ANFATEC PRESENT – THE IMAGE ANALYSIS

1 PROGRAM PHILOSOPHY

Anfatec file format provides the *.txt-file, where all simultaneously acquired images are referred. Opening this *.txt-file, all images open, each as one new "image window".

Each Window contains:

- ✗ picture data displayed as square
- ✗ name displayed in the caption of the form equals the *.int-file name and the meaning
- ✗ scaling and acquisition data
- ✗ independent scaling options
- ✗ display of vertical axis scale ("Z Scaling")
- ✗ scale bar for lateral scaling ("XY Scaling")

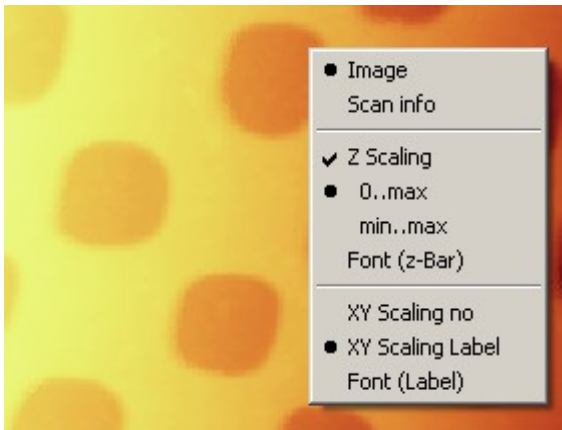Click with the right mouse button into the image to reach the pop-up menu.

Image / Scan info – is a switch between display of the image and the acquisition data (*.txt file contents).

2 FILE HANDLING

Open   opens the Anfatec files and some other image formats

Close all   closes all opened files. This function is helpful, when too many data are open.

Save As   allows to save the picture

         as 32 bit integer (*.int) or 32 bit real data (*.sin)

         and as Bitmap (*.bmp) or Jpeg Graphic (*.jpg)
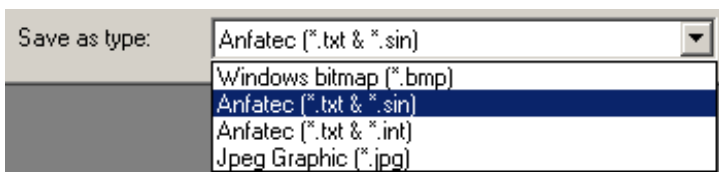
Export   as ASCII-file (*.dat) or as StL-file (*.StL)

3 IMAGE HANDLING

Copy copies the analysed image in the clipboard to make use of it in other windows applications (Power Point, CorelDraw, ...). The data are copied as extended *.wmf, so they exist as vectors and can be un-grouped and changed afterwards.

4 IMAGE PROCESSING [PROCESS/..]

Inverse inverts the data (sign) and thus the colour scale

Leveling allows to subtract planes (0D, 1D), lines and rows (0D, 1D or 2D). 0D is just a constant and necessary for FFT. 1D is linear, 2D is quadratic fitted. Select "**points**" to subtract a plane, when certain parts of the image cannot be used or when the image data consist of plane which are not detected with the plane method.
When using **"points"**, you can set a certain number of points (left mouse button click on the "new picture") in the picture. The plane is calculated using only these points.

Noise noise reduction. The procedure checks whether a pixel is a certain percentage too far away from its surrounding pixels. If yes, it is replaced by the average of its surrounding pixels.

Arithmetic can calculate new images from scanned images

Sphere is a special low pass filter, which simulates a tip with a diameter given by the user in physical units. This tip is "scanned over the surface" and the resulting picture is visualized as "low pass" result. In contrast to the low pass, a high pass result sharpens the picture with the action radius of the simulated spherical tip.

Rescale allows to rescale an image, if necessary. When the image is saved as *.sin or *.int with the new scaling, this scaling is kept.

FFT Fast Fourier Transformation. Make sure, that a "0-order plane" (= constant value which equals the average image height) is subtracted before FFT. Otherwise, the central point of the transformed image is "over-illuminated".

For options which are not explained here, please check on the following pages.

GENERAL IMAGE PROCESSING WINDOW

All image processing windows use the scheme displayed here:

 ✗ original image on the left side
 ✗ filter options or possible selections under the original image
 ✗ new image enlarged on the right side
 ✗ **functions to give commands**

Functions:
 ✗ **UNDO** restores the original image
 ✗ **DO** calculates results and displays it in the "new image" (old data still kept in the background)
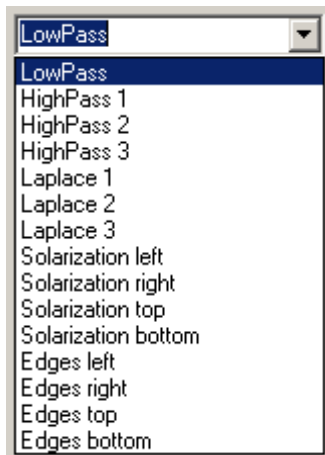 ✗ **CANCEL** quit without changes

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✗ **TAKE OVER** uses "new image" data as valid data in the image window and closes
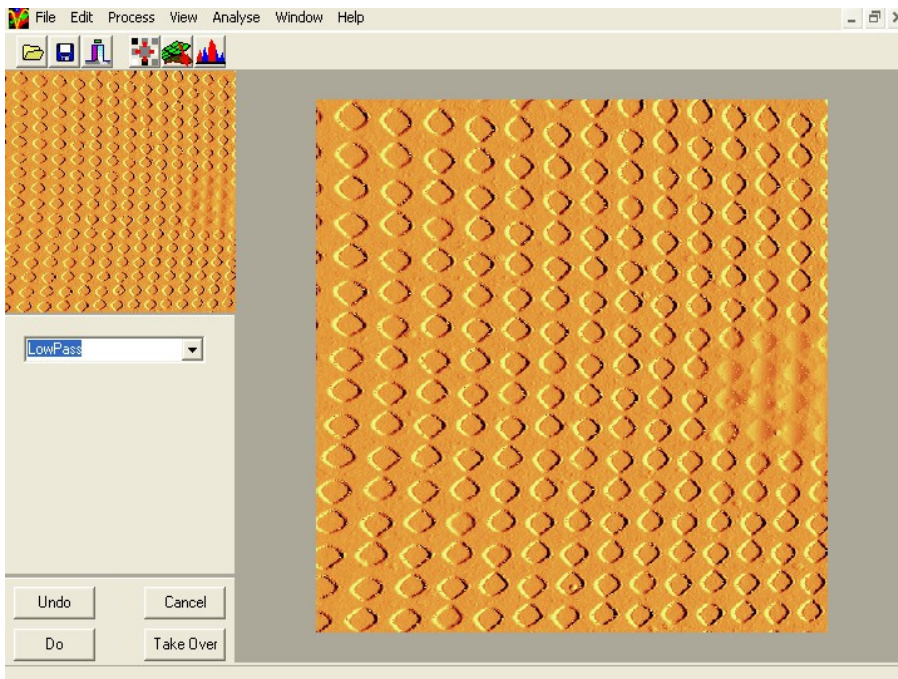
filter window

SIMPLE FILTER

allows the basic filtering with the following selections:

Parameters for these filters are not adjustable.

The values of the pixels are multiplied with the values in the filter kernel and added together. The middle pixel will be replaced by the result.

Low Pass Filtering (Blurring)

This filter retains low frequency information and reduces high frequencies. It's a smoothing filter which averages rapid changes in the intensity out.

0	1/8	0
1/8	1/2	1/8
0	1/8	0

High Pass Filtering (Sharpening)

This filter reduces low frequency information and sharpens details.

-1	-1	-1
-1	9	-1
-1	-1	-1

0	-1/4	0
-1/4	2	-1/4
0	-1/4	0

-1/9	-1/9	-1/9
-1/9	8/9	-1/9
-1/9	-1/9	-1/9

Laplace Filter

It's an edge detecting filter which reduces low frequency information like the high-pass filter. The difference is the weight of the middle pixel as shown in the grids:

-1	-1	-1
-1	8	-1
-1	-1	-1

0	-1	0
-1	4	-1
0	-1	0

-2	1	-2
1	4	1
-2	1	-2

Solarization and Edges

are edge enhancement filters with different directions.

MEAN FILTER

This filter takes the data of the surrounding pixels and replaces the central data point by the mean (average) value.

MEDIAN FILTER

This filter replaces the centre value with the median of all pixel values in the 3x3 window. The nine values are sorted in numerical order as shown in the example:

4	8	5
3	22	15
9	5	7

in order: 3, 4, 5, 5, **7**, 8, 9, 15, 22

The centre pixel (22) will be replaced by the fifth value (7):

|		
*	*	*
*	7	*
*	*	*

NOISE FILTER

This filter helps to reduce noise by replacing single pixels in the image by the average of their surrounding pixels. As criteria for replacement, the user can set a **border** on % in the left part of the filter image.

This filter takes all values around one pixel and calculates their average. If this average is more than this **border** different from the average, then the pixel is replaced by the average.

LEVELING

This filter option can also be opened with the icon

In the options part of the leveling, one find a selection for the filter dimension and the type. In order to subtract a plane from the image, one chooses 2Dim (x- and y-direction) and 1st order (only polynomials of 1st order are calculated).
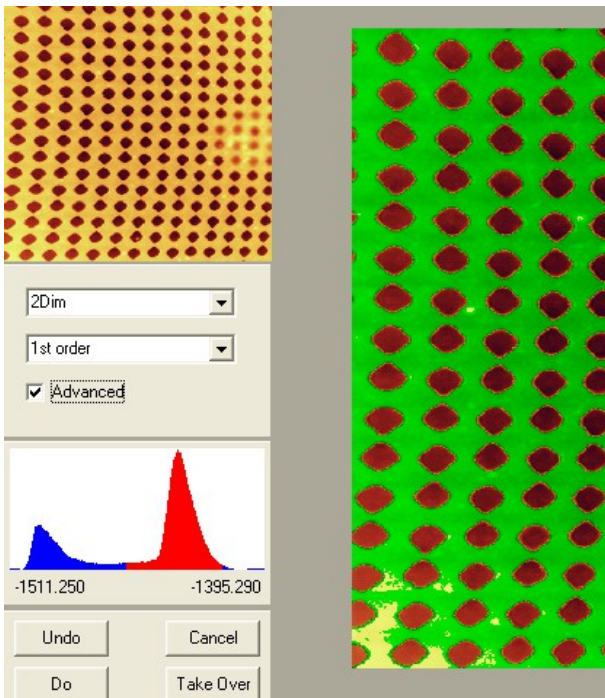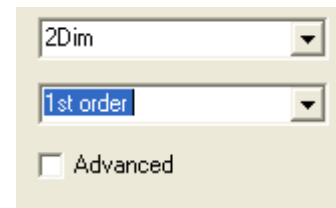
With **Advanced**, a histogram appears. One can select the grey scale values which are taken into account for the calculation. With a drag&drop with the left mouse button, new values are selected. With the right mouse button, values in the histogram can be deleted again. The Histogram shows the selected values in red, while in the picture green is added to the image colour for all selected values.

In the example, only parts of the top-layer will be recognized in the calculation, because the height values of the bottom layer are not selected.
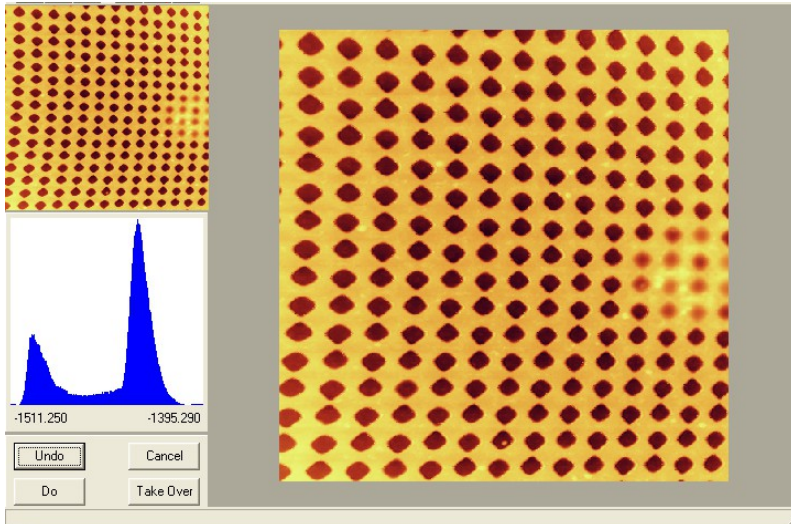
The Points-selection

allows to set single points inside the picture. With this option, only these single points are taken into account for the slope correction.

HISTOGRAM

changes the brightness and the contrast of the image.

In the selection area appears a histogram of the data. Drag & drop inside the histogram, in order to select an area. It appears in red in the histogram and green in the image.

With "Do", the image is scaled in a way, that the colour scale equals the red selected values.

If more than one region is selected, the range in between is taken as if selected.
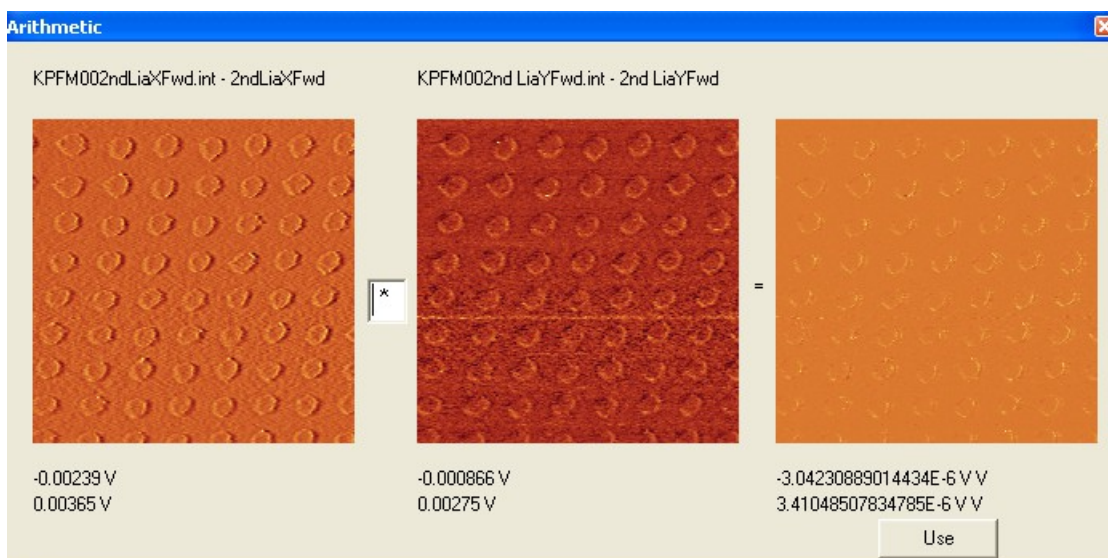
In order to scale different images exactly in the same way, one can set the maximum and the minimum value, directly:

◆ click into one of the numbers displayed below the histogram

◆ enter a new value
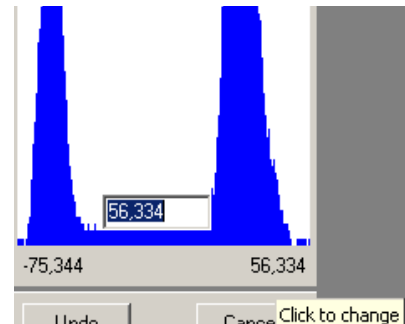
ARITHMETIC

With this window, pictures can be subtracted from each other or divided by each other:

In order to get a certain picture into the original data parts, one drags the picture and drops it into Arithmetic. The operation can be printed into the related Edit-window between the two original pictures. With a double click in the right-most picture, one gets the result.

In this example, the X and Y of the 2ⁿᵈ lockin have been multiplied.

Zoom

In order to zoom into an image, click with the left mouse button in the "new image" and move with the left mouse button pressed to the second corner of the range, you like to zoom in. While moving the mouse, an colour inverted rectangle shows the image range. When leaving the mouse button, the zoom is done.
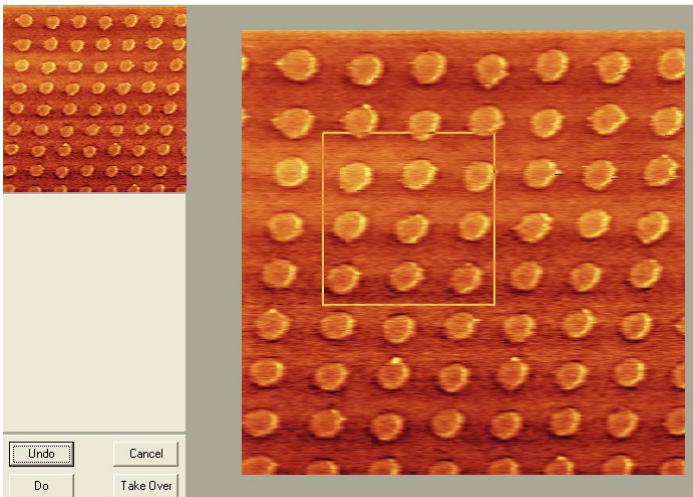
Sphere

In this filter, one can try to estimate the maximum tip diameter used for the imaging of a surface.
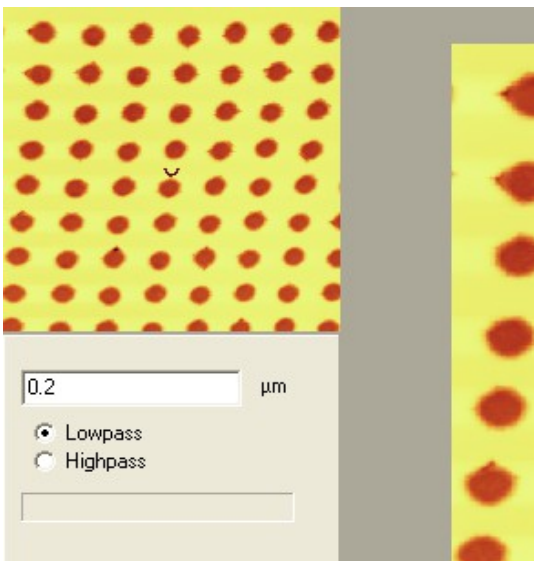
The user gives a tip diameter estimation. The program draws the tip as half-circle inside the image.

Now, one can choose between low-pass filtering and high-pass filtering. A sphere with the suggested diameter is shifted over the surface as if it images the surface. A status bar shows the current calculation state, because this function might take some time.

In case of a low-pass, the virtual trace of the tip is drawn as new image. In case of a high-pass, the difference between the virtual image and the original image is drawn.

5 VIEW OPTIONS FOR THE IMAGES [VIEW/...]

Refresh   refreshes the image plot

**Palette**   is a tool to change the colour palette of the images. The palettes can be loaded and saved.

Font (z-Bar) changes the font settings for the vertical scale bar.

Font (Label) changes the font settings for the XY scale bar.

Scale Bars   opens the same window as visible, when the right mouse button is used on an image and allows to change the scaling visualization for the active image window.

View3D   is a 3D plot of the data

the z-gain allows to change the z-scaling of the plot.

PALETTE
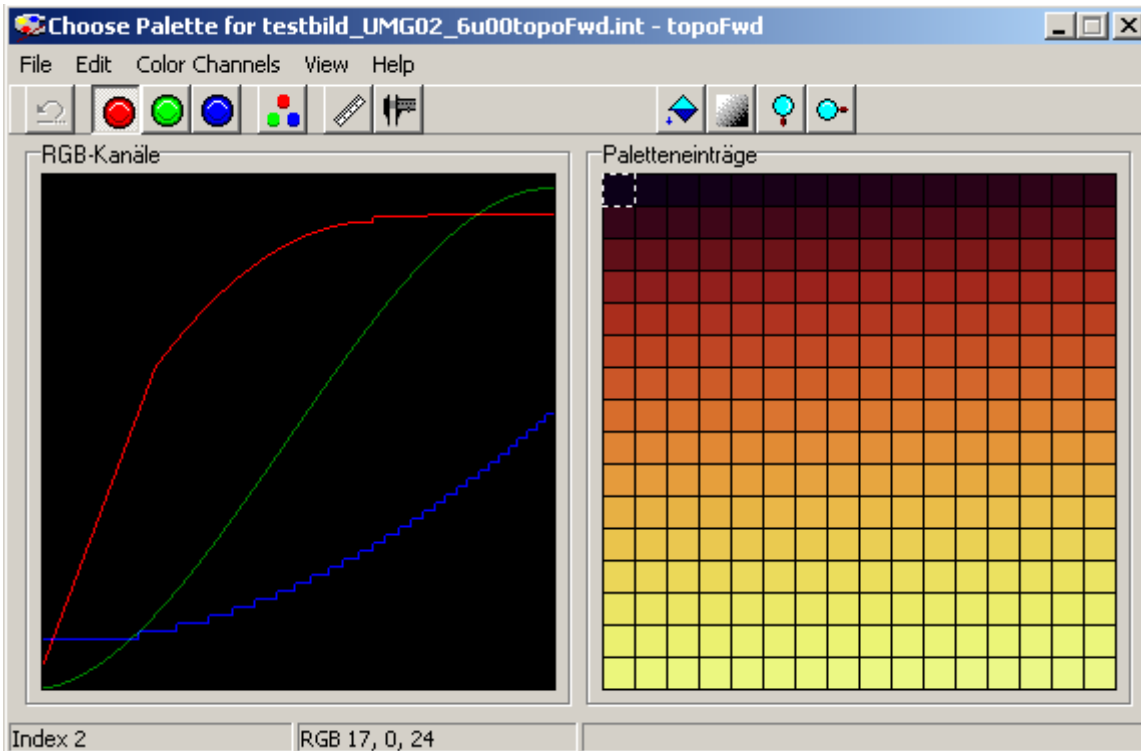
This part allows to load and to save user palettes for the images. One can change single colours in the image with a double click on one field. Also, one can select a range in the colour palette and use the entry to generate a new gradual decay inside the palette:
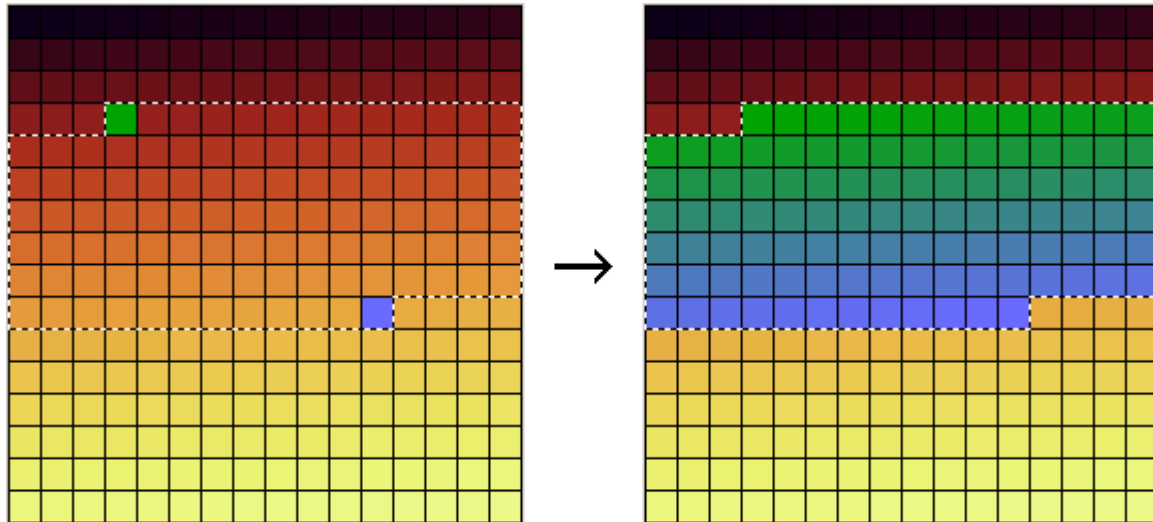
If necessary, one can select a single colour with one of these knobs:

and move the mouse in the left image in order to change the intensity of the selected colour.

FONT (z-BAR) AND FONT (LABEL)

These functions equal the settings called with the right mouse button on an image. They open a standard Windows surface for the font settings. When a new file is opened in Present, the last font setting is kept and used on all newly opened windows.

SCALE BARS

Opens the same window, which is opened with the right mouse button inside a picture:
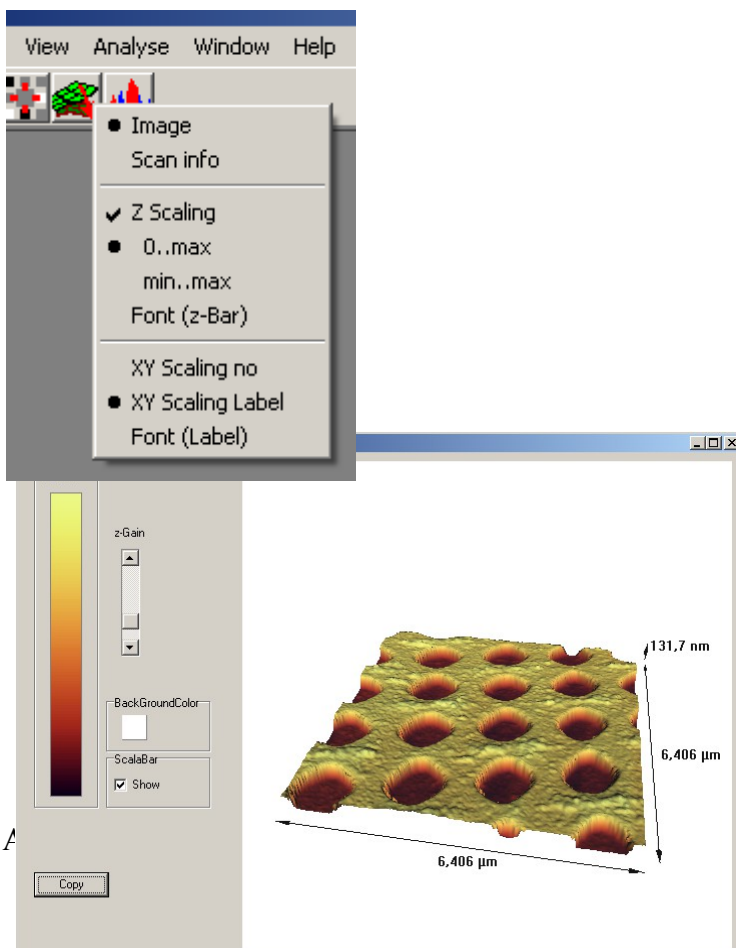
For more information look also here.

3D-VIEW

Allows to visualize a picture in 3D.

The slider allows to change the height of the image. One can enable or disable the visualization of the axis description.

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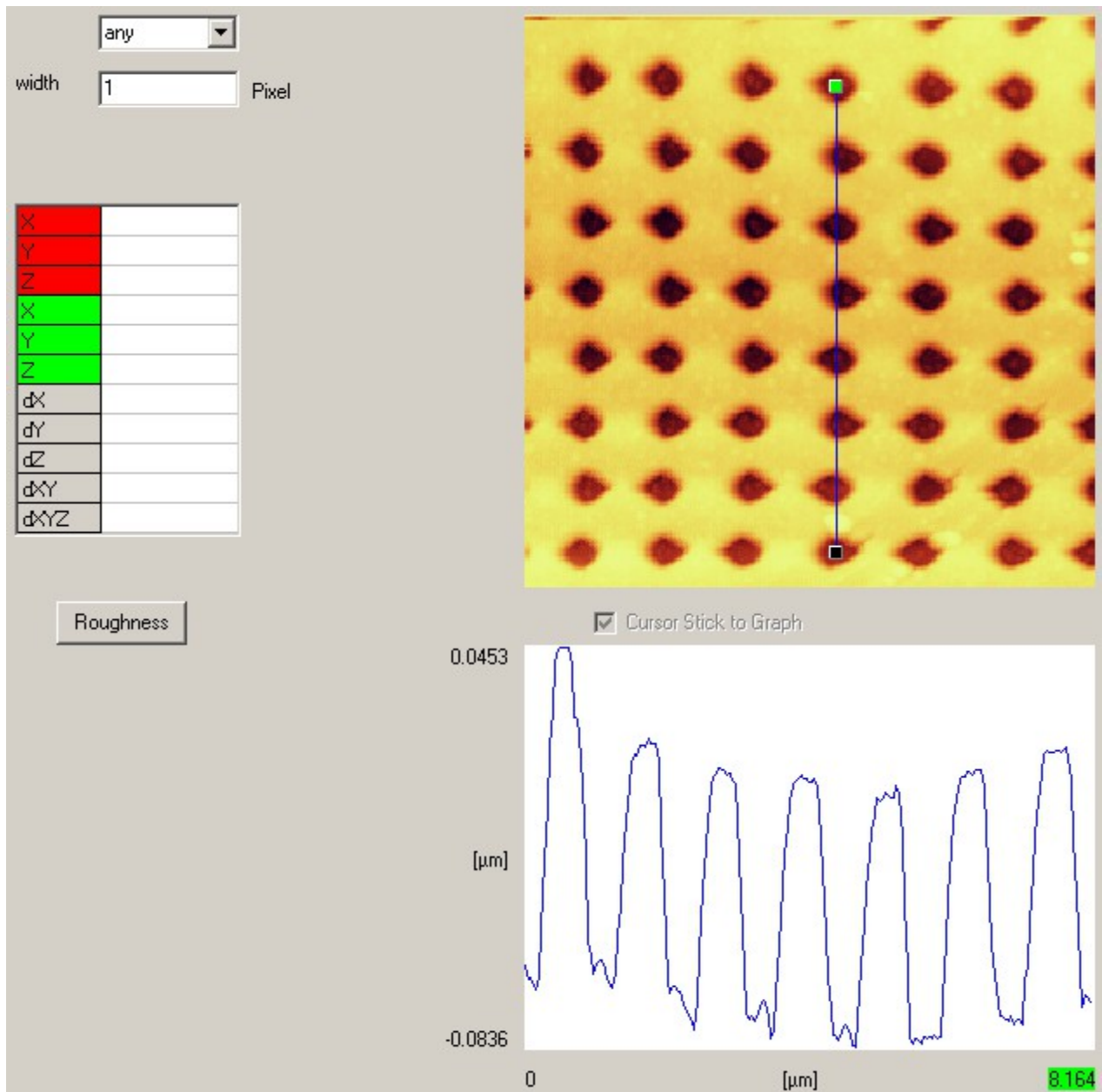The image is rotated simply with the mouse.
Copy puts the image in the Clipboard of the PC.

6 ANALYSIS TOOLS [ANALYSE/...]

These tools are thought for the evaluation of the data.

LINE ANALYSIS

It works on the active window. The image is shown.

The line selection can be done as

- ➢ **row**   horizontal line through the whole image

- ➢ **column**   vertical line through the whole image

- ➢ **any**   line with start and end point. The points can be moved by a drag&drop function with the left mouse button.

- ➢ **radial**   line starts in the image centre and ends at the edge.

- ➢ **width**   is used to average over the here given number of lines for the "row", "column" or "any" selection. For "radial" it is the angle in degree, over which the averaging is done.

- ➢ **number** is the line number (for row or column) or the angle in degree (for radial)
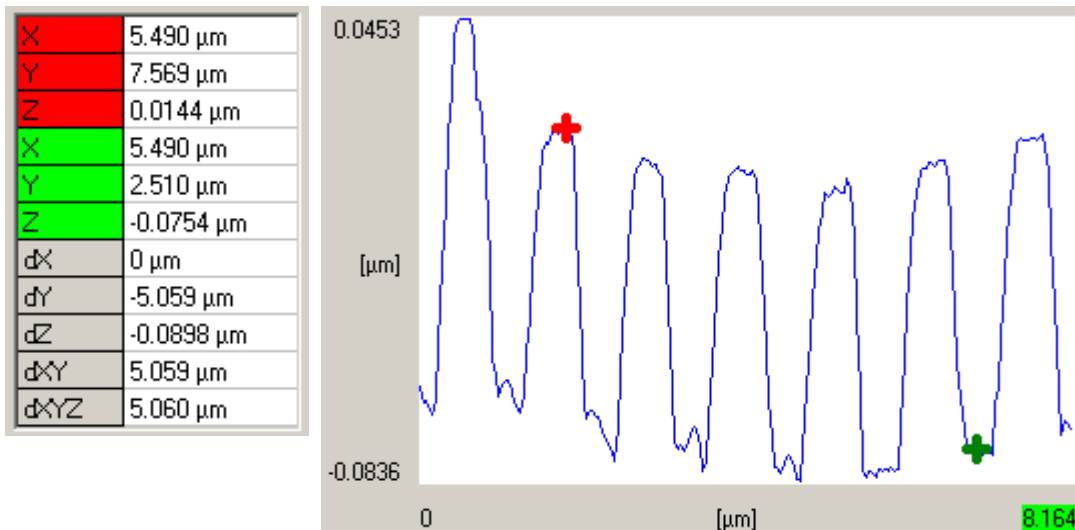
After selecting the line, it is drawn as a blue line in the white window. Click into this image to place crosses. When two crosses are placed, the crosses can be moved by a drag&drop function. Scaling numbers show the distance (horizontal) and height (vertical). Positions of and distances between the crosses are displayed left in the grid:

- dZ   height difference between the crosses
- dXY   distance in the XY-plane
- dXYZ distance in the 3-dimensional data

The data can be stored in different file formats. Click with the right mouse button into the upper image. An additional menu appears (as shown in the picture). It allows to choose between "Copy Picture" (copies the image with the blue line into the clip board) and "Save as..." (opens a save dialog box which allows to set a file name and saves the image as Bitmap).

If the right mouse button is used on the lower part (line diagram), one can choose between two copy functions and three save functions:

Copy Data: copies the ASCII data into the clipboard

Copy Picture: copies the Bitmap only

Save Data As... :   saves the line analysis data as ASCII file

Save Picture as *.bmp: saves the picture only as bitmap (without text)

Save Picture as *.wmf: saves the picture and the scaling text as wmf-file. The WMF can be broken into its parts later in order to move the text separately.

Hint: A left click with the mouse on one of the numbers allows to change the printing style of the numbers.
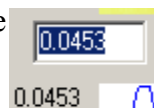
The text is exported in the standard text set with "View/Font(Label)".

A left click on "Roughness" calculates different roughness values for the selected part of the image. The roughness profile is divided into five sections. All roughness parameters are average of the five sections, except the R_{max}. The parameters are defined in the DIN 4768.

R_a: is the arithmetical mean deviation of the roughness profile

$$R_a = \frac{1}{n}\sum_{i=1}^{n}|y_i|$$

Rpm: is the average maximum peak height
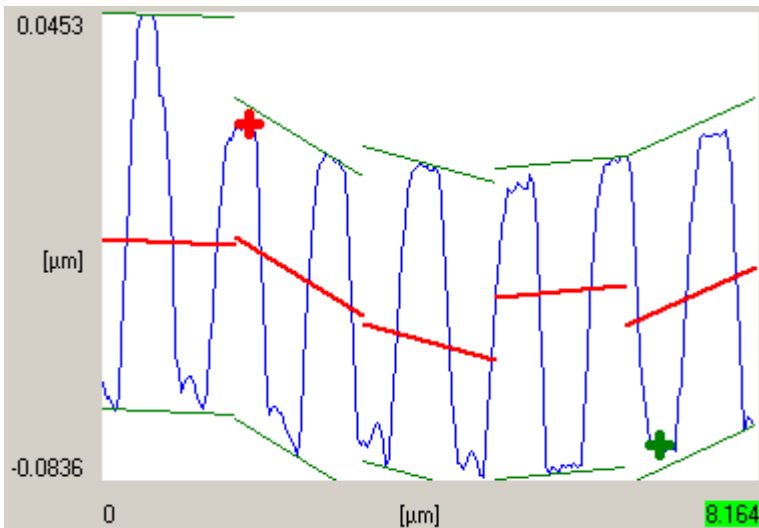
Rvm: is the average maximum valley depth

Rz: is the average maximum height of the surface

$R_z = R_{pm} - R_{vm}$

Rmax: is the maximum height of the surface

Rq: is the root mean square surface roughness value and equivalent to the standard deviation (SD)
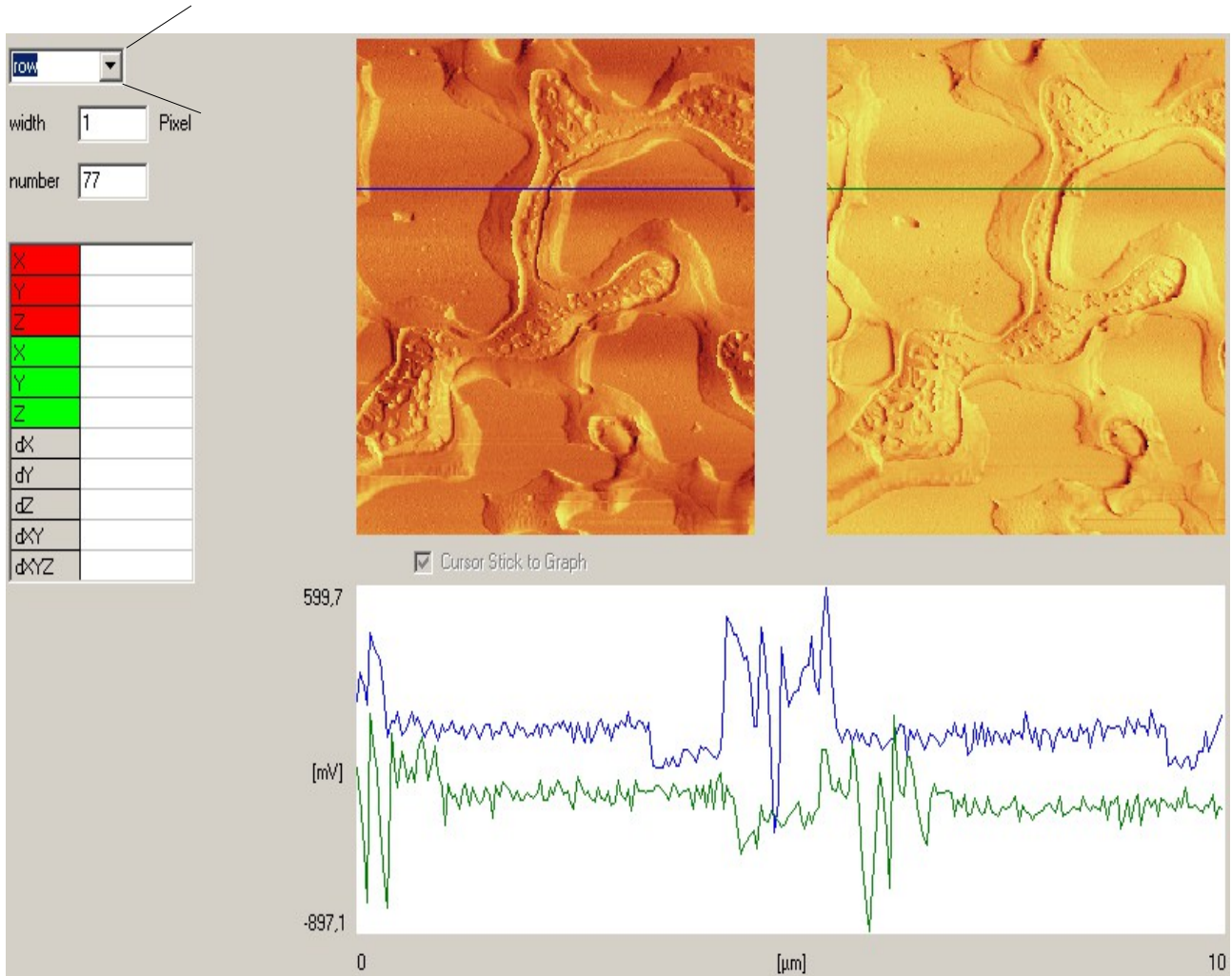
$$R_q = \sqrt{\frac{1}{n}\sum_{i=1}^{n}y_i^2}$$

The centre lines of the five measured sections are shown in red. The green lines are parallel to the centre lines and tangent to the highest peak, and deepest valley respectively.

DUAL LINE

Following active window is opened:

row
col
any
radial

Explanation of line selection, see above ('Line Analysis').
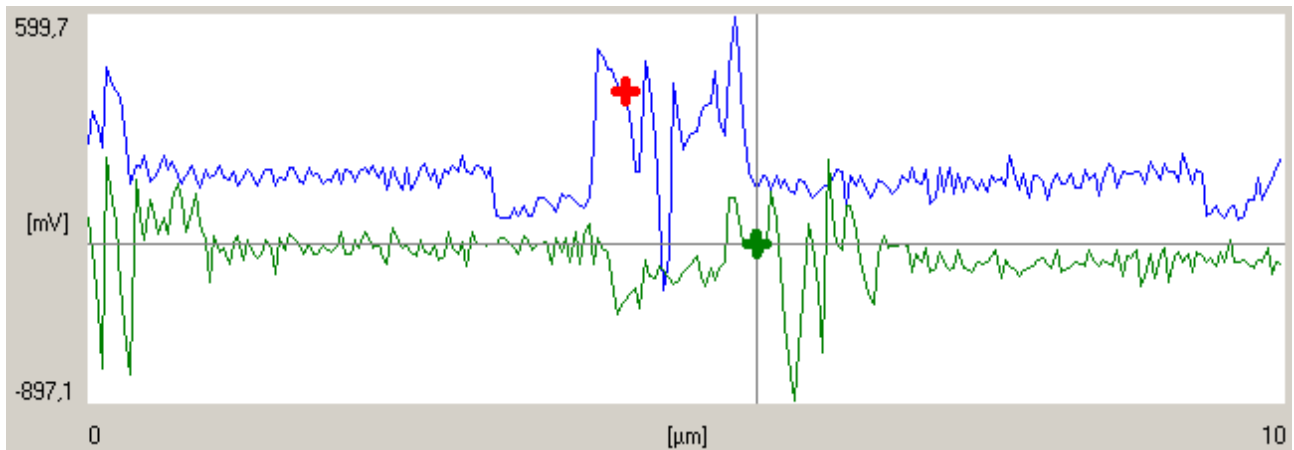
After selecting the line, it is drawn as a blue line for the left image (above) and as a green line for the right image (below) in the white window. Click into this image to place crosses. When two crosses are placed, the crosses can be moved by a drag&drop function. Scaling numbers show the distance (horizontal) and height (vertical). Positions of and distances between the cross of the left and the right image are displayed left in the grid:

- dZ height difference between the crosses
- dXY distance in the XY-plane
- dXYZ distance in the 3-dimensional data

X	4,510 µm
Y	3,020 µm
Z	299,5 mV
X	5,608 µm
Y	3,020 µm
Z	-295,9 mV
dX	1,098 µm
dY	0 µm
dZ	-595,4 mV
dXY	1,098 µm
dXYZ	595,4

Copy functions as well as save functions for the images and the line diagram you can find above (see 'Line Analysis').

Hint: A left click with the mouse on one of the numbers allows to change the printing style of the numbers.

The text is exported in the standard text set with "View/Font(Label)".

ROUGHNESS

Mean is the averaged height of the whole image.

SD is the rms roughness of the picture analysed.

UNIT CELL

This function allows to find a unit cell inside an image.

1)move the three green points to the corners of the unit cell you expect to be the correct one.

2)press "Cross Correlation". The system will find all points in the picture which fit best to the user defined unit cell.

3)one can adjust the edge from which the found intensities are taken into account with the slider next to the buttons. Take care that the spots are separated as shown in the picture:
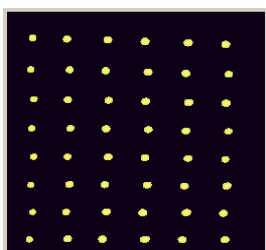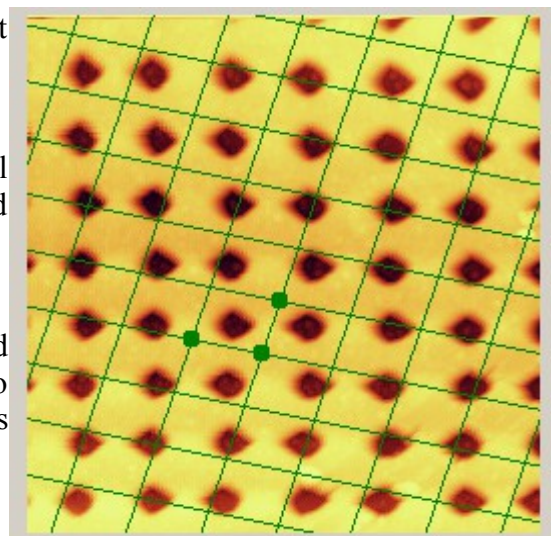
4)press "Find Grid" to let the system calculate unit cell vectors.

After this, the found intensity maxima in the cross correlation picture are marked with white spots.

Between them, unit cell vectors are calculated in two directions. In the original picture, these vectors "a" and "b" are drawn in green and blue, respectively.

In the lower part of the window appears a drawing in which the components of the two unit vectors can be shown in dependence on their position in the image. Each vector is visible as one blue cross.

One can select single crosses (they get red) and delete them.

Inside the crosses, a green fit is drawn, whose parameters are given in the lower right part of the window. From these parameters, the lengths of the unit cell vectors can be obtained.
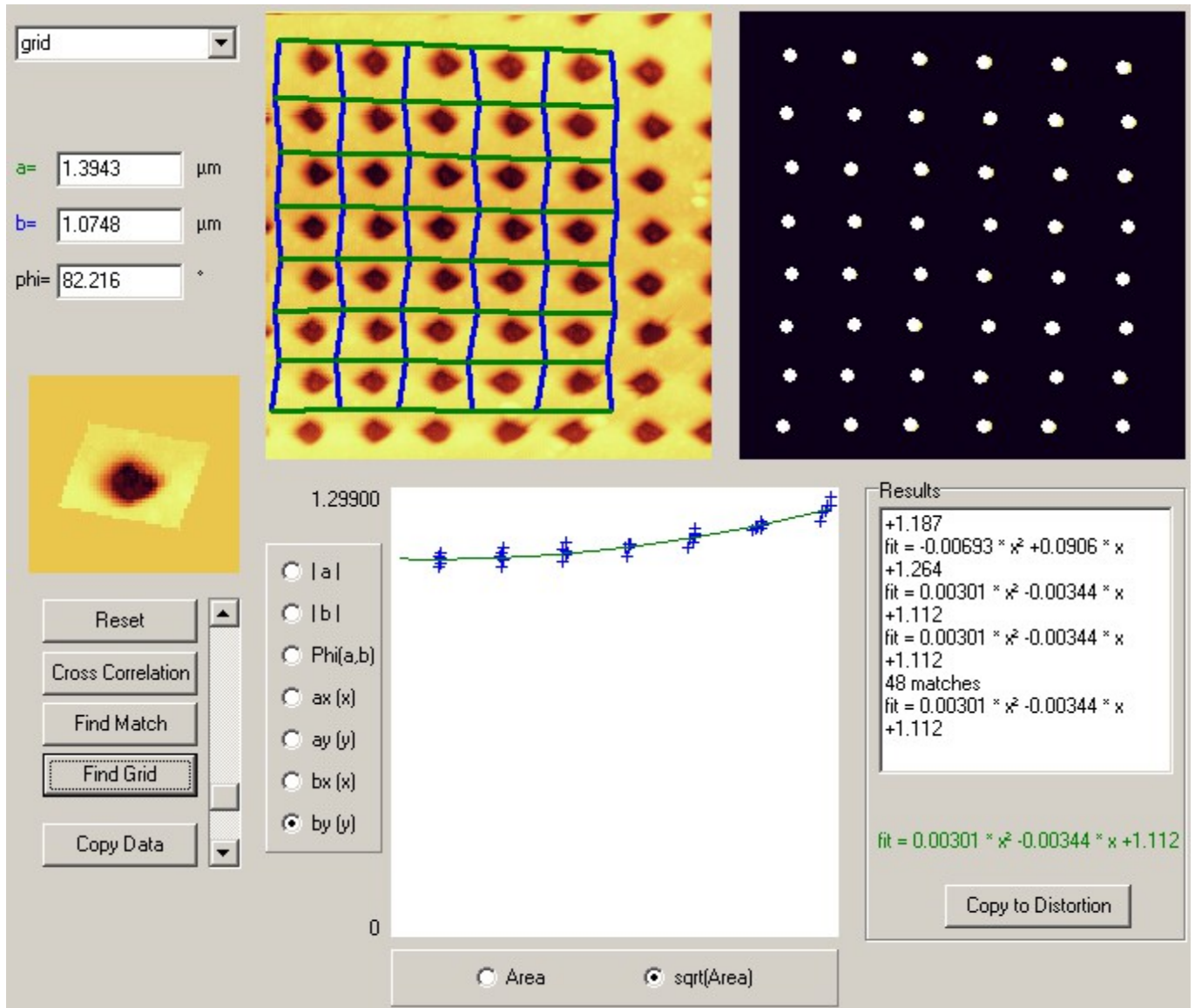
For a completely linearised image, the vectors should not depend on the position in the image.

"Copy to Distortion" sends the data to the distortion window. To open it, click on Process → Distortion. Now press "Do" to use the data from the Unit Cell to linearise the image.

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ALPHABETICAL INDEX