Number: ___02_____

WORK INSTRUCTION BREAKDOWN SHEET

Operation: Scanning Electron Microscope (SEM) Operations
Instrument: ASPEX EXplorer SEM

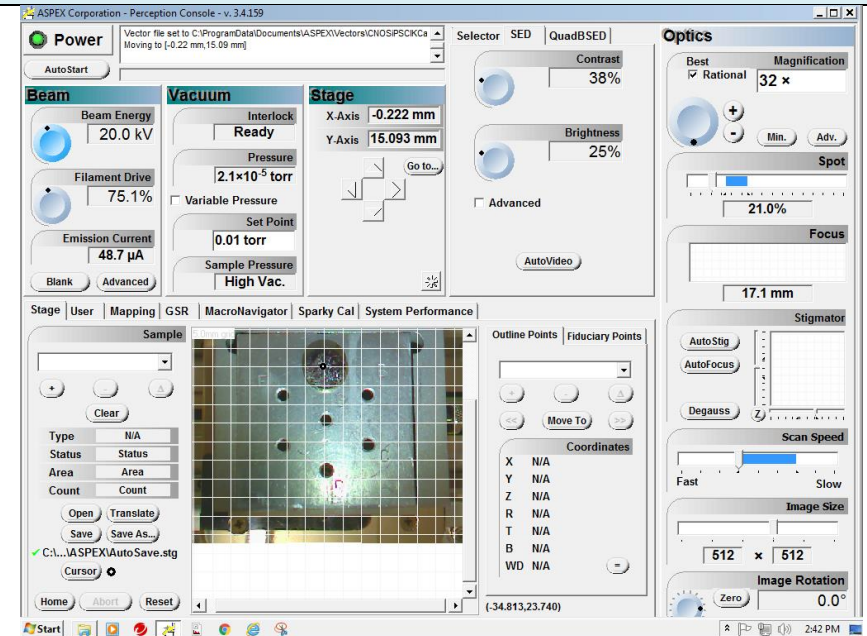| IMPORTANT STEPS	KEY POINTS	REASONS WHY
A logical segment of the operation when something happens to advance the work.	Anything in a step that might: 1. **Make or break the job** 2. **Injure the worker** 3. **Be a Cultural Consideration** 4. **Make the work easier to do (i.e., "knack", "trick", special timing, or bit of special information).**	Reasons for each key point.

VACUUM CONTINUITY POLICY FOR SEM (Read before proceeding!)

- *Sample Chamber* is under high vacuum.
- Computer and SEM are to be left **ON at all times** to insure continuity of vacuum per NanoLab policy.
- Rapid shift to ambient atmospheric pressure can cause significant damage to the instrument's components!
- Vacuum is maintained in *Sample Chamber* to minimize contamination and to decrease rate of oxidation of the tungsten (W) *Filament*; thus, vacuum continuity maximizes the *Filament* lifetime.
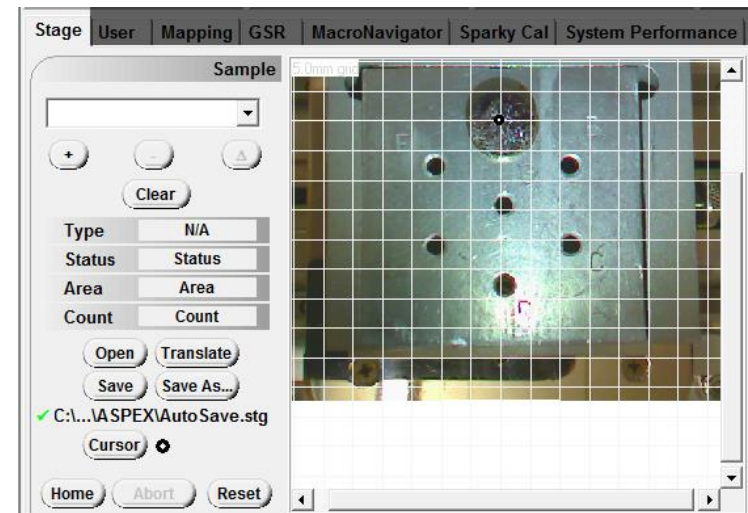
Imaging

Imaging consists of:
- **Navigation**
- **Brightness & Contrast (i.e., exposure)**
- **Magnification**
- **Focus (i.e., sharpness)**
- **Stigmator function**
- **Degauss function**
- **Saving Images**

Navigation - Perception Suite User Documentation § 3-10

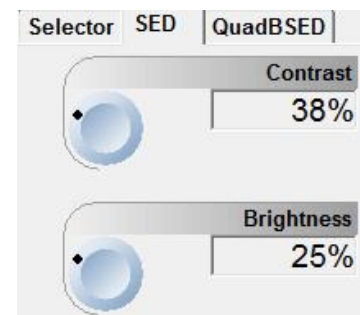|		

Manipulate the sample location to begin imaging.	• CTRL & LEFT-CLICK to position the ***Stage*** beneath the electron beam.
	  ○ Electron beam position is approximated by black circle with white dot in center.
	  ○ Operator can select color of circle by clicking on "***Cursor***" button.
	• Both of the following methods will center the ***Stage*** wherever the image is clicked:
	  ○ To move between samples on the ***Sample Stub Holder***, CTRL & LEFT-CLICK on the image on the left monitor.
	  ○ To move around an individual sample, CTRL & LEFT-CLICK on the image on the right monitor.	

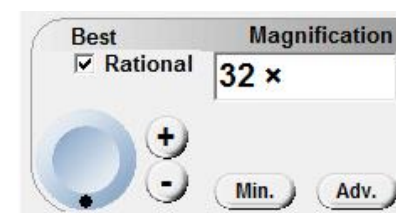| Brightness & Contrast (i.e., exposure) - Perception Suite User Documentation § 3-12 – 3-15		
Adjust Brightness and Contrast using the labeled knobs under the *Selector*/*SED*/*QuadBSED* tabs.	Adjustments to Brightness and Contrast knobs in the imaging modes (i.e., *Selector*, *SED*, or *QuadBSED*) must be made while the respective mode is active; adjustments made in one mode do not automatically adjust the other two modes. • *SED* (Secondary Electron Detector) emphasizes topology or structure of the sample. • *QuadBSED* (Quadrant BackScatter Electron Detector) emphasizes compositional information. • *Selector* allows the Operator to blend SED and QuadBSED modes.	• Unlike focusing an image, brightness and contrast are subjective. What looks "right" may depend on the intended use of the image. • For more information on detection modes, see sections 3-13 - 3-15 in the Perception Suite User Documentation.

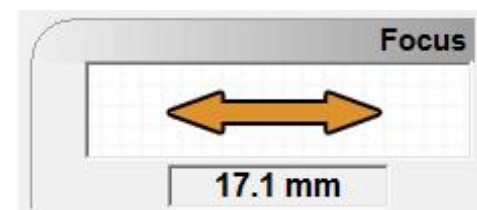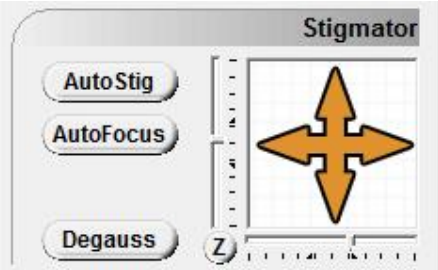| Magnification - Perception Suite User Documentation § 3-17		
ZOOM the image in and out to analyze areas of interest.	• Increase or decrease magnification using either the **+** and **–** buttons, or the knob. • Image resolution significantly decreases at magnification greater than 25,000X.	

Focus (i.e., sharpness) - Perception Suite User Documentation § 3-19

Focus/sharpen the image using the **Focus** control grid.

• LEFT-CLICK and drag the cursor to the right or left to increase or decrease the focus distance.
• Focal changes may be easier to observe on the edges of objects' features.
• Focus precision is directly proportional to magnification – higher zoom levels correspond to finer focal adjustments.
• NOTE: magnification levels will automatically change when focus is adjusted.

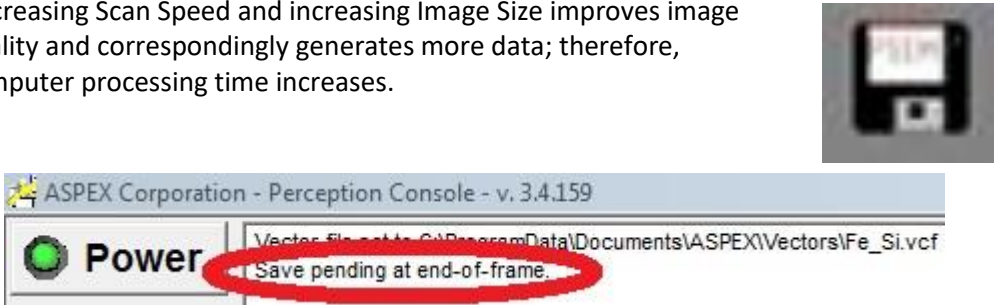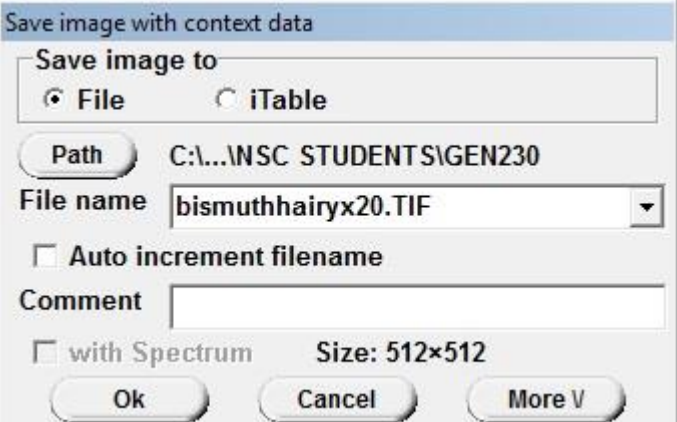| **Stigmator** - Perception Suite User Documentation § 3-19		
OPTIONAL: Operator may adjust the *Stigmator* by LEFT-CLICKing and dragging the cursor to slide the grid in the x and y directions individually.	Only If Stigmation adjustments are desired by Operator: • Manual adjustment of *Stigmator* should be performed along one axis (i.e., x or y) at a time; dragging *Stigmator* grid diagonally does not achieve desired results. • A poorly stigmated image may display sharp edges along one axis, but fuzzy edges along another. • The *AutoStig* button typically yields satisfactory results. • Cycling between **Focus** and the *Stigmator* may be necessary a few times to achieve optimal results.	• At magnification greater than 2500x, **Focus** alone may not be sufficient to produce a sharp image. • The *Stigmator* provides a mechanism to fine tune image sharpness by compensating for shape imperfections inherent in electron optics. • *Stigmator* adjusts the shape of the electron beam from an ellipse (undesired) to a perfect circle (desired).
Degauss - Perception Suite User Documentation § 3-19		
OPTIONAL: Operator may LEFT-CLICK the *Degauss* button for additional image improvement.	Only If Degaussing is desired by Operator: • Click the *Degauss* button located in the *Stigmator* control area. • The image will probably go out of focus but to a lesser degree with each Degaussing. • Note that the image will be refocused at a shorter focal length • Depending on updated focus/resolution, Operator may repeat the *Degauss* process a few times (typically up to 3 times) until satisfactory focus/resolution is achieved.	• The *Degauss* function corrects discrepancies between the objective lens's current and its field strength. • A consistent relationship between these two variables is important to ensure reproducibility in measurements of the working distance and magnification.
Note on image quality		
For optimal imaging results, it may be necessary to cycle between **Focus,** *Stigmator,* and *Degauss* a few times. In-depth explanation of these principles is beyond the scope of this SOP; refer to the Perception Suite User Documentation if additional information is desired.		

Saving Images will entail use of the **Toolbar** located on the right monitor in addition to some functions on the **Perception Console** in the left monitor.

When satisfied with an optimally focused image, increase image resolution.	On the left monitor: • **Decrease *Scan Speed***: LEFT-CLICK and drag the cursor to slide the vertical bar to the right end of the blue range. • **Increase *Image Size***: LEFT-CLICK and drag the cursor to slide the vertical bar to the right one or two notches to 1024X1024 or 2048x2048.	
Initiate the Save function.	On the right monitor: • Select the *Diskette* icon. On the left monitor: • It can take several seconds to minutes for the Windows "**Save image with context data**" dialog box to appear. • NOTE: To verify Save function is proceeding, "Save pending at end-of-frame." will display in the *Message Area* immediately to the right of the *Power* button when the *Diskette* icon is clicked.	Decreasing Scan Speed and increasing Image Size improves image quality and correspondingly generates more data; therefore, computer processing time increases.
Finalize the Save function.	• Click on "*Path*" in the "**Save image with context data**" dialog box and choose the appropriate file folder. • Name the .TIF image file and include any additional information in the "*Comments*" area.	All settings and "*Comments*" will be saved in the metadata of the .TIF image file and can be viewed later using Aspex Personal Image Print II or other programs.

When finished inspecting and/or saving images, proceed to the **SEM STARTUP / SHUTDOWN Work Instructions** to end your session on the SEM.