Titan on-line help manual -- TIA

Table of Contents

1   Introduction

This manual covers signal acquisition with TEM Imaging & Analysis (TIA).

Please note that the chapters on TEM UI control panels are duplicated with the Titan User Interface manual for easy reference.

2 TIA Acquisition basics

Notes:
- This document may apply wholly, partly, or not at all to your microscope, dependent on hardware and software present.
- TIA does not have an undo function so think twice before you delete anything so that you will not lose valuable data. In general, save your results on a regular basis. You can use the AutoSave functionality to save acquisition data automatically.

2.1 Introduction to TIA

TIA (TEM Imaging & Analysis) contains software used for a wide variety of purposes associated with image and spectrum acquisition and analysis of these. Although it is a separate program, it is under control of the TEM microscope software which displays the TIA window inside the 'data' area (the area left open by the TEM User Interface in its various view formats). TIA contains two main modes, one being acquisition, the other analysis. On the whole, TIA itself is as complex and wide-ranging as the TEM microscope software itself (perhaps even more so) and full coverage of all its functionality is beyond the scope of this on-line help (for more details, see the TIA Help system itself, accessible by selecting Help while TIA is in analysis mode - in acquisition mode you get - this - acquisition help). This TEM on-line help covers mainly the aspects of the TIA acquisition and a few, often-used analysis functions.

2.2 TIA modes

2.2.1 TIA Acquisition mode

In the TIA Acquisition mode, TIA will be displayed at a fixed position with a thin frame ▭ (no title bar, no menu, limited toolbar, default display of data only) inside the TEM data area. This mode is geared towards acquisition of data on the microscope. The major part of the functionality is controlled from various relevant TEM UI Control Panels (STEM imaging, EDX spectroscopy, EELS spectroscopy, Spectrum profiling and imaging, CCD/TV imaging, Experiments). The TIA acquisition mode is automatically activated when the TEM User Interface view format has the control panels visible (Full screen).

2.2.2 TIA Analysis mode

In the TIA Analysis mode, TIA will be displayed as a normal window (with title bar, menu, normal toolbars, etc). The TEM User Interface software will still adjust the TIA position, but in addition the user is free to move and resize the window. The TIA Analysis mode is automatically activated when the TEM User Interface view format has no control panels visible (Taskbar only) or the TEM user Interface is not running at all.

2.2.3 Switching between TIA acquisition and TIA analysis

The switch between TIA acquisition mode and TIA analysis is controlled by the TEM User Interface view format, Full screen for acquisition and Taskbar only for analysis. The switch can be made by a button next to the list of popup panels.

The button with the square blue block (far left) brings up the Application Selection Control Panel, while the button with the L shape switches to Full size mode.

The button with the _ shape switches to Taskbar-only mode.

If TIA is displayed on a second monitor, you have the choice of TIA reacting automatically to the TEM UI mode (Full frame or Taskbar only) or fixed to either acquisition or analysis mode. The choice is made in the Application Preferences control panel.

To close TIA while in acquisition mode, click inside the TIA window and press Alt + F4 (on the keyboard) or click with the right-hand mouse button on the TEM Imaging & Analysis button on the Windows taskbar and select Close.

2.3   Elements of TIA

TIA contains different kinds of elements that can be visible or hidden in its window. Many of these elements have properties (which can be accessed by double-clicking on the element or its content - such as an image - with the left-hand mouse button) and popup menu with relevant functions (accessed by clicking with the right-hand mouse button on the element). Many of those elements can be selected by clicking on them with the left-hand mouse button, with the selected element displayed by handles, small white squares at the corners of the element.

2.4   Using display windows

Display windows contain the data acquired in TIA. There are two ways the data acquisition can be handled:

- Each new acquisition takes place in a **separate** display window, while Search and Preview will re-use their own display window (if they exist; otherwise the display windows will be created).
- Each new acquisition takes place in the **same** display window. This mode of operation suffers from the fact that new acquisitions overwrite existing data so it is possible to lose data (if you do not save between acquisitions).

Note: These two types of behavior apply to acquisitions, not to experiments. The behavior in experiments is governed by the use of the functions in the Experiments control panel.

The second way of handling is used when you check the **Reuse Display Window** option in the Acquire menu of TIA (we might call this the "old-fashioned way" as it is the way that TIA normally worked a while ago and some users appear to prefer this way).
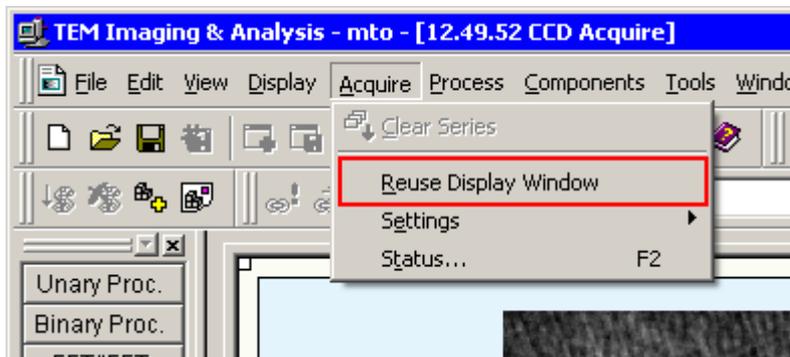
To do so, switch to Analysis mode and in the Acquire menu click on the Reuse Display Window menu item. A check mark will appear next to it, indicating that the option is active. The option is user-specific and automatically restored when TIA is reopened.
The two systems work as follows.

2.4.1   Option 1 (default), Reuse Display Window not selected:

- In imaging (CCD or STEM), Search and Preview will acquire their images in dedicated Search and Preview display windows (multiple display windows are now shown as tabs at the bottom). CCD and STEM will have their own Search and Preview windows. These windows are automatically selected (brought to front) as needed. Search and Preview are re-used (so you will at most have four, CCD Search, CCD Preview, Scanning Search, Scanning Preview).
- In spectroscopy (EDX and EELS) the situation is similar except that here there is only a single mode View additional to Acquire.
- For Search or Preview you can define a series size other than 1. If so, each image of spectrum will be acquired and added to the existing data until the current acquisition exceeds the series size defined in which case the new acquisition will start overwriting the existing data from the beginning. For Acquire a series size other than 1 has no meaning since each acquisition takes place in a dedicated display window (or a dedicated display pane if in STEM mode, see last bullet below).
- All acquisitions through Acquire will result in new display windows. The name of the display window reflects the time of acquisition plus the name of the technique involved (time is time of day, as e.g. in 15.42.50 CCD Acquire which is a CCD image acquired at 15 hours, 42 minutes and 50 seconds). Generally you cannot read much more than the time as the tabs are too short. The full name will be visible in TIA Analysis mode in the TIA title bar, or the windows listed at the bottom of the Windows menu. If you do not see the tabs in TIA Analysis mode, switch on Workbook mode in the Windows menu (the menu item should be checked). You can also see the contents of the Window menu in Analysis mode by clicking on the Window button ⬜ of the toolbar. The name will also be the default file name suggested for saving.
- To these rules there is one exception: Any acquisitions of other detectors (CCD, EDX, EELS) in STEM mode are always inserted into separate panes in the most recent STEM display window. The rationale here is that such data in STEM bear a relation to the STEM image itself, because the data have been recorded at the beam position in the STEM image.

2.4.2   Option 2, Reuse Display Window selected:

- The name of the display window used can be anything (it depends on the particular data acquisition mode that was used when it was created - for example, if you start with CCD Search, it will be named CCD Search, but if you start with an EDX Acquire it could be something like 12.23.31 EDX Acquire).
- Each detector will create its own pane. So typically at most you will get what is shown below (except that there may be more STEM signals and that CCD can be an image "CCD" or a diffraction pattern "CCD Pattern"). All acquisitions of a detector (Search, Preview, Acquire) will reuse the same display.
- The series size has meaning for all acquisitions, including Acquire, since the data are added to the same display.
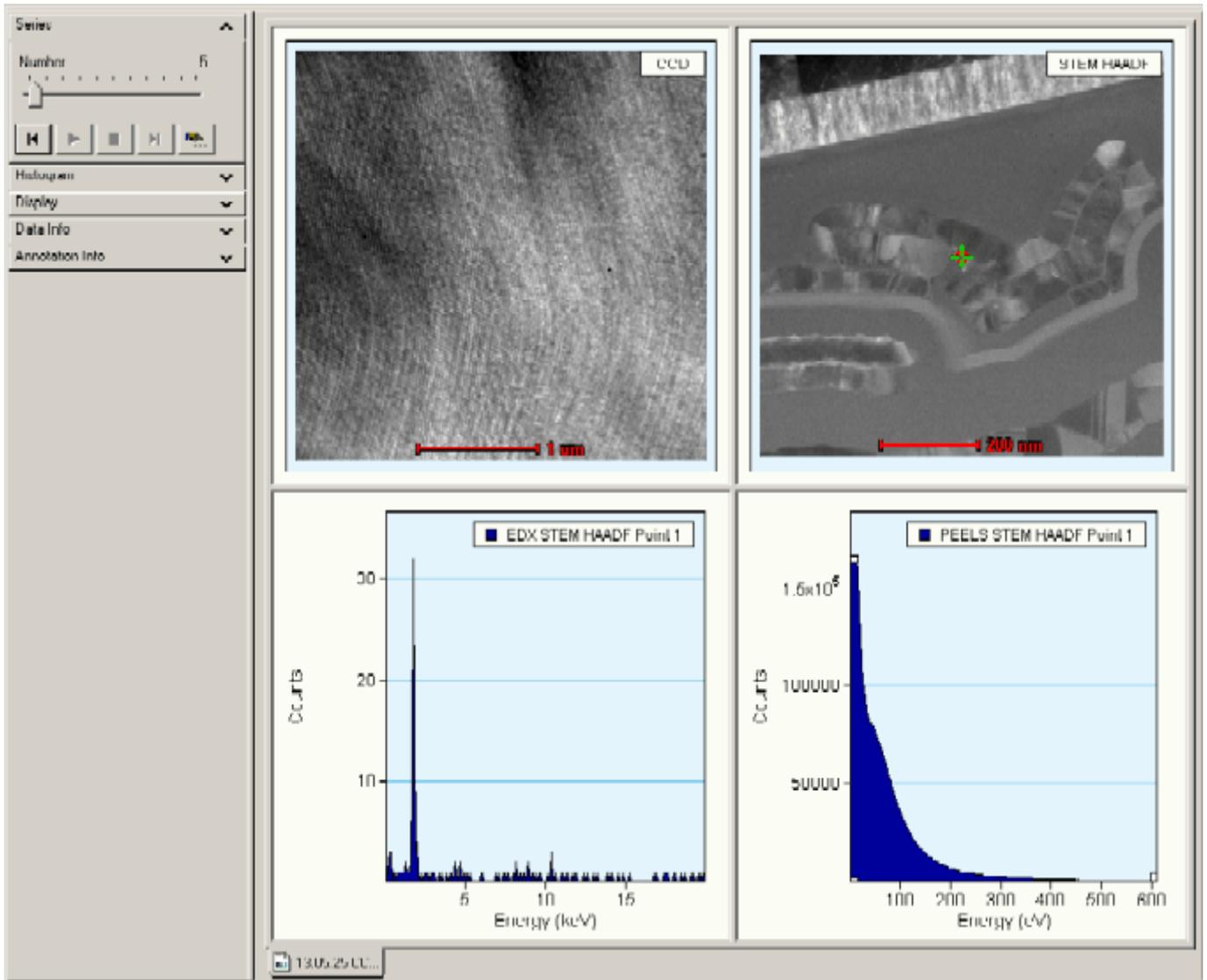
Reused display window, created by starting a CCD Acquire, containing a CCD image, STEM HAADF image, EDX spectrum and EELS spectrum. The EELS Spectrum (currently selected) is number 5 in a series of 100.

2.5   Display window

The display window is the most important part of TIA as it will contain the data collected on the microscope. The display window can be split into various fields, called panes, but it forms one integrated whole containing all the data. When the data are saved, the display window is saved as a whole (it is also possible to save individual elements of a display window separately such as an image or a spectrum). The display window by default fills all the space remaining after all other elements that must be shown are displayed. The display window forms the basis on which other elements are displayed. Close the display window and all is removed. The display window will contain at least one pane. The pane in turn can contain a display (real-space image, reciprocal-space image, real-space profile, reciprocal-space profile, EDX spectrum, EELS spectrum). On the display can be data and markers. If you delete a display or an image, the whole pane is removed. The same applies to spectra or profile but in this case you are asked to confirm because especially with multiple profile lines it isn't always obvious whether you have selected a profile line (to delete that particular line) or the whole display. If you get the

request for confirmation, you have selected the whole display, not an individual line. Confirming will then delete the whole pane.

If you delete the last pane of a display window, the whole display window is removed (it doesn't contain data any more so there is no point in keeping it).
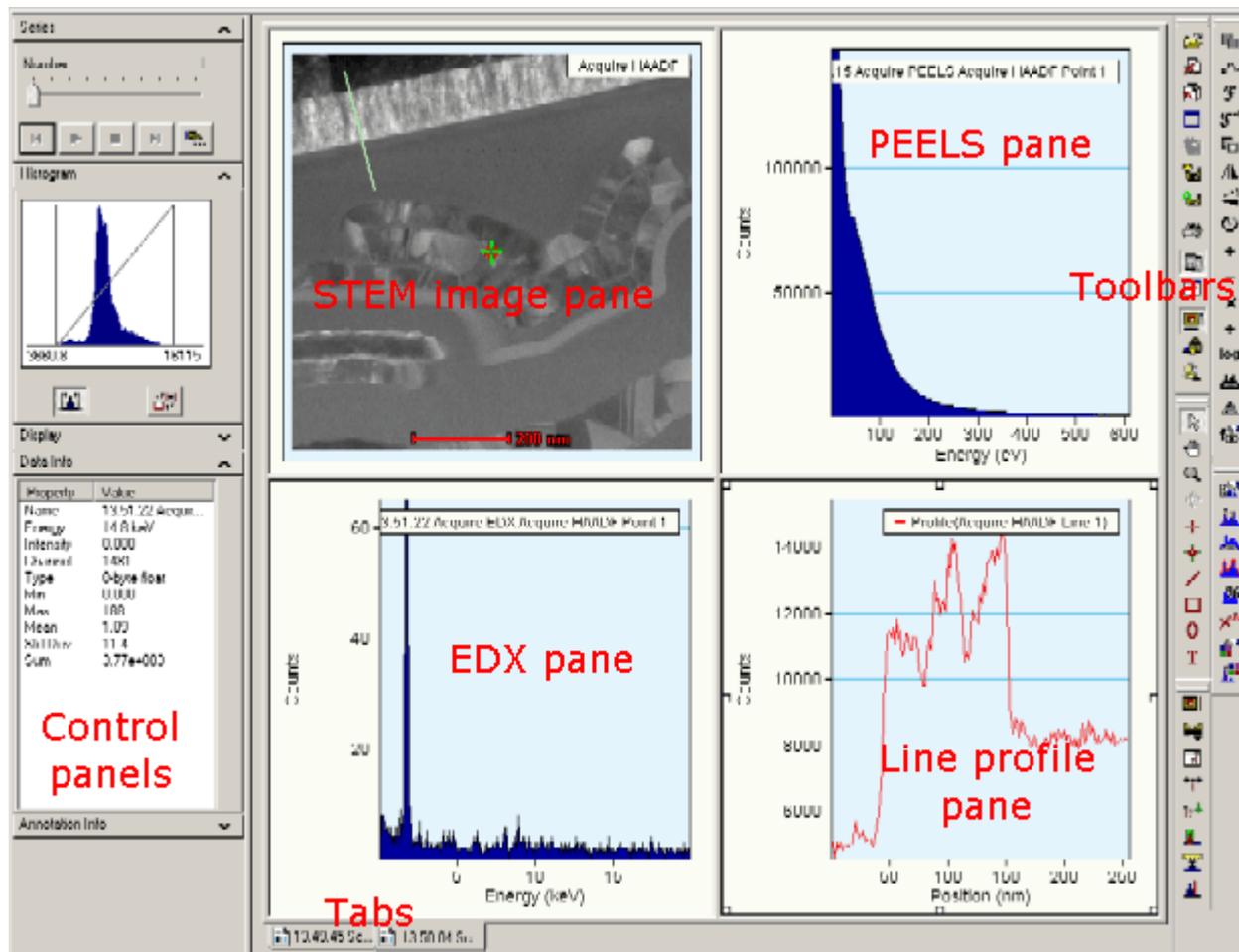
A display window with a few panes filled with displays, the control panels and the toolbar. At the bottom are the tabs that give access to other display windows.

To delete all display windows, click on the **Close all** button ▣ (third from the top) of the toolbar in TIA Acquisition mode. You will be asked to confirm this. To delete the current display window, click on the **Close** button ▣ (second from the top). Again you will be asked for confirmation. For deleting the current display window, you can also delete all the panes. This requires no confirmation.

2.6   Pane

The display window is filled with one or more sizeable display areas called panes. There is a practical limit to the number of panes that can be defined in view of the limited room for data display. Panes can be filled by various displays (real-space and reciprocal-space image and profile displays, EELS and EDX spectrum displays). In acquisition mode, the panes and their displays are generated automatically as needed. If a pane is too small to display its data, a label will be displayed instead. The display will become visible only when the size of the pane is increased sufficiently.

Panes can be manipulated as follows:
- Change panes in size by moving the cursor to the horizontal or vertical gray bars separating individual panes (called splitters; the cursor changes to two parallel lines with arrows pointing away from the lines), clicking on the splitter and dragging it sideways (vertical splitters) or up or down (horizontal splitters).
- Click with the right-hand button of the mouse on a pane away from any data like an image or spectrum. Various functions related to panes will appear in the popup menu, such as arrange panes (redistribute the existing panes to give them equal width or height), delete pane (removes the pane; WARNING: this operation cannot be undone in TIA and may lead to loss of acquired data) or split pane horizontally or vertically (divide the pane in two, with one pane of half width or half height containing the original pane's contents and a new empty one besides it).
- Drag the contents of a pane to another pane (click with the left-hand mouse button on a pane outside the area filled with data such as image or spectrum and drag the contents of the pane to another pane). The contents of the 'sending' and 'receiving' panes will be exchanged.
- Copy the contents of a pane:
  - Click on a pane (outside any data area) and press Ctrl+C (or click with the right-hand mouse button and select Copy).
  - Click on a pane with the right-hand mouse button and select Past Right or Paste Down (new display panes are created with a copy either to the right of or below the pane selected).

  or

  - Create an empty pane by splitting an existing pane. Click in the empty pane and press Ctrl+V (or click with the right-hand mouse button and select Paste).
  - Even shorter: click with the left-hand mouse button on the 'sender' pane and keep the Ctrl key pressed while dragging to an empty pane.

2.7 Images

2.7.1 Zoom factor

Generally TIA displays images (and other data) such that it uses the available space in the optimum way. That can mean that one screen pixel does not correspond to one individual image pixel (or a binned variant thereof, such as 2x2). You can fix the zoom factor by opening the Image/Display Properties dialog (double-click on the image or the background around it). Under Axes you can select Integral Display Pixels as well as a Zoom factor.
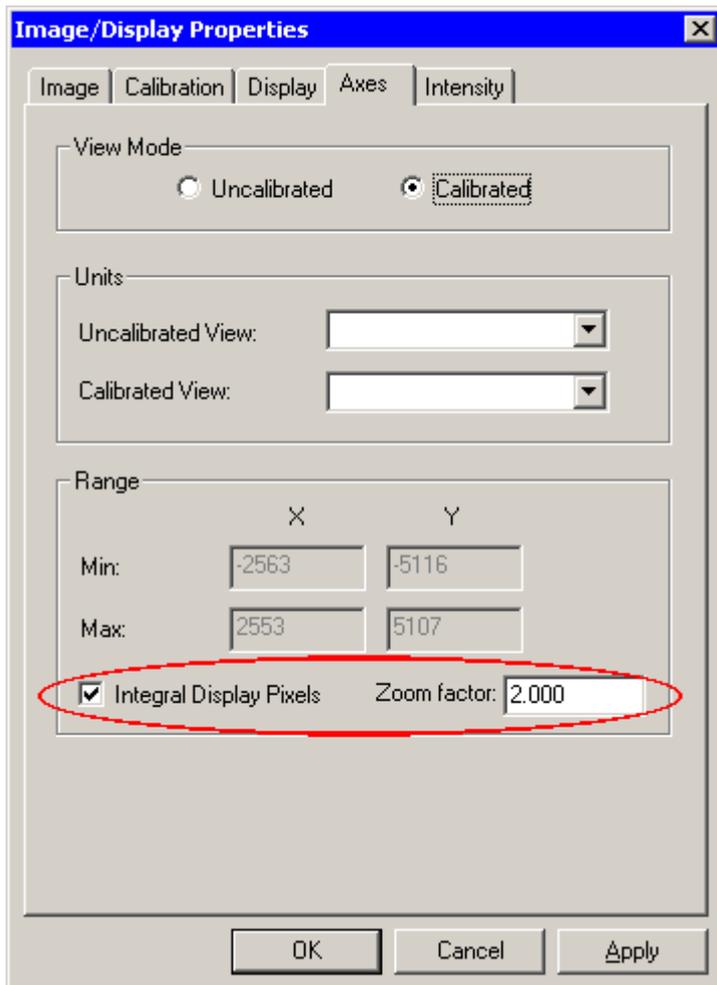
2.7.2   Bilinear / nearest neighbor display

TIA has two image display modes, bilinear and nearest neighbor. In the former all pixels contribute to the image display what results in a smoother, less noisy image. In the latter, only the image pixel closest to the screen pixel is used. The former is the default for acquired images. Especially on FFTs the difference can be substantial. Examples are shown below.
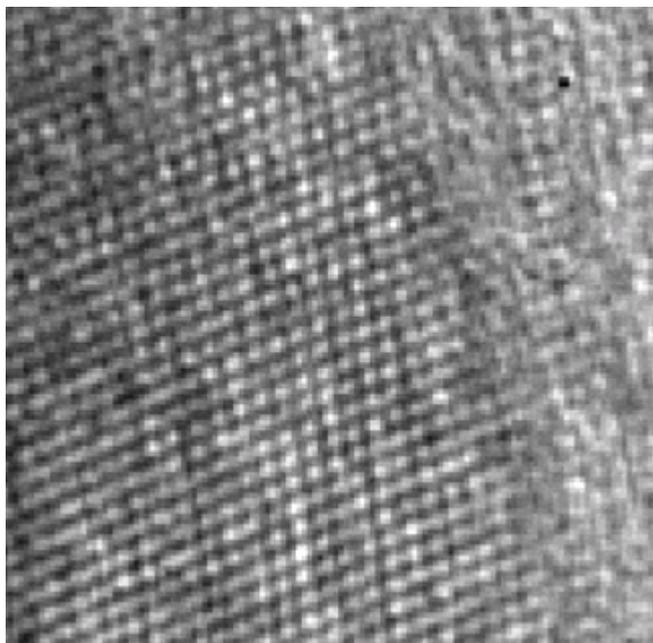
Interpolated image.
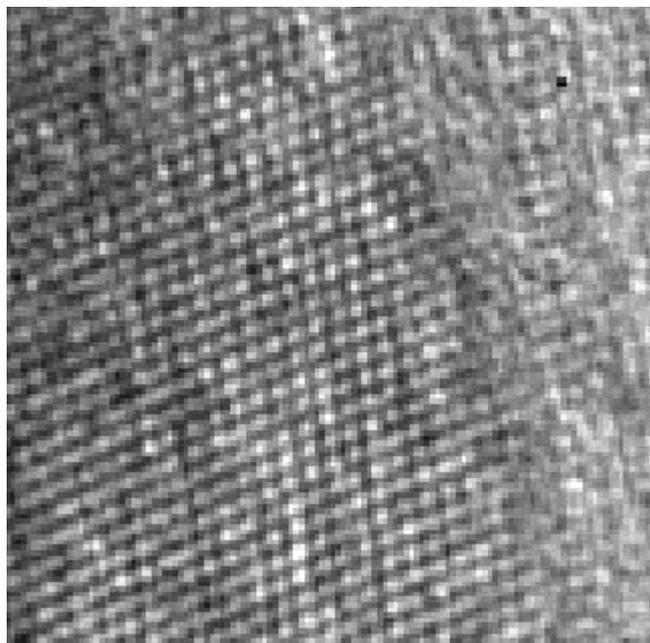
Nearest neighbor image.
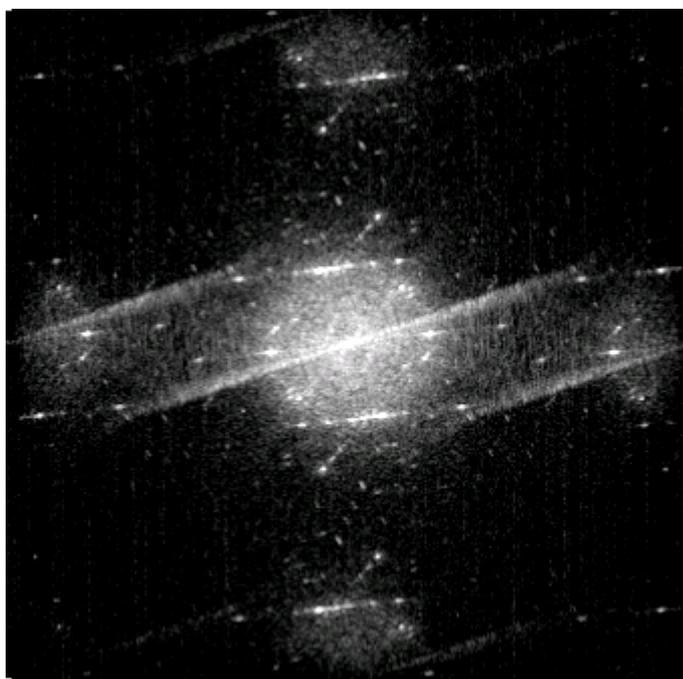
Interpolated FFT.
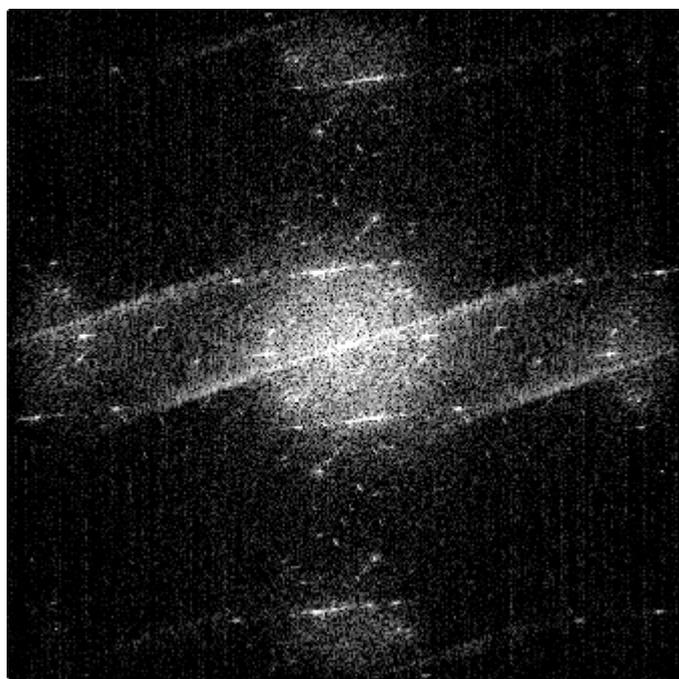
Nearest neighbor FFT.

To change from one display mode to another, open the Image/Display Properties dialog (double-click on the image or the background around it). Modify the interpolation setting.
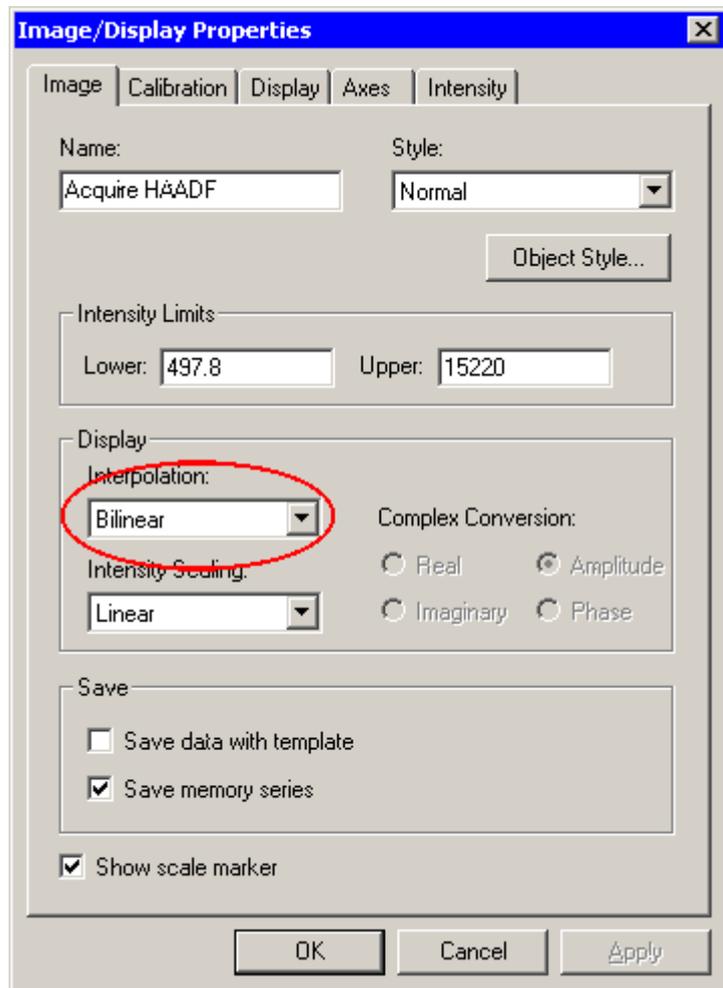
2.8   Output window

The Output window displays text information related to an operation performed. Examples are the results from data analysis such as peak fitting or elemental composition calculation from EDX spectra. The Output window is shown or hidden through the toolbar function in acquisition mode.
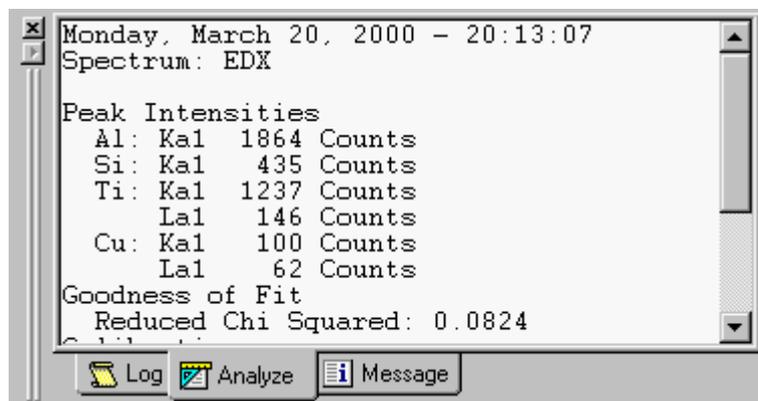
2.9   Control panels

TIA control panels are designed to browse through data series (Series panel), set the display image's dynamic range via the histogram (Histogram panel), set the display image's brightness, contrast and gamma (Display panel), display data information (Data info panel), and annotation information (Annotation info panel) on the selected annotation.

Five control panels are provided. The control panels occur in a bar that can be floating or fixed to the TIA window. If the panel is floating and you want it fixed, drag it by the top until it slots into place (left- or right-hand side of the TIA window).
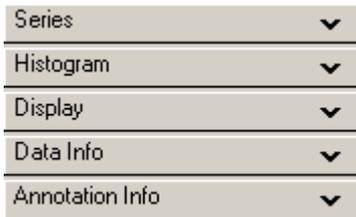
The control panels can be flipped open or close (up/down) by the small arrow button at the right-hand top of each control panel title bar.

Here all panels are closed.

Note: To keep the position of the control panel bar as defined after closing and re-opening TIA, switch to analysis mode and back to acquisition mode once. This forces TIA to store the setting.

2.9.1   Series Control Panel

Data from a specific detector can be stored in series, with only one item visible at any time. This can apply for example to the EDX spectra from a line profile or map. To browse through the data, you use the "Series" Control Panel (sometimes you can also use linked markers, for example in line profiles or maps by dragging the marker).

The Series control panel.

Select the data containing the series by clicking on the data. The Number in the Series control panel will give the currently visible data. You can scroll through the data with the scroller. You also play the data as a "movie" by the buttons underneath (from left to right, back, play, stop, forward, play settings – the latter brings up a dialog in which you define how the movie will be played).

Number trackbar
The Number trackbar can be dragged to show the data at any point in the series.

Beginning
The Beginning button resets the display to the first series item.

Play
The Play button start the display of the series as a video sequence. The settings of the video sequence are defined under More.

Stop
The Stop button stops the display of the series as a video sequence.

End

The End button resets the display to the last series item.

More

The More button at the bottom-right of the panel provides control of other parameters associated with automated series playback.
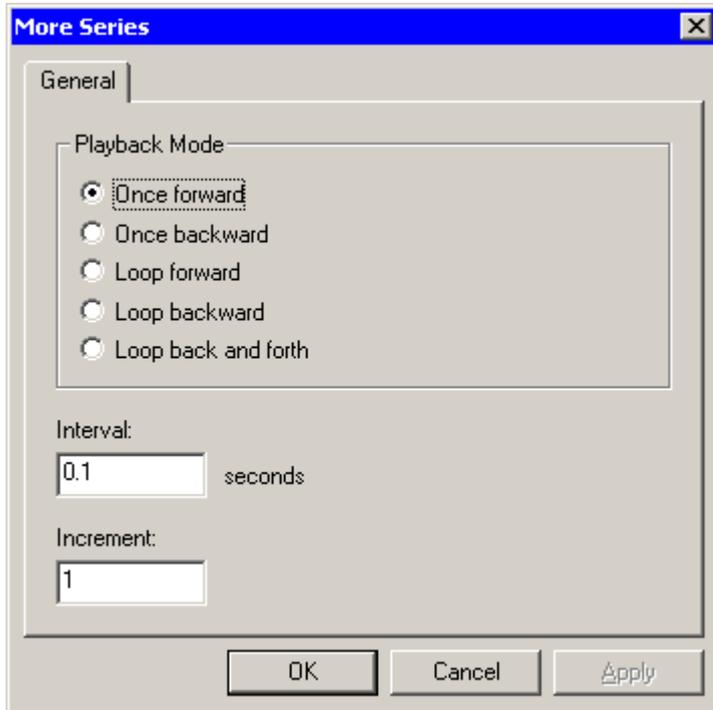
Note: If you want a series of images displayed with the same fixed intensity limits (see below), you have to switch the autoscaling of the display range off, otherwise scrolling through the series will revert to the automatic display range selection.

2.9.2   Histogram Control Panel

The histogram control panel contains various items that define how the image is displayed. The dark blue area shown is the histogram, the frequency distribution of the intensity levels in the image. The range of the horizontal axis is determined by the minimum and maximum intensity levels in the image. The values shown – which correspond to the vertical lines – are the intensity levels TIA uses for displaying the image – called the intensity limits. The sloping line from bottom left to top right shows the gamma function.

The Histogram control panel.
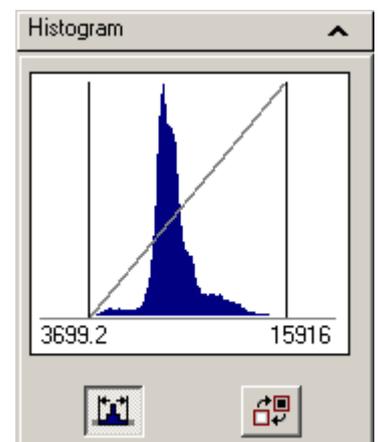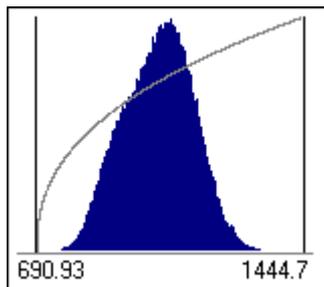
The gamma has been changed from 1.0 to a positive value of 2.5.

You can change the intensity limits by dragging the vertical lines.
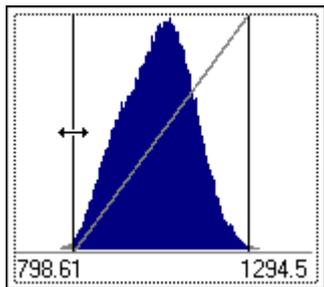
With the cursor (changed to a double-headed arrow) over one of the vertical lines you can drag the line to the left or right.
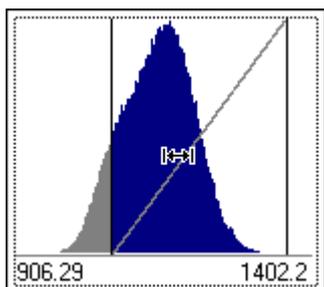
With the cursor (changed to a double-headed arrow between bars) in the area between the vertical lines you can drag the whole range to the left or right (so the total range stays the same while both lines are shifted together).

You can change the horizontal axis scale as well as the intensity limits by double-clicking below the histogram itself (so on the "axis area").
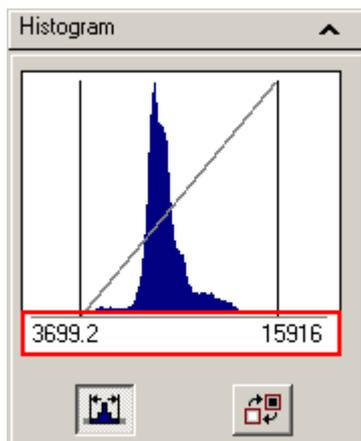
The histogram scale, outlined in red.

This will bring up the following dialog:
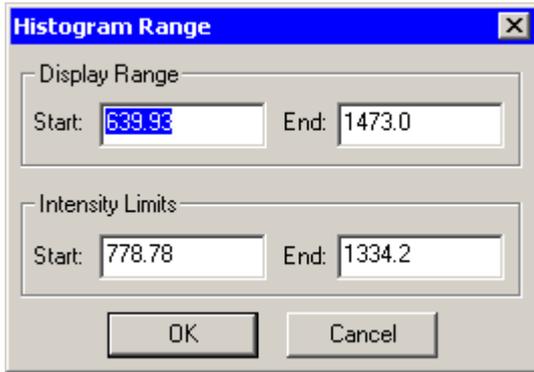
The Histogram Range dialog.
The Display Range contains the values that control the minimum and maximum scale of the histogram itself. The Intensity Limits are the values that are used to calculate how the image is displayed. The Intensity Limits are the values that are shown by the vertical black lines in the histogram and the two values displayed. Generally the Intensity Limits are set just inside the overall range in the histogram.

The intensity limits can also be set by double-clicking on an image and changing the Intensity limits values.

The two buttons underneath the histogram have the following functionality:

- Autoscale the intensity limits. The button has two states, off (the button is not "depressed") and on (the button is "depressed") . If intensity autoscale is on, each new acquisition (or update, e.g. when the image is an FFT that is linked by processing to an image that has been updated) will result in a recalculation of the intensity limits based on the data in the image. If autoscale is off, the intensity limits will be kept as they are. To reset the intensity limits with autoscale off, simply press the button twice (goes to on, limits are recalculated, then to off again).

- Invert the image (goes to its negative). The button also has normal (not "depressed") and inverted ("depressed") states.

2.9.3 Display Control Panel

The display control panel allows you change the way the image is displayed (brightness, contrast and gamma). You can reset the values by clicking on the relevant buttons (brightness , contrast and gamma) on the left-hand side of the control panel..
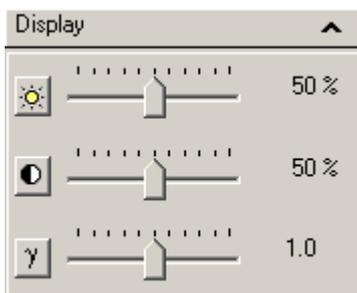
The Display Control Panel.

2.9.3.1 Intensity limits, contrast, brightness and gamma

Note: The contrast and brightness functions to some extent have similar effects to settings the intensity limits, but the latter always works without problems while manipulating contrast and brightness can have undesirable effects like reducing the number of gray levels in the image. It is best therefore to use a combination of setting intensity limits and using the gamma where necessary and to leave the contrast and brightness at default values.
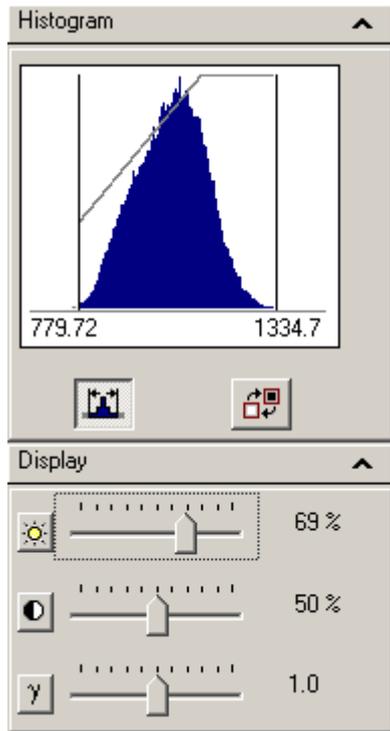
The **brightness** value has been increased. The sloping line has shifted to the left (the higher intensity values in the histogram now have become white) and the image looks brighter. Something similar could have been achieved by setting the intensity levels to the points where the sloping line intersects the bottom and top of the histogram.
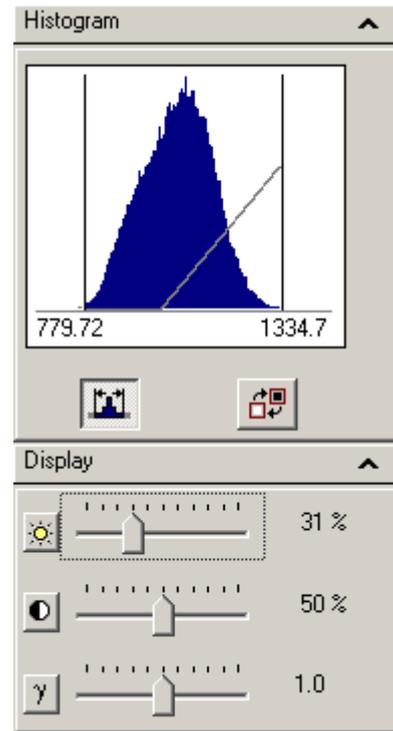
The **brightness** value has been decreased. The sloping line has shifted to the right (the lower values in the histogram now have become black) and the image looks darker. Something similar could have been achieved by setting the intensity levels to the points where the sloping line intersects the bottom and top of the histogram.
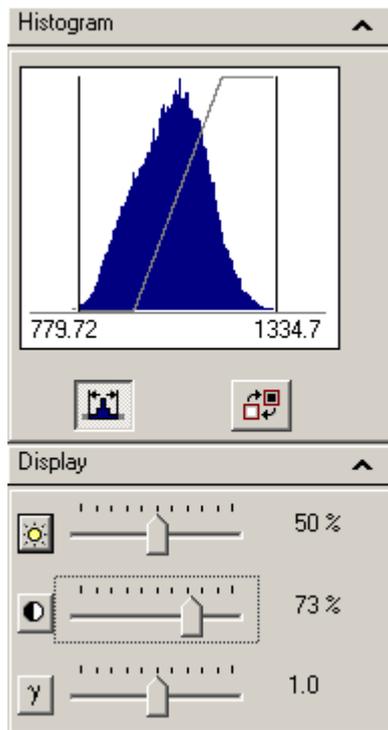
*The **contrast** value has been increased. The sloping line has become steeper and the image has more contrast. Something similar could have been achieved by setting the intensity levels to the points where the sloping line intersects the bottom and top of the histogram.*
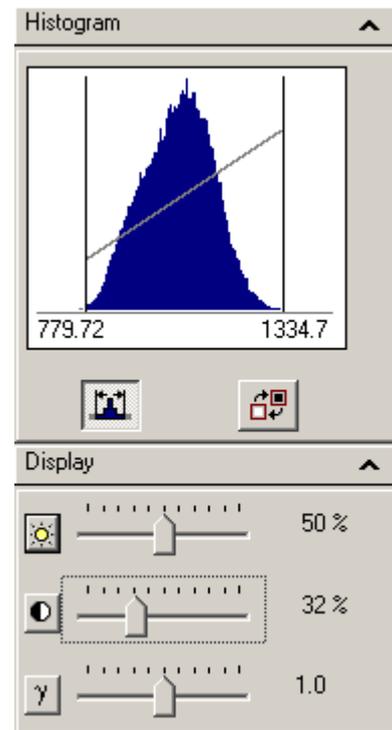
*The **contrast** value has been decreased. The sloping line has become less steep and the image has less contrast. Something similar could have been achieved by setting the intensity levels to the points where the sloping line intersects the bottom and top of the histogram.*
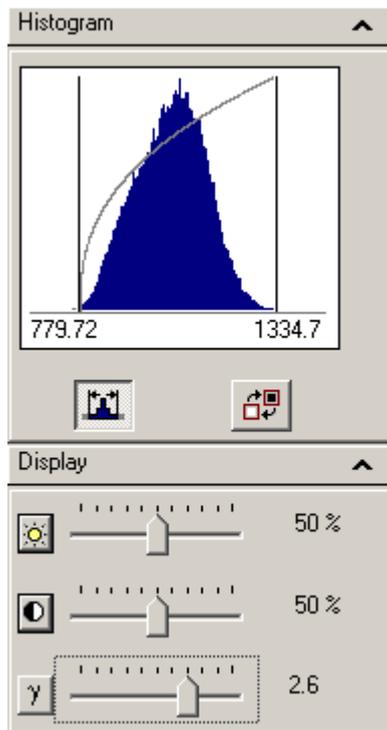
*The **gamma** value has been increased. The sloping line has become curved, rising steeply at the lower histogram intensity levels and becoming flatter at the higher levels. In the image the higher intensity levels are undifferentiated while the lower intensity levels show strong differentiation. This gamma increase visibility of features with low intensity levels while keeping some degree of visibility of the higher levels (while a shift of the brightness would have made higher levels uniformly white).*
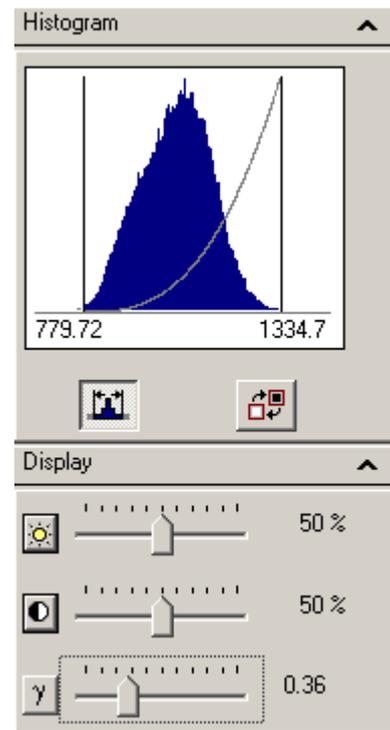
*The **gamma** value has been decreased. The sloping line has become curved, starting out relatively flat at the lower histogram intensity levels and rising steeply at the higher levels. In the image the lower intensity levels are undifferentiated while the higher intensity levels show strong differentiation. This gamma increase visibility of features with high intensity levels while keeping some degree of visibility of the lower levels (while a shift of the brightness would have made lower levels uniformly black).*

2.9.4   Data Info Control Panel

The data info control panel contains various information about the data selected (image, spectrum, etc).

Property	Value
Name	STEM HAADF
Intensity	8149
X	82 pixel
Y	234 pixel
X (real)	-280 nm
Y (real)	-34.5 nm
Size	512 × 512
Type	2-byte unsigned ...
Min	3.42e+003
Max	1.66e+004
Mean	8.98e+003
Std Dev	1.42e+003
Sum	2.36e+009

The Intensity, X and Y values will update as you move the cursor over the data. The remaining values apply to the data as a whole.

2.9.5   Annotation Info Control Panel

The annotation info contains information about the selected annotation. This can be any of the marker or text annotation. Any relevant information the annotation conveys is also shown. For example an image position marker will give the image intensity in addition to the X,Y position.

Property	Value
Name	Line 1
Length	180 pixel
CenterX	214 pixel
CenterY	141 pixel
Angle	-37.5 deg
Width	0 pixel
Intensity	8777
Mean	8.93e+003
Min	7.95e+003
Max	1.01e+004
Variance	2.06e+005
StdDev	454
Sum	1.62e+006

An image selection marker (example shown to the left) will show information about the marker as well as of the data (mean, minimum, maximum, etc).

2.10   Periodic table

There are two periodic tables for selecting elements in TIA. One is for quick access, the other one is the full periodic-table control panel with four tabs. The quick-access periodic table is accessible from the toolbar ⬛ in acquisition and analysis mode, while the full periodic table is accessible only from the menu in analysis mode.

The quick-access periodic table gives the same information as the currently active tab of the full periodic table (but you cannot see what that tab is except by going to analysis mode and displaying the full periodic table). Elements are selected (or deselected) in the quick-access periodic table by moving the cursor to the required element and then pressing the space bar on the keyboard. Elements selected are shown with a dark gray background (O, Al, Si and Ti in the example above).

The full periodic table (accessible only in analysis mode) has four tabs with independent settings:
- Markers
- Fitting
- Standards
- Auto ID

The Markers and Fitting tabs are the most important in acquisition mode. Elements selected in the periodic table of the Markers tab get their peaks identified in the EDX or EELS spectrum. Elements selected in the Fitting tab are used in the spectrum fitting procedure (these are not necessarily the same

as those marked; it is e.g. possible to mark peaks from the specimen grid, such as Cu, but not use them in the fitting). The Standards tab is important only for analysis, while the Auto ID tab shows the elements to be taken into account during automatic element identification (in general this can stay as it is).
In the full periodic table elements are selected or deselected by double-clicking on them with the left-hand mouse button. The elements from the Markers tab can be copied to the Fitting tab through the Copy KLM Setup toolbar button 🔧 function.

2.11   Toolbars and menu in acquisition

This section gives a description of the available tools with some examples of how these tools can be used.

2.11.1   Modifying the toolbar

You can modify the acquisition toolbars. You can drag them to any position (top, left, bottom, right of the window or floating above it). You can arrange them (initially they will come up side by side but if you grab a toolbar by its handle you can shift it. That way you can change the layout from

to
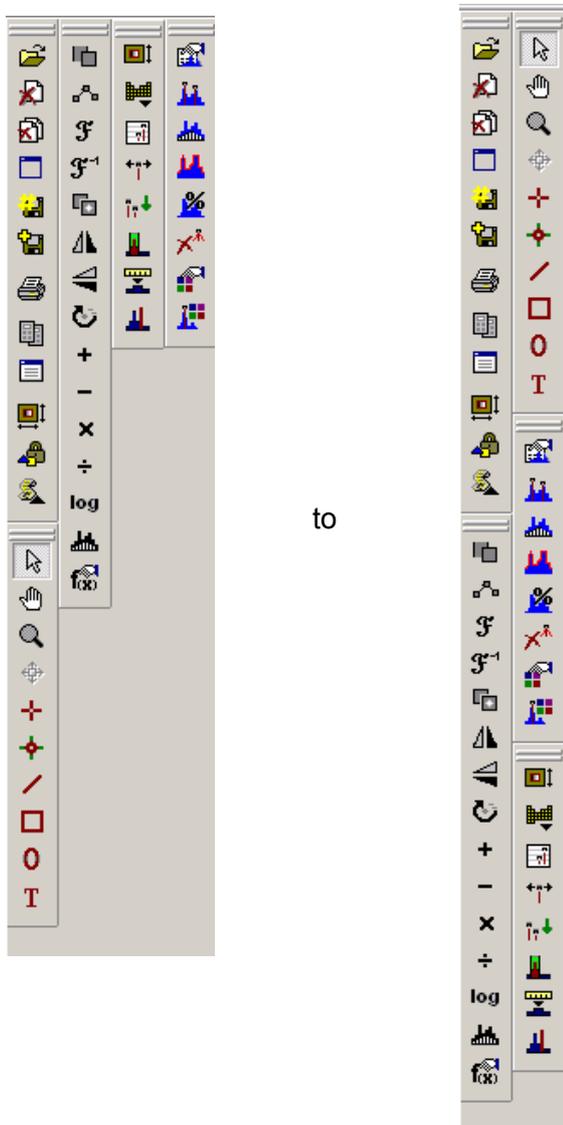
If you need to re-arrange the toolbars and there is not enough room (the toolbar area is not wide enough), drag one toolbar to the right until you are just still inside the toolbar area, then release it. The toolbar area will become wider.

You can also modify the contents of the toolbars or re-arrange the positions of the buttons. To modify the toolbars:

- Switch to TIA Analysis mode.
- In the menu select Tools, Customize, Acquire Toolbar. TIA will switch to Acquire mode and display the Customize dialog.
- To re-arrange buttons or remove them, click on a button in the toolbar(s) and either drag it to another position or drag it outside the toolbar(s).
- To add buttons to the toolbar(s), switch to the Commands tab of the Customize dialog.
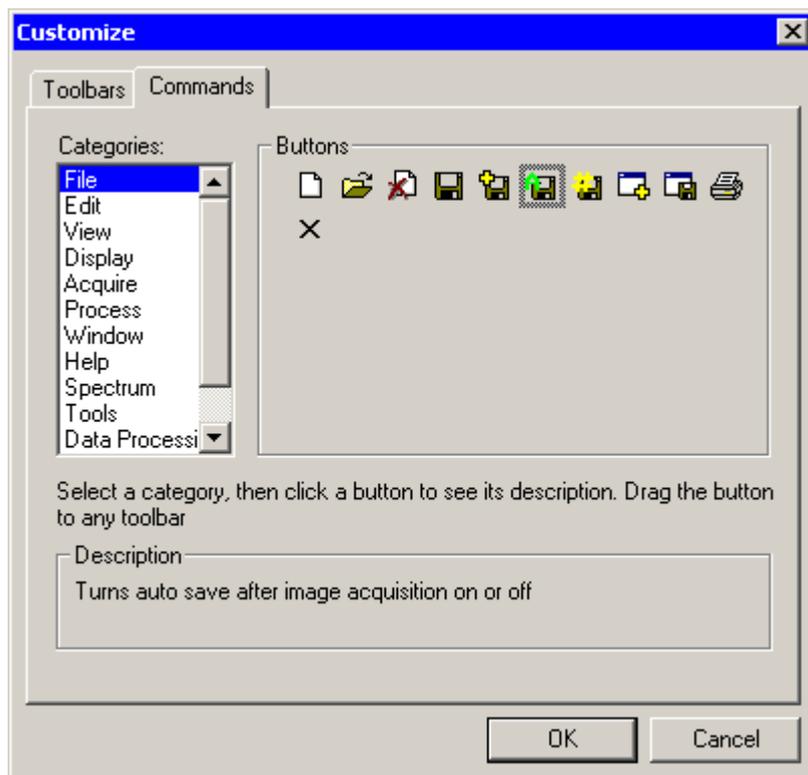
- You will see a list of Categories, each of which has a series of buttons. The categories correspond to the TIA main menu items, while the individual buttons correspond to the items in each of those main menu. Click on a button in the Buttons field and you will see a description of what the button does. If it is the button you want, drag it into a toolbar.

Note: Depending on the previous history the acquisition toolbars may have one or more (recently added) buttons missing in your TIA user interface. You can add them by modifying the toolbar as described above. You can also revert back to the default settings. To do so, close TIA and then in Windows Explorer delete the _TiaAcquisition.wsp workspace file. This file is located in your users folder under Workspaces\Layout (it depends on how TIA was configured but a typical example would be c:\Users\your user name\Workspaces\Layout). When you then restart TIA it will revert to default layout settings. Change the layout to whatever you like, then switch to Analysis and back to Acquisition mode (this forces a save of the layout file).

2.11.2 The Mini toolbar

	📂	**Open**	Open an existing file
	📄	**Close**	Close the active (currently selected) display window
	📄	**Close All**	Close all display windows
	▢	**Window**	Show the Window menu
	💾	**Save Sequentially**	Save active display window with next serial number. See description below.
	💾	**Save As**	Save active display window with user-defined file name
	💾	**Auto Save**	Switch Auto Save function on or off. See description below.
	🖨	**Print**	Print active display window with next serial number
	🗐	**Show/Hide Control Panels**	Shows or hides Control Panels. The button has two states, "depressed" (Control Panels shown) and not "depressed"
	▤	**Show/Hide Output Window**	Shows or hides Output Window. The button has two states, "depressed" (Output Window shown) and not "depressed"
	🖳	**AutoScale**	Autoscale currently selected object (image, spectrum) vertically and horizontally. The button has two states, "depressed" and not "depressed". When "depressed" the data are automatically rescaled as necessary (e.g. after a new acquisition has finished). When not "depressed", the data scaling is not changed automatically. For example, if you have Live FFT shown and zoomed in on the center, then when the button is "depressed" an update of the FFT will change the scaling back so the whole FFT becomes visible again. If you want to keep it zoomed in, press the button so it is no longer "depressed". When you use the zoom (see section 2.11.3), the AutoScale is automatically switched off.
	🔒	**Lock Object**	Lock object (fixes object position, cannot be changed until unlocked). The button has two states, "depressed" (locked) and not "depressed"
	🔍	**Components**	Access to processing functions. For more information, see section 2.11.4.

2.11.2.1   Printing

You can print either the whole display window, a single display or an image. The selection is made in the Print dialog that comes up when you print something.
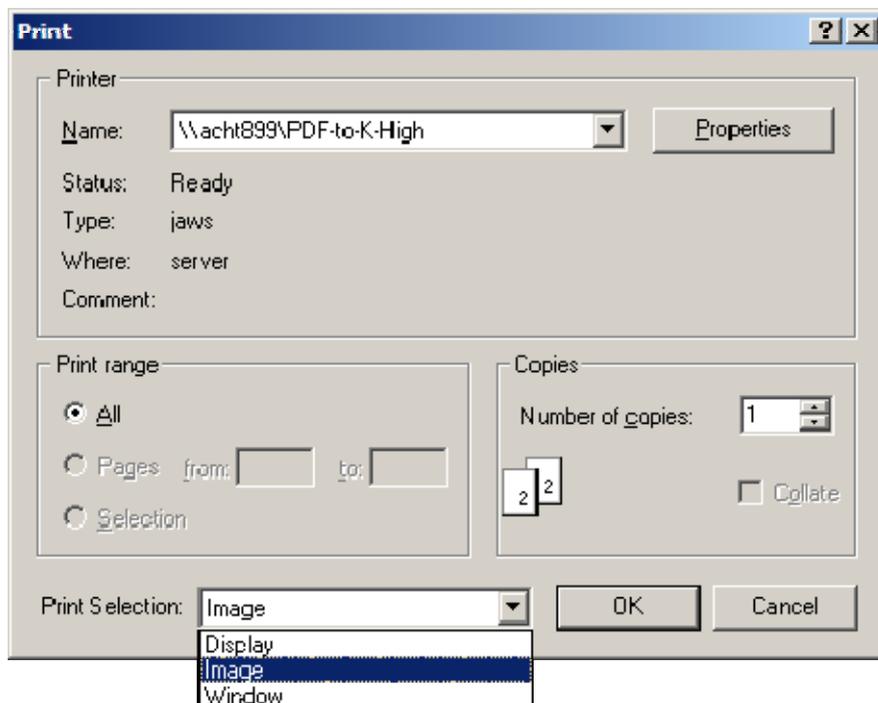
The Image option is only present when an image has been selected (clicked). To print an image of a display only, make sure the display or image is selected before printing (click on the display or image). Note: The image is printed as is. This may result in part of the image being blocked by the display legend. To ensure proper printing of the image when the legend is visible over (part of) the image, either rescale the image so the legend does not overlap or hide the legend. To do the latter, right-click on the display (not the image) and select Properties or double-click on the display and switch Show Legend off.

2.11.2.2   TIA Acquisition series

TIA can acquire data (images, spectra) in series. In some cases (e.g. spectrum profiling or imaging) this is automatic (that is, the series is made by TIA to allow all the individual spectra to fit). In other cases, the user must select a series size (larger than one) for data to be collected in a series. One example of series in data collection is recording a series of TV or CCD images of an area. These images will then record the dynamic behavior of the specimen during the recording.

Note: For Acquisition it is not possible to define a series unless **Reuse Display Window** is on. Instead you can use the sequential save feature to save each acquired image separately.

2.11.2.3   Sequential image save

There is an easy saving feature called "Save sequentially". This allows you to define a filename. All files can then be saved with increasing serial number by a single press on a toolbar button. To use Save sequentially, select the first display window to be saved and press the Save As button 🔚. In the Save As dialog (center picture), check the "Save Sequentially" checkbox and define your choice of filename.
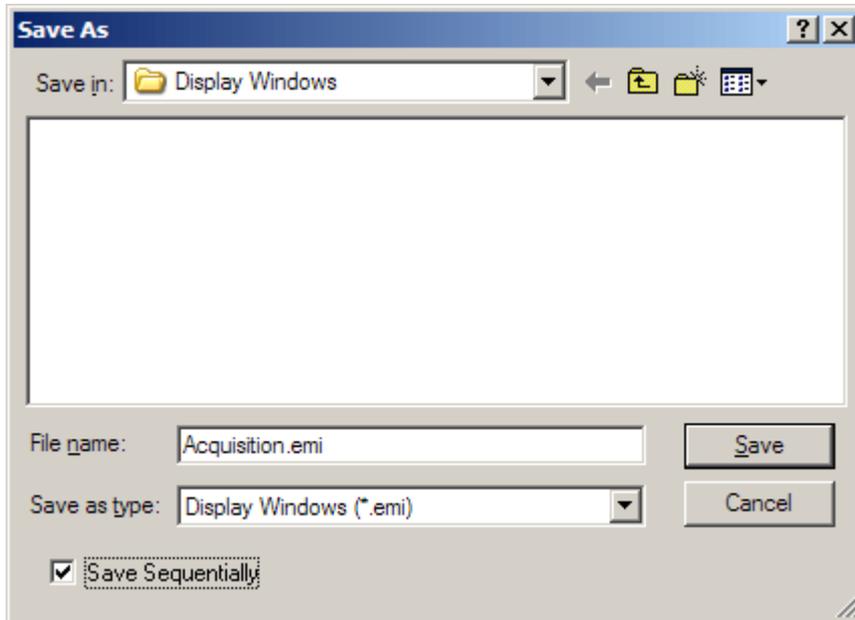
The Save Sequential toolbar button 🔚 will become enabled. Each time you press this button the currently selected display window will be saved under your choice of filename followed by an underscore and a serial number.

2.11.2.4   Auto Save

You can also have the data acquired saved automatically. Select a display window for saving, then press the 🔚 button. Define a filename in the dialog. After that, the button will remain "depressed" and each new acquisition will be saved automatically. To switch Auto Save off, press the button again (it now no longer should be "depressed").

2.11.3   Mini Tools toolbar

Note: The selection of the tools other than the arrow tool is generally for a single action. If you want to use another tool repeatedly, press the Shift key while selecting the particular tool. To go back to using the arrow tool, press Shift and click on the arrow tool.

	▶	Arrow Tool	Default cursor to select objects
	✍	Move Tool	Click and drag to move an image around
	🔍	Zoom Tool	Click on the image and zoom by a factor 2 (with Shift key = zoom out). You can also drag with the zoom tool (the cursor will change to a cross), thereby outlining the area that will be shown in the zoomed image. The outline is shown as a dashed rectangle, with a shape that matches the available space in the pane. When you use the zoom, the AutoScale is automatically switched off.
	◆	Specimen Center Tool	Use the click-center feature functionality to center the clicked feature in the image using the stage shift.
	✛	Image Position Marker Tool	Insertion of a position selection marker into an image. For more information, see section 2.11.3.2.
	✛	Beam Position Marker Tool	Insertion of a beam position marker into an image. For more information, see section 2.11.3.3.
	╱	Line Marker Tool	Insertion of a line marker into an image. For more information, see section 2.11.3.4.
	□	Image Selection Tool	Insertion of a rectangle for selection of part of an image. For more information, see section 2.11.3.5.
	0	Oval Marker Tool	Insertion of a circle or ellipse in images
	T	Text Marker Tool	Allows you to insert text annotation

Note: you can edit the settings of markers in various ways by double-clicking on them or right-clicking with the mouse. Generally you can define starting and ending values, or center and size. Both you can do in real or in pixel units. Markers have ordinals (serial numbers) that can be displayed (a number shown next to the marker) or not.
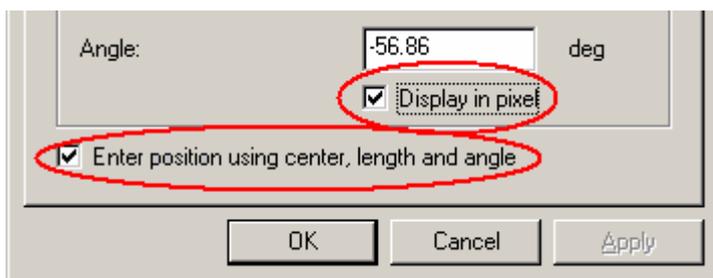
2.11.3.1   Useful keyboard key combinations when working woth markers

Ctrl+ Shift + resize/positioning marker   Width + Height stay the same
Alt + resize/positioning marker   Marker will be centered in image
Ctrl + Shift + Alt + Marker resize/positioning   Combination of above

2.11.3.2   Image position marker tool

The image position marker tool ✚ defines a position in an image. Its properties (accessed by double-clicking on the marker or clicking with the right-hand mouse button on a marker and selecting Properties in the popup menu) include a name, a style (color for this type of marker; users can define different styles for the various display elements, see under the menu Edit., Styles ... in analysis mode), ordinal number and position X and Y.

To insert an image position marker in an image, click on the image position marker tool button ✚ and then click in the image. An image position marker will now be present in the image.

Examples:
- **Displaying spectrum locations**: Once a spectrum has been acquired, the image position marker can be used to display the position of the spectrum in the image. Insert an image position marker in the image. Press the Alt key on the keyboard down, click on the image position marker and drag it (the cursor will change, part of it now displays a 'shortcut' type arrow) onto the spectrum (important, it must be on the spectrum, not just the spectrum pane). The image position marker will now be linked to the spectrum and be locked to the spectrum position.
- **Displaying locations of spectra from a profile or spectrum image:** Once a series of spectra has been acquired, the image position marker can be used to display the position of any spectrum of the series. Insert an image position marker in the image. Keep the Alt key on the keyboard pressed, click on the image position marker and drag it (the cursor will change, part of now displays a 'shortcut' type arrow) onto the spectrum (important, it must be on the spectrum, not just the spectrum pane). The image position marker will now be linked to the spectra. If the spectra define a profile, the marker can only move along the line. If it was a spectrum image, the marker must stay within the spectrum image area. If the marker is moved, the spectra will scroll through the series from one position to the other. Similarly if the spectra are scrolled through the series, the marker will move along with them. Even if the original line or image selection is moved, the image position marker will still display the proper position of the spectrum (for keeping the original line or image selection in place, lock it by selecting the line or image selection - click on it with the left-hand mouse button, then press the Lock toolbar button 🔒).

2.11.3.3   Beam position marker tool

The beam position marker tool ✚ is a combination of two features, a circle and a green crosshair. The circle is the real tool, the crosshair indicates the current beam position. Thus if two beam position marker tools are inserted into an image, only one will have the green cross (the one where the beam currently is). Clicking on the marker without the cross moves the beam position to that marker (and thus the green cross switches position). The beam position marker properties (accessed by double-clicking on the marker or clicking with the right-hand mouse button on a marker and selecting Properties in the popup menu) include a name, a style (color for this type of marker; users can define different styles for the various display elements, see under the menu Edit., Styles ... in analysis mode), ordinal number and position X and Y.
The beam position marker only functions in STEM images. It has no meaning in CCD or Video images.

To insert a beam position marker in an image, click on the beam position marker tool button ✚ and then click in the image. A beam position marker will now be present in the image.

Examples:

- **Positioning the stationary beam:** With the beam position marker it is possible to define the position where the beam will be stationed while there is no acquisition active. Drag the marker to the position where you want the beam to stay while no image scan or other acquisition is taking place.
- **Defining beam positions for multiple spectrum acquisition:** Click on the beam position marker tool while keeping the Shift keyboard key pressed. Click with the left-hand mouse button in the image at all the positions where spectra must be recorded. Beam position markers will now be inserted in the image. Shift-click on the arrow tool to change the cursor back to the arrow. Go to the Experiments Control Panel and select Spectrum positions in the drop-down list. Define the required settings and press Acquire. A series of spectra will be acquired at the beam positions marked. Afterwards you can link an image position marker to the spectra (as described above under image position marker) which, while changing from one spectrum to another in the series, will move the image position marker where the spectrum currently displayed was collected.

2.11.3.4   Line marker tool

The line marker tool ✏ can be used to draw a line in an image. Its properties (accessed by double-clicking on the marker or clicking with the right-hand mouse button on a line and selecting Properties in the popup menu) include a name, a style (color for this type of marker; users can define different styles for the various display elements, see under the menu Edit., Styles ... in analysis mode), ordinal number and position (start and end X and Y).

To insert a line marker in an image, click on the line marker tool button ✏ . Click in the image at the starting point of the desired line and drag to the end point. The start and end positions can be modified by clicking on the line handles (white squares and dragging them elsewhere). The line can also be moved by clicking on it (away from handles) and dragging it to another position or by changing the values in the Properties dialog (double-click on the line or click with the right-hand mouse button on the line and select Properties).

Examples:

- **Calibrating images:** Image dimensions are in real units (mm, nm, etc.). The accuracy of these units depends on two factors, the magnification on the microscope and the image calibration in TIA. The latter can only be set by TIA administrators (these settings then become system-wide and are used by all users). If several calibrations exist, recorded at different magnifications, TIA will automatically use the value for the calibration magnification that is closest to the magnification currently on the microscope. For STEM imaging three or four calibrations spanning the whole magnification range will generally be sufficient (the change between different scan magnifications is quite accurate). For CCD or Video imaging, it may be desirable to calibrate each TEM magnification separately (because there is no fixed pattern to any deviation between the true magnification and displayed magnification when going through the TEM magnifications). Images can also be calibrated by users after acquisition (provided the image contains features that allow calibration).
  To calibrate an image, insert a line marker in the image (see above). Click on the image with the right-hand mouse button and select Properties in the popup menu. Select the Calibration tab. Click on the Scale... button. In the dialog that is shown, select the line in the Line 1 drop-down list box and enter its length to the right of it. If there are two lines, select the other line in the Line 2 drop-down list box and enter its length. For one line, click on the Keep square checkbox. Click OK on all dialogs. The image is now calibrated.
  To make the calibration a system setting, see the relevant sections for STEM, CCD and Video.
  Note: Never use calibration using two directions as this will result in different pixel dimensions for x and y and some software may not be able to handle that.
  Note: For best results and easy calibration of images and (CCD) camera lengths, use the Magnification Calibration accessory (if available).
- **Displaying an intensity profile:** Insert a line marker in the image (as described above) at the position where the intensity profile should be obtained. Press the ⌁ button in the Data Processing

Toolbar and the intensity profile is automatically inserted into a new pane. If you move the line marker around, the intensity profile will be updated.

- **Defining scope profile positions:** If image acquisition is not active, a scope display can be obtained from a line in any orientation in the image. To obtain such a scope display, first insert a line marker in the image (as described above) at the position where the scope profile should be obtained and then press the Scope button in the STEM Imaging Control Panel. The scope signal will be acquired continuously along the line. The line can be dragged to other positions to change the position of the scope signal.
  Note: Scope displays are not persistent and disappear automatically when scope is switched off again. To create persistent intensity profiles, switch to analysis mode, split a pane to create room for the intensity profile display. Then click on a line marker tool in the image and select from the menu Process, Line profile. Move the changed cursor to the empty pane and click there.
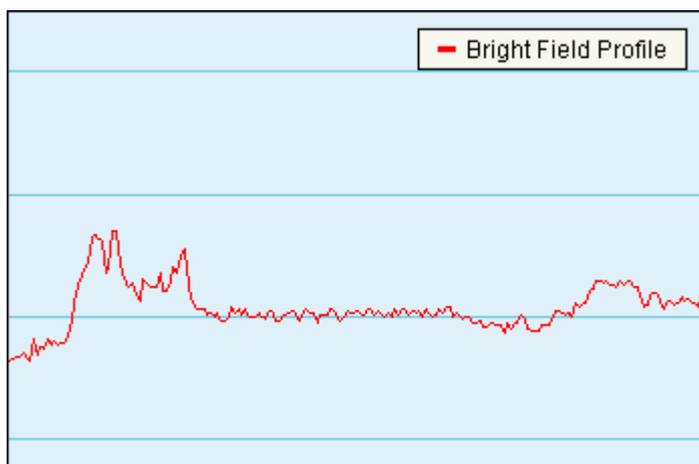
A scope display. The signal from the (BF) detector is displayed with high intensity (white) at the top and low intensity (black at the bottom). The vertical scale covers the full range of the possible detector signal (0-64000).

- **Acquiring a single spectrum while the beam is scanning along a line:** Insert a line marker in a STEM image and select the marker (handles are visible). Go to the EDX Control Panel (or PEELS), set the required conditions and press Acquire. The beam will be scanning continuously along the line while the spectrum is acquired, giving a spectrum that is an average of the line.
- **Defining spectrum profile positions:** See the Experiments Control Panel.
- **Measuring distances:** Draw a line in an image. As you are drawing TIA will display a hint with the length of the line in pixels and physical units. The Annotation Info Control panel also shows the measurement information.
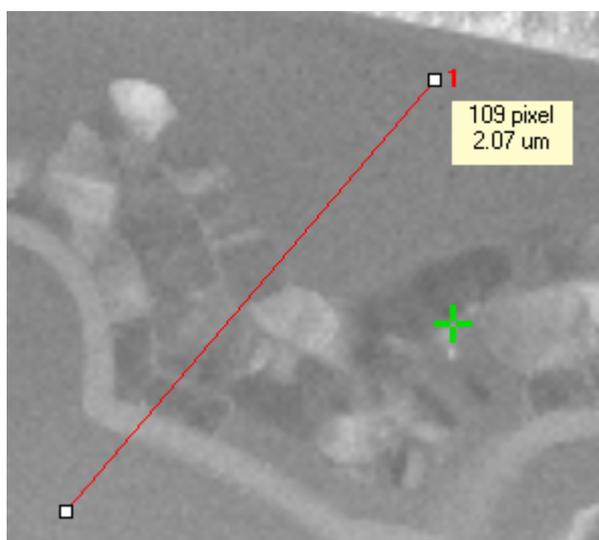
Display of measurement information.

2.11.3.5   Image selection tool

The image selection tool ☐ can be used to draw a frame in an image. Its properties (accessed by double-clicking on the marker or clicking with the right-hand mouse button on a marker and selecting Properties in the popup menu) include a name, a style (color for this type of marker; users can define different styles for the various display elements, see under the menu Edit., Styles ... in analysis mode), ordinal number and position (start and end X and Y).

To insert an image selection marker in an image, click on the image selection marker tool button ☐. Click in the image at the top left corner of the desired frame and drag to the bottom right corner. The start and end positions can be modified by clicking on the handles (white squares and dragging them elsewhere). The frame can also be moved by clicking on it (away from handles) and dragging it to another position or by changing the values in the Properties dialog (click with the right-hand mouse button on the marker and select Properties).

Examples:

- **Calculating an FFT from an area inside an image:** FFTs (Fast Fourier Transforms) can be calculated from essentially any rectangular area (down to a horizontal or vertical line; the area does not have to have power of 2 dimensions). To obtain an FFT, draw an image selection marker around the area to be used for the FFT and press the 𝔉 button in the Data Processing Toolbar. A new pane will be created with the FFT in it. The FFT will be updated automatically when the image changes (new acquisition) or the image selection marker is changed (moved or changed in size).
- **Creating a copy of part of an image:** Insert an image selection marker in an image. Split a pane to create room for a new display. Go to analysis mode. Select the image selection marker and press the ▤ button in the Data Processing Toolbar. An image display is created in a new pane with in it the part of the image covered by the image selection marker. The new image is linked to the image selection marker (it moves or resizes when the marker in the original image is moved or resized).
- **Acquiring a single spectrum while the beam is scanning an area:** Insert an image selection marker in a STEM image and select the marker (handles are visible). Go to the EDX Control Panel (or PEELS), set the required conditions and press Acquire. The beam will be scanning the area continuously while the spectrum is acquired, giving a spectrum that is an average of the area. Note that the image is not updated during the spectrum acquisition.
- **Defining spectrum image positions:** See the Experiments Control Panel.

2.11.4   Processing functions

Unary Proc. ➡		Line Profile
Binary Proc. ▶		Log
FFT/IFFT ▶		Flip Horiz
Correlation ▶		Flip Vert
Rot. Average ▶		Rotate
Quant Setup ▶		Selection
EDX Quant ▶		Background
AutoMap ▶		Extract Map/Profile
Lattice ▶		Unary Params
View Seq. ▶		
Export Series ▶		
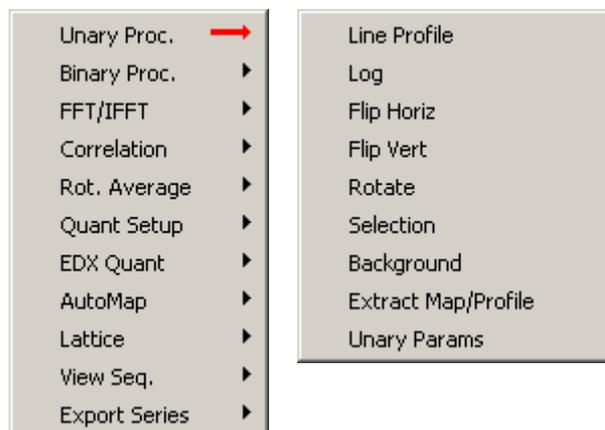
Processing functions working on a single image or spectrum
- Line profile - Extracts intensity profile from an image. For more information, see section 2.11.5.2.
- Log - Makes log (natural log, not base 10) of the image.
- Flip Horiz - Flips image horizontally. For more information, see section 2.11.5.10.
- Flip Vert - Flips image vertically. For more information, see section 2.11.5.10.
- Rotate - Rotates image. For more information, see section 2.11.5.10.
- Selection - Copies part of an image. For more information, see section 2.11.5.1.
- Background - Perform a background correction on an EDX or EELS spectrum. For more information, see section 2.11.5.12.
- Extract Map/Profile - Extracts a map or line profile from Experiments data.
- Unary Params - Opens the Unary Processing Parameters dialog.

Unary Proc. ▶		+
Binary Proc. ➡		-
FFT/IFFT ▶		*
Correlation ▶		/
Rot. Average ▶		
Quant Setup ▶		
EDX Quant ▶		
AutoMap ▶		
Lattice ▶		
View Seq. ▶		
Export Series ▶		
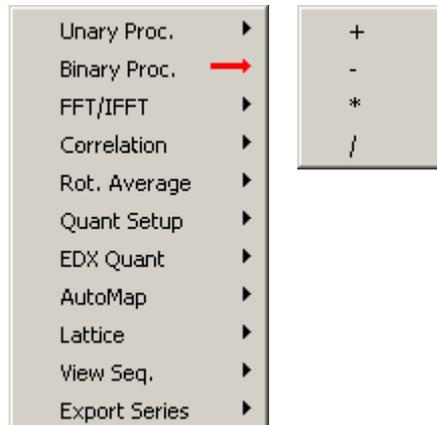
Processing functions working on a combination of images or image and scalar
- + Adds data or constant to data. For more information, see section 2.11.5.11.
- - Subtracts data or constant from data.
- * Multiplies data with data or constant.
- / Divides data by data or constant.

| Unary Proc. ▶ |
| Binary Proc. ▶ |
| FFT/IFFT ▶ |
| Correlation ➡ |
| Rot. Average ▶ |
| Quant Setup ▶ |
| EDX Quant ▶ |
| AutoMap ▶ |
| Lattice ▶ |
| View Seq. ▶ |
| Export Series ▶ |

| FFT |
| IFFT |
| Mask Filter |
| FFT/IFFT Params |
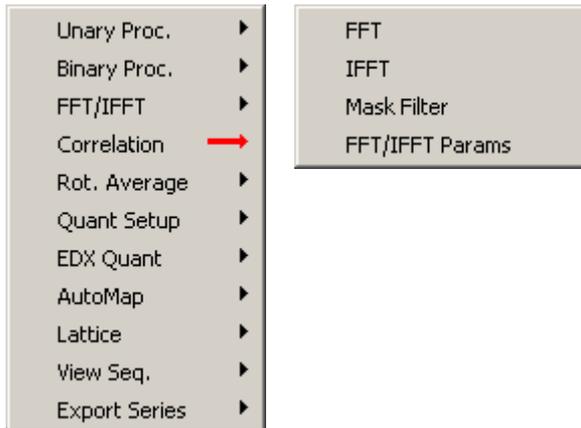
Fast Fourier processing functions
- FFT - Calculates FFT from 2- or 1-dimensional data. For more information, see section 2.11.5.3.
- IFFT - Calculates inverse FFT from FFT. For more information, see section 2.11.5.4.
- Mask Filter - Applies mask(s) to FFT. For more information, see section 2.11.5.6.
- FFT/IFFT Params - Opens FFT/IFFT Parameters dialog.

| Unary Proc. ▶ |
| Binary Proc. ▶ |
| FFT/IFFT ▶ |
| Correlation ➡ |
| Rot. Average ▶ |
| Quant Setup ▶ |
| EDX Quant ▶ |
| AutoMap ▶ |
| Lattice ▶ |
| View Seq. ▶ |
| Export Series ▶ |

| Auto Corr. |
| Cross Corr. |
| Corr. Params |
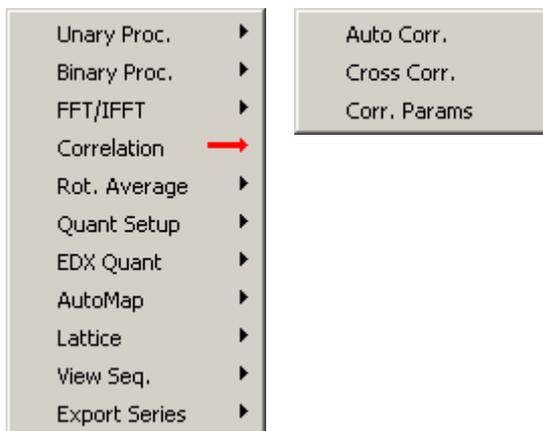
Correlation functions
- Auto Corr. - Calculates auto-correlation of an image. For more information, see section 2.11.5.7.
- Cross Corr. - Calculates cross-correlation of two images. For more information, see section 2.11.5.8.
- Corr. Params - Opens Correlation Parameters dialog.

| Unary Proc. ▶ |
| Binary Proc. ▶ |
| FFT/IFFT ▶ |
| Correlation ▶ |
| Rot. Average ➡ |
| Quant Setup ▶ |
| EDX Quant ▶ |
| AutoMap ▶ |
| Lattice ▶ |
| View Seq. ▶ |
| Export Series ▶ |

| Rotational Average |
| Rot. Avg. Params |
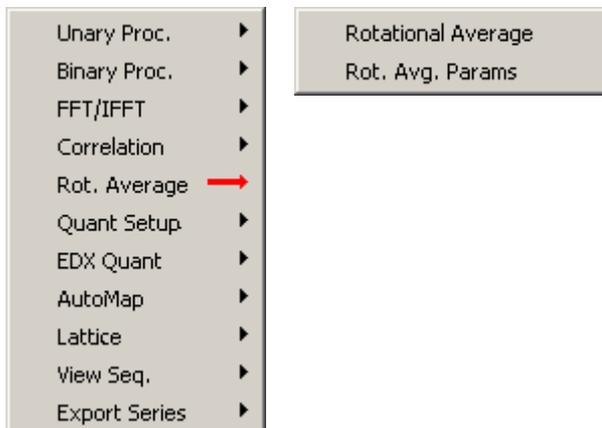
Rotational average functions
- Rotational Average - Calculates rotational average of FFT over angular range defined. For more information, see section 2.11.5.13.
- Rot. Avg. Params - Opens Rotational Average Parameters dialog.

Unary Proc. ▶		Analysis Setup
Binary Proc. ▶		Manage Setups
FFT/IFFT ▶		Spectrum Conditions
Correlation ▶		Manage Conditions
Rot. Average ▶		Manage Standards
Quant Setup →		Copy Conditions to Spectrum
EDX Quant ▶		
AutoMap ▶		
Lattice ▶		
View Seq. ▶		
Export Series ▶		

Quantification Setup functions
Not covered in this help file.

Unary Proc. ▶		Peak ID
Binary Proc. ▶		Correct Background
FFT/IFFT ▶		Fit Peaks
Correlation ▶		Quantify
Rot. Average ▶		Clear
Quant Setup ▶		
EDX Quant →		
AutoMap ▶		
Lattice ▶		
View Seq. ▶		
Export Series ▶		

EDX Quantification functions
Not covered in this help file.

Unary Proc. ▶		Diffractogram
Binary Proc. ▶		Center
FFT/IFFT ▶		Calibrate
Correlation ▶		Add Spacing
Rot. Average ▶		Add Angle
Quant Setup ▶		Adjust Search
EDX Quant ▶		Options
AutoMap →		
Lattice ▶		
View Seq. ▶		
Export Series ▶		

AutoMap functions
Not covered in this help file.

Unary Proc. ▶	Diffractogram
Binary Proc. ▶	Center
FFT/IFFT ▶	Calibrate
Correlation ▶	Add Spacing
Rot. Average ▶	Add Angle
Quant Setup ▶	Adjust Search
EDX Quant ▶	Options
AutoMap ▶	
Lattice →	
View Seq. ▶	
Export Series ▶	

Lattice Analysis functions
Note: This functionality is not visible by default. If you wish to use Lattice Analysis, the LatticeAnalysis.wsc component must be installed (see section 2.11.4.1).
Lattice analysis can be used to analyze diffraction patterns.
Not covered in this help file.

Unary Proc. ▶	Open Next
Binary Proc. ▶	Open Prev
FFT/IFFT ▶	Delete
Correlation ▶	
Rot. Average ▶	
Quant Setup ▶	
EDX Quant ▶	
AutoMap ▶	
Lattice ▶	
View Seq. →	
Export Series ▶	

View Sequential functions
When images have been saved with the sequential save function, you can go through these images and review them. You must (have) one image from the series open before the functions work. If you go through with Next and Prev(ious), only one display window is kept open (so if you open the Next, the Previous display window is closed). Delete deletes the currently open images from disk.

Unary Proc. ▶	Export
Binary Proc. ▶	
FFT/IFFT ▶	
Correlation ▶	
Rot. Average ▶	
Quant Setup ▶	
EDX Quant ▶	
AutoMap ▶	
Lattice ▶	
View Seq. ▶	
Export Series →	

Export Series function
Note: This functionality is not visible by default. If you wish to use Export Series, the ExportSeries.wsc component must be installed (see section 2.11.4.1).
Export Series exports a series of data in a user-specified format. You are asked to identify the data series first in a dialog, then a second dialog allows you to specify the export format. For more information, see section 2.11.5.15.

2.11.4.1   Installing components

To install a component, proceed as follows:
- Switch TIA to Analysis mode.
- From the menu select Tools, Components...
- In the Installed Components dialog, select Install.
- Enter the name of the component (LatticeAnalysis.wsc, ExportSeries.wsc) and press OK. The name of the component should be added to the list and the functionality visible in the shortcut bar (Analysis mode) and toolbar.

2.11.5   Data Processing Toolbar

	🛅	**Image Selection**	Copies part of an image. For more information, see section 2.11.5.1.
	⚘	**Intensity Profile**	Extracts intensity profile from an image. For more information, see section 2.11.5.2.
	𝔉	**FFT**	Calculates FFT from 2- or 1-dimensional data. For more information, see section 2.11.5.3.
	𝔉¹	**Inverse FFT**	Calculates inverse FFT from FFT. For more information, see section 2.11.5.4.
	🛅	**Autocorrelate**	Calculates auto-correlation of an image. For more information, see section 2.11.5.7.
	🔼	**Flip Horizontally**	Flips image horizontally. For more information, see section 2.11.5.10.
	◁	**Flip Vertically**	Flips image vertically.
	↻	**Rotate**	Rotates image. For more information, see section 2.11.5.10.
	+	**Add**	Adds data or constant to data. For more information, see section 2.11.5.11.
	−	**Subtract**	Subtracts data or constant from data.
	✗	**Multiply**	Multiplies data with data or constant.
	÷	**Divide**	Divides data by data or constant.
	log	**Log**	Makes log (natural log, not base 10) of the image.
	📊	**Correct Background**	Perform a background correction on an EDX or EELS spectrum. For more information, see section 2.11.5.12.
	🔺	**Rotational Average**	Calculates rotational average of FFT over angular range defined. For more information, see section 2.11.5.13.
	f(x)	**Data Processing Setup**	Leads to dialog with settings. For more information, see section 2.11.5.14.

Notes:

- All processing creates a processed copy of the original data.
- You can track what has been done to generate data by inspecting the data name. It will reflect the processing stages. For example IFFT(FFT(Acquire HAADF)) is the inverse FFT of the FFT of "Acquire HAADF".
- During processing TIA will often generate temporary empty panes. This is necessary to keep an even and controlled pane distribution.

2.11.5.1   Image selection

This processing tool provides a digital zoom ability to help users resolve image details from a high resolution image or to copy part of an image. To execute the function:

- Acquire an image.
- Place an image selection marker ▫ to mark the region of interest (ROI).
- Select Image Selection ▣ to create a digital-zoomed image.

Hint: Drag/move the marker will update the digital-zoomed image. If you do not want the image selection to update, right-click on the digital-zoomed image and uncheck Link processing. Or make a copy of the digital-zoomed image into another pane.

2.11.5.2   Intensity profile

This processing tool provides a quick way of retrieving an image intensity profile from a selected area. To execute the function:

- Acquire an image.
- Place a line marker ✎ to mark the region of interest (ROI).
- Select Intensity Profile ⊹ to retrieve the image intensity profile.

Hints:
- Drag/move the marker will update the intensity profile from the new ROI.
- The intensity profile can be averaged over the width perpendicular to the line marker.
- The integrated area is indicated in the source image by a green outline.
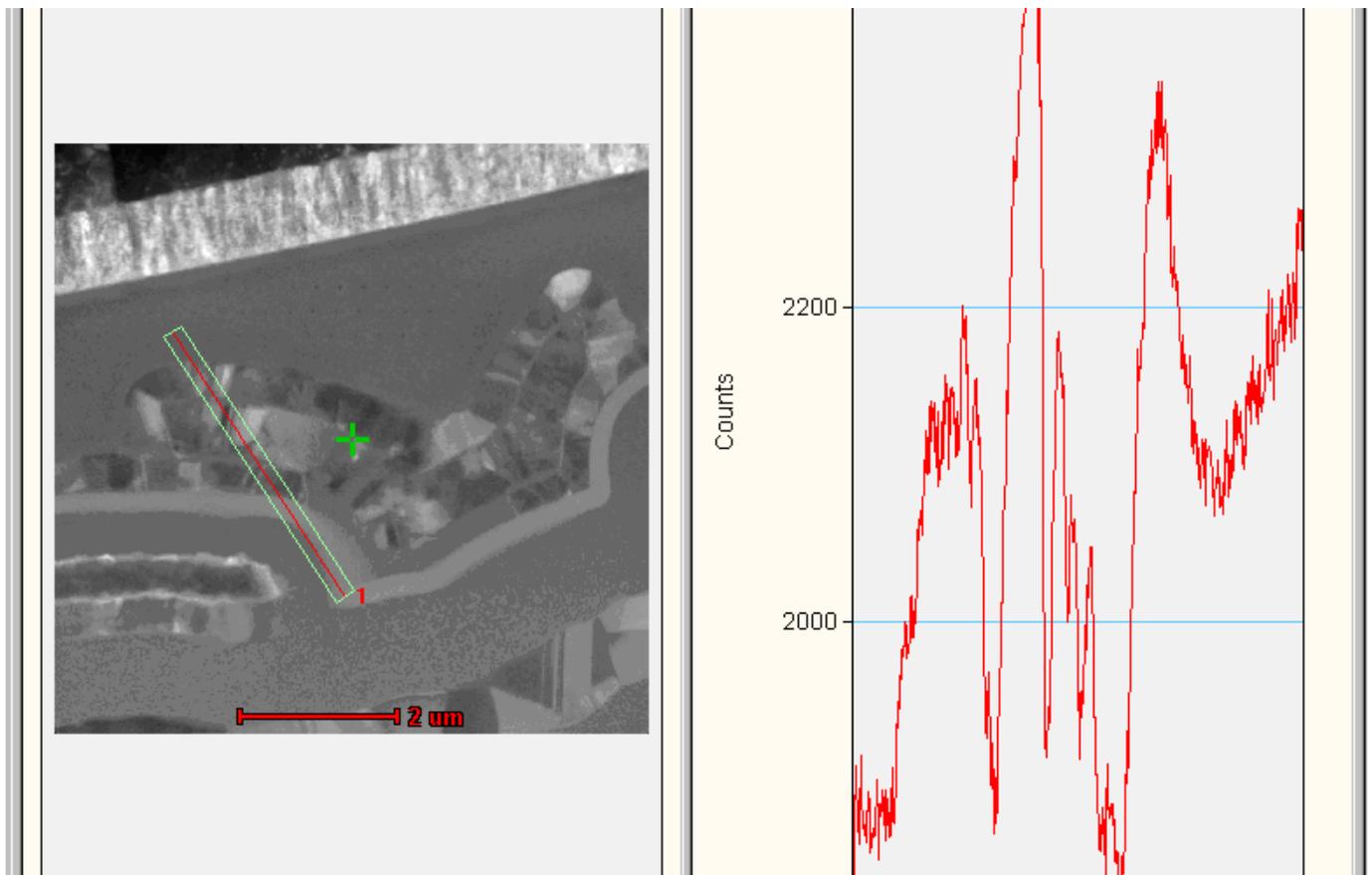
There are two ways to define the integration width of the profile:
- Right-click on the extracted profile and select Edit Line Profile… from the pop-up menu. The line width (in pixels or calibrated units) can be changed in the dialog. This affects the current line profile.

Line Profile Properties

General

Line Marker:

Acquire HAADF Scanning Display1/Line 1

Line Width:

250   nm

☐ Width in pixel

OK   Cancel   Apply
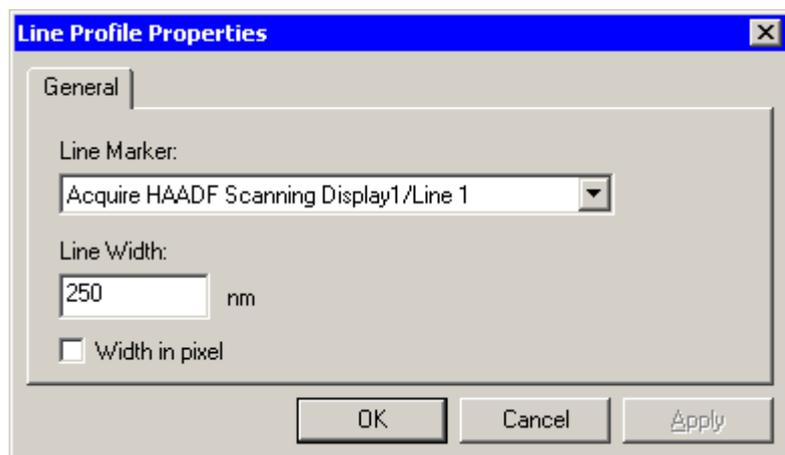
- Define the width in micrometers in the Unary Processing Parameters dialog The line profile width can be entered in physical units in the unary parameters dialog. This only affects line profiles created after the change has been made.

Unary Processing Parameters

Parameter:

| Line Profile width (um) | 0.250 |
| Extract energy profiles in same display | ☑ |

OK   Cancel
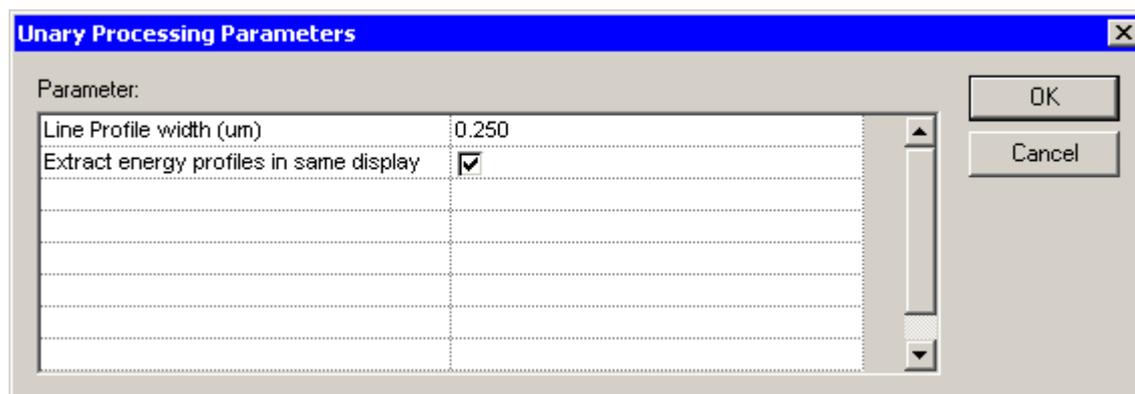
2.11.5.3   FFT

This processing tool provides a way to analyze high-resolution images or images with periodic features. A quick example shows how to measure d-spacings and angles from a high resolution image.
- Select a suitable image or select a sub-area of an image with the Image Selection marker.
- Select FFT 𝄆 on the toolbar to generate a Fourier transform of the image.
- Place an image position marker on one of the diffraction spots using the Image Position Marker Tool.
- Select Add Spacing function of the Lattice component (available from the shortcut bar in Analysis mode) to measure the d-spacing from the original HREM image. The measured result will be displayed in the output measurement window.
- You can measure angles between two diffraction spots using the Add Angle function of the Lattice component. Place and select two markers (using mouse selection while holding down the Shift key), then apply the processing.

Please note:

- FFTs of very large images can take a significant amount of time. TIA therefore by defaults uses a selection of a maximum of a 2k image when FFT is selected on an image larger than 2k (the selection of shown by an image selection marker). If you do want an FFT of the whole image and the image is larger, insert an image selection marker yourself and set it to cover the whole image (edit the properties of the marker).
- The FFTs are by default displayed on a log scale with a gamma value of 0.45. If you want to use a linear scale, use a gamma value around 2.2 for best results. You can change the default behavior for normal FFTs (not Live FFT) by selecting FFT/IFFT Parameters but make sure you keep the proper combination of log/linear and gamma (0.45/2.2).

Hints:

- It is not necessary that images or sub-area selections of images used for FFT are square or in power-of-two sizes. TIA automatically pads the data to power-of-two before creating the FFT. The padding will mean that an inverse FFT of an FFT of a non-square or non-power-of-two image will include the padding (so that image does not have the same size as the original image).
- You can do FFTs of line profiles (and inverse FFTs of FFTs of line profiles).
- To reduce the computation time of calculating FFT/IFFTs on large images (for example, a 2048x2048 image), a digital-binning or reduced FFT can be used. Right-click on the FFT image and select Edit FFT… from the pop-up menu, and select a different Sampling Interval value. Alternatively use the FFT/IFFT parameters dialog.
- To calculate the FFT from a sub-area of an image, place a suitably sized and positioned Image selection marker ☐ in the image, make sure it is selected (the white-square handles are visible) and do the FFT.
- To improve the FFT image quality, a filtered FFT image can be generated. In TIA, a Hanning window will be applied if this option had been selected from the Edit FFT… dialog. Alternatively use the FFT/IFFT parameters dialog.

2.11.5.4   Inverse FFT

The inverse FFT inverts a Fourier transform. As input it requires a reciprocal-space image. Generally the IFFT of the FFT of an image will reproduce the image. But the effect of various parameters can be seen by an IFFT of an FFT. In the example below you can see the effect of the Hanning window used for creating the FFT: the image edges are softened.
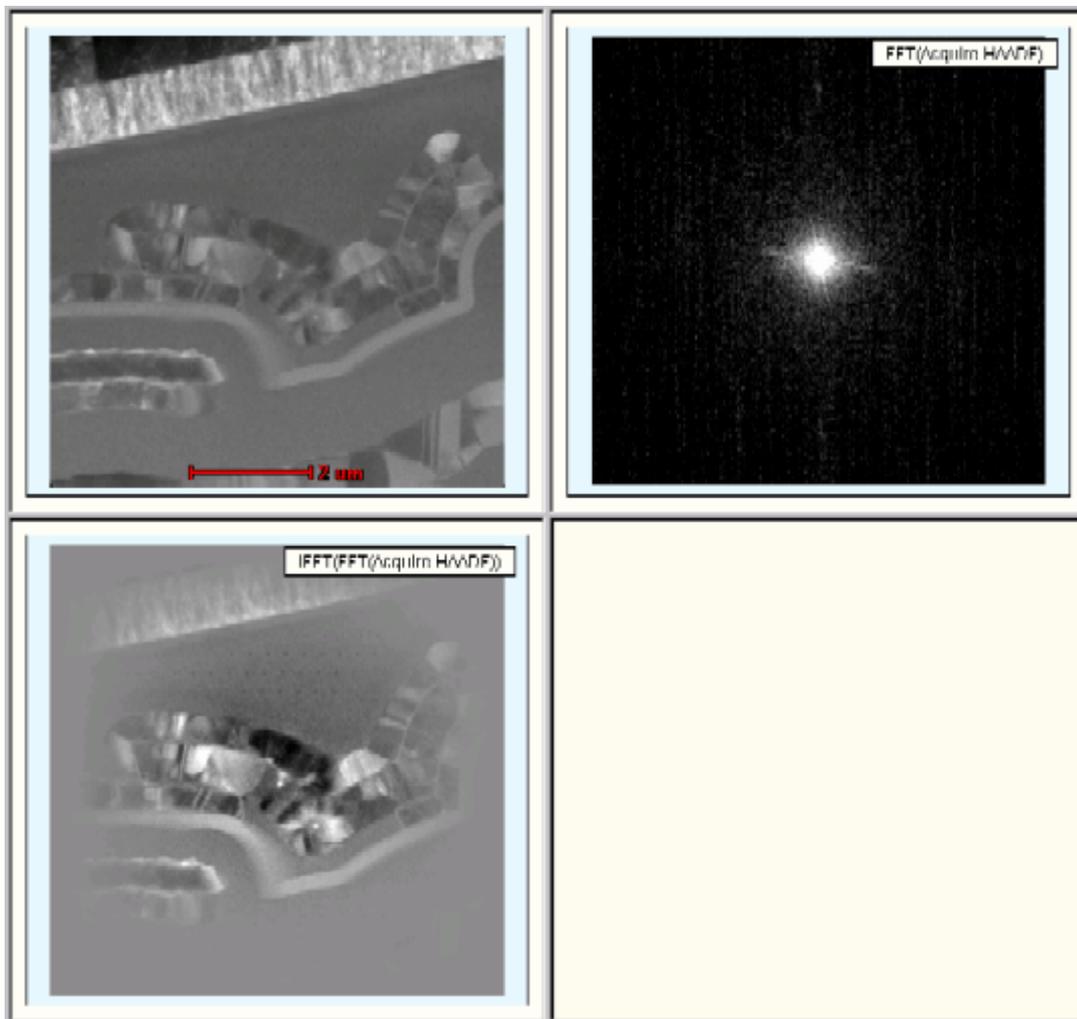
Top left: Original image

Top right: FFT of image

Bottom left: Inverse FFT of FFT

2.11.5.5   FFT/IFFT Processing Parameters
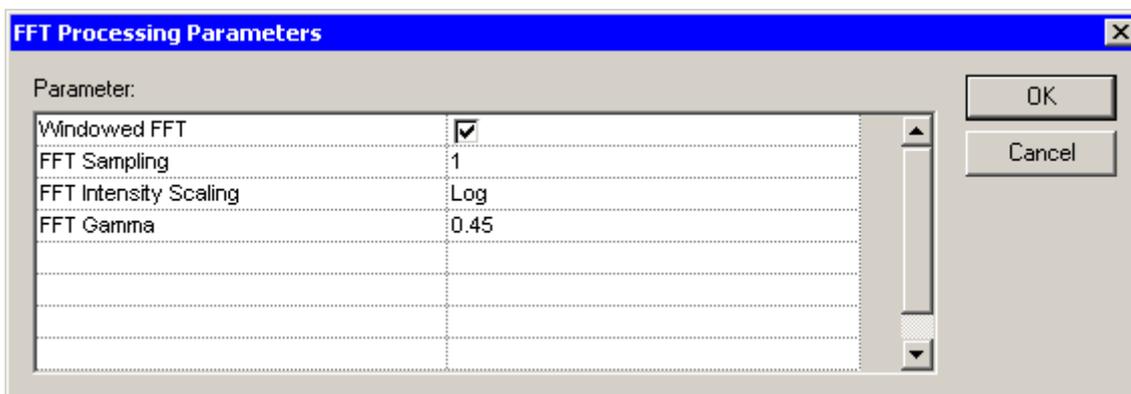
The FFT Processing Parameters dialog provides access to the Windowed FFT option (generally this should be on, otherwise the hard edges of the image may give artefacts in the FFT), the FFT sampling (a bit similar to binning; a sampling interval of 2, 4, 8, etc, results in an FFT sampling fewer pixels) and the intensity scaling of the FFT (generally log units gives the best results because of the large dynamic range in FFTs) and the gamma (the setting shown here is a good default value).

2.11.5.6   Mask / filter

This process tool provides a way to improve the image signal/noise ratio by filtering out the image noise in reciprocal space. This is a very useful procedure on any given HREM image or images containing periodic structures. A circular band filter will be used as an example in this instruction.

- Open or acquire a HREM image.
- Create the diffractogram (FFT).
- Apply Mask Filter processing on the FFT. A copy of the FFT will be generated.
- Place two circular markers on the FFT image using the Oval Marker Tool to mark the ROI (inner and outer boundaries) used for filtering. Use the marker properties dialogs to center the markers and make them circular (Center values to 0,0 and Size values equal).
- Right-click on the FFT image marked as Mask and select Edit Mask… from the pop-up menu, a Mask Properties dialog is displayed. Use it to control the mask filtering process.
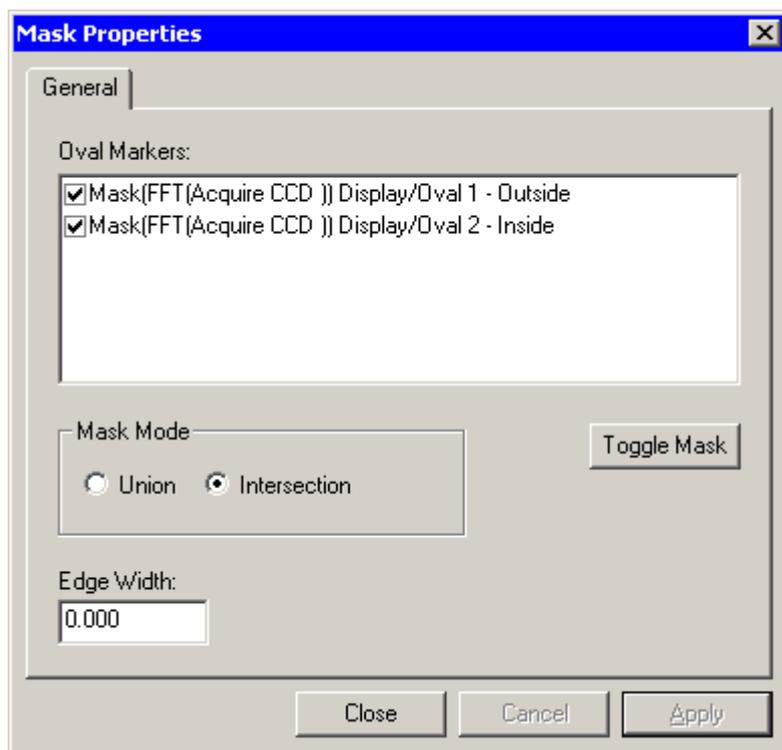
- Select/enable both markers to use for the filtering process.
- Change the Mask Mode from Union to Intersection.
- Single click on the first marker text to select it. If it is the smaller of the two, click Toggle Mask to toggle its masking area from inside changed to outside. Otherwise do this for the second marker. You check by pressing the Apply button whether the result is what you want.
- Click OK to apply the changes.

- Select filtered FFT image and apply the "IFFT " process tool to generate the filtered real space image which has a better signal-to-noise ratio than the original image.

Hint: You can change the mask markers and the mask as well and the IFFT will be updated automatically.
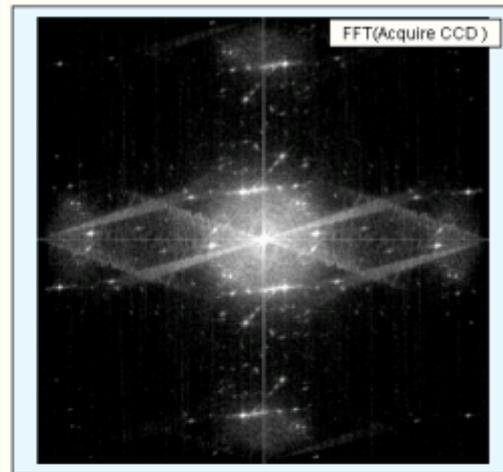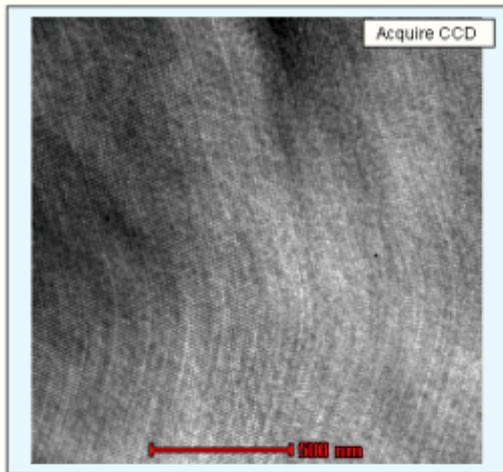
Top left: Original image

Top right: FFT

Bottom left: Masked FFT with markers and effect of masking

Bottom right: Inverse FFT of masked FFT
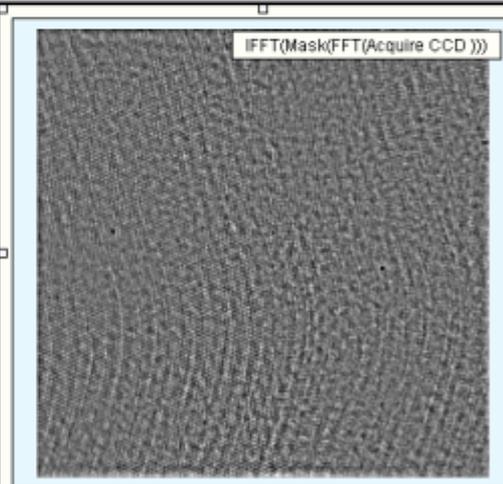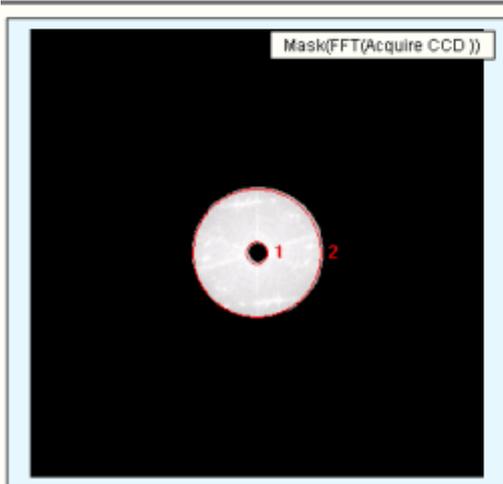
2.11.5.7   Autocorrelate

This process tool calculates the autocorrelation function of the image. In essence the autocorrelation shows how an image is similar to itself. If the image has repeating features as in the cross-grating (left-hand image shown below), you see the repeat pattern in the autocorrelation (right-hand image). Otherwise it can be used for example as a (rough) measure of the resolution of a CCD camera. If each pixel is totally independent of its neighbors, the autocorrelation of a noise image will be a spike. In practice there is a broader peak which reflects the fact that the CCD is only imperfectly able to resolve each incoming electron.
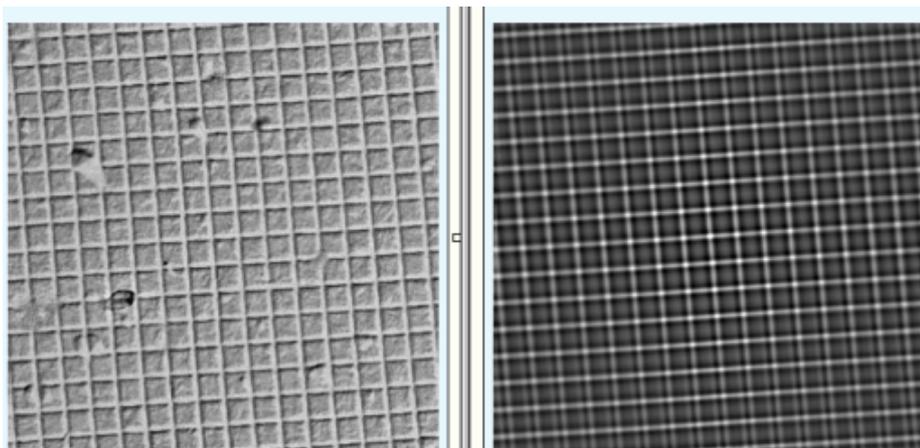
2.11.5.8   Cross-correlate

The cross-correlation requires two images in a single document. The cross-correlation is useful to determine shifts between images. When you use cross-correlate, the following dialog is displayed.
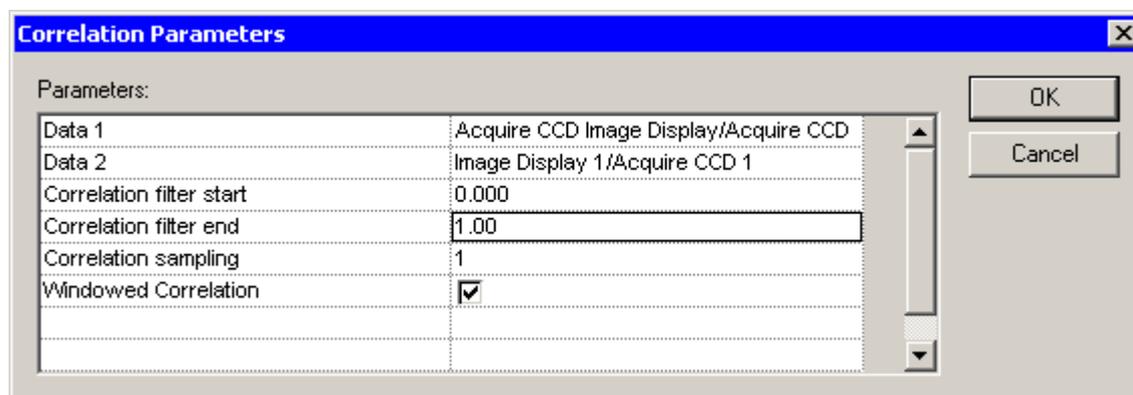
Select the two images required under Data 1 and Data 2.
The marker in the cross-correlation shown below has been placed at the maximum. The marker position demonstrates a shift of 94, -329 nanometers.
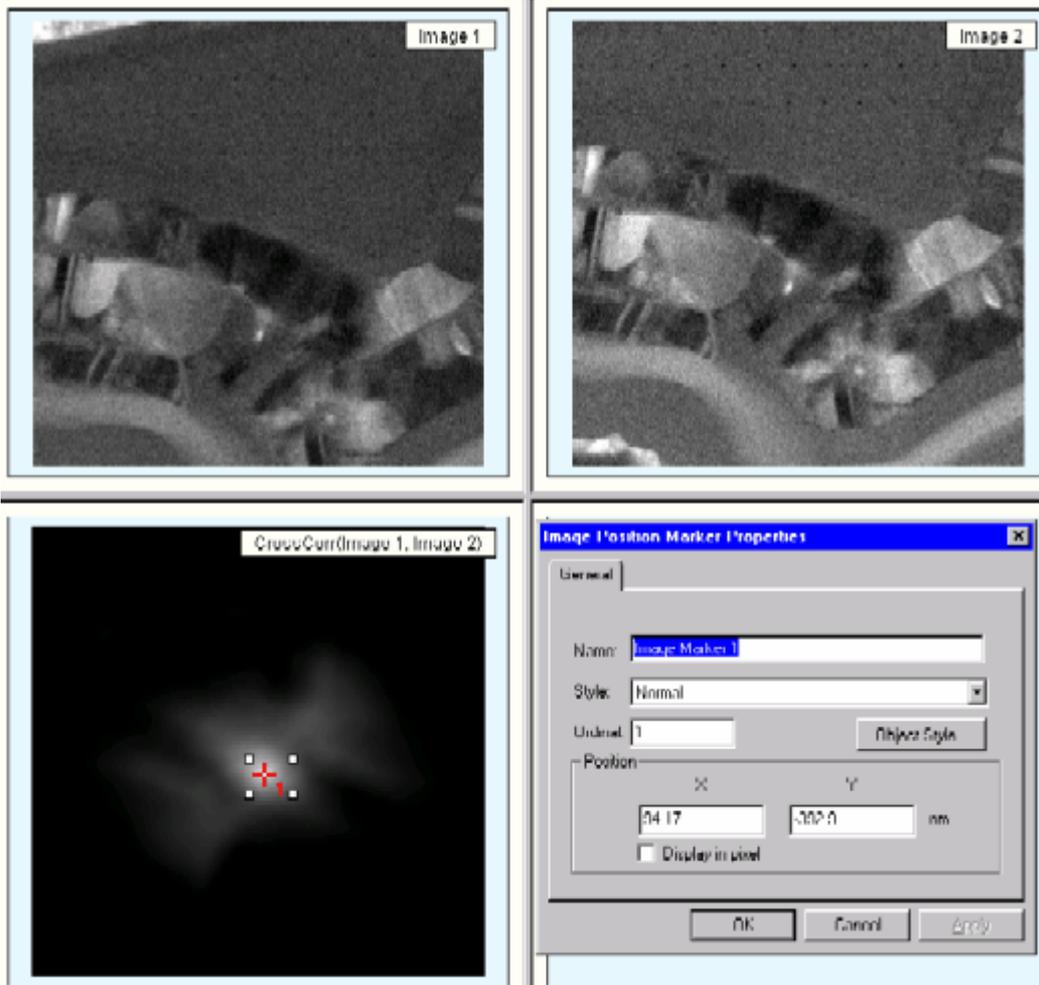
2.11.5.9   Correlation parameters
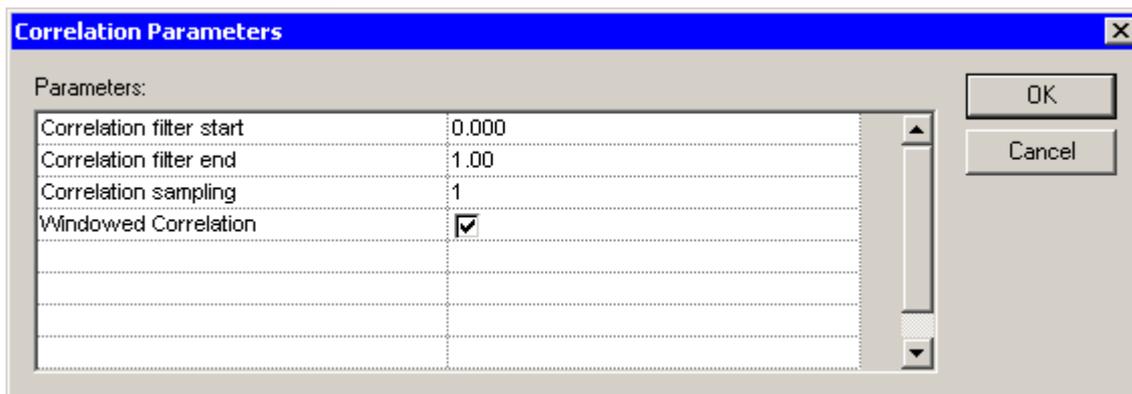
You can select filter parameters for the correlation. Be very careful with the filter start value, because an improper selection can cause severe ringing in the correlations. The sampling and windowing options are as for FFTs.

2.11.5.10   Image transformations

This processing tool provides a quick way to align the image to a certain orientation via flipping or rotation. Flipping provides a quick way to flip image vertically or horizontally, and rotation can rotate images at any given angle.

Acquire an Image, select Flip Horizontally ⚱ , Flip Vertically ◀ , or Rotate ↻ to process the image. To change the rotation parameters, right-click on the result image and select Edit transformation. There you will find a number of additional transformations such as rescale, resize and shear.

Transformation Properties

General

Transformation
- ○ Rescale
- ○ Resize
- ○ Flip with respect to axis
- ○ Flip with respect to center
- ● Rotate
- ○ Shear

Settings

Angle:

45.0   deg

[OK]   [Cancel]   [Apply]
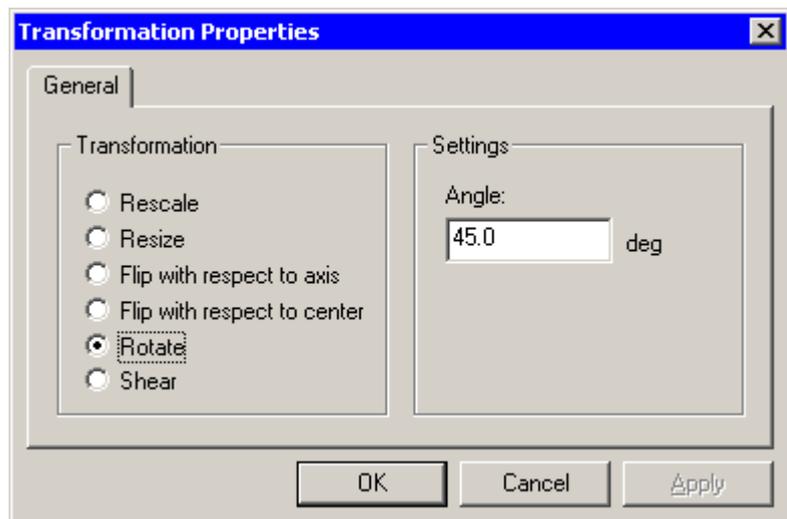
Note: Rotating images will generally increase the image size. The current default rotation is 45° so the rotated image becomes √2 larger than the original. If you change the transformation and change the angle e.g. to 90°, the image will revert back to its original size. But if you take a 45°-rotated image and rotate it again 45°, the new image will be double in size to the original image.

2.11.5.11   Simple math

This processing tool provides a quick way to add, subtract, multiply and divide either a (scalar) constant or data with an image. For processing two images mathematically, both images have to be in the same document. Here, a simple adding process will be used as an example.
- Open a file (or emi document) containing two images.
- Select Add and the Basic Math Parameters dialog will be opened.

Basic Math Parameters

Parameters:

Data 1	Acquire CCD Image Display/Acquire CCD
Operand 2 type	Scalar
Data 2	Acquire CCD Image Display/Acquire CCD
Scalar	5.00

[OK]   [Cancel]
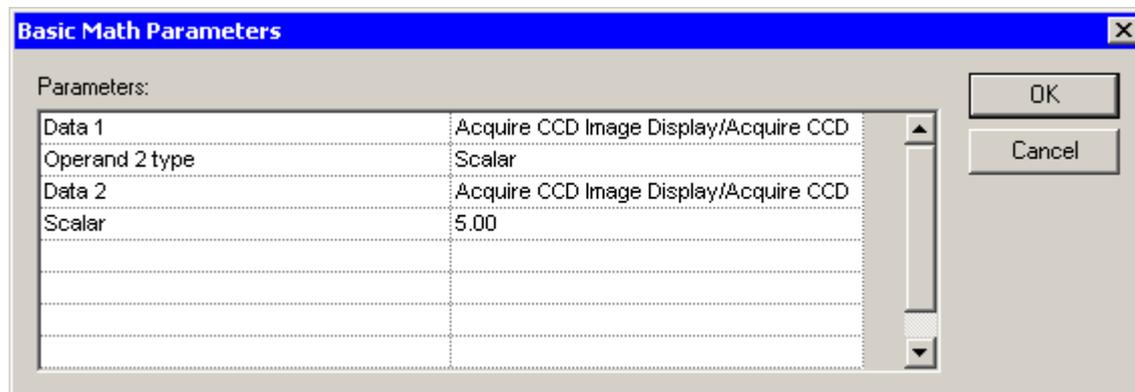
- To add two images, select image name 1 for the Data 1 drop-down list and image name 2 for the Data 2 list. Use Data as the Operand 2 Type to process the image.
- A processed image will be created.

Notes:
- When image data are used, make sure that the images have the same calibrations (which means they have been recorded at the same magnification). If the calibrations are not the same, TIA will adjust one of the images to make it match the other, which can lead to a lot of memory being required. To make calibrations equal, double-click on one of the images, inspect the calibrations. And copy those over to the other image.
- To subtract data from a scalar, first multiply the data by -1, then add the data and the scalar (necessary as the first element of the processing is always data).
- Through the toolbar and menu not all processing functions are directly available. By right-clicking the result of an existing processing function, you can select 'Edit unary math'. Now you can choose additional processing like cos, sin, tan, sqrt and more.

2.11.5.12   Correct Background

This tool allows the user to perform a background correction on an EDX or EELS spectrum using one or more user-defined energy windows. Follow these steps to correct background on a spectrum:
- Acquire a spectrum or open a file containing a spectrum.
- Click on the spectrum to select it and press the Correct Background button in the Data Processing toolbar.
- A new display will be added to the Display Window containing the spectrum with the option to perform background correction.
- Use the Energy Window tool to create one or more energy windows over an appropriate background region(s) of the spectrum.
- Right-click over the new spectrum and select Edit Background…. The Background Properties dialog will be shown:

Background Properties

General

Energy Windows:

☑ Background(Acquire EDX) Display/Energy Window 1
☑ Background(Acquire EDX) Display/Energy Window 2
☑ Background(Acquire EDX) Display/Energy Window 3

Model Order

● 1 ○ 2 ○ 3 ○ 4 ○ 5

Model Type

● Polynomial
○ Power Law

OK   Cancel   Apply
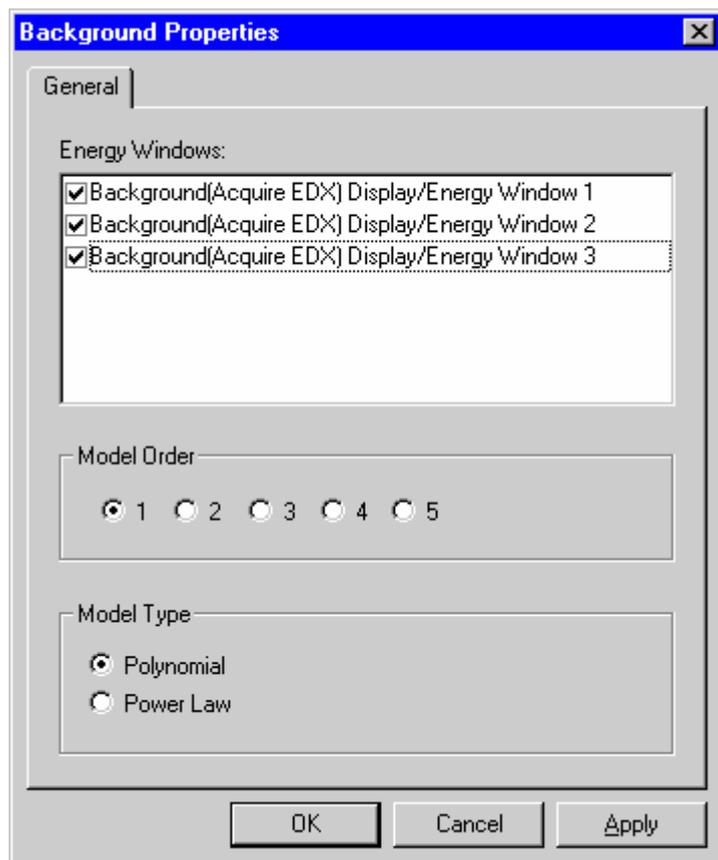
- Check the checkbox next to the desired energy window(s) in the list to be used for correction.
- Choose the Model Order and Model Type, then Press "OK" to apply the correction.

2.11.5.13 Rotational Average

The rotational average processing can be done on reciprocal-space images such as FFTs and diffraction patterns. However, because the function assumes the pattern to be centered properly, it will only work on diffraction patterns if the pattern is centered. FFTs are centered by default so there the function always works.

Rotational Averaging Parameters

Parameter:		
Rotational Averaging Sampling Method	Auto	
Rotational Averaging Step Size (Deg)	1.00	
Rotational Averaging Start Angle (Deg)	0.000	
Rotational Averaging Stop Angle (Deg)	180	

OK
Cancel
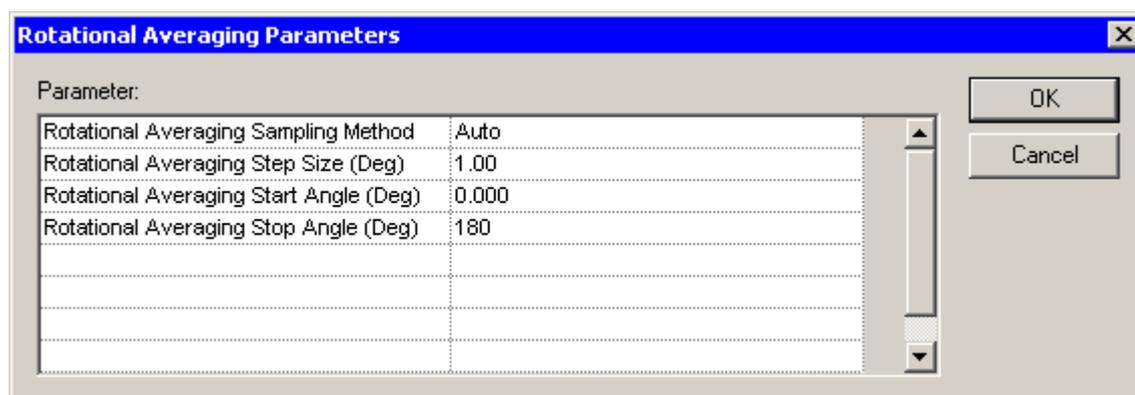
For the rotational average you can specify a step size in degrees, which is used if you use the Manual sampling method, and the start and ending angles. Typically the latter are 0 and 180° (there is no point in taking more than a total of 180° as the information in the FFT is identical when rotated 180°).
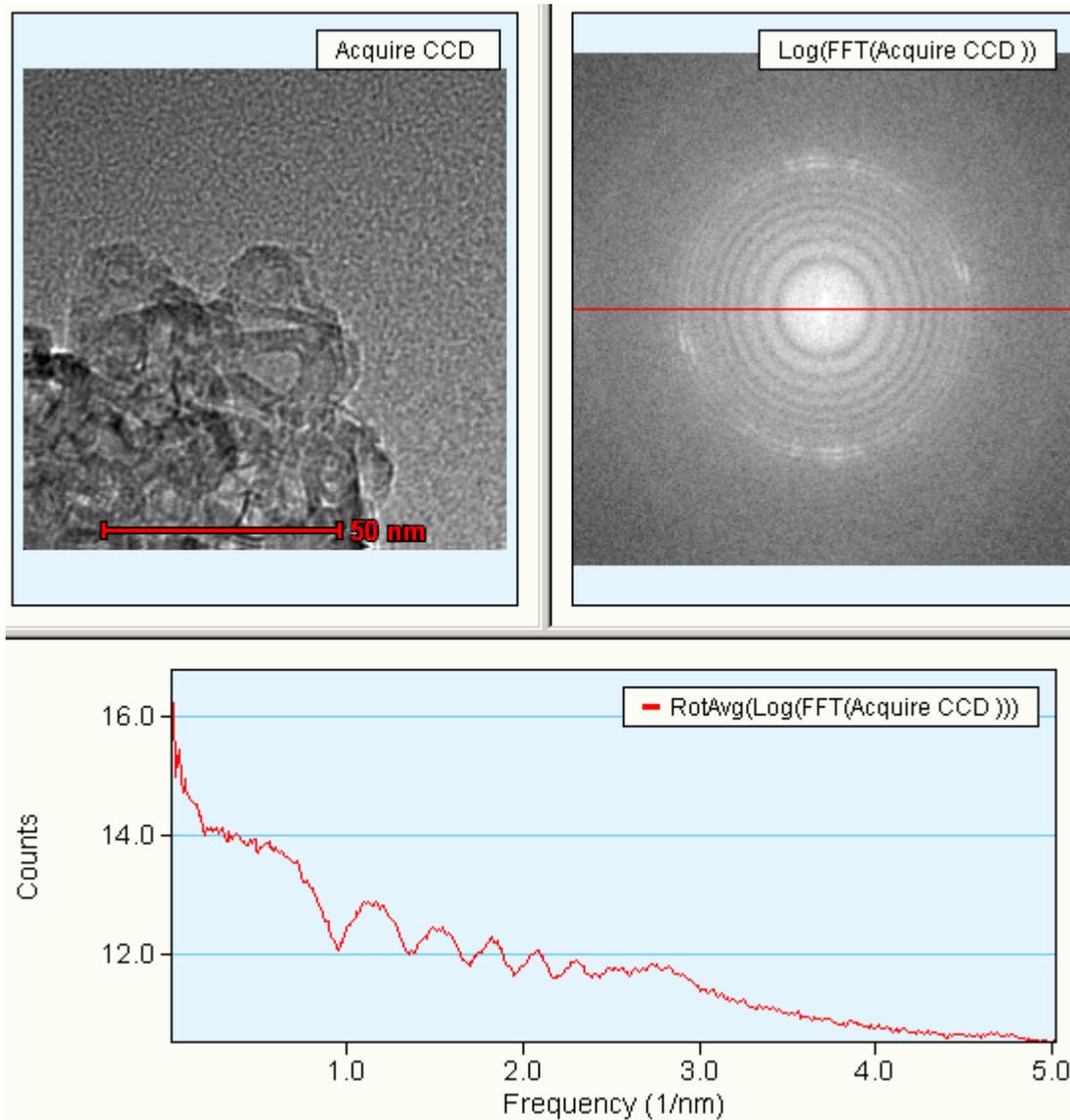
Example of the rotational average of the log of an FFT of an image. The rotational average has been done from 0 to 180°. The limits of the rotational average are shown by two red lines in the FFT (one at 0° from center to right, the other at 180° from center to left; in this case they appear to be a single line).

2.11.5.14 Data Processing Setup

Data processing setup produces a dialog with all processing parameters (Unary, FFT and Correlate).
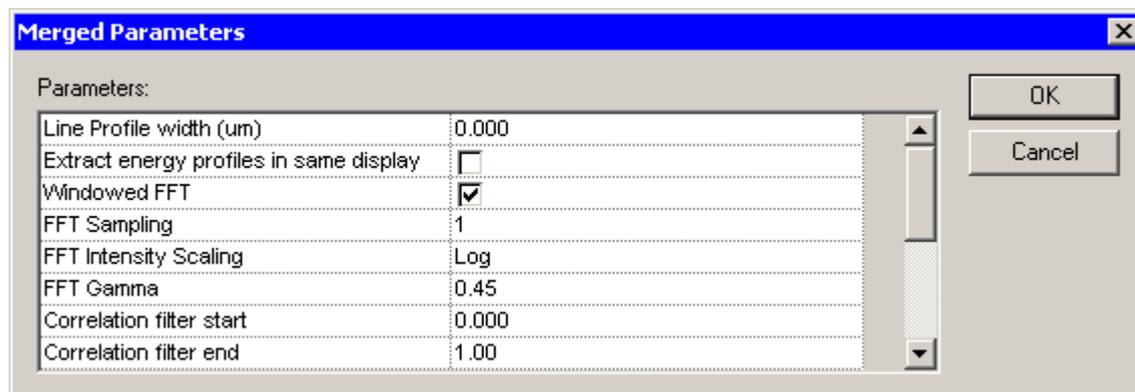
2.11.5.15 Export data series

Export data series exports 1-D series data (spectra and images) into various kinds of formats. Select the required display window and select Export series / Export. The following dialog will become visible:
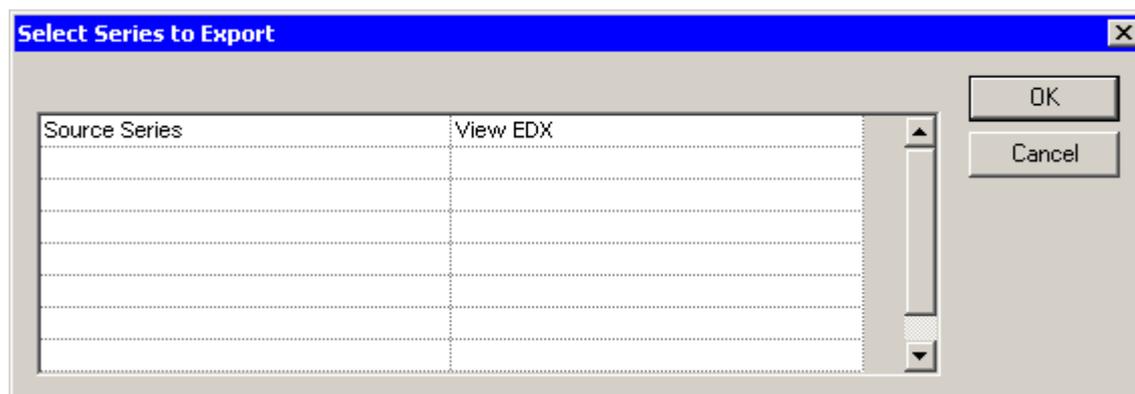
Select the data series to be exported. In the next dialog
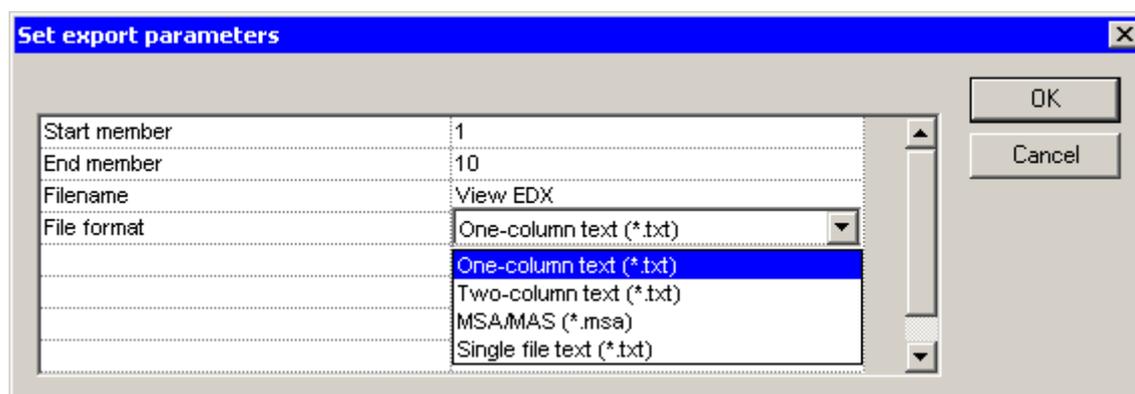
Set export parameters dialog for spectra.
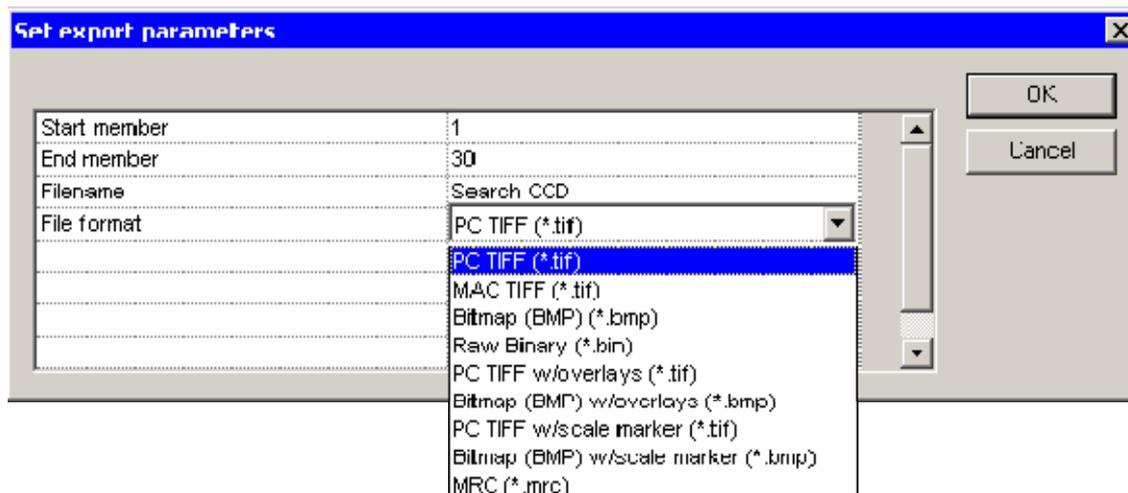
Set export parameters for images.

Start and End member define the start and end data from the series that will be exported. You can specify a filename and a file format. The data will be exported to the folder Exported Data as defined for the current user in the TIA Administrator.

2.11.6 Mini Spectroscopy Toolbar

	▣	Vertical AutoScale	Autoscale currently selected spectrum vertically. The button has two states, "depressed" and not "depressed". When "depressed" the data are automatically rescaled as necessary (e.g. after a new acquisition has finished). When not "depressed", the data scaling is not changed automatically.
			When you change scale manually, the AutoScale is automatically switched off.
	▦	Periodic Table	Display the Periodic Table.
	▥	KLM Setup	Not covered in this help file. See the Analysis mode help file (see section 2.1).
	⁙	KLM Labels	Not covered in this help file. See the Analysis mode help file (see section 2.1).
	⬇	Clear All	Not covered in this help file. See the Analysis mode help file (see section 2.1).
	⬜	Energy Window Tool	The energy window tool can be inserted in spectra to define a range in the spectrum. For more information, see section 2.11.6.2.
	⬛	Calibration Shift Tool	The calibration shift tool can be used for calibration of spectra. For more information, see section 2.11.6.3.
	⬜	Marker Tool	The marker tool can be inserted in profiles and spectra to mark a position. For more information, see section 2.11.6.1.

2.11.6.1   Marker tool

The marker tool ⬚ can be used to draw a vertical marker in a spectrum or profile display. Its properties (accessed by double-clicking on the marker or clicking with the right-hand mouse button on a marker and selecting Properties in the popup menu) include a name, a style (color for this type of marker; users can define different styles for the various display elements, see under the menu Edit., Styles ... in analysis mode), ordinal number and position.

To insert a marker in a profile or spectrum display, click on the marker tool button ⬚ . Click in the display and a marker will be inserted. The marker can be moved by clicking on it and dragging it sideways.

Examples:
- **Displaying the profile position in the image:** Create a line profile (e.g. an intensity profile, see under line marker tool above) from an image. Insert a marker in the profile. Keep the Alt key on the keyboard pressed, click on the marker in the profile and drag to the line in the image. The cursor will have changed to one with a 'shortcut' arrow in it. Release the mouse button. In the image the line now has a small square marker on it. When you move the marker in the profile to select another position there, the small square on the line will move to the corresponding position along the line in the image. Something similar can be done with spectrum positions of a spectrum line profile but in this case you must link an image position marker to the spectrum and the profile marker to the spectrum. The three (image position marker, profile marker and spectrum displayed) are now linked.
- **Extracting numerical data from an energy window:** Inspect the Annotation Info Control Panel.
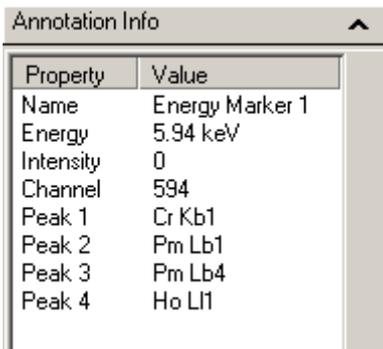
Property	Value
Name	Energy Marker 1
Energy	5.94 keV
Intensity	0
Channel	594
Peak 1	Cr Kb1
Peak 2	Pm Lb1
Peak 3	Pm Lb4
Peak 4	Ho Ll1

Annotation info for a spectrum energy marker includes element identification information.

2.11.6.2   Energy window tool

The energy window tool ⬚ can be used to draw an energy window in a spectrum display. Energy-window properties (accessed by double-clicking on the marker or clicking with the right-hand mouse button on a line and selecting Properties in the popup menu) include a name, a style (window-fill spectrum-fill and border color for this type of marker; users can define different styles for the various display elements, see under the menu Edit., Styles ... in analysis mode), ordinal number and start and end energy.

To insert an energy window, click on the energy window tool button ⬚. Click in the spectrum on one side of the desired position of the window and drag to the other side. Energy windows can be changed in width (click on one of the borders of the window and drag it sideways) and moved sideways (click inside the window and drag it. Settings of the window can also be defined by double-clicking on the window and entering the required numerical values.

Examples:

- **Extracting numerical data from an energy window:** Inspect the Annotation Info Control Panel, values are listed there.

Annotation info for an energy window marker.

- **Processing spectrum profile or spectrum image data:** Acquire a spectrum profile (see above under line marker, section 2.11.3.4) or spectrum image (see above under image selection marker, section 2.11.3.5). Insert an energy window around a peak of interest. Click on the energy window and select Extract Map/Profile from the Processing functions menu.
  Note: Line profiles can be combined into a single display if the Unary Processing Parameter Extract energy profiles in same display is checked.
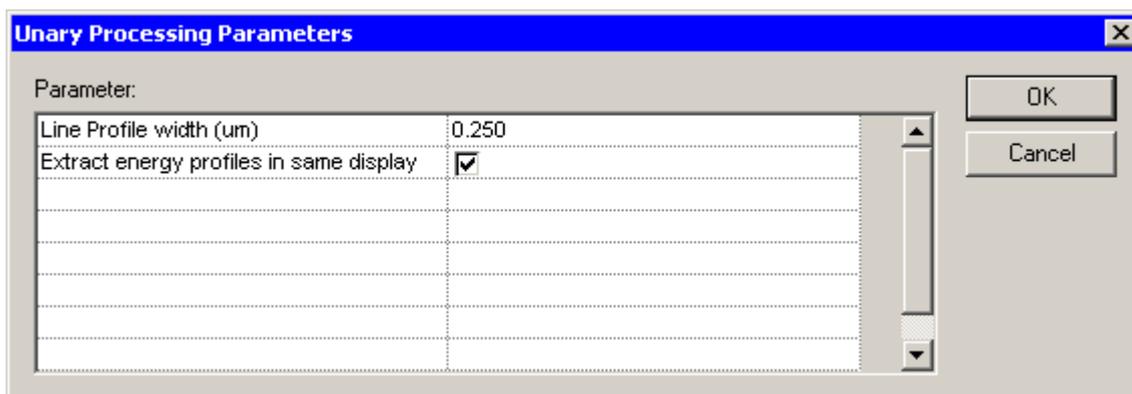
2.11.6.3   Calibration shift tool

The calibration shift tool can be used for calibrating spectra. Since EDX spectra should remain close to properly calibrated at all times, this tool applies mainly to PEELS spectra where the spectrum offset can vary from microscope session to session or even within a session, dependent on PEELS hardware settings. For quickly calibrating the PEELS spectrum, select the Calibration shift tool. Click on the spectrum on a peak (edge) with known energy, and drag it to the correct energy in the spectrum display. The entire spectrum shifts while the energy axis remains fixed.
Use the Offset button in the PEELS Control Panel of the TEM User Interface to apply the calibration to new acquisitions.

3   CCD / TV (Titan UI Control Panel)
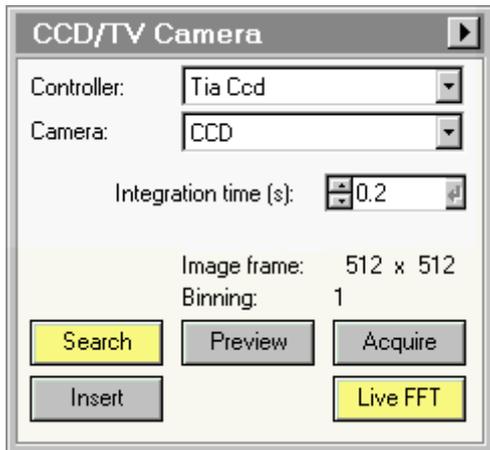
The CCD / TV Camera Control Panel.

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.
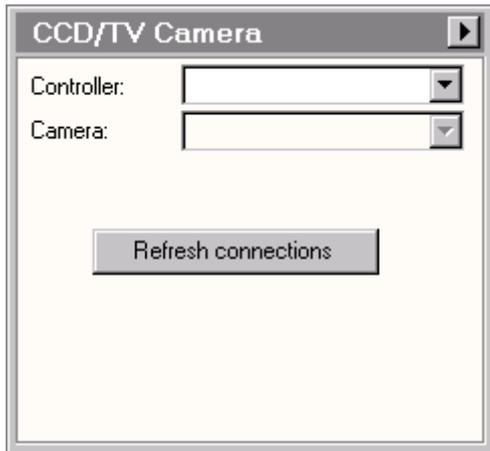
Notes:
- If no controller is visible or the required CCD camera is missing in the list (while the CCD Camera Server given should be the controller to be used), you may need to reconnect to the driver. Click on the control panel with the right-hand mouse button and a popup menu with a single line 'Refresh 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.

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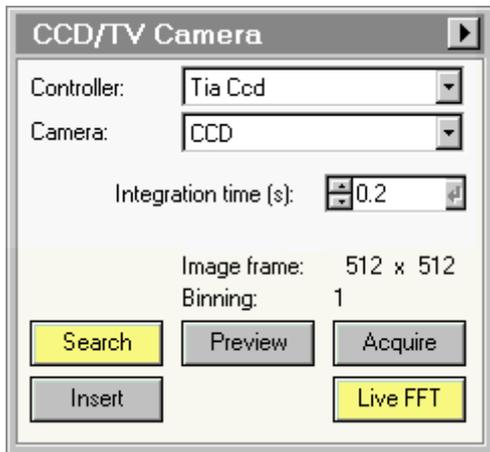
For TIA CCD the CCD / TV Camera Control Panel has one special function in the case of an Eagle CCD camera. If the connection to the camera is lost, a red button "Online", located above the Search button will become visible. Press the OnLine button to attempt to restore the connection to the camera.

3.2   CCD / TV Camera Settings
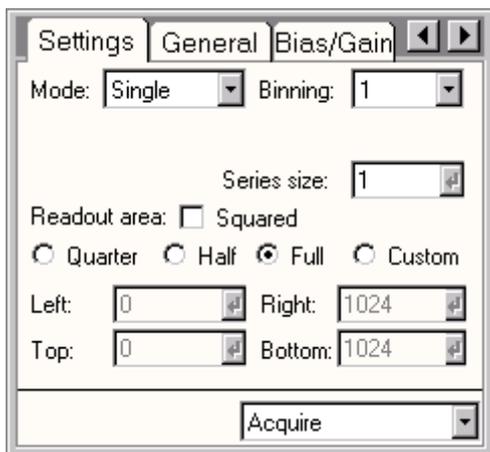
The CCD / TV Camera Settings Control Panel.

In the CCD / TV Camera Settings Control Panel the CCD/TV camera acquisition parameters are defined.

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 that 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.

3.3   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

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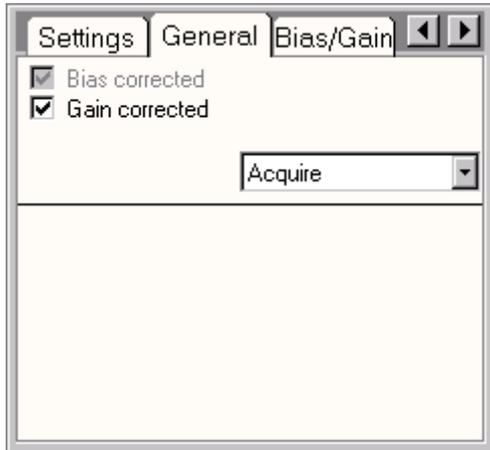
The CCD / TV Camera General Control Panel for TIA CCD.

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.

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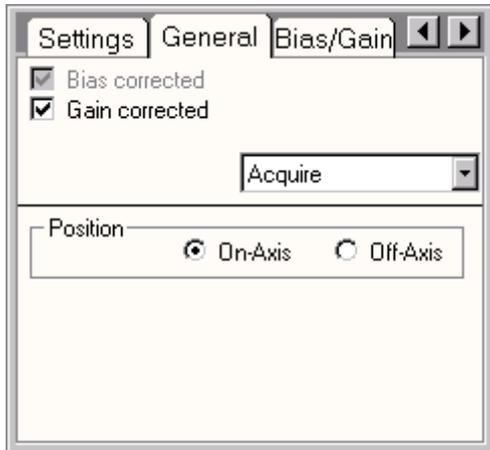
The CCD / TV Camera General Control Panel for TIA Video.

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.

3.4   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

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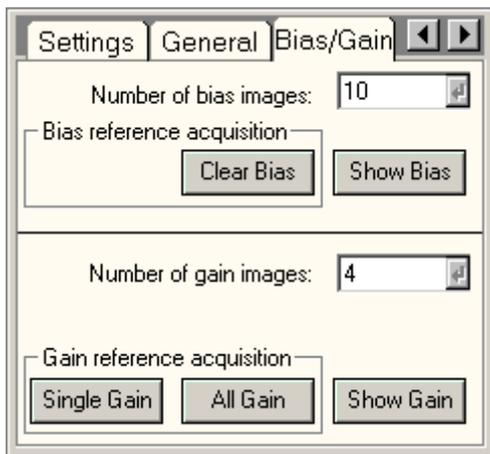
The CCD / TV Camera Bias/Gain Control Panel for TIA CCD.

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).
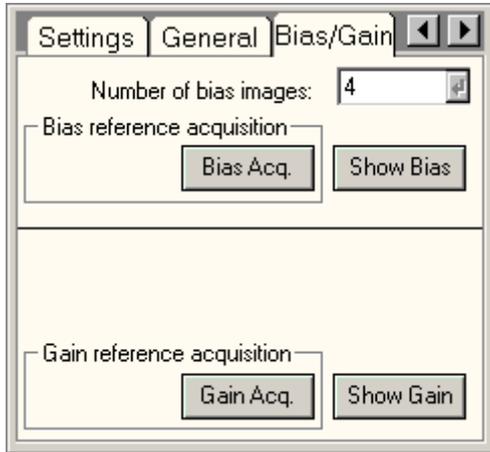
3.4.2   TIA Video

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).

3.5   CCD / TV Camera Shutter
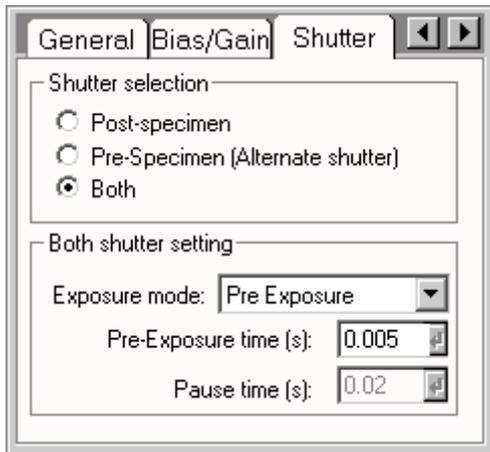
The CCD / TV Camera Shutter Control Panel.

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.

3.5.1   DigitalMicrograph CCD (also TIA CCD using Gatan CCDs)
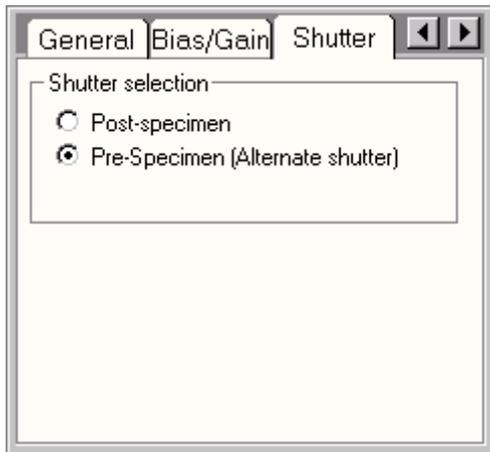
Note on the use of shutters through DigitalMicrograph
DigitalMicrograph can use one of two shutters for the acquisition of images on the CCD. The standard (post-specimen) shutter is generally the same one as used by the microscope plate camera that is located in the projection system of the microscope (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.

3.5.2   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.

4   TIA CCD image acquisition

4.1   CCD Image

CCD acquisition in TIA is controlled through the CCD/TV Camera Control Panel of the TEM User Interface.

Note: With Reuse Display Window active (see section 2.4.2), all three acquisition modes (Search, Preview, Acquire) write their images into the same display, so after an image has been acquired, the data must be saved before restarting acquisition, otherwise the image acquired will be overwritten. To save the current image, you can also split the pane and copy the current image to the new, empty pane. You can also change the name of the display (not the image itself) and TIA will create a new display for continued acquisition.
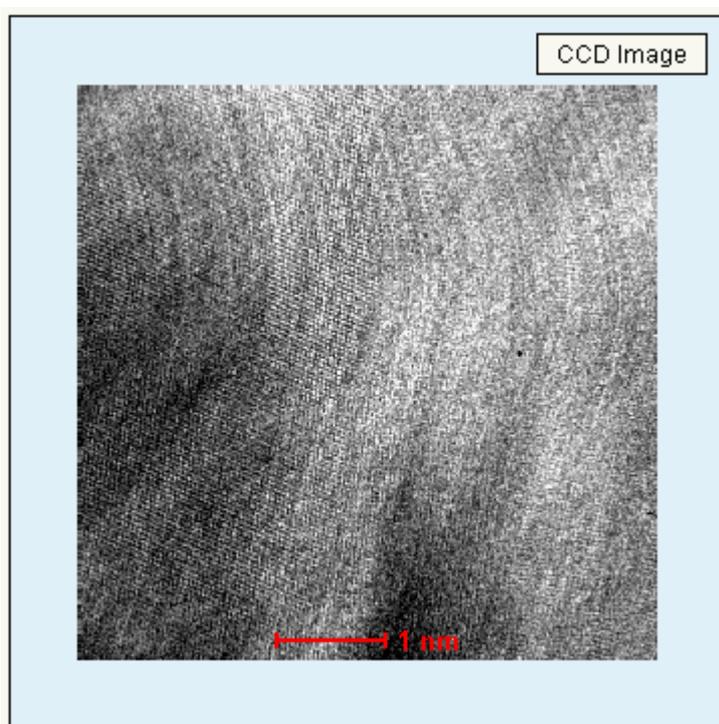
CCD image display. At bottom center a scale bar is shown (in red).

4.2   Calibration of TEM images

Note: For best results and easy calibration of CCD images and camera lengths, use the Magnification Calibration accessory (if available).

Image dimensions are in real units (μm, nm, etc.). The accuracy of these units depends on two factors, the magnification on the microscope and the image calibration in TIA. The latter can only be set by TIA administrators (these settings then become system-wide and are used by all users). If several calibrations exist, recorded at different magnifications, TIA will automatically use the value from the calibration magnification that is closest to the magnification currently on the microscope. For CCD or Video imaging, it may be desirable to calibrate each TEM magnification separately (because there is no fixed pattern to any deviation between the true magnification and displayed magnification when going through the TEM magnifications). Images can also be calibrated by users after acquisition (provided the image contains features that allow calibration).

To calibrate an image, insert a line marker in the image, selected via the line marker tool button . For calibration using two directions, insert another line at approximately 90 (in this case the lines should be approximately horizontal and vertical; calibration with one line at +45 and the other at -45 doesn't work properly). Click on the image with the right-hand mouse button and select Properties in the popup menu. Select the Calibration tab. Click on the Scale... button.

The Scale dialog with calibration data using one line.

In the dialog that is shown, select the line in the Line 1 drop-down list box and enter its length to the right of it. If there are two lines, select the other line in the Line 2 drop-down list box and enter its length. For one line, click on the Keep square checkbox. Click OK on all dialogs. The image is now calibrated.

Note: Never use calibration using two directions as this will result in different pixel dimensions for x and y and some software may not be able to handle that.
To make the calibration done a system calibration (functionality accessible to TIA administrators only), switch to analysis mode. From the menu select Acquire, Settings, CCD. In the More CCD dialog, select the Magnifications tab.
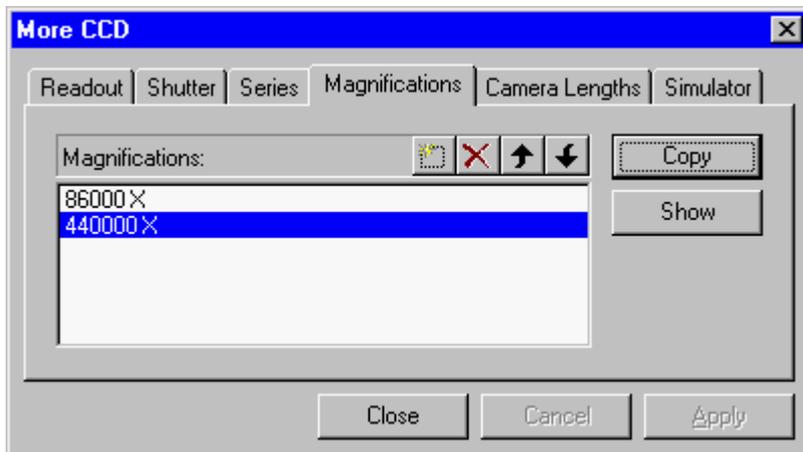
The Magnifications tab of the More CCD dialog.

If the TEM magnification used for recording the image is already listed, click on the magnification in the list (it becomes highlighted) and press the Copy button. If the TEM magnification is not yet in the list, click on the New (Insert) button . TIA will create a new item in the list and put the cursor at the front of the line. Enter the numerical value of the TEM magnification (you do not have to enter the X) and press the Enter key on the keyboard. The value listed will be put into proper format (including the X). Click on the new value in the list (it becomes highlighted). Press the Copy button to insert the values in the calibration for the magnification. After the Copy button has been pressed the values used will be displayed.

Note: Even if the CCD camera is a wide-angle CCD (located above the viewing screen), the magnification set in TIA should always be the value with the screen up.

5   TIA Video image acquisition

5.1   Video Image

Video acquisition in TIA is controlled through the CCD/TV Camera Control Panel of the TEM User Interface. In Video acquisition TIA will display a single image display.

Note: With Reuse Display Window active (see section 2.4.2), all three acquisition modes (Search, Preview, Acquire) write their images into the same display, so after an image has been acquired, the data must be saved before restarting acquisition, otherwise the image acquired will be overwritten. To save the current image, you can also split the pane and copy the current image to the new, empty pane. You can also change the name of the display (not the image itself) and TIA will create a new display for continued acquisition.
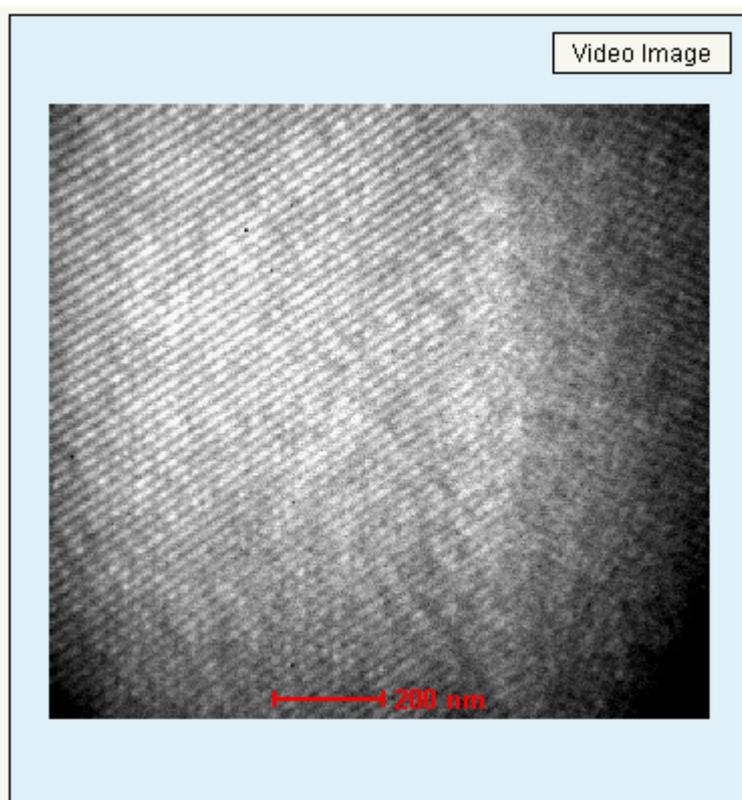
Video image display. At bottom center a scale bar is shown (in red).

5.2   Calibration of TEM images

Image dimensions are in real units (μm, nm, etc.). The accuracy of these units depends on two factors, the magnification on the microscope and the image calibration in TIA. The latter can only be set by TIA administrators (these settings then become system-wide and are used by all users). If several calibrations exist, recorded at different magnifications, TIA will automatically use the value from the calibration magnification that is closest to the magnification currently on the microscope. For CCD or Video imaging, it may be desirable to calibrate each TEM magnification separately (because there is no fixed pattern to any deviation between the true magnification and displayed magnification when going through the TEM magnifications). Images can also be calibrated by users after acquisition (provided the image contains features that allow calibration).

To calibrate an image, insert a line marker in the image, selected via the line marker tool button . For calibration using two directions, insert another line at approximately 90 (in this case the lines should be approximately horizontal and vertical; calibration with one line at +45 and the other at -45 doesn't work properly). Because the scan directions of the TV tube can be adjusted separately, it is advised to calibrate video images always with two lines. Click on the image with the right-hand mouse button and select Properties in the popup menu. Select the Calibration tab. Click on the Scale... button.
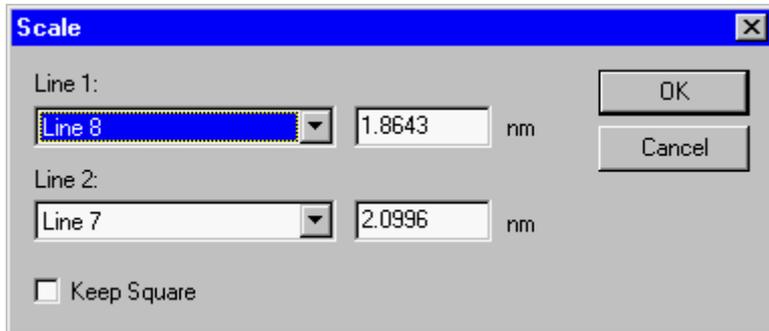
The Scale dialog with calibration data using two lines.

In the dialog that is shown, select the line in the Line 1 drop-down list box and enter its length to the right of it. If there are two lines, select the other line in the Line 2 drop-down list box and enter its length. For one line, click on the Keep square checkbox. Click OK on all dialogs. The image is now calibrated.

To make the calibration done a system calibration (functionality accessible to TIA administrators only), switch to analysis mode. From the menu select Acquire, Settings, Video. In the More Video dialog, select the Magnifications tab.
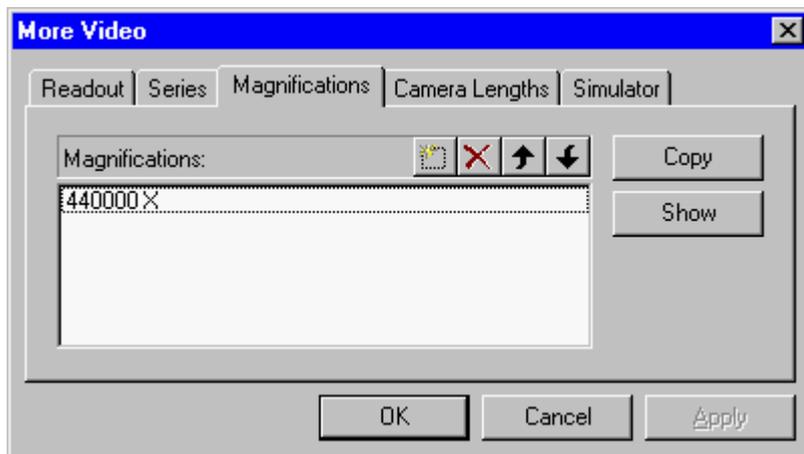
The Magnifications tab of the More Video dialog.

If the TEM magnification used for recording the image is already listed, click on the magnification in the list (it becomes highlighted) and press the Copy button. If the TEM magnification is not yet in the list, click on the New (Insert) button . TIA will create a new item in the list and put the cursor at the front of the line. Enter the numerical value of the TEM magnification (you do not have to enter the X) and press the Enter key on the keyboard. The value listed will be put into proper format (including the X). Click on the new value in the list (it becomes highlighted). Press the Copy button to insert the values in the calibration for the magnification. After the Copy button has been pressed the values used will be displayed.

If you cannot move the last entry of magnification up, add a dummy entry and move it to the end. Now you can move up the entry that you wanted. Afterwards remove the dummy.

6   STEM Imaging (Expert) (Titan UI Control Panel)
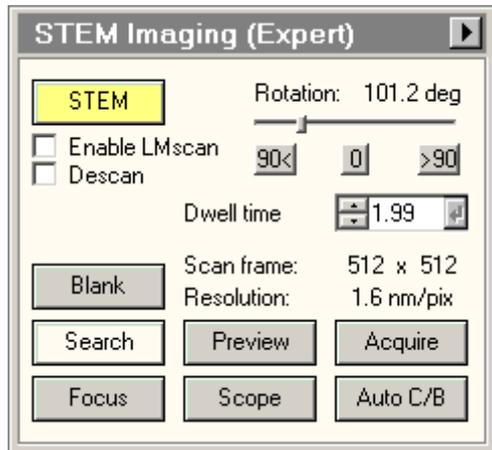
The STEM Imaging Control Panel.

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.

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.
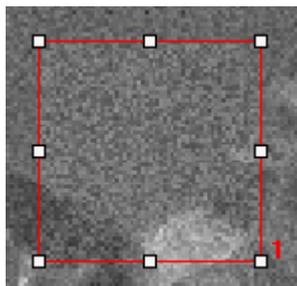
The Focus window with handles to change its position or size.

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.

6.1   STEM Imaging Focus (Expert)
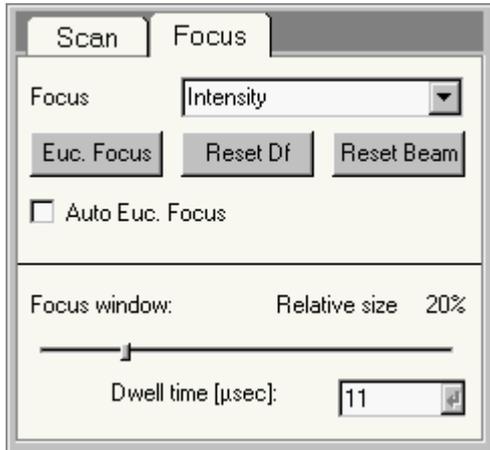
The STEM Imaging Focus Control Panel.

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.

6.2   STEM Imaging Scan (Expert)
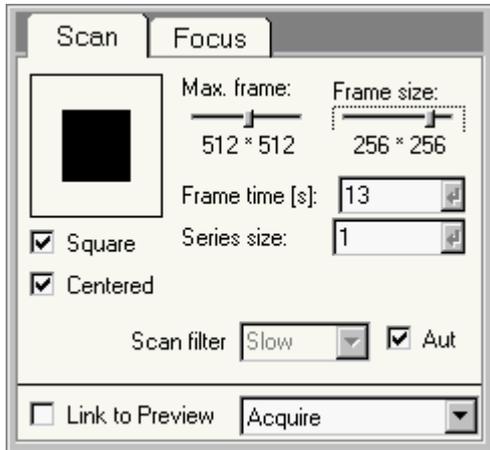
The STEM Imaging Scan Control Panel.

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.
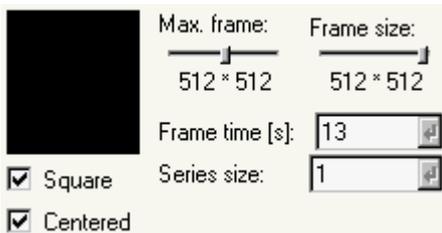
When the Max. frame and Frame size are equal, the scan frame fills the full frame.
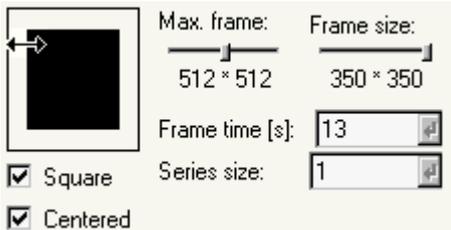
Move the cursor to the edge of the scan frame. It will change to a Resize cursor (horizontal, vertical or diagonal, depending on the cursor position relative to the frame). Click with the left-hand mouse button and drag to change the size of the scan frame.
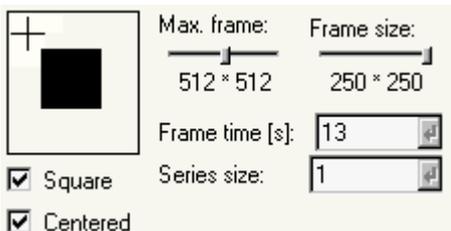
If the scan frame is smaller than the full frame, the cursor will change to the Precision select cursor inside the full frame but outside the scan frame. Click with the left-hand mouse button and the frame size will 'jump' to the cursor positions. Drag to adjust the scan frame.
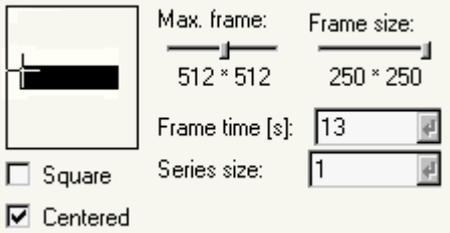
If square is not checked, the cursor position inside the full frame will determine the scan frame dimensions in x and y as well.
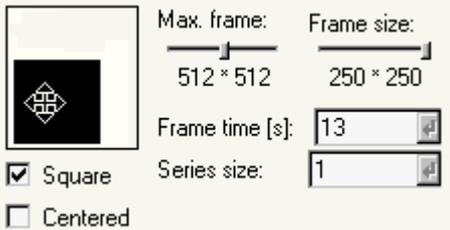
When centered is not checked, the cursor will change to to the Move cursor when it is inside the black rectangle representing the scan frame. Click with the left-hand mouse button on the frame and drag it to any position within the full frame.

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.

7   TIA STEM image acquisition

7.1   STEM Image

STEM acquisition in TIA is controlled through the STEM Imaging and STEM Detector Control Panels of the TEM User Interface. In STEM acquisition TIA will display one or more image displays, dependent on the detector choice.

Note: With Reuse Display Window (see section 2.4.2) active, all three acquisition modes (Search, Preview, Acquire) write their images into the same display, so after an image has been acquired, the data must be saved before restarting acquisition, otherwise the image acquired will be overwritten. To save the current image, you can also split the pane and copy the current image to the new, empty pane. You can also change the name of the display (not the image itself) and TIA will create a new display for continued acquisition.

STEM image display. At top right is displayed the detector with which the image was collected. At bottom center a scale bar is shown (in red).

Each image is properly labeled with the name of the detector. Examples:
- One detector (BF) is chosen, no displays are present yet. Acquisition of an image creates a new display, labeled Bright Field, with the STEM image in it.
- Two detectors (BF and DF) are chosen, no displays are present yet. Acquisition of the images creates two new displays, labeled Bright Field and Dark Field, with the STEM images in them.
- One detector (DF) is chosen, a BF image is already present. Acquisition of an image creates a second, new display, labeled Dark Field, with the STEM image in it.
- The maximum number of image displays created automatically is thus limited by the number of detectors on the microscope (but if you rename one of the existing displays, a new one will be created when image acquisition is repeated).

7.2   Scope signal

In addition to image displays, the videoscope signal can be displayed. There are three possibilities for obtaining a scope profile (to obtain the scope display, press the Scope button in the STEM Imaging Control Panel):

1. If image acquisition is active, the scope profile (a videoscope signal - a display of image intensity along a line) follows the current scan line in the image. To obtain the scope display, press the Scope button in the STEM Imaging Control Panel.
2. If image acquisition is not active and no line marker has been selected, the scope profile is along a horizontal line in the center of the image.
3. If image acquisition is not active and a line marker has been selected, the scope profile is along the line selected (which can be anywhere and in any orientation in the image).
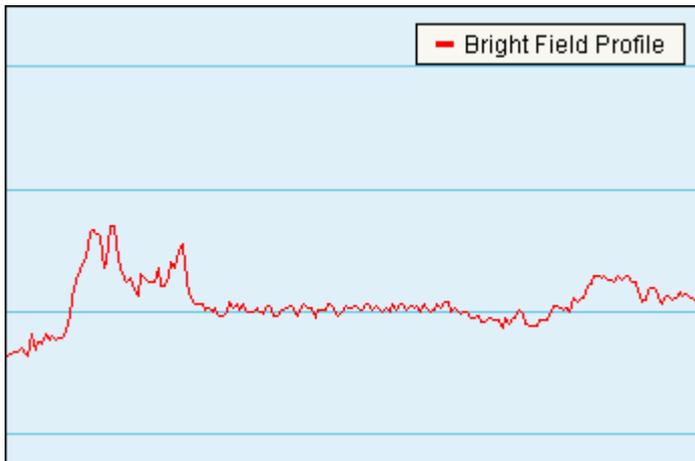
A scope display. The signal from the (BF) detector is displayed with high intensity (white) at the top and low intensity (black at the bottom). The vertical scale covers the full range of the possible detector signal (0-64000).

7.3   Calibration of STEM images

Note: For best results and easy calibration of STEM images and camera lengths, use the Magnification Calibration accessory (if available).

Image dimensions are in real units (μm, nm, etc.). The accuracy of these units depends on two factors, the magnification on the microscope and the image calibration in TIA. The latter can only be set by TIA administrators (these settings then become system-wide and are used by all users). If several calibrations exist, recorded at different magnifications, TIA will automatically use the value from the calibration magnification that is closest to the magnification currently on the microscope. For STEM imaging three or four calibrations spanning the whole magnification range will generally be sufficient (the change between different scan magnifications is quite accurate). Images can also be calibrated by users after acquisition (provided the image contains features that allow calibration).

To calibrate an image, insert a line marker in the image, selected via the line marker tool button . For calibration using two directions, insert another line at approximately 90 (in this case the lines should be approximately horizontal and vertical; calibration with one line at +45 and the other at -45 doesn't work properly). Click on the image with the right-hand mouse button and select Properties in the popup menu. Select the Calibration tab. Click on the Scale... button.

The Scale dialog with calibration data using one line.

In the dialog that is shown, select the line in the Line 1 drop-down list box and enter its length to the right of it. If there are two lines, select the other line in the Line 2 drop-down list box and enter its length. For one line, click on the Keep square checkbox. Click OK on all dialogs. The image is now calibrated.

Note: Never use calibration using two directions as this will result in different pixel dimensions for x and y and some software may not be able to handle that.
To make the calibration done a system calibration (functionality accessible to TIA administrators only), switch to analysis mode. From the menu select Acquire, Settings, Scanning. In the More Scanning dialog, select the Magnifications tab.
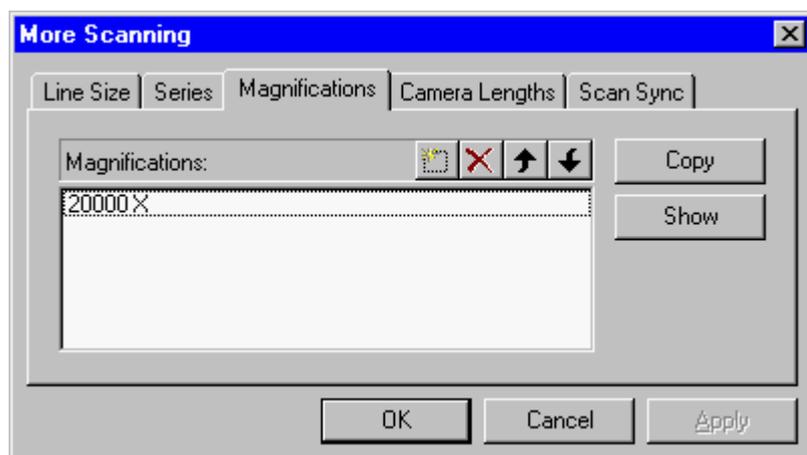
The Magnifications tab of the More Scanning dialog.

If the STEM magnification used for recording the image is already listed, click on the magnification in the list (it becomes highlighted) and press the Copy button. If the STEM magnification is not yet in the list, click on the New (Insert) button ⬚ . TIA will create a new item in the list and put the cursor at the front of the line. Enter the numerical value of the STEM magnification (you do not have to enter the X) and press the Enter key on the keyboard. The value listed will be put into proper format (including the X). Click on the new value in the list (it becomes highlighted). Press the Copy button to insert the values in the calibration for the magnification. After the Copy button has been pressed the values used will be displayed.

If you cannot move the last entry of magnification up, add a dummy entry and move it to the end. Now you can move up the entry that you wanted. Afterwards remove the dummy.

8 EDX (Titan UI Control Panel)
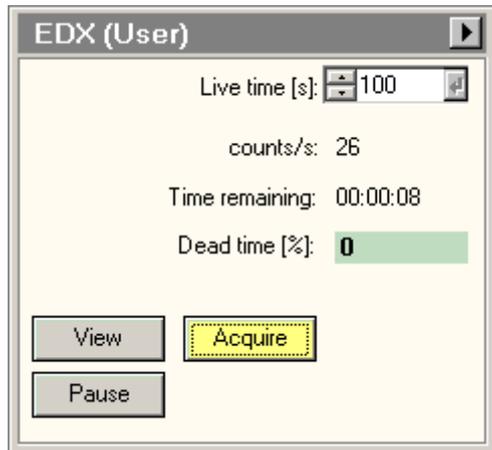
The EDX Control Panel.

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

Preset time
The Preset 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.

8.1   EDX settings
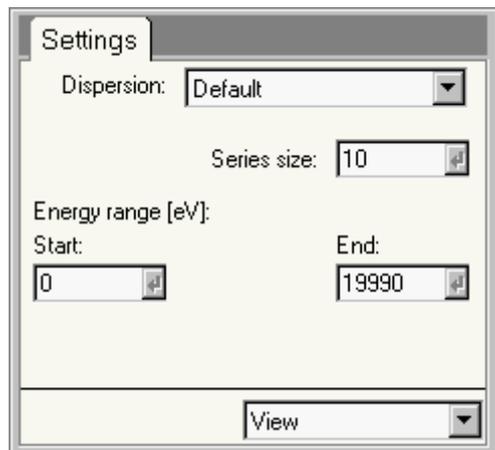
The EDX Settings Control Panel.

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.

9   TIA EDX spectrum acquisition

9.1   EDX Spectrum

EDX spectrum acquisition in TIA is controlled through the EDX Control Panel of the TEM User Interface. In EDX spectrum acquisition TIA will display an EDX spectrum display.

Note: With Reuse Display Window active (see section 2.4.2), both acquisition modes (View, Acquire) write their spectra into the same display, so after an spectrum has been acquired, the data must be saved before restarting acquisition, otherwise the spectrum acquired will be overwritten. To save the current spectrum, you can also split the pane and copy the current spectrum to the new, empty pane. You can also change the name of the display (not the spectrum itself) and TIA will create a new display for continued acquisition.
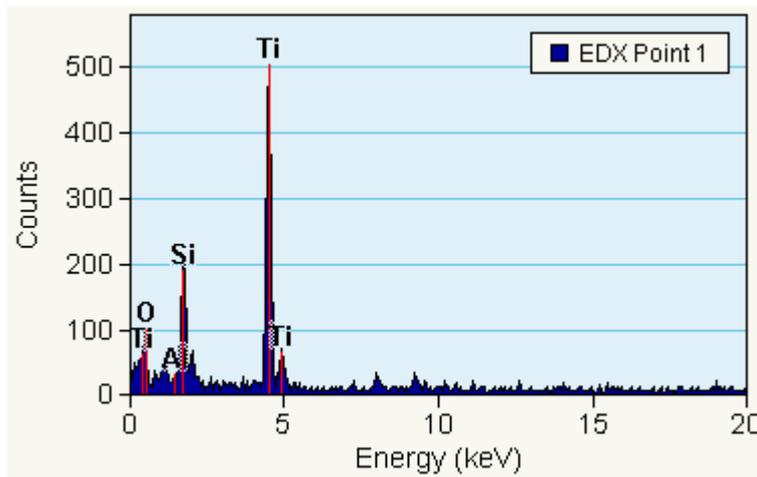
EDX spectrum display.

9.2   Manipulation of spectrum displays

The spectrum display has a vertical scale (Counts) and a horizontal scale (Energy). The scale can be manipulated as follows :
- Move the cursor over one of the scales. The cursor will change to a splitter cursor (two parallel lines with arrows on either side pointing away from the lines). Clicking with the left-hand mouse button on the scale and :
    - On the horizontal scale dragging to the right - the scale expands around the point where the scale was clicked.
    - On the horizontal scale dragging to the left - the scale contracts around the point where the scale was clicked.
    - On the vertical scale dragging up - the scale expands around the 0 count level.
    - On the vertical scale dragging down - the scale contracts around the 0 count level.
- Move the cursor over one of the scales while keeping the **Shift ke**y on the keyboard pressed. The cursor will change to a modified splitter cursor (one line with arrows on either side pointing away from the line). Clicking with the left-hand mouse button on the scale and :
    - On the horizontal scale dragging to the right or left - the scale shifts to the right or left.
    - On the vertical scale dragging up or down - the scale shifts up or down. The 0 count level is now displaced, but any expansion or contraction (see above) still takes place around the 0.

- Double-click anywhere on the display except on the spectrum itself and the scales (where the cursor is modified) or click with the right-hand mouse button and selecting Properties gives the Properties dialog. Select the X-Axis or Y-Axis tab and modify the Min and/or Max values of the Range. Press Apply button to see the effect of the change immediately or press OK (then the changes are made when the dialog is closed).

The style of the display can be modified (in analysis mode, select from the menu Edit, Styles, then select Display, Normal Spectrum Display) with regard to colors (plot area, background, grid), the style of the grid lines and the visibility of the X and Y axes.

9.3   Calibration of EDX spectra

There are different systems for calibrating EDX spectra.

9.3.1   Individual spectrum calibration

Whenever a spectrum fit is done with energy calibration as a variable (accessible in analysis mode from the menu by selecting Analyze, Edit Setup, Vary energy calibration on the Fitting tab), the spectrum is automatically recalibrated during the fitting procedure.

9.3.2   System calibration

Insert a specimen into the microscope that will give clearly defined peaks suitable for calibration (a combination of Al and Cu is generally used, either as two grids together or an Al foil on a Cu grid). Set up the analysis conditions on the microscope (make sure to have no more than ~1000 counts per second for normal pulse processing times and at maximum 2000-3000 for the very short pulse processing times).

There is some dependence on the hardware present :
- For an EDAX detector with the EDAMIII (Phoenix) system, it is best to calibrate the detector in the EDAX service software for the various spectrum processing times and keep the calibration settings in TIA to an offset of 0.000 and a scale of 0.0100 kV. To set the TIA settings with a properly calibrated EDAMIII system, simply double-click on a spectrum, select the Calibration tab and enter the two numbers. For making this calibration system-wide, see below.
- For a Link (Oxford) detector with XP3 pulse processor, the six different pulse processing times (selected through a switch on the pulse-processor box) should be calibrated separately. Start with pulse processing time 4 as the default. If the hardware must be adjusted as well, first set the calibration settings in TIA to an offset of 0.000 and a scale of 0.0100 kV (double-click on a spectrum, select the Calibration tab and enter the two numbers; make this calibration system-wide for the Default dispersion as described below). Then change the hardware settings so that the spectrum peaks are present as near as possible to their true positions. After that acquire a spectrum for about 60 seconds, identify the peaks (use only the Ka peaks in the fitting) and do a fit. Make this calibration the Default system calibration (see below). Repeat the software calibration (do not change the pulse processor hardware anymore - except for the switch to the other pulse processing times) for the other pulse processing times. Save these also as system calibrations (see below) under dispersion names that make it clear which is which.

To make a calibration done a system calibration (functionality accessible to TIA administrators only), switch to analysis mode. From the menu select Acquire, Settings, EDX. In the More EDX dialog, select the Magnifications tab.
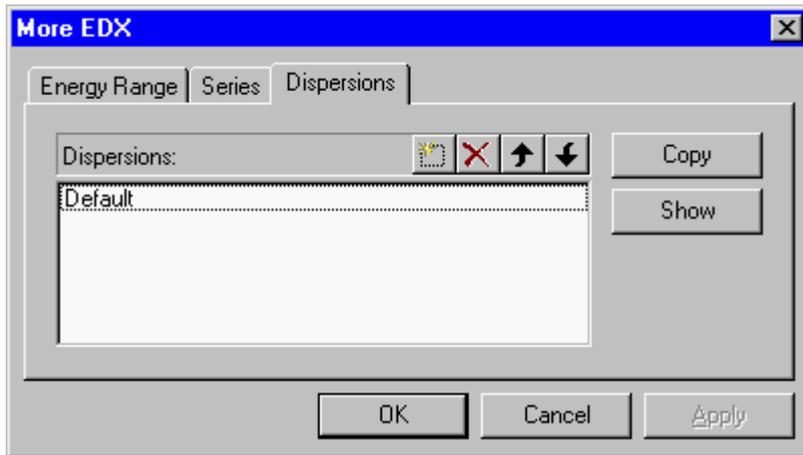
The Dispersions tab of the More EDX dialog.

If only one calibration is used (e.g. EDAX detector) , click on the Default in the list (it becomes highlighted) and press the Copy button.

If several calibrations are used for different settings, select the proper dispersion setting by clicking on it or add one. Press the Copy button to insert the values in the calibration. After the Copy button has been pressed the values used will be displayed.

To add a dispersion to the list, click on the New (Insert) button . TIA will create a new item in the list and put the cursor at the front of the line. Enter the name of the new dispersion and press the Enter key on the keyboard. Click on the new item in the list (it becomes highlighted).

10   PEELS (Titan UI Control Panel)
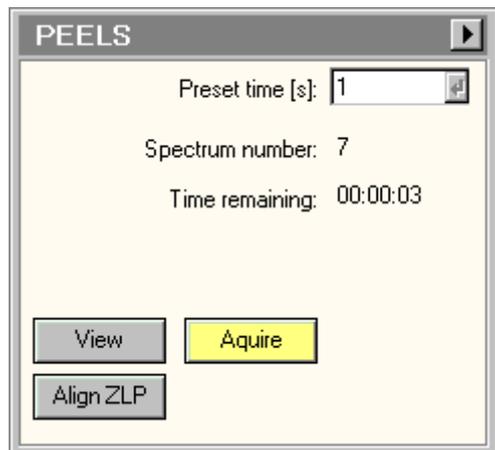
The PEELS Control Panel.

In the PEELS Control Panel the controls for (single-point) PEELS spectrum acquisition are located.

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.

10.1   PEELS Settings
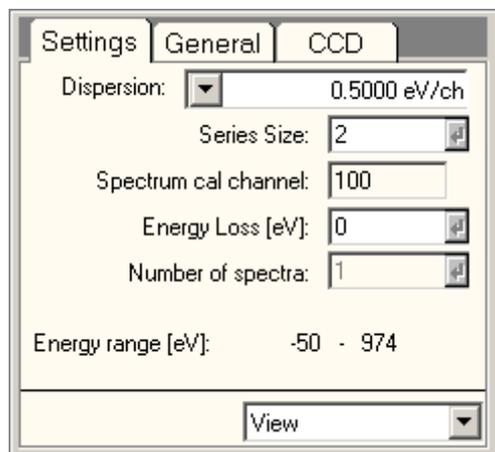
The PEELS Settings Control Panel.

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.

10.2   PEELS General
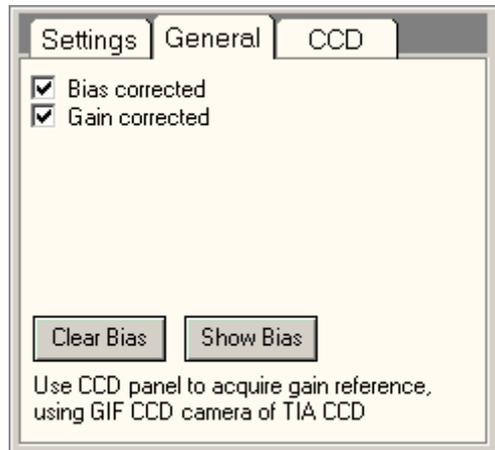
The PEELS General Control Panel.

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.

Gain corrected
Under Gain corrected the gain correction of the spectrum acquisition is switched on (checkbox checked) or off.

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

Clear Bias
Pressing Clear Bias clears the current bias spectrum.

Show Bias
When the Show Bias button is pressed, TIA will display the bias image.

10.3   PEELS CCD
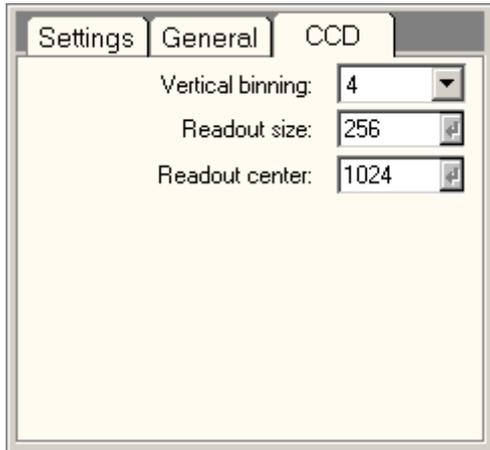
The PEELS CCD Control Panel.

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 pectrum.

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.

11   TIA PEELS spectrum acquisition

11.1   PEELS Spectrum

PEELS spectrum acquisition in TIA is controlled through the PEELS Control Panel of the TEM User Interface. In PEELS spectrum acquisition TIA will display a PEELS spectrum display.

Note: With Reuse Display Window active (see section 2.4.2), both acquisition modes (View, Acquire) write their spectra into the same display, so after an spectrum has been acquired, the data must be saved before restarting acquisition, otherwise the spectrum acquired will be overwritten. To save the current spectrum, you can also split the pane and copy the current spectrum to the new, empty pane. You can also change the name of the display (not the spectrum itself) and TIA will create a new display for continued acquisition.
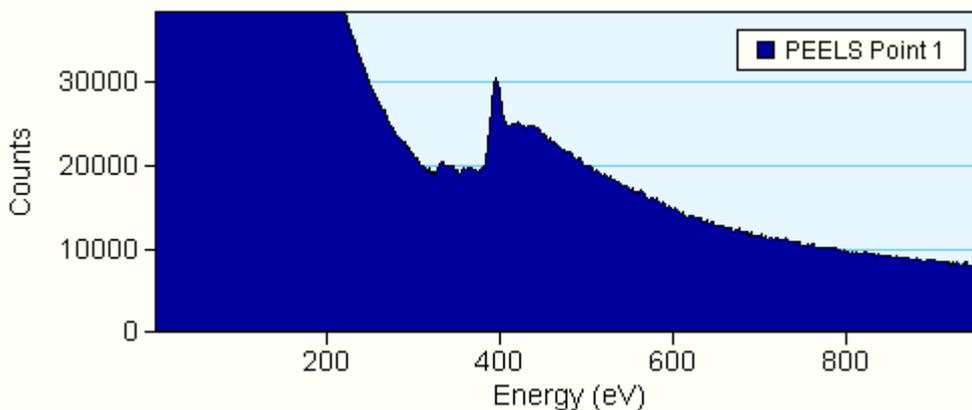
PEELS spectrum display.

11.2   Manipulation of spectrum displays

The spectrum display has a vertical scale (Counts) and a horizontal scale (Energy). The scale can be manipulated as follows :
- Move the cursor over one of the scales. The cursor will change to a splitter cursor (two parallel lines with arrows on either side pointing away from the lines). Clicking with the left-hand mouse button on the scale and :
    - On the horizontal scale dragging to the right - the scale expands around the point where the scale was clicked.
    - On the horizontal scale dragging to the left - the scale contracts around the point where the scale was clicked.
    - On the vertical scale dragging up - the scale expands around the 0 count level.
    - On the vertical scale dragging down - the scale contracts around the 0 count level.
- Move the cursor over one of the scales while keeping the Shift key on the keyboard pressed. The cursor will change to a modified splitter cursor (one line with arrows on either side pointing away from the line). Clicking with the left-hand mouse button on the scale and :
    - On the horizontal scale dragging to the right or left - the scale shifts to the right or left.
    - On the vertical scale dragging up or down - the scale shifts up or down. The 0 count level is now displaced, but any expansion or contraction (see above) still takes place around the 0.
- Double-click anywhere on the display except on the spectrum itself and the scales (where the cursor is modified) or click with the right-hand mouse button and selecting Properties gives the Properties dialog. Select the X-Axis or Y-Axis tab and modify the Min and/or Max values of the Range. Press

Apply button to see the effect of the change immediately or press OK (then the changes are made when the dialog is closed).

The style of the display can be modified (in analysis mode, select from the menu Edit, Styles, then select Display, Normal Spectrum Display) with regard to colors (plot area, background, grid), the style of the grid lines and the visibility of the X and Y axes.

11.3   Calibration of PEELS spectra

11.3.1   Individual spectrum calibration

If the **spectrum is single** (not one of a series) and the **dispersion is correct** (the eV/channel) :
- Select the Calibration shift tool ![tool].
- Click on the spectrum.
- Shift the spectrum to where it should be on the energy scale.

If the spectrum is one of a series and the dispersion is correct (the eV/channel) :
- Click with the right-hand mouse button on the PEELS spectrum display (not on the spectrum itself).
- Select Unhide Objects from the popup menu.
- Select the Acquire PEELS Point 1 object.
- Select the Calibration shift tool ![tool].
- Click on the spectrum (this now is the Acquire PEELS Point 1 spectrum).
- Shift the spectrum to where it should be on the energy scale.
- Click with the right-hand mouse button on the spectrum and select Hide Object.
- Now the whole series of spectra has been recalibrated.

If the **spectrum is singl**e (not one of a series) and the **dispersion is not corre**ct (the eV/channel) :
- Switch to analysis mode.
- Select the Calibration shift tool ![tool].
- Click on the spectrum at a known edge (the position is important because it defines the point around which the stretch of the spectrum in the next steps is done).
- Shift the spectrum to where it should be on the energy scale.
- Select the Calibration scale tool.
- Click on the spectrum at another know edge.
- Shift this edge to where it should be on the energy scale (the spectrum will be stretched or compressed around the position used for the calibration shift).

If the **spectrum is one of a series** and the **dispersion is not correc**t (the eV/channel) :
- Click with the right-hand mouse button on the PEELS spectrum display (not on the spectrum itself).
- Select Unhide Objects from the popup menu.
- Select the Acquire PEELS Point 1 object.
- Select the Calibration shift tool ![tool].
- Click on the spectrum (this now is the Acquire PEELS Point 1 spectrum) at a known edge (the position is important because it defines the point around which the stretch of the spectrum in the next steps is done).
- Shift the spectrum to where it should be on the energy scale.
- Select the Calibration scale tool.
- Click on the spectrum at another know edge.
- Shift this edge to where it should be on the energy scale (the spectrum will be stretched or compressed around the position used for the calibration shift).

- Shift the spectrum to where it should be on the energy scale.
- Click with the right-hand mouse button on the spectrum and select Hide Object.
- Now the whole series of spectra has been recalibrated.

11.3.2   System calibration

Insert a specimen into the microscope that will give a clearly defined edge suitable for calibration (nickel-oxide is generally used). Set up the analysis conditions on the microscope and collect a spectrum. Calibrate as described above.

To make a calibration done a system calibration (functionality accessible to TIA administrators only), switch to analysis mode. From the menu select Acquire, Settings, PEELS. In the More PEELS dialog, select the Dispersions tab.
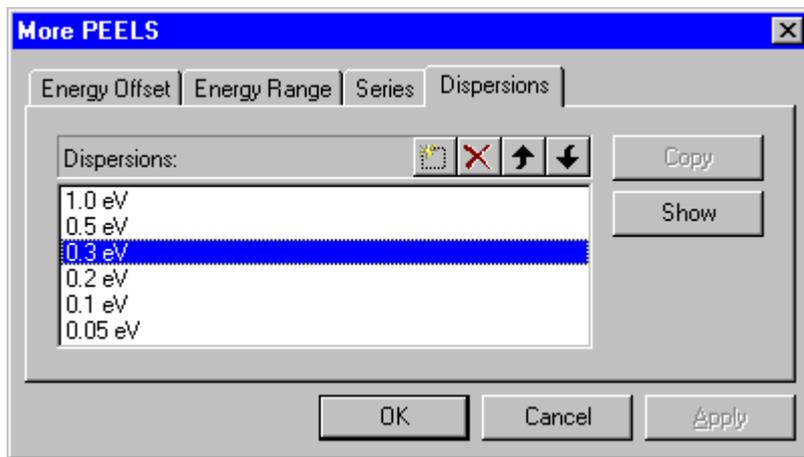
The Dispersions tab of the More PEELS dialog.

Select the proper dispersion setting by clicking on it or add one. Press the Copy button to insert the values in the calibration. After the Copy button has been pressed the values used will be displayed.

To add a dispersion to the list, click on the New (Insert) button 🗋 . TIA will create a new item in the list and put the cursor at the front of the line. Enter the name of the new dispersion and press the Enter key on the keyboard. Click on the new item in the list (it becomes highlighted).

12   Experiments (Titan UI Control Panel)
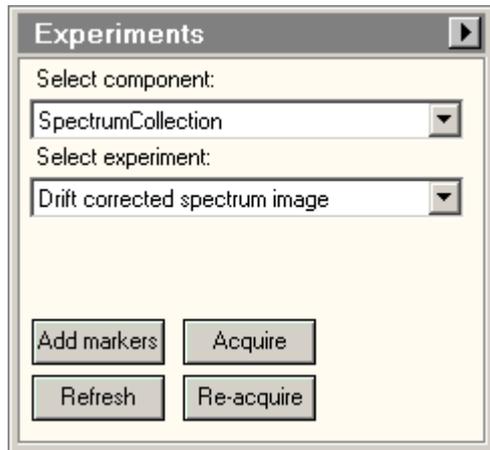
The Experiments Control Panel.

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.

12.1   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.

12.2   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.

12.3   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.

12.4   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.
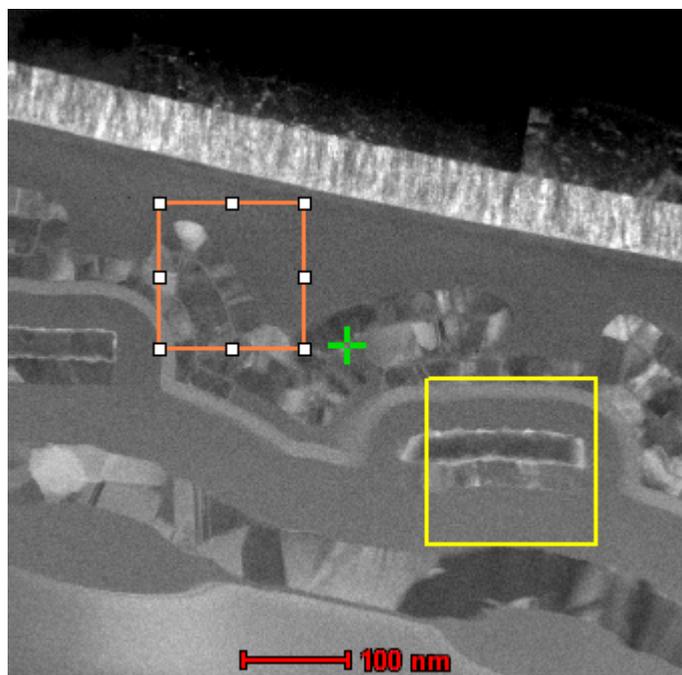
The markers also have distinctive names, but this is not essential. E.g. if you add markers manually and you give them the required style, TIA will recognize them. Also, if you change the names according to the default, TIA will also recognize them.
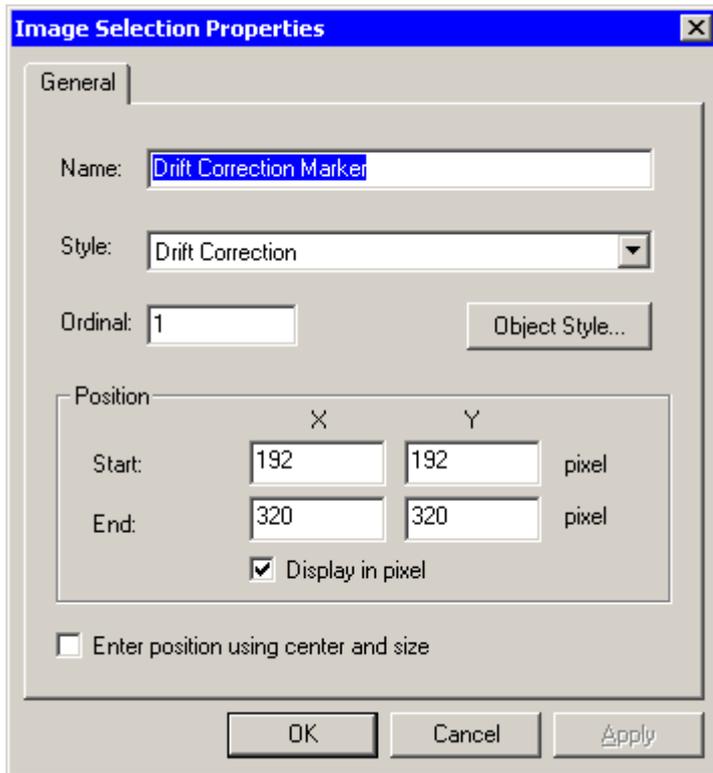
If you do not like the style of the markers (e.g. in the image you typically have, the colors chosen are not well visible), you can change the style of the markers. If you go through Object Style, only the properties of the selected marker will be changed.
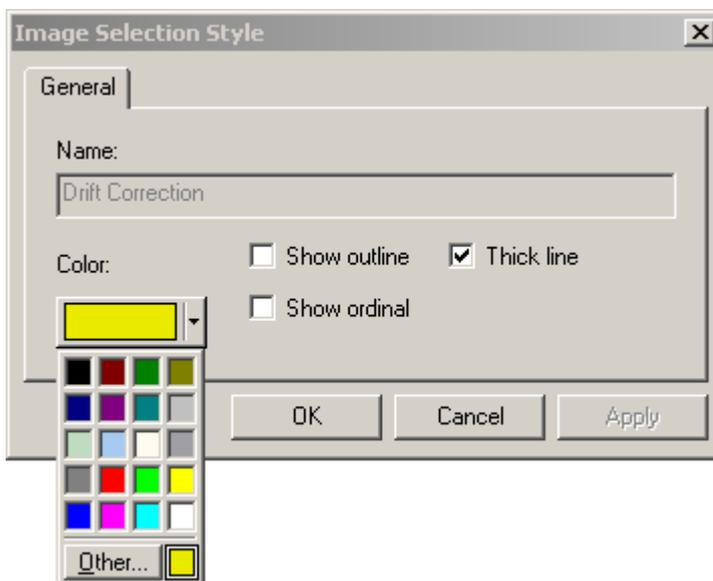
If you want to change the style of the markers persistently, go to TIA Analysis mode and in the menu select Edit, Styles. Find the required type of the marker in the dialog and select the marker style. Through Properties you can adjust the style.
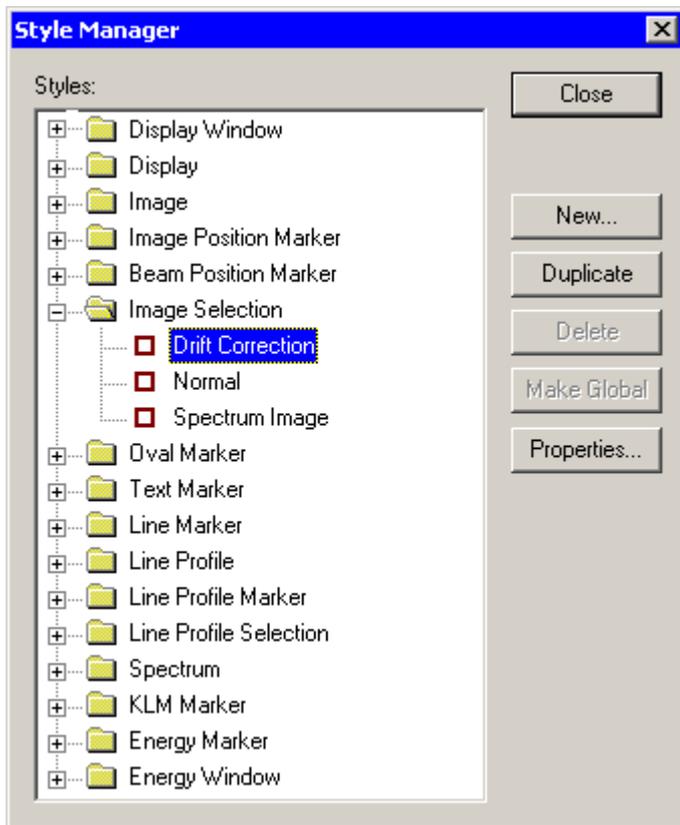
Note: Spectrum position experiments with drift correction will move the beam back to the 1st marker when it performs the cross-correlation to determine drift. This could damage your specimen at the 1st marker position when your specimen is beam sensitive. To avoid this, put the 1st marker at a position 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 2)
- TIA STEM image acquisition (chapter 7)
- TIA EDX spectrum acquisition (chapter 9)
- TIA EELS spectrum acquisition (chapter 11)
- TIA CCD image acquisition (chapter 4)

12.5   Experiments Settings
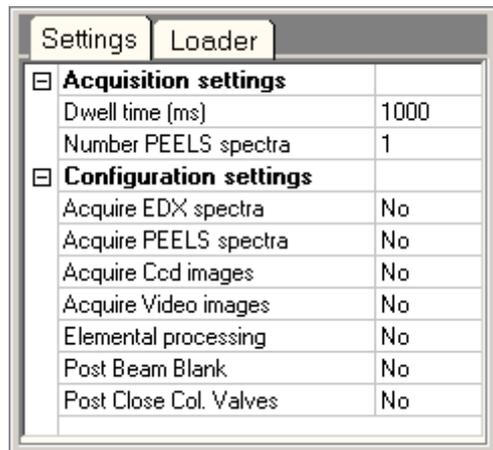
The Experiments Settings Control Panel.

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.

12.5.1 Acquisition settings

12.5.1.1 Spectrum position acquisition settings
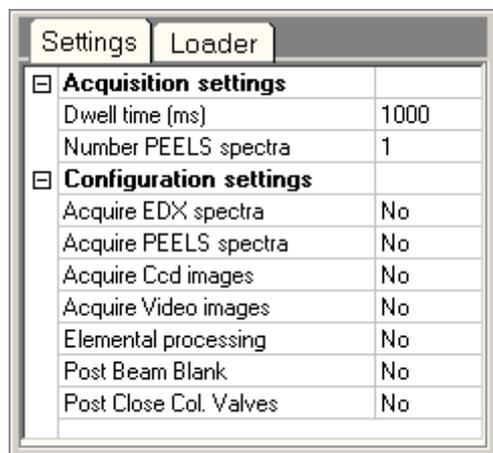
Settings	Loader	
Acquisition settings		
Dwell time (ms)	1000	
Number PEELS spectra	1	
Configuration settings		
Acquire EDX spectra	No	
Acquire PEELS spectra	No	
Acquire Ccd images	No	
Acquire Video images	No	
Elemental processing	No	
Post Beam Blank	No	
Post Close Col. Valves	No	

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).

12.5.1.2 Spectrum profile acquisition settings
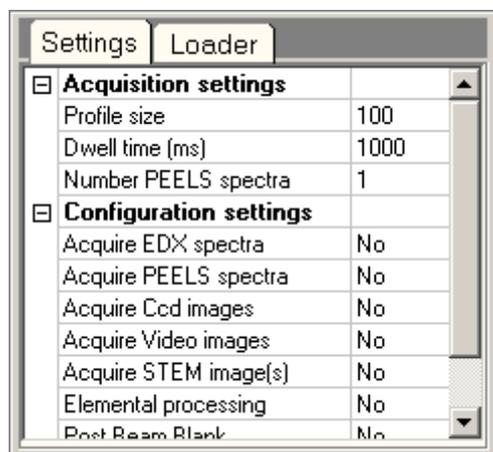
Settings	Loader	
Acquisition settings		
Profile size	100	
Dwell time (ms)	1000	
Number PEELS spectra	1	
Configuration settings		
Acquire EDX spectra	No	
Acquire PEELS spectra	No	
Acquire Ccd images	No	
Acquire Video images	No	
Acquire STEM image(s)	No	
Elemental processing	No	
Post Beam Blank	No	

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).

12.5.1.3   Spectrum image acquisition settings

Settings	Loader		
⊟ **Acquisition settings**			▲
Image size (X)	50		
Image size (Y)	50		
Fixed direction	none		
Dwell time (ms)	1000		
Number PEELS spectra	1		
⊟ **Configuration settings**			
Acquire EDX spectra	No		
Acquire PEELS spectra	No		
Acquire Ccd images	No		
Acquire Video images	No		
Acquire STEM image(s)	No		▼
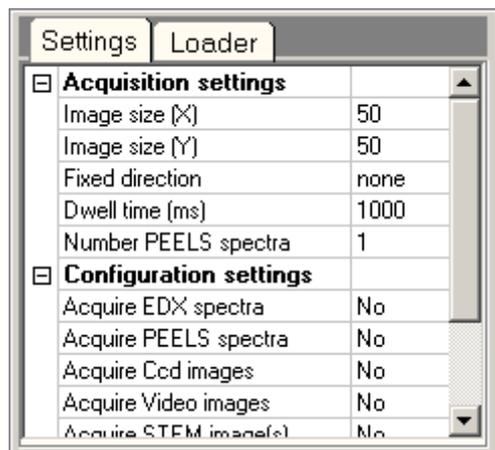
Note: The spacing between the acquisition positions is identical in both (X and Y) directions.

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).

12.5.2   Configuration settings

Settings	Loader		
Dwell time (ms)	1000		▲
Number PEELS spectra	1		
⊟ **Configuration settings**			
Acquire EDX spectra	No		
Acquire PEELS spectra	No		
Acquire Ccd images	No		
Acquire Video images	No		
Acquire STEM image(s)	No		
Elemental processing	No		
Post Beam Blank	No		
Post Close Col. Valves	No		▼
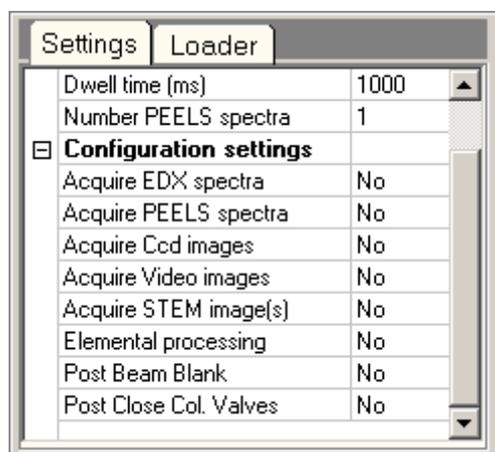
Note: Some acquisition settings are mutually exclusive because they make use of detectors that are located at different physical locations, where one detector (e.g. a CCD) blocks the view of the other (e.g. PEELS) or a detector is used for more than one type of data and only one can be selected at a 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.

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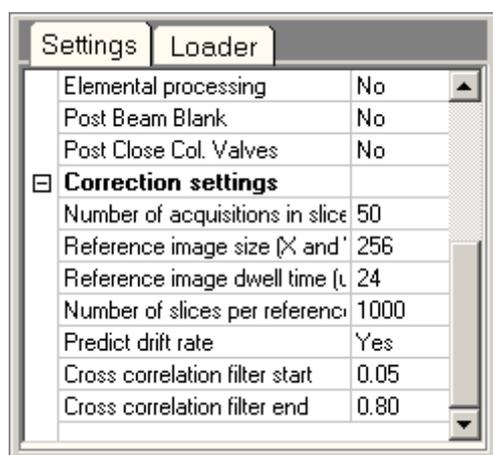
Number of acquisitions in slice
A slice is the period between successive checks of the drift, so the number of acquisitions in the slice is the number of data acquisitions done before a new drift check is done.

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.

12.6 Experiments Loader
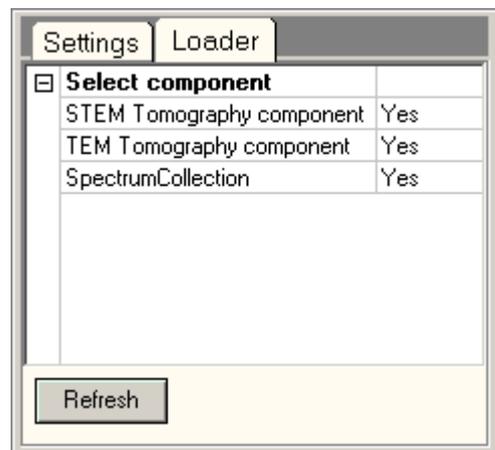
The Experiments Loader Control Panel.

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.