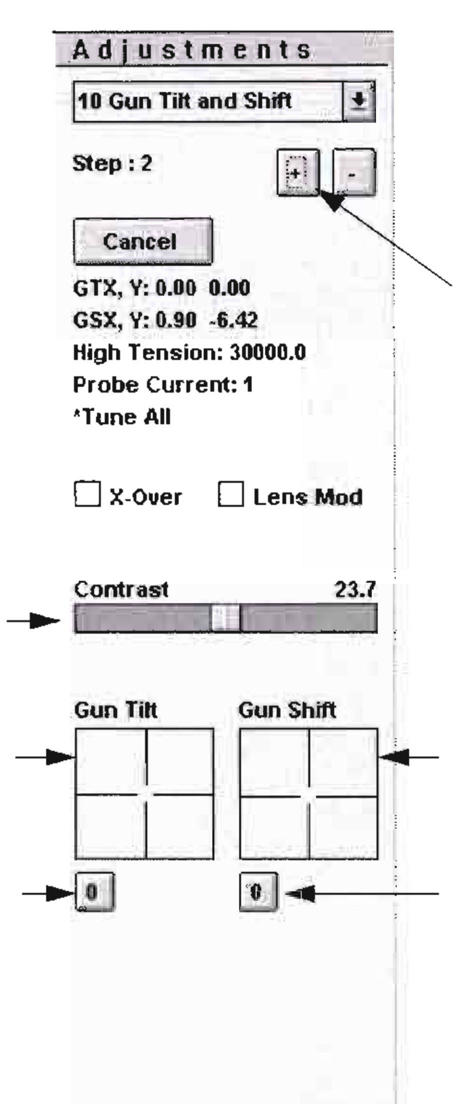


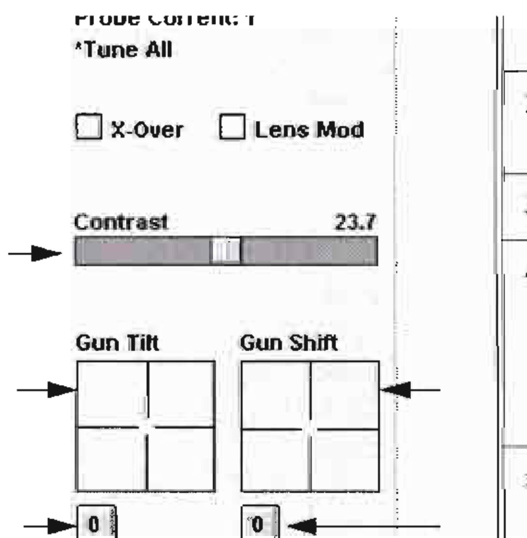
Step: 2

Use Crossover (X-Over) mode only as a check on where the illumination centre is if gross misalignment is suspected.

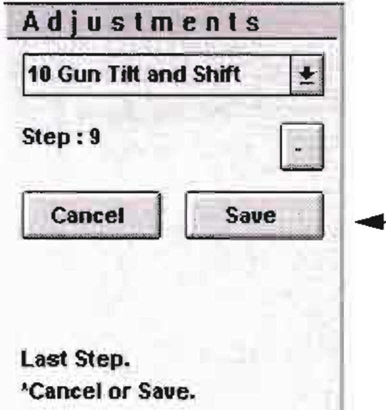
TABLE 6-24 GUN TILT AND SHIFT, STEP 2

Order	Action
1	Select TV Rate from the Scan pulldown menu and Average 4 from the Filter pulldown menu.
2	Use the contrast adjuster to see the image on the screen.
3	*Do not change aperture position during the alignment.*
4	At 30kV, spot1 move the stage to align the feature of interest from the sample under the cross on the screen at a magnification of 20,000X. To assist alignment, you can make two videoprints, one at 5000X and one at 20,000X to record the original position.
5	Click on + to move to the next spotsize (probe current). The image may shift slightly. If necessary use the contrast control to see the image.

NOTE	For spotsizes >4, adjust both Gun Tilt and Gun Shift. For spotsizes <4, adjust only Gun Shift.



	Average 4 from the Filter pulldown menu.
2	Use the contrast adjuster to see the image on the screen.
3	*Do not change aperture position during the alignment.*
4	At 30kV, spot1 move the stage to align the feature of interest from the sample under the cross on the screen at a magnification of 20,000X. To assist alignment, you can make two videoprints, one at 5000X and one at 20,000X to record the original position.
5	Click on + to move to the next spotsize (probe current). The image may shift slightly. If necessary use the



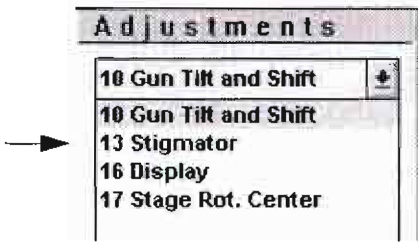
Steps: 3 through 9

TABLE 6-25 GUN TILT AND SHIFT, STEPS 3 THROUGH 9

Order	Action
1	Use Gun Shift to bring the image feature back under the reference point. Gun Tilt usually will only need to be use from spot 4 to spot 7. Use Gun Tilt to change the beam illumination if necessary. Do not use Gun Tilt in preference to Gun Shift to correct image feature position.
2	Click on + to move to the next spotsize. Repeat the previous step.
3	When all seven spotsizes are aligned, click on the SAVE button. The system is aligned for 30 kV.
4	Repeat the procedure for all kVs in the list. Be sure that you do not move the stage, and keep Beam Shift at zero. Use the same feature to align each kV and spot.
5	When alignment is completed any small change in rotation centre over the final lens aperture, during daily use, can be adjusted out by fine correction with the X and Y adjusters on the Final Lens Aperture rod.

Last Step.
'Cancel or Save.

	the beam illumination if necessary. Do not use Gun Tilt in preference to Gun Shift to correct image feature position.
2	Click on + to move to the next spotsize. Repeat the previous step.
3	When all seven spotsizes are aligned, click on the SAVE button. The system is aligned for 30 kV.
4	Repeat the procedure for all kVs in the list. Be sure that you do not move the stage, and keep Beam Shift at zero. Use the same feature to align each kV and spot.
5	When alignment is completed any small change in

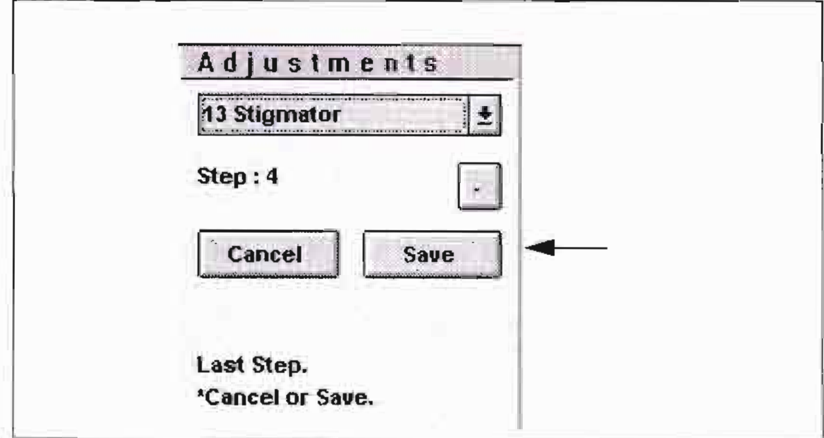


Stigmator Adjustment

This adjustment allows you to minimize the image shift during stigmation. When you click on Stigmator and the + button, the magnification is set to 60,000X. Make sure an image with sufficient detail is visible.

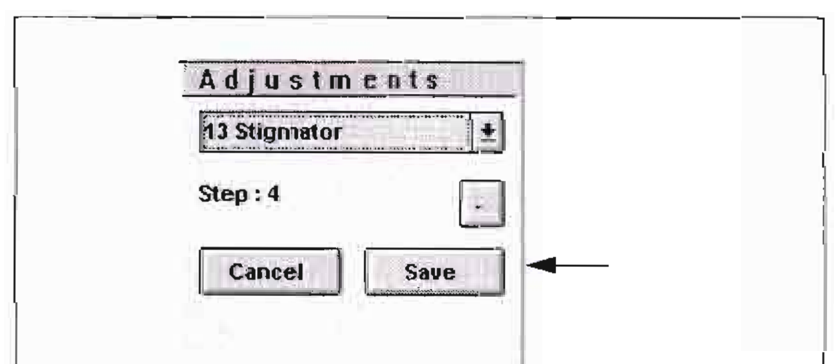
If necessary, move the stage to find an area of interest. (You can change the magnification, but once a proper area has been found, set the magnification back to 60,000X).

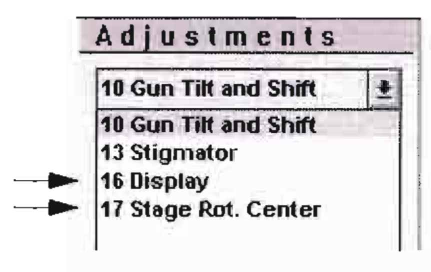
Follow the four-step procedure to minimize the image movement in both the X and Y direction using the X-Y controls available in the control area. Save the values at the end of the procedure by pressing the SAVE button in step 4.



The correction values for the stigmator, as obtained with this procedure, are stored in the computer.

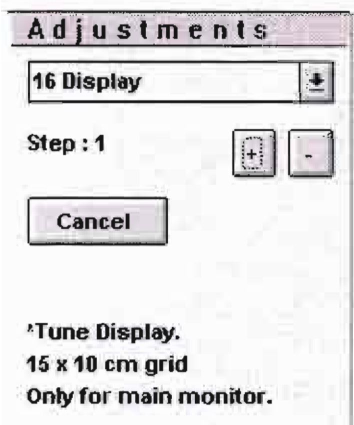
Follow the four-step procedure to minimize the image movement in both the X and Y direction using the X-Y controls available in the control area. Save the values at the end of the procedure by pressing the SAVE button in step 4.





Display Adjustment

When you select Display, a white grid appears on the monitor, overlaying the image. Use this grid as a reference to set the correct image size vertically and horizontally, using the monitor controls. Tune the grid to 10 x 15 cm to obtain the correct display magnification and aspect ratio. Display can also be used to minimize the pin/barrel distortion of the monitor.



This adjustment allows you to set up the display monitor so the images are linear in both X and Y with the correct display magnification. A click on the + button produces a white grid onscreen. Use the monitor controls to define the proper dimensions and linearity of the grid.

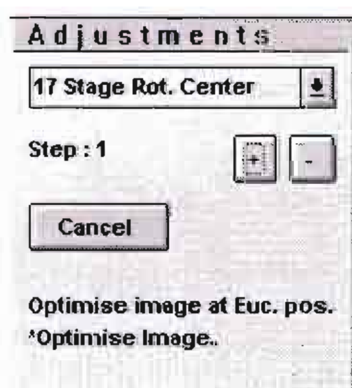
Stage Rot. Centre

This adjustment sets up the compensation factors for the stage X= 0 and Y = 0 positions, as well as the stage rotation centre.

The procedure should be performed at zero tilt unless you are working at a specified tilt angle. Load the appropriate stage mapping file before using this procedure.

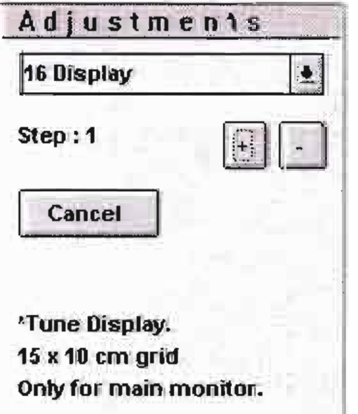
TABLE 6-26 STAGE ROTATION CENTER ADJUSTMENT

Order	Action
1	Stage moves to eucentric position (0,0). Optimize image.
2	Select the Get function and double-click on the feature to move it to the screen centre.
3	Stage rotates to 180°.
4	Select the Get function and double click on the feature to move it to the screen center.
5	Cancel or save valid result.



To make use of this feature during normal operation go to the 'Stage' menu and select 'Eucentric Rotation' on.

While 'Eucentric Rotation' is ticked 'Align X, Align Y and Align Feature' can be used to orientate the viewing direction of the field in



images are linear in both X and Y with the correct display magnification. A click on the + button produces a white grid onscreen. Use the monitor controls to define the proper dimensions and linearity of the grid.

Stage Rot. Centre

This adjustment sets up the compensation factors for the stage X= 0 and Y = 0 positions, as well as the stage rotation centre.

The procedure should be performed at zero tilt unless you are working at a specified tilt angle. Load the appropriate stage mapping file before using this procedure.

TABLE 6-26 STAGE ROTATION CENTER ADJUSTMENT

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7 STAGES

Overview

FEG and SFEG Stages

The Stages covered in this Chapter are the following:

- XL30 (early version) 50 x 50 mm Manual. (FEG)
- XL30 (early version) 50 x 50 mm Motor driven. (FEG)
- XL30 50 x 50 mm Manual. (some FEG mainly SFEG)
- XL30 50 x 50 mm Motor 4 axes. (mainly SFEG)
- XL30 50 x 50 mm Motor 5 axes. (only SFEG)
- XL30 100 x 100 mm Motor 5 axes. (some FEG mainly SFEG)
- XL40 150 x 150 mm Motor 3 axes. (only FEG)
- XL40 150 x 150 mm Motor 5 axes. (only SFEG)

The software control for each stage differs mainly due to the amount of integration via motorisation. The Stage page layout remains the same so that it is easily recognised by users of other XL systems.The significant differences are with such controls as Z, Tilt, and Rotation.

The clamping mechanism and has also changed due to progress made with stage design, and although the early stages were with manual locking the latest are via pneumatic clamping and software control.

FEG and SFEG Stages

The Stages covered in this Chapter are the following:

- XL30 (early version) 50 x 50 mm Manual. (FEG)
- XL30 (early version) 50 x 50 mm Motor driven. (FEG)
- XL30 50 x 50 mm Manual. (some FEG mainly SFEG)
- XL30 50 x 50 mm Motor 4 axes. (mainly SFEG)
- XL30 50 x 50 mm Motor 5 axes. (only SFEG)
- XL30 100 x 100 mm Motor 5 axes. (some FEG mainly SFEG)
- XL40 150 x 150 mm Motor 3 axes. (only FEG)
- XL40 150 x 150 mm Motor 5 axes. (only SFEG)

XL30 Stages (Early)

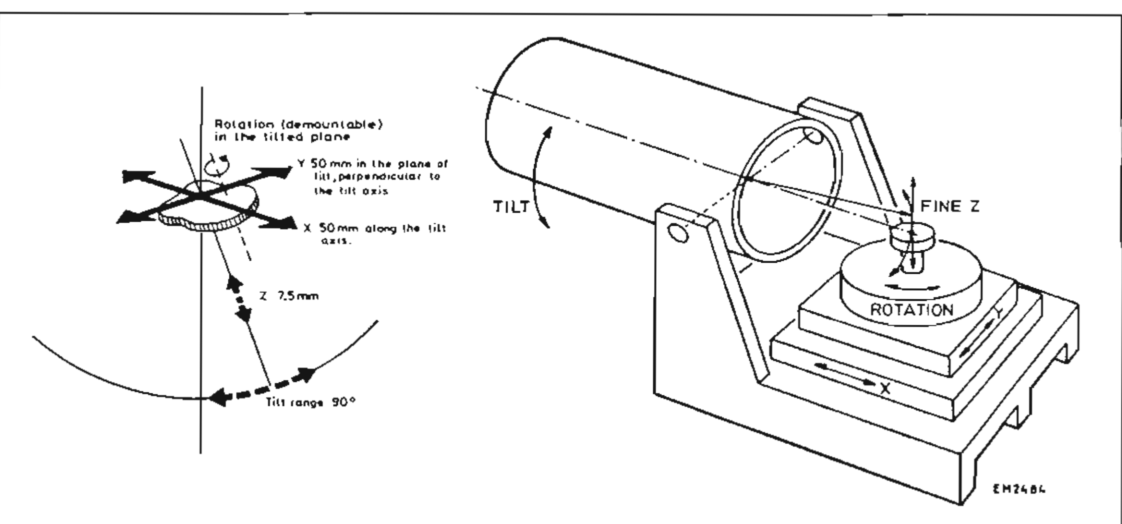
XL30 Stage 50 x 50 mm

The basic stage of the XL30 is controlled manually by micrometers and screw-type adjusters on the stage door. Motorisation of the stage is optional; if fitted. The motors are located on the outside and control x, y and Rotation axes. This movement is integrated in the software. For further reference to motorisation see the section on the later version XL30 (50 x 50 mm stages), in this chapter, to see axes movement similarities with the earlier XL30 stage.

Stage movement

The specimen stage allows movement of the specimen along five axes as indicated in Fig. 7-1.

FIGURE 7-1 STAGE MOVEMENTS FOR XL30



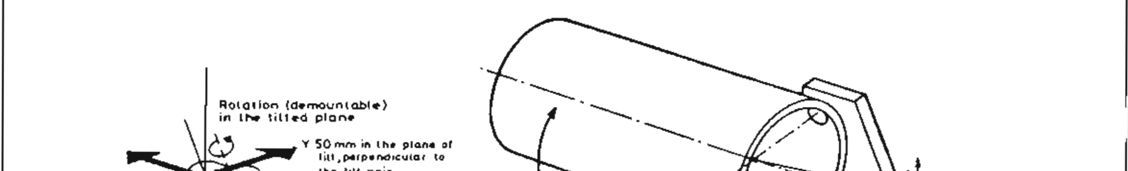
The stage can be tilted over 90°. The tilt axis always intersects the electron optical axis of the column at the same height (10 mm FWD). When the specimen is positioned at this height, it can be tilted in the eucentric plane. This means that almost no image displacement occurs during tilt. The tilting mechanism can be locked for more stability at high magnifications using the 'LOCK' lever on the stage door.

movement similarities with the earlier XL30 stage.

Stage movement

The specimen stage allows movement of the specimen along five axes as indicated in Fig. 7-1.

FIGURE 7-1 STAGE MOVEMENTS FOR XL30



X, Y and rotation movements can be adjusted using micrometer screws on the stage door. *If the stage is motorised, these controls are operated by software only (GET, TRACK functions, see Section XL30 50 x 50 mm motorised stage).*

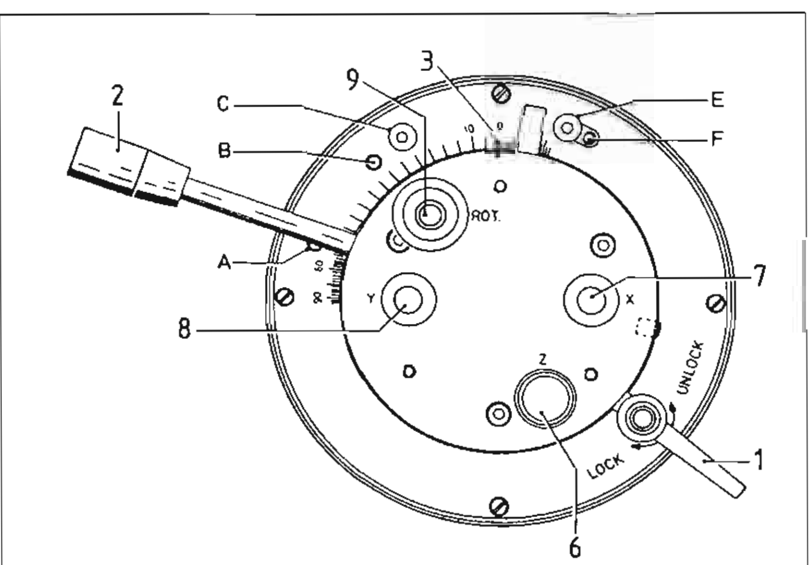
Tilting the specimen

The specimen can be tilted using the lever (2) as follows (see Fig. 7-2).

Check that the 'LOCK' lever (1) is in the 'UNLOCK' position (counter-clockwise movement).

- Set the tilt to the desired angle by moving the tilt lever (2) up and down.
- The tilt angle can be read from the scale (3) on the stage door.
- When desired (at high magnifications), the tilt mechanism can be locked using the 'LOCK' lever (1).

FIGURE 7-2 MECHANICAL CONTROLS ON THE STAGE DOOR



Note: The 'LOCK' lever is adjustable with a ratchet mechanism. The position of the lever can be adjusted by pulling it gently until the ratchet mechanism freewheels, then adjusting it to the desired position.

Check that the 'LOCK' lever (1) is in the 'UNLOCK' position (counter-clockwise movement).

- Set the tilt to the desired angle by moving the tilt lever (2) up and down.
- The tilt angle can be read from the scale (3) on the stage door.
- When desired (at high magnifications), the tilt mechanism can be locked using the 'LOCK' lever (1).

FIGURE 7-2 MECHANICAL CONTROLS ON THE STAGE DOOR

The following tilt stops are recommended:

FIGURE 7-3 STAGE TILT STOPS

Working distance	Tilt range	Positions
10 mm FWD	-7 to +45	E - B
Backscatter det. mounted	-7 to +27	E - C
other	-15 to +75	F - A

Specimen height adjustment

Depending on the specimen holder used, it is possible to change the specimen height inside the chamber in various ways. The following holders are supported:

- The standard holders on the rotation sub-stage;
- Clamp holder, pre-tilt holder in specimen holder kit PW6820;
- Multiple analytical specimen sub-stage PW6830.

Fine height adjustment (over 8 mm) is possible using the 'Z' knob on the stage door (6), Fig 7-2. Turning this knob clockwise results in an upward movement of the specimen.

X, Y and R manual stage control

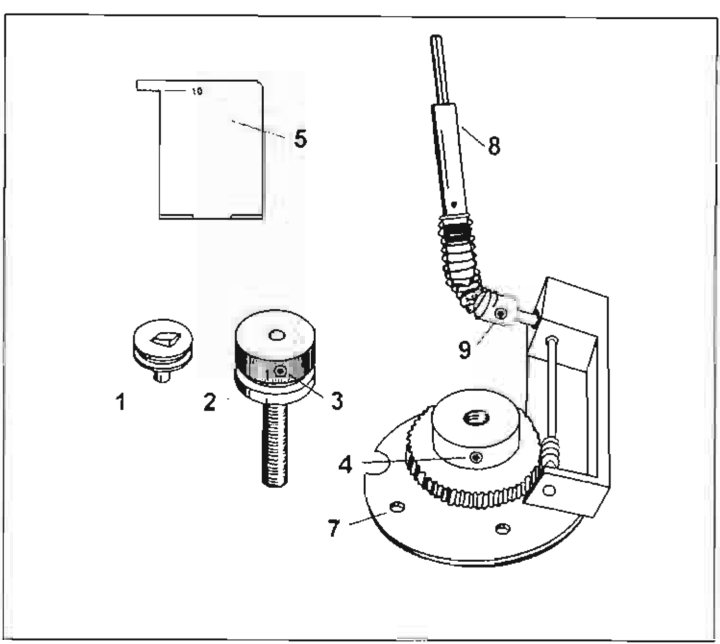
These movements are driven by rotation of controls (7), (8) and (9), shown in Fig. 7-2. For X and Y a range of 50 mm is available. A read-out with an accuracy of 25 μm is provided. The rotation movement is supplied by the rotation sub-stage and operates continuously over 360°. A read-out with an accuracy of 1° is provided.

Backscatter det. mounted	-7 to +27	E - C
other	-15 to +75	F - A

Specimen height adjustment

Depending on the specimen holder used, it is possible to change the specimen height inside the chamber in various ways. The following holders are supported:

FIGURE 7-4 THE ROTATION SUB-STAGE



The Rotation sub-stage

The demountable rotation sub-stage provides externally controlled rotation of the specimen over a range of 360° (continuous) with indication to 1° (9), Fig. 7-2). It is designed for use with stub-mounted specimens and incorporates a facility for pre-adjusting specimen height. A bayonet fitting on the base of the sub-stage positions it in the goniometer stage. The drive assembly for the rotation movement is built into the goniometer mounting plate and is connected by a demountable shaft linkage.

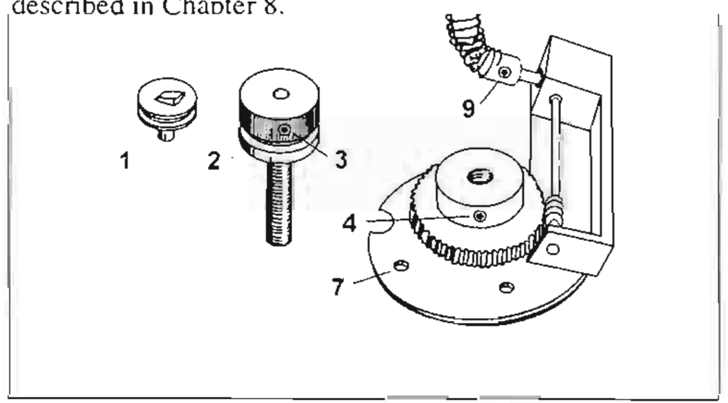
Caution!Every precaution should be taken to ensure that grease and other contaminants are not introduced into the vacuum system.

a.When manipulating a specimen stub always use a clean pair of tweezers. When handling the specimen holders use gloves.

b.Use a freshly cleaned stub for each specimen.

c.Ensure that the sub-stage is clean.

Check for deposits and discoloration. Cleaning procedures are described in Chapter 8.



The Rotation sub-stage

Using the rotation sub-stage

The sequence given below describes pre-adjustment of the specimen height to a level which will allow eucentric motion to be subsequently attained, using the external goniometer controls. For some specimens this will not be possible, and in some applications, not required. Insert the pin, 2 of the specimen stub, 1 into the head of the stub holder, 3 and press it down. A spring catch holds the stub in position.

1. Insert the pin of the specimen stub, 1 into the head of the stub holder, 2 and press it down. A spring catch holds the stub in position. For more stability, the stub can be tightly secured using the securing screw (3).
2. If necessary, slightly loosen the clamping screw, 4 in the base of the holder so that the head of the holder is free to rotate.
3. Place the metal adjuster, 5 on the stage, next to the stub holder.
4. Turn the stub holder clockwise or counter-clockwise to lower or raise the height of the specimen until its surface just fits under the adjuster.
5. Remove the height adjuster.
6. Tighten the clamping screw, 4.
7. To dismount the stub, reverse the procedure given in step 1.

Removing the rotation sub-stage

1. Remove the three securing screws, 7.
2. Loosen the screw in the bush connecting the rotation drive at the rear upper right-hand side of the goniometer mounting plate and carefully disconnect the shaft, 9.
3. Withdraw the rotation sub-stage from the goniometer.

Installing the rotation sub-stage

1. Support the sub-stage just above the goniometer with the drive linkage, 8 on the near side.
2. Locate the position of the built-in rotation drive on the rear upper right-hand side of the goniometer mounting plate.

4. Slide the shaft, 9 at the end of the drive linkage into the bush on the built-in drive assembly.

holder, 2 and press it down. A spring catch holds the stub in position. For more stability, the stub can be tightly secured using the securing screw (3).

2. If necessary, slightly loosen the clamping screw, 4 in the base of the holder so that the head of the holder is free to rotate.
3. Place the metal adjuster, 5 on the stage, next to the stub holder.
4. Turn the stub holder clockwise or counter-clockwise to lower or raise the height of the specimen until its surface just fits under the adjuster.
5. Remove the height adjuster.
6. Tighten the clamping screw, 4.
7. To dismount the stub, reverse the procedure given in step 1.

XL30 Stages (Later)

XL30 Stage 50 x 50 mm

There are two types of XL30 50 x 50 mm stage for this series, a manual stage, and 4 axes motorised version.

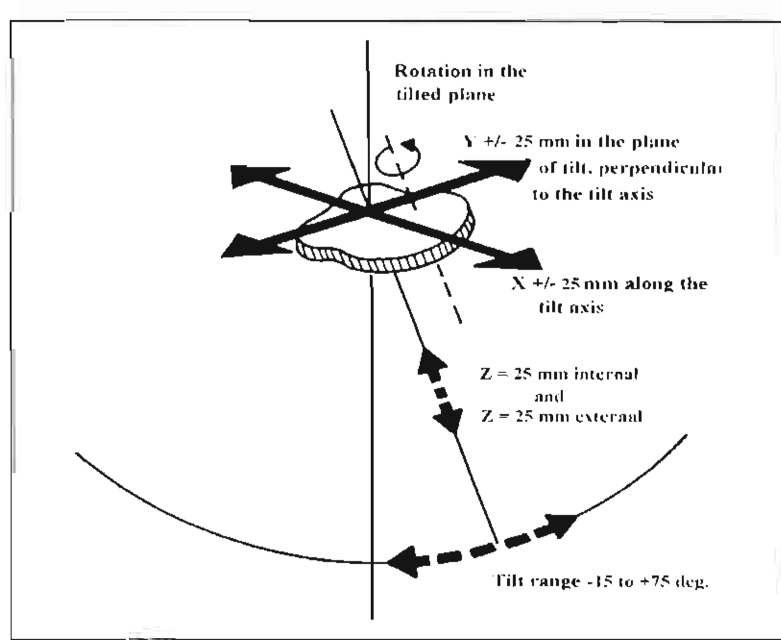
The basic stage is controlled manually by micrometers and screw-type adjusters on the stage door. The motorised stage has motors driving the X,Y, Z and Rotation controls, all with manual override, Tilt is manual for both stages but for the motorised type the tilt is read out on screen, under software control, along with the other movements. For the manual stage Tilt, X,Y and Z are read out on the stage door. Rotation is continuous and therefore does not need read-out.

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 90°. The tilt axis always intersects the electron optical axis of the column at the same height (10 mm FWD). When the specimen is positioned at this height, the specimen can be tilted in the eucentric plane. This means that during tilt, almost no image displacement occurs. The tilting mechanism can be locked for more stability at high magnifications using the 'LOCK' lever.

FIGURE 7-5 XL30 50 x 50 mm STAGE MOVEMENT



screen, under software control, along with the other movements. For the manual stage Tilt, X,Y and Z are read out on the stage door. Rotation is continuous and therefore does not need read-out.

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 90°. The tilt axis always intersects the electron optical axis of the column at the same height (10 mm FWD). When the specimen is positioned at this height, the specimen can be tilted in the eucentric plane. This means that during tilt, almost no image displacement occurs. The tilting mechanism can be locked for more stability at high magnifications using the 'LOCK' lever.

FIGURE 7-5 XL30 50 x 50 mm STAGE MOVEMENT

XL30-50 X 50 mm (Manual)

Using Tilt

The specimen can be tilted using the lever (1) as follows:

- Check that the 'LOCK' lever (F) is in the unlocked position (counter-clockwise movement).
- Set the tilt to the desire angle by moving the tilt lever (1) up or down.
- The tilt angle can be read from the scale (E) on the door.
- If desired (at high magnifications), the tilt mechanism can be locked using the 'LOCK' lever (F) (clockwise movement).

The 'LOCK' lever position is adjustable using a ratchet mechanism. The lever can be adjusted by pulling it out gently until the ratchet mechanism freewheels, then moving it to the desired position.

In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), the tilt has to be restricted under certain conditions. In order to facilitate this, several tilt stops are provided.

FIGURE 7-6 MANUAL CONTROLS ON THE STAGE DOOR

A = Negative end stop
B = 30 deg. stop
C = 45 deg. stop
D = 75 deg. stop
E = Tilt Scale
F = Stage Lock
G = Stage ground
1 = Tilt lever
2 = Digital readout
3 = X axis
4 = Rotation
5 = Z height
6 = Y axis

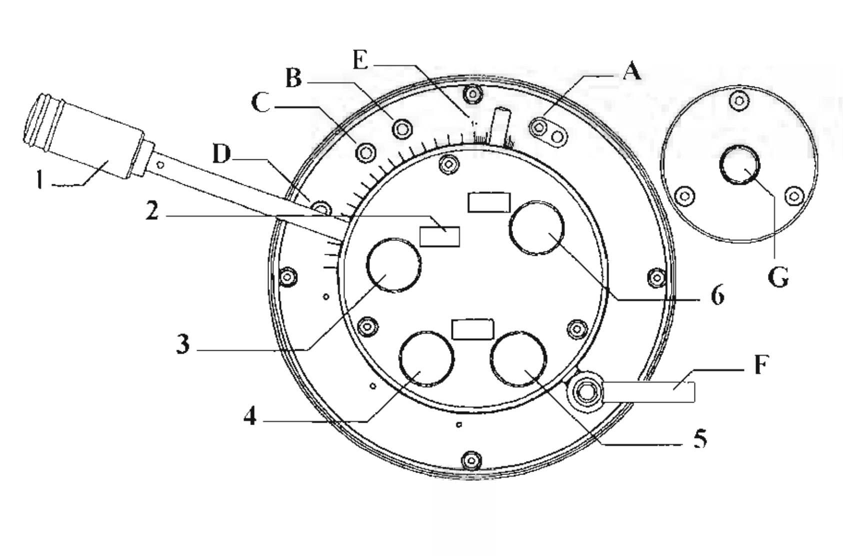


TABLE 7-1 RECOMMENDED TILT STOPS

- The tilt angle can be read from the scale (E) on the door.
- If desired (at high magnifications), the tilt mechanism can be locked using the 'LOCK' lever (F) (clockwise movement).

The 'LOCK' lever position is adjustable using a ratchet mechanism. The lever can be adjusted by pulling it out gently until the ratchet mechanism freewheels, then moving it to the desired position.

In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), the tilt has to be restricted under certain conditions. In order to facilitate this, several tilt stops are provided.

FIGURE 7-6 MANUAL CONTROLS ON THE STAGE DOOR

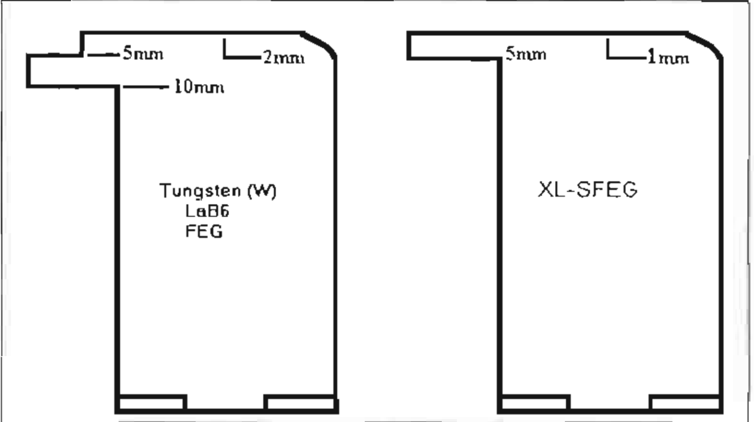
A = Negative end stop

Using Z (Height) adjustment

With the standard specimen holder it is possible to change the specimen height inside the chamber, to bring the sample to a eucentric position and have flexibility to then move Z from outside the chamber to another position if required. The internal distance Z is 25 mm of movement, and the external distance Z (5) is also 25 mm. This allows a flexibility to load large or different height specimens onto the stage by reducing the internal Z but still be able to manipulate the difference in height from outside.

A digital read-out (2) can be seen next to the Z control knob (5). 1 digit is 16 micron, and 1 turn of the knob is 0.23 mm displacement. The smallest step is 1 micron.

FIGURE 7-7 EUCENTRIC ADJUSTERS FOR XL-30 50 X 50 STAGES

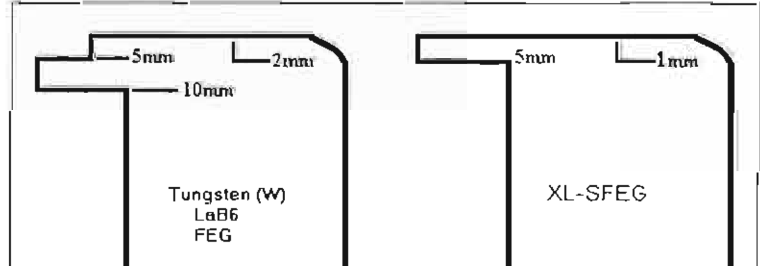


To set the specimen height to the eucentric position and at the same time prevent any possibility that the specimen should touch the lens pole if the Z is increased can be done as follows:

- Load a specimen onto the specimen holder.
- With the stage still open adjust the external Z (5) to the highest position.
- Set the Eucentric Height Adjuster on the stage base.
- Bring the highest specimen or point on the specimen to the 2 mm (1mm SFEG) position on the Height Adjuster by turning the internal screw of the specimen holder. Lock the position with the locking cone.
- Reduce the Z so that the specimen now coincides to the Eucentric position on the Height Adjuster by use of the external Z control (5).

A digital read-out (2) can be seen next to the Z control knob (5). 1 digit is 16 micron, and 1 turn of the knob is 0.23 mm displacement. The smallest step is 1 micron.

FIGURE 7-7 EUCENTRIC ADJUSTERS FOR XL-30 50 X 50 STAGES



Using X, Y and Rotation

These movements are driven by the turning of controls X(3), Y(4) and Rotation (6).

For X and Y a range of 50 mm is available. A digital readout(2) can be found next to the respective control knobs. 1 digit is 36 micron, and 1 turn of either knob is 0.5 mm displacement. The smallest step is approximately 1 micron.

To rotate the specimen mechanically turn the Rotation control knob (6) in either direction, this control operates continuously through 360°. There is no read-out but 1 turn of the knoh is 27° rotation, and the smallest step is 0.04°.

Shift

For very high magnification this function performs an onscreen image shift, using beam shift coupled to magnification.This is not stage movement, but beam movement. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

The range of beam shift is $\pm 15 \mu m$ in X and Y. The computer beeps when the beam shift limit is reached.

This mode is independent of the selected scan mode and can be operated at slow scan.

(6) in either direction, this control operates continuously through 360°. There is no read-out but 1 turn of the knoh is 27° rotation, and the smallest step is 0.04°.

Shift

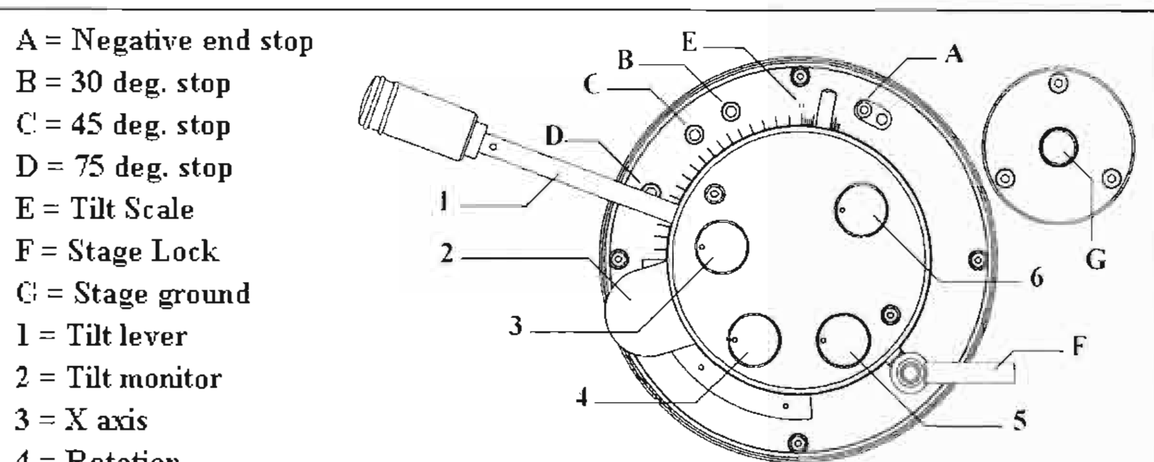
For very high magnification this function performs an onscreen image shift, using beam shift coupled to magnification.This is not stage movement, but beam movement. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

The range of beam shift is $\pm 15 \mu m$ in X and Y. The computer beeps when the beam shift limit is reached.

This mode is independent of the selected scan mode and can be

XL30-50 X 50 mm (4 axes Motor)

FIGURE 7-8 MOTOR DRIVE CONTROLS WITH MANUAL OVERRIDE



Stage movement

A live image can be positioned with either stage movement (manual or software) or beam shift.

TABLE 7-2 MOVEMENT TYPES

Stage Movement	Beam Shift
Get (icon) X and Y	**Get** (above 6200X only)[1]
Track (icon) X and Y	**Shift** (icon) X and Y
Tilt (1) and Z height (5)	Scanrotation
Rotation (4)	
Manual X (3), Y (6), Z, T, R	
Stage Position Controls / Map	

1. This number is set in the Stage Setup dialogue box

E = Tilt Scale
F = Stage Lock
G = Stage ground
1 = Tilt lever
2 = Tilt monitor
3 = X axis
4 = Rotation
5 = Z height
6 = Y axis
1
2
3
4
5
6
F
G

Stage movement

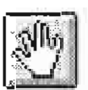
A live image can be positioned with either stage movement (manual

Get

When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

Shift 

This function performs an onscreen image shift, using beam shift coupled to magnification.The stage does not move during beam shift. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

The range of beam shift is ±15 μm in X and Y. The computer beeps when the beam shift limit is reached. This mode is independent of the selected scan mode and can be operated at slow scan.

Track

The track function allows continuous directional movement of the stage with variable speed. The speed range is coupled to the magnification and selectable within certain limits.

Select the track function by clicking on the Track icon. A green overlay appears onscreen. Position the cursor somewhere in the image and hold down the left mouse button. The cursor can move between the inner and outer green circles. Moving toward the outer circle increases the stage speed; moving toward the inner circle decreases stage speed.

The direction of movement is always toward the centre along the green straight line. You can move the cursor around on the field of

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

Shift

This function performs an onscreen image shift, using beam shift coupled to magnification.The stage does not move during beam shift. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

XL30-50 X 50 mm (5 axes Motor)

XL30 Stage 50 x 50 mm

This XL30 50x50 mm stage is a 5 axes motorised version based on the previous design.

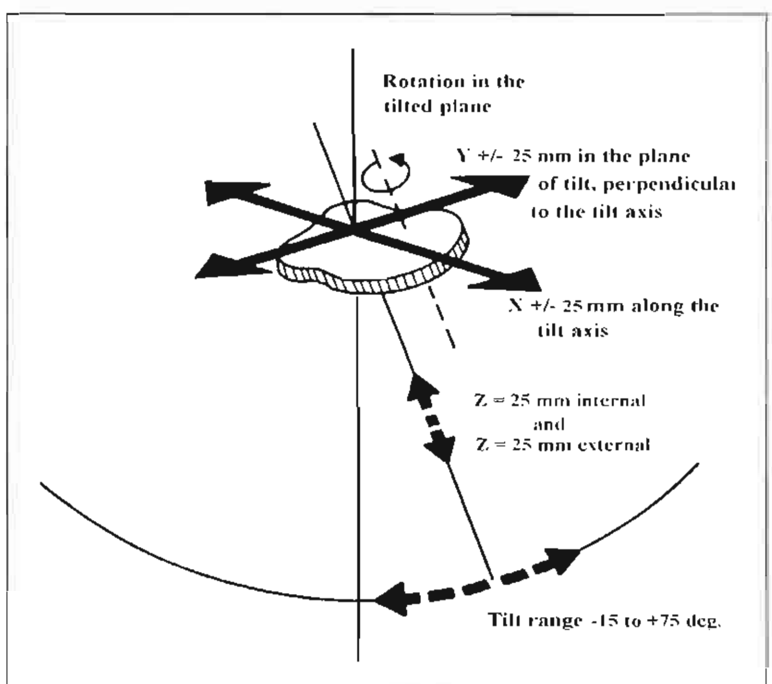
The stage has motors driving the X, Y, Z, Rotation and Tilt controls, all with manual override except Tilt. All movements are read out on screen, under software control.

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 75°. The tilting mechanism can be locked for more stability at high magnifications using the 'Clamp' feature.

FIGURE 7-9 XL30 50 x 50 mm STAGE MOVEMENT



The Z height of the specimen can be regulated by the external 25 mm Z control and or the 25 mm internal Z movement. The Z is eucentric at WD = 5 mm for SFEG.

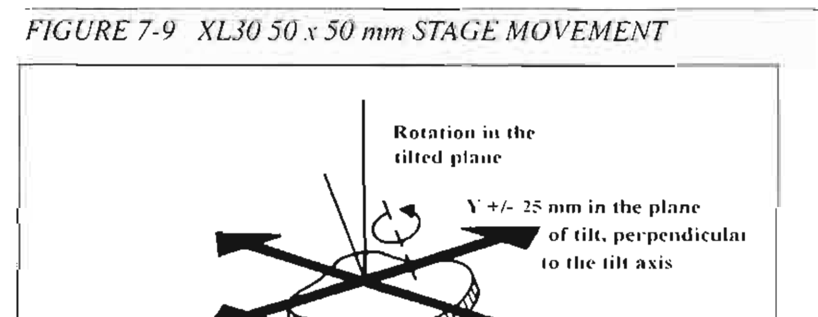
X, Y, Z, Rotation and Tilt movements on the motorised stage can be operated under software control for more advanced movement combinations.

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 75°. The tilting mechanism can be locked for more stability at high magnifications using the 'Clamp' feature.

FIGURE 7-9 XL30 50 x 50 mm STAGE MOVEMENT

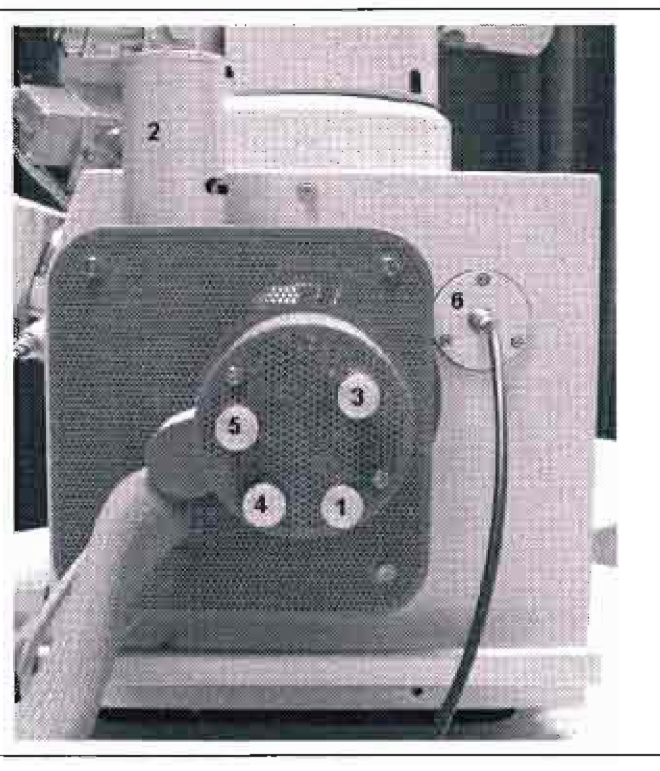


XL30 (5 axes) Stage Controls

FIGURE 7-10 CONTROLS ON THE STAGE DOOR

Legend:

1 = Z height
2 = Tilt
3 = Y axis
4 = Rotation
5 = X axis
6 = Interface control connectors



Total software control

On the 5 axes motorised stage the X, Y, Z, Rotation and Tilt movements can be operated under total software control.

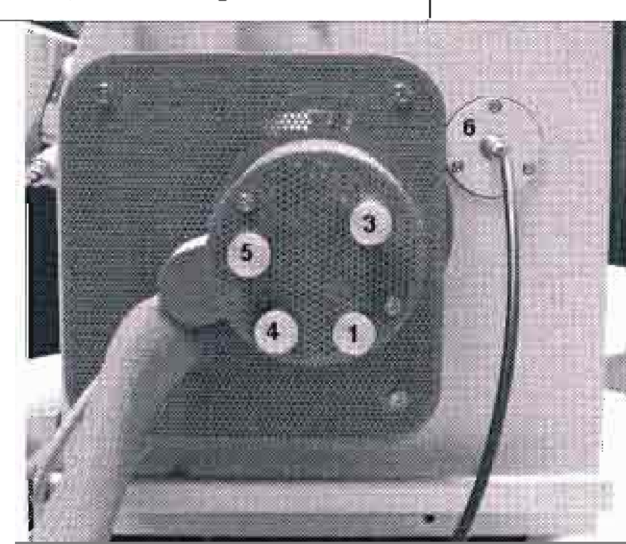
Stage movement

A live image can be positioned with either stage movement (manual or software) or beam shift.

TABLE 7-3 MOVEMENT TYPES

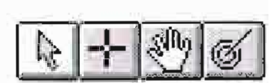
Stage Movement	Beam Shift
Get (icon) X and Y	**Get** (above 6200X[1] only)
Track (icon) X and Y	**Shift** (icon) X and Y
Tilt (2) and Z height (1)	Scanrotation

3 = Y axis
4 = Rotation
5 = X axis
6 = Interface control connectors

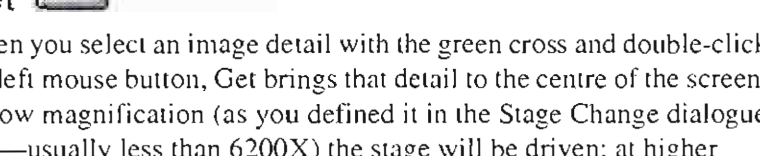


> **NOTE**
> When you move the stage or tilt the specimen, you may need to lower the magnification so you do not lose the feature of interest on the screen.

Five axes of stage movement are available: X, Y, Z, T and R. Software controls for movement include the Get, Shift and Track icons and the Stage control area. You can access this control area by maximizing the Stage control group, or clicking on the Stage icon.



Get



When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

Shift

This function performs an onscreen image shift, using beam shift coupled to magnification.The stage does not move during beam shift. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

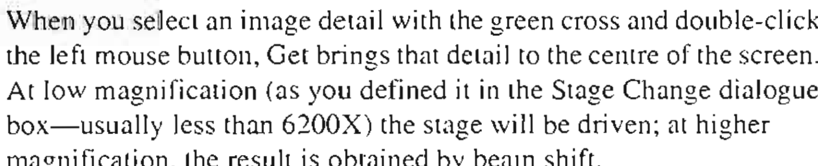
The range of beam shift is ±15 μm in X and Y. The computer beeps when the beam shift limit is reached.

This mode is independent of the selected scan mode and can be operated at slow scan.

Track

The track function allows continuous directional movement of the stage with variable speed. The speed range is coupled to the magnification and selectable within certain limits.

Select the track function by clicking on the Track icon. A green



Get

When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

The direction of movement is always toward the centre along the green straight line. You can move the cursor around on the field of view; direction and speed change accordingly. When you are done, click on the arrow tool.

For a given magnification, the minimum speed is obtained when the cursor is on the inner circle. The maximum speed (for that magnification) is a multiple of the minimum speed. The maximum speed can be customized and is given by a ratio value established in the position setup dialogue box. The default value is 4 (slow); the maximum value is 10 (fast).

maximum value is 10 (fast).

XL30-100 X 100 mm Stage

XL30 Stage 100 x 100 mm

There are two types of XL 30 100x100 mm stage, a manual and a motorised version.

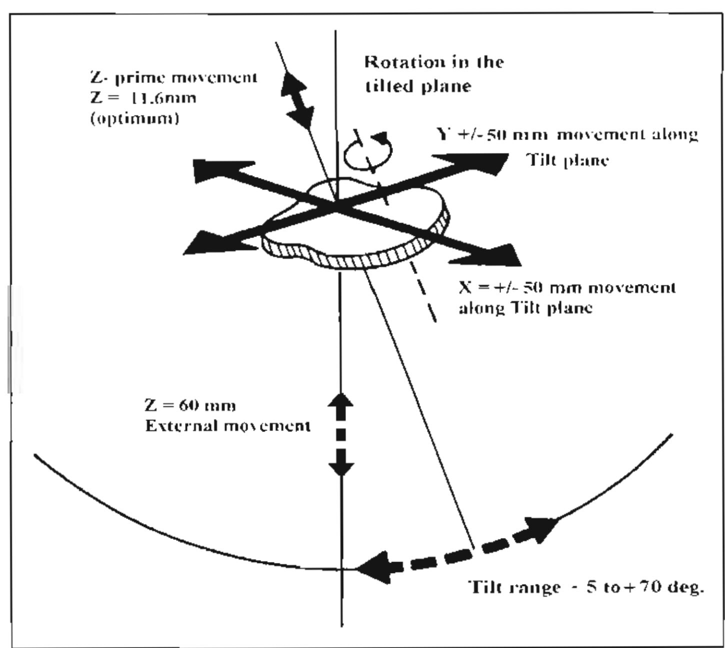
The basic stage is controlled manually by micrometers and screw-type adjusters on the stage door. The motorised stage has motors driving the X, Y, Z, Rotation and Tilt controls, all with manual override. For the motorised type the tilt is read out on screen, under software control, along with the other movements. For the manual stage Tilt, Rotation, X, Y, and Z are read out on the stage door.

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 75°. The tilting mechanism can be locked for more stability at high magnifications using the 'LOCK' knob.

FIGURE 7-11 XL30 100 x100 mm STAGE MOVEMENT ILLUSTRATION



The height of the specimen can be regulated by the external 60 mm Z control

control, along with the other movements. For the manual stage Tilt, Rotation, X, Y, and Z are read out on the stage door.

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 75°. The tilting mechanism can be locked for more stability at high magnifications using the 'LOCK' knob.

FIGURE 7-11 XL30 100 x100 mm STAGE MOVEMENT ILLUSTRATION

Rotation in the

XL30-100 x 100 mm (Manual)

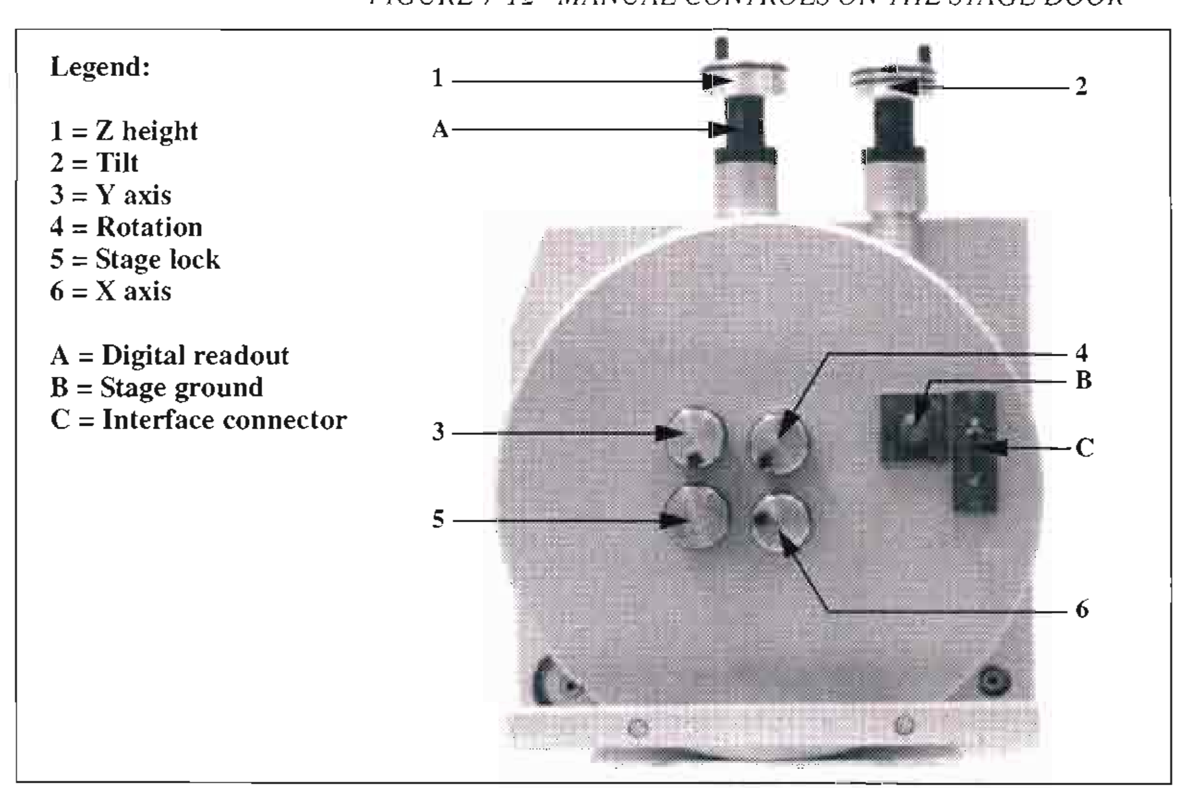
Using Tilt

The specimen can be tilted using the turning control (2) as follows:

- Check that the 'LOCK' turning control (5) is in the unlocked position (counter-clockwise movement).
- Set the tilt to the desired angle by turning the control (2) clockwise or counter-clockwise
- The tilt angle can be read from the digital read-out below the control knob. One digit is 0.2×, and one turn of the knob is 2× displacement.
- If desired (at high magnifications), the tilt mechanism can be locked using the 'LOCK' turning control (5) (clockwise movement)

In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), tilting has to be done carefully.

FIGURE 7-12 MANUAL CONTROLS ON THE STAGE DOOR



- The tilt angle can be read from the digital read-out below the control knob. One digit is 0.2×, and one turn of the knob is 2× displacement.
- If desired (at high magnifications), the tilt mechanism can be locked using the 'LOCK' turning control (5) (clockwise movement)

In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), tilting has to be done carefully.

FIGURE 7-12 MANUAL CONTROLS ON THE STAGE DOOR

Legend:

1 = Z height

1

A

2

To set the specimen height and at the same time prevent any possibility that the specimen should touch the lens pole if the Z is increased can be done as follows:

- Load a specimen onto the specimen holder.
- Adjust the Z, so that the specimen is approximately 10 mm below the lens.
- Close the chamber, and pump down.
- When the beam is switched on the Z<->FWD Dialogue box appears, follow the instructions and focus the sample. Press OK.

Now the Z can be changed by the software interface or the manual external Z control to other positions, but for safety, not less than 2 mm or1mm (SFEG) from the lens.

Using X, Y and Rotation

These movements are driven by the turning of controls X(6), Y(3) and Rotation (4).

For X and Y a range of 100 mm is available. A digital read-out can be found next to the respective control knobs. One digit is 0.1 mm, and one turn of either knob is 1 mm displacement. The smallest step is approximately 2 µm.

To rotate the specimen mechanically turn the Rotation control knob (4) in either direction, this control operates continuously through 360°. One Turn of the knob is 10° rotation, and the smallest step is 0.1°.

Shift

For very high magnification this function performs an on screen image shift, using beam shift coupled to magnification. This is not stage movement, but beam movement. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want by dragging it.

The range of beam shift is ±15µm in X and Y. The computer beeps when the beam shift limit is reached.

This mode is independent of the selected scan mode and can be operated at slow scan.

Stage Lock

appears, follow the instructions and focus the sample. Press OK.

Now the Z can be changed by the software interface or the manual external Z control to other positions, but for safety, not less than 2 mm or1mm (SFEG) from the lens.

Using X, Y and Rotation

These movements are driven by the turning of controls X(6), Y(3) and Rotation (4).

For X and Y a range of 100 mm is available. A digital read-out can be found next to the respective control knobs. One digit is 0.1 mm, and one turn of either knob is 1 mm displacement. The smallest step is approximately 2 µm.

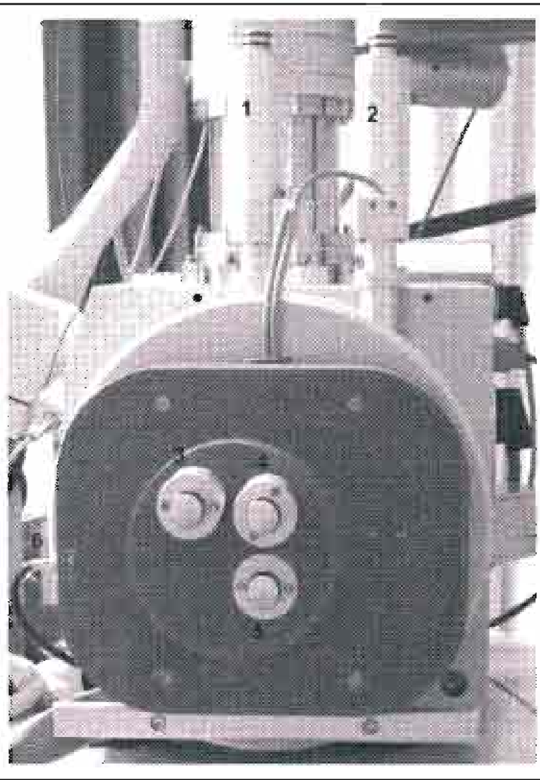
XL30-100x100 mm(5 axes Motor)

On the motorised stage the X, Y, Z, Rotation and Tilt movements can be operated under software control, with manual override.

FIGURE 7-13 XL30 100x100 mm MOTOR STAGE CONTROLS

Legend:

1 = Z height
2 = Tilt
3 = Y axis
4 = Rotation
5 = X axis
6 = Stage ground and Interface connector



Stage movement

A live image can be positioned with either stage movement (manual or software) or beam shift.

TABLE 7-4 MOVEMENT TYPES

Stage Movement	Beam Shift
Get (icon) X and Y	**Get** (above 6200X only)[1]
Track (icon) X and Y	**Shift** (icon) X and Y
Tilt (2) and Z height (1)	Scanrotation

1 = Z height
2 = Tilt
3 = Y axis
4 = Rotation
5 = X axis
6 = Stage ground and Interface connector

NOTE	When you move the stage or tilt the specimen, you may need to lower the magnification so you do not lose the feature of interest on the screen.

Five axes of stage movement are available: X, Y, Z, T and R. Software controls for movement include the Get, Shift and Track icons and the Stage control area. You can access this control area by maximizing the Stage control group, or clicking on the Stage icon.

Get

When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

Shift

This function performs an onscreen image shift, using beam shift coupled to magnification.The stage does not move during beam shift. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

The range of beam shift is ±15 μm in X and Y. The computer beeps when the beam shift limit is reached.

This mode is independent of the selected scan mode and can be operated at slow scan.

Track

The track function allows continuous directional movement of the stage with variable speed. The speed range is coupled to the magnification and selectable within certain limits.

Select the track function by clicking on the Track icon. A green

Get

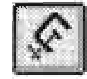
When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

The direction of movement is always toward the centre along the green straight line. You can move the cursor around on the field of view; direction and speed change accordingly. When you are done, click on the arrow tool.

For a given magnification, the minimum speed is obtained when the cursor is on the inner circle. The maximum speed (for that magnification) is a multiple of the minimum speed. The maximum speed can be customized and is given by a ratio value established in the position setup dialogue box. The default value is 4 (slow); the maximum value is 10 (fast).

Clamp 

Select the Clamp function by clicking on the Clamp icon to clamp the stage. While the stage is clamped, normal operation of x,y movement and rotation is possible, but the height and tilt cannot be changed.

When selected, the clamp button in the button bar will change colour (yellow), indicating that the stage clamp has been activated. This selection is a toggle.

maximum value is 10 (fast).

Clamp

Select the Clamp function by clicking on the Clamp icon to clamp the stage. While the stage is clamped, normal operation of x,y movement and rotation is possible, but the height and tilt cannot be changed.

When selected, the clamp button in the button bar will change colour (yellow), indicating that the stage clamp has been activated. This selection is a toggle.

XL40 Stages (Early)

XL40 Stage 150 x 150 mm

The XL40 150 x 150 mm stage is a dedicated motorised version.

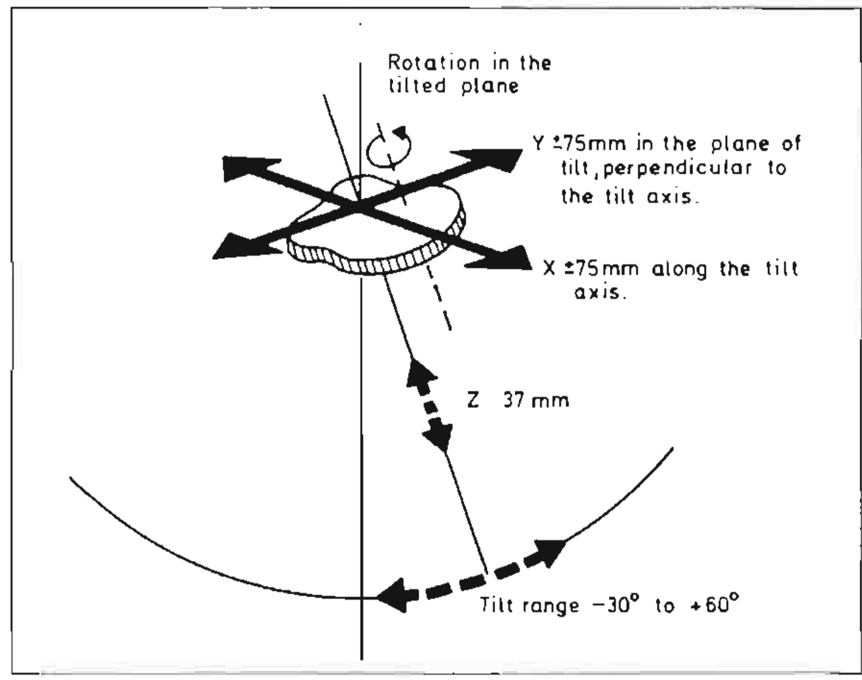
The basic stage has motors driving the X,Y. and Rotation controls with read-out on screen.Tilt and Z are manual and read-out is found on the door of the stage.

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted from -30° to +60°. The tilt axis always intersects the electron optical axis of the column at the same height (10 mm FWD). When the specimen is positioned at this height, the specimen can be tilted in the eucentric plane. This means that during tilt, almost no image displacement occurs. The tilting mechanism can be locked for more stability at high magnifications using the 'LOCK' lever.

FIGURE 7-14 XL40 150 x 150 mm STAGE MOVEMENT



The height of the specimen can be regulated by a the external Z control and is a manual method. X,Y, and Rotation movements can be

Stage movement

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted from -30° to +60°. The tilt axis always intersects the electron optical axis of the column at the same height (10 mm FWD). When the specimen is positioned at this height, the specimen can be tilted in the eucentric plane. This means that during tilt, almost no image displacement occurs. The tilting mechanism can be locked for more stability at high magnifications using the 'LOCK' lever.

FIGURE 7-14 XL40 150 x 150 mm STAGE MOVEMENT

Rotation in the

Using Tilt

The specimen can be tilted using the lever (2) as follows:

- Check that the 'LOCK' lever (1) is in the unlocked position (counter-clockwise movement).
- Set the tilt to the desire angle by moving the tilt lever (2) up or down.
- The tilt angle can be read from the scale (3) on the door.
- If desired (at high magnifications), the tilt mechanism can be locked using the 'LOCK' lever (1) (clockwise movement).

The 'LOCK' lever position is adjustable using a ratchet mechanism. The lever can be adjusted by pulling it out gently until the ratchet mechanism freewheels, then moving it to the desired position.

In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), the tilt has to be restricted under certain conditions. In order to facilitate this, several tilt stops are provided.

FIGURE 7-15 MANUAL CONTROLS ON THE STAGE DOOR

A = 60 deg. stop
B = 45 deg. stop
C = 30 deg. stop
D = 15 deg stop
E = 0 deg. stop
F = -30 deg. stop
1 = Tilt Lock lever
2 = Tilt lever
3 = Tilt angle scale
4 = Z height control
5 = Z read-out

TABLE 7-5 RECOMMENDED TILT STOPS

FWD	Tilt range	Positions
10 mm	[illegible]	B - F

locked using the 'LOCK' lever (1) (clockwise movement).

The 'LOCK' lever position is adjustable using a ratchet mechanism. The lever can be adjusted by pulling it out gently until the ratchet mechanism freewheels, then moving it to the desired position.

In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), the tilt has to be restricted under certain conditions. In order to facilitate this, several tilt stops are provided.

FIGURE 7-15 MANUAL CONTROLS ON THE STAGE DOOR

Using Z (height) adjustment

It is possible to change the specimen height from outside the chamber with the Z Height Control (4) over 37 mm of movement.

A Z readout (5) can be seen on top of the Z Height Control knob (4) and is scaled in mm. 1 turn of the knob is 0.75 mm displacement.

Height is measure from the Eucentric point which is 10 mm. It is possible to move the stage 5 mm above and 32 mm under this point.

To set the specimen height to the eucentric position and at the same time prevent any possibility that the specimen should touch the lens pole can be done as follows:

- Load a specimen onto the specimen holder.
- with the stage door still open adjust the external Z (4) to the lowest position.
- Close the stage door and pump down the system.
- When the vacuum is OK switch on the beam and make an image. Bring the WD read-out on screen to 10 mm (the image will be out of focus).
- Turn the Z Height Control (4) so that the specimen comes into focus on screen. Select a suitable area on the sample.
- Pivot the stage Tilt lever (2) between -5° and +5° while fine tuning the Z Height Control (4) to create no shift in the image at the centre horizontal axis of the screen.

Using X, Y and Rotation

These movements are motor driven and controlled by software.

For X and Y a range of 150 mm is available.

To set the specimen height to the eucentric position and at the same time prevent any possibility that the specimen should touch the lens pole can be done as follows:

- Load a specimen onto the specimen holder.
- with the stage door still open adjust the external Z (4) to the lowest position.
- Close the stage door and pump down the system.
- When the vacuum is OK switch on the beam and make an image. Bring the WD read-out on screen to 10 mm (the image will be out of focus).
- Turn the Z Height Control (4) so that the specimen comes into focus on screen. Select a suitable area on the sample.
- Pivot the stage Tilt lever (2) between -5° and +5° while fine tuning the Z Height Control (4) to create no shift in the image at the centre

Stage movement

A live image can be positioned with stage movement or beam shift (software driven).

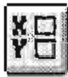
TABLE 7-6 MOVEMENT TYPES

Stage Movement	Beam Shift
Get (icon) X and Y (software)	**Get** (above 6200X only)[1]
Track (icon) X and Y (software)	**Shift** (icon) X and Y
Tilt (2) and Z height (4) (manual)	Scanrotation
Rotation (software)	
Stage Position Controls / Map	

1. This number is set in the Stage Setup dialog box and can be changed.

NOTE: When you move the stage or tilt the specimen, you may need to lower the magnification so you do not lose the feature of interest on the screen.

Five axes of stage movement are available: X, Y, Z, T and R. Software controls for movement include the Get, Shift and Track icons and the Stage control area. You can access this control area by maximizing the Stage control group, or clicking on the Stage icon.



Get

When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

Track (icon) X and Y (software)	**Shift** (icon) X and Y
Tilt (2) and Z height (4) (manual)	Scanrotation
Rotation (software)	
Stage Position Controls / Map	

1. This number is set in the Stage Setup dialog box and can be changed.

OTE: When you move the stage or tilt the specimen, you may need to lower the

Five axes of stage movement are available: X, Y, Z, T and R. Software controls for movement include the Get, Shift and Track icons and the Stage control area. You can access this control area by

the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

The range of beam shift is ±15 μm in X and Y. The computer beeps when the beam shift limit is reached.

This mode is independent of the selected scan mode and can be operated at slow scan.

Track

The track function allows continuous directional movement of the stage with variable speed. The speed range is coupled to the magnification and selectable within certain limits.

Select the track function by clicking on the Track icon. A green overlay appears onscreen. Position the cursor somewhere in the image and hold down the left mouse button. The cursor can move between the inner and outer green circles. Moving toward the outer circle increases the stage speed; moving toward the inner circle decreases stage speed.

The direction of movement is always toward the centre along the green straight line. You can move the cursor around on the field of view; direction and speed change accordingly. When you are done, click on the arrow tool.

For a given magnification, the minimum speed is obtained when the cursor is on the inner circle. The maximum speed (for that magnification) is a multiple of the minimum speed. The maximum speed can be customized and is given by a ratio value established in the position setup dialogue box. The default value is 4 (slow); the maximum value is 10 (fast).

Clamp

Select the Clamp function by clicking on the Clamp icon to clamp the stage. While the stage is clamped, normal operation of x,y movement and rotation is possible, but the height and tilt cannot be changed.

When selected, the clamp button in the button bar will change colour (yellow), indicating that the stage clamp has been activated. This selection is a toggle.

Track

The track function allows continuous directional movement of the stage with variable speed. The speed range is coupled to the magnification and selectable within certain limits.

Select the track function by clicking on the Track icon. A green overlay appears onscreen. Position the cursor somewhere in the image and hold down the left mouse button. The cursor can move between the inner and outer green circles. Moving toward the outer circle increases the stage speed; moving toward the inner circle decreases stage speed.

The direction of movement is always toward the centre along the green straight line. You can move the cursor around on the field of view; direction and speed change accordingly. When you are done, click on the arrow tool.

XL40 Stages (Later)

XL40 Stage 150 x 150 mm

The XL40 150x150 mm stage is a 5 axes motorised version.

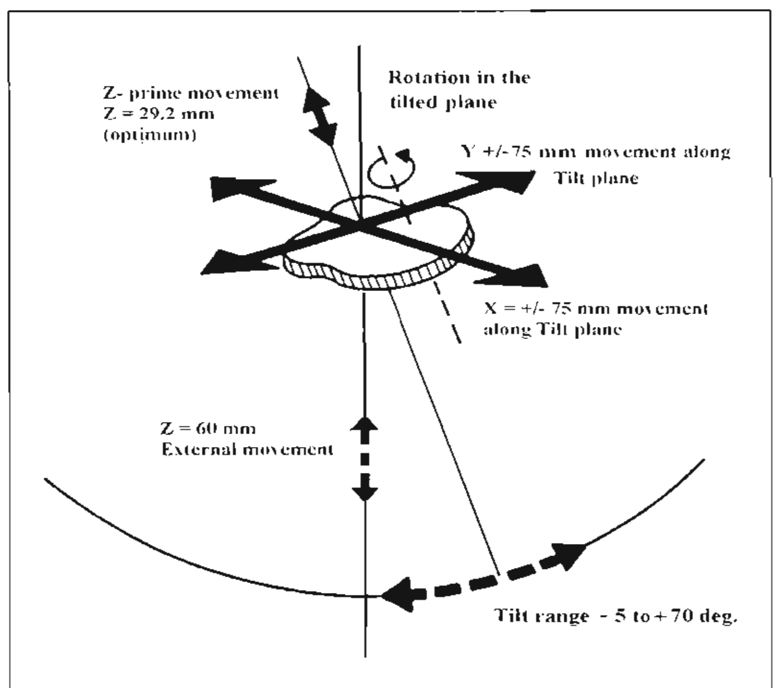
The stage has motors driving the X, Y, Z, Rotation and Tilt controls, all with manual override. All movements are read out on screen, under software control.

Stage movements

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 75°. The tilting mechanism can be locked for more stability at high magnifications using the 'Clamp' feature.

FIGURE 7-16 XL40 150 x150 mm STAGE MOVEMENT



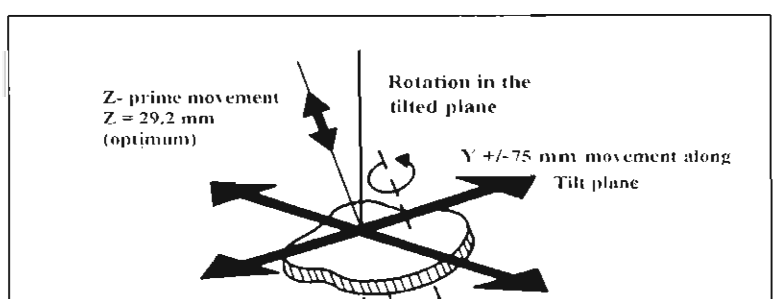
The Z height of the specimen can be regulated by the external 60 mm Z control and by the Z prime internal movement. The Z prime is eucentric at 29.2 mm from the stage base to sample top surface otherwise is fococentric.

X, Y, Z, Rotation and Tilt movements on the motorised stage can be operated under software control for more advanced movement combinations.

The specimen stage allows movement of the specimen along 5 axes.

The stage can be tilted over 75°. The tilting mechanism can be locked for more stability at high magnifications using the 'Clamp' feature.

FIGURE 7-16 XL40 150 x150 mm STAGE MOVEMENT



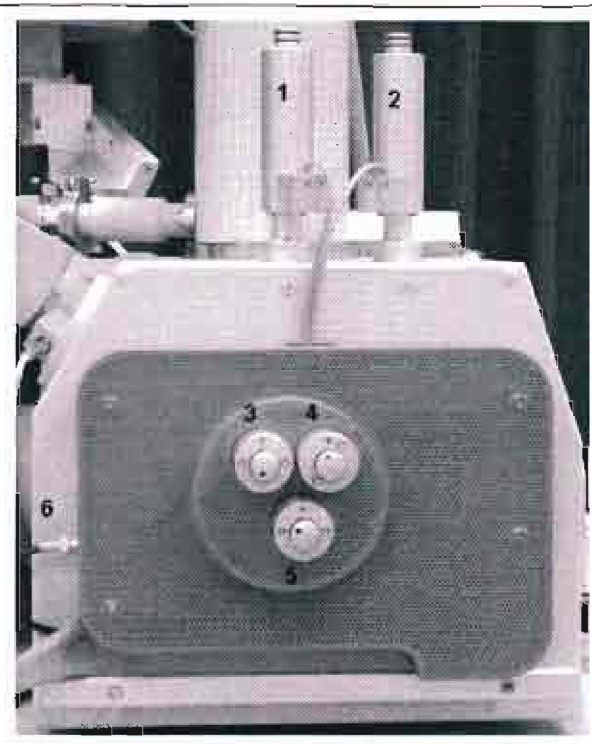
XL40-150x150 mm(5 axes Motor)

XL40 (5 axes) Stage Controls

FIGURE 7-17 CONTROLS ON THE STAGE DOOR

Legend:

1 = Z height
2 = Tilt
3 = Y axis
4 = Rotation
5 = X axis
6 = Interface control connectors



Stage movement

On the 5 axes motorised stage the X, Y, Z, Rotation and Tilt movements can be operated under software control, with manual override. A live image can be positioned with either stage movement (manual or software) or beam shift.

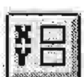
TABLE 7-7 MOVEMENT TYPES

Stage Movement	Beam Shift
Get (icon) X and Y	**Get** (above 6200X only)[1]
Track (icon) X and Y	**Shift** (icon) X and Y
Tilt (2) and Z height (1)	Scanrotation

1 = Z height
2 = Tilt
3 = Y axis
4 = Rotation
5 = X axis
6 = Interface control connectors

> **NOTE**
> When you move the stage or tilt the specimen, you may need to lower the magnification so you do not lose the feature of interest on the screen.

Five axes of stage movement are available: X, Y, Z, T and R. Software controls for movement include the Get, Shift and Track icons and the Stage control area. You can access this control area by maximizing the Stage control group, or clicking on the Stage icon.

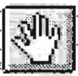


Get

When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

Shift 

This function performs an onscreen image shift, using beam shift coupled to magnification.The stage does not move during beam shift. When you click on the shift icon and hold down the left mouse button, the cursor changes into a small hand, allowing you to position the image where you want it by dragging it.

The range of beam shift is ±15 μm in X and Y. The computer beeps when the beam shift limit is reached.

This mode is independent of the selected scan mode and can be operated at slow scan.

Track

The track function allows continuous directional movement of the stage with variable speed. The speed range is coupled to the magnification and selectable within certain limits

Get

When you select an image detail with the green cross and double-click the left mouse button, Get brings that detail to the centre of the screen. At low magnification (as you defined it in the Stage Change dialogue box—usually less than 6200X) the stage will be driven; at higher magnification, the result is obtained by beam shift.

If Auto Beam Shift Zero is checked on the Stage pulldown menu, Get moves stage movement only; beam shift is independent of magnification.

The maximum range for successive Get operations equals the range of the stage. At high magnifications, the range is limited by the maximum beam shift.

The direction of movement is always toward the centre along the green straight line. You can move the cursor around on the field of view; direction and speed change accordingly. When you are done, click on the arrow tool.

For a given magnification, the minimum speed is obtained when the cursor is on the inner circle. The maximum speed (for that magnification) is a multiple of the minimum speed. The maximum speed can be customized and is given by a ratio value established in the position setup dialogue box. The default value is 4 (slow): the maximum value is 10 (fast).

Clamp

Select the Clamp function by clicking on the Clamp icon to clamp the stage. While the stage is clamped, normal operation of x/y movement and rotation is possible, but the Z height and Tilt cannot be changed.

When selected, the clamp button in the button bar will change colour (yellow), indicating that the stage clamp has been activated. This selection is a toggle.

maximum value is 10 (fast).

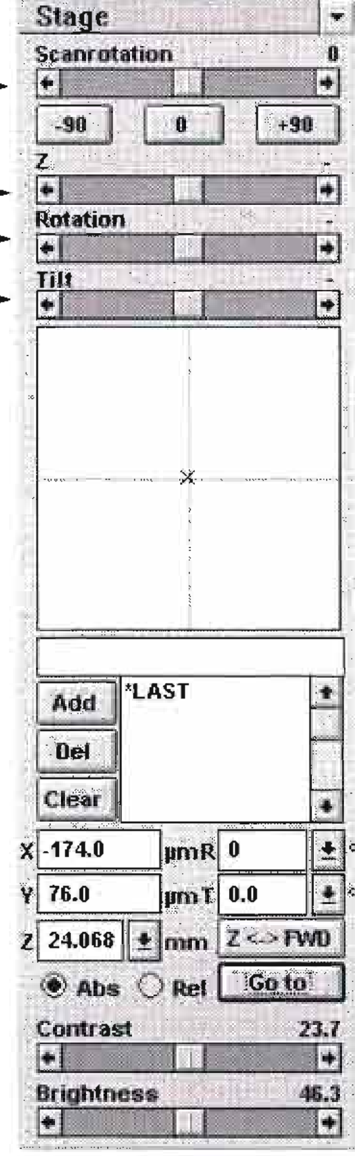
Clamp

Select the Clamp function by clicking on the Clamp icon to clamp the stage. While the stage is clamped, normal operation of x/y movement and rotation is possible, but the Z height and Tilt cannot be changed.

When selected, the clamp button in the button bar will change colour (yellow), indicating that the stage clamp has been activated. This selection is a toggle.

Stage Control Group

MAXIMIZED



The maximized Stage control group is the same as the Stage control area. Its functions control movement of the stage and the beam to correct the positioning of the specimen.

Scanrotation

Use this adjuster to rotate the scan and align the image onscreen. Shadowing and other charged particle optical and geometrical effects can only be modified by changing the orientation of the specimen with stage rotation. Clockwise moves are positive; counterclockwise moves are negative.

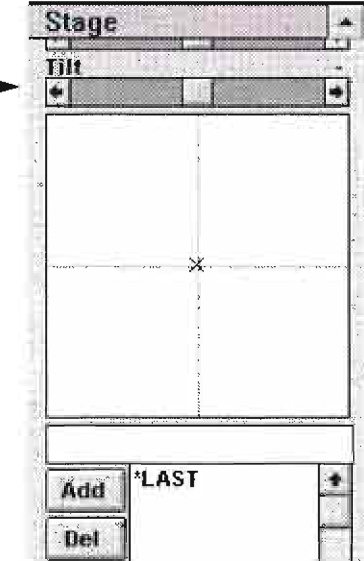
TABLE 7-8 ROTATING A SCAN

Option	Result
-90	Results in an additional - 90° scan rotation.
0	Sets the scan rotation to zero.
+90	Results in an additional + 90° scan rotation.

Z, Rotation and Tilt

The Z (specimen position), Rotation and tilt adjusters control the amount and direction of those functions. The farther from centre you drag the middle slider, the faster the movement. The longer you hold it down, the farther the amount of movement. These adjusters trap the cursor within them and can only be adjusted with the middle slider, not by clicking within the gray bar.

MINIMIZED



can only be modified by changing the orientation of the specimen with stage rotation. Clockwise moves are positive; counterclockwise moves are negative.

TABLE 7-8 ROTATING A SCAN

Option	Result
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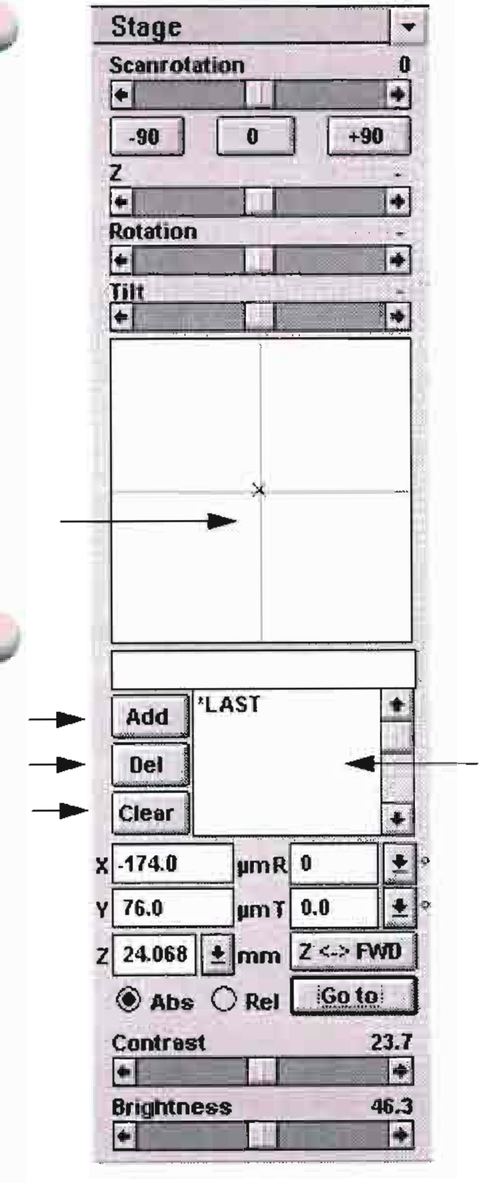
Z, Rotation and Tilt



Stage Map

The stage map function shows an X-Y control with a crosshair. The axes represent the total X and Y range for the stage; the position of the crosshair represents the actual position of the stage with respect to the stage limits. The multiple stub holder doesn't display.

When the stage has just been homed, the crosshair is in the centre of the grid (0, 0 coordinates). As a reference, the detector is positioned at the top of the grid and the stage door is located at the bottom of the grid.

Double-clicking in the grid causes the computer to calculate stage coordinates and move to the new position. The function is used to move over long distances, for example, when going from one specimen to another mounted on the multiple stub holder. Initial you have to estimate the location of each stub.

Stage rotation is not affected by this function; movement is only in X and Y.

Stored Stage Positions

You can store stage positions that you want to use routinely. Use the list box to view the list of stage positions. Highlight the position you want to work with, and double-click to select it.

Add

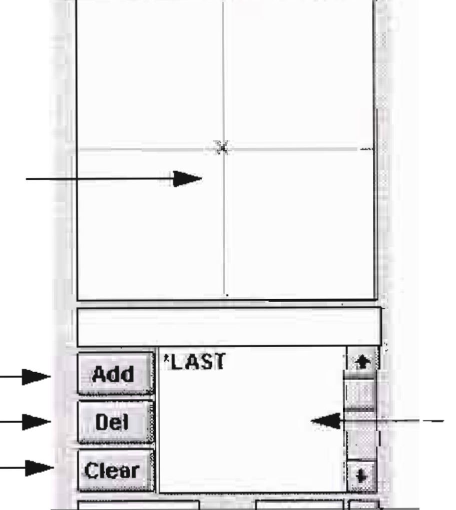
To add the current stage position to the list, type the label in the edit box and click the ADD button.

Del

To delete a stage position from the list, highlight the name of the position and click the DEL button.

Clear

Use the CLEAR button to delete all stored stage positions from the list. A confirmation dialogue box appears.



grid.

Double-clicking in the grid causes the computer to calculate stage coordinates and move to the new position. The function is used to move over long distances, for example, when going from one specimen to another mounted on the multiple stub holder. Initial you have to estimate the location of each stub.

Stage rotation is not affected by this function; movement is only in X and Y.

Stored Stage Positions

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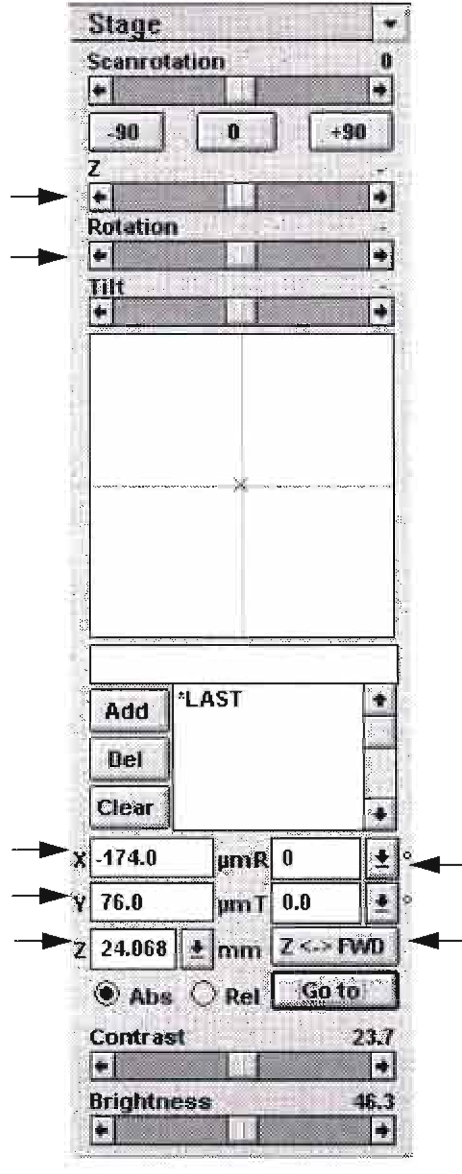
Add



X, Y

Use these text boxes to view existing coordinates and to enter desired coordinates to position the stage on the X and Y axes. Values are entered in microns. After you press ENTER or GO TO, the stage will move to the value entered.

Z (edit box)

Enter the position of the specimen in the Z text box or choose from the list, accessed by clicking on the down arrow. After you press ENTER or GO TO, the stage will move to the value entered.

After you have found the eucentric height for a particular sample and clicked the GET button in the Position Setup dialogue box, this number appears in the Z pulldown list.

Z <-> FWD

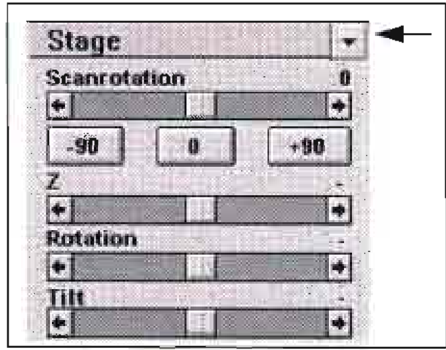
This button can be pressed to relate the Z value to working distance, so that movements of the stage can be made safely in a vertical direction. Once pressed a dialogue box appears to remind one to check the focus, as the readout accuracy in the databar relies on the objective lens focus. Once the relationship is made the Z text box can be used as FWD values, where 0 is seen as the final lens pole and positions below it such as the eucentic position are positive in value. The same dialogue box appears automatically after sample change or opening of the specimen chamber.

Z (adjuster)

You can also use the Z adjuster for immediate visual feedback and continuous control.

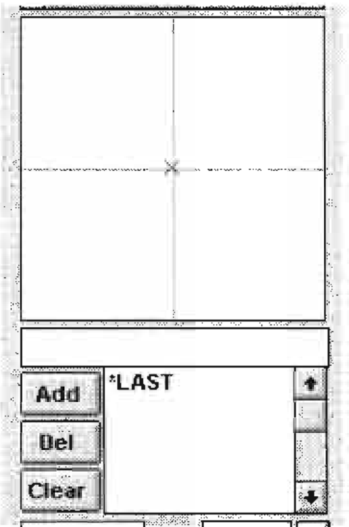
R

Enter degrees of rotation in this text box or choose from the list, accessed by clicking on the down arrow.



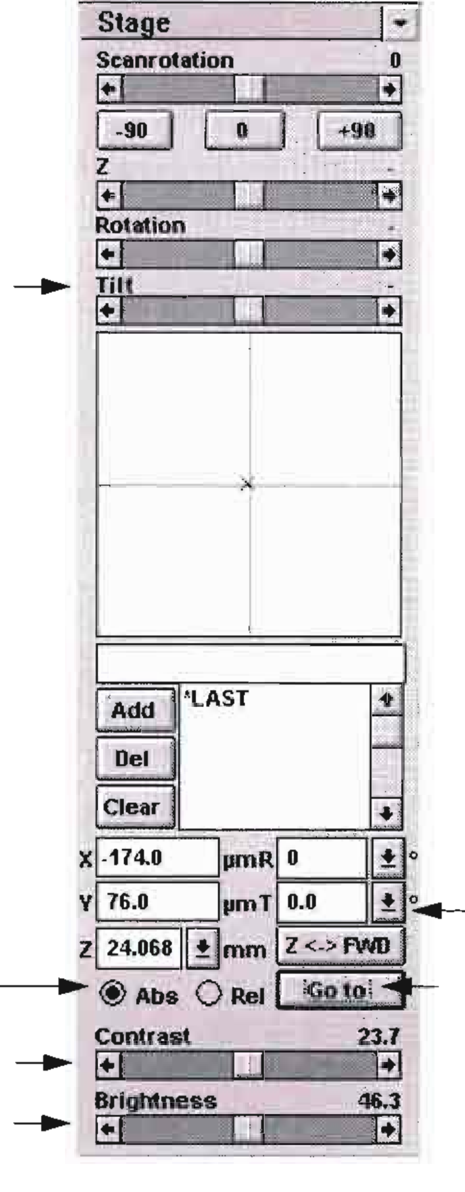
GO TO, the stage will move to the value entered.

After you have found the eucentric height for a particular sample and clicked the GET button in the Position Setup dialogue box, this number appears in the Z pulldown list.



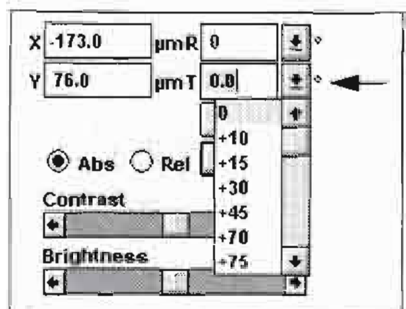
Z <-> FWD

This button can be pressed to relate the Z value to working distance, so that movements of the stage can be made safely in a vertical direction. Once pressed a dialogue box appears to remind one to check the focus, as the readout accuracy in the databar relies on the objective lens focus. Once the relationship is made the Z text box can be used as FWD values, where 0 is seen as the final lens pole and positions below it such as the eucentic position are positive in value. The same dialogue box appears automatically after sample change or



T

Enter degrees of tilt in this text box or choose from the list, accessed by clicking on the down arrow.



After you press ENTER or GO TO, the stage will move to the value entered.

Abs/Rel

Choose either absolute or relative stage movements. Absolute coordinates are measured from the absolute zero (0,0,0,0,0) of the stage. Relative coordinates are measured from the present location on the stage.

Go To

Click on this button after setting X, Y, Z, R and T parameters to move the stage to the value entered. You can also use the ENTER key on the keyboard.

Contrast

Use this adjuster to control the contrast displayed in the image.

This has the same functionality as the contrast adjuster on the Beam and Video control groups.

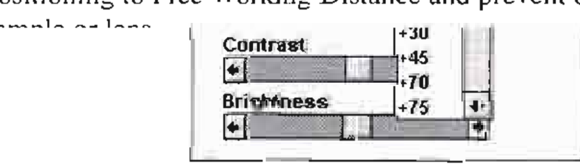
Brightness

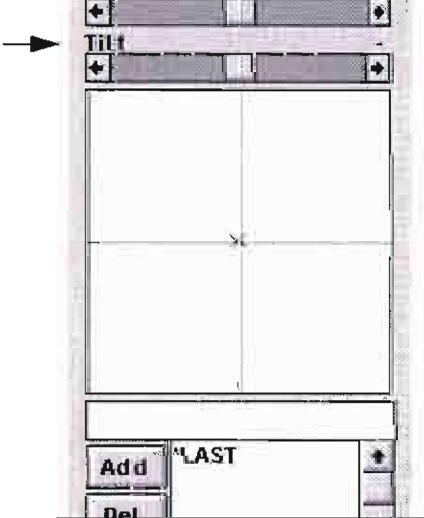
Use this adjuster to control the brightness displayed in the image.

This has the same functionality as the brightness adjuster on the Beam and Video control groups.

Z<->FWD Dialogue Box

This dialogue box appears automatically after sample change or opening of the specimen chamber to remind the operator to link the Z positioning to Free Working Distance and prevent damage to either





After you press ENTER or GO TO, the stage will move to the value entered.

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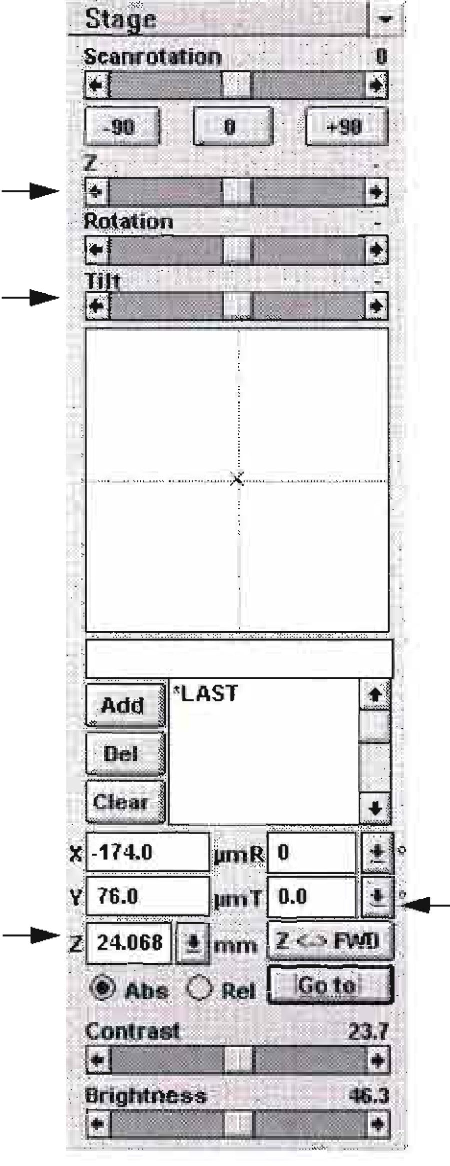
Choose either absolute or relative stage movements. Absolute coordinates are measured from the absolute zero (0,0,0,0,0) of the stage. Relative coordinates are measured from the present location on the stage.

Go To

Use of Stage Functions



Using Tilt

You can adjust Tilt using either the "T" edit box, or the Tilt adjuster on screen within the Stage control area, or manual Tilt control (2) on the stage. The range is -5 to + 70.

The specimen can be tilted using the turning control (2) as follows:

- Check that the Clamp button is in the unlocked position (grey).
- Set the tilt to the desired angle by turning the control (2) clockwise or counter-clockwise
- The tilt angle can be read from the "T" edit box
- If desired (at high magnifications), the tilt mechanism can be locked using the Clamp button in the button bar

In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), tilting has to be done carefully.

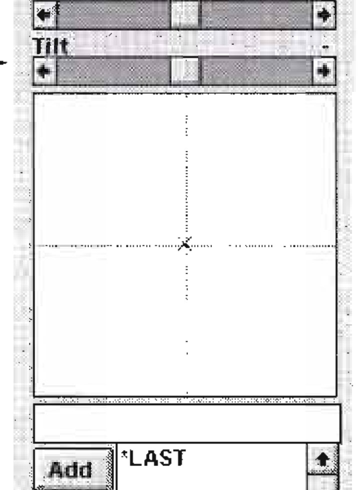
Using Z (height) adjustment

With the various sample holders it is possible to move Z height (1) to another position if required from outside the chamber. The external movement (Z) is 60 mm for SFEG. This allows a flexibility to load large height specimens onto the stage.

To set the specimen height and at the same time prevent any possibility that the specimen should touch the lens pole if the Z is increased can be done as follows:

- Load a specimen onto the specimen holder.
- Adjust the Z with the external and internal movements, so that the specimen is approximately 5 mm below the lens. For Eucentric positioning the internal Z should always be 29.2 mm.
- Close the chamber, and pump down.
- When the beam is switched on the Z<->FWD Dialogue box appears, follow the instructions and focus the sample. Press OK.

Now the Z can be changed by the software interface or the manual external Z control to other positions, but for safety, not less than 1 mm from the lens.



- Check that the Clamp button is in the unlocked position (grey).
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In order to prevent damage to the specimen or the detector (e.g. the Backscatter detector), tilting has to be done carefully.

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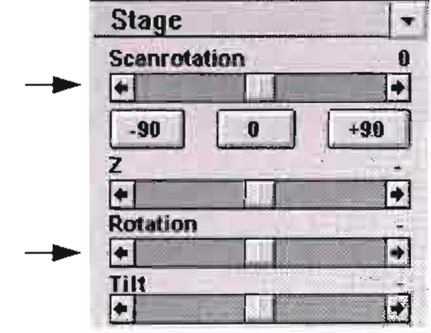

Using Rotation

You can adjust Rotation using either the 'R' edit box, or the Rotation adjuster on screen within the Stage control area, or manual Rotation control (4) on the stage. The range is 360° continuous.

Using Scanrotation

Use the adjuster either on the Stage or Imaging control area, to rotate the scan and align the image onscreen. Shadowing and other optical geometric effects can be modified only by changing the orientation of the specimen with stage rotation. Use the Scan rotation adjuster to make incremental changes, or choose one of the following buttons below the adjuster:

TABLE 7-9 ROTATING A SCAN

Option	Result
-90	Results in an additional - 90° scan rotation.
0	Sets the scan rotation to zero.
+90	Results in an additional + 90° scan rotation.

the scan and align the image onscreen. Shadowing and other optical geometric effects can be modified only by changing the orientation of the specimen with stage rotation. Use the Scan rotation adjuster to make incremental changes, or choose one of the following buttons below the adjuster:

TABLE 7-9 ROTATING A SCAN

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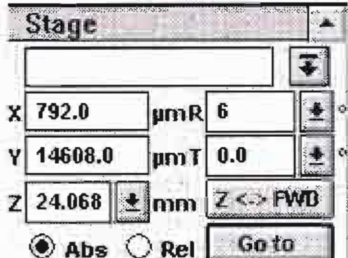
MINIMIZED



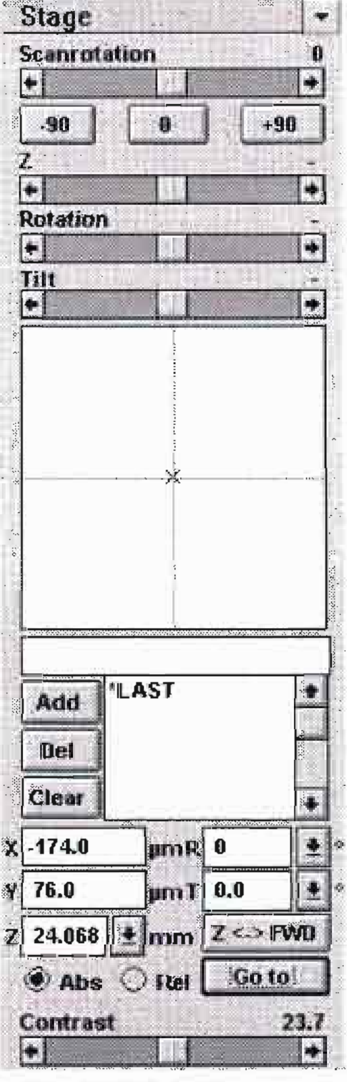
Using Stage Position Controls

The Stage area shows the actual stage coordinates in microns for X and Y, and millimetres for Z. Rotation and tilt display in degrees. You can move to new coordinates by entering the values in the X,Y text boxes or by clicking on stored stage positions on the map area.

Using Stored Stage Positions

Double-clicking on a Stage Position label in the stage position list, such as *Last, causes the stage to move to a prestored location. If you want to store a new location, type a new label in the edit box above the list (up to 32 alphanumeric characters excluding spaces) and then click on ADD. Highlight a label and then click on DEL to remove an unwanted location. Click on the CLEAR button to delete all stored stage positions in the list except *Last.

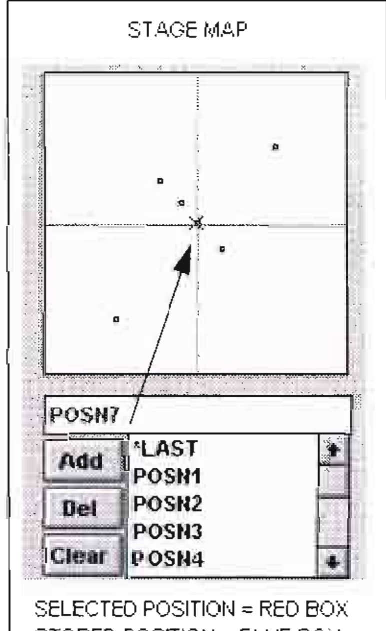
MAXIMIZED



The Stage Map

This function shows an X-Y control with a crosshair. The axes represent the total X and Y range for the stage.

Blue boxes represent stored stage positions. The selected stage position displays as a red box. The black cross represents the current stage position.



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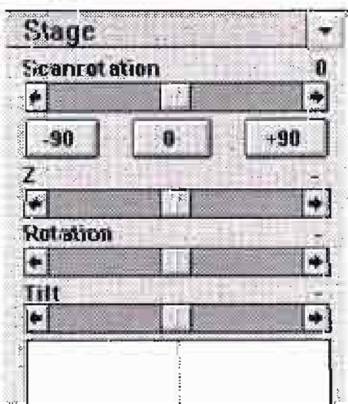
MAXIMIZED



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This function shows an X-Y control with a crosshair. The axes represent the total X and Y range for the stage.

Blue boxes represent stored stage positions. The selected stage position displays as a red box. The black cross represents the current

Stage Menu

Stage
- Home...
- Clamp
- Align X
- Align Y
- Align Feature
- Specimen Alignment
- Use Spec. Alignment
- Setup Z correction
- Use Z correction
- Eucentric Rotation
- Zero Beam Shift
- Auto Beam Shift Zero
- Beam Shift Reset Pr.
- Read Mapping File
- Change...

The Stage menu functions control movement of the stage and the beam to correct the position of the specimen.

Home

Home the stage by pressing YES on the Stage Control dialogue box.

The Homing Stage Active dialogue box flashes onscreen.

When the stage is homed correctly, all five coordinates will be 0.

Clamp

Select Clamp to clamp the stage. While the stage is clamped normal operation of x/y movement and rotation is possible, but the Z height and tilt cannot be changed.

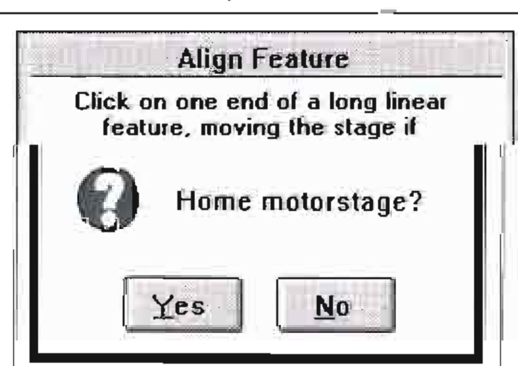
When selected from the menu, the clamp button in the button bar will change colour (yellow), indicating that the stage clamp has been activated. This selection is a toggle.

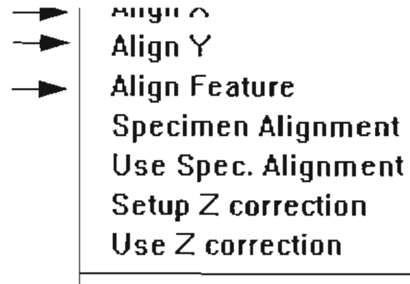
Align X/Align Y

Use Align X or Align Y to align rows or columns on the sample with the vertical or horizontal axes on the screen. Use Slow Scan for greater accuracy.

Align Feature

This allows you to align the vertical axis of an entire regular feature over a long distance. **You must use the arrow tool.** Although the alignment can be performed using TV rate scan speed, slow scan speed will give the best accuracy.





The Homing Stage Active dialogue box flashes onscreen.

When the stage is homed correctly, all five coordinates will be 0.

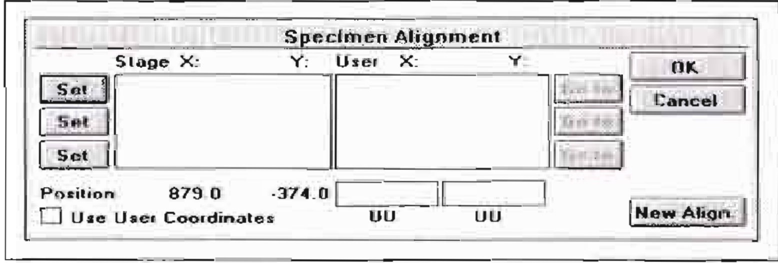
Clamp

Select Clamp to clamp the stage. While the stage is clamped normal operation of x/y movement and rotation is possible, but the Z height

Stage
- Home...
- Clamp
- Align X
- Align Y
- Align Feature
- → Specimen Alignment
- → Use Spec. Alignment
- Setup Z correction
- Use Z correction
- → Eucentric Rotation
- → Zero Beam Shift
- Auto Beam Shift Zero
- Beam Shift Reset Pr.
- Read Mapping File
- Change...

Specimen Alignment

Specimen alignment is a navigation aid. It can be used to convert alignment points from microns to user units and to further increase stage accuracy. Use the arrow tool or Get moves to select the alignment points.



Use Specimen Alignment

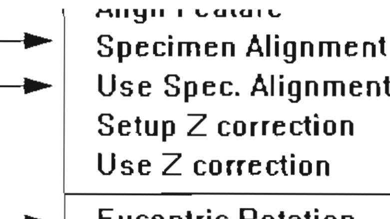
This selection is a toggle for using an established Specimen Alignment.

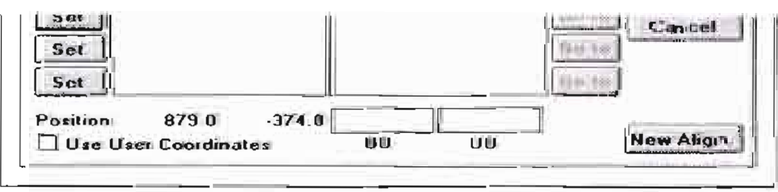
Eucentric Rotation

Select Eucentric Rotation to make all stage moves eucentric. Computer calculations make adjustments for changes in position that would move the area of interest out of view. This shifts the centre point from the stage centre to the field-of-view centre.

Zero Beam Shift

When beam shift has reached maximum limits, choose Zero Beam Shift to restore X and Y beam shifts to zero values. The computer beeps when maximum limits are reached.





Use Specimen Alignment

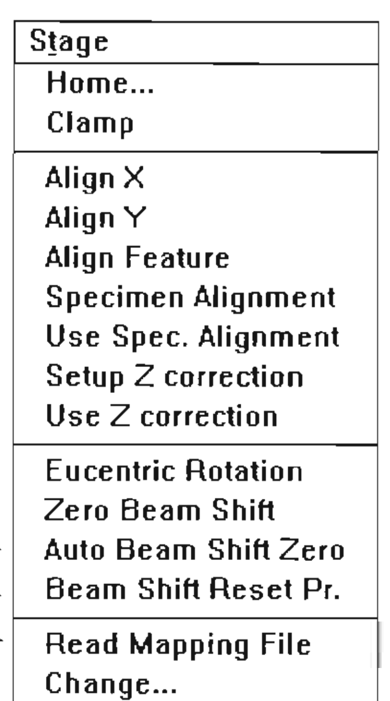
This selection is a toggle for using an established Specimen Alignment.

Eucentric Rotation

Select Eucentric Rotation to make all stage moves eucentric. Computer calculations make adjustments for changes in position that would move the area of interest out of view. This shifts the centre

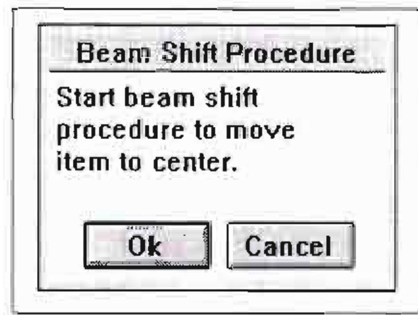
Auto Beam Shift Zero

Select Auto Beam Shift Zero to automatically set beam shift to zero after a stage move. This also prevents Get moves from using beam shift.



Beam Shift Reset Procedure

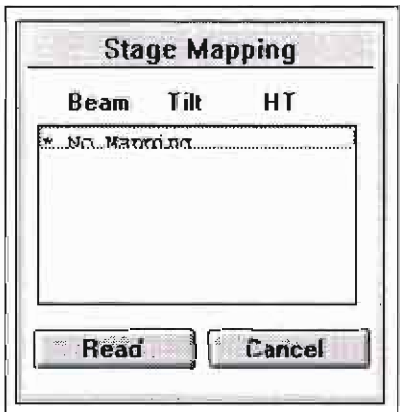
Use this function to begin the beam shift procedure to zero beam shift and move the feature to the centre of the field of view with the stage.



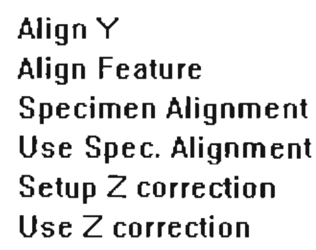
A powerzoom procedure begins that combines a preset zoom rate with autofocus and autocontrast/brightness. You set the parameters in advance in the Position Setup dialogue box. If you have chosen autofocus (ACB), this will extend the time the procedure takes.

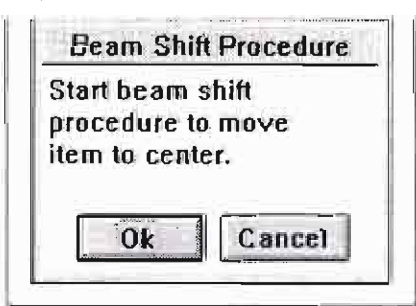
Read Mapping File (Option)

When selected, the Stage Mapping dialogue box displays a list of mapping files that can be used to make stage movement more accurate at various tilts and high tensions.



The asterisk indicates which map file is currently being used by the software. You can also select no mapping, but none of the stage moves will be eucentric.





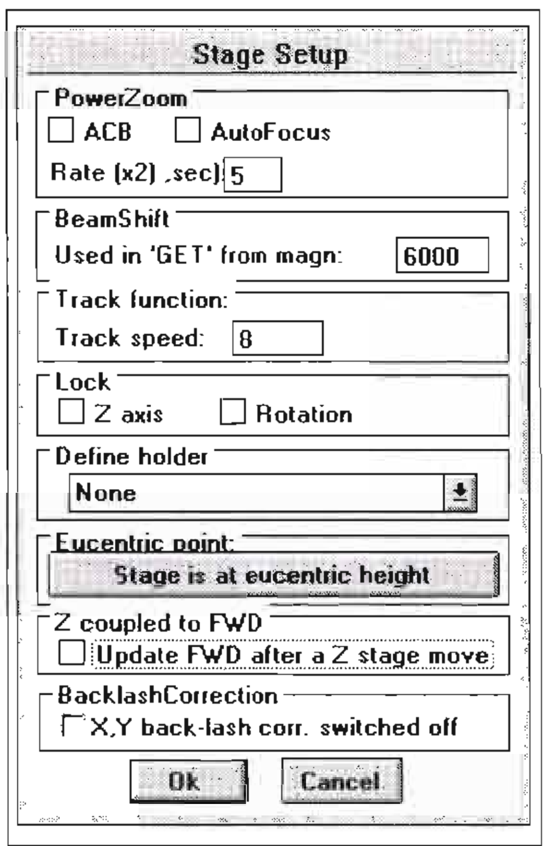
A powerzoom procedure begins that combines a preset zoom rate with autofocus and autocontrast/brightness. You set the parameters in advance in the Position Setup dialogue box. If you have chosen autofocus (ACB), this will extend the time the procedure takes.

Read Mapping File (Option)

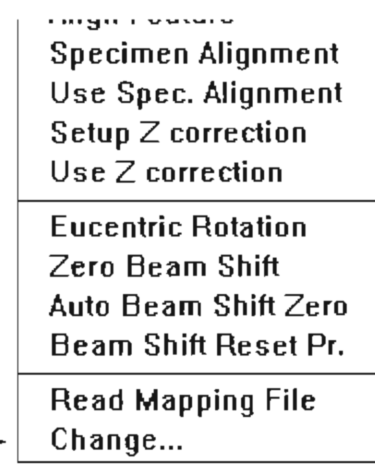
Change

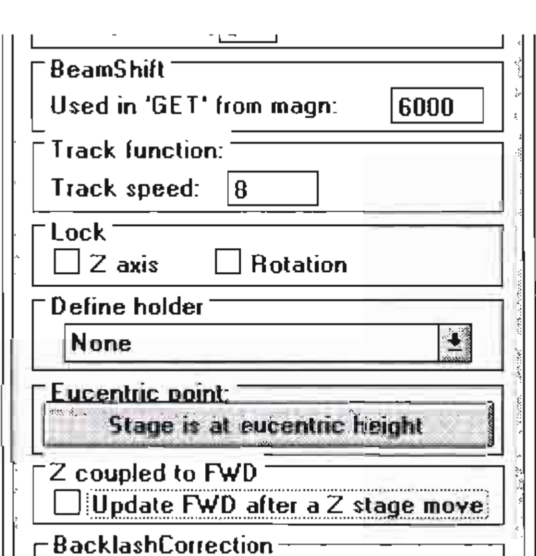
Use this dialogue box to set parameter inputs for PowerZoom image positioning functions, Beamshift, Track function, Lock, Holder

Stage
Home...
Clamp
Align X
Align Y
Align Feature
Specimen Alignment
Use Spec. Alignment
Setup Z correction
Use Z correction
Eucentric Rotation
Zero Beam Shift
Auto Beam Shift Zero
Beam Shift Reset Pr.
Read Mapping File
Change...



definition, and Eucentric point Z calibration.





Position Setup Functions

TABLE 7-10 POSITION SETUP FUNCTIONS

Item	Function
PowerZoom ACB (only before version 5.9)	Performs contrast and brightness at the end of the powerzoom operation.
PowerZoom Autofocus (only before version 5.9)	Performs autofocus at the end of the PowerZoom operation. Extends the time the procedure takes.
PowerZoom Rate (x2) (only before version 5.9)	Determines the time in seconds it takes to increase the PowerZoom magnification by a factor of 2. The larger the number, the more time you will have to find detail.
Beam Shift used in GET from magn	The maximum magnification setting used with the Get function to move the stage if Auto Beam Shift Zero is not selected; beyond that, image shift is used.
Track speed	Sets the ratio between the minimum and maximum speed. The minimum default value is 4, the maximum is 10. The ratio only influences maximum speed at a given magnification. The minimum speed is always coupled with the magnification value.
Lock Z axis	Lock/unlock function, locking stops use of axis
Lock Rotation	Lock/unlock function, locking stops use of axis
Lock Tilt	Lock/unlock function, locking stops use of axis
Define holder	Contains list box to choose holder.
Eucentric Point	Defines the eucentric position for tilt and Z safety. Depending on the tilt, Z is limited to some distance above the eucentric point. By pressing the large button the stage moves to the Eucentric point.
Z coupled to FWD	If the check box is active the FWD is updated to the Z value chosen, therefore retaining focal condition. If the check box is non-active moving Z will result in no change to the FWD value. This can be overcome by pressing Ctrl-Z.
Backlash correction **PowerZoom Autofocus** **(only before version 5.9)**	A switch to control backlash correction, On or Off. Default Off. Performs autofocus at the end of the PowerZoom operation. Extends the time the procedure takes.
PowerZoom Rate (x2) (only before version 5.9)	Determines the time in seconds it takes to increase the PowerZoom magnification by a factor of 2. The larger the number, the more time you will have to find detail.
Beam Shift used in GET from magn	The maximum magnification setting used with the Get function to move the stage if Auto Beam Shift Zero is not selected; beyond that, image shift is used.
Track speed	Sets the ratio between the minimum and maximum speed. The minimum default value is 4, the maximum is 10. The ratio only influences maximum speed at a given magnification. The minimum speed is always coupled with the magnification value.

Using Stage Alignments

Stage
Home...
Clamp
→ Align X
→ Align Y
Align Feature
Specimen Alignment
Use Spec. Alignment
Setup Z correction
Use Z correction
Eucentric Rotation
Zero Beam Shift
Auto Beam Shift Zero
Beam Shift Reset Pr.
Read Mapping File
Change...

Depending on the type of specimen and specimen holder you are using, you may need to use an alignment function to work more easily with the features you want to.

Using Align X or Align Y

Use Align X or Align Y to align rows or columns on the sample with the vertical or horizontal axes on the screen.

TABLE 7-11 USING ALIGN X OR ALIGN Y

Order	Action
1	Select Align X (or Align Y). The cursor changes to a small angle that you can reposition. (The angle shown below is larger than what you would ordinarily need.) PATH OF LINEAR FEATURE MOVES TO ALIGN WITH X OR Y AXIS CHOSEN
2	Drag the angle with the left mouse button to match the position of the feature to be aligned to.
3	When you release the mouse button, the following dialog box appears: Align to Angle Angle = 15.9 Degrees; Rotate? OK Cancel When you click on OK, the stage rotates eucentrically so the line drawn is on the screen's horizontal (or vertical) axis but the feature remains within the field of

Use Spec. Alignment
Setup Z correction
Use Z correction
Eucentric Rotation
Zero Beam Shift
Auto Beam Shift Zero
Beam Shift Reset Pr.
Read Mapping File
Change...

TABLE 7-11 USING ALIGN X OR ALIGN Y

Order	Action
1	Select Align X (or Align Y). The cursor changes to a small angle that you can reposition. (The angle shown below is larger than what you would ordinarily need.) PATH OF LINEAR FEATURE MOVES TO ALIGN WITH X OR Y AXIS CHOSEN

Stage
Home...
Clamp
Align X
Align Y
Align Feature
Specimen Alignment
Use Spec. Alignment
Setup Z correction
Use Z correction
Eucentric Rotation
Zero Beam Shift
Auto Beam Shift Zero
Beam Shift Reset Pr.
Read Mapping File
Change...

Using Align Feature

Designed specifically for wafers, Align Feature is similar to Align X and Align Y, but applies the de-skew process across the entire wafer. The larger distance involved results in greater accuracy.

TABLE 7-12 USING ALIGN FEATURE

Order	Action
1	Select the Arrow icon if it is not already active.
2	Click on ALIGN FEATURE from the Stage menu. Follow the directions in the dialog box that appears. **Align Feature** Click on one end of a long linear feature, moving the stage if necessary. Cancel
3	A second dialog box prompts you to click on the other end of the wafer. After doing so, the stage will move to that location and apply the alignment across the length of the wafer.

Using Eucentric Rotation

Stage rotation will be performed eucentrically or noneucentrically, depending on whether or not Eucentric Rotation is checked on the stage pulldown menu.

Eucentric Rotation should always be checked but it is less accurate when you are using a working distance other than 10 mm and the specimen is tilted. Also, its accuracy depends on selecting the appropriate mapping file. Choose Read Mapping File and select from the Stage Mapping dialogue box. If you have no mapping selected, none of the stage moves will be eucentric

Setup Z correction
Use Z correction
Eucentric Rotation
Zero Beam Shift
Auto Beam Shift Zero
Beam Shift Reset Pr.
Read Mapping File
Change...

1	Select the Arrow icon if it is not already active.
2	Click on ALIGN FEATURE from the Stage menu. Follow the directions in the dialog box that appears. **Align Feature** Click on one end of a long linear feature, moving the stage if necessary. Cancel
3	A second dialog box prompts you to click on the other end of the wafer. After doing so, the stage will move to

About Specimen Alignment

Stage
- Home...
- Clamp
- Align X
- Align Y
- Align Feature
- → Specimen Alignment
- Use Spec. Alignment

Specimen alignment associates stage points with user-defined points to set up a mapping between stage and user coordinate systems. After that, the computer uses these specimen coordinates rather than stage coordinates for positioning.

For example, a die of an integrated circuit has its own coordinate system. If you choose a 0,0 position, you can drive the stage relative to that position using your own coordinate system. These are expressed in User Unit (UU) coordinates, which may be microns, multiples or fractions of microns, etc.

Using 1-, 2- or 3-Point Alignments

Table 7-24 illustrates the differences between alignment types.

TABLE 7-13 ALIGNMENT TYPE DIFFERENCES

	1-Point Alignment	2-Point Alignment	3-Point Alignment
Major Use	Aligning to an new point directly offset from the existing location	Aligning the stage axes with the specimen X-Y orientation to correct for any skew	Re-scaling to nonstandard units on dies or RAM arrays; correcting for any skew
Change in Scale	None	Scales the axes together	X can be scaled differently from Y
Change in Orientation	None	Rotates both axes with a fixed 90° angle between axes	X and Y orientations can be different

Use Spec. Alignment

to that position using your own coordinate system. These are expressed in User Unit (UU) coordinates, which may be microns, multiples or fractions of microns, etc.

Using 1-, 2- or 3-Point Alignments

Table 7-24 illustrates the differences between alignment types.

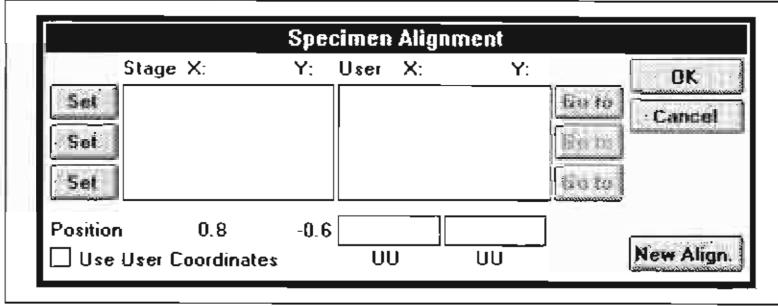
TABLE 7-13 ALIGNMENT TYPE DIFFERENCES

	1-Point Alignment	2-Point Alignment	3-Point Alignment
Major Use	Aligning to an new point directly offset from the existing	Aligning the stage axes with the specimen X-Y orientation to correct	Re-scaling to nonstandard units on dies or RAM arrays;

Using Specimen Alignment

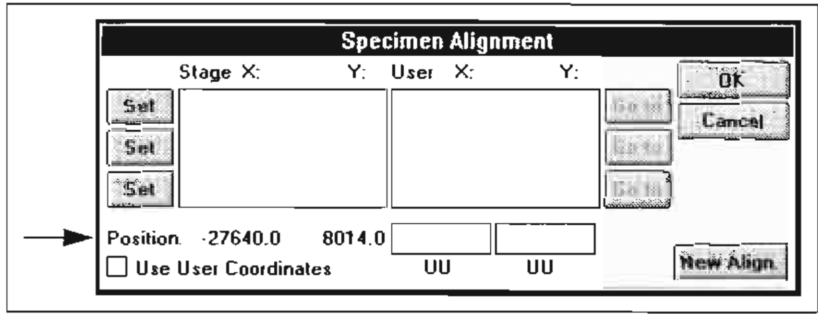
If you have a previous alignment when you select Specimen Alignment, a dialog box asks for confirmation that you want to correct alignment points for rotation.

After choosing YES, a dialog box appears.

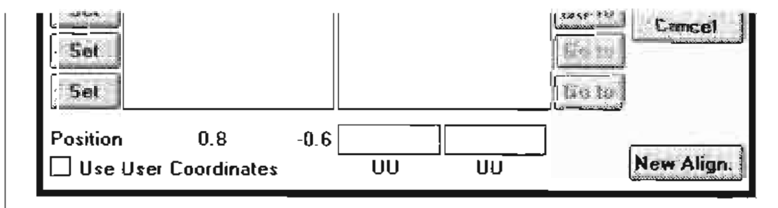


Using Get versus Arrow Tool

During the alignment, you'll be clicking on features and setting those coordinates as alignment points. If you use the Get function, you'll double-click on the feature to bring that detail to the center of the screen. The absolute stage position will be displayed in the lower left corner of the dialog box opposite the word Position.



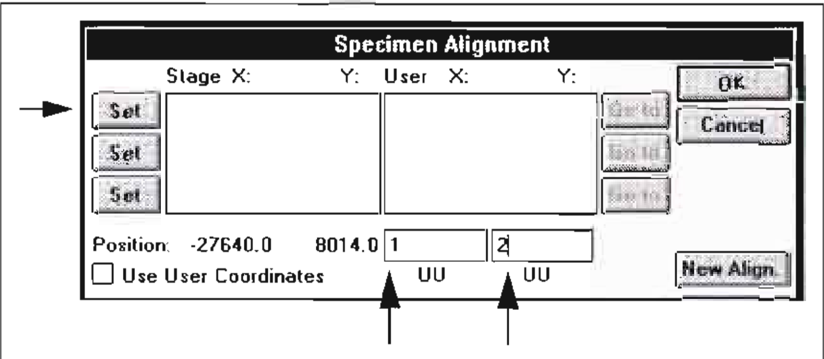
If you choose the Arrow tool, you can single-click anywhere onscreen to select the feature. The calculated stage position displays in blue. With this method, you can choose an alignment feature not at display center. Because this is a calculated value, use the Get function to move the detail fairly close to the display center before using the Arrow tool to select it as the alignment point.



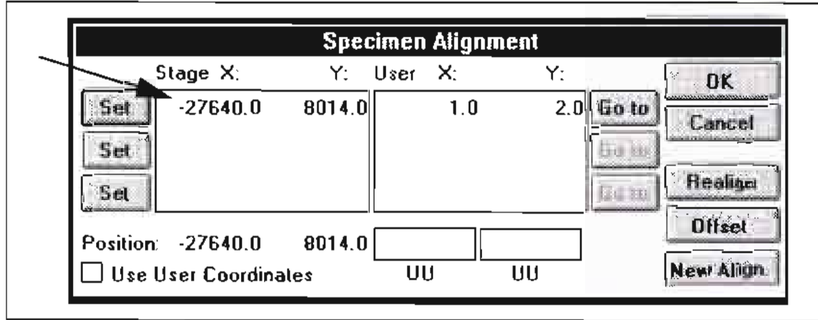
Using Get versus Arrow Tool

During the alignment, you'll be clicking on features and setting those coordinates as alignment points. If you use the Get function, you'll double-click on the feature to bring that detail to the center of the screen. The absolute stage position will be displayed in the lower left corner of the dialog box opposite the word Position.

After you have chosen the alignment feature with either method, type in your own coordinates in the UU field without pressing ENTER. You can type in any number of digits in this field.



After the user point has been typed in, click on SET. This enters the pair of coordinates into the top box as a first, second, or third alignment points.

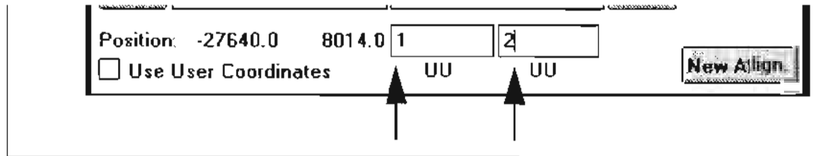


Alignment points can be entered in any order. To edit or correct a location, use the GO TO button to return to a position. Redefine the coordinates by moving the desired feature under the cross in the center of the screen with the Get function (or use the Arrow tool to click on the feature). Press SET again.

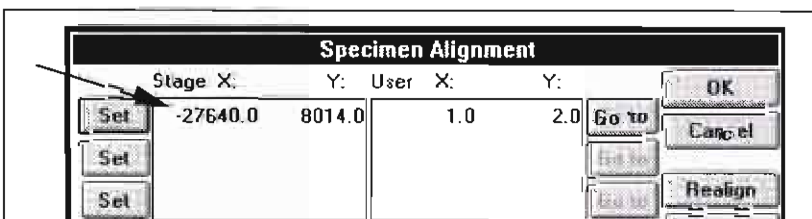
Choose points that are not in a straight line, for example, at the corners of a die or the edges of an area or wafer. You can align up to three points but you will have the greatest accuracy with three.

When all points have been defined to your satisfaction, press OK to store them into memory. The stage position edit boxes now display user coordinates instead of coordinates.

At any time during the alignment (until OK is selected), pressing CANCEL will stop the procedure. Choose NEW ALIGN. to clear the existing alignment completely and begin again.

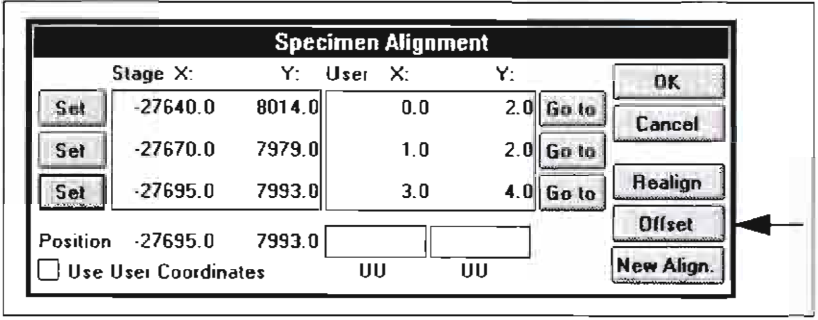


After the user point has been typed in, click on SET. This enters the pair of coordinates into the top box as a first, second, or third alignment points.



Using Offset Alignment

Offset is a shortcut that allows you to move to new points relative to the existing alignment but at a new location, for example, stepping between identical points on different dies quickly.



explains how to use this function

TABLE 7-14 USING OFFSET ALIGNMENT

Order	Action
1	Click on the OFFSET button. The existing alignment points display in blue type.
2	Click on the GO TO button next to the first alignment point. Edit the User Units if you want to change them.
3	Move the stage to the target die and click on the corresponding feature. (Or use Get to move the feature under the crosshair.
4	Click on the first SET button. The type will change to black and the other two points will change to the same position relative to the new first alignment point.
5	Click on the GO TO button next to the revised second alignment point. The stage will drive to the vicinity of the corresponding alignment point on the second target die.
6	Click on the feature with either Get or the Arrow tool.
7	Click on the second SET button.

Set -27695.0 7993.0 3.0 4.0 Go to Realign
Offset
Position -27695.0 7993.0
Use User Coordinates UU UU New Align.

explains how to use this function

TABLE 7-14 USING OFFSET ALIGNMENT

Order	Action
1	Click on the OFFSET button. The existing alignment points display in blue type.

In/Out Menu

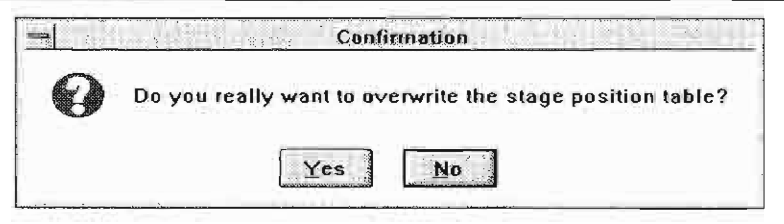
In/Out Stage
Image...
Parameters...
Photo!
Databar...
Grayscale...
Videoprint!
Printer
Configuration...
Stage Table Load...
Save...
Change Photo...

Stage Table

Use this function to retrieve or store stage files from the list of stored stage position that include settings for stage alignment.

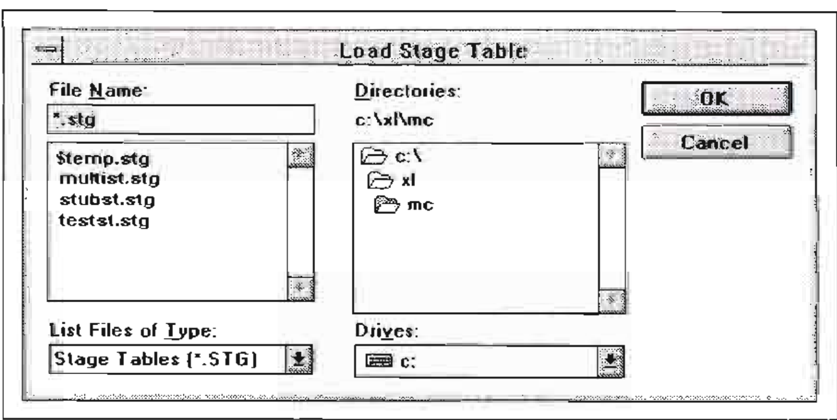
Load

Choose Load from the Stage Table submenu to open a stage position file. If you have a prestored stage position table, a Confirmation dialogue box appears:



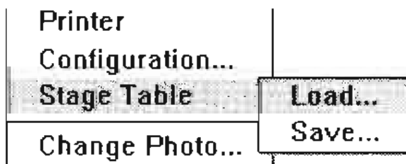
Also, if you have an existing Specimen Alignment defined, a dialogue box will say "The stage table file includes Specimen Alignment information. Do you want to overwrite?

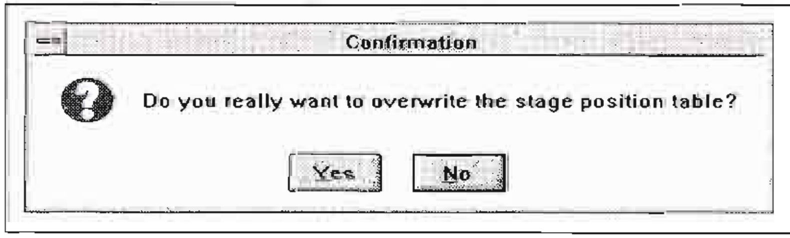
If you click on YES the Load Stage Table dialogue box appears:



Select a stage file and click OK.

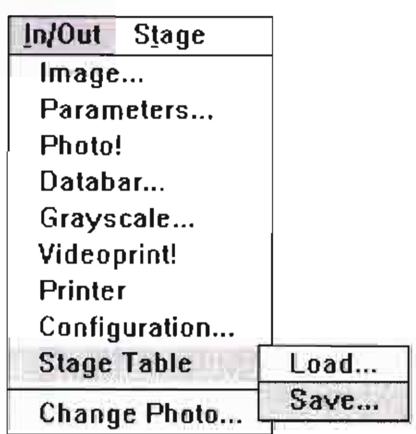
dialogue box appears:





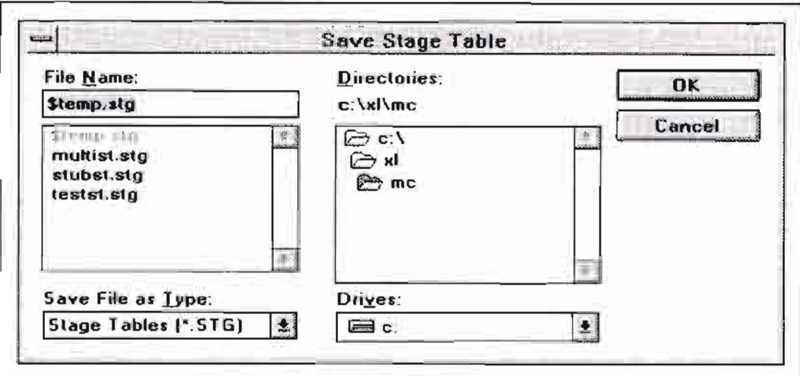
Also, if you have an existing Specimen Alignment defined, a dialogue box will say "The stage table file includes Specimen Alignment information. Do you want to overwrite?

If you click on YES the Load Stage Table dialogue box appears:



Save

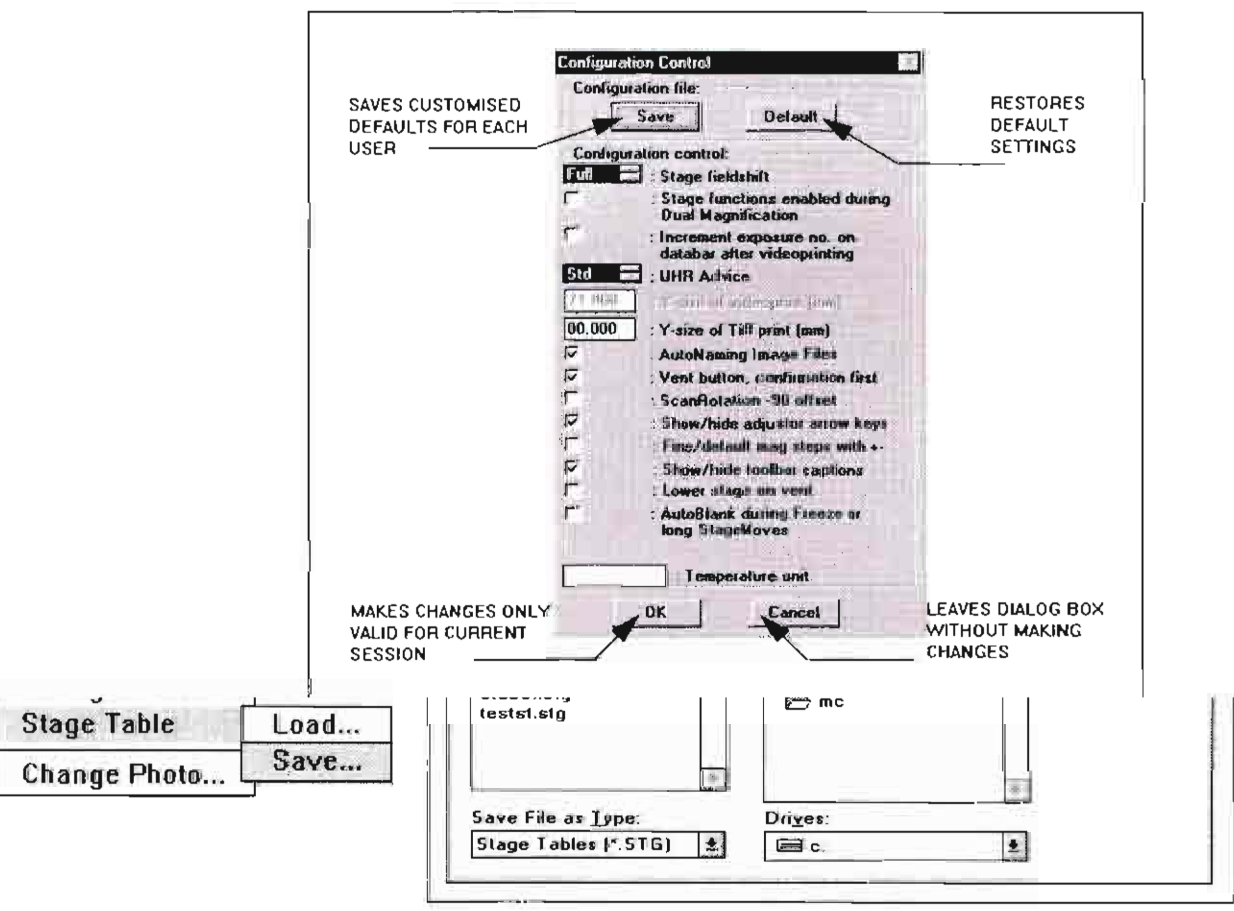
If you choose Save from the Stage Table submenu, a similar dialogue box appears.



The saved stage file will include all preset stage locations at the time you saved.

Configuration

This dialog box contains default settings for some aspects of the user interface that can be customized. Changes are saved for each user.



Stage Table
Load...
Save...
Change Photo...
testst.stg
mc
Save File as Type:
Stage Tables (*.STG)
Drives:
c:

The saved stage file will include all preset stage locations at the time you saved.

Configuration

This dialog box contains default settings for some aspects of the user interface that can be customized. Changes are saved for each user.

TABLE 7-15 CONFIGURATION CONTROL

Control Option	How it Works
Stage fieldshift	Arrow keys move the stage by a full or half screen width. **Full** = arrow key moves full screen; Shift arrow moves half screen. **Half** = arrow key moves half screen: Shift arrow moves full screen. **None** = no stage fieldshift
Stage functions enabled during Dual Magnification	**Unchecked** = disabled **Checked** = enabled, use the arrow keys for stage field shift.
Increment exposure no. on data bar after videoprinting	**Unchecked** = disabled **Checked** = automatically increments
UHR Advice (SFEG only)	Full / Std / Off: Different levels of guidance for the UHR Mode
Y size of videoprint (mm)	Display only, specific to installed device
Y size of Tiff print (mm)	Changeable Y size depending on printer in use
AutoNaming Image Files	**Unchecked** = disabled **Checked** = Consecutive naming (numbering) of Image files. Used with the Printing function.
Vent button, confirmation first	**Unchecked** = disabled **Checked** = enabled
Scan Rotation -90 offset	Makes scan vertical to the tilt axis instead of parallel to it. For use with stereo pairs, color option. **Unchecked** = disabled **Checked** = enabled
Show/hide adjuster arrow keys	Adds arrow keys to the ends of the adjusters for incremental changes. Change takes affect after choosing a different control area. **Unchecked** = disabled (Hides) **Checked** = enabled (Shows)
Fine/default mag steps with +-	Modifies the step sizes when using the + - keys on the keyboard for changing magnification. **Unchecked** = disabled (Default Presets) Increases magnification by default factor of 2X. **Checked** = enabled (Adds Fine Steps) Increases magnification according to the pulldown menu presets, but adds extra steps between.
Show/hide tool bar captions	Shows/hides captions on tool bar icons. **Unchecked** = disabled (Hides)**Checked** = enabled (Shows)
Stage functions enabled during Dual Magnification	**Unchecked** = disabled **Checked** = enabled, use the arrow keys for stage field shift.
Increment exposure no. on data bar after videoprinting	**Unchecked** = disabled **Checked** = automatically increments
UHR Advice (SFEG only)	Full / Std / Off: Different levels of guidance for the UHR Mode
Y size of videoprint (mm)	Display only, specific to installed device
Y size of Tiff print (mm)	Changeable Y size depending on printer in use
AutoNaming Image Files	**Unchecked** = disabled **Checked** = Consecutive naming (numbering) of Image files. Used with the Printing function.

Operational Maintenance 8-1
Overview 8-1

8.1 Aperture maintenance FEG 8-2
XL FEG Single Apertures 8-2
8.1.1 Removing the Aperture rod . . 8-2
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8.1.3 Cleaning the Aperture rod . . . 8-3
8.1.4 Cleaning the apertures 8-3
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8.2 Aperture maintenance SFEG 8-5
XL SFEG Strip Aperture Module1 8-5
8.2.1 Removing the Aperture rod . . 8-5
8.2.2 Replacing the Aperture Module 8-6
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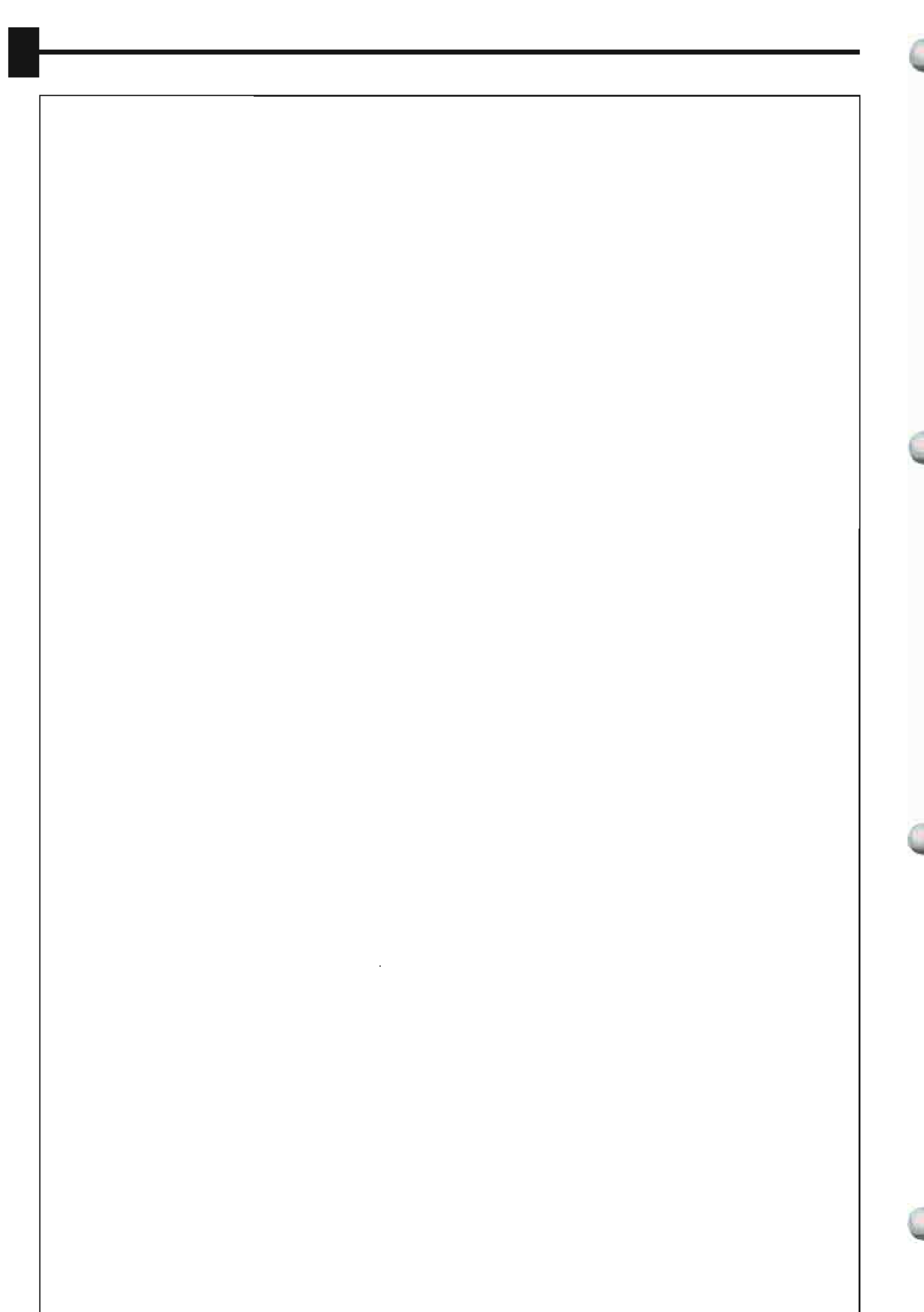


8 MAINTENANCE

Operational Maintenance

Overview

This section describes the maintenance necessary for the microscope that can be carried out by the user. For the FEG and the SFEG User maintenance is at a minimum due to Gun and Column design and the long uptime expected from this class of instrumentation. Therefore the more complicated maintenance is normally contained in a service contract to be performed by a qualified XL FEG service engineer.

At the user level items such as the following can be maintained:

- Aperture maintenance
- Stage maintenance
- Rotary Pump maintenance

Caution! Parts that operate in vacuum should be handled carefully using clean gloves. Parts not in use should be stored in suitable containers or packed in aluminium foil.

Note: Gas back fill (N_2) should be maintained while the specimen chamber is at ambient pressure. However, to avoid gas wastage it is recommended that the chamber should be left open no longer than necessary.

Overview

This section describes the maintenance necessary for the microscope that can be carried out by the user. For the FEG and the SFEG User maintenance is at a minimum due to Gun and Column design and the long uptime expected from this class of instrumentation. Therefore the more complicated maintenance is normally contained in a service contract to be performed by a qualified XL FEG service engineer.

At the user level items such as the following can be maintained:

- Aperture maintenance
- Stage maintenance
- Rotary Pump maintenance

8.1 Aperture maintenance FEG

XL FEG Single Apertures

The design of the original FEG aperture rod was with 4 positions for individual 3 mm round apertures. This meant that the apertures could be placed in any position, or be all the same, or a cascade of sizes to suite many applications. Usually one position (1st) was reserved for a Gold foil aperture for low voltage work where as the remainder were of Platinum for more general uses. The rod itself had no cable or heater installed.

FIGURE 8-1 FEG APERTURE HOLDER

8.1.1 Removing the Aperture rod

With the high voltage off, let the specimen chamber up to atmospheric pressure. The Aperture rod is held at the same vacuum as the specimen chamber so no special vacuum need be broken to remove it.

Unscrew the end of the Aperture rod and carefully remove it from the microscope. Preparation to clean or replace apertures should be immediately available as the specimen chamber has to stay at atmosphere for the duration of maintenance.

8.1.2 Removing the apertures

heater installed.

FIGURE 8-1 FEG APERTURE HOLDER

8.1.3 Cleaning the Aperture rod

The end of the rod around where the apertures sit becomes contaminated. If this is not removed before replacing the new or cleaned apertures contamination will migrate over a short time to the clean apertures and may cause excessive astigmatism.

The flat part of the rod for cleaning can be seen in Figure 8.1 with the exclusion of the spring and plunger.

Carefully remove the small 'o' ring further down the rod. This is to prevent it becoming exposed to solvents.

1. Clean with a mild abrasive domestic cleaner (see list of preferred cleaners at the end of this chapter) using cotton wool wrapped on a wooden spill.

2. Rinse in tap water.

3. Clean in an ultrasonic cleaner for 5 minutes using a neutral cleaning fluid (like **EXTRAN** MA02*, 5% solution in water).

4. Rinse in distilled water for 5 minutes.

5. Clean in an ultrasonic cleaner for 5 minutes using alcohol p/a.

6. Rinse in alcohol p/a.

7. Dry thoroughly under an infrared lamp (15 min. to 1 hr.) at a temperature of between 80°C and 100°C.

8.1.4 Cleaning the apertures

The Gold foil aperture cannot be cleaned by abrasive or flaming methods, therefore it is usually replaced if very dirty as in Figure 8.1.The lifetime of the Gold foil can be approximately 1 year if used only for low voltage as it self-cleans under the beam to some extent.

The Platinum apertures can be cleaned by holding each one individually in Platinum ended tweezers and placing them into a clean butane gas flame until the contamination is seen to disappear at red heat.They should be allowed to cool while in the tweezers, then be removed by other clean stainless steel tweezers and replaced into the clean Aperture rod holder the correct way up, flat side up one by one (Figure 8.2). The apertures when clean should not come into contact with anything other than the tweezers and Aperture rod holder.

FIGURE 8-2 APERTURE CROSS-SECTION

prevent it becoming exposed to solvents.

1. Clean with a mild abrasive domestic cleaner (see list of preferred cleaners at the end of this chapter) using cotton wool wrapped on a wooden spill.

2. Rinse in tap water.

3. Clean in an ultrasonic cleaner for 5 minutes using a neutral cleaning fluid (like **EXTRAN** MA02*, 5% solution in water).

4. Rinse in distilled water for 5 minutes.

5. Clean in an ultrasonic cleaner for 5 minutes using alcohol p/a.

6. Rinse in alcohol p/a.

7. Dry thoroughly under an infrared lamp (15 min. to 1 hr.) at a temperature of between 80°C and 100°C.

8.1.5 Replacing the Aperture rod

Replace the 'o' ring back onto the rod, check that there is no fibres or such on the 'o'ring. Do not apply grease to the 'o' ring as it is not necessary and can only add to contamination possibilities.

Replace the Aperture rod holder back into the Aperture Adjuster assembly on the column and turn the end screw mechanism until the holder is hand tight.

Pump the microscope specimen chamber

Set the aperture on any other than the Gold foil, preferably a 30 micron Platinum so that a high kV can be used for alignment.

Set the aperture on any other than the Gold foil, preferably a 30 micron Platinum so that a high kV can be used for alignment.

8.2 Aperture maintenance SFEG

XL SFEG Strip Aperture Module1

The design of the original SFEG apertures was as thin metal foils with 5 positions, one of the positions being a 2 mm alignment hole. The foil came prealigned in a metal module which was connected to the end of the Aperture rod by a Titanium screw, and would normally be replaced if heavily contaminated. Again, similar to the Gold foil of the FEG these aperture strips were to some extent self-cleaning. They also had a heater in the rod to assist the cleaning mechanism. All screws were of Titanium as to have no magnetic effect.The introduction of this strip aperture coincided with the introduction of the 7 position Aperture adjuster assembly for SFEG.

FIGURE 8-3 SFEG APERTURE MODULE 1

8.2.1 Removing the Aperture rod

With the high voltage off, let the specimen chamber up to atmospheric pressure. The Aperture rod is held at the same vacuum as the specimen chamber so no special vacuum need be broken to remove it.

Remove the heater cable from the outer end of the rod.

Unscrew the end of the Aperture rod and carefully remove it from the microscope. Preparation to replace apertures should be immediately available as the specimen chamber has to stay at atmospheric pressure for the duration of maintenance.

also had a heater in the rod to assist the cleaning mechanism. All screws were of Titanium as to have no magnetic effect.The introduction of this strip aperture coincided with the introduction of the 7 position Aperture adjuster assembly for SFEG.

FIGURE 8-3 SFEG APERTURE MODULE 1

8.2.2 Replacing the Aperture Module

The new Aperture Module comes in a fluoroware container, has been pre-cleaned. and is ready to be fitted to the rod.

Firstly, release the Titanium screw holding the old module onto the rod. Keep the screw in the hole of the rod and let the module fall away.

Open the new module pack and let the new module sit with the connection end uppermost to the edge of the container base.

Now pick up the new module with the Titanium screw end and fasten. making sure of a good fit.

8.2.3 Replacing the Aperture rod

Check that there are no fibres on the rod 'o' ring. Do not grease the 'o' ring.

Replace the Aperture rod back into the Aperture Adjuster assembly on the column and turn the end screw mechanism until the holder is hand tight.

Pump the microscope specimen chamber

Reconnect the heater cable to the outer end of the rod.

Set the aperture at a 30 micron hole so that alignment can be performed.

Now pick up the new module with the Titanium screw end and fasten. making sure of a good fit.

8.2.3 Replacing the Aperture rod

Check that there are no fibres on the rod 'o' ring. Do not grease the 'o' ring.

Replace the Aperture rod back into the Aperture Adjuster assembly on the column and turn the end screw mechanism until the holder is hand tight.

Pump the microscope specimen chamber

Reconnect the heater cable to the outer end of the rod.

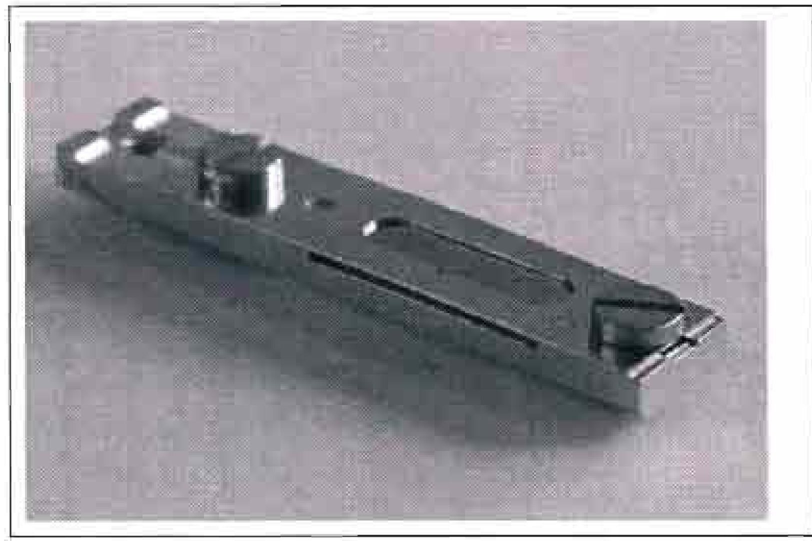
8.3 Aperture maintenance SFEG

XL SFEG Strip Aperture Module2

This is a improved design of the original SFEG aperture using more axial stable materials with a Molybdenum finish. The strip has 5 aperture positions now with a 1 mm alignment hole in the frame and not the aperture. The strip comes prealigned in a metal module which is connected to the end of the Aperture rod by a Titanium screw. The module is considered a consumable and therefore would be normally replaced when heavily contaminated. If a Fischione plasma cleaner is available these aperture modules can be cleaned while still connected to the rod. Lifetime of these strips can be up to +4 times longer than the previous module 1 design, which has stopped.There is also a heater in the rod to assist the cleaning mechanism for high water vapour or expected high contamination levels. otherwise the heater is not necessary for this type of strip aperture. All screws are of Titanium as to have no magnetic effect.

This type of Mo/Si strip aperture can directly replace the metal strip aperture module 1 which it supersedes.

FIGURE 8-4 SFEG APERTURE MODULE 2



8.3.1 Removing the Aperture rod

With the high voltage off, let the specimen chamber up to atmospheric pressure. The Aperture rod is held at the same vacuum as the specimen chamber so no special vacuum need be broken to remove it.
replaced when heavily contaminated. If a Fischione plasma cleaner is available these aperture modules can be cleaned while still connected to the rod. Lifetime of these strips can be up to +4 times longer than the previous module 1 design, which has stopped.There is also a heater in the rod to assist the cleaning mechanism for high water vapour or expected high contamination levels. otherwise the heater is not necessary for this type of strip aperture. All screws are of Titanium as to have no magnetic effect.

This type of Mo/Si strip aperture can directly replace the metal strip aperture module 1 which it supersedes.

FIGURE 8-4 SFEG APERTURE MODULE 2

8.3.2 Cleaning the Aperture Module

This is only possible if a Fischione Plasma cleaner is available. Take the complete rod with module attached and place in the TEM opening on the plasma cleaner. The screw at the end of the Aperture rod screws into the TEM opening and seals against the rod 'o' ring.

Give the rod 5 minutes at 4.5 volts plasma generation. This should remove all hydrocarbon base contamination. If the contamination is stubborn longer times will be necessary, this should not damage the aperture as the plasma only removes organic bases.

8.3.3 Replacing the Aperture Module

The new Aperture Module comes in a fluoroware container, has been pre-cleaned, and is ready to be fitted to the rod.

Firstly, release the Titanium screw holding the old module onto the rod. Keep the screw in the hole of the rod and let the module fall away.

Open the new module pack and let the new module sit with the connection end uppermost to the edge of the container base.

Now pick up the new module with the Titanium screw end and fasten, making sure of a good fit.

8.3.4 Replacing the Aperture rod

Check that there are no fibres on the rod 'o' ring. Do not grease the 'o' ring.

Replace the Aperture rod back into the Aperture Adjuster assembly on the column and turn the end screw mechanism until the holder is hand tight.

Pump the microscope specimen chamber

Reconnect the heater cable to the outer end of the rod if necessary.

Set the aperture at a 30 micron hole so that alignment can be performed.

8.3.5 Aperture availability

These apertures are the present used and come in two size types.

FP 6174/33 Mo Strip Aperture (30,30,40,50,100 micron) This type

aperture as the plasma only removes organic bases.

8.3.3 Replacing the Aperture Module

The new Aperture Module comes in a fluoroware container, has been pre-cleaned, and is ready to be fitted to the rod.

Firstly, release the Titanium screw holding the old module onto the rod. Keep the screw in the hole of the rod and let the module fall away.

Open the new module pack and let the new module sit with the connection end uppermost to the edge of the container base.

Now pick up the new module with the Titanium screw end and fasten, making sure of a good fit.

8.4 Stage maintenance

Specimen Holders

Recommended cleaning procedures are given below for parts which operate in vacuum and that are subject to possible contamination. Frequency of cleaning is, in most cases, determined by necessity (image quality or astigmatism level).

8.4.1 Cleaning specimen holders

1. Clean these parts using cotton wool and a mild abrasive domestic cleaner (see list of preferred cleaners at the end of this chapter).

2. Rinse in tap water.

3. Clean in an ultrasonic cleaner for 5 minutes using a neutral cleaning fluid (like **EXTRAN** MA02*, 5% solution in water).

4. Rinse in distilled water for 5 minutes.

5. Clean in an ultrasonic cleaner for 5 minutes using alcohol p/a.

6. Rinse in alcohol p/a.

7. Dry thoroughly under an infra-red lamp (15 min. to 1 hr.) at a temperature of hetween 80°C and 100°C.

Stage mechanics

Checking the condition of the stage should be a weekly exercise as many differing samples may be exchanged in this time period. Some samples may be powders or composite materials that inadvertently drop particles on or in the stage. If a Silicon wafer breaks in the chamber it can shatter into hundreds of pieces. In this case the stage should be thoroughly cleaned before attempting movement again

8.4.2 Cleaning Stage parts

Abrasives and solvents must not be used on the stage moving parts. Cleaning should be made by using dry nitrogen gas bursts around the stage mechanics to blow out any foreign materials. Make sure the final lens and detectors are protected from the turbulence. Do not use sharp metal objects to scrape away debris. A fine pair of plastic tweezers can be used to pick up difficult particles. Spillages on the stage should be wiped up using a lint-free cloth, followed by blowing with N_2

8.4.1 Cleaning specimen holders

1. Clean these parts using cotton wool and a mild abrasive domestic cleaner (see list of preferred cleaners at the end of this chapter).

2. Rinse in tap water.

3. Clean in an ultrasonic cleaner for 5 minutes using a neutral cleaning fluid (like **EXTRAN** MA02*, 5% solution in water).

4. Rinse in distilled water for 5 minutes.

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6. Rinse in alcohol p/a.

7. Dry thoroughly under an infra-red lamp (15 min. to 1 hr.) at a temperature of hetween 80°C and 100°C.

8.5 Rotary pump maintenance

Oil level check

The Rotary pump supplied with the FEG or SFEG has a dual roll by giving primary pumping to parts of the system such as the specimen chamber, when changing sample, and a secondary roll for backing the main pumping system, either Oil Diffusion (ODP) or Turbo Mechanical (TMP). Because of the frequency the pump has to process large volumes of air loss of oil level over time is inevitable. Therefore a check on the oil level at frequent periods is advised.

8.5.1 Periodic check

This should be planned no less than every month, although every 3 months is more realistic.

The Rotary pump becomes very hot while in use. be careful not to touch the main frame of the pump.

Rotary pumps can be switched off for short periods of time, although necessary when changing the total oil reserve (Service function) it is not absolutely necessary when only topping up the oil level. The switch for ON/OFF can be found on the side of the pump.

The level indicator window is usually found on the front end of the Rotary pump, and shows minimum and maximum level markers.

8.5.2 Topping-Up

The filling position is a plastic hand screw stopper on the top of the same end as the level indicator.

- Switch off the pump if felt necessary.
- Unscrew the stopper.
- Clean around the stopper hole with a lint-free cloth.
- Fill with the recommended oil to the upper level.
- Clean up any spillage on the pump.
- Replace the stopper.
- Switch on the pump.

Never fill the pump through the exhaust hole by removing the exhaust pipe, as this will result in the oil being removed from the pump by pressure build-up. Excessive back pressure in the exhaust pipe will eventually over-heat the pump, so it is important to allow good

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8.6 List of Applied Cleaners

- De-ionised or distilled water
- Ethanol - C_2H_5OH
- Ethanol p/a (Pro Analysis: 99.8% pure) - C_2H_5OH
- EXTRAN - MA02 (neutral cleaning fluid)
- CIF* or SOFT SCRUB (household fine abrasive cleaner)

*** CIF is found in the following countries**

Country	Name
Austria	*
Australia	*
Finland	*
France	*
Germany	*
Italy	*
Japan	*
Netherlands	*
Switzerland	*
UK	*
USA	SOFT SCRUB

> **WARNING!** **As cleaning solvent Ethanol is highly flammable, do not use open flames and do not smoke while cleaning. Ventilate the room properly.**

*** CIF is found in the following countries**

Country	Name
Austria	*
Australia	*
Finland	*
France	*
Germany	*
Italy	*
Japan	*
Netherlands	*
Switzerland	*

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9 SYSTEM OPTIONS

XL FEG Hard and Software Options

Overview

This chapter covers hardware and software that is integrated, as an option, into the XL FEG system control and operated from the microscope monitor.

The items covered here are:

- AccountLog package (Multi-User Shell) option
- STEM Detector option
- Metrology package option
- EBSP Detector option
- Manual User Interface (MUI) option
- CCD Camera option
- Histograph Analysis option
- Electrostatic Beam Blanker

Overview

This chapter covers hardware and software that is integrated, as an option, into the XL FEG system control and operated from the microscope monitor.

The items covered here are:

- AccountLog package (Multi-User Shell) option
- STEM Detector option
- Metrology package option
- EBSP Detector option
- Manual User Interface (MUI) option
- CCD Camera option

AccountLog (Multi-User Shell)

Introduction

The AccountLog software shell lets you monitor use of the system by keeping a log of up to 50 individual users, including Supervisor. You can set up levels of security to limit the kind of system access for each user and assign individual passwords.

The software recognizes a list of users. The user called Supervisor has special system access and can define the user list and give each user access to system functions. The supervisor can exclude users from certain functions and print out lists of activity of all system users.

After the supervisor defines users, the software prompts users for a password each time the software is activated. If the name and password combination is defined in the system, the user obtains access to the software. If the user has limited access to some functions, the corresponding menu items are greyed and are inactive.

Starting Up as Supervisor

When the AccountLog software is installed, only the user called Supervisor is identified in the system. The person designated as Supervisor must log in for the first time.

When you click on the Microscope Control software icon, a dialogue box is displayed.

Microscope control

Please enter your identification

Username :

Password :

Ok Cancel

Type in your user name, then your password (which shows onscreen as asterisks for security) and click on OK.

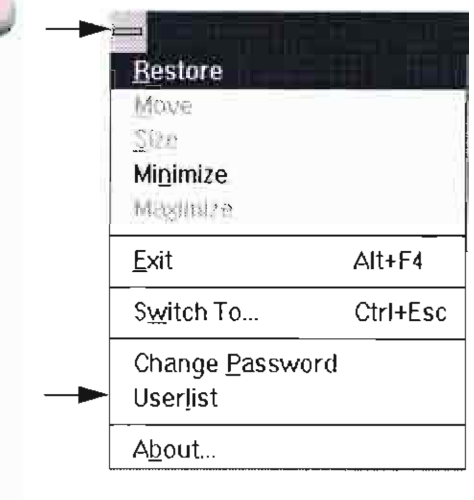
access to system functions. The supervisor can exclude users from certain functions and print out lists of activity of all system users.

After the supervisor defines users, the software prompts users for a password each time the software is activated. If the name and password combination is defined in the system, the user obtains access to the software. If the user has limited access to some functions, the corresponding menu items are greyed and are inactive.

Starting Up as Supervisor

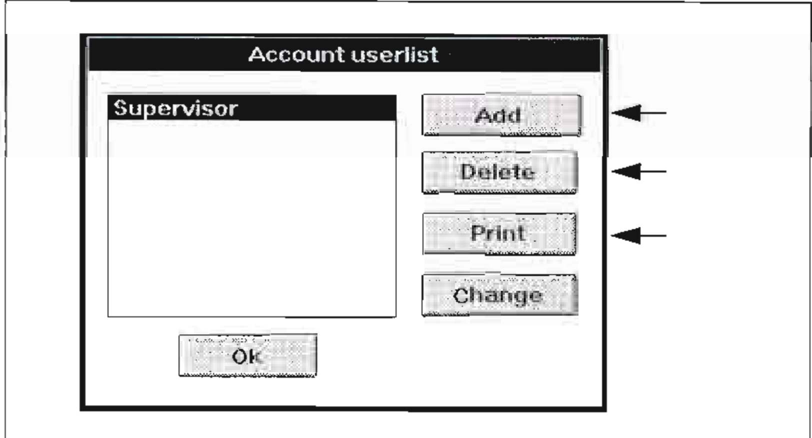
When the AccountLog software is installed, only the user called Supervisor is identified in the system. The person designated as Supervisor must log in for the first time.

When you click on the Microscope Control software icon, a dialogue box is displayed.



Defining Users

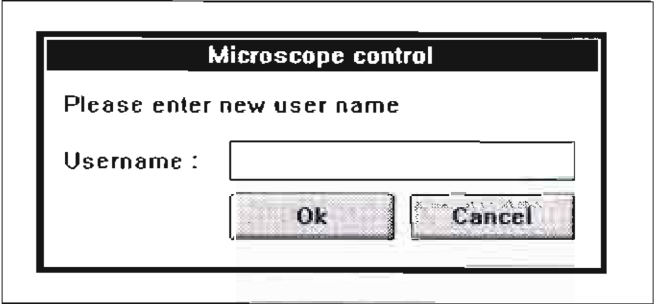
Select the menu item Userlist from the System pulldown menu. A dialogue box displays one user: Supervisor.



The dialogue offers the following possibilities:

Add

When you click on ADD a dialogue is displayed allowing you to define a new user to the system.



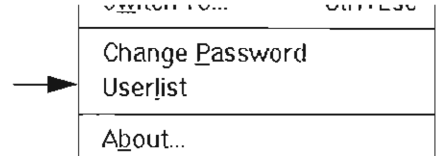
Up to 50 users can be assigned passwords.

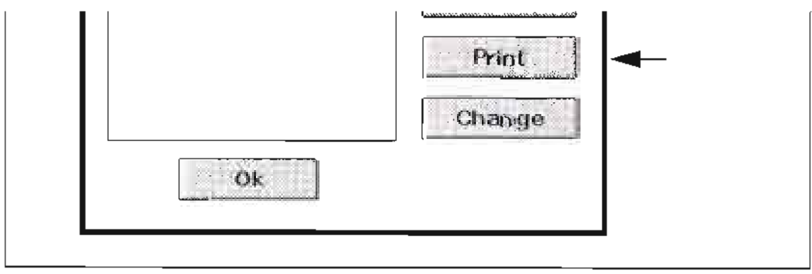
Delete

This function deletes the highlighted user name, which results in removal from the list of users. The AccountLog records of this user will be redefined as "unknown user." Be sure to save and archive the *AccountLog.txt* file before deleting the name.

Print

Use this function to print the user list (not yet implemented).





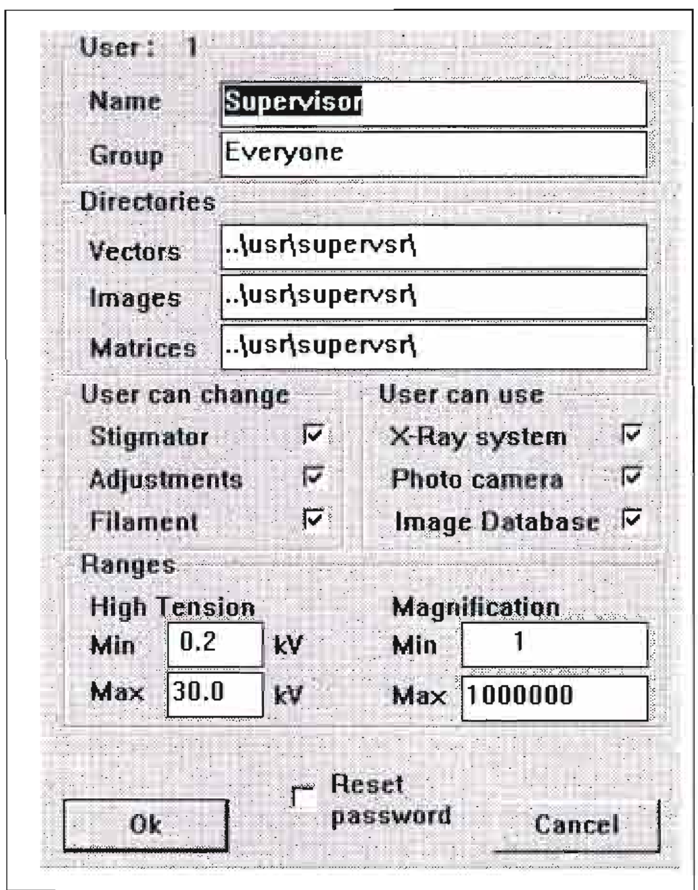
The dialogue offers the following possibilities:

Add

When you click on ADD a dialogue is displayed allowing you to define a new user to the system.

Change

Click on CHANGE to restrict user access to the instrument. The following dialogue box displays:



The following fields allow you to give specific access privileges for several system functions.

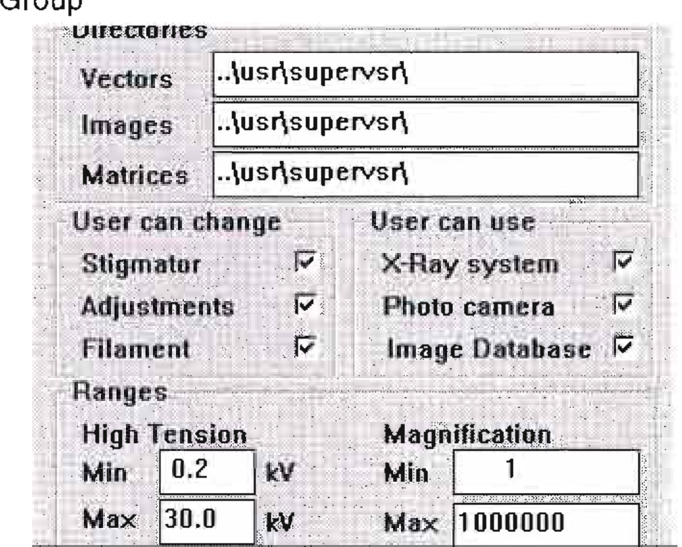
User

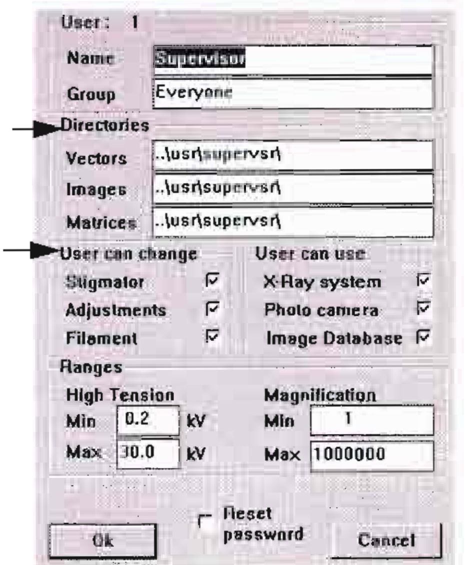
A user defined by the supervisor can always access system software by typing his name and password. If the supervisor has limited a user's access to various functions, certain controls or numbers are grey, indicating that they cannot be selected and/or activated.

Name

Edit the name of the user.

Group





Directories

The system is configured so that all software is in a subdirectory called *\x*. The system software (server, stage) is in a subdirectory called *\x\mc* and all user files in a subdirectory called *\x\usr*. In the AccountLog option every user gets his own subdirectory in the *\x\usr* directory. However, you can change these default directories by typing a different DOS directory path.

Vectors

Vector files refer to Parameters in the In/Out pull down menu with the extension **.vct*.

Images

Image files refer to Image in the In/Out pull down menu with extension **.img*.

Matrices

Matrix files refer only if the option for customized convolution is installed offering the ability to store convolution matrices with extension **.mtx*.

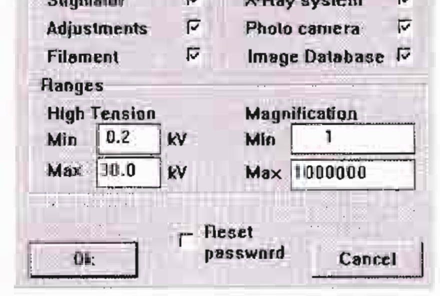
When a new user wants to store any of the three above-mentioned types of file for the first time, the system asks the user for confirmation for the creation of his own subdirectory.

User Can Change

Using these fields, the supervisor can define user access to the following functions:

- Stigmator
- Alignments
- Filament limit

The user does not have access to unchecked functions. Those items on the control areas and menus are greyed out and inaccessible to that user. If Alignments is unchecked, the Adjustments control area and its icon will be missing.



Vector files refer to Parameters in the In/Out pull down menu with the extension **.vct*.

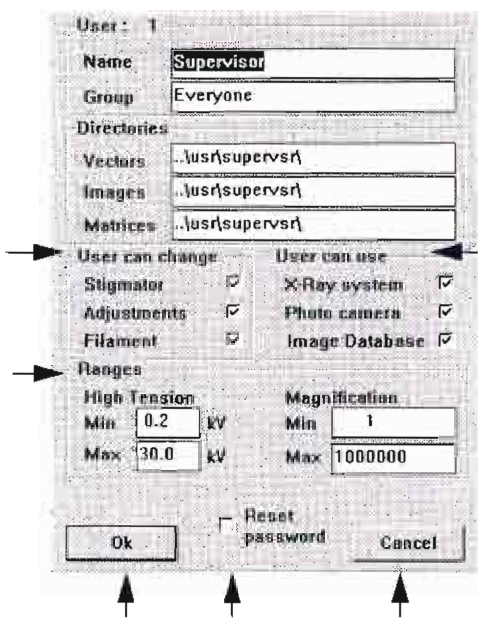
Images

Image files refer to Image in the In/Out pull down menu with extension **.img*.

Matrices

Matrix files refer only if the option for customized convolution is installed offering the ability to store convolution matrices with extension **.mtx*.

When a new user wants to store any of the three above-mentioned types of file for the first time, the system asks the user for confirmation for the creation of his own subdirectory.



User Can Use

In this section the supervisor can decide which of the following functions the user can access:

- X-Ray system (dot maps)
- Photo camera
- Image database (if option installed)

The user does not have access to unchecked functions. Those items on the control areas and menus are greyed out and inaccessible to that user.

Ranges

In these fields, the supervisor can set minimum and maximum ranges for high tension and magnification.

Reset Password

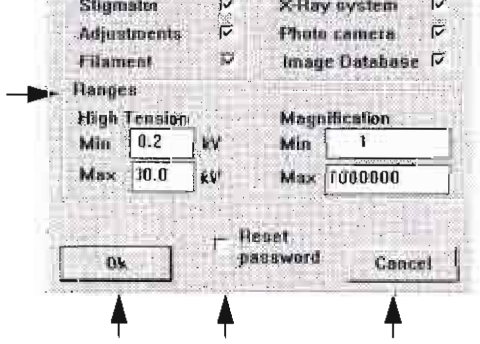
The supervisor resets the password of the user by checking the Reset Password checkbox and clicking on OK. The next time the user logs in, he or she must define a new password. This function is useful in case the user has forgotten his password.

OK

When you click on OK user privileges are stored and the new user name is added to the list of those with access to the system software.

Cancel

Click on CANCEL to stop the editing process.



the control areas and menus are greyed out and inaccessible to that user.

Ranges

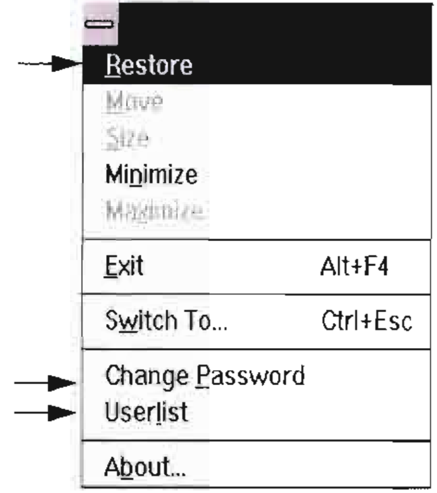
In these fields, the supervisor can set minimum and maximum ranges for high tension and magnification.

Reset Password

The supervisor resets the password of the user by checking the Reset Password checkbox and clicking on OK. The next time the user logs in, he or she must define a new password. This function is useful in case the user has forgotten his password.

OK

When you click on OK user privileges are stored and the new user



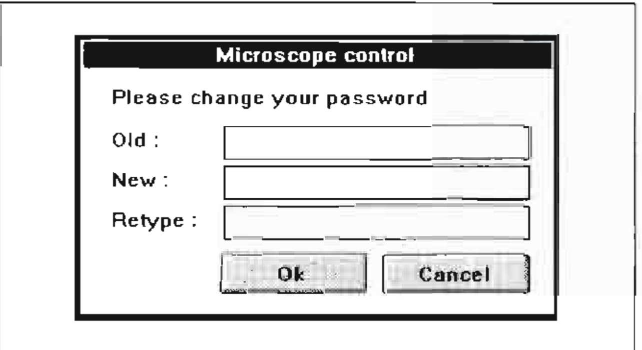
Information for the Authorized User

The user can get information on his or her access privileges by selecting Userlist from the Control menu. When any user other than Supervisor accesses Userlist, it results in a menu that offers only the button INFO. Info is only available for the user's account. When you click on this button, the screen displays a summary of functions and high tension and magnification ranges that you do not have access to.

Changing Password

If you need to change your password, click on the System menu box in the upper left corner of the screen. Select Change Password from the pulldown menu that displays.

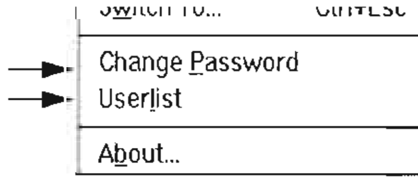
The screen displays another dialogue box:



Follow these steps:

TABLE 1 CHANGING USER PASSWORDS

Step	Action
1	Type the old password for verification.
2	Type the new password, and then retype it as a check on typing errors.
3	Click on OK to confirm the definition.
4	Press CANCEL to stop the process and keep the old password.



If you need to change your password, click on the System menu box in the upper left corner of the screen. Select Change Password from the pulldown menu that displays.

The screen displays another dialogue box:

Microscope control
Please change your password
Old :
New :
Retype :
Ok
Cancel

System Reset

In the rare case of universal amnesia (all users including the supervisor have forgotten their passwords), the software cannot be accessed. The user names and passwords are stored in the file *accntusr.bin* (in the *c:\xl\mc* directory). **Keep a backup of this file on floppy disk.**

The problem of forgotten passwords can be solved only by re-installing the complete system software from the diskettes delivered with the system or with the latest software version. This results in a clean system on which only the supervisor is defined and he or she can add the user names again.

Logging Menu

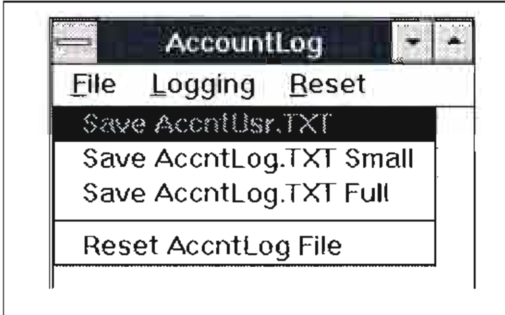
When you double-click on the AccountLog icon, the Account Log menu displays. If any one else but the supervisor does so, all functions are greyed.

The Supervisor has the following options:

- File
- Logging
- Reset

File Menu

When you click on File, a pulldown menu displays offering choices for saving and resetting files:



Save AccntUsr.txt

(Feature not yet implemented.)

Save AccntLog.txt small (saves in C:\xl\mc)

This produces a text file containing on each line the following data: logging number, day, date, time, user number, user name, action

with the system or with the latest software version. This results in a clean system on which only the supervisor is defined and he or she can add the user names again.

Logging Menu

When you double-click on the AccountLog icon, the Account Log menu displays. If any one else but the supervisor does so, all functions are greyed.

The Supervisor has the following options:

- File
- Logging
- Reset

File Menu

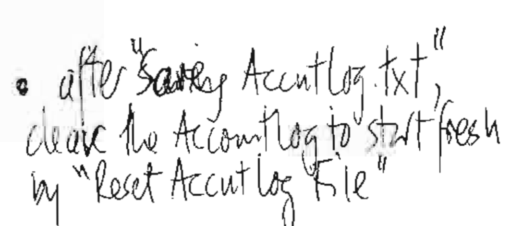
Save AccntLog.txt full (Service Use)

This produces a text file similar to *AccntLog.txt* small but it also contains the following items:

- Vacuum status of the specimen chamber given by a number and a related description
- Vacuum read-out of Penning Gauge (mbar) (specimen chamber pressure)
- Vacuum read-out of IGP (mBar) for both columns
- High Tension value of electron beam (kV)
- Filament adjuster number
- Filament current (Å)
- Filament voltage (V)

Both files have a format that makes them suitable as input for the spread sheet program Excel® from Microsoft. For importing, columns are separated by tab stops.

Reset AccntLog File



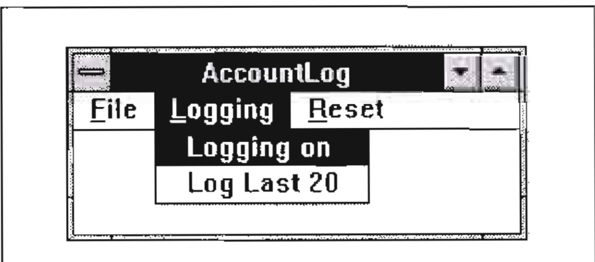
This option displays a dialogue box:

Account history will be cleared. Create a new account log file?

When you select NO, the file is not deleted. If select YES, the existing *AccntLog.bin* is deleted and an empty one is created.

Logging Menu (Service only)

When you click on Logging, a pulldown menu gives two options, Logging On and Log Last 20.



- High Tension value of electron beam (kV)
- Filament adjuster number
- Filament current (Å)
- Filament voltage (V)

Both files have a format that makes them suitable as input for the spread sheet program Excel® from Microsoft. For importing, columns are separated by tab stops.

Reset AccntLog File

• after "Saving AccntLog.txt", clear the AccountLog to start fresh

This option displays a dialogue box:

Account history will be cleared. Create a new account log file?

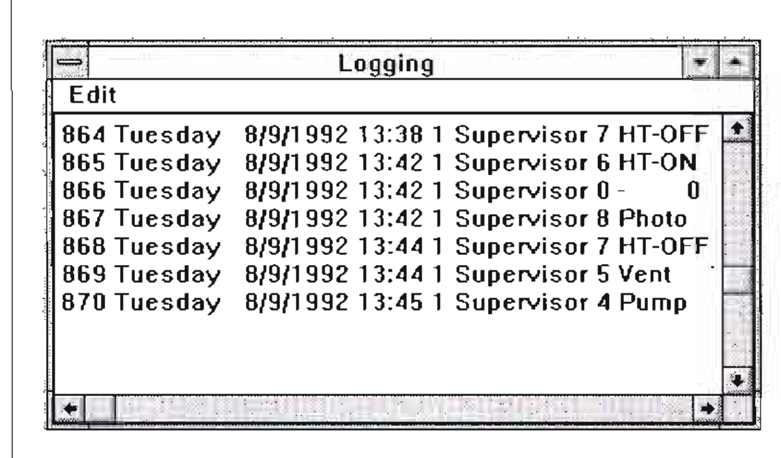
NOTE	Change the logging time interval or the maximum length of the logging file in the c:\xl\mc\mctrl.ini file. [Software Control] Accountlogminutes=15 Accountlogmax=1000 Set the desired values for the logging interval and the maximum length of the logging file by changing the numbers.

6/20/07
Set AccountLogminutes = 5
& AccountLogmax = 30000.
With 5 mins:
⇒ 12 pts/hr.
⇒ 288 pts/day
⇒ 2016 pts/week
⇒ 20160 pts/10 weeks!
safely collect 10 weeks of data.

Logging On

Logging is always on, but this selection generates a table of data in which every line represents either a user action or status information.

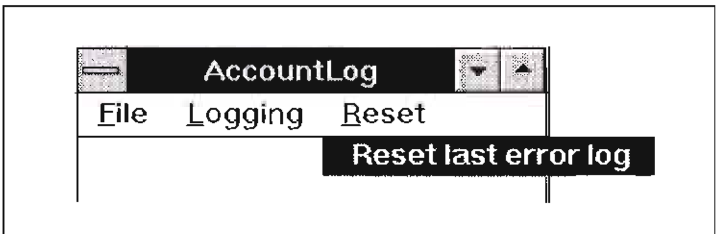
To prevent this list from taking too much disk space, you can define a maximum length (default = 1000 lines). When the maximum is reached, every time a new log is added the oldest line is deleted. The log file created is a binary file called AccntLog.bin.



Log Last 20

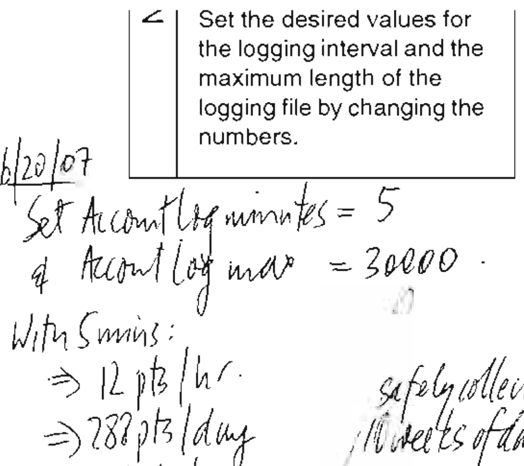
This produces a Logging window on your screen containing only the last 20 logging data entries. Recent user activity displays without having to create an extra text file on the hard disk.

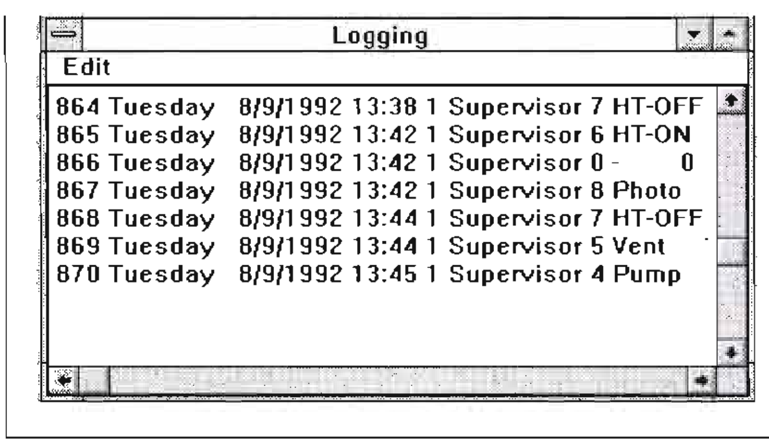
Reset Menu



Reset last error log

Clears the error list. View the error list by double-clicking on the Server icon. Select Logging on in the Logging menu. This results in a list of the last 10 error message that have appeared onscreen.


Set the desired values for the logging interval and the maximum length of the logging file by changing the numbers.


Log Last 20

This produces a Logging window on your screen containing only the

XL FEG/SFEG STEM Detector

Introduction

The STEM detector is a two segment solid-state device mounted underneath a Grid holder assembly. Since the STEM Detector is mounted on the stage it can be used at any available working distance preferably close to the lens for high resolution or at the eucentric position for simultaneous use of EDX. The mounting pin below the detector locates into the standard conical single stub mount provided with each FEG The locking screw should be tightened to stop unnecessary rotation of the detector. The plug located at the end of the cable from the detector is connected to the solid state amplifier (usually on the back right port).

The STEM holder has 8 positions for sample grids. Two of these positions are specifically for Darkfield observation and are marked accordingly (1D, 5D). For Darkfield observation the chosen sample grids should be loaded in these 2 positions when loading the entire holder prior to closing the specimen chamber.

The two detector segments, left (L) and right (R) can be switched independently, enabling the possibility of Brightfield contrast mode (positions 2,3,4,6,7,8), or Darkfield contrast mode (positions 1D and 5D). Operation is fully integrated in the main software.

The STEM detector uses slowscan rates for normal imaging. Automatic contrast and brightness routines are not applicable.

Normally prepared TEM samples should be used with this detector although thick sections of biological tissue up to 2 mm can be observed with only OsO4 fixation/staining.

Materials or hard samples should also be prepares as for the TEM by either Electro-chemical or Ion beam thinning techniques.

FIGURE 9-1 THE STEM DETECTOR ON A XL30 STAGE

with each FEG The locking screw should be tightened to stop unnecessary rotation of the detector. The plug located at the end of the cable from the detector is connected to the solid state amplifier (usually on the back right port).

The STEM holder has 8 positions for sample grids. Two of these positions are specifically for Darkfield observation and are marked accordingly (1D, 5D). For Darkfield observation the chosen sample grids should be loaded in these 2 positions when loading the entire holder prior to closing the specimen chamber.

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The STEM detector uses slowscan rates for normal imaging.

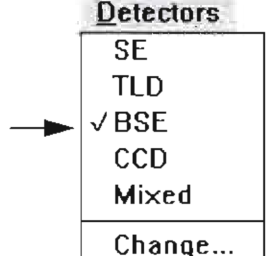
Sample Grid positions for BF/DF

By loading the Stem holder with a sample (tem grid) in one of the appropriate positions provided Brightfield and or Darkfield imaging can be achieved. The following table refers to the numbering of the positions and their related capabilities.

TABLE 9-1 STEM DETECTOR ON A XL30 STAGE

Grid Position	Observation and Diode switching
6,7,8	Brightfield observation - use Left segment switch only.
2,3,4	Brightfield observation - use Right segment switch only.
D1 and D5	Darkfield/Brightfield observation - If the object for observation is left of the segment separator then Left switching will give Brightfield and Right switching will give Darkfield observation. The opposite applies if the object is right of the segment separator.

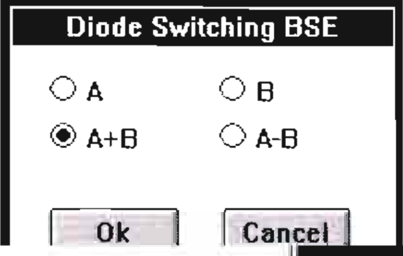
User interface



The STEM detector like other detectors is selectable from the 'Detectors' menu within MCTRL. As a temporary measure in MCTRL versions 5.50 to 5.70 use the BSE detector option to switch on the STEM detector. The 'A+B' condition (default) can be used to first setup as the total detector is then working. To switch BF/DF use the capability of switching either side of the detector diode by means of 'A' or 'B' in the 'Change' dialogue box. The 'A-B' condition can be ignored as this will give an artifactual image.

The Left segment represents the positions 6,7 and 8 and therefore switch 'A' diode.

The Right segment represents the positions 2,3 and 4 and therefore switch 'B' diode.



Loading samples

The STEM holder part of the detector therefore it can either be loaded with samples while outside the SEM or when it is mounted and fixed to the stage movement.

6,7,8	Brightfield observation - use Left segment switch only.
2,3,4	Brightfield observation - use Right segment switch only.
D1 and D5	Darkfield/Brightfield observation - If the object for observation is left of the segment separator then Left switching will give Brightfield and Right switching will give Darkfield observation. The opposite applies if the object is right of the segment separator.

User interface

place. The numbers on the top should overlay the same numbers on the base plate when replacing the holder top. Replace the holder top carefully and tighten down the central screw. The detector and sample holder is now primed for use.

The removal of sample grids is in the reverse order.

Free Working Distance position.

When vacuum is obtained in the SEM switch on the high voltage at 10kV, spot 3, TV scan and focus on the top of the STEM holder surface with the SE detector. Correct Z<>FWD and bring the focused surface to 5 mm FWD by changing the Z value on the Stage Control Page. Move to the appropriate sample position and refocus on the grid bars of the TEM grid. The FWD and Z position has now lengthened and re-selection of 5 mm in the Z value on the Stage Control Page is necessary. This procedure is necessary to prevent inadvertently bringing the detector in contact with the final lens. The minimum safe distance to the sample surface for FWD is 3 mm, be aware that the holder surface is now closer to the lens than the sample.

By moving off the grid bars and fine focusing on the sample most correction of image rotation (mainly SFEG) and astigmatism can be performed in the SE or TLD (SFEG) mode.

Obtaining a Brightfield (BF) image.

The STEM detector like the BSE detector is solid state it must be operated at slow scan rates and not at TV. Switch to a slow scan, approximately 20 ms / 968 lines.

Choose the BSE detector from the Detector Menu and select the correct diode operation either A or B, from the 'Change' dialogue, depending on the sample position in the holder. An image should be visible of the transmission sample at low magnification.

Change the kV to suit the contrast necessary through the sample. For example light element materials such as biological samples which are unstained may work better with 3 - 6 kV to create contrast, whereas metal stained samples need higher 5 - 8 kV accelerating voltage. Dense materials such as metals may require 10 - 15 kV or higher.

Finally increase the magnification to that required and fine focus and stigmate the image.

If adjustment of the aperture is needed while in the STEM mode by
When vacuum is obtained in the SEM switch on the high voltage at 10kV, spot 3, TV scan and focus on the top of the STEM holder surface with the SE detector. Correct Z<>FWD and bring the focused surface to 5 mm FWD by changing the Z value on the Stage Control Page. Move to the appropriate sample position and refocus on the grid bars of the TEM grid. The FWD and Z position has now lengthened and re-selection of 5 mm in the Z value on the Stage Control Page is necessary. This procedure is necessary to prevent inadvertently bringing the detector in contact with the final lens. The minimum safe distance to the sample surface for FWD is 3 mm, be aware that the holder surface is now closer to the lens than the sample.

By moving off the grid bars and fine focusing on the sample most correction of image rotation (mainly SFEG) and astigmatism can be performed in the SE or TLD (SFEG) mode.

Obtaining a Darkfield (DF) image.

The samples that reside in the D1 and D5 positions can be observed in Darkfield mode.

The separator line of the two diodes crosses vertically the positions of D1 and D5 so that an area of interest on the left side of the line can be observed with the right-hand diode for Darkfield and with the left-hand diode for Brightfield observation. The opposite is true for the right side of the line.

Dark Field observation may require higher kV to create a suitable image as the angle subtended to the detection diode can be wide.

EDX analysis with STEM.

Operate the EDX system (EDX or UHR mode for SFEG) as if using the normal SE detector mode.

Set the sample surface to 10 mm FWD for standard FEG or 5 mm FWD for SFEG.

Select the area of interest in the STEM mode and perform X-ray analysis, Mapping or Linescans as appropriate.

Because the samples are not bulk in nature the beam spread normally associated with SEM samples will be greatly reduced and therefore higher spatial resolution can be obtained in the STEM mode. This also provides less background in the spectrum and allows better separation of peaks as well as lower count rate mapping.

The kV chosen for analysis will still depend mainly on the composition of the sample.

Dark Field observation may require higher kV to create a suitable image as the angle subtended to the detection diode can be wide.

EDX analysis with STEM.

Operate the EDX system (EDX or UHR mode for SFEG) as if using the normal SE detector mode.

Set the sample surface to 10 mm FWD for standard FEG or 5 mm FWD for SFEG.

Select the area of interest in the STEM mode and perform X-ray analysis, Mapping or Linescans as appropriate.

Because the samples are not bulk in nature the beam spread normally associated with SEM samples will be greatly reduced and therefore

Metrology Package

Introduction

The semiconductor process industry is demanding more and more inspections for quality control. One such inspection procedure is Critical Dimension (CD) measurements of line width structures. Because of inherent limitations in light microscopes, the tool of choice for such inspections is the Scanning Electron Microscope (SEM) equipped with a Line Width Measurement System (LWMS).

The SEM uses a finely focused beam of electrons to scan over the area of interest. The beam–specimen interaction is a complex phenomenon. The electrons actually penetrate into the sample surface, ionizing the sample and causing the release of electrons from the sample. These electrons are detected and amplified into a SEM image that consists of Back Scattered Electrons (BSE) and Secondary Electrons (SE). Since the electron beam has a specific energy and the sample a specific atomic structure, different images will be collected from different samples, even if they have the same geometric appearance.

There are two basic requirements for LWM - accuracy and repeatability. Accuracy is only as good as the standards or procedure that a company chooses to use. It must be noted that a standard (ideally) should have the same elemental make up and approximate geometric features as the inspected product. It does little good to calibrate with a gold and nickel sample and measure (for example) a photo resist on Silicon specimen with such a calibration.

To avoid such problems, more and more companies are performing calibrations on their own samples using the known pitch of the patterned wafer. Pitch should be constant, regardless of the process. This procedure also eliminates variables such as elemental make up of the line and substrate and the subsequent changes in the beam–specimen interaction.

Repeatability is essential, once a calibration procedure is determined. Repeatability includes controlling the SEM operating parameters to the precise conditions day in and day out. A computerized SEM is essential for such control.

The SEM uses a finely focused beam of electrons to scan over the area of interest. The beam–specimen interaction is a complex phenomenon. The electrons actually penetrate into the sample surface, ionizing the sample and causing the release of electrons from the sample. These electrons are detected and amplified into a SEM image that consists of Back Scattered Electrons (BSE) and Secondary Electrons (SE). Since the electron beam has a specific energy and the sample a specific atomic structure, different images will be collected from different samples, even if they have the same geometric appearance.

There are two basic requirements for LWM - accuracy and

The LWMS is integrated into the Philips XL series of SEMs using Windows 3.1 software. By merely pointing and clicking to the desired menu one engages the operation of choice.

Philips offers several different measurement algorithms to the user. Each algorithm can be tailored to a specific process. The initial procedure to set up a measurement is quite simple.

- First, one determines the type of profile to be measured – a line profile with distinct peaks or one where the profile is flattened.
- Second, one determines what is to be measured – a line, a space, and pitch and a line or to force a pitch to a specific value and measure the subsequent line based on the value of the forced measurement.
- Thirdly, one determines the actual measurement algorithm.

There are five basic algorithms available with the Philips LWMS. They are **peak-to-peak, linear regression, gradient (point of steepest slope), and inner and outer thresholds**. The latter two can have a continuously variable percentage selected. Each algorithm will give the user a different measurement, based on what they are actually measuring.

All data can be stored into a results file to be used with Lotus, Excel, etc. Data can also be displayed as histogram information.

Using Metrology in Windows

When first loaded into Windows, the Metrology program is displayed across the lower portion of the viewing CRT. Since Microscope Control (MCTRL) is assumed to be engaged at the same time, the 'Metrology' program may cover up a part of the MCTRL program. Simply click and drag the lower portion of MCTRL so that all information is displayed at the same time 'Metrology' is displayed.

FIGURE 9-2 THE METROLOGY MENU

- First, one determines the type of profile to be measured – a line profile with distinct peaks or one where the profile is flattened.
- Second, one determines what is to be measured – a line, a space, and pitch and a line or to force a pitch to a specific value and measure the subsequent line based on the value of the forced measurement.
- Thirdly, one determines the actual measurement algorithm.

There are five basic algorithms available with the Philips LWMS. They are **peak-to-peak, linear regression, gradient (point of steepest slope), and inner and outer thresholds**. The latter two can have a continuously variable percentage selected. Each algorithm will give the user a different measurement, based on what they are actually

Acquire

When clicking on the **Acquire** function a pull down menu appears.

The following commands appear on this menu.

FIGURE 9-3 THE ACQUIRE MENU

Metro XL Metrology Application
Acquire Calibrate Measure Sem Stage Print Statistics Job File
Integrate Ctrl+F9
Select Window Ctrl+F10
Clear Graphics
Running Average 4
Settings...

- **Integrate** - when engaged, this performs image integration. The number of frames to be integrated is selected below in the **Settings** command. This setting dialogue also appears the first time one selects **Integrate**. The scan rate is selected in MCTRL (i.e. TV scan, SS1, SS2 or SS3).

- **Select Window**- This allows the operator to determine the 'space' from the image in which video information is acquired to derive a line profile. This is done by clicking and dragging a window from the upper left to the lower right of the desired area. The larger the window is drawn the more information will be averaged.

- **Clear Graphics**- This allows the user to clear all frame store graphics from the viewing area. This includes text, windows, line profiles and data.

- **Settings** - The **Settings** command allows the user to select, via a sliding bar, the number of frames to be averaged. One must select a value here before **Integrate** can be performed. An invert command is also located in this menu. This inverts the line profile, not the SEM image.

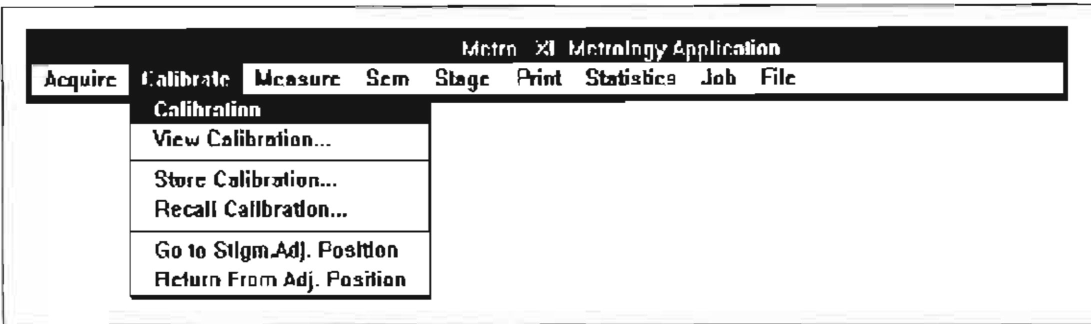
Integrate Ctrl+F9
Select Window Ctrl+F10
Clear Graphics
Running Average 4
Settings...

- **Integrate** - when engaged, this performs image integration. The number of frames to be integrated is selected below in the **Settings** command. This setting dialogue also appears the first time one selects **Integrate**. The scan rate is selected in MCTRL (i.e. TV scan, SS1, SS2 or SS3).

Calibrate

The **Calibrate** menu has several commands listed.

FIGURE 9-4 THE CALIBRATE MENU



- **Calibration** - This routine allows the operator to input measurement data to the system. This data is in the form of a known numeric value of a sample in microns. Within this menu other input data must be entered.

- **Track Direction**: The operator selects X or Y. Vertical lines are in the Y direction.

- **Waveform Type**: The are two categories of waveforms – **Flat** and **Peaks**. Either is selected based on the line profile displayed of the calibration sample. **Flat** denotes a profile that rises but has no distinct peaks. **Peak** is a more common waveform type and is characterized by distinct peaks on the edge of the line profile.

After one **Waveform Type** is selected another menu pops up showing the different algorithms available for that particular type of line profile. The five measurement algorithms are:

1 - **Gradient**

2 - **Inner Threshold** - default is 50%, the user can select desired value (peaks only)

3 - **Peak-to-Peak** (peaks only)

4 - **Outer Threshold** - default is 50%, the user can select desired

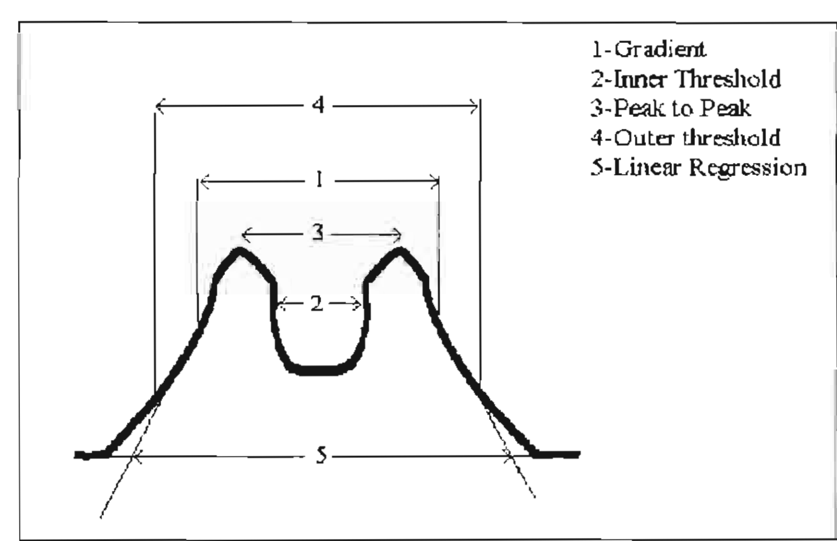
View Calibration...
Store Calibration...
Recall Calibration...
Go to Stigm.Adj. Position
Return From Adj. Position

- **Calibration** - This routine allows the operator to input measurement data to the system. This data is in the form of a known numeric value of a sample in microns. Within this menu other input data must be entered.

- **Track Direction**: The operator selects X or Y. Vertical lines are in

These are shown graphically in Fig. 4.

FIGURE 9-5 VARIOUS MEASUREMENT ALGORITHMS ON A PROFILE



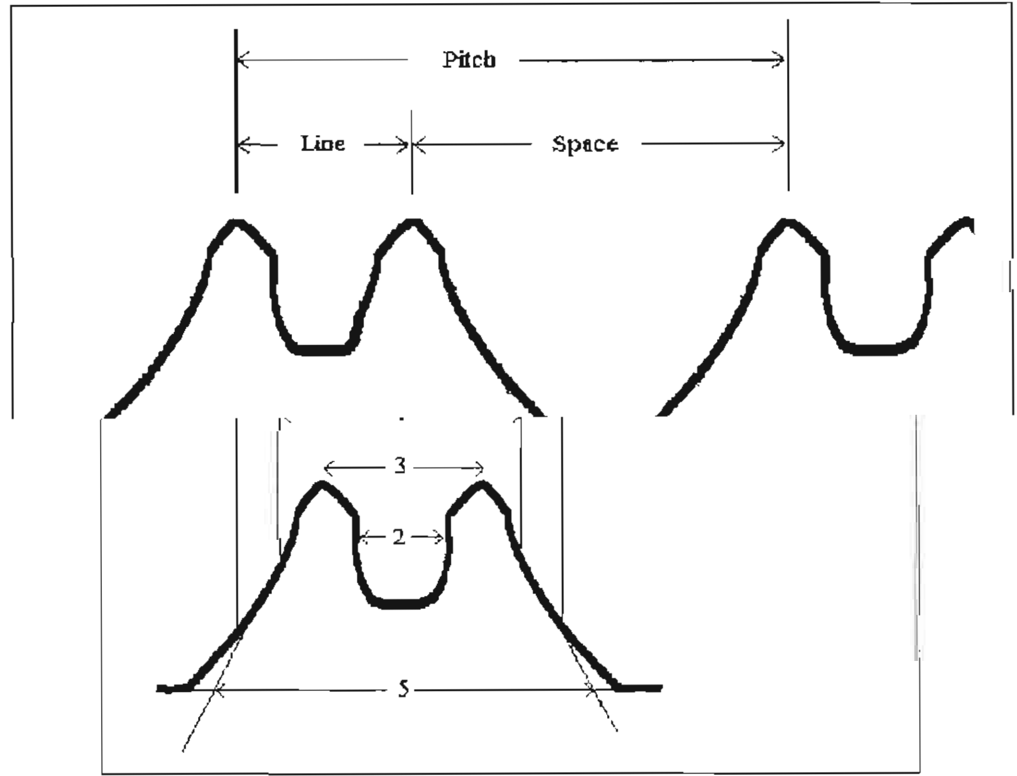
- **Strategy**- This determines what is actually measured on the line profile. The points are determined by the **Waveform Type** selected (i.e. the measurement algorithm). The choices are:

1 - **Line** - The first pair of points on the profile are measured

2 - **Space** - The second pair of points on the profile are measured

3 - **Pitch** - the distance from the first to third point is measured.

FIGURE 9-6 THE THREE BASIC STRATEGIES



- **Strategy**- This determines what is actually measured on the line profile. The points are determined by the **Waveform Type** selected (i.e. the measurement algorithm). The choices are:

3 - **Pixel Size**

4 - **Calibration Distance**

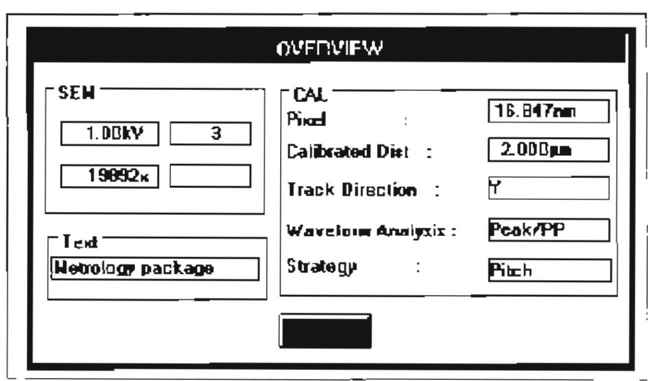
5 - **Track Direction**

6 - **Waveform Analysis**

7 - **Strategy**

The **View Calibration** Window is Shown below in Fig. 6.

FIGURE 9-7 THE VIEW CALIBRATION MENU



- **Store Calibration** - This allows the storage of calibration files for later recall. These files are stored with a ".CLB" extension
- **Recall Calibration** - This procedure allows retrieval of a previously stored calibration. The file recalled must have a ".CLB" extension.

- **Go To Stigmator Adjustment Position** - It is often difficult to adjust the stigmator adjustment coils on vertical lines. To aid the operator, a sample whose astigmatism is easy to adjust can be mounted in a pre-determined stage location. This sample may be gold grids, tin balls, metal grains, etc. Once the image is corrected the operator can return to the previous position on the wafer. The stigmator adjustment position can be specified in the "Metro.INI" file (in microns).

- **Return from Stigmator Adjust Position -** This returns the wafer to the last stage position before the **Go To Stig...** command was

FIGURE 9-7 THE VIEW CALIBRATION MENU

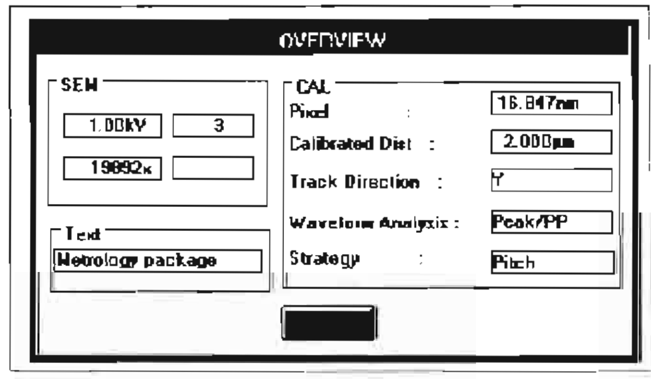


FIGURE 9-8 THE MEASURE MENU

Acquire Calibrate Measure Sem Stage Print Statistics Job File

Measurement Ctrl+F11
Measurement on same profile
Store Result Ctrl+F12
Settings... Ctrl+F4

- **Measurement** - This command institutes the measure sequences. The Metrology package will take the information with the selected window, display the line profile, show locations on the profile where the measurement is taken and display the subsequent value (or values if **Pitch** is selected).

- **Measurement on Same Profile** - One may choose to change measurement algorithm or parameters but still measure on the same profile without acquiring a new image. This will allow such action.

- **Store Result** - The **Measurement** results will be stored into a file selected in **File**.

- **Settings** - This menu is very similar to the menu used in **Calibration**. This allows the operator to select:

1 - **Track Direction** - X or Y based on orientation of lines in the viewing area

2 - **Type of Structure** - Flat or Peak as described in 1.2.2

3 - **Type of Width** - **Line, Space or Pitch** as described in 1.2.2. Also added is **Pitch Cal/Line**. This latter command forces the pitch to be a predetermined value and then does the subsequent measurement based on that value. A line/pitch ratio is also displayed when **Pitch Cal/Line** and **Pitch** are selected.

- **Calculation Method** - This allows the operator to perform an **Auto** or **Manual** or **Line** measurement. The **Auto** will be based on the above settings (**Direction, Type of Structure and Type of Width**)

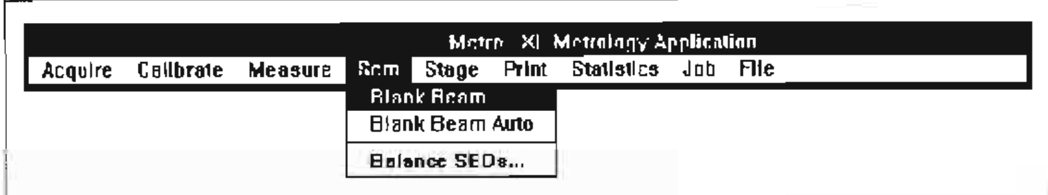
- **Measurement** - This command institutes the measure sequences. The Metrology package will take the information with the selected window, display the line profile, show locations on the profile where the measurement is taken and display the subsequent value (or values if **Pitch** is selected).

- **Measurement on Same Profile** - One may choose to change measurement algorithm or parameters but still measure on the same profile without acquiring a new image. This will allow such action.

Sem

This menu allows the user to control certain features of the SEM.

FIGURE 9-9 THE SEM MENU



- **Beam Blank** - This engages the beam blanking system. This system puts a voltage on the electron gun coils that deflect the beam and prevent the beam from scanning on the sample.

- **Beam Blank Auto** - This feature will automatically blank the beam when an image is 'frozen'. This will prevent the electron beam from continuing to scan the sample, possibly inducing a charge or polymerizing the sample surface.

- **Balance SED's** - If the SEM is equipped with two secondary electron detectors it will be necessary to balance them for optimum detection conditions (i.e. balancing the peaks on the profile). This command is actually changing the bias on the E-T detector of the SED.

Stage

This menu allows the control of stage coordinates.

FIGURE 9-10 THE STAGE MENU

- **Beam Blank** - This engages the beam blanking system. This system puts a voltage on the electron gun coils that deflect the beam and prevent the beam from scanning on the sample.

- **Beam Blank Auto** - This feature will automatically blank the beam when an image is 'frozen'. This will prevent the electron beam from continuing to scan the sample, possibly inducing a charge or polymerizing the sample surface.

- **Go To first Position** - This sends the stage to the first position on the stage table as well as showing the **Specimen Alignment** dialogue box.

- **Stage Table** - This command allows one to build a stage table for storage or recall. When engaged, another menu appears on the screen. This **Stage Table Manager** has seven buttons on it.

1 - Move to: - A specific stage location may be typed in via the keyboard into the X and Y value boxes. Note that putting values into these boxes does not automatically put the values into the stage table. Clicking on an entry in the table also fills the X and Y boxes.

2 - Read - This reads the current position of the stage and adds the values to the X and Y boxes. Note that putting values into these boxes does not automatically put the values into the stage table.

3 - Add - This allows the stage co-ordinates that are displayed in the X and Y value boxes to be added to the stage table.

4 - Insert - This editing feature allows the displayed stage value to be inserted before the highlighted item on the stage table. This is useful for modifying a specific stage position without making a whole new table.

5 - Update - This editing feature replaces the selected stage table entry with the values in the X and Y edit boxes.

6 - Delete - This deletes only the highlighted position on the stage table.

7 - Clear - This clears the entire stage table. If the stage table has not been previously stored then this table is permanently lost!

- **Store Stage Table** - This allows the above stage table to be stored in a file with a ".STG" extension.

keyboard into the X and Y value boxes. Note that putting values into these boxes does not automatically put the values into the stage table. Clicking on an entry in the table also fills the X and Y boxes.

2 - Read - This reads the current position of the stage and adds the values to the X and Y boxes. Note that putting values into these boxes does not automatically put the values into the stage table.

3 - Add - This allows the stage co-ordinates that are displayed in the X and Y value boxes to be added to the stage table.

4 - Insert - This editing feature allows the displayed stage value to be

Print

This menu allows the operator to get hard copies via a print-out of the measurements taken so far. It is necessary to have a printer installed on the PC or network to perform these functions.

FIGURE 9-11 THE PRINT MENU

- **Result File Print** - This command will allow the selected result file to be printed.

- **Histogram** - This allows the histogram to be printed.

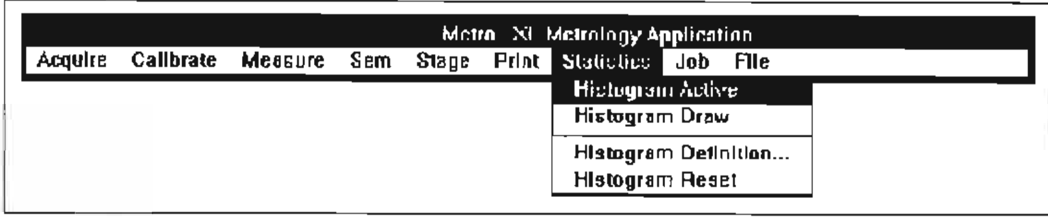
- **Result File Print** - This command will allow the selected result file to be printed.

- **Histogram** - This allows the histogram to be printed.

Statistics

This menu allows the display of Measurements in a graphical bar chart form.

FIGURE 9-12 THE STATISTICS MENU



- **Histogram Active** - This engages the histogram. Note that one must define the histogram before using this command.

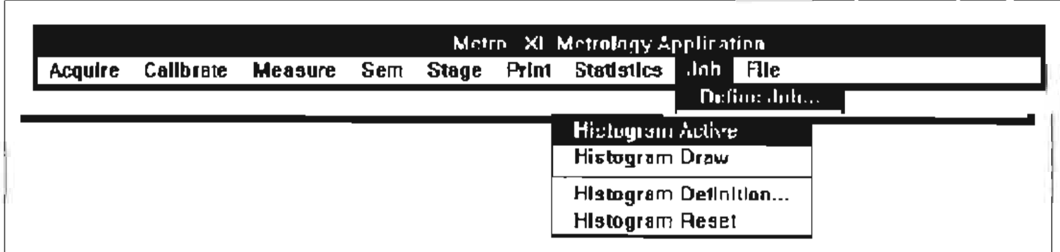
- **Histogram Draw** - This displays the histogram on the viewing screen.•**Histogram Definition** - To define the histogram display one must input the 'ideal' value of the measured lines. A percentage variance is added. This will now define the range of the displayed data. If data is collected outside this range, the computer will 'beep'. Note that the percentage variance can be changed without losing the data already collected.

- **Histogram Reset**- This erases all histogram data.

Job

A Job is a repetitive routine. Once written, one may call up this routine over and over again.

FIGURE 9-13 THE JOB MENU



- **Histogram Active** - This engages the histogram. Note that one must define the histogram before using this command.

- **Histogram Draw** - This displays the histogram on the viewing screen.•**Histogram Definition** - To define the histogram display one must input the 'ideal' value of the measured lines. A percentage variance is added. This will now define the range of the displayed

2 - **Measurement - Grab (On or Off)** - Operations set up in **ACQUIRE** are performed

3 - **Measurement-Measure (On or Off)** - Operations set up in **MEASURE** are performed

4 - **Measurement-Save (On or Off)** - The measured result is sent to the file specified in **FILE.**

- **Execute Job** - This executes the active job.

- **Store Job** - This allows the job and all subsequent parameters to be stored in a file with a ".JOB" extension.

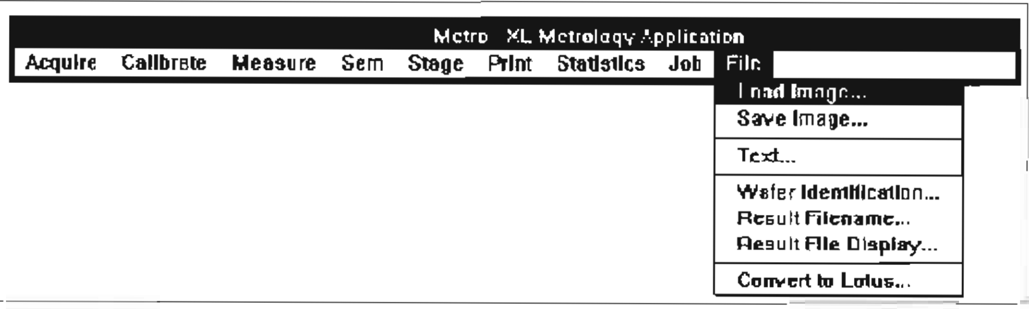
- **Recall Job** - This allows a previously stored job to be recalled from storage.

- **Overview** - This displays all operating conditions and job conditions that are active.

File

This menu allows the storage of images, adds text on display and sets up file information.

FIGURE 9-14 THE FILE MENU



- **Load Image** - This allows the input of a stored image from **Metrology.**

- **Save Image** - Any image in the viewing screen may be saved for

- **Store Job** - This allows the job and all subsequent parameters to be stored in a file with a ".JOB" extension.

- **Recall Job** - This allows a previously stored job to be recalled from storage.

- **Overview** - This displays all operating conditions and job conditions that are active.

File

- **Wafer ID** - When a new wafer is introduced to the SEM its ID number or any label can be entered. This will categorize all subsequent measurements into the result file.

- **Result File** - This menu allows the user to define the file that the results will be stored into. This file will have a ".RES" extension. This file can be converted by **Convert to Lotus** into a file that can be read by Lotus, Excel or other data manipulation programs.

- **Result File Display** - This allows the user to view the entire result file. One may wish to click on the upper right Maximize button to observe all information. When **Metrology** asks for the Wafer ID, one can enter "all" to view all data in the file.

- **Convert to Lotus** - This converts the file to a format that is compatible to Lotus 1,2,3 and Excel. The files will be ASCII with tabs to separate fields.

Calibration Procedure

A calibration standard must have an optical signature similar to the sample being measured. This optical signature is displayed as a line profile. Several conditions must be met:

1 - Similar elemental make up - It is no good calibrating on a Silicon sample and measuring on Gallium Arsenide!

2 - Similar geometries - Just as one cannot measure centimetres with a foot rule, one must calibrate with geometries that are close to the unknown. A ± 50% variance is the maximum recommended. (i.e. if you plan on measuring a 0.7 micron line you should calibrate on a line from 0.4 to one micron in size).

3 - Similar operating conditions - This includes accelerating voltage, spot size, magnification (although the software does correct for magnification differences between the standard and the unknown), stage tilt, contrast and brightness, scan rates, integration time and window size (to name but a few!).

- **Result File Display** - This allows the user to view tbe entire result file. One may wish to click on the upper right Maximize button to observe all information. When **Metrology** asks for the Wafer ID, one can enter "all" to view all data in the file.

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Calibration Procedure

A calibration standard must have an optical signature similar to the

Note that these are all ideal requirements. Reality strikes home when one realizes that some of the above mentioned requirements are nearly impossible to achieve!

The most important consideration is consistency. The actual accuracy can be negligible. It is repeatability that counts.

What standard to use?

More and more fabrication plants are accepting the fundamental limitations of LWM techniques and the lack of available standards with an optical signature similar to their product. More fab. areas accept that pitch is the only known and repeatable measurement and use the pitch of their product as their calibration 'standard'.

Some companies sell LWM standards. Many of the 'standards' may not give your fab. area the desired results when used with your product. This entire subject is an emotional issue with some companies. It is up to the user to determine the proper method and type of calibration to be used.

A step by step calibration

1 - Set up SEM parameters - Accelerating voltage, spot size scan rate (TV scan is most popular but slow scan may achieve better accuracy).

2 - **ACQUIRE** the image

3 - **SELECT WINDOW** - click and drag a window over the desired area on the image.

4 - go to **CALIBRATION** and enter desired value (i.e. pitch or actual known line width). One may have to try several algorithms to find the correct one for this optical signature.

5 - Try a **MEASURE** on this standard to make sure it will be correct. If it is, it is suggested to **STORE** this calibration file immediately.

If the measurement value is wrong from step #5, then one may have to

What standard to use?

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How to Measure

After following the Calibration routine the measurement is rather easy. The following sets are all that is needed to measure:

1 - Use **MCTRL** to locate and focus the region of interest (ROI).

2 - **ACQUIRE** the image in **METROLOGY**. Make certain that the acquisition is done at the same scan rates as those with which the calibration was done!

3 - Use **SELECT AREA** to draw the window around the desired ROI.

4 - Verify the measure algorithm under **MEASUREMENT, SETTINGS**.

5 - **MEASURE** (or press Crtl, F11). The measurement will automatically perform using the algorithms selected.

Storage of results

The file name that was last selected in **RESULT FILENAME** is the active file at this point. **STORE RESULT** automatically stores the present measurement value and Wafer ID into that file.

To display the results the **DISPLAY FILE RESULTS** routine can be selected. The results can be printed by selecting **PRINT, RESULT FILE PRINT**.

calibration was done!

3 - Use **SELECT AREA** to draw the window around the desired ROI.

4 - Verify the measure algorithm under **MEASUREMENT, SETTINGS**.

5 - **MEASURE** (or press Crtl, F11). The measurement will automatically perform using the algorithms selected.

Storage of results

The file name that was last selected in **RESULT FILENAME** is the active file at this point. **STORE RESULT** automatically stores the present measurement value and Wafer ID into that file.

EBSP Detector

EBSP Control Area

If the instrument is equipped with an EBSP detector, a special control area will be available. This control area is named "EBSP" and can be selected from the control area pull-down menu or button bar as usual, or may be selected from the detector pull down menu.

In this control area the system can be used to obtain Electron Backscatter Diffraction Patterns (EBSP's) that provide information about the crystallographic orientation of the specimen under investigation. It should be used in conjunction with the Crystal Orientation Software (COSi) to index the EBSP's and obtain a result.

EBSP
EBSP
Gen.Back
Sub. Back
Quantif.
Modify L.
Modify R.
Contrast 30.0
Brightness 30.0

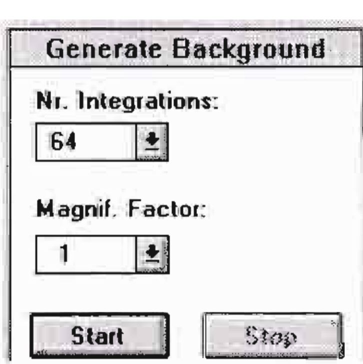
The EBSP control page initially contains one control area (named EBSP), with two expandable sub-pages (named Generate background and Subtract background).

EBSP

This button will start the EBSP mode. It invokes the following actions: The image on the right monitor will be frozen to display the so-called "landscape image". The microscope will be switched to spot mode, the position of the spot on the landscape image displayed by the intersection of green cross-hairs. On the left monitor, a live EBSP pattern will be shown as taken from the current beam position. All buttons in the control area will be activated.

The live EBSP pattern will be copied to the first memory plane of the microscope and named: "EBSP live". The landscape image will be copied to the third memory plane of the microscope and named: "Landscape". These names will be displayed in the Image Manipulation page.

When switching off the EBSP mode, the camera will be switched off. The previous microscope scan parameters and video system parameters will be restored to the original values.



Gen. Back

This button is enabled if EBSP mode has been switched on. By pressing the button, an extra control area is displayed for the user to select settings for the generation of an EBSP background image. Through this control area a background image can be generated and stored in the second memory plane.

about the crystallographic orientation of the specimen under investigation. It should be used in conjunction with the Crystal Orientation Software (COSi) to index the EBSP's and obtain a result.

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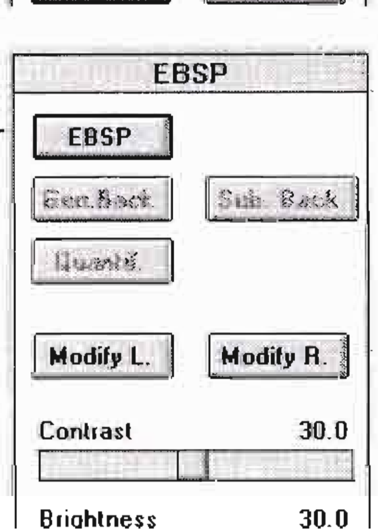


EBSP

This button will start the EBSP mode. It invokes the following actions: The image on the right monitor will be frozen to display the so-called "landscape image". The microscope will be switched to spot mode, the position of the spot on the landscape image displayed by the intersection of green cross-hairs. On the left monitor, a live EBSP

Pressing the OK button copies the background image, displayed on the left monitor, to the second memory plane. This second memory plane will be named: "Background".

Sub. Back

Subtract Background
Subtract Factors:
Back:-50% Live:50%
Subtract Cancel

When pressing the "Sub. Back" button, a control area is shown below the main control area for the user to select the settings for background subtraction. A slidebar appears in the new control area which allows to modify the subtract factors. Default these factors are set to 50%, 50%.

When pressing the SUBTRACT button, the background image will be subtracted from the live EBSP pattern to form a live background-subtracted EBSP pattern on the left monitor. The right monitor displays the background image.

When pressing the CANCEL button, the original settings are restored. The left monitor displays the live EBSP pattern and the right monitor the landscape image.

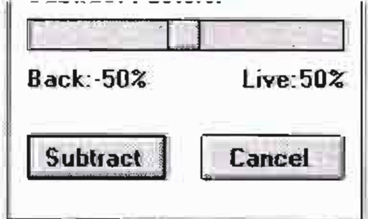
Quantif.

When pressing the QUANTIFY button. the background-subtracted EBSP pattern is now displayed on the right monitor. while the landscape image is now displayed on the left monitor. This is necessary for the Crystal Orientation Software to copy the EBSP pattern, and indexing of the pattern may now proceed. In addition, the user may now record or print the EBSP pattern using all available output-media.

Switching off the QUANTIFY button will restore the original settings, i.e. puts the EBSP pattern back to the left monitor and the landscape to the right monitor.

Modify R./Modify L.

After pressing these buttons, the monitor will display the histogram to modify the grey look-up table according to wish. This functionality is similar to the functionality present in the image manipulation control page. This function is very useful the stretch the contrast in the original background subtracted EBSP pattern



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Quantif.

When pressing the QUANTIFY button. the background-subtracted EBSP pattern is now displayed on the right monitor. while the

Set-up for EBSP

To set up for EBSP proceed as follows:

1. Clip the backscatter detector below the phosphor screen. With this detector the forward scattered electrons may be used for orientation imaging.

2. Find your area of interest at 0 degrees tilt unless working at eucentric working distance, and tilt specimen to 70 degrees. Note that large samples may cause damage by striking the final lens when tilting to 70 degrees while at eucentric working distance.

3. If using the backscatter detector for imaging, insert the phosphor screen to an intermediate specimen to screen distance and find the highest intensity of the BSE signal. Prepare a landscape image, preferably with some orientation contrast. During the operation of the EBSP system, this distance may be reduced to enlarge the capture angle for the EBSP patterns.

4. Switch on the camera control box. Turn gain one mark clockwise, turn offset fully clockwise. Turn sensitivity off (i.e. fully counter-clockwise) to prevent overexposure of the camera at all times. Shading correction can be off. The video select button should be in neutral position. These settings can be adjusted as desired, and the indicated settings are those recommended for getting started.

Practical Operation

This series of instructions will guide you through a number of steps necessary to obtain a result. Proceed as follows.

1. Set up the EBSP as outlined in the preceding section.
2. Press the EBSP button, locate the spot on the area of interest by clicking on the landscape image.
3. Focus the camera lens if necessary.
4. Adjust the specimen to screen distance to select the capture angle of the EBSP pattern. This angle increases to 90 degrees when the specimen to screen distance is reduced to 2 cm (minimum distance).
5. Adjust contrast/brightness on the EBSP pattern on the left monitor, and find maximum sensitivity of the camera by turning the sensitivity knob clockwise. Prevent overexposure, indicated when the red light is lit.
6. Generate and subtract background. Note: on single crystal

tilting to 70 degrees while at eucentric working distance.

3. If using the backscatter detector for imaging, insert the phosphor screen to an intermediate specimen to screen distance and find the highest intensity of the BSE signal. Prepare a landscape image, preferably with some orientation contrast. During the operation of the EBSP system, this distance may be reduced to enlarge the capture angle for the EBSP patterns.

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Crystal Orientation Software.

10. De-activate the quantify button and return to normal EBSP operation mode.

CAUTION 1: Increasing acceleration voltage and/or spot size may cause overexposure of the camera during operation.

CAUTION 2: De-activate EBSP mode before closing Microscope Control to switch off the camera.

Manual User Interface (MUI)

Overview

The Manual User Interface (MUI) provides knobs to perform functions that can also be performed with the software:

- Stigmation
- Image contrast and brightness
- Magnification
- X and Y scan shift
- Coarse and fine focus

FIGURE 9-15 MANUAL USER INTERFACE (MUI)

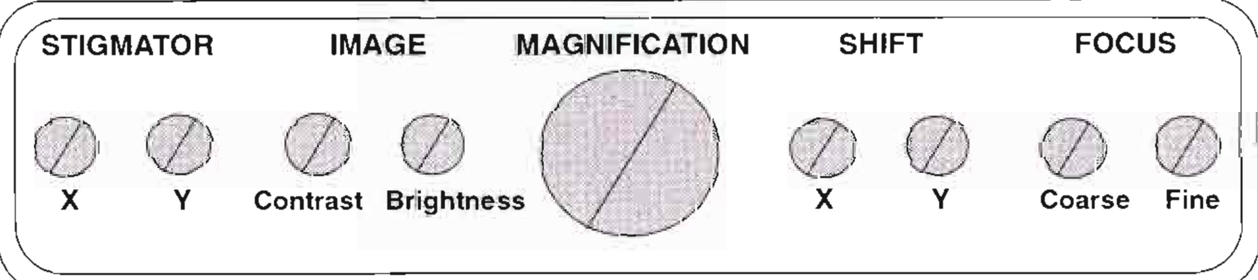
STIGMATOR IMAGE MAGNIFICATION SHIFT FOCUS
X Y Contrast Brightness X Y Coarse Fine

TABLE 9-2 MUI SOFTWARE EQUIVALENTS

MUI	Software Equivalent
Stigmator	Shift + right mouse button Stigmator two-dimensional X-Y control on Imaging control area
Image	Contrast and brightness adjusters in all areas
Magnification	+/- keys on numeric keypad For small steps, use the Magnification adjuster on the Imaging control area.
Shift	Beam shift icon (hand)
Focus	Right mouse button

- X and Y scan shift
- Coarse and fine focus

FIGURE 9-15 MANUAL USER INTERFACE (MUI)



The CCD Camera

The CCD camera is a small infrared inspection camera, usually mounted on the upper left port. The camera allows you to view directly the positioning of large and irregular specimens. It also is used to see the position of the sample in relation to the final lens. This is convenient with nonstandard working distances and conditions.

Select the CCD camera from the Detectors pulldown menu. Since the CCD camera only operates in TV mode, the slow scan modes are blocked. There are no other software controls.

The camera image is prefocused during installation. The intensity of the image is controlled by the diaphragm setting of the camera.

The camera is equipped with a built-in light source. This source is switched on and off when selecting the camera. When not in use, the infrared LEDs for illumination are switched off because EDX detectors and the solid state back scatter detector are sensitive to this light.

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The camera image is prefocused during installation. The intensity of the image is controlled by the diaphragm setting of the camera.

The camera is equipped with a built-in light source. This source is switched on and off when selecting the camera. When not in use, the infrared LEDs for illumination are switched off because EDX detectors and the solid state back scatter detector are sensitive to this light.

Histogram Analysis

Introduction

Histogram Analysis software is a separate program (icon) running with system software in the Windows™ environment.

Using this option, the screen displays a graylevel histogram representation of an image (either live or stored). After calibration of this histogram using phases of known atomic numbers, an atomic number interpolation can be performed. You can define four windows yielding area percentages. If the Color Imaging option is installed, the image on the left monitor and the histogram display are in color.

The mean atomic number interpolation procedure is based on the fact that the higher the mean atomic number of a material, the more electrons are scattered back. Using a suitable electron detector, such as the BS detector, this is reflected in the image as different graylevels:

- White is an indication of high mean atomic numbers
- Black represents relatively low mean atomic numbers.

The relationship between gray level and mean atomic number is determined by:

- Specific setting of beam current
- Working distance
- Contrast/brightness setting of the detector.

The calibration routine represents this relationship by approximating a curve using a second order polynomial. The accuracy of interpolation is optimum if the calibration points are relatively close in atomic number to the unknown phase.

Before you begin a histogram analysis, be sure that the specimen is sufficiently flat (preferably polished) and that its surface is parallel to the BS detector (no local tilt). A Live image suitable for atomic number calibration should be visible on the right monitor. The sample should show at least three different phases (different mean atomic numbers), so that the unknown mean atomic numbers can be found from interpolation between these known phases.

Adjust the gain and brightness settings of the detector so that the corresponding video levels are between white and black as indicated by the videoscope. This lets you use the full graylevel range for optimum accuracy.

yielding area percentages. If the Color Imaging option is installed, the image on the left monitor and the histogram display are in color.

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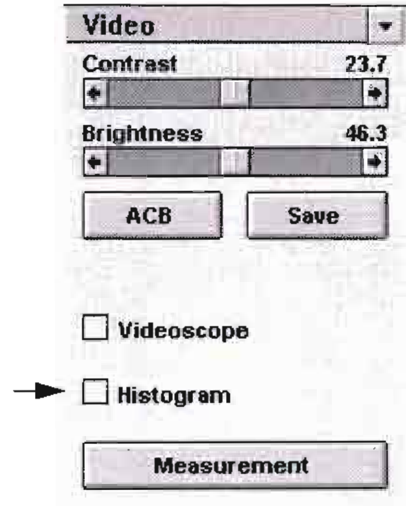


Start-up

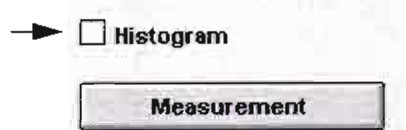
To activate and de-activate the histogram analysis function, click in the checkbox next to the Histogram function found in the maximized Video control group available on the Settings control area. The system overlays a gray level histogram on the column image and displays several menu items.

Before the histogram is analyzed, a calibration of the graylevels is required (a translation from graylevels to atomic number). A special calculation routine is used for this purpose.

Calculating Atomic Weight

When you select Calculate from the menu, the system calculates the mean atomic number and mean atomic weight of chemical compounds. Formulas must be entered using the following conventions:

- Use a capital letter as first letter of the element. For example: type Cu instead of cu.
- Type subscripts as normal numbers. Example SiO_2 can be typed in as SiO2.
- Use one level of nesting: $X_2(Y_3Z_4)_2$, where X,Y and Z denote elements.
- Subscripts do not have to be positive integers, so $X_{2.45}Y_{1.34}Z$ is allowed.
- Add groups of water in the usual way: $XY_2{*}nH_2O$ where n is a positive integer.



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Calculating Atomic Weight

When you select Calculate from the menu, the system calculates the mean atomic number and mean atomic weight of chemical compounds. Formulas must be entered using the following conventions:

- Use a capital letter as first letter of the element. For example: type Cu instead of cu.
- Type subscripts as normal numbers. Example SiO_2 can be typed in as SiO2.
- Use one level of nesting: $X_2(Y_3Z_4)_2$, where X,Y and Z denote elements.
- Subscripts do not have to be positive integers, so $X_{2.45}Y_{1.34}Z$ is

Calibrating the Histogram

When you select Calibrate from the menu, the screen displays a dialog box to set the three required calibration points:

TABLE 9-3 CALIBRATING A HISTOGRAM

Step	Action
1	Put the cursor at the top of a peak representing a known phase on one of two ways: • Place the mouse cursor on the peak and click with the left mouse button. Release the mouse button. • Grab the line cursor and move it to the desired position. Put the mouse cursor on top of the line cursor. The mouse cursor changes into a hand symbol. Now press the left mouse button and move the line cursor to the desired position. Release the mouse button.
2	Press the button labeled POINT 1. The screen displays the video value associated with the cursor position.
3	Type in the corresponding mean atomic number.
4	Enter calibration points so that Point 1 corresponds to the lowest atomic number and Point 3 to the highest.
5	Be sure to enter three different atomic numbers.

Calibrate the two other histogram peaks.

If some peaks of interest are too small to view adequately, rescale the histogram using the UP and DOWN buttons. The RESTORE button resets the histogram size to its default value.

When you click on OK, the calibration curve is calculated. The software is calibrated for that particular set of beam parameters and detector settings. If the points you entered are not adequate to determine a calibration curve, a dialog box displays.

To stop calibration, press CANCEL.

known phase on one of two ways:
• Place the mouse cursor on the peak and click with the left mouse button. Release the mouse button.
• Grab the line cursor and move it to the desired position. Put the mouse cursor on top of the line cursor. The mouse cursor changes into a hand symbol. Now press the left mouse button and move the line cursor to the desired position. Release the mouse button.
2 Press the button labeled POINT 1. The screen displays the video value associated with the cursor position.
3 Type in the corresponding mean atomic number.

Changing Column Conditions

When your inspection of the histogram requires a change in column parameters, simultaneously press the SHIFT F2 keys. The screen displays the Video control group in the foreground allowing you to make adjustments. When you press SHIFT F2 again, the histogram analysis is displayed as a refreshed graylevel histogram. SHIFT F2 toggles between the two applications.

Select YES to restore the original contrast and brightness settings. The current calibration curve remains valid. When you select NO, the system does not restore column parameters and the calibration curve is deleted; the software needs to be recalibrated.

Inspect

When you select INSPECT, the screen displays a dialog box. The displayed atomic value represents the current cursor position. When you move the cursor, the value is updated continuously. By typing in an atomic value followed by pressing the SET CURSOR button, the cursor is positioned on the corresponding atomic number value in the histogram.

Color

When you select COLOR, the screen displays a dialog box. Use this dialog box to define windows in the histogram, and to show the total area fraction of the phase corresponding with the windows defined.

When the Color Imaging option is installed, the image is shown in colors corresponding to those defined by the windows in the histogram. If the color option is not available, it is possible to see only one phase at the time (in gray) on the right monitor.

current calibration curve remains valid. When you select NO, the system does not restore column parameters and the calibration curve is deleted; the software needs to be recalibrated.

Inspect

When you select INSPECT, the screen displays a dialog box. The displayed atomic value represents the current cursor position. When you move the cursor, the value is updated continuously. By typing in an atomic value followed by pressing the SET CURSOR button, the cursor is positioned on the corresponding atomic number value in the histogram.

Color

When you select COLOR, the screen displays a dialog box. Use this dialog box to define windows in the histogram, and to show the total

To set up a window, follow these steps:

TABLE 9-4 SETTING A COLOR WINDOW

Step	Action
1	Select the Red, Blue, Yellow, or Aqua button; the selected button starts blinking.
2	Create a window using the Click and Drag technique: • Put the mouse cursor on first window boundary. • Press the mouse button and drag the line cursor to the second window boundary. • Release the mouse button; the window is defined and colored.
3	The screen displays a check in the box next to the color button and the area fraction (expressed as a percentage of the total image area) is displayed.

This procedure allows you to define up to four windows. If the color option is available, the corresponding phases are displayed on the left monitor. To temporarily switch off a window, click in the corresponding check box. The related color disappears and the color box is unchecked. Click in the check box to switch on the window again.

Settings

When you select the menu item Settings, a short pull down menu is displayed. Selecting Grayscale! resets all color windows to black and white.

• Put the mouse cursor on first window boundary.
• Press the mouse button and drag the line cursor to the second window boundary.
• Release the mouse button; the window is defined and colored.
3 The screen displays a check in the box next to the color button and the area fraction (expressed as a percentage of the total image area) is displayed.

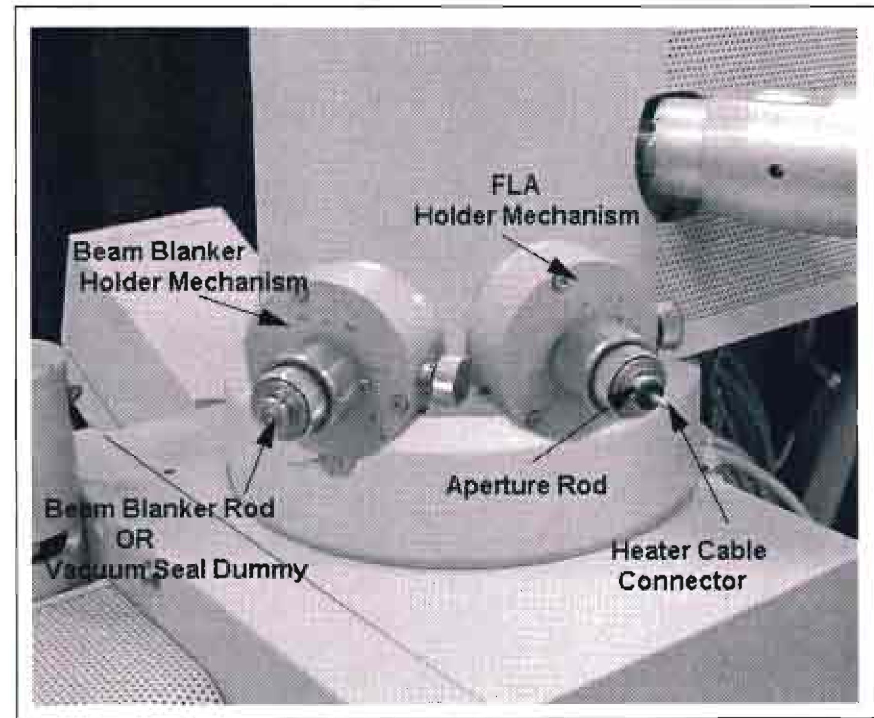
This procedure allows you to define up to four windows. If the color option is available, the corresponding phases are displayed on the left monitor. To temporarily switch off a window, click in the

The Electrostatic Beam Blanker

Overview

On the XL FEG, SFEG and Sirion a 'High-speed electrostatic beam blanker' can be mounted. The XL FEG has the blanking beam operating over a 200 µm aperture which has to be inserted in the final lens.The difference for the SFEG/Sirion blanker is that the blanking of the beam takes place on a 300 µm aperture which is permanently mounted in the column liner tube, just above the scan coils. This aperture replaces the 1.5 mm stray aperture which is located at the top of this lining tube in a standard XL SFEG/Sirion.

FIGURE 9-16 BEAM BLANKER CONTROL FOR SFEG/SIRION



Installing the Beam Blanker

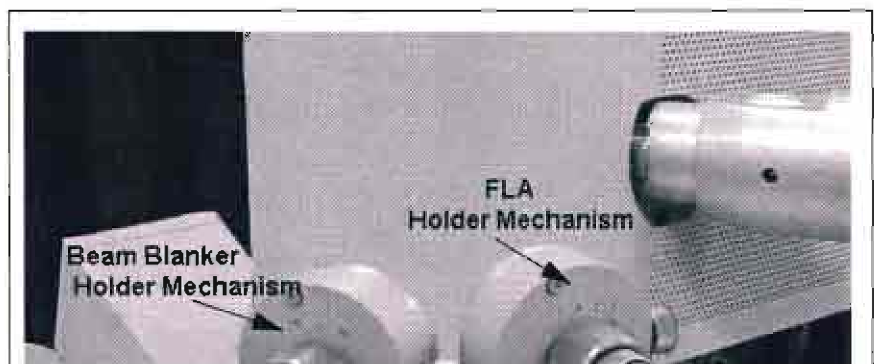
Vent the specimen chamber

Replace the VACUUM SEAL DUMMY in the BB HOLDER MECHANISM just below the FLA HOLDER MECHANISM on the XL FEG column with the BEAM BLANKER ROD.

Pump down the specimen chamber.

aperture replaces the 1.5 mm stray aperture which is located at the top of this lining tube in a standard XL SFEG/Sirion.

FIGURE 9-16 BEAM BLANKER CONTROL FOR SFEG/SIRION



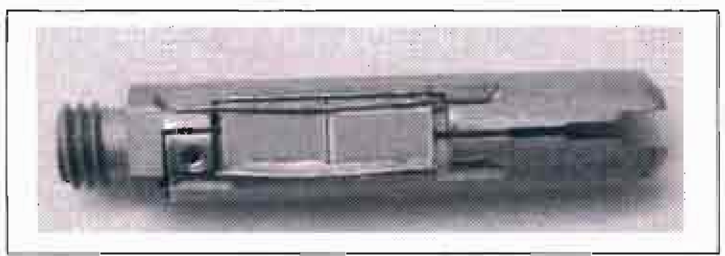
Align the blanking plates in all 4 positions (see below) to the electron beam in the lowest magnification, NOT the other way around!!!

Beam blanking will take place when a +5V signal is applied to the blanking plates. The position of the blanking plates depends on the accelerating voltage of the electron beam:

TABLE 9-5 ALIGNMENT OF PLATES TO KV

High Voltage (kV)	Position	Plate Gap Distance(mm)
>20	1D	0.25
>10	2D	0.5
>5	3D	1.0
>5	4D	2.0

FIGURE 9-17 BEAM BLANKER PLATES



In order to get maximum blanking effect of the beam the APERTURE ROD can be moved a little outwards of the column axis in the direction of the FLA HOLDER MECHANISM. The best position is just before the beam current starts decreasing because of the misalignment of the aperture.

Other options for increasing the On/Off ratio of the blanker are:

- Use a smaller distance between the blanker plates (lower position number) than is prescribed in the table above. This may also increase chances of charging effects on the blanker plates.
- Use a higher voltage on the blanker plates. To allow voltages significantly above the standard value of +5V the 50 Ohm resistor between the plates has been disconnected to prevent overheating

(kV)		Distance(mm)
>20	1D	0.25
>10	2D	0.5
>5	3D	1.0
>5	4D	2.0

FIGURE 9-17 BEAM BLANKER PLATES

When the beam blanker plates are positioned correctly with reference to the electron beam there should be no limitation in the field-of-view of the SEM image. Place the beam blanker in position 4 when it is not in used. Also disconnect the external cable and short-circuit the plates.

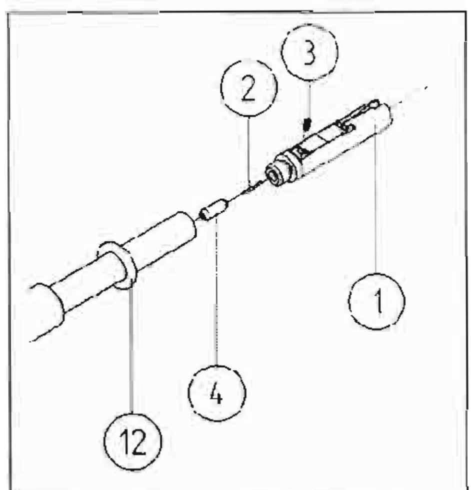
Re-align the FLA for high resolution performance.

CAUTION: Do not fully retract the aperture rod on the XL30 FEG when the Beam Blanker is mounted. You must (partially) retract the Beam Blanker first before the aperture rod can be fully retracted. Otherwise damage to the aperture foil and/or the blanker plates may occur.

Cleaning the Blanking Plates

After intensive use the blanking plates of the Electrostatic Beam Blanker can become contaminated. This will lead to charging and beam drift effects that will make the SEM difficult to use for lithography applications.

FIGURE 9-18 CLEANING THE BEAM BLANKER



For initial cleaning a plasma cleaner is ideal as this can remove hydrocarbon based material very effectively. In cases where the Beam Blanker cannot be cleaned with a Plasma system only because it has been excessively contaminated, follow the procedure described below:

Cleaning of the blanking plates normally involves Cyclo Hexane (or Isopropanol) with ultrasonic aggitation.

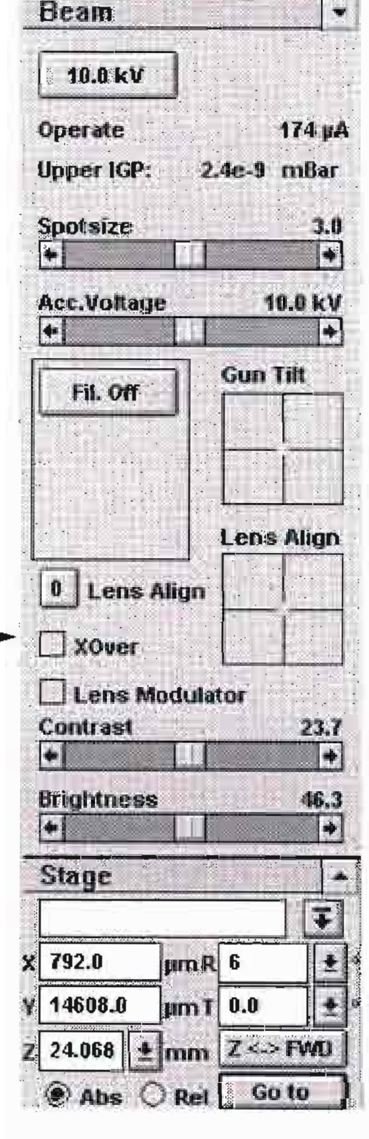
Otherwise damage to the aperture foil and/or the blanker plates may occur.

Cleaning the Blanking Plates

After intensive use the blanking plates of the Electrostatic Beam Blanker can become contaminated. This will lead to charging and beam drift effects that will make the SEM difficult to use for lithography applications.

FIGURE 9-18 CLEANING THE BEAM BLANKER

4. Clean the blanking plates for 15 minutes in a Cyclo Hexane vapour bath.
5. Make sure that all the Cyclo Hexane has left the openings of the blanking plates.
6. Dry the blanking plates with dry nitrogen gas.
7. Do a visual inspection (magnifying glasses, light microscope) for dust particles etc. between the blanking plates. Repeat the cleaning steps 3-6 if necessary.



8. Mount the blanking plates again on the BEAM BLANKER ROD, using <u>clean</u> gloves.
9. Do not touch the blanking plates and repeat inspection of step 7.
10. Measure the resistance between the blanking plates (50 Ohm or infinite in case of a large [>10 V] blanking signal) and the resistance between connector and plates (< 1 Ohm).
11. Short circuit the plates by making contact between the connector kernel and shield.
12. Place the beam blanker in a clean holder and insert in the plasma cleaner.
13. Plasma cleaning: Ar/O 75/25% with 4 V pressure reading for 5 minutes
14. Take the beam blanker out of the plasma cleaner, remove short circuit and repeat step 10.
15. Remove VACUUM SEAL DUMMY from XL-SEM column and put the BEAM BLANKER ROD in without hitting anything inside.
16. Start the Pump on XL-SEM, generate a beam and switch to X-OVER mode found in the enlarged **Beam** control area of MCTRL. Align the blanker plates to the beam for all four positions (gap widths). Also make sure that the plate surface is parallel to the beam.

8. Mount the blanking plates again on the BEAM BLANKER ROD, using <u>clean</u> gloves.
9. Do not touch the blanking plates and repeat inspection of step 7.
10. Measure the resistance between the blanking plates (50 Ohm or infinite in case of a large [>10 V] blanking signal) and the resistance between connector and plates (< 1 Ohm).
11. Short circuit the plates by making contact between the connector kernel and shield.
12. Place the beam blanker in a clean holder and insert in the plasma cleaner.
13. Plasma cleaning: Ar/O 75/25% with 4 V pressure reading for 5 minutes
14. Take the beam blanker out of the plasma cleaner, remove short

APPENDIX

Overview

This Appendix includes the following documents:

- Technical References

Technical References

The following books and periodicals are among those available that provide in-depth background information:

Books

Armstrong, J. (1988). *Microbeam Analyis-1988* (D.E. Newbury, ed.) (San Francisco Press, San Francisco).

Bright, D.S., E.B. Steel and D.E. Newbury (1991). *Microbeam Analysis--1990* (D. G. Howitt, ed.) (San Francisco Press, San Francisco).

Goldstein, Joseph I. et al. (1992). *Scanning Electron Microscopy and X-Ray Microanalysis, 2nd ed.* Plenum Press, New York).

Heinrich, K.F.J., and D.E. Newbury, eds. (1991). *Electron Probe Quantitation* (Plenum Press, New York).

Heinrich, K.F.J., ed. (1968). *Quantitative Electron Probe Microanalysis* (National Bureau of Standards Special Publication 298).

McKinley, T.D., K.F.J. Heinrich, and D.B. Wittry, eds. (1966). *The Electron Microprobe* (Wiley, New York).

Periodicals

Scanning Microscopy

Proc. of Int. Conf. on X-Ray Optics and Microanalysis (Hermann, Paris).

This Appendix includes the following documents:

- Technical References

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Books

Armstrong, J. (1988). *Microbeam Analyis-1988* (D.E. Newbury, ed.) (San Francisco Press, San Francisco).

GLOSSARY

Symbols

kV: see *kilovolt.*

nA: see *nanoamp.*

Ω: see *ohm.*

pA: see *picoamp.*

μA: see *microamp.*

μm: see *micron.*

V: see *volt.*

A

absolute coordinates: coordinates measured from the logical zero of the stage. The opposite of *relative coordinates.*

aperture: the final lens aperture holder contains physical apertures that vary for different imaging needs. See *spotsizes.*

artifacts: smearing that typically occurs with inverted contrast as a result of specimen charging, scan distortions, stray fields, or vibrations.

astigmatism: an imperfection in the circularity of the beams that results in elliptically shaped features in the image. This may be due to the system cleanliness, stray fields, or from the specimen itself.

B

beam blanking: deflecting the beam aside so that it does not hit the specimen.

beam current: the current arising from the electron beam being absorbed by the specimen.

beam diameter: determined by column parameters. Also known as *spotsizes.*

kV: see *kilovolt.*

nA: see *nanoamp.*

Ω: see *ohm.*

pA: see *picoamp.*

μA: see *microamp.*

μm: see *micron.*

V: see *volt.*

A

absolute coordinates: coordinates measured from the logical zero of the stage. The opposite of *relative coordinates.*

C

contrast: a range of brightness between highlights and shadows on a reproduced image.

convolutions: one type of image processing filters used to decrease noise and enhance features.

Controlled Pressure: a mode of vacuum operation that reduces charging. Sometimes referred to as Low Vacuum.

D

delta brightness: the increment by which brightness is changed for each step in the photo calibration routine.

detector: a device for detecting and counting objects or events, often incident-charged particles or photons. In this system, it detects X-rays, photons and electrons generated when the electron beam strikes the sample.

digitize: conversion of analog information into a digital format.

drift: a combination or individual effect of thermal, mechanical and electrical changes that prevents the beam from remaining in the precise initial location.

dynamic range: the full extent of the signal range that can be handled without excessive distortion.

E

earth: see *ground.*

emitter: a substance or electrode that emits particles.

eucentric: in relation to the centre of the field of view; eucentric moves allow the field of view to remain centred even after rotation or tilt.

F

FEG: Field Emission Gun.

field of view: the area of the specimen visible on the video monitor; varies with magnification levels.

frame: rows and columns of pixels from one complete raster scan.

framestore: a dedicated computer processor that implements all storage and processing

delta brightness: the increment by which brightness is changed for each step in the photo calibration routine.

detector: a device for detecting and counting objects or events, often incident-charged particles or photons. In this system, it detects X-rays, photons and electrons generated when the electron beam strikes the sample.

digitize: conversion of analog information into a digital format.

drift: a combination or individual effect of thermal, mechanical and electrical changes that prevents the beam from remaining in the precise initial location.

dynamic range: the full extent of the signal range that can be handled

G

gain: a video system control designed to amplify sample signals until the amplitude matches the separation of the black and white levels. See *brightness*.

gamma correction: software feature used in conjunction with Gain and Bias to provide greyscale correction to enhance detail. Gamma + and Gamma - are available parameters in the computer menus.

greyscale: the number of discrete steps between black and white.

ground: a conducting path between an electric circuit or equipment and the earth. Also known as *earth*.

gun module: the portion of the system, including the emitter, suppressor, extractor, and first condensor lens, that produces the initial electron beam.

H

high tension: synonym for high voltage, anything over 30 volts.

histogram: a global description of the distribution of pixels with respect to greylevel intensity.

HR Mode: High resolution mode of the S-FEG

I

icon: a small symbol indicating a specific software application.

image: a visual representation of the specimen.

image processing enhancements: enhancements applied after the frame has been grabbed.

IMG files: a system file format for stored images or graphics.

interpolation: to fill in missing data based on a chosen method, for example, linear interpolation.

interpolation nodes: points on a line representing greyscale. Computer calculations interpolate (fill in) missing data between the nodes.

K

kernel: the range of neighbouring pixels for which a filter samples.

kilovolt (kV): 10^3 volts.

ground: a conducting path between an electric circuit or equipment and the earth. Also known as *earth*.

gun module: the portion of the system, including the emitter, suppressor, extractor, and first condensor lens, that produces the initial electron beam.

H

high tension: synonym for high voltage, anything over 30 volts.

histogram: a global description of the distribution of pixels with respect to greylevel intensity.

HR Mode: High resolution mode of the S-FEG

I

L

last position: the last predefined position saved in the stage table to which the stage will drive.

LaB_6: Lanthanum Hexaboride crystal used as a source material for emitting electrons.

M

microamp (μA): 10^{-6} amp

micron (micrometer) (μm): 10^{-6} meter.

micron bar: a bar that shows distances in microns in relation to the current magnification of the displayed image.

mrad: milliradian, one thousandth of a radian (10^{-3}).

N-O

nanoamp (nA): 10^{-9} amps.

ohm (Ω): measurement of electric resistance.

P

picoamp (pA): 10^{-12} amps

pixel: a picture element or data bit from the image.

R

ramp: rate at which something is changing.

raster scan: a left-to-right, top-to-bottom (X,Y) movement of the beam. This series of lines is shifted slightly from one axis to the other. A raster, while appearing continuous, consists of as many as one million individual locations (pixels) that the beam visits.

real time enhancements: enhancements applied during the imaging process.

relative coordinates: coordinates measured from the present location on the stage. See *absolute coordinates.*

micron (micrometer) (μm): 10^{-6} meter.

micron bar: a bar that shows distances in microns in relation to the current magnification of the displayed image.

mrad: milliradian, one thousandth of a radian (10^{-3}).

N-O

nanoamp (nA): 10^{-9} amps.

ohm (Ω): measurement of electric resistance.

P

picoamp (pA): 10^{-12} amps

S

sample: see *specimen*.

scan: the collection and amplification of the signal emitted by the specimen surface as it is illuminated with the primary beam. Scans, normally done in a regular pattern called a *raster*, can be stored or manipulated for later access of data.

secondary electrons (SE): electrons leaving the specimen surface after the beam strikes it.

source: the emitter, including the suppressor, from which the electron beam is generated. Also known as *emitter*.

specimen: also known as *sample*; the item to be imaged.

specimen alignment: a method that associates stage points with user-defined labels to set up a mapping between stage and user coordinate systems.

specimen chamber: includes the specimen stage and other supporting equipment; where the specimen is placed under vacuum.

specimen charging: typically seen in nonconducting specimens while operating at voltages other than E^2 (charge neutral). Positive charging is self-balancing; negative charging creates image artifacts (smearing with inverted contrast).

specimen coordinates (uu): see *user-defined units*.

specimen stage: a platform that supports and positions the specimen.

spotsize: Spotsize has an assigned number that ranges from 1 to 7, with numbers corresponding to beam currents from low to high. It is proportionally related to aperture size, beam current (given in pA), and beam voltage (given in kV).

stage coordinates (µm): actual physical location on the stage from the 0,0 centre; given in microns.

specimen current: amount of current measured at the sample surface. Also known as *sample current*. See *beam current*.

stigmator: adjusts the shape of the beam by applying currents to quadrupole correction coils. See *astigmatism*.

T

TIFF files: a standard file format for stored images or graphics; acronym for Tagged Image File Format.

tip: the essential part of the source emitting the electrons

source: the emitter, including the suppressor, from which the electron beam is generated. Also known as *emitter*.

specimen: also known as *sample*; the item to be imaged.

specimen alignment: a method that associates stage points with user-defined labels to set up a mapping between stage and user coordinate systems.

specimen chamber: includes the specimen stage and other supporting equipment; where the specimen is placed under vacuum.

specimen charging: typically seen in nonconducting specimens while operating at voltages other than E^2 (charge neutral). Positive charging is self-balancing; negative charging creates image artifacts (smearing with inverted contrast).

specimen coordinates (uu): see *user-defined units*.

U-V

UHR Mode: Ultra-High Resolution Mode of the S-FEG.

User Units (UU) coordinates: coordinates specified by the user during 3-point alignment and shown as UU on the Static User Interface.

video monitor: the main display screen for specimen viewing and software manipulation.

W

working distance: the distance from the bottom of the final lens to the specimen surface, otherwise known as the free working distance (FWD).

W

working distance: the distance from the bottom of the final lens to the specimen surface, otherwise known as the free working distance (FWD).