



Supplier:	Anfatec Instruments AG, Melanchthonstr. 28, 08606 Oelsnitz
Device:	Scanning Kelvin Probe System "AFT-KP150" - Konstanz
Document:	Operational Manual

LARGE KELVIN PROBE SYSTEM

FOR UNIVERSITY OF KONSTANZ



Manual Version: Rev3.0, June 2011

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GENERAL INFORMATION / SYSTEM SETUP

1 PART LIST

- ◆ Controlling System **AFT-KP150**
 - ◆ PC (one Touch-Screen LCD-Monitor, keyboard, mouse) with
 - ◆ Windows XP Prof. UK Engl.
 - ◆ AMU2.6-card (AMU2.6-1067)
 - ◆ LCD-Monitor
 - ◆ USB-Keyboard, USB-Mouse
 - ◆ driver for the PCI-Card
 - ◆ Kelvin Probe Software
 - ◆ Present-Software
 - ◆ KP-Controller Thomson II (S/N: Thom1102)
- ◆ mechanical set-up with 156 mm rails
- ◆ two KP-Heads (1 x with 1.4 mm Au-electrode, 1 x with 0.2 mm Au-electrode)
- ◆ Cover shield

2 DEVICE SET-UP

The main set-up is provided through the supplier.

FACILITIES

The instruments require a stable base floor. Direct air flow and illumination should be avoided.

SIMPLIFIED FUNCTIONALITY TEST

These test can be used to check fastly, whether the system works. They are not necessary!

1. Communications-Test:

- ◆ Re-Open "Kelvin" program.
- ◆ communication errors are tested and displayed here.

2. Toggle-Test

- ◆ move the Kelvin sensor close to the surface of a conducting sample. Set Toggle-time to 1.
- ◆ approach step-wise
- ◆ check the values of X or Y in the oscilloscope.

x Criteria: each second, the signal should change.

3 SOFTWARE UPDATES & DRIVER UPDATES

The system is ready to work, when you get it. If we provide a software update later, please follow these instructions:

✗ Close all programs

✗ Log on as administrator

Step 1): Copying the new files to the system

- Create a directory <C:/Program Files/Anfatec/driver/old>
- Copy the driver files sxm.sys and sxm.inf into this directory
- Rename the old driver files (for example to sxm17j.sys and sxm17j.inf or other, if your version number is different)
- Copy the new files sxm.sys and sxm.inf into the directory <C:/Program Files/Anfatec/driver>
- Copy the files install.exe and setup.bat into the directory <C:/Program Files/Anfatec/driver> (if they are not yet there).
- Create a directory <C:/Program Files/Anfatec/bin/old>
- Copy the file sxm.exe into this directory
- Rename the old file ../old/sxm.exe to ../old/sxm17j.exe (or different version name)
- Copy the new file sxm.exe into the directory <C:/Program Files/Anfatec/bin>

General information: when the version number is counted up (e.g. from 17k to 18a), you need a new driver file (inf and sys). If only the letter behind the version is counted up (e.g. from 18c to 18d), the sxm.exe is needed only.

Step 2): Updating the driver (if necessary):

- execute the setup.bat (the command screen should show a message, that the driver has been successfully updated and you should restart the PC).
- reboot the PC

4 HOW TO ADD NEW KP-HEADS


Each KP head uses its own parameter set. In order to make it easier for the user, the program is started with a parameter that describes the KP head in use. In Windows, for each KP-head a start-button needs to be created on the desktop.



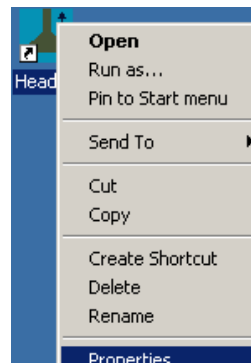
Each of the start-buttons is connected to its own ini-file which includes the parameter setup for the head.

If you want to add a new KP-head, paste the provided ini-file to the following folder:

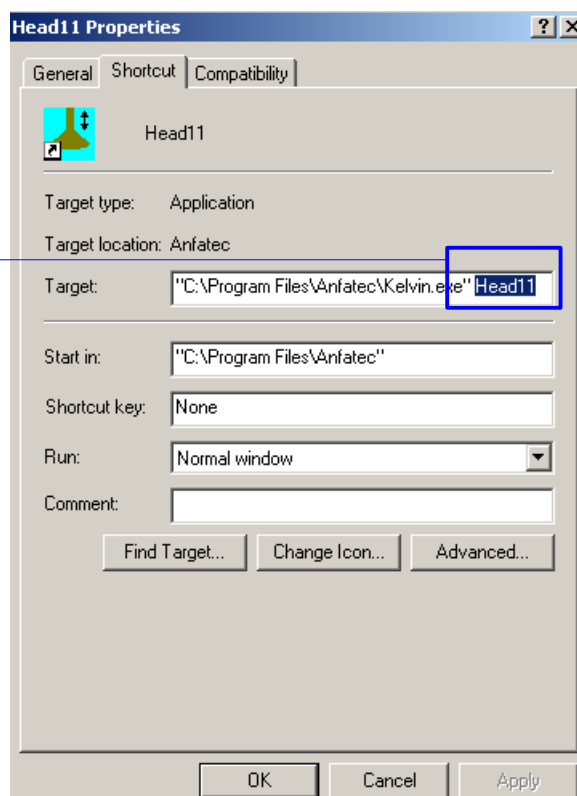
<C:/Program Files/Anfatec>

 Create a new start-button for the new head by copy and paste of an existing link on the desktop. Change the name of the parameter file as follows:

- Click with the right mouse button on the start-button
- Open 'Properties'



- Replace the last part of the field 'Target' with the name of your new ini.file
- For example Head11:
name of the ini-file: 'Head11.ini'
so, last part of the field 'Target' is named: Head11
- Press OK
- now if you open the Kelvin program with the new start-button, the related parameter setup for the new KP-head should appear



OPERATIONAL MANUAL

1 TERMINOLOGY

Head: is the KP measurement head, which holds the oscillator and the sensor tip.

Sensor axis: is the whole axis system, which translates the Head.

Base plate: is the table, on which the whole translation system is mounted

Rails: are the mono carriers, which move the head and the reference. Their current state is monitored in the "Rails Window" of the software.

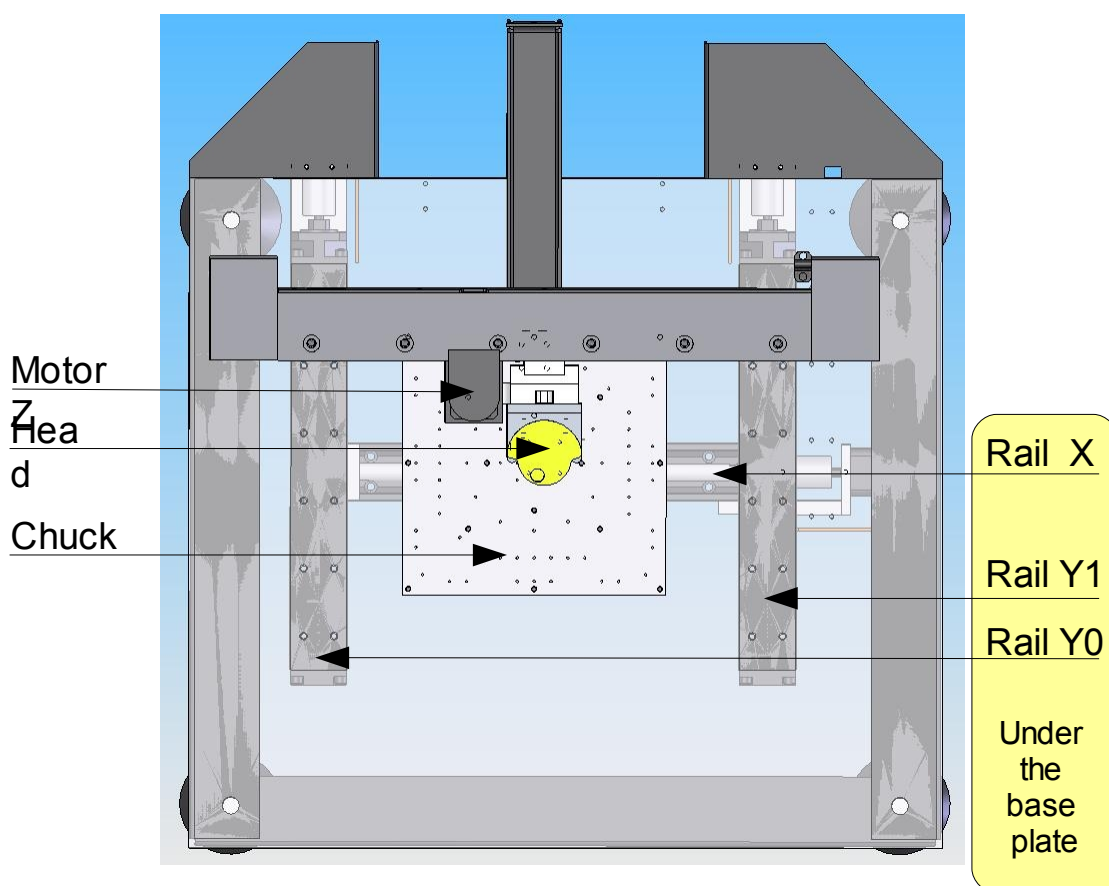


Figure 1: Top view of the system with semi-transparent base plate to show the rails under the base plate.

2 RAILS

The motors at the rails operate with 21 V power supply. Each rail contains an encoder, which detects the current position. The power supply of the encoder is directly connected to the power supply of the motors.

When the motor power fails the system forgets the current position and needs to be homed!

After system start, the current position of each axis (as last read from the encoders) is stored inside the controller. When the system software is switched OFF and ON, this current position is read from the hardware. Also, when the rails were stopped with the game pad (soft emergency STOP), the motor position is overtaken from the last read encoder position.

3 RAILS OPERATION

The rails can be operated

- 1 with the rails windows in the software (relative and absolute positioning)
- 2 with the game pad (manual positioning)
- 3 with commands in scripts called by the user (automated positioning)

A) For the administrator, the rails window is available from the function line. For the user, the rails form is hidden. It appears only, when the rails have a power fail or emergency stop.

In the rails form (see figure 3)

- select a single axis (X or Z) or two Y-axis at its selection point (the selected axis gets green)
- enter a number into the edit window "Distance" for relative movements or "GoTo" for absolute movements.
- The number is overtaken with "Enter" → then the axis moves immediately
- During movement, the axis appears in blue colour.
- When the axis moves against a barrier, so that the encoder's value differs from the expected stepper motor position, the system stops immediately. The failed axis is displayed in red.

B) The game pad allows to move the axis manually:



Figure 2: Joystick functions.

- select a channel: "1" selects the sensor head axis
- use the joystick knobs to move the selected axis

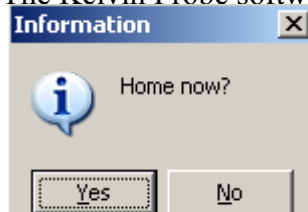
C) an automatic movement is done with

- MoveSonde(X,Y,Z) for the Sensor head
- commands Line, Point or Image during measurements

4 SYSTEM START – HOME POSITION



The Kelvin Probe software is started from the desktop with this icon.



Attention: Use the icon referring to the mounted head-number, only!!

After each software start, the system asks whether the axis should be homed or not.

Mote_ When the hardware was OFF, the system needs to be homed!!

When the software (and only the software) is switched OFF while the controller remained ON, the system reads its current position from the controlling system. Then, homing is not required, however, it is useful to home the system from time to time in order not to lose the current position.

Home moves the axis separately into their end positions. During homing, the movements are slow. Therefore, it is useful to move the axis manually close to their home positions, so that the homing process takes not too long.

- After homing, the system asks you to reset encoder positions → please confirm.
- Repeat "HOME" and check that the encoder values remain when confirmed.

After home, the system writes start coordinates for the two axis onto the screen.

5 RAILS EMERGENCY STOP

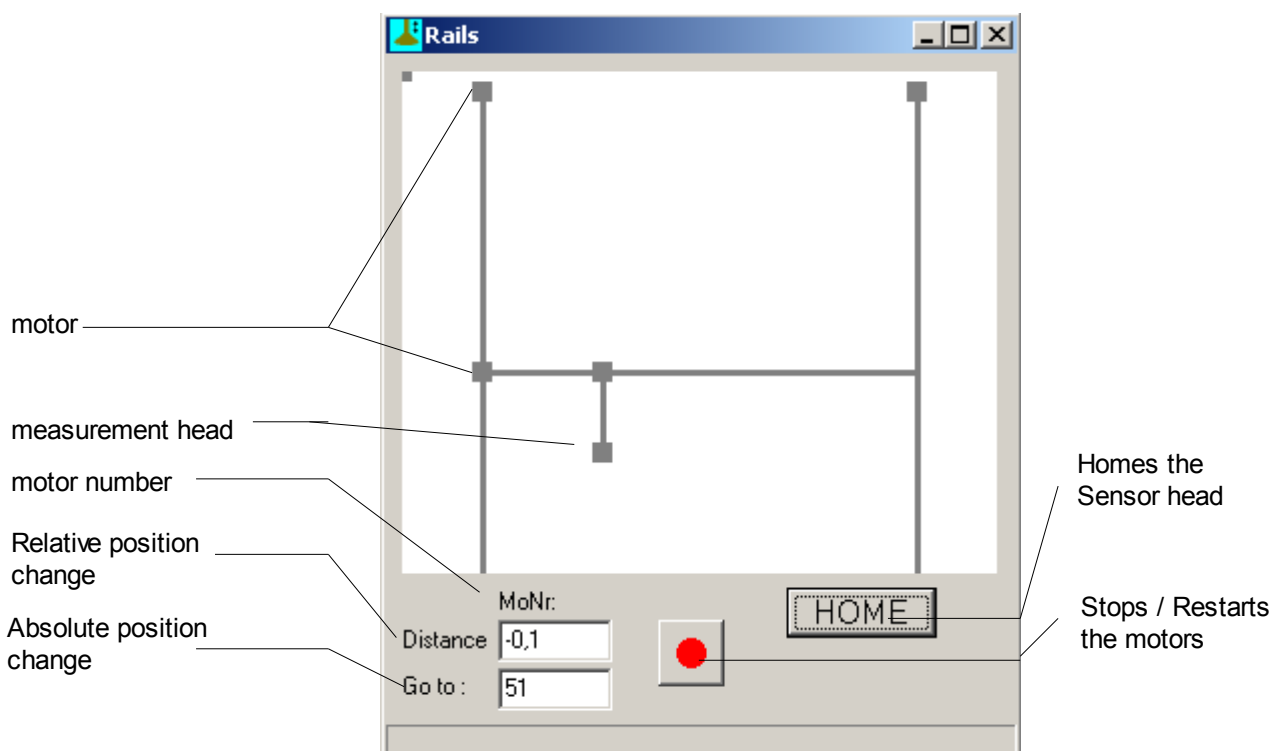


Figure 3: Rails form after start-up of the system.

When the rails move in an unintended direction, the user has the possibility to stop the Rails in three different ways with different consequences.

1) STOP with Esc

Use the Esc-button (press 2 times) on your keyboard to stop the Rails. Press the motor button in the rails window from green to red to continue.

2) STOP with the game pad

Use knobs 3 or 4 of the game pad to stop the motors (knob 3 and 4 – see figure 9). Press the motor button in the rails window from green to red to continue.

3) STOP with the NOT-AUS knob (Home required!)

The user can stop the movement immediately with the NOT-AUS knob.

This soft emergency stop

- stops the movement immediately
- brings the rails window to the front
- shows the axis state (last moved axis is red) and
- shows the rails switch in green.

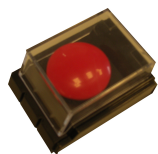
In this configuration, the internal position of the steppers (this is the last value transferred from the software to the controller which is shown in the table as well) might differ from the real position detected with the encoders. Therefore, the axis shows a failure (red colour) = a mismatch between intended stepper position and real encoder position.



Practical Advice:

- Before you start a measurement, open the lid of the NOT-AUS knob and place it near to you

- If you have to use the NOT-AUS knob, the system loses its operating voltage and the motor stops
- Press the motor button in the rails window from red to green



- Close the lid of the NOT-AUS knob to get the operating voltage back
Closed lid ≡ reactivation-function

- With the rails switch from green to red, the encoder position is used to restore the stepper position.

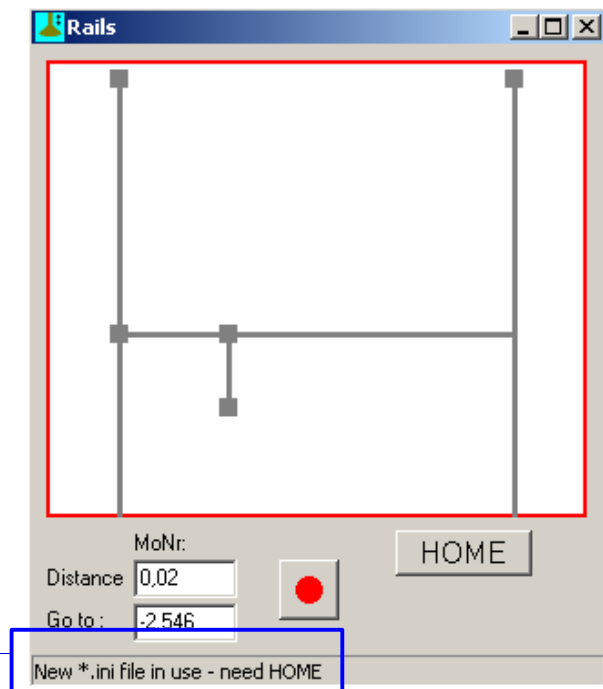


- The red rectangle in the Rails-window should vanish

Attention: the system needs to be homed afterwards!

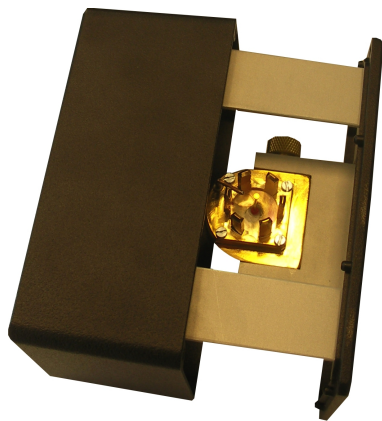
6 HOW TO CHANGE THE MEASUREMENT HEAD

- Home the system
- Close the Kelvin program
- Remove the excitation-cable (Only Pull, NEVER turn around) and plug it in the silver fixture
- Loosen the two golden screws which fix the head
- Pull the head out of the connector
- Plug in the new head
- Fix the head with the two golden side screws
- Reconnect the excitation-cable (Only Push)
- Switch the Kelvin program on
- Before starting with measurements, the system needs to be homed

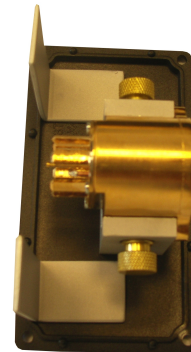


7 SAFEKEEPING OF KP-HEADS

- Unused KP-heads are kept in the provided black head-boxes
- Plug in the unused head in the fixture
- Attend that the tip should show toward the two silver brackets
- Fix the head with the two golden side screws



- Stick together carefully the lid with the housing of the head-box
- The two silver brackets are directed downwards along the inner surface of the housing; so the tip is protected for breaking
- Fix the lid on the housing with the four silver screws

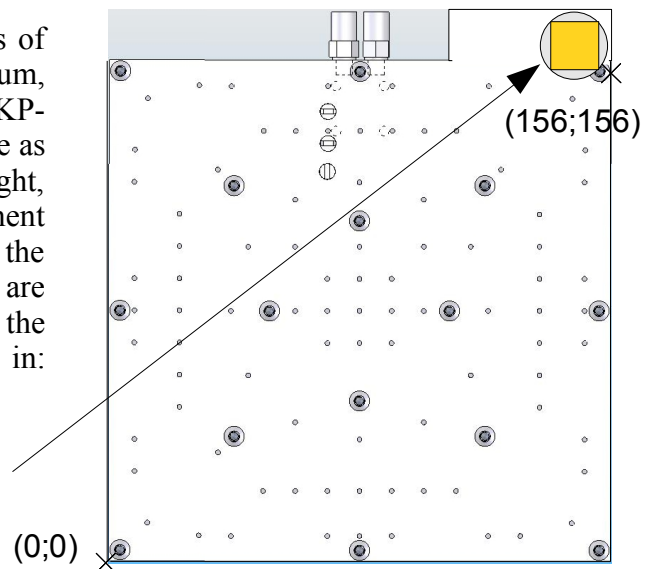


with the
directed

8 MOUNTING OF REFERENCE SAMPLES

The Kelvin Probe System "AFT-KP150" consists of several reference samples (e.g.: gold, aluminium, HOPG) to prove the functionality of the used KP-heads. The reference samples could add or remove as required. For this a magnet was fixed at the right, back corner of the chuck. If a reference measurement is needed, place the sample on this corner. If the sample is near to the magnet, magnetic attractions are noticeable. For reference measurements, use the prepared reference scripts which are located in:
<C:\Program Files\Anfatec\scripts\Referenzproben>

reference sample



9 ADD SELF MADE FILE-NAMES

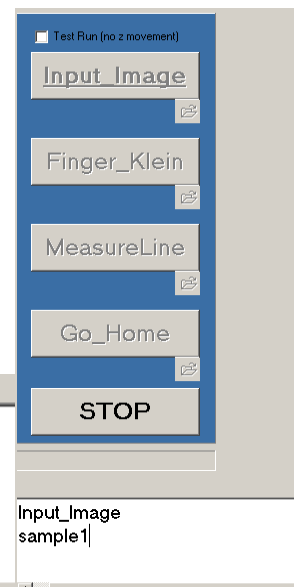
- Create a new script



- Change Filename(' xxx') in Filename(input);
(word input without ' ')
- Open the Kelvin program and load the new created script
- Start the script
- The measurement stops until a file-name is pasted in the Memo-window (below the script-name)
- Then, press Enter to start the measurement

script-name
pasted file-name

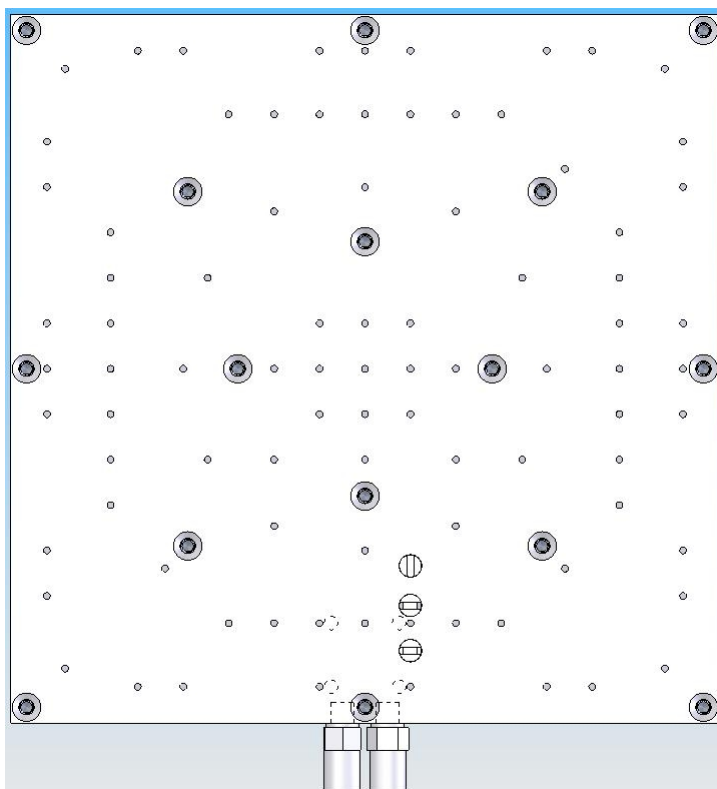
Input_Image
sample1|



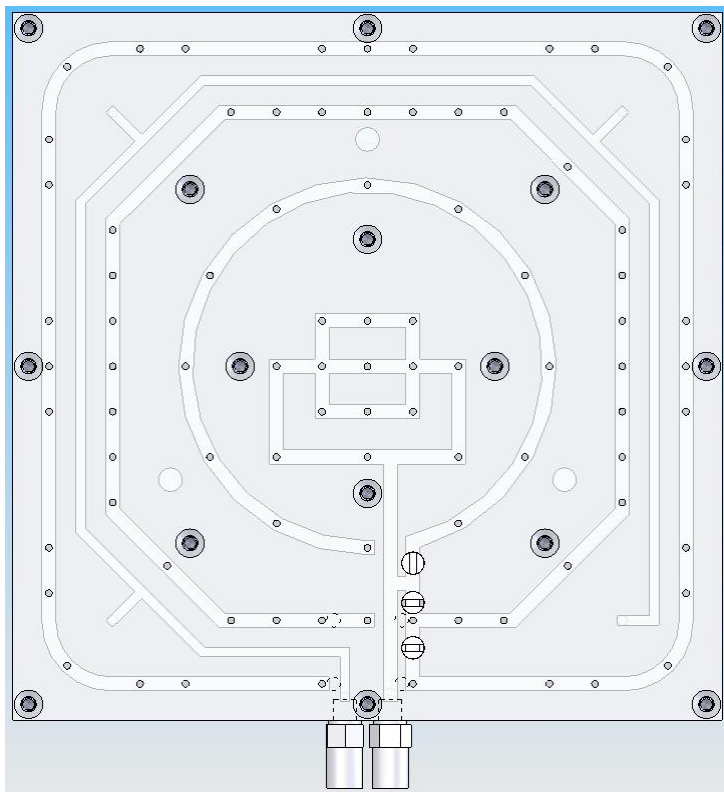
10 VACUUM CHUCK OPERATION

The Top side

has holes as requested for different samples sizes. Vacuum is pumped through the right connector. The inner part is always connected. The outer ring can be added to the vacuum line with the screws (2 mm hexagon).



Inside, are the connections as follows:



The three plastic screw allow to switch on additional pumping lines from inside to outside.

Use a 2.5 mm hexagon to turn them.



June 2011:

The 24 V power supply and the hardware for an external air-pressure switch is implemented, however, the software is missing due to late delivery of the switch and no possibility to test it. An update is expected in early September 2011.



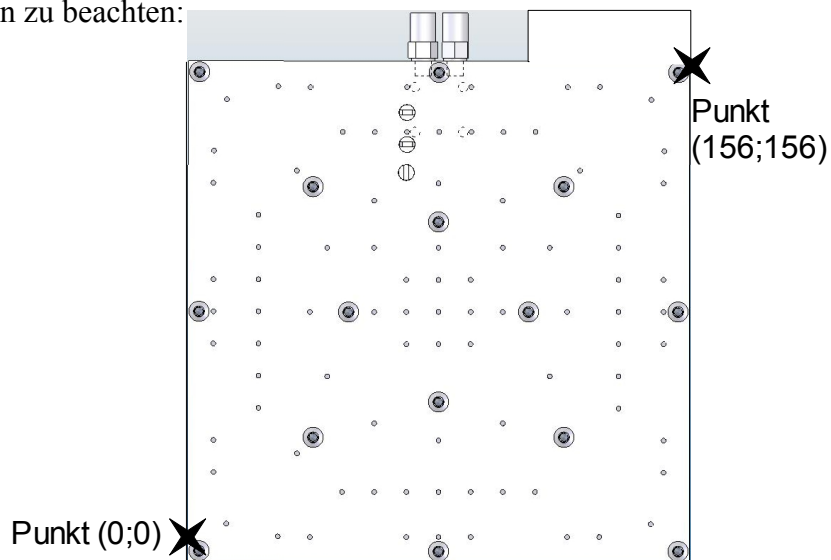
To activate the vacuum pump, press the green start-button .

11 BENUTZERHANDBUCH

- Computer hochfahren
- Controller 'Thomson II' an der Rückseite anschalten
- gewünschten Messkopf an die vorgesehene Halterung montieren und mit beiden Schrauben fixieren
- das Anregungskabel in die Buchse am Messkopf stecken (nicht drehen!)
- um das Messprogramm zu starten, den Startknopf mit der entsprechenden Messkopfnummer auswählen
z.B.: bei Benutzung von Messkopf 11, den Startbutton 'Head11' verwenden
- die Information 'Home now?' erscheint
'Yes' drücken
- es folgt die Nachfrage 'Set all Encoder to HOME?'
'Yes' drücken
- das Login-Fenster erscheint, um den Zugang zum Messprogramm zu ermöglichen
User:
Pwd:
- um die Eingabe zu bestätigen, die 'Enter'-Taste drücken
- mit dem Ordner-Knopf  das gewünschte Skript laden
- die Messung wird gestartet, indem der Knopf mit dem gewählten Skript gedrückt wird
z.B.: 
- am Ende der Messung werden die Daten automatisch unter <C:\Program Files\Anfatec\data> abgespeichert
- die eigenen Messdaten sind in einen eigenen Ordner zu kopieren
- alle unbenötigten Daten bitte stets löschen
- alle Bilder ('Image') werden unter <C:\Program Files\Anfatec\picture> abgespeichert

– weitere Hinweise:

1) Beim Erstellen von Skripten sind bei der Auswahl für x und y die folgenden Koordinateneinstellungen zu beachten:



2) Beim Kopieren von Bildern in den eigenen Ordner ist zu beachten, dass alle zugehörigen Bilddaten mitkopiert werden müssen.

Dies umfasst:

- filename_z.sin*
- filename_UKelvin.sin*
- filename_Slope.sin*
- filename.txt*
- filename.dat*

KELVIN PROBE SOFTWARE

The Kelvin Probe software package provides two operation modes:

- ◆ the ADMIN mode (user name = 'ADMIN', password required) allows
 - ☒ to access all system specific parameters
 - ☒ to develop script files
 - ☒ to observe the current system state
 - ☒ an unlimited rails operation
 - ☒ measure frequency dependence and
- ◆ the USER mode (user names can vary, no password required) enables
 - ☒ manual and automatic rails operation
 - ☒ run scripts
 - ☒ soft emergency STOP and reactivation of rails position (including Homing)

12 EXPLANATION OF THE WINDOWS / BUTTONS AND KEYS

Figure 4: Main window of the Kelvin program with description of the functions

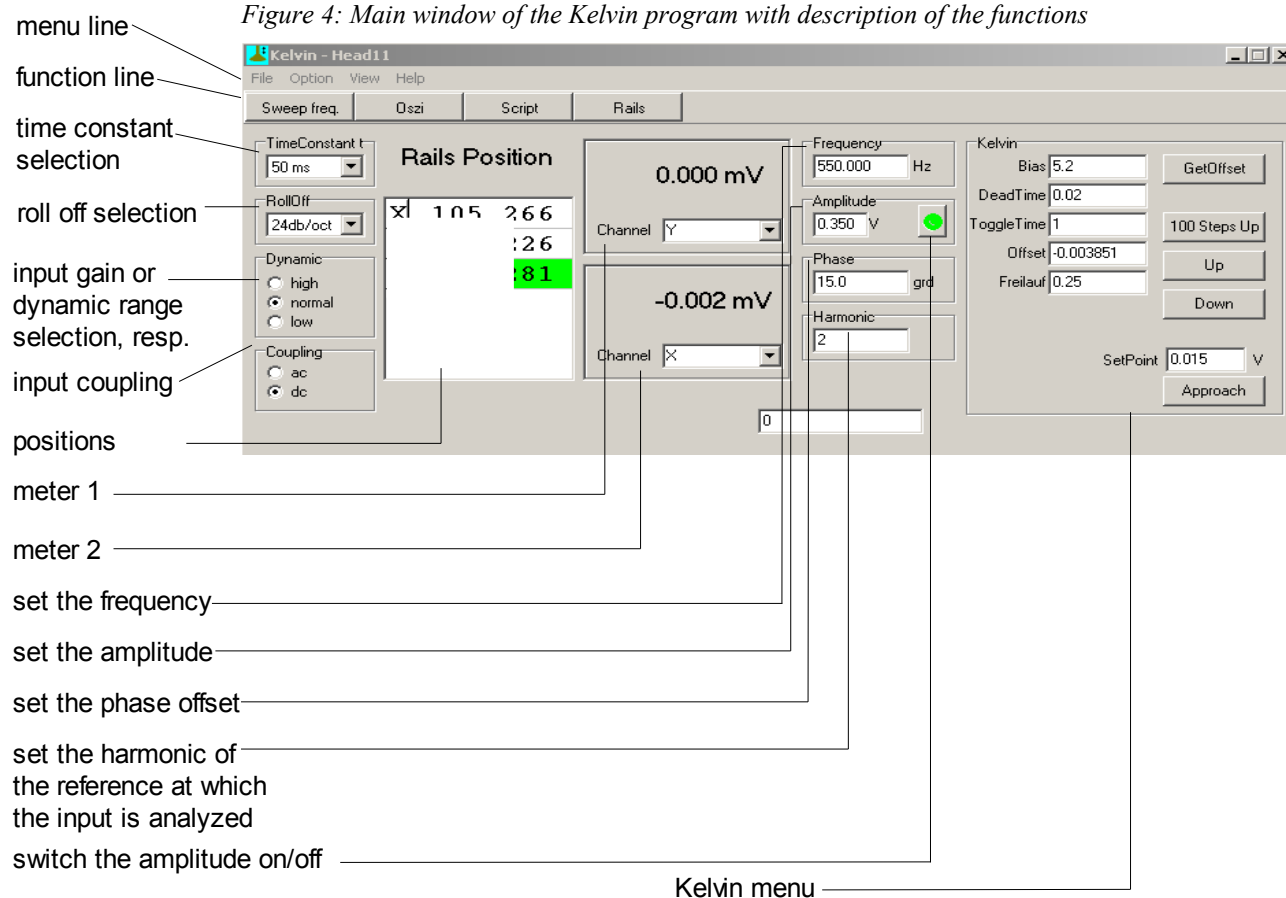


Figure 7 shows the main window of the Kelvin program, which appears when the program is opened in ADMIN mode with explanations of the single program parts.

The current position of the two rails is written into the "Rails Position" table. For checking the actually detected values of any of the input channels, the two meters are available. Basic input parameters for the lockin amplifier (frequency, amplitude, offset phase and harmonic) can be selected in the par right of the meters. Parameters, which concern the input stage (time constants, RollOff, and input gain) are chosen in the left part of the window. Settings referring to the Kelvin measurement (Bias, Offset, DeadTime, ToggleTime, Freilauf) are set in the Kelvin Menu.

The menu line allows typical Windows functions, while the buttons in the function line open new windows with specific functions.

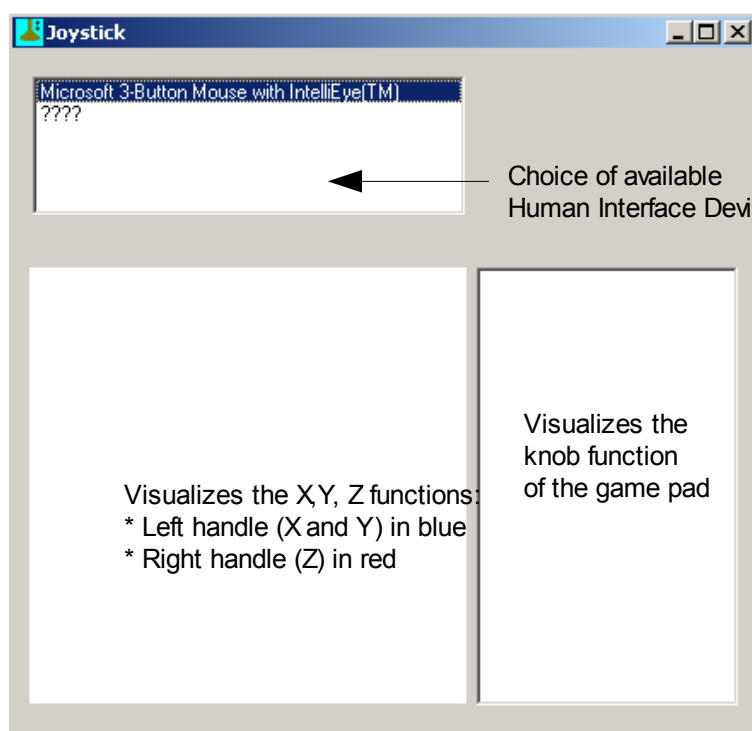
13 FUNCTIONS IN THE MENU LINE

FILE

Exit - Exits the program.

OPTION

- **Scale AUX** ... is a hidden window which contains the scaling factors for the A/D- and D/A-channels
- **AutoOffset AUXIn** ... is a hidden window for the offset correction of the input current
- **Joystick**



Opens a window, which allows to check the function of the joystick.

If the joystick does not operate properly, one can open this window, chose the "Logitech Rumble Pad" from the list and test, that the input knobs and the handles are working properly.

Figure 5: Joystick window

- **Overload**
Overload occurs, when the dc input signal exceeds the full scale sensitivity for the selected range. This full scale sensitivity is $7 V_{rms}$ for high reserve, $700 mV_{rms}$ for normal reserve and $70 mV_{rms}$ for

- ✓ on overload: beep
- ✓ on overload: change color

low reserve. With this option you can select whether a beep and/or a color change is shown in case of overload.

VIEW

Select, which of the meters should be shown.

HELP

About – shows the current program version.

14 FUNCTIONS IN THE FUNCTION LINE

Sweep freq.	Oszi	Generator	Display A/D	Sweep bias	Rails	UI	Humidity
-------------	------	-----------	-------------	------------	-------	----	----------

The function line might contain a list of useful functions for the analysis of the system state. Some of the functions are switched off in the ini.file. If you want to switch on any functions, see appendix 1 – Description of the ini.file.

- ☒ Sweep freq. – allows to check the frequency response of the sensor head
- ☒ Oszi – opens a 3-channel software-oscilloscope, which allows to check that the toggling of the Kelvin Probe sensor works properly
- ☒ Generator – sets output values to single D/A-channels or digital outputs
- ☒ Display A/D – allows to check the encoder values and the stepper deviation as well as the input value of the capacitive reference contact
- ☒ Sweep bias – allows to sweep the bias voltage for the sensor head
- ☒ Rails – Rails window for the relative and absolute positioning
- ☒ UI – user interface window used to run scripts (top-most window in user-mode)
- ☒ Humidity – shows the current humidity

SWEEP FREQUENCY

This window serves the acquisition of frequency dependent spectra of any of the LockIn input channels.

The number of data points, parameters for the visualisation as well as for the saving and copying the acquired data can be changed in the [option window](#).

WINDOW DESCRIPTION

“Delay”: is the time delay between each acquired data point. During spectrum acquisition, the frequency is set to the next value. Then, the system waits “Delay” and takes one single value from the acquired Channel.

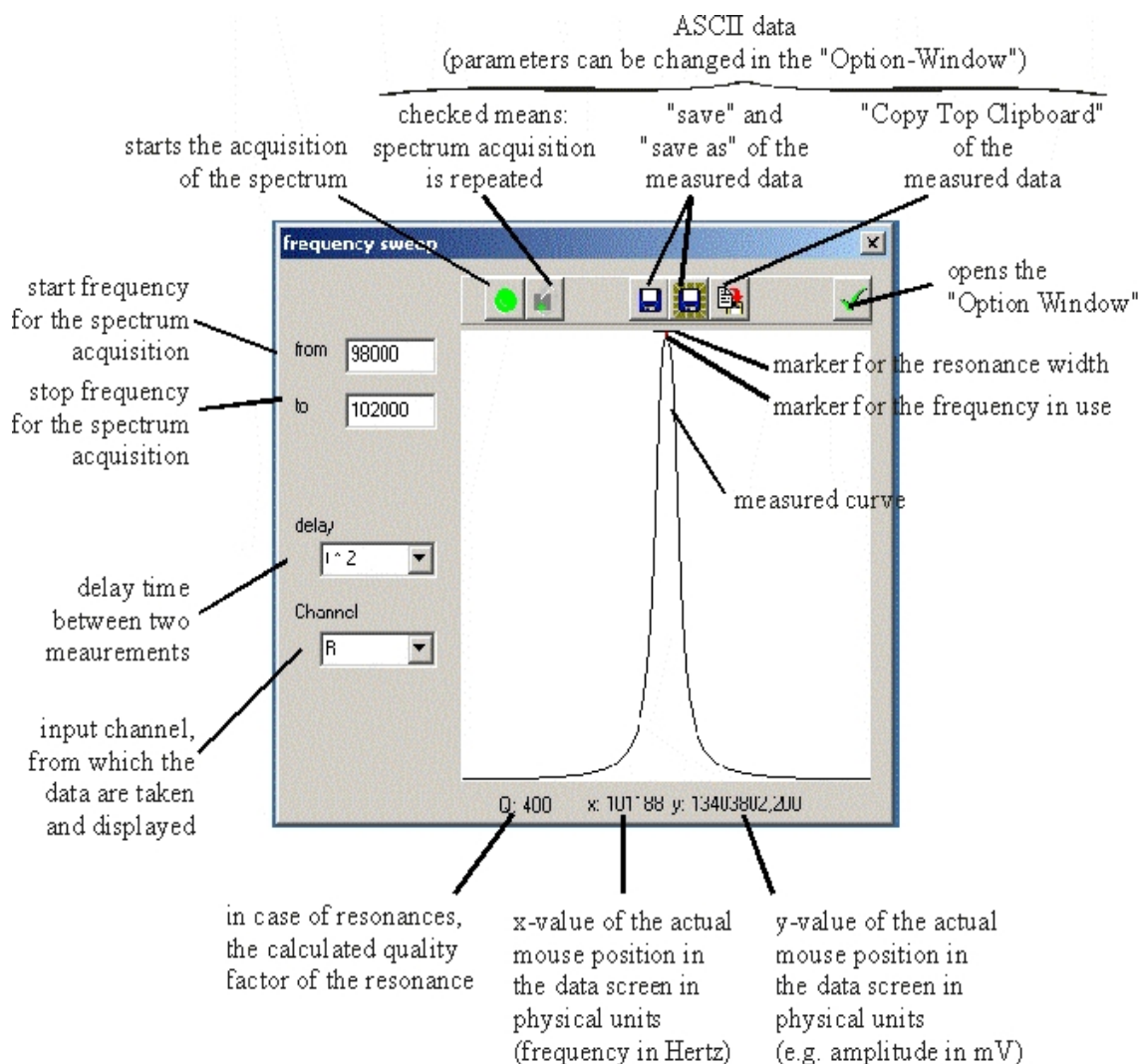


Figure 6: Window for the spectra acquisition.

As this delay has to be related to the time constant of the LockIn, the options in the drop down list for the delay are given in multiples of τ . Thus, independently of the [time constant \$\tau\$ given in the main window](#), the time constant for the acquisition of the spectrum is always correct.

“from” and “to” define the values of the start frequency and the stop frequency. For the spectrum's acquisition, one chooses the wanted frequency range, and presses the “start-button”. If the time constant was very high, the spectrum might take a while. In order to stop the acquisition, the start-button can be pressed a second time.

“Channel” is a drop down list of available data channels (X, Y, R, and Phi).

“Range back” - click with the right mouse button in the data screen, and a pop-up menu with list of four frequency ranges appears. The upper one is a standard range, which can be changed in the “Option/acquire” part. The next three are, from the bottom to the top, the last three used frequency ranges.

OPTIONS FOR THE FREQUENCY SWEEP

The option window provides three cards:

“**save**” - parameters about the saving and copying format of data,

“**acquire**” - parameters about the data acquisition, and

“**view**” - parameters, that specify how to show the data

The saved files and the data copied to the clipboard have an ASCII structure. The data are written in lines (each frequency value one line) and delimited by the given delimiter (“TAB” in the example) are saved. The frequency values are only saved, if “Save x-Axis” is checked. All history data are saved too and also delimited the same character.

Data file example:

```
1000,00      234,09
1200,00      237,98 ...
```

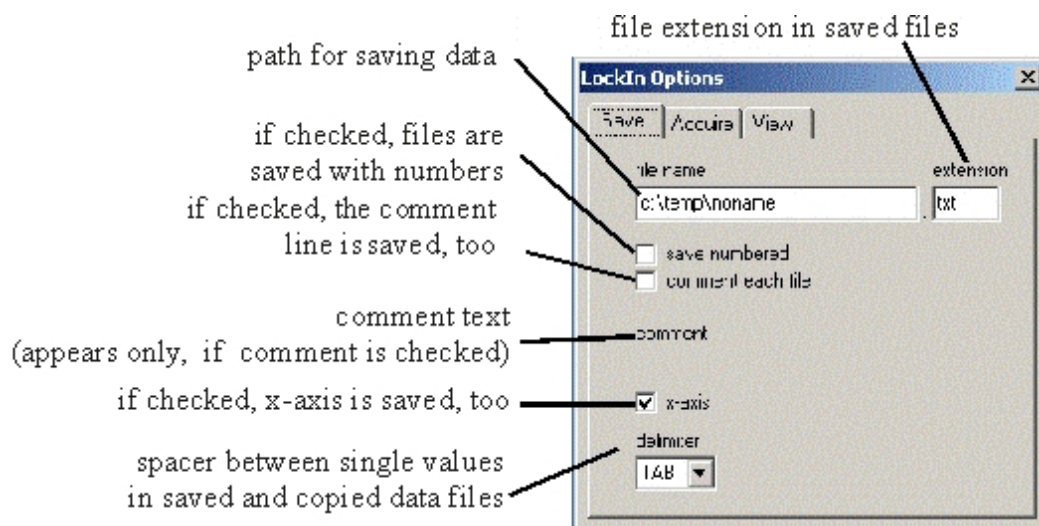


Figure 7: description of the card "save" in the sweep frequency options.

“**Wobbel**” - if a large range is scanned for overview purposes and the frequency peak, which should be found, is too small to be excited (because the single frequency steps are too big), the wobble option can help. If wobble is checked, the frequency is not kept constant during scan. It is varied (wobbled) between the neighboured values while the data are taken. This makes sure, that even small peaks can be found in an overview spectrum with only some 100 data points.

“**Standard frequency**” - is the range, which appears at the topmost position, if the right mouse button is used in the data screen of the “Sweep Frequency” window.

In the data screen, several data curves can be displayed simultaneously.

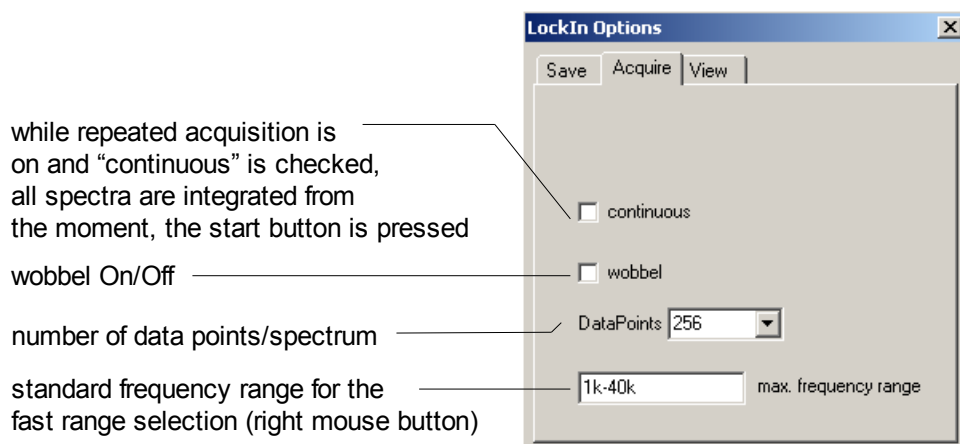


Figure 8: Description of the card "acquire" of the sweep frequency options.

Therein, the "History depth" is the number of old curves added to the actual one. If the depth is 2, the actual, the last and the last but one curves are displayed. The actual curve is always of black colour. The last is red, and the last but one is green. More curves get the next colours from the Windows™ palette.

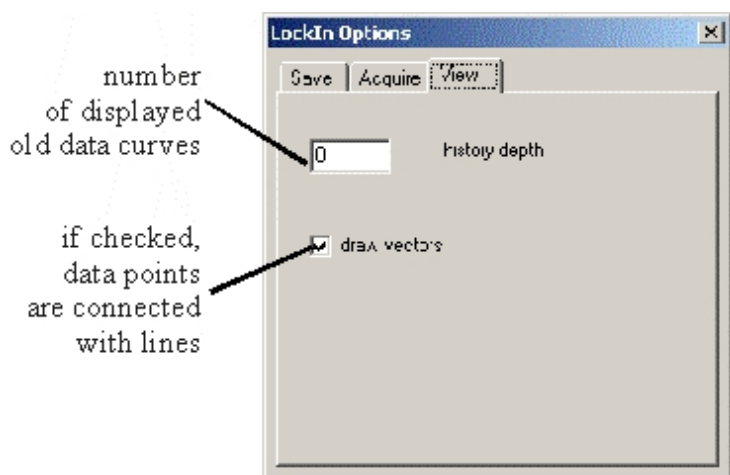
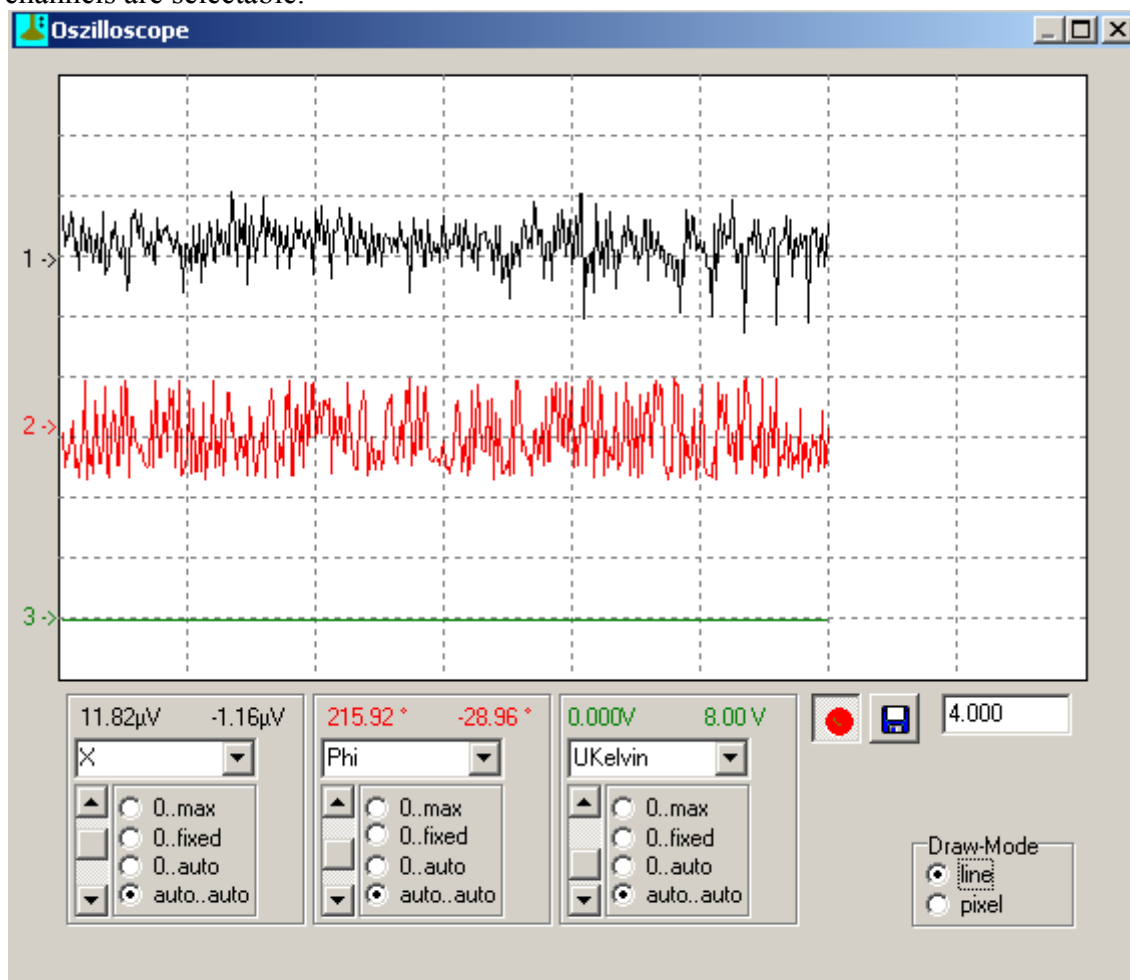


Figure 9: View options for the frequency sweep.

It can be chosen between pixel and vector drawing of data.

OSCILLOSCOPE

The oscilloscope works like a real 3-channel-oscilloscope. Content, scaling type and offset of the three channels are selectable.



Channel selection: is done from a drop down list, which shows only the available channels.

The two **numbers** above the drop down list for channel selection display the “scaling factor per vertical division” (= left number, hint: “y-scale in /div”, example: 11.82 µV/div) and the mean value. Both are calculated from all data acquired from the left oscilloscope edge till the current oscilloscope time. Therefore, these numbers are subsequently re-calculated.

Vertical scaling types:

- 0..max the scaling is set to maximum value of the channel
- 0..fixed the maximum value can be changed by a slider appearing on the right sight of the scaling type selection
- 0..auto the program calculates the optimum, but takes always “0” as minimum
- auto..auto automatically scaled



Time scaling is done with the edit window (right side) in seconds.

If “**Scan**” is shown in red, then the Oscilloscope is scanning, press the button in order to stop

the scan. The button will be shown in green then.



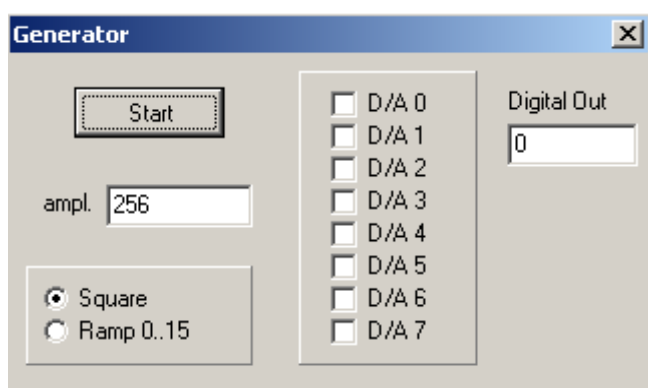
"Save Pic" saves the oscilloscope screen in a bitmap file.



"Draw mode" selects whether the data are drawn as dots or lines.

1 -> If you want to move one of the three channels, drag&drop the arrow, at the start of your scan, to the place you want your scan shown.

GENERATOR



This window allows to test the D/A-channels as well as the digital output settings.

ampl. Allows to set the output amplitude in digital units (0 = no output, 1 = last bit toggles, maximum value: 2047).

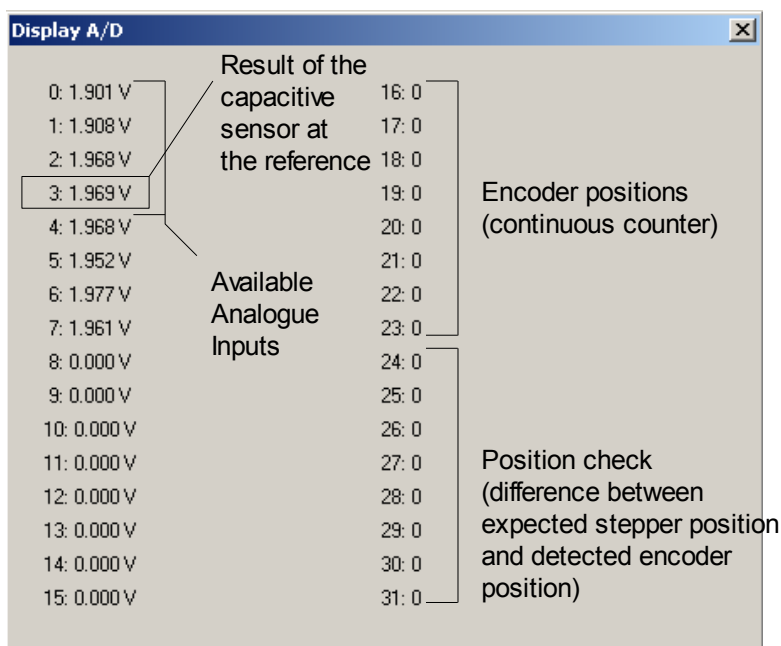
Square / Ramp 0..15 the output is either a triangular ramp. Then, "ampl." is the height of the steps. Or the output is a square pattern with "ampl." as height.

Digital Out defines the digital output channel to access single bits in the digital output chain.

One selects the D/A channels to be tested. With "Start", the output of the ramp or triangle is enabled. It can be stopped with the 2nd click onto the start button.

D/A 1 = bias output for the Kelvin toggling.

DISPLAY A/D



This window is for service purposes, only. It allows to check the values for the encoders and steppers.

Channel 3 of the inputs detects the output signal of the capacitive sensor mounted at the reference electrode.

SWEEP BIAS

WINDOW DESCRIPTION

This window serves the acquisition of voltage dependent spectra of any of the LockIn input

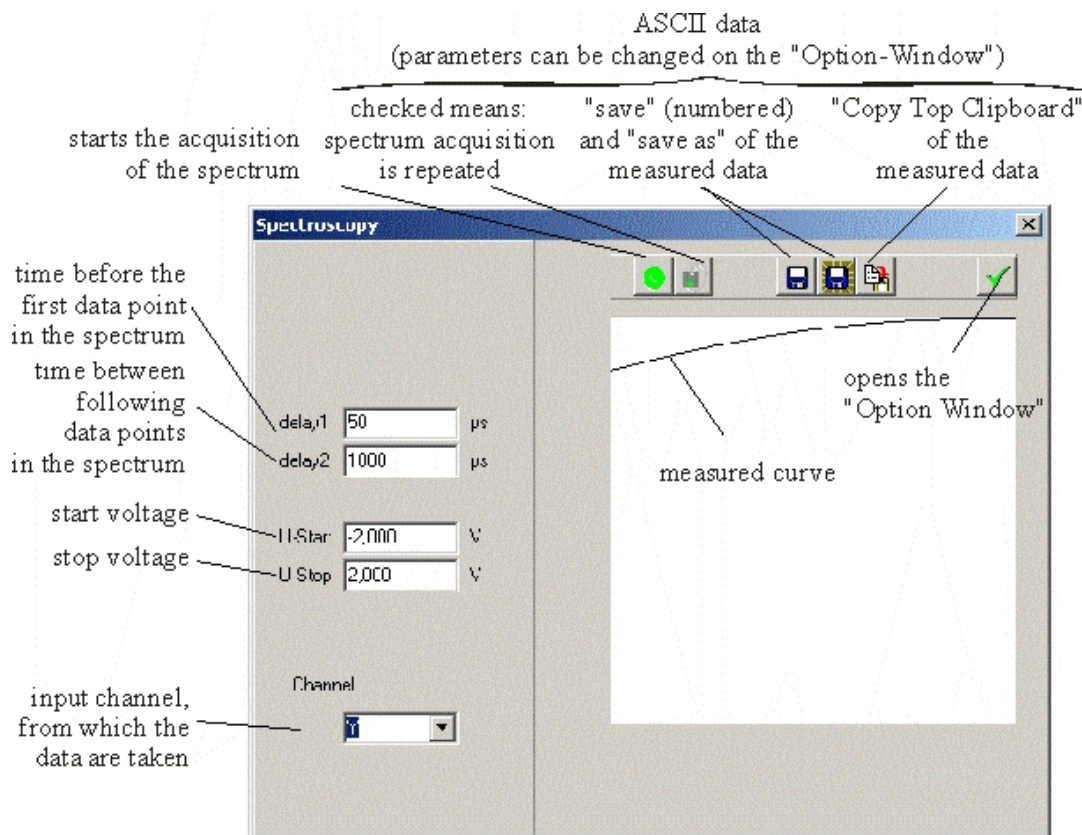


Figure 10: Window for the spectra acquisition.

channels. Usually, the time constant has to be related to the time constant of the LockIn.

The number of data points, parameters for the visualisation as well as for the saving and copying the acquired data can be changed in the option window.

OPTIONS FOR THE BIAS SWEEP

The option window provides, in analogy to the option window of the frequency sweep, three cards: **“save”** - parameters about the saving and copying format of data, **“acquire”** – parameters about the data acquisition, and **“view”** – parameters around the screen of showing the data.

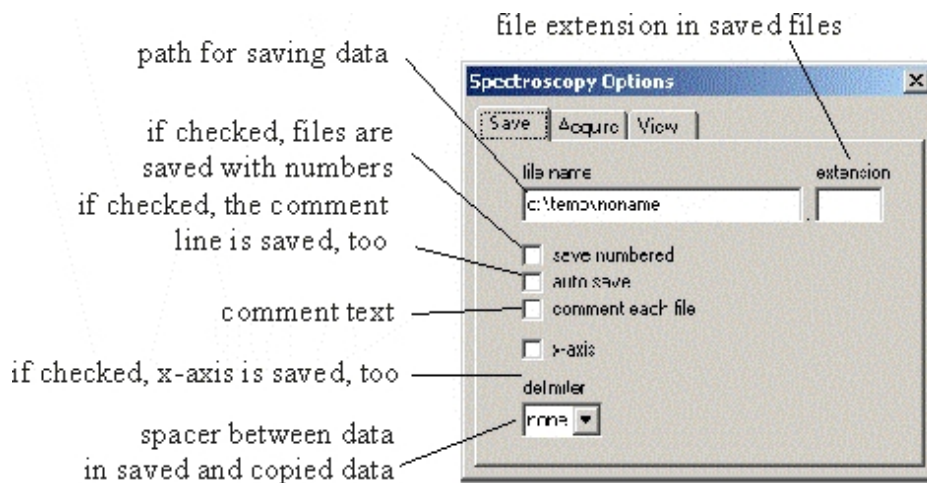


Figure 11: description of the card "save" in the sweep bias options.

The saved files and the data copied to the clipboard have an ASCII structure. The data are written in lines (each frequency value one line) and delimited by the given delimiter ("TAB" in the example) are saved. The voltage values are only saved, if "Save x-Axis" is checked. All history data are saved too and also delimited by the same character.

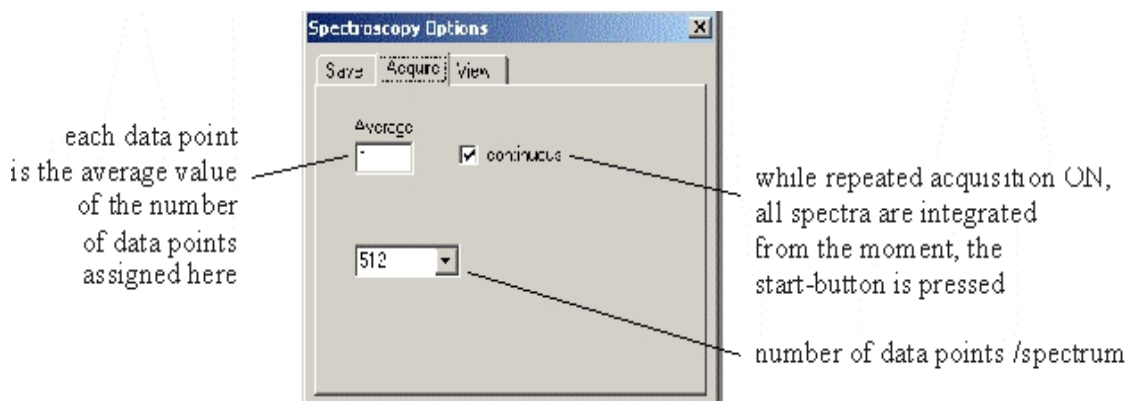


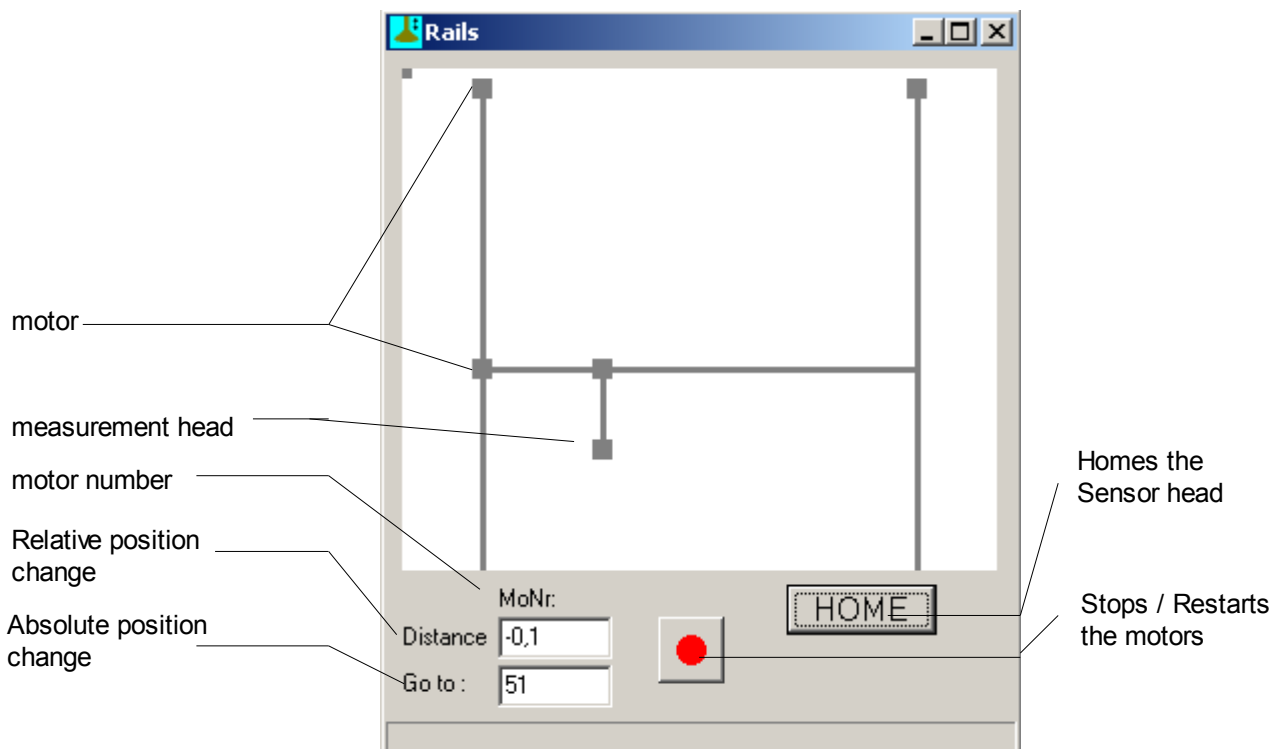
Figure 12: Description of the card "acquire" of the sweep frequency options

Therein, the "History depth" is the number of old curves added to the actual one. If the depth is 2, the actual, the last and the last but one curves are displayed. The actual curve is always of black colour. The last is red, and the last but one is green. More curves get the usual next colours from the Windows™ palette.

The card "View" is almost equal to the card "View" of the sweep frequency options window.

RAILS

This menu makes it possible to move a distinct rail.



When selecting an axis at its motor, the motor number is shown after the label "MoNr". Simultaneously, the selected axis gets green. When selecting the Y-Axis, always two axes will be marked in green, because these axes are linked. Therefore two motor numbers will appear in the label.

In order to move a rail relatively to its current position, select its motor and type in a value in the field "Distance". As the coordinate system is right handed, a positive value for an X-axis will move the head to the right. A positive value for an Y-axis will move the head upwards (as seen in the picture, this means it will move closer to the Y-motors), while a positive value for the Z-axis will move the selected head upwards (away from the base plate).

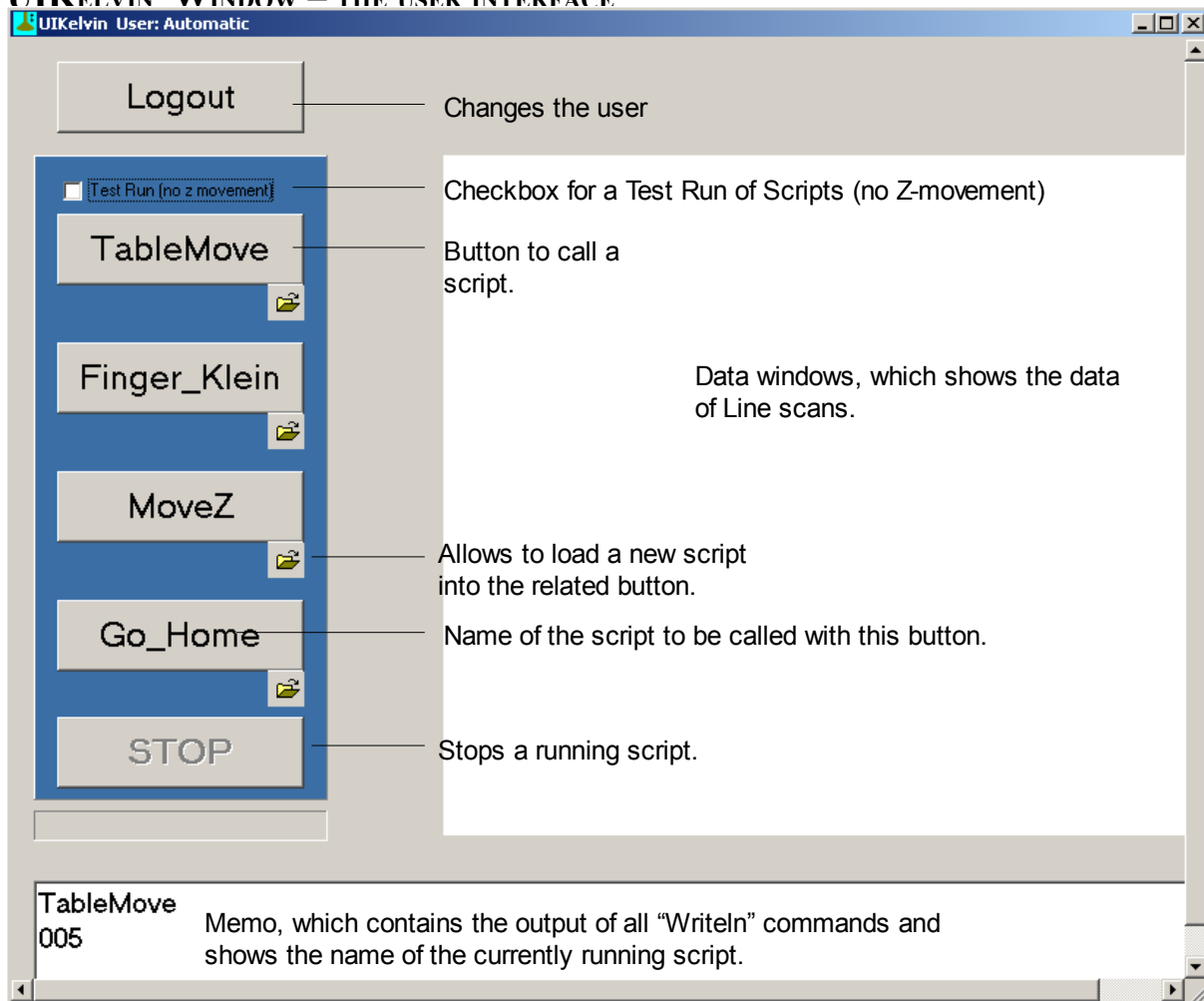
An absolute movement is done with "Goto". When any axis is selected, the number behind the entry "Goto" shows the current position. One can enter another position. Which "Enter", the selected motor moves directly to this as final position.

"Start / STOP" – the red knob – is used as emergency STOP for the rails. After a soft emergency STOP with the game pad, this knob is green and pressed. Press it, to enable the motors and overtake the currently detected encoder positions into the currently stored motor positions.

As the position detection of the rails is a counter inside the controlling system, which loses its value after a "Not-Aus" or power fail, the rails need to be homed to find back their original coordinates. Press the "home" button. The upper button will bring home the reference head, while the lower button calibrates the measurement head.



UIKELVIN WINDOW – THE USER INTERFACE



The "UIKelvin" window allows the user to run predefined scripts. If the systems fails during a running script, it stops and the rails window pops up to the front display.

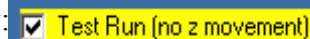
In ADMIN-mode (password protected mode), one can change the predefined scripts and load other scripts into the UIKelvin Window.



This icon is used to load a new script. Scripts are written in ASCII-format and saved with a *.SCR extension (see: Language description).



The test run allows to run a script without the z-movement. The tip is moved to the safe height which is pre-defined in the ini-file and stays in this height during all movements. During test run, the background of the left is yellow:



STOP

The STOP button allows to stop a script after the running command is closed.

In order to be able to read the whole file name in the button label, save your programs with names not longer than 12 letters. In case your program uses "writeln", the output will be shown in the Memo below all buttons. Data produced with the "Line"-commands appear in the data window.

HUMIDITY

This button allows to show the room humidity in %.

15 POSITIONS

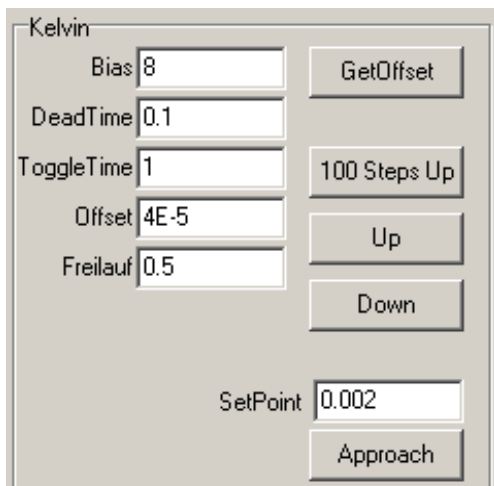
This menu shows the position of the rails.

The first three lines show the position of the measurement head. The coordinates for the reference head are given in the last three lines.

While selecting a coordinate of a head, it turns green, showing that you are now able to copy the given number to clipboard. Press "Ctrl" and "C" to do so.

X	0.000
Y	0.000
Z	57.000
X	600.000
Y	819.856
Z	49.951

16 KELVIN MENU



The "Kelvin Menu" is needed, whenever you want to approach to your sample.

While "100 Steps Up" moves the measurement head 100 steps upwards, the "Up" and "Down" buttons make only one step in the selected direction. To automatically approach the tip, choose "Approach". Before you do this, make sure that the "Kelvin Menu" parameters are set correctly, in order not to crash your tip.

"Bias" is the voltage in V set between sample and tip.

"Dead time" is the length of the sleep period in seconds after each step.

"Toggle time" is the time for one cycle, in which the bias is applied in one sign.

The "Offset" is a correction value. It can be set by pressing "GetOffset". Please make sure, that your reference head is approached to your reference sample(e.g. Al, Au) before doing so.

"Freilauf" gives the safety of the tip. The bigger the "Freilauf" value, the safer the trip of your tip.

"SetPoint" is the reference value of X, at which the automated approach stops

17 LOCKIN AMPLIFIER MENU

TIME CONSTANT

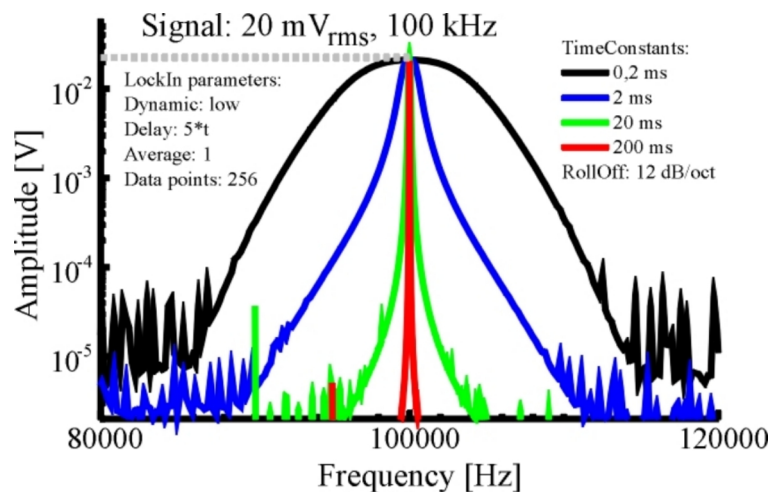


Figure 13: Effect of different time constants.

This option selects the used time constant for the low-pass filter. The internal LockIn functions give the lower limit of 0.2 ms (5 kHz). The possible time constants range in a logarithmic scale between 0.2 ms and 1 s.

The low-pass filter itself is a Butterworth with an effective noise bandwidth of

$$B_n = \int_0^{\infty} \frac{1}{1 + \omega^{2n}} d\omega$$

The normalized Butterworth filter noise bandwidths are:

<i>Filter order</i>	<i>Bandwidth</i>
1	1.570796
2	1.110721
4	1.026172

ROLLOFF

The “RollOff” equals the degree of the lowpass filter. One can chose between 6 dB/oct (1st order), 12 dB/oct (2nd order) and 24 dB/oct (4th order).

DYNAMIC

This switches the input amplification of the LockIn. With "high" dynamic, input amplification is 1. The maximum signal amplitude is then +/-10 V. The "normal" input amplification is 10, which equals maximum signal amplitudes of +/- 1 V. When the low dynamic is chosen, the resolution of the LockIn is highest, but the signals cannot exceed 100 mV.

COUPLING

If the specification of the instrument allows it, this option switches between DC coupled input and AC coupled input. Note: The 3dB corner frequency of the input high pass is around 2Hz. Reference frequencies around 2 Hz and below may cause misleading results.

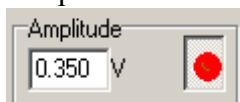
FREQUENCY

If written in black letters, this is the actual reference frequency which is used at the reference output and as reference frequency for the signal evaluation of the input. Click with the right mouse button to switch from external to internal reference. In case of internal reference, the numbers are written in grey.

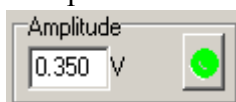
AMPLITUDE

This is the amplitude of reference output. The button right aside sets the amplitude on or off.

Amplitude On



Amplitude Off



PHASE

Allows to give a phase offset between the reference output and the input. It can be used to adjust the maximum signal amplitude into the X-part of the signal, so that optimum conditions are reached.

HARMONIC

Selects, which harmonic of the reference frequency is evaluated. The possible values range from 1 to 9. When selecting higher harmonics, take care, that, due to low pass filtering, the maximum input frequency the LockIn cannot be higher than 2 MHz.

In this Kelvin Probe set-up, the harmonic should be set to 2.

LANGUAGE DESCRIPTION

1 GENERAL SYNTAX

The general style is Pascal:

- ✗ There is no case sensitivity.
- ✗ The program starts with **begin** and stops at **end..**
- ✗ **()** - brackets are used in mathematical formulas.
- ✗ Strings are enclosed in **' '** (**" "** is also working).
- ✗ Decimal separator for floating point numbers is a point: **"."**.
- ✗ Each command is completed with a semicolon: **";"**.
- ✗ Available mathematical operations:
- ✗ Available relational operations:

+ **-** ***** **/** **^** **e**
= **>** **<** **<>**

2 VARIABLES & ASSIGNMENTS

Variables are single characters only. The data format of all variables is real.


Predefined variables are:

Temp for temperature, **Uk** for the Kelvin potential and **Humi** for the Humidity, the names of the reference samples **AU**, **AL**, **HOPG**, **USER1** and **USER2** as well as **Ch** as result of GetChannel.

Example: **A := A + 1.2;**

3 COMMAND OVERVIEW

<i>Command</i>	<i>Meaning</i>
ClrScr	Deletes the visible data on the data screen
Color (r,g,b)	Set the color of the next drawn data line
if ... then	Condition
Execute('filename')	Executes another script <i>./script/filename.scr</i>
Filename ('name1')	Defines the name of the data storage file as <i>./data/name1.txt</i>
Filename(input)	User set the filename in the Memo
for ... to ...	Loop definition
Freilauf(fl)	Defines the safety height for line and point measurements in mm
Goto <i>marke</i>	Jumps to the position <i>marke</i> defined as Label
Image(s,d)	Acquires a square image with s pixels and d mm x d mm size
Line(dir,s,d)	Measures s points from here to d along a line in direction dir
MoveRef(x,y,z)	Moves the contact to a new absolute position
MoveSonde(x,y,z)	Moves the sensor to a new absolute position
Point(x,y)	Measures data set at the absolute coordinate (x,y)

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SetPoint(sp)	Sets the parameter SetPoint in V
SetChannel('string',value)	Sets the output D/A-channels
SetKelvin('string',value)	Changes variables for the Kelvin-Measurement
SetLockin('string', value)	Changes variables for the lockin amplifier
SetPoint(sp)	Sets the setpoint in V
ToggleTime(tt)	Sets the parameter Toggle Time in seconds
Wait(t)	Waits for a time t in seconds
Writeln('text',...)	Displays text in the Memo

4 COMMANDS (ALPHABETICAL)

CLR SRC

deletes all visible data and spectra on the data screen.

Example: `ClrSrc;`

COLOR (RED, GREEN, BLUE)

sets the color for the next graph to be drawn in the diagram

Parameters: **red, green, blue:** integer 0 .. 255

Example:
`Color(0,0,0)` → sets the color to black
`Color(255,0,0)` → sets the color to red

IMAGE (POINTS, DELTA)

Scans an image

Parameters: **points:** integer
delta: real

Example:

`Image(64,5);` → scans an image with 64 x 64 points over a range of 5 mm x 5 mm

IF CONDITION THEN COMMAND

Evaluation of conditions. ELSE is not supported.

Example:

```
Point(100.56, 200.87);
if (U < -1.6) then writeln('Potential in Al out of range =', U)
```

EXECUTE (SCRIPTFILENAME)

Calls and executes another script file.

Parameters: **scriptfilename:** string


Example:

`Execute('Ref-HOPG');` → calls the script "`./scripts/Ref-HOPG.scr`".

FILENAME (DATAFILENAME)

defines a file name for the data file, which collects all data during the measurements.

Parameters: **datafilename :** string → file is `./data/name.txt`

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Example: `Filename('test3');` → the data are written to
`./data/test3.txt`

FILENAME(INPUT)

The user gets the possibility to insert the desired filename directly in the Memo.

Example: `Filename(input);`
→ Memo text: `image5x5`, the data are written to `./data/image5x5.txt`

FOR START COUNTER TO STOP COUNTER DO BEGIN COMMAND(s) END;

Loop definition based on an integer counter. The commands `begin` and `end` are always required.

Example (measures 20 points along a line in x-direction):

```
X:=100; Y:= 100;
for i:=1 to 20 do begin
    Point(X,Y);
    X:=X+i/10;
end;
```

FREILAUF (HEIGHT)

defines a relative height above the sample surface in mm, which is used in movements between point or linear measurements called with `point(x,y)` or `line('type',steps,endpos)`.

Parameters: `height`: real

Example: `Freilauf(0.25);` → retracts 250 µm after each measurement

GETCHANNEL(CHANNELNUMBER)

Acquires the data of one A/D input channel.

Parameters: `channelnumber`: integer

<i>Channelnumber</i>	<i>Meaning</i>	<i>Channelnumber</i>	<i>Meaning</i>
0 ... 3	Auxiliary In1 to In 4	16	Temperature (AD-In)
10 ...13	X, Y, R, Phi	17	Humidity
14	Uk [V]	18	Temperature (USB)
15	Kelvin Slope	19	Absolute Z-Height [mm]

Example: `GetChannel(10);` → reads the input data of the reference electrode
`writeln('X=',Ch);` → writes the result of GetChannel in the Memo

GETOFFSET

Starts the procedure, which detects the offset automatically channel.

Example: `GetOffset;`

GOTO MARKE

Allows to jump to a *marke*. It requires:

- the definition of a label with a `LABEL` statement



- a **Goto** command followed by the labels name
- the label followed by a colon

Labels always start with a character..

Example:

```
LABEL foo, foo2;
```

```
begin
```

```
    Point(100,100);
```

```
    if U > 0.05 then Goto foo;
```

```
    Goto foo2;
```

```
foo:
```

```
    writeln('Reference Potential too large. U =',U);
```

```
foo2;
```

```
end.
```

IMAGE (STEPS, DISTANCE)

starts an automated image acquisition from the current position towards the direction +X and +Y.

Parameters:

- steps** : number of steps along x- and y-direction
(always square image)
- distance** : size of the image in mm

Example: **Image (128 , 20);** → acquires an image with 128 x 128 point. The points are distributed over an area of 20 mm x 20 mm.

After each measured point, the tip is retracted to the height "Freilauf"; the next position is chosen and the tip is automatically approached until the "SetPoint" is reached. After each line, the tip is additionally retracted in a safer height for long distance movement. After the whole image, the tips back to the start position. Data are stored in "./picture" folder.

LINE (TYPE, STEPS, DISTANCE)

starts an automated measurement along a line

Parameters:

- type** : direction of the line scan, can be '**X**', '**Y**' or '**t**' for time
- steps** : number of steps between start and end point
- distance** : relative position of end point vs. the current position in mm
or in seconds for the type = 't'

Example: **Line ('X', 10 , 20);** → measures 10 points along a line of 20 mm length in x-direction. After each measured point, the tip is retracted to the height "Freilauf"; the next position is chosen and the tip is automatically approached until the "SetPoint" is reached.

MOVEREF (X,Y,Z) – NOT USED IN AFT_KP150 !

positions the top contact at the coordinates (X,Y, Z) given in mm.

Parameters: **x, y, z:** real

Example: **MoveRef (200 , 25.3 , 5.1);** → the contact is retracted to a safe height of z = 50 mm in z-direction; is laterally moved to the coordinate (x = 200 mm , y = 25.3 mm) – first X then Y movement – and vertically approached to the final height z = 5.1 mm. The safe height is defined in the user.ini as "SafeZPos".

MOVESONDE (X,Y,Z)

positions the sensor head at the coordinates (X,Y, Z) given in mm.

Parameters: x, y, z: real

Example: `MoveSonde(76.2, 50, 2.6);` → the head is retracted to a safe height of z = 50 mm in z-direction; is laterally moved to the coordinate (x = 76.2 mm, y = 50 mm) – first X then Y movement – and vertically approached to the final height z = 2.6 mm.

POINT (X, Y)

measures a surface potential at the position (x,y) given in mm. The tip is retracted from the current position to the z-value "Freilauf" and moved to the new position. Then, the tip is approached automatically based on the value SetPoint. The Kelvin potential is acquired with an integration time given as 2 * ToggleTime.

Parameters: x, y : real

Example: `Point(100, 200);` → acquires a Kelvin potential at the point
x = 100 mm and y = 200 mm.
`Writeln (Uk);` → displays the result in the Memo

SETCHANNEL ('STRING', VALUE)

Set the D/A-converter outputs to certain values:

Parameters: **string** : 0...3 → channel number
value : real → value in volts

Example: `SetChannel('2', 1.2);` → sets the voltage at Aux-Out1 to 1.2 V

<i>Channelnumber</i>	<i>Meaning</i>		<i>Channelnumber</i>	<i>Meaning</i>
0	Sample		2	Out1
1	Tip		3	Out2

SETKELVIN ('STRING', VALUE)

Changes parameters in the Kelvin-Window as follows:

Parameters: **string** : Bias, DeadTime, ToggleTime, Offset, Freilauf, SetPoint
(or the 1st character: B, D, T, O, F, or S)
value : real → value in displayed units

Example: `SetKelvin('F', 0.1);` → sets the parameter Freilauf to 0.1 mm
or
`SetKelvin('Freilauf', 0.1);`

SETLOCKIN ('STRING', VALUE)

Changes parameters in the Kelvin-Window as follows:

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Parameters: **string** : Frequency, Amplitude, Phase, Harmonic
(or the 1st character: F, A, P, or H)
value : real → value in displayed units

Example: **SetLockin('F',1000);** → sets the frequency to 1 kHz
or
SetLockin('Frequency',1000);

SETPoint (VALUE)

defines the SetPoint for the distance feedback. The automated approach used in point or linear measurements called with **point(x,y)** or **line('type',steps,endpos)** stops, when the signal X reaches this value is given in V.

Parameters: **value** : real → value in volts
Example: **SetPoint(0.0015);** → the auto-approach stops at 1.5 mV

TOGGLETime(VALUE)

defines the time for each measurement cycle (switching time of the applied backing potential) in s.

Parameters: **value** : real
Example: **ToggleTime(0.8);** → the bias is 0.8 ms positive and 0.8 ms negative in all following measurements.

WAIT (TIME)

Allows to pause the operation a time given in seconds.

Parameters: **time** : real
Example: **Wait(1.5);** → waits for 1.5 seconds

WRITEln ('TEXT1', VARIABLE, 'TEXT2', VARIABLE2 ...)

Allows to write additional information in the memo. In the brackets, a series of strings, variables and numbers can be written, which are separated by commas. Strings should be enclosed in ' '.

Parameters: **text1, text2** : string; **variable1, variable2** : real
Example: **a := 5;** → sets the value of the variable a to 5
writeln('a=', a); → writes "a = 5" in the Memo

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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.

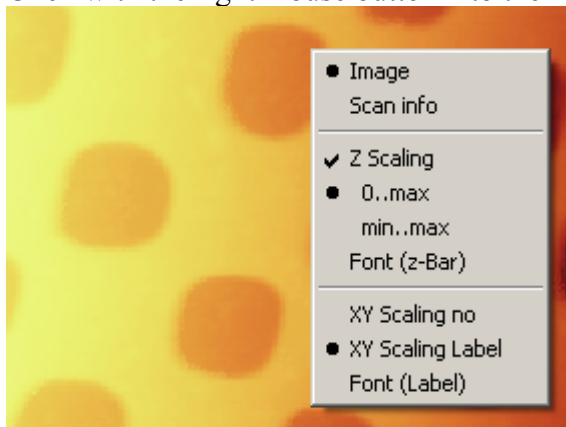


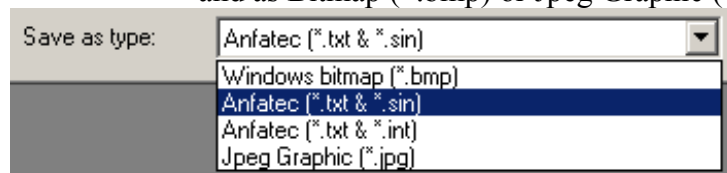
Image / Scan info – is a switch between display of the image and the acquisition data (*.txt file contents).

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.

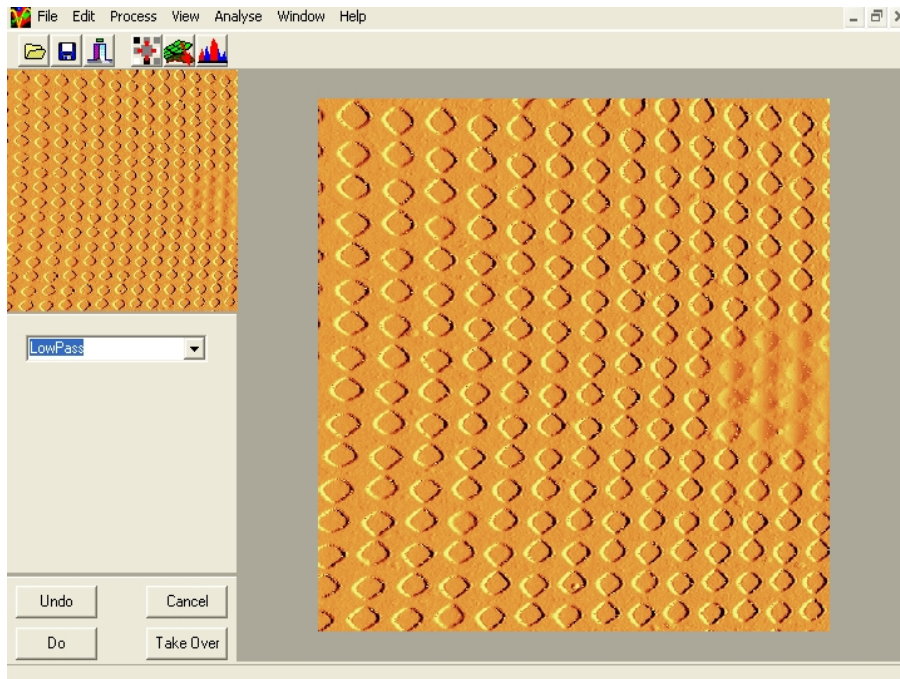
GENERAL IMAGE PROCESSING WINDOW

All image processing windows use the scheme displayed here:

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

Functions:

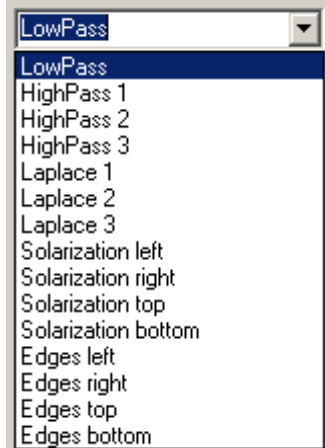
- x **UNDO** restores the original image
- x **DO** calculates results and displays it in the "new image" (old data still kept in the background)
- x **CANCEL** quit without changes
- x **TAKE OVER** uses "new image" data as valid data in the image window and closes



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

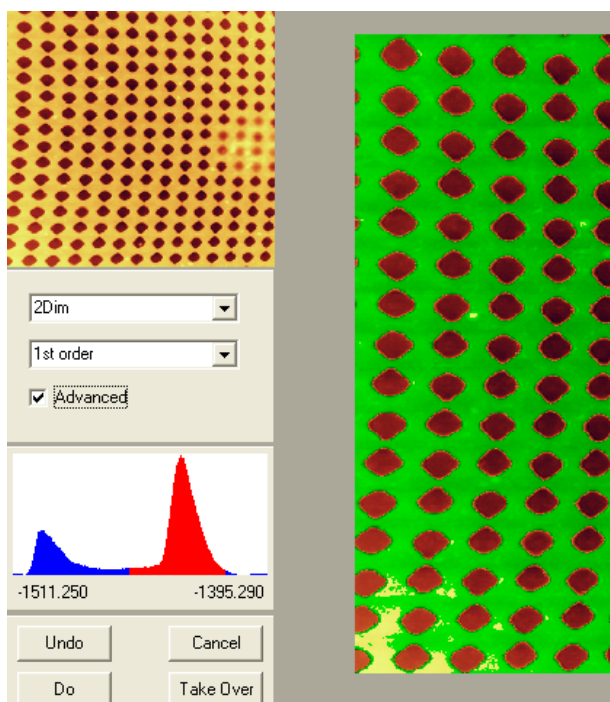
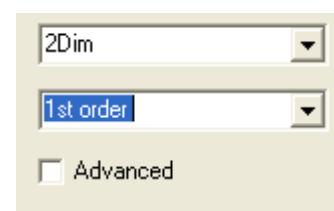
This filter helps to reduce noise by replacing single pixels in the image by the average of their surrounding pixels. As criteria for replacement, the user can set a **border** on % in the left part of the filter image.

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.

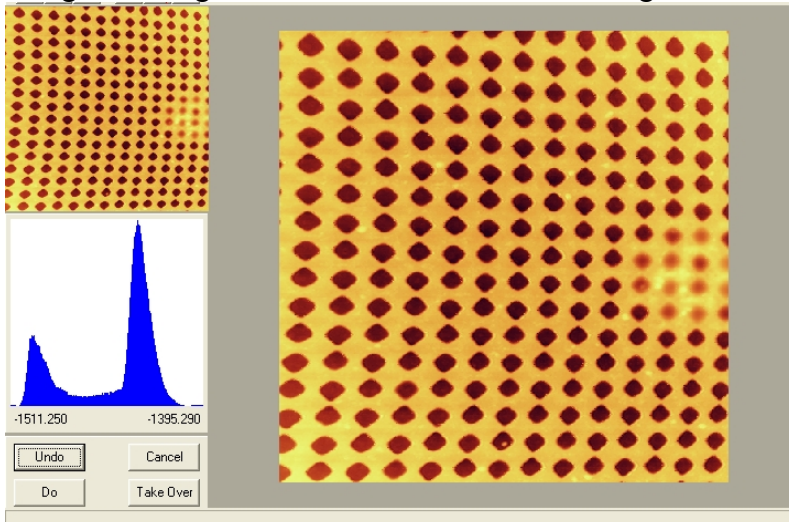
The Points-selection

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.



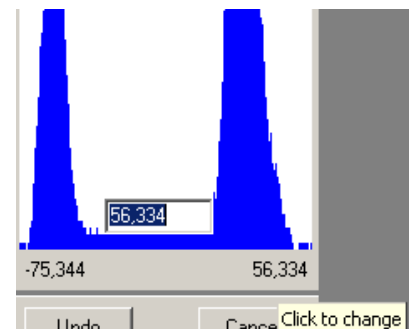
In the selection area appears a histogram of the data. Drag & drop inside the histogram, in order to select an area. **It appears in red in the histogram and green in the image.**

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:

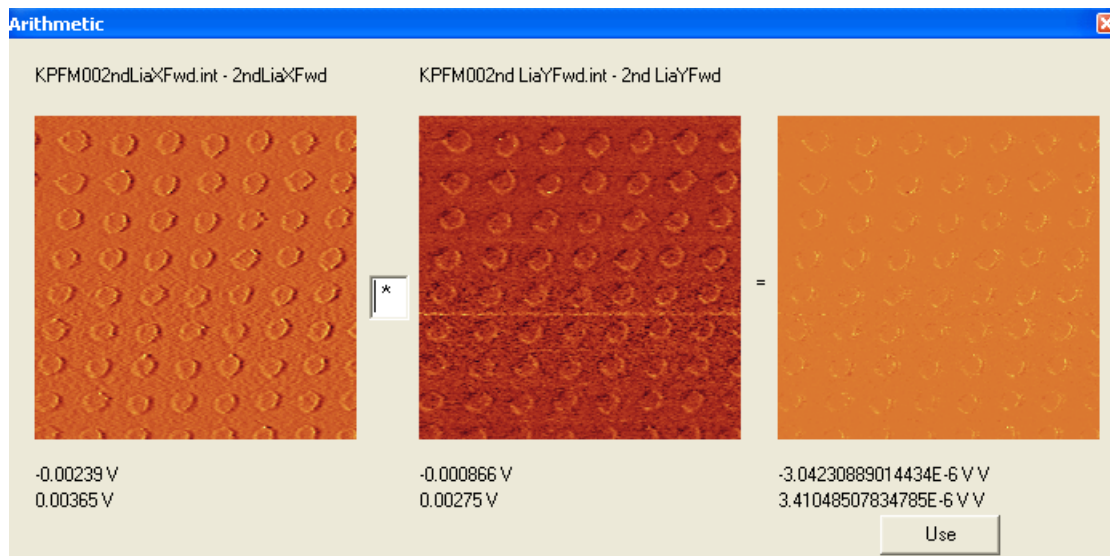
- ◆ click into one of the numbers displayed below the histogram
- ◆ enter a new value



ARITHMETIC

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

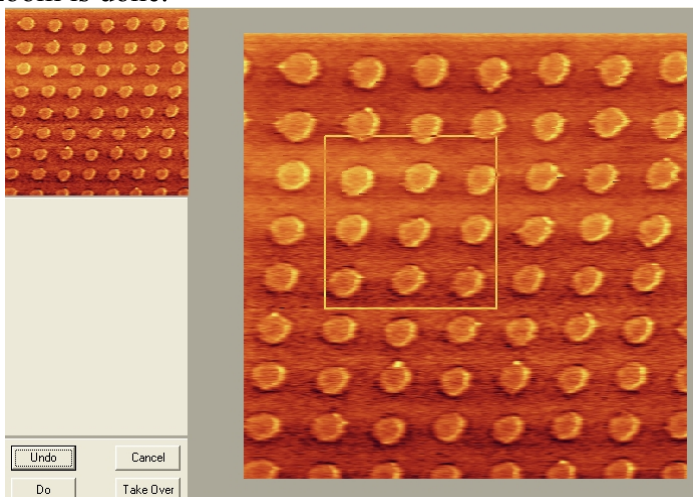
In order to get a certain picture into the original data parts, one drags the picture and drops it into Arithmetic. The operation can be printed into the related Edit-window between the two original pictures. With a double click in the right-most picture, one gets the result.



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

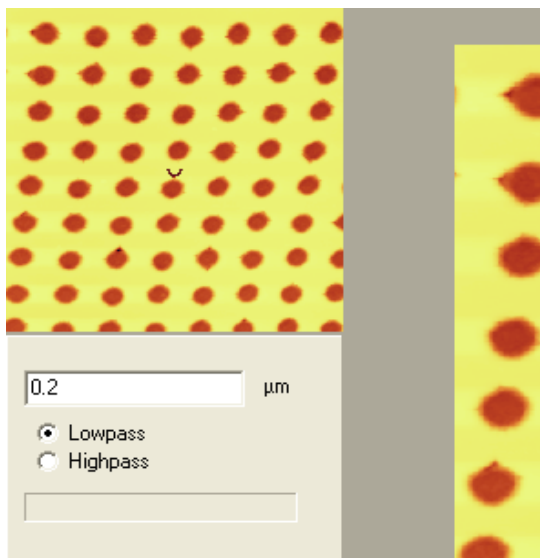
ZOOM

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.

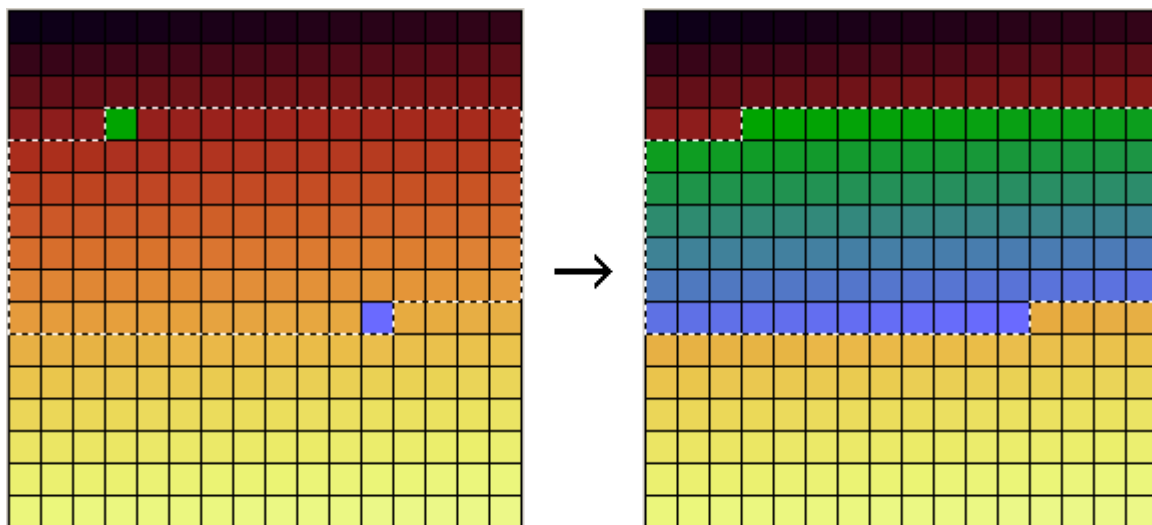
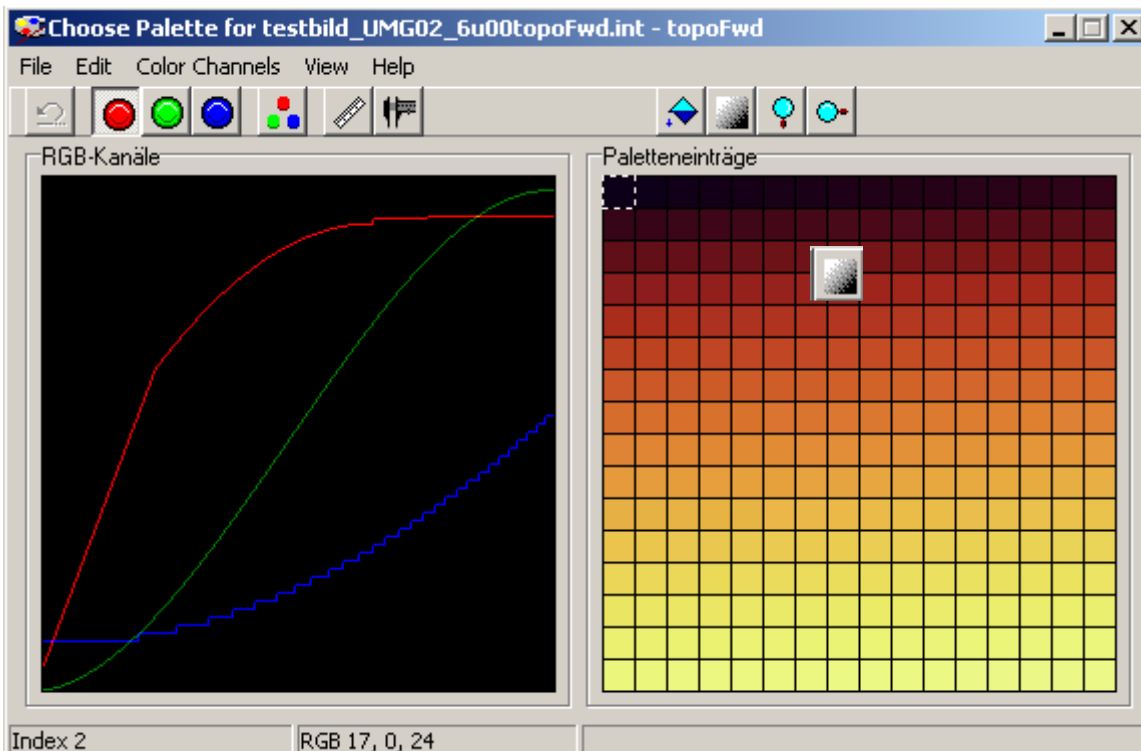
Font (Label) changes the font settings for the XY scale bar.

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.

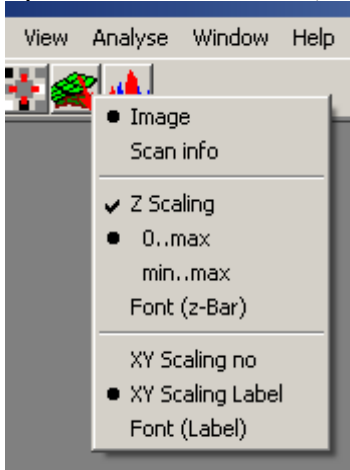
FONT (Z-BAR) AND FONT (LABEL)

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

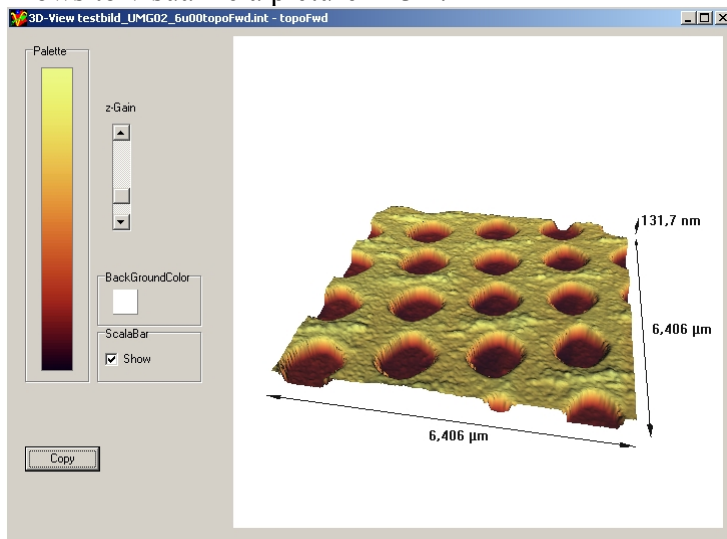
Opens the same window, which is opened with the right mouse button inside a picture:



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.

The image is rotated simply with the mouse.

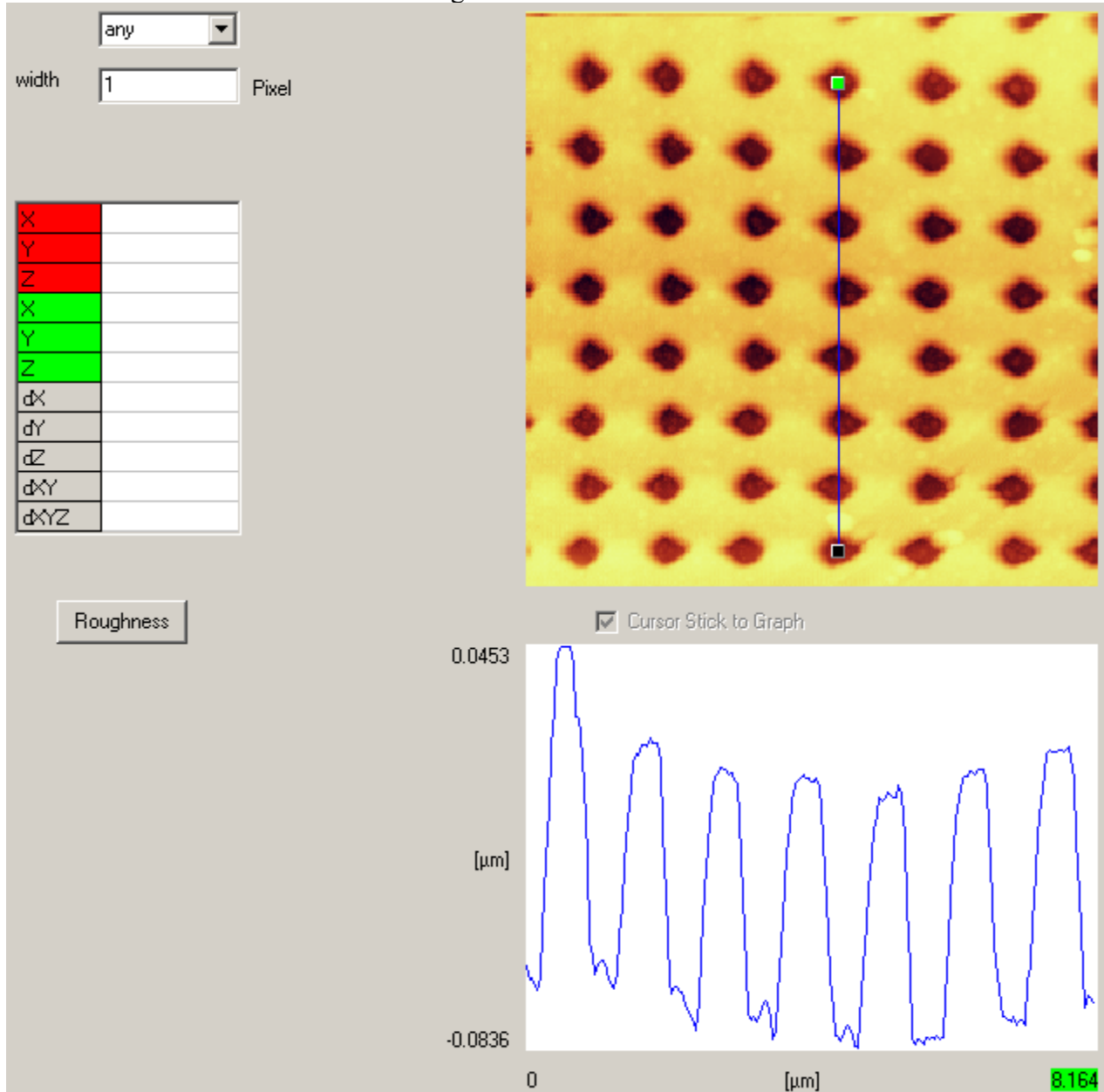
Copy puts the image in the Clipboard of the PC.

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.

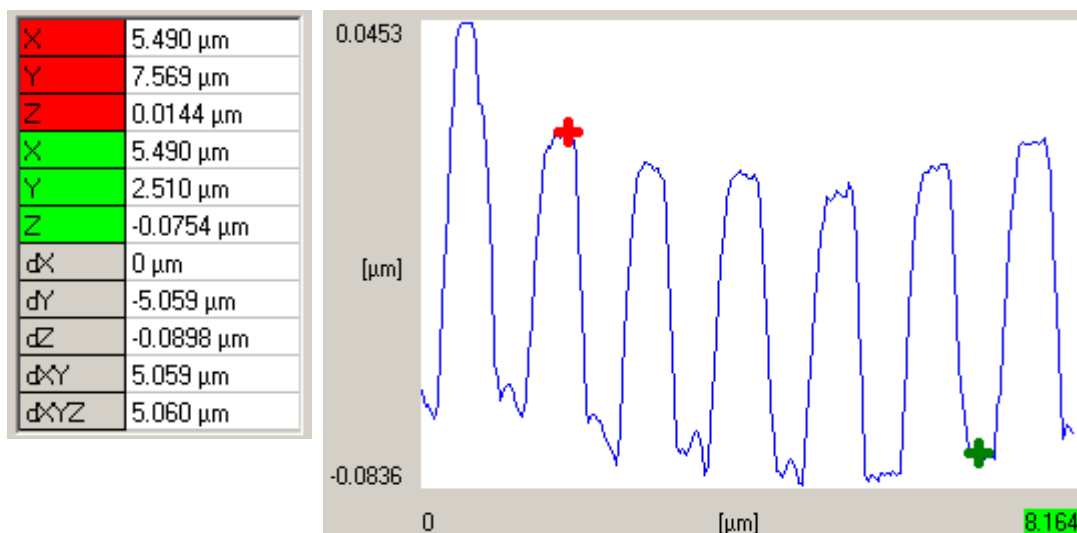


The line selection can be done as

- **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

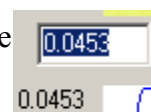
The data can be stored in different file formats. Click with the right mouse button into the upper image. An additional menu appears (as shown in the picture). It allows to choose between “Copy Picture” (copies the image with the blue line into the clip board) and “Save as...” (opens a save dialog box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

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

R_{pm} : is the average maximum peak height

R_{vm} : is the average maximum valley depth

R_z : is the average maximum height of the surface

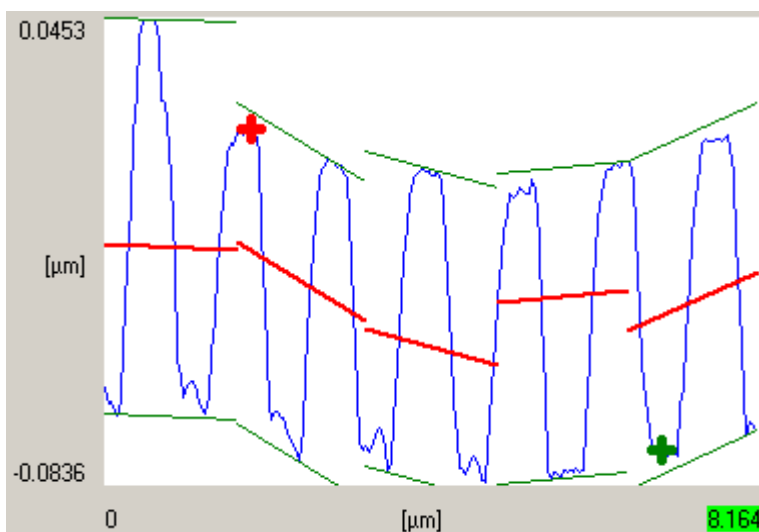
$$R_z = R_{pm} - R_{vm}$$

R_{\max} : is the maximum height of the surface

R_q : is the root mean square surface roughness value and equivalent to the standard deviation

$$R_q = \sqrt{\frac{1}{n} \sum_{i=1}^n y_i^2}$$

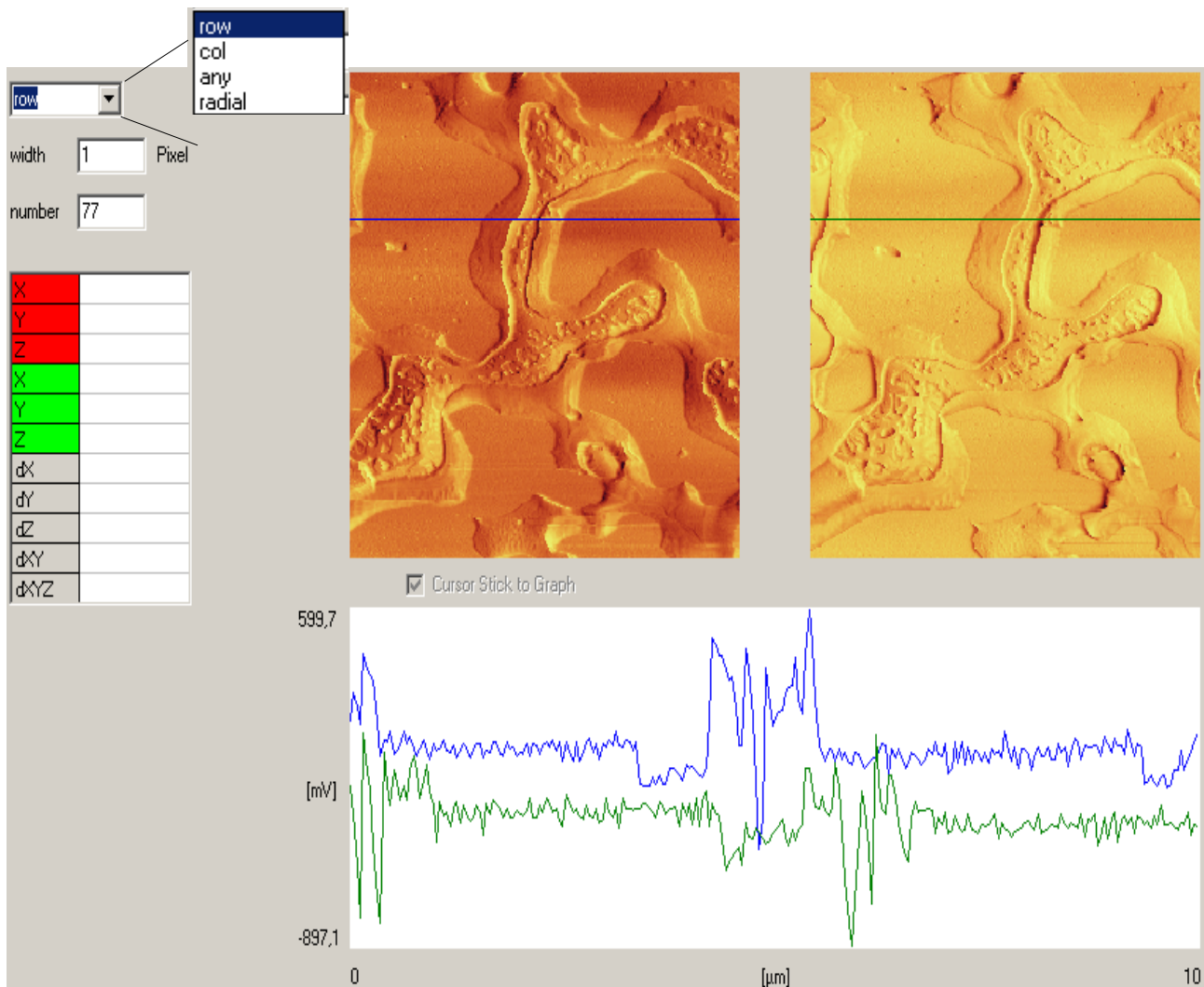
(SD)



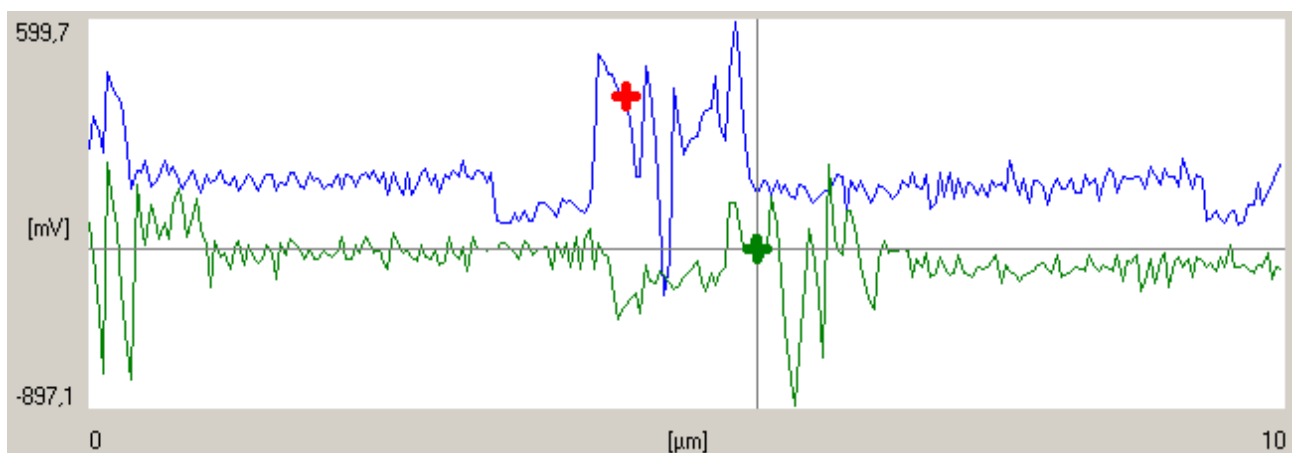
The centre lines of the five measured sections are shown in red. The green lines are parallel to the centre lines and tangent to the highest peak, and deepest valley respectively.

DUAL LINE

Following active window is opened:



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

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)".

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

ROUGHNESS

Mean is the averaged height of the whole image.

SD is the rms roughness of the picture analysed.

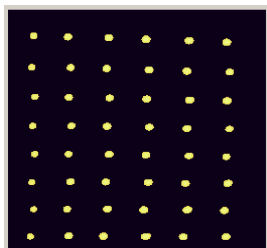
UNIT CELL

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

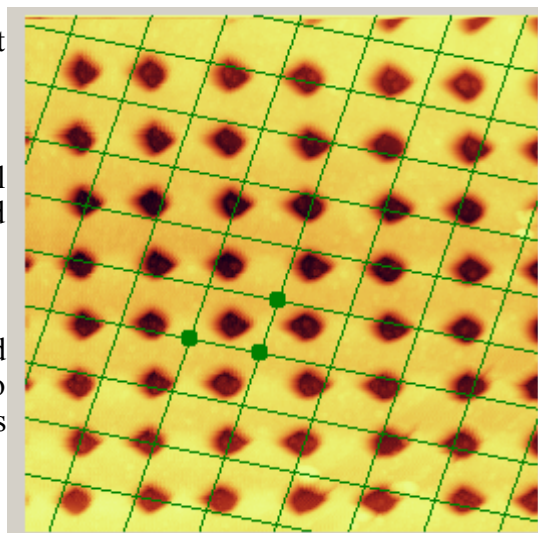
1)move the three green points to the corners of the unit cell you expect to be the correct one.

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.



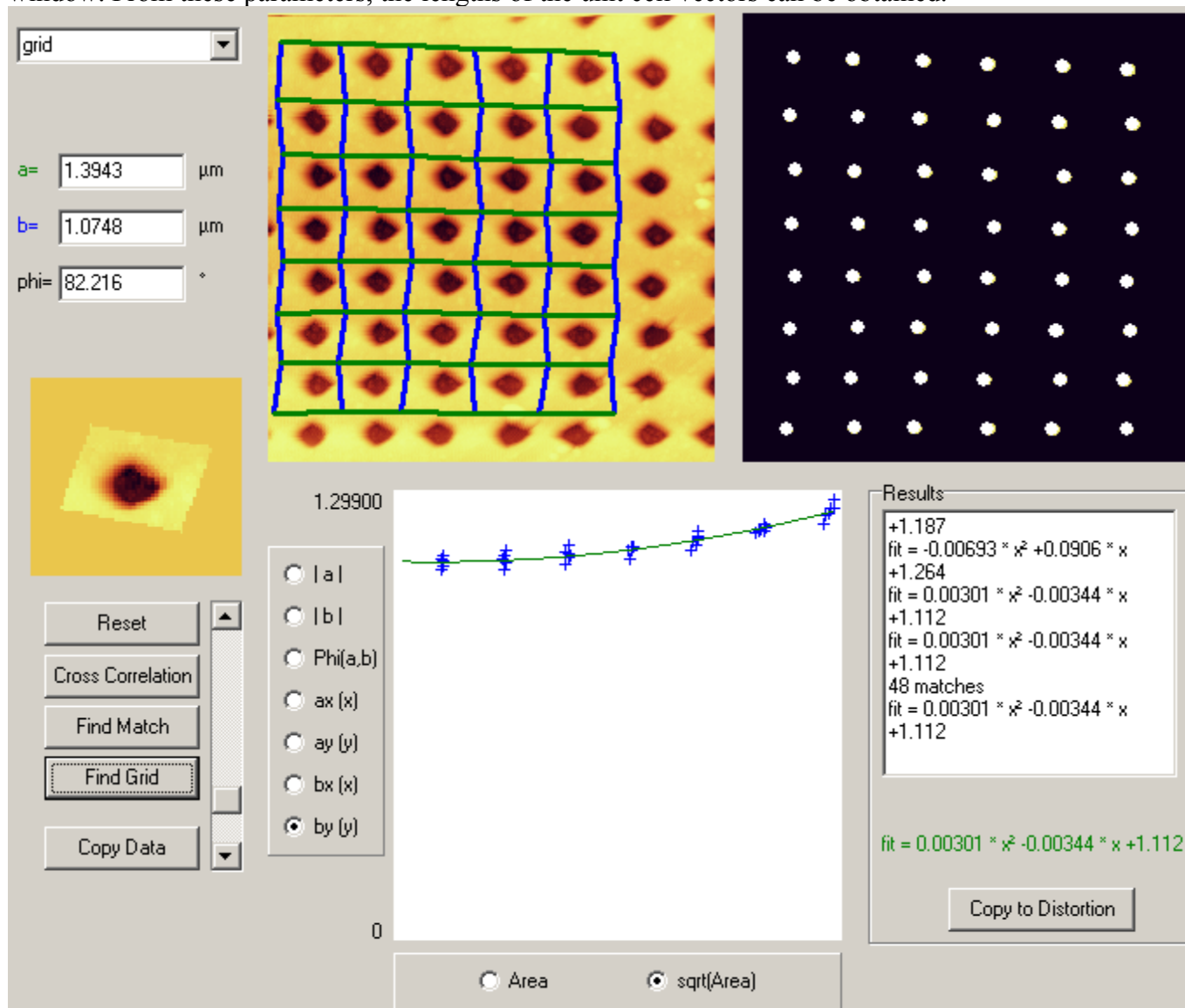
After this, the found intensity maxima in the cross correlation picture are marked with white spots.

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.

$f(x) = (1 - c \cdot d) x + c x^2 + d x^3$

c_x:


d_x:

c_y:

d_y:

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	Supplier: Anfatec Instruments AG, Melanchthonstr. 28, 08606 Oelsnitz Device: Scanning Kelvin Probe System "AFT-KP150" - Konstanz Document: Operational Manual
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