Software Reference

easyScan 2

Version 1.3

Table of contents

About this Manual

This manual is meant as a reference for the Nanosurf easyScan 2 Control Software. It applies to software version 1.3.

For instructions for the day-to-day operation of the easyScan 2 instruments, refer to the *easyScan 2 AFM/STM Operating Instructions*.

For more information on the optional Scripting interface, refer to the online help file *easyScan 2 Programmers Manual*, that is installed together with the easyScan 2 software.

For more information on the optional Nanosurf Report software, refer to the on-line help, included with the Nanosurf Report software.

The user interface

This chapter explains the general concepts of the user interface that controls the functions of the easyScan 2 software. These functions are:

- Setting up the Nanosurf easyScan 2 hardware,
- moving toward the measurement position,
- performing measurements,
- displaying the measurement results,
- evaluating the measurements,
- permanently storing measurements and instrument.

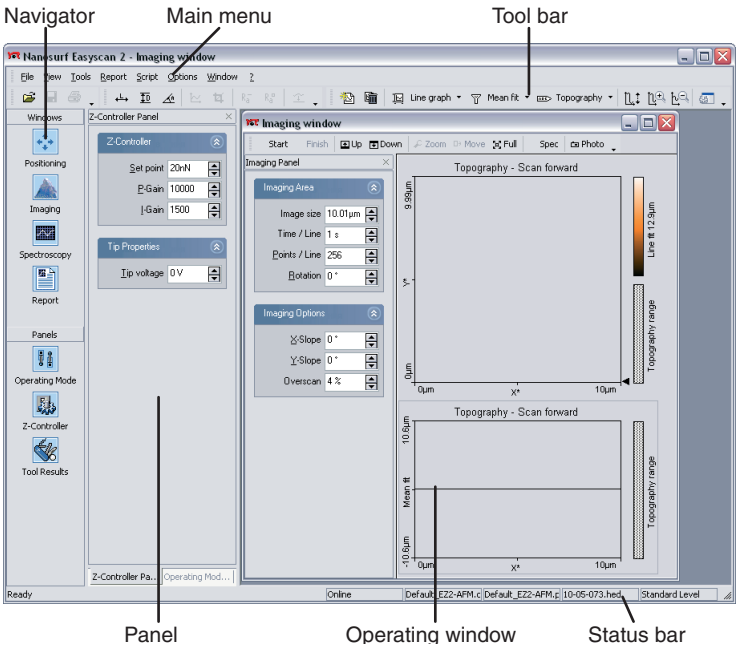
These functions can be accessed via the easyScan 2 software, which is called 'workspace'. In the following, the workspace will be explained first, then the actual functions of the software will be discussed in more detail. The workspace of the easyScan 2 software consists of the following parts:

1. The main window,
2. operating windows,
3. measurement document windows,
4. tool bars,
5. control panels.

The main window

The main window is opened as soon as the easyScan 2 software starts. It gives access to the whole functionality of the easyScan 2 software, and contains all other windows:

- The Main menu.
- Operating windows that are used to perform specific operations with the microscope.
- Measurement document windows that are used to evaluate previously made measurements.



- Several tool bars that are used to issue commands.
- Several control panels that are used to set measurement parameters.
- The Navigator that is used to quickly select between the most often used operating windows and panels.
- The Status bar that displays the state of the instrument.

Operating windows

Operating windows are used to perform specific operations with the microscope. These operations are controlled using specific panels and tool bars that are part of these windows. The Operating windows are:

- Positioning window: positioning the tip with respect to the sample, with the aid of the built-in optical microscope (chapter *Positioning* (p.35)).

- Imaging window: generating images of the sample (chapter *Imaging* (p.39)).
- Spectroscopy window: measuring various 'A as a function of B' curves at certain sample locations, such as force-distance curves, or current-voltage curves (chapter *Spectroscopy* (p.46)).

Measurement document windows

The Measurement document windows visually represent previously made measurements. They are created when you decide to keep the current measurement result. The measurement documents are used for storing, loading, printing and evaluating measurements. The measurement document is described in more detail in the chapters *Viewing measurement data* (p.51) and *Storing measurements and further data processing* (p.65).

Tool bars

The tool bars can either be free floating windows (figure below, left), or they can be 'docked' to the top or the sides of the window they are associated with (Figure below, right).

Most tool bars dock to the Main window, some dock to a task specific window.

Arranging tool bars

The tool bars have several features that allow you to arrange them in a way that is most efficient for your application.

To display a tool bar that is invisible, select the window it is associated with, and tick the tool bar's name in the View menu.

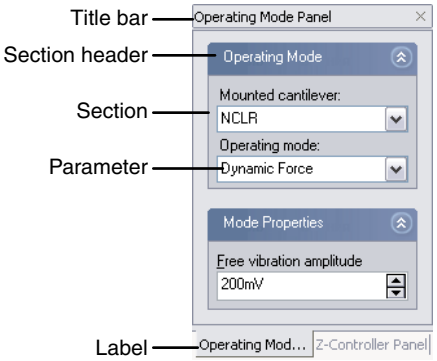
To dock a tool bar to the sides of its associated window, or to the side of, or below another tool bar that is already docked to this window, drag its title bar using the mouse cursor.

To move a docked tool bar, use the mouse cursor to drag its handle on the left side of the tool bar. When the mouse cursor is over the handle, the cursor changes to a four pointed arrow.

To un-dock a docked tool bar, doulbe click its handle, or drag the handle outside the area reserved for tool bars on the sides of its associated window.

Control panels

Just like the tool bars, control panels can be either be free floating windows, or they can be 'docked' to the sides of the window they are associated with. Most control panels dock to the Main window, some dock to a task specific window. The control panels give access to specific functions of the easyScan 2. The control panels contain one or more function sections, that can be collapsed and opened by clicking on the section header.



A stack of panels

The number of visible sections and the number of visible parameters depends on the user interface mode selected in the User Interface Configuration dialog (section *The User Interface Dialog* (p.13)). To see in which user interface mode a certain parameter is available, look at the title of the manual section in which it is described.

Arranging control panels

The control panels have several features that allow you to arrange them in a way that is most efficient for your application.

A control panel associated with the main window is opened and brought on top of the other windows by clicking on its icon in the navigator. Any control panel can be opened and brought on top of the other windows, by selecting the window it is associated with, and ticking the panel's name in the View menu.

Control panels can be stacked to save display space. When panels are stacked, labels are displayed on the bottom of the control panel stack. To put a control panel on top of the stack, click its label. To add a control panel to a stack, drag either its title bar or its label to either the title bar or labels of the stack. To remove a panel from a stack, drag its label away from the stack.

To dock a (stack of) panels to the side of its associated window, or to the side of, or below another panel that is already docked to this window, drag its title bar to the desired position using the mouse cursor.

It is possible to scroll the content of a control panel up and down, when it is too small to display all the parameters it contains. To do this, move the mouse cursor over an area where it changes to a four pointed arrow. Then, drag the content up and down with the mouse cursor.

Storing and retrieving the workspace

When panels are opened, they appear at predefined places in the main window. This arrangement of the 'workspace' is stored in the configuration file 'Default EZ2-AFM.gui' or 'Default EZ2-STM.gui' by default. The location of the configuration files on the hard-disk depends on the operating system you use. Functions for storing and retrieving the workspace are accessed via the menu 'File>Workspace'.

'Save' saves the workspace to the currently selected workspace file.

'Save as...' saves the current arrangement of the panels under another name.

'Load' loads a previously saved workspace.

Entering values in the control panels

To change a parameter in any panel, use on of the following methods:

- Activate the parameter by clicking it with the mouse pointer, or by selecting it with the Tab key.
- The value of an activated parameter can be increased and decreased using the up and down arrow keys on the keyboard. The new value is automatically used after one second.
- The value of a numerical parameter can also be increased and decreased by clicking the arrow buttons with the mouse pointer. The new value is automatically used after one second.
- The value of an active numerical parameter can also be entered using the keyboard.
  The entered value is used on pressing the 'Enter' or 'Return' key, or by activating another input.
  The entered value is discarded on pressing the 'Esc' key.
  Type the corresponding character to change the unit prefix:

prefix	keyboard key	prefix	keyboard key
femto	f	no prefix	space bar
pico	p	kilo	k
nano	n	mega	shift - M
micro	u	giga	shift - G
milli	m	tera	shift - T

Unit prefixes with corresponding character

  For example, if the basic unit is Volts, type 'm' to change to millivolts, type the space bar for volts, type 'u' for microvolts.

- The selection of a drop-down menu (e.g.: 

) can be changed using the mouse or the up and down arrow keys on the keyboard.

Sometimes the program will change an entered parameter value to a slightly different value. This happens when the desired value is outside the range that the easyScan 2 Controller can handle, for example due to the resolu-

tion limits or timing limits. The desired value is automatically changed to the nearest possible value.

Storing and retrieving measurement parameters

All measurement parameters are stored in a configuration file with the extension '.par'. When the easyScan 2 software is started, default values are loaded from a file that is selected in the Controller Configuration Dialog (section *The Controller Configuration dialog* (p.31)). Functions for storing and retrieving parameters are accessed via the menu 'File>Parameters'.

'Save' saves the parameters to the currently selected parameter file. The name of this file is indicated in the status bar at the bottom of the main window.

'Save as...', saves the parameters under a new file name.

'Load' loads a previously saved parameter file.

Important!

When you have not loaded another file, 'Save', will overwrite the original default parameter file with you current settings.

The User Interface Dialog

The User Interface dialog is opened via the menu 'Options>Config User Interface...'

Program Skin

Select the look of the easyScan 2 software you are most comfortable with. All screen-shots in this manual were made with the Windows XP skin.

User Interface Mode

Determines the number of parameters displayed in the various panels:

Easy level	only those parameters that are absolutely necessary to do a measurement
Standard level	the commonly useful parameters
Advanced level	all available parameters

Options

Save workspace on exit

When active, the workspace settings are saved to the system registry when the software is exited (section *Storing and retrieving the workspace* (p.11))

Animated menu

When active, the opening of the menu is nicely animated.

Hardware setup

Some changes to the hardware setup must be made during the operation of the microscope. Other changes are generally only made when the hardware is changed. The Operating mode panel and the Z-Controller panel are used to change the hardware setup during the operation of the instrument. The rest of the hardware setup is distributed over several dialogs that are reached via the Options menu. These panels and dialogs are discussed in this chapter.

The Operating mode panel

The operating mode panel allows you to select the operating mode that you wish to use, and to set up several operating mode related parameters. The operating mode determines which signals are measured, and which signal is used to control the Z-position. To open the Operating mode panel, click  in the navigator.

The number of available modes depends on the Scan head and on the modules built into the easyScan 2 controller. The modules required to be able to use a certain operating mode are listed in table *Operating modes and required modules*. The modes can be divided into the static operating modes that control the Z-position using the Cantilever deflection, the dynamic operating modes that control the Z-position using the vibration amplitude, and the STM mode that controls the Z-position using the tunnelling current.

Operating mode	Required modules
STM	STM scan head
Static force	AFM Basic
Dynamic force	AFM Basic, AFM Dynamic
Phase contrast	AFM Basic, AFM Dynamic, AFM Mode Extension
Force Modulation	AFM Basic, AFM Dynamic, AFM Mode Extension
Spreading Resistance	AFM Basic, AFM Dynamic, AFM Mode Extension

Operating modes and required modules

The signals measured with each of the operating modes are listed in table *Operating modes and measured signals*. Note that the names of the signals can be changed in the 'Scan Head Calibration' dialog.

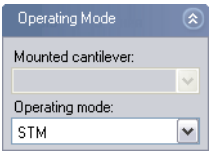
Operating mode	Signals measured
Static force	Topography, Cantilever deflection(, User Input 1, User Input 2)
Dynamic force	Topography, Vibration amplitude(, User Input 1, User Input 2)
Phase contrast	Topography, Vibration amplitude, Vibration phase(, User Input 1, User Input 2)
Force modulation	Topography, Cantilever deflection, Vibration amplitude(, User Input 1, User Input 2)
Spreading Resistance	Topography, Cantilever deflection, Tip current(, User Input 1, User Input 2)
STM	Topography, Tip Current (User Input 1, User Input 2)

Operating modes and measured signals: The User Inputs are only avaliable when they are enabled and the Signal Module: A is installed.

STM mode

This mode is only available when an STM head is connected to the controller. In this case, it is the only available mode setting.

Operating mode (Easy, Standard, Advanced)



Mounted cantilever (Easy, Standard, Advanced)
Not available, this input is only used for AFM modes.

Operating mode (Easy, Standard, Advanced)
STM mode by default.

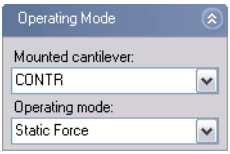
User Input/Output (Standard, Advanced)

See the description under Static Force mode.

Static Force mode

In the static force mode, the Operating Mode and User Input sections are available.

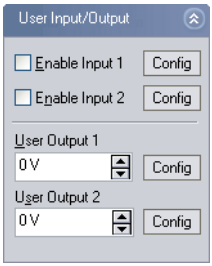
Operating mode (Easy, Standard, Advanced)



Mounted cantilever (Easy, Standard, Advanced)
The mounted cantilever type. The mounted cantilever type is used to automatically determine the search range in the dynamic operating modes, and to determine the correct calibration for the force set point in the static operating modes.

Operating mode (Easy, Standard, Advanced)
Changes the operating mode.

User Input/Output (Standard, Advanced)



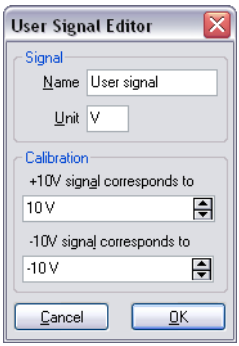
Enable User Input1, 2
When active, the data from the User input (manual *Operating Instructions*, chapter *The Signal Modules*) is measured and stored. Enabling the user inputs significantly increases the measurement file size.

User Output 1, 2
The output value of the user output.

Config...
Opens the User Signal Editor dialog.

The User Signal Editor

The User Signal Editor dialog is used for editing the calibration of the User input signal. The same calibration values can also be edited in the Scan Head Calibration dialog. Changing the values here will also change the corresponding values in the Scan head calibration file.



Signal

Name
The name of the user signal. This name is used throughout the program to refer to the user signal.

Unit
The base unit of the physical signal, without prefix (i.e. m, not nm or µm).

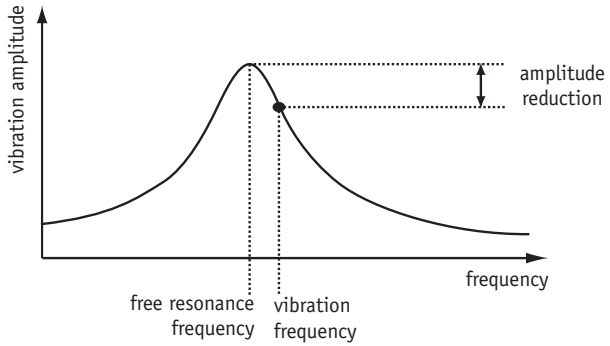
Calibration

The physical signal values that correspond to the maximum and minimum signal voltages should be entered here. Prefixes can be used here.

Dynamic Force mode

In addition to the same Operating mode and the User Input section as in the static operating mode, two sections of parameters may be available, depending on the user interface mode.

The dynamic force mode parameters can either be set manually or determined using an automatic search procedure. The automatic search starts with the coarse measurement of a cantilever resonance curve (figure *Determination of the vibration frequency*). Throughout this measurement, the cantilever is excited with a fixed amplitude, whilst the excitation frequency is varied. The resonance curve contains a measurement of the resulting cantilever vibration as a function of the excitation frequency. When the search is successful, the resonance curve contains a single peak at the free resonance frequency of the cantilever. Afterward, a second, fine-tuning search is performed in a 3 kHz frequency range around the resonance frequency detected in the coarse search.



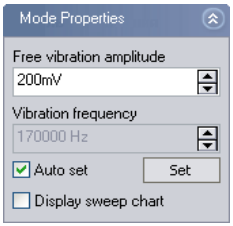
Determination of the vibration frequency

The computer adjusts the value of Vibration frequency so that the cantilever vibration amplitude is reduced by the amount set in 'Amplitude reduction' in the Freq. Peak Search section.

Mode Properties (Easy, Standard, Advanced)

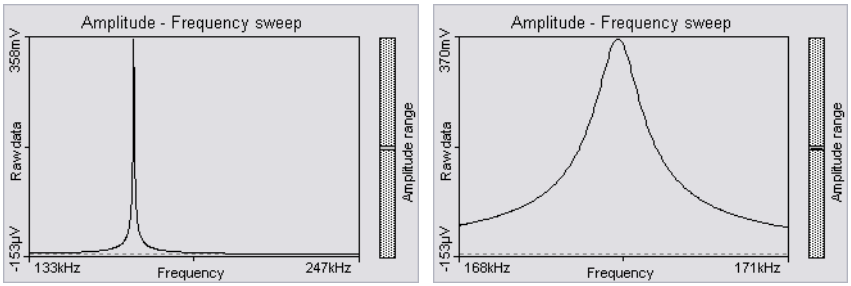
Free vibration amplitude (Easy, Standard, Advanced)
The desired reference amplitude of the cantilever vibration. The cantilever vibrates at this amplitude when it is far away from the sample. The excita-

tion strength is adjusted so that this vibration amplitude is reached.



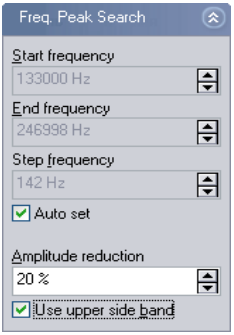
Vibration frequency (Standard, Advanced)
The frequency at which the cantilever vibrates during the measurement. This frequency can automatically be set as described at the start of this section. When 'Auto set' is enabled, the Vibration frequency is automatically set each time an approach is started. Clicking Set starts the automatic setting immediately.

Display sweep chart (Standard, Advanced)
When active, the results of the vibration frequency search measurements are transferred to a measurement document, and displayed on the screen.



Cantilever resonance curve: left: coarse search; right: fine-tuning search

Freq. peak search (Advanced)



The parameters for the automatic vibration frequency search are set here.

Start frequency (Advanced)
The start frequency for the coarse search

End frequency (Advanced)
The end frequency for the coarse search

Step frequency (Advanced)
The difference between two frequency points at which the cantilever vibration amplitude is measured during the coarse search. If the increment is large, the search takes less time. When however the increment is too large, there is a risk that the resonance frequency may not be found.

Auto set (Advanced)
When active, the range and frequency increment are automatically set to suitable values for currently selected cantilever type.

Amplitude reduction (Advanced)
Indirectly determines the 'Vibration Frequency' in the 'Auto set' mode: The computer adjusts the Vibration frequency so that the cantilever vibration amplitude is 'Amplitude reduction' percent smaller than the vibration amplitude at the resonance frequency.

Use upper sideband (Advanced)
When active, the vibration frequency is set larger than the resonance frequency. Otherwise, the vibration frequency is set smaller.

Phase Contrast mode

In addition to the parameters in the Dynamic Force operating mode, the Reference Phase is available in the Standard and Advanced user interface modes.

Reference Phase (Standard, Advanced)
The reference phase for the detected cantilever vibration. Changing the reference phase changes the offset of the phase signal. The phase reference can be automatically set so that the phase signal is zero. When 'Auto set' is enabled the phase reference is automatically set after finishing the approach. Clicking Set starts the automatic setting immediately.

Force Modulation mode

In addition to the parameters in the Static Force operating mode, two additional parameters are available.

Excitation amplitude
The amplitude of the sensor excitation during a force modulation mode measurement.

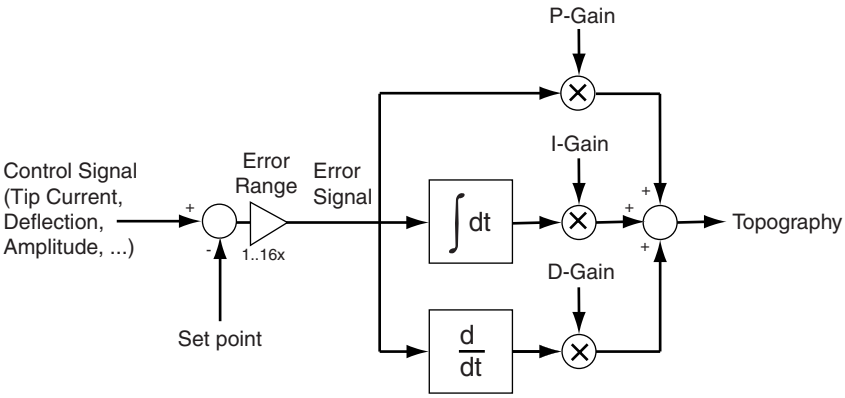
Excitation frequency
The frequency of the sensor excitation during a force modulation mode measurement. Clicking Set starts a measurement of the cantilever resonance curve, that helps you to select the excitation frequency. The settings for this measurement are the same as those for the Dynamic Force measurement.

Spreading Resistance mode

The operating mode panel for the Spreading Resistance mode is the same as that for Static Force operating mode.

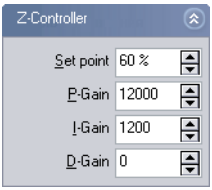
The Z-Controller Panel

The tip-sample interaction is normally kept constant using the Z-Controller. The Z-Controller is a PI(D) controller as is shown in figure *Z- Controller*. The settings of this controller are set in the Z-Controller panel. To open the Z-Controller panel, click  in the Navigator.



Z- Controller

Z-Controller (Easy, Standard, Advanced)



Set point (Easy, Standard, Advanced)
The working point for the controller. Depending on the operating mode, this is the tunneling current (STM mode), cantilever deflection (static force mode) or relative cantilever vibration amplitude (dynamic force mode). In the latter case, the set amplitude is relative to the operating amplitude, set in the Operating mode panel. For example, when a set point of 70% is used, the controller will move the tip closer to the sample until the vibration amplitude has decreased to 70% of the vibration amplitude far away from the sample.

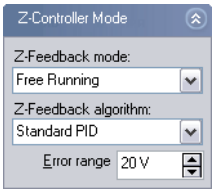
Loop-Gain (Easy)
The speed of the controller. If the gain is too low, the controller will not follow the surface fast enough. Thus, the image will not be as sharp as it could be. If the gain is too high, the controller will overshoot and may start to oscillate. Thus, the image will contain many measurement artifacts.

P-Gain (Standard, Advanced)
The strength of the controller reaction that is proportional to the error signal. Increasing the P-Gain decreases the error signal.

I-Gain (Standard, Advanced):
The strength of the controller reaction that is proportional to the integral of the error signal. Increasing the I-Gain decreases the error signal over time. It is the least sensitive to noise, and usually the dominant contributor to the topography measurement.

D-Gain (Advanced)
The strength of the controller reaction that is proportional to the derivative of the error signal. Increasing the D-Gain decreases fast changes in the error signal, but also amplifies high frequency noise. The D-Gain is only available in the 'Standard PID' Z-feedback mode of the Z-Controller (see following section).

Z-Controller Mode (Advanced)



Z-Feedback Mode

Free Running	The Z-Controller is active.
Freeze Position	The Z-Controller is not active, the scanner remains in its current Z-position.
Stop and Clear	The Z-Controller is not active, the scanner is moved to the 'Ref. Z Plane', set in the Imaging Panel.

The Probe Status light will blink green as long as the controller is deactivated.

Important:

If the Ref. Z Plane is much lower than the current position of the tip, or the scan range contains large height differences, turning off the controller

(and clearing it) will result in the tip crashing into the sample, damaging the tip!

Z-Feedback algorithm

Standard PID A standard PID controller is used for Z-Feedback.

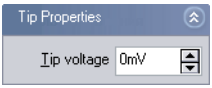
Adaptive PI A standard PI controller is used for feedback. In addition, the bandwidth of the Topography measurement is adapted to the number of measured points per second.

The adaptive PI controller reduces noise in the measurement. However, topography changes that happen faster than the time between two measured points are also lost. This makes it more difficult to detect vibrations due to instability of the feedback loop. These vibrations remain visible in the Current, Amplitude or Deflection signal. Therefore, always monitor these signals when optimising controller settings, especially when using the Adaptive PI setting.

Error Range (Advanced)

The range of the error signal used to control the Z-Position. The error signal is the difference between the signal used for topography feedback and the current set point. When the value of 'Error Range' is reduced, the resolution of the error signal is increased.

Tip Properties (Standard, Advanced)



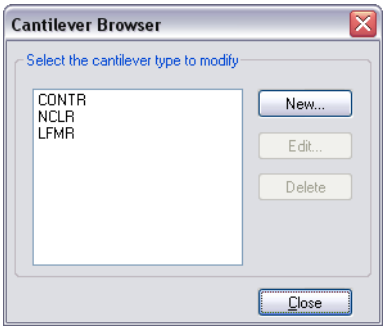
Tip Voltage (Standard, Advanced)

The potential to be applied to the tip. The usable voltage range is between -10V and +10V. In the STM, the sample is automatically connected to the ground of the instrument. In the AFM, the sample has to be electrically connected to the instrument chassis ground for accurate measurements.

Cantilever types configuration

The cantilever types that you can select from in the Operating Mode Panel are configured using two dialogs: The cantilever browser, and the cantilever editor dialog. The cantilever types configuration is stored in a file called 'cantilever.ini', located in the local settings directory of the user logged on to the PC.

The cantilever browser dialog



The cantilever browser dialog is opened via the menu 'Options>Config Cantilever Types...'. The cantilever browser allows the editing and creation of cantilever types.

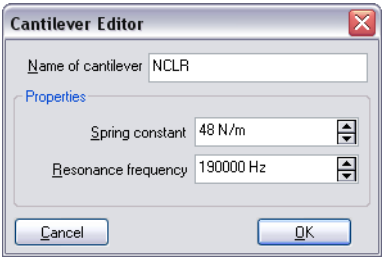
New
Opens the cantilever editor dialog for a new cantilever type. You can create new cantilever types that are not defined in the default configuration. The AFM head requires the following cantilever properties:

- The bottom of the sensor chip must have grooves that fit into the alignment chip.
- The cantilever should have a nominal length of 225 µm or more, and a width of 40 µm or more.
- The back of the cantilever must have a coating that reflects infrared light. Uncoated cantilevers transmit much of the infrared light of the deflection detection system.

Edit...
Opens the cantilever editor dialog to modify the currently selected cantilever type.

Delete...
Deletes the currently selected cantilever type using the cantilever editor dialog.

The cantilever editor dialog



The following properties of a cantilever type are entered in this dialog:

Name of cantilever
The name of the cantilever type. This name appears in the cantilever browser and the Cantilever type drop-down in the Operating Mode Panel.

Spring constant
The (nominal) spring constant of this cantilever type. This value is used to calculate the correct force Set point in the operating modes that use the static force for Z-Control. (section *Static Force mode* (p.17))

Resonance frequency
The (nominal) resonance frequency of the cantilever type. This frequency is used for the calculation of the automatic resonance frequency search range (section *Dynamic Force mode* (p.19)).

Scan head configuration

The scan head configuration is used to store all calibration values specific to a certain scan head. The configuration of each scan head is stored in a file with the extension '.hed'. This file is copied from the software installa-

tion CD on installation of the instrument. When you change the scan head, you should also load the correct configuration file.

The scan head selector dialog

The scan head selector dialog is opened via the menu 'Options>Config Scan Head...'.

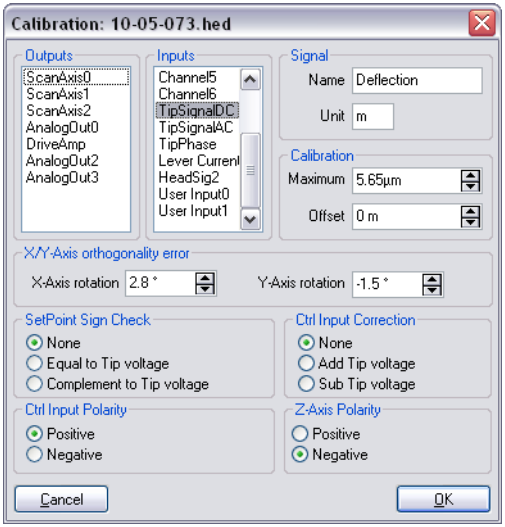
Load...
Loads a different scan head configuration file.

Save as...
Saves the current scan head configuration under another name.

Edit...
Edit the currently loaded scan head configuration using the scan head calibration dialog. Always save a backup of the Scan head configuration by clicking 'Save As...'.

The scan head calibration dialog

In this window the calibration of all Inputs and Outputs can be configured individually along with some scan head properties.



Warning!

Changes to these settings should be performed with great care. False settings can lead to false interpretation of the data and false operation of the controller.

The available Output and Input signals and their calibration are listed in the upper part of the dialog.

Outputs/Inputs/Signal

In the field 'Signal', a 'Name' and a 'Unit' are assigned to each Input and Output. These names along with their units are used by the program wherever the signals are displayed.

Note that the inputs 'Channel0...n' are automatically configured by the software, depending on the measurement mode. Changing the settings for these inputs has no effect. An exception to this rule is Channel1.

Calibration

The 'Calibration' values indicate the maximum input and output range of the respective parameters and are used to calibrate the respective inputs and outputs. 'Maximum' is set for the positive range of the value, e.g. for a scan range of 100 µm a 'maximum' of 50 µm (+50 µm, -50 µm) must be set. 'Offset' is the difference in value relative to zero.

The lower half of the dialog contains settings that enable the controller's setting to be adapted to different scan head types. The figure *Signal flow* shows where the settings take effect.

X/Y-axis orthogonality error

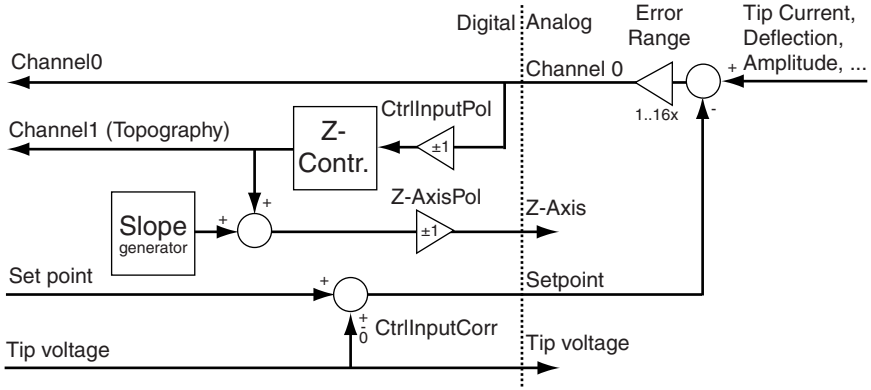
If the orthogonality of the scanner is not absolutely perfect, it can be corrected by entering the appropriate angle for 'X-Axis rotation' and 'Y-Axis rotation'. The scan axis coordinate system is rotated clockwise.

SetPoint Sign Check

The sign (+/-) of the 'SetPoint' is adjusted to the sign (+/-) of 'Tip Voltage':

none 'SetPoint' and 'Tip Voltage' have independent signs (normal AFM setting).

Equal to Tip Voltage 'SetPoint' adopts the sign of 'Tip Voltage' (normal



Signal flow

STM setting).

Complement to Tip Voltage'SetPoint' adopts the opposite polarity to the 'Tip Voltage'.

CtrlInput correction

The Tip Voltage can be subtracted from the input signal before it is digitised:

none the voltage from the scan head's preamplifier is not changed (normal AFM setting).

Add TipVoltage Tip Voltage is added to the output voltage of the scan head's preamplifier.

Sub TipVoltage Tip Voltage is subtracted from the output voltage of the scan head's preamplifier (normal STM setting).

CtrlInput pol.

Before the measured signal is passed to the Z-Controller it can be inverted. Whether this is necessary depends on the type of scan head.

positive the signal remains unchanged (normal setting).

negative the signal is inverted.

Z-Axis polarity

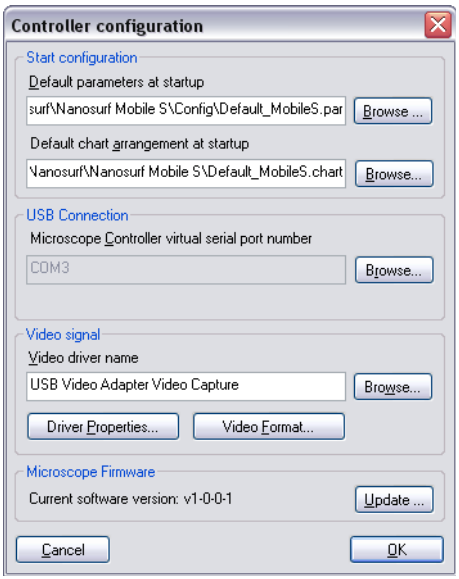
The output of the controller can be inverted after the alignment of the scan plane and output to the Z-axis.

positive the signal remains unchanged (normal STM setting).

negative the signal is inverted (normal AFM setting).

The Controller Configuration dialog

The Controller configuration dialog is opened via the menu 'Options>Config Controller...'. On a correctly configured system, it should not be necessary to change the settings in this dialog, except for the startup parameters and chart arrangement file configuration.



Start configuration

The parameter and chart arrangement files that are loaded when the software starts (section *Storing and retrieving the chart arrangement* (p.52)).

USB Connection

The easyScan 2 controller uses a virtual serial port that is connected to the USB port. The number of this virtual serial port should be the same as the one shown in your the windows device manager dialog.

Video Signal

The configuration of the easyScan 2's internal video capture device. The default configuration should normally not be changed. This feature is only available when the video camera is installed.

Microscope Firmware

Click the Update button to install firmware updates that you receive from Nanosurf support.

The Edit Access Codes Dialog

The Edit Access Codes Dialog is used to enter the access code for software modules. At the moment, the only software module is the scripting interface. The dialog is accessed via the menu entry 'Options>Config Access Codes...'

The Scan head Diagnosis dialog

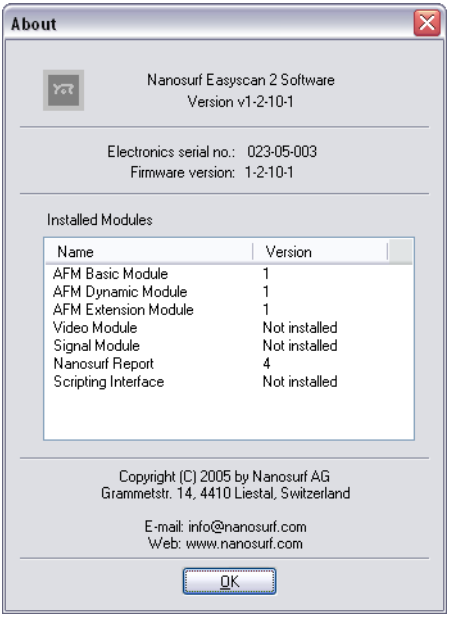
The Scan head Diagnosis dialog is opened via the menu 'Options>Check Scan Head...'. In it, the controller reports the current status information of the sensor or the approach platform. If the Status light on the easyScan 2 controller is blinking red, more detailed information about the failure is displayed in the 'Microscope Diagnosis' dialog.

Simulate Microscope

Check or uncheck the menu item 'Options>Simulate Microscope' to enter and exit the simulation mode. Once the simulation mode is active, the first field in the status bar of the easyScan 2 software displays the text 'Simulation', otherwise this field displays the text 'Online'.

In the simulation, many functions of the microscope are performed on a mathematically generated surface. Thus, the software functionality and working methods of the microscope can be practised.

The About dialog



The About dialog displays the serial number of the connected Controller and version numbers of the installed modules. It is opened via the menu entry '?>About...' If the microscope simulation is active 'SerialNr. 000-00-000' is displayed. The Nanosurf Web site and contact address for information and software updates are also displayed here.

Positioning

The Positioning window contains all the software tools for positioning the tip with respect to the sample:

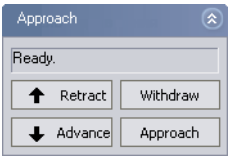
- The Approach panel
- The Video panel (with the Video Module)
- The Video display (with the Video Module)

Click  in the Navigator to open the Positioning window.

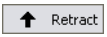
The Approach panel

The motor for the tip-sample approach is operated using the 'Approach Panel'.

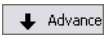
Approach (Easy, Standard, Advanced)



Status
Displays the current status of the approach stage.

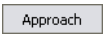


Increases the tip-sample distance at maximum speed until the button is released.



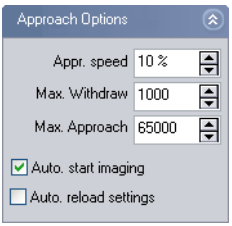
Decreases the tip-sample distance at maximum speed until the button is released.

Increases the tip-sample distance with the settings given in the Apporach Options.



Starts the automatic approach. During the automatic approach, the tip-sample distance is decreased until the Set point, set in the Z-Controller panel, is reached, or until the maximum approach time is reached.

Approach Options (Standard, Advanced)



Appr. speed (Standard, Advanced)
The speed of the motor during the automatic approach and withdraw.

Important!

If the approach is too fast, the sensor or the sample surface can be damaged. However, the motor will not move when Appr. speed is too small.

Max. Withdraw (Standard, Advanced)

The maximum withdraw duration after clicking 

.

Max. Approach (Advanced)

The maximum approach duration after clicking 

.

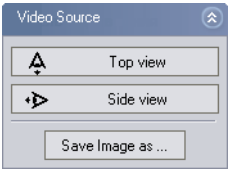
Auto. start imaging (Standard, Advanced)
When selected, the system automatically starts imaging after a successful approach. Scanning is automatically stopped when the approach motor is moved.

Auto reload settings (Advanced)
When selected, the software reloads the default start-up parameter file each time an approach is started (section *The Controller Configuration dialog* (p.31)).

The Video panel

The video panel controls the video display in the Positioning window. Changing these settings only has effect when a Video camera is fitted on your system.

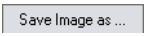
Video source



The video source section determines which video signal is currently displayed.

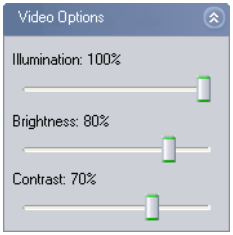
Switches the video display to the top view.

Switches the video to the side view.



Saves the currently displayed image to a JPEG file that is selected using a Save file as... dialog.

Video Options



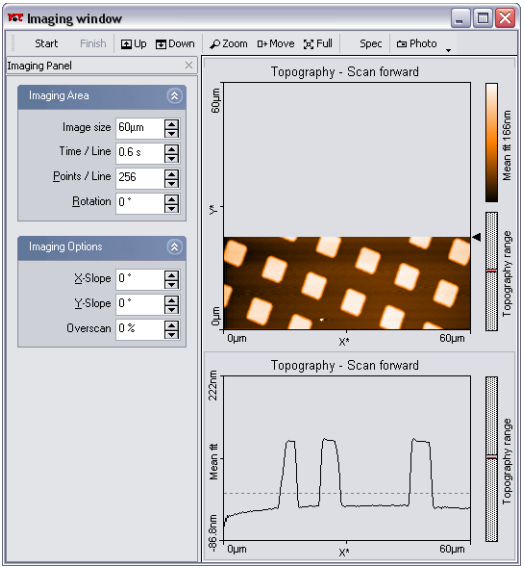
The Video Options section determines how the video signal is displayed. There are separate sets of options for the side and the top view.

Illumination
The intensity of the sample illumination on the scan head.

Brightness
The brightness of the video display

Contrast
The contrast of the video display

Imaging



The imaging window

Imaging measurements of the sample are controlled using the Imaging window. The Imaging window can be opened by clicking  in the navigator. The Imaging window contains the Imaging bar, with commands that control the imaging processes, and the Imaging panel, with parameters that determine how the imaging is done.

The Imaging window also contains a number of charts that display the data from the ongoing measurement. The imaging window can display as many charts as the size of the window can accommodate. By default, two charts are displayed, a Line graph, and a Color map of the sample's Topography. For more information on adding and changing charts (chapter *Viewing measurement data* (p.51)).

The imaging bar

Start / Stop

Start starts a measurement and then changes to Stop. Clicking Stop aborts the measurement immediately.

Finish

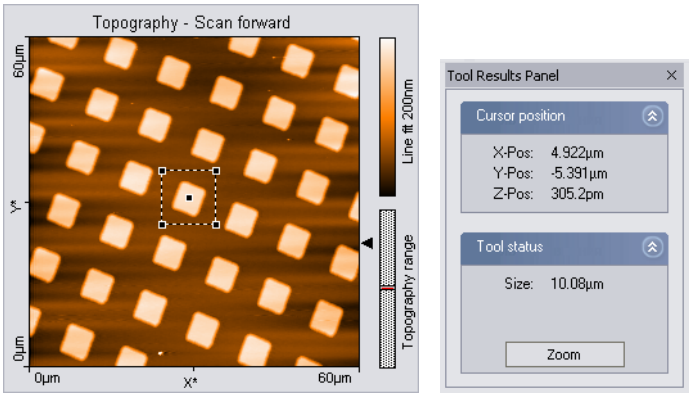
After clicking Finish the measurement stops when the current measurement has finished.

Up / Down

Starts a single measurement or changes the scanning direction of the measurement in progress. With Up the image is scanned from the bottom to top, with Down it is scanned from the top to the bottom. If a measurement has been started using Up or Down the measurement stops automatically after one full image.

Zoom

Selects an area that is to be measured in more detail. The size and area of the area is displayed in the Tool Results panel.

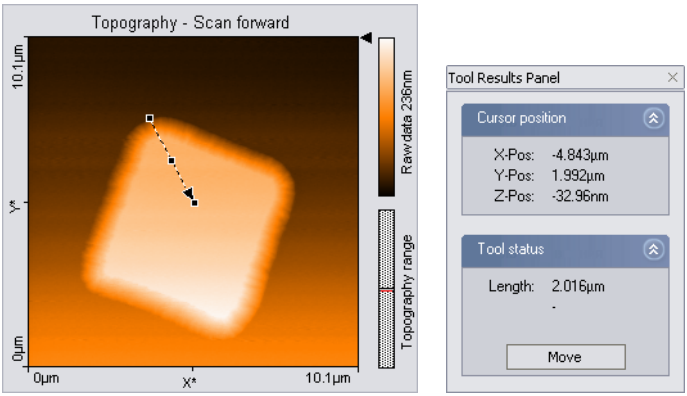


One corner of the zoomed area is defined by the mouse cursor position where the left mouse button is clicked, the opposite corner by the position where the button is released. When the mouse is not moved between clicking and releasing, an area is defined that has a size of 33% of the current measurement, and centred on the clicked location. Once an area is defined,

it can be resized by dragging one of its corners, and moved to the desired position by dragging its centre point.
A double click with the left mouse button in the chart, or clicking the Zoom button in the Tool Results panel, modifies the parameters Scan range, X-, Y-Offset in the Imaging window accordingly. When the zoom function is active it can be aborted by clicking Full again.

Move

Moves the position of the imaged area. An interesting corner can thus be moved to the centre of the measurement. The Tool Results panel numerically displays the change in position.
The change in the position is indicated by an arrow. The start of the arrow is defined by the mouse cursor position where the left mouse button is clicked, the end of the arrow by the position where the button is released. When the mouse is not moved between clicking and releasing, an arrow ending in the centre of the measurement is drawn. The direction of the arrow can be adjusted by dragging its end markers, it can be moved by dragging the centre marker.
The image is moved by double clicking, or clicking the Move button in the Tool Results panel. The move function can be aborted by clicking Move again.



Full

Returns the parameters Scan range to the largest possible values, and 'X-Offset' and 'Y-Offset' to zero.

Spec

Transfers the current measurement data to the spectroscopy window. If a measurement is in progress, it is interrupted. It is advisable to use Finish to complete the current measurement before starting the spectroscopy measurement.

Photo

Captures the measurement currently displayed in the 'Imaging window' in a measurement document.

If Photo is clicked when a scan is in progress, the measurement document will generated when the measurement in progress is finished. During the scan, the button remains pressed. The capture process is cancelled by clicking Photo a second time.

To capture an image without waiting for the scan to be completed, stop the scanning by clicking Stop. The image can then be captured immediately by clicking Photo.

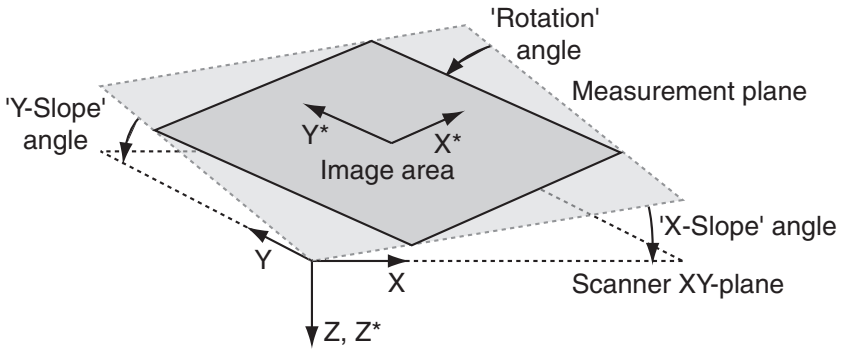
The measurement documents are labelled automatically with increasing numbers (i.e. Image1, Image2,...). When leaving the program you will be asked if you want to save the unsaved measurement documents.

The Imaging panel

The imaging settings use two coordinate systems: The Scanner coordinate system and the Measurement image coordinate system. To separate the two systems, the image axes are denoted by an asterisk (i.e. X*, Y*). The relation between the two coordinate systems is determined by various parameters in the imaging panel. The effect of these parameters is illustrated in figure *Coordinate systems*.

Imaging Area (Easy, Standard, Advanced)

Image size (Easy, Standard)
The image size in both the X* and Y* direction. The size is doubled or halved when using ⇕.



Coordinate systems

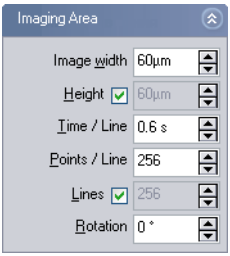


Image width (Advanced)
The image size in X* direction. The width is doubled or halved when using ⇕.

Height (Advanced)
The image size in Y* direction. The height is doubled or halved when using ⇕. When the Check-box is active, the image Height is always identical to the Image width.

Points / Line (Easy, Standard, Advanced)
The number of measured data points per line.

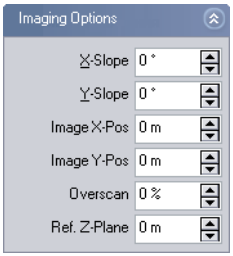
Lines (Advanced)
The number of measured data lines in an image. When the Check-box is active, the number of Lines is always equal to the number of Points / Line. In the easy and standard user interface mode, the number of Lines is always equal to the number of Points / Line.

Time / Line (Easy, Standard, Advanced)
The time needed to acquire a data line. The time needed for the entire image is approximately:

$$\textit{Image time} = \textit{'Time / Line'} \cdot \textit{'Lines / Frame'} \cdot 2 \quad .$$

Rotation (Easy, Standard, Advanced)
The angle between the X-direction of the scanner and the X* direction of the measurement (figure *Coordinate systems*).

Imaging Options (Standard, Advanced)



The reference plane for the image can be aligned to the surface of the sample using the slope parameters (figure *Coordinate systems*).

X-Slope (Standard, Advanced)
A positive value rotates the image plane around the Y-axis in the counterclockwise direction.

Y-Slope (Standard, Advanced)
A positive value rotates the image plane around the X-axis in the counterclockwise direction.

The centre position of the measured area can be changed by typing its position as well as by using the Move tool in the imaging bar. The zero position is the centre position of the scanner.

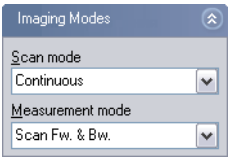
Image X-Pos, Y-Pos (Advanced)
The centre position of the measured area.

Overscan (Standard, Advanced)
The amount by which the scan range of each line is made larger than the measurement range, relative to the image width. Thus edge effects, caused by the reversal of the scanning motion, are not displayed in the measure-

ment. Disadvantages of using Overscan are that the maximum scan range is reduced, the tip moves slightly faster over the sample with the same 'Time/Line' setting, and the tip may hit large features outside the measured image. The value of 'Overscan' determines how much the scan range is increased relative to the Image width.

Ref. Z-Plane (Advanced)
The height of the reference plane. This height reference is used when the Z-Controller output is cleared, and when the Z-position is not modulated relative to the current surface position during spectroscopy measurements.

Imaging Modes (Advanced)



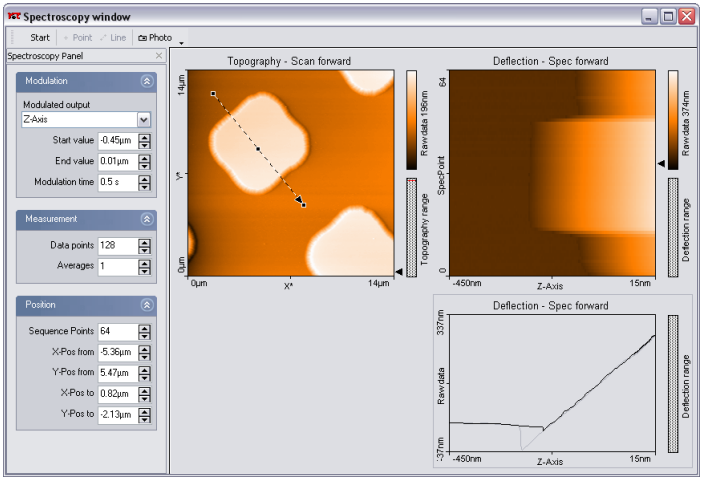
Scan mode
The Y* direction in which the data is acquired and displayed:

Continuous	the acquisition direction is reversed after each scan: from bottom to top and vice versa
Cont.Up	from bottom to top
Cont.Down	from top to bottom

Measurement mode
The X* direction in which the data is acuqired and stored:

Forward	during forward scan only (left to right in the image)
Backward	during backward scan only (right to left in the image)
Forw.&Backw.	during both forward and backward scan

Spectroscopy



Spectroscopy window

In a spectroscopic measurement, the input channels are measured as a function of a modulated parameter. This modulated parameter can be the Z-distance to the sample, the tip voltage, or a User output channel (when the Signal Module: A is installed). Note that you must electrically connect the sample to the ground connector on the easyScan 2 AFM scan head to apply a tip-sample voltage difference. The measured parameter can be any available input channel. Examples of a spectroscopic measurements are force/distance curves in the AFM static force mode, amplitude/voltage curves in the AFM dynamic mode, or current/voltage curves with the STM.

The accuracy of the spectroscopic measurements can be increased by averaging the measurement results of several consecutive modulations. A spectroscopic measurement sequence consists of a number of spectroscopic measurements of the same type, measured along a user defined line in the XY-plane. A point measurement is made if the number of points is one. The measurement sequence is carried out as follows:

1. The tip is moved with active Z-control to the start of the line.
2. The controller is switched off.

3. A spectroscopic measurement is recorded.
4. The controller is turned on again.
5. The tip is moved to the next point on the line in the XY-plane.

Steps 2.-5. are repeated for each points on the line.

Spectroscopic measurement sequences are controlled using the Spectroscopy window. The Spectroscopy window can either be opened by clicking  in the navigator, or by clicking Spec in the Imaging bar. When the Spectroscopy window is activated from the Imaging bar, the currently measured image is transferred to the Spectroscopy window.

The Spectroscopy window contains the Spectroscopy bar, with commands that control the spectroscopy processes, and the Spectroscopy panel, with parameters that determine how the spectroscopy measurement is done.

The Spectroscopy window also contains a number of charts that display the data from a previous imaging measurement and the data from the ongoing spectroscopic measurement. The Spectroscopy window can display as many charts as the size of the window can accommodate. It is recommended to display at least two charts, one a Color map of a previous Topography measurement of the area where the spectroscopy measurement is performed, and one a Dual Line graph of the current spectroscopy measurement. For more information on adding and changing charts (chapter *Viewing measurement data* (p.51)).

The Spectroscopy bar

Start

Starts a spectroscopy measurement sequence.

+ Point / Line

Starts the selection of the XY measurement position(s) in a topography Color map chart using the mouse cursor. These positions are automatically transferred to the appropriate entries in the Position section of the Spectroscopy panel. When selecting a line, clicking the chart once creates a line from the clicked position to the centre of the image.

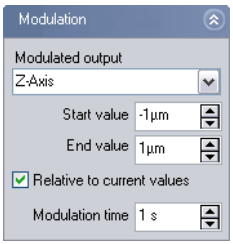
Photo

Captures the measurement currently displayed in the Spectroscopy window in a measurement document, and displays it in a separate window.
If Photo is clicked during the measurement, a copy is generated when the measurement in progress is finished. During the measurement, the button remains pressed. The capture process is cancelled by clicking Photo a second time.

The measurement documents are labelled automatically with increasing numbers (i.e. Image1, Image2, ...). When leaving the program you will be asked if you want to save the unsaved measurement documents.

The Spectroscopy panel

Modulation (Easy, Standard, Advanced)



Modulated output (Easy, Standard, Advanced)
The modulated output.

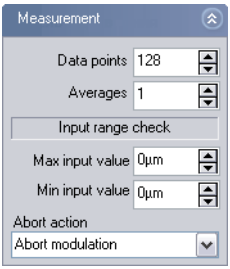
Start value/End value (Easy, Standard, Advanced)
The range over which the Modulated output is changed. The 'Spec Forward' data is measured from the Start to the End value, the 'Spec backward' data is measured in the opposite direction. The 'Spec forward' data is always measured before the 'Spec backward' data.

Relative to current value (Standard, Advanced)
When active, the Start and the End values are added to the value the modulatedy output had before starting the modulation.
When the Tip Potential is modulated, the current value is the Tip voltage set in the Z-Controller panel.

When the Z-Axis is modulated, the current value is the sample surface height, as measured using the Z-Controller output. Otherwise, the measurement z-position is given by the value of the Ref. Z-Plane in the Imaging Panel.

Modulation time (Easy, Standard, Advanced)
The time used to change the Modulated output from the Start to the End value.

Measurement (Easy, Standard, Advanced)



Data points (Easy, Standard, Advanced)
The number of data points in one spectroscopic measurement. The data points are equally distributed over the modulation range.

Averages (Easy, Standard, Advanced)
The number of times the modulation is repeated to obtain an averaged spectroscopic measurement.

Input range check (Standard, Advanced)
In order to prevent tip damage due to too high tip-sample interaction, the settings below 'Input range check' define a safe range of tip-sample intereacion. When the interaction signal (Deflection in static modes, Amplitude in dynamic modes, Current in STM mode) leaves this safe range, the measurement is aborted. When a spectroscopy measurement has been aborted, a warning dialog is displayed. The number of aborts that occurred in a measurement is reported in Data Info panel as: ModAborted=<number of aborts>.

Max / Min input value (Standard, Advanced)
The Minimum/maximum value that the feedback signal is allowed to have.

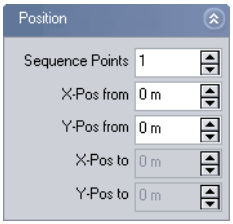
Abort action (Standard, Advanced)
What is to be done when the measurement is aborted:

Abort modulation aborts the current modulation period, and continues with the next modulation until the number of modulations in 'Averages' is reached.

Abort current measurement aborts the spectroscopy measurement for the current point and continues with the next point of the line, if a Line spectroscopy is being performed.

Abort measurement sequence aborts the entire spectroscopy measurement sequence (cancels all 'Averages' and points).

Position (Easy, Standard, Advanced)



The Position parameters can be used to define a sequence of spectroscopy measurements on positions that are equally distributed over a line.

Sequence Points (Easy, Standard, Advanced)
The number of Spectroscopy Measurements to be made in the sequence.

X-Pos from/Y-Pos from (Easy, Standard, Advanced)
The XY-coordinates of the measured point in a Point-spectroscopy measurement. Sets the XY-coordinates of the starting point of the line in a Line-spectroscopy measurement sequence.

X-Pos to Y-Pos to (Easy, Standard, Advanced)
The XY-coordinates of the end-point of the line in a Line-spectroscopy measurement sequence.

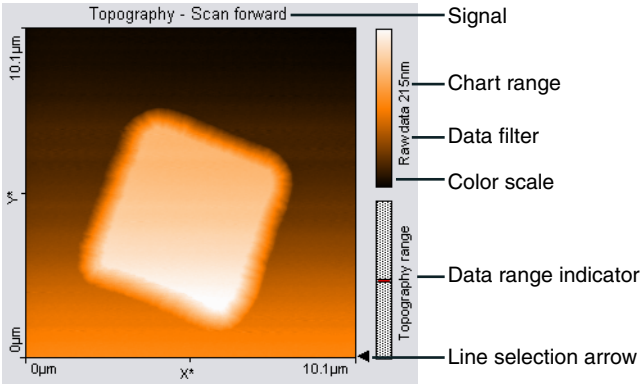
The from and to coordinates are more convenently chosen using the Point or Line tools in the Spectroscopy bar.

Viewing measurement data

Measurement data are displayed in charts. Charts are used in Measurement document windows, the Imaging window and the Spectroscopy window. The measurement settings are displayed in the Data Info panel.

Charts

A Chart is a graphical representation of the measured data, and additional elements that give information about the chart itself (figure *Elements of a Chart*).



Elements of a Chart

These elements show the displayed Signal, Chart type, the type of Filtering applied to the data, and the Color scale used to display the data. The Color scale shows which measured signal level is mapped to which colour. The colour mapping can be changed using the Color Palette dialog, described further on in this section. The Data range indicator shows the range of possible measurement values that is occupied by the measured data.

The Chart bar is used to create new charts and to modify their properties. The chart configuration of the Imaging and Spectroscopy window can be saved to a file. The chart configuration of the measurement documents is saved together with the document.

Storing and retrieving the chart arrangement

The chart arrangement of the Imaging and Spectroscopy windows is stored in a configuration file with the extension '.chart'. When the easyScan 2 software is started, a default arrangement is loaded from a file that is selected in the Controller Configuration dialog (section *The Controller Configuration dialog* (p.31)). Functions for storing and retrieving the chart arrangement are accessed via the menu 'File>Chart Arrangement'.

'Save' saves the chart arrangement to the currently selected chart file. The name of this file is indicated in the status bar at the bottom of the main window.

'Save as...', saves the chart arrangement under a new file name.

'Load' loads a previously saved chart file.

Important!

When you have not loaded another file, 'Save', will overwrite the original default chart arrangement file with the current settings.

The Chart bar

The properties of the charts are set using the Chart bar. The settings displayed in the Chart bar refer to the currently active chart. This chart is indicated by a grey line around the chart. A Chart is activated by clicking it with the mouse cursor.

The following buttons control the creation and modification of the charts.

 **(Create new Chart)**
Creates a copy of the currently active chart and adds it as the last chart in the active window. Charts are first ordered top to bottom, then left to right. The window may have to be resized to see all charts.

 **(Delete Current Chart)**
Removes the currently active chart.

 **(Chart type)**
The chart type:

Line graph data is displayed as a plot. Points outside the range of the scanner are displayed in red. The displayed line is

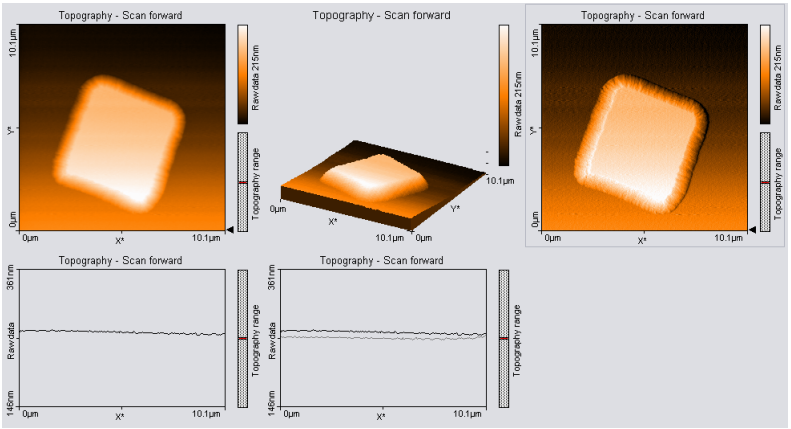
selected by dragging the Line selection arrow in a Color map or Shaded map chart (figure *Elements of a Chart* (p.51)).

Color map data is encoded in a color scale

3D view data is shown as a 3-dimensional representation in a parallel perspective.

Shaded map creates an impression of the surface with lighting from the left. This is achieved by combining the topography with its derivative.

Dual line graph both the Forward and the Backward data (when available) are displayed as in the 'Line graph'. The line of the data type selected in 'Signal' is black, the line of the reverse direction data is grey.



Data represented using different chart types

(Data filter)

The way data is processed before it is displayed, evaluated or exported:

Raw data the data is not processed.

Mean fit the mean value of each line of data points is calculated and then subtracted.

Line fit	the best fit line for each line of data points is calculated and then subtracted.
Derived data	the difference between two successive data points (derivative) is calculated.
Parabola fit	the best fit parabola for each line of data points is calculated and then subtracted.
Polynomial fit	the best fit fourth order polynomial for each line of data points is calculated and then subtracted.

(Signal)
The input channel that is displayed. The available signals depend on the operating mode, the status of the User input (section *The Operating mode panel* (p.15)) and the measurement mode (section *The Imaging panel* (p.42)).

(Optimise Chart range)
Adjust the chart scale so that it optimally fits the measurement data.

(Decrease Chart range)
Halves the chart scale, thereby increasing feature contrast / height.

(Increase Chart range)
Doubles the chart scale, thereby decreasing feature contrast / height.

(Chart properties dialog)
Opens the chart properties dialog.

The Chart properties dialog

Chart range

Span
The signal span that corresponds to the full chart scale. Increasing Span decreases the feature contrast. The current Span is also displayed next to the color bar / axis in the chart

Center
The signal that corresponds to the center of the chart scale.

Auto set / set
When active, the chart scale is automatically set to optimally fit the meas-

urement data, as it is being acquired. Clicking Set has the same effect as clicking the Optimise Chart range button.

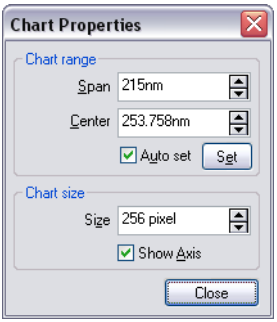


Chart size

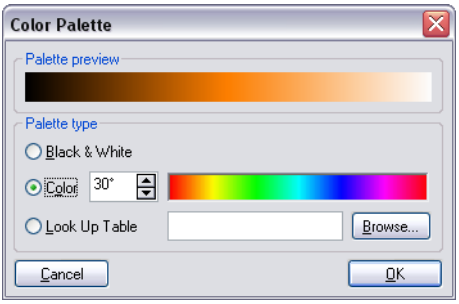
Size

The size of the chart in pixels.

Show Axis

When active, the labels in charts and the color-bar in 'Color map' window, are displayed.

The Color Palette dialog



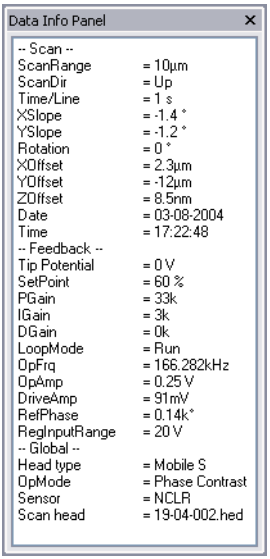
The color palette dialog is reached via the menu item 'Options>Config Color palette...'. The color palette is used to map the display range of the measured values to a color. Three different palette types are available:

Black&White The color map is a linear grey scale

Color The color selection uses the HSB-color model where the color (H) is set in ° value. The color is selected by entering a number or by clicking a color in the color bar.

Look Up Table A user definable palette (with max. 256 color entries) can be selected. This palette is stored in a '.lut' file that contains an ASCII table with RGB color values. A different look up table can be selected by clicking the 'Browse...' button.

The Data Info panel



Data Info Panel: Display of measurement parameters

The Data Info panel displays the parameters of the active measurement and the current tool results.

Quick Evaluation Tools

The easyScan 2 software has several tools that allow quick evaluation of a measurement while it is being acquired. This helps find optimal measurement settings. For more elaborate evaluations, the optional Nanosurf Report software package can be used (section *Creating a report* (p.67)).

The quick evaluation tools are activated using the Tools bar or the Tools menu. The number of tools available depends on the type of the currently active chart. The evaluation results are displayed in the Tool Results panel.

Important!

All results are calculated after the 'Data filter' has been applied to the data. The results will generally vary when a different 'Data filter' option is used.

The Tool Results panel

The Tool Results panel displays the results of the currently active tool. The panel should automatically become visible when a tool is selected. To make the panel visible, click  in the navigator. The contents of the tool results panel depend on the tool that is active. It will always contain a Cursor position and a Tool status section, and may also contain a Tool result and a Tool chart section. Because the content of the Tool Results panel depends so strongly on the active tool, this panel is described in more detail with each of the tools.

The Tools bar

Properties of the measurements can be evaluated numerically using the tools. The tools are activated via the corresponding menu item or by clicking the respective button in the tool bar. Tools can be used in all charts, both during measurement and off-line. Before using a tool on a chart, activate the chart by clicking onto it. To stop using a tool, select another tool, or click its button a second time.

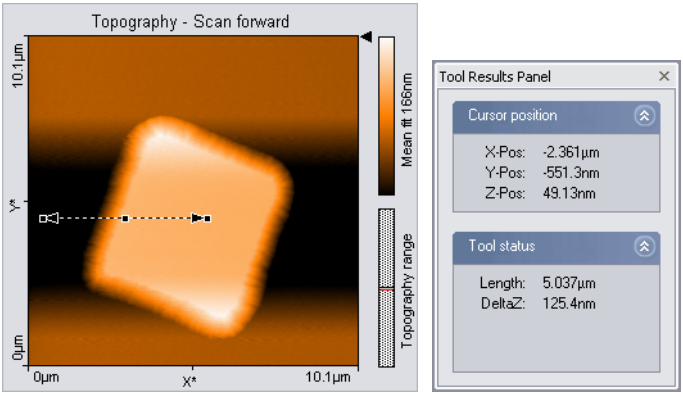
Measure Length

Starts measuring the distance and signal difference between two points.

The measurement results are displayed in the Tool Results panel.

The two points are defined by drawing a double arrow. The first point is defined by the mouse cursor position where the left mouse button is clicked, the second point by the position where the button is released. When the mouse is not moved between clicking and releasing, an arrow parallel to the X*-axis is drawn.

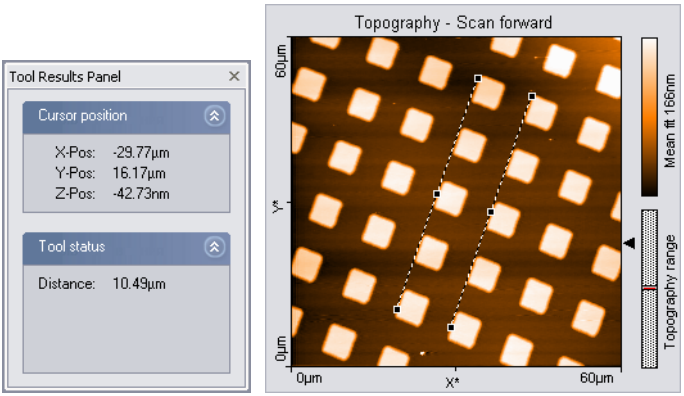
The direction of the arrow can be adjusted by dragging its end markers; it can be moved by dragging the centre marker.



Measure Distance

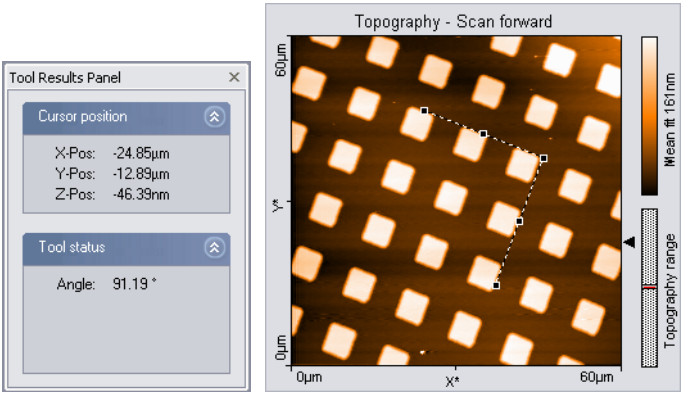
Starts measuring the distance between two parallel lines. The measurement result is displayed in the Tool Results panel.

Distance is measured by drawing two lines in the chart. The first point of the first line is defined by the mouse cursor position where the left mouse button is clicked, the second point by the position where the button is released. When the mouse is not moved between clicking and releasing, a line parallel to the X*-axis is drawn. After releasing the mouse button, a second parallel line sticks to the mouse cursor, that is released by clicking its desired position. The direction of the parallel lines can be adjusted by dragging their end markers; they can be moved by dragging the centre marker.



Measure Angle

Starts measuring the angle between features in the measurement. The measurement result is displayed in the Tool Results panel. In Line graph-type displays, this tool can only be used when the signal displays height data.

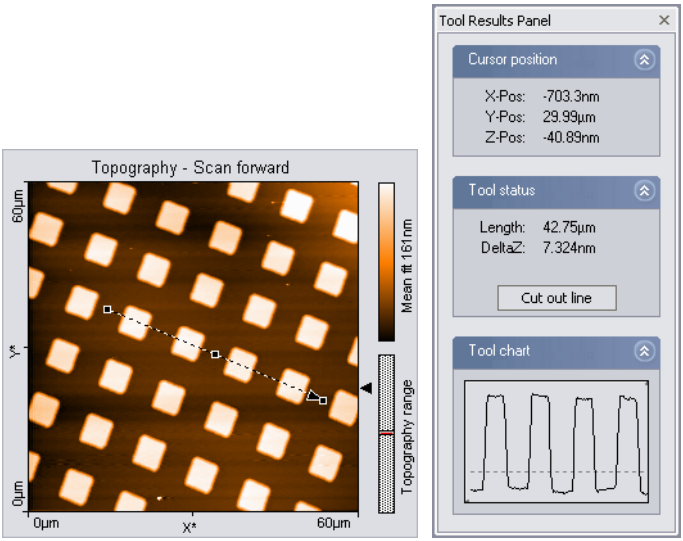


The angle is measured by drawing two meeting lines in the chart. The first point of the first line is defined by the mouse cursor position where the left mouse button is clicked, the second point by the position where the button is released. When the mouse is not moved between clicking and releasing, a line parallel to the X*-axis is drawn. After releasing the mouse button, the end of the second line sticks to the mouse pointer. The end is released by clicking its desired position. The angle can be changed by dragging the

line's end point markers or the corner mark; it can be moved by dragging the line's centre markers.

Create Cross Section

Displays and can create a new measurement document containing a line cross-section of a Color map display. The line is displayed in the Tool Results panel. The line can be stored in a new measurement document.



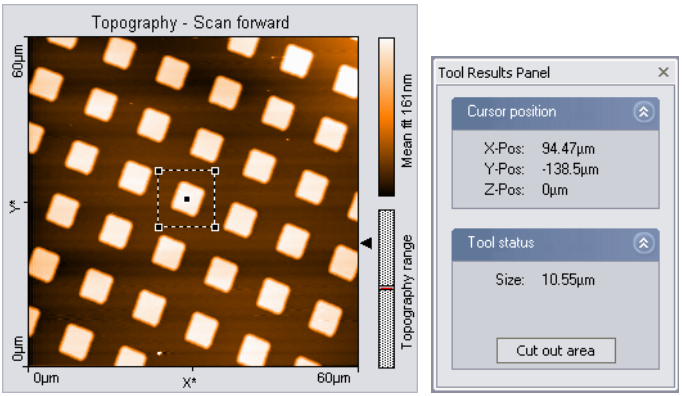
The line is defined by drawing an arrow. The arrow points toward the forward direction of the line. The start of the arrow is defined by the mouse cursor position where the left mouse button is clicked, the end of the arrow by the position where the button is released. When the mouse is not moved between clicking and releasing, an arrow ending in the centre of the measurement is drawn. The direction of the arrow can be adjusted by dragging its end markers; it can be moved by dragging the centre marker.

A new measurement document containing the line section is created by double clicking the graph, or by clicking 'Cut out line' in the Tool Results panel.

Cut Out Area

Creates a new measurement document containing a subsection of an exist-

ing measurement. The size and area of the area is displayed in the Tool Results panel.



One corner of the area is defined by the mouse cursor position where the left mouse button is clicked, the opposite corner by the position where the button is released. When the mouse is not moved between clicking and releasing, an area is defined that has a size of 33% of the current measurement, and is centred on the clicked location. Once an area is defined, it can be resized by dragging one of its corners, and moved to the desired position by dragging its centre point. It is possible to define a rectangular (i.e. non-square) area by pressing the 'Shift' key whilst dragging a corner.

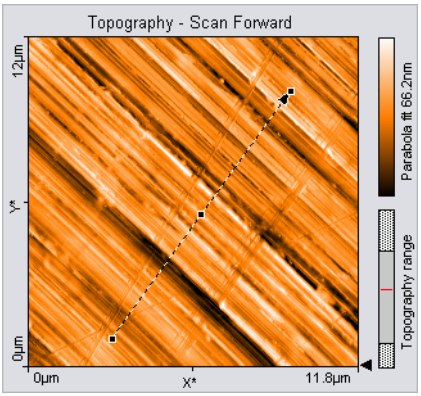
A new measurement document containing the area is created by double clicking the graph, or by clicking the 'Cut out area' button in the Tool Results panel.

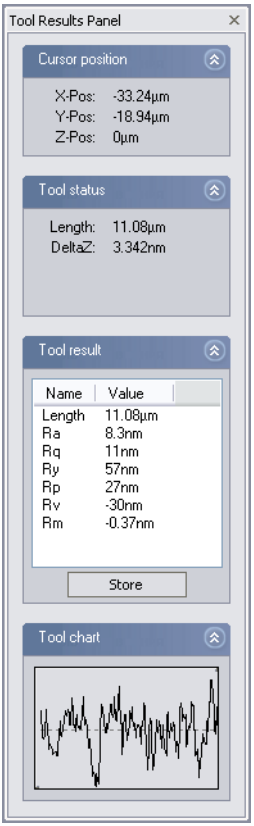
Calculate Line Roughness

Calculates certain roughness parameters along a line. Both the selected line and calculated values are displayed in the Tool Results panel.
The cross-section is selected in the same way as with the Cut out Line tool. The calculated parameters are stored in the measurement document when the 'Store' button in the Tool Results panel is clicked.

Calculate Area Roughness

Calculates certain roughness parameters of an area. The calculated values are displayed in the Tool Results panel.





The parameters are calculated as follows:

The Roughness Average, S_a

$$S_a = \frac{1}{MN} \sum_{k=0}^{M-1} \sum_{l=0}^{N-1} | z(x_k, y_l) |$$

The Mean Value, S_m

$$S_m = \frac{1}{MN} \sum_{k=0}^{M-1} \sum_{l=0}^{N-1} z(x_k, y_l)$$

The Root Mean Square, S_q

$$S_q = \sqrt{\frac{1}{MN} \sum_{k=0}^{M-1} \sum_{l=0}^{N-1} (z(x_k, y_l))^2}$$

The Valley depth, S_v

S_v = *lowest value*

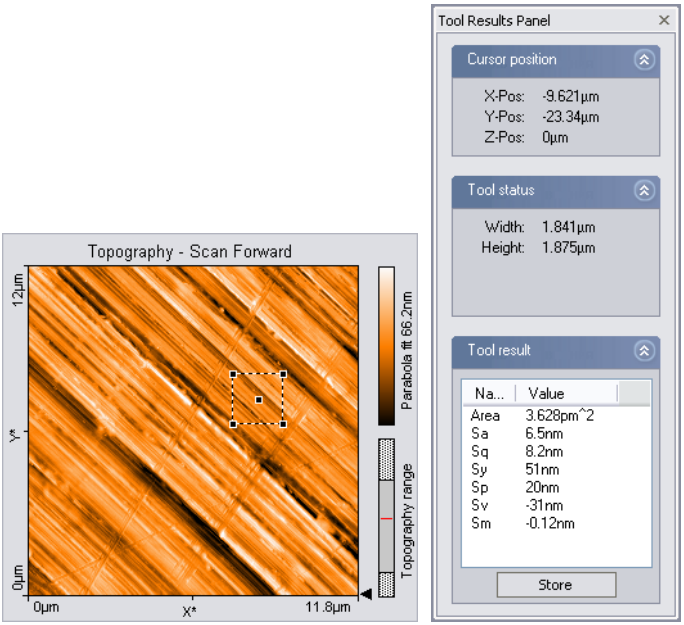
The Peak Height, S_p

S_p = *highest value*

The Peak-Valley Height, S_y

$S_y = S_p - S_v$

The area is selected in the same way as with the Cut out Area tool.
The calculated parameters are stored in the measurement document when the 'Store' button in the Tool Results panel is clicked.



Tip:

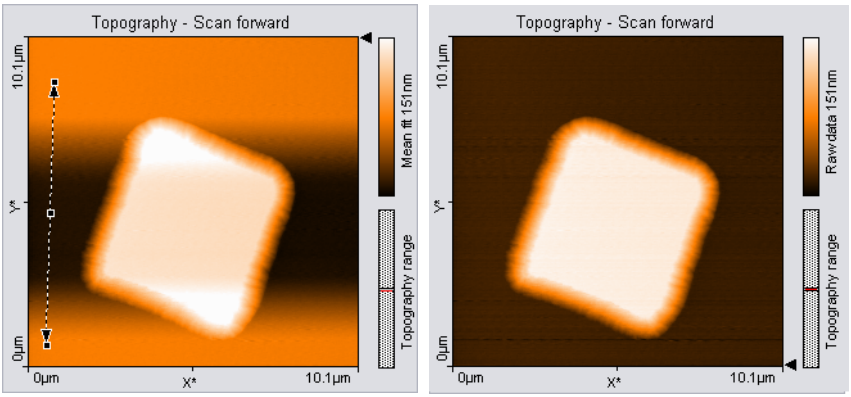
The Area Roughness tool can be used to determine the mean height difference between two plateaus with more accuracy than with the 'Measure Distance' tool. To determine the mean height difference, select an area on each plateau, and calculate the difference between their Sm-values.

Correct scan line levels

Removes the effect of a wrong scan plane or drift when the 'average' and 'plane' Data filter options do not give satisfactory results. This may occur when the scan lines in different parts of the measurement have a different average height. An example of such a measurement is shown in figure *Correct scan line levels*.

To use the tool, draw a line through points that should have the same height in the same way as with the Measure Length tool.

After clicking the 'Execute' button in the Tool Results Panel, the average level of each scan line is adjusted so that all points along the drawn line have the same height. To get useful results, the Data filter option for the display in which you draw the line should generally be 'Raw data' or 'Mean fit'.



Correct scan line levels: left: uncorrected image with a line through points that should be at the same height; right: corrected image

Storing measurements and further data processing

Storing and Printing measurements

Storing and Printing of measurement documents can be performed using the File menu. The functions Open, Save and Print are also available via the File bar.

Menu item 'File' contains the items for opening, closing, saving, and printing the measurement documents and for exiting the program. In the following only the special functions are mentioned.

Open

Opens a dialog for opening Nanosurf .nid or .ezd (easyScan 1) files. The same dialog is opened using the menu 'File>Open...'. It is possible to select more than one file at the same time by using the 'Shift' and 'Ctrl' keys.

'Save' and 'Save as...'

Save a measurement document in Nanosurf image data format (file extension .nid). The same dialog is opened using the menu 'File>Save' and 'File>Save as...'.

Export >Current Chart as / Current document as

Exports either the active chart or the whole active measurement document for use in other programs or image processing software. Available data types for documents are windows bitmap (.bmp), 16 bit data file (.dat), plot file (.plt). For Charts, additional available data types are comma separated z values (.csv), and (X,Y,Z)-points (.csv).

When the data is exported using the function 'Export>Current document as..', every Chart in the measurement document is stored in the export file consecutively. In the binary format, the blocks of data from each Chart are stored directly one behind the other. In the 'ASCII' text format the blocks of data for each Chart are separated by two empty lines.

Windows Bitmap (.bmp)

A Windows Bitmap image is suitable for including in documents, e.g. word or image processing software. The exact image as seen on the computer screen will be saved in the file ('screen shot').

Data file 16Bit (.dat)

A binary data file can be processed in image processing software. This 'binary' data format contains only the measured data. The data is stored consecutively line by line upwards as 16-bit values (-32768 - +32767). The data is first processed using the settings chosen in the Data filter setting of the Chart bar.

Plotfile ASCII (.plt)

This is an 'ASCII' text format which contains the measured data as well as a small header with a description of the scan. The data is stored using the setting 'Data filter' in the 'Chart bar'. A measurement as a plotfile can be used for detailed data analysis by various mathematical software packages such as MathLab or plotted by GnuPlot.

- If 'Line graph' is selected as 'Display' in the 'Chart bar', only the visualised lines will be stored. Each data point is stored as a pair of floating point numbers on a separate line. The number pairs are separated by a blank character (SPACE).
- If any other chart type is selected, all measured values are stored. All values in a data line are stored on a separate line in the text file. An empty line is inserted after every data line. The data lines are stored from the bottom to the top. A small header at the beginning of the first data line contains the names of the channel and frame, as well as x-, y-, and z-ranges with their physical units.

Comma separated z values (.csv)

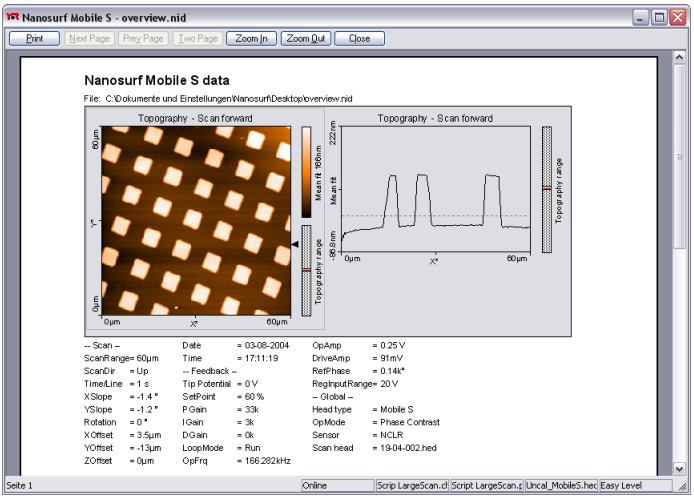
This format stores all the measured data in a chart, as a matrix of floating point numbers in ASCII format separated by a 'comma' and 'SPACE' character. This enables easy data exchange with commonly used spread sheet and database applications.

(X, Y, Z)-Points (.csv)

This format stores the coordinates of all measured points in a chart as a list of floating point number pairs. For Line graphs, only X and Z points are exported.

Print, Print preview...

Prints the currently selected measurement document together with the values shown in the Data Info panel.



Creating a report

The Nanosurf Report software package offers a powerful and extensive set of analysis functions. Complex analyses can be created interactively, and then displayed and printed in visually appealing reports. These reports can then be used as templates to apply the same analysis to another measurement.

The Report software is started from the easyScan 2 software by either clicking  , or using the Report menu. When a measurement is opened by the report software, it will import all measurement channels that are displayed in the current measurement document.

Important!

- If you do not save the measurement in the easyScan 2 software, but only save the report, the data in measurement channels that were not displayed is lost.
- A measurement document should only display those channels that are used in a template. When a template is applied to a measurement document that displays different, or a different number of measurement channels than the template uses, the results may not be correct.

The Report generator configuration dialog is used to configure the behaviour of the Navigator Icon and the Report menu. For an in depth introduction to the Nanosurf Report software, refer to the Introduction section of the Nanosurf Report on-line help.

The Report Menu

New Report

An empty report is opened.

Add Measurement

The currently active measurement is added to the currently opened report.

Apply Template...

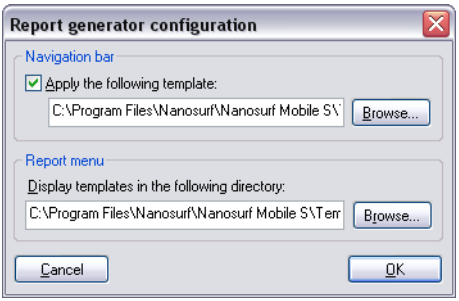
Opens a dialog that allows you to select a template that is applied to the currently active measurement.

Template list

The template list is a list of the templates that are stored in the template directory (section *The Report generator configuration dialog* (p.68)). Selecting a template applies this template to the currently active measurement.

The Report generator configuration dialog

The Report generator configuration dialog is used to configure the behaviour of the Navigator Icon and the Report menu. It is opened using the menu ‘Options>Config Report...’.



Navigation bar

Determines what happens when the  icon is clicked. The check box determines whether the active measurement is evaluated using a template. The Browse-button is used to select the template that is used when the icon is clicked.

Report menu

Determines which templates are displayed in the lower part of the Report menu. The Browse-button allows the selection of the directory where the templates are stored.

Automating measurement tasks

The Nanosurf easyScan 2 Scripting Interface is an optional component for automating measurement tasks. It offers several possibilities to automate measurement tasks:

- Create scripts inside the easyScan 2 software.
- Create external software that controls the easyScan 2 software.

This chapter describes the user interface features that are related to creating scripts inside the easyScan 2 software.

After purchasing it, the Scripting Interface must be activated using the Edit Access Codes dialog (section *The Edit Access Codes Dialog* (p.32), or follow the instructions on the Access code certificate delivered with the instrument.)

For more information about the automating measurement tasks, and the available script commands, refer to the *Programmers Manual*. This manual is available as an on-line help file, that can be opened via the windows Start menu: 'Start>Program files>Nanosurf>Nanosurf easyScan 2>easyScan 2 Programmers Manual'.

The Script Menu

The scripting functions of the easyScan 2 software are reached via the entries in the Script menu:

Script Editor...

Opens the Script Editor dialog.

Run From File...

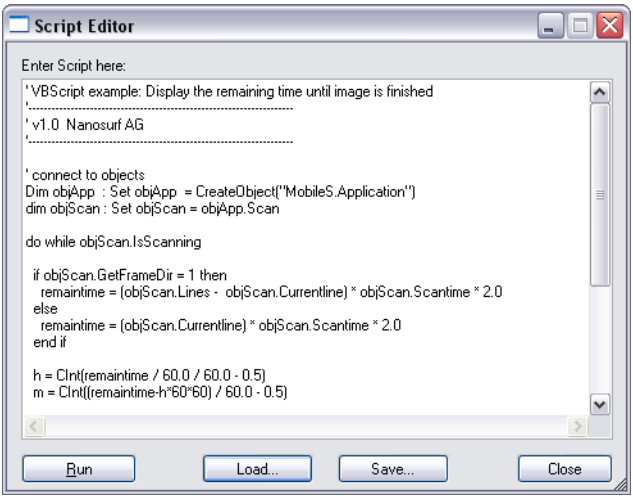
On selecting this menu entry, a file dialog appears that allows selecting a script file by browsing. When the script is error free, the script will start executing on clicking the 'Load'-button. Otherwise, and error message with an error description will appear.

Other entries

All scripts in the script directory are displayed below the Run From File menu entry. Selecting one of these entries starts the corresponding script. The example script 'Show Remain Scantime', which is installed in the default installation, should normally be listed here.

The Script Editor

The easyScan 2 software has an simple integrated Script Editor that allows editing, running, loading and saving scripts. The can be used in parallel with other application windows, so you can work with other parts of the application while editing a script. The Script Editor is accessed via the menu 'Script>Script Editor...'.



The script editor

Editor field

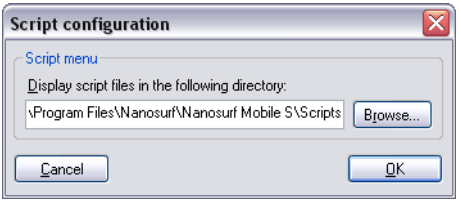
In the editor field in the center of the dialog you can edit scripts.

Run Button

Starts the currently loaded script. If there is an error in the script, a dialog box will appear.

The Script Configuration Dialog

The Script Configuration Dialog allows you to set the search path for the scripts that are displayed in the Script menu. The dialog is accessed via the menu entry ‘Options>Config script...’.



Quick Reference