Titan on-line help manual -- User Interface

Table of Contents

1 User Interface 6
1.1 View modes 7
1.2 Workset tabs 7
1.3 Control panels 7
1.4 Popup panels 9
1.5 Display 12
1.5.1 Binding display 13
1.5.2 Messages 15
1.5.3 Status displays 16
1.6 Help window 16
2 System settings and logging off 18
3 Windows Controls on Titan microscopes 19
4 Control panels 22
5 Alignments 23
5.1 Alignment Deflectors 27
5.2 Alignment File 28
6 Apertures 31
6.1 Motorized Apertures 32
6.2 Apertures Enable 33
6.3 Apertures Reset 34
6.4 Apertures Options 34
6.4.1 Reacting on mode switches 35
6.5 Apertures Slit 36
6.6 Application Selection 37
6.7 Application Preferences 37
7 AutoFilter (User) 38
7.1.1 EFTEM, Filtered On 40
7.1.2 EFTEM, Filtered On, Plasmon, Pre-C or Custom 41
7.1.3 EFTEM Spectroscopy 42
8 AutoFilter (Expert) 43
8.1.1 EFTEM, Filtered On 45
8.1.2 EFTEM, Filtered On, Plasmon , Pre-C or Custom 46
8.1.3 EFTEM Spectroscopy 47
8.2 AutoFilter setup 48
8.2.1 AutoFilter Technique Options 49
8.2.2 AutoFilter View Options 49
8.2.3 AutoFilter Image Recording Options 50
8.2.4 AutoFilter Tune GIF Options 50
8.2.5 AutoFilter Energy Options 51
8.2.6 Filtered Imaging Setup 51
8.2.7 Elemental Mapping Preferences 51
8.2.8 Drift Measurement Preferences 52
8.2.9 Map Computation Preferences 52
8.2.10 Elemental Mapping Setup 53
8.2.11 Jump Ratio Mapping Setup 53
8.2.12 Spectroscopy Setup 54

9 AutoFilter Tools 55
9.1.1 Compensation of high-tension change 55
9.1.2 Compensation of spectrum shift 56
9.1.3 Voltage center 56
9.1.4 The AutoFilter Tools Control Panel 56
9.2 AutoFilter Tools Calibrate 58
10 AutoFilter Tuning (User) 59
10.1.1 Imaging 60
10.1.2 Spectroscopy 61
11 AutoFilter Tuning (Expert) 63
11.1.1 Imaging 64
11.1.2 Spectroscopy 65
11.2 AutoFilter Tuning Restore 67
12 AutoLoader Life Science 68
12.1 AutoLoader Options Life Science 71
12.1.1 Vacuum 71
12.1.2 Control 72
12.1.3 Cassette Undock 72
13 AutoLoader Materials Science 73
13.1 AutoLoader Options Materials Science 76
13.1.1 NanoCab state (this dock only) 76
13.1.2 NanoCab state (this undock only) 76
13.1.3 Vacuum 77
13.1.4 Control 77
14 Beam Settings 78
14.1 Beam Settings Tune 79
14.2 Beam Settings Free Ctrl 80
15 CCD / TV 82
15.1.1 DigitalMicrograph CCD 84
15.1.2 TIA CCD 84
15.2 CCD / TV Camera Settings 85
15.3 CCD / TV Camera General 86
15.3.1 DigitalMicrograph CCD 86
15.3.2 TIA CCD 87
15.3.3 TIA Video 88
15.4 CCD / TV Camera Bias/Gain 88
15.4.1 DigitalMicrograph CCD 89
15.4.2 TIA CCD 89
15.4.3 TIA Video 90
15.5 CCD / TV Camera Shutter 91
15.5.1 DigitalMicrograph CCD (also TIA CCD using Gatan CCDs) 92
15.5.2 TIA CCD 92
15.6 CCD camera acquisition 92
15.6.1 CCD camera parameters 94
15.7 TV camera acquisition 95
16 Control Pad Lighting 97
17 Dark Field 98
17.1 Dynamic conical dark field 99
18 Direct Alignments 100
19 EDX 101
19.1 EDX settings 102
20 Enfina (User) 103
21 Enfina (Expert) 105

22 Enfina Tuning (User) 107
22.1 Enfina Tuning Restore 108
23 Enfina Tuning (Expert) 109
23.1 Enfina Tuning Restore 110
24 Experiments 111
24.1 Experiment behavior - Reuse display window or not 112
24.2 Using existing display windows as a template 112
24.3 Available experiments 112
24.4 Drift correction 113
24.5 Experiments Settings 116
24.5.1 Acquisition settings 117
24.5.1.1 Spectrum position acquisition settings 117
24.5.1.2 Spectrum profile acquisition settings 117
24.5.1.3 Spectrum image acquisition settings 118
24.5.2 Configuration settings 118
24.5.3 Correction settings 119
24.6 Experiments Loader 121
25 FEG Control (User) 122
25.1.1 Standby and Operate 123
26 FEG Control (Expert/Supervisor) 124
26.1.1 Standby and Operate 125
26.2 FEG Options 126
26.2.1 Power and FEG 127
26.2.2 Starting the FEG 129
26.2.3 Shutting the FEG down 131
26.3 FEG Timers (Supervisor/Expert) 131
27 FEG Control (User) - Monochromator 132
27.1.1 Standby and Operate 133
28 FEG (Expert/Supervisor) - Monochromator 134
28.1 Standby and Operate 135
28.2 FEG Options 136
28.2.1 Power and FEG 137
28.2.2 Starting the FEG 139
28.2.3 Shutting the FEG down 141
28.3 FEG Timers (Supervisor/Expert) 141
29 FEG Registers 142
29.1 Introduction 142
29.2 The settings 143
29.3 The control panel 144
29.4 FEG Registers Options 146
29.4.1 Settings files 146
29.4.2 Settings options 146
29.5 FEG Registers Service 148
30 High Tension (Expert/Supervisor) 149
30.1 Conditioning 151
31 Holography 153
31.1 Holography / Biprism 155
31.1.1 Holography 155
31.1.2 Motorized biprism 156
31.2 Holography Biprism 157
32 Image Settings 158
32.1 Image settings 158
32.2 Image shift 159

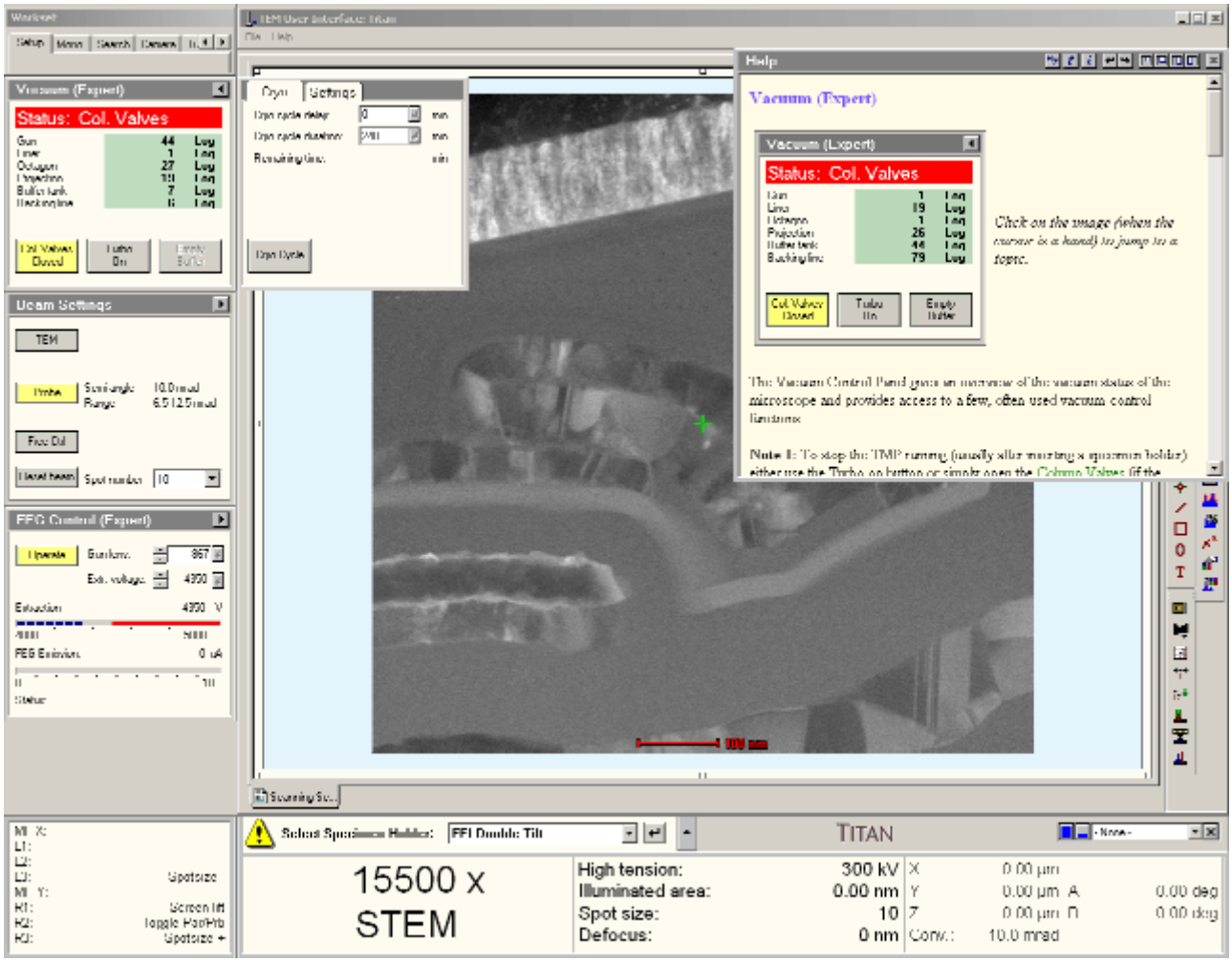
32.2.1 Popup menu functions ... 160
32.2.2 The image shift ... 161
32.3 Image Settings Focus ... 162
33 Lorentz ... 163
34 Measuring ... 165
34.1.1 Measuring in imaging ... 166
34.1.2 Measuring in diffraction ... 168
35 Monochromator (User) ... 170
35.1 Monochromator Settings (User) ... 171
35.2 Monochromator Gun lens (User) ... 172
35.3 Monochromator Find Beam (User) ... 173
36 Monochromator (Expert) ... 175
36.1 Monochromator Settings (Expert) ... 176
36.2 Monochromator Gun lens (Expert) ... 177
36.3 Monochromator Find Beam (Expert) ... 178
37 Monochromator Tune (User) ... 180
37.1 Monochromator Tune Offsets (User) ... 181
37.2 Monochromator Tune Outputs (User) ... 182
38 Monochromator Tune (Expert) ... 183
38.1 Monochromator Tune Offsets (Expert) ... 184
38.2 Monochromator Tune Outputs (Expert) ... 186
38.3 Monochromator Tune File ... 186
39 Multiple Exposure ... 188
39.1 Series ... 189
39.2 Double ... 190
40 Normalizations ... 191
40.1 Introduction to normalizations ... 191
41 PEELS ... 196
41.1 PEELS Settings ... 197
41.2 PEELS General ... 198
41.3 PEELS CCD ... 199
42 Plate Camera ... 200
42.1.1 Combining plate camera and CCD ... 200
42.2 Plate Camera Options ... 202
42.3 Plate Camera Settings ... 203
42.4 Plate Camera Stock ... 205
43 Stage² ... 206
43.1 Stage² Control ... 210
43.2 Stage² Control (dual-axis tomography holder) ... 212
43.3 Stage² File ... 214
43.4 Stage² Set ... 216
43.5 Stage² Settings ... 218
43.6 Specimen-stage Move To's and Go To's ... 218
44 STEM Imaging (User) ... 221
44.1 STEM Imaging Focus (User) ... 225
44.2 STEM Imaging Scan (User) ... 226
45 STEM Imaging (Expert) ... 227
45.1 STEM Imaging Focus (Expert) ... 231
45.2 STEM Imaging Scan (Expert) ... 232
45.3 STEM Detector (User) ... 235
45.4 STEM Detector Selection (User) ... 236
45.5 STEM Detector (Expert ... 237
45.6 STEM Detector Selection (Expert) ... 238

45.7 STEM Detector Auto CB 239
46 Stigmator 240
46.1 Stigmator Popup 242
47 System Status 243
48 Temperature Control 245
48.1 Temperature Controller State 247
48.2 Temperature Controller Filling 248
49 Vacuum (User) 249
49.1 Vacuum Cryo (User) 251
49.2 Vacuum Settings (User) 252
50 Vacuum (Expert) 253
50.1 Vacuum Cryo (Expert) 255
50.2 Vacuum Settings (Expert) 256
51 Vacuum (Supervisor) 257
51.1 Vacuum Cryo (Supervisor) 259
51.2 Vacuum Settings (Supervisor) 260
51.3 Vacuum Control (Supervisor) 261
52 Vacuum Overview 263
53 Workspace Layout 265
54 Control Pads 269
54.1 Left-hand Control Pad 269
54.2 Right-hand Control Pad 271

1 User Interface

The user interface consists of a number of separate elements. We can divide these into different categories:

- The **Main program**. This consists of the program title and menu bar. It basically is a shell that allows the user to define the where, what and how of the other user interface elements. The user interface provides a number of fixed layouts (view modes) with rapid switching between them.
- The **Control panels**. These are sets of controls that belong together and that are displayed in a fixed window (normally one of three or four displayed on the left-hand side of the main screen). Control panels are grouped in worksets which can be selected via a tab at the top of the area with the Control panels.
- The **Information panels**. These consist of a set of windows displayed near the bottom of the screen. They contain binding, microscope status information and messages or questions from the microscope to the operator.



The empty area to the right is reserved for data like images, spectra, etc. Currently it shows the flap-out of the topmost Control panel as well as the minimum-size help window.

1.1 View modes

The microscope user interfaces supports a number of different viewing modes:

- Full-size open-frame view (data area left open).
- Taskbar only (user interface hidden except for a small band at the bottom).

A rapid way of switching between Full-size open frame en Taskbar only is provided by a button next to the list of popup panels (see section 1.4).

1.2 Workset tabs

At the top left of the user interface is a small window containing a (user-defined) number of tabs. Each of these tabs controls access to a number of Control panels (typically a set of three). Click on any of the tabs to access its workset. Workset configuration (contents, name, order, color selection) can be default or as defined by the user.

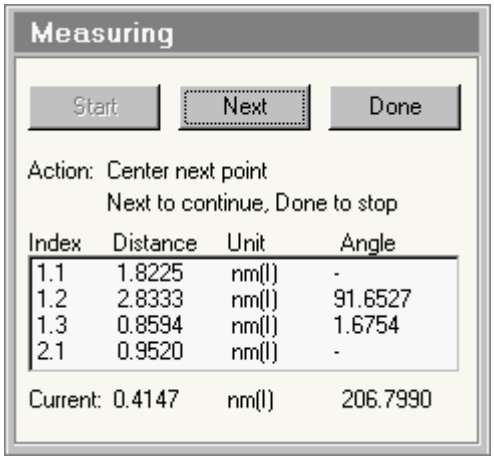
A simple workset definition.

Worksets are intended to be arranged in sets that reflect a certain stage of operation of the microscope (but of course you are free to arrange them in any manner that you find suitable for the work you do). Thus the Setup workset could contain those controls needed when starting a microscope session (vacuum, high tension and FEG control). The Search workset provides controls that are useful when searching around the specimen for areas suitable for further investigation (the Stage² control panel, for example, allows storing and recall of specimen-stage positions). The Camera workset provides access to plate camera functions that allow recording of data like images and diffraction pattern during the more detailed investigations.
Control-panel access is also possible through the popup-panel selection (see section 1.4, in that case the current selection remains on the left-hand side and the selected Control panel appears at the bottom right). Most control panels can only be selected for popup when they are already somewhere located in a tab.
When there are more tabs than can be fitted in the width of the workset tab window, right-left arrow buttons appear on the right-hand side. With those you can scroll the tabs to the right or left.

Modifying the worksets
The worksets are defined using the Workspace Control Panel (see chapter 53; because of its size accessible only in the popup selection).

1.3 Control panels

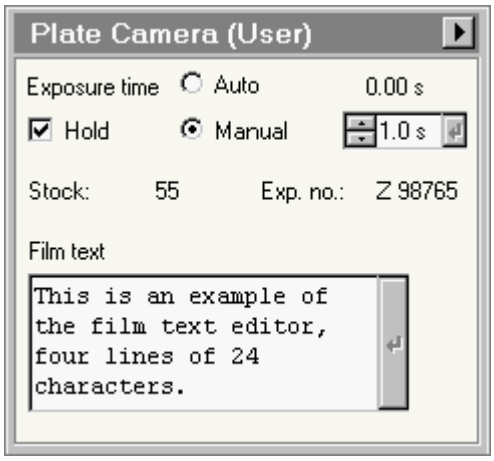
Control panels are small windows, typically arranged in sets of three or four (dependent on the font setting of the PC and the size of the monitor) above one another on the left-hand side of the screen (some Control panels are double-height and can therefore only be combined with one additional panel). Each Control panel contains a coherent set of microscope controls (like vacuum system, electron gun or stigmators). The combination Control panels forms a workset, defined by name and accessible through a tab in the workset selection window above the Control panels themselves.



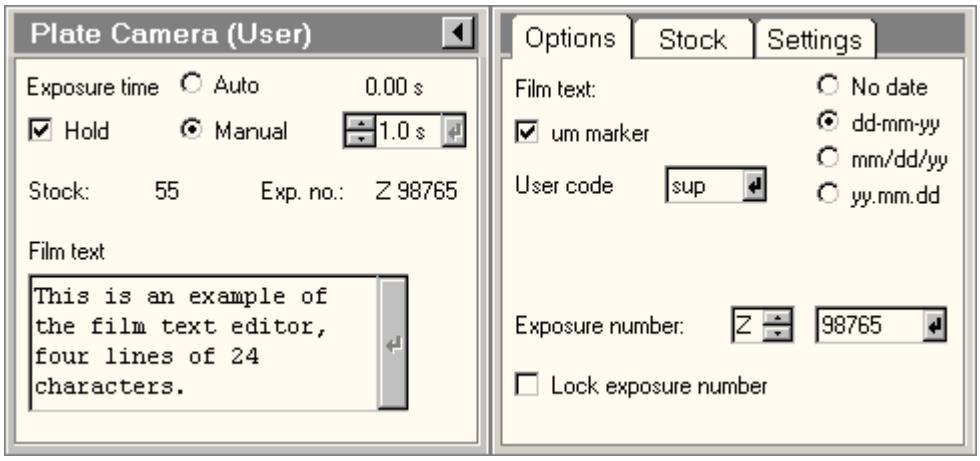
The Measuring Control panel (see chapter 34), one of the control panels without a flap-out.

The rationale behind the Control panels is very simple. They are meant to give rapid access to elementary (often-used) microscope functionality. Selection of microscope settings (used much less often) is not accessible through the Control panels themselves but is 'hidden' away conveniently in flap-outs.

Panel flap-out
Some Control panels (like the Measuring Control Panel shown above) are simple and have no 'hidden' settings. Other panels are equipped with so-called flap-outs: additional panels that appear to the right of the main panel. Panels with flap-outs are recognizable by the flap-out button at their top right.

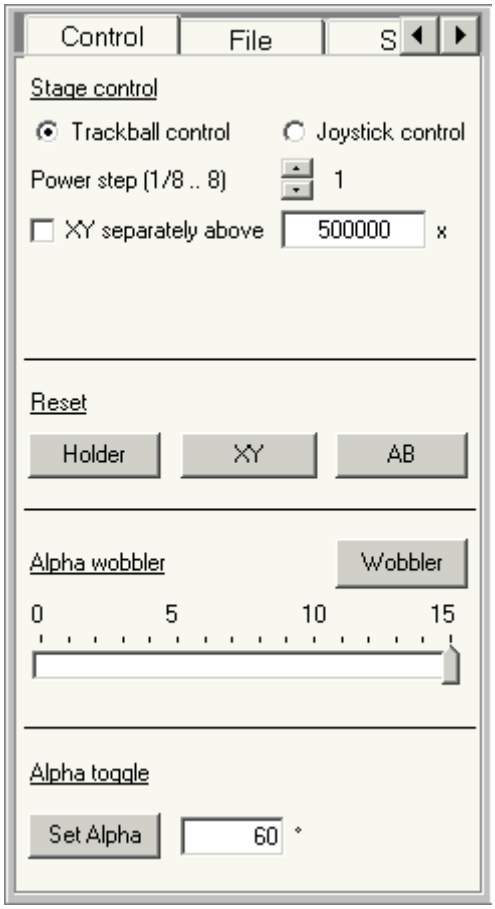


The Plate camera Control panel (see chapter 42) with the flap-out button (arrow pointing to the right at top right) and the flap-out closed.



The Plate camera Control panel with the flap-out open.

When the flap-out button is pressed, the flap-out panel appears. This panel has one or more panels itself, combined through the use of tabs. Click on a tab to access that particular panel. If the total series of tabs doesn't fit in the panel, left-right arrow buttons at top right allow shifting of the whole series of tabs to left or right.



The Control tab of the Stage² Control panel flap-out (see chapter 43).

Flap-outs remain visible until they are closed again (with the flap-out button which has reversed its pointing direction). They disappear from view when another workset is chosen but will reappear when the workset with the 'flapped-out' Control panel is chosen again.

On-line Help
Each Control panel has its own on-line help, accessible by clicking somewhere inside the Control panel, and then pressing F1. The Alignments Control panel and Direct Alignments Control Panel additionally have on-line help pages for each of the alignment subprocedures or direct alignments.

1.4 Popup panels

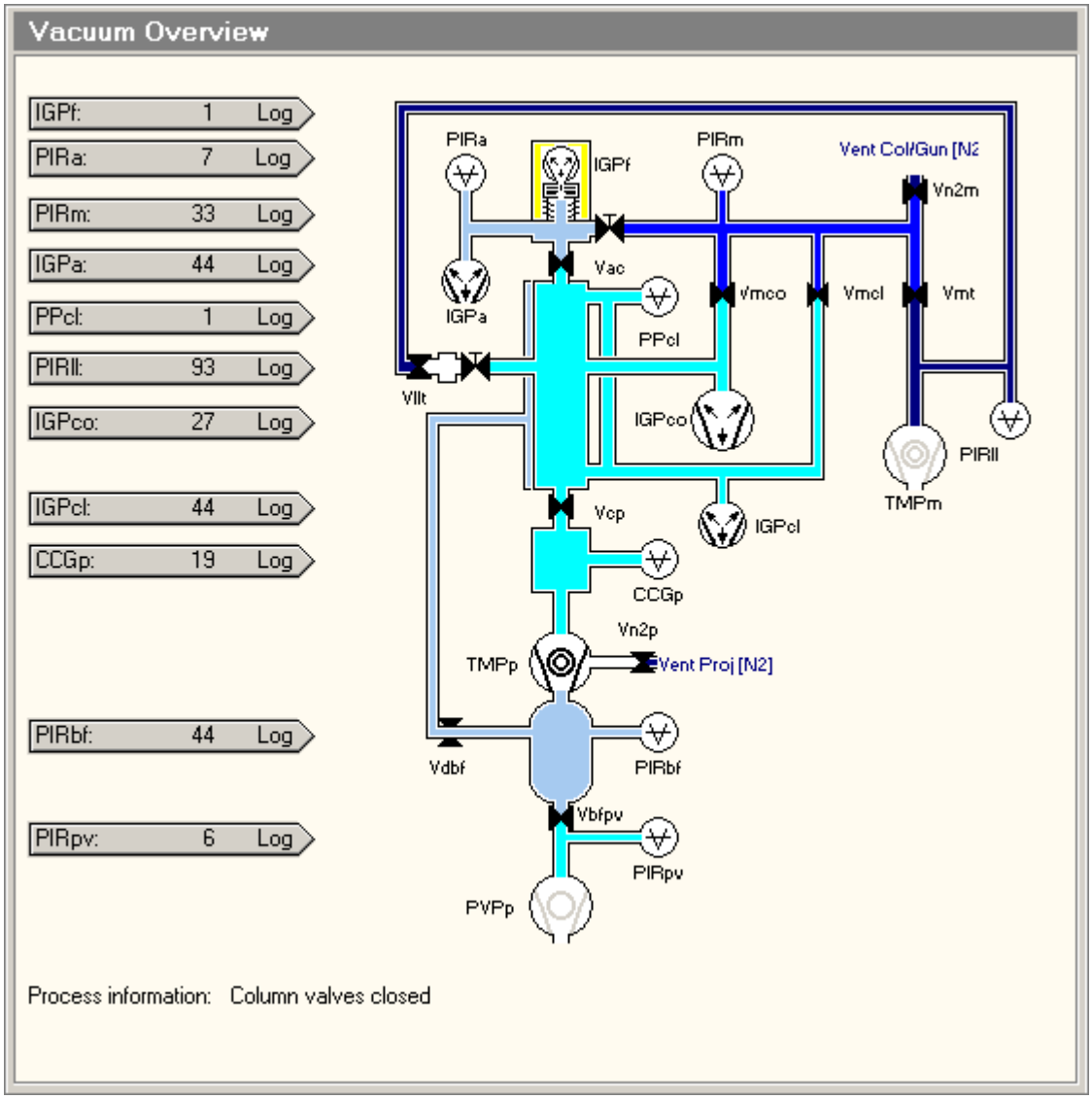
At the bottom right-hand side of the screen (right next to the microscope name) is a drop-down list box with a small 'x' button next to it (in other views than the standard frame it may be located elsewhere on

the screen).
The drop-down list gives access to Control panels that will be displayed in the corner just above the list box itself. The selection of these 'popup' panels includes a number of Control panels that cannot be assigned to worksets (because of their size). The selection also includes those Control panels that are not currently visible on the screen. This means, for example, that you can have the microscope display the Plate camera control panel to have rapid access to the plate-camera settings, without changing from the current workset tab. As soon as the workset tab is changed to one containing the panel visible as a

popup, the popup panel will disappear from the bottom right and is only visible in the regular column of control panels on the left.
The popup is hidden again when:

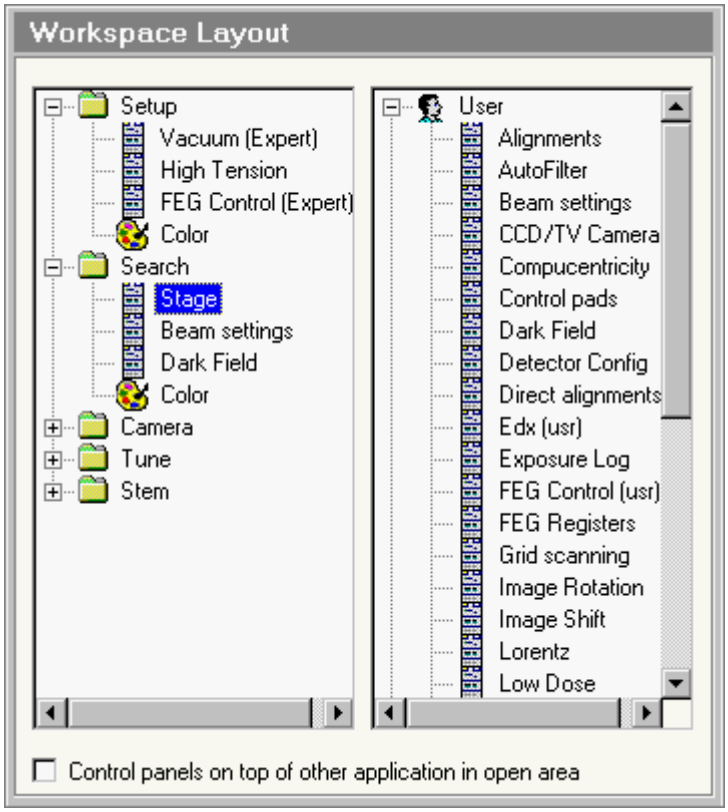
- the small 'x' button is pressed.
- - None - is selected in the popup.
- the currently visible Control panel is already present in the workset tab being selected.

Special popup panels
Three popup Control panels are worth mentioning here since they can only be accessed in the popup because they are too large to fit inside the space normally reserved in the worksets for Control panels: the Vacuum overview, the Workspace lay-out and the System Status. The on-line help for these panels is once again accessible by clicking in them and pressing F1.



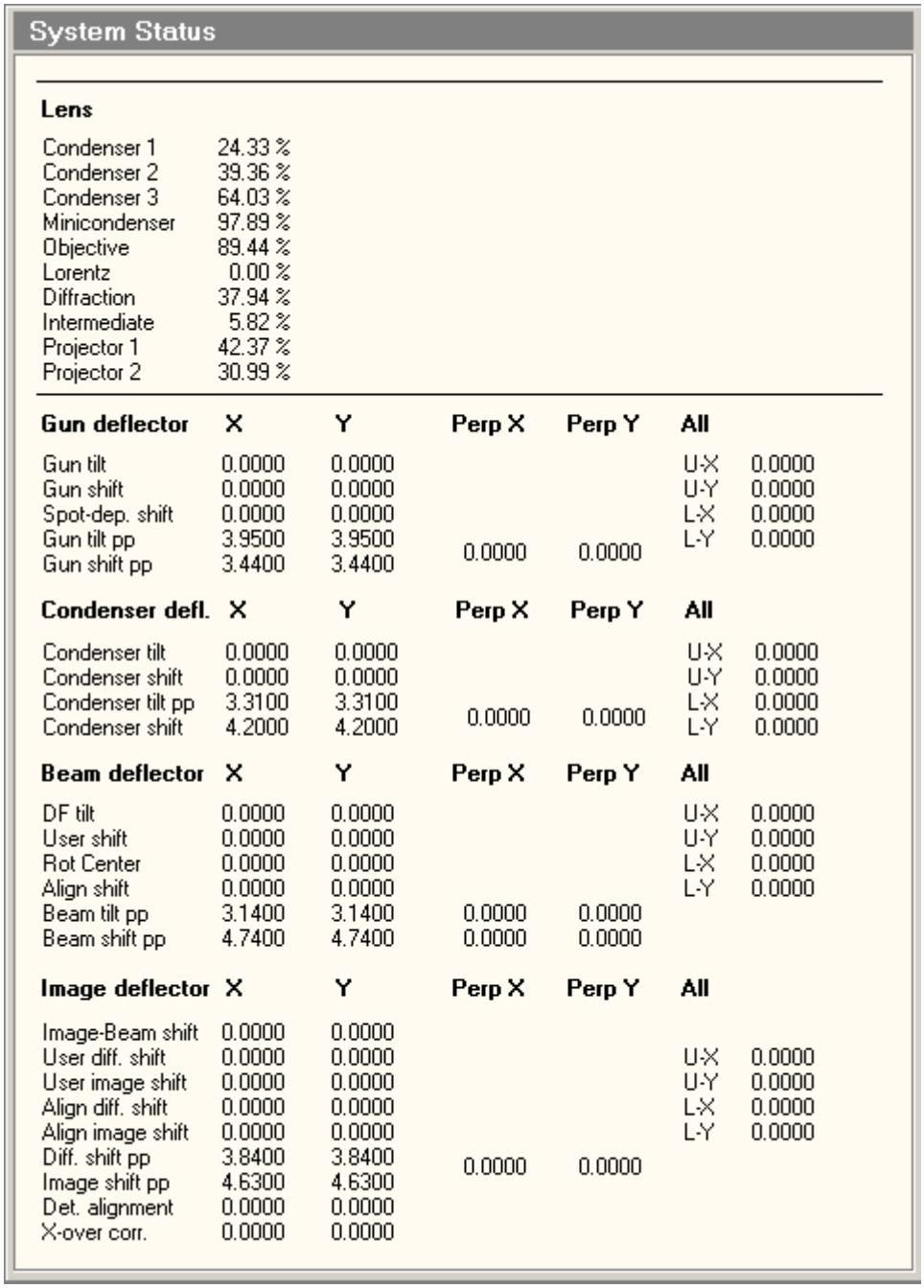
The Vacuum Overview Control Panel (see chapter 52).

The Vacuum Overview Control Panel displays a graphical overview of the current status of the vacuum system.



The Workspace Layout Control Panel (see chapter 53).

The Workspace Lay-out Control Panel provides the tools for customizing the worksets: Control-panel selection, color selection, etc.



The System Status Control Panel (see chapter 47).

The System Status Control Panel provides an overview of the (software) settings of all lenses and deflection coils.

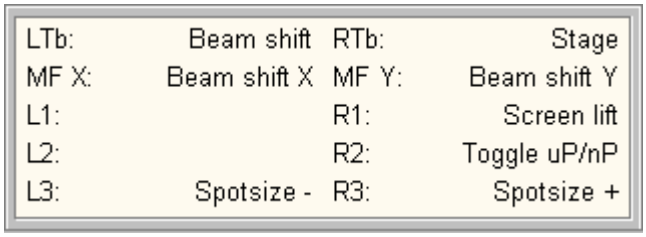
1.5 Display

The microscope user interface provides a series of panels containing microscope status information. These cover the binding display, message area and microscope status display.

1.5.1 Binding display

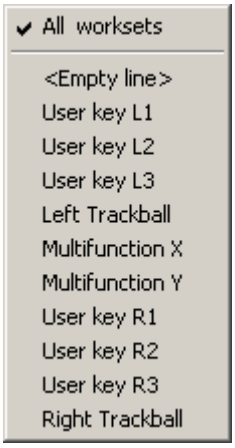
The binding display panel shows how the user-assignable knobs and buttons on the left-hand and right-hand Control Pads are linked to microscope functions. These knobs and buttons are:

- Left-hand track ball (typically assigned to beam shift)
- Right-hand track ball (typically assigned to CompuStage X and Y)
- Multifunction X
- Multifunction Y
- User button L1
- User button L2
- User button L3
- User button R1
- User button R2
- User button R3



The selection of the assignments displayed is up to the user. A typical selection could be displaying two columns:

Depending on the number of items present, the display will contain one (with subcolumns for knobs/buttons; their functions) or two columns (2x knobs/buttons; their functions). Empty lines can be used to give a balanced display selection.



Adding items

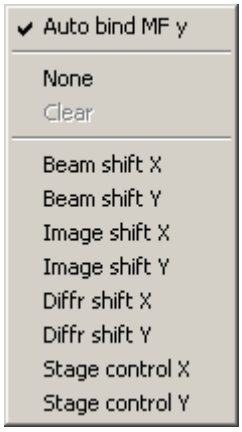
Click with the right-hand mouse button on a part of the binding display panel that holds the names of knobs and buttons (the far left or the left-hand side of the second column). A popup menu will appear.

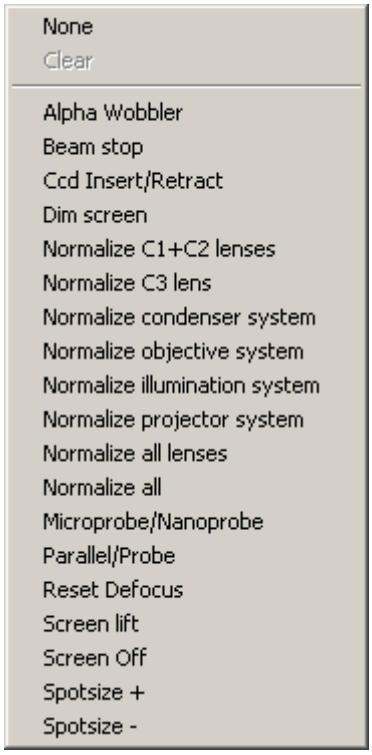
Click on the item required and it will be added to the current selection. The All worksets item can either be checked (in which case the selection displayed is the same for all worksets) or not (in which case each workset can have its own selection). Note that the actual knob or button functionality selected is not dependent on the workset (only what is displayed).

Note: The Right Trackball is available only if the right-hand control pad is not equipped with a joystick.

Removing items

Click on the desired item and drag it out of the binding display panel.





Changing a function assignment
Click with the right-hand mouse button on a part of the binding display panel that holds the function description for the knob or button required (the right-hand side of the first column or the far right). A popup menu will appear, whose content will depend on the type of knob/button selected (track ball, multifunction knob, user button). In the case of the Multifunction knobs, near the top of the popup menu is an item Auto bind MF y (when the MF-X selection is clicked) that, when checked makes the Multifunction knobs follow each other (that is, when the Multifunction knob X is given to the x parameter of a function, then Multifunction Y will automatically assume the y parameter of that function).

Note: The Stage control is available only if the right-hand control pad is not equipped with a joystick.

Multifunction knob assignments
The Multifunction knobs have a wide range of functions. All functions (wobbler, stigmators, dark field, alignment, etc.) that assign functionality to the multifunction knobs also release that functionality when the particular function is switched off again (after which the multifunction knobs regain their previous functionality). The functions are typically assigned whenever needed (e.g. during alignment). The user can also assign functions to the knobs (these functions will be overruled when necessary). There are two possibilities:

1. The assignment is **persistent** (these functions will be overruled when necessary but the function is always returned when automatic assignments are taken off).
2. The assignment is **temporary** (these functions will also be overruled when necessary and the function is not returned when automatic assignments are taken off).

A persistent assignment can only be made when the Multifunction knobs are not currently occupied by an automatic assignment, otherwise the assignment is temporary.

Examples

- The Multifunction knobs are currently assigned to the Diffraction shift (a user assignment). The user clicks with the right-hand mouse on the Binding display panel and chooses another function. This assignment is persistent.
- The Multifunction knobs are currently assigned to the Wobbler (after the Wobbler button has been pressed). The user clicks with the right-hand mouse button on the Binding display panel and chooses another function. This assignment is temporary (comes on top of the automatic Wobbler assignment) and will disappear when the Wobbler is switched off.

The None and Clear functions
The popup menu that allows setting of the binding configuration can have two functions, None and Clear. None is always enabled, Clear only when the current assignment is temporary. If None is selected, all functions are removed, independent of the nature of the current assignment (persistent, temporary or automatic). If Clear is selected (thus only possible if the assignment is temporary), the knob or button reverts to its prior automatic setting. Thus if you assigned the Beam shift function to the Multifunction

knobs in an alignment procedure and then select None, the Multifunction knobs are completely cleared of all functions. Whereas if you used clear, the Multifunction knobs get back their setting from the alignment procedure.

Changing the relative position of items
Click on an item with the left-hand mouse button and drag it to a new position.

1.5.2 Messages

Messages by the microscope are shown in a dedicated part of the information area (above the status panel that typically contains the magnification and operating mode). Messages can have three different levels. Since only one message can be displayed at a time, important (higher level) messages will displace simple information messages.

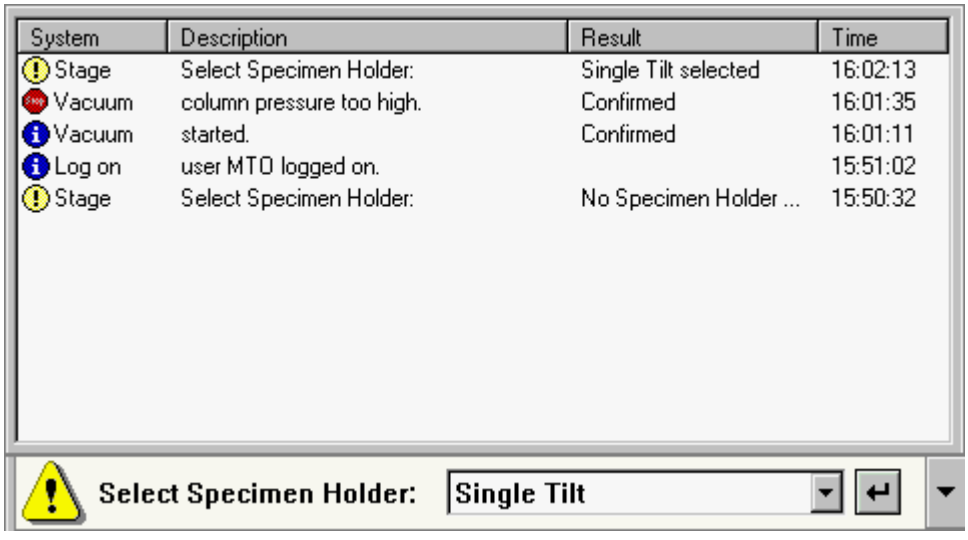
The different levels are indicated by different icons:

Error

Warning

Information

If the message requires confirmation, it will stay displayed until the Enter button is pressed. Some other messages automatically disappear after a minute. All messages are kept in a list which becomes visible when the Up button on the right-hand side of the message area is pressed:



To close the list click the Up button (now changed to a down arrow) again.

1.5.3 Status displays

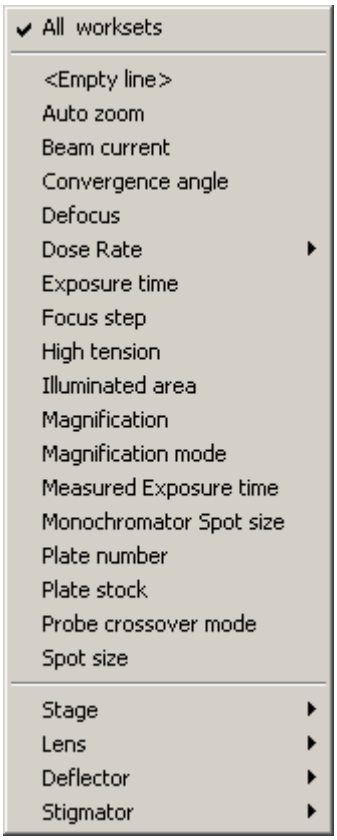
Up to three status display panels (in the minimum-size info area view this number is reduced to one). These status display panels can display a wide range of user-selectable microscope settings.

SA 97000 x	HT:	190 kV	Defoc:	-13.00 um
TEM	Spot size:	3	Focus step:	5

The left-most typically will display the microscope magnification and mode. This panel is also the one displayed in the minimum-size info area view. The two others are up to the user (by default they will contain the settings shown at the right of the picture above, while the third panel will display the specimen-stage position). All settings can be changed by the user.

Note: The magnification/camera length displayed depends on the position of the viewing screen. If the viewing screen is raised, the magnification/camera length values are those of the plate camera. If the viewing screen is down, the values are those as seen on the viewing screen.

Removing settings from status panels
Click on a setting in the status panel and drag it outside the panel.



Adding settings to status panels
Click with the right-hand mouse button on the status panel in the position where a new settings must be added. A popup menu will appear:

At the top of the menu (All worksets) the user selects (by checking or unchecking the item) whether the configuration as currently displayed is valid for all worksets (checked) or whether each workset can have its own settings. The other selections in the popup menu enter the required value into the status panel (in some cases one has to select via a submenu - move to the right where the small, right-pointing arrows are displayed). Empty lines can be added to give a balanced display. The font size will be adjusted automatically to the amount of space available.

1.6 Help window

The Help window, used for displaying the on-line help, is displayed in the area reserved for data (the empty area in the user interface). When F1 is pressed in the TEM user interface the help window becomes visible near the top left of the screen. Four views of different sizes are selectable through small buttons at the top of the Help window.

Note: The content of the Help window depends on the position of the cursor at the moment you press F1. If the cursor is over a main control panel, the help page of the main panel is shown; if it is over a flap-out panel, then you get the help of that panel - even if the original click with the left-hand mouse button was in the main panel. For proper operation of the help system, do not move the cursor out of the area for which help is requested until F1 has been pressed.

How does on-line help work?
The on-line help system consists of a series of html (Hypertext Mark-up Language: Internet browser) files. The contents of these files are displayed in the on-line help window of the TEM user interface. (But they can equally well be 'browsed' off-line using an Internet browser. The entry point is a file called Index.htm.)
In order to minimize the number of pages involved, many topics are arranged together with related topics on a single page. To allow rapid selection of relevant topics on such pages, they have been equipped with bookmarks (hyperlinks to the topics further down the page). The hyperlinks are clearly recognizable as such in the case of text (the unused hyperlinks are green, the used ones take the default color of the browser). It may also happen that hyperlinks are present on images, for example of control panels. Move the cursor over the image and hyperlinks will show up by the changing of the cursor to a hand.

For each topic lower on the page there is an up button: ▲ When the Up button is pressed, the page jumps back to the top. Technically speaking the Up button is again a hyperlink to a bookmark, but it doesn't show a hyperlink border.

The Help window can have three different formats, small, long and full. The 'small' help window covers a 1/4 area at top right. The 'long' window covers the vertical 1/2 area either on the left or on the right. The 'full' window covers the data window.

The window sizes (as well as some other functions) are controlled with the buttons that are present in the window title bar.

From left to right these buttons are:
- Load alphabetical index (a..z)
- Load topics index (t)
- Load main page (i)
- Back
- Forward
- Small help window
- Full help window
- Long help window on the left
- Long help window on the right
- Close help window

Back and forward work like in a normal Internet browser.

2 System settings and logging off

When you log off from the microscope (close the TEM User Interface) system settings will be saved. What are these 'system settings'? They are not the changes you have made to the TEM User Interface layout like the selection of control panels and their arrangement over the tabs and the color selections made in Workspace Layout. Those changes are saved immediately as you make them.

What is saved under system settings is the following :

Column
- Operational settings (modes, spot number, intensity,...)

Note: In order to get the microscope at log on always to an easily usable state, the microscope will always switch out of STEM, EFTEM and Lorentz microscopy when logging on, even if that was the state the microscope was in while logging off.

Detectors
- Detector selection
- Contrast, brightness and filter settings per detector
- STEM acquisition settings
- EDX acquisition settings
- PEELS acquisition settings
- CCD acquisition settings

Knobs
- User settings on L1..L3, R1..R3
- User settings on the Multifunction knobs
- User settings on the trackballs

Plate camera
- um marker state
- Exposure number
- Plate label date type
- User code
- Exposure time type selection and hold
- Film types and settings
- Link to HT
- User stock value
- Exposure stock (system-wide)
- Selected film type (system-wide)
- For supervisor exposure number lock

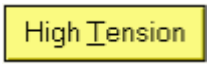
Vacuum
- Vacuum display units
- Airlock time
- For supervisor the visibility of the Projection Vented button

Accessories (Low Dose, AutoAdjust, Photomontage, etc.), see under the help of the various accessories.

3 Windows Controls on Titan microscopes

The user interface of the microscope contains a number of Windows control elements like buttons, etc. For those unfamiliar with the terminology, these controls are listed below.

Button
Press it to have the program to execute a certain function. If the function cannot be done under the current conditions, the button is grayed.

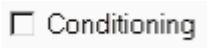


Three-state button
In addition to the normal and grayed states, this button has a yellow state which indicates that the function is on.

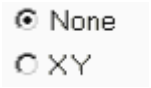
Four-state button
In addition to the normal and grayed states, this button has a white state which indicates that the selection is on and a yellow state which indicates that the selection is on and the function is active.
Some four-state buttons have an orange color, indicating that the function is on but not yet ready to run. An example is the Turbo On button in the Vacuum control panel. When the button is pressed (from gray) the TMP must first be ready before it can starts pumping. While it is started but not ready, the button color is orange. Once it is ready and pumping, the color changes to yellow.
There are also buttons that have a red color (some of the acquisition button for CCD or STEM) which indicates that other software is doing an acquisition (e.g. Tomography of Scripting).

Label
Simple text in a window. Display only.

Edit
Allows insertion of text or numbers. Only used if there is some other way of having the program act on the change.



Check box
Selects (a check mark is displayed in the square) or deselects a particular option. It also works when you click on the caption of the check box (so not only when you click inside the box itself).

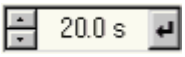


Radio buttons
Makes a selection from a series of mutually exclusive options. Clicking an unchecked option, checks that options and unchecks all others. Also works when you click on the caption of a radio button (so not only when you click on the circle itself).

Drop-down list
A list of items from which a selection can be made. In order to save space, the whole list only becomes visible when the arrow on the right is clicked. If text or a value can be entered at the top line, it is called a drop-down combo box.

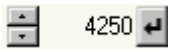
Spin buttons
Change a number up or down by clicking on the up or down buttons. The numbers will spin faster if you keep one of the buttons pressed instead of giving single clicks.

Enter button
Confirm changes by pressing the enter button (pressing the button on the keyboard does the same). The TEM server is not informed of the change until the button has been pressed.



Spin-enter-edit
An edit control with spin buttons to change the value and an enter button to confirm the change (after which the program will act on it). The enter button indicates the status of the value. When the enter button is enabled, the value has been changed but not yet updated in the microscope (the update is done by pressing the enter button). When the enter button is disabled, the value indicated is the same as that on the microscope. When you use the spin buttons the value is directly transmitted to the server and the enter button will remain disabled. When you change the value by typing, the enter button will become enabled and you have to force the update by pressing the enter button.

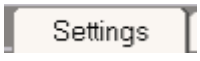
Spin-label
A control with an indicated value and spin buttons. Here the value can only be changed with the spin buttons. The change is transmitted immediately to the TEM server.



Spin-label-enter
A control with an indicated value, spin buttons and an Enter button. You change the value with the spin buttons but the change is not transmitted to the TEM server until the Enter button has been pressed.

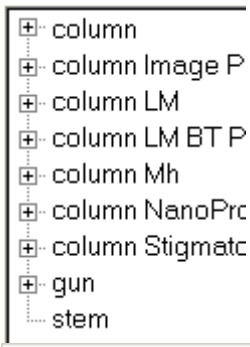
Trackbar
Drag the gray handle to another setting to change a value. You can also click to the left or right of the handle to make it jump one step.

Progress bar
Displays progress of a process or the current status as a fraction of the total range.

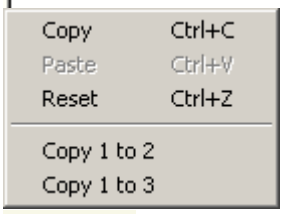


Tab
Allows selection of one of a series of displays.

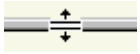
Bitmap button
A button with a picture on it. These are used for the flap-out buttons, but also in toolbars, etc. They usually work the same as normal buttons, except that some toolbars buttons are flat (only show their outline when the cursor hovers above them) and can show an 'on' state by remaining 'pressed down'.



Treeview
Display a list of items, some of which (marked by a '+' sign) can be expanded to show their sub-items, and so on. Expansion happens when you click on the '+' (it will contract again when you click on the '-' sign that will take the place of the '+'). Alternatively you can expand by double-clicking on the caption (not double on the '+', that expand and contracts again). Select an item by clicking on the caption.



Popup menu
A single-column menu that becomes visible when the right-hand mouse button is clicked.



Splitter
A bar separating two areas in a window that allows changing the size of the two areas. The cursor show two lines drawn apart by two arrows.

4 Control panels

The Control Panels are covered in the chapters below.

Note: The panels described may not all available to all users on your microscope because:
- Some panels differ according to user level (User, Expert, Supervisor)
- The required hardware (STEM, Energy Filter) may not be present on the microscope.

The order in which the control panels are covered is alphabetically.

5 Alignments

The alignment procedures of the TEM microscope are accessible through the Alignment control panel. The procedures, split into logical units are displayed in a treeview. Each procedure contains subprocedures that are accessible by clicking on the '+' in front of the procedure name (or double-clicking on the procedure name).

Important note: When the microscope reports that an alignment has been saved, it means the alignment is saved to the settings (registry), NOT to a file!

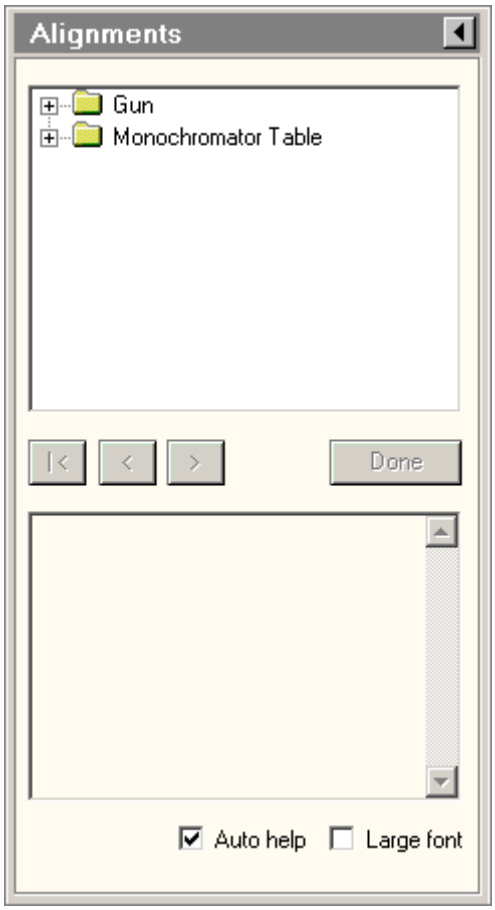
Alignments can be stored to file (supervisor, service or factory) and wholly (everyone) or in part (supervisor, service or factory) restored to the microscope. Each alignment part corresponds to an alignment procedure. Alignments for all users are located together and listed in the list of available alignments. The controls for saving and restoring alignments are found in the Alignment File Control Panel.

For more background information on how the microscope works with alignments, see 'Alignments in the TEM microscope' (align.pdf).

A few rules:

- You do not change any alignments by walking through a procedure. Only when you change a setting in a step (usually with the Multifunction knobs, but in some cases also the Focus or Intensity) do you change alignments. Changes become operational immediately. They are stored (to the registry, not file!) when the alignment procedure is exited (Done).
- Start a procedure by clicking on the title of the first subprocedure (or the individual subprocedure required if not the whole procedure is needed). Stop a procedure by pressing Done, or Previous while in the first subprocedure step, or Next on the last subprocedure step. Going to another tab (where the Alignment Control Panel is no longer visible) also exits the alignment procedures.
- Navigation through a procedure is normally done with Next or Previous (the buttons on the control panel or R1 and L1 on the Control Pads). Using these buttons proceeds through the 'short' procedure, automatically skipping less-often used alignments (like pivot points). The skipped subprocedures can be accessed only by clicking on the title of the particular subprocedure. Navigation then may proceed to other, less-often used subprocedures. Subprocedures that are skipped are indicated by a different icon (blue arrow, on yellow, pointing down) and which are not (blue arrow, on white, pointing to the right).
- Each subprocedure can contain several steps (which are listed as '1 of 4' or '2 of 3'). You cannot go directly to a 'hidden' step because the first step sets the microscope in an appropriate condition for the alignment. In some cases first steps are skipped when using Next (because the previous subprocedure already put the microscope in the proper operating conditions so it doesn't need to be done again).
- Each (main) procedure is stand-alone in the sense that you cannot move automatically from one procedure to another by using Next or Previous, only with the mouse.
- Alignment procedures may differ depending on the level of user, with supervisor, service and factory having more alignments accessible than users.
- All subprocedures have on-line help pages that describe the purpose and operation of the particular alignment. Press F1 while a subprocedure is active and the proper page should come up. If another page comes up instead, the Alignment control panel was not the last window used. Click on the panel and press F1 again. When the Auto help check box is checked, the help pages are displayed and updated automatically.
- You can move to another control panel as long as you stay within the current tab (you can also pop-up panels on the lower right), but if you move to another tab, then the alignment is exited.

- In many alignment steps the microscope is switched to specific magnifications, intensity settings, spot sizes, etc. There is not always a protection against changes (sometimes a procedure step warns against staying within the current magnification range).



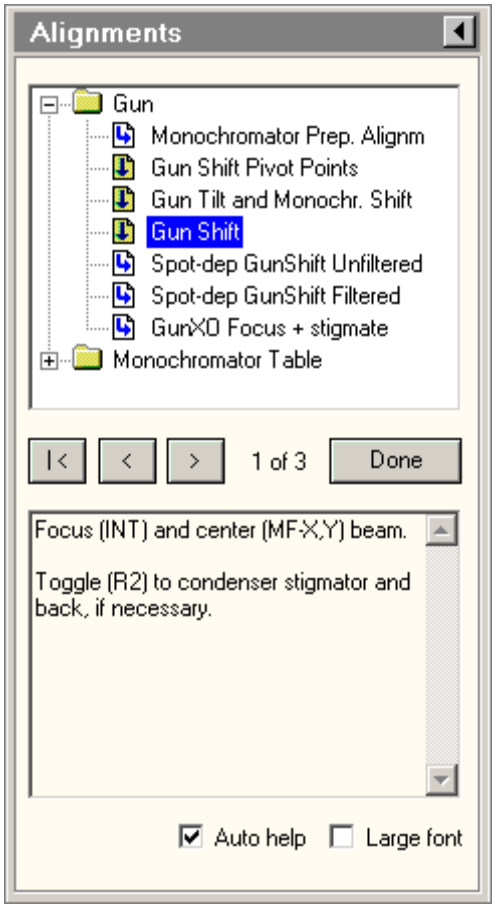
Tip: In some cases it may be useful to be able to see the settings of the most important lenses (C2, Obj, Diff). If the Alignments control panel is inserted in the user interface under a workset tab, define the status panel display (typically the one on the right) to have these settings listed.

The Alignments Control Panel.

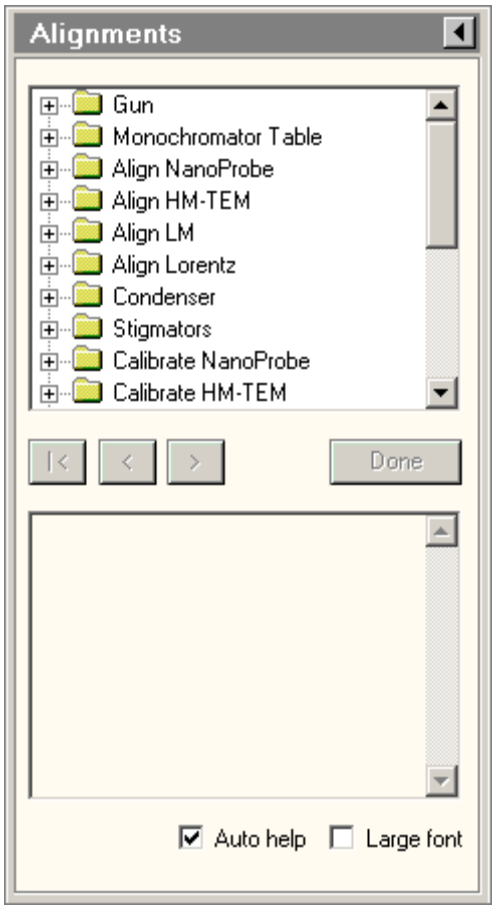
Procedures available for normal users.

Clicking on the "+" expands a procedure, while clicking on a "-" contracts it.

When a subprocedure is selected, the selection list will become disabled until the microscope is ready to proceed.



When a subprocedure is active, the number of steps in the subprocedure is displayed.



The list of procedures available for supervisor, service and factory.

Procedure selection
Selection is done in the treeview that lists the procedures. Click on the '+' in front of the procedure name (or double-clicking on the procedure name). The treeview branch of the procedure will open and display the subprocedures. Click on the first subprocedure visible or any other subprocedure if only part of the alignment needs to be (re)done.
Subprocedures that follow the standard sequence (that is, they are not skipped) are designated by the icon with the blue arrow (on white) pointing to the right (into the subprocedure), whereas skipped subprocedures are designated by an icon with a blue arrow (on yellow) pointing down.

| <
Pressing the '|<' button moves to the first step of the alignment procedure (back to the very beginning).

<
Pressing the '<' (Previous) button steps one step back in the alignment procedure. If the current step is a first step of a subprocedure, the step always goes to the first step of the previous subprocedure (you cannot step backwards through one subprocedure to another). This button is equivalent to the L1 user button on the right-hand Control Pad.

>
Pressing the '>' (Next) button steps to the next step of the alignment procedure.

xx of yy
Indicates the current page of the subprocedure (xx) and the total number of pages (yy), where xx and yy are numbers (e.g. 1 of 3).

Done
Switches alignment off.

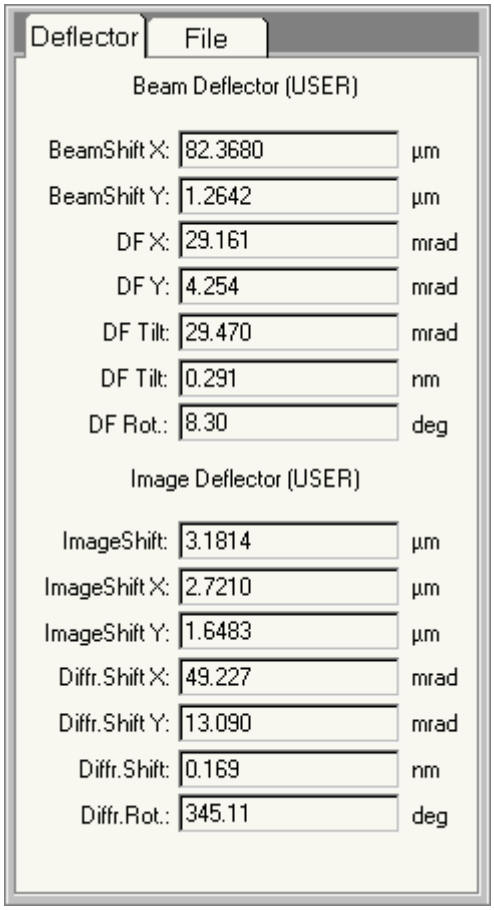
Procedure instructions
This field displays the instructions for the current alignment step.

Auto help
When the Auto help function is on, the on-help topic for the particular subprocedure is displayed automatically alongside (and also updated when a new subprocedure is started).

Large font
When the Large font option is checked, the instructions are displayed in a much larger (more easily readable) font (the downside is that the instruction will often not fit into the area available and the scrollbar on the right-hand side must be used to scroll the rest of the instructions into view).

Flap-out
The flap-out button leads to the Alignment control panel flap-out containing the Deflectors and File control panels.

5.1 Alignment Deflectors



The Alignment Deflectors Control Panel.

The Alignment Deflectors Control Panel displays the calibrated values of settings of various deflections used. These settings are adjusted when they are calibrated in the beam shift, beam tilt, image shift and diffraction shift calibration procedures.

Note: In order to have realistic and accurate values for beam shifts and tilts and for image and diffraction shifts (e.g. for measuring) it is important to calibrate these settings.

Beam shift
Beam shift values are listed in micrometers for X and Y.

DF (beam) tilt
Dark field (beam) tilt values are listed in various ways:

- Separate X and Y values (items #3 and #4 for the Beam Deflector).
- A total dark field tilt angle and a rotation angle (items #5 and #7).
- The d spacing corresponding to the total dark field tilt angle (item #6)

The d spacing is calculated from the dark field tilt angle and the high tension of the microscope. The high tension defines the electron wavelength, which allows conversion of an angle (in this case the dark field tilt) into a d spacing through Bragg's Law $2 \sin\theta = \lambda / d$.

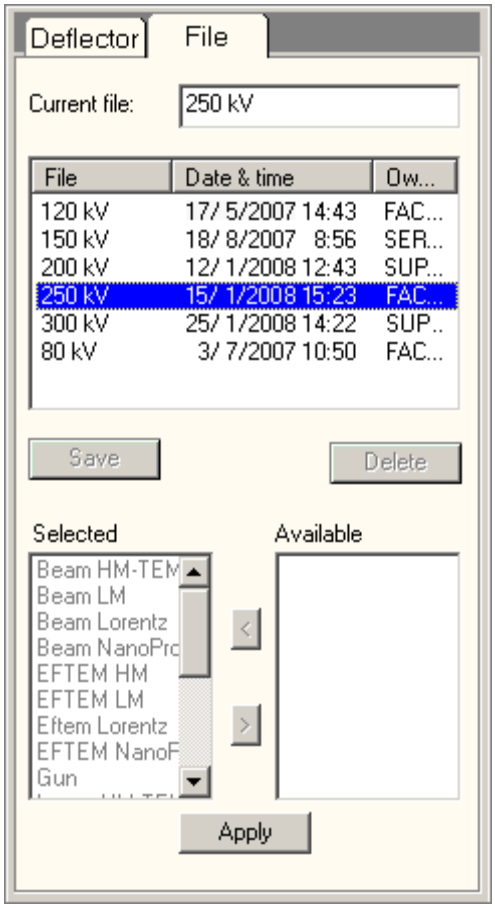
Image shift
Image shift values are listed for the total shift (item #1 for the Image Deflector, having X and Y combined) and X and Y separately (items #2 and #3).

Diffraction shift
Diffraction shift values are listed in various ways:

- Separate X and Y values (Image Deflector items #3 and #4).
- The d spacing corresponding to the total dark field tilt angle (item #5).
- A diffraction shift rotation angle (item #6).

A shift of the diffraction pattern corresponds to a certain diffraction angle (for example, if you shift the pattern from the central, transmitted beam to a diffracted beam, you have shifted the pattern by the Bragg angle of the diffracted beam). The d spacing corresponding to the diffraction angle is calculated from the diffraction shift angle and the high tension of the microscope. The high tension defines the electron wavelength, which allows conversion of an angle (in this case the diffraction shift) into a d spacing through Bragg's Law $2 \sin\theta = \lambda / d$.

5.2 Alignment File



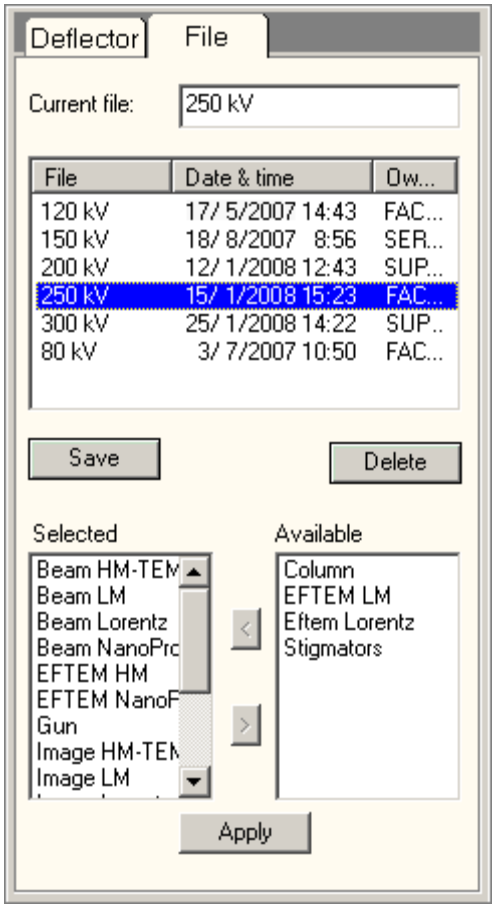
The Alignment File Control Panel.

The available alignment files and the choices available to microscope users :

- Save and Delete are disabled
- Buttons with < and > are disabled
- Selected always contains the complete list of settings

The available alignment files and the choices available to supervisor, service and factory :

- All controls are enabled when a filename has been given or a file has been selected
- Selected and available contain the settings that can be chosen



The Alignment File Control Panel contains the controls for saving alignments to and loading them from file. Alignments can be stored to file and wholly or in part restored to the microscope. Each alignment part corresponds to an alignment procedure . Alignments for all users are located together and listed in the list of available alignments.

Current file
For creating a new alignment type a name in the edit control. The characters in the name must all be valid for filenames (so do not use characters like * / ? or \). If an alignment is selected in the file list, its name is automatically filled in under current file.

File list
The file list contains all available alignments. The alignments are listed with their name, their date and time of creation and the owner (creator of the alignment). Initially the list is sorted alphabetically on alignment name, but the sorting order can be changed by clicking on the buttons above the columns (File, Date & time, Owner). Clicking the same button again reverses the sorting order.
The width of the columns of the list can be adjusted by clicking at the boundary between the buttons at the top of the columns (the cursor changes to a vertical bar with two arrows pointing sideways) and dragging it sideways.
Multiple entries can be selected (for deletion only, you can of course not reload multiple alignments) by clicking on more than one name with the Ctrl key on the keyboard pressed (each click selects - or deselects again - a single entry) or by first clicking one name and then clicking on another name with the Shift key (selects all entries between the two names at top and bottom as well).

Save
When the Save button is pressed an alignment is saved under the name defined. The Save button is only enabled when it is valid for the user to save an alignment (a valid name has been entered that is not the same as that of another alignment from a different user). If you are overwriting an existing alignment, you are asked for confirmation.

Delete
When the Delete button is pressed the alignment(s) selected is (are) deleted.

Selected list
For supervisor, service and factory :
When an alignment from the list is selected, the microscope compares the date of the alignment with the date for your current alignment. If elements (currently only Gun or Column) of the alignment stored are more recent than your alignment, those elements are inserted in the Selected list. If the stored alignments are older, they are inserted in the Available list on the right. Alignment elements can be moved from one list to the other with the < and > buttons. The elements in the Selected list are restored to the microscope when the Apply button is pressed.

Note: When you press Ctrl + A after clicking in the Selected or Available lists, all items are selected and are more easily transferred from one list to the other.

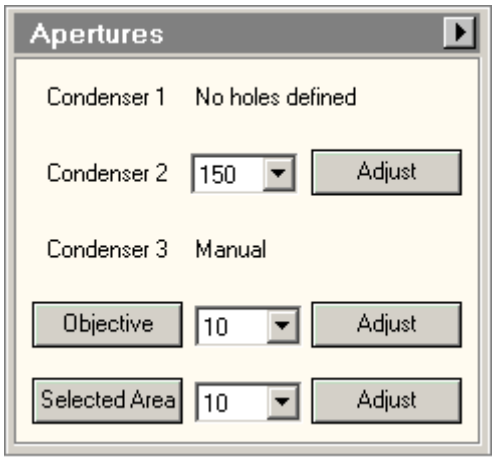
Available list
For supervisor, service and factory :
When an alignment from the list is selected, the microscope compares the date of the alignment with the date for your current alignment. If elements (currently only Gun or Column) of the alignment stored are older than your alignment, those elements are inserted in the Available list. If the stored alignments are more recent, they are inserted in the Selected list on the left. Alignment elements can be moved from one list to the other with the < and > buttons. The elements in the Available list are not restored to the microscope when the Apply button is pressed.

Note: When you press Ctrl + A after clicking in the Selected or Available lists, all items are selected and are more easily transferred from one list to the other.

< >
For supervisor, service and factory :
Alignment elements can be moved from the Selected to the Available list and vice versa. Click on an element in one of the lists (the element becomes highlighted) and press the < or > button (with the direction of movement indicated by the < and >). Only the elements in the Selected list are restored to the microscope.

Apply
When the Apply button is pressed, the alignment elements in the Selected list are restored to the microscope. If the Selected list is empty, the Apply button is disabled.

6 Apertures



The Apertures Control Panel.

The layout and contents of the Apertures control panel is strongly dependent on the configuration of the microscope (which apertures are located where) and the current status of each aperture. Sometimes apertures are not enabled (Condenser 1 in the picture above) or manual (not motorized, Condenser 3 above) and their controls (or absence of controls) reflect that. Potentially there are up to five different aperture mechanism with motor control, Condensers 1, 2, 3, objective and selected area. Condenser 1 may contain the slit for the monochromator, while the selected-area aperture mechanism also may contain the biprism for holography.

Warning: On microscopes equipped with the S-TWIN or X-TWIN lenses do NOT insert the objective aperture when the CompuStage is at high tilt. The objective aperture is in the same space as the specimen holder and, when it is inserted, may hit the specimen holder, resulting in a damaged aperture blade. When you wish to insert the aperture, first tilt back to a low tilt (<20), insert the aperture and then tilt back to the previous tilt angle.

Each aperture that is currently controllable displays a drop-down list with the sizes of the apertures. Sizes may exist in duplicate (if more apertures of the same size have been installed). The list may also display "slit" or "biprism".

Note: Misaligned apertures can be one reason for not being able to see the electron beam (other reasons are closed column valves, beam shifted off the screen, beam focused on a specimen grid bar, small spot nearly invisible, etc.). To make sure none of the apertures is actually blocking the beam, change the selected aperture (and back, if necessary). For Condenser 1, select 2000 (but go to another aperture first). For Condenser 2 and 3 change to a large aperture size (if already at the largest, go to another aperture first). For insertable apertures, first insert and then again retract them.

Aperture disabled
When an aperture is disabled, its positions cannot be selected. After the name of the aperture is an explanation why the aperture selection drop-down list and the Adjust button are absent.

Aperture enabled, always inserted
Apertures that are enabled come in two flavors, ones that are always inserted (one of the aperture is always in the beam) and ones that can be retracted or inserted. The Condenser 2 mechanism is always in the beam so the mechanism displays the name, the aperture selection drop-down list and the Adjust button.

Aperture selection list
The aperture selection list contains the sizes (in micrometers) of all available aperture for the mechanism. When a selection from the list is made that differs from previous, the aperture mechanism will move to the newly selected aperture position. While the aperture is moving, the drop-list stays accessible so if you change the selection again, the aperture will immediately start moving to the new selection (it does not need to drive to the first selection, then on, etc.).

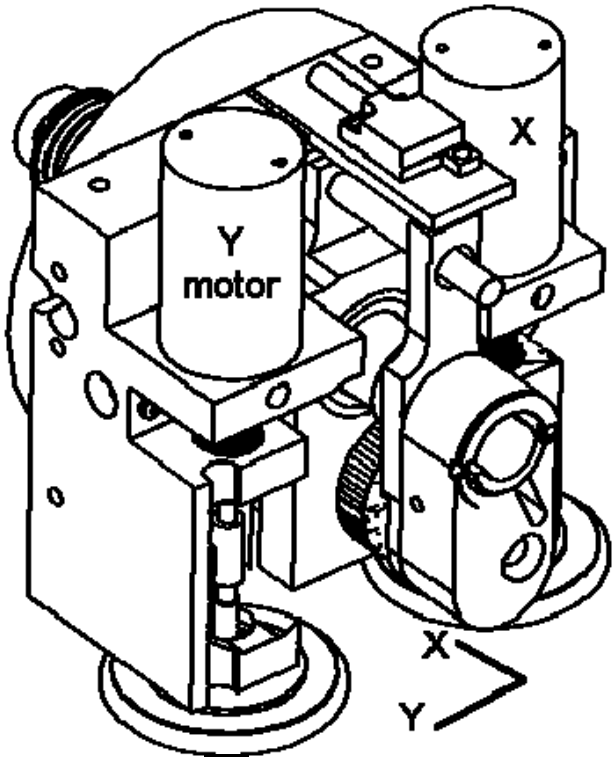
Aperture insertable
If an aperture can be inserted or retracted, the name of the aperture mechanism appears on a button. If the button is pressed (when gray), it will become yellow and the aperture is inserted. If the button is pressed when it is yellow, the aperture is retracted and the button becomes gray again.

Adjust
For proper operation it is often necessary to center an aperture. When the aperture is not centered properly, click on the Adjust button for the aperture required. The Multifunction knobs of the microscope will be linked to the aperture mechanism and you can move the aperture to its proper position by turning the knobs. Once the aperture is centered, click on the button again and the knobs will be disconnected again. The center position of the aperture has now been updated.
While the Adjust button is yellow, the other controls for the particular aperture mechanism are disabled.

Flap-out button
Pressing the flap-out button displays the flap-out with the Enable, Reset, Options and Slit Control Panels.

6.1 Motorized Apertures

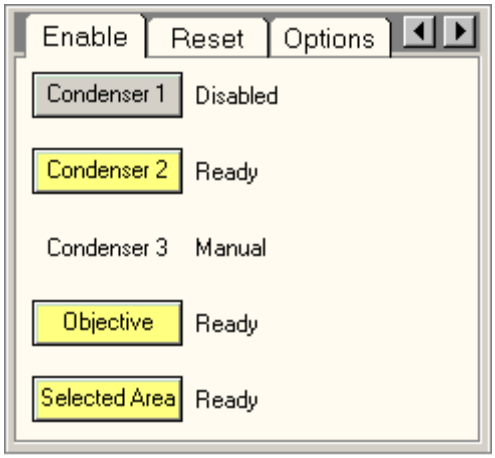
The motorized apertures have motors that drive the aperture holder in two perpendicular directions, called X and Y.



A motorized aperture mechanism.

The X direction is defined as being perpendicular to the wall of the microscope (and typically is the direction of the row of apertures), while the Y direction is parallel to the wall of the microscope.
Some aperture mechanisms are not retractable (they cannot be moved out of the beam) such as the condenser aperture(s). Other mechanisms are retractable. The retraction direction (and as a consequence retraction distance and time required) may differ from one mechanism to another. The Selected Area mechanism is always retracted sideways (the Y direction). In the case of the objective aperture it depends on the type of mechanism, sideways for some four-aperture holders such as with the TWIN lens or outwards in the case of eight-aperture blades as on the S-TWIN.
In addition to the motors, there are thumbwheels (the horizontal wheels at the bottom in the picture above). These thumbwheels can be used to move the aperture. In general it is preferred that you do not use the thumbwheels; they are there just in case. You cannot use the thumbwheels while the microscope is moving the apertures. During movement, the drives are locked and you can only move them with the thumbwheels by forcing them. This will not damage the mechanism and the lock will be removed, but the aperture will generate a movement error.

6.2 Apertures Enable



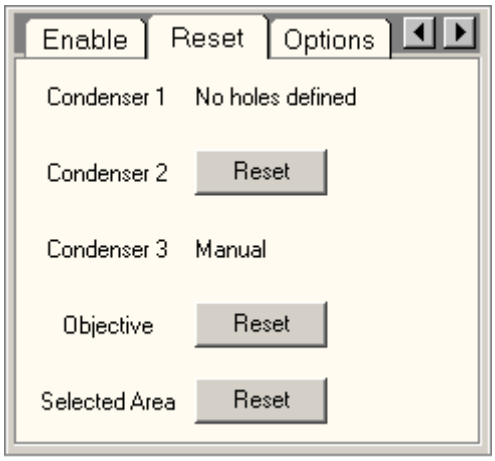
The Apertures Enable Control Panel.

In the Apertures Enable Control Panel the controls for enabling and disabling aperture positions are located.

Aperture buttons
The aperture buttons control whether an aperture is or is going to be enabled (the button is yellow) or disabled (the button is gray). When is aperture changes from disabled to enabled, it will need to be homed. Both axes are driven to fixed, recognisable positions that are used as reference positions by the aperture mechanism to ensure the apertures are found at the same positions each time the aperture mechanism is enabled, .

Aperture status
The aperture status can have various values such as Ready, Disabled or Moving.

6.3 Apertures Reset

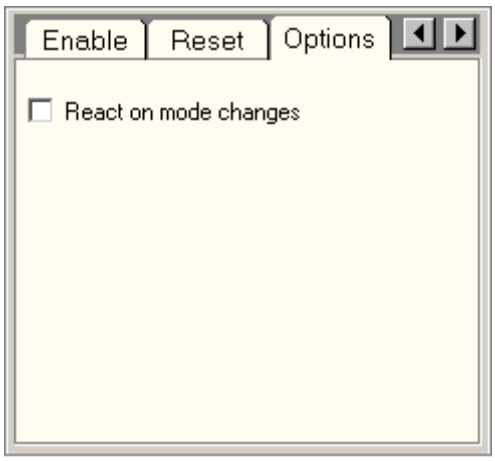


The Apertures Reset Control Panel.

In the Apertures Reset Control Panel the controls for resetting aperture positions are located.

Reset
Pressing the Reset button resets the position values for all apertures of the mechanism selected for the currently active mode to the positions when the microscope software was started up.

6.4 Apertures Options



The Apertures Options Control Panel.

In the Apertures Options Control Panel you can define how the apertures react to mode switches.

React on mode changes
When the react on mode switches selection is on, the microscope will react to changes in the mode by inserting or retracting apertures and/or selecting apertures last used in the particular mode. The behavior is according to the table shown below.

6.4.1 Reacting on mode switches

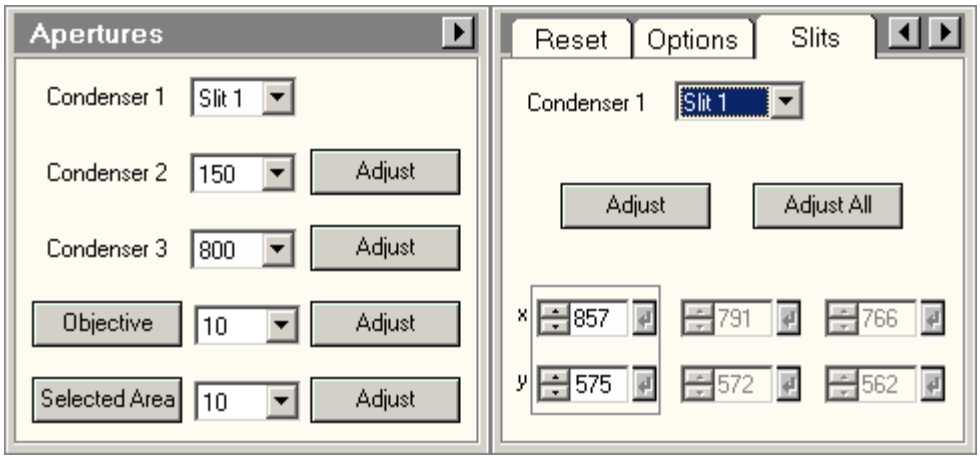
The behavior of the apertures during mode switches with the React on mode switches option enabled is given by the table below. In this table, the meaning of the behavior per aperture mechanism is as follows:

Out Retract aperture
In select aperture last used by the user in that mode
None no automatic user selection possible*

Modes	**C1**	**C2**	**C3**	**Obj**	**SA**
LM	None	In	None	Out	In
LAD	None	None	None	None	Out
HM Microprobe	None	In	None	In	Out
D Microprobe	None	None	None	Out	None
HM Nanoprobe	None	In	None	Out	Out
D Nanoprobe	None	None	None	Out	None
LM-STEM	None	In	None	Out	Out
Microprobe STEM	None	In	None	Out	Out
HM-STEM	None	In	None	Out	Out

* Although in the microscope software this means resetting the aperture to the proper position (for the particular mode), in practice it means that nothing happens, because the "None" selections are always for the same mode (you can only go to diffraction in Microprobe from imaging in Microprobe, not directly from LM or Nanoprobe).

6.5 Apertures Slit



The Apertures Slit Control Panel.

In the Apertures Slit Control Panel you can control the position of the slit for the monochromator. The slit is wedge-shaped so different positions along its lengths result in different slit widths. The position as such is no different from an aperture position, but for the slit you can have three different positions (and thus three different slit widths) in channels for easy switching.

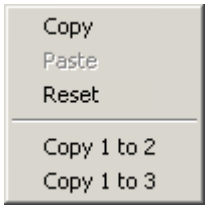
Slit selection list
The slit selection drop-down list allows you to select the slit (one of two).

Adjust
When Adjust is pressed (starting from a gray button), the button becomes yellow and the Multifunction knobs will move the slit, adjusting the values for the active channel only. To disconnect the Multifunction knobs again, press the Adjust button (it will become gray again).

Adjust All
When Adjust All is pressed (starting from a gray button), the button becomes yellow and the Multifunction knobs will move the slit, adjusting the values for all the channels while keeping the differences between the channels. To disconnect the Multifunction knobs again, press the Adjust All button (it will become gray again).

Channels
The slit position can be stored in three channels. You can easily move from one position to another by clicking on each of the channels.

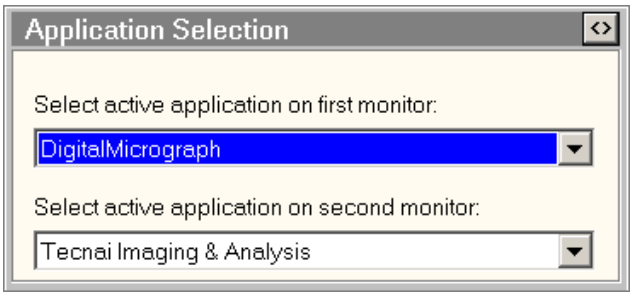
Special function : Click with the right-hand mouse button on one of the channels to get a popup-menu.



With the functions in the popup menu you can reset channels, and copy and paste them.

Active channel
The active channel is shown with a gray rectangle around it. The spin buttons are only enabled for the active channel.

6.6 Application Selection

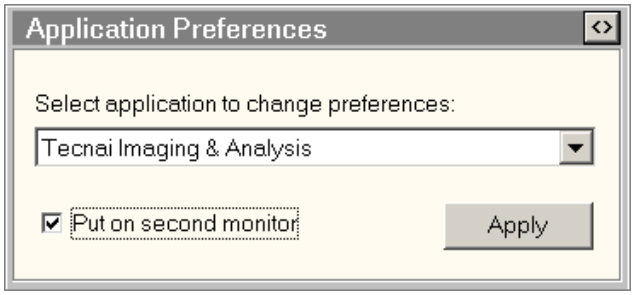


The Application Selection Control Panel provides the tools for adjusting applications to fill either the data space of the TEM User Interface or a second monitor. Choose the applications for the first and second monitor from the two drop-down lists.

The Application Selection Control Panel is brought up by clicking on the (left-most) "square" blue button in the popup selection panel (bottom right of the TEM User Interface).

The <> button (top right) switches to the Application Preferences Control Panel.

6.7 Application Preferences

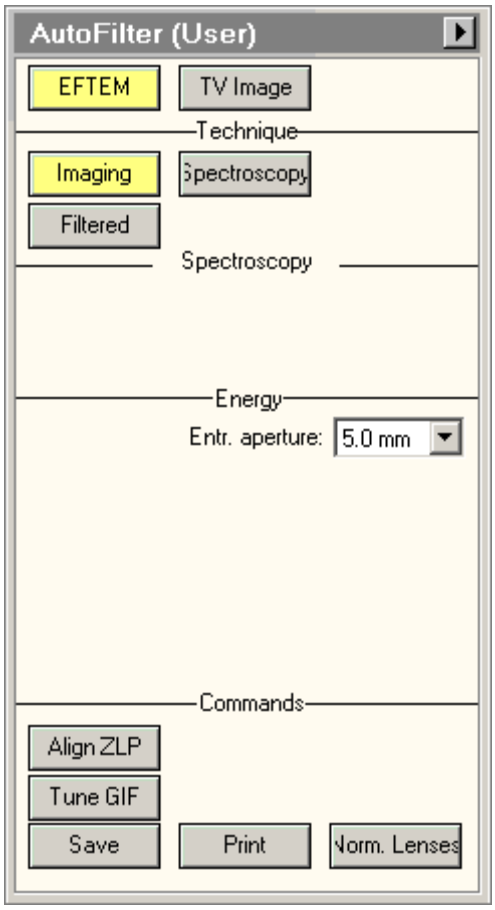


The Application Preferences Control Panel is used to determine where selected applications will be shown, in the data space of the TEM User Interface or on a second monitor.

Select an application form the drop-down list and change the setting of the check box Put on second monitor. Press Apply to activate the changed setting.

The <> button (top right) switches to the Application Selection Control Panel.

7 AutoFilter (User)



The AutoFilter control panel.

The AutoFilter control panel contains a number of controls for the Imaging Filter. The visibility of a number of buttons and other controls (under Energy and Commands) depends on the current state of EFTEM. For more background information on EFTEM, see the description of the Energy-Filtered TEM (EFTEM) mode (see the modes.pdf document, chapter 8).

EFTEM
The EFTEM button controls the microscope status:

- EFTEM off : the button will be gray.
- EFTEM on : the button will be yellow.

TV Image
If a TV camera is available on the filter:The TV Image button toggles between Imaging Filter TV-rate camera inserted (button yellow) and retracted (button gray).

Imaging
When the Imaging button is yellow, the Imaging Filter is in the imaging state (display of spectrum instead of image). To acquire the images on CCD, use the controls in the CCD/TV Camera control panel.

Spectroscopy
When the Spectroscopy button is yellow, the Imaging Filter is in the spectroscopy state (slit out, display of spectrum instead of image). In order to prevent overloading of the CCD, the user interface will display a message “Please make sure you reduce beam intensity”. This message must be confirmed (by pressing the enter button next to the message) before the system will switch to spectroscopy.

Filtered
When the Filtered button is pressed, the Imaging Filter switches between the filtered state (slit in) and unfiltered state (slit out).

Entrance aperture
The Imaging Filter has a number of entrance aperture. For imaging you typically use the largest aperture available, for spectroscopy one of the smaller ones. Select the required entrance aperture from the drop-down list.

Align ZLP
When the Align ZLP button is pressed, the AutoFilter goes through its Align Zero Loss Peak routine, wherein it will attempt to center the zero-loss peak of the energy spectrum in the center of the slit. For proper operation of this function, the slit width should not be too small (at least 10 eV). If the zero-loss peak is only slightly misaligned, the procedure should work under all conditions, but if no previous filtered image has been obtained, make sure that the magnification selected is in the middle of the range (~100 000x) and not too low (where the differential pumping aperture can partially block the beam so the Filter cannot find sufficient intensity).

Make sure you do not do the Align ZLP on a thick specimen, otherwise the highest value of the spectrum - centered in the slit - will be part of the plasmon range, not the zero-loss peak.

Tune GIF
When the Tune GIF button is pressed, the AutoFilter will start its tuning procedure, as defined under the AutoFilter Setup (see section 8.2).

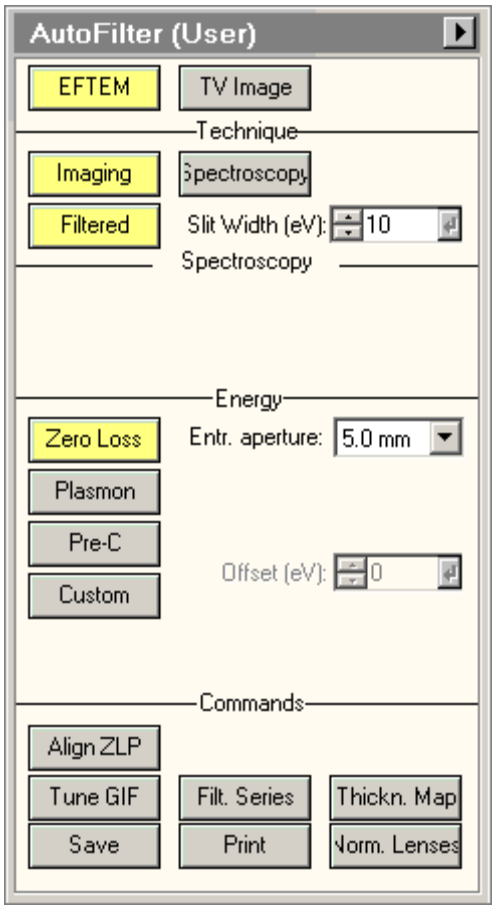
Save
When the Save button is pressed, the last Acquired image is saved to disk in the DigitalMicrograph Film stock folder (a folder called Film stock under the DigitalMicrograph folder) either under a generic file name or a user-specified name (dependent on the choice under the Action options).

Print
When the Print button is pressed the currently active image is printed (a default printer must be installed for this option to work).

Norm. lenses
Because of the settings of the lenses of the projection system, especially for the very low magnifications and camera lengths, the image/diffraction shift and cross-over corrections can be very sensitive to the accuracy with which the lenses are set. In order to make this more reliable, the normalization procedure is used. The automatic normalizations will normalize the lenses when the magnification or camera length is changed in EFTEM.

Flap-out button
The flap-out button leads to the AutoFilter Setup Control Panel.

7.1.1 EFTEM, Filtered On



Slit width
The slit width control determines the width of the slit on the Imaging Filter.

Zero Loss
When the Zero Loss button is pressed, the Imaging Filter goes to Zero-Loss imaging (the zero-loss peak is centered in the energy slit). By definition the Energy Loss value is 0 so the energy offset control is disabled.

Plasmon
When the Plasmon button is pressed, the Imaging Filter goes to Plasmon imaging (the plasmon energy selected is centered in the energy slit).

Pre-C
When the Pre-C button is pressed, the Imaging Filter goes to Pre-C imaging (the Pre-C - pre-carbon - energy selected is centered in the energy slit).

Custom
When the Custom button is pressed, the Imaging Filter goes to Custom imaging (the custom energy selected is centered in the energy slit).

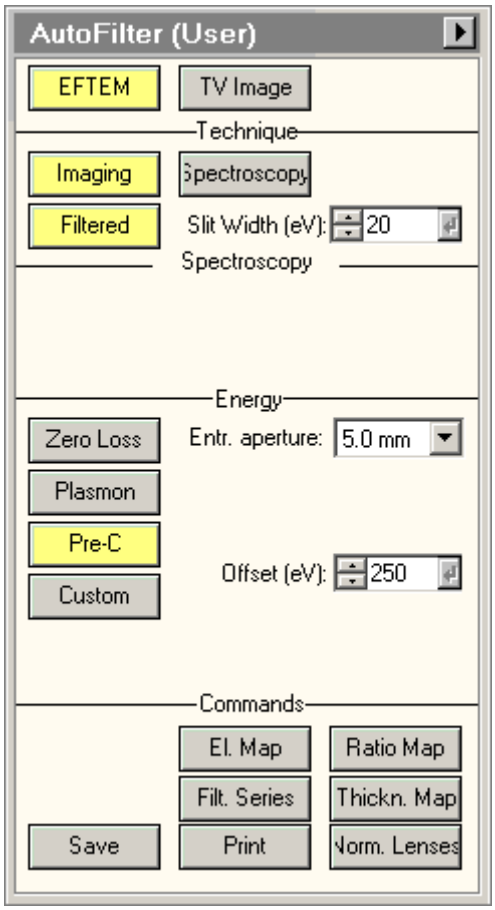
Offset (eV)
With the Offset control, the value of the energy loss is chosen. The control panel keeps separate values for the three conditions in which the energy loss can be chosen: Plasmon, Pre-C and Custom. If you type the value, it must be activated by pressing the enter button.

Slit Width
With the Slit Width control, the width of the slit is chosen (in eV). The control panel keeps separate values for the four different conditions, Zero-Loss, Plasmon, Pre-C and Custom.

Filtered Series
When the Filt. Series button is pressed, the Imaging Filter will acquire a filtered series (a series of filtered images at specified starting energy and energy interval).

Thickness Map
When the Thickness Map button is pressed, the Imaging Filter will acquire two images, one filtered, the other unfiltered and from those calculate a thickness map (expressed in mean free path units).

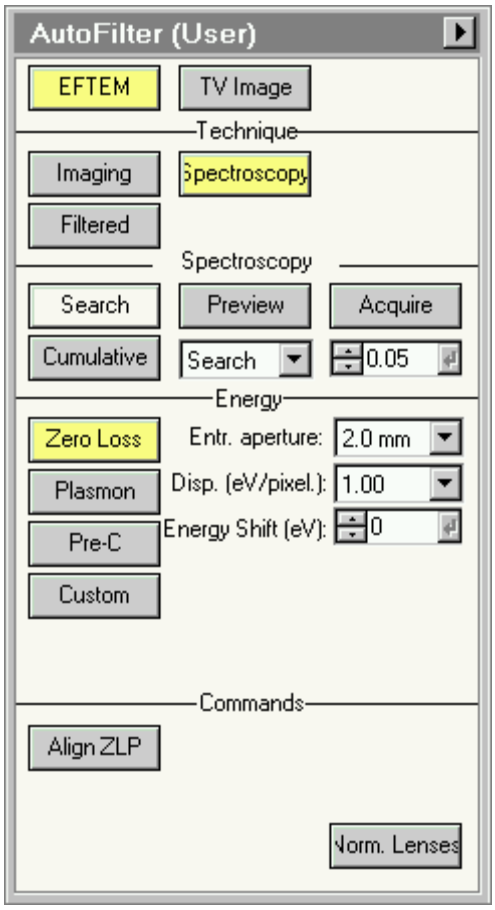
7.1.2 EFTEM, Filtered On, Plasmon, Pre-C or Custom



El. Map
When the El. Map button is pressed, the Imaging Filter Elemental Mapping procedure (three-window method) is started. The element settings are those chosen in the AutoFilter Setup (see section 8.2).

Ratio Map
When the Ratio Map button is pressed, the Imaging Filter Ratio Mapping procedure (two-window method) is started. The element settings are those chosen in the AutoFilter Setup (see section 8.2).

7.1.3 EFTEM Spectroscopy



Search, Preview, Acquire
Spectroscopy has three acquisition states which are independent from those of imaging : Search, Preview and Acquire. You can switch from one state to another or switch active acquisition on or off by pressing the Search, Preview and Acquire buttons.

Cumulative
Switches Cumulative acquisition on or off (in cumulative, spectra acquired are added together, otherwise each new spectrum replaces the one acquired previously). If Cumulative was off, the button will turn yellow. If Cumulative was already on, spectrum acquisition in the Cumulative state stops and the button will turn white.

Exposure time
The exposure time for the three spectrum acquisition states can be adjusted by selecting the state through the drop-down box and changing the value of the exposure time. If you type the value, it must be activated by pressing the enter button.

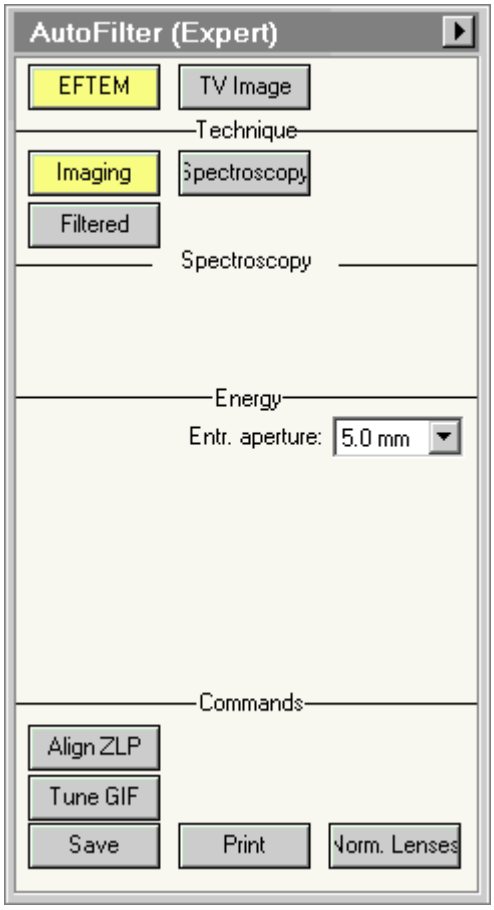
Dispersion (eV/pixel)
The dispersion in spectroscopy (the energy width per pixel) is selected via the drop-list box.

Align ZLP
The Align Zero-Loss Peak function in spectroscopy works different from that in imaging. In spectroscopy you use to set the scale of the EELS spectrum. Operation of the function is as follows:

- Acquire an EELS spectrum (continuous or single acquisition),
- Type in the value of the energy where the zero-loss peak is currently displayed under Energy shift and press the Enter button.
- Press the Align ZLP button.

The energy scale should now have 0 at the position of the zero-loss peak.

8 AutoFilter (Expert)



The AutoFilter control panel.

The AutoFilter control panel contains a number of controls for the Imaging Filter. The visibility of a number of buttons and other controls (under Energy and Commands) depends on the current state of EFTEM. For more background information on EFTEM, see the description of the Energy-Filtered TEM (EFTEM) mode (see the modes.pdf document, chapter 8).

EFTEM
The EFTEM button controls the microscope status:
- EFTEM off : the button will be gray.
- EFTEM on : the button will be yellow.

TV Image
If a TV camera is available on the filter:The TV Image button toggles between Imaging Filter TV-rate camera inserted (button yellow) and retracted (button gray).

Imaging
When the Imaging button is yellow, the Imaging Filter is in the imaging state (display of spectrum instead of image). To acquire the images on CCD, use the controls in the CCD/TV Camera control panel.

Spectroscopy
When the Spectroscopy button is yellow, the Imaging Filter is in the spectroscopy state (slit out, display of spectrum instead of image). In order to prevent overloading of the CCD, the user interface will display a message “Please make sure you reduce beam intensity”. This message must be confirmed (by pressing the enter button next to the message) before the system will switch to spectroscopy.

Filtered
When the Filtered button is pressed, the Imaging Filter switches between the filtered state (slit in) and unfiltered state (slit out).

Entrance aperture
The Imaging Filter has a number of entrance aperture. For imaging you typically use the largest aperture available, for spectroscopy one of the smaller ones. Select the required entrance aperture from the drop-down list.

Align ZLP
When the Align ZLP button is pressed, the AutoFilter goes through its Align Zero Loss Peak routine, wherein it will attempt to center the zero-loss peak of the energy spectrum in the center of the slit. For proper operation of this function, the slit width should not be too small (at least 10 eV). If the zero-loss peak is only slightly misaligned, the procedure should work under all conditions, but if no previous filtered image has been obtained, make sure that the magnification selected is in the middle of the range (~100 000x) and not too low (where the differential pumping aperture can partially block the beam so the Filter cannot find sufficient intensity).

Make sure you do not do the Align ZLP on a thick specimen, otherwise the highest value of the spectrum - centered in the slit - will be part of the plasmon range, not the zero-loss peak.

Tune GIF
When the Tune GIF button is pressed, the AutoFilter will start its tuning procedure, as defined under the AutoFilter Setup (see section 8.2).

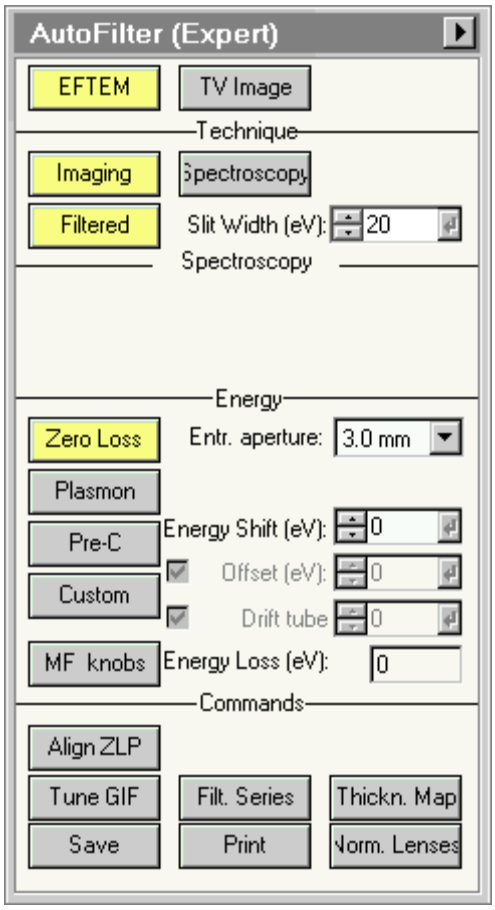
Save
When the Save button is pressed, the last Acquired image is saved to disk in the DigitalMicrograph Film stock folder (a folder called Film stock under the DigitalMicrograph folder) either under a generic file name or a user-specified name (dependent on the choice under the Action options).

Print
When the Print button is pressed the currently active image is printed (a default printer must be installed for this option to work).

Norm. lenses
Because of the settings of the lenses of the projection system, especially for the very low magnifications and camera lengths, the image/diffraction shift and cross-over corrections can be very sensitive to the accuracy with which the lenses are set. In order to make this more reliable, the normalization procedure is used. The automatic normalizations will normalize the lenses when the magnification or camera length is changed in EFTEM.

Flap-out button
The flap-out button leads to the AutoFilter Setup Control Panel.

8.1.1 EFTEM, Filtered On



Slit width
The slit width control determines the width of the slit on the Imaging Filter.

Zero Loss
When the Zero Loss button is pressed, the Imaging Filter goes to Zero-Loss imaging (the zero-loss peak is centered in the energy slit). By definition the Energy Loss value is 0 so the energy offset control is disabled.

Plasmon
When the Plasmon button is pressed, the Imaging Filter goes to Plasmon imaging (the plasmon energy selected is centered in the energy slit).

Pre-C
When the Pre-C button is pressed, the Imaging Filter goes to Pre-C imaging (the Pre-C - pre-carbon - energy selected is centered in the energy slit).

Custom
When the Custom button is pressed, the Imaging Filter goes to Custom imaging (the custom energy selected is centered in the energy slit).

Energy shift, Offset, Drift tube, Energy Loss
On the Imaging Filter there are three ways to change the energy of the spectrum:

- With the current of the energy-loss prism in the Imaging Filter - called Energy shift.
- With the high tension of the microscope - called Offset.
- With the electrostatic drift tube of the Imaging Filter - called Drift tube.

The Energy Loss value given is the sum of all three values mentioned above.

Note: The convention used in the AutoFilter control panel is that positive values always indicate energy losses. Thus a value of 284eV on any of these controls always displaces to the carbon K edge. This usage differs from that in Gatan's FilterControl where the behavior is not consistent and therefore difficult to follow.

The Offset is normally used in Imaging because in that case when you look at another energy level, the image in the microscope remains in focus (the energy-loss electrons are focused the same as the zero-loss electrons in zero-loss imaging). For spectroscopy, however, using the Offset to move the spectrum is not the optimum, especially if the spectrum is acquired in focused-probe mode (the change in high tension will effectively defocus the probe). For spectroscopy at energy changes less than 1000 Volts typically the drift tube voltage is used. When properly calibrated, the drift tube is easy to use and

accurate, without significant hysteresis. For higher energy changes, the prism current is used (possibly in combination with the drift tube).

With the Offset control, the value of the energy loss is chosen. The control panel keeps separate values for the three conditions in which the energy loss can be chosen: Plasmon, Pre-C and Custom. If you type the value, it must be activated by pressing the enter button.

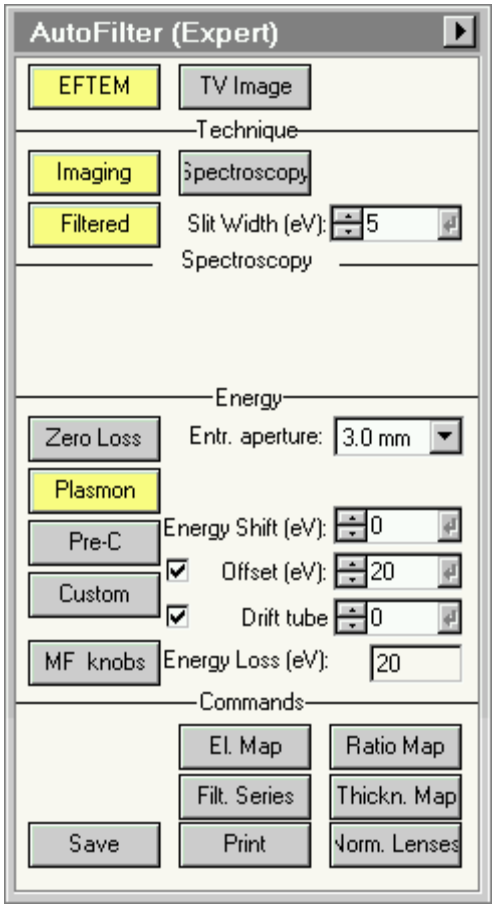
The Energy shift is always set at the voltage indicated, while the Offset and Drift tube are only set to those values when the check box are checked.

MF knobs
The multifunction knobs can be used to control the Offset (MF-X) and the Energy Shift (MF-Y).

Filtered Series
When the Filt. Series button is pressed, the Imaging Filter will acquire a filtered series (a series of filtered images at specified starting energy and energy interval).

Thickness Map
When the Thickness Map button is pressed, the Imaging Filter will acquire two images, one filtered, the other unfiltered and from those calculate a thickness map (expressed in mean free path units).

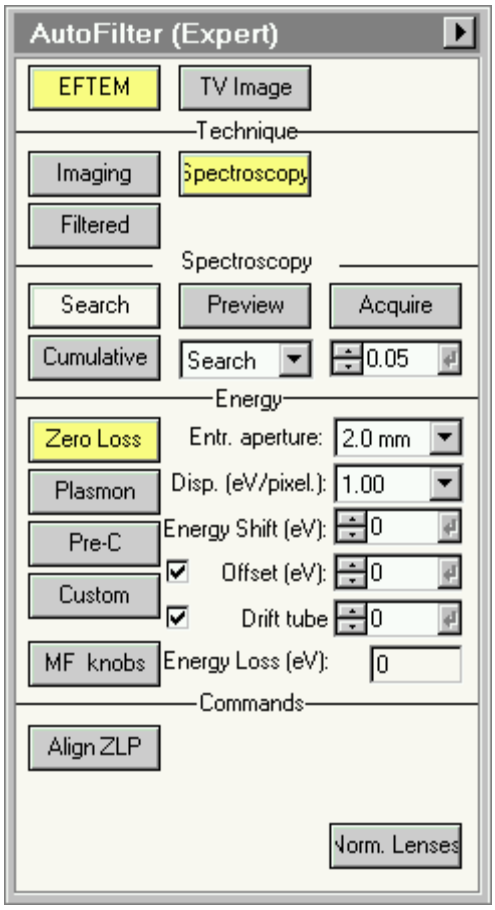
8.1.2 EFTEM, Filtered On, Plasmon , Pre-C or Custom



El. Map
When the El. Map button is pressed, the Imaging Filter Elemental Mapping procedure (three-window method) is started. The element settings are those chosen in the AutoFilter Setup (see section 8.2).

Ratio Map
When the Ratio Map button is pressed, the Imaging Filter Ratio Mapping procedure (two-window method) is started. The element settings are those chosen in the AutoFilter Setup (see section 8.2).

8.1.3 EFTEM Spectroscopy



Search, Preview, Acquire
Spectroscopy has three acquisition states which are independent from those of imaging : Search, Preview and Acquire. You can switch from one state to another or switch active acquisition on or off by pressing the Search, Preview and Acquire buttons.

Cumulative
Switches Cumulative acquisition on or off (in cumulative, spectra acquired are added together, otherwise each new spectrum replaces the one acquired previously). If Cumulative was off, the button will turn yellow. If Cumulative was already on, spectrum acquisition in the Cumulative state stops and the button will turn white.

Exposure time
The exposure time for the three spectrum acquisition states can be adjusted by selecting the state through the drop-down box and changing the value of the exposure time. If you type the value, it must be activated by pressing the enter button.

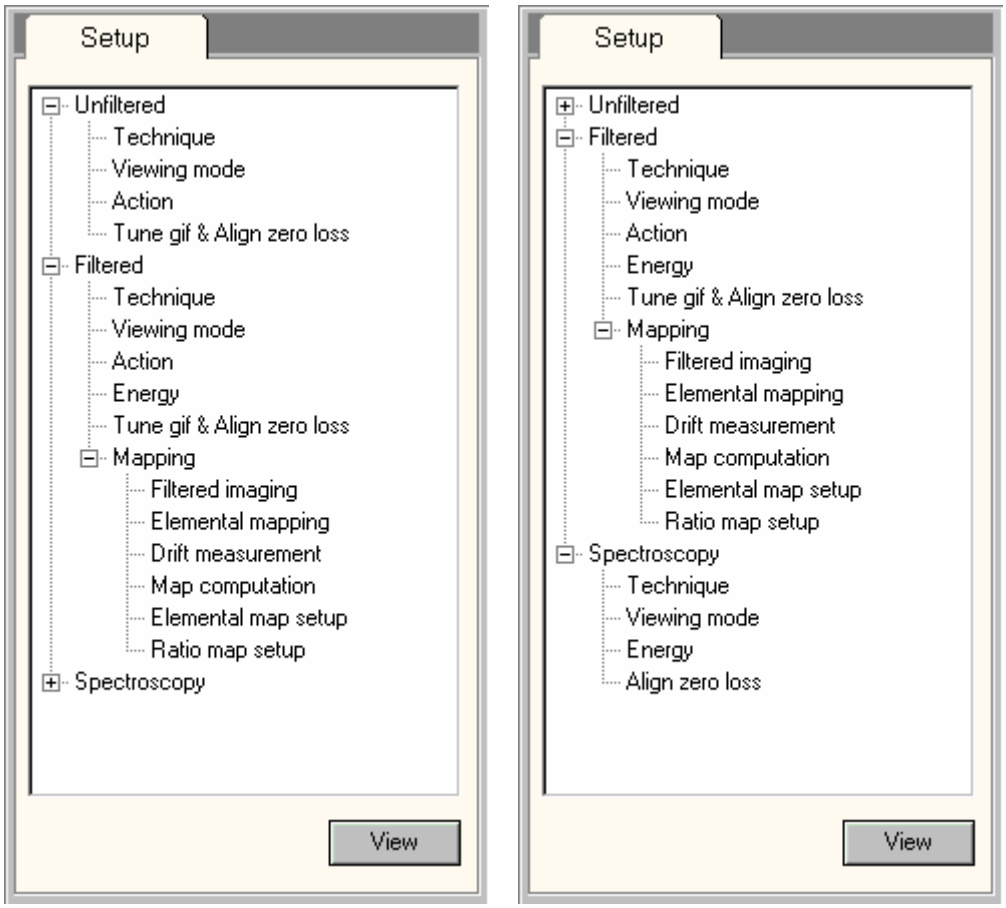
Dispersion (eV/pixel)
The dispersion in spectroscopy (the energy width per pixel) is selected via the drop-list box.

Align ZLP
The Align Zero-Loss Peak function in spectroscopy works different from that in imaging. In spectroscopy you use to set the scale of the EELS spectrum. Operation of the function is as follows:

- Acquire an EELS spectrum (continuous or single acquisition),
- Type in the value of the energy where the zero-loss peak is currently displayed under Energy shift and press the Enter button.
- Press the Align ZLP button.

The energy scale should now have 0 at the position of the zero-loss peak.

8.2 AutoFilter setup



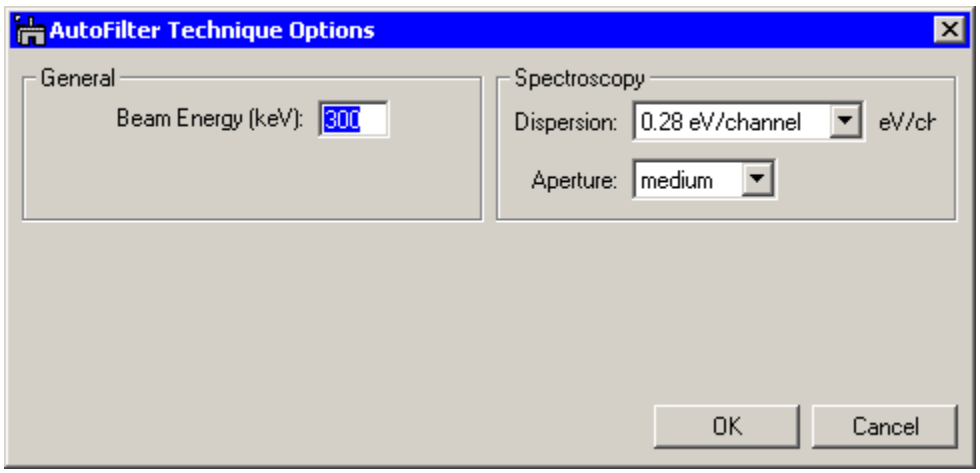
The AutoFilter Setup Control Panel.

The AutoFilter Setup Control Panel gives access to the dialogs in DigitalMicrograph that define the various AutoFilter settings.

Note: This page only shows the dialogs. For an explanation of the functionality see the Gatan documentation.

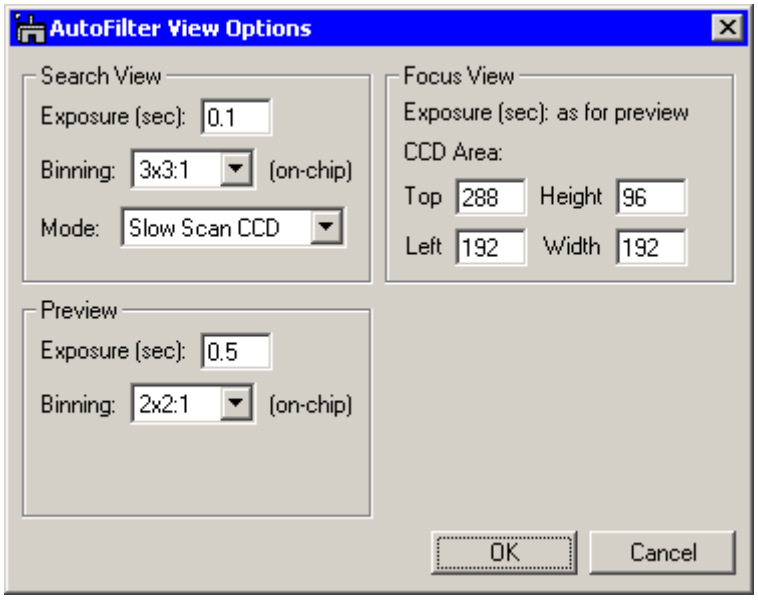
View
When the View button is pressed, the relevant dialog is brought up in DigitalMicrograph.

8.2.1 AutoFilter Technique Options



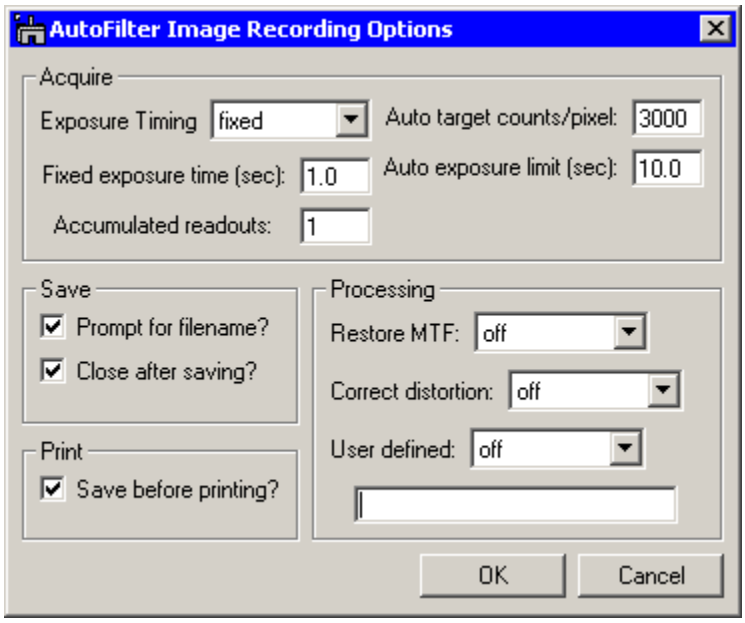
("Technique" in list)

8.2.2 AutoFilter View Options



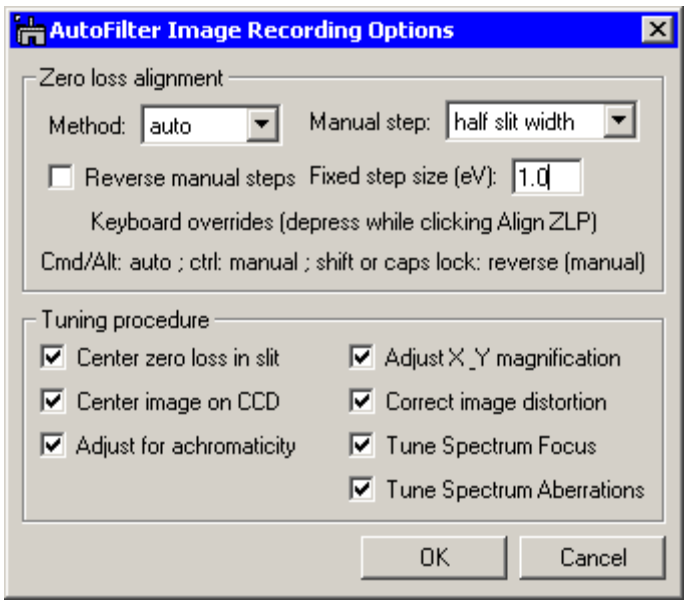
("Viewing mode" in list)

8.2.3 AutoFilter Image Recording Options



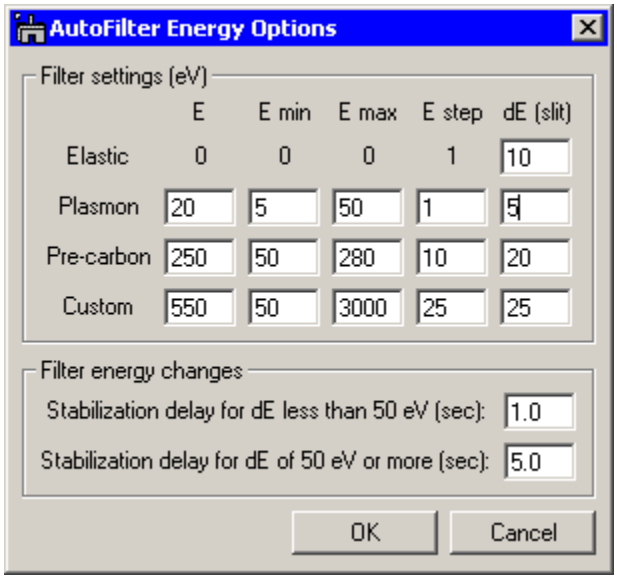
("Action" in list)

8.2.4 AutoFilter Tune GIF Options



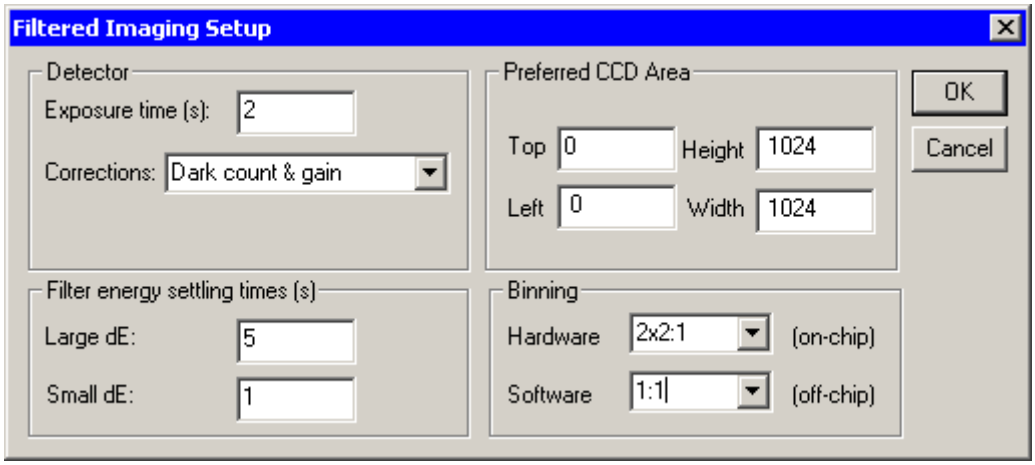
("Tune gif & Align Zero loss" in list)

8.2.5 AutoFilter Energy Options



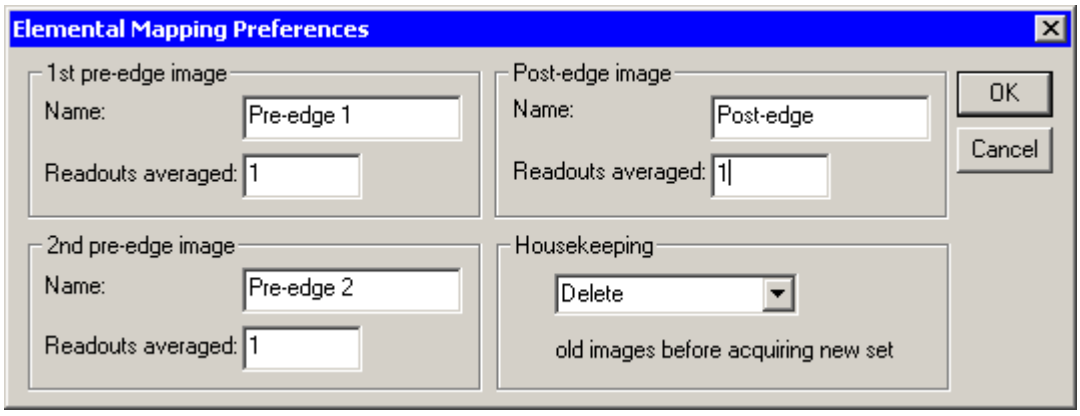
("Energy" in list)

8.2.6 Filtered Imaging Setup



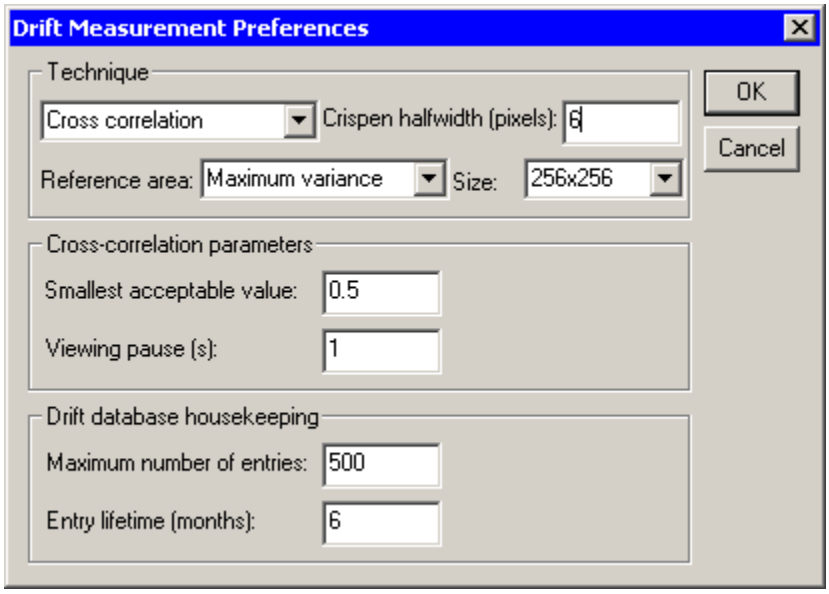
("Filtered imaging" in list)

8.2.7 Elemental Mapping Preferences



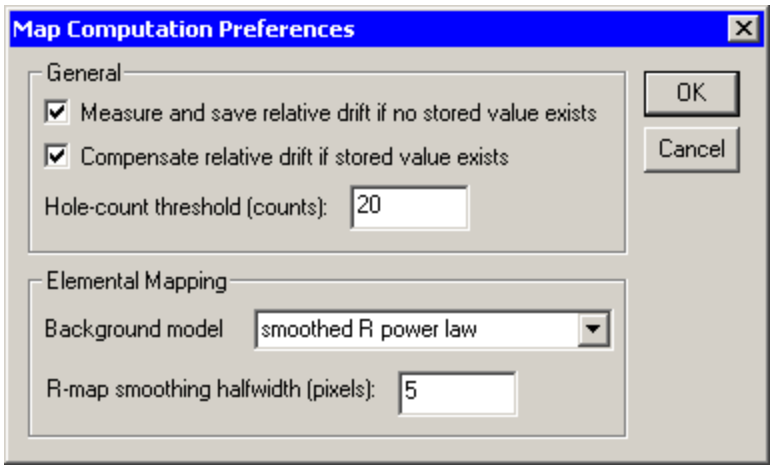
("Elemental mapping" in list)

8.2.8 Drift Measurement Preferences



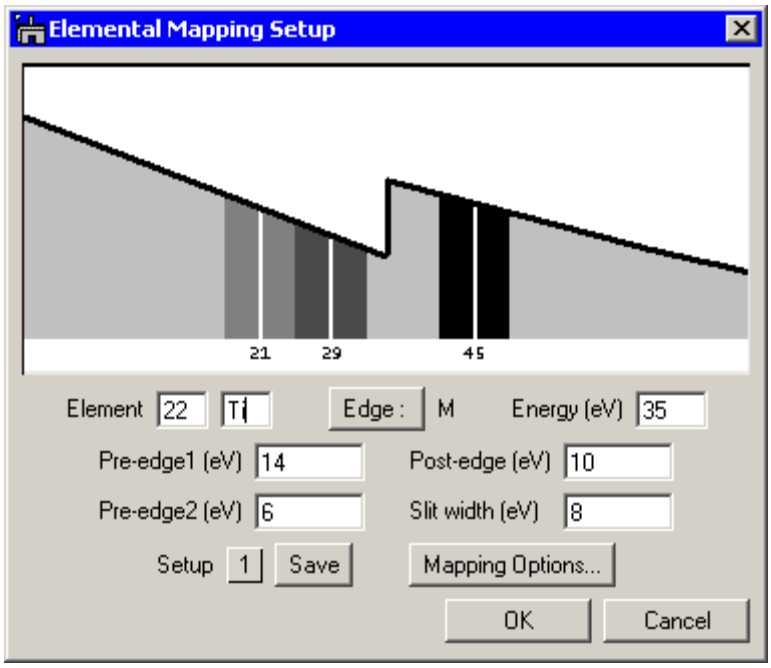
("Drift measurement" in list)

8.2.9 Map Computation Preferences



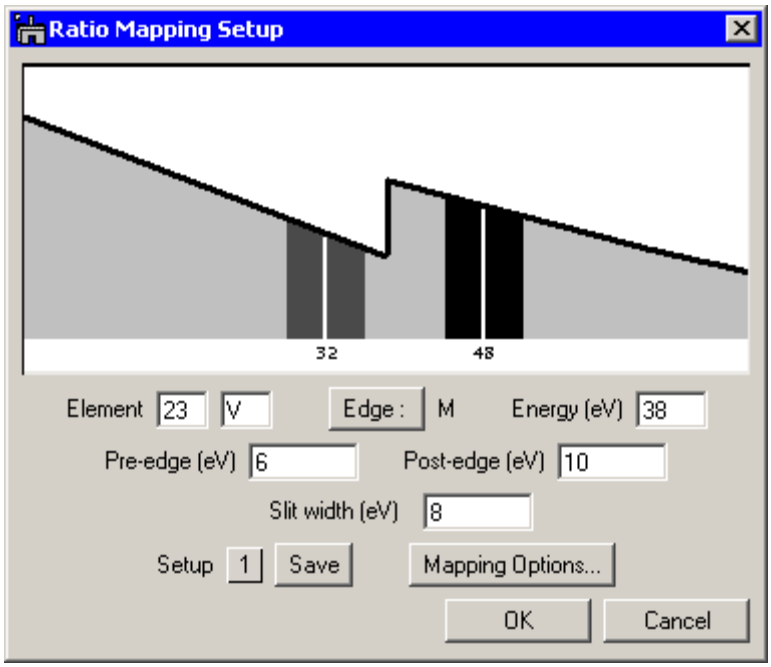
("Map computation" in list)

8.2.10 Elemental Mapping Setup



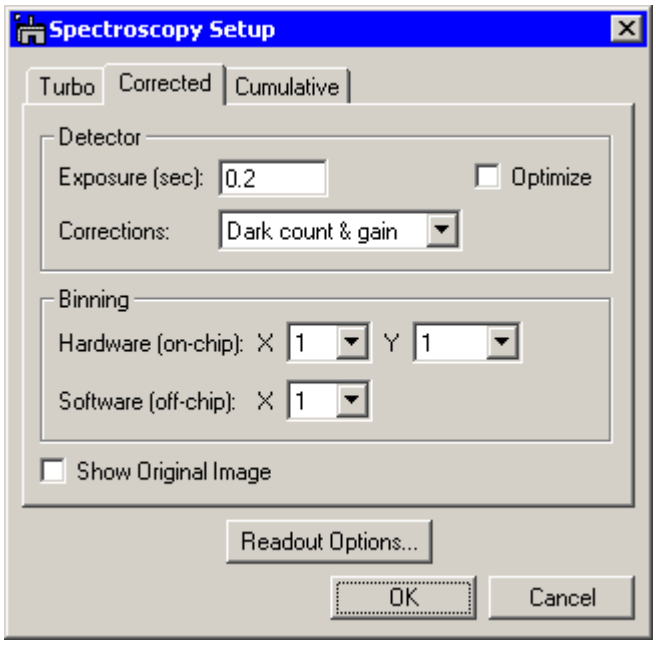
("Elemental map setup" in list)

8.2.11 Jump Ratio Mapping Setup



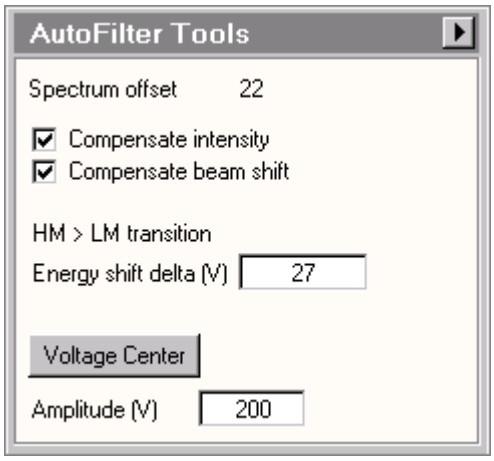
("Ratio map setup" in list)

8.2.12 Spectroscopy Setup



("Spectroscopy, Viewing mode" in list)

9 AutoFilter Tools



The AutoFilter Tools Control Panel.

The AutoFilter Tools Control Panel provides a number of functions that improve the handling of the Gatan Imaging Filter:

- Compensation of the effect of high-tension change on the illuminated area size and position.
- Compensation of the shift of the spectrum encountered in the transition between energy-filtered imaging in HM and LM.
- Voltage center alignment of the objective lens.

Note: Part of the software in the AutoFilter Tools was previously available via two separate programs, Compensate High-Tension Change (comphtchange.exe) and Energy-Shift Monitor (eshiftmonitor.exe). Both programs are obsolete now. If they are still present on your microscope, please remove them, since those programs will not work any longer with this TEM software version.

9.1.1 Compensation of high-tension change

During energy-filtered imaging the high tension of the microscope is changed by up to 3 kiloVolts without any of the normal compensations that are built in to the microscope when the high tension is changed. The reason the high tension is used this way is simple. If we want to acquire an image at say an energy loss of 500 eV, we can do so by raising the high tension by that amount. Because the microscope optics have been adjusted earlier for an energy loss setting of 0, the offset makes sure that the image at 500 eV loss is now imaged under exactly the same conditions as the 0 eV image earlier: one consequence is that the focus doesn't change.

However, the high tension change does have some effects on the optics. The most noticeable and worrisome effects are a change in the size of the illuminated area as well as a shift of the illumination. The latter is generally small and only starts to be a problem if the energy range during acquisition is large (as is e.g. the case when a series of images is acquired over a large energy range to construct a spectrum image). The change in the size of the illuminated area is more problematic, because it affects the quantification of elemental maps (based on the three- or two-window methods). The inherent assumption in the mapping procedure is that the illumination on the specimen is identical for the edge and the background images. Without compensation this is not the case as the electron dose per unit area changes when the size of the illumination area changes. One way to reduce the effect is to spread the beam so the change in size has little effect, but that comes at the price of either lower signal or longer exposure times. The best way to resolve the problem is to change the intensity to compensate for the change in high tension so that the illuminated area stays the same.
Note: The compensation only works in Probe mode. Because of the position of the C2 aperture outside the C2 lens, the current in the beam is not constant when C2 is changed and therefore keeping the

illumination area constant does not work in Parallel (TEM) mode where changes in illumination include changes in C2.

9.1.2 Compensation of spectrum shift

When going from HM to LM and vice versa there always is a spectrum shift (typically around 20 eV). This shift is due to a change of the position of the cross-over in the differential pumping aperture. The result is that the transition always results in a loss of the zero-loss energy-filtered image. In principle the way to compensate such shifts is to use the cross-over correction. Unfortunately the range of the cross-over correction in LM is far too small to be able to compensate the apparent spectrum shift fully. Using the cross-over correction in HM instead is also undesirable because the size of the correction needed is such that the image quality is severely affected. The only practical way is therefore to shift the spectrum one way when going to LM and back when going to HM.

9.1.3 Voltage center

Because of the frequent use of changes in high tension during energy-filtered imaging, the optimum way for aligning the objective is through the voltage center method, whereby the effects of a change in the high tension are minimised (the other ways are the current center where the effects of changes in the objective-lens current are minimised, and coma-free alignment which is the proper high-resolution imaging method). Voltage centering can only be done on the TEM microscope by using the energy offset of the Imaging Filter, which changes the high tension on the microscope.

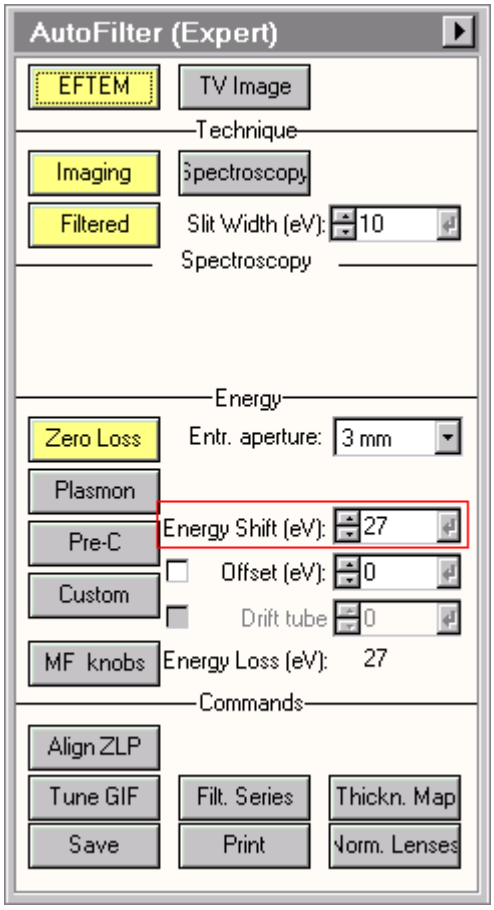
9.1.4 The AutoFilter Tools Control Panel

Spectrum offset
The spectrum offset indicates the current spectrum offset set by the Gatan Imaging Filter. This value is the change in high-tension from the value for the zero-loss image.

Compensate intensity / compensate beam shift
The check boxes for Compensate intensity and Compensate beam shift control whether a change in the spectrum offset is automatically compensated by a change in the microscope's intensity and beam-shift position values. The check boxes are only enabled when the compensation has been calibrated. The microscope will store the calibration when the user interface is closed and reload the values when the user interface is re-opened. It is advised, however, to check the calibration on a regular basis.

If a user has not done the calibration, he/she will inherit any calibration from a higher user level (going from supervisor to service to factory, whichever is found first).

HM > LM transition
The spectrum shift caused by the HM <> LM transition can be compensated automatically. If a value other than 0 is entered in the edit control to the right, that offset will be applied . Note that this offset is not the same as the spectrum offset above (which is a high-tension change on the microscope) but a spectrum shift in the Imaging Filter (called Energy shift).



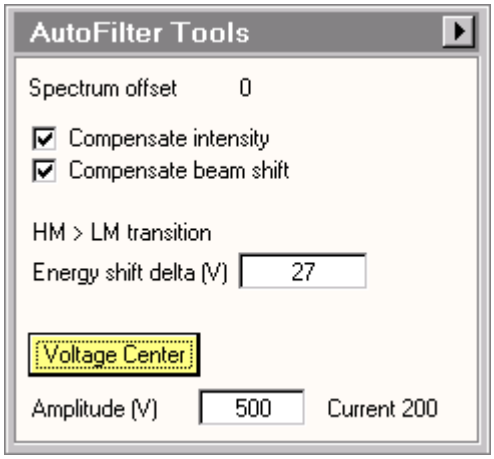
The energy shift of 27 eV applied automatically on the transition from HM to LM.

To calibrate the value of the energy shift that must be applied, start with a zero-loss image in HM and execute Align ZLP to make sure the zero-loss peak is centered properly in the slit. With a delta value of 0 eV set in AutoFilter Tools, change to LM. In all likelihood the image has disappeared (the zero-loss peak has shift behind the slit). Change the Energy shift value in the AutoFilter Control Panel, first to obtain light, then fine-tune to center the zero-loss peak properly. Copy the required energy shift value to the AutoFilter Tools Control Panel.

An alternative is to go to spectroscopy in HM imaging and collect a spectrum or watch the image of the spectrum on the TV. Note the position of the zero-loss peak. Switch to LM and move the zero-loss peak back to where it was in HM, again using the energy shift.

Voltage center

When the voltage center button is pressed (it becomes yellow), the software will slowly wobble the amplitude of the offset (which controls the microscope high tension between the amplitude defined and a value of 1 (not 0 because then Filter automatically keeps switching the offset off). The Multifunction knobs are now controlling the objective-lens alignment, which you can control in exactly the same way as during rotation centering (minimise image shifts). The Focus Step can be used to change the amplitude of the high-tension wobble (the currently active value is displayed to the right of the edit control in which you can define the wobble amplitude at which the center function starts.

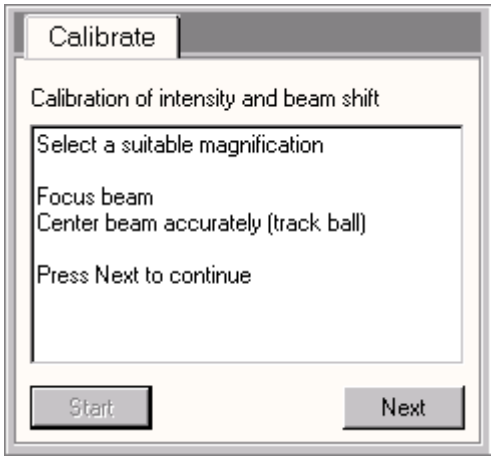


The currently active wobble amplitude is displayed to the right of the user-defined value when the voltage-center function is active.

Amplitude
The amplitude for the voltage center is defined by the value in the edit control.

Flapout
The flapout button leads to the Calibrate tab of the AutoFilter Tools Control Panel.

9.2 AutoFilter Tools Calibrate



The AutoFilter Tools Control Panel provides the calibration procedure for the intensity and beam-shift compensation. There are two ways to run the calibration:

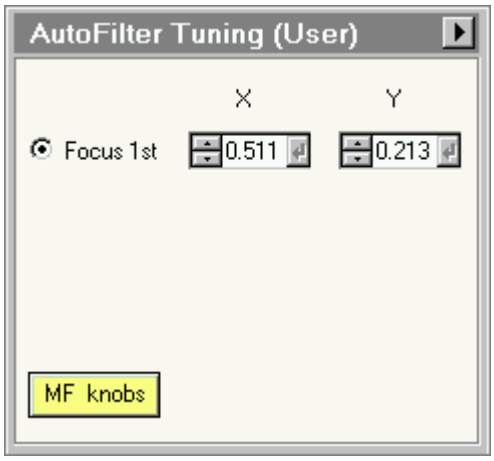
- Easier but less accurate : lower the main screen and calibrate on there.
- More difficult but more accurate : use the TV or CCD image for the calibration, make sure there is a suitably thick specimen in the beam, and make the beam a bit smaller than the CCD or TV image.

Instructions
When the calibration procedure is running, instructions are displayed here.

Start
The calibration procedure is started by pressing the Start button.

Next
Follow instructions and press Next to go to the next step of the procedure.

10 AutoFilter Tuning (User)



The AutoFilter Tuning Control Panel.

The AutoFilter Tuning control panel contains controls for focusing the Imaging Filter used for EFTEM. For more background information on EFTEM, see the description of the Energy-Filtered TEM (EFTEM) mode (see the modes.pdf document, chapter 8). For imaging, the controls can be used for coarse tuning, since the automatic procedures of the Filter are usually adequate for the fine-tuning. For spectroscopy, the controls may be needed to focus the spectrum properly.

The optics of the energy filter produces some geometrical and energy-dispersive plane aberrations in the image plane. The post-column filter can correct these automatically in imaging mode by pressing the align zero-loss and tune GIF button. When pressing the Align zero-loss button in the AutoFilter window the peak of elastically scattered electrons will be centered in the middle of the energy selecting slit. If in unfiltered mode you see the light but in zero-loss filtered mode the image disappears, it may be due to the zero-loss peak misalignment. With the tune GIF button all aberrations within the post-column filter can be minimized. The settings of the post-column filter for each magnification will be stored after the automatic routine has been successfully finished. The next time this magnification is chosen, it will be recalled.

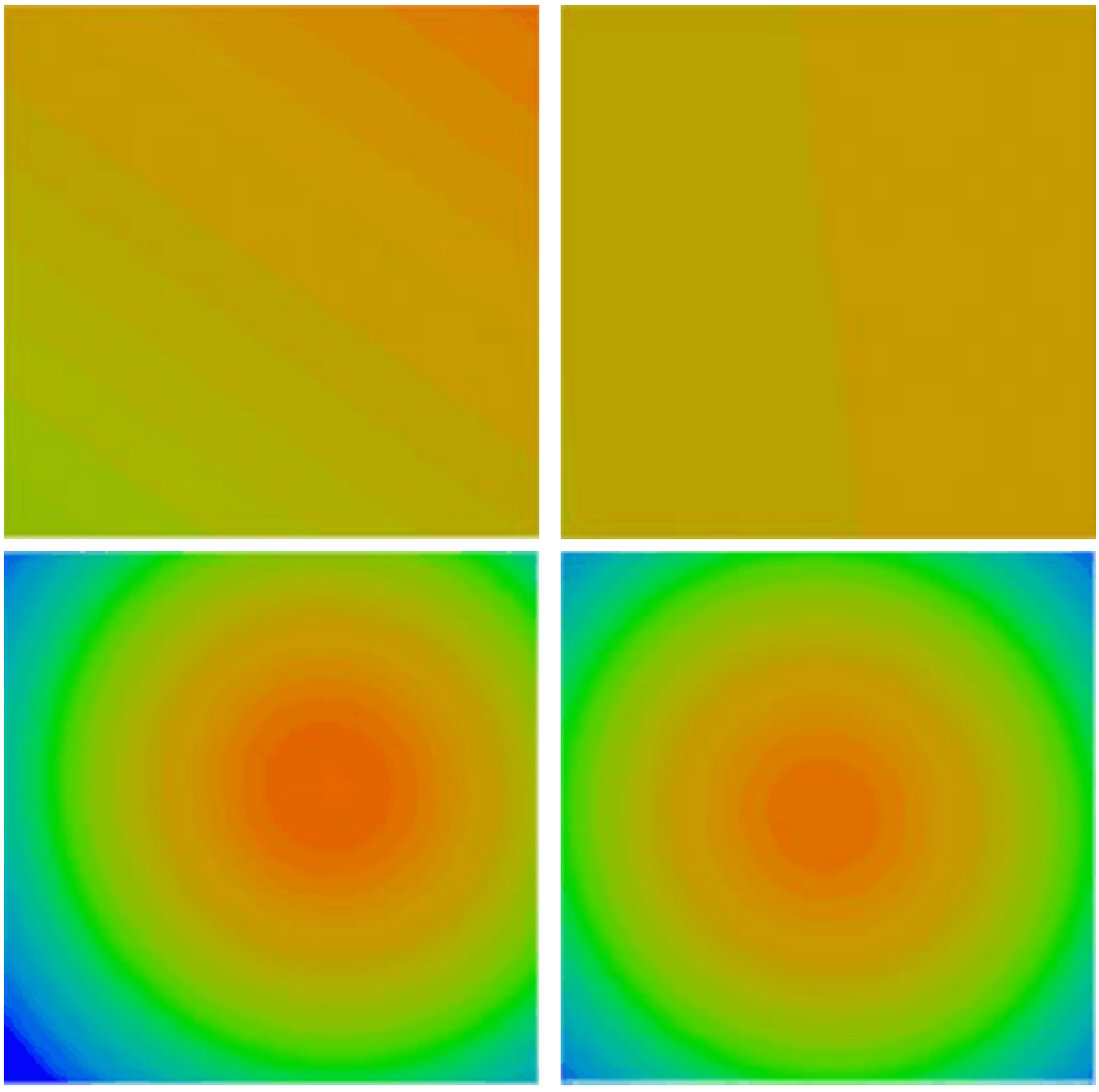
Note: After a longer period of time, it is sometimes necessary to re-do the 'tune GIF'. If you re-do this, it is important to do it at all magnifications. Otherwise you can end up with an inconsistent set of GIF alignments where one magnification is aligned for the present state and another magnification is aligned for an old state. Such an inconsistent set can falsely give you the impression that the GIF is unstable. An alternative way for ensuring that the GIF is consistently aligned at all magnifications is to do the cross-over alignments carefully for all magnifications. With good cross-over alignments it is usually not necessary to do the "tune GIF" for each magnification separately.

The Filter can be used optically in two main ways, one for imaging (recreating an “image” of what is received at the entrance aperture), the other for spectroscopy. If the Filter settings selected are double-focusing (the image is in focus and the spectrum is focused at the energy-selecting slit), the corrections are usually similar for imaging and spectroscopy. Where no double-focusing is possible (e.g. the larger dispersions in spectroscopy), the aberration corrections will be different.

The manner of correcting for the aberrations is different for imaging and spectroscopy. Below we will first consider imaging.

10.1.1 Imaging

First we need to describe the concept of isochromaticity. In a perfect filter, the energy across the field of view is the same. If we would introduce an infinitely small slit, the image would either be totally blocked by the slit (dark) or totally transmitted (bright). In practice, there is a small variation in energy across the field of view. In the case of the first-order achromaticity, the effect is a linear change, in the case of the second order it is non-linear.



An example of the first and second order isochromaticity correction is shown in the figure above. On the left are the data obtained during the aberration correction procedure before correction and on the right the data after. At the top is the first-order isochromaticity, at the bottom second order.

In the top left image there is a range in energy across the field of view, changing from bottom left to top right, as indicated by the colors which cover a range of 0.16eV. After correction, there still is a change in energy (now more from left to right) but now the total range has decreased to 0.03eV.

The second-order aberration, which produces a circular distribution is not well centered initially, so the energy range from the bottom left corner to the maximum is unnecessarily large (1.8eV). After correction the centering is better and the range is now 1.25eV (from the center to the four corners of the image).

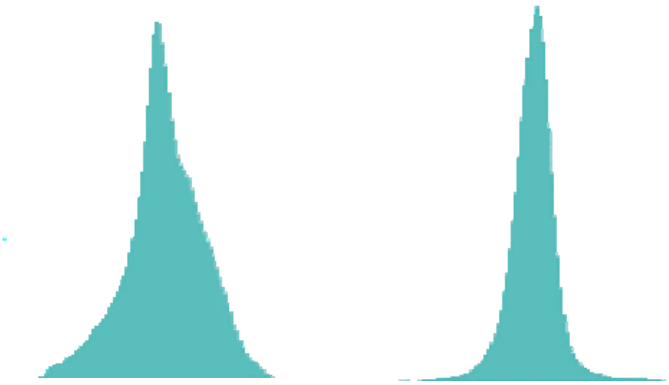
For manual adjustment, insert a small slit (1 to 2 eV) and make sure the beam (zero-loss) passes through the slit. When the Focus 1st order X is changed, the slit will become visible as black bars along the sides of the field of view on either side of the proper focus value. Change the Focus 1st X until the bars are gone (or as small as possible), iterating from over- to underfocus and back to find the optimum. For Y the bars will will be at top and bottom.

During these adjustments you may have to recenter the zero-loss energy relative to the slit.

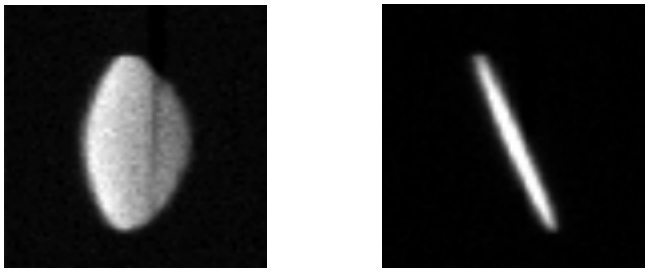
10.1.2 Spectroscopy

In spectroscopy, there are two ways of observing the effects. You can either insert the TV (if available on the filter, otherwise use the CCD) and look at the “image” of the spectrum or you can collect spectra and observe the effect on the zero-loss peak.

When collecting spectra, the aim is to make the zero-loss peak as narrow as possible.



The spectrum on the left is not focused properly, that on the right is.



When looking at the image of the spectrum on the TV, the above images can be observed. A perfectly focused spectrum would display a thin vertical line. When the Focus 1st order X is defocused, the line broadens (top left image). When the Focus 1st order Y is changed, the line will rotate (top right image).

Note: Because of the position of the TV camera, there is a slight change in spectrum focus between the TV and the CCD. The TV can be used very well for coarse focusing, but for fine focusing always use the CCD.

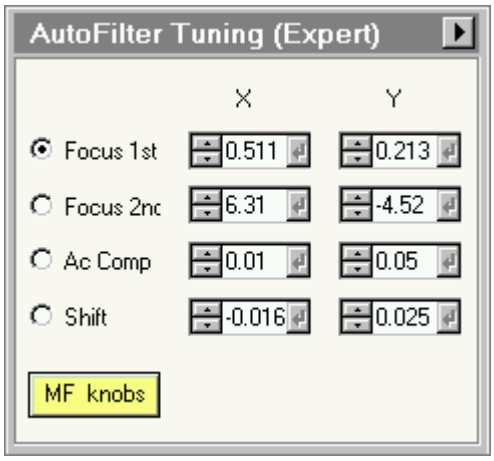
Focus 1st

The controls for the 1st order achromaticity correction are accessed under Focus 1st X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls.

MF knobs
The Multifunction knobs can be used to change the settings of the Focus 1st function described above. To connect the Multifunction knobs to one of the functions, select the particular functions through its radio button and press the MF knobs button (it will become yellow). You can change the sensitivity of the MF knobs with the MF - and + buttons.

Flap-out button
The flap-out button leads to the AutoFilter Tuning Restore Control Panel.

11 AutoFilter Tuning (Expert)



The AutoFilter Tuning Control Panel.

The AutoFilter Tuning control panel contains a number of controls for tuning the Imaging Filter used for EFTEM. For more background information on EFTEM, see the description of the Energy-Filtered TEM (EFTEM) mode (see the modes.pdf document, chapter 8). For imaging, the controls can be used for coarse tuning, since the automatic procedures of the Filter are usually adequate for the fine-tuning. For spectroscopy, the controls may be needed to focus the spectrum properly.

The optics of the energy filter produces some geometrical and energy-dispersive plane aberrations in the image plane. The post-column filter can correct these automatically in imaging mode by pressing the align zero-loss and tune GIF button. When pressing the Align zero-loss button in the AutoFilter window the peak of elastically scattered electrons will be centered in the middle of the energy selecting slit. If in unfiltered mode you see the light but in zero-loss filtered mode the image disappears, it may be due to the zero-loss peak misalignment. With the tune GIF button all aberrations within the post-column filter can be minimized. The settings of the post-column filter for each magnification will be stored after the automatic routine has been successfully finished. The next time this magnification is chosen, it will be recalled.

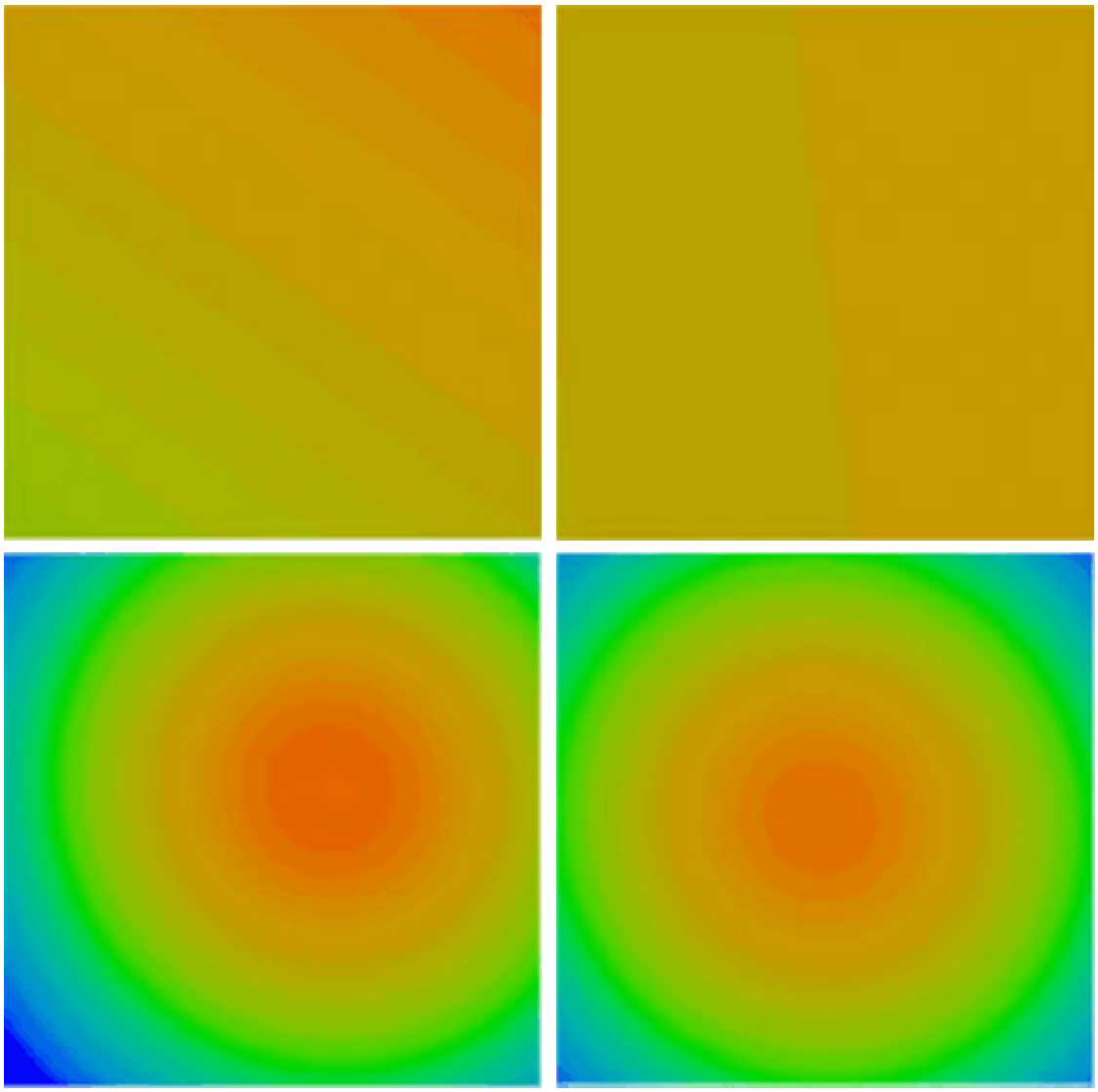
Note: After a longer period of time, it is sometimes necessary to re-do the 'tune GIF'. If you re-do this, it is important to do it at all magnifications. Otherwise you can end up with an inconsistent set of GIF alignments where one magnification is aligned for the present state and another magnification is aligned for an old state. Such an inconsistent set can falsely give you the impression that the GIF is unstable. An alternative way for ensuring that the GIF is consistently aligned at all magnifications is to do the cross-over alignments carefully for all magnifications. With good cross-over alignments it is usually not necessary to do the "tune GIF" for each magnification separately.

The Filter can be used optically in two main ways, one for imaging (recreating an “image” of what is received at the entrance aperture), the other for spectroscopy. If the Filter settings selected are double-focusing (the image is in focus and the spectrum is focused at the energy-selecting slit), the corrections are usually similar for imaging and spectroscopy. Where no double-focusing is possible (e.g. the larger dispersions in spectroscopy), the aberration corrections will be different.

The manner of correcting for the aberrations is different for imaging and spectroscopy. Below we will first consider imaging.

11.1.1 Imaging

First we need to describe the concept of isochromaticity. In a perfect filter, the energy across the field of view is the same. If we would introduce an infinitely small slit, the image would either be totally blocked by the slit (dark) or totally transmitted (bright). In practice, there is a small variation in energy across the field of view. In the case of the first-order achromaticity, the effect is a linear change, in the case of the second order it is non-linear.



An example of the first and second order isochromaticity correction is shown in the figure above. On the left are the data obtained during the aberration correction procedure before correction and on the right the data after. At the top is the first-order isochromaticity, at the bottom second order.

In the top left image there is a range in energy across the field of view, changing from bottom left to top right, as indicated by the colors which cover a range of 0.16eV. After correction, there still is a change in energy (now more from left to right) but now the total range has decreased to 0.03eV.

The second-order aberration, which produces a circular distribution is not well centered initially, so the energy range from the bottom left corner to the maximum is unnecessarily large (1.8eV). After correction the centering is better and the range is now 1.25eV (from the center to the four corners of the image).

For manual adjustment, insert a small slit (1 to 2 eV) and make sure the beam (zero-loss) passes through the slit. When the Focus 1st order X is changed, the slit will become visible as black bars along the sides of the field of view on either side of the proper focus value. Change the Focus 1st X until the bars are gone (or as small as possible), iterating from over- to underfocus and back to find the optimum. For Y the bars will will be at top and bottom.

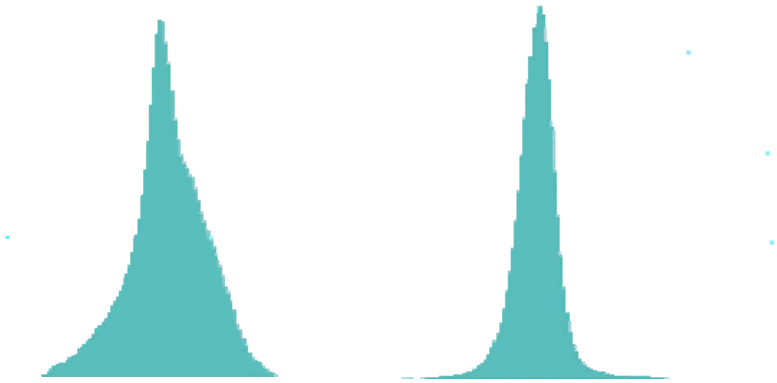
For the second-order focus, the area blocked by the slit will not be roughly circular but elongated. Optimise until it is circular.

During these adjustments you may have to recenter the zero-loss energy relative to the slit.

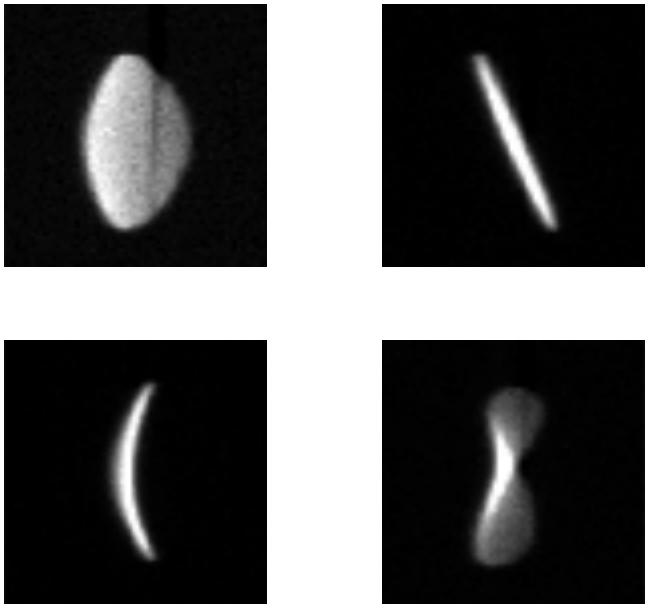
11.1.2 Spectroscopy

In spectroscopy, there are two ways of observing the effects. You can either insert the TV (if available on the filter, otherwise use the CCD) and look at the “image” of the spectrum or you can collect spectra and observe the effect on the zero-loss peak.

When collecting spectra, the aim is to make the zero-loss peak as narrow as possible.



The spectrum on the left is not focused properly, that on the right is.



When looking at the image of the spectrum on the TV, the above images can be observed. A perfectly focused spectrum would display a thin vertical line. When the Focus 1st order X is defocused, the line broadens (top left image). When the Focus 1st order Y is changed, the line will rotate (top right image). The Focus 2nd order X will cause a curving of the line (bottom image on the left) while the Focus 2nd order Y will give a complex distortion (bottom right-hand image).

Note: Because of the position of the TV camera, there is a slight change in spectrum focus between the TV and the CCD. The TV can be used very well for coarse focusing, but for fine focusing always use the CCD.

Focus 1st
The controls for the 1st order achromaticity correction are accessed under Focus 1st X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls.

Focus 2nd
The controls for the 2nd order achromaticity correction are accessed under Focus 2nd X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls.

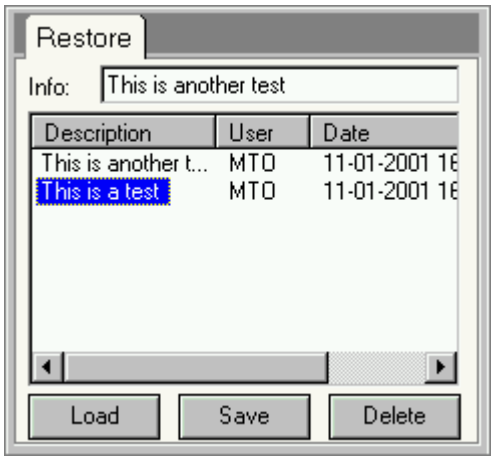
Ac Comp
The Ac compensation controls define the Ac (stray field) compensation for the Imaging Filter. The compensation applies a 50 or 60 Hz (dependent on the local situation) frequency in two perpendicular directions, thereby compensating a stray field in the opposite direction. The controls for it are accessed under Ac Comp X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls.

Shift
The shift controls allow the user to shift the spectrum. The controls for the shift are accessed under Shift X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls. Note that the shift shifts both slit and spectrum and has no effect when in imaging mode. Normally the shift is used to set the spectrum to such a position that the inserted slit can be seen on the left-hand side of the TV monitor.

MF knobs
The Multifunction knobs can be used to change the settings of the four Filter elements described above. To connect the Multifunction knobs to one of the functions, select the particular functions through its radio button and press the MF knobs button (it will become yellow). You can change the sensitivity of the MF knobs with the MF - and + buttons.

Flap-out button
The flap-out button leads to the AutoFilter Tuning Restore Control Panel.

11.2 AutoFilter Tuning Restore



The AutoFilter Tuning Restore Control Panel.

The AutoFilter Tuning Restore Control Panel allows the loading and saving of Imaging Filter setting set via the AutoFilter Tuning control panel. With the settings are stored a comment (entered under Info), the username of the user (the name under which you or another was logged on) and the date and time. All settings are accessible to all users and stored in a single file

Info
The Info entered by the user is included with the file and allows the user to store a comment with the settings.

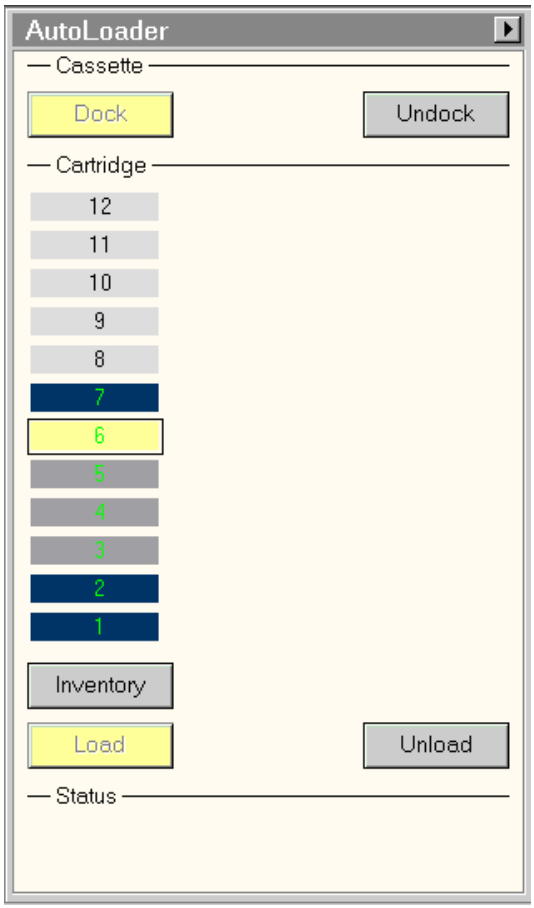
List
The list contains an overview of the files with settings available, sorted according to the alphabetical order of the description, username or date/time. You can change the sorting by clicking on the buttons at the top of the list (Description, User, ...). Clicking again reverses the order.

Load
When the Load button is pressed, the settings currently selected in the list are loaded and sent to the Imaging Filter.

Save
When the Save button is pressed, the currently active settings are stored.

Delete
When the Delete button is pressed, the currently selected setting is deleted. Note that there is no protection against deleting other users' settings.

12 AutoLoader Life Science



The AutoLoader Control Panel.

The AutoLoader Control Panel provides functionality to control the AutoLoader. The AutoLoader is a device mounted on the column opposite the CompuStage that makes it possible to transfer samples automatically into the microscope's vacuum space onto the CompuStage and back out. By placing a NanoCab with cassette on the AutoLoader, cassettes can be transferred from or to the AutoLoader. A cassette typically contains one or more cartridges and a cartridge contains a number of specimens. These cartridges can be transferred automatically from the cassette to the CompuStage and vice versa.

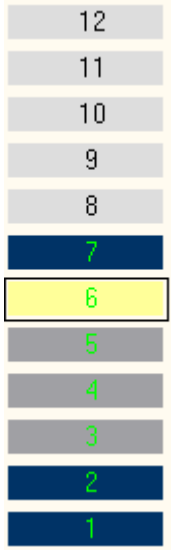
The AutoLoader Control Panel offers five major functions:

- Dock cassette : transfer a cassette from the NanoCab into the AutoLoader.
- Undock cassette : transfer a cassette from the AutoLoader to the NanoCab.
- Perform cassette inventory : scan each slot of the cassette to identify its contents (does the slot contain a cartridge or is it empty?).
- Load cartridge : transfer a cartridge from the selected cassette slot to the CompuStage.
- Unload cartridge : transfer a cartridge from the CompuStage to the cassette slot it was originally located at.

Dock
The first step in transferring samples to the CompuStage is docking the cassette. Pressing the Dock button results in locking the NanoCab followed by transferring the cassette from the NanoCab into the AutoLoader. The Dock button is disabled if there is no NanoCab placed. Note that for cryo (Life Science) AutoLoaders the NanoCab is unlocked once the cassette has been docked in the AutoLoader. The NanoCab is unlocked, so that it can be refilled with liquid nitrogen.

Undock
When finished analyzing all cartridges in the cassette, another cassette can be docked. In order to do so, the currently docked cassette must be undocked first. This can be achieved by pressing the Undock button. Pressing this button may result in the following behavior, depending on the state of the system:
If it is unknown whether there is a cartridge loaded on the CompuStage (typically the case when the system has been (re)started or when the CompuStage has been disabled and enabled again or when an AutoLoader compatible holder was retracted and inserted by another one), an inventory of the CompuStage is performed first before the cassette is actually being undocked. The reason for this is that there might be a cartridge loaded on the CompuStage, which must be unloaded to the cassette first before the cassette is actually being undocked.
If there is a cartridge loaded on the CompuStage, first this cartridge is unloaded to the cassette before the cassette is actually being undocked.

Cassette overview
The cassette overview visualizes the contents of a docked cassette. This cassette overview becomes visible when a NanoCab is placed. There are a number of colors used to indicate the status of a cassette slot:



Slot characteristics	Explanation
Light gray color	Slot has an unknown state (can be either empty or occupied; no inventory performed yet)
Black slot number	No inventory of slot has been done by the AutoLoader hardware
Green slot number	An inventory of this slot has been performed by the AutoLoader hardware
Yellow slot color	Cartridge from this slot is either in the progress of being loaded / unloaded or cartridge from this slot has been loaded on the CompuStage
Dark gray color	Slot is empty
Dark blue color	Slot is occupied

Besides these colors there is one special color: red. A red cassette slot means there was a mismatch during cartridge detection (an inventory of a cassette slot was done and identified as occupied, but when loading the cartridge from this slot, the cartridge gripper appears to be empty; this is a mechanical error).

Inventory
Pressing the Inventory button results in examining all cassette slots that have an unknown state to see whether there is a cartridge in the slot. When the Inventory button has been pressed, its name changes into ‘Stop inv.’. This makes the button a toggle button: pressing the ‘Stop inv.’ button results in stopping the ongoing inventory. ‘Stop’ means that the current action is nicely finished. It does not mean that the process is immediately aborted (it is not an ‘emergency stop’). Once stopped, the button name changes back into ‘Inventory’. When all unknown cassette slots have been identified (and thus all slots have a known state), pressing the Inventory button results in re-examining all cassette slots, starting at cassette slot 1 (all cassette slots are reset and get an unknown state).

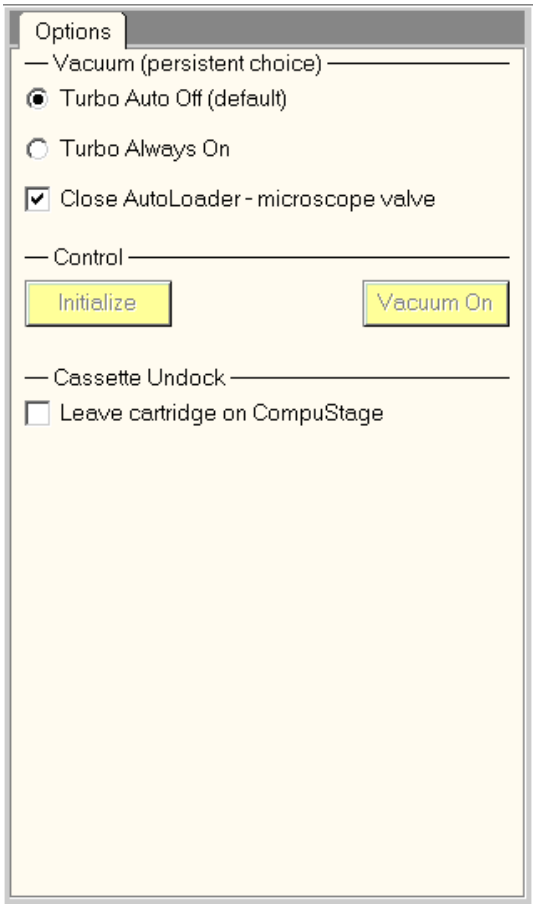
Load
There are two approaches when a cassette has been docked:
1. Before loading a cartridge to the CompuStage, first perform a complete inventory of the cassette by pressing the Inventory button. When all cassette slots have a known state, select an occupied slot and press the Load button. As is the case for pressing the Undock button, pressing the Load button may result in different behavior, depending on the state of the system:
   - If it is unknown whether there is a cartridge loaded on the CompuStage (typically the case when the system has been (re)started or when the CompuStage has been disabled and enabled again or when an AutoLoader compatible holder was retracted and inserted by another one), an inventory of the CompuStage is performed first before the selected cartridge is actually being loaded. The reason for this is that there might be already a cartridge loaded on the CompuStage, which must be unloaded to the cassette first before a new cartridge can be loaded.
   - If there is a cartridge loaded on the CompuStage, first this cartridge is unloaded to the cassette before the selected cartridge is actually being loaded.
2. Instead of first performing a cassette inventory, it is also possible to select a cassette slot with an unknown state (light gray colored slot). Selecting a cassette slot with an unknown state followed by pressing the Load button results in an attempt to load a potentially available cartridge from the selected cassette slot. If there appears to be a cartridge in the cassette slot, the cartridge is loaded to the CompuStage. If no cartridge is detected, the cassette slot is marked as empty. In fact, by following this approach an inventory of the cassette is implicitly performed.

Unload
Pressing the Unload button results in unloading the cartridge from the CompuStage to the cassette slot it was loaded from. There is one exception: if after a (re)start of the system there appears to be a cartridge on the system, this cartridge is unloaded to the first empty cassette slot that is available. This does not necessarily have to be the slot where the cartridge was loaded from.

Note: Access to the CompuStage is not always allowed. If the Load, Unload an Undock buttons are disabled, keep in mind that this is most likely due to one of the following situations:
- The CompuStage is not ready (e.g. it is disabled, homing, etc.).
- The AutoLoader vacuum and microscope vacuum are not compatible.
- The state of the Temperature Control system is ‘conditioning column’, ‘conditioning AutoLoader’ or ‘conditioning both’.

Flap-out button
The flap-out button leads to the Options tab of the AutoLoader Control Panel.

12.1 AutoLoader Options Life Science



The AutoLoader Life Science Options Control Panel.

The Options flap-out provides functionality to influence the behavior of the AutoLoader.

12.1.1 Vacuum

Turbo Auto Off
When this option is selected, the AutoLoader vacuum is switched to the so-called STANDBY state when the microscope liner valves are opened. In STANDBY state, the AutoLoader vacuum turbo pump is switched off, but it is switched on occassionally to maintain good vacuum (the AutoLoader vacuum is monitored such, that when the AutoLoader vacuum pressure drops below a certain threshold the AutoLoader turbo pump is switched on for a while to obtain good vacuum). If the microscope liner valves are already opened at the moment this option is selected, the AutoLoader vacuum is immediately switched to STANDBY state.

Turbo Always On
When this option is selected, the AutoLoader vacuum is switched to the so-called ACTIVE state, meaning that the AutoLoader turbo pump is switched on. The AutoLoader vacuum remains in the ACTIVE state even if the microscope liner valves are opened (i.e. the AutoLoader turbo pump is continuously on). Note that selecting this option results in immediately switching on the AutoLoader turbo pump, while selecting the Turbo Auto Off option does not have immediate effect, except when the microscope liner valves are already opened (see above).

Close AutoLoader - microscope valve

For cryo AutoLoaders, there is the possibility to leave the valve between the AutoLoader and the microscope either open or closed after a cartridge has been loaded or unloaded to / from the CompuStage. If this option is set, the valve between the AutoLoader and the microscope is closed when a cartridge has been loaded or unloaded to / from the CompuStage. If this option is not set, the valve between the AutoLoader and the microscope remains open when a cartridge has been loaded or unloaded to / from the CompuStage. In this way, the AutoLoader and the microscope form one space.

12.1.2 Control

Initialize
Pressing this button initializes the AutoLoader. This button is only available when the AutoLoader is in the ‘Not initialized’ state.

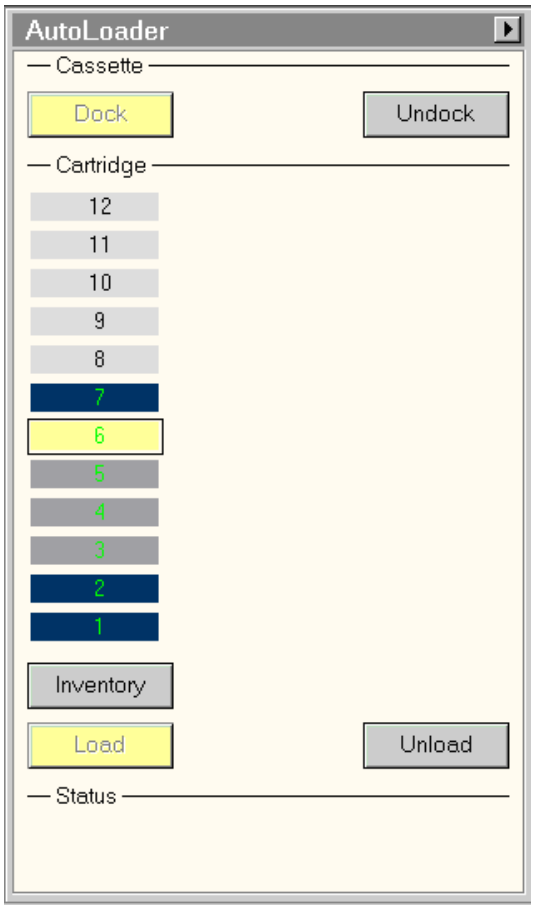
Vacuum On
Pressing this button, switches the AutoLoader vacuum on. This button is only available when the AutoLoader vacuum is in the so-called OFF state. A button push actually results in a transition from the OFF state to the ACTIVE state (see Turbo Always On option).

12.1.3 Cassette Undock

Leave cartridge on CompuStage
There is the possibility to undock the cassette while leaving the cartridge on the CompuStage. Normally, when a cartridge is loaded on the CompuStage, pressing the Undock button results in first unloading the cartridge from the CompuStage to the cassette followed by undocking the cassette to the NanoCab. However, for cryo AutoLoaders, cooling the docker after an undock takes a significant amount of time. In order to avoid this, the Leave cartridge on CompuStage option can be selected, so that the cassette can already be undocked while the last cartridge of the cassette is being analyzed. Note that by setting this option, the cassette - cartridge integrity is ignored. Normally, a cartridge is always unloaded to the cassette and cassette slot it was loaded from. However, by undocking the cassette while leaving a cartridge on the CompuStage, one can dock any cassette and unload the cartridge to a cassette where it was not originally loaded from. Unloading the cartridge to a newly docked cassette will only succeed if there is at least one empty cassette slot available. Typically, a cassette inventory is needed first in order to successfully unload the cartridge. The Inventory button can be pressed for this purpose.

This option is persistent, meaning that its value is stored and that the last stored value applies each time the server software is started.

13 AutoLoader Materials Science



The AutoLoader Control Panel.

The AutoLoader Control Panel provides functionality to control the AutoLoader. The AutoLoader is a device mounted on the column opposite the CompuStage that makes it possible to transfer samples automatically into the microscope's vacuum space onto the CompuStage and back out. By placing a NanoCab with cassette on the AutoLoader, cassettes can be transferred from or to the AutoLoader. A cassette typically contains one or more cartridges and a cartridge contains a number of specimens. These cartridges can be transferred automatically from the cassette to the CompuStage and vice versa.

The AutoLoader Control Panel offers five major functions:

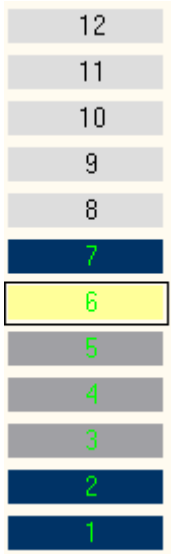
- Dock cassette : transfer a cassette from the NanoCab into the AutoLoader.
- Undock cassette : transfer a cassette from the AutoLoader to the NanoCab.
- Perform cassette inventory : scan each slot of the cassette to identify its contents (does the slot contain a cartridge or is it empty?).
- Load cartridge : transfer a cartridge from the selected cassette slot to the CompuStage.
- Unload cartridge : transfer a cartridge from the CompuStage to the cassette slot it was originally located at.

Dock
The first step in transferring samples to the CompuStage is docking the cassette. Pressing the Dock button results in locking the NanoCab followed by transferring the cassette from the NanoCab into the AutoLoader. The Dock button is disabled if there is no NanoCab placed.

Undock
When finished analyzing all cartridges in the cassette, another cassette can be docked. In order to do so, the currently docked cassette must be undocked first. This can be achieved by pressing the Undock button. Pressing this button may result in the following behavior, depending on the state of the system:
If it is unknown whether there is a cartridge loaded on the CompuStage (typically the case when the system has been (re)started or when the CompuStage has been disabled and enabled again or when an AutoLoader compatible holder was retracted and inserted by another one), an inventory of the CompuStage is performed first before the cassette is actually being undocked. The reason for this is that there might be a cartridge loaded on the CompuStage, which must be unloaded to the cassette first before the cassette is actually being undocked.
If there is a cartridge loaded on the CompuStage, first this cartridge is unloaded to the cassette before the cassette is actually being undocked.

CAUTION: NEVER RETRACT AN AUTOLOADER-COMPATIBLE HOLDER CONTAINING A LOADED CARTRIDGE BY THE AUTOLOADER, NOR INSERT AN AUTOLOADER-COMPATIBLE HOLDER WITH A CARTRIDGE WHEN ALL CASSETTE SLOTS ARE OCCUPIED.
If any of these actions is done, the relation between a specimen cartridge and its slot in a cassette is lost.

Cassette overview
The cassette overview visualizes the contents of a docked cassette. This cassette overview becomes visible when a NanoCab is placed. There are a number of colors used to indicate the status of a cassette slot:



Slot characteristics	Explanation
Light gray color	Slot has an unknown state (can be either empty or occupied; no inventory performed yet)
Black slot number	No inventory of slot has been done by the AutoLoader hardware
Green slot number	An inventory of this slot has been performed by the AutoLoader hardware
Yellow slot color	Cartridge from this slot is either in the progress of being loaded / unloaded or cartridge from this slot has been loaded on the CompuStage
Dark gray color	Slot is empty
Dark blue color	Slot is occupied

Besides these colors there is one special color: red. A red cassette slot means there was a mismatch during cartridge detection (an inventory of a cassette slot was done and identified as occupied, but when loading the cartridge from this slot, the cartridge gripper appears to be empty; this is a mechanical error).

Inventory
Pressing the Inventory button results in examining all cassette slots that have an unknown state to see whether there is a cartridge in the slot. When the Inventory button has been pressed, its name changes into ‘Stop inv.’. This makes the button a toggle button: pressing the ‘Stop inv.’ button results in stopping the ongoing inventory. ‘Stop’ means that the current action is finished in a proper and safe way. It does not mean that the process is immediately aborted (it is not an ‘emergency stop’). Once stopped, the

button name changes back into ‘Inventory’. When all unknown cassette slots have been identified (and thus all slots have a known state), pressing the Inventory button results in re-examining all cassette slots, starting at cassette slot 1 (all cassette slots are reset and get an unknown state).

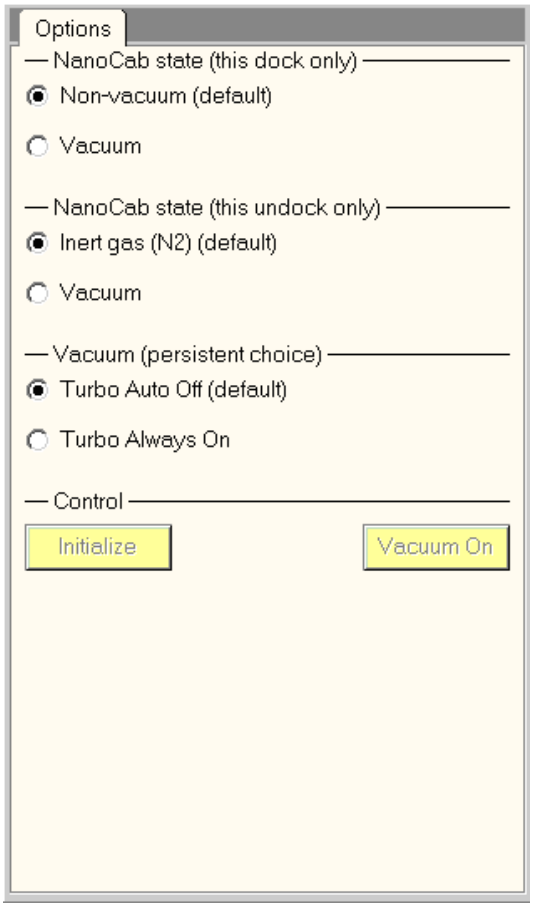
Load
There are two approaches when a cassette has been docked:
1. Before loading a cartridge to the CompuStage, first perform a complete inventory of the cassette by pressing the Inventory button. When all cassette slots have a known state, select an occupied slot and press the Load button. As is the case for pressing the Undock button, pressing the Load button may result in different behavior, depending on the state of the system:
   - If it is unknown whether there is a cartridge loaded on the CompuStage (typically the case when the system has been (re)started or when the CompuStage has been disabled and enabled again or when an AutoLoader compatible holder was retracted and inserted by another one), an inventory of the CompuStage is performed first before the selected cartridge is actually being loaded. The reason for this is that there might be already a cartridge loaded on the CompuStage, which must be unloaded to the cassette first before a new cartridge can be loaded.
   - If there is a cartridge loaded on the CompuStage, first this cartridge is unloaded to the cassette before the selected cartridge is actually being loaded.
2. Instead of first performing a cassette inventory, it is also possible to select a cassette slot with an unknown state (light gray-colored slot). Selecting a cassette slot with an unknown state followed by pressing the Load button results in an attempt to load a potentially available cartridge from the selected cassette slot. If there appears to be a cartridge in the cassette slot, the cartridge is loaded to the CompuStage. If no cartridge is detected, the cassette slot is marked as empty. In fact, by following this approach an inventory of the cassette is implicitly performed.

Unload
Pressing the Unload button results in unloading the cartridge from the CompuStage to the cassette slot it was loaded from. There is one exception: if after a (re)start of the system there appears to be a cartridge on the system, this cartridge is unloaded to the first empty cassette slot that is available. This does not necessarily have to be the slot where the cartridge was loaded from.

Note: Access to the CompuStage is not always allowed. If the Load, Unload an Undock buttons are disabled, keep in mind that this is most likely due to one of the following situations:
- The objective lens apertures are disabled.
- There is no AutoLoader-compatible holder inserted.
- The CompuStage is not ready (e.g. it is disabled, homing, etc.).
- The AutoLoader vacuum and microscope vacuum are not compatible.

Flap-out button
The flap-out button leads to the Options tab of the AutoLoader Control Panel.

13.1 AutoLoader Options Materials Science



The AutoLoader Materials Science Options Control Panel.

The Options flap-out provides functionality to influence the behavior of the AutoLoader.

13.1.1 NanoCab state (this dock only)

A cassette from a NanoCab can either be docked under vacuum or non-vacuum conditions. As soon as the cassette has been docked and the selected NanoCab state has been applied, the NanoCab state is automatically set to the default depending on the installed options (actually, there are two install options: ‘vacuum default’ and ‘non-vacuum default’; in the first case, the selection is automatically changed to ‘Vacuum’ when the current selection is ‘Non-vacuum’ and the cassette has been docked; in the second case, the selection is automatically changed to ‘Non-vacuum’ when the current selection is ‘Vacuum’ and the cassette has been docked).
Note: Changing the NanoCab state requires at least Expert user level.

13.1.2 NanoCab state (this undock only)

There is also a NanoCab state that applies for undocking a cassette. For non-cryo AutoLoaders, there is the possibility to either fill the NanoCab with inert gas or have the NanoCab under vacuum after undocking the cassette. As soon as the cassette has been undocked and the selected NanoCab state has been applied, the NanoCab state is automatically set to the default depending on the installed options (actually, there are two install options: ‘vacuum default’ and ‘inert gas default’; in the first case, the selection is automatically changed to ‘Vacuum’ when the current selection is ‘Inert gas (N2)’ and the cassette has been undocked; in the second case, the selection is automatically changed to ‘Inert gas (N2)’ when the current selection is ‘Vacuum’ and the cassette has been undocked).
Note: Changing the NanoCab state requires at least Expert user level.

13.1.3 Vacuum

Turbo Auto Off
When this option is selected, the AutoLoader vacuum is switched to the so-called STANDBY state when the microscope liner valves are opened. In STANDBY state, the AutoLoader vacuum turbo pump is switched off, but it is switched on occassionally to maintain good vacuum (the AutoLoader vacuum is monitored such, that when the AutoLoader vacuum pressure drops below a certain threshold the AutoLoader turbo pump is switched on for a while to obtain good vacuum). If the microscope liner valves are already opened at the moment this option is selected, the AutoLoader vacuum is immediately switched to STANDBY state.

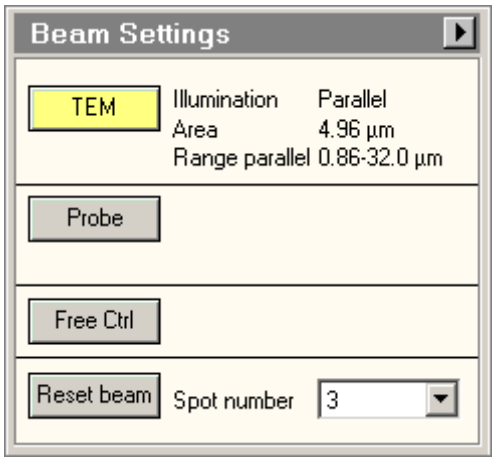
Turbo Always On
When this option is selected, the AutoLoader vacuum is switched to the so-called ACTIVE state, meaning that the AutoLoader turbo pump is switched on. The AutoLoader vacuum remains in the ACTIVE state even if the microscope liner valves are opened (i.e. the AutoLoader turbo pump is continuously on). Note that selecting this option results in immediately switching on the AutoLoader turbo pump, while selecting the Turbo Auto Off option does not have immediate effect, except when the microscope liner valves are already opened (see above).

13.1.4 Control

Initialize
Pressing this button initializes the AutoLoader. This button is only available when the AutoLoader is in the ‘Not initialized’ state.

Vacuum On
Pressing this button, switches the AutoLoader vacuum on. This button is only available when the AutoLoader vacuum is in the so-called OFF state. A button push actually results in a transition from the OFF state to the ACTIVE state (see Turbo Always On option).

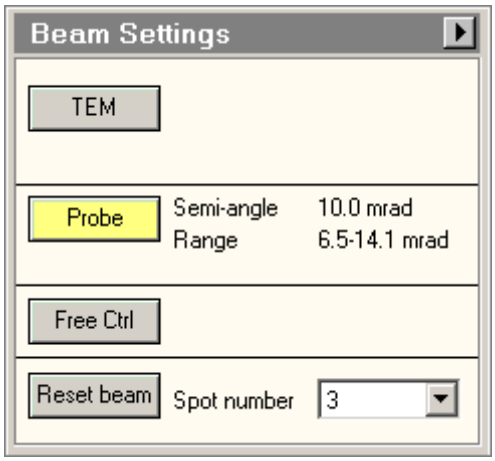
14 Beam Settings



The Beam Settings Control Panel.

The illumination on the microscope is controlled through the 'Beam Settings' control panel and its flap-outs.

TEM
Select this mode if you want to do normal TEM imaging. The size of the illuminated area is indicated to the right of this button. The illuminated area is changed with the Intensity knob on the left hand control pad. The illumination is parallel when the illuminated area is within the range indicated to the right of the 'TEM' button. The area and range are directly proportional to the size of the C2 aperture. For example, when the C2 aperture is changed from 50 um to 100 um, the area and range are doubled.
When the illuminated area is smaller than the minimum of the range of parallel illumination, then the illumination system automatically switches to 'condensing mode'. In this mode, the beam is slightly converging towards the sample.
When the illuminated area is larger than the maximum of the range of parallel illumination, then the illumination system automatically switches to 'spreading mode'. In this mode, the beam slightly diverges towards the sample.



Probe
Select Probe if you want to have a focused probe on the sample, for example for STEM, EDX, EELS, or CBED. The semi-convergence angle of the probe is indicated on the right of this button. The focus of the probe is controlled with the Intensity knob on the left hand control pad (except when the microscope is in STEM mode, then it is usually controlled with the Focus knob on the right hand control panel).
The default semi-convergence of 10 mrad is optimum for most Titans without Probe Cs-corrector. The semi-convergence angle can be varied in the Tune flap-out. The range of convergence angles is indicated on the right of the 'Probe' button. The semi-convergence and range are directly proportional to

the size of the C2 aperture. For example, when then the C2 aperture is changed from 50 um to 100 um, the semi-convergence angle and range are doubled.

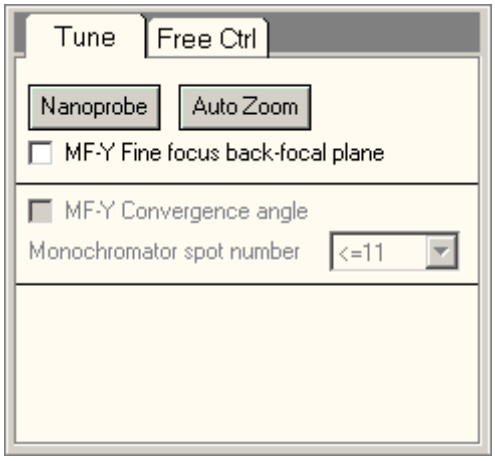
Free Ctrl
Select Free Ctrl if you want to illuminate the sample in a way that is not covered by the two basic modes TEM and Probe. When the Free control mode is selected, the Free Ctrl flap-out automatically opens. This flap-out contains several more options for adjusting the illumination.

Reset beam
Press Reset Beam to set the user-shift (normally set with the left-hand trackball) and user-defocus to zero. This helps to find the beam when it is lost.

Spot number
The beam current is controlled with the Spot number setting. Spot number 1 has the highest beam current, and spot number 11 has the lowest beam current. With each step, the beam current reduces by about a factor of two.
With a monochromator further spot numbers are available in filtered mode. These spots are selected in the Tune flap-out.

Flap-out
The flap-out button leads to the Tune and Free Ctrl tabs of the Beam Settings Control Panel.

14.1 Beam Settings Tune



The Beam Settings Tune Control Panel in TEM mode.

Nanoprobe
By default, the TEM illumination uses the Microprobe setting. Press Nanoprobe to switch the TEM illumination to the Nanoprobe setting (this switches the minicondenser lens off). The minimum and maximum area that can be illuminated with a parallel beam in Nanoprobe are five times smaller than in Microprobe. However, when the illuminated area is outside the range of parallel illumination, so when the illumination system has switched to condensing mode or spreading mode, then the beam converges or diverges five times stronger in Nanoprobe than in Microprobe. Therefore, it is advised not to use Nanoprobe in combination with condensing mode or spreading mode.

Auto Zoom
When Auto Zoom is on, the size of the illuminated area automatically scales with the magnification.

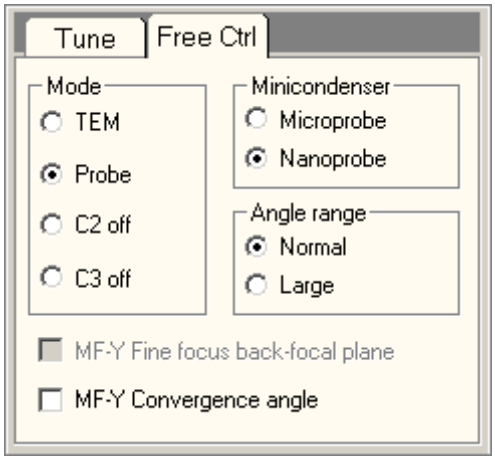
Fine Focus Back-focal Plane
Select MF-Y Fine Focus Back Focal Plane to fine-tune the position of the diffraction pattern at the objective aperture. When selected, the Multifunction-Y knob controls the position of the diffraction plane. In normal use, this needs seldom to be changed.

The Beam Settings Tune Control Panel in Probe mode.

Convergence angle
When MF-Y Convergence angle is selected, the semi-convergence angle of the probe can be varied with the Multifunction-Y knob.

Monochromator spot number
When the monochromator is in Filtered mode, further spot numbers than 11 (up to 17) can be selected. When these spots are to be used, the C3 aperture is used as the beam-defining aperture (instead of C2) and the C2 lens acts optically as an additional C1 lens. The normal C2 function (focusing/defocusing the beam) is switched to C3.

14.2 Beam Settings Free Ctrl



The Beam Settings Free Ctrl Control Panel.

The Free Control flap-out automatically opens when the Free Control mode is selected in the Beam Settings control panel. When the user switches from TEM or Probe to Free Control mode, the illumination does not change. The main difference is that several additional options become available. When the user switches back from Free Control to TEM or Probe mode, the illumination is set back to fit within the restricted range of options available in these two main modes.

Mode
The mode option controls how the C2 and C3 lens are set. The TEM and Probe modes correspond to the TEM and Probe modes in the main Beam Settings control panel.
In the modes "C2 off" or "C3 off", the second or third condenser lens is set to zero and the condenser column behaves as a two-condenser system (very much comparable to the Tecnai and CM microscopes). Normally, the "C2 off" and "C3 off" modes will be seldom used. They may be helpful to circumvent problems when the condenser lenses have become misaligned for some reason. In the "C2 off" mode, the Intensity knob controls the C3 strength and the C3 aperture must be used to limit the beam. In the "C3 off" mode, the Intensity knob controls the C2 strength and the C2 aperture must be used to limit the beam.

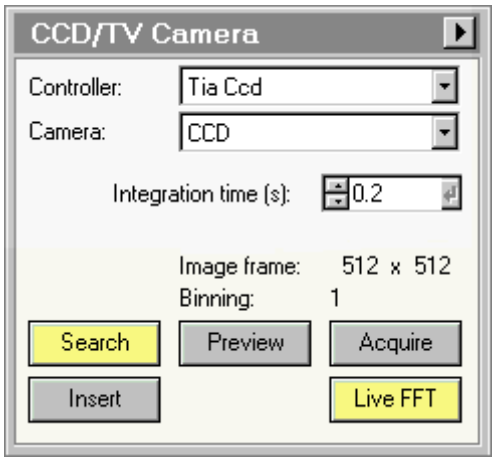
Minicondenser
Normally, the TEM illumination uses the Microprobe setting (minicondenser lens on) and Probe illumination uses the Nanoprobe setting (minicondenser lens off). In Microprobe, the illuminated area and probe size are five times larger than in Nanoprobe. The convergence angle in Microprobe is five times smaller than in Nanoprobe.

Angle range
The angle range option is only available in Probe mode. When the user switches from normal range to large range, the C2 and C3 lenses get strongly excited and an additional intermediate image of the source is created between the C2 and C3 lens. This gives optically more flexibility, resulting in a larger range of convergence angles. This mode is especially suited for LACBED (large angle convergent beam electron diffraction). However, the strong excitation of the C2 and C3 lenses also gives more spherical aberration, especially at small convergence angles where it can contribute up to 0.3 mm to the total spherical aberration of the objective lens. Therefore, in order to obtain a very low convergence angle in probe mode, it is better not to switch to the large angle range, but instead to switch to Microprobe setting.

Fine Focus Back-focal Plane
Select MF-Y Fine Focus Back Focal Plane to fine-tune the position of the diffraction pattern at the objective aperture. When selected, the Multifunction-Y knob controls the position of the diffraction plane. In normal use, this needs seldom to be changed.

Convergence angle
When MF-Y Convergence angle is selected, the semi-convergence angle of the probe can be varied with the Multifunction-Y knob.

15 CCD / TV



The CCD / TV Camera Control Panel.

The CCD / TV Camera Control Panel allows control over image acquisition using CCD and TV (TV-rate) cameras. In order to allow acquisition, a controller must be present. This controller can be :

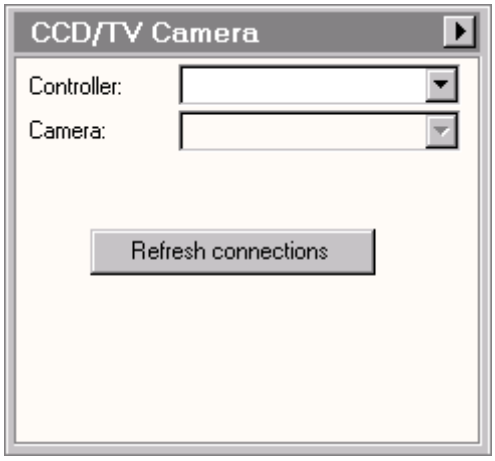
- DigitalMicrograph
- TIA CCD
- TIA Video

The controller takes care of the actual image acquisition and display in the 'data space' of the TEM user interface.

Search, Preview, Acquire
For easy operation, the CCD / TV acquisition system has three preset acquisition modes with their own buttons, Search, Preview and Acquire. Each of the three can have its own, separate settings (Integration time, Frame size, Binning, bias and gain correction), allowing rapid switching between different settings. The actual settings are up to the user. Typical settings could be:
Search : Integration time 0.2 seconds, Image frame 256*256, Binning 4.
Preview : Integration time 0.5 seconds, Image frame 512*512, Binning 2.
Acquire : Integration time 1 second, Image frame 1024*1024, Binning 1.
Normally Search and Preview are continuous acquisition, while Acquire acquires a single frame.
Note: Although the acquisition presets in the TEM are similar to those in DigitalMicrograph, the actual values are decoupled. So a change in the TEM settings does not cause a change in the DigitalMicrograph settings. Starting Search in the TEM user interface forces DigitalMicrograph to use the TEM settings, but if you start Search in DigitalMicrograph itself, the settings used will be from DigitalMicrograph. It is advised therefore to use only the TEM user interface for controlling the CCD camera (the more so as the CCD settings in the TEM software are user-specific and can be stored and recalled, while those in DigitalMicrograph are overwritten by changes made by other users).

Camera
If more than one camera is present (e.g. a slow-scan CCD camera below the projection chamber or in the wide-angle TV port above the projection chamber, and an Imaging Filter), the camera to be used can be chosen from the drop-down list with cameras.

Controller
Active controllers (e.g. Gatan CCD, TIA CCD, TIA Video) are displayed in a drop-down list. Select one of the options to determine the controller to be used.



Notes:
- If no controller is visible or the required CCD camera is missing in the list (while the CCD Camera Server given should be the controller to be used), you may need to reconnect to the driver. Click on the control panel with the right-hand mouse button and a popup menu with a single line 'Refresh connections' will be visible. Click on the line and a reconnect will be attempted. This function does not work for any other driver (in those cases the "driver" - such as Gatan DigitalMicrograph, TIA must be restarted).
- In order to allow CCD image acquisition on a Gatan CCD camera using TIA, DigitalMicrograph must be running (otherwise TIA cannot access the camera).

Integration time
The integration time sets the CCD camera integration time for the currently active acquisition mode (Search, Preview, Acquire). Not active for TV-rate camera acquisition.

Acquisition settings
Various settings, dependent on the camera type, are displayed.

Search
Pressing the Search button :
- When the button is gray, switches the acquisition settings to those of the Search mode and starts acquisition.
- When the button is yellow, pauses the acquisition.
- When the button is white, resumes the acquisition.

When the button is red, other software (Tomography) is acquiring images.
Normally Search is continuous acquisition.

Preview
Pressing the Preview button :
- When the button is gray, switches the settings to those of the Preview mode and starts acquisition.
- When the button is yellow, pauses the acquisition.
- When the button is white, resumes the acquisition.

When the button is red, other software (Tomography) is acquiring images.
Normally Preview is continuous acquisition.

Acquire
Pressing the Acquire button :
- When the button is gray, switches the settings to those of the Exposure mode and starts acquisition.
- When the button is yellow, pauses the acquisition.

- When the button is white, start the acquisition of a new frame.

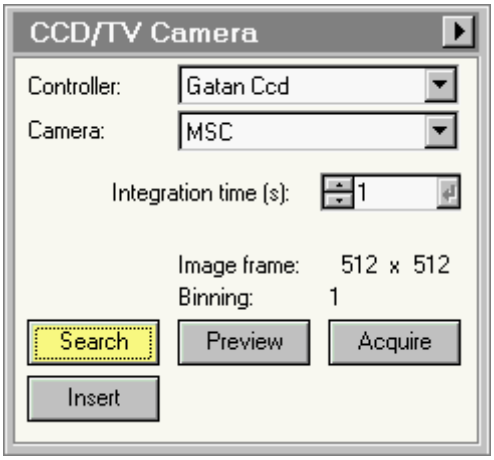
When the button is red, other software (Tomography) is acquiring images.
Normally Acquire acquires a single frame.

Insert
If the camera is insertable (moves in and out), it can be inserted or retracted by pressing the Insert button.

Live FFT
Live FFTs can be started and stopped when TIA is the CCD or Video server and either Search or Preview acquisition is active.

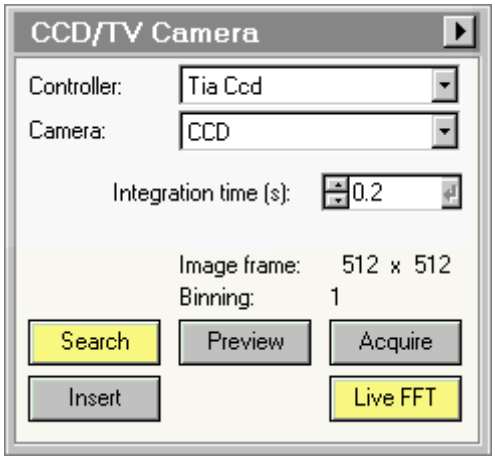
Flap-out button
Pressing the flap-out button displays the flap-out with the CCD / TV Camera Settings, General, Bias/Gain and Shutter Control Panels.

15.1.1 DigitalMicrograph CCD



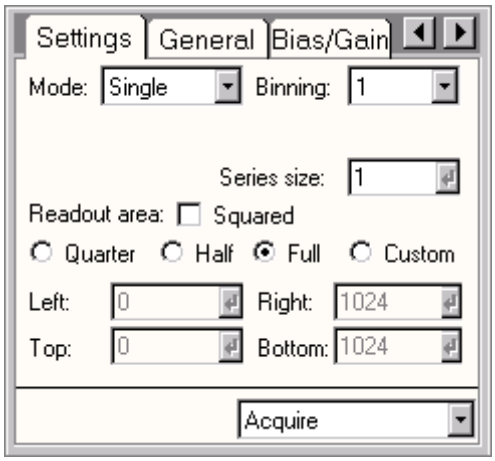
For DigitalMicrograph the CCD / TV Camera Control Panel has no Live FFT function. Live FFTs can be started via the DigitalMicrograph menu.

15.1.2 TIA CCD



For TIA CCD the CCD / TV Camera Control Panel has one special function in the case of an Eagle CCD camera. If the connection to the camera is lost, a red button "Online", located above the Search button will become visible. Press the OnLine button to attempt to restore the connection to the camera.

15.2 CCD / TV Camera Settings



The CCD / TV Camera Settings Control Panel.

In the CCD / TV Camera Settings Control Panel the CCD/TV camera acquisition parameters are defined. For an explanation of the CCD basics, see the explanation of the CCD cameras (section 15.6).

Mode
Under Mode the acquisition mode (continuous or single) is selected. In Continuous the image is acquired continuously until the user stops acquisition. In Single image is acquired after which acquisition stops. Search and Preview are typically set to continuous, while Acquire is set to single.

Binning
Under binning the binning factor of the CCD/TV camera is selected. For Search the binning factor typically is between 2 and 4, for Preview 1 and for Acquire 1.

Series size (TIA only)
Under Series size the number of images acquired in a TIA series is defined.

Readout area
The readout area of the CCD/TV camera can be set by entering appropriate numbers (after selecting the Custom settings - and pressing the the Enter button when a number has been changed) or pressing one of the buttons (Quarter, Half, Full). If the CCD/TV camera is not square, the Squared checkbox allows you to force the system to use square image size (so, e.g., if the CCD/TV has 1500 x 1024 pixels, the resulting Full image will be 1024x1024 and centered in the horizontal direction).
Note: The readout area cannot be set directly on the Eagle CCD. For this CCD only the Quarter, Half and Full options can be used (in addition to binning) to affect the readout area and image size.

Squared
The Squared option is available for non-square CCD cameras. If this option is switched on, the readout area selection is forced to square images.

Quarter, Half, Full buttons
With the Quarter, Half and Full buttons the CCD/TV camera readout area can be set to 1/4, 1/2 and the full size of the CCD/TV, respectively. These images are always centered, so Quarter corresponds to pixels 384 to 640 (for a 1024x1024 camera) in both x and y directions, while Half corresponds to pixels 256 to 768.

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and

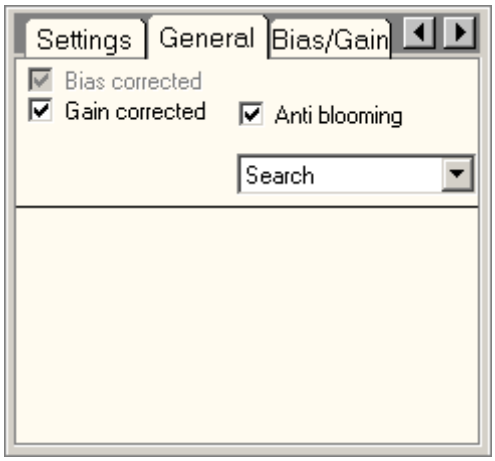
by pressing the equivalent button in the main control panel is that the drop-down list selection selects the mode but does not automatically start acquisition.

15.3 CCD / TV Camera General

In the CCD / TV Camera General Control Panel various settings related to CCD/TV camera image acquisition are defined. The controls present depend on the controller and type of camera:

- DigitalMicrograph CCD
- TIA CCD
- TIA Video

15.3.1 DigitalMicrograph CCD



The CCD / TV Camera General Control Panel for DigitalMicrograph.

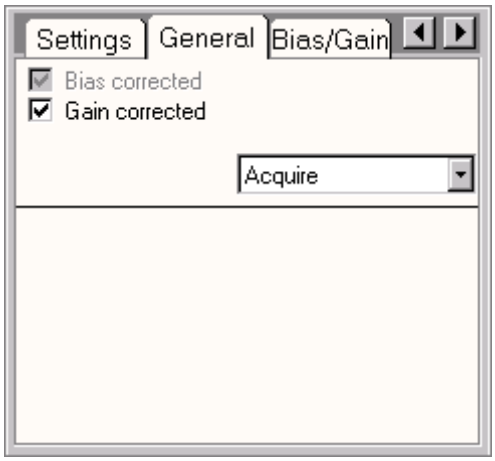
Bias (dark) corrected
Under Bias corrected the dark-current correction of the image acquisition is switched on (checkbox checked) or off.

Gain corrected
Under Gain corrected the gain correction of the image acquisition is switched on (checkbox checked) or off. Gain corrected can only be on when Bias corrected is on (the Bias corrected check box becomes disabled when Gain corrected is checked).

Anti blooming (availability depends on type of CCD)
Under Anti blooming the anti-blooming option (reduces blooming) of the CCD camera is switched on (checkbox checked) or off.

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and by pressing the equivalent button in the main control panel is that the drop-list selection selects the mode but does not automatically start acquisition.

15.3.2 TIA CCD



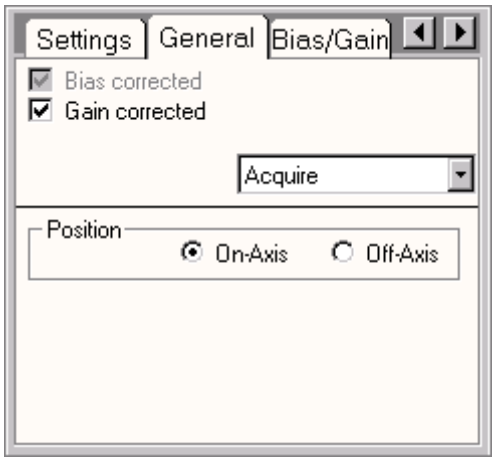
The CCD / TV Camera General Control Panel for TIA CCD.

Bias corrected
Under Bias corrected the bias or dark-current correction of the image acquisition is switched on (checkbox checked) or off.

Gain corrected
Under Gain corrected the gain correction of the image acquisition is switched on (checkbox checked) or off. Gain corrected can only be on when Bias corrected is on (the Bias corrected check box becomes disabled when Gain corrected is checked).

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and by pressing the equivalent button in the main control panel is that the drop-list selection selects the mode but does not automatically start acquisition.

15.3.3 TIA Video



The CCD / TV Camera General Control Panel for TIA Video.

Bias corrected
Under Bias corrected the bias correction of the image acquisition is switched on (checkbox checked) or off. The bias correction for a TV-rate camera is analogous to the dark-current correction for a CCD camera.

Gain corrected
Under Gain corrected the gain correction of the image acquisition is switched on (checkbox checked) or off. Gain corrected can only be on when Bias corrected is on (the Bias corrected check box becomes disabled when Gain corrected is checked). The gain correction for a TV-rate camera is analogous to the gain correction for a CCD camera.

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and by pressing the equivalent button in the main control panel is that the drop-list selection selects the mode but does not automatically start acquisition.

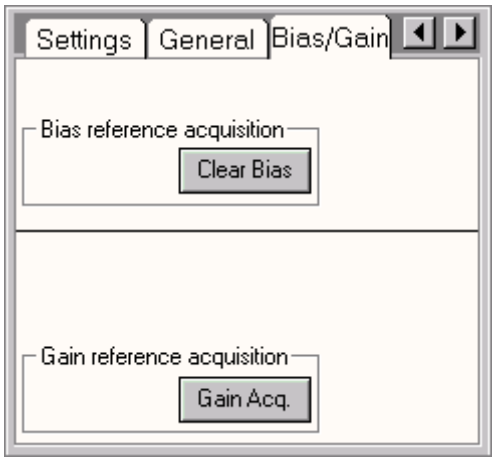
Position
On microscopes where more than one camera is mounted and the control through these is such that the microscope is not able to tell from the selected camera which it is and where it is located (such as when controlled by a switchbox), the switch between on-axis and off-axis position can be made by selecting the appropriate radio button under Position.

15.4 CCD / TV Camera Bias/Gain

In the CCD / TV Camera Bias/Gain Control Panel various settings related to CCD/TV camera bias/gain image acquisition are defined. The controls present depend on the controller and type of camera:

- DigitalMicrograph CCD
- TIA CCD
- TIA Video

15.4.1 DigitalMicrograph CCD

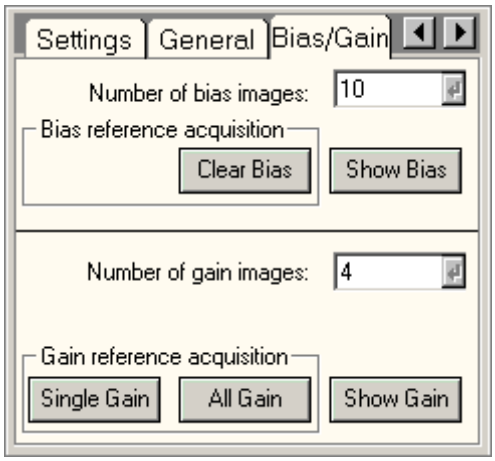


The CCD / TV Camera Bias/Gain Control Panel for DigitalMicrograph.

Clear Bias
Clear Bias removes all bias (dark-current) correction images from DigitalMicrograph memory. Before the next acquisition is done, DigitalMicrograph will re-acquire the bias-correction image.

Gain Acq.
During gain-correction image acquisition, the microscope should be in a suitable condition, with flood-beam illumination of sufficient intensity, spread such that the illumination distribution is flat (typically achieved at lower magnifications). Make sure no specimen is visible on the area covered by the CCD. The beam should be sufficiently intense to avoid excessively long exposure times (set the beam intensity to have the target intensity level in an image recorded at ~1 sec exposure).

15.4.2 TIA CCD



The CCD / TV Camera Bias/Gain Control Panel for TIA CCD.

Number of bias images
Under Number of bias images is defined the number of images that is averaged for the final bias image. Typically an average of 4 is used.

Clear Bias
Pressing Single Bias clears the current bias-correction image for the current acquisition settings.

Show Bias
Show Bias displays the current bias-correction image used.

Number of gain images
Under Number of gain images is defined the number of images that is averaged for the final gain image. Typically an average of 4 is used.

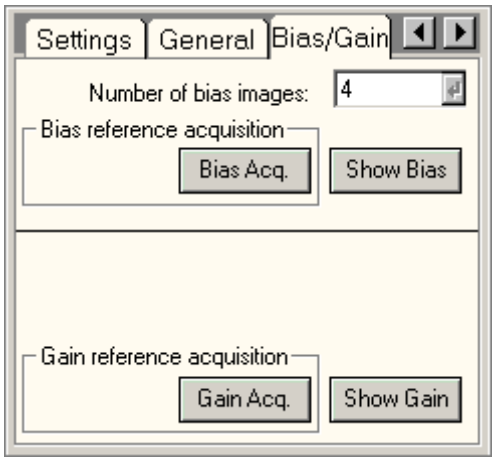
Acquisition of gain images
During gain-correction image acquisition, the microscope should be in a suitable condition, with flood-beam illumination of sufficient intensity, spread such that the illumination distribution is flat (typically achieved at lower magnifications). Make sure no specimen is visible on the area covered by the CCD.

Single Gain
Pressing Single Gain starts acquisition of the gain-correction image for the current acquisition settings (frame size and binning).

All Gain
Pressing All Gain starts the automatic procedure that acquires the gain-correction images for all necessary CCD acquisition settings.

Show Gain
When the Show gain button is pressed, TIA will display the gain image (for inspection).

15.4.3 TIA Video



The CCD / TV Camera Bias/Gain Control Panel for TIA Video.

Number of bias images
Under Number of bias images is defined the number of images that is averaged for the final bias image. Typically an average of 4 is used.

Bias Acq.
Pressing Bias Acq. starts acquisition of the bias-correction image for the current acquisition settings.

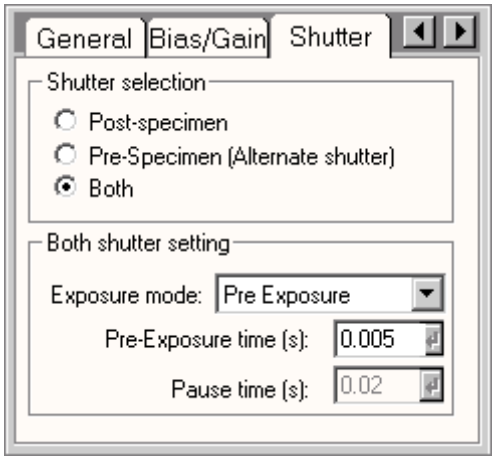
Show Bias
Show Bias displays the current bias-correction image used.

Acquisition of gain images
During gain-correction image acquisition, the microscope should be in a suitable condition, with flood-beam illumination of sufficient intensity, spread such that the illumination distribution is flat (typically achieved at lower magnifications). Make sure no specimen is visible on the area covered by the CCD.

Gain Acq.
Pressing Gain Acq. starts acquisition of the gain-correction image for the current acquisition settings.

Show Gain
When the Show Gain button is pressed, TIA will display the gain image (for inspection).

15.5 CCD / TV Camera Shutter



The CCD / TV Camera Shutter Control Panel.

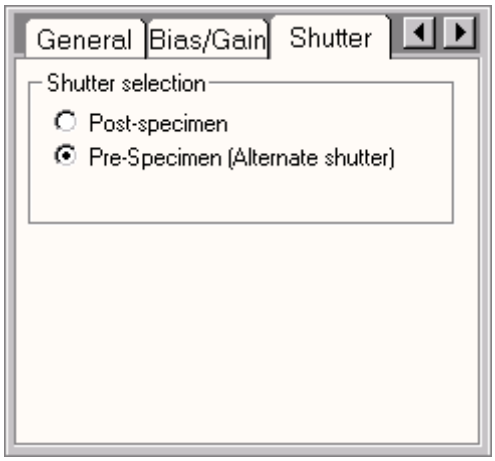
In the CCD / TV Camera Shutter Control Panel the shutter used by the CCD camera during image acquisition is defined. The controls present depend on the controller and type of camera:

- DigitalMicrograph CCD
- TIA CCD

Shutter selection
Under Shutter selection you choose which of the shutters (post- or pre-specimen or both) is used for image acquisition. The post-specimen shutter (usually the shutter located in the projector system of the microscope column) is typically used with specimens that are not sensitive to beam damage. Because the beam remains on the specimen even when no acquisition is taking place, there are no problems with charging-induced drift. The pre-specimen shutter is located in the gun and blanks the beam before the specimen. Options may change depending on the CCD camera present.

Both shutter setting
Some CCD cameras allow manipulation of both shutters simultaneously. In all cases the speed-limiting shutter will be the post-specimen shutter. When using both shutters, there are three possible modes:
Simultaneous - both shutters are used at the same time.
Pre Exposure - the specimen is exposed to the electron beam (pre-specimen shutter opens) for a user-defined time, while the post-specimen shutter prevents the beam from reaching the CCD.
Pre Exposure with Pause - the specimen is exposed to the electron beam (pre-specimen shutter opens) for a user-defined time, while the post-specimen shutter prevents the beam from reaching the CCD. Just before the actual exposure the pre-specimen shutter closes for the user-defined Pause time.

15.5.1 DigitalMicrograph CCD (also TIA CCD using Gatan CCDs)



Note on the use of shutters through DigitalMicrograph
DigitalMicrograph can use one of two shutters for the acquisition of images on the CCD. The standard (post-specimen) shutter is generally the same one as used by the microscope plate camera that is located in the projection system of the microscope (but on an Imaging Filter may be the shutter in the Filter itself). Using this shutter allows normal image acquisition where the beam remains on the specimen all the time. The other shutter blanks the beam in front of the specimen. There are a few things to note about the use of these shutters.
First of all, the identification of these shutters only applies to the outputs on the Gatan camera control unit. If the cables coming from this unit to the microscope are hooked up incorrectly, the naming of these shutters in the software will be incorrect. Therefore, never disconnect the cables from the unit.
Second, DigitalMicrograph uses these shutters for two purposes, to blank then beam during actual image acquisition and to blank the beam while no acquisition is taking place. The setting defined in the Titan control panel is the one used for acquisition. But, as all other acquisition parameters, this setting is decoupled from that in DigitalMicrograph itself (thus the setting in DigitalMicrograph can be one, while the Titan setting can be the other). You cannot define the setting used while no image acquisition is taking place through the Titan control panel. That can only be done in DigitalMicrograph.

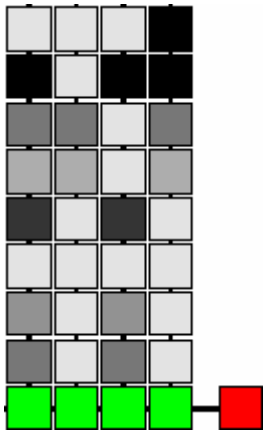
15.5.2 TIA CCD

TIA CCD can control a wide range of CCD cameras:

- Gatan cameras. The control panel will look that for DigitalMicrograph.
- Eagle cameras. These cameras allow use of post- and pre-specimen shutters, alone or combined.

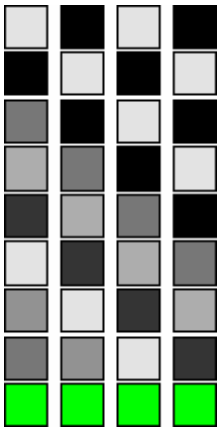
15.6 CCD camera acquisition

A CCD camera (Charge-Coupled Device) is a camera that consists of a two-dimensional array of light-sensitive elements. When struck by light, the elements generate electrons that are stored inside the element until the camera is read-out. On a so-called slow-scan CCD camera an image is acquired by letting the electrons from the beam strike the camera for the full integration time (so an image is acquired in a single cycle; TV-rate CCD cameras also exist). The read out is done by an Analog-to-Digital Converter (ADC) that lies at the end of a special row on one side of the light-sensitive element array. The result is a digital signal (a value) for each element.



Schematic diagram of part of a CCD camera. The green elements are the pixels of the read-out line from where the signal is shifted to the ADC(red), while the gray elements are the image pixels, showing different image intensities.

A CCD camera typically used in the TEM consists of an array of 1024x1024 elements. In one direction these elements are connected by 'wiring'. Through the connections the whole image can be shifted row by row. During read-out the whole array is shifted one row down so the contents of the last row move into the read-out line. The contents of the read-out line are then moved sideways into the ADC where each pixel is read out individually. Then the whole array is shifted down again, and so on.



Schematic diagram of the read-out of a single column of pixels, with the horizontal dimension representing the time axis. The column on the left indicates the initial position. The whole column is then shifted one row down and the lowermost element is shifted into the read-out line from where it is shifted into the ADC. The downward shift is repeated (shown by the columns to the right) until the whole image has been read out.

Because the whole image shifts during read out, the camera must be blanked during the read-out, otherwise image acquisition continues during the image shifting and the image will be blurred in one direction.

In order to be useful for imaging with a CCD, the electrons of the beam are first converted to light. This is done through a scintillator - a material that emits light when struck by electrons. Two types of scintillator are commonly used, single-crystal YAG (Yttrium-Aluminium Garnet) and phosphor. YAG is most commonly used in applications where the electron-conversion ratio should be low (e.g. diffraction in materials science). Phosphor is used in life science applications and at high voltages (300 kV).

In principle a CCD camera could be exposed directly to electrons (instead of using light to generate electrons). In practice this is not done for two reasons, one being that conversion to light is more efficient in generating charge in the elements (each incoming electron results in more than one electron stored - the conversion depending on the type of phosphor and typically being around 1:3 for YAG and 1:15 for phosphor). The other reason is that the high-energy electrons of the beam in the TEM will damage the CCD.

One disadvantage of converting electrons to light first is that the electrons are scattered in the scintillator and part of the light signal from one electron ends up in adjacent pixels instead of the pixel directly

underneath the position where the electron struck. This causes a loss of resolution in CCD cameras so pixels must be sufficiently large to limit the resolution loss to acceptable values (there isn't much point of employing a camera with e.g. 4096x4096 pixels if the resolution of the camera is equivalent to 4x4 pixels; in that case a cheaper and faster 1024x1024 pixel camera with pixels 4x larger is a better option).

15.6.1 CCD camera parameters

Read-out area
The area of the CCD that is read out can have any rectangular shape. Thus it is possible to read out a single line of 1024 pixels, or all 1024x1024 pixels, or 456x123 pixels (or any other set of numbers) anywhere on the CCD. Reading out a subarea of the CCD is faster than reading out the whole CCD. The charge in the pixels not used is simply flushed out and not read. Because it goes by area, read-out of 1/4th of the area of the CCD is about 4x4 = 16 times faster than reading out the whole area. For faster read-out but still good resolution (focusing), a subarea read-out is typically chosen.

Binning
Another method to get a faster read out is binning. In this case the contents of adjacent pixels are added together before being read out. A binning factor of 2 means that 2x2 pixels are taken together, while binning 8 means 8x8 pixels together. The advantage of binning over reading out a subarea is that the whole area of the CCD is seen (the image covers a larger area of the specimen, so it is typically used for searching). The disadvantage of binning is the fact that the exposure time or illumination must be adjusted. Because the pixels are added together before the read-out, the same maximum video level that can be read out before saturation of the camera (say 14-bit or 16384) now applies to the pixels together. So for binning 8 the maximum video level that can be allowed on the camera is 1/64th of that for no binning.

Read-out rate and video levels
The read-out of a CCD array is a (relatively) time-consuming step (individual read outs are fast, but because of the large number of rows to read out it is still time-consuming). The read out can be speeded up in some CCDs, so a higher speed is possible (e.g. the Turbo mode on Gatan CCDs). This goes at the expense of the video levels however. The highest-frequency read out typically has an image depth of 8-bit (256 gray levels which is normally sufficient for viewing), intermediate speeds may be 12-bit (4096 gray levels), while the best (but slowest) read-out typically goes to 14-bit (16384). Because of the gain variation (see below) the maximum usable video level (the highest-intensity pixel) is usually around 14000 for a 14-bit camera.

Dark current
The dark current is a current that is present even when no signal falls onto the CCD camera. The dark current builds up slowly in the camera elements. It is therefore dependent on the integration time. For high-quality imaging the dark current is subtracted from the image as read out. When the same integration time is used, the dark current will remain the same, so the dark current is typically only read out only when the integration time is changed and no 'dark-current image' (an image read out after an integration time in which no signal is allowed to fall on the CCD) is already present (dark-current images are typically kept in memory for the current microscope session). In order to make the dark current reproducible, the CCD camera is always flushed (the image is shifted out of the camera - without actually reading it) one or more times just before a real exposure is made.

The dark current is one main reason for using a slow-scan CCD. Because only a single-readout is made, the dark current contributes only once to the image. Whereas in TV-rate cameras the dark-current contributes to the image in each read-out cycle (tens of times per second) so even if the image is integrated (many read-outs taken together) the image quality is less because of the multiple dark-current contribution.

Gain
There is some variation between different elements in a CCD camera, so if uniform illumination falls on a CCD camera there are still differences in signal intensity between the different pixels. This variation is due to variations in size or effectiveness of the elements (high-frequency variation) and due to the fact that scintillator is not completely homogeneous (low-frequency variation). These variations can be corrected by collecting a gain image (an image taken with uniform illumination and then recalculated to the inverse of the maximum intensity in the image - that is, find the maximum in the image collected and for each pixel divide that value by the actual value of the pixel) and multiplying each image collected with the gain image (multiplication is done rather than division because that is faster on a computer, so the division is done only once, when the gain image is acquired).

Gain images are stored on disk and retrieved automatically by the software. The gain images should be checked and, if necessary, updated on a regular basis. It is easy to judge if it necessary to acquire new gain images. Simply collect an image with no specimen visible (e.g. in a hole) with uniform intensity. If the image only shows noise, the gain images are still good. If features are seen in the image, the gain correction must be updated.

One effect of the application of the gain correction is the appearance of a negative gain correction image when the CCD is saturated (too much beam intensity or integration time too long). If you see features that look like the gain correction image (very often circular bands or a hexagonal chickenwire pattern) and gain correction is on, very likely the camera is saturated. Decrease the integration time or reduce the beam intensity. (The circular bands come from the scintillator; the chickenwire pattern from the fiber-optic coupling between the scintillator and the CCD chip: bundles of optical fibers that ensure a high efficiency of transfer of light from the scintillator to the CCD.)

Blooming
Because the elements of the CCD must be connected in the direction of the columns (otherwise it would be impossible to read out the CCD), charge from one element can overflow into adjacent elements along a column. Along rows this effect is much less because the columns are typically separated by so-called trenches that prevent charge flowing in the row direction.

Blooming is often seen with very high-intensity beams (central beam in a diffraction pattern or the small, focused beams as used during analysis) on the CCD camera, giving a pattern like a very elongated, white ellipse. Avoid this situation as much as possible (the intense beams can leave 'ghost' images that remain visible for a long time unless the cooling of the CCD is switched off). If weak diffraction spots must be recorded, either shift the diffraction pattern so the intense central beam does not hit the CCD camera or collect multiple images with a shorter integration time and add them together to improve the signal-to-noise ratio).

Cooling
In order to reduce the dark current, slow-scan CCDs are typically cooled with a Peltier cooler to temperatures between -20 and -40°C. Because it can take a while for a camera to cool down to its working temperature, it is generally best to keep the cooling on all the time. It may be necessary to switch the cooling off for a while if persistent 'ghost' effects remain visible in the images (easy to check by collecting images with the CCD camera not in the beam or the screen down if the camera is located below it). If the 'ghost' effects cannot be erased by flooding the CCD with a high but uniform intensity, switch the cooling off for several minutes while collecting images with no beam on the camera.

15.7 TV camera acquisition

TV (TV-rate) cameras can be used to acquire TEM images. Because the image quality of TV-rate cameras is at best mediocre, they are most often used for focusing and stigmation of the image before

the actual image is acquired on plate or a slow-scan CCD camera. The big advantage of TV-rate cameras over slow-scan CCD cameras is the high frequency of the image, giving a live image.

TV-rate cameras consist of a device that can detect light. The light is generated by allowing the electrons from the beam to fall on a scintillator that converts electrons to light. Because the light signals from electron images are often weak, many TV-rate cameras have image intensifiers, where the originally weak image is amplified to a usable level.

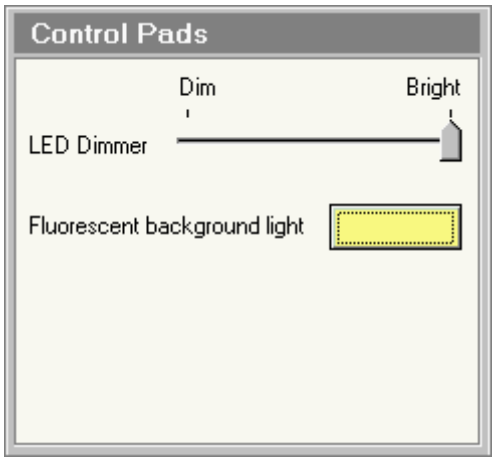
There are two main types of TV-rate cameras, cameras with tubes and CCD cameras. In the tube cameras a beam scans across the area where the image is and puts out a signal that changes when the amount of light changes. CCD (Charge-Coupled Devices) are similar to the slow-scan CCDs except that the image is not digitized. In both tube- and CCD-cameras the signal is put out continuously and normally fed into a monitor that scans with the same frequency as the camera itself. The frequency and the number of lines per frame and pixels per line depends on the (electricity) mains cycle. For 50 Hertz there are 512x480 (PAL) while for 60 Hertz there are fewer lines and pixels (NTSC).

On the microscope TV-rate camera signals can be fed into stand-alone monitors. The signal can also be fed into a frame-grabber board in the PC and then read out through TIA and displayed on the monitor of the TEM microscope. In the latter case images can also be acquired and stored to disk.

16 Control Pad Lighting

The left-hand and right-hand pads have background lighting available to make it easier to locate the controls on the pads when working in the dark. The lighting of both pads can be switched on and off. The LED Dimmer has no function on the Titan microscope (the hardware it refers to - the System On/Off Panel - only exists on Tecnai microscopes).
To switch the lighting on or off, click on the control panel list (None) in the lower bottom right of the screen (in normal status display).

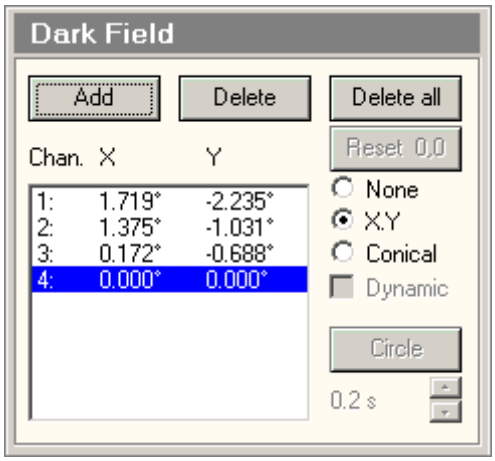
Select the item listed as 'Control Pads'. The following control panel will pop up.



The Control Pad Lighting Control Panel.

Press the button to switch background lighting on (button becomes yellow).

17 Dark Field



The Dark Field Control Panel.

The Dark Field Control Panel allows control of dark-field imaging. The beam tilts are set with the Multifunction-X,Y knobs.

Channel
An unlimited number of dark-field tilt settings can be stored. Each setting is stored in a channel. If the list of channels has the 'input focus' (is the last Windows control clicked), you can change the channel with the Left or Up arrows of the keyboard. You can also select a channel from the list (the channel becomes highlighted) by clicking on one.

Add
Adds a channel to the list. The new value will be equal to the currently active tilt setting.

Delete
Deletes the currently active channel from the list.

Delete all
Clears the whole list of stored dark-field tilt settings.

Reset 0,0
Resets the currently active (highlighted) channel to 0,0 tilt (that is, no beam tilt).

None
Switch Dark Field off (the equivalent of pressing the Dark Field button on the right-hand control pad).

XY
Tilt the beam in X-Y mode, where a beam tilt in one direction (X) is set with the Multifunction-X knob and the tilt in the perpendicular direction is set with the Multifunction-Y knob.

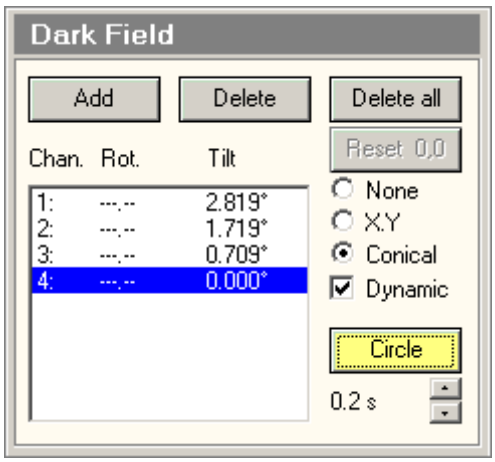
Conical
Tilt the beam in conical mode, where a tilt angle is set with the Multifunction-Y knob while turning the Multifunction-X changes the azimuth angle of the tilted beam.

17.1 Dynamic conical dark field

On STEM systems, it is possible to have the microscope drive the beam around in conical dark field (dynamic conical dark field or hollow-cone illumination).

Note: For dynamic conical dark field the AC (STEM) beam deflection coils are used instead of the DC (TEM) beam deflection coils (because it is not possible to control the DC coils with an external signal). This has a number of consequences:

- **TIA (TEM Imaging & Analysis) must be running** because this is the software that drives the beam in a circle.
- The pivot points and other adjustments like calibrations are independent of those of the DC coils used for static dark field and must be set separately.
- The switch between static and dynamic conical dark field means switching between the DC and AC coils. The software will keep the tilt angle as much as possible identical but differences may occur.
- The maximum tilt angle in static conical dark field is quite a bit larger than for dynamic conical dark field.
- Dynamic conical dark field is not supported (no alignment possibilities) in LM (since the dark-field tilt angles there are so small that there is no point is supporting dynamic conical dark field).



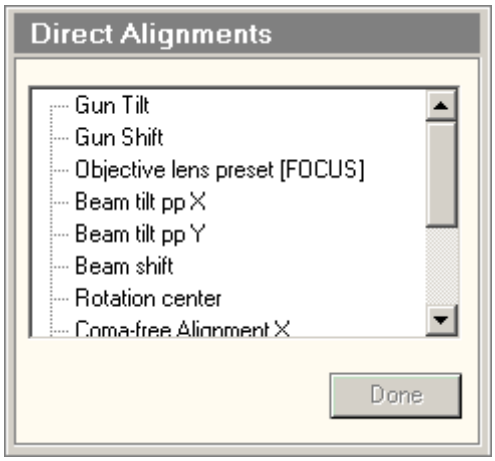
To switch to dynamic conical dark field, first go to static conical dark field (press the Conical radio button). Check the Dynamic checkbox. The system will now have switched from DC to AC coils. Press Circle to start and stop movement.

Dynamic
Switches the microscope from DC to AC (when checked) and back.

Circle
Press Circle to start and stop movement.

Speed
Defines the speed with which the beam drives around in a circle.

18 Direct Alignments



The Direct alignments Control Panel.

The Direct Alignments Control Panel offers access to the microscope's direct alignments. In addition to the alignment procedures where the operator is taken through a set of alignments in a structured way, the TEM microscope provides (rapid) access to a restricted set of direct alignments. In contrast with the procedures, direct alignments do not switch the microscope to predefined states but instead are applicable to the current microscope state. The direct alignments are shown in a list. Which alignments are available depends on the microscope mode.
Alignments are stored immediately when Done is pressed or the Direct Alignments control panel is closed (e.g. by going to another tab). Note that the storage is not into a file. For storing into a file you will need to go to the File tab of the Alignment Control Panel.
Alignments can be stored to files and wholly or in part restored to the microscope. Alignments for all users are located together and listed in the list of available alignments. The controls for saving and restoring alignments are found in the Alignment File Control Panel.

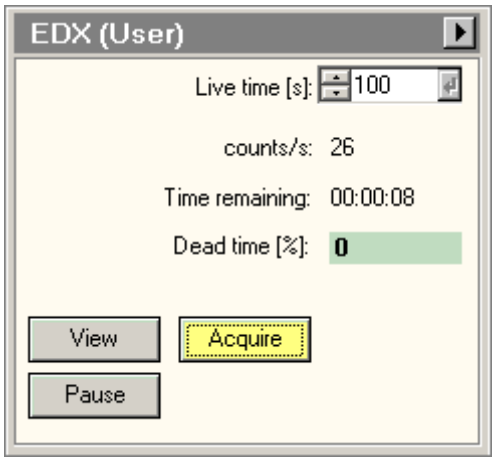
A few rules:

- You do not change any alignment by activating it. Only when you change a setting with the Multifunction knobs, do you change alignments. Changes become operational immediately. They are stored when the alignment is exited (Done).
- Direct alignments may differ depending on the level of user, with experts and supervisor levels having more alignments accessible than users.
- All direct alignments have on-line help pages that describe the purpose and operation of the particular alignment. Press F1 while a direct alignment is active and the proper page should come up.
- You can move to another control panel as long as you stay within the current tab (you can also pop-up panels on the lower right), but if you move to another tab, then the alignment is exited.

Direct alignment selection
Selection is done in the list of alignments. Click on a direct alignment to activate it.

Done
Switches alignment off.

19 EDX



The EDX Control Panel.

In the EDX Control Panel the controls for (single) EDX spectrum acquisition are located.

Note: TIA must be running. If it is not running, the buttons are disabled.

Live time
The Live time sets the acquisition time for the currently active acquisition mode (View, Acquire).

Count/s
During acquisition the count rate (in counts per second) is displayed.

Time remaining
During acquisition the time remaining before acquisition is finished is displayed.

Dead time
During acquisition the detector dead time is displayed. At high dead times the background of the label becomes red, otherwise it is green.

View
Pressing the View button:
- When the button is gray, switches the EDX acquisition settings to those of the View mode and starts acquisition.
- When the button is yellow, pauses EDX acquisition.
- When the button is white, resumes EDX acquisition (but starting with a new spectrum) if possible. If the start command could not be given to TIA, the button will remain white.

By definition View is continuous acquisition.

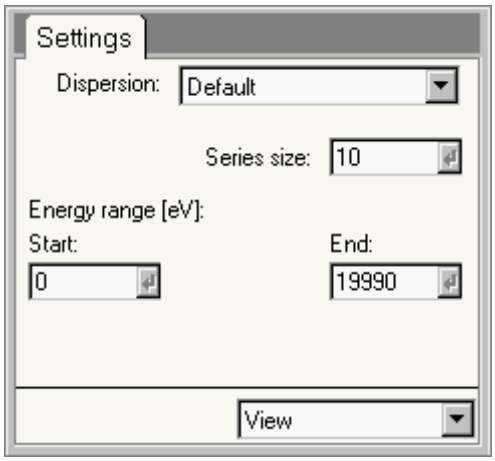
Acquire
Pressing the Acquire button:
- When the button is gray, switches the EDX acquisition settings to those of the Acquire mode and starts acquisition.
- When the button is yellow, stops EDX acquisition.
- When the button is white, resumes EDX acquisition (but starting with a new spectrum) if possible. If the start command could not be given to TIA, the button will remain white.

By definition Acquire is single acquisition.

Pause
The EDX acquisition can be paused and continued by pressing the Pause button.

Flap-out
Pressing the arrow button displays the flap-out with the EDX Settings Control Panel.

19.1 EDX settings



The EDX Settings Control Panel.

In the EDX Settings Control Panel the EDX acquisition parameters are defined.

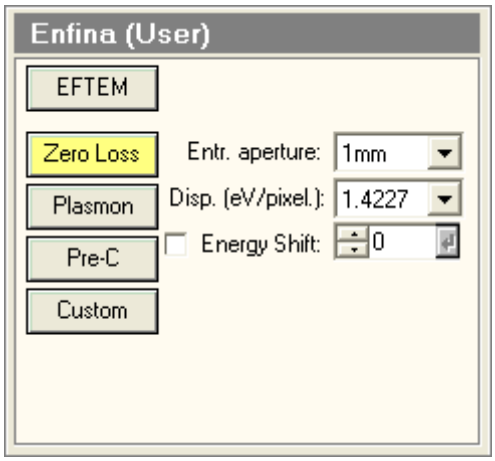
Dispersion
The drop-down list contains the accessible dispersion settings for the EDX detector (depend on the type of EDX detector present). This list corresponds to the list of the More EDX Dispersions tab in TIA.

Series size
Under series size the size of the acquisition series for the currently active acquisition mode is set.

Energy range
The Start and End values define the start and end energy (in electronvolt) of the spectrum.

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and by pressing the equivalent button in the main control panel is that the drop-list selection selects the mode but does not automatically start acquisition.

20 Enfina (User)



The Enfina Control Panel.

The Enfina Control Panel contains a number of controls for the Gatan Enfina Spectrometer. Most controls can only be used when the Gatan software is running (i.e. DigitalMicrograph and FilterControl). Spectroscopy is typically carried out when the microscope is in the normal (non-EFTEM) diffraction mode. Using the EFTEM mode allows the use of slightly lower camera lengths. Note, however, that you have to compensate the displayed camera length by the demagnification applied for the Imaging Filter (~15x). So a camera length of 200 mm as displayed typically is ~15 mm. Camera lengths below ~200 mm (displayed) usually cannot be used because the alignments have insufficient range. For background information on EFTEM, see the description of the Energy-Filtered TEM (EFTEM) mode.

EFTEM
The EFTEM button controls the microscope status:

- EFTEM off : the button will be gray, the screen will be down, and the magnification series will be the normal series
- EFTEM on : the button will be yellow, the screen will be up, and the magnification series will be the special EFTEM series

Zero Loss
When the Zero Loss button is pressed, the Spectrometer goes to Zero-Loss mode (zero-loss peak is centered). By definition the Energy Loss value is 0, however the energy offset control is still enabled – this allows advanced users to make small adjustments, e.g. for drift compensation.

Entrance aperture
The Enfina has a number of entrance apertures. Select the required entrance aperture from the drop-down list.

Plasmon
When the Plasmon button is pressed, the spectrometer goes to Plasmon mode (the plasmon energy selected is centered).

Dispersion (eV/pixel)
The dispersion in spectroscopy (the energy width per pixel) is selected via the drop-list box.

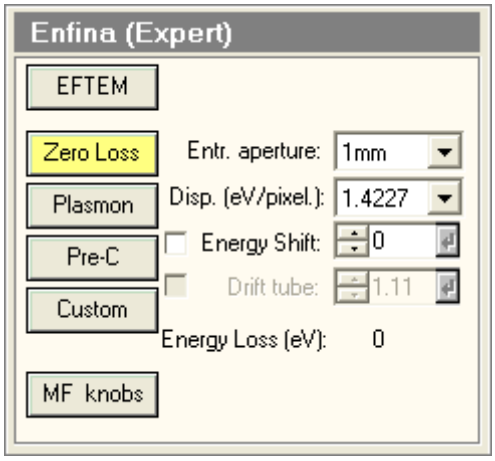
Pre-C
When the Pre-C button is pressed, the spectrometer goes to Pre-C mode (the Pre-C, pre-carbon, energy selected is centered).

Custom
When the Custom button is pressed, the spectrometer goes to Custom mode (the custom energy selected is centered).

Energy shift
You can change the energy of the spectrum with the Energy shift.

Note: the Gatan FilterControl program uses different names from those just listed. Energy Shift is displayed in FilterControl as ‘Magnetic’ (same sign).

21 Enfina (Expert)



The Enfina Control Panel.

The Enfina Control Panel contains a number of controls for the Gatan Enfina Spectrometer. Most controls can only be used when the Gatan software is running (i.e. DigitalMicrograph and FilterControl). Spectroscopy is typically carried out when the microscope is in the normal (non-EFTEM) diffraction mode. Using the EFTEM mode allows the use of slightly lower camera lengths. Note, however, that you have to compensate the displayed camera length by the demagnification applied for the Imaging Filter (~15x). So a camera length of 200 mm as displayed typically is ~15 mm. Camera lengths below ~200 mm (displayed) usually cannot be used because the alignments have insufficient range. For background information on EFTEM, see the description of the Energy-Filtered TEM (EFTEM) mode.

EFTEM
The EFTEM button controls the microscope status:

- EFTEM off : the button will be gray, the screen will be down, and the magnification series will be the normal series
- EFTEM on : the button will be yellow, the screen will be up, and the magnification series will be the special EFTEM series

Zero Loss
When the Zero Loss button is pressed, the Spectrometer goes to Zero-Loss mode (zero-loss peak is centered). By definition the Energy Loss value is 0, however the energy offset control is still enabled – this allows advanced users to make small adjustments, e.g. for drift compensation.

Entrance aperture
The Enfina has a number of entrance apertures. Select the required entrance aperture from the drop-down list.

Plasmon
When the Plasmon button is pressed, the spectrometer goes to Plasmon mode (the plasmon energy selected is centered).

Dispersion (eV/pixel)
The dispersion in spectroscopy (the energy width per pixel) is selected via the drop-list box.

Pre-C
When the Pre-C button is pressed, the spectrometer goes to Pre-C mode (the Pre-C, pre-carbon, energy selected is centered).

Custom
When the Custom button is pressed, the spectrometer goes to Custom mode (the custom energy selected is centered).

Energy shift, Drift tube, Energy Loss
There are two ways to change the energy of the spectrum:
- With the current of the energy-loss prism in the spectrometer - called Energy shift.
- With the electrostatic drift tube of the spectrometer - called Drift tube.

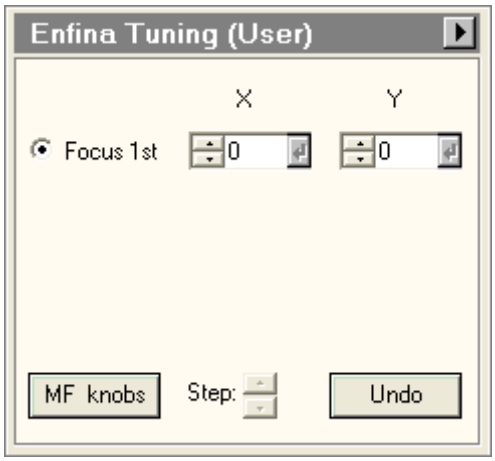
The Energy Loss value given is the sum of the Energy Shift and Drift Tube.

Note: the Gatan FilterControl program uses different names from those just listed. Energy Shift is displayed in FilterControl as ‘Magnetic’ (same sign), and Drift Tube is displayed as both ‘Voltage’ and ‘Drift Tube’ (both same sign).

When properly calibrated, the drift tube is easy to use and accurate, without significant hysteresis. For higher energy changes, the prism current is used (possibly in combination with the drift tube).

MF knobs
The multifunction knobs can be used to control the Drift Tube (MF-X) and the Energy Shift (MF-Y).

22 Enfina Tuning (User)



The Enfina Tuning Control Panel.

The Enfina Tuning Control Panel contains a control for focusing the Enfina spectrometer.

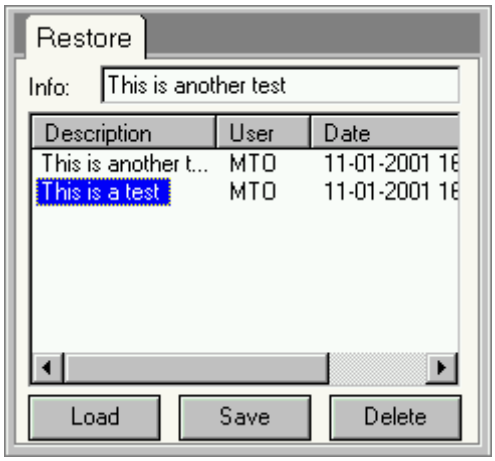
Focus 1st
The controls for the 1st order achromaticity correction are accessed under Focus 1st X and Y. The MF knobs can be connected to these controls (the MF knobs button will be yellow). The controls themselves are standard spin-edit-enter controls.

MF knobs
The Multifunction knobs can be used the change the settings of the Focus 1st. To connect the Multifunction knobs to it, press the MF knobs button (it will become yellow). You can change the sensitivity of the MF knobs with the MF - and + buttons or with the spin buttons in the control panel.

Undo
Pressing the Undo button restores the Focus 1st setting (when it is under control of the Multifunction knobs) to the value it had when the Multifunction knobs were coupled to that particular setting (it doesn't step back through the changes you made, it goes directly to the original setting).

Flap-out button
The flap-out button leads to the Enfina Tuning Restore Control Panel.

22.1 Enfina Tuning Restore



The Enfina Tuning Restore Control Panel.

The Enfina Tuning Restore Control Panel allows the loading and saving of Enfina spectrometer settings set via the Enfina Tuning control panel. With the settings are stored a comment (entered under Info), the username of the user (the name under which you or another was logged on) and the date and time. All settings are accessible to all users and stored in a single file.

Info
The Info entered by the user is included with the file and allows the user to store a comment with the settings.

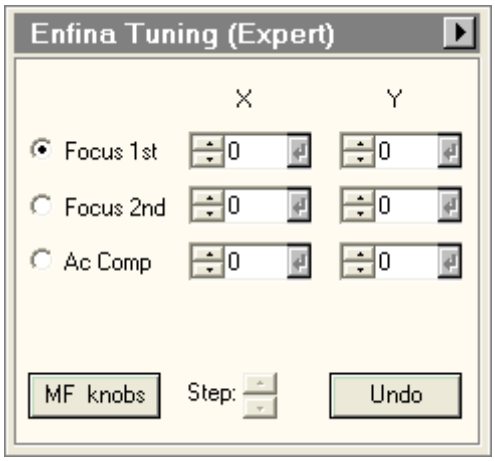
List
The list contains an overview of the files with settings available, sorted according to the alphabetical order of the description, username or date/time. You can change the sorting by clicking on the buttons at the top of the list (Description, User, ...). Clicking again reverses the order.

Load
When the Load button is pressed, the settings currently selected in the list are loaded and sent to the Imaging Filter.

Save
When the Save button is pressed, the currently active settings are stored.

Delete
When the Delete button is pressed, the currently selected setting is deleted. Note that there is no protection against deleting other users' settings.

23 Enfina Tuning (Expert)



The Enfina Tuning Control Panel.

The Enfina Tuning Control Panel contains a number of controls for tuning the Enfina spectrometer.

Focus 1st
The controls for the 1st order achromaticity correction are accessed under Focus 1st X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls.

Focus 2nd
The controls for the 2nd order achromaticity correction are accessed under Focus 2nd X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls.

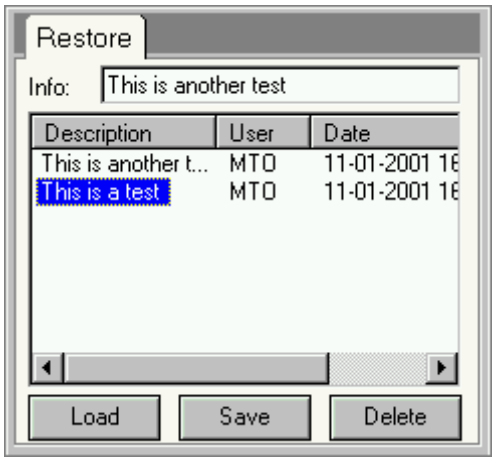
Ac Comp
The Ac compensation controls define the Ac (stray field) compensation for the Enfina spectrometer. The compensation applies a 50 or 60 Hz (dependent on the local situation) frequency in two perpendicular directions, thereby compensating a stray field in the opposite direction. The controls for it are accessed under Ac Comp X and Y. When the radio button is checked, the MF knobs are connected to these controls (when the MF knobs button is yellow). The controls themselves are standard spin-edit-enter controls.

MF knobs
The Multifunction knobs can be used the change the settings of the four spectrometer elements described above. To connect the Multifunction knobs to one of the functions, select the particular functions through its radio button and press the MF knobs button (it will become yellow). You can change the sensitivity of the MF knobs with the MF - and + buttons or with the spin buttons in the control panel.

Undo
Pressing the Undo button restores the setting currently under control of the Multifunction knobs to the value it had when the Multifunction knobs were coupled to that particular setting (it doesn't step back through the changes you made, it goes directly to the original setting).

Flap-out button
The flap-out button leads to the Enfina Tuning Restore Control Panel.

23.1 Enfina Tuning Restore



The Enfina Tuning Restore Control Panel.

The Enfina Tuning Restore Control Panel allows the loading and saving of Enfina spectrometer settings set via the Enfina Tuning control panel. With the settings are stored a comment (entered under Info), the username of the user (the name under which you or another was logged on) and the date and time. All settings are accessible to all users and stored in a single file

Info
The Info entered by the user is included with the file and allows the user to store a comment with the settings.

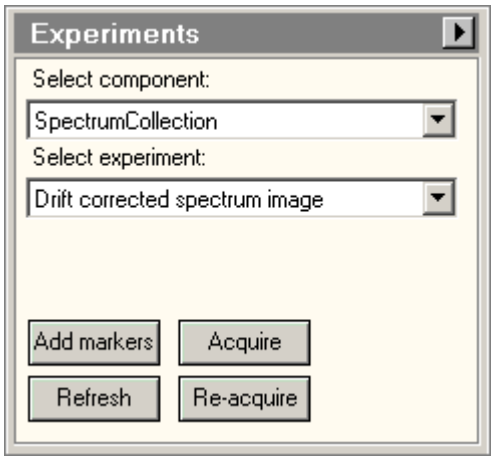
List
The list contains an overview of the files with settings available, sorted according to the alphabetical order of the description, username or date/time. You can change the sorting by clicking on the buttons at the top of the list (Description, User, ...). Clicking again reverses the order.

Load
When the Load button is pressed, the settings currently selected in the list are loaded and sent to the Imaging Filter.

Save
When the Save button is pressed, the currently active settings are stored.

Delete
When the Delete button is pressed, the currently selected setting is deleted. Note that there is no protection against deleting other users' settings.

24 Experiments



The Experiments Control Panel.

In the Experiments Control Panel several types of experiments are controlled. For the tomography experiments, please see the tomography documentation. This section deals with the spectrum collection experiments.

The spectrum collection experiments are based on a STEM image. In the STEM image you define lines or areas where you can collected various types of data, depending on the types of hardware present. For each of the experiments, you define which settings and detectors to use in the Settings flap-out of the control panel.

Components
The drop-down list allows selection of a type of experiment component (spectrum or CCD diffraction-pattern acquisition).

Experiments
The drop-down list allows selection of a type of experiment.

Add markers
To make sure the proper markers are present in the STEM image, you press the Add markers button. This will have the following effects:

- If the proper markers are already present (recognized on the basis of marker style or name), nothing will happen. The one exception is in the case of a "Spectrum positions" or "Drift-corrected spectrum positions" experiment. Pressing Add markers will always add a new spectrum position marker to the image (the drift correction area marker will only be added once, if necessary).
- If one or more required markers are not found, new markers will be added to the image.
- If markers were present and recognized as such but originally had the wrong name or style, the name and style of the markers will be changed.

Acquire
Pressing the Acquire button :

- When the button is gray, start the experiment acquisition.
- When the button is yellow, stops the experiment acquisition.
- When Acquire is used and the current display window had already been used before for experiment acquisition and "Reuse display window" is not checked, a copy is made of the current display window and the acquisition is done in the copy.

Refresh
Pressing the Refresh button restarts acquisition of the main STEM image (using the conditions defined for the currently active mode in the STEM Imaging control panel; thus it can happen that you used Acquire for the image initially, but if in the meantime you used Search, the Search conditions - but single

frame) will be used). This function allows a refresh of the STEM image so you can check that all markers are still in their correct positions before really starting the experiment.

ReAcquire
Pressing the ReAcquire button :
- When the button is gray, start the experiment acquisition.
- When the button is yellow, stops the experiment acquisition.
- When ReAcquire is used the acquisition is done in the current display window (thus overwriting what had been acquired before).

Flap-out button
Pressing the flap-out button leads to the flap-out with the Settings, and Loader control panels.

24.1 Experiment behavior - Reuse display window or not

The behavior of the spectrum collection experiments depends on the way you handle the actual acquisition. The two extreme cases are:
Each new experiment is recorded in a completely new display window (tabs in TIA). Acquiring another one means that the last experiment display window is copied and the new acquisition is done in that copy. For this case, use the Acquire function in the control panel.
Each new experiment is recorded always in the same display window. No new display windows are created. For this case, use the Refresh and ReAcquire functions.

24.2 Using existing display windows as a template

You can use existing display windows (e.g. saved and re-opened) as a template for acquiring experiment data. Make sure that the template and current experiment selection match, and with the template display window selected use the Refresh function to re-acquire the STEM image, reposition the required markers and then either Acquire or ReAcquire.

24.3 Available experiments

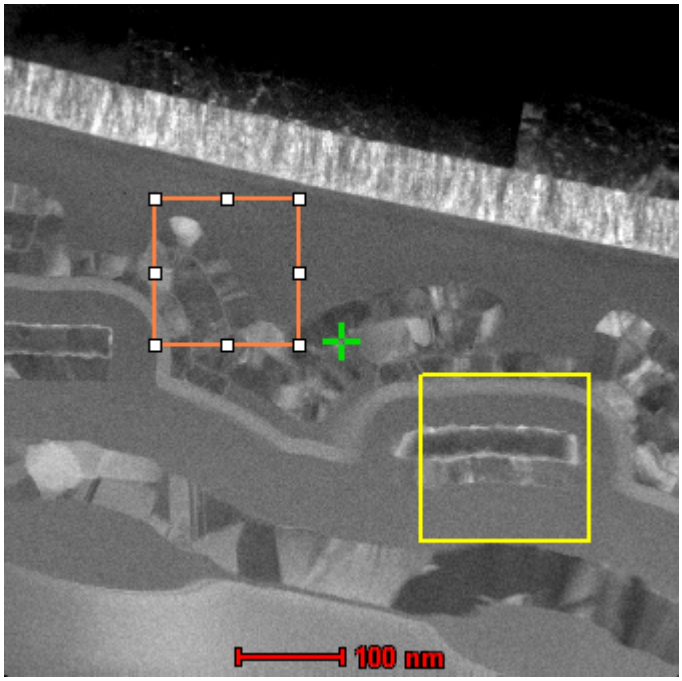
Currently the experiments cover :
- Spectrum positions - acquire the chosen signals for the positions defined in the STEM image by beam-position markers .
- Spectrum profile - acquire the chosen signals for a user-defined number of positions along a line marker in the STEM image.
- Spectrum image - acquire the chosen signals for a user-defined number of X, Y positions in an image-selection marker in the STEM image.
- Drift-corrected spectrum time series - acquire a series of chosen signals for the position
- Drift-corrected spectrum positions - acquire the chosen signals for the positions defined in the STEM image by beam-position markers with drift correction at user-defined intervals. If more than one beam-position marker is present in the image, the last one visited is kept and the other ones removed.
- Drift-corrected spectrum profile - acquire the chosen signals for a user-defined number of positions along a line marker in the STEM image with drift correction at user-defined intervals.
- Drift-corrected spectrum image - acquire the chosen signals for a user-defined number of X, Y positions in an image-selection marker in the STEM image with drift correction at user-defined intervals.

Note: Before an experiment can be started, you must at least once have acquired a STEM image. When you select a profile or image experiment, the required markers will automatically be placed in the STEM image if they are absent.

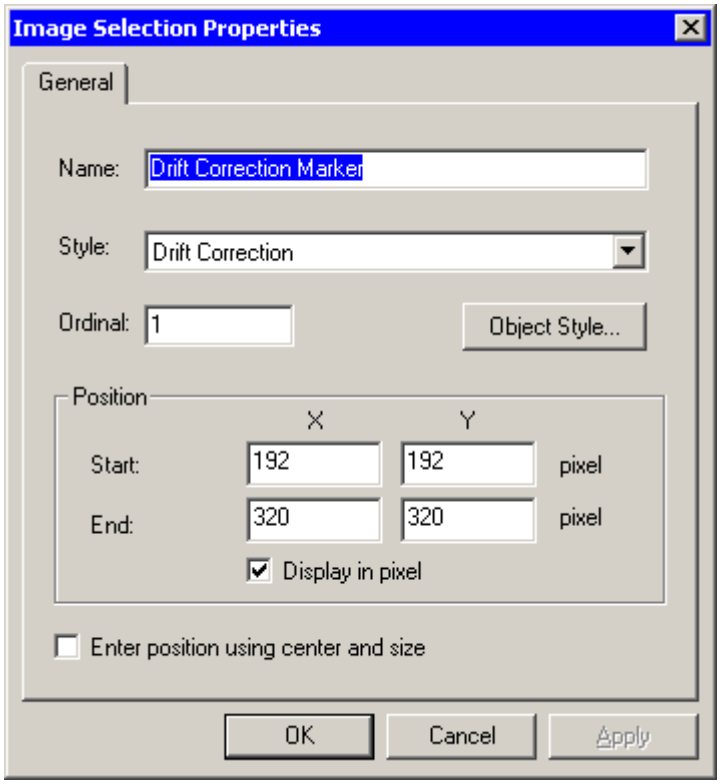
24.4 Drift correction

For drift correction the experiment will repeatedly acquire a STEM image and measure the shift relative to a similar image acquired at the start of the experiment. Any shift detected is compensated (with the scan signal, not the DC beam shift). The compensation is limited to the area covered by the starting image (STEM magnification). If high drift is encountered, reduce the STEM magnification, if possible, to have the STEM range cover a larger area.

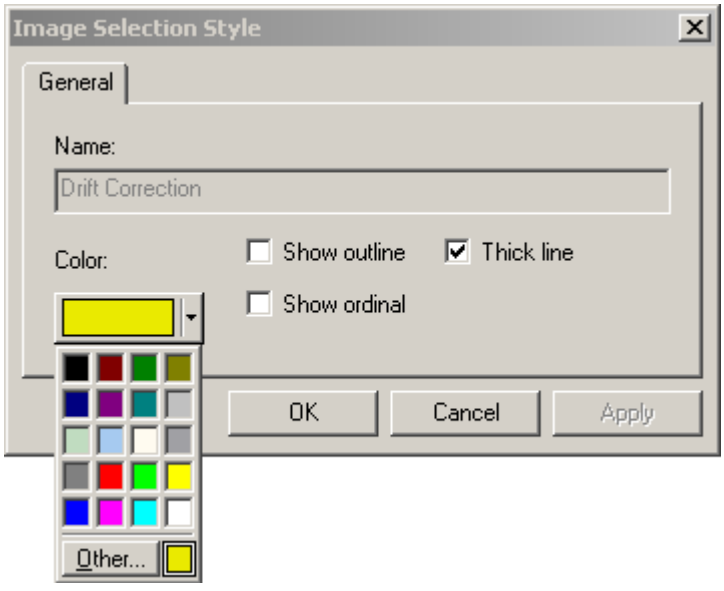
In order to make it easy to recognize the markers, they will be given different styles (in previous versions the markers were always the default style, typically thin red). In the current version the data positions are distinguished by a thick orange style (e.g. the data collection are in the image below is inside the orange box), while the drift correction area typically is distinguished by a thick yellow style.



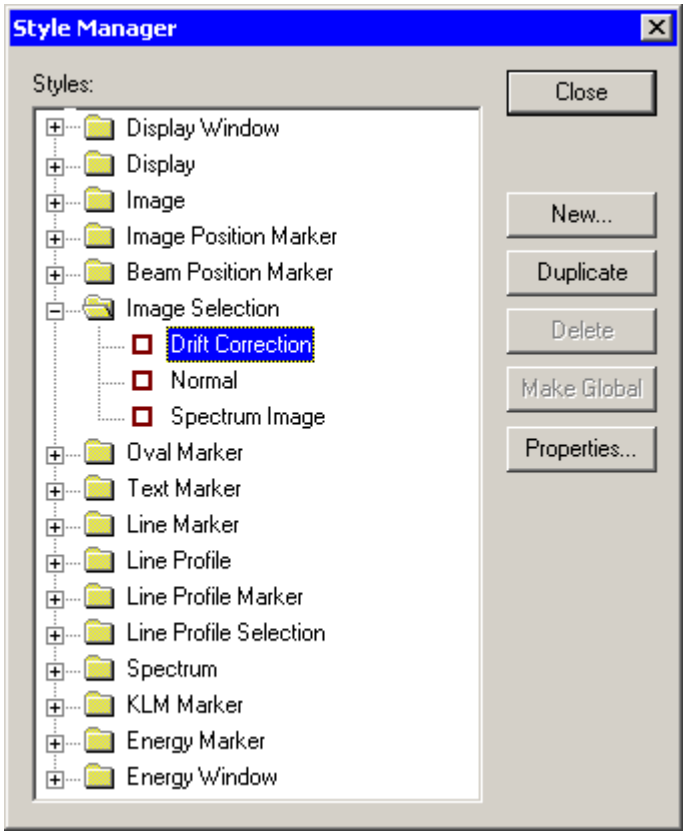
The markers also have distinctive names, but this is not essential. E.g. if you add markers manually and you give them the required style, TIA will recognize them. Also, if you change the names according to the default, TIA will also recognize them.



If you do not like the style of the markers (e.g. in the image you typically have, the colors chosen are not well visible), you can change the style of the markers. If you go through Object Style, only the properties of the selected marker will be changed.



If you want to change the style of the markers persistently, go to TIA Analysis mode and in the menu select Edit, Styles. Find the required type of the marker in the dialog and select the marker style. Through Properties you can adjust the style.

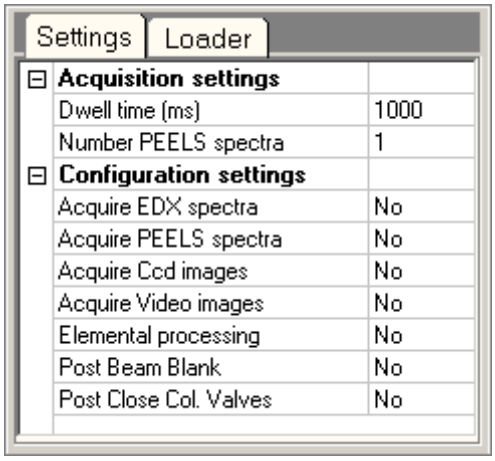


Note: Spectrum position experiments with drift correction will move the beam back to the 1st marker when it performs the cross-correlation to determine drift. This could damage your specimen at the 1st marker position when your specimen is beam sensitive. To avoid this, put the 1st marker at a position which is less important.
For non-position (line, area) experiments: Use a beam position marker to define the rest position.

For additional information, please also refer to:

- TIA basics (chapter **Error! Reference source not found.**)
- TIA STEM image acquisition (chapter **Error! Reference source not found.**)
- TIA EDX spectrum acquisition (chapter **Error! Reference source not found.**)
- TIA EELS spectrum acquisition (chapter **Error! Reference source not found.**)
- TIA CCD image acquisition (chapter **Error! Reference source not found.**)

24.5 Experiments Settings



The Experiments Settings Control Panel.

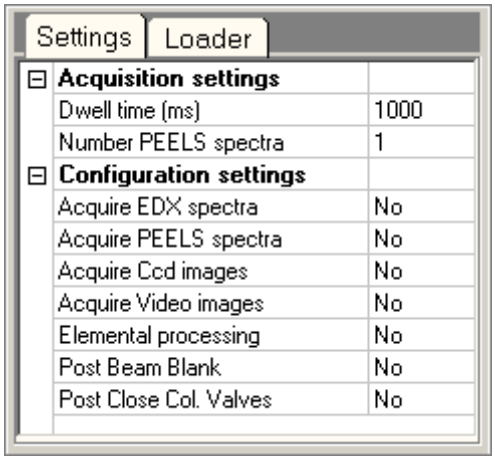
In the Experiments Settings Control Panel the acquisition parameters for the experiment are defined. The settings are displayed in a so-called property editor. This is a two-column grid, listing the setting on the left-hand side and its value on the right-hand side. You can change the settings by clicking on the value. Sometimes you have to type in a number or other setting. In the case where a limited selection is possible (for example with Yes or No) a small down arrow on the right-side allows selection of the one of the possibilities. Setting changes are updated as soon as you move to another setting value (e.g. by pressing the down or up arrow). Settings are grouped under headers (like Acquisition settings). You can open or close a group by clicking on the + or - sign to the left of the group name. Settings that are grayed out are disabled under the current combination of settings selected.

There are three categories of settings:

- Acquisition settings, which differ for spectrum positions, line profiles and images.
- Configuration settings.
- Correction settings.

24.5.1 Acquisition settings

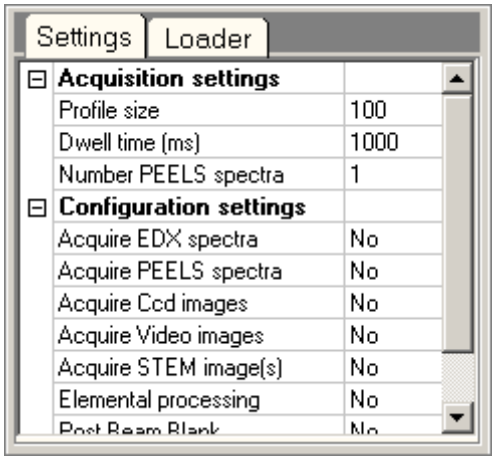
24.5.1.1 Spectrum position acquisition settings



Dwell time
The amount of time in milliseconds used to collect the signal(s) at each point.

Number of PEELS spectra
How many spectra are to be acquired within the dwell time set (these spectra are added together).

24.5.1.2 Spectrum profile acquisition settings

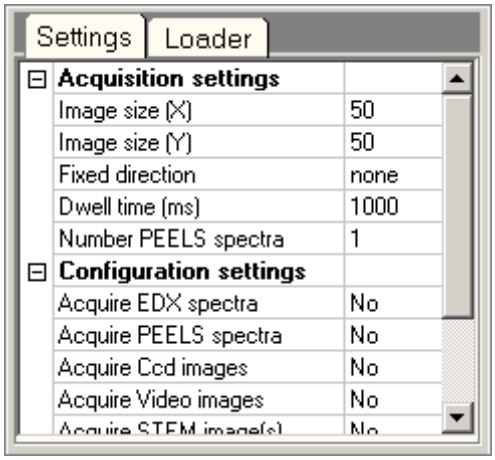


Profile size
The number of points along the profile line.

Dwell time
The amount of time in milliseconds used to collect the signal(s) at each point.

Number of PEELS spectra
How many spectra are to be acquired within the dwell time set (these spectra are added together).

24.5.1.3 Spectrum image acquisition settings



Note: The spacing between the acquisition positions is identical in both (X and Y) directions.

Image size X
The number of points in the image in the horizontal direction.

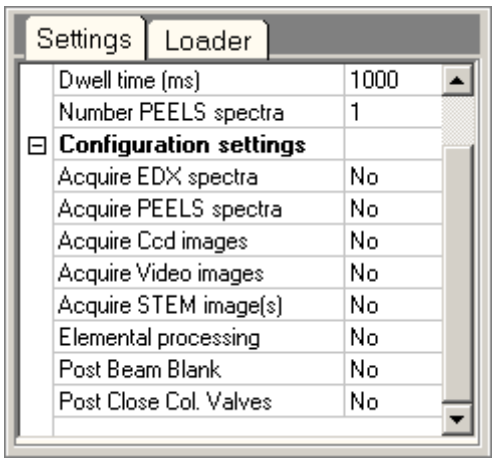
Image size Y
The number of points in the image in the vertical direction.

Fixed direction
X, Y or none. If either X or Y is chosen, that direction is made the same as the other (so the image automatically stays square). In case of one, the image selection marker size is adjusted to reflect the X and Y dimensions whenever you change a dimension in the control panel (there is no feedback from the marker back into the control panel).

Dwell time
The amount of time in milliseconds used to collect the signal(s) at each point.

Number of PEELS spectra
How many spectra are to be acquired within the dwell time set (these spectra are added together).

24.5.2 Configuration settings



Note: Some acquisition settings are mutually exclusive because they make use of detectors that are located at different physical locations, where one detector (e.g. a CCD) blocks the view of the other (e.g. PEELS) or a detector is used for more than one type of data and only one can be selected at a time (e.g. an Imaging Filter CCD to acquire diffraction patterns as well as PEELS spectra). Excluded detectors are shown disabled (grayed).

Acquire ... spectra, images
For each of the available detectors, select Yes or No. Remember that CCD image acquisition means you are recording diffraction patterns. Also be aware that CCD images contain a lot of data and that large CCD image sizes (as defined in the CCD/TV control panel for the Acquire mode) for a large number of point may exceed TIA's capacity to handle them.

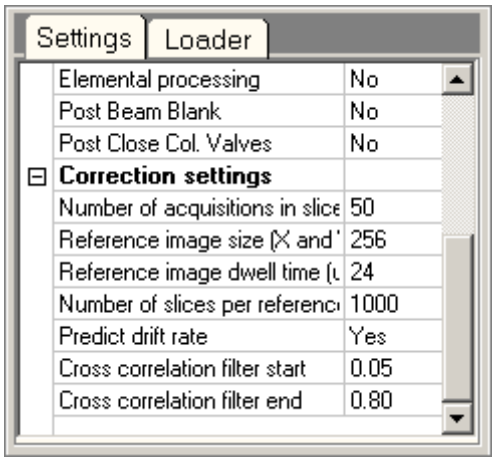
Note: Depending on the the number of detectors selected as well as any processing active during acquisition, it may happen that TIA cannot keep up with acquisition and processing at the same time. In that case acquisition may become unreliable (the beam doesn't move any more after moving a few pixels along a scan line - you can observe this because e.g. the spectrum or STEM image signal remains the same except for some noise variation, or by going out of diffraction and observing the movement of the beam on the fluorescent screen or flu cam). Either increase the dwell time so TIA has more time or remove some of the processing or signals (e.g. STEM detector).

Elemental processing
When Yes is selected, elemental processing based on energy windows in EDX or EELS spectra will be done. See the note above.

Post Beam Blank
When Yes is selected, the beam will be blanked when the experiment has finished. You can use this function to safeguard the specimen integrity (the beam will no longer be on the specimen) after a time-consuming experiment run unattended or overnight.

Post Close Col. Valves
When Yes is selected, the microscope's column valves are closed when the experiment has finished. You can use this function to safeguard the microscope and specimen integrity after a time-consuming experiment run unattended or overnight.

24.5.3 Correction settings



Number of acquisitions in slice
A slice is the period between successive checks of the drift, so the number of acquisitions in the slice is the number of data acquisitions done before a new drift check is done.

Reference image size
The size in pixels of the reference image.

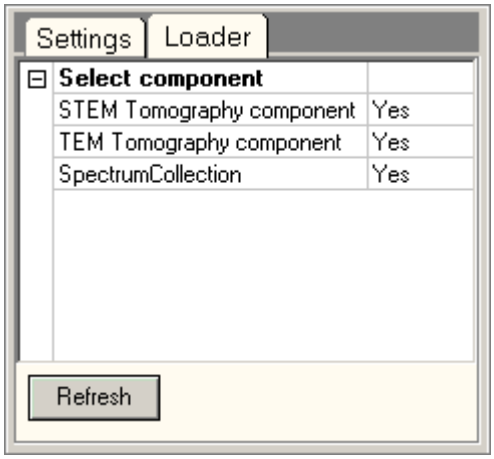
Reference image dwell time
The dwell time in microseconds used for (STEM) acquisition of the reference image.

Number of slices per reference
The slices per reference parameter defines the number of drift correction measurement cycles after which the drift correction data base is reset (it is always reset as well at the start of an experiment).

Predict drift rate
When the Predict drift rate is selected, the drift correction will apply a drift correction to individual spectra within a drift correction slice on the basis of the historically measured drift rate (otherwise the drift correction is applied once per slice).

Cross-correlation filter
The start and end parameters of the cross-correlation filter define two settings used to filter the drift-correction images. The filtering is used to make drift measurement more reliable. The filter is a band-pass filter that removes the low and high frequencies from the image. Cutting off the low frequencies is important because they do not contribute to accurate drift measurements (the distances they represent are too large) and they can lead to erroneous cross-correlation peak measurements. The high frequencies are generally dominated by noise and thus only cause imprecision in the drift measurement. In general the settings are only important for noisy images, where some adjustment may be necessary for drift measurement to work. If (in exceptional cases) there is only low-frequency contrast (e.g. only a single grain boundary visible), it may be necessary to adjust the Start parameter down.

24.6 Experiments Loader



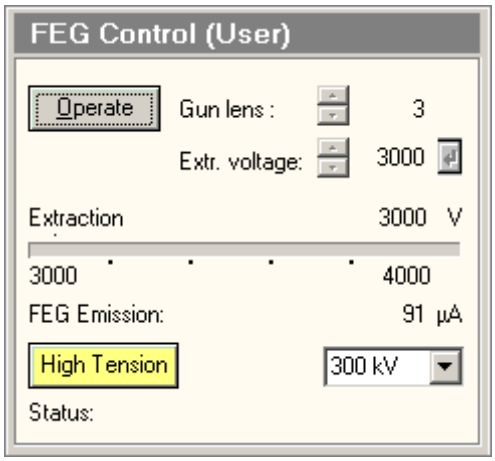
The Experiments Loader Control Panel.

In the Experiments Loader Control Panel is defined which experiment groups are loaded.

Experiments selection
The experiments selection list defines which experiments are loaded or unloaded.

Refresh
When the Refresh button is pressed, the experiments are reloaded.

25 FEG Control (User)



The FEG Control Control Panel.

The FEG Control Control Panel provides control over the Field Emission Gun and high tension.

Operate
The Operate button switches between the Operate and Standby FEG states. The button is only enabled when the FEG is on.

Gun lens
The Gun lens setting can be changed with the spin control within the range 1 to 8.

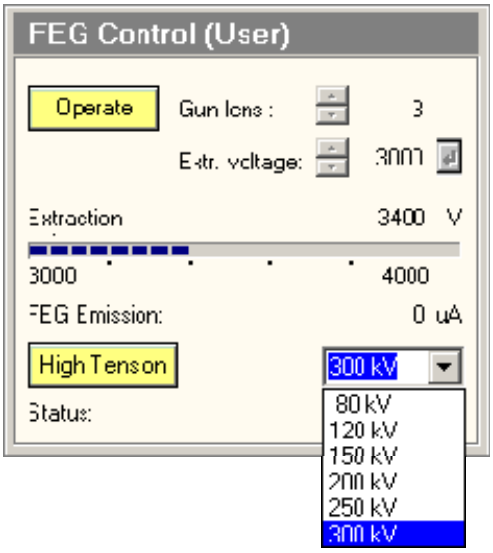
Extr. voltage
The Extraction voltage is set with the spin control. Spin the value to the required setting. The value of the Extraction voltage cannot exceed the Extractor limit set by the supervisor. When the Enter button is enabled (which occurs after the value has been changed by the user), the value currently displayed can be sent to the server by pressing the button (as long as the button is enabled, the server has not been updated).

Extraction voltage display
The Extraction voltage display shows the value of the extraction voltage. The value is displayed in numerical format on the right as well as in a progress bar. The progress bar always has a range of 1000 Volts, changing dynamically from 2000-3000 to 3000-4000, etc.

FEG Emission
The FEG Emission current display shows the value of the emission current. The value is displayed in numerical format on the right.

High tension
Pressing the High tension button switches the high tension on and off. The high-tension setting is is the one shown in the drop-down list box on the right. The High tension button has three possible settings:

- The high tension is enabled but off: the button is 'normal' gray.
- The high tension is on: the button is yellow.
- The high tension is disabled: the text in the button is gray.

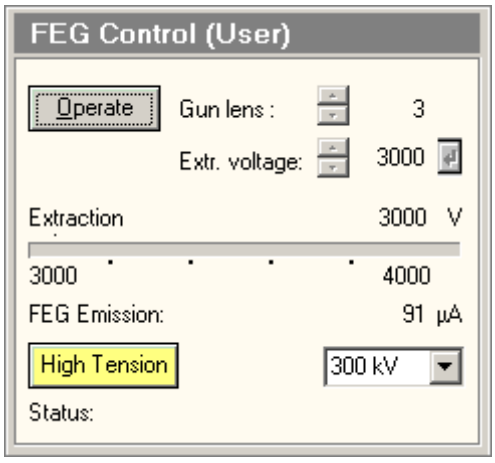


High tension setting
The high tension setting is by clicking in the drop-down list box and selecting the required setting (a range of fixed settings, normally comprising 80, 120, 150, 200, 250 and 300 kV).

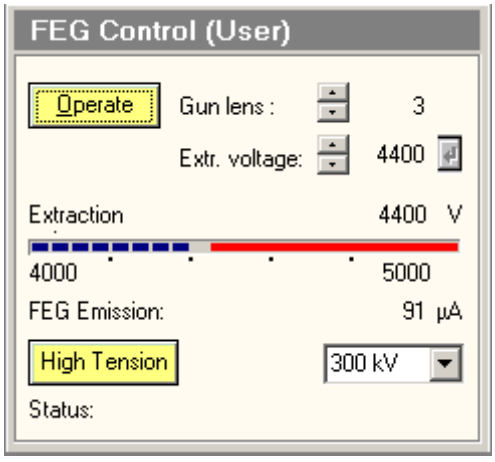
Status
Changing FEG settings is subject to delays necessary to safeguard the emitter. These delays are shown in the message display area. The delays used for changing extraction voltage depend on the height of the starting and ending extraction voltage and on recently used voltages (it takes less time to go back up to a recently used setting than going there for the first time).

25.1.1 Standby and Operate

Note: Under normal circumstances it is not necessary to switch either FEG or Power off. The FEG may be left in the Operate state when the microscope is not being used.

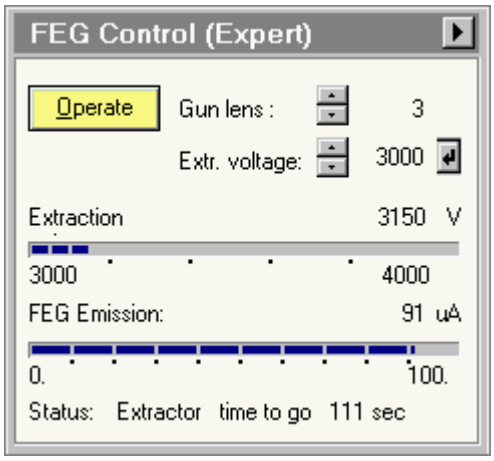


Standby: a FEG-on substate with a fixed extraction voltage (3kV) and slightly lowered filament temperature. The Operate button is gray.



Operate: a FEG-on substate with user-defined extraction voltage and normal filament temperature. The Operate button is yellow.

26 FEG Control (Expert/Supervisor)



The FEG Control Control Panel.

The FEG Control Control Panel provides control over the Field Emission Gun and its setting.

Operate
The Operate button switches between the Operate and Standby FEG states. The button is only enabled when the FEG and high tension are on.

Gun lens
The Gun lens setting can be changed with the spin control within the range 1 to 8.

Extr. voltage
The Extraction voltage is set with the spin control. Spin the value to the required setting. The value of the Extraction voltage cannot exceed the Extractor limit set in the FEG Options Control Panel. When the Enter button is enabled (which occurs after the value has been changed by the user), the value currently displayed can be sent to the server by pressing the button (as long as the button is enabled, the server has not been updated).

Extraction voltage display
The Extraction voltage display shows the value of the extraction voltage. The value is displayed in numerical format on the right as well as in a progress bar. The progress bar always has a range of 1000 Volts, changing dynamically from 2000-3000 to 3000-4000, etc.

FEG Emission
The FEG Emission current display shows the value of the emission current. The value is displayed in numerical format on the right as well as in a progress bar.

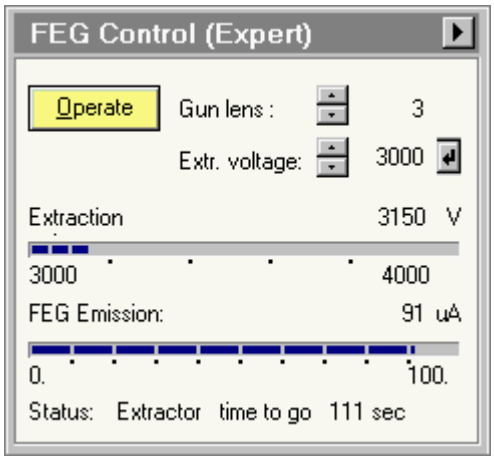
Status
Changing FEG settings is subject to delays necessary to safeguard the emitter. These delays (minutes in the case of start-up procedures; seconds in the case of changes of extraction voltage) are shown in the message display area. The delays used for changing extraction voltage depend on the height of the starting and ending extraction voltage and on recently used voltages (it takes less time to go back up to a recently used setting than going there for the first time).

FEG flap-out
Pressing the arrow button displays the flap-out containing the Options and Timers control panels.

26.1.1 Standby and Operate

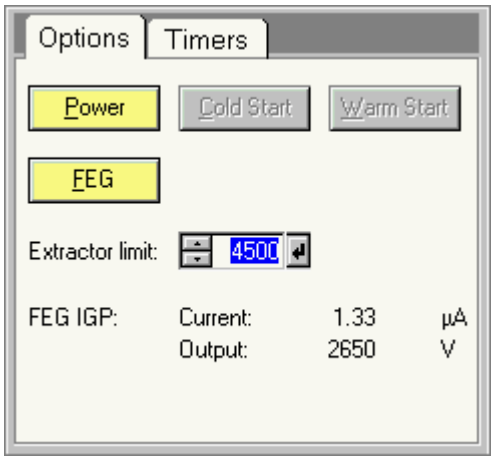
Note: Under normal circumstances it is not necessary to switch either FEG or Power off. The FEG may be left in the Operate state when the microscope is not being used.

Standby: a FEG-on substate with a fixed extraction voltage (3kV) and slightly lowered filament temperature. The Operate button is gray.



Operate: a FEG-on substate with user-defined extraction voltage and normal filament temperature. The Operate button is yellow.

26.2 FEG Options

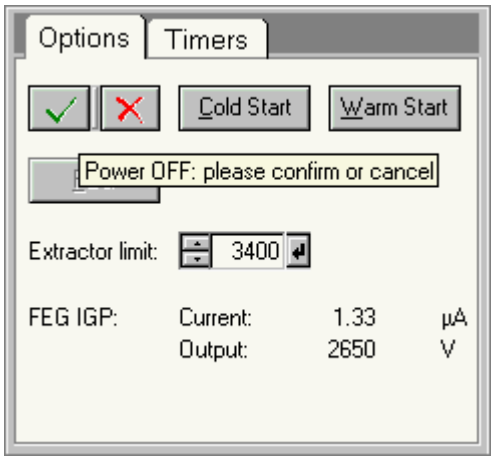


The FEG Options Control Panel.

The FEG Options Control Panel provides control over the Field Emission Gun and its setting.

Note: Until the FEG has been started - through either the Warm or Cold Start procedure, it is not possible to switch the high tension to more than 120 kV for TEM F20 instruments and 200 kV for TEM F30 instruments.

Power
The Power button switches power to the FEG on or off. When Power is on, pressing the button requires confirmation before the power is switched off. The button changes to two buttons with 'V' (OK) and 'X' (Cancel) marks. The cursor is positioned exactly between the two new buttons (to prevent accidental double-clicks from pressing either).



Press the 'V' to switch Power off or the 'X' button to Cancel.

Cold Start
Once Power has been switched on (and IGPa and IGPf are running), the FEG can be started either by the Cold Start or Warm Start procedures. See the detailed instructions on start-up below. The Cold Start procedure takes about 100 minutes. It is only required if IGPa has been off for more than 48 hours. Pressing the Cold Start button during the Cold Start procedure (when the button is yellow) stops the Cold Start.

Warm Start
Once Power has been switched on (and IGPa and IGPf are running), the FEG can be started either by the Cold Start or Warm Start procedures. See the detailed instructions on start-up below. The Warm

Start procedure takes about 25 minutes. It is the normal procedure for starting the FEG (to be used if IGPa has been off for less than 48 hours). Pressing the Warm Start button during the Warm Start procedure (when the button is yellow) stops the Warm Start.

FEG
The FEG button becomes yellow (on) automatically at the end of the Cold Start or Warm Start procedure. When it is yellow, it is possible to switch the FEG off by pressing the button (subject to confirmation, similar to Power off). Switching FEG off leads to the Power on state. The difference between FEG Off and Power Off is that IGPf is running in the FEG Off state and not in the Power Off state.

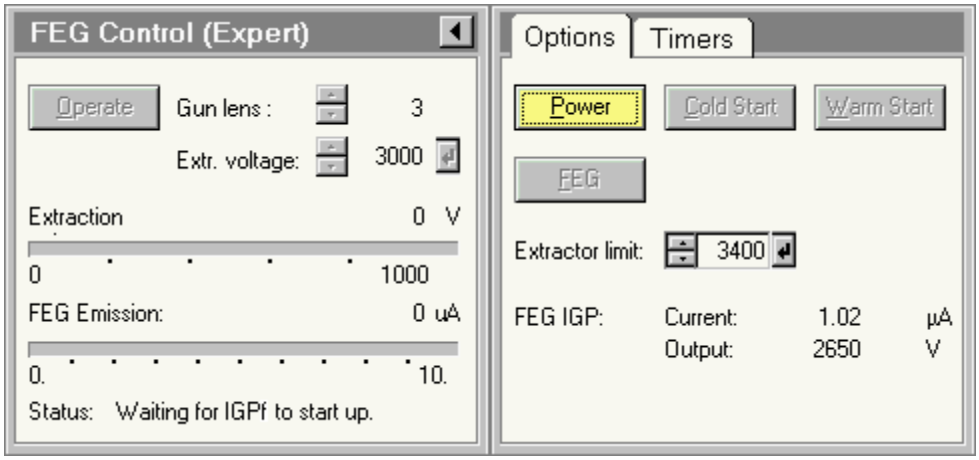
Extractor limit
The Extractor limit sets a limit on the extraction voltage that can be set in the FEG Control Panel. Use the spin buttons to change the value of the extractor limit and then press the Enter button to update the value to the gun.

FEG IGP
The FEG IGP display shows the voltage running through IGPf. Starting the FEG (Cold or Warm Start) is subject to current having run through IGPf after start-up (when the vacuum in the gun is very low, IGPf may not display any current during operation).

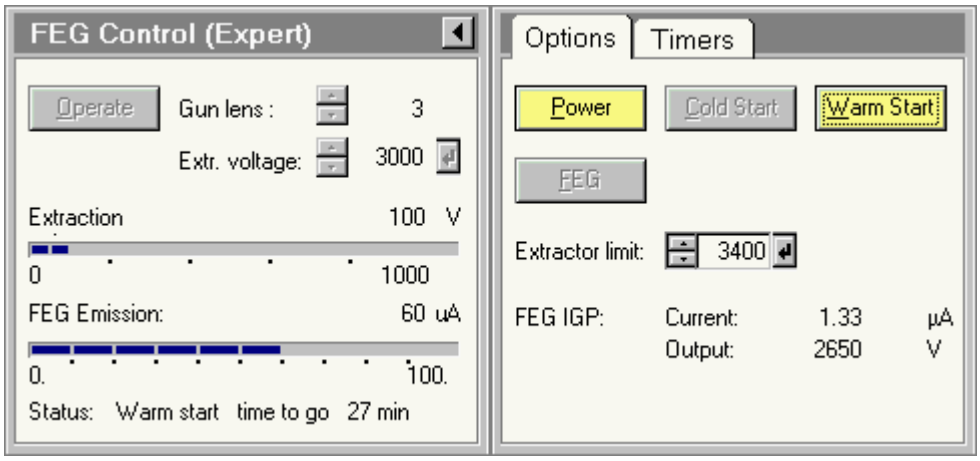
26.2.1 Power and FEG

The FEG has a number of operational states, described by the following conditions:

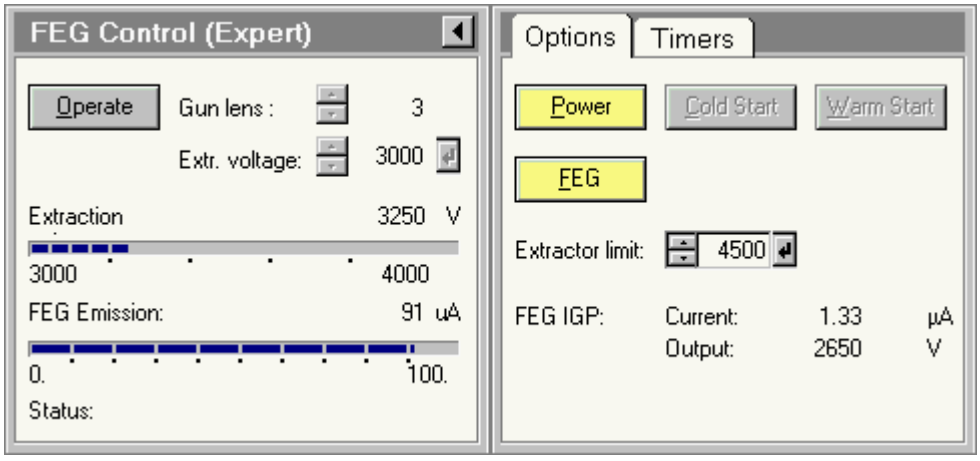
- Power on: IGPf is running (or attempting to start up), but otherwise all FEG electronics are off. The Power button is yellow, the FEG button is disabled. Warm and Cold Start are enabled once IGPf is running.



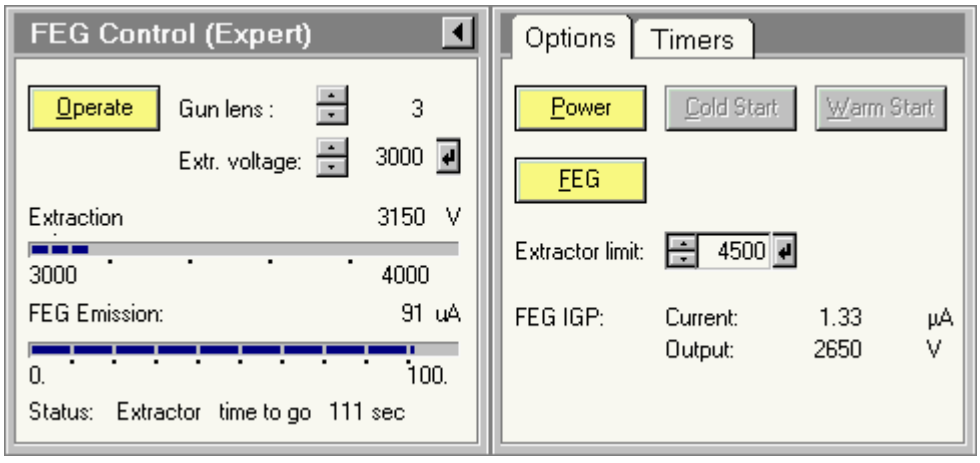
- Cold Start or Warm Start: FEG Start-up procedures, leading to FEG on.



- FEG on: all electronics are on. The Power and FEG buttons are yellow.
  1. **Standby**: a FEG-on substate with a fixed extraction voltage (3kV) and slightly lowered filament temperature. The Operate button is gray. It is disabled when the high tension is off and enabled when the high tension is on.

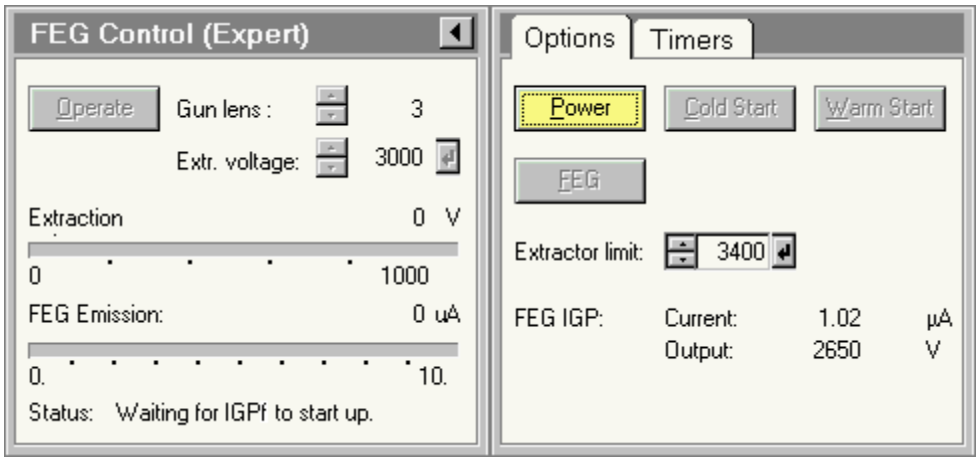


  2. **Operate**: a FEG-on substate with user-defined extraction voltage and normal filament temperature. The Operate button is yellow.

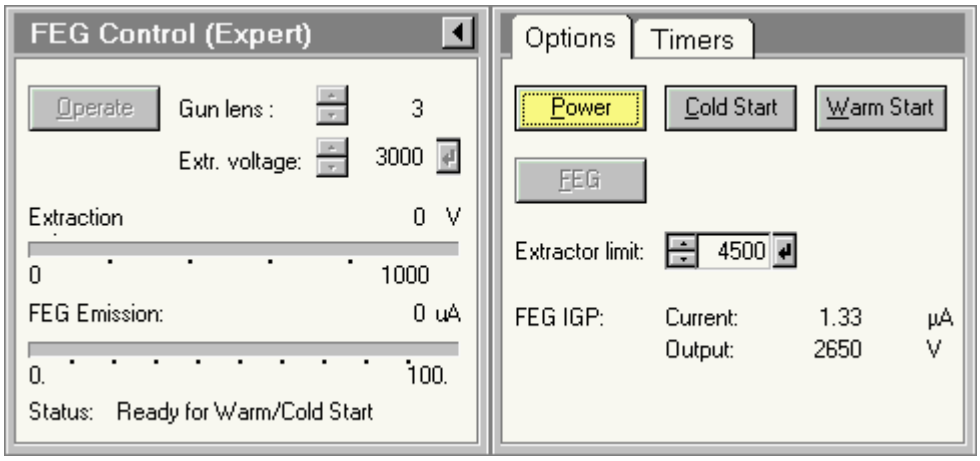


26.2.2 Starting the FEG

Note: Until the FEG has been started - through either the Warm or Cold Start procedure - it is not possible to switch the high tension to more than 200 kV.

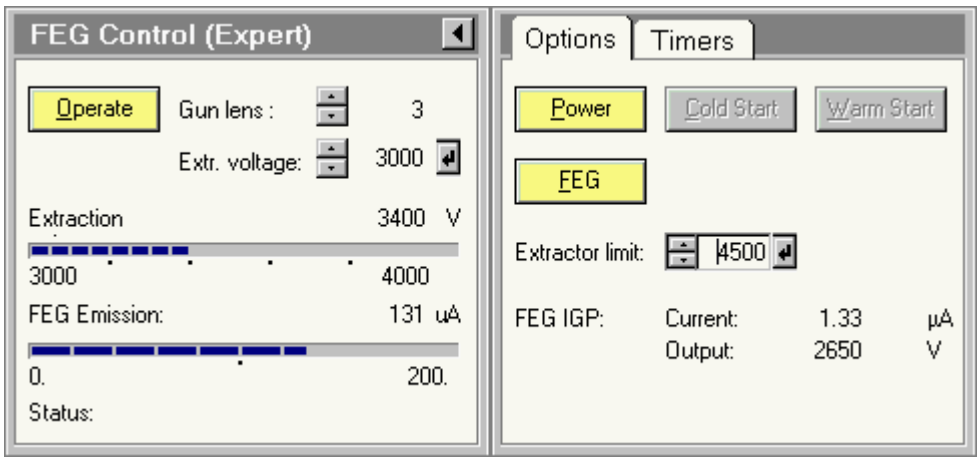


- Press the Power button. The software will now start IGPf (the Cold Start and Warm Start buttons will not be enabled until a current has been measured on IGPf ; after the initial current in IGPf , the value may drop to zero, but the initial current shows that the pump is truly running). If IGPf doesn't start within a certain amount of time, the software will switch off IGPa. This will slightly deteriorate the vacuum and make it easier for IGPf to start up. When IGPa is switched off, the system may display an error message 'Gun pressure too high' which can be ignored (click on the Enter button to remove it). Once IGPf has started, the software will (if it had been switched off) restart IGPa. Once IGPa is running again (checked by a significant lowering of the IGPf pressure), the system is ready for a Warm Start or Cold Start.

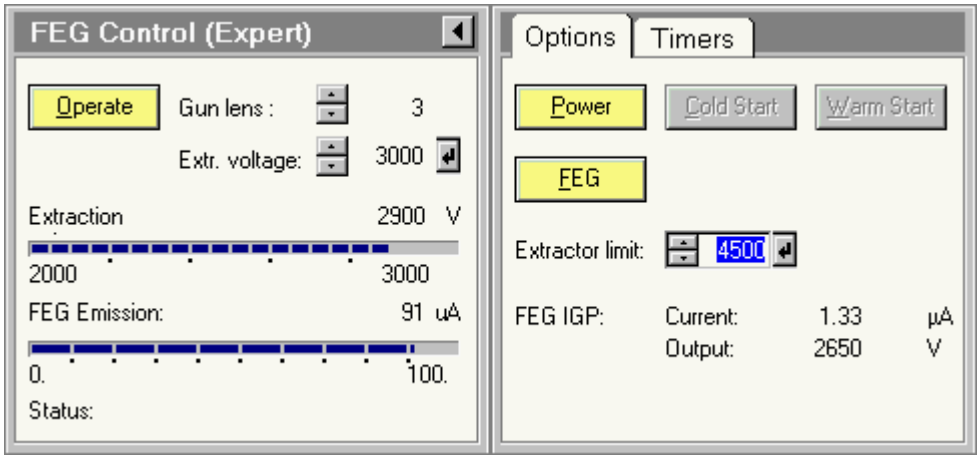


- Press the Warm Start (normal procedure if IGPa has not been off longer than 48 hours) or Cold Start to begin the FEG start procedure. The time required (under normal conditions) for the procedure is displayed.

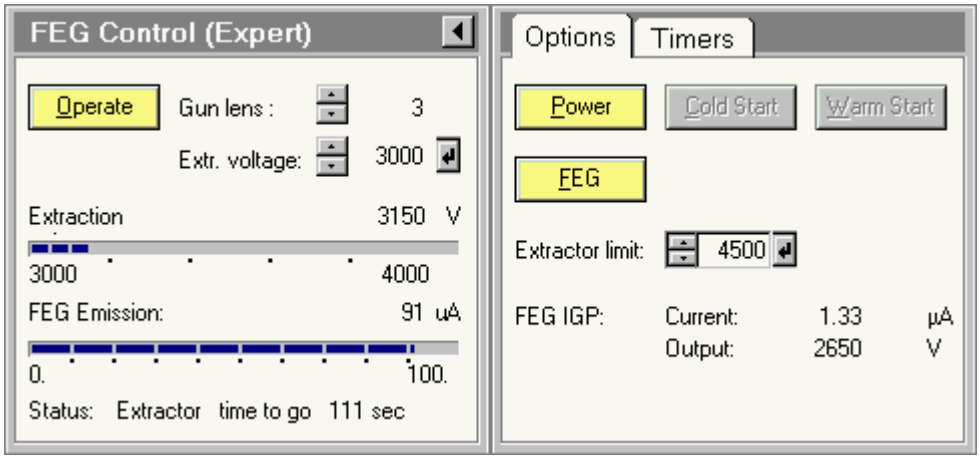
- The start-up procedure will lead to the FEG on, Operate state, with an extraction voltage of 3.4kV.



- Set the Extractor limit to the value required for normal operation, with the spin buttons and confirm by pressing the Enter button.



- Change the Extraction voltage and gun lens settings to the values required for operation.

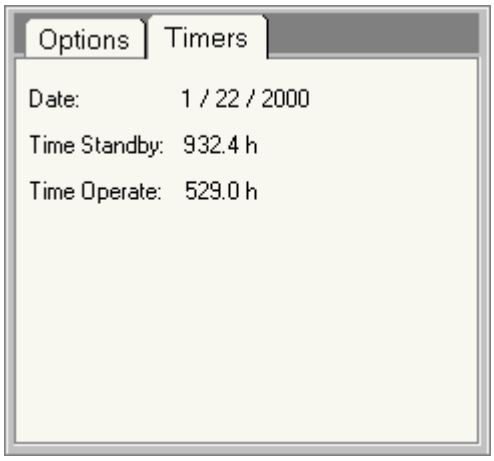


26.2.3 Shutting the FEG down

Note: Under normal circumstances it is not necessary to switch either FEG or Power off. The FEG may be left in the Operate state when the microscope is not being used.

The FEG can be shut down partially (all electronics except the power to IGPf off) or completely. To shut the FEG down but keep IGPf running, press the FEG button (this action must be confirmed before it is executed). To shut the FEG down completely, press the Power button (also subject to confirmation). When the high tension is higher than 200 kV, the high tension will switch off automatically. At or below 200 kV, high tension can remain on.

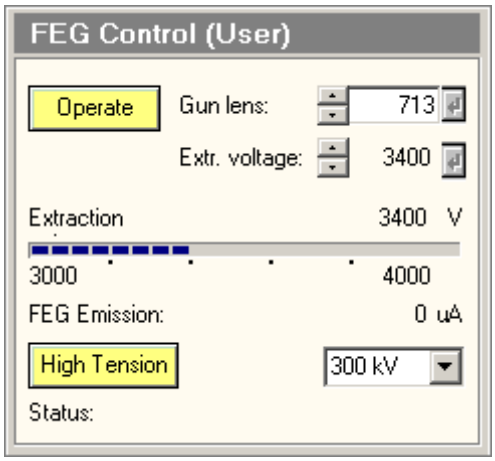
26.3 FEG Timers (Supervisor/Expert)



The FEG Timers Control Panel.

The FEG Timers Control Panel displays the date the timers were started (FEG tip installation) and the hours the FEG tip has run in Standby and Operate modes. The timers can be reset only by service.

27 FEG Control (User) - Monochromator



The FEG Control Control Panel.

The FEG Control Control Panel provides control over the Field Emission Gun and high tension.

Operate
The Operate button switches between the Operate and Standby FEG states. The button is only enabled when the FEG is on.

Gun lens
The Gun lens setting can be changed with the spin control or by typing a value and pressing the Enter button. The range is 300 to 5500 V. Usually the gun lens is operated from the Monochromator Tune control panel (see chapter 37).

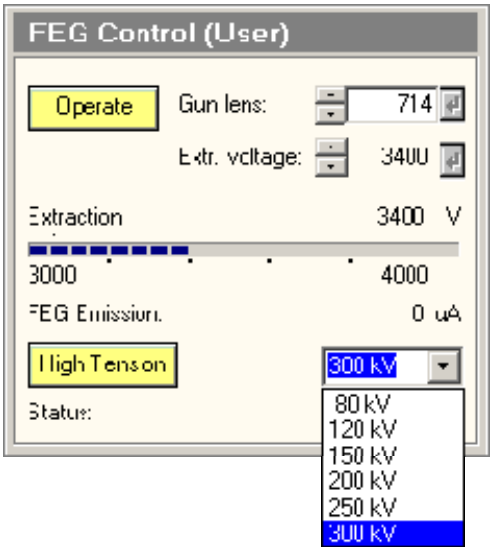
Extr. voltage
The Extraction voltage is set with the spin-label-enter control. Spin the value to the required setting and set it by pressing the Enter button. The value of the Extraction voltage cannot exceed the Extractor limit set by the supervisor.

Extraction voltage display
The Extraction voltage display shows the value of the extraction voltage. The value is displayed in numerical format on the right as well as in a progress bar. The progress bar always has a range of 1000 Volts, changing dynamically from 2000-3000 to 3000-4000, etc.

FEG Emission
The FEG Emission current display shows the value of the emission current. The value is displayed in numerical format on the right.

High tension
Pressing the High tension button switches the high tension on and off. The high-tension setting is is the one shown in the drop-down list box on the right. The High tension button has three possible settings:

- The high tension is enabled but off : the button is 'normal' gray.
- The high tension is on : the button is yellow.
- The high tension is disabled : the text in the button is gray.

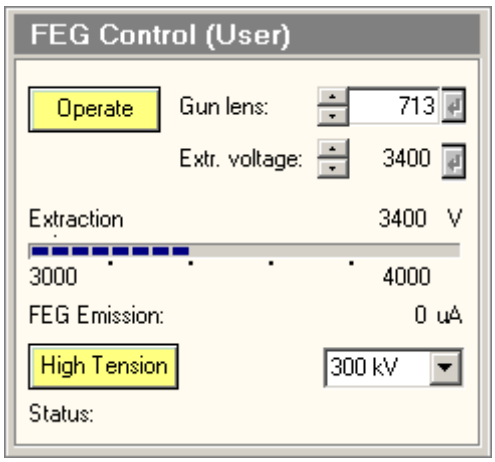


High tension setting
The high tension setting is selected by clicking in the drop-down list box and selecting the required setting (a range of fixed settings, normally comprising 80, 120, 150, 200, 250 and 300 kV).

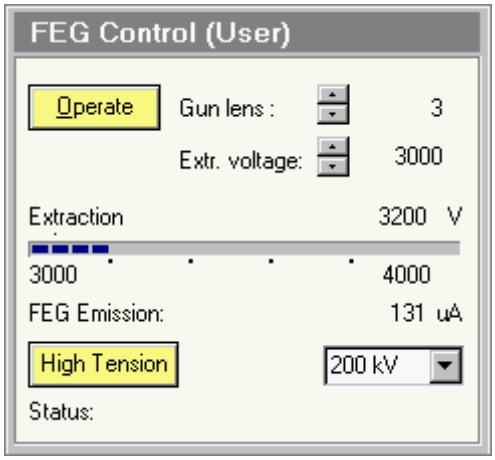
Status
Changing FEG settings is subject to delays necessary to safeguard the emitter. These delays are shown in the status display area. The delays used for changing extraction voltage depend on the height of the starting and ending extraction voltage and on recently used voltages (it takes less time to go back up to a recently used setting than going there for the first time).

27.1.1 Standby and Operate

Note: Under normal circumstances it is not necessary to switch either FEG or Power off. The FEG may be left in the Operate state when the microscope is not being used.

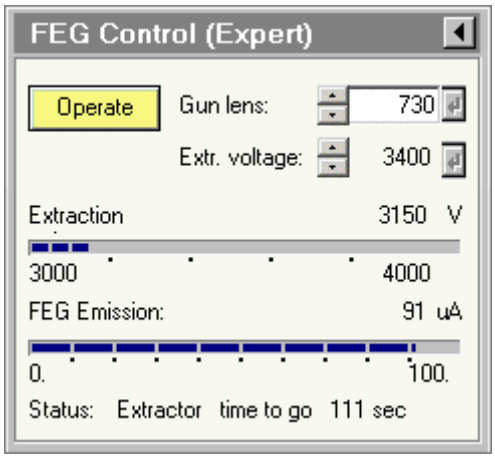


Standby : a FEG-on substate with a fixed extraction voltage (3kV) and slightly lowered filament temperature. The Operate button is gray.



Operate : a FEG-on substate with user-defined extraction voltage and normal filament temperature. The Operate button is yellow.

28 FEG (Expert/Supervisor) - Monochromator



The FEG Control Control Panel.

The FEG Control Control Panel provides control over the Field Emission Gun and its setting.

Operate
The Operate button switches between the Operate and Standby FEG states. The button is only enabled when the FEG and high tension are on.

Gun lens
The Gun lens setting can be changed with the spin control or by typing a value and pressing the Enter button. The range is 300 to 5500 V. Usually the gun lens is operated from the Monochromator Tune control panel (see chapter 38).

Extr. voltage
The Extraction voltage is set with the spin-label-enter control. Spin the value to the required setting and set it by pressing the Enter button. The value of the Extraction voltage cannot exceed the Extractor limit set in the FEG Options Control Panel.

Extraction voltage display
The Extraction voltage display shows the value of the extraction voltage. The value is displayed in numerical format on the right as well as in a progress bar. The progress bar always has a range of 1000 Volts, changing dynamically from 2000-3000 to 3000-4000, etc.

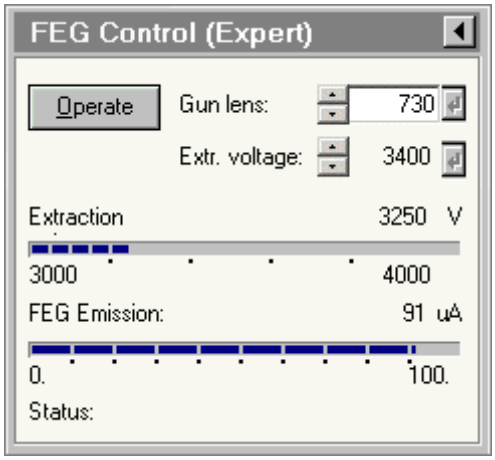
FEG Emission
The FEG Emission current display shows the value of the emission current. The value is displayed in numerical format on the right as well as in a progress bar.

Status
Changing FEG settings is subject to delays necessary to safeguard the emitter. These delays (minutes in the case of start-up procedures; seconds in the case of changes of extraction voltage) are shown in the message display area. The delays used for changing extraction voltage depend on the height of the starting and ending extraction voltage and on recently used voltages (it takes less time to go back up to a recently used setting than going there for the first time).

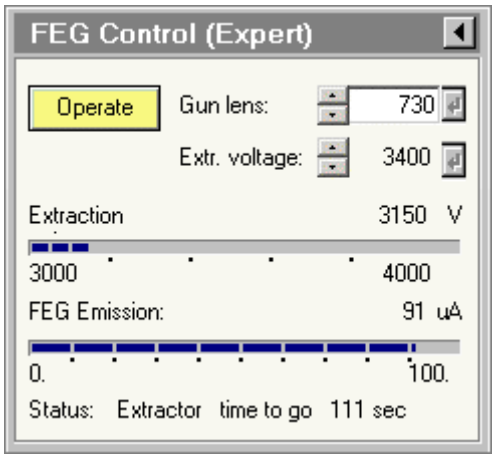
Flap-out button
Pressing the flap-out button displays the flap-out containing the Options and Timers control panels.

28.1 Standby and Operate

Note: Under normal circumstances it is not necessary to switch either FEG or Power off. The FEG may be left in the Operate state when the microscope is not being used.

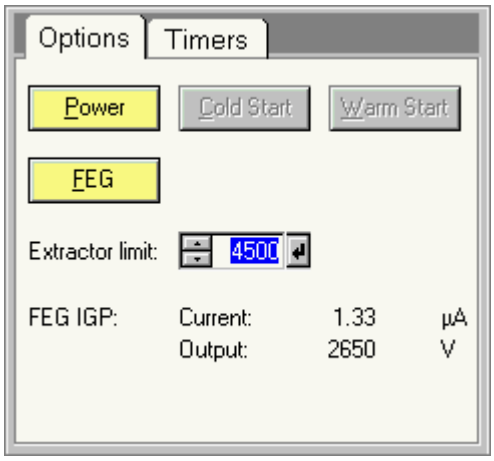


Standby : a FEG-on substate with a fixed extraction voltage (3kV) and slightly lowered filament temperature. The Operate button is gray.



Operate : a FEG-on substate with user-defined extraction voltage and normal filament temperature. The Operate button is yellow.

28.2 FEG Options

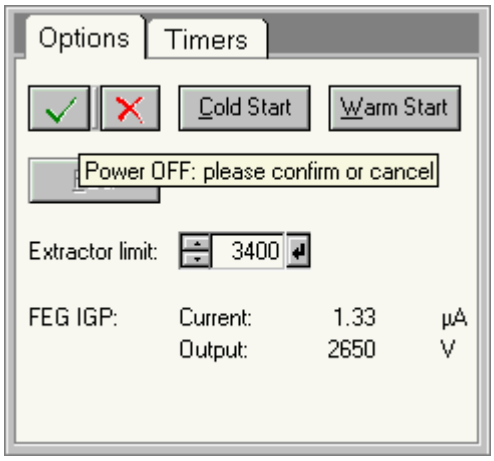


The FEG Options Control Panel.

The FEG Options Control Panel provides control over the Field Emission Gun and its setting.

Note: Until the FEG has been started - through either the Warm or Cold Start procedure, it is not possible to switch the high tension to more than 120 kV for TEM F20 instruments and 200 kV for TEM F30 instruments.

Power
The Power button switches power to the FEG on or off. When Power is on, pressing the button requires confirmation before the power is switched off. The button changes to two buttons with 'V' (OK) and 'X' (Cancel) marks. The cursor is positioned exactly between the two new buttons (to prevent accidental double-clicks from pressing either).



Press the 'V' to switch Power off or the 'X' button to Cancel.

Cold Start
Once Power has been switched on (and IGPa and IGPf are running), the FEG can be started either by the Cold Start or Warm Start procedures. See the detailed instructions on start-up below. The Cold Start procedure takes about 100 minutes. It is only required if IGPa has been off for more than 48 hours. Pressing the Cold Start button during the Cold Start procedure (when the button is yellow) stops the Cold Start.

Warm Start
Once Power has been switched on (and IGPa and IGPf are running), the FEG can be started either by the Cold Start or Warm Start procedures. See the detailed instructions on start-up below. The Warm

Start procedure takes about 25 minutes. It is the normal procedure for starting the FEG (to be used if IGPa has been off for less than 48 hours). Pressing the Warm Start button during the Warm Start procedure (when the button is yellow) stops the Warm Start.

FEG
The FEG button becomes yellow (on) automatically at the end of the Cold Start or Warm Start procedure. When it is yellow, it is possible to switch the FEG off by pressing the button (subject to confirmation, similar to Power off). Switching FEG off leads to the Power on state. The difference between FEG Off and Power Off is that IGPf is running in the FEG Off state and not in the Power Off state.

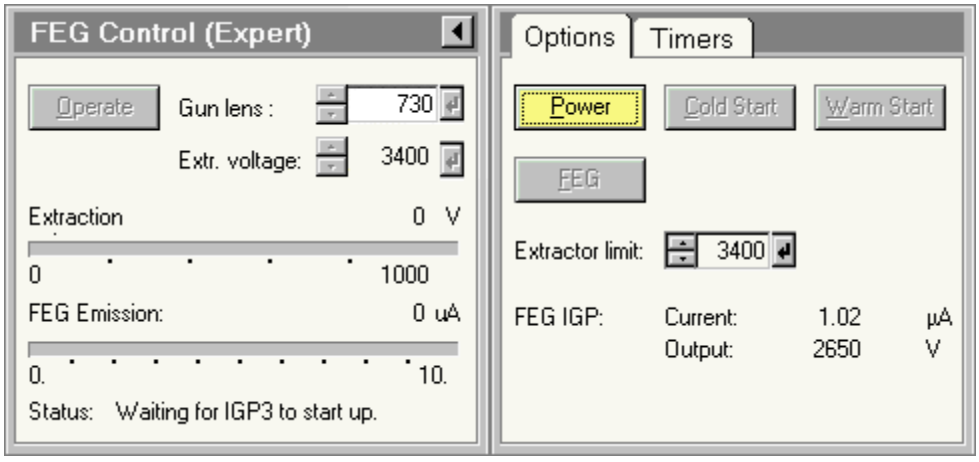
Extractor limit
The Extractor limit sets a limit on the extraction voltage that can be set in the FEG Control Panel. Use the spin buttons to change the value of the extractor limit and then press the Enter button to update the value to the gun.

FEG IGP
The FEG IGP display shows the voltage running through IGPf. Starting the FEG (Cold or Warm Start) is subject to current having run through IGPf after start-up (when the vacuum in the gun is very low, IGPf may not display any current during operation).

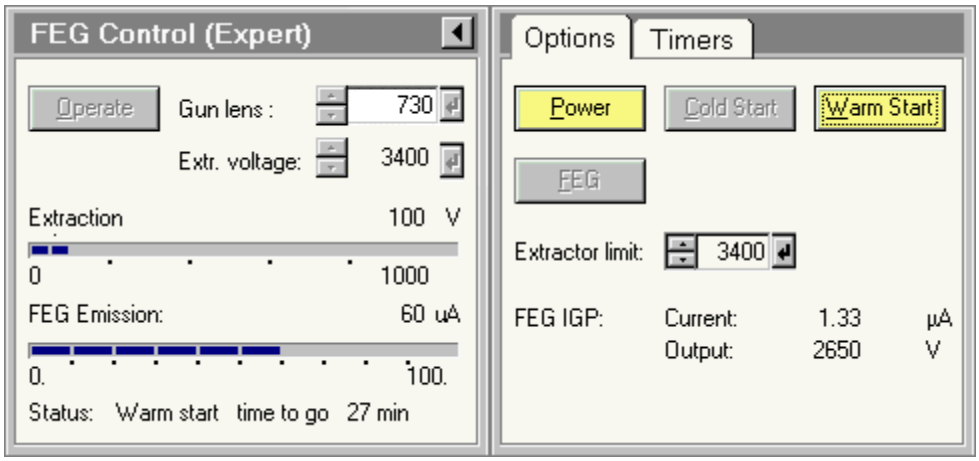
28.2.1 Power and FEG

The FEG has a number of operational states, described by the following conditions:

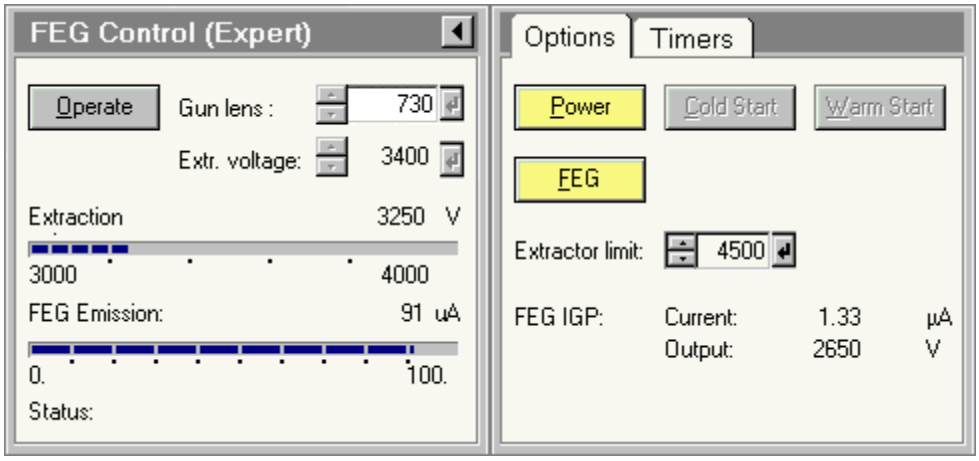
- Power on: IGPf is running (or attempting to start up), but otherwise all FEG electronics are off. The Power button is yellow, the FEG button is disabled. Warm and Cold Start are enabled once IGPf is running.



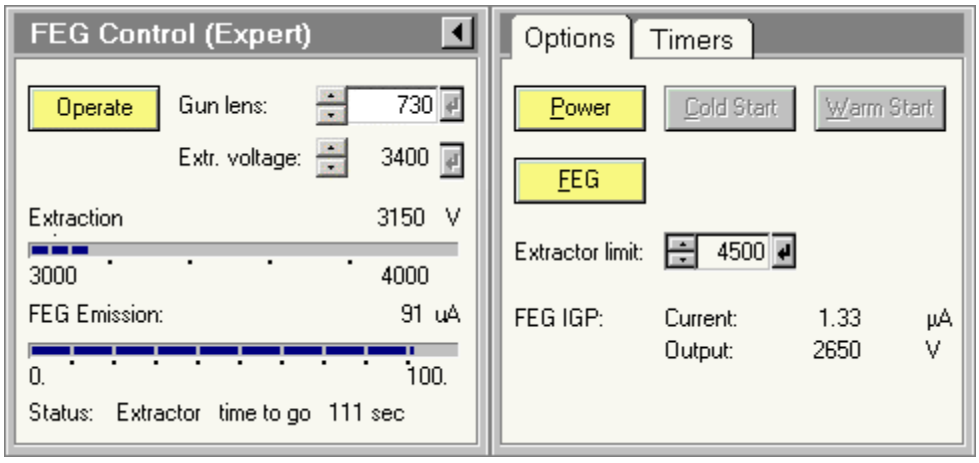
Cold Start or Warm Start: FEG Start-up procedures, leading to FEG on.



- FEG on: all electronics are on. The Power and FEG buttons are yellow.
  3. **Standby**: a FEG-on substate with a fixed extraction voltage (3kV) and slightly lowered filament temperature. The Operate button is gray. It is disabled when the high tension is off and enabled when the high tension is on.

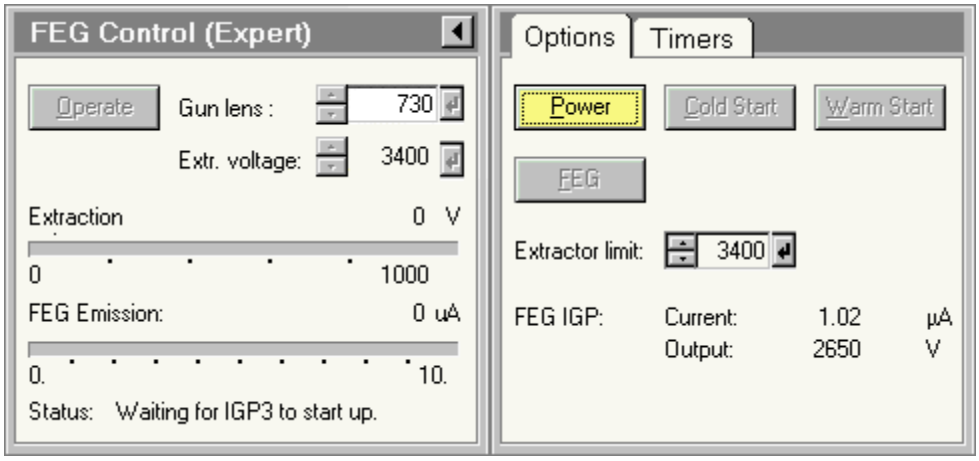


  4. **Operate**: a FEG-on substate with user-defined extraction voltage and normal filament temperature. The Operate button is yellow.

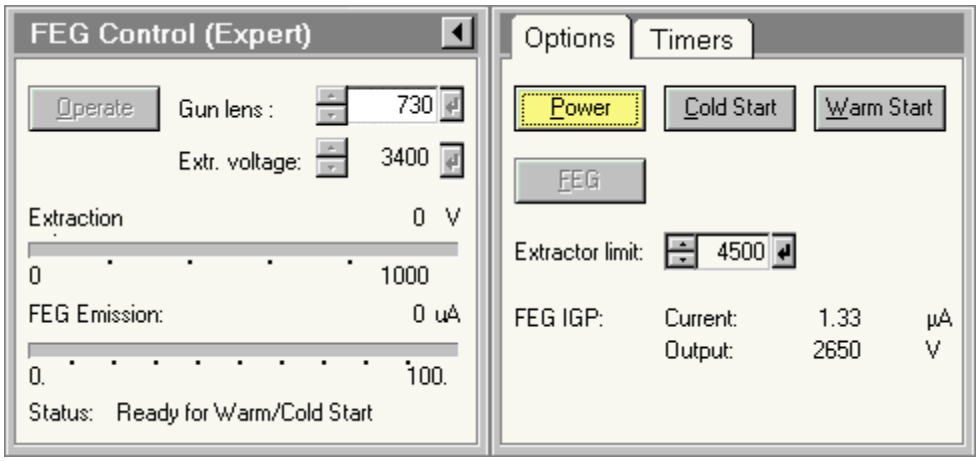


28.2.2 Starting the FEG

Note: Until the FEG has been started - through either the Warm or Cold Start procedure - it is not possible to switch the high tension to more than 200 kV.

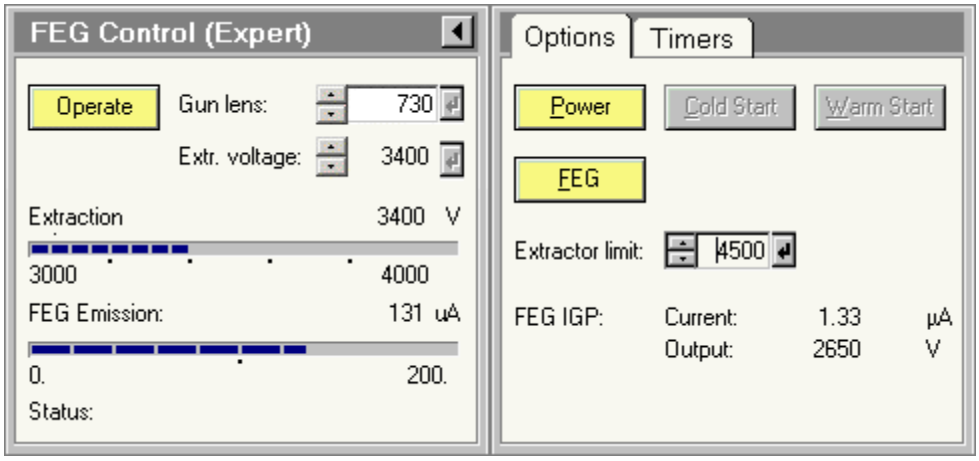


- Press the Power button. The software will now start IGPf (the Cold Start and Warm Start buttons will not be enabled until a current has been measured on IGPf ; after the initial current in IGPf , the value may drop to zero, but the initial current shows that the pump is truly running). If IGPf doesn't start within a certain amount of time, the software will switch off IGPa. This will slightly deteriorate the vacuum and make it easier for IGPf to start up. When IGPa is switched off, the system may display an error message 'Gun pressure too high' which can be ignored (click on the Enter button to remove it). Once IGPf has started, the software will (if it had been switched off) restart IGPa. Once IGPa is running again (checked by a significant lowering of the IGPf pressure), the system is ready for a Warm Start or Cold Start.

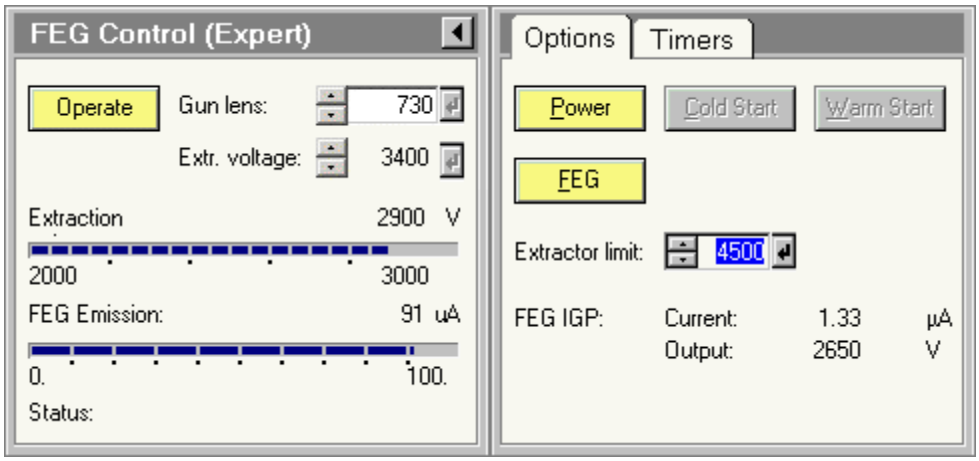


- Press the Warm Start (normal procedure if IGPa has not been off longer than 48 hours) or Cold Start to begin the FEG start procedure. The time required (under normal conditions) for the procedure is displayed.

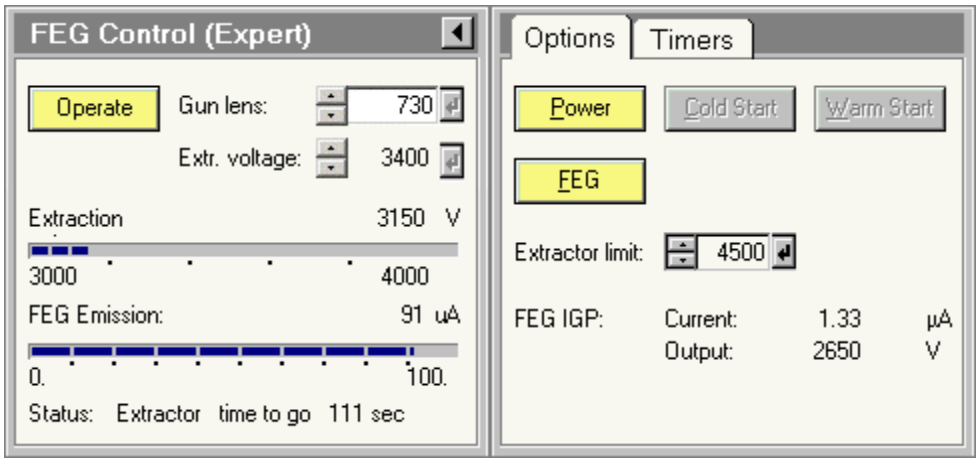
- The start-up procedure will lead to the FEG on, Operate state, with an extraction voltage of 3.4kV.



- Set the Extractor limit to the value required for normal operation, with the spin buttons and confirm by pressing the Enter button.



- Change the Extraction voltage and gun lens settings to the values required for operation.

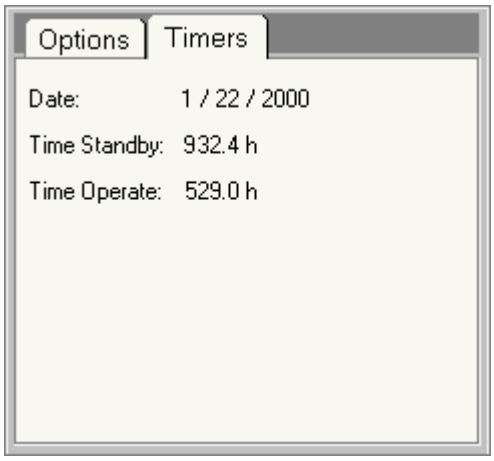


28.2.3 Shutting the FEG down

Note: Under normal circumstances it is not necessary to switch either FEG or Power off. The FEG may be left in the Operate state when the microscope is not being used.

The FEG can be shut down partially (all electronics except the power to IGPf off) or completely. To shut the FEG down but keep IGPf running, press the FEG button (this action must be confirmed before it is executed). To shut the FEG down completely, press the Power button (also subject to confirmation). When the high tension is higher than 200 kV, the high tension will switch off automatically. At or below 200 kV, high tension can remain on.

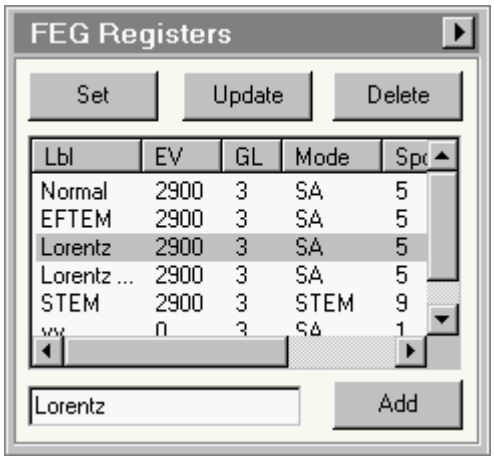
28.3 FEG Timers (Supervisor/Expert)



The FEG Timers Control Panel.

The FEG Timers Control Panel displays the date the timers were started (FEG tip installation) and the hours the FEG tip has run in Standby and Operate modes. The timers can be reset only by service.

29 FEG Registers



The FEG Registers Control Panel.

29.1 Introduction

The control of the FEG is somewhat complicated because of the wide range of settings under which the gun can be used and the nature of its construction. Two elements that can be varied, the extraction voltage and the gun lens setting, are located above the alignment coils and therefore the alignment of the gun doesn't stay the same when these parameters are changed. The high tension in turn affects the way the extraction anode and gun lens are used, making things even more complicated. The control of the FEG can significantly slow down microscope operation if it is necessary to change gun settings several times during a single microscope session because of the need to adjust many settings of the column. FEG Registers is there to assist in such cases, making the transition from one state of the microscope to another fast and reproducible.
Using FEG registers one can switch between previously defined setting by simply selecting the required setting from a list. Each user can store up to 200 registers under a user-defined label. These settings are saved in a file (one for each user) under the Windows NT user name preceded by usr_. Whenever the user logs in, the settings are loaded from the file. Settings can also be updated and deleted, and can be saved to and loaded from files with user-defined names (see Options).

Important note: Because of the high degree of complexity of the Titan alignments and frequent misalignment (due to user error, not alignment reproducibility problems), the alignment philosophy of the Titan software has been changed. From version 1.0 onwards, users cannot execute a full alignment anymore nor can they save alignment files. In essence users can only make minor modifications (e.g. rotation center) through direct alignments (or alignment procedures for the gun). Because users can no longer save alignment files, the only way to have sets of the alignments saved with easy switching is to use FEG Registers.

29.2 The settings

The following settings are stored for each register.

Category	Setting
FEG	• Extraction voltage • Gun lens • Gun tilt • Gun tilt pivot points • Gun shift • Gun shift pivot points • Spotsize-dependent gun shift • Gun cross-over • Gun stigmator
Monochromator (on monochromator systems only)	• Potential • Excitation • Monochromator settings (file)
Microscope mode	• TEM / STEM • LM, SA, Mh, LAD, D • Microprobe / Nanoprobe • Lorentz • Dark field • Normal / EFTEM
Illumination **Note:** When motorized apertures are present, the C2 aperture MUST be enabled, otherwise you cannot restore the illumination settings.	• C2 Aperture selected and position • Illumination mode (Parallel / Probe) • Condenser lens mode • C2 cross-over mode • Condenser free control mode • Spot number • Intensity • Projection diameter • Illumination diameter (parallel mode) • Convergence angle (probe mode)
Magnification	• Magnification (TEM or STEM) • Camera length
Direct alignments	• Spot-size dependent intensity correction • Beam shift • Beam tilt pivot points • Rotation center • Diffraction shift • Dynamic conical dark field pivot points • Descan corrections

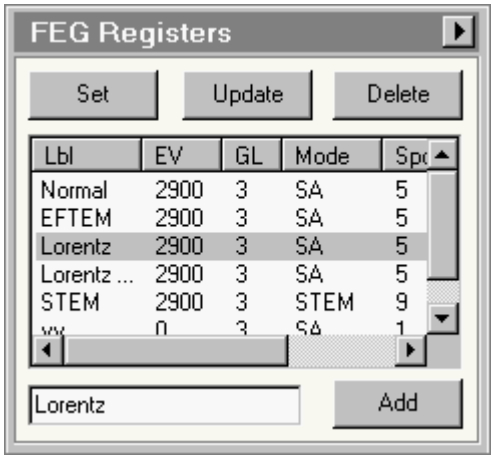
Stigmators (current channel only)
- Condenser stigmator (the complete list for all spots)
- Three-fold condenser stigmator
- Objective stigmator
- Diffraction stigmator

High tension is stored but not recalled automatically (on restore FEG Registers displays a warning).

Note: Currently FEG Registers stores all aperture positions and selections but only restores the C2 aperture. Because it is possible that the apertures have been changed physically, FEG Registers performs the following checks:
- If the size of the aperture and the aperture index match, the C2 aperture is selected and its position will be restored.
- If the size of the aperture does not match the size of the current aperture size at the index (which may mean that the size of the aperture as indicated has been changed on the system, but more likely that the apertures have been changed), FEG Registers will attempt to find an aperture in the system that has a size matching the stored aperture size. If that is found, that aperture will be selected but the position will not be set to that in the register. If no matching aperture size is found, any aperture that differs in size by less than 5 micrometers will be selected (but again its position will not be set). If no matching aperture within 5 micrometer is found, you cannot restore the FEG Registers beyond the FEG and monochromator setting listed above.

Note that changing the C2 aperture may take a little time and FEG Registers has to wait until the aperture has changed before it can continue setting the optical settings. Because of this, setting a FEG Register may take more time than previously.

29.3 The control panel



Set
When the Set button is pressed the settings from the register currently selected in the list will be set to the microscope.

Update
When the Update button is pressed, the selected setting is updated to the settings currently active on the microscope. Typical use of this function would be to select a setting and set it back to the microscope. Then modify any microscope settings needed (e.g. the gun alignment) and then update. Update requires confirmation (since the old setting will be overwritten).

Delete
When the Delete button is pressed the setting currently selected in the list will be deleted. To guard against accidental deletion, the Delete button will request confirmation. Multiple settings can be selected for deletion (use Shift+Click to select a range or Ctrl+Click to select individual settings).

Settings list
The setting list gives an overview of all settings of the current user. The settings are automatically stored when the user logs off (it is not necessary to save them to file, settings are added simply by Add and removed by Delete). The settings list initially will display the registers in the sequence they have been defined. It is possible to sort the settings in the list differently by pressing one of the buttons at the top of

the list (Lbl, EV, GL, ...). At the first press, the settings are sorted in normal order. When the same button is pressed again the sequence is reversed. The width of the columns can be adjusted by moving the cursor to the boundaries between the buttons and dragging the boundary to left or right.
The columns in the list have the following meaning:

Lbl : user-defined label for the setting.
EV : extraction voltage.
GL : gun-lens setting.
Mode : microscope mode
Spot : spot number
Date (usually out of sight due to lack of space) : the date at which the setting was added.
On monochromator systems EV and GL are replaced by Pot (Potential) and Exc (Excitation), respectively.

These data are only a subset of the settings stored, but they are the important ones that allow the user to see which setting should be recalled.

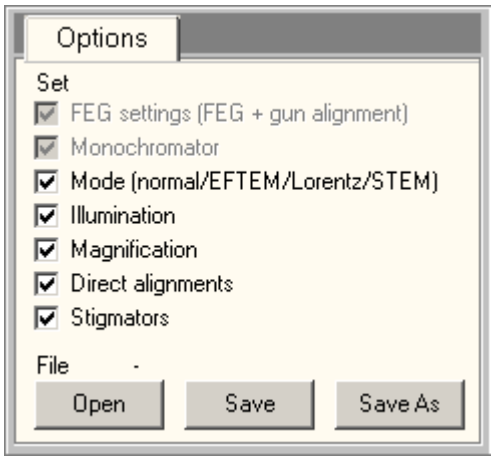
A setting is selected for setting to the microscope or updating by clicking the required row. The label of the setting is automatically copied to the settings label edit field to ensure the proper setting is used for updating.

Settings label
The settings label defines the name of a new register setting (when Add is pressed). If no text is entered, the software will add a label 'Register' with some number attached.

Add
When the Add button is pressed the settings currently on the microscope are stored in a new register which is added to the list.

Flap-out button
The flap-out button leads to the Options tab of the FEG Registers Control Panel.

29.4 FEG Registers Options



The FEG Registers Options Control Panel.

The Options tab contains a few options concerning which settings are restored to the microscope, and controls for saving the settings to file and loading them from file.

29.4.1 Settings files

Settings files can be saved under any file name and in any location with the following restriction: filenames with names that start with usr_ and then a Windows NT username (that is, the name under which users log in) are not allowed. These files will in fact exist for users who have used FEG Registers before and contain their settings. You can open those files and use the settings in there, but you cannot overwrite them.
The location of the user files is by default in a folder \titan\data\ followed by the user name.

Note: If you save a file in a location other than c:\titan or subfolders, the file will not be found by the update function (available to service) that makes sure that C2 aperture positions are updated when the apertures on the microscope are changed (meaning physically removed and replaced by another aperture).

Files do not contain a single setting but all settings together. **When you load settings from file you automatically remove all currently existing settings!**

29.4.2 Settings options

The settings that will be restored to the microscope can be chosen by checking the required check boxes. The categories are listed in the settings table.

The FEG and monochromator settings are always restored. For clarity the check boxes are displayed so you can see that these settings are included, but the check boxes disabled. Generally for the other settings there are dependencies, e.g. on mode. If a check box is not enabled, it means that another check box higher up is unchecked and those settings are required for correct restore of the settings.

The magnification (which includes camera length in TEM and STEM) is always optional. If you restore mode settings and not magnification, the microscope will switch to the proper mode but the magnification or camera length remains as it was (the last time the particular mode was used).

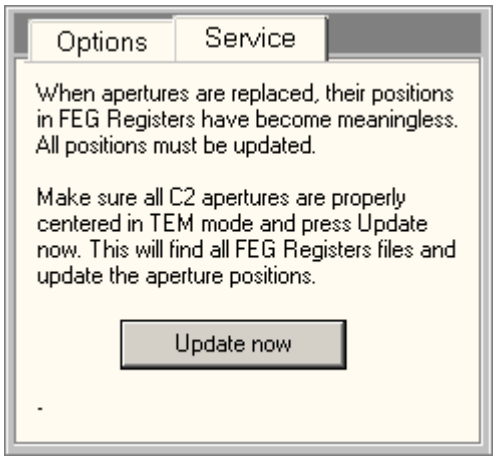
File Open
The Open button brings up the standard Open file dialog from which a file can be selected for loading. See the remark above about overwriting the currently existing settings.

File Save
The currently existing settings can be saved to file. When the Save button is pressed the settings are saved under a user-defined filename.

Note: Under normal circumstances it is not necessary to save settings in a file because a user's settings are saved automatically. Saving files is only useful when a user wishes to have several sets of settings of FEG Registers.

File Save As
Save as is the same as Save except that another filename can be chosen.

29.5 FEG Registers Service



The FEG Registers Service Control Panel.

Important notes:

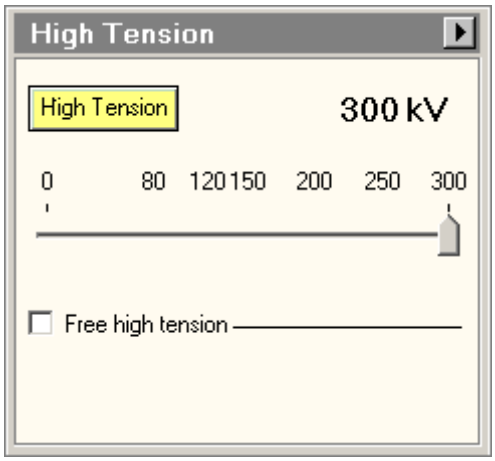
- This action must be done each time :
    1. The C2 aperture holder has been removed from the column and one or more apertures have been exchanged.
    2. One or more read heads of the C2 aperture have been replaced.
- Make sure the aperture sizes as displayed by the Apertures control panel are correct!

Because the FEG Registers contain (and restore) the position of the C2 aperture, it is important that those positions are correct. When the apertures are physically changed (the aperture holder has been removed from the column and one or more apertures are replaced), the stored positions are not relevant anymore because they refer to an aperture that is no longer present. As a consequence a microscope user could face the situation that she/he is forced to find apertures each time a FEG Registers is restored.
FEG Registers therefore has an update function, accessible only to factory and service. This function will load the current positions of the C2 apertures and go through all FEG Registers files (*.feg) located in c:\titan and subfolders, replacing the stored positions with the updated values. The function writes a log file in c:\titan\log\feg registers. Each log file has the date and time in the file name so log files do not get overwritten.

Update now
Make sure that all the C2 apertures are properly centered in HM-TEM mode. When Update now is pressed, the button becomes yellow and the function will process all files. Generally the process is very quick so you may not even see the change in color before it reverts back to gray again. You can see that the function is done from the status label (Update done).

Status label
The status label displays the status of the function (which file is being processed, error messages, etc).

30 High Tension (Expert/Supervisor)



The High Tension Control Panel.

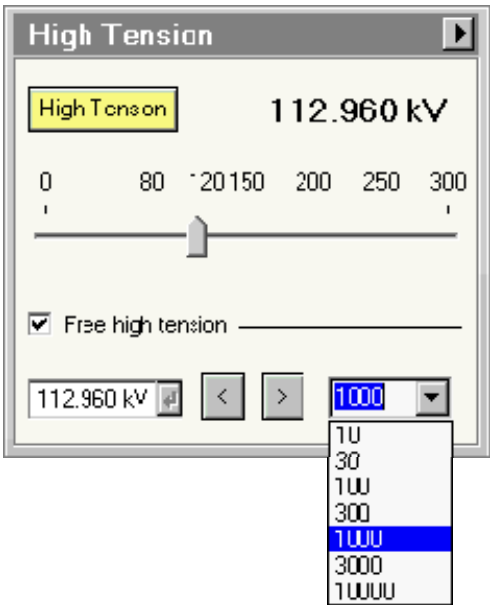
The High Tension Control Panel provides control over the high tension and its setting.

High tension
Pressing the High tension button switches the high tension on and off. The high-tension setting is displayed on the right. The High tension button has three possible settings:
The high tension is enabled but off : the button is 'normal' gray.
The high tension is on : the button is yellow.
The high tension is disabled : the text in the button is gray.

Display value
The high tension display value shows the current high-tension setting. (Note that this is not a measured value.) If the high tension is on the fixed steps, the value is displayed as integer, otherwise (in Free high tension control) it is displayed with three decimals.

High tension setting
The high tension setting is selected by dragging the marker on the high-tension trackbar to the required setting (a range of fixed settings, normally comprising 80, 120, 150, 200, 250 and 300 kV). Settings other than the fixed high tension steps are available through the Free high tension control.

Free high tension
Through the Free high tension control any high-tension setting between 0 and 300 kV can be set with a minimum step size of 10 volts. (Note that at very low high-tension settings below 20 kV the high tension may effectively switch off.) To go to Free high tension control, click on the Free high tension check box. The Control panel will change to the following:



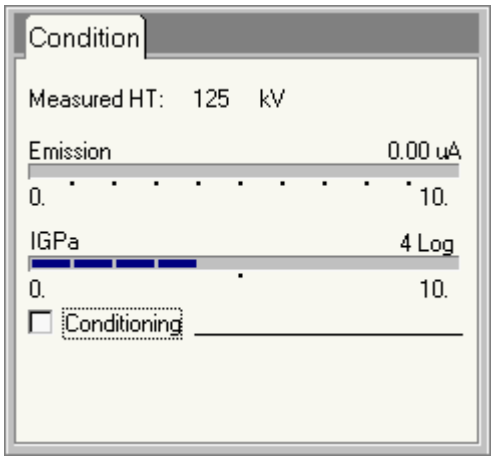
Free high tension value
The Free high tension value is set by changing the number in the edit control. The value set by the microscope will be as close as possible to the value indicated (within the limitations given by the smallest hardware step for the high tension). The high tension is changed only when the Enter button is pressed. The default units expected are in kiloVolts. You can also use Volts but then you have to add the unit for the value typed (V or Volts).

< >
Pressing the <> button instructs the microscope to change the Free high-tension value by the step size indicated.

Free high-tension step
The Free high-tension steps (used by the < > buttons) can be selected from the step drop-down list. When the Free high tension is switched off (by clicking on the check box again), the high tension will go the nearest fixed high tension step that is lower or equal to the Free high tension step.

Flap-out button
Pressing the flap-out button displays the flap-out containing the Conditioning control panel.

30.1 Conditioning



The Conditioning Control Panel.

The Conditioning Control Panel provides the controls needed for conditioning the high tension (the high tension of the microscope can be increased to 110% of the normal maximum to allow the high tension hardware to stabilise). During conditioning the high tension should be increased slowly while monitoring the emission current and IGP display for signs of instability. In case of severe instability, the high tension should be decreased quickly to allow the system to recover.

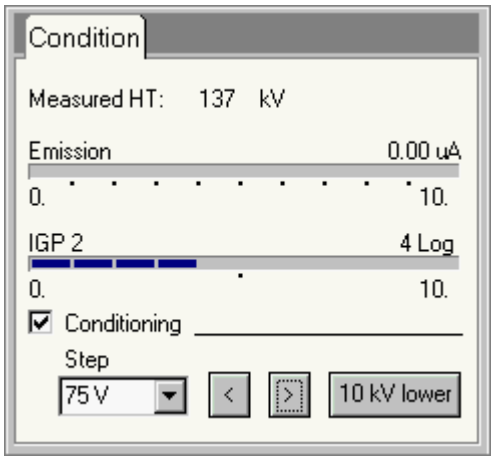
Note: During Conditioning both Spotsize (C1) and Intensity (C2) settings are fixed and cannot be changed.

Measured HT
The Measured HT shows the current measurement of the high tension. This measurement is not accurate (values can differ by 1-2 kV from the nominal value) and is solely meant as a display that the high tension is actually there.

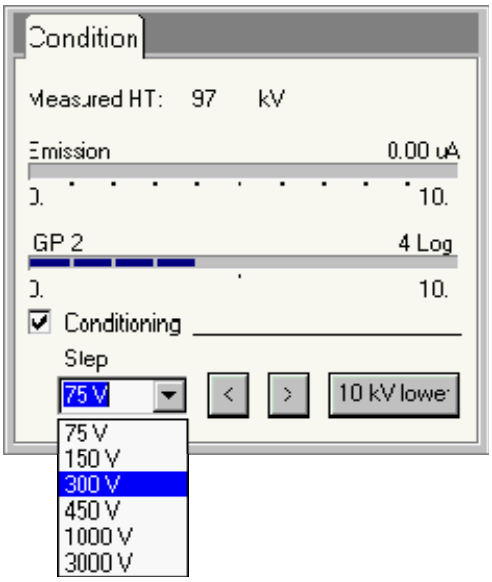
Emission display
The emission display shows the current emission value. During conditioning this display should be monitored for signs of instability.

IGPa display
The IGPa display shows the current IGPa value. The IGPa used is the one that is most sensitive to changes when the high tension becomes unstable. During conditioning this display should be monitored for signs of instability.

Conditioning
When the conditioning check box is checked, the control panel changes and displays the following additional controls:



Step
The step displays the high tension step taken when the < or > button is pressed. Other values can be selected from the list. However, at particular settings of the high tension, the step size will automatically be decreased (for safety) and larger steps will no longer be available.

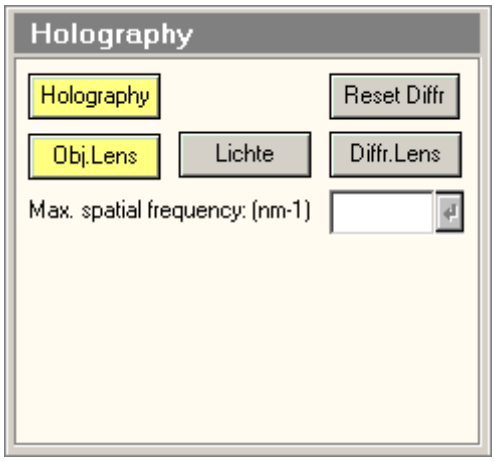


<
Decreases the current high tension value by the step shown.

>
Increases the current high tension value by the step shown. The system regulates the frequency of the steps (it doesn't allow too frequent steps shortly after one another).

10 kV lower
In case of severe instabilities or flash-overs, the 10 kV lower button allows the user to decrease the current high tension quickly to a setting 10 kV below the current one.

31 Holography



The Holography Control Panel.

The Holography Control Panel contains the controls needed for holography. The functionality for holography consists of two parts:

- The ability to change the diffraction lens (in HM imaging or LAD diffraction) or the objective lens (in LM imaging or D diffraction) to create a distance between the first intermediate image and the level of the SA aperture (where the biprism is located) so the biprism fringes can become visible. This setting is specific to the mode and magnification/camera length, so you can define optimum settings for each magnification/camera length independently.
- The Lichte focus function (see further below).

Holography
Pressing the Holography button activates/deactivates holography. If the current microscope setting does have a holography value (for the diffraction or objective lens), that value is activated when holography is activated.

Obj. Lens
Pressing the Obj. Lens button switches the Focus knob to control of the objective lens. When the Focus knob is normally connected to the objective lens (as in HM imaging and LAD diffraction), the situation is the same as with holography off (as far as the control is concerned). Otherwise the Focus knob now controls the special holography setting for the particular LM magnification or D camera length.

Diffr. Lens
Pressing the Diffr. Lens button switches the Focus knob to control of the diffraction lens. When the Focus knob is normally connected to the diffraction lens (as in LM imaging and D diffraction), the situation is the same as with holography off (as far as the control is concerned). Otherwise the Focus knob now controls the special holography setting for the particular HM magnification or LAD camera length.

Reset Diffr
Pressing the reset Diffr. button resets the special holography value for the current magnification/camera length.

Lichte
For holography the Lichte focus defines the optimum focus for achieving a certain spatial resolution. The Lichte focus button provides an easy means of going to the Lichte focus for the spatial frequency desired

(set under the max. spatial frequency). The Lichte focus only has meaning in HM imaging. The Lichte focus function is not compatible with the simultaneous use of the Scherzer focus function.
There are three focus settings on the microscope that are important for high-resolution holography: Gaussian (absolute) focus, minimum-contrast focus and Lichte focus.

Gaussian focus	0 nm
Minimum-contrast focus	~ 0.4 * Scherzer
Lichte focus	$-0.75 * C_s * (q_{max} * \lambda)^2$

where q_{max} is the maximum spatial frequency required.

Note: When the spherical aberration is corrected by a Cs corrector, Minimum contrast focus and Lichte focus are equal to Gaussian focus.

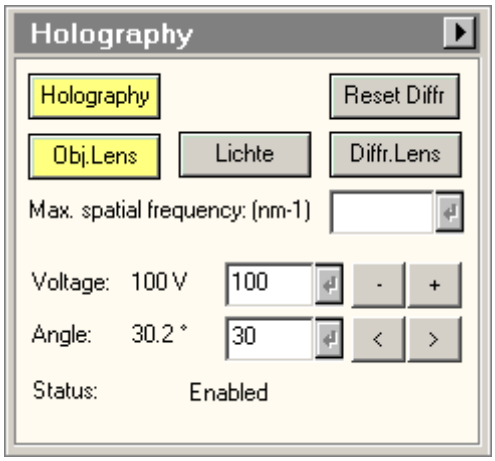
Of the three focus settings only minimum contrast is recognisable at high magnifications and is therefore the only one that can be used as a reference point. However, it should be realised that the uncertainty in the setting of minimum contrast focus is about 5 to 10 nm.
The Lichte function should only be activated when the image is at minimum contrast. The microscope will reset the defocus display value to the correct, absolute value of the Lichte focus. When Lichte is switched off, the focus will return to minimum contrast and the defocus display will read 0.4 * Scherzer. By pressing the Lichte focus the defocus display therefore goes from a relative setting (relative to the last time Reset Df was pressed) to an absolute setting.

	Lichte on	**Lichte off**
Objective-lens focus set	-Lichte + 0.4 * Scherzer	Lichte - 0.4 * Scherzer
Focus display value	Lichte	Δ = Lichte - 0.4 * Scherzer

If the focus is changed with the focus knob while Lichte is active, the change in focus will be added to/subtracted from the value displayed for Lichte focus. If Lichte is then turned off, the display value will add the defocus difference between Lichte and minimum contrast focus.

Max. spatial freq.
The maximum spatial frequency (in inverse nanometers) for Lichte focus is defined by the value in the edit control. If another value is required, change the value and press the enter button to activate the new setting.

31.1 Holography / Biprism



The Holography / Biprism Control Panel.

The Holography Control Panel contains the controls needed for holography and the motorized biprism control.

The functionality for holography consists of three parts:

- The ability to change the diffraction lens (in HM imaging or LAD diffraction) or the objective lens (in LM imaging or D diffraction) to create a distance between the first intermediate image and the level of the SA aperture (where the biprism is located) so the biprism fringes can become visible. This setting is specific to the mode and magnification/camera length, so you can define optimum settings for each magnification/camera length independently.
- The Lichte focus function (see further below).
- Voltage and rotation angle of the biprism. The xy position adjustment of the biprism can done in the apertures control panel.

31.1.1 Holography

Holography
Pressing the Holography button activates/deactivates holography. If the current microscope setting does have a holography value (for the diffraction or objective lens), that value is activated when holography is activated.

Obj. Lens
Pressing the Obj. Lens button switches the Focus knob to control of the objective lens. When the Focus knob is normally connected to the objective lens (as in HM imaging and LAD diffraction), the situation is the same as with holography off (as far as the control is concerned). Otherwise the Focus knob now controls the special holography setting for the particular LM magnification or D camera length.

Diffr. Lens
Pressing the Diffr. Lens button switches the Focus knob to control of the diffraction lens. When the Focus knob is normally connected to the diffraction lens (as in LM imaging and D diffraction), the situation is the same as with holography off (as far as the control is concerned). Otherwise the Focus knob now controls the special holography setting for the particular HM magnification or LAD camera length.

Reset Diffr
Pressing the reset Diffr. button resets the special holography value for the current magnification/camera length.

Lichte
For holography the Lichte focus defines the optimum focus for achieving a certain spatial resolution. The Lichte focus button provides an easy means of going to the Lichte focus for the spatial frequency desired (set under the max. spatial frequency). The Lichte focus only has meaning in HM imaging. The Lichte focus function is not compatible with the simultaneous use of the Scherzer focus function.
There are three focus settings on the microscope that are important for high-resolution holography: Gaussian (absolute) focus, minimum-contrast focus and Lichte focus.

Gaussian focus	0 nm
Minimum-contrast focus	~ 0.4 * Scherzer
Lichte focus	$-0.75 * C_s * (q_{max} * \lambda)^2$

where q_{max} is the maximum spatial frequency required.

Note: When the spherical aberration is corrected by a Cs corrector, Minimum contrast focus and Lichte focus are equal to Gaussian focus.

Of the three focus settings only minimum contrast is recognisable at high magnifications and is therefore the only one that can be used as a reference point. However, it should be realised that the uncertainty in the setting of minimum contrast focus is about 5 to 10 nm.
The Lichte function should only be activated when the image is at minimum contrast. The microscope will reset the defocus display value to the correct, absolute value of the Lichte focus. When Lichte is switched off, the focus will return to minimum contrast and the defocus display will read 0.4 * Scherzer. By pressing the Lichte focus the defocus display therefore goes from a relative setting (relative to the last time Reset Df was pressed) to an absolute setting.

	Lichte on	**Lichte off**
Objective-lens focus set	-Lichte + 0.4 * Scherzer	Lichte - 0.4 * Scherzer
Focus display value	Lichte	Δ = Lichte - 0.4 * Scherzer

If the focus is changed with the focus knob while Lichte is active, the change in focus will be added to/subtracted from the value displayed for Lichte focus. If Lichte is then turned off, the display value will add the defocus difference between Lichte and minimum contrast focus.

Max. spatial freq.
The maximum spatial frequency (in inverse nanometers) for Lichte focus is defined by the value in the edit control. If another value is required, change the value and press the enter button to activate the new setting.

31.1.2 Motorized biprism

The biprism is motorized and can be controlled through the TEM User Interface. The actual selection of the biprism position in the Selected Area aperture holder is int he Apertures control panel. The biprism-specific controls are in the Holography control panel.

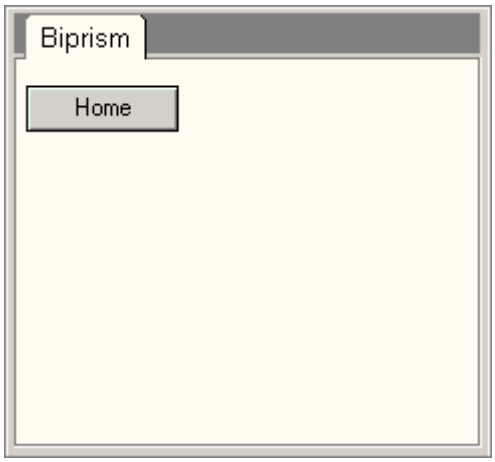
Voltage
The biprism voltage can be set by entering a value or using the '+' and '-' buttons. To preserve the biprism wire the voltage is changed at a certain rate, the actual value is displayed on the left.

Angle
The rotation angle of the biprism can be adjusted by entering a value or by clicking the '<' or '>' buttons.

Status
The status line shows the current status of the biprism.

Flap-out button
Pressing the flap-out button displays the flap-out with the Holography / Biprism Home Control Panel.

31.2 Holography Biprism

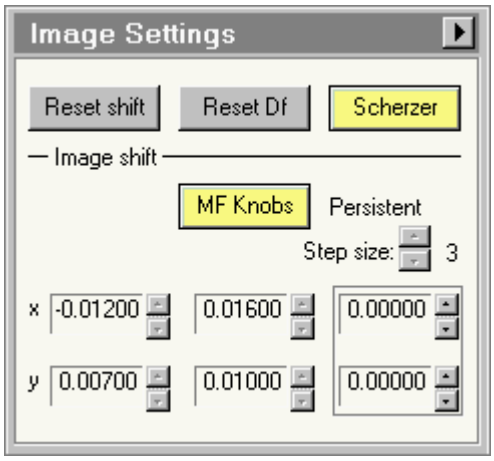


The Holography Biprism Control Panel.

The Holography Biprism Control Panel contains the homing function for the biprism.

Home
Home performs the homing of the biprism. The biprism will be rotated until it finds an end of range, defining the reference position for the biprism rotation angle.

32 Image Settings



The Image Settings Control Panel.

The Image Settings Control Panel contains two sets of controls, general image settings control and the image shift settings.

Flap-out
Pressing the flap-out button displays the flap-out containing the Focus control panel.

32.1 Image settings

Reset shift
Pressing the reset shift button reset all relevant shifts. In imaging this applies to any user-defined image shift (user shift and coupled image-beam shift, see below). In diffraction, the diffraction shift is reset.

Reset Df
Pressing the Reset Df button resets the defocus display value to 0 (the objective or diffraction-lens current itself is not changed).

Scherzer/Contrast
Pressing the Scherzer/Contrast button activates/deactivates the Scherzer or Contrast functions. Which function is used is defined in the Focus control panel of the flap-out. A description of the functions is given below.

Note: The Scherzer/Contrast functions are available only in HM. In other modes the button will be disabled. If you switch from HM with Scherzer or Contrast on to another mode, the button becomes disabled but stays yellow (to indicate that the function is still on in HM; functionally it doesn't anything in the other mode). You can only switch the function off by going back to HM.

Scherzer function
The Scherzer function provides a means for quickly switching to the Scherzer focus and back. Scherzer focus is a focus setting often used in high-resolution imaging. It is the focus where the largest number of diffracted beams have the same phase and therefore the image in thin parts of the specimen will look similar to a projection of the structure.

There are three focus settings on the microscope that are important for high-resolution imaging: Gaussian (absolute) focus, minimum-contrast focus and Scherzer focus.

Gaussian focus	0 nm
Minimum-contrast focus	~0.4 * Scherzer
Scherzer focus	$-1.2 * (Cs * \lambda)^{0.5}$

Note: Because some people use a different definition of Scherzer focus (a constant different from 1.2 as used here), for example 1.0 or 1.1, it is possible to change the constant in the Focus control panel.

Of the three focus settings only minimum contrast is recognisable at high magnifications and is therefore the only one that can be used as a reference point. However, it should be realised that the uncertainty in the setting of minimum contrast focus is about 5 to 10 nm.

The Scherzer function should only be activated when the image is at minimum contrast. The microscope will reset the defocus display value to the correct, absolute value of the Scherzer focus. When Scherzer is switched off, the focus will return to minimum contrast and the defocus display will read 0.4 * Scherzer. By pressing the Scherzer focus the defocus display therefore goes from a relative setting (relative to the last time Reset Df was pressed) to an absolute setting.

	Scherzer on	**Scherzer off**
Objective-lens focus set	0.6 * Scherzer	-0.6 * Scherzer
Focus display value	Scherzer	D = -0.6 * Scherzer

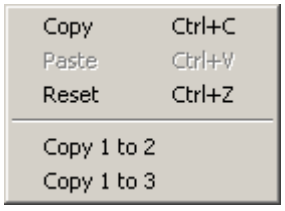
If the focus is changed with the focus knob while Scherzer is active, the change in focus will be added to/subtracted from the value displayed for Scherzer focus. If Scherzer is then turned off, the display value will add the defocus difference between Scherzer and minimum contrast focus.

Contrast function
By applying a certain amount of underfocus the contrast in the TEM image can be enhanced. The increased contrast comes at the expense if image resolution. How much underfocus to apply depends on personal preference (balancing the amount of contrast enhancement needed and how blurry the image can become without losing information required) and the magnification (what may look alright at low magnification looks terribly blurred at high magnification). The microscope offers an automatic function for contrast enhancement. When activated the microscope will apply a certain amount of underfocus, dependent on the choice of the degree of contrast enhancement (in the Focus control panel) by the user (from very low to very high) and the magnification. The function assumes that the image has been set to Gaussian focus (0 nm) before it is activated. Because of the magnification dependence, the amount of defocus will automatically change when the magnification is changed with Contrast enhancement active.

32.2 Image shift

Caution: In the current version of the TEM software there is no software limitation on the amount of image shift allowed (the range of the image deflection coils is the limit). However, it should be realised that working far off-axis can affect the quality of the images due to the normal lens aberrations that occur away from the center of the magnetic lenses (such as coma). For lower-magnification work it is advised not to exceed a few micrometers for recording images, while for high-resolution imaging the image shift should ideally be limited to several hundreds of nanometers (200-300). For looking around the image shift can be used, but it is always advised to record images as close as possible to the center.

Special function: Click with the right-hand mouse button on one of the channels to get a popup-menu.



MF knobs
Pressing the MF knobs button couples (the button turns yellow) or decouples the Multifunction knobs to/from the Image shift. When the Image shift is controlled with the Multifunction knobs, the nature of the coupling (persistent or temporary) is indicated. Pressing the MF knobs is equivalent to clicking with the right-hand mouse button on the binding panel and selecting Image shift for the Multifunction knobs (coupling) or None/clear (decoupling).

Sensitivity
The sensitivity spin buttons set the step size for the image shift. Pressing the Multifunction -/+ buttons is the same as decreasing/increasing the sensitivity when the Multifunction knobs are coupled to the image shift.

Channel
Shift settings can be stored in three channels. The active channel is outlined by a frame around it and by the enabled nature of its spin buttons (the arrows are black; those of the inactive channels are gray).

Spin control
Use the buttons of the spin control to change the Image shift setting (an alternative to using the Multifunction knobs).

32.2.1 Popup menu functions

Copy
Copies the contents of the channel in which the mouse was clicked to the clipboard.

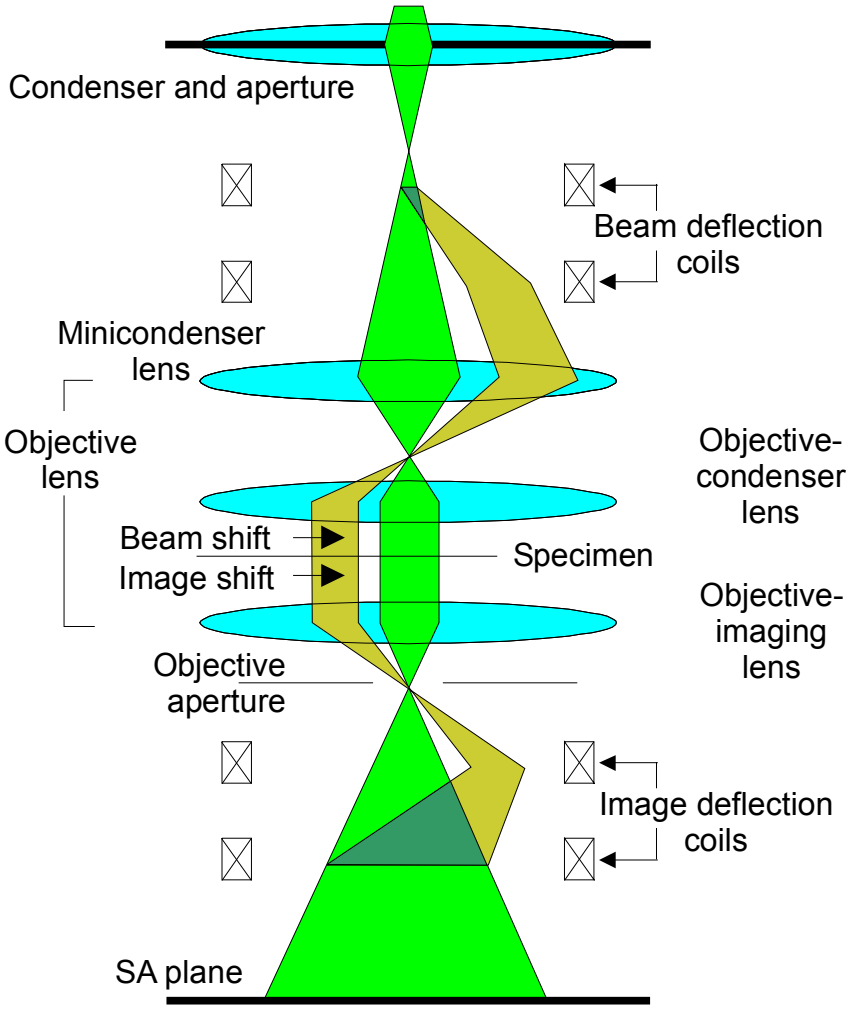
Paste
Pastes the contents of the clipboard into the channel where the mouse was clicked. This menu items remains grayed (disabled) until a copy action has been done.

Reset
Resets the image shift channel to zero.

Copy ... to ...
Copies the content of the channel listed first to the channel listed second. The copy action is always from the channel where the right-hand mouse click was done to one of the other channels.

32.2.2 The image shift

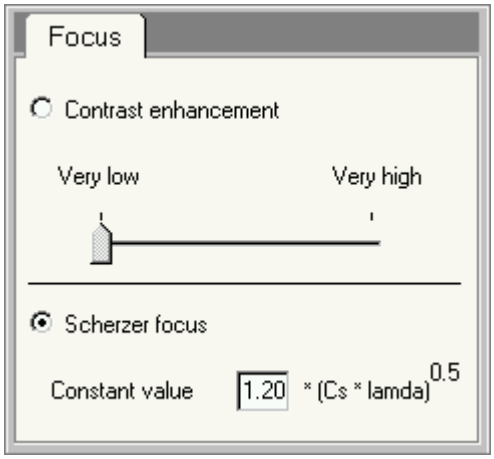
The microscope is equipped with an image shift effected through the image deflection coils. The image shift has a compensating beam shift to keep the illumination centered on the area of interest. The beam shift compensation must be calibrated for the various modes (Microprobe, LM , Nanoprobe) before it will work properly.



When the user shifts the image (from the central green ray path to the off-axis, tan ray path), the microscope automatically applies a compensating beam shift.

Note: The settings of the image shift are not persistent (they are not stored by the microscope when a user logs out; all three channels are reset when the user logs in to the TEM User Interface).

32.3 Image Settings Focus



The Image Settings Focus Control Panel.

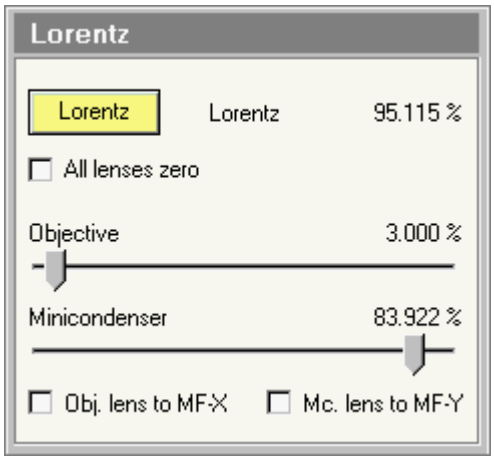
The Image Settings Focus Control Panel contains the parameter settings for the focus functions (Scherzer and Contrast enhancement).

Contrast enhancement / Scherzer focus selection
The two focus functions are accessed via the same button in the Image settings control panel (since their effect is similar and their application totally different, there is no point in having both functions directly accessible. Which function is selected is controlled by the two radio buttons (Contrast enhancement and Scherzer focus). You cannot change the selection when the focus function on the Image settings control panel is active.

Contrast enhancement setting
The slider defines the strength of the contrast enhancement, in five steps, from very low to very high. Higher contrast comes at the expense of resolution (image blurriness).

Scherzer focus
Although Scherzer focus is commonly defined as $1.2 * (Cs * \lambda)^{0.5}$, some people use other constants (like 1.0 or 1.1). You can change the value of the constant to the value you wish to use in the Scherzer focus edit control.

33 Lorentz



The Lorentz Control Panel.

The Lorentz Control Panel contains the controls for the Lorentz mode. In the Lorentz mode the objective-lens function is replaced by the Lorentz lens, a small lens that is located at the bottom of the objective-lens lower pole piece (quite similar to the minicondenser lens).

The Lorentz lens fills an intermediate position between 'objective-lens on' (high magnification values and good resolution) and 'objective-lens off' (low magnification values and poor resolution). Typically attainable maximum magnification values for the Lorentz lens are ~60kx (as opposed to ~3kx for LM) and the resolution is somewhere between 1 and 2 nm. The Lorentz lens thus provides magnifications and resolutions adequate for studying magnetic materials without having the objective lens on (whose field normally wipes out the magnetic structure of the specimen).

The standard mode for imaging is Lorentz microscopy, whereby the magnetic structure is imaged by going under- or overfocus. It is also possible to use the Lorentz lens for Foucault imaging. However in this case an aperture must be used. Since the objective aperture cannot be used due to its position (before the Lorentz lens), the Selected Area aperture must be used. This means changing the optics to bring the Selected Area aperture into the back-focal plane of the Lorentz lens (normally it is in the first intermediate plane) and then changing the Diffraction lens to focus it on the new intermediate image plane of the Lorentz lens. As a rough guide, start off in normal Lorentz imaging. Change the focus step to 9 and go one step underfocus. You should now be close to having a diffraction pattern instead of an image. Fine focus the pattern. Insert the Selected Area aperture to the position needed. Change to diffraction. Set the focus step to 9 and go one step overfocus. You should now be close to focus in a Foucault image. Because of the change in optics the Foucault image is more limited in maximum magnification than the normal Lorentz image.

Lorentz
The Lorentz mode is activated by pressing the Lorentz button. The Lorentz mode is only accessible from the HM Microprobe (Mi, SA, Mh) mode.

Caution: Switch to the Lorentz mode **before** inserting magnetic specimens into the microscope.

Lorentz excitation
The Lorentz excitation displays the excitation value (on a scale of 0-100%) of the Lorentz lens. The setting is controlled via the Focus knob.

All lenses zero
The wall of the microscope column is made of a type of steel that can be made magnetic (as a shielding measure for the inside of the microscope from outside fields). The magnetic fields of all lenses together create a magnetic field at the wall of the column that can be strong enough to destroy or affect the magnetism in specimens when they are inserted into the microscope through the airlock. Always use the

option All lenses zero to switch all lenses to zero when inserting (or removing specimens). Once the specimen is inside the microscope, the wall field will no longer affect the specimen magnetism.

Objective lens
For dynamic experiments it is possible to switch the objective lens on with a user-defined field.

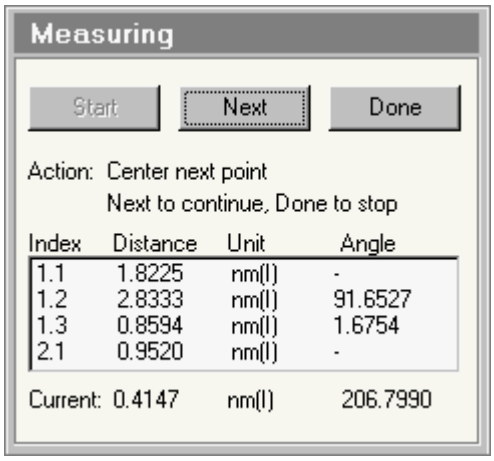
Minicondenser lens
The Minicondenser lens has a weak leak field into the objective-lens gap. It may be desirable to switch the minicondenser lens off. Alternatively the minicondenser lens field can be used to compensate any leak field of the Lorentz lens itself in the objective lens gap. The easiest way to ascertain the presence of leak fields is to tilt a weakly magnetic specimen and observe the behavior of the domain walls. If the domain walls move, there is a residual field in the objective-lens gap. If not, any such residual field is too weak to be detected.
It is also advantageous to switch off the minicondenser lens because this improves the parallelity of the illumination, and thus reduces the variation of focus and astigmatism over the field of view.

Note: The Lorentz minicondenser lens value is decoupled from the normal microprobe/nanoprobe minicondenser setting (and thus has no effect on that setting).

Bind to MF-X
The setting of the objective lens can be coupled to the Multifunction X knob.

Bind to MF-Y
The setting of the minicondenser lens can be coupled to the Multifunction Y knob.

34 Measuring



The Measuring Control Panel.

The Measuring Control Panel is used for on-line measuring on the microscope. On-line measuring can be performed in image mode (giving distances in the image and the angles between the distance vectors) and in diffraction (giving d spacings and the angles between the corresponding lattice planes).

Note: For accurate measurement it is very important that the image shift calibration and diffraction shift calibration have been done properly.

Start
When the Start button is pressed, a measurement cycle is started. Each cycle has its own serial number (the number before the period under Index in the measurement list) and within each measurement cycle individual measurements are also numbered (the number behind the period). Measurement cycles are unique for the current microscope session (the number 1 is used only once, etc.).

Next
When the Next button is pressed, the current measurement values are moved to the measurement list and a new (single) measurement is started.

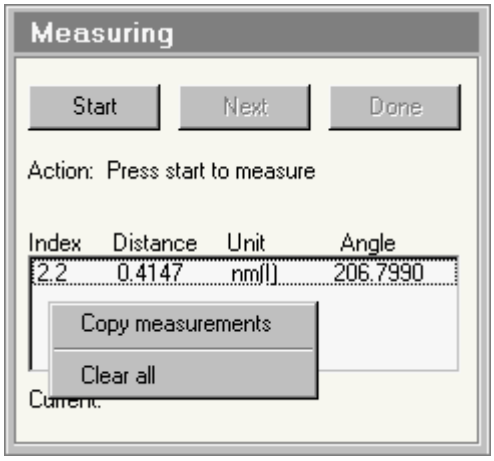
Done
When the Done button is pressed, the current measurement value is moved to the measurement list and the current measurement cycle is closed.

Instructions
Before and during measurement, instructions are listed in the control panel.

Measurement list
The measurement list contains the values of all measurements performed. Each individual measurement occupies a line in the list. Each line contains four items:

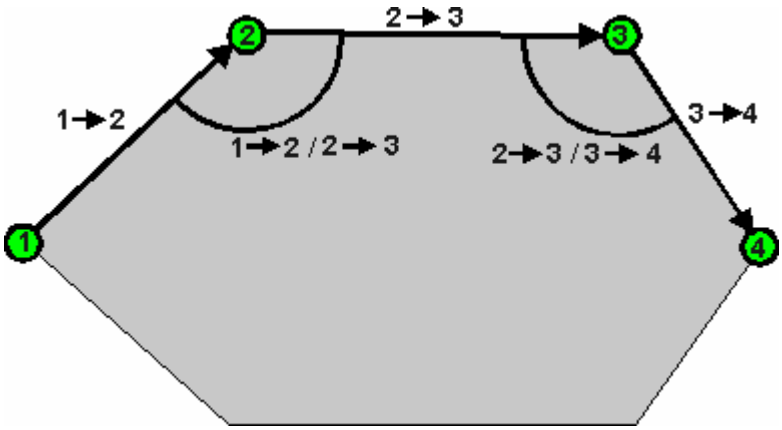
- Index: contains the values of the measurement cycle (before the period) and the individual measurement (after the period). Measurements having the same cycle number belong together in a sequence.
- Distance: the distance value measured (distance in image mode, d spacing in diffraction).
- Unit: the unit (micrometer - um - or nanometer - nm) of the measurement and the mode in which the measurement was done, (I) stands for imaging, (D) for diffraction.
- Angle: the angle between individual measurements of a cycle. These values have different meaning in imaging and diffraction, see the description below.

Current
The values listed under Current show the values of the measurement currently being done.



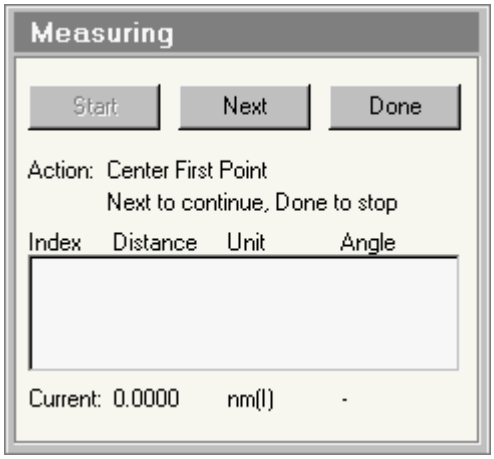
When the right-hand mouse button is clicked on the measurement list, a popup menu becomes visible that allows copying of all the measurements currently in the list to the clipboard (from where it can be pasted into Notepad, for example) or to clear all measurements (empty the list).

34.1.1 Measuring in imaging

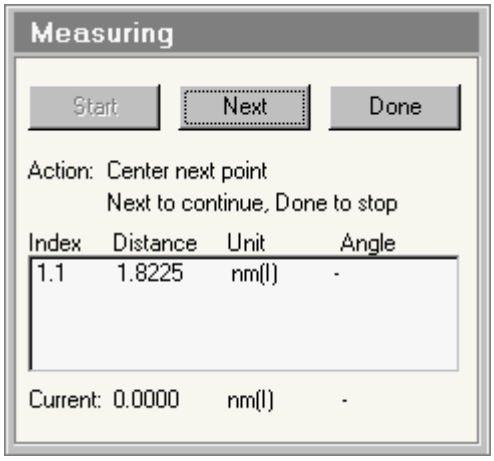


Schematic diagram of measuring in imaging, showing the vectors of consecutive measurements and the meaning of the angles.

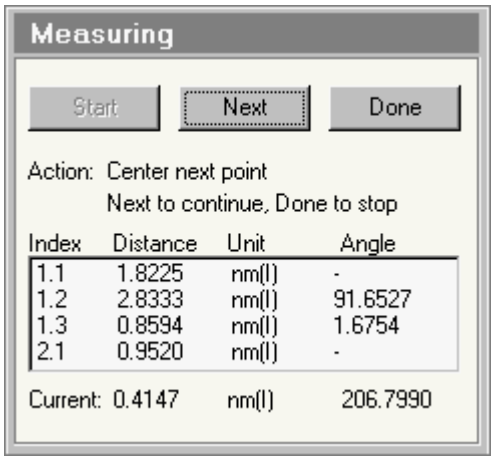
Note: The image shift used for measuring is not the one with the compensating beam shift. During measuring the beam will move off with the image and must be recentered if the measuring goes beyond the edge of the beam.



After the Start button has been pressed, the Multifunction knobs can be used to center a first image feature on the screen. Once the image feature has been centered, the Next button is pressed.



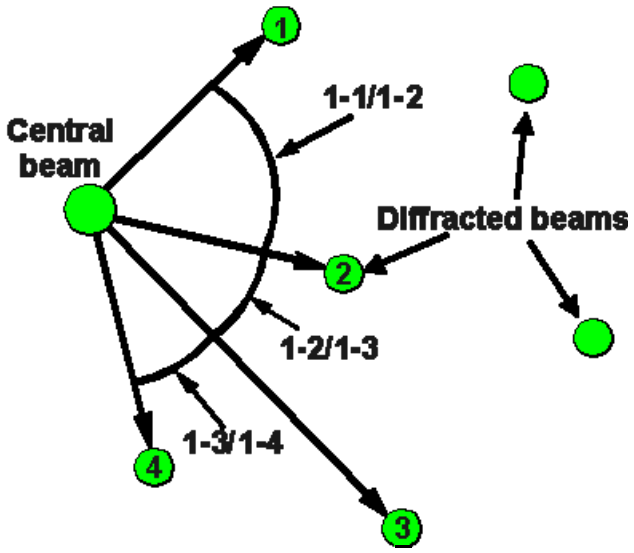
When the Next button has been pressed, the measurement is moved to the list and a next feature can be centered.



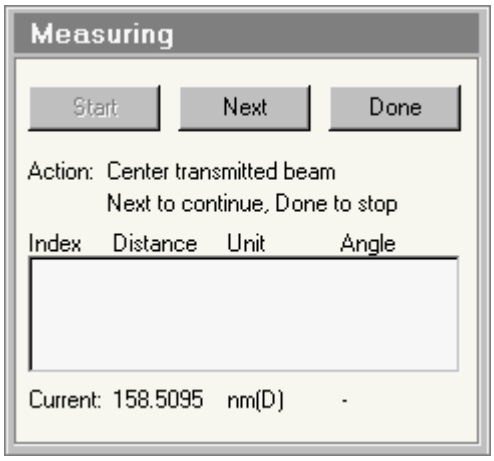
Measurements can be continued as long as is necessary by pressing Next once each new point has been centered.

34.1.2 Measuring in diffraction

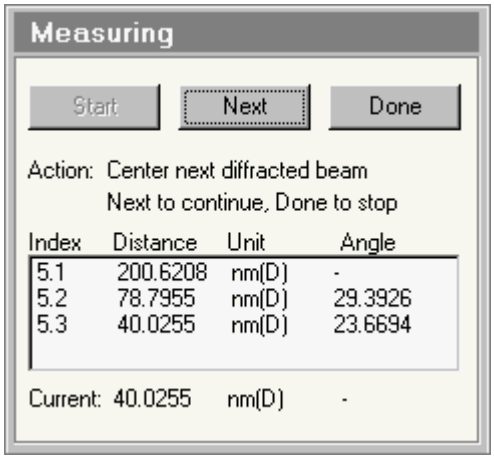
Measuring in diffraction in essence works the same as in imaging, but with one major difference. In diffraction all measurements are done relative to the transmitted (central) beam. In imaging the vectors are 1-2, 2-3, 3-4, etc., while in diffraction they are 1-2, 1-3, 1-4, etc. The reason for this difference is very simple: when defined in this way, the angles are the angles between the lattice planes in the crystal structure.



Schematic diagram of measuring in diffraction. All vectors are relative to the central beam.

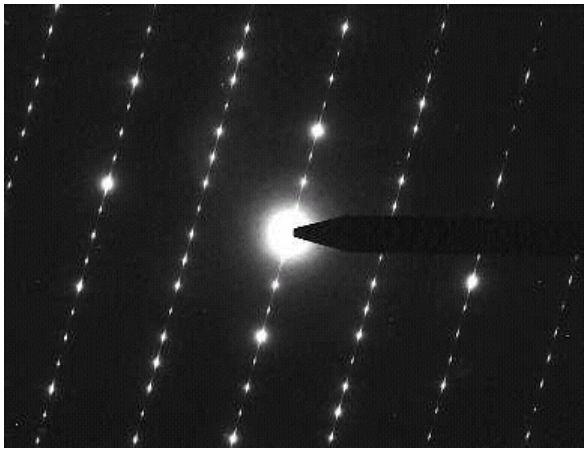


To measure in diffraction, press the Start button and center the central (transmitted) beam on the screen.

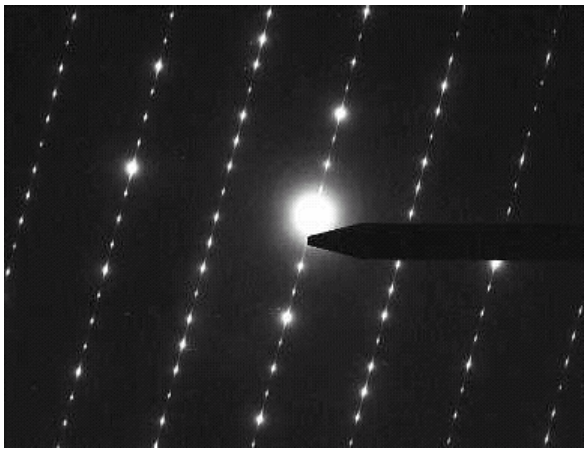


Once the central beam has been centered, press Next. Center the first diffracted on the screen and press Next to repeat the measurement for further diffracted beam.

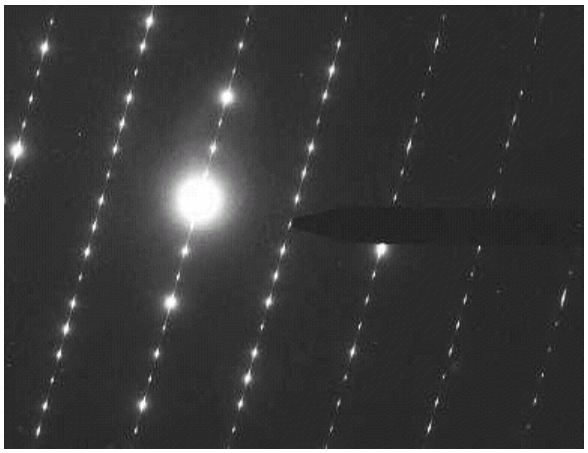
The images below show diffraction measuring using the beam stop as reference point.



The central beam has been moved to the tip of the beam stop.

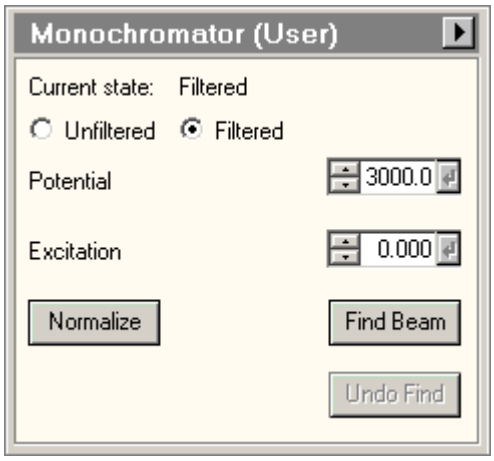


A diffraction beam has been moved to the beam stop. Now the d spacing for the diffracted is displayed.



A second diffracted beam has been moved to the beam stop, and the d spacing of this second beam as well as the angle between diffracted beams 1 and 2 is displayed.

35 Monochromator (User)



The Monochromator Control Panel.

The Monochromator Control Panel contains the main control functions of the monochromator.
For a step by step procedure for setting up for using the monochromator, see the monochromator manual.

State control
With these radio buttons one can choose between two states for the monochromator

- **Unfiltered**: Monochromator supplies are on. It is assumed that the user does not want to monochromize the beam. The excitation is set to zero and cannot be changed. The spot-size dependent gun-shifts are optimized such that the movement of the beam at the sample is minimal when spot size is changed.
- **Filtered**: Monochromator supplies are on. It is assumed that the user wants to monochromize the beam. The excitation control is enabled. The spot-size dependent gun-shifts are optimized such that the movement of the beam at the monochromator slit is minimal when spot size is changed.

Potential
With the Potential control, the beam potential inside the monochromator is selected. Its voltage supply can deliver any value between 300 and 3600 V. However, the software accepts only those values for which the present Excitation can be realized.

Excitation
The Excitation control sets the strength of the deflection fields inside the monochromator. It is a dimensionless number between and 0 and 2.3.

Normalize
Pressing the Normalize button starts a sweep of the magnetic deflection field of the monochromator. The field goes from its present value to its maximum value, then to its minimum value, and back to its present value. The total sweep takes about 10 seconds. The monochromator alignments apply this normalization, so it is advised to use always the proper normalization. This is most easily done by selecting the default option “Automatic Normalization” of the Settings flap-out (see next section).

Find Beam
Pressing the Find Beam button starts an automatic sweep of the monochromator shift offsets. The sweep halts as soon as the beam is detected on the viewing screen or when it has reached its maximum range. The sweep can be interrupted by pressing the Find Beam again. Parameters controlling the sweep pattern can be set in the FindBeam flap-out (see next section).

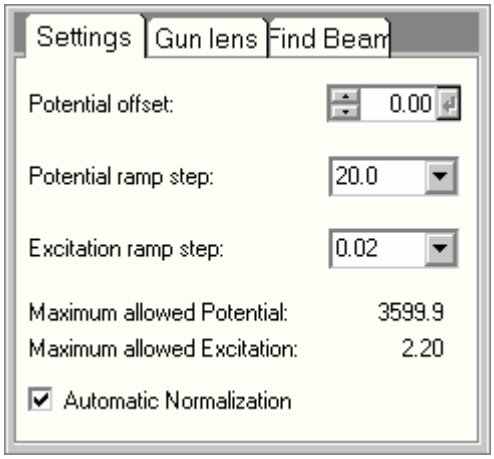
Note: If the beam is just gone but should be visible (it was just there previously), simply press Find Beam. If you are not certain that the beam would be visible on the main screen even if the monochromator settings would not prevent it from being seen, switch to conditions that make it more likely that the beam will be found :

- Select a suitable mode (TEM) and spot number (low number)
- Lower the magnification
- Press Reset beam
- If possible, partially retract the specimen so it is out of the way
- Remove all apertures than can be retracted
- For C2, if you are certain the largest C2 aperture is well-aligned, select the largest C2 aperture. Otherwise do no change apertures.

Undo Find
The Undo Find button becomes available after a Find Beam action. Pressing the Undo Find button will reset the monochromator shift offsets to their values before the Find Beam action was started.

Flap-out button
Pressing the flap-out button displays the flap-out containing the Settings, Gun lens and Find Beam control panels.

35.1 Monochromator Settings (User)



The Monochromator Settings Control Panel.

In the Settings flap-out options can be set which relate to the main operation controls of the monochromator.

Potential offset
With this spin-enter-edit controlan offset (in Volts) can be set on the monochromator potential. This offset can be used to calibrate the dispersion of the monochromator since it gives a shifting of the beam in the dispersed direction equal to the offset divided by the dispersion.

Potential ramp step
When the Potential control in the monochromator panel is set to a new value, the actual potential ramps to this new value with steps of which the size is set by the Potential ramp step control (in Volts). The Potential ramp step is also the step with which the potential is changed when the spin button of the Potential control is pressed in the Monochromator panel.

Excitation ramp step
When the Excitation control in the monochromator panel is set to a new value, the actual excitation ramps to this new value with steps of which the size is set by the Excitation ramp step control (in

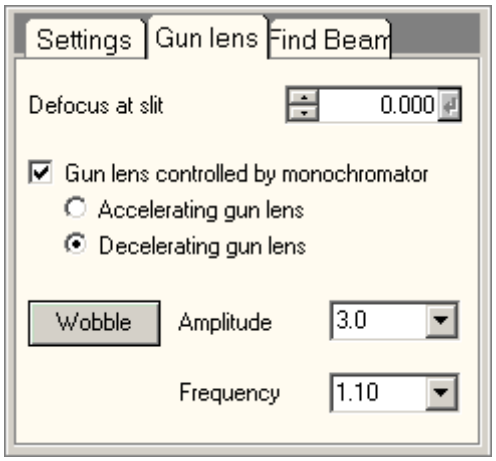
radians). The Excitation ramp step is also the step with which the excitation is changed when the spin button of the Excitation control is pressed in the Monochromator panel.

Maximum allowed Potential
This is the maximum monochromator potential (in Volts) that can be set at the present excitation. The potential is in most cases limited by the maximum that the monochromator potential supply can deliver (namely 3600V). However, at high excitations it is limited by the maximum that the supplies for the monochromator deflection fields can deliver.

Maximum allowed Excitation
This is the maximum excitation (in radians) that can be set at the present potential.

Automatic Normalization
When the Automatic Normalization option is selected, the magnetic deflection is automatically normalized each time when the excitation is lowered. It is recommended to select this option.

35.2 Monochromator Gun lens (User)



The Monochromator Gun lens Control Panel.

When the energy selection slit is used, it is essential to focus the dispersed beam in the plane of this slit. The focussing is done with the gun lens. The software which controls the monochromator can calculate which gun lens strength is needed for this focus. In the Gun lens flap-out options can be set which relate to this calculation.

Defocus at slit
For special applications it can be desirable not to focus in the plane of the energy selection slit. With the Defocus at slit control one can choose the size of the defocus (in meters) at this plane.

Gun lens controlled by monochromator
When this option is not selected, the gun lens is set through the Gun lens control in FEG panel (as in a standard TEM).
When this option is selected (which is default), the gun lens is automatically set by the monochromator software to the value which is needed to have the dispersed beam focused on the energy selection slit. This option is automatically selected when one switches the monochromator to the unfiltered or filtered state.

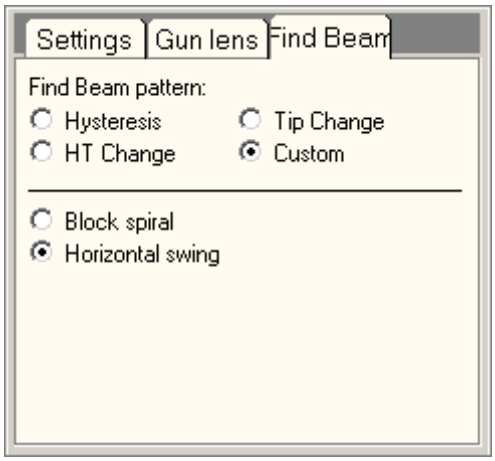
Accelerating gun lens
When the gun lens is used as an accelerating lens, the potential of the gun lens electrode is higher than the potential of the monochromator. As a consequence, most of the focusing action of the gun lens takes place at the entrance plane of the monochromator. At this plane, the gun lens aberrations are very small. Moreover, the Coulomb interactions are relatively small due to the high potential in the gun lens. Therefore, this mode gives the highest brightness and highest energy resolution. However, the total current in the beam is only a few nA. Due to the limited voltage supply of the gun lens, the accelerating

gun lens can only focus at the slit when the monochromator potential is around or below 1kV. Use this mode for STEM or for (sub)-0.1eV TEM experiments.

Decelerating gun lens
When the gun lens is used as an decelerating lens, the potential of the gun lens electrode is lower than the potential of the monochromator. As a consequence, most of the focusing action of the gun lens takes place at the gun lens electrode. At this plane, the gun lens aberrations can be quite noticeable. The total current in the beam can be up to 50 nA. Use this mode for all TEM applications which do not require the ultimate resolution.

Wobble, Amplitude and Frequency
When the wobble button is pressed, the voltage on the gun lens will be wobbled according to the parameters set with the Amplitude and Frequency controls. Wobbling the gun lens can be helpful for stigmating the (dispersed) image at the energy selection slit, or for finding the beam.

35.3 Monochromator Find Beam (User)



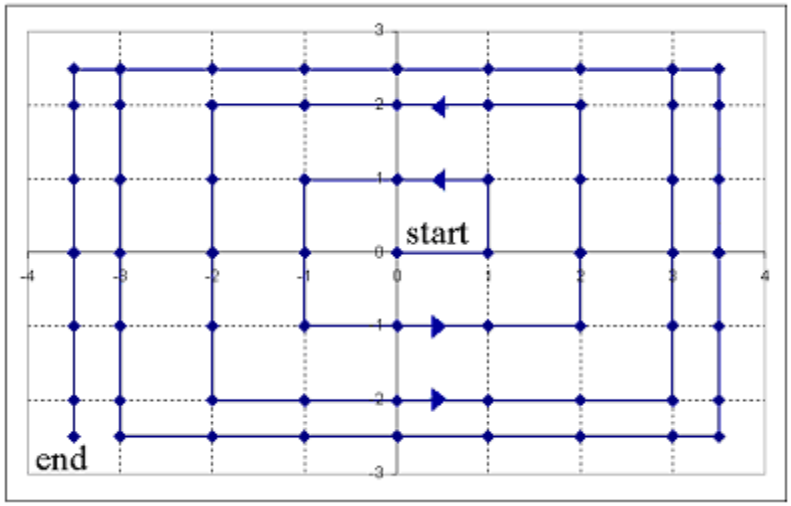
The Monochromator Find Beam Control Panel.

The beam can be missing due to wrong deflections in the monochromator. In this case, the Find Beam routine can help finding the beam. Pressing the Find Beam button starts an automatic sweep of the monochromator shift offsets which halts as soon as the beam is detected on the viewing screen, or when the maximum ranges of the sweep have been reached. Options of this sweep are set in the Find Beam flap-out.

Find Beam pattern
The user can select the following beam patterns:

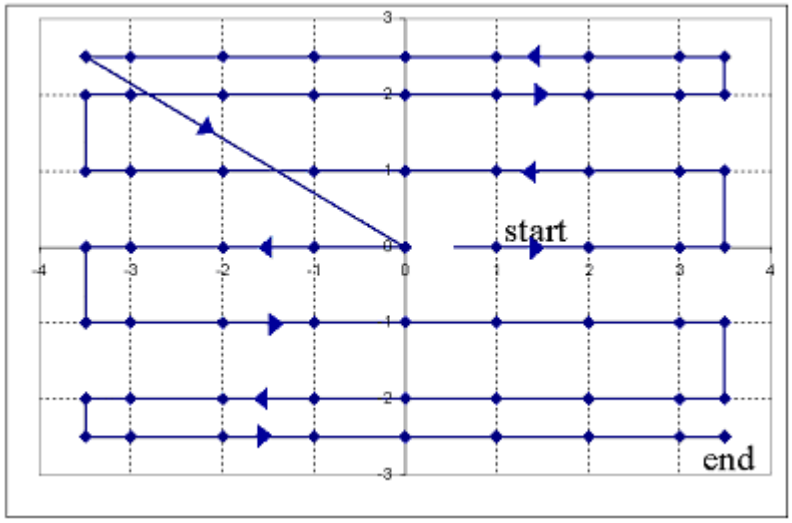
- Hysteresis: for finding a beam which is probably lost due to hysteresis. The beam is swept up and down in the dispersive direction.
- HT Change: for finding a beam which is probably not far away. The beam is swept over a small square area around the present position.
- Tip Change: for finding a beam which is at different position (e.g., because of a tip change). The beam is swept over a large square area around the present position. This can take a few minutes.
- Custom: use the following controls to define one’s own beam pattern:

Block spiral



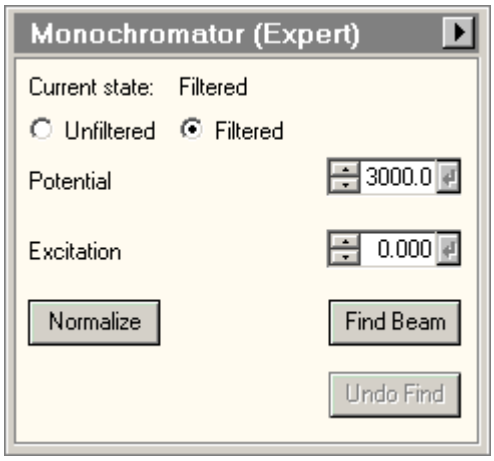
The block spiral starts from the current position and spirals outward.

Horizontal swing



The horizontal swing starts from the current position and goes back and forward in the x-direction, each time at a different y-shift. Use this pattern if you expect that the beam has gone due to hysteresis.

36 Monochromator (Expert)



The Monochromator Control Panel.

The Monochromator Control Panel contains the main control functions of the monochromator.
For a step by step procedure for setting up for using the monochromator, see the monochromator manual.

State control
With these radio buttons one can choose between two states for the monochromator

- **Unfiltered:** Monochromator supplies are on. It is assumed that the user does not want to monochromize the beam. The excitation is set to zero and cannot be changed. The spot-size dependent gun-shifts are optimized such that the movement of the beam at the sample is minimal when spot size is changed.
- **Filtered:** Monochromator supplies are on. It is assumed that the user wants to monochromize the beam. The excitation control is enabled. The spot-size dependent gun-shifts are optimized such that the movement of the beam at the monochromator slit is minimal when spot size is changed.

Potential
With the Potential control, the beam potential inside the monochromator is selected. Its voltage supply can deliver any value between 300 and 3600 V. However, the software accepts only those values for which the present Excitation can be realized.

Excitation
The Excitation control sets the strength of the deflection fields inside the monochromator. It is a dimensionless number between and 0 and 2.3.

Normalize
Pressing the Normalize button starts a sweep of the magnetic deflection field of the monochromator. The field goes from its present value to its maximum value, then to its minimum value, and back to its present value. The total sweep takes about 10 seconds. The monochromator alignments apply this normalization, so it is advised to use always the proper normalization. This is most easily done by selecting the default option “Automatic Normalization” of the Settings flap-out (see next section).

Find Beam
Pressing the Find Beam button starts an automatic sweep of the monochromator shift offsets. The sweep halts as soon as the beam is detected on the viewing screen or when it has reached its maximum range. The sweep can be interrupted by pressing the Find Beam again. Parameters controlling the sweep pattern can be set in the FindBeam flap-out (see next section).

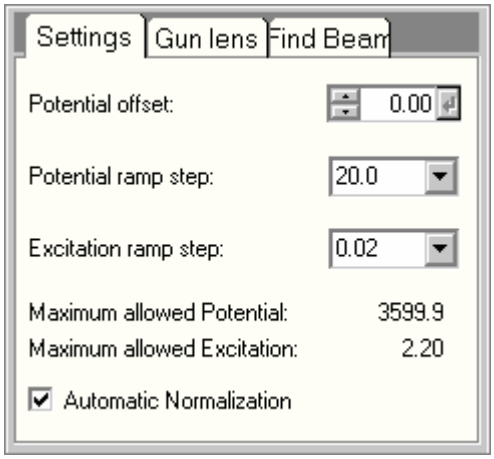
Note: If the beam is just gone but should be visible (it was just there previously), simply press Find Beam. If you are not certain that the beam would be visible on the main screen even if the monochromator settings would not prevent it from being seen, switch to conditions that make it more likely that the beam will be found :

- Select a suitable mode (TEM) and spot number (low number)
- Lower the magnification
- Press Reset beam
- If possible, partially retract the specimen so it is out of the way
- Remove all apertures than can be retracted
- For C2, if you are certain the largest C2 aperture is well-aligned, select the largest C2 aperture. Otherwise do no change apertures.

Undo Find
The Undo Find button becomes available after a Find Beam action. Pressing the Undo Find button will reset the monochromator shift offsets to their values before the Find Beam action was started.

Flap-out button
Pressing the flap-out button displays the flap-out containing the Settings, Gun lens and Find Beam control panels.

36.1 Monochromator Settings (Expert)



The Monochromator Settings Control Panel.

In the Settings flap-out options can be set which relate to the main operation controls of the monochromator.

Potential offset
With this spin-enter-edit control an offset (in Volts) can be set on the monochromator potential. This offset can be used to calibrate the dispersion of the monochromator since it gives a shifting of the beam in the dispersed direction equal to the offset divided by the dispersion.

Potential ramp step
When the Potential control in the monochromator panel is set to a new value, the actual potential ramps to this new value with steps of which the size is set by the Potential ramp step control (in Volts). The Potential ramp step is also the step with which the potential is changed when the spin button of the Potential control is pressed in the Monochromator panel.

Excitation ramp step
When the Excitation control in the monochromator panel is set to a new value, the actual excitation ramps to this new value with steps of which the size is set by the Excitation ramp step control (in

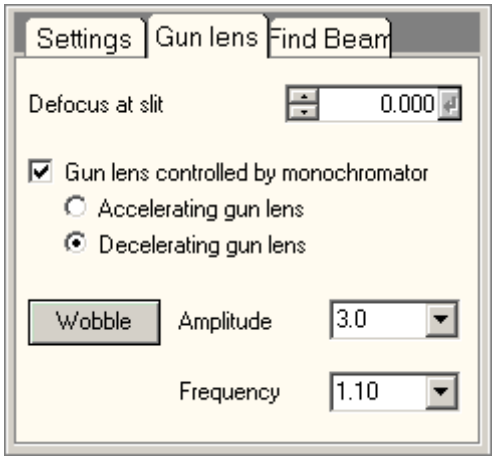
radians). The Excitation ramp step is also the step with which the excitation is changed when the spin button of the Excitation control is pressed in the Monochromator panel.

Maximum allowed Potential
This is the maximum monochromator potential (in Volts) that can be set at the present excitation. The potential is in most cases limited by the maximum that the monochromator potential supply can deliver (namely 3600V). However, at high excitations it is limited by the maximum that the supplies for the monochromator deflection fields can deliver.

Maximum allowed Excitation
This is the maximum excitation (in radians) that can be set at the present potential.

Automatic Normalization
When the Automatic Normalization option is selected, the magnetic deflection is automatically normalized each time when the excitation is lowered. It is recommended to select this option.

36.2 Monochromator Gun lens (Expert)



The Monochromator Gun lens Control Panel.

When the energy selection slit is used, it is essential to focus the dispersed beam in the plane of this slit. The focussing is done with the gun lens. The software which controls the monochromator can calculate which gun lens strength is needed for this focus. In the Gun lens flap-out options can be set which relate to this calculation.

Defocus at slit
For special applications it can be desirable not to focus in the plane of the energy selection slit. With the Defocus at slit control one can choose the size of the defocus (in meters) at this plane.

Gun lens controlled by monochromator
When this option is not selected, the gun lens is set through the Gun lens control in FEG panel (as in a standard TEM).
When this option is selected (which is default), the gun lens is automatically set by the monochromator software to the value which is needed to have the dispersed beam focused on the energy selection slit. This option is automatically selected when one switches the monochromator to the unfiltered or filtered state.

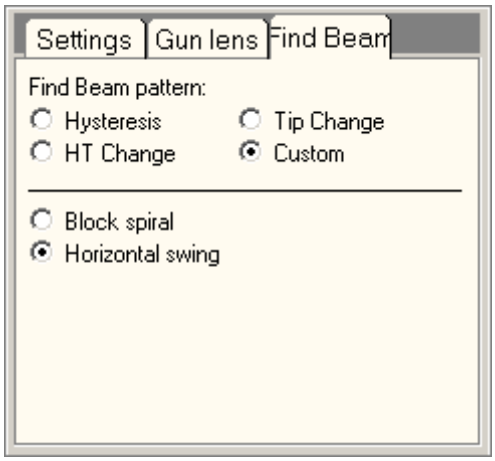
Accelerating gun lens
When the gun lens is used as an accelerating lens, the potential of the gun lens electrode is higher than the potential of the monochromator. As a consequence, most of the focusing action of the gun lens takes place at the entrance plane of the monochromator. At this plane, the gun lens aberrations are very small. Moreover, the Coulomb interactions are relatively small due to the high potential in the gun lens. Therefore, this mode gives the highest brightness and highest energy resolution. However, the total current in the beam is only a few nA. Due to the limited voltage supply of the gun lens, the accelerating

gun lens can only focus at the slit when the monochromator potential is around or below 1kV. Use this mode for STEM or for (sub)-0.1eV TEM experiments.

Decelerating gun lens
When the gun lens is used as an decelerating lens, the potential of the gun lens electrode is lower than the potential of the monochromator. As a consequence, most of the focusing action of the gun lens takes place at the gun lens electrode. At this plane, the gun lens aberrations can be quite noticeable. The total current in the beam can be up to 50 nA. Use this mode for all TEM applications which do not require the ultimate resolution.

Wobble, Amplitude and Frequency
When the wobble button is pressed, the voltage on the gun lens will be wobbled according to the parameters set with the Amplitude and Frequency controls. Wobbling the gun lens can be helpful for stigmating the (dispersed) image at the energy selection slit, or for finding the beam.

36.3 Monochromator Find Beam (Expert)



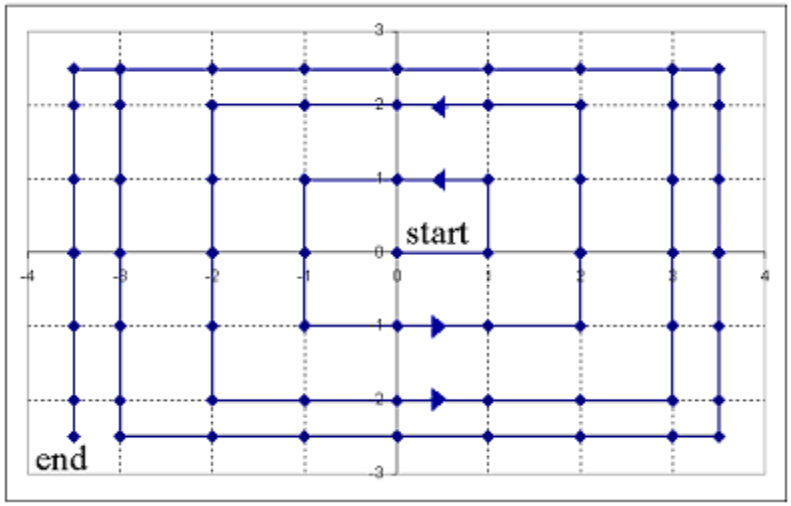
The Monochromator Find Beam Control Panel.

The beam can be missing due to wrong deflections in the monochromator. In this case, the Find Beam routine can help finding the beam. Pressing the Find Beam button starts an automatic sweep of the monochromator shift offsets which halts as soon as the beam is detected on the viewing screen, or when the maximum ranges of the sweep have been reached. Options of this sweep are set in the Find Beam flap-out.

Find Beam pattern
The user can select the following beam patterns:

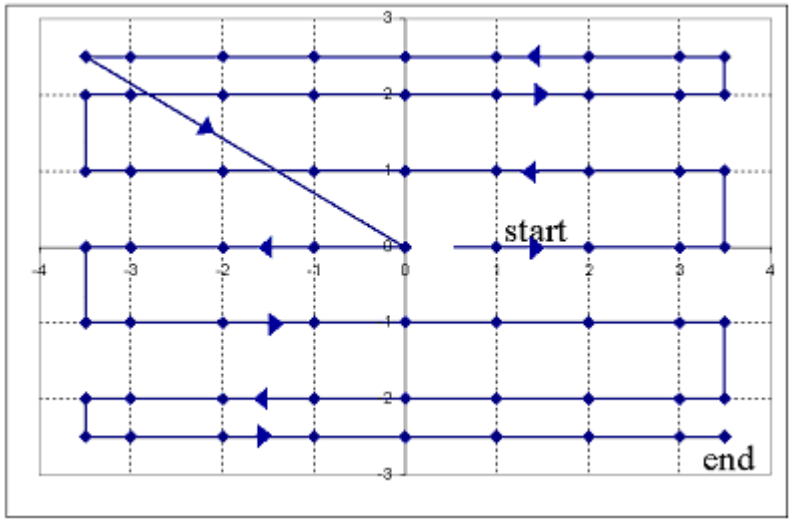
- Hysteresis: for finding a beam which is probably lost due to hysteresis. The beam is swept up and down in the dispersive direction.
- HT Change: for finding a beam which is probably not far away. The beam is swept over a small square area around the present position.
- Tip Change: for finding a beam which is at different position (e.g., because of a tip change). The beam is swept over a large square area around the present position. This can take a few minutes.
- Custom: use the following controls to define one’s own beam pattern:

Block spiral



The block spiral starts from the current position and spirals outward.

Horizontal swing

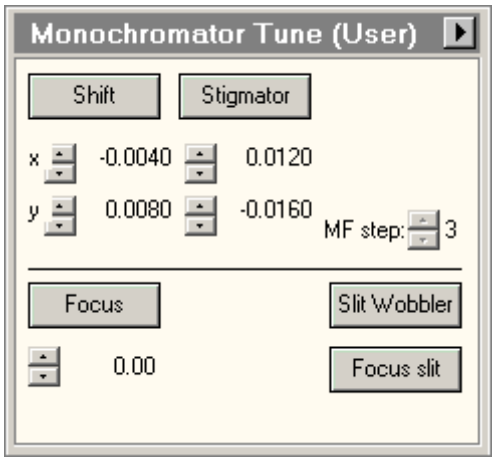


The horizontal swing starts from the current position and goes back and forward in the x-direction, each time at a different y-shift. Use this pattern if you expect that the beam has gone due to hysteresis.

Step size for shift x and shift y
These controls are for the shift sizes of the steps with which the Find Beam routine sweeps. Since Shift-x is the step of the monochromator's magnetic field (in mT) and Shift-y is the step of the monochromator's electric correction field (in V/mm), equal numbers in the x and y field do not correspond to equal deflection angles. It is advised to use step-x =0.0010 - 0.0020 and step-y=0.1000 - 0.2000.

Maximum for shift x and shift y
These controls determine the boundary of the pattern with which the Find Beam routine sweeps. Since the hysteresis effect in shift-x is about 0.1000, it is not very useful to use maximum x values large than 0.2000. Entering very large values for these controls can lead to very long search times, since the number of steps is about 3 per second.

37 Monochromator Tune (User)



The Monochromator Tune panel.

The Monochromator Tune panel contains the controls for aligning the monochromator:

- The position with which the beam exits the monochromator (and consequently, with which the beam hits the monochromizing slit) can be adjusted with the shift buttons. The x shift adjusts the main magnetic field (displayed in mT) which results in a shift in the direction of the dispersion of the monochromator. The y shift adjusts an electrostatic deflection (displayed in V/mm) perpendicular to the dispersion.
- The astigmatism of the beam at the monochromizing slit can be adjusted with the monochromator stigmator buttons. The x stigmator stigmates in the direction of the dispersion. The y stigmator stigmates in the direction rotated 45 degrees from the dispersion. Both stigmating fields are in V/mm^2.
- The position of the focus of the dispersed spot can be adjusted with the focus control. This button sets an offset on the gun lens (in V).

The monochromator shift, stigmator, and focus can be stored in the alignment tables by pressing the Store buttons. The section on the Offsets flap-out will explain this functionality in detail.

Shift
When the Shift button is pressed, the multi-function buttons get connected to the monochromator User shift offsets.

Note: For some applications, the smallest step of monochromator-shift can be too large. Finer shifts can be made with the 'User gun shift' which is available in the Direct Alignments control panel (see chapter 18).

Stigmator
When the stigmator button is pressed, the multi-function buttons get connected to the monochromator User stigmator offsets.

Focus
When the Focus button is pressed, the intensity button gets connected to the gun lens offset.

Slit Wobbler
An easy way to focus the monochromizing slit is to switch on the Slit Wobbler (which wobbles the gun shift) and to minimize the movement of the image of the slit by adjusting the C2 lens (=Intensity button).

Focus Slit
When Focus Slit is pressed the condenser system is preset to a setting that focuses the slit at the level of the specimen.

Flap-out button
Pressing the flap-out button displays the flap-out containing the Offsets and Outputs control panels.

37.1 Monochromator Tune Offsets (User)

The Monochromator Tune Offsets Control Panel.

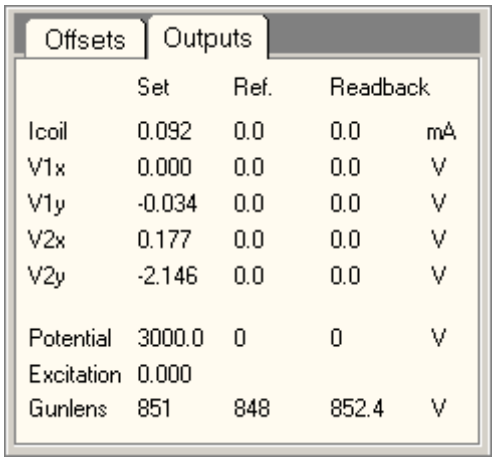
The Offsets flap-out lists three columns of offsets. The first column shows the Stored offset, the second column lists the User offsets, and the third column lists the Total offset which is the sum of the Stored offset and the User offset.

The Stored offsets are saved in the alignment file (see File flap-out of the Alignment panel) and are restored by selecting the monochromator part of the alignment file.
The User offsets are set in Monochromator Tune panel, either by using their spin controls or by using the Multifunction knobs.
The Total offsets can be saved with FEG Registers.
There are two different alignment tables for the monochromator offsets, one for the accelerating gun lens, one for decelerating gun lens.

Reset
When the Reset button is pressed, all Stored offsets are deleted. The User offsets are adjusted such that the Total offsets do not change for the present settings.

Default
When the Default button is pressed, a simple factory alignment (consisting of only a few stored values) is set. The User offsets are adjusted such that the Total offsets do not change for the present settings.

37.2 Monochromator Tune Outputs (User)

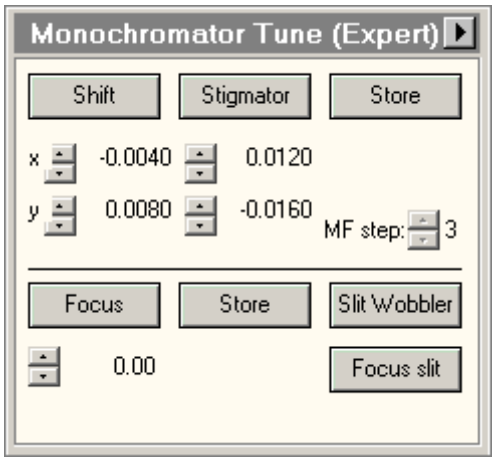


The Monochromator Tune Outputs Control Panel.

The Outputs flap-out can be used by Service to check the supplies of the monochromator. These are the supplies for the main magnetic deflection field (Icoil), the main electric deflection field (V1x), the perpendicular deflection field (V1y), the two stigmator fields (V2x and V2y), and the monochromator and gun lens potential. The flap-out also lists the present excitation.

The first column lists the values that are sent to the DACs. The second column lists the measured values that are sent from the DACs to the power amplifiers (this can be used to check the communication between the PC and monochromator supplies at HT). The last column lists the values that are actually measured at the outputs of the amplifiers (these can be used to check the amplifiers).

38 Monochromator Tune (Expert)



The Monochromator Tune Control Panel.

The monochromator Tune panel contains the controls for aligning the monochromator:

- The position with which the beam exits the monochromator (and consequently, with which the beam hits the monochromizing slit) can be adjusted with the shift buttons. The x shift adjusts the main magnetic field (displayed in mT) which results in a shift in the direction of the dispersion of the monochromator. The y shift adjusts an electrostatic deflection (displayed in V/mm) perpendicular to the dispersion.
- The astigmatism of the beam at the monochromizing slit can be adjusted with the monochromator stigmator buttons. The x stigmator stigmates in the direction of the dispersion. The y stigmator stigmates in the direction rotated 45 degrees from the dispersion. Both stigmating fields are in V/mm^2.
- The position of the focus of the dispersed spot can be adjusted with the focus control. This button sets an offset on the gun lens (in V).

The monochromator shift, stigmator, and focus can be stored in the alignment tables by pressing the Store buttons. The section on the Offsets flap-out will explain this functionality in detail.

Shift
When the Shift button is pressed, the multi-function buttons get connected to the monochromator User shift offsets.

Note: For some applications, the smallest step of monochromator-shift can be too large. Finer shifts can be made with the 'User gun shift' which is available in the Direct Alignments control panel (see chapter 18).

Stigmator
When the stigmator button is pressed, the multi-function buttons get connected to the monochromator User stigmator offsets.

Store (next to Shift and Stigmator)
When this Store button is pressed, the User shift offsets and User stigmator offsets are made permanent by replacing the stored offset values by the sum of the User offsets and the old stored offsets. After this replacement, the User shift and User stigmator offsets are set to zero. The Total shift and stigmator offsets do not change.

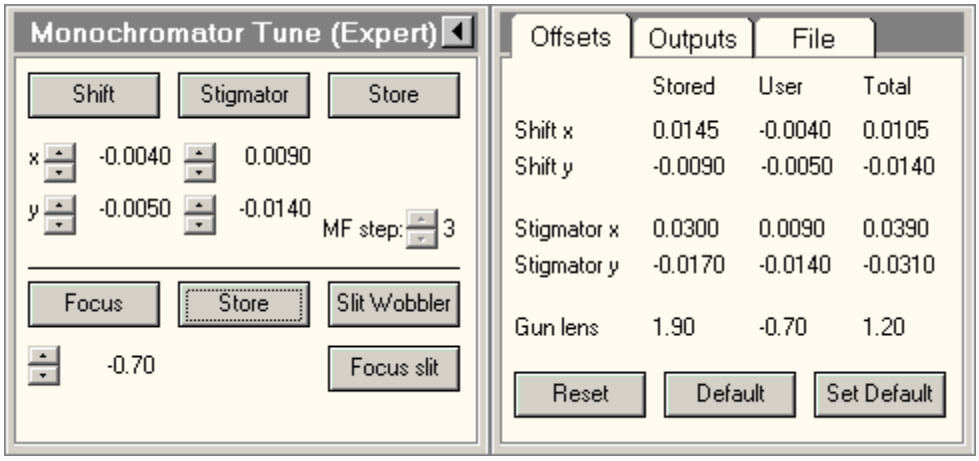
Focus
When the Focus button is pressed, the intensity button gets connected to the gun lens offset.

Store (next to Focus)
When this Store button is pressed, the User Gun lens offset is made permanent by replacing the stored offset value by the sum of the User offset and the old stored offset. After this replacement, the User Gun lens offset is set to zero. The Total gun lens offset does not change.

Slit Wobbler
An easy way to focus the monochromizing slit is to switch on the Slit Wobbler (which wobbles the gun shift) and to minimize the movement of the image of the slit by adjusting the C2 lens (=Intensity button).

Focus Slit
When Focus Slit is pressed the condenser system is preset to a setting that focuses the slit at the level of the specimen.

Flap-out button
Pressing the flap-out button displays the flap-out containing the Offsets, Outputs and File control panels.



38.1 Monochromator Tune Offsets (Expert)

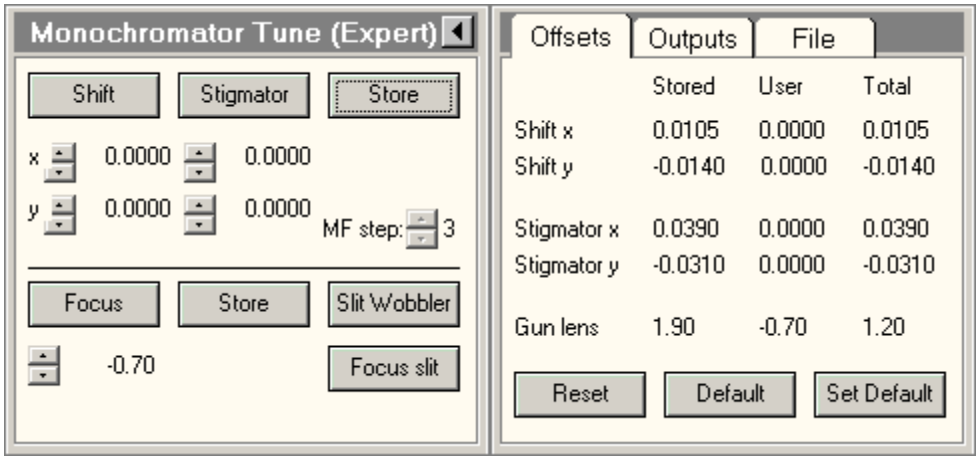
The Monochromator Tune Offsets Control Panel.

The Offsets flap-out lists three columns of offsets. The first column shows the Stored offset, the second column lists the User offsets, and the third column lists the Total offset which is the sum of the Stored offset and the User offset.

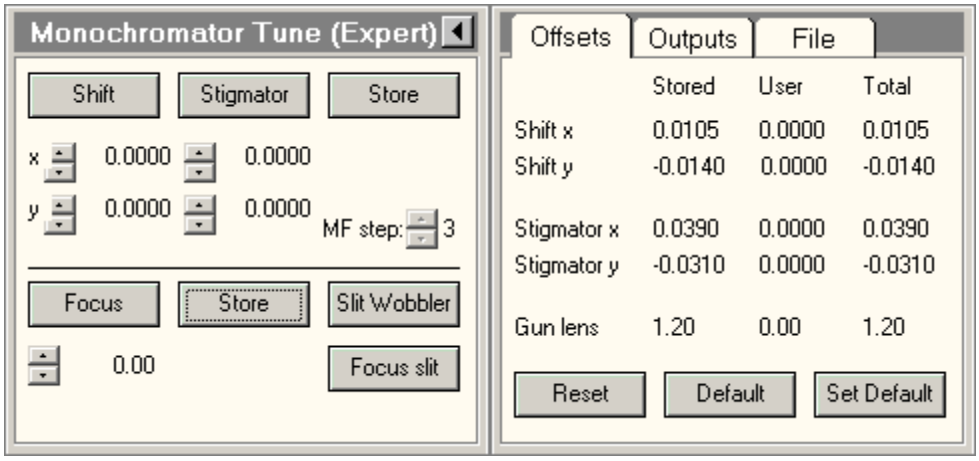
The Stored offsets are saved in the alignment file (see File flap-out of the Alignment panel) and are restored by selecting the monochromator part of the alignment file.

The User offsets are set in Monochromator Tune panel, either by using their spin controls or by using the Multifunction knobs.

The Total offsets can be saved in the File flap-out or with FEG Registers.



When the Store (Shift, Stigmator) button is pressed, the Stored Shift and Stigmator offsets are replaced by the sum of the Stored Shift and Stigmator offsets and the User Shift and Stigmator offsets. Next, the User Shift and Stigmator offsets are set to zero. The Total Shift and Stigmator offsets do not change.



When the Store (focus) button is pressed, the Stored Focus offset is replaced by the sum of the Stored Focus offset and the User Focus offset. Next, the User Focus offset is set to zero. The Total Focus offsets do not change.

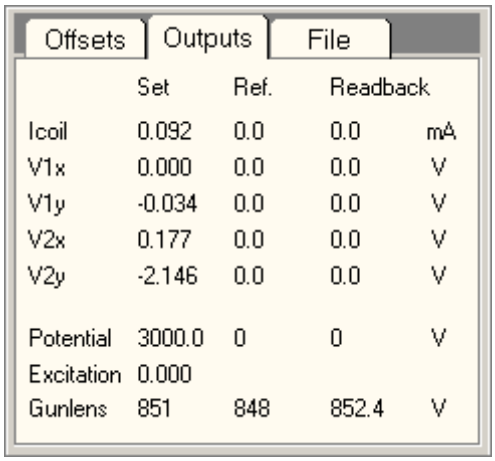
Initially, when no alignments have been stored, all Stored offsets are zero. When only one store has been made at some particular setting A (characterized by the monochromator potential and excitation), and the user changes to a different setting B, the routine will use the Stored offsets from A at B (taking into account a scaling with the monochromator potential).
When two stores have been made at settings A and B, and the user changes to a different setting C, the routine will linearly inter- or extrapolate the stored offsets at A and B to C (taking into account a scaling with the monochromator potential).
When three or more stores have been made, and the user changes to a new setting, the routine will quadratically inter- or extrapolate the stored offsets at the three nearest settings to get to the new setting (again taking into account a scaling with the monochromator potential).
There are two different alignment tables for the monochromator offsets, one for the accelerating gun lens, one for decelerating gun lens.

Reset
When the Reset button is pressed, all Stored offsets are deleted. The User offsets are adjusted such that the Total offsets do not change for the present settings.

Default
When the Default button is pressed, a simple factory alignment (consisting of only a few stored values) is set. The User offsets are adjusted such that the Total offsets do not change for the present settings.

Set Default
When this button is pressed, the present Stored offsets are set as the default Stored offsets. The User offsets are adjusted such that the Total offsets do not change for the present settings.

38.2 Monochromator Tune Outputs (Expert)

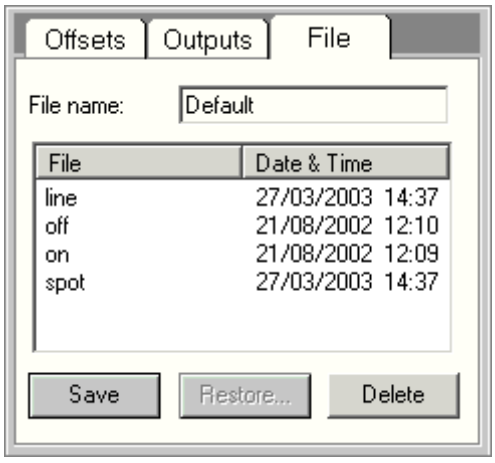


The Monochromator Tune Outputs Control Panel.

The Outputs flap-out can be used by Service to check the supplies of the monochromator. These are the supplies for the main magnetic deflection field (Icoil), the main electric deflection field (V1x), the perpendicular deflection field (V1y), the two stigmator fields (V2x and V2y), and the monochromator and gun lens potential. The flap-out also lists the present excitation.

The first column lists the values that are sent to the DACs. The second column lists the measured values that are sent from the DACs to the power amplifiers (this can be used to check the communication between the PC and monochromator supplies at HT). The last column lists the values that are actually measured at the outputs of the amplifiers (these can be used to check the amplifiers).

38.3 Monochromator Tune File



The Monochromator Tune File Control Panel.

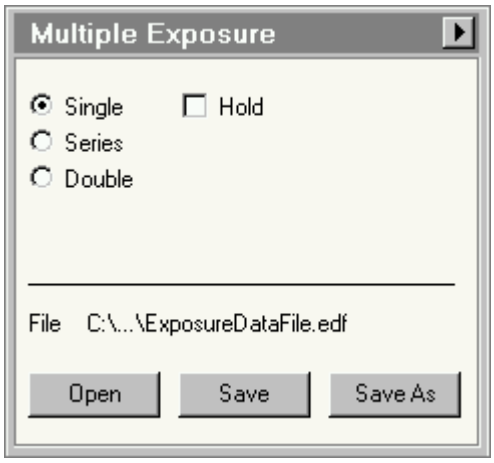
The monochromator settings (potential, excitation, total shift, total stigmator offset, gun lens, accelerating/decelerating mode, unfiltered/filtered mode) can be saved in and restored from files. It should be noted that this flap-out is superfluous when settings are stored and recalled with FEG Registers.

Save
Favorite settings can be saved by typing a name in the File name field and pressing Save.

Restore
Settings can be restored by clicking on the desired file name and pressing Restore. The Restore function adjusts the User offsets such that the Total offsets correspond to the saved values.

Delete
Settings can be deleted by clicking on the desired file name and pressing Delete.

39 Multiple Exposure



The Multiple Exposure Control Panel.

The Multiple Exposure Control Panel contains the controls used for recording multiple exposures. Multiple exposure can either be in series (a set of exposures on separate plates with user-defined focus values) or as double (a set of exposures on the same plate with user-defined exposure times).

Multiple exposure selection
The type of multiple exposure selection is chosen through one of the three radio buttons, Single (the normal default), Series or Double. The latter two radio buttons are only enabled when proper settings have been entered for them in the Series and Double control panels of the flap-out.

Note: If the Multiple Exposure control panel is not selected into the user-interface (through Workspace layout), the Multiple exposure setting by definition is single.

Hold
If the user selects a multiple exposure method that deviates from the default (single), the microscope will use the method set. If Hold is not checked, this new settings applies only to the next (series of) exposure(s). Afterwards the microscope will reset to the default method. To keep the method as selected by the user for more than one exposure, check the Hold option. If Hold is on, the method will stay as set until the user changes the selection or switches Hold off.

Saving/loading multiple exposure data to/from file
The multiple exposure settings can be saved to a file and reloaded later. This function can be useful when the same type of multiple exposures is recorded repeatedly. When a filename has been defined (either through a load or save) the name is displayed on the control panel.

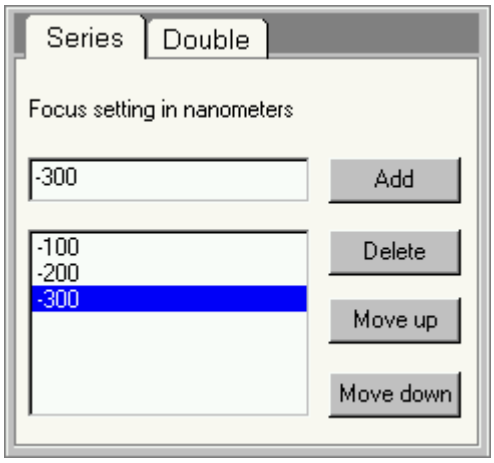
Open
When the Open button is pressed, a standard Open File dialog will come up, where a file can be selected for reloading. The current series and double settings lists will be cleared and the values from the file entered in the lists.

Save
When the Save button is pressed, the settings are stored in a file. If a filename had been defined previously (through either Save, Save As or Open), that is the file under which the values will be saved. If no filename has been defined yet, a standard Save File dialog will come up, where a filename (and folder) can be set.

Save As
When the Save button is pressed, a standard Save File dialog will come up, where a filename (and folder) can be set. The current setting list will be saved in that file.

Multiple exposure flap-out
Pressing the arrow button displays the flap-out containing the Series and Double control panels.

39.1 Series



The Multiple Exposure Series Control Panel.

The series panel contains settings used for automated through-focus series. The through-focus series is totally flexible. It simply will execute as many exposures as there are entries in the list, changing the focus by the amount in the list for the particular setting. Multiple entries with the same value, or the value 0 are allowed. It is also allowed to enter a single non-zero value In that case each exposure will be made with the focus offset by the specified amount (making it e.g. possible to focus to minimum contrast - close to zero or Gaussian focus - and have each image recorded at -1000 nm).

Note: The focus settings are not absolute but are values relative to the focus set when the exposure series is started.

Focus setting
The Focus settings list is filled by entering values for the focus (underfocus is taken as negative) in the Focus setting edit control in nanometers and pressing the Add button.

Focus settings list
The Focus settings list contains the list of values used for the through-focus series.

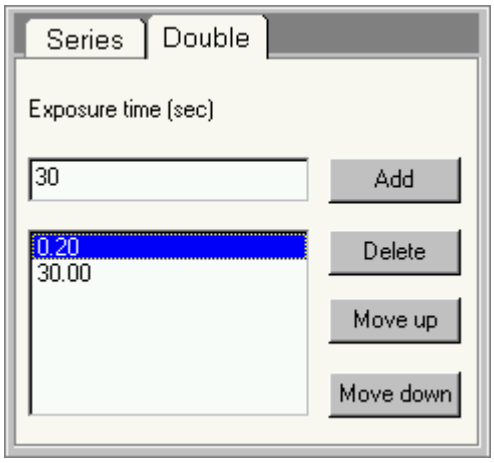
Add button
The Add button allows insertion of a new setting into the focus settings list. The value for the new focus must be inserted into the Focus setting edit control. The maximum number of values is 20.

Delete button
The Delete button allows removal of settings from the list. Select a setting and press Delete.

Move up
The through-focus exposures are recorded in the sequence as they occur in the list. To change the sequence, select a setting and press Move up to move it up in the list.

Move down
The through-focus exposures are recorded in the sequence as they occur in the list. To change the sequence, select a setting and press Move down to move it down in the list.

39.2 Double



The Multiple Exposure Double Control Panel.

The double panel contains settings used for recording double exposure (multiple exposures on a single plate). The double exposure setup is totally flexible. It simply will execute as many exposures as there are entries in the list, changing the exposure times as indicated in the list for the particular setting.

The double exposure sequence is similar to that for a normal exposure except that the plate is not removed until the last double exposure has been done (or the exposure is cancelled). After one exposure has been recorded, further execution pauses until the operator presses the Exposure button (on the left-hand TEM Control Pad) again. Pressing this button while an exposure is taking place cancels further exposure, otherwise it starts the next exposure in the sequence. The dimmed screen will display a message alerting the operator to press Exposure to start the next exposure.

Between individual exposures of a double exposure sequence, it is possible to lower the screen and look at the image.

Exposure time
The exposure times list is filled by entering values for the exposure time (in seconds) in the exposure time edit control and pressing the Add button.

Exposure times list
The exposure times list contains the list of values used for the double exposure times. The maximum number of values is 20.

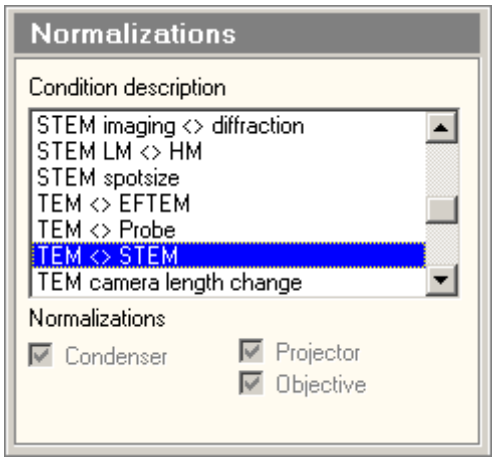
Add button
The Add button allows insertion of a new setting into the exposure times list. The value for the new exposure time must be inserted into the exposure time edit control.

Delete button
The Delete button allows removal of settings from the list. Select a setting and press Delete.

Move up
The double exposures are recorded in the sequence as they occur in the list. To change the sequence, select a setting and press Move up to move it up in the list.

Move down
The double exposures are recorded in the sequence as they occur in the list. To change the sequence, select a setting and press Move down to move it down in the list.

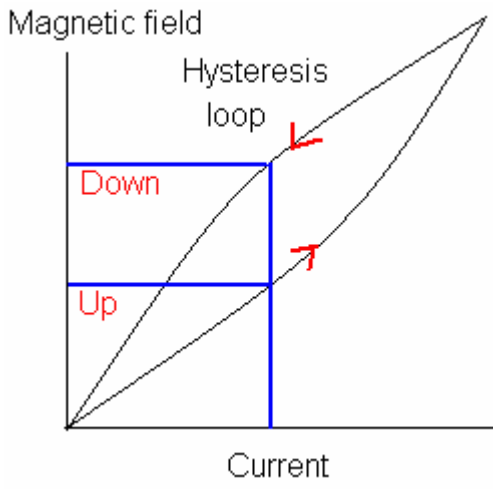
40 Normalizations



The Normalizations Control panel.

The Normalizations Control Panel provides control over the normalizations executed by the microscope.
Note: Because normalizations are essential to obtaining proper and reproducible optical settings, microscope users cannot change the selections applied. Only service and factory can temporarily switch normalizations off (the changes are discarded when the Titan user interface is closed).

40.1 Introduction to normalizations



Magnetic lenses suffer from hysteresis, which causes a certain degree of non-reproducibility of the magnetic fields, dependent on the direction of change. The diagram below sketches how the magnetic field changes when the current through the lens coils goes up (lower curve) and goes down (upper curve). When the current goes up, the field increases but 'lags' somewhat behind. The opposite occurs when the lens current goes down. Therefore the effective field is higher when going down than when going up.

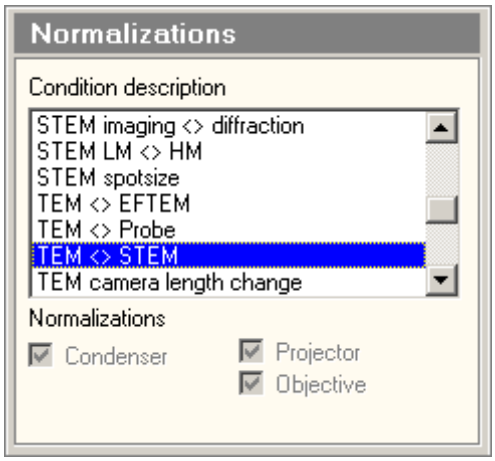
Hysteresis can have appreciable effects on the illumination system (condenser lenses) and the magnification system (projector lenses) and as a consequence affect the spot position (illumination system) as well as the true magnification or camera length (magnification system). The image or diffraction shifts used for the image/diffraction alignment and the cross-over alignment (for Energy-Filtered TEM) can also be sensitive to the actual values of the magnetic fields of the lenses in the magnification system.

In order to make the lens fields more reproducible, the lens normalization is executed. In the normalization procedure the lens(es) involved is (are) taken through a sequence completely up - then completely down - completely up again - and then down to the required value. The normalization brings the lenses to more reproducible settings - and, as a consequence, more reproducible magnifications/camera lengths, image/diffraction shifts and cross-over corrections.

Normalizations can be executed by hand (e.g. by assigning projector normalization to one of the Control Pad user buttons) and/or automatically. The automatic normalizations are determined by the settings in the Normalizations control panel. Because automatic normalizations can be done for a number of different conditions, it is possible that more than one normalization is done. The system has been made such that it doesn't start a new normalization while another normalization is still being executed, but only

executes one final normalization. Thus, if automatic normalizations occur for each change in magnification step, then a normalization will be done for each individual step only if the magnification is changed very slowly. Otherwise the following happens:

- Change magnification -> execute normalization
- Normalization has started, magnification changed again
- x times magnification changed again, previous normalization still running
- Previous normalization finished, no more magnification changes
- Execute one final normalization



Condenser
When Condenser is checked for the normalization condition in the list selected, the condenser lenses will be normalized when the condition (from the list) is encountered.

Projector
When Projector is checked for the normalization condition in the list selected, the Projection system (Diffraction, Intermediate, Projector 1 and Projector 2 lens) will be normalized when the condition (from the list) is encountered.

Objective
When Objective is checked for the normalization condition in the list selected, the Objective lens will be normalized when the condition (from the list) is encountered.

List of normalizations
The list of normalizations contains a series of possible conditions (changes in system settings) that can lead to automatic normalizations. Each of these conditions can have normalizations associated for condenser, projector and/or objective. Associated normalizations have their check boxes enabled. All lenses selected for normalization are normalized together.
The list in the control panel is arranged alphabetically, so STEM-, EFTEM- and Lorentz-related items can come between the TEM conditions (dependent on the hardware configuration of the microscope). In the table below, the STEM and EFTEM conditions are listed separately from the TEM conditions for clarity.

TEM Conditions	Description	Default normalizations
TEM camera length change	When changing camera length	Projector
TEM eucentric focus HM diffraction	When eucentric focus is pressed in HM diffraction (D)	Objective, Projector
TEM eucentric focus HM imaging	When eucentric focus is pressed in HM (SA, Mh) imaging	Objective, Projector
TEM eucentric focus LM diffraction	When eucentric focus is pressed in LM diffraction (LAD)	Objective, Projector
TEM eucentric focus LM imaging	When eucentric focus is pressed in LM imaging	Objective, Projector
TEM imaging <> diffraction	When switching between imaging (SA, Mh or LM) and diffraction (D or LAD)	Objective, Projector
TEM LM <> SA	When switching between LM (objective lens off) and SA (objective lens on)	Objective, Projector
TEM magnification change	When changing magnification (LM, SA, Mh)	Condenser, Projector
TEM SA <> Mh	When changing between SA and Mh	Objective, Projector
TEM spot number	When changing spot number setting	Condenser
uP <> nP	When changing between microprobe and nanoprobe modes	Condenser, Objective, Projector
TEM <> Probe	When switching between parallel and probe illumination	Condenser

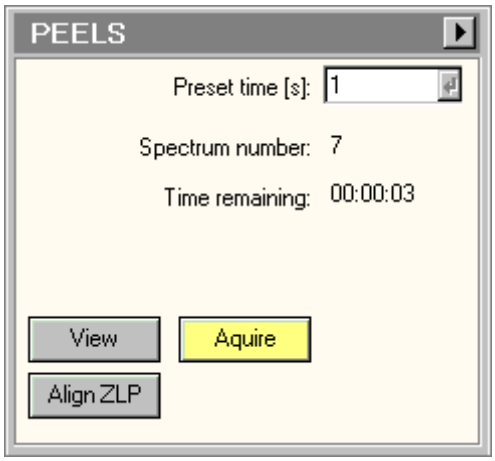
STEM-related Conditions	Description	Default normalizations
STEM camera length change	When changing camera length	Projector
STEM eucentric focus diffraction	When eucentric focus is pressed in STEM (TEM diffraction)	Objective, Projector

STEM eucentric focus imaging	When eucentric focus is pressed in STEM (TEM imaging)	Objective, Projector
STEM imaging <> diffraction	When switching between TEM imaging and diffraction in STEM (press Diffraction button)	Projector
STEM LM <> HM	When switching between LM-STEM and HM-STEM	Objective, Projector
STEM spot number	When changing spot number in STEM	Condenser
TEM <> STEM	When switching between TEM and STEM	Condenser, Objective, Projector

EFTEM-related Conditions	**Description**	**Default normalizations**
EFTEM camera length	When changing camera length in EFTEM	Projector
EFTEM eucentric focus HM diffraction	When eucentric focus is pressed in EFTEM HM diffraction (D)	Objective, Projector
EFTEM eucentric focus HM imaging	When eucentric focus is pressed in EFTEM HM (SA, Mh) imaging	Objective, Projector
EFTEM eucentric focus LM diffraction	When eucentric focus is pressed in EFTEM LM diffraction (LAD)	Objective, Projector
EFTEM eucentric focus LM imaging	When eucentric focus is pressed in EFTEM LM imaging	Objective, Projector
EFTEM imaging <> diffraction	When going from imaging (LM or SA, Mh) to diffraction (LAD or D) in EFTEM	Projector
EFTEM LM <> SA	When switching between LM (objective lens off) and SA (objective lens on) in EFTEM	Objective, Projector
EFTEM magnification change	When changing magnification (LM, SA, Mh) in EFTEM	Projector
EFTEM SA <> Mh	When changing between SA and Mh (in EFTEM)	Objective, Projector
TEM <> EFTEM	When switching between TEM and EFTEM	Objective, Projector

Lorentz-related Conditions	Description	Default normalizations
Lorentz Mode On <> Off	When switching from or to Lorentz mode	Objective, Projector

41 PEELS



The PEELS Control Panel.

In the PEELS Control Panel the controls for (single-point) PEELS spectrum acquisition are located.

Note: TIA must be running. If it is not running, the buttons are disabled.

Preset time
The Preset time sets the acquisition time for the currently active acquisition mode (View, Acquire).

Spectrum number
During acquisition the spectrum number is displayed when more than one spectrum is acquired in a single acquisition.

Time remaining
During acquisition the time remaining before acquisition is finished is displayed.

View
Pressing the View button :
- When the button is gray, switches the PEELS acquisition settings to those of the View mode and starts acquisition.
- When the button is yellow, pauses PEELS acquisition.
- When the button is white, resumes PEELS acquisition.

By definition View is continuous acquisition.

Acquire
Pressing the Acquire button :
- When the button is gray, switches the PEELS acquisition settings to those of the Acquire mode and starts acquisition.
- When the button is yellow, stops PEELS acquisition.
- When the button is white, starts PEELS acquisition of a new spectrum.

By definition Acquire is single acquisition.

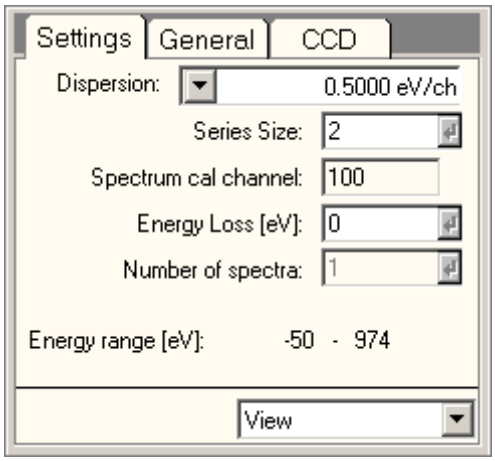
Align ZLP
The Align Zero-Loss Peak function in spectroscopy works different from that in imaging. In spectroscopy you use to set the scale of the EELS spectrum. Operation of the function is as follows:
- Acquire an EELS spectrum (continuous or single acquisition),
- Type in the value of the energy where the zero-loss peak is currently displayed under Energy shift in the Settings flap-out and press the Enter button.
- Press the Align ZLP button.

The energy scale should now have 0 at the position of the zero-loss peak.

Flap-out button

Pressing the flap-out button displays the flap-out with the PEELS Settings, General and CCD Control Panels.

41.1 PEELS Settings



The PEELS Settings Control Panel.

In the PEELS Settings Control Panel the settings used for PEELS spectrum acquisition are defined.

Dispersion
The drop-down list contains the accessible dispersion settings for the PEELS detector. This list corresponds to the list of the More PEELS Dispersions tab in TIA.

Series size
Under series size the size of the acquisition series for the currently active acquisition mode is set.

Spectrum cal. channel
The spectrum cal. channel parameters defines the channel at which the Calibration shift tool is applied (the same as under Properties of the spectrum in TIA itself)

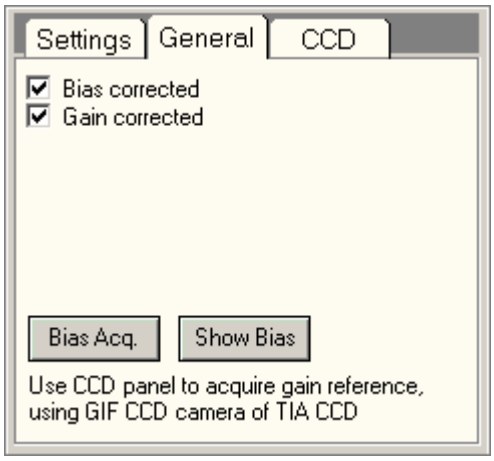
Energy shift
The energy shift defines the energy offset of the spectrum (the same as under Properties of the spectrum in TIA itself).

Number of spectra
Under number of spectra is defined how many spectra are acquired (added together) during a single acquisition. The control is enabled only when the Acquire mode is selected.

Energy range
The Start and End values define the start and end energy (in electronvolt) of the spectrum.

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and by pressing the equivalent button in the main control panel is that the drop-down list selection selects the mode but does not automatically start acquisition.

41.2 PEELS General



The PEELS General Control Panel.

In the PEELS General Control Panel general settings for PEELS spectrum acquisition are defined.

Note: The acquisition of the gain reference is the same as that for CCD imaging.

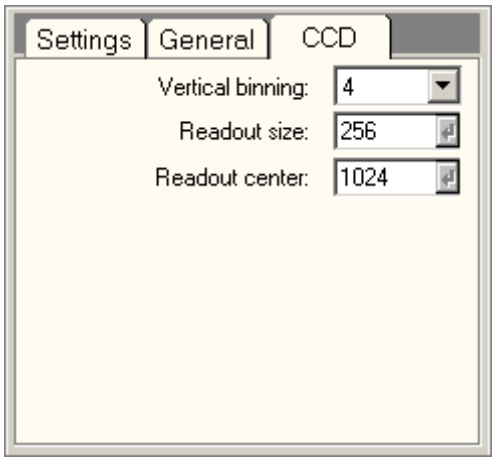
Bias corrected
Under Bias corrected the bias (dark current) correction of the spectrum acquisition is switched on (checkbox checked) or off.

Gain corrected
Under Gain corrected the gain correction of the spectrum acquisition is switched on (checkbox checked) or off.

Bias Acq
Pressing Bias Acq acquires a new bias spectrum.

Show Bias
When the Show Bias button is pressed, TIA will display the bias spectrum.

41.3 PEELS CCD



The PEELS CCD Control Panel.

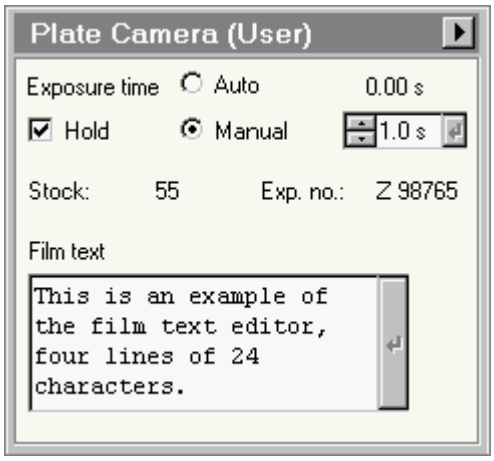
In the PEELS CCD Control Panel the parameters for PEELS spectrum acquisition on a CCD camera (Imaging Filter) are defined.

Vertical binning
The vertical binning parameter defines the binning factor used for spectrum acquisition. This binning value is applied in the vertical (constant-energy) direction in the spectrum.

Readout size
The readout size parameter defines the number of pixels (perpendicular to the direction of the spectrum) read out during spectrum acquisition. Since the spectrum fills only a narrow band on the CCD, this number is typically around 100.

Readout center
The readout center defines the pixel (in the direction perpendicular to the direction of the spectrum) where the center of the spectrum is located. Unless the spectrum is displaced from the center of the CCD, this number is the half-height number of the CCD.

42 Plate Camera



The Plate Camera Control Panel.

The Plate Camera Control Panel contains the controls used for the plate camera.

Description
The plate camera is located immediately underneath the viewing screen (the magnification ratio between main screen and plate camera is 0.885). On the bottom of the projection chamber a guide is mounted along which the tray containing the negative in its film holder will be slid forward, out of the cassette, and backward after the exposure. The complete exposure sequence contains the following steps:

- Check external shutter control status and switch external shutter control off (see below)
- Close microscope shutter
- If necessary, move viewing screen up
- Load plate
- After the settling time expose the plate label
- Make the real exposure (open shutter, wait for the exposure time to finish, close shutter)
- Unload the plate
- Open the microscope shutter
- If necessary move viewing screen down and restore external shutter

The microscope will automatically restore the main screen to the position it had before the exposure and also restore the external shutter control to its previous setting.

42.1.1 Combining plate camera and CCD

The shutter control on the TEM microscope differs from that of the CM series (because of occasional problems there in case plate-camera use was combined with a slow-scan CCD camera; unless one was careful the CCD camera would keep the shutter closed during plate-camera exposure, resulting in blank negatives). On the TEM microscopes the shutter control is not serial. The shutter is controlled either by the plate camera or by the CCD, with the switch under software control. Before a plate-camera exposure is taken, the microscope checks the status of the shutter control (internal = plate camera; external = CCD) and automatically switches the external control off. The status of the shutter control of the CCD is thus not important for plate-camera use.

Note: Because of the construction of the camera, the negative will lie exposed to any light coming in through the windows of the projection chamber. Before taking any exposure, make sure:

- The windows (especially the side window) are covered with the covers provided.
- Room light are off (or strongly dimmed).
- No bright displays are on the monitor, from which light could reflect off the operator into the projection chamber.

Exposure time
The exposure time is measured continuously when the main viewing screen is down. The time is based on a conversion of the screen current coming from the main screen or the focusing screen, via the emulsion setting, to an exposure time. When the focusing (small) screen is in, the measurement is automatically adjusted for the smaller area of the focusing screen. If the image intensity is reasonably uniform across the whole viewing screen, the exposure time measured on the large screen, with the small, focusing screen out, can be used to determine the exposure time for the plate camera. If the image intensity is not uniform (strong differences, for example because part of the image is covered by grid bars), the exposure time from the small screen should be taken.

Note 1: When the small-screen exposure time must be used, do not move the small screen back by hand (the exposure measurement will immediately jump back to the main screen). Lift the main viewing screen (the small screen will be moved out automatically) or start the exposure itself by pressing the Exposure button on the left-hand Control pad. Alternatively, note the exposure time as measured with the small screen and set that as the manual exposure time.

Note 2: As a rough guide for diffraction patterns, 1/3 of the exposure time measured (and then set as manual time) is often a good value. Exposures of diffraction patterns should not be taken for very short exposure times. In general diffraction patterns (especially Selected-Area diffraction patterns) have very intense spots and because the microscope shutter is not instantaneously off, short exposure times will lead to spots displaying a (curved) tail. In general diffraction pattern exposure times should be 5 seconds or more.

From the exposure time it is possible to get an estimate of the beam current by making sure the beam is not (partly) off the viewing screen, then using the following formula:

Beam current (in nanoAmps) = 2.15 x emulsion setting / exposure time

Auto
If Auto is checked, the plate camera will use the exposure time as measured. If Hold is on, the microscope will not adjust the exposure time method to the mode defaults (automatic in image, manual in diffraction) but keep it as set.

Hold
The plate-camera exposure time method used by the microscope depends on the mode (automatic in image, manual in diffraction). If the user selects a method that deviates from the default, the microscope will use the method set. If Hold is not checked, this new settings applies only to the next exposure. Afterwards the microscope will reset to the default method. To keep the method as selected by the user for more than one exposure, check the Hold option. If Hold is on, the method will stay as set until the user changes the selection or switches Hold off.

Manual
If Manual is checked, the plate camera will use the exposure time set with the spin-edit control. If Hold is on, the microscope will not adjust the exposure time method to the mode defaults (automatic in image, manual in diffraction) but keep it as set.

Stock
The stock value displays how many exposures are still available in the plate-camera magazine.

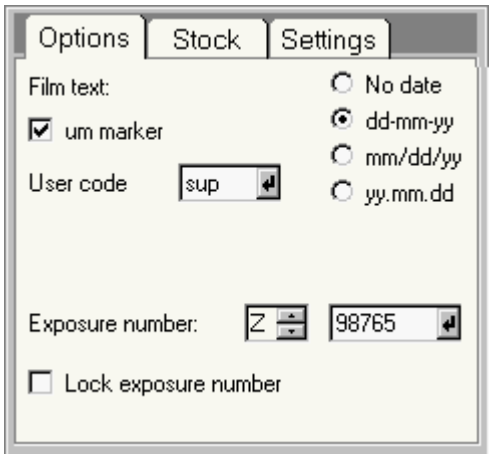
Exposure number
The exposure number is a six-character code that is printed on the negative. The first character can be a letter (A..Z) or a number (0..9), the remaining five are a number that goes from 00000 to 99999. When the number exceeds 99999, the number automatically switches to the next character up for the first one (9 goes to A, Z goes back to 0).
The exposure number is updated immediately after the exposure has been taken. The number displayed is therefore the number that will be printed on the next negative.

Film text
The plate labeling system of the plate camera prints a number of settings on each negative. The magnification and plate number are always printed. Other values such as mm marker, date and user code are optional, set under Plate camera options. These values take up the two top lines of the plate labeling system. Underneath is room for four lines of 24 characters each, available for user comments. These four lines are defined in the edit control underneath the film text label. The size of the edit control is set automatically so that no more than 24 characters fit on a line (hence also the non-proportional Courier font used). New words that do not fit at the end of a line will automatically be wrapped to the next line.

Note: The film text is set only when the Enter button to the right of the edit control is pressed. Once the film text has been updated, the Enter button becomes disabled until the text in the edit control is changed. The status of the Enter button thus indicates the status of the film text. Only when the button is disabled, is the film text up-to-date.

Plate camera flap-out
Pressing the arrow button displays the flap-out containing the Options, Stock and Settings control panels.

42.2 Plate Camera Options



The Plate Camera Options Control Panel.

The Plate Camera Options Control Panel (in the Plate Camera flap-out) covers various aspects of the plate label displayed on the negatives. These options are specific for individual users. They are stored and are reset automatically when the user logs in.

um Marker
If the um marker option is checked, the plate labeling system will write a micrometer marker on the negative. The marker is in real-space units (micrometers, nanometers) in image mode and in reciprocal-space units (inverse micrometers or nanometers, denoted by a superscript -1).

User code
The user code is a sequence of up to three characters that is printed on the negative behind the exposure number. To leave a space between the user code and the exposure number, start with a space and then add two more characters. The user code is set when the enter button of the control is pressed.

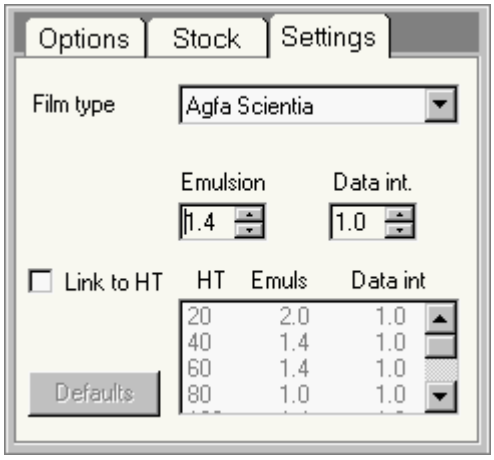
Date
The microscope can add a date to the plate label in various formats a displayed by the various options.

Exposure number
The exposure number is a six-character code that is printed on the negative. The first character can be a letter (A..Z) or a number (0..9), the remaining five are a number that goes from 00000 to 99999. When the number exceeds 99999, it automatically switches to the next character up for the first one (9 goes to A, Z goes back to 0).

Lock exposure number
There are two methods for using the exposure number system (the method is decided by the supervisor):

- Users are free to change the exposure number. In this case, each user can adjust the exposure number. When the user logs out, the last exposure number used is remembered and restored automatically when the user logs in again (any changes made by others users therefore have no effects on the user's own exposure numbers).
- The exposure number system is locked. The exposure number can be changed only by the supervisor. The exposure numbers run in sequence, independent of the users.

42.3 Plate Camera Settings



The Plate Camera Settings Control Panel.

The Plate Camera Settings Control Panel (in the Plate Camera flap-out) provides control over film type settings.

Film type
The film type drop-down list box provides settings for a number of different film types. This list makes it easy to switch between different film types (in case more than one film type is used). Currently it is not possible to add or change film type settings.

Emulsion
The emulsion setting determines the effective exposure time through the conversion factor (multiplication) between screen current and exposure time. In general the emulsion setting will be a function of the type of film and the developing conditions used. However, be aware that the effect of electrons on film depends on the high tension, with a peak in the interaction around 80 kV.

Note 1: Do not assume that emulsion settings are the same as ones used on other instruments (unless the instrument used before is of the same type as the TEM microscope). Differences in instrument make (manufacturer) and high tension do affect the emulsion setting. Always test a range of emulsion settings and developing times to find the optimum setting.

Note 2: Although it usually is possible to vary both emulsion setting and developing conditions, there are certain consequences. One aspect of electron images is the so-called shot noise. The shot noise is equivalent to the square root of the signal. Thus the change from emulsion 2.8 to 1.4 increases the noisiness of the image by the square root of 2. Unless it is necessary to use lower emulsion settings, it is advised to use somewhat higher settings and develop for a shorter time.

Data intensity
The plate label is exposed on the negative with an exposure time that is determined by the data intensity. The higher the number the longer the exposure time and the stronger the exposure of the label. The exposure of the plate labeling is separate from that of the electron image. A setting of 1.0 corresponds to a plate-labeling exposure time of 0.5 seconds.

Note: Fuji image plates are not sensitive to the light used for the plate labeling and the data intensity is meaningless in that case.

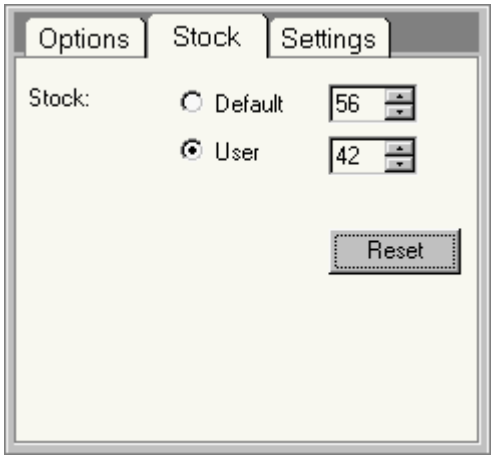
Link to HT
If the Link to HT option is checked, the emulsion setting and data intensity will be set automatically to the values in the table when the HT is changed. This option therefore automatically compensates for the change in interaction between electrons and film at different high tension settings.

Table
The table lists the high-tension specific settings used when the Link to HT option is on. The setting high-lighted is determined by the currently active high-tension. The values in the table can be changed by changing the emulsion and data intensity settings in the spin-edit controls above the table. To change values for other high-tension settings, change to the required high tension and then change the values.

Note: In general there is no reason to assume the data intensity should be different for the various high-tension values, unless different developing conditions are used for different high-tension settings.

Defaults
Resets the table of HT-linked emulsion settings to the default settings.

42.4 Plate Camera Stock



The Plate Camera Stock Control Panel.

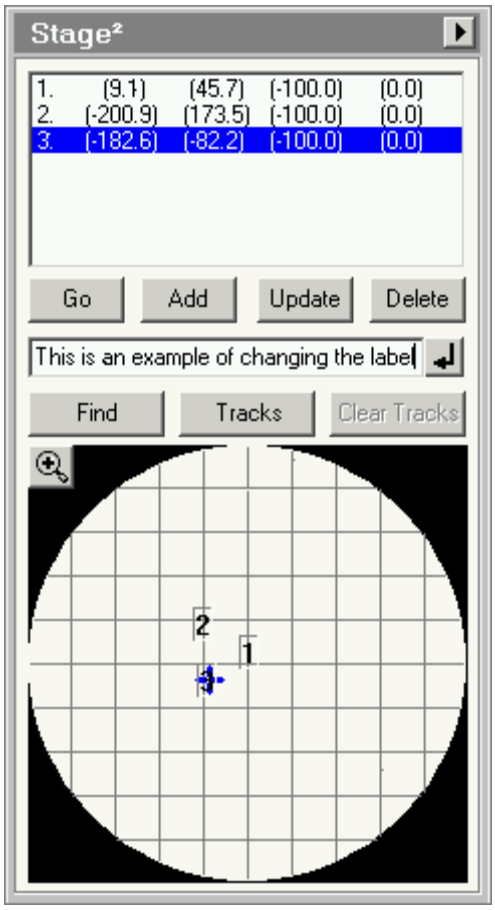
The Plate Camera Stock Control Panel (in the Plate Camera flap-out) provides access to controls for the stock of exposures. The stock is a system-wide (not user-specific) setting.

Default
If a full cassette with plate camera negatives has been loaded, the available stock can be reset to the default value (typically 56, but other settings may be customary). Select the Default option and press Reset.

User
If the cassette placed in the plate camera is not full, the stock can be reset by changing the number of negatives in the spin-edit control, selecting the User option and pressing Reset.

Reset
Reset sets the current stock value to the number set under Default (if the Default option is checked) or the number under User (if the User option is checked).

43 Stage²



The Stage² Control Panel.

The Stage² Control Panel provides functionality for controlling the CompuStage, storing positions and tracks.

A more detailed description of the CompuStage and specimen-holder handling is given elsewhere. Two important topics are pointed out here especially :

- Movement: selection of trackball or joystick mode, the two different ways of using the trackball to move the stage.
- Specimen-holder selection : for single-tilt holders the message where the holder type selection must be done can be avoided and the last-used single-tilt holder will be selected automatically.

Note: The positions list nor the file format for storing positions is NOT compatible between the 'old' Stage control panel and the new Stage² panel. Use one or the other, but not both intermixed. Neither control panel is aware of stage positions stored in the other panel.

Positions

The Stage² control panel allows the user to store stage positions. All positions are stored with five axes (if no b tilt is available, b will be 0). In addition a series of optics settings are stored :

- Magnification mode and magnification index
- Spot size
- Intensity setting
- Lens series (Zoom or EFTEM) (if available)
- TEM or STEM (if available)
- Lorentz mode off or on (if available)
- Defocus

These settings can be recalled together with the stage position (user-defined option).

Furthermore, the software keeps a label with each stage position (if no label is defined by the user the label will be a serial number plus the stage position).
Finally the software keeps track of plate and CCD exposures made at stored positions.

Tracks
Tracks are a list of stage positions automatically recorded and drawn as connected lines on the display. You can use tracks e.g. to mark which part of the specimen has been seen or to draw the outline of different areas on the specimen. For the latter, go to the perimeter of a first area, switch tracking on and move around the perimeter of the area until you are back where you started. Switch tracking off and move to the next area. Switch tracking on again and move around the perimeter of the new area. When done, switch tracking off again. Repeat as often as needed. By switching tracking off when going from one area to another, the tracks of the separate areas will be shown without any connection between them.

Confirmation
Several actions require confirmation. This means that the button pressed will disappear and its place will be taken by an a combination of an OK  and a Cancel  button. The Cancel button is given the focus (which means that if you e.g. press the keyboard Enter, you cancel) and the cursor position is moved in between the two buttons (so that you do not accidentally press OK by clicking twice on the original button). The action is performed when the OK button is pressed (this will bring back the original button). Pressing the Cancel button will bring back the original button without performing the action.

Files
Stored positions and tracks can be saved to and loaded from file. The file format is for loading is digital only, for saving you can choose digital or text. The digital file format is described separately.

Positions list
The positions list contains the list of stored positions. These are shown as a serial number plus a label. The serial number is set automatically and is not necessarily consecutive. If you delete stored positions, the numbers will not be redone but stay as they are. So if you have stored 6 positions, then delete 5 and 6, then add a new position, that new position will be number 7.
The serial number only gets reset when all positions are deleted.

Go
When the Go button is pressed, the stage will move to the stored position selected in the list. If more than one position is highlighted (this is possible with Shift+Click or Ctrl+Click to allow the deletion of more than one position at a time), the position selected is the one that was clicked on first.
The method of movement, Move To or Go To is defined on the Settings Control Panel.

Add
When the Add button is pressed the current stage position and the optics are stored into a new position.

Update
When the Update button is pressed the selected position is updated with the current stage position and the stored optics settings. The position update must be confirmed.

Delete
When the Delete button is pressed, two different things can happen:
If only one position is selected in the list, that position is deleted immediately. There is no confirmation needed.
If more than one position is selected in the list (with Shift+Click or Ctrl+Click), the deletion of all positions selected must be confirmed. To empty the complete list you can use the Delete all button on the File tab.

Label
The edit control allows the definition of a label to be used for a stored position. If you wish to change the label of a position, you must enter the text in the edit control and then press the Enter button. The text in the edit control is also used with the Find function.

Enter button
The Enter button allows changing the label of the position selected in the positions list. Enter the new label in the edit control and press the Enter button. The changing of the label must be confirmed.

Find
When there are more positions stored than visible in the list (or their labels are so large that they are not visible completely), the Find function allows searching for positions on the basis of text in the labels. Enter the search text in the edit control for the label and press the Find button. The search function will go down the list to the next position that has a match, starting at the currently selected position. If nothing is found further down, the function will continue from the top of the list down. If nothing is found at all (which means that the required text does not exist - with the possible exception of the currently selected position which is not included in the search), the software will sound a beep. If the text occurs in more than one position, you can simply press the Find button again to go further through the list.

Note: The separation between the serial number and the rest of the label and stage position values in labels is a tab, not a space. Generally you cannot enter a tab in the edit control with the keyboard (Windows will move the focus to the next control). If you need to search with tabs included, type the text, including tabs in Notepad, then copy the text into the edit control (Ctrl+V).

Tracks
Pressing the Tracks button switches tracking on (the button becomes yellow) and off.

Clear tracks
Pressing the Clear Tracks buttons removes all tracks together (you cannot remove separate tracks). This requires confirmation.

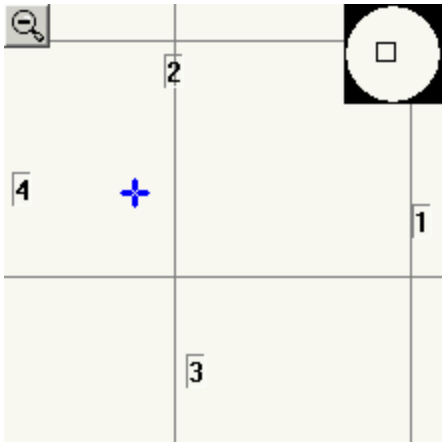
Zoom
When the Zoom button is pressed, the display zooms in or out, depending on its current status (which can be seen from the plus or minus sign in the magnifying glass).

Display
The display shows an overview of stored positions and tracks. Positions are shown by their serial number, outlined by a box. Tracks are shown as lines. The current position is shown by a blue cross.
There are two major functions associated with the display :
When you let the cursor hover over a stored position, a hint will come up that lists the label, stage position (X,Y) plus, if relevant the notice 'Plate recorded' with the plate number or 'CCD image recorded'. If the hint disappears before you have been able to read all, move the cursor a bit off and back and the hint will re-appear.
When you double-click on a stored position in the display, the stage will go there, including restoring the optics if selected (the function is thus the same as selecting the position in the list and pressing the Go button). When you double-click on the display outside any stored position, the stage will move to that position.
The display has two zoom positions. In the Out position (the magnifying glass in the Zoom button has a plus sign), you see a representation of the whole specimen area - a circle with a diameter of 2 mm. The black edges are outside realistic positions (the stage can move there but the specimen holder will block the beam). The stage X axis is horizontal in the display, while the Y is vertical.
Note: The orientation of the display does NOT correspond to what you see on the fluorescent screen. This is done on purpose. Depending on the type of microscope, there may be one ore more changes in

the orientation of the stage axes on the fluorescent screen (e.g. LM-TEM is typically 180° rotated relative to HM-TEM, with the stage X running in the north-south direction; and in STEM the image can be rotated freely). If Stage² would link its display to the screen orientation, stored stage positions would frequently (and confusingly) change where they are found on the Stage² display.

In the In position (the magnifying glass in the Zoom button has a minus sign), the size of the area is determined by the minimum and maximum of the stored positions and tracks or by the zoom magnification defined.

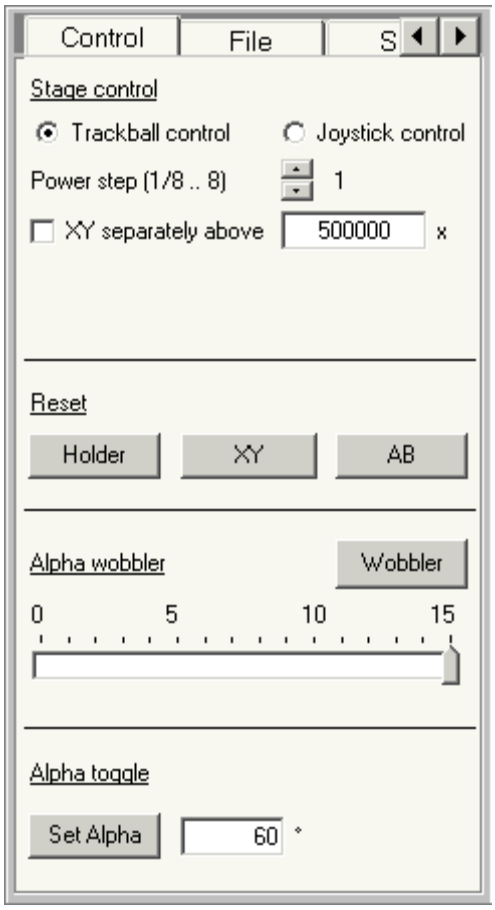
Note that in automatic zoom mode the current stage position may fall outside the area defined. In the top



right corner is a small display of the whole specimen (circle with black edges) with a red square marking the zoomed area.
If a stored position falls either underneath the Zoom button or the overview top right, it is not displayed.
Gray grid lines at 200 um intervals (stage coordinates) may be displayed (user option).

Flap-out button
The flap-out button of the Stage² Control Panel opens the flap-out with the Control, File, Set and Settings tabs.

43.1 Stage² Control



The Stage² Control Control Panel.

The Stage² Control Control Panel provides control over stage settings.

Trackball / joystick control
The CompuStage trackball has two modes of operation, trackball mode and joystick mode. You can change between these modes by pressing the trackball buttons (left and right) simultaneously or by changing the selection through the radio buttons in the Stage² Control Control Panel. The radio buttons also display the currently active setting.
If the right-hand control pad has a joystick instead of a trackball, the radio buttons for switching between trackball and joystick mode are disabled.

Trackball / joystick power
The speed of movement of the CompuStage depends on a number of factors. One of these is the setting of the trackball / joystick power, which is defined in 9 steps by the buttons on the control pad (left is down, right is up). You can also set the trackball / joystick power value with the spin buttons in the Stage² Control Control Panel. The spin buttons also display the currently active setting.

XY separately
Generally the movement of the CompuStage when driven with the trackball / joystick is in the direction defined by the direction of trackball / joystick movement. It is thus a combined X,Y movement. This works well at lower magnifications where the movement on both axes is generally large enough, but at high magnifications one of the axes may no longer be able to make sufficiently small steps (so instead of moving 2+0.5, 2+0.5 for X+Y the stage may do 2+0, 2+1, etc.). The resulting movement is not as predictable in the movement direction. Under these circumstances it may be better to switch to XY separately. In that mode, only one axis is driven at a time. The trackball / joystick movement is divided

into segments (north, east, south, west) and the trackball / joystick movement only makes the stage move in those fixed directions.
Since the change from XY separately to normal movement and back is largely a matter of magnification, you have the microscope change to XY separately automatically (when a check mark is present in the check box) at the magnification defined.

Reset holder
Resets all axes to zero. It is advised to use this function (or at the very least Reset AB before removing a specimen holder from the microscope).

Reset XY
Resets the XY position to 0,0.

Reset A / Reset AB
Reset the tilts to zero.

Wobbler
The Alpha wobbler tool helps in setting the eucentric height. When the wobbler is switched on (the button will turn yellow), the CompuStage will tilt continuously on a from minus to plus by the value set with the alpha wobbler trackbar. By changing the Z height and minimizing the image movement, the CompuStage is set to the eucentric height.

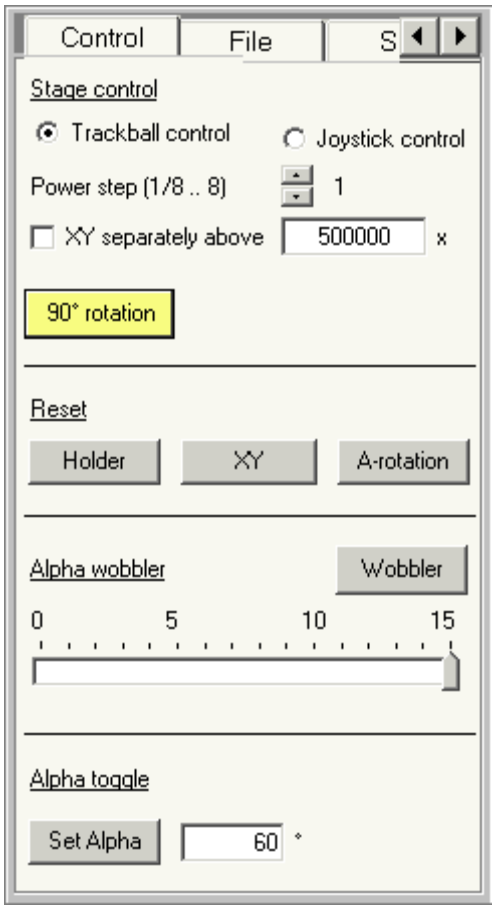
Wobbler amplitude
The alpha wobbler trackbar sets the alpha wobble angle. The maximum value is 15 degrees (5 degrees for the U-TWIN lens), but the user can set any angle less than that (except 0 which will lead to a disabled Wobbler button).

Set alpha
The Set alpha function provides a rapid toggle between an a angle and back to 0°. This function can be used for different things:

- Inserting a cryo holder with liquid nitrogen in the dewar into the airlock without spilling the nitrogen. Tilt the stage with the Set alpha function to 60°. Insert the holder into the airlock. Once the airlock pumping is finished, hit the Set alpha button again (it will automatically have focus normally so you can also do this by hitting the keyboard Enter button or the spacebar). As the CompuStage tilts back, insert the holder further into the microscope.
- Toggling between a preset angle for EDX spectrum acquisition (typically 10 to 20°) and back to 0°.

To work with the Set alpha function, enter the desired angle. Press the Set alpha button. During movement it will become disabled, but afterwards it will be yellow and have the focus. Hit it again and the stage will tilt back to 0° and the button will become gray again.

43.2 Stage² Control (dual-axis tomography holder)



The Stage² Control Control Panel.

The Stage² Control Control Panel provides control over stage settings.

Note: The dual-axis tomography holder uses the "beta" tilt drive for moving between no rotation and 90°. Stage² is aware of the difference and hence displays a large "beta" angle as rotated (90°) and a small angle as non-rotated (0°). In Stage² you cannot manipulate the rotation by setting a "beta" angle. Instead you have to toggle the 90° rotation button. The TEM user interface is not aware of the difference between a double-tilt holder and the dual-axis tomography holder and therefore it will display real "beta" angles.

Trackball / joystick control
The CompuStage trackball has two modes of operation, trackball mode and joystick mode. You can change between these modes by pressing the trackball buttons (left and right) simultaneously or by changing the selection through the radio buttons in the Stage² Control Control Panel. The radio buttons also display the currently active setting.
If the right-hand control pad has a joystick instead of a trackball, the radio buttons for switching between trackball and joystick mode are disabled.

Trackball / joystick power
The speed of movement of the CompuStage depends on a number of factors. One of these is the setting of the trackball / joystick power, which is defined in 9 steps by the buttons on the control pad (left is down, right is up). You can also set the trackball / joystick power value with the spin buttons in the Stage² Control Control Panel. The spin buttons also display the currently active setting.

XY separately
Generally the movement of the CompuStage when driven with the trackball / joystick is in the direction defined by the direction of trackball / joystick movement. It is thus a combined X,Y movement. This works well at lower magnifications where the movement on both axes is generally large enough, but at high magnifications one of the axes may no longer be able to make sufficiently small steps (so instead of moving 2+0.5, 2+0.5 for X+Y the stage may do 2+0, 2+1, etc.). The resulting movement is not as predictable in the movement direction. Under these circumstances it may be better to switch to XY separately. In that mode, only one axis is driven at a time. The trackball / joystick movement is divided

into segments (north, east, south, west) and the trackball / joystick movement only makes the stage move in those fixed directions.
Since the change from XY separately to normal movement and back is largely a matter of magnification, you have the microscope change to XY separately automatically (when a check mark is present in the check box) at the magnification defined.

90° rotation
Toggles the rotation between 0 (button is gray) and 90° (button is yellow).

Reset holder
Resets all axes to zero.

Reset XY
Resets the XY position to 0,0.

Reset A-rotation
Reset the A tilt and the rotation to zero.

Wobbler
The Alpha wobbler tool helps in setting the eucentric height. When the wobbler is switched on (the button will turn yellow), the CompuStage will tilt continuously on a from minus to plus by the value set with the alpha wobbler trackbar. By changing the Z height and minimizing the image movement, the CompuStage is set to the eucentric height.

Wobbler amplitude
The alpha wobbler trackbar sets the alpha wobble angle. The maximum value is 15 degrees (5 degrees for the U-TWIN lens), but the user can set any angle less than that (except 0 which will lead to a disabled Wobbler button).

Set alpha
The Set alpha function provides a rapid toggle between an a angle and back to 0°. This function can be used for different things:

- Inserting a cryo holder with liquid nitrogen in the dewar into the airlock without spilling the nitrogen. Tilt the stage with the Set alpha function to 60°. Insert the holder into the airlock. Once the airlock pumping is finished, hit the Set alpha button again (it will automatically have focus normally so you can also do this by hitting the keyboard Enter button or the spacebar). As the CompuStage tilts back, insert the holder further into the microscope.
- Toggling between a preset angle for EDX spectrum acquisition (typically 10 to 20°) and back to 0°.

To work with the Set alpha function, enter the desired angle. press the Set alpha button. During movement it will become disabled, but afterwards it will be yellow and have the focus. Hit it again and the stage will tilt back to 0° and the button will become gray again.

43.3 Stage² File

The Stage File Control Panel.

The Stage File Control Panel allows saving and reloading of stage positions to and from file. The positions are those as listed in the positions list of the Stage² Control Panel.

Note: The positions list and the file format for storing positions is NOT compatible between the 'old' stage control panel and the new Stage² panel. Use one or the other, but not both intermixed.

Comments
Comments can be added to files with specimen-stage positions. Enter the comment before saving the file. After opening the file, the comment from the file is listed under the file data.

Author
The name of an author (the person storing the positions and saving the file) can be added to the files with specimen-stage positions. When first used, the software will automatically enter your Windows logon name here. Once you change it, the software will remember and re-insert it automatically.

Save
When the Save button is pressed, the specimen-stage positions and/or tracks are stored in a file. If a filename had been defined previously (through either Save, Save As or Open), that is the file under which the positions will be saved. If no filename has been defined yet, a standard Save File dialog will come up, where a filename (and folder) can be set.

Save As
When the Save button is pressed, a standard Save File dialog will come up, where a filename (and folder) can be set. The current positions list will be saved in that file.

Two file formats can be used for saving files. The Stage² file format can be used for saving and reading stage positions. The tab-delimited file format (text) can only be used for saving (data export). The latter file format can be read in e.g. in spreadsheet programs.

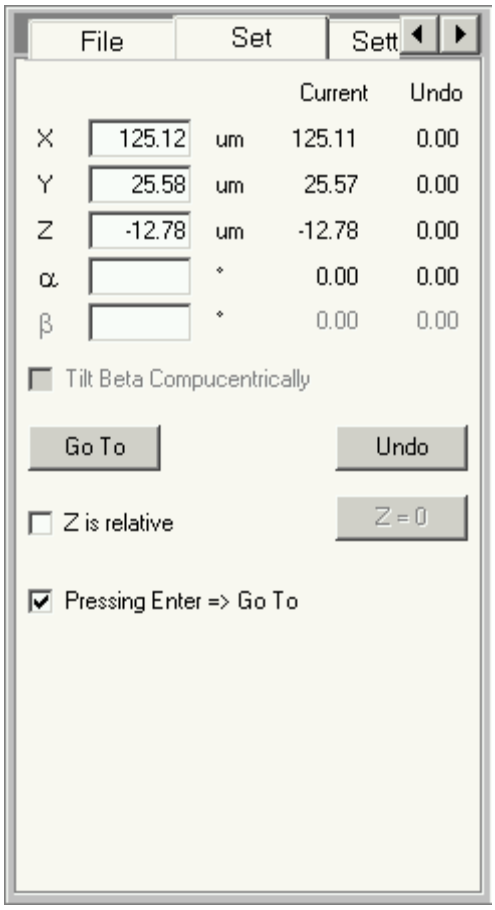
Open
When the Open button is pressed, a standard Open File dialog will come up, where a file can be selected for reloading. The current positions list will be cleared and the positions from the file entered in the list.

Delete All
The Delete All button clears all stored positions and tracks (it is thus equivalent to selecting all positions in the list and pressing Delete + confirm plus pressing Clear Tracks + confirm). This function may be useful in connection with opening files or clearing data that have been reloaded automatically. Delete All requires confirmation.

File data
After a file has been opened the essential data of the file are displayed. Note that the path may be in short format (with part of the path - between \\ - replaced by ...) in case the path is too long.

Automatically store
The stored positions and tracks may be saved automatically to a temporary file and reloaded when the TEM user interface is closed and re-opened. Note that temporary files are not replaced if there currently are no data (positions or tracks). If there are no data, the file stays as is, so the next opening of the TEM user interface will reload the data from the session before the last one.

43.4 Stage² Set



The Stage² Set Control Panel.

The Stage² Set Control Panel allows control over specimen-stage positions by entering stage-axis values.

Set position
The specimen-stage X, Y, Z, a, b position defines the value (in mm for X, Y, Z, degrees for a, b) for the new specimen-stage position set after the Go To button is pressed. If no value is entered for a particular axis, that axis remains unchanged.

Current position
The current position lists the current stage position.

Undo position
The undo position lists the position where the stage will go back to when the Undo button is pressed. Note that this movement is the reverse of the Go To, so only those axes used in the Go To will be used in the Undo.

Tilt beta compucentrically
If Compucentricity is available on the microscope, tilting on the b axis can be done compucentrically. See the compucentricity documentation for more details.

Go To
When the specimen-stage position Go To button is pressed, the specimen-stage is instructed to go to the position as defined by the four (X, Y, Z, a) or five (X, Y, Z, a, b) position edit controls. The button remains disabled until at least one value for a new stage position has been entered. If no value has been entered for a particular axis, the setting of that axis will remain unchanged in the Go To.

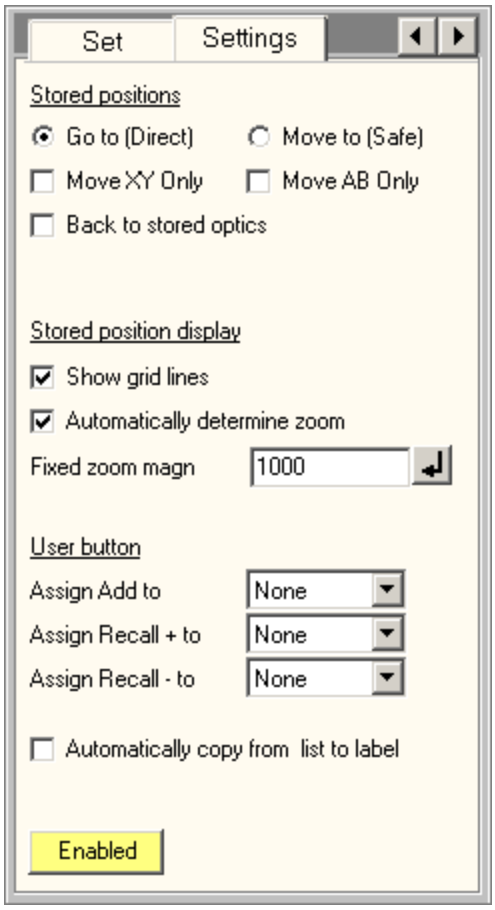
Undo
When the Undo button is pressed, the specimen-stage returns to the last position set by a Go To.

Z is relative
The Z position as reported by the stage is normally defined by the eucentric height (since that is where you should be working). Manipulating the Z then always means you have to start calculations with the Z position for the eucentric height, which may be cumbersome. The "Z is relative" function allows an automatic recalculation of the eucentric Z so this becomes 0 as displayed. All other positions are then displayed in values relative to this.
Note: Only the values as displayed in the Stage² Set Control Panel have their Z values adjusted, NOT any other displayed values (as e.g. in the general microscope information display).
When Z is relative is activated the current Z position is automatically made the reference. To use an other Z position as the reference, move the stage to that Z position and press the Z = 0 button.

Z = 0
Pressing the Z = 0 button makes the current Z position the relative Z reference value.

Pressing Enter => Go To
When the Pressing Enter => Go To checkbox is checked, you can press the Enter keyboard key while in one of the edit controls for the stage axes (X, Y, Z, A, B) and this will immediately force a Go To (so the effect is the same as pressing the Go To button). This feature makes it possible to define a stage position and execute a Go To without having to switch from keyboard to mouse.

43.5 Stage² Settings



The Stage² Settings Control Panel.

The Stage² Settings Control Panel provides access to a number of Stage² options and the function for enabling/disabling the CompuStage.

43.6 Specimen-stage Move To's and Go To's

There are two different types of specimen-stage movements (apart from the ones initiated by the trackball) : Move To's and Go To's. The difference between these two is in the procedure followed by the specimen-stage to reach the new position. With Go To's the specimen stage will move on all axes (as far as necessary) at the same time. This is the mode of movement used when the Go To or Undo buttons are pressed. The Go To is more direct and therefore faster than the Move To.

With Move To's a fixed procedure is used to enhance safety during movement (to remove the possibility altogether of a high-speed collision between the moving stage and a fixed part of the microscope). This fixed procedure consists of the following steps:

- Set β tilt to zero.
- Set α tilt to zero.
- Go to the new X, Y, Z position.
- Set α tilt to new value.
- Set β tilt to new value.

Some of these steps may be absent. For example if a single-tilt holder is used, the b tilt steps are omitted. Or if no new values for X and Y are entered, only a Z go to is done in the third step.

Note: The Move To method is strongly advised if large specimen-stage movements are made.

Go To / Move To
Defines the type of movement used for recalling stored stage positions. This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

Move XY Only
When checked, this option will result in move only to the X,Y values of stored stage positions (thus ignoring Z, a and b). This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

Move AB Only
When checked, this option will result in move only to the a,b values of stored stage positions (thus ignoring X, Y and Z). This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

Back to stored optics
When checked, this setting result in restoring of the optics settings together with the stored stage position, as a result of Go or double-click on the display. This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

Show grid lines
When checked, the display shows grid lines at 200 um (stage coordinates) intervals. This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

Zoom functions
The zoom on the main panel can either be determined automatically on the basis of the stored positions and tracks (Automatically determine zoom is checked) or it can be set according to a user-defined magnification. In the latter case the field of view corresponds roughly to that of the large viewing screen at the magnification given and the display is centered around the current stage position. Any change in magnification must be confirmed by pressing the Enter button.

Please note that the display will generally be rotated relative to what is visible on the large viewing screen. On the latter the stage X axis generally is running North-South (rotating ~180° between LM and HM), while on the Stage² display the stage X and Y axes are East-West and North-South, respectively. These settings are stored and automatically recalled when closing and re-opening the TEM user interface.

User button Add
The user buttons R1..R3 and L1..L3 can be used for adding the current stage position to the list of stored positions. To use this function, select one of the user buttons in the drop-down list. This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

User button Recall +
The user buttons R1..R3 and L1..L3 can be used for moving the stage position to next position in the list of stored positions. If the currently selected position is at the end of the list, the selection will automatically wrap around to the first position. To use this function, select one of the user buttons in the drop-down list. This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

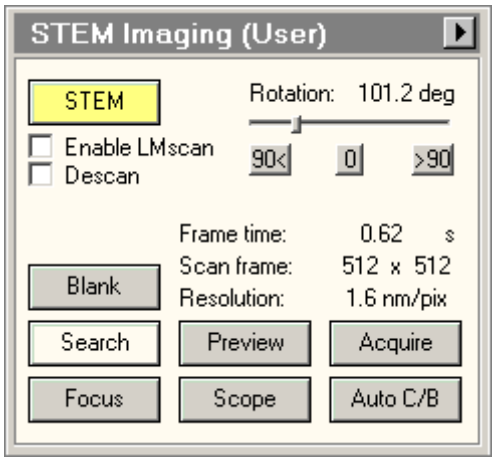
User button recall -
The user buttons R1..R3 and L1..L3 can be used for moving the stage position to previous position in the list of stored positions. If the currently selected position is at the top of the list, the selection will automatically wrap around to the last position. To use this function, select one of the user buttons in the

drop-down list. This setting is stored and automatically recalled when closing and re-opening the TEM user interface.

Auto copy
When checked, the software will automatically copy the currently selected item in the list - if that is a user-defined label, not the stage position as initially inserted - back into the place for the label. From there you can copy it by selecting the text and pressing Ctrl+C.

Enabled
The Goniometer enabled option allows switching the CompuStage off in case it is on (the Gonio enabled button is yellow) or on when it is off.
Note: If the CompuStage is switched off and on, it needs to be homed before it can move. The homing procedure requires removal of the specimen holder.

44 STEM Imaging (User)



The STEM Imaging Control Panel.

The STEM Imaging Control Panel contains the most important STEM controls. For a description of the basic concept of scanning, see the STEM mode description. The details of scanning operation itself are described separately.

Note: TIA must be running. If it is not running, many of the buttons are not present.

For easy operation, the scanning system has three preset modes with their own buttons, Search, Preview and Acquire. Each of the three can have its own, separate scanning settings (Frame size, Frame Time), allowing rapid switching between different settings. The actual settings are up to the user. Typical settings could be:

- Search: Frame size 256*256, Frame time 1 second.
- Preview: Frame size 512*512, Frame time 5 seconds.
- Acquire: Frame size 1024*1024, Frame time 30 to 60 seconds.

By definition Search and Preview are continuous acquisition, while Acquire acquires a single frame and stops (to allow the operator to save the image).

The Focus state is different from the previous three settings. It will display a small window inside an image already collected. Only the image inside the frame is then collected and updated. The frame can be moved around and changed in size to select an area more suitable for focusing.

STEM
The STEM button switches the TEM microscope to the STEM mode (the button becomes yellow) and back (the button becomes gray).

Scan rotation
The scanning image can be rotated continuously. Click on the trackbar and drag the handle to left or right to change the scan rotation or (as long as the trackbar has the Windows focus - denoted by the dashed lines around it), use the arrow keys on the keyboard to change the rotation angle. When the button 0 is pressed, the scan rotation is reset to 0°. When the buttons 90< and >90 are pressed, the scan rotation is changed 90° from its current setting to left or right.

Enable LMscan
By default, the STEM system will not switch to LM scanning (in which the objective lens is off) when the operator turns the magnification further down than the lowermost scanning magnification step. If you want to go to LM scanning, the checkbox must first be checked. Only then is it possible to change to LM scanning by turning the magnification knob further down. The checkbox is reset to the default (off) each time STEM is switched off and on.

Descan
In STEM mode the diffraction pattern is stationary and is located on the STEM detector. When EELS spectroscopy is used in STEM the microscope is in the so-called image-coupling mode, which means that the diffraction pattern is at the PEELS or Imaging Filter entrance aperture, while the image, located at the level of the differential pumping aperture between the projection chamber and the column, is also found at the level of the spectrometer detector. The movement of the beam during scanning will cause the energy-loss spectrum to shift across the spectrometer, both sideways (no change in apparent energy but a movement that could lead part of the spectrum off the detection area) as well as in the energy direction. The movement is directly coupled to the movement of the beam so the effect is much more pronounced at low STEM magnifications (large beam movements) and negligible at very high magnifications.
The shifting of the spectrum can be avoided by using the descan functionality of the STEM mode. When descan is on, the image deflection coils below the specimen are coupled to the STEM scanning coils (above the specimen) in such a way that the compensate for the beam shift, so the beam appears to remain stationary when seen below the specimen.
Another reason for using the descan is when the HAADF detector is used in combination with a very small camera length. In that case the image at the level of the differential pumping aperture is large and may actually be larger than the diameter of the aperture. In that case the aperture will block the beam for part of the image (the corners are cut off). If descan is used, the beam once again will remain stationary in the differential pumping aperture and the HAADf is no longer partially blocked.

The checkbox is reset to the default (off) each time STEM is switched off and on.

Frame time
The Frame time indicates the time a single frame will require for the currently active viewing mode (Search, Preview, Acquire).

Scan frame / resolution
The Scan frame and resolution values indicate the settings of the currently active viewing mode (Search, Preview, Acquire). The two parameters are linked but give different types of information. The scan frame indicates the size in pixels of the image collected, whereas the resolution indicates how large a single pixel is. The latter value is a useful indication for selecting spot size. For example, if the spot size used on the microscope is much larger than the indicated resolution, then the resolution in the image will be wholly determined by the microscope's spot size. If on the other hand, the indicated resolution is much larger than the spot size, the spot size could be increased to give better signal without loss of resolution.

Blank
The STEM Imaging Control Panel provides a function for blanking of the electron beam to avoid beam damage of other undesired effects when the beam remains on a fixed location of the specimen (that is, while it is not scanning). The beam is blanked then the button is yellow.

Note 1: The unblanking of the beam is not instantaneous and may take a short while to become effective. If a scan is started too quickly after unblanking of the beam the start of the image may look distorted.

Note 2: The microscope does not check that the beam is unblanked when a scan is started. It is entirely up to the user to make sure that the electron beam can reach the specimen when needed. Only when STEM is stopped or the user interface closed is the beam blanking switched off automatically.

Search
Pressing the Search button:
- When the button is gray, switches the scan settings to those of the Search mode and starts scanning.
- When the button is yellow, pauses the scan acquisition.
- When the button is white, resumes the scan acquisition (but starting with a new frame) if possible. If the start command could not be given to TIA, the button will remain white.

When the button is red, other software (Tomography) is acquiring images.
By definition Search is continuous acquisition. The scan parameters are set in the STEM Imaging Scan Control Panel.

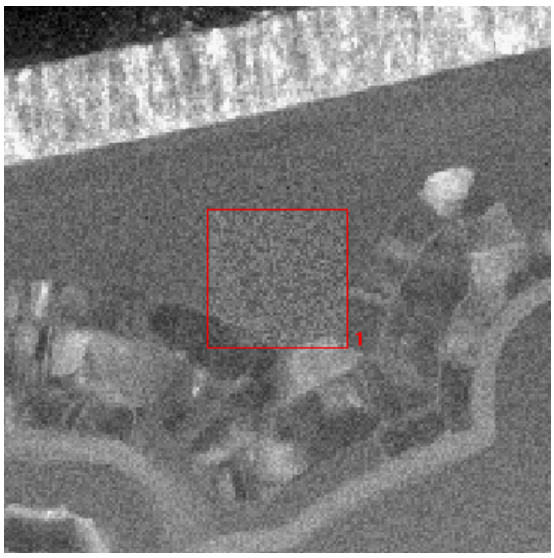
Preview
Pressing the Preview button:
- When the button is gray, switches the scan settings to those of the Preview mode and starts scanning.
- When the button is yellow, pauses the scan acquisition.
- When the button is white, resumes the scan acquisition (but starting with a new frame) if possible. If the start command could not be given to TIA, the button will remain white.

When the button is red, other software (Tomography) is acquiring images.
By definition Preview is continuous acquisition. The scan parameters are set in the STEM Imaging Scan Control Panel.

Acquire
Pressing the Acquire button:
- When the button is gray, switches the scan settings to those of the Acquire mode and starts acquisition.
- When the button is yellow, pauses the scan acquisition.
- When the button is white, resumes the scan acquisition (but starting with a new frame) if possible. If the start command could not be given to TIA, the button will remain white.

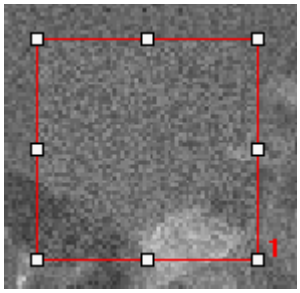
When the button is red, other software (Tomography) is acquiring images.
By definition Acquire acquires a single frame and stops (to allow the operator to save the image). The scan parameters are set in the STEM Imaging Scan Control Panel.

Focus
Pressing the Focus button activates (button becomes yellow) or stops (button becomes gray) the acquisition of the Focus image. When active, the Focus window is displayed in the center of the STEM image. Only the area inside the Focus window is now scanned, the remainder of the image is 'frozen'.



Part of a STEM image with the Focus window in the center.

The Focus window can be moved around or changed in size by clicking on it with the left-hand mouse button and dragging between the handles (small squares at corners and centers of the lines) to move it around or dragging a handle to change the size. The focus parameters are set in the STEM Imaging Focus Control Panel.



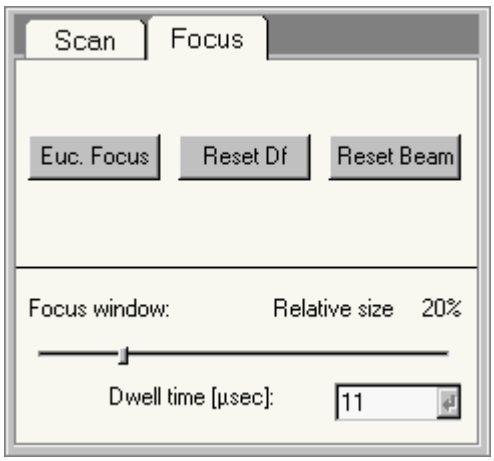
The Focus window with handles to change its position or size.

Scope
The Scope button enables or disables acquisition of images with a videoscope signal displayed as well. The videoscope signal shows the full range of signal levels available and the video levels along the lines of the scan. When scan acquisition is not active the scope signal shows the video levels along a line in the center of the image.

Auto CB
Press Auto CB to instruct the system to optimize the Contrast and Brightness of the detector selected automatically. The Auto Contrast Brightness function will repeatedly collect an image, determine its range of video levels (for a selected number of points), and adjust the contrast and brightness settings of the detector, until the contrast and brightness are optimized.

Flap-out
Pressing the arrow button displays the flap-out with the STEM Imaging Scan and Focus Control Panels.

44.1 STEM Imaging Focus (User)



The STEM Imaging Focus Control Panel.

In the STEM Imaging Focus Control Panel various parameters related to focusing in STEM are controlled.

Euc. focus
Pressing the Euc. focus button executes the Eucentric focus function. In the case of STEM, this function sets the intensity and objective-lens currents to their (pre-aligned) value for focus at the eucentric height and normalizes the lenses.

Note: the eucentric focus only sets the objective lens for the eucentric height, not the specimen itself (if the specimen is off the eucentric height, it will then appear out of focus).

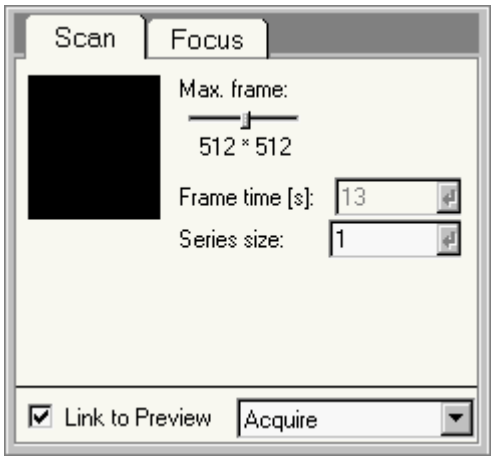
Reset Df
Pressing the Reset Df button reset the Defocus display value to 0.

Reset beam
Pressing the reset beam button reset the user beam shift setting (as set with the trackball) to 0.

Focus window
The Focus window parameters defines the size of the Focus window relative to the STEM image.

Dwell time
The dwell time parameters defines the dwell time (the amount of time the beam resides at a pixel) for the Focus function.

44.2 STEM Imaging Scan (User)



The Scanning Scan Control Panel.

In the Scanning Scan Control Panel the scan parameters are defined.

Max. frame
The maximum frame parameter defines the size of the scan frame for the currently selected acquisition mode.

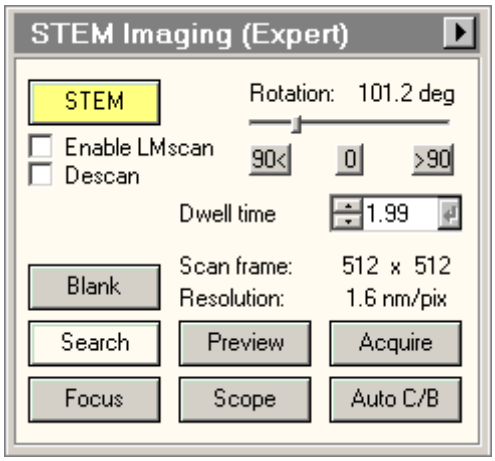
Frame time
The Frame time for the scan frame is set by changing the value in the spin-enter-edit control. Press the Enter button to set the value.

Series size
Under Series size the number of images acquired in a TIA series is defined.

Link to Preview
The Acquire acquisition mode settings can be defined as totally independent or they can be linked to the Preview settings. In the latter case, any change in the Preview settings (frame time, etc.) will automatically be used in Acquire as well (the typical difference then being that Preview is continuous acquisition while Acquire results in a single image).

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and by pressing the equivalent button in the main control panel is that the drop-list selection selects the mode but does not automatically start acquisition.

45 STEM Imaging (Expert)



The STEM Imaging Control Panel.

The STEM Imaging Control Panel contains the most important STEM controls. For a description of the basic concept of scanning, see the STEM mode description. The details of scanning operation itself are described separately.

Note: TIA must be running. If it is not running, many of the buttons are not present.

For easy operation, the scanning system has three preset modes with their own buttons, Search, Preview and Acquire. Each of the three can have its own, separate scanning settings (Frame size, Frame Time), allowing rapid switching between different settings. The actual settings are up to the user. Typical settings could be:

- Search: Frame size 256*256, Frame time 1 second.
- Preview: Frame size 512*512, Frame time 5 seconds.
- Acquire: Frame size 1024*1024, Frame time 30 to 60 seconds.

By definition Search and Preview are continuous acquisition, while Acquire acquires a single frame and stops (to allow the operator to save the image).

The Focus state is different from the previous three settings. It will display a small window inside an image already collected. Only the image inside the frame is then collected and updated. The frame can be moved around and changed in size to select an area more suitable for focusing.

STEM
The STEM button switches the TEM microscope to the STEM mode (the button becomes yellow) and back (the button becomes gray).

Scan rotation
The scanning image can be rotated continuously. Click on the trackbar and drag the handle to left or right to change the scan rotation or (as long as the trackbar has the Windows focus - denoted by the dashed lines around it), use the arrow keys on the keyboard to change the rotation angle. When the button 0 is pressed, the scan rotation is reset to 0°. When the buttons 90< and >90 are pressed, the scan rotation is changed 90° from its current setting to left or right.

Enable LMscan
By default, the STEM system will not switch to LM scanning (in which the objective lens is off) when the operator turns the magnification further down than the lowermost scanning magnification step. If you want to go to LM scanning, the checkbox must first be checked. Only then is it possible to change to LM scanning by turning the magnification knob further down. The checkbox is reset to the default (off) each time STEM is switched off and on.

Descan
In STEM mode the diffraction pattern is stationary and is located on the STEM detector. When EELS spectroscopy is used in STEM the microscope is in the so-called image-coupling mode, which means that the diffraction pattern is at the PEELS or Imaging Filter entrance aperture, while the image, located at the level of the differential pumping aperture between the projection chamber and the column, is also found at the level of the spectrometer detector. The movement of the beam during scanning will cause the energy-loss spectrum to shift across the spectrometer, both sideways (no change in apparent energy but a movement that could lead part of the spectrum off the detection area) as well as in the energy direction. The movement is directly coupled to the movement of the beam so the effect is much more pronounced at low STEM magnifications (large beam movements) and negligible at very high magnifications.
The shifting of the spectrum can be avoided by using the descan functionality of the STEM mode. When descan is on, the image deflection coils below the specimen are coupled to the STEM scanning coils (above the specimen) in such a way that the compensate for the beam shift, so the beam appears to remain stationary when seen below the specimen.
Another reason for using the descan is when the HAADF detector is used in combination with a very small camera length. In that case the image at the level of the differential pumping aperture is large and may actually be larger than the diameter of the aperture. In that case the aperture will block the beam for part of the image (the corners are cut off). If descan is used, the beam once again will remain stationary in the differential pumping aperture and the HAADf is no longer partially blocked.

The checkbox is reset to the default (off) each time STEM is switched off and on.

Dwell time
The Dwell time indicates the time needed for acquisition of a single pixel for the currently active viewing mode (Search, Preview, Acquire).

Scan frame / resolution
The Scan frame and resolution values indicate the settings of the currently active viewing mode (Search, Preview, Acquire). The two parameters are linked but give different types of information. The scan frame indicates the size in pixels of the image collected, whereas the resolution indicates how large a single pixel is. The latter value is a useful indication for selecting spot size. For example, if the spot size used on the microscope is much larger than the indicated resolution, then the resolution in the image will be wholly determined by the microscope's spot size. If on the other hand, the indicated resolution is much larger than the spot size, the spot size could be increased to give better signal without loss of resolution.

Blank
The STEM Imaging Control Panel provides a function for blanking of the electron beam to avoid beam damage of other undesired effects when the beam remains on a fixed location of the specimen (that is, while it is not scanning). The beam is blanked then the button is yellow.

Note 1: The unblanking of the beam is not instantaneous and may take a short while to become effective. If a scan is started too quickly after unblanking of the beam the start of the image may look distorted.

Note 2: The microscope does not check that the beam is unblanked when a scan is started. It is entirely up to the user to make sure that the electron beam can reach the specimen when needed. Only when STEM is stopped or the user interface closed is the beam blanking switched off automatically.

Search
Pressing the Search button:
- When the button is gray, switches the scan settings to those of the Search mode and starts scanning.
- When the button is yellow, pauses the scan acquisition.
- When the button is white, resumes the scan acquisition (but starting with a new frame) if possible. If the start command could not be given to TIA, the button will remain white.

When the button is red, other software (Tomography) is acquiring images.
By definition Search is continuous acquisition. The scan parameters are set in the STEM Imaging Scan Control Panel.

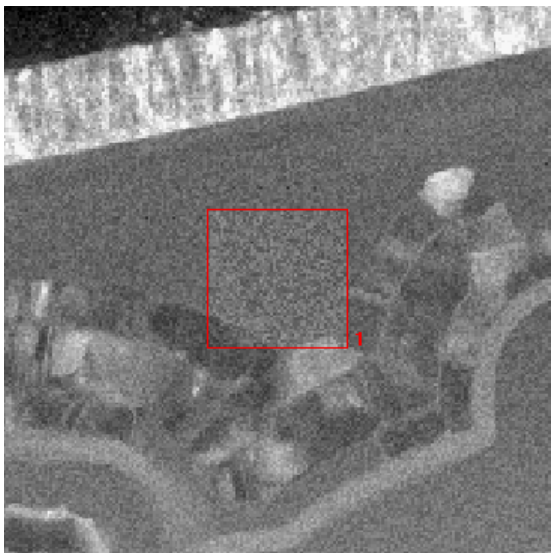
Preview
Pressing the Preview button:
- When the button is gray, switches the scan settings to those of the Preview mode and starts scanning.
- When the button is yellow, pauses the scan acquisition.
- When the button is white, resumes the scan acquisition (but starting with a new frame) if possible. If the start command could not be given to TIA, the button will remain white.

When the button is red, other software (Tomography) is acquiring images.
By definition Preview is continuous acquisition. The scan parameters are set in the STEM Imaging Scan Control Panel.

Acquire
Pressing the Acquire button:
- When the button is gray, switches the scan settings to those of the Acquire mode and starts acquisition.
- When the button is yellow, pauses the scan acquisition.
- When the button is white, resumes the scan acquisition (but starting with a new frame) if possible. If the start command could not be given to TIA, the button will remain white.

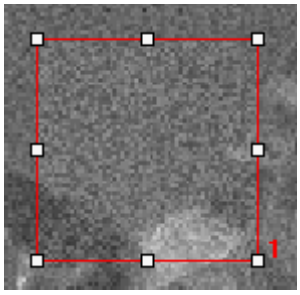
When the button is red, other software (Tomography) is acquiring images.
By definition Acquire acquires a single frame and stops (to allow the operator to save the image). The scan parameters are set in the STEM Imaging Scan Control Panel.

Focus
Pressing the Focus button activates (button becomes yellow) or stops (button becomes gray) the acquisition of the Focus image. When active, the Focus window is displayed in the center of the STEM image. Only the area inside the Focus window is now scanned, the remainder of the image is 'frozen'.



Part of a STEM image with the Focus window in the center.

The Focus window can be moved around or changed in size by clicking on it with the left-hand mouse button and dragging between the handles (small squares at corners and centers of the lines) to move it around or dragging a handle to change the size. The focus parameters are set in the STEM Imaging Focus Control Panel.



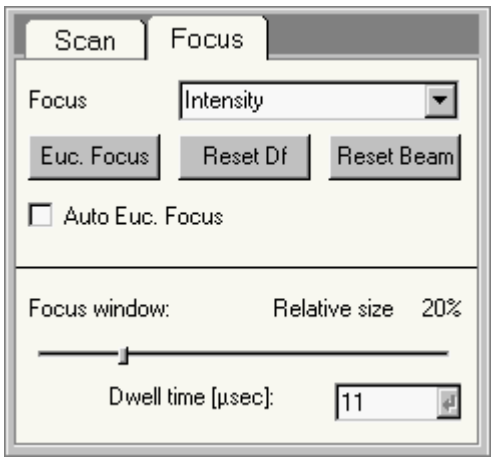
The Focus window with handles to change its position or size.

Scope
The Scope button enables or disables acquisition of images with a videoscope signal displayed as well. The videoscope signal shows the full range of signal levels available and the video levels along the lines of the scan. When scan acquisition is not active the scope signal shows the video levels along a line in the center of the image.

Auto CB
Press Auto CB to instruct the system to optimize the Contrast and Brightness of the detector selected automatically.

Flap-out
Pressing the arrow button displays the flap-out with the STEM Imaging Scan and Focus Control Panels.

45.1 STEM Imaging Focus (Expert)



The STEM Imaging Focus Control Panel.

In the STEM Imaging Focus Control Panel various parameters related to focusing in STEM are controlled.

Focus
The selection of the Focus drop-down list defines how the operator wants to focus in STEM imaging. Possible choices are:

- Intensity - the default setting, the same as the normal user, with the Focus knob controlling the Intensity setting, the objective-lens fixed and the Intensity knob decoupled.
- Objective - the Focus knob controls the Objective-lens setting and the Intensity is fixed, with the Intensity knob decoupled.
- Step-size dependent - the microscope automatically changes the Objective-lens setting for small focusing steps and the Intensity setting for larger focusing steps, both from the Focus knob, while the Intensity knob is decoupled.
- Intensity and objective - both Intensity and Objective-lens setting can be controlled freely, with the Focus knob controlling the Objective-lens setting and the Intensity knob the Intensity setting.

Euc. focus
Pressing the Euc. focus button executes the Eucentric focus function. In the case of STEM, this function sets the intensity and objective-lens currents to their (pre-aligned) value for focus at the eucentric height and normalizes the lenses.

Note: the eucentric focus only sets the objective lens for the eucentric height, not the specimen itself (if the specimen is off the eucentric height, it will then appear out of focus).

Auto Euc. focus
If the Auto Euc. focus checkbox is checked, the microscope will execute the Eucentric focus function each time when the STEM mode is entered (to reset the focusing conditions to good default values).

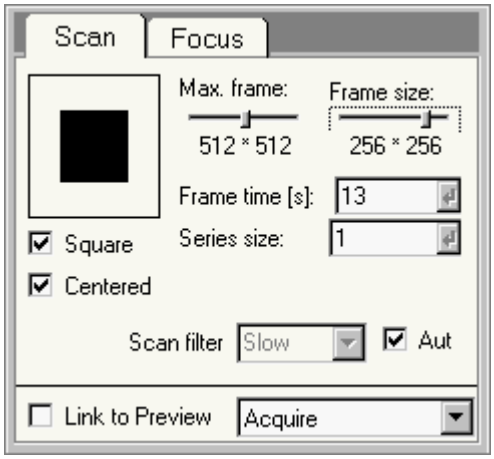
Reset Df
Pressing the Reset Df button reset the Defocus display value to 0.

Reset beam
Pressing the reset beam button reset the user beam shift setting (as set with the trackball) to 0.

Focus window
The Focus window parameters defines the size of the Focus window relative to the STEM image.

Dwell time
The dwell time parameters defines the dwell time (the amount of time the beam resides at a pixel) for the Focus function.

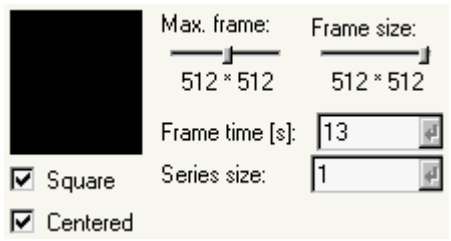
45.2 STEM Imaging Scan (Expert)



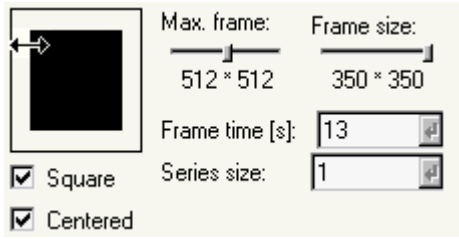
The STEM Imaging Scan Control Panel.

In the STEM Imaging Scan Control Panel the scan parameters are defined.

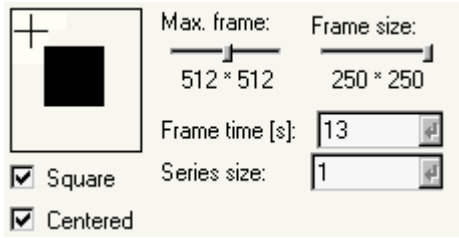
Scan frame
The scan frame is a graphic representation of the frame size that allows setting of frame-size parameters with the mouse.



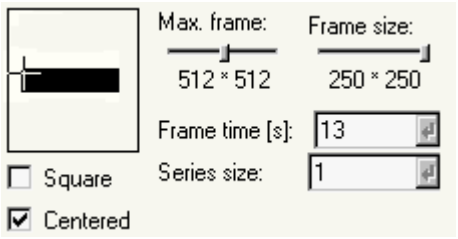
When the Max. frame and Frame size are equal, the scan frame fills the full frame.



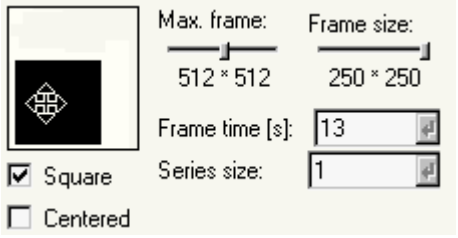
Move the cursor to the edge of the scan frame. It will change to a Resize cursor (horizontal, vertical or diagonal, depending on the cursor position relative to the frame). Click with the left-hand mouse button and drag to change the size of the scan frame.



If the scan frame is smaller than the full frame, the cursor will change to the Precision select cursor inside the full frame but outside the scan frame. Click with the left-hand mouse button and the frame size will 'jump' to the cursor positions. Drag to adjust the scan frame.



If square is not checked, the cursor position inside the full frame will determine the scan frame dimensions in x and y as well.



When centered is not checked, the cursor will change to to the Move cursor when it is inside the black rectangle representing the scan frame. Click with the left-hand mouse button on the frame and drag it to any position within the full frame.

Max. frame
The Max. frame sets the number of pixels (in powers of 2) for the maximum scan range for the currently selected acquisition mode.

Frame size
The Frame size parameter determines the actual size of the scan frame. The value of the Frame size can be anywhere from the Resolution values downwards. To reset the Frame size to power of 2 values, drag the slider fully to the right and it will clip at the Resolution value. The Square and Centered checkboxes will be checked automatically.

Square
When Square is checked, the scan frame is forced to be square (x and y dimensions equal). Otherwise the scan frame can have any (rectangular) shape.

Centered
When Centered is checked, the scan frame is forced to remain centered within the full frame. Otherwise the scan frame can be positioned anywhere within the full frame.

Scan filters
The Scan filter defines the setting of the beam-deflection filter. There are four manual settings, Off (very fast scanning), Fast, Medium and Slow (final image acquisition). The use of the wrong setting can lead to excessive noise (Off while doing the final image acquisition slowly) or image distortion especially at the left-hand side where each new line starts (Slow while scanning very rapidly). The filter must therefore be matched to the scan speed used.

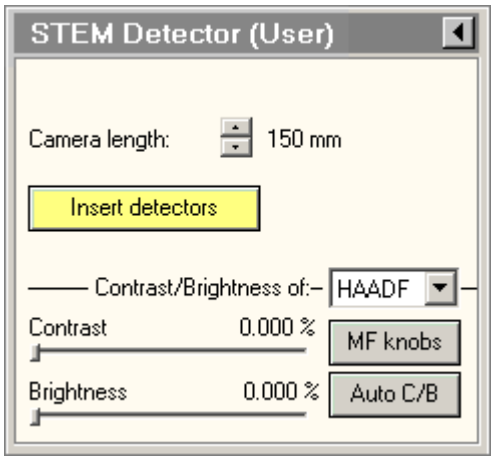
Frame time
The Frame time for the scan frame is set by changing the value in the spin-enter-edit control. Press the Enter button to set the value.

Series size
Under Series size the number of images acquired in a TIA series is defined.

Link to Preview
The Acquire acquisition mode settings can be defined as totally independent or they can be linked to the Preview settings. In the latter case, any change in the Preview settings (frame time, etc.) will automatically be used in Acquire as well (the typical difference then being that Preview is continuous acquisition while Acquire results in a single image).

Acquisition mode
In the acquisition mode drop-down list, the acquisition mode for which the parameters must be defined, can be selected. The difference between selecting the acquisition mode through the drop-down list and by pressing the equivalent button in the main control panel is that the drop-list selection selects the mode but does not automatically start acquisition.

45.3 STEM Detector (User)



The STEM Detector Control Panel.

In the STEM Detector Control Panel various detector settings are controlled.

Camera length
The camera length for STEM is set with the spin buttons (there is no other way to control the camera length in STEM because the magnification knob is coupled to the STEM magnification).

Insert detectors
Pressing the Insert detectors button inserts or retracts the selected detector(s).

Contrast / Brightness of ...
In the drop-down list box after Contrast / Brightness of is selected which detector is controlled by the functions underneath (Contrast and Brightness track bars, MF knob control and Auto CB).

Contrast
With the Contrast track bar the contrast (gain) setting of the detector is controlled.

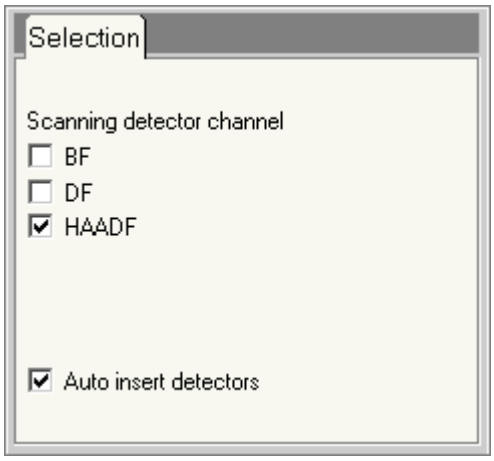
Brightness
With the Brightness track bar the brightness (offset) setting of the detector is controlled.

MF knobs
Press MF knobs to couple the Multifunction X and Y knobs to the contrast and brightness settings of the detector.

Auto C/B
Press Auto CB to instruct the system to optimize the Contrast and Brightness of the detector selected automatically. The Auto Contrast Brightness function will repeatedly collect an image, determine its range of video levels (for a selected number of points), and adjust the contrast and brightness settings of the detector, until the contrast and brightness cover specified levels.

Flap-out
Pressing the arrow button displays the flap-out containing the STEM Detector Selection CB Control Panels.

45.4 STEM Detector Selection (User)



The STEM Detector Selection Control Panel.

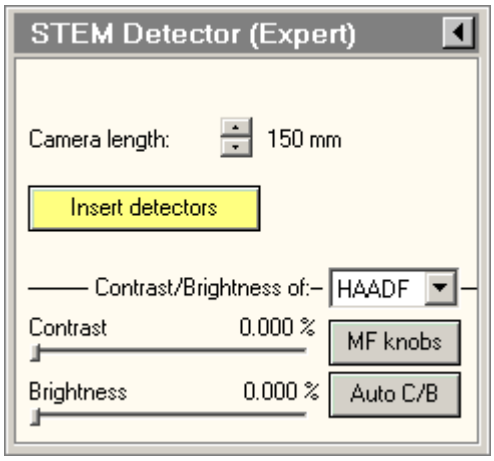
In the STEM Detector Selection Control Panel the STEM detector(s) to be used are selected.

In the STEM Selection Control Panel the STEM detector(s) to be used are selected.

Scanning detector channel
Each of the STEM detectors present can be selected with the check boxes. The detectors selected determine which images are displayed in TIA during scanning.

Auto insert detectors
The Auto insert detectors determines whether the detector(s) selected is(are) automatically inserted or retracted when appropriate. If not checked, the detector must be inserted or retracted by hand (operator instruction).

45.5 STEM Detector (Expert



The STEM Detector Control Panel.

In the STEM Detector Control Panel various detector settings are controlled.

Camera length
The camera length for STEM is set with the spin buttons (there is no other way to control the camera length in STEM because the magnification knob is coupled to the STEM magnification).

Insert detectors
Pressing the Insert detectors button inserts or retracts the selected detector(s).

Contrast / Brightness of ...
In the drop-down list box after Contrast / Brightness of is selected which detector is controlled by the functions underneath (Contrast and Brightness track bars, MF knob control and Auto CB).

Contrast
With the Contrast track bar the contrast (gain) setting of the detector is controlled.

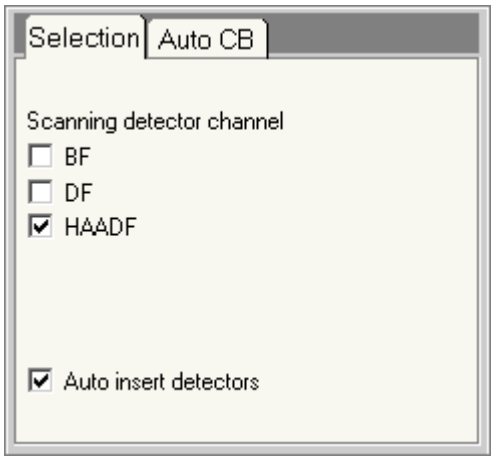
Brightness
With the Brightness track bar the brightness (offset) setting of the detector is controlled.

MF knobs
Press MF knobs to couple the Multifunction X and Y knobs to the contrast and brightness settings of the detector.

Auto C/B
Press Auto CB to instruct the system to optimize the Contrast and Brightness of the detector selected automatically. The Auto Contrast Brightness function will repeatedly collect an image, determine its range of video levels (for a selected number of points), and adjust the contrast and brightness settings of the detector, until the contrast and brightness cover specified levels.

Flap-out
Pressing the arrow button displays the flap-out containing the STEM Detector Selection Control Panel.

45.6 STEM Detector Selection (Expert)



The STEM Selection Control Panel.

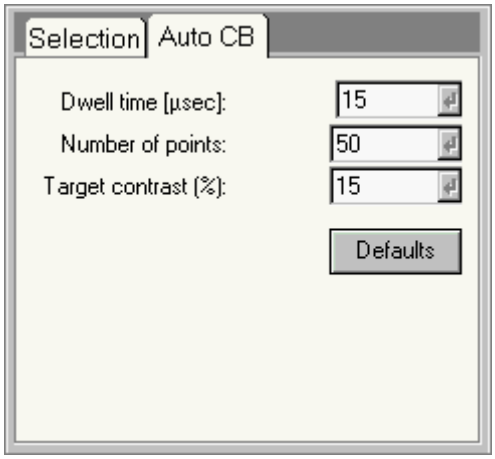
In the STEM Selection Control Panel the STEM detector(s) to be used are selected.

In the STEM Selection Control Panel the STEM detector(s) to be used are selected.

Scanning detector channel
Each of the STEM detectors present can be selected with the check boxes. The detectors selected determine which images are displayed in TIA during scanning.

Auto insert detectors
The Auto insert detectors determines whether the detector(s) selected is(are) automatically inserted or retracted when appropriate. If not checked, the detector must be inserted or retracted by hand (operator instruction).

45.7 STEM Detector Auto CB



The STEM Detector Auto CB Control Panel.

In the STEM Detector Auto CB Control Panel the settings used for the Auto Contrast Brightness function are defined. The Auto Contrast Brightness function will repeatedly collect an image, determine its range of video levels (for a selected number of points), and adjust the contrast and brightness settings of the detector, until the contrast and brightness cover the specified levels (contrast to the target contrast, brightness within the accessible range of video levels).

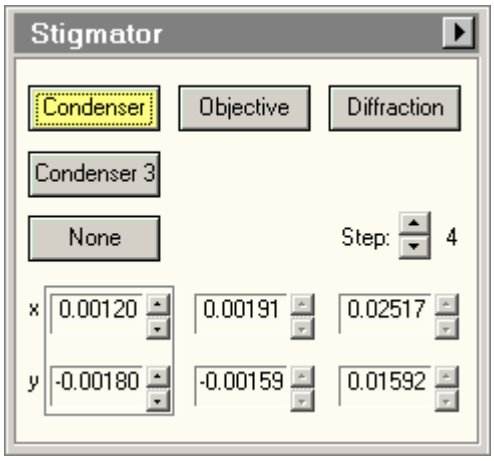
Dwell time
The dwell time defines the time per pixel for measuring the video level. Longer times lead to less noisy signal but increase the time necessary for the Auto Contrast Brightness function to finish.

Number of points
The number of points determines at how many points the video level is measured for each cycle. Increasing the number of points increases the 'relevance' of the Auto Contrast Brightness function but also increases the cycle time. The points are distributed over a whole image. If the total range of video levels is spread out over a whole image with each level present in an area of reasonable size (more than just a few pixels), run the Auto Contrast Brightness function over the image as is. If, however, the video levels change on a small scale (as e.g. with small particles), increase the magnification so just a few particles are visible and/or increase the number of points before running the Auto Contrast Brightness function (otherwise the pixels used for measuring the video levels may miss the small features altogether).

Target contrast
The target contrast defines how much of the total available signal range should be filled by the detector signal. Thus 100% would have the lowest signal from the detector at 0 and the highest at 64000. Under normal circumstances a range of 10 to 15% is sufficient (the display software then automatically optimizes the image display from black to white).

Defaults
Press the Defaults button to reset all values to their default.

46 Stigmator



The Stigmator Control Panel.

The Stigmator Control Panel allows the operator to control the stigmators of the microscope.

Condenser
The condenser stigmator is used to stigmate the electron beam. It is the default stigmator for modes where the beam is important (like nanoprobe and STEM). Pressing the Condenser stigmator button is equivalent to pressing the Stigmator button on the left-hand control pad plus selecting the condenser stigmator.
Each spot size has its own condenser stigmator settings.

Condenser 3
The Condenser 3 stigmator is used to correct 3-fold astigmatism of the probe-forming system. The 3-fold condenser stigmation is done after the 2-fold condenser astigmatism has been corrected (go towards a beam that is as round as possible with the normal Condenser stigmator, then make the beam round with the 3-fold condenser stigmator).
Notes:

- The 3-fold stigmator only works properly in the Nanoprobe or STEM mode. Although it is available in the Microprobe (TEM) and LM modes, the 3-fold condenser stigmator does not have the working range to have any effect there.
- 3-fold condenser stigmator settings are stored per spot size (three channels for each).

Objective
The objective stigmator is used to stigmate the HM (high-magnification) TEM image and the LAD (Low-Angle Diffraction) pattern. Pressing the Objective stigmator button is equivalent to pressing the Stigmator button on the left-hand control pad plus selecting the objective stigmator.

Diffraction
The diffraction stigmator is used to stigmate the D (high-magnification) diffraction pattern and the LM (low-magnification) TEM image. Pressing the Diffraction stigmator button is equivalent to pressing the Stigmator button on the left-hand control pad plus selecting the diffraction stigmator.

None
The None button allows the operator to deselect all stigmators. Pressing None is equivalent to pressing the stigmator button on the left-hand control pad when it is on.

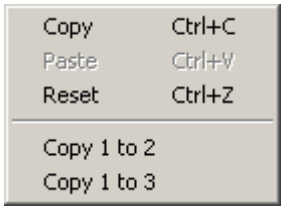
Step size
Each stigmator has its own step size. The step size determines the increment with which the stigmator is changed when the Multifunction buttons are turned or the spin buttons of the channels pressed. The step

size is changed either with the spin buttons in the control panel or by pressing the -/+ buttons left of the Multifunction-X knob on the left-hand control pad.

Channel
Stigmator settings can be stored in three channels. One possible use of the channels is for optical modes that can be slightly different (such as SA and Mh magnifications, because of the small change in objective-lens current). They can also be used to store intermediate results during stigmation (if you are unsure you can get the astigmatism correction better, copy the contents of the current channel to another and continue stigmation with the other channel. You can then always go back to first channel if it gets worse).
The active channel is outlined by a frame around it and by the enabled nature of its spin buttons (the arrows are black; those of the inactive channels are gray).

Spin control
Use the buttons of the spin control to change the stigmator setting (an alternative to using the Multifunction knobs).

Flap-out button
The flap-out button leads to the Stigmator flap-out with the Stigmator Popup control panel.



Special function : Click with the right-hand mouse button on one of the channels to get a popup-menu.

Popup menu functions

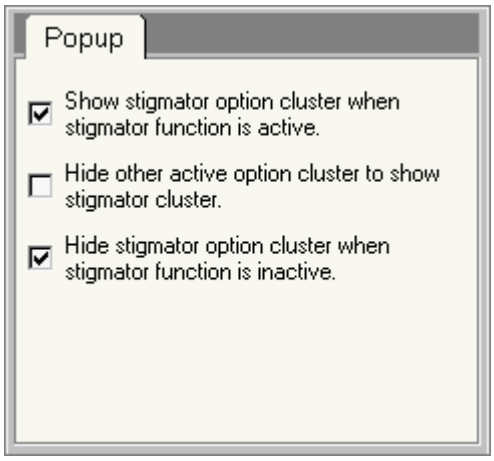
Copy
Copies the contents of the channel in which the mouse was clicked to the clipboard.

Paste
Pastes the contents of the clipboard into the channel where the mouse was clicked. This menu items remains grayed (disabled) until a copy action has been done.

Reset
Resets the stigmator channel to zero.

Copy ... to ...
Copies the content of the channel listed first to the channel listed second. The copy action is always from the channel where the right-hand mouse click was done to one of the other channels.

46.1 Stigmator Popup



The Stigmator Popup Control Panel.

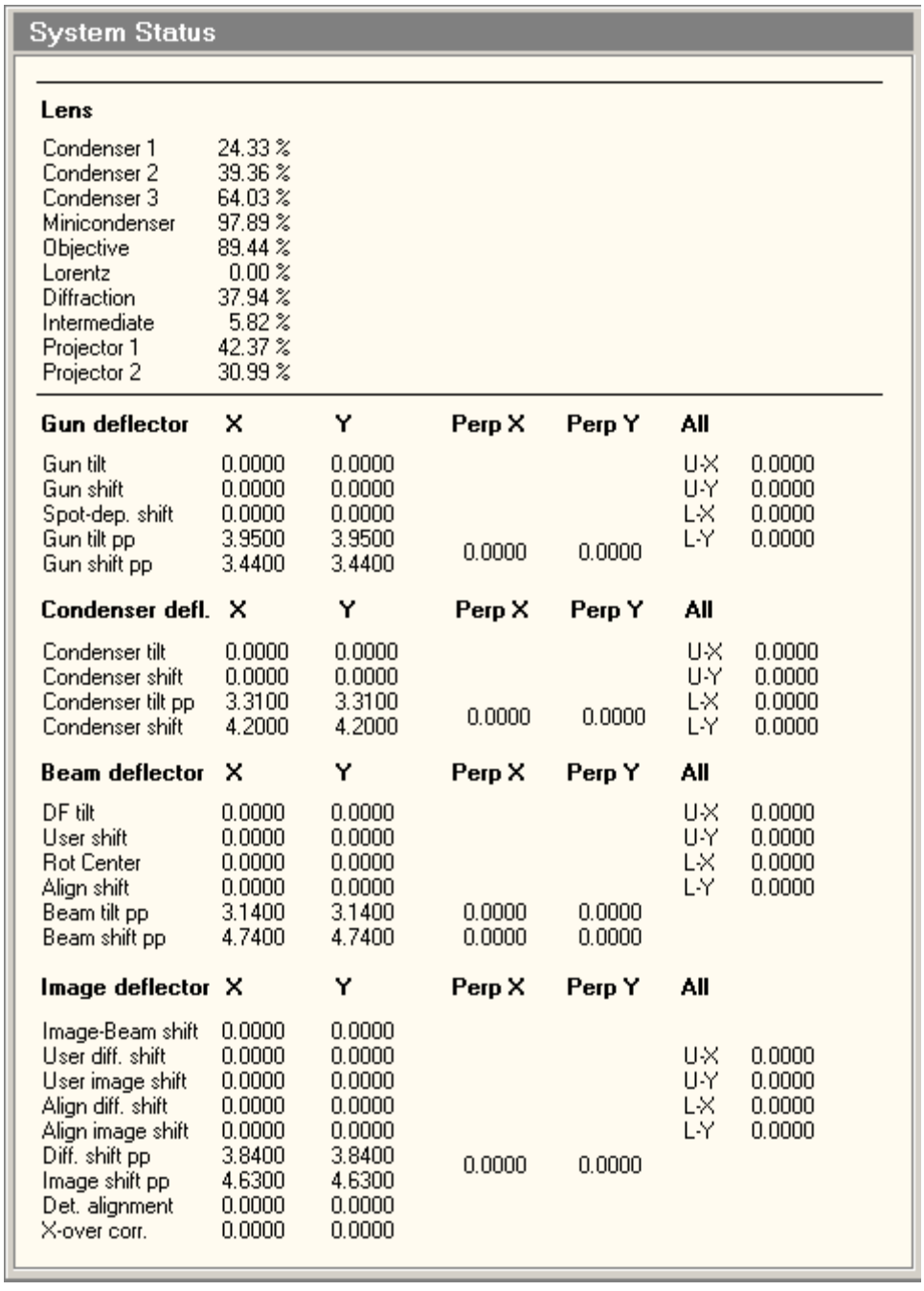
The Stigmator Popup Control Panel contains a number of options related to the behavior of the Stigmator control panel.

Show .. when .. active
When checked, this option automatically makes the Stigmator control panel pop up at the standard panel popup position (bottom right - unless it is already visible) when stigmator selection is on (through pressing of the Stigmator button on the left-hand Control Pad).

Hide other ..
This option, when checked, makes the Stigmator control panel replace any other control panel currently popped up.

Hide stigmator ...
When checked, this option makes the Stigmator control panel disappear again when the stigmator selection is switched off (by pressing the Stigmator button on the left-hand Control Pad).

47 System Status



The System Status Control Panel.

The System status control panel provides an overview of all (software) values of lenses and deflection coils.

Lens values
The lens values display the currently active lens settings as a percentage of the lens maximum.

Deflection coils
The deflection coils values are shown in non-physical units. These values always lie between -1 and +1, except for the pivot points that lie in the range 2-6.

X-Y values
The X-Y values are the values on the X and Y coils, respectively, for the entries listed on the left.

Perpendicular values
The perpendicular values display the perpendicular corrections applied to the coils. Only one set of perpendicular values exists for a particular deflection coil (thus the shift and tilt components use the same value).

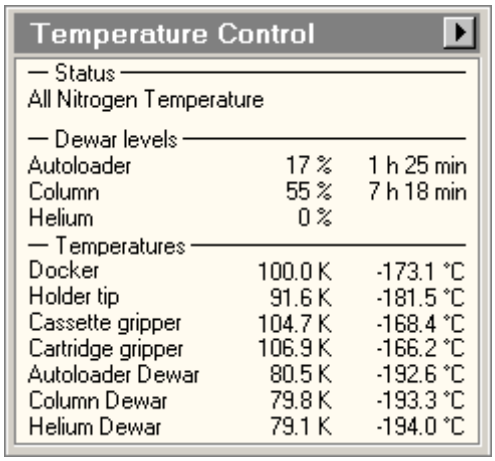
All values
The settings on the deflection coils are first added together. These are then converted by the pivot points into settings applied to upper and lower coils.

Gun coils
The settings on the gun deflection coils consist of the gun tilt, the gun shift and the spot-size dependent gun shift.

Beam coils
The settings on the beam deflection coils consist of four factors, two user factors (user beam shift as set with the trackball, and dark field tilt) and two alignment factors, the align beam shift and the rotation center. Not listed is the contribution from the image shift - beam shift.

Image coils
The settings on the image deflection coils consist of four main factors, two user factors (user image shift and user diffraction shift) and two alignment factors, the align image shift and align diffraction shift. Additionally there are the magnification correction (used for the alignment of the magnifications within a range) and the cross-over correction (used in EFTEM). Not listed is the contribution from the image shift - beam shift.

48 Temperature Control



The Temperature Control Control Panel.

The Temperature Control Panel allows monitoring and controlling the temperature state of the Life Science system. The temperature control system consists of dewars on both the autoloader and column, connected to a liquid nitrogen storage vessel via the autofill system. It gives the ability to automatically fill and empty the nitrogen dewars. Filling the autoloader dewar will cool and maintain the specimens in the autoloader cassette to near-liquid-nitrogen temperatures. Filling the column dewar will cool and maintain the cryobox and the specimen holder tip to near-liquid-nitrogen temperatures. In case a thermal switch is present, there is an additional choice to cool only the cryobox and keep the specimen-holder tip near room temperature. In case the Life Science system is a helium system, the specimen-holder tip and helium cryobox can be cooled to near-liquid-helium temperatures. A helium system has an additional helium dewar integrated in the column dewar. Automatic filling of the helium dewar is not supported.

Status
This part of the control panel shows the current status of the temperature control system. Possible states are:

- **All Room Temperature** : in this state the autofill system is idle. All dewars are empty and all temperatures are around room temperature.
- **All Nitrogen Temperature** : use this state to operate the microscope with frozen samples close to liquid nitrogen temperatures. The specimen holder tip is cooled to near liquid nitrogen temperatures. The cryobox is also cold and shields the holder tip from its surroundings, reducing the change that gases in the column vacuum freeze on the cold sample. The samples inside the autoloader are also maintained near liquid nitrogen temperatures. In this state all temperatures are near liquid nitrogen temperature.
- **Cryobox N2, Sample RT** : in this state the cryobox is cold while the samples in the autoloader and on the specimen holder are around room temperature. Gases around the specimen holder (mainly water) freeze on to the cryobox surface, reducing the partial pressure of these gases in the vacuum around the specimen. The autofill system keeps the column dewar filled with liquid nitrogen, resulting in a near liquid nitrogen column dewar temperature, while all other temperatures are near room temperature. This option is only available if the system has a thermal switch.
- **Cryobox He, Sample He** : use this state to cool the specimen holder tip to near liquid helium temperatures. When going to this state, temperature control first heats the helium dewar to remove the liquid nitrogen inside. When the dewar is empty the user is asked to manually fill the helium dewar with liquid helium. All this time the autofill system keeps the column and autoloader dewar filled with liquid nitrogen. In this state the helium dewar, helium cryobox and holder tip temperature are near liquid helium temperature, while all other temperatures are near liquid nitrogen temperature. This option is only available if the system has a helium dewar.

In the above temperature states, the autoloader vacuum is on and the column vacuum is ready, which means that its ion getter pumps (IGP) are on and the column valves can be opened for operating the microscope.

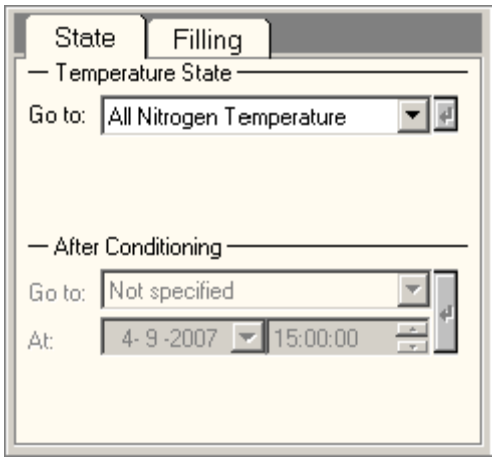
- **Conditioning Autoloader** : use this state to remove any water vapor from the autoloader vacuum which is released when the cold autoloader parts warm up. In this state the autoloader turbo pump (TMP) pumps actively on the autoloader, while heaters in the autoloader dewar warm the autoloader to room temperature. This state affects only the autoloader. If in the preceding state the column dewar was cold, it will remain being filled with liquid nitrogen and the column vacuum remains ready.
- **Conditioning Column** : use this state to remove any water vapor from the column vacuum which is released when the cold column parts warm up. In this state the column IGP's are switched off and the column turbo pump (TMP) pumps actively on the column, while heaters in the column dewar (and helium dewar if present) warm the column to room temperature. This state affects only the column. If in the preceding state the autoloader dewar was cold, it will remain being filled with liquid nitrogen and the autoloader vacuum remains on.
- **Conditioning Both** : use this state to condition the autoloader and column simultaneous.

Dewar levels
The Dewar levels section shows the actual liquid level in each dewar as measured with the level gauge. The liquid level is depicted as a percentage and as the remaining time before the dewar is empty.
Note: The measurements may fluctuate slightly (up to a few percent) due to the nature of the construction of the measurement gauges.

Temperatures
Under Temperatures the current temperatures of different parts within the system are displayed in Kelvin and degrees Celsius. There are four temperature sensors inside the autoloader : docker, cassette gripper, cartridge gripper and autoloader dewar. The holder tip is the temperature sensor measuring the temperature near the specimen holder. The column dewar displays the temperature of the bottom of the column dewar. And if there is a helium dewar present the bottom temperature of this dewar is also depicted.

Flap-out button
Pressing the flap-out button displays the flap-out containing the State and Filling control panels.

48.1 Temperature Controller State



The Temperature Controller State Control Panel.

The State flap-out provides the control over the state of the temperature control system.

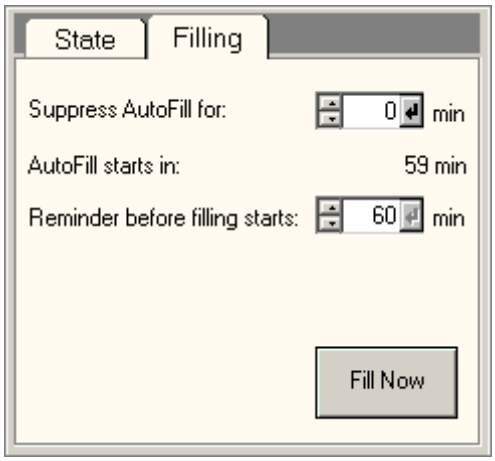
Temperature State
The current temperature state can be changed by selecting a different state from the dropdown list. When the command is given, the temperature control system will automatically execute the required actions. First, temperature control will put the column and autoloader vacuum in the correct state and second, fill or empty one or more dewars.

Note that the dropdown list does not always show all existing temperature states. For example :
All Room Temperature: this state is unavailable if the column dewar is cold. The cryobox is cold and gases are frozen on its surface. On going to all room temperature, the column dewar and cryobox warm up and the frozen gases evaporate, contaminating the column vacuum. Select first the state Conditioning Column or Conditioning Both to remove the evaporating gases. When the column is warmed up the All Room Temperature state becomes available.
Cryobox He, Sample He: this state is only available if the column and helium dewar are near liquid nitrogen temperature. The helium dewar must first be pre-cooled with liquid nitrogen. When the helium and column dewar have reached this state the Cryobox He, Sample He state becomes available.

Notes :
- If, due to exceptional circumstances, the temperature control system is in an error state, a recover button will become available here. On pressing this recover button, the temperature control system will try to recover from this error state. In case the error state does not recover, or the error reappears again, customer service must be contacted.
- Dewar increase not detected. This error message appears if temperature control does not measure any liquid nitrogen level increase during filling. In this case it is good to check if the liquid nitrogen storage vessel is empty or closed.

After Conditioning
Temperature control gives the possibility to schedule the desired temperature state after conditioning is finished. When the system is put into a conditioning state, these states become available in a dropdown list. At the preset time and date temperature control will stop conditioning and put the system in the desired temperature state.

48.2 Temperature Controller Filling



The Temperature Controller Filling Control Panel.

The Filling flap-out is dedicated to the liquid-nitrogen autofill system of the autoloader and column dewar.

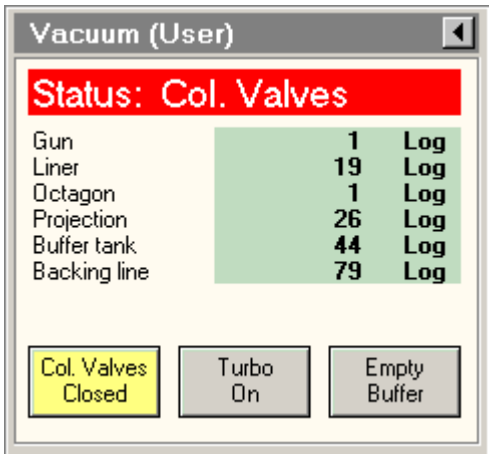
Suppress Autofill for
This option allows continued operation the microscope for a user-defined time without being disturbed by the autofill system. Normally, filling starts if one dewar is almost empty. The Suppress Autofill for postpones filling for the desired period. Note that the cold parts will eventually warm up if the filling is postponed for a long time.

AutoFill starts in
This shows the remaining time before the autofill system starts its next filling cycle.

Reminder before filling starts
The software displays a warning message in the information area of the user interface before the automatic filling starts. The user can specify the amount of time before a refill when this reminder will be given.

Fill Now
When the Fill Now button is pressed temperature control will start the autofill process. Note that this button is not available if both dewars are nearly full.

49 Vacuum (User)



The Vacuum Control Panel.

The Vacuum Control Panel gives an overview of the vacuum status of the microscope and provides access to a few, often-used vacuum-control functions.

Note 1: To stop the TMP running (usually after inserting a specimen holder) either use the Turbo on button or simply open the Column Valves (if the "Auto stop Turbo when col. valves opened" function on the Vacuum Settings Control Panel is active).

Note on the Turbo-molecular pump (TMP) : When the TMP is switched off, it is forced to run down completely, otherwise there may be situations where it does not start up properly. The run-down of the TMP takes about 3 minutes. While it is running down it cannot be switched on.

Note 2: Vacuum terminology tends to be confusing. People talk about high or ultra-high vacuum when they mean very low pressures. Where it could be confusing, vacuum status will therefore be referred to as 'good' or 'poor'.

Status
The status line of the Vacuum Control panel displays the status of the vacuum in words. Examples of status values are "Initial", "Busy", and "Col. Valves". A green status display is used for ready, red status displays for not ready. In the example above, the display indicates that the Column Valves are closed.

Pressure read-out
The essential pressures of the microscope are read out, either by pressure gauges like Pirani's or Pennings or by converting the currents going through Ion Getter Pumps to pressures. The important pressures are listed in the Vacuum Control Panel. The pressure units are as set in the Vacuum Settings control panel (or defined by the supervisor for users). Possible units are Pascal, Torr and Log. Log units are defined in such a way that a realistic range of pressures (for that vacuum element) goes from 0 to 100. The advantage of the log units is simplicity and high sensitivity for the good vacuum values (where it matters) and low sensitivity for poor vacuum values.

The gauges measuring the displayed vacuum levels are (compare to the Vacuum Overview).

Vacuum level	Gauge
Gun	IGPa
Liner	IGPcl
Octagon	IGPco
Projection	CCGp
Buffer tank	PIRbf
Backing line	PIRpv

Column Valves Closed
The Column Valves Closed button closes and opens the two valves in the column separating the column from the projection chamber (Vcp) and the column from the gun (Vac). These two valves are always opened and closed together. The high tension and filament can remain on when opening and closing these valves. The functionality of the button is chosen such that it highlights (yellow) when the column valves are closed (as a warning that the beam will not be visible). The same is indicated, when possible, by the status display.

It is good practice to keep these valves closed whenever the microscope is not actively used, to keep the column vacuum at its optimum condition and prevent air from entering the gun area during specimen exchange.

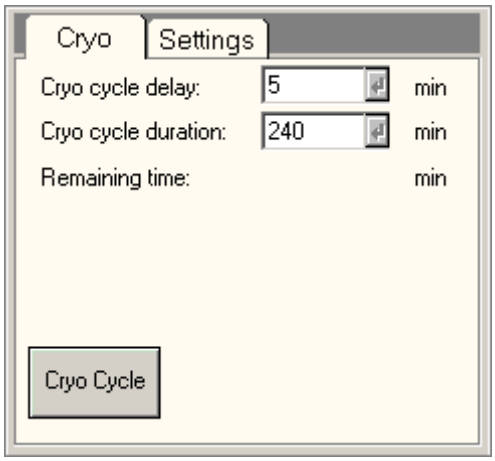
Turbo On
In cases where the pre-pump airlock action is not necessary (all airlock actions without cryo holders), it may still be advantageous to switch the TMP on (or off). An example is the removal of the specimen holder in order to exchange the specimen. Since the TMP takes some time to reach Ready status, it can be switched on before removing the specimen holder, so it is ready immediately after the specimen has been exchanged. The switch on and off of the TMP can be done through the "Turbo On" button.

Note: The Turbo button is orange when the TMP is on but not yet at operational speed. When the TMP is on and at speed, the button is yellow.

Empty Buffer
The "Empty Buffer" button starts the cycle that empties the buffer tank. This may be useful in cases where it is necessary that the buffer cycle doesn't interrupt operation for a period of time (e.g. when a series of exposures is to be made).

Flap-out button
Pressing the flap-out button displays the flap-out containing the Vacuum Cryo and Vacuum Settings control panel.

49.1 Vacuum Cryo (User)



The Vacuum Cryo Control Panel.

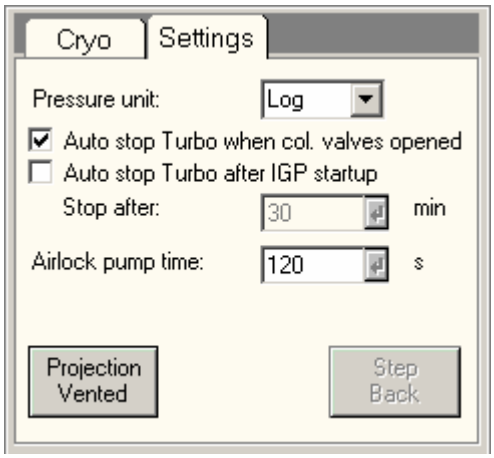
The Vacuum Cryo Control panel contains special functions for the cryo cycle (for removal of water vapor coming off the cold trap or cryo blades when the liquid-nitrogen cooling is removed).

Cryo Cycle
The Cryo Cycle is a special vacuum procedure for removing the water vapor from the microscope column that is released when the cold trap or cryo blades are being warmed up at the end of a microscopy session. The Ion Getter Pump (IGP) that pumps the microscope column is not a very effective pump for removal of water vapor and ages more rapidly when it is forced to pump a lot of water vapor. Therefore the TMP is used to pump away the water vapor while IGP is temporarily switched off. After a set time has elapsed, the IGP is automatically switched on again so the microscope is ready for operation the next morning.

During the cryo cycle a number of vacuum controls (column valves, etc.) are disabled. It is also not possible to change the cryo cycle settings while the cycle is running. The cryo cycle can be aborted by clicking the "Cryo Cycle" button again.

Two parameters can be set for the cryo cycle: the delay and duration. The delay specifies the number of minutes the system will wait before pumping with the TMP. The value can be set to the warm-up time of the cold trap, usually 5 minutes if the dewar is removed. A good setting for the duration is 240 minutes (4 hours).

49.2 Vacuum Settings (User)



The Vacuum Settings Control Panel.

The Vacuum Settings control panel allows access to various settings concerning the vacuum system.

Pressure Unit
Vacuum pressures can be listed in three types of units, Pascal (Pa), Torr and Log unit. Log units are defined in such a way that a realistic range of pressures (for that vacuum element) goes from 0 to 100. The advantage of the log units is simplicity and high sensitivity for the good vacuum values (where it matters) and low sensitivity for poor vacuum values.

Auto stop Turbo when col. valves opened
Normally, when opening the column valves the Turbo molecular pump (TMPm) is stopped to prevent vibrations to disturb the experiments. If needed (when screening multiple samples for example) the TMPco can be kept running by unchecking this box.

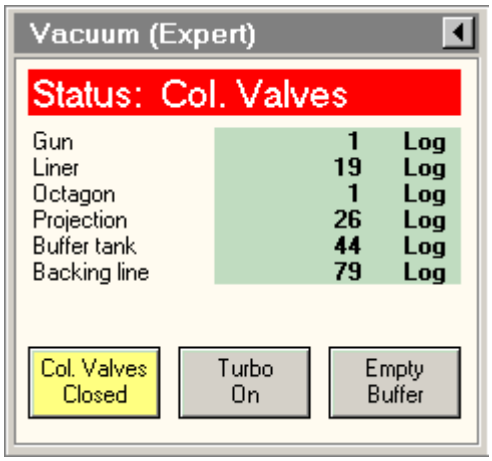
Auto stop Turbo after IGP startup
Aftter starting the IGPco the turbo pump is normally stopped. To speed up sample loading it can be kept running. The 'Stop after' time keeps the TMPm running for the specified time to backup IGPco if it fails to start the first time.

Airlock pump time
The airlock pump time is selected from a drop-down list of values. The minimum airlock pumping time advised is 50 seconds.

Projection Vented
The Projection vented button starts the vacuum cycle that vents the camera chamber and, when the camera is vented, starts the cycle that pumps the camera chamber again. Projection vented must be confirmed. For this purpose, the button disappears and is replaced by two buttons, one with a 'V' sign for OK, the other with and 'X' sign for Cancel.
The Camera Vented button may be absent. In that case the system Supervisor has chosen to remove the button. This is often done when no plate camera is used on the system so there is no reason for users to vent the camera.

Step back
In case an action on the vacuum system results in a non-workable situation, the vacuum system allows recovery through the Step back button.

50 Vacuum (Expert)



The Vacuum Control Panel.

The Vacuum Control Panel gives an overview of the vacuum status of the microscope and provides access to a few, often-used vacuum-control functions.

Note 1: To stop the TMP running (usually after inserting a specimen holder) either use the Turbo on button or simply open the Column Valves (if the "Auto stop Turbo when col. valves opened" function on the Vacuum Settings Control Panel is active).

Note on the Turbo-molecular pump (TMP) : When the TMP is switched off, it is forced to run down completely, otherwise there may be situations where it does not start up properly. The run-down of the TMP takes about 3 minutes. While it is running down it cannot be switched on.

Note 2: Vacuum terminology tends to be confusing. People talk about high or ultra-high vacuum when they mean very low pressures. Where it could be confusing, vacuum status will therefore be referred to as 'good' or 'poor'.

Status
The status line of the Vacuum Control panel displays the status of the vacuum in words. Examples of status values are "Initial", "Busy", and "Col. Valves". A green status display is used for ready, red status displays for not ready. In the example above, the display indicates that the Column Valves are closed.

Pressure read-out
The essential pressures of the microscope are read out, either by pressure gauges like Pirani's or Pennings or by converting the currents going through Ion Getter Pumps to pressures. The important pressures are listed in the Vacuum Control Panel. The pressure units are as set in the Vacuum Settings control panel (or defined by the supervisor for users). Possible units are Pascal, Torr and Log. Log units are defined in such a way that a realistic range of pressures (for that vacuum element) goes from 0 to 100. The advantage of the log units is simplicity and high sensitivity for the good vacuum values (where it matters) and low sensitivity for poor vacuum values.

The gauges measuring the displayed vacuum levels are (compare to the Vacuum Overview).

Vacuum level	Gauge
Gun	IGPa
Liner	IGPcl
Octagon	IGPco
Projection	CCGp
Buffer tank	PIRbf
Backing line	PIRpv

Column Valves Closed
The Column Valves Closed button closes and opens the two valves in the column separating the column from the projection chamber (Vcp) and the column from the gun (Vac). These two valves are always opened and closed together. The high tension and filament can remain on when opening and closing these valves. The functionality of the button is chosen such that it highlights (yellow) when the column valves are closed (as a warning that the beam will not be visible). The same is indicated, when possible, by the status display.

It is good practice to keep these valves closed whenever the microscope is not actively used, to keep the column vacuum at its optimum condition and prevent air from entering the gun area during specimen exchange.

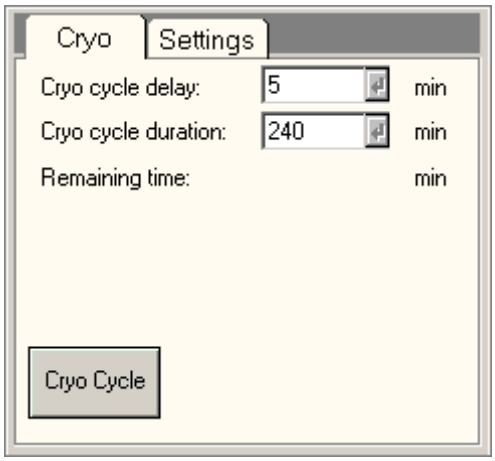
Turbo On
In cases where the pre-pump airlock action is not necessary (all airlock actions without cryo holders), it may still be advantageous to switch the TMP on (or off). An example is the removal of the specimen holder in order to exchange the specimen. Since the TMP takes some time to reach Ready status, it can be switched on before removing the specimen holder, so it is ready immediately after the specimen has been exchanged. The switch on and off of the TMP can be done through the "Turbo On" button.

Note: The Turbo button is orange when the TMP is on but not yet at operational speed. When the TMP is on and at speed, the button is yellow.

Empty Buffer
The "Empty Buffer" button starts the cycle that empties the buffer tank. This may be useful in cases where it is necessary that the buffer cycle doesn't interrupt operation for a period of time (e.g. when a series of exposures is to be made).

Flap-out button
Pressing the flap-out button displays the flap-out containing the Vacuum Cryo and Vacuum Settings control panel.

50.1 Vacuum Cryo (Expert)



The Vacuum Cryo Control Panel.

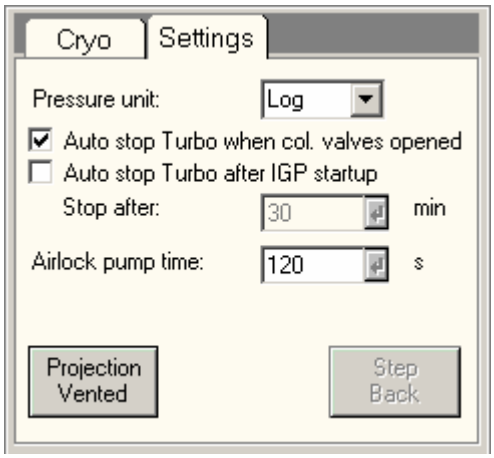
The Vacuum Cryo Control panel contains special functions for the cryo cycle (for removal of water vapor coming off the cold trap or cryo blades when the liquid-nitrogen cooling is removed).

Cryo Cycle
The Cryo Cycle is a special vacuum procedure for removing the water vapor from the microscope column that is released when the cold trap or cryo blades are being warmed up at the end of a microscopy session. The Ion Getter Pump (IGP) that pumps the microscope column is not a very effective pump for removal of water vapor and ages more rapidly when it is forced to pump a lot of water vapor. Therefore the TMP is used to pump away the water vapor while IGP is temporarily switched off. After a set time has elapsed, the IGP is automatically switched on again so the microscope is ready for operation the next morning.

During the cryo cycle a number of vacuum controls (column valves, etc.) are disabled. It is also not possible to change the cryo cycle settings while the cycle is running. The cryo cycle can be aborted by clicking the "Cryo Cycle" button again.

Two parameters can be set for the cryo cycle: the delay and duration. The delay specifies the number of minutes the system will wait before pumping with the TMP. The value can be set to the warm-up time of the cold trap, usually 5 minutes if the dewar is removed. A good setting for the duration is 240 minutes (4 hours).

50.2 Vacuum Settings (Expert)



The Vacuum Settings Control Panel.

The Vacuum Settings control panel allows access to various settings concerning the vacuum system.

Pressure Unit
Vacuum pressures can be listed in three types of units, Pascal (Pa), Torr and Log unit. Log units are defined in such a way that a realistic range of pressures (for that vacuum element) goes from 0 to 100. The advantage of the log units is simplicity and high sensitivity for the good vacuum values (where it matters) and low sensitivity for poor vacuum values.

Auto stop Turbo when col. valves opened
Normally, when opening the column valves the Turbo molecular pump (TMPm) is stopped to prevent vibrations to disturb the experiments. If needed (when screening multiple samples for example) the TMPco can be kept running by unchecking this box.

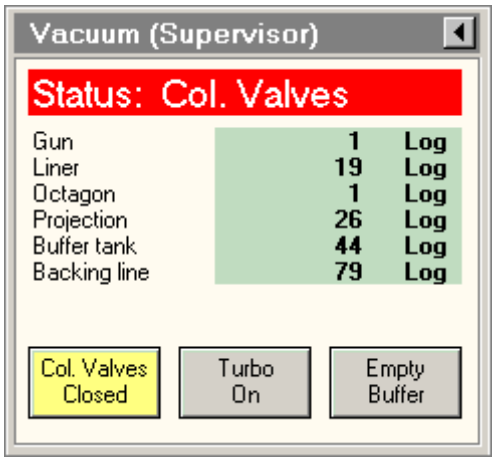
Auto stop Turbo after IGP startup
Aftter starting the IGPco the turbo pump is normally stopped. To speed up sample loading it can be kept running. The 'Stop after' time keeps the TMPm running for the specified time to backup IGPco if it fails to start the first time.

Airlock pump time
The airlock pump time is selected from a drop-down list of values. The minimum airlock pumping time advised is 50 seconds.

Projection Vented
The Projection vented button starts the vacuum cycle that vents the camera chamber and, when the camera is vented, starts the cycle that pumps the camera chamber again. Projection vented must be confirmed. For this purpose, the button disappears and is replaced by two buttons, one with a 'V' sign for OK, the other with and 'X' sign for Cancel.
The Camera Vented button may be absent. In that case the system Supervisor has chosen to remove the button. This is often done when no plate camera is used on the system so there is no reason for users to vent the camera.

Step back
In case an action on the vacuum system results in a non-workable situation, the vacuum system allows recovery through the Step back button.

51 Vacuum (Supervisor)



The Vacuum Control Panel.

The Vacuum Control Panel gives an overview of the vacuum status of the microscope and provides access to a few, often-used vacuum-control functions.

Note 1: To stop the TMP running (usually after inserting a specimen holder) either use the Turbo on button or simply open the Column Valves (if the "Auto stop Turbo when col. valves opened" function on the Vacuum Settings Control Panel is active).

Note on the Turbo-molecular pump (TMP) : When the TMP is switched off, it is forced to run down completely, otherwise there may be situations where it does not start up properly. The run-down of the TMP takes about 3 minutes. While it is running down it cannot be switched on.

Note 2: Vacuum terminology tends to be confusing. People talk about high or ultra-high vacuum when they mean very low pressures. Where it could be confusing, vacuum status will therefore be referred to as 'good' or 'poor'.

Status
The status line of the Vacuum Control panel displays the status of the vacuum in words. Examples of status values are "Initial", "Busy", and "Col. Valves". A green status display is used for ready, red status displays for not ready. In the example above, the display indicates that the Column Valves are closed.

Pressure read-out
The essential pressures of the microscope are read out, either by pressure gauges like Pirani's or Pennings or by converting the currents going through Ion Getter Pumps to pressures. The important pressures are listed in the Vacuum Control Panel. The pressure units are as set in the Vacuum Settings control panel (or defined by the supervisor for users). Possible units are Pascal, Torr and Log. Log units are defined in such a way that a realistic range of pressures (for that vacuum element) goes from 0 to 100. The advantage of the log units is simplicity and high sensitivity for the good vacuum values (where it matters) and low sensitivity for poor vacuum values.

The gauges measuring the displayed vacuum levels are (compare to the Vacuum Overview).

Vacuum level	Gauge
Gun	IGPa
Liner	IGPcl
Octagon	IGPco
Projection	CCGp
Buffer tank	PIRbf
Backing line	PIRpv

Column Valves Closed
The Column Valves Closed button closes and opens the two valves in the column separating the column from the projection chamber (Vcp) and the column from the gun (Vac). These two valves are always opened and closed together. The high tension and filament can remain on when opening and closing these valves. The functionality of the button is chosen such that it highlights (yellow) when the column valves are closed (as a warning that the beam will not be visible). The same is indicated, when possible, by the status display.

It is good practice to keep these valves closed whenever the microscope is not actively used, to keep the column vacuum at its optimum condition and prevent air from entering the gun area during specimen exchange.

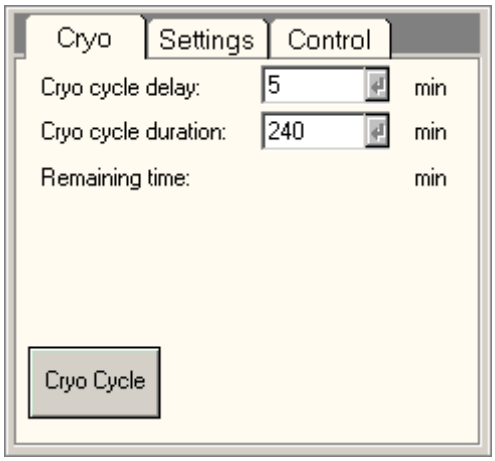
Turbo On
In cases where the pre-pump airlock action is not necessary (all airlock actions without cryo holders), it may still be advantageous to switch the TMP on (or off). An example is the removal of the specimen holder in order to exchange the specimen. Since the TMP takes some time to reach Ready status, it can be switched on before removing the specimen holder, so it is ready immediately after the specimen has been exchanged. The switch on and off of the TMP can be done through the "Turbo On" button.

Note: The Turbo button is orange when the TMP is on but not yet at operational speed. When the TMP is on and at speed, the button is yellow.

Empty Buffer
The "Empty Buffer" button starts the cycle that empties the buffer tank. This may be useful in cases where it is necessary that the buffer cycle doesn't interrupt operation for a period of time (e.g. when a series of exposures is to be made).

Flap-out button
Pressing the flap-out button displays the flap-out containing the Vacuum Cryo, Vacuum Settings and Vacuum Control control panel.

51.1 Vacuum Cryo (Supervisor)



The Vacuum Cryo Control Panel.

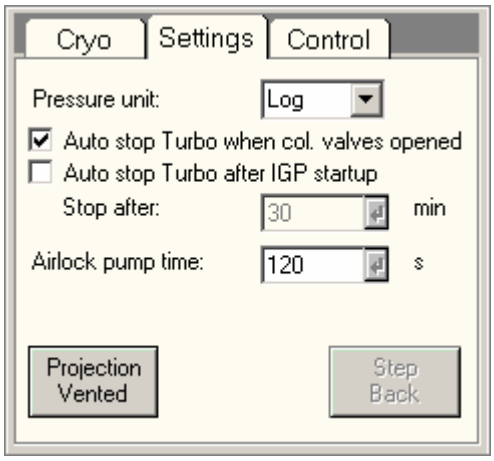
The Vacuum Cryo Control panel contains special functions for the cryo cycle (for removal of water vapor coming off the cold trap or cryo blades when the liquid-nitrogen cooling is removed).

Cryo Cycle
The Cryo Cycle is a special vacuum procedure for removing the water vapor from the microscope column that is released when the cold trap or cryo blades are being warmed up at the end of a microscopy session. The Ion Getter Pump (IGP) that pumps the microscope column is not a very effective pump for removal of water vapor and ages more rapidly when it is forced to pump a lot of water vapor. Therefore the TMP is used to pump away the water vapor while IGP is temporarily switched off. After a set time has elapsed, the IGP is automatically switched on again so the microscope is ready for operation the next morning.

During the cryo cycle a number of vacuum controls (column valves, etc.) are disabled. It is also not possible to change the cryo cycle settings while the cycle is running. The cryo cycle can be aborted by clicking the "Cryo Cycle" button again.

Two parameters can be set for the cryo cycle: the delay and duration. The delay specifies the number of minutes the system will wait before pumping with the TMP. The value can be set to the warm-up time of the cold trap, usually 5 minutes if the dewar is removed. A good setting for the duration is 240 minutes (4 hours).

51.2 Vacuum Settings (Supervisor)



The Vacuum Settings Control Panel.

The Vacuum Settings control panel allows access to various settings concerning the vacuum system.

Pressure Unit
Vacuum pressures can be listed in three types of units, Pascal (Pa), Torr and Log unit. Log units are defined in such a way that a realistic range of pressures (for that vacuum element) goes from 0 to 100. The advantage of the log units is simplicity and high sensitivity for the good vacuum values (where it matters) and low sensitivity for poor vacuum values.

Auto stop Turbo when col. valves opened
Normally, when opening the column valves the Turbo molecular pump (TMPm) is stopped to prevent vibrations to disturb the experiments. If needed (when screening multiple samples for example) the TMPco can be kept running by unchecking this box.

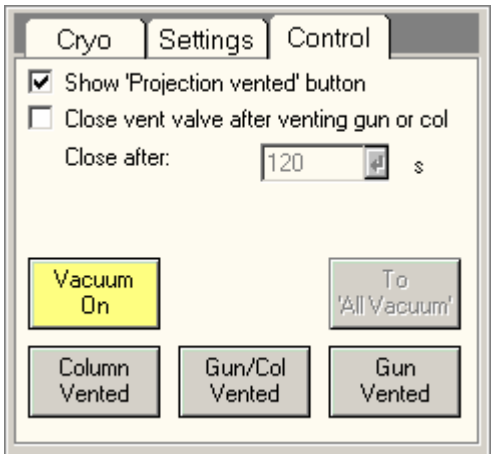
Auto stop Turbo after IGP startup
Aftter starting the IGPco the turbo pump is normally stopped. To speed up sample loading it can be kept running. The 'Stop after' time keeps the TMPm running for the specified time to backup IGPco if it fails to start the first time.

Airlock pump time
The airlock pump time is selected from a drop-down list of values. The minimum airlock pumping time advised is 50 seconds.

Projection Vented
The Projection vented button starts the vacuum cycle that vents the camera chamber and, when the camera is vented, starts the cycle that pumps the camera chamber again. Projection vented must be confirmed. For this purpose, the button disappears and is replaced by two buttons, one with a 'V' sign for OK, the other with and 'X' sign for Cancel.
The Camera Vented button may be absent. In that case the system Supervisor has chosen to remove the button. This is often done when no plate camera is used on the system so there is no reason for users to vent the camera.

Step back
In case an action on the vacuum system results in a non-workable situation, the vacuum system allows recovery through the Step back button.

51.3 Vacuum Control (Supervisor)



The 'Vacuum Control' Control Panel.

Show 'Projection vented' button
The checkbox 'Show 'Projection vented' button' determines whether the 'Projection vented' button on the Vacuum Control Panel is visible or not. This option can only be set by the Supervisor and applies to all users (Experts and Users) of the microscope. If the plate camera is never used the 'Projection vented' button can be made invisible since there is no reason for users to vent the projection chamber.

Close vent valve after venting gun or col.
The checkbox 'Close Vn2m after venting gun or column' determines whether the Nitrogen flow to the Manifold is automatically switched off after a venting procedure on either gun or column, or both, is completed. The time can be defined with the 'Close after' setting.

Vacuum On
This button is colored gray when the system is idle and in an undefined state. This usually means that all valves are closed, all gauges that can be disabled are disabled and all pumps (including IGPa) are switched off. The 'Off' state is also called 'Initial', because it is the initial state assumed when the electronics are powered up. In any other case, the button is colored yellow.
When the button is colored gray and the button is clicked, the vacuum software will attempt to bring the vacuum system to the 'Ready' state, which means the column valves can be opened for imaging.
When the button is colored yellow and the button is clicked, the vacuum system will unconditionally close all valves, disable all gauges and switch off all pumps.

Column Vented
The 'Column Vented' button starts or stops venting the column. The column vented functionality is only available to the supervisor. Choosing this function requires confirmation. For this purpose, the button disappears and is replaced by two other buttons, one with a "V" sign for OK and one with "X" for Cancel.

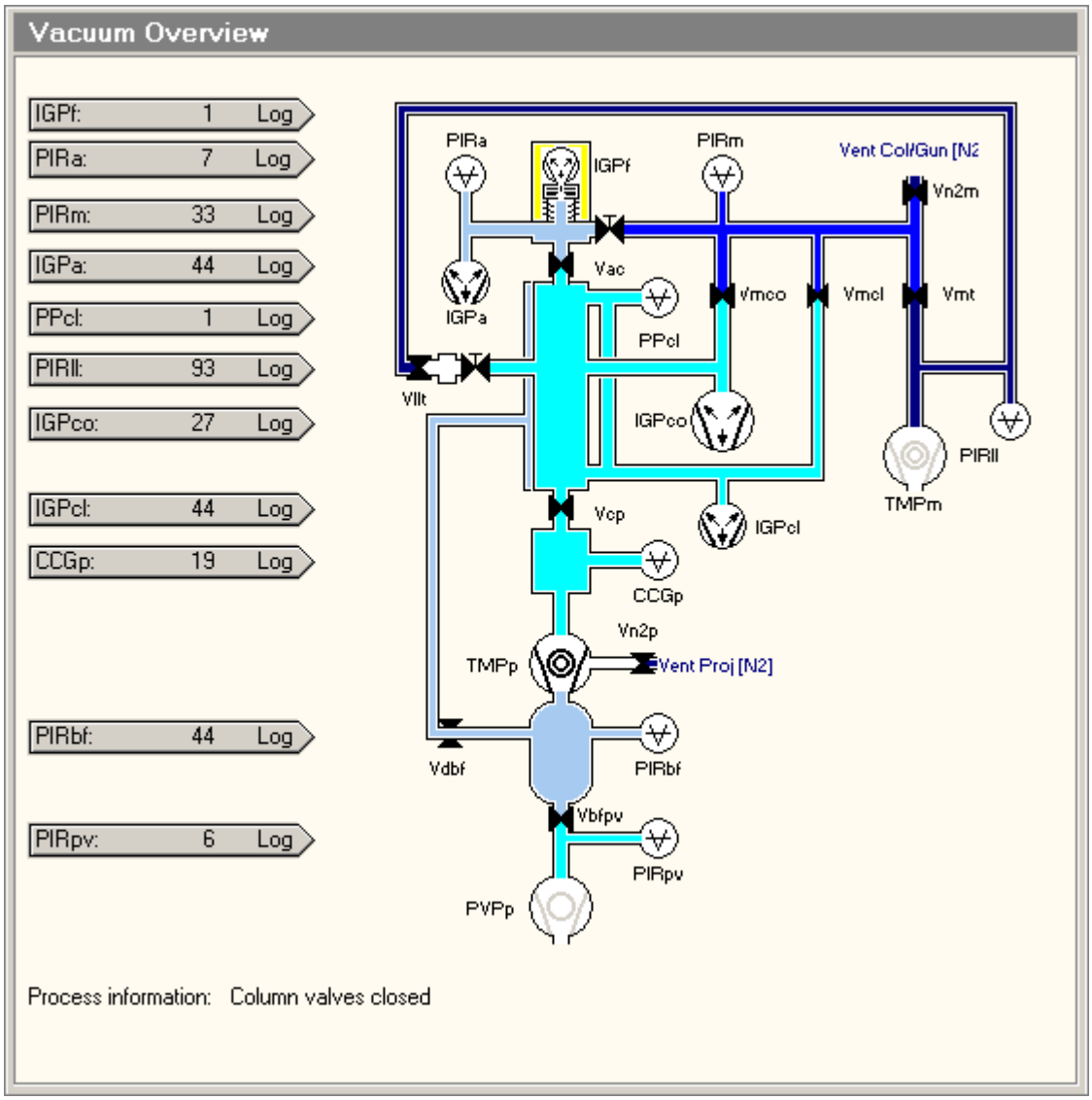
Gun/Col Vented
The 'Gun/Col Vented' button starts or stops venting the column and gun area. The Gun/Col vented functionality is only available to the supervisor. Choosing this function requires confirmation. For this purpose, the button disappears and is replaced by two other buttons, one with a "V" sign for OK and one with "X" for Cancel. The cursor is placed between the two buttons so that it is not possible to press either of them accidentally.

Gun Vented

The 'Gun Vented' button starts or stops venting the gun area. The Gun Vented functionality is only available to the supervisor. Choosing this function requires confirmation. For this purpose, the button disappears and is replaced by two other buttons, one with a "V" sign for OK and one with "X" for Cancel. The cursor is placed between the two buttons so that it is not possible to press either of them accidentally.

To 'All Vacuum'
This button is enabled (clickable) when the vacuum system is idle in a defined state (i.e. not BUSY) and not in the 'All Vacuum (liner closed)' or All Vacuum (liner opened) state. For example, the button will be enabled when the vacuum state is 'Projection Vented', but when the vacuum system is busy evacuating the projection chamber, the button will be disabled (visible, but not clickable).

52 Vacuum Overview



The Vacuum Overview Control Panel.

The Vacuum Overview control panel is available only under the control panel selection at the bottom right (its size is too large to fit otherwise). The overview display the current status of the vacuum system. The overview displays the following elements:

- pumps (indicated by their vacuum-technology symbols)
- pumping lines and volumes
- gauges
- valves
- pressure read outs
- process information

N2 indicates connections for inlet of nitrogen gas when a certain volume is vented (let up to air).

Pumps
The microscope contains a number of pumps, of different types. The various pumps are indicated by their vacuum technology symbols:


Ion-getter pump (IGP)


Turbo-molecular pump


Pre-vacuum pump (PVP)

Pumps that are active are shown in black on the inside, inactive pumps in gray.

The microscope contains the following pumps:
- IGPco pumps on the specimen area.
- IGPa pumps on the gun accelerator area.
- IGPf pumps on the FEG emitter area.
- IGPcl pumps on the liner tubes at the condenser and selected-area aperture level.
- TMPm (and its backing diaphragm pump; the latter not shown in this diagram) prepumps the column (and gun) and pumps on the specimen-holder airlock.
- TMPp pumps on the projection chamber.
- PVPp pumps on the buffer tank (backing of the TMPp) and on the projection chamber before the TMPp.

Pumping lines and volumes
Lines and volumes are indicated in colors, with the blue colors indicating active lines and volumes, and a lighter color indicating lower pressure (higher vacuum). Yellow indicates SF6 (in the gun).

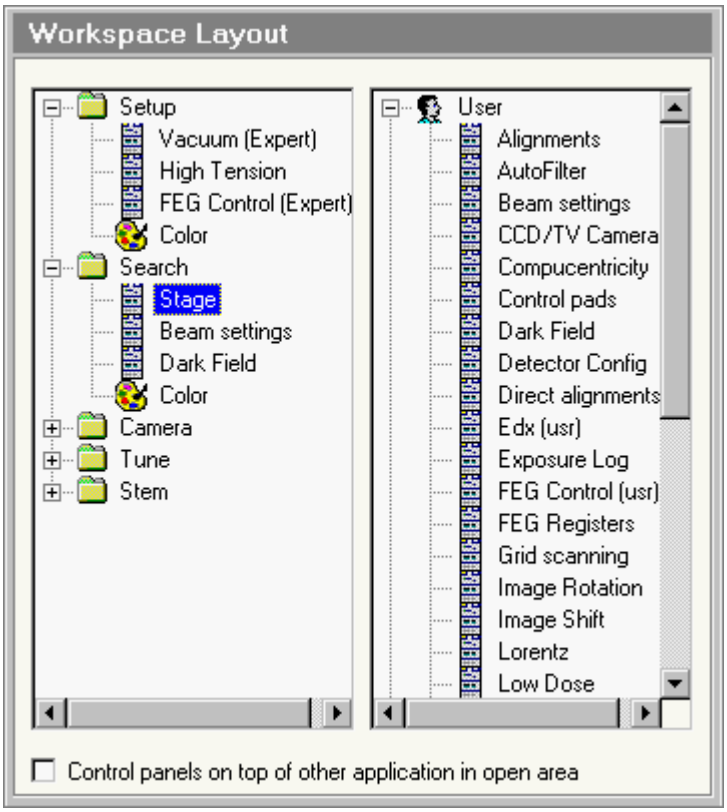
Gauges
Gauges are vacuum elements that are used to measure pressures (in addition to pressure measurements derived from the current of the Ion Getter Pumps). Three types of gauges exist, Pirani's, Pennings and combined Pirani-Pennings.

Valves
Valves are indicated by a butterfly-like symbol. In closed valves the 'butterfly wings' touch each other, for open valves there is an opening between the 'wings'. Valves with a 'capital T'-like symbol between the 'wings' indicate a manual valve. Of the valves present in the system, the following have special importance:
- Vcp and Vac are the column valves, which are under user control (as well as automatic control by the vacuum system).
- The unmarked valve to the right of Vllt (the airlock valve) is the valve inside the CompuStage goniometer that is opened and closed by the rotation of the specimen holder during insertion or retraction. It is therefore a manual valve (as indicated by the T on the valve).

Pressure read-out
The gray arrows indicate the values of the pressures read-out (units are as selected in the Vacuum Settings control panel). The arrows roughly point to the vacuum gauge or pump used to read out the pressure.

Process information
The process information lists up to four messages about the status of the vacuum system. Processes that will take some time are listing the expected time needed to finish the process.

53 Workspace Layout



The Workspace Layout Control Panel.

The Workspace Layout Control Panel provides the tools for adjusting the worksets to user preferences.

Worksets
The worksets are represented by folder icons in the left-hand treeview. Clicking on the '+' sign (or double-clicking the folder icon) opens the branch of the workset selected, displaying from - top to bottom - up to three Control panels, the Binding display panel, three status display (Multiselection) panels and Color control.

The following actions are possible on whole worksets:

- **Change the name** : click with the right-hand mouse button on a workset and select Edit label from the popup menu or click on the name and press Enter, type the new text when the label changes to an edit control.
- **Copy a workset** : click with the right-hand mouse button on a workset and select Copy from the popup menu, or press the Ins(ert) key.
- **Delete a workset** : click with the right-hand mouse button on a workset and select Delete from the popup menu, or press the Del(ete) key.
- **Change the sequence of the worksets** : click on a workset and drag it to another position.

To make a new workset, copy an existing workset. Remove any Control panels not needed (Delete), then drag new Control panels from the repository.

Control-panel repository
The treeview on the right-hand side contains a list of all available Control panel (ones that can be inserted into worksets). The panels are separated according to user level (User, Expert, Supervisor) and availability depends on the user levels. Click on the '+' sign or double-click the 'user' icon to expand the particular repository. Control panels can be dragged from the repository into any existing workset.

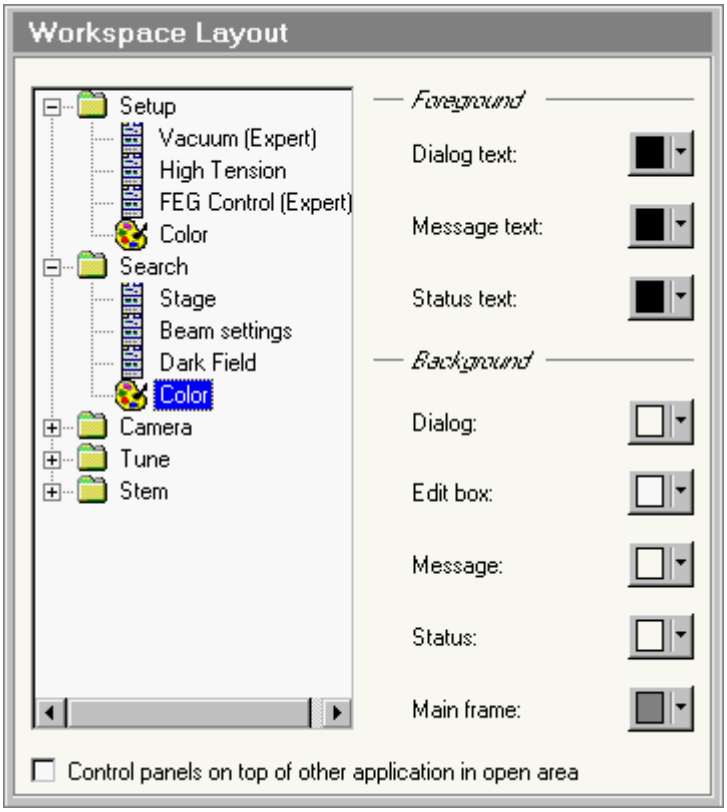
Control panels
The following actions are possible on Control panels:

- **Delete a panel** : click with the right-hand mouse button on the Control panel and select Delete from the popup menu, or click and the press the Del(ete) key.
- **Change the sequence of panels** : click on a panel and drag it to another position.
- **Move a panel** to another workset by dragging it from one workset into another (drop it on the folder icon).

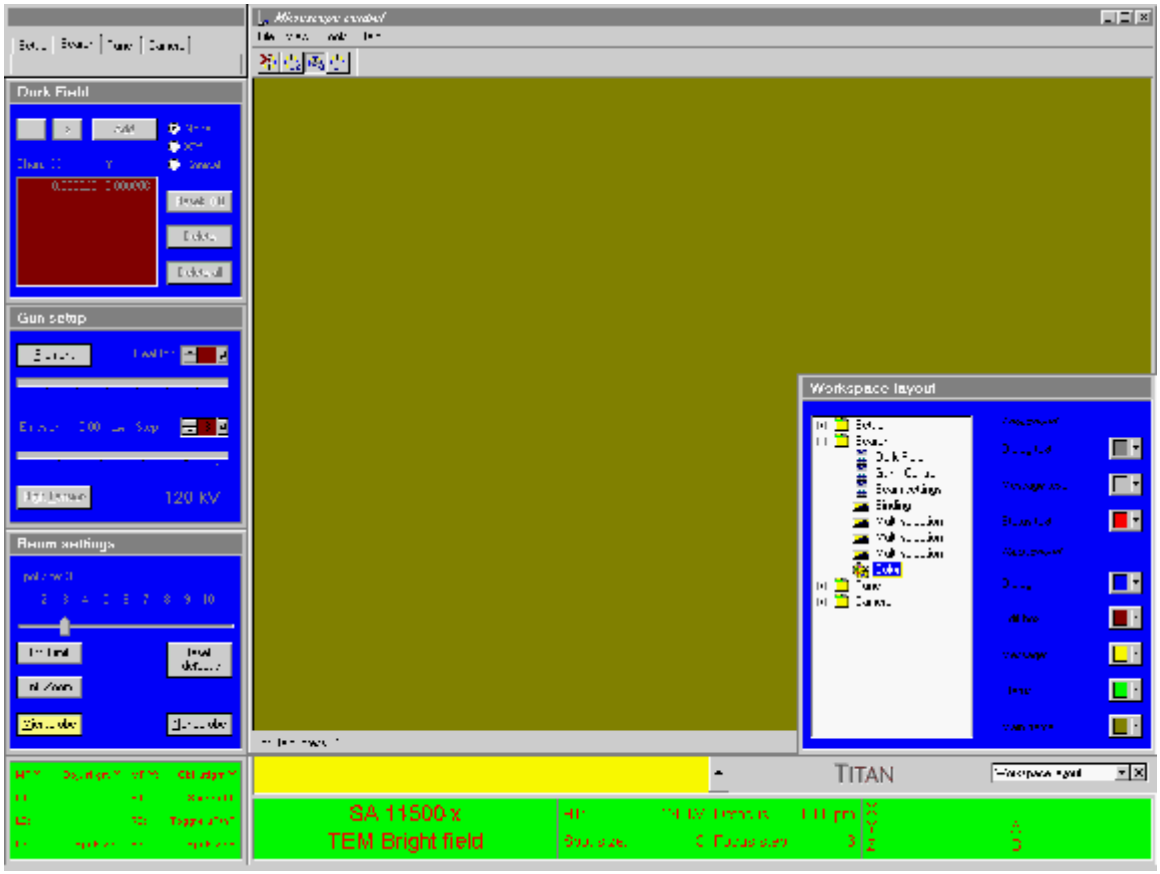
Binding
The binding display cannot currently be defined in the workspace layout. Click with the right-hand mouse button on the display panel itself to modify settings.

Multiselection
The Multiselection status display cannot currently be defined in the Workspace layout. Click with the right-hand mouse button on a status display panel to modify settings.

Color
When the Color icon of a workset is clicked, the right-hand side of the Workspace layout Control panel changes to the following:



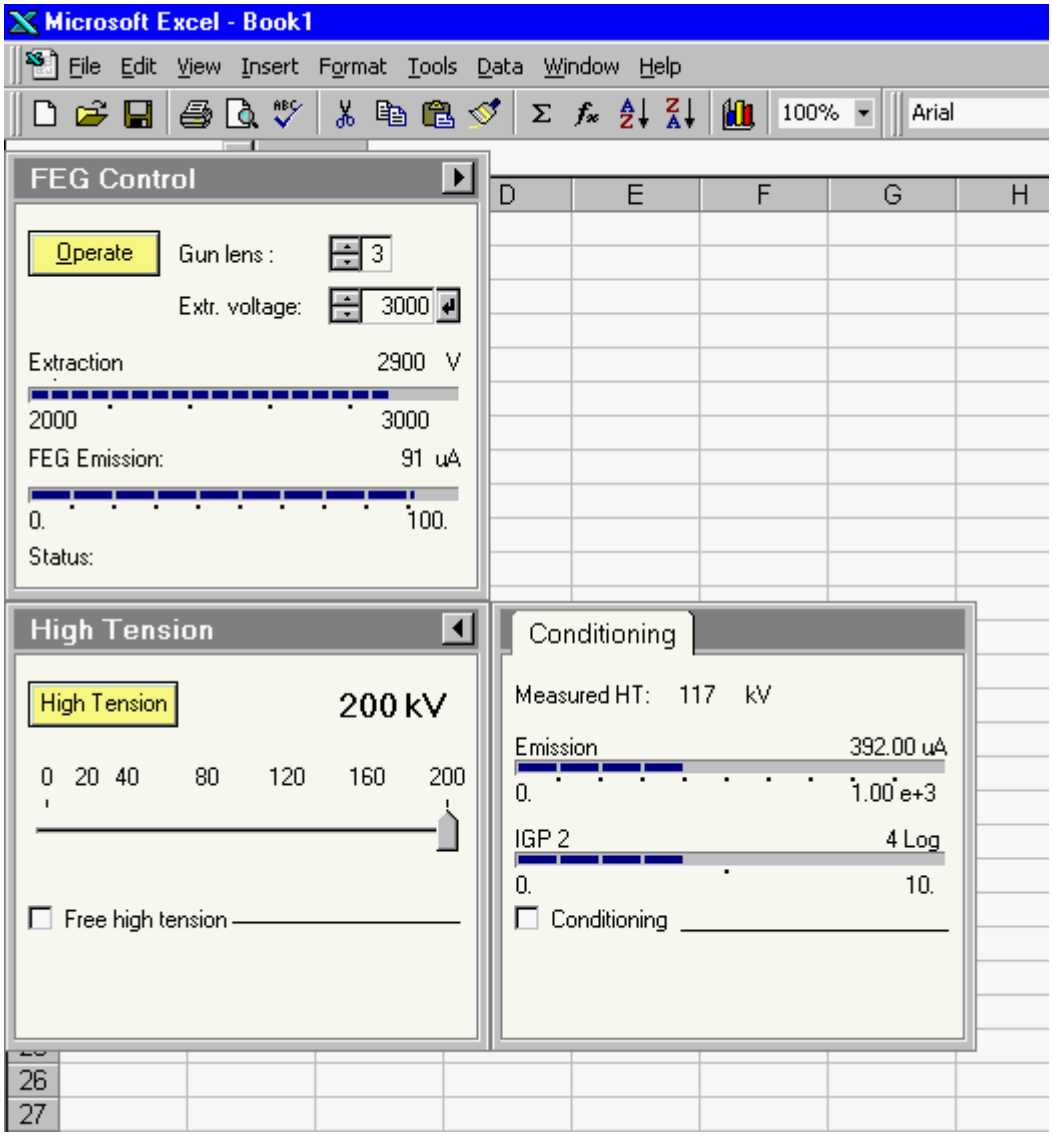
Some of the items listed are standard Windows controls (Dialog, Edit box), other are specific to the Titan user interface (Message and Status). Note that Control panels fall under Dialog. The down buttons on the controls on the right-hand side give access to a (standard Windows) 16-color palette from which a color can be selected. An example of a (pretty awful) selection that differs from the default is:



In order to achieve some of these color adjustments the workset temporarily changes the default Windows color selection (if you change the window background - like the olive background in the picture above, other programs will display the same background when the colored workset is active).

Changing colors allows quick adjustment of the amount of light coming from the monitor (without having to fiddle with the monitor controls themselves). It is possible, for example to make a copy of an existing workset and then change the colors in the copy to dark colors for working in dim room lighting while the original could be used for a brighter environment.

Control panels on top of other application in open area
In some cases settings in control panel flap-out must be set but the flap-out disappears behind another application (such as TIA - TEM Imaging & Analysis - or DigitalMicrograph). In that case checking Control panels on top of other application in open area will keep the control panel flap-out over the other application. Be aware that this can lead to some bizarre-looking effects due to the limitations of Windows (in positioning windows) and the fact that the on-top effect is applied only to control panels with flap-out. It can also be difficult to get back to the user interface as a whole (to get back, minimize other applications until the whole user interface is displayed). Use the feature when necessary but be aware of its effects.



Strange effects can occur when 'on-top' is enabled. Here two TEM control panels float over Microsoft Excel seemingly disconnected from the rest of the Titan user interface.

54 Control Pads

54.1 Left-hand Control Pad

The left-hand Control Pad (called that way because it will normally be to the left of the microscope column) contains a track ball, a number of buttons and turn (rotary) knobs, and two tilt switch controls. The functions of some of these controls can be reprogrammed by software. In the overview below the 'standard' functionality is therefore indicated.

The left-hand pad has background lighting available to make it easier to locate the controls when working in the dark.

Control	Default function
Exposure	Executes (or interrupts) a TEM exposure
Stigmator	Makes stigmator active or inactive
α tilt	Changes α tilt of stage up or down
β tilt	Changes β tilt (only for double-tilt holders) up or down
Track ball	Beam shift
Multifunction +/-	Changes step size of Multifunction knobs
Multifunction X	Variable
Intensity Fine/Coarse	Switches Intensity between Fine-Medium-Coarse
Intensity	Changes Intensity setting
User button L1	None
User button L2	None
User button L3	Spot size - (to a larger spot size)

Exposure button
The Exposure button starts a TEM exposure on the plate camera. If the viewing screen is down, it will automatically be lifted. The exposure conditions used are those selected previously.

If the Exposure button is pressed again while an exposure is taking place, the exposure is broken off and, if necessary, the plate inserted is removed.

Stigmator button
The Stigmator button activates/deactivates the stigmator functionality of the microscope (access to the setting of the default stigmator under the multifunction knobs). The default stigmator is assigned automatically to the stigmator that is used most often in the current microscope mode (objective stigmator in TEM HM imaging and LAD; diffraction stigmator in HM diffraction and LM imaging, condenser stigmator for nanoprobe and STEM). To switch to a different stigmator, press the corresponding button in the stigmator control panel.

α Tilt Switch
The α tilt switch controls the α tilt of the CompuStage (the axis along the specimen-holder rod that is the eucentric tilt). The tilt switch is pressure sensitive. The α tilt will tilt faster when the switch is pressed harder.

β Tilt Switch
The β tilt controls the β tilt of the CompuStage (the axis perpendicular to the specimen-holder rod that is not eucentric) when a double-tilt holder is used. The tilt switch is pressure sensitive. The β tilt will tilt faster when the switch is pressed harder.

Track ball Left-hand Pad
The left-hand track ball controls the shift of the electron beam. The beam shift operates such that moving the track ball to the right moves the beam as seen on the screen to the right. The speed at which the beam moves is dependent on the magnification and further controlled with the left-hand (speed down) and right-hand (speed up) buttons of the track ball.

Multifunction knobs
The Multifunction knobs have a wide range of functions. All functions (wobbler, stigmators, dark field, alignment, etc.) that assign functionality to the multifunction knobs also release that functionality when the particular function is switched off again (after which the multifunction knobs regain their previous functionality). The functions are typically assigned whenever needed (e.g. during alignment). The user can also assign functions to the knobs (these functions will be overruled when necessary). There are two possibilities:

- The assignment is persistent (these functions will be overruled when necessary but the function is always returned when automatic assignments are taken off).
- The assignment is temporary (these functions will also be overruled when necessary and the function is not returned when automatic assignments are taken off).

A persistent assignment can only be made when the Multifunction knobs are not currently occupied by an automatic assignment, otherwise the assignment is temporary.

Examples

- The Multifunction knobs are currently assigned to the Stage axes (a user assignment). The user clicks with the right-hand mouse on the Binding display panel and chooses another function. This assignment is persistent.
- The Multifunction knobs are currently assigned to the Wobbler (after the Wobbler button has been pressed). The user clicks with the right-hand mouse button on the Binding display panel and chooses another function. This assignment is temporary (comes on top of the automatic Wobbler assignment) and will disappear when the Wobbler is switched off.

The None and Clear functions
The popup menu that allows setting of the binding configuration for the Multifunction knobs can have two functions, None and Clear. None is always enabled, Clear only when the current assignment of the Multifunction knobs is temporary. If None is selected, all functions of the Multifunction knobs are removed, independent of the nature of the current assignment (persistent, temporary or automatic). If Clear is selected (thus only possible if the assignment is temporary), the Multifunction knobs revert to their prior automatic setting. Thus if you assigned the Beam shift function to the Multifunction knobs in an alignment procedure and then select None, the Multifunction knobs are completely cleared of all functions. Whereas if you used clear, the Multifunction knobs get back their setting from the alignment procedure.

Intensity
The Intensity button controls the intensity on the screen (through focusing or defocusing of the electron beam). The intensity step size is controlled by the fine and coarse buttons directly to the left of the knob (there are three settings: Fine - the Fine LED will be illuminated; Medium - no LED is illuminated; and Coarse - the Coarse LED is illuminated).
Turning Intensity clock-wise is going towards overfocus with the C2 lens.

User buttons Left-hand Pad
The user buttons can be used to program in specific functionality, either by assigning it by right-clicking in the binding display panel and selecting a function or by connecting the user-button input to user programs.

54.2 Right-hand Control Pad

The right-hand Control Pad (called that way because it will normally be to the right of the microscope column) contains a track ball, and a number of buttons and turn (rotary) knobs. The functions of some of these controls can be reprogrammed by software. In the overview below the 'standard' functionality is therefore indicated.

The right-hand pad has background lighting available to make it easier to locate the controls when working in the dark.

Control	Default function
User button R1	Screen lift
User button R2	Switch microprobe <-> Nanoprobe
User button R3	Spot size + (to a smaller spot size)
Track ball (more commonly now a joystick)	Stage X,Y
Z-axis	Changes Z position of stage up or down
Eucentric focus	Sets objective lens focus for eucentric height / Diffraction focus
Wobbler	Switches wobbler on or off
Diffraction	Switches between Image and Diffraction
Dark Field	Switches between Dark Field and Bright Field
Focus step	Changes the step size of the Focus control
Focus	Changes the focus
Magnification	Changes magnification or camera length up or down
Multifunction Y	Variable

User buttons Right-hand Pad
The user buttons can be used to program in specific functionality, either by assigning it by right-clicking in the binding display panel and selecting a function or by connecting the user-button input to user programs.

Track ball or joystick Right-hand Pad
The right-hand track ball in its default setting controls the X-Y movement of the CompuStage. The functionality is such that moving the track ball to right moves the stage (as seen on the viewing screen) to the right, etc. The axes of the CompuStage usually coincide with the principal directions of the viewing screen (N-S, E-W), somewhat dependent on the nature of the magnification series (some magnifications may not be achievable without rotation relative to the majority of the magnifications). The track ball buttons (top left and top right of the track ball itself) have the following meaning when the track ball is assigned to the CompuStage movement :

- Left-hand button : CompuStage speed value adjusted one step down.
- Right-hand button : CompuStage speed value adjusted one step up.
- Both buttons at the same time : toggle between track ball and 'joy stick' movement modes of the CompuStage.

Note: At the lowermost speed setting the CompuStage will also step by its smallest step, independent of the magnification. At low magnifications these steps may be so small as to be unnoticeable.

If the control is a joystick, the function (stage or other) can no longer be changed. The joystick only controls the stage.

Z-axis control
The Z-axis control is a double switch that controls the height of the CompuStage (Z axis). It is used to change the specimen height to make the point of interest coincide with the eucentric height.

Eucentric focus
The Eucentric focus button sets the objective-lens current to the (pre-aligned) value for focus at the eucentric height and normalizes the objective lens. Different microscope modes, like microprobe and nanoprobe, have their own independent settings.

Note: the eucentric focus only sets the objective lens for the eucentric height, not the specimen itself (if the specimen is off the eucentric height, it will then appear out of focus).

The eucentric focus can be used to bring the specimen to the eucentric height easily. Press the eucentric focus to set the objective lens. Switch on the wobbler and focus the specimen by moving the Z height up or down (the wobbler makes it easy to see if the specimen Z height moves in the right direction - the distance between the two wobbler images will become smaller).

Wobbler
The Wobbler button switches the wobbler focusing aid on and off. When the wobbler is on, the LED of the Wobbler button is lit. When the wobbler is on, its (beam-tilt) amplitude can be changed with the Multifunction-Y knob, while the Multifunction-X knob can be used to rotate the direction of the wobbler tilt.

Diffraction button
The Diffraction button switches between image and diffraction modes. When the microscope is in diffraction, the LED of the diffraction button is lit.

Dark-field button
The Dark-field button toggles between dark field and bright field. When dark field is active, the LED of the button is lit.

Focus
The Focus knob is a double control, with Focus and Focus Step integrated. The focusing function is performed by turning the inner, top-most knob. The step size used for focusing depends on the current focus step which is set by the Focus Step control, the outer, lower-lying ring around the Focus knob itself.

Magnification
The magnification knob turns the magnification or camera length on the microscope up (when turned clock-wise) or down.

Multifunction knobs
The Multifunction knobs have a wide range of functions. All functions (wobbler, stigmators, dark field, alignment, etc.) that assign functionality to the multifunction knobs also release that functionality when the particular function is switched off again (after which the multifunction knobs regain their previous functionality). The functions are typically assigned whenever needed (e.g. during alignment). The user can also assign functions to the knobs (these functions will be overruled when necessary). There are two possibilities:

- The assignment is persistent (these functions will be overruled when necessary but the function is always returned when automatic assignments are taken off).
- The assignment is temporary (these functions will also be overruled when necessary and the function is not returned when automatic assignments are taken off).

A persistent assignment can only be made when the Multifunction knobs are not currently occupied by an automatic assignment, otherwise the assignment is temporary.

Examples
The Multifunction knobs are currently assigned to the Stage axes (a user assignment). The user clicks with the right-hand mouse on the Binding display panel and chooses another function. This assignment is persistent.
The Multifunction knobs are currently assigned to the Wobbler (after the Wobbler button has been pressed). The user clicks with the right-hand mouse button on the Binding display panel and chooses another function. This assignment is temporary (comes on top of the automatic Wobbler assignment) and will disappear when the Wobbler is switched off.

The None and Clear functions
The popup menu that allows setting of the binding configuration for the Multifunction knobs can have two functions, None and Clear. None is always enabled, Clear only when the current assignment of the Multifunction knobs is temporary. If None is selected, all functions of the Multifunction knobs are removed, independent of the nature of the current assignment (persistent, temporary or automatic). If Clear is selected (thus only possible if the assignment is temporary), the Multifunction knobs revert to their prior automatic setting. Thus if you assigned the Beam shift function to the Multifunction knobs in an alignment procedure and then select None, the Multifunction knobs are completely cleared of all functions. Whereas if you used clear, the Multifunction knobs get back their setting from the alignment procedure.