Stereoscan 440

Operator Manual

cannin Electron Microscope

Leica

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Stereoscan 440 Operator Manual

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Getting Started

1.1. Introduction

Components of the *Stereoscan 440*

The *Stereoscan 440* is a software-controlled scanning electron microscope, whose major components are (see Figure 1.1)

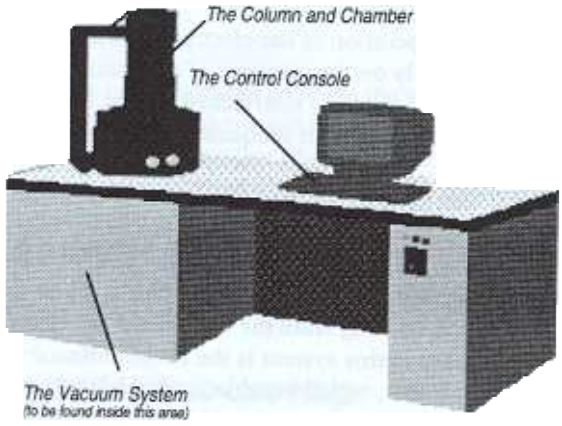


Figure 1.

1.1.1. The Column and Chamber

The *Stereoscan 440* column is used to generate and focus a fine beam of electrons upon the specimen mounted in the specimen chamber. The electron gun has a thermionic emitter as a source of electrons - the normal source is a tungsten hairpin filament, although the *Stereoscan 440* may have the lanthanum hexaboride LaB_6 option fitted (recognised by the presence of two valves - one at the interface of column and chamber, the other near the top of the gun pumping tube - and an ion pump mounted at the rear of the gun). Three electromagnetic lenses beneath the gun, focus and shape the electron beam before it strikes the specimen in a scanned, or rastered, fashion. The energy of the electron beam is adjustable from 300 volts to 30 kilovolts in 10 volt steps and the electron beam current is continuously adjustable from 1 pico-amp to 1 micro-amp to suit the type of examination in progress.

The specimen chamber of the *Stereoscan 440* holds the specimen to be viewed in such a way that it may be freely manoeuvred during examination. The specimen stage which holds the specimen is attached to the door of the chamber and may be of the normal cartesian type or the optional eucentric type. The cartesian stage permits movements of 100mm in both X and Y directions, 30mm in the Z direction, 0 to 90° tilt and 360° rotation. Control of the stage movements may be either manual, from the front of the stage door, or motorised using the optional stage motorisation package. The stage may be opened for examination once the vacuum within the chamber has been released.

1.1.2. The Vacuum System

The operation of the electron optical column and specimen scanning is dependent not only on the presence of a vacuum, but also the degree of vacuum, i.e. the system is safely interlocked so that it is not possible to switch on any of the high voltages until an adequate vacuum is reached.

The vacuum system is simple and efficient. A turbomolecular pump, backed by a rotary pump, is mounted on the lower face of the specimen chamber and commences pumping when the system is being evacuated and comes to rest during system venting. The electron gun and column are pumped through the tube running from the left side of the chamber up to the gun section. The only valve in this system is the air-admittance valve attached to the rear of the chamber, which automatically opens when venting is requested. Normal operating vacuum should be in the range to 10^{-4} to 10^{-6} torr. No water cooling is required.

If the lanthanum hexaboride option is fitted, a greater degree of vacuum is required in the gun section and for this reason provision is made to independently pump the gun and column to a level of about 10^{-7} torr using an ion-getter pump The pump is mounted on the rear of the gun section and the column may be isolated during specimen exchange by the two valves associated with the LaB_6 option.

1.1.3. The Control Console

Complete software control of the *Stereoscan 440* means that operation of the instrument is rather like operating a desktop computer - all operations are controlled through the mouse and keyboard. Within the console of the microscope, the computer is used to communicate your operations and commands into actions by the SEM. The PC environment used is Microsoft® Windows™ 3.11 and the SEM control application (LEO) runs within this well known and easy to use system. Section 1.2 provides an introduction to Windows™ and how to use the system of Help provided. If you are unfamiliar

Selecting Help from a Menu

Where **Help** is displayed in a menu (e.g. at the extreme right of the LEO top window) selecting it will display the index to help relating to that window.

Selecting Help from a Button

Where a button labelled Help appears in a dialog box selecting it will display an index of help relating to the dialog box functions.

Context Sensitive Help

This is frequently the most useful method of using Help.

To select this mode press the shift key and while holding it down press special function key F1.

While in Context sensitive help mode the cursor will be displayed as

wherever help information is provided. In this mode mouse selections do not perform their normal operations but display help on the specific item selected

Some examples of what may be selected are:-

- A menu item - describes its function
- A window background - describes the function of the window
- A displayed parameter - describes the parameter, and under what conditions it is enabled (useful to discover why a parameter is greyed out).
- A toolbar Icon - describes it's function.
- A Panel Background - describes its use and components

To switch off Context help mode press the <Esc> key while the context help cursor is displayed.

The User Interface

Overview

The user interface is used to control the *Stereoscan 440* and is a normal Windows$_{TM}$ application. The minimum that may be on display is the Top Window within which appears the Image Window. Other components may be called up as required, either explicitly (eg by menu selection) or implicitly as an implied response to some action or event. When the system is started up, you will also usually have the Toolbar displayed.

The Mouse

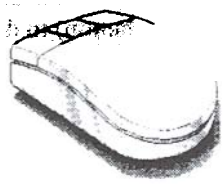


Figure 1.2

The mouse is the primary adjustment and selection control of the microscope. As such there are carefully defined conventions governing its use:-

1. Selection and Dragging

The normal Windows$_{TM}$ convention of pointing and clicking with the **left** mouse button is used for menu selection, dragging and sizing of objects.

For example, the status window can be selected from the **View** menu by clicking with the **left** mouse button on **View** in the menu bar and then clicking on the status entry. The position of the status menu can then be altered by clicking on the title bar of the status window and moving the mouse with the **left** mouse button held down.

2. Icon Selections

The **left** mouse button is also used to select icons. Selecting an icon will either assign the adjustment parameters (displayed in the top right corner of the toolbar), or cause the icon to execute immediately.

Examples of parameter assignment icons include the EHT icon, the Signal Level icon and the Mag/Focus icon. Immediate action icons include Scan Rate + and - icons and the Start icon.

3. Parameter Adjustment

The **left** and **middle** mouse buttons are used for parameter adjustment when the cursor is over the image window while adjust mode is selected. To adjust the parameter displayed in the toolbar:-

- Move the cursor over the image area.
- Select the **left** mouse button for the left toolbar parameter, or
- Select the **middle** mouse button for the right toolbar parameter.
- Move the mouse to the left (while holding down the mouse button) to decrease the parameter, or to the right to increase the parameter.

*There are two speeds of adjustment available, coarse and fine. The selected speed is displayed to the left of the adjustment parameters in the toolbar, with (< >) for fine and (<< >>) for coarse. The speed can be toggled by pressing the **tab** key.*

For example, to adjust the magnification, select the Mag/Focus icon. This assigns magnification control to the **left** mouse button. Now move the cursor over the image and press the **left** mouse button. By holding the button down and moving the mouse to the left, the magnification can be decreased. A movement to the right will increase the magnification.

Some parameters such as Gun Align and Stigmation provide adjustment in both the X and Y directions. This is indicated by the appearance of the adjustment icon in the bottom left corner of the image.

4. Pop-up Menus

The **right** mouse button is used to display a pop-up menu while over the image. Once the pop-up menu has been displayed, all selections on it are made with the **left** mouse button.

*The image is not the only interface component which has a pop-up menu associated with it. Most objects which do not have their own menu have a pop-up menu which is displayed with the **right** mouse button.*

5. Panel Selection

There is one other use for the **right** mouse button which is to bring up the control panel associated with each icon. This is done by putting the cursor over the icon and selecting the **right** mouse button.

The control panels are not unique to the icon, so more than one icon may bring up any given control panel.

Once the control panel has been displayed selections can be made with the **left** mouse button.

With the mouse pointer positioned over the image, the right mouse button obtains a pop-up menu allowing further mode selection, eg Annotation.

A little practice will be required to gain familiarity with the three button mouse. However, it is an extremely quick and convenient method of SEM control.

1.3.2. The Keyboard

In addition to mouse control of parameters, many keyboard keys have been assigned special functions and these can sometimes be a valuable aid to instrument operation. The keys have been designated (also to be found by pressing F9 - keys Help) as follows:-

F1 Help (see 1.2)

F1 + Shift Context sensitive Help (see 1.2)

F2 Performs a lens hysteresis correction for all column lenses. This has the effect of improving the accuracy of both the Probe current indication and the magnification, which in turn improves the accuracy of on-screen measurement.

F2 + Shift Toggles the toolbar at the top of the screen on and off.

F3 Closes all additional Windows other than the toolbar and status window. This also closes any currently iconised Windows.

F3 + Shift Toggles the PC-plane (ie the Windows plane) on and off. When the PC plane is off, the space bar can be used to switch it back on. This is particularly useful for viewing the full size image without obstruction by any menus which might need to be kept open.

All keyboard commands remain active.

F4 is used to step through each entry in the magnification table (**Tools Mag Table**). Selection of a mag-table entry does not lock out normal operation of the instrument.

F4 + Shift exits from mag-table mode. Re-entry into mag-table mode then re-commences at the first entry.

F5,F6,F7,F8 (with or without shift) Executes the installed macro (if it exists). If the macro does not exist, a 'beep' is given.

F9 Help on key usage

F11 Selects the Annotate/Measure function and toggles between Move and Edit modes.

F11 + Shift Toggles the Datazone overlay on and off.

F12 Stage scan step to next field.

F12 + Shift Stage scan step to previous field.

Tab Toggles coarse and fine adjustment mode (< > to << >>

<Ctrl>+<Tab> Centre point.

<Home> Resets Beam shift to zero.

<Scroll Lock> Toggle freeze

<Pause> Pauses/resumes execution of a macro

***** Performs a Find Image function

Esc Aborts Stage movement or current Macro execution or context sensitive help mode.

A Performs a combined auto-stigmation and fine auto focus routine. This may be aborted by pressing the Esc key.

A + Shift Performs an auto stigmation routine

B If B is pressed, the arrow keys may be used to control Beam Shift, or fine image movement.

F starts a fine autofocus routine. This may be aborted by pressing the Esc key.

The area used for autofocus, a reduced area at the centre of the screen, may be moved after obtaining the image pop-up menu and selecting Focus Area.

F + Shift Performs a coarse auto focus routine.

<Ctrl> F Starts a focus scan where the focus distance is cycled between limits. The space bar is used to stop the cycle.

G Auto Gun Alignment.

I If I is pressed the arrow keys may be used to adjust the two parameters currently displayed in the image window. The left/right keys decrease and increase the left parameter and the up/down keys increase and decrease the right parameter. If the arrow keys are temporarily allocated to any other parameter (eg by pressing B,M,S or Z), the keys may be returned to the default mode by pressing I.

M If M is pressed the arrow keys are temporarily assigned to control magnification and focus. The left/right keys increase and decrease the magnification whilst the up/down keys increase and decrease the focus.

Optibeam is switched on, focus means Working Distance. If Optibeam is off, focus means C3 lens current.

S If S is pressed the arrow keys can be used to control the Stage XY position, or stage tilt/rotate position if shift is used with the arrow keys.

S+Shift If this key sequence is pressed the arrow keys can be used to control the Step field.

V Displays the vacuum status panel.

Z If Z is pressed the arrow keys are temporarily assigned to control the stage Z position. While an up or down arrow key is held down, the stage moves in the appropriate direction, with the speed controlled by the

coarse/fine selection (tab). If stage motorisation is not installed, this function has no effect.

+ is used to increment through the available scanning rates.

- is used to decrement through the available scanning rates.

Space is used to reveal the PC plane if hidden by shift F3 or to stop a focus scan started by <Ctrl> F.

Alt followed by arrow key movements allow navigation of the pull-down menus of the **currently selected** (highlighted in the title bar) window.

*These key designations are in addition to the keys already designated for Windows$_{TM}$ operation - consult Windows$_{TM}$ Help for a list of these keys. One particularly useful keyboard shortcut is **Alt/Tab** which enables fast switching from one Windows$_{TM}$ application to another. To use, hold down the **Alt key** and repeatedly press Tab until the title of the required application is shown and then release the **Alt key**. The selected application then becomes the current application.*

1.3.3. The Top Window

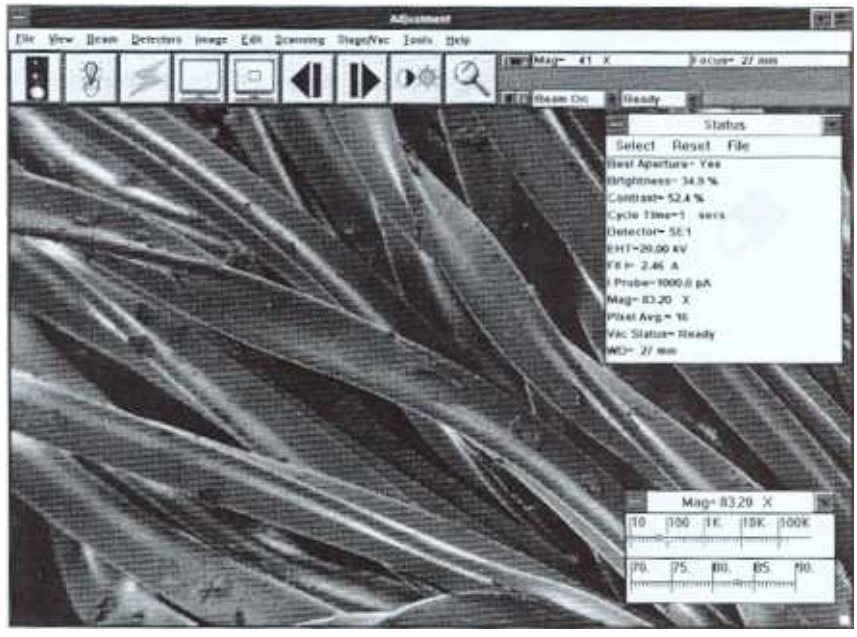


Figure 1.3 Top Window

The top window, see Figure 1.3, provides the environment within which the other Windows reside. It contains:-

The caption bar, which displays the Version number of the LEO software in use together with the release date. In some circumstances, the caption bar displays messages to the user.
The System button permitting the system to be shutdown or put into Standby mode.
The minimise button which enables the user interface to be iconised while leaving the SEM operational.
The reduce/full size button allows you to work with the Top Window at a reduced size or at full screen size by alternate clicks.
The top level menu from which all system operations may be selected. Help may also be selected from this level. Context sensitive Help (shift-F1) may be used to obtain help on each function.

The Image Window

The image window is used to display the live image, and may either occupy the whole screen or a quarter of the screen as selected by the top menu selection View->Full screen image. When in quarter screen mode it may be moved with the mouse by dragging the caption bar. The caption bar indicates the current mode and implies how the mouse is to be used.

Quarter screen mode is especially useful when other Windows - such as the profile window, status window, etc - must all be displayed simultaneously with the image since they can be positioned so as not to obscure any of it.

The Toolbar

The toolbar, see Figure 1.4, is displayed at the top of the main window and provides access to commonly used functions. The toolbar consists of a fixed portion and a variable portion. The fixed portion makes up the right half of the toolbar and displays the current mouse adjustment parameters (eg Mag and Focus), the state of the vacuum system (eg Ready, Venting or Pumping), the state of the EHT system (eg Beam On, Beam Off or Standby), coarse/fine adjustment icon (< > for fine, << >> for coarse) and the identity of any currently executing macro function.

Figure 1.4 Toolbar

The variable portion contains icons which may be selected with left or right mouse buttons to perform required operations. A standard set of icons is provided, although different sets of icons may be loaded according to the application requirements and operator skill level, ie Novice or Expert. Novice mode provides three rows of large icons whilst Expert mode provides two rows of small icons. The operational convention adopted is that the left mouse button initiates an action or adjustment mode, the right button displays a panel associated with the selected function which may be used for more detailed setting up or control.

The toolbar itself may be disabled from the top menu View->Toolbar.

1.3.6. Other Components

As a result of menu actions or other events, various other interface components may be displayed. These are:-

Status Window

The Status Window, see Figure 1.5, displays a user selected group of instrument parameters which are continuously updated.

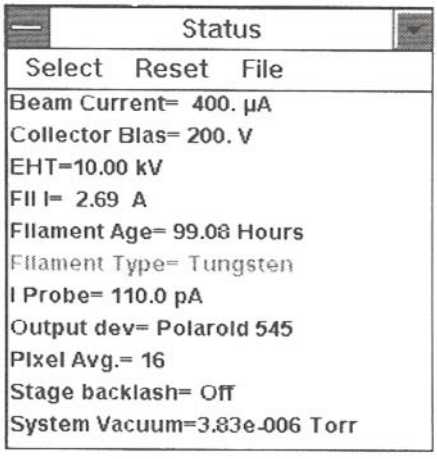


Figure 1.5 Status Window

Individual items can be selected or deselected from within the status menus select window. In addition files of status menu selections can be saved and loaded from within the Status File Menu.

Datazone

The datazone displays information concerning the current state of the system, and since it is a form of annotation (displayed in the overlay plane), it may therefore be included in exported and hard-copied images etc.

The datazone is only displayed in full screen image mode. Its contents and position is user definable from within the annotation plane control pop-up menu.

The datazone may be switched on and off from the main window menu selection **View->Datazone**.

Magnification Control Window

This window, see Figure 1.6 may be invoked from the top menu **Image->Mag/Foc** function and is used to set the base magnification of the instrument to a specific value. The use of the magnification control window is fully described in Section 2.3.4 *Setting Focus and Magnification*.

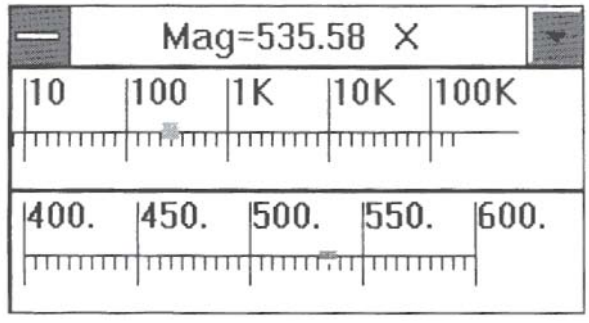


Figure 1.6 Magnification Control Window

Navigation Box - (*Top menu selection View->Nav box*)

The navigation box, see Figure 1.7, provides visual indication of the range and current value of one and two dimensional parameters. Any variable may be selected to the Navbox by selecting the parameter within the status window or toolbar, however not every parameter is well suited to this type of control (e.g. parameters with non-linear control characteristics such as magnification and probe current).

Figure 1.7 Navigation Box

The edges of the box represent the limits of the variable range (eg - 100%, + 100%) and cross hairs indicate the centre of the box, not necessarily the centre of the range. The current parameter value is indicated by a red marker. The parameter value may be adjusted by dragging the marker to the required position. Alternatively the X and Y values may be individually adjusted using the scroll bars and the parameters set to zero using the origin button (labelled with O) at the junction of the X and Y scroll bars. If this button is selected the current parameters are set to zero.

This method of adjustment is also to be found within control panels such as Stigmation.

Stage Window *(if stage motorised)*

This Stage Window, see Figure 1.8, represents the XY co-ordinate space of the stage and provides both joystick and absolute movement facilities for a motorised stage. Pressing the right mouse button over the window displays a popup menu which gives access to the stage functions from which co-ordinate storage (if installed) can be obtained.

Movement of the stage is controlled by dragging the blue dot within the stage window. The blue dot represents the joystick and its deflection causes the stage to move in the direction of deflection. The speed of stage movement is linked to both the extent of joystick deflection and the current image magnification. For further information on Goto mode and co-ordinate storage, see Appendix E, *Options*.

Shutting Down

When a working session on the microscope has finished and the microscope is to be left overnight, over the weekend or longer, there are two ways to close down the system:-

Standby

This is the recommended state to leave the system in overnight and is again selected from the system button at the top left of the screen. Note that this is a software standby, not to be confused with the standby button above the disk drive which switches off power to the computer. Having selected SEM Standby, the software puts the SEM into standby mode. This includes setting the EHT, Lens currents, HRRU (if fitted), imaging and overlay planes to standby conditions. This is indicated by the user interface iconising with the text SEM Standby.

Shutdown

This is the recommended state to leave it for two days or longer. Click on the system button at the top left of the screen and select **SEM Shutdown**. You will be asked if you wish to save the current operating conditions - if you choose yes, then the conditions are stored in a file called Restore.Leo, which is a macro and can be used to restart the system later. The software then goes through a controlled shutdown, during which important files are written to disk - on no account press the Standby button or power off at this point. When the Program Manager can again be seen, close this down in the same way i.e. from the system button, then press the Standby button. Starting up again is then as described in Section 1.4.1 *To Obtain an Image* later in this Chapter.

It is quite a good idea either to switch off the viewing monitor or switch on a screen-saver (such as provided in the Program Manager/Main/Control Panel/Desktop menu) to prevent any burning of the screen.

1.3.8. Some Important Do's and Don'ts

DO

- Use the software routines provided for shutting down and standby mode
- Check filament saturation, as described, after the first runup of a new session
- Create user directories as necessary and keep all user data within them
  Read the Help provided. It is there for your guidance
  Try to keep a note of any important error messages for diagnostic purposes

Call your local Leica customer care office in the event of problems
Keep the chamber door and gun "O" rings clean

DON'T

- Fill the hard disk with images, use floppies where possible or use a mass storage disk
  Try to edit or alter, in any way, the system files. This **will** cause operational problems
  Try to install any peripheral without first seeking advice from Leica Cambridge

Common Operating Routines

To Obtain an Image

Before commencing to turn on the filament there should be a sample inside the chamber and there should be a satisfactory vacuum, i.e. **Vacuum Ready** displayed. The vacuum status and operating status are displayed towards the right of the toolbar.

If the vacuum is satisfactory **Ready** will be displayed, and the operating status will display **Shutdown.** If the operating status displays **Beam Off,** this indicates that a run-up file has been loaded but the filament has subsequently been turned off.

After loading the control program the image area may be displayed at 1/4 full screen size. The operator may, at any time, change the displayed image to full screen size. This can be done by selecting **View** (with the left button) from the top row of the toolbar and then selecting **Full Screen Image** from the drop down menu. Similarly the datazone can be displayed by selecting **Datazone** from this same drop down menu.

The datazone will not be displayed while the image area is displayed at 1/4 full screen size, and while this mode is set the option of displaying the datazone is greyed out, so that it cannot be selected.

Clicking with the left button over the **Run Up** icon

will cause a macro called RESTOREn.LEO to be loaded and executed, n is the ordinal number of the current filament type (eg Tungsten = 0). This macro holds

all the operating conditions of the SEM and corresponds to the last set of operating conditions that were saved when the microscope was shutdown.

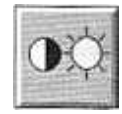
Should the operator require other specific operating conditions please refer to *Saving and Loading Conditions* in Section 3.7.2.

This operation will take several seconds, during which time the macro will appear and then be executed. When the macro has been removed and BEAM ON displayed in the toolbar the SEM is ready to use. Normally there will be some form of recognisable image displayed on the screen, at worst it may show only as a change in signal brightness.

The following steps should provide the operator with an image of the sample with which to work.

Adjust the Image Brightness to a Suitable Level

Set the mouse control to Brightness and Contrast control by clicking with the LEFT button over the icon



With the mouse pointer over the image hold down the LEFT button and slide the mouse either left or right to decrease or increase the image brightness to a satisfactory level.

Select a Very Low Magnification, i.e. about 20X

Set the mouse control to Magnification and Focus by clicking with the LEFT button over the Mag/Focus icon. Then, with the mouse pointer over the image hold down the LEFT button and slide the mouse to the left to reduce the magnification. The value of the magnification will decrease while this operation is continued, or repeated, until the minimum value is attained.

Focus the Image

Unless already selected, set the mouse control to Magnification and Focus control, by clicking with the Left button over the Mag/Foc icon. Place the mouse pointer over the image and hold down the CENTRE button and then slide the mouse to the left or right until the image becomes more recognisable and into focus.

If difficulty is experienced, note the value of the focus displayed in the toolbar. Most samples will usually be in focus somewhere within the range 5mm to 30mm. If the sample is out of the field of view altogether, then an image of part of the stage mechanism or even of the mesh covering the turbo-molecular pump, may be produced, to do this a focus distance greater than about 30mm is required. If this is the case, the sample will have to be moved into the field of view by manually moving the stage X and Y controls mounted on the door of the chamber. The simplest thing is to move the controls until both X and Y position counters indicate approximately 0500. This will place the stage at the centre of its travel and, if a single stub is mounted in the chamber this will now be under the beam, or if the carousel is present, the centre of this will be under the beam. Repeat the above focusing operation to achieve a recognisable image.

Optimisation of Settings

Once a recognisable image has been obtained the operator can optimise the conditions prior to examining the sample in detail. The following procedures should be done at the start of a session, but any part of the following can be repeated subsequently, should the operator feel it necessary.

Setting kV and Probe Current

The accelerating voltage to be used will depend greatly upon the sample being examined, and will require some experimentation by the operator to achieve the best results. As a rough guide, uncoated non-conductive samples should be examined using between 1 and 3 kV, non-conductive but coated samples should be examined using between 5 and 15 kV and conductive samples can be examined using between 10 and 25 kV.

It is recommended that inexperienced users start with a conductive sample and set the accelerating voltage to 15 kV and the probe current to 200pA.

To Adjust the kV

Set the mouse control to kV and probe current control by clicking with the **Left** button over the icon

The current values of the kV and probe will be displayed in the toolbar. Then with the mouse pointer over the image, hold down the **Centre** button and slowly

move the mouse to the left or right to decrease or increase the kV to the desired value.

To Adjust the Probe Current

If not already active, set the mouse control for kV and probe adjustment by clicking on the icon with the **Left** button. With the mouse pointer over the image hold down the **Left** button and slowly slide the mouse to the left or right decrease or increase the probe current to the desired value. It may then be necessary to adjust the brightness of the image as described above.

The value of the probe current chosen will affect the signal to noise level within the displayed image, and also the achievable resolution. A large probe current will produce a good noise free image, but it will not be possible to obtain good resolution at higher magnifications, and conversely a low probe current will enable high resolution images to be obtained but the image will become progressively more noisy as the probe current is decreased. Inexperienced operators may choose to run in the Auto-probe mode when the magnitude of the probe current is varied as the magnification is changed, see Section 2.3.2 *Setting EHT and Probe Current*.

Any parameter assigned to mouse control may be set directly by double clicking on that parameter display in the toolbar. A number entry box appears allowing the value to be typed in.

Setting the Filament Current and Beam Alignment

Simple Alignment

The optimum alignment of the beam down the column may be checked at any time by clicking with the **Left** button over the icon

and then with the mouse pointer over the image hold down the **Left** button and slide the mouse to the left or right and up or down until the brightness of the image is at a maximum. This is a quick way of checking the alignment during operation having first carried out a full alignment at the start of a session or when the filament has been changed, as described below.

Filament Setting

The setting of the filament current will have a large effect of the brightness and stability of the image, as well as influencing the lifetime of the filament. As the filament current is increased the brightness of the signal increases until a small plateau is reached, this is known as the "first peak" (see Figure 1.9), increasing the filament further will again cause the signal brightness to increase until another plateau is reached, further increase of the filament current will not improve the signal brightness, this is referred to as the fully saturated condition. The lifetime of the filament decreases as the filament current increases, there is no advantage in increasing the filament current above the just saturated condition.

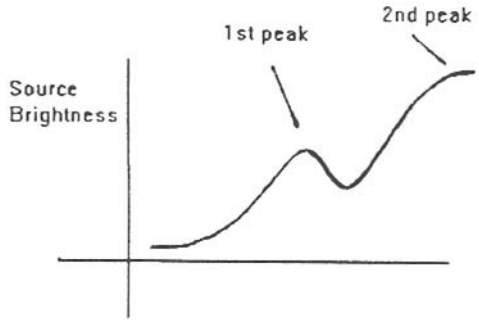


Figure 1.9 First Peak

The filament should be operated at one of two conditions, either at the first peak setting or where the filament has become just fully saturated. These two positions will provide conditions for stable brightness operation. Operating at the first peak setting will give a long filament life, but is not satisfactory for high resolution imaging, while the fully saturated condition will give the brightest signal and allow the best resolution images to be obtained, but the lifetime of the filament will be reduced. The above conditions can easily be achieved by using the Emission Image mode.

Emission Image Mode

Using the Right button, click on the align icon, this will display the Gun Alignment panel. With the Left button, select Emission Image to switch the display into the emission imaging mode. This enables the operator to determine the setting of the filament current by the image displayed on the screen. The best effect will be achieved if the beam is NOT focused on the sample. The emission image will vary as the filament current is changed. The images corresponding to First peak and fully saturated, which are shown in Figures 1.10 and 1.11 respectively.

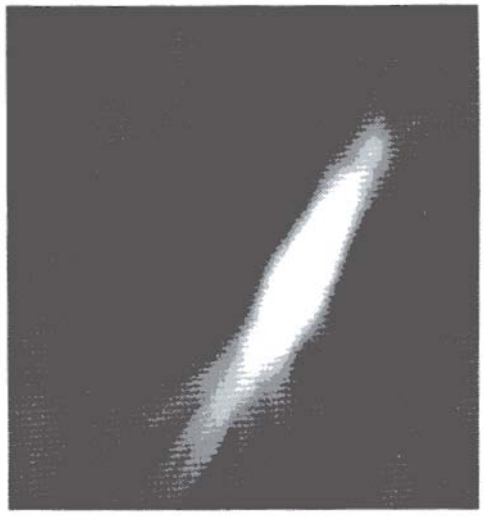


Figure 1.10 Image of First Peak Setting

The filament current may be varied by using the associated scroll bar within the Gun Alignment panel, either by SLOWLY dragging the slider in the appropriate direction, or by clicking over the arrow at the appropriate end of the scroll bar.

This should be done carefully and slowly, otherwise a blown filament may result.

Alignment

For the best performance of the microscope the electron beam should pass down the column along the electron optical axis, and any aperture in use should also be centred about this axis. As no column can be perfect, various adjustments are provided to compensate for this.

Final Aperture Alignment

The centring of the final aperture can easily be checked by having a recognisable feature at the centre of screen and then taking the focus through focus and back again. When aligned, the image will only rotate and not shift laterally. If the aperture is mis-aligned the image will move backwards and forwards across the screen in a slight arc. If the aperture is mis-aligned it will be necessary to move the position of the aperture using the X and Y micrometers on the side of the column until the image ceases to shift laterally.

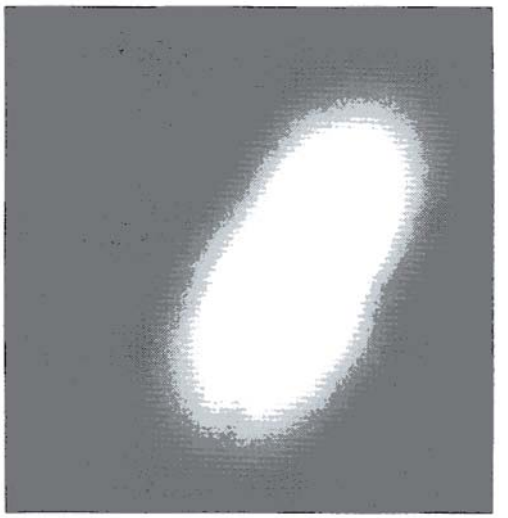


Figure 1.11 Image of Fully Saturated Condition

Focus Wobble

To facilitate setting the optimum aperture position the operator may find it helpful to select Focus Wobble. This may be selected from the Gun Align panel or directly from the drop down menus under Beam.

When selected, this automatically sweeps the objective lens backwards and forwards through focus, the speed and amplitude of the sweep can be altered from the Wobble panel. Selecting or de-selecting Fast will change the speed from fast to slow, and using the Amplitude scroll bar will enable a suitable excursion of the sweep to be set. Selecting reduced raster and a fast scan speed will also facilitate this operation.

Adjust the X and Y aperture micrometers carefully until the images ceases to shift laterally and only rotates. The Focus wobble can then be de-selected by selecting **Off** from within the Focus Wobble panel.

Beam Alignment

The beam is correctly aligned down the column when the emission image is at the centre of the screen, when viewed in resolution mode and in depth mode. Correct alignment will be affected by the alignment of the final aperture, it may therefore be necessary to repeat the final aperture alignment after aligning the beam. The beam may also be aligned using the Auto Gun Align function selected from the Alignment panel (or by selecting 'G' on the keyboard).

Operation

This chapter contains the information necessary to operate the standard functions of the *Stereoscan 440*. The structure of this chapter is as follows:-

Overview of the user interface
Operation of the instrument
Customisation of the user interface

In many cases additional information on a given topic is available within the on-line help mechanism. It is good practice to refer to it when a difficulty with the user interface is encountered (see Section 1.2 *Microsoft® Windows™ and How to Use Help).*

2.1. User Interface Description

2.1.1. The Menus

The following text is a brief outline of the functions provided on the main menu bar. Details of how these options are used is included in the Instrument Operation section of this chapter.

Some of the options listed below only appear if the system is switched into ***Expert*** *mode (selected on the* ***File*** *menu).*

File

The file menu provides options to:-

- Select the user directory
- Restore and load states (including the last state and the standard state)
- Import and export images
- Select **Novice** or **Expert** mode

View

The view menu provides the means to allow the user to control the appearance of the user interface. This includes options to:-

- Display the image as full screen or quarter screen
- Select which planes are to be displayed (Windows, Image and Overlays)

- Toggle the toolbar on and off
- Display a Status window and/or a Datazone
  Assign the current control parameters to a Navigation Box

Beam

The beam menu provides options to:-

- Turn the beam on and off
- Select the gun and column control panels and parameters
- Control the *Optibeam* operating mode
- Identify the current aperture and check whether it is appropriate for the current operating conditions

Detectors

The detectors menu provides options to:-

- Select and configure the detectors assigned to the current zone
- Adjust the collector bias
- BSD setup (option)
- X-ray setup (option)

Image

The image menu provides options to:-

- Assign the signal level and magnification parameters for mouse control
- Select the noise reduction and signal mixing panels
- Freeze or Unfreeze the current zone
- Display a histogram or a line profile of the current image
- Apply beam shift and centre points of interest on the image
- Image mats (option)

Edit

The edit menu provides options to:-

- Edit save and load the display LUT
- Edit save and load the toolbar

Select the pressure units for the vacuum level display
Select annotation and measure mode

Scanning

The scanning menu provides options to:-

- Select the scanning speed
- Select the scanning mode (Normal, Reduced, Emission or Line scanning)
- Static or dynamic stereo (options)

Stage/Vac

The stage and vacuum menu provides options to:-

- Inspect the vacuum status
- Control the beam and vacuum system to perform a specimen change
- Initialise and move the motorised stage (if fitted)

Tools

The tools menu provides options to:-

- Select the macro editor
- Define the magnification table
- Specify the links between certain functions
- Go directly to any system control panel

Help

The help menu provides information on topics related to the control of the *Stereoscan 440*. Items on the menu include:-

- An introduction to using help (Help on Help)
- Help with the Leo interface (Leo Help - F1)
- Help with special keys used by the interface (Keys Help - F9)
- The Release Notes for the version of software currently running

2.1.2. The Icons

The icons in the standard toolbar provide a set of operations associated with the left and right mouse buttons. It is possible to modify the arrangement of icons and actions (or even to define completely new toolbars) using the toolbar editor (see Section 3.7.4 *The Toolbar Editor*).

The icons described in this section are those for the novice toolbar. Selecting Expert Mode will cause a more extensive set of icons to appear. Context sensitive help can be used to examine the functions associated with each icon.

Icon: **Run Up**
Left: Executes the Restore Conditions macro
Right: Previews the Restore state

Icon: **Align**
Left: Assigns Gun Tilt control to the mouse
Right: Selects the Gun Alignment Panel

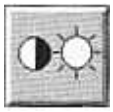
Icon: **kV/Probe Current**
Left: Assigns EHT and Probe Current to the mouse
Right: Selects the Gun Set Up Panel

Icon: **Normal Mode**
Left: Selects Normal scanning
Right: Selects the Scanning panel

Icon: **Reduced Mode**
Left: Selects Reduced scanning
Right: Selects the Signal Adjust panel

Icon: **Scan -**
Left: Decrements the scan speed (pixel averaging)
Right: Selects the Scanning panel

Icon: **Scan +**
Left: Increments the scan speed (pixel averaging)
Right: Selects the scanning panel



Icon: **Signal**
Left: Assigns Brightness and Contrast to the mouse
Right: Selects the Signal Adjust panel

Icon: **Mag/Focus**
Left: Assigns Magnification and Focus to the mouse
Right: Selects the Auto Focus/Auto Stigmation panel

Icon: **Noise Reduction**
Left: Assigns N (number of frames to average) to the mouse
Right: Selects the Noise Reduction panel

Icon: **Photo**
Left: Initiates an image record sequence
Right: Selects the Image Export panel

Icon: **Stigmation Correction**
Left: Assigns Stigmator X and Y to the mouse
Right: Selects the Stigmation panel

Instrument Operation

Specimen Handling and Vacuum Control

The routines described below are required to get the specimen into the chamber, under vacuum and in the right position to be scanned by the beam. In addition some less frequent operations such as changing the filament and installing the anode spacer are also included here.

Changing the Specimen

The beam must be switched off before opening the chamber for a specimen change. Proceed as follows:-

Select the drop-down box for beam state in the toolbar.

2. From the list, choose **Beam Off**.
3. A message will be displayed to show that the filament current is being decreased before the state Beam Off is displayed.

Alternatively:-

From the menu **Stage/Vac**, select **Specimen change**

2. A control panel will be displayed from which the beam can be switched on and off and the chamber vented or pumped.

When Beam On is selected, the beam conditions used when Beam Off was selected are restored.

Before loading a specimen into the specimen chamber, the chamber must first be brought to atmospheric pressure by selecting **Vent** in the vacuum status drop-down box in the toolbar. Safety interlocking of high voltage supplies results in the Vent command being disabled unless the beam is first switched off. To open the chamber and change the specimen:-

Ensure that the beam is off (indicated in the toolbar). If it is not, switch it off using the previous routine.

2. Vent the chamber using the drop-down box in the toolbar.

3. Release the chamber door catch

4. When the chamber is at atmospheric pressure, the door can be pulled open.

5. Remove the previous specimen, if there is one, by loosening the small locating screw holding the specimen stub in position.

Any one of a variety of specimen holders may be in use - however, they are all held in position with a small locating screw. To loosen the screw, use the smaller of the two ball-ended drivers provided.

6. Insert the new specimen and tighten the locating screw

Close the chamber door and fasten the door catch.

8. Select **Pump** from the drop down box in the toolbar. The pumps should now start.

9. Within 5 minutes, depending on the specimen and the length of time the chamber was left open, the vacuum status should reach Ready. This is indicated both in the toolbar and in the vacuum status panel, obtained using keyboard key V. If vacuum is not achieved within this time, see Section 2.2.6 *Getting a Vacuum.*

10. Resume specimen examination by selecting Beam On.

Some stage movement may be required to locate the specimen area requiring examination.

2.2.3. Specimen Handling

Cleanliness of all items to be placed within the vacuum system is essential Anything that has any oil or grease on it must first be cleaned with solvent, preferably using an ultra-sonic bath. Anything to be handled should be done so using lint free gloves to avoid contaminating it with finger grease. Failure to do so will eventually cause a degradation of the vacuum and resultant contamination of the sample over the area being examined.

Specimens should normally be fixed to a stub prior to loading onto the stage within the chamber. The sample can be fixed down into the stub by the use of conductive glue, either carbon or silver. It is also possible to use conductive double sided sticky tape. If this type of tape is used there is the possibility that the sample may move very slightly during examination, this may become apparent at high magnifications or if the sample is heavier than normal.

Larger samples should be fixed to the 4 inch diameter holder. This may be achieved by making use of the many tapped holes present in this holder to either tie the sample down using uncoated wire or to use screws to secure the sample.

The ideal sample is one that is electrically conductive as no other preparation is required. However if the sample is non-conductive such as plastic or a biological sample the operator must decide whether or not to coat the sample with a conductive layer. The subject of specimen preparation and the selection of operating conditions is covered in Chapter 3 *Advanced Operation*.

2.2.4. Changing the Filament

Whenever the filament blows, or is otherwise open-circuit, a message is displayed on the screen to inform the operator that the filament has blown.

To change the filament

Admit air to the column and chamber and open the gun. Remove the emitter assembly by loosening the three locating screws holding the emitter assembly in place, close the gun and pump down the system.

2. Take the emitter assembly to a clean area for cleaning and reassembly

3. Place the assembly on a clean sheet of paper with the grid aperture downward. Using the flat metal key unscrew the height adjusting ring. As this is done the filament will move away from the grid.

4. Grip the filament pins with the tweezers provided and lift the filament assembly out of the grid cap.

5. Release the filament clamp screws (visible in the four large holes) and, using the tweezers, lift out the filament.

6. If the cathode assembly or grid aperture is not excessively contaminated a new filament can be fitted. If any contamination is present, dismantle the unit and clean the components, paying particular attention to the inside of the grid aperture. This must be free of all contamination and particles.

7 Using the tweezers, put the new filament into the filament holder, first ensuring that the pins are clean. Align the filament legs with the marks and ensure the ceramic is centralised when tightening the filament clamp screws. Do not overtighten as this can cause the ceramic to crack when the filament becomes hot.

8. Replace the filament assembly in the grid cap. Replace the height adjusting ring and screw it down until it touches the sleeve.

9. Adjust the filament height and centralising as described below.

To adjust the tip position:-

Using a low power magnifier and a good source of illumination, ideally a stereo zoom microscope, look through the grid aperture hole and locate the filament tip. It may be necessary to adjust the height adjusting ring to move the filament forward so that the tip can be seen. Do not move the tip forward so that it touches the grid.

As soon as the tip can be seen through the grid aperture hole, adjust the filament centralising screws to centre the tip in the grid hole. Set the height adjusting ring so that the tip of the filament is level with the front face of the grid aperture.

3. When in this position the tip is inside the hole in the grid, so care must be taken to ensure that the tip is correctly centred before adjusting its height.

1. Admit air to the gun. Open the gun.

2. Lift out the anode.

3. Fit the anode spacer on the top of the gun align coils. Take care, this is a high precision fit.

4. Fit the anode back on top of the spacer. This is also a good fit.

5. Select **Low kV anode** in the Gun Setup panel.

This automatically restricts the acceleration voltage to 3kV.

6 Close the gun, pump down, select the desired low voltage and obtain an image.

The *Stereoscan 440* should not be used at an acceleration voltage higher than 3kV with the anode spacer fitted. It is important to ensure that the state of the anode spacer parameter reflects the state of the machine.

2.2.6. Getting a Vacuum

If the vacuum ready state is not achieved after several minutes of pumping, the following guidelines provide an ordered approach to diagnosing the problem.

Investigating a vacuum leak, few simple rules:-

Before looking for a vacuum leak give the vacuum system time to pump. If you have just changed a specimen in a very humid atmosphere the pump down may take longer. If the specimen is wet it may take several minutes (up to 1 hour with a very large, very wet specimen has been known.) If the stage has been left open for long periods it will take longer to pump. If the column or chamber have been washed with solvents then it may take several hours to achieve a good vacuum.

2 Vacuum leaks rarely happen by themselves; they are often caused. If you have just done anything to the column or chamber then that is the most likely cause of the leak. If the specimen has just been changed, check the stage door 'O' ring. Similarly if the filament has been changed check the gun 'O' ring.

3. The most frequent cause of leaks is dust or fibres on 'O' rings. 'O' rings may be cleaned with a fluff free tissue. 'O' ring grease should never be used. Grease traps fibres and may cause leaks.

4. Do not use any metal tools to remove 'O' rings from their grooves. A small scratch in the bottom of a groove causes a big leak.

5. If the pump down is slow, check the air admittance drier and renew the desiccant before looking for a leak.

If none of the above point to the cause of the leak, refer to Section 5.*4 Looking for Vacuum Leaks.*

2.2.7. *Initialising the Stage*

If a motorised stage is fitted it must be initialised before it can be used with the absolute stage movement function (or with any of the stage options). Stage initialisation is the process by which the system finds out the actual position of the stage relative to its limits. There are two ways of performing stage initialisation:-

Manual
The stage initialisation panel is selected from the **Stage/Vac** menu. It contains fields for X, Y and Z stage positions.

The field on the stage initialisation panel which reports the initialisation status cannot guarantee that the stage position is correct (it cannot detect the fact that the stage might have been manually moved while the system was switched off). The test to see if the stage is correctly initialised is to compare the actual stage position (read off the stage motors) to the stage position displayed in the status window. If they are the same then the stage is correctly initialised.

To initialise the stage:-

1. Read the stage X position from the stage X motor.
2. Select stage set X and enter the X position.
3. Repeat for Y and Z.
   Select **Stage: set position** to send the new position values to the stage controller.

This last action will cause the stage position in the status window to update (if it is being displayed).

Automatic Stage Initialise

The stage can also be initialised automatically by selecting the Auto Initialise **Stage Init** button on the initialise panel. The stage is then driven to its limits in X, Y and Z to locate and set the stage origin. It is then moved off the limits by a small amount to allow normal operation of the stage.

2.2.8. Moving the Stage

The stage can be moved in two ways from the **Stage Move** panel (selected from the **Stage/Vac** menu). **Joystick** mode simulates the action of a joystick with a window. While **Goto** mode allows absolute movements to be made. A pop up menu on the stage move window allows selection different modes.

Joystick

In joystick mode the stage position is represented by a red square on the stage window. A blue square represents the joystick position. To move the stage select and drag the blue square in the required direction (horizontal for X, vertical for Y). The speed of movement is proportional to the displacement of the blue square from the centre. When the mouse button is released the blue square returns to the centre and the stage stops moving.

Stage Z movement is performed using the scroll bar on the right of the stage window. This is done by selecting the scroll box on the scroll bar and dragging it up or down. The scroll box acts like a one dimensional joystick, so the speed increases with the displacement from the centre position. On release the scroll box will return to the central position and the stage will stop.

Goto

In Goto mode the red square in the display still represents the stage position. But the blue square now represents the stage target position. Clicking with the left mouse button anywhere in the window will cause the stage to move to that position (the edges of the box represent the stage limits).

The stage Z position is indicated by the position of the scroll box within the scroll bar. Movement in Z is achieved by clicking with the left mouse button at the desired position within the scroll bar.

Electron Gun and Column

Setting Filament Current and Aligning the Beam

Filament Setting

Optimum performance of the SEM is achieved only after saturation and alignment of the electron gun. The gun runup function sets the filament current at the value it was last set, so it is important to keep a check on this as the filament ages and after large changes to accelerating voltage, so that its working life is maximised.

Saturation and alignment can both be adjusted, quite quickly from the same operating panel - **Gun Alignment**. This panel is obtained by pressing the Align icon with the right mouse button. Adjust as follows:-

For Tungsten:

Press the **Emission** button. The filament emission profile can now be seen - adjust the manual brightness, if necessary, or switch on autovideo peak from the signal adjust panel. The profile should be roughly egg-shaped, depending on the present value of filament current.

2. Using the arrows at each end of the Filament current scroll-bar, adjust the filament current so that the profile **just** condenses down to an egg-shaped mass. This is the saturation point (or second peak see Figure 2.2) and usually occurs at about 2.75A for a new filament. If "first peak" operation is required, reduce the filament current to about 2.25A when a bright central emission image will be seen surrounded by an outer "halo". Operation at this point gives reduced resolution but much longer lifetime.

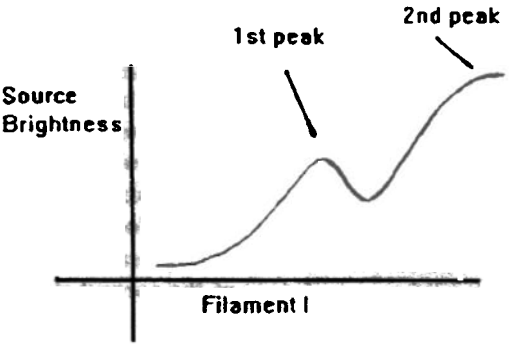


Figure 2.2 Second Peak

For LaB_6:-

1 Press the **Emission** button. The filament emission profile can now be seen Adjust the manual brightness so that the bright control region can be seen. Ensure Auto Signal Level is OFF.

2. Adjust the filament current until the central image is at its smallest, then reduce the current slightly.

   Using a line profile (selected from the **Annotations Measurement** popup menu) through the central image adjust the filament current to maximise the height of the central peak on the line profile. This will only require a small adjustment.

*If the filament current is increased beyond 2nd peak saturation, no advantage is gained but the life will be **considerably** shortened (the emission profile also does not change for currents higher than saturation point).*

For Automatic Alignment:-

Press **Auto Align**. When complete (the text on the button no longer greyed-out), the profile should be at the centre of the screen - this can be checked by enabling **Crosshairs** from the View menu. Now go to 7 below.

For Manual Alignment:-

Select emission image from the Gun Align panel

2. From the Status Panel select the parameter Emission Zoom and set this to be 2. ***(Please read notes below regarding Emission Zoom Factor Settings)***

EMISSION ZOOM FACTOR SETTINGS

A Systems with the Modified Gun Align Modules

Build Standard 3/10 or later

(i) Software Version 2.01 and earlier
Use an Emission Zoom Factor of 2 to display an emission image of the correct size.

(ii) Software Version 2.02 and later
Use an Emission Zoom Factor of 1 to display an emission image of the correct size.

B Systems without the Modified Gun Align Modules

Build Standard 3/9 or ealier

(i) Software Version 2.01 and earlier
Use an Emission Zoom Factor of 1 to display an emission image of the correct size.

(ii) Software Version 2.02 and later
Use an Emission Zoom Factor of 1 to display an emission image of the correct size (will be slightly bigger).

3. Select *Optibeam* mode **depth** in the Gun Align panel.
4. Select **Gun Shift**.
5. Defocus the image.
6. Adjust the magnification until an oval spot is clearly visible, ~ 100x.
7. Centre the spot using the crosshairs if required.
8. Undo *Optibeam* depth mode.
9. Select **Gun Tilt**.
10. Centre the emission image, if required.

    Select normal image.

12. Select reduced raster
13. Select the gun alignment icon.
14. Adjust for maximum brightness in X and Y directions.
15. Press the normal icon to resume normal imaging.

If the image moves laterally when you adjust the focus, it may be necessary to adjust the aperture position. If so, consult Section 2.3.3 *Adjusting the Aperture*.

A Check filament saturation about once a day. Saving conditions when you close down ensures that new values of filament current will be used when you restart the system.

B As an aid to fast manual alignment, a useful facility is provided under ***Tools->Links****. This provides the ability to select auto-contrast, a particular scan speed, and crosshairs to be set when* ***Emission*** *is pressed.*

C If only minor optimisation of the gun tilt is required, this can be achieved by pressing the Align icon with the left mouse button and use mouse adjustment to optimise the signal.

2.3.2. Setting EHT and Probe Current

Accelerating Voltage

The accelerating voltage and probe current can be assigned to the mouse buttons from the **Beam** menu or by clicking on the kV icon. Whenever the accelerating voltage is changed it is important to check that the beam and the final aperture are correctly aligned.

In addition to adjusting these parameters with a mouse it is possible to double click on the parameter display (in the toolbar) which will bring up a dialog box allowing the value for the selected parameter to be entered from the keyboard (this applies to any parameter assigned to the mouse).

The accelerating voltage must be set for the type of specimen under examination:-

- For low atomic number or beam sensitive specimens, choose a voltage between 1kV to 5kV
- For high atomic number specimens, a voltage of 25kV to 30kV is normal
- For atomic numbers in between (say 20 to 50), a voltage of 10kV to 20kV is best
- For X-ray analysis, the voltage is dictated by the elements under analysis

The subject of selecting appropriate operating conditions for the specimens is explored further in Chapter 3 *Advanced Operation*.

Probe Current

The probe current effectively controls the spot size of the beam on the specimen. *Optibeam* Auto Resolution mode (selected on the **Beam** menu) sets the probe current to give the best resolution. If auto resolution is left on then changes in

magnification will result in changes of probe current, so it is advisable to enable auto brightness.

Further guidance on selecting the correct probe current is given in the Chapter 3 *Advanced Operation.*

Optibeam

The *Optibeam* program takes the requirements for probe current, working distance, etc and determines the optimum lens settings to achieve the best performance from the column. Usually the best performance is defined as the highest resolution, but *Optibeam* can be told to optimise for the greatest depth of focus instead. This is done by selecting **Depth Mode** on the **Beam** menu.

2.3.3. Adjusting the Aperture

Optimum imaging can sometimes depend on the correct choice of aperture size. The internal software model, *Optibeam*, continually calculates the best setup for the selected aperture, however it will sometimes recommend using a different aperture. This message is displayed in the **Beam->Apertures** menu, as **Recommended Aperture =.** If preferred, this information can be displayed automatically on screen by switching off **Suppress Aperture Warning.**

The four apertures installed (sizes as displayed in the Apertures menu) are all located on the Y axis of the aperture changer mechanism. To reach another aperture, simply rotate the Y micrometer either clockwise or counter-clockwise according to the direction of the required aperture - refer to the X and Y positions displayed in the Apertures menu.

As the micrometer is rotated, the signal will disappear as the current aperture moves out of position. The signal returns as the next aperture moves into position, however there will either be much less or much more signal according to the change in aperture size. For this reason, it is sometimes easier if auto brightness is enabled during the change.

Having located the aperture in position, click on the "radio button" next to the new current aperture selection and **OK** the menu. This ensures that *Optibeam* will continue to achieve the best column performance.

Finally, it is necessary to make a fine adjustment to the aperture position to ensure that it lies exactly on the electron optical axis. Select a focused field of view at about 1000x and switch on focus **Wobble** under the **Beam** menu. The speed and amplitude of the wobble can be adjusted from the operating panel that

appears, and should be adjusted so that the change of focus of the image can be easily followed. This requires a fast scan speed, and preferably reduced raster.

*Reduced mode can be automatically enabled with focus wobble in the **Links** menu under **Tools**.*

Carefully adjust both X and Y micrometers until no **lateral** movement of the image can be seen during the focus wobble. Switch off focus wobble.

If adjusted carefully, preferably just after gun alignment, further aperture alignment adjustments can be avoided except when large changes in either probe current, working distance or accelerating voltage are made.

2.3.4. Setting Focus, Stigmation and Magnification

Focus

The focus can be controlled by clicking on the Mag/Focus icon. This will assign focus control to the centre mouse button. Alternatively it can be set directly by double clicking on the Focus=display in the toolbar.

In some places the focus value is displayed as the Working Distance, these two parameters describe the same thing.

Optibeam uses the working distance value to set the lens currents to achieve the required focusing. If *Optibeam* is not active the focus is adjusted by controlling the C3 lens current directly.

Auto Focus

Auto Focus can be initiated from the keyboard or from the Auto Focus/Stigmation Panel (see Figure 2.3), which can be called up from the **Mag Focus** icon. The algorithm uses a portion of the image to select the best focus. By default this is the centre of the image, but the user can adjust this by selecting **Focus Area** on the **Image** pop-up menu. The right mouse button cancels adjustment of focus area.

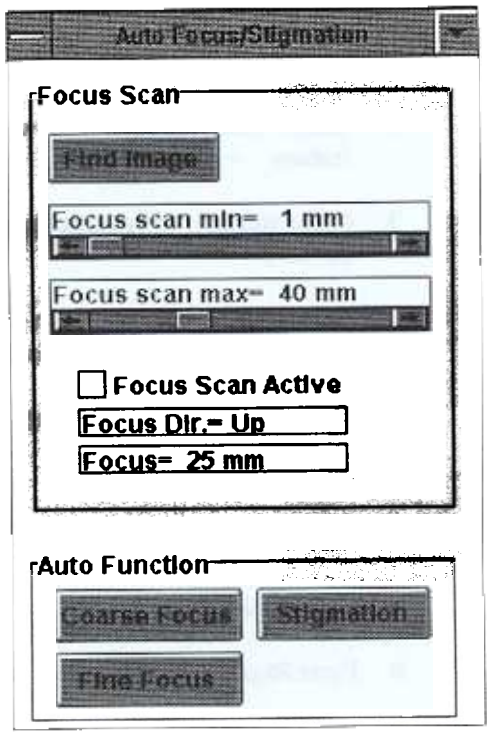


Figure 2.3: Auto Focus/Stigmation Panel

You may select **Coarse Auto Focus** (Shift F on keyboard) and **Fine Auto Focus** (F on keyboard). You may also select a new function **Focus Scan** by Ctrl F on the keyboard. This scans the focus between defined limits and will stop when the spacebar is pressed. While active the direction of scan may be changed by pressing the left or right cursor keys.

If a large change in working distance is made, then it is recommended that the **Remove Hysteresis** function (F2) to ensure the accuracy of the magnification and probe current values.

Stigmation

High resolution images can only be obtained after correct adjustment of the stigmators. Astigmatism (non-roundness of the beam) is caused by microscopic contamination within the column charging up and applying an asymmetric field that affects the focus of the beam usually in one direction. It can be corrected, if not too serious, as follows:-

1 Select the Stigmation panel by pressing the Stig icon with the right mouse button.

2 Choose a suitable field of view at about 5kX to 10kX containing a round feature.

3. Focus normally to optimum focus so that the feature does not "smear" in any direction.

4. Select the reduced raster icon and, using the **Beam Shift** function in the Stigmation panel, bring the feature to the centre of the reduced raster.

5. Press **Stigmation** in the navigation box and adjust for best focus.

6. Repeat 3 and 5 as necessary.

Alternative methods are provided:

A Press **Auto Stig** in the Stigmation panel.

B Press Stigmation on the Auto Focus/Stimgation Panel

C Press **Dynamic Stig** and, using the mouse pointer click on the region of best image focus using the left mouse button.

D Press the Stig icon with the left mouse button and adjust the Stig X and Stig Y parameters as normal parameter adjustments with the mouse.

It is a good idea to align the aperture correctly before adjusting stigmation.

It is generally considered easier to adjust just one stigmation area axis at a time. The best way to do this is to use the scroll bars for X and Y adjustment picking up the scroll box with the mouse and dragging it to find the best stigmator setting.

Auto Stigmation

The Auto Stigmation Correction function now performs a combined focus/stig correction. Press A on the keyboard or the Stigmation button on the Auto Focus/Stigmation Panel (see Figure 2.3)

Find Image

A new Find Image function is introduced which is useful when you have just changed specimens. This function will perform an auto focus with the focus scanning between the defined working distance limits. It is the same as the Coarse Focus operation but in addition it will set the magnification to the highest value at which it is able to set the focus, whereas the Coarse Focus operation returns to the initial magnification.

This can be selected by pressing * on the keyboard or the Find Image button on the Auto Focus/Stigmation Panel (see Figure 2.3).

Magnification

Before describing how to adjust the magnification, it is important to understand the precise definition used on the *Stereoscan 440*. Each output device (HRRU, video printer, etc) is calibrated and the magnification relates to the selected output device. So the magnification for a video printer is larger than that for an HRRU (because the print is larger). The process of calibrating an output device is described in Section 2.6.

Like many other parameters magnification can be adjusted by assigning control to the mouse. In addition the magnification control window can be selected from the **Mag/Focus** option of the **Image** menu. Due to the wide range of available magnification, the window is divided into two parts. At the top is the coarse scale bar which presents a logarithmic scale, with a green marker indicating the mid range value of the lower fine scale bar. The required scale is selected with the mouse, the nearest graduation to the cursor will become the fine scale centre.

Because the green marker only indicates the range centre it only changes position when there is a range change.

The fine scale bar presents a linear portion of the magnification range. The red marker indicates the current magnification, which is also display in the caption area in the magnification control window. The required magnification is simply selected on the lower control bar.

A further facility for setting the magnification is provided by the mag table which can be accessed using the **F4** and **Shift F4** keys. The table is defined by selecting **Mag Table** on the **Tools** menu. Each non zero entry is active and pressing F4 will step the magnification through the values defined in the table. Pressing Shift F4 returns the magnification to the value it had before the first selection of F4.

If the word 'LOW' is entered in the mag tab, the magnification will be set to the lowest value achievable when that entry is selected.

Low Mag

If the word "LOW" is placed in a mag table entry, selection of that entry will cause the magnification to be set to the lowest achievable value. Subsequent changes to other electron optic parameters may cause this low value to change

Adjusting Beam Shift

Beam shift appears as an option on the Stigmation panel. Selecting it allows the beam shift to be controlled from the navigation box on the panel. The beam shift function allows a small amount of movement across the specimen and can be used at high magnifications where it is impossible to position the specimen with the stage.

The beam shifts are also used in the **Centre Point** Function on the **Image** menu. Centre point can be used to bring any point of interest to the centre of the screen (if it is within the range of the beam shifts). Select **Image->Centre Point** and the click on the image feature required.

The beam shifts can be zeroed by selecting the **Home** key on the keyboard.

Blanking the Beam

The beam can be blanked by selecting the **Beam Blanked** check box on the Gun Align panel.

Blanking the beam while scanning is not required will reduce electron beam damage to sensitive specimens.

2.4. *Imaging and Image Processing*

Adjusting Signal Level

Signal level can be adjusted manually or automatically. Automatic signal adjustment is controlled from the Signal Adjust panel (right mouse button on the Signal Level icon).

Manual

The signal level can be adjusted using the brightness and contrast controls assigned to the mouse with the signal level icon. If more than one zone is displayed, then the detector controlled is the detector assigned to the current zone (which is indicated by the anchor symbol). The concept of zones will be described in the Section 2.4.2 *Scanning Modes*.

Auto Signal Level

The Signal Adjust panel provides the controls for the auto signal level functions. Brightness and contrast can also be controlled directly from this panel using the slider bars labelled accordingly.

There are two types of auto signal level function which each operate in two ways. The auto signal level function will either control the **Mean** signal level or the **Peak** signal level. The mean signal level is defined as being the average brightness of all the pixels in the image, while the peak level is defined as the brightness of the brightest part of the image.

Peak and mean signal level controls each operate in two ways. The **Find** function is a single shot activation which sets the peak or mean to the level defined in the associated Auto Video slider bar. The **Keep** function activates the auto video function to maintain the video level (peak or mean) of the image at the time of selection.

Typically the Find function will be used to set the required video level if the image is a long way from the required brightness. The Keep function is useful when the content of the image is likely to change, for example if the stage is being moved across a specimen with distinct light and dark phases, or if the probe current is being adjusted.

Auto video control can be disabled at any time by selecting the **Auto Video Off** button.

2.4.2. Using Scan Modes

Before considering the different scan modes available, it is necessary to define some terms which will simplify the whole issue of scan modes, signals and Windows.

The Zone

The basic concept underlying all the display and scanning modes it that of a **ZONE**. A zone is an area of image store which can be mapped onto part of the image window. In normal imaging only one zone is used, but for split or quad modes two or more zones are required.

Inputs

Associated with each zone are two input signals **A** and **B** which can be selected from the list of detectors configured on the system. The full chain of processing is shown in Figure 2.4.

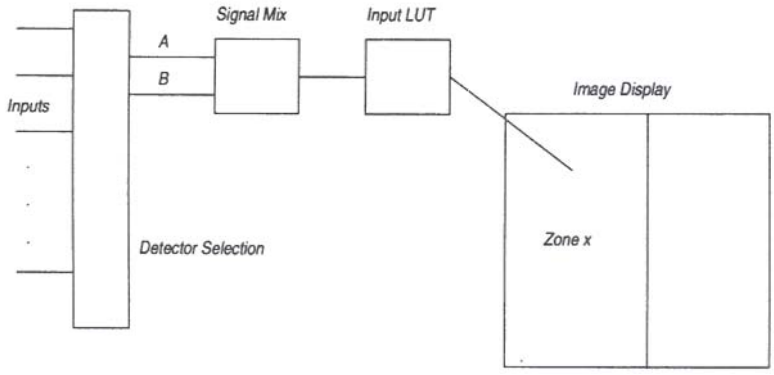


Figure 2.4

The signal mixing and Input LUT can be adjusted by the user if the appropriate software option has been purchased, otherwise the default settings will apply (no mixing, output = input LUT).

The Anchor Symbol

When working in a display mode with multiple visible zones the anchor symbol will appear.

It signifies which zone on the display is the current zone. This is important because many operations act on the current zone, these include:-

- Detector selection
- Frame averaging
- Freeze and unfreeze

In addition to these, the signal level controls adjust the settings of the detector assigned to the current zone.

It is easy to select a new zone to be the current zone. Select the anchor symbol with the mouse and drag it to the new zone. Thus whichever zone the anchor is in is by definition the current zone.

Double clicking on the anchor symbol will select '**All Zones**' (denoted by a blue border to the symbol). When 'All Zones' is selected any zone specific function will apply to all the zones on the display.

Scan Rotation

This allows electronic rotation of the image by rotating the scanning of the beam.

Scan Rotation is selected from either the **Scanning** menu or from the Scan Rotate icon in the Expert Toolbar. It is switched on and off using the **Scan Rot** check box on the Rotate/Tilt panel.

The angle of rotation can be adjusted using the slider bar on the Rotate/Tilt panel, or by assigning control to the mouse (using the Rotate icon). It is also possible to enter the exact value by double clicking on the rotate value on the Rotate/Tilt panel.

Scan rotation can be used to set the orientation of an image to the desired angle without having to rotate the specimen. Care should be taken when using stage controls while scan rotation is active as the actual direction of stage movement will not correspond to the screen axes.

Split Screen

In split screen mode (selected from the **Scanning** menu), the image area is divided into half with a different zone being displayed in each part. Different detectors can be assigned to each zone and each zone can be frozen independently of the others.

Quad Mode

Quad mode is selected from the **Scanning** menu or the Quad Mode icon in the Expert Toolbar.

When in quad mode scanning the anchor symbol indicates which zone is being controlled by any zone specific function. A different zone can be selected by dragging the anchor symbol into it. Zone specific functions include:-

- Detector selection
  Frame averaging
  Freeze and unfreeze

In addition to these, the signal level controls adjust the settings of the detector assigned to the current zone.

Quad mode can be used to display four different images acquired in different ways. For example the first image might be a low magnification image of the specimen, the second a higher magnification detail, the third might be the same detail using a different detector and the fourth might be the same image inverted

This type of effect can be set up by freezing each zone when its contents are acceptable and moving the anchor symbol to the next zone. Once all the zones are set up, the whole image can be printed, recorded or exported in the usual way.

Normal scanning can be returned to by selecting the Normal icon, or by selecting the **Normal** option from the **Scanning** menu.

Reduced

When adjusting focus or stigmation, it is often convenient to use the Reduced function to increase the frame rate without having to increase the pixel rate. **Reduced** is selected from the icon or the **Scanning** Menu.

2.4.3. Detector Control

The detector controlled by the brightness and contrast functions is determined by the detector assignment to the current zone. A detector is assigned to a zone using the **Select Signal A** field in the **Detector** menu. Selecting this field displays a list of the available detectors from which the required detector can be selected.

Each zone has its individual detector assignment, so in quad mode as many as four different detectors could be displayed. The detector controlled by the signal level functions is determined by the current zone, although if that detector is assigned to more than one zone then more than one part of the quad image may be affected.

It is possible to set up different auto signal level controls for different zones. If there is a conflict between two zones which have the same detector assigned to them, then the first zone with that detector will take precedence.

Collector Bias

The Collector Bias can be assigned to mouse control from the option in the **Detectors** menu. It can be varied in the range -250V to +400V. For normal operation of the secondary electron detector this value should be set to maximum.

Four Quadrant BSD

The four quadrant back scattered detector has a configuration panel dedicated to it, which can be selected from the **Detectors** menu. Each quadrant of the detector can be in one of three states **(Off, Normal or Invert)**. When normal the signal from that quadrant is added to the total signal, when inverted the signal is subtracted. Clicking on the quadrant fields allows each one to be configured as desired.

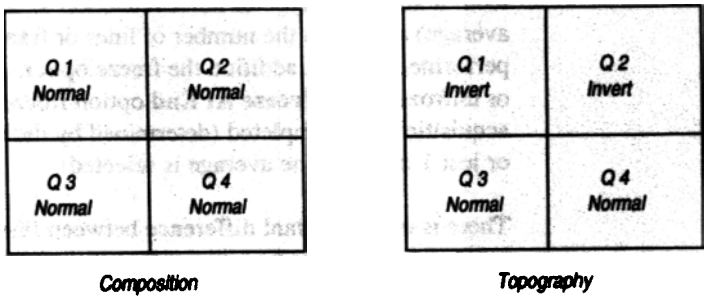


Figure 2.5

Two predefined configurations of quadrants are available to set the detector to give best performance for composition (Compo), that is atomic number contrast, or surface topography (Topo). Selecting these predefined configurations will set up the detector quadrants according to Figure 2.5.

Other mountings for the BSD may require different settings for Topo - these may be defined by setting the individual segments to the required values and pressing the Define Topo buttons. These settings will then be used for future selections of Topo.

There are two other fields on this panel. The Four Quadrant BSD: Gain field indicates which range the amplifier is currently on, it is set automatically from the signal level controls and need not be changed by the user. The Four Quadrant BSD: Fast field selects the bandwidth from the detector, it should be set to FAST for normal visual scan rates and to SLOW for slower scan rates and photo recording.

2.4.4. *Scan Rate and Noise Reduction*

Scan Rate

There are 4 scan rates available as standard on the *Stereoscan 440*. They are represented by the Pixel Average parameter which can have values 1, 4, 16 or 128. The scan rate is usually changed using the scan rate icons, but there are also options on the **Scanning** menu and on the Noise Reduction panel to do the same.

Noise Reduction

The Noise Reduction panel is selected with the right mouse button on the Filter icon. It allows the type of noise reduction to be selected (Line average or Frame average) as well as the number of lines or frames the averaging is to be performed over. In addition the freeze options allow the current zone to be frozen or unfrozen. The **Freeze At End** option freezes the zone when the image acquisition has completed (determined by the number of frames in frame average, or just 1 frame if line average is selected).

There is one important difference between line and frame average. In line average mode the same noise reduction is applied to all the active zones. But for frame average it is possible to set different frame counts for each zone.

The use of noise reduction is explained further in Chapter 3 *Advanced Operation*.

2.4.5. *Live Line Scanning*

The **Line** option on the **Scanning** menu selects live line scanning. In this mode a single line of the image is scanned repeatedly and a profile of that line is displayed. The rest of the image is frozen during line scanning and a line cursor is used to select the line to be scanned.

The profile's appearance is controlled through the pop-up menu associated with it. The following fields are used:-

X Scale - determines the width of the profile (displays every nth pixel)
Y Scale - determines the height scaling of the profile
Static/Active - Determines whether the profile is redrawn at the end of each line scan
Copy - Link for transfer of data to spreadsheets.

Selecting normal scanning will deselect line scanning.

One special case of live line profiling exists when the system is also in split screen scanning. In this mode two traces are displayed on the profile, the usual green trace represents zone 0 and a red trace represents zone 1 (the left and right hand sides of the image respectively).

2.4.6. *Spot Mode*

Spot mode is selected from the **Scanning** menu. On selection the image is frozen and a crosshair cursor appears to indicate the beam position. The cursor may be moved by dragging with the mouse. Selecting normal scanning deselects spot mode.

2.4.7. *Histograms*

Selecting the **Histogram** option on the **Image** menu displays a grey level histogram of the image, that is a bar chart showing the number of pixels at each grey level. A pop-up menu controls the appearance of the histogram with the following fields:-

- **Bin Width** - Sets the width of each bin on the display
- **Height** - Sets the height of the histogram display
- **Source** - Selects the source of the histogram data
- **Sample, Start and Stop** - Control the updating of the histogram data
  Copy - Link for transfer of data to spreadsheets.

The source can be defined as either the stored image, the current zone or a specified zone. If the stored image is selected then the histogram data will only be updated when the **Sample** option is selected. If the data source is a zone, then the **Start** and **Stop** options control the updating of the data. The source of the image is important because stored data has been processed by the input LUT and the noise reduction, whereas the zone data is entirely unprocessed.

On the histogram display there is a black cursor which may be positioned by the mouse, the selected bin number and its contents are displayed below it (B and N respectively).

2.4.8. Dynamic Focus

The dynamic focus licence enables the dynamic correction of focus within the frame for tilted specimens.

The dynamic focus control panel (see Figure 2.6) is displayed by selecting Top Menu - scanning - dynamic focus.

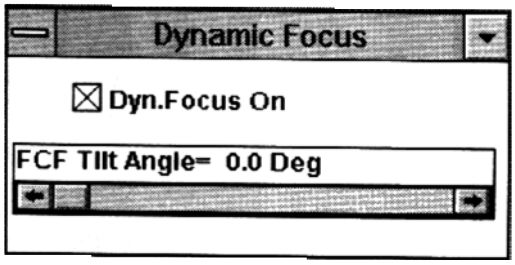


Figure 2.6 Dynamic Focus Panel

The Dynamic focus function is switched on/off using the checkbox on the panel.

The FCF (Frame Corrected Focus) Tilt angle is the angle of tilt about the middle of the image frame (i.e. about a horizontal line mid way down the image). The procedure is as follows:-

- Switch on Dynamic Focus
- When Dynamic focus is switched on the scan rotation is automatically switched on, this should be set to 0 degrees so that the angle of tilt goes down the frame
- If the specimen is itself tilted adjust the scan rotation so that the angle of tilt is down the frame
- Adjust the focus so that the middle (horizontal) is in focus
- Adjust the FCF Tilt Angle so that the top and bottom of the frame is in focus

2.5. Annotation and Measurement

The annotation and measurement functions are accessed via the image pop-up menu (press right mouse button while over the image area). To get the annotation menu select the **Annotation** option, then press the right mouse button

again to bring up the annotation pop-up menu. This menu can now be used to do any of the following:-

- Display a user defined datazone
- Place annotation text on the image
- Display a system parameter on the image
- Place a magnification marker on the image
- Perform point to point or linewidth measurement
- Save or load a file of annotation objects

When in annotation mode the image window title bar displays additional information concerning the annotation state. Annotation mode is deselected when the Adjust option is selected from the pop-up menu and also when a parameter is assigned to the mouse for adjustment.

Before considering how the annotation menu is used to achieve the above effects, it is important to clearly define some concepts upon which the annotation system is built.

Annotation Modes

There are three annotation modes **Move, Edit** and **Delete.** The current mode is indicated in the title bar at the top of the image window. In move mode an item can be selected and dragged to any position on the screen. Edit mode allows the contents of text strings to be edited, but the precise edit operation depends on the kind of object selected. Delete mode is used to remove any annotation object selected.

The annotation mode is set using the **Mode** option on the pop-up menu.

Annotation Objects

An annotation object is any item which is displayed on the image which is contained in the overlay plane. Turning the overlay plane on and off from the **Planes** field of the **View** menu will cause any annotation objects to appear and disappear. There are several different kinds of annotation object, including:-

- Text
- Parameters
- Panels
- Measurements

The use of each of these objects is described below.

Panels

A panel is a special kind of annotation object in that it is essentially a collection of other objects. Panels provide a convenient way to manipulate a collection of other annotation items, in fact a datazone is a panel although it does have a special status within the annotation system. Panels are created from the **Annotation->Panel** field on the menu, then other annotation objects can be moved into them. A panel can be locked (using the **Panels->Lock** option) which prevents the selection of objects within the panel and means that any operation will be on the whole panel. Panels can be moved by dragging with the mouse and resized by selecting and dragging the edge of a panel in edit mode.

A special type of panel can be selected from the annotation menu ***Annotation->ZPanel****, these are Zone Panels. A zone panel will display parameters which relate to a particular zone display. Please refer to the on-line help text for further information concerning zone panels.*

2.5.1. Datazone

The datazone can only be displayed on a full screen image. It is selected using the **Datazone** field on the **View** menu.

The datazone is normally not part of the annotation system and is therefore not affected by annotation operations. In particular it is not removed when the **Reset** option is selected from the pop-up menu (which removes all other annotation objects from the display). However for the purposes of customising the datazone it can be brought into the annotation system. This is done by selecting **Panels->DZone->Edit** from the menu and results in the datazone becoming a panel in the annotation system. It can then be unlocked (**Panels->Unlock** and select on the panel) to allow its contents to be edited.

A new customised datazone can be created from any panel by selecting **Panels->DZone->Install** and selecting on the panel in question. This operation takes the panel out of the annotation system and saves it in the user directory as the file DZ.ANN. The default datazone file is not overwritten, but any previous user defined datazone will be.

When the datazone is displayed the system looks for the file DZ.ANN in the user directory and if it does not find one there, it looks in the LEO directory for the system default.

Annotation Files

A file of annotation objects can be saved as either a panel, or a complete set of annotation. To save a panel, select **File->Save** and click on the panel to save. A file dialog will then appear to allow the file name to be entered. To save a set of annotation, make the same menu selection, then click on any part of the image. Again a file dialog will prompt for the file name.

There is a small difference between loading panels and sets of annotation. If a set is loaded (by selecting **File->Load**), it replaces any existing annotation (except for the datazone), whereas if a panel is loaded, it is merged in with the existing annotation.

Text Annotation

To add text annotation to an image, select **Annotation->Text** from the pop-up menu. A dialog box then appears which allows annotation text to be defined. The actual text is entered in the scrollable text window, foreground and background colours can be selected, as well as text fonts and styles. It is also possible to add a μ symbol or any other special character available in the selected font.

When the text has been typed select OK on the dialog and the text will appear on the image. To move the text to the desired position, select and drag it with the mouse (move mode must be selected to do this).

If it is necessary to change some existing text, it can be edited by selecting it in edit mode. The text dialog then reappears with the selected text already in the text window.

Special Characters

The μ symbol is probably the most common non standard character required for annotation, so a panel button has been dedicated to it. Selecting this button will insert the μ character into the text string at the cursor position. Other special characters are available from the special character scroll box. The characters are scrolled until the desired character is displayed, then the Insert key is selected to place it into the text string.

Text Attributes

The foreground and background colours for the text can be set by selecting the appropriate colour panel (this does not change the system defaults, only the

current text string). In addition the font and style of the text can be modified. The fonts available are:-

- Leica 29
- Leica 24
- Leica 16
- Arrows 31
- Arrows 25
- Maths 24
- Maths 16

The µ character is only available in the Leica fonts.

Each text string is of a single font. Mixed strings can only be achieved by placing two or more strings of different fonts next to each other on the image. It is recommended that all annotation and measurement is performed in full screen mode (using the large fonts). If quarter screen mode is selected, then the small fonts will be substituted for the large ones, but the proportionate sizing is not exact and may cause the text to change size or position slightly.

The style of the text reflects the way in which the foreground and background colours are used to display text. The different selections available are:-

- Unbacked Normal - Text on a transparent background
- Backed Normal - Text on a solid background colour
- Halo - Text with a transparent background but with a single pixel halo of background colour
- Unbacked Bold - Bold text on a transparent background
- Backed Bold - Bold text on a solid background colour

Pins and Links

It is possible to indicate the area of the image referred to by some text by using pins and links. Both these objects are selected from the Annotation menu. A pin is a round dot which can be placed anywhere on the image. A link is a line which can be attached between any two annotation objects (usually one is a pin). If either object attached to a link is moved, then the link will be redrawn to follow the shortest line between the two objects.

Attributes

Each object displayed by the annotation system has a set of attributes which describe the way in which the object is displayed. For each attribute a default can be set up using the **Attributes->Defaults** menu. When an attribute has been

changed, existing annotations can be made to reflect that change by selecting edit mode and selecting **Attributes->Modify Item** and clicking on the appropriate object. All existing objects can be made to reflect a change by selecting the **Attributes->Modify All** option.

The set of attributes available are:-

- Text Font
- Text Foreground
- Text Background
- Text Style
- Panel Colour
- Line Style
- Line Width
- Line Colour

Clearly some of these attributes only apply to a subset of the objects displayed by the annotation system.

Parameters

A display of any system parameter can be placed as annotation on the image. These options are selected from the **Annotation->Analogue** and **Annotation->Digital** options which each display a list of available parameters. When displayed the parameter's value text is updated as the parameter changes.

Time and Date

In addition to the system parameters, it is also possible to display the time and the date as annotation objects. They are selected directly from the Annotation menu and inherit the same default attributes as annotation text strings.

Zone Magnification

The zone magnification object is similar to the analogue parameter Mag. But unlike Mag it changes its value according to the magnification of the zone it is placed in. Apart from this difference in behaviour, there is no way of distinguishing between the Mag parameter and a Zone Mag object. It is therefore recommended that zone mag objects be used to display the magnification to avoid confusion.

Micron Markers

Two types of micron marker can be placed on the image, fixed and variable. Both types of marker show a line and a length, the line size will change according to the magnification of the image. However the variable marker will change scale according to the magnification, while the fixed one will not.

If multiple zones are displayed, the micron marker will display the magnification of the zone in which its top left corner appears.

Editing a variable micron marker changes the maximum size limit for the line. Editing a fixed micron marker allows its fixed size to be changed. If a fixed micron marker is inserted into a datazone it will be converted to a normal micron marker using base magnification.

Point to Point

The point to point measurement facility consists of a pair of related pointers and a measurement panel and is selected from the Measurement menu. The points are labelled **Pn** and **PnR** where **n** is the number of the instance of the point to point object (it is possible to have multiple point to point objects concurrently).

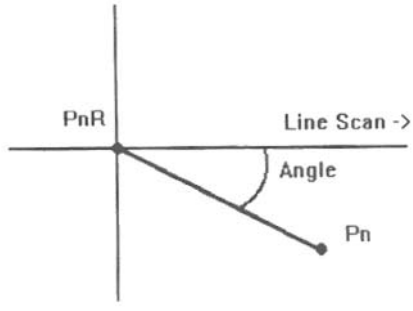


Figure 2.7 Point to Point Measurement Facility

In the measurement panel the distance between the markers is displayed along with the angle of the line joining the markers. The angle is defined as the angle between the line PnR and Pn and the line scan direction, measured in a clockwise direction (see Figure 2.7).

Either point may be moved by selecting and dragging with the mouse, but this method of control has two disadvantages:-

The mouse cursor may cover the area of interest.

2. Very fine control may be required which cannot be achieved with the mouse.

For these circumstances precision adjustment mode is available.

Precision Adjustment

Any measurement marker may be controlled in precision adjustment mode (point to point, linewidth, etc.). It is used in the following way:-

Select annotation edit mode.

Select the object to be moved.

3. Select a *handle* on the selected object and while holding the mouse button down press a keyboard arrow key.

4. Keeping the mouse button depressed, move the mouse cursor away and continue to adjust the position of the marker with the arrow keys.

5. Release the mouse key to end the precision adjustment.

A *handle* is a point associated with an object which allows some property of that object (either its position, shape, size or orientation) to be adjusted in some way. Selecting the object (point 2 above) causes a small square to be displayed on points which may be selected. There is only one handle for each point to point marker which controls its position, other measurement objects may have multiple handles.

The selected object remains selected after adjustment so that further adjustments may be made. To deselect the object press the right mouse button or select "escape" on the pop up menu.

2.5.8. *Linewidth*

When the linewidth selection is made, a rectangle appears with an associated measurement panel which contains the height, width and orientation of the rectangle. The rectangle can be positioned in move mode and sized in edit mode. The handles on the corners of the rectangle are used to rotate it, while the handles on the sides are used to adjust its size. The precision adjustment mode described above is available for linewidth objects.

Graticule and Crosshairs

Graticule and crosshairs are toggled on/off from the **View** menu. A grid of evenly spaced horizontal and vertical lines or intersecting 45° lines in the overlay plane is displayed. The spacing of the lines is user defined from the **View** menu, an appropriate pixel distance is entered between the values of 50 to 512.

Recording an Image

There are three ways of recording an image on the *Stereoscan 440*:-

1 Micrograph on HRRU (if fitted).

2. Image print on a Video Printer (if fitted).

3. Image Save to disk (as a TIFF file).

The last of these is available on all systems, the others require the necessary options to be fitted.

The photo icon provides an interface to all the record methods. In the **File** menu the **Export/Photo set up** option allows the output device to be selected from those fitted. The selection is made by clicking on the **Output to:** field, which displays a dialog box of the available selections. Once a destination has been set up, selecting the photo icon with the left mouse button initiates a record sequence. Selecting it with the right mouse button brings up the appropriate record set up panel.

In addition to the icon, record sequences can be initiated from the **File** menu **Export/Photo** option, while the set up panels can be accessed from the **Set up** option on the Export/Photo set-up panel.

Magnification Calibration

The magnification is defined as the scaling between the size of a pixel scanned on the specimen and the size of that pixel on the final image. Clearly the latter is dependent on the way in which the image is recorded. An image recorded on an HRRU will not be the same size as one recorded on a video printer. The Export/Photo set up panel provides a means of calibrating the magnification according to the user's own requirements.

An output device can be calibrated in the following way:-

1 Freeze a full size image.

2. Select **Calibrate** on the Export/Photo set up panel.

3 Move the markers so that they are well apart.

4 Take a photo (or print).

5 Measure the physical separation of the line on the print.

6. Enter the separation in the calibration panel

The displayed magnification value will then be adjusted for the final image size.

2.6.1. *The High Resolution Record Unit*

If the HRRU is correctly set up, a micrograph can be taken by selecting the photo icon with the left mouse button. The right mouse button on the same icon will display the HRRU set up panel. When a photo record is completed, the camera status returns to idle and a dialog box appears to confirm that the record sequence has finished.

The set up page allows several parameters of the camera, HRRU and film to be set up (some of these parameters are located on the **HRRU settings** submenu).

Camera Image

This can be selected from Stored, Live , Cal Bri or Cal Con. Of these only Stored or Live should be used. A live image is used to take a micrograph which has more pixels (thus higher resolution) than can be held in the image store. For more information on Cal Bri and Cal Con see *Appendix E*, at Section 2.2.

Camera Overlay

When set to **Yes**, any annotation, datazone or other items in the overlay plane will be included with the photographed image. For more information on Cal Bri and Cal Con see *Appendix E*, at Section 2.2.

Film Speed

The film speed in use, 800, 400, 200, 100 or 50 ASA.

HRRU Camera

This sets the type of camera being used, this will affect the magnification value of the final image.

HRRU Brightness and Contrast

These parameters are best set using the grey wedge (from the output LUT set up menu). The brightness should be adjusted until the darkest level is just black and the contrast should then be adjusted until the brightest level is white.

Development Timer

The Development Timer is a simple count down timer which 'Beeps' on completion. The duration (in seconds) can be entered by clicking on the time. The timer is initiated with the start Development Timer button.

Photo Number

The photo number increments each time an image export is performed (regardless of output device). Besides appearing in the HRRU panel, it can also be displayed in the status window or used as annotation. It can be set to a new value by clicking on it whenever it appears.

In addition to the fields mentioned above, the **Photo** and **Abort** photo buttons operate in the obvious way.

2.6.2. Video Printers

The sequence of operation to take a video print is as follows:-

Ensure the video printer is selected as the current output device.

2. Optimise thc brightness and contrast of the image.

3. Apply any noise reduction and freeze the full size image to be printed.

4. Select photo icon with the right mouse button.

5. Set up the required size and orientation.

6. Select OK to initiate the print sequence.

When the record is complete the **Video print to do** field will return to zero. If the settings are known to be correct for the next print, then operations 4 to 6 above can be replaced with a single selection of the photo icon with the left mouse button.

Image Content

The Image, Overlay and PC Plane check boxes on the set up page determine what appears on the final print. The grey data is part of the image, annotation and the datazone are in the overlay plane and the menus are all in the PC plane. A plane will appear in the image if its check box is selected.

One other field is relevant to the image content, but only applies to Monochrome printers. The **As seen** check box will cause the image data to be passed through the display LUT to make the recorded image the same as the displayed image (only the red part of the LUT is used to produce the monochrome output). If the box is not checked, then the stored image will be sent directly to the printer.

Image Orientation

Two orientations of the image are possible, portrait or landscape. Printing an image in landscape format will take slightly longer than portrait. The format used will depend on the printer resolution and the size of the image to be printed.

Image Size

Three options are available for image size. A full size image could be printed (whole image), or a portion of the image (adjustable) using the mouse to position and size the red box which selects the part of the image to be printed. The third selection (best) uses the known resolution capabilities of the installed printer to select the largest possible image which can be displayed at full resolution. Selecting this option will also override the image orientation setting.

Paper Size

The Large Paper checkbox is used to set Large rather than Standard paper size for the CP100, CP210 and CP200BH printers. The setting of this checkbox affects the best resolution image dimensions.

Form Feed

Selecting this checkbox causes a form feed code to be transmitted to the printer following the video print.

It has been reported that in some cases, Mitsubishi P78 printers are affected with a particular problem in which a grey-scale is printed rather than an image. This tends to be associated with the length of time in which the printer is left in standby mode (powered on at the rear, but off on the front panel). The ***solution*** *is as follows:-*

If the printer has been in standby mode for several minutes, the following procedure will prevent the above problem:

1. *Switch the printer on at the front panel. This will enable the "Ready" lamp.*
2. *Switch the printer off and on again immediately, again using the front panel switch.*

The copier is now reset and should not print grey scales.

2.6.3. Saving TIFF Files

Tag Image File Format[1] (TIFF) provides a standard format for various kinds of image files. Images can be binary, grey, grey with a colour palette, or true colour. They can also be of various sizes with additional data stored with the image. It is to enable easy use of *Stereoscan 440* images that TIFF import and export facilities are provided.

TIFF export can be set up as the action taken by the photo icon by setting the **Export/Photo setup** to **File/Display.** In addition the TIFF File Export panel is always available from the TIFF Export option of the **File** menu.

The TIFF Export Panel allows various image parameters to be set up before the image is written to disk. When all the parameters are correctly set, pressing the **OK** button will save the image to disk.

Image Content

The type of file saved is determined by the radio buttons of **Save Binary**, **Save Grey** or **Save Colour**. It should be noted that of these only Binary and Grey files may be reloaded into the *Stereoscan 440*. If grey is selected then the **Palette** option can be selected to save the colour LUT with the image. The **As seen** box may also be selected to save the image after it has been processed by the display LUT, rather than as it is in the image store. The **Reduced** option saves a reduced

[1]Tag Image File Format Specification Version 5.0 - The Aldus Corporation

resolution image which can later be used with the grey directory function on the TIFF import panel.

The **Image, Overlay and PC Plane** fields have the same function as those on the Video Printer set up panel.

If the file type is selected as binary, then the image content is determined by the RGB colour setting. Any pixel in the image which is the colour defined in the threshold will be saved as a binary 1. The RGB levels can be set by typing absolute numbers in to the RGB fields, or by selecting **Threshold** and then clicking on the part of the image which represents the colour to be saved.

The binary condition is determined by the colour on the display. It is possible to set up the display LUT so that several grey levels are mapped onto the same display colour.

When saving a binary file Huffman run length encoding can be applied to reduce the size of the file by selecting the Compression check box. It is stressed that **No** data loss occurs when such encoding is used.

Image Size

The whole image or an adjustable portion of it may be saved. The portion of the image is selected in the same way as for video prints.

Info

When an image is saved the operator may, if desired, save a list of various parameter values to be associated with the image. Select the **Info** option will call up a panel which will allow the operator to create the desired list. This list of parameters will then be associated with all subsequent saved images.

Subsequently, this data can be read by selecting the **Info** option from the **Import Tiff** panel after highlighting the filename of the appropriate image. Alternatively, after importing the image into the frame store, the list can be recalled as annotation by using the **Annotation->TIFF data** option from the **Annot/Meas** panel.

Save State

Clicking on this box will cause a macro of the current operating conditions to be saved at the same time as the image is saved, and with the same name. This macro can then be used to reset the microscope to the conditions that were

current when the image was saved. These macros can be found from the **Tools->Macro** option of the drop down menus and then by selecting **Macro->From Tiff**.

File Name and Directory

The directory in which the image file will be saved is shown on the panel and can be changed with the file dialog selected from the **Change Dir** option. The filename generated for the file is also shown. It consists of a 5 character name with up to 3 digits. The digits are automatically incremented each time a file is saved. A list box of the TIFF files in the selected directory is also displayed on the setup panel.

2.7. Recalling an Image

Unlike the options for recording an image, there is only one way to import an image to the *Stereoscan 440*. The TIFF Import panel is selected from the **File** menu and allows a file to be selected for import as well as controlling the way it is displayed.

*Before an image can be recalled **Freeze** must first have been selected.*

File Selection

The current directory and the list of TIFF files in it are displayed on the Import panel. The required file is selected from this list. The directory can easily be changed using the **Change Dir** dialog.

Image Information

When a file is selected information contained in the TIFF file is displayed, including:-

- The type of image
- The size of the image
- The size of any reduced image saved with it
- The description text saved with it
- Whether a colour palette is present

The only type of TIFF file that cannot be imported is true colour files. Binary (compressed or uncompressed) and Grey (with or without colour palette) can all be imported. If a grey file has a colour palette, it is optional whether the palette is

imported into the display LUT when the file is loaded (click on the **palette** box to import a palette).

Loading Grey Images

For a grey image the only other consideration when loading it is where on the screen it should be positioned. Clearly if it is a full size image then there is no option, but if it is smaller it can either be loaded at (0,0) screen co-ordinates, or at a position defined by moving the red outline with the mouse. The red outline appears when the **Load at 0,0** option is deselected.

*Care must be taken when loading grey images which have been saved with the **As Seen** option. Because the saved image has already been processed by the display LUT, it is necessary to reset the display LUT (to linear) so that the image will appear as it did when it was saved.*

The **Grey Dir** button can be used to display the reduced images of all the grey files in the current directory, then selecting with the mouse on any of the reduced images will load the full image associated with it. Individual reduced images can be loaded with the **Reduced** button.

Once a grey image has been selected and the red outline box has been position (if not at 0,0) then the load is initiated with the **OK** button.

Loading Binary Images

If the image being loaded is binary, then two other fields come into play. Firstly it is necessary to define the binary plane into which the image is to be loaded and secondly the other bits option must be set to the required state. If a binary image is to be loaded with no reference to anything in the image store at present, then the other bits option must be set to **Clear other bits**. If the binary image is to overlay another binary image, then the bit plane must be changed and the other bits option must be set to **Keep other bits**. To overlay a binary image on a grey image select **Grey backed** as the option for other pixels.

In all cases it will be necessary to define a suitable display LUT to allow the binary information to be seen. This process is described in Customising the User Interface.

The Clipboard

The clipboard is a Windows$_{TM}$ feature which allows information to be copied or cut to it and pasted from it. Many Windows$_{TM}$ applications make use of it to exchange data. The *Stereoscan 440* makes use of the clipboard for the following purposes:-

To import certain types of image data from other applications.
To temporarily store part of an image.

The **Clipboard** option is selected from the **File** menu. Its appearance is similar to the TIFF import and export panels with many of the fields being common. The actual operation is defined by the Copy Grey, Copy Binary and Paste buttons.

2.8.1. Copying to the Clipboard

The following procedure copies a portion of the image to the clipboard:-

- Freeze the image
- Select image type (Copy Grey or Copy Binary)
- Select portion of the image with red outline (or select Whole Screen)
  Select OK

The selected area of the image is then copied into the clipboard. If Overlays or PC Plane options are selected, then the relevant data is merged with the image as it is copied. The format of the data put into the clipboard by the LEO user interface is application specific and therefore cannot be read by other applications.

Pasting from the Clipboard

Grey image data can be copied from the clipboard by selecting Paste on the Clipboard panel. The position for the past can then be adjusted with the mouse before selecting OK to copy and therefore cannot be read by other applications.

The clipboard contents will be determined by the last copy (or cut) made to the clipboard by any application. If the format of the data is not supported by the *Stereoscan 440*, the OK button will be disabled when Paste is selected. The following types of image format are supported:

Monochrome as a binary image
4 bit grey as a grey image (as bits 4 through 7, other bits cleared)
4 bit planes as a grey image (as bits 4 through 7, other bits cleared)
8 bit grey as a grey image
8 bit planes as a grey image
24 bit colour as a pseudo colour image

If the format of the data in the clipboard is supported the Paste function will be available.

Advanced Operation

Having now become familiar with the *Stereoscan 440* controls, sample insertion and basic micrography the operator may find that there are still a number of effects limiting image quality. This section describes some of these effects and ways to reduce them. Complete elimination of all problems is often impossible, and a compromise is usually reached. In order to get the best results from the *Stereoscan 440* it is important to consider the following:-

- Instrument familiarity
- Photographic considerations
- Choice of instrument parameters
- Specimen charging
- Specimen preparation

These factors are treated separately below. In addition the ways in which the user interface can be customised to meet the individual user's needs are described and finally a section on troubleshooting is included.

Instrument Familiarity

To get the best results from the *Stereoscan 440* it is important to be familiar with the operations described in this document. If possible attend a Leica Cambridge operators course which can be arranged by your local Leica representative listed in Appendix D of this Manual.

Photographic Considerations

A good micrograph is sharply focused, free of astigmatism, noiseless, with optimum contrast and brightness. These factors are very user dependent but are easily achieved with a little practice. Setting image levels correctly results in an image which is better looking and more readily interpreted. Understanding how to manipulate grey levels allows tailoring of images for specific purposes.

The camera and record CRT or video copier/printer should be correctly calibrated and the signal waveform should be evenly distributed between the upper and lower video level markers, nearly spanning the range but never going outside the limits set by them. Try to select the profile scan position on the image to span the brightest and darkest areas to give a representative sample of grey or video levels. The display look-up table editing facility can be used to create a 'visual' exposure meter that clearly indicates lower and upper levels in the grey scale. This is a modification of the display look-up table, where the black level is changed to blue and the white level changed to red. Hence, an image containing

a good grey scale range will just begin to show areas shaded blue and red. With this look-up table active, areas of too low a signal show blue whereas areas of too high a signal show red. See Section 3.7.1 *The Display LUT Editor.*

Other forms of display LUT can be used to enhance the contrast or adjust the brightness of the frozen image.

Many samples exhibit a small amount of charging due to oxide layers or other surface coatings. These samples show changes in signal level and contrast with scan speed. For live micrographs of these samples, the signal should be set up using a scan speed similar to that to be used for the photograph. The image store is particularly useful, as it can be used to save film by allowing the image to be acquired and checked before photographing it. Also, many identical prints may be taken without the need to scan the sample again.

3.3. Choice of Instrument Parameters

Instrument parameters have a large effect upon the final image quality. To some extent the parameters chosen are dedicated by the sample and its interaction with the beam. For each different specimen, some experimentation will usually be required before arriving at the optimum conditions. Having achieved these conditions, they may be saved on disk (as a Macro file) for future reference, see Section 3.7.2 *The Macro Editor.*

3.3.1. Accelerating Voltage (EHT)

The accelerating voltage, or beam energy, is one of the most important factors in achieving a satisfactory sample examination. It will affect:-

- Damage to the specimen by the beam
- Visible surface detail
- The production of X-rays for analysis
- Image resolution

In determining the accelerating voltage, the following factors must be considered:-

Beam Damage

If the specimen is beam sensitive, a higher accelerating voltage will result in a greater risk of the sample being damaged by the beam. This can introduce artefacts into the image which may appear as cracking or darkened areas in the image. The cause of this phenomenon is a localised heating or ionisation of the specimen in the area of examination, hence the problem worsens as the magnification is increased. Beam damage can also be the result of using too

high a probe current, thus the accelerating voltage and probe current should both be adjusted together to determine the optimum settings. This problem is usually exhibited by low atomic weight specimens such as plastics or biological samples. Coating the specimen with conducting film such as gold often helps to dissipate the heat generated by the beam. However, better results are usually obtained by operating at lower voltages. A beam-blank facility is provided on the *Stereoscan 440* so that, for sensitive samples, electron beam exposure can be minimised.

Surface Detail

The accelerating voltage of the electron beam directly affects the amount of surface detail seen in the image. This is most easily understood by considering the simplified beam-specimen interaction volume shown in Figure 3.1.

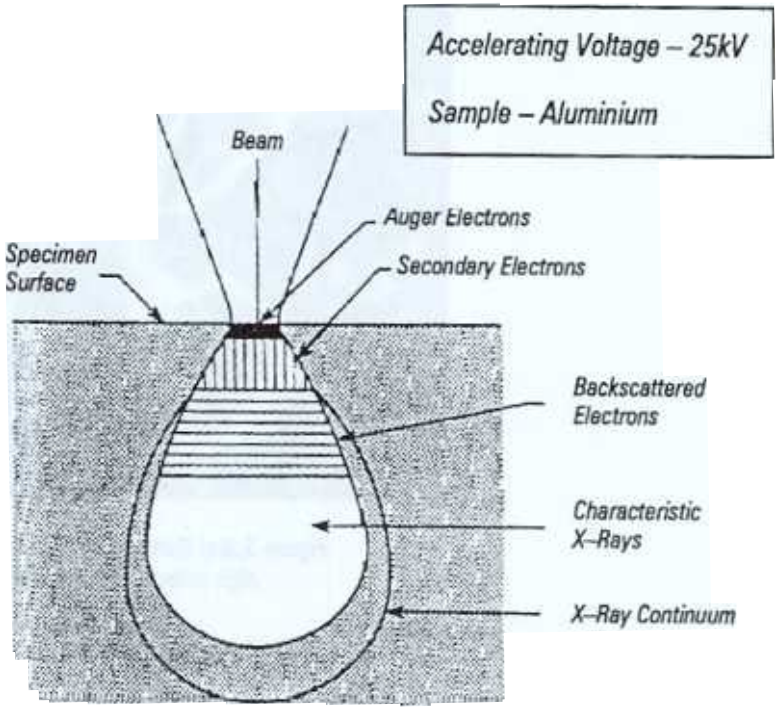


Figure 3.1

The zone of primary excitation increases in depth and diameter with a high accelerating voltage. Backscattered electrons which are generated mainly beneath the specimen surface possess enough energy to ionise one or more specimen atoms before escaping from the specimen surface. Each of these ionisations produces more secondary electrons which are added to the true secondary electron signal and result in a loss of surface detail. The use of too high a voltage also results in parts of the sample exhibiting very bright edges. The 'edge effect' is caused by the electron beam completely penetrating the edge of the feature, so that secondary electrons are produced from a larger effective surface area, see Figures 3.2(a) and 3.2(b) below.

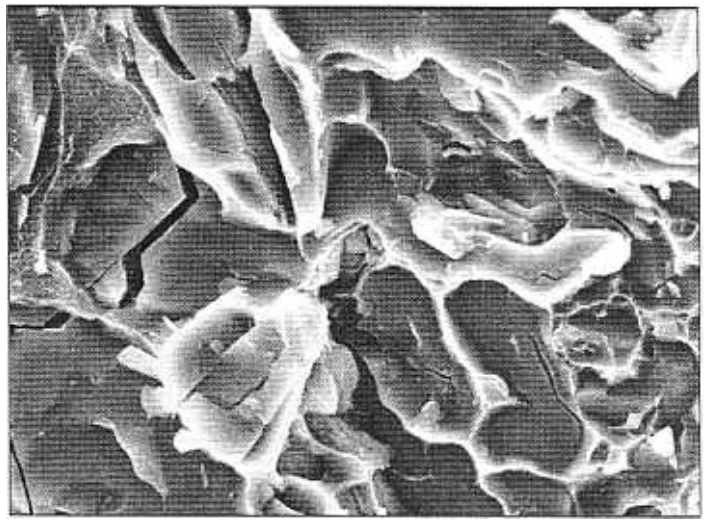


Figure 3.2(a) Sample of fractured aluminium at high voltage showing edge effect

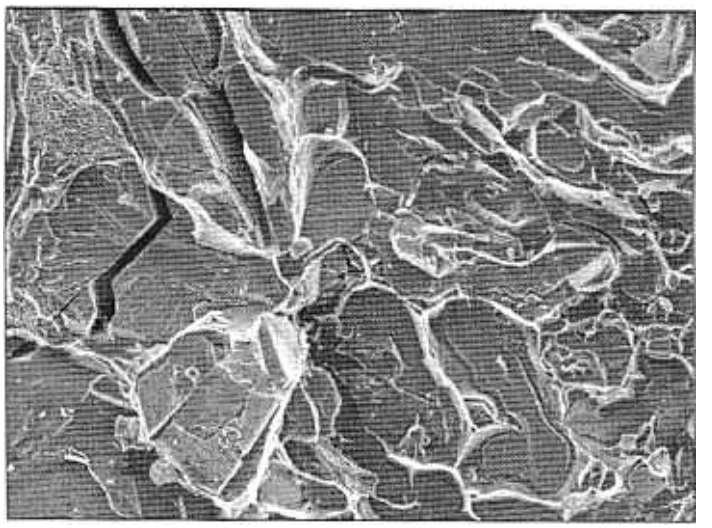


Figure 3.2(b) Sample of fractured aluminium at low voltage without edge effect

X-Ray Analysis

The production of X-rays from the specimen is caused by the removal of an electron from one of the atom's shells and the subsequent re-arrangement of the remaining electrons. The initial removal of an electron is caused by the primary electron beam, therefore the beam energy must be sufficient to overcome the binding energy of the electron to be removed. X-rays may be emitted as a result of ionisations within any of the electron shells - K, L or M and are then termed, K, L or M X-rays. The energy required to stimulate a particular X-ray is known as the critical energy, therefore if the energy of the primary beam is less than the critical energy, no X-ray is produced. Thus, for example if analysis for iron is required, then the beam energy must be at least 6.4KeV (to produce an iron K peak). In fact, for ideal analysis (especially quantitative) the accelerating voltage should be 1.5 to 2 times the critical energy of the highest energy peak to be analysed; this is known as the `overvoltage'. Samples that charge, or are non-conducting should be coated with a suitable material chosen to give electrical and thermal conductivity, but not to interfere with the elements specifically being analysed. For example, if carbon is the element of interest in the spectrum then it would not be a good idea to coat the sample with carbon. In this case, aluminium would be better because it has a sufficiently low atomic number not to attenuate too much of the carbon signal (whereas coating with gold probably would).

Resolution

Resolution can be defined as the minimum distance by which two adjacent features can be seen to be separated, as two discrete points. The best resolution is usually obtained at high accelerating voltages since the shorter wavelength of electrons at high voltages minimises any diffraction.

Other instrument parameters also significantly affect the resolution achievable including Probe Current, Working Distance and Aperture Size.

Probe Current

The probe current is defined as the total electron current reaching the specimen surface. The value can be adjusted from the user interface in the range 1pA to 1μA. In most cases, a value of 100pA gives a good video signal without over exposing the sample to electron bombardment. Other settings would be as follows:-

High Resolution:	5pA to 25pA
Backscattered electron imaging:	200pA to 500pA
X-Ray analysis:	600pA to 1nA
Charge or beam sensitive samples:	10pA to 20pA

The improved resolution performance at low probe currents is achieved because the diameter of the beam on the specimen is reduced. A larger beam diameter is acceptable for X-ray analysis because of the larger volume of interaction (see Figure 3.1).

Working Distance

Working distance is defined as the distance in millimetres between the bottom of the lens and the sample surface. In common with many of the other SEM parameters, choice of working distance for the specimen may have to be a compromise. The factors to be considered are:-

1. As the working distance is decreased the available resolution increases. The optimum position is in the range 3 to 10mm.

2. If a large sample is to be examined and there is a danger of contact with the BSD or lens, it is wise to use a longer working distance.

3. The retractable backscattered electron detector occupies a finite space beneath the final lens. All parts of the sample should therefore be just clear, particularly when the detector is to be moved in or out of position. A safe working distance is 12mm.

4. The geometry used for X-ray analysis, at a 35° take-off angle, dictates that the surface to be analysed should be at a working distance of 25mm.

5. An improvement in depth of focus, the vertical distance over which the sample appears to be in focus, can usually be made by increasing the working distance. An increased working distance has the effect of decreasing the angular aperture of the electron beam. (See Figure 3.3)

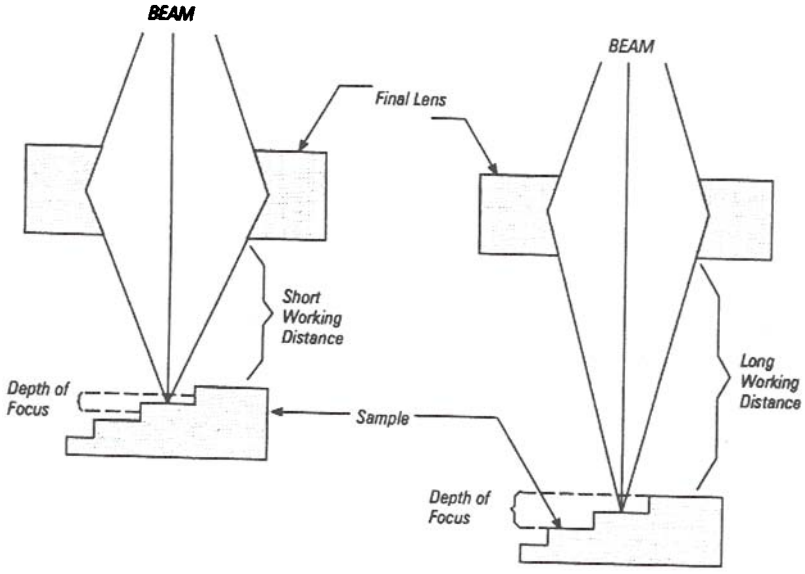


Figure 3.3 Enhancement of Depth of Focus

Item 5 above directly conflicts with item 1. However, improvements in depth of focus are usually required at relatively low magnifications where the minimal loss of resolution caused by using a longer working distance would not be noticed. Depth of focus can also be improved by using a smaller aperture, say 30µm or 20µm, or by selecting *Optibeam* depth of focus mode. This selects the lens settings which give the greatest depth of focus while maintaining the selected probe current.

Specimen Tilt

Tilting the specimen can greatly affect the SEM image, not only by changing the area excited but also by altering the zone of secondary electron emission. The size of this zone varies with the angle at which the primary beam strikes the specimen. When the specimen surface is perpendicular to the beam, the zone from which secondary electrons are emitted is smaller than when the specimen surface is tilted. Since more secondary electrons are emitted, the tilted surface gives a brighter signal. Tilting in the range 20 to 40° gives the best result. Very often, a small amount of tilt adds some depth to the final image which gives more visual appeal than a flat image.

Other Parameters

In addition to the parameters mentioned previously, the following should all be checked:-

Electron gun correctly aligned
Stigmators correctly adjusted

- Aperture centred
- Correct film speed selected
- Gamma and derivative as required

3.4. Specimen Charging

Electrons incident upon the sample which do not escape as backscattered or secondary electrons are absorbed by the sample. Unless these absorbed electrons can find their way to ground (as in a conductive sample) they will remain in the sample resulting in a negative charge build up exhibited as one of the following image defects:-

- Loss of image contrast (see Figure 3.4)
- Very bright or dark areas (see Figure 3.5)
- Image or beam shift (shearing) (see Figure 3.6)

Dust and other debris on the sample surface can also charge up, and appear as a bright area on the image surrounded by a dark region. The charged debris may deflect secondary electron emission and sometimes the incident beam, causing dark region and possibly image 'shearing' (see Figure 3.6). If the sample itself is charging, beam deflection will occur during scanning, the effect being seen as a slow image drift followed by a jump back to its original position.

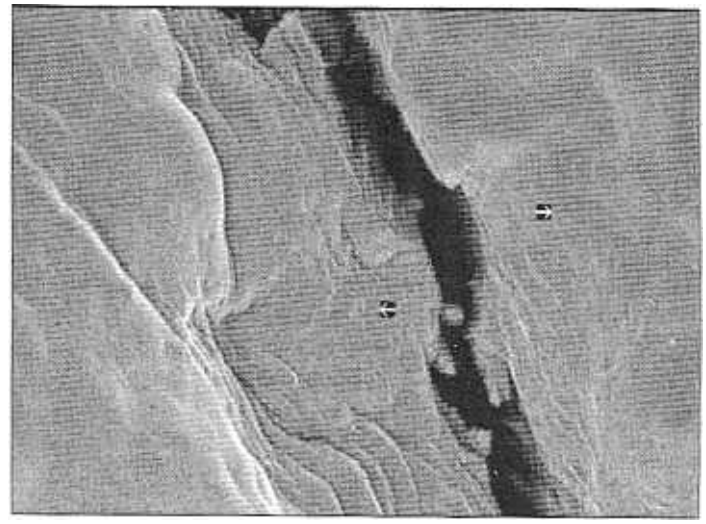


Figure 3.4 Loss of Contrast Due to Charging

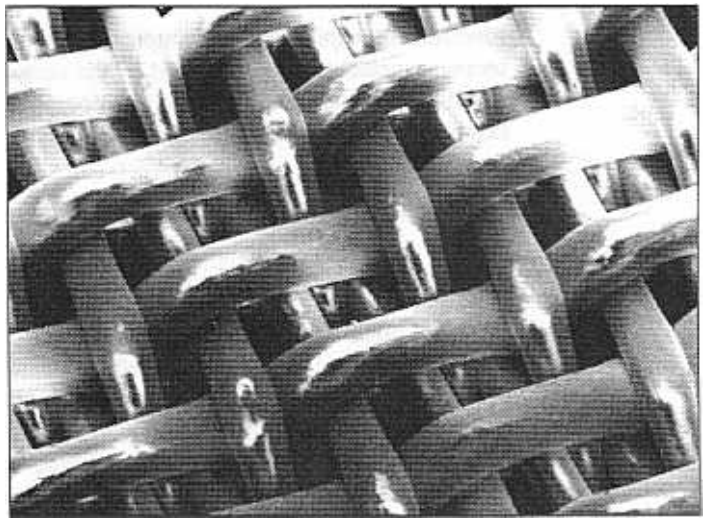


Figure 3.5 Bright/Dark Areas Due to Charging

Specimen charging of non or badly conducting specimens is dependent on the charge equilibrium inside the sample. The secondary electron yield (S) is defined as the number of secondary electrons which leave the sample for one incoming primary electron. The corresponding number for backscattered electrons is the backscatter coefficient (B). If the total electron yield T=B+S equals 1, the charge balance is zero and therefore no charging occurs. If T increases above 1, the sample should charge up positively because more electrons leave the sample than primary electrons enter it. If T falls below 1, the sample will charge up negatively. One of the most important parameters for changing the total electron yield T is the primary beam energy. This is shown in Figure 3.7 which shows the typical dependence of T on the primary beam energy Eo. If the primary beam = Ec_2, then no specimen charging occurs. Typically, Ec_2 lies between 500eV and 2KeV.

Figure 3.6 Image Shearing Due to Charging

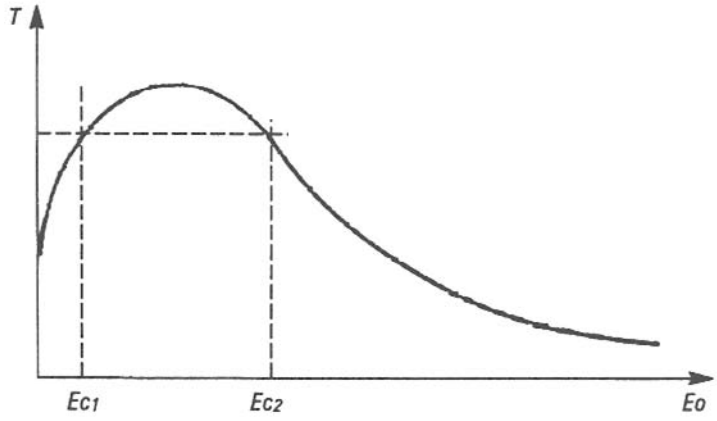


Figure 3.7 Relationship Between Primary Energy Eo and Total Electron Yield T

The total electron yield can also be increased by tilting the specimen. A tilt in the region of 20 to 40 will greatly reduce charging.

The other most important factor affecting charging is electron "dose rate". This can be defined as the total number of primary electrons per unit area of the specimen as a function of time. In other words, the scan speed of the beam is critically important. It can be seen that on some beam sensitive materials a fast scan speed gives a good screen image with good contrast and topography (see Figure 3.8(a)) whilst a slow scan speed, ie for live photography, (see Figure 3.8(b)) causes the image to display the defects mentioned previously. The following diagrams illustrate this effect.

Figure 3.8(a) Taken at a fast scan speed
The above shows a sample of Ceramic

In this case, the image store can be used to acquire the image, with noise reduction if necessary, at a fast scan speed. The stored image can then be photographed or stored to disk.

Figure 3.8(b) Taken at a slow scan speed
The above shows a sample of Ceramic

3.5. Specimen Preparation

Specimens which are studied in the SEM can be divided into two main categories, namely conductors and non-conductors. Factors to consider during specimen preparation are given below:-

The size of the specimen must be reduced (if necessary) to fit the available specimen holders and specimen stages, but there is often an advantage in selecting an even smaller sample size for ease of observation.

2 The object must be able to withstand being in the high vacuum of the SEM; it must not change its shape, and it must not outgas. A cold stage may help here.

3. It should be clean, ie free of dust, oils and greases. (Their presence can lead to charging and contamination effects.)

4. It may be treated to improve the secondary yield if this is low, eg coating of the sample with gold.

5. Any disturbance in the surface structure caused by preparation procedures should give rise to surface details which are too fine to be resolved at the magnification used to record the images.

6. If an artefact is suspected as a result of a preparative procedure, a control specimen should be utilised.

7. The specimen stub should be in good electrical contact with ground potential.

8. There should be good electrical contact between the surface of the specimen and the specimen stub, ie attach sample to stub with conducting paint such as Silver-Dag and coat the specimen adequately if necessary.

9. The specimen stub should give rise to as few backscattered and secondary electrons as possible. Aluminium stubs are normally used, although carbon stubs are used for some X-ray microanalysis applications.

10. Very small particles are best mounted on a low mass foil to give rise to minimal background signals, eg nylon film stretched over an aluminium ring.

11 The sample must be attached to the specimen holder (stub) so that it does not move whilst being irradiated by the electron beam.

12 The sample should be attached to the specimen holder (stub) so that all the surface can be studied using the existing stage movements (eg tilt, rotate, X, Y, Z).

Conductors

These fall into two groups:-

- Metallic: these are generally excellent conductors and need no preparation
- Semi-conducting samples with a resistance of less than 10^{-10} ohms can be examined without special preparation

Non-Conductors

This group includes all samples which are not electrically conducting, eg those generally not containing volatiles, eg fibres, plastics, polymers, semi-conductors with a resistance greater than about 10^{-10} ohms.

Those generally containing volatiles, eg biological and botanical material

Non-Volatile, Non-Conductors

If it is not possible to obtain suitable resolution by using a low accelerating voltage and leaving the sample uncoated, then the following applies:-

For most non-conductors which contain no volatile components, eg water, that would outgas in the vacuum system it is sufficient to coat the sample with a thin layer of conducting medium such as Au, C, Au/Pd, Al etc. This layer is typically 20-30nm in thickness. There are several reasons for this coating:-

- Increased conductivity of the sample, thus minimising sample charge up, which results in deflection of the incident beam and severe degradation of the final image. (see Section 3 .4 *Specimen Charging*)
- Increased mechanical stability of the sample due to increased heat condition.
- Increase in primary and secondary electron emission.
- Decrease in beam penetration, resulting in better spatial resolution. The two important current techniques of applying a coating are vacuum evaporation and ion sputtering.

Gold is generally used for the following reasons:-

- High secondary emission co-efficient.
- High conduction of electrons and heat.
- Does not oxidise.
- Good granularity of evaporated or sputtered particles.

Carbon coating by evaporation is generally used if X-ray microanalysis is to be undertaken on the sample unless, of course, the element under investigation happens to be carbon. Aluminium could be used in this case.

More recently Pt/Pd and Au/Pd have been used since their granularity is smaller. Aluminium can also be used, but it has low mechanical strength and can oxidise.

Non-Conductors (Volatile)

Biological and botanical samples, by their nature, require relatively more complex preparation procedures. The samples fall into two main categories: a) hard, b) soft.

a. **Hard samples (eg bone, teeth, wood).** These, if necessary, can be washed to remove extraneous fluids such as blood and mucus, dried in air and coated in the normal way.

b. Soft Samples

• **Untreated** - Soft tissue needs more specialised treatment. Most soft tissue contains up to 90% water which must be removed without altering the structure. If this is not done, there will be difficulty in achieving adequate vacuum in the SEM, and complete or partial sample collapse and distortion will occur.

Some botanical specimens can be observed successfully for short periods provided that thought is given to the selection of instrument parameters, eg using a low accelerating voltage and beam current.

• **Replication** - Although it is usually only adequate for low magnification work and for comparatively simple surface topography, replication has the advantage that the sample can be totally preserved. One method of replication uses an elastomeric material such as silicone rubber to obtain an impression. A positive replica is then obtained from the impression by coating it with low-viscosity polymethylmethacrylate solution, allowing this to dry and then stripping the resultant film away. Coating and examination follow in the usual manner.

With suitable modification, transmission electron microscope replication techniques can be utilised.

• **Chemical Pre-Treatment** - This technique involves chemical fixation of the material to strengthen the tissue. There is a large range of chemicals used in this process (eg glutaraldehyde and osmium tetroxide) and there are numerous publications discussing the benefits of each. After fixation, it is necessary to displace the water in the sample by a solvent to aid drying. The method must be such that the specimen suffers no physical change. The commonest drying agent used is a series of ethanol/water mixtures through to 100% ethanol. Having replaced the water present in the sample there is a choice of three methods for drying:-

i) Freeze Drying
This is a complicated procedure, and may not be too successful. The sample is quench-frozen and maintained at low temperature (about -130°C) until the sublimation process is complete.

ii) Air Drying
It is worthwhile first transferring the specimen to a solvent of low volatility (eg amyl acetate) as the last stage of dehydration.

The solvent is then allowed to evaporate from the sample under carefully controlled temperature conditions. As this is a gentle process, there is little chance of any specimen damage.

iii) Critical Point Drying
The specimen is dehydrated as previously described and the solvent replaced with a liquified gas in small pressure vessel. The vessel is then heated to above the critical temperature of the selected gas. Under these conditions the liquid and vapour phases have the sample physical properties, so that on venting, the liquid vapourises across cell boundaries and therefore minimum sample distortion occurs.

The sample may however, undergo some mechanical shock during the venting stage. The choice of gas for this process is limited by the number of available gases which have a critical temperature relatively close to ambient, a safe pressure level and low toxicity, whilst at the same time being completely miscible in all proportions with the solvent selected in the final stages of dehydration. It is important to replace the solvent completely with the liquified gas (usually carbon dioxide) before venting.

General Considerations
The methods described above for soft tissue preparation are mainly for secondary electron imaging. The problems facing the biologist or botanist who wishes to undertake X-ray microanalysis are different in that the requirements in this case are to maintain the element(s) of interest in their original position in the sample. There is not one major preparative technique for biological/botanical samples. Where possible, several combinations should be tried for a particular type of sample, giving prime consideration to the information sought. Once a technique has been established, instrument parameters and specimen coating methods must be carefully considered.

Using the Digital Image Store

Noise

The image store of the *Stereoscan 440* is particularly useful in situations where use of poor signal-to-noise conditions is forced. In these circumstances, noise can be removed from the image before photography. For example, samples that exhibit charging often require the use of a very small probe current. Noise arises from the electronics of the video system and gives a grainy appearance to the

image. This occurs in situations where there is little signal detected from the specimen and the photomultiplier gain (or amplifier gain for BSD) is increased to compensate. A low signal can be the result of a small electron emission co-efficient of the sample or of the choice of microscope operating conditions, eg low probe current. The amount of signal compared to the noise content is known as the signal to noise ratio.

3.6.2. Noise Reduction

Prior to the use of digital techniques the only way to reduce the noise in the signal was to use a slower scan speed. This allows the beam to dwell longer on each scanned point of the specimen so that more signal is collected. Digital methods of noise reduction utilise the fact that the noise is random in nature. If the signal from a single specimen point is sampled repeatedly and the average taken, noise will be averaged out and the signal will be reinforced.

On the *Stereoscan 440* the concept of scan rate is replaced by pixel averaging. The pixel average parameter determines the number of times each pixel is sampled with the average making up the signal to the image store. Increasing the pixel averaging has an effect similar to using a slower scan rate (thus the image takes longer to acquire, but will have less noise in it). Reduced raster mode does not change the pixel averaging, but does reduce the cycle time (the time taken to perform an image acquisition) which makes adjusting certain parameters easier.

Additional noise reduction of two other types may be applied.

Frame Average

When frame average is selected the live signal is proportionally mixed with the store signal so that the image reflects the average of the recent frames. The proportion of live to stored can be adjusted with the parameter N which represents the number of frames to be averaged. Frame average can be selected with any level of pixel average, but is generally most useful at the faster speeds (lower pixel average) where a larger amount of noise reduction can be obtained without introducing a long cycle time.

Line Average

Selecting the line average causes each line to be scanned a number of times before the scan moves on. The average line signal is stored and displayed.

Choice of Technique

The decision as to which noise reduction technique is to be used will depend to some extent on the specimen being imaged. If it is sensitive or prone to charging then frame average may well be the best option because the beam does not dwell at one place for a long period of time. Line average is used when the result of the noise reduction needs to be seen without waiting for the cycle to complete. Increased pixel average is most useful when doing live photo records (where the image goes directly to the HRRU without being processed in the image store).

On the Noise Reduction panel there are two options for freezing the store. **At End** is used to freeze the store when an acquisition cycle completes, whereas **Now** causes the image to freeze as soon as the button is selected.

Customising the User Interface

Careful thought and design has gone into producing a user interface which meets the requirements of *Stereoscan 400* users. However it is recognised that user requirements are so diverse that it is impossible to provide one interface which meets every requirement. Therefore several features are provided which allow the user to customise the interface to meet their individual needs. The following parts of the user interface can be customised:-

- The display look up table (LUT)
- The action of function keys F5 - F8 (Macros)
- The status display
- The appearance and operation of the tool bar

The Display LUT Editor

The display LUT editor provides a mechanism for altering the mapping between the grey level in the image store and the way in which the pixel is displayed on the monitor. The LUT is really three LUTs in one, a mapping exists for each video colour (Red, Green and Blue). If these three mappings are the same then the image will appear as monochrome (grey) on the monitor.

There is one important rule to bear in mind when editing LUTs, which is

Each grey level must have one and only one LUT value.

It is however permissible for several grey levels to be mapped onto a single colour (or shade), in fact this is one of the more useful features of the display LUT.

The LUT Editor

The display LUT editor is selected from the **Edit** menu. Its own menu provides option for both grey and colour LUTs as well as facilities for loading and saving LUT files. Before considering the menu options in detail it is necessary to understand the concept of a LUT, as seen by the system.

A LUT is a collection of **points** which are connected by **arcs**. The simplest LUT has just two points (0,0) and (255,255) connected by a straight line. Various operations can be performed on points (they can be **added, moved** or **deleted**), other operations are performed on arcs (actually on the two points defining an arc) including **level** and **threshold**.

In the LUT editor, the middle and right mouse buttons have a special meaning The middle button is used to select the colour being adjusted (when editing a colour LUT). The right button is used to select between **move, add** and **level** modes, which determine the operation on the points.

Move
When in move mode, selecting a point in a LUT allows it to be moved. A point can be positioned anywhere on the vertical scale, but must lie between its neighbouring points along the horizontal scale. It is always the point nearest to the cursor when the left mouse button is clicked which will move.

There is one further restriction required to ensure the LUT remains consistent, that is the two end points of the LUT can only be moved vertically.

Add
On a click of the left mouse button a point will be added at the cursor position. The LUT curve will be redrawn so that the point is included at its proper place. Note that point delete mode can only be selected from the **Points** menu appearing in the **Grey** and **Colour** options.

Level
In level mode, a click on an arc of the LUT will cause that arc to become horizontal. This is accomplished without moving the end points of the arcs either side of the selected arc, so it is sometimes necessary to introduce a new point at either end of the selected arc. Once the arc is horizontal it can be dragged upwards or downwards to the desired level.

A similar function exists for the vertical steps in the LUT curve, that is the **Threshold** function which can be selected from the **Points** menu. It allows a step in the LUT to be moved left or right.

Other Menu Features

The display of the LUT diagram can be scaled as 1 or 2 pixels per grey level in the horizontal scale. This is done with the **Scale** menu option.

The **Reset** menu option should be used with care. It will replace the existing LUT with the default linear grey LUT. Although **Reset** appears in several menus, its operation is always identical, with one exception - when it is selected from the **Colour->Points** menu, only the currently selected colour is reset. In all other cases the entire LUT is reset to linear.

When setting up a LUT it is sometimes useful to refer to the grey level of an area of the image, the **atPoint** function allows this. Selecting atPoint displays a line cursor on the LUT profile. Then when the mouse is clicked on a point of the image, the grey level at that point is reflected by the position of the line cursor.

There is one further feature which is often helpful in setting up LUTs, that is the **Grey Wedge** option on the **Grey** menu. If the store is frozen, this option can be selected to fill the store with a grey slope image (black on the left, to white on the right). This image clearly shows the effect of any changes to the display LUT in either grey or colour mode.

Colour LUTs

Colour LUTs can be set up to achieve a variety of effects. It is possible to have a normal grey LUT, with a different colour set up for the low grey levels, to achieve a background effect for an image. A blue/red LUT for the low and high grey levels (described earlier in this chapter) may be useful for setting brightness levels, the operations to set it up are described below as an example.

A high/low limit LUT:-

1. Select Red colour (middle mouse button)
2. Select Add Point mode (right mouse button)
3. Add a point on the red line at the lowest grey level required (using grey wedge and atPoint if necessary)
4. Add a point at the highest grey level required
5. Repeat the above steps for green and blue
6. Select Level mode (right mouse button)
7. Select blue (if not already selected)
8. Select the low arc (between 0 and the low point)
9. Move the blue level to maximum (highest point)
10. Select the high arc
11. Move the blue level to minimum
12. Select Green
13. Select the low arc

14. Move the green level to minimum
15. Select the high arc
16. Move the green level to minimum
17. Select Red
18. Select the low arc
19. Move the red level to minimum
20. Select the high arc
21. Move the red level to maximum
22. Save the LUT as points or a LUT if required (see Saving and Loading LUTs)

Monochrome LUTs

Monochrome LUTs operate in two distinct ways. *Points* mode is similar to colour LUTs, *Formula* mode is an entirely different approach. In points mode the LUT consists of a series of points connected by straight lines, but in formula mode an equation is used to calculate the grey level at any given point. In this mode changes to the LUT are made by changing the coefficients of the LUT equation. Different equations are used for the different types of control required. The equation can be either **Brightness and Contrast** or **Gamma**. In addition to these the whole grey profile can be inverted with the **Invert** option (only available in formula mode), and plotted on the LUT display with the **Plot** option.

Brightness and Contrast
When **Brightness** or **Contrast** is selected a scroll bar appears at the bottom of the display LUT window. For brightness it controls the vertical position of the curve, for contrast the slope of the curve is adjusted. The effect of these controls is similar to the signal level brightness and contrast controls and can be used to adjust the overall appearance of the image. The LUT is determined by the straight line equation:-

$$y = ax + b$$

where **a** is the contrast and **b** the brightness. Any point which is less than zero is set to black and any point exceeding 255 is set to white.

Gamma
The **Gamma** option allows the LUT to be defined as a curve. The gamma parameter can be adjusted either way from a straight line so that the LUT can be made to expand the low or high grey levels. This function can be used to enhance an image where a large amount of detail is contained within a few grey levels.

Points and Steps
In addition to the formula mode monochrome LUTs, it is possible to use a monochrome LUT in points mode (in the same way as colour LUTs). Points can be added, moved and deleted in the same way as for colour and the level and threshold functions are also available.

One further function is defined for monochrome LUTs, the **Steps** function. When steps is selected, the LUT is turned into a monotonic series of grey level steps. The height of each step (**Amplitude**), the position of the first step (**Offset**) and the number of steps (**Period**) can all be adjusted. It is also possible to subsequently modify the LUT using the point functions.

Saving and Loading LUTs

The are two ways of saving and loading LUT files. A LUT can be saved as a series of values (one for each grey level), or it can be saved as a series of points. Both types of LUT can subsequently be reloaded, but only a points file can be modified after it has been reloaded. Points and LUT files have different default extensions, .OLT for LUT and .DLU for points files.

Monochrome LUTs defined in formula mode can only be saved as LUT files.

3.7.2. The Macro Editor

A macro is a sequence of instructions which can be executed by the user to achieve a specific result. Macro execution is initiated in several ways:-

- From icons
- By panel buttons
- By function keys
- When restoring conditions

In addition it is also possible to edit, load and save macros and macro libraries. It is also possible to record a sequence of user instructions to generate a macro.

Each macro has a name which is displayed on the right of the toolbar while the macro is executing.

Macro execution may be terminated by pressing the **Esc** on the keyboard or by clicking on the macro name in the toolbar. Execution can be suspended by use of the keyboard **Pause** key. A paused Macro is indicated by the **!** character before the macro name in the toolbar. The macro may be resumed by a second selection of the **Pause** key.

Instructions

The following types of instruction can be used within macros:-

Calls
A call instruction executes another installed macro. The maximum nesting level of calls is 5.

Comments
A comment provides the user with the ability to annotate a macro and performs no action when executed.

Commands
A command executes a specific SEM command. If the command is disabled, the macro will not step on to the next instruction.

Set Digital State
Sets the specified digital parameter into the defined state. It will not step on to the next instruction if the parameter is currently disabled.

Set Analogue Value
Sets the specified analogue parameter to the defined value. If the value is outside the parameter's allowed range, then the parameter will be set to the nearest limit. It will not step on to the next instruction if the parameter is disabled.

Set Co-ordinate Value
This instruction performs the same action as *set analogue value* except that it sets the value for a pair of parameters making up a co-ordinate pair (x and y).

Stage Goto
This instruction moves the stage to the defined X, Y and Z co-ordinates. It does not step on to the next instruction if stage movement is currently disabled.

Wait For
The wait for instruction waits until the specified state is achieved. An optional timeout parameter may be specified (in seconds) which limits the amount of time the instruction will wait. If no timeout parameter is specified (not zero seconds, but no characters) then the instruction will wait for the state indefinitely.

Delay
This instruction waits for the specified number of seconds before continuing.

Pause
The pause instruction acts in the same way as the pause key. It causes the execution of the Macro to be suspended.

Confirm
This instruction check that the instrument configuration matches the defined configuration. If the configuration is different, the user is given the option of continuing the execution or aborting the macro.

Message
The defined text is displayed in a dialog box until the user clicks on the **OK** button. Execution of the macro then continues.

Show/Hide Panel
The show and hide panel instructions are used to display and remove panels to and from the screen.

Load Display LUT
The load display LUT instruction loads the display LUT from the specified .OLT file. When this instruction is inserted into a macro, the current display LUT is used to generate a file and the user is prompted for a filename.

Function
Performs one of the set of specially defined actions if the appropriate licences are installed.

Control Structures

There are two types of control structure provided:-

While
If then

While Constructs
The While construct allows a series of instructions to be repeatedly executed while the specified condition is true. It takes the form:-

While <condition> (alternatively While Not <condition>)
other statements
End While

While Statement
The While statement is part of the While construct. If the condition defined is true then the next instruction in sequence is executed, otherwise execution continues after the End While statement.

While Not Statement
The While Not statement is part of the While construct. If the condition defined is false then the next instruction in sequence is executed, otherwise execution continues after the End While statement.

End While Statement
The End While statement is part of the While construct. When this function is executed it resets the statement counter to the corresponding While or While Not statement. Each While or While Not statement must have one and only one End While statement.

If Constructs

The If construct allows selection of the appropriate set of instructions based on a condition. It takes the form:-

> If <condition> (alternatively If Not <condition> then)
> other statements
> optional else
> other statements for else clause
> End If

If <condition> then
The If statement is part of the if construct. If the condition is true execution continues at the statement after the If. If the condition is false execution continues after the Else statement if one exists, or after the End If if there is no Else clause.

If Not <condition> then
The If Not statement is part of the if construct. If the condition is false execution continues at the statement after the If. If the condition is true execution continues after the Else statement if one exists, or after the End If if there is no Else clause.

Else statement
The Else statement is an optional part of the if construct and is used to indicate the start of the Else Clause.

End If statement
The End If statement is part of the if construct and identifies the end of the conditional sequence. Each If or If Not statement must have one and only one End If statement.

Editor Facilities

The macro editor is selected from the **Tools->Macro** menu option. The name of the macro is displayed in the window caption together with the mode. The macro instructions are displayed in the window in the sequence in which they will be executed. The menu offers a range of options which are described below:

Reset
The reset instruction clears the macro window and name (setting the name to *ANON*) and inserts a comment defining the time and date in the macro window.

New
This option performs the same action as reset, except that the user is prompted for the name of the new macro.

Rename
Allow the user to change the name of a macro.

Insert
Initiates the dialog which adds an instruction of the specified type into the macro after the current instruction. The type of instruction is selected from a list box, then according to the type of instruction, the user is presented with further options to specify the instruction.

Edit
Some but not all instructions may be edited. Selecting edit allows the text of an instruction to be changed. If an instruction is not editable, delete it and insert an new one.

Delete
The delete functions deletes the currently highlighted instruction.

Load/Save
A macro may be saved in a file with a .MAC extension by the save option. The user is able to specify the filename for the file. Any .MAC files can also be loaded into the macro editor for further alteration or for execution with the load option.

Save as Text
This option allows a macro file to be written in text format. The default .TXT extension is used and the resulting file can be read by the notepad editor. It is not possible to load a text macro file.

Fetch/Install/Remove
The fetch, install and remove options all relate to the subject of macro libraries which are described below.

Execute/Stop/Continue
The **Execute** command causes the current macro to be executed from the beginning. Execution can be interrupted at any point with the **Stop** function. It is then possible to edit the macro before selecting **Continue** which will resume execution of the macro from the currently highlighted instruction.

Record
The record option allows a sequence of user interface operations to be converted into a macro. All operations between selecting **Record** and the subsequent selection of **Stop** are recorded as a macro.

To reduce redundant instructions only the final value of analogue parameters is inserted as an instruction. There is no sense of time delay in the recorded sequence, each instruction follows directly after its predecessor. To introduce time delays, ***Wait For*** *and* ***Delay*** *instructions must be inserted with the editor.*

Libraries

A library is a collection of macros. The *Stereoscan 440* comes with a standard library which contains the macros required by the user interface for standard calls from menus and panels.

All macro libraries must contain the standard macros as a subset.

Once a macro is in a library it can be assigned to a toolbar icon (see Section 3.7.4 *The Toolbar Editor*) or called from one of the user defined function keys.

The assignment to function keys is made entirely by the macro name. For example, macro **F5** is assigned to function key 5, while macro **Shift F6** is assigned to the shifted function key 6.

The following operations may be performed on macro libraries:-

Install
A macro can be installed into a library, which means that it will appear in the list of macros which can be selected. If a macro of the same name already exists in the library, the user is asked whether the old macro should be overwritten.

Fetch
Fetching a macro from a library, loads it into the edit window where it can be executed or edited.

Remove
Removing a macro from a library deletes that macro from the library.

Save/Load
Macro libraries may be saved as files as well as individual macro files. Libraries have the .MLF extension. Note that the standard library calls should not be altered as this could cause unexpected side effects when loading macro libraries. The **Load->Standard** option is provided to allow an easy route back to the default macro library should it be required.

Example

This macro will enable the operator to select operating conditions suitable for adjusting the final aperture, by selecting function key F5.

Click on words in normal type, enter text and values in bold type on the keyboard:-

Tools, Macro, Macro, New, **F5**, OK
Insert, Instructions, Analogue, **M**, Mag, OK, **2000**, OK
Insert, Instructions, Command, **R**, Reduced, OK
Insert, Instructions, Analogue, **R**, Red. Raster posn X, OK, **384**, OK
Insert, Instructions, Analogue, **R**, Red. Raster posn Y, OK, **256** OK
Insert, Instructions, Analogue, **R**, Red. Raster height, OK, **256**, OK.
Insert, Instructions, Analogue, **R**, Red. Raster width, OK **256**, OK
Insert, Instructions, Command, **P**, Pixel average 4, OK
Insert, Instructions, Command, **F**, Frame average
Insert, Instructions, Digital, **F**, Focus wobble, OK, On, OK
Insert, Instructions, Digital, **W**, Wobble rate, OK, Fast, OK
Insert, Instructions, Analogue, **C3W**, C3 Wobble Amplitude, **50**
Install, Yes

Press function key F5 to see it working.

Now to save this macro:-

Click on Macro->Save, then delete the default name and enter WOBBLE.MAC. You can then FETCH the file from the macro library or load it from the file and EXECUTE it if required.

Saving and Loading Conditions

A further use for macros is in saving and loading instrument conditions. The **Restore** macro has already been described (Chapter 1 *Getting Started* Section 1.4 *Common Operating Routines*). It is initiated from the run up icon and restores

the previous operating conditions. Those conditions are saved when the system is closed down by the macro generator.

The macro generator builds a macro which when executed restores the previous condition of the instrument. It can be selected at any time from the **File->Save State** menu option and can be made to generate a macro to restore any combination of the following:-

- Configuration
- Setup
- Gun Conditions
- Application Conditions
- Display LUT

The user is prompted for a LUT file name (if that option is chosen) and a name for the macro.

*The **Standard** option is provided to set the instrument to a default state should the restore macro be saved as some undesirable state.*

Any instrument conditions macro may be loaded directly in and executed with the **Load State** option. However the **Preview State** option has the advantage that the conditions can be examined before the macro is executed. The preview menu also allows the conditions to be executed (**OK**), edited (**Edit**) or changed for another set (**Fetch**).

*Any macro of instrument conditions that is created by the **File->Save State** menu option is saved with the file extension .APP and not .MAC so that it is easier for the operator to separate the two types of macro.*

3.7.3. The Status Display

The status display was introduced in Chapter 1. There is a little more to it than meets the eye. It is of course a window for displaying instrument parameters which can be chosen using the **Select** menu option. But it also provides certain control facilities which will be described in this section. The basic operation of the display will be covered first.

Selecting a Set of Parameters

The status display can be cleared at any time using the **Reset** menu option. The **Select** option is used to add or remove individual items from the display. When select is chosen, a select box will appear containing a list of all the possible system parameters which may be displayed. Highlighting a value means that it will appear in the display when **OK** is selected.

The position in the list can be controlled using the scroll bar or by typing the first one or two letters of the required parameter in the text entry box. When all the required parameters are selected, the OK button will cause the status display to be reconfigured to reflect the new selections.

Some of the parameters in the display may appear *greyed out* which means that in the current operating mode, that parameter cannot be altered by the user.

Saving and Loading Status Display Files

It is likely that the user will require different parameters in the status display for different activities. To avoid the need to constantly reconfigure the display, a file save and load facility has been provided. Selecting **File->Save** from the menu will cause a dialog box to appear allowing the user to specify the filename before the file is saved. All status display files are saved with the .SSL extension. **File->Load** works in the usual way (overwriting the current status display configuration).

Adjusting Parameters from the Status Display

The way in which a parameter can be adjusted from the status display varies according to the parameter type. Parameters may be read only, analogue, binary digital (boolean) or multi value digital. The methods of adjusting them are summarised below:-

	Left Button	**Middle Button**	**Right Button**	**Left Double Click**
Analogue	Assign to Left Mouse Parameter	Assign to Right Mouse Parameter	Preset Values	Dialog Value Entry
Binary Digital	Toggle	-	-	-
Multi Value Digital	Select Box	-	-	-
Keyboard Only	Dialog Value Entry	Dialog Value Entry	Dialog Value Entry	-
Read Only	-	-	-	-

The actions listed above are defined as follows:-

Assign to Mouse
Control of the parameter is assigned to the mouse (and navigation box if present) for adjustment.

Dialog Value Entry
A dialog box appears which allows the new value for the parameter to be entered.

Preset Values
A select box appears which displays all the previously defined preset values for that parameter. A new preset value can be defined as a label for the current parameter value, or a previously defined value can be used. The preset values are labels which can be used to set an individual parameter to a fixed value.

Toggle
A binary digital parameter has only two states (Off/On, Yes/No, Fast/Slow, etc). Selecting such a parameter simply changes it to its alternative state.

Select Box
A select box appears with all the possible values for the parameter in question. A value is selected from the list and the parameter is set to it.

Whenever a double click is performed the relevant left or middle single click action is performed before the double click action.

3.7.4. The Toolbar Editor

The final option available for modifying the user interface is the toolbar editor. It allows the actions and appearance of the icons in the toolbar to be modified. Icons may be added, deleted or edited using the toolbar editor which is selected from the **Toolbar** option of the **Edit** menu. Different toolbars can be loaded and saved and a new toolbar can be installed from the editor.

Toolbars

A toolbar is a sequence of icons with their associated bitmaps and actions. A popup menu controls the changes to the icons in the editor. Some operations apply to the whole list, others apply to individual icons. The former are considered in this section.

Reset
The reset command deletes the current icon list.

Fetch
This command loads the current toolbar into the editor, overwriting any icons in the editor at the time.

Load/Save
A toolbar can be saved as a file (with an .ITB extension). A toolbar file can be loaded into the editor overwriting its current contents.

Install
The install option copies the icon list from the editor into the toolbar area. The current icon list is then lost. The current toolbar is saved when the system is shutdown.

Should the distribution toolbar be inadvertently lost, it can be restored by selecting ***Novice*** *or* ***Expert*** *mode (as appropriate) from the* ***File*** *menu.*

Icon Order
The order of the icons in the toolbar can be changed simply by dragging an icon to another position, this will swap the icon with the one currently occupying that position. Identical icons may appear several times in the toolbar to ensure that any given icon is always visible.

Icons

Individual icons in the toolbar can be defined to appear and behave in certain ways. There are two types of icons, *Buttons* and *Toggles.* A button executes an action when it is selected, whereas a toggle changes state (for example, image *inverted* to *not inverted* or vice versa). New icons of either type may be created and also deleted (by selecting an icon then **delete** on the popup menu).

A red border is used to indicate the currently selected icon. The following properties of the selected icon may be edited:-

Size
There are two sizes of icon available large (64 x 64 pixels) and small (36 x 36 pixels). Selecting the smaller icons allows more icons to be displayed.

Bitmaps
The bitmap associated with any given icon may be altered using the **Next** and **Prev** options on the popup menu. Repeated selections will cycle through the set of installed bitmaps for that type of icon.

Actions
Each icon has an action associated with a selection with the left mouse button and one associated with the middle or right mouse buttons. The actions can be selected using the **Edit** option on the popup menu. The choices available for an icon depend on its type, but will be from the following list:-

- Command
  Executes the low level command
- Panel
  Displays the panel.

Macro
Executes the defined macro

- Mouse
  Assigns the selected parameters to mouse control
  Function
  Executes the high level function
  State
  Toggles the state of the binary parameter

Icon Example

This example shows how to add an icon to the toolbar which blanks and unblanks the beam on selection:-

1. Select **Edit->Toolbar**.
2. Select right mouse button (to bring up popup menu).
3. Select **Fetch**.
4. Select **New Toggle**.
5. Select **Next** (until desired bit map is selected).
6. Select **Edit** (on popup menu).
7. Select **State**.
8. Select **Beam Blanked, OK**.
9. Select **Panel** (for right button action).
10. Select **Gun Align** (or any preferred panel), **OK**.
11. Select **OK** on the edit panel.
12. Select **Install, Off**.

Selecting the new icon with the left mouse button will cause the beam to be alternately blanked and unblanked.

3.8. Trouble-Shooting

(A)	Lack of Sharpness	(C)	Poor Final Image Quality
	CAUSES		CAUSES
	Astigmatism not correct		Incorrect LEVEL & CONTRAST settings
	Misaligned final aperture		Incorrect acceleration voltage
	Poor focusing		Incorrect probe current
	Sample charge-up or vibration		Inadequate specimen preparation
	Magnetic fields (from sample or external)		
	Poor depth of focus		
	Too much noise		
	Specimen contaminated or of low potential reduction		
(B)	Image Noise	(D)	Image Distortion
	CAUSES		CAUSES
	Probe current too low		Specimen charge-up
	Sample not facing electron collector		Specimen magnetism
	Faulty scintillator and/or photomultiplier		Specimen vibration
	Too much CONTRAST, incorrect LEVEL		Specimen damage
	Dark regions of sample being observed		External magnetic fields
			External vibration

Table "Summary of Image Defects"

(A)	**Operator Error**	
	DEFECT	CAUSE
(1)	Low contrast, lack of video signal (if probe current too low), possible specimen damage (if too high)	Incorrect probe current
(2)	Lack of image sharpness, image shift when focusing	Incorrect final aperture alignment
(3)	Less image sharpness in one direction, poor resolution	Insufficient astigmatism correction
(4)	Noisy image, beam deflection on charging sample, specimen damage	Wrong scanning period
(5)	Poor image quality	Wrong brightness level selected
(6)	Poor image quality	Wrong contrast level selected
(7)	Influence on penetration and charging	Wrong accelerating voltage
(B)	**External Influence**	
	(DEFECT)	(CAUSE)
(1)	Image distortion, jagged edges in image	Magnetic fields
(2)	Jagged edge in image	Vibration
(C)	**Sample Type and Penetration**	
	DEFECT	CAUSE
(1)	Reflected and secondary electron images brighten with increasing atomic number	Atomic number effect
(2)	Image shift and distortion, abnormal contrast and unstable image	Charge-up
(3)	Deformation and cracking of specimen, coating peeling	Overheating (kV or probe current too high)
(4)	Charge-up or sample damage	Incorrect or inadequate sample coating
(5)	Surface coating leading to poor image quality	Contamination
(6)	Sample deformation, damage and charge-up	Incorrect sample preparation (especially soft tissues etc)

Table "Image Defect Causes"

PARAMETER	EFFECT	OPTIMUM CONDITIONS	COMMENTS
Mounting on to specimen stub	Charging, Vibration	Securely attached	Use quick - drying adhesive (preferably conducting)
Conductivity and grounding	Charging	Good conduction to earth	Use conducting paint (Dag)
Sensitivity to beam damage	Specimen distortion	Use:- Low beam current and/or low kV, short frame period. Focus away from area of interest	Optimum conditions may result in poor SNR
Coating	Conductivity	No charging	Charging seen as: local intensity changes; astigmatism; image distortion; dark micrographs
Coating	S.E. Signal	20nm metal coating	If too thick can mask detail
		Carbon coating	If too thick will absorb signal
Coating	C.L. Signal	Carbon, aluminium coating	If too thick will absorb signal
Coating	X-Ray Signal	Carbon, aluminium coating	Avoid interference with element(s) of interest
Coating	Specimen Current	C - Material contrast Au - Topography	Use inverted S.C. image for best topography
Coating	Resolution	Gold/Palladium	Grain size of coating may be resolution limit
Mechanical Stability	Resolution: Cracks in coating	Vibration amplitude less than required resolution	Reduce kV, and beam current
Eucentric Position	Specimen tilting, Stereo pairs	No translation motion during tilting	Use Eucentric goniometer stage for best results
Specimen Tilting	Topography, signal to noise ratio	About 45° for SE1 detector. Zero for BSD	Found by expt. Depends on sample
Specimen Tilting	Stereo Viewing	Tilt difference 5-10°	Use low angles for large height differences
Working Distance	Resolution	Short	Beware of final lens damage
	Depth of focus	Long	Limit = Loss of resolution
Working Distance	Sample - BSD Distance	Long - Best for Topog and Crystal Orientation Short - Best for Z-Contrast	

Table "Specimen Parameters"

System Management

Hard Disk Directory, Structure and Management

The LEO UIF runs under the Microsoft® Windows$_{TM}$ operating system. This graphical operating system is loaded on top of a base disk operating system known as DOS. The DOS operating system is responsible for storing and handling files on the system.

If you are new to computers or DOS, you may have trouble understanding certain terms used in this manual. This section provides you with a brief overview of the following DOS concepts and functions.

This information is by no means a complete explanation of the DOS operating system. If you need more details, please refer to the MS-DOS® users manual that was delivered with the system.

What is DOS?

As mentioned above, DOS is shorthand for Disk Operating System. MS-DOS® is Microsoft's® version of DOS, while DR-DOS and PC-DOS are renditions from Digital Research and IBM. DOS is the traffic co-ordinator, manager, and operator for the transactions that occur between the parts of the computer system and the computer system and the user. DOS operates in the background, taking care of low level computer tasks for example, the flow of characters between the keyboard and the computer, between the computer and printer, and between disk(s) and internal memory (RAM).

Other transactions are initiated by entering commands on the DOS command line; in other words, immediately after the DOS prompt. The DOS prompt probably looks like one of the following:-

```
A>
B>
C>
```

The capital letter refers to the active disk drive (the one DOS is using right now). For instance, if the prompt is `A>`, it means that drive *A* is active and that commands given to DOS will refer to that drive. When another disk is required, the only command needed is the letter of the disk, followed by a colon and *Return* (usually the key marked ↵). For instance, to switch to drive *A*, just type

`A:` *Enter*

4.5. Good Housekeeping, i.e. keeping sufficient free disk space

As the LEO User Interface operates as a Windows™ Application, it relies on sufficient system resources from the Windows™ operating system itself. In this case, system resources refer to both free physical memory, and free hard-disk space.

If either of the above resources are in short supply, system performance can be impaired. As the physical memory fitted in the machine is managed by the system software itself, little can be done to improve system performance in this way, other than ensuring that only the applications that are required are loaded into memory at any one time.

Because Windows™ provides a 'virtual machine' environment to its applications, generally an application can demand as much memory from the system as it needs. When physical memory is full, Windows™ will temporarily swap 'chunks' or 'pages' of it onto the hard-disk using a process known as paging. If the hard disk is nearly full, this reduces the size of the temporary files Windows™ creates, and thus increases the frequency at which these files are accessed.

As free hard-disk space is a premium, there are a number of good housekeeping strategies the system administrator can employ to ensure maximum software efficiency. All the functions shown below can be performed using the Windows™ File Manager:-

- Ensure that any unused user directories are backed up and removed from the system
- Remove any unwanted image files from the system regularly by backing the files up then deleting them from the hard-disk
- Check that any temporary files from the `\Windows\TEMP` subdirectory are deleted

There are a few frequently used DOS commands which it is necessary to be familiar with :

DEL or ERASE	To erase a file
DIR	To see a list of files on the logged disk
COPY	To copy files from one disk or disk area to another
REN or RENAME	To rename a file

DOS is not case sensitive, so commands can be entered in upper or lower case as preferred by the user.

The remainder of this chapter assumes familiarity with the above commands, refer to the DOS manual for further information about them.

4.1.2. *Directories, Subdirectories, and Directory Structure*

A *directory* is a convenient way to organise floppy or hard disk files. Directories allow the disk to be subdivided into sections, in a similar manner to conventional paper filing systems with draws and files. For example, a "Reports" subdirectory could contain a document template for a standard report, together with images to be included in reports and even spreadsheets containing additional information to be included.

On the system, it may be convenient to create a directory to hold all SEM image files, another for reports, another for notes, and so on. That way, it isn't necessary to wade through hundreds of files looking for the right one. Only the files from the current directory are listed with the DIR command or in a file selection box.

Although directories can be created on either floppy or hard disks, they are used most often on hard disks. Because hard disks can hold a greater volume of data, there is a greater need for the organisation and compartmentalisation.

At the DOS level, rather than in for example the LEO User Interface, DOS can be told to create directories, move files around between directories, and display which files are in a particular directory. See Section 4.2 *Creating and Using User Directories* for a practical example.

4.1.3. Subdirectories

For a greater degree of organisational structure it is possible to create subdirectories, or even subdirectories of subdirectories. There is no limit to the number which can be created, but too much structure may make it difficult for the user to keep track of where files are stored.

To set the currently logged directory, use the CHDIR or CD command followed by the name of the directory.

The DOS *prompt* indicates the current directory. If a subdirectory of IMAGES called TIFF, which is in turn a subdirectory of drive *C* is the current directory, the DOS prompt will look like:-

```
C:\IMAGES\TIFF>
```

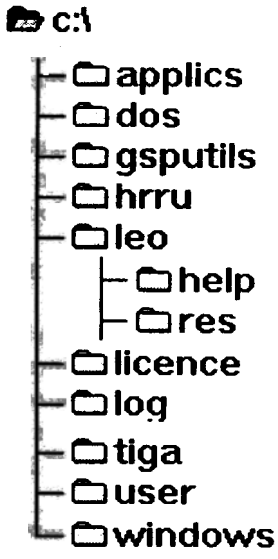
Notice the backslash (\) before the directory names. When moving from one directory to another unrelated directory, type the name of the directory preceded by a backslash. The *parent* of any subdirectory is the directory immediately above it. In the example above, the parent of TIFF is IMAGES—TIFF is the subdirectory, IMAGES is the directory.

A backslash inserted directly after the drive characters refers to the *top-level* or *root* directory. The root directory does not have a parent directory.

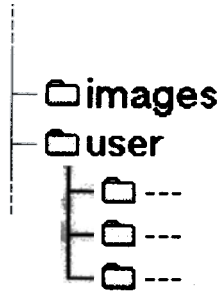
- To switch to the root directory, simply enter `CHDIR \` followed by *Return*. To enter the IMAGES directory, type `CHDIR \IMAGES`, to enter the TIFF subdirectory, type `CHDIR \IMAGES\TIFF` and so on.
- DOS always works relative to the currently logged directory. In IMAGES, to go to TIFF, simply enter `CHDIR TIFF`. To go straight to the root directory type `CHDIR \` or `CHDIR C:\`
- Finally, to move from a subdirectory to its parent directory, for example to move from TIFF to IMAGES, specify '..' as the directory in the `CHDIR` command

4.1.4. The LEO Directory Structure

Below is a graphical representation of how the files are arranged for the LEO User Interface—LEO UIF. Each directory is shown as a 'folder'. This format is compatible with Windows$_{TM}$ File Manager:



In addition there are two generic directories:-



Except where specifically defined, files or directories should NOT be modified in any way. Leica Cambridge will not be responsible for consequences if the above files or directories are modified.

4.1.5. Directory Contents

Directory:	Directory Contents:
\GSPUTILS	This directory is used to hold files for use by Leica personnel only
\LEO	This is the main LEO software directory which holds the major part of the LEO application software. The subdirectory \LEO\HELP contains the LEO Help files. LEO also holds the following special files Standard *.ANN files Vacuum System files CONFIG.LEO. Annotation fonts. POINT.BMP
LICENCE	This directory contains the licence files which have been installed into the microscope. It will also contain any licence report files which may have been generated.
\LOG	This directory is used to hold the LEO log file and archived log file This directory should be checked to ensure the log files are not becoming too large.
\TIGA	This directory is used to hold the graphics processor files.
\USER	This is a root directory for a collection of user directories. On delivery one subdirectory is set up USER\DEFAULT Other subdirectories may be used as required.
User Directory	A subdirectory of the \USER directory is selected on system startup which is used to hold customisation or user specific files. The directory may be subsequently changed from the Top Menu. Such files may include : APP.LEO, LAYOUT.LEO, MACROS.LEO, OUTLPTS.LEO, OUTLUTL.LEO, STATWIND.SSL, TOOLBAR.LEO, *.ANN, *.ITB, *.MAC, *.MLF, *.OLT, *.PRE, *.SSL, *.TIF, *.ULU, *.XYZ.
Image Directory	This is a user selected directory in which TIFF files are stored. By default this is the user directory, it may be set to any directory on any device from any of the TIFF functions.

Creating and Using User Directories

From DOS

In the examples that follow, it is assumed that the hard disk is the current drive so that the prompt on the screen is *similar* to `C:\>`. To create directories on floppy disks, substitute *A* or *B* for *C* in this example.

To make directories for USER files, do the following:-

1. Select the MS-DOS® Prompt icon from the Windows™ Main Group—as shown below.

2. Type `CHDIR \USER` and press *Return*. The CHDIR command tells DOS to move into the USER directory. See above for an explanation on directories and subdirectories.

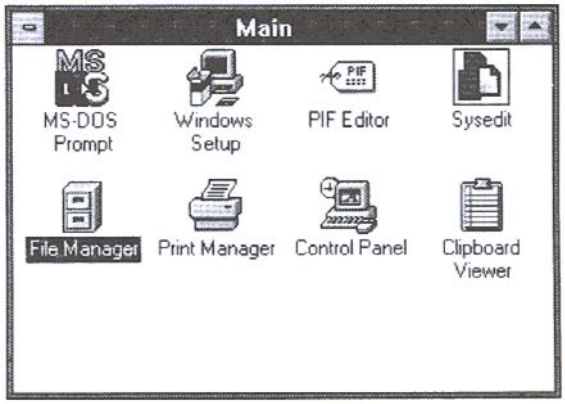
3. At the `C:\USER>` prompt, type `MKDIR NEWUSER` and press *Return*. The MKDIR command tells DOS to make a directory called NEWUSER in subdirectory USER. To create additional directories, simply substitute NEWUSER for the new directory name. For example, try `MKDIR HENRY` or `MKDIR DAVE`.

4. If you make a mistake, simply remove the directory with the command `RD NEWUSER` *Return*, where NEWUSER represents the directory you wish to delete.

That's all there is to it. A directory should be treated in the same way as a disk drive: To access any specific DOS file such as a saved TIFF image for example, the correct directory must be specified, or DOS won't be able to find the file.

From Windows™

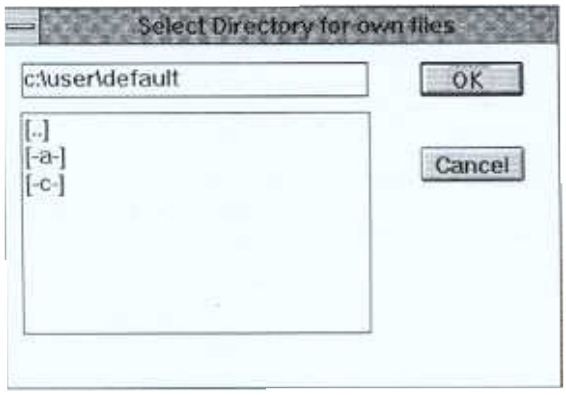
The concept and final results are the same as in DOS when creating directories from within Windows™. Simply click on the File Manager icon instead of the MS-DOS® Prompt icon—shown below. Refer to the Windows™ on-line help, or the Windows User Guide for File Manager operation.



4.3. The User Directory Concept

A user directory is simply a convenient way of separating the frequently changing LEO User Interface configuration parameters, from the system software data files. It can also be used to keep each user's files separate. If each user has their own configuration parameter directory, the system can be configured to suit each user in terms of tool-bars, menus, modes of operation etc, without having to re-configure the User Interface each time it is loaded.

As mentioned above, a subdirectory of the \USER directory is selected on system startup which is used to hold these customised or user specific files. The directory may be subsequently changed from the Top Menu. This is the directory that should be entered into the dialog box displayed during LEO UIF initialisation:-



Such files found in this directory may include :

APP.LEO, LAYOUT.LEO, MACROS.LEO, OUTLPTS.LEO, OUTLUTL.LEO, STATWIND.SSL, TOOLBAR.LEO, *.ANN, *.ITB, *.MAC, *.MLF, *.OLT, *.PRE, *.SSL, *.TIF, *.ULU,*.XYZ

Refer to the section on file types for an explanation of the various uses for each of the file types listed above.

4.3.1. Backing Up The User Directory

It is advisable to make frequent backups of this directory onto floppy-disk for safe keeping. In this way, any unwanted changes to the User Interface configuration or operating conditions can be partially restored by copying the files back as required. See the Microsoft® Windows™. User Guide for details on copying files using the Windows™ File Manager.

File Types, e.g. TIF, OLT, MAC etc.

LEO Files

File type:	Description :
Standard Annotation	These are files with the extension ANN. They contain annotation panels for measurement (e.g. angular, radial, profile etc.) and datazone. The master copies are held in \LEO, if required modified versions may be saved in the user directory where they will be used in preference to the master copies. For further information use context help on the annotation and measurement popup menu.
Vacuum System	These files are specific to the vacuum system and electron optics of the SEM. They hold calibration information essential to the operation of the microscope. DEFAULT.VAC is used for initialising the vacuum system Non Volatile RAM (NVRAM) and DATA.VAC holds a backup copy of the NVRAM current data.
CONFIG.LEO	This file holds configuration information specific to the microscope.
Annotation font	These files with extension FNT are Font files for use in the SEM overlay plane for annotation and measurement functions.
POINT.BMP	This file contains the bitmap used for point to point measurement. If required this may be replaced by an alternative bitmap.
Licence	These are files with the extension LIC which are used to install licences which enable microscope functions to be used. A licence file is specific to a microscope and may only be installed by the LEO licence install application. A copy is held in the \LICENCE directory for reinstallation should this be required.
Licence report	These are text files with extension REP which contain the report generated by the LEO Licence Install application when a licence file is installed. They may be inspected using NOTEPAD.
LOG.LEO	This is a text file which records all significant events on the microscope. **Note** that while the interface is running this file is being accessed and partial contents may still be in memory. This file is for use by Leica Service personnel. For further information use context sensitive help on the Configuration menu.
LOG.OLD	This is an archived log file. This file is for use by Leica Service personnel. For further information use context sensitive help on the Configuration menu.

4.4.2. Machine Specific Interface Files

File :	Description :
EXPERT.LAY, NOVICE.LAY, FTEST.LAY	These files contain the EXPERT, NOVICE and SERVICE user interface panels
EXPERT.ITB, NOVICE.ITB, FTEST.ITB	These files contain the EXPERT, NOVICE and SERVICE toolbars
MACROS.LEO	This file contains the installed macro library. The standard macro library file is located in the \S440 directory. On system shutdown a copy of the current installed macro library is saved as MACROS.LEO in the user directory On system startup the macro library is loaded from file MACROS.LEO in the user directory if one exists, otherwise the standard macro library is loaded.
APP.LEO	This file is located in the user directory and records the user customisation on shutdown (e.g. window positions).
LAYOUT.LEO	This file is located in the user directory and records the current set of user panels on shutdown.
OUTLPTS.LEO	This file is located in the user directory and records the display LUT Window points list on shutdown.
OUTLUTL.LEO	This file is located in the user directory and contains the display LUT contents on shutdown.
STATWIND.SSL	This file is located in the user directory and contains the status selection list for the status window on shutdown.
TOOLBAR.LEO	This file is located in the user directory and contains the current TOOLBAR on shutdown.
.ANN files	These are annotation panels or complete overlay information saved by the annotation/measurement function
.ITB files	These are files containing Toolbar sequences (Icon Toolbar) created with the Toolbar Editor.
.MAC files	These are macro files created by the macro editor.
	These are Macro Library files saved by the macro Editor.
.OLT files	These are files containing actual display LUT contents saved by the display LUT Window
.DLU files	These are files containing display LUT points lists saved by the display LUT Window
.ULU files	These are files containing a User defined points list generated by the input LUT Window
.PRE files	These are files containing predefined values for specific parameters. The file name is derived from the parameter mnemonic.
.XYZ files	These are files of stage position information generated by the stage window.
.TIF files	These are files in TIFF format
.SSL files	These are status selection lists saved in the Status window

The printer can only print Grey or binary files.

CLIPBOARD BITMAP CREATE ERROR

This failure is given when cutting an image to clipboard.

This is typically caused by inadequate PC memory (or disk swap file). Close any other applications.

CLIPBOARD - BITMAP DATA ERROR

This error indicates that the data in the bitmap is corrupt.

CLIPBOARD CONVERSION MEMORY ERROR

This failure is given when cutting an image to clipboard.

This is typically caused by inadequate PC memory (or disk swap file). Close any other applications or free up space on hard disk. (N.B. swap file must be contiguous space).

CLIPBOARD FETCH FAILED

This failure is given when pasting an image from clipboard.

The call to the clipboard returned a failure.

CLIPBOARD - GET CONTEXT FAILED

This error indicates that a display context could not be obtained.

Inadequate resources. Close other applications.

CLIPBOARD - UNKNOWN BITMAP TYPE

The clipboard contains a bitmap of a type which cannot be handled by the LEO software.

CONFIG FILE READ ERROR - USING DEFAULT

This error occurs when an attempt is made to access a parameter or state which is currently disabled by the operational rules.

This error is given when a file error is detected on reading the configuration file CONFIG.LEO or when a format error is detected.

Maintenance

User maintenance on this series of instruments is very limited, and is restricted to items that do not require any panels to be removed in order to gain access to them.

THERE ARE NO USER SERVICEABLE PARTS BEHIND THE PANELS, AND REMOVAL OF A PANEL EXPOSES HIGH VOLTAGES AND HIGHLY SENSITIVE ELECTRONIC CIRCUITRY.

User serviceable items are as follows:-

- Firing Unit
- Anode Cleaning
- Final Aperture replacement
- Desiccator Silica Crystal replacement
- Liner Tube Cleansing and Aperture replacement (if suitable cleaning facilities exist)
- Rotary pump oil changes

ALL other maintenance operations, including these, if required, should be carried out by Leica Service Engineers, or authorised agents, and will be done on Service and Period Maintenance visits. These include:-

- Turbo pump maintenance (as well as the rotary pump)
- Collector system maintenance (including light pipe change IF required)
- Cleaning of fans
- Full column cleaning - if necessary

5.1. Routine Basic Maintenance

5.1.1. Rotary Pump Oil Level

Check the oil level in the sight glass on the pump. The minimum oil level is the lower edge of the sight glass. The maximum level is 25mm below the top of the glass. When necessary top up with oil of the type specified for the particular pump in use (ie Edwards no 15 for Edwards pump, or Alcatel VP1 for Alcatel pumps).

5.1.2. Air Admittance Drier Assembly

If the air drier is allowed to become ineffective the pump down time of the *Stereoscan 440* will become longer than normal. The assembly is mounted on the rear panel of the plinth. The colour of the desiccant in the assembly should be checked daily and if it shows signs of becoming saturated ie turning from to pink or white, it should be replaced or reactivated. To renew the desiccant:-

1. Unclip the drier from the rear of the plinth.

2. Unscrew the large knurled retaining ring from one end of the assembly and remove the end cap. Remove the filter washer beneath it. The desiccant can now be poured out and either dried or discarded. Remove the remaining filter washer and the perforated metal support.

3. Clean the parts by washing in a suitable solvent, eg liquid detergent, after which each part must be thoroughly rinsed and dried.

4. Replace the perforated metal support with the concave side facing away from where the desiccant will be. Cover with two filter washers (shiny side away from the desiccant). Fill the assembly with new or reactivated desiccant. Fit a filter washer with the shiny side towards the desiccant. Fit the end cap and kurled clamp ring.

5. Refit the assembly to the rear of the plinth.

5.2. Six Monthly Maintenance

5.2.1. Changing the Rotary Pump Oil

It is recommended that the rotary pump oil is changed after the first 100 hours operation and thereafter at 6-monthly intervals, with intermediate checks on the oil level.

To change the oil:-

1. Select CHAMBER vacuum vent and wait for the rotary pump to stop.

2. Place a container of not less than 2.5 litres capacity under the oil drain plug at the bottom of the pump. Remove the plug and drain the oil.

3. Replace the drain plug and remove the filler plug at the top of the pump. Refill the pump with the oil recommended in the pump manufacturers handbook.

4. Replace the filler plug. Refit the 'O' ring carrier, 'O' ring, pump hose manifold clamp ring and 2 screws.

5. While pumping the system down, check the condition of the oil mist filter (if fitted). If a strong smell of oil vapour can be detected the elements of the filter must be changed. In addition if the oil within the filter reaches the maximum mark, it should be drained. The pump should be switched off for both of these operations.

Column Servicing

The periods between cleaning will depend on the frequency of use, type of specimens and environmental conditions, etc. As a general rule, if the required performance can be achieved then leave well alone. Cleaning is only necessary if the resolution deteriorates and cannot be improved by adjustment. The degree of cleaning needed can only be determined by inspecting the column components.

Routine cleaning consists of cleaning the grid and anode and inserting clean apertures. If this does not restore the performance, then the whole column must be dismantled and cleaned. The extent of this depends on the severity of contamination, which can only be found by inspecting the column as it is dismantled.

Cleaning Recommendations

All swabs should be made from clean, absorbent, lint free material which will leave no dust or particles on the cleaned surfaces. A low power binocular microscope is useful to enable dust particles to be seen. All cleaned components must be covered to protect them from dust in the atmosphere. Great care must be taken when handling any part of the column since all parts are machined to close tolerance. Nylon gloves must be worn when handling all polepieces, gun parts and other components exposed to the electron beam.

An aerosol of compressed gas is very useful for blowing the dust off each component as it is replaced in the column. Commercial compressed air should not be used as it contains oil vapour.

Do not allow any liquid to come into contact with the gun ceramic. It is essential to avoid magnetising any part of the column. The steel used for components in the magnetic circuits (ie polepieces) is of a very soft type and will rust very quickly if left in the atmosphere. Where possible the column should be kept under vacuum.

STEEL AND STAINLESS STEEL, COPPER AND HIDURAL COMPONENTS. (Hidural is the coppery looking metal.)

ALUMINIUM AND ALUMINIUM ALLOY COMPONENTS

These components may be cleaned with Hyprez diamond compound grade 1-W-47 or, in the case of severe contamination, grade 4-W-47. Wash off all Hyprez with the solvent recommended by the local Service Centre (see *Appendix D*), preferably in an ultrasonic cleaner, and dry off using a hot air blower.

DO NOT USE QUADRALENE ON ANY COMPONENTS CONTAINING ALUMINIUM.

2. MOLYDENUM SPRAY APERTURES AND PLATINUM FINAL APERTURES

   Molydenum spray apertures may be cleaned by Method 1 above. It is recommended that the platinum final apertures are replaced when they become dirty or discoloured.

3. MU METAL These components should not be cleaned except for the removal of dust. It is important that the metal is not strained or dropped as this will reduce its effectiveness as a magnetic screen.

4. 'O' RINGS 'O' rings may be cleaned with, a lint free tissue. The use of 'O' ring grease is not recommended on any 'O' rings, but a small amount may be used, if necessary, on moving seals eg in the specimen stage and aperture changer micrometers. The grease must be applied with a lint free tissue to avoid contamination with natural oils, using only enough grease to just put a shine on the 'O' ring. High vacuum (eg FOMBLIN) grease is recommended.

5 'O' RING GROOVES AND FACES should be cleaned using the appropriate solvents for the particular material.

Any component with 'O' ring grooves and/or mating surfaces, and which is to be ultrasonically cleaned, should be placed in the cleaner tank in such a way that the groove or face does not touch the walls of the tank, or any other components.

5.3.2. Routine Column Cleaning

The numbers quoted thus (23) refer to the identification markers in the diagram below (Figure 5.1):-

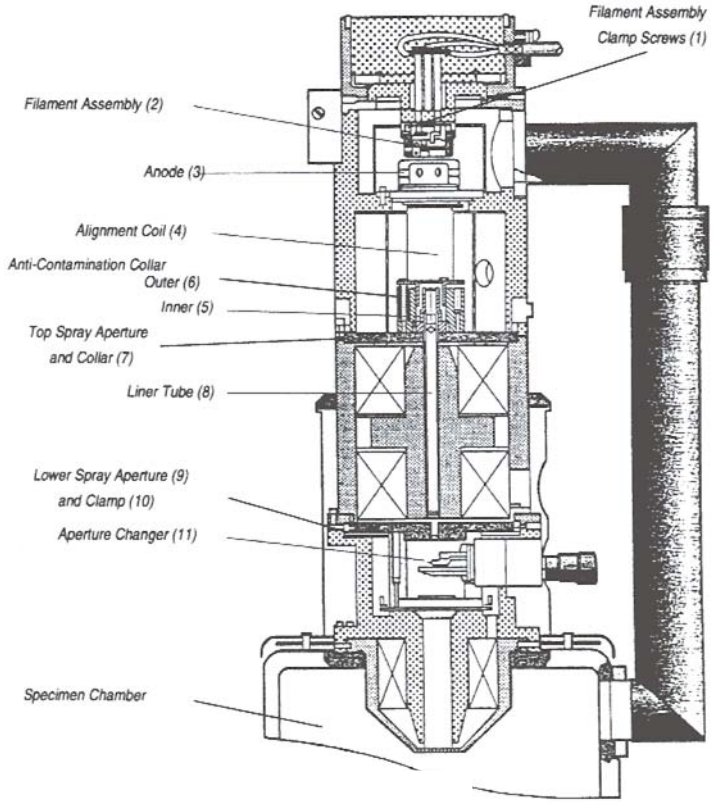


Figure 5.1 The Column

Certain screws in the column are connected with the electron optical alignment of the column. If these screws are touched, the column alignment will be affected, leading to time consuming realignment. Therefore only those screws identified in the following instructions should be adjusted or unscrewed.

Cleaning the Gun Assembly

1. Vent the column and chamber to air.

   Open the gun.

3. Loosen the three filament assembly clamp screws (1) and remove the filament assembly (2).

4. Lift out the anode (3). Take care, as the anode is a very good fit on the top of the alignment coils (4).

5. Close the gun while the components are cleaned. Take the filament assembly and anode to a clean area for cleaning.

6. Using the flat metal key unscrew the height adjustment ring and remove the filament carrier.

   Loosen the four screws (see Figure 5.2) holding the filament into the carrier and remove the filament.

8. Clean the grid and anode.

9. Replace the anode on top of the alignment coil making sure that it is correctly seated into its location boss. The anode should sit level on the alignment coil and be free to rotate, but not loose.

10. If necessary change the filament, centre it in the grid and replace the assembly in the gun (as described in Section 2.2.4 *Changing the Filament*).

11 Pump down the column and chamber and run up the gun, not forgetting to check the filament saturation and gun alignment, as these may have changed with the new filament.

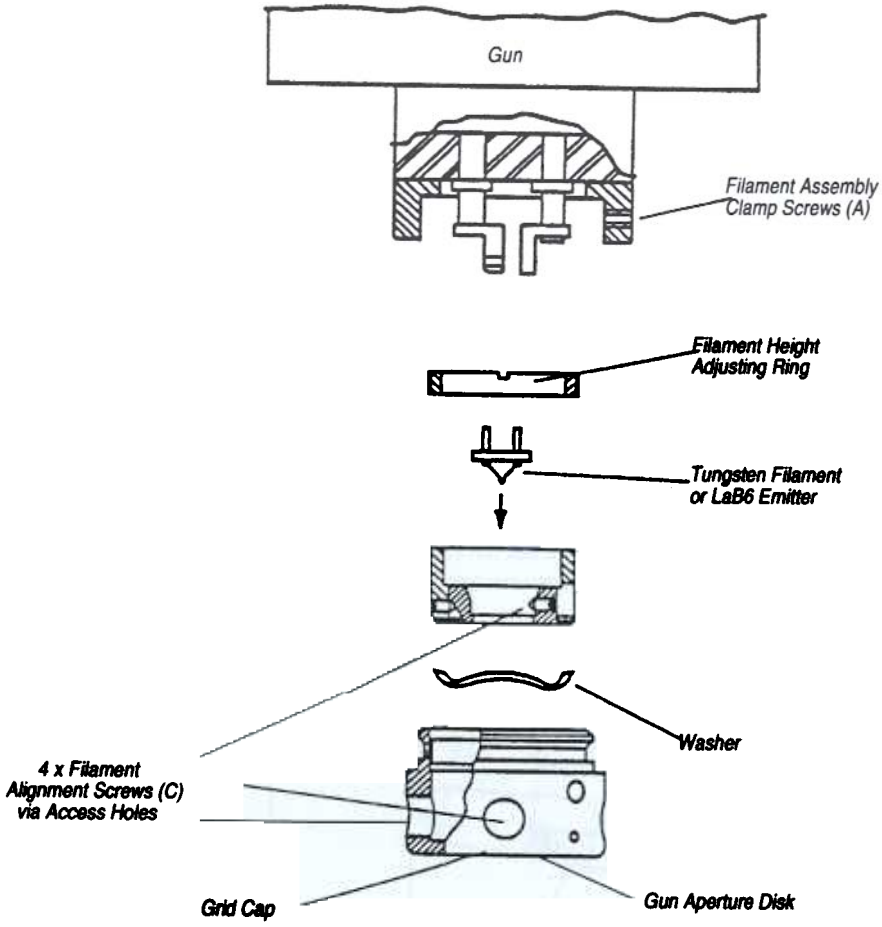


Figure 5.2 The Firing Unit

Cleaning the Aperture Assembly

Vent the column and chamber to air.

2. Remove the four M3 screws holding the aperture changer (11) into the column and remove this assembly from the column.

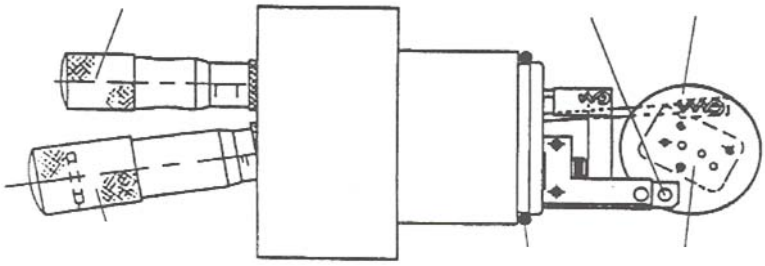
3. Take the aperture assembly to a clean area for cleaning.

4. Remove the three screws holding the aperture clamp plate onto the aperture blade (see Figure 5.3). Lift off the clamp plate and remove the apertures.

5. Clean the aperture clamp plate.

6. Insert new apertures into the aperture blade and fit the aperture clamp plate and screws.

   Clean the 'O' ring on the aperture changer and replace the assembly into the column and secure with the four screws.



Fault Diagnosis

The *Stereoscan 440* has been designed to achieve a high standard of reliability. However as with any complex system faults do occur from time to time. When they do the key requirement is to identify the fault and rectify it with the minimum possible inconvenience to the user. This chapter is provided to assist in diagnosing faults and identifying the correct course of action.

In the event of some difficulty being experienced with the instrument, it is strongly recommended that the *HELP* messages available are read. With the aid of these it should be possible to either identify and rectify the problem, or to be able to provide enough information to the local service centre for them to be able to remedy any fault speedily and efficiently.

Please note that in the event of having to contact your local service centre, the following information will be required:-

Instrument serial number
Order number
Software version number
Description of error messages

Any given fault in the system is either a PC fault or a fault within the *Stereoscan* system. Because the error messages and symptoms of these fault types differ, they will be treated separately. But first it is necessary to review the diagnostic information available from the system.

6.1. Diagnostic Aids

There are various aids available to help in diagnosis of any problems, these are:

The Front Panel illuminated switches
The Status LEDs at the rear of the instrument
The various Error Messages generated by the instrument
The effect of various controls on image quality

They should all be noted when troubleshooting, and the results passed back to your Service Centre, if you do not manage to clear the fault from this information.

PC Related Faults

PC related problems are usually diagnosed by the BIOS (Basic I/O System) when the machine boots up. There are two ways in which such problems are reported to the user, by "BEEP" codes or by BIOS error messages.

Beep Codes

If an error occurs during the **Power On Self Test (POST)** routines, this is usually communicated to the user through a series of audible beeps. In the event of any of the BEEP codes sounding, it is highly likely that the PC card will have to be replaced, although some may help identify a more simple problem.

The following is a list of BEEP codes with possible causes:-

BEEPS	ERROR MESSAGE	POSSIBLE CAUSE
1	Refresh Failure	
2	Parity Error	
3	Base 64KB Memory Failure	Memory fault - check SIMMS are seated correctly
4	Timer not Operational	
5	Processor Error	
6	8042 - Gate Failure	Keyboard Fault ?
7	Processor Exception Interrupt Error	
8	Display Memory Read/Write Error	VGA Card Fault ?
9	ROM Checksum Error	
10	CMOS Shutdown Register Read/Write Error	

All these faults will prevent the system from booting up, with the exception of **No.8.** This error will allow boot-up to be completed and cause an error message to be printed on the screen.

BIOS Error Codes

In the event of a non-fatal error occurring, the BIOS diagnostic system provides a series of error messages. These error messages are displayed in the following format:-

```
ERROR Message Line 1
ERROR Message Line 2
Press <F1> to RESUME
```

The non-fatal error messages are displayed first, and then

Press the <F1> key to continue with the boot procedure

is displayed. The <F1> prompt message is not displayed if

"Wait for <F1> if any Error

in ADVANCED CMOS SET-UP has been **DISABLED.** For most non-fatal error messages there is only one message. If a second message appears it will be :-

RUN SETUP UTILITY

If this message occurs, press <F1> to run AMI BIOS SETUP

Overleaf is a listing of all the AMI Non-Fatal Error Messages

6.2.3. AMI BIOS Non-Fatal error Messages

ERROR MESSAGE	EXPLANATION
8042 Gate A20 Error	Gate A20 on the keyboard controller (8042) is not working. Replace the 8042
Address Line Short!	An Error has occurred in the address decoding circuitry
C: Drive Error	The BIOS is not receiving any response from hard disk drive C:. Run the Hard Disk Utility to correct this problem. Also, check the C: hard disk type in the Standard CMOS Setup to make sure
C: Drive Failure	The BIOS cannot get a response from the hard disk C Replace the Hard Disk
Cache Memory Bad. Do not Enable Cache	Cache Memory is defective. Run a Diagnostic Utility such as AMI Diagnostic.
CH-2 Timer Error	An AT system has two timers. There is an error with timer #2
CMOS Battery State Low	CMOS RAM is powered by a battery. The battery power is low. Replace the battery.
CMOS Checksum Failure	After CMOS RAM values are saved, a checksum value is generated for error checking. The message appears if the previous value is different from the current value. Run Setup.
CMOS System Options not set	The values stored in CMOS RAM are either corrupt or non-existent. Run Setup.
CMOS Display type Mismatch	The video type in CMOS RAM does not match the type detected by the BIOS. Run Setup.

CMOS Memory size Mismatch	The amount of memory found by the BIOS is different from the amount in CMOS RAM. Run Setup.
CMOS Time & Date Not Set	Run the Standard CMOS Setup to set the date and time in CMOS RAM
D: Drive Error	The BIOS is not receiving any response from the hard disk drive D:. Run the Hard Disk Utility. Also check the D: hard disk type in Standard CMOS Setup to make sure that the hard disk type is correct.
D: Drive Failure	The BIOS cannot get a response from hard disk drive D:. Replace the hard disk.
Diskette Boot Failure	The boot diskette in floppy drive A: is corrupt. It cannot be used to boot the system. Use another boot diskette and follow the screen instructions.
Display Switch not properly set	Some systems require that a video switch be set to either colour or monochrome. Turn the system off, set the switch properly, then power on.
DMA Error	An error has occurred in the DMA Controller.
DMA #1 Error	An error has occurred in the first DMA Channel.
DMA #2 Error	An error has occurred in the second DMA Channel.
Invalid Boot Diskette	The BIOS can read the diskette in floppy drive A:, but it cannot boot the system with it. Use another boot diskette and follow the screen instructions.
Keyboard is locked - Unlock it	The keyboard lock on the system is engaged. The system must be unlocked to continue the boot process.
Keyboard Error	There is a timing problem with the keyboard. Make sure an AMI Keyboard BIOS is installed. Set "Keyboard" in the Standard CMOS to "Not Installed", which skips the keyboard POST routines.
Keyboard Interface Error	There is an error with the keyboard connector.
No ROM BASIC	Cannot find a proper bootable sector on either diskette drive A: or hard disk Drive C:. The BIOS cannot find ROM Basic.

OFF Board Parity	There is a parity error with memory installed in an I/O (BUS) slot. The message format is **OFF BOARD PARITY ERROR ADDR = XXXX** where XXXX is the address (in Hexadecimal) where the error has occurred. Off Board means that it is part of the memory installed via an adaptor card in an I/O (bus) slot. Run memory diagnostic software, such as AMI Diag, to find and correct memory problems.
ON Board Parity	There is a parity error with memory installed in an I/O (bus) slot. The message format is **ON BOARD PARITY ERROR ADDR = XXXX** where XXXX is the address (in Hexadecimal) where the error occurred. On board means that it is part of the memory attached directly to the BIOS. run memory diagnostic software, such as AMI Diag, to find and correct memory problems.
Parity Error ???	There is a parity error with the system memory, but the address of the error cannot be determined. Run memory diagnostic software, such as AMI Diag, to find and correct memory problems.

Stereoscan 440 Faults

The Image Processor

The Image Processor, together with the PC, forms the heart of the entire system.

It controls all the other modules, supplying both data and timing signals
It accepts all the various input signals i.e. SE, BSD, 4QBSD, CL etc, and processes them for display on the monitor

- It provides the display video
- It provides all the graphics in the form of annotation and PC Windows$_{TM}$

Therefore, if there is a problem with an entire sub-system, for example, no Electron Optical control at all and vacuum system problems, or no EHT operation, the possibility is that the Image Processor is at fault.

If there is no video signal of any kind on the monitor, or if the video or display are corrupted in any way, the Image Processor is suspect.

The Image Processor has it's own power supply, and this is monitored by LEDs 4, 6 and 8 at the rear of the instrument. Therefore it is important to check their status and inform the Service Centre when reporting any problem.

6.3.2. The Vacuum System

Most major vacuum problems are communicated to the operator by error messages internally generated by the instrument. In the event of a vacuum problem that does not generate an Error message, here are some hints and tips that may help locate the source of the problem, and either resolve it, or give your Sevice Centre adequate information with which to rectify it.

Check the vacuum seals that have been broken since the fault appeared, these are usually the stage door or the gun "O" rings, to ensure that they are clean and free of any particles of dirt or hair and that they are not in any way damaged.

If an "O" ring is found to be dirty, carefully remove and clean it. When replacing an "O" ring it is essential to ensure that the inner face where the "O" ring sits is perfectly clean and free of dirt and hairs and that the seam of the "O" ring itself does not lie across the sealed surface.

The use of grease is not recommended, as this can cause contamination of the column leading to degraded performance. It has been found that the action of cleaning an "O" ring with fingers applies enough grease to provide adequate lubrication.

Ensure that any samples that have been put in the chamber are not porous and that the fixative used, is not outgassing. If in doubt about the samples, remove them in order to check that the system vacuum returns to a normal level without them after about 4 hours pumping.

Check that the cooling fans for the plinth are operating correctly. If the turbo pump is too hot it will not be able to pump efficiently.

Confirm that the temperature and humidity in the room are not unusually high, this would again adversely affect pumping efficiency.

Check the condition of the silica crystals in the dessicator to ensure that they are still blue, pink crystals allow too much moist air into the chamber which would increase the pump down time and also degrade the system vacuum.

Is there a vacuum reading available?

Does the turbo pump sound as if it is operating at full speed, or does a high pitched whine suggest that it cannot reach full speed?

6.3.3. Electron Optics

Most Electron Optical (EO) problems will be evident by looking at the image on the monitor, and are likely to be caused by one of three possibilities:-

A power supply failure
An internal communications problem
An EO failure

A Power Supply Failure

This can be identified by the condition of the Status LED's at the rear of the instrument. They should be inspected, and a note taken of which LEDs are illuminated in both the STANDBY and OPERATE modes, and this information passed to your Service Centre.

An Internal Communications Problem

Will probably cause a series of EO faults, that is a number of functions will not work. For example, there may be no STIGMATOR correction **AND** no C3 LENS control, or some other combination, **BUT**, all the STATUS LED's will be illuminated. This, again, should be reported to your Service Centre.

An EO Failure

It is probable (though not definite) that only one EO function will not work, such as , one lens or that there is no Beam Shift available, or similar. This points to the likelihood that the EO system has failed, and this should be reported to your Service Centre.

6.3.4. The EHT System

An EHT set fault is likely to be shown by an Error Message generated by the instrument, however, in the absence of any Error Message, it could well be possible to identify a problem by the following symptoms:-

No electron beam possible, even though the filament is known to be OK.

2. No PM (Photo-Multiplier) noise (or snow), even with maximum signal brightness.

3. Reduced PM noise, even with maximum signal brightness.

4. Unstable beam, or filament current, especially noticeable in the emission image.

5. EHT tripping out.

6. Image drifting out of focus.

7. Unacceptable change in the instrument calibration.

1, 2 and 3 could also be caused by:-

a) a vacuum interlock problem
b) the wrong (or NO) detector being selected
c) the aperture changer being out of position (especially no.1)

4 and 5 can also be caused by:-

a) a cracked filament base
b) an incorrectly fitted or postitioned filament in the firing unit
c) dirty filament contacts either in the gun or in the EHT set.
d) a dirty firing unit, especially the grid aperture
e) an old filament
f) a dirty anode
g) an inadequate vacuum, especially when using high KV.

6 and 7 can also be caused by:-

a) a faulty Electron Optical system

Short Filament Life

If short filament life is experienced the following factors should be checked as they will almost certainly shorten a filament's operational life.

Ensure that the vacuum is good before firing up a filament. Although a filament can be fired up as soon as "*Vac Ready*" is achieved, the longer that it is possible to wait for the vacuum to improve, before using the filament, the better for filament life (and also signal quality!).

Filament positioning in the firing unit will also affect filament life for both better or worse, and the following tips may be useful for optimising the instrument performance and filament life:-

Tungsten Emitter

Fitting a New Tungsten Filament

When fitting a new filament to a firing unit, insert the filament as described in Section 2.2.4 *Changing the Filament*, ensuring the filament is visible in the centre of the firing unit aperture. Once the filament is central, using the firing unit tool supplied, screw the adjusting ring in until the filament is level with the front face of the firing unit aperture. Then bring the filament back as far as is required for your operating requirements according to the following guide:-

High Resolution/ Optimum Signal	$^3/_4$	turn back from front face of aperture
Medium Resolution/ General applications	1	turn back from front face of aperture
Low Resolution/ Maximum Filament Life	$1^1/_4$	turns back from front face of aperture

Additionally, for maximum beam stability, essential for long EDX/WDX analysis, as well as setting the filament back $1^1/_4$ turns, it is recommended that the Beam Current be reduced from 400uA to about 100-200uA. This will increase, still further, the life span of the filament.

Running Up a New Tungsten Filament

When running up a new Filament (Tungsten or LaB_6) it is good practice to select the New Filament checkbox on the Gun Set Up panel (**Beam-> Gun Setup**). This will select a run up routine tailored to the new filament. The field will automatically be deselected when the run up completes.

It is advisable to run a new Tungsten filament up carefully for the first time, if possible starting at a relatively low KV (5-10 KV) and letting the filament get warmed up, before gradually increasing to any working KV significantly above 5-10 KV.

That it may be noticed the filament position may drift having been heated, and might need to be re-centred after being heated up for the first time.

LaB_6 Emitter

The most important things to ensure long filament life with an LaB_6 emitter are basically the same as for Tungsten, but to remember that LaB_6 requires far more care and attention.

Fitting a New LaB_6 filament

The new emitter should be fitted, accurately, according to Section 2.2.4 *Changing the Filament*.

Running Up an LaB_6 Filament

A LaB_6 emitter should also be run up using the instrument's automatic procedure (selcting **Beam On** from the gun control box on the toolbar). The procedure is designed to maximise the filament life. Similarly the **Beam Off** procedure should always be used to run the gun down.

The only exception to this is when a Kimball LaB_6 emitter is installed for the first time. To ensure that the Kimball emitter is saturated at the correct filament current (1.8-2.0A) it should be run up slowly using the **Manual** option and the **Gun Set Up** panel. Once the filament has been saturated, the automatic routines can be used safely.

The most important factor of all in maximising LaB_6 life is to ensure that the emitter has been fully cooled down before exposing it to air, as otherwise, the LaB_6 crystal is liable to be severely damaged, or even destroyed.

LaB_6 Beam Current.

The beam current is fixed for LaB_6 operation, and not user changeable.

6.4. LEO Error Messages

There are many reasons why error messages may appears. With each message on-line help is available. In addition an alphabetical list of all error messages is included below.

6.4.1. Error Messages

ACQUIRE COMMAND ERROR

This error is given when a signal acquisition command fails.

Code numbers greater than 40 indicate the failure of an internal consistency check. Contact Leica

Code numbers less than 40 indicate that there is a failure in the communication to the DSP subsystem.

Please report the problem.

The code number given identifies the failing command as follows:-

1	SET_ZONE_K1_CMD
2	SET_ZONE_K2_CMD
3	SET_ZONE_ALPHA_CMD
4	SET_ZONE_BETA_CMD
5	SET_ZONE_SUB_CMD
6	SET_ZONE_PORT_CMD
7	SET_ZONE_OFFSET_CMD
8	SET_ZONE_GAIN_CMD
9	SET_ZONE_INVERT_CMD
A	CREATE_IDENTITY_LUT
B	CREATE_GAMMA_LUT
C	CREATE_INVERT_LUT
D	CREATE_USER_LUT
E	COMBINE_USER_LUTS
F	ENABLE_WINDOW_PLANE
10	SET_DETECTOR_MIXING
11	SET_FAVE_NOISE_REDN
12	SET_LINT_NOISE_REDN
13	SET_FINT_NOISE_REDN
14	SET_WINDOW_SEL
15	SET_FREEZE_CMD
16	COPY_USER_LUT
17	SEE_LUT
18	DEFINE_WINDOW

BRIGHTNESS RLM FAILED TO INITIALISE

This is an internal software error which should not occur.

If the fault should occur please contact Leica.

BRIGHTNESS RLM FAILED TO LOAD

This is an internal software error which should not occur.

If the fault should occur please contact Leica.

CANNOT PRINT COLOUR TIFF

This error is given when an attempt is made to print a TIFF file which contains a real colour image.

This file contains the configuration data (options etc) for the Right Hand Side of the SEM (electronics).

When this error occurs a default minimum configuration is assumed.

CONFIG FILE WRITE ERROR

This error is given when a file error is detected on writing the configuration file CONFIG.LEO.

This file contains the configuration data (options etc) for the Right Hand Side of the SEM (electronics).

The most likely cause of error is inadequate disk space.

COULD NOT READ DATA FROM NVRAM, READ FROM DATA.VAC

Configuration and calibration information relating to the column is saved in Non Volatile RAM.

This data could not be read correctly. The standby copy of this data held in file DATA.VAC has been used.

If the format of NVRAM data has been altered (check release notes) then on first startup of the system this error will be given.

If this is not the first use after an upgrade please report the problem.

DEFAULT.VAC FILE USED

Configuration and calibration information relating to the column is saved in Non Volatile RAM.

Due to a problem reading the NVRAM an attempt has been made to use the standby DATA.VAC file and either the data is corrupt, an incompatible version or the file could not be found. The file DEFAULT.VAC has been used which contains a default set of data. Any calibration data has therefore been lost.

Please report the problem.

EHT COMMS FAILED TO OPEN/CLOSE

This error is given when there is a failure in the communications to the EHT set. A Status code is given which will enable details of the fault to be determined.

'lease report problem

EHT FILAMENT BLOW

Thi message ndicates that the ame... has blown and shou be replaced.

An ted firin, uni dirty ontacts may this

EHT INHIBITED SYSTEM

ppli by the Vacuum system

typically arning

EHT SET COMMS TIMEOUT

fai respond within a reasonable period.

Please report probl

EHT SET INTERNAL

eported internal error

Pl report problem

EHT SET TRIPPED

This indi of th EHT set.

Tl typical used by

Dirt caing unit

ncorrectl tted (i.e too close aperture

Broken cracked

Inadequ ially used

HT SPURIO RESET

EHT set has been by soft

can Ope

FAILED TO ACTIVATE:-

ACQ. PROCESS
DSP PROCESS
EHT PROCESS
EO PROCESS
STAGE PROCESS
VAC PROCESS

These are internal software errors which should not occur. If the fault should occur please contact Leica.

FAILED TO LOAD:-

ACQUIRE RLM
DSP RLM
EHT RLM
EO RLM
IMEX RLM
OVERLAY MANAGER
STAGE RLM
VAC RLM

These are internal software errors which should not occur. If the fault should occur please contact Leica.

FAILED TO WRITE DATA.VAC

DATA.VAC is the standby file containing the configuration and calibration for the column.

An attempt has been made to update this file and has failed. This is typically due to lack of disk space.

Please check free space on disk and discard or archive files as necessary.

FAILED TO WRITE NVRAM

Configuration and calibration information relating to the column is saved in Non Volatile RAM.

An attempt has been made to update this information which has failed. The information will have been saved in the standby file DATA.VAC.

Please report the problem.

FAILED TO WRITE NVRAM AND DATA.VAC

Configuration and calibration information relating to the column is saved in Non Volatile RAM.

An attempt has been made to update this information which has failed.

DATA.VAC is the standby file containing the configuration and calibration for the column.

An attempt has been made to update this file and has failed. This is typically due to lack of disk space.

HRRU COMMAND ERROR

This error is given when a command to the HRRU fails.

Code numbers greater than 40 indicate the failure of an internal consistency check. Contact Leica.

Code numbers less than 40 indicate that there is a failure in the communication to the DSP subsystem.

Please report the problem.

The code number given identifies the failing command as follows:-

1	HRRU_FITTED
2	TAKE_LEFT_STORED_PHOTO
3	TAKE_RIGHT_STORED_PHOTO
4	TAKE_LIVE_PHOTO
5	GAMMA_OVERLAY_HRRU_LUT
6	GAMMA_HRRU_LUT
7	SET_FILM_SPEED
8	SET_LIVE_REPEAT
9	SET_CAMERA_TYPE
A	SET_HRRU_FOCUS
B	SET_HRRU_BRIGHTNESS
C	SET_HRRU_CONTRAST
D	SAVE_HRRU_CONFIG

IMEX FAILED TO INITIALISE

This is an internal software error which should not occur.

If the fault should occur please. Contact Leica.

INCORRECT IDENT CODE

This error occurs when the user interface attempts to access a system parameter in the Master DLL using an incorrect identification code. Contact Leica.

INVALID DEFAULT.VAC FILE

Configuration and calibration information relating to the column is saved in Non Volatile RAM. The file containing the initial default data is corrupt, an incompatible version or not found.

Please report the problem.

INVALID PARAMETER RECEIVED BY EHT SET

This error is given when the EHT set receives a command with invalid parameter(s).

This may be symptomatic of a communications error.

Please report the problem.

INVALID STAGE COMMAND

This error is given when a command is issued to move the stage to an invalid position (i.e. beyond the limits). This may be due to defining an invalid stage scan pattern which would result in limit violation.

INVALID STATE VALUE

This error occurs when the user interface attempts to set a system parameter in the Master DLL to an incorrect state. Contact Leica.

NO BITMAP IN CLIPBOARD

This failure is given when pasting an image from clipboard.

The clipboard does not contain a bitmap.

NVRAM DATA INCONSISTENT WITH CONFIG FILE

Configuration and calibration information relating to the column is saved in Non Volatile RAM.

The config file contains the configuration data (options etc) for the Right Hand Side of the SEM (electronics).

This message indicates that an inconsistency has been found. A default configuration is assumed.

This message should only occur where hardware changes have taken place (e.g. new board installed).

If necessary please report the problem.

BOTH COPIES OF DATA HAVE THEREFORE BEEN LOST.

Please report the problem.

OPEN CLIPBOARD ERROR

This failure is given when cutting/pasting an image to/from clipboard.

PARAMETER OR STATE CURRENTLY DISABLED

This error occurs when an attempt is made to access a parameter or state which is currently disabled by the operational rules.

PARAMETER RANGE ERROR FROM EHT SET

This error is given when the EHT set receives a command with parameter value(s) out of valid range.

This may be symptomatic of a communications error.

Please report the problem.

READ TIFF DIRECTORY ERROR

This error is given when reading a TIFF file.

The error occurred when reading the TIFF file internal image directory.

The file is corrupted.

This is typically due to a partially written file, truncated due to inadequate disk space.

READ TIFF HEADER ERROR

This error is given when reading a TIFF file.

The error occurred when reading the TIFF header.

This error may be given if an attempt is made to read a TIFF file (e.g. to determine it's header information) while the file is being printed.

Alternatively the file may have been corrupted.

This is typically due to a partially written file, truncated due to inadequate disk space.

READ TIFF IMAGE ERROR

This error is given when reading a TIFF file.

The error occurred when reading a TIFF image structure.

The file is corrupted.

This is typically due to a partially written file, truncated due to inadequate disk space.

STAGE COMMAND ERROR

This error is given when a stage command fails.

Code numbers greater than 40 indicate the failure of an internal consistency check/queueing. Contact Leica.

Code numbers less than 40 indicate that there is a failure in the communication to the stage/vac subsystem.

Please report the problem.

The code number given identifies the failing command as follows:-

1	SET_UP_STAGE_REQ
2	MANUAL_INIT_REQ
3	AUTO_INIT_REQ

4	LOWER_USER_LIMITS_REQ
5	UPPER_USER_LIMITS_REQ
6	TIGA_TIMER_TICK_REQ
7	SPEED_MOVE_REQ
8	STAGE_POSITION_REQ
9	BACKLASH_REQ
A	MOVE_MODE_REQ
B	ABORT_REQ
C	STAGE_PARAMS_V_START
D	STAGE_PARAMS_V_INC
E	STAGE_PARAMS_T_STEP
F	STAGE_PARAMS_BACKLASH_SPD
10	STAGE_PARAMS_BACKLASH_DST
11	STAGE_PARAMS_MAXIMUM_SPD
12	GET_ERROR_STATUS
13	CHECK_STAGE_PSU

STAGE X -15V FAILED

Please report the problem.

STAGE X +15V FAILED

Please report the problem.

STAGE Y -15V FAILED

Please report the problem.

STAGE Y +15V FAILED

Please report the problem.

STAGE Z -15V FAILED

Please report the problem.

STAGE Z +15V FAILED

Please report the problem.

TIFF ANNOTATION MEMORY LOCK ERROR

This error is given when attempting to lock in memory the image annotation associated with a worksheet.

This is typically caused by inadequate PC memory (or disk swap file). Close any other applications or free up space on hard disk. (N.B. swap file must be contiguous space).

TIFF FILE ERROR

This error is given when reading a TIFF file.

Either the file could not be found or error in reading first block.

TIFF IMAGE SELECT ERROR

This error is given when an inconsistent image selection is defined (e.g. no image selected).

UNKNOWN COMMAND RECEIVED BY EHT SET

This error is given when the EHT set receives a command it does not understand. This may be symptomatic of a communications error.

Please report the problem.

VACUUM BOARD -12V FAILED

Please report the problem.

VACUUM BOARD +12V FAILED

Please report the problem.

VACUUM BOARD -5V FAILED

Please report the problem.

VACUUM BOARD +5V FAILED

Please report the problem.

VACUUM COMMAND ERROR

This error is given when a vacuum command fails.

Code numbers greater than 40 indicate the failure of an internal consistency check. Contact Leica. Code numbers less than 40 indicate that there is a failure in the communication to the stage/vac subsystem. Please report the problem.

The code number given identifies the failing command as follows:-

1	CONFIGURE_FRONT_PANEL_REQ
2	SYSTEM_PUMPING_REQ
3	CONFIG_VIEWING_WINDOW_REQ
4	CONFIG_COLUMN_PUMPING_REQ
5	COLUMN_PUMPING_REQ
6	COLUMN_ISOLN_REPLY_REQ
7	EDX_CONFIGURE_REQ
8	WDX_CONFIGURE_REQ
9	FILAMENT_THRESH_REQ
A	EDX_THRESH_REQ
B	SET_4QBSD_QUADRANT_REQ
C	SET_4QBSD_VISIBILITY_REQ
D	SET_4QBSD_GAIN_REQ
E	SET_SCM_RANGE_REQ
F	SCM_READINGS_REQUIRED_REQ
10	VACUUM_TIMER_ROUTINE_REQ
11	WRITE_VACUUM_DATA_REQ
12	READ_VACUUM_DATA_REQ
13	OPER_WDX_GATE_VALVE_REQ
14	AIRLOCK_CONFIGURE_REQ
15	SET_TILT0
16	SET_TOUCH_ALARM_OFF
17	GET_VACUUM_ERRORS
18	GET_COMMS_PSU
19	SPECIMEN CURRENT MONITOR MEASUREMENT ERROR

The following errors refer to failures in the communications with the Vacuum subsystem:-

21	Comms timeout
22	Comms overrun
23	Unknown command
24	Invalid parameter
25	Out of range parameter
26	Command failed
27	Bad reply
28	Put Queue error
29	Get Queue error
2A	Wrong parameter

2B Space error
2C Reply parameter error

VACUUM SYSTEM LEAK

This error is given when the turbo pump takes an excessive time to reach its maximum speed, which is indicative of a vacuum system leak or poor sample preparation.

VAC SYSTEM PENNING GAUGE FAILURE

Please report the problem.

WRITE TIFF DIRECTORY ERROR

This error is given when writing a TIFF file.

An error occurred while writing the directory portion of the TIFF file.

This is typically due to inadequate disk capacity. Delete excess files.

WRITE TIFF HEADER ERROR

This error is given when writing a TIFF file.

Either the file cannot be created or an error occurred when writing the TIFF header.

This is typically due to inadequate disk capacity. Delete excess files.

WRITE TIFF IMAGE ERROR

This error is given when writing a TIFF file.

An error occurred while writing the image portion of the TIFF file.

This is typically due to inadequate disk capacity. Delete excess files.

6.4.2. Other Errors

In addition to the errors listed above there are two types of error which may (but should not) occur. The usual explanation of such an error is a failure in the LEO software.

WINDOWS$_{TM}$ APPLICATION ERROR

When a Windows$_{TM}$ application error occurs the user is presented with two options 'IGNORE' or 'CLOSE'. It is strongly recommended that the application should be closed. Further to this it is also recommended that the system should be powered off and on again to ensure that it is returned to a consistent state.

Actor Error

When an Actor error occurs the options available are 'Debug' or 'OK'. The only valid selection in this case is OK, but before selecting it please note down the information contained in the error window. Again a power off reboot should be performed (even if the LEO application appears to continue correctly).

When either of the above errors are encountered please inform Leica Cambridge of the circumstances leading to the error together with any information from the error window.

Keyboard Shortcuts

Keystrokes	Function
F1	Help
F1 + Shift	Context Sensitive Help
F2	Performs a hysteresis correction for C1, C2, C3
F2 + Shift	Toggles the Toolbar On/Off
F3	Closes all windows except the Toolbar and Status Bar
F3 + Shift	Toggles the PC Plane On/Off
F4	Step to next Mag Table entry, or undo centre feature mag change
F4 + Shift	Exits from mag table mode
F5,F6.F7,F8 (+/- Shift)	Executes installed macros
F9	Keys Help (Display this Information)
F11	Selects the Annotate/Measurement Function and toggles between Move and Edit Modes
F11 + Shift	Toggles the Datazone On/Off
F12	Stage scan step to next field
F12 + Shift	Stage scan step to previous field
<Tab>	Toggles coarse/fine adjustment
<Ctrl>	Centre point
<Home>	Resets Beam shift to zero
<Scroll Lock>	Toggle Freeze
<Pause>	Pauses/Resumes execution of the macro
*	Performs Find Image function
A	Performs combined auto-stigmation and fine auto focus routine
A + Shift	Performs an auto-stigmation routine
B	Use ARROW keys to control Beam Shift
F	Performs a fine auto focus routine
F + Shift	Performs a coarse auto focus routine

Further keyboard shortcuts overleaf

Guidance on Installing Other Windows™ Applications

Introduction

As new Windows™ applications are being created and updated from week to week, it is impossible to keep track of each one as it becomes available. Although a standard is slowly emerging for installing these third party applications, each application usually still has a unique set-up procedure.

A general set of guidelines however should be considered before installing any Windows™ application on your system.

- Always back-up your system disk before modifying it. The easiest way is to simply back-up you configuration files only; such as: `\CONFIG.SYS, \AUTOEXEC.BAT, \WINDOWS\*.INI,WINDOWS\*.GRP`. Although this is not a complete back-up, most of the old system configuration files will have been saved.

- Always read the application manual thoroughly before starting any installation.

  Always check that your hardware configuration is compatible with this application.

  Always check that you have at least the recommended hard disk space free for the application - use Windows™ File Manager.

  With Microsoft® Applications, choose Express Set-up if this option is available.

- Only choose advanced, or custom installation options if you are confident that you will be able to answer all the questions the installation program may ask you. These options usually require a good knowledge of how DOS, or the specific Windows™ Application works.

Below is a list of applications already installed and tested on Leica *Stereoscan 400* Series SEMs. If you are in any doubt as to the compatibility of a third party application you wish to install, telephone Leica Customer Care Department (44) 223 411411 or fax (44) 223 412776.

Microsoft® MS-DOS® 5.0
Microsoft® Windows™ 3.1
Microsoft® Word for Windows™ 2.0
Microsoft® Excel™ 4.0
Microsoft® Visual Basic™ 1.0
Zenographics Super Print 2.2
Micrografx® Picture Publisher® 3.0
Novell® Netware™ 3.11
Adaptec ASPI SCSI Disk Module 3.0

This list is by no means a commitment of Leica Cambridge to support any of the above.

It is most strongly recommended that only Leica supplied and distributed and proprietary branded software is used with this instrument. Leica will bear no responsibility for software corruptions or viruses caused by using pirated or suspect copies of any software. Indeed Leica reserve the right to take any action they deem necessary, in the event of a virus finding its way back to the factory from a corrupted instrument we have had to visit.

It is also highly recommended that back-ups are made regularly, especially of important and valuable data such as images.

Windows™ Expansion via the PC/AT Backplane

The *Stereoscan 440* PC/AT backplane consists of six 16-bit standard AT bus slots, two of which are used. If the *Stereoscan 440* has any factory fitted options, then some of the free slots may be occupied, for example the WORM drive interface occupies one slot.

Each card that is installed must not interfere with the cards already installed on the bus. There are four areas in which a card may interfere with the existing hardware, memory, I/O, DMA channels and interrupts.

The following sections deal with each of these areas in turn. Space is provided in each table which may be used to record the settings of installed cards.

Memory

The standard PC memory map for DOS reserves space in the 640kB to 1MB range for ROM BIOS code and display memory. The gaps left between the standard components are available for other options. For example a network card may have a small amount of SRAM in which to buffer communicated data, this SRAM would be configured in a spare address in the 640kB to 1MB range.

The following shows the memory map of a standard *Stereoscan 440* in the 640kB to 1BM range:-

Address	Description
A0000-BFFFF	VGA Display Memory
C0000-C7FFF	VGA BIOS ROM
C8000-CFFFF	
D0000-DFFFF	Leica Hardware
E0000-EFFFF	
F0000-FFFFF	System BIOS ROM

There are two regions available for use by optional cards, C8000 to CFFFF and E0000 to EFFFF. Any extra cards fitted should therefore be configured to use a range in these areas.

One further complication is that on the *Stereoscan 440* it is possible to map PC DRAM into the C8000 to CFFFF area and load device drivers into this area, thus saving space in the DOS application area. This will not happen if there is hardware occupying this range and therefore the EMM386.EXE used to control access to the area will have been loaded unnecessarily.

I/O Space

Expansion cards are most likely to include a set of registers with which to control the card. These are usually I/O registers occupying space in the I/O map of the *Stereoscan 440* PC (as opposed to the memory map, see above).

The cards fitted must be configured not to clash with the existing registers. There is however some scope for disabling registers on the PC card in the *Stereoscan 440's* when other options are fitted, this is a trade off between items. For example, if an internal modem card is fitted, then it is usual to configure it at the address occupied by a serial COM port and to disable the existing serial COM port.

The following shows the I/O map of a *Stereoscan 440*:-

Address	Device
000-01F	DMA Controller 1
020-03F	Interrupt Controller 1
040-05F	Timer
060-06F	Keyboard Controller
070-07F	Real Time Clock
080-09F	DMA Page Registers
0A0-0BF	Interrupt Controller 2
0C0-0DF	DMA Controller 2
0E0-0EF	
0F0-0FF	Reserved for maths co-processor
100-1EF	
1F0-1FF	Fixed Disk Controller
200-207	Reserved for Games Port

208-277	
278-27F	Reserved for Parallel Port Controller 2
280-2F7	
2F8-2FF	Serial Port Controller 2
300-307	Leica Hardware
304-377	
378-37F	Parallel Port Controller 1
380-3BF	
3C0-3DF	Video Controller
3E0-3EF	
3F0-3F7	Floppy Disk Controller
3F8-3FF	Serial Port Controller 1
400-877	
878-87F	Reserved for Diagnostic Port
880-FFF	

There are several ranges available for plug in cards.

12 bits of I/O address are decoded by the PC, whereas the 80 x 86 supports the use of 16 bit I/O addresses. This means that the PC will respond to addresses above the 1000 boundary.

DMA Channels

There are 8 DMA channels on a PC, two of which are used by the PC. These are as follows:-

Channel	Device
0	
1	
2	Floppy Disk Controller
3	
4	Cascade for DMA Controller 1
5	
6	
7	

The free channels 0, 1 and 3 are available for 8 bit DMA transfers, channels 5,6 and 7 are available for 16 bit transfers.

Interrupts

The interrupt controller supports 16 interrupts, which are used as follows:-

Interrupt	Device
0	Timer
1	Keyboard
2	Reserved
3	Serial Port 2
4	Serial Port 1
5	
6	Floppy Disk Controller
7	Parallel Port 1
8	Real Time Clock
9	Reserved
10	COM 3
11	
12	
13	Maths Co-Processor
14	Hard Disk Controller
15	

The remaining interrupts are available for any plug in cards

Standard Options

The following is a summary of settings used by cards that are supplied with options fitted by Leica:-

Peripheral	DMA Channel	Memory	I/O Register	Interrupt
SCSI	-	E400-E7FF	-	-
NETWORK	-	CC00-EFFF	280-29F	15
LASERPIX	-	C800-CBFF	-	12
ISIS TRANSLINK	1	-	2C0	5
LPT 2	-	-	278-27F	5
SCREEN MACHINE	-	-	318	15
COM 3	-	-	3E8-3EF	10
COM 4	-	-	2E8-2EF	11
OTHER				

Leica Service Centres and Approved Agents

Reporting software problems, please report to:-

Leica Cambridge Ltd
Clifton Road
Cambridge
CB1 3QH England
Tel: (44) 223 411411
Fax: (44) 223 412776

Please include software version number, system serial number together with a full description of the symptoms and circumstances leading to the error.

Service Problems

Please report to your local Service Centre.

Service Manager - SEM
Leica Instruments Pty Ltd
45 Epping Road, PO Box 21
North Ryde
New South Wales 2113
Australia

Service Manager - SEM
Leica Handelsges.M.B.H.
Koppstrasse 116
A-1160 Vienna
Austria

Zaf Sistemas
Rua Braganca Paulista 132
04727 Sao Paulo S.P.
Brazil

Service Manager - SEM
Leica Canada Inc
513 McNicoll Avenue
Willowdale
Ontario M2H 29C
Canada

Service Manager - SEM
Arotec Columbia SA
CRA 15 No 38-23
Apartado 050862
Bogota
Colombia

Service Manager - SEM
Micro Service
01 BP 1344
Abodjan 02
Cote D'ivoire

Service Manager - SEM
Leica A/S
Sydvestvej 102
DK-2600 Glostrup
Denmark

Service Manager - SEM
Nilomark OY
Box 111, Sinimäentie
FIN-02631 Espoo
Finland

Service Manager - SEM
Leica Sarl, Div LMG
Departement SCI
86 Avenue du 18 Juin 1940
F-92563 Rueil-Malmaison Cedex
France

Service Manager - SEM
Leica Vertrieb GmbH
Lilienthalstrasse 39-45
Postfach 1651
64606 Bensheim
Germany

Service Manager - SEM
Leica Instruments Ltd
19th Floor North, Cornwall House
Taikoo Trading Estate
28 Tong Chong Street
Quarry Bay
Hong Kong

Service Manager - SEM
Branch Office-India
Leica Cambridge Ltd (UK)
401 Vikram Tower
16 Rajendra Place
New Dehli 110 008
India

Service Manager - SEM
Jam Ara
Flat 6, No 1 2nd Street
Kouye Nasr
Tehran
Iran

Service Manager - SEM
SM Technology Ltd
7 Links View Close
Stanmore
Middlesex HA7 3AW
United Kingdom

Service Manager - SEM
Saifan Precision Instruments
4R Wallenberg Street
PO Box 13266
Tel Aviv 61130
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Service Manager - SEM
Assing Spa
Via Edoardo Amaldi N.14
00016 Monterotondo
Rome
Italy

Service Manager - SEM
Leica KK
Sarugakuho Building
8-8 Sarugakuho, 2-chome
Chiyoda-ku, Tokyo 101
Japan

Service Manager - SEM
Leica Instruments Ltd
3FL, Dongsung Bldg
52-1 Samsung Dong
Kangam-Gu Seoul
Korea

Service Manager - SEM
Harry Mazal SA
Laguna De Tamiahua 204
Col Anahuao Del Miguel Hidalgo
11320 Mexico DF
Mexico

Service Manager - SEM
Leica BV
Verrijin Stuartlaan 7
NL-2288 EK Rijswijk
PO Box 80
NL 2280 AB Rijswijk
Netherlands

Service Manager - SEM
Leica Mikroskopi AS
Ostre Akar Vei 206F
Postboks 48 Veitvet
N-0518 Oslo 5
Norway

Service Manager - SEM
Makkays Hi-Tech Services
Kulsum Plaza, Jinnah Avenue
Islamabad
Pakistan

Service Manager - SEM
Leica Pte Ltd
77 Ayer Rajah Crescent
Ayer Rajah Industrial Estate
Singapore 0513

Service Manager - SEM
SMM Instruments (Pty) Ltd
SMM House, Kyalami Boulevard
Kyalami Park,
Midrand, PO Box 11400
Vorna Valley, RSA 1686
South Africa

Service Manager - SEM
Leica Espana SA
Freixa 45
08021 Barcelona
Spain

Service Manager - SEM
Leica AB
Stromogatan 6
S-16440 Kista
Sweden

Service Manager - SEM
Leica AG
Kanalstrasse 21
8152 Glattbrugg
Switzerland

Service Manager - SEM
Saintech International Inc
12-2 Fl, No 57 Section 3
Sec 3, Taipei Ming-Sheng
Taipei
Taiwan ROC

Service Manager - SEM
Gulf and World Traders
PO Box 5527
Dubai
U.A.E.

Service Manager - SEM
Leica Inc
111 Deerlake Road
Deerfield, IL-60015
USA

Service Manager - SEM
Ola SA
c/o SR Ar Filio Martinez
CALLE "C"-QTA 123
Sector Santa Marta
Caracus
Venezuela

1. Software Options

Adjustable Reduced Raster

Introduction

This facility which is enabled when the **Reduced raster** licence is present allows the user to adjust the size and position of the reduced raster.

Operation

Selection

Adjustable reduced raster is selected in the same manner as the fixed reduced raster.

Procedures

When in reduced raster scanning and raster control (i.e. **RASTER** displayed in the window caption) the shape of the cursor will change according to the element of the raster which may be dragged (e.g. raster edge, corner or move whole raster).

There are scan rate restrictions according to the width of the raster. The software will reduce the scan speed automatically if this is necessary.

Advanced Annotation

Introduction

The advanced annotation software option provides the following:-

Alternative Fonts. The ability to select a greater range of annotation fonts.

Bitmap annotation objects. A Bitmap Object is a bitmap loaded from a file which may be embedded in an annotation panel or datazone.

Tag Annotation objects. A Tag object is a bitmap for use as a special marker of areas of interest on the image.

Operation

Selection

Annotation Fonts

When the advanced annotation licence is present Font2 through Font6 may be changed via Top Menu - Edit - Ann Fonts.

Tags and Bitmaps

Select annotation/measurement mode (Special Function key F11 or Top Menu - Edit - Annot/Meas).

Display the Annotation/measurement Popup Menu by pressing the right mouse button over the image.

The Tag and Bitmap entries are found on the popup menu under 'Annotation'.

Controls

Annotation Fonts

As Standard the annotation logical fonts Font0 through Font6 are the fonts Leica24, Leica16, Leica29, Arrows25, Arrows31, Math16 and Math24. Font2 through Font6 may be individually substituted with other TIGA fonts via Top Menu.

Bitmap

A Bitmap Object is a bitmap loaded from a file, which may be any .BMP file such as generated by Paintbrush or SDK Paint.

The use of the transparent colour is determined by the **Transparency** attribute.

A Bitmap is a non anchor object and may be embedded into annotation panels.

Tag

A **Tag object** is the same as a **Bitmap object** except in the following respects:-

A Tag is an anchor object and does not embed in panels.

The transparency attribute is initially set

Procedures

When a logical font is changed any annotation will be deleted.

Tags and Bitmaps may be moved and deleted in the same way as any other annotation objects.

1.3. Advanced Measurement

Introduction

The advanced measurement software option provides the following:-

Angular Measurement
Radial measurement
Vector Profile

Operation

Selection

Select annotation/measurement mode (Special Function key F11 or Top Menu - Edit - Annot/Meas).

Display the Annotation/measurement Popup Menu by pressing the right mouse button over the image.

The measurement entries are found on the popup menu under 'Measure'

Controls

Angular Measurement

The angular measurement facility comprises a related pair of measurement lines, a reference line (identified by the symbol AnR at it's midpoint) and a measurement line (identified by An at it's midpoint).

Each line has a 'blob' at the end which identifies it's centre of rotation. Each line may be adjusted in length, angle and position.

Associated with the objects is an annotation panel loaded from file An.ANN containing the measurement parameter which is:

An Angle between the reference line and the associated line

Where n is the instance identifier (i.e. 1 for first object created, 2 for second).

Radial Measurement

The radial measurement object is a circle which may be adjusted in diameter.

Associated with the object is an annotation panel loaded from file Dn.ANN containing the measurement parameter which is:-

Dn Diameter of circle

Where n is the instance identifier (i.e. 1 for first object created, 2 for second etc up to the limit permitted).

The dimensional measurement is derived from the **zone magnification** hence in situations where multiple zones are present (e.g. split or quad modes) the bounding rectangle must lie wholly within a zone. If the bounding rectangle is moved so that it spans zones the dimensional value is set to zero and a 'BEEP' given.

Vector Profile

Selecting the vector profile measurement facility brings up the profile display and creates a measurement line (with the identifier '**Prof**'). This line may be moved on the stored image and each end positioned individually.

When the line is dropped the trace on the profile display describes the grey levels lying under the line. Note that the leftmost point of the line is the leftmost position on the profile display.

The profile display has a pair of cursors which may be moved horizontally. The grey level at each cursor position is displayed on the profile display.

Associated with the measurement line is an annotation panel loaded from file PROF.ANN containing the profile width measurement parameter which is the distance (along the measurement line) reflected by the cursor spacing.

As with other measurement objects if the profile line crosses into another zone the measurement is invalidated and displayed as zero. A warning BEEP is given.

Procedures

The normal operational procedures for measurement objects apply to these measurement objects:-

In **Move** mode the individual objects may be moved about the image

In **Edit** mode selecting the object causes the 'handles' for the object to be displayed, these may be dragged or moved using the 'precision' technique described in the On-line Help. The object may be deselected either by selecting **escape** on the popup menu or, if the popup menu is displayed, by clicking the right mouse button over the image.

Angular Measurement

Each measurement object has two handles; one at each end, these may be moved to redefine the line.

Selecting the measurement parameter An in the annotation panel while in Edit mode, or selecting the parameter in the status list, will prompt for a new value. If a new value is entered the reference line remains fixed and the other line rotates to the specified angle.

Radial Measurement

Each measurement object has 9 handles; centre, N, S, E, W, NE, NW, SE, SW.

The centre handle moves the entire object without change in diameter.

The N, S, E, W handles adjust the diameter with the diametrically opposed point remaining fixed.

The NE, NW, SE, SW handles adjust the diameter with the centre remaining fixed.

Selecting the measurement parameter Dn in the annotation panel while in **Edit** mode, or selecting the parameter in the status list, will prompt for a new value. If a new value is entered the object is altered to the specified diameter with the centre point remaining fixed.

Vector Profile

The measurement line has two handles; one at each end, these may be moved to redefine the line.

Selecting the Profile Width parameter in the annotation panel while in **Edit** mode, or selecting the parameter in the status list, will prompt for a new value.

The profile cursors will be positioned to reflect the value entered. This is achieved by first moving the right cursor. The left cursor is moved if necessary.

1.4. Derivative

Introduction

This option allows an image to be enhanced by mixing it with the derivative of itself. This has the effect of highlighting vertical surface detail and edges within the image.

Operation

Selection

Derivative is selected from the Gamma/Diff option of the **Image** menu. This brings up the Gamma/Diff panel from which the derivative mixing can be controlled.

Controls

The derivative value is adjusted using the slider bar on the Gamma/Diff panel. It is also possible to enter the exact value by double clicking on the derivative value on the Gamma/Diff panel.

1.5. Dual Magnification

Introduction

This option allows a zoomed image to be displayed in split screen mode without having to freeze the image at the base magnification.

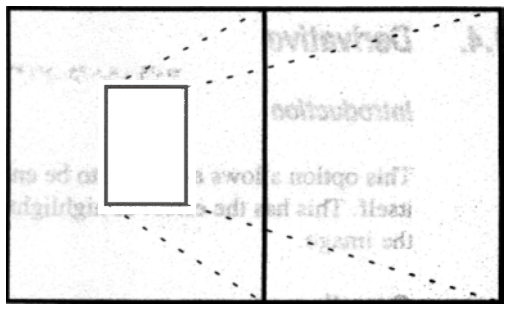
Operation

Selection

Dual Magnification can be selected from the **Scanning** menu or Dual Magnification icon in the Expert Toolbar.

Controls

When Dual Magnification is selected, the left hand image is enclosed by a green boarder which can be sized in the same way as a normal Windows$_{TM}$ panel. The right hand image displays the area of the specimen enclosed by the box on the left hand image. Thus the zoom factor is determined by the size of the box.



The position of the box can be adjusted in Raster mode by placing the cursor inside the zoom box and dragging it to a new position. Raster mode is selected by clicking over the image area with the right mouse button (bringing up the mode popup menu) and selecting **Raster**.

Procedures

Dual magnification can be used to highlight a feature of the image while showing a lower magnification view of the specimen, thus indicating how the feature is positioned on the specimen.

1.6. Dynamic Stereo

Introduction

The dynamic stereo software licence provides:

Dynamic Stereo Imaging

This facility sets the scanning to generate alternate images as a stereo pair which are merged into the image. The display Look Up Table is set into stereo mode such that the left image is displayed in Red, the right image is displayed in Cyan. The image is viewed using stereo glasses.

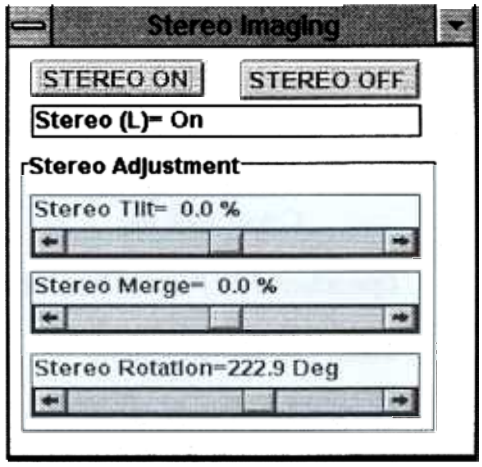
3 Dimensional Point To Point Measurement

This facility enables true depth measurement to be performed when viewing the image in stereo mode.

Operation of Dynamic Stereo imaging

Selection

Select Top Menu - Scanning - Stereo, this will display the Stereo Control Panel.



The Stereo Panel

Procedures

Set up

Set the magnification to a higher value than that to be used for stereo viewing and focus the image.

Select Stereo mode by pressing the **Stereo On** button.

Set **Stereo Tilt** and **Stereo Merge** to zero.

Vary the **Stereo Tilt** and observe the direction of image separation.

Adjust the **Stereo Rotate** to give separation in the horizontal direction

Adjust **Stereo Tilt** to give the required angle (separation) between the stereo images (N.B. the red image must be on left!).

Adjust the **Stereo Merge** to bring the images together.

Set the magnification to the required value.

To exit from Stereo mode press the **Stereo Off** button.

Exporting Stereo Images

Stereo images may be saved in TIFF files using the **TIFF Export**.

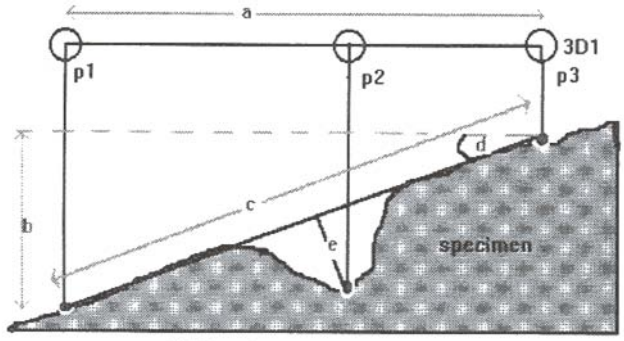
If the file is for subsequent import for viewing as a stereo image it should be saved as a Palletted Grey image. **DO NOT** select **as seen**.

A Stereo Image may be saved in a TIFF file for colour printing as a Colour TIFF file.

Operation of 3D Point to Point Measurement

Theory of Measurement

This facility comprises a line (identified by the symbol 3Dn) with three location points p1, p2, and p3. The image is focused on each point.



Side view

(a) apparent distance
(b) depth of plane
(c) actual distance on plane
(d) slope of plane
(e) true depth of feature

Selection

Select annotation/measurement mode (Special Function key F11 or Top Menu - Edit - Annot/Meas).

Display the Annotation/measurement Popup Menu by pressing the right mouse button over the image.

The measurement function is found on the popup menu under 'Measure'

Selecting the measurement will create a measurement object and select the Magnification and Focus as mouse control parameters.

Because of the interactive nature of this measurement it may only be performed on live images and may only be performed with Optibeam **ON.**

Controls

This facility comprises a line (identified by the symbol 3Dn) with three location points

The measurement object may be moved (dragged) when in move mode or the individual measurement points (p1,p2,p3) may be adjusted in position.

Associated with the objects is an annotation panel loaded from file 3Dn.ANN containing the measurement parameters which are:

3Dna : apparent distance
3Dnb : depth of plane
3Dnc : actual distance on plane
3Dnd : slope of plane
3Dne : true depth of feature

Where n is the instance identifier (i.e. 1 for first object created, 2 for second etc up to the limit permitted)

The dimensional measurements are derived from the **zone magnification** hence in situations where multiple zones are present all points must lie in the same zone. If a point is moved so that it is in a different zone the parameter values are set to zero and a 'BEEP' given.

Positioning the Points

In **Move** mode the measurement object may be dragged about the image

In **Edit** mode selecting the object causes the 'handles' for the object to be displayed (one at each of p1, p2, p3). To indicate which 'handle' would be selected if the left mouse button is pressed the 'handle' will change colour when the mouse cursor is in close proximity. These handles may be dragged or moved using the 'precision' technique described in the On-line Help. The object may be deselected either by selecting **escape** on the popup menu or, if the popup menu is displayed, by clicking the right mouse button over the image.

Recording Focus Distance for a Point

To select a location marker to record focus distance the measurement object must be selected in Edit mode and the 'handles' displayed.

When the cursor is over the location mark (becomes coloured RED) press the Ctrl key on the keyboard. You will see the location marker change from a round shape to a square shape - this indicates that it is now recording the focus position. Adjust the focus with the mouse (by holding down the mouse middle key) until the surface point is in focus

As the focus is changed you will observe the parameters being updated.

Procedures

3D Point to Point Sequence

1 Position the location markers p1, p2, p3 at suitable positions on the specimen.

2 Select in turn each location marker and record the focus distance.

Hint

For a quick 2 point depth measurement (surface is assumed horizontal) use only p1 and p3. Depth is given by **3Dnb**, ignore **3dne**.

1.7. Image Maths

Introduction

The Image Maths option enables the contents of the image store to be manipulated using by a 'Convolution Kernel", addition and subtraction of images, detection of image levels, area fraction measurement and histogram equalisation. This option requires the Image Maths Licence.

Convolution Transforms

The following types of convolution kernels may be used to transform the image:-

- Sharpen 1
- Sharpen 2
- Horizontal Edge Detection
- Vertical Edge Detection
- Laplace 1
- Laplace 2
- Prewitt
- Sobel
- Average
- Gaussian

Image Manipulation

The following types of image manipulation may be used on an image:-

- Copy Image A to Image B
- Copy Image B to Image A
- Exchange Image A and Image B
  Add Image A to Image B
- Subtract Image A from Image B
- Subtract Image B from Image A
- Find the minimum value of each pixel from Image A and Image B
  Find the maximum value of each pixel from Image A and Image B

Image Detection

The following types of image detection may be used on an image:-

- Black level Detection
  White level Detection
  Grey Level Detection
  Area fraction

Histogram Equalisation

The following types of histogram equalisation may be used on an image:-

Output Display Look up table equalisation
Image Store equalisation

Operation

Selection

Top Menu - Image - Image Maths

Controls

This panel handles the transformation of the image.

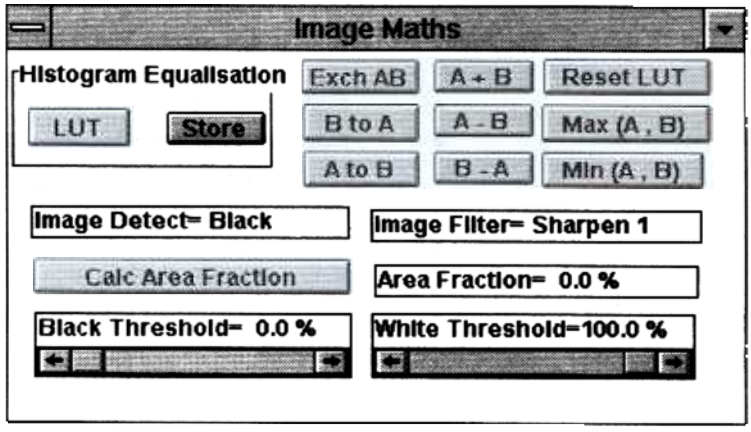


Image store A is the visible image store while image store B is the off screen image store.

Exch AB
This function freezes the image store and then exchanges the contents of the off screen image store with the contents of the image store.

B to A
This function freezes the image store and then copies to the image store the contents of the off screen image store.

A to B
This function copies to the off screen image store the contents of the image store.

A + B
This function freezes the image store and then adds the contents of the image store to the contents of the off screen image store and stores the result in the image store.

If the result is greater than 255 then the result is truncated to 255.

A - B
This function freezes the image store and then subtracts the contents of the off screen image store from the contents of the image store and stores the result in the image store.

If the result is less than 0 then the result is truncated to 0.

B - A
This function freezes the image store and then subtracts the contents of the image store from the contents of the off screen image store and stores the result in the off screen image store.

If the result is less than 0 then the result is truncated to 0.

It then transfers the contents of the off screen image store to the contents of the image store.

Reset LUT
This function will set the output look up table back to a linear transform.

A Min B
This function freezes the image store and then sets each pixel in the image store to the minimum grey level from the corresponding pixels in the image store and off screen image store.

A Max B
This function freezes the image store and then sets each pixel in the image store to the maximum grey level from the corresponding pixels in the image store and off screen image store.

Image Filter
This function defines which of the convolution kernels is to be swept across the image store producing a result for each pixel. The result is then normalised to the range 0.255.

This process can give effects such as High-Pass and Low-Pass filtering.

All the Kernels are a 3 by 3 matrix of signed integers.

Sharpen 1
Sharpens the image by combining a **Laplace 1** edge detection with the original image.

Sharpen 2
Sharpens the image by combining a **Laplace 2** edge detection with the original image.

Laplace 1
Detects edges in the image by performing a Laplace transform using the 4 neighbouring pixels. Laplace transforms are second order gradient functions.

Laplace 2
Detects edges in the image by performing a Laplace transform using the 8 neighbouring pixels. Laplace transforms are second order gradient functions.

Horiz Edge
Detects horizontal edges in the image.

Vert Edge
Detects vertical edges in the image.

Prewitt
Performs a non-directional edge detection by using a combination of horizontal and vertical edge detection.

Sobel
Performs a non-directional edge detection by using a combination of horizontal and vertical edge detection.

Average
Smoothes the image using a unity kernel.

Gaussian
Smoothes the image using a kernel with weights similar to a Gaussian (bell) function.

Image Detect
This function defines threshold criteria.

Black
Any pixel in the image store with a value less than the black threshold percentage will be coloured red.

White
Any pixel in the image store with a value greater than the white threshold percentage will be coloured red.

Grey
Any pixel in the image store with a value greater than the black threshold percentage and with a value less than the white threshold percentage will be coloured red.

Black Threshold
This slider bar controls how much of the image is detected when the Image Detect is either Black or Grey.

White Threshold
This slider bar controls how much of the image is detected when the Image Detect is either White or Grey.

Calc Area Fraction
This button initiates an area fraction calculation based on the detected area defined by the Image Detect State and the Black and White Slider bars.

Area Fraction
The result of a calc area fraction is displayed as a percentage of the image store.

Histogram Equalisation
The histogram equalisation uses the contents of the image store to calculate a look up table to transform the image to stretch the contrast of the image.

LUT
The image transformation is performed using the Output Lookup Tables, this allows the image to still be live.

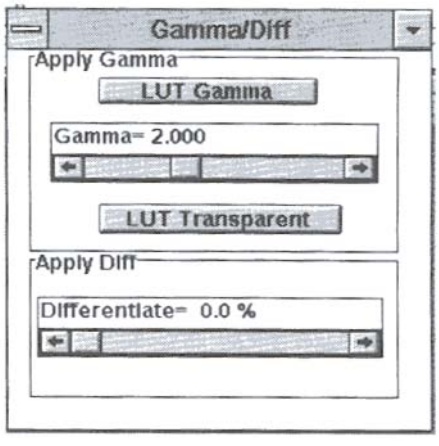
STORE
The image transformation is performed by converting the contents of the image store so the image store has to be frozen.

1.8. Gamma and Input LUT

Introduction

The Gamma and Input LUT licence provides control of the Input Look Up Tables.

There is one LUT for each zone (e.g. each quadrant in quad screen mode), the LUT transforms the input signal according to the pattern loaded. The pattern may be transparent (no transformation), a gamma transformation or other pattern as defined by the input LUT Window.



Operation of Gamma Facility

Selection

Select Top Menu - Image - Gamma\Diff, this will display the Gamma/Diff panel.

Procedures

To select the Gamma transform press the **Gamma** button.

Adjust the gamma parameter using the scroll bar.

To deselect the Gamma transform press the **Transparent** button.

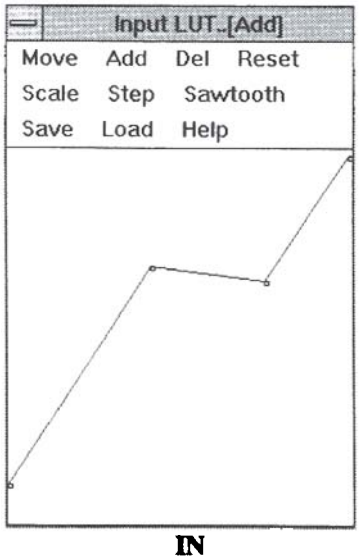
If there are multiple zones the anchor symbol should be positioned in the zone for which the LUT should be controlled.

Operation of the Input LUT Window

Selection

Select Top Menu - Edit - Input LUT

Controls



Overview

The input LUT is used to perform a translation on the input signal as defined by the pattern loaded into the LUT.

The pattern may be transparent (no transformation), a gamma transformation or a user defined pattern created in the Input LUT Window.

The LUT pattern is represented by a set of lines connecting points. Each point has as its co-ordinates the input grey level (X in the range 0.255) and the output grey level (Y in the range 0.255). The minimum definition is two points at X=0 and X=255. Other points may be added at other X values, only one point may reside at a specific X value.

The points list may be manipulated using the **add**, **move** and **delete** functions. In addition patterns of points may be created using the **steps** or **sawtooth** functions. The list of points may be **saved** or **loaded** from file. The width of the window may be changed using the **scale** function.

Reset
This resets the points list to a transparent function (2 points 0,0 and 255,255).

Add
This function will add a point to the trace at the position of the mouse cursor when the left mouse button is pressed, the point may be dragged to the desired position.

Move
This function will select the nearest point on the trace to the mouse cursor when the left button is pressed. The point may be dragged to the desired position. The point is constrained to lie between the two adjacent points.

Delete
This function will select the nearest point on the trace to the mouse cursor when the left button is pressed and delete it.

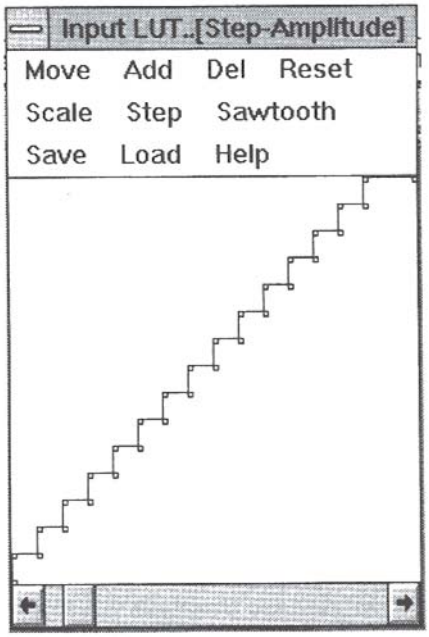
A minimum of two points must remain

Scale
This function controls the width of the window, either one pixel per grey level (width 255) or 2 pixels per grey level (width 512).

Save
This function saves the points list into a file with extension ULU (User defined Look Up table). By default the file will be saved in the user directory.

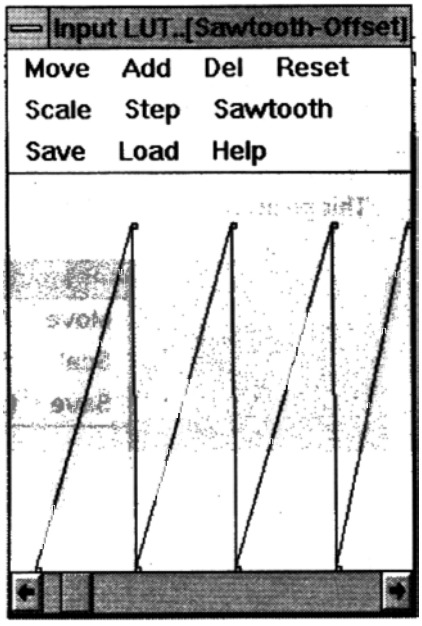
Load
This function loads the points list from a file with extension ULU (User defined Look Up table). By default the selection will be from the user directory.

Steps
This points function generates a set of points forming steps.



The amplitude, period and offset of the steps may be selected and adjusted using the scrollbar at the bottom of the window. The points generated may be individually moved, deleted etc.

Sawtooth
This points function generates a set of points forming a sawtooth waveform.



The amplitude, period and offset of the waveform may be selected and adjusted using the scrollbar at the bottom of the window. The points generated may be individually moved, deleted etc.

Procedures

The current mode may be selected from the menu as shown above.

Alternatively clicking the right mouse button over the window will toggle between functions.

The current function is displayed in the window caption.

1.9. Port Expansion from 4 to 8

Introduction

The port expansion licence increases from 4 to 8 the number of signal sources (e.g. detectors) that may be simultaneously connected.

Operation

Selection

When the licence is present the total connection capacity is increased.

After the licence is installed it is necessary to define the configuration, this is performed using the Configuration window which is displayed using Top Menu Tools - Service - configure.

If a supervisor password has been defined it must be entered to gain access to these facilities:-

Configuration - define signal sources present

- Select **detectors** from the configuration menu
- Check the identities of the sources fitted. A detector presence may not be altered if it is **connected** (see below)
- Select **OK**

Configuration - define any auxiliary inputs

- Select **Aux** from the configuration menu
- Enter the auxiliary detector characteristics (see below)
- Select **OK**

Configuration - define connections

- Select **connections** from the configuration menu
- Using the mouse manipulate the connections to achieve a suitable configuration (see below)
- Physically connect cables to agree with configuration
- Exit from Configuration menu

Procedures

Auxiliary Detector Characteristics

This window is used to define the identity, resource requirements and signal output for auxiliary detectors.

For information the standard detector information is displayed.

Aux information may not be changed if the **user password** has not been correctly entered, if the **detector** is not present or if the detector is **connected**.

A group box at the top left of the window displays the detector identities, selecting one of these with the mouse will display the resource requirements, signal output and detector name which in the appropriate instances may be altered.

The signal and resource information is used in the connections window to determine the suitability of plugging modules. Incorrect data may result in damage for which Leica Cambridge will not accept responsibility.

Connections Window

This window defines the plugging of detectors

The components involved are **connectors**, **detectors** and **resources** which may be selected by the mouse , dragged and dropped onto the receiving component or a parking area to indicate graphically the plugging of the system.

Connectors

On the right of the window are a set of connectors.

Connector properties are:-

Identity e.g. Connector 1
Label e.g. PL13, the back plate label
Signal e.g. 50mV, the signal level accepted

Each connector has a slot into which a detector may be plugged.

A configured **detector** may be dropped into an empty slot which has suitable electrical characteristics. While a detector is selected suitable empty slots are coloured RED.

A detector may be unplugged from a connector and dropped into the detector parking area (centre screen).

Detector

The detector parking area is the centre portion of the screen

Unused detectors are parked in this area.

A detector may require some **resources** in order to be configured and will have empty slots where these may be inserted. If a detector is not fully configured it cannot be picked up and suitable resources will be identified by a RED border.

If a detector is fully configured it may be picked up and a suitable empty **connector** slot will be coloured RED if one exists.

*The resource requirements of **auxiliary** detectors must be correctly specified.*

Detector Resources

Detectors may require none, one or two of the following:-

- PM1, PM2, PM3 : Photo multiplier supplies from the EHT set
- BSDA : Back scattered Detector Amplifier.
- SCMA : Specimen Current Monitor Amplifier.

The parking area for these objects when not in use is the left side of the screen.

A resource when picked up will cause the appropriate potential empty slots in detectors to be coloured RED.

Resources may not be unplugged from detectors in use (i.e. plugged into connectors).

1.10. RS232 Remote Control

Introduction

This option provides remote control of the S400 via an RS232 input port. The RS232 licence is required for this option. A document specifying the protocol used is available under a non disclosure agreement.

Operation

Configuration

The communications characteristics of the port to be used should be defined in **WIN.INI**

e.g.
[ports]
COM1:=9600,n,8,1,x

The communication port used by the Remote Control Application is defined in **WIN.IN.**

e.g.
[REMCON]
Primary = COM2
Secondary = COM4

Procedures

The remote control application is started by double clicking the Remote Control icon in Program Manager. The LEO software provides access facilities for Remcon, LEO should therefore be running before starting REMCON. Make sure Tools->Remote Control is selected.

1.11. Scan Rate (Expanded)

Introduction

This option allows a larger range of scan rates to be selected, ie pixel average values from 1 to 32k (in powers of 2).

Operation

Selection

The additional scan rates can be selected in the usual ways, ie:-

The scan plus and scan minus icons
2. The + and - keys on the keyboard
3. Via the **Scan->Speeds** pull down menu

Procedures

Expanded scan speeds are used in exactly the same way as the standard set of scan rates.

1.12. Signal Mixing

Introduction

This option provides the ability to mix the live signals from two detectors.

The signals are referred to as **Signal A** (the normal signal) and **Signal B** (the mix signal).

Each of signal A and Signal B may be chosen from any of the connected detectors.

The mix proportions may be adjusted.

Operation

Configuration

If a Supervisor password has been defined it must be entered to perform the following actions.

Select the configuration window using Top Menu - Tools - Service - Configure.

Select **Options** from the Configure menu.

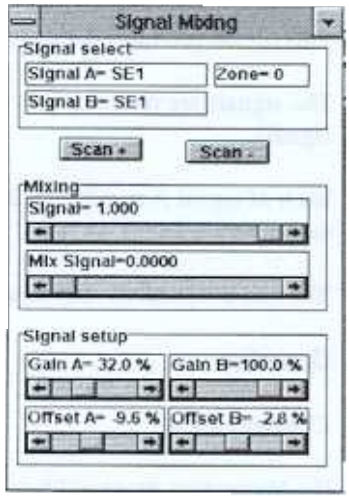
Select the **Mixer** state to **Present.**

Exit from the Configuration Window.

The functions below will only operate if the Mixer State is present and the signal mixing licence is installed.

Selection

The signal mixing panel is displayed using Top Menu - Image - Signal Mixing.



Controls

Signal A
To alter the signal source for Signal A click on the definition and select from the list displayed.

Signal B
To alter the signal source for Signal A click on the definition and select from the list displayed.

Scan +
This increases the scanning speed by changing the pixel average dwell time.

Scan -
This decreases the scanning speed by changing the pixel average dwell time.

Mixing
The mixing controls allow the relative proportions of signal A and B to be determined. If the Signal parameter is adjusted, then the Mix Signal parameter will be changed so that the sum of the two parameters is always 1 (and vice versa).

1.13. Stage Centre Feature

Introduction

This function allows the user to draw a box around an object in the field of view, bring it to the centre and increase the magnification such that the object fills the field of view.

The function is provided as part of the 'Centre Feature and Stage Map' software option.

A prerequisite is a motorised stage.

Operation

Selection

The function may be selected as follows:-

- From the Top Menu - Stage/Vac - Feature
- From the Stage Move popup menu (press the right mouse button over the stage move window)
- Via the Centre Feature Macro function
- Via the Centre Feature Icon Function

Controls

There is a LINK facility (use Top Menu - tools - links) provided which enables the user to inhibit the use of beam shift for this function below a specified magnification.

Procedures

When this function is performed the initial magnification is saved, and may be restored by pressing special function key F4. Note that subsequent presses of F4 perform Mag Table functions (until another centre feature function is performed).

When the function is selected other windows will be temporarily hidden and messages in the image window caption area will guide you through the procedure.

Select one corner of the area required

Over the image click on one corner of the area of interest. Once this point is selected there is no need to hold the mouse button down. A rectangle will be drawn representing the area. If required you may cancel this function with the right mouse button.

Select the opposite corner of the area required

Over the image click on the opposite corner to complete the selection of the area of interest. Alternatively click the right mouse button to reselect the top left corner.

The software will attempt to use the beamshift to move the area to the centre of the screen. If the movement required is outside the range of the beamshift then a stage movement will be used, with the positioning such that following the move the beamshift will be zero.

The magnification will then be increased such that the defined area fills the field of view.

F4 will return the magnification to its previous value.

1.14. Stage Centre Point

Introduction

This function allows the user to point to an object in the field of view and bring it to the centre. The function is provided as part of the standard software but requires the stage motorisation option.

Operation

The function may be selected as follows:-

- From the Top Menu - Stage/Vac - Centre Point
- From the Stage Move popup menu (press the right mouse button over the stage move window)
- Via the Centre Point Macro function
- Via the Centre Point Icon Function
- By pressing Ctrl Tab on the keyboard

There is a LINK facility (use Top Menu - tools - links) provided which enables the user to inhibit the use of beam shift for this function below a specified magnification.

Procedures

When the function is selected the cursor will change to a four arrow symbol ***(see margin)*** and the caption of the image window will indicate that the user is expected to select a point with the left mouse button or cancel the function by pressing the right mouse button over the image window.

The software will attempt to use the beamshift to move the point to the centre of the screen. If the movement required is outside the range of the beamshift then a stage movement will be used, with the positioning such that following the move the beamshift will be zero.

1.15. Stage Control

Introduction

This facility provides the software control for a motorised stage. The functionality is provided as part of the standard software but requires the stage motorisation hardware option.

Operation

Configuration

The stage type and the axes that are motorised must be defined in the configuration window options list.

The Configuration window is displayed by selecting Top Menu - Tools - Service Configure.

Limits and Touch Alarm

On each axis there are 7 states:-

None
Low Outer Limit
Low Inner Limit
Low User Limit

- High User Limit
- High Inner Limit
- High outer Limit

The current limit state may be displayed in the Status window by selecting the parameters X limit hit, Y Limit hit and Z limit hit.

A user limit is a software limit. They may be selected in the status window (Stage High X, Stage Low X, Stage High Y, Stage Low Y, Stage High Z and Stage Low Z). To change a user limit click on the required limit and enter the value. Note the limits may be set by a macro.

If a user limit is hit a warning is given and the stage slowed to a halt. Position is not lost.

If an Inner limit is hit the motor is slowed to a halt and the axis may only be moved away from the limit.

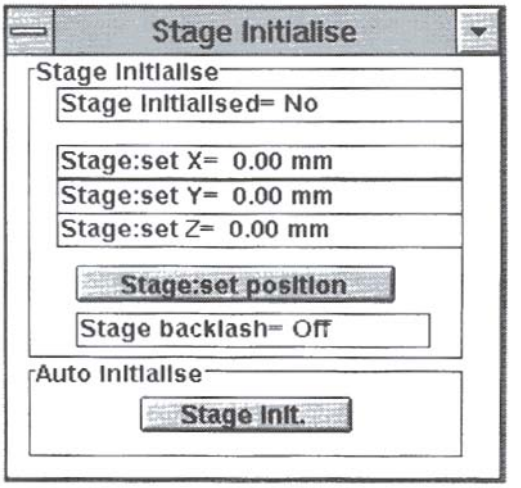
If an outer limit is hit the motors are stopped and may only be moved manually. Position is lost.

If the touch alarm is detected a buzzer is sounded, an error is given, position is lost and the motors must be moved manually until the buzzer is silent.

Controls

Stage Initialisation

The Stage Initialisation panel is used to define the actual position and is displayed by Top Menu - Stage/Vac - Stage Init. On initial installation, or if an axis outer limit limit has been hit, or if the touch alarm has occurred the stage position is unknown. The Stage Initialisation panel is used to define the actual position and is displayed by Top Menu - Stage/Vac - Stage Init.



There are two methods of defining the stage position:-

Manual initialisation Click on Stage:Set X and enter the actual position by reading the micrometer position (note that a line is drawn on the micrometer showing the position of the decimal point).

Repeat for Y and Z axes. Then press Stage:Set Position.

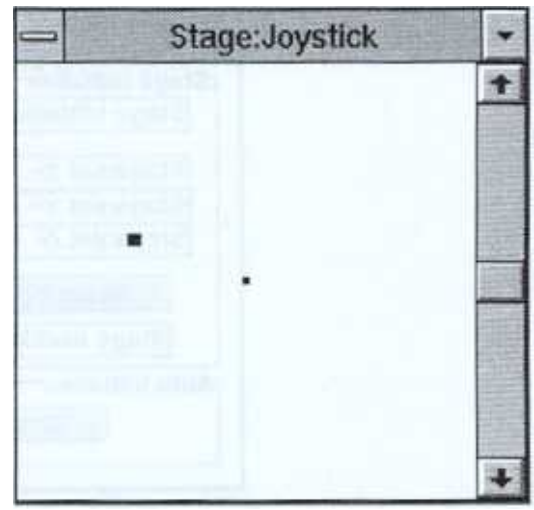
Auto Initialisation Click on Stage Init, the stage will move until the inner limits are found, this will determine the origin.

Stage Move Window

The Stage Move window is used to display the current stage position and to provide a control interface.

The Stage Move Window may be displayed by:-

Top Menu - Stage/Vac - Stage move
The Icon Function 'Stage Move'
The Macro function 'Stage Move'



The stage Move window comprises a square area which represents the XY co-ordinate space of the stage together with a scroll bar on the right hand side which is used for stage Z control.

The stage may be in either Joystick or Goto mode. The caption indicates the current mode. Initially the stage is in Joystick mode, Goto mode is only possible when the stage has been initialised. These functions allow the stage to be moved using the mouse.

Popup Menu

The stage window mode and additional functions are provided by a popup menu. This menu is displayed by pressing the right mouse button over the Stage Move Window.

Joystick Mode

When in joystick mode the mouse may be used in the stage window as a joystick. The current position of the stage is indicated by a RED dot. A BLUE dot indicates the joystick position. The Joystick dot may be dragged away from the centre causing the stage to move in the required direction. The further from the centre the faster the stage speed. The speed is also adjusted according to magnification. Releasing the mouse button causes the joystick marker to return to the centre and the stage to stop.

In joystick mode the stage Z scrollbar thumb button is centrally positioned and may be dragged up or down to move the Z travel. Again the further from the centre the faster the movement, and movement is stopped when the button is released. The scroll bar increment and decrement functions give a single shot magnification related movement.

Joystick mode may be used before the stage is initialised (i.e. when it's true position is entered) and in this case the position indication may be erroneous.

Goto Mode

The stage may only be selected to GOTO mode when it has been initialised (i.e. when it's true position has been defined). In this mode the window represents the XY co-ordinate space of the stage and it's current position is indicated by a RED dot. The mouse may be used to select a point within this space to define the absolute stage position required. A BLUE dot is used to indicate the required position. When the required position is requested the stage will move to it. If a stage request is made while the stage is already in motion then the current motion will be aborted.

The stage Z scroll bar in GOTO mode indicates the current Z position by the thumb button, this may be dragged to a desired ABSOLUTE position or the coarse/fine scroll bar functions used to adjust the position of Z.

Backlash

Two functions are provided on the popup menu, a backlash state which toggles on/off to indicate that backlash correction should be performed when in Goto mode, and an Execute Backlash command which initiates a backlash correction manoeuvre.

Off

This function on the popup menu closes both the Popup menu and the Stage Window.

Quit

This function on the Popup Menu closes the Popup Menu

Keyboard Control

The cursor (arrow) keys may be used to control the stage as follows:-

Use of ARROW keys for Stage XY control

If **S** is pressed the ARROW keys are temporarily assigned to control the stage XY position. While an ARROW key is held down the stage moves in the appropriate direction. Steps may be coarse or fine as defined by the toolbar icon or using the *tab* key.

If Esc is pressed while the stage is moving the movement is aborted.

To Return to default use of the ARROW keys press **I.**

Use of ARROW keys for field stepping

If **shift S** is pressed the ARROW keys are temporarily assigned to perform field stepping.

While in this mode pressing an ARROW key will step the image by an exact field size in the appropriate direction. In SPLIT and QUAD modes the step size is correspondingly sized. The movement is achieved by a combination of stage movement and beamshift as used in the centre pointfunction.

To Return to default use of the ARROW keys press **I.**

Use of ARROW keys for Stage Z control

If Z is pressed the ARROW keys are temporarily assigned to control the stage Z position.

While an up/down ARROW key is held down the stage moves in the appropriate direction.

Steps may be coarse or fine as defined by the toolbar icon or using the *tab* key.

If Esc is pressed while the stage is moving the movement is aborted

To Return to default use of the ARROW keys press I.

1.16. Stage Co-ordinate Store and Recall

Introduction

This option allows a list of stage positions together with magnification, focus and beamshift to be saved so that the user may easily return to the positions. Optionally the position may be given a symbolic name. Lists of positions may be saved to or loaded from file.

A prerequisite is a motorised stage.

Operation

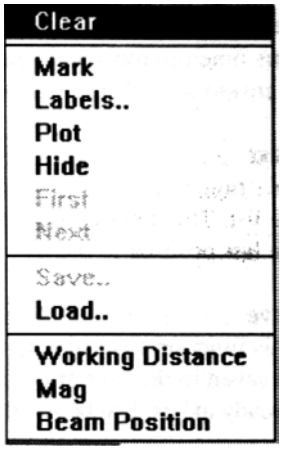
Selection

The position recording functions are provided on the popup menu associated with the Stage Move window. To display the Stage Move window select Top Menu Stage/Vac - Stage Move. Pressing the right mouse button over the Stage Move window will display the popup menu. The menu item **Record** provides the co-ordinate store and recall functions

The stage must be initialised for the functions to be operational (i.e. the correct position of the stage must be known).

Controls

The submenu provides the following functions:-



In addition Macro functions are provided for Mark Position, Goto First mark and Goto Next mark.

Procedures

The list of points is held in memory and on LEO start up it is initially empty

Clear
This function clears the points list. Confirmation is requested.

Mark
This function saves the current stage position, working distance (focus), magnification and beam shift position in the points list without a label. This function is available as a Macro function.

Labels
This function displays the STAGE LABEL dialog box which is used to save the current stage position , working distance (focus), magnification and beam shift position in the points list with a user defined label. It is also used to go directly to labelled positions. For more detail see below.

Plot
This function displays a black dot on the stage window for each position stored in the points list.

Hide
This function removes from the stage window the position markers displayed by plot.

First
This function moves the stage to the first position stored in the list. The function is greyed if the list is empty. This function is also available as a Macro function.

Next
This function moves the stage to the next sequential (chronological) position in the list. The function is greyed out if the stage is not at the first position or is at the last position in the list.

Save
This function saves the points list in a file with the extension XYZ. The file will be saved in the user directory by default. Confirmation is requested if the file already exists. See below for file format.

Load
This function loads the points list from a file with extension XYZ. The previous contents of the list will be overwritten.

Working Distance
The current working distance (focus) is saved whenever an entry is made into the points list. If this function is selected then whenever the stage is moved to a saved position the working distance is set to the stored value.

Magnification
The current base magnification is saved whenever an entry is made into the points list. If this function is selected then whenever the stage is moved to a saved position the magnification is set to the stored value.

Beam Position
The current beam shift distance (Beam offset) is saved whenever an entry is made into the points list. If this function is selected then whenever the stage is moved to a saved position the beam offset is added to the stage position (within the step size limitations of the appropriate stage) and the beam shift set to the sub step component.

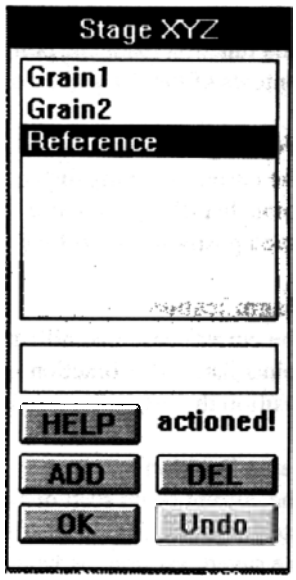
The points list is not destroyed by closing the Stage Move or Stage Map Windows. Confirmation is requested on Shutdown of LEO if a points lists exists which has not been saved.

Hint

Create macros for special function keys to call each of the Mark, First and Next functions (e.g. F7 for mark). When roaming the specimen pressing F7 will then record the position for you to revisit later.

Stage Labels Dialog Box

The dialog box displays the currently stored labels in a list box (in alphanumeric order). Below the list box is a text entry window, characters typed here will be matched to the entries in the list box and the nearest match highlighted. Selecting a list box entry will cause the stage to move to the stored position.



To indicate if the stage is currently positioned at the highlighted entry the legend "actioned!" will be displayed when this is the case.

Stage Label : ADD
This function brings up a data entry dialog box into which the user may type any string of text to identify the current stage position. OK will enter the position and label into the list, CANCEL will remove the data entry box without action.

Stage Label :DEL
This function deletes the currently highlighted list box entry from the list.

Stage Label : UNDO
This function causes the stage to move to the position which was current when the dialog box was requested.

Stage Label : OK
This function removes the stage label dialog box, all list entries are preserved.

File Format
The format of the XYZ file is as follows:

XYZ	Fixed identifier
Stage XYZ	Fixed identifier
Stage Position	Fixed identifier
c:\user\default\three.XYZ	File details

3	Number of points
Reference	Label for first point
4.013e-002	X (meters)
2.956e-002	Y (meters)
5.07e-003	Z (meters)
0	Reserved
0	Reserved
0	Reserved
16.55287743	Magnification
2.643531375e-002	Working Distance (Meters)
0	Beam shift X (Meters)
0	Beam Shift Y (Meters).
	Second point - no label
3.687e-002	X
3.163e-002	Y
5.07e-003	Z
0	Reserved
0	Reserved
0	Reserved
16.55287743	Mag
2.643531375e-002	WD
0	Beam shift X
0	Beam Shift Y
	Third point - no label
73.968e-002	X
3.281e-002	Y
5.07e-003	Z
0	Reserved
0	Reserved
0	Reserved
16.55287743	Magnification
2.643531375e-002	Working Distance (Meters)
0	Reserved
0	Reserved

1.17. Stage Map

Introduction

The Stage Map function enables a low magnification frozen image in Zone 0 (i.e. the left half in split screen mode or the top left quadrant in quad screen mode) to be used as a map for selecting stage positions.

The function is provided as part of the 'Centre Feature and Stage Map' software option. A prerequisite is a motorised stage.

Operation

Selection

Stage Map is only operational if the stage is initialised.

Stage map may be selected by:-

Top Menu - Stage/Vac - Stage Map

- Macro Function Stage Map
- Icon Function Stage Map

Controls

To use this function:-

- Select a mode (SPLIT or QUAD)
- Adjust the stage position at a low magnification such that the required area of the specimen is wholly displayed
- Select Stage Map
- This will cause the zone to be frozen and the current stage position and magnification to be saved for the map
  The stage map function requires accurate positioning of the stage, hence a warning will be given if the backlash correction is not enabled

Procedures

While over the map the cursor will be a four arrow symbol ***(see margin)*** but normal elsewhere.

The magnification may now be increased and the other live zone(s) used to observe features of interest. The mouse may be used to select a point on the 'map' and the stage (and hence live image) moved to the required position.

To display the popup menu press the right mouse button over the map.

The Record functions (available if Stage Co-ordinate store and recall licence is present) may be used to save and recall positions. This is the same points list as used by the Stage Move Window.

The map may be removed using **Close map** from the popup menu or by selecting Normal mode scanning.

Any positions recorded are preserved and may be saved/used by the Stage Move Window Record functions.

Alternatively **Remap** from the popup menu will save a new stage position and magnification for the map.

Hint

If on requesting stage map the stage backlash correction is off and you require accurate positioning:-

Unfreeze the image (press *scroll lock* on the keyboard).

2. Select backlash correction to be on (√) from the popup menu.

3. Select execute backlash from the popup menu.

4. Select Remap from the popup menu.

1.18. Stage Scan

Introduction

The Stage scan software option provides the facility of using the motorised stage to inspect an area of the specimen as a series of fields.

There is a choice of four types of scan pattern, and several methods of defining scan areas.

Once the scan pattern is defined commands may be used to step through the fields.

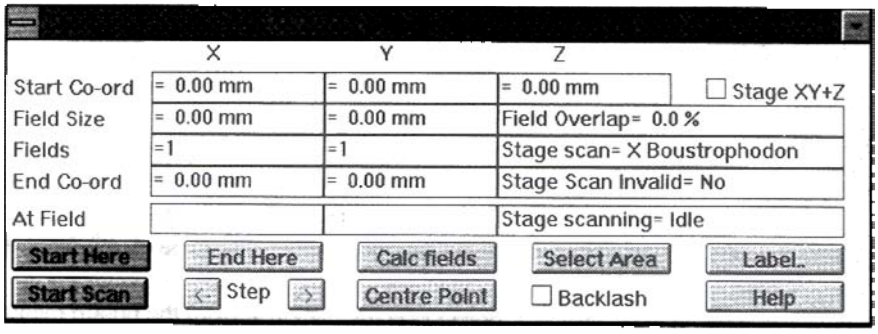
The stage window also provides buttons which give access to the label and centre point functions (if licensed).

Operation

Selection

Operation of this facility is only enabled when the stage has been initialised.

The Stage Scan Window is displayed by selecting Top Menu - Stage/Vac - Stage Scan.



Controls

Stage Scan Patterns
There are four different field patterns, for this example assume there are 9 fields numbered 1 through 9.

X Boustrophodon 1 2 3 6 5 4 7 8 9	**X Raster** 1 2 3 4 5 6 7 8 9
Y Boustrophodon 1 6 7 2 5 8 3 4 9	**Y Raster** 1 4 7 2 5 8 3 6 9

Stage Scan Start Position
These are the X, Y and Z positions at which the stage scan will start.

The stage will move to this position on execution of the **Start scan** command.

The values may be defined manually (select the parameter with the mouse), by the **select area** button or by the **start here** button.

Field Size
The X and Y field size parameters define the distance the stage will step between fields.

The values may be defined manually, or will be entered by the **calculation** function.

Fields
The X and Y fields parameters define the number of fields the stage will step in the appropriate direction for the scan pattern.

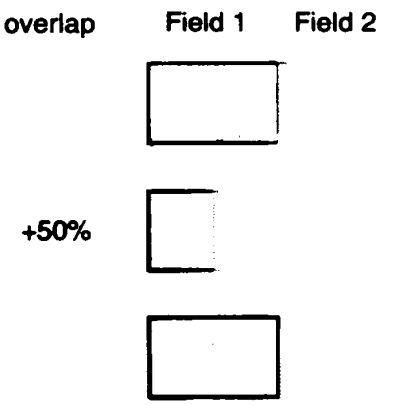
The values may be defined manually, or will be entered by the **calculation** function.

Stage Scan End position
This is the X Y position which will be used in the calculation function and defines the position at which the stage scan will end.

The values may be defined manually, by the **select area** button or by the **End here** button.

At Field
The X and Y **At Field** parameters define at which field the stage is currently positioned. These parameters may be used as annotation so that the correct field identity may be identified in video prints.

Field Overlap
This parameter may be set manually and is used in the **calculation** function to determine the amount of overlap between fields. A field overlap of 0% will result in a set of fields which butt together.



Stage Scan Invalid
This indicates if the current stage scan pattern is invalid or not.

The scan will be invalid if the combination of scan parameters would take the stage beyond the user defined stage limits (in X, Y or Z).

Stage Scanning
This parameter indicates the current state of stage scanning:-
Idle Stage scan has not been started
At Field Stage is positioned at a field in the scan pattern
Moving The stage is in motion as a result of a Next field Command
At End The scan pattern has been completed

Stage XY+Z
This state is used when tilt compensation is operative.
If the checkbox is empty then no Z movement is made.
If the checkbox is marked then movement in Z is made relative to the startZ when movement is made in the tilt direction.

Backlash
If this box is checked backlash correction will be performed on each stage step.

Start Here
Executing this command will set the **start co-ords** to the current stage position.

End Here
Executing this command will set the **End co-ords** to the current stage position.

Calc Fields
This function performs the following calculation.
The field of view is determined from the current magnification (i.e. the physical dimensions on the specimen of the image in normal mode).
The field of view is used with the **field overlap** to determine the **field size.**
Using the **Start co-ord**, the **End Co-ord** and the **field size** the **number of fields** is determined.

Select scan area
This function is used to set the **Start co-ord** and **End Co-ord** when the whole of the area to be scanned is visible at a suitable low magnification.

It is used as follows:-

1 **Press the select area button.**
Messages will be displayed in the image caption area to guide you.

2 **Select one corner of the area to be scanned**
Over the image click on one corner of the area to be scanned. Once this point is selected there is no need to hold the mouse button down. A rectangle will be drawn representing the scan area. If required you may cancel this function with the right mouse button.

3 **Select the opposite corner of the area to be scanned**
Over the image click on the opposite corner.

Stage Scan : Commands
There are three commands provided:-

Start scan
This moves the stage to the start position and sets the scan status to **at field**.

2. **Next step** (Button labelled ->)
This moves to the next field in the scan pattern. If the current field is the last field in the pattern the stage is not moved but the scan status is set to **end scan**.

3. **Previous step** (Button labelled <-)
This moves to the previous field in the scan pattern. If the current field is the first field in the pattern the stage is not moved but the scan status is set to **end scan**.

*The special function key **F12** performs a **Next step** function and **shift F12** performs a **Previous Step** function.*

Procedures

Methods of defining the stage scan area

1 Manually enter the **start co-ords** and **end co-ords** and then use **calc fields**.

2 Manually enter the **start co-ords** , **field size** and **number of fields**.

3. Position the stage at the location where the scan is to start (using the **stage move window** or **centre point** then press **start here**. Then position the stage at the location where the scan is to end and press **end here**.

4. Where the whole area to be scanned can be viewed at a suitable low magnification use **select area.**

The stage position represents the position of the centre of the image.

Hints

Stage macro functions

Examples of macros including stage functions are given below, associating them with special function keys provides some useful functionality.

Macro F8
Comment:1-Apr-1993 8:49 Stage scan macro
If Stage Scan Invalid=No then
Stage start scan
While Not Stage scanning=end scan
Delay[5]:
Stage Next Field
End While
Else
Message:Scan is invalid
End If

If this macro is executing the ***pause*** *key will cause the macro to be temporarily suspended. Pressing* ***pause*** *again will resume the macro. This is particularly useful with the window and overlay planes turned off, providing a 'survey' function.*

Macros using the stage position recording functions.

Macro F5
Comment: 1-Apr-1993 12:12
Func:Stage:Mark Position

This macro executes the **mark point** so that the location of fields of interest may be recorded for future inspection.

Macro Shift F6
Comment: 1-Apr-1993 12:13
Func:Stage:Goto First mark

This function moves the stage to the first recorded position

Macro F6
Comment: 1-Apr-1993 12:14
Func:Stage:Goto Next mark

This function steps to the next recorded position.

1.19. Static Stereo

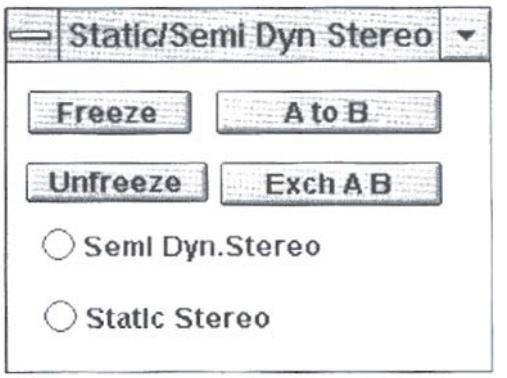
Introduction

The Static Stereo option enables the user to either combine two stored images or one stored image and one live image to form a stereo image in the image store. This option requires the Static Stereo Licence.

Operation

Selection

Select Top Menu - Scanning - Static Stereo, this will display the Static/Semi Dyn Stereo panel. This panel handles the production of static and semi dynamic stereo images.



Freeze
This function will freeze the image store.

Unfreeze
This function will unfreeze the image store.

A to B
This function copies to the off screen image store the contents of the image store.

Exch. A B
This function freezes the image store and then exchanges the contents of the off screen image store with the contents of the image store.

Semi Dyn. Stereo
This radio button will freeze the right hand part of a stereo image in the image store, keeping the left hand part of the stereo image in the image store live.

Static Stereo
This radio button will combine the left hand image of a stereo pair of images from the off screen image store with the right hand image of a stereo pair of images from the image store.

Procedures

Semi Dyn. Stereo
Set the sample to one position, press the **Semi Dyn. Stereo** radio button, this will freeze the blue portion of the Semi Dynamic Stereo image, leaving the red portion live.

Tilt the sample to produce a stereo effect

Static Stereo
The left hand image of a static stereo image can be loaded into the image store.

This can be copied to the off screen area using the **A to B** button.

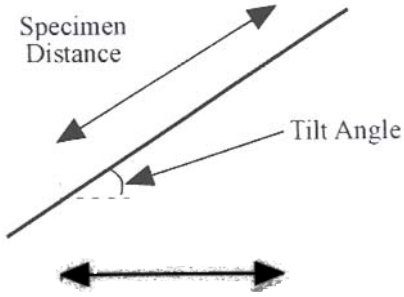
The right hand image of a static stereo image can be loaded into the image store.

Press the **Static Stereo** radio button to combine the two images

1.20. Tilt Compensation

Introduction

This option allows the image to be corrected for the foreshortening effect of scanning a tilted specimen. At high tilt angles the beam scans more of the specimen in the tilted direction giving the image a *squashed* appearance. By resizing the scans in the tilt direction this effect can be eliminated.



The important angle is the angle of the specimen surface to the horizontal, which may be different to the stage tilt angle (if the specimen is not flat).

Operation

Selection

Tilt compensation is selected from the Rotate / Tilt option on the **Scanning** menu. Tilt compensation is enabled by selecting the check box.

Controls

The compensation angle is adjusted using the slider bar on the Rotate / Tilt panel. It is also possible to enter the exact value by double clicking on the tilt compensation value on the Rotate / Tilt panel.

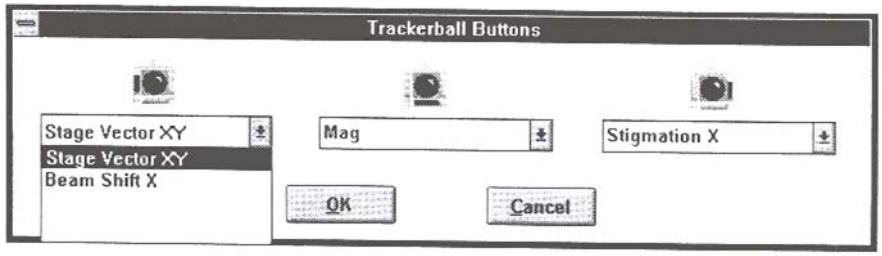
Procedures

Tilt compensation should be selected when viewing samples at high angles of tilt. The angle of compensation should be adjusted until the normal aspect ratio of the specimen is restored.

1.21 Trackerball

Introduction

This option comprises a 3-button trackerball which permits the user to control a user definable selection of parameters. This option may be used in addition to any of the other methods of parameter control. This option requires the Beta Site Licence to be present.



Installation

The Trackerball may be plugged into any available serial port (COM1 through COM4)

Display the configuration window (Tools->Service->Configure) and select the **Options** menu item

- Select the Trackerball item and set the stat to the appropriate COMn.

Exit from the Configuration window.

The Trackerball Icon will appear and stay 'On Top'

Operation

The Trackerball Icon displays the identity of the parameter currently being controlled. Repeated pressing of the same button will cycle through the parameters in that button's list. When a different button is pressed the parameter selected is the last one that was in use for that button.

Hint

A useful set of parameters are:-

Left Button	Stage Vector X (stage XY control) Stage Vector Z (stage Z control) Beam Shift X (Beam Shift XY control)
Middle Button	Magnification Focus N (Noise reduction value)
Right Button	Brightness Contrast Stigmation X Stigmation Y (Note that the Stigmation values are not a two dimensional pair)

1.22. Window Mode

Introduction

This facility allows the user in **Normal** scanning mode to define 'windows' within the image to show an alternative signal.

Zones

In **Normal mode** the whole of the image are is defined as being **Zone 0**.
In **Split screen mode** the left half is **Zone 0** and the right half is **Zone 1.**
In **Quad screen mode** the quadrants are **Zone 0** through **Zone 3** for the top left, top right, bottom left and bottom right respectively.
In **Window mode** the **alternative signal** is **Zone 2.**

Each zone may have it's own signal source (detector or mixed signal), noise reduction coefficients, etc.

Operation

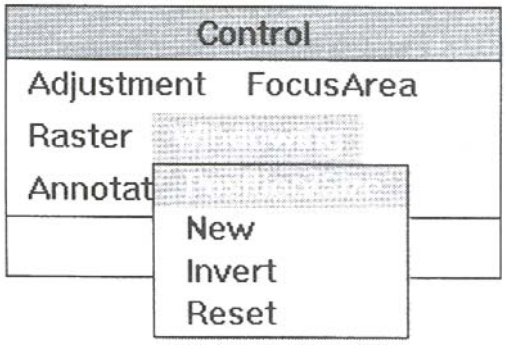
Selection

Top Menu - Scanning - Window mode.

Controls

Display the pop up control menu by clicking the right mouse button over the image while in **adjustment, raster** or **windowing** control mode.

The windowing controls are available under **windowing**.



Windowing Size/Position

In this mode the mouse is used to manipulate the size and position of the **windowing elements**. The cursor shape changes to indicate which component (side, corner, whole raster) may be dragged.

When an item is dropped such that it overlays another item the last one dropped overwrites the overlapped area.

Windowing New item

When this function is selected a new **windowing element** is created of default size and position. On creation it will be defined as **Zone 2.**

Windowing: Invert

This function selects a sub mode (indicated by the caption) in which any **windowing element's zone** state is inverted. (i.e. if Zone 2 then switch to Zone 0, if Zone 0 then switch to Zone 2).

The zone state of the background may be inverted.

This sub mode may be cancelled by selecting another **control mode**.

Windowing Reset

This function resets the list of **Window elements** to be the background (as Zone 0) and a single rectangular window (as Zone 2). The Control mode is selected to be position/size.

Procedures

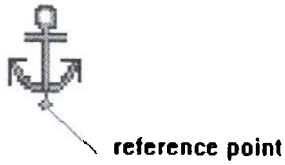
Windowing Elements

When windowing is initially switched on, or if **Reset** is given, the windowing list is reset such that the whole image area is **zone 0** and there is a single **Zone 2** element of default size and position.

Each **windowing element** may be **zone 0** (normal - green border) or **zone 2** (alternative - blue border).

Windowing elements may be superimposed one upon another.

To determine which zone, or to select control for a zone, the anchor icon may be positioned as required.



1.23. X-Ray Dot Mapping

Introduction

This option provides the ability to display multiple presence dot maps or an intensity dot map for EDX and WDX data.

When in Xray mode the image store is partitioned into two overlaid planes; one for Xray data, one for grey Image data. The dot maps may therefore be displayed grey backed if required.

Operation

Configuration

XRay Interface Kit

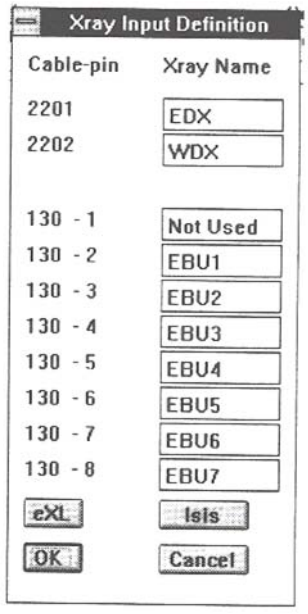
The rear panel provides connection for a multiple dot map EDX cable (130), a single dot map EDX cable (2201) and a single WDX dot map cable (2202).

Internal to the electronics pod are two switches which are set on installation by the service engineer.

- **Single/Multiple EDX** Defines if single or multiple cable is in use
- **WDX/EDX** Defines if the WDX input is used

Software

Top Menu - Tools - Service - Configure to display the configuration window
Select **Options**
Set the **EDX Dots** to **None/Single/Multiple** as required
Set the **WDX** to **Absent/Present** as required
Select **XRayNames**

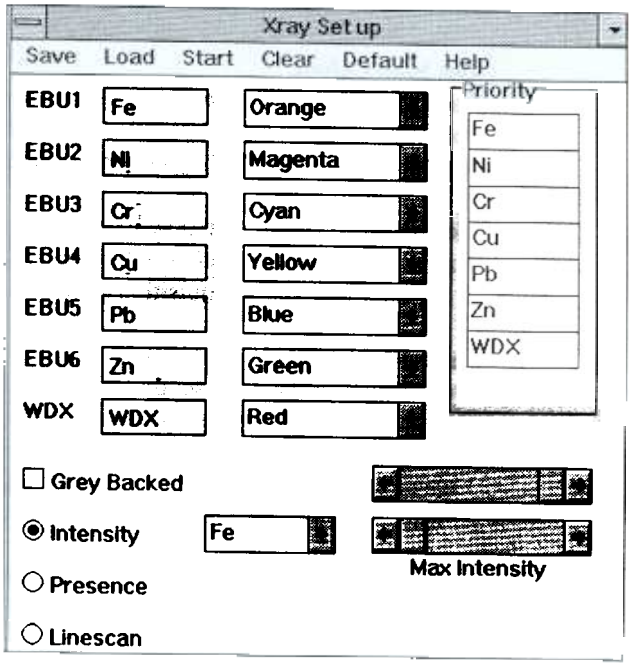


This function enables the annotation of the Xray inputs to be related to the energy window names used on the Xray system, these identifiers appear on the left side of the Xray set up window. The dialog box shows the cable and connector pin numbers of the signals. For ease of use two sets of identifiers are selectable, eXL and ISIS. Other identifiers may be entered individually if required.

If the identifiers are changed the menu option default should be selected on the next use of the Xray Set up window to utilise the changed identifiers.

Selection

The Xray set up panel is displayed using Top Menu - Detectors - Xray.



Controls

This window provides set up and control for X Ray dot map input and adapts itself according to the configuration (i.e. if WDX is present, if EDX is present, and if so if single or multiple dot map signals are available). The example above is for WDX plus multiple EDX dot maps.

X Ray dot map inputs are connected to X Ray ports. At installation these ports are given identifiers consistent with the XRay system in use, these identifiers appear on the left of the window.

Each port supplies the count pulses for a selected energy window. These pulses are accumulated on a pixel basis and used as source information for the Dot Map function.

X Ray Data Identifiers
For convenience the text description of the port data (energy window) may be entered by the user. These descriptions are in the column immediately to the right of the input port identity. Just click the cursor in the edit box and the text may be edited in the normal way (e.g. enter the chemical symbol). This new description will be actioned when the mouse is clicked anywhere else in the Xray window.

Dot Map Colour
Each of the Xray Ports data may be displayed in one of a number of colours. The colour is shown in the Combo Box in the third column from the left. The colour may be changed by clicking on the box and selecting the preferred colour.

Note that one colour is **transparent**, this may be chosen if the data for this X ray port is not to be displayed, useful for **presence** dot maps. If the transparent colour is selected when data acquisition starts, data for that port will not be acquired.

Presence Priority
On the right of the Xray set up window is a box containing all the identities of the non transparent data sources. This window determines the priority of the presence dot when two or more occur in the same pixel. The top of the box is the highest priority. The priority may be changed by selecting an entry with the mouse and dragging it to the required priority position.

Once the data has been collected the priority may be rearranged interactively to see the effect on the display. This is non destructive to the Xray data.

Grey Backed
Select **grey backed** if you wish to retain the grey image under the dot map, otherwise this will be set to black.

Grey Intensity
This scroll bar adjacent to the **Grey Backed** check box controls the intensity of the grey image.

Intensity
This radio button selects the intensity dot map mode. Adjacent to this button is a Combo Box to define which data is to be collected. The scroll bar in the same row as the intensity radio button defines the count value which will represent the maximum colour brightness. At it's left position only 2 counts will be required to give the full colour value and at it's right position a count of 128 will be required to give the full colour value.

Linescan
This button selects Xray Linescan if the Xray Linescan licence is present.

Xray Menu : Save
This command saves the current Xray set up to a file with the extension **XRS** in the user directory.

Xray Menu : Load
This command loads the Xray set up from a file with the extension **XRS** in the user directory.

Xray Menu : Start/Stop
These commands start and stop the Xray acquisition.

Xray Menu : Clear
This command clears both the Xray and Grey planes.

Xray Menu : Default
This function resets the Xray set up to the default state.

Procedures

General

On entry to the Xray set up window the normal mode display LUT contents are stored and the display LUT switched into Xray mode.

There are three parts to the dot map function:-

a) set up of the required function
b) data acquisition
c) colour coding of the display LUT

Closing the Xray window will give an **XRayReset** which stops X ray acquisition and restores the display LUT to Normal mode.

Intensity Dot Map Set Up

In dot map intensity mode the counts are collected from one energy window, if the count is non zero then the intensity value is inserted into the image pixel.

- Select **grey backed** if you wish to retain the grey image under the dot map, otherwise this will be set to black
- Select the **Intensity** radio button
- Select the **colour** for the required energy window (non transparent)
- Select the energy window from the list adjacent to the radio button
- Select **Start** from the menu to acquire the Xray data

LUT Manipulations on Intensity Dot Maps

After data collection:-

- The colour of the energy window may be changed
- The Max. Intensity value may be changed

Presence Dot Map Set Up

In dot map presence mode the counts are collected from all energy windows which are defined as having a non transparent colour. If there is a count in any window then the pixel is designated as a **dot** and the presence information replaces the image pixel.

- Select **grey backed** if you wish to retain the grey image under the dot map, otherwise this will be set to black
- Select the **Presence** radio button
- Select the **colours** for the required energy windows (transparent if the data is not to be acquired)
- Select **Start** from the menu to acquire the Xray data

LUT Manipulations on Presence Dot Maps

During or after data collection:

- The colour of each energy window may be changed. Note if the colour was transparent when the data was acquired then the data will not have been collected.

  When a pixel contains non zero counts on two or more ports (energy windows) which are not transparent then the one displayed is determined by the presence **priority** which may be altered as required.

Hint

It is important to choose the correct colours for dot maps if they are to be output to monochrome video printers, Grey TIFF files (as seen) or clipboard

Recommended colours are:

One map	white
Two maps	white, dark red.
Three maps	white, orange, green
Four maps	white, dark red, magenta, dark green

When exporting annotation for dot maps

If the grey intensity function is used to reduce the intensity of the grey image it will also reduce the intensity of any annotation merged with the image for export.

Registration of Xray Data with Image

Different Xray systems may have different internal timings which may give rise to a slight mismatch in registration between the Xray data and the image. If this is found to be the case reducing the data acquisition scan rate will reduce the mismatch. It may be necessary to experiment to find the fastest acquisition rate which gives a suitable registration where high accuracy is required.

1.24. X-Ray Linescan

Introduction

When in Xray Linescan mode the speed is automatically reduced to a maximum pixel average rate of 1024 and the line position indicated by a green raster line which may be moved using the mouse in Raster control mode.

On entering Xray Linescan mode the data acquisition is initiated. The data from up to 7 energy windows (according to configuration) is simultaneously loaded into an internal buffer. Data from successive line scans are accumulated.

Each Energy window is identified by a **user defined identifier** which is defined in the **Xray set up window**.

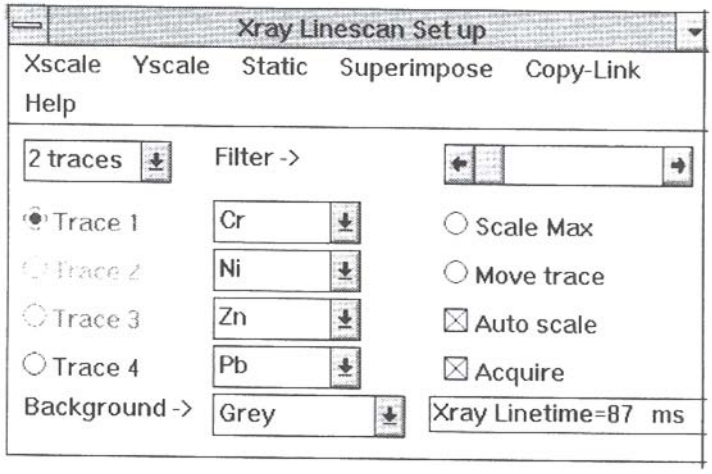
The Linescan data is displayed in a profile window in the same manner as the other line profiles (e.g. Linescan, live line scan etc.) . The profile display may be user configured from the **Xray Linescan control window.**

If **DDE support** is configured **copy-link** is provided.

Operation

Selection

The Xray Linescan facility may be switched on either via Top menu - scanning - Xray Linescan or by selecting the Linescan radio button in the **Xray set up window** (Top Menu - detectors - Xray).



The **Xray Linescan control window** may be displayed by clicking the right mouse button over the profile window.

Controls

The facilities controlled by this window may be performed whether the acquisition is active or not.

Facilities provided are:-

Number of Traces
The profile may display from one to four traces simultaneously as selected from

the drop down box. Each trace is displayed in a different colour, as shown by the colour of the **current trace** selection radio buttons.

Current Trace for Control
The **trace offset** and **scaling** functions operate on the current control trace. This trace is indicated by selecting one of the four radio buttons on the left of the window.

Filter Value
The current filter value used for all displayed traces may be set using the scroll bar at the top right of the window. This may be done at any time and is non destructive of the acquired data.

The filter value, which is in the range 1 through 16, is the number of adjacent pixel values which are merged to provide the mean of the pixel. i.e. with a filter value of 8 the pixel value displayed is the mean of the pixel at a position and the 8 pixels preceding it and 8 pixels following it.

Trace Source Selection
The drop down box associated with each trace may be set to any of the 7 energy windows acquired. Each window is identified by the **user defined identifier** (see Xray Dot map description).

Auto Scaling
When data acquisition is started each trace defaults to Auto scaling mode.

In this mode a trace has it's data scaled for display such that the maximum value in the line will give a full scale excursion of the trace.

*Full scale for the trace is 256 pixels with **yScale** = 1*

If **Scale Max.** has been in use auto scaling may be reselected using the check box.

Scale to Trace Point

For the **current trace** this scaling mode may be selected using the radio button on the right labelled **Scale Max**.

In this mode a blue line is displayed in the profile window which selects an X position on the trace. The pixel value at this position is used to define the full scale excursion of the trace, hence pixels with greater values will be truncated at

full scale. The X position marker may be dragged to a new position using the mouse. The new value takes effect when the marker is dropped.

The scaling may be returned to auto scaling by selecting the **auto scale** check box.

Superimposed or Offset Traces

By default all traces are superimposed on the same Y axis

If required a trace may be offset by selecting the **move trace** radio button. When in offset mode the y size of the profile is doubled permitting up to full scale offset, note that this does not increase the full scale excursion of the trace.

When this mode is selected a marker is displayed on the profile window showing the current baseline of the trace. This baseline may be dragged to a new position using the mouse. If acquisition is currently on the new baseline only takes effect when dropped at the new position, otherwise the baseline is continuously changed.

The speed of response is affected by the scale values chosen - the greater the screen area to be drawn the slower the response.

To revert to superimposed traces select the **superimpose** function from the menu.

*The offset values are not destroyed in superimpose mode, clicking on **move trace** will restore them.*

Background Colour

Using the drop down box at the bottom of the window the colour of the profile background may be selected from one of:-

Grey
Black
Transparent

The trace colours have been selected such that they will appear white against a black or transparent background on monochrome hard copy. Grey will appear as black.

Data Acquire On/Off

The acquisition may be started or stopped by the check box on the lower right of the window.

If the line position is changed the data buffer will be cleared and acquisition restarted.

X Scale

The xScale value determines the display width of the profile window. A scale value of 1 will give a full width (every pixel) display. A scale value of 2 will display a half width (every other pixel) display, etc.

Y Scale

The yScale value determines the display height of the profile window.

A scale value of 1 will give a full height (256 pixel) display. A scale value of 2 will display a half height display, etc.

This height will be doubled if the trace offset function is used.

Drawing Active/Static

The drawing of the profile (not to be confused with the acquisition of the data) may be switched on (active) or off (static) using the menu function.

While an image export is in operation the traces will temporarily be static.

Copy-Link

This function is provided if **DDE support** is configured. This performs a DDE copy-link function via the clipboard to any applications which have requested profile data. The data for the current trace is transferred.

Linetime

This parameter displays the time to acquire a line of data. (Note data from multiple windows is collected in a single linetime).

Annotation

A set of annotation labels may be created for Linescan traces

Select annotation mode (press F11);

Display the annotation pop up menu (click right mouse button over image)

Select **Annotation - Xray Traces**. This will create one annotation item per trace with the **identifier** text.

Move these items to suitable positions.

1.25. 2D Ymod

Introduction

The term Ymod comes from the technique of Y axis modulation used historically to generate a topographical image on a display tube.

The Ymod function draws a series of line profiles scanned across the stored image to represent the signal level in the image. A hidden line removal algorithm gives a reasonable topological representation, although any interpretation must be carefully considered.

Operation

Selection

Top Menu - Image - Ymod.

Controls

On selection of this function the Ymod window is displayed together with it's popup menu.

If the popup menu is closed using the **Quit** command it may be re displayed by pressing the right mouse button over the Ymod window.

Amplitude Scale
This value controls the scaling of the amplitude signal. A value of 2 means that for a grey level of 200 above the **threshold** an amplitude of 100 pixels is drawn.

Line Increment
This value defines the separation between lines scanned over the image. A value of 4 means that every fourth line is scanned.

Threshold
This value defines the threshold grey level value below which the trace is drawn as a horizontal line. Correct choice of the threshold can greatly improve the appearance.

Coloured
This control selects if the trace is monochrome or coloured. If coloured is selected the range of grey levels above the **threshold** is divided into four equal parts. The colour of the line drawn from the previous sample point to the current sample point is determined by the grey level of the sample point.

Superimpose
This control determines if the display is to be in a separate window (in which case the size is determined by the **X scale** and **Y scale** settings) or superimposed over the image.

Transparent Background
This control determines if the background to the Ymod display is to be transparent (i.e. the image is visible behind it) or opaque.

Procedures

The drawing is time consuming hence redrawing is initiated using **sample**.

The size and granularity of the drawing is controlled by the **X scale**, **Y scale** and **line increment**.

The appearance is controlled by the **threshold**, **amplitude scaling**, **colour selection** and **transparency selection**.

Optionally the traces may be **superimposed** over the image.

Any change in the characteristics or position of the Ymod will cause the traces to be deleted. To re acquire the data use **sample!**

2. Hardware Options

2.1 Stage Motorisation

The stage motorisation kit is available for either X and Y or X Y and Z stage axes. Included are over travel protection and audible touch alarm. This accessory is required for the software options:-

Stage Control
Stage Co-Ordinate Store and Recall
Stage Centre Feature
Stage Centre Point
Stage Map
Stage Scan

2.2 High Resolution Record Unit (HRRU)

Introduction

The *Stereoscan 400* Series HRRU is a pod fitted to the right hand side of the instrument. It is connected to the instrument internally by two fibre-optic connectors, and externally by a mains lead which is plugged into the mains connection block at the rear of the instrument.

The HRRU is capable of taking either a Stored or a Live Image micrograph with or without an Overlay (Data Zone or other annotation), using a variety of camera types at different record rates and with different film speeds. It is also possible to set the development time required for a particular type of film.

In order to operate, the system must know that an HRRU is actually fitted, and this can be checked by looking at the Options section of the Configure menu. This is reached by selecting from the Menu Line:-

Tools -> Service ->Configure -> Options

The ***HRRU*** line should read ***HRRU = Mark 2***

Operation

As the HRRU is so flexible, the system has to be told exactly what type of micrograph the operator wants to take, using which type of camera and film speed etc. This can be done by selecting from the menu line:-

File -> Export/ Photo setup

And from the panel that is then revealed select:-

Output To = HRRU followed by ***Set Up***

This will then reveal the Photo Set Up Panel (see Figure 1) and from that the HRRU Settings Panel (see Figure 2) can be selected.

Using these two panels every detail of how, and on what medium the micrograph is to be recorded can be set.

Photo Set up Panel

Figure 1 Photo Set Up Panel

Camera Image
Select between **Live, Stored, Cal Br, Cal Con**

Camera Overlay
Select between **Yes or No**

HRRU Settings ->
Will reveal the HRRU Settings Panel.

Photo No =
Displays the current Photo Number and allows operator to select (by clicking the box) a new number.

Photo Time =
Displays the time a micrograph will take for particular settings of Film Speed and whether Photo Fast or Slow has been selected.

Camera Status =
Displays either **Busy** or **Idle**.

HRRU To Do =
Gives indication between 100 and 0% of progress of record scan.

The button marked **Photo** will start a record scan, while the button marked **Abort Photo** will stop a record scan immediately regardless of it's progress.

By clicking on the **Developing Time = 0 ms** box, the operator can enter any time required for developing the type of film being used, and once the button marked **Start Develop Timer** has been selected, this time will count down to zero to indicate that the film has been developed correctly.

If the Output Device has already been set to the HRRU, but the conditions for taking a micrograph need to be changed for any reason, the **Photo Setup** panel can be revealed by clicking on the photo Icon of the Tool Bar with the right hand mouse button.

Also see note on next page.

HRRU Settings Panel

Figure 2 HRRU Settings Panel

Film Speed = ASA
Allows selection of ASA 800, 400, 200, 100 and 50.

HRRU Camera =
Allows the following to be selected :-

120mm Camera
35mm Camera, and
either Polaroid Types 545 or 500.

HRRU Bright. and **HRRU Contrast** enable the Operator to set the brightness and contrast settings of the HRRU as required. This can be tested, and if necessary adjusted, using the Grey Wedge available in the Display LUT.

Caution should be exercised when adjusting these settings as excessive brightness can burn the HRRU Tube!

Photo Fast Pix Avg. =
Sets the fast record rate.

Photo Slow Pix Avg. =
Sets the slow record rate.

If the box marked **Fast** is selected, then a fast record speed is performed, and if it is not, then a slow record rate will be performed.

It should be noted that once the various photo settings have been made it, is not necessary to access these panels every time that a photo dump is required. If the Output Device has been set to be the HRRU, all that is then required to initiate a Micrograph recording is to select the Photo Icon in the TOOL bar with the left mouse button. Ensure that the image is frozen, if a Stored image is required or NOT if a Live image is required.

HRRU Camera

The *Stereoscan 400* Series can accommodate a variety of camera types. Each camera type fits onto a camera assembly which slots into the HRRU CRT assembly. To gain access to the HRRU, simply slide the top cladding away to the rear of the HRRU CRT assembly.

- **Polaroid 545**

The lens unit is setup as shown in Figure 3. The lens unit is fitted to the camera body using 4 M4 X 20mm screws.

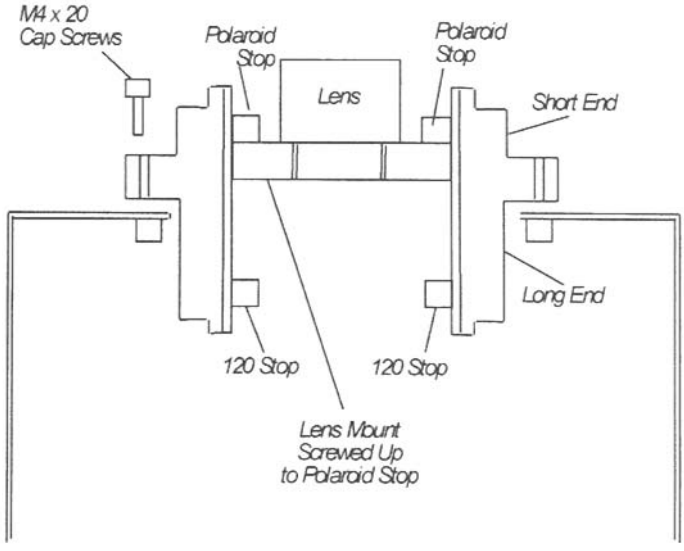


Figure 3 Polaroid Camera Lens Mounting

The camera unit is then inserted into the camera housing with the **red spot** *towards* the operator. It is important to ensure that the unit has been inserted as

far as it will go, if this is not done the focus will be incorrect. The unit is clamped in place using the knurled head screws in the upper set of screw holes. The camera back is then fitted to the casting ensuring that the key fits into it's slot, and is locked in place using the two sliding clamps. If the aperture is set correctly, the unit is now ready for use.

- **Polaroid 550**

The setup for this camera back is identical to that for the 545 above, except for the fact that the camera unit is inserted into the camera housing with the **red spot** on top of the casting *away* from the operator.

- **35mm (RICOH)**

This unit complete is inserted in place of the Polaroid camera unit and is locked into place using the knurled head screws. The shutter remote cable is plugged into it's socket on the rear of the camera and the shutter set to 'Bulb' (see the camera instruction booklet).

- The **120mm** camera back will usually be sent with it's own camera assembly but some early *Stereoscan 400's* may have a camera assembly that is interchangeable between Polaroid and 120mm. The procedure to change camera backs with this type of assembly is shown in Figure 4 as follows:-

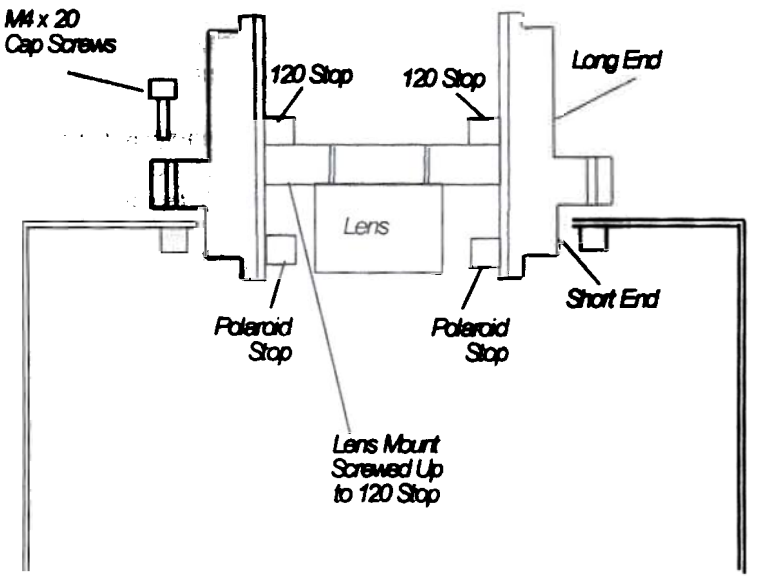


Figure 4 120mm Camera Lens Mounting

Remove the Camera assembly from the HRRU assembly by pushing the top cladding back towards the rear of the instrument (it may be necessary to loosen the fixing screws securing the cladding from within the HRRU pod- if they are not already loose enough), and loosening the 4 knurled knoblets. The camera assembly should now be loose enough to pull out of the HRRU CRT assembly.

2. The lens spacer itself will be currently screwed up against a lens positioning stop ring, this must now be screwed clockwise up to the alternative lens stop ring at the opposite end of the lens spacer body, using the tool provided. **These lens stop rings are preset and should not be re-adjusted.**

3. The lens spacer assembly which holds the lens in the correct position must now be reversed. This is done by removing the 4 M4 allen screws securing it to the camera assembly and simply inverting the spacer assembly before refitting it back to the camera assembly.

4. Refit the lens into the spacer assembly, ensuring that the aperture is set to the correct position.

5. The 4 knoblets that secure the camera assembly into the HRRU CRT assembly must be fitted to the lower set of holes (there are two holes per screw) in order to ensure that the camera assembly can be secured into the HRRU CRT assembly correctly.

6. Refit the camera assembly to the HRRU CRT assembly, ensuring that the **red spot** on top of the camera housing is *away* from the operator. It is important to ensure that the unit has been inserted as far as it will go into the housing otherwise focus will be incorrect.

7. The camera should now be fitted onto the casting, ensuring that the key fits into it's slot, and is secured using the two sliding clamps.

8. Ensure that the correct camera type is entered in the HRRU Camera field of the HRRU Settings panel.

9. To swap back again the reverse procedure applies.

2.3 LaB_6

Ensure that the LaB_6 filament is correctly installed in the firing unit. Refer to Figures 5,6 and 7.

Fit the LaB_6 firing unit into the gun and, once fitted, select **pump** to evacuate the system.

As soon as a LaB_6 filament has been fitted into the gun it is advisable to set the software to recognise that a LaB_6 is present. This can be done by calling up the Gun Set Up panel from the kV adjustment icon. Click on the Filament Type = box from within the Gun selections, to call up a list of different filaments. Select the appropriate filament type, probably this will be Denka M3. Also, if appropriate the New Filament box can be selected, see below. Setting the filament type will prevent the filament from being turned on when the vacuum conditions are incorrect.

*If you are using a **Kimball** type LaB_6 filament and this option is not present within the list, you should select **Denka M3**.*

Select **Vac Status** from the menu line, and click on the button marked **Column Pumping**. This will call up another panel and from this click on **Start Column Pumping,** this will set the ion pump to switch on at the appropriate vacuum level. If the buttons within the **Column Pumping** panel are greyed out it is because the option **Column Pump = Present** has n7ot been set. This can be set by selecting **Tools** from the menu line, followed by **Service > Configure > Options**. From the list provided change **Column Pump = Absent** to **Column Pump = Present**.

After clicking on the **Start Column Pumping** button; the column pumping status should read Column Pumping Requested. When the System Vacuum (Chamber Vacuum) reaches about 5×10^{-6} torr, the Ion Pump will be enabled and a Column Vacuum reading will now be present.

When the Column Vacuum reaches about 5.0×10^{-7} torr Vac Ready is reached and the red LED on the Gun Isolation valve (see Figure 8) will start to flash indicating that this valve can now be closed. However, it is possible to close this valve before Vac Ready has been reached and the LED starts to flash, this action may improve the pump down time to Vac Ready.

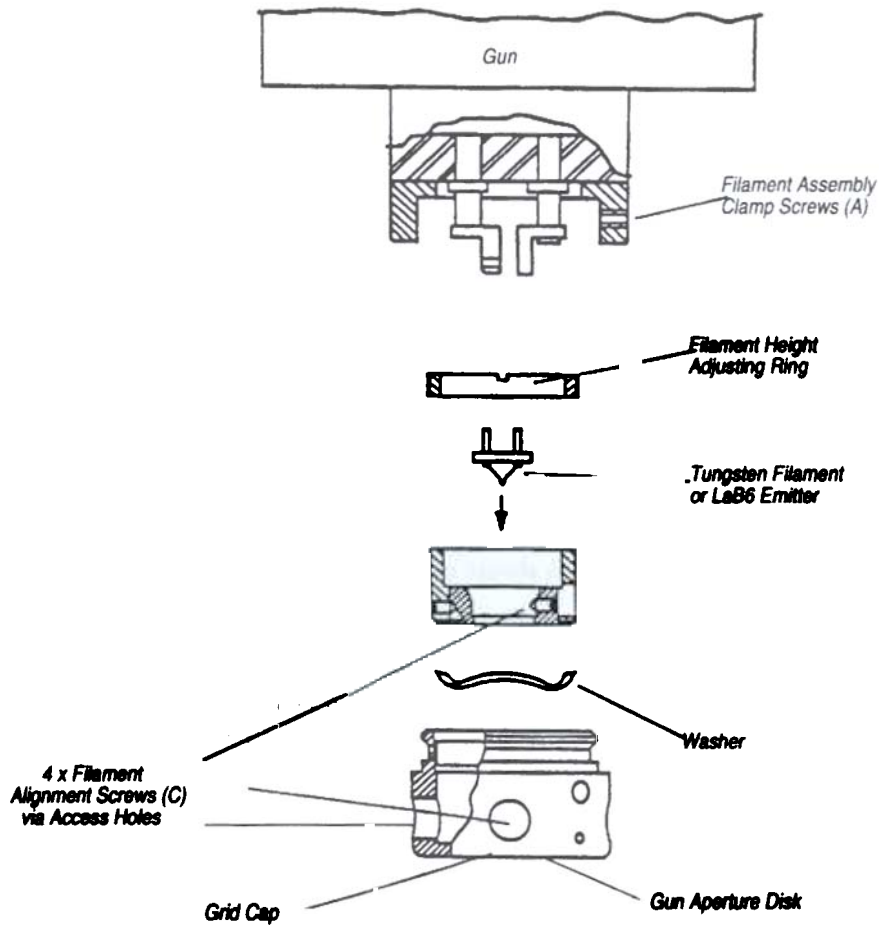


Figure 5 Firing Unit Assembly

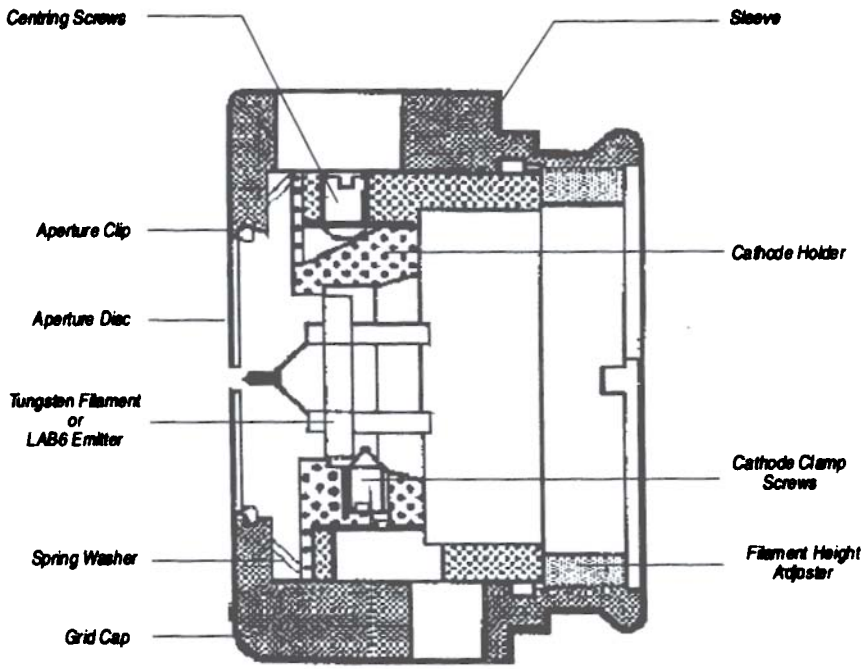


Figure 6 Cross Section of Firing Unit

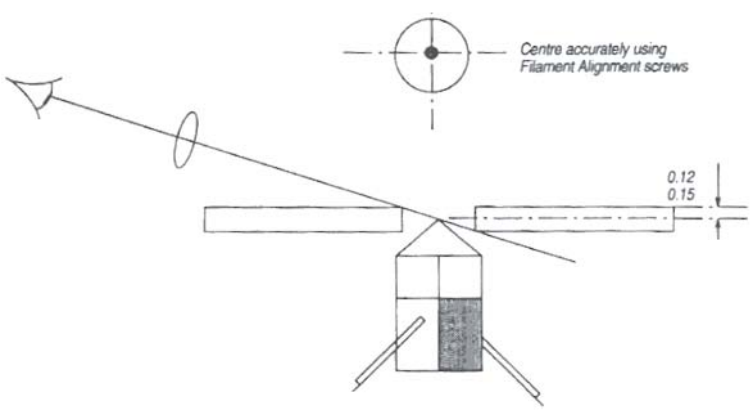


Figure 7 Lab_6 Cathode Height Setting

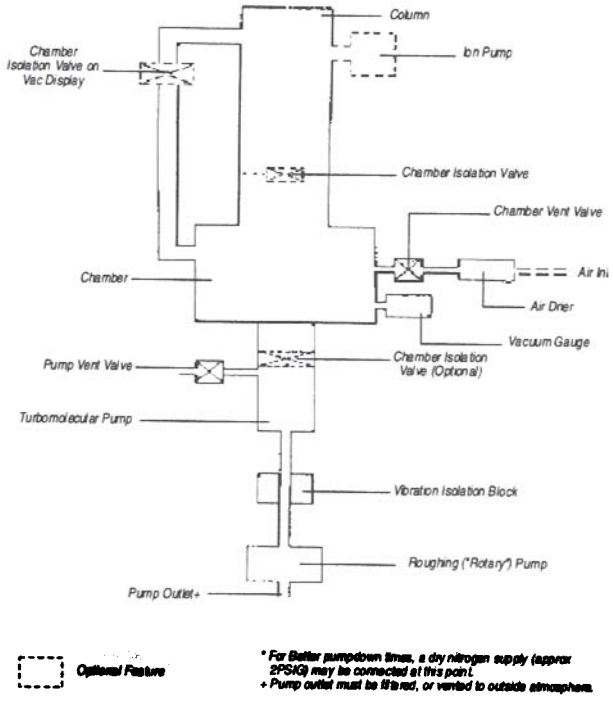


Figure 8 Identification of Isolation Valves

Alternatively, the valve need not be closed when Vac Ready has been reached, and the system can be operated with the valve open and the LED flashing, especially if the vacuum in the column is good. This has the advantage that if, when the filament is being run up, it outgasses, the vacuum system may overcome the temporary rise in pressure without losing the Vac Ready condition.

Once Vac Ready has been achieved it is now possible to run the filament up. Before doing this however, it is important to check that the correct type of filament has been entered into the Gun settings within the **Gun Set Up** panel, ie either Denka M3 or Denka M7, and also whether or not the filament is new or old (this will change the run up procedure for the filament - a new filament will be run up more slowly than an old one to maximise filament lifetime).

'New' filament means that the filament has never been used and run up to any operating condition. 'Old' means that it has been used, although it should be noted that if a filament has only been run at a low kV, care should be taken when running at a higher kV. If, for example, a filament has only ever been run at 5kV and the new operating requirement is now 20kV, it would be worthwhile re-

designating the filament 'New' and allowing the slower run up procedure to take effect.

In order to maximise filament life, it would also be advisable to re-designate a filament to 'New' again if it has ever been exposed to atmosphere, even after being used. This would then allow the oxidisation that will have built up after the exposure to atmosphere to be evaporated off again.

Running the Filament Up

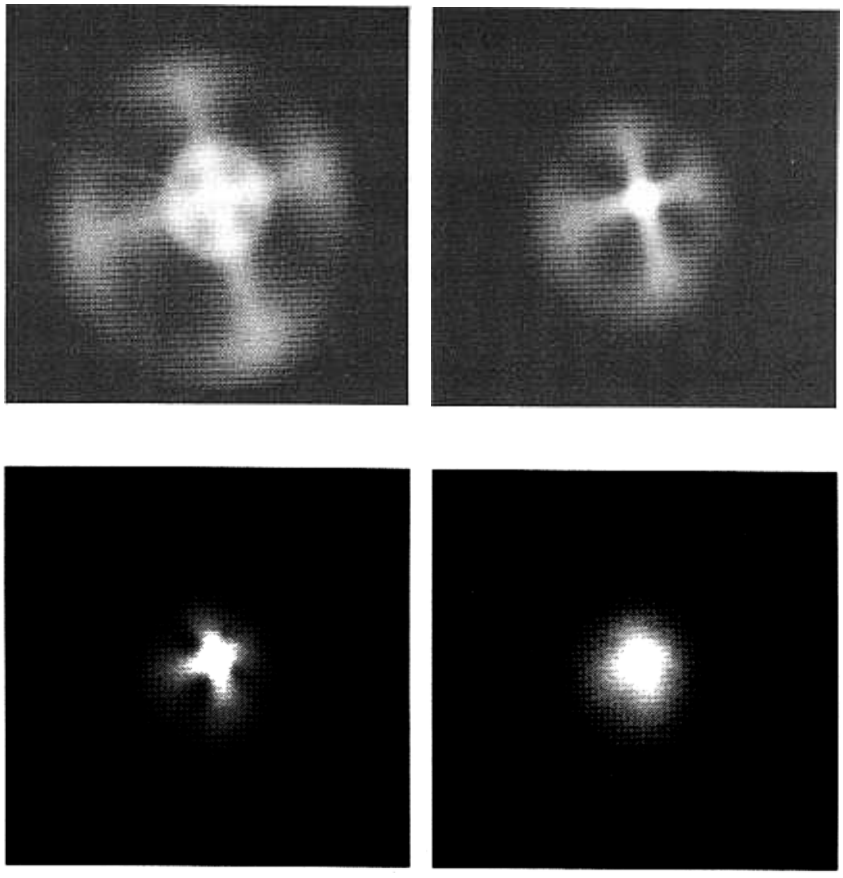
Standard run-up macros for Denka and Kimball LaB_6 filaments are provided by Leica. These will set the EHT to 5kV and the filament current to a value normally below the saturation point for the appropriate filament type. It is recommended that these are used initially when running with LaB_6 and then when the desired operating conditions are achieved that additional run-up macros are created for future use.

To select the appropriate macro select **File** from the top menu line followed by **Load state**. This produced a list of application macros from which the appropriate run-up macro can be selected. Select **Denka5.app** for Denka M3 filaments and **Kimb5.app** for Kimball Physics filaments.

Kimball filaments run with a much lower heating current so the selection of an incorrect macro could result in the filament being destroyed.

Once **Open** has been selected the macro will be loaded and run up of the filament will commence. If there is a conflict between the conditions in the macro and those currently set on the system then the macro will halt and a warning will be given and the operator will be asked whether or not to proceed. It is advisable to select **No** and to investigate the reason for the conflict. Once this has been corrected then the macro can be loaded and run again.

Once the run up sequence is completed it is advisable to check for correct filament saturation and beam alignment. Use the **Gun Align** panel to select **Emission Image** mode and adjust the filament current to produce the desired emission image (see Figures 9,10,11,12).



Figures 9,10,11,12 Emission Images

Changes to the filament current will be implemented slowly in order to safeguard the filament.

Use the **Gun Tilt** control to position the emission image in the centre of the screen. Then with the magnification set to very low and **Optibeam depth mode** selected, re-centre the emission image using the **Gun shift** controls. Turn off Optibeam depth mode and increase the magnification and re-check the position of the emission image, if necessary make adjustments using the **Gun Tilt** controls. When the alignment has been completed the emission image mode can be turned off by selecting the **Normal** button within the Gun Align panel.

If preferred the beam alignment can be carried out by observing the screen brightness while in normal mode and adjusting the gun tilt and shift controls to produce the maximum screen brightness.

Once the filament has been saturated and centred correctly, the system can be operated as normal and when, on SEM Shutdown, the Operating Conditions are saved, the system can be brought back to these operating conditions simply by pressing the RUNUP icon.

It is worth noting that when SEM Standby is selected, the EHT is removed from the filament, but filament current continues to flow through it at a reduced level, thus keeping the filament warm and improving stability.

Sample Changing

When changing the sample, it is only necessary to close the column isolation valve before venting the chamber (the gun isolation valve should already be closed). The filament will remain on during this operation, but the EHT. will be turned off. When the chamber has been pumped out again and the vacuum ready state achieved, the column isolation valve can be re-opened, whereupon the EHT will be switched back on and the image restored. It is advisable at this point to check the beam alignment by adjusting the **Gun tilt** for maximum signal brightness.

2.4 Scanning Transmission Detector

From an Operators' point of view, the STEM attachment is comprised of three main parts :

The detector assembly, which houses the BSD diode, and should be fitted at the rear of the stage assembly. The detector assembly has a hole cut out of a metal plate, beneath which can be seen the detector diode.

2. The STEM sample holder which fits onto the SEM ZTR module in place of the standard SEM carousel. This is a circular assembly, with a series of small holes on it's perimeter which accommodate the transmission samples which are held in special holders.

3. The STEM detector electrical feed-through, which is normally mounted on one of the "ears" of the SEM chamber. The Operator must connect the cable coming from the STEM detector to this feedthrough before use

Assembly

Assembly of the STEM detector is a very simple procedure.

- Remove the ZTR module from the stage in the normal manner.

- Position the STEM detector assembly onto the rear of the stage. Underneath the detector assembly are two pins, these help to locate the detector assembly correctly onto the stage where it can then be secured using the two M3 x 12 screws provided.

- Refit the ZTR module onto the SEM stage, ensuring that there is enough Z clearance to allow the STEM sample holder to be fitted without hitting and damaging the STEM detector.

  Once the samples have been mounted into the STEM sample holder, this can then be fitted in place of the normal SEM carousel. It is a good idea to position an empty sample hole over the detector cut-out to aid final positioning of the stage during operation.

- Partially close the stage door ensuring that there is adequate clearance for the stage beneath the final lens and any other detectors in the chamber, and carefully fit the cable from the detector to the feedthrough. Ensure that this cable will not foul on anything inside the chamber during operation before closing the chamber completely and pumping the system down again.

Operation

To use the STEM detector, it is first necessary to ensure that the stage with the STEM sample holder is correctly positioned over the STEM detector to allow the electron beam to pass through the sample holder and reach the STEM detector. This is the reason for leaving a empty sample hole over the detector during assembly. Using the stage X and Y controls manoeuvre the stage in order to find this empty sample hole whilst viewing the image with the SE detector, and once found it is wise to record this position to simplify STEM operation and assembly on the next occasion. Typical figures should be about X = 49.2 and Y = 10.1.

Now that the stage has been correctly positioned over the STEM detector it is now simply a case of providing the correct SEM operating conditions to provide good STEM imaging for the sample being investigated. Typical working conditions would be

kV	20 - 40 kV
IProbe	5 - 50pA
WD	5 - 12mm (WD is limited by the height of STEM Detector)

All of these parameters depend on the type of work being undertaken and the resolution required.

The next step is to select the **QBSD** detector (the STEM is a BSD variant using the same input into the SEM) from the ***Select Signal A*** in the ***Detector*** pull down panel selected from the ***Menu Line***, and to ensure that the STEM detector diode quadrant configuration has been set correctly which is as follows :-

Q1 = OFF **Q2 = INVERT** **Q3 = NORMAL** **Q4 = OFF**

To achieve STEM imaging all that is now required is to set the Brightness and Contrast settings to provide the correct video levels for your sample.

2.5 Specimen Current Monitor

The Specimen Current Monitor (SCM) is both a specimen current measurement tool and an imaging device that can also provide an image of absorbed current from a sample. It is mounted on the left hand side of the chamber and connects to the specimen contact feed through on the stage door in place of the specimen touch alarm cable.

Operation

Image Mode

Select the **Specimen Current** panel from the **Detector** menu (not available on software version V02.01). Alternatively, select the following from the **Status!** menu - **SCM mode**, **SCM range**, **SCM Image**, **SCM Measure** and **Specimen I**.

2. Obtain a secondary electron image and bring it to focus.

3. Select **SCM** from the **Select Signal A** field in the **Detector** menu.

4. Select **SCM Image** from the **Specimen Current** panel or from the **Status!** menu, set **Brightness** to 50% and adjust **Contrast** until an image is seen. Then adjust **Brightness** and **Contrast** to obtain the required image.

At low probe currents i.e. on SCM ranges lower than 1nA full scale, the image can become degraded by mains field effects and other forms of interference. Also, on these ranges, the signal bandwidth is very low. The use of long scan times will overcome the bandwidth restrictions and will also help to reduce interference effects, but image quality may not be perfect under these conditions.

Measure Mode

Because of the way in which the SCM is configured, selecting Measure mode increases the Image mode signal level. If you wish to measure the specimen current in a displayed specimen image, **Freeze** the image before proceeding.

Select **SCM Measure** from the **Specimen Current** panel or from the **Status!** menu.

2. The specimen current measured will be displayed beside the **Specimen I** legend in the **Specimen Current** panel or in the **Status!** menu.

3. To measure the current at one particular point on the specimen, select **Spot** from the **Scanning** menu, click on the cross and drag it to the point of interest.

Specification

Measurement mode

Measurement Range	10pA to 100µA in 12 ranges (auto ranging)
Bandwidth	5Hz
Resolution	1pA
Accuracy	± 2% of Full Scale
Residual Error	< 10pA

Image Mode

Image Range (Full)	3pA to 10µA in 13 ranges (selected by **Contrast**)
Image Range (Useful) *	1nA to 10µA
Bandwidth	6kHz to 2MHz (see Table on next page)

IMAGE MODE	
Full Scale Range	Typical Bandwidth
10pA	6kHz
30pA	6kHz
100pA	6kHz
300pA	20kHz
1nA	20kHz
3nA	60kHz
10nA	60kHz
30nA	200kHz
100nA	200kHz
300nA	600kHz
1µA	600kHz
3µA	2MHz
10µA	2MHz

*** Images can be obtained at currents below 1nA. However, at such low currents, images cannot be guaranteed to be free of mains field effects and other forms of interference.**

Index

Keystrokes	Function
<Ctrl> + F	Performs a focus scan
G	Auto Gun Alignment
I	
M	ARROW keys to control Mag/Focus
S	ARROW keys to control Stage XY position (or stage tilt/rotate position if Shift is used with ARROW keys)
S + Shift	ARROW keys to control Step field
V	Displays the vacuum status information
Z	
Esc	
+	Increments the scan rate
	Decrements the scan rate
Space	Display PC plane if hidden by shift-F3
	Followed by arrow key movements allow navigation of the pull-down menus of the currently selected window