

TEM on-line help manual -- TIA

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1 Introduction

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

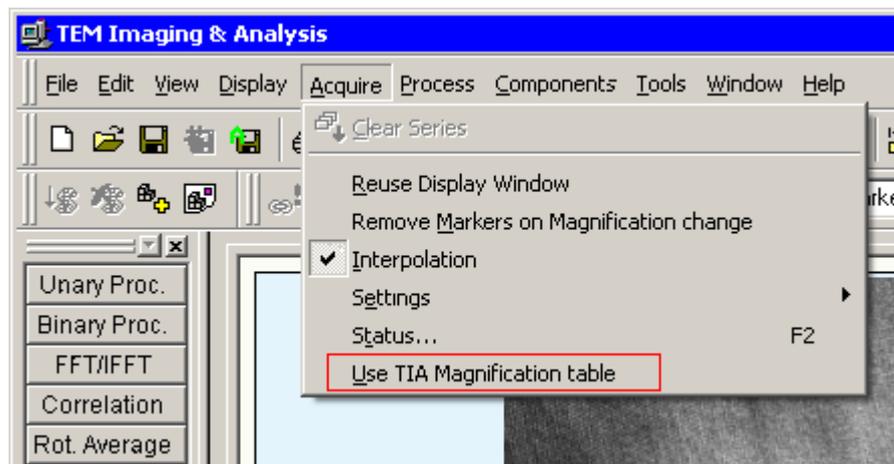
1.1 Significant changes in the calibration system for TIA (versions Titan 1.5/Tecnai 4.5 onwards)

A major change has been made in the TIA calibration system. Instead of using its own (but not high-tension-dependent magnification tables) TIA can now use the calibrations in the TEM server.

Advantages in using this functionality are:

- Users no longer need to download magnification tables in TIA when the high tension is changed.
- TEM server calibrations follow the optics model so there is no possibility of duplicate magnifications (e.g. in differing optical modes) leading to errors in calibration (because TIA - and DigitalMicrograph as well - store magnifications by magnification value).

The functionality is activated by a check box in the Acquire menu of TIA. Note that only TIA Administrators can change the selection, for other users the setting is visible but disabled.

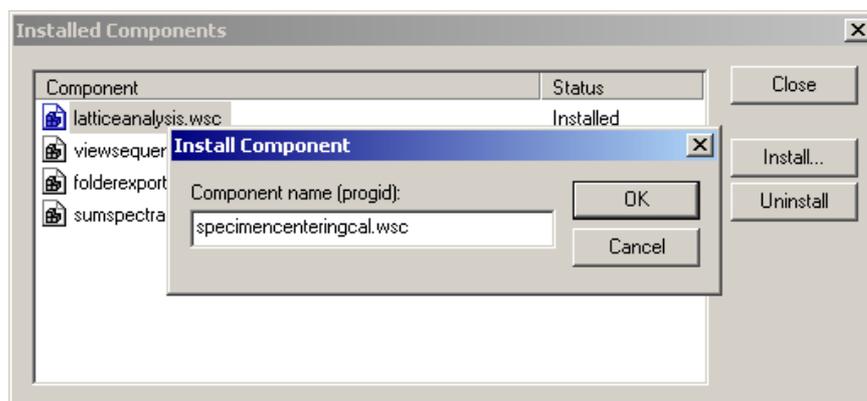


The selection of the TEM server calibrations (the checkbox in the menu, outlined in red, is unchecked).

1.2 Important change for the specimen centering calibration system

The specimen centering tool in TIA  relies on a calibration of the movement direction (the distance is simply derived from the pixel size in the image – this will work properly only if that pixel size has been calibrated!) Previously the calibration of the specimen centering was very complicated, prone to failure and unclear. In the newer version of TIA (as of Titan 2.0 and Talos 1.0), the calibration has been greatly simplified.

There are two separate calibrations, one for cameras (each camera separately), the other for STEM. Use a suitable specimen for the calibration (one that has lots of distinctive features) and a relatively low magnification (lowermost HM TEM or HM-STEM magnification). If the specimen centering calibration (called 'Centering' in the TIA shortcuts ribbon on the left) is not visible in TIA, it must be loaded first. To do so, in the menu select Tools, Components, Install, insert the text `specimencenteringcal.wsc` and press OK.



To execute the calibration, click on the Calibrate button in the Centering shortcut bar, select a detector in the dialog that comes up and let TIA do the calibration. If the shift measurement fails (especially on cameras – a good gain correction is important), find a better feature on the specimen and try again.

Note: The centering uses the microscope stage (for small shifts the piezo's will be used if they are available). The movements are subject to the mechanical behavior of the stage and at high magnifications the centering may have to be repeated a number of times before a good end result is obtained.

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.

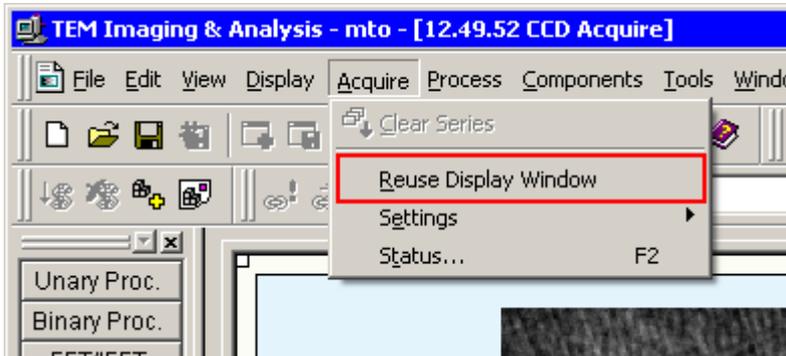
2.4 Using display windows

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.

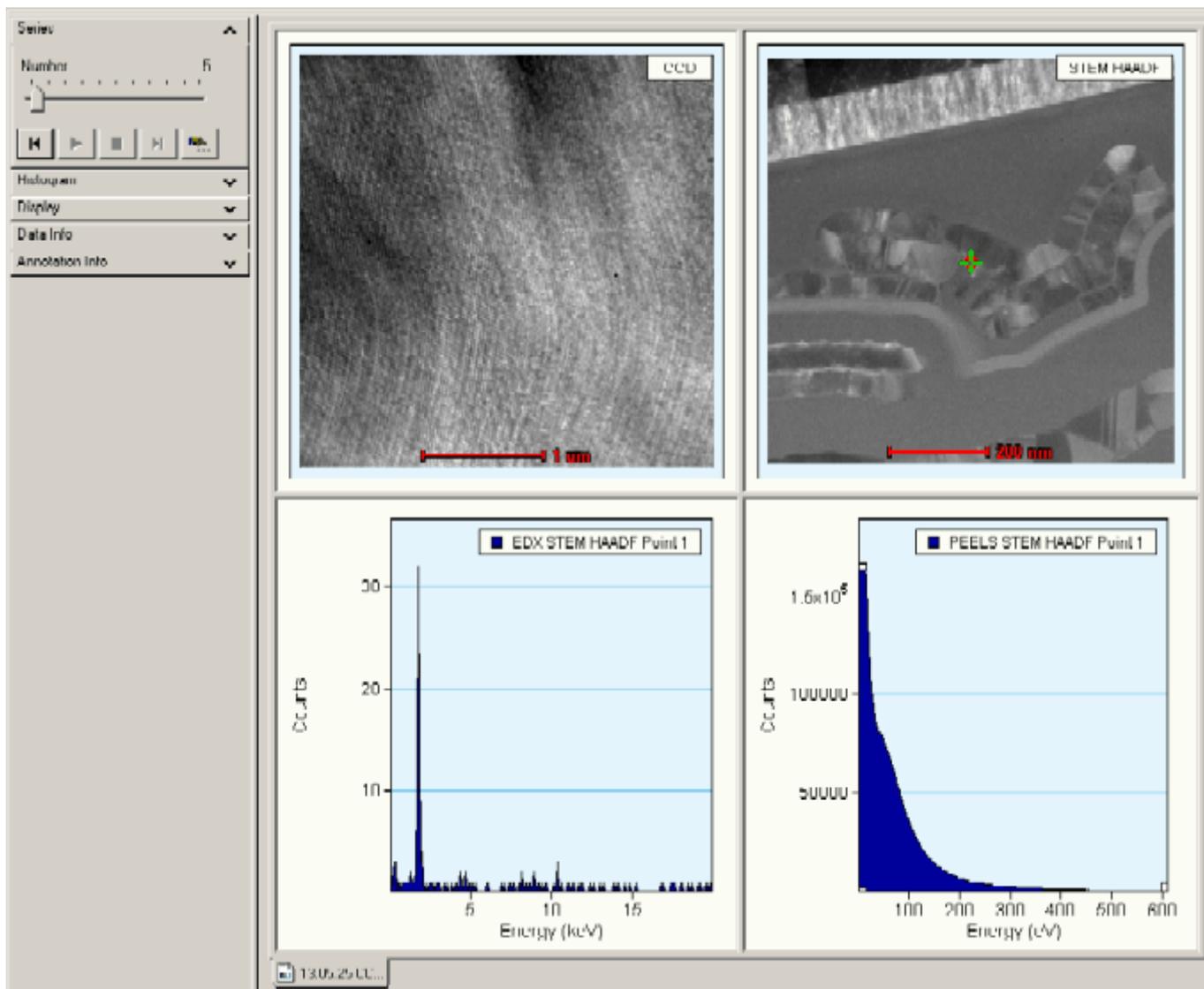
The two systems work as follows.

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.

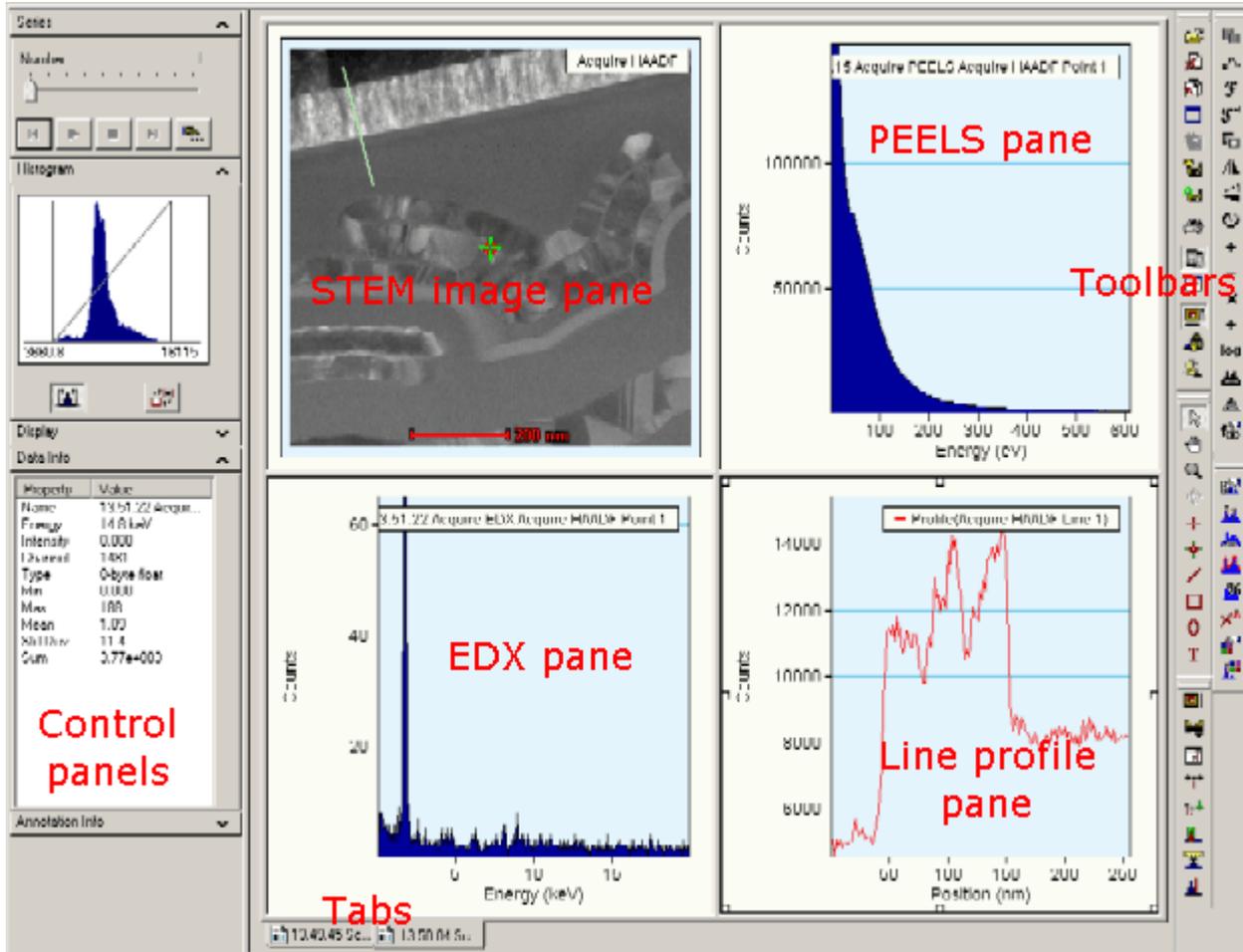


Reused display window, created by starting a CCD Acquire, containing a CCD image, STEM HAADF image, EDX spectrum and EELS spectrum. The EELS Spectrum (currently selected) is number 5 in a series of 100.

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 Paste Right or Paste Down (new display panes are created with a copy either to the right of or below the pane selected).

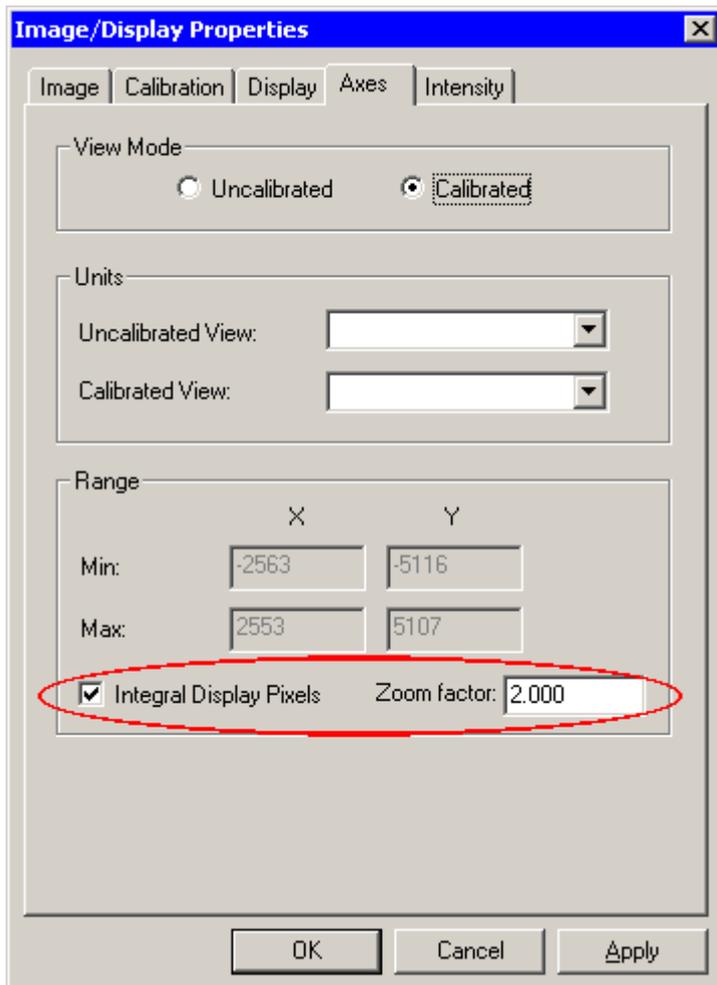
or

- 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 Right or Paste Down).
- 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

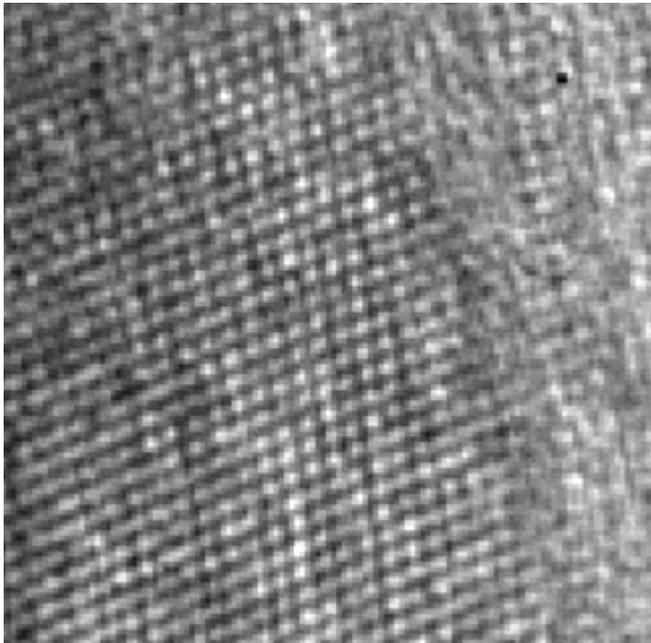
2.7.1 Zoom factor

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.

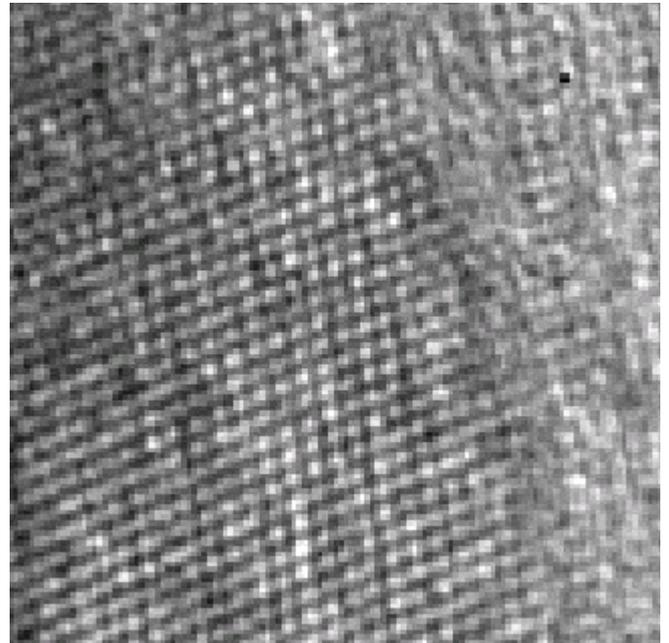


2.7.2 Bilinear / nearest neighbor display

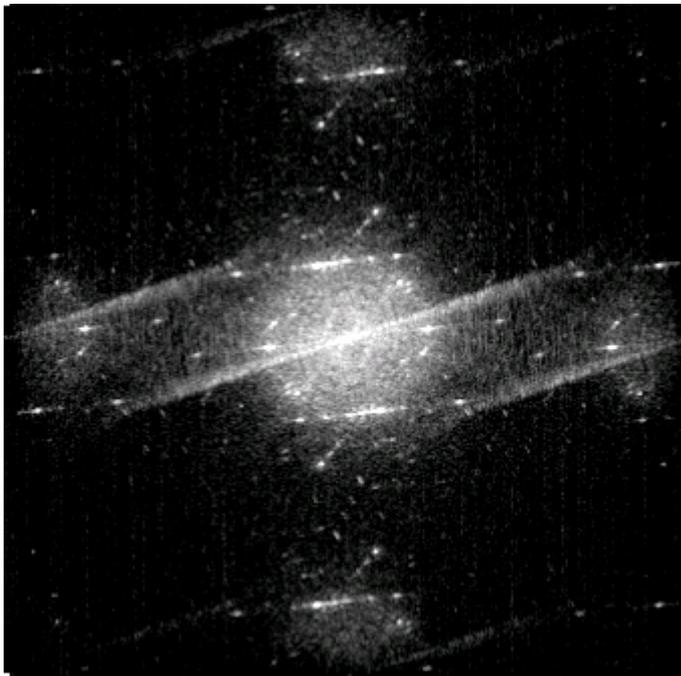
TIA has two image display modes, bilinear and nearest neighbor. In the former all pixels contribute to the image display what results in a smoother, less noisy image. In the latter, only the image pixel closest to the screen pixel is used. The former is the default for acquired images. Especially on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



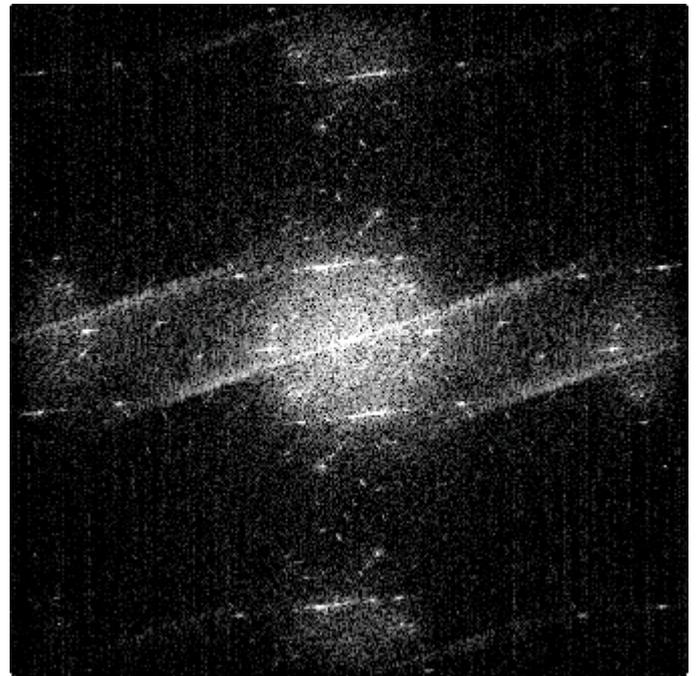
Interpolated image.



Nearest neighbor image.

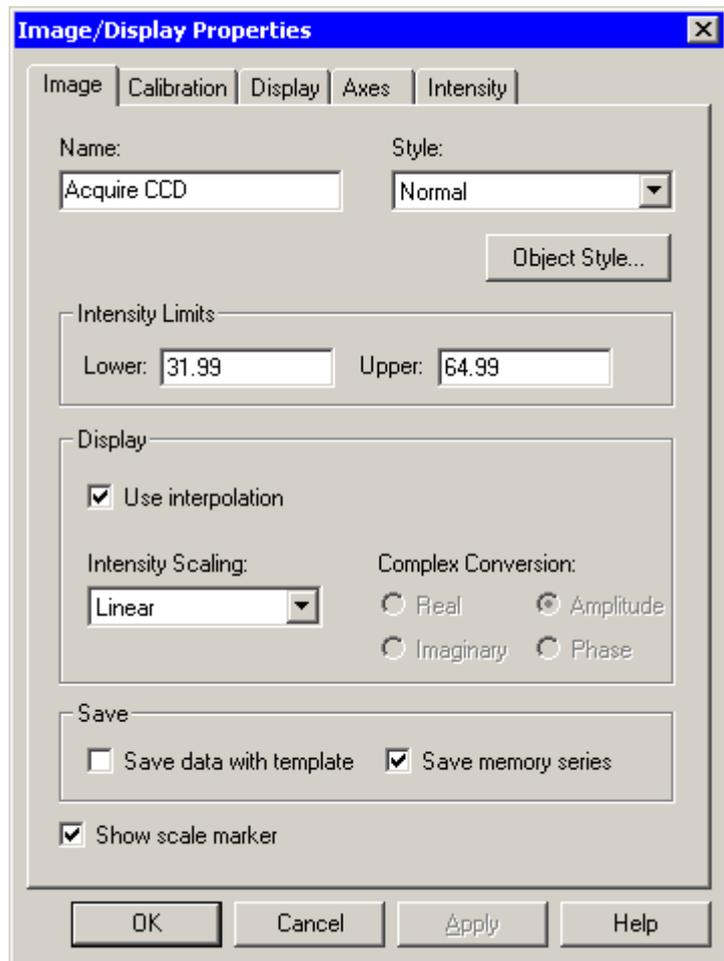


Interpolated FFT.



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

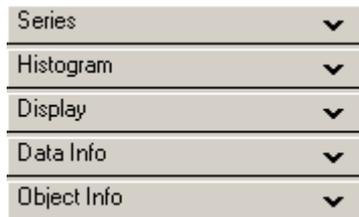
The Output window displays text information related to an operation performed. Examples are the results from data analysis such as peak fitting or elemental composition calculation from EDX spectra. The Output window is shown or hidden through the toolbar function in acquisition mode.

Peak	Integrated Intensity	Uncertainty
O-K	23046.669	2142.160
Mg-K	8198.017	1334.520
Al-K	1319.853	544.666
Si-K	23677.800	2081.230
Ca-K	9863.875	1292.100
Fe-K	8103.957	1140.320
Fe-L	2828.273	693.305
Cu-K	5626.049	1038.930
Cu-L	636.789	404.380

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 object information (Object 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).



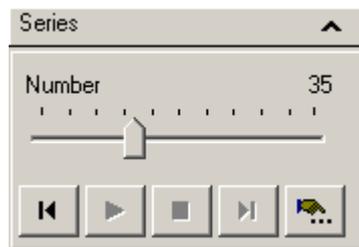
The control panels can be flipped open or close (up/down) by the small arrow button at the right-hand top of each control panel title bar.

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

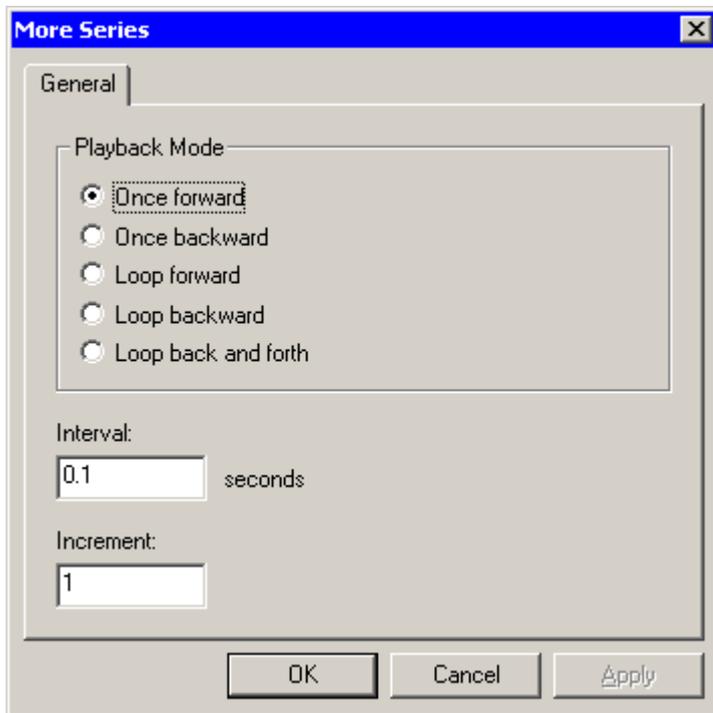
The Stop button stops the display of the series as a video sequence.

End

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

More

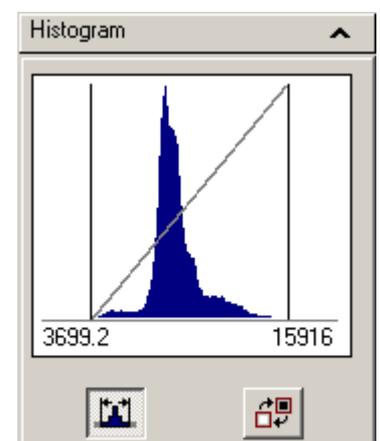
The More button at the bottom-right of the panel provides control of other parameters associated with automated series playback.



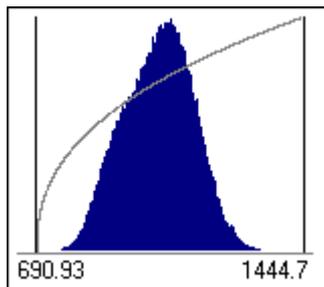
Note: If you want a series of images displayed with the same fixed intensity limits (see below), you have to switch the autoscaling of the display range off, otherwise scrolling through the series will revert to the automatic display range selection.

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.

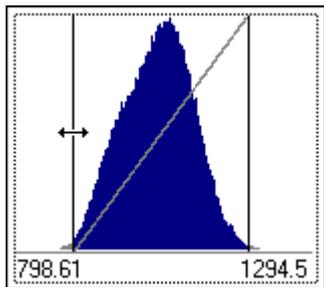


The Histogram control panel.

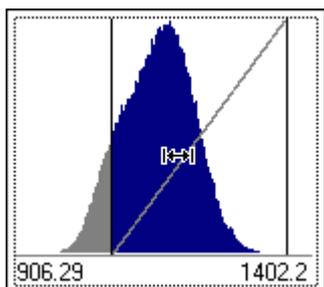


The gamma has been changed from 1.0 to a positive value of 2.5.

You can change the intensity limits by dragging the vertical lines.

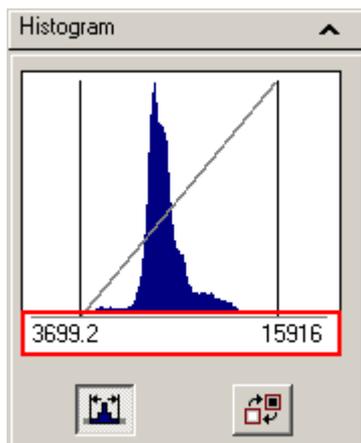


With the cursor (changed to a double-headed arrow) over one of the vertical lines you can drag the line to the left or right.



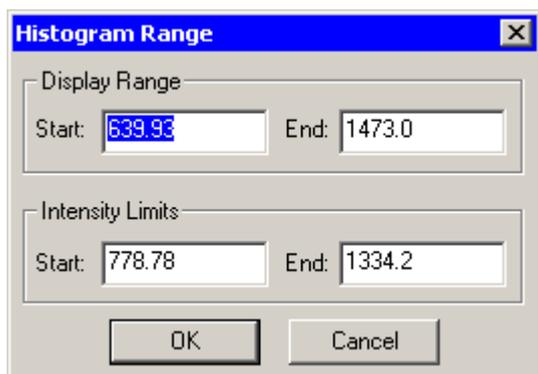
With the cursor (changed to a double-headed arrow between bars) in the area between the vertical lines you can drag the whole range to the left or right (so the total range stays the same while both lines are shifted together).

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.

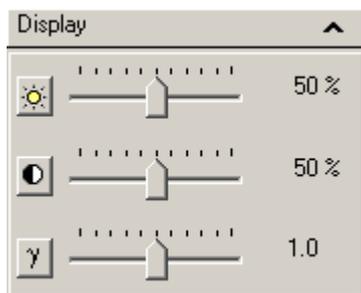
The intensity limits can also be set by double-clicking on an image and changing the Intensity limits values.

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

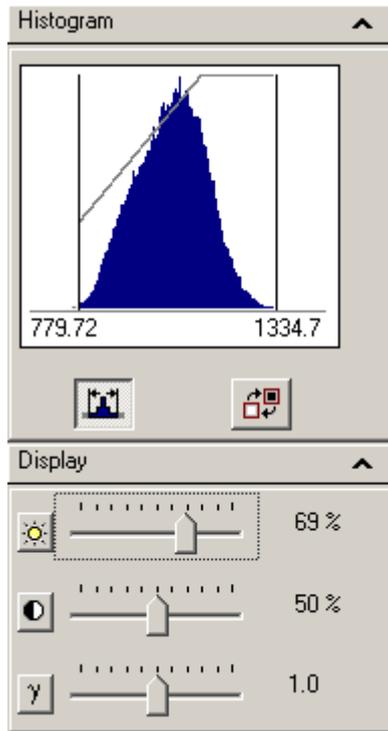
The display control panel allows you change the way the image is displayed (brightness, contrast and gamma). You can reset the values by clicking on the relevant buttons (brightness , contrast  and gamma ) on the left-hand side of the control panel..



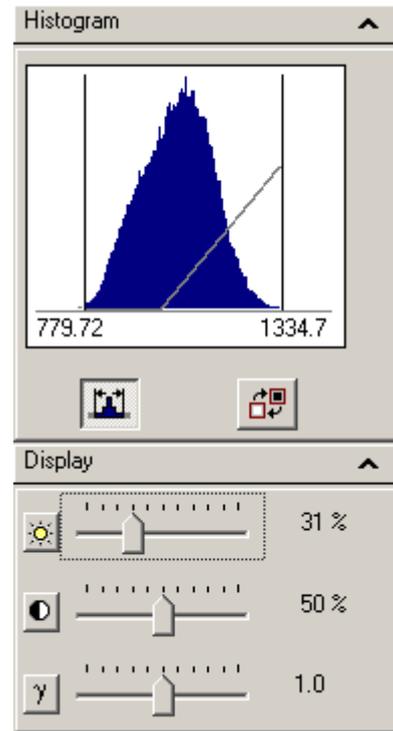
The Display Control Panel.

2.9.3.1 Intensity limits, contrast, brightness and gamma

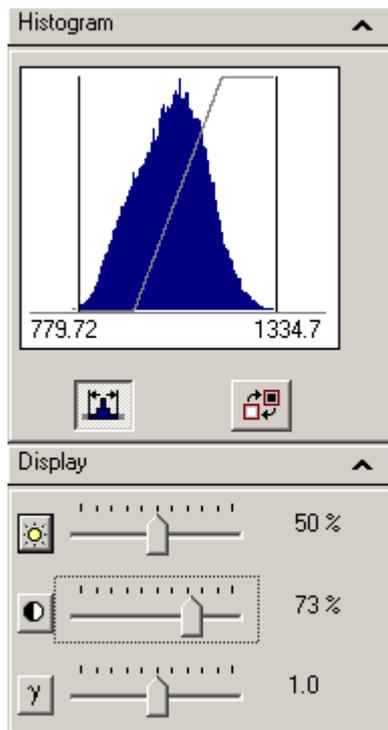
Note: The contrast and brightness functions to some extent have similar effects to settings the intensity limits, but the latter always works without problems while manipulating contrast and brightness can have undesirable effects like reducing the number of gray levels in the image. It is best therefore to use a combination of setting intensity limits and using the gamma where necessary and to leave the contrast and brightness at default values.



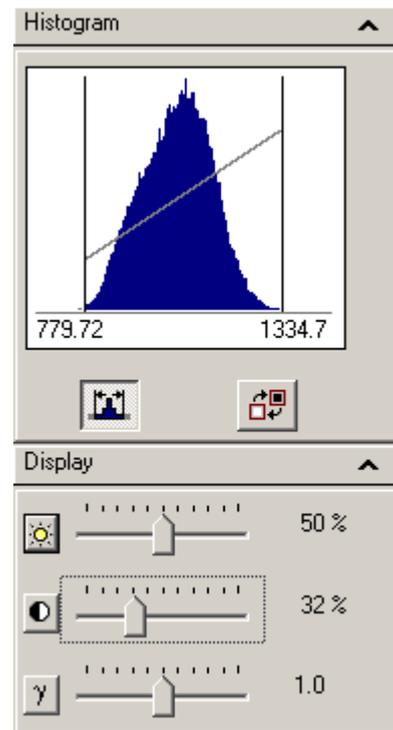
The **brightness** value has been increased. The sloping line has shifted to the left (the higher intensity values in the histogram now have become white) and the image looks brighter. Something similar could have been achieved by setting the intensity levels to the points where the sloping line intersects the bottom and top of the histogram.



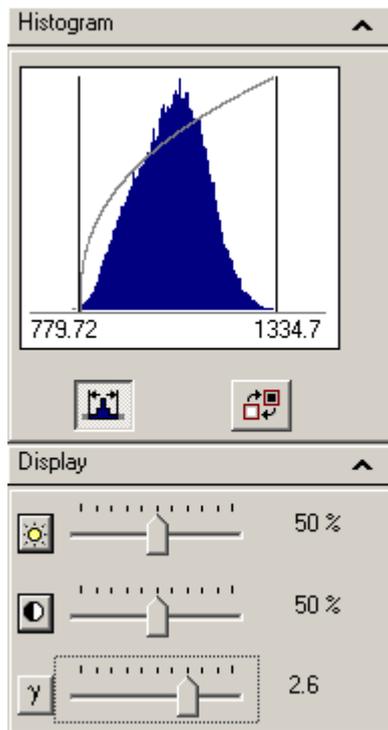
The **brightness** value has been decreased. The sloping line has shifted to the right (the lower values in the histogram now have become black) and the image looks darker. Something similar could have been achieved by setting the intensity levels to the points where the sloping line intersects the bottom and top of the histogram.



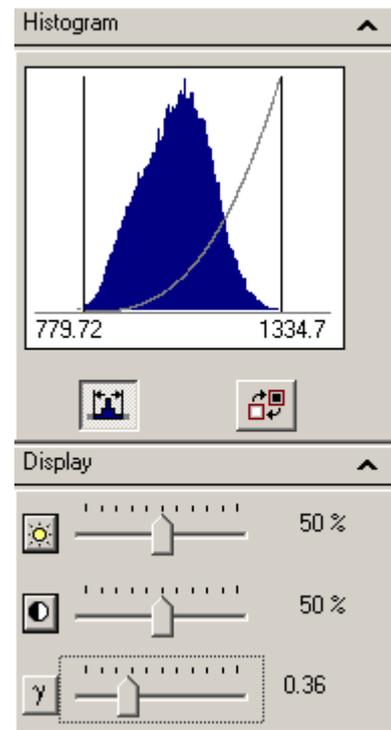
The **contrast** value has been increased. The sloping line has become steeper and the image has more contrast. Something similar could have been achieved by setting the intensity levels to the points where the sloping line intersects the bottom and top of the histogram.



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 X 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 Object Info Control Panel

The object info contains information about the selected object. This can be any of the marker or text annotations. 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.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															
		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

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).

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	86 Rn
87 Fr	88 Ra	89 Ac															
		58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
		90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

Markers ROI % EDX Stds. Auto ID

The full periodic table (accessible only in analysis mode) has four tabs with independent settings:

- Markers
- ROI
- EDX Stds.
- 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

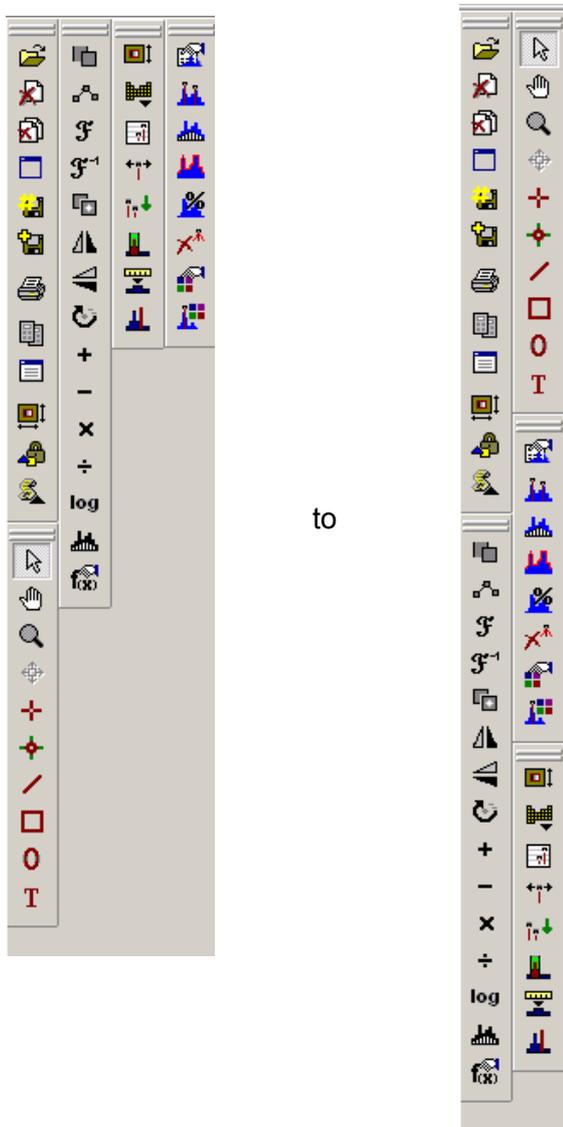
as those marked; it is e.g. possible to mark peaks from the specimen grid, such as Cu, but not use them in the fitting). The Standards tab is important only for analysis, while the Auto ID tab shows the elements to be taken into account during automatic element identification (in general this can stay 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

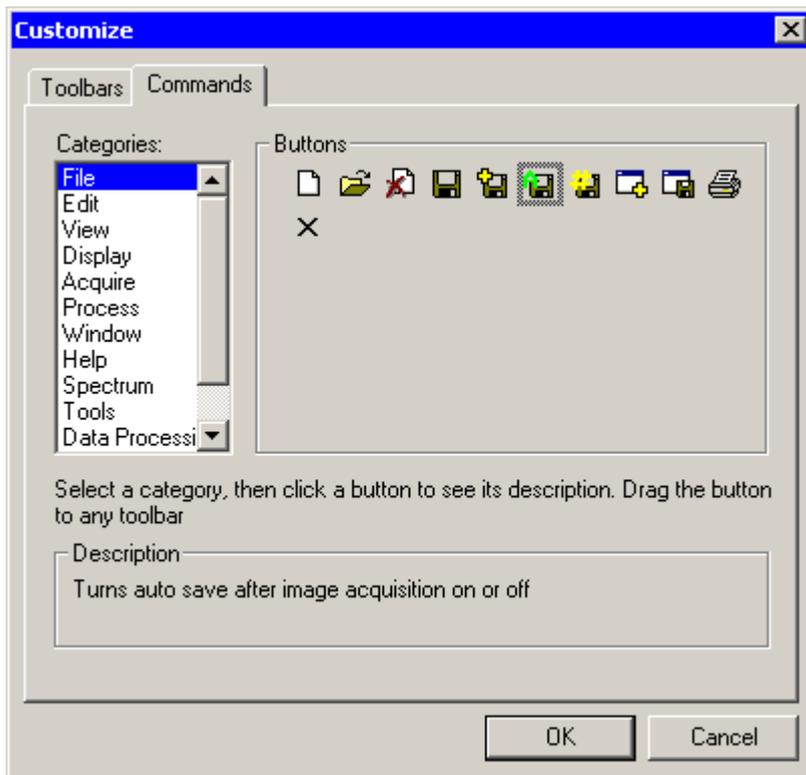
You can modify the acquisition toolbars. You can drag them to any position (top, left, bottom, right of the window or floating above it). You can arrange them (initially they will come up side by side but if you grab a toolbar by its handle you can shift it. That way you can change the layout from



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.

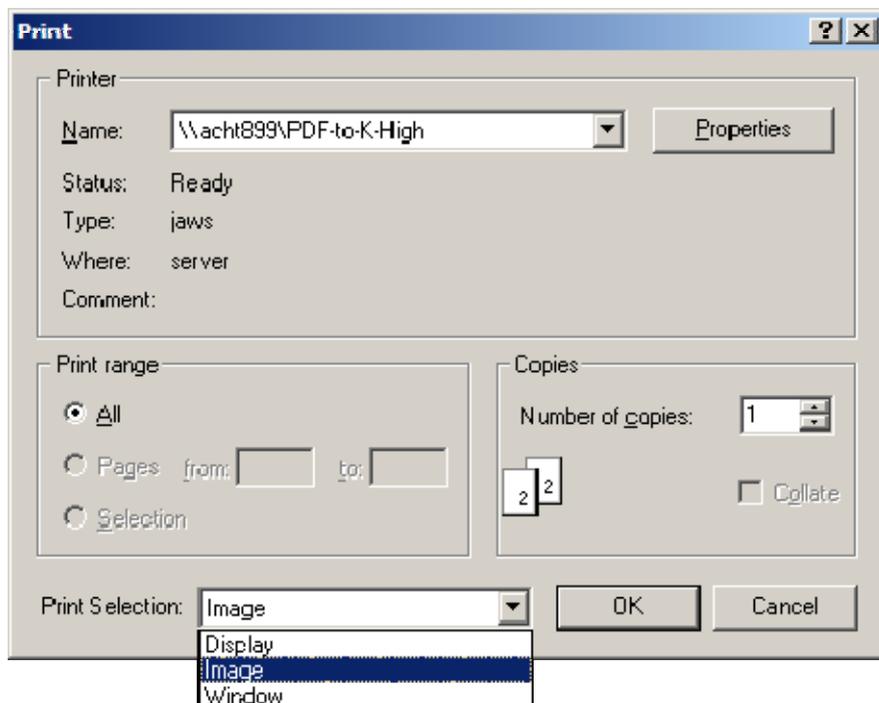
Note: Depending on the previous history the acquisition toolbars may have one or more (recently added) buttons missing in your TIA user interface. You can add them by modifying the toolbar as described above. You can also revert back to the default settings. To do so, close TIA and then in Windows Explorer 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 displayed. 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.

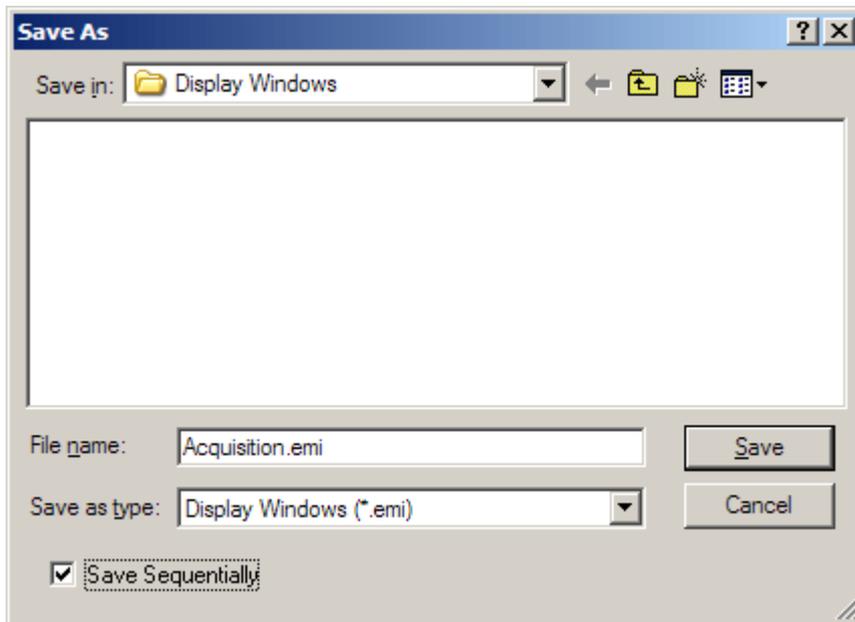
2.11.2.2 TIA Acquisition series

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

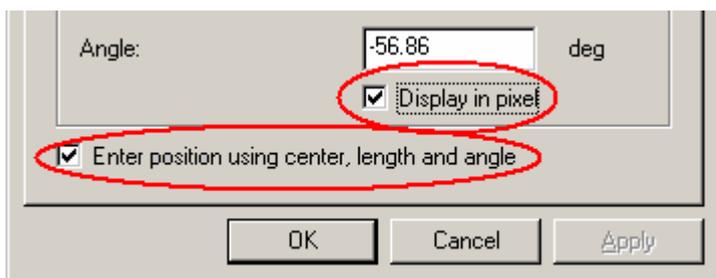
You can also have the data acquired saved automatically. Select a display window for saving, then press the  button. Define a filename in the dialog. After that, the button will remain "depressed" and each new acquisition will be saved automatically. To switch Auto Save off, press the button again (it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

2.11.3 Mini Tools toolbar

Notes:

1. 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.
2. Not all the tools may show up on the mini toolbar. If you are missing one or of them, switch TIA to Analysis mode and modify the toolbar (see section 2.11.1).

	 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.
	 Oval Marker Tool	Insertion of a circle or ellipse in images
	 Text Marker Tool	Allows you to insert text annotation
	 Delete all markers	Deletes all markers from the selected display



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 with markers

Shift + resize/positioning marker	Width-Height ratio stays the same
Ctrl + resize/positioning marker	Marker resizes centered on center of marker
Alt + resize/positioning marker	Marker will be centered in image

Combinations of the above can also be used.

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.

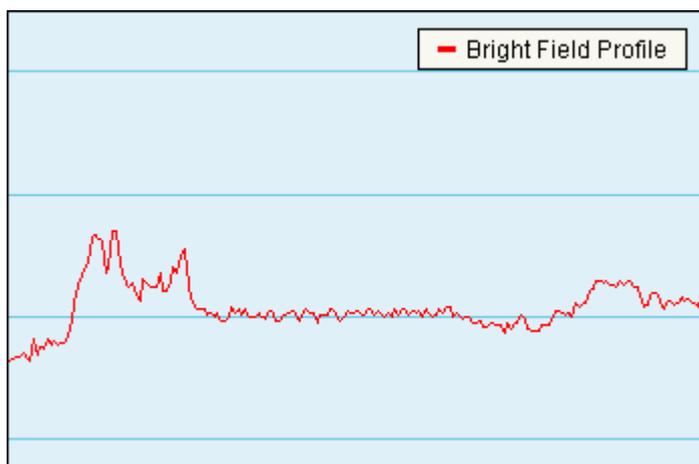
To make the calibration a system setting, see the relevant sections for STEM, CCD and Video.

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).

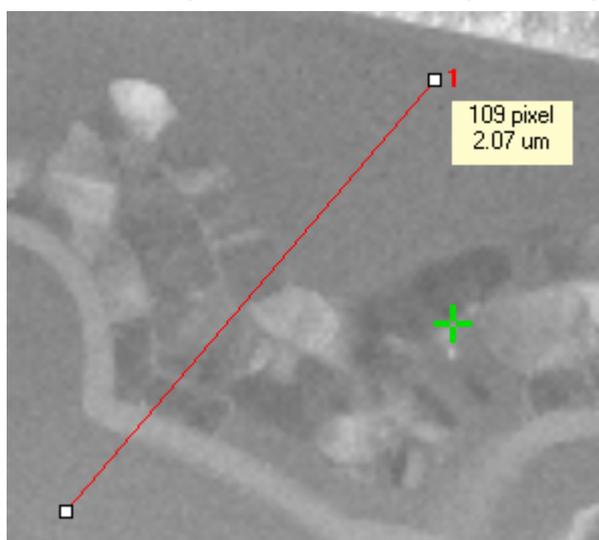
- **Displaying an intensity profile:** Insert a line marker in the image (as described above) at the position where the intensity profile should be obtained. Press the  button in the Data Processing Toolbar and the intensity profile is automatically inserted into a new pane. If you move the line marker 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 Object Info Control panel also shows the measurement information.

Display of measurement information.

2.11.3.5 Image selection tool

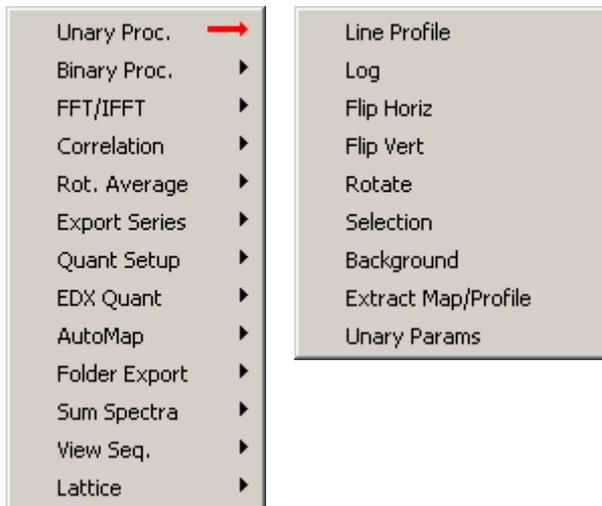
The image selection tool  can be used to draw a frame in an image. Its properties (accessed by double-clicking on the marker or clicking with the right-hand mouse button on a marker and selecting Properties in the popup menu) include a name, a style (color for this type of marker; users can define different 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:

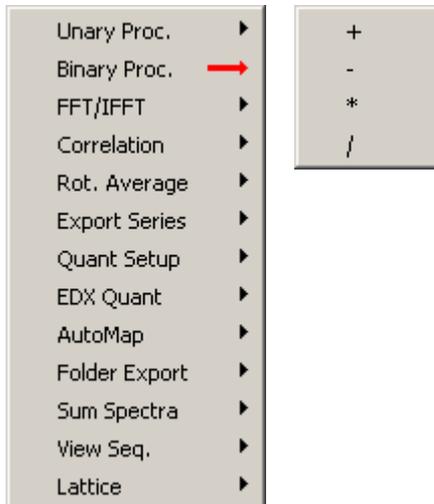
- **Calculating an FFT from an area inside an image:** FFTs (Fast Fourier Transforms) can be calculated from essentially any rectangular area (down to a horizontal or vertical line; the area does not have to have power of 2 dimensions). To obtain an FFT, draw an image selection marker around the area to be used for the FFT and press the  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.
- **Defining spectrum image positions:** See the Experiments Control Panel.

2.11.4 Processing functions



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 3.
- Flip Vert - Flips image vertically. For more information, see section 3.
- Rotate - Rotates image. For more information, see section 3.
- 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 2.11.6.2.
- Extract Map/Profile - Extracts a map or line profile from Experiments data.
- Unary Params - Opens the Unary Processing Parameters dialog.



Processing functions working on a combination of images or image and scalar

- + Adds data or constant to data. For more information, see section **Error! Reference source not found.**
- - Subtracts data or constant from data.
- * Multiplies data with data or constant.
- / Divides data by data or constant.



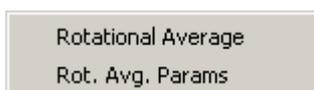
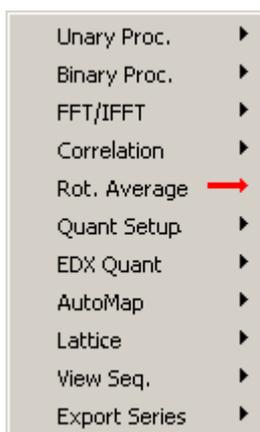
Fast Fourier processing functions

- 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.



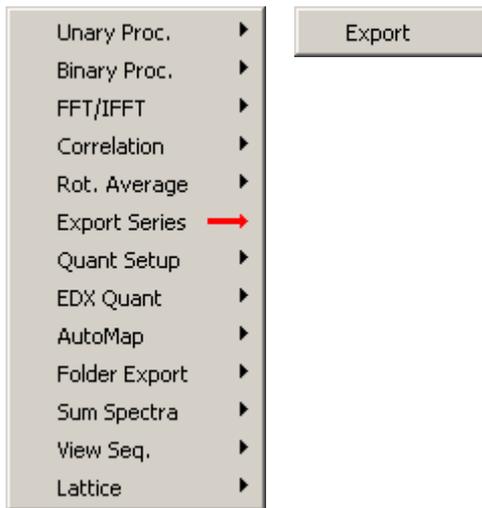
Correlation functions

- 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.
- MCF – Calculates the mutual correlation function of two images. Similar to the corss-correlation but much less sensitive to repeating features (as in high-resolution images).
- Corr. Params - Opens Correlation Parameters dialog.



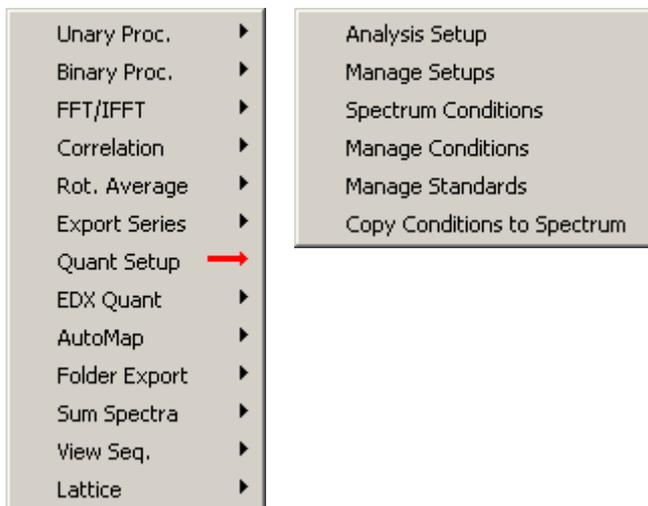
Rotational average functions

- Rotational Average - Calculates rotational average of FFT over angular range defined. For more information, see section 2.11.6.3.
- Rot. Avg. Params - Opens Rotational Average Parameters dialog.



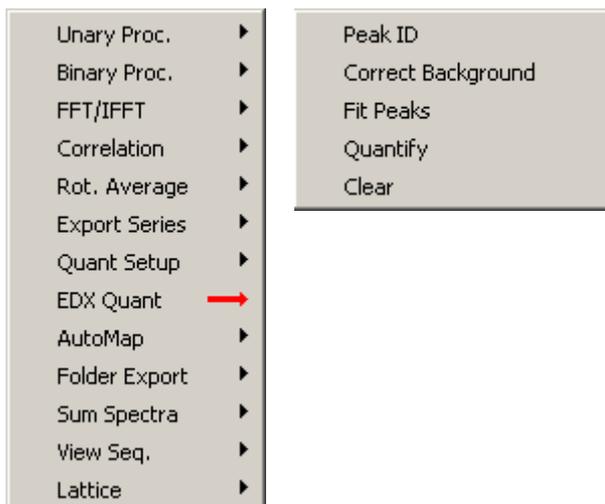
Export Series function

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 2.11.6.4.



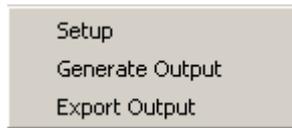
Quantification Setup functions

Not covered in this help file.



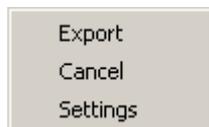
EDX Quantification functions

Not covered in this help file.



AutoMap functions

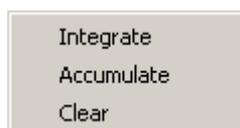
Not covered in this help file.



Folder Export functions

Note : This functionality is not visible by default. If you wish to use Folder Export, the FolderExport.wsc component must be installed.

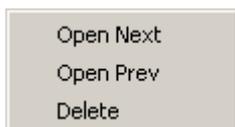
With Folder Export you can export images or spectra from TIA (*.emi) files in a folder or series of subfolders. The function will iterate over all the files present and export the images or spectra according to the options defined under Settings.



Sum Spectra functions

Note : This functionality is not visible by default. If you wish to use Sum Spectra, the SumSpectra.wsc component must be installed.

For more information, see section 2.11.6.5.



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.

Note : This functionality is not visible by default. If you wish to use View Sequential, the ViewSequential.wsc component must be installed.



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.

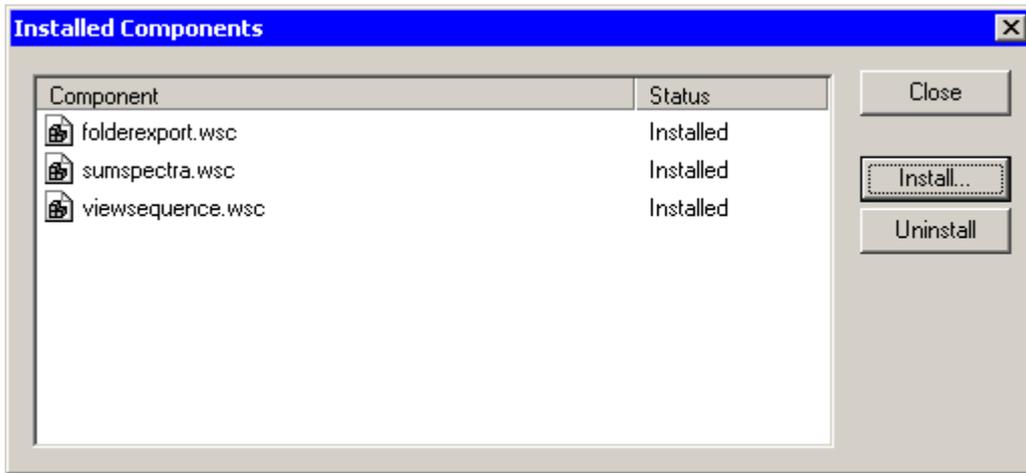
Not covered in this help file.

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.

Important note: If the .wsc file to be installed has "En" in its name, you must omit that.



For example, the components shown have the (Windows Explorer) names FolderExportEn.wsc, SumSpectraEn.wsc and ViewSequenceEn.wsc

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.
	FFT	Calculates FFT from 2- or 1-dimensional data. For more information, see section 2.11.5.3.
	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 3.
	Flip Vertically	Flips image vertically.
	Rotate	Rotates image. For more information, see section 3.
	Add	Adds data or constant to data. For more information, see section 2.11.6.1.
	Subtract	Subtracts data or constant from data.
	Multiply	Multiplies data with data or constant.
	Divide	Divides data by data or constant.
	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 2.11.6.2.
	Rotational Average	Calculates rotational average of FFT over angular range defined. For more information, see section 2.11.6.3.
	Data Processing Setup	Leads to dialog with settings. A combination of all parameters for the individual data processing functions.

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.

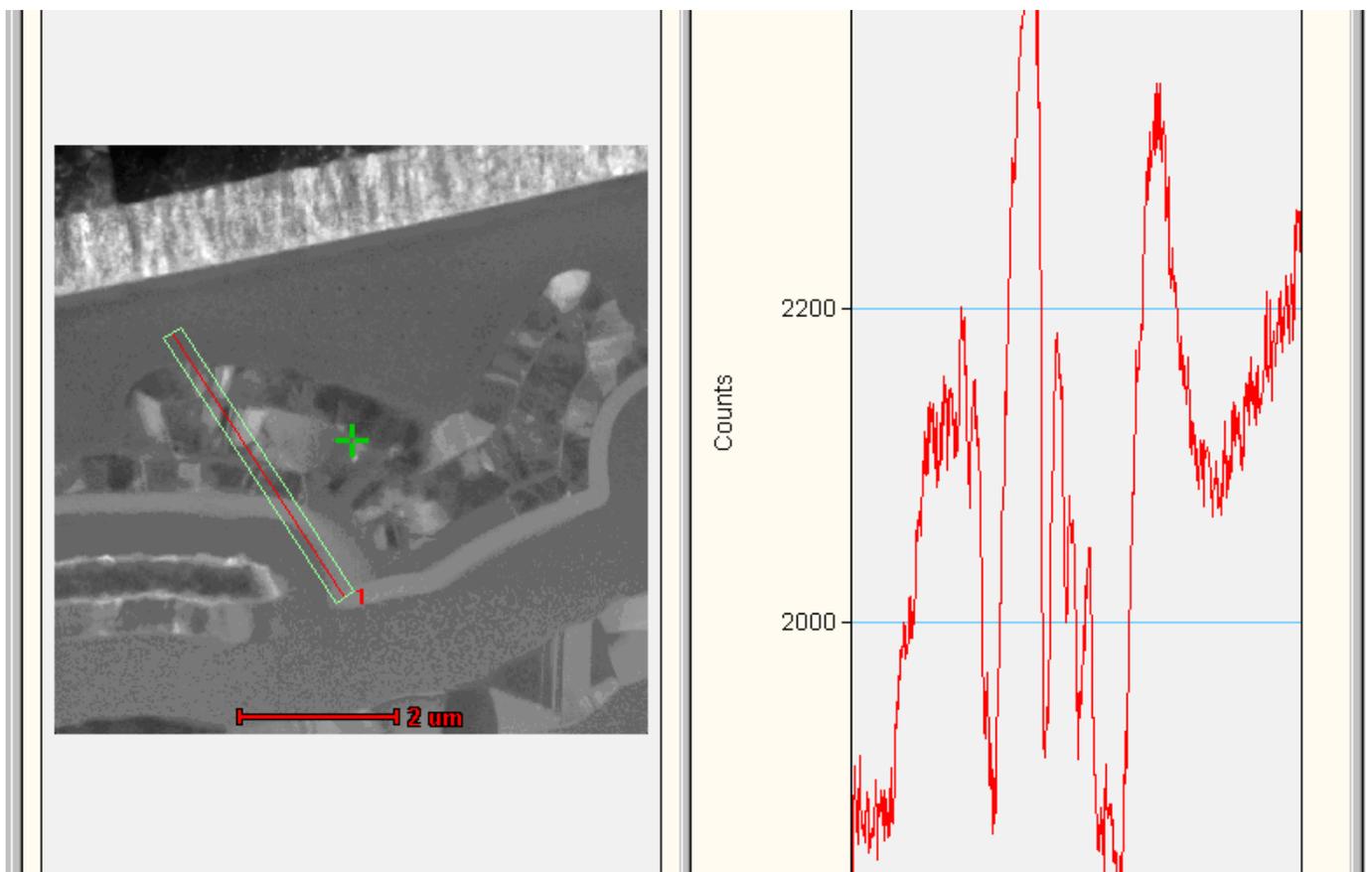
2.11.5.2 Intensity profile

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.

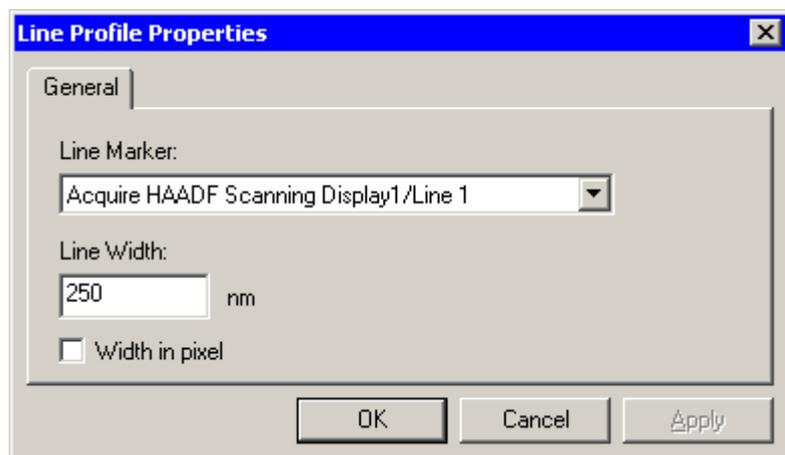
Hints:

- 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.

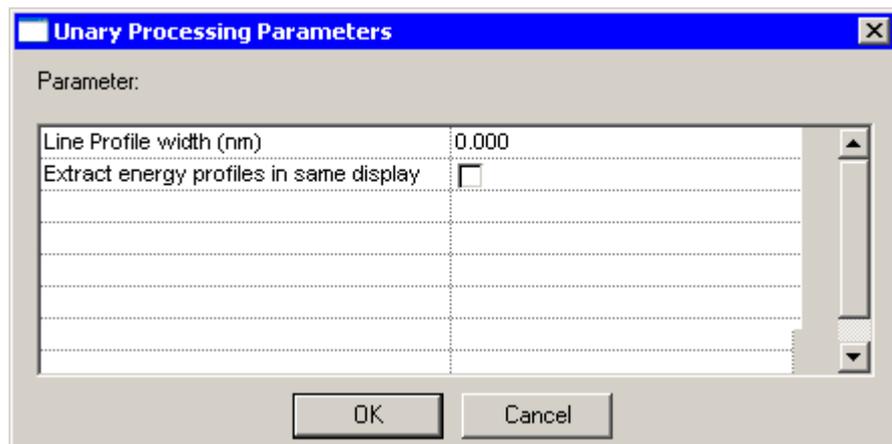


There are two ways to define the integration width of the profile:

- 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.



- 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.



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:

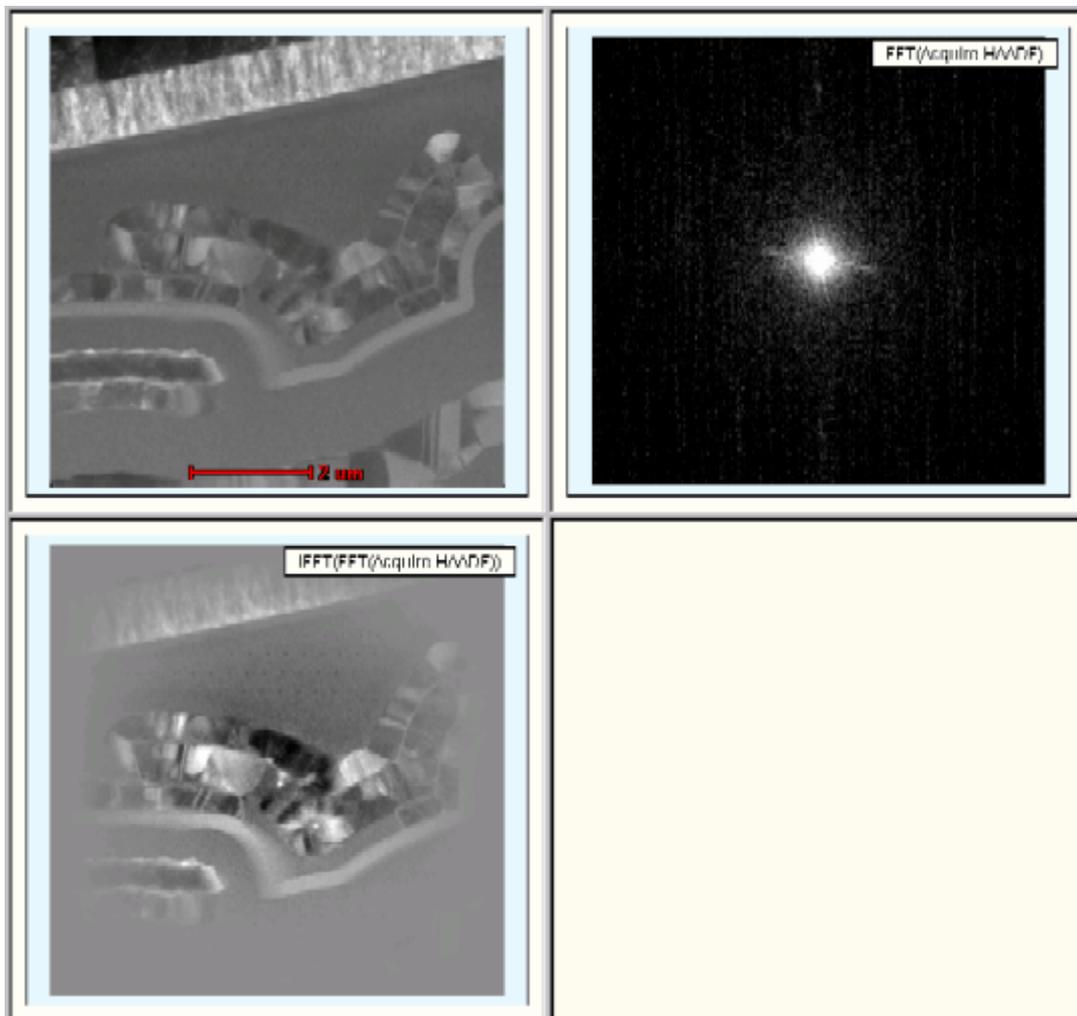
- FFTs of very large images can take a significant amount of time. TIA therefore by defaults uses a selection of a maximum of a 2k image when FFT is selected on an image larger than 2k (the selection of shown by an image selection marker). If you do want an FFT of the whole image and the image is larger, 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.

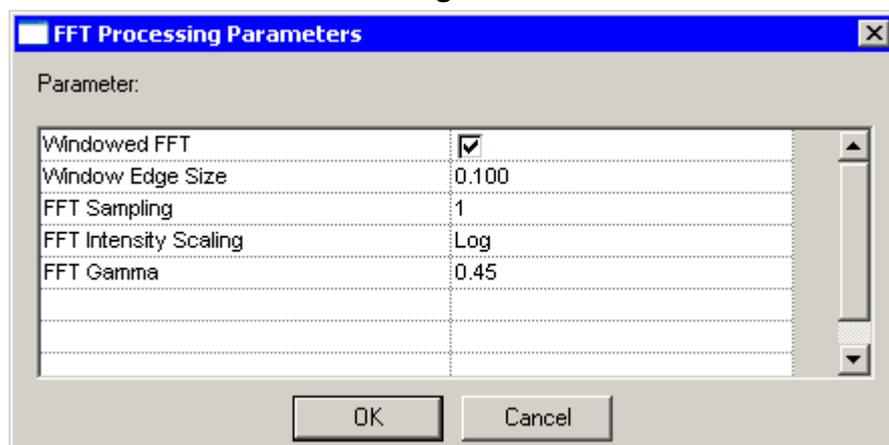


Top left: Original image

Top right: FFT of image

Bottom left: Inverse FFT of FFT

2.11.5.5 FFT/IFFT Processing Parameters

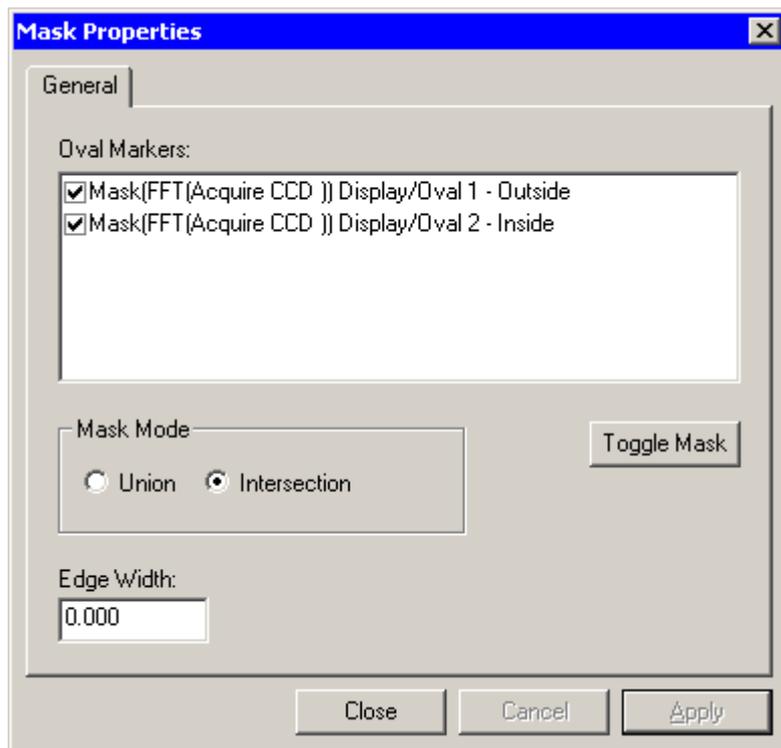


The FFT Processing Parameters dialog provides access to the Windowed FFT option (generally this should be on, otherwise the hard edges of the image may give artefacts in the FFT), the FFT sampling (a bit similar to binning; a sampling interval of 2, 4, 8, etc, results in an FFT sampling fewer pixels) 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.

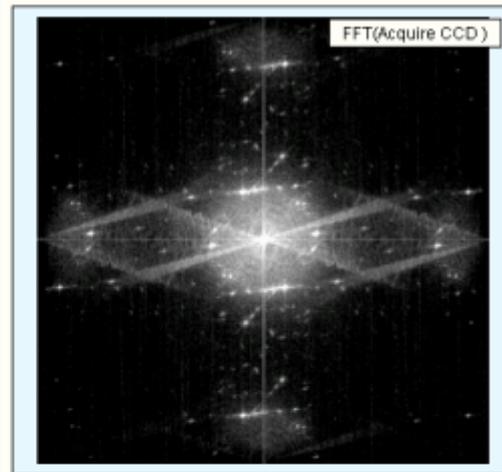
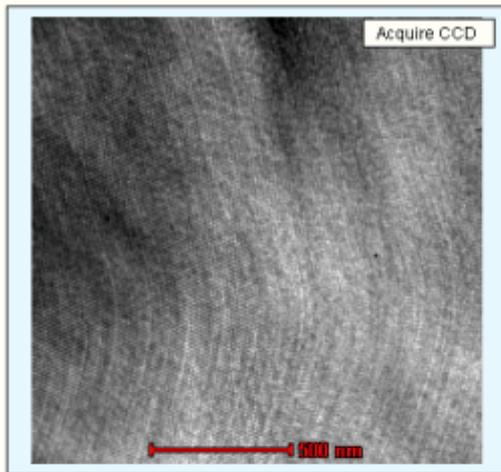
- Open or acquire a HREM image.
- Create the diffractogram (FFT).
- Apply Mask Filter processing on the FFT. A copy of the FFT will be generated.
- Place two circular markers on the FFT image using the Oval Marker Tool to mark the ROI (inner and outer boundaries) used for filtering. Use the marker properties dialogs to center the markers and make them circular (Center values to 0,0 and Size values equal) or use Alt + resize to keep the marker centered in the FFT.
- 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.

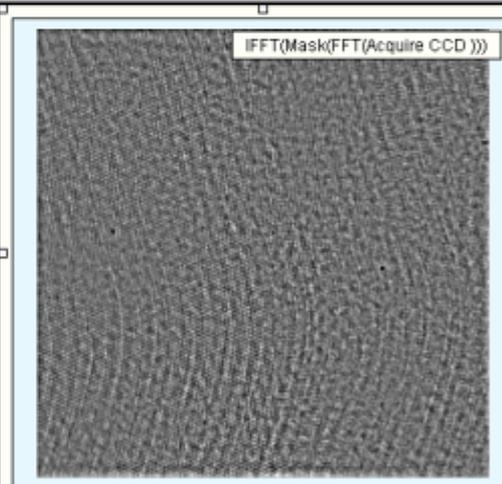
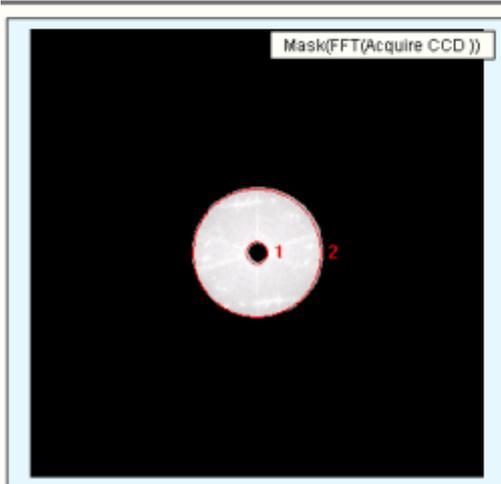


Top left: Original image

Top right: FFT

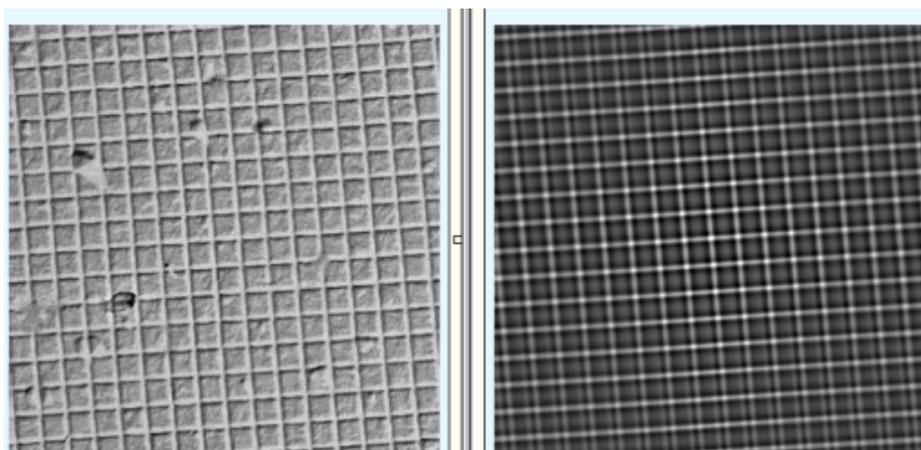
Bottom left: Masked FFT with markers and effect of masking

Bottom right: Inverse FFT of masked FFT



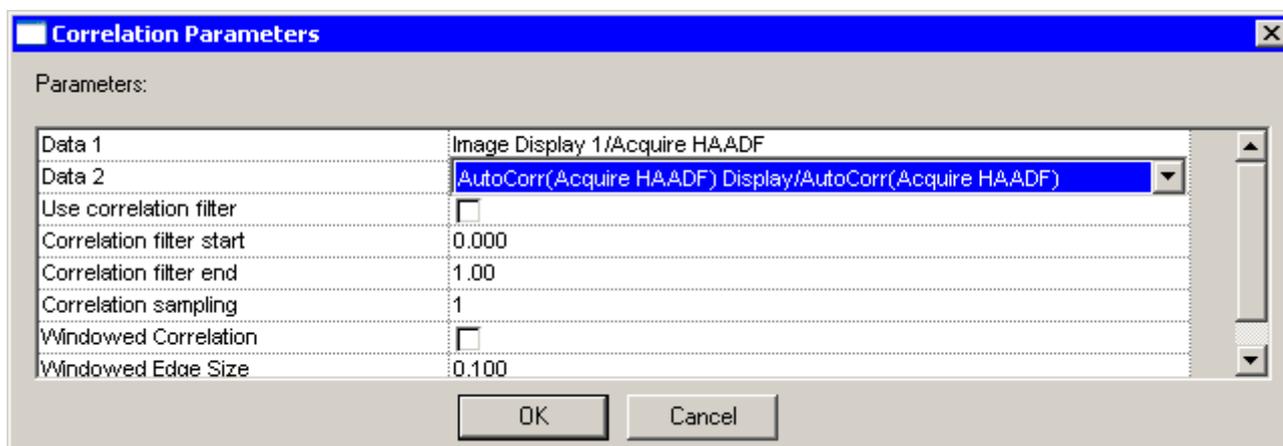
2.11.5.7 Autocorrelate

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.



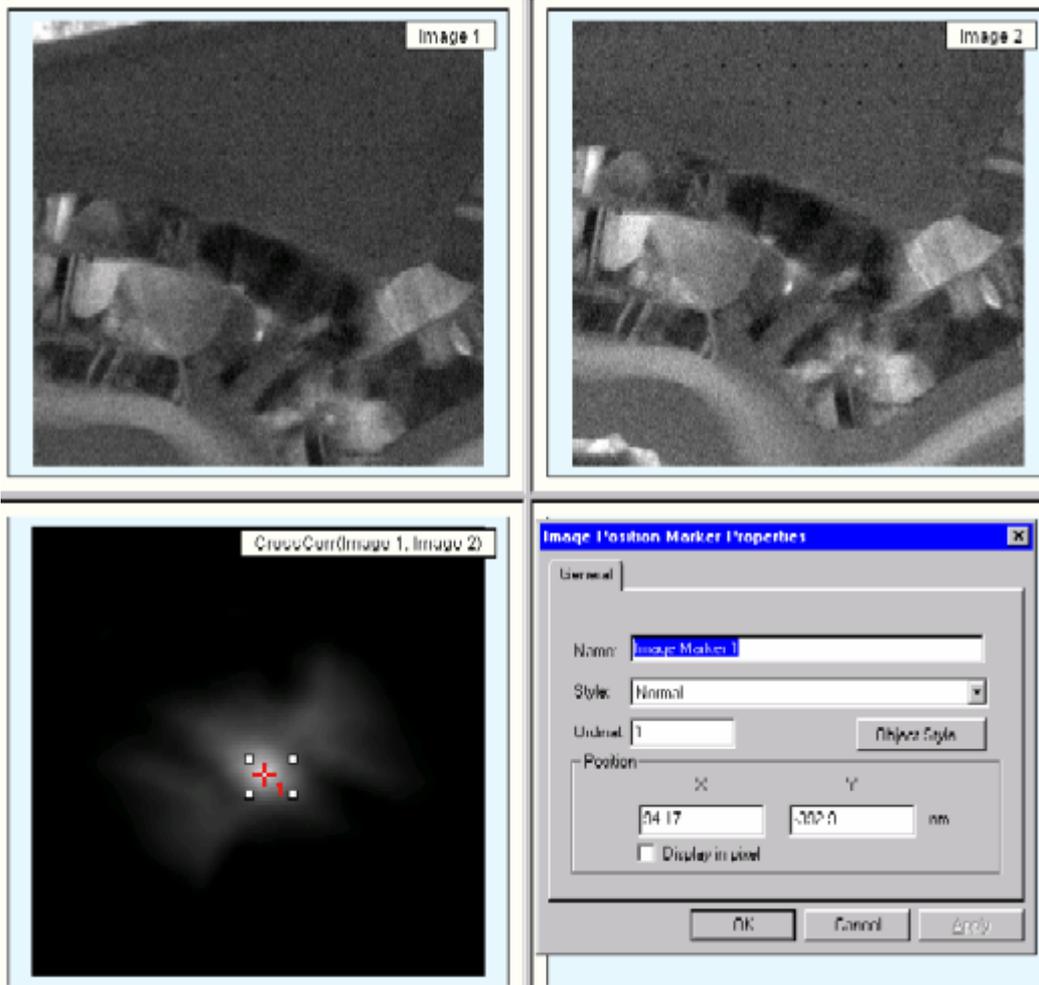
2.11.5.8 Cross-correlate

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.

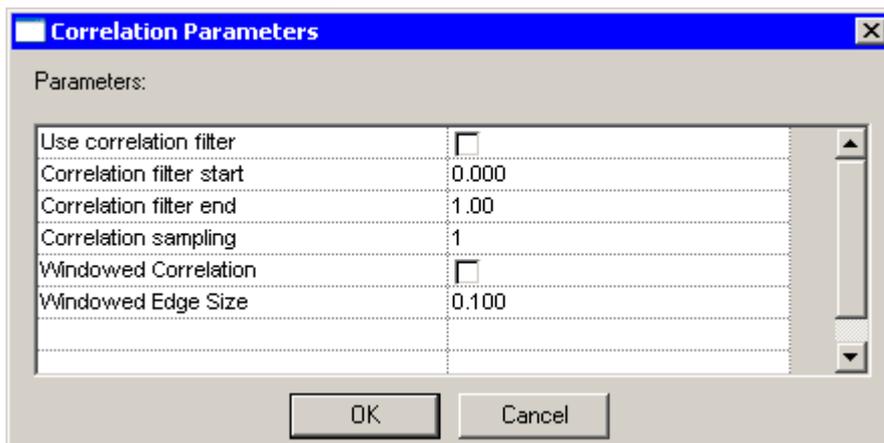


Select the two images required under Data 1 and Data 2.

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.

2.11.6 Image transformations

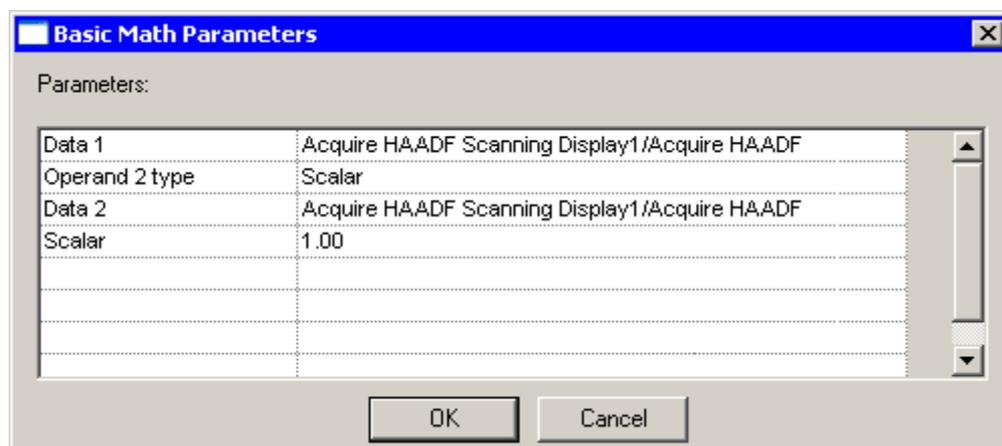
This processing tool provides a quick way to align the image to a certain orientation via flipping or rotation. Flipping provides a quick way to flip image vertically or horizontally, and rotation can rotate images at any given angle.

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.

2.11.6.1 Binary processing

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.



- 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.

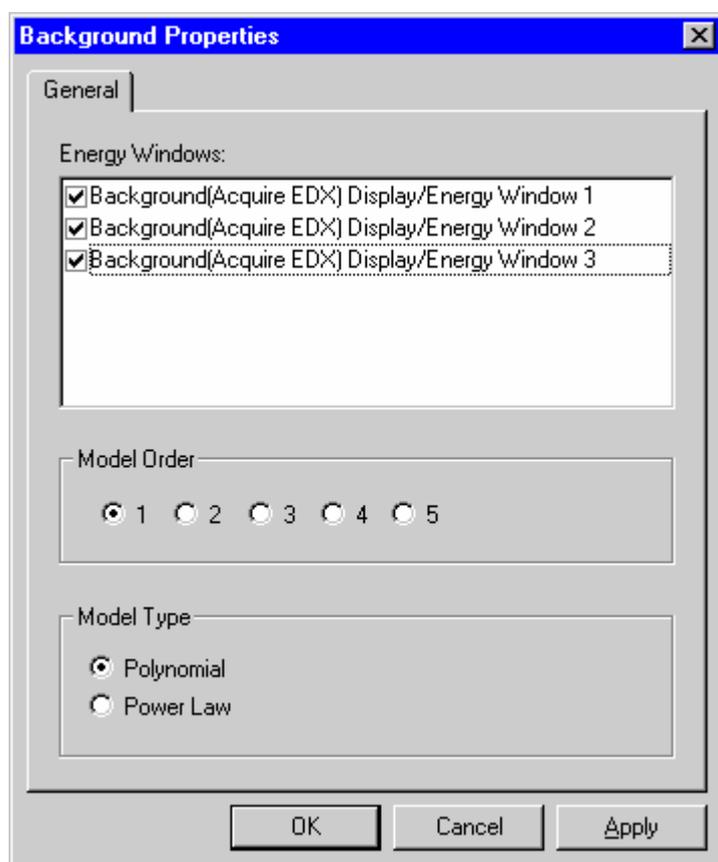
Notes:

- 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.

2.11.6.2 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:

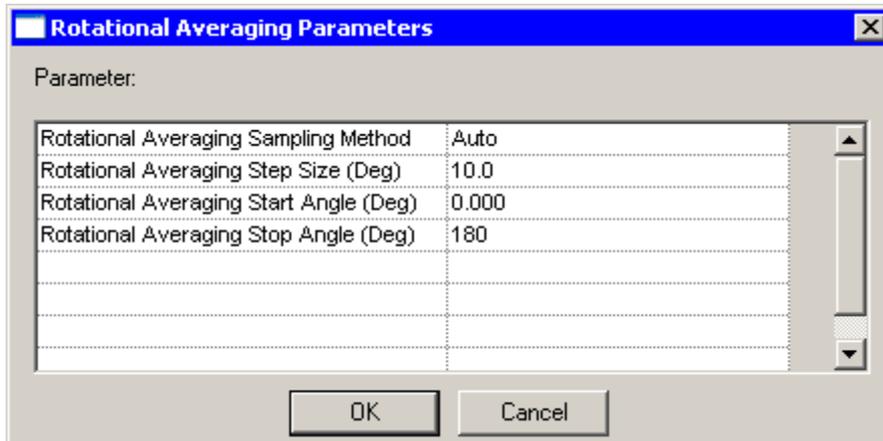
- Acquire a spectrum or open a file containing a spectrum.
- Click on the spectrum to select it and press the Correct Background button in the Data Processing toolbar.
- A new display will be added to the Display Window containing the spectrum with the option to perform background correction.
- Use the 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:



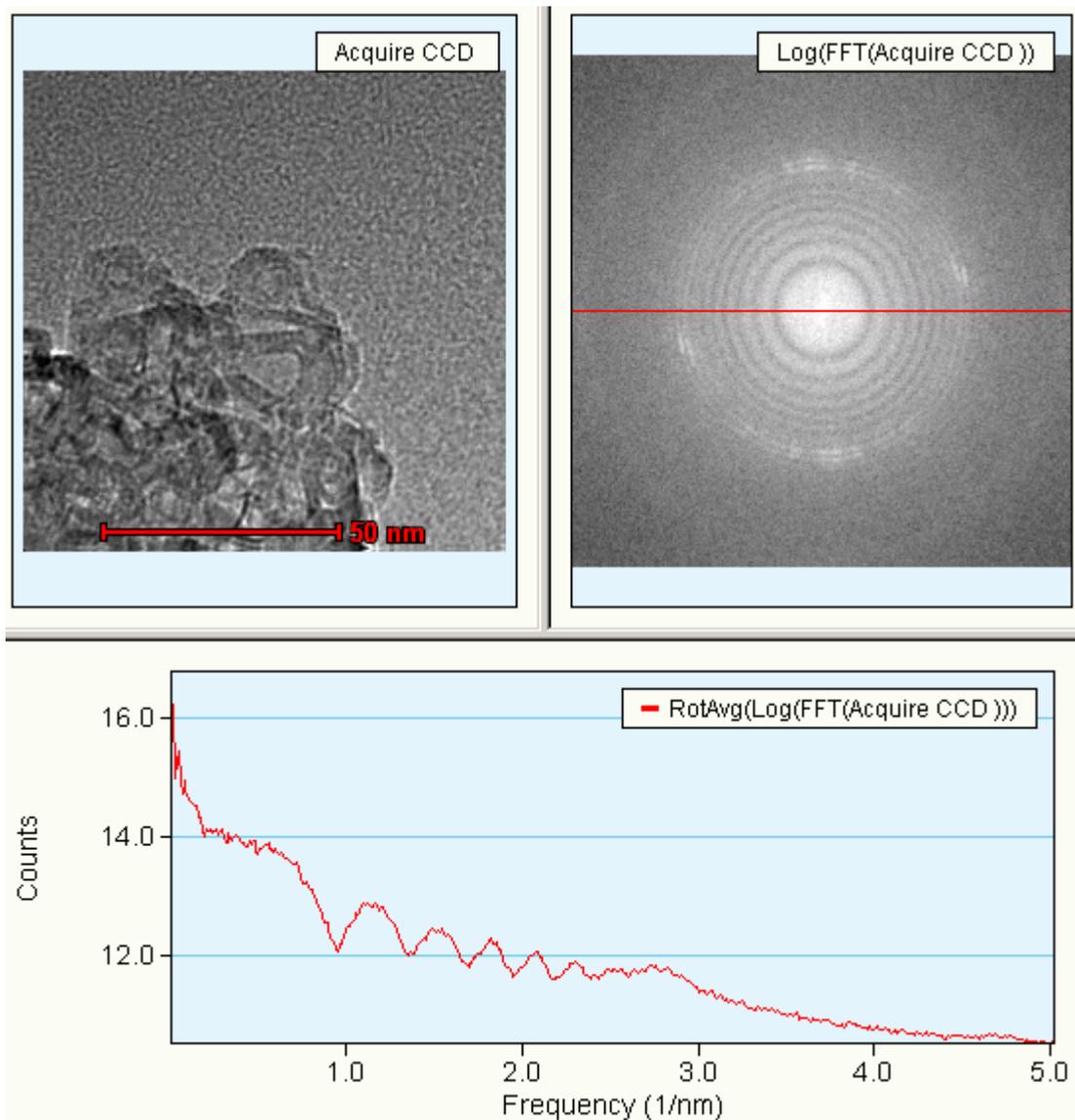
- Check the checkbox next to the desired energy window(s) in the list to be used for correction.
- Choose the Model Order and Model Type, then Press “OK” to apply the correction.

2.11.6.3 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.



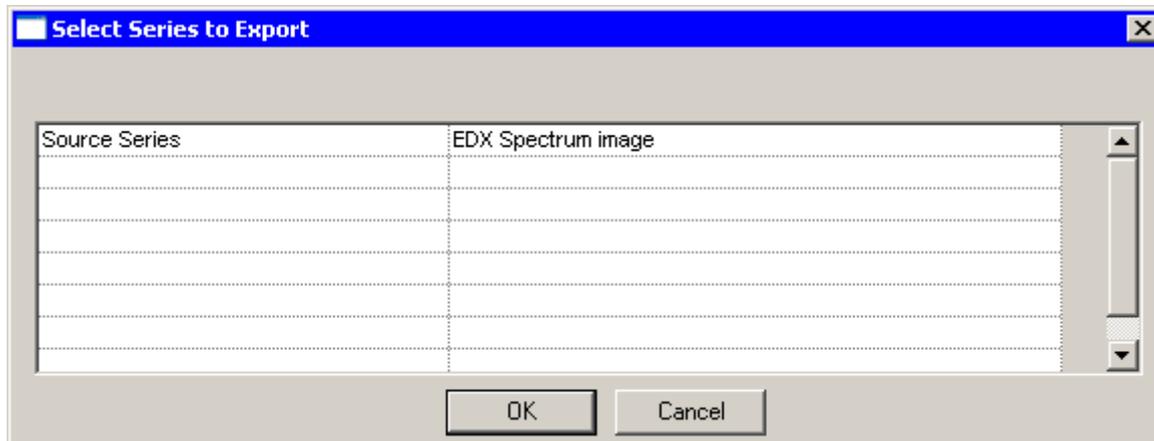
For the rotational average you can specify a step size in degrees, which is used if you use the Manual sampling method, and the start and ending angles. Typically the latter are 0 and 180° (there is no point in taking more than a total of 180° as the information in the FFT is identical when rotated 180°).



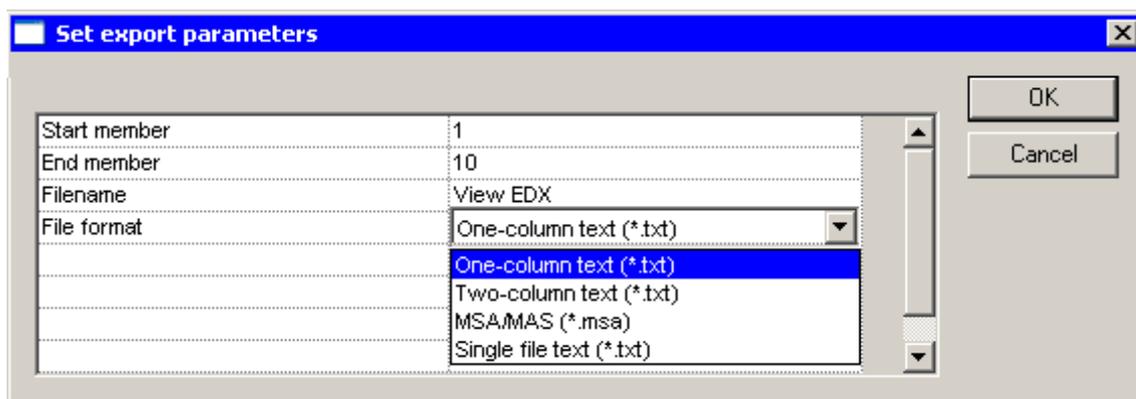
Example of the rotational average of the log of an FFT of an image. The rotational average has been done from 0 to 180°. The limits of the rotational average are shown by two red lines in the FFT (one at 0° from center to right, the other at 180° from center to left; in this case they appear to be a single line).

2.11.6.4 Export series

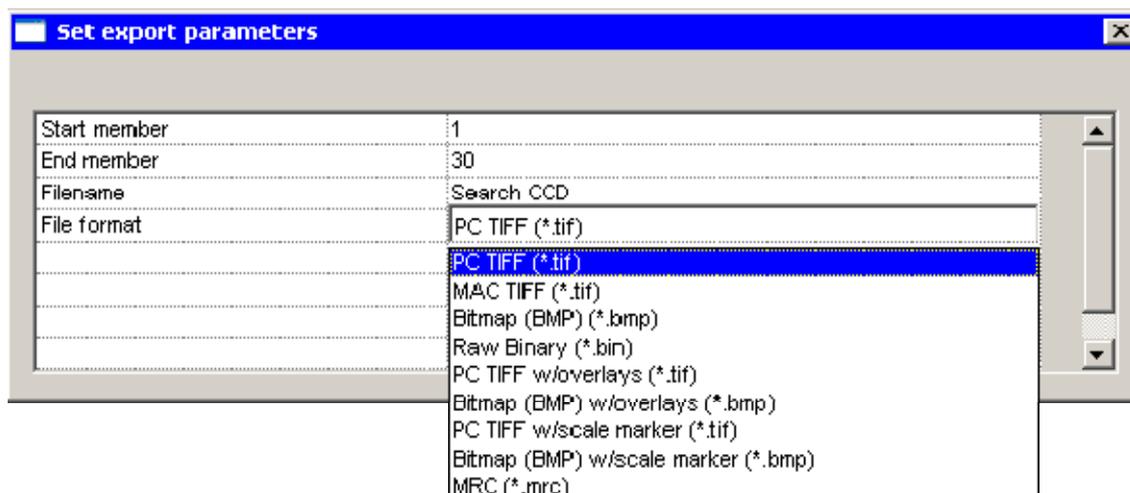
Export data series exports 1-D series data (spectra and images) into various kinds of formats. Select the required display window and select Export series / Export. The following dialog will become visible:



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.

2.11.6.5 Sum Spectra

The sum spectra function allows you to sum the spectra from pixels in a line profile or map. The difference between "integrate" and "accumulate" is that the former only sums spectra from a single selection. When accumulate is used, the spectra from additional selections are added to the existing selection. So, for example, if you want to sum the spectra for three particles of a different composition, you would use integrate. If the particles have the same composition and you want the overall spectrum, you would use accumulate.

To sum spectra, insert an area selection marker into the STEM image and select Sum Spectra, Integrate or Accumulate. If you shift the marker later on, the sum will be recalculated. If you want to have several different displays with integrated spectra, rename the spectrum/display once the summing is done. This make sure the data are not subsequently overwritten (e.g. when you select another marker) and so it is clear which area the spectrum refers to (e.g. display the ordinal of the marker and put the number in the name).

2.11.7 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 2.11.7.2.
		Calibration Shift Tool	The calibration shift tool can be used for calibration of spectra. For more information, see section 2.11.7.3.
		Marker Tool	The marker tool can be inserted in profiles and spectra to mark a position. For more information, see section 2.11.7.1.

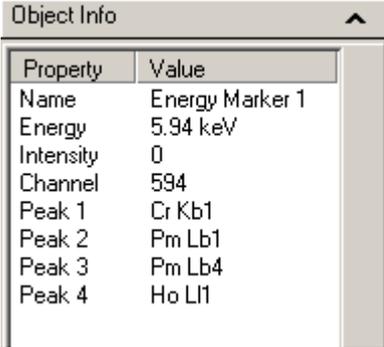
2.11.7.1 Marker tool

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 Object 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 LII

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

2.11.7.2 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.

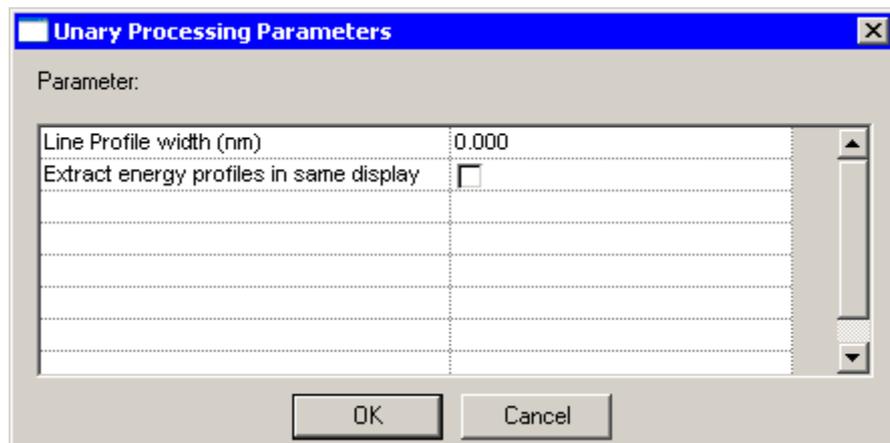
Examples:

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

Property	Value
Name	Energy Window 1
Center	1.78 keV
Width	572 eV
Mean	15.1
Min	0.000
Max	78.0
Variance	461
StdDev	21.5
Sum	877

Object 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.



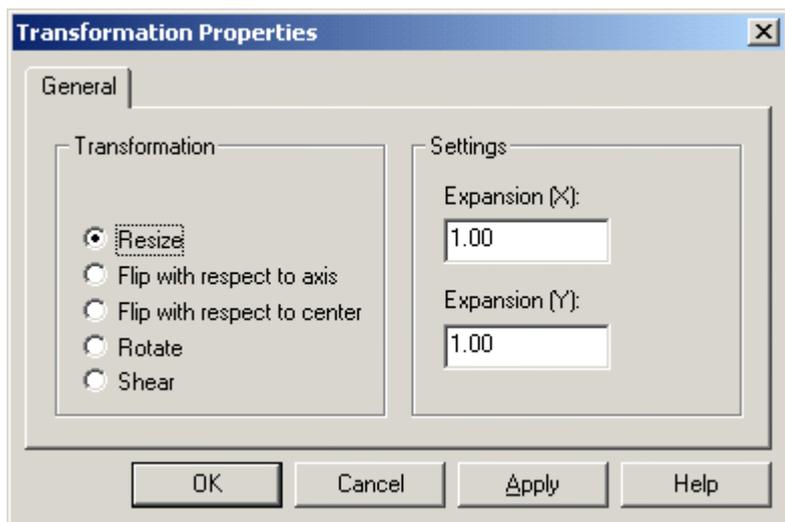
2.11.7.3 Calibration shift tool

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.

3 Image transformations – general

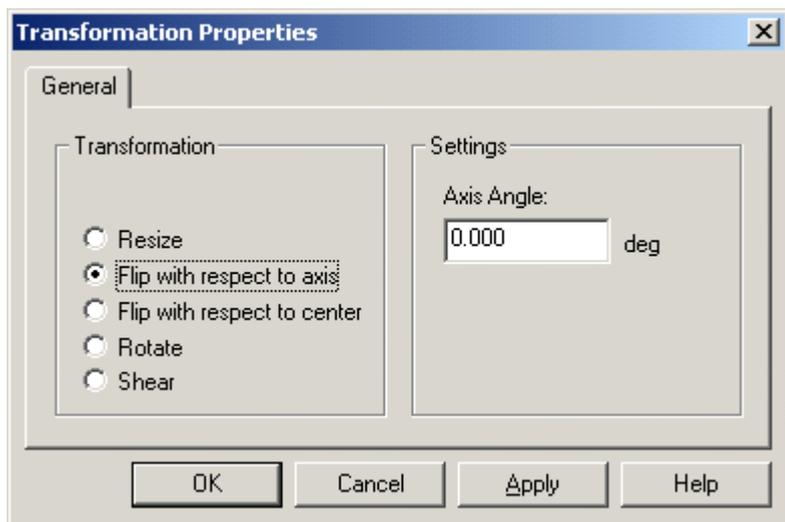
TIA has a large number of image transformation function, but not all are readily exposed. To look for the "hidden" functions, in general pick an exposed image transformation function like Flip Horizontally (see section 0). Click on the resulting image with the right-hand mouse button and in the popup menu select "Edit Transformation". Not only can you then change the setting for the transformation selected, but you can actually select a completely different transformation.

3.1 Resize

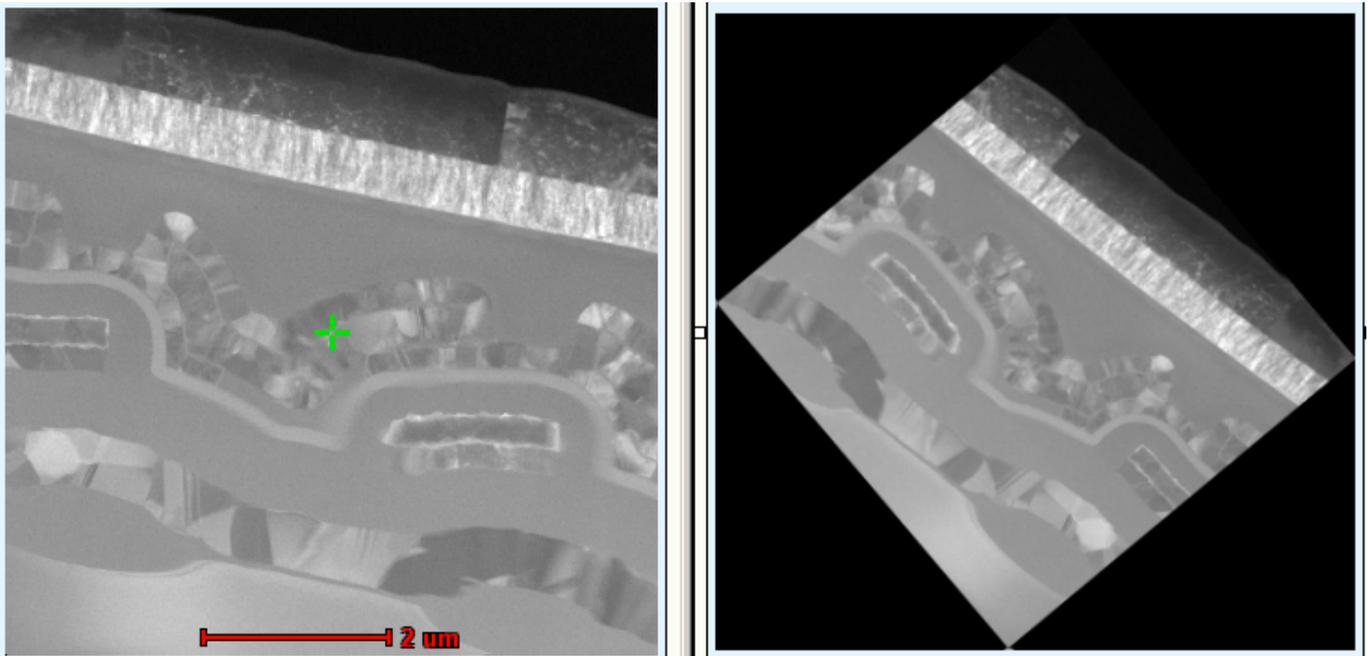


Resize allows you to resize the image. The resizing can be an expansion (no pixel interpolation is done) or a contraction. The values you can enter are not restricted so that the resulting transformation is done through a power of two value. For a "rebin" by two enter values of 0.5,0.5 for X and Y, for a rebin by four enter 0.25,0.25. But you can also use any other number.

3.2 Flip with respect to axis

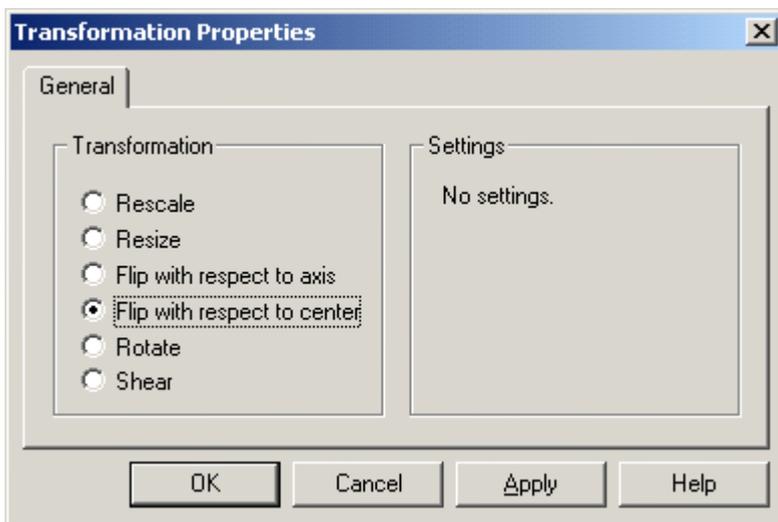


Flip with respect to axis executes a flip operation relative to the axis specified. An angle of 0° result in a left-right inversion, an angle of 90° to a top-bottom inversion.

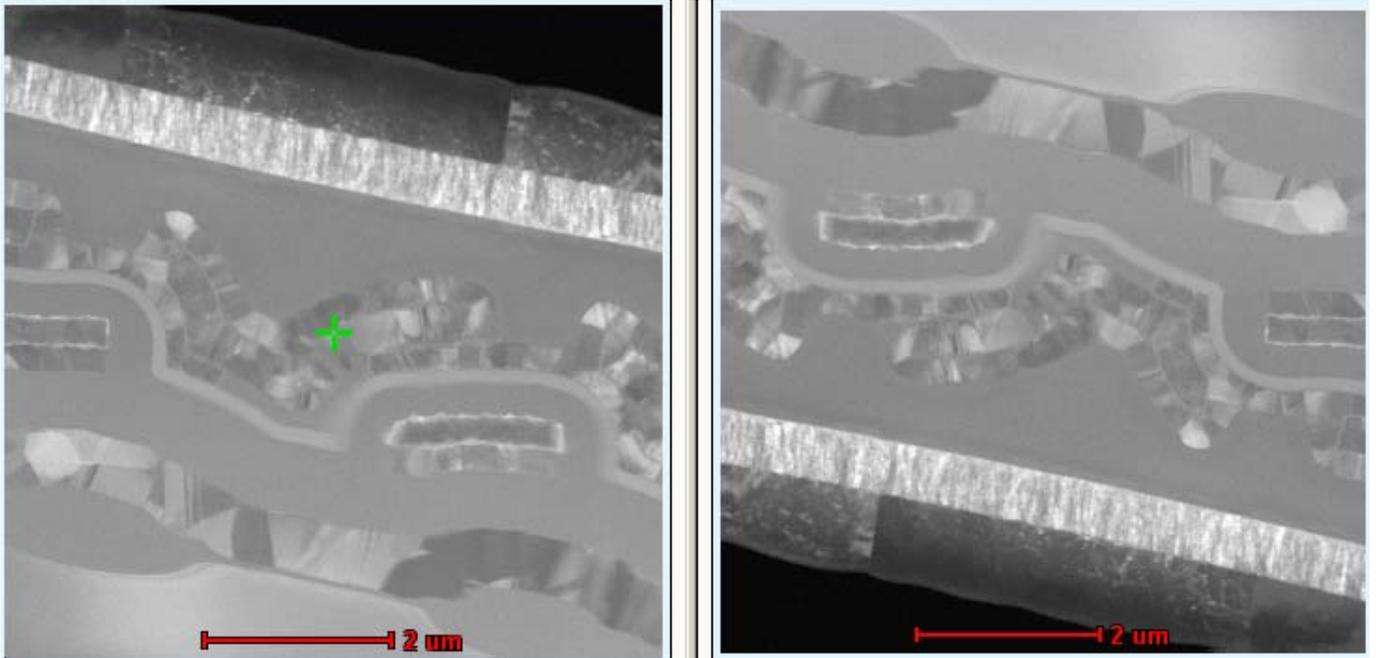


Original image (left) and flipped with respect to a 25° axis (right).

3.3 Flip with respect to center

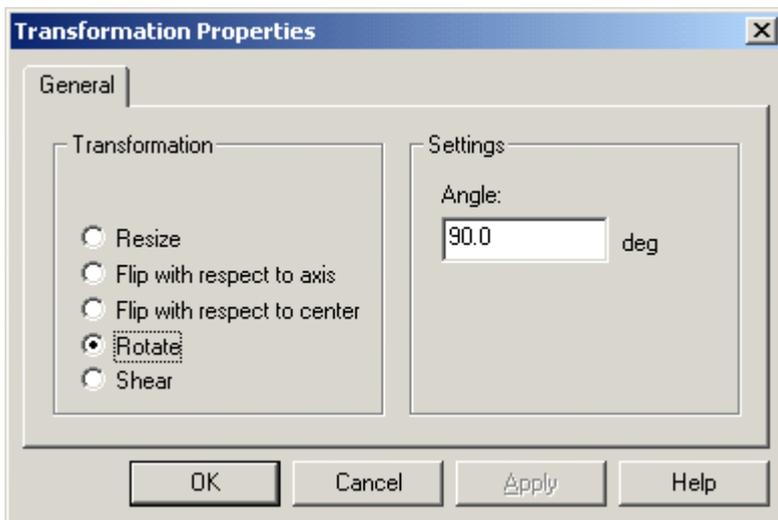


Flip with respect to center flips (mirrors) the image through its center. Which in effect is the same as a rotation by 180°.

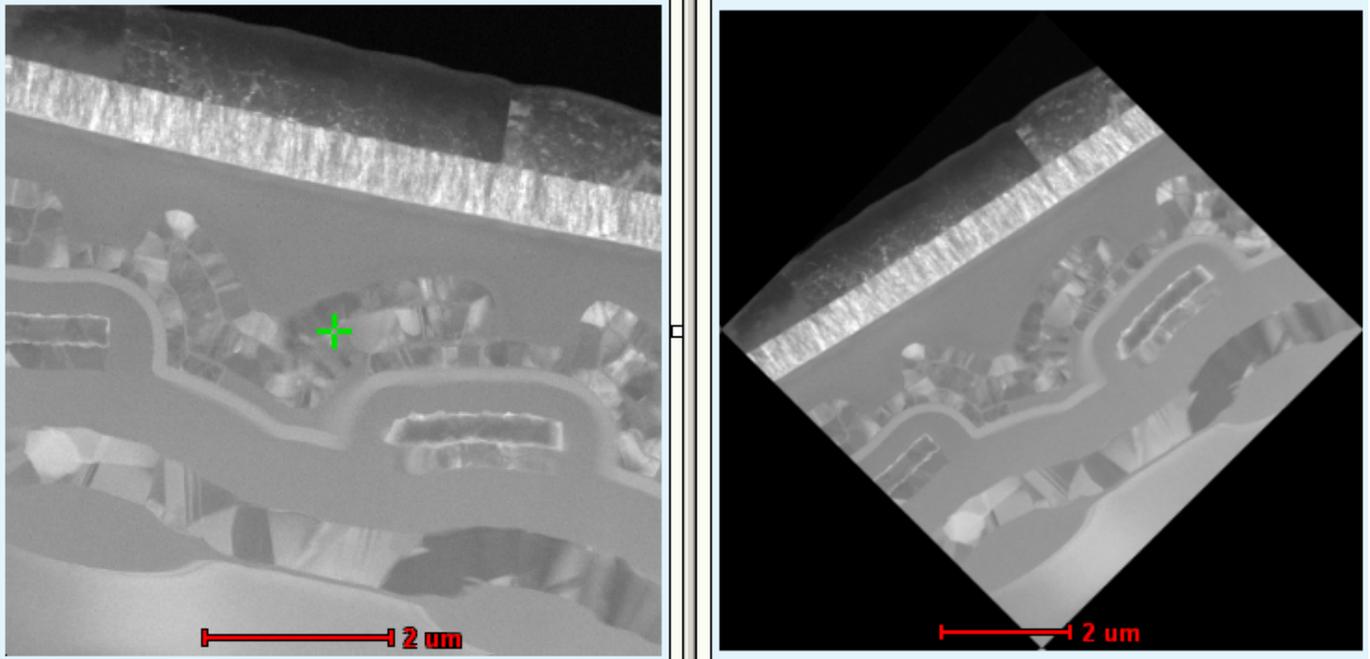


The original image (left) flipped with respect to its center (right).

3.4 Rotate

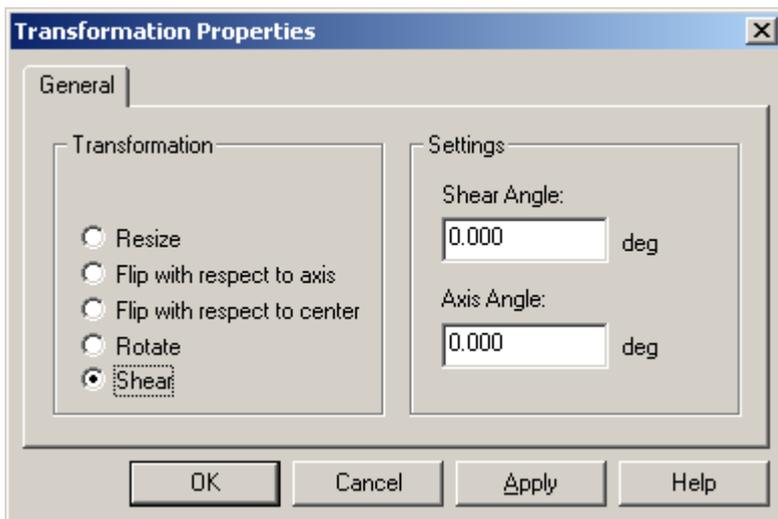


Rotate allows you to rotate the image. Note that if the angle is not a multiple of 90°, the resulting image will increase in size (up to $\sqrt{2}$ at 45°, etc.) to accommodate the new image. Undefined pixels around the old image margins will be black.



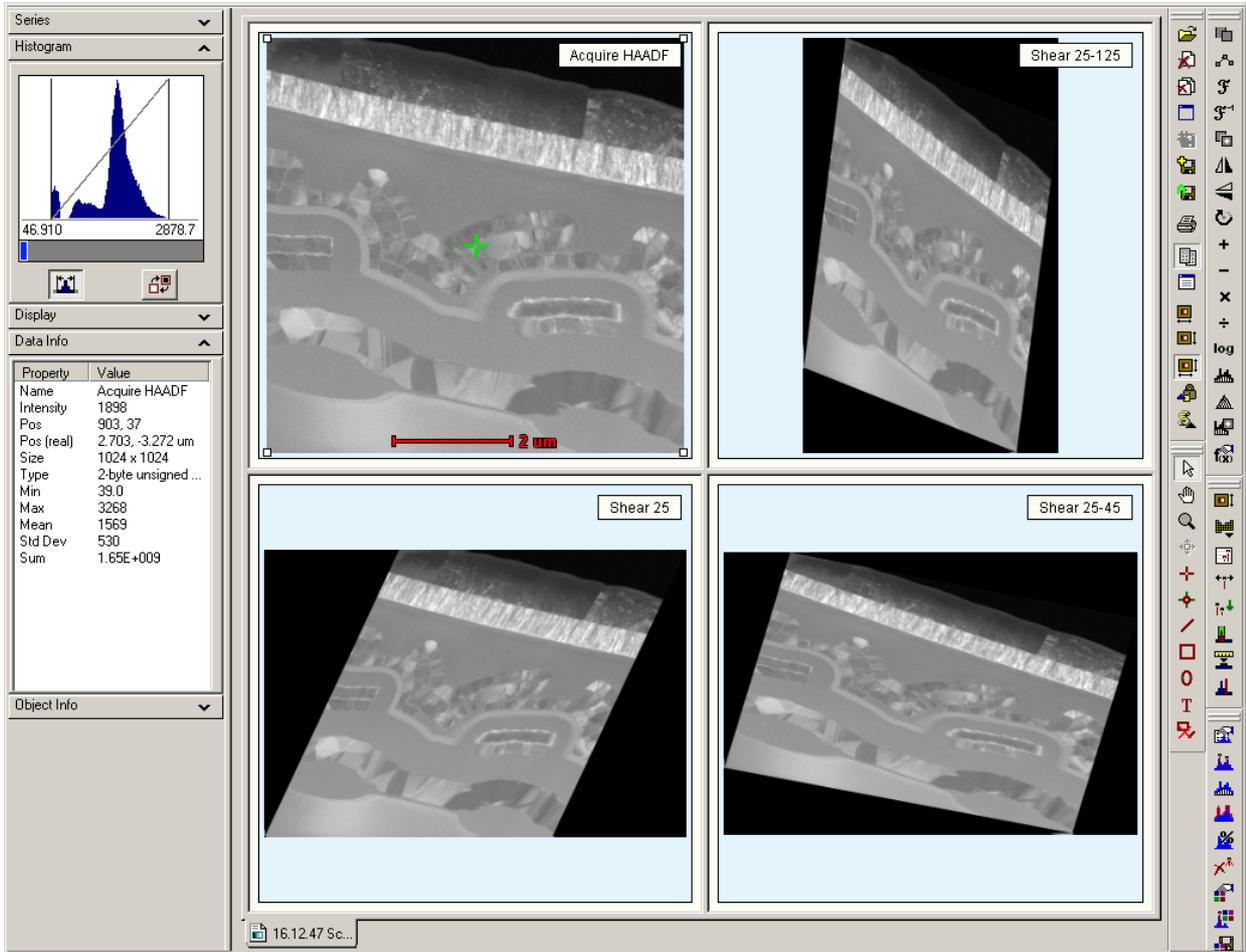
The original image (left) rotated 45° (right).

3.5 Shear



With shear you can shear the image. One example of this transform might to undo the distortion caused by drift during STEM acquisition. The shear angle typically is the value to be changed while the axis angle normally should remain 0°.

The image shows three shear transformations of the same image (top left) with shear angle/axis angle of 25/0 (bottom left), 25/125 top right and 25/45 bottom right.

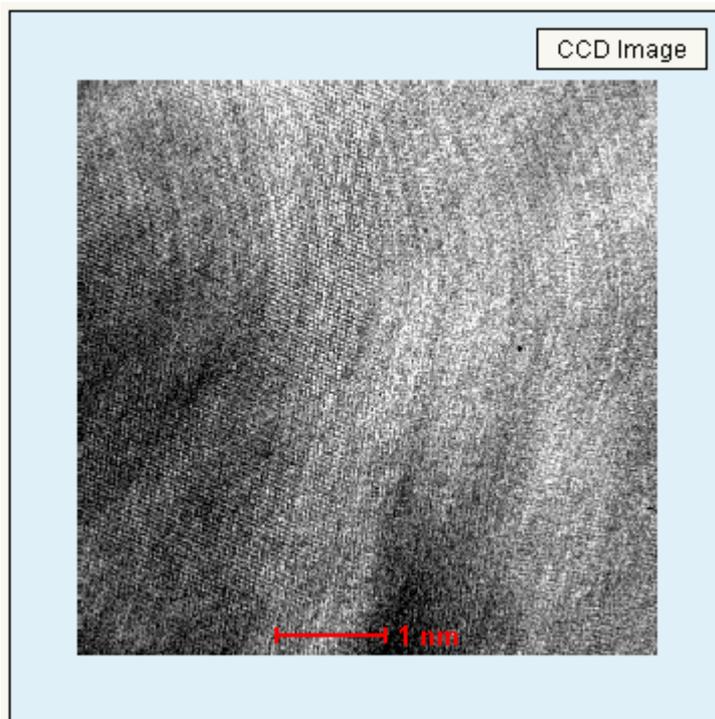


4 TIA CCD image acquisition

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.



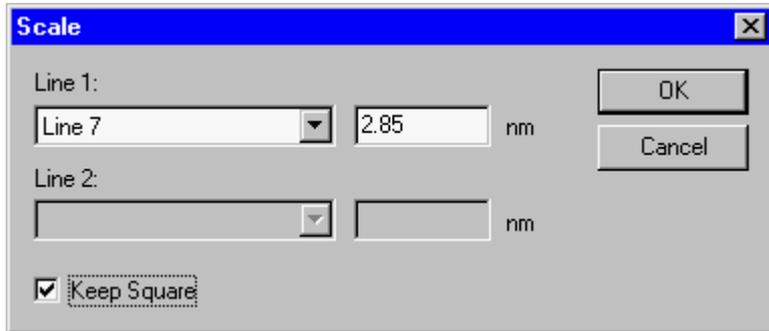
CCD image display. At bottom center a scale bar is shown (in red).

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.

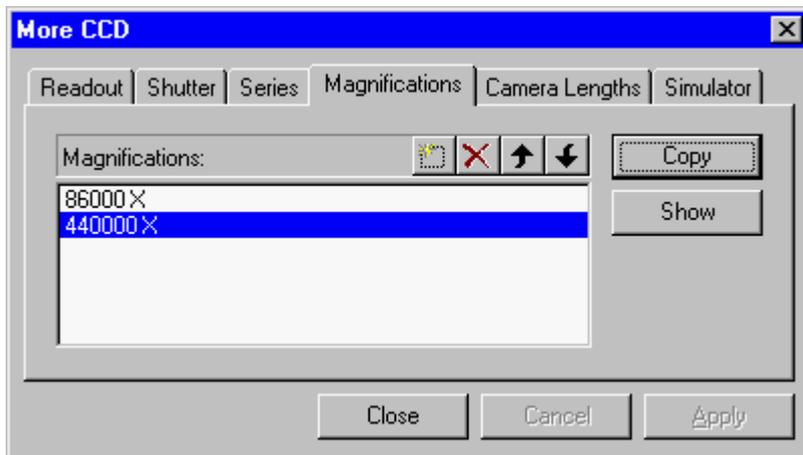


The Scale dialog with calibration data using one line.

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.

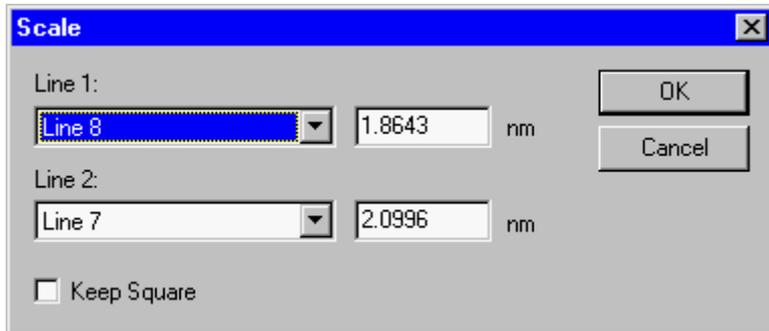


Video image display. At bottom center a scale bar is shown (in red).

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).

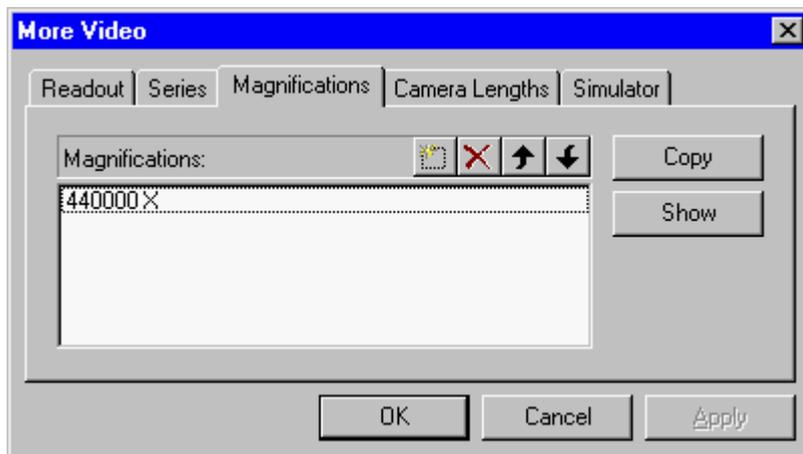
To calibrate an image, insert a line marker in the image, selected via the line marker tool button . For calibration using two directions, insert another line at approximately 90 (in this case the lines should be approximately horizontal and vertical; calibration with one line at +45 and the other at -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.

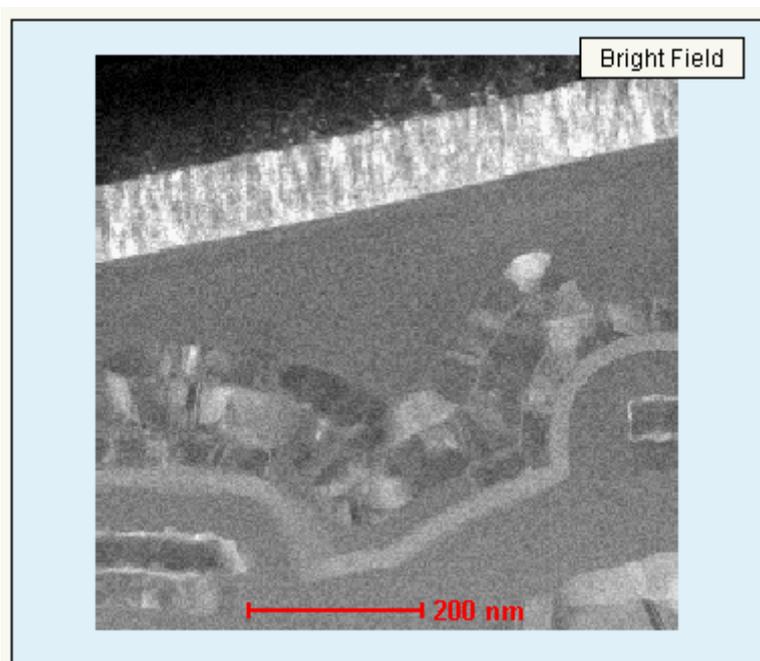
If the TEM magnification used for recording the image is already listed, click on the magnification in the list (it becomes highlighted) and press the Copy button. If the TEM magnification is not yet in the list, click on the New (Insert) button . TIA will create a new item in the list and put the cursor 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. TIA STEM image acquisition

5.3 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).

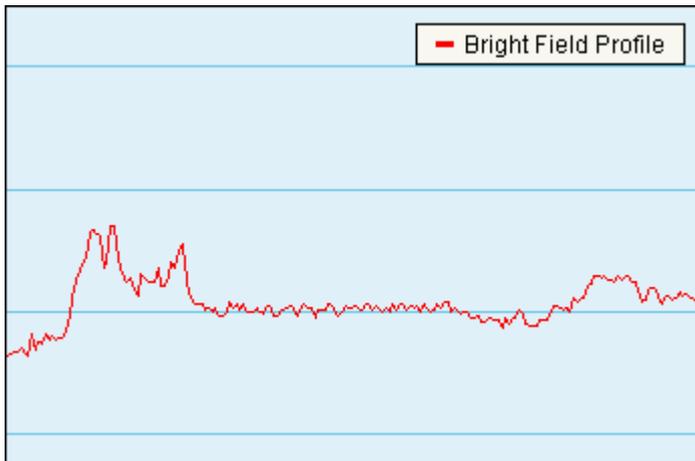
Each image is properly labeled with the name of the detector. Examples:

- 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).

5.4 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).



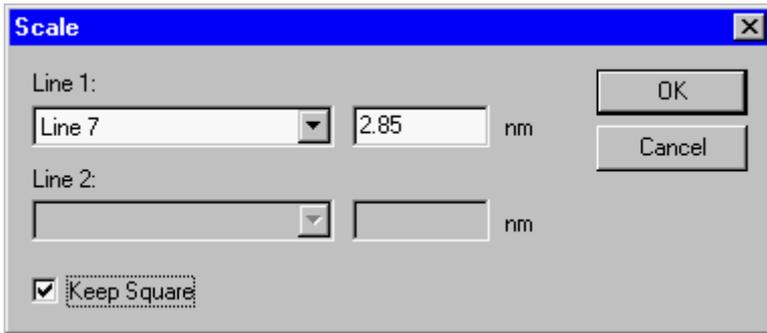
A scope display. The signal from the (BF) detector is displayed with high intensity (white) at the top and low intensity (black at the bottom). The vertical scale covers the full range of the possible detector signal (0-64000).

5.5 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.

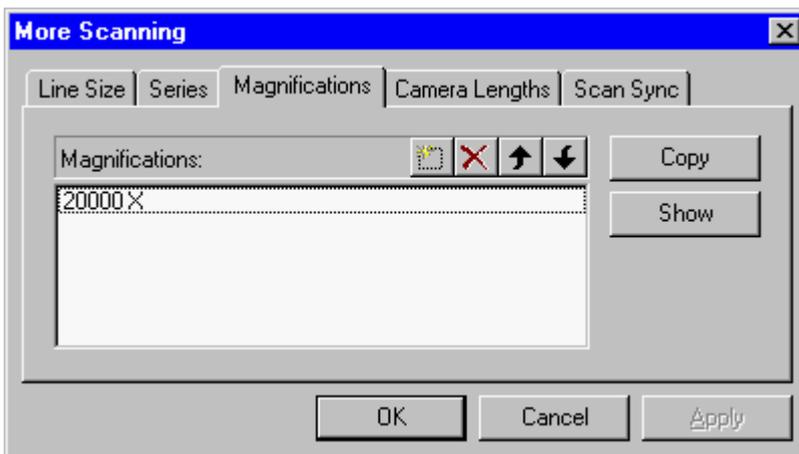


The Scale dialog with calibration data using one line.

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.

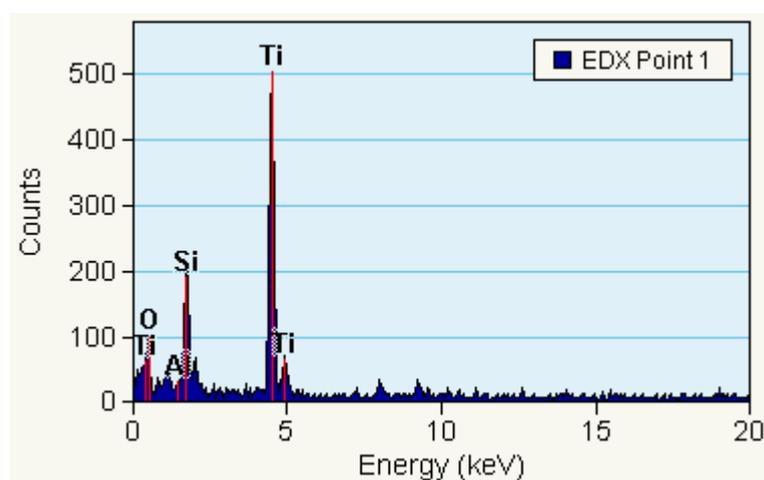
If you cannot move the last entry of magnification up, add a dummy entry and move it to the end. Now you can move up the entry that you wanted. Afterwards remove the dummy.

6 TIA EDX spectrum acquisition

6.1 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.

6.2 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.

6.3 Calibration of EDX spectra

There are different systems for calibrating EDX spectra.

6.3.1 Individual spectrum calibration

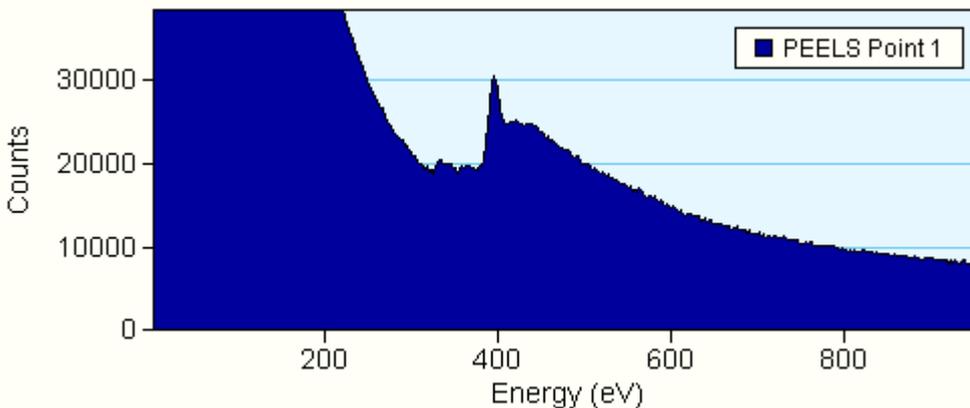
Whenever a spectrum fit is done with energy calibration as a variable (accessible in analysis mode from the menu by selecting Analyze, Edit Setup, Vary energy calibration on the Fitting tab), the spectrum is automatically recalibrated during the fitting procedure.

7 TIA PEELS spectrum acquisition

7.1 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.

7.2 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.

7.3 Calibration of PEELS spectra

7.3.1 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 .
- 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 .
- 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 single** (not one of a series) and the **dispersion is not correct** (the eV/channel) :

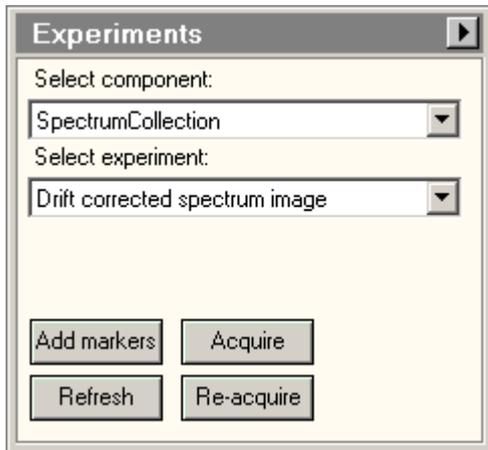
- Switch to analysis mode.
- Select the Calibration shift tool .
- Click on the spectrum at a known edge (the position is important because it defines the point around which the stretch of the spectrum in the next steps is done).
- Shift the spectrum to where it should be on the energy scale.
- Select 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 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 .
- 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.

8 Experiments (TEM 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 collect 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.

8.1 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.

8.2 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.

8.3 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.
- 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.

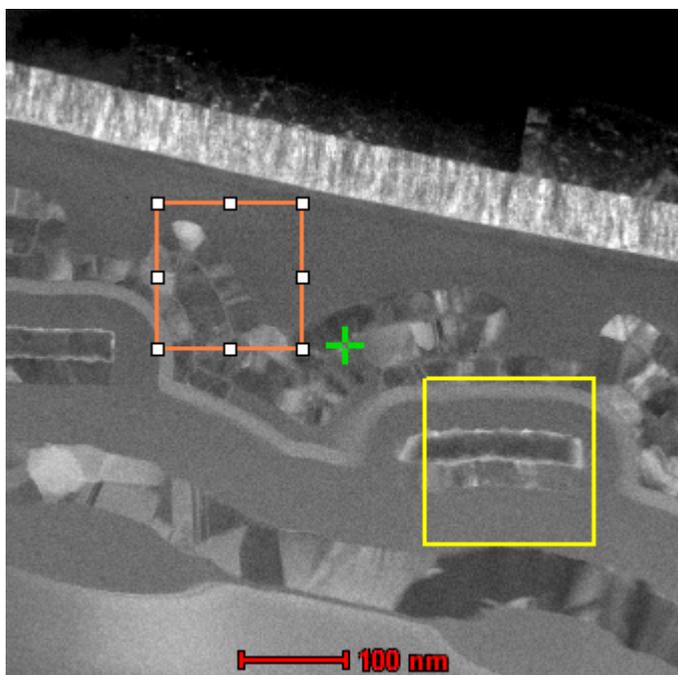
Note: Before an experiment can be started, you must at least once have acquired a STEM image. When you select a profile or image experiment, the required markers will automatically be placed in the STEM image if they are absent.

8.4 Drift correction

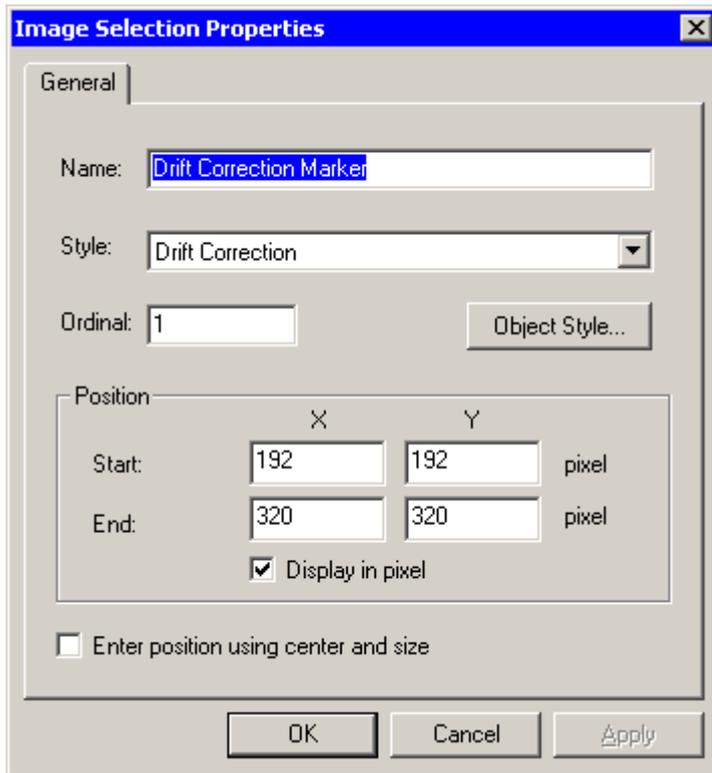
For drift correction the experiment will repeatedly acquire a STEM image and measure the shift relative to a similar image acquired at the start of the experiment. Any shift detected is compensated (with the scan signal, not the DC beam shift). The compensation is limited to the area covered by the starting 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 area in the image below is inside the orange box), while the drift correction area typically is distinguished by a thick yellow style.

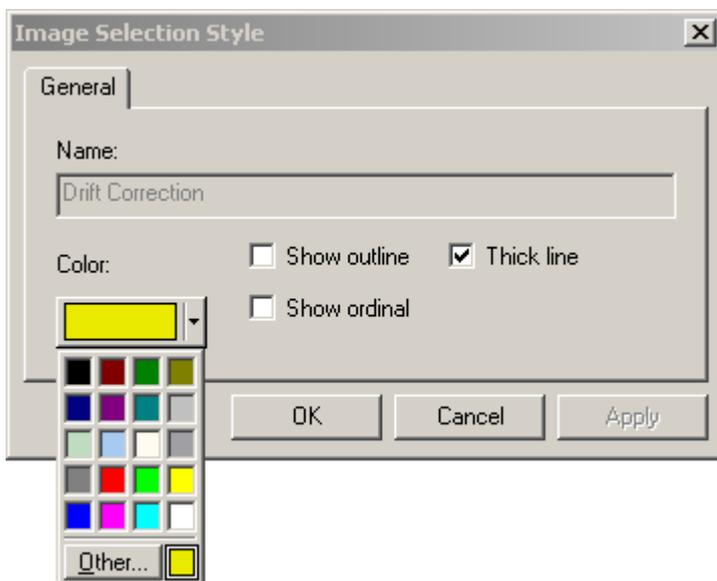
The markers also have distinctive names, but this is not essential. E.g. if you add markers manually and you give them the required style, TIA will recognize them. Also, if you change the names according to



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.

