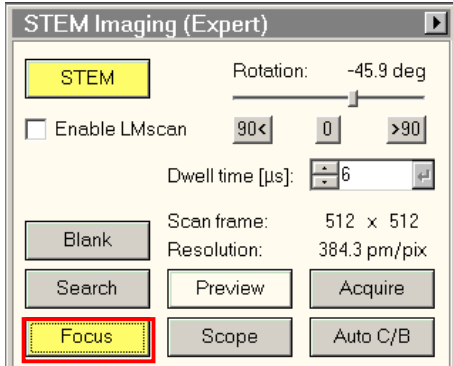
- 6.1. After finding an area of interest, set “Magnification” to the setting you wish to acquire your final image at.
- 6.2. In the “STEM Imaging” control panel, select “Preview” to switch to preview mode (the button will turn yellow); set the “Dwell time” to $\sim 30 \mu\text{s}$.



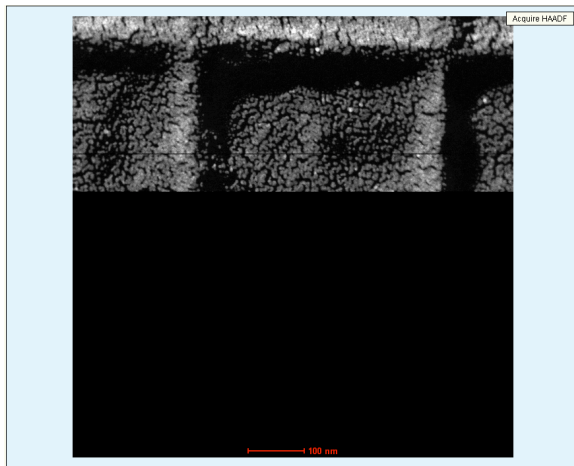
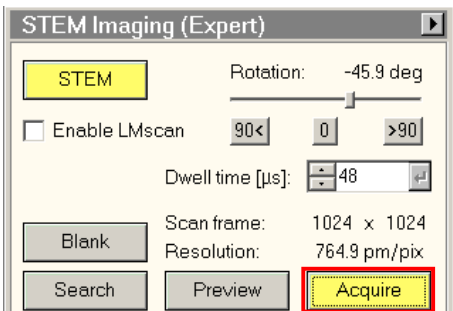
- 6.3. If desired, the STEM image can be rotated to align certain features in the image along preferred directions. In the “STEM Imaging” control panel, adjust “Rotation” until the STEM image is oriented as desired; keep mind a negative rotation is a clockwise rotation.



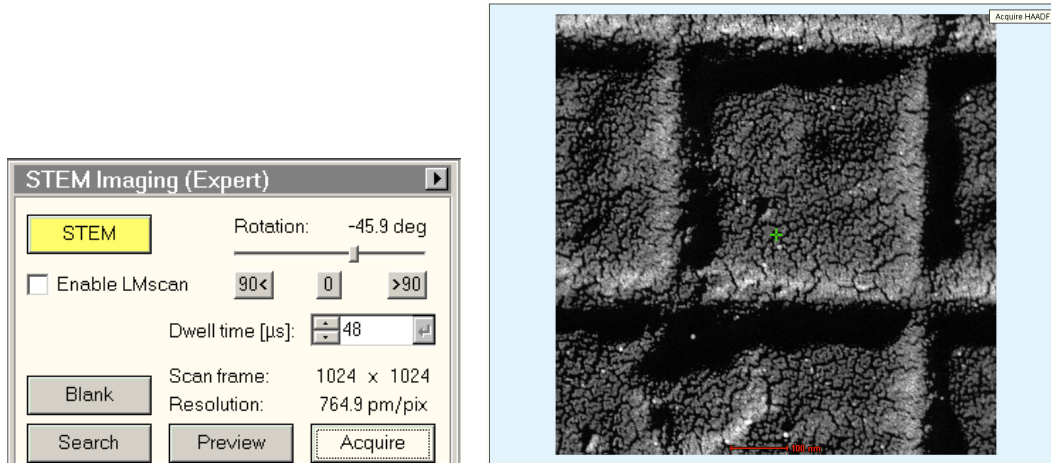
- 6.4. Increase “Magnification” a few settings beyond the desired value; in the “STEM Imaging” control panel, select “Focus” to activate the focusing box (which can be positioned/sized as desired); use the “Focus” knob to finely focus the image; if any astigmatism is present, correct using the condenser stigmator; when finished, select “Preview” to turn off the focusing box and then adjust “Magnification” back to the desired setting.



- 6.5. In the “STEM Imaging” control panel, select “Acquire” to acquire a high-quality STEM image (the button will turn yellow while acquisition is active); a “Dwell time” of 20 – 60 μs is usually sufficient (if adjusted from the initial value, acquisition will automatically restart).

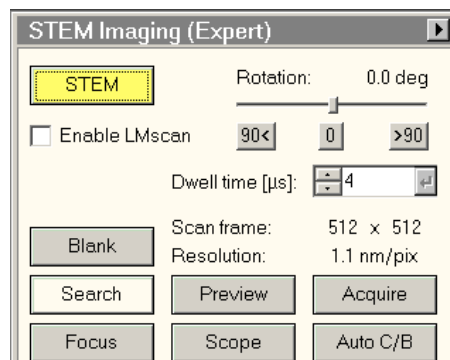


- 6.6. When acquisition is finished, the scan will stop and “Acquire” will turn white; to reactive the live image, select “Search” (the button will turn yellow).

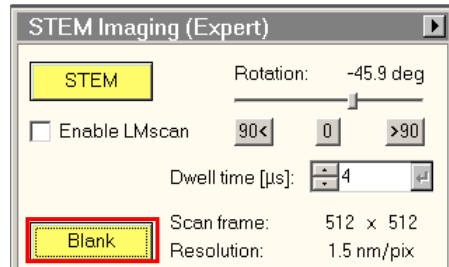


7. Blanking the beam (if needed)

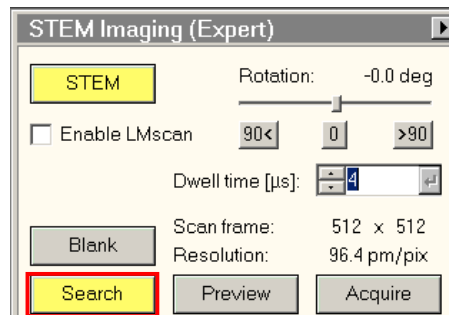
- 7.1. If for some reason you need to stop STEM imaging for an extended period of time, but want to leave the instrument in STEM mode, the scanning should be stopped and the beam blanked.
- 7.2. In the “STEM Imaging” control panel, make sure none of the “Search”, “Preview”, “Acquire”, or “Focus” buttons are yellow; if one of these buttons is yellow, simply select it and this will turn the scanning off.



- 7.3. To blank the beam (so it is no longer irradiating the specimen), select “Blank” (the button will turn yellow).

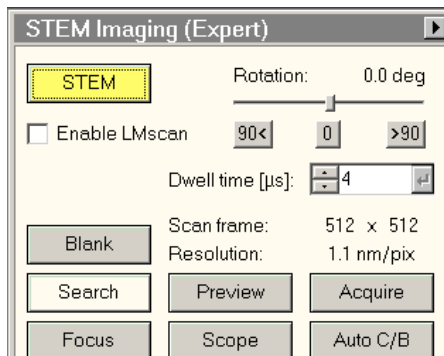


- 7.4. When you are ready to start live imaging again, simply select “Blank” (the button will turn gray) and then select “Search” (the button will turn yellow).

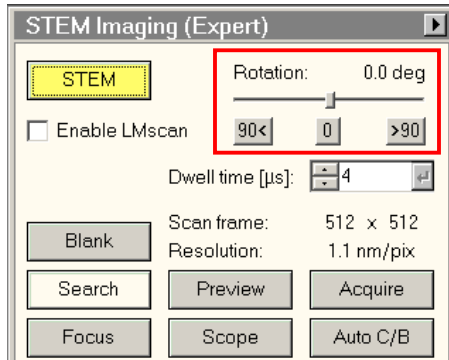


8. Finishing in STEM mode

- 8.1. When you are finished operating in STEM mode, select the **STEM** tab; navigate to the “STEM Imaging” control panel and make sure none of the “Search”, “Preview”, “Acquire”, or “Focus” buttons are yellow; if one of these buttons is yellow, simply select it and this will turn the scanning off. Likewise, make sure the “Blank” button is also gray (blanking off).



8.2. If it was adjusted, set “Rotation” back to zero.



8.3. Select the “STEM” button to return to TEM mode (button will turn gray).



8.4. Re-insert the #2 C2 aperture and re-center as described for TEM mode.

8.5. If TEM imaging is to be performed, the full TEM alignment procedure should be carried out.

8.6. If no TEM imaging is to be performed, simply finish the session as you would normally (close column valves, reset stage, remove holder, etc).

Appendix: shorthand procedure for performing STEM imaging

1. Set specimen at eucentric height in TEM mode
2. Enter STEM mode
3. Set spot size
4. Perform STEM alignment
 - a. Rotation centering
 - b. Correct condenser astigmatism
 - c. Align #1 C2 aperture
5. Set camera length as intended for imaging
6. Center Ronchigram relative to STEM detector
7. Use "Search" mode to start imaging
8. Perform auto contrast/brightness as needed
9. Adjust magnification as needed
10. Switch to "Preview" mode
11. Adjust "Rotation" (if needed)
12. Use condenser stigmators to stigmatize image (if needed)
13. Focus image
14. Acquire final image
15. When finished in STEM mode, freeze scanning
16. Set "Rotation" to 0°
17. Exit STEM mode
18. Realign #2 C2 aperture in TEM mode