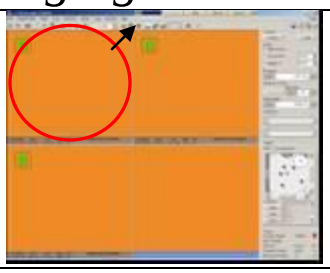
Standard Operating Procedures:
SEM Imaging

1. **Activate a SEM viewing window** by left-clicking a quadrant.

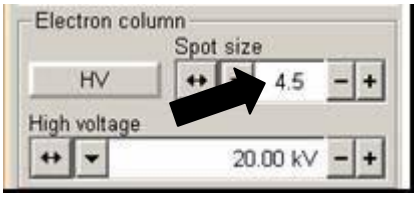
Then un-pause the SEM image by clicking the pause button (||) located in the top tool bar.



2. **Set the** "*Spot size*" per your application (see below). For general imaging purposes a spot size of 4.5 is recommended.

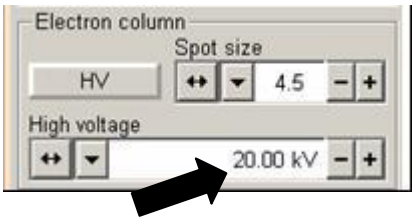
Spot Size Guideline:
1,2 = Very High Resolution (> 50,000X)
3,4,5 = Standard Imaging (SE, BSE, LFD, GSED).
6,7 = BSE, CL, EDX, EBSD, WDX, Lithography

Note: *Spot size refers to the actual focused area or diameter of the beam on the sample at any point. Spot size is defined using assigned numbers from 1 to 7 which correspond to beam current values. Spot size is considered ideal when the edges of the beam just touch when adjacent lines are scanned. If the spot size is too large, overlaps occur and the image will appear out of focus. If the diameter is too small, electronic noise will appear in the image.*

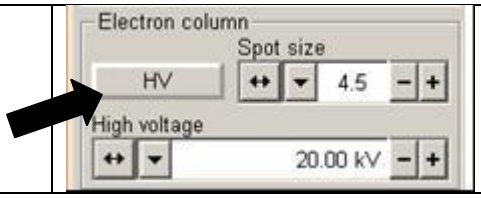


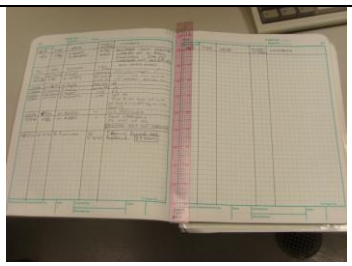
3. **Set the high voltage** "*HV*" level per your application (see below). For general imaging purposes a HV level of 15 kV is recommended.

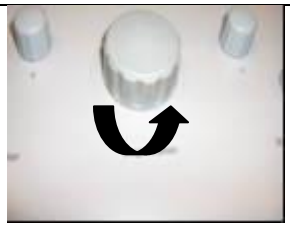
High Voltage (HV) Guideline:
Biological = 0.2 kV - 10 kV
Insulators = 1- 5 kV
Semiconductors = 2 - 15 kV
Conductors = 15 - 30 kV



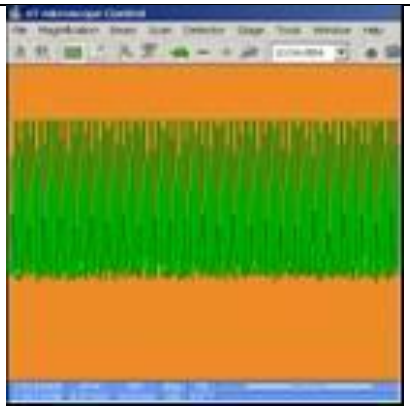
4. **Click** the "*HV*" button.



5. **Using a pen**, enter the high voltage, filament current, and the emission current into the Log Book. ***WARNING*: If the filament current is zero**, *shut down the microscope following the "Logging Off" procedures and contact a faculty member within the Materials Engineering Department.*	

6. **Set the magnification** to the lowest level by turning the large knob on the console counterclockwise. ***Note:** The magnification will have to be adjusted per your application once the sample has been focused.*	

7. **Press** "*F9*" to activate the "*Auto Contrast Brightness*"	

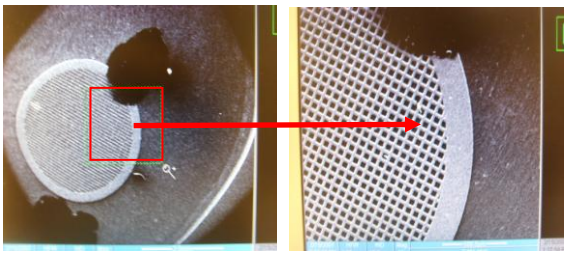
8. If the "*Contrast*" and "*Brightness*" are not balanced per your application, **turn on the** "*Videoscope*" by **pressing** "*F3*". ***Note:** When activated, the screen will display an overlay of two separated horizontal lines indicating white (top line) and black (bottom line). A monitor waveform is displayed between the two lines.* ***Contrast** is represented by the amplitude of the waveform, and **Brightness** is represented by the central position of the waveform between the two lines. **The high and low peaks should just clip the dashed lines.***	 

9. **Focus your sample** using the "*Course*" and "*Fine*" focus knobs on the front right of the console.

10. **To move the sample stage beyond the viewing area**, sequentially **click** the mouse wheel in the center of the upper left quadrant and **then move** the mouse in the direction of interest.

11. **To zoom into a sample feature**, draw a box around the feature of interest using the left mouse button by doing a click-and-drag technique. The size of the box will approximately be the new area of focus.

Note: *Step 11 can also be accomplished by re-centering the feature of interest by double clicking the mouse on the feature of interest. Once the image has re-centered, increase the magnification by turning the "Magnification knob" on the front console.*



12. **Locate and focus** the highest sample feature.

WARNING: ***Do not skip this step!!!***

Note: *Always focus your sample between 2 and 3 times the magnification required for your final image.*

13. For best scan rate**,** Select "**Average**" rather than "Live" (default)

The "Integrate" function is the slowest scan; therefore, it will give the clearest images. This mode will be used automatically once a photo taken.

WARNING: ***Do not skip this step!!!***

Note: *Always focus your sample between 2 and 3 times the magnification required for your final image.*

13. **For precision focusing:**
a) Press "*F7*" to activate the "*Reduced Area"* window
b) Focus your image using the "*Fine Focus*" knob on the front console
c) Sequentially adjust the X and Y "*Stigmator*" knobs on the front console as if they were focus knobs
d) Rrefocus your image using the "*Fine Focus*" knob
e) Press "*F7*" to turn off the "*Reduced Area"* window
f) Repeat the above listed, as necessary.

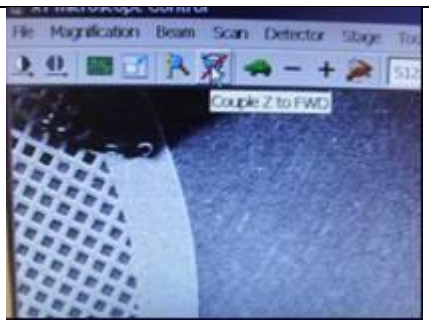
Note: *Astigmatism refers to the condition where the lens system does not have perfect rotational symmetry, that is, when the beam is not round. This can be caused by machining errors, heterogeneities in the iron of the lens, asymmetry in the copper winding, and dirty apertures. When the lens has a slightly elliptical shape, the electrons will come into focus as two separate foci at right angles to each other, instead of as a point. Stigmation is controlled through a set of coils in the objective lens of the microscope called the stigmation coils. These coils push and/or pull the electron beam into a round beam.* ***Astigmatism is usually*** *only visible in the image at higher magnifications* ***(> 3000x)****. An astigmatic image will look slightly out of focus and have a slight stretching in one direction or another.*

Note: The next step is especially important if you plan to do EDS!

14. **Once focused:**
a) Press the "*Couple Z to FWD*" button
b) Set the Z coordinates equal to **10 mm** in the right hand column under the "*Stage*" tab
c) Press "*Go to*".

Warning**: *If the sample looks like*** *it might hit the SEM gun press "****Stop****" immediately!!!*

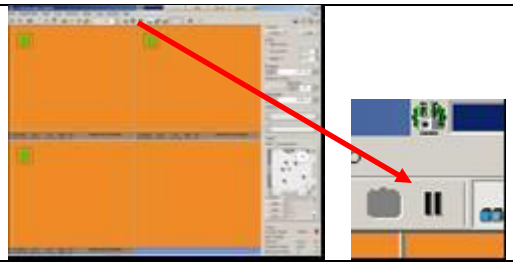
Note: *Selecting "Couple Z to FWD" will couple the monitored height of the sample, to the working distance. Linking these two values together will give accurate movement between the known height of the sample and the end of the microscope lens.*



15. Scan speed can be slowed by pressing the turtle button and sped up by pressing the rabbit button, with a range of scan speeds in between using the + and – buttons.

Note: *Faster scans will have more noise and will not appear as clearly, but allow for fine-tune adjustments to be observed faster. Slower scans will give clearer images.*

16. **Capture an image** by clicking the camera button on the tool bar.

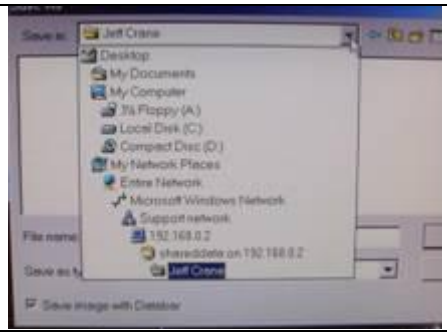


NOTE: Once the image scan is complete, it will PAUSE AUTOMATICALLY. If you plan to save the image, do NOT un-pause it until you save the image.

17. S**ave the image by clicking**
- *File …Save As*

In the save window, **select the desktop.**
- *Select your designated folder*
- *Name your image*
- *Save your image*

Recommend save format: bmp, jpg or tif8



18. **To retrieve your image**:
A) Copy your folder into the "*Shared Data"* folder on the desktop (login and password are *mate*).

B) Login to the middle computer (Login: Mate Guest User / Password: *mate*)

C) The image is in the folder titled "SEM images"

D) Save the image to your own personal memory stick.