SAFE USAGE OF THE FEI SEM (SMIF SEM1)

- If the Vacuum is reading $3.0 \times 10^{-6}$ mBar, vent the SEM immediately. When the SEM reads idle, pump the system back down again.
- **Don't** press the buttons on the SEM module (on the front of the chamber)
- **Don't** make any changes to the computer settings (including screen resolution) as the current settings are needed for proper SEM functionality
- Check for E-beam lithography:
  - Verify no DOS program running on the second computer
  - Make sure that the **beam blanker electronics controller** (an external unit sitting on the left of the second computer) is **switched off**
- Loading the sample into the chamber
  - **Don't** touch the interior of the chamber
  - Check the height of the sample using “elephant’s ear” height gauge
  - Open and close the chamber door using the EXTERNAL door handle only
  - Watch the door closing on the monitor (change the **detector** setting to ‘CCD’). **Verify the sample/holder is low enough to fit under the lens.**
  - Make sure the door is fully closed before you start pumping.
- Before turning beam on verify the **contrast** setting isn’t too high (typical:20-50%)
- Set **contrast** and **brightness** manually the 1st time before using the ACB button
- Moving the stage
  - The easiest way to damage the SEM is to crash your sample into the pole piece (a cone just above the sample). Unfortunately, the microscope has **no interlocks** for this case, so if you move the stage always check using CCD that you are far enough from the pole piece.
  - Have Z distance (pole piece – sample distance) set correctly. When loading the sample, this distance is unknown (the SEM assumes that it’s the same distance as it was for the previously loaded sample). After focusing the beam on the surface of your sample, “working distance” (WD) shows the actual distance between the pole piece and the sample. Have Z set equal to WD at this point! (The SEM asks to confirm that $Z \Rightarrow WD$ every time you turn the beam on, don’t click “OK” without focusing the sample first). **Stop and ask clarifications if you do not understand the difference between $Z$, WD and the actual distance between the pole piece and the sample.**
  - Having several samples of different height and moving from one of them to another can also lead to crashing into the pole piece. To avoid it increase Z and check with CCD what is happening inside the chamber as you are moving the stage.
- **Don't** use magnetic holders or samples in the system as they can be peeled off by the magnetic field created in the chamber and damage the pole piece
- **Don't** use powdered samples or powdered gloves in the chamber

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Any Questions or Problems: **Contact SMIF Staff**

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**Operating Procedures for SEM1**

**FEI XL30 FE-SEM**

**Start-Up**

1) Sign in usage via the support computer.

2) If Scandium is not up on the middle monitor, double-click \[\text{ON} \] button.

3) Click on the CCD button \[\text{ON} \] in Microscope Control (if not already yellow). This will give you a view of the sample chamber on the screen.

4) Check and if necessary adjust X (0), Y (0), Rotation (0), Tilt (0) and Z (15-20mm).

5) Select the Vent button in the Vacuum control box. Click OK in the dialog box and wait for the vacuum Idle message. It will take about 3mins for the chamber to vent.

6) Put on gloves and carefully open the chamber with handle. Place the specimen stub on the stage.

7) Check the height with the "elephant ear" gauge. The top of the sample should be just below the bottom of the "trunk". If it is not, lower the stage with the Z knob.

8) Carefully close the door – watch the monitor to be sure the sample does not hit anything.

9) Hold the door closed and press the Pump button.

10) Go to the Detectors menu and select SE.

11) From the Beam menu, select an appropriate kV (e.g. 1-30 kV) and set the spot size to 3.

12) From the Scan menu, select Slow Scan 1.

13) From the Magnification menu, check that the Reference is set to (Display). If it has something other than Display inside the ( ), click on it. A menu box will appear. Select Display and close the menu box.

**Imaging samples**

14) If the Vacuum is reading \[3.0 \, \text{e}^6 \, \text{mBar}, \text{vent} \] the SEM immediately. When the SEM reads idle, pump the system back down again.

15) Once you see Vacuum OK and the vacuum reads \[\ldots \, \text{e}^5 \, \text{mBar} \], click the kV button (in the Beam control box). Do not remove the Confirm Focus message.

16) Click the Autocontrast button \[\text{ON} \] or modify the brightness and contrast using the sliders.

17) Magnification can be adjusted using the +/- keys on the numeric keypad, in the Magnification menu, or by clicking in the inner circle in \[\text{ON} \] mode.

18) Focus by pressing the RIGHT mouse button and dragging to left or right. Selecting the Selected area box button \[\text{ON} \] and Slow Scan 2 may be helpful.

19) Once the sample is in focus, click OK on the Confirm Focus window. If at any time the WD on the databar does not match the Z in the Stage control box, click on the Z\[=\]FWD button to link them.

20) Move the sample using one of the following methods: \[\text{ON} \] (click and hold in the direction you want to move the stage), \[\text{ON} \] (double click will bring that point to center), or arrows on the keyboard. Rotate using the R knob on chamber door, or adjust R field in Stage control group.

21) Adjust the working distance of the sample by typing a value in the Z box or by turning the Z knob on the front of the SEM. When changing the working distance, use the CCD \[\text{ON} \] view to ensure the sample does not hit the pole piece. The pole piece is very expensive and not covered under the service contract. The optimal working distance for the SE detector is between 10-12mm. The optimal working distance for the UHR detector is around 7mm.

22) Correct the astigmatism if necessary and only if you are above \(10,000x\). Access the stigmator function by pressing the SHIFT and right mouse button together. Move the cross hair left to right and top to bottom to until the image improves. Try to make the edges in the image as sharp as possible.

23) Adjust Spot Size if necessary (e.g., try \(2 \, \text{@} \, >50000x\)). A smaller spot size will give better resolution, but a grainier image.
24) To acquire a digital image, press **F2** for standard definition images (338KB) or press **F5** for high definition images (5MB).

25) For an F2 capture, wait for the button to turn yellow. Then click the button on the Scandium toolbar to transfer the image.

26) The image will not freeze when collection is complete for an F5 capture. To get a high resolution image to transfer to Scandium press the arrow button next to the button. This will give you a drop down menu. Select XHD Capture. Select Standard Image when you wish to switch back to the normal imaging mode.

27) Click to have the data bar at bottom of the image.

28) To preview the scale bar on the image, click .

29) To burn the scale bar on to the image, go to the top menu bar. Press Image. Go down to Scale bar and follow the arrow across. Select “Burn into Image”

30) To save the images, click . Select Users on the F drive. Type file name, press Enter.

31) If you have used an F2 capture, click off to revert to a live scan. An F5 capture will automatically go back to a live scan.

32) To use the Ultra High Resolution detector press the UHR button. The working distance must be set around 7.0mm and magnification must be higher than 1500x. The UHR button letters will turn black when the SEM conditions are met for UHR mode to function. The samples will need to be re-focused and the stigmation readjusted. **Do not use the UHR detector with any magnetic samples.**

33) To tilt the sample, move the sample to a working distance of >15mm and keep it there for imaging. Change detector and watch the tilting procedure on the CCD camera to be sure the sample does not hit the pole piece. The pole piece is very expensive and not covered under the service. Adjust tilt angle by typing a value in the box (the range is 0º to 50º).

34) Images can be printed out on the small Sony photo printer using the IN/OUT menu and selecting “Video print”.

**Leaving the SEM for the Next User**

35) Decrease the magnification to the minimum value.

36) In the Beam control group, click on the **kV** button to turn the filament off.

37) Click the CCD button to view the inside of the chamber.

38) Set stage Tilt to 0, Z to >15mm, X, Y, R to 0.

39) In the Vacuum control group, click the Vent button. Wait for Idle message.

40) Carefully open chamber, with handle, and remove samples (wear gloves).

41) Close door and hold shut. In the Vacuum control group, select Pump. Verify the chamber starts to pump down.

42) Remove images from the support computer via e-mail or storage media.

43) Close Scandium.

44) Sign out of the usage log via the computer.