alicona

# IF-MeasureSuite

Version 5.1

Manual EN

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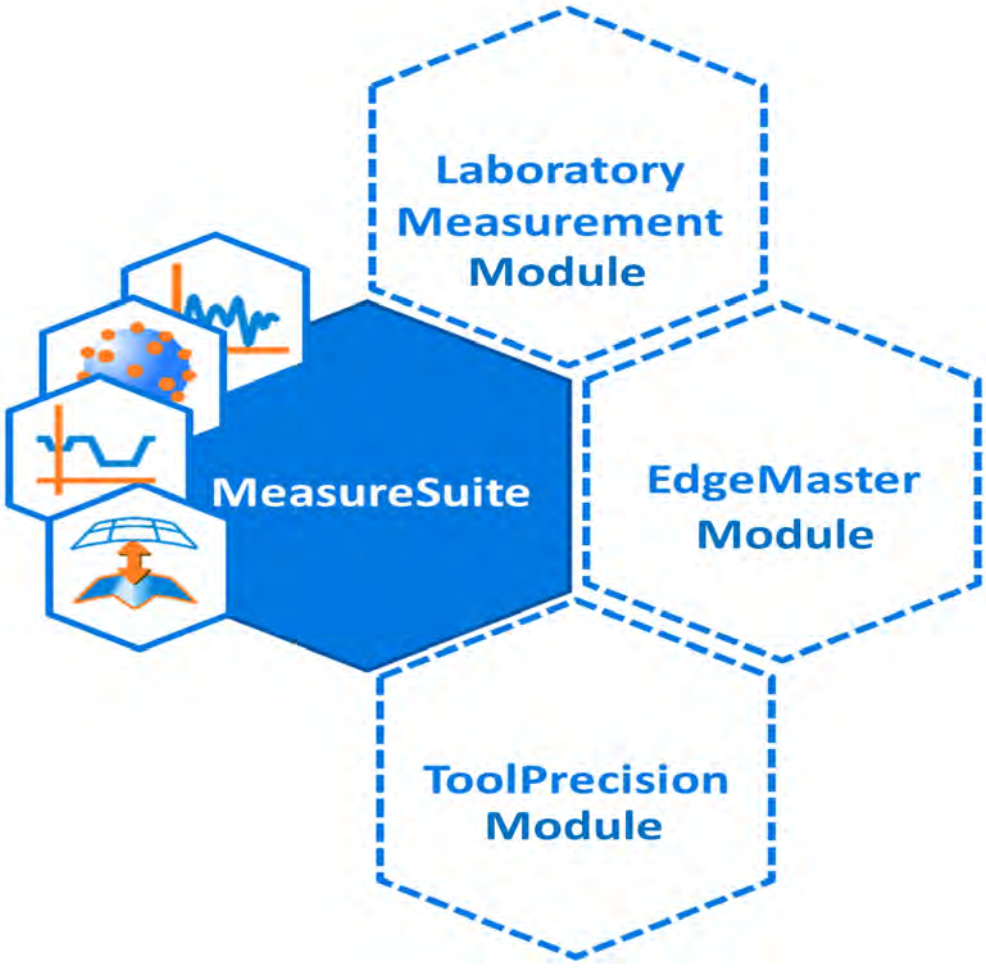
# Chapter 1

# Introduction

This help document is a guide to learn the essential basics of the program. It is strongly recommended to read it in order to use it efficiently.

## 1.1 MeasureSuite and ExtensionModule Concept



The Alicona software has been split into the following parts since Version 3.7:

- **IF-MeasureSuite**
  - contains database viewing and manipulation functionality
  - contains Measurement Modules (e.g. ProfileRoughnessMeasurement, 2DImageMeasurement,...)
  - can launch other ExtensionModules
- **Extension Modules**
  - IF-LaboratoryMeasurement (Module for IFM G4, IF-EdgeMaster,...)
  - IF-EdgeMasterModule (Guided measurement for IF-EdgeMaster Hardware)
  - IF-Portable
  - IF-ToolPrecisionModule

### 1.1.1 Separate configuration in each individual ExtensionModule

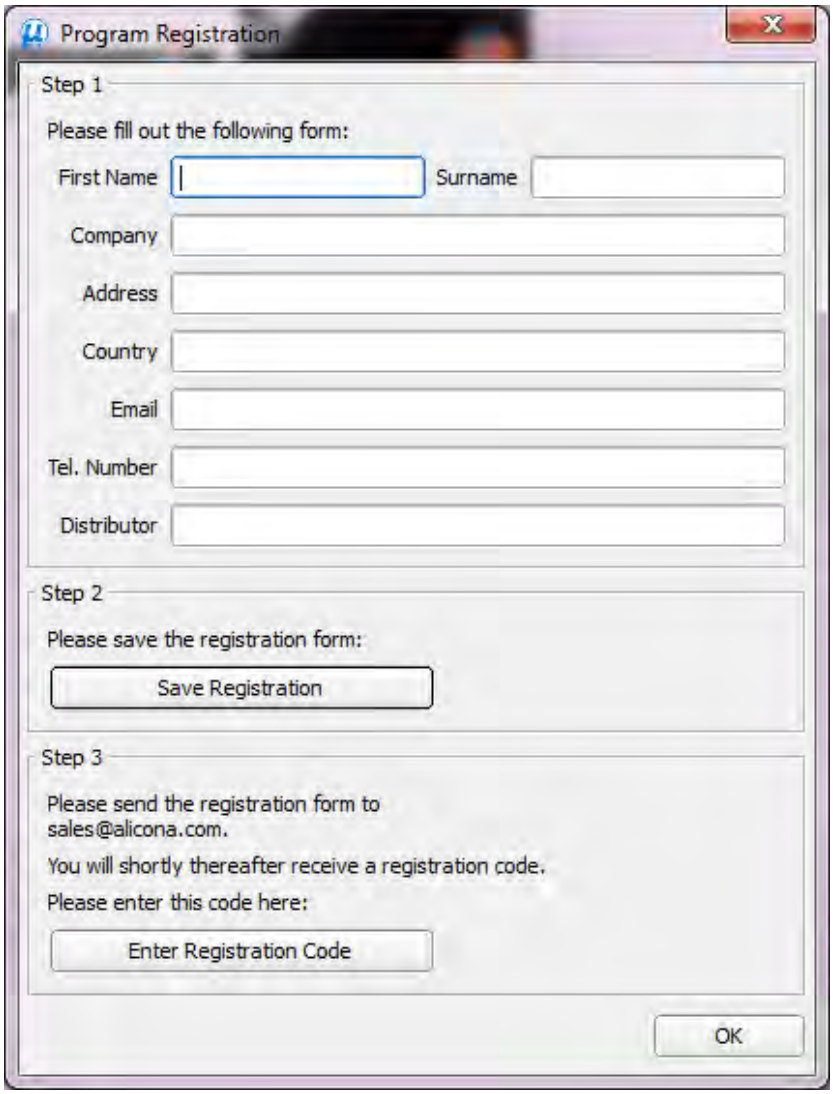
Each ExtensionModule

- has its own version ID (e.g. IF-MeasureSuite 3.8, IF-EdgeMaster 1.2)
- needs its own license file (.lcn)
- has its own settings and user profiles
- has its own error and program report handling. That means that in case of an error you have to generate a program report in the ExtensionModule that produced the error, and send this report to Alicona Support.

### 1.1.2 Registration of your Software

When you start IF-MeasureSuite for the first time you will be asked for your license codes. To activate your copy of IF-MeasureSuite please register your copy of the software. Therefore open *Extras* → *Register Program...* and fill in each of the fields. Save the registration and send the registration

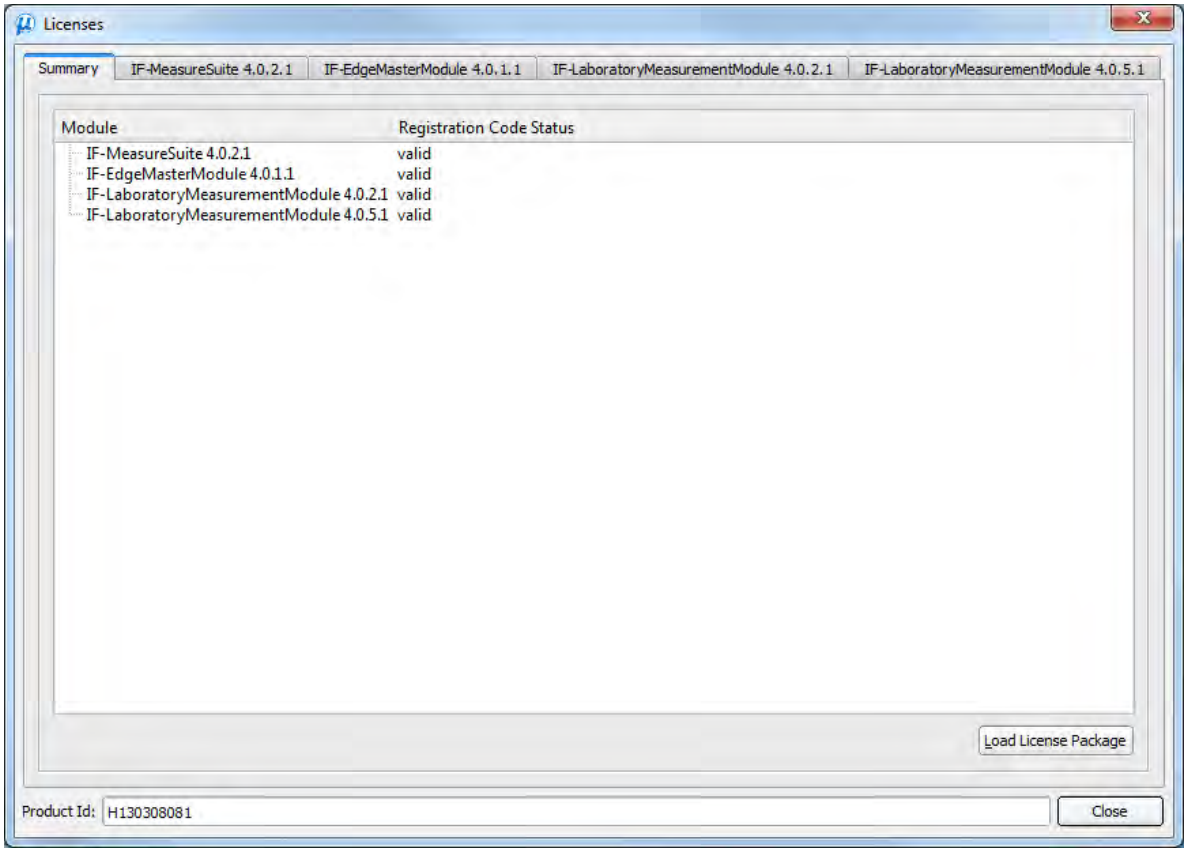
file to *sales@alicona.com*. After entering the received registration code in the license dialog your software is activated properly.




Registration Window

### 1.1.3 License Code Management

The IF-MeasureSuite is equipped with a central license code management. In the menu item *Extras* → *Installed Licensecodes* you get an overview of modules available and their registration code status. On the overview page you can also load a license package (zip file) for more than one module. On the particular tabs you can load single license files for the relevant module too.




License Dialog

# Chapter 2

# Database View

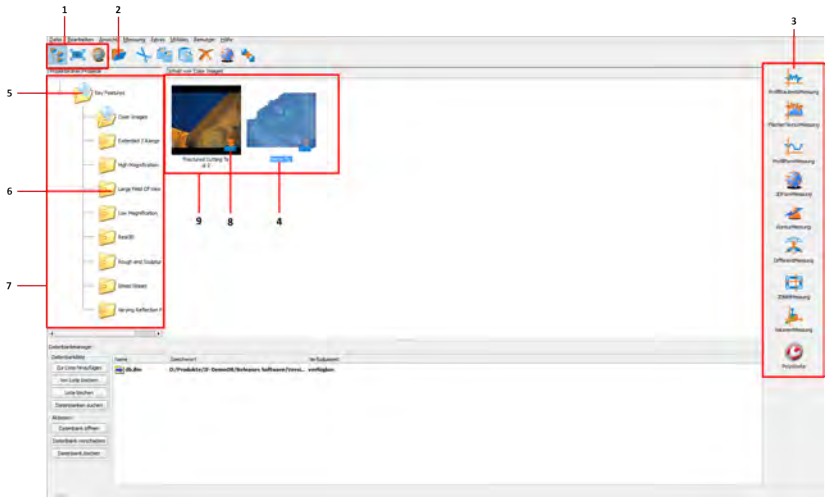
## 2.1 General Structure

The database has a hierarchical structure.

- Folders
  - Projects
    - Objects

Objects hold the basic data (meta data, images, ...) within the database. They can be modified, explored, analysed or exported. To create a new object, you have to use one of the import functions which are provided by the *File* → *New* menu. The import functions are described later in this manual.

Folders are intended for different users. Each user has its folder where he/she can organize his/her projects. Captured images (or objects) are stored in several projects.



Database View

1. switch actual view (texture image, depth image, ...; not every view is available at any time)
2. open database
3. start the measurement module for selected object
4. selected object; double click for opening
5. folder
6. project
7. database structure
8. object
9. database content (project)

You can always display the database by calling *View* → *Database* from the menu. To view an object within the database, you can simply double-click the image icon that represents it in the project content view and it will be displayed.


View Tools

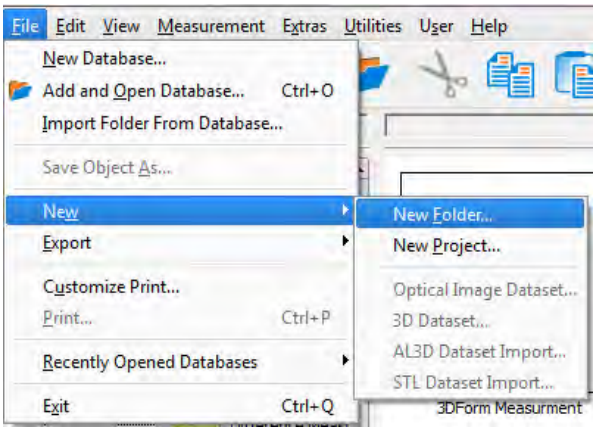
1. Start IF-EdgeMasterModule (might not be included in your package)
2. Start IF-LaboratoryMeasurementModule
3. Show database
4. Show texture image of the selected object
5. Show 3D dataset of the selected object

If the object has a digital elevation model, you can also select: *View* → *Digital Elevation Model* to view a 3D model of the surface of the specimen. This function is also available if you click on the object with the right mouse

button and select the sub menu *Display*. Other elements of an object are accessible through *View* → *[Texture/Depth Image, ...]* if available. You can also find the measurement functions in the context menu in the sub menu *Measurement*.

## 2.2 Creating and Editing Folders

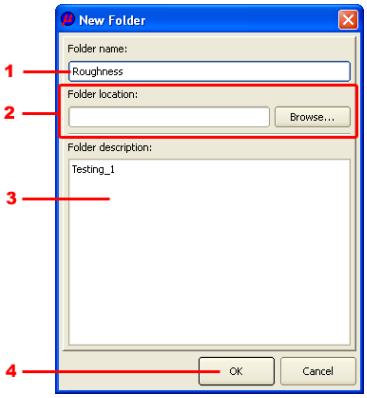
In order to create a new folder select *File* → *New* → *Folder...* from the menu.




Create New Folder

This will open a dialog where you can create a new folder. The first thing you have to do is to give the folder a name. Each folder must have a unique name within the database. Different folders are intended for different users or different specimen categories.

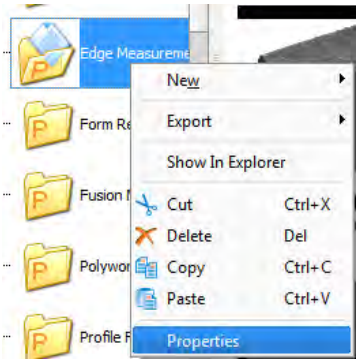
Optionally, you can assign a location for the folder on your harddisk where all the data belonging to this folder should be stored. If, for example, you plan to include huge amounts of image data into a folder, you might want to store this folder somewhere on a machine, on your network, which has enough hard disk capacity. If you leave the folder location field empty, a default location is taken. You can also store some descriptive data with your folder.




New Folder

1. enter folder name
2. normally enter nothing; used for creating an "external folder" = folder that is not stored in the database tree
3. enter optional description
4. press *OK* to create the folder

To edit a folder click on it with the right mouse button and select *Properties*. You can also *Copy*, *Paste* and *Delete* folders or export them to another disk location. These functions are also available in the *Edit* menu.

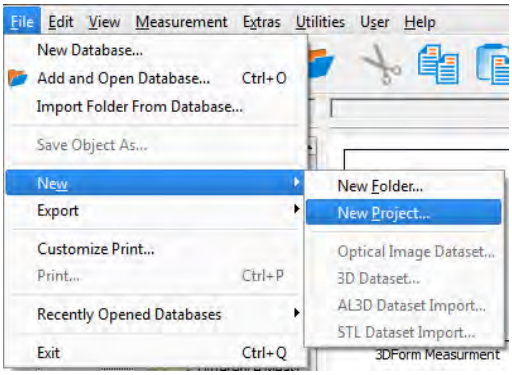



Folder Properties

## 2.3 Creating and Editing Projects

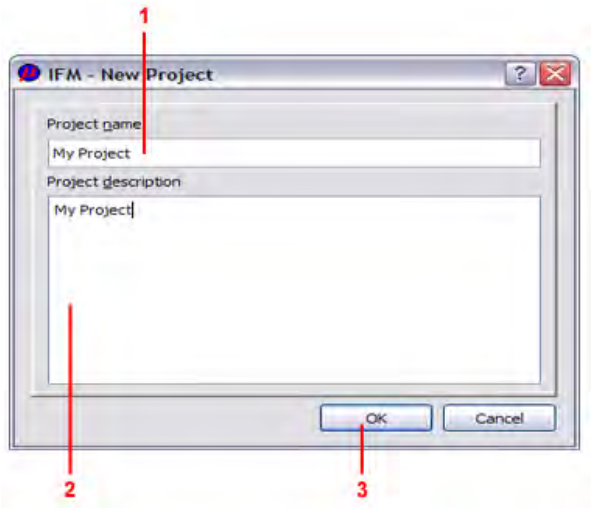
In order to create a new project select from the menu: *File* → *New* → *Project...*

This operation can only be performed if you have already selected a folder where you would like to store your project.




New Project

Now you can create a new project using the new project dialog. You have to give your project a name. Again the project name has to be unique within a specific folder. Optionally, you can also give a description to your project.




Name Selection

1. enter project name

2. enter optional description

3. press *OK* to create the project

To edit a project click on it with the right mouse button and select *Properties*. You can also *Copy, Paste* and *Delete* folders or export it to another disk location. These functions are also available in the *Edit* menu.

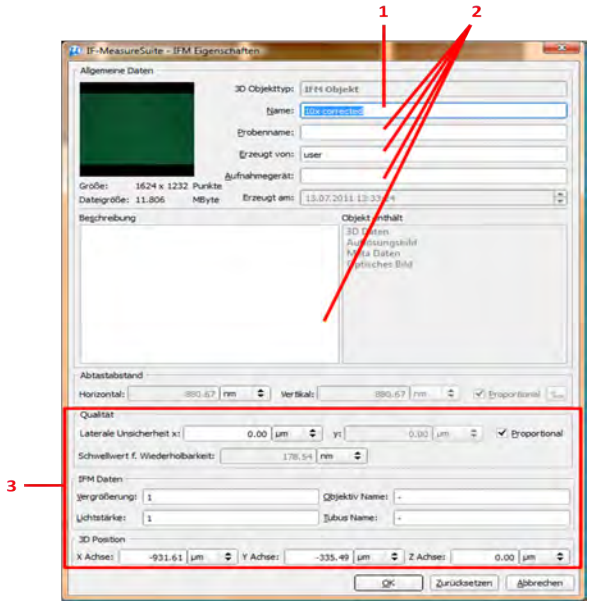
## 2.4 Save measurement results

If the measurement process is finished, the measurement result will be presented in a viewer (see illustration). The shown object can be stored in the current database (please read the database instructions for more information). If you want to go back to the Live View, choose *View* → *Live Image* from the menu or press the IF-Laboratory-MeasurementModule icon (  ) on top of the window. To go to the database invoke *View* → *Database* or the button  . To save the shown object, select *File* → *Save Object As...* from the menu and the project selection dialog will appear. Select a project in a folder to specify the save location and press OK. Afterwards, you will be asked to enter a valid name for the object (Name Dialog). Just enter a valid name and press *OK* again. If you change the view without saving, you will be asked if you want to save first.

## 2.5 Editing Objects

You can cut, copy, paste and delete Objects. To move an object from one folder to another, select (click) a desired object and use *Edit* → *Cut* from the menu. Select another folder and use *Edit* → *Paste* from the menu or from the object's context menu (click with the right mouse button on the object). You can also grab objects and drag them on another folder to move them to this location. The other functions work analogous.

To modify or examine objects properties, select *Edit* → *Properties* from the menu and the properties dialog will open. Change some data if you want and press *OK* to commit your changes, *Reset* to restore all modified values and *Cancel* to abort the operation. Some data fields are optional and some have to be filled out, otherwise you can't commit. Depending on the object you can modify more or less data.




Data Properties

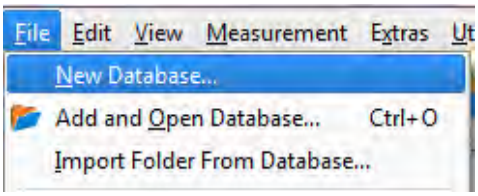
1. enter database name
2. extended object description
3. extended options; different fields for different datasets

### 2.5.1 Specify Qualities in Properties

The specification of qualities for the calibration parameters gives you a way to judge the effect of inaccuracies in the calibration parameters onto the final measurements. You can specify a range of values for the *sampling distance,* the *tilt angle* and the *working distance.* Once you have specified possible deviations for the calibration parameters, you get an accuracy statement for your measurement values in the measurement modules. Please note that qualities values are only handled for stereopairs at the moment.

## 2.6 Open and Create a Database

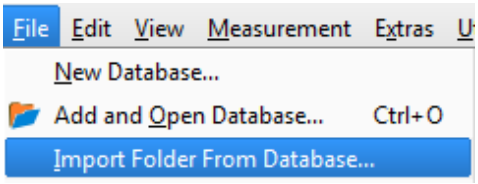
You can open other existing databases or create entirely new ones. Simply select *File* → *New Database* or *File* → *Open Database* to do so. A file dialog will appear. Simply choose a database file you want to create or open. **Note:** You should not create two databases in the same directory and you can't create a database in a database subfolder!




New Database

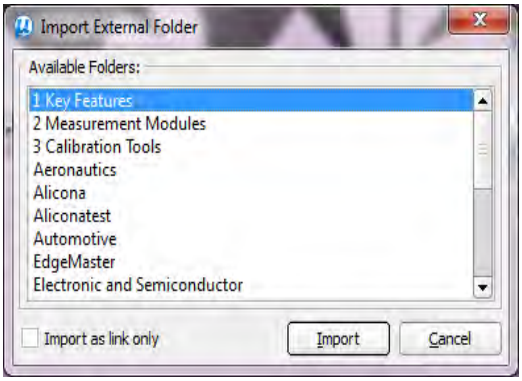
## 2.7 Folder Import

There is the possibility to import folders from other databases (external folders) into the current database. To start this action select *File* → *Import folder* from database... from the menu bar. Please note that this import function works like the icons on your desktop. It creates a kind of symbolic link that points to a location of another database. If you delete this external database or move it to another location, all folders you have imported from this database will disappear.




Import Folder

Immediately after you have activated the function in the menu a open dialog will be shown. With this dialog you can select the database (database file) from which you want to import a folder. Now select the a database file from a existing database and click on *Open*. The open dialog closes and an import dialog comes up. This dialog displays a list with all available local folders from the chosen database.




Import External Folder

Simply select the folders you want to import from the list by clicking on the names in the list and press *Import*.

# Chapter 3

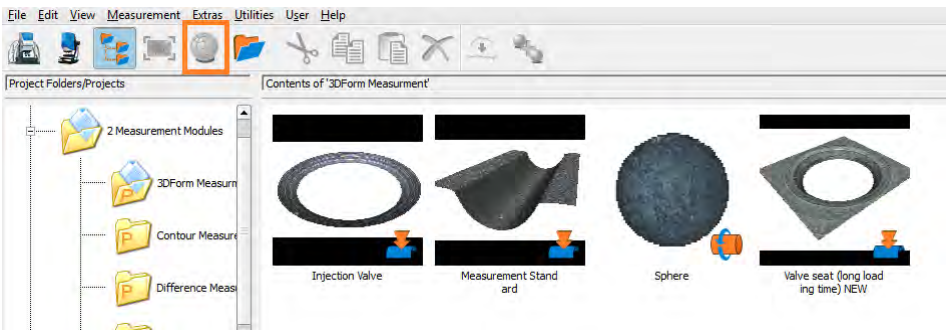
# Object Viewers

## 3.1 3D-Viewer

The 3D-Viewer can be opened to view a dataset from different perspectives. Additionally it is used in many different measurement modules for the 3D-view of the dataset.

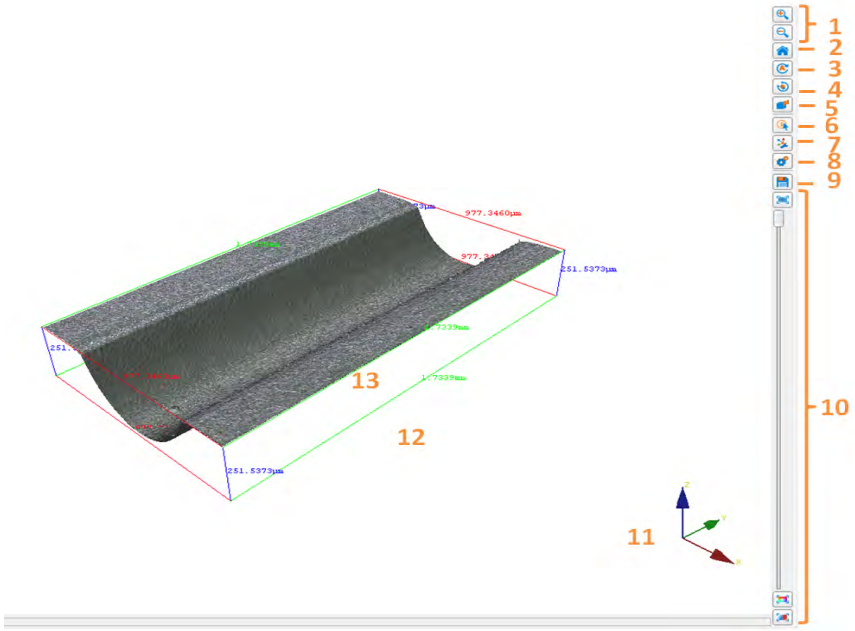
### 3.1.1 Starting the 3D-Viewer

Move to the database view. First select the dataset by clicking. Then start the 3D-Viewer with a click on the 3D-Viewer icon or simply double click the dataset.




Highlighted 3D-Viewer Icon

### 3.1.2 Operating the 3D-Viewer

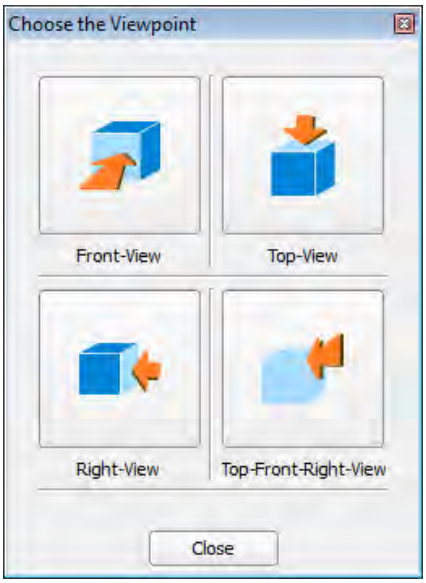



3D-Viewer Screenshot

1. Zoom in/out (zoom in/out also works via scrolling the mouse wheel)
2. Resets the dataset view to the default position
3. Automatic rotation function (Click and move the mouse - as a result the dataset will rotate automatically)
4. Adjust center of rotation
5. View point selection (see chapter on view point selection)
6. Information about a certain point (see chapter on single point information)
7. Adjust workpiece coordinate system (see chapter on workpiece coordinate system)
8. Viewer settings (see chapter on viewer settings)
9. Export function
10. view texture only, true color /pseudo color and anaglyph view (see chapter on view options)
11. Axis orientation of the dataset
12. Bounding box with brief size description
13. Loaded dataset

### 3.1.3 View Point Selection

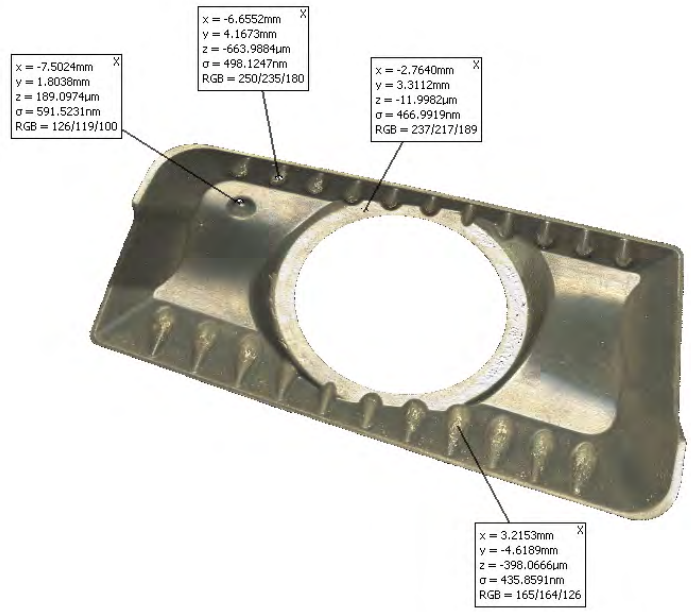
This window allows viewing the dataset from predefined perspectives. Through this dialog you have a quick access to the front view, the top view, the view from the right side and from the upper right corner.




View Point Selection

### 3.1.4 Single Point Information

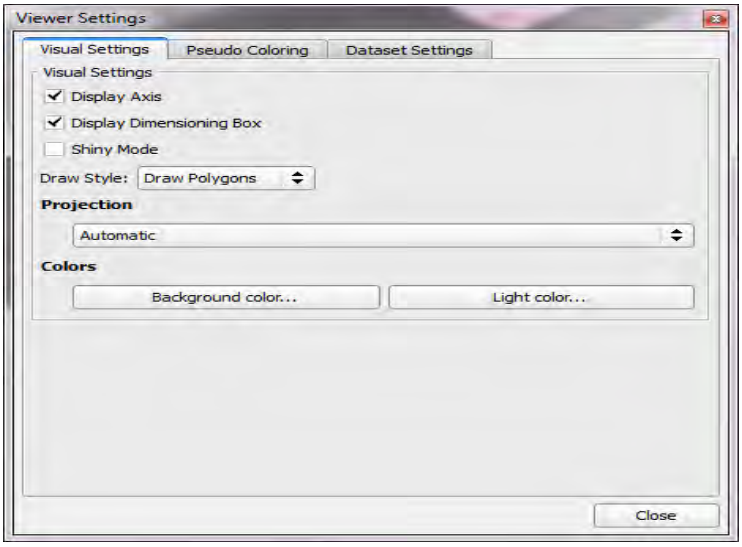
If this tool is activated and a single click into the dataset is performed an information box will appear in the 3D viewer. This box states the x/y and z coordinates of this measure point as well as its repeatability and RGB color. If a difference dataset has been opened up the deviation to the original dataset for this single point will be displayed as well.




Single Point Information

### 3.1.5 Viewer Settings

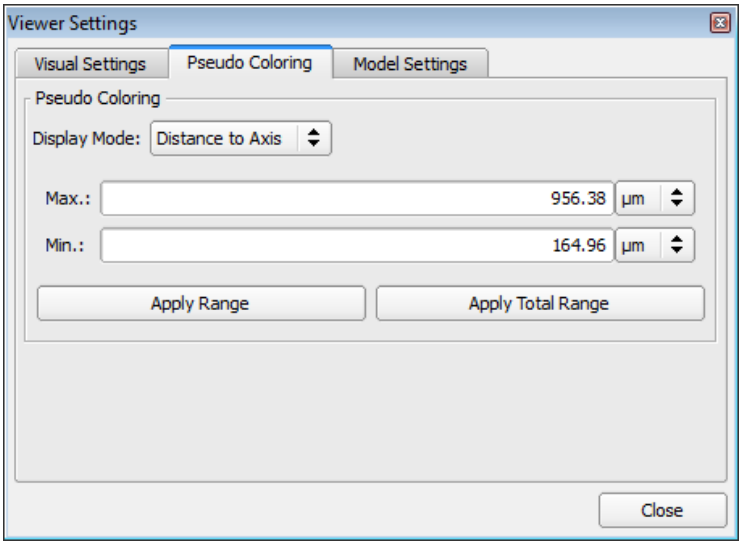
- **Visual Settings**




Visual Settings

This tab includes options for visualization only. These settings do not have any impact on the measurement.
The projection can be set automatic, always perspective or always parallel.

- **Pseudo Coloring**



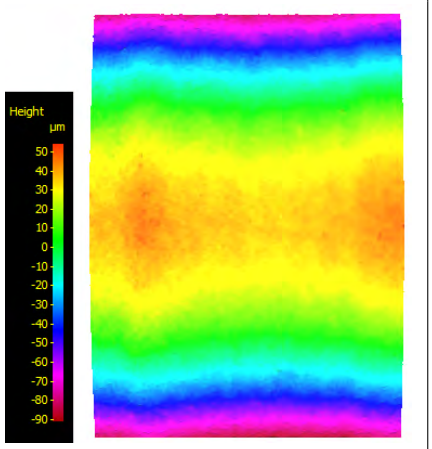

Pseudo Coloring

Activate the pseudo color view before you adjust the parameters within this dialog.

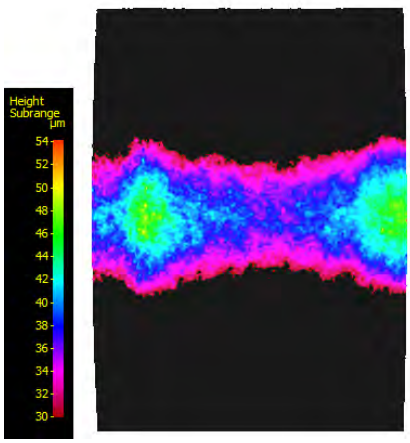
Different display modes can be selected:

- Distance to Axis
- Height
- No Color
- Repeatability
- Original Dataset Color
- Deviation

Additionally the range for the pseudo colors can be adjusted within this dialog.

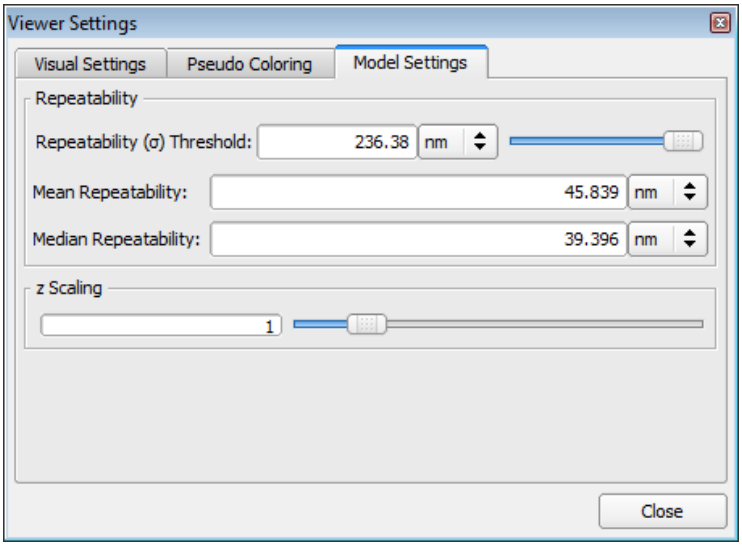



Default pseudo colors



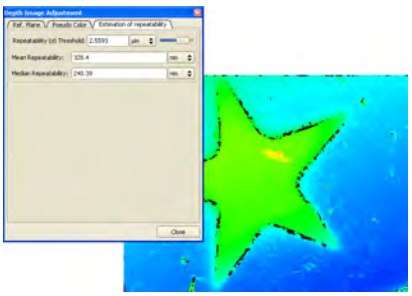

Reduced pseudo color range for detailed views

- **Model Settings**

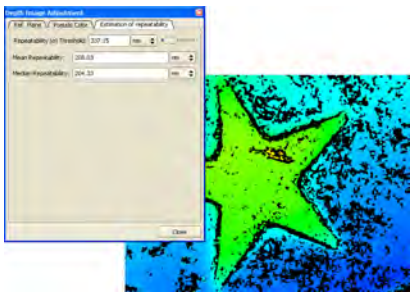



Model Settings

The slider for adjusting the repeatability threshold is displayed on top. The repeatability information helps the user to accomplish the measurement only with the best 3d-points. The system estimates repeatability during the measurement time and stores the information to each 3d-point. Additional information is provided in the publication from R. Danzl, F.Helmli, S. Scherer: "Automatic Measurement of Calibration Standards with Arrays of Hemi-Spherical Calottes", Proc. 11th Int. Conf. on Metrology and Properties of Engineering Surfaces, 2007, S. 41-46.



Before Modification



After Modification

**Result of Measurement:**

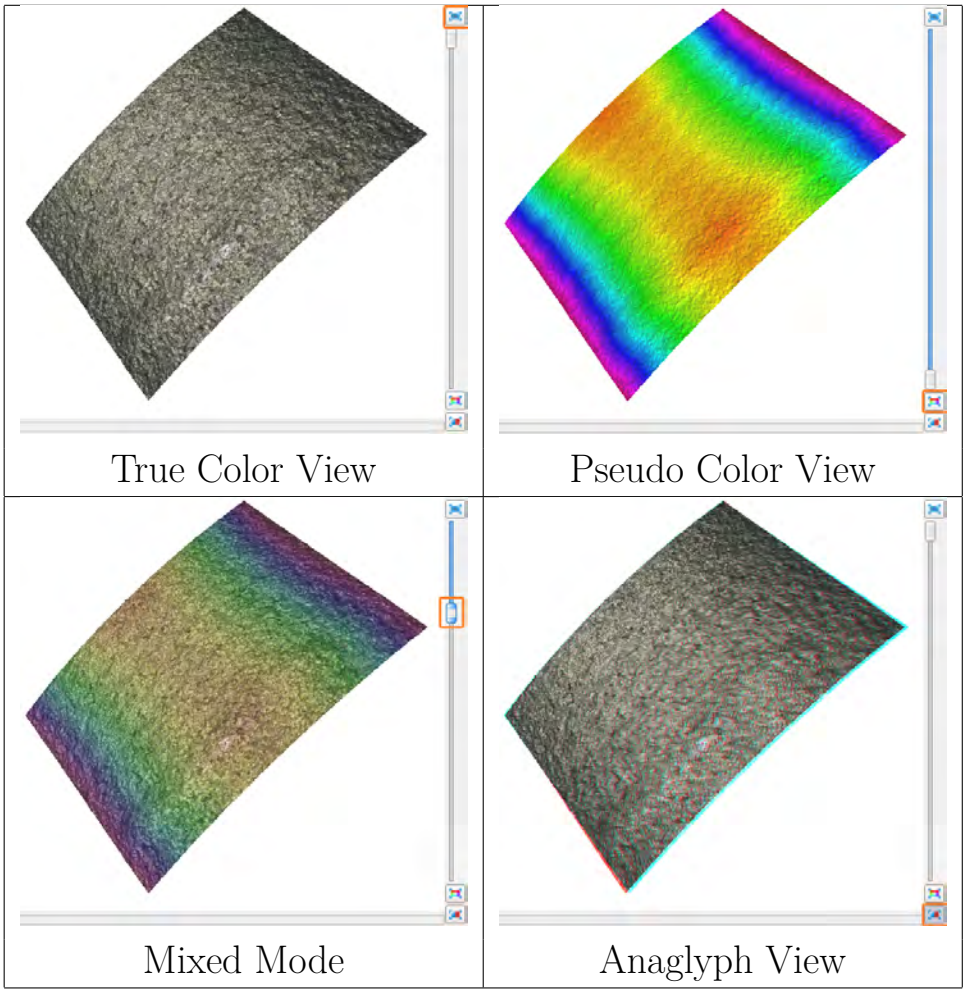
- XYZ coordinates
- Color information for each point
- Repeatability information for each point ( metric)

**Repeatability can be used for:**

- Getting information of the quality of the measurement
- Filter the bad points and keep only the good ones.

The slider for the z-scaling allows scaling the dataset only in z-direction. This scaling factor is only for visualization purposes.

### 3.1.6 View Options




## 3.2 2D-Viewer

The 2D-Viewer can be opened to view the optical image of a dataset. Additionally it is used in many different measurement modules for the optical image view of the dataset.

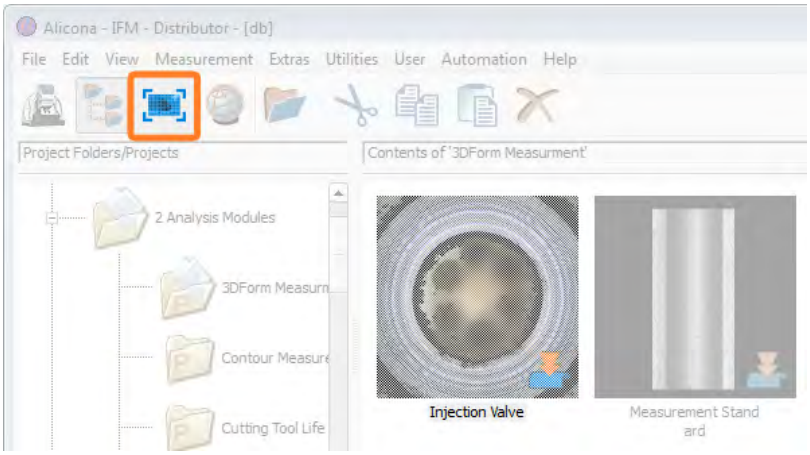
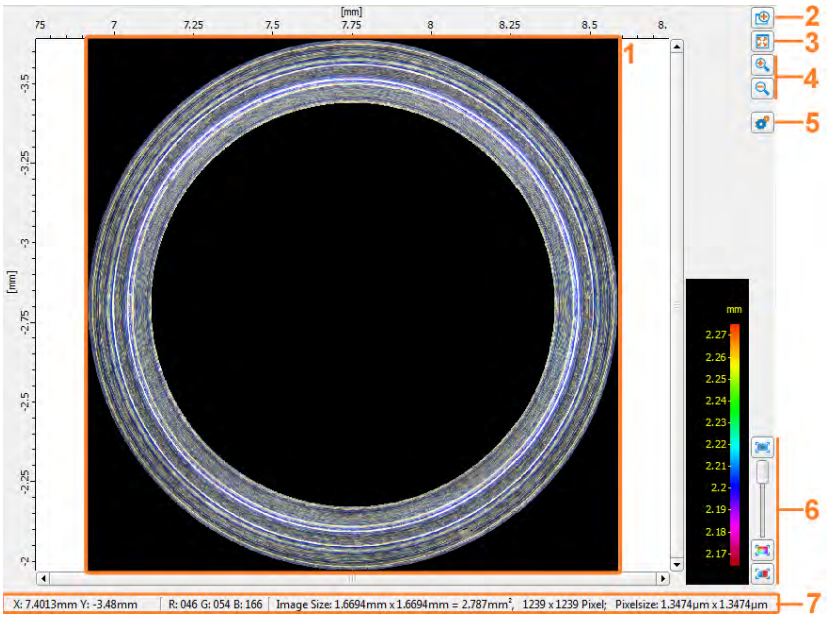



Figure 3.1: Highlighted 2D-Viewer Icon

### 3.2.1 Starting the 2D-Viewer

Move to the database view. First select the dataset by clicking. Then start the 2D-Viewer with a click on the 2D-Viewer icon or with the menu entry *View/Optical Color Image.*

### 3.2.2 Operating the 2D-Viewer



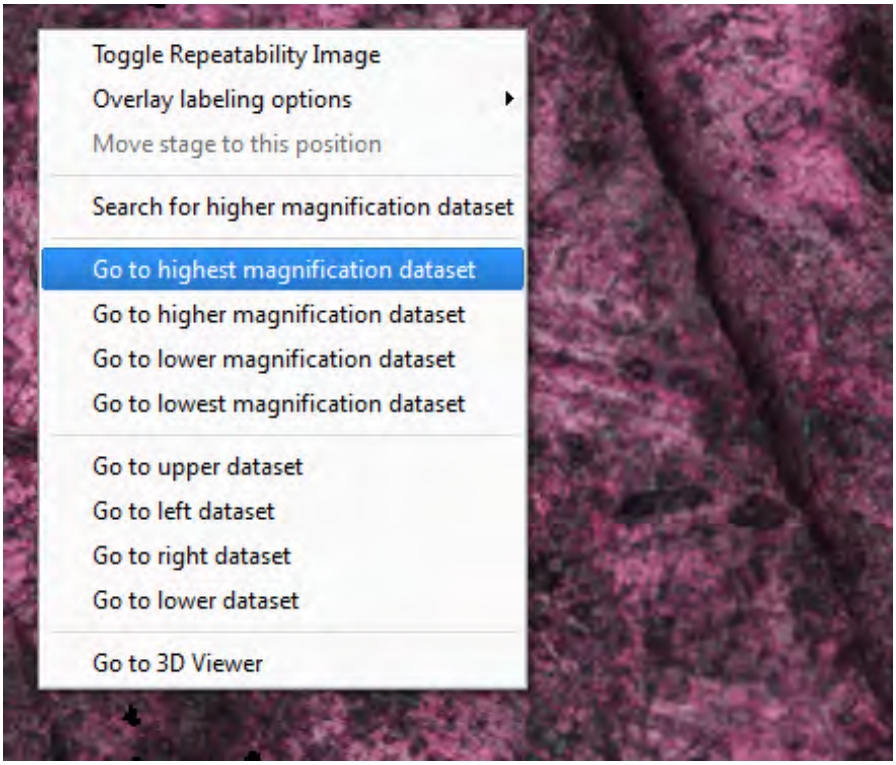

2D-Viewer Screenshot

1. Loaded dataset
2. Zoomwindow
3. Fit the optical image into the window

4. Zoom in/out (zoom in/out also works via scrolling the mouse wheel)
5. Viewer settings (see chapter on viewer settings of 3D-Viewer)
6. True/pseudo color and anaglyph view (see chapter on view options of 3D-Viewer)
7. Point information to current cursor position, image size, sampling distance

### 3.2.3 Usage of 2D-Viewer for X-Large ImageField

To start navigation select the overview image in the database and open it in the 2D-Viewer. With a right click on the dataset a context menu opens up. This can be used for navigation of an X-Large ImageFiled. You can then browse through the different accuracy levels and datasets.




Context Menu X-Large ImageField

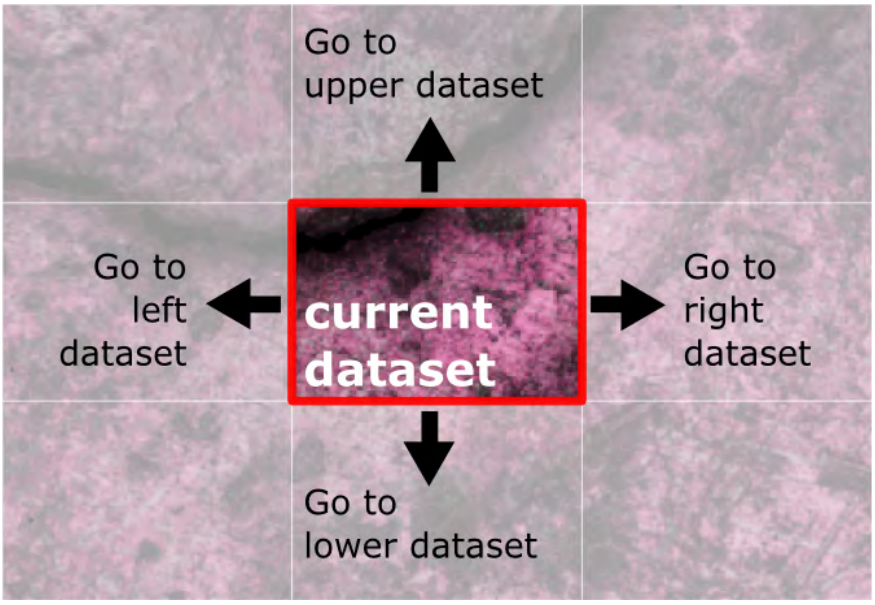
#### Accuracy Navigation

- Go to highest. magnification dataset - Overview dataset
- Go to higher magnification dataset - change to a less detailed dataset

- Go to lower magnification dataset - change to a more detailed dataset
- Go to lowest magnification dataset - Dataset with highest resolution

### Lateral Navigation in this Accuracy Level

- Go to upper dataset
- Go to left dataset
- Go to right dataset
- Go to lower dataset




Lateral Navigation in an X-Large ImageField

# Chapter 4

# Measurement Modules

## 4.1 Brief Description of All Measurement Modules

| | Surface-Dataset | Real3D-Dataset |
|---|---|---|
| ProfileFormMeasurement | x | |
| ProfileRoughnessMeasurement | x | |
| SurfaceTextureMeasurement | x | |
| VolumeMeasurement | x | |
| ContourMeasurement | x | x |
| 3DFormMeasurement | x | x |
| DifferenceMeasurement | x | x |
| 2DImageMeasurement | x | |
| Alicona Inspect | x | x |

- **ProfileFormMeasurement**
  A free definable profile is extracted for this measurement. The extracted profile path can be measured with a selection of manual as well as automatic measurement modes.

- **ProfileRoughnessMeasurement**
  A free definable profile is extracted for this measurement. This measurement module allows to calculate roughness and waviness values of the extracted profile.

- **SurfaceTextureMeasurement**
  The surface can be assayed for roughness and waviness. This measurement outputs a variety of roughness parameters conforming to international standards. Result values are: Sa, Sq, Sz,...

- **VolumeMeasurement**
  The volume measurement is a tool that calculates the volume of a defined area or the whole object.

- **ContourMeasurement**
  With this measurement a free definable cutting layer can be placed into the object. Circles, angles, lines... are measured within the extracted profile. Furthermore the rotundity of cylindrical objects can be determined.

- **3DFormMeasurement**
  Geometrical shapes like spheres, cones, cylinders etc. of a measured dataset can be measured. This measurement calculates the deviation from the measured dataset to the geometric object.

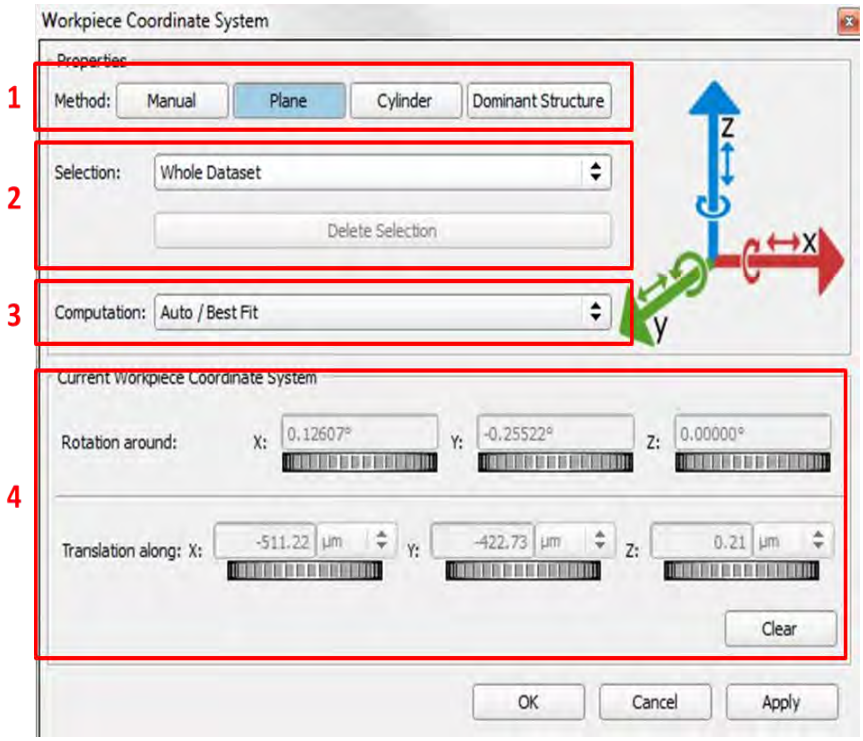
- **DifferenceMeasurement**
  Two SurfaceDatasets or Real3D-Datasets can be compared. Thereby deviations such as difference volume, difference area and difference height can be determined and measured.

- **2DImageMeasurement**
  The image measurement is a tool for two dimensional measurements of digital surfaces and images. It allows manual and automatic image measurements.

- **Alicona Inspect**
  Provideds further 2D and 3D measurement options including GD& T, reporting and trend analysis.

Note: If you load very large datasets in the measurement modules, the dataset will be reduced automatically if the size exceeds a certain limit. During this reduction no original data is lost, i.e. the original dataset in the database will not be changed.

## 4.2 Workpiece Coordinate System




Adjust Workpiece Coordinate System

1. Method: Choose which way you would like to adjust the cutting plane
2. Selection: Depending on the dataset either the whole dataset is selected for the workpiece adjustment or only an area.
3. Computation: in most cases *Automatic/Best Fit* delivers the best results
4. Current Workpiece Coordinate System: this is just for your information except you have chosen the *manual* method

### 4.2.1 Method

Dependent on the dataset and the following measurement a method needs to be selected. Available methods are

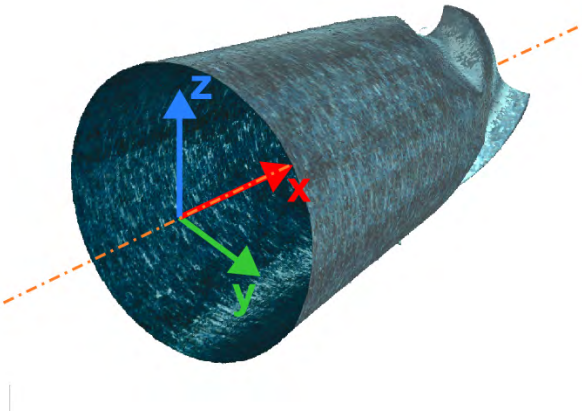
- Manual: In this mode, the translation and rotation can be adapted manually.
- Plane: In this mode, a reference plane is used for adaption. Here the whole dataset or a selection can be used for adjustment.

- Cylinder: In this mode, a reference cylinder is used for adaption. Here the whole dataset or a selection can be used for adjustment.

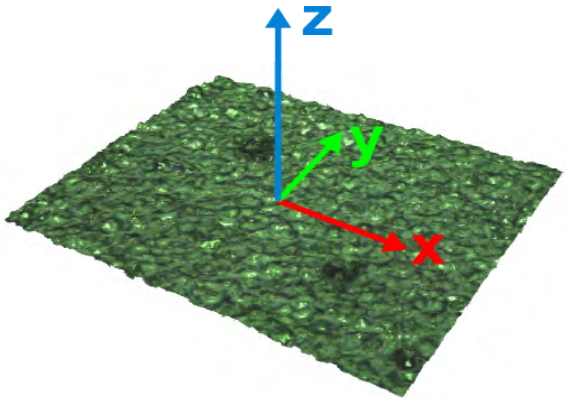
- Dominant structure: In this mode, dominant structure as edges or grooves are used for adaption.

Example: For roughness measurements of a plane surface the mode *plane* has to be selected. For form measurements of a shaft of a milling cutter's shaft the cylinder method shall be used.

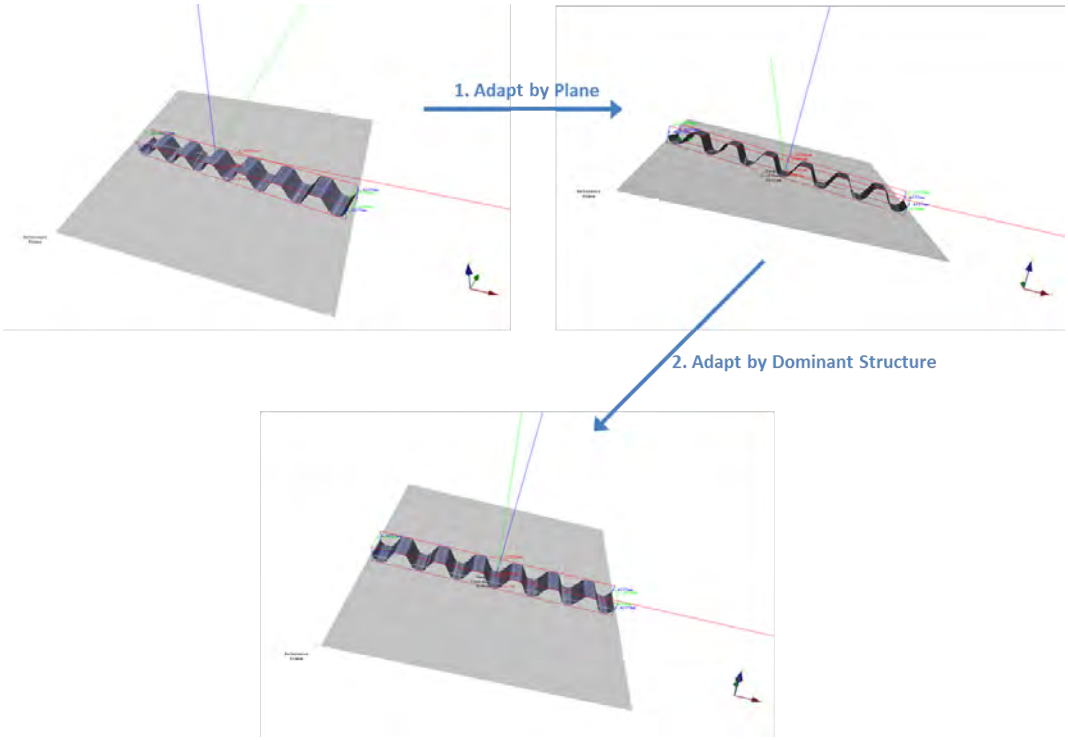
**Please note that when you use the method *Cylinder* on a surface dataset, the dataset might be rotated by 90° after the coordinate system adjustment.**




Method: Cylinder




Method Plane




Method Dominant Structure
1) Define on axis by plane adaption
2) Define other axis by dominant structure adaption

### 4.2.2 Selection

- **Select Region:** With this button a specific area of the dataset can be selected. This area will be used for the reference plane/reference cylinder calculation.
- **Select Whole Dataset:** If this button is activated all 3D-points are used for the reference plane/reference cylinder calculation.

### 4.2.3 Computation

- **Automatic/Best Fit:** This method uses all points of the dataset for adjusting the reference plane/reference cylinder. It is faster than the robust method but doesn't lead to results as good as the robust method on some datasets. Peaks/valleys in the model will influence the calculation of the reference plane and lead to non-optimal results.
- **Automatic Robust:** The robust method is not influenced by peaks/ valleys and will lead to a reference plane/reference cylinder that is well fitted onto the even part of the dataset. The robust method of the

reference plane needs a longer calculation time than the calculation from all points.

### 4.2.4 Current Workpiece Coordinate System

Within this area the rotations and translations according to the world coordinate system are displayed. If the "manual" mode is selected the workpiece coordinate system can be altered by turning on these wheels.

## 4.3 Choose the Correct Module for Roughness Measurements

Depending on the following parameters ProfileRoughnessMeasurement or SurfaceTextureMeasurement should be chosen:

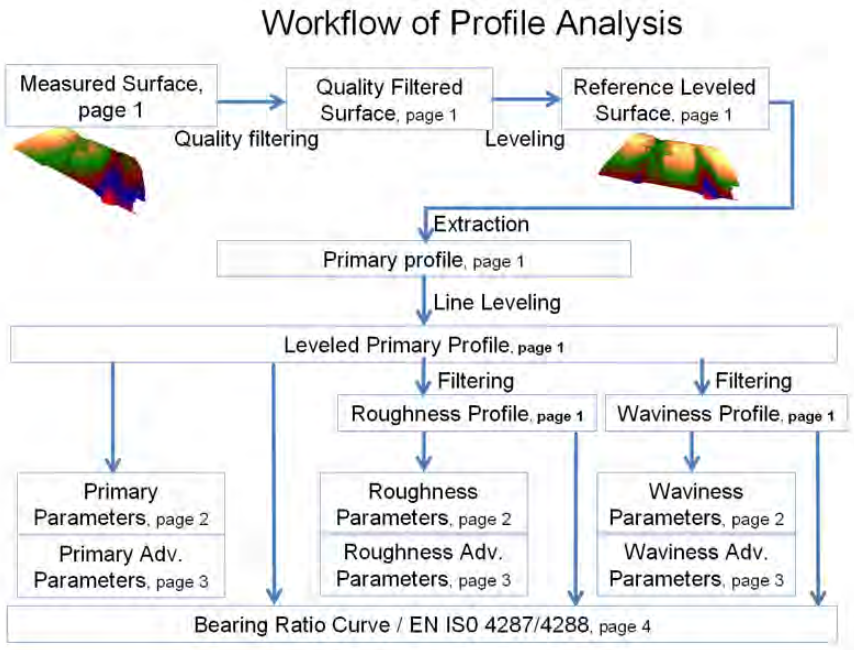
| **Criterion** | **ProfileRoughness-Measurement** | **SurfaceTexture-Measurement** |
|---|---|---|
| Popularity | Well known | New |
| Background | ISO 4287, 4288 | Surfstand book |
| Repeatability | medium | high |
| Measured area | small | large |
| Result values | Ra, Rq, Rz | Sa, Sq, Sz |
| Surface structure | With direction | Without direction |

Specific examples of when to use ProfileRoughnessMeasurement or the SurfaceTextureMeasurement:

- ProfileRoughnessMeasurement
  - Turned surfaces
  - Twist measurement
  - Roughness measurement that must be compared with a tactile instrument
- SurfaceTextureMeasurement
  - Measurement of the flatness of a surface
  - Measurement of the roughness of paper
  - Surfaces with random surface texture

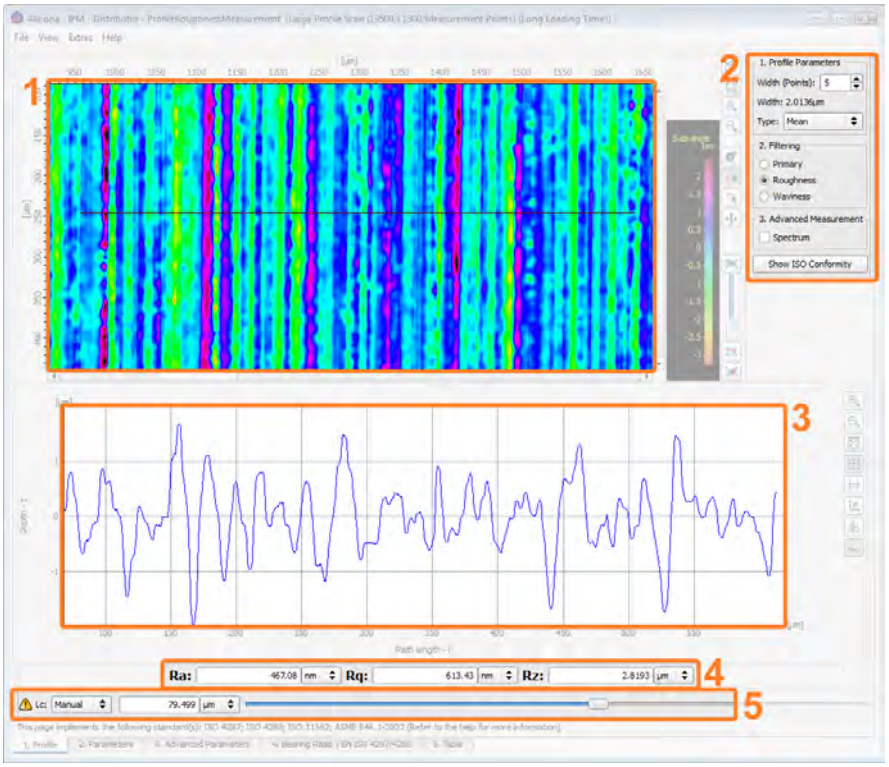
## 4.4 ProfileRoughnessMeasurement

In the following image you see an overview how the ProfileRoughnessMeasurement is working and which functions and parameters you find on the different tabs.




Workflow - ProfileRoughnessMeasurement

To measure the roughness of a profile please select *Measurement→ ProfileRoughnessMeasurement* from the menu bar.




ProfileRoughnessMeasurement

1. 2D-optical image of a loaded dataset with extracted profile line
2. Measurement settings
3. Extracted roughness profile
4. Measured Ra, Rq and Rz value
5. Slider to adjust the Lc value

The ProfileRoughnessMeasurement consists of a number of tabs that provide you with different levels of information about the specified profiles.

1. tab *Profile*: Main screen of the ProfileRoughnessMeasurement module. Used to specify the path along you wish to extract your profiles. Furthermore, it allows you to filter and measure within the extracted profiles.
2. tab *Parameters*: several statistical measurements of the current profile.
3. tab *Advanced Parameters*: additional information about statistical values of the profile.

4. tab *Bearing Ratio/EN ISO 4287/4288* : bearing ratio curve and material ratio parameters.

5. tab *Table*: numerical values of the current profile in tabular form.

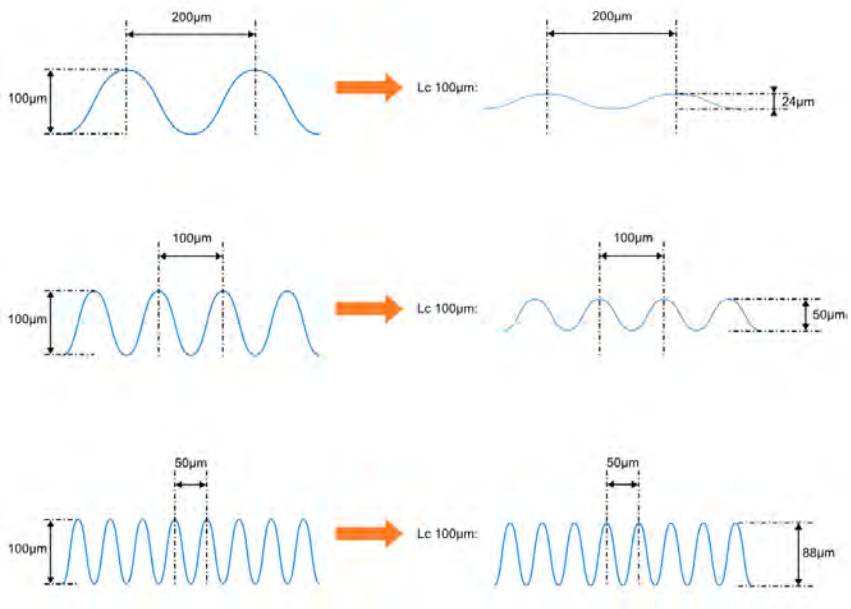
During the profile specification you can remove the last set point using the *Del* key. Once you have specified a profile, you also have the possibility to apply two filters to it:

- A *roughness* filter is used to eliminate low frequency components from the profile. It basically acts like a high-pass filter.
- A *waviness* filter is used to eliminate high frequency components from the profile. It basically acts like a low-pass filter.

The filter cutoff wavelength is given in micrometers. Frequency components having a wavelength equal to the cutoff wavelength will be reduced to 50% of their original amplitude. Note: In order to avoid disturbing border effects, 10% of the primary profile at the beginning and the end of the profile path are not included in the filtered profiles.

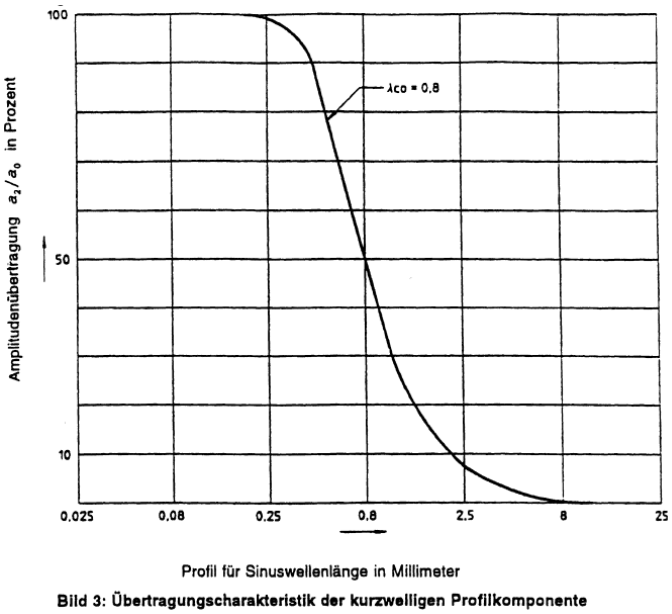
### Filter Characteristic for Lc Filterings

For the roughness filtering a filter of first-order is used. With this filter the features with a wave lenght close to the Lc-value will be damped. On basis of the following example it is shown how the filter characteristic impacts certain wave lenghts.



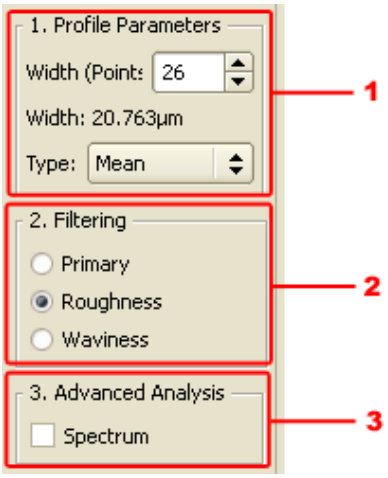

Impact Of the Filter Characteristic

These examples are conform to the ISO 16610-21 for surface texture. The impact of this filter characteristic can be read out of the following figure. The filter characteristic can be characterized by the following curve.




Filter Characteristic At an Lc Of 800$\mu$m

Some settings concerning the profile like its type and width can be adjusted:



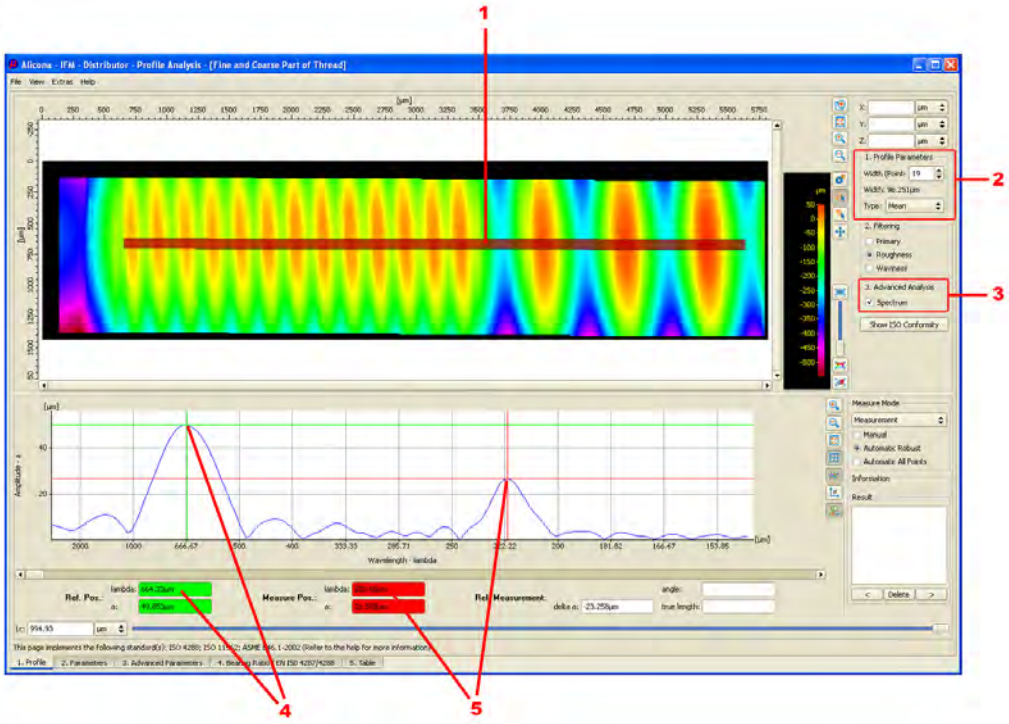

Adjust Profile Settings

1. select extraction parameters
2. select profile type
3. activate spectrum extraction

### The Profile Viewer - Spectrum Measurement

The ProfileRoughnessMeasurement is able to calculate the spectrum of a profile. This can be calculated from the primary, roughness or waviness profile. The calculation is done by using the Fast Fourier Transform (FFT) of the profile with zero padding. The result is the square root of the real and the imaginary part of the FFT results. Use the spectrum analysis to measure periodical intervals of a profile.

To start a spectrum measurement you have to switch to the spectrum measurement mode first.



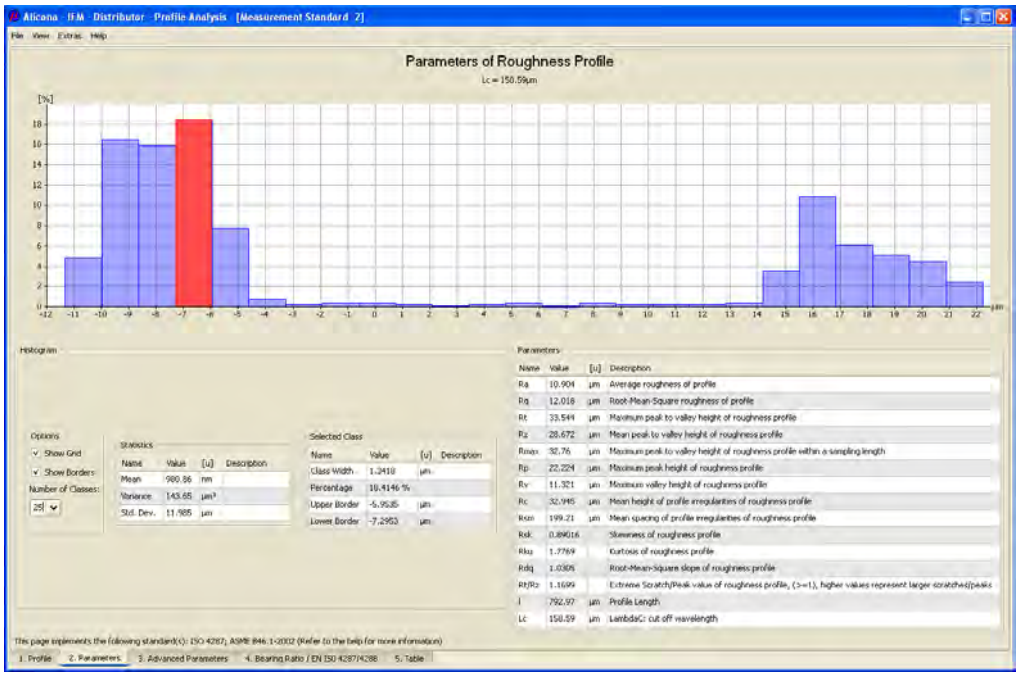

Spectrum Measurement

In this example you have to do the following steps:

1. Set a profile inside the image (the transparent red line or polygon)
2. Set the width and the type of the red measurement line
3. Activate *Spectrum* checkbox in the *Advanced Measurement* section to display the spectrum curve
4. The first significant wavelength in this example is 664,33 $\mu$m (see green line and green lambda value).
5. The second significant wavelength in this example is 220,95$\mu$ m (see red line red lambda value).

### 4.4.1 Tab *Parameters*

The tab Profile Parameters is used to display various statistical values of the currently active profile. At the moment, only the z value of the profile is used to compute the statistics.




Profile Statistics

Select the wanted class (vertical bar) to show any class information.

Values in the *Statistics* group:

- Arithmetic mean
- Variance
- Standard deviation

The first letter of the calculated values indicates whether the values are for a primary(P), roughness(R) or waviness(W) profile. The calculated values are:

- Pa/Ra/Wa: Average height of profile
- Pq/Rq/Wq: Root-Mean-Square height of profile
- Pt/Rt/Wt: Maximum peak to valley height of primary profile
- Pz/Rz/Wz: Mean peak to valley height of primary profile

- Pmax/Rmax/Wmax: Maximum peak to valley height of primary profile within a sampling length
- Pp/Rp/Wp: Maximum peak height of primary profile
- Pv/Rv/Wv: Maximum valley height of primary profile
- Pc/Rc/Wc: Mean height of profile irregularities of primary profile
- Psm/Rsm/Wsm: Mean spacing of profile irregularities of primary profile
- Psk/Rsk/Wsk: Skewness of primary profile
- Pku/Rku/Wku: Kurtosis of primary profile
- Pdq/Rdq/Wdq: Root-Mean-Square slope of primary profile

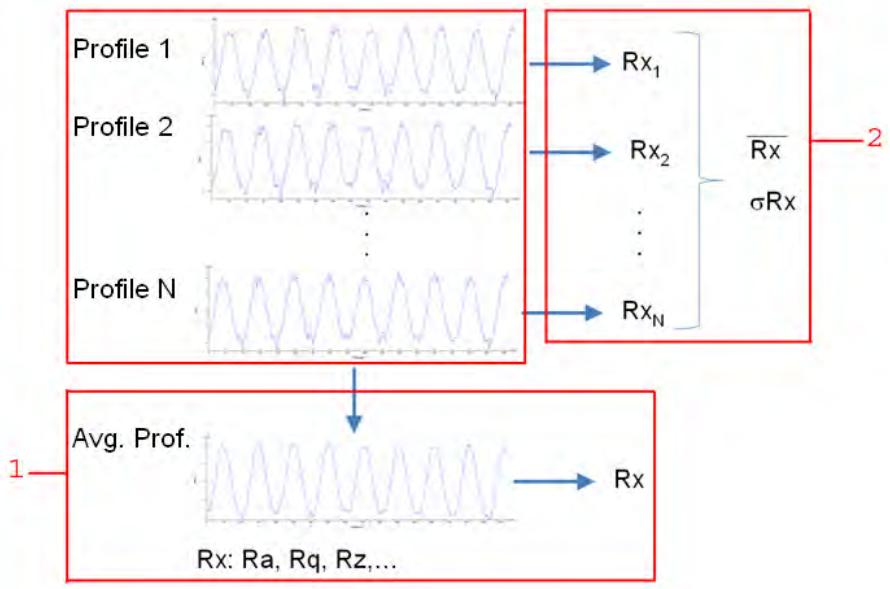
All values that are used to compute statistical values are additionally grouped into classes and displayed as a histogram. Each class information can be requested by clicking the class in the histogram view. The results of the red-colored class are displayed in the *selected class* group.

Values in the *Selected class* group:´

- Class index: Index of selected class
- Percentage: how many percent of all values used to compute the statistics fall within this class
- Upper border: upper bound of the actual class
- Lower border: lower bound of the actual class

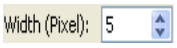
### 4.4.2 Tab *Advanced Parameters*

The tab Advanced Parameters shows statistical values as seen on the tab parameters calculated in a different way.




statistical calculation

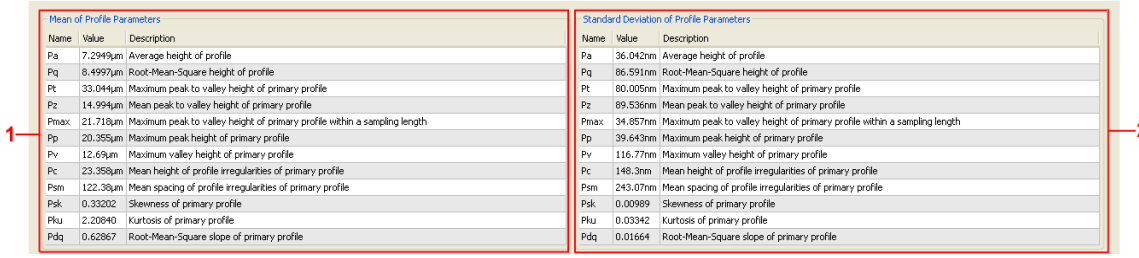
By choosing a profile at the tab Profile, depending on the adjusted profile width, several profiles are calculated




. E.g. a profile width of five points leads to five calculated profiles. The statistical parameters of the profiles can be calculated in different ways:

1. Out of these profiles an average profile is generated, which is used to calculate the statistical values. These results can be seen on the tab Parameter.

2. Each statistical value is separately calculated out of each single profile. Then the arithmetic mean and the standard deviation of these values are calculated. These results can be seen on the tab Advanced Parameters.




Mean of Profile Parameters

| Name | Value | Description |
|---|---|---|
| Pa | 7.2949µm | Average height of profile |
| Pq | 8.4997µm | Root-Mean-Square height of profile |
| Pt | 33.044µm | Maximum peak to valley height of primary profile |
| Pz | 14.994µm | Mean peak to valley height of primary profile |
| Pmax | 21.718µm | Maximum peak to valley height of primary profile within a sampling length |
| Pp | 20.355µm | Maximum peak height of primary profile |
| Pv | 12.69µm | Maximum valley height of primary profile |
| Pc | 23.358µm | Mean height of profile irregularities of primary profile |
| Psm | 122.38µm | Mean spacing of profile irregularities of primary profile |
| Psk | 0.33202 | Skewness of primary profile |
| Pku | 2.20840 | Kurtosis of primary profile |
| Pdq | 0.62867 | Root-Mean-Square slope of primary profile |

Standard Deviation of Profile Parameters

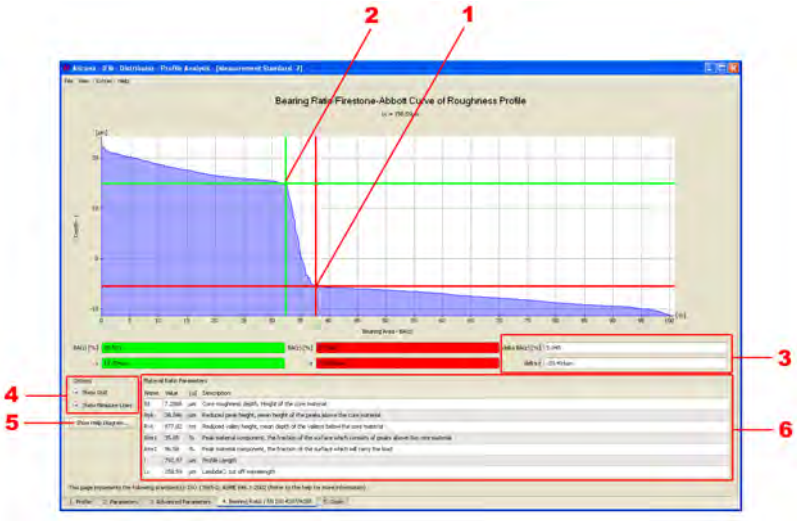
| Name | Value | Description |
|---|---|---|
| Pa | 36.042nm | Average height of profile |
| Pq | 86.591nm | Root-Mean-Square height of profile |
| Pt | 80.005nm | Maximum peak to valley height of primary profile |
| Pz | 89.536nm | Mean peak to valley height of primary profile |
| Pmax | 34.857nm | Maximum peak to valley height of primary profile within a sampling length |
| Pp | 39.643nm | Maximum peak height of primary profile |
| Pv | 116.77nm | Maximum valley height of primary profile |
| Pc | 148.3nm | Mean height of profile irregularities of primary profile |
| Psm | 243.07nm | Mean spacing of profile irregularities of primary profile |
| Psk | 0.00989 | Skewness of primary profile |
| Pku | 0.03342 | Kurtosis of primary profile |
| Pdq | 0.01664 | Root-Mean-Square slope of primary profile |

advanced parameters

1. Mean value of the profile parameters
2. Standard deviation of the profile parameters

### 4.4.3 Tab *Bearing Ratio/EN ISO 4287/4288*

The EN ISO 4287 standard is an international standard used to characterize surface profiles. It defines values for primary, roughness and waviness profiles. These profile types can be generated by setting different filters in the tab Profile Extraction.



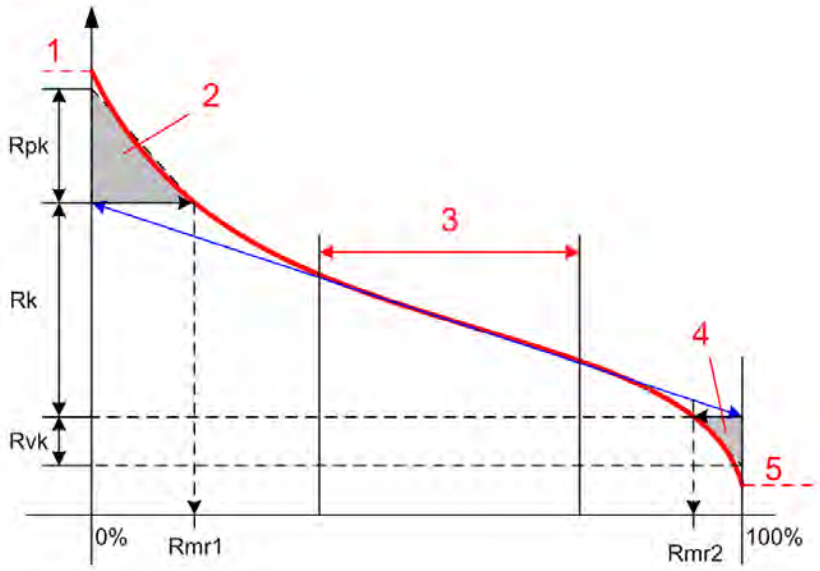

Bearing Ration Curve

1. Measurement position (red crosshair)
2. Reference position (green crosshair)
3. Values of the bearing ratio curve: Ba[z], z, delta
4. Options: Show / hide grid, Show / hide measure lines
5. Show Help Diagram...
6. Values of the bearing ratio curve

You will see the actual measure values after setting the red crosshair with a mouse click. To set a reference position (green crosshair) double click on the desired position or click with the middle button of your mouse. The delta values are only displayed if the green crosshair is set.

***Bearing Ratio Curve Parameters:*** The first letter (P, R, W) of the calculated values indicates whether the values are for a primary (P), roughness (R) or waviness (W) profile.

| Bearing Ratio Curve Parameters | | | |
|---|---|---|---|
| **Primary** | **Roughness** | **Waviness** | **Description** |
| Pk | Rk | Wk | Core roughness depth |
| Ppk | Rpk | Wpk | Reduced peak height |
| Pvk | Rvk | Wvk | Reduced valley height |
| Pmr1 | Rmr1 | Wmr1 | Peak material ratio 1 component in % |
| Pmr2 | Rmr2 | Wmr2 | Peak material ratio 2 component in % |
| - | Lc | Lc | LambdaC |

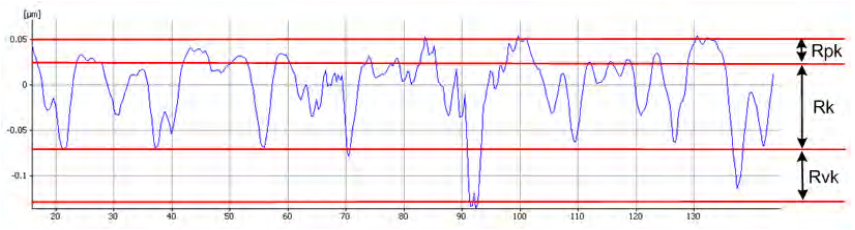



Bearing Ratio Curve Parameters

1. Maximal Height
2. Peak Area
3. 40% of minimum slope
4. Valley area
5. Minimal Height

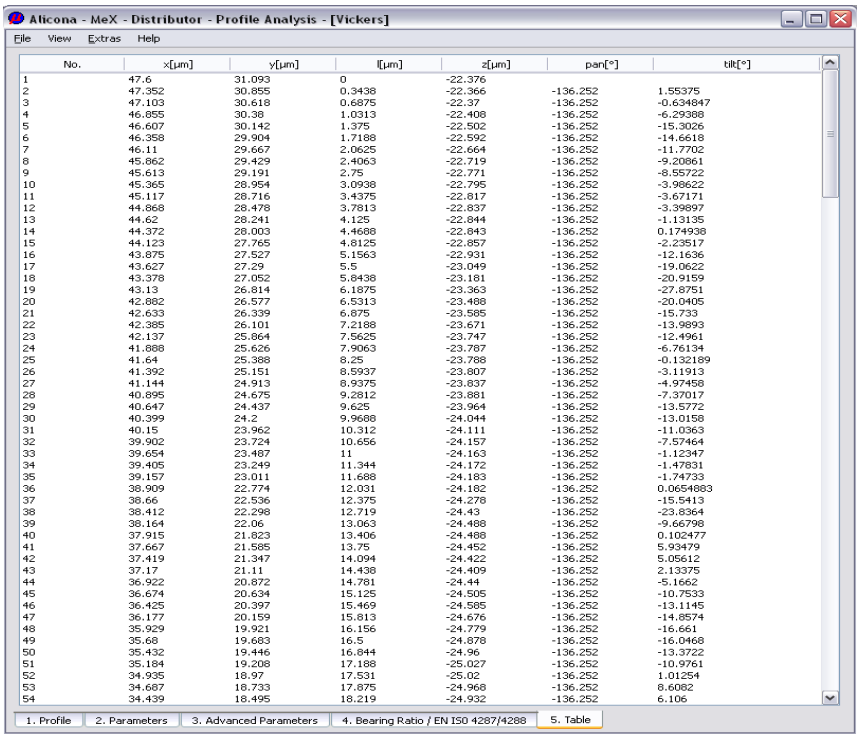
**The Algorithm Works As Follows:** A blue line is fitted into the red bearing curve in an ISO conform way. The cross points of this line with the vertical lines at 0% and 100% are determined. With this information the Rk, Rmr1 and Rmr2 are determined from these crossing points. The grey areas define the parameters Rpk and Rvk.

**Example for Rk, Rpk and Rvk Parameters:**




### 4.4.4 Tab *Table*

The tab Table displays the current profile values in tabular form.




| No. | x[µm] | y[µm] | l[µm] | z[µm] | pan[°] | tilt[°] |
|---|---|---|---|---|---|---|
| 1 | 47.6 | 31.093 | 0 | -22.376 | | |
| 2 | 47.352 | 30.855 | 0.3438 | -22.366 | -136.252 | 1.55375 |
| 3 | 47.103 | 30.618 | 0.6875 | -22.37 | -136.252 | -0.634847 |
| 4 | 46.855 | 30.38 | 1.0313 | -22.408 | -136.252 | -6.29388 |
| 5 | 46.607 | 30.142 | 1.375 | -22.502 | -136.252 | -15.3026 |
| 6 | 46.358 | 29.904 | 1.7188 | -22.592 | -136.252 | -14.6618 |
| 7 | 46.11 | 29.667 | 2.0625 | -22.664 | -136.252 | -11.7702 |
| 8 | 45.862 | 29.429 | 2.4063 | -22.719 | -136.252 | -9.20861 |
| 9 | 45.613 | 29.191 | 2.75 | -22.771 | -136.252 | -8.55722 |
| 10 | 45.365 | 28.954 | 3.0938 | -22.795 | -136.252 | -3.98622 |
| 11 | 45.117 | 28.716 | 3.4375 | -22.817 | -136.252 | -3.67171 |
| 12 | 44.868 | 28.478 | 3.7813 | -22.837 | -136.252 | -3.39897 |
| 13 | 44.62 | 28.241 | 4.125 | -22.844 | -136.252 | -1.13135 |
| 14 | 44.372 | 28.003 | 4.4688 | -22.843 | -136.252 | 0.174938 |
| 15 | 44.123 | 27.765 | 4.8125 | -22.857 | -136.252 | -2.23517 |
| 16 | 43.875 | 27.527 | 5.1563 | -22.931 | -136.252 | -12.1636 |
| 17 | 43.627 | 27.29 | 5.5 | -23.049 | -136.252 | -19.0622 |
| 18 | 43.378 | 27.052 | 5.8438 | -23.181 | -136.252 | -20.9159 |
| 19 | 43.13 | 26.814 | 6.1875 | -23.363 | -136.252 | -27.8751 |
| 20 | 42.882 | 26.577 | 6.5313 | -23.488 | -136.252 | -20.0405 |
| 21 | 42.633 | 26.339 | 6.875 | -23.585 | -136.252 | -15.733 |
| 22 | 42.385 | 26.101 | 7.2188 | -23.671 | -136.252 | -13.9893 |
| 23 | 42.137 | 25.864 | 7.5625 | -23.747 | -136.252 | -12.4961 |
| 24 | 41.888 | 25.626 | 7.9063 | -23.787 | -136.252 | -6.76134 |
| 25 | 41.64 | 25.388 | 8.25 | -23.788 | -136.252 | -0.132189 |
| 26 | 41.392 | 25.151 | 8.5937 | -23.807 | -136.252 | -3.11913 |
| 27 | 41.144 | 24.913 | 8.9375 | -23.837 | -136.252 | -4.97458 |
| 28 | 40.895 | 24.675 | 9.2812 | -23.881 | -136.252 | -7.37017 |
| 29 | 40.647 | 24.437 | 9.625 | -23.964 | -136.252 | -13.5772 |
| 30 | 40.399 | 24.2 | 9.9688 | -24.044 | -136.252 | -13.0158 |
| 31 | 40.15 | 23.962 | 10.312 | -24.111 | -136.252 | -11.0363 |
| 32 | 39.902 | 23.724 | 10.656 | -24.157 | -136.252 | -7.57464 |
| 33 | 39.654 | 23.487 | 11 | -24.163 | -136.252 | -1.12347 |
| 34 | 39.405 | 23.249 | 11.344 | -24.172 | -136.252 | -1.47831 |
| 35 | 39.157 | 23.011 | 11.688 | -24.183 | -136.252 | -1.74733 |
| 36 | 38.909 | 22.774 | 12.031 | -24.182 | -136.252 | 0.0654883 |
| 37 | 38.66 | 22.536 | 12.375 | -24.278 | -136.252 | -15.5413 |
| 38 | 38.412 | 22.298 | 12.719 | -24.43 | -136.252 | -23.8364 |
| 39 | 38.164 | 22.06 | 13.063 | -24.488 | -136.252 | -9.66798 |
| 40 | 37.915 | 21.823 | 13.406 | -24.488 | -136.252 | 0.102477 |
| 41 | 37.667 | 21.585 | 13.75 | -24.452 | -136.252 | 5.93479 |
| 42 | 37.419 | 21.347 | 14.094 | -24.422 | -136.252 | 5.05612 |
| 43 | 37.17 | 21.11 | 14.438 | -24.409 | -136.252 | 2.13375 |
| 44 | 36.922 | 20.872 | 14.781 | -24.44 | -136.252 | -5.1662 |
| 45 | 36.674 | 20.634 | 15.125 | -24.505 | -136.252 | -10.7533 |
| 46 | 36.425 | 20.397 | 15.469 | -24.585 | -136.252 | -13.1145 |
| 47 | 36.177 | 20.159 | 15.813 | -24.676 | -136.252 | -14.8574 |
| 48 | 35.929 | 19.921 | 16.156 | -24.779 | -136.252 | -16.661 |
| 49 | 35.68 | 19.683 | 16.5 | -24.878 | -136.252 | -16.0468 |
| 50 | 35.432 | 19.446 | 16.844 | -24.96 | -136.252 | -13.3722 |
| 51 | 35.184 | 19.208 | 17.188 | -25.027 | -136.252 | -10.9761 |
| 52 | 34.935 | 18.97 | 17.531 | -25.02 | -136.252 | 1.01254 |
| 53 | 34.687 | 18.733 | 17.875 | -24.968 | -136.252 | 8.6082 |
| 54 | 34.439 | 18.495 | 18.219 | -24.932 | -136.252 | 6.106 |

profile value table

The columns are:

1. No. : each measurement point on the profile gets numbered

2. x: the x-value of the 3D profile point

3. y: the y-value of the 3D profile point

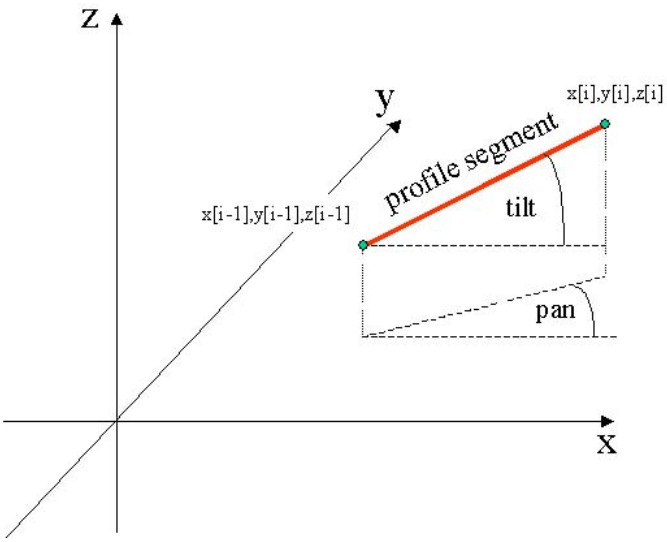
4. l: the path length parameter of the profile point

5. z: the z-value of the 3D profile point

6. pan: the pan angle of the segment {(x[i],y[i],z[i]) - (x[i-1],y[i-1],z[i-1])}

7. tilt: the tilt angle of the segment {(x[i],y[i],z[i]) - (x[i-1],y[i-1],z[i-1])}

The values of this table view can be exported to a text file and imported into Microsoft Excel.




A profile line segment and the corresponding pan and tilt angle definitions.

### 4.4.5 Export Profile Data

#### Export as Text File

Once you have extracted and/or filtered a profile you also have the possibility to export the profile values in tabular format as human readable text file. First switch to the *Table* page and then simply select *File* → *Export* → *Profile Table* from the menu in the ProfileMeasurement window.

### Export as SMD or PR files

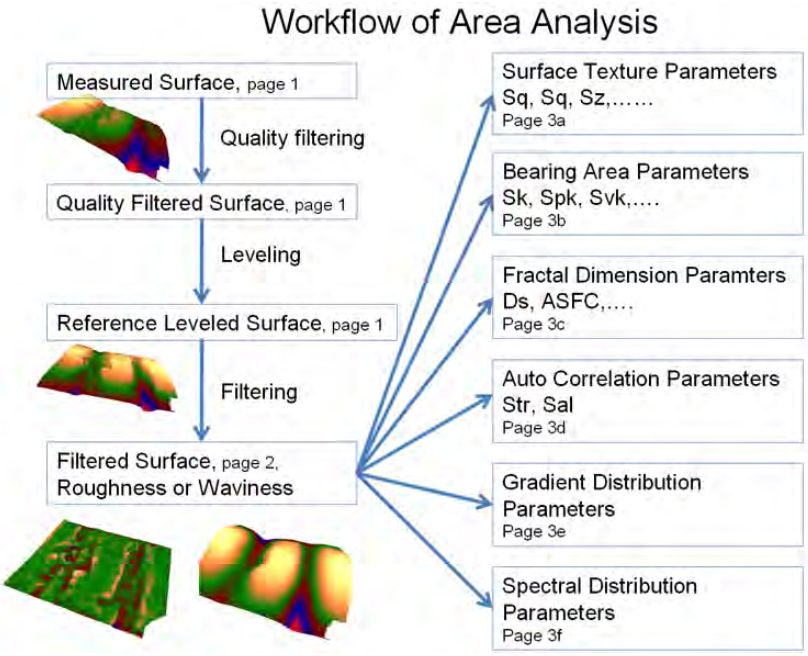
You can export your profile in the PR data file format or the SMD data file format (specified in EN ISO 5436-2:2000) by clicking on *File* → *Export* → *Profile as PR file* or *SMD file.*

### 4.4.6 Save Profile Path

The profiles are saved in metric image coordinates, i.e. they remain independent of world coordinates and workpiece coordinate system of specific datasets. When a profile is loaded it is adapted to the world coordinates (meaning the stage position at measurement time) and the workpiece coordinate system of the current dataset. Thus it is assured that the profile remains at the position it was drawn at on the dataset, even if changes to the workpiece coordinate system occur.

## 4.5 SurfaceTextureMeasurement

The following image provides an overview how the SurfaceTextureMeasurement is working and which functions and parameters you find on the different tabs.




Workflow of Area Analysis

To measure an area select the object in the database view and select *Measurement → SurfaceTextureMeasurement* from the menu bar, or select the object and press the button SurfaceTextureMeasurement  in the toolbar. The module for surface texture measurements consists of several tabs that provide you with different levels of information about the specified area patches. All parameter tables on the following pages can be saved with the menu which appears by doing a *right mouse click* on the parameter table.

**Overview of All Tabs:**

1. *Measured Surface*: This is the main page of the SurfaceTextureMeasurement. Here you select the reference plane.

2. *Filtered Surface*: Is used to specify the area you want to measure.

3. *Surface Texture*: Is used to show different statistical values and parameters of the selected area.

4. *Bearing Area Curve*: Shows the *Bearing Area Curve* and its parameters (parameters are new in this version).

5. *Fractal Dimension*: This tab displays a graph showing the values for calculating the fractal dimension of the currently selected area.

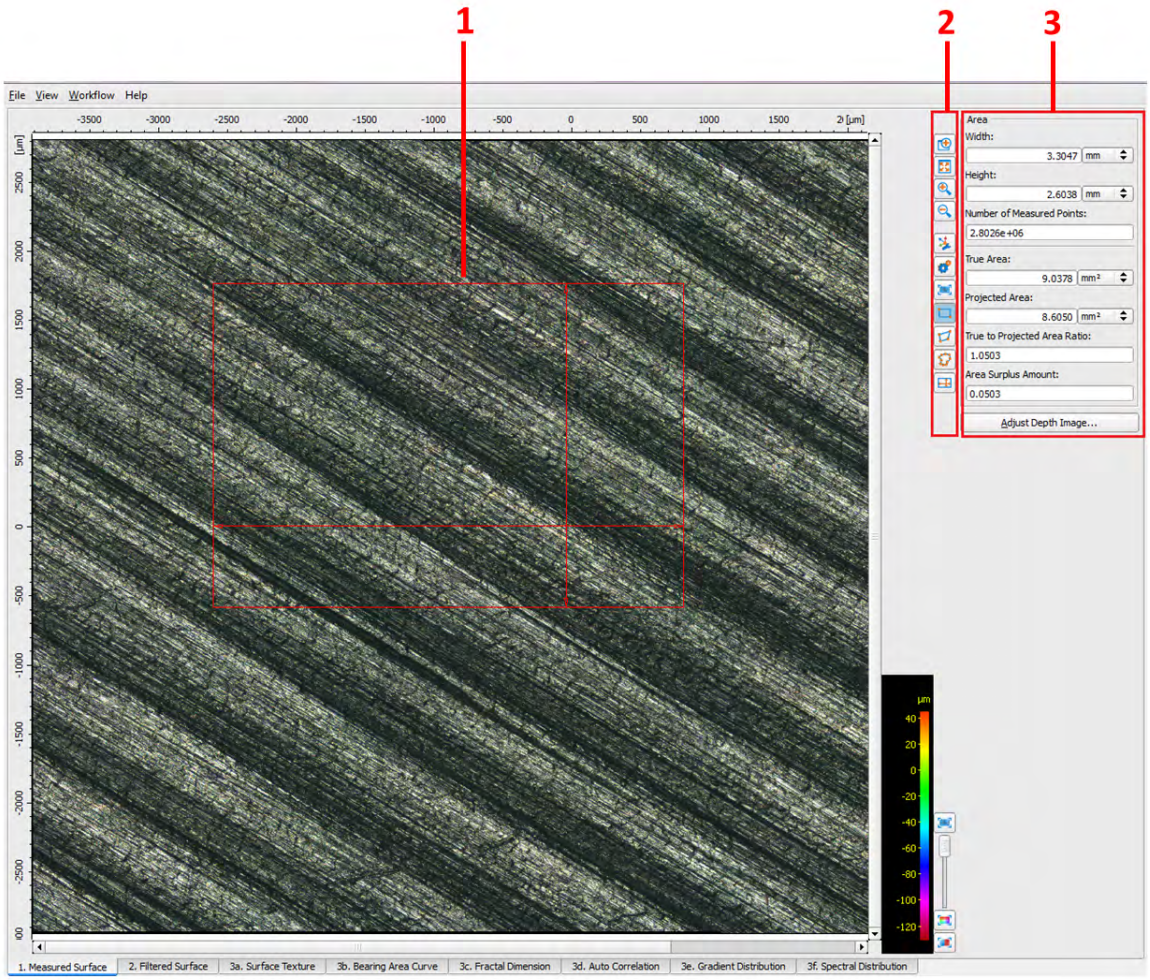
6. *Automatic Correlation*: Is used to show the preferential direction of the surface.

7. *Gradients Distribution:* Shows a distribution of the gradients and corresponding parameters.

8. *Spectral Distribution:* Shows a distribution of all occuring frequencies within the selected area and some statistical parameters.

### 4.5.1 Tab *Measured Surface*

This is the main page of the SurfaceTextureMeasurement. To measure the area of your specimen you have to set the reference plane. At this tab you can also select the part of the area you want to measure.




Measured Surface

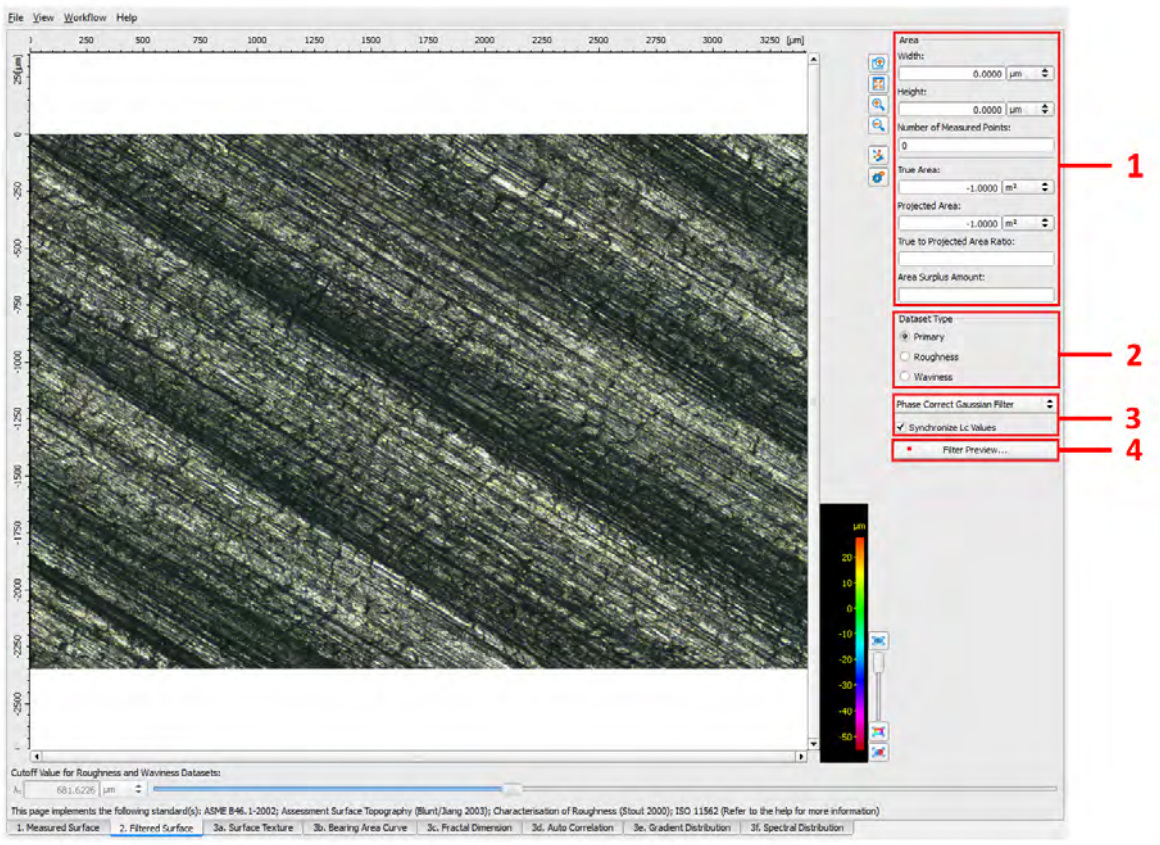
1. Selected Area

2. Tools for selecting an area

3. Area information (projected area, true area,...)

### 4.5.2 Tab *Filtered Surface*

This tab is for specifying a region of interest. All changes here will effect the calculation.




Tab Filtered Surface

1. Area Information
2. Dataset Type (Primary, Roughness, Waviness)
3. Filter Settings
4. Filter Preview

At the section area (area information) you see the actual height, width, the projected area and the true area. You also can select between 3 different filters:

- *Primary*: Use the measured surface for the calculation
- *Roughness*: To eliminate low frequency components from the profile. It basically acts like a high-pass filter.
- *Waviness*: To eliminate high frequency components from the profile. It basically acts like a low-pass filter.

The filter cut off wavelength is given in micrometers. Frequency components having a wavelength equal to the cut off wavelength will pass the filter with 50% of their original amplitude.

**Note:** All following tabs are calculated from the selected area and the selected filter.

**Tool Overview for Selecting an Area:**

1.  Remove selected areas (use the whole surface)

2.  Draw a rectangle

3.  Draw a polygon

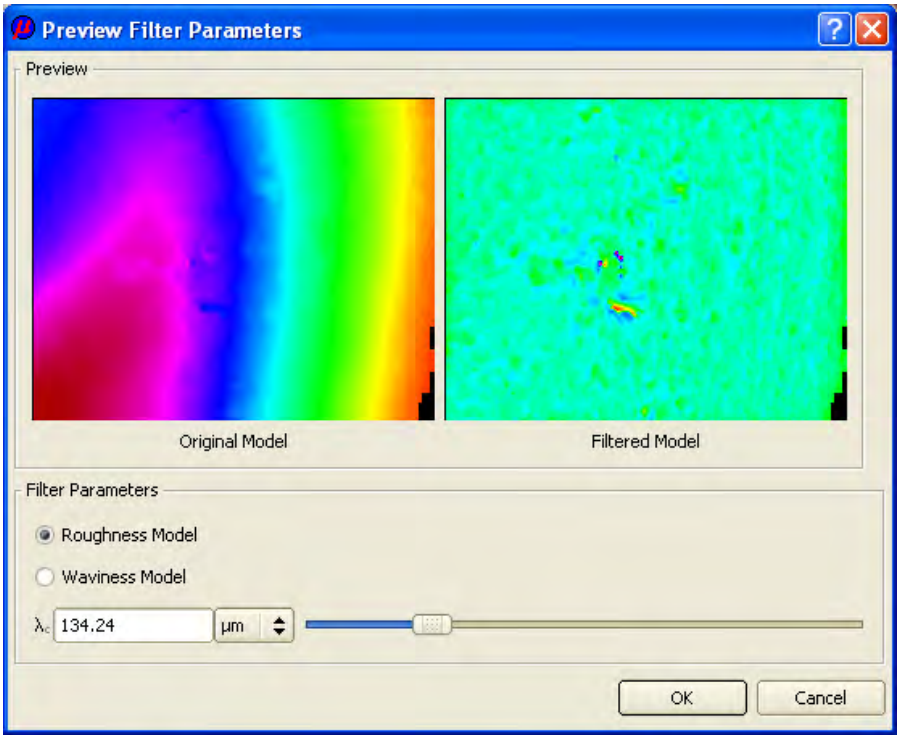
4.  Draw a freehand polygon

5.  Draw a predefined rectangle. The size of the rectangle can be defined on the right side of the screen.

**Filter Settings:** At the section Filter Settings you have the option to choose between Gaussian Filter according to EN ISO 11562 and Phase Correct Gaussian Filter. By deactivating the Synchronize Lc Values box you can adjust the Lc value for the x- and y-direction.

**Filter Preview:**

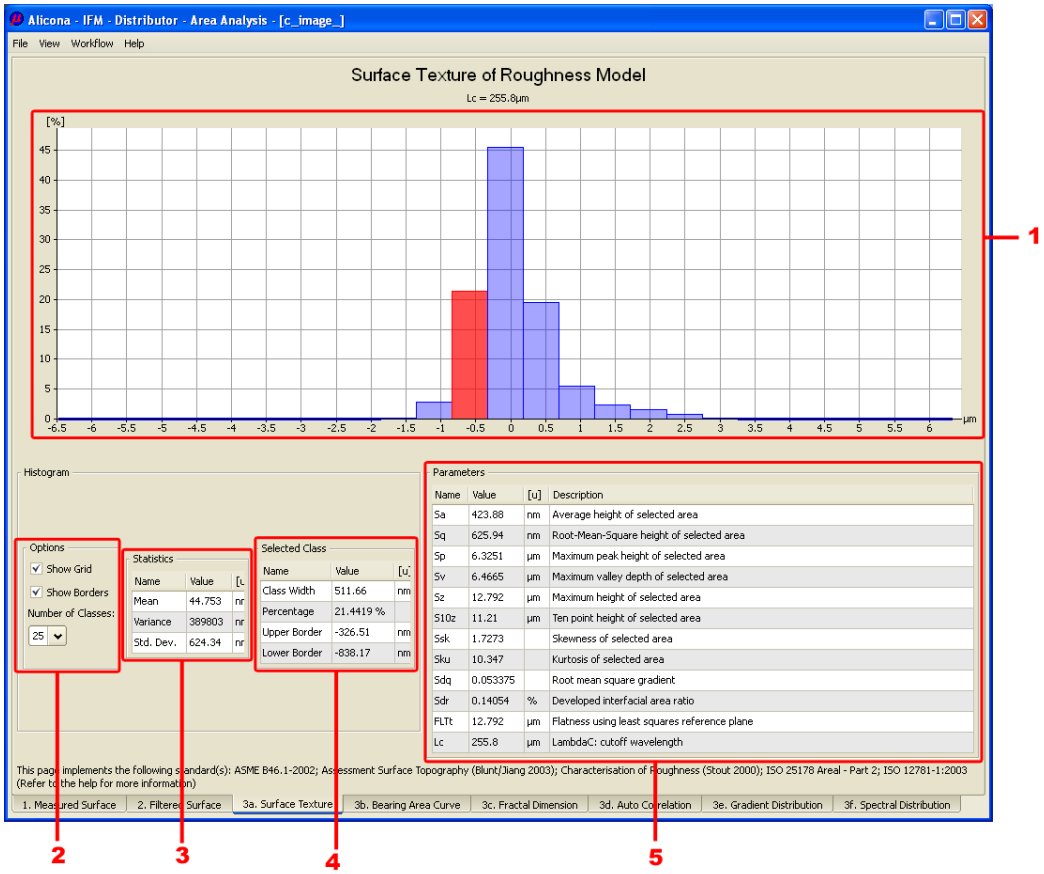
Because filtering the surface is a very time-consuming calculation you can adjust the Lc value and the filter type in the *Filter Preview*.




Filter Preview

### 4.5.3 Tab *Surface Texture*

The SurfaceTextureMeasurement supports the calculation of standard ISO values from either the mean primary, roughness or waviness profile according to EN ISO 4287. The EN ISO 4287 standard is an international standard used to characterize surface profiles. It defines values for primary, roughness and waviness profiles. These profile types can be generated by setting different filters in the tab Profile.




Surface Texture

1. Class histogram
2. Options
   - show / hide grid
   - show / hide borders
   - number of classes
3. Statistic data
4. Selected class information
5. Surface parameters

All the values used to compute statistical values are additionally grouped into classes and displayed as a histogram. For each class, information can be requested by clicking the class in the histogram view. The results of the red-colored class are displayed in the *Actual class* group.

**Values of the Selected Class:**

- *Percentage:* How many percent of all values are involved in the calculation of this class' statistics.
- *Upper border:* upper bound of the actual class
- *Lower border:* lower bound of the actual class

**Description of the Surface Parameters:**

- *Sa :* Average height of selected area
  This parameter is like Sq an often used value to describe surfaces. Please note that this parameter is very simple and can not be used to distinguish between surfaces or to describe surfaces in a more precise functional way. Sa is significant when machined surfaces are analyzed. Deviations on the surface structure can also be detected with the Sa value. A change in the Sa value suggests a change in the production process.
- *Sq :* Root-Mean-Square height of selected area
- *Sp :* Maximum peak height of selected area (max_z - mean_line)
  This parameter describes the height of the highest peak in relation to the zero level. This also means that the parameter will be affected by a single measure point. A more robust peak value is the Spk value calculated from the bearing ratio curve.
- *Sv :* Maximum valley depth of selected area (mean_line - min_z)
  This value is calculated similar to the Sp value.
- S*z :* Maximum height of selected area (max_z - min_z)
  This value is the sum of Sp and Sv. Like Sv and Sp this value is also influenced only by a single value. A more robust version of this value is the S10z value. This parameter is used to measure surfaces in grooves and valleys. It is especially useful if extreme peaks and depths are expected in this area. Scratches are filtered when the Sz value is calculated.
- *S10z :* Maximum height of 10 peaks/valleys of selected area
- *Ssk :* Skewness of selected area
  This parameter describes whether more values are below or above the zero plane. This value is calculated from all 3D points of the surface and is therefore an average value of the surface. Ssk shows the

bearing capacity, the porosity and the characteristic of a non standard machinery production. Ssk is very sensitive to outliers on the surface.

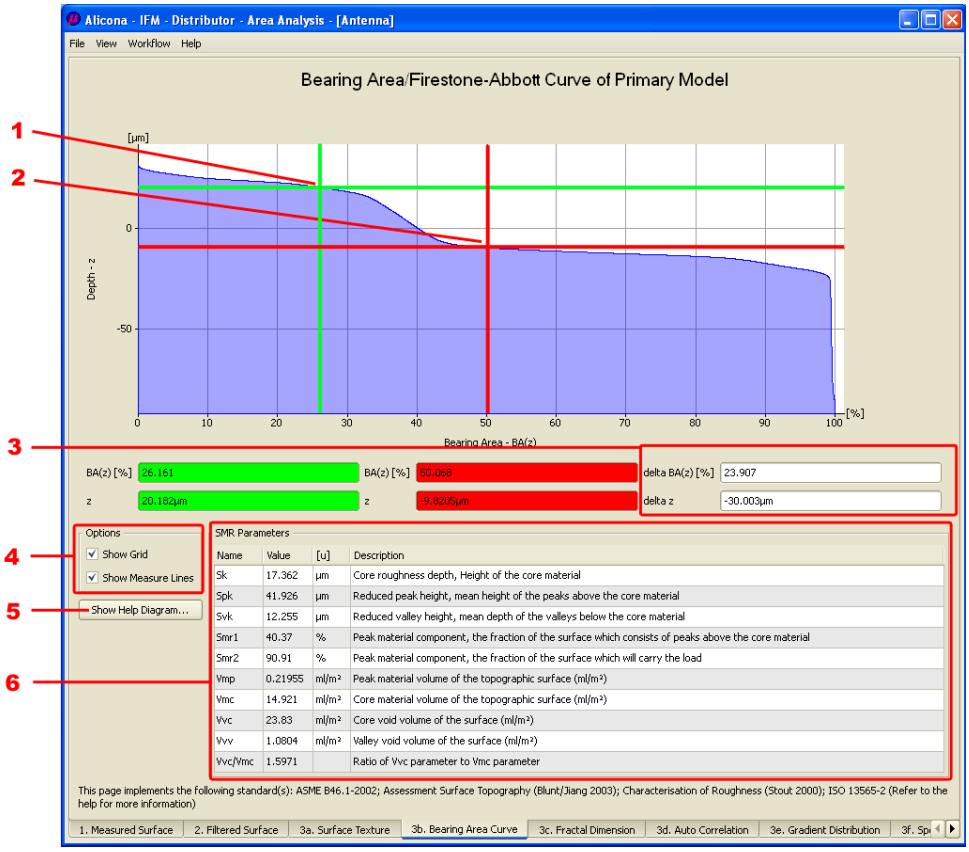
- *Sku :* Kurtosis of selected area
  This parameter describes the expansion and the distribution of heights. The Sku value is small if the majority of the heights are in a small range of height.

- *Sdq :* Root mean square gradient
  This parameter describes the mean slope of the surface. If this parameter is high, the surface is composed of steep surface parts. If the parameter is small, the surface consists mainly of flat surface parts.

- *Sdr:* Developed interfacial area ratio

### 4.5.4 Tab *Bearing Area Curve*

At this tab you can perform measurements in the bearing area curve of the selected area.



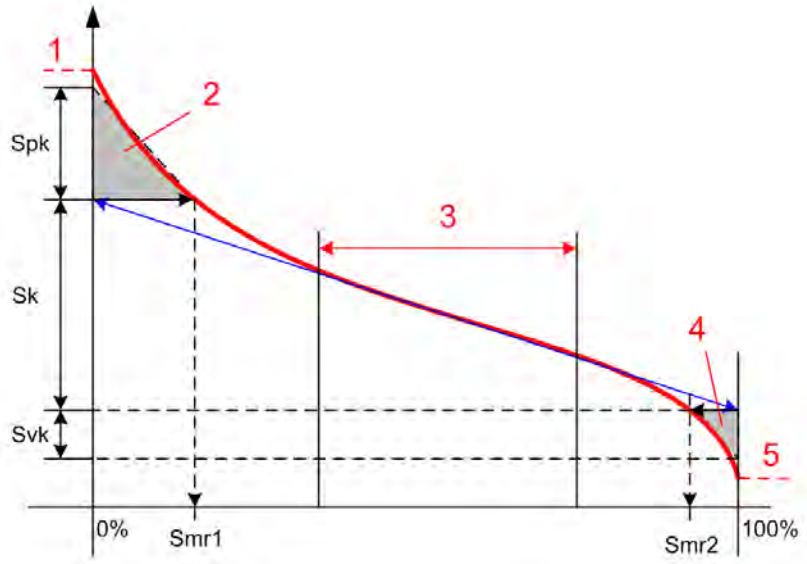

Tab Bearing Area Curve

1. Reference position (green cross)

2. Measurement position (red cross)
3. Values of the bearing area curve: Ba[z], z, delta
4. Options: show/hide grid, show/hide measurement lines
5. Show help diagram
6. Values of the bearing area curve

You see the actual value by moving the red cross by mouse. To set a reference position (green cross) double click on the desired position or click with the middle button of your mouse.

**Description of the Bearing Parameters:**




1. Maximal Height
2. Peak Area
3. 40% of minimum slope
4. Valley area
5. Minimal Height

**List of Parameters:**

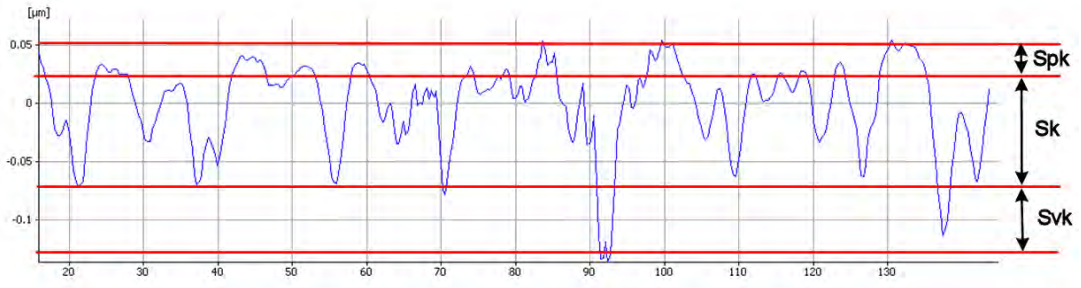
- *Sk*: Core roughness depth
- *Spk*: Reduced peak height

- *Svk*: Reduced valley height
- *Srm1*: Peak material component
- *Srm2*: Peak material component

The algorithm works in the following way:

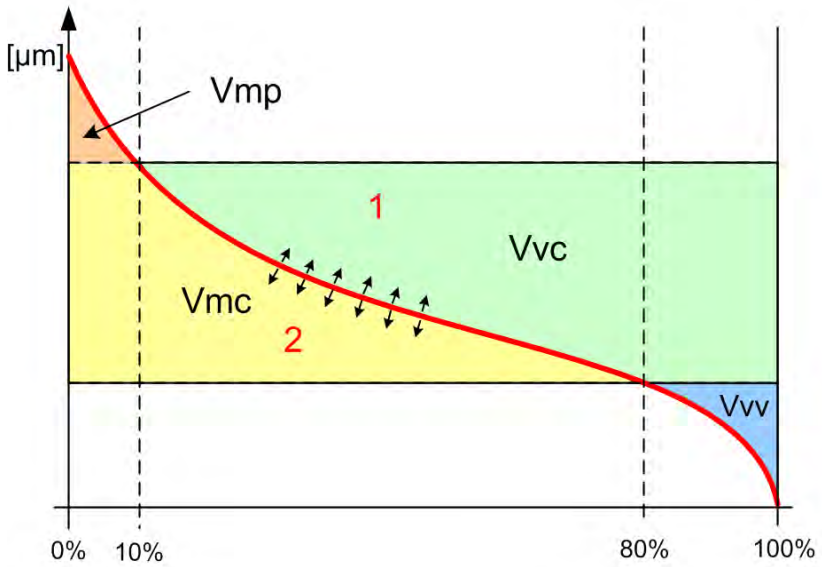
A blue line is fitted into the red bearing curve in an ISO conform way. The cross points of this line with the vertical lines at 0% and 100% are determined. With this information the Sk, Smr1 and Smr2 are determined from these crossing points. The grey areas define the parameters Spk and Svk.

**Example for Sk, Spk and Svk Parameters:**




In this illustration only one profile is shown, but the software evaluates the whole area for computation of the parameters.

**Description of the Volumes Parameter:**



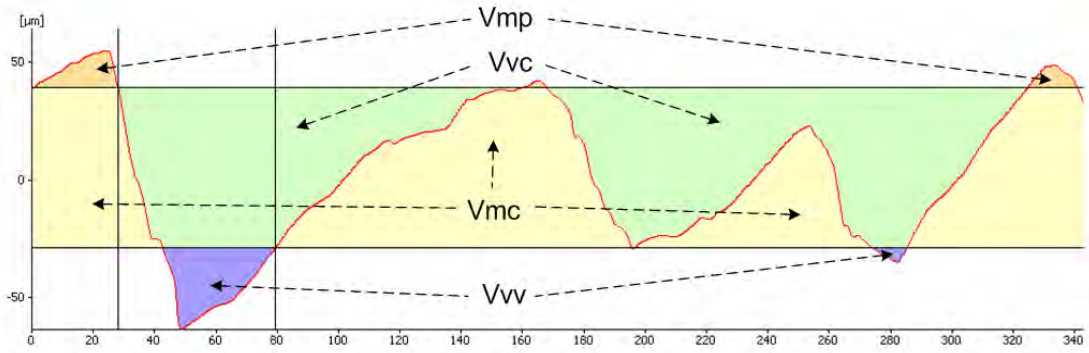
1. void volume

2. material volume

**List of Parameters:**

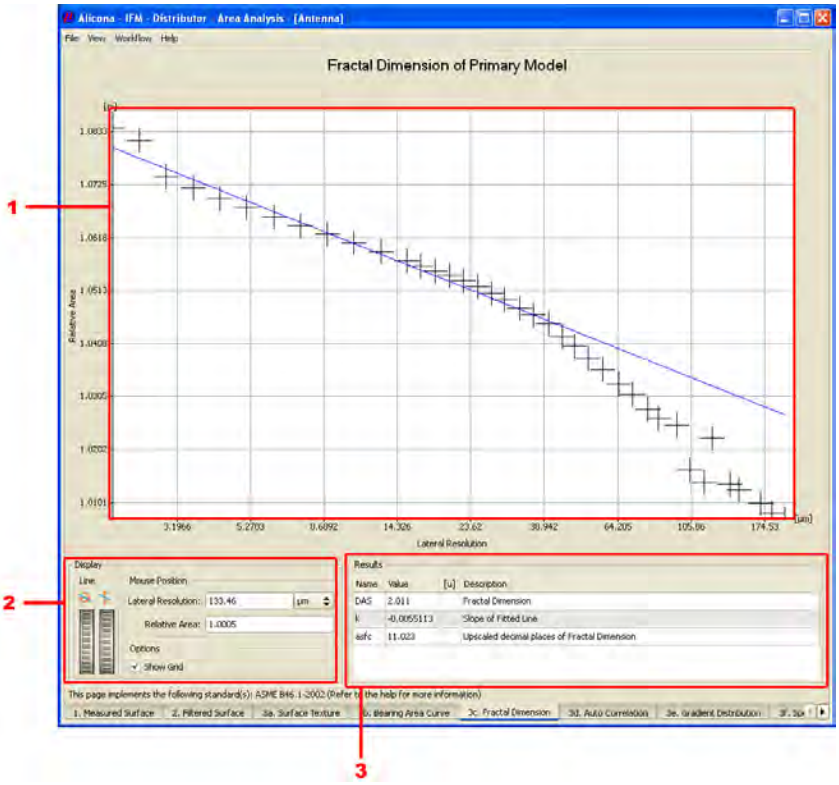
- *Vmp*: Peak material volume of the topographic surface
- *Vmc*: Core material volume of the topographic surface
- *Vvc*: Core void volume of the surface
- *Vvv*: Valley void volume of the surface

Volume parameters are calculated for the whole surfaces. For better visualization only a profile through the surface is shown above.




### 4.5.5 Tab *Fractal Dimension*

The tab Fractal Dimension displays a graph showing the values to calculate the fractal dimension of the currently selected region of interest.




Fractal Dimension

1. Result diagram
2. Display options: (line, mouse position, show grid)
3. Result parameters

The graph shows the values for $ln\ A$ drawn against $ln\ r$, where $A$ denotes the area calculated for a step size of $r$, and $ln$ denotes the natural algorithm. The fractal dimension $DS$ of the selected region of interest is given by the slope of the line fitted through the data points. This value is noted below the graph.

By manually moving and rotating the line, it is possible to eliminate the influence of outliers on the calculation of the fractal dimension. To move the line vertically, you have to point on the line, using the mouse pointer and click the left mouse button. If you drag the mouse up or down while keeping the left mouse button pressed, the line will follow. To rotate the line, you have to point on the line, using the mouse pointer, press the SHIFT-key on the keyboard and click the left mouse button. If you drag the mouse up or down while keeping the SHIFT-key pressed and the left mouse button clicked, the line will rotate around its center point.

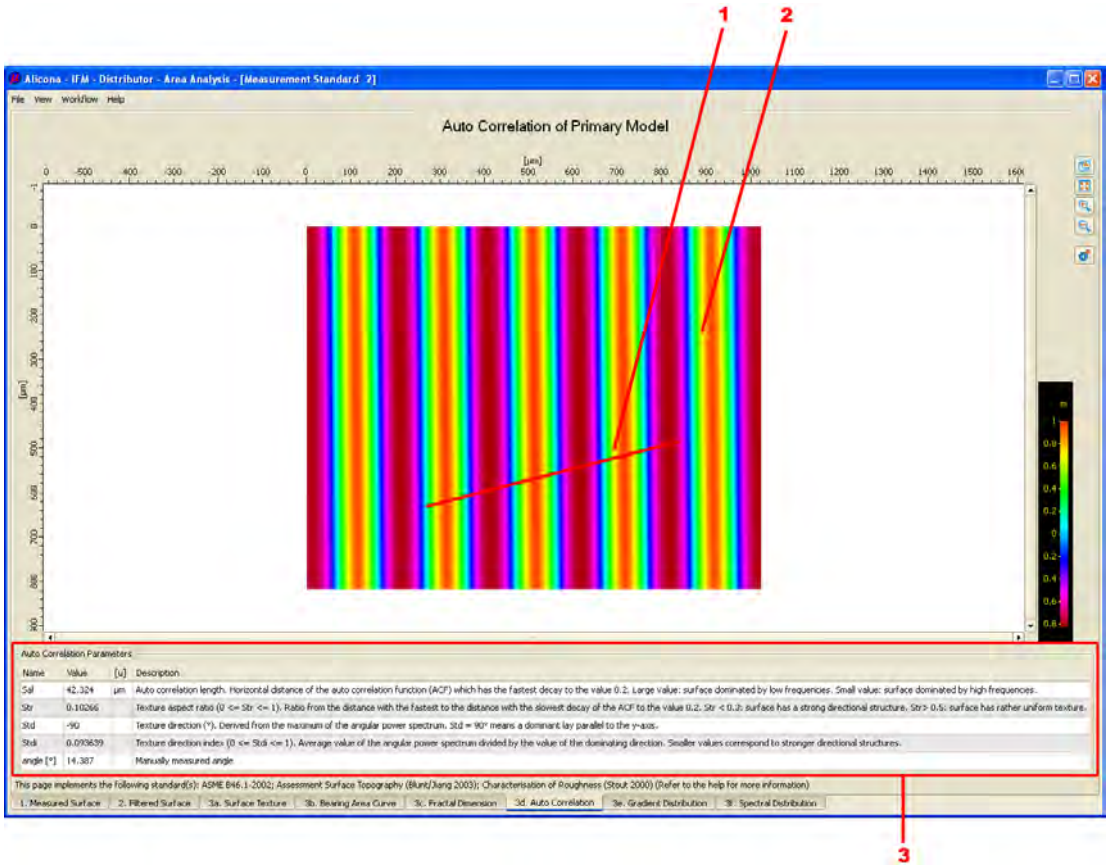
You should know that by repositioning and rotating the fitted line, one can obtain results for the fractal dimension that do not represent the analyzed

area at all. Furthermore it is possible to get values that are not even valid values for the fractal dimension parameter (a valid *DS* is always greater than 2.0).

The fractal dimension of a surface is a parameter that can be used to characterize different surface types.

### 4.5.6 Tab *Auto Correlation*

At this tab you can see the preferential direction of a periodically iterated surface structure.




Auto Correlation

1. Manually drawn angle
2. Graphically shown correlation values
3. Calculated parameters

**Description of the Parameters:**

- *Sal*: Auto correlation length: dominated by low or high frequencies

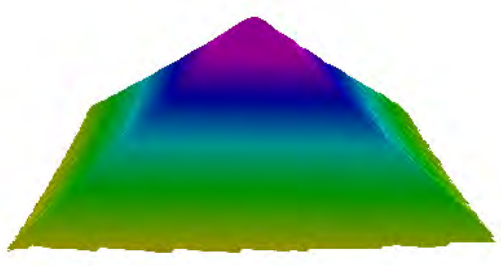
- *Str*: Texture aspect ratio: strong or weak dominant structures 0...1 (strong...weak)
- *Std*: Texture direction degree (°)
- *Stdi*: Texture direction index
- *angle[°]:* Manually measured angle

### 4.5.7 Tab *Gradient Distribution*

This tab shows the gradients of the surface of the selected area or the whole model. You can choose between two types of gradient distribution.
These two types are:

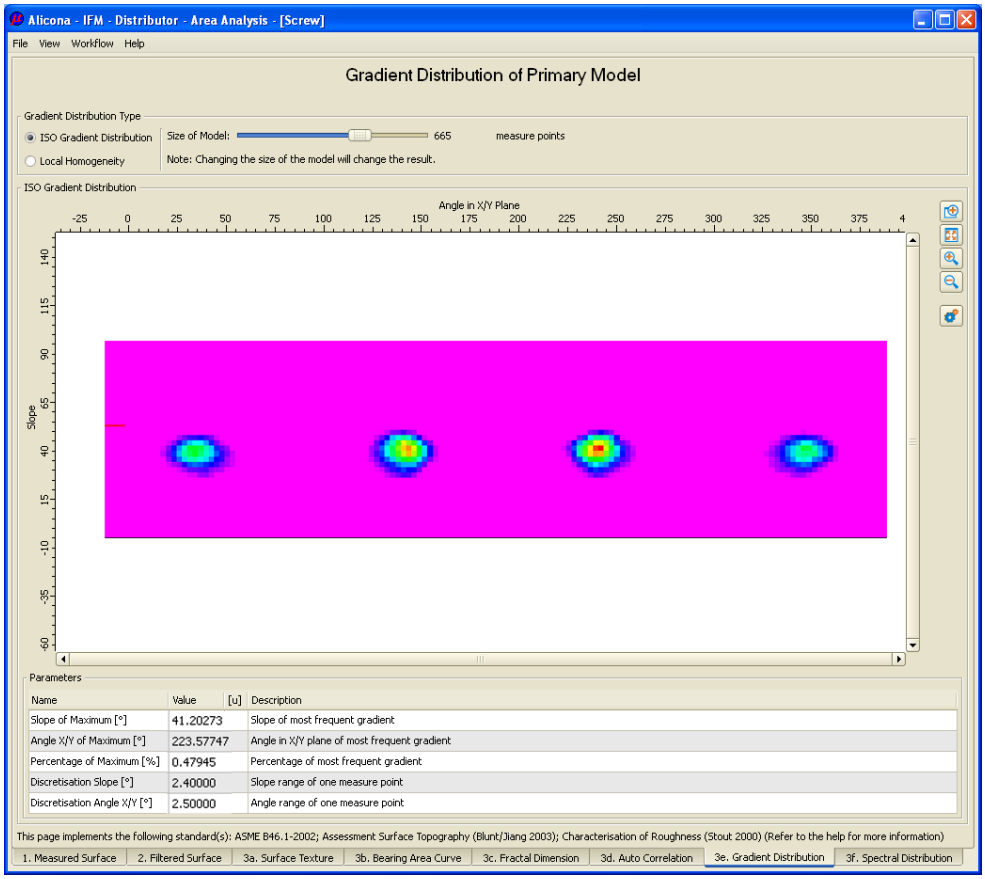
- ISO Gradient Distribution
- Local Homogeneity

Further on, the tab shows several parameters corresponding to the chosen type.
Both types will be explained by applying the method to a pyramide object.



Pyramid

## Type 1: ISO Gradient Distribution




Gradient Distribution

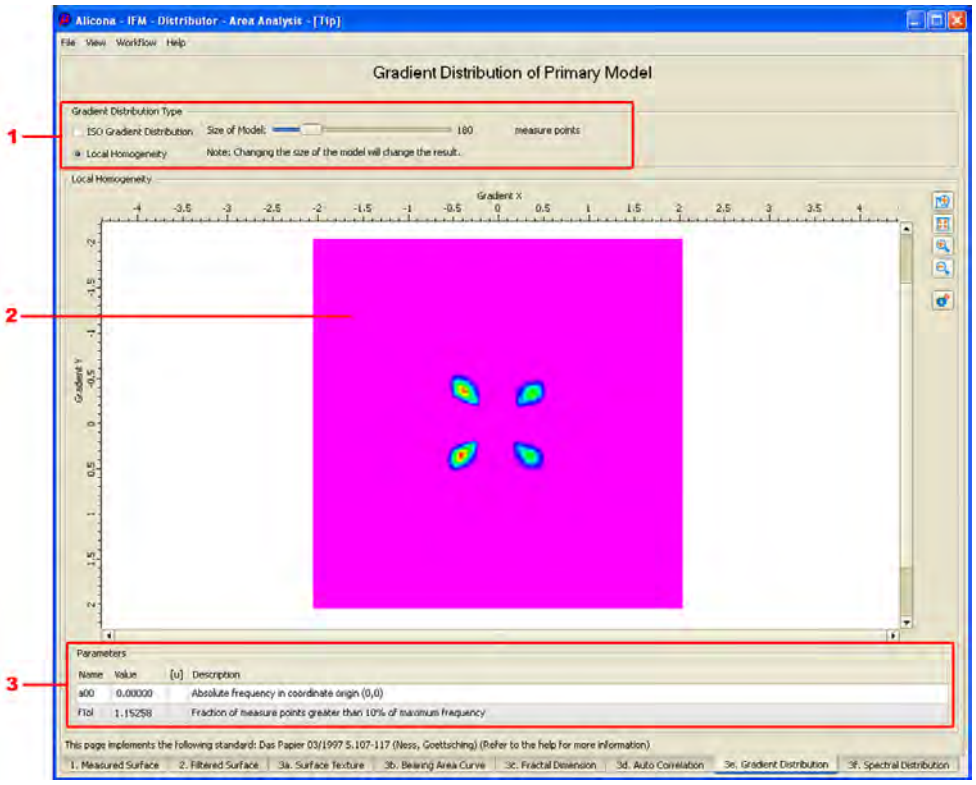
1. Visualization as diagram:

   The x axis shows the orientation of the slope in the x/y plane. The y axis shows the degree of the slope. Again, you see the four dominant slopes of the pyramid visualized in the distribution. This kind of gradient distribution refers to **[9]** from the reference list.

2. Parameters:

   - Max. Slope[°]
   - Max. Angle X/Y[°]
   - Percentage of Maximum[%]
   - Discretisation X[°]: Slope range of one measure point
   - Discretisation Y[°]: Angle range of one measure point

### Type 2: Local Homogeneity




Local Homogeneity

1. Gradient distribution Type

   - Type choice: Local Homogeneity
   - Adjust size of the model: This slider defines the number of classes along the x-axis. E.g. If the silder is set to 360 every degree will be visualized in one class.

2. Visualization:

   The visualization of the local homogeneity shows the distribution of the gradients in x and y direction of your actual selection. The four dominant slopes of the pyramid lead to four dominant peaks in the local homogeneity visualization. This kind of gradient distribution refers to **[10]** from the reference list.

   The color labeling of frequencies is set relatively and therefore depends on the specimen.

3. Parameters:

- Discretisation slope and discretisation angle indicates the class width

- a00: Relative frequency in coordinate origin (0,0) compared to all points. This indicates the frequency of the gradients that are (nearly) even. In detail these are the gradients that maximally fluctuate over +/- half of the class width! This value is not very stable and should therefore be treated accordingly.

- fTol: Number of measured points that are larger than 10% of the maximum frequency. This value includes many measured points and is therefore a more stable value.

- In summary it can be said that the value Ftol provides results that are more stable. Therefore Ftol should preferably be used.

### 4.5.8 Tab *Spectral Distribution*

This tab offers the possibility to view two kinds of spectral distribution of the selected region.

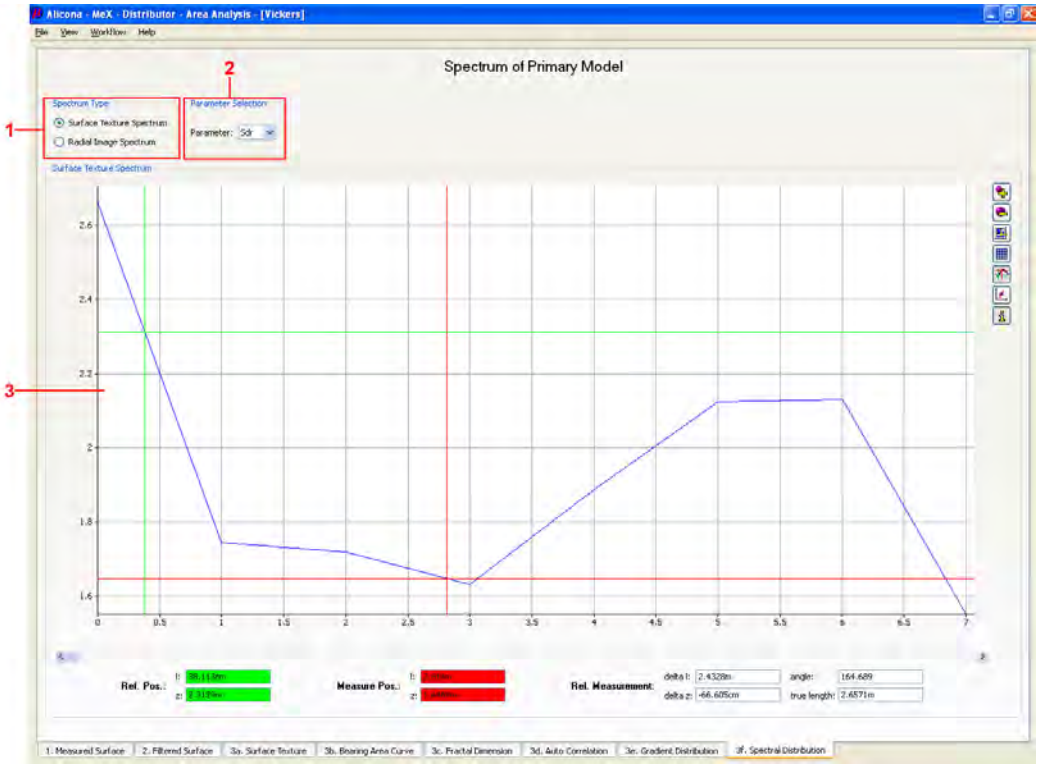
These two types are the

- Surface Texture Spectrum

- Radial Image Spectrum

- Roughness Power Spectrum

### Type 1: Surface Texture Spectrum




surface texture spectrum

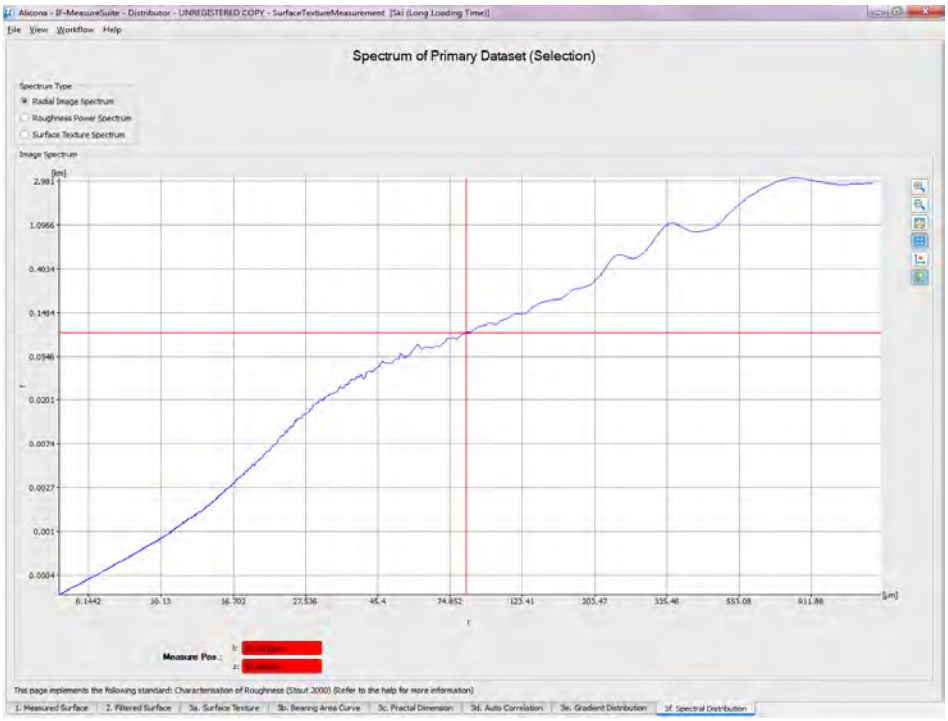
1. Type choice
2. Parameter choice
3. Visualization: Shows the selected parameter in certain wavelength ranges

Parameters:

- Sa: Average height of selected area
- Sq: Root-Mean-Square height of selected area
- Sp: Maximum peak height of selected area
- Sv: Maximum valley depth of selected area
- Sz: Maximum height of selected area
- Sz10: Ten point height of selected area
- Ssk: Skewness of selected area
- Sku: Kurtosis of selected area

- Sdq: Root-Mean-Square gradient
- Sdr: Developed interfacial area ratio

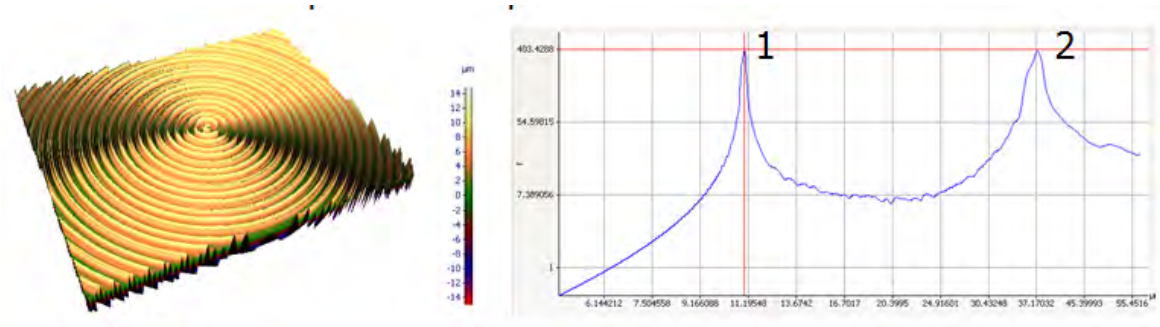
### Type 2: Radial Image Spectrum:




Radial Image Spectrum

The radial image spectrum displays a spectrum over the frequencies which appear in the selected region. This kind of spectral distribution refers to [**9**] from the reference list.

### Example 1:



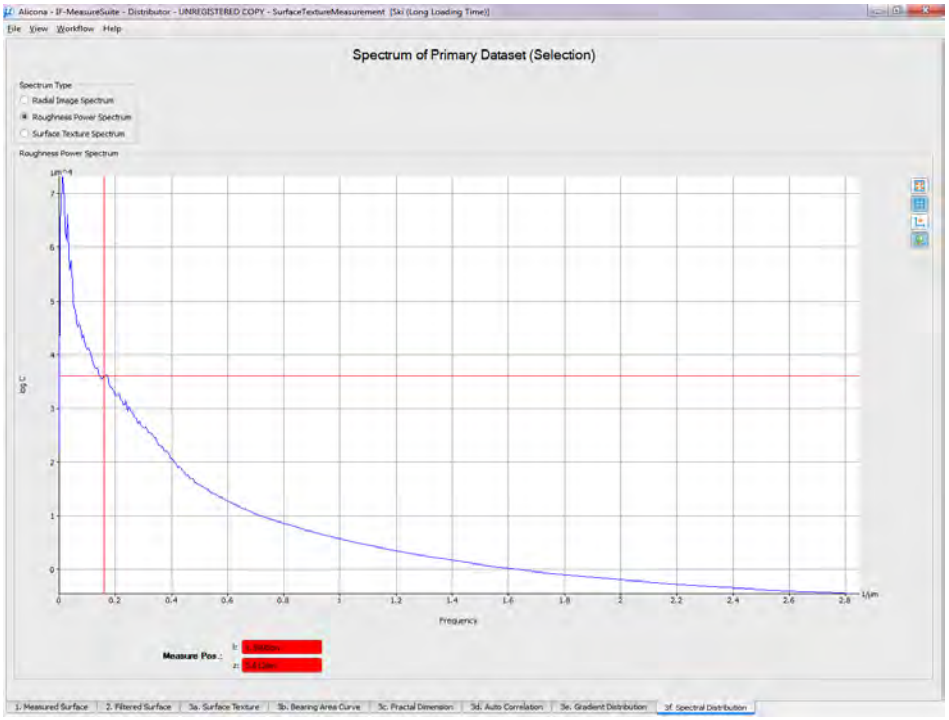

The surface on the left side has 11$\mu$m and 37$\mu$m waves. The radial image

spectrum shows the dominating frequencies on the surface as peak 1 and 2.

In the diagram the x direction defines the Wave Length (logarithmic scale), the y direction defines the Frequency of Wavelength (logarithmic scale). You can see in the spectral distribution diagram peak 1 at 11$\mu$m and peak 2 at 37$\mu$m wavelength.

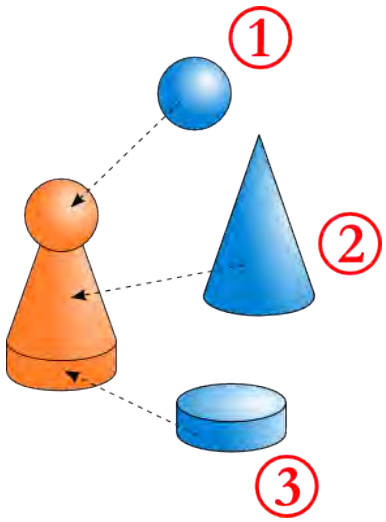
### Type 3: Roughness Power Spectrum:

The Roughness Power Spectrum describes how the power of a signal is distributed over the different frequencies. Here, the power of the signal is the squared value of the signal times the area of the dataset. The spectrum is visualized with the logarithmic frequency on the x-axis with unit $\frac{1}{\mu m}$, and the logarithmic power values on the y-axis with unit $\mu m^4$.

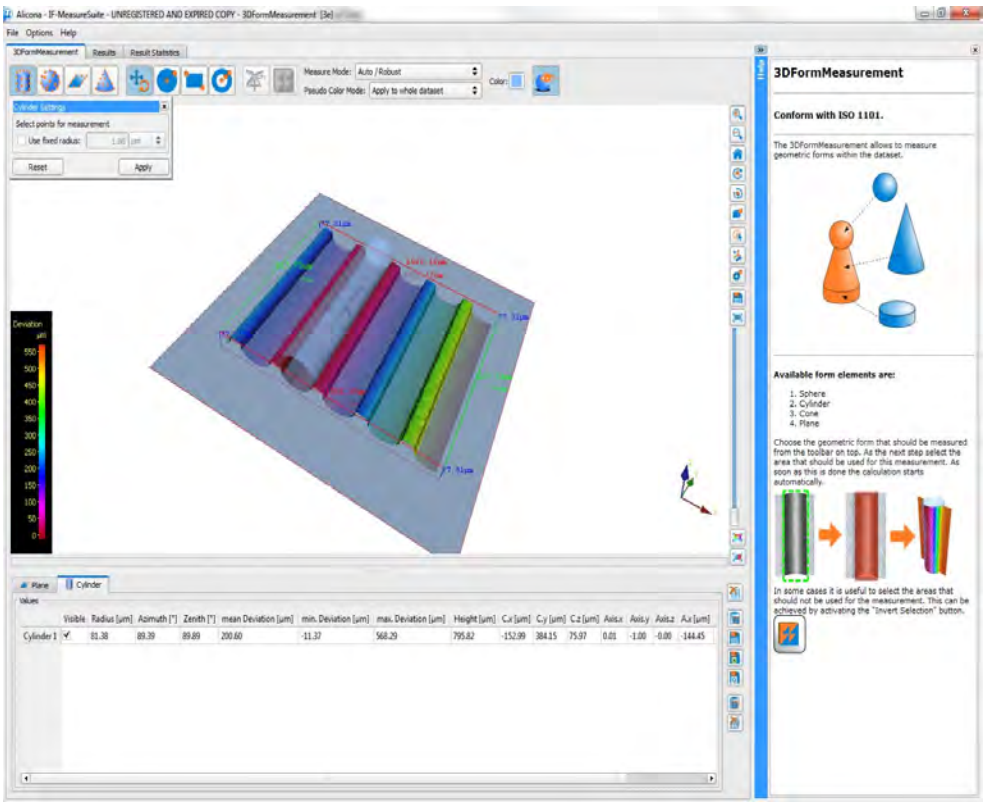



## 4.6 3DFormMeasurement

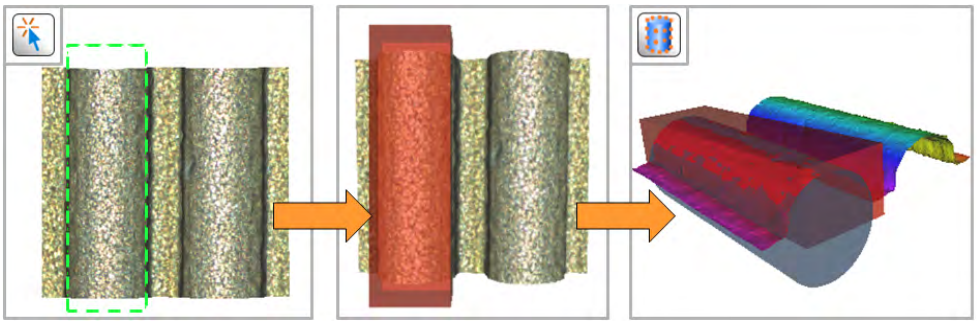
The 3DFormMeasurement is used to evaluate the deviation of a Real3Dataset or a SurfaceDataset to a plane geometric shape. You can choose one the following shapes for form measurements of your object: sphere, cone, cylinder and plane;




### 4.6.1 Tab Perform the 3DFormMeasurement




1. Select a point cloud. Select the areas where you want to fit in the geometric shape afterwards.

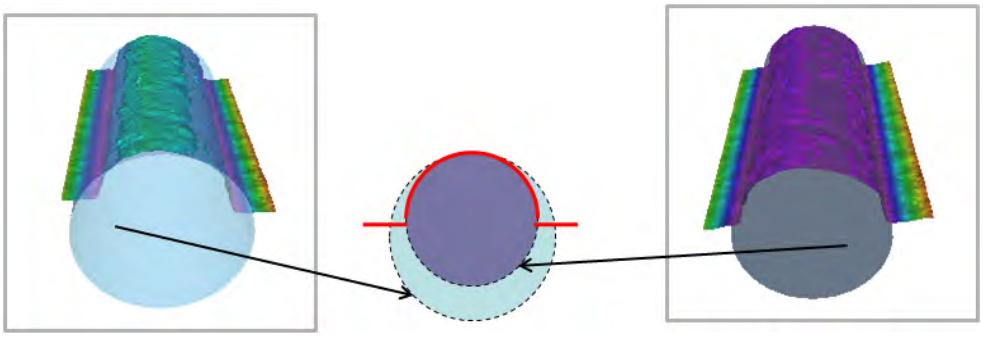


2. Choose the object that should be fitted into the previously selected point cloud. If no point cloud was selected the whole dataset will be used for the measurement.

3. Choose a fitting type

   - automatically
   - automatic robust: Measurement area is selected automatically.

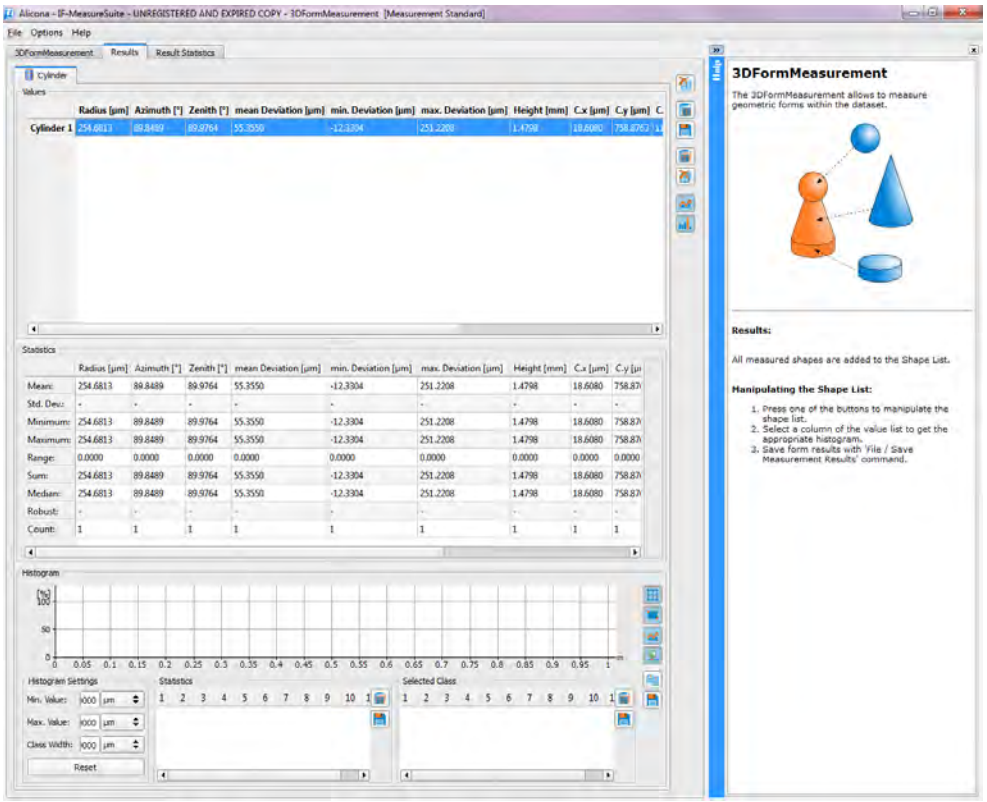
     **Note:** Please keep in mind that the automatic robust mode depends on the parameters you have set in the expert settings. (see page 153)



Automatic Measurement (left) vs. Robust Measurement (right)

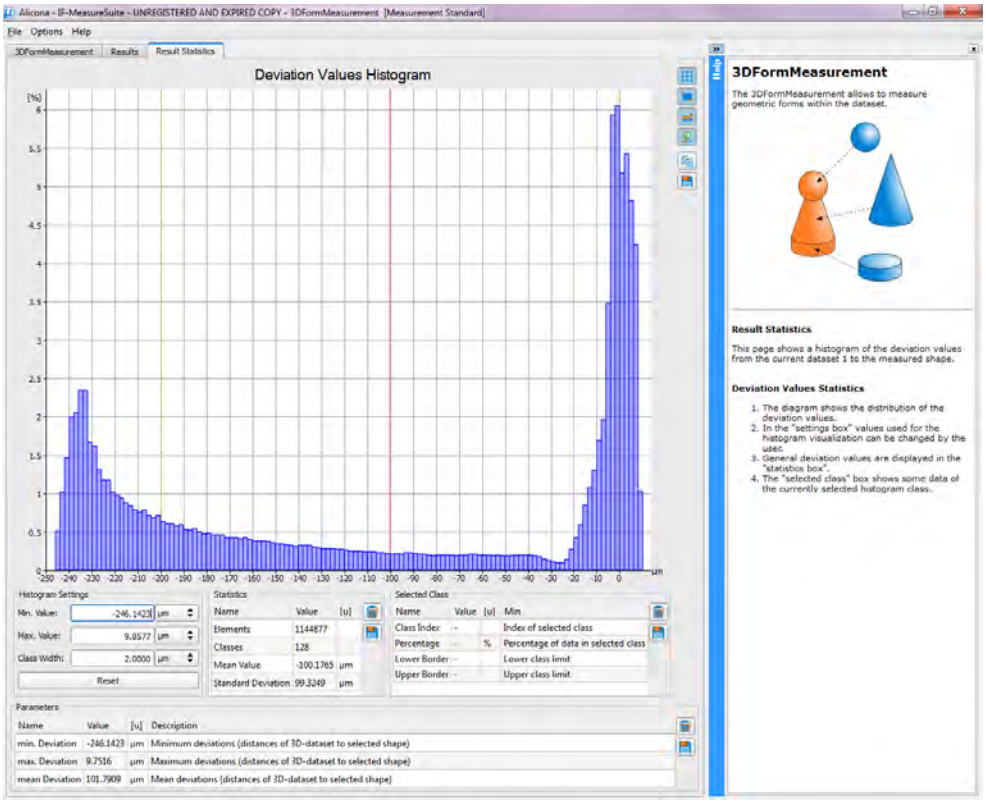
4. Start measurement

### 4.6.2 Tab Result Page




Result Page

### 4.6.3 Tab Statistic Evaluation



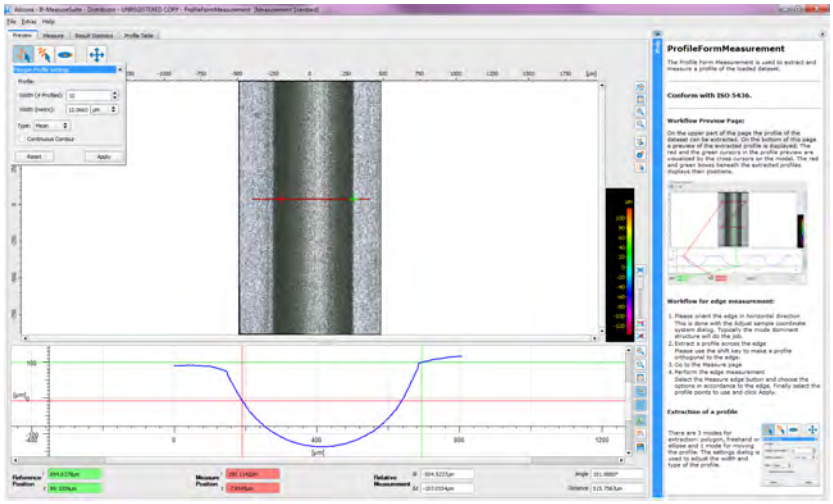

Statistic Evaluation

## 4.7 ProfileFormMeasurement

The Profile Form Measurement is used to extract and measure a profile of the loaded dataset.

### 4.7.1 Tab Extract a Profile

Below, the profile extraction page of the ProfileFormMeasurement is shown. On the upper part of the page the profile of the dataset can be extracted. On the bottom of this page a preview of the extracted profile is displayed. The red and the green cursors in the profile preview are visualized by the cross cursors on the model. The red and green boxes beneath the extracted profiles displays their positions.

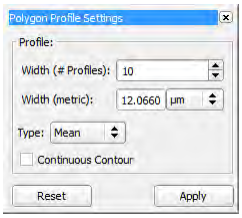



Tab Extract a Profile

There are three modes for extraction:

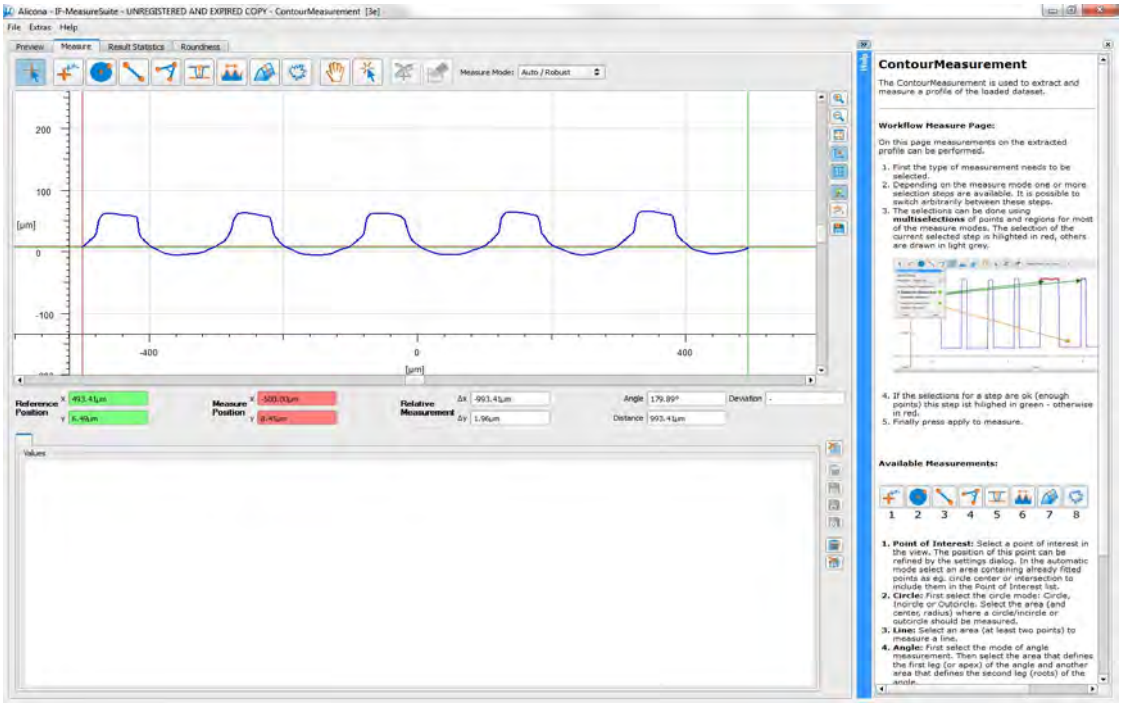
- polygon,
- freehand, und
- circle - ellipse.

Moreover, there is one mode for moving the profile. The settings dialog is used to adjust the width and type of the profile. The option *Continuous contour* can be chosen to generate a continuous visualization for disconnected profile parts. To apply settings changes, press *Apply*, otherwise press *Reset* to restore the default settings.




Settings dialog

### 4.7.2 Tab Measure the Extracted Profile




Measure the Extracted Profile

1. Activate a form tool from the top row of this page.
2. Choose the measurement mode: automatic or automatic robust. **Note:** Please keep in mind that the automatic robust mode depends on the parameters you have set in the expert settings. (see page 153)
3. Select one up to four areas on the profile path. As soon as enough areas are selected the shape will be measured in automatically. The number of areas that need to be chosen is defined by the form tool.
4. After this step you can already see the measured shape and the corresponding values in the table below.

**Positioning and Marking:**


**Cursor**

Move measure and reference position on the profile. The measure and reference position are visualized by the red and green crosses.


**Point**

Select a point in the view. The position of this point can be refined by the settings dialog. In the automatic mode select an area containing already fitted points as eg. circle center or intersection to include them in the point list.

**Measurement:**

 **Circle**

First select the circle mode: Circle, Incircle or Outcircle. Select the area (and center, radius) where a circle/incircle or outcircle should be measured.

 **Line**

Select an area (at least two points) to measure a line.

 **Angle**

First select the mode of angle measurement. Then select the area that defines the first leg (or apex) of the angle and another area that defines the second leg (roots) of the angle.

 **Height Step - ISO 5436 Height Step - Maximum distance**

First select the mode of distance measurement. Select first the areas that define the reference level, afterwards select the areas which define the measure level (in the ISO 5436 height-step mode only one area containing the height-step). As result you will get the height-step (maximum distance).

 **Thread Information**

Select a thread contour. Please ensure that the coordinate system goes straight through the center of the rotation axis.

 **Edge**

Select an area containing an edge shape. The chipping side of the edge is

visualized in green, the clearance side in blue.

### Additional Tools:

 **Roundness (Only in ContourMeasurement)**

Select an area to measure the deviations of the shape to a circle.

 **Drag view**

Drag view.

 **Select fitted objects**

Select already fitted objects. This is also possible by clicking with right mouse button on the fitted object. The selected object is highlighted in the viewer and the table.

 **Remove selections**

Remove all selections.

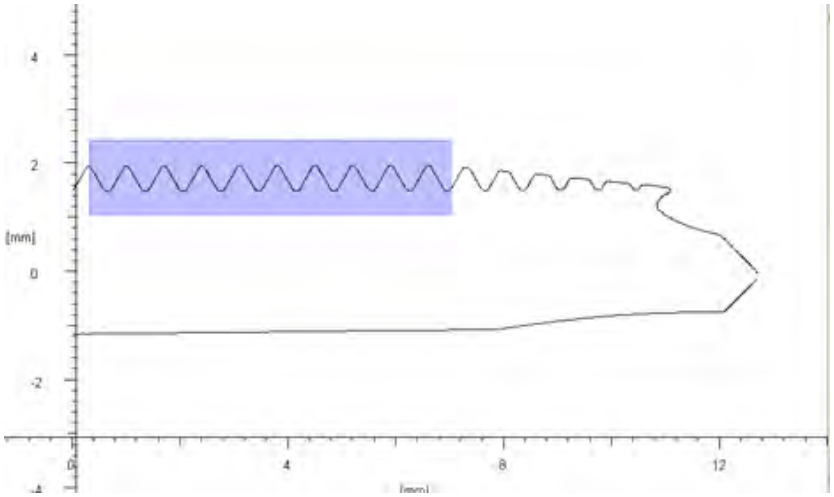
 **Unmark**

Unmark selected points or selected areas.

### Measurement of Thread Parameters

To perform a thread measurement do the following steps:

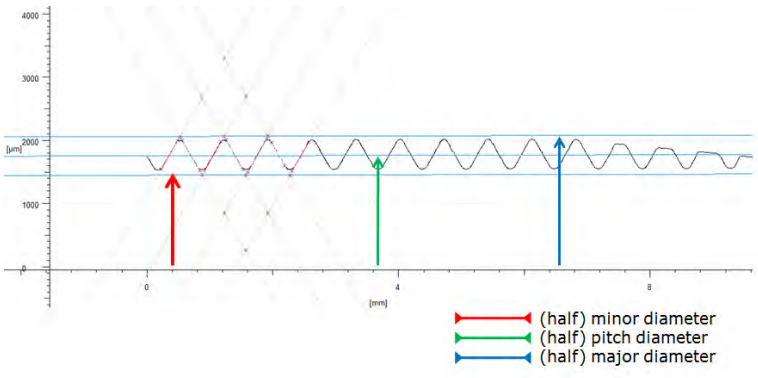
- Choose tread button
- Select area of thread (without first cut)

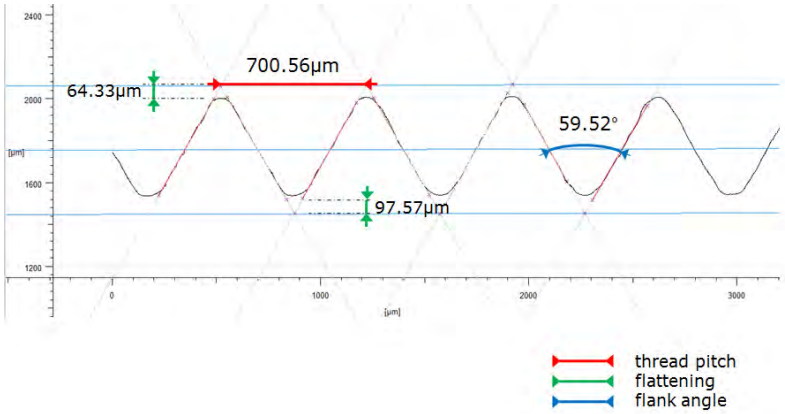



Selection for thread measurement

- Attention: Cutting plane should pass through rotation axis
- Press *Apply* to measure the paraemters:
  - Thread pitch,
  - Major-, minor- und pitch ø
  - Thread angle
  - Half included thread angle left/right
  - Flattening on major- and minor- ø,
  - Tapering

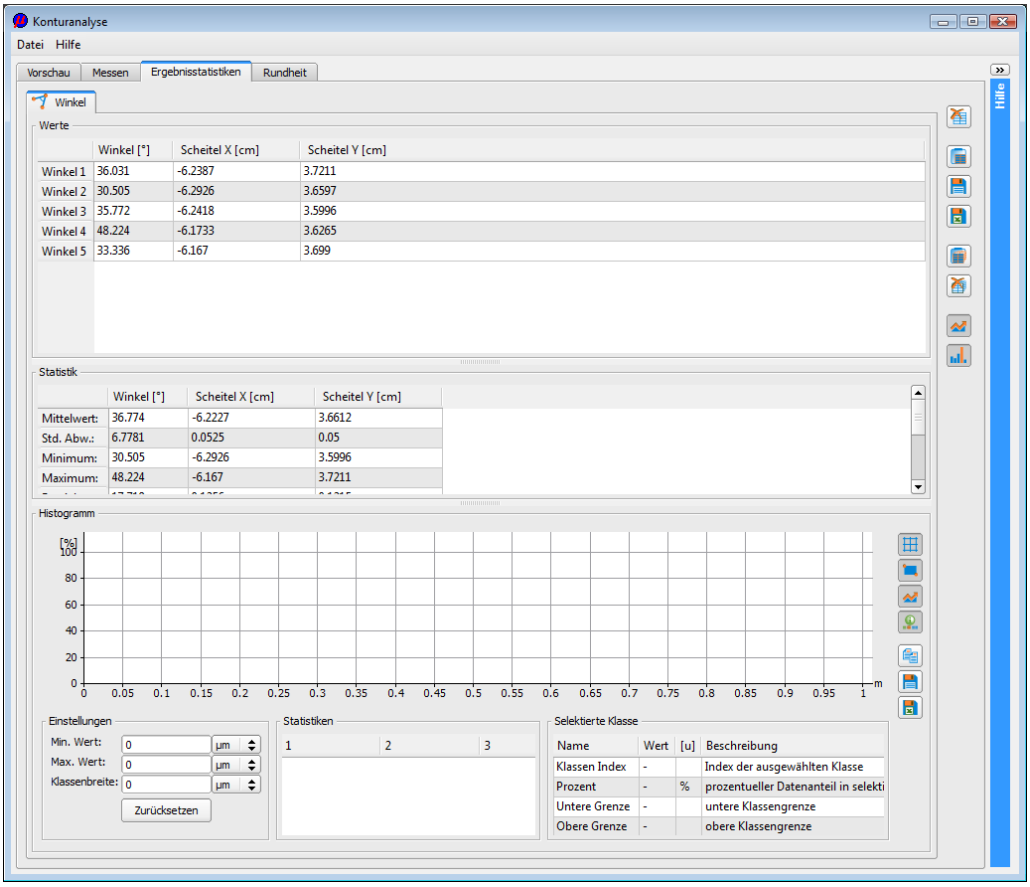
  In addition to these parameters also the standard deviations of these parameters along the different threads are provided.





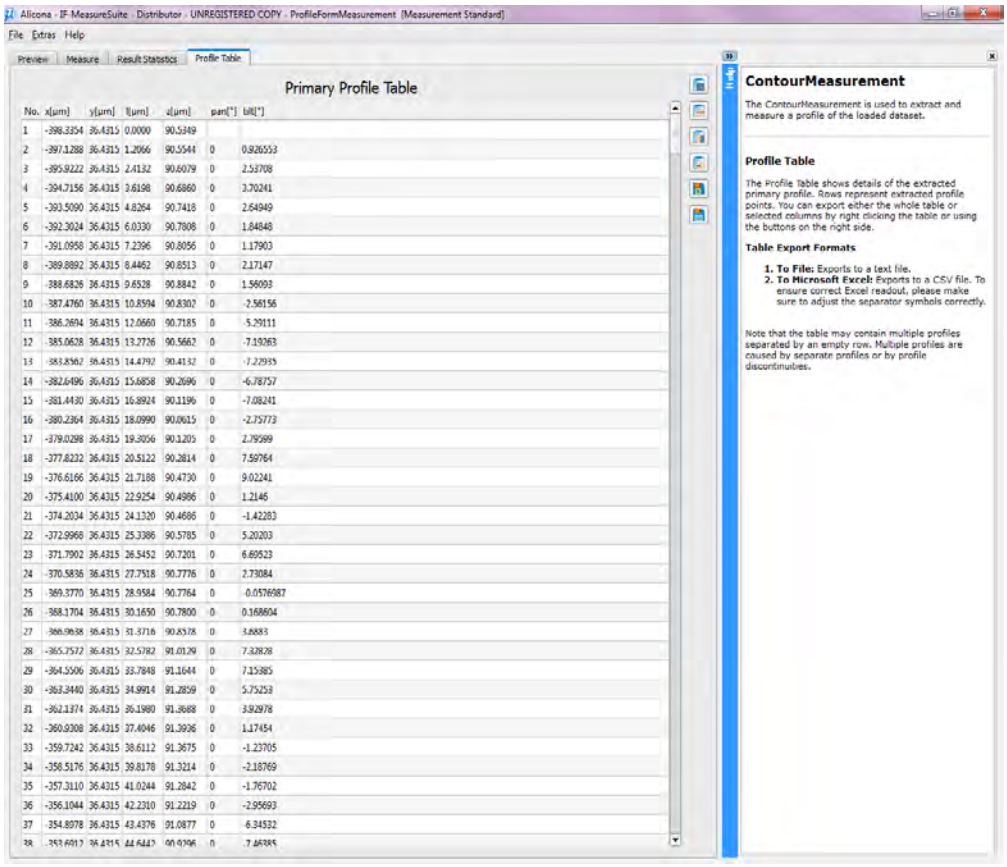

### 4.7.3 Tab Result Statistics

The tab visualized an overall statistic of fitted objects. The statistic evaluation include minimum, maximum, mean, standard deviation and other statistical parameters displayed in a table view. Selected columns can be visualized by histograms.




Detailed Measurement

### 4.7.4 Tab Profile Table




Profile Table

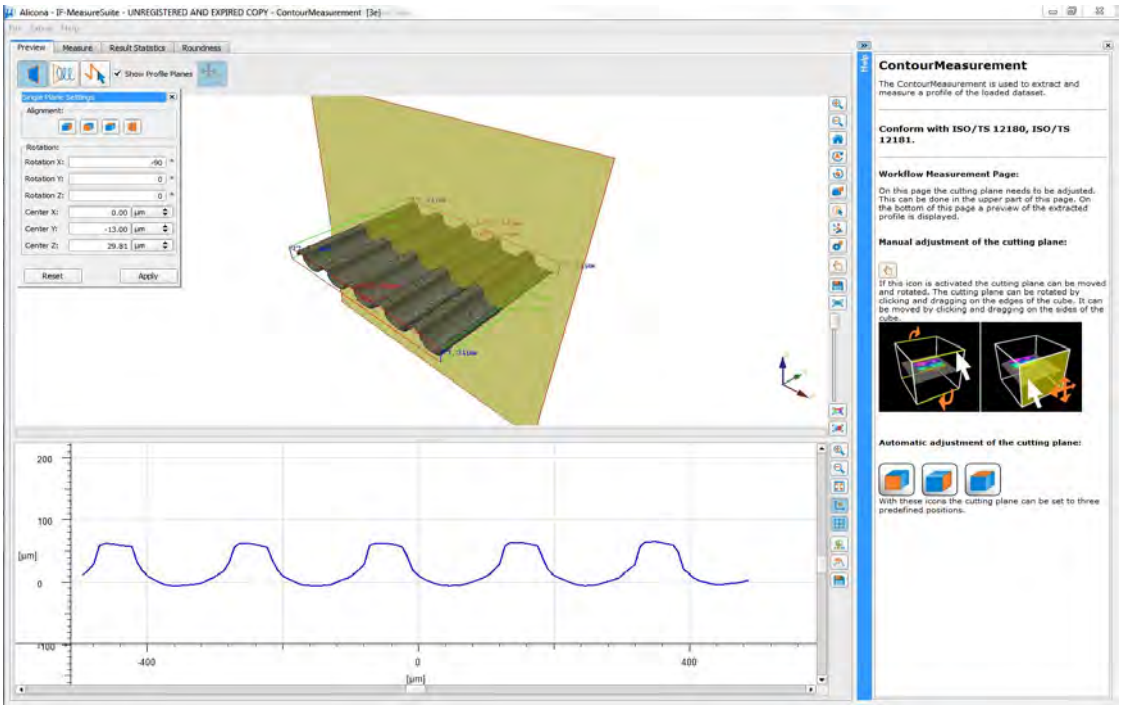
The Profile Table shows details of the extracted primary profile. Rows represent extracted profile points. You can export either the whole table or selected columns by right clicking the table or using the buttons on the right side. Moreover you can copy several table parts to the clipboard. Available Table Export Formats are

- To File: Exports to a text file.
- To Microsoft Excel: Exports to a CSV file. To ensure correct Excel readout, please make sure to adjust the separator symbols correctly.

## 4.8 ContourMeasurement

The ContourMeasurement module is optional. It allows to extract and measure a profile out of your dataset.

### 4.8.1 Tab Extract a Profile - Cutting Plane

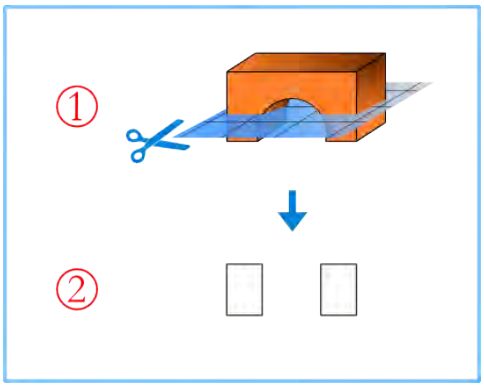



Adjust Cutting Plane

1. Fit the cutting plane to your desired position. (You can rotate, scale, and move the cutting plane.)

2. You can already see a preview of the extracted profile below your dataset. In this editor you can already perform manual measurements. Depending on your object and the position of the cutting plane you can now have one or more profiles.

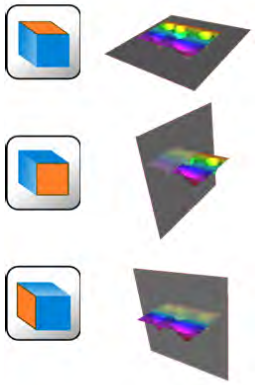
3. On tab 2 you find more detailed profile data. Here you can measure e.g. circles, angles... or you can also perform manual measurements.



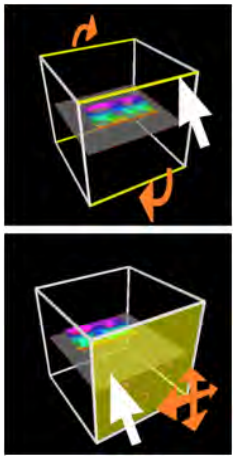

Adjust Cutting Plane: (1) place and adjust cutting plane, (2)preview of the profile (depending on position of the cutting plane)

### Align the cutting plane


Activate this icon to align the cutting plane. If you want to rotate the dataset in between the alignment process press the *alt*-key while clicking on the dataset.

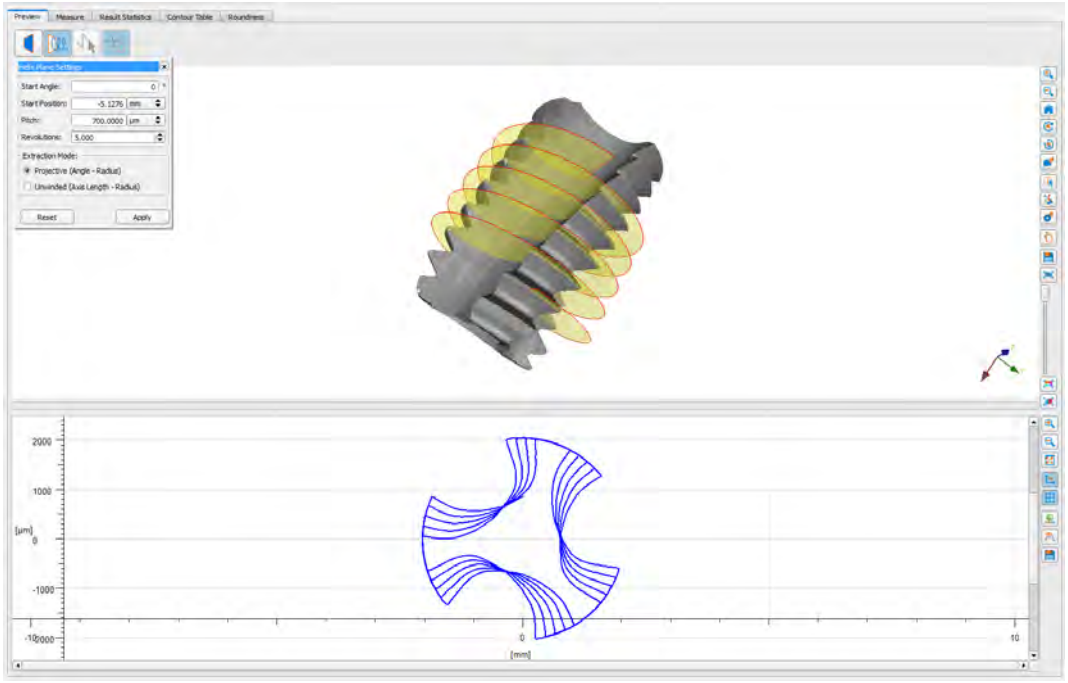


Automatic alignment



Manual alignment

### 4.8.2 Tab Extract a Profile - Helix Plane



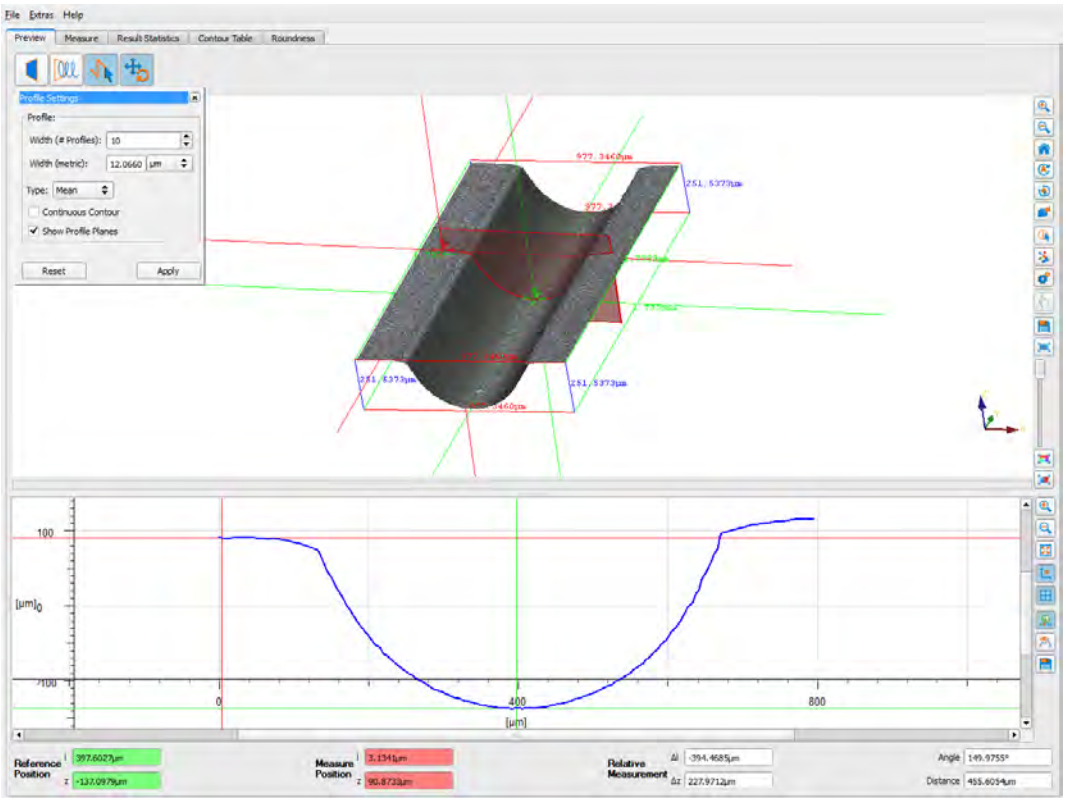
Helix contour

With this mode, a helix structure can be used for a dataset. Based on settings as start angle, start position, pitch and revolutions, the helix can be adapted optimal to the dataset e.g. screw tap. These parameters are

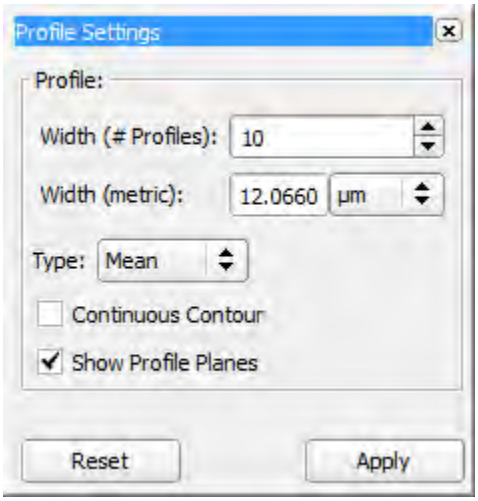
- Start angle: Start position of the helix defined by an angle around the x-axis.
- Start position: Start position of the helix along the x-axis.
- Pitch: Expansion of a revolution along the axis.
- Revolutions: number of revolutions.
- Extraction Mode: projectiv or unwinded.

### 4.8.3 Tab Extract a Profile - Polyline

Analogue to the ProfileMeasurement a polyline profile can be extracted. The settings dialog is used to adjust the width and type of the profile. The option **Continuous contour** can be chosen to generate a continuous visualization for disconnected profile parts. To apply settings changes, press Apply, otherwise press Reset to restore the default settings.

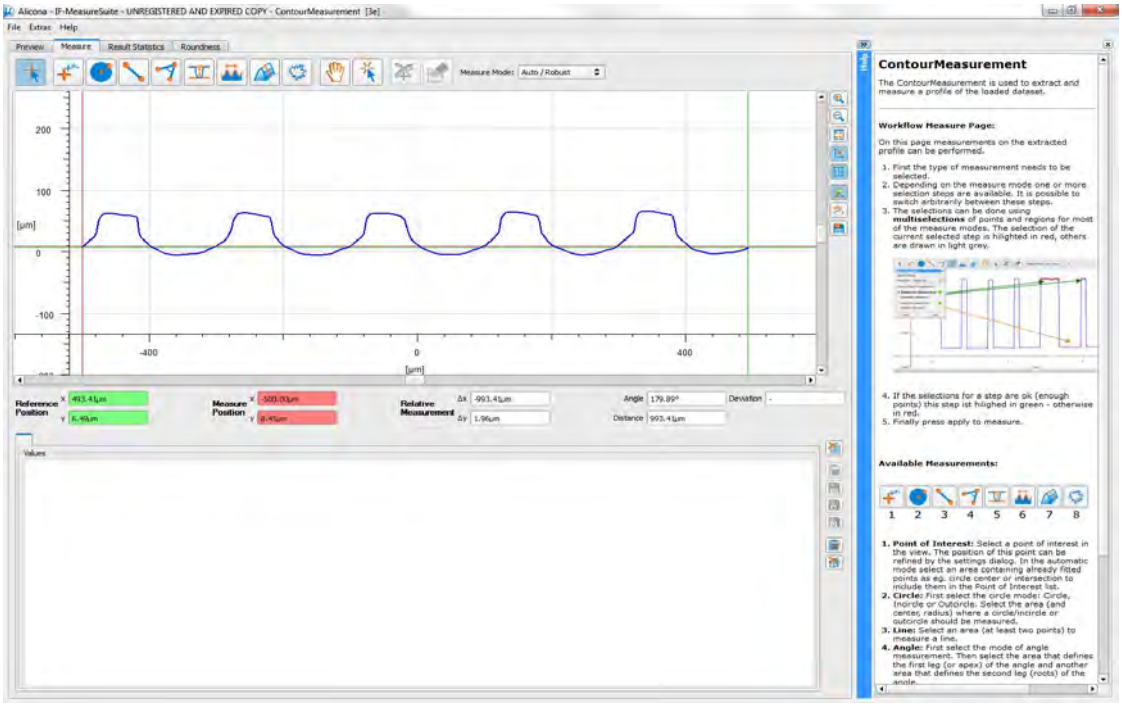



Polyline Profile




Settings dialog

### 4.8.4 Tab Measure the Extracted Profile




Measure the Extracted Profile

1. Activate a form tool from the top row of this page.
2. Choose the measurement mode: automatic or automatic robust. **Note:** Please keep in mind that the automatic robust mode depends on the parameters you have set in the expert settings. (see page 153)
3. Select one up to four areas on the profile path. As soon as enough areas are selected the shape will be measured in automatically. The number of areas that need to be chosen is defined by the form tool.
4. After this step you can already see the measured shape and the corresponding values in the table below.

**Positioning and Marking:**


**Cursor**

Move measure and reference position on the profile. The measure and reference position are visualized by the red and green crosses.


**Point**

Select a point in the view. The position of this point can be refined by the settings dialog. In the automatic mode select an area containing already fitted points as eg. circle center or intersection to include them in the point list.

**Measurement:**

 **Circle**

First select the circle mode: Circle, Incircle or Outcircle. Select the area (and center, radius) where a circle/incircle or outcircle should be measured.

 **Line**

Select an area (at least two points) to measure a line.

 **Angle**

First select the mode of angle measurement. Then select the area that defines the first leg (or apex) of the angle and another area that defines the second leg (roots) of the angle.

 **Height Step - ISO 5436 Height Step - Maximum distance**

First select the mode of distance measurement. Select first the areas that define the reference level, afterwards select the areas which define the measure level (in the ISO 5436 height-step mode only one area containing the height-step). As result you will get the height-step (maximum distance).

 **Thread Information**

Select a thread contour. Please ensure that the coordinate system goes straight through the center of the rotation axis.

 **Edge**

Select an area containing an edge shape. The chipping side of the edge is

visualized in green, the clearance side in blue.

### Additional Tools:

 **Roundness (Only in ContourMeasurement)**

Select an area to measure the deviations of the shape to a circle.

 **Drag view**

Drag view.

 **Select fitted objects**

Select already fitted objects. This is also possible by clicking with right mouse button on the fitted object. The selected object is highlighted in the viewer and the table.

 **Remove selections**

Remove all selections.

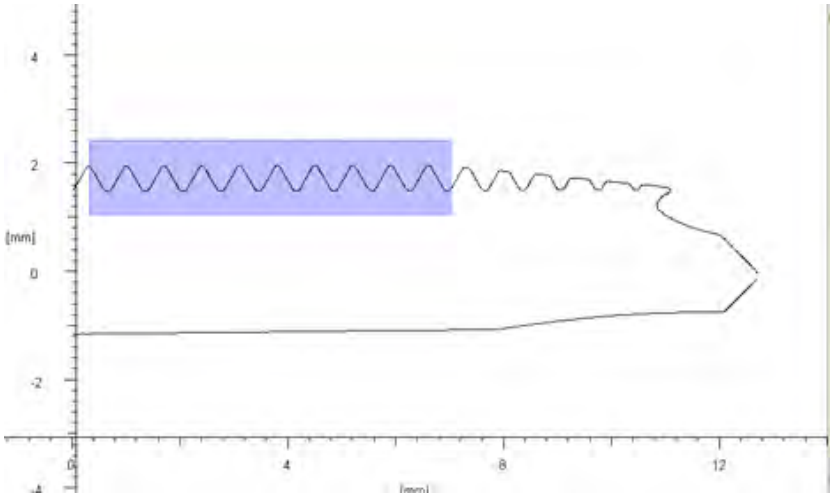
 **Unmark**

Unmark selected points or selected areas.

### Measurement of Thread Parameters

To perform a thread measurement do the following steps:

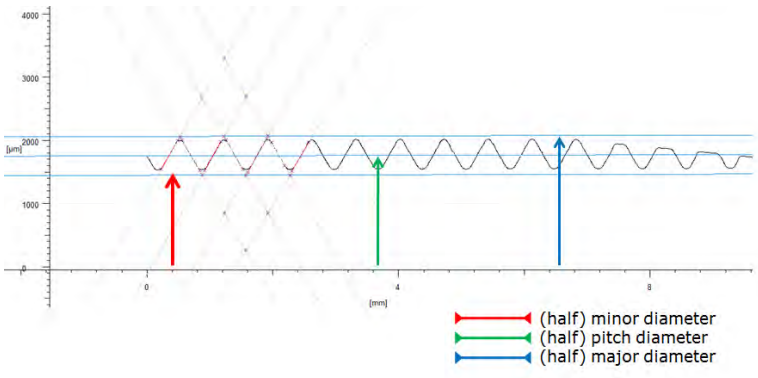
- Choose tread button
- Select area of thread (without first cut)

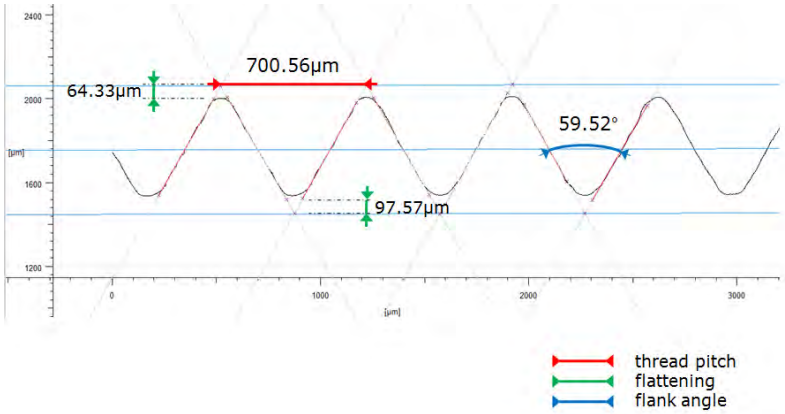



Selection for thread measurement

- Attention: Cutting plane should pass through rotation axis
- Press *Apply* to measure the paraemters:
  - Thread pitch,
  - Major-, minor- und pitch ø
  - Thread angle
  - Half included thread angle left/right
  - Flattening on major- and minor- ø,
  - Tapering

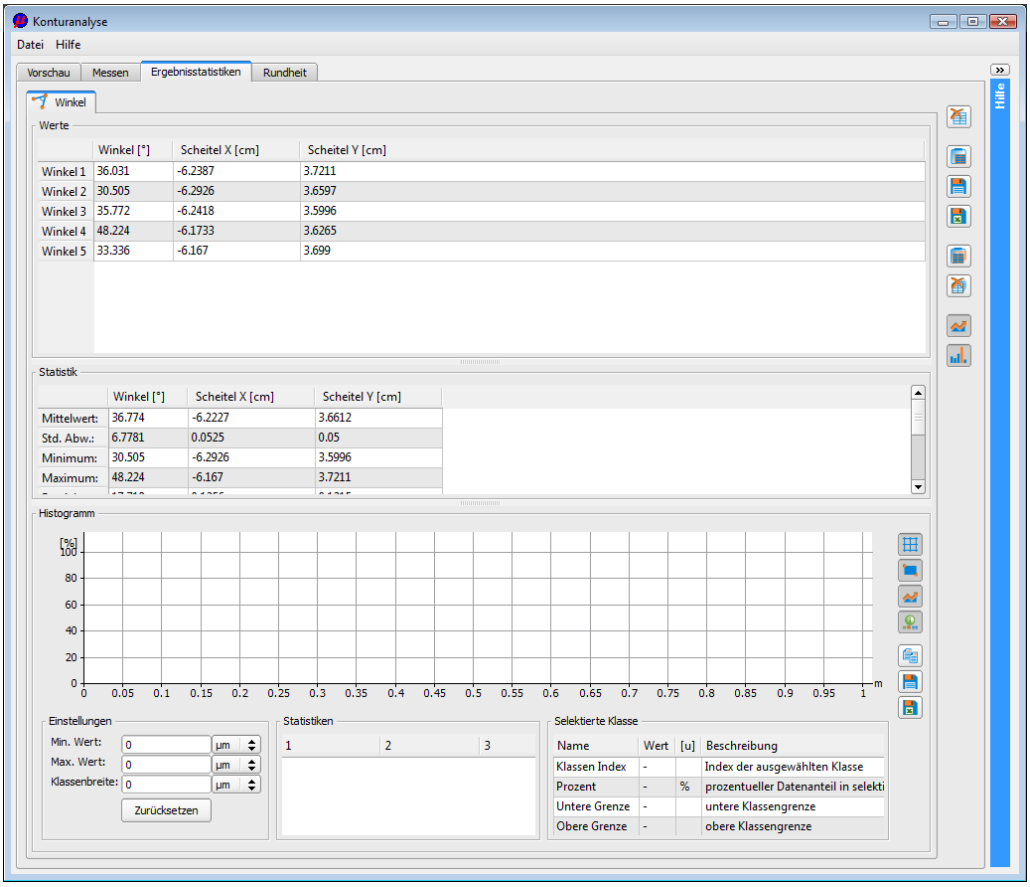
  In addition to these parameters also the standard deviations of these parameters along the different threads are provided.






### 4.8.5 Tab Result Statistics

The tab visualized an overall statistic of fitted objects. The statistic evaluation include minimum, maximum, mean, standard deviation and other statistical parameters displayed in a table view. Selected columns can be visualized by histograms.

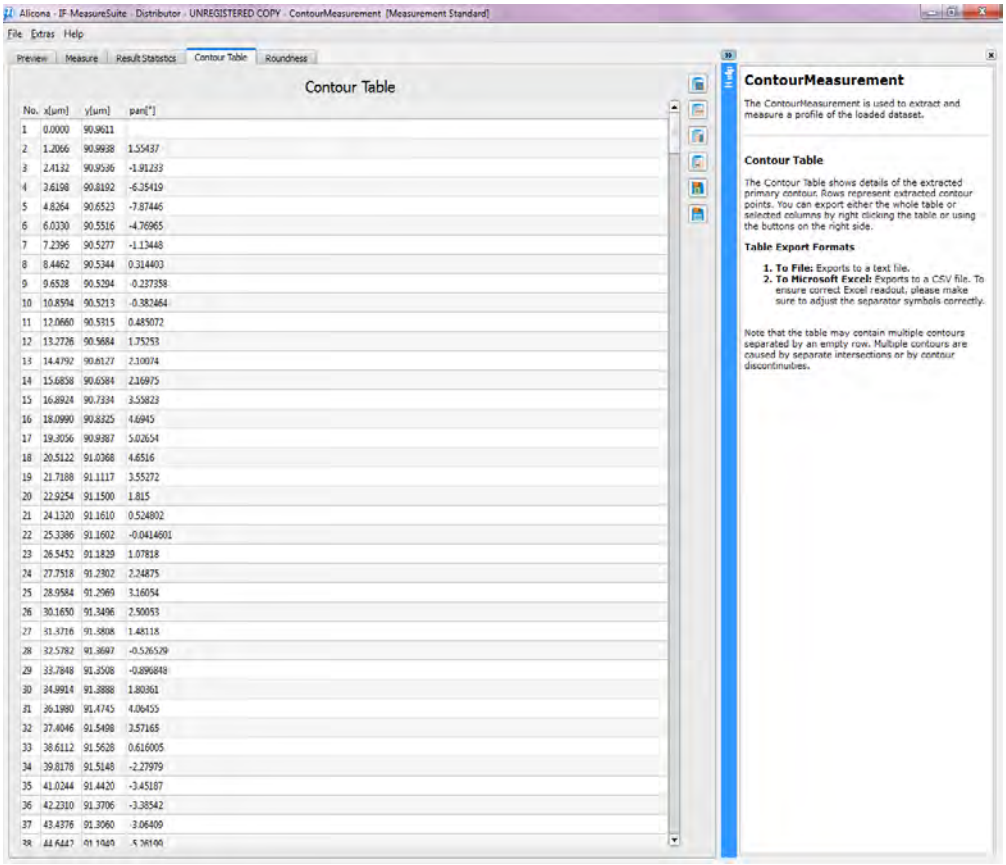



Detailed Measurement

### 4.8.6 Tab Contour Table

The Profile Table shows details of the extracted primary profile. Rows represent extracted profile points. You can export either the whole table or selected columns by right clicking the table or using the buttons on the right side. Moreover you can copy several table parts to the clipboard. Available Table Export Formats are

- To File: Exports to a text file.
- To Microsoft Excel: Exports to a CSV file. To ensure correct Excel readout, please make sure to adjust the separator symbols correctly.




Profile Table

### 4.8.7 Tab Roundness Measurement

The Roundness tab measures the deviation of one shape to a circle. The deviations are described in five parameters. These Roundness Parameter are:

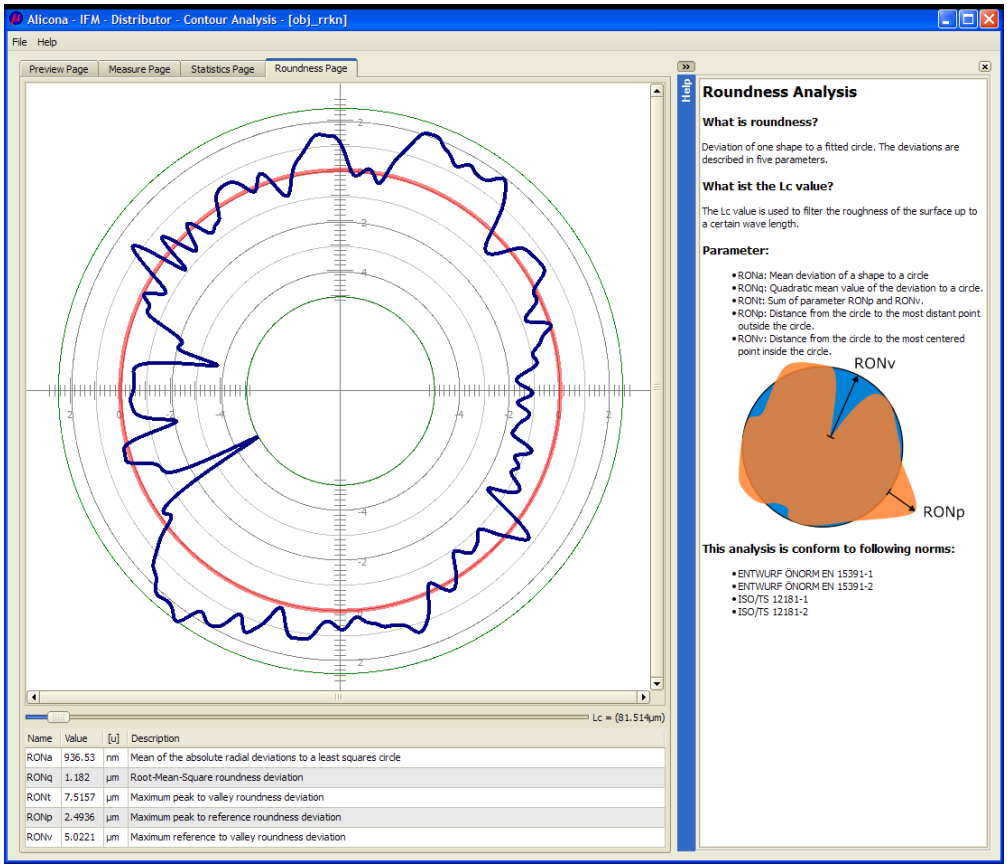
- RONa: Mean deviation of a shape to a circle

- RONq: Quadratic mean value of the deviation to a circle.

- RONt: Sum of parameter RONp and RONv.

- RONp: Distance from the circle to the most distant point outside the circle.

- RONv: Distance from the circle to the most centered point inside the circle.




Tab Roundness

## 4.9 DifferenceMeasurement

The DifferenceMeasurement is optional.

The DifferenceMeasurement is used to determine how much and where one dataset differs from a second dataset, by measuring deviations as difference volume and difference area. In the DifferenceMeasurement, two Surface-Datasets can be compared as well as Real3D-datasets or combinations. Moreover, CAD-data can be interpreted and used for measurement.

### 4.9.1 Steps to Perform a DifferenceMeasurement

- Alignment: Alignment of two datasets by different modi:
  - Automatic Rough Alignment
  - 3(n) Point Alignment
  - Manual Alignment
  - Automatic Fine Alignment
- Difference Visualisation: The depicted difference-dataset can be visualized in different modi:
  - Continuous Mode
  - Tolerance Mode
- Statistics: Result data as deviations are visualized in a histogram.

### 4.9.2 Result Values

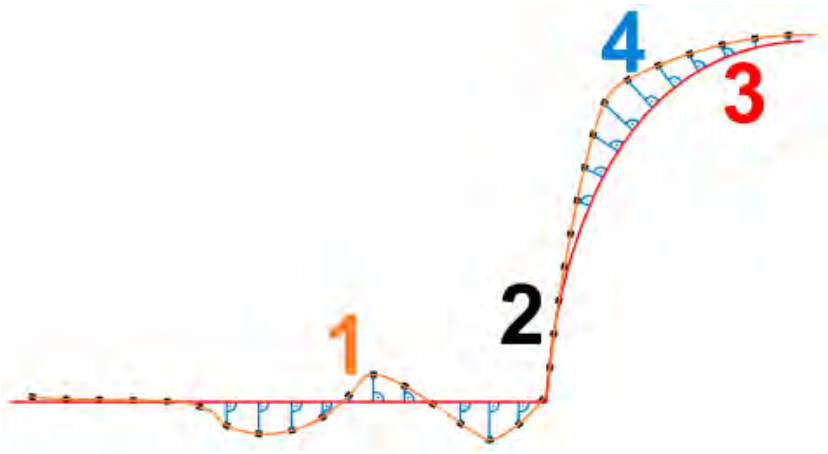
The measured parameters depend on the model type. The values maximum deviation below and above reference surface, and mean deviation are available for SurfaceDatasets and Real3D-datasets. Measured parameters are:

- Tolerance value for defect detection
- Max. deviation below reference surface
- Max. deviation above reference surface
- Mean deviation

- Volume of peaks above reference surface
- Volume of valleys below reference surface
- Volume of peak defects extending above tolerance
- Volume of valley defects extending below tolerance
- Projected area of specimen
- Proj. Area of peaks above tolerance
- Proj. Area of valleys below tolerance
- Coverage Percentage (Area within tolerance)
- Greatest depth of defects (ISO 8785)
- Greatest height of defects (ISO 8785)
- Whole Area of defects (ISO 8785)

**Detailed descriptions of deviations:**

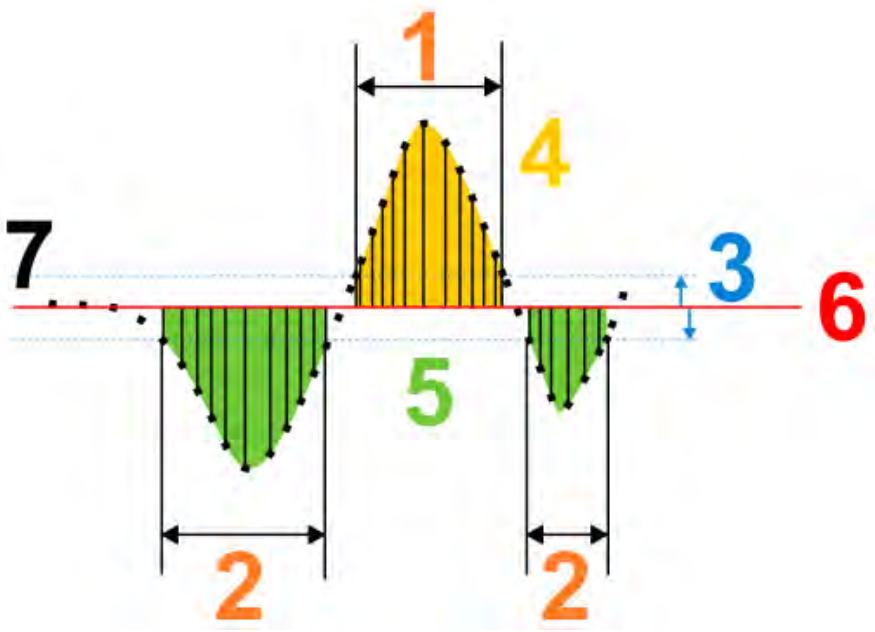
- Dneg: Max. deviation below reference surface
- Dpos: Max. deviation above reference surface
- Dmean: mean value of all difference values.




Differences - Mean, Neg and Pos

1. Measured dataset
2. Measure points of measured dataset

3. Reference dataset
4. Deviations (including the parameters mean, new and pos)




Differences - Area Below/Above and Volume Below/Above

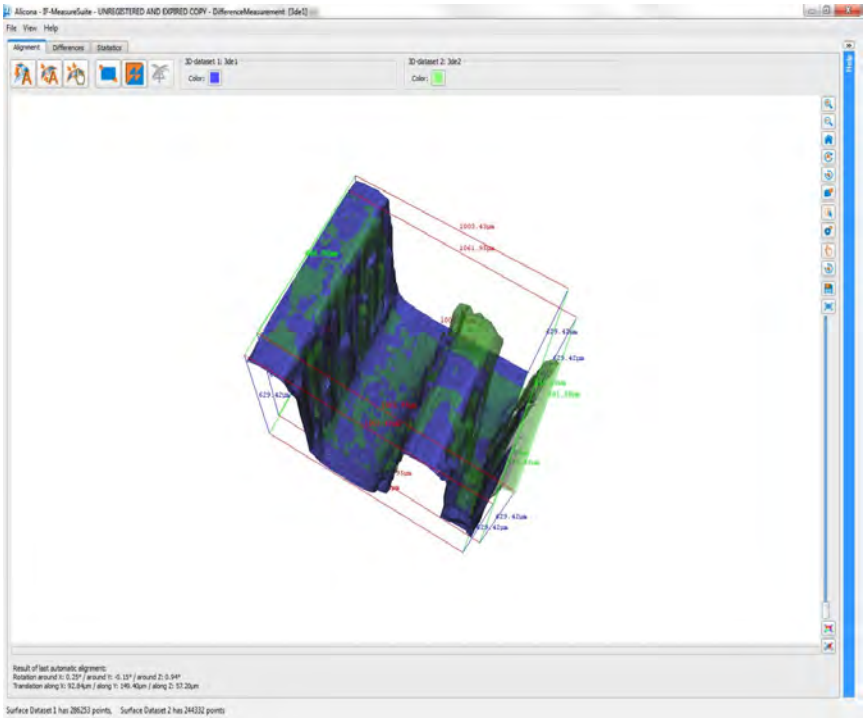
1. Area above
2. Area below
3. Tolerance threshold
4. Volume above
5. Volume below
6. Reference dataset
7. Measured dataset (visualized measurement points)

### 4.9.3 Workflow

Load the reference geometry dataset at first and then the dataset where you want to see the deviations. Please pay attention to the order in which the datasets are loaded! The order has a significant impact on the difference measurement.

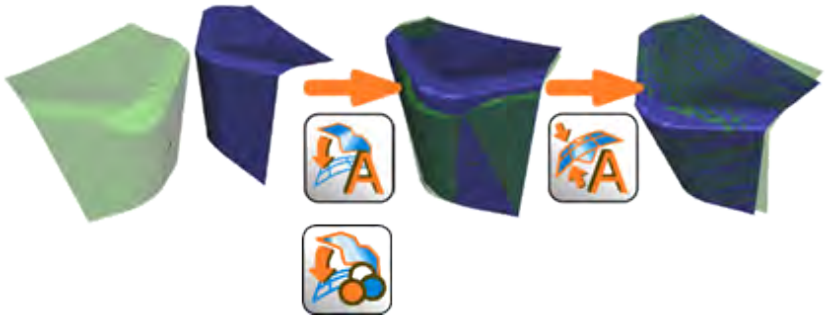
E.g. Load the CAD-dataset first followed by the measured 3D-dataset.

### Tab 1: Alignment



Tab Alignment

To get significant results you first need to position the objects one upon the other. Only if this step is done properly results will be significant. For a better differentiation “Dataset 1” and “Dataset 2” are colored differently. The color for each dataset can be chosen.



Alignment of datasets

In order to align "Dataset 1" with "Dataset 2" please use one or more of the following modes:

1. **Automatic Coarse Alignment Mode**:

   In order to position "Dataset 2" near to "Dataset 1" press the coarse alignment button. As a result the center of gravity of both datasets is at the same position.

2. **3(n) Point Alignment Mode**:

   In order to position "'Dataset 2"' near to "'Dataset 1"' based on selected points, press the 3(n) point alignment button. In this mode, points can be selected on "Dataset 1" and "Dataset 2". The transformation between the two models are calculated on these point pairs. This leads to a coarse alignment of the two datasets. The alignment can be refined by selecting more points or by redefining already selected points. If "'Fine Alignment"' is chosen, an automatic alignment with minimum deviation is performed after the coarse alignment. "'Only translation"' cause in an alignment, where only translation - no rotation - is performed.

3. **Automatic Fine Alignment Mode**:

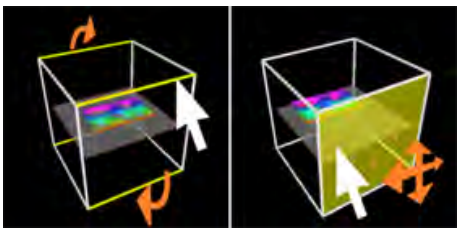
   In order to align "Dataset 2" best with "Dataset 1" press the automatic alignment button. This can take some time. In order to shorten this time you can do a coarse alignment beforehand.

4. **Manual Alignment Mode**:

   To manually align "Dataset 2" press the manual alignment button. It can now be rotated by klicking and dragging on the edge of the cube and you can move it by klicking and dragging on the side of the cube.

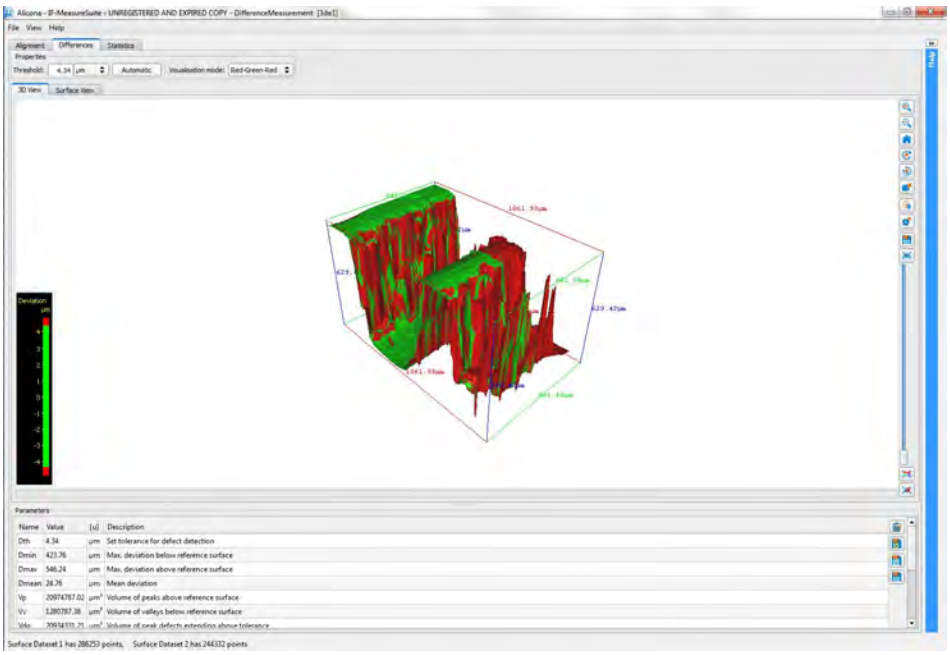


Manual Alignment

As a result "Dataset 1" should be optimally aligned with "Dataset 2". As soon as “Dataset 1” is aligned with “Dataset 2” you can go on with the

DifferenceMeasurement on tab two. It may take some time until the differences are calculated.

### Tab 2: Differences



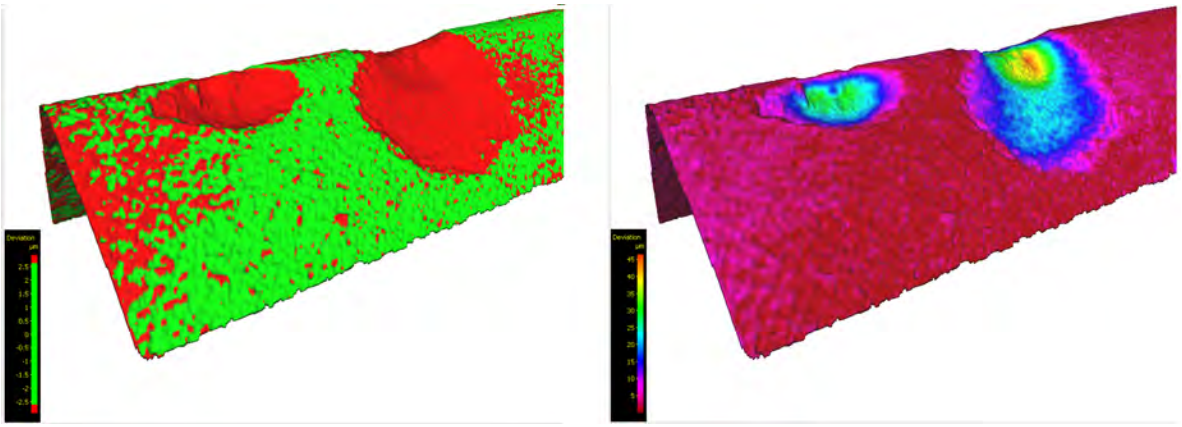
Tab DifferenceMeasurement

On tab two the differences of “Dataset 1” to “Dataset 2” are depicted in colors. The color bar tells you how big this deviation between “Dataset 1” and “Dataset 2” is. On basis of “Dataset 1” you see the deviation to “Dataset 2” visualized by pseudo colors. The difference visualisation mode can be chosen in the top bar to be either

- **Tolerance:** seperate colors for difference values inside / outside a selectable threshold, or

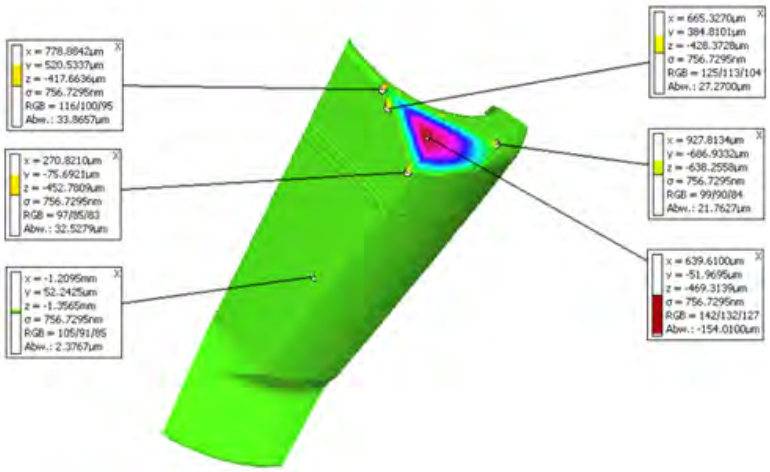
- **Continuous:** gradual color coded differences.

See the figure below for a comparision of the visualisation modes.



Left: tolerance visualisation mode, right: continuous mode

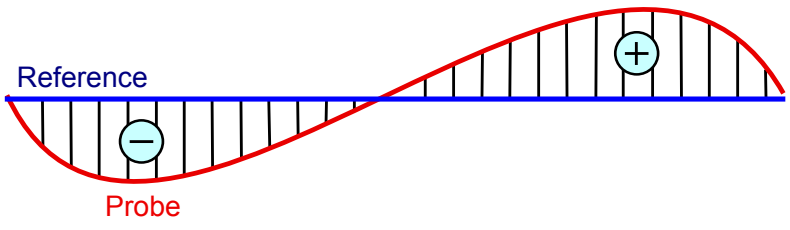
The result values are displayed in the table below. If you chosse the single point information of the viewer detailed information about selected points with the deviation to the original dataset for this single point will be displayed.



Single point information with deviation

There are two modes for difference calculation:

- zValues:



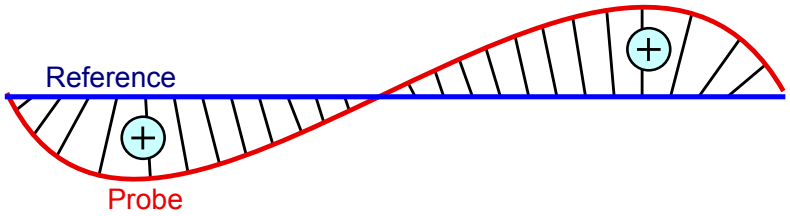

Mode: zValues

– This mode is default for SurfaceDatasets, but not available for Real3D-datasets.

– The computation ist fast.

– As a result positive and negative deviations are shown (depending on the model loading order).

- nearest:




Mode: nearest

– This mode is default for Real3D-datasets, and it is an option for SurfaceDatasets.

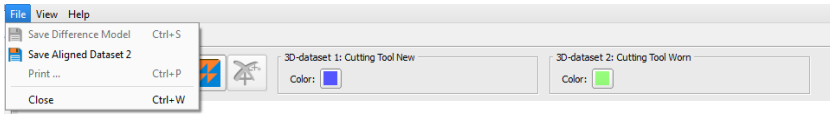
– The calculation is slower than the computation of zValues.

– As a result all deviations (positive and negative) are shown as positive deviations.

– The result depends on the order of loading. Dataset 1 always ist the reference model.

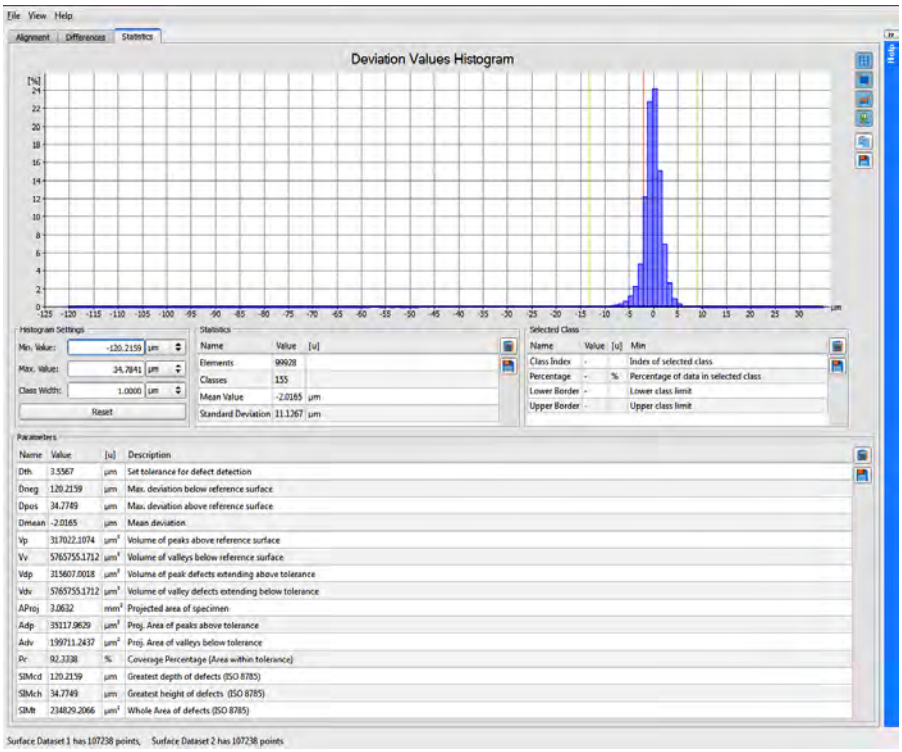
### Saving the Difference Dataset

In order to save the difference dataset for further measurements with other measurement modules you can save the difference dataset. Open the menu *File/Save Results*




Save Difference Dataset

### Tab 3: Statistics




Tab DifferenceMeasurement

On tab three you can see the result values displayed in a histogram. This may help you to interpret the variations of the deviations.

### Attention

- Concerning the alignment of the two loaded datasets 80% of the surface must be similar in order to allow an automatic alignment.

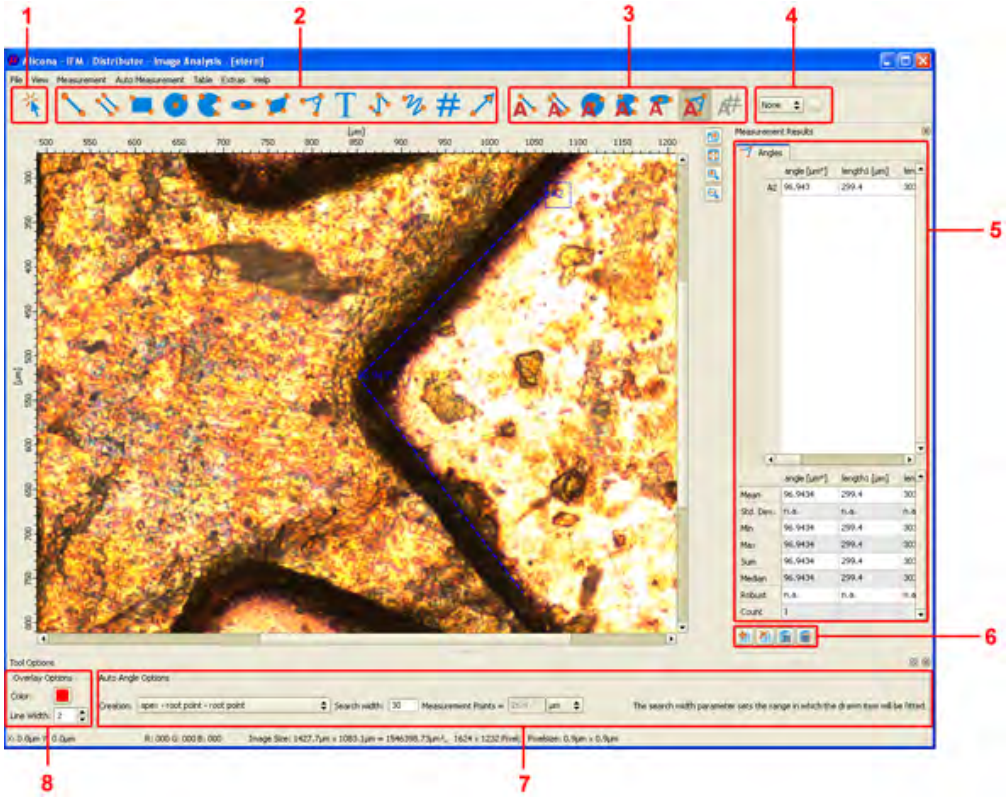
- CAD-data must fulfill certain requirements. (E.g. a dense triangle net is needed)

  For useful measurements the triangular lenghts of the CAD-datasets should be aproximately three times as long as the sampling distance of the dataset that will be measured.

## 4.10 2DImageMeasurement

### 4.10.1 The User Interface

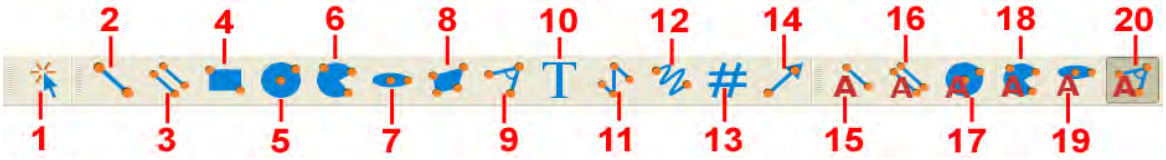
The user interface of the 2DImageMeasurement consists of the following elements:




2DImageMeasurement

1. Selection Tool
2. Manual Draw Tools
3. Automatic Fit Tools
4. Overlay Options
5. Measurement Result Table
6. Result Table Operations
7. Specific Options: e.g. Creation Mode, Search range parameters
8. Overlay Options: Color and Linewidth

### The Toolbar




Toolbar 2DImageMeasurement

1. Selection
2. Line
3. Parallel line
4. Rectangle
5. Circle
6. Arc
7. Ellipse
8. Polygon
9. Angle
10. Text
11. Polyline
12. Freehand lines
13. Manual counting
14. Arrow
15. Auto line
16. Auto parallel line
17. Auto circle
18. Auto arc
19. Auto elipse
20. Auto angle

All available tools are located at the toolbar. For your convenience, you can choose any tool by clicking on the icon. After selecting a specific tool, just click with the mouse on the loaded image to add the selected form. There are two categories of tools in the 2DImageMeasurement. We distinguish between:

### Manual Drawing Tools

Shape as well as position of the item are completely choosen by the user. Depending on the chosen tool you can adjust properties and the color of the item to be drawn. Choose the parameters at the tab properties of the tool. Of course every drawn item can be deleted from the image and the table. Select the item you want to delete and press *DEL* on the keyboard.

- Line

  Draws a single line. The first mouse click sets the starting point of the line, the second click sets the ending point.

- Parallel line

  Draws two parallel lines. The first line is drawn like an ordinary line. The next mouse click determines the distance of the second line.

- Rectangle

  The first click sets one corner of the rectangle, the second click sets the opposite corner.

- Circle

  You can choose between three creation modes:

  - center + radius

    First click at the center of the circle, then click on a point at the circumference.

  - 3-point

    Click on three points at the circumference. A circle will be drawn which exactly intersects the three points.

  - n-point

    Click on at least three points at the circumference, indicate the last point by double clicking. A circle will be drawn which matches the points best.

- Arc

  To draw an arc click on three points at the circumference, just as you draw a circle in 3-point creation mode.

- Ellipse

  To draw an ellipse click on opposite points of a rectangle which surrounds the ellipse.

- Polygon

  You can draw a polygon with an arbitrary amount of corners.

  You can choose between two creation modes:

  - Lines: Every cornerpoint is indicated by a click and the last corner is indicated by a double click.
  - Freehand: Move the mouse to draw a freehand polygon. The last corner is indicated by a single click.

- Angle

  You can choose between four creation modes:

  - Apex - Rootpoint - Rootpoint: Click three times to define rootpoints and apex of the angle in the given order
  - Apex - Rootpoint - Rootpoint (same line length): Like above, but both legs have the same length
  - Rootpoint - Apex - Rootpoint: Click three times to define rootpoints and apex of the angle in the given order
  - Rootpoint - Rootpoint - Apex: Click three times to define rootpoints and apex of the angle in the given order
  - Freehand: Move the mouse to draw a freehand polygon. The last corner is indicated by a single click.

- Text

  Just click at the place you want the text to appear, then type the text on the keyboard. Later on you can change the displayed text in the column *comment* of the Result Table.

- Polyline

  Each mouse click determines one point of the polyline. You can draw a polyline with an arbitrary amount of points, the last point is indicated by a double click.

- Freehand line

  To draw a freehand line click on the point you want it to start from. Then move around with the mouse freely, the freehand line will follow your mouse moves. The end of the freehand line is indicated by a mouse click.

- Manual counting

  Click on the screen once for every point you want to be counted. For each click an entry will be added to the feature counting section of the Result Table.

- Arrow

  The first mouse click sets the starting point of the arrow, the second click sets the ending point.

### Automatic Tools

For highly accurate measurement the Image Analysis software provides automatic fitting tools. To use these tools draw the item as you would do with the corresponding manual drawing tool. You just have to determine the shape and position of the item roughly, though: After you have drawn the item an internal algorithm fits shape and position in the best possible way into the picture or the region of the image. To get the best results adjust the "Search width" parameter in the Tool Properties window. This parameter sets the range in which the drawn item will be fitted.

- Parallel line
  You can choose to fit more than one parallel line pair. Enter the wanted number into the spin box titled *Parallel Line Pairs*. The distance between the pairs can also be given. The pairs will be created with the given distance, and fitted separately.

- Auto Counting *(Deactivated in this version)*
  To start Auto Counting put a rectangle around the pattern you want to be counted, and confirm. Afterwards, an algorithm will automatically search for the selected pattern and create an entry in the feature counting section of the Result Table for every match.

  – Sensiblility: Use the slider to control the sensibility of the auto counting operation. The higher the value, the more objects will be found.

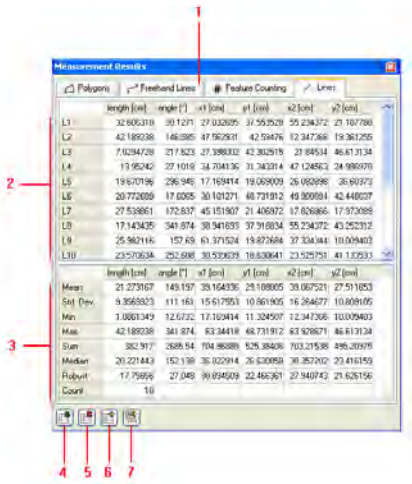
– Color sensibility: Use the silder to control to which extent the color of the pattern is taken into account. A value of 0.00 means the color doesn't matter, whereas a value of 1.00 means the color is taken fully into account.

### How the automatic tools work

These measurement capabilities work in the following way: The first step consists of selecting the rough position of the form (line, circle, ...) The second step consists of the software extracting profiles orthogonal to the form. The length of these profiles can be adjusted at the bottom of the image analysis window. Along this small profiles the software is measuring the contrast. The highest value gives a correct position. At the end all these positions are used to calculate the resulting form element. This is done in an robust way.

### Results

You can find a very detailed and concise representation of your analysis results in the Result Table. The different tables contain the characteristic parameter of the specific tool. Additionally the table provides a statistic evaluation about all items located at one table. You can easily copy the content of a table to the clipboard and/or to another application. For that purpose highlight the entries to copy and click the right mouse button on the marked area. Now choose *Copy Selection* at the appearing menu to copy the highlighted area to the clipboard. To copy the whole content of the table just choose the entry *Copy Table* or use the button below the table. Of course you can delete the whole table or certain entries of the table.




1. Tabs to switch tables of overlay types

2. Measurement results

3. Statistical evaluation

4. Create a new (empty) table

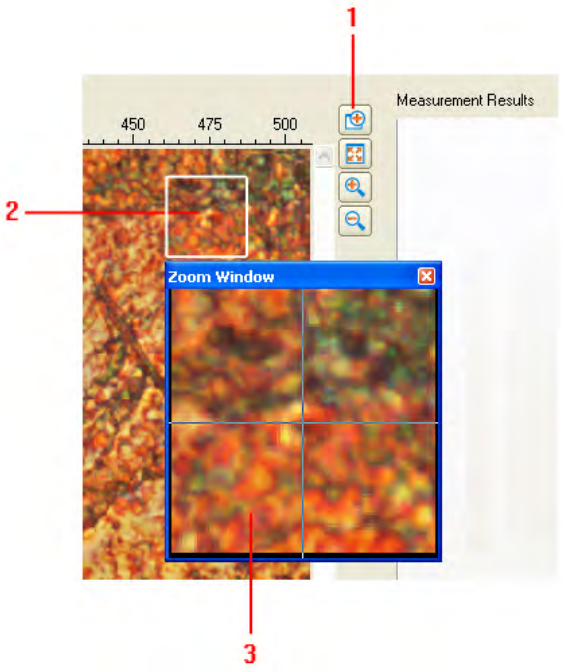
5. Delete table

6. Export table to clipboard

7. Export all tables to clipboard

## Zoom Window

By clicking the magnifier-icon in the viewer's toolbar you activate or close the so called *zoom window* of the Image Analysis.




Zoom Window

1. Zoom window toggle button: Click to show or hide zoom window.
2. Position of mouse cursor is in the middle of the zoom window.
3. Zoom Window

The zoom window provides a permanent magnification of a certain area around the current mouse cursor position, this helps the user to work more precisely.

### Export / Import Function

The export / import features of the image analysis can be accessed via the *File* menu:

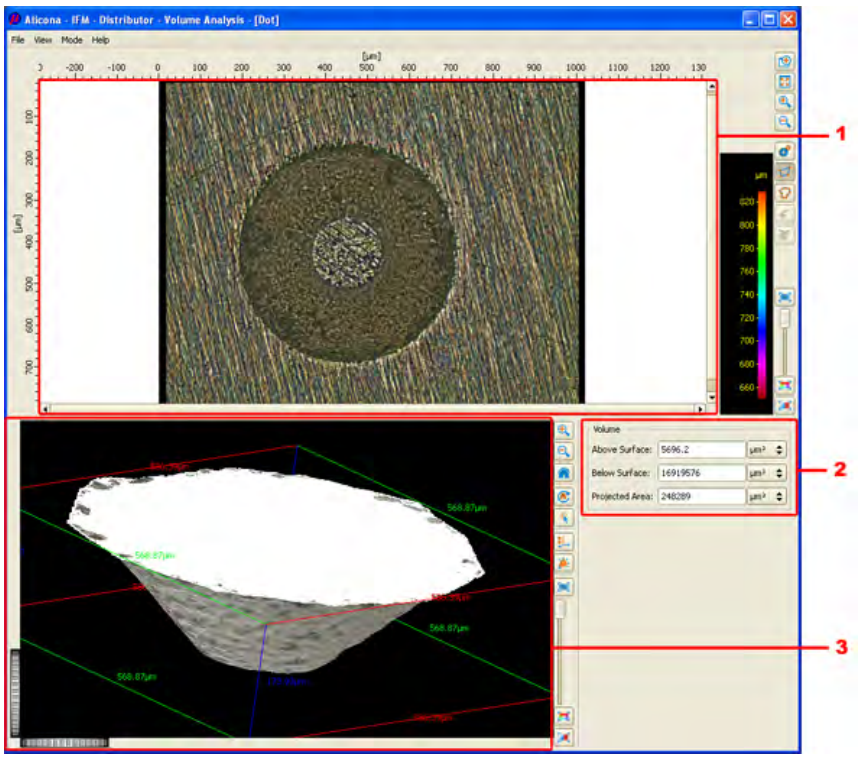
- *Load overlays from database*: Using this feature you can import overlays from an existing object in the database.
- *Export:* You can choose to export the image with overlays or image only. To export measurement results, use the *Copy All Tables* command in the *Table* menu.
- *Printing*: You can choose to print the image with overlays, the image only or the measurements.

## 4.11 VolumeMeasurement

To measure a volume select the VolumeMeasurement from the menu bar.


The VolumeMeasurement allows you to measure volumes of voids or protrusions in a comfortable and intuitive manner.

The screen is divided into three parts:




Volume Measurement Screen

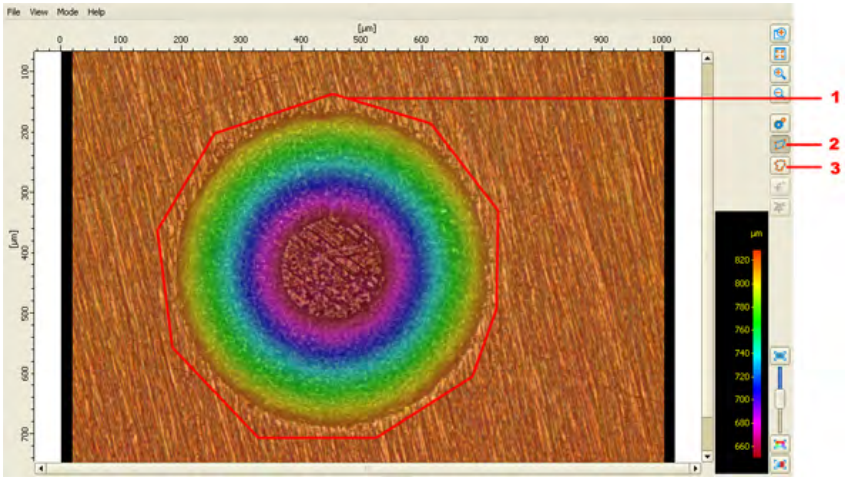
1. *Image viewer:* Here you can select the area you want to measure.
2. *Volume viewer:* Here you can see the extracted volume and the calculated ISO-plane.
3. *Volume parameters:* Here you can see the results of this measurement

### 4.11.1 Steps for the Volume Detection

- Adjust reference plane
- Select an area of the image. This area will be used for the volume calculation. To make this selection you have to activate either the polygon

 or the freehand polygon

 tool. A double click closes your selection. If you do not make a selection the volume of the whole object will be calculated. This may take some time.

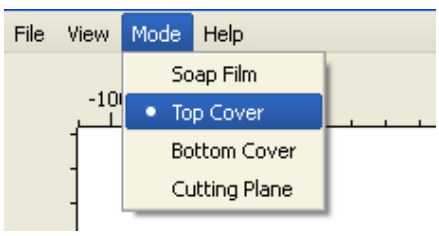



Select Calculation Area

1. Selected area
2. Selection mode polygon
3. Selection mode freehand polygon

- Now you can already see the calculated model at the lower part of your screen. On the right side of this model you can see the calculated volume which is divided into two parts: the part above the surface and the part below the surface. Furthermore you are informed about the size of the ISO-surface that covers the object. You can choose between four different calculation modes.

### 4.11.2 Calculation Modes




Select Mode

- **Soap Film**

  The soap film mode covers the object with a slight bulge but does not include areas that surmount the selected area. The soap film mode is set as the default mode.

- **Top Cover**

  The top cover mode covers the object with a slight bulge completely including all surmounting areas. It might occur that minor volume areas are above the ISO-surface. This happens because of the algorithmic calculation. These areas are mostly negligible. The volume measurement with the top cover mode can be considered as preferable to the computation with the soap film mode. The computed volume is closer to what you might want than the soap film mode.

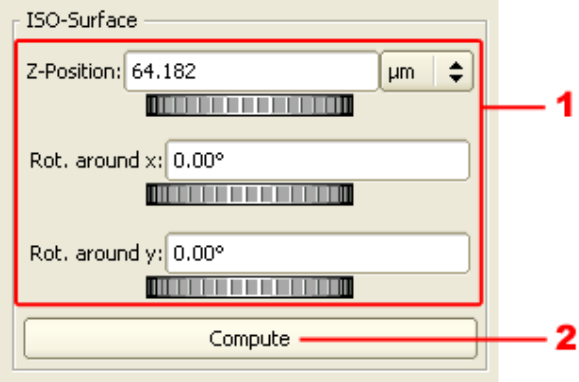
- **Bottom Cover**

  The bottom cover mode covers the object with a slight bulge completely including all surmounting areas. Use the bottom cover mode when you want to measure a volume that is beneath the surface. It might occur that minor volume areas are above the ISO-surface. This happens because of the algorithmic calculation. These areas are mostly negligible.

- **Cutting Plane**

  When using the cutting plane mode you have to adjust the cutting plane to your desired position. You can either do this by moving the plane with the wheels on the right side of the screen or you can draw points for the ISO-plane computation in the image above. To select these points activate the

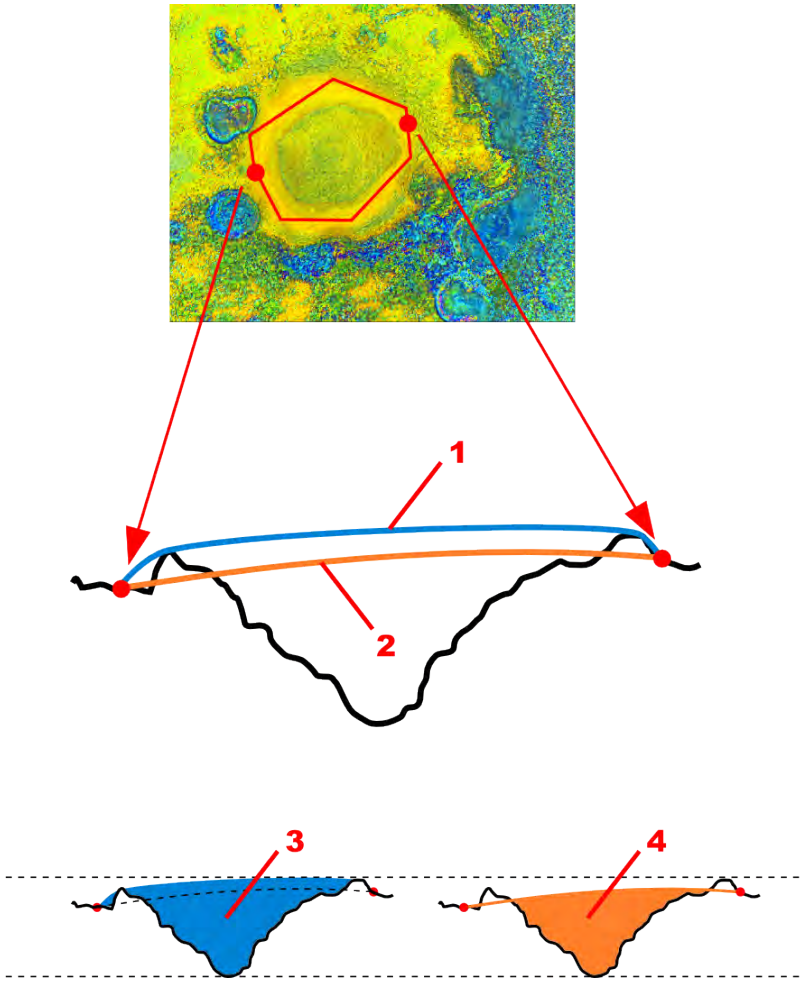
   button. You have to select at least three points to compute an ISO-plane. Once you have finished your selection you have to click the button “Compute” on the right side of your volume model.




Adjust Cutting Plane

1. Adjust cutting plane with wheels (x,y,z;)
2. Generate cutting plane at the previously selected points

Difference between top cover mode and soap film mode:




Top Cover Versus Soap Film

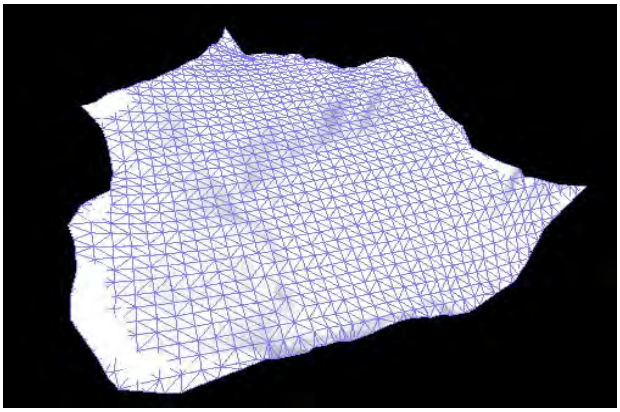
1. Top cover mode

2. Soap film mode
3. Top cover mode: Volume including surmounting areas
4. Soap film mode: Volume excluding surmounting areas

### 4.11.3 ISO-Surfaces

One problem that comes along with measuring volumes from the datasets is that there are rather surfaces than volumes. As soon as the user defines a measurement area of the surface, it has to be dealt with the fact that the new computed SurfaceDataset is open on one side. Hence, we have to find a way of defining a cover or bounding surface. There are various ways to define such a cover. The simplest way is to only use a plane. However, this has the severe drawback that many structures you are interested in cannot be accurately bounded by a plane.

A more intuitive definition of a volume is to use a bounding surface that follows the shape of the polygon defining your volume structure (see image viewer). However, the polygon in 3D is rather used than the one in 2D. Inside this 3D polygon curve, we would like a smooth bounding surface. There is a natural class of objects that have just this kind of behaviour - soap films. Imagine the reproduction of a 3D polygon that forms the bounding curve of your volume, using a thin wire frame. Now dip this wire in soap sud and upon removal, a thin soap film will appear inside the wire frame. Our software emulates this behaviour in order to compute a bounding surface for volume calculations. This bounding surface has the characteristic that it is the surface with the minimum possible area.

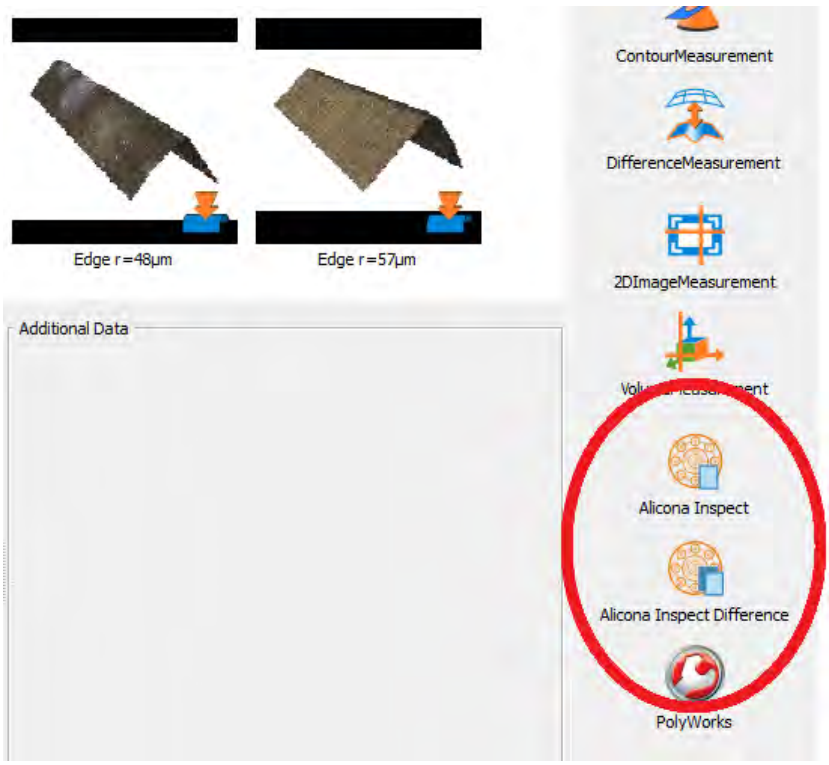


ISO Surface

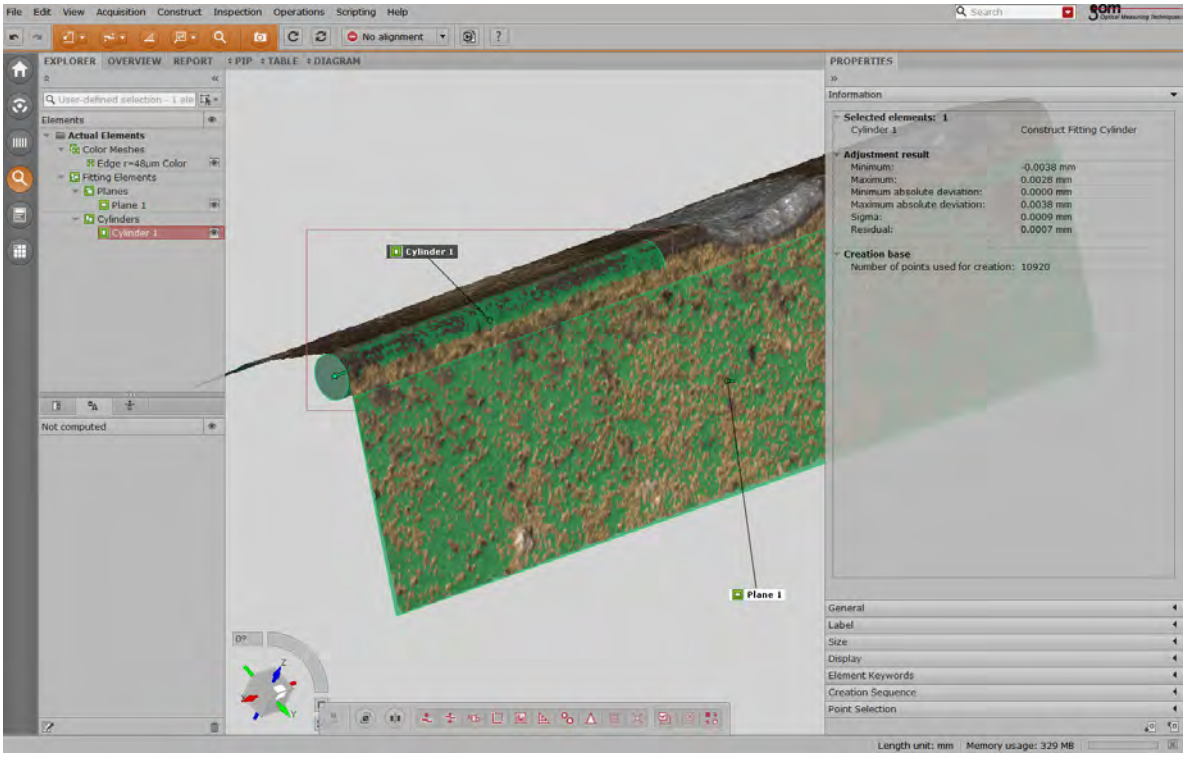
## 4.12 Alicona Inspect

This module provides further 2D and 3D measurement options including GD& T, reporting and trend analysis. See the installation document for proper installation and setup. The mesh type to be used can be chosen in the *Expert Measurement Settings* in the tab *Alicona Inspect* to be either *Mesh only, Color only* or *Mesh and Color*.

To open a single dataset with Alicona Inspect, go to the database view, select a model and click the *Alicona Inspect* icon located in the bottom right, as shown below.

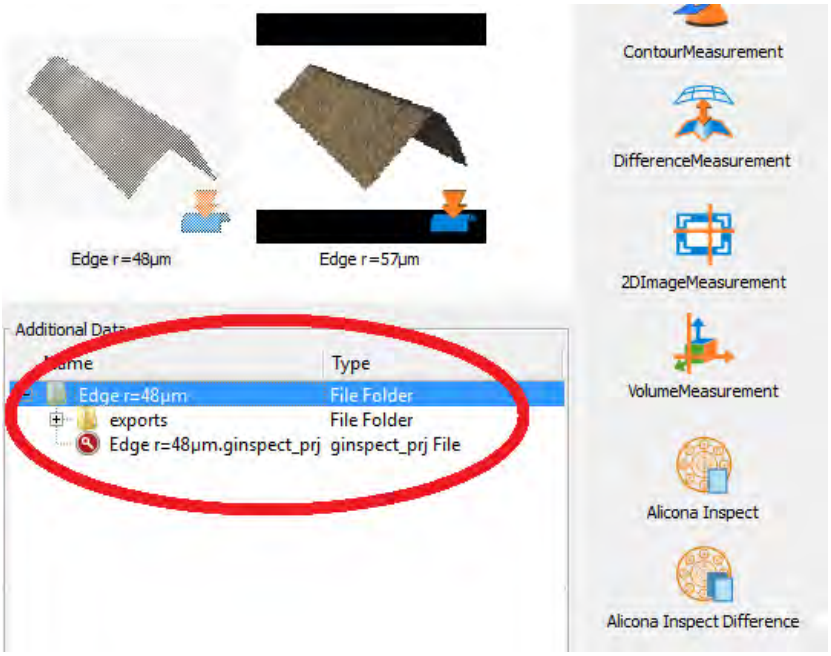



Alicona Inspect start-up icons




Alicona Inspect dataset view

If Alicona Inspect is started for the first time on a dataset, a new *Additional Data* item entitled with the model name is created, see the figure below.




Additional Data Item

Changes made in Alicona Inspect are saved to the corresponding *ginspect_ prj* file which becomes visible by unfolding the Additional data item. Double click the *ginspect_ prj* file to open it again with Alicona Inspect.

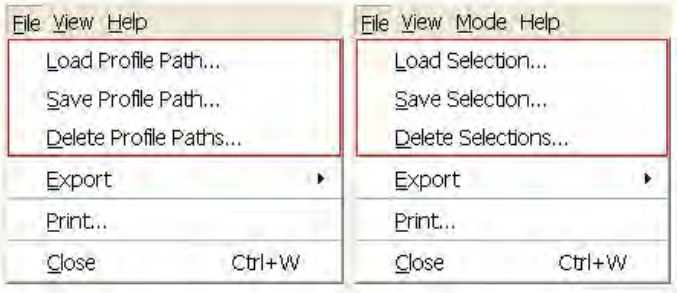
On clicking the *Alicona Inspect* icon with a model which already has an Additional data item, you are provided the option to either overwrite the existing item or to create a new one.

To open two dataset for difference analysis, select the first dataset, hit the *Alicona Inspect Difference* icon and choose the second dataset.

For a detailed description of the module functionality, we refer to the separate Alicona Inspect manual.

## 4.13 Loading and Saving Measurement Profiles/Selections

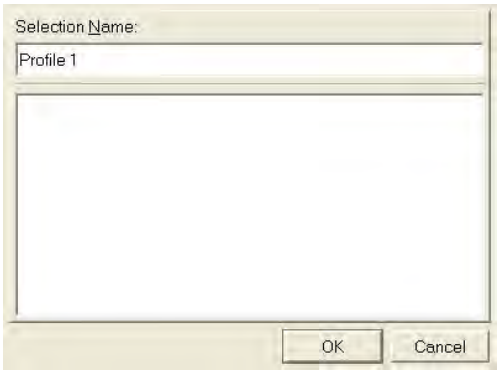
Within the measurement modules, it is possible to save and load drawn profiles and selections. Once a profile or selection is saved, it can be loaded in all measurement modules (draw and save an area selection in the SurfaceTextureMeasurement and load it with the volume analysis). Profiles and selections are stored within a project folder, so you can access them for all objects in that folder. You can find these functions (load, save and delete) in the File menu.




Menu Loading and Saving

### 4.13.1 Save a Profile or a Selection

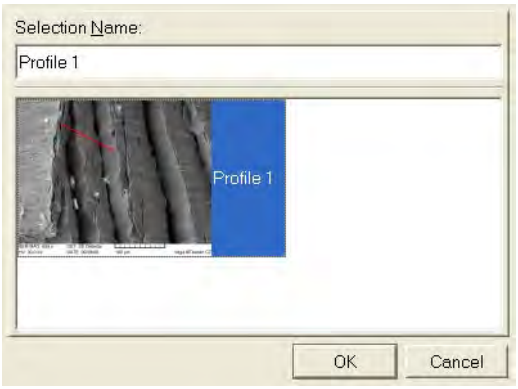
First open up a measurement module and draw a profile line or a selection (area, volume). Choose *File* → *Save Profile Path...* in the ProfileFormMeasurement or *File* → *Save Selection...* in the other measurement modules. A save dialog will pop up. Enter a specific name for the profile or selection and press *OK* to save. *Cancel* will abort the operation.




Save Profile Selection

### 4.13.2 Load a Profile or a Selection

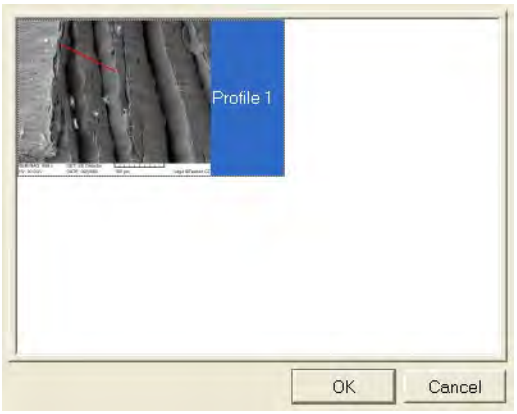
If you want to load a saved profile or selection, choose *File → Load Profile Path/ Selection...* from the menu. A load dialog which shows previously saved profiles and selections will appear as preview. Click on one of the icons within the dialog and press *OK* to load the selected profile or selection into the measurement. *Cancel* will abort the operation.




Load Profile Selection

### 4.13.3 Delete a Profile or a Selection

To delete one or more profiles and/or selections select *File → Delete Profile Paths/-Selections...* from the menu, select one or more profiles and/or selections by clicking on the icons. Click on a selected icon again to deselect it. Press *OK* to delete or *Cancel* to abort.




Delete Profile Selection

# Chapter 5

# Utilities

## 5.1 Brief Description of All Utilities

| | Surface-Dataset | Real3D-Dataset |
|---|---|---|
| Dataset Conversion | | x |
| Form Removal | x | |
| Fusion Measurement | x | x |
| 3D-Editor | x | |
| Real3D-Editor | x | x |
| Dataset Reduction | x | x |
| ImageQualityAnalyzer | x | x |

- **Dataset Conversion**

  The dataset conversion is used to create a SurfaceDataset out of a Real3D-Dataset. This is done by either a projection or a flat projection. To a SurfaceDataset a number of different measurements can be applied.

- **Form Removal**

  The Form Removal allows to reduce the geometric form of a measurement and remains the roughness.

- **Fusion Measurement**

  The Fusion Measurement supports combining two datasets in one.

- **3D-Editor**

The 3D-Editor is a tool for editing SurfaceDatasets and Real3D-Datasets. Objects can be cropped to a desired size and defects of the surface can be deleted.

- **Real3D-Editor**

  The Real3D-Editor is a module to alter Surface- and Real3D-Datasets. Features of the Real3D-Editor are to cut, crop and refine datasets. Additionally you can apply an overlapp refinement.

- **Dataset Reduction**

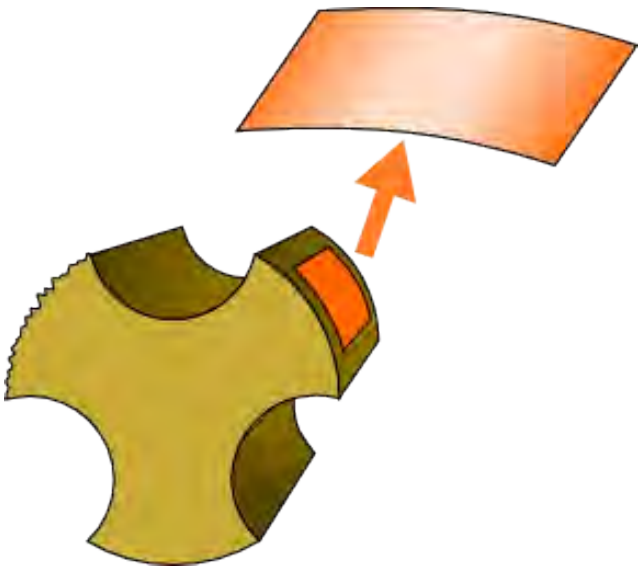
  This module allows to reduce the size of datasets. Bear in mind that his also influences the quality of the dataset!

- **ImageQualityAnalyzer**

  This module enables to measure the quality of an image. The contrast, the image noise and the texture is evaluated within this utility.

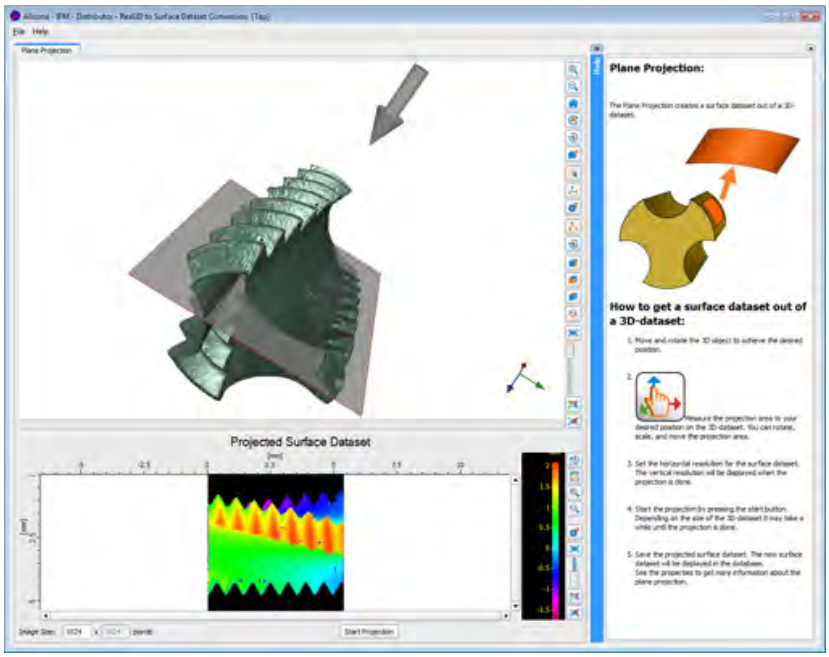
## 5.2 Dataset Conversion Utility

The dataset conversion is used to convert Real3D-Datasets to Surface-Datasets. This is necessary to enable measurement with the ProfileRoughness -, SurfaceTexture- and the VolumeMeasurement. With the dataset conversion utility a SurfaceDataset can be created. Note that not the whole dataset can be converted.



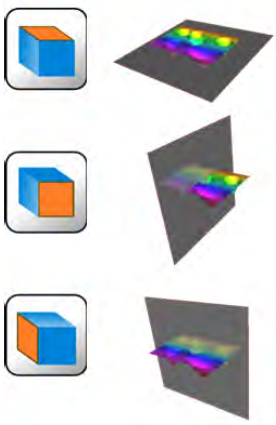
Dataset Conversion

The surface dataset is always created out of the perspective of the displayed arrow.




Projection - Creation of a Surface Dataset out of a Real3D-Dataset

Three different automatic alignments for the projection plane are available:



Automatically Aligned Projection Plane

With the *swap* icon you can change the projection direction.

### 5.2.1 Steps to Obtain a SurfaceDataset

1. Start the dataset Conversion
2. Move the object to your desired position

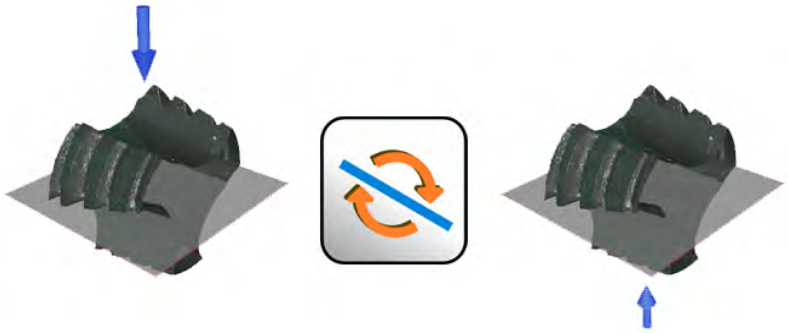


Figure 5.1: Change Projection Direction

3. Set the projection area

4. Fit the projection area to your desired position on the Real3D-Dataset (You can rotate and move the projection area.)

5. Set the horizontal resolution for the SurfaceDataset

6. Start the projection

7. Save the SurfaceDataset

## 5.3 Form Removal Utility

The Form Removal utility can remove a geometric form from a dataset. On the left side the original dataset is displayed. On the right side two tabs are available. One displays the form removed dataset whereas the other displays the removed form. The form removal utility straightens the overall shape of your object but maintains the roughness of the surface. Please note that the workpiece coordinate system will not be applied in this utility.

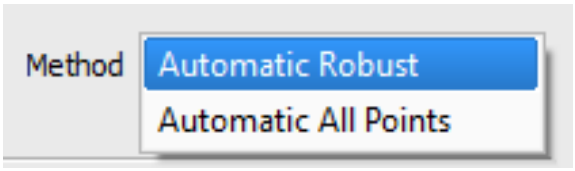
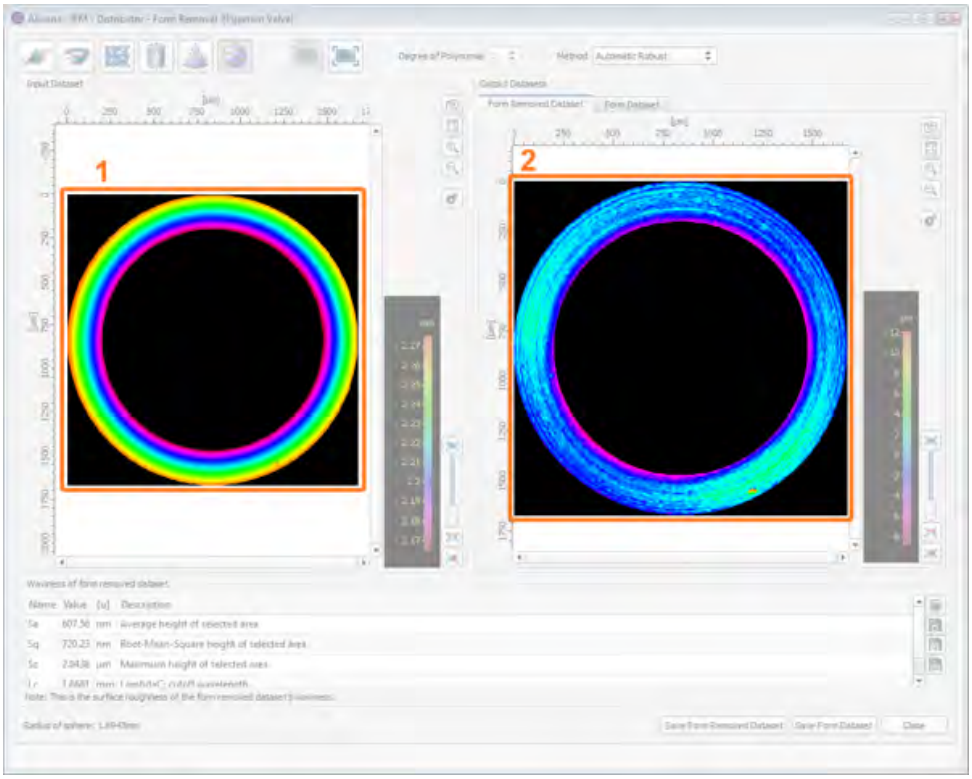



Figure 5.2: Mode Selection (Positioned in toolbar on top)




Form Removal Utility

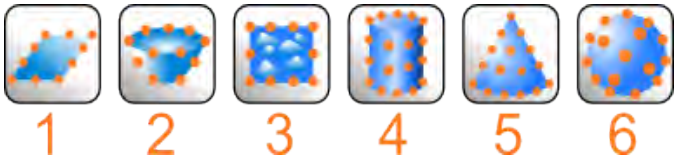
1. Loaded original dataset
2. Form reduced dataset

### 5.3.1 Form Removal Mode

- Automatic Robust
- Automatic All Points

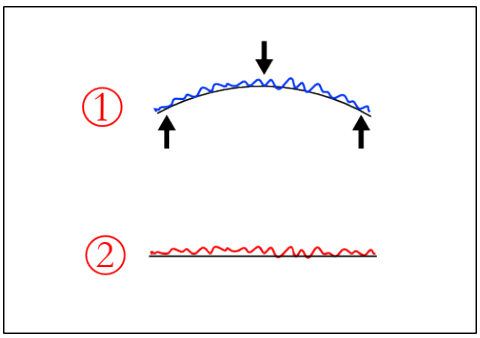
### 5.3.2 Form Selection

First the form that shall be removed needs to be selected




Form Selection

1. Plane
2. Parabola
3. Polynomial (different degrees of polynomial can be selected (2-5))
4. Cylinder

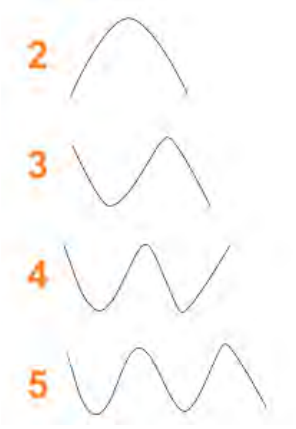



Cylinder Form Removal (1) cylindrical form with roughness, (2) Form reduced dataset with roughness

5. Cone
6. Sphere

### 5.3.3 In Case of Polynomial

Select the degree of the polynomial that shall be removed. The more complex a surface is, the higher the degree of polynomial needs to be selected.



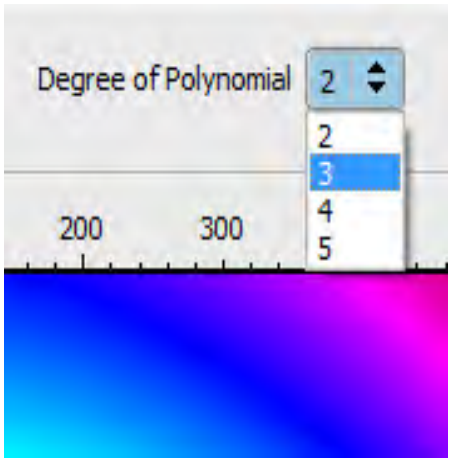



Figure 5.3: Selection for Degree of Polynomial

Complexity Of Different Degrees of Polynomials

### 5.3.4 Area Definition for Form Removal

As the next step the area that is used for this removal process needs to be selected


Area Definition

1. Select rectangular area
2. Select the whole dataset

As soon as the area is defined the form removal operation is started.

Once it is finished the form removed dataset and the form that was removed are displayed in the right half of the screen. Additionally a number of waviness parameters are displayed on the bottom of this screen.

### 5.3.5 Save Datasets

Both datasets, the form removed dataset as well as the plane form dataset can be saved to the database. These buttons are available on the bottom right side of this screen.

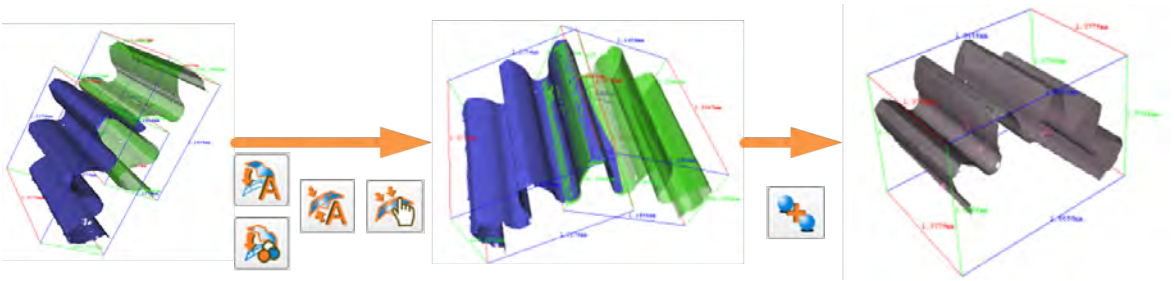
## 5.4 Fusion Measurement Utility

The Fusion Measurement is used to combine two single datasets in one. For the automatic alignment of the two datastets there must be some areas with significant details that overlap.

**For a good result follow these steps:**

1. Perform coarse manual alignment
2. Select region where the two datasets overlap
3. Select *Automatic Alignment*
4. Save the two datasets as one fused object.

### 5.4.1 Alignment



Alignment of datasets

In order to align "Dataset 1" with "Dataset 2" please use one or more of the following modes:

1. **Automatic Coarse Alignment Mode**:

   In order to position "Dataset 2" near to "Dataset 1" press the coarse alignment button. As a result the center of gravity of both datasets is at the same position.

2. **3(n) Point Alignment Mode**:

   In order to position "'Dataset 2"' near to "'Dataset 1"' based on selected points, press the 3(n) point alignment button. In this mode, points can be selected on "Dataset 1" and "Dataset 2". The transformation between the two models are calculated on these point pairs. This

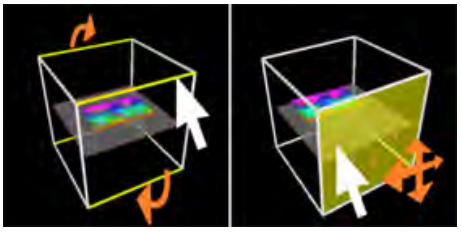
leads to a coarse alignment of the two datasets. The alignment can be refined by selecting more points or by redefining already selected points. If "'Fine Alignment"' is chosen, an automatic alignment with minimum deviation is performed after the coarse alignment. "'Only translation"' cause in an alignment, where only translation - no rotation - is performed.

3. **Automatic Fine Alignment Mode**:

   In order to align "Dataset 2" best with "Dataset 1" press the automatic alignment button. This can take some time. In order to shorten this time you can do a coarse alignment beforehand.

4. **Manual Alignment Mode**:

   To manually align "Dataset 2" press the manual alignment button. It can now be rotated by klicking and dragging on the edge of the cube and you can move it by klicking and dragging on the side of the cube.



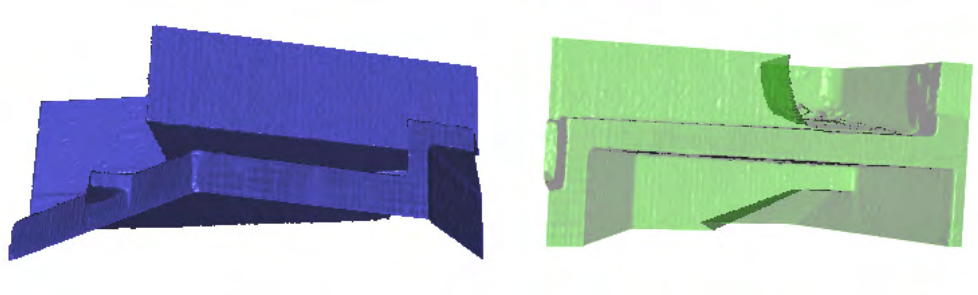
Manual Alignment

As a result "Dataset 1" should be optimally aligned with "Dataset 2". As soon as “Dataset 1” is aligned with “Dataset 2” you can go on with the Fusion Measurement by using the fusin button. It may take some time until the dataset are fused. The fused dataset is shown on the result tab.

### 5.4.2 Example for Fusion Measurement

In the following you see an example of the FusionMeasurement Utility in practice.

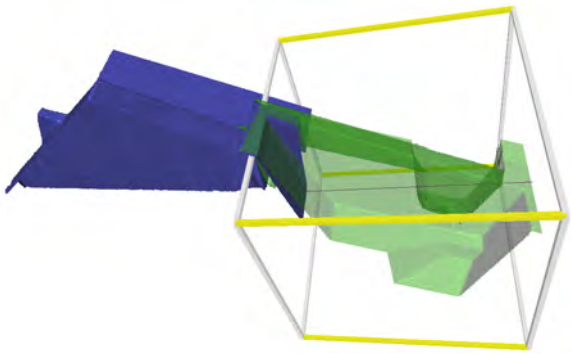
Two single datasets are loaded with the FusionMeasurement. One displayed in blue, the other one in green.



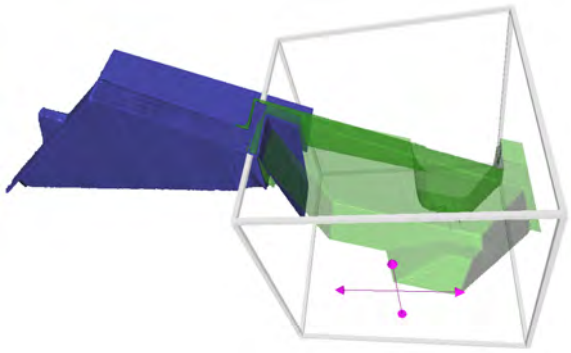
Loaded Datasets

For a coarse alignment of dataset 1 to dataset 2 use either the icon *Automatic Rough alignment* or use the following manual alignment tool:

 This tool is located in the icon bar on the right side. You have the option to rotate and move the second (in this case green) dataset.

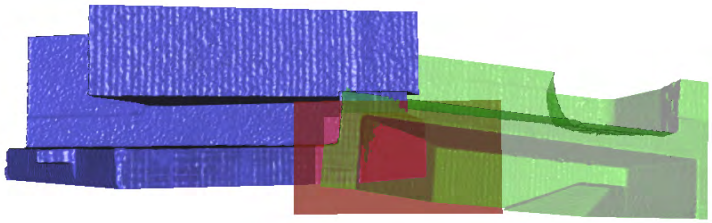


Rotate the Dataset



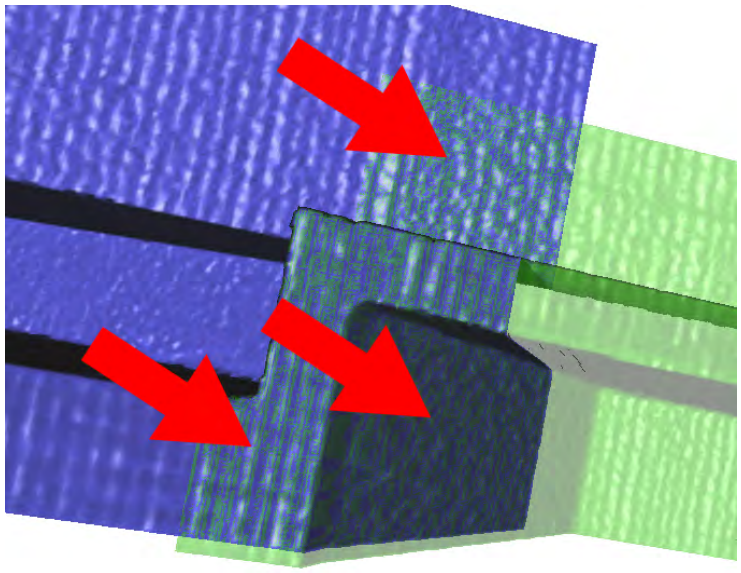
Move the Dataset

Select the region where dataset 1 and dataset 2 overlap. These regions are then used for the next step - the automatic alignment.



Select regions used for automatic alignment

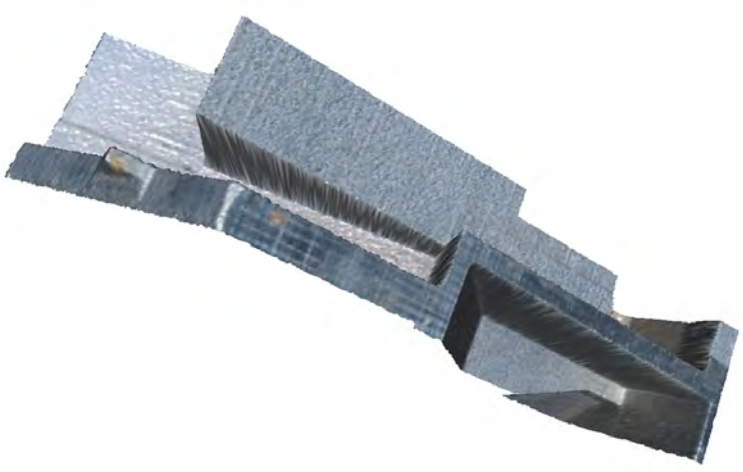
Press the icon *automatic alignment* on top. The alignment worked out well if the overlaping regions are speckled blue and green.



Check if Automatic Alignment Worked Well

Press the icon *Merge Datasets* to merge the two dataset to a fused dataset. The resulting can be saved by opening the menu *File/Save As...*

NOTE: Fused datasets are always saved as Real3D-Datasets. Real3D-Datasets can only be measured with the 3DFormMeasurement, the ContourMeasurement and the DifferenceMeasurement.



Fused Dataset

## 5.5 Dataset Reduction

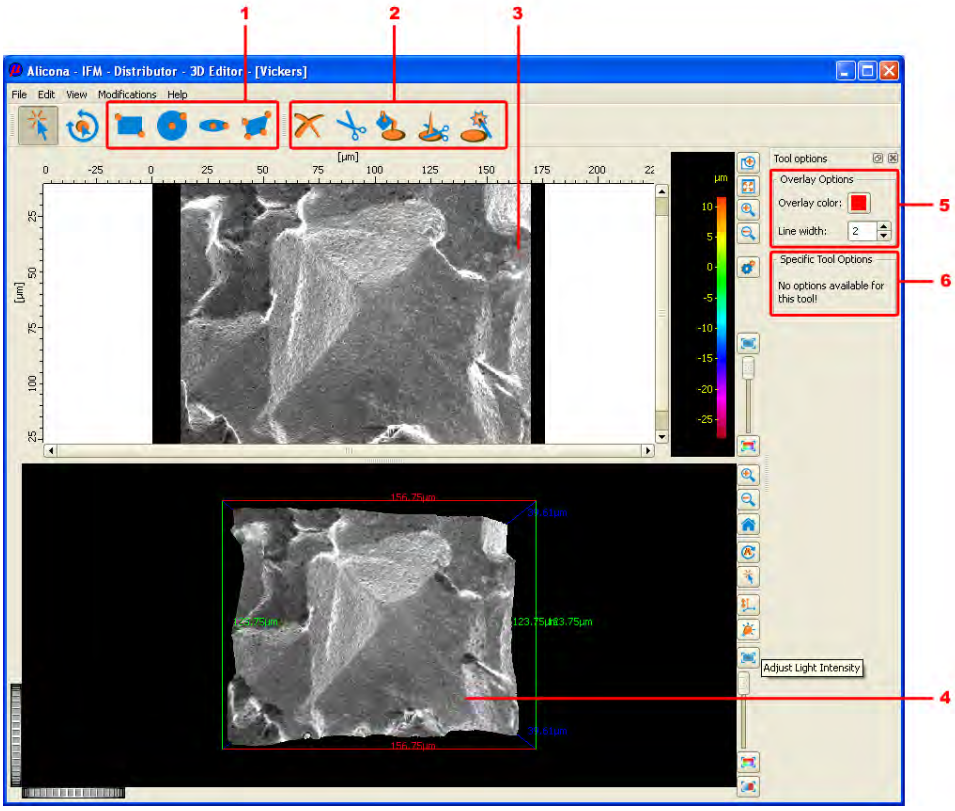
If a dataset is too large for beeing opened in a measurement module it might help to use the dataset reduction utility. Please note that this function reduces the measurement point density. When reducing surface datasets a factor needs to be selected. For Real3D-Datasets the maximum allowed deviation needs to be given. According to this information the dataset gets reduced. In this case no estimation about the dataset size is available beforehand.

## 5.6 3D Editor

The 3D Editor can be used for modifying a 3D object. For example you can remove spikes from the surface and fill the empty area with interpolated values from the surrounding areas. To edit a 3D object select the object in the database view and select *Measurement* → *3D Editor* from the menu bar, or select the object and press the button

 in the side bar of the database view.

### 5.6.1 The User Interface




Interface 3D Editor

1. Toolbar for selecting the areas (rectangle, circle, ...)
2. Tools for modifying the 3D dataset (crop, fill, ...)
3. 2D view of the object
4. 3D view of the object
5. preferences for the area selection
6. preferences for the selected modifying tool

### The Horizontal Toolbar


Horizontal Toolbar

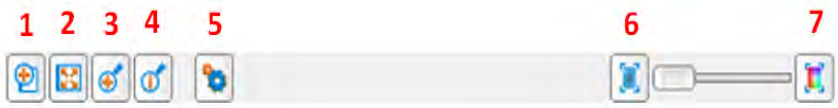
1. select area

2. rectangle selection
3. circle selection
4. select ellipse
5. polygon selection
6. remove data from the selected area
7. remove data outside the selected area (crop)
8. fill selected area with interpolated data
9. remove spikes
10. remove data from the area and fill it with interpolated data

The first part of the toolbar is for selecting the area. Simply click on the icon and draw. The second part is for modifying the dataset.

### The Vertical Toolbar

These tools are for modifying the view of the 2D/3D view




Vertical Toolbar

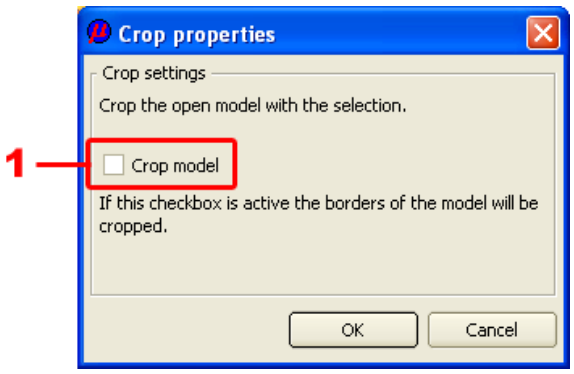
1. show/hide zoom window
2. fit image to the window size
3. zoom in
4. zoom out
5. adjust depth image
6. show only true colors of the optical image
7. show only pseudocolors

## Modify a 3D Object

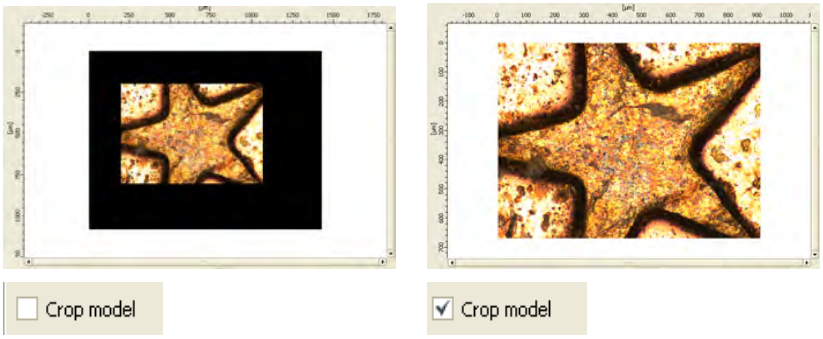
You can use a number of different tools which are described in the following.

### Crop 

If you want to reduce your dataset to specific areas you can do this with the cropping tool. First you select the part you want to remain and then you press the button. You have one option in the upcoming window for the crop properties.




Crop Properties



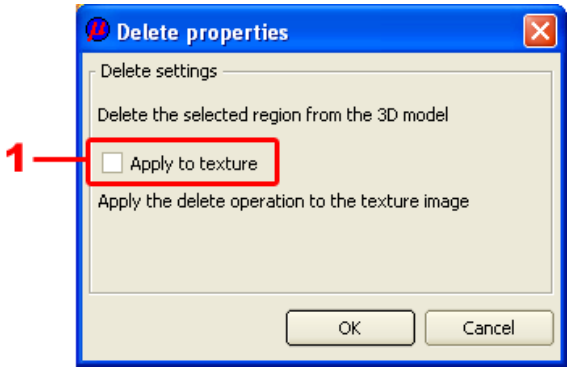

If crop dataset is unchecked your dataset will be croped but will remain the same size.

If crop dataset is checked your dataset is cropped to the size of your selection.

### Delete 

If you want to delete parts of your dataset you can do this with the delete tool. You select the parts you want to delete and then you press the

delete button. You have one option in the upcoming window for the delete properties.



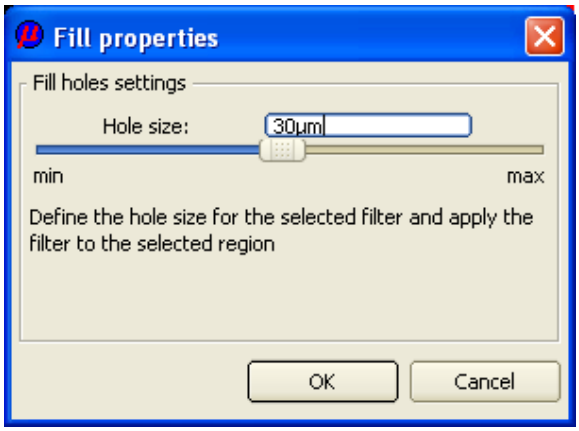

Delete Properties


The surface texture of your dataset will be stored in the object data but will disappear visually. In case you want to fill this region later on you will get the original surface data of this area.


The selected part of the surface texture will be deleted. The original texture is then deleted. In case you want to fill this region later on you will get interpolated data from the area around the hole.

## Fill 

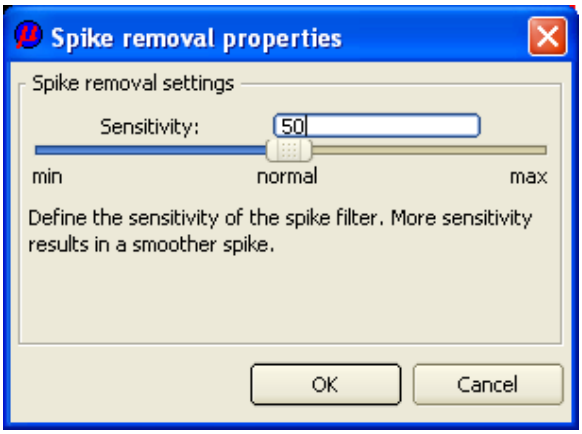
If you want to fill a previously deleted area you can do this with the fill tool. You select the parts you want to fill and then you press the fill button. You can define the hole size up to which the holes should be filled with texture.



Fill Properties

### Spike Filter 

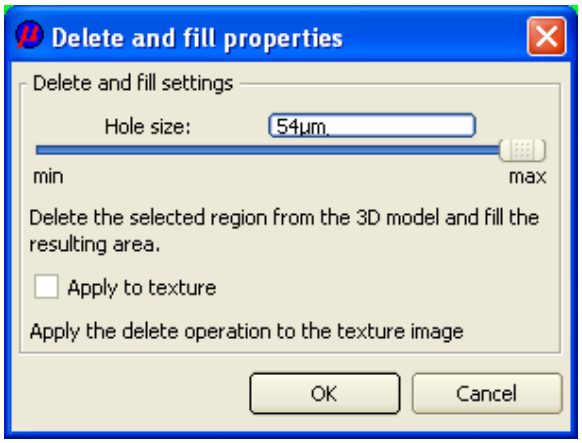
If you want to delete the spikes of your object you do this by using the spike filter tool. First you select the part where you want to use the spike filter and then you press the button spike filter. You have one option in the upcoming window for spike filtering. You can define how sensitive this filtering method should be applied.




Spike Filter

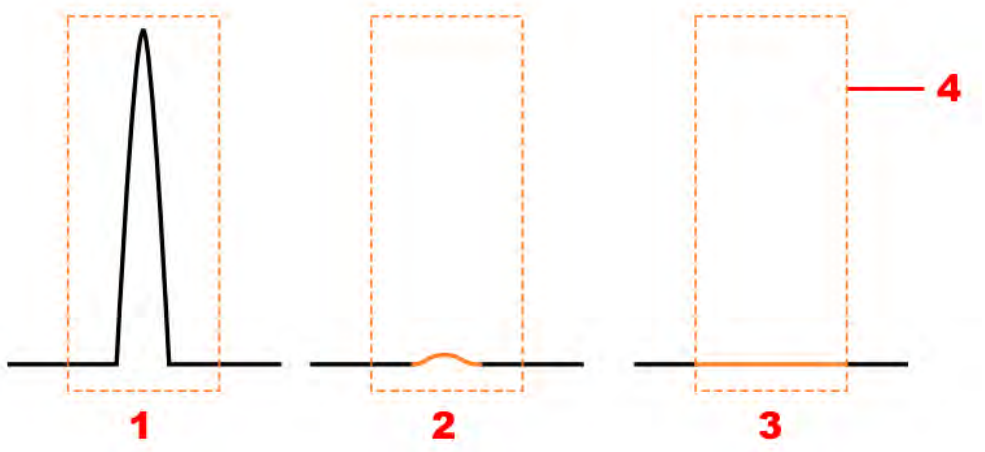
### Delete and Fill Selected Region 

If you want to delete an area and fill it afterwards again you do this by using the magic wand tool. First you select the part you want to delete and fill with interpolated data from the areas around the hole. You can define the hole size up to which the holes should be filled with texture.



Delete and Fill Properties

### Difference Between Spike Filter and Magic Wand Tool:




Spike Filter and Magic Wand Tool

1. Spike profile
2. Spike filter applied
3. Magic wand tool applied
4. Selection for filtering

### Change 3D View

There are some actions that can be performed by the mouse:

- left mouse button + SHIFT: move the 3D model
- mouse wheel: scale up or down

### Export Functions

To access the export functions select *File* → *Export* from the menu bar,

- *3D View*: Exports the 3D dataset in the lower area as an image.
- *Image*: Exports the image in the support area.

# Chapter 6

# Exporting Functions

## 6.1 Data Export

There are various data sets that can be exported.

### 6.1.1 Whole Datasets with AL3D - Alicona Imaging 3D Format Import

AL3D (*.al3d) is a 3D format specified by Alicona Imaging. It supports textures and meta data and is meant for easy data exchange with other applications. You can simply export AL3D files from the database view. Select *File* → *Export* → *As AL3D* from the menu bar for export.

### 6.1.2 Other File Formats

- Q-DAS ASCII Transferformat (*.dfq): Every parameter table in the program can be exported in this format. The Q-DAS format can be imported e.g.by the qs-STAT program.

- CSV (*.csv): Every parameter table in the program can be exported in this format. The CSV format can be imported by many spreadsheet applications.

- DXF (*.dxf): You can export contours in the contour measurement in this format. The DXF format can be imported by many CAD programs. The export unit is meter.

### 6.1.3 Images

You can export images (without overlays) in the image and stereo viewer display by selecting *File* → *Export* → *Image as* from the menu. This gives you a list of all file formats currently supported.

Image export from the stereo viewer display is only possible once you have selected the left, the right or the anaglyph display mode (not left AND right).

You can also export the current surface dataset viewer display by selecting *File* → *3D View as*. This will also give you a list of all file formats currently supported.

Furthermore, it is possible to export the images seen in the various measurement modules. The actual shown selections will be exported as well.

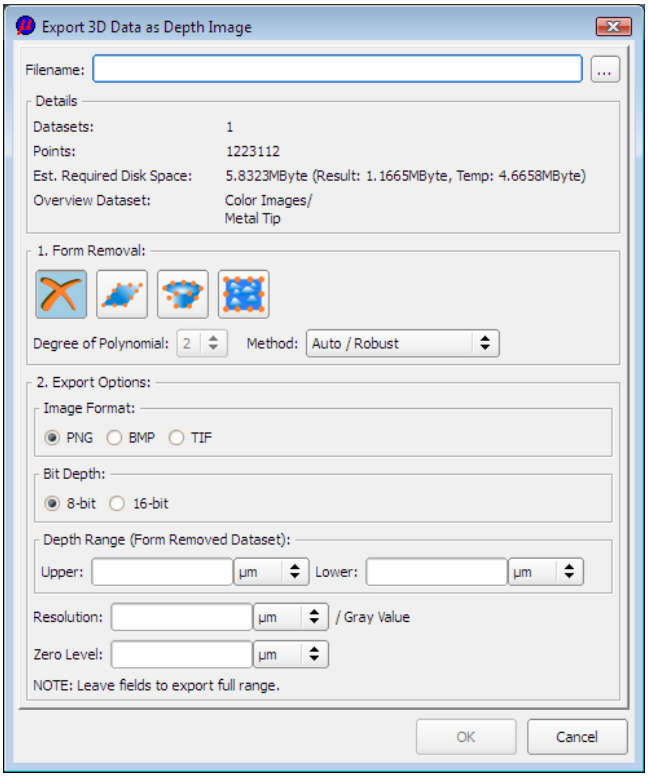
### 6.1.4 Depth Image Export of X-Large ImageFields

You can export the whole dataset of an X-Large ImageField in full resolution as a depth image. Click with the right mouse key on the folder containing all datasets of the X-Large ImageField. A context menu opens up.Select the menu entry *Save As...*

In step one you can activate a form revomal for the whole dataset.

Step two allows to choose settings for the depth image export.

- Image format: PNG, BMP, TIF
  - Please note that BMP does not support export with a bit depth of 16-bit.
  - Please note that BMP and TIF do not support export of images with file size of more than 4GB.
- 8-bit vs. 16-bit
- Depth range of the form reduced dataset that should be exported
- Resolution: defines which range should be exported as one gray value
- Zero-Level: Defines the z-position where the new zero-level should be located deriving from the current position.




Export Dialog Depth Image

### 6.1.5 Diagrams

The diagrams shown in the measurement modules can also be exported as images. This can be done by selecting *File* → *Export* → *Diagram as* from the menu. This will give you a list of all file formats currently supported.

### 6.1.6 3D-Data

The 3D data points of the currently active surface dataset can be exported as plain text, VRML2.0, Digital Surf SUR, STL, OpenGPS or AL3D - a depth image file format specified by Alicona Imaging. Export to VRML2.0 format is achieved by selecting *File* → *Export* → *Export 3D data as*. VRML2.0 can be viewed with many plugins in your favourite web browser. An AL3D file format specification can be obtained from Alicona Imaging.

The format of the plain text file is very simple. The entry in the first line (12882) represents the total number of 3D points in the file. The actual 3D points are then written line-by-line as (x,y,z) tuples. The unit for the values is selectable.

GPoint3DVector { 12882 n {

-29.4057 21.7905 -8.44613
-29.5918 21.486 -8.42908
-29.6828 20.9831 -8.58605
-29.4386 20.6653 -8.6306
-29.6777 20.3831 -8.55708
...
}

### 6.1.7 Profile Data

See *Exporting profile data.*

## 6.2 Printing

You can print the actual display of the image viewer, the stereo viewer or the surface dataset viewer by selecting *File* → *Print...*. This prints what is currently on the screen including all overlays like measurement lines or points. In the stereo viewer you can only print either left or right image but not both at the same time. The printing function will only be enabled once you have selected the left, the right or the anaglyph view.

Furthermore, you can print all pages of the profile measurement module. Again, the printout depends on the current display on the screen. Activate this function by selecting *File* → *Print page...* from the menu.

## 6.3 Customize Print


Customize Print

You can have a custom header and footer on the printouts of the program. For this, open the *Custom Print* Dialog from the *File* menu. The custom title will be printed on the first page, the custom header and footer will be printed on every page of the printout.

# Chapter 7

# Import

## 7.1 Supported File Formats

Following file formats can be imported:
al3d, png, tif, d2, lei, afm, smd, sur, ub3, plu, sdf, tfr, x3p.

### 7.1.1 AL3D - Alicona Imaging 3D Format Import

AL3D (*.al3d) is a 3D format specified by Alicona Imaging. It supports textures and meta data and is meant for easy data exchange with other applications. You can simple import or export AL3D files from the database view. Select *File* → *New* → *AL3D Dataset Import...* from the menu bar for import.

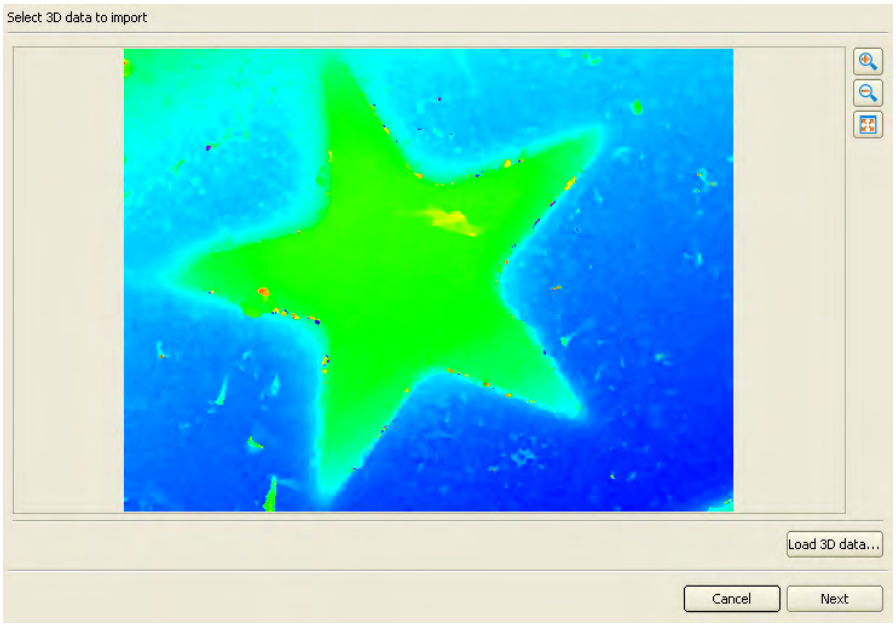
## 7.2 3D Data/Image Import

The 3D Reader is a tool that allows you to import 3D data or optical images from different sources into the database. A wizard will guide you through the steps necessary to import the data. Open it with *File* → *New* → *3D Dataset* resp. *Optical Image Dataset,* if you want to import an optical image only (in that case, skip the 3D Data Import section below).

Note: The reader is only available if you have selected a target project (click on a project folder).

### 7.2.1 3D Data Import

By clicking *Load 3D data...*, you can choose the 3D dataset which you want to import. You can choose between different file formats from different vendors of 3D measurement systems. Once a file has been chosen, a preview of the data appears.




Import 3D Data

Note that at any moment, clicking *Cancel* will stop the import of the 3D data and will abandon all selections made. Using *Next* will lead you to the next page of the wizard. If you only want to import an optical image, click *Next* without loading a 3D dataset.

### 7.2.2 3D Data in Ascii Format (DAT Format)

This format contains 3D Data in a matrix in floating point notation, separated by spaces:

E.g. an ASCII File of a 3D Object with 3 rows and 3 columns should look like this:

3,946950E-002 7,736550E-002 1,121770E-001

7,736550E-002 1,516470E-001 2,198820E-001

1,121770E-001 2,198820E-001 3,188210E-001

Each number has 7 significant digits: 1 before and 6 after the decimal point (comma). Lines are separated with line feeds. The File has no header but

begins immediately with the first number. All rows must contain the same number of columns.

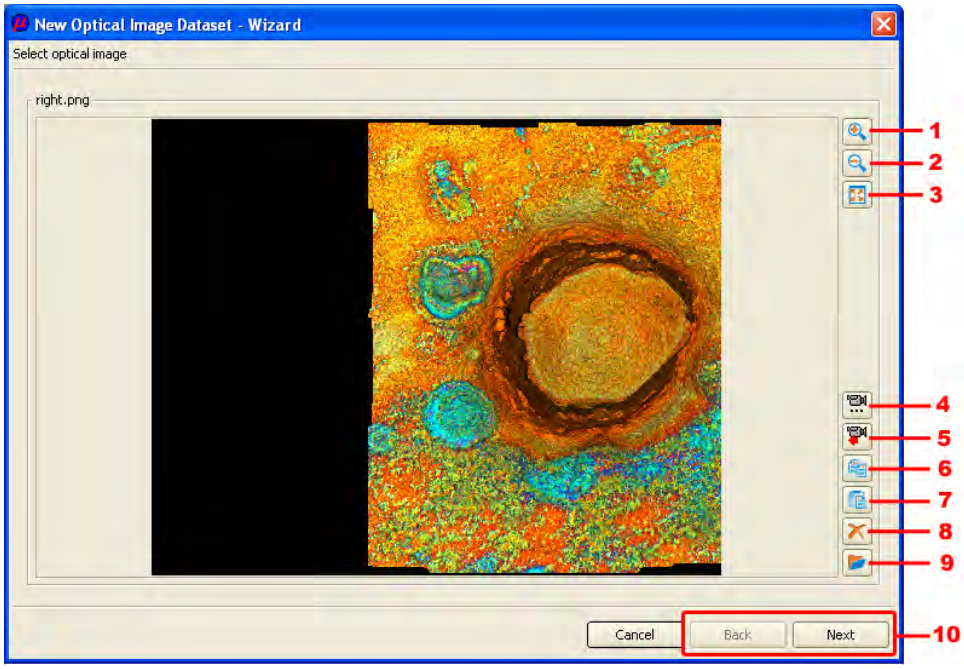
How to import DAT Files in the application:

- Click *File→New→3D Dataset* in the menu.
- Click *Next*.
- Click *Import 3D Data*
- Select the 3D Dataset you want to import.
- Click *Next*.
- If you have an additional texture image (color image), you can import this now, else click *Next*.
- Enter the name of the data set.
- Enter the horizontal and vertical sampling distance.
- Click *Finish*

The file can then be viewed and analyzed in the database view.

### 7.2.3 Optical Image Import

Press *Load Optical Image...* to assign a texture image to the 3D dataset or to load an image if you didn't load a 3D dataset before. Note that if you don't assign a texture to a 3D dataset it will be calculated out of it. Then, click *Next* to go further or *Back* to correct your settings.

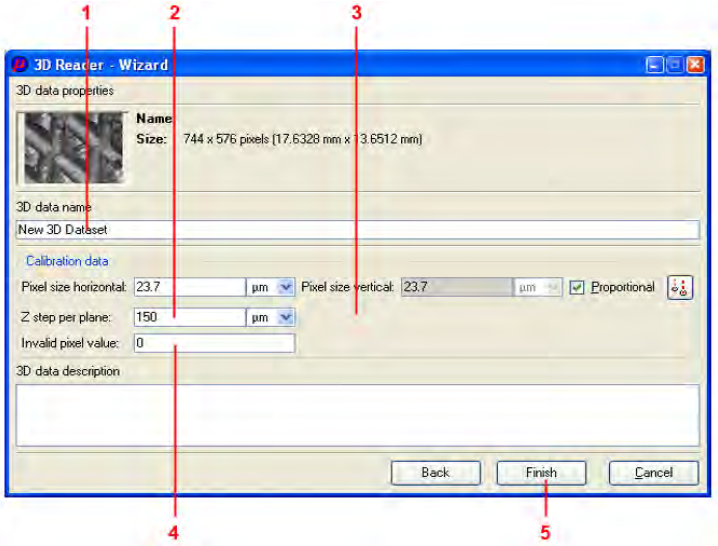



Optical Image Import

1. zoom in
2. zoom out
3. fit to window
4. select camera (TWAIN)
5. capture image with selected camera
6. copy to clipboard
7. paste from clipboard
8. delete
9. load image from disk
10. navigation buttons

If you want to capture an image via the TWAIN interface of a camera, click *Select Camera*. A dialog with all available cameras shows up. Select the wanted camera in the *Product* selection box and click *OK*. You can then capture an image using *Capture image with selected camera.*


By clicking *Next*, a page will appear which enables you to specify calibration data according to your dataset.




1. select dataset name

2. Z step per plane: This is the value that lies between two gray scale values of imported images. This value is given in in metric units. Example: The input image depicts a height step of 50$\mu$m. The lower part of this dataset is positioned at the gray scale value 50. The upper part is positioned at the gray scale value 200. That means that 150 gray scale values depict 50$\mu$m. Which means that a single gray scale value (50/150$\mu$=333,33nm) depicts 333,33nm.

3. enter calibration data

4. Invalid pixel value: The gray scale value of the imported image that is set to an unmeasurable point after the import. If a value outside of the used gray scale value area is inserted no measurement point will be set to unmeasurable.

5. finish import

If the 3D reader was able to detect calibration values by itself, all fields will be filled out properly. Otherwise you have to enter the sampling distance, the z step between the height values and the invalid data value (all measure point values that are equal to this value are treated as invalid height information). By clicking *Finish* the 3D data or the image will be imported into the database.

### 7.2.4 Supported File Formats

The 3D Reader supports the following file formats for importing 3D data:

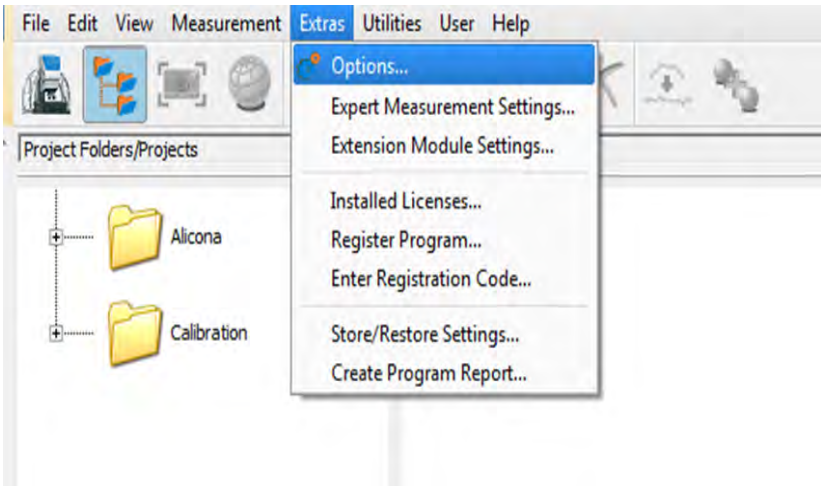
- MeX depth image files (*.tif)
- MeX ASCII data files (*.txt)
- MicroMap data files (*.d2)
- Digital Instruments NanoScope ASCII data files (*.txt)
- JEOL WinSPM data files (*.tif)
- PL$\mu$ Confocal Microscope measurement file (*.plu)
- Surface data files (*.sdf)
- TopoMetrix topography data files (*.tfr, *.trr, *.zfr, *.zrr)
- Quesant Instrument Corporation data files (*.afm)
- MeX ASCII data files (*.dat)
- Leica Confocal Microscope data files (*.lei)
- PNG 8-bit range image files (*.png)
- EN ISO 5436-2:2000 data files (*.smd)
- CAD files (*.cad)
- STL files (*.stl)

# Chapter 8

# Settings

## 8.1 Software Settings

This dialog allows you to choose several options concerning the program. You can open the options dialog by selecting it from the menu: *Extras* → *Options...*




Settings Dialog

Each program user has his own settings file which is saved to the disk. Therefore, every change to your settings is preserved over the following sessions.

The settings dialog consists of several pages that allow you to change different options.

### 3D Settings:

- The *Anaglyph* page: This page is used to set up the colors used for the anaglyph view of stereo image pairs.

- The *Colormap* page: This page allows you to select and set up the colormap used for pseudocolor views.
- The *Graphics Speed* page: This page allows you to specify the performance of your graphic card.

**Common Settings:**

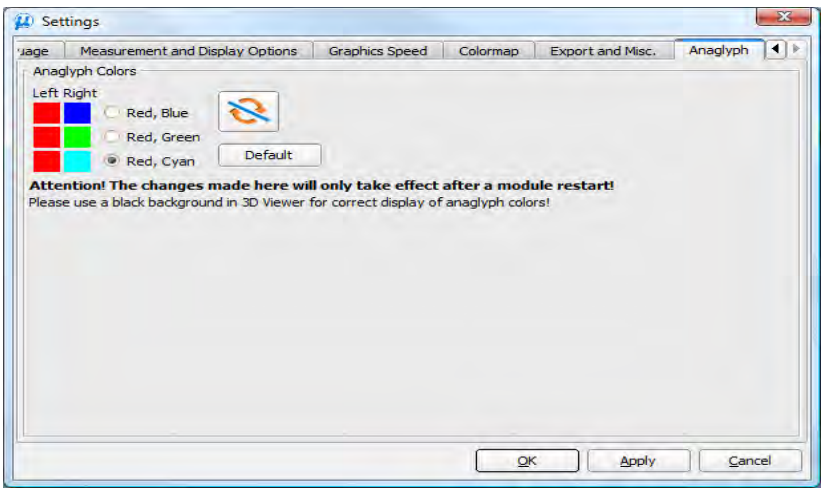
- The *Language* page: This page allows you to choose your preferred language to use.
- The *Measurement and Display Options* page: Selection of the global unit system (metric/inch) and display precision.
- The *Export and Miscellaneous* page: Parameters for Export of 3D Data and miscellaneous options.

**Buttons:** In addition to the pages the dialog has three buttons to decide how to proceed with changes.

1. *OK*: saves all changes made and closes the dialog
2. *Apply*: saves all changes made and keeps the dialog open
3. *Cancel*: discards all changes made and closes the dialog

### 8.1.1 Anaglyph Page

This page is used to set up the colors used for the anaglyph view of stereo image pairs.



Anaglyph Page

In the left part you can choose the color combination used for anaglyph images.

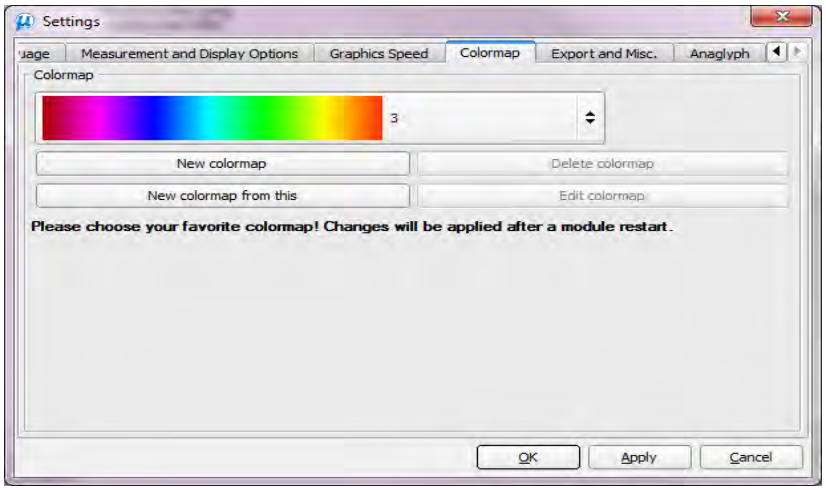
By clicking the

 button you can swap the left and right colors.

Clicking the *Default* button reset the changes to the default value.

### 8.1.2 Colormap Page

This page allows you to select and set up the colormap used for pseudocolor views.




Colormap Page

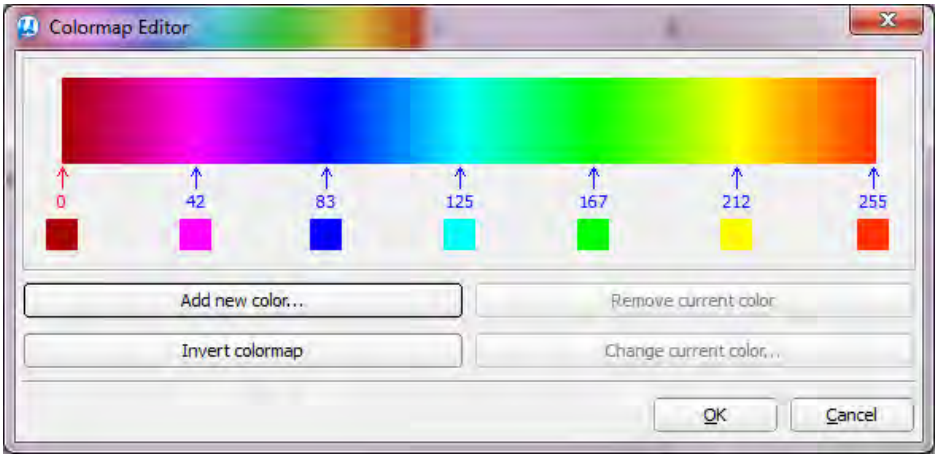
In the upper part you see the currently chosen color map. In the lower part, there are several buttons which allow you to manipulate the chosen colormap or to create a new colormap. The four buttons have the following meaning:

- *New colormap...:* opens the colormap editor which allows you to define a new colormap
- *New colormap from this...:* opens the colormap editor with the currently chosen colormap to modify and save it as a new colormap
- *Delete colormap:* allows you to delete colormaps created by you. Colormaps defined by the program can not be deleted.

- *Edit colormap...:* opens the colormap editor with the currently chosen color map for modification

### The Colormap Editor

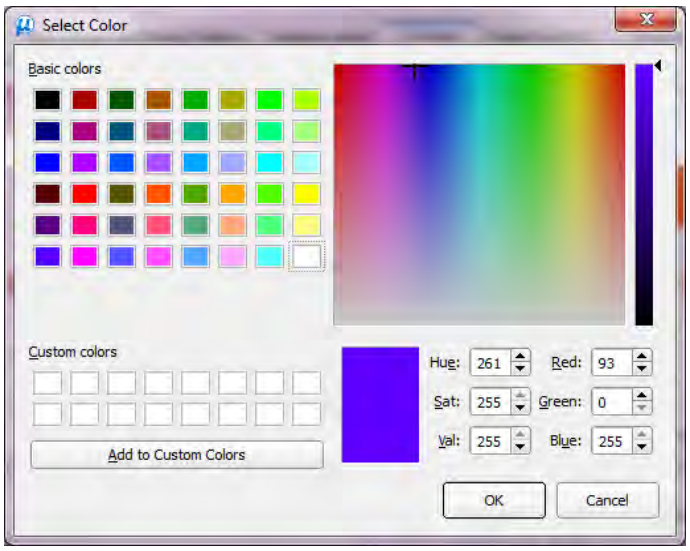
The colormap editor allows you to create a new colormap or modify an existing one.




Colormap Editor

- *Colormap click:* By clicking into the colormap area you can add a new color at a specific index. To choose the color a color selection dialog pops up.
- *Color index click*: By clicking on the color index you can select a color as current color. By clicking and dragging a color index you can change its position.
- *Color rectangle click:* By clicking on the color rectangle below an index you can change its color.
- *Add new color...:* Select a new color which will be added at colormap index 127.
- *Invert colormap:* inverts all colors of the colormap.
- *Remove current color:* removes the selected color from the colormap.
- *Change current color...:* allows you to change the selected color.
- *OK*: use color map and close the dialog
- *Cancel*: close the dialog, all changes are lost

### The Color Selection Dialog

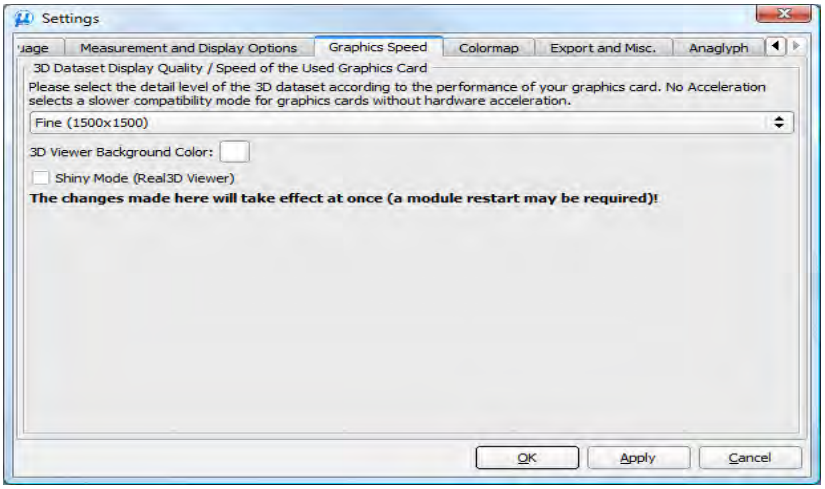



Select Color

- This dialog is used to choose a color
- *Add to Custom Colors:* add the selected color to the table *custom colors*
- *OK*: use color selection and close the dialog
- *Cancel*: close the dialog, all changes are lost

### 8.1.3 Graphics Page

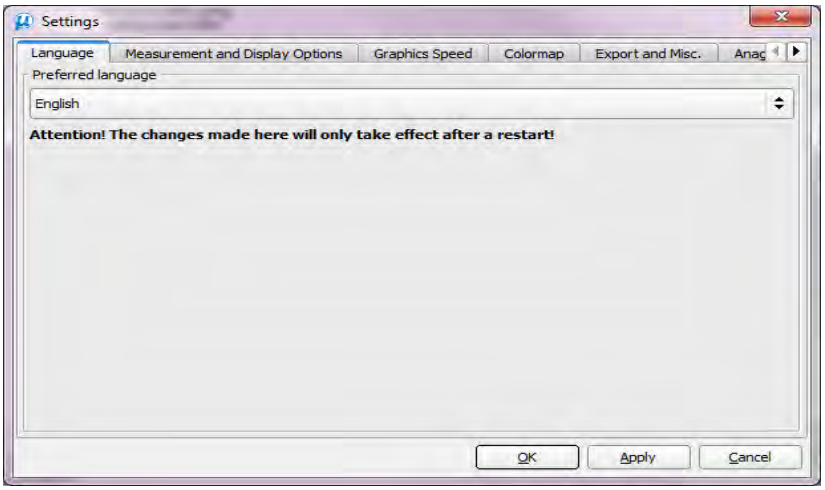
This page allows you to specify the display quality of a surface dataset within the 3D viewer. The higher the quality level is set, the finer a digital elevation model will be displayed within the 3D viewer. But be aware that the higher the chosen level is the more graphic card performance and memory is required. The more performance your graphic card has a higher level can be set. Try to evaluate which available options suits you and your hardware best. If your graphic card has problems with 3D display, please select *No Accleration*. Please note that these settings will only take affect after a 3D viewer restart.




Graphics Speed

### 8.1.4 Language Page

This page allows you to choose the language you prefer.

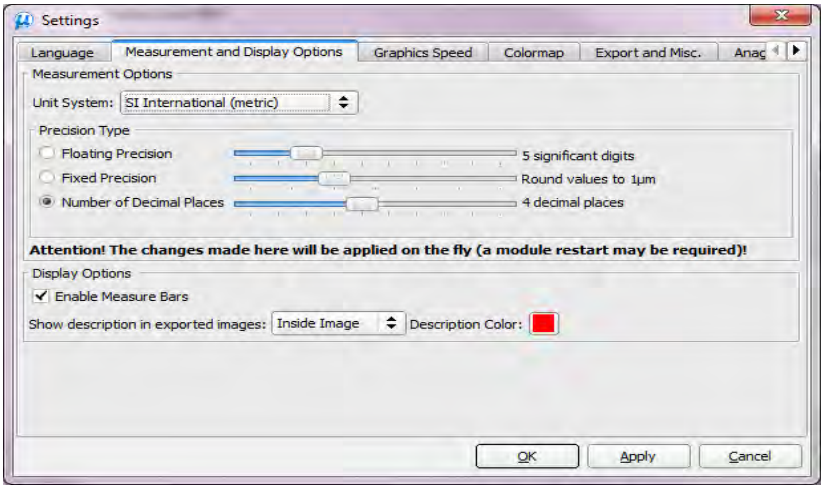



Language Page

**Please note that the changes made on this page will just take affect after a restart.**

### 8.1.5 Measurement and Display Options

This page allows you to choose settings for measurement and to set some display options.




Measurement and Display Page

## Measurement Options

- Unit System: Select the unit system that is used within the application. Per default the *Metric System* is selected.
  - *SI International (metric)*: Values will be displayed using the International Metric System (Système international d'unités).
  - *Inch, mil, tenth:* use British Unit System with inch values
  - *Inch, micro inch*: use American Unit System with inch values
  - *other unit systems*: Values will always be displayed with the selected unit system.
- Precision Type: Floating point values may be displayed with Floating or Fixed Precision.
  - *Floating Precision*: Set the number of significant precision digits for displaying floating point values.
  - *Fixed Precision*: Set the basic unit for displaying floating point values.
  - *Number of Decimal Places*: Set the number of shown decimal places for all floating point values.
  - The following table shows some example values:

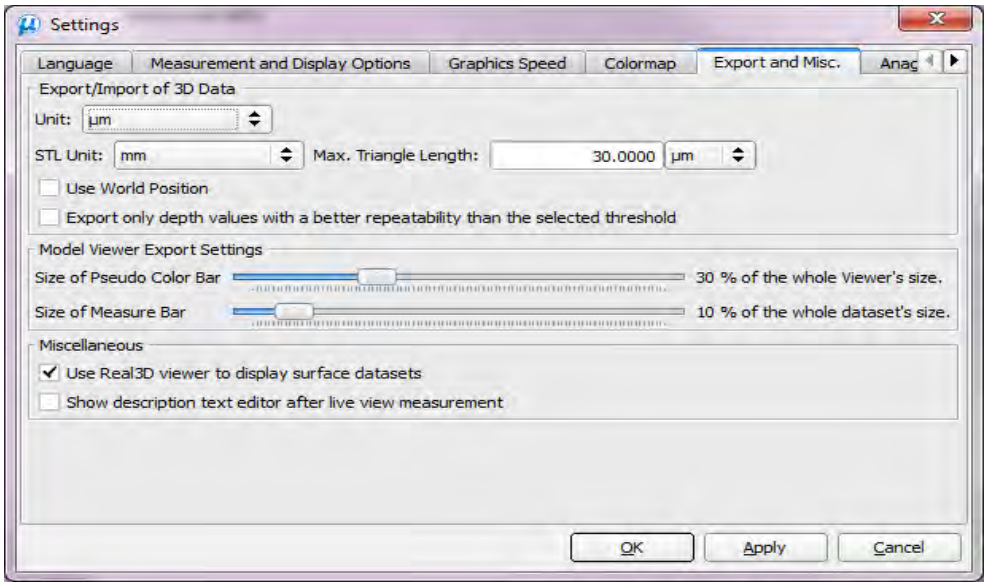
| value | float =3 | float =4 | float =5 | fixed =1$\mu$m | fixed =100nm |
|---|---|---|---|---|---|
| 0.000000380736m | 3.81$\mu$m | 3.807$\mu$m | 3.8074$\mu$m | 4$\mu$m | 3.8$\mu$m |
| 0.0000380736m | 38.1$\mu$m | 38.07$\mu$m | 38.074$\mu$m | 38$\mu$m | 38.1$\mu$m |
| 0.0000380736m | 381$\mu$m | 380.7$\mu$m | 380.74$\mu$m | 381$\mu$m | 380.7$\mu$m |

### Display Options

- *Enable Measure Bars*: A measure bar with the unit length will be displayed in the left top corner of the image.
- *Show description in exported images*: Choose description display "*inside the image*", "*outside the image*" or "*No description*".
- *Description Color*: Defines the text color of the description.

## 8.1.6 Export and Miscellaneous

This page allows you to choose settings for the export of 3D data and for miscellaneous program behaviour.




Export and Miscellaneous Page

### Export/Import of 3D Data

- *Unit:* Select the basic unit for exporting 3D data.

- *Use World Position:* Check this option if you want to export all coordination values as world positions.

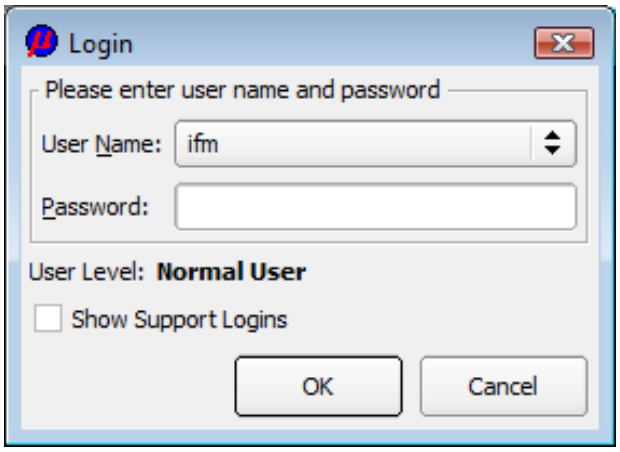
- *Export only depth values with a better repeatability than the selected threshold:* The depth value is set in dialog "Depth Image Adjustment / Estimation of Repeatability

### Miscellaneous

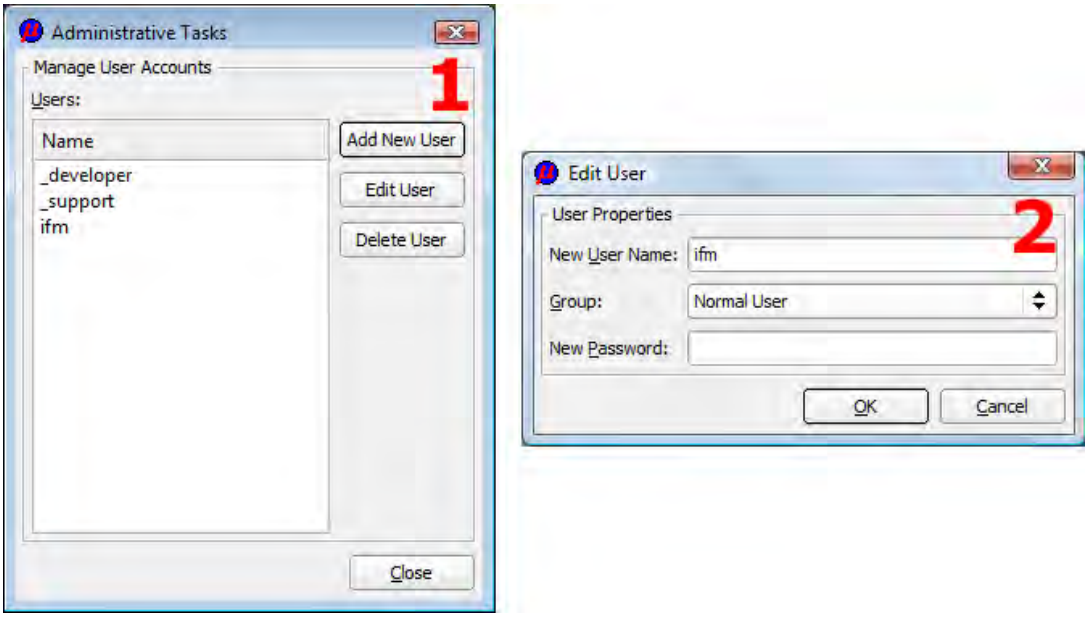
- *Show description text editor after capture:* Check this option if you want to edit the description text right after capturing the image. If you don't check it, you can still edit the description text in the properties dialog.

## 8.1.7 User Management

When you start the software, you see a login window. When starting the first time you can select the predefined user *ifm* (user management and hardware configuration). The checkbox Support Login is only provided for support logins of Alicona personnel and Alicona distributors.[ *_support* (reserved for Alicona distributors) and *_developer* (reserved for Alicona staff)]. Furthermore, a user with the current windows user name will be created.




Login Window




User Management

1. This window shows a list of available users. (_developer and _support are predefined users for Alicona which cannot be edited or deleted)
2. This window allows to edit the user group (qualification) and change the password of a user.

For the first login you don't need a password but you can change your user password anytime in the *User* menu.

For user management you must log in as *normal user*, then you can select the additional item *User Management* in the *User* menu.

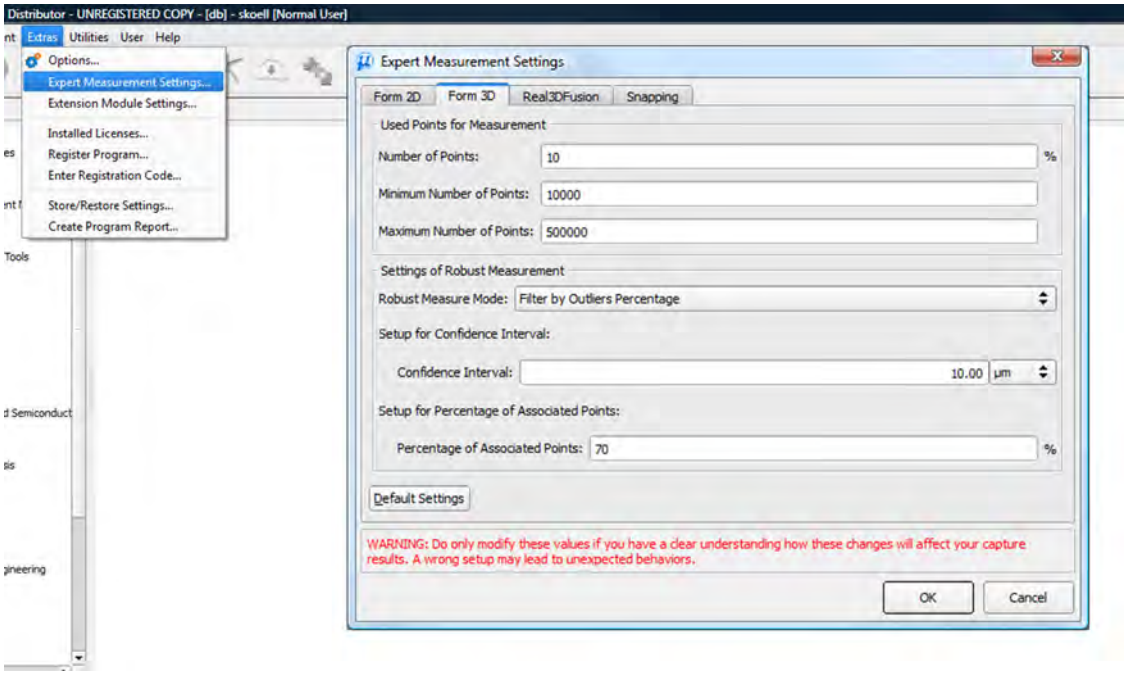
### User Authorization

- **Normal User:**
  - Expert measurement settings
  - User management
  - Load licence files
  - Register program
  - Hardware configuration
  - Store/restore program settings
  - System calibration (calibrate field of curvature, vertical and lateral calibration)

  - Gray balance
  - Rotation axis adjustment (if Real3D available)
  - Roughness calibration

- **Support:** additional authorization to Administrators
  - System adjustment (Adjust field of curvature, lateral adjustment)
- **Developer:** additional authorization to Administrators and Supporters
  - Advanced system calibration (Adjust sensor rotation, adjust optical axis)

## 8.2 Expert Measurement Settings

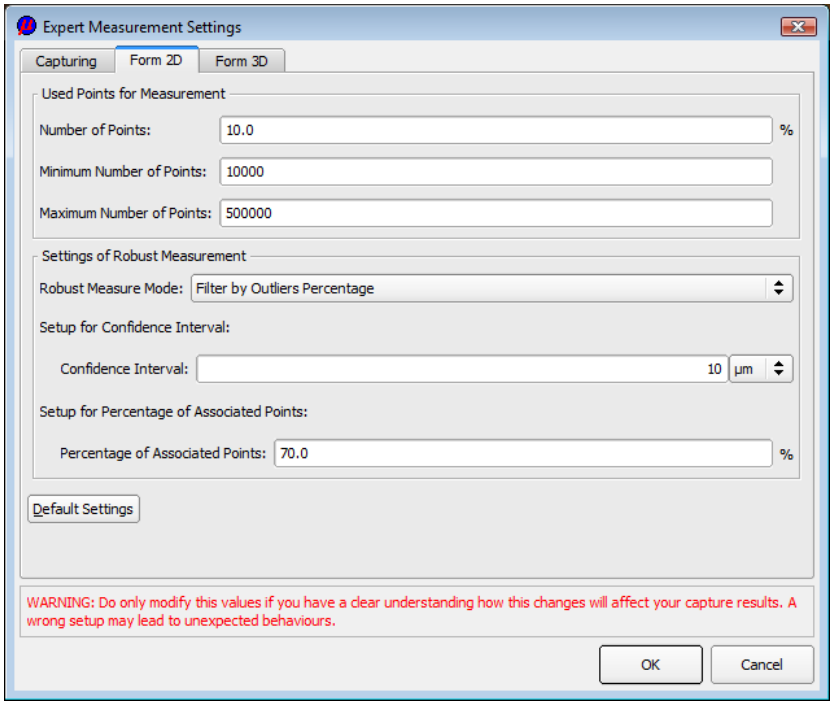



Expert Measurement Settings

### 8.2.1 Form 2D/Form 3D

The measurement settings in the tab Form 2D are used for the ContourMeasurement.

The measurement settings in the tab Form 3D are used for the 3DFormMeasurement and the Form Removal utility.




Expert Measurement Settings - Form 2D/3D

## Used Points for Measurement

In order to shorten the time for measurements of affected measurement modules the size of the loaded dataset can be reduced by using these settings.

- Percentage of all available 3d-points that are used for measurements.
- Min./max. amount of 3d-points that are used for measurements.

*Example:*

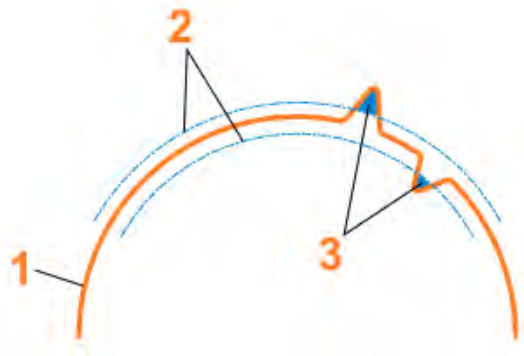
A dataset originally contains 400.000 3d-points.

If a percentage of 10% is used 40.000 3d-points will be used for the measurement.

If additionally the min. number of 60.000 3d-points is set than the dataset will be loaded with 60.000 3d-points.

## Settings of Robust Measurement

- **Filter by confidence interval**

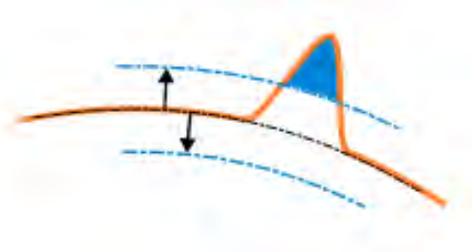



Filter by Confidence Interval

1. Measured profile
2. Confidence interval
3. Filtered areas

Using the confidence interval all 3d-points that lie inbetween the confidence interval area are used for determining the form.

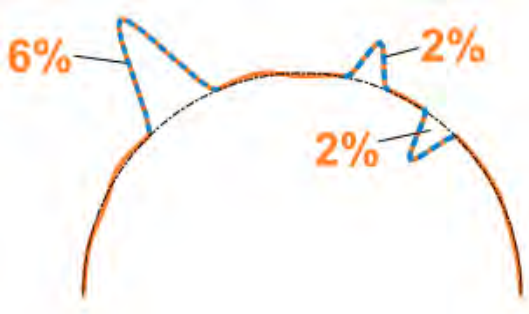
In the following figure the confidence interval area is visualized. The whole confidence area is as large as two times the confidence interval.



Area Of the Confidence Interval

- **Filter by outliers percentage**

  In the displayed example 10% has been used for the outlier percentage. The 3d-points that contain the largest deviation compared to the measured form are not used for the form measurement.




Filter by Outliers Percentage

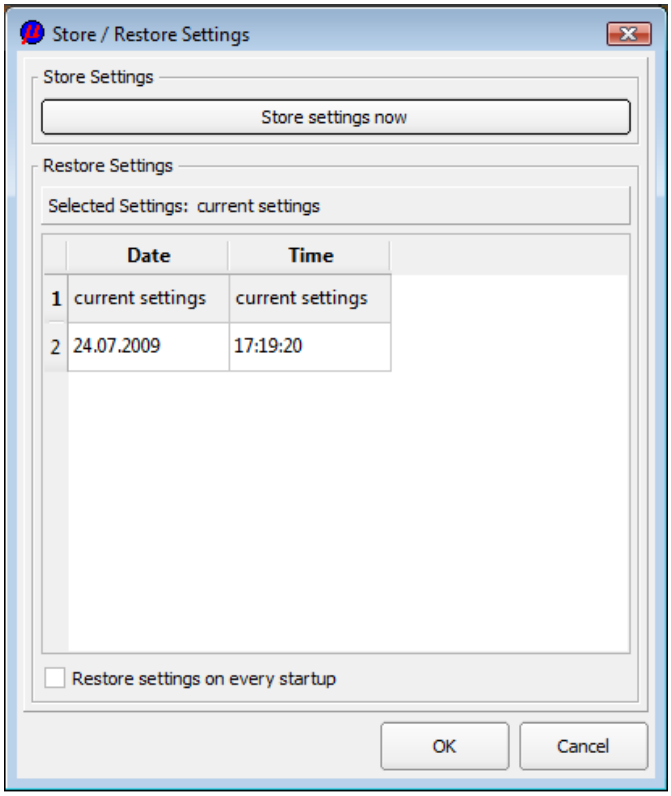



Figure 8.1: Store/Restore Settings

## 8.3 Store/Restore Settings

This dialog is found in the menu *Extras/Store/Restore Settings.*

All settings that can be altered by the users are saved in this report. (Settings such as hardware settings, calibration data, IF-LaboratoryMeasurementModule settings...) Once these settings are saved they cannot be overwritten. The checkbox "Restore settings on every startup" restores the same settings at every start up no matter which settings have been changed the previous times the System has been used.

# Appendix A

# Appendix

## A.1 License Agreement

This agreement applies to the IF-MeasureSuite. Alicona Imaging GmbH Software License Agreement.

THIS IS A LEGAL AGREEMENT BETWEEN YOU AND ALICONA IMAGING GMBH. BY INSTALLING OR USING THE SOFTWARE, YOU ARE AGREEING TO BE BOUND BY THE TERMS OF THIS LICENSE. IF YOU DO NOT AGREE TO THE TERMS OF THIS LICENSE, YOU ARE NOT AUTHORIZED TO USE THE SOFTWARE.

1. Definitions:

The term "Software" shall mean the executable files, other files, and related explanatory materials accompanying this License. The term "Software" shall also include any upgrades, modified versions or updates of the Software licensed to You by Alicona. "Use" means storing, loading, installing, executing, or displaying the Software, and "You" means the company, entity, or individual whose funds are used to pay the License fee.

2. Grant of License:

Subject to the terms of this Agreement, Alicona Imaging GmbH ("Alicona")grants You a non-exclusive, non-transferable license to use the Software accompanying this License SOLELY FOR EVALUATION PURPOSES. This, specifically, does not allow You to use any results or output produced by the Software for commercial purposes.

3. Term of License:

This License is in effect until terminated. You may terminate this License at any time by destroying the Software and all copies You have made. This

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4. Copyright:

The Software is owned by Alicona, and the Software structure, organization and code are the valuable trade secrets of Alicona. The Software is protected by Copyright Law and International Treaty provisions. You agree not to modify, adapt, translate, reverse engineer, decompile, disassemble or otherwise attempt to discover the source code of the Software. You may use trademarks only to identify printed output produced by the Software, in accordance with accepted trademark practice, including identification of trademark owner's name. Such use of any trademark does not give You any rights of ownership in that trademark.

5. Ownership:

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## A.2 Dongle and License Files

- **Virtual Private Network (VPN) is not supported by the Alicona Software.**

- **Is the license code different for 32bit an 64bit?**

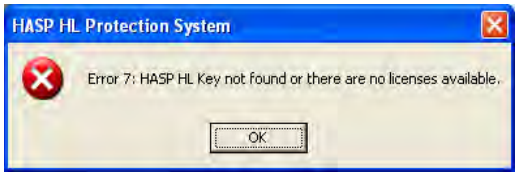
  The same code is valid for 32bit and for 64bit version. Only if another software version is used you need a different code.

- **You start the software and see the following error message:**


  *Reason:* The license file (*modules.lcn*) was not found in the program directory.

  *Solution:* Download the appropriate *.lcn* file from the customer area, click on *Load License File* and load the *.lcn* file.

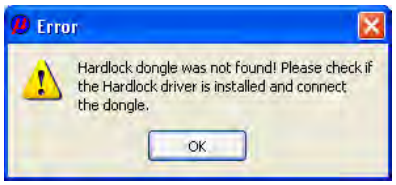
- **You start the software and see the following error message:**




*Solution:*

- Check if the dongle is working and connected at the server
- Check if the network connection is working (see below)
- Check if the program is already started on other PC's and the maximum license number is exceeded

- **You start the software and see the following error message:**




*Solution:*

You have probably selected *Hardlock* as Hardware Type instead of *HASP* resp.

*HASP.NET.* Delete the modules file in the program directory (*modules.lcn*) and try again.

- **Solution for network problems using floating licenses:**

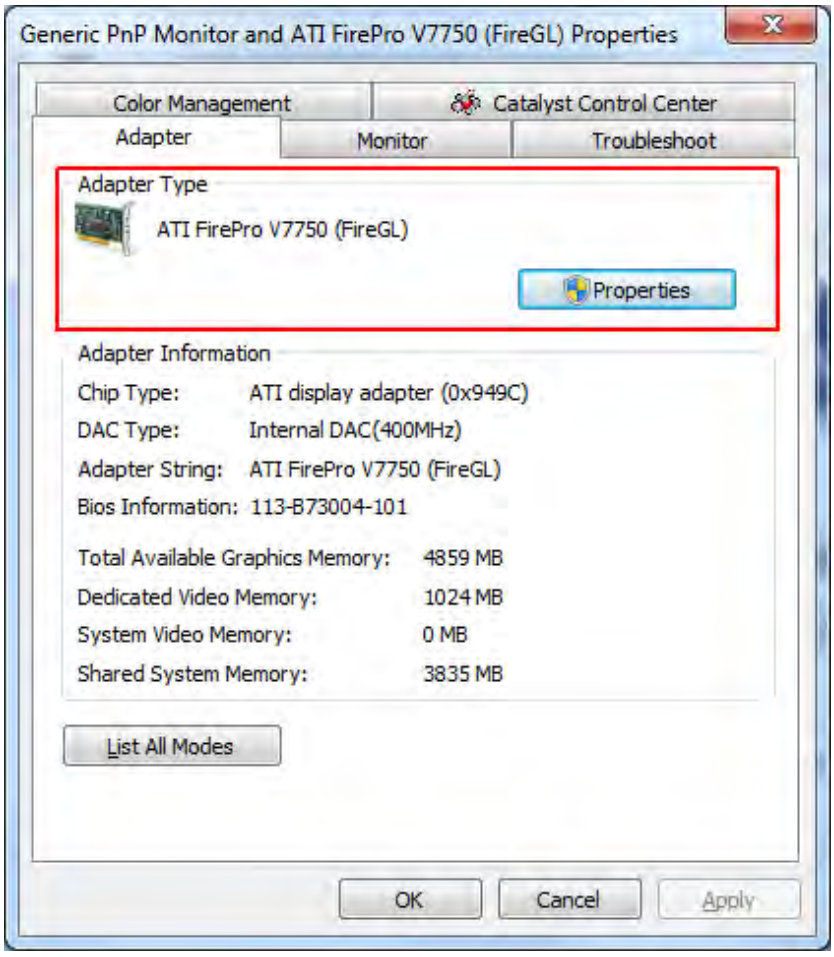
Please copy the file *nethasp.ini* from the directory *Support* on the CD of your Alicona product into the program directory on each Client (normally C:\ Program Files \ Alicona \ XXX, where XXX stands for your product). If the file *nethasp.ini* is not available on your CD, ask Alicona Support to send you the file. Next, open *nethasp.ini* using an editor and go to line 59 (NH_SERVER_ADDR = xxx). Replace xxx with the IP-Address (or host name) of the Server. Ask your system administrator if you do not know the IP-Address.

## A.3 Troubleshooting

### A.3.1 Problems with 3D viewer on IFM G4 systems

If you have problems in the 3D viewer e.g. the model either disappears or explodes into a strange green and black large triangle, a graphic card driver update may help. Threrefore follow the following isntructions

1. Check your graphic card:
   - Windows 7:
     (a) Open Screen Resolution by clicking the Start button, clicking Control Panel, and then, under Appearance and Personalization, clicking Adjust screen resolution.
     (b) Click Advanced Settings, and then click the Adapter tab.




Graphic card

2. Windows Vista:

(a) Open Display Settings by clicking the Start button, clicking Control Panel, clicking Appearance and Personalization, clicking Personalization, and then clicking Display Settings.

(b) Click Advanced Settings, and then click the Adapter tab.

3. If your driver is of type **ATI FirePro V7750 or ATI FirePro V8700**, you can find the driver for Vista and Windows 7 32bit and 64 bit on your installation directory of the IF-MeasureSuite in the folder *Drivers\AMD FirePro* e.g.

   - D:\Alicona\IF-MeasureSuite 4.1 x64\Drivers\AMD FirePro\ $FirePro\_8.911.3.4\_VistaWin7\_X32X64\_140087.exe$

   **Otherwise**, please contact the Support.

4. If your driver is of type **ATI FirePro V7750 or ATI FirePro V8700**, install the driver by double clicking the .exe and following the instruction by the setup.

   - Choose a destination folder for the extraction and press *Next*
   - If the Installation Manager starts, please choose *Express*, choose the destination folder and press *Next*.
   - Accept the licence agreement and start the installation.
   - Please restart the computer after the installation.

### A.3.2 Problems with 2 monitors on Infinite Focus SL systems

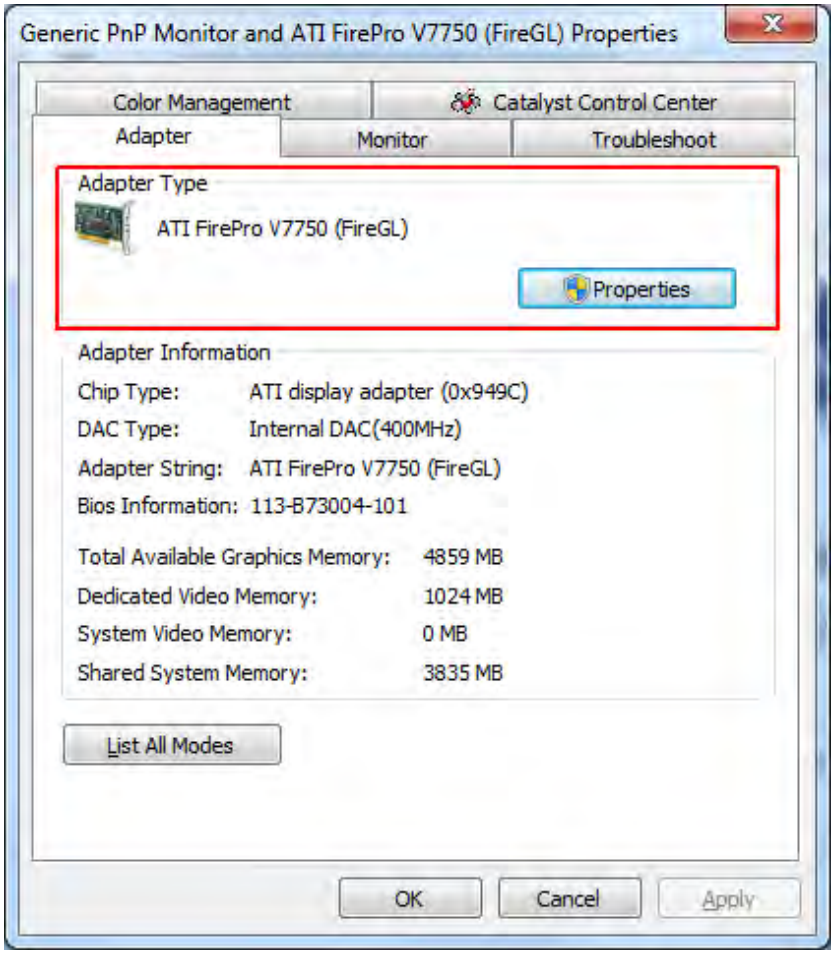
If you have a blue Screen bei Multi-Monitor Setup, then a driver update to version 8.98 can help to solve this problem.

1. Check your graphic card:

   - Windows 7:

     (a) Open Screen Resolution by clicking the Start button, clicking Control Panel, and then, under Appearance and Personalization, clicking Adjust screen resolution.

     (b) Click Advanced Settings, and then click the Adapter tab.




Graphic card

2. Windows Vista:

   (a) Open Display Settings by clicking the Start button, clicking Control Panel, clicking Appearance and Personalization, clicking Personalization, and then clicking Display Settings.

   (b) Click Advanced Settings, and then click the Adapter tab.

3. If your driver is of type **AMD Radeon HD 7900 or AMD Radeon HD 7800**, you can find the current driver on your installation directory of the IF-MeasureSuite in the folder *Drivers\AMD Radeon* e.g.

   - D:\Alicona\IF-MeasureSuite 5.0.0.1 x64 \Drivers\AMD Radeon\ $13-9\_win7\_win8\_64\_dd\_ccc\_whql.exe$

   **Otherwise**, please contact the Support.

4. If your driver is of type **AMD Radeon HD 7900 or AMD Radeon HD 7800**, install the driver by double clicking the .exe and following the instruction by the setup.

### A.3.3 Software

- **The software does not start:**
  - Check if the supplied dongle is connected to your computer and the dongle drivers are installed.
  - Check if the dongle LED is on and try to reconnect the dongle.
- **The software does not start the measurement module:**
  - Please check if the size of the data is too big (>100MB). If this is the case, please reduce the source file size.
- **An error message pops up after the start of the 3d-viewer :**
  - Check the selected color depth in the windows display properties (should be 32 bit).
  - Install the latest available graphic driver from your graphic card vendor.
  - Go to the program options dialog and select the non hardware accelerated mode from the graphic settings tab.

### A.3.4 Installation

- **Error message during installation (*iKernel.exe*):**
- Check if you have administrator rights. (Administrator rights are mandatory for installing the software).

### A.3.5 Measurement values

- **The measurement results do not correspond to the real world facts:**
  - Check if you have entered the right calibration data during the import into the database.
- **The measured roughness is different to values measured with other devices:**
  - Check if the chosen $\lambda_C$ value is correct.

## A.4 Recommended PC-Configuration for Offline Licenses

Minimum:

| | |
|---|---|
| CPU | Dual Core (recommended Intel) |
| RAM | 4GB |
| Graphics Card | DirectX 9 compatible GPU |
| Operating System | Windows 64bit |

Recommended:

| | |
|---|---|
| CPU | Quad Core or higher (recommended Intel) |
| RAM | 8GB |
| Graphics Card | DirectX 9 compatible GPU |
| Operating System | Windows 7 64bit |

## A.5 List of norms and references

### A.5.1 General

| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
|---|---|---|---|
| ISO 25178-6 | 2010 | Geometrical product specifications (GPS) - Surface texture: Areal - Part 6: Classification of methods for measuring surface texture. | Approval stage (refer to ISO/TS 14253-4:2010) |
| ISO/CD 25178-606 | - | Nominal characteristics of non-contact (focus variation) instruments | Committee draft |
| Ö-Norm 1388 | 2002 | Geometrical product specification and verification (GPS) - Guide for operation and definition of the competence of operators of optical surface topography measurement devices. | Published |
| VIM ISO IEC | 2008 | International Vocabulary of Metrology - Basic and General Concepts and Associated Terms , 3rd edition | Published |

### A.5.2 Adjustement/Calibration

| General | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
| Bosch Nr. 10 | 2008 | Fähigkeit von Mess- und Prüfprozessen | Published |

| Roughness | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
| ISO/CD 25178-706 | - | Calibration and measurement standards of non-contact (focus variation) instruments | Committee draft |

| Coordinate measuring technology | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
| VDI 2634-1 | 2002 | Optical 3D measuring systems - Imaging systems with point-by-point probing | Published |
| VDI 2634-2 | 2002 | Optical 3D-measuring systems - Optical systems based on area scanning | Published |
| VDI 2617-6.1 | 2007 | Accuracy of coordinate measuring machines - Characteristics and their testing - Coordinate measuring machines with optical probing | Published |
| VDI 2617-6.2 | 2007 | Accuracy of coordinate measuring machines - Characteristics and their testing | Published |
| VDI 2617-12.1 | 2011 | Accuracy of coordinate measuring machines - Characteristics and their checking - Acceptance and reverification tests for tactile CMM measuring microgeometries | Published |
| VDI 2617-12.2 | - | Testing of optical CMMs used for measuring microgeometries | Planned |
| ISO 10360-1 | 2002 | Geometrical Product Specifications (GPS) - Acceptance and reverification tests for coordinate measuring machines (CMM) - Part 1: Vocabulary | Published |

| | | | |
|---|---|---|---|
| ISO 10360-2 | 2009 | Geometrical product specifications (GPS) - Acceptance and reverification tests for coordinate measuring machines (CMM) - Part 2: CMMs used for measuring linear dimensions | Published, not yet implemented |
| ISO 10360-3 | 2000 | Geometrical Product Specifications (GPS) - Acceptance and reverification tests for coordinate measuring machines (CMM) - Part 3: CMMs with the axis of a rotary table as the fourth axis | Published |
| ISO 10360-4 | 2000 | Geometrical Product Specifications (GPS) - Acceptance and reverification tests for coordinate measuring machines (CMM) - Part 4: CMMs used in scanning measuring mode | Published, not yet implemented |
| ISO 10360-5 | 2010 | Geometrical product specifications (GPS) - Acceptance and reverification tests for coordinate measuring machines (CMM) - Part 5: CMMs using single and multiple stylus contacting probing systems | Published, not yet implemented |
| ISO 10360-6 | 2001 | Geometrical Product Specifications (GPS) - Acceptance and reverification tests for coordinate measuring machines (CMM) - Part 6: Estimation of errors in computing Gaussian associated features | Published |
| ISO 10360-7 | 2011 | Geometrical product specifications (GPS) - Acceptance and reverification tests for coordinate measuring machines (CMM) - Part 7: CMMs equipped with imaging probing systems | Published |

### A.5.3 Measurement of Roughness

| Profile and Roughness Measurement | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |

| | | | |
|---|---|---|---|
| ISO 4287 | 1997 | Geometrical Product Specifications (GPS), Surface texture: Profile method – Terms, definitions and surface texture parameters (Ra, Rq, Rz, ...) | Published |
| ISO 4288 | 1996 | Surface texture: Profile method – Rules and procedures for the assessment of surface texture | Published |
| ISO 5436-1 | 2000 | Geometrical Product Specifications (GPS) - Surface texture: Profile method; Measurement standards Material measures; Definition of how to measure height steps | Published |
| ISO 5436-2 | 2001 | Geometrical Product Specifications (GPS) - Surface texture: Profile method; Measurement standards Software measurement standards; Definition of interaction file format for surface profiles | Published |
| ISO 12085 | 1996 | Geometrical Product Specifications (GPS) - Surface texture: Profile method - Motif parameters | Published |
| ISO/TS 16610-1 | 2006 | Geometrical product specifications (GPS) – Filtration – Part 1: Overview and basic concepts | Published |
| ISO/TS 16610-20 | 2006 | Geometrical product specification (GPS) – Filtration – Part 20: Linear profile filters: Basic concepts | Published |
| ISO/TS 16610-21 | 2011 | Geometrical product specifications (GPS) – Filtration – Part 21: Linear profile filters: Gaussian filters | Published |
| ISO/TS 16610-22 | 2006 | Geometrical product specifications (GPS) – Filtration – Part 22: Linear profile filters: Spline filters | Published, not yet implemented |
| ISO/TS 16610-28 | 2010 | Geometrical product specifications (GPS) – Filtration – Part 28: Profile filters: End effects | Published |

| | | | |
|---|---|---|---|
| ISO/TS 16610-29 | 2006 | Geometrical product specifications (GPS) – Filtration – Part 29: Linear profile filters: Spline wavelets | Published, not yet implemented |
| ISO/TS 16610-30 | 2009 | Geometrical product specifications (GPS) – Filtration – Part 30: Robust profile filters: Basic concepts | Published, not yet implemented |
| ISO/TS 16610-31 | 2010 | Geometrical product specifications (GPS) – Filtration – Part 31: Robust profile filters: Gaussian regression filters | Published, not yet implemented |
| ISO/TS 16610-32 | 2009 | Geometrical product specifications (GPS) – Filtration – Part 32: Robust profile filters: Spline filters | Published, not yet implemented |
| ISO/TS 16610-40 | 2006 | Geometrical product specifications (GPS) – Filtration – Part 40: Morphological profile filters: Basic concepts | Published, not yet implemented |
| ISO/TS 16610-41 | 2006 | Geometrical product specifications (GPS) – Filtration – Part 41: Morphological profile filters: Disk and horizontal line-segment filters | Published, not yet implemented |
| ISO/TS 16610-49 | 2006 | Geometrical product specifications (GPS) – Filtration – Part 49: Morphological profile filters: Scale space techniques | Published, not yet implemented |
| - | 2004 | M. Krystek - Die digitale Implementierung des Profilfilters nach DIN EN ISO 11562, (2004) | |
| JIS B0601 | | Japan Industrial Standard: Surface Characteristics: Terminology, Definition and Surface Characteristics Parameter | |
| ASM-HB18 | - | T. V. Vorburger - Methods for Characterizing Surface Topography (National Institute of Standards and Technology NIST) | |

| | | | |
|---|---|---|---|
| ISO 11562 | - | - | withdrawn: revised by 16610-21 |

| Face and Roughnesss Measurement | | | |
|---|---|---|---|
| **Nummer / Abk.** | **Year** | **Title** | **Status** |
| ISO 25178-2 | - | Geometrical product specifications (GPS) – Surface texture: Areal – Part 2: Terms, definitions and surface texture parameters | Under development, but already implemented |
| ISO 25178-6 | 2010 | Geometrical product specifications (GPS) - Surface texture: Areal - Part 6: Classification of methods for measuring surface texture. | Approval stage (refer to ISO/TS 14253-4:2010) |
| ISO/TS 16610-1 | 2006 | Geometrical product specifications (GPS) – Filtration – Part 1: Overview and basic concepts | Published |
| ISO/WD 16610-61 | - | Geometrical product specifications (GPS) – Filtration – Part 61: Linear areal filters: Gaussian | Working Draft, but already implemented |
| ISO/CD 16610-71 | - | Geometrical product specifications (GPS) – Filtration – Part 71: Robust areal filters: Gaussian regression filters | Committee Draft, but already implemented |
| ISO 13565-2 | 1996 | Geometric Product Specification (GPS) - Surface texture: profile method - surfaces having stratified functional properties - Part 2. Height characterisation using the linear material ratio curve. | Published |

| | | | |
|---|---|---|---|
| ASME B46.1-2002 | - | Surface Texture (Surface Roughness, Waviness, and Lay); Revision of ANSI/ASME B46.1-1995 | |
| ISO 8785 | 1998 | Geometrical Product Specification (GPS) - Surface imperfections - Terms, definitions and parameters | Published |
| ISO/TS 12781 - 1 | 2011 | Geometrical Product Specification (GPS), Flatness: Vocabulary and parameters of flatness | Published |
| ISO/TS 12781 - 2 | 2011 | Geometrical Product Specification (GPS), Flatness: Specification operators | Published |
| - | 1997 | DAS PAPIER 3/1997: Zweidimensionale Erfassung der Oberflaechenstruktur von Papier im Hinblick auf seine Bedruckbarkeit, pp.107-117, C. Ness, L. Goettsching | Published |
| - | 2003 | L. Blunt and Xiang Jiang, Advanced Techniques for Assessment Surface Topography: General description of surface texture parameters. | Published |
| - | 2000 | K. J. Stout (Editor), Development of Methods for the Characterization of Roughness in Three Dimensions: General description of surface texture parameters. | Published |

### A.5.4 Form Measurement

| Profile Form Measurement | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
| ISO 5436-2 | 2001 | Geometrical Product Specifications (GPS) - Surface texture: Profile method; Measurement standards Software measurement standards; Definition of interaction file format for surface profiles | Published |

| 3D-Form Measurement | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
| ISO 1101 | 2004 | Geometrical Product Specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out | Published |

| Contour Measurement | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
| ISO/TS 12180 - 1 | 2011 | Geometrical Product Specification (GPS), Cylindicity: Vocabulary and parameters of cylindrical form | Published |
| ISO/TS 12180 - 2 | 2011 | Geometrical Product Specification (GPS), Cylindicity: Specification operators | Published |
| ISO/TS 12181 - 1 | 2011 | Geometrical Product Specification (GPS), Roundness: Vocabulary and parameters of roundness | Published |
| ISO/TS 12181 - 2 | 2011 | Geometrical Product Specification (GPS), Roundness: Specification operators | Published |

### A.5.5 Edge Measurement

| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| DIN 6581 | 1985 | Begriffe der Zerspantechnik; Bezugssysteme und Winkel am Schneidteil des Werkzeuges. | - |
| DIN 32877 | 2008 | Optoelectronic measurement of form, profile and distances | - |
| ISO 13715 | 2000 | Technical drawings - Edges of undefined profile - Vocabulary and indications | Published |
| ISO 1832 | 2004 | Indexable inserts for cutting tools – Designation | Published |

### A.5.6 Tool Measurement

| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
|---|---|---|---|
| MBN-31007-7 | - | Test of the twist | - |
| DIN2192 | 2002 | Flat form springs - Quality requirements | - |
| EN25967 | 1990 | Screwing taps. Nomenclature and terminology | - |

### A.5.7 Safety

| CE Certificate | | | |
|---|---|---|---|
| **Nr. / Abbr.** | **Year** | **Title** | **Status** |
| 2006/42/EG | 2006 | Machinery directive | Published |
| 2004/22/EG | 2004 | Directive of measuring instruments | Published |
| 2006/95/EG | 2006 | Low-voltage directive | Published |
| 2004/108/EG | 2004 | Electromagnetic compatibility | Published |

## A.6 Glossary

- **3D Measuring:** 3D Measuring generates 3D data. Through usage of this 3D data measurands as for example rotundity can be determined.

- **3D Surface Measurement Technique:** This is a technique for the three dimensional measurement of surfaces.

- **Ability of measurement equipment:**

  The ability of the measurement equipment defines how capable (how good) a measurement equipment performs a certain measurement. This capability is evaluated with different procedures (1, 2, 3) which provide certain parameters. If an influence of the examiner on the measurement exists procedure 2 otherwise procedure 3 has to be used.

  **Parameters:**

  - *Cg:* Ability-parameter of one measurement process without paying attention to the systematic deviation

    This parameter gives information about the repeatability of a measurement. If this value is larger than 1.33 the measurement equipment is acceptable for this application and its requested tolerance.

  - *Cgk:* Ability-parameter of one measurement process with paying attention to the systematic deviation

    This parameter gives information about the repeatability of the absolute error of one measurement. If this value is larger than 1.33 the measurement equipment is acceptable for this application and its requested tolerance.

  - %GRR: Overall spread of the measurement process in relation to the tolerance of the characteristic.

    If this parameter is smaller than 10 percent this measurement equipment is adequate.

  - GRR: Gage Repeatability and Reproducibility

  **Procedure:**

  - Procedure 1 (determination Cg and Cgk):

    This procedure uses serial parts or reference parts with at least 25 measurements in order to define the values Cg and Cgk.

  - Procedure 2 (GRR):

    Must be carried out after procedure 1 has been completed positively. Within this procedure 10 serial parts are evaluated by three examiners over two measurement rows in order to determine the capability.

  - Procedure 3 (GRR):

Must be carried out after procedure 1 has been completed positively. 25 parts are evaluated in two measurement rows in order to investigate the capability.

**Measurement uncertainty**

According to VIM the measurement uncertainty is the difference between the measured value and the reference value. It is therefore the actual measurement error of one measurement. To determine the measurement uncertainty general procedures exist:

- Procedure according to the Guidelines for evaluating and Expressing the Uncertainty of Measurement (GUM).
- Creation of a measurement uncertainty budget. This procedure lists the impact factors on the measurement error and later on combines these to a measurement uncertainty.

**Links:**

- http://en.wikipedia.org/wiki/Measurement_systems_analysis
- http://en.wikipedia.org/wiki/Measurement_uncertainty
- http://www.itl.nist.gov/div898/handbook/
- Bosch booklet 10

- **Accuracy of measurement:** "Closeness of agreement between a quantity value obtained by measurement and the true value of the measurand". From: International vocabulary of basic and general terms in metrology (VIM)

  Easier: *The accuracy is the error of a measurement.*

  Accuracy = Reference Measurement – IF-MeasureSuite Measurement

  How to measure the accuracy:

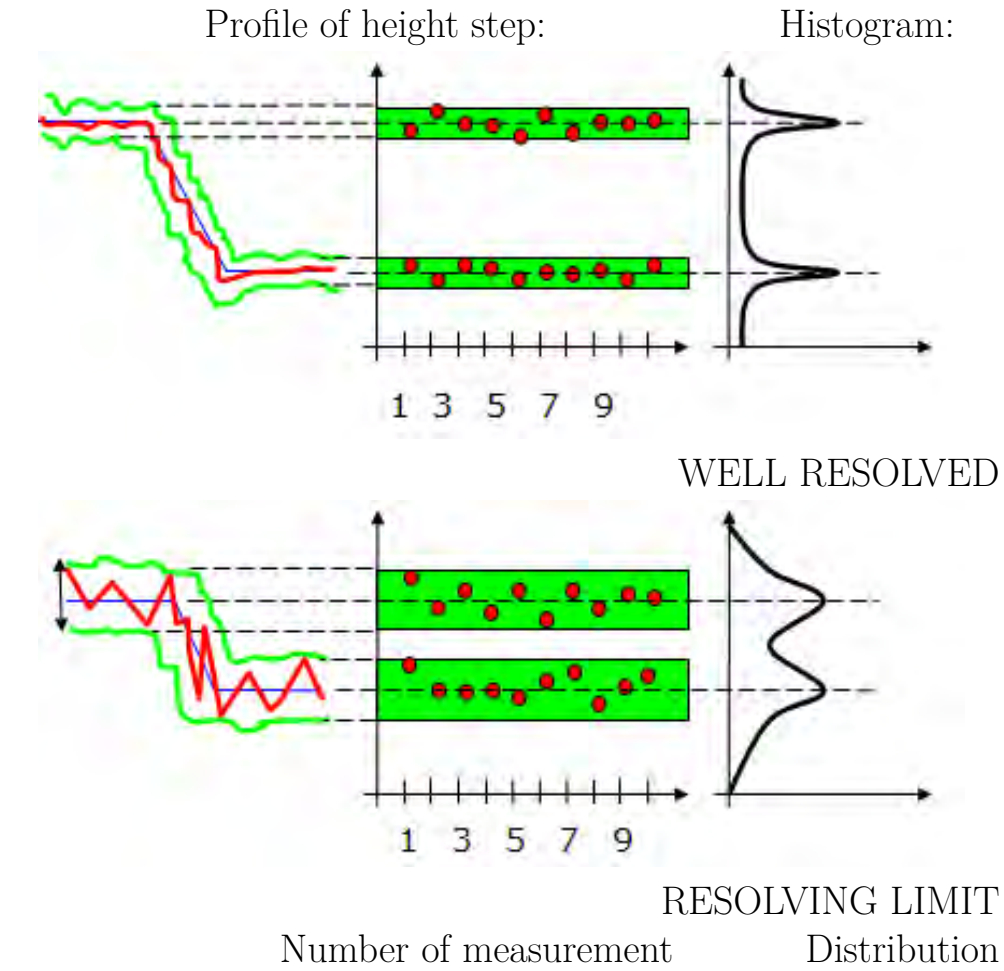
1. Select a measurement type ( Height, length, radius. . . )
2. Select an artifact that can be used with IF-MeasureSuite ( No glass, no wafer).
3. Perform measurement
4. Compare measurement with reference measurement

- **Amplitude Parameter:** Roughness parameter from the draft of ISO 25178 (e.g. Sa, Sq,...)

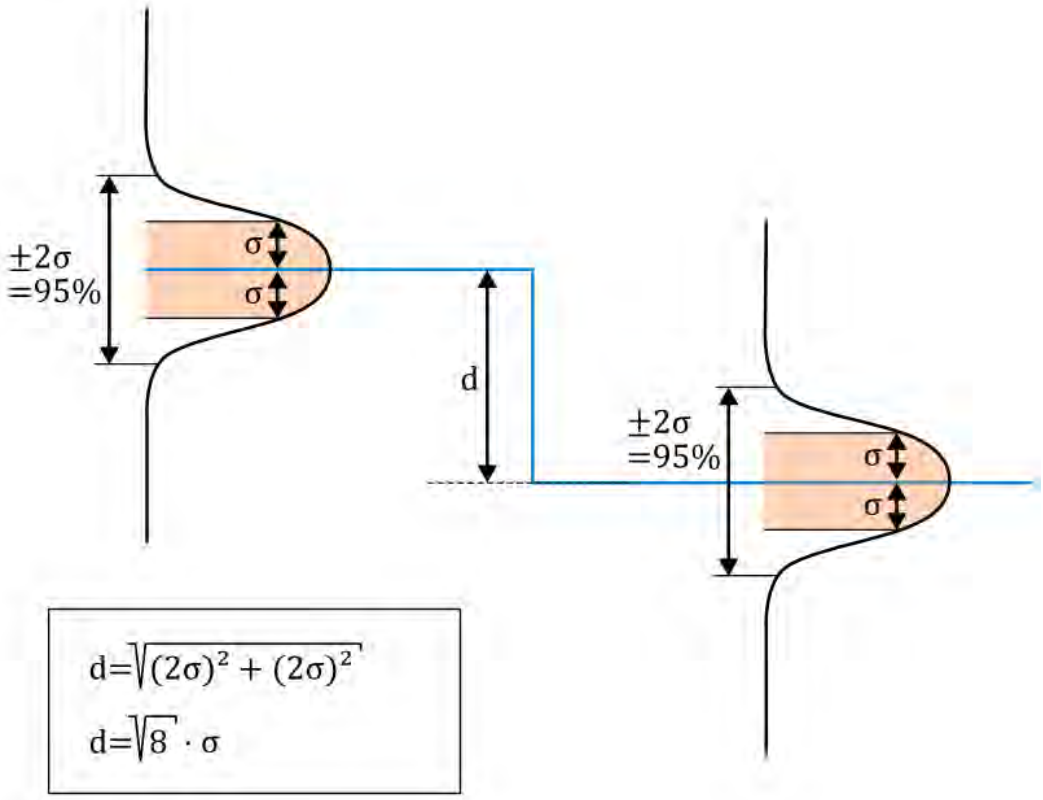
- **Anaglyph Image:** an image suitable to be viewed with red-blue (or red-green) glasses

- **Autocorrelation Parameter:** With the help of the auto correlation parameters it is possible to identify the structures of the surface of a specimen.

- **Correlation between repeatability and Resolution:**




**Ratio between repeatability and vertical resolution:**




Repeatability or Standard Deviation of the Measurement

In order that in 95% of all cases the upper and the lower steps can be distinguished d has to be larger than $\sqrt{8} \cdot \sigma$ .

In this figure $\sigma$ represents the repeatability or the standard deviation of the measurement. In this case the height step can be resolved. If: d $>\sqrt{8} \cdot \sigma$ the height step can be resolved. This means that the vertical resolution is $\sqrt{8}\cdot$ repeatability.

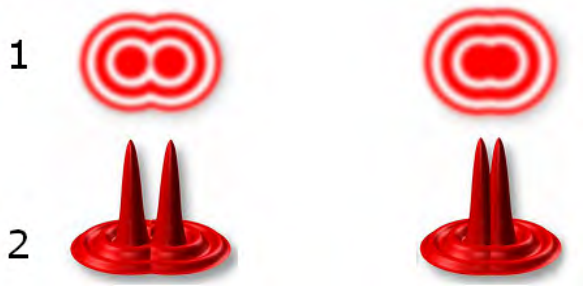
- **Cutting Edge Measurement:** The edge measurement is used to measure the edge fillet radius and the edge fillet angle of different cutting tools.

- **DEM:** Digital Elevation Model - the measured surface model of your specimen

- **Dimension:** Dimensions are the macroscopic sizes of a part, e.g. diameter or length.

- **Disparity:** the vertical or horizontal displacement between two corresponding object points in the two stereo images

- **Draft of ISO 25178:** The ISO 25178 includes a collection of international standards relating to the measurement of 3D areal surface texture.
- **Eucentric Tilting:** the way stereo images should be recorded
- **Exposure Dynamic:** Number of height steps that can be measured.
- **Fast Fourier Transformation (FFT):** With the FFT you can analyse which parts of a frequency are represented in a signal. You can also tell how strong each frequency is represented in the signal.
- **Focus Variation:** Its operating principle combines the small depth of focus of an optical system with vertical scanning.
- **Form:** Form refers to the intentional shape of a surface which differs from a flat line.
- **Form Error:** Form error encompasses the long wavelength deviations of a surface from the corresponding nominal surface. Form errors result from large scale problems in the manufacturing process such as errors in machine tool ways, guides, or spindles, insecure clamping, inaccurate alignment of a workpiece, or uneven wear in machining equipment. Form error is on the dividing line in size scale between geometric errors and finish errors.
- **Gradient Allocation:** The gradient allocation describes how slopes are arranged on the surface of the specimen.
- **Image Resolution:** Smallest detectable detail.




discriminable not discriminable

1. Image

2. 3D Visualization of intensities in image
   Note: The lateral measurement resolution may be higher and is indicated by the sampling distance.

- **Kappa Angle:** The kappa angle describes a rotation around the z-axis.
- **Measure Point:** A measure point consists of an X, Y and Z value. The object is created out of a multitude of measure points.
- **Measured Surface:** A measured surface is a representation of the real surface obtained with some measuring instrument. This distinction is made because no measurement will give the exact real surface.
- **Modulated Light:** Modulated Light is the light that strikes the specimen with variable intensity.
- **Nano Coordinate Measurement Technique:** The object to be measured is captured by a coordinate measurement device. The Coordinate measurement technique collects several measure points. The measurement results are calculated out of all single points with a certain algorithm.
- **Nominal Surface:** A nominal surface is the intended surface. The shape and extent of a nominal surface are usually shown and dimensioned on a drawing. The nominal surface does not include intended surface roughness.
- **Optical Measurement:** Generally you can differ between optical and tactile measurements. When using the optical measurement you do not need to touch or adapt the object of interest.
- **Optical Testing Technology:** This is a technique for optical measurement and inspection of components.
- **Outlier:** a large measurement error
- **Pan Angle:** The pan angle describes a rotation around the x-axis.
- **Primary Profile:** the profile extracted in the profile analysis module without the application of a filter
- **Real Surface:** A real surface is the actual boundary of an object. It deviates from the nominal surface as a result of the process that

created the surface. The deviation also depends on the properties, composition, and structure of the material the object is made of.

- **Repeatability:** The standard deviation of a series of the same measurement. If you repeat a measurement you will never get the same (sensor noise, temperature, stage errors,...)

  Example (10x, VR = 150nm) result.

| Number: | 1 | 2 | 3 | ... | 30 | mean | Std. dev. |
|---|---|---|---|---|---|---|---|
| Height( $\mu$m): | 10.5 | 10.4 | 10.6 | ... | 10.7 | 10.6 | 0.05 |

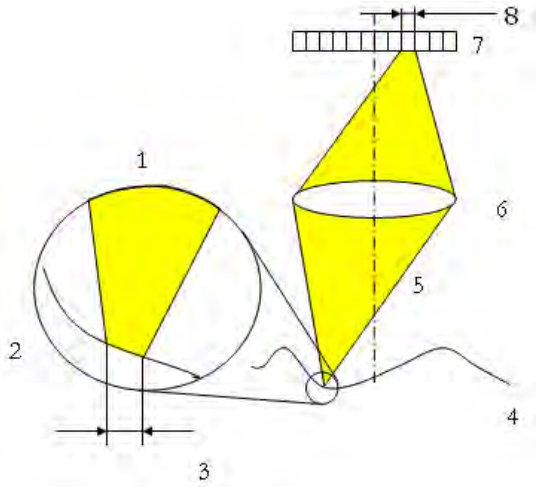
  From the statistics lesson: 95% of the values are between +-100nm.

- **ROI:** Region of Interest - specifies the region of an image that should be processed

- **Roughness:** Roughness includes the finest (shortest wavelength) irregularities of a surface. Roughness generally results from a particular production process or material condition.

- **Roughness Profile:** the primary profile after the application of a roughness filter

- **Sampling Distance:** The sampling distance is the distance from one measurement point to the next measurement point on the specimen.




1. Light cone
2. Surface of specimen
3. Lateral resolution
4. Surface of specimen

5. Light cone
6. Lens or optic
7. Sensor with measurement point
8. Sampling distance

- **SEM:** Scanning Electron Microscope
- **SmartFlash**: SmartFlash is the combination of XSmartFlash/High Dynamic and modulated light. Through individual light control optimal measurement data can be created for steep flanks as well a s for specimens with different reflection characteristics.
- **Spectroscopic Analysis:** Spectroscopic analysis is the analysis of the frequency spectrum.
- **Stereo Images:** two images captured from different viewing angles
- **Surface:** A surface is a boundary that separates an object from another object or substance
- **Texture:** Surface texture is the combination of fairly short wavelength deviations of a surface from the nominal surface. Texture includes roughness, waviness, and lay, that is, all of the deviations that are shorter in wavelength than form error deviations.
- **Tilt Angle:** The tilt angle describes a rotation around the y-axis.
- **Tolerance:** A tolerance is an allowable range for a dimension to take, a specified interval of dimensions where the part will still function acceptably.
- **Tribology:** The tribology investigates e.g. friction, lubrication and attrition of bearings, guides, gear mechanisms, motors and other machine elements.
- **Vertical Dynamic:** Number of possible Z values over the scan height.

  *Example*: Scan height: 1000$\mu$m:

Vertical Resolution: 20$\mu$m
Vertical Dynamic: 1000/20 = 50

Small vertical dynamic
- step artefacts are visible

Vertical Resolution: 1$\mu$m
Vertical Dynamic: 1000/1 = 1000

High vertical dynamic - even small surface details can be measured

- **Vertical Resolution:** The vertical resolution of a measurement is the smallest height step that can be measured.

Good VR

Height step can be well resolved

Resolving limit

Bad VR

Height step cannot be resolved

- **Waviness:** Waviness includes the more widely spaced (longer wavelength) deviations of a surface from its nominal shape. Waviness errors are intermediate in wavelength between roughness and form error. Note that the distinction between waviness and form error is not always made in practice, and it is not always clear how to make it.

- **Waviness Profile:** the primary profile after the application of a waviness filter

- **XSmartFlash/High Dynamic:** XSmartFlash/High Dynamic is the adaptive control of exposure time / illumination of every single measurement point.

- **Zero Plane:** the reference plane for the depth measurements; normally located at the point of eucentric tilting; normally, however, you should not perform absolute measurements as the exact location of the zero plane is hard to define; make relative depth-difference measurements instead; they are much more accurate;

## A.7 Warranty

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### A.7.1 Compatibility with other Products

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