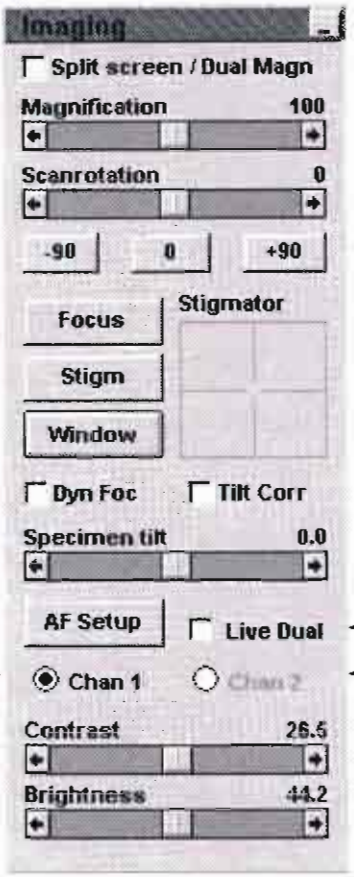
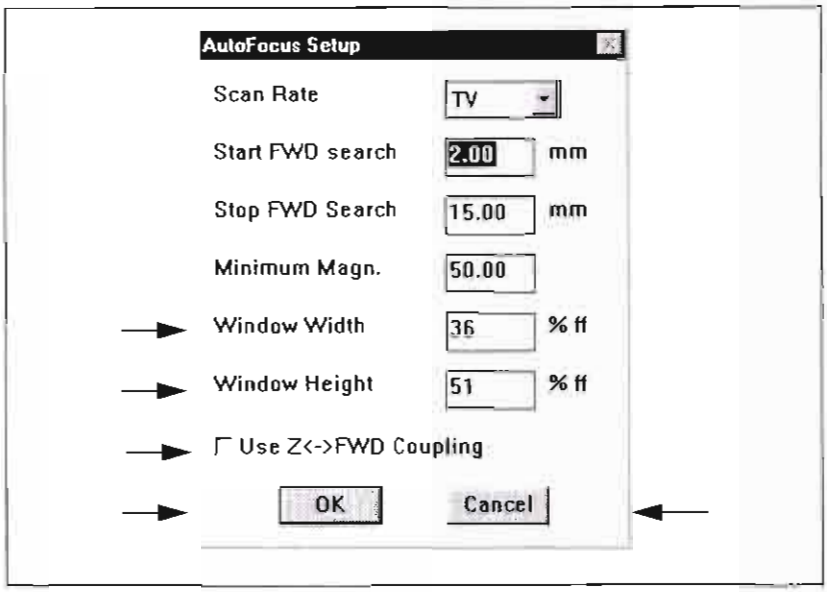




Window Width/Height

The window is the sensitive area of the image. Put the feature in the centre of the screen. Type in the edit box the percent of full frame (% ff) to size the window for more precise, faster autofocus.

If working with highly tilted specimens, decrease the window height to increase the speed of the autofocus routine.

Use Z<>FWD Coupling

When this check box is ticked it restricts the search range to the region of the focal condition.

OK

Click on OK to save changes before exiting the Setup dialogue box.

CANCEL

Click on CANCEL to close the Setup dialogue box without saving any changes.

Live Dual

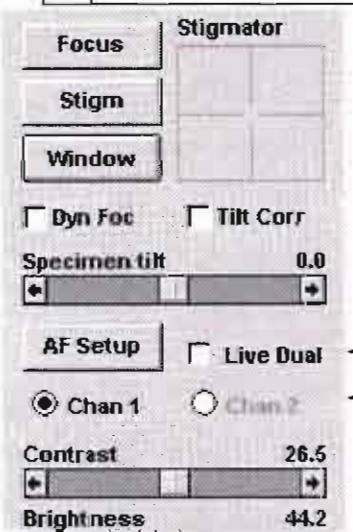
If the system is equipped with an optional second monitor, Live Dual can be used to compare the condition of two live signals. The system must be in Live, Slow scan mode for this process.

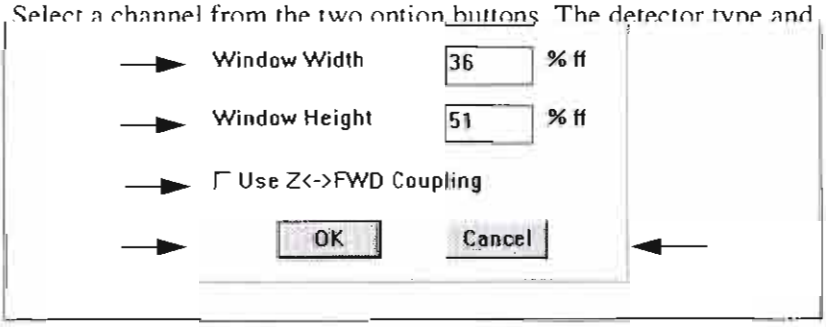
Chan 1/ Chan 2

Select a channel from the two option buttons. The detector type and

NOTE

Other imaging and framestore functions such as dual magnification and autofocus should not be used during Dual Live imaging.



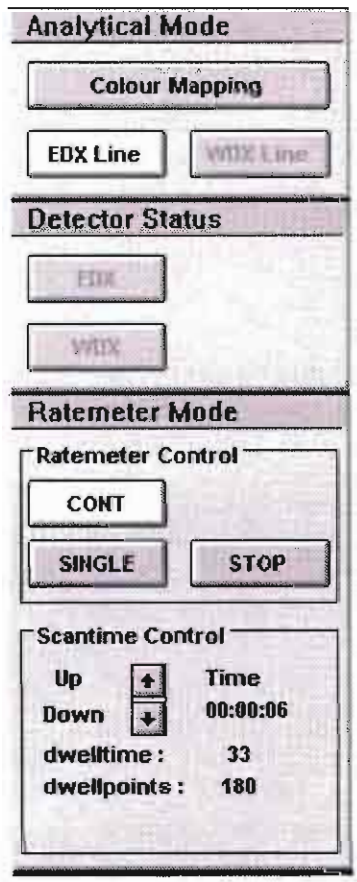


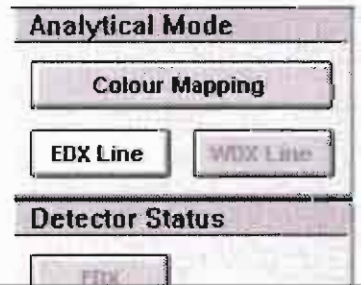
Window Width/Height

The window is the sensitive area of the image. Put the feature in the centre of the screen. Type in the edit box the percent of full frame (% ff) to size the window for more precise, faster autofocus.

If working with highly tilted specimens, decrease the window height

Analytical (Optional)





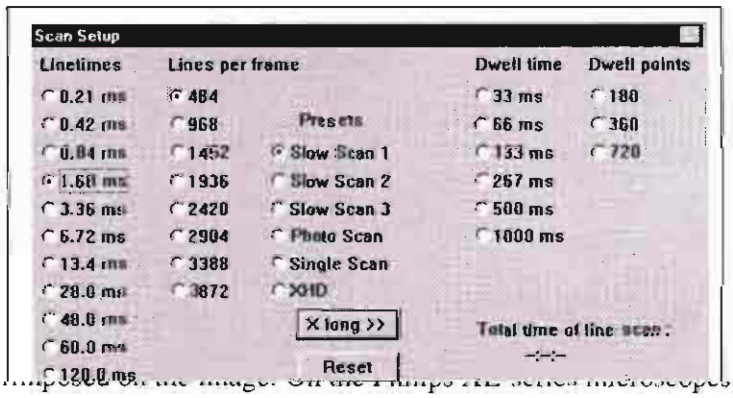
Elemental line scan

EDX Line

If you have the EDX option, the Analytical control area will display on your system.With the addition of an Energy Dispersive X-ray system (EDX) it is possible to make a horizontal line scan across an area of interest, with the corresponding analogue output (ratemeter) superimposed on the image. On the Philips XL-series microscopes, the control area 'Analytical' shows the buttons EDX line and WDX line. The operation for both EDX and WDX line is the same, as far as the microscope is concerned. Prior to operation of the EDX line scan, make sure that all parameters are correct, like count rate, spot size and focus and that the area of interest is shown on the screen. As line scans are made only in the horizontal direction, application of scan rotation for proper orientation might be necessary.

When the EDX line button is clicked, the instrument will be set to line scan mode, using the default line scan setting of 6 seconds. The frame store will be frozen and a line is displayed on top of the image. The dashed lines correspond to the minimum and maximum cps for the selected peak (on the MCTRL image). A line scan can only be made for one element at a time.

The microscope conditions of the line scan can be modified by clicking on the window buttons arrow up/arrow down under 'Scantime Control'. Both dwelltime and number of dwellpoints can be modified. When new settings are made, the response of the system is a little slow, due to the internal synchronisation of the newly selected line scan. It is also possible to modify these features on the Scan pull down menu. In the lower right hand corner the button XLONG has turned yellow. When clicking this button the dwelltime and dwellpoints can be set immediately.



the control area 'Analytical' shows the buttons EDX line and WDX line. The operation for both EDX and WDX line is the same, as far as the microscope is concerned. Prior to operation of the EDX line scan, make sure that all parameters are correct, like count rate, spot size and focus and that the area of interest is shown on the screen. As line scans are made only in the horizontal direction, application of scan rotation for proper orientation might be necessary.

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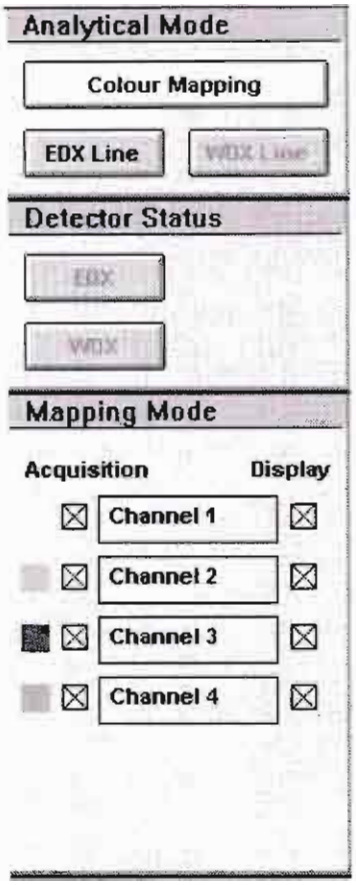


Elemental Mapping

The distribution of elements within the sample is often considered more important than the elemental concentration. X-ray mapping, developed as a means of analysing the distribution of elements within the sample, is performed by sending X-ray pulses to modulate the brightness of the SEM's CRT during raster scanning. X-ray pulses appear as dots on the CRT, which is scanned synchronously with the electron beam. The resulting X-ray image displays a higher density of X-ray pulses (dots) where the concentration of a particular element is greater and fewer dots at areas of low concentration.

Normally it is possible to map one element at a time, with a colour option it is possible to map four elements at the same time. There are four different channels available to select a region of interest (ROI).

The quality of the dotmap depends on several parameters. One of the most important parameters is line time. By increasing the line time a better dotmap is made. An other possibility is to decrease the time constant of the detector to 20 msec. This means a higher throughput of cps, so a more intensive mapping is the result. The resolution will also decrease, but for mapping this is less important.

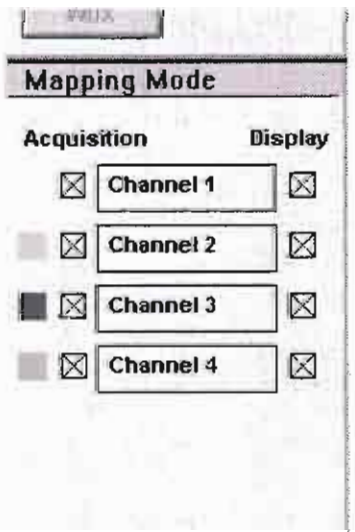
Between the combination Philips XL series microscopes and the EDAX DX4i, two mapping configurations are possible.

Colour mapping

On the Analytical page a button Colour mapping is present which when pressed configures the system in a certain way. For example a standard line time of 40 msec is chosen.

A simultaneous input of up to four channels can be selected. In the case of a WDX system being on the microscope, channel 4 will be automatically assigned to pulses from the WDX system. The other three channels are used for EDX mapping. Another slow scan rate may be selected, or slow scan 3 may be redefined to any other value longer than the default value of 40 msec.

Integration can be selected in the Filter menu. The instrument will then start with a Boolean integration: a pixel will be set (=dot on) if a pixel was already set, or a new pulse has been received. In this way the number of dots will increase with each frame, and hence the signal-to-noise ratio will gradually improve.



X-ray pulses (dots), where the concentration of a particular element is greater and fewer dots at areas of low concentration.

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Between the combination Philips XL series microscopes and the EDAX DX4i, two mapping configurations are possible.

The intensity of the pulses can be changed by changing the line time. When the line time is increased, pulses dwell on the CRT longer, appearing more intense (brighter) and larger in size.

The variable line time is particularly useful when X-ray intensity is low. By increasing line time, the dots become brighter and easier to see. By increasing the line time, dot size and brightness may be raised to a satisfactory level.

NOTE: When analysing an unpolished specimen, topographical features may attenuate the X-ray signal. Shadowing effects decrease the dot density in certain areas of the X-ray image. The analyst should be aware of this when analysing an unpolished or rough sample.

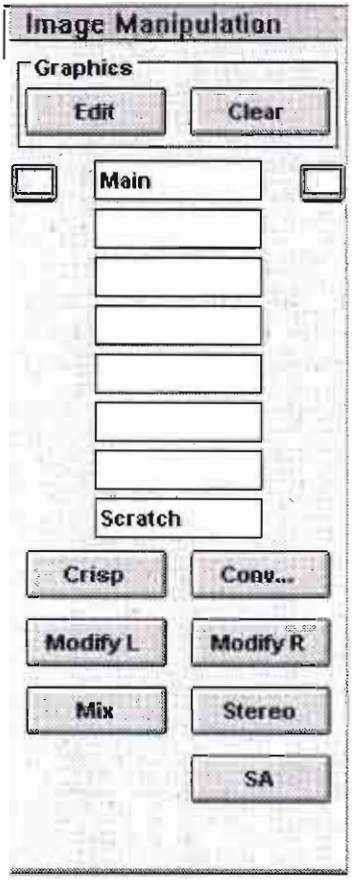
Further information can be found in Chapter 5 "*Using the EDX Analytical Functions*".

NOTE: When analysing an unpolished specimen, topographical features may attenuate the X-ray signal. Shadowing effects decrease the dot density in certain areas of the X-ray image. The analyst should be aware of this when analysing an unpolished or rough sample.

Further information can be found in Chapter 5 "*Using the EDX Analytical Functions*".

Image Manipulation

WITH COLOUR OPTION



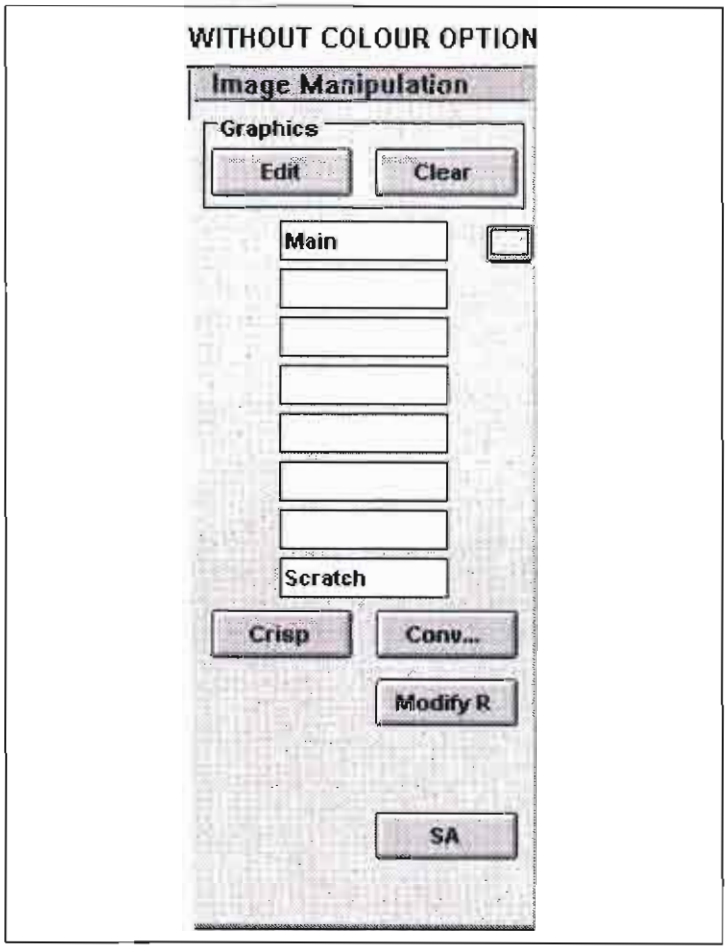
Overview

Use the Image Manipulation control area to edit or clear a graphics image. You can crisp the image, enhance resolution, converge graphic images, apply gamma curves, and colour-code images.

Use these controls after you have obtained a satisfactory image and stored it in the computer as a live or frozen image. You can manipulate images with text annotation, use image memory, and perform digital operations on the image.

The Image Manipulation control area also includes the same Stage control group as the other control areas.

Without the colour option, the control area will look like this:



perform digital operations on the image.

The Image Manipulation control area also includes the same Stage control group as the other control areas.

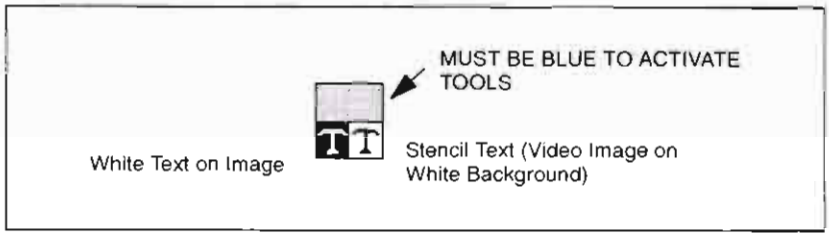
Without the colour option, the control area will look like this:

Graphics

Select GRAPHICS to switch on the graphics toolbox. You will have different tools available to use depending on which graphics card you have on your system.

The standard toolbox looks like this:

FIGURE 4-4 GRAPHICS TOOLBOX: Standard



You have two options for writing text on the image:

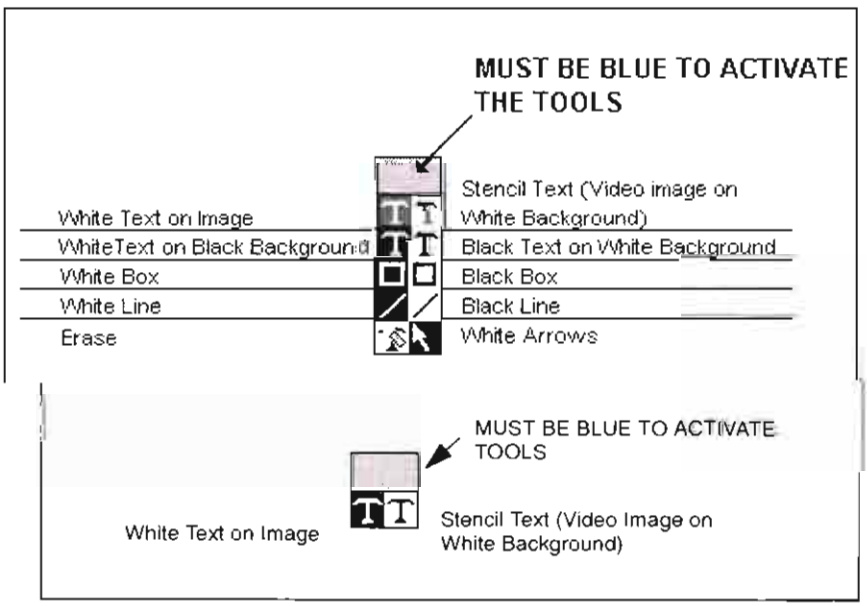
- White text on the image
- Stencil text (video image on white background)

The generated graphics are on a separate overlay that does not modify the image itself. The text can be stored on hard disk for standard definition images.

Extended Graphics

With the optional extended graphics card, you have more tools to work with. You can write text, draw lines, boxes and arrows, or remove text from images.

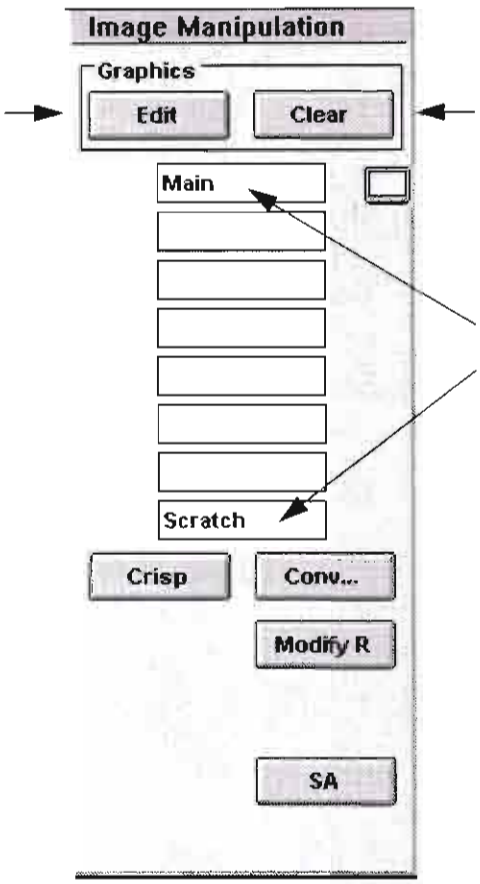
FIGURE 4-5 EXTENDED GRAPHICS TOOLBOX: Option



You have two options for writing text on the image:

- White text on the image
- Stencil text (video image on white background)

The generated graphics are on a separate overlay that does not modify the image itself. The text can be stored on hard disk for standard definition images.



Edit

Click on EDIT to switch on the graphics editor. A small graphics toolbox appears in the top left corner of the image, giving several options to choose from. This is the same functionality as the GRAPHICS button on the Imaging control area. You can write text, draw lines, boxes and arrows, or remove text from images.

The graphics generated are on a separate overlay that does not modify the image itself. You can choose whether to save these graphics with the image from the Save or Restore Image dialogue box.

Clear

Click on this button to clear all the graphics content of the image. The graphics generated are on a separate overlay plane; the image itself is not modified. The text cannot be stored on hard disk.

Image Memory

Main Memory

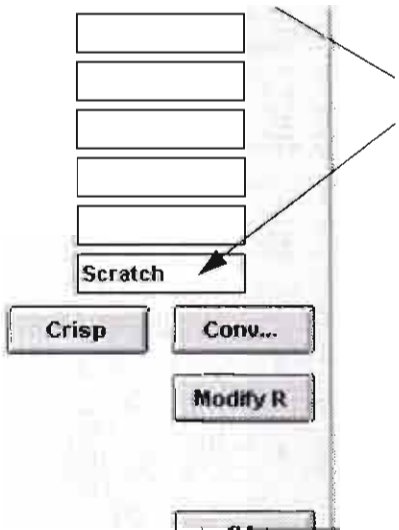
Main memory is used with live images for photography, video printing and loading of images from the hard disk back into the system. If the Integrate or Average function has been selected, the main memory and the scratch memory work together with the true image information being stored in the main memory.

Scratch Memory

Scratch memory is temporary memory that the system uses only when required. The contents of the scratch memory may disappear during normal use.

The Scratch memory is always used by the system when:

- The system is in Averaging or Integration mode
- The Crisp function is used
- The Convolution function is used.



the image from the Save or Restore Image dialogue box.

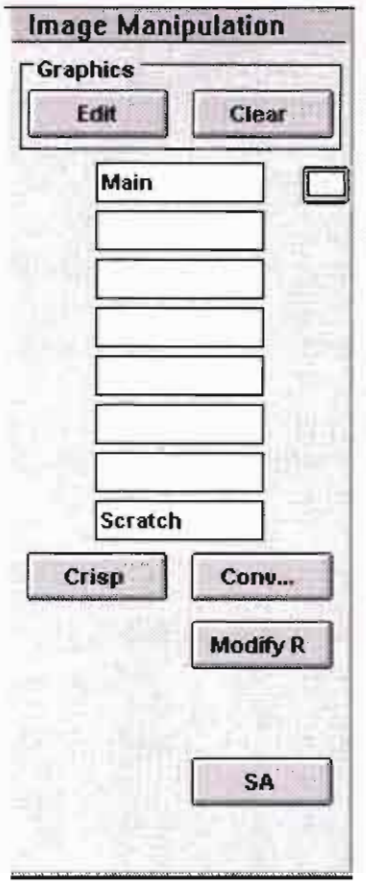
Clear

Click on this button to clear all the graphics content of the image. The graphics generated are on a separate overlay plane; the image itself is not modified. The text cannot be stored on hard disk.

Image Memory

Main Memory

Main memory is used with live images for photography, video printing and loading of images from the hard disk back into the system. If the Integrate or Average function has been selected, the main memory and the scratch memory work together with the true image information being stored in the main memory.



Framestore Memory

The Image Manipulation control area shows two high definition memory planes available instead of the eight standard memory planes. If no averaging or integration is used, one high definition image can be stored in direct memory, together with one live image.

Other Memory

You can copy standard definition images to these memory planes at any time.

Monitor Symbol

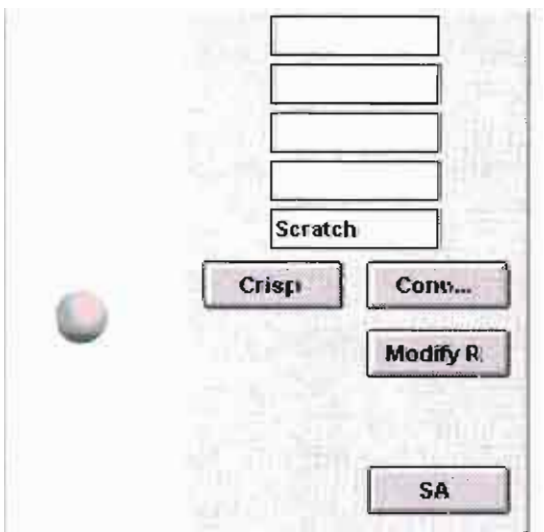
A monitor symbol appears to the right of the Main memory field. It represents the main monitor (the one with the software control area in overlay). Click and drag on the monitor to move it next to another memory field. When you release the button, the image of that memory is visible on the right monitor.

The left monitor (available with colour option) can be connected the same way to one of the memory planes. The images on the left and right monitors are independent. Note that the image in the main memory (the first one of the list) can be live and the monitors could show one live and one frozen image (such as a previous image of the specimen stored on hard disk).

Image Name and Image Copy

The name of each image (memory plane) can be typed in to simplify recognition. In principle, images are generated in the main memory. Once an acceptable image is obtained, copy it into one of the other memories by clicking and dragging the name of the memory plane to another plane and rename it accordingly.

Images can also be copied directly from the selected memory plane (selected with the right monitor symbol, and visible on the right monitor) onto the hard disk of the system. Move the image to the main memory plane, then save it as an IMG or TIFF file with the Save or Restore Image dialogue box accessed by clicking on Image in the In/Out pulldown menu.

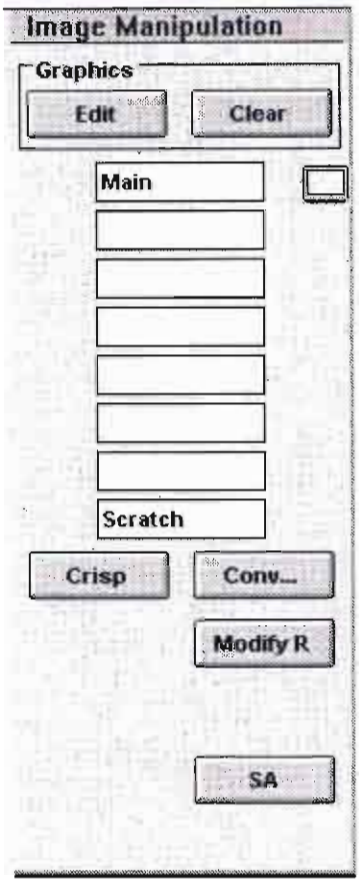


Monitor Symbol

A monitor symbol appears to the right of the Main memory field. It represents the main monitor (the one with the software control area in overlay). Click and drag on the monitor to move it next to another memory field. When you release the button, the image of that memory is visible on the right monitor.

The left monitor (available with colour option) can be connected the same way to one of the memory planes. The images on the left and right monitors are independent. Note that the image in the main memory (the first one of the list) can be live and the monitors could show one live and one frozen image (such as a previous image of the specimen stored on hard disk).

Image Name and Image Copy



Crisp

Crisp is a special case of the convolution function, allowing omnidirectional differentiation. It is very useful for improving noise-free images at low kV, with limited sharpness. This function represents a 3 x 3 matrix operation on a stored image. You cannot change the applied matrix. It results in sharpening of the image (a little bit of derivative is mixed in with the original image).

A click on this button results in a freeze of the image and a calculation of the result. The input image for this operation is the one stored in main memory. The result of the operation is put in the scratch memory as well as in the main memory.

If your system has more memory, make a copy of the image in memory before using the CRISP button. Then you can compare the original image with the crisp image by viewing the different memory contents.

Conv... (Optional)

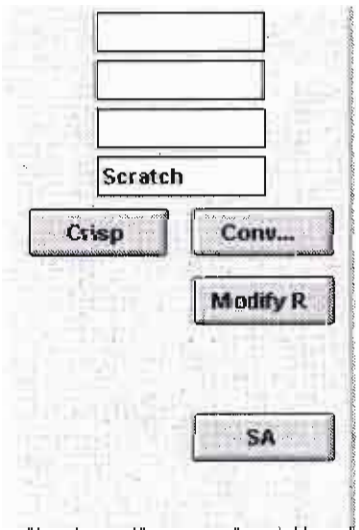
This button is inaccessihle unless the system is equipped with the customized convolution option. Convolutions apply algorithms to a grabbed image to enhance various aspects of it, such as edge enhancement, region thinning, crisping, etc.

This function allows you to define a matrix (up to 5 x 5 elements) to use for enhancement of an image in the framestore. As matrix elements, various weight factors for each pixel can be used.

This function uses the image in the main memory as the input image (standard definition). The result is calculated in the system's framestore and put back in the main memory. A copy of the result is in the scratch memory.

To compare the result of an operation with the original image, make a copy of the image prior to operation (either on hard disk or into one of the other framestore memories).

Also, when defining and experimenting with matrices, it is recommended to store the image, set up a matrix and study the result. If the result is not satisfactory, copy the original image back again into the main memory, modify the matrix and repeat the operation.



of the result. The input image for this operation is the one stored in main memory. The result of the operation is put in the scratch memory as well as in the main memory.

If your system has more memory, make a copy of the image in memory before using the CRISP button. Then you can compare the original image with the crisp image by viewing the different memory contents.

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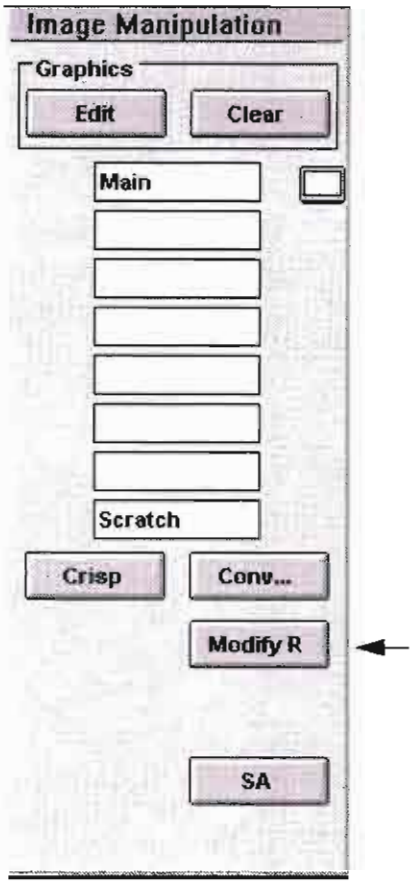
This button is inaccessible unless the system is equipped with the customized convolution option. Convolutions apply algorithms to a grabbed image to enhance various aspects of it, such as edge enhancement, region thinning, crisping, etc.

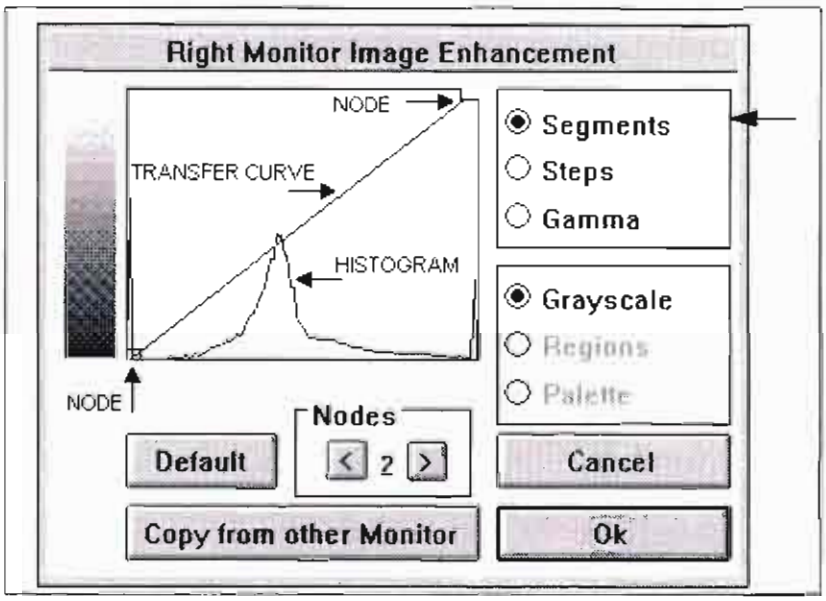
This function allows you to define a matrix (up to 5 x 5 elements) to



Modify R (Right)

Images can be enhanced by digital manipulation of the greylevels. The enhancement is copied if the image is copied into another memory of the framestore.

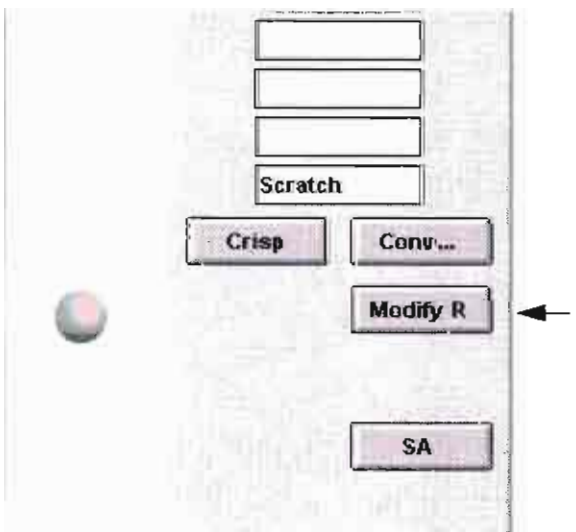
Clicking on the MODIFY R (for right monitor) button brings up a dialogue box for user input. The dialogue box can be moved anywhere on the screen by clicking on its title bar and dragging it to a new location.

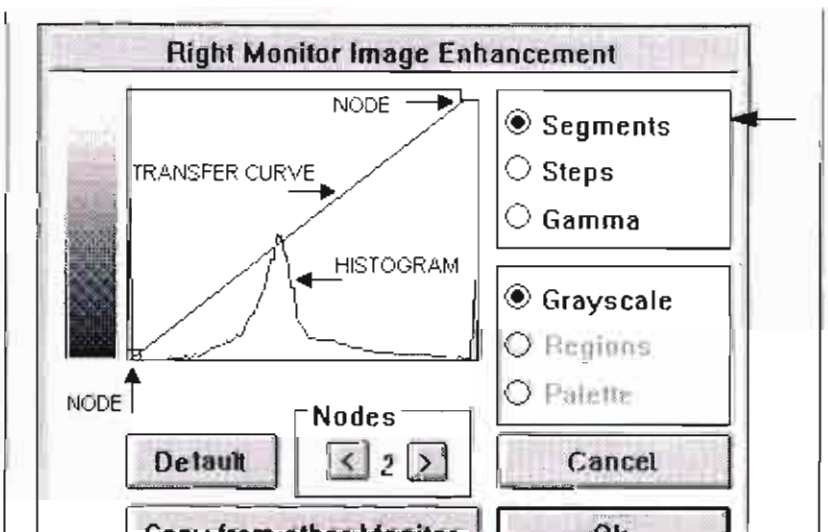


A graphical presentation of the histogram (blue) is in overlay with the transfer curve (black). The horizontal axis for the transfer curve represents the range from black to white. The vertical axis represents the output after application of the transfer curve, also ranging from black to white.

Segments

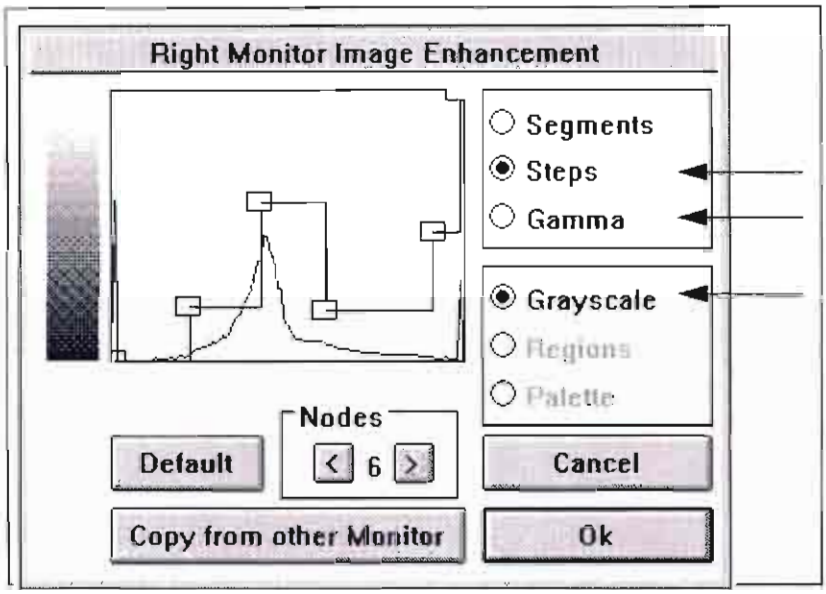
Choosing Segments implements a linear method of interpolation between the nodes.





Steps

Choosing Steps implements a user-defined posterization method of interpolation that links the nodes in a stair-step fashion. It results in a high contrast image with fewer grey scale levels. Black, dark grey, light grey and white is an example of four-level posterization.



Gamma

Gamma is the standard curve for non-linear transfer of greylevels. It has only one node to define the strength of the gamma operation. Gamma is sometimes used to get more detail out of relatively black parts of the specimen (such as holes) without getting too much white on the image.

Gamma correction adjusts the midtone contrast and the brightness of an image.

Grayscale

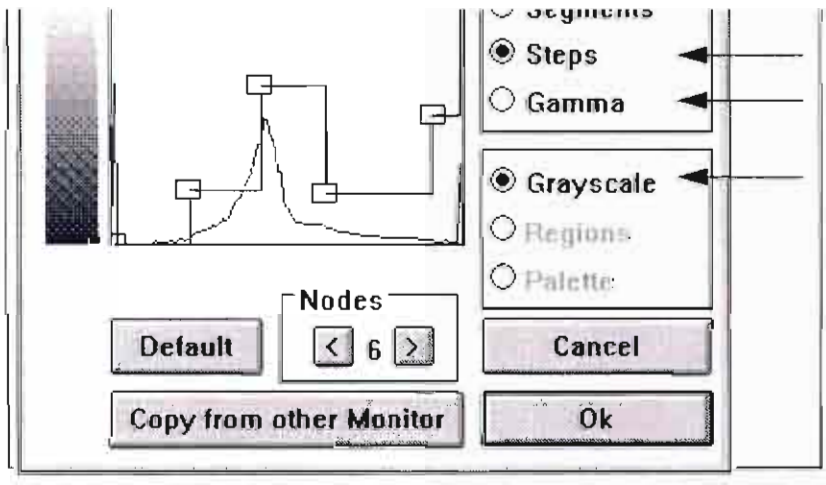
With this selected, output colours are greyscale only.

Regions

Available only with the colour option.

Palette

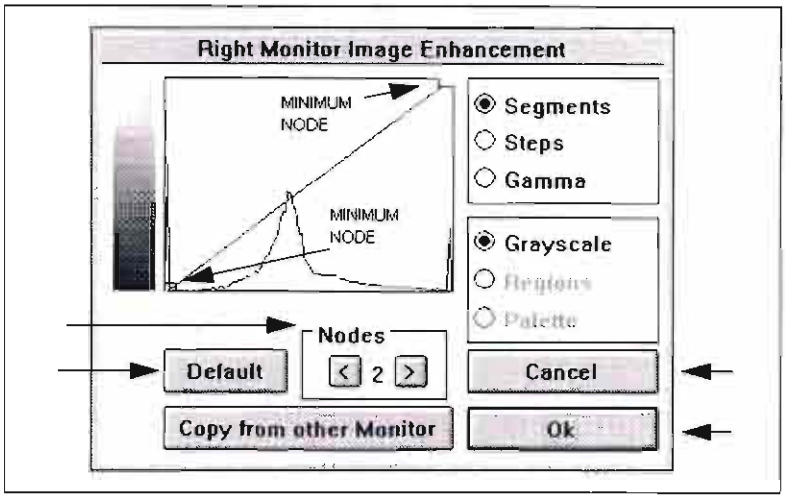
Available only with the colour option.



Gamma

Default

Use this command button to return to default node settings.



Nodes

The number of interpolation nodes, from two to six, can be selected with the left and right arrow buttons. The computer interpolates, or fills in missing data, between the nodes.

To move a node, click on it and drag it to any position in the box. The effect on the image will be shown immediately. To delete a node, click on the left arrow button.

The two minimum nodes are anchored at the left and right sides of the box. These nodes can be dragged vertically but not horizontally. To manipulate contrast and brightness, slide the two nodes up and down.

Copy from other Monitor

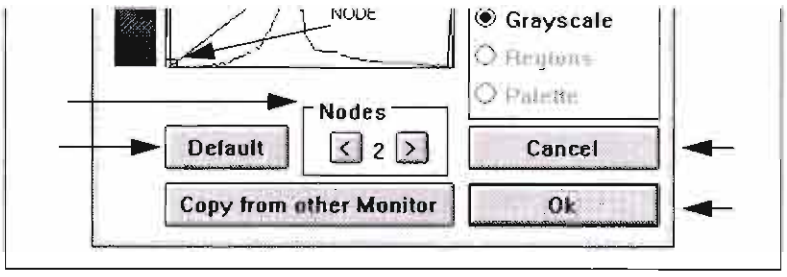
Available only with the colour option.

Cancel

Choose CANCEL to exit the dialogue box without saving changes.

OK

Choose OK to save changes before exiting dialogue box.



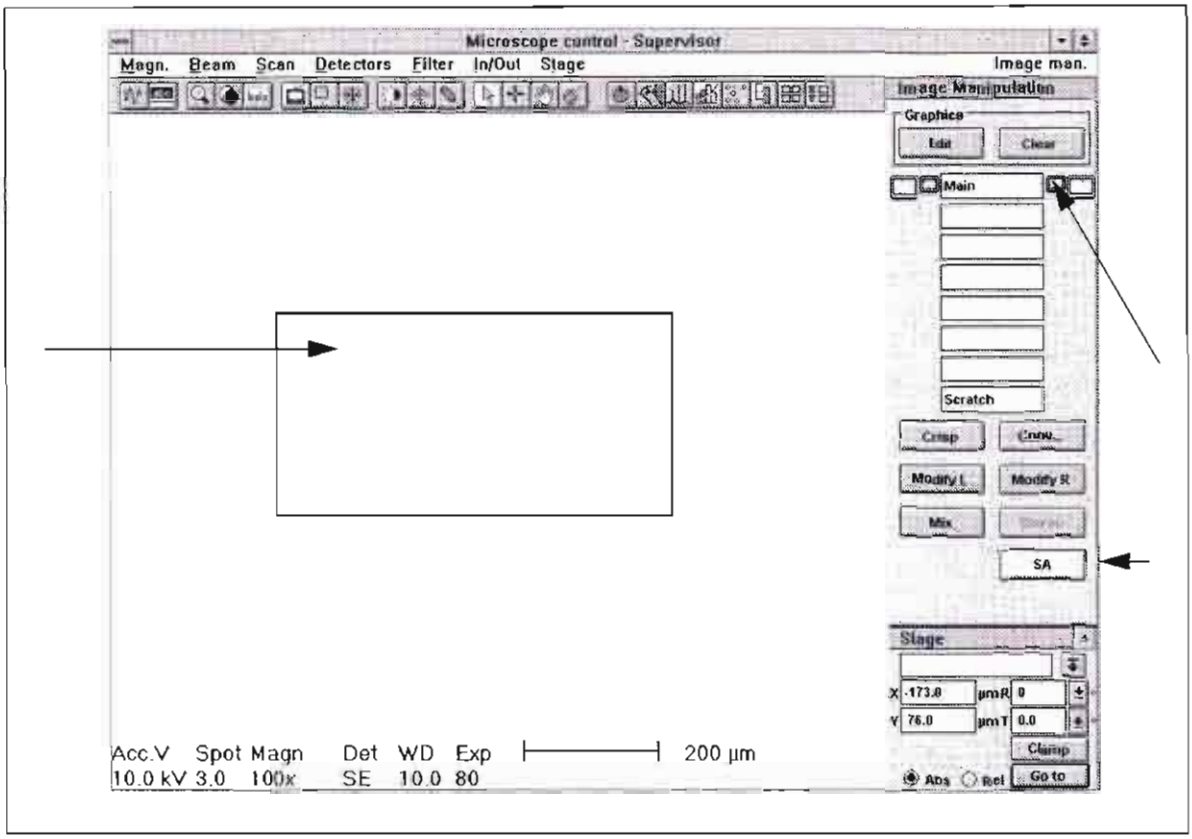
Nodes

The number of interpolation nodes, from two to six, can be selected with the left and right arrow buttons. The computer interpolates, or fills in missing data, between the nodes.

To move a node, click on it and drag it to any position in the box. The effect on the image will be shown immediately. To delete a node, click

SA (Selected Area)

When SA is selected, the button turns yellow and an additional small monitor is displayed next to the Main memory field. The reduced area shows in this small monitor and a "picture-in-picture" shows onscreen.



Selected Area can be used to see a part of an image stored in an image memory within the total frame of another image from another memory plane.

Live Images

If the selected memory is showing a live image, the corresponding frame image or SA image will do the same.

Processed Images

If the selected memory is showing a processed image (such as TV/Average), the frame image will show the processed image, but the SA image will show the live image (or, if the scratch memory is used, no image).

Second Monitor

If you have a second monitor on you system, a green overlay is displayed on it, indicating the position and size of the viewing window. This box can be moved in the same way as the Selected Area from the Scan pulldown menu, by clicking in the box and moving it across the image screen, or by clicking outside the box to define a new selected area.

The monitor icons displayed next to a memory plane can be repositioned by clicking and dragging with the mouse. The moment the monitor icon is released next to a memory plan, that memory becomes active and the corresponding image on the monitor is adapted accordingly.

The Scratch memory plane can also be used for this operation, but make sure the framestore is not in a processing mode such as averaging or integrating. Also note that the lookup table as addressed by "modify left" and "modify right" only influences the frame image and not the selected area image.

repositioned by clicking and dragging with the mouse. The moment the monitor icon is released next to a memory plan, that memory becomes active and the corresponding image on the monitor is adapted accordingly.

The Scratch memory plane can also be used for this operation, but make sure the framestore is not in a processing mode such as averaging or integrating. Also note that the lookup table as addressed by "modify left" and "modify right" only influences the frame image and not the selected area image.

Survey

The Survey control area allows a survey of the specimen surface to be easily made. It is used for storing specimen positions with their associated microscope parameters (the same parameters as those used for storage on hard disk). The positions can be easily reviewed for further inspection.

Survey Mode

Start

Click on START. The button changes from grey to yellow, indicating the procedure has started. The survey magnification is now recorded. This is the magnification value that the system will switch back to in between the selection of various points of interest. It defines the reference frame (image) for the Survey mode.

When making a list of features, you can define a new reference frame by clicking on START again. The system will take the current condition as the new reference frame without losing the positions of the features already stored in the list.

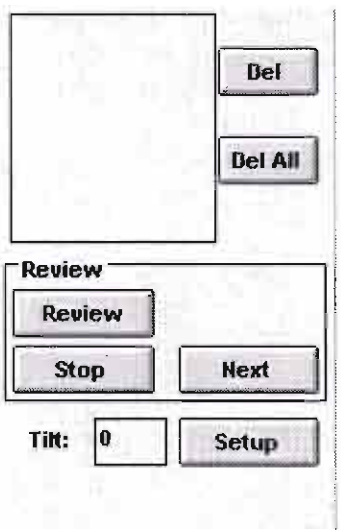
End

Click on END to switch off Survey mode. A dialogue box displays a confirmation indicating that all stored specimen positions will be lost.

Survey

Click on SURVEY to start the actual collection mode. The button stays yellow as long as this mode is active. Collection is also initiated automatically when the START button is clicked.

The system can either be in Survey mode (collection of positions) or in Review mode (for a review of already collected positions). The cursor becomes a green cross, indicating that the Get function is active.



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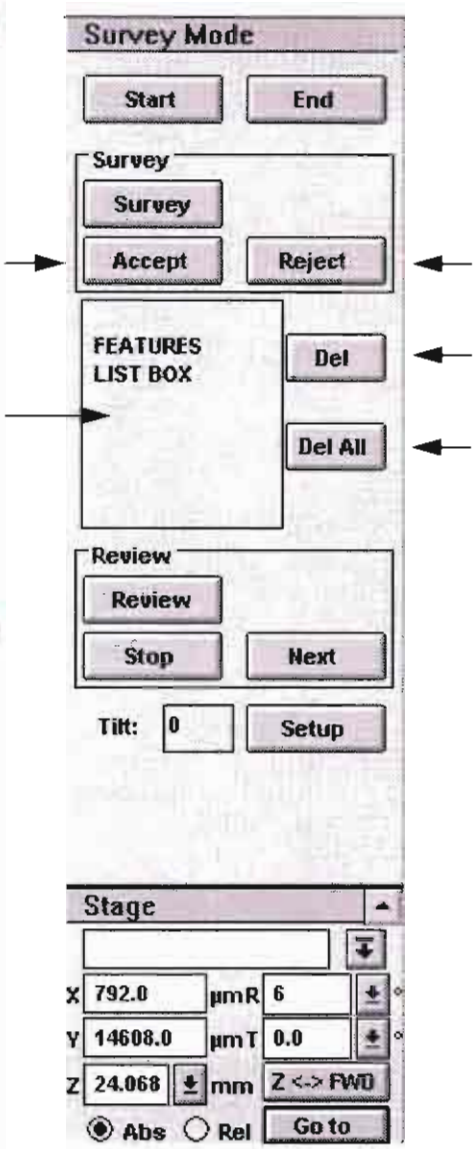
When making a list of features, you can define a new reference frame by clicking on START again. The system will take the current condition as the new reference frame without losing the positions of the features already stored in the list.

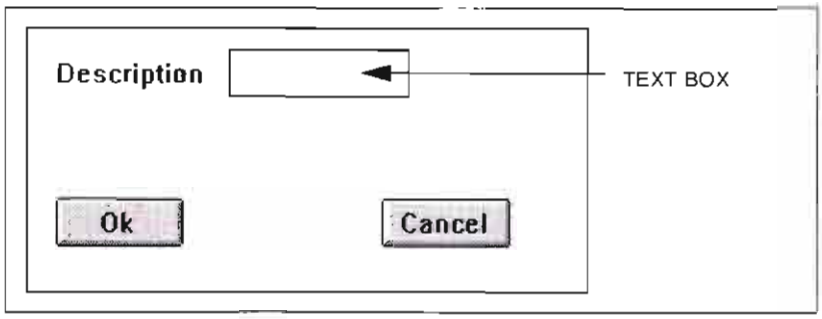
End

Click on END to switch off Survey mode. A dialogue box displays a confirmation indicating that all stored specimen positions will be lost.



Accept

Click on ACCEPT to save the actual position and all its associated microscope parameters. A dialogue box displays.



Type a label description in the text box. The label will automatically be extended with an incremented number, so don't enter your own numbering. Once the label is entered, it will appear in the features list box on the Survey control area.

Reject

Click on REJECT to restore the condition of the system as it was before the zoom function was activated. The stage position is not changed and no data is saved for later reference.

Features List Box

The features list box contains a label catalog of stored positions and their associated microscope parameters. It is used only in the Review process and is not saved once you are through with your session.

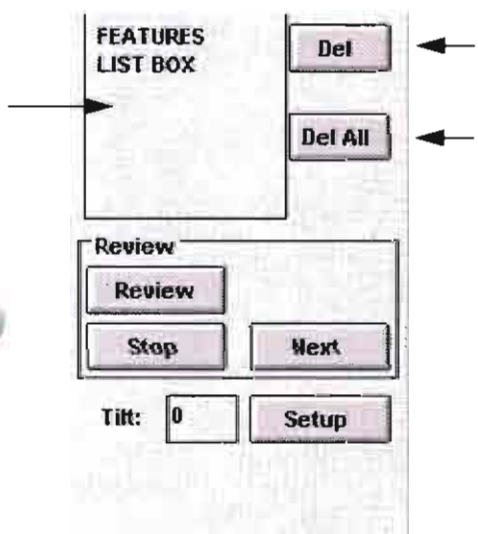
Click once on a label to make the position active. Double-click on a label for an actual retrieval of the position by the microscope.

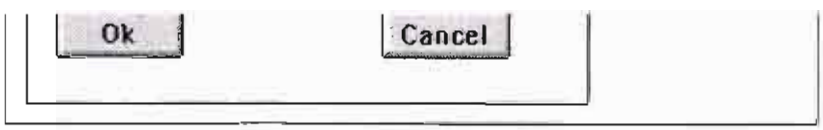
Del

Use DEL to selectively eliminate choices in the features list box. Click on DEL to delete the currently active position, highlighted in the features list box.

Del All

Click on DEL ALL to delete all positions from the features list box. A dialogue box appears for confirmation.



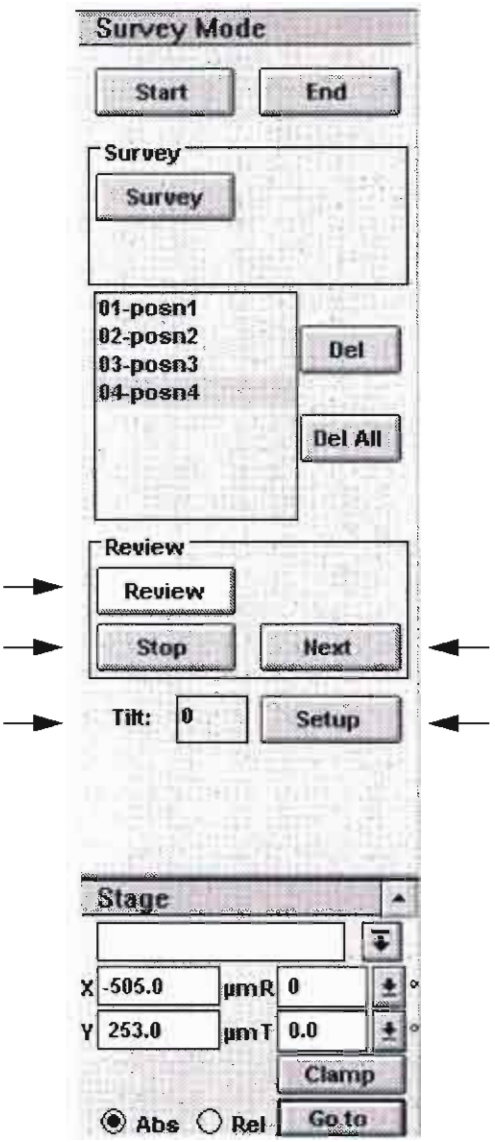


Type a label description in the text box. The label will automatically be extended with an incremented number, so don't enter your own numbering. Once the label is entered, it will appear in the features list box on the Survey control area.

Reject

Click on REJECT to restore the condition of the system as it was before the zoom function was activated. The stage position is not changed and no data is saved for later reference.

Features List Box



Review

Click on REVIEW to activate the Review mode. The stored positions in the features list box will display for a predefined time in the reverse order of their original selection.

Stop

Click on STOP to halt the reviewing action. The current image can then be improved and further investigated.

Next

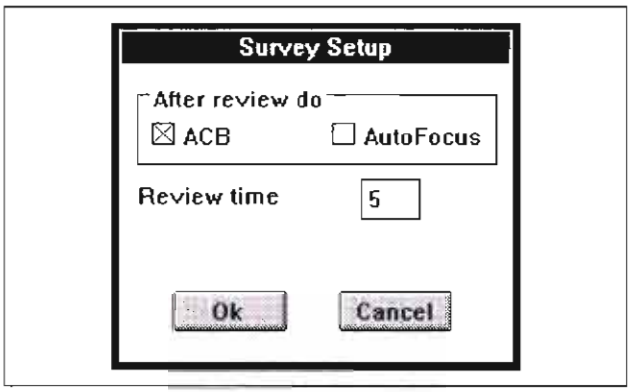
Click on NEXT to continue the review process after a stop command. The next position will be displayed.

Tilt

If the stage is tilted, the tilt angle will be automatically displayed in this text box. This will ensure correct movement of the Get function, since the movement along the Y-axis will automatically be corrected.

Setup

Click on SETUP to access the Survey Setup dialogue box.



ACB

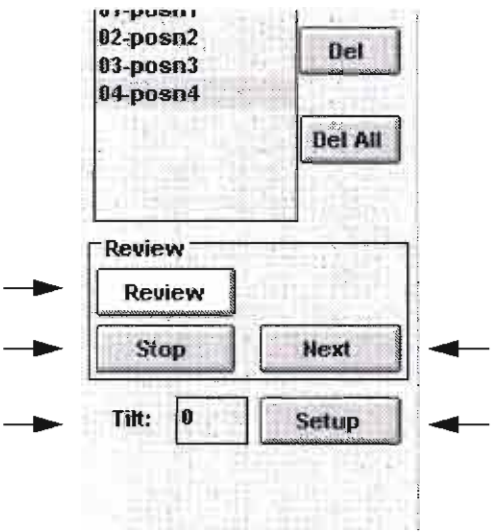
Click on this checkbox if you want each retrieved position to be followed by an automatic contrast and brightness setup.

AutoFocus

Click on this checkbox if you want each retrieved position to be followed by an autofocus sequence.

Review Time

Type in the text box the number of seconds you want each position to stay in view during the review session.



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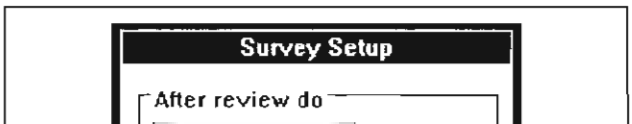
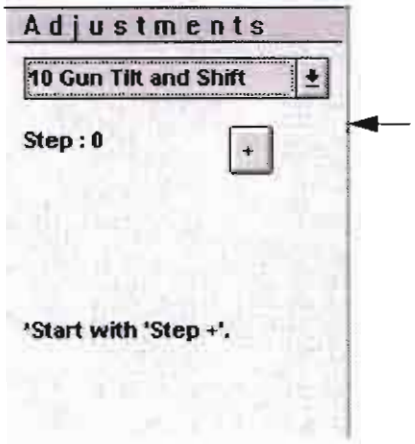
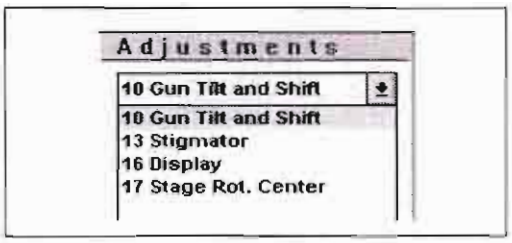


Adjustments



If the column is misaligned for some reason, use this control area to align the electron column and determine fine tuning for the electromagnetic system. Reasons for adjusting alignment include large image movements when you change focus, stigmators or high tension.

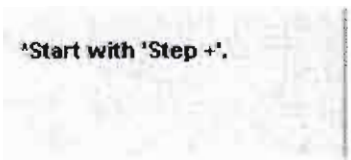
Click on the down arrow to select from a list of available adjustments:

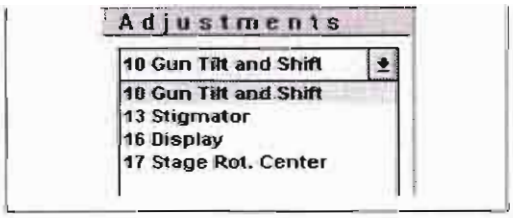


The control area displays all required actions for the fine-tuning procedures. Each adjustment is a complete step-by-step procedure. You can step back and forth through each procedure (using the + or - buttons) and go to another control area for further optimization of the image. When each procedure ends, the adjustments are stored in the computer.

For procedural information, see the Alignment chapter.

For alignment, use the rectangular X-Y control with crosshair. Press the left mouse button in this area to change the setting of the corresponding parameter (similar to the stigmator setting).

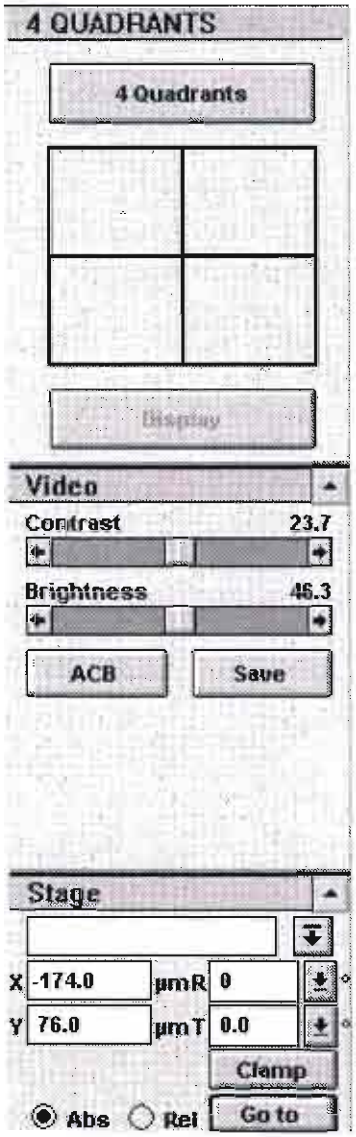




The control area displays all required actions for the fine-tuning procedures. Each adjustment is a complete step-by-step procedure. You can step back and forth through each procedure (using the + or - buttons) and go to another control area for further optimization of the image. When each procedure ends, the adjustments are stored in the computer.

For procedural information, see the Alignment chapter.

4 Quadrants



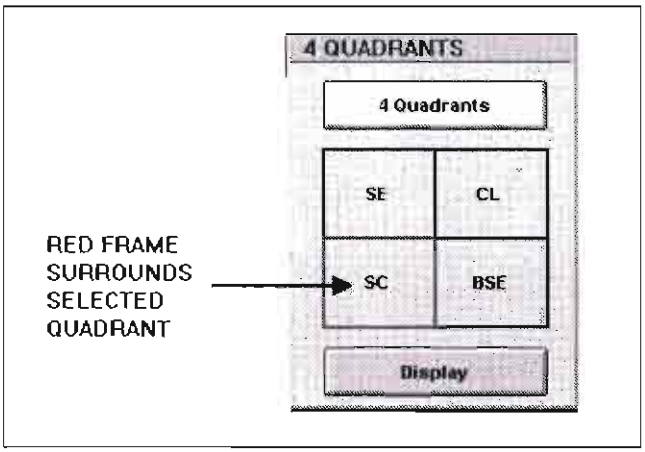
Use the 4 Quadrant mode for viewing the image in four quadrants of the screen, using up to four different conditions (magnification, contrast/brightness) and/or detectors. Once the conditions used have been defined, the system will update the four quadrants in rotational sequence.

4 Quadrants

Click on the 4 QUADRANTS button to begin 4 Quadrant mode. The button changes to yellow, indicating the mode is active, and the image window is divided into four quadrants. The upper left quadrant displays a Live image using Slow scan 1 by default. This is indicated by a red frame around the upper left quadrant in the control area, with the name of the current detector inside the frame.

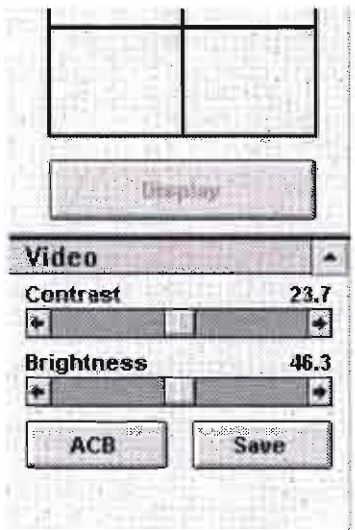
Change the detector for this quadrant using the Detector pulldown menu. Contrast and brightness can be adjusted as usual.

Define the other quadrants in the same way. Click in another quadrant. The red frame surrounds it. By default, the detector and contrast and brightness values will be the same as the first defined quadrant until you change them.



Click on 4 QUADRANTS again after using Display mode to exit 4 Quadrant mode.

NOTE	Don't use Autocontrast/ brightness, Autofocus, or Autostigmation with 4 Quadrant mode.



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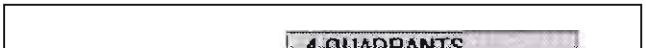
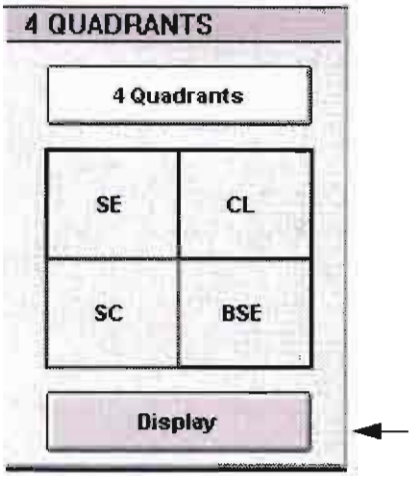


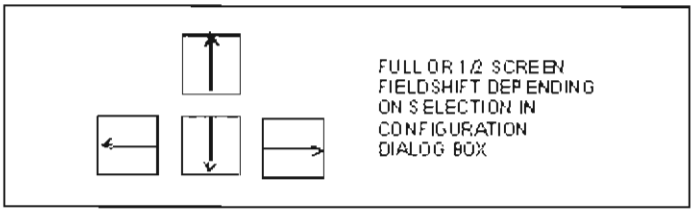


Display

Click on DISPLAY to active the Display mode. The button changes to yellow. The images in the four quadrants will be updated clockwise, one at a time, beginning with the upper left quad. The images are updated by scanning one frame. After all four quadrants have been updated the cycle is repeated.

While in Display mode, the stage position can be changed using the keyboard ARROW keys.

FIGURE 4-6 KEYBOARD ARROW KEYS



Then you can view different sample areas with different detector signals simultaneously.

Photos and videoprints can be made. The detector used will be displayed in each of the four quadrants.

Click on DISPLAY again to switch-off Display mode and return to 4 Quadrants mode.

This mode is non-operative in UHR Mode with SFEG systems.

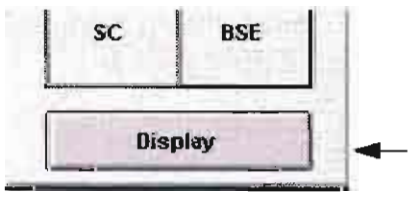
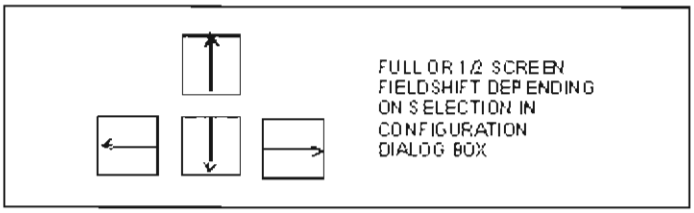


FIGURE 4-6 KEYBOARD ARROW KEYS



Then you can view different sample areas with different detector signals simultaneously.

Photos and videoprints can be made. The detector used will be displayed in each of the four quadrants.

Click on DISPLAY again to switch-off Display mode and return to

Stage

The Stage control area is the same as the maximized Stage control group at the bottom of the other control areas. See *Chapter 7 on Stages*.

Help

Press SHIFT + F1 to activate the Help function keys graphic.

You can click on these buttons as well as on the actual keyboard F keys. Press SHIFT +F1 again to eliminate this graphic from the screen.

Press SHIFT + F1 to activate the Help function keys graphic.

You can click on these buttons as well as on the actual keyboard F keys. Press SHIFT +F1 again to eliminate this graphic from the screen.

50101

Beginning Your Session 5-2

Ending Your Session 5-2

Inserting a Specimen 5-3
Needed Tools and Supplies 5-3
Preparing the Specimen 5-3
Mounting the Specimen 5-3

Sample Holders and Fixtures 5-4
Sample Holders 5-4
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5 OPERATIONS

Procedures

Overview

This chapter describes how to use the XL system from a task-oriented point of view. It begins with how to start your session and includes procedures for inserting specimens, imaging, making hard copies of images, and saving or recalling images.

You'll learn how to optimize your image and use the image manipulation functions for custom enhancements.

These procedures assume you are familiar with the software interface described in the previous chapter.

Overview

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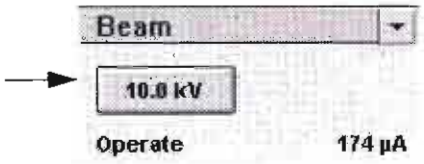
Beginning Your Session



Usually, the system and the emitter both remain on. High tension is typically off but the mechanical HIGH TENSION enable button on the control panel is left on.

TABLE 5-1 BEGINNING YOUR SESSION

Step	Action
1	If a specimen is not already in the sample chamber, insert one according to the directions in the item 'Changing a Specimen' later in this chapter.
2	Click on the kV button of the Beam control group.

Ending Your Session

For daily operation, follow Table 5-2 after you finish your session to leave the system in Overnight mode.

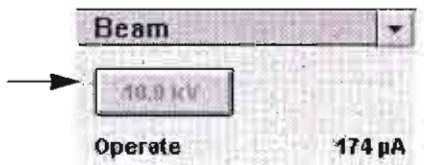


TABLE 5-2 ENDING YOUR SESSION

Step	Action
1	Turn off the high tension to the column by clicking on the kV button of the Beam control group. **Do not** press the FILAMENT OFF button.
2	Remove your sample and pump the system.
3	Leave the software with the Settings control area displayed.

For longer periods of system downtime, see the System On/Off Chapter.

1	If a specimen is not already in the sample chamber, insert one according to the directions in the item 'Changing a Specimen' later in this chapter.
2	Click on the kV button of the Beam control group.

Ending Your Session

Inserting a Specimen

NOTE

Always wear lint-free clean room gloves when reaching into the specimen chamber to reduce leaving oils, dust, or other contaminants inside the chamber.

Needed Tools and Supplies

- Class 100 clean room gloves
- Specimen stubs and conductive adhesive material
- Tools: tweezers, hex wrench, screwdriver
- Prepared specimen

Preparing the Specimen

The specimen material must be able to withstand a high vacuum environment without outgassing and the bombardment of electrons. It must be clean. Oil and dust may contaminate the chamber, which could hinder or even prevent evacuation.

If the specimen contains any volatile components such as water, this will need to be removed by using a drying process (or in some circumstances, it can be frozen solid).

If the specimen is nonconductive (plastic, fiber, polymer, or other substance with an electrical resistance greater than 10^{10} ohms), the specimen may be coated with a 10 nm layer of gold. Because a heavy element like gold also gives a good yield of secondary electrons and thereby good image quality, it is favored over other elements.

Rough surfaced specimens must be evenly coated from every direction. This conductive layer increases beam stability and improves image quality.

Biological, cloth and powder specimens may require carbon or other conductive painting on portions of the specimen that are hard to coat.

For more information on specific preparation techniques, see *Scanning Electron Microscopy and X-Ray Microanalysis, 2nd ed.* by Joseph Goldstein et al., Plenum Press, New York, 1992.

Mounting the Specimen

Wafers have individual specimen-mounting procedures depending on the type and size. These are generally clamped by the frame of the holder.

If you are using a wafer piece or other sample, attach the specimen to the specimen holder using any suitable SEM vacuum-quality adhesive, either silver or carbon. The specimen must be electrically

Preparing the Specimen

The specimen material must be able to withstand a high vacuum environment without outgassing and the bombardment of electrons. It must be clean. Oil and dust may contaminate the chamber, which could hinder or even prevent evacuation.

If the specimen contains any volatile components such as water, this will need to be removed by using a drying process (or in some circumstances, it can be frozen solid).

If the specimen is nonconductive (plastic, fiber, polymer, or other substance with an electrical resistance greater than 10^{10} ohms), the specimen may be coated with a 10 nm layer of gold. Because a heavy element like gold also gives a good yield of secondary electrons and thereby good image quality, it is favored over other elements.

Sample Holders and Fixtures

Sample Holders

The sample holders described here are used in the FEG systems.

- **Specimen holder kit for XL-30FEG staged systems**—various single holders, multiple holders and EDX holder for the XL-30 type stages in one kit.
- **Specimen holder kit for XL-30SFEG staged systems**—non-magnetic UHR single holder, multiple holder and EDX collimator for the XL-30 / 50 x 50 mm type stage in one kit.
- **Specimen holder kit for XL-40FEG**—various single holders and multiple holders for the XL-40 type stage in one kit.
- **Wafer holders for the XL-40FEG**—various designed sizes for: 75 mm, 100 mm, 125 mm, 150 mm and 200 mm
- **XL-40FEG Analytical holder**—a flat plane holder for 5x 1 inch or 1.25 inch encapsulated samples. It also has provision for 5x .standard 13 mm stubs and 2x Faraday cup positions.
- **Universal holder kit for XL-30/40 staged systems**—various single holders and multiple holders for all XL-30/40 type stages in one kit. (Should not be used for SFEG UHR mode)
- **Wafer holders for the XL-40SFEG**—large non-magnetic designed sizes, 150 mm and 200 mm.

CAUTION

Always wear lint-free gloves when handling sample holders.

Mounting Fixtures

Each holder comes with its own mounting screws.Tools are provided with each kit. XL-40 stage holders also have fixtures as premounts for location purposes. Install the fixture on the stage. Place the holder on the fixture. Align the sample on the holder following to the correct orientation.

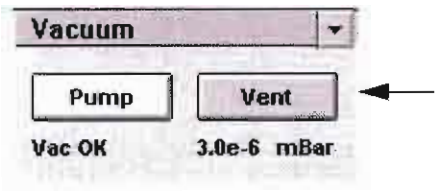
Specimen holders compatable to the SFEG systems do not have magnetic materials in their construction due to the possible influence on the high strength lens field effective in the UHR mode at low voltages.

magnetic UHR single holder, multiple holder and EDX collimator for the XL-30 / 50 x 50 mm type stage in one kit.

- **Specimen holder kit for XL-40FEG**—various single holders and multiple holders for the XL-40 type stage in one kit.
- **Wafer holders for the XL-40FEG**—various designed sizes for: 75 mm, 100 mm, 125 mm, 150 mm and 200 mm
- **XL-40FEG Analytical holder**—a flat plane holder for 5x 1 inch or 1.25 inch encapsulated samples. It also has provision for 5x .standard 13 mm stubs and 2x Faraday cup positions.
- **Universal holder kit for XL-30/40 staged systems**—various single holders and multiple holders for all XL-30/40 type stages in one kit. (Should not be used for SFEG UHR mode)
- **Wafer holders for the XL-40SFEG**—large non-magnetic designed sizes, 150 mm and 200 mm.

CAUTION

Always wear lint-free gloves when handling sample holders.



Exchanging a Specimen

To insert a specimen, select the **Vacuum** control group or press the **Vent** button. If the High Voltage is on the Vent condition is interlocked to switch it off before actual venting.

TABLE 5-3 EXCHANGING A SPECIMEN

Step	Action
1	Click on the **Vent** button found on the Settings control area, control group **Vacuum**. The system will start to vent after a short delay, this is to verify that the high tension is off. (security HT interlock).
2	When vented, open the specimen chamber and using lint-free gloves or tweezers place a specimen into the specimen holder. Secure the specimen stub with an appropriate hexkey unless a spring-clip type holder has been used e.g. Multiple specimen holders for XL30 and XL40.
3	Check and if necessary adjust the X, Y, Z, Rotation or Tilt before closing the chamber door.
4	Click on the **Pump** button found on the **Vacuum** control group.
5	Wait for the vacuum status message '**Vac OK**' found underneath the **Pump** button.

Working with the Stage

There are different size and types of stages for the FEG systems. These can be found in the Chapter on Stages. To be certain of optimum and safe operation it is recommended that the appropriate Stage section (50x50, 100x100, 150x150 mm) for the users own system be read thoroughly.

1	Click on the **Vent** button found on the Settings control area, control group **Vacuum**. The system will start to vent after a short delay, this is to verify that the high tension is off. (security HT interlock).
2	When vented, open the specimen chamber and using lint-free gloves or tweezers place a specimen into the specimen holder. Secure the specimen stub with an appropriate hexkey unless a spring-clip type holder has been used e.g. Multiple specimen holders for XL30 and XL40.
3	Check and if necessary adjust the X, Y, Z, Rotation or Tilt before closing the chamber door.

Operations Pre-Check

To ensure correct operation, check the following list of guidelines before using the system.

TABLE 5-4 OPERATIONS CHECKLIST

Setting	Optimum Value
kV (Accelerating Voltage)	Select kV relative to specimen type: low kV for nonconductors, high kV for conductors. For example, metal sample = 10 - 20 kV. biological sample = 1 - 10 kV.
Spotsize	2 - 3
Scan	TV rate
Magnification	Set to lowest
Working Distance (distance from column end to sample)	10 mm (XLFEG) 5 mm (SFEG in HR Mode, later move to UHR Mode if necessary)
Detector	Start with the secondary electron detector (SE) and switch to other (if installed) when needed.
Filter	AVERAGE 4
Contrast and Brightness	Regulate contrast to zero and move brightness so that the screen comes just above black to gray. Then regulate the contrast to give a well balanced image.The Videoscope can be used to help adjust the overall greylevel value of the image.

(Accelerating Voltage)	for nonconductors, high kV for conductors. For example, metal sample = 10 - 20 kV. biological sample = 1 - 10 kV.
Spotsize	2 - 3
Scan	TV rate
Magnification	Set to lowest
Working Distance (distance from column end to sample)	10 mm (XLFEG) 5 mm (SFEG in HR Mode, later move to UHR Mode if necessary)

Obtaining an Image

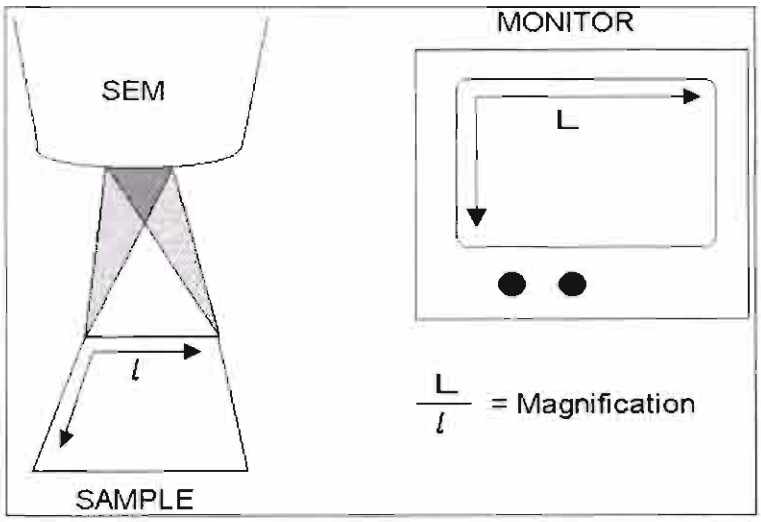
Scanning the Sample

All scanning beam microscopes produce images with the same fundamental technique. The primary beam is scanned across the sample surface in a regular pattern called a *raster*. Normally, this raster consists of a series of lines in the horizontal (X) axis, shifted slightly from one another in the vertical (Y) axis. Simultaneously, a spot of controllable brightness is scanned over the display area of a monitor in the same pattern.

The signal emitted by the sample surface as it is illuminated with the primary beam is collected, amplified, and used to adjust the intensity of the spot scanning over the video monitor.

Because of this direct correspondence, the image displayed on the monitor is directly related to the sample surface.

FIGURE 5-1 SCAN TO MONITOR IMAGE



monitor in the same pattern.

The signal emitted by the sample surface as it is illuminated with the primary beam is collected, amplified, and used to adjust the intensity of the spot scanning over the video monitor.

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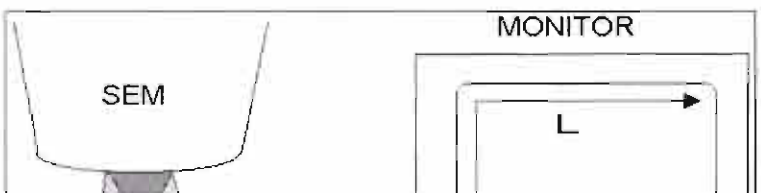
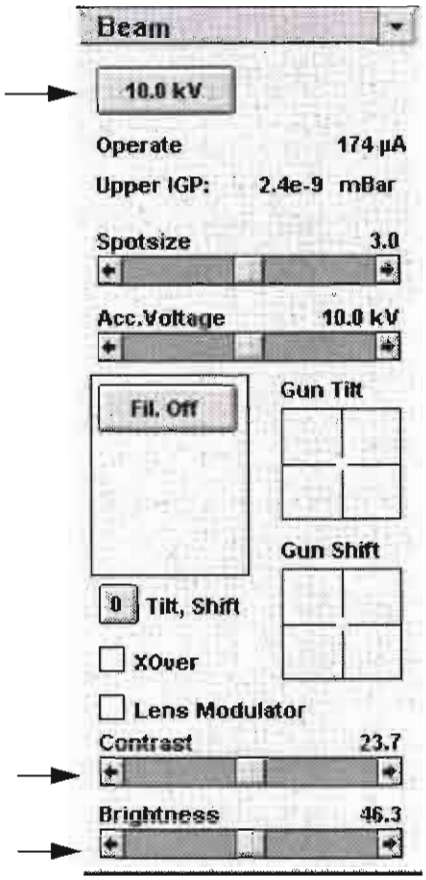
FIGURE 5-1 SCAN TO MONITOR IMAGE





Imaging Procedure

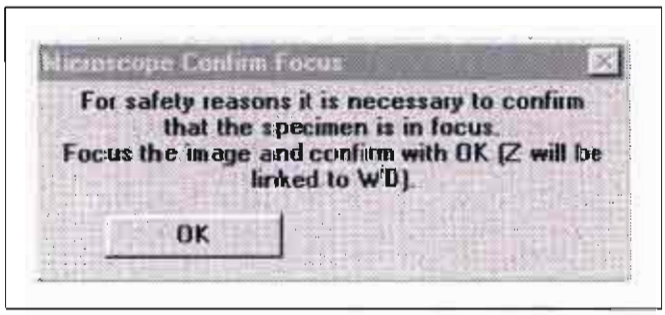
The following assumes that the filament is already on. Use the following procedure to obtain an image of the specimen:

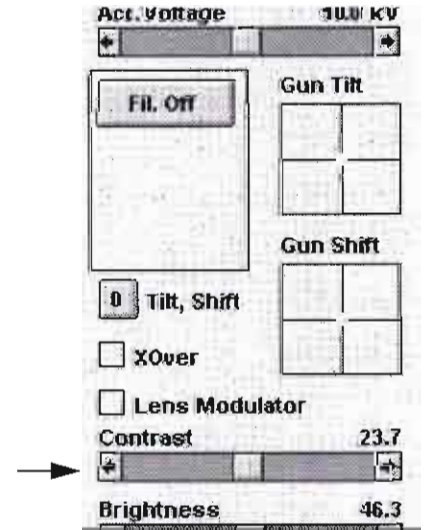
TABLE 5-5 OBTAINING AN IMAGE

Step	Action
1	On the Settings control area, click on the kV button to ramp up the high voltage. The button turns yellow.
2	An image appears with a dialogue asking if the focus is correct. Correct if necessary and press OK. If there is no image, press F9 and follow the dialogue.
3	Correct the contrast and brightness with the adjusters on the Settings control area.
4	Correct the focus and astigmatism.

Confirm Focus Dialogue(Z<->FWD)

As mentioned in step2 above 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 sample or lens.





	ramp up the high voltage. The button turns yellow.
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3	Correct the contrast and brightness with the adjusters on the Settings control area.
4	Correct the focus and astigmatism.

Confirm Focus Dialogue(Z<->FWD)

Optimizing the Image

Correcting Focus

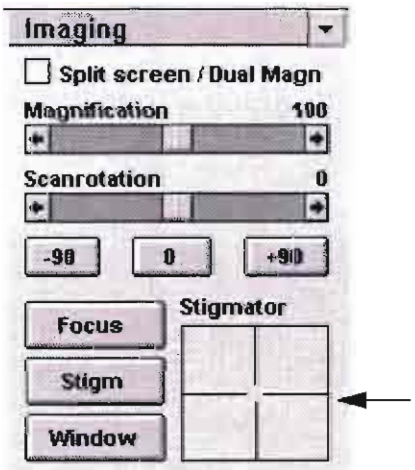
The easiest way to focus is to find a feature of interest on a specimen with distinct edges. Use a combination of contrast, brightness, magnification, and focus adjustments to maximize the image quality.

Correct the focus by holding down the right mouse button and moving the mouse from side to side until the image is sharp. Move the specimen to a suitable area with the X and Y stage controls and refocus until the image is sharp.

Correcting Astigmatism

You need to correct astigmatism in the image (also known as "stigmate") when you change apertures, samples or working distance. Astigmatism in the image is usually only visible at higher magnifications (3000X or more). If astigmatism is present, the result is a directional distortion change of 90° between the two out-of-focus conditions.

TABLE 5-6 CORRECTING ASTIGMATISM



Step	Action
1	Focus the image as well as possible using the mouse.
2	Bring the image just slightly out of focus in one direction to see any astigmatic distortion.
3	Defocus in the other direction to observe a different astigmatic distortion.
4	Bring the focus to the midpoint between the two distortions.
5	Click anywhere in the Stigmator X-Y control on the Imaging control area, and keep the left mouse button pressed to display a crosshair on the image.
6	The computer will beep when you have reached the limits of stigmation.
7	Move the crosshair over the image to improve focus and sharpness. Remember to hold down the mouse button. When you are satisfied with the image, release

refocus until the image is sharp.

Correcting Astigmatism

You need to correct astigmatism in the image (also known as "stigmate") when you change apertures, samples or working distance. Astigmatism in the image is usually only visible at higher magnifications (3000X or more). If astigmatism is present, the result is a directional distortion change of 90° between the two out-of-focus conditions.

TABLE 5-6 CORRECTING ASTIGMATISM

Step	Action
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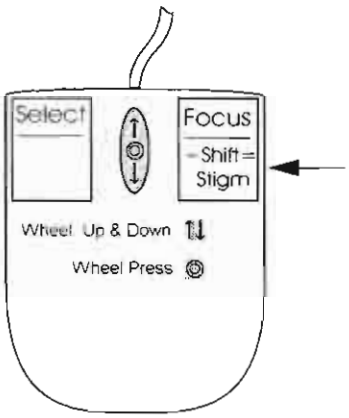
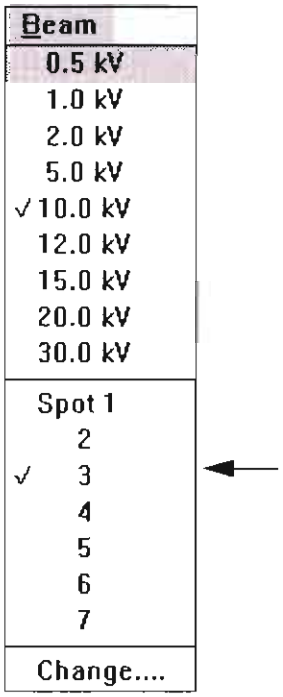


Alternate Method

The stigmator function can also be accessed by pressing the SHIFT and right mouse button in combination. The stigmator crosshair will appear. Move the crosshair left to right and top to bottom of the viewing area to improve the image.



Beam Spotsize

The actual focused area of the beam on the sample is referred to as spotsize. Spotsize has an assigned number that ranges from 1 to 7 with values corresponding to beam currents from low to higher beam voltages.

Adjusting Spotsize for Imaging

Spotsize is considered to be close to ideal when the edges of the beam just touch when adjacent lines are scanned. If the spotsize is too large, overlaps occur and the image appears out of focus. If the diameter is too small, electronic noise appears in the image. Additionally, too small a beam diameter can miss important information on the specimen surface.

Deciding which spotsize is correct for a particular magnification can be determined when you achieve good focus and astigmatism correction easily at the chosen magnification.

Use the focus control with the right mouse button to correct the sharpness of the image. Focusing at 2X - 3X the magnification needed for the final result makes the lower magnification sharper. For example, set photo magnification to 2000X, and focus with mag at 4000X - 8000X.

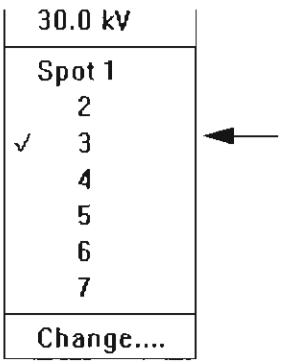
When you change spotsize, press F9 to do an auto contrast/brightness routine to refresh the image onscreen. An alternate approach is to use the videoscope.

Optimum Spotsize

The best spotsizes for making images vary:

TABLE 5-7 OPTIMUM SPOTSIZES

Spotsize	Best Use
1 & 2	Very high resolution (mag >50 kX)
3	Standard imaging, SE, BSE, CL
4, 5, 6, 7	BSE, CL, X-ray analysis



overlaps occur and the image appears out of focus. If the diameter is too small, electronic noise appears in the image. Additionally, too small a beam diameter can miss important information on the specimen surface.

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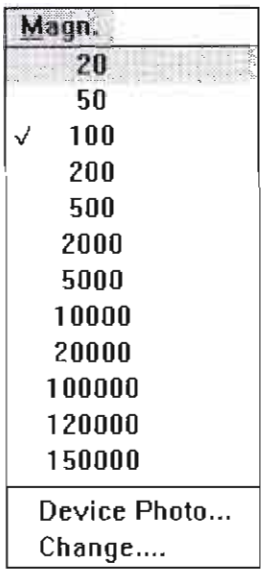
When you change spotsize, press F9 to do an auto contrast/brightness

Magnification



Magnification is the ratio of the scanned area on the sample to the viewing area.

$$MAGNIFICATION = \frac{Viewed\ Area}{Scanned\ Area}$$

The viewing area changes depending on your output, whether a Polaroid print, videoprint, or the computer monitor.

If the size of the raster on the sample is made smaller while the raster on the monitor remains constant in size, the magnification of the image increases. At low magnification, you will see a large field of view. At medium magnification, you see a portion of the scanned area. At high magnification, you are zoomed in on only a small portion of the total scanned area.

Use the Magnification settings from the pulldown menu to select from a list of predefined values. If the current value is in the list, it is indicated with a check mark.

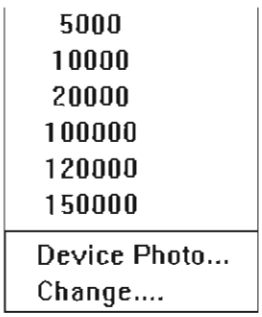
Changing Magnification Levels

Selecting a different magnification results in a change of magnification on the screen during live imaging.

Magnification can also be changed by using the + and - keys on the numeric keypad. The results depend on whether you have the Fine/ Default mag steps with +- selected in the Configuration Control dialog box.

TABLE 5-8 CHANGING MAGNIFICATION WITH NUMERIC KEYPAD

Key	Function
+	Increases magnification.
-	Decreases magnification.
SHIFT +	Increases magnification in large steps (2X).
SHIFT -	Decreases magnification in large steps (0.5X).
CTRL -	Decreases magnification to minimum magnification. Pressing CTRL - again returns you to the previous magnification.



If the size of the raster on the sample is made smaller while the raster on the monitor remains constant in size, the magnification of the image increases. At low magnification, you will see a large field of view. At medium magnification, you see a portion of the scanned area. At high magnification, you are zoomed in on only a small portion of the total scanned area.

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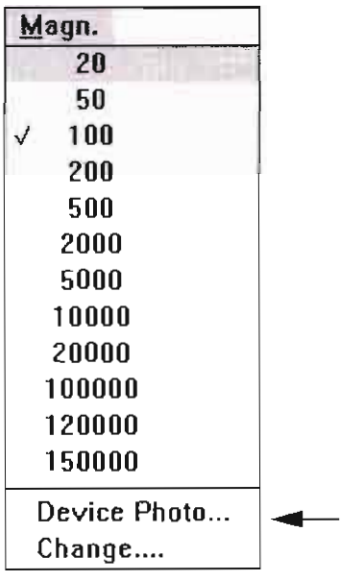
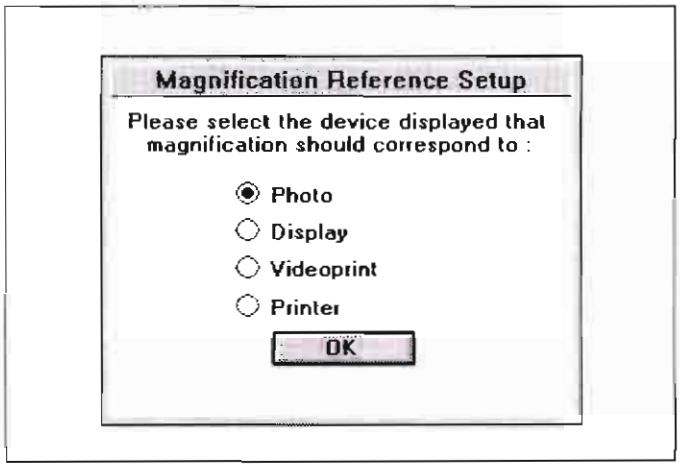
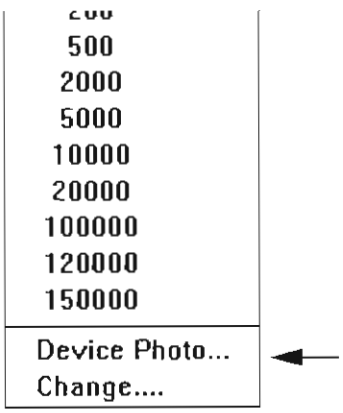
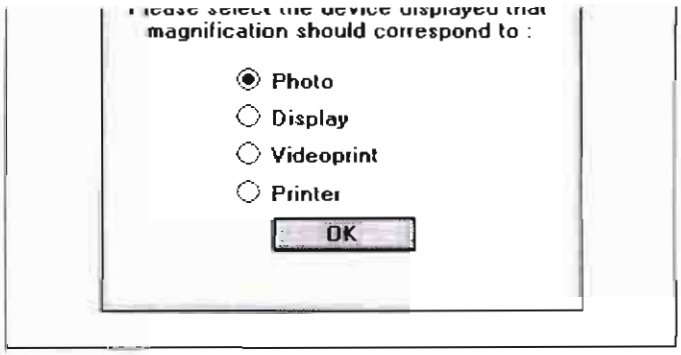
Selecting the Device for Magnification

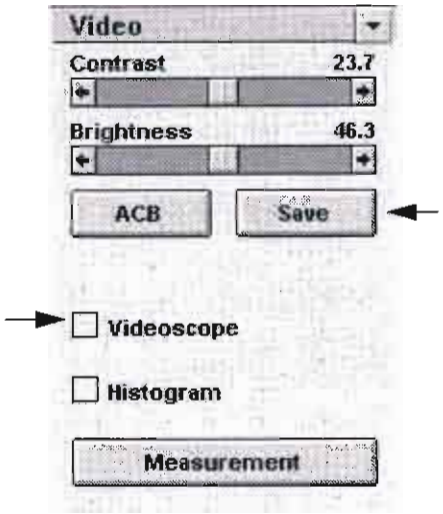
The magnification value in the caption of the active window and the magnification adjuster are calibrated to the device selected in the Select Output Device dialogue box accessed from the Magn. pulldown window.











Using the Videoscope

The contrast and brightness settings in Videoscope mode are the ones used when you click on the autocontrast/brightness icon or press F9. Use the Videoscope option to adjust these default settings when necessary.

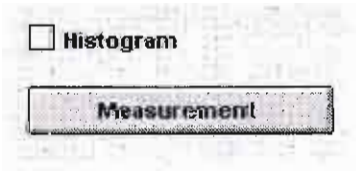
You can access Videoscope three ways:

- Press F3
- Click on the Videoscope icon.
- Select Videoscope from the expanded Video control group.

- Click on the SAVE button below the brightness adjuster to save these intensity levels.

TABLE 5-9 VIDEOSCOPE SETTING OF C&B

Step	Action
1	Reduce the contrast to zero and adjust the brightness level to the lower dashed line (black).
2	Adjust the contrast up so that the signal level just clips the upper dashed line (white).
3	If necessary, adjust the brightness level once more to have the average signal level roughly in the middle.



- Click on the Videoscope icon.
- Select Videoscope from the expanded Video control group.

- Click on the SAVE button below the brightness adjuster to save these intensity levels.

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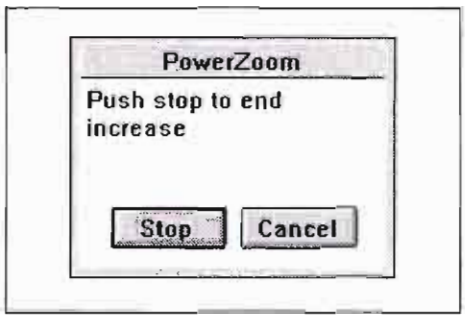
Step	Action
1	Reduce the contrast to zero and adjust the brightness level to the lower dashed line (black).
2	Adjust the contrast up so that the signal level just clips the upper dashed line (white).

Using PowerZoom

Most of the time you will manually set the appropriate magnification level. The PowerZoom procedure combines a preset zoom rate with autofocus and autocontrast/brightness that you specify in advance.

Use the PowerZoom icon to activate the PowerZoom procedure. Magnification is increased at the predefined rate entered in the Position Setup dialogue box (see below).



Press STOP when the desired magnification has been reached. Press CANCEL to return the magnification to the original level.

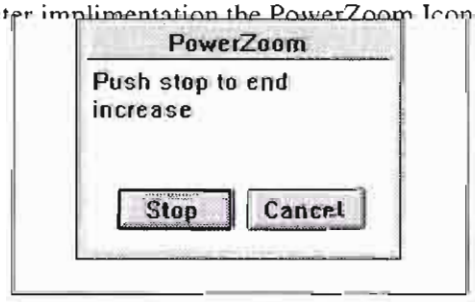
This item is removed from the user interface from software version 5.9 on in favour of the following function Track Zoom.

Track Zoom

The Track function displays 2 circles to distinguish speed difference when the track function is in operation. In the past (prior ver.5.90) the centre circle has been a forbidden zone for the cursor. With ver. 5.90 release the centre circle is active and holds at the top of the circle a highlighted plus sign (+), and at the bottom a minus sign (-). These represent a Zoom function for continual magnification change either up (+) or down (-). This is activated as follows:

- Select the Track function from the Icon Bar.
- Bring the cursor to the centre circle, a highlighted plus or minus sign will appear depending on the cursor position in the circle as descibed above.
- Select the appropriate zoom function.
- Press the lefthand mouse button and the total image will zoom.
- The zoom can be halted at any time by releasing the left mouse button and the image will remain at the zoomed condition.

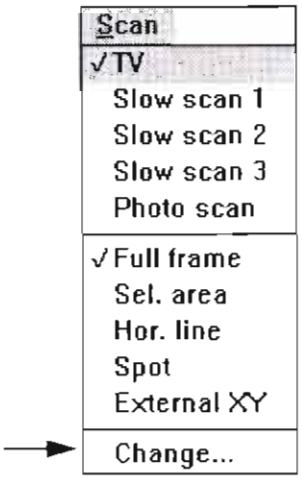
Due to this faster implimentation the PowerZoom Icon button has



Press STOP when the desired magnification has been reached. Press CANCEL to return the magnification to the original level.

This item is removed from the user interface from software version 5.9 on in favour of the following function Track Zoom.

Changing Slow Scan Presets



Select Change from the Scan pulldown menu to change Slow scan presets. A dialog box displays:

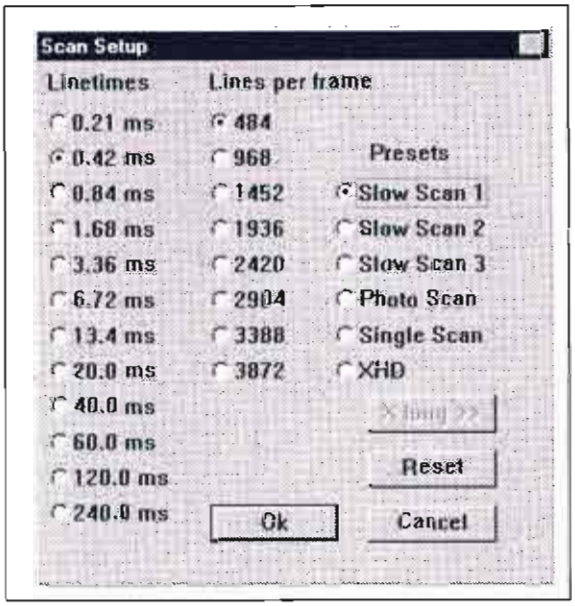
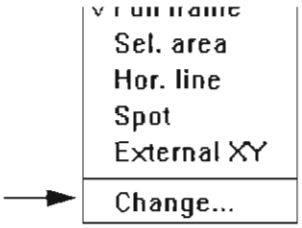


Table 5-10 provides guidelines for choosing the appropriate lines per frame:

TABLE 5-10 GUIDELINES FOR CHANGING SLOWSCAN PRESETS

Lines per Frame	Typical Use
484 - 968	Videoprinting
484 - 968	STD DEF and HD DEF
968 - 1452	Photographing on film or Printer (Resolution imaging)
484 - 2904	XHD
1936 - 3872	Dual Magnification EDX



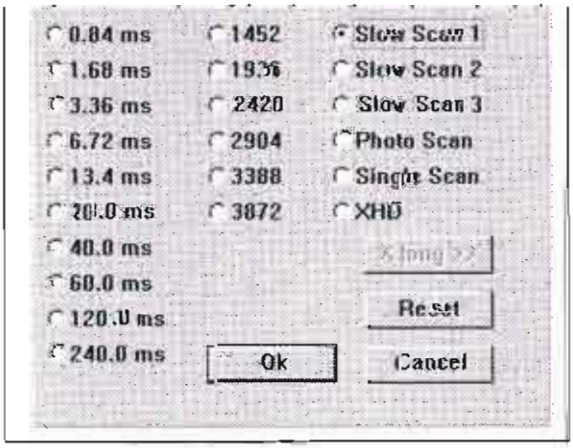
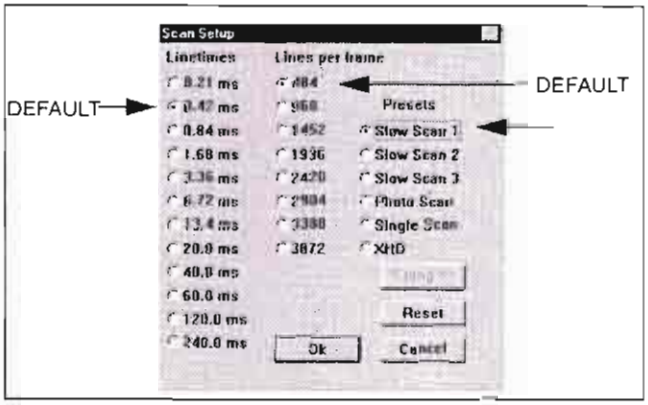
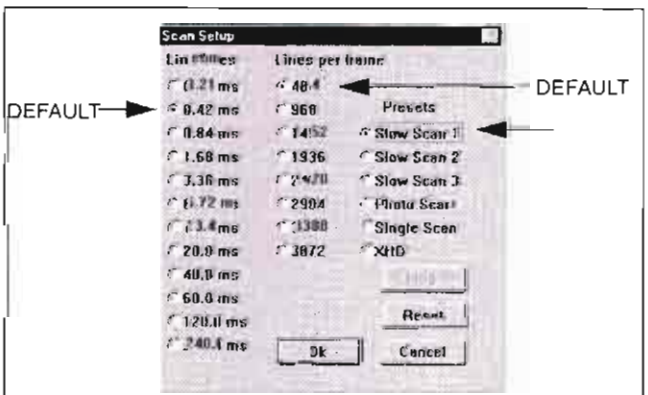


Table 5-10 provides guidelines for choosing the appropriate lines per

Define the presets for the slow scan times using the following procedure:

TABLE 5-11 DEFINING SLOW SCAN PRESETS

Step	Action
1	Click on the Slow Scan 1 option button.
2	The default Linetime (the time it takes to scan one line) associated with Slow Scan 1 will automatically be selected. If necessary, change the Lines per frame to any other value. 
3	The default Lines per frame associated with Slow Scan 1 will automatically be selected. If necessary, change the Linetime to any other value.
4	Click on the Slow Scan 2 option button. If necessary, change its default Linetime and Lines per frame to any other value.
5	Click on the Slow Scan 3 option button. If necessary, change its default Linetime and Lines per frame to any other value.
6	Click on the Photo Scan option button. If necessary, change its default Linetime and Lines per frame to any other value.
7	Click on the Single Scan option button to set-up the snapshot record speed. If necessary, change its default Linetime and Lines per frame to any other value. line) associated with Slow Scan 1 will automatically be selected. If necessary, change the Lines per frame to any other value. 

Defining a Long Line Scan

Long line scans can be defined especially for microanalysis applications. The maximum line time is 12 minutes and the line is defined by dwell points (180, 360 or 720) and dwell time (33 ms...1000 ms). Any of the slow scan rates can be set up for line scan.

Note that after definition the system will automatically change the selected Slow Scan to a horizontal line mode. The other slow scan modes will still allow use of a full frame, selected area or spot mode. Line scan can also be defined in the Analytical control area.

modes will still allow use of a full frame, selected area or spot mode. Line scan can also be defined in the Analytical control area.

Changing Lens Modes

Conditions of Operation

Switching conditions of operation is in general a matter of choosing a different Mode of operation, such as , either HR, UHR or EDX Mode. Further, the choice may be to obtain a longer/shorter Working Distance (WD) or a Higher/Lower Accellerating Voltage while remaining in the same Mode.There are a set of dialogues to help the user find the right operating Mode or conditions in that Mode. These generally are popping up if the present conditions are not ideal for the proposed condition, and therefore a choice of processes to obtain optimum working conditions are described with active functionality. The most common switching conditions are as follows:

FIGURE 5-2 SWITCHING CONDITIONS FOR HR TO UHR MODE

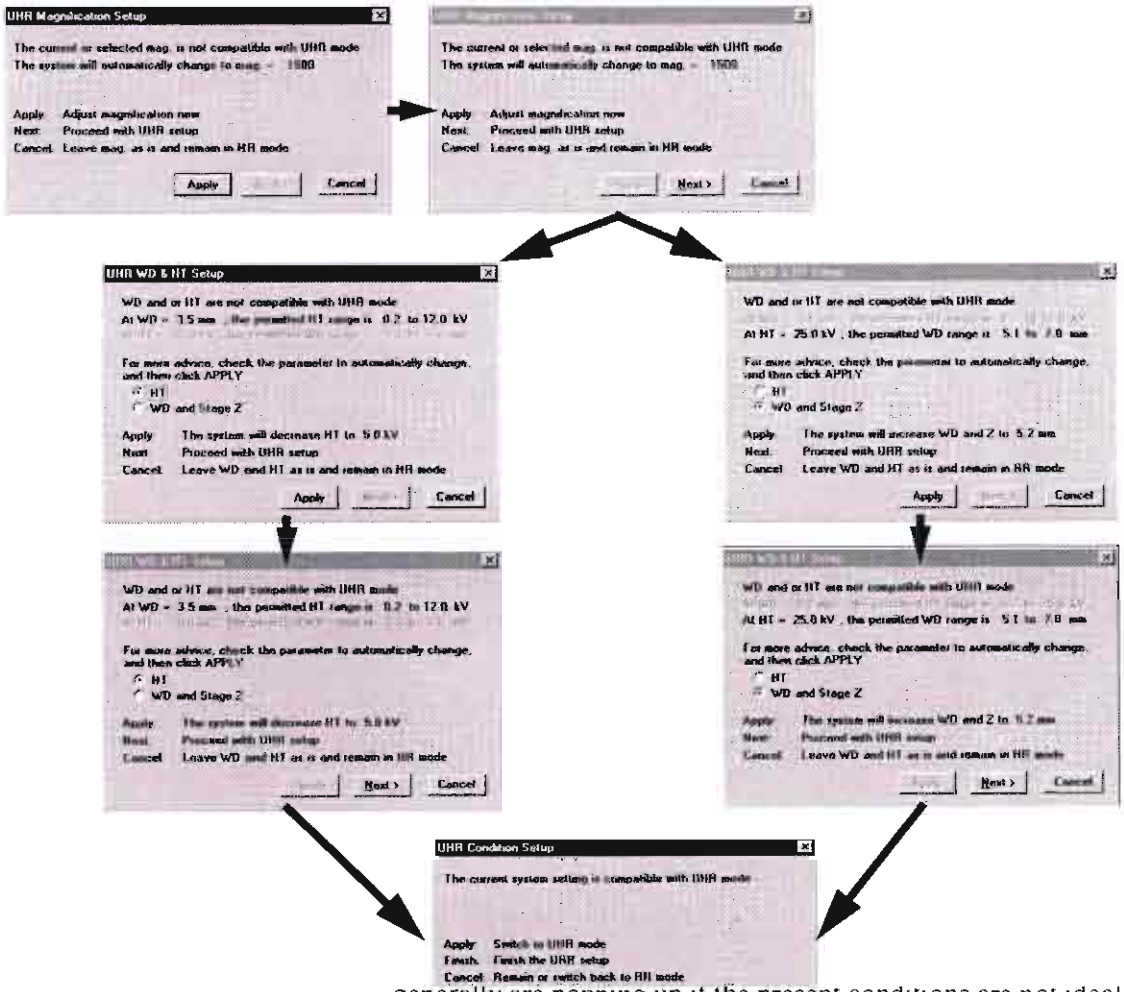


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FIGURE 5-2 SWITCHING CONDITIONS FOR HR TO UHR MODE

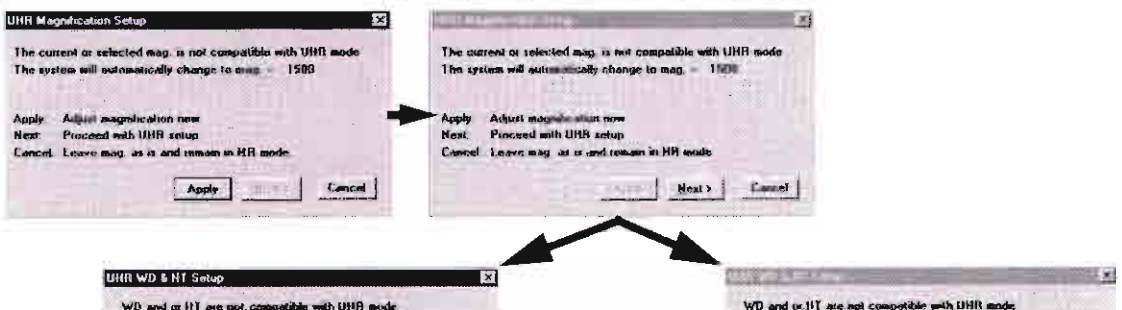


FIGURE 5-3 UHR MODE: GO TO SHORT WD

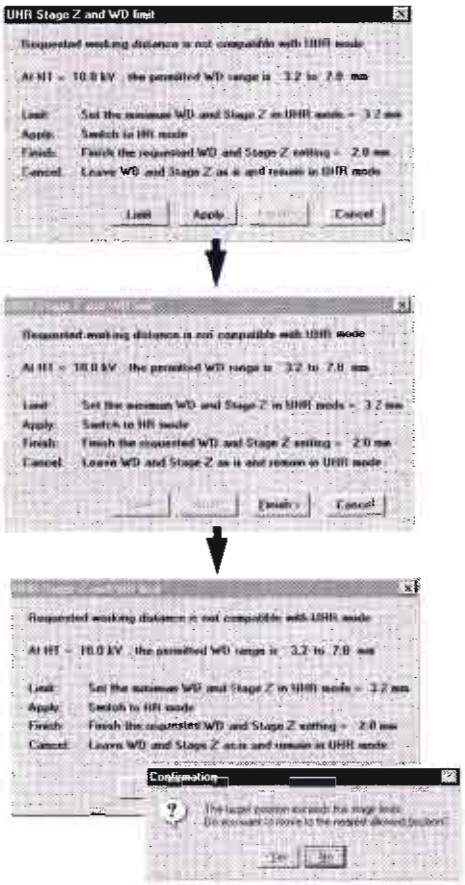


FIGURE 5-4 UHR MODE: REQUEST TO INCREASE KV

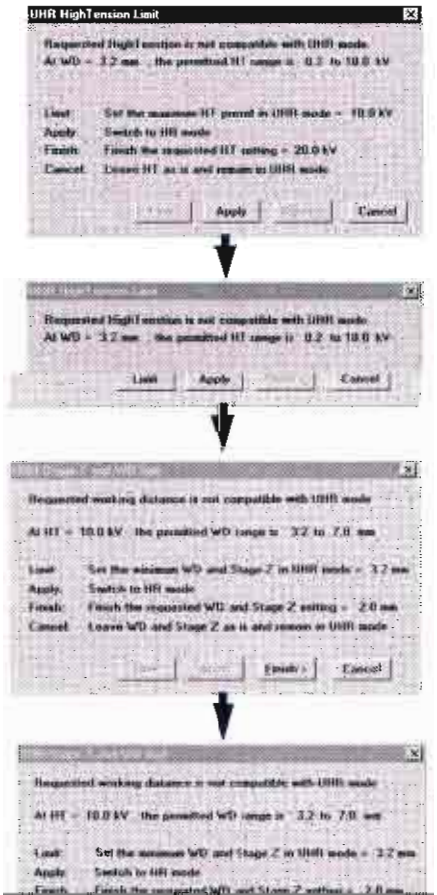
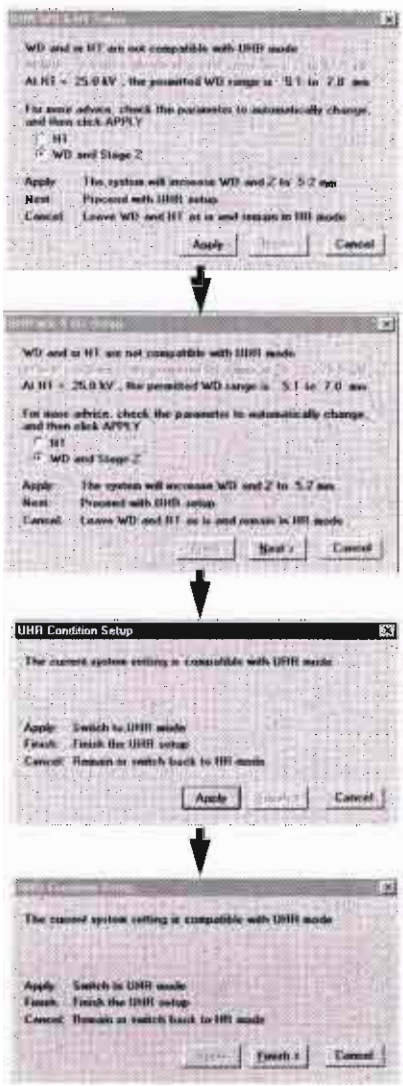


FIGURE 5-5 HR AND EDX MODE: SWITCHING TO UHR



Dialogue information level

The dialogues are provided for guidance and can be presented at two levels or not at all (none). The level above is call the FULL level and the other is called STANDARD which is a shorter version which does not have such full style explanations. The changing of these information levels can be found as **UHR Advice** under **Configuration...** in the **In/Out** menu.

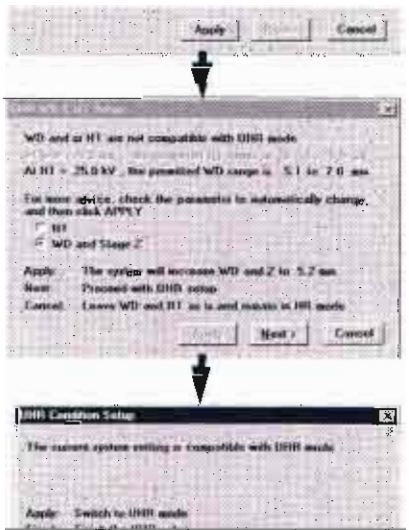
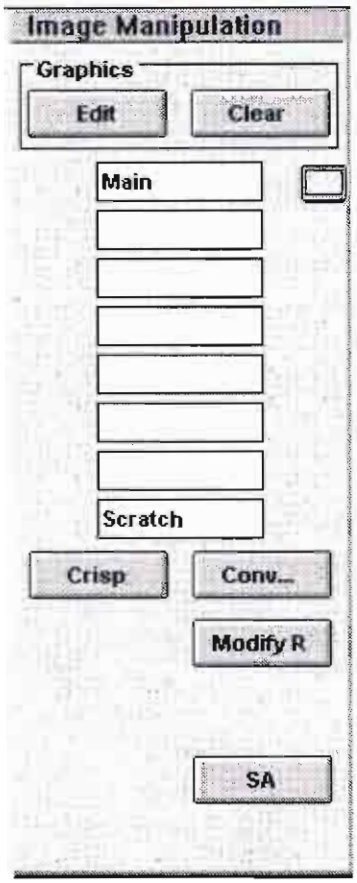
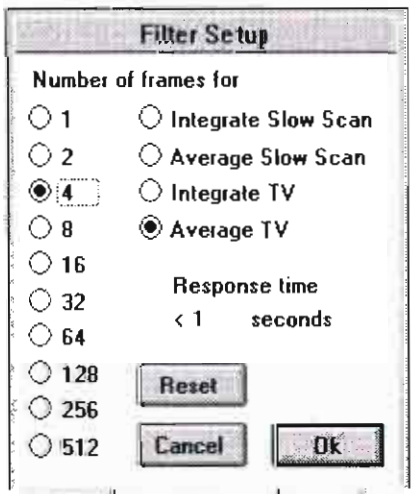


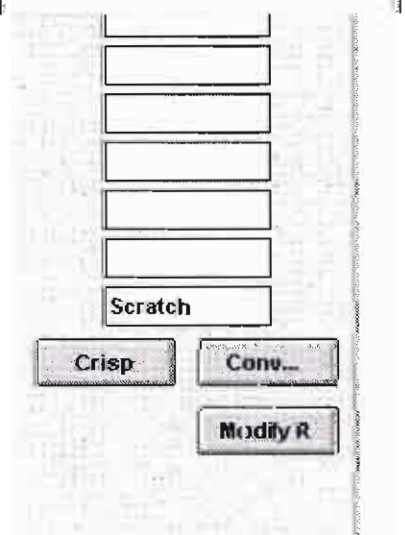
Image Enhancement Methods

WITHOUT COLOR OPTION



REAL-TIME FILTERS





Two Types of Image Enhancement

Image enhancement methods permit you to alter and enhance images for analysis and measurement. **Filters** are applied during the imaging process. **The Image Manipulation functions** (post processing) are applied after the frame has been grabbed.

Both forms of image processing involve algorithmic manipulation of a lookup table (LUT) associated with the image data. Only the Image Manipulation functions allow you to undo the effects of processing by saving the image first under a separate image name, or copying it first to another memory plane. Once the enhancement is performed, copying it to another memory plane will copy the enhancement as well. Convolutions, averaging, or integrations cannot be undone.

Real-Time Options

Real-time options include Live, which applies no processing, Average, and Integrate. High Definition, if installed, increases the number of pixels used to build the image. They are accessed from the Filter menu. (Additionally, the Modify R and Modify L functions will be applied real-time to any displayed or stored image after they have been defined the first time.)

Using Average

Average, which overwrites the accumulation buffer with a weighted average of new frames as they are grabbed, is generally used to decrease the effects of image noise. The effects of the first frame will diminish as new ones are added into the calculations; the most recent frame has the greatest effect.

You may select a real time average of 1, 2, 4, 8, 16, 32, 64, 128, 256, or 512 frames from the Change option on the Filter menu. The resulting better-quality image is useful for taking photographs of images or defining patterns without having to use a slow scan. Average can be setup independently for TV scan and Slow scan by going to Change in the Filter Menu.

Using Integrate

Integrate gives you an arithmetic average of image based on the number of integrations chosen. Each frame grab is added to the others and divided by the number of integrations; therefore, each image is of equal weight. The number of frames for integration is the same set of choices as those for averaging. Integrate can also be setup independently for TV scan and Slow scan by going to Change in the Manipulation functions allow you to undo the effects of processing by saving the image first under a separate image name, or copying it first to another memory plane. Once the enhancement is performed, copying it to another memory plane will copy the enhancement as well. Convolutions, averaging, or integrations cannot be undone.

Real-Time Options

Real-time options include Live, which applies no processing, Average, and Integrate. High Definition, if installed, increases the number of pixels used to build the image. They are accessed from the Filter menu. (Additionally, the Modify R and Modify L functions will be applied real-time to any displayed or stored image after they have been defined the first time.)

Using Average

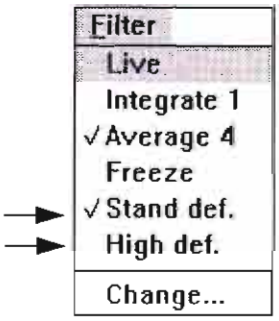


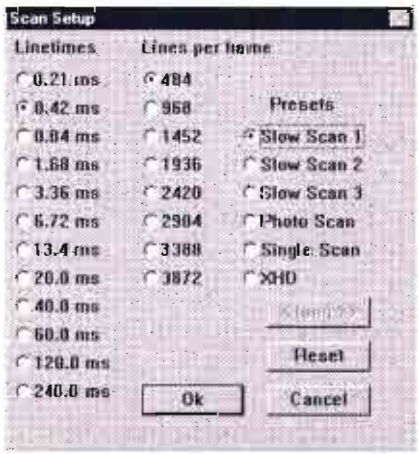
Image Resolution and Quality

Choose standard definition or the high definition mode from the Filter pulldown menu. Selecting an inactive option (one with no checkmark next to it) activates that mode. You can alternate between the two modes to find the best result and then choose the appropriate definition after images are optimized.

If you do not have the high definition option installed, the selection is grayed out on the menu. Note that a higher resolution image takes longer to display but results in a clearer image.

Standard Definition

Standard Definition (Stand def.) for digital images has a pixel format of 702 x 484 and is used for images with normal working conditions. Each standard definition image needs 373 kB of disk space in **.img* format, and 344 kB in **.tif* format.



High Definition (Optional)

High Definition (High def.) for digital images has a pixel format of 1404 x 968 and is used for slides or display on a higher resolution monitor. Each high definition image needs 1.48 MB of disk space in **.img* format, and 1.45 MB (fit on a 3.5-inch floppy disk) in **.tif* format.

XHD

Extended High Definition (XHD) for digital images has a pixel format maximum of approximately 4000 x 3000 and is used for slides, enlargements and publications where ultra-high resolution is needed. Image disk space can range from 308 kB to 10.99MB in **.tif* format.

The XHD selector is found in the Scan Setup dialogue via the 'Change' item on the end of the Scan menu. When clicked on it displays the appropriate linetimes and lines per frame necessary to choose from.

Image Quality and Scan Speeds

If an image is noisy in Live mode with TV scan speed, changing the scan speed to a slow scan or using averaging will improve the image quality by increasing the signal-to-noise ratio. Photo scan speeds should use at least one minute of acquisition time to be fully functional.

Change...

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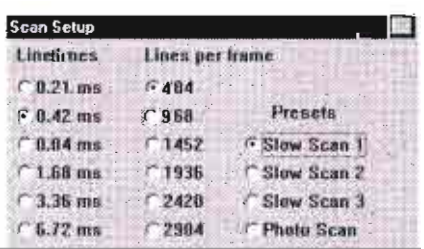

High Definition (Optional)

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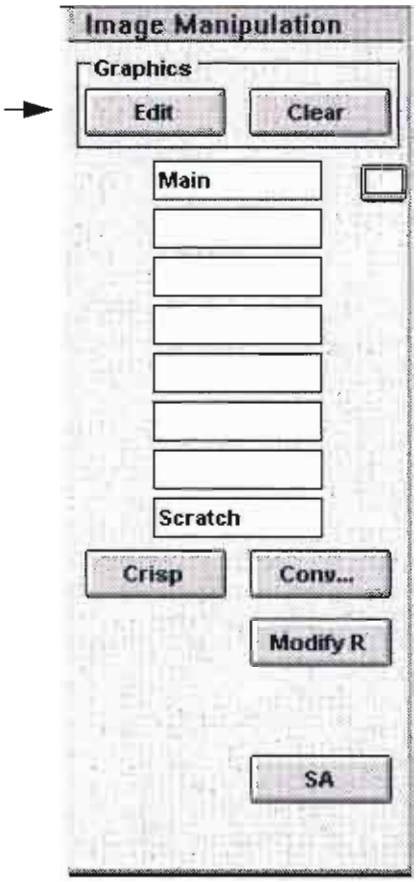
XHD

Adding Graphics and Text to Images

WITHOUT COLOR OPTION

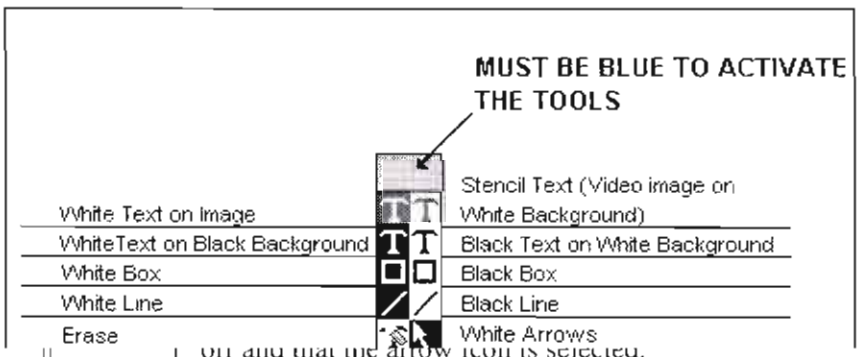


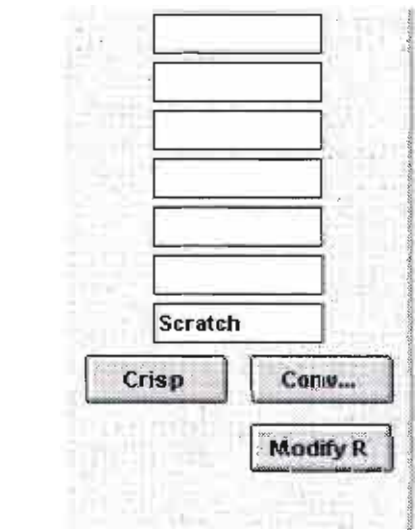
Writing Text on Images

TABLE 5-12 WRITING TEXT ON IMAGES

Step	Action
1	Be sure that the Get and Shift functions are switched off and that the arrow icon is selected.
2	Click on the EDIT button. It turns yellow and a graphics toolbox appears in the top left corner of the image. Refer to Figure 5-6.
3	Select a character mode in the toolbox by clicking on it. A red outline indicates the selected mode.
4	Move the cursor to the text position and click the left mouse button.
5	Type the desired text. You can use BACKSPACE and ENTER, which acts as a line return.
6	To write text in a new location or use another character mode, click once on the image screen. Then click the tool again and indicate the new position. Be sure the toolbox header is blue to indicate the tools can be selected.
7	Stop text mode by clicking again on the EDIT button.

FIGURE 5-6 GRAPHICS TOOLBOX WITH EXTENDED OPTION





Step	Action
1	Be sure that the Get and Shift functions are switched off and that the arrow icon is selected.
2	Click on the EDIT button. It turns yellow and a graphics toolbox appears in the top left corner of the image. Refer to Figure 5-6.
3	Select a character mode in the toolbox by clicking on it. A red outline indicates the selected mode.
4	Move the cursor to the text position and click the left mouse button.
5	Type the desired text. You can use BACKSPACE and ENTER, which acts as a line return.
6	To write text in a new location or use another character

Drawing Lines, Boxes, and Arrows

To create a line, box or arrow, proceed as follows:

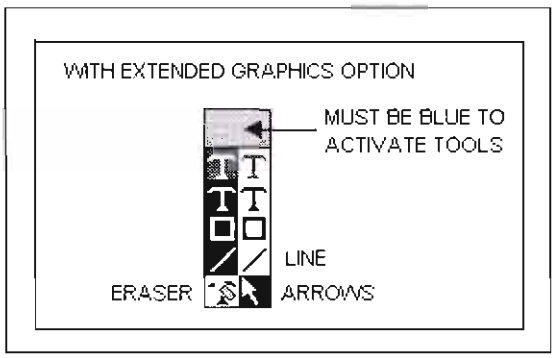
TABLE 5-13 DRAWING GRAPHICS ON IMAGES

Step	Action
1	Click on EDIT. The button turns yellow and a graphics toolbox appears in the top left corner of the image.
2	Select line or arrow mode in the toolbox by clicking on it. A red outline indicates the selected mode.
3	Move the cursor to the position where the line (box, arrow) should start and click the left mouse button.
4	Hold down the button and drag the line, box, or arrow to the desired end position. Release the button.
5	Stop graphics mode by clicking again on the EDIT button.

Removing Text

To selectively remove text, use the eraser (bottom left) in the toolbox and draw a box around the text or other graphics to be removed. The text disappears when you release the mouse button.

If you don't have the extended graphics option, use the CLEAR button and begin again.



2	Select line or arrow mode in the toolbox by clicking on it. A red outline indicates the selected mode.
3	Move the cursor to the position where the line (box, arrow) should start and click the left mouse button.
4	Hold down the button and drag the line, box, or arrow to the desired end position. Release the button.
5	Stop graphics mode by clicking again on the EDIT button.

Removing Text

Using Image Manipulation Functions

How Convolutions Work

Convolutions are filters used to enhance specific features. They work by transforming the relationship between spatial and frequency domains. For example, some convolutions are designed to create a sharpening effect by accentuating high frequency information in the image, while others are designed to remove noise by diminishing such high frequency information.

Most convolutions are mathematical functions that assign gray values to pixels based on the gray values of neighboring pixels. The range of neighboring pixels for which a filter samples is called a kernel. This kernel is a rectangular matrix that measures a number of pixels on a side. The pixels that surround the center pixel are sampled and the result is inserted in the center of the kernel.

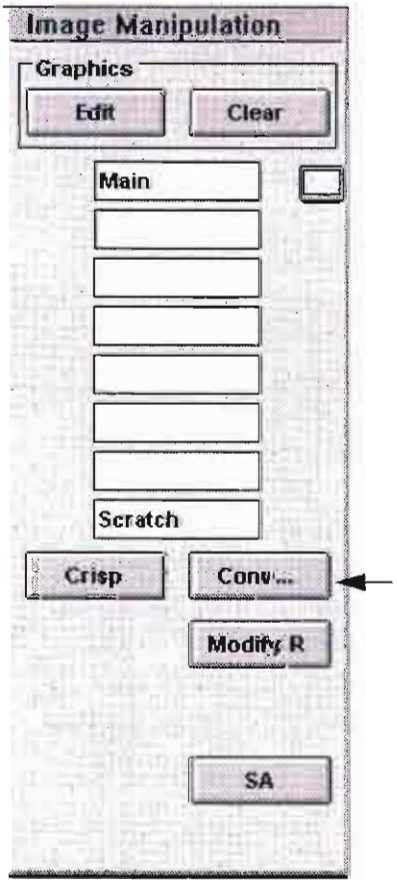
Matrices can be defined to differentiate in either X or Y or in both directions resulting in edge enhancement of the image (known as a LaPlace operation). With weighted averaging, the numerical values of each kernel cause certain pixels to have more influence on the result. Median filters replace the target pixel with the median luminance of the neighboring pixels. This preserves edge sharpness in the image where noise appears as spikes. Other filters are designed for region thinning and edge detection.

Once matrices have been defined, they can be stored on the hard disk of the system.

Most convolutions are mathematical functions that assign gray values to pixels based on the gray values of neighboring pixels. The range of neighboring pixels for which a filter samples is called a kernel. This kernel is a rectangular matrix that measures a number of pixels on a side. The pixels that surround the center pixel are sampled and the result is inserted in the center of the kernel.

Matrices can be defined to differentiate in either X or Y or in both directions resulting in edge enhancement of the image (known as a LaPlace operation). With weighted averaging, the numerical values of each kernel cause certain pixels to have more influence on the result. Median filters replace the target pixel with the median luminance of the neighboring pixels. This preserves edge sharpness in the image where noise appears as spikes. Other filters are designed for region thinning and edge detection.

WITHOUT COLOR OPTION

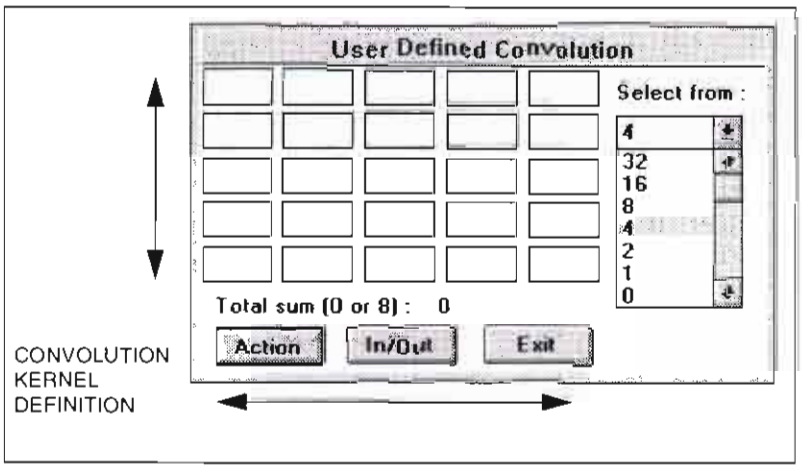


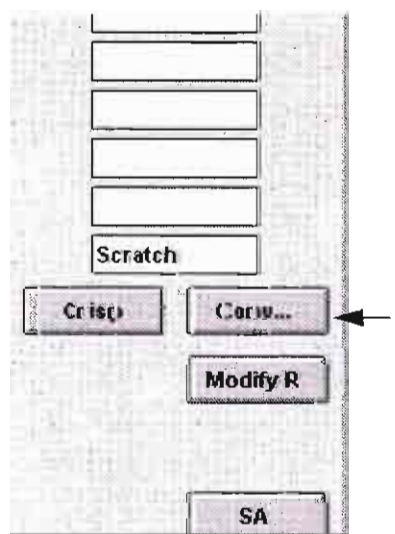
Applying Convolutions

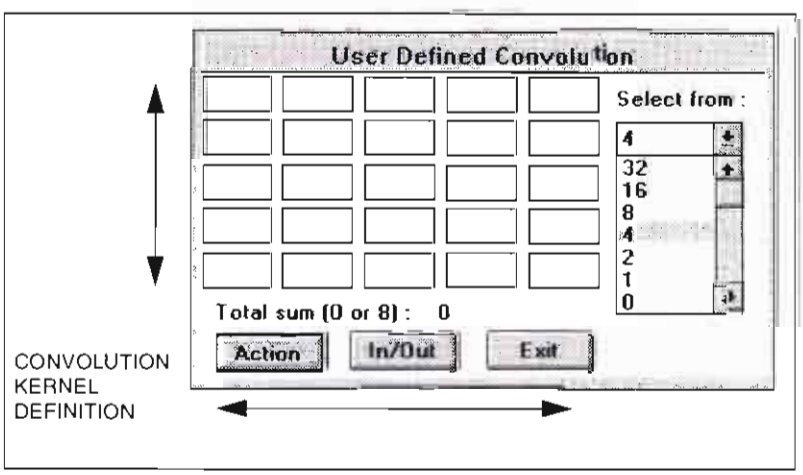
The CONV button is inaccessible unless the system is equipped with the customized convolution option.

This function allows you to define a matrix (up to 5 x 5 elements) to use for enhancement of an image in the framestore. As matrix elements, various weight factors for each pixel can be used.

When you click on the CONV button, a matrix for user-defined convolutions displays.







Creating a Valid Matrix

You can type in values (minus sign allowed) or select from the list and click in the edit box to enter the number. The total sum of all elements is continuously calculated and shown below the matrix. **For proper operation, the sum of all elements should either be zero or eight.** This ensures that the newly calculated image has gray levels in the valid range of the system.

TABLE 5-14 VALID ELEMENT MATRICES

Matrix Size	Element Definitions
5 x 5	All elements should be given a value. If nothing is put in a certain field the system assumes an element with a zero value.
2 x 2	Can be positioned anywhere in the matrix field, as long as the reduced matrix is one symmetrical block of numbers.
3 x 3	Can be positioned in the top left corner of the system, or with the central element at the same position as the central element for the 5 x 5 matrix.

Valid matrices meet three requirements:

1. They have a value of 1, 2, 4, 8, 16, 32 or 64 (with or without a minus sign). If not, an error message reads: *Invalid matrix value.*
2. The matrix does not have two adjacent matrix fields on a horizontal line with a zero value. If not, an error message reads: "*Wrong delta x.*"
3. The total sum is 0 or 8 (the overall brightness of the image is not changed).

Matrix Size	Element Definitions
5 x 5	All elements should be given a value. If nothing is put in a certain field the system assumes an element with a zero value.
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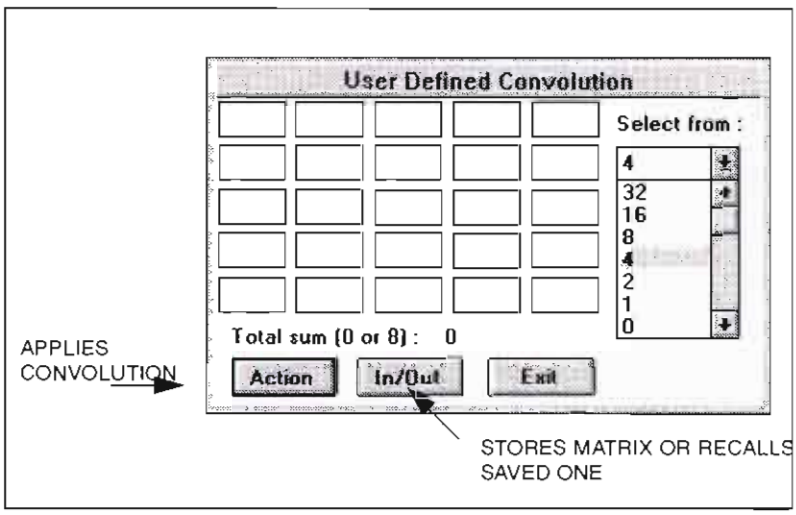
Experimenting with Matrices

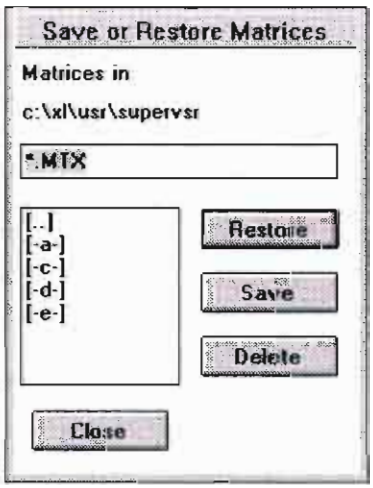
Convolution uses the image in the main memory as the input image. The result is calculated in the system's framestore and put back in the main memory. A copy of the result is in the scratch memory.

To compare the result of an operation with the original image, make a copy of the image prior to operation (either on hard disk or into one of the other framestore memories).

Also, when defining and experimenting with matrices, it is recommended to store the image, set up a matrix and study the result. If the result is not satisfactory, copy the original image back again into the main memory, modify the matrix and repeat the operation.

After defining the matrix, click on ACTION to start the operation, which affects the image in the main memory of the system.





The result can be treated as a normal system image, i.e., it can be sent to the photo monitor, stored on disk, used for coloring or copied to another memory of the system.

Click on the IN/OUT button to call up a dialog box for storing the matrix or retrieving the previously generated matrices.

Matrices have the default extension **.mtx*, which is generated by the system. The matrices are stored in the *\xl\usr* directory. The procedure for storing or retrieving matrices is similar to the one used for images.

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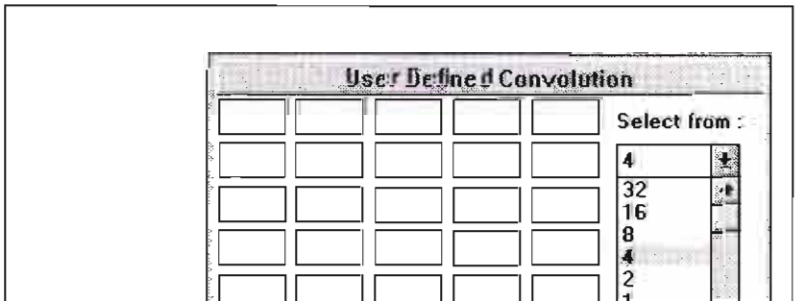
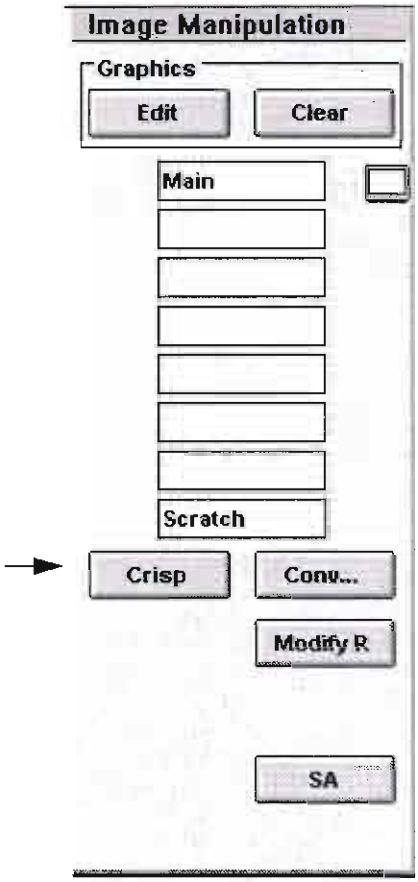


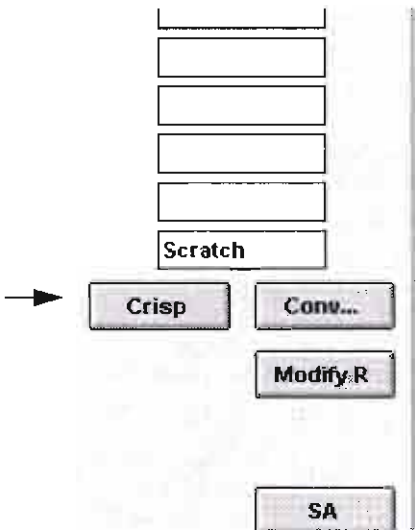
Using Crisp



Crisp, a convolution that is a 3 x 3 matrix, is very useful for improving noise-free images, especially at low kV, with limited sharpness. This convolution is predefined; you cannot change the applied matrix. It's omnidirectional differentiation results in a sharpening of the image (a little bit of derivative is mixed in with the original image).

Click on CRISP to freeze the image and apply the convolution. The input image for this operation is the one stored in main memory. The result of the operation is put in the scratch memory as well as in the main memory.

If your has more memory, make a copy of the image in memory before using the CRISP button. Then you can compare the original image with the crisp image by viewing the different memory contents.



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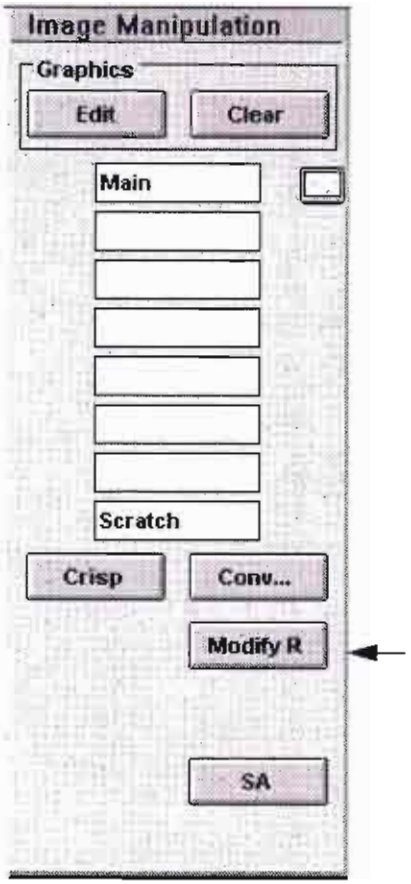
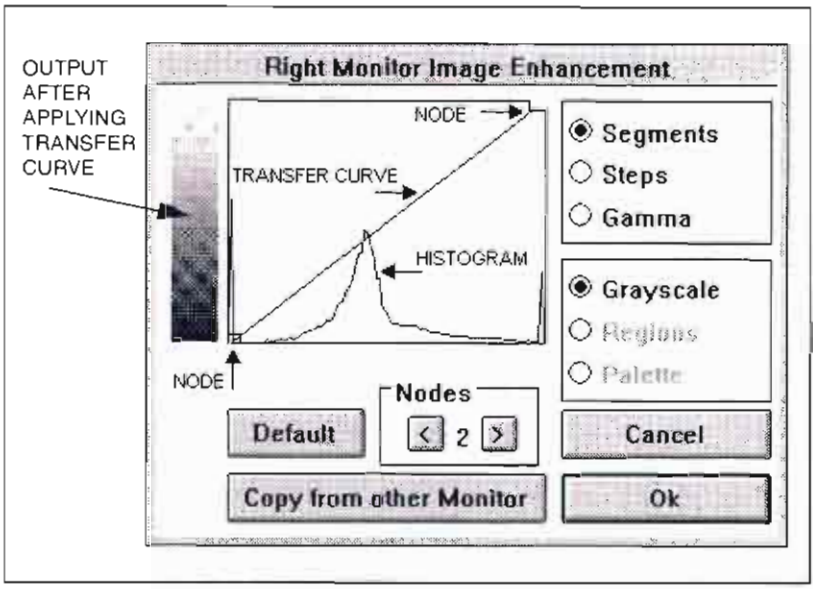


Using Modify R (Right)

Images can be enhanced by digital manipulation of the pixel graylevels. You can do this by viewing a histogram of the image, which shows the pixel distribution with respect to graylevel intensity, and then manipulating a transfer curve, which allows you to reassign pixel intensities.

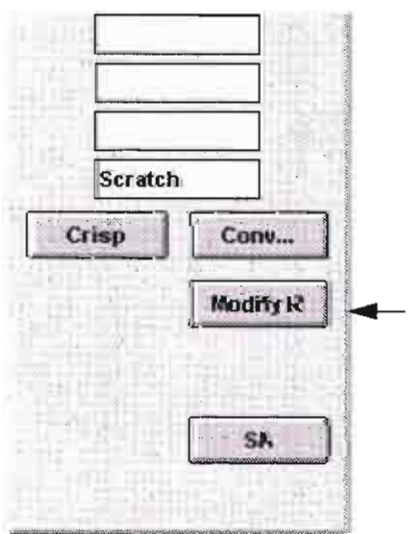
Click on the MODIFY R (for right monitor) button to bring up a dialog box for input. The dialog box can be moved anywhere on the screen by clicking on its title bar and dragging it to a new location.

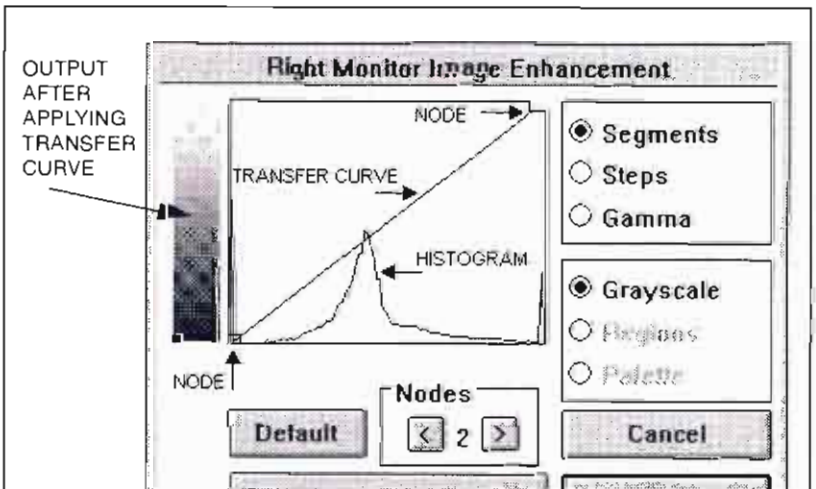


The dialog box displays the results of the histogram (in blue) and the transfer curve (a black line). The horizontal axis for the transfer curve represents the pixel range from black to white. The vertical axis represents the output after application of the transfer curve, also ranging from black to white.

Once you've defined a new lookup table with Modify R, these enhancements will apply to future grabbed frames unless you click on the DEFAULT button.

by clicking on its title bar and dragging it to a new location.

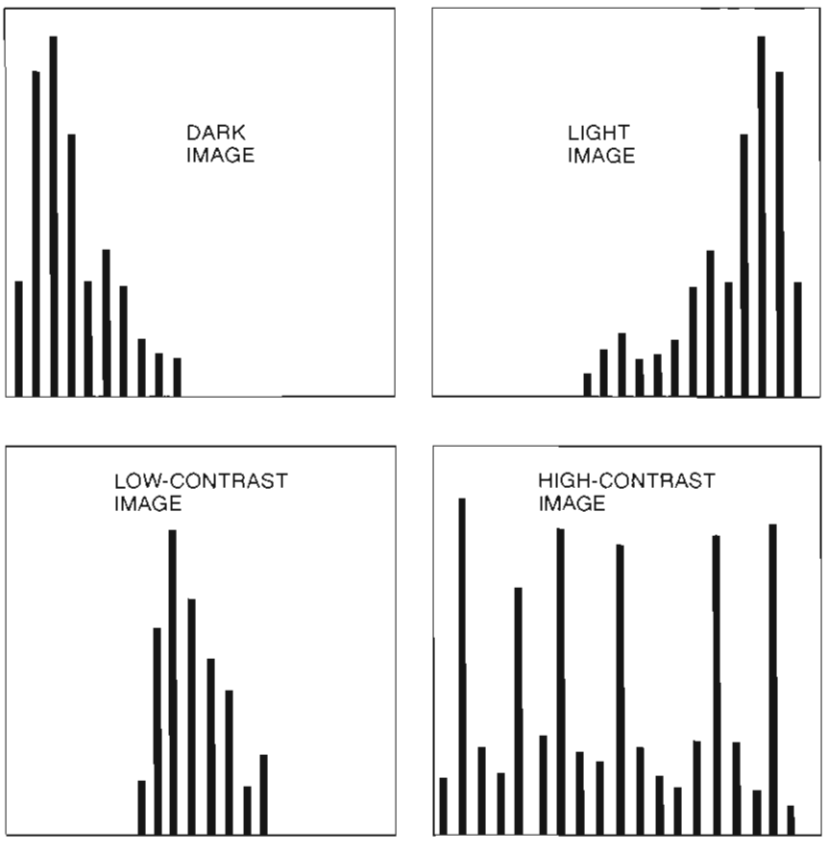


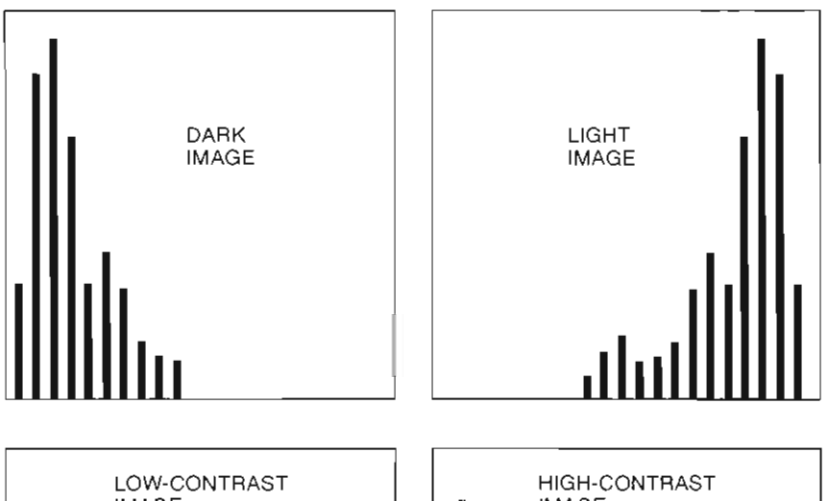


How a Histogram Works

A histogram is a global summary of the pixel intensities across an image based on a computer calculation. Table 5-3 shows the histogram shapes for four basic image types where the X axis represents input intensities from black to white and the Y axis represents the relative number of pixels of each intensity.

FIGURE 5-7 FOUR BASIC IMAGE HISTOGRAM SHAPES



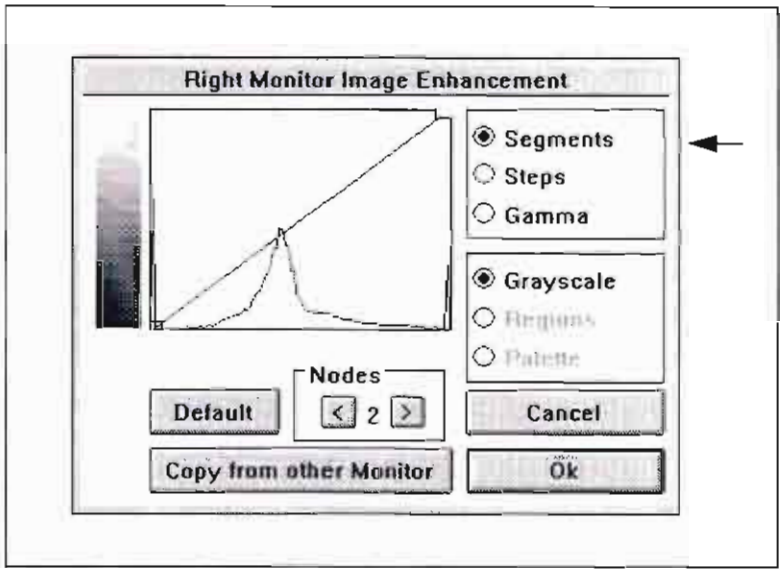


Enhancing Contrast and Details

Using Segments

Using Segments allows you to stretch or adjust contrast regions independently. The more nodes you add, the more regions you can control, although each are connected to adjacent nodes.

To make a linear contrast adjustment only, adjust the nodes up or down until the center of the black line (transfer curve) is in the center of the blue line (histogram)..



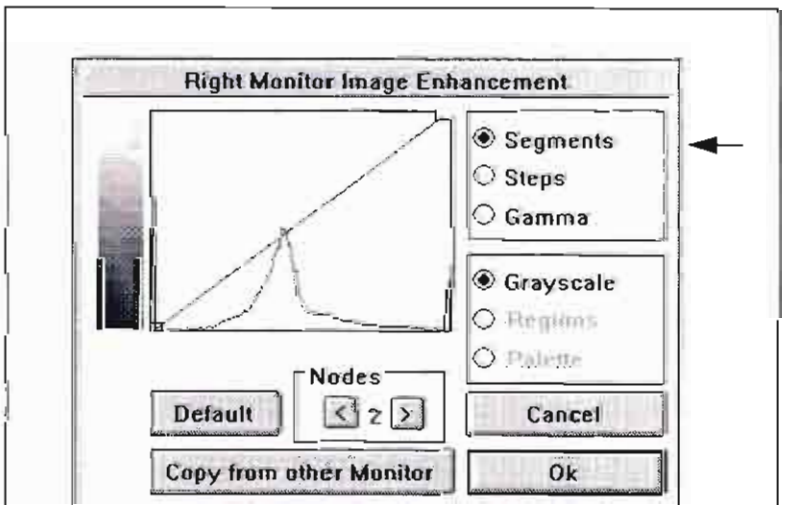
Adding Nodes to Improve Contrast

One approach to improving contrast involves increasing the number of interpolation nodes shown in the histogram LUT box.

The number of interpolation nodes, from two to six, can be selected with the left and right arrow buttons. The computer interpolates, or fills in missing data, between the nodes.

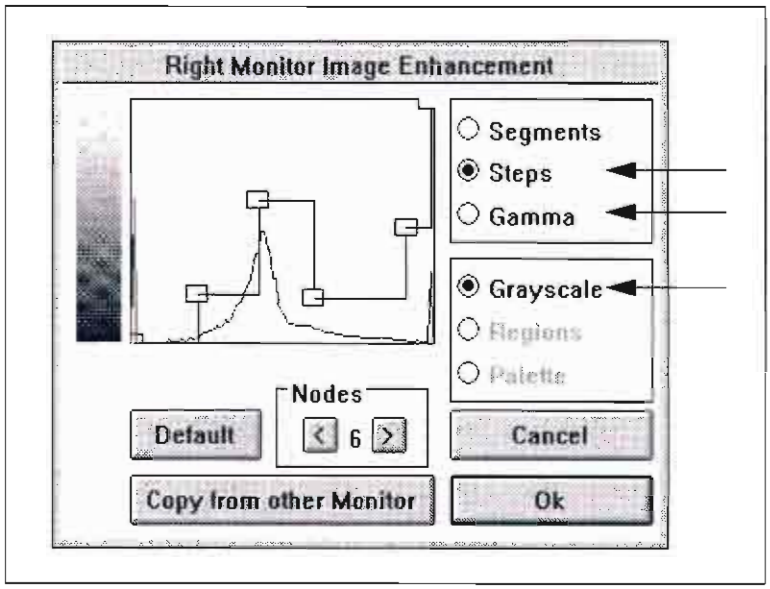
To move a node, click on it and drag it to any position in the box. The effect on the image will be shown immediately. To delete a node, click on the left arrow button.

The two minimum nodes are anchored at the left and right sides of the box. These nodes can be dragged vertically but not horizontally.



Using Steps

Choose Steps to implement a user-defined posterization method of interpolation that links the nodes in a stairstep fashion. It results in a high contrast image with fewer gray scale levels. Black, dark gray, light gray and white is an example of four-level posterization.



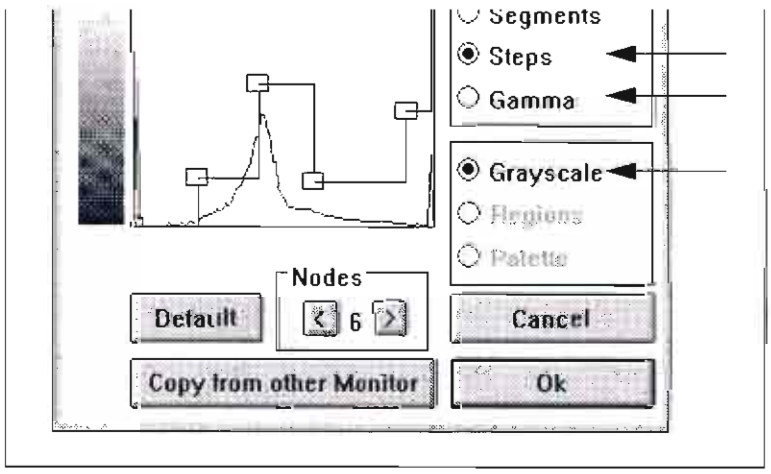
Greater Detail using Gamma

Gamma is the standard curve for nonlinear transfer of graylevels. It has only one node to define the strength of the gamma operation. Gamma is sometimes used to get more detail out of relatively black parts of the specimen (such as holes) without getting too much white in the image.

Gamma correction adjusts the midtone contrast and the brightness of an image.

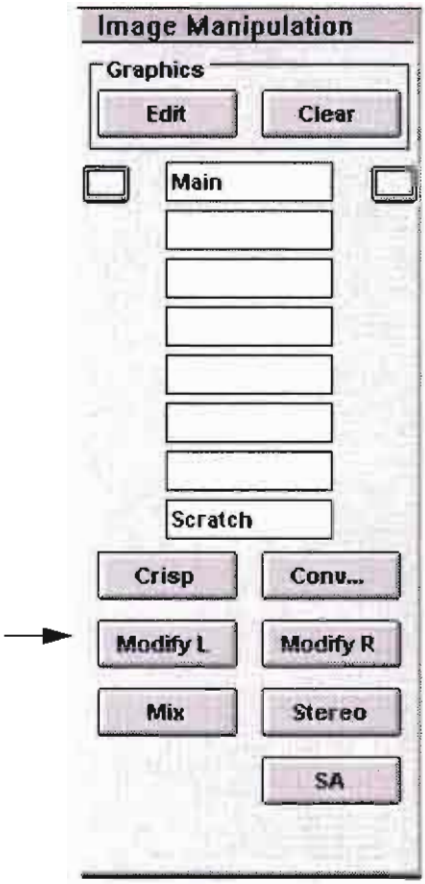
Using Greyscale for Image Output

With this selected, intensity values are mapped to different shades of gray—output colours are grayscale only. Unless you have the colour option, this is your output choice; Regions and Palette will be greyed.



Greater Detail using Gamma

Using the Colour Option Functions



With the colour option and two monitors, you can manipulate the mapping of pixel intensity, either by mapping the area between each node to a different colour (Regions) or by mapping to a predefined range of colour values (Palette) that allows you to set the relationship between greylevel and colour. Both of these functions are accessible with the MODIFY L button.

This option enables colour output for EDX mapping. Other colour Imaging functions are in the Image Manipulation control area.

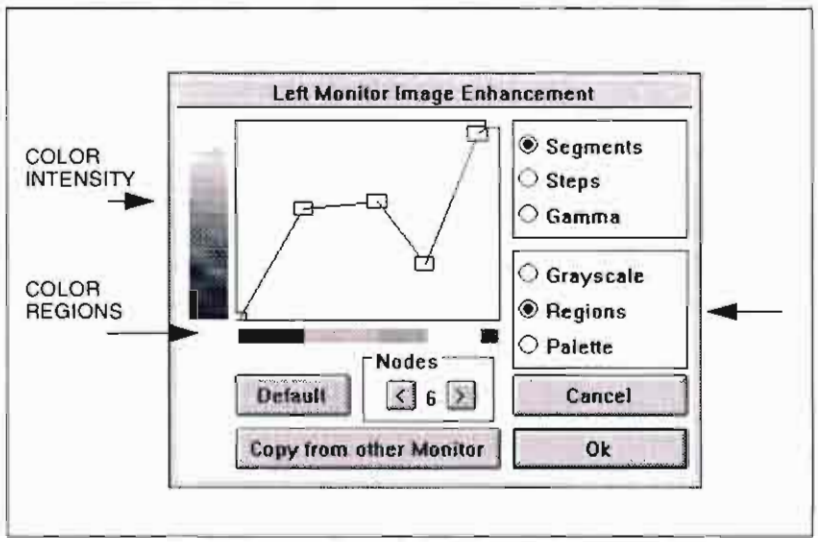
Using Modify L (Left)

This button only appears with the colour option and two monitors. Each monitor has its own transfer curve. Image enhancements are related to the image involved.

This dialogue box is the same as the one for Modify R (Right), but the colour options of Regions and Palette are available for use, as well as COPY FROM OTHER MONITOR.

Each monitor has its own transfer curve. Image enhancements are related to the image involved.Using Regions

Select Regions to map the area between each node to a different colour without changing its intensity. The number of colour regions equals one plus the number of active nodes.



NOTE

Color scheme information is not stored when an image is saved to a hard disk.

The colour regions are displayed at the horizontal axis. Drag a node from left to right to modify the corresponding input range for the colour.

Imaging functions are in the Image Manipulation control area.

Using Modify L (Left)

This button only appears with the colour option and two monitors. Each monitor has its own transfer curve. Image enhancements are related to the image involved.

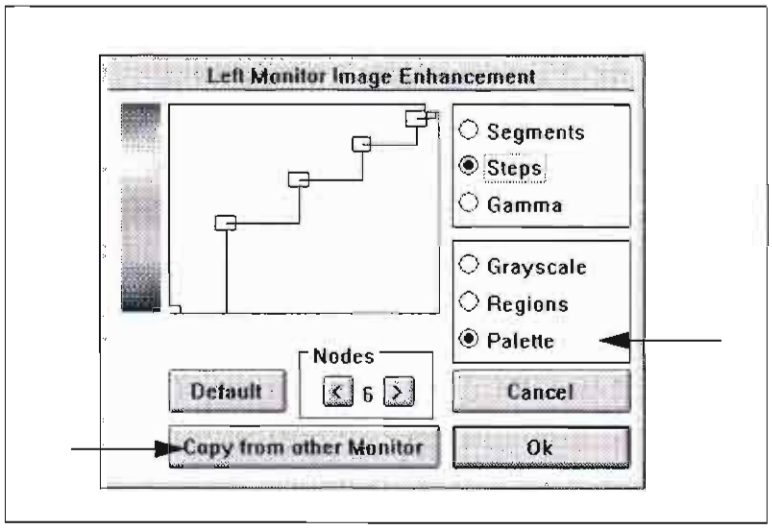
This dialogue box is the same as the one for Modify R (Right), but the colour options of Regions and Palette are available for use, as well as COPY FROM OTHER MONITOR.

Each monitor has its own transfer curve. Image enhancements are related to the image involved.Using Regions

Select Regions to map the area between each node to a different colour without changing its intensity. The number of colour regions equals one plus the number of active nodes.

Using Palette

The palette is a colour scheme shown on the left vertical axis. The horizontal axis represents the input gray levels of the image. The intensity of the colour palette is set to a fixed value. By shifting the nodes you define the curve and set the relation between greylevel and colour.



NOTE

Color scheme information is not stored when an image is saved to a hard disk.

Without the colour option, Palette is greyed out and inaccessible.

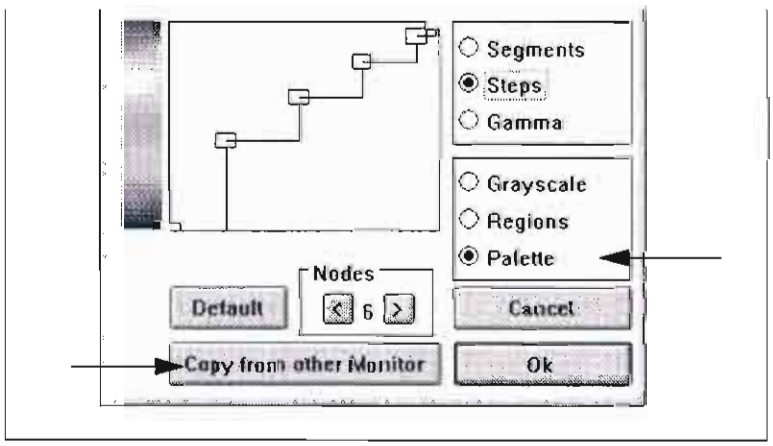
With two monitors, you can copy the curve for the image on the left monitor directly to the right monitor by clicking on the COPY FROM OTHER MONITOR button.

Use the grayscale function from the In/Out menu as a kind of test image to try manipulation with the colour imaging facility. The grayscale shows a range of greylevels (vertical bands of constant intensity) at regular intervals, and the histogram is shown by narrow peaks at the different greylevels so that you can select a particular graylevel easily.

Copy from other Monitor

If two monitors are present, the curve defined for the image on the left monitor can be copied directly to the right monitor by clicking on the COPY FROM OTHER MONITOR button.

Without the colour option, COPY FROM OTHER MONITOR is grayed out and inaccessible.

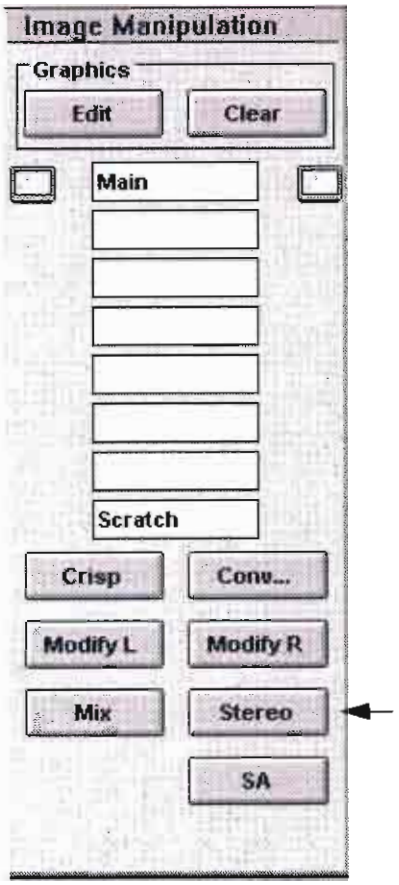


NOTE

Color scheme information is not stored when an

Without the colour option, Palette is greyed out and inaccessible.

WITH COLOR OPTION



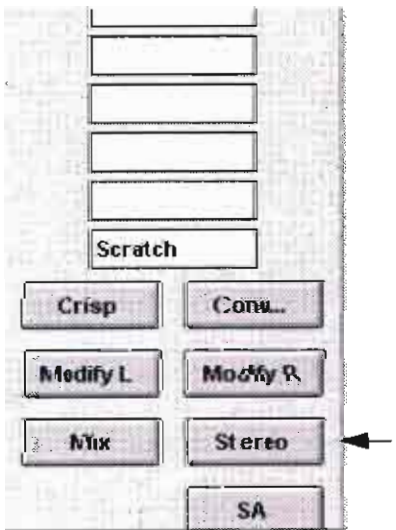
Red/Green Stereo Images

The Red/Green stereo procedure makes use of two images that are each colour coded (one in green and one in red) and shown in overlay on the left monitor. It requires the use of two memory planes. If the system is not equipped with more memory planes, use the scratch memory but avoid averaging functions and automatic functions.

Stereo viewing is based on the fact that the spatial impression of an image is generated by two images of the same object, but taken at different viewing angles. Stereo impressions are generated by the human brain and are only possible if the two images are seen separated—each image by one eye only. This can be achieved by some means of separation. Here separation is done by colour filtering once the images are displayed simultaneously on one screen.

The different viewing angles are obtained by two images taken at different tilt angles. Work as close as possible to the eucentric working distance. The amount of tilt determines the strength of the stereo effect. There is no fixed rule for obtaining the best image because it largely depends on personal taste.

The tilt axis at the column is horizontal so the scan rotates - 90° prior to displaying the images for the proper stereo effect.



different viewing angles. Stereo impressions are generated by the human brain and are only possible if the two images are seen separated—each image by one eye only. This can be achieved by some means of separation. Here separation is done by colour filtering once the images are displayed simultaneously on one screen.

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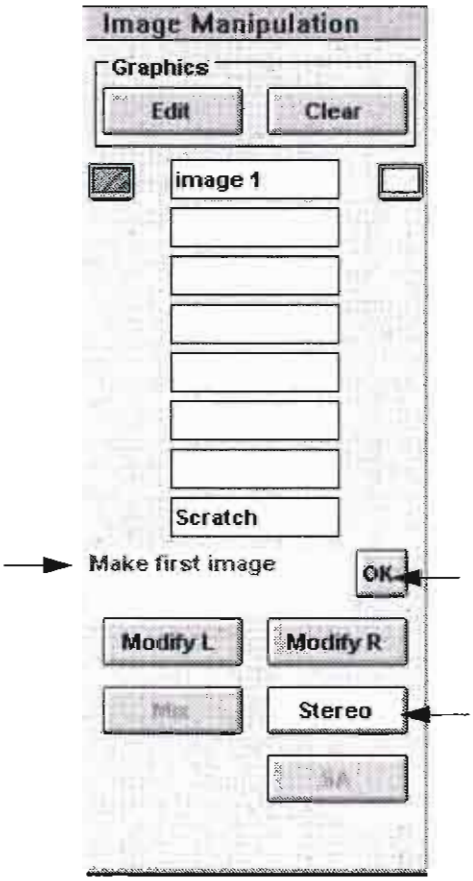
The tilt axis at the column is horizontal so the scan rotates - 90° prior to displaying the images for the proper stereo effect.

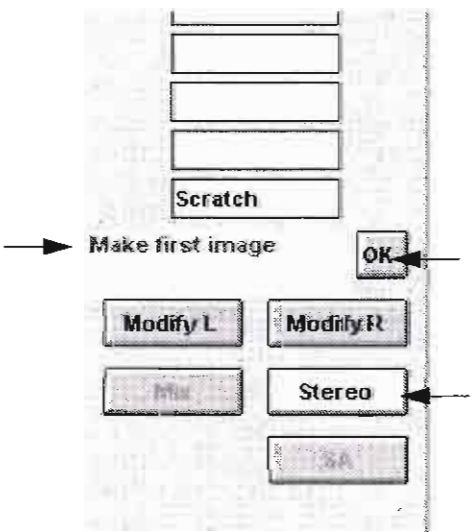


Producing A Stereo Image

Follow the procedure to create a correct stereo image.

TABLE 5-15 PRODUCING A STEREO IMAGE

Step	Action
1	Make sure that one memory plane can be used for storage of an image. Set both monitors to the Main memory.
2	Make sure the specimen is at the proper area of interest and at the eucentric working distance. At the eucentric position, the image does not shift when changing the tilt angle (up to a magnification level of about 4000X).
3	Optimize the setting for focus, stigmator, contrast and brightness and click on the STEREO button. The button turns yellow, the left monitor symbol turns red, and a white field next to the OK button displays instructions, *"Make first image."*
4	The scan rotates over - 90°. If necessary, optimize the image further (as indicated by the text on the screen). For best results, use Slow scan 3 and wait for a complete frame.
5	Freeze the image and click on the OK button.
6	Follow the instructions on the screen. *"Move left monitor to other memory."* Put the left monitor icon next to the free memory; the image is copied and the word *Stereo* appears.) At the left side, two monitors are visible: a red one at the selected memory and a green one at the Main memory.
7	At this point, the image is already displayed in Stereo but since both images are equal, nothing is yet visible. Click OK to continue.
8	*"Increase tilt, make second image."* Set the scan back to Live and change to Slow scan 1. Increase the tilt of the stage and, using red/ [illegible] memory.
2	Make sure the specimen is at the proper area of interest and at the eucentric working distance. At the eucentric position, the image does not shift when changing the tilt angle (up to a magnification level of about 4000X).
3	Optimize the setting for focus, stigmator, contrast and brightness and click on the STEREO button. The button turns yellow, the left monitor symbol turns red, and a white field next to the OK button displays instructions, *"Make first image."*
4	The scan rotates over - 90°. If necessary, optimize the image further (as indicated by the text on the screen).

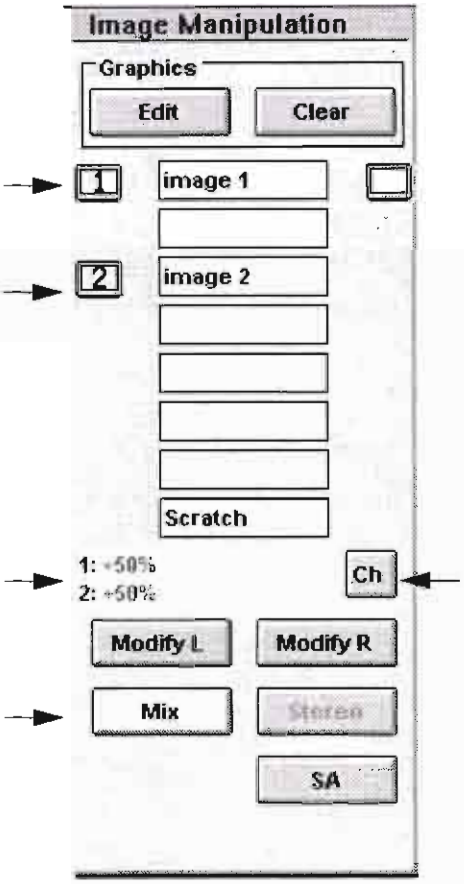


Storing Stereo Images

The stereo image cannot be stored as one unit on the hard disk. Instead, store the image in the main memory (the green image) and the image in the other memory (the red image). Replay the image by selecting the Stereo mode, and instead of optimising the image prior to the copying action, load the image from hard disk in main memory. After copying as part of the stereo procedure, the second image can be loaded in main memory. The Docu package from SIS can be used to permenantly bring the two images (red and green) into one printable image.

image.

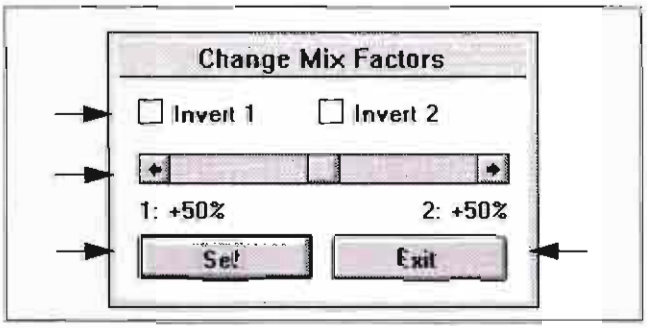
WITH COLOR OPTION

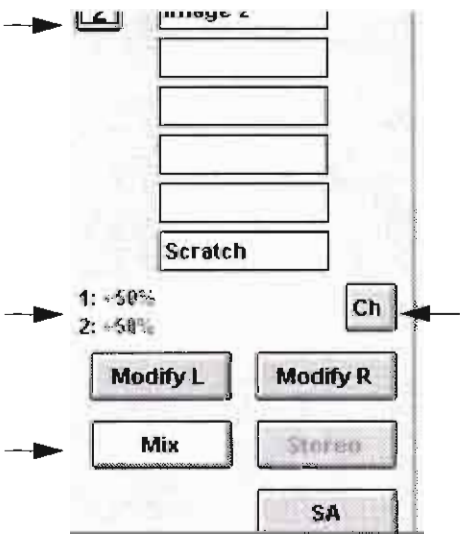


Mixing Digital Images

The MIX button refers to digital post-mixing of any of two image planes. The result is displayed on the second monitor. The memory selection is completely free, so one image could be a live image. The mix factor is adjustable between 0 and 100% and the signals can be inverted.

TABLE 5-16 MIXING DIGITAL IMAGES

Step	Action
1	Click on the MIX button. It turns yellow, the numeral 1 appears in the left monitor symbol and a white field displaying the default mixing ratio appears with a Ch (Change) button.
2	Place the cursor over the left monitor symbol. The cursor becomes another monitor symbol with the numeral 2 in it. Click on the first monitor symbol and drag the second one to another memory plane. The memory planes next to the monitor symbols are taken as input images for the digital mix.
3	Click on Ch to access the Change Mix Factors dialog box: 
4	Choose Invert 1 or 2 to change a positive number into a negative number, for example, +50% becomes -50% when inverted.
5	Use the adjuster to change the mixing ratio between the two images. The totals must always equal 100. The default value is 50/50.



Step	Action
1	Click on the MIX button. It turns yellow, the numeral 1 appears in the left monitor symbol and a white field displaying the default mixing ratio appears with a Ch (Change) button.
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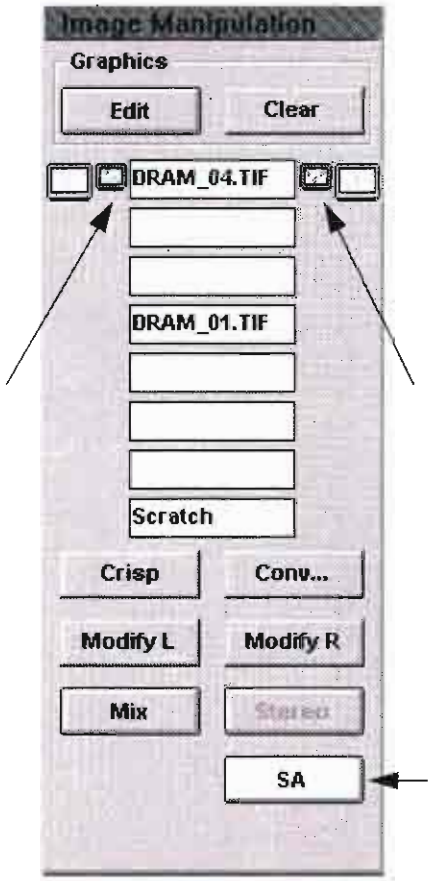
3	Click on Ch to access the Change Mix Factors dialog

TABLE 5-16 MIXING DIGITAL IMAGES

Step	Action
CONTINUED	
6	Click on the SET button. The result of the mix is shown on the left monitor after about 6 seconds. The new values appear in the white field to the left of the CH button.
7	Click on EXIT to end Mix mode and escape the dialog box.



Using SA (selected area)

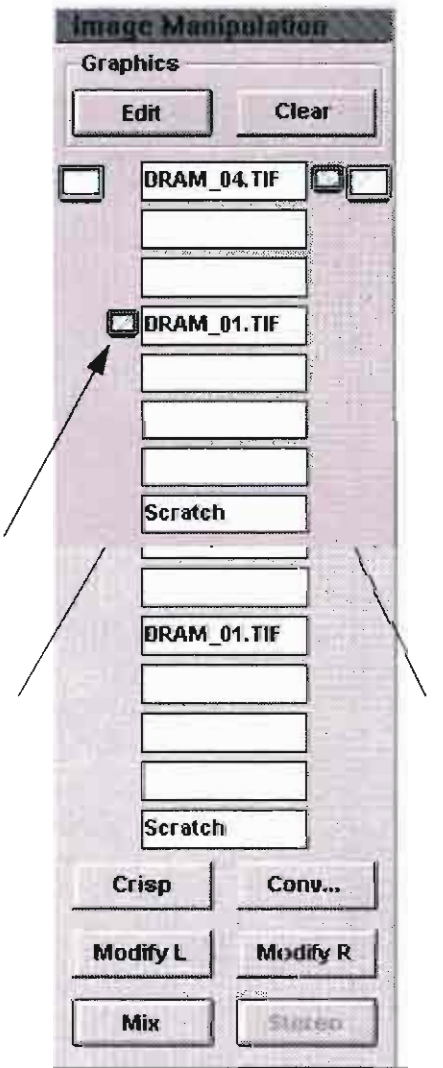
Selected area can be used to see a part of an image stored in an image memory within the total frame of another image from another memory plane. Selected area is available for both monitors and can be controlled independently. If the selected memory is showing a live image, the corresponding frame image or SA image will do the same. If the selected memory is showing a processed image (such as TV/Average), the frame image will show the processed image, but the SA image will show the live image (or, if the scratch memory is used, no image).

For frozen images both the frame image and the SA image will show the frozen image. With this facility it is possible to look "through" a window into the contents of another memory. The size and position of the window can be selected freely.

Clicking on the SA button will turn it yellow, indicating that the function is active. By default, a small monitor icon will appear at the position of the main memory. In addition, larger monitor icons are also present. If the system is equipped with two monitors both monitor icons will appear on the left as well as on the right hand-side, referring to the left and right monitor displays, respectively.

In addition a green overlay is shown on the right-hand side monitor. This green box indicates the position and size of the viewing window, and can be controlled in exactly the same way as the selected area in the scan pull down menu, i.e. by a click in the box it can be moved across the image screen and by a click outside the box a new selected

7	Click on EXIT to end Mix mode and escape the dialog box.



Using SA (selected area)

Selected area can be used to see a part of an image stored in an image memory within the total frame of another image from another memory plane. Selected area is available for both monitors and can be controlled independently. If the selected memory is showing a live image, the corresponding frame image or SA image will do the same. If the selected memory is showing a processed image (such as TV/Average), the frame image will show the processed image, but the SA image will show the live image (or, if the scratch memory is used, no

outside area of the selected area) can be positioned at any memory, and hence many combinations are possible (for 4 memories 16 combinations).

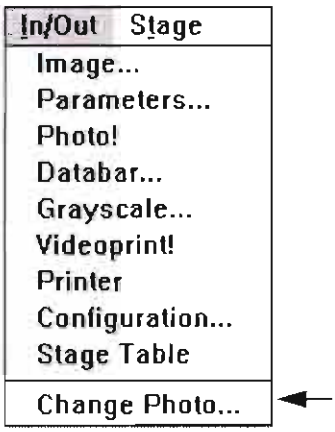
Notes:

1)The scratch memory can also be used for this operation, but then the frame store should not be in a processing mode i.e. averaging or integrating.

2)The look-up table as addressed by "modify left" and "modify right" only influences the frame image and not the selected area image.

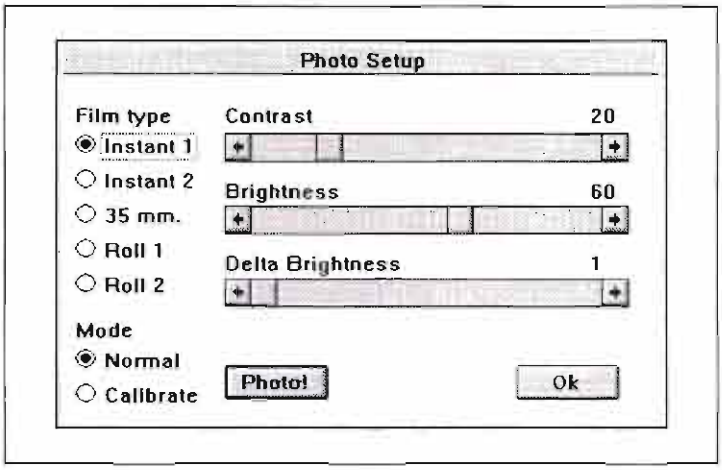
2)The look-up table as addressed by "modify left" and "modify right" only influences the frame image and not the selected area image.

Image Output



The image must be correctly focused and stigmated before printing. The TV scan speed can be used for this operation, but the use of slow scan rates for setting contrast and brightness can be more accurate.

Load the camera with film and select the correct exposure parameters from the dialog box that appears when you select Change Photo under the In/Out menu.



Five film types are available with user-selectable values of contrast and brightness. This allows you to use different speed film without making changes to the videoscope settings.

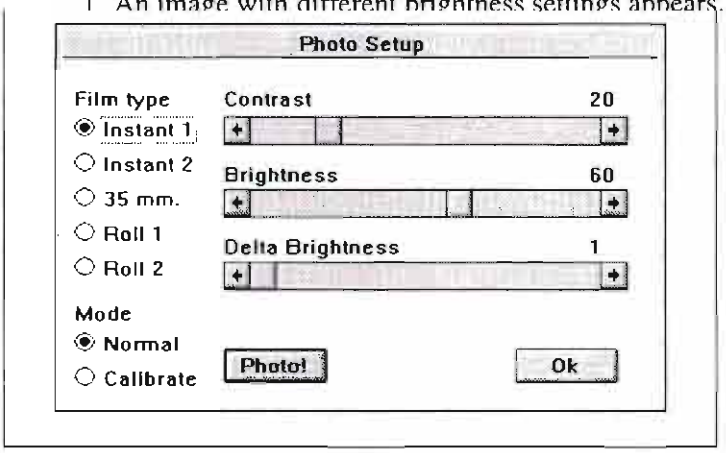
The preset parameters have been chosen for optimum output with standard settings for contrast and brightness. If you change these to a nonstandard film type, the values become the default until you enter new values or select a new film type.

Calibrating the Camera

To calibrate the camera with the photo monitor screen, follow the steps in Table 5-17.

TABLE 5-17 CALIBRATING THE CAMERA

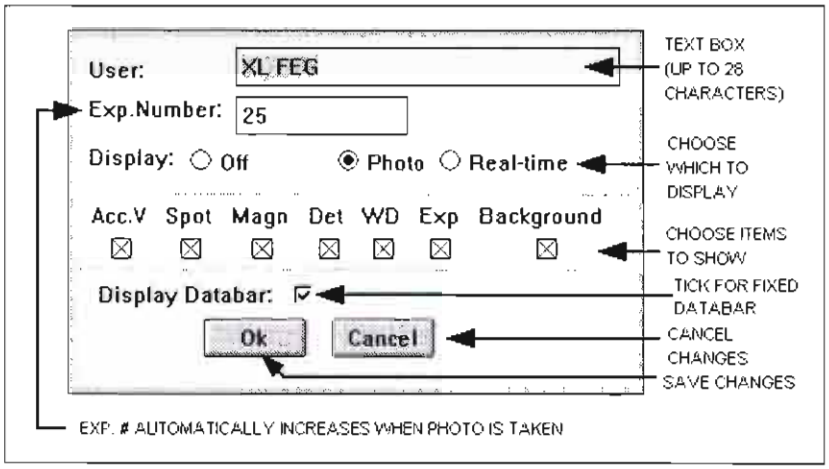
Step	Action
1	Choose Calibrate and set the contrast and brightness exposure.
2	After putting the film in the camera, click on PHOTO!. An image with different brightness settings appears.



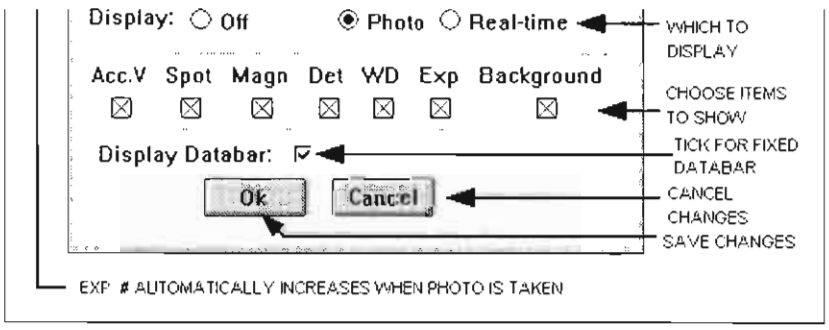
Five film types are available with user-selectable values of contrast

Displaying the Data bar

If you want to display the photo data bar on your image, be sure that it is selected in the dialog box that appears when you click on Databar under In/Out.



Make your selections regarding the parameters to be printed and click on OK.

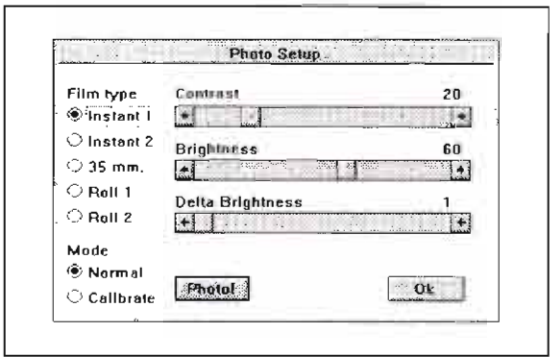
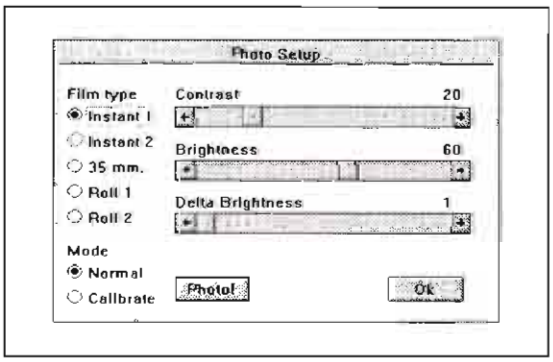


Make your selections regarding the parameters to be printed and click on OK.

Photographing the Image

Follow these steps to use the camera (Polaroid or 35 mm film camera):

TABLE 5-18 USING THE POLAROID OR 35 MM CAMERA

Function	Action
Calibrate the camera.	Calibrate the camera. If this is not known read 'Calibrating the Camera' previously described in this chapter.
Load the camera.	Use Polaroid 553 (8 pack) or 35 mm film as provided. Select the correct exposure parameters under Change Photo in the In/Out menu. 
Optimize the image.	Focus and stigmate the image. Adjust contrast and brightness, using videoscope or contrast/brightness controls.
Prepare the film.	With the Polaroid camera, pull out the metal sheet up to the blue line to expose the film. For the 35 mm camera, set the remote lock to keep the shutter open during exposure.
Take the photo.	Select Photo! from the In/Out pulldown menu. The selected photoscan speed now starts. The exposure progress shows onscreen in a display that ends in 100%. Replace the metal sheet or close the shutter of the camera. Click on DONE to restore the normal screen. The scan speed returns to the previous scan speed.
Develop the film.	For the Polaroid camera, push in the metal tab, pull out the white paper, then pull the black film tab out of the camera in one movement. Wait the necessary time for development, then open the film. For the 35 mm camera, advance the film after each exposure until the entire roll has been exposed. Remove the film from the camera and process in a photographic darkroom. previously described in this chapter.
Load the camera.	Use Polaroid 553 (8 pack) or 35 mm film as provided. Select the correct exposure parameters under Change Photo in the In/Out menu. 

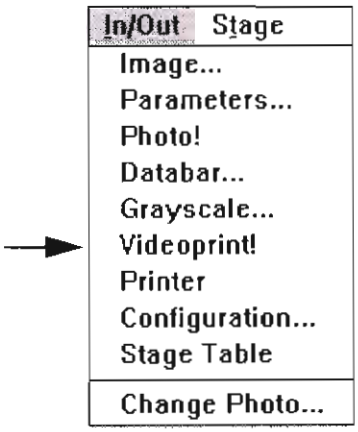
Printing Colour Images

A hard copy of the colour images can be made only on a colour video copier. However, any hard copy unit that has an analogue RGB input can be used.

Connect the hard copy unit directly to the left monitor with coax video cables (75 Ω). Switch either the monitor or preferably the color copier to a 75 Ω shut-off impedance. The computer offers NTSC frame frequency with sync on all cables. With the video copier, it is possible to copy color images, stereo images and graphics made with the system.

to copy color images, stereo images and graphics made with the system.

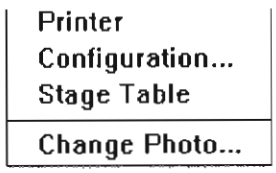
Taking a Videoprint



The videoprinter always grabs what is displayed on the screen. All scan rates, including TV, can be copied on a videoprint. When you need a high quality image, use Slow scan 3 and freeze or integrate 1 at photo scan speed. Follow these steps to make a videoprint:

TABLE 5-19 MAKING A VIDEOPRINT

Step	Action
1	Prepare an image of the same quality required for the photo camera output. Use the videoscope to set the correct Contrast and Brightness.
2	Choose a scan speed that gives adequate signal-to-noise ratio in a single scan. If you are using slow scan, choose integrate 1, which will automatically freeze at the end of one frame.
3	Switch on the videoprinter.
4	Select Videoprint! from the In/Out pulldown menu. The software starts the printer, which produces output showing what is displayed on the screen. The data bar can be printed on the videoprint (if that option is selected), showing the magnification used to make the videoprint.



1	Prepare an image of the same quality required for the photo camera output. Use the videoscope to set the correct Contrast and Brightness.
2	Choose a scan speed that gives adequate signal-to-noise ratio in a single scan. If you are using slow scan, choose integrate 1, which will automatically freeze at the end of one frame.
3	Switch on the videoprinter.
4	Select Videoprint! from the In/Out pulldown menu. The software starts the printer, which produces output showing what is displayed on the screen. The data bar

Saving Images

You can save images digitally on diskette, hard disk, or laser optical disk using options on the In/Out menu. These image file formats are available:

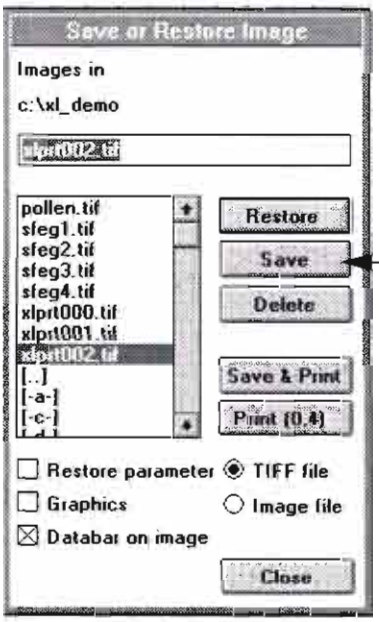
- **.img*

  Scanning Electron Microscope (SEM) format. This format can be restored to the screen, including vectors. The restoring of High Definition *.img* files is currently implemented.

- **.tif*

  TIFF format is used to export files to other programs. Standard Definition *.tif* files can be restored to the screen and includes all vector and overlay information. The restoring of High Definition *.tif* and XHD *.tif* files are not implemented due to their dimensions. Images are stored in the TIFF format at the resolution they were acquired: 702 x 484 pixels for Standard Definition and 1404 x 968 pixels for High Definition. XHD depends on conditions chosen in the Scan Setup dialogue and is explain in the following section..

TABLE 5-20 SAVING IMAGES



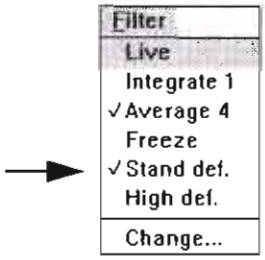
Step	Action
1	Obtain photographic quality images before saving. This is important if reprints are needed from the stored image.
2	When the image is acceptable onscreen, select Image from the In/Out menu. The screen displays a list box showing the disk drives available and the allocated directory. The default drive and directory is *c:\xl\usr*.img*. **For **.img* Files:** Text can be entered at the **.img* prompt in the text box, typing over the * up to 8 characters long (in agreement with DOS conventions). **For **.tif* Files:** Click on the TIFF file option button to save **.tif* files in the same directory. If you are saving the image to a floppy disk, click on the drive you want in the list box. Be sure there is a formatted floppy disk in the drive before you select Image from the In/Out menu. TIFF

- **.tif*

TIFF format is used to export files to other programs. Standard Definition *.tif* files can be restored to the screen and includes all vector and overlay information. The restoring of High Definition *.tif* and XHD *.tif* files are not implemented due to their dimensions. Images are stored in the TIFF format at the resolution they were acquired: 702 x 484 pixels for Standard Definition and 1404 x 968 pixels for High Definition. XHD depends on conditions chosen in the Scan Setup dialogue and is explain in the following section..

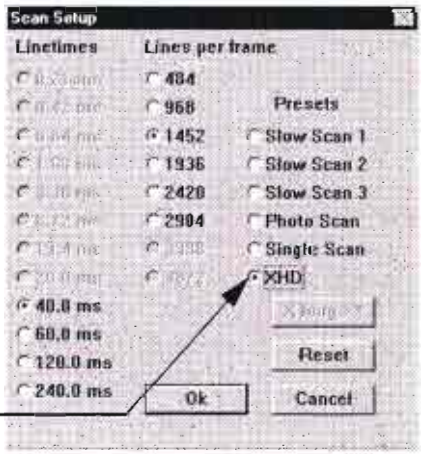
TABLE 5-20 SAVING IMAGES

Step	Action



Extended Image Definition XHD

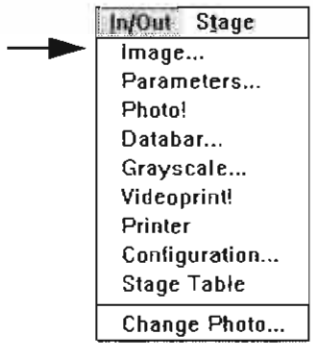
This is only for systems with XHD. To extend the resolution capability of the Image Saving function on the XL microscope, the implimentation of larger pixel formats has been installed in the computer hardware. The software to drive these larger formats is logically positioned on the Image dialogue from the In/Out menu.



XHD TIFF file

Activation of this radio button brings the dialogue under extended format control. Images can then be saved to the list in the same way as lower resolutions via entering a label in the top text area and then pressing the 'Save' button.

Restore, Save & Print, Print (0,4), and all 'check boxes' are non operative with this function activated.

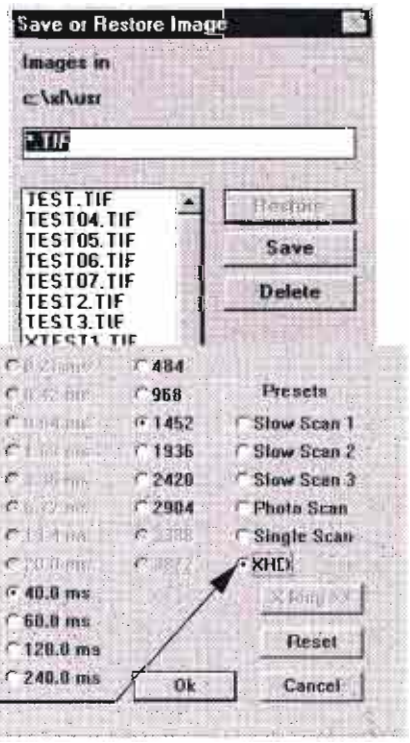


Setup for using large Pixel formats

The Scan definition, number of lines and line time has to be set prior to saving the required definition image. The process is as follows:s

TABLE 5-21 MAKING HD TIFF FILES

Step	Action
1	Click on the 'Filter menu' and select 'Stand def.'
2	Click on the 'Scan' menu and select 'Change' at the bottom of the list.
3	Choose XHD scan mode and allocate the required number of lines and line time to it, for example 2904/ 40ms. Only the relevant conditions are highlighted on the Scan Setup dialogue. Press the 'OK' button
4	Adjust Contrast and Brightness. Press the F5 function key and the image starts to scan at the selected format.
5	Click on the 'In/Out' menu and select 'Image'. Activate the 'XHD TIFF file' radio button, enter the label and press the 'Save' button. The scan restarts and the image is saved to disk.



Pixel Format

format control. Images can then be saved to the list in the same way as lower resolutions via entering a label in the top text area and then pressing the 'Save' button.

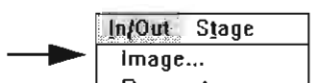
Restore, Save & Print, Print (0,4), and all 'check boxes' are non operative with this function activated.

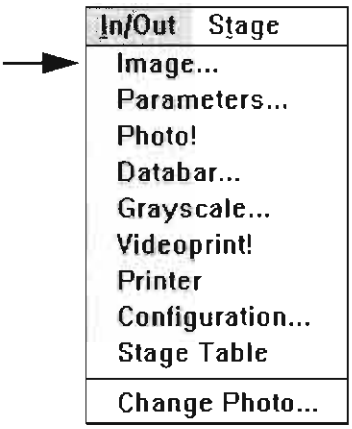
Setup for using large Pixel formats

The Scan definition, number of lines and line time has to be set prior to saving the required definition image. The process is as follows:s

TABLE 5-21 MAKING HD TIFF FILES

Step	Action

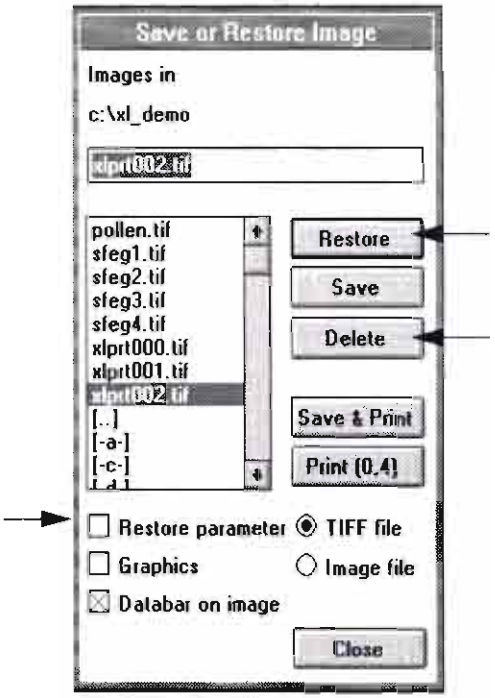




Restoring Image (IMG and TIFF) Files

TABLE 5-22 RESTORING IMG & TIFF FILES

Step	Action
1	Select Image from the In/Out pulldown menu. The Save or Restore dialogue box appears.
2	Select the file from the listbox by clicking once on it. It appears in the edit box.
3	If you want to restore the data saved with the file, click in the checkbox labelled Restore Parameter. Click on RESTORE; the time lapse bar appears. The image is restored and the data bar reverts to the original settings. The only exception to this is a High Definition File in Tiff format, this cannot be loaded back to the screen.



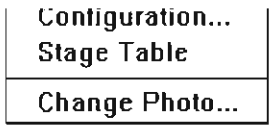
Deleting Image (IMG and TIFF) Files

While the list box for Image is open, an image item can be deleted by clicking once on an image item from either the **.img* or **.tif* list so that it appears in the edit box. That image item can then be deleted by clicking on the DELETE button.

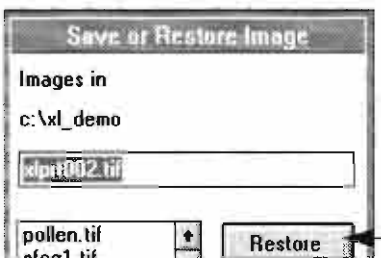
You can also use File Manager to rename or delete files.

Personal Directory

Using File Manager in Windows, you can create a personal directory for storing images. Once the directory is made, you can select it as the default directory when you are saving or restoring image files.

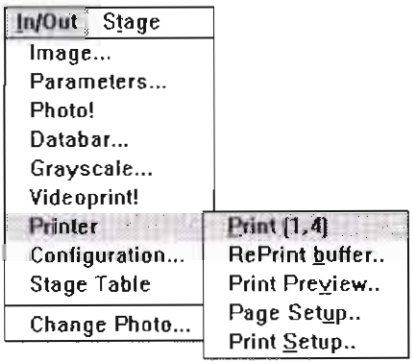


Step	Action
2	Select the file from the listbox by clicking once on it. It appears in the edit box.
3	If you want to restore the data saved with the file, click in the checkbox labelled Restore Parameter. Click on RESTORE; the time lapse bar appears. The image is restored and the data bar reverts to the original settings. The only exception to this is a High Definition File in Tiff format, this cannot be loaded back to the screen.



Deleting Image (IMG and TIFF) Files

While the list box for Image is open, an image item can be deleted by clicking once on an image item from either the **.img* or **.tif* list so that it appears in the edit box. That image item can then be deleted by



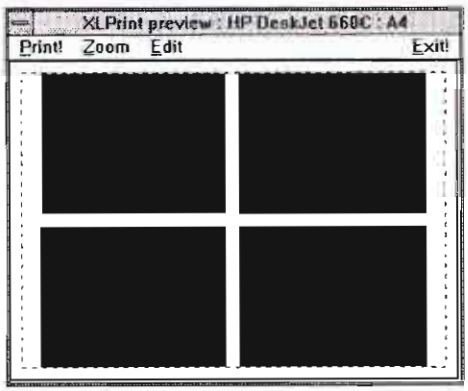
Using the Printer functions

Click on Printer in the In/Out menu to open control for the configuration of images, reprint buffer, print preview, page setup and print setup functions.

Print (x,y)

This item operates in the same way as the printer icon button, causing the current framestore image to be saved to disk and deposited in the print buffer. The value assigned to X will indicate the number of images currently stored in the printer buffer. The value assigned to 'y' will indicate the possible number of images per printed page as defined by the user in the Page Setup dialogue box. The possibilities are 1, 2 or 4 images per page.

Each time this menu item is selected the current framestore image will be saved to disk and deposited in the printer buffer, unless the buffer is full. The value of 'x' displayed in the menu item will be incremented accordingly.

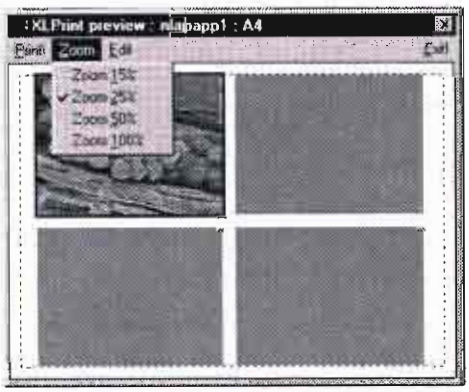


When the printer buffer is full the Print Preview dialogue box will automatically be opened from where it is possible to Print!, Zoom, Edit or Exit!

If the AutoTiffnaming function in the Page Setup dialogue box is checked ON, then the file-name will be incremented at each save action. If this item is not checked then the filename printbf1 will be automatically assigned to this file and incremented thereafter.

Re-Print buffer..

This activates the Print Preview dialogue box (see next), which will display the contents of the print buffer. It also contains the Print! Zoom, Edit and Exit! commands.



Print Preview..

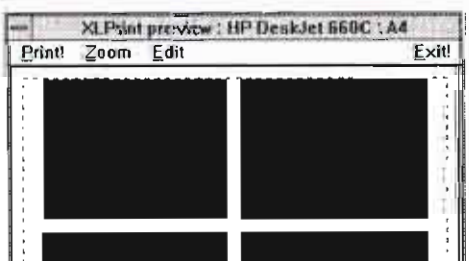
This dialogue box displays the contents of the print buffer. The number of image areas is determined by user input in the Page Setup dialogue box.

Print Preview Dialogue Box

The functions of the above dialogue box are discussed below.

images currently stored in the printer buffer. The value assigned to 'y' will indicate the possible number of images per printed page as defined by the user in the Page Setup dialogue box. The possibilities are 1, 2 or 4 images per page.

Each time this menu item is selected the current framestore image will be saved to disk and deposited in the printer buffer, unless the buffer is full. The value of 'x' displayed in the menu item will be incremented accordingly.



When the printer buffer is full the Print Preview dialogue box will automatically be opened from where it is possible to Print!, Zoom, Edit or Exit!

If the AutoTiffnaming function in the Page Setup dialogue box is checked ON, then the file-name will be incremented at each save

Zoom

Selecting this item displays a menu containing the items:

15%

25%

50%

100%

Each of these items will cause the image page and dialogue box to be resized. When necessary, scroll bars are provided to enable the entire image to be viewed. To move the image, grab the slider and reposition so the desired portion is in view.

Edit

This displays a menu containing the following.

Discard Selected Image (Delete)

First use the right mouse button to select one of the displayed image areas. This will be indicated by a blue frame around the selected image. Selecting Discard Selected Image will now cause the highlighted image to be removed from the image area.

Discard all images

Selecting this item causes all images in the print buffer to be removed.

Recall selected image (Insert)

This allows the last discarded image to be restored to the print buffer.

Recall all images

This allows a full set of discarded images to be restored to the print buffer.

Each of these items will cause the image page and dialogue box to be resized. When necessary, scroll bars are provided to enable the entire image to be viewed. To move the image, grab the slider and reposition so the desired portion is in view.

Edit

This displays a menu containing the following.

Discard Selected Image (Delete)

First use the right mouse button to select one of the displayed image areas. This will be indicated by a blue frame around the selected image. Selecting Discard Selected Image will now cause the highlighted image to be removed from the image area.

Discard all images

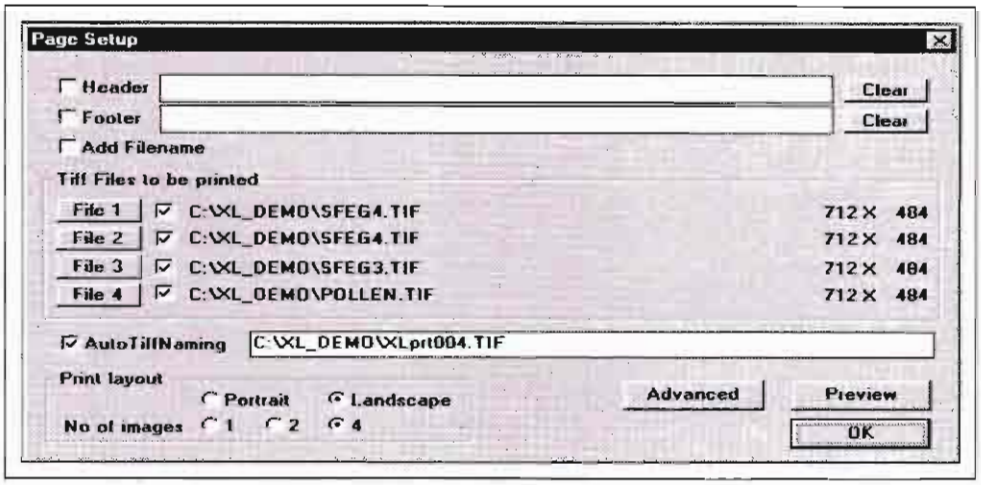
Selecting this item causes all images in the print buffer to be removed

Page Setup

This dialogue box contains a number of items associated with the format of the printed page.

Page setup dialogue box

The Page Setup dialogue box is as follows:



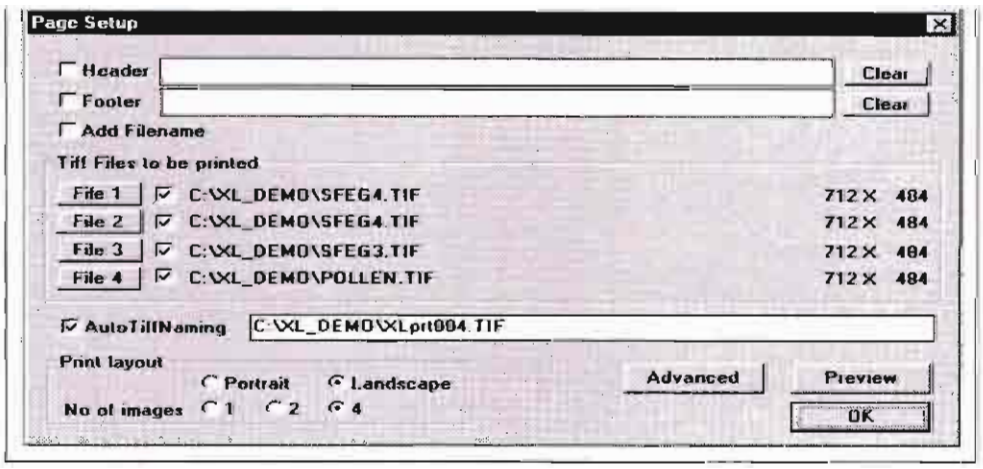
Selecting the check box Header will activate a text box used to enter a header label. The contents of this text box are editable and can be cleared using the Clear button just to the right of the box.

Selecting the check box Footer will activate a text box used to enter a footer label. The con-tents of this text box are editable and can be cleared using the Clear button.

Selecting the Add Filename check box will display the relevant filename below each image on the page. This information will also be printed as part of the page.

The number of files available to load into the buffer will depend on the No of images setting. For example, if 4 images per page has been chosen, then the File 1 to File 4 buttons in the Tiff Files to be printed section will be active. If 2 is selected, then File 1 and File 2 will be active and File 3 and File 4 will be dimmed (inactive). If 1 image per page has been chosen then only File 1 will be active.

Selecting any active File button will cause the Load Tiff dialogue to appear. This dialogue box al-lows the user to scroll through filenames contained in any directory or connected disk location and select a file for recall.



Selecting the check box Header will activate a text box used to enter a

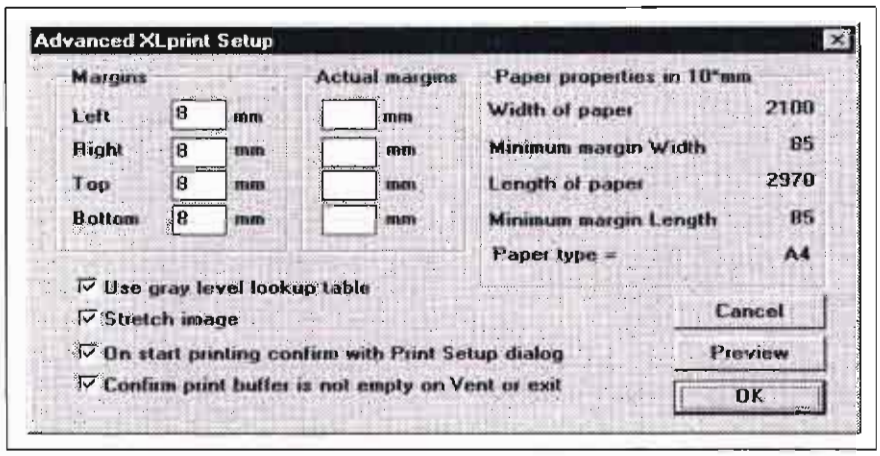
The print layout will toggle automatically between Portrait and Landscape and between 1, 2 or 4 images per page.

Selecting the Advanced button displays the Advanced XLprint Setup dialogue box.

Selecting the Preview button displays the Print Preview dialogue box.

Advanced Setup

The Advanced XLPrint Setup dialogue box is as follows:



This box allows the user to input the desired page Margins. When switching between multiple printers, the page margins may change. If this happens, reset the margins to their maximum values by typing all zeroes into the Margins text boxes.

Information about Paper properties is also available in the above dialogue box. The check boxes at the bottom are described as follows:

Use gray level lookup table

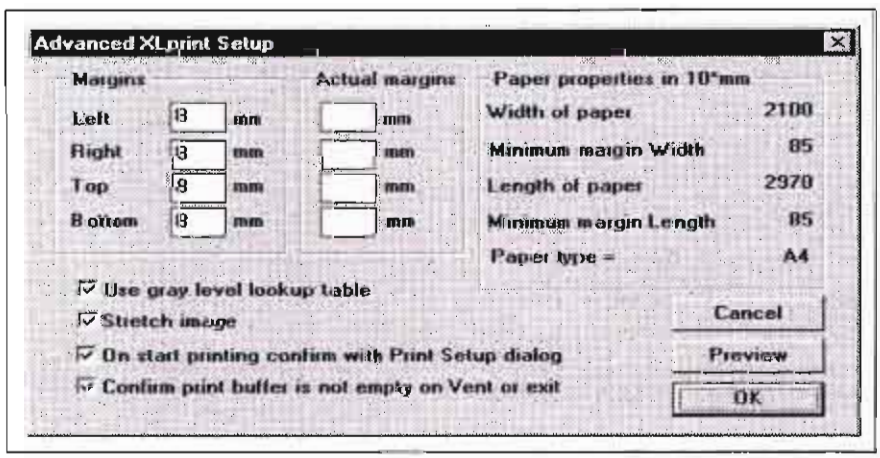
If this item is checked, any non-default values of contrast / brightness, selected with the Modify function in the Image Manipulation page, will also be applied to the printed image.

Stretch image

If this item is checked the image has it's aspect ratio corrected for printout.

On start printing confirm with Print Setup dialogue

If this item is not checked, selecting Print! in the Print Preview dialogue box will cause the image page to print immediately. This is suitable for the situation where the system is connected to one printer



This box allows the user to input the desired page Margins. When

Exit!

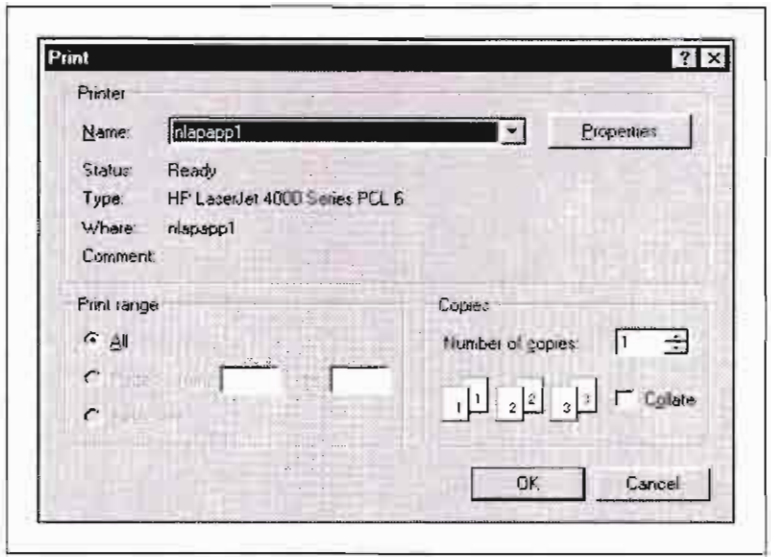
This exits the Print Preview dialogue box with a confirmation box:

"Do you want to discard all images that are currently in the print buffer?"

Selecting Yes will cause the images to be discarded; and No will leave the images in the buffer.

Print Setup

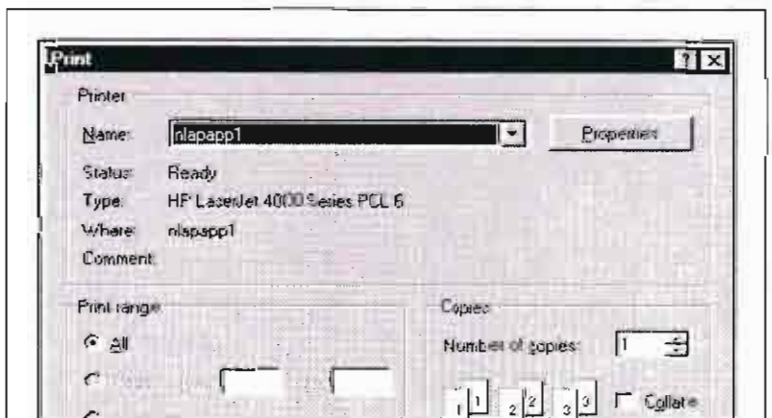
This menu item opens the standard Windows print dialogue box.



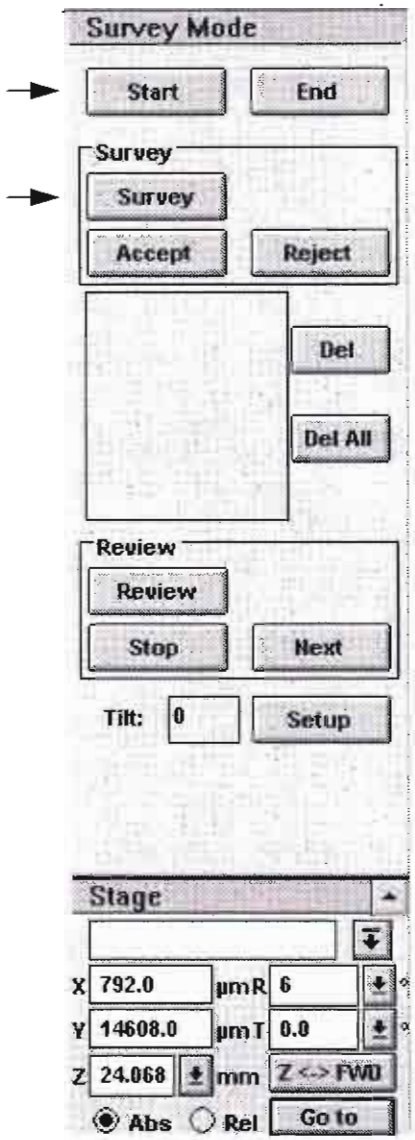
The Printer text area indicates the selected printer, which can be changed using Setup.

Print Setup

This menu item opens the standard Windows print dialogue box.



Using Survey Mode



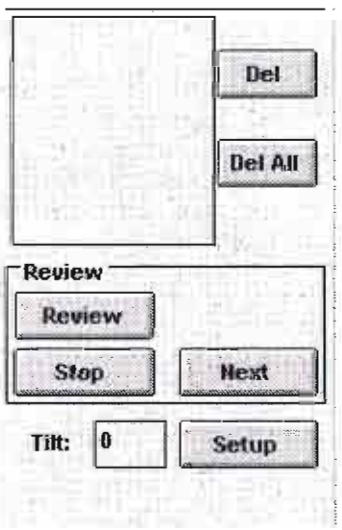
Survey mode allows you to rapidly survey a series of features at various stage positions without formally saving and recording stage positions and parameters.

As you revisit each location in reverse order in the Review mode, you can then select only the best images for optimization and recording.

Follow the steps below for completing a survey:

TABLE 5-23 COMPLETING A SURVEY

Step	Action
1	Click on the START button to initiate the survey procedure. The button turns yellow.
2	Click on SURVEY to start the actual collection mode. The cursor changes to a green cross, indicating that the Get function is active.
3	Move the cursor over a feature to be studied in more detail and double-click the left mouse button (Get mode). The feature will be moved towards the center of the screen using the stage or beam shift, depending on the magnification.
4	The powerzoom function is automatically activated. Magnification is changed gradually. Click on STOP to end powerzoom. Then click on ACCEPT to save the position or REJECT to dispose of the position. Alternately, click on CANCEL to end powerzoom. The magnification will reset to its original setting and you can search for a new feature.



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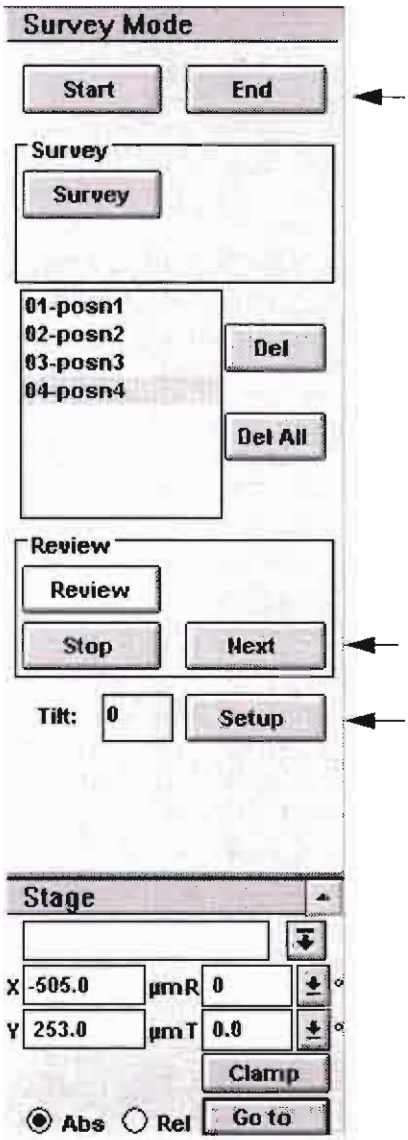
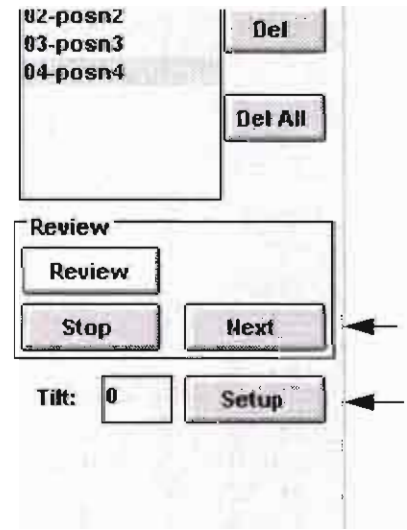


Reviewing a Survey

Follow the steps below for reviewing a survey:

TABLE 5-24 REVIEWING A SURVEY

Step	Action
1	Click on the SETUP button to review survey settings. Check to see if the tilt angle has changed.
2	Click on REVIEW to begin revisiting surveyed locations in reverse order.
3	Click on STOP to pause on individual images.
4	Click on REJECT to restore the condition of the system as it was before the zoom function was activated.
5	Click on DEL to selectively eliminate choices in the features list box.
6	Use the DEL ALL button to delete all positions from the features list box.
7	Click on ACCEPT to record and store desired images.
8	Click on NEXT to stop and start the review process.
9	Click on END to leave Survey mode.



2	Click on REVIEW to begin revisiting surveyed locations in reverse order.
3	Click on STOP to pause on individual images.
4	Click on REJECT to restore the condition of the system as it was before the zoom function was activated.
5	Click on DEL to selectively eliminate choices in the features list box.
6	Use the DEL ALL button to delete all positions from the features list box.

Using the EDX Analytical Functions

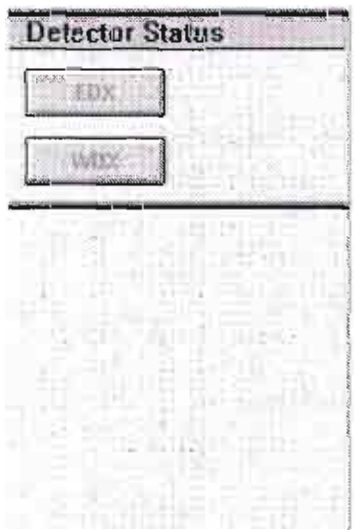
The EDX detector is an option on the XL-FEG and either is delivered as an integrated part of the microscope system or as a stand alone system of various manufacture. The detector is mounted at the left corner at the back of the specimen chamber, resulting in a take-off angle of 35°.

The take-off angle is calculated from the geometry of the installation and from parameter settings, such as working distance and scale factor. Input data for the geometry factors is usually available in the EDX manual.

When your XL-FEG is equipped with non-integrated EDX (stand alone), the EDX basic mapping and line functions are accessed in this Analytical control area. Use this control area to select dedicated EDX functions, allowing input from the detector systems, such as single channel output from an EDX window (dot map). Layout of the control area depends on whether or not your system has the colour option.

Analytical Mode

This mode allows you to collect spectrum data and X-ray maps from the electron microscope to perform high quality spectral analysis. You can store the data in computer files, output maps to black and white or colour printers.



factor. Input data for the geometry factors is usually available in the EDX manual.

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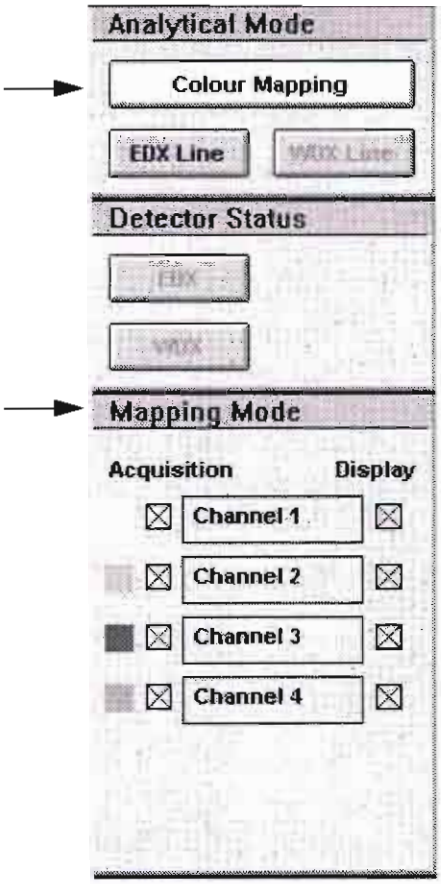


Colour Mapping Mode

Click on the COLOR MAPPING button to display the Mapping Mode control group.

The computer does the following:

- Sets Scan to Full frame
- Sets Filter to Live
- Sets: Slow Scan 3 (a line time of 40 ms)
- Clears image in main memory
- Switches on a colour mode.

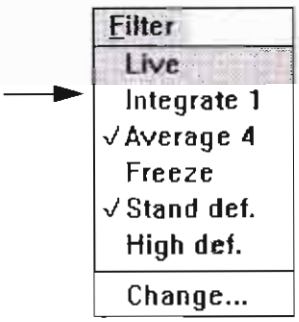
In colour Mapping Mode, you may select a simultaneous input of up to four channels. Selection of channels is independent of the display mode, using the colours red, yellow, green and aqua. Type in the corresponding channel names to relate the channel/colour to the applied EDX window or element. The colour coding is equal to the definition of the EDX windows.

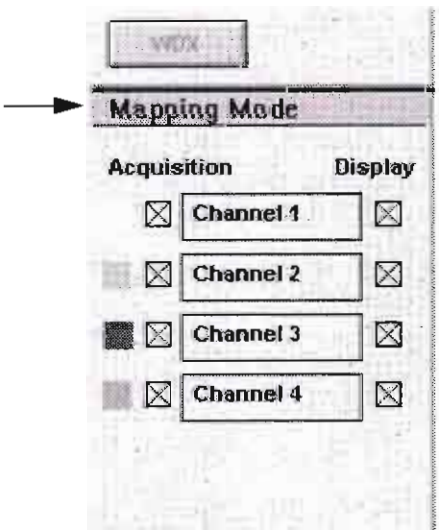
You can select another slow scan rate or redefine Slow scan 3 to any longer value than the default value of 40 ms.

Integration

You may also select Integrate from the Filter menu. In this integration, the number of dots increases with each frame and the signal-to-noise ratio gradually improves.

Integration is stopped when the selected number of frames has been reached. When the image is acceptable, X-ray maps can be stored on disk. Retrieve a dot map after selecting colour mapping mode, not before.





- Clears image in main memory
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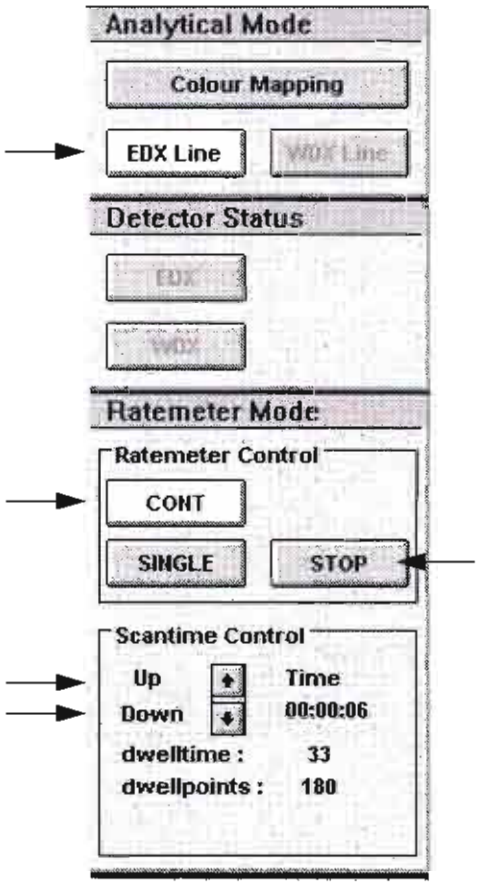
Integration

You may also select Integrate from the Filter menu. In this integration,



EDX Linescan

This function allows you to make horizontal linescans across an area of interest and the corresponding analog output (ratemeter) is superimposed on the image.

Before using the EDX linescan, be sure that the analyzer conditions are correct (count rate, window setting, spotsize and focus) and that the area of interest is displayed on the screen. Since line scans are only in the horizontal direction, application of scanrotation for proper orientation might be necessary.

Linescan Profile

Click the EDX LINE button. The computer is set in line scan mode, using the default setting for a linescan of six seconds. The framestore image is frozen and a line displays on top of the image. Click on the image to choose the vertical position of the horizontal line.

The profile overlaid on the image represents EDX analog output, for example, the EDAX ratemeter. The horizontal lower dashed line corresponds to the minimum counts per second for the peak selected in the EDX spectrum. The higher dashed line is the maximum counts per second of the element. This is similar to the functionality of the videoscope.

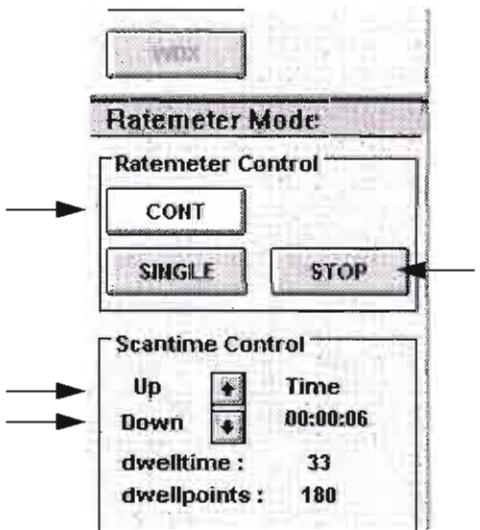
Modifying Linescan Column Conditions

Modify linescan column conditions by clicking on the Up or Down arrow in the Scantime control area. When you choose new settings, the EDX System responds somewhat slowly because of the internal synchronization of the newly selected linescan.

After completion of the first linescan, a new one starts and the profile refreshes. You can interrupt the linescan at any time by a click on the STOP button. To obtain one linescan (from far left to far right), click on the SINGLE button.

When a linescan is ready (stopped) and overlaid on the image, the computer sends it to the photo monitor to make a photo. It can also be printed as a videoprint.

The range of the analog EDX output signal is electronically adjusted to the expected input level for the column. The maximum and minimum of the ratemeter generated by a ramp should correspond to the levels indicated by the two horizontal dashed lines respectively. If this is not the case, a Service Engineer should set the correct levels.



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Linescan Profile

Click the EDX LINE button. The computer is set in line scan mode, using the default setting for a linescan of six seconds. The framestore image is frozen and a line displays on top of the image. Click on the image to choose the vertical position of the horizontal line.

The profile overlaid on the image represents EDX analog output, for example, the EDAX ratemeter. The horizontal lower dashed line corresponds to the minimum counts per second for the peak selected in the EDX spectrum. The higher dashed line is the maximum counts per second of the element. This is similar to the functionality of the videoscope.

Modifying Linescan Column Conditions

Detector Status

The Detector Status control group contains the controls for the EDX window and WDX detector. Click on the EDX button to display the EDX window.

There is one button labelled ECON and one field for text messages next to it. The colour of the ECON button represents the status of the window:

- A gray button means the detector window is closed
- A yellow button means the detector window is open.

Manually Controlled EDX Window

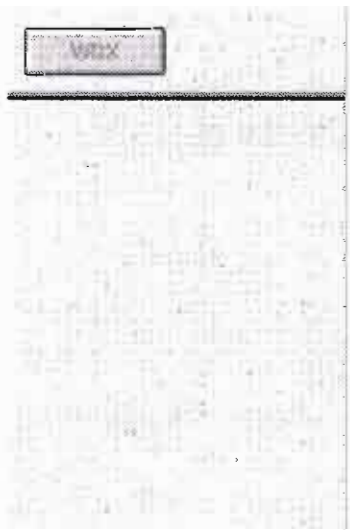
When the window is open, the vacuum logic protects the chamber from venting and related warnings are presented on the screen. When the window is closed and the vacuum level, as measured by the optional Penning gauge, is not good enough, the status line next to the button reads "Not Ready."

Motor-Controlled EDX Window

The window status is software controlled. Click on the gray EDX button to open the detector window:

- If a Penning gauge is installed, the EDX window opens when the pressure is below 2 x 10^{-5} mbar. If the pressure is not low enough, the status line reads "Not Ready."
- If a Penning gauge is not installed, the window opens after a nine-second delay, assuming that the status message VacOK is displayed below the PUMP button on the Settings control area.

When the window opens, the button colour changes from gray to yellow. The window status is indicated next to the control button. Status messages are: "Open," "Closing," "Close," or "Opening." When the column vents, the motorized EDX window closes before venting starts.



- A yellow button means the detector window is open.

Manually Controlled EDX Window

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Motor-Controlled EDX Window

The window status is software controlled. Click on the gray EDX button to open the detector window:

- If a Penning gauge is installed, the EDX window opens when the pressure is below 2 x 10^{-5} mbar. If the pressure is not low enough,

Mapping for EDX (Standard)

Mapping EDX signals refers to dot maps of the specimen's elemental distribution. If the colour option is not installed, the Analytical control area displays the EDX MAP button.

Before using this feature, be sure that the proper specimen area is located and the count rate and EDX window setting are correct for mapping. When you click on the EDX MAP button, the computer defaults to:

TABLE 5-25 EDX DEFAULT MODE

Setting	Function
Scan	Full frame
Filter	Live
Scan	Slow Scan 3 (a line time of 40 ms)

Signal input is connected to the SCA output of the EDX system and the dots are visible.

Wait for a complete scan to finish and freeze the image. Then store the image on a photograph or a video print.

The signal is treated as greylevels and therefore it is not possible to accumulate the map by integration.

TABLE 5-25 EDX DEFAULT MODE

Setting	Function
Scan	Full frame
Filter	Live
Scan	Slow Scan 3 (a line time of 40 ms)

Signal input is connected to the SCA output of the EDX system and the dots are visible.

Wait for a complete scan to finish and freeze the image. Then store the

Software Configuration Files

Windows 3.11

Many XL FEG instruments have Windows 3.11 still running as the computer operating system, therefore the following table (5-25) only applies to these instruments as they start-up from a DOS base to load the 'Config.sys' and the 'Autoexec.bat' files.

The system comes ready for use. This means that the computer is configured in the proper way and all required software programs (MS-DOS, Windows, system control software) are loaded. The following files play an important role in the actual setup of the system:

TABLE 5-26 SYSTEM CONFIGURATION FILES

File	Description
config.sys	Lists the computer configuration and defines the communication between computer and system. Defines the use of higher memory in the *config.sys* file. If you have to modify the *config.sys* file for other application programs, be sure that all commands required to run the system are still present.
autoexec.bat	Defines the automatic start-up procedure for the computer. For example, the path will be set correctly so the operating system has access to the different files. Also defines the automatic startup of the Windows environment. If the *autoexec.bat* file has to be modified because of other applications, make sure that the system specific commands are still available.
system.ini **win.ini** ***.ini**	Do not modify, move, remove, or replace these important files.

Windows NT

Windows NT does not rely on the same type of file system as version 3.11 and therefore dispenses with the DOS base loading mechanism and is automatic in start-up.

The MCTDA are proprietary and dedicated software programs (MS-DOS, Windows, system control software) are loaded. The following files play an important role in the actual setup of the system:

TABLE 5-26 SYSTEM CONFIGURATION FILES

File	Description
config.sys	Lists the computer configuration and defines the communication between computer and system. Defines the use of higher memory in the *config.sys* file. If you have to modify the *config.sys* file for other application programs, be sure that all commands required to run the system are still present.

Software Control Programs

The programs for controlling the system are in the *c:\xl\mc* directory. The most important files are listed below with a brief explanation. These files automatically load in the Windows environment when the system is started.

TABLE 5-27 SOFTWARE CONTROL PROGRAMS

File	Description
server.exe:	This program connects the user interface (*mctrl*) and the subcomputers in the system but has no actual controls. During startup, the program checks the hardware to configure the next software level properly. You can expand the icon and select the SDB item to see the hardware definition of the system (jumper settings) and the information available in the customer key.
scs.exe:	Present only with the remote control option. This program loads in the Windows environment (iconized) and allows communication between the system's PC and an external computer.
mctrl.exe:	This main program represents the actual user interface. It takes user input and sends commands to the next program level (server, stage) for execution.
frcs.exe:	Controls serial devices in general.
md.txt: **icmd.txt:** **acctusr.bin** **xlcui.ini** **mctrl.ini** ***.map** ***.mtr** ***.stg**	Instrument parameters are stored in these files, which are custom to your system because they contain factory adjustments. In addition, each time you perform an alignment procedure, the md.txt file is updated to store the alignment settings. **Keep a backup of these files on disk.**
additional	If you look at the *c:\xl\mc* directory, you'll see that the system has many more files not explained here in detail. But files such as p90cc.abs, p90fs.abs and others are critical to operation of the system and should never be removed from this directory. The files are low-level programs that are automatically loaded into the subcomputers of the system. Also, DLL files (Dynamic Linkable Libraries) allow communication at the Windows level between system control and other software programs such as the Image Database Management Software. Larger optional software programs are the Image Analysis program (*Analysis.exe*),

File	Description
server.exe:	This program connects the user interface (*mctrl*) and the subcomputers in the system but has no actual controls. During startup, the program checks the hardware to configure the next software level properly. You can expand the icon and select the SDB item to see the hardware definition of the system (jumper settings) and the information available in the customer key.
scs.exe:	Present only with the remote control option. This program loads in the Windows environment (iconized) and allows communication between the system's PC and an external computer.
mctrl.exe:	This main program represents the actual user interface. It takes user input and sends commands to the next program level (server, stage) for execution.

Another directory called *c:\xl\td* (TD refers to Test and Diagnosis) contains additional test programs not used in day-to-day operation. They can be used only by a service engineer when checking the microscope.

A third directory, *c:\xl\usr*, is empty initially. It is the default directory for storing images and parameter settings (files with extensions **.img* and **.vct*). During operation, the contents of this directory will grow. **Back up these files on a regular basis.**

The total software set is delivered on diskettes or CD. These disks should be kept as backup only.

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Filament Current 6-2
Extraction Voltage 6-2
Suppressor Voltage 6-2

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6 ALIGNMENT

Aligning the SFEG Column

Overview

CAUTION

Read this entire chapter before attempting any alignment corrections.

Gun and column parameters can be adjusted to get an optimal functioning system. Although the gun parameters should not be modified by the user, they are discussed here to get an idea of their values and of their influence on the total performance of the system.

The alignment of the system consists of two parts:

- Customer Service engineer-only procedures:

  Gun set-up and conditioning.

  Mechanical alignment of the column and software controlled definition of the lens system.

- User procedures:

  Software controlled alignment of the beam using well-defined procedures for adjustment of Gun Tilt and Gun Shift, Image Shift, Stigmator and electronic alignment of the final lens aperture.

NOTE

It is assumed that the Customer Service engineer mechanical alignment of the column is correct before the user can properly perform the software alignment.

When all alignments are done properly the image will stay in focus, and will not show a substantial image displacement when changing kV and spot.

Recommendation

Total alignment of the column in order includes:

Alignment of the Final Aperture

10 Gun Tilt and Shift procedure

43 UHR Image Shift procedure

45 Image Shift procedure (HR)

42 UHR Stigmator procedure

The above alignments should only be attempted when the column has been misaligned by opening for repair, Schottky tip change or other

Overview

CAUTION

Read this entire chapter before attempting any alignment corrections.

Gun and column parameters can be adjusted to get an optimal functioning system. Although the gun parameters should not be modified by the user, they are discussed here to get an idea of their values and of their influence on the total performance of the system.

The alignment of the system consists of two parts:

- Customer Service engineer-only procedures:

  Gun set-up and conditioning.

  Mechanical alignment of the column and software controlled definition of the lens system.

- User procedures:

TE

It is assumed that the Customer Service engineer mechanical

CAUTION

Working above 2 x 10^{-8} is not recommended.

Column Status and Parameters

Column parameters determine the emission and stability of the source. Heating of the source is closely coupled to the vacuum levels. Incorrect vacuum may destroy the source when it is hot. The source is automatically switched off if the pressure of the upper IGP is less than 2 x 10^{-7} mbar. It is recommended that you regularly check the pressure of the upper IGP. Normal working pressure for the source is about 2 x 10^{-9} mbar or better.

Filament Current

During system operation, the filament current is about 2.4 A and the temperature of the source is around 1700 - 1800 K. When combined with correct vacuum levels, this results in sufficient emission.

CAUTION

Do not change extraction voltage. The source is conditioned so that it uses the optimal extraction voltage of ≅ 5 kV.

Extraction Voltage

Extraction voltage is the voltage as seen by the electrons as they leave the tip. Extraction voltage plays a major role in obtaining emission. It is set to a predefined value of ≅ 5.0 kV. This precise value is factory adjusted and is part of the initial conditioning of the source.

Suppressor Voltage

Suppressor voltage (fixed at -500 V) influences the shape, position, and size of the source. Both extractor and suppressor voltages determine this virtual source of electrons.

As part of electron column operation, the software regularly checks the values of the applied voltages and currents to provide protection from excessively high emission levels. If the built-in limit is exceeded, a warning message displays onscreen.

Filament Current

During system operation, the filament current is about 2.4 A and the temperature of the source is around 1700 - 1800 K. When combined with correct vacuum levels, this results in sufficient emission.

CAUTION

Do not change extraction voltage. The source is conditioned so that it uses the optimal extraction voltage of ≅ 5 kV.

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Suppressor voltage (fixed at -500 V) influences the shape, position, and size of the source. Both extractor and suppressor voltages determine this virtual source of electrons.

Aligning the Final Lens Strip Aperture for the S-FEG column

Recommended Apertures

Aligning the final lens aperture is a mechanical process. The present apertures (superseded all others) are in a Mo/Si strip form (module 2), so it is a case of choosing the one most applicable to your imaging needs. For more detail over the types of aperture strips made for the SFEG see chapter 8. Table 6-1 provides guidelines for the use of aperture sizes.

TABLE 6-1 GUIDELINES FOR APERTURES SIZES AND THEIR USES

Aperture	Use
1000µm	Service Alignment (hole in frame)
100	High current applications
50 µm	X-ray mapping of low-Z elements at low kV
40 µm	General imaging or X-ray analysis
30 µm	High resolution imaging

Aperture Loading Guidelines

The aperture holder rod is heated while in operation to keep the apertures in a clean state. In addition the aperture strip is mounted within a module that can be attached to the rod by a single screw.The aperture strip and module is supplied as a complete unit for ease of mounting. The aperture strips come in two types:

- 5 hole 30, 30, 50, 30, 30 micron (factory default)
- 5 hole 30, 30, 40, 50, 100 micron,

FIGURE 6-1 S-FEG HEATED APERTURE HOLDER MODULE

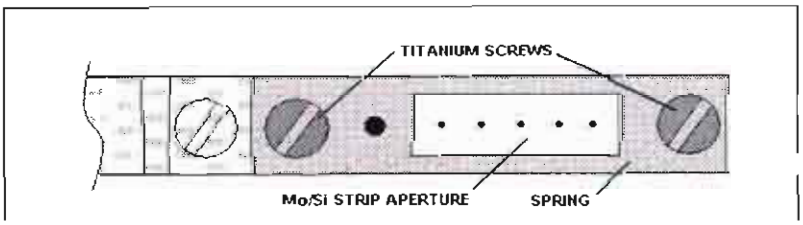


TABLE 6-1 GUIDELINES FOR APERTURES SIZES AND THEIR USES

Aperture	Use
1000µm	Service Alignment (hole in frame)
100	High current applications
50 µm	X-ray mapping of low-Z elements at low kV
40 µm	General imaging or X-ray analysis
30 µm	High resolution imaging

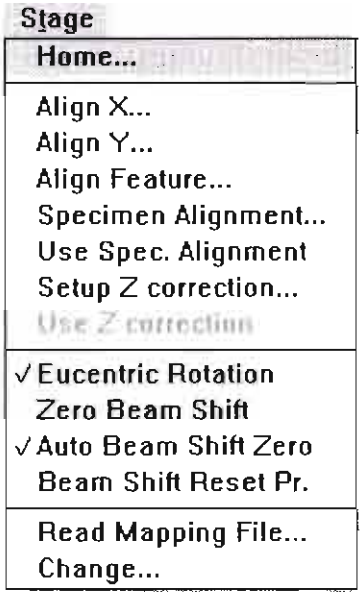
Changing Final Lens Aperture Sizes

The external control of the final lens aperture is used to change from one aperture to the next one. It has a click-stop mechanism. A left-hand turn on the large ring moves the aperture holder inward toward the larger aperture. After you change the aperture, use the inner knob and the knob on the right side to tune its position. The two knobs control the X, Y movement in a horizontal plane.

Strip Aperture Alignment Procedure

Before you align the column, be sure that the final lens aperture is correctly aligned. If the final lens aperture has to be aligned, choose the smallest for the best results. It is recommended to use 20 kV and spot 3, UHR Mode, with the specimen at a working distance of 5 mm, the eucentric working distance in the S-FEG.

When the aperture is well aligned, the image does not rotate at low magnification or move at high magnification during focusing. The position of the final aperture should remain constant and should not be changed further during the alignment procedures.



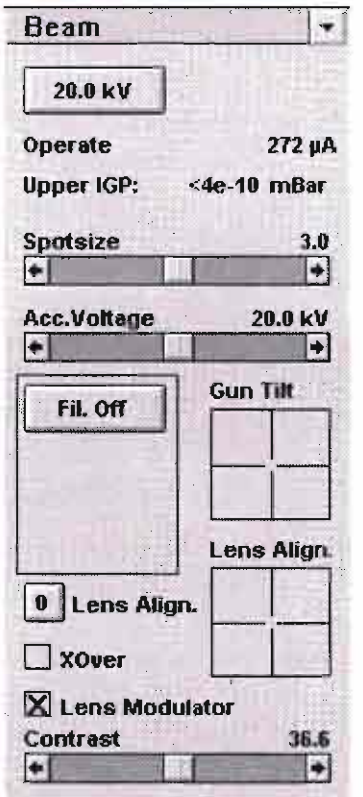


TABLE 6-2 ALIGNING THE FINAL LENS APERTURE

Step	Action
1	Go to the UHR Mode at 5 mm WD. 20kV, spot=3 Select Zero Beam Shift from the Stage menu.
2	Make an image at a magnification of about 10,000X. Select TV Rate from the Scan pulldown menu and Average 4 from the Filter pulldown menu.
3	Move the stage to find a good area of interest, and focus as best one can. (using manual x, y stage movement)
4	Centre a feature with the Get function. (No "pitch" beam shift!)
5	Click in the Final Lens Modulator check box in the Beam control area, a cross appears in the centre of the screen and the image rotates about a point on the screen (also click on Lens Align to zero first)
6	Adjust the position of the aperture so that the centre of the rotation is over the cross. (ie centre doesn't move

Before you align the column, be sure that the final lens aperture is correctly aligned. If the final lens aperture has to be aligned, choose the smallest for the best results. It is recommended to use 20 kV and spot 3, UHR Mode, with the specimen at a working distance of 5 mm, the eucentric working distance in the S-FEG.

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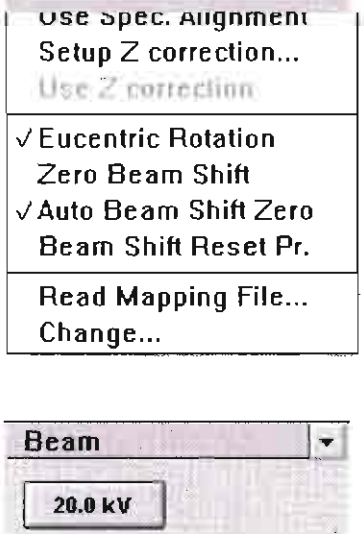
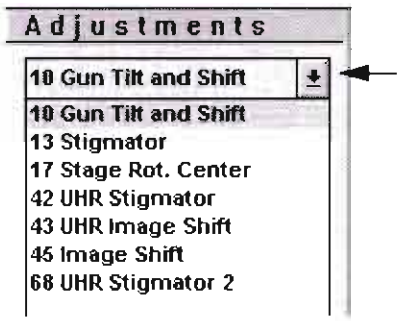


TABLE 6-2 ALIGNING THE FINAL LENS APERTURE

Step	Action

Adjustment Procedures



Software Alignment Overview

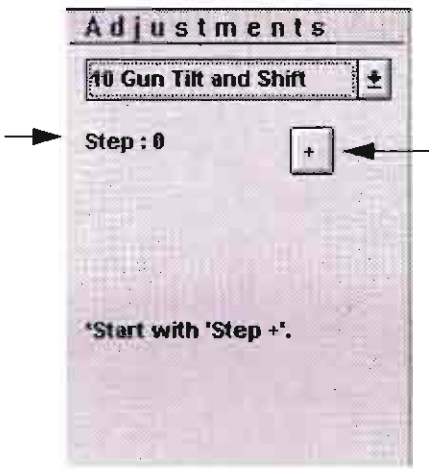
Before you align the column, be sure that the final lens aperture is correctly aligned. All alignment procedures should be operated in the TV mode of scan and with a average of 4 or 8.

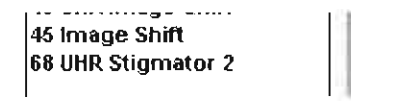
Adjustments

Use the Adjustments control area to align the column and determine fine tuning for the electromagnetic system. The software stores column parameters such as Gun Tilt X, Y, Gun Shift X, Y, and other data that ensures minimum image shift when focusing and stigmating images. When you click on the list box arrow, various available adjustments are displayed.

TABLE 6-3 ADJUSTMENTS

Adjustment	Function
Gun Tilt and Shift	Performs main column alignment for Spot sizes for each kV step. 20kV to 500v in UHR Mode. 30kV only in HR Mode.
UHR Image Shift	Aligns voltages in UHR Mode so that minimal Image Shift is seen at voltage changes.
Image Shift	Aligns voltages in HR Mode so that minimal Image Shift is seen at voltage changes and between UHR and HR modes.
UHR Stigmator	Minimizes image shift during total Stigmator correction of X and Y in the UHR Mode.
Stigmator	Corrects fine local changes to astigmatism shift in the HR Mode.
UHR Stigmator 2	Corrects fine local changes to astigmatism shift in the UHR Mode.
Stage Rot. Centre	Activates CompEucentric rotation. This allows redefining the centre of rotation to any X, Y position of the stage by computer correction.





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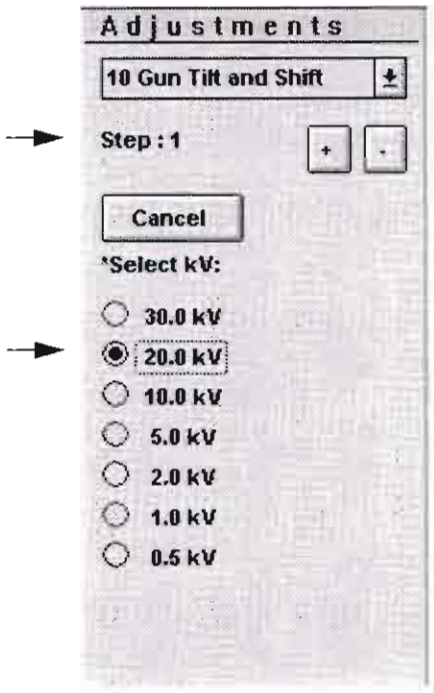
Adjustment	Function
Gun Tilt and Shift	Performs main column alignment for Spot sizes for each kV step. 20kV to 500v in UHR Mode. 30kV only in HR Mode.



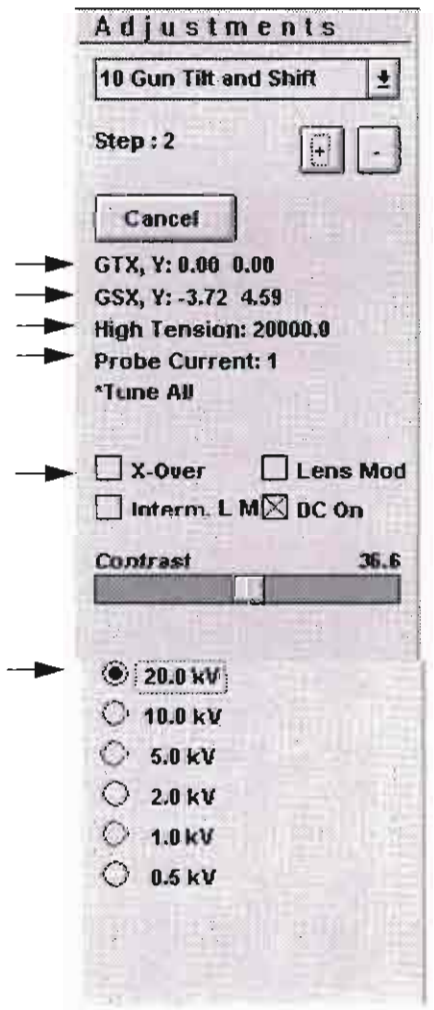
Gun Tilt and Shift Field Adjustments

To perform a complete column alignment, use the adjustment procedures starting with 20kV at Step 1 in the UHR Mode and work down to 500V, saving the results at each procedure. Each individual adjustment is a complete step-by-step procedure. For 30kV the mode can be changed to the HR Mode, the sequence in the procedure being the same.

Use the rectangular X-Y control with crosshair to change the setting of the corresponding parameter. Click the left mouse button in this area. You can step back and forth through each procedure (using the + or - buttons) and go to another control area for further optimization of the image.

When each procedure ends, the adjustments are stored in the computer. When the column is correctly aligned, the image stays in focus, and it does not show substantial image displacement when you change kV and spotsize.

Later when you select a kV that is not in the list, the software performs an interpolation between the values stored in the table.



Gun Tilt and Shift Functions

The Gun Tilt and Shift adjustment control area shows the following Information and functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user.*

TABLE 6-4 GUN TILT AND SHIFT FUNCTIONS

Field Name	Function
GTX,Y	Displays actual value of Gun Tilt X and Gun Tilt Y stored during last alignment.
GSX,Y	Displays actual value of Gun Shift X and Gun Shift Y stored during last alignment.
High Tension	Displays actual value of the kV.
ProbeCurr	Displays spotsize. The procedure starts with spotsize 1 and steps up to spotsize 7.

of the corresponding parameter. Click the left mouse button in this area. You can step back and forth through each procedure (using the + or - buttons) and go to another control area for further optimization of the image.

When each procedure ends, the adjustments are stored in the computer. When the column is correctly aligned, the image stays in focus, and it does not show substantial image displacement when you change kV and spotsize.

Later when you select a kV that is not in the list, the software performs an interpolation between the values stored in the table.

Gun Tilt and Shift Functions

The Gun Tilt and Shift adjustment control area shows the following

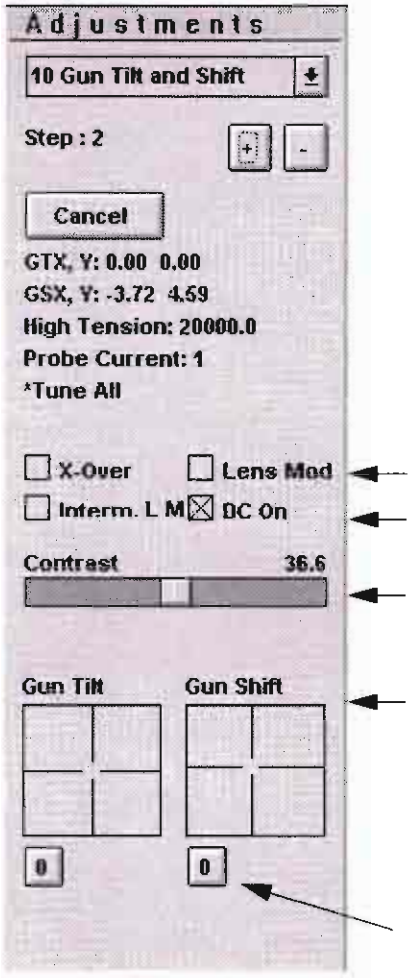
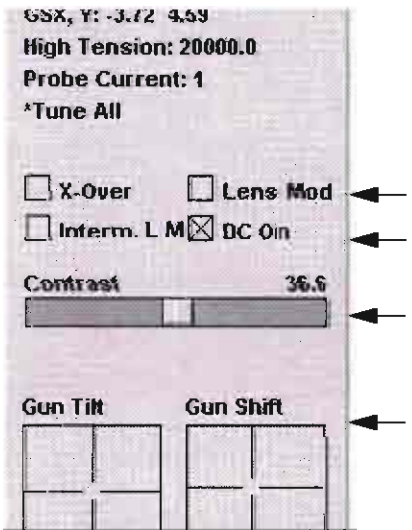


TABLE 6-4 GUN TILT AND SHIFT FUNCTIONS

Field Name	Function
Lens Mod	Switches on the final lens modulator that modulates the final lens at the given magnification with amplitude coupled to magnification. Switch the scan mode to TV rate before using this mode. If the system is correctly aligned, the rotation centre is in the centre of the screen.
Intermediate Lens Mode	Service use only
DC On	Service use only. Default ON
Contrast	Controls contrast of the applied detector. Use it if the contrast changes when spotsize is changed during the alignment steps.
Gun Tilt/ Shift	Controls Gun Tilt and Gun Shift adjustments in both X and Y. The actual Gun Tilt and Gun Shift setting is indicated by the position of the cross in the field. If more tilt/shift is required at the edge of the screen, release the mouse button and click again in the control.
0 Tilt, Shift	These buttons set Gun Tilt and Gun Shift to zero.



Intermediate Lens Mode	Service use only
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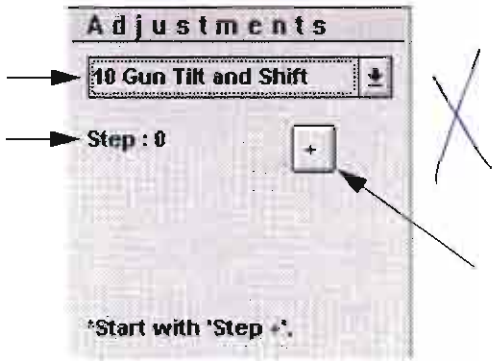
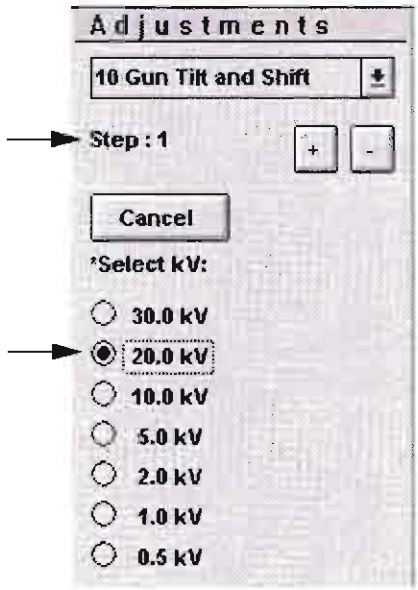
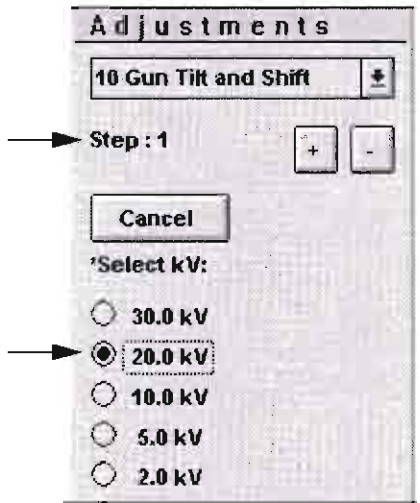
Contrast	Controls contrast of the applied detector. Use it if the contrast changes when spotsize is changed during the alignment steps.
Gun Tilt/ Shift	Controls Gun Tilt and Gun Shift adjustments in both X and Y. The actual Gun Tilt and Gun Shift setting is indicated by the position of the cross in the field. If more tilt/shift is required at the edge of the screen, release the mouse button







Gun Tilt and Shift Procedure

Step: 0

Click on the + button.

A reference mark in the shape of a cross appears on the screen. Move a feature of interest under the cross. This position serves as a reference point for the complete alignment of the system. Use the same feature of interest to align each kV and spot, by returning the feature to the centre of the cross.

Step: 1 ([redacted]HR Mode)

Click on the 20 kV high tension button. Click on the + button.

The procedure starts with spotsize 1.

Step: 2 (20kV - [redacted]HR)

TABLE 6-5 GUN TILT AND SHIFT

Order	Action
1	Use the contrast adjuster to see the image on the screen. Select the magnification, to start 10,000x
2	Use Gun Shift to bring the image feature back under the reference point. Use Gun Tilt to check the illumination of the sample, but only above spot 4.
3	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. When the 7 spotsizes are aligned, click on the SAVE button.

Steps: 3 through 9 (10kV to 500v -[redacted]HR / 30kV -HR)

TABLE 6-6 GUN TILT AND SHIFT

Order	Action
1	Repeat the procedure for 10kV to 500v in the [redacted]HR Mode. Be sure that you do not move the stage or beam shift. Use the same feature to align each kV and spot.

Step: 1 ([redacted]HR Mode)

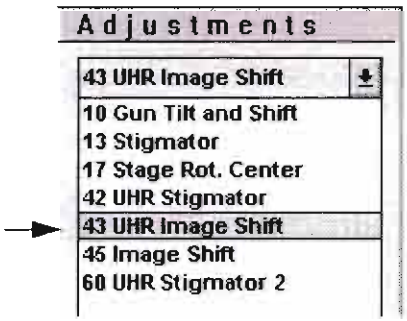
Click on the 20 kV high tension button. Click on the + button.

The procedure starts with spotsize 1.

Step: 2 (20kV - [redacted]HR)

TABLE 6-5 GUN TILT AND SHIFT

Order	Action
1	Use the contrast adjuster to see the image on the screen. Select the magnification, to start 10,000x
2	Use Gun Shift to bring the image feature back under



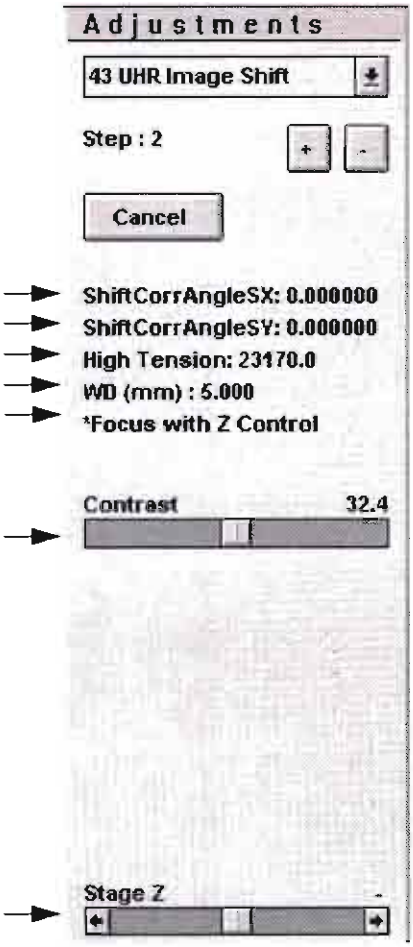
UHR Image Shift Adjustment

This adjustment allows you to minimize the image shift during change of kV in UHR Mode. The system is first aligned at 1.0 mm for all kV's at that setting and after at 5.0 mm for all appropriate kV's.

UHR Image Shift Functions

The main UHR Image Shift adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user.*

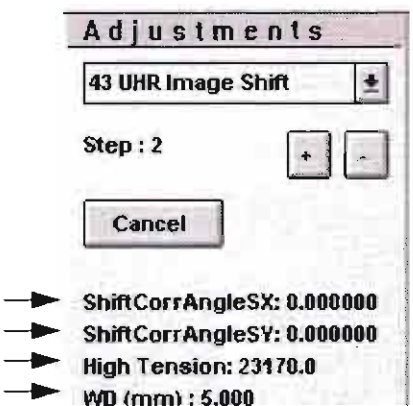
TABLE 6-7 UHR IMAGE SHIFT FUNCTION



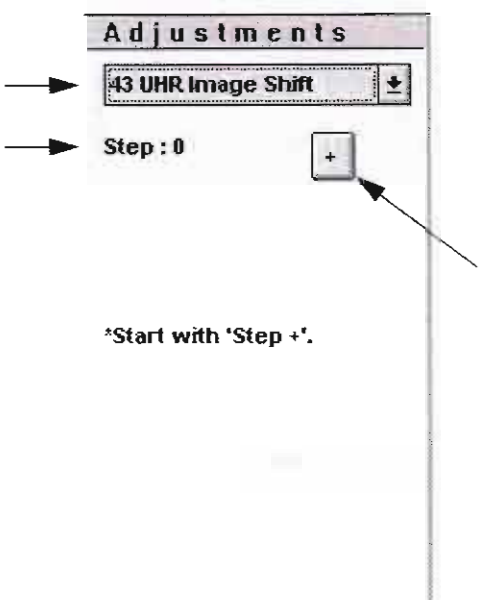
Field Name	Function
ShiftCorr AngleSX	Displays actual value of Shift Correction Angle for X stored during last alignment.
ShiftCorr AngleSY	Displays actual value of Shift Correction Angle for Y stored during last alignment.
High Tension	Displays actual value of the kV.
WD (mm)	Displays Working Distance value set by focus control.
***Message**	Important guideline instructions.
Contrast	Controls contrast of the applied detector. Use it if the contrast changes when spotsize is changed during the alignment steps.
Stage Z	This slider control is used to correct focus for this procedure.
MdShift CorrAngle	At **Step 3** the Stage Z is replaced with a 2D (X,Y) box for centring the object of interest.

user.

TABLE 6-7 UHR IMAGE SHIFT FUNCTION



Field Name	Function
ShiftCorr AngleSX	Displays actual value of Shift Correction Angle for X stored during last alignment.
ShiftCorr AngleSY	Displays actual value of Shift Correction Angle for Y stored during last alignment.
High Tension	Displays actual value of the kV.



UHR Image Shift Procedure(1mm WD)

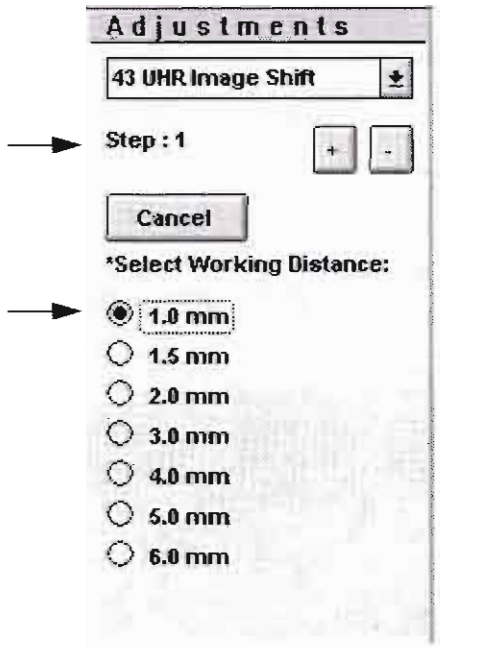
Step: 0

Start with 20kV, spot 3, 10,000x in the UHR Mode and set an object of interest at the centre of the screen. Control X will give an approximate centre for initial centring by presenting a small red cross on the screen. The rotation centre of the image should be in the centre of the screen as set up at the beginning with the Aperture alignment. The red cross may not accurately match as this is slightly to the side of centre. **Do Not change the aperture condition**.

Click on the + button.

If the system is not in the UHR Mode the program will show a message asking for the mode to be changed when entering **Step 1**.

If this is so, return to Step 0 to confirm the setup.



Step: 1

Click on the Working Distance **1.0 mm** button. Click on the + button.

A reference mark in the shape of a cross appears on the screen. This position serves as a reference point for the complete alignment of the system. Use the same feature of interest to align each kV, by returning the feature to the centre of the cross.

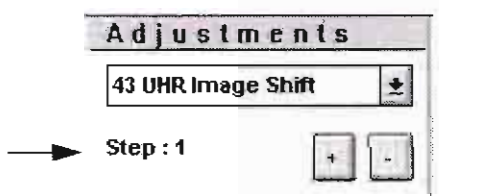
The procedure starts with 1.24kV, spot 3, 10.000x magnification at **Step 2**.

centre. **Do Not change the aperture condition**.

Click on the + button.

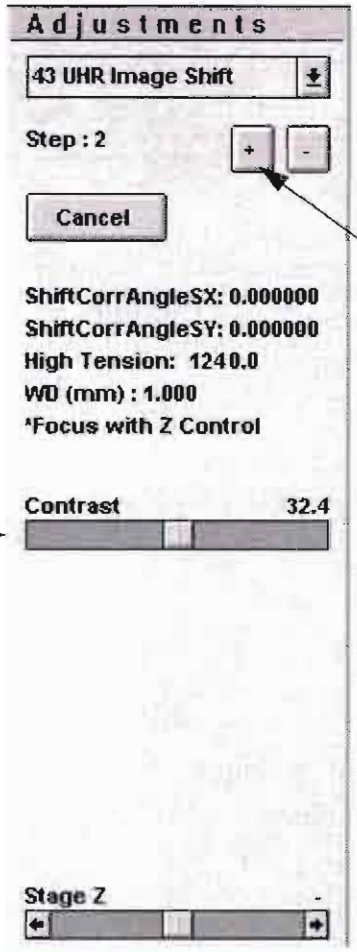
If the system is not in the UHR Mode the program will show a message asking for the mode to be changed when entering **Step 1**.

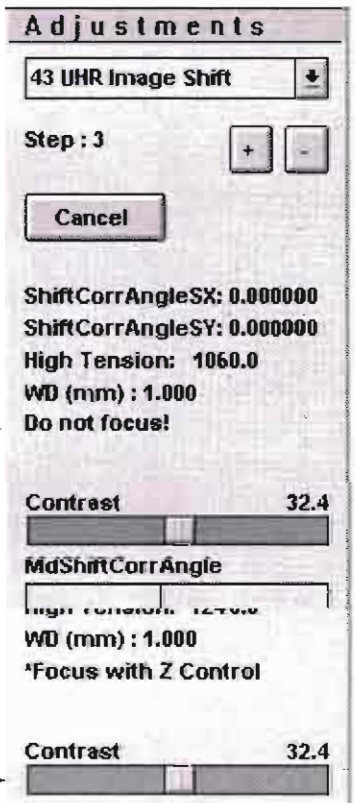
If this is so, return to Step 0 to confirm the setup.



Step: 1

Click on the Working Distance **1.0 mm** button. Click on the + button.

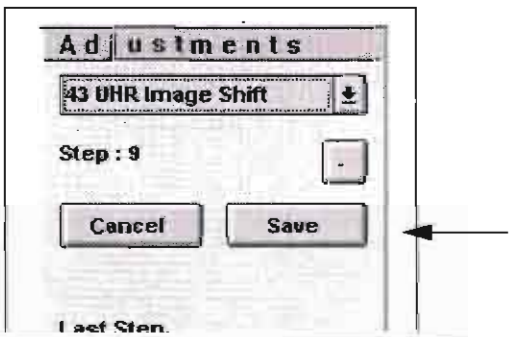




Step: 2 through 9 (UHR Mode)

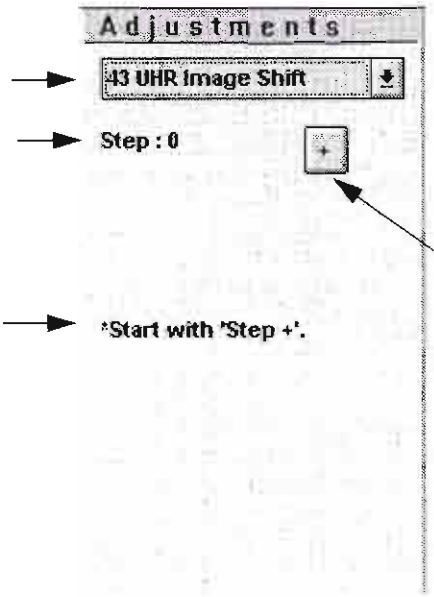
TABLE 6-8 UHR IMAGE SHIFT

Order	Action
1	Control the Contrast to suit.
2	Focus the Image with the Stage Z slider control.
3	Reset the object of interest under the white cross by mechanical movement.
4	Click on the + button to continue to the next kV level (**Step 3**).
5	Control the Contrast to suit.
6	**Do Not Focus**
7	Click in the 2D box labelled MdShiftCorrAngle to move the object of interest back to under the white cross.
8	Click on the + button to continue to the next kV level (**Step 4**) and repeat the procedure from Point 5 to Point 8 in this table. Continue through the kV's.
9	At **Step 9** save the results by clicking on the Save button, or if the result is incorrect for some reason the Cancel button will return the original condition from the start of the procedure.



3	Reset the object of interest under the white cross by mechanical movement.
4	Click on the + button to continue to the next kV level (**Step 3**).
5	Control the Contrast to suit.
6	**Do Not Focus**
7	Click in the 2D box labelled MdShiftCorrAngle to move the object of interest back to under the white cross.
8	Click on the + button to continue to the next kV level

UHR Image Shift Procedure(5mm WD)

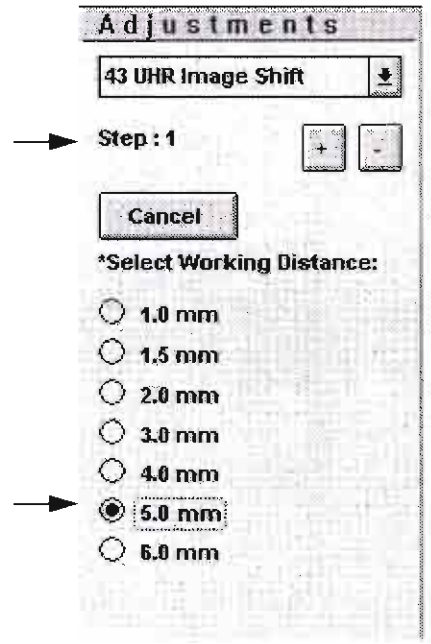


Step: 0

Start with 20kV, spot 3, 10,000x in the UHR Mode and set an object of interest at the centre of the screen. Control X will give an approximate centre for initial centring by presenting a small red cross on the screen. The rotation centre of the image should be in the centre of the screen as set up at the beginning with the Aperture alignment. The red cross may not accurately match as this is slightly to the side of centre. **Do Not change the aperture condition**.

Click on the + button.

If the system is not in the UHR Mode the program will show a message asking for the mode to be changed when entering **Step 1**.



Step: 1

Select the UHR Mode if necessary by clicking on the UHR icon and click on the + button.

Otherwise:

Click on the Working Distance **5.0 mm** button. Click on the + button.

A reference mark in the shape of a cross appears on the screen. This position serves as a reference point for the complete alignment of the system. Use the same feature of interest to align each kV, by returning the feature to the centre of the cross.

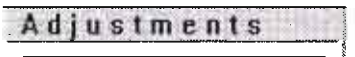
The procedure starts with 23.9kV, spot 3, 10,000x magnification at **Step 2**.

*Start with 'Step +'.

centre. **Do Not change the aperture condition**.

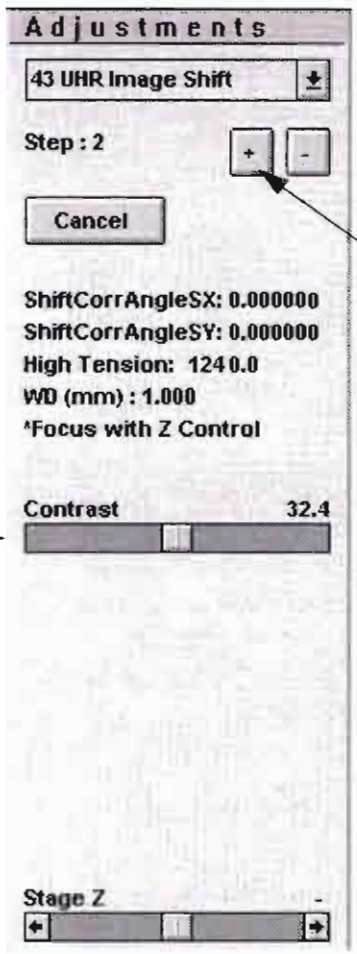
Click on the + button.

If the system is not in the UHR Mode the program will show a message asking for the mode to be changed when entering **Step 1**.



Step: 1

Select the UHR Mode if necessary by clicking on the UHR icon and click on the + button.



Step: 2 through 9 (UHR Mode)

TABLE 6-9 UHR IMAGE SHIFT

Order	Action
1	Control the Contrast to suit.
2	Focus the Image with the Stage Z slider control.
3	Reset the object of interest under the white cross by mechanical movement.
4	Click on the + button to continue to the next kV level (**Step 3**).
5	Control the Contrast to suit.
6	**Do Not Focus**
7	Click in the 2D box labelled MdShiftCorrAngle to move the object of interest back to under the white cross.
8	Click on the + button to continue to the next kV level (**Step 4**) and repeat the procedure from Point 5 to Point 8 in this table. Continue through the kV's.
9	At **Step 9** save the results by clicking on the Save button, or if the result is incorrect for some reason the Cancel button will return the original condition from the start of the procedure.

Order	Action
3	Reset the object of interest under the white cross by mechanical movement.
4	Click on the + button to continue to the next kV level (**Step 3**).
5	Control the Contrast to suit.
6	**Do Not Focus**
7	Click in the 2D box labelled MdShiftCorrAngle to move the object of interest back to under the white cross.
8	Click on the + button to continue to the next kV level

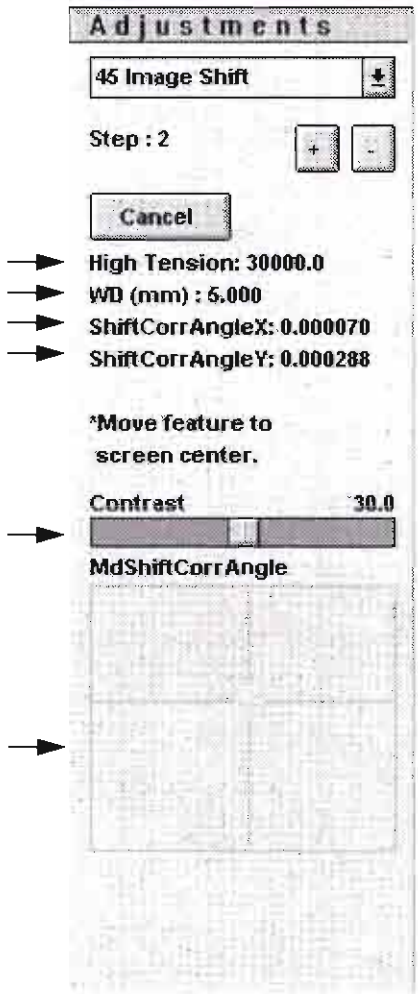
Image Shift Adjustment (HR Mode)

This adjustment allows you to minimize the image shift during change of kV in HR Mode.

Image Shift Functions (HR Mode)

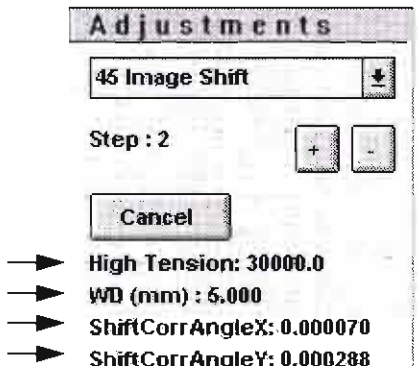
The main HR Image Shift adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

TABLE 6-10 IMAGE SHIFT FUNCTION (HR MODE)



Field Name	Function
ShiftCorr AngleX	Displays actual value of Shift Correction Angle for X stored during last alignment.
ShiftCorr AngleY	Displays actual value of Shift Correction Angle for Y stored during last alignment.
High Tension	Displays actual value of the kV.
WD (mm)	Displays Working Distance value set by focus control.
***Message**	Important guideline instructions
Contrast	Controls contrast of the applied detector. Use it if the contrast changes when spotsize is changed during the alignment steps.
MdShift CorrAngle	A 2D (X,Y) box for centring the object of interest to below the white cross.

TABLE 6-10 IMAGE SHIFT FUNCTION (HR MODE)



Field Name	Function
ShiftCorr AngleX	Displays actual value of Shift Correction Angle for X stored during last alignment.
ShiftCorr AngleY	Displays actual value of Shift Correction Angle for Y stored during last alignment.
High Tension	Displays actual value of the kV.

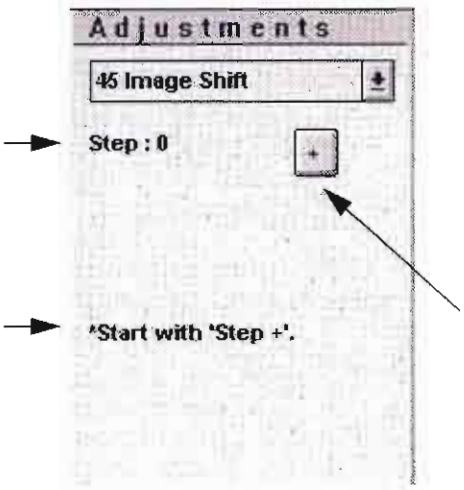


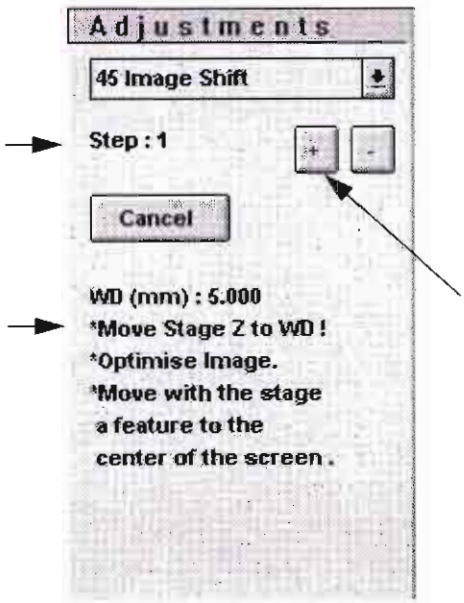
Image Shift Procedure (HR Mode)

Step: 0

Click on the + button.

If the system is not in the UHR Mode the program will show a message asking for the mode to be changed when entering Step 1.

Start with a check at 20kV, spot 3, 10,000x, 5 mm WD in the UHR Mode and set an object of interest at the centre of the screen. Control X will give an approximate centre for initial centring by presenting a small red cross on the screen. The rotation centre of the image should be in the centre of the screen as set up at the beginning with the Aperture alignment. This may not accurately match the red cross as this is slightly to the side of centre. **Do Not change the aperture condition**.



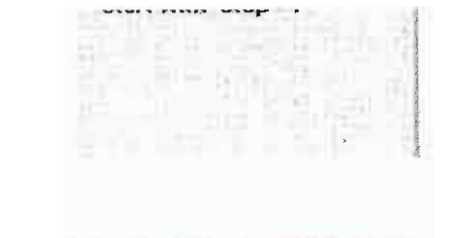
Step: 1

Click on the + button.

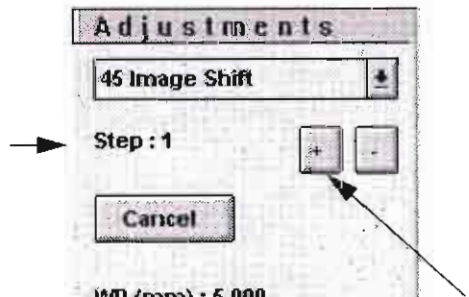
The Working Distance is set at 5 mm and the sample must be brought to this position if it is not already there (move stage Z to WD).

Optimise the image.

Move an object of interest to the centre of the screen with the stage movements.



X will give an approximate centre for initial centring by presenting a small red cross on the screen. The rotation centre of the image should be in the centre of the screen as set up at the beginning with the Aperture alignment. This may not accurately match the red cross as this is slightly to the side of centre. **Do Not change the aperture condition**.

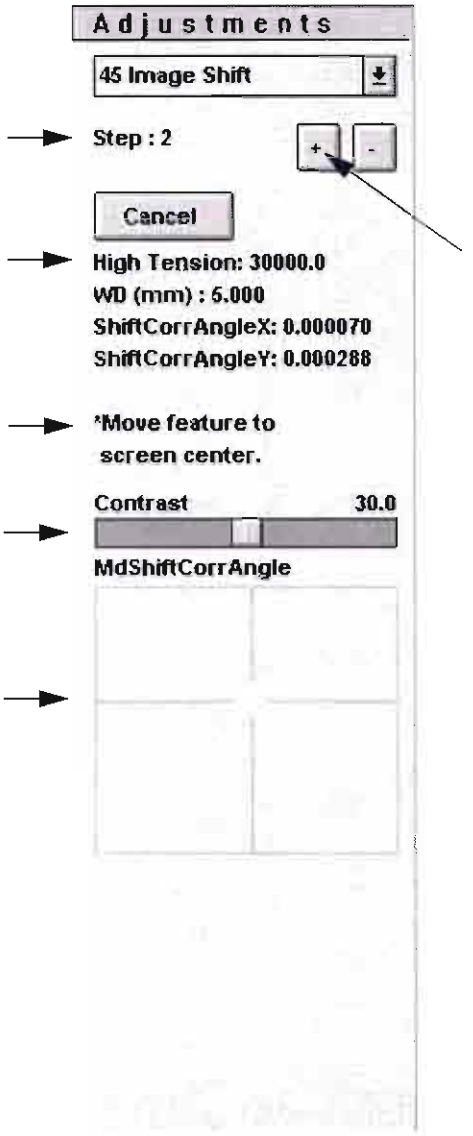


Step: 1

Click on the + button.

The Working Distance is set at 5 mm and the sample must be brought to this position if it is not already there (move stage Z to WD).

Optimise the image.



Step: 2

Step 2 starts with 30kV, spot 3, 10,000x magnification and proceeds to 500V in 7 steps.

Do Not change the aperture condition

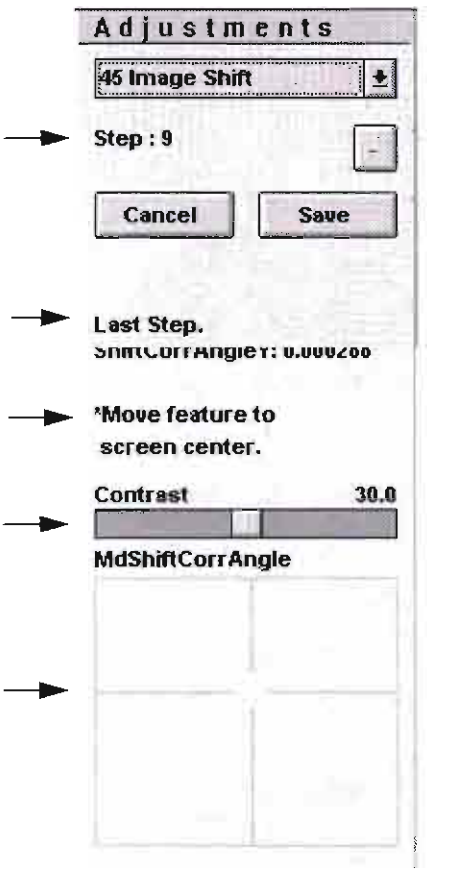
A reference mark in the shape of a white cross appears on the screen.

NOTE: To minimise the image shift between UHR and HR modes use the same object of interest under the cross by moving it by mechanical stage correction. This position serves as a reference point for the complete alignment of the system. Use the same feature of interest to align each kV, by returning the feature to the centre of the cross.

Step: 2 through 9 (HR Mode)

TABLE 6-11 HR IMAGE SHIFT

Order	Action
1	Control the Contrast to suit.
2	Click in the 2D box labelled MdShiftCorrAngle to move the object of interest back to under the white cross.
3	Click on the + button to continue to the next kV level (**Step 3**) and repeat actions 1 and 2.
4	**Do Not Focus**
5	Click on the + button to continue to the next kV level (**Step 4**) and repeat the procedure to **Step 8**.
6	At **Step 9** save the results by clicking on the Save button, or if the result is incorrect for some reason the Cancel button will return the original condition as from the start of the procedure.



stage correction. This position serves as a reference point for the complete alignment of the system. Use the same feature of interest to align each kV, by returning the feature to the centre of the cross.

Step: 2 through 9 (HR Mode)

TABLE 6-11 HR IMAGE SHIFT

Order	Action
1	Control the Contrast to suit.
2	Click in the 2D box labelled MdShiftCorrAngle to move the object of interest back to under the white

UHR Stigmator Adjustment

This adjustment allows you to minimize the image shift on the Stigmator for the voltage range related to the Working Distance (WD) in UHR Mode. To correct the whole stigmator alignment will entail 7 steps of kV for each of the 7 working distances. This should be totally corrected if the complete alignment is being attempted at any time, for instance, after column service on the microscope or after the replacement of a new Schottky emitter. Otherwise the **UHR Stigmator 2** adjustment should be used for any local shift on stigmator change. The system can be first aligned at 6.0 mm WD for all kV's at that setting followed by 5.0 mm WD for all appropriate kV's and so on by steps to 1.0 mm WD.

UHR Stigmator Functions

The main UHR Stigmator adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

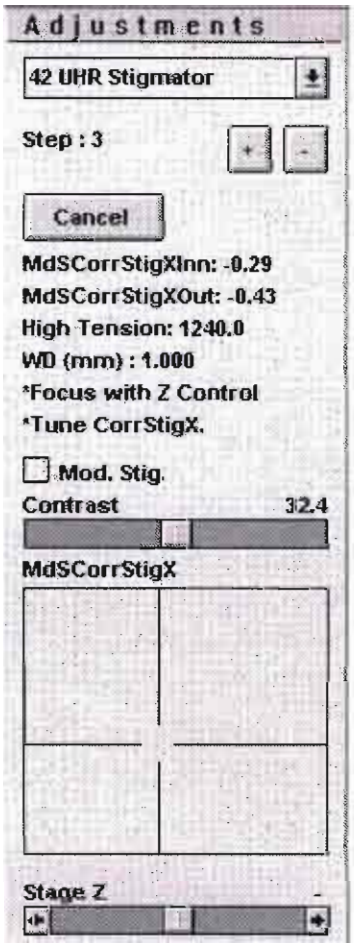


TABLE 6-12 UHR STIGMATOR FUNCTIONS

Field Name	Function
MdSCorr StigX (Y)Inn	Displays actual value of Shift Correction for X (Y) Inn stored during last alignment.
MdSCorr StigX(Y)Out	Displays actual value of Shift Correction for X (Y) Out stored during last alignment.
High Tension	Displays actual value of the Voltage level being correct relative to the WD chosen.
WD (mm)	Displays Working Distance value selected from Step 2.
***Messages**	Important guideline instructions.
Mod. Stig	This is the check box to switch on and off the Modulator used in conjunction with the 2D (X,Y) box to minimise shift.
Contrast	Controls contrast of the applied detector. Use it if the contrast changes when Voltage is changed

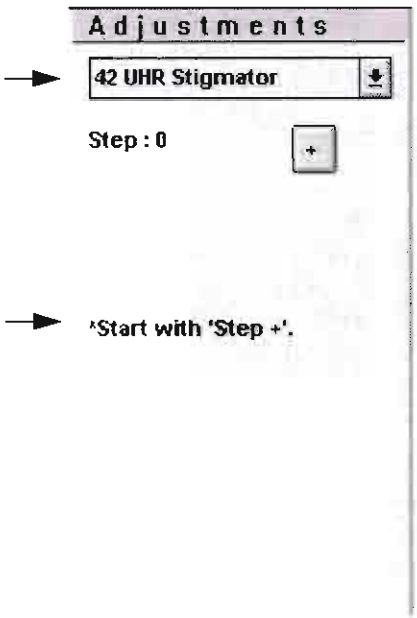
stigmator change. The system can be first aligned at 6.0 mm WD for all kV's at that setting followed by 5.0 mm WD for all appropriate kV's and so on by steps to 1.0 mm WD.

UHR Stigmator Functions

The main UHR Stigmator adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

TABLE 6-12 UHR STIGMATOR FUNCTIONS

Field Name	Function
MdSCorr	Displays actual value of Shift Correction for X

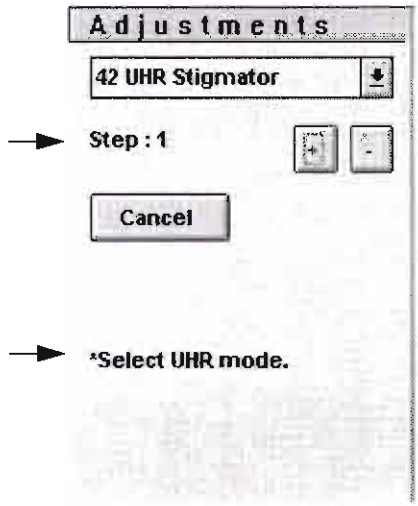


UHR Stigmator Procedure from 6 mm through to 1 mm WD

Step: 0

Check that the rotation centre of the image is correct with the aperture at 20kV, spot 3, 10,000x, and WD = 5 mm in the UHR Mode. This can be controlled from the Beam page. The rotation centre of the image should be in the centre of the screen as set up at the beginning of the total alignment procedure. **Do Not change the aperture condition.**

Click on the + button.



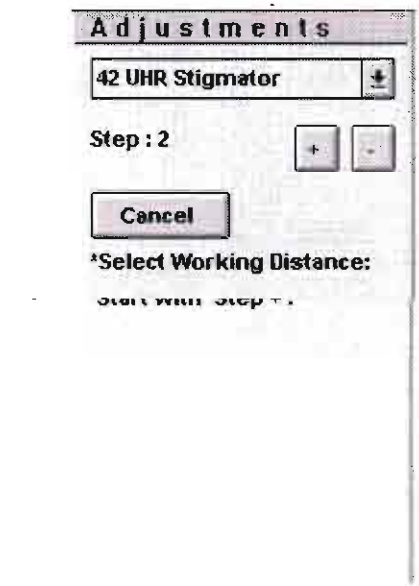
Step: 1

If the system is not in the UHR Mode the program will show a message asking for the mode to be changed when entering **Step 1**.

Step: 2

Click on the Working Distance **6.0 mm** button. Click on the + button.

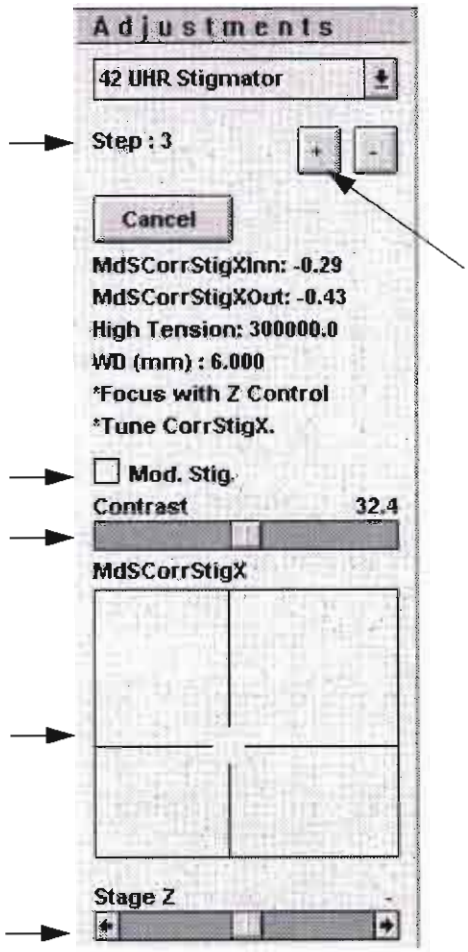
The ranging values of kV will be different for the respective working distances. For instance, at 6 mm the start kV is 30kV, for 5 mm it will be 23.8kV, etc.

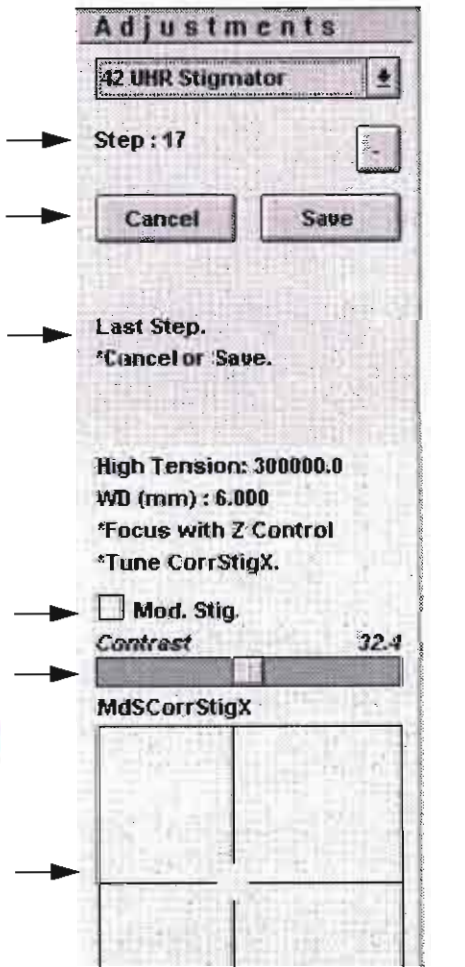


Click on the + button.

Step: 1

If the system is not in the UHR Mode the program will show a message asking for the mode to be changed when entering **Step 1**.



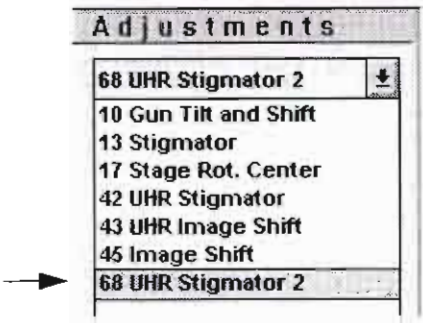


Step: 3 through 17 (UHR Mode)

TABLE 6-13 UHR STIGMATOR

Order	Action
1	Control the Contrast to suit.
2	Focus the Image with the Stage Z slider control.
3	Click on Mod. Stig. (modulator) to modulate the image to show the shift characteristic on the stigmator.
4	Remove all shift movement from the image by clicking on the 2D box labelled MdSCorrStigX and controlling the 'onscreen' X,Y crosshairs. Click on the + button to go to the 'Y' correction condition and repeat the procedure as for 'X'
5	Click on the + button to continue to the next kV level (**Step**) and repeat the procedure from Point 1 to Point 4 in this table. Continue through the kV's for 6 mm WD.
6	At **Step 17** save the results by clicking on the Save button, or if the result is incorrect for some reason the Cancel button will return the original condition from the start of the procedure.
7	Return to the start of the procedure to select the next Working Distance value (5 mm). Repeat the procedure until all Working Distance values are corrected.

3	Click on Mod. Stig. (modulator) to modulate the image to show the shift characteristic on the stigmator.
4	Remove all shift movement from the image by clicking on the 2D box labelled MdSCorrStigX and controlling the 'onscreen' X,Y crosshairs. Click on the + button to go to the 'Y' correction condition and repeat the procedure as for 'X'
5	Click on the + button to continue to the next kV level (**Step**) and repeat the procedure from Point 1 to Point 4 in this table. Continue through the kV's for 6 mm WD.

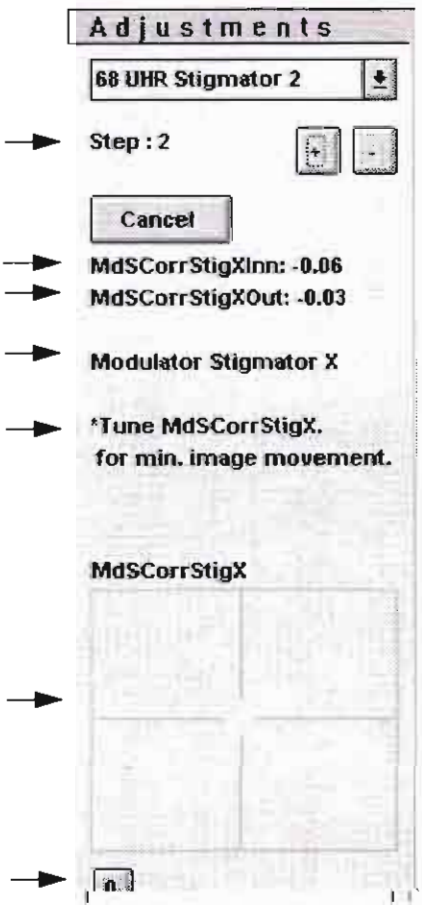


UHR Stigmator 2 Adjustment

This adjustment allows you to minimize the image shift during stigmation in UHR Mode. When you click on Stigmator and the + button, the condition is set to spot 3, 60,000X. The kV stays as is. 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.



UHR Stigmator 2 Functions

The main UHR Stigmator 2 adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

TABLE 6-14 UHR STIGMATOR 2 FUNCTIONS

Field Name	Function
MdCorrStig X(Y)Inn	Displays actual value of Shift Correction for X (Y) Inn stored during last alignment.
MdCorrStig X(Y)Out	Displays actual value of Shift Correction for X (Y) Out stored during last alignment.
Modulator Stigmator X or Y	Displays the stigmator axis being modulated. Modulation is automatic in the procedure.
***Messages**	Important guideline instructions.
MdCorrStig X (Y)	This is a 2D (X,Y) hox for removing shift in X and Y during modulation of the image.
'0' button	When clicked-on this zeros the MdSCorrStig values, and returns the crosshairs of the 2D box to centre position

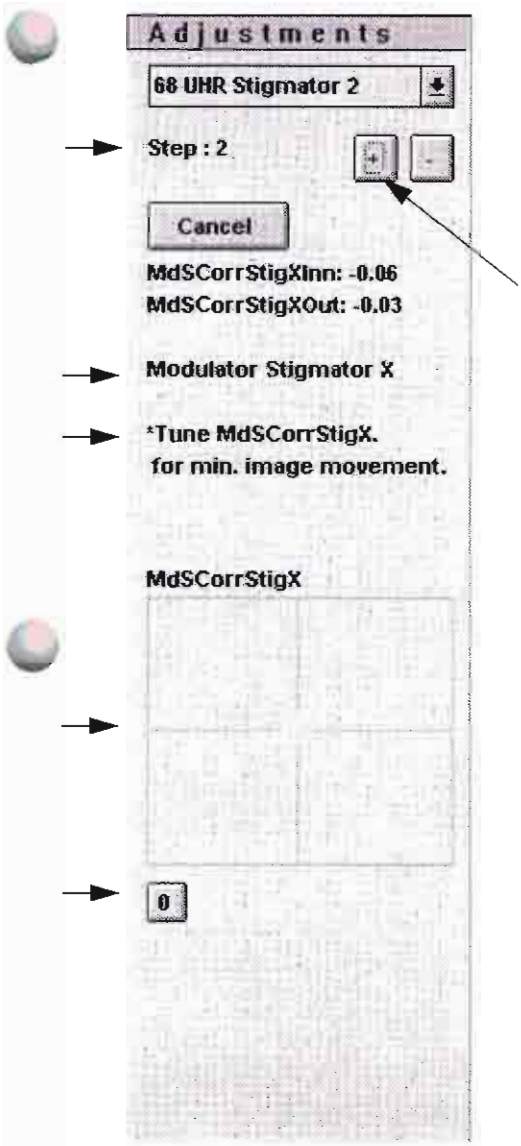
Follow the four-step procedure to minimize the image movement in both the X and Y direction using the X-Y controls available in the control area.

UHR Stigmator 2 Functions

The main UHR Stigmator 2 adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

TABLE 6-14 UHR STIGMATOR 2 FUNCTIONS

Field Name	Function



UHR Stigmator 2 Procedure for fine correction in UHR Mode

Step: 0

Check that the rotation centre of the image is correct with the aperture at the working kV and spotsize being used in the UHR Mode. This can be controlled from the Beam page. The magnification should be good for this procedure. The working distance can be used as is. **Do Not change the aperture condition.**

Click on the + button.

Step: 1

The system will prompt for optimising of the image.

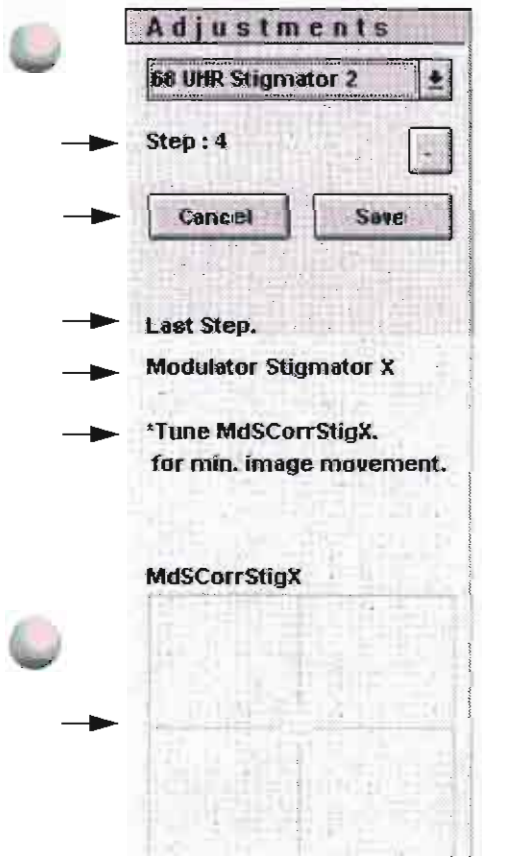
Click on the + button.

Step: 2

Click on the MdSCorrStigX 2D box to control the crosshair 'onscreen' to remove all shift in the image as it modulates. The modulator is automatically switched on when the page appears for the relevant X or Y correction. The zero button can be used to start from centre values.

Step: 3

Click on the MdSCorrStigY 2D box to control the crosshair 'onscreen' to remove all shift in the image as it modulates.



Step: 4

Save the results by clicking on the save button, or if the result is incorrect the Cancel button will return the original conditions from the start of the procedure.

Click on the + button.

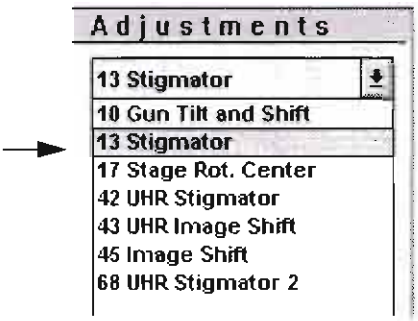
Step: 1

The system will prompt for optimising of the image.

Click on the + button.

Step: 2

Click on the MdSCorrStigX 2D box to control the crosshair

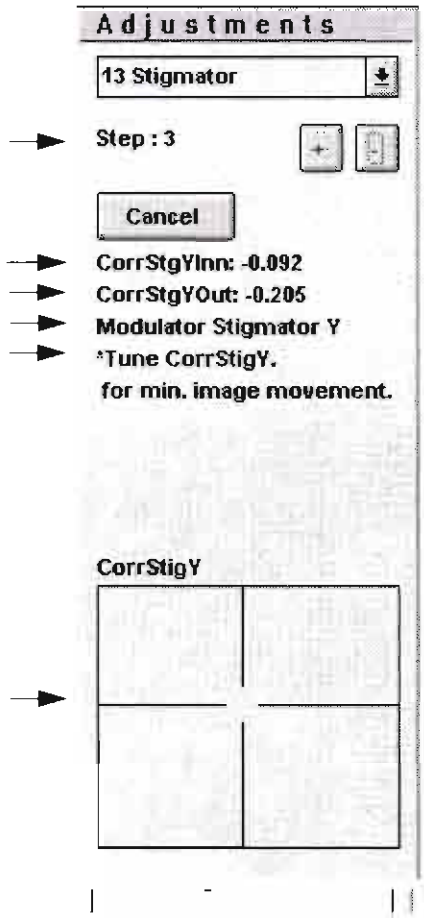


Stigmator Adjustment (HR Mode)

This adjustment allows you to minimize the image shift during stigmation in HR Mode. When you click on Stigmator and the + button, the conditions are set to 20kV, spot 3, 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 2D control area.



Stigmator Functions (HR Mode)

The main HR Stigmator adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

TABLE 6-15 STIGMATOR FUNCTIONS (HR MODE)

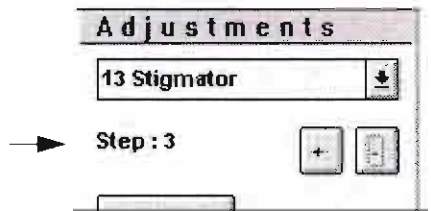
Field Name	Function
CorrStgX(Y) Inn	Displays actual value of Shift Correction for X (Y) Inn stored during last alignment.
CorrStgX(Y) Out	Displays actual value of Shift Correction for X (Y) Out stored during last alignment.
Modulator Stigmator X or Y	Displays the stigmator axis being modulated. Modulation is automatic in the procedure.
***Messages**	Important guideline instructions.
CorrStigX (Y)	This is a 2D (X,Y) box for removing shift in X and Y during modulation of the image.

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 2D control area.

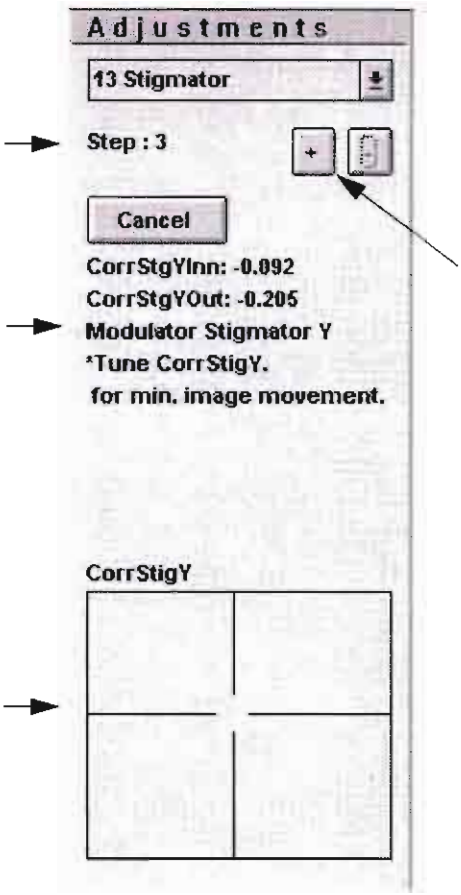
Stigmator Functions (HR Mode)

The main HR Stigmator adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

TABLE 6-15 STIGMATOR FUNCTIONS (HR MODE)



Field Name	Function



Stigmator Procedure for fine corrections in HR Mode

Step: 0

Check that the rotation centre of the image is correct with the aperture at the working kV and spotsize being used in the HR Mode. This can be controlled from the Beam page. The magnification should be good for this procedure and 5 mm WD is recommended for optimum condition. **Do Not change the aperture condition.**

Click on the + button.

Step: 1

The system will degauss the Final Lens and Condenser then prompt for optimising of the image. The conditions change to 20kV. spot 3. 60,000x. The kV and spot can be changed from the Beam Menu to preferred values.

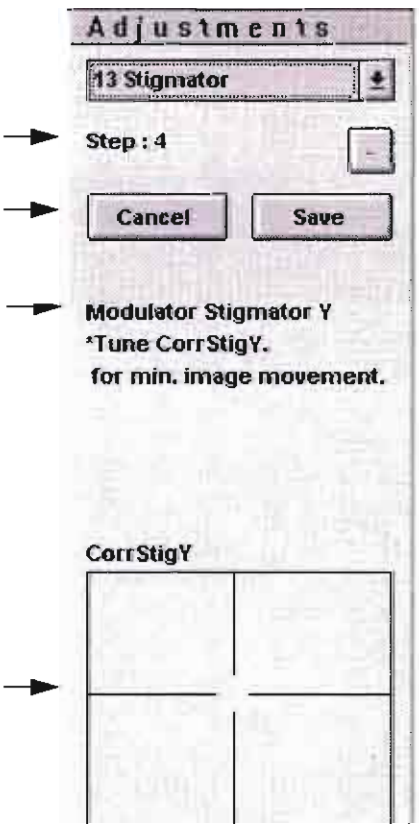
Click on the + button.

Step: 2

Click on the CorrStigX 2D box to control the crosshair 'onscreen' to remove all shift in the image as it modulates. The modulator is automatically switched on when the page appears for the relevant X or Y correction.

Step: 3

Click on the CorrStigY 2D box to control the crosshair 'onscreen' to remove all shift in the image as it modulates.



Step: 4

Save the results by clicking on the save button, or if the result is incorrect for some reason the Cancel button will return the original conditions from the start of the procedure.

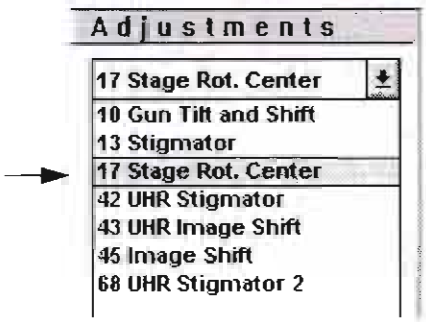
Click on the + button.

Step: 1

The system will degauss the Final Lens and Condenser then prompt for optimising of the image. The conditions change to 20kV. spot 3. 60,000x. The kV and spot can be changed from the Beam Menu to preferred values.

Click on the + button.

Stage Rotation Centre

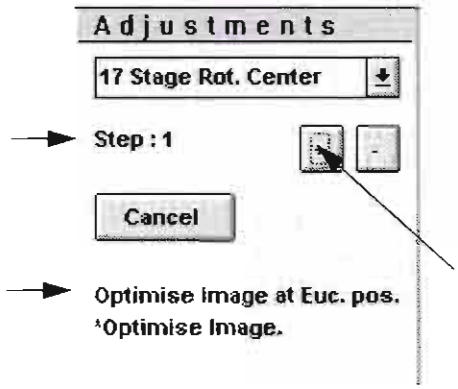


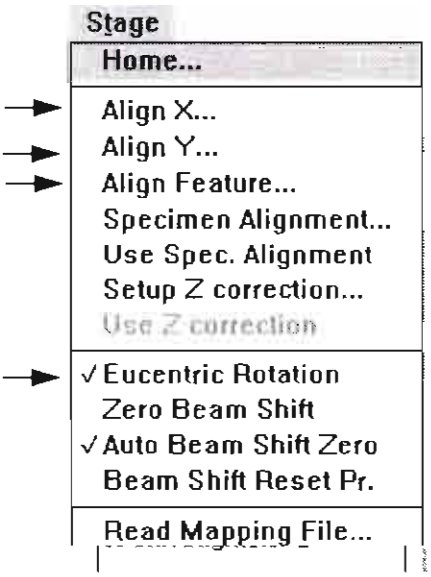
This adjustment sets up the compensation factors for the stage X= 0 and Y = 0 positions, as well as the stage rotation centre.

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 6-16 STAGE ROTATION CENTER ADJUSTMENT

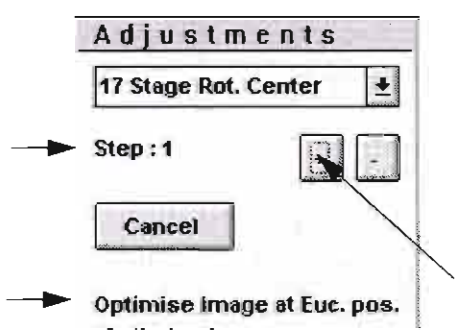
Step	Action
1	Stage moves to eucentric position (0,0). Optimize image.
2	Select the Get function and double-click on the feature to move it to the screen centre.
3	Stage rotates to 180°. Select the Get function and double click on the feature to move it to the screen centre.
4	Cancel or save valid result.





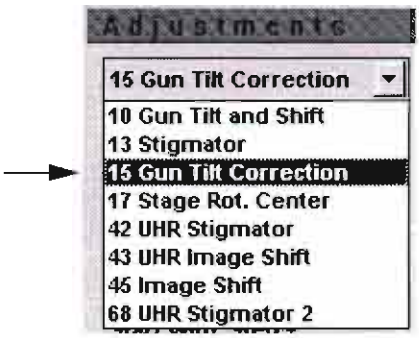
To make use of this feature during normal operation go to the 'Stage' menu and select 'Eucentric Rotation' on.

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



Step	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°. Select the Get function and double click on the feature to move it to the screen centre.
4	Cancel or save valid result.

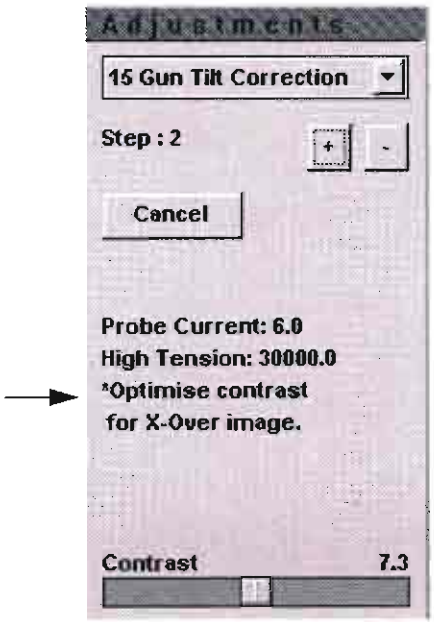
Additional Alignment for Sirion



Overview

The Sirion SFEG has the same alignments as specified for the standard SFEG, and the procedures should be followed as for an SFEG. The difference in alignment comes as an additional Gun Tilt Correction, which is a semi-automatic procedure and therefore can be used with ease. The Gun Tilt Correction procedure can be used independent of the other procedures, once they are completed, and therefore can be effected at any time after when needed.

The Gun Tilt Correction will need to be used if the beam illumination is seen to drift over time. This will show as less signal than usual especially in the larger spotsizes. It also can be monitored via the crossover as this has an internally defined position, and this is used in the Gun Tilt Correction procedure, where it is seen as moving to the defined position from the off-set automatically.



15 Gun Tilt Correction

This alignment has a choice of two methods to achieve correction of the Gun Tilt:

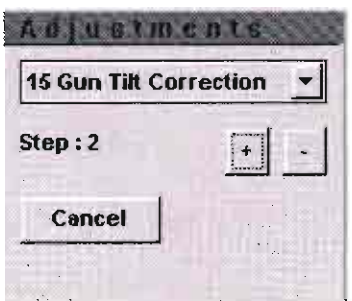
1 INDIVIDUAL-Choice of any voltage level from 30kV to 500V, taken from a defined list. Once chosen, and the after Step:2 of the procedure the rest becomes automatic taking in account all necessary spotsize steps for that voltage i.e. 30kV spots 1 to 7. The result can be stored, cancelled (back to original state), or repeated. Each voltage level can be processed individually.

2 AUTO-ALL-Clicking on ALL allows the operator to use a procedure where the complete number of voltage levels covered by automatic sequence through all the voltages and susequent spotsizes. Again this procedure starts after Step:2 for the first voltage level 30kV spot 1, and ends with 500V spot 6. The result can be stored, cancelled (back to original state), or repeated.

Step:2

NOTE: The significance of Step:2 is that the X-over image (cross-over) is displayed at this point and the operator is requested to correct the Contrast manually. Once this is set the procedure is automatic. If the sequence is broken because of the contrast being too low, or too therefore can be effected at any time after when needed.

The Gun Tilt Correction will need to be used if the beam illumination is seen to drift over time. This will show as less signal than usual especially in the larger spotsizes. It also can be monitored via the crossover as this has an internally defined position, and this is used in the Gun Tilt Correction procedure, where it is seen as moving to the defined position from the off-set automatically.



15 Gun Tilt Correction

This alignment has a choice of two methods to achieve correction of the Gun Tilt:

1 INDIVIDUAL-Choice of any voltage level from 30kV to 500V, taken from a defined list. Once chosen, and the after Step:2 of the procedure the rest becomes automatic taking in account all

Control Functions

The main Gun Tilt Correction adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user*

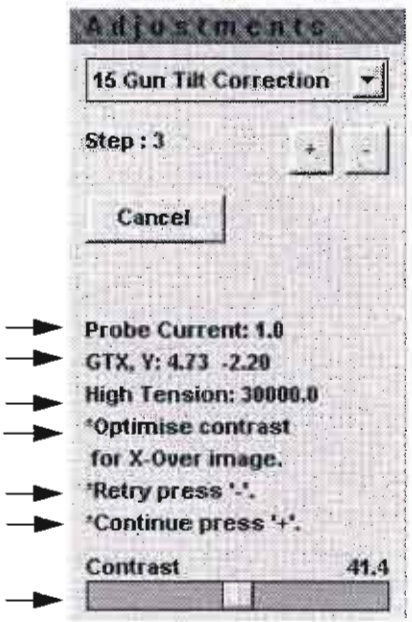


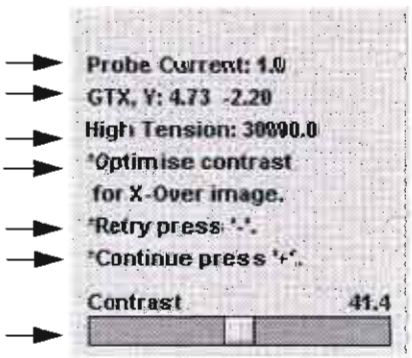
TABLE 6-17 GUN TILT CORRECTION FUNCTIONS

Field Name	Function
Probe current	Displays probe current step between 1 to 7
GT X, Y	Displays value of Gun Tilt Correction for X, Y before and after correction.
High Tension	Displays the High Tension being used
***Messages**	Important guideline instructions (see below)
*	*Optimise contrast for X-over image
*	*Retry press '–'
*	*Continue press '+'
Contrast	A contrast slider used to correct contrast during the process.

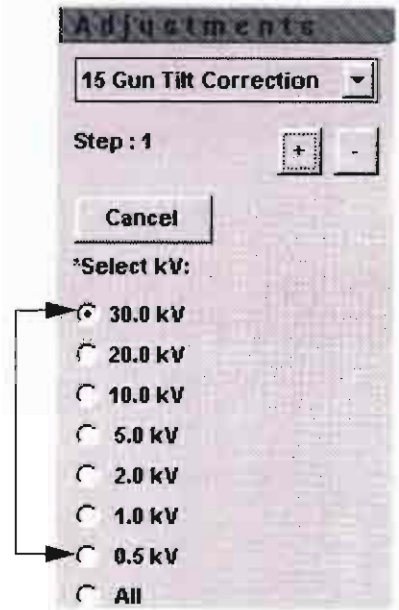
Set-up conditions

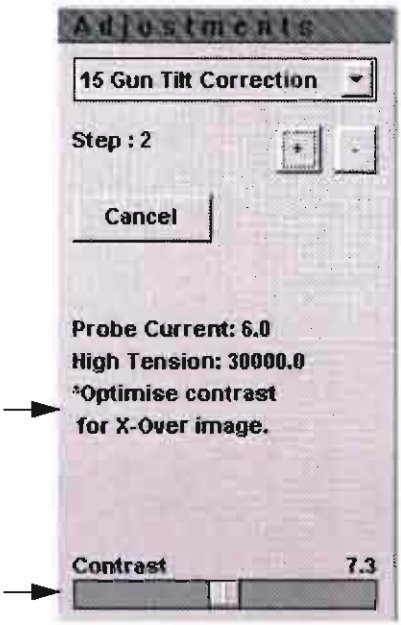
Before attempting Gun Tilt Correction, be sure that the final lens aperture is correctly aligned. When the aperture is well aligned, the image does not rotate at low magnification or move laterally at high magnification during focusing under the following conditions:

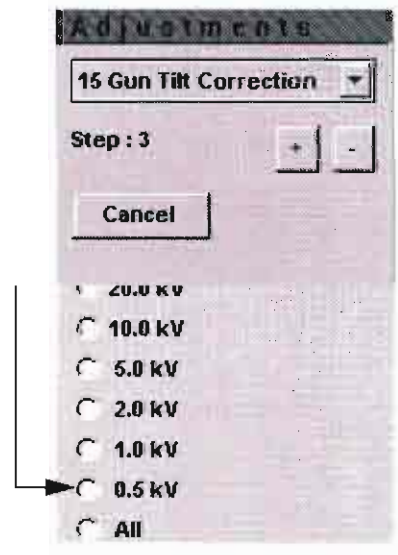
- a 30 micron aperture
- 20 kV
- spot 3
- UHR Mode

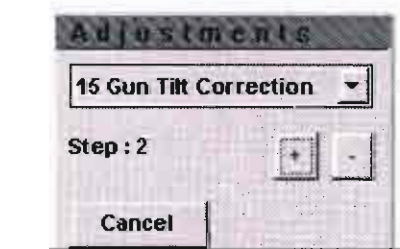


Probe current	Displays probe current step between 1 to 7
GT X, Y	Displays value of Gun Tilt Correction for X, Y before and after correction.
High Tension	Displays the High Tension being used
***Messages**	Important guideline instructions (see below)
*	*Optimise contrast for X-over image
*	*Retry press '–'





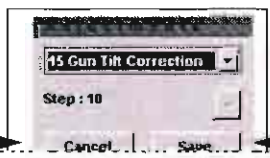


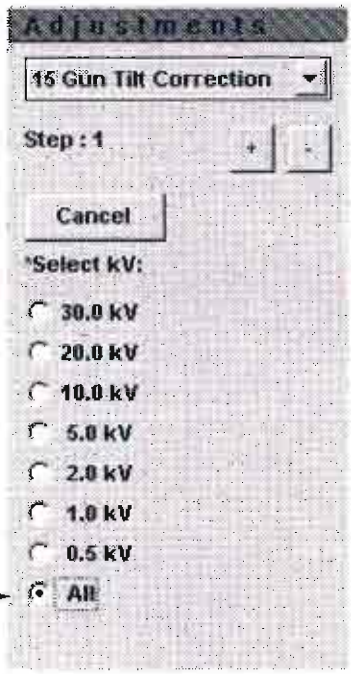


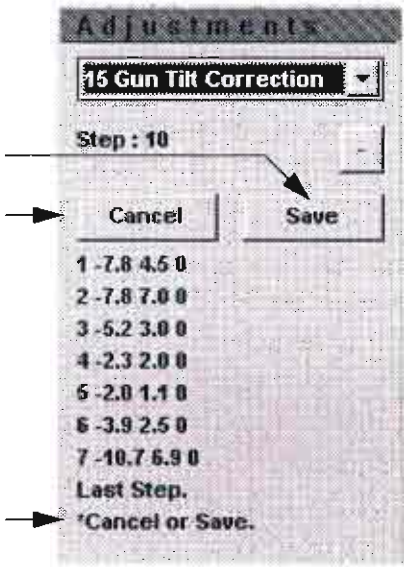
Individual procedure

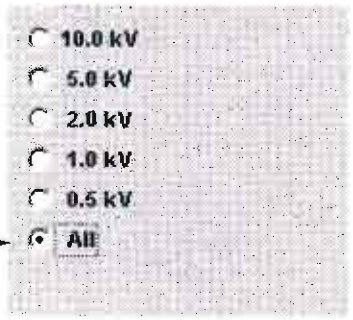
Follow this procedure to complete any number of voltage levels rather than all.

TABLE 6-18 INDIVIDUAL GUN TILT CORRECTION

Order	Action
1	Click on 15 Gun Tilt Correction in the dropdown list box for Adjustments.
2	The control page will open with Step:0. Press the '+' button.
3	Step:1 displays a list of voltage levels from 30kV to 500V. Select the appropriate one. Press the '+' button.
4	Step:2 displays a large Probe current and the High Tension selected from the list in Step:1 A X-Over (crossover) appears on screen. There is a message: *Optimise contrast for X-Over image Control the Contrast control to give a illumination that is even over the shape of the X-Over i.e. not too bright or dark. Press the '+' button.
5	Step:3 displays the smallest Probe current and the High Tension selected from the list in Step:1 There are messages in case the procedure needs to be corrected. Press the '+' button and the automatic sequence through the spotsizes starts. At each spotsize the system automatically tracks the X-Over back to its system predifined position to regain good Gun Tilt alignment.
6	At Step:10 the sequence stops and displays all values in X,Y for the spotsizes. Click on Save to store the values or cancel to return to the original status. 
1	Click on 15 Gun Tilt Correction in the dropdown list box for Adjustments.
2	The control page will open with Step:0. Press the '+' button.
3	Step:1 displays a list of voltage levels from 30kV to 500V. Select the appropriate one. Press the '+' button.
4	Step:2 displays a large Probe current and the High Tension selected from the list in Step:1 A X-Over (crossover) appears on screen. There is a message: *Optimise contrast for X-Over image Control the Contrast control to give a illumination that







Auto-All procedure

Follow this procedure to complete All of the voltage levels automatically. It is similar to the Individual procedure but covers all conditions of voltage and spotsize.

TABLE 6-19 AUTO-ALL GUN TILT CORRECTION

Order	Action
1	Click on 15 Gun Tilt Correction in the dropdown list box for Adjustments.
2	The control page will open with Step:0. Press the '+' button.
3	Step:1 displays a list of voltage levels from 30kV to 500V + All position. Select All. Press the '+' button.
4	Step:2 displays Probe current 6, and the High Tension of 30kV A X-Over (crossover) appears on screen. There is a message: *Optimise contrast for X-Over image.Control the Contrast control to give a illumination that is even over the shape of the X-Over i.e. not too bright or dark. Press the '+' button.
5	Step:3 displays Probe current 1 and the High Tension of 30kV. There are messages in case the procedure needs to be corrected. Press the '+' button and the automatic sequence through the voltages and spotsizes starts. At each voltage the spotsizes are adjusted by automatically tracking the X-Over back to its system predifined position to regain good Gun Tilt alignment.
6	The following sequence is: 20kV, spot 1 - 7 10kV, spot 1 - -7 and so on till 2kV, spot 1 - 7 Then 1kV, spot 1 - 6 and 500V, spot 1 - 6

Order	Action
1	Click on 15 Gun Tilt Correction in the dropdown list box for Adjustments.
2	The control page will open with Step:0. Press the '+' button.
3	Step:1 displays a list of voltage levels from 30kV to 500V + All position. Select All. Press the '+' button.
4	Step:2 displays Probe current 6, and the High Tension of 30kV A X-Over (crossover) appears on screen. There is a message: *Optimise contrast for X-Over image.Control the Contrast control to give a

Aligning the XLFEG Column (no UHR mode) (we don't have this one).

Overview

> **CAUTION** Read this entire chapter before attempting any alignment corrections.

> **NOTE** It is assumed that the Customer Service engineer mechanical alignment of the column is correct before the user can properly perform the software alignment.

Gun and column parameters can be adjusted to get an optimal functioning system. Although the gun parameters should not be modified by the user, they are discussed here to get an idea of their values and of their influence on the total performance of the system.

The alignment of the system consists of two parts:

- Customer Service engineer-only procedures:

  Mechanical alignment of the column and software controlled definition of the lens system.

- User procedures:

  Software controlled alignment of the beam using a well-defined procedure for adjustment of Gun Tilt and Gun Shift and mechanical alignment of the final lens aperture, that may need to be adjusted several times during the day.

When all alignments are done properly the image will stay in focus, its rotation will be corrected and it will not show a substantial image displacement when changing kV and spot.

Column Status and Parameters

Column parameters determine the emission and stability of the source. Heating of the source is closely coupled to the vacuum levels. Incorrect vacuum may destroy the source when it is hot. The source is automatically switched off if the pressure of the upper IGP is less than 2×10^{-7} mbar. It is recommended that you regularly check the pressure of the upper IGP. Normal working pressure for the source is about 2×10^{-9} mbar or better.

Filament Current

During system operation, the filament current is about 2.4 A and the temperature of the source is around 1700 - 1800 K. When combined with correct vacuum levels, this results in sufficient emission.

Extraction Voltage

> **CAUTION** Do not change extraction voltage. The source is conditioned so that it uses the optimal extraction voltage of $\cong$ 5 kV.

Extraction voltage is the voltage as seen by the electrons as they leave the tip. Extraction voltage plays a major role in obtaining emission. It is set to a predefined value of $\cong$ 5.0 kV. This precise value is factory adjusted and is part of the initial conditioning of the source.

Suppressor Voltage

> **NOTE** It is assumed that the Customer Service engineer mechanical alignment of the column is correct before the user can properly perform the software alignment.

- Customer Service engineer-only procedures:

  Mechanical alignment of the column and software controlled definition of the lens system.

- User procedures:

  Software controlled alignment of the beam using a well-defined procedure for adjustment of Gun Tilt and Gun Shift and mechanical alignment of the final lens aperture, that may need to be adjusted several times during the day.

When all alignments are done properly the image will stay in focus, its rotation will be corrected and it will not show a substantial image displacement when changing kV and spot.

Column Status and Parameters

Aligning the Final Lens Aperture for the XL-FEG column

Recommended Apertures

Aligning the final lens aperture is a mechanical process. Several final lens apertures are shipped with your microscope so you can choose the ones most applicable to your imaging needs. Table 6-17 provides guidelines for using these apertures:

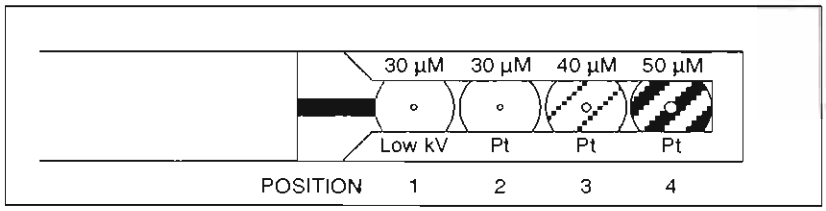
TABLE 6-20 GUIDELINES FOR BEAM APERTURES AND THEIR USES

Aperture	Material	Use
30 µm	Au	High resolution imaging **5 kV, Spot 3 or less only** (Higher voltages or current can damage them.)
30 µm	Pt	General use
40 µm	Pt	X-ray mapping of low-Z elements at low kV
50 µm	Pt	As above

Aperture Loading Guidelines

Figure 6-2 gives guidelines for the loading sequence in the aperture holder.

FIGURE 6-2 LOADING THE FEG APERTURE HOLDER

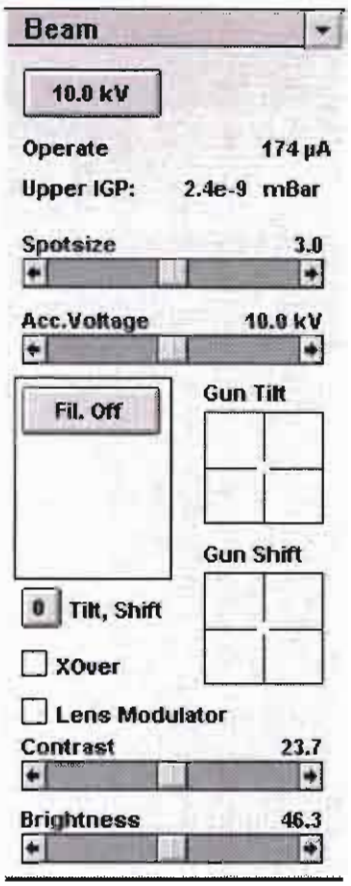


Low kV Aperture Use

The 30 µm, low kV apertures (shown in position 1 in Figure 6-2) are designed for optimum performance at low voltages. Use them at a

AND THEIR USES

Aperture	Material	Use
30 µm	Au	High resolution imaging **5 kV, Spot 3 or less only** (Higher voltages or current can damage them.)
30 µm	Pt	General use
40 µm	Pt	X-ray mapping of low-Z elements at low kV
50 µm	Pt	As above



Changing Final Lens Aperture Sizes

The external control of the final lens aperture is used to change from one aperture to the next one. It has a click-stop mechanism. A right-hand turn on the large ring moves the aperture holder outward toward the larger aperture. After you change the aperture, use the inner knob and the knob on the right side to tune its position. The two knobs control the perpendicular movement in one plane.

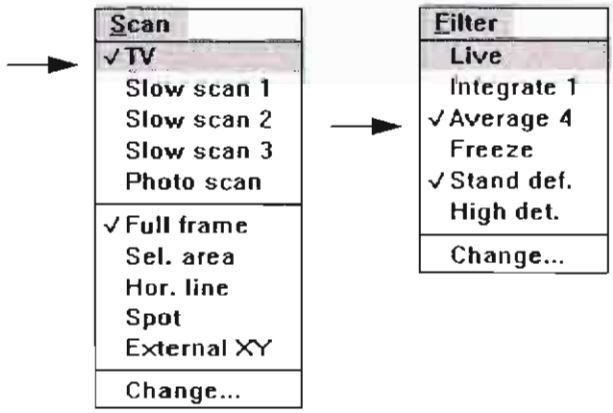
Final Lens Alignment Procedure

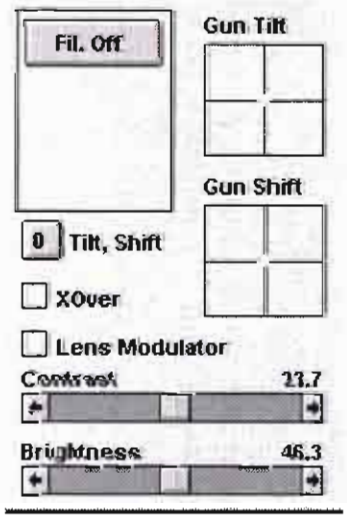
Before you align the column, be sure that the final lens aperture is correctly aligned. If the final lens aperture has to be aligned, any kV and spot can be used. However, it is recommended to use 30 kV and spot 3, with the specimen at a working distance close to the eucentric working distance.

When the system is well aligned, the image does not rotate at low magnification or move at high magnification during focusing. This should be the case for all kV and spotsizes at which the system is aligned. The position of the final aperture should remain constant but needs some fine tuning occasionally.

TABLE 6-21 ALIGNING THE FINAL LENS APERTURE

Order	Action
1	Select Zero Beam Shift from the Stage menu.
2	Make an image at a magnification of about 200X. Select TV Rate from the Scan pulldown menu and Average 4 from the Filter pulldown menu.
3	Move the stage to find a good area of interest at a





Before you align the column, be sure that the final lens aperture is correctly aligned. If the final lens aperture has to be aligned, any kV and spot can be used. However, it is recommended to use 30 kV and spot 3, with the specimen at a working distance close to the eucentric working distance.

When the system is well aligned, the image does not rotate at low magnification or move at high magnification during focusing. This should be the case for all kV and spotsizes at which the system is aligned. The position of the final aperture should remain constant but needs some fine tuning occasionally.

TABLE 6-21 ALIGNING THE FINAL LENS APERTURE

Order	Action

TABLE 6-21 ALIGNING THE FINAL LENS APERTURE

Order	Action
6	Adjust the position of the aperture so that the center of the rotation is over the cross.
7	Increase the magnification to 5000X and realign. If necessary, repeat at 20,000X. At higher magnification the image moves very slightly in a certain direction. By tuning the aperture, you can minimize this movement.
	movement.

Column Adjustment Procedures

Adjustment Overview

Before you align the column, be sure that the final lens aperture is correctly aligned.

Use the Adjustments control area to align the column and determine fine tuning for the electromagnetic system. The software stores column parameters such as Gun Tilt X, Y, Gun Shift X, Y, and other data that ensures minimum image shift when focusing and stigmating images.

When you click on the list box arrow, four available adjustments are displayed.

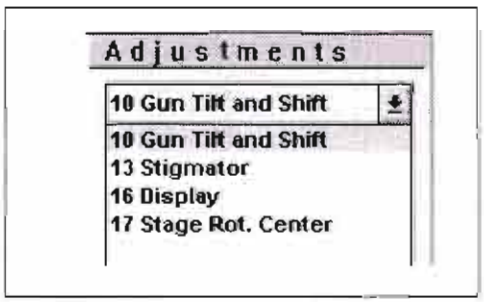
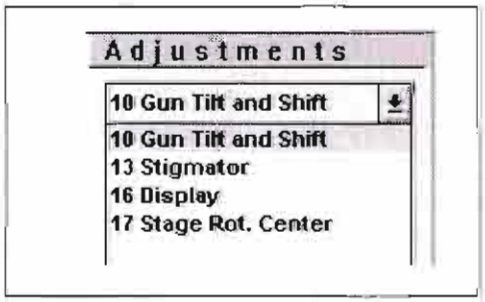


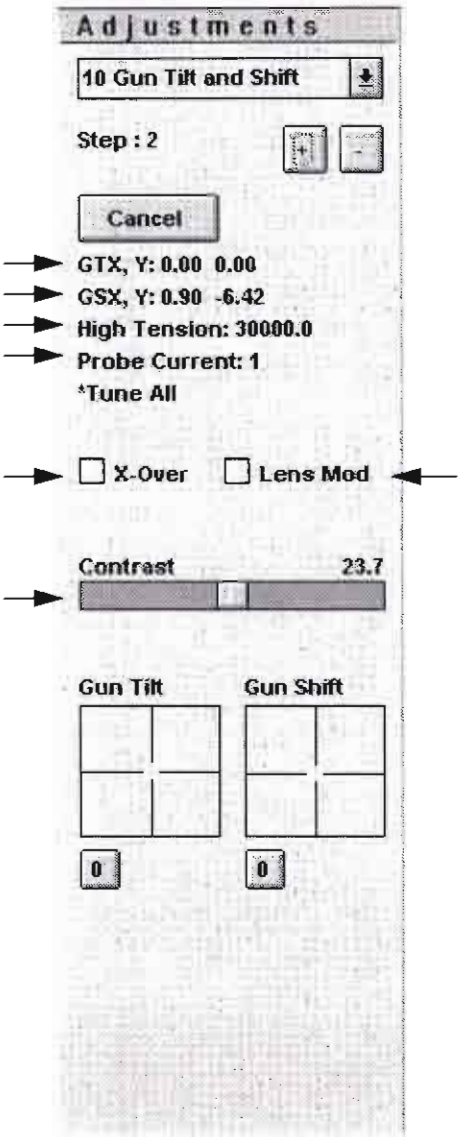
TABLE 6-22 ADJUSTMENTS

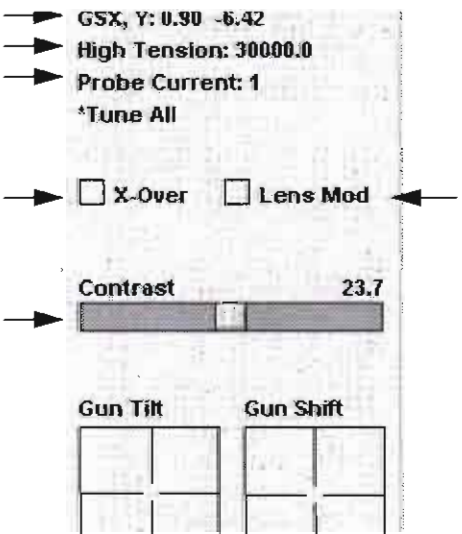
Adjustment	Function
Gun Tilt and Shift	Performs main column alignment.
Stigmator	Minimizes image shift during stigmation.
Display	Corrects vertical/horizontal image size of the monitor.
Stage Rot. Center	Moves the center of the stage into the center of the field-of-view to locate the rotation axis with respect to X and Y.

To perform a complete column alignment, use the adjustment procedures in the order in which they are presented in the above table. Each adjustment is a complete step-by-step procedure. Use the [illegible] images.

When you click on the list box arrow, four available adjustments are displayed.







Gun Tilt and Shift Functions

The Gun Tilt and Shift adjustment control area shows the following functions. *The White items in the table are significant to the alignment and the Gray items are for additional information to the user.*

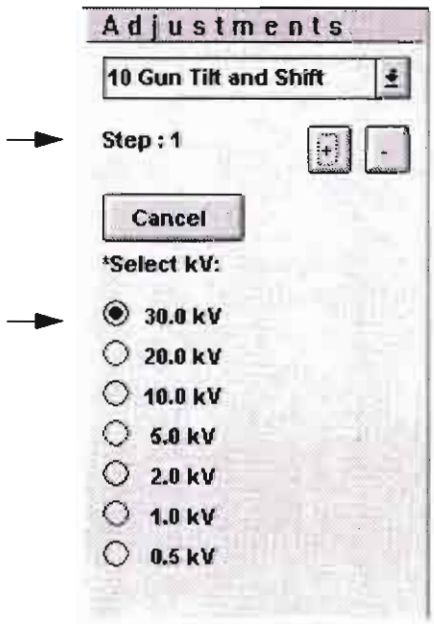
TABLE 6-23 GUN TILT AND SHIFT FUNCTIONS

Field Name	Function
GTX,Y	Displays actual value of Gun Tilt X and Gun Tilt Y stored during last alignment.
GSX,Y	Displays actual value of Gun Shift X and Gun Shift Y stored during last alignment.
High Tension	Displays actual value of the kV.
ProbeCurr	Displays actual spotsize. The procedure starts with spotsize 1 and steps up to spotsize 7.
X-Over	Switches to crossover mode. Shows a marker onscreen and positions the crossover relative to it. Use crossover mode only when there is no image. Use Gun Tilt and Gun Shift controls to bring the crossover to the center of the onscreen marker.
Lens Mod	This activates the final lens modulator so that a check can be made as to the rotation centre position determined by the Final Lens Aperture. Switch the scan mode to TV rate before using this mode. To retain the specimen position without image shift throughout the whole alignment procedure of Gun Shift and Tilt do not change the condition set at the beginning with Alignment of the Final Lens Aperture at 30kV, spot 3.
Contrast	Controls contrast of the applied detector. Use it if the contrast changes when spotsize is changed during the alignment steps.
CONTINUED	
GTX,Y	Displays actual value of Gun Tilt X and Gun Tilt Y stored during last alignment.
GSX,Y	Displays actual value of Gun Shift X and Gun Shift Y stored during last alignment.
High Tension	Displays actual value of the kV.
ProbeCurr	Displays actual spotsize. The procedure starts with spotsize 1 and steps up to spotsize 7.
X-Over	Switches to crossover mode. Shows a marker onscreen and positions the crossover relative to it. Use crossover mode only when there is no

TABLE 6-23 GUN TILT AND SHIFT FUNCTIONS

Field Name	Function
CONTINUED	
Gun Tilt/ Shift	Controls Gun Tilt and Gun Shift adjustments in both X and Y. The actual Gun Tilt and Gun Shift setting is indicated by the position of the cross in the field. If more tilt/shift is required at the edge of the screen, release the mouse button and click again in the control.
0 Tilt, Shift	These buttons set Gun Tilt and Gun Shift to zero.

Gun Tilt And Shift Adjustment



Use this adjustment when the image does not remain with the same centre when you change kV's and spotsizes. The procedure defines values for Gun Tilt and Gun Shift over the full range of kV and spotsize at each stage. To do a full alignment, align all kV's, starting at 30 kV and gradually step down to 0.5 kV. If you want to do a partial alignment with the kV's you are working with, then begin with those kV's.

Step: 0

Click on the + button.

Step: 1

Click on the 30 kV high tension button. The software starts with spotsize 1.

Alignment values for kV's that are not in the list are interpolated from the values stored in the table.

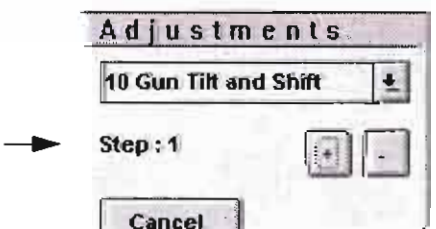
A reference mark in the shape of a cross appears on the screen. Centre a feature of interest on the specimen under the cross. This position serves as a reference point for the complete alignment of the system. Use the same feature of interest to align each kV and spot.

If the system is poorly aligned Gun Tilt and Shift must be corrected to bring the feature to image centre onscreen and illuminated correctly.

NOTE	Click on the + button to skip the kVs you do not want to change.

	and click again in the control.
0 Tilt, Shift	These buttons set Gun Tilt and Gun Shift to zero.

Gun Tilt And Shift Adjustment



Use this adjustment when the image does not remain with the same centre when you change kV's and spotsizes. The procedure defines values for Gun Tilt and Gun Shift over the full range of kV and spotsize at each stage. To do a full alignment, align all kV's, starting at 30 kV and gradually step down to 0.5 kV. If you want to do a partial alignment with the kV's you are working with, then begin with those