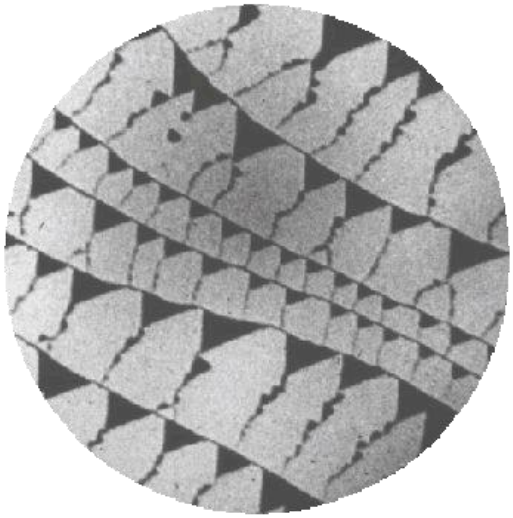
U-VIEW2002 Image Acquisition Software

for PCO-Sensicam, PCO.xxx, Hamamatsu, Retiga, TVIPS Cameras and Matrixvision Frame Grabber on Elmitec Electron microscopes.

Manual

U-view software developed by Uwe Knipping
Manual completely revised by Dr. H.Marchetto

Manual Release 2019 – U-view Version 18.4.0



Please direct questions about U-view software and LEEM, PEEM or SPLEEM instruments to Elmitec GmbH, mail@elmitec.de

CONTENTS

Setup

Computer and Operating System Requirements

Most modern PCs fulfill the minimum requirements. However, two 1900x1200 pixel monitors and a large and fast hard drive are recommended.
The operating system must be Microsoft Windows 7, 8 or 10.

Before Installing U-view

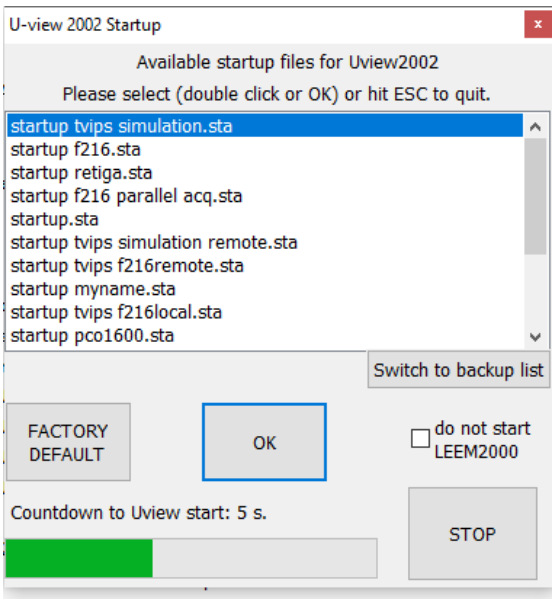
Any **camera interface card** and ***drivers must be installed before U-view***. Please see the camera manufactures installation instructions for details. When updating U-view you may also need to update, that means, reinstall the camera drivers. You may download the latest drivers for PCO cameras from www.pco.de.

U-view License Registration

In case U-view is accessed from a user-account for the first time or U-view has been reinstalled, a registration window will be displayed. You need to enter your PC specific unlock code to proceed. This unlock code can be obtained from Elmitec. To get the unlock code you need to email, fax or phone the serial number which is shown in the first line of the registration window to Elmitec. You will receive the unlock code. Please enter it into the appropriate line and hit the Continue button. You will now be able to use U-view.

Startup

U-view can be started with different cameras or configurations. If you only have one startup.sta file the following window may not appear (unless explicitly selected in Uview setup window) This window may also appear if the startup file has been corrupted. In that case you may select from up to 10 backup files which are automatically generated.
This window is similar to the startup window in LEEM2000 with the difference that in LEEM2000 you select startup folder instead of files because of the complexity of the parameter set.

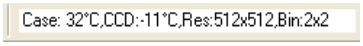


If you do not want to change anything from the last time you started U-view you simply let the timer countdown run out or press the ok button.
If you do want to start Uview with a different camera just double click on the corresponding list entry while the countdown is still in progress, or press stop, to have more time for the selection.
In case you want to pick an entry from the backup startup (.oldsta) files, click on *Switch to backup list.* You may go back and forward between the lists. In case you select an entry from the backup list you will get a 'save file' window to select a name (new or existing) under which you want to store that backup file. It will then appear in the regular startup list next time you start uview. This paragraph will also apply if you attempt to load at startup file which is corrupt.
There is also the option the check *do not start LEEM2000.* This may be useful if your startup file was setup to start LEEM2000 but for some reason you do not want to do it this time. Maybe you just want to look at some images while the LEEM electronics is turned off.

Quick Guide to Getting an Image

- Double click the U-view icon 

on your desktop or select U-view from the Windows *start* menu or *task bar*.

- The information 

field in the *Camera Toolbar* will show any problem with camera or interface board. During normal operations it displays all important camera parameters.

- Click the red *Acquire* Images button to start collecting and displaying images. By default a window to display these images will be on the screen.

- To observe the intensity distribution of the image and to adjust contrast make sure the *Image Rendering Window* is on the screen. If not select the *U-View* menu and click the *Image Rendering* entry.

- To automatically adjust contrast and brightness of the image click the *Auto Adjust* 

button.
- To save a still image, select the *Save Current Frame As* button  .
- To save a generic or an AVI video press the *Record* button  in the *Record* toolbar.

- If you want to connect to the LEEM software (LEEM2000) on another computer, please make sure that the LEEM program is running, the network connection to the LEEM computer is operational (check firewall settings) and the appropriate interface (DCOM, CORBA or TCP) has been setup properly. If necessary consult the section: *Setting up LEEM2000, U-VIEW for access (DCOM, CORBA) on a network*.

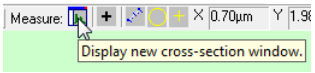
Reference Manual

This manual contains the description of all functionality contained in U-view. The manual is organized in three main sections:

- Image Window
- Menus
- Toolbars

Because of its importance, the image window is described first and starts on page 11.
U-View toolbars are located in a band of the main window near the top of the screen. The individual toolbars can be moved around within that band. The arrangement of the toolbars will be saved when you quit U-View. This is what the toolbars look like (may differ on other installations):

Notice that the Toolbars have so-called *Tooltips*: when you move the cursor over a button or list box on the toolbar a short description of the button functionality will appear. These tool tips are implemented for all buttons in U-view. Here is an example:

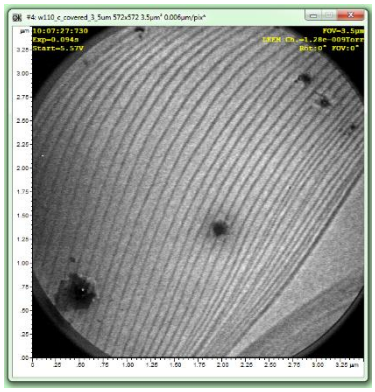


Here is the structure of the Menus and Toolbars:

Menus	Uview	New Cross-Section U-view Setup Camera Setup Image Rendering Signal(Intensity) vs. Time Coverage Measure&Place Markers Process Crop Parking List
	Image	New New Image Sequence [Available Sequences List, Custom] Open… Save Save As… Export As… Print Preview… Print… Copy to Clipboard Copy to Image window [1…20] Postprocess Image Fixed Size 1:1 Fixed Size 2:1 Adjustable No Coordinates Cascade Image Windows

		Tile Image Windows Park All Images Last file names
	Overlays	Show Overlays on this Image Assign Overlays Select Overlay Color Overlay Grid Overlay Mask [None, White, Black] Overlay Time Overlay Rotation
	Scripts	Edit Script List
	Colors	Edit Color List
	Window	Copy Window Print Window Save Window
	Help	Contents Homepage Support E-Mail Check for Updates About List Program Changes
Toolbars	Camera	
	Measure	
	Process	
	Crop	
	LEEM	
	Playback	
	Image	
	Record	

Image Window



This is the window which contains the collected or loaded images. In the following the words *Image* and *Frame* are used interchangeably.
The window in which each image is displayed on the screen can be either fixed to the resolution of the camera or adjustable. U-view always keeps the correct aspect ratio (x-to-y ratio) of the image while sizing it. To size the window, the right margin of the window can be adjusted with the mouse. When releasing the left mouse button the window will be redrawn with the correct aspect ratio. See also *Image Sizing options* on page 63.
The image window can be moved anywhere within the desktop. The position and size will be remembered when closing U-view and re-opening it.
The image window can be minimized; it will remain minimized in the lower left corner of the U-view window.
To close the window completely click the  in the window title bar. You will be asked if you want to save the image before the window closes (if an image exists in the window and it hasn't been saved yet).

If there are more image windows on the screen, only one can be the *Active Frame*. This is indicated by a ***** next to the name in the title bar of the window.

All *Tools* work on this *Active Image*.

After an image acquisition is started , U-view will collect and display the image into the window which is currently active. When you change this window or open a new one, acquisition will still continue into the window which was active when acquisition was started. This means you can open a new window and load images from a file and do image processing while a new image is still acquired and displayed the active frame window.

Menus

The U-view Menus are: U-view, Image, Overlays, Scripts, Colors, Window, Help.

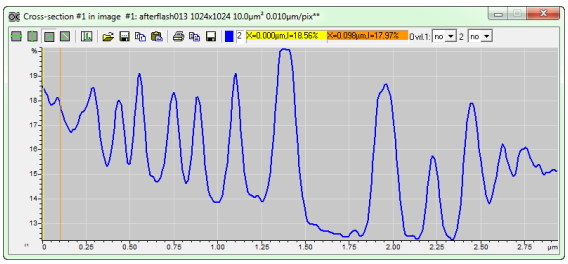
Menu: U-View

The U-view menu allows you to display the various dialog windows in U-view.
Use the mouse to click on the name of the window and it will appear on the screen. If the window is already on the screen, but hidden under another window, it will be brought to the foreground. To remove the window from the screen click the X in the upper right corner of the window in question.
Notice: the three windows *Coverage*, *Measure & Place Markers* and *Crop* are mutually exclusive. This means that if one of the three is open, the other two will be closed.

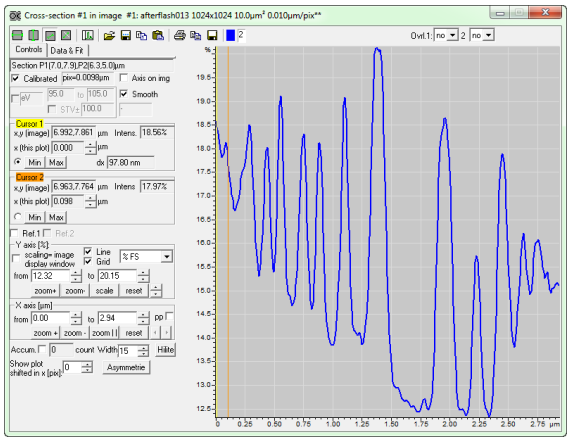
Cross-sections

Clicking *New Cross-section* in the U-view Menu or the *New Cross-section* button in the *Measure* toolbar (described on page 75) opens a new window in which horizontal, vertical or arbitrary linear cross-sections (also called *image profiles*) may be displayed. These cross-sections can be positioned on the selected image using the mouse. When the real-time image acquisition is turned on, the cross-sections are also taken and displayed in real-time. The cross-section window can be saved, loaded, printed and copied to any other application (i.e. Powerpoint). The position of the window is saved when you exit u-view. *Up to 13* cross section windows can be open at one time. Each cross section window can be placed anywhere on the screen, it can be resized and it can be displayed in two different ways:

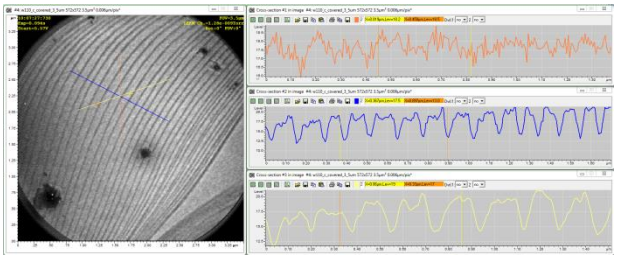
compact – cross-section and important functions displayed:



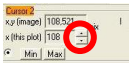
expanded - all functions available:

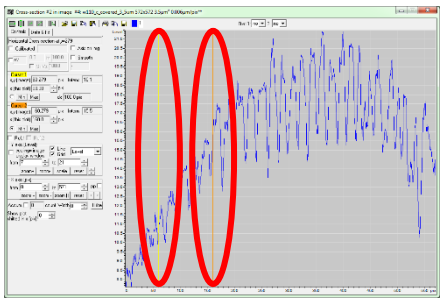


Each image can have multiple cross sections assigned to it. You may also have multiple different cross sections on several different images of different size.



Cursors in cross-section window

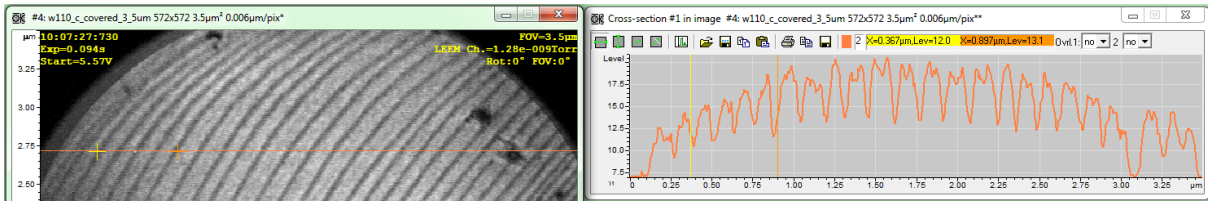
Each cross section has 2 cursors, shown on the image and on the cross section. They can be move by mouse click on the respective cursor in the cross section window. They can also be moved by using the spin-controls  in the expanded cross section window. The cursors are color coded and their x and y values on the image as well as in the cross-section plot are always shown.



Toolbar buttons

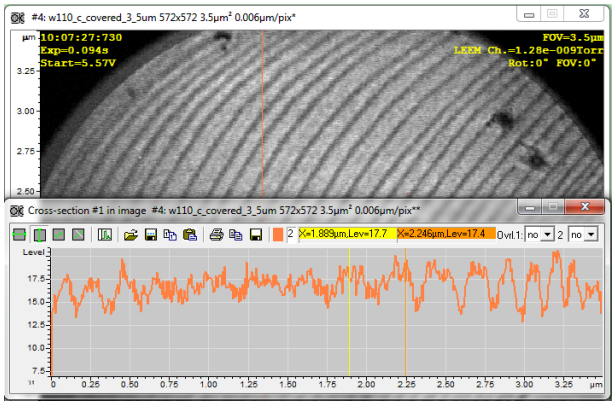
Toolbar: Horizontal cross-section 

Click the Horizontal Cross-section tool button. It will go from inactive  to active  . Move the cursor to the line on the image you want to take the cross section. Click left mouse button. A colored line will indicate the position of the cross section. The cross section plot will be displayed in the Cross section Window.

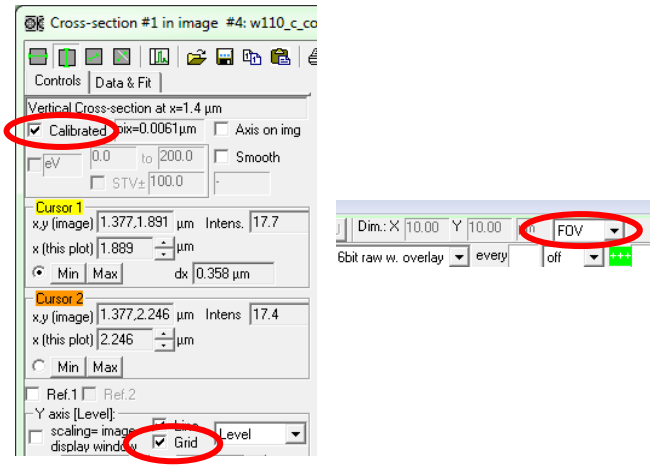


Toolbar: Vertical cross-section 

Click the Vertical Cross-section tool button. It will go from inactive  to active  . Move the cursor to the column on the image you want to take the cross section. Click left mouse button. A colored line indicates the position of the cross section. The actual cross section plot will be displayed in the Cross section Window.

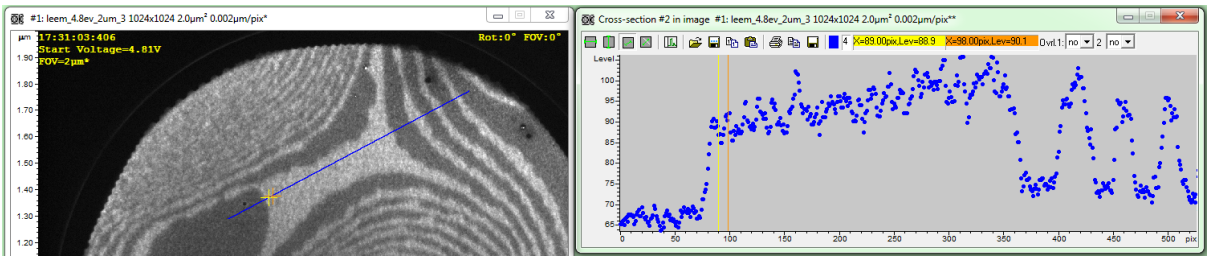


In this example in the *cross-section* window, the *Calibrated* and *Grid* buttons are checked and an image with *FOV* selected is used in the *Crop* toolbar (see page 82 for more details):



Toolbar: Arbitrary cross-section 

Click the arbitrary cross-section tool button. It will go from inactive  to active  . Then move the cursor over the image, press the left mouse button over the point you want to start the cross section, hold the button down and move the mouse. A red rubber band will appear indicating where the cross section will be taken. When you positioned the red band where you want, release the left mouse button. The cross-section, with correct x and y axes will be displayed in the cross section window. The cross-section will be also be indicated by a colored line on the image. You may reposition the arbitrary cross-section by clicking near an end of the line and dragging it.
In this example the *calibrated*, *line* and *grid* options are unchecked and a different color and thickness have been selected.



Toolbar: Remove/Show controls 

Click on this button to switch between expanded and compact cross-section window.

Toolbar: Open, Save, Copy Data, Paste Data 

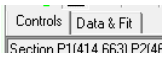
The cross-section *data* can be saved and loaded (format see appendix) and copied and pasted.

Toolbar: Print Window, Copy Window and Save Window to jpg 

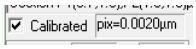
The cross-section *window* can be printed, copied to other applications (i.e. PowerPoint) and saved as .jpg.

Toolbar: Color and line width 

Click on the colored square to change the color of the line and enter a new line width (only for drawing purposes).

Expanded Window – Tabs 

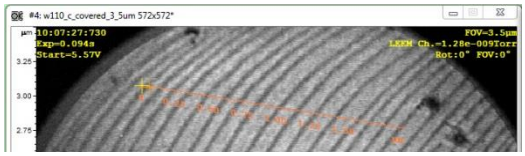
There are two tabs available in the expanded window. Typically only the *Controls* tab is used. The *Data & Fit* tab offers advance fitting functions for cross-sections. Please inform Elmitec in case you wish to have more fitting functions available.

Expanded Window – Controls: Calibrated 

If checked the scaling units determined by the selected field of view (Preset) are used. This option is available only when FOV is selected in the dropdown menu of crop toolbar (see page 82). The pixel size is also displayed.

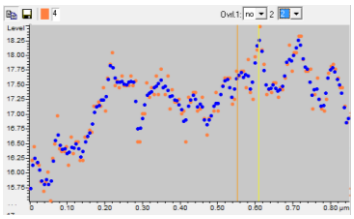
Expanded Window – Controls: Axis on img 

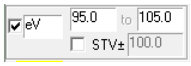
If checked, the cross-section line on the image will be converted to an axis with the same units as in the cross-section plot.



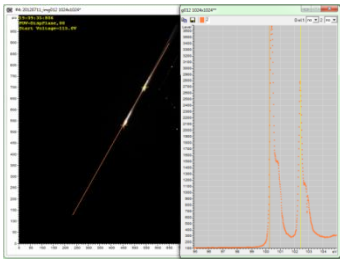
Expanded Window – Controls: Smooth 

If checked, the cross-section is smoothed using a 3-point running average smoothing method. In the figure, the blue data has been smoothed and is compared with non-smoothed data (orange).

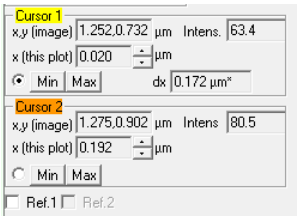


Expanded Window – Controls: eV settings 

This can be used to arbitrarily scale the x-axis of the cross-section plot for dispersive plane analysis (XPS). The x-scale is set then linearly scaled between the two values and eventually an offset given by STV ± can be added.



Expanded Window – Controls: Cursor



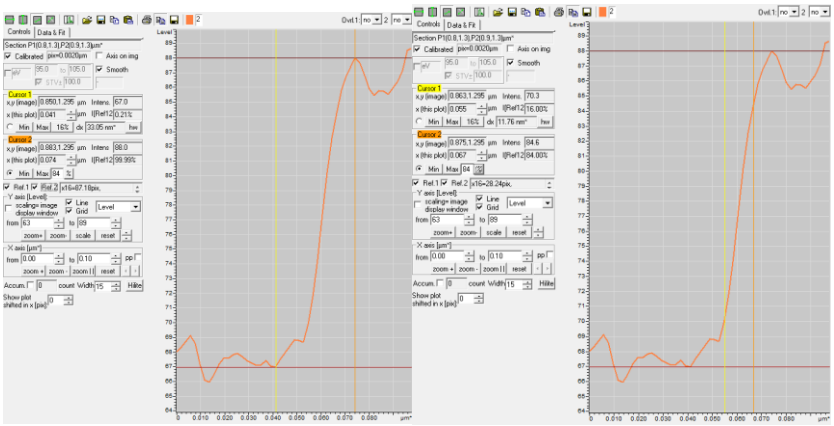
There are two available cursors, yellow and orange. The dialog shows:

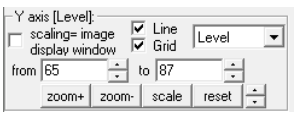
- x,y (image) → cursor position in the image
- Intens. → intensity at the cursor position in the image
- x (this plot) → cursor position in the current plot
- Min/Max buttons → move the cursor to the position along the cross-section with the highest/lowest intensity
- dx → gives the distance between the two cursors
- Ref. 1 and Ref. 2 → these two buttons can be used to measure lateral or energy resolution. An example is shown below.

The units used depend on the choice made in the crop toolbar (Pix or FOV) as described on page 82.

Measuring resolution

This purpose of the resolution measurement tool is an online resolution evaluation tool and should not substitute standard resolution measuring tools. As a first step, look for a dark/bright step and place there the cross-section marker. Select the yellow cursor (nr. 1) and place it at the low side of a step and press Ref. 1. Now select the orange cursor (nr. 2) and place it at the top side of a step and press Ref. 2. Now three new buttons will be visible: *16%*, *84%* and *hw* (for half-width). The *16%* and *84%* buttons will move the cursor towards each other until the intensity is increased by 16% on the lower side and decreased by 16 % (to 84%) on the higher side. The distance between the cursors is the lateral resolution under the 16%-84% criteria assumption. Alternatively, the peak full-width at half-maximum (FWHM) can be evaluated using the hw button.



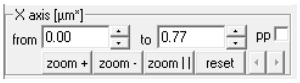


Expanded Window – Controls: Y axis

These set of options are used to adapt the y-scaling. Using the *scaling=image display window* option, the min and max values of the y-axis will be the same as those used in the image to define black and white levels. The *line* button toggles between dots (off) and line (on) display. The grid displays a grid in the plot at major axis ticks. The dropdown menu defines the units used and this is also displayed next to Y axis in parenthesis. These can be:

Level – the raw number of counts
% FS – the percentage to full scale (typically 4095 for 12 bits)
Log Level – the logarithmic display of Level
Normalized – Number of counts normalized to 1 in the current plot visible range

The *from* and *to* fields and the spin-control allow to adapt the range per hand. The *zoom+* and *zoom-* buttons expand or reduce the viewing range. The *scale* button fits the range to the viewable region and the *reset* button expands the range to the maximum (camera full scale).



Expanded Window – Controls: X axis

The *from* and *to* fields and the spin-control allow to adapt the range per hand. The *zoom+* and *zoom-* buttons expand or reduce the viewing range. The *zoom||* button fits the range to the viewable region between the yellow and orange cursors. The *reset* button expands the range to include the whole length of the cross-section line. The *pp* button allows fixing the cursor positions to the data points.

Expanded Window – Controls: Further options

The *Accum.* button can be used during live view to sum new data onto previous. This will generally speaking reduce random noise. The *Width* value allows taking several adjacent cross-sections which are then averaged and displayed in the cross-section plot. The *Hilite* button highlights the width of the cross section on the image. The spacing between adjacent lines used for averaging is 1 pixel. The *Show plot shifted in x (pix):* field and spin-control allows shifting the plot on the horizontal. The *Asymmetry* button opens a window that shows the asymmetry that is defined as:

$$\frac{I_B - I_A}{I_B + I_A - 2I_{Dark}}$$

Where I_A and I_B are the intensities at the yellow and orange cursor respectively. I_{Dark} is the dark field intensity. This is the intensity found at the corners of the image and depending on the camera this may vary between about 50 and 100 counts.

Expanded Window – Data & Fit:

The Data and Fit section can be used as follows. Select the data range using the two cursors. Choose between two functions:

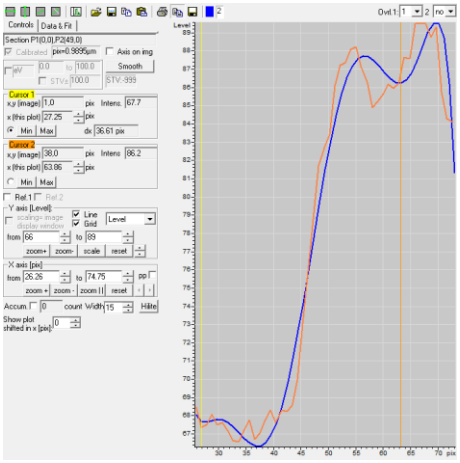
polynomial function $\sum_{k=0}^{7} c_k x^k$

step function (gauss) or complementary error function $\frac{c_0}{2}\operatorname{erfc}\left(\frac{c_1 - z}{c_2}\right) + c_3$

Where $erfc(z)$ is the complementary error function:

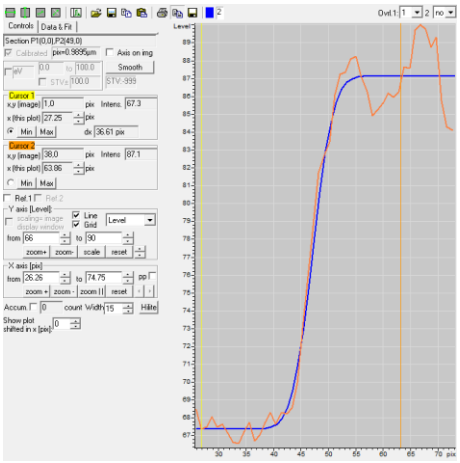
$$\operatorname{erfc}(z) = \frac{2}{\sqrt{\pi}} \int_z^\infty e^{-t^2}\, dt$$

The fit is a conventional least-squares fit that can be applied to both linear and non-linear equations.
When performing a polynomial function fit, simply click on *Fit between cursors*. The result will be shown in a new cross-section window as shown here:



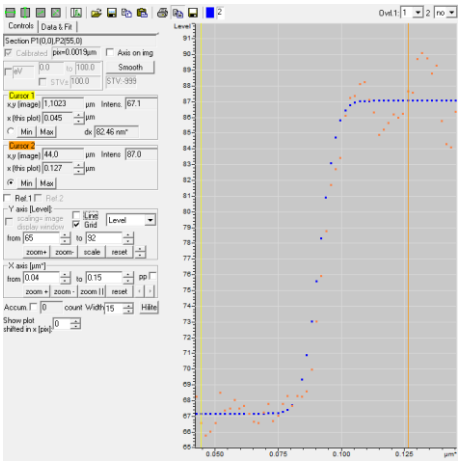
Fitted coefficients:
c7*x^7+c6*x^6...+c0
c0= 6.95e+003
c1= -1.18e+003
c2= 8.45e+001
c3= -3.27e+000
c4= 7.41e-002
c5= -9.79e-004
c6= 7.00e-006
c7= -2.09e-008
RSS= 8.46e+001
ResStdDev= 1.44e+000

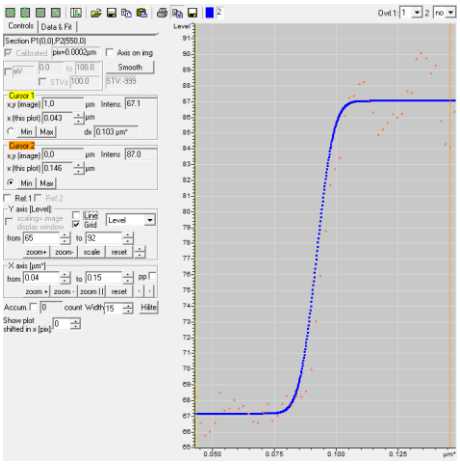
Above, the blue line is the fitted has been fitted to the orange line. The fitted coefficients are shown in the original window, along with the Residual Sum of Squares (RSS) and the Residual Standard Deviation of the fit (ResStdDev or RStdErr). In case of a *step function* fit, the FWHM is also shown



Fitted coefficients:
((c0/2)*erfc((c1-x)/c2)+c3)
c0=1.98e+001±0.00e+000
c1=4.77e+001±0.00e+000
c2=4.26e+000±0.00e+000
c3=6.73e+001±0.00e+000
RSS=7.76e+001
RStdErr=1.31e+000
FWHM=7.09e+000±0.00e+000

The *plot 10 points between datapoints* simply generates more datapoints as shown on the right figure:

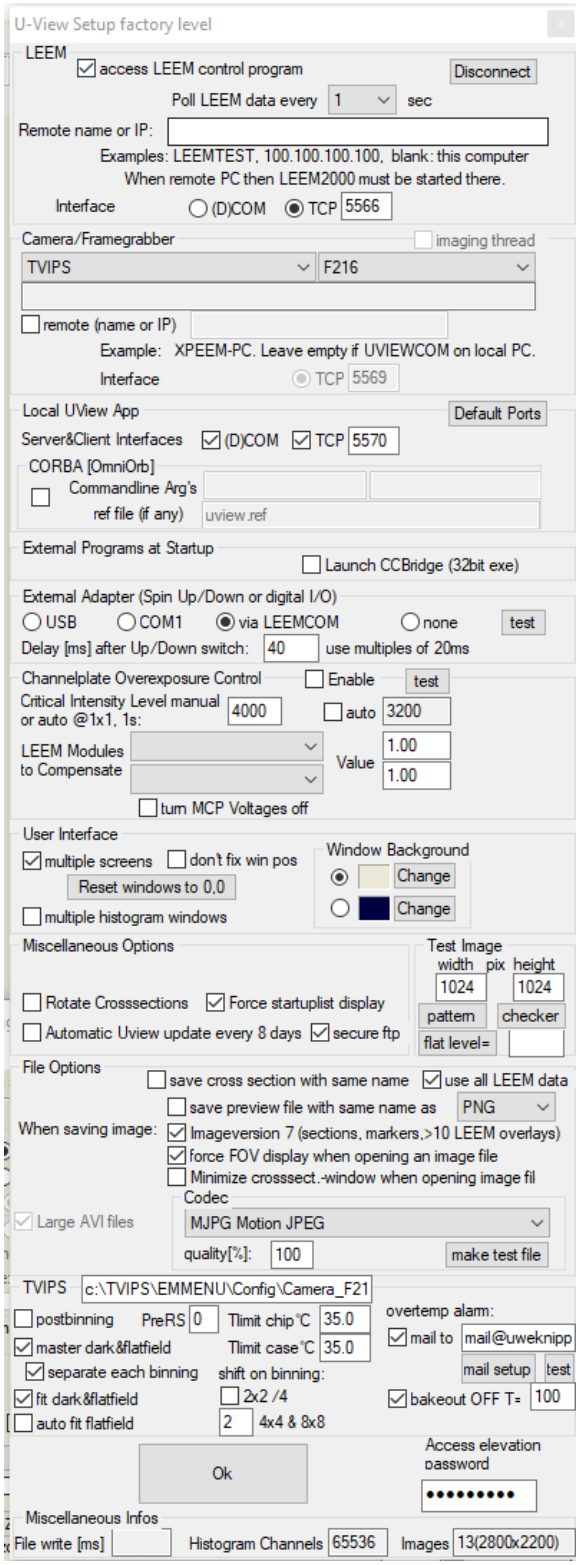




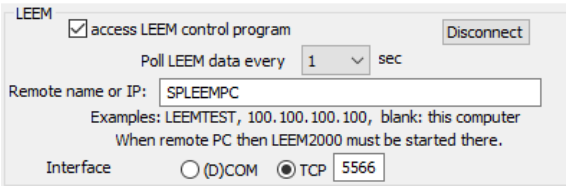
U-view Setup

This window allows editing the settings of U-view. The settings are divided into categories:

- LEEM
- Camera/Framegrabber
- Local Uview App
- External Programs at Startup
- External Adapter (Spin Up/Down or digital I/O)
- Channelplate Overexposure control
- User Interface
- Miscellaneous Options
- File Options
- Miscellaneous Info
- TVIPS options (only visible for TVIPS cameras)



LEEM



Access LEEM control program

Check *access LEEM control program*. This will allow you to read information from the LEEM control program, i.e. sample temperature, and overlay them onto your images.

Connect/Disconnect

The *Connect/Disconnect* button will change labels depending on the state of the connection to the LEEM program.

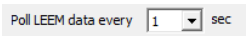
Connect

Press *Connect* to establish a connection through the internet to the LEEM computer. The LEEM control software must be running already. U-view cannot start or stop the LEEM program if it is running on a remote computer.
If the connection to LEEM2000 cannot be made you may get several possible responses and error messages. If this occurs please consult the Troubleshooting section at the end of this manual.

Disconnect

Press *Disconnect* to terminate the connection between the 2 programs.

Poll interval for LEEM



Select how often the information from the LEEM is refreshed. This may impact the performance of the image acquisition. Unless really necessary to go faster choose 2, 5 or 10 seconds.

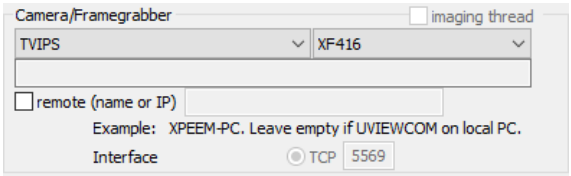
Remote name or IP

If the LEEM control program resides on another computer which is connected over the internet, please enter the name of that computer. You can use the IP address instead of the name using the format: xxx.xxx.xxx.xxx. Don't add \\ in front of name or IP.

Interface

Can be selected between two available interfaces: (D)COM and TCP. In case of a TCP interface, the port can be selected (typically 5566).

Camera/Framegrabber



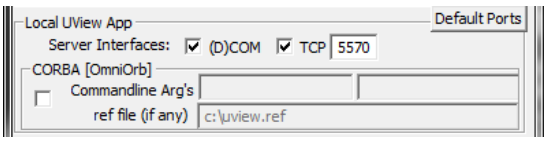
Remote

Select this option in case the camera/framegrabber is on a separate machine from where U-view is running. In case remote is selected, please enter the name of that computer. You can use the IP address instead of the name using the format: xxx.xxx.xxx.xxx. Don't add \\ in front of name or IP.

Camera/Frame Grabber

U-view supports either local cameras or grabbers or a remote U-view or uviewcom version running on a remote PC. The cameras that can be selected are: PCO *Sensicam*, *PCOxxx with USB3.0, CamlinkME4, GigE interfaces, PCO.EDGE with USB3.0* or *Camlink, Hamamatsu ORCA 4 Flash* with *Camlink* or *USB3.0*, Photometrics Retiga USB 3.0, *TVIPS F216* or *XF416* in vacuum scintillator cameras. Framegrabber support has been discontinued.
Only some of the buttons may be enabled. The matrixvision enabled version of U-view requires a specially compiled version of U-view. For the remote U-view a field for the IP-address or computer name is supplied. If necessary please supply a share folder and TCP port.
Changes require a restart.
For an explanation of Image Threading, see the paragraph on Camera Setup.

Local Uview app



Server Interfaces

Typically both (D)COM and TCP (on port 5570) are selected. If needed, you can restore the original ports by clicking Default Ports.

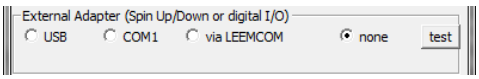
CORBA [OmniOrb]

Here the Object Request Broker can be initialized with either command line settings or reference file.

External Programs at Startup– Launch CCBridge

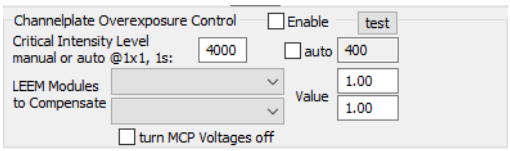
This button instructs U-view to start the CCBridge program after connecting to LEEM2000. CCBridge acts as a DCOM to CORBA bridge, allowing CORBA access to U-view and LEEM2000.

External Adapter



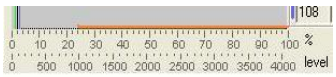
This applies only to SPLEEM and selects the device which controls the Spin Up/Down operation. Requires a restart.

Channelplate Overexposure Control



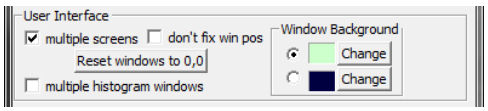
This feature, if enabled, monitors the image and notifies the user if any bright spots, beyond a given intensity level are detected. The user can select up to two LEEM power supplies, i.e. the Start Voltage and Wehnelt, to compensate for the detected overexposure. The critical intensity level is defined for *no binning* (1x1) and 1 sec acquisition time. If *auto* is selected, U-view will calculate the critical level as a function of the camera exposure time and binning. The overexposure notification message is shown in the LEEM toolbar. Channelplate overexposure!

The critical level is also displayed in the 'Image Rendering" window in the "Distribution histogram". There an orange line at the x-axis indicates where the intensity levels are possibly too high and where they generate a warning message. If the overexposure control is off, the indicator line is not shown.



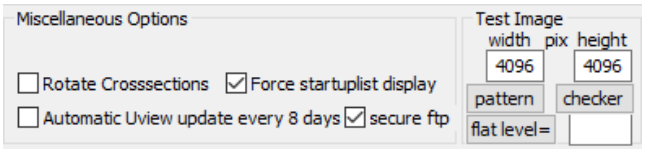
The test button can be used to test the LEEM modules that are changed upon overexposure.

User Interface



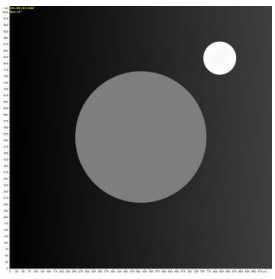
Most systems work with two monitors connected to the LEEM/U-view pc. These options allow setting multiple screens, restoring all windows to the top left corner of the monitor (with the *Reset windows to 0,0* button). The *don't fix win pos* button avoids fixing the position of the U-view window. The background color of the main U-View windows may also be changed. Multiple histograms may also be taken. This may however prove computationally expensive.

Miscellaneous Options

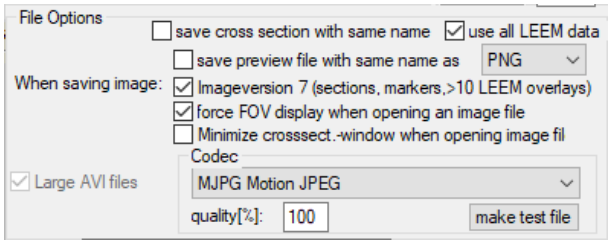


Here some special options may be selected. For instance the cross-sections may be rotated with the image. The user may choose if U-view searches automatically for updates every 8 days. A secure ftp connection should always be used. A startuplist can be displayed when different configurations are available. And a test image may be generated with different patterns and intensities. For instance:

This image may be used to adjust vertical and horizontal size of your display monitor to compensate for distortions in the screen aspect ratio.

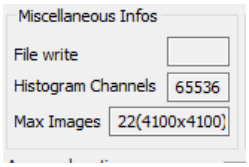


File Options



It is possible to automatically save cross-sections (*save cross section with same name*) and automatically save preview images as jpg (*save jpg or png preview file with same name*). Typically the *Imageversion 7 (sections, markers, >10 LEEM overlays)* should be checked in order to store as much information in the file header as possible (strongly recommended).
Use all LEEM data should be checked also, it will save all available LEEM data in the *.dat* file header. If this is not checked only the LEEM data selected in the *overlay* window in the *Recorded Parameters* window will be saved to file.
However, old analysis software may not be able to read the new header and only in these specific cases the file header should be rolled back to a previous version (version 5). The *force FOV display when opening an image file* button, if clicked, shows a scale bar at the bottom right of the image. Normally cross-sections are restored when opening a file. With the option *Minimize crosssect. when opening image file* this can be avoided. The *Large AVI files* button is automatically selected starting for Windows version from 7. This way file sizes may be beyond 2 Gb (given a 64-bit environment). The wished codec may be chosen (normally MJPG Motion JPEG is a good choice) and the compression quality adjusted between 0 and 100% (0% bad quality, 100% high quality). Typically two codecs are available in Windows 7: *MJPG Motion JPEG* and *Raw Uncompressed*. Other formats will be displayed if available. For instance XVID and x264 can be used if theses codecs are available in Windows.
A test file may also be produced and this will be saved in the local U-view directory (typically *C:\Program Files\Uview2002*).

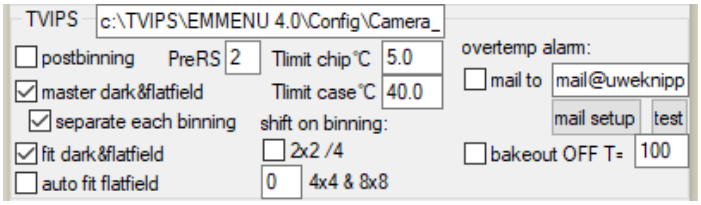
Miscellaneous Infos



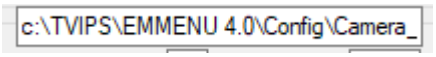
This box displays

- the time it took to write the last image file to disk in ms
- the number of channels in the image histogram
- the max. number of images (+2 for SPLEEM) and max. supported image resolution

TVIPS options

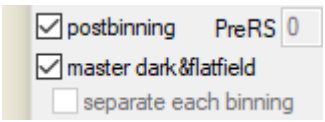


The options *master dark&flatfield*, *Separate each binning*, *fit dark&flatfield* and *auto fit flatfield* will be further explained in *Camera Setup – TVIPS models* (pages 29 & 30).



name and path to the TVIPS camera .ini file is shown here. In the *factory level* it can be modified. This entry may be used by uview to modify some settings in the ini file. For instance the *PreRS* and *shift on binning 2x2* values, which the TVIPS camera takes from the ini file only.

Postbinning:

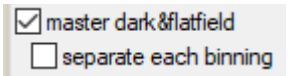


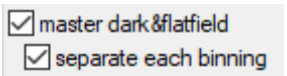
If this is checked the image is acquired always without binning (!:1 binning) and any selected binning is done in Uview (instead of the camera) after dark und flatfield corrections have been applied. This has 2 advantages:

1. Only one set of dark and flatfield images are needed for each shutter mode (uview automatically selects *master dark&flatfield* and turns off *separate each binning*).
2. And more important: 4x4 and 8x8 binning will not work in most instances without the option. The reason is that the darkfield of a 4x4 or 8x8 image exceeds in most cases the 16bit data range (F216 only). Which means no 4x4 or 8x8 image can be effectively corrected and displayed. This applies only if binning is done without dividing the binned pixel by the numbers of pixels (SHIFTONBINNING is off). This again is necessary because we want as much intensity in the images as possible.

Postbinning should only be checked for the F216. For the XF416 it has little if no effect and would slow down acquisition significantly. The F216 on the other hand acquires much slower than the XF416, so the software can do the calculations in between images without much slow down in acquisition speed.

Dark and flatfield master image:

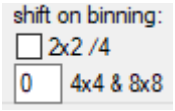




Because of the linearity of the CMOS sensor it is possible reduce the number of dark and flatfield images. Ideally only one set of those images is needed (for each shutter mode), called master images, acquired with 1:1 binning and full sensor area. Then when you select a different binning and/or a different region of interest for imaging then Uview calculates the dark and flatfield images accordingly from those master images. While this works fine with the XF416, the F216 has some deficiencies in regard to binning, so it is necessary for quality images to make one set of master images for each binning (check the *separate each binning*). If you uncheck both boxes then you need to supply sets of dark and flatfield images for each roi of the sensor you want to image and also for each binning you select. But for all protical purposes you will use always only one roi and possibly 2 different binning options, so the number of sets of normalization images will not be that high.
Recommended are: F216 both checked, XF416 only *master* .. checked.

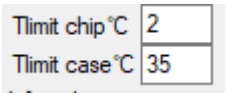
PreRS 

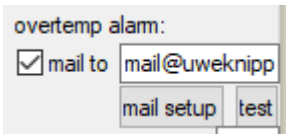
specifies the number of images that are taken before the actual exposure is taken. This applies to images acquired in rolling shutter (RS) mode. The TVIPS cameras take several exposures for reference and discard them before acquiring an image in RS mode. This applies to each single images as well as the first image in a live or burst sequence. By default this number is 3 or 4. This number is entered into the camera ini file in section [EXPOSURE] NumberofExposureToTake=2.
Because this could slow down the image acquisition significantly it would be advisable to reduce the number of those images. Because the first image is always of poor quality it should be discarded always. Beyond that one should take a sample image with 2 or more exposures discarded and see which number in PreRS results an acceptable image.

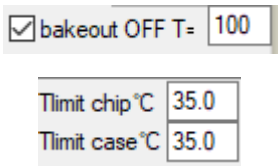
Shift on binning: 

Pixel binning can either be done to increase image intensity or to reduce noise. In the first case binned pixels are simply added, in the second they are added and then divided by the number of binned pixels to obtain an average. Because for LEEM the increased intensity is most important, we only add the binned pixels. TVIPS uses the term ShiftOnBinning due to the fact that the division by 4 (for 2x2 binning) is done fastest by shifting the 16bit pixel values by 2 positions to the right. For 4x4 binning the data are shifted 4 positions (divided by 16).
In case you selected 2x2 binning and want to activate the division by pixel count check the 2x2 /4 box. This will modify the ini file of the camera and tell the camera to do the divison (aks shift). In case you are using 4x4 or 8x8 binning, this is done in Uview (F216) and you may enter different shift values to be able to better utilize the dynamic range of the image while still trying to keep the pixel intensity within the 16bit range. In case of 4x4 binning the value would be 4 (/16) for averaging, but instead you could enter 1 or 2 to keep the pixel intensity below 16bit and still get a high enough image intensity for LEEM.

Note: in most all the cases shift on binning should be off, respectively 0.

Overtemperature alarm 

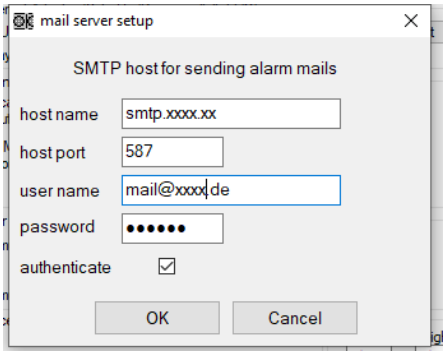




This feature allows you to (a) send an email if the camera temperature(s) rise above a set limit and (b) automatically turn the bakeout, controlled by LEEM2000, off if the temperatures exceed the set limits. The temperatures monitored are the chip (imaging sensor) temperature and the camera housing temperature.
During a bakeout you need to enter a different chip temperature because in this case the camera Peltier cooling must be turned off. You may enter for instance 35 for both temperatures. Do not enter higher temperatures because the camera power supply will show 'open' for chip temperatures >35C (approx.value, may be lower).
In the above shown example the bakeout temperature would be reduced to 100C once the measured temperatures are exceeded. This T value will stay until it is reset manually in LEEM2000.

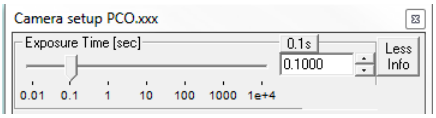
Note: Both temperatures are also saved continuously to a file (CamLogFile xx-xx-xxx xx-xx.ivs). This file can be opened in the Uview *Signal vs. Time* window. It is also possible to Monitor the temperature real time in a signal vs. time graph.

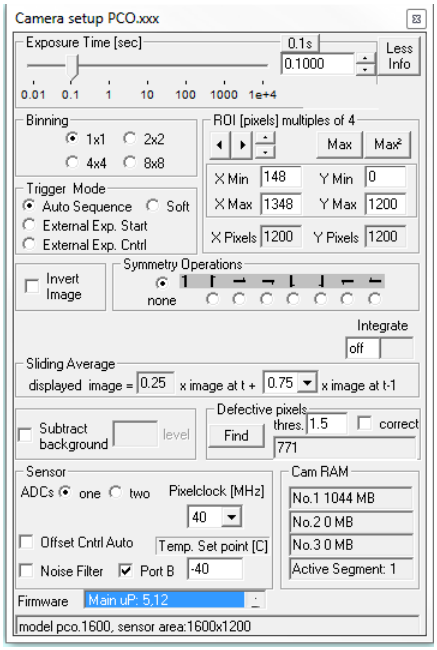
Setup of email for over temperature alarm. This requires factory access. This window allows you to enter the usual parameters for the email account you want to use to send the alarm mail. This mail is only send one time when the temperature is exceeded.



Camera Setup

All main camera adjustments, like the acquisition time, are made from this window. Depending on the type of camera used, the window will look somewhat different. This window should typically be used in the compact version to set the acquisition time. The extended version shows setup up parameters typical of the camera used. In this case those of a PCO.xxx are shown.

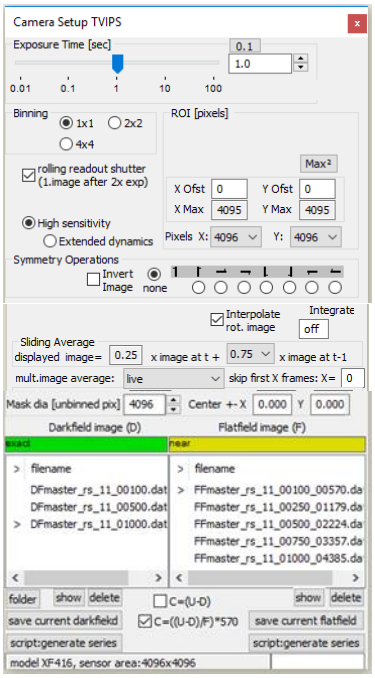




Less Info	This button switches between a smaller window containing just the exposure
More Info	Time controls and the full window with all controls
Exposure	1ms … 3600s, adjustable in 1 ms steps. Adjustment can be done moving the marker with the mouse or with the spin-control or keyboard input
Elapsed time	For exposure times >10s the elapsed time is displayed underneath the edit field (next to the time scale)
Binning	Four different combinations are offered to form *superpixels*: 1x1, 2x2, 4x4, 8x8. Please note that the resolution will be reduced when binning. The image rate on the other hand can be increased by vertical binning
Region of Interest	Selection of the sensor area used for exposure. The smallest unit is a 4x4 pixel block. Enter values through the keyboard and press *Enter*. Or use the spin-control to move the region of interest. Areas outside the ROI are scanned at 4 times the rate which allows a general increase of the frame rate and reduction in data amount per image.
Max	Pressing this button will generate an image of the maximum size given the selected binning
Max²	Pressing this button will generate an image of the maximum square size given the selected binning
Trigger Mode	**Auto Sequence** (default): Triggering of images is done by camera hardware **Soft:** each image is software triggered (slower, so use only in special cases)

Invert Image	Inverts the intensity of each image pixel (black to white and vv.)
Symmetry operations	These operations are done on the acquired image in *real-time* and without loss of acquisition speed. Fixed rotation in 90 degrees intervals and mirroring about an axis are supported. A special option is arbitrary rotation of the image in 1 degree increments. Square or rectangular images can be mirrored and rotated in 90/180/270 deg. The arbitrary rotation is only possible on square images
Sliding average	When using sliding average, the previous image is multiplied by a factor *f* and summed to the current (new) image times a factor *f-1*. Higher *f* values will reduce noise but slow/delay appearance of changes in the image. With lower *f* values, images will be more responsive, but might be more affected by noise
Subtract background	Cameras have typically a constant background. Depending on the model, this might vary between 50 and 100 counts per image. This noise is independent of acquisition time. The value inserted in this field will be subtracted from all acquired images
Stuck pixels	By clicking on FIND the software will look for stuck pixels. Please notice that image settings (binning, averaging,…) will be lost in the process. By activating the correct button the stuck pixels that have been found will be removed.
Integrate	Multiple images can be added up to increase the intensity of the resulting final image. This is only necessary if the camera itself does not allow for long exposure times. Most CMOS sensors have a maximum of a few seconds exposure time. Integrating over multiple images will therefore be necessary if your LEEM/PEEM image is of low intensity. Entering a number <2 will turn integration to OFF.
Info	This field contains information regarding • camera type • CCD size in pixels • Trigger options

Camera Setup – TVIPS models



The TVIPS camera models (F216 or XF416) have a slightly different camera setup window as shown on the right.
Two main differences will be discussed:

- Changing the exposure time
- Image normalization

Furthermore the TVIPS cameras offer extra options:

- Rolling shutter readout
- High sensitivity
    - Extended dynamics

For details about these features, please consult the TVIPS manual.

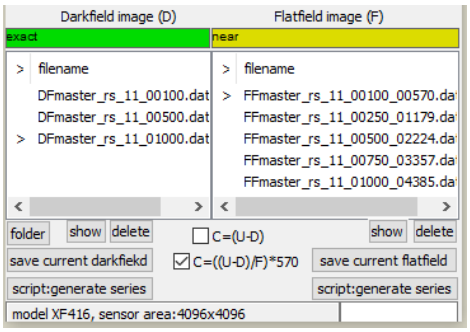
Changing the exposure time

Whereas with other cameras the exposure time can be changed at any time, TVIPS camera models allow only changes of the exposure time:

- Once the current exposure is finished
- When the acquisition is paused

This is a limitation/feature of the underlying camera hardware. The main implication is that in case of long acquisition times, one has to wait a bit longer and that to change the acquisition time the current acquisition has to be paused.

Image normalization



The raw data acquired with TVIPS cameras needs normalization in order to be correctly used. Each image has to be normalized using two reference images: a darkfield and a flatfield (sometimes called gain-) image. These will be shortened D and F respectively in the following.

The normalization is performed with one of the following equations:

a. $NormedImage = RawImage - D$

b. $NormedImage = \frac{RawImage - D}{F - D} * factor$

Option a. is used when C=(U-D) is selected and option b is used when C=((U-D)/F)*_xxx_ is selected. xxx is the *factor* from equation b. above, and changes depending on the image mean intensity of F. It is used so that the final image has the same intensity range as the source image. The software also makes sure that divisions by zero are avoided (near-neighbor interpolation of zero points).

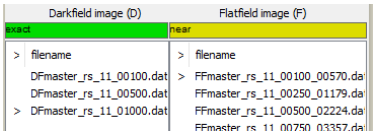
If sufficient normalization images are available, the software can calculate the normalized image by:

1) **Finding** the D image with the closest acquisition time and F image with the closest mean intensity

2) **Calculating** a linear interpolation between the two D images with the closest acquisition time and the two F images with the closest mean intensity

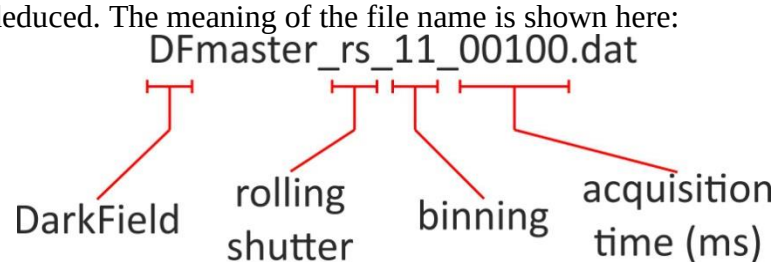
Option 1) is always used when the option *fit dark&field* in Uview Setup is **not** selected. When *fit dark&field* is selected, then option 2) is used when the acquisition time of the raw image does not match that of any D image or when the mean intensity of the raw image does not match that of any F image. The option *auto fit flatfield* will find the best D and F image as described above for every **new** raw image. If the option *auto fit flatfield* is not selected, uView will fix the ideal D and F images only when the button C=(U-D) or C=((U-D)/F)**xxx* is pressed.
The *Auto fit* .. option is experimental and not recommended (pending further testing).

Important note: during experiments it is best **not** to select *auto fit flatfield*, otherwise the normalized image intensity might not be linear with the raw input.



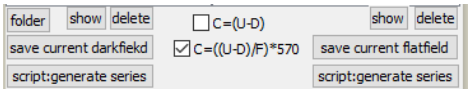
As shown on the right, a list of the currently available D and F images is shown in two lists. The normalization images currently used are highlighted with a ">" sign on the left. The >-sign will either be on the left of one image, or in front of two images if interpolating. If the match between acquisition time of raw image and D image is exact, this is highlighted in green. A yellow bar indicates the used of interpolation or best fit (lower or higher of the available list range). A red bar indicates that no normalization images are available.

Notice that the raw image and the normalization images must have same acquisition *options*: same binning and shutter options. The stored normalization images are named so that these settings can be deduced. The meaning of the file name is shown here:



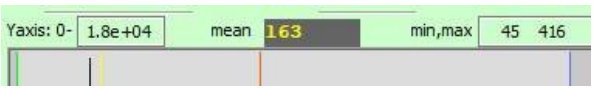
The buttons *folder*, *show* and *delete* can be used to open the folder where the normalization files are saved, show a normalization file and delete a normalization file, respectively.

Acquisition of normalization images



For the acquisition of the two images the lower part of the camera setup window is used.
The stability of darkfield and flatfield images will typically depend on external factors such as temperature and use/wear of the detector. To generate the normalization images:

- Darkfield images are images without any electrons from the sample reaching the detector. The images can be acquired either manually or with a script. First, close the micro-gate valve between the main chamber and the imaging column or, alternatively, turn off the HV (20 kV). Then either start the script with the *script:generate series* button or "save current darkfield" using various acquisition times in a range compatible to those that will be used during the experiments.
- Flatfield images are acquired with a homogeneous detector illumination (see below) at different image mean intensities. The current image mean intensity you can find the rendering window as



shown here. Start from a low value in the range of ~100-500 counts with a fast acquisition time (~100 ms). Then either start the script with the *script:generate series* button or *save current flatfield* button and then do this for increasing mean by either increasing the intensity (e.g. with the Wehnelt) or acquisition time.

Notice that it is always best to average multiple images when generating each normalization image. Typically averaging 8 images will be sufficient.

The scripts are available under the scripting menu and can be edited. See below for some more information on the scripts.

Homogeneous detector illumination

Depending on the sample and illumination type, the procedure might vary. Remove all apertures (contrast or selected area aperture or energy/exit slit), search for a flat/homogeneous region on the sample, defocus and zoom in. Check that a translation of the sample does not change the image.

Normalization file acquisition scripts

Below is a script for acquiring DarkField images automatically. The script sets the image averaging to 8 to improve statistics and acquires images of 100 ms, 500 ms and 1 s. This can be easily edited and extended to other acquisition times. Notice that in the line containing

```
UView.ExportImage("dummy", 100, 0)<0
```

the value `100` is used to tell the software if the image is to be considered as a DarkField (=100) or FlatField (=101).

```
Option Explicit
' Uview must be running when this script is started !
call acquiredarkfields
Dim UView
Sub acquireAndSaveOne
	WScript.Sleep 1000			'crash without a delay
'acquire image
	UView.AcquireSingleImage -1		'start image acquisition
	WScript.Sleep 1				'sleep 1 msec
	while UView.AcquisitionInProgress
		WScript.Sleep 10		'sleep 10 msec
	wend
'save image: use 100 for Darkfield, 101 for FlatField
	if UView.ExportImage("dummy", 100, 0)<0 then
		msgbox "error writing file, script terminated"
		exit sub
	end if
End sub

'------------------- main routine ---------------------------------

Sub acquiredarkfields
	Set UView=CreateObject("UviewInt")

	UView.EnableControls 20,2	'activate progress bar in camera control window
	WScript.Sleep 1000
	UView.AverageImages= 8

	UView.EnableControls 40,2	'advance progress bar
	UView.CameraExpTime= 100	'msec
	call acquireAndSaveOne

	UView.EnableControls 60,2
	UView.CameraExpTime= 500	'msec
	call acquireAndSaveOne

	UView.EnableControls 80,2
	UView.CameraExpTime= 1000	'msec
	call acquireAndSaveOne

	UView.EnableControls 100,2
End sub
```

Handling acquisition of multiple images

This determines the way TVIPS cameras take multiple images internally and greatly influences acquisition time if averaged images. This is important especially in scripts where taking averages of multiple images is common practice. The TVIPS camera needs quite a long setup time for an individual image (see also PreRS In U-view setup window p.24). It is therefore much faster to implement averaging in the 'live' mode or the 'burst mode' (TVIPS terms). In these modes you have only a setup time for the first image, the following images are acquired immediately after, without delays in between.

In the "*mult. image average"* list you may select either *live*, *single* or *burst.* "*live*" is the fastest mode and is the default when you start uview. This setting is used throughout uview. This means when clicking the '*acquire continuous*' or '*acquire single*' buttons as well as in image sequences and also in scripts.

"*live*" is about as fast a "*burst'* mode – in both cases raw images are transferred from the camera as quickly as possible (except for the first image as I mentioned above).

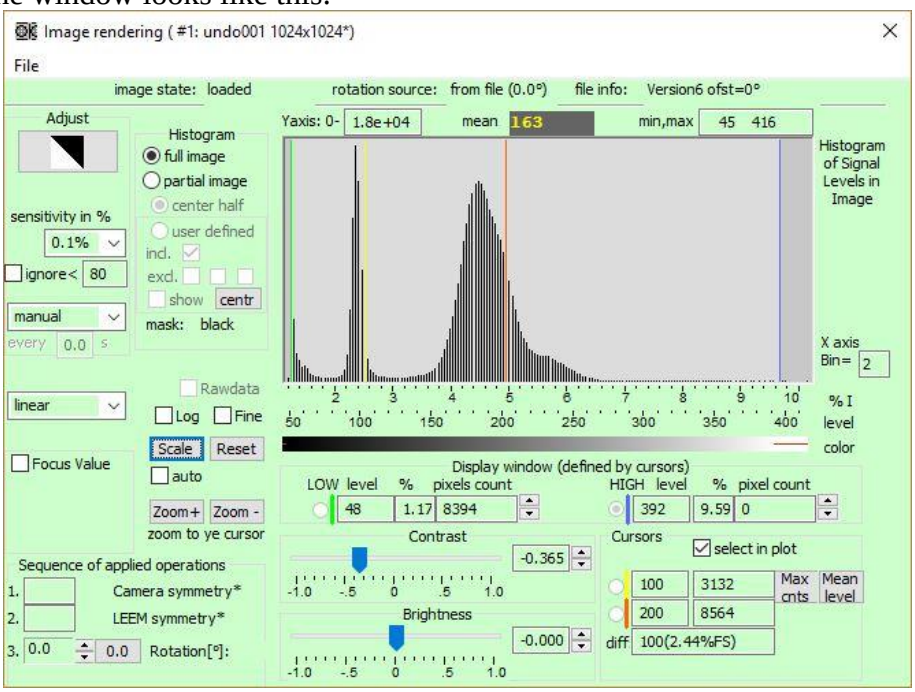
Compared to '*single'* the "*live'* and "*burst*" modes are **5x as fast** (16 image averaged in RS mode 0.2s exposure).

The first few images in "*burst'* mode are unevenly illuminated. Therefore Uview allows you to skip the first X images. This number you may enter into the box "*skip first frames*".

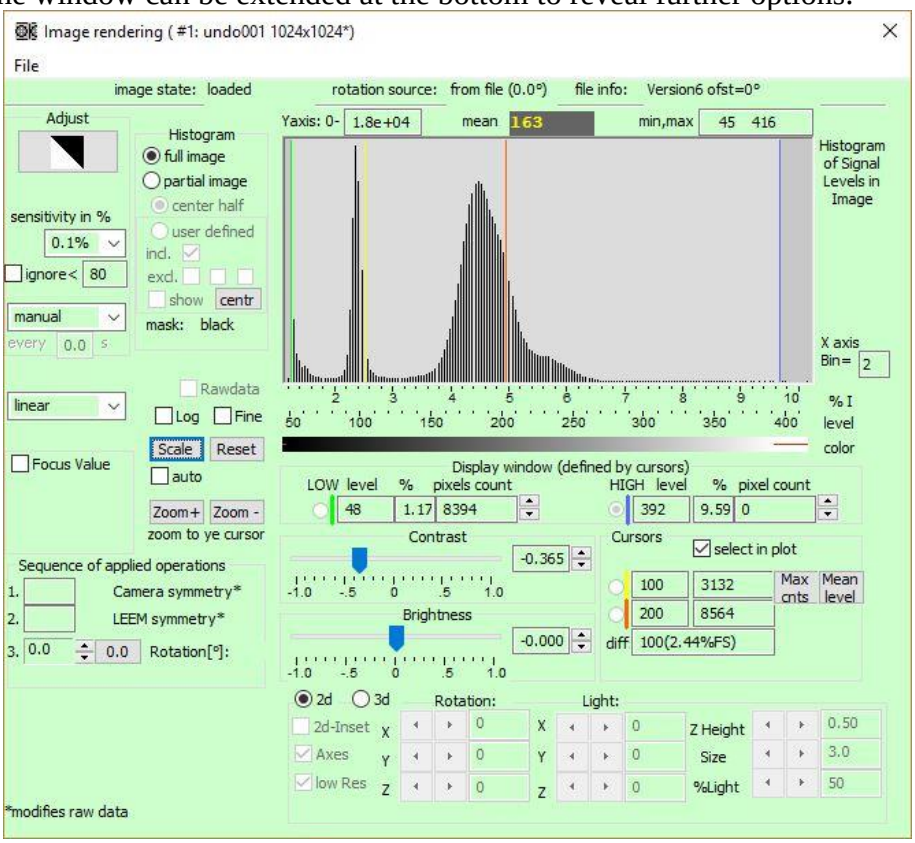
As was described above there is another setting to skip frames, it is in the Uview setup window and called *PreRS*. This entry is send directly to the TVIPS camera software while *Skip first frames* is used in uview internally. The sum of both are the numbers of images actually skipped before the first image is acquired and displayed in Uview. PreRS also applies to wherever images are taken – not only to *bursts*.

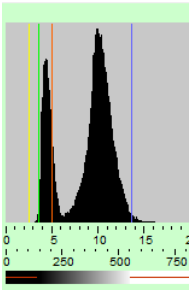
Image Rendering Window

The *rendering* window displays the distribution of intensity levels in the currently selected image and provides the controls to adjust contrast and brightness of the image. The window can be printed and copied to other application (in File menu). The histogram data can be saved to a text file.
Typically the window looks like this:



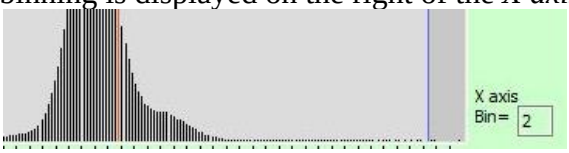
However, the window can be extended at the bottom to reveal further options:



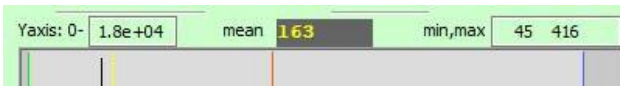


Distribution of Intensity Levels

This plot displays the histogram of the intensity levels in the current image. There are 4096 histogram channels. To fit the histogram into the window space, the histogram channels are binned (combined). The binning is displayed on the right of the *X axis*:



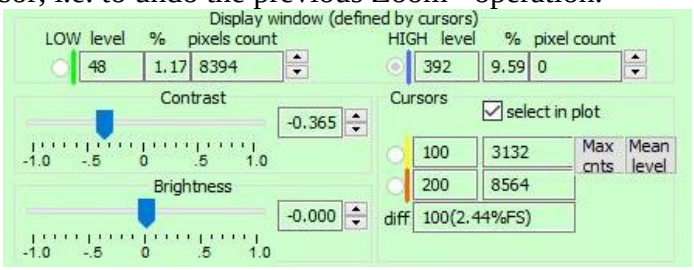
The histogram is updated in real-time while acquiring images, or when loading a video or loading a single image. The x-axis shows the available bit levels in percentage (first scale). In case of SensiCam there are 12bit equals 4096 intensity (gray) levels these are shown in the second scale. A third scale shows how the gray-levels are distributed with respect to the first two axis.



Above the histogram three fields show the following information:

- The maximum histogram value (*Yaxis:*)
- The mean histogram value (*mean*)
- The lowest and highest histogram values (*min,max*)

The histogram can be displayed on a *linear* or *log* y-scale. There is also the option to display either a dense histogram (*fine* selected) or a course histogram. The histogram X-axis can also be *scaled* to fit the width of the entire window and *reset* such that the entire histogram is shown. The *Auto* option scales automatically the histogram. To *zoom* into the histogram, position the yellow cursor at the desired new center of the plot and press *Zoom+***.** Use *Zoom-* to zoom out from the yellow cursor, i.e. to undo the previous Zoom+ operation.



The blue and green markers indicate the display window. The green marker defines the black color level and the blue marker defines white color level in the displayed image. The color levels in between are linearly scaled. Changing *Contrast* and *Brightness* will move the markers and change the rendering of the displayed image accordingly. You may also click on either of the 2 markers to move them individually and see simultaneously the other related controls as well as the image change.

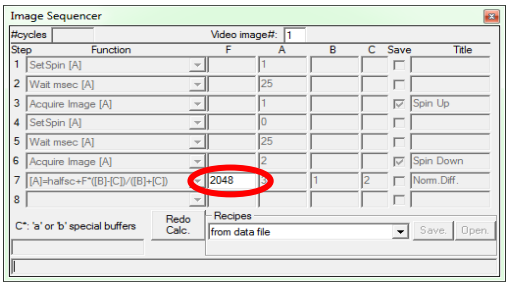
The contents of the histogram channels corresponding to the green, blue are displayed in the *Display window (defined by cursors)* box below the histogram**.** These values are updated in real-time. Below *level* you see the intensity level of the marker, below "*%*" the intensity

percentage at the marker and below *pixel counts* you see how many times that intensity level occurs in the image.
The yellow and orange markers values shown in the sub-*cursor* box can be used to take measurements (difference in intensity level at the marker and counts) on the histogram without changing the display-window. The two buttons next to the yellow cursor can be used to position the yellow cursor to the maximum counts (*Max cnts* button) and average intensity level (*Mean level* button).
The checkbox *select in plot* allows selecting each cursor directly by clicking a button in addition to selecting by clicking on the cursor in the histogram plot.

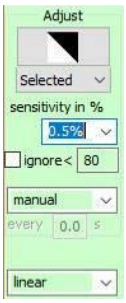
Contrast controls
The Contrast of the current image can be adjusted either by entering a value or by using the spin-control or by moving the slider.

Brightness controls
The brightness of the current image can be adjusted either by entering a value or by using the spin-control or by moving the slider.

Spin images and asymmetry
When images containing spin information are available (sequence of two images with spin up and spin down), the *Asym* button will be enabled. When pressed, the orange cursor is moved to the *middle* value of the histogram. The exact value is defined in the sequencer:



In this case this value corresponds to the middle of the histogram (half of 4096 or 12-bit). The yellow cursor is moved to the top of the first peak as shown here:



Adjust

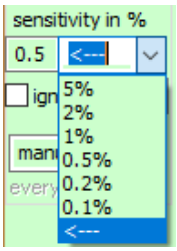
These options, together with the scaling type (see below), define where the green and blue scaling cursors will be placed when automatically scaling the image intensity and which conversion function (linear, square root,…) is used for the intensities in between.

Auto Adjust
Pressing the button automatically adjust brightness and contrast of the current image to an optimal value (depending on the selection of the options below). The button can be pressed any time, either during acquisition or after.

Image to adjust contrast

Three options are available: *all*, *all=selected* and *selected*. This defines on which images the *Auto Adjust* button will act on when the brightness is adjusted. The *all=selected* option will adjust the selected image and use the same scaling conditions for all other images.

Sensitivity in percent



This drop list offers histogram clipping percentages from 5%, to 0.1% and a special options: <-- The percentage values determines where the *auto adjust* button should clip the histogram using the two scaling bars (green and blue). A small percentage value means that the scaling bars will be further apart when the *Auto Adjust* button is pressed. The auto contrast algorithm scans the histogram from both ends towards the center and stops when the desired percentage amount of the total intensity has been clipped. When the <-- option is selected a new field will be visible that allows to freely set the clipping percentage.

Ignore low intensity levels

When this button is checked all signal levels below a certain value, specified in the adjacent box, are ignored when pressing the *Auto Adjust* button. The selected value then becomes the *black level* of the image. This is useful when cameras have a dark count offset.

Continuous Auto Adjust

If this feature is selected *Auto adjust* is continuously performed at a rate defined in the adjacent box. The *Auto adjust* button will be grayed while *Continuous* is selected.

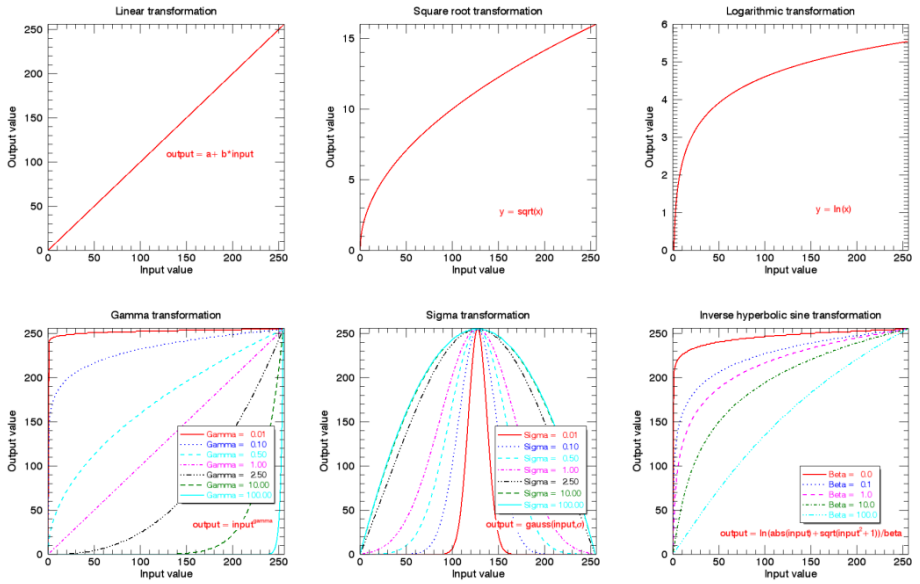
Scaling type

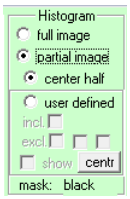
The image intensity scaling, performed between low (green) and high (blue) intensity values can be chosen between:

linear	Linear scaling this is the most common scaling and should always be used.
equalized	Histogram equalization (or linearization). See for example paragraph 3.3.1 of Digital Image Processing, R.C. Gonzalez and R.E. Woods, Third Edition
gamma	Gamma correction uses a power-law expression $I_{out} = I_{in}^{Gamma}$ Where $Gamma$ can be specified in the adjacent box.
Log (LEED)	Logarithmic correction using a log expression $I_{out} = \log I_{in}$
sqrt	Square root correction $I_{out} = \sqrt{I_{in}}$
Gauss	Gaussian correction $I_{out} = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{I_{in}^2}{2\sigma^2}}$ Where $Sigma$ (σ) can be specified in the adjacent box
AsinH	Performs inverse hyperbolic sine function intensity transformation according to Lupton, et. al, in The Astronomical Journal, 118:1406-1410, 1999 September. *Beta* can be specified in the adjacent box. *Beta* is the softening parameter and should approximately be equal to the amount of noise in the input image. See below for the use of *beta*.

clahe	Contrast Limited Adaptive Histogram Equalization. See for example paragraph 3.3.3 of Digital Image Processing, R.C. Gonzalez and R.E. Woods, Third Edition

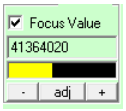
The plots below show the transformations and the effects of the various parameters.





Histogram

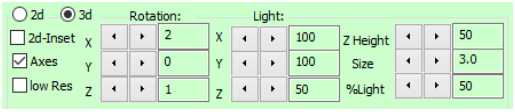
These options define where the histogram is calculated. One may choose between *full image* and *partial image*. Choosing *partial image* is often convenient because the corners of the image outside the channelplate screen may be excluded from the histogram calculation and resulting therefore in more accurate scaling and histogram information. When *partial image* is selected, two options are available: *center half* and *user defined*. In the former case, a central squared area is used for histogram analysis. In the latter case, the user may include one squares area and exclude up to three squared areas. Click *show* to visualize the areas once they are clicked and use the *centr* button to move the areas to the center in case they are not easily visible.



Focus value

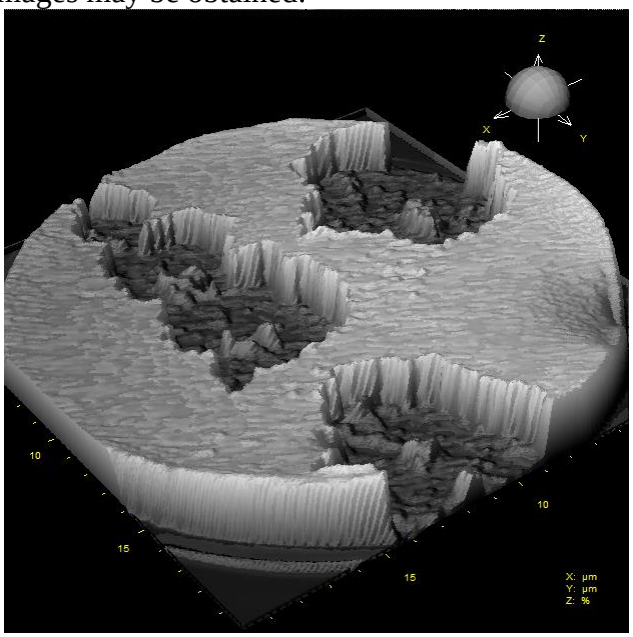
The focus value field, when activated, will calculate total sum of the x and y derivatives of the image. This value can be used as arbitrary focus reference. A better focused image will have a higher focus value and a worst focused image will have a lower focused value. The trend, improvement or not, is displayed in the yellow bar below. This bar may be centered with the *adj* button or moved left or right with the – and + buttons, respectively. It is possible to monitor the focus value in the *Signal(Intensity) vs Time* window as described starting on page 39.

Extra options



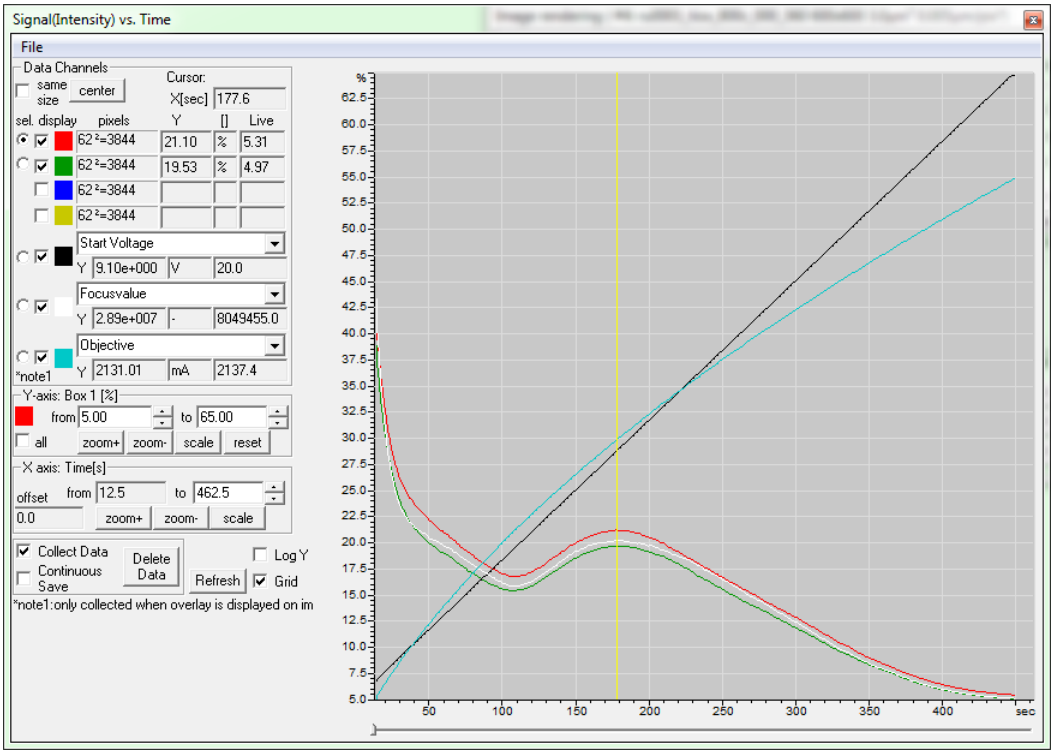
When the window is extended, extra options are visible. If the 3d-option is activated, the image can be rotated around any axis in the *Rotation:* fields. The position of the 3d illumination can be adapted with in the *Light:* position options. The height of the image (intensity→height) may be adjusted in the z direction with *Z Height*. Image size and light percentage may also be adjusted.
The *2d-Inset* option allows to show a small 2d caption image in the bottom right. *Axes* allows to show/hide the image axes. And *low res* to show high or low resolution 3d-images.

As an example, such images may be obtained:

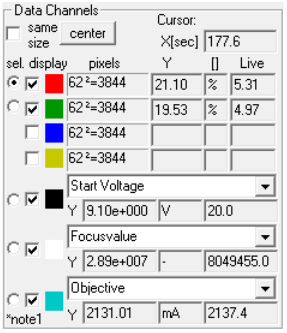


Signal(Intensity) vs. Time Window

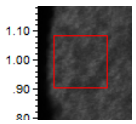
Selecting the *Signal(Intensity) vs. Time* entry in the *View Menu* opens the Signal(Intensity) vs. Time window.
It allows you to measure intensities integrated over one or more user defined areas of different sizes on the currently collected image in real-time. The collected values can be displayed on a linear or log scale, saved to a file, printed and loaded from a file. There is full control over the displayed plot and its axes. Traces are shown in different user selectable colors and can be individually or jointly scaled in Y. A cursor can be used to measure x and y values of all traces simultaneously. One trace can be assigned to monitor a LEEM parameter i.e. pressure in one of the vacuum chambers or the start voltage.



Data Channels



Data is only collected from the channels checked boxes (☑). When you activate a box, a red square appears on the image:



This is the area in which all intensity values are integrated in real-time. You can position and size this box. When you move the cursor on top of this box, its shape will change to indicate which part of the box can be modified. If for instance you want to move the entire box, move the cursor into the center of the box until the cursor transforms into a cross shape ✣. Press the left mouse button and while holding it down move the mouse and the intensity box to its destination on the image.
Sizing the box can be done moving the cursor over a rim or corner of the box. The cursor will change to ⤢ or ⤡ or ↕ or ↔ and you can modify the intensity box size accordingly. However, the box will always be a square (no rectangles).

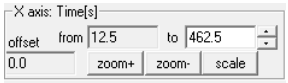
The *pixels* column shows the square width and area in pixels. The *Y* column shows the area normalized intensity within the square in the units specified under the *[]* column (in this case %) at the position of the yellow cursor (bar) in the plot. The current intensity is shown below the column *live*.
The *same size* button can be used to unify the size of the square to that of the first square. The *center* button can be used to move all active squares to the center of the image. This can be useful if the squares are small or *hidden* below overlays. The cursor position (yellow bar in the plot) is shown in the field next to *X(sec)*.
Besides intensity boxes (squares), one may also choose between among three image parameters, *Coverage, Focus Value and Drift*. To use the coverage, this has to be activated in the U-view dropdown menu. The Focus Value has to be activated in the *Image Rendering* window.
Further LEEM parameters are available *only* if these are displayed as overlays in the image.

Collect Intensity Data

Press the *Collect Data* button the software begins measuring the intensity of the selected data channels on the image (checked boxes).
This feature works on live images as well as videos or images sequences loaded from file.
The *Continuous Save* feature allows you to save a continuous stream of intensity data to a file. When you press this button a *Save As* dialog box will appear for you to specify the name of the file receiving the intensity data. The file itself contains the data as readable text which you can

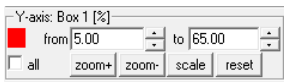
import into other applications for further processing and display. The files can also be read back and displayed by U-view. The complete set of data can be deleted with the *Delete Data* button. Be careful, it can't be undone.
Notice that there is a crucial difference between *Collect Data* and *Continuous Save*. Whereas the latter option allows saving a very large set of data (limited by operating system and available storage), the *Collect Data* option is limited to 20000 data points.

X-Axis: Time



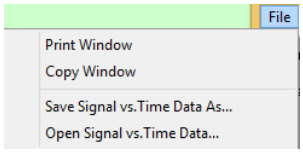
Intensity data are collected indefinitely as long as the *Collect Data* button is checked. The dialogs allow to *zoom* in (+) and out (-), centering on the yellow cursor in the plot, and *scale* to display as much data as is available. The time is displayed in seconds. The *offset* refers to the start of the current acquisition in case the *Delete Data* button has been pressed.

Y-Axis: Intensity



The intensity value will always be displayed in the Intensity Display Field. Even if no image acquisition is on and on still frames loaded from a file.
FYI: the intensity values change while you are moving the intensity box across the image.

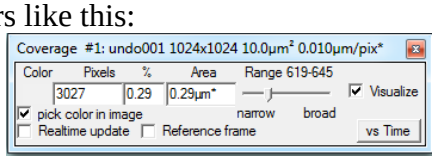
Intensity vs. Time Menu



From this menu you can *Print* or *Copy* the Signal(Intensity) vs. Time window. You can also Save and Load Signal(Intensity) vs. Time data files. Save and load will first display the appropriate Windows dialogs for you to selected the file to save to or load from. The file format is explained in File Formats.

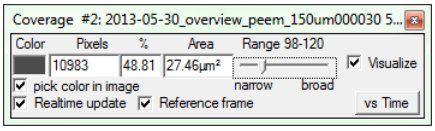
Coverage Window

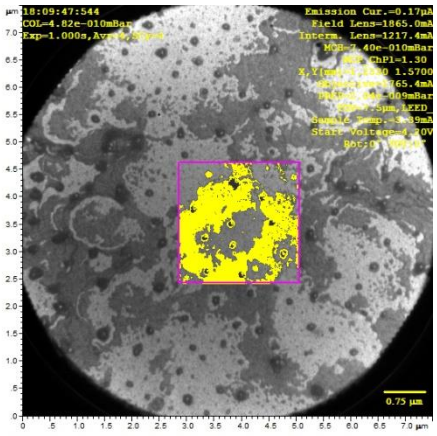
The coverage window allows measuring (counting) the number of pixels fulfilling a specific condition. The window appears like this:



The *Color* shows the selected main intensity value I_0. All the pixels in the image that fall within an intensity band centered at I_0 will be counted ($I_0 - \text{Range} < I < I_0 + \text{Range}$). In the above example, the intensity band is between 619 and 645 and 3027 pixels have been found within this intensity band, representing 0.29% of the total number of pixels (in this case the image has 1024x1024 = 1048576 pixels). The total area covered by the pixels is 0.29 µm^2. The area will

not be shown when the units are not defined: either because the image has no calibration or because in the crop toolbox the selected units are not FOV (see page 82).
If *Visualize* is active, then all pixels falling within the intensity band will be colored yellow in the image:



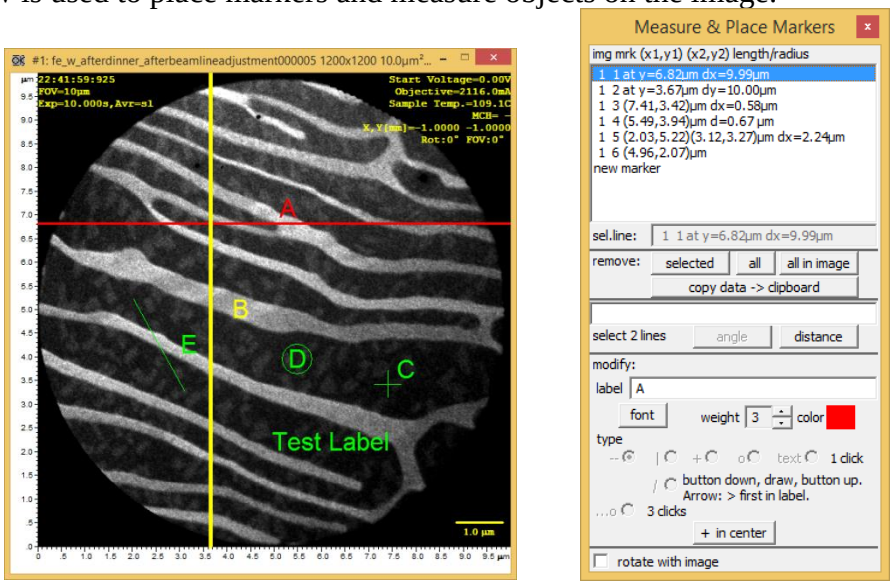


If *Pick color* is selected, by clicking on the image coverage will be automatically updated. If not selected, the same value is kept and clicking on the image has not effect.
With *Realtime update* new images will be re-evaluated for coverage. This is useful to monitor growth processes in real-time.
The *Reference frame* option allows limiting the evaluation to a squared region as shown here:

In this case the purple square cuts the region of interest.
The *vs Time* button opens the *Signal(Intensity) vs time* window described on page 39.
The Coverage measurement will always use a mask if this is active. This means that points (intensities) behind the mask are not considered.

Measure & Place Markers Window

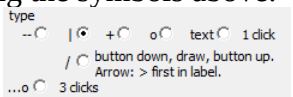
This window is used to place markers and measure objects on the image:



At the top of the window a list shows all the currently active markers. It is possible to place the following type of markers:

Symbol	Type	Nr of clicks	Mouse Wheel
--	Horizontal line	1	
|	Vertical line	1	
+	Vertical cross	1	Change cross size
o	Circle (Marker)	1	Change circle size
text	Text	1	Change font size (applies to all markers!)
/	Line (any direction and length)	1	
..o	Circle	3	Change circle size

These symbols can be selected *only* when *new marker* is selected in the marker list. The different markers are displayed using the symbols above:

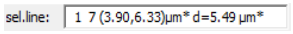


The appearance of all markers can be individually changed without affecting their positions. It is possible to set the label name (typically a letter "A", "B",…), the Font (font selection window will appear), the line thickness and the color. Except for the Font, the appearance of each marker may be different (markers may have different colors, thickness and labels, but always the same font).

Each marker has positional properties and these differ slightly depending on the marker. All units used are either pixels or µm. The latter case is only used if the image is calibrated and FOV is selected in the dropdown menu of the crop toolbar as described on page 82. All entries in the list have the following properties:

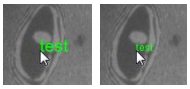
Title	Meaning
img	Image number on which the marker is placed
mrk	Marker number (starting at 1) identifier

(x1,y1)	Marker first set of coordinates: **Symbol** **Meaning** `--` Vertical position `|` Horizontal position `+` Center of cross `O` Center of circle `text` Position of bottom left corner of text `/` Position of the start of the line (*mouse down*) `..o` Center of circle
(x2,y2)	Marker second set of coordinates. Only used for Line (/) markers and is determined by the *mouse up* coordinate. All other markers don't use this value.
Length/radius	The length/radius depends on the selected marker. **Symbol** **Meaning** `--` Length of the line = width of the image `|` Length of the line = height of the image `+` Size of the cross (width=height) `o` Radius of the circle `Text` Empty `/` Length of the line `..o` Radius of the circle

The text in sel.line 

can be edited only in the case of a Circle (Marker) or ○. You may only change the position using the displayed coordinates.

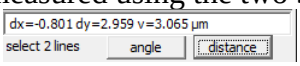
Except for text markers, all markers are drawn with a *dash-dash* line (--) when selected in the markers list.
Markers may be moved using the mouse and they may be enlarged or made smaller with the mouse wheel (all except lines). Notice that to move or enlarge the text marker with the mouse, the lower left corner of the text has to be used as shown here (mouse wheel):



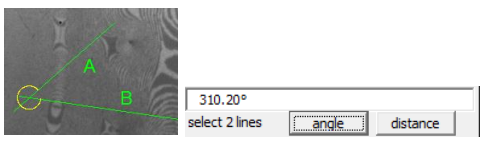
In case of a Circle (three point circle) or `..o`, the center of the circle has to be clicked to move it.

Making measurements

Either angles or distances may be measured using the two buttons:

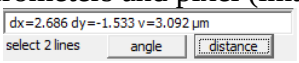


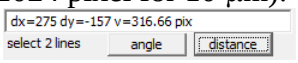
The field above the two buttons shows the current results. To measure the angle between two lines, select the lines in the markers list, click on *angle*. The result is shown above the button in degrees:



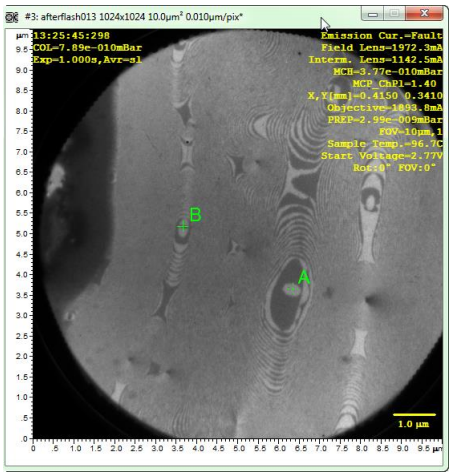
To measure the distance between two points, select the points in the markers list, click on *distance*. The result is shown above the button in either pixel or micrometers, depending on the

current image calibration and if FOV is selected in the crop toolbar (see page 82). Here is an example in both micrometers and pixel (image of 1024 pixel for 10 µm):





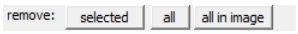
And the source image:

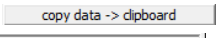


To measure angles and distances the two markers must be able to satisfy an angle or distance relation. For example, it does not make sense to measure an angle between two points.

Deleting and copying markers

Markers can be deleted using one of the three buttons *selected*, *all* and *all in image*:



The 

button will copy text contained in the above sel.line 

to the clipboard.

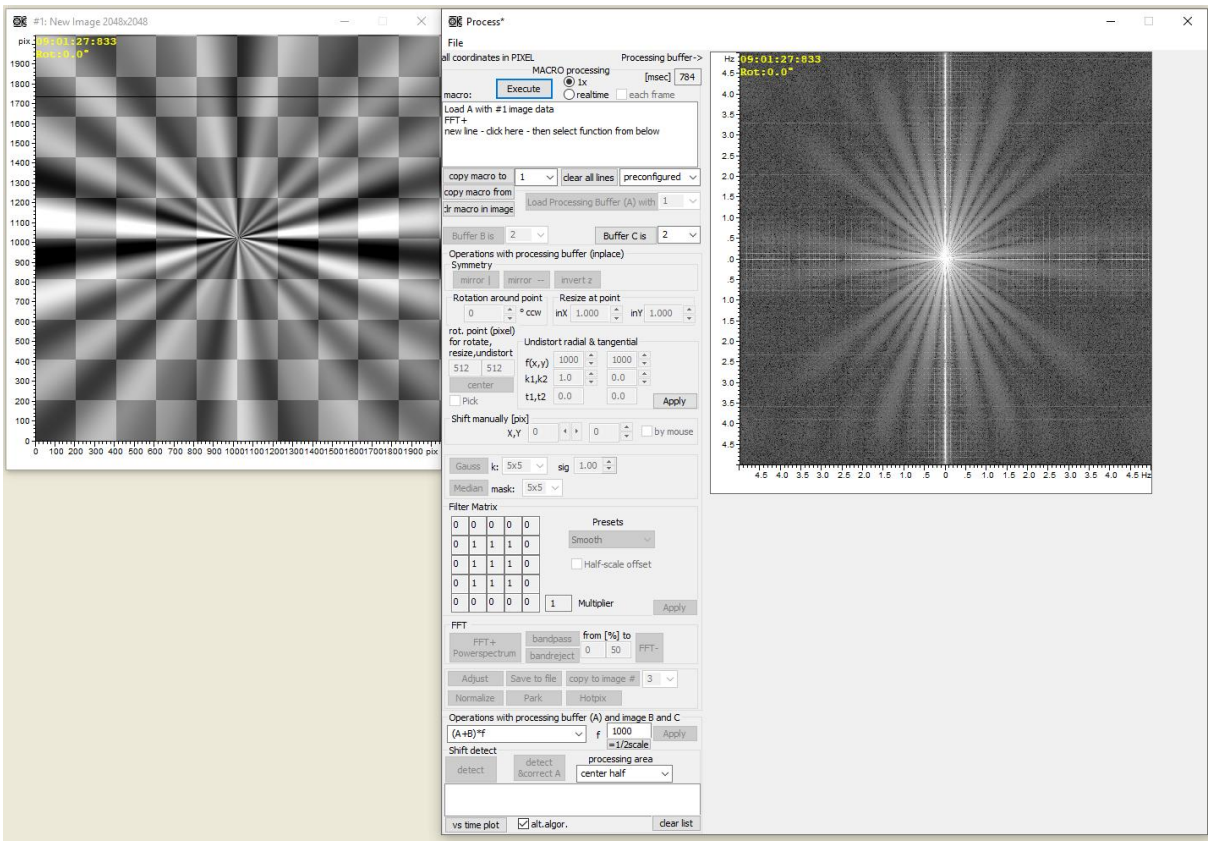
Cross in center and rotate with image

The button 

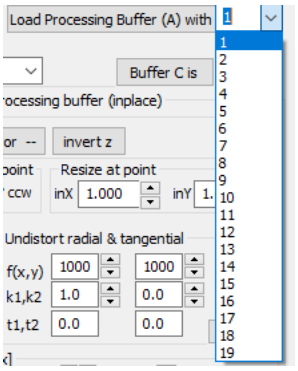
adds a vertical cross in the center of the image.
Since images may be rotated, the *rotate with image* button rotates objects around the center of the image of the according angle.

Process Window

With the *Process* window it is possible to perform mathematical operations on images in real-time or post-processing. The window appears as follows:

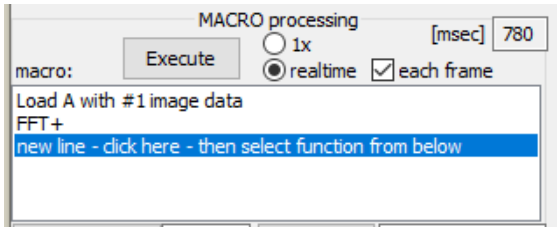


On the left side are the control options (image selection and operations) and on the right side the image resulting from the operations in shown.
All image operations act on a single image except the ones described at the bottom (*Operations with 2 Images (A and B)*). The image can be easily selected in the top left from the dropdown menu:



The window number that is shown in the top left of each image window may be used.
The operations requiring two images are those at the bottom left of the window in the *Operations with 2 Images (A and B)* section. If necessary, the second image can be selected as *Image B:*.

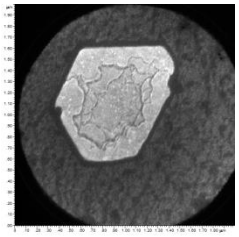
Below the *MACRO processing* section the sequential list of operations to be performed on image a is shown (see below for a list of possible operations). As an example:

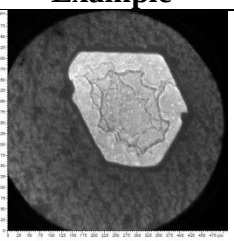
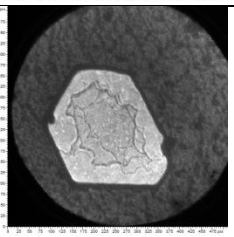


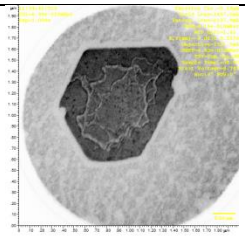
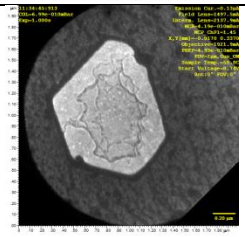
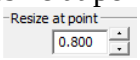
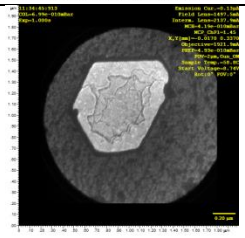
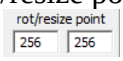
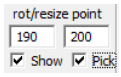
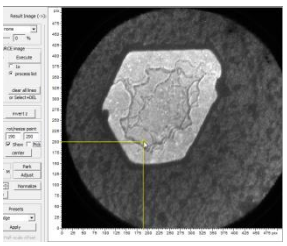
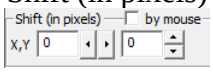
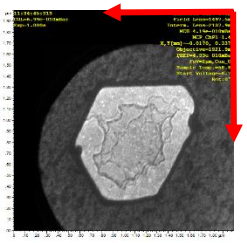
On still images the shown sequence will be performed in the given order (in this case: y-mirror, center rotation point, 45 deg rotation around rotation point, resize 0.8, translation (21,-39), 5x5 Gaussian smoothing).
If a new image is selected in *Image A: (source image)*, then the *Execute* button has to be pressed in order to have the updated processed image shown on the right side. The *realtime* option will process one image every second and should hardly affect the acquisition frame rate. This option should be used for live imaging. Activating the *each frame* option, all acquired images will be processed and will most likely result in a reduction of the acquisition frame rate (of course depending on the complexity of the mathematical operations involved).
The list of operations may be completely erased with the *clear all lines* button or by selecting one or more operations from the list and clicking the *del* button on the keyboard.
The execution time for the macro, in msec, is shown in the upper right of this box.

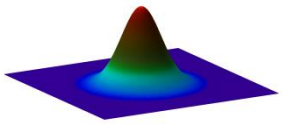
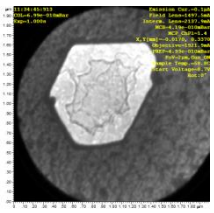
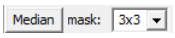
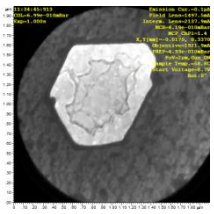
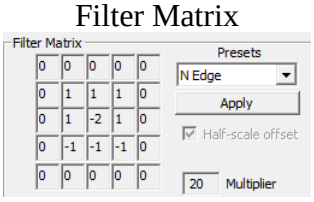
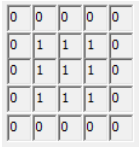
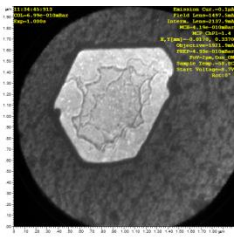
Image Operations

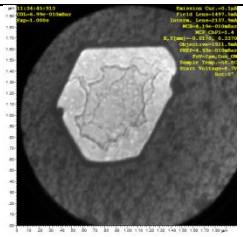
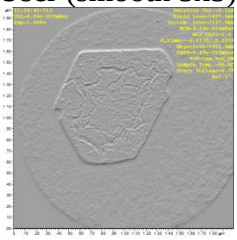
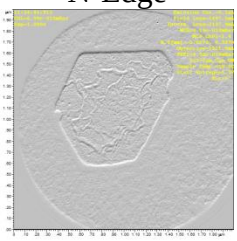
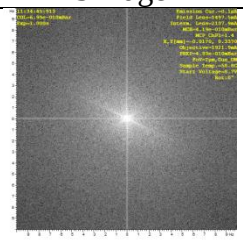
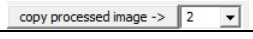
These operations will result in an entry in the macro list. The following table shows how the following image would be modified:



Name	Description	Example
mirror along y 	Order of y positions inverted	
mirror along x 	Order of x positions inverted	

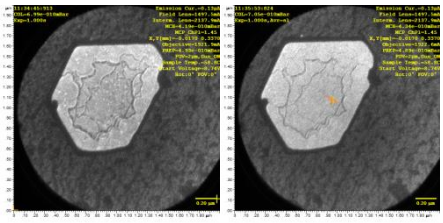
invert z 	Intensity recalculation as a result of 4095-I (for 12 bit camera). Equivalent to	
rotation around point 	Degrees of rotation around the point (in pixels) specified in *rot/resize at point*	
resize at point 	Resize factor at point specified in *rot/resize at point*	
rot/resize point 	The position of rotation/resize point (x,y) may be edited. If changed, all rotations and scaling will be adapted	
Pick 	Select the turning point with the mouse. Click on “Pick” first, then on the image. The *Pick* box will be cleared and the coordinates written in the rot/resize point boxes (190,200 in this case). If changed, all rotations and scaling will be adapted. The *Show* button will display the turning point with a cross	 (yellow lines have been added to guide the eyes)
center button 	Sets the rot/resize point to the middle of the image. If changed, all rotations and scaling will be adapted	
Shift (in pixels) 	Shifts the image. The origin is in the top right, the x-axis points left and the y-axis points downwards. The shift on the right is (-49,78) pixels. It is possible to move the image by clicking on it and dragging it to shift it if the *by mouse* button is activated. The pixel values will be automatically updated	
Save to file 	Saves the current image using the currently available settings	

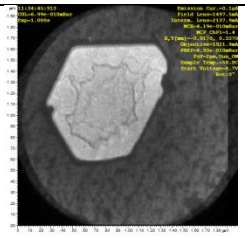
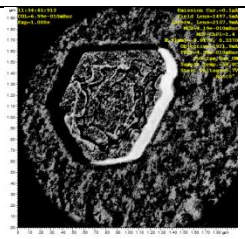
	in the image toolbar (filename and auto-increment on/off)	
Park 	Adds the current image to the *Image Parking* window	
Adjust 	Adjust the image rendering as the adjust button 	
Normalize 	Normalizes the image intensity (to 16384 for most cameras). Changes the histogram	
Hotpix 	Replace *out of line pixels* with averages. Useful for defective cameras	
Gauss 	Convolutes the image with a kernel of sizes varying between 3x3 and 15x15 (droplist).  The *width* (sigma) of the Gaussian is specified in the *sig* field. Sigma values should be about less than one third of the kernel width. Larger values will result in cropped gaussians. Guassian filtering is typically used to remove high frequency noise (low band pass filter)	 Kernel 7x7 Sigma 2.0
Median 	A median filter substitutes every central pixel within a kernel with the median of the kernel. The kernel type may be chosen between 3x3 and 7x7. This type of filter is very useful for removing *salt and pepper* noise while preserving as much as possible the edges sharpness (low resolution loss)	 Kernel 5x5
Filter Matrix 	The filter matrix performs a convolution of the image with the shown kernel:  There are some preset kernels available: *None*, *User*, *Smooth*, *N-E-S-W-NE-SE-SW-NW Edges*. The Smooth option, with a 3x3 kernel, is also known as	 Smooth (3x3)

	boxcar averaging. Every pixel is substituted by the average of 3x3 window around it. The *Edges* filters will create an asymmetric filter to enhance features along these directions (north, east, …). Edge Filters can be added to images to enhance steps in given directions)	 User (smooth 5x5)  N-Edge  S-Edge
FFT+ 	Performs the forward Fourier transform and displays the magnitude spectrum	
bandpass 	Is used to perform frequency domain filtering by applying a ring mask (bandpass). The forward FFT is calculated and all values NOT between *from* and *to* are set to zero. A low pass filter would require setting *from* to zero and tuning *to* to an appropriate value. This option has to be used between FFT+ and FFT-	
bandreject 	The same as bandpass, but the values between *from* and *to* are set to zero. This option has to be used between FFT+ and FFT-	
copy processed image -> 	Will transfer the process image to the selected image window	

Operations with 2 images (*uses image B)

The images used are the following:

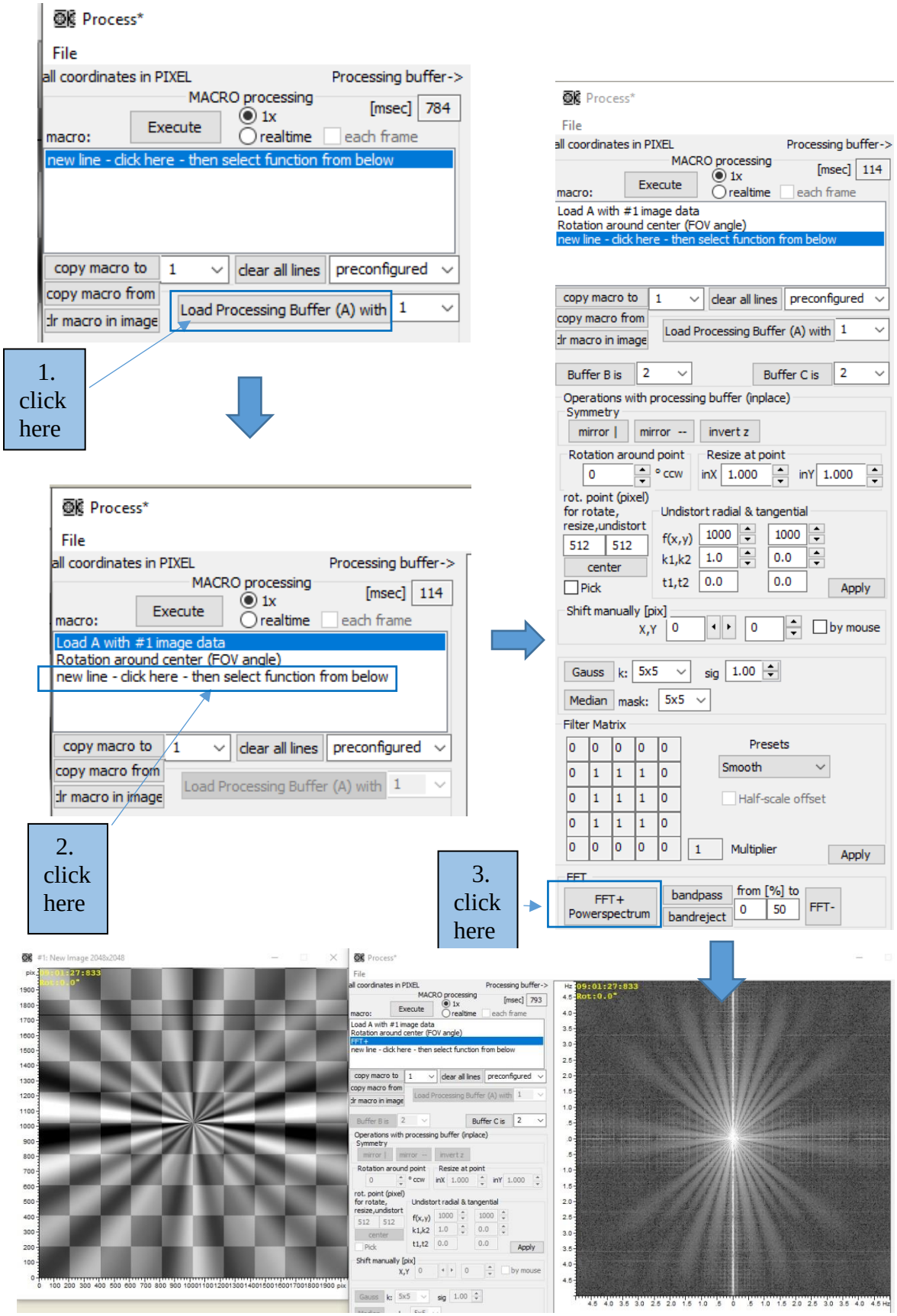


Detect	Measures the shift (drift) between two images using the phase correlation method. The calculation may be processed over the center half of the image, a user defined area or the whole image. Processing the center half for the above images results in a shift detection of (23,-2) Pixels. This can be displayed overlaying one image to the other and using the transparency at 50% as shown on the right	 Overlapped images after shift compensation (notice the image borders shifted horizontally, but the island is overlapping)
Image math operations	The possible operations are: (A+B)*f (A-B)*f (A-B)-MIN (A*B)*f (A/B)*f (A-B)/(A+B)*f Where f is a factor that can be freely defined. Notice that: – (A-B)*f sets values lower than zero to zero – MIN calculates the minimum value of (A-B). This way the result of (A-B)-MIN will always be positive and the lowest value will be zero	 (A-B)*f

In the *Operations with 2 Images* section, the *vs time plot* button allows to show the drift direction in the signal vs time window. This can be useful when working on image stacks.

“Process window” example: How to set up power spectrum display in 3 steps

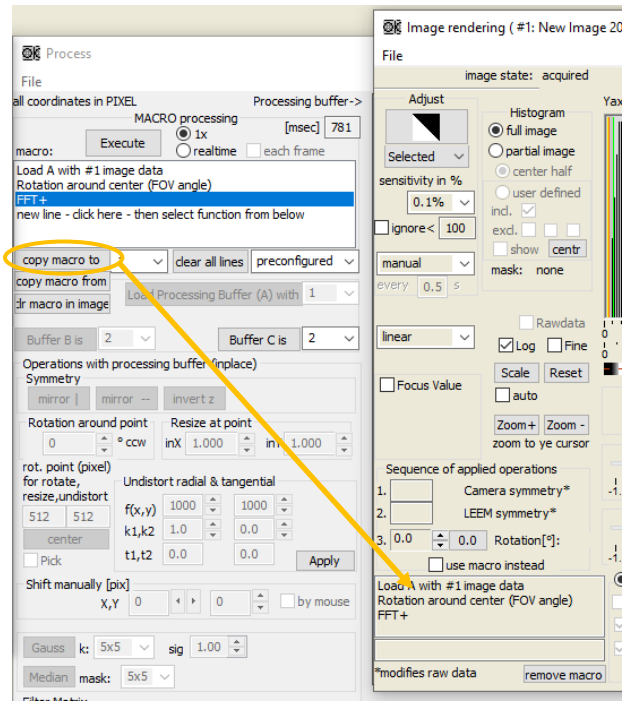
Note: In case the macro contains already entries press “clear all lines”



Note: you probably need to press the "Adjust" button in the "image rendering" window to display the power spectrum as seen here.
Note: The "image rendering" window is shown for the currently selected image. If you click on the left window, in the example above, it will show histogram and selected options for this image (image #1) if you click on the "Process" window the "image rendering" window will show histogram etc. for the "Process" window (image #22)

Further options for this example:
A. Use macro on any other buffer

In case you want to copy the macro to another image-buffer press the "copy macro to" button. If you do this and then acquire images into this buffer, then Uview can automatically, in real time, process the acquired image with the instructions given in the macro IF the checkbox "use macro instead" is pressed.

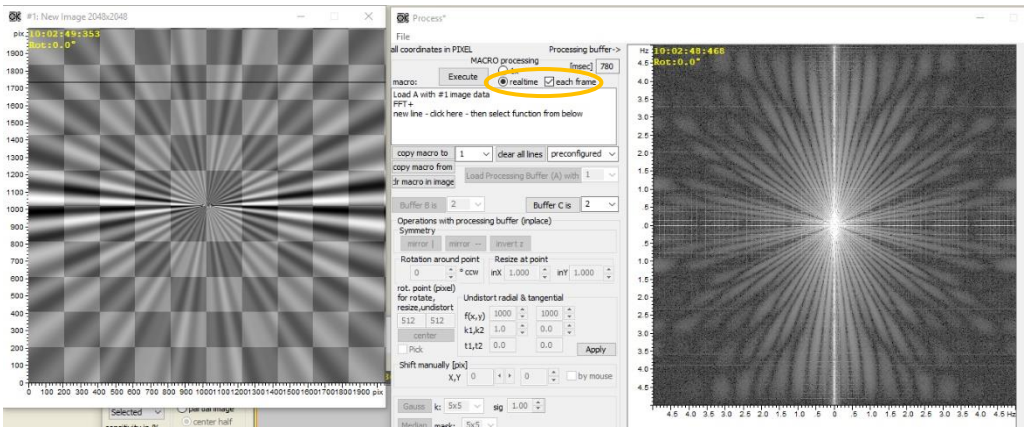


Note: When doing so, please make sure you select the image buffer before pressing the "image acquisition" button, else you will get an error message:

Processing window can not be used for acquiring images.
Please select image buffer 1 to 20 instead!

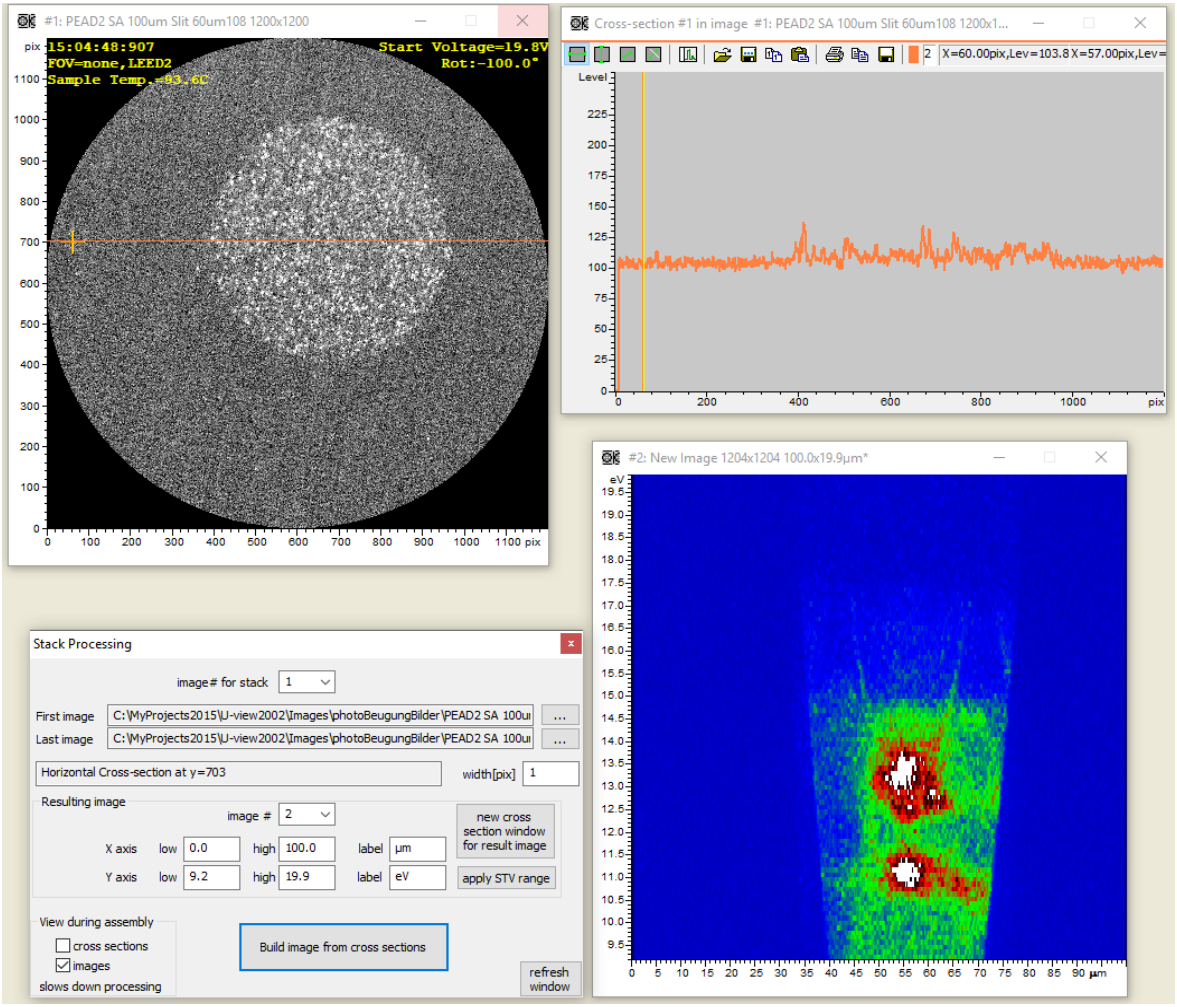
B. Display original image and processed image simultaneously in real-time

- click "realtime"
- optionally check "each frame" else processed is done every second or so
- click the source image
- press the red camera acquisition button.



Stack Processing Window

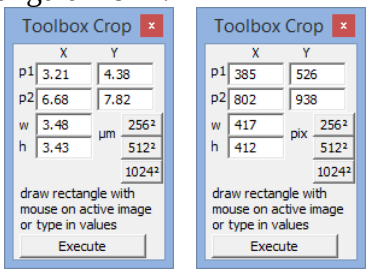
Stack processing at this time is limited to taking a perpendicular cut through a stack of image files. The cut is defined by taking a cross section with the cross section tool at any direction across the image window. The image stack can be scaled in eV if the STV was saved with the original images (which should be the default).



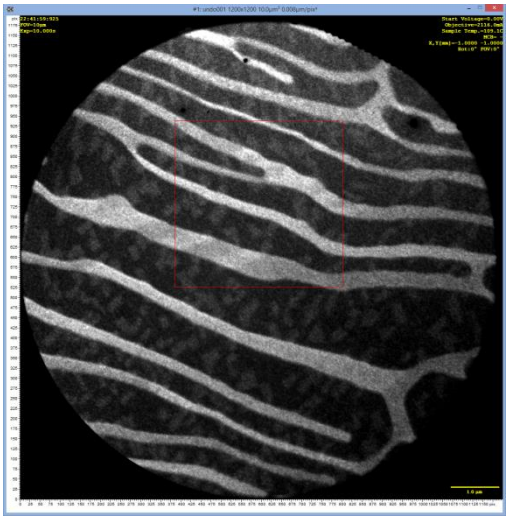
In the *Stack processing window* select the first and last images *(.dat)* you want to use. These images need to be in one common folder and need to be numbered in ascending order. This means the same format and names as they were stored with Uview. Once you entered the first image (… button) this will be displayed in the selected image window. The *image# for stack* should be 1 or your currently selected image window. Now you can define a cross section in the cross section window and also specify the width of the cross section in pixels. This allows for a better statistics because Uview averages the #cross sections specified in *width.*
After that select the last image (… button). The more images are in the stack the better the final result. For the resulting image, the cut through the stack, you can specify *image#* and the labels on x and y axis (y axis is the z axis of the stack). Uview will preset these values from the information it finds in the image files. *Apply STV range* uview will take the first and last STV value from the files and use those to label the y axis of the resulting image.
Press assemble .. to generate the resulting image containing the cut through the stack.
There are also options to view the cross sections and images while they are loaded.
The resulting image can be handled like any other image, i.e. cross sections can be taken.

Crop Window

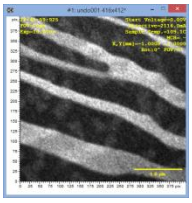
The crop window allows selectin a relevant part of the image and disregarding the rest. Cropping is only allowed in rectangular form.



p1 and *p2* are two points defining the bottom left and top right points of the bounding box. The units used are either µm or pixel. The bounding box can either be drawn with the mouse or typed in. *w* and *h* are the width and height of the box. The three buttons 256^2, 512^2 and 1024^2 can be used to *fix* the box size to these presets (valid for width and height in pixel units).
Pressing *Execute* the image will be cropped to the selected dimensions. To undo the operation use the button labelled *U* in the Cropping Toolbar.

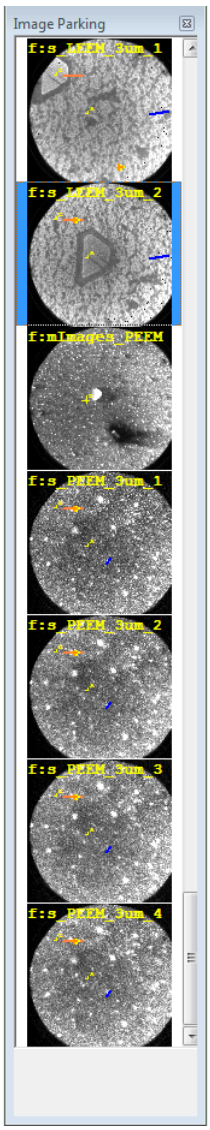


Original Image



Cropped Image

Parking Window

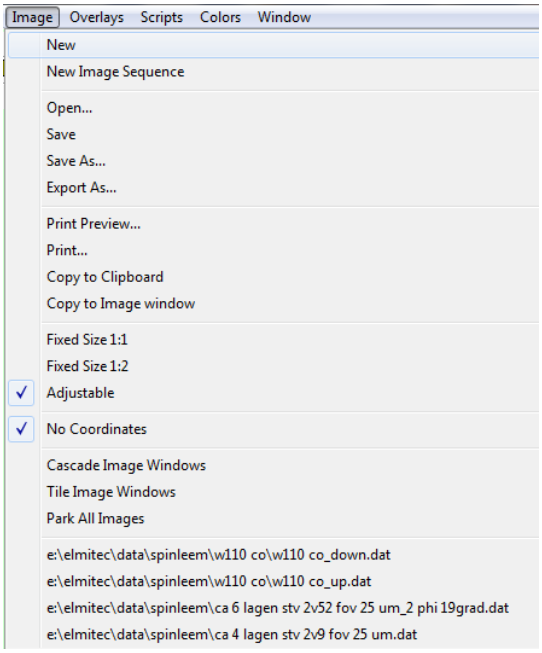


The parking is useful to temporarily store images and reload them. This window is typically located on the right side of the U-view window (although this may be changed by the user). The images in this window are saved in a special folder and are again available when restarting the software. One or more images may be selected (blue edges) with the mouse. If one image is selected and double clicked, it will be loaded in the currently active window. Alternatively pressing the *s* button on the keyboard will open the *save image* dialog window and the *del* button will remove the image from the parking and memory.
With a mouse right click four options will be available:

- Save one or more selected images
- Save all images
- Open one or more images
- Open all images in folder

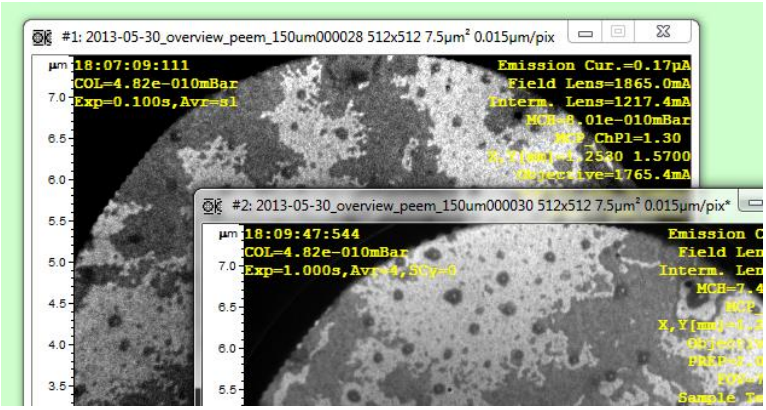
Menu: Image

Contains the menu item which shows new image frames on the screen. It also is used to change the image size from fixed to adjustable and to remove the coordinate system.



New Image

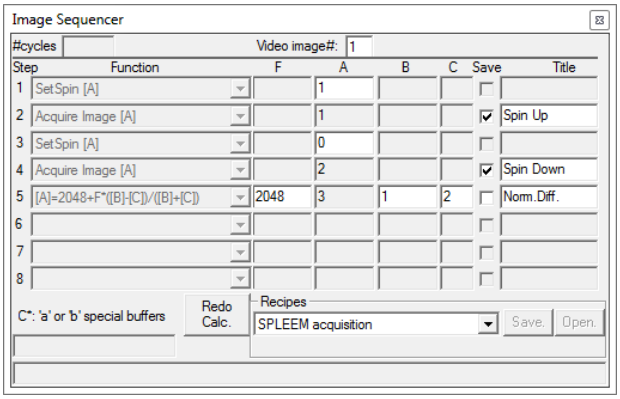
Places a new image frame on the screen. The newly created frame is made the **Active Image** (* marker in the top bar). Up to **13 images** can be open at one time, and then the *New Image* field will gray out and be disabled until you close one or more of the images.
New Image can be selected when image acquisition is on or off.
When closing the image window with new data you will be asked if you want to save the current image (if the content of the image has changed).



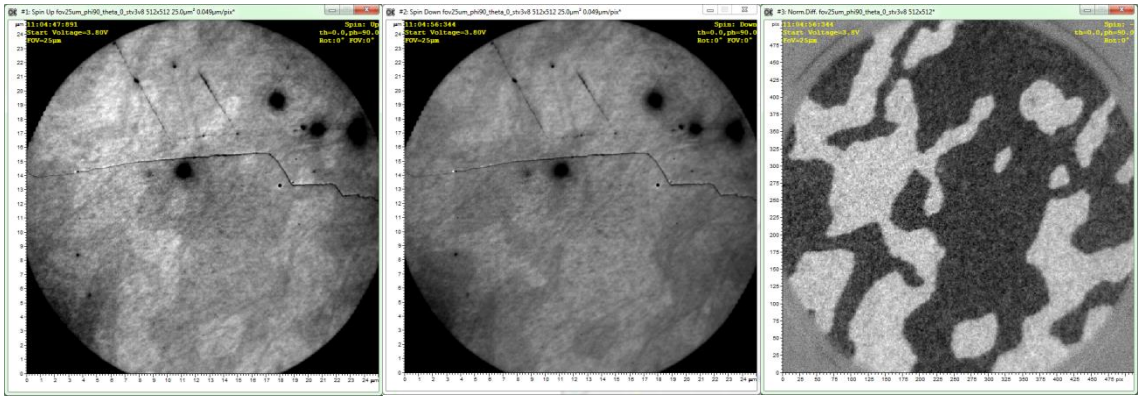
Notice that the menu field *New* will gray out when *Playback* toolbar is active.

New Image Sequence

This feature allows the acquisition of multiple images, each associated with a different LEEM parameter or preset or the result of an arithmetic operation of 2 other images. A sub-menu will show the available recipes (LEEM raw and backgroundsubtracted,…) and with *Custom* new recipes can be made. When any recipe or *Custom* is selected, the *Image Sequencer* window appears:



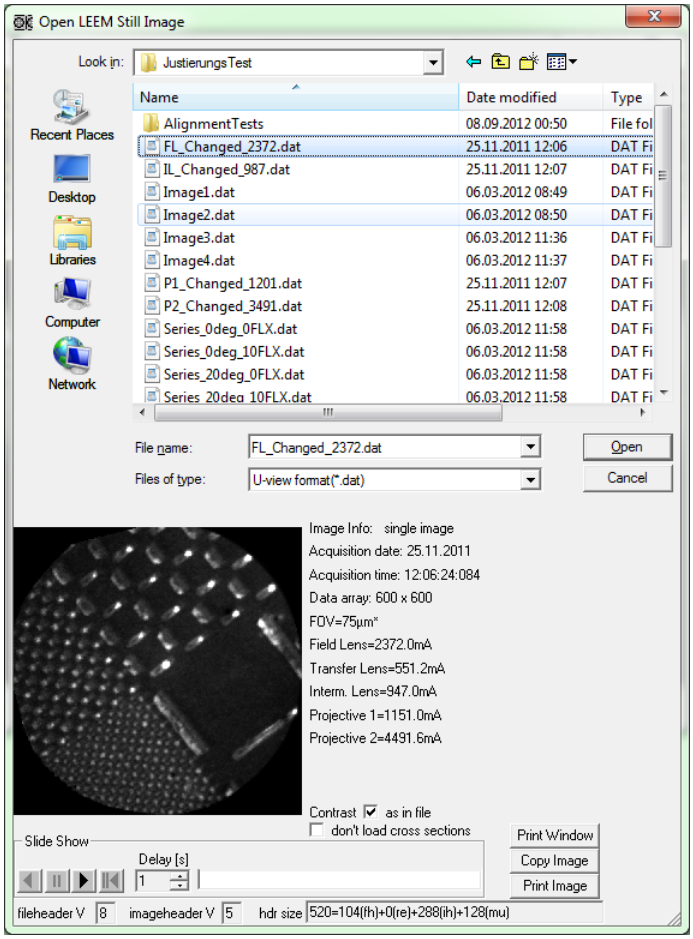
And the following images can be acquired:



The *Image Sequencer* window allows the user to choose from *recipes* which define what images are acquired. A typical SPLEEM recipe for instance allows collecting one spin up image, then a spin down image and following that, calculates image asymmetry.
If Custom is selected in the recipe list, then the user can create his own recipe and save it.

Open Image

The *Open* Dialogbox uses a typical windows *open file* and below useful information is listed. A preview of the currently selected image is shown. On the right of the image preview *image info* shows relevant image information and overlay data from LEEM2000.
Further below a *slide-show* can be used to preview the images available in the current folder. It allows at a selected rate to go through a folder of images Back and Forward. Stop and Rewind are also available. The images are displayed in the order of the time they were saved.
For the selected image the contrast can be either set to be as in the original file or to a desired value between *low*, *medium* and *high*.
Typically when opening a file U-view restores all cross sections displayed in the image. This can be avoided by clicking the *don't load cross sections* box.
It is also possible to print the current window with the Print Window button.
The currently previewed image can be copied to the clipboard with the *Copy Image* button or printed with the *Print Image* button. Before the image is sent to the printer, a window will allow resizing and centering of the image. This can be done without having to open the image in U-view. This can be done *while* images are being collected in U-view.



Save options

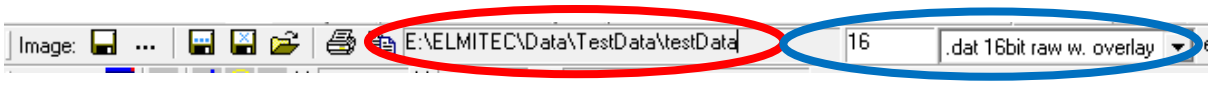
Image saving can be divided in two categories: for data analysis and for display. In order for the image data to be analyzed at a later stage, the images must be saved in a file format that does not alter or reduce the acquired information. These formats are:

U-view format (.dat)*
PNG (.png)*
TIFF (.tif)*

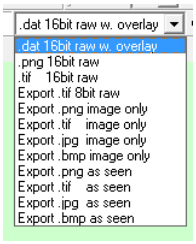
All these three formats use 16-bits per data point and do not alter the original data acquired by the camera. However, the U-view format has the useful advantage giving the possibility of saving in the image header image parameters from the instrument (pressure, sample temperature, field of view, lens currents, …). The other formats (png and tiff) only save the image data. **Therefore ELMITEC always recommends saving new data in U-view format.** Often it is however necessary to save or export the data to presentations, word processing software or emails. The fast way to do this is simply to *copy-and-paste* the image; otherwise hard-copies can be made in the following formats: PNG, TIFF, JPEG, BMP and raw ascii.

Save

This will save the current image. The file name use will the one selected in the *Image Toolbar* as shown here:



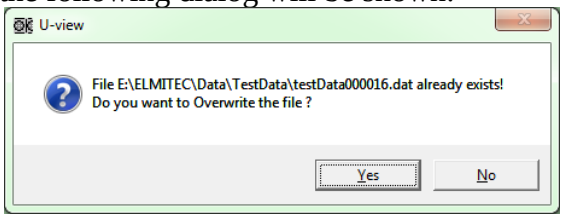
The folder and file name root are shown in the red oval. Then a six digit numbering extension is added. The current index is shown in the blue oval along with the file type. The available export types are:



The first three export the image data, whereas the *Export* labelled options compress the data (information loss) and are only suitable for display/sharing.
In the present case, the resulting file name will be:

E:\ELMITEC\Data\TestData\testData000016.dat.

If the file already exists, the following dialog will be shown:

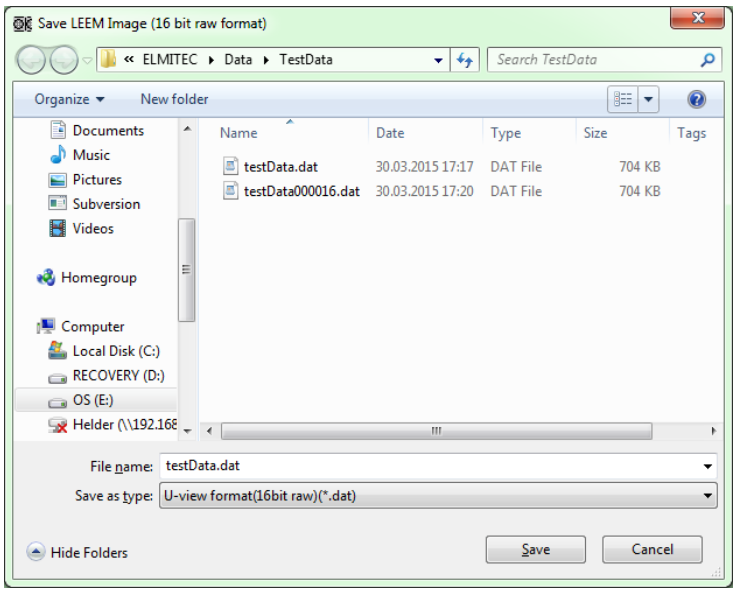


After save, the file number extension will be increased (in this example it will be 17).

Save As ...

A Windows *Save LEEM Image* dialog box will appear. It allows saving the selected image in one of three available data formats:

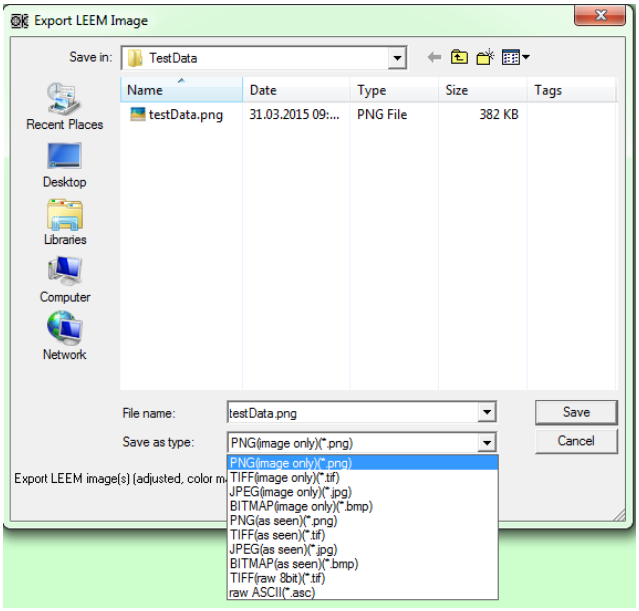
U-view format(16bit raw)(.dat)*
PNG(16bit raw)(.png)*
TIFF(16bit raw)(.tif)*



The U-view file format is the only that saves the image with overlay data and exactly as acquired from the camera. PNG and TIFF 16-bit formats cannot save the overlay data. The 16 bit gray-level TIFF format is rarely supported by other applications while 16 bit gray-level PNG is. Raw means that the image is save exactly as acquired, without contrast and brightness adjusted the image data, if you load such a TIFF or PNG file into i.e. Adobe Photoshop, it will very often appear to be black. You need to use the Photoshop tools to adjust brightness and contrast such that a viewable image appears.

Export as …

This allows saving either the image without overlays (*image only*) or with overlays (*as seen*). The available formats are PNG, TIFF, JPEG and BMP. An extra option allows saving the image as raw ASCII data.



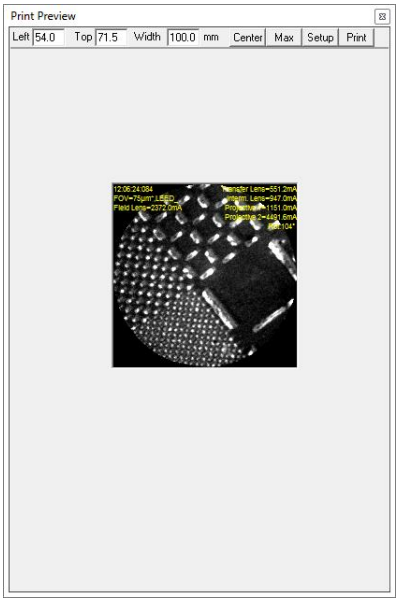
When exporting JPEGs, it is possible to set the quality factor (100% highest quality):

Description of file formats:

Name	n-bits	Color	Export type	Type	Loadable in U-view
.dat	16-bit	No	Data	Raw	Yes
.png	16-bit	No	Data	Raw, without axis and overlays, lossless compression	Yes
.tif	16-bit	No	Data	Raw, without axis and overlays	No
.tif	8-bit	No	Export	Image only, without axis and overlays	No
.png	8-bit/channel	Yes	Export	Image only, without axis and overlays	Yes*
.tif	8-bit/channel	Yes	Export	Image only, without axis and overlays	No
.jpg	8-bit/channel	Yes	Export	Image only, without axis and overlays	Yes*
.bmp	8-bit/channel	Yes	Export	Image only, without axis and overlays	Yes*
.png	8-bit/channel	Yes	Export	As seen, with axis and overlays	Yes*
.tif	8-bit/channel	Yes	Export	As seen, with axis and overlays	No
.jpg	8-bit/channel	Yes	Export	As seen, with axis and overlays	Yes*
.bmp	8-bit/channel	Yes	Export	As seen, with axis and overlays	Yes*

* - Although possible, it is not recommended because any measurement operation (cross-section,…) will operate on modified data.

Print Preview …



Selecting this menu entry will display the *Print Preview* dialog. It shows the layout of the page to be printed with the correct aspect ratio. The selected image is shown in the correct size and position in relation to the paper. The image can be moved around by selecting it with the mouse. Size and position can be entered numerically in mm. The image can be centered (*center* button) and maximized (*Max* button). The *Setup* button calls up the Windows *Print Setup* dialog. The *Print* button displays the Windows *Print* dialog to start the printout.

Print …

The Windows *Print* dialog is displayed for the currently selected image (without preview).

Copy to Clipboard

The current image will be copied into the Windows clipboard from which it then can be pasted into numerous other applications.

Copy to Image window

This option allows copying the current image to another window. This can useful when comparing images.

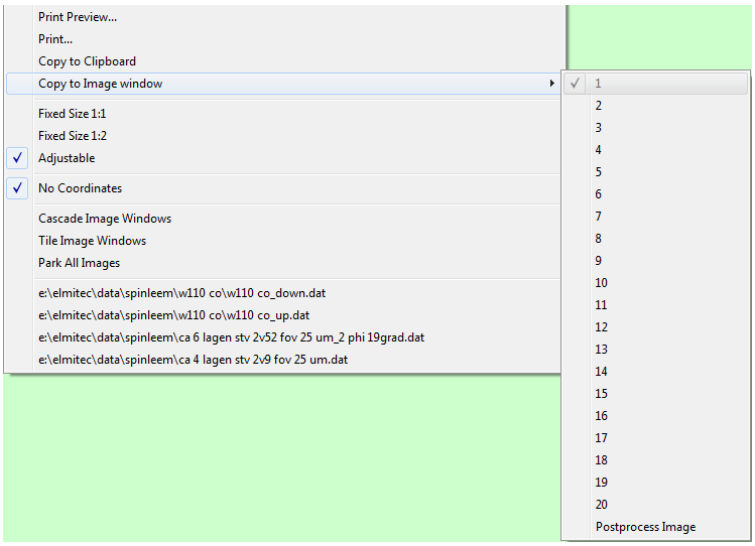


Image Sizing Options (1:1, 1:2, Adjustable)

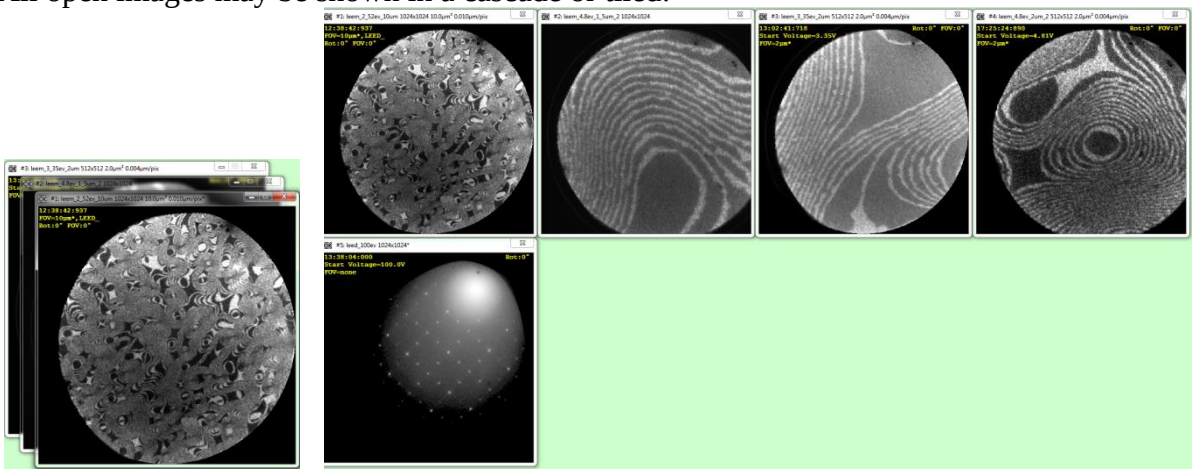
The window in which each image is displayed on the screen can be either fixed to the resolution of the camera (1:1), to half the size of the camera resolution (1:2) or freely adjustable (retaining the aspect ratio of the camera resolution). With fixed image ratios images can be acquired with slightly higher frames-per-second ratios.

No Coordinates

This option displays the image without the x and y axes.

Arranging Windows

All open images may be shown in a cascade or tiled:



Park all images

All available images are stored in the Image Parking list. Images can then be loaded, saved or removed from the parking list.

Recent files menu

Like in most Windows applications, these entries list the four last recently saved or opened files. To load one of those files in the currently active image window simply click the file name. If no window is available, a new one will be created.

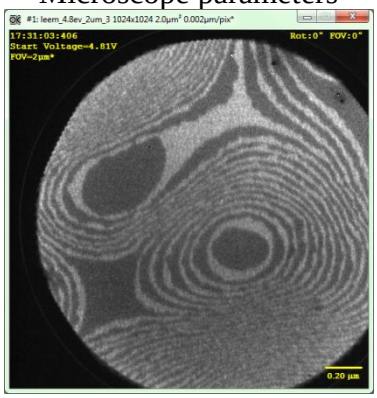
Menu: Overlays

In the *Overlays* menu graphical information to be overlaid to the image can be found. All overlayed parameters (in text form) and grid will never be included in the online analysis tools (the image data is not modified). Only masks are used during analysis (for example to cut out unwanted regions in the image rendering – histogram) in U-view. The original data is however never changed.
Overlays may be one of the three sorts:

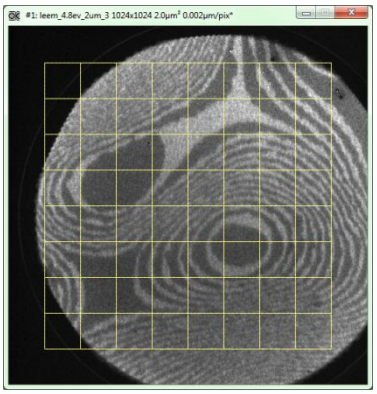
- Microscope parameters
- Grid
- Mask

Here are three examples:

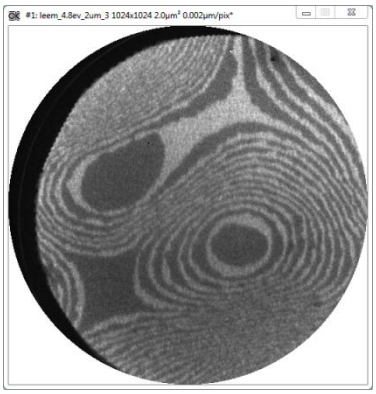
Microscope parameters



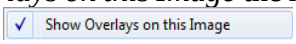
Grid



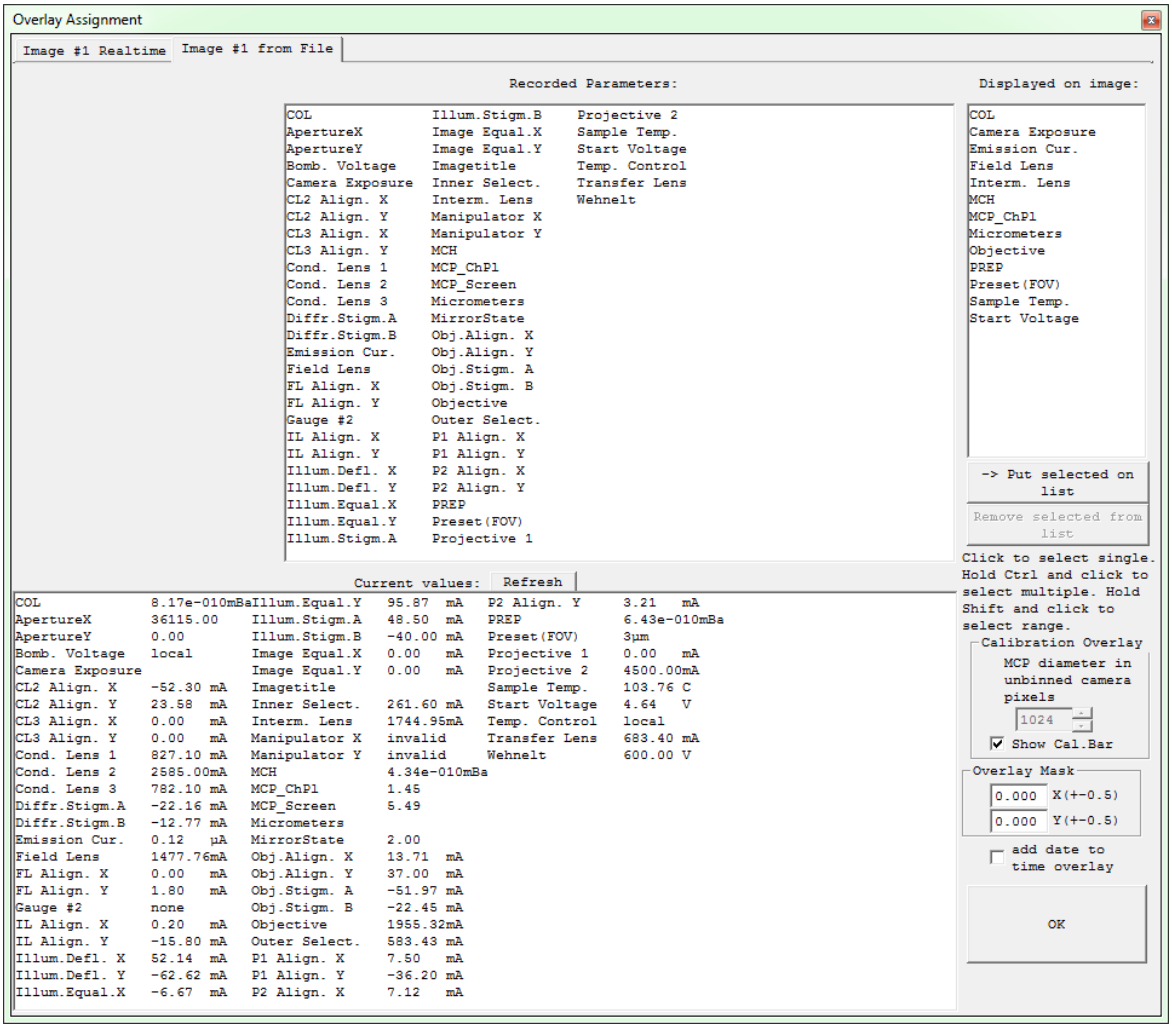
Mask



Microscope parameters

By clicking the *Show Overlays on this Image* the microscope parameters will be shown/hidden. If the check mark next to 

is present, than the overlays will be shown.
To see which parameters are available and select which parameters should be shown select *Assign Overlays* from the *Overlays* menu and the following window will appear:



The window has always two tabs: *Image #1 Realtime* and *Image #1 from File* (the image number, *#1* in this case, will depend on the currently active image). Whereas the *from File* tab shows the LEEM information stored in the file header of the image loaded in window #1, the *Realtime* tab will display the current available parameters from LEEM2000. Notice that the *Realtime* tab can only be accessed when connected to LEEM2000 and the *from File* tab cannot be accessed when Realtime acquisition is running. *The Recorded parameters:* list will differ depending on instrument type, available devices in LEEM2000 and file version, all at the moment of creation of the file. Up to 10 parameters may be displayed on the image. The displayed parameters are shown in the *Displayed on image:* list. To add parameters:

- Select one or more parameters under *Recorded parameters:*
- Click on -> *Put selected on list*

To remove the parameters:

- Select one or more parameters under *Displayed on image:*
- Click on *Remove selected from list*

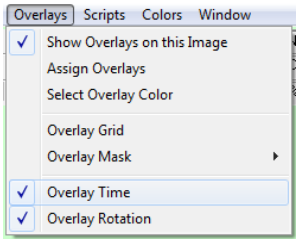
To select multiple parameters from the lists you may:

- Keep Ctrl pressed on the keyboard
- Click on elements you want to select with the left mouse button (pressing down the left mouse button and moving over more parameters is also possible)
- Release the Ctrl key

Or select a range by:

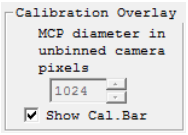
- Selecting the first element with the left mouse button

– Keep Shift pressed on the keyboard
– Click on the last element of the range with the left mouse button
– Release the Shift key

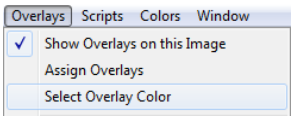


In *Current values:* the values assigned to each available parameter are displayed.

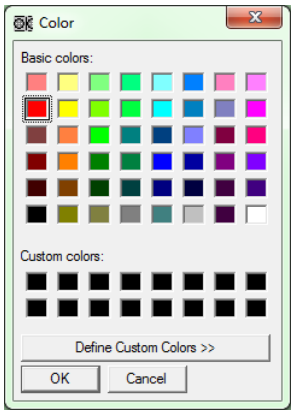
Two parameters are always available: *Time* and *Rotation*. These can be shown/hidden directly from the Overlays menu.

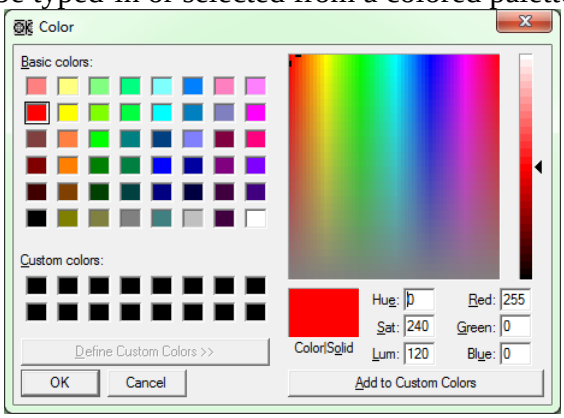


In the *Calibration Overlay* field, it is possible to set the *MCP diameter in unbinned camera pixels* value. This is the pixel pitch of the MCPs in the current camera conditions and this value is used to calibrate the field of view (nm/pixel) and to show the appropriate calibration bar. This field cannot be edited when *the from* File tab is displayed (this parameter is set when saving an image).
It is only possible to display a calibration bar when the *Preset (FoV)* is an available parameter.
To show the calibration bar simply activate the box *Show cal.bar*.



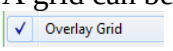
To set the Overlay and Grid color, click on Select Overlay Color and the *Color* window will open.
It is then possible to choose among *Basic colors*, *Custom colors* and *Define Custom Colors*. In the latter case the Color window is extended to the right and RGB or HSL color can be typed-in or selected from a colored palette.



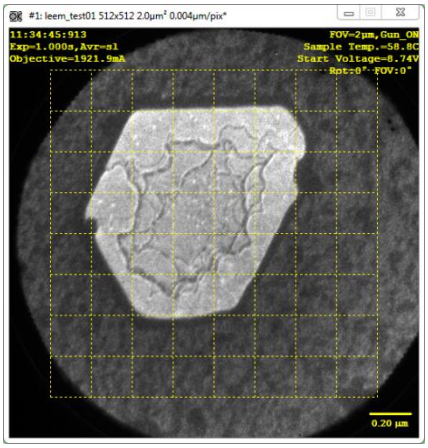


Grid

A grid can be overlaid to the image by clicking the *Overlay Grid* button in the *Overlays* menu.



The color of the grid is the same as the Overlays.

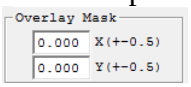


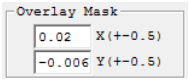
Mask

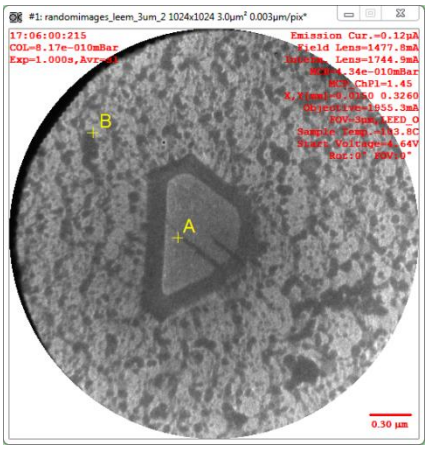
If selected, a black or a white mask with a round opening of the size of the channel plates is placed over the image. The exact placement and size can be adjusted in the *Overlay Assignment* window. The purposes of this mask are:

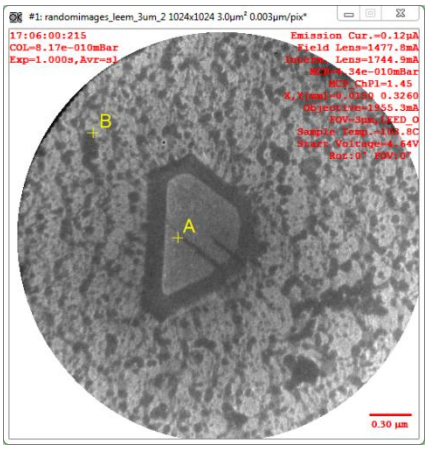
- Cut out unwanted parts of the image when displaying the histogram
- Cosmetic
- Saves toner when printing
- Higher image compression when saving or transferring over the network (valid only for PNG, JPEG and TIFF).

The mask position can be adjusted, in case the camera is not perfectly centered on the screen, within the *Overlay Mask* field in *Overlay Assignment* window.
This allows the mask to be shifted (up to half the image size) in the x and y directions.
Here is a Mask shift example:

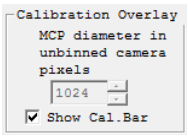








The mask size can be adjusted in the Calibration Overlay by setting a different pixel value:



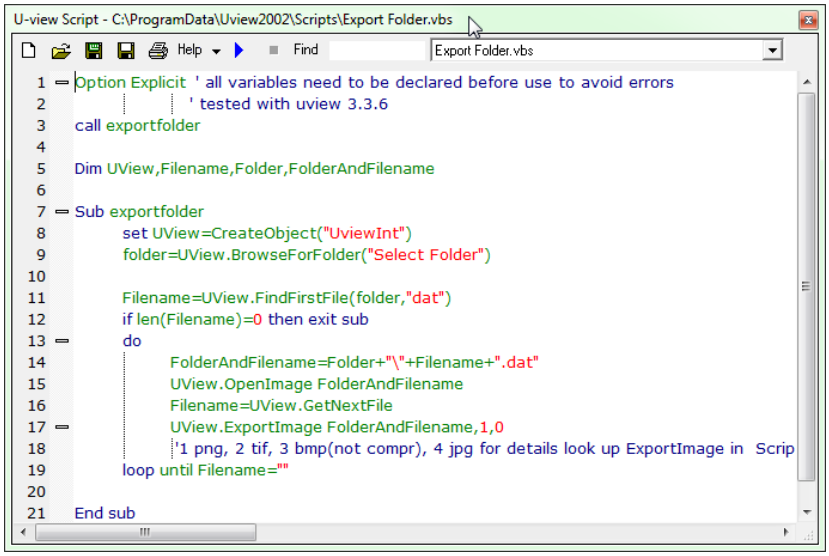
Notice: that the size of mask, in pixels, *must* match the size of the detector screen. The size of the screen in pixels is used to define the field of view calibration bar, the pixel calibration in cross-section and all other functions making use of calibrated spatial coordinates. However, this value should hardly change, unless the camera objective lens to screen distance is changed.

Menu: Script

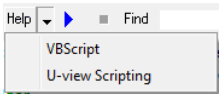
To start the execution of a script, selects its name in the *Script menu*. While the script is running a checkmark is placed next to its name. It is usually not necessary to abort a script, unless it was written to run endlessly. But in case a script needs to be aborted you can click its name in the menu again.
What scripts appear in the Script Menu? All files with the extension *vbs*, *js*, or *exe* which are located in the *Scripts* folder in the windows C:\ProgramData\Uview2002\ folder will appear listed in the *Scripts menu*.

Script Editor

Select the *Script Editor* if you want to look at the contents of an existing script or edit an existing script or write a new script. Vbs and js files can be edited, exe are applications generated by other means and cannot be edited.
The editor is based on the Scintilla (www.scintilla.org) source code editor. Reserved and language specific words are highlighted. Otherwise the editor works as any normal text editor (Notepad or Wordpad). That means you can use the left mouse to select text, cut, copy and paste it within the script or to and from an outside source.
When you made changes to a script, you will always be prompted to save it when closing the script editor or selecting a new script or hitting the run button.



Script Toolbar

Button	Meaning	Description
	New Script	This button will clear the editor window. Type the script and save when you are done
	Open Script	Opens an existing script. A standard windows *open file* dialog is displayed for the selection of the script
	Save Script As	Select this button if you want to save the current script under with a certain name. A standard Windows *Save File As* dialog is displayed
	Save Script	This button will save the current script
	Print Script	Prints the text of the current script. A standard Windows *Print* dialog is displayed
	Help	Two help files can be accessed from the *Help menu* in the script editor. The most important is a download of the Microsoft Scripting Help. It explains in great detail what a script is, how it works, how to write it and contains a complete reference of all Vbscript and Jscript features and language elements. The second help file lists the properties and methods available in U-view
	Run Script	This button will start the execution of the script. Only one script can be running at one time
	Find	Allows searching for text in the currently active script. Type the search string in the field and then click on the *Find* button
	Script Selector	Choose the script you would like to edit by clicking on the down arrow and selecting the desired script with the mouse. If the current script was changed since it was opened you will be prompted to save it

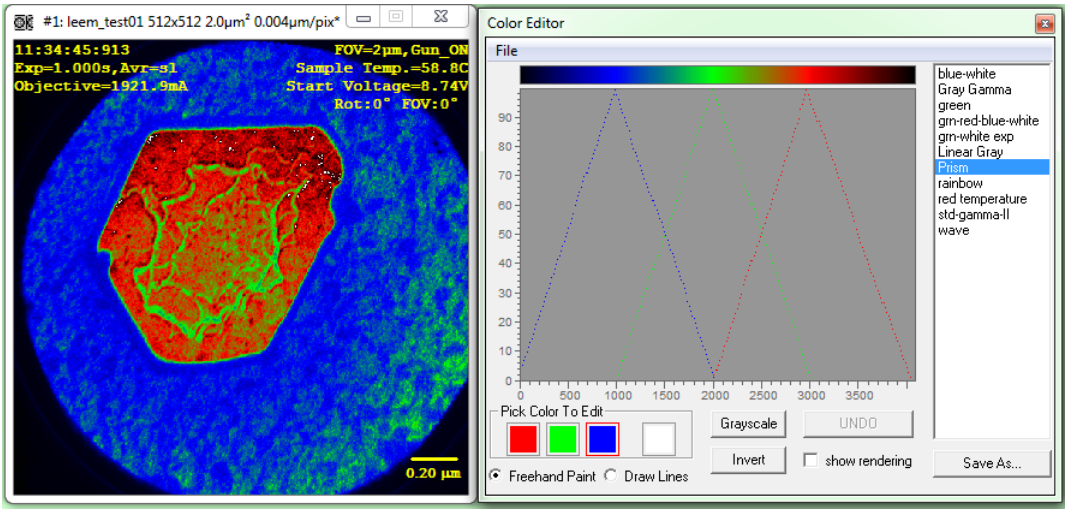
Menu: Color

This menu contains the tools to load and edit color tables. Color tables are used to provide false coloring schemes for your LEEM images. The currently active color table has a marker next to it.

Color Selection

Click on the name of the color scheme you want to apply to your image. As soon as you select the color entry, the color of the currently displayed image will change. You can edit the color table by selecting the *Edit* menu entry. The selected color choice will be saved when you quit U-view.
What colors appear in the Color Menu? All files with the extension *col* which are located in the *Colors* folder, in *C:\ProgramData\Uview2002* will appear listed in the *Colors Menu*.

Color Editor



The color editor allows you to generate any coloring for your images you want. You can draw the red, green and blue parts of the color table by hand and see the image colors change at the same time. First select the color you want to change. Then move the cursor over the diagram, press the left button and begin drawing the color response graph. The x-axis for the plot is in image levels (typically 4096). The y-axis is the corresponding intensity in percent.

Pick Color

Click on the color you want to edit. Red, Green, Blue or a combination of all can be selected. A red box indicates which color is selected. Select white and you can draw the response for all colors at the same time.

Drawing Mode

Freehand paint allows you to draw by holding the left mouse button down. *Draw Lines* allows you to click on the start point and end point of a line. When you click the left mouse button a line is generated from that point to the previous point you clicked.

Grayscale

This button generates a color table in shades of gray, from black to white.

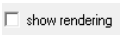
Invert Colors

This button inverts the color table.

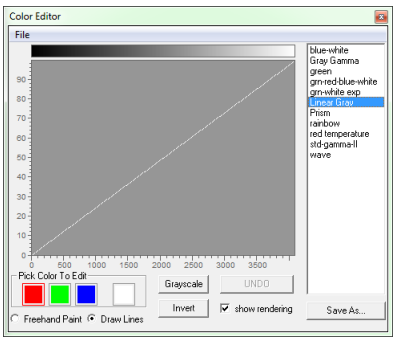
Undo Color Changes

Undo restores the colors as they were when you entered the color editor.

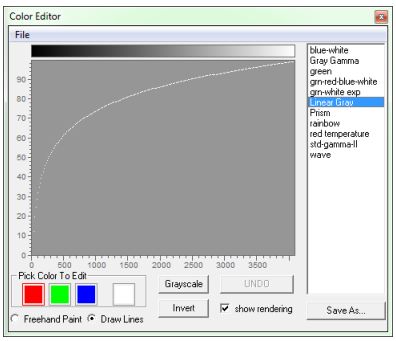
Show rendering



Activating this option will modify the color curves according to the type of rendering used: *linear*, *gamma*, *log*, *sqrt* or *Gauss*.
Here is for example the comparison between linear and Gauss:



Linear rendering



Log rendering

Due to the type of transformation, *equalized*, *AsinH* and *clahe* cannot be displayed as curves and will therefore be shown as linear.

Color Editor Menu

From this menu you can *Print* the entire color window, *Copy* the window to the clipboard or to other applications, *Save* the color table currently displayed under the same name or with *Save As* under a different name or *Open* another color file.

Menu: Window

This menu contains functions to *Copy*, *Print* and *Save* the entire U-view window with all its contents.

Menu: Help

Contents

Displays this manual in pdf format using the installed pdf reader.

Homepage

Goes on-line to the Elmitec Homepage.

Support E-Mail

Opens a new email to mail@elmitec.de in your email client, i.e. Outlook or Thunderbird.

Check for Updates

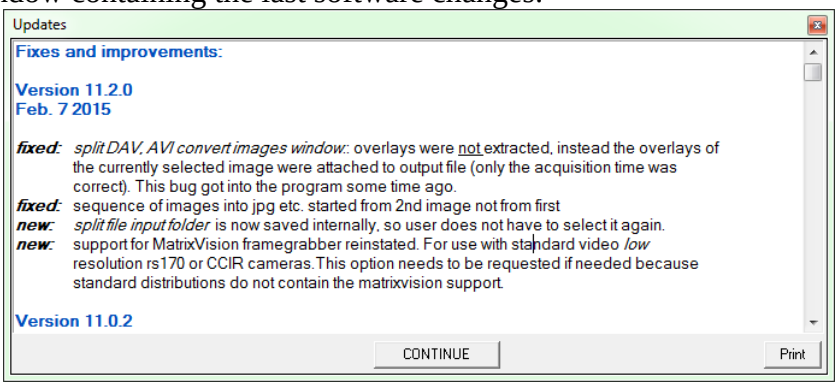
Goes on-line, checks the *elmitec.de* update server and downloads any U-view updates.
If files are found, they will be downloaded. This could takes some time depending on your network connection (with Ethernet cable usually less than a minute). The installation of the new files will begin when you quit U-view. All replaced files (the least recent ones) will be put into a backup folder in the U-view folder located typically in *C:\ProgramData\Uview2002\backup*.

About

Displays U-view version information and copyright notices.

List Program Changes

Displays a window containing the last software changes:



Toolbars

In this section the following toolbars will be described: *Camera*, *Measure*, *Process*, *Crop*, *LEEM*, *Playback*, *Image* and *Record*.

Toolbar: Camera

This toolbar shows the camera status and contains controls for image acquisition.

Acquire

This button will only be enabled (red) if a camera is connected and ready for acquisition. Once pressed, image acquisition starts and the images are shown in the selected window in real-time. At that point the *Acquire* button changes into a stop button  and can now be used to stop/pause the acquisition.

Acquire X image(s)

This feature allows to acquire a number X of images and X is defined in the field slightly to the right  . After X images have been acquired, the camera will be stopped. Notice that if n images are being averaged, e.g. *average 8* is selected, then a total of 8*X images will be acquired, but only X saved (each an average of 8).

Clear image

This option is used to clear the last image in memory. It is mainly useful when using sliding average with somewhat longer acquisition times.

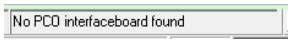
Frames per second (Fps)

This is the frames-per-second (fps) Indicator. Displays current raw frame acquisition rate. ‘Raw’ means numbers of frame acquired but not necessarily displayed. In the case you select i.e. a 16 frame average and the raw frame rate is 8 fps. The rate at which images are collected, displayed and eventually saved would be 1 every 2 seconds.
The raw frame rate depends on

- Exposure time (adjusted in ‘Camera Setup’ window)
- Binning (ditto)
- Region of interest (ditto)
- Computer speed
- Other programs running on computer (those should be held to a minimum, i.e. anti-virus scans, disk maintenance scans will reduce the frame rate significantly)
- Other selected operations (cross section, intensity measurements, multiple images [SPLEEM])
- Real-time image storage to hard disk, especially if system disk is used and disk is fragmented.

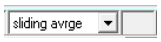
Camera Info

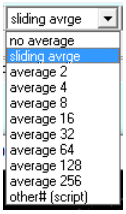
If the camera is on and working the information field in the camera toolbar will show camera information: CCD temperature, internal case temperature, image resolution, binning. Important is the camera CCD temperature, make sure you don't start acquisition until optimum temperature is reached (see camera manual). This will guarantee the lowest possible noise.



In case of problems with camera or interface, messages like *No PCO interfaceboard found*, *No PCO camera connected*, *Interface card not found* will be displayed. You then need to check all the camera components (camera, cable, power supply, optical cable and connection, interface card)
If the problem persists please contact Elmitec.

Averages





Single images may be displayed or, if wished, combinations of more images may be displayed. It is possible to choose among: *no average*, *sliding average*, *average n* and … Where $n = 2,4,8,16,32,64,128,256$.
Except for the case of no average, in all other cases, the displayed or saved image is the result of an average from a sequence of raw frames.
The *other# (script)* option will be automatically selected when scripting requires a different number of average images (e.g. 99).

No Average

Images are displayed at the rate they are acquired. Raw and collected (displayed) images are the same.

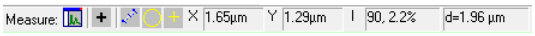
Sliding Average

When using sliding average, the collected (displayed or saved) new image is calculated from the previous image multiplied by a factor *f* and summed to the current image times a factor *f-1*. Higher *f* values will reduce noise but slow/delay appearance of changes in the image. With lower *f* values, images will be more responsive, but might be more affected by noise. This averaging method is very useful for alignment, but it is not recommended for measurements.

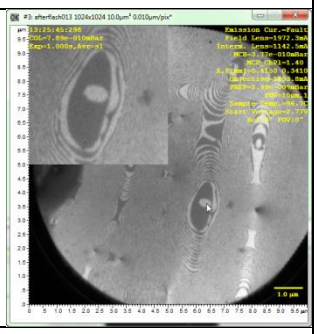
Average Images

The collected (displayed or saved) image is the average of X images divided by X. With X=2,4,8,16,32,64,128,256.
The resulting image has less noise than the raw images but any motion in the images will be smoothed (blurred). When using this averaging method, the current image number is displayed on the right side: 

Toolbar: Measure

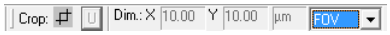


The measure toolbar offers 5 buttons:

Button	Meaning	Description
	New Cross Section	This button opens a *cross section* window. Please refer to page 12 for more information
	Magnifying Tool	Pressing this button a corner of the image will contain a magnified image. To change the magnified region, click on the image with the mouse. The mouse wheel can be used to zoom in and out (magnifications: x2, x4, x8, x16, x32, x64) 
	Place Marker and Measure Distance	This button opens the *Measure & Place Markers* window and sets the marker type to *line* (/). Please refer to page 43 for more information
	New Cross Section	This button opens the *Measure & Place Markers* window and sets the marker type to *circle* (○). Please refer to page 43 for more information
	New Cross Section	This button opens the *Measure & Place Markers* window and sets the marker type to *vertical cross* (+). Please refer to page 43 for more information

Cursor Coordinates

When moving the cursor over the current image, the *X* and *Y* coordinates underneath the cursor hot spot (tip of arrow) are shown in this toolbar. The intensity *I* at that spot is shown in counts and % of full scale (typically a scale of 4096 for 12-bit cameras). If the image is calibrated and FOV is selected in the crop toolbar:



Then the *X* and *Y* values are in micrometers, otherwise they are in pixels. One additional field displays the length *d* of the current cross section marker line in the same units as the coordinates *X* and *Y*.
The cursor can be moved while images are acquired or on still, i.e. loaded images.

Toolbar: Image

This toolbar contains the buttons and controls for image storage, printing and copying.
The following buttons have been already discussed in previous sections. Please refer to those pages:

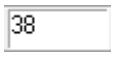
Button	Page
	59
	60
	61
	58
	62
	62

Select Folder for saving images and filename base 

Before saving a file with the *Save Current Image* button you may want to select a folder and a name for the file. This is done with the *Select Folder for saving images* button. If you click this button a dialog box will appear. Please browse and select the folder, or create a new folder, and type the name you want to use in the *File name* field. Then press the *Save* button to close the dialog box. Note that you will *not* save the file immediately, the save will occur when pressing the *Save Current Image* button. In most cases the name you select will be the *base name* for a series of saved images. To save a series of images with a *base name* followed by a number you must select the *Append Number and Auto-increment* button.

Auto increment filename after each save 

Press the button to select  or deselect  . If selected, a number is appended to the name of the current image. When the image is successfully saved to a file with the same name, the number will be incremented. Every time the collected image is saved, manually or automatically the number will be incremented. You can select the starting number by entering it into the *File Number* field.

File Number Field 

Used in conjunction with the *Auto increment filename after each save*  button. The number you enter into this field (enter: type in and hit Enter key), will be appended to the filename of the current image when it is saved to disk with the *Save Current Image* button.

Auto Save List box 

A selection in this list box allows you to choose among:

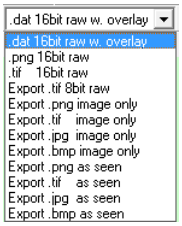
– *off*: nothing happens
– *sec*: an image is saved every *n* seconds. *n* is defined in the box 

.
– *image*: an image is saved every *n* images. *n* is defined in the box 

.

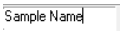
This will of course only be active when images are acquired. Note that when this button is activated, the *Auto increment filename after each save*  feature will automatically be enabled to avoid saving images with all the same names.

File Format Field



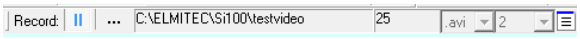
In this list you select the format of the image files saved with *Save Image* Button or menu or the automatic file saving features.
For further details and file formats please see the section *Image menu, Save* on page 59**.**

Title Field



In this field you can enter a Title for the images. This will be saved in the image header (for .dat formats only) and can be overlaid to the images.

Toolbar: Record Video



This Toolbar contains the controls for recording sequences of collected images. The images can be stored in a proprietary .dav format or in AVI format. With .dav they are stored as raw data with 12-bit per pixel (PCO Sensicam) and are not compressed to preserve all image features. The .dav recorded video can be played back and still frames can be printed, copied and exported into other formats. A special tool allows converting the recorded .dav files into the standard Windows AVI format for playing in the Window Media Player, PowerPoint, web applications etc. See page 23 for further details. Each frame within the file has a time tag, this way it can be replayed at the speed as it was acquired, even if the speed was not uniform i.e. through delays in file access or Windows related operations. For all of these reasons, we recommend using the .dav format. This way you have full access to the data within the movie and can convert the file when necessary to AVI for export to other applications.

Important: While recording is in progress the frame rate will slow down. How much depends on your computer hardware. To speed up recording:

- Don’t use the system disk for video file storage. Instead save the file to a separate fast drive (SSD, 7200 rpm, large buffer, fast access time).
- Be careful storing to zip disks, CDs, DVDs etc. directly. Those may be too slow. 16x DVDs may be used if you don’t store more than 2-4 images per second.
- De-fragment your drive regularly.
- Don’t have virus scans or other programs running which access the drive.

Record

With the *Record* button you can start and stop the recording of image sequences. This button changes from the inactive state  to the active state when the camera is working and image acquisition is turned on. To indicate that recording is in progress the button changes to  . To stop recording press the recording button a second time.

Select Filename

Before recording an image sequence you need to assign a name for the resulting video file. When the *Select Filename* button is pressed a dialog appears on the screen, which lets you brows for a destination folder and enter the name for the video file.

Video File Name

The name of the currently recorded image sequence is shown in the *Video File Name* field.

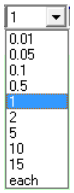
Frame counter

While recording images the currently saved frame is shown in the *Frame counter* field.

Video file format

You may select the generic .dav format (not compressed) or the Windows AVI format.
If AVI is selected the *AVI Properties* button will be enabled.

Video file frames per second

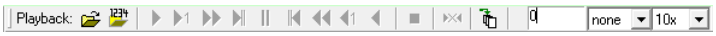


You may select frames per second from the list or select *image* for storing every image to the video file.

AVI Properties

The AVI properties button is only clickable ( ) when AVI is selected as video file format, otherwise it will appear as such . When clicked, the *U-view setup* window will open. Please refer to *File Options* in *U-view Setup* on page 23. If you use AVI video file format than you may select the most suitable codec (**co**der-**dec**oder). You should adjust the compression quality, but be aware that you can either have good quality and large file size (lower frame rate) or poorer quality and small file size (high frame rate). A good compromise is a 90% quality setting.

Toolbar: Playback



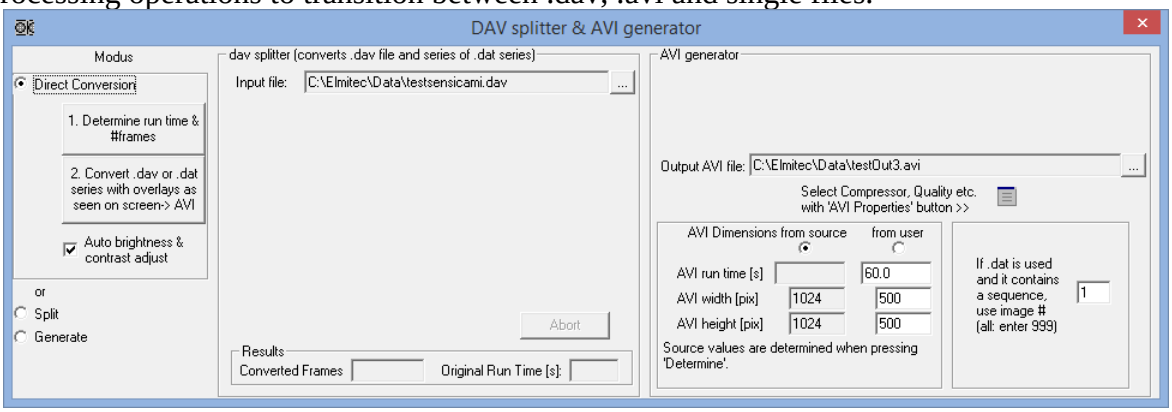
This toolbar contains the buttons to load a video file or load sequence of image files and play them back. Depending on where you are in the video sequence a different set of playback control buttons will be active. These controls apply equally to videos as well as series of frames.

Button	Meaning	Description
	Load Video File	Opens an *Open File ...* dialog box to browse for a folder and to select a video file. Once opened, the file will begin playing in the currently active window. Only .dav files can be opened
	Load Series of Frames	Opens a *Open File ...* dialog box to browse for a folder and to select a starting file. When the Open button is pressed the file is loaded and begins playing the sequence of frames in the active window. You can playback any sequence of images you have collected with *Auto Save* on. It is important the series of images has a base filename with numbers attached to it which are continuous. You don't need to start with the first file but any file in the series you want to
	Play Video	Plays the video forward in real-time, which is the time it was recorded in
	Advance 1 frame	Advance single frame
	Fast Forward	Plays the video forward as fast as possible
	Jump to last frame	Advances to the last frame in the video
	Pause playback	Stops playback but does not close the file
	Rewind video	Rewinds video to the first frame
	Fast Backward	Plays the video backwards as fast as possible
	Rewind 1 frame	Goes to the previous frame and displays it
	Play backwards	Plays the video backward in real-time
	Stop Playback	Stops the video and closes the file
	Go to selected frame	This control allows jumping directly to any frame within the video or sequence. Just enter the number of the frame in the edit box of the *Playback frame counter* and press this button

586	Playback frame counter	Indicates the currently displayed frame
none none m 90° 90°m 180° 180°m 270° 270°m	Symmetry operation	This list lets you select which symmetry operation should be applied to the file during playback. The m stands for *mirror*
	DAV splitter and AVI generator	This will open the *DAV splitter & AVI generator* window. Please refer to the following section for further instructions

DAV splitter and AVI generator

This button opens the *DAV splitter & AVI generator* window. This dialog all necessary processing operations to transition between .dav, .avi and single files.



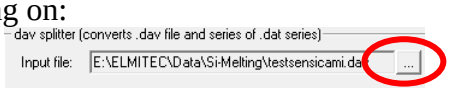
The window offers three operation modes on the left side:

- Direct Conversion
- Split
- Generate

The use of these three modes is described in the following.

Direct Conversion

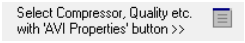
This mode allows generating an .AVI file from single frames or from a .dav file. First load the still images or .dav by clicking on:



Once loaded, please click on the *1. Determine run time & #frames*. This will examine all images and the image counter 

will show the progress. When finished, you have to select an output file name:

Then select the AVI image dimensions (in pixels). You may either use the source size or user defined sizes. Be aware that if you change the output image size, you should take care to keep the aspect-ratio as in the source. Failure to do so will result in distorted video output. You may also define the output AVI properties by clicking on the button on the right:



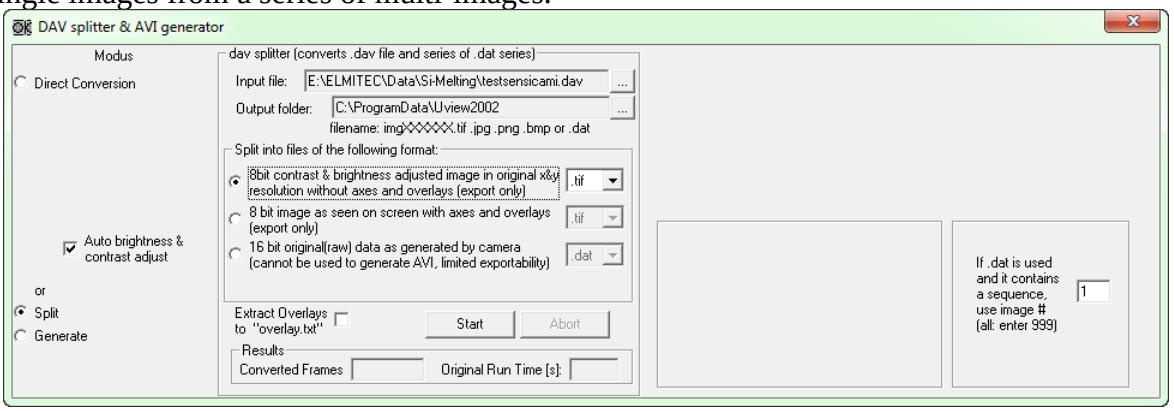
This will open the *U-view Setup* window where you will be able to change the AVI codec settings. See page 23 for details.
If you are using single .dat files with more than one image inside each file (only true for images acquired with the sequencer, like for SPLEEM), then you can choose which image to use. In all other cases it is useless.

If the check button Auto brightness & contrast adjust is marked, then for every image the contrast will be adapted according to the settings in the *rendering* window. If not, the settings used when acquiring the image will be used.

Now if you press the *Convert .dav or .dat series with overlays as seen on screen->AVI*, the AVI production will start.

Split

This mode allows splitting a .dav file into single image files. It can also be used for sequences of images where more than one image is fitted into a .dat file. Then it is possible to extract single images from a series of multi-images.



One should first select an output folder (make sure that it is empty or that nothing might be overwritten) and then select the type of output:

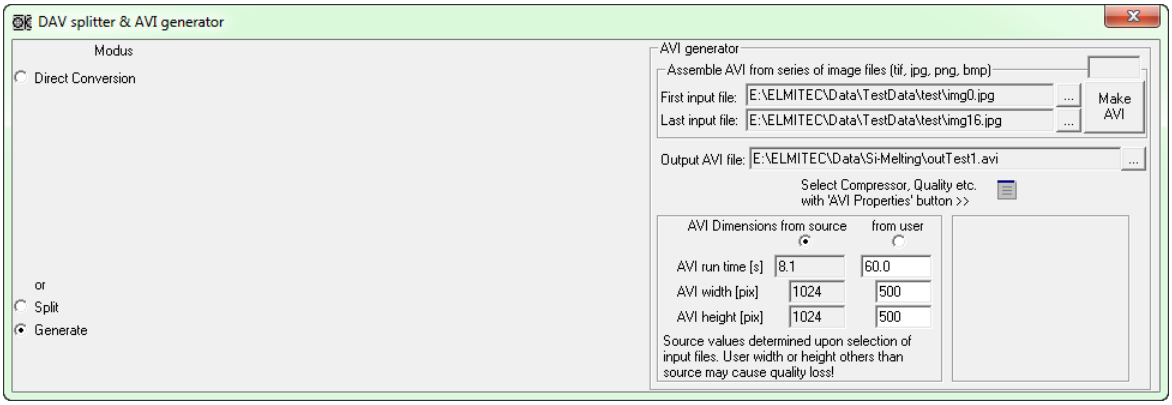
Bit depth	Description	File types
8bit	Contrast & brightness adjusted. Original size and without axes and overlays.	TIFF, PNG, JPEG† and BMP
8bit	As seen on screen with axes and overlays	TIFF, PNG, JPEG† and BMP
16bit	Raw data as generated by camera	DAT, PNG, TIFF, ASCII

† in case of JPEG export, you may specify the quality of the output (0=low quality, 100=high quality)

It is also possible to extract overlays to a text file named *overlay.txt* by clicking the appropriate check button. Press start to start the conversion.

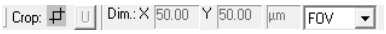
Generate

This mode allows generating an AVI from single image files.

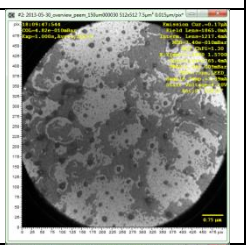
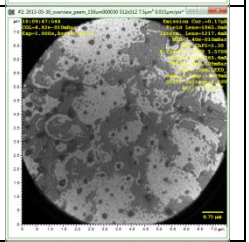
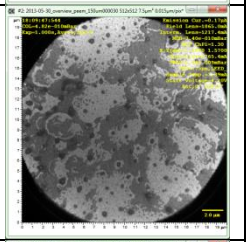
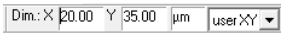
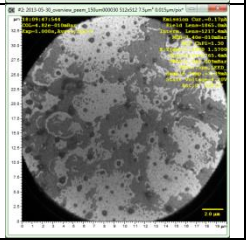


Here you may specify a starting file (*First input file*) and an ending file (*Last input file*). You have to choose TIFF, JPEG, PNG or BMP image files. Specify the output file and fix other parameters as above and press *Make AVI* to start converting.

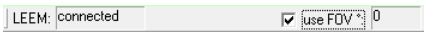
Toolbar: Crop



This toolbar offers two buttons. The first will open the *Crop window* that is described on page 55. The next button allows undoing the last cropping action and restores the previous image size.
The drop down list shows 4 options:

Option	Description	
pix	The image units are set to pixel	
FOV	The image units are set to µm and the scaling depends on the current image Field of View (FOV). If no FOV is available, then pixel coordinates are shown. When working in real-time, FOV will only be available when U-view is connected to LEEM2000 and a FOV is currently selected	
user x	Allows defining the image size in µm. The inserted value will be used for both x and y 	
user xy	Allows defining the image size in µm. Two separate values can be inserted for x and y 	

Toolbar: LEEM

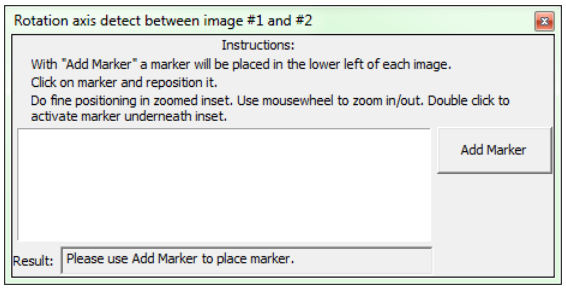


This toolbar shows the current connection status to the LEEM2000 software. If connected, a check box can be activated or deactivated to rotate the image following the FOV calibration. If active the image will have the rotation shown in the preset values of LEEM2000.

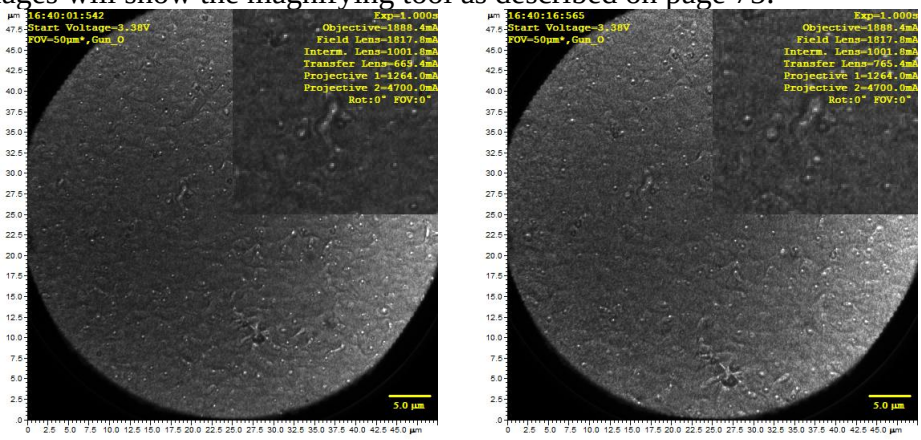
Toolbar: Process

This allows to process images with another one. The target of the operation is *always* the currently selected image. Then you may choose a second image from the drop down menu. The possible operations are: *none*, *minus*, *divide* and *run macro*. The software does not check for image size differences and therefore choosing images with different sizes will result in unexpected errors or results.
The *minus* operation will perform an integer subtraction. Please notice that this means that the result will be *always* a positive number (any negative value result will be set to zero).
The *divide* operation will perform floating-point division (pc representation of real numbers $\mathbb{R}$) and convert the result back to integer by rounding. It is therefore convenient to divide and use the appropriate scaling factor *f*. The multiplication factor *f* can be edited only when *divide* is selected.
The *run macro* operation will open the *process* window which is described on page 46.
To perform the desired operations press the *exec* button.

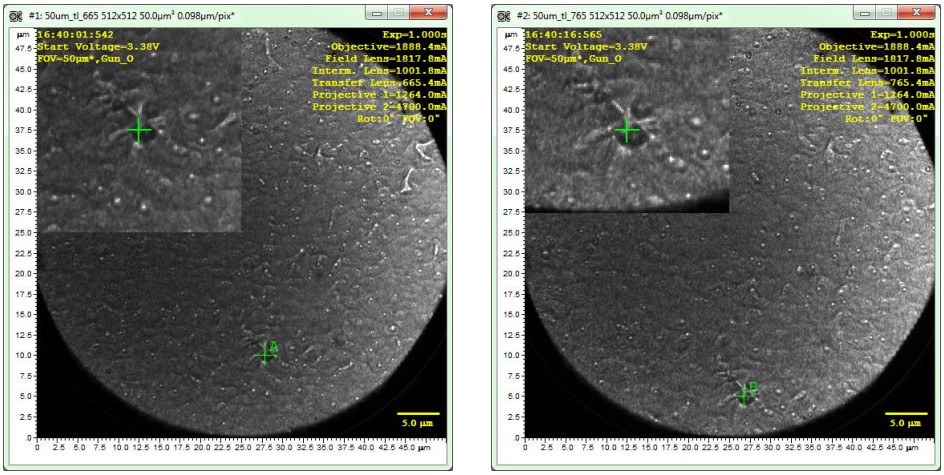
The *ax* button opens the *Rotation axis detect* window:



This window can be used to find the turning point between two still images that have been rotated and magnified around the same point with respect to one another. When opened the two selected images will show the magnifying tool as described on page 75:

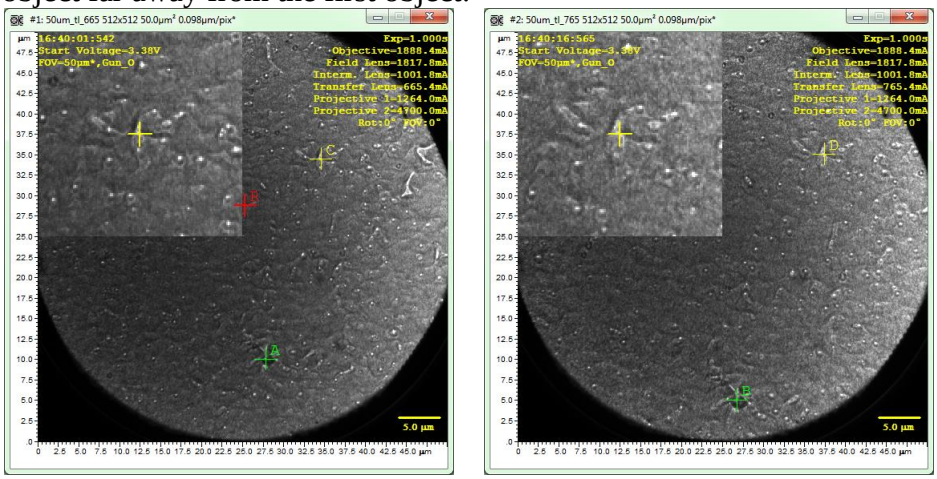


Then click in the *Rotation axis detect* window the *Add Marker* button and one cross per image will appear. Move the each cross to the *same* recognizable object, center it as good as possible, as shown here:

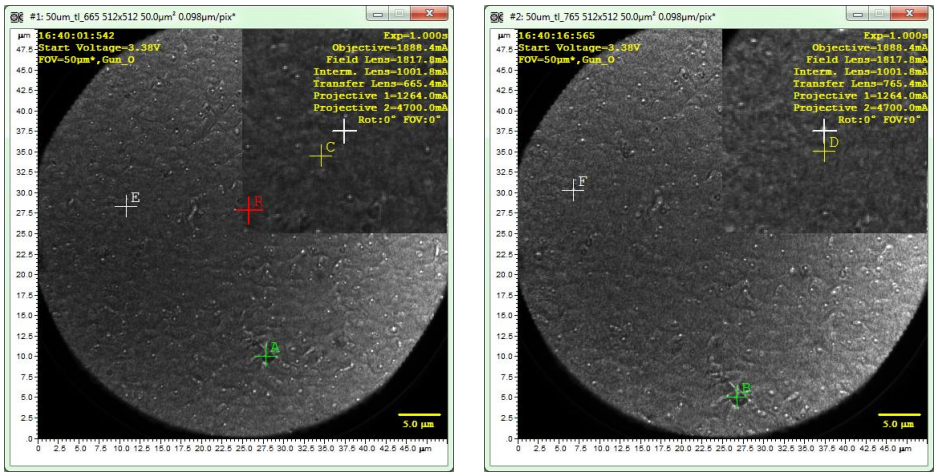


Make sure not to choose an object that disappears or is not recognizable in one of the two images.

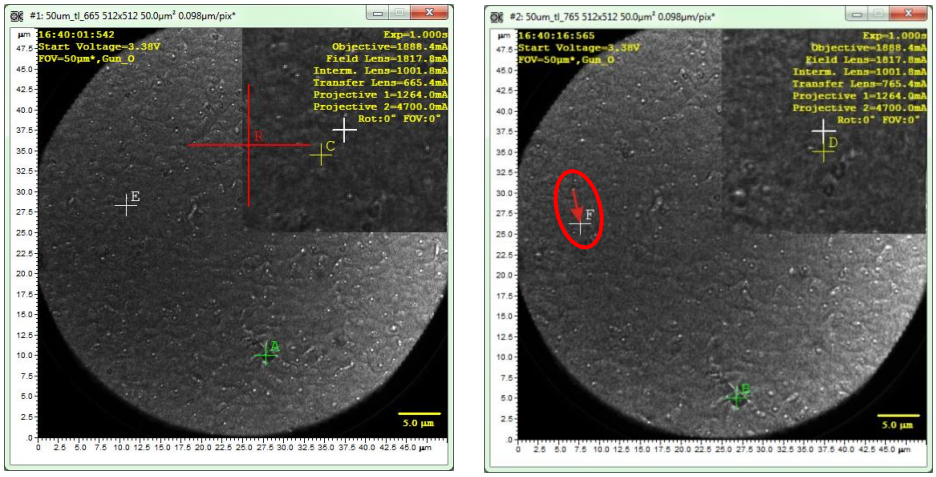
Add a second marker with the *Add Marker* button and place it on a different object. Possibly choose an object far away from the first object:



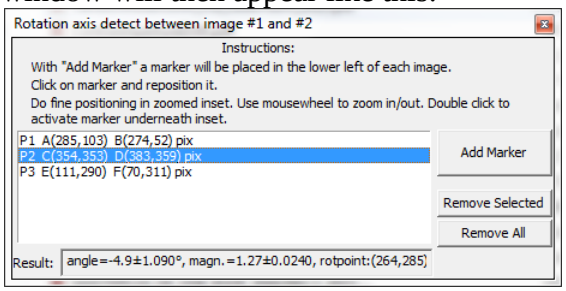
Now a new red crossed marked with the letter R may appear on the image. This is the position of the calculated center of rotation. The position of the center of rotation cross will be updated in *real-time* while moving the other crosses. By choosing only two objects there will be no information on the accuracy of the calculation. To achieve some accuracy (standard deviation) use at least 3 markers:



The size of the result cross (marked with an R) will be the standard deviation. If the crosses have not been placed properly and result in a large standard deviation, the result cross will get accordingly large:



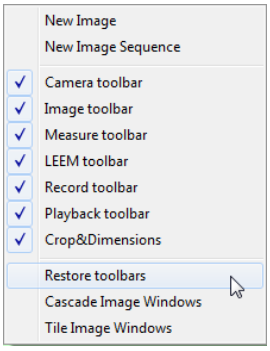
Notice that in the last step the cross F has been moved by approximately 40 pixels as shown in the image on the right side by the red arrow and the red ellipse. The error has increased from about 9 pixels to 80 pixels (generally the error is not linear with the movement).
The *Rotation axis detect* window will then appear like this:



It shows every inserted point. In the first column are the cross numbers, the second column shows the cross positions (in pixels) in the first (source) image and the third column shows the cross positions (in pixels) in the second image.
The lower line shows the results of the calculation giving:

- The rotation angle: (-4.9±1.090) °deg
- The magnification: 1.27±0.0240
- The rotation/magnification point (x,y) = (264,285) ± 18.112 pixels

Appendix



Troubleshooting – Tips and Tricks

Q: A toolbar has gone missing
A: Right-click on the main U-view window and select *Restore toolbars.*

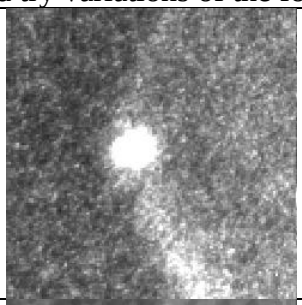
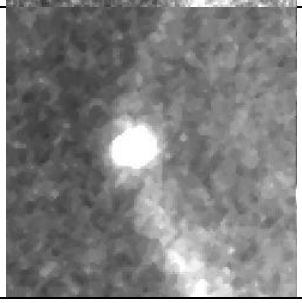
Q: Everything is in pixel units instead of micrometers
A: If you are working with live images, then you must check that:

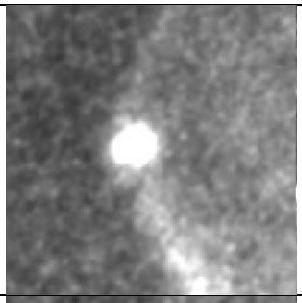
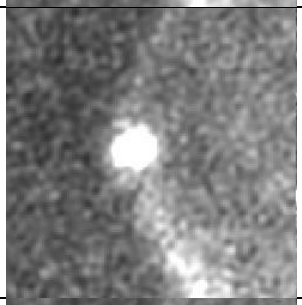
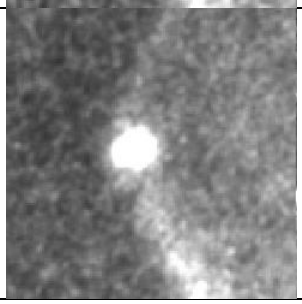
- Uview is connected to LEEM2000 (see page 83)
- LEEM2000 has a field of view defined. If using LEED or disp.plane or if some lenses have changed the field of view, then Uview will not recognize the units
- In the *Crop* toolbar (see page 82) FOV is selected
- If using a cross-section, then *calibrated* must be selected (see page 15)

If you are working with saved images, then make sure that the image has a calibrated field of view. There should be a microscope parameter named *preset (fov)* that shows a micrometer value (see page 62 for details). If not, the image is not calibrated and the software cannot guess the field of view. If you know what the field of view is, you can set this using the units *user x* or *user xy* in the crop toolbar (see page 82 for details).

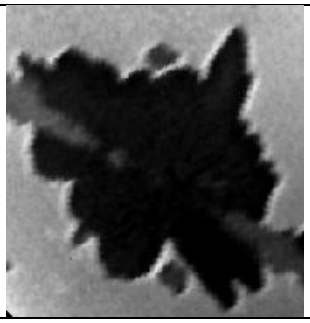
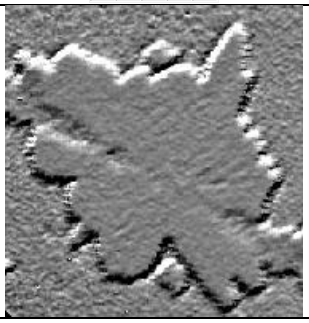
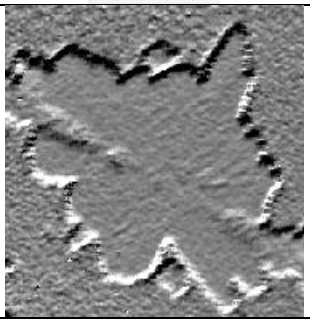
Q: I can't see one of U-view windows (camera setup, coverage, image rendering,…)
A: Go to the *U-view* menu and select the window you want to see again. If it is hidden, it will be brought to the foreground.

Q: How can I reduce the image noise in post-processing?
A: Noise can be reduced in various ways and depending on the noise one method will be better than the other. Open the post processing window and try variations of the following:

Source image (zoomed)	
Median 3x3	

Smooth 5x5	
FFT bandpass (0-40%)	
Boxcar Smooth (filter matrix *Smooth*) 0 0 0 0 0 0 1 1 1 0 0 1 1 1 0 0 1 1 1 0 0 0 0 0 0	

Q: How can I enhance edges (steps) in images in post-processing?
A: This can be done using asymmetric filters for static images or, if observing a growth process, by looking at image differences. In both cases, open the post-processing window and try variations of the following:

Source Image	S Edge 0 0 0 0 0 0 -1 -1 -1 0 0 1 -2 1 0 0 1 1 1 0 0 0 0 0 0	N Edge 0 0 0 0 0 0 1 1 1 0 0 1 -2 1 0 0 -1 -1 -1 0 0 0 0 0 0
		

For growth fronts, given two source images A and B, you may try the following:

Image A

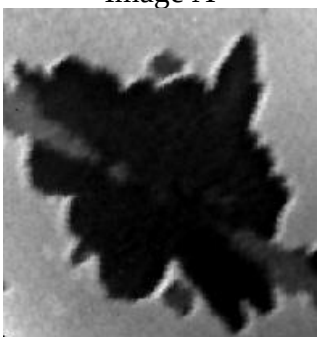
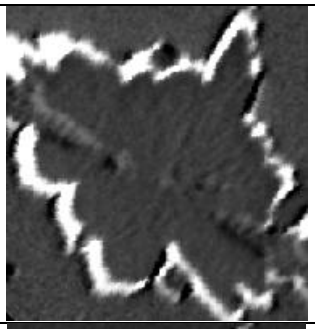
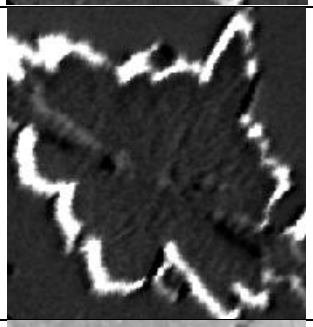


Image B

(A-B)-MIN	
(A/B)*f with f = 1000	
Transparency: