S wide

SENSOFAR METROLOGY

# SYSTEM MANUAL


IFU10-01-EN, B
Software version: 1.1

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CHAPTER

1

# WELCOME TO S WIDE!

**S wide** is a dedicated system designed to rapidly measure large surfaces up to 300 x 300 mm. It provides all the benefits of a digital microscope integrated into a high resolution measuring instrument. It offers sub-micron height repeatability over an entire extended area, as well as one shot height measurement up to 40 mm without Z scanning. Very low field distortion is achieved by using bi-telecentric lenses, providing accurate metrology. Every S wide is manufactured to deliver accurate and traceable measurements, and the systems are validated using traceable standards according to ISO 25178 and VDI 2634-2.

To help you get familiarized with your surface metrology system, this system manual will guide you through the acquisition software **SensoSCAN S wide**. This software drives the system with its clear, intuitive and user-friendly interface with which any measurement can be easily taken. To streamline the reading of this manual, the software will be referred to as **SensoSCAN**.

**SensoVIEW**, is a software offering a comprehensive set of tools for displaying and analyzing measurements. The user is guided through the 3D environment, delivering a unique user experience.

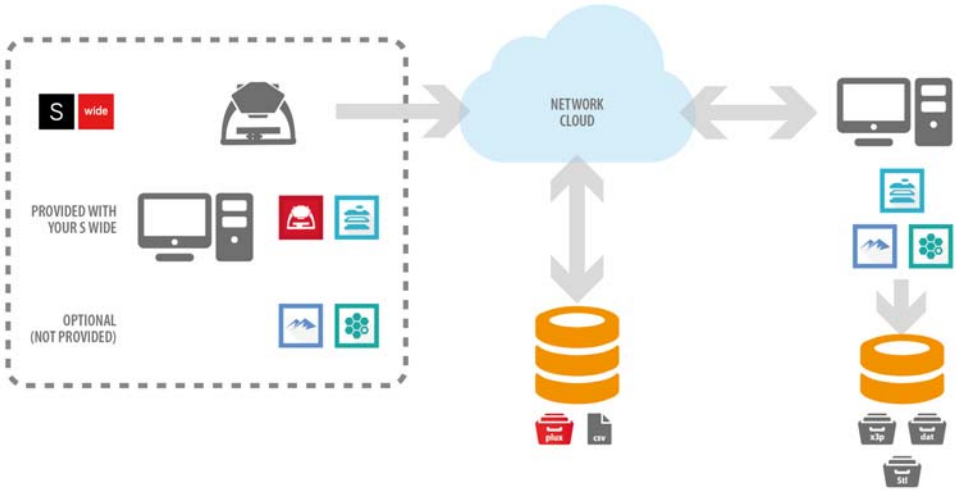
For applications requiring more advanced analysis tools, specific analysis software packages are optionally available.

For powerful and flexible data manipulation we offer **SensoMAP**, a state-of-the-art surface analysis software based on Mountains technology. Typical uses for **SensoMAP** include off-line 2D/3D surface characterization in R&D departments and laboratories, and near-line process control in production facilities (usually 2D).

**SensoPRO** is an optional tool for easy and rapid quality control. The operator only needs to load the sample and follow guided instructions. Plug-in based data analysis algorithms provide high-degree of flexibility. Available algorithms include Bump, Double Step Height, Dual Hole, Edge, FTrace, Hole, Laser Cut, Laser Hole, Pad, R Hole, Spacer, Step Height, Step Height ISO, Surface Texture, Surface Texture Profile, Trace and Trench, among others. New modules can be easily developed for other industry needs.

Another optional software is **Geomagic Wrap,** a 3D scan-to-model metrology software used for reverse engineering and CAD comparisons, transforming the scanned information into 3D models to be represented in 3D environments. This software allows for in detail inspection of acquired data to create complex models.

All analysis software can be run on the computer serving the system, or other computers, as shown below:




The main advantage of distributing the applications is that existing data can be analyzed while new data is being acquired.

**NOTE** When analysis applications are run on the system computer, it is very important not to do analysis while the system is taking a measurement, as this can reduce the performance.

Lastly, it is possible to remotely run specific **SensoSCAN**'s commands and events by using a software development kit (SDK). If your system has a SDK, refer to its documentation for more information.

To learn more about surface metrology solutions, please visit www.sensofar.com to access application examples and research papers.

# 1.1 Basic features of your system

## Technology – FRINGE PROJECTION

The **S wide** system uses Fringe Projection technology, able to acquire large area measurements in a short amount of time, while maintaining a high vertical resolution.

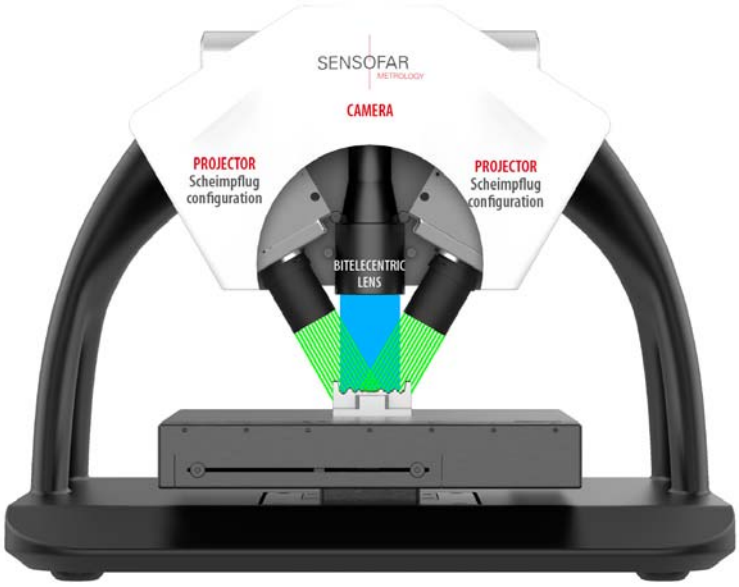
The vertical resolution of techniques based on depth of focus – such as Ai Focus Variation and Confocal– is affected by the numerical aperture (NA) of the objective used to acquire. To quickly measure large FOVs, low magnification objectives must be used. These objectives have small NA, which leads to having large vertical resolution values. One of the advantages of using Fringe Projection over other techniques is the ability of acquiring large FOVs while maintaining a **vertical resolution of the order of 1 micron**. Similar resolutions could be achieved with interferometric techniques but these techniques can only measure smooth samples, while Fringe Projection is able to evaluate a diverse range of surfaces.

With Fringe Projection it is possible to measure both step height and surface roughness with low uncertainty values, while providing repeatability on the nanometer scale.

## Setup

To acquire using Fringe Projection the S wide is composed of the following main parts:

- Two projectors
- 5Mpx color camera and a bi-telecentric lens for image inspection and acquisition
- Unit to process and analyze the acquired data

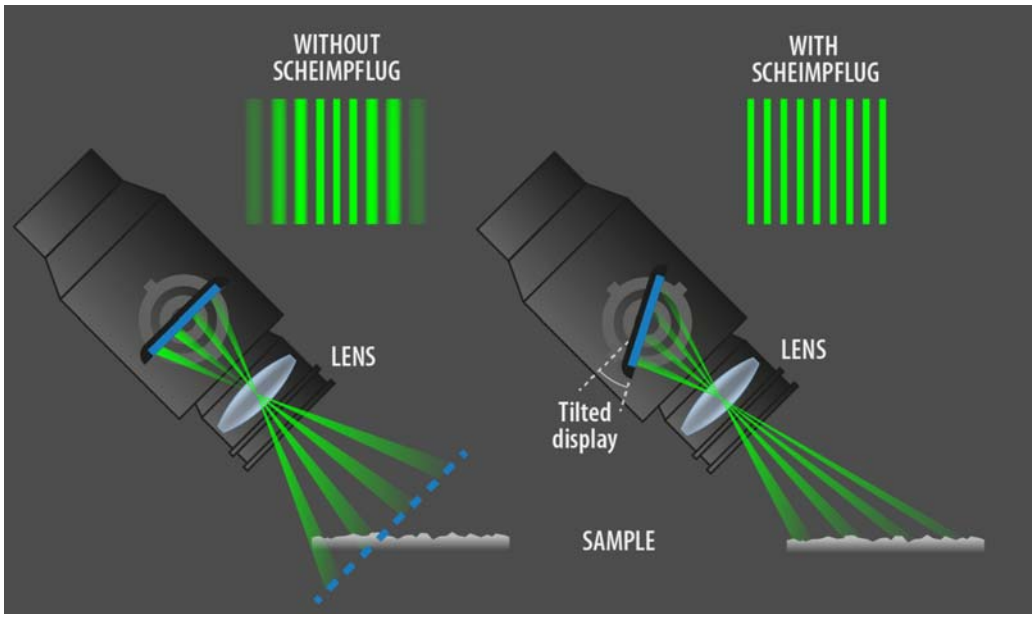



The projectors generate a set of fringe patterns and project them onto the object that is being measured from two different angles. Once the patterns hit the surface they become distorted by the object's geometry. These distorted patterns carry the depth/height information and are captured by the camera to be processed and analyzed.

## PROJECTORS

There are two projectors, tilted 30º from the vertical axis. Having multiple projectors avoids problems such as the appearance of artifacts created by shadows and invalid regions on the surface. Projecting fringes from two different directions covers more area, thus allowing the acquisition of more information that otherwise would be missing.

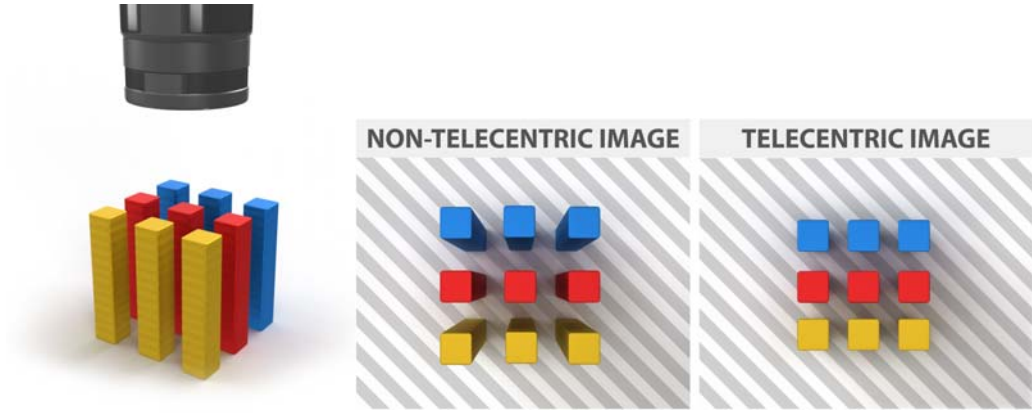
The setup follows the Scheimpflug principle, which allows for a homogeneous focusing of objects that are not parallel to the image plane. Without this setup the measurement of tilted samples would only show a certain region in focus instead of the whole field of view:




## BI-TELECENTRIC LENS

The lens is bi-telecentric, meaning that only the rays that are parallel to the optical axis are detected by the camera. This results in objects maintaining their size constant regardless of the distance from the lens. In conventional lenses objects closer to the lens will appear larger.

Bi-telecentric lenses avoid errors caused by perspective (parallax). Any object inside the FOV will appear sharp and in focus, without apparent tilts and unwanted shadows.




Sample with vertical columns showing the difference between a telecentric and a non-telecentric lens

Another advantage of using this kind of lens is the large depth of focus. For most samples, it is possible to measure both the substrate and the highest peaks of the surface. The vertical measuring range of the S wide is 10 mm, with no need for Z scanning.

**NOTE** Samples with heights up to 40 mm can be measured, although only 10 mm will be in focus. Outside this range, where the surface is not in focus, the lateral resolution decreases.

Surfaces with slopes up to 86º can be measured.

## MULTIPLE LIGHT SOURCES

To optimize the light settings for each application, S wide provides white light illumination generated from a ring light, as well as two LED light sources inside its optical core to project fringe patterns: green (530 nm) and blue (460 nm). The LEDs are used to acquire height information while the ring light is used to get the color information.

The default LED is green, but it is possible to choose blue if required. As a consequence of the pixel distribution in the camera, a better lateral resolution is achieved when measuring with the green LED. Nevertheless, using a lower wavelength LED produces more scattering, a positive factor for Fringe Projection acquisitions which are affected by light diffusion.

**WARNING**

**The choice of LED is an important step, as all measurements should be acquired with the same LED to be consistent. If the LED is changed, recalibrate for that LED.**

## COLOR CAMERA

The S wide uses a high-resolution color camera of up to 2448 x 2048 pixels, in combination with high-resolution display of 3840x2160 pixels. The images acquired with S wide do not need to be up- or downscaled, so they always appear sharp, vivid and realistic on-screen.

The camera detects and captures the light reflected from the white ring light source. The end result is an image with high color fidelity and saturation, as well as real pixel-to-pixel color information.

# 1.2 Software introduction

**SensoSCAN** software has two different user interface modes: Inspection & Acquisition and Configuration & Calibration.

## Inspection & Acquisition

On start-up, the software shows the Inspection & Acquisition mode. This mode is used to:

- place the sample in the right position and focus on it
- select the measurement parameters in preparation for a measurement

Depending on the options installed for your particular system, this mode can also be used to control the system's motorized stages (see Position & Motor control).

Measured data is sent to the software application selected in Analysis. By default, measurements are sent to **SensoVIEW**. Refer to its user manual to learn about all its features. The manual is available in **SensoVIEW**'s software help menu as a pdf.

## Configuration & Calibration

This mode can be accessed by clicking Configuration / Calibration in the menu or clicking on the Calibration icon in the Quick Bar:

**NOTE** Configuration & Calibration is only visible/accessible to Administrators of the system.

Configuration & Calibration is used to:

- select software options and hardware components
- calibrate the system

Configuration & Calibration procedures are carried out using a White balance card and a S wide calibration specimen as a sample. Both are provided with the system.

## Using the interface

It is important to fully familiarize yourself with the interface, the controls and the functionality of the software. Understanding of the technology used in the system and the features available in the **SensoSCAN** software, as well as experience in measurement of comparable materials/ structures, are absolutely essential for obtaining accurate and meaningful 3D topography measurements.

To help the user become familiar with the system:

- Inspection & Acquisition mode is briefly summarized to provide an overview of the interface.
- Extensive details are provided for Sample Inspection and Acquisition Settings.

- Configuration & Calibration routines are described – only for system Administrators.
- An Errors & Diagnostics guide is also provided.
- Finally, details of System Preferences and all other globally relevant topics can be found in the Appendix.

If additional help is needed to use the system, contact Service & Support.

# 1.3 Service & Support

## Contact

If you have any problems with the system you can contact your local Service & Support center (usually your local Distributor). You are welcome to do this even if the warranty on your system has expired.

The contact details for Sensofar headquarters in Spain are shown below:

Sensofar-Tech, S.L.
Parc Audiovisual Catalunya
Ctra. BV1274, KM 1
08225 Terrassa, Spain

Tel.: +34 937 001 492
Fax: +34 937 860 116

support@sensofar.com
www.sensofar.com

Sensofar and all recognized Distributors can supply all system components and spare parts and carry out any necessary calibrations and repairs.

## Updates & Upgrades

Software updates (defect fixing in current version) are available for free.

When a new software version is made available that adds features and/or is compatible with new components, customers with previous versions might be able to upgrade depending upon their system configuration. New software versions might require installing new components at additional costs. For more information, please contact your local Distributor.

**NOTE** The license serial number is required to update/upgrade a system.

## Locating your Serial Number

To locate your Serial Number (SN) open the **SensoSCAN** software. Click on Menu > *Help* > *About*… The *About* panel will open and your SN and version will be shown.

It is also visible on a label located at the top of the sensor head, next to the power button.

# 1.4 Important safety information

This section provides important information about safety procedures, routine maintenance, and general considerations for using your S wide.

For your safety and that of your equipment, follow these rules for handling and cleaning your system. Keep these instructions handy for reference by you and others.

**WARNING**

**Failure to follow these safety instructions could result in fire, electric shock or other injury or damage.**

**WARNING**

**The computer is the main controller of the system. It has already been optimized for performance, thus external software and/or other drivers must not be installed in the system. Any modification to the main controller will automatically void the manufacturer's warranty.**

**NOTE** Incorrect storage or use of the system will also void the manufacturer's warranty.

## System updates

We have set a custom configuration regarding the Windows update procedure. These settings must not be altered in order to ensure the correct performance of the system.

Our custom configuration prevents the drivers updates. The automatic reboot of the computer that often follows an update has also been disabled.

## Start up

The following power-up procedure must be followed before the start of every **S wide** session.

**NOTE** Ensure that all the cables are connected correctly before proceeding.

1. Press the power button on the main controller (PC). Wait until Windows shows the login window and log in.
2. Wait until all Windows services have been loaded. Connect the power supply.
3. Connect the sensor head by pushing the power button located on the top.
4. Wait approximately 10 s and start up the software.
5. Double click on the **SensoSCAN** software icon.

**NOTE** SensoSCAN must have administrator rights on Windows

6. When **SensoSCAN** has started, the login window prompts the user to enter a username and a password. To log in with the default administrator user enter the username **Administrator** and the password **adm1234**. For more information on user rights, see System Preferences / Users.

## Power specifications

- AC line input
- Voltage range: 100-240 V alternating current (AC)
- Frequency: 50–60 Hz single phase
- Max power: 400 W
- Fuse rating and model: 5 x 20mm, 10A (ceramic HRC type, IEC 127)

**WARNING**

**A protective earth (PE) connection with the mains is always required.**

To completely disconnect the power from your S wide follow these steps:

1. Disconnect the sensor head by pushing the button located on the top.
2. Disconnect the power supply, either by pressing the appropriate button or by unplugging the power cord.
3. Disconnect the main controller and the monitor.

Make sure that at least one end of the device's power cords is within easy reach so that you can unplug the computer or display if necessary.

**WARNING**

**The equipment cannot be installed in a position that can hinder the disconnection.**

Use a $CO_2$ fire extinguisher in case of fire.

**WARNING**

**There are fans and a heat sink on the sensor head to avoid overheating and burning. In case of fire, do not block the air access and heat flow.**

## Do not carry out repairs yourself

Do not attempt to open your system. If your system needs a service, contact the local distributor or support service.

If you open your equipment or install other items, you risk damaging it. Such damage is not covered by the limited warranty on your S wide.

## Important handling information

### Operating environment

- Temperature: 10 °C to 35 °C
- Relative humidity: 5 to 80%
- Altitude: < 2000 m
- Acoustic noise: should not exceed 75 dBC

### Carrying your S wide

Before you lift or re-position your S wide, shut down the system and disconnect all cables.

**WARNING**

**At least two people are required to lift and carry the system.**

## General maintenance

### Clean your system

If you need to clean your system, follow these instructions:

- Turn off your computer and display.
- Clean the system with a soft cloth dampened with water. Do not use detergent.
- The lens should only be cleaned with a blower.

**NOTE** Do not use alcohol, aerosol sprays, solvents or abrasives that might damage the finish on the case.

## Spray use

Optionally, two sprays can be provided with the system to coat highly reflective and transparent surfaces before an acquisition:

- Sublimating scanning spray (blue can). No subsequent cleaning is required because 99.9% of applied coating will disappear from the surface within four hours.
- Permanent scanning spray (white can). This spray leaves a coat on the surface which can be cleaned after the acquisition.

**WARNING**

**When using the sprays do so in a well ventilated room. Maintain the spray at least 20 cm away while using it to avoid accidental inhalation.**

# 1.5 Copyright

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## Regulatory Compliance Information

Sensofar-Tech, S.L. declares that the system is in compliance with the requirements of the Low Voltage directive 2014/35/EU, the EMC directive 2014/30/EU and the RoHS directive 2011/65/EU and carries the CE marking accordingly.

## European Union - Disposal Information

The above symbol means that according to local laws and regulations your product should be disposed of separately from household waste. When this product reaches the end of its life, take it to a collection point designated by the local authorities. Some collection points accept products for free. The separate collection and recycling of your product at the time of disposal will help conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment.

## Registration or update of this manual: November 2020

CHAPTER

# 2

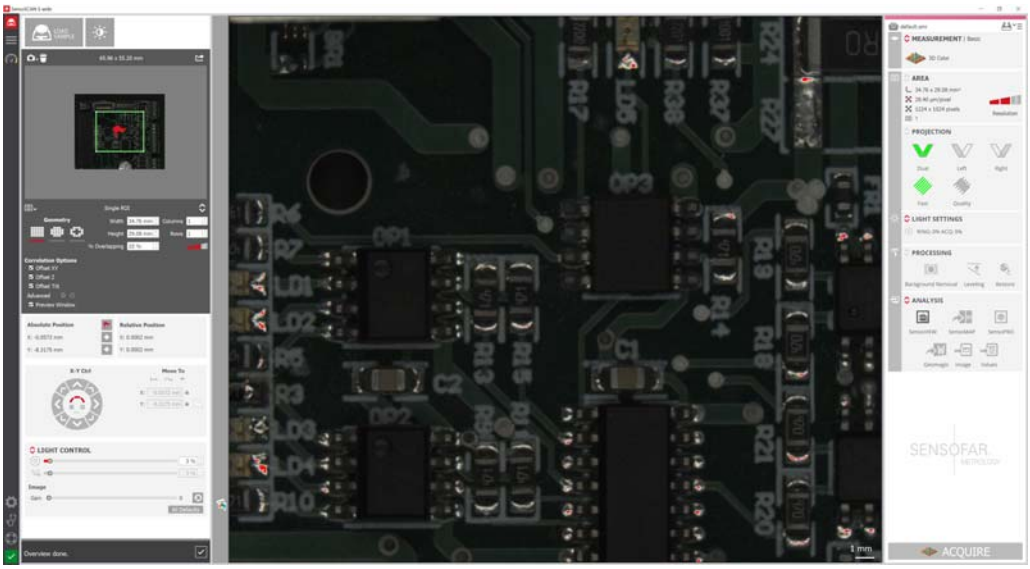
# QUICK START GUIDE

**SensoSCAN** requires a username and a password to log in. See System Preferences / Users to learn how to manage users. To have full access to **SensoSCAN**'s functions, log in with Administrator (password: adm1234).

The user interface has two modes: Inspection & Acquisition and Configuration & Calibration. After the login, the software enters the Inspection & Acquisition mode.

## Inspection & Acquisition

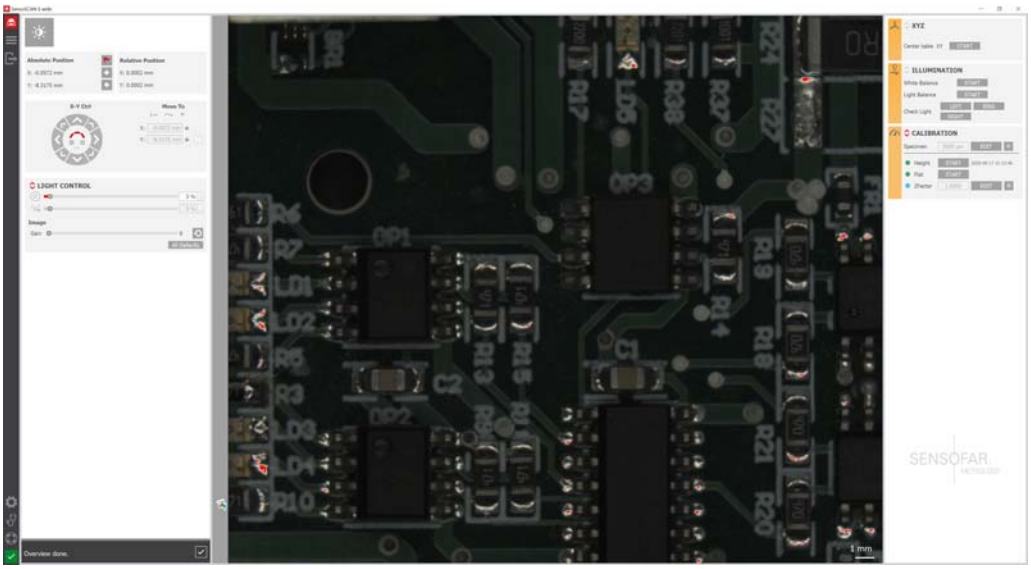
Inspection & Acquisition mode comprises five principal interaction areas: toolbar on the left, settings for Sample Inspection next to the toolbar, the System Status below the Sample Inspection, the Central Viewer area in the center, and Acquisition Settings to the right.



SensoSCAN interface overview when in Inspection & Acquisition mode

## Configuration & Calibration

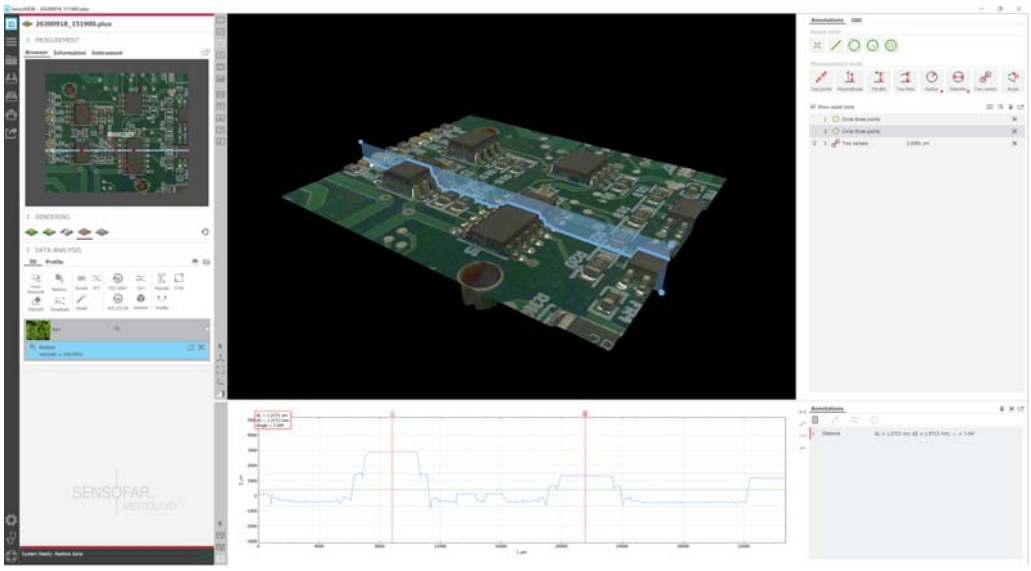
Configuration & Calibration mode comprises the same five principal interaction areas, with a less extended Sample Inspection pane and Configuration & Calibration tools to the right instead of Acquisition Settings.



SensoSCAN interface overview when in Configuration & Calibration mode

## Analysis software

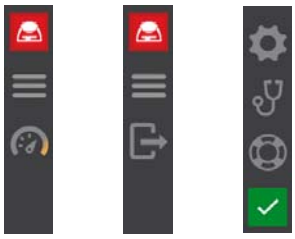
Measurements are displayed and analyzed in **SensoVIEW** or an alternative analysis software. After acquisition, data is transferred to **SensoVIEW** and its screen is automatically shown maximized. At any time you can press F5 or use windows controls to move the focus from **SensoSCAN** to **SensoVIEW** and vice-versa.



SensoVIEW interface overview

# 2.1 Quick Bar

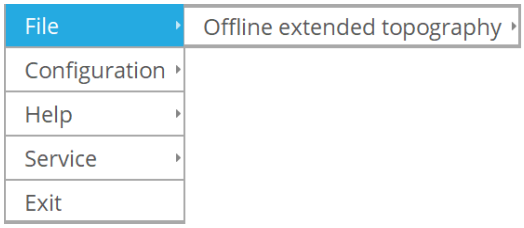
The quick bar contains quick access icons to general software tools. At the top there is the menu and an icon to switch between Inspection & Acquisition and Configuration & Calibration modes. At the bottom there are the System Preferences, Diagnostics, Help and System Status icons.



Quick Bar view in Inspection & Acquisition mode

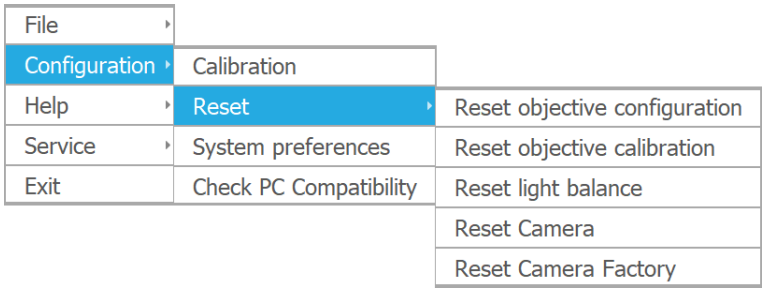
## The Quick Bar icons

This icon opens the menu with File, Configuration, Help, Service and Exit tools. The ones that are used more often have an icon in the toolbar itself.




File menu

Selecting **File / Offline extended topography** provides access to a tool that imports and stitches a collection of individual topographies. For more information see Offline Extended Topography in the Appendix.




Configuration menu

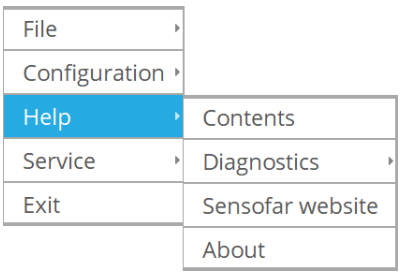
Configuration menu can be used to enter Configuration & Calibration mode, to reset some configurations and calibrations and to enter System Preferences.

The following configurations can be reset:

- ***objective configurations***, including Z Factor
- ***objective calibrations***, including Height and Flat
- ***light balance*** calibration
- ***camera***, shutting it off and on
- ***camera factory***, going back to its factory settings

Resetting any of these configurations – except for light balance – automatically closes the software in order to apply the changes.

**Check PC compatibility** is a routine which validates the PC's characteristics. It runs a test to make sure that the acquisition and processing settings are valid. This test is not necessary for tabletop systems, since it has been designed for sensors. Detailed information about this routine can be found in the Integration Manual.

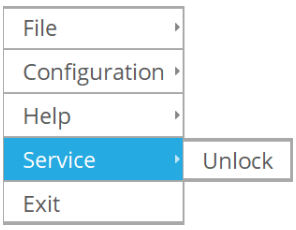



Help menu

**Contents** and **Diagnostics** from the **Help** menu can also be found on the Quick Bar, each represented by its own icon. These options will be explained below.

**Help / Sensofar** website leads opens the **Sensofar Metrology**'s website in the browser.

Selecting **Help / About** opens a system window showing the following information – the software version, the serial number of the system, the company and the user.




Service menu

The **Service** menu is for technical service users and should be unlocked by a qualified user.

**Exit** closes **SensoSCAN**.

This icon switches to Configuration & Calibration mode.

This icon exits Configuration & Calibration mode.

This icon (also **Help / Diagnostics** in the Menu) opens a diagnostics menu that provides access to technical log files. Normally, these log files are not relevant for everyday measurement tasks. This information can, however, be very useful when troubleshooting problems with the system, for example in order to remotely reproduce or understand customer issues. In this case, all or specific log files may be requested by a technician or by Service & Support for diagnostic analysis.

More information regarding diagnostics can be found in the Errors & Diagnostics chapter.

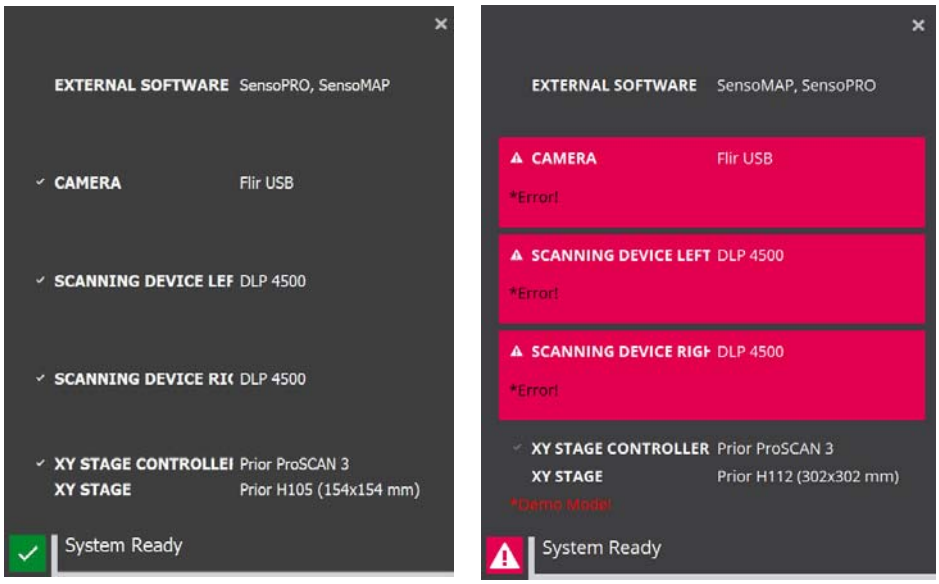
This icon achieves the same as selecting **Help / Contents** from the Menu. Both actions open this system manual.

This icon (also **Configuration / System Preferences**) provides access to System Preferences.

This icon shows the current system status and opens the System Status window.

The symbol shows a large green tick when a device has performed a function and is ready to perform the next function, a red warning icon when a device is not correctly initiated, as well as other symbols (depending on the activity).

Clicking the system status symbol reveals detailed information about the system, the configuration and any errors and warnings:




System status examples: ready (left) and hardware errors (right)

## 2.2 Sample Inspection

In this area on the left of the Inspection & Acquisition interface, the user will find tools for the initial sample inspection. Many of these settings are also carried over to their counterparts in Acquisition Settings, i.e. some are also valid for the acquisition process.

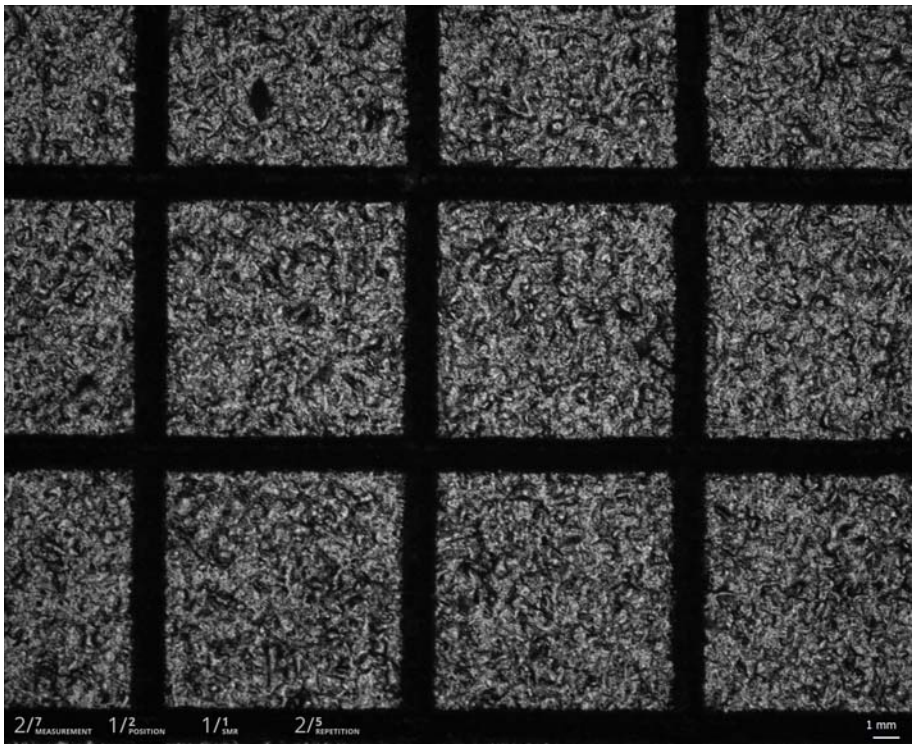
The tools available here include:

- Providing a Sample ID (see Sample Inspection and further details for use in System Preferences / Sample ID)
- Loading a sample (see Load Sample)
- Automatically set the sample illumination (see Autolight)
- Take an inspection viewer image to navigate the sample or define extended measurements layout (see Inspection Viewer)
- Absolute and relative XY movements (see Position & Motor control)
- Manually control the motorized XY stage (see Position & Motor control)
- Manually control the intensity of illumination (see Light Control)


Overview of the settings available for Sample Inspection

## 2.3 Central Viewer

When in Inspection & Acquisition mode, the information about the steps, FOV's (fields of view) & MMR repetition during the scanning is visible over the live image.




Real time information during acquisition in central viewer live image

The bottom right corner of the live image shows a scale value. It can be enabled/disabled in System Preferences / Live Image.

### Live Image

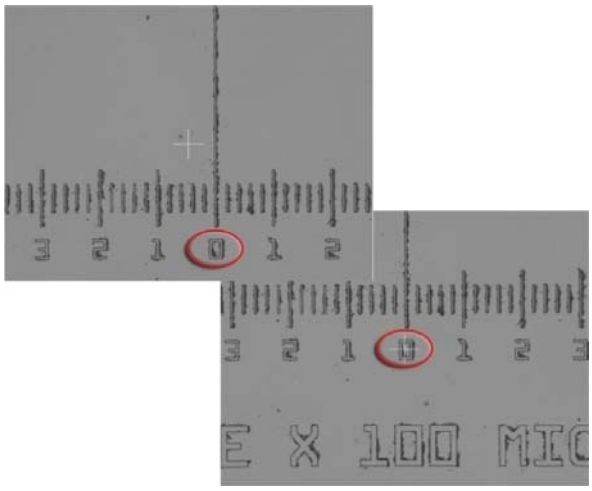
Three live image types are available:

- **Bright Field Color**: shows a color bright field image, visible by being illuminated with the white ring light.
- **Iris**: a tool that helps focus the sample. Each display projects a circular iris using the LED set in System Preferences. By moving Z coarse, the two irises change their position on the Central Viewer. The sample is brought into focus when both irises coincide in the same position and overlap.
- **Slits**: a tool is most useful for irregular samples with a complex surface configuration. It projects slits on the sample using the LED selected in System Preferences, showing jumps in height and any problematic regions of the surface. Those regions where the slits are not shown or are not well-defined could not be measured correctly.

  In addition, this live image mode allows the user to see the light levels that will be used during the acquisition, produced by the projectors. The light intensity may need to be increased to measure the regions that do not show well-defined slits.

## Moving XY with the Central Viewer

Any feature visible in the FOV can be centered in the Central Viewer by placing the mouse cursor on the feature and double clicking with the left button.



Double-click a feature to center it in the Central Viewer

To move any feature to any part of the Central Viewer, use the mouse to click and drag.


Click & Drag a feature to any position within the Central Viewer

## 2.4 System Status

An area below the Sample Inspection area shows information about the procedure that is currently running. It includes a symbol that shows a tick when a process finishes without error as well as other symbols (depending on the activity). It also includes a progress bar:


System process information

# 2.5 Acquisition Settings

## Setting measurement parameters

This area to the right of the Inspection & Acquisition mode lists all settings that must be defined before acquiring a new measurement. Some settings are determined by changes made in Sample Inspection. Others must be defined here in the order provided by the interface, from top to bottom.

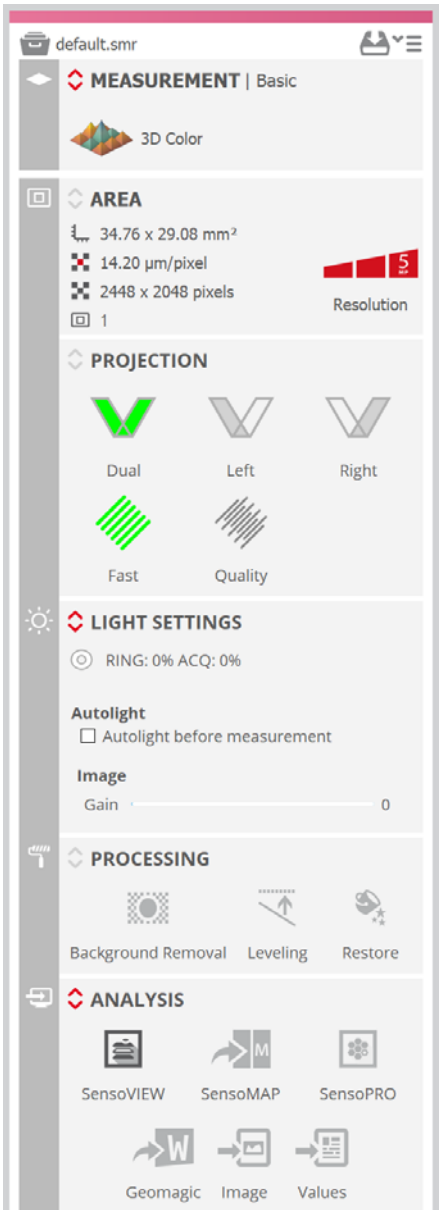
The settings are grouped into these categories:

- The Measurement type (surface, image, expert mode, etc.)
- The measurement Area (determined by the Inspection Viewer) and the resolution options
- Projection settings
- Light Settings
- Processing options
- Analysis options

Basic settings are always visible, but additional advanced settings can be modified by clicking icon to see them.

Once these settings have been configured, clicking Acquire will trigger the measurement process. Upon completion of a successful measurement, the interface will automatically send the results to **SensoVIEW** (if enabled in the Analysis options).

See the detailed description in the Acquisition Settings chapter for a more detailed description of all acquisition settings.




Acquisition settings pane

# 2.6 Acquire a measurement

Understanding of the technology used in the system and the features available in the **SensoSCAN** software, as well as experience in measurement of comparable materials/structures, are essential for obtaining accurate and meaningful measurements. It is strongly recommended that the user fully familiarizes him– or herself with the system before trying to acquire reliable results. Thus, Sample Inspection, Acquisition Settings and **SensoVIEW**'s user manual should all be considered essential reading.

The following outlines the steps needed to take a measurement manually.

## Focusing on the sample

- Set the sample you want to focus on. It is more straightforward to focus on smooth samples, such as the S wide calibration specimen.
- Change the Live Image type to Iris. Two irises will be displayed, one by each projector, using the LED selected in System Preferences. The sample will be in focus when both irises completely overlap on the same position.
- If the two irises are not overlapping completely, the Z coarse position must be changed. In that case, unlock the locking handle rotating it counterclockwise:

- Change the Z coarse position, either lowering it or raising it, until both irises overlap. Lock the locking handle, rotating it clockwise.

**WARNING**

**To achieve the best metrological performance the Z coarse position must be locked.**

When the sample is in focus the light intensity must be adjusted: both the acquisition and the ring light. To adjust the acquisition light set the Live Image to Iris or Slits. When Bright Field Color is set the image is shown using the ring light. If some of the pixels are saturated due to excessive

light intensity, the software shows these regions in red. For flat samples, increase the intensity to just below saturation.

**NOTE** By default saturated pixels are shown in red, this can be disabled in System Preferences / Live Image, so that these pixels are shown as white.

## Acquisition parameters

There are various parameters in Inspection & Acquisition mode that must be selected before a measurement can be made. They include:

- Measurement type (image, 3D, expert mode, etc.)
- Measurement area (including any stitching options, if a XY stage is available)
- Projection
- Light options
- Processing settings
- External Analysis

To inspect a three dimensional structure you can either acquire an Image Capture or measure a 3D Topography. Capturing an image using the Inspection Viewer (overview) can help considerably when inspecting the sample during the measurement preparation, when checking the measurement positions before measurement, and when setting up an automatic procedure.

## Acquisition

When all settings and options have been selected, click Acquire to perform the measurement.

Once the acquisition is complete, the interface will automatically change to **SensoVIEW** (if enabled in Analysis).

## 2.7 Scanning spray (optional)

S wide offers a very straightforward measuring process for most samples. Usually there is no need to adjust any advanced settings, it is enough to focus on the sample, adjust the light settings and click on acquire. Some samples are made of materials that make the acquisition process more difficult, thus extra steps have to be taken in order to measure.

To acquire using the Fringe Projection technique light is first projected onto the surface. It is then reflected by said surface and captured by the camera to construct the final image. Ideally, the reflected light is diffuse, which means that it is scattered in all directions. In this case the light is more likely to reach the camera.

Problems may arise while measuring the following kind of materials:

- Very **reflective materials** scatter the light in only one direction, the reflection is specular. The chances of this main direction being pointed at the camera are slim. In most cases not enough information is collected to reconstruction the surface.
- **Transparent and translucent materials** allow a large percentage of light to be transmitted. In this case the light is not scattered from the surface of the sample, but from some point below the surface, which makes the correct characterization of the surface very difficult. Examples of these materials are optical surfaces, some plastics and ceramics.

The solution to this problem is to coat the surface with scanning spray. These kinds of spray apply a layer to the surface with a high index of scattering, allowing easy surface reconstruction. The optional sprays offered by Sensofar are:

- Sublimating scanning spray (blue can). No subsequent cleaning is required, the 99.9% of applied coating will disappear from the surface within four hours.
- Permanent scanning spray (white can). This spray leaves a coat on the surface which can be cleaned after the acquisition.


Sublimating scanning spray (left) and permanent scanning spray (right)

CHAPTER

# 3

# SAMPLE INSPECTION

Before performing a measurement on a sample, it is necessary to locate the regions of interest on the sample. This is achieved using lighting and positional controls in order to obtain the best initial sample view.

To capture an overview of the sample, one must first understand the function of these tools.

The function and purpose of the tools available in the Sample Inspection pane are detailed in the following sections.


The Sample Inspection pane

## Sample ID

An important aspect for traceability for many applications is the ability to give samples a specific Sample ID. This is possible in **SensoSCAN** by activating the option in System Preferences.


Sample ID label at Sample Inspection top area

Details on how to configure and use this tool are given in Sample ID section in the Appendix. Discussion of how to handle naming strategies, either for individual samples or for multiple acquisitions/samples via an MMR, is discussed there also.

## Load Sample

The *Load Sample* button performs a predefined XY movement to help the user load and unload the sample. The settings for this function can be configured in System Preferences, all are explained in the Positions section in the Appendix.


Load Sample icon at Sample Inspection top area

When the user clicks on *Load Sample*, the software displays the *Load sample position* window. Click on the Accept button to start loading a new sample.


Load sample position window

The system then moves the XY stage to position 1, defined in System Preferences / Positions. The default values are X center (0 mm) and Y range/2 (forward) to unload and load the sample easily.

Once at position 1, the system displays the *Measurement position* window. At this point it is possible to unload the current sample and load the next one. Then, the user must click Accept. The system moves XY to position 2, the default values are X center and Y center.


Measurement position window

- Define Reference with  before starting to *Load Sample* and use *Go to Reference* once the process has finished in order to set the system at the desired XY position. See Position & Motor control for more information.
- If the Sample ID function is enabled, the user will be able to identify the sample during the load process. If this function is disabled click on the *Sample ID* icon  to open the Sample ID window where the sample can be identified.

# 3.1 Autolight

The Autolight command is an automated routine available in Sample Inspection:

The Autolight command in Sample Inspection

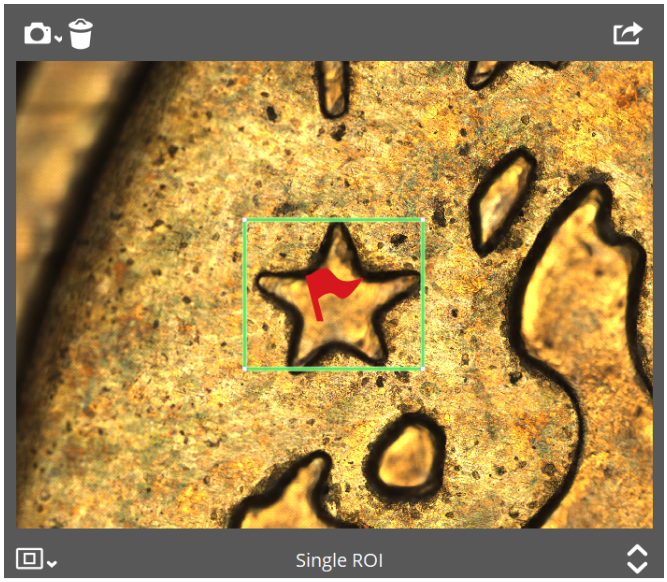
The Autolight command optimizes the light intensity for the surface in focus. The light intensity illuminating the surface is automatically set so that no more than 5% of the camera pixels are saturated. By default saturated pixels are shown in red, this can be disabled in System Preferences / Live Image, so that these pixels are shown as white.

While the Autolight function may be adequate for most surfaces, some samples may need to have the light manually adjusted.

**NOTE** Autolight only adjusts the ring light intensity. The acquisition light levels are affected by the Autolight process only when both light sources are linked. See Light Control for more information.

## 3.2 Inspection Viewer

The Inspection Viewer is used to acquire an image of the surface, for inspection and region-of-interest location purposes. The (extended) Inspection Viewer pane is also used to define acquisition layout when it is necessary to acquire measurements over regions of the sample that go beyond a single FOV (Extended Measurement).




The Inspection Viewer panel

The dimensions at the bottom of the pane show the dimensions for the current view on the sample. By placing the cursor over the viewer pane, the image can be panned by grabbing with the mouse or trackpad, and zoomed directly at the cursor location by scrolling (particularly useful with large extended measurements).

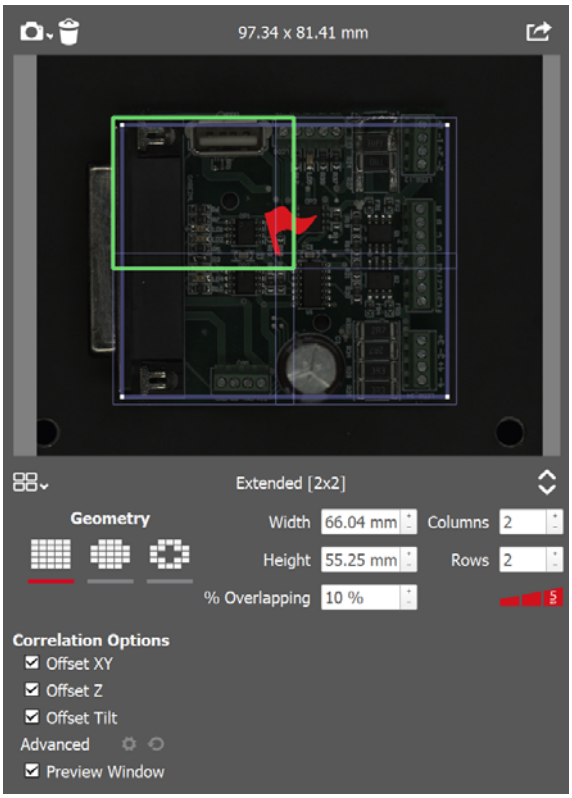
The following options are available within the standard viewer pane:

- : Set the area and do a new capture. The sample is automatically scanned under the objective, capturing 2x2, 3x3, 4x5, 5x6, 6x7 or 7x8 FOVs (standard options), or up to 10 x 12 FOVs (i.e. custom, depending on the options selected in the drop-down menu). The individual FOV images are stitched together to form an extended sample view (scene). Note that the F10 shortcut repeats the last capture.
- : Delete the current view.
- : Export the current image or scene as an image using the format specified in System Preferences / General.
- / : Select single Area (1 FOV measurement) or Stitching Area (Extended measurement). When Stitching Area is selected the pane extends to reveal more options (see the next section).

### 3.2.1 Extended Measurement

When the system is equipped with a motorized XY stage, it is capable of acquiring Extended Measurements. It does this by acquiring individual – but partly overlapping – FOVs, scanning the sample accordingly, and stitching the individual measurements together as a patchwork when acquisition is complete. The shape and extent of the surface area for these Extended Measurements, as well as how adjacent FOVs should be acquired and positioned (i.e. stitching algorithm) can be configured within **SensoSCAN** using the extended Inspection Viewer pane.

Choosing Stitching Area in the Inspection Viewer panel extends it to reveal more options (see image below, or alternatively, simply click the drop-down icon ):




Stitching Area options in the Inspection Viewer pane

The settings made here in the extended pane determine the area, geometry and correlation options for any subsequent acquisition.

#### Geometry settings

Three basic geometries are available: rectangular, circular and annular. Various dimension parameters pertaining to the different geometries can be set manually:

- *Rectangular*: the number of rows and columns, the degree of overlap between FOVs, and dimensions in mm for each FOV
- *Circular*: the number of columns, the degree of overlap between FOVs, and dimensions in mm for the circular ring (outer diameter only)
- *Annular*: the number of columns, the degree of overlap between FOVs, and dimensions in mm for the annular ring (inner & outer diameter)

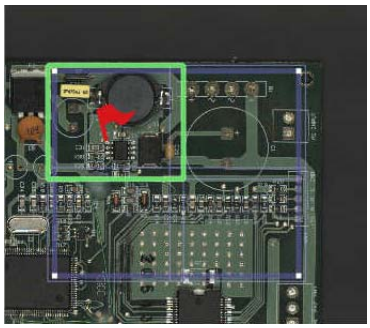
Note that by changing columns, rows or scene size for any one of these geometries, all other dimension parameters are automatically re-calculated to match (i.e. to optimize the measurement). The maximum number of columns and rows in each case is 10 x 12.

**WARNING**

**If the number of rows or columns is set so that an Extended Measurement would move the XY stage beyond its travel range, an attempted acquisition will fail with an error message.**

## Interactive overlay

The area layout is displayed as an interactive overlay on the current scene. The overlay shows the current FOV (outlined in green), the selected measurement area (blue, bold), and how the various FOVs will overlap (blue, light). By grabbing the anchor points in the overlay and dragging to move, expand or contract the total measurement area, the dimension parameters for any chosen geometry can be visually adjusted as necessary.



Area layout

Just as for manual changes to the selected measurement area, the parameters in the extended viewer pane are modified and optimized automatically to mirror any changes made in the overlay.

**NOTE** For annular and circular geometries, regions of FOVs that lie outside the measurement area are automatically deactivated (i.e. shown darkened on the overlay) and are not measured.

Once the geometry settings have been selected, the overlay displays an optimized mesh of single FOVs as defined by the chosen number of columns and rows. By moving the mouse over the overlay, the individual FOVs are highlighted. The user can interact with this mesh by selecting individual FOVs, or by clicking and dragging to select many FOVs at the same time. The following options can be set by right-clicking the selection:

- *Set start*: sets the selected FOV in the grid to be the region of measurement that is in focus when ACQUIRE is pressed.
- *Enable/Disable*: FOVs can be enabled or disabled as necessary. Disabled FOVs are shown darkened on the overlay and are not measured.
- *Invert all*: disables all enabled FOVs and vice-versa.

## Overlap

This is the amount of overlapping area between contiguous FOVs. The default overlap is 10%, but it can also be set up to 25%. The greater the overlap, the more single measurements are needed to cover the desired area.

## Correlation options

There are three options to choose from:

- **XY** – FOVs are stitched using the best fit in the XY plane, as if seen from above, without considering the changes in Z (height).
- **Z** – stitching done by considering the height differences between two consecutive FOVs.
- **Tilt** – works best for large area acquisitions (high number of measured FOVs or low magnification objectives). It corrects the tilt that may appear on the FOVs near the edges of the acquisitions as a result of the XY table movement.

**WARNING**

**Tilt is not enabled by default because it can have negative effects on the stitching of smaller areas, as it can remove a tilt that does not exist.**

Multiple correlations can be selected at the same time by checking the corresponding checkbox. By not checking any boxes the result is shown without any adjustment. Additional options are available by clicking the  icon.

**NOTE** The default settings work on most cases and usually there is no need to alter the additional options. These options are complex and should only be altered by very experienced users who know what to expect when applying each setting.

Activating the Preview checkbox at the bottom of the correlation options provides a preview of the stitched result in the stitching preview window after Acquisition has successfully completed. There the user can switch between the different correlation options and adjust any necessary settings to achieve the best result before it is shown in SensoVIEW.

For more information about the available settings and the stitching preview window go to Offline Extended Topography in the Appendix.

## Pause/Stop the acquisition process

The acquisition process can be interrupted by pressing Pause on the keyboard. The following options are then available to the user on a Lost Topography dialog:

- *Retry FOV*: A further dialog window appears that provides basic means to (i). check the current position, and (ii) adjust the light intensity. Note that these changes are applied only to the current (failed) FOV – if they should be applied to all remaining FOVs, select the option *Apply to following FOVs*. By clicking

Accept, the acquisition continues as originally planned, first repeating the acquisition of the current (failed) FOV.

- *Skip FOV*: Do not retry current FOV (keep current measurement) and move on to the next FOV.
- *Finish*: Stop the acquisition and display the FOVs already measured.
- *Cancel*: Cancel the entire acquisition.

## Large area measurements

The reason for this hardware/software option is to enable the acquisition and analysis of very large areas, i.e. up to the maximum range of the XY stage (150 mm x 100 mm for manual or 302 mm x 302 mm for motorized). An acquisition of this type thus involves many FOVs.

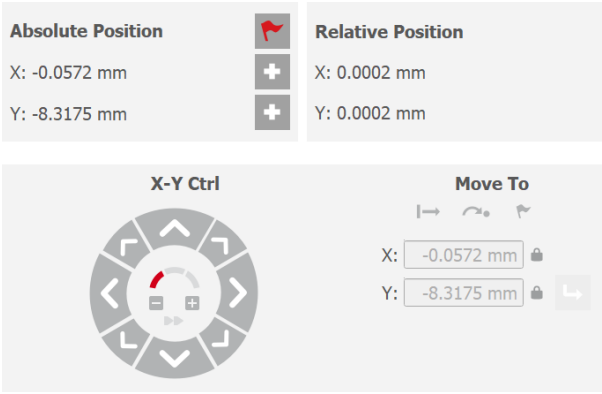
When attempting an acquisition over a large area, it is important to be aware of the following points:

- A large number of FOVs requires longer acquisition times, during which the system must remain stable and free of disturbances.
- This type of acquisition requires large amounts of installed RAM. If necessary, **SensoSCAN** will automatically **reduce the resolution** to make sure that the desired number of FOVs can be successfully acquired. For largest area measurements resolution is reduced to minimum value (all elements in resolution icon are in gray color) which is not available for user selection in the Acquisition settings.

  A system-forced change in resolution is indicated in the pane with a small warning triangle –  – clicking the triangle to dismiss it indicates to the system that the user has acknowledged the change. The resolution indicated here matches that shown/selected in the Area pane.
- Stitching of adjacent FOVs must be performed over many FOVs.

Just as for any other acquisition, large area measurements can be saved as a Recipe (see Recipes) and reused later, or on other systems.

# 3.3 Position & Motor control




Position & Motor Control panes in Inspection Settings

## Position

The absolute and relative coordinates are displayed on the panes Absolute Position and Relative Position, respectively:

- *Absolute Position* is relative to the zero (center) position of each motorized axis.
- *Relative Position* is relative to a user-defined reference point that can be set (and repeatedly reset) by clicking the Define Reference icon for any available locations. Up to three references can be set. It is possible to choose between them by right clicking on the mouse. Left clicking on the mouse calls up a dialog with three possible options – Overwrite reference with current position, Delete reference, and Cancel.

**NOTE** Only one reference can be active at a time, in order to show the relative distance or to apply a movement.

## Motor control

Movement and positioning of the stages can be controlled via **SensoSCAN** using the software motor control pane. A little time spent playing with the "X-Y Ctrl" controls with a sample visible in the viewer pane will quickly provide adequate explanation of their function.

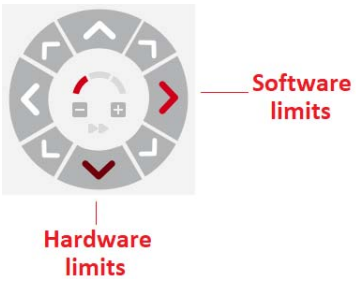
Relative movement from the current position, movement to an absolute position, or relocation to the reference point can be readily achieved by choosing the appropriate icon , respectively. Enter the desired X and Y movement or absolute coordinates as needed, and then confirming the command by clicking . These options are available in the "Move to" section of the Position & Motor control pane.

## Movement range XY

The XY movement is ultimately limited by the travel limits of the stage, but there are additional software and hardware limit controllers. To acquire data, or to be able to move along the XY axes, the system has to be within the XY software limits as defined in the Configuration Files StageX.xml and StageY.xml.

## Movement beyond software/hardware limits

When the X and/or Y position is beyond hardware or software limits, this status is indicated interactively in the software motor control graphic:




Position & Motor Control limits warning colors

In this situation, the user cannot acquire data and no movement is allowed except when using the motor control pane to return within the limits.

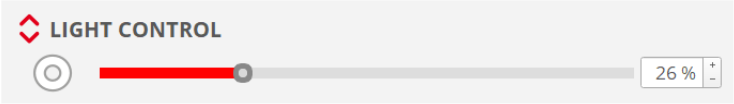
## XY stage speed

The speed of the motorized XY stage is represented by three arc sectors in the center of the Position & Motor control pane:


It can be adjusted by clicking the corresponding sector or by clicking on the +/- icons. By default the slowest speed is set. Clicking on the ▸▸ icon enables the fastest speed.

# 3.4 Light Control

The Light Control pane is used to adjust the light on the sample.




Light Control in Inspection Settings

S wide has two available light sources: a ring light and two projectors. The source used to inspect the sample is the ring light, while the projectors generate the light used during most acquisitions. In the Light Control pane the user can adjust the settings for both light sources.

The first icon in the Light Control pane corresponds to the ring light. Its intensity can be changed using the slider control, and/or the input field to the right. The same can be done for the projectors, represented by the second icon.

**NOTE** To access the acquisition light settings click on the drop-down arrows, which will extend the Light Control pane to reveal advanced settings.

Note that too much ring light incident on the digital camera is indicated by red pixels in both the Inspection Viewer and the Central Viewer. Nominally, a level of 5% over-saturated pixels is tolerated by the system, and this is the level targeted by the Autolight function.

## Ring light

The ring light is the light source used to inspect a sample in the Central Viewer. Whenever the live image is set to Bright Field Color the sample is illuminated with the ring light.

Its other use is to acquire in color both images and 3D surfaces. When an acquisition procedure is started, the current sample is illuminated with the light produced by the ring light. This allows the color camera to register the necessary color information in order to construct the final surface composition. The ring light does not take part during other steps of the acquisition.

The ideal light intensity for the ring light can be set automatically by choosing Autolight. Alternatively, the light intensity can be changed manually by moving the slide bar or simply changing the value on the right of the pane. The light intensity is scaled from 0% (lowest intensity) to 100% (highest intensity).

## Acquisition light

The fringe patterns projected by the S wide's two projectors produce the light used during acquisition. The light is monochromatic, and the user can choose between a green LED (530 nm) and a blue LED (460 nm) in the System Preferences.

**WARNING**

**The system LED color is a setting that should not be changed frequently. Changing the LED color implies recalibrating.**

To change the acquisition light intensity click on the drop-down arrows . Then, move the slide bar or simply change the value on the right of the pane. The light intensity is scaled from 0% (lowest intensity) to 100% (highest intensity).

Changing the Live Image to Iris or Slits changes the light source to the one produced by the projectors. This is the light used during the majority of the acquisition process. Use the Slits Live Image to fine-tune the light intensity before starting an acquisition.

## Manual / Automatic

The two light sources are linked by default; changing the intensity of one changes the intensity of the other. To unlink the light sources click on the acquisition light icon .

When the sources are linked, the icon representing the acquisition light shows a magnet and the slider is gray, when they are unlinked no magnet is shown and the slider is red:


Automatic mode (linked, left) and manual mode (unlinked, right)

**WARNING**

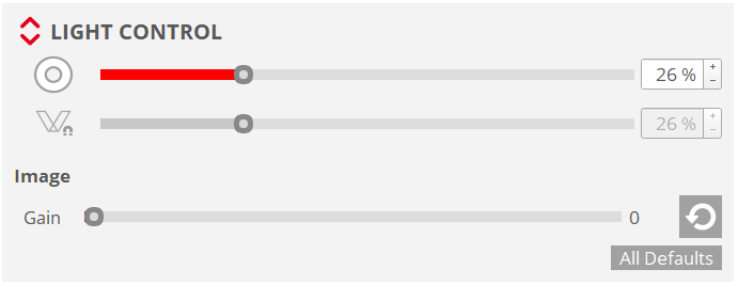
**Only when the light sources are linked does the Autolight procedure affect the acquisition light. If you unlink them and set an "Autolight before measurement" it may not have the desired effect.**

## Linking to Acquisition Settings

Illumination settings chosen in Light Control are forced (or mirrored) over to Light Settings in Acquisition Settings. There is no provision for changing the illumination in the Light Settings pane, thus the illumination options made in Light Control are valid throughout the system.

## Advanced settings

By clicking the drop-down arrows , the Light Control pane extends to reveal advanced options:




Advanced Light Control settings

The advanced settings are:

- **Acquisition light**. Here you set the light intensity used during the acquisition.
- **Image Gain**. This setting is applied to the camera.
  - Decreasing the gain reduces the contrast in the image.
  - Increasing the gain gives the image greater intensity. This can be useful for areas of the sample in which the reflectivity is low (due to the material properties, surface structure, high slope, etc.). However, image noise is also increased, and some noisy peaks may appear in the measurement. One way to remove the spikes is applying the operator Smart > Despiking in **SensoVIEW**. See the settings in 3D Expert Mode for more options to remove noise.

  Like other light options, the image gain is saved in the SMR. Conversely, loading an SMR can result in a change in the image gain.

**WARNING**

**Changing camera image gain globally affects ALL measurements. The only exception to this is the Configuration & Calibration mode, where the CCD camera always works with the default gain value.**

**NOTE** Clicking the reset icon for the gain slider returns the value to the default. Clicking "All Defaults" not only resets the image gain, it also links the two light sources, if those were unlinked.

Some samples require an adjustment in advanced light options, so the window remains open unless the drop-down arrows are toggled. While the window is open, the user can change the settings and the result is shown on the live image.

# 3.5 Keyboard Shortcuts

## Save time with Keyboard Shortcuts

A number of keyboard shortcuts are available in the various different modes. Keyboard shortcuts are keys or key combinations that invoke a specific software task.

| Keyboard shortcut | Task | Inspection & Acquisition | Configuration & Calibration |
|---|---|---|---|
| **F1** | Help | X | X |
| **F3** | Autolight | X | X |
| **F4** | Acquire (new measurement) | X | |
| **F5** | Switch to SensoVIEW | X | X |
| **F9** | Acquisition: switches between the small cross-hair (or nothing – see System Preferences) and a large cross-hair Configuration & Calibration: switches between nothing and a large cross-hair | X | X |
| **F10** | Repeat previous Inspection Viewer capture (stitched images) | X | |
| **Esc / Spacebar** | The single or extended measurement is canceled and the data is lost. | X | |
| **Pause** | Pauses a Stitching Area measurement at the end of the current FOV acquisition and shows the Lost Topography dialog. | X | |

CHAPTER

# 4

# CONFIGURATION & CALIBRATION

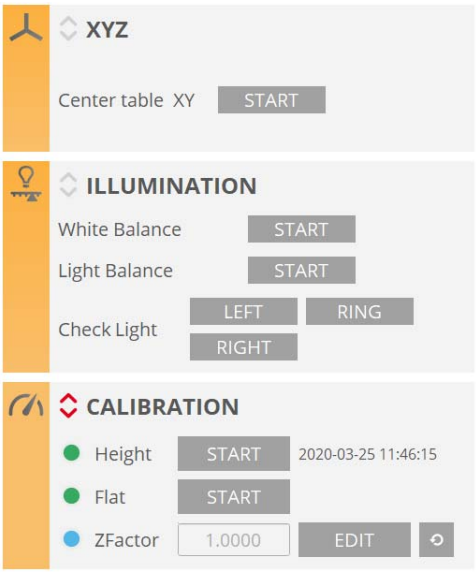
The Configuration & Calibration mode can be accessed by clicking the Calibration icon  or selecting **Configuration / Calibration** from the Menu icon.

The Configuration Menu also provides access to dialogs for globally resetting the following:

- objective configurations, including Z Factor
- objective calibrations, including Height and Flat
- light balance calibration
- camera, shutting it off and on
- camera factory, going back to its factory settings

Resetting any of these configurations – except for light balance – automatically closes the software in order to apply the changes.

To leave the Configuration & Calibration mode, select either Configuration / Exit calibration from the Menu icon, or click the Exit icon  on the left of the Quick Bar.




The calibration tool

Sensofar systems are calibrated during the verification and calibration process at Sensofar, after the manufacturing process and before shipping the system to end users/customers. Different parts of the system are calibrated in a different way and with different frequency over time. This section describes general concepts related to calibrations.

## How often is the system calibrated?

The advantage of Sensofar's systems is our patented technology having no moving parts in the sensor head, there are no maintenance and alignment issues, and the effective lifetime of the sensor head is not limited by mechanical wear and tear.

We recommend repeating the calibration in the following situations:

- The system has been moved
- Some component, such as the XY stage, has been moved
- Ring light or projector lenses have been adjusted
- The sensor head is fixed to the main support structure

### XY Stage

The manufacturing process assures correct position of mechanical limit switches and good performance in terms of accuracy and repeatability. The calibration of XY center is only needed after installing the system the first time, if the system is moved to another place and if XY stage position is manually moved while the system is off.

## What standards are available for calibrating the system?

The S wide system comes with three specially design calibration specimens to assure accurate and reliable measurement data. The materials used to create the specimens are ideal to send the correct amount of light scattering to the camera, and the different step height and shapes have been perfectly measured.

The samples for different calibration procedures are:

- White balance card

  This sample is used for all illumination related calibration as well to achieve a uniform image with the Flat calibration

- 01040512 – S wide calibration specimen:


  Used to calibrate the relation between fringes projected on the surface and the analogue interpretation of the different heights.

- 01040513 – Verification specimen (Sensofar certified):

  This specimen consists of various shapes and step heights, especially constructed to verify the calibration process.

The following sections describe each individual configuration & calibration options.

# 4.1 XY options


XY calibration tools

Center table XY executes a movement in the X and Y direction to search for the middle point of the stage. It then moves to this point and defines XY home in this position.

**WARNING**

**Center table must be executed the first time that the stage is manually moved and/or installed. When the program executes this movement, it is important to ensure that nothing blocks the stage displacement.**

## Editing limits

The travel limits are the limit positions that the software has enabled.

In the **SensoSCAN** folder (C:\ProgramData\Sensofar\SensoSCAN S wide 1.x\Configuration), there are StageX.xml and StageY.xml Configuration Files that can be used to edit travel limits. In all cases, all editable values cannot be higher than the physical limits.

# 4.2 Illumination

The Illumination pane contains settings related to the light levels used for inspection and acquisition processes.


Illumination pane

The sample used to perform this set of calibrations is the white balance card, with the rough side up and in focus.

**NOTE** Change the Live Image to Iris to simplify the focusing process and adjust the light until the image is not saturated. Have in mind that every function – except for the light slider – is disabled when in Iris/Slits mode.

- White Balance (white balance card)

  This calibration defines the shade of white that will be used as reference by the camera. The sample is illuminated with the white ring light, thus showing the whole spectrum. True white is defined using the white balance card as a reference. All other colors are balanced with respect to this white, and the change is applied to all channels.

- Light Balance (white balance card)

  This calibration balances all light sources along the intensity range to find a similar intensity. A correct Light Balance calibration means equal amounts of energy being projected onto the sample by the projectors and the ring light.

**NOTE** If the calibration is not correct it can be reset through the Calibration menu on the Quick Bar.

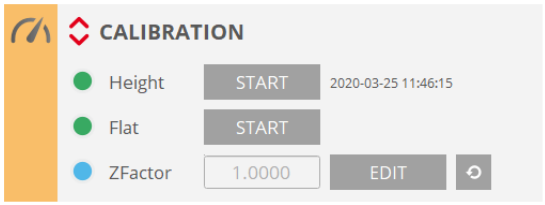
- Check Light

  This tool does not change any configuration settings; its purpose is to provide a way to check all three light sources independently of one another. While any of the light sources is being checked, the other two will be turned off.

  Choose any of the light sources by clicking on the corresponding icon and vary the light intensity to check if the changes are being applied. Click finish before checking another source or before exiting the Calibration screen.

# 4.3 Calibration

This set of calibrations comprise all necessary settings required for correct height interpretation of acquired measurements.




Calibration pane

- **Height (S wide calibration specimen)**

  The Height calibration measures different regions of a sample with known heights, calculating factors which will be applied to all pixels of subsequent measurements.

  To calibrate, place the calibration specimen in the middle of the stage, in such a way that the lowest step is located to the right. Focus on the cross of the middle step, the calibration reference. Toggle a large cross-hair with the F9 keyboard shortcut to use as a guide while centering the reference.


  Make sure that the step is in focus changing the Live Image mode to Iris, otherwise the calibration will fail. Once the sample is focused, change back to Bright Field Color and start the calibration.

**NOTE** If an XY motorized stage is available, this calibration will be performed automatically, and measurements will be taken on all three steps. Otherwise, the user will have to move the specimen manually.

- **Flat (white balance card)**

  Used to correct for non-uniform illumination and color across the Field of View. Multiple images are taken on different points of the sample to average them and achieve a smooth and homogeneous result.

- **Z Factor**

  The Z Factor is used to fine-tune the heights set by the Height calibration. It requires a calibration sample with known height parameters, such as a step height standard, the S wide calibration specimen or the Sensofar certified verification specimen.

Follow these steps to calibrate the Z factor:

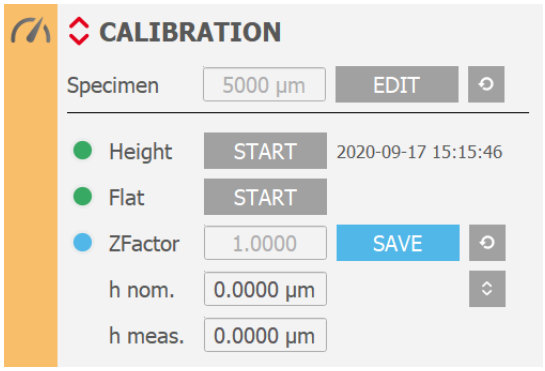
1. Place the sample and acquire with a Z Factor of 1.0000 (default value)
2. Measure the step height value in **SensoVIEW**
3. Go to the calibration screen, click on the icon to expand the Calibration menu and enter the data. The value "h nominal" corresponds to the known value of the step, while "h measured" corresponds to the value measured in **SensoVIEW**
4. Once both values are entered, the factor will change accordingly. The factor is the ratio between the nominal and the measured step height
5. Check the calibration taking another acquisition. The new measured value in **SensoVIEW** should be similar to the nominal value

**WARNING**

**An incorrect value of the Z Factor may result in larger or smaller measured height. If you doubt the accuracy of the value, reset to 1.0000.**

### 4.3.1 Advanced settings

Click on the arrow icon to access the advanced settings:




The dimensions of the calibration specimen can be changed here. The default value is 5000 µm, which corresponds to the s wide calibration specimen.

**WARNING**

**This value affects the calibration results. Do not change it if you are unsure about the specimen's dimensions.**

CHAPTER

# 5

# ACQUISITION SETTINGS


The Acquisition Settings interface

The Acquisition Settings interface is used to set the Measurement type and appropriate parameters for a measurement. The exact configuration depends on the nature of the surface to be measured and the application for which a measurement needs to be made.

To streamline the experience for the user, the Acquisitions settings interface has been designed to appear the same independently of the Measurement type.

Some of the parameters required for a measurement are determined by options set in Sample Inspection (see e.g. linking of Light Control to Light Settings, see also Extended Measurement). Other parameters, as discussed in the following sections, are set in Acquisition Settings.

The Processing pane allows to process the data before it is sent to external software to be analyzed. The available operators are Background Removal, Leveling and Restore.

The Analysis pane is used to direct data acquired with the system to external software (**SensoVIEW**, **SensoMAP**, **SensoPRO** and **Geomagic**) or to Export Image and Export Values.

Recipes (described in next chapter) are an important tool for repetitive data acquisition cycles. Recipes allow the user to save and reload predefined parameter sets that typically apply to a given application (Single Measurement Recipe, SMR) and/or that are used to automate complicated measurement processes involving many separate SMRs (Multiple Measurement Recipe, MMR).

When all settings and options have been selected, click Acquire to perform the measurement – if you have not already done so, you will be asked to provide a Sample ID (if the user enables "Use Sample ID" and "Confirm ID before acquisition" in System Preferences).

When all settings and options have been selected, click Acquire to perform the measurement. Once finished, the result will be sent to **SensoVIEW** (if enabled in Analysis).

# 5.1 Measurement technique

## Fringe Projection

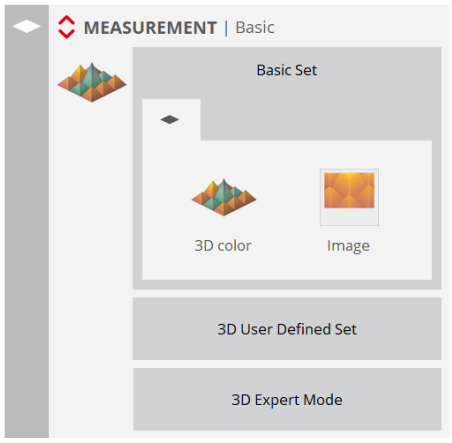
The **S wide** system uses Fringe Projection technology, able to acquire large area measurements in a short amount of time, while maintaining high vertical resolution values.

The vertical resolution of techniques based on depth of focus – such as Ai Focus Variation and Confocal– is affected by the numerical aperture (NA) of the objective used to acquire. To quickly measure large FOVs, low magnification objectives must be used. These objectives have a small NA, which leads to having large vertical resolution values. One of the advantages of using Fringe Projection over other techniques is the ability to acquire large FOVs while maintaining a **vertical resolution of the order of 1 micron**. Similar resolutions could be achieved with interferometric techniques but these techniques can only measure smooth samples, while Fringe Projection is able to evaluate a diverse range of surfaces.

With Fringe Projection it is possible to measure both step height and surface roughness with low uncertainty values, while providing repeatability on the nanometer scale.

## 5.2 Measurement type

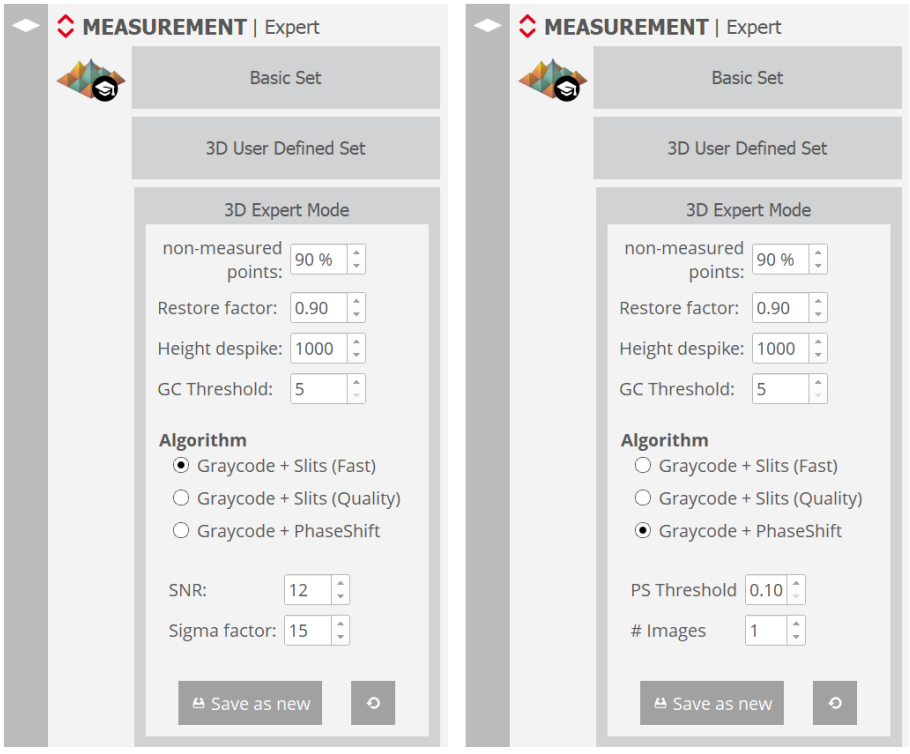
There are two measurement types available: 3D Surface and Image:




Basic Set standard Measurement types

To access the different Measurement types, click the red up/down arrows on the upper left of the Measurement pane. The standard Measurement types are visible in the Basic Set pane (see figure above).

In addition to the basic set of Measurement types, a 3D Expert Mode is available. In this mode, the user has access to individual settings for measurement algorithms as well as other options. By enabling individual selection of these options, the expert user can create new user-defined Measurement types specific to particular applications. When saved, these so-called Applications are listed under 3D User Defined Set.

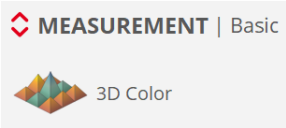



3D Expert Mode

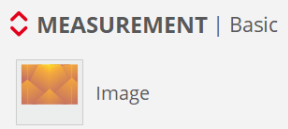
## 5.2.1 Basic Set

The basic suite of Measurement types include:

- 3D surface measurement:



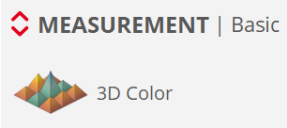

- Image capture:




For both of the basic Measurement types, the optimal system configuration and choice of algorithm is pre-determined.

If more control and flexibility is needed for any application, the user can switch to 3D Expert Mode and configure application-specific Measurement types (so-called Applications).

### 5.2.1.1 3D Topography




A 3D topography measurement acquires the current FOV, while an extended 3D topography measurement covers a greater area by acquiring multiple FOVs. Options for setting the shape of an Extended Measurement, including options for deactivating individual FOVs, can be found in Extended Measurement.

**NOTE** The Extended Measurement option is only available for configurations that include an XY motorized stage and the Extended Measurement Module.

#### Single 3D topography measurement

To measure a single 3D topography measurement, place the sample under the objective and focus. Then set the desired FOV and the correct light level and click on the Acquire button. Once all of the optical information has been acquired, the software calculates the metrological data and switches to **SensoVIEW** to show the result.

There are two keys which prematurely can stop the measurement:

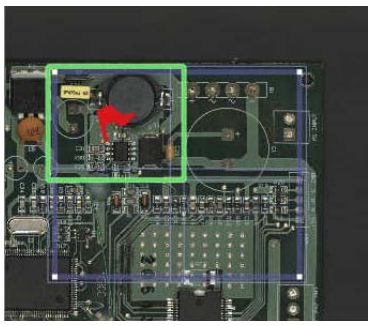
| Option | STOP function |
|---|---|
| **Esc / Space** | Cancel the measurement and lose the data. The software shows an Acquisition Error message. |

## Extended 3D topography measurement

To measure an extended 3D topography measurement, place the sample under the objective and focus. Next, choose the desired settings following these steps:

- set Extended Measurement options
- set Light Settings
- set Projection settings
- set Processing options
- set Analysis options

If an Inspection Viewer image has been captured before defining an extended image, the chosen extended area is shown as an overlay in this image, together with the initial FOV (green rectangle). The Extended Measurement area is displayed as a blue rectangle, over which it shows the overlap of different FOVs, represented as a light blue grid. The user can change the extended area interactively by clicking and dragging on the anchor points on the overlay.



Area layout

**SensoSCAN** automatically calculates how many single measurements (FOVs) are needed to fill the desired area. Once the user has clicked Acquire, the software makes the initial measurement. Subsequent measurements are made in accordance with the Light Settings, taking in the full FOV of the objective minus a user-defined amount of overlapping area.

| Resolution | FOVs (total) | Area (FOVs) |
|---|---|---|
| **5 Mpx** | 120 | 10x12 |
| **HD** | 480 | 20x24 |
| **SD** | 1920 | 32x38 |

Limited to 381 Mpx or 3 GB

When all measurements have been completed, the software calculates the stitching parameters and copies all the data to a final result. Finally, the software switches to the **SensoVIEW**'s screen, where the stitched measurements are treated as a single topography.

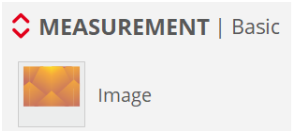
There are two ways to prematurely stop an Extended measurement:

| Option | STOP function |
|---|---|
| **Esc / Spacebar** | Cancel the measurement and lose the data. The software shows an Acquisition Error message. |
| **Pause** | Show the Lost Topography dialog window. |

Each measurement is saved in a temporary folder (the default folder path is C:\TMP\ExtendedMeasurements). This is useful if the software crashes in the middle of the Extended Measurement process, because then it is possible to stitch the individual measurements using the "Offline extended topography" option in the File menu (see Quick Bar).

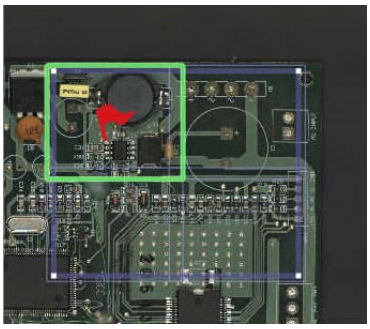
**NOTE** PLUX files corresponding to previous FOVs will be deleted from the folder every time an Extended Measurement process is started.

### 5.2.1.2 Image Capture




An image can be captured directly from the camera. To acquire an image, simply set the area (single or extended) and click on the Acquire button. **SensoSCAN** drives the system appropriately and shows the result in **SensoVIEW**.

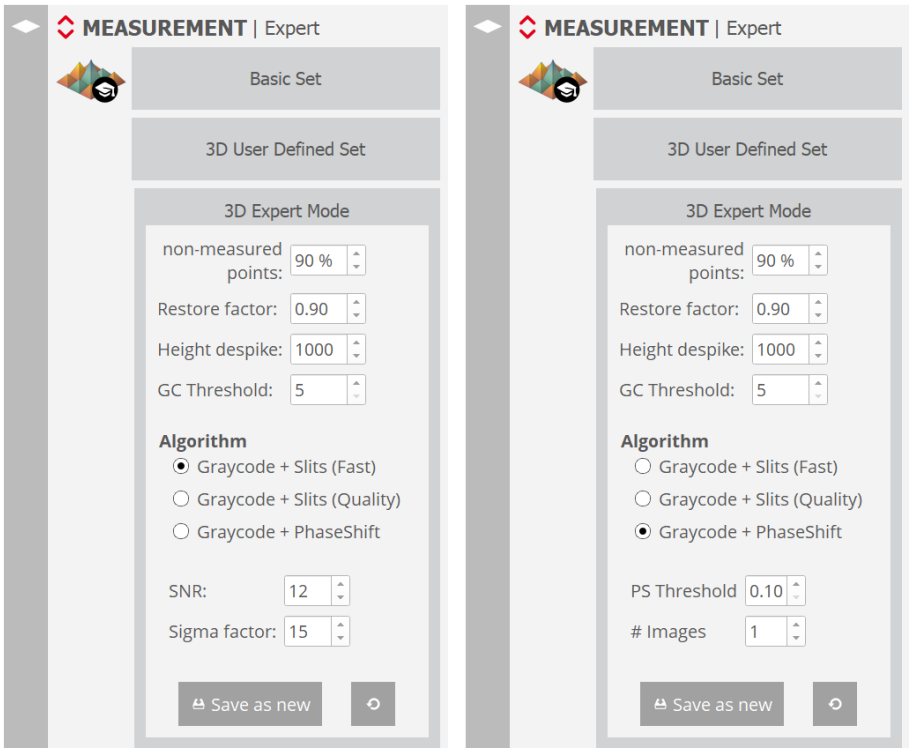
If an Inspection Viewer image has been captured, the extended area selected by the user is shown as an overlay in this image, together with the starting FOV (green rectangle). The Extended Measurement area is displayed as a blue rectangle, over which the overlap of different FOVs is shown, represented as a light blue grid. The user can change the extended area interactively by clicking and dragging on the anchor points on the overly.



Area layout

### 5.2.2 3D Expert Mode

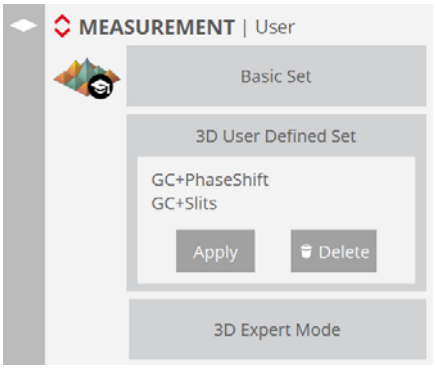
In addition to the standard Measurement types, a 3D Expert Mode is available:




3D Expert Mode

In this mode, experienced users can create new Measurement types specific to particular applications or surface configurations. These are discussed in the following sections.

Once the user has optimized the settings for the particular application, this configuration can be saved as a new Measurement type – these are known as Applications. Applications appear under 3D User Defined Set:




Applications are useful because 3D Expert Mode is not available for use in Recipes. The workaround is thus to create Applications with the required parameter settings and use these in a Recipe instead. A further advantage of this approach is that Applications can be shared with multiple systems.

#### 5.2.2.1 Common pre-processing options

The following options are common to all 3D Expert Mode Algorithms:

- Maximum non-measured points – This value is between 0% and 100%, and refers to the maximum acceptable percentage of points that are not measurable. If the measurement has a percentage of non-measured points exceeding this value, **SensoSCAN** displays a message indicating that there are too many lost pixels and it remains in acquisition mode. No results are shown.
- The Restore factor is a parameter related to the quality in the Gray Code boundaries. The default value is 0.9. Decrease this value if the 3D measurement shows vertical lines composed of non-measured points.
- Height despike – Used to remove unwanted spikes that appear on the surface. It works as a threshold, a value between 100 and 10000 microns is defined, which corresponds to the maximum allowed height difference between a point and its neighbors. The data points that exceed this height difference are removed.
- GC Threshold is related to the quality of the Gray Code signal when the whole FOV has been measured. Low threshold values lead to more measured points but a greater risk of spikes appearing on the surface. The default value is 5, the lowest that can be set.

#### 5.2.2.2 Measurement algorithms

Configuration in 3D Expert Mode provides access to algorithms and options other than those used as default in Basic Mode. The features and function of these algorithms and options are explained below.

##### Gray Code + Slits

An approximate map of the surfaces is generated using an 18-bit Gray Code sequence. This map is further fine-tuned by Slits, filling in the information where Gray Code could not find reliable data. Slits uses 1-bit images, consisting of clearly defined and equally spaced fringes. This pattern covers the surface, tracking the whole region and obtaining the detailed 3D information.

Combining Gray Code and Slits leads to a robust and universal algorithm, allowing for an acquisition on most surfaces while achieving sub-micron resolutions.

There are two different Gray Code + Slits algorithms: Fast and Quality.

- Fast is the default algorithm and it can be used to measure most samples. It is the fastest of the two Gray Code + Slits algorithms.
- Quality algorithm allows to achieve higher resolutions. This option can be used to measure those samples that could not be properly measured with the Fast algorithm.

The available settings are:

- SNR is the signal to noise ratio. The background noise and the signal maximum are evaluated, and for every axial response the point will be dismissed if its SNR is below the indicated value. Increasing this value limits the measured points to

only those with the strongest signal, which results in more non-measured points. When the SNR is decreased more points are shown, leading to more noise.

- The sigma factor is added to the average of the axial response's width for the whole topography. Then, every response's width is compared to this value, filtering any signal that goes above it. More points are measured when this value is increased, but the noise also increases.

## Gray Code + Phase Shift

This algorithm combines Gray Code and Phase Shift, combining their positive aspects into one powerful measurement process.

Phase Shift consists of projecting a set of periodic sinusoidal patterns with different relative phases. We use a 5-step phase shifting sequence, obtaining the wrapped phase distribution. The phase must be unwrapped to obtain the real distribution, acquiring thus the 3D shape.

For samples showing complex regions on their surface the unwrapping may be difficult because the phases of the projected fringes are discontinuous. To achieve a correct unwrapping an 18-bit Gray Code sequence is used. It allows for a correct unwrapping even on problematic regions.

This algorithm provides the option of averaging images, which reduces system noise.

The available settings are:

- PS Threshold is related to quality of the Phase Shift signal – i.e. the contrast of the sinusoid. Low values represent a lower threshold, thus letting more points to be measured but increasing the noise. Raising the threshold leads to less measured points: only those that reach the quality level of the set threshold.
- # Images, used to reduce the noise by increasing the number of images taken at the same point.

# 5.3 Area


The Area pane in Acquisition Settings

**SensoSCAN** automatically calculates the real area seen by the objective and shows the result in the Area pane. This calculation is based on the FOV cropping geometries set and various FOV options selected in Extended Measurement options.

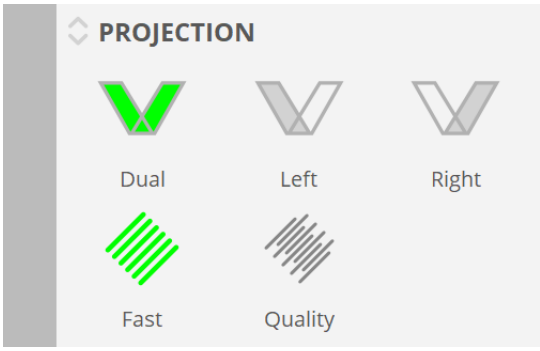
The only selectable option available in this pane relates to the Resolution of the measurement, regardless of single or Extended Measurements. Changes to the resolution are made by clicking the required Resolution segment in the Area pane. The highest resolution corresponds to one measurement point per camera pixel. Lower resolutions are achieved by binning camera pixels - 2x2 or 4x4. The default system resolution is HD.

- 5 Mpx: 2448x2048 pixels (resolution 1)
- HD: 1224x1024 pixels (resolution 2)
- SD: 612x512 pixels (resolution 4)

In Extended Measurements, the Resolution is changed automatically to keep the number of measured points below the maximum that can be acquired, and this depends on the system's available memory. Lower resolution mean fewer measured points, thus the topographic detail in the measurement result is reduced.

The resulting pixel size for the chosen (or calculated) resolution is indicated in the pane, in the Extended Measurements pane, and is also listed in the Measurement information in **SensoVIEW**.

## 5.4 Projection




The Projection pane in Acquisition Settings

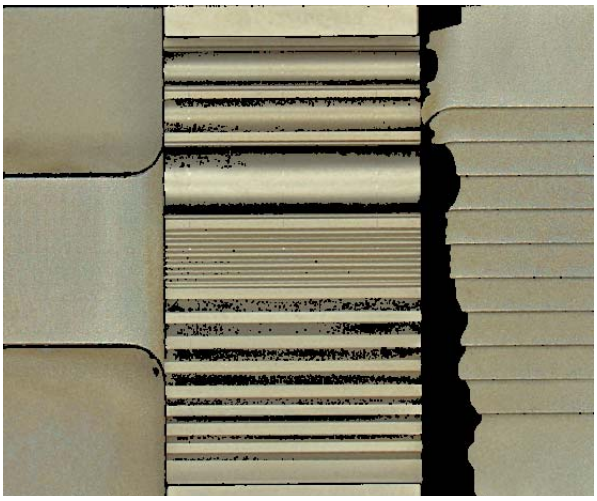
The S wide system has two projectors at a 60º angle from one another; the fringe patterns are projected from two different directions. Having multiple projectors avoids problems such as the appearance of artifacts created by shadows and invalid regions on the surface.

For generally smooth samples without abrupt changes in height, the acquisition can be done using only one projector without reducing the quality of the result, while also increasing considerably the speed.

The projection pane allows the user to choose between using both projectors, using only the left or only the right to acquire samples.

**WARNING**

**Selecting only one projector to acquire samples with large differences in height will result in areas of non-measured points, where the fringe pattern can not reach due to the geometry of the surface.**



Acquisition of a non-smooth surface using only one projector

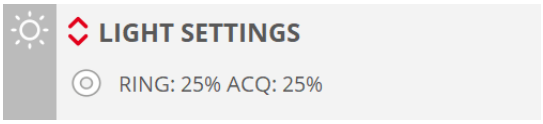
## Algorithms

The projection pane also allows the user to choose between two Gray Code + Slits algorithms: Fast and Quality.

- Fast is the default algorithm and it can be used to measure most samples. It is the fastest of the two Gray Code + Slits algorithms.
- Quality algorithm allows to achieve higher resolutions. This option can be used to measure those samples that could not be properly measured with the Fast algorithm.

Both algorithms can also be configured in 3D Expert Mode, to use them in an Application.

# 5.5 Light Settings

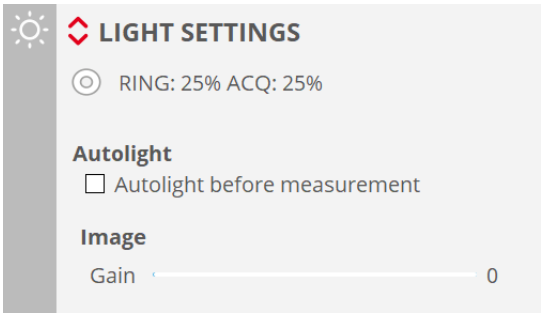



Light Setting pane

By default, the illumination options set in Light Control, or those pre-selected by the system, are forced (mirrored) over to Light Settings. The illumination options made in Light Control are valid throughout the system.

## Advanced options

The Light Settings pane extends to reveal the advanced light settings selected in Light Control – as explained above, the light intensity and the currently active light source(s) are forced to those values shown in Light Control. There is thus no provision for changing the illumination options in the Light Settings pane.




Light Setting pane Advanced options

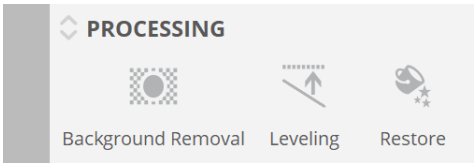
Enabling Autolight before measurement sets the system to perform an Autolight routine before each measurement.

**NOTE** Autolight only adjusts the ring light intensity. The acquisition light levels are affected by the Autolight process only when both light sources are linked. See Light Control for more information.

When the surface is out of focus, Autolight may select a light level that is not suitable for a measurement. Make sure the surface is in focus before enabling Autolight. See Focusing on the sample for more information on how to focus.

When Autolight is enabled, the light level used during acquisition can be fine-tuned with the Autolight factor. If a value smaller than the default 1.00 is introduced the light intensity used during acquisition will be lower than the intensity selected by the Autolight function. On the other hand, if this factor is above 1.00, more light will be used during the acquisition.

## 5.6 Processing



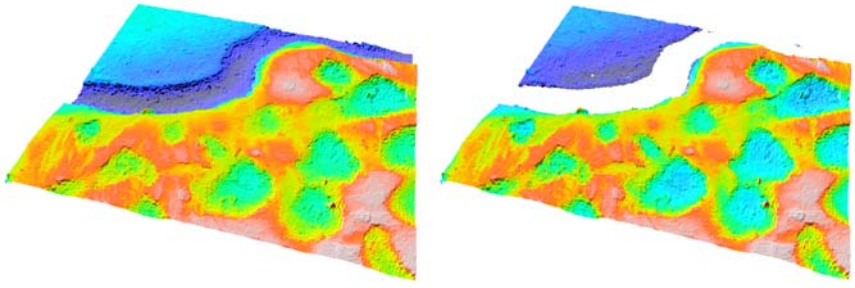

Processing pane

In this pane it is possible to apply processing settings to the data before sending it to External Analysis Software. The available settings are:

- Background removal – Automatically removes the background, leaving only the main feature to be analyzed. This configuration is particularly useful when only one FOV is acquired (Single Acquisition). Usually the measured samples do not fill the whole FOV, and given the large depth of focus the background is visible.

Acquisition without removing the background (left) and with the background removed (right)

The background removal operator is intended to work on samples with a clear distinction between the background and the main feature. It works best when the background is uniform, if there are multiple levels to the background only the lowest level will be removed. This operator analyzes the histogram, finding the first peak and removing it. In a uniform background one clearly defined peak will be removed, while in a complex background there will be multiple peaks and only the first one will be removed.



The background has two layers (blue), only the lowest will be removed

- Leveling – Removes a predominant tilt leaving a leveled sample. It uses an algorithm which removes a plane.
- Restore – Automatically restores any non-measured points.

All of these settings are also available in **SensoVIEW**. The advantage of enabling the operators in Processing is that the operators are applied automatically and consecutively, whereas in **SensoVIEW** the user must apply each operator manually and separately. This is ideal when multiple measurements with similar processing options have to be taken, as the user does not have to apply the same operator to each individual acquisition. If you want more control over the operators, **SensoVIEW** offers advanced settings.

When multiple operators are selected in the processing pane the order by which these operators will be applied is the following:

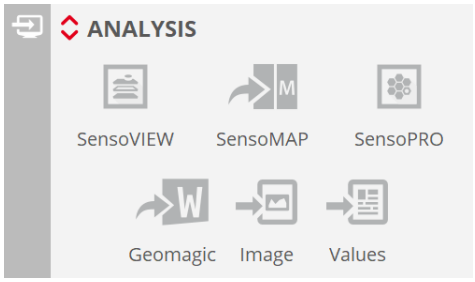
1. The background is removed
2. A leveling is done using only the remaining data points
3. Non-measured points are restored

**NOTE** When both the Background removal and the Restore operators are enabled, only the non-measured points from the foreground object will be restored. The reason for this is to avoid the Restore operator from generating a new background after one has already been removed.

# 5.7 Analysis

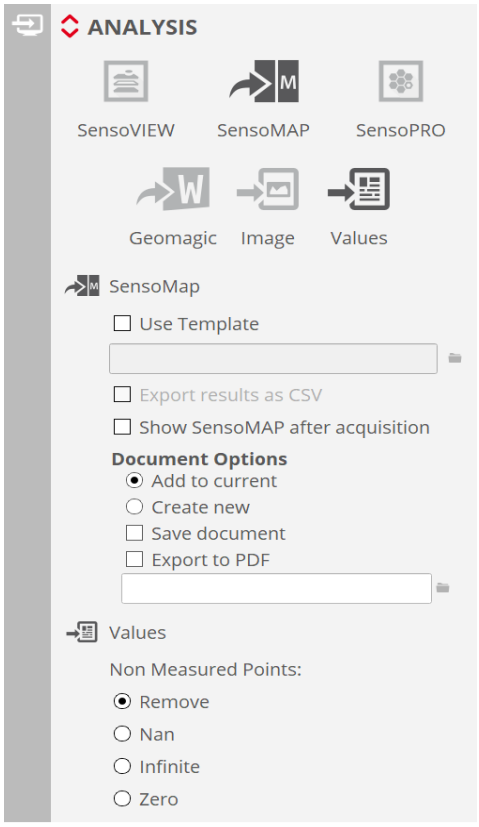
**SensoSCAN** acquires one single measurement if no Recipe (i.e. default.smr) or a Single Measurement Recipe (SMR) is used. Alternatively, **SensoSCAN** can acquire a series of measurements by means of a Multiple Measurement Recipe (MMR). See the Recipes chapter for more details about using recipes.

The Analysis window is used to direct data acquired with the system to **SensoVIEW** software (also **SensoMAP**, **SensoPRO** or **Geomagic**), Export Image or Export Values.




Analysis window

To enable each option, click on the label name(s) – advanced options for each selection can then be accessed by clicking on the red up/down arrows .

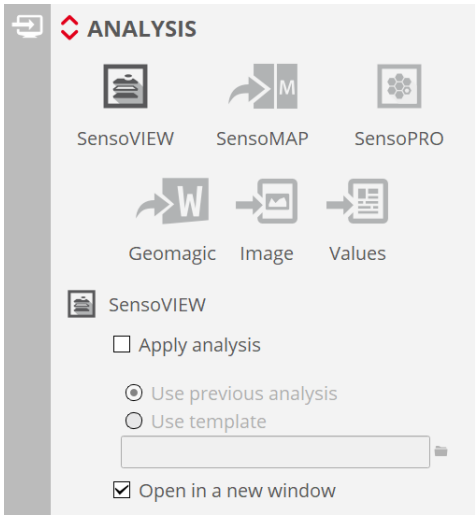



Analysis window with Advanced options displayed

### 5.7.1 SensoVIEW

When sending measurement to **SensoVIEW** there are two options:

- Analyze every measurement manually starting from raw data.
- Enable *Apply analysis* to apply a predefined analysis to the new measurement result. The predefined analysis can be the analysis applied to the last measurement (*Use previous analysis*) or the analysis defined by a template (*Use template*).




Analysis pane selecting SensoVIEW

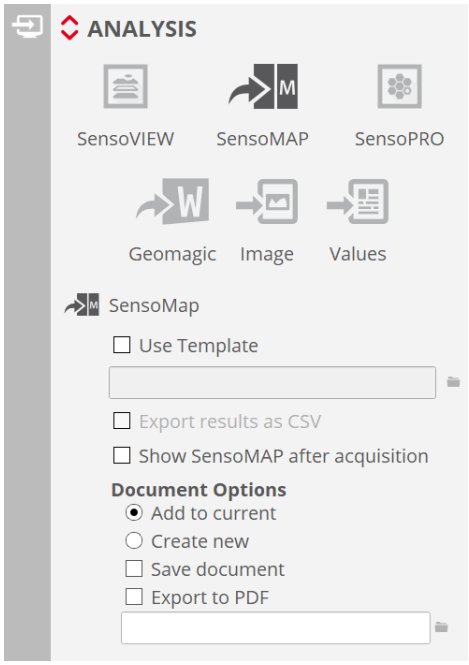
**NOTE** When "Open in a new window" is enabled every acquisition will be sent to a new **SensoVIEW** window. This is useful for comparing multiple measurements.

### 5.7.2 SensoMAP

There are three ways of analyzing system data using **SensoMAP**:

- The first option is to manually load data into **SensoMAP**. The user saves the measured data using **SensoSCAN** menus and manually loads data into **SensoMAP**. **SensoSCAN** saves the data using a proprietary file format (**.plux* files) that **SensoMAP** can load.
- The second option is to automatically load measured data into **SensoMAP** (SMR analysis). The user must enable an automatic connection with **SensoMAP**. When this option is enabled, new data is automatically transferred to **SensoMAP**.
- The third option is to automatically analyze a series of measurements (MMR analysis). The user can either apply a **SensoMAP** template to a directory that contains a series of system files or setup **SensoSCAN** to automatically analyze the results using a Multiple Measurement Recipe (see MMR set-up).

The Analysis options depend on whether acquisition is single or multiple.




Analysis pane selecting SensoMAP

A detailed description of the **SensoMAP** application is found in its own help menu.

## SMR analysis

Options for how the measurement is handled together with **SensoMAP** are accessed by clicking on the red up/down arrows in the Analysis pane.

- *Use Template*: the selected template is used by **SensoMAP** to analyze the measurement. When the user checks this option, the folder button is enabled, allowing the user to select a template.
- *Export results as CSV*: this option can only be used together with a template. Note that there are no analysis results to export *unless* the template obtains exportable values from the data analysis. Results of the analysis performed by **SensoMAP** will be exported into a comma-delimited file. The name of the *.csv file is automatically generated according to document naming rules detailed below.
- *Show SensoMAP after acquisition*: a successful measurement will be automatically displayed in **SensoMAP**.
- *Document Options*: **SensoMAP** documents consist of a set of data, operators, illustrations and parameters, amongst others:
  - Add to current: the measurement is loaded into the current document in **SensoMAP**.

**WARNING**

**If the current document contains more data than is required by a selected template, SensoMAP will discard some data and this may cause misleading results.**

- Create new: the measurement is loaded into a new **SensoMAP** document.

**WARNING**

**If Create new is active, any previous document currently open in SensoMAP will be lost.**

- Save document: the updated or new **SensoMAP** document will be automatically saved. The usual workflow is to enable Save document when the Create new option is enabled, but **not** enable it when Add to current is enabled. The name of the **SensoMAP** document (*.mnt) is automatically generated according to document naming rules detailed below.
- Export to PDF: the analysis is saved as a pdf file. This feature is only available for SensoMAP 7 and onwards.

### Document naming rules

- If Use Template is checked, the name is composed of the template name and a time stamp.
- If Use Template is unchecked, the name depends on the type of measurement. The name is composed of a fixed extension (*.*plux*) and a time stamp.

The file is saved to the current path (measurement folder, i.e. where the last measurement was saved or loaded).

## MMR analysis

After acquiring an MMR, the measured data is saved in files using a predefined folder structure. At the end of the acquisition of all measurements, the measurements that have been selected to be analyzed using **SensoMAP** are sent to **SensoMAP** folder by folder.

**WARNING**

**Configuration of SensoMAP options has to be done in the SMR. That is, an MMR will only send the results obtained using the SMRs that have SensoMAP enabled.**

Options for how the measurement is handled together with **SensoMAP** are accessed by clicking on the red up/down arrows ⇕ in the Analysis pane.

- *Use Template:* templates allow the same analysis to be performed, or the same report to be given on the new data. The usual workflow is to enable this option when a series of measurements needs to be analyzed. When enabled, the

selected template is used by **SensoMAP** to analyze the measurement. When the user checks this option, the folder button is enabled, allowing the user to select a template.

- *Export results as CSV:* this option can only be used together with a template. Note that there are no analysis results to export *unless* the template obtains exportable values from the data analysis. Results of the analysis performed by **SensoMAP** will be exported into a comma-delimited file. The name of the *.csv file is automatically generated according to document naming rules detailed below.
- *Show SensoMAP after acquisition:* a successful measurement will be automatically displayed in **SensoMAP**.

**NOTE** When data is the result of an MMR, it is not sent to **SensoMAP** until the entire MMR acquisition process has finished. If Show **SensoMAP** after acquisition is enabled, **SensoSCAN** sends measured data to **SensoMAP** but the window remains blank.

- *Document Options:* **SensoMAP** documents consist of a set of data, operators, illustrations and parameters, amongst others:
  - Add to current: all the measurements grouped in the same result folder are loaded into the same document. A new document is created for each result folder.

**WARNING**

**If the current document contains more data than is required by a selected template, SensoMAP will discard some data and this may cause misleading results.**

  - Create new: each measurement of the series is loaded into a new document in **SensoMAP**, i.e. one document for each *.plux file.
  - Save document: **SensoMAP** documents are saved automatically. This usual workflow is to enable Save document when the result of the analysis of the series of measurements is the **SensoMAP** document itself, but **not** enable it when the results of interest are the values exported to as a *.csv file. The name of the **SensoMAP** document (*.mnt) is automatically generated according to document naming rules detailed below.

### Document naming rules

The documents are saved in the same folder as *.plux files (folder structure for MMR results).

The *.csv file name will be the template name. One single *.csv file will be created for each folder of *.plux files analyzed.

- If Add to current is enabled:
  - and Use Template is enabled, the file name is composed of the template name and the MMR's base name. Example: template zRGB --- MMRRecipe.mnt

- and Use Template is **not** enabled, the file name is the MMR's base name. Example: MMRRecipe.mnt

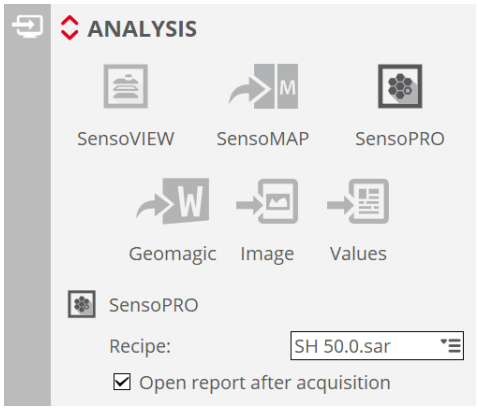
- If Create new is enabled:
  - and Use Template is enabled, the file name is composed by the template name and the **.plux* file extension. Example: template zRGB --- TopoRecipe_R0001.mnt
  - and Use Template is **not** enabled, the file name is the name of the **.plux* file except for the extension (*.mnt). Example: TopoRecipe_R0001.mnt

### 5.7.3 SensoPRO

There are three ways of analyzing data using **SensoPRO**:

- The first option is to manually load data into **SensoPRO**. The user saves the measured data using **SensoSCAN** menus and manually loads data into **SensoPRO**. **SensoSCAN** saves the data using a proprietary file format (*.plux files) that **SensoPRO** can load.
- The second option is to automatically load measured data into **SensoPRO** (SMR analysis). The user must select a predefined SMR. When this option is enabled, new data is automatically transferred and analyzed to **SensoPRO**.
- The third option is to automatically analyze a series of measurements (MMR analysis).The user can either apply a **SensoPRO** recipe to a directory that contains a series of *.plux files or setup **SensoSCAN** to automatically analyze the results obtained by a Multiple Measurement Recipe (MMR).

The analysis settings depend on whether the acquisition is single or multiple.




Analysis settings selecting SensoPRO

**NOTE** **SensoPRO** must be running alone in conjunction with **SensoSCAN**. Additionally **SensoPRO** must be initialized as an Administrator of the **SensoPRO** software in order to properly configure the communication.

A detailed description of the **SensoPRO** application is found in its own manual.

## SMR analysis

Options for how a measurement is handled together with **SensoPRO** are accessed by clicking on the red up/down arrows ⇕ in the Analysis pane.

- Recipe: **SensoPRO** recipes allow the same analysis to be repeatedly performed, or a report to be made on the new data. Select a Recipe as appropriate.
- Open report after acquisition: a successful measurement will be automatically displayed if the option has been enabled in the **SensoPRO** recipe.

The results from the data analysis are exported as an *.xlsx or *.csv file, depending on the **SensoPRO** Recipe configuration. The name of the file is automatically generated according to document naming rules detailed below.

### Document naming rules

The name is composed of the Recipe name and a timestamp. The file is saved to the current path (measurement folder, i.e. where the last measurement was saved or loaded).

## MMR analysis

After acquiring an MMR, the measured data is saved in files using a predefined folder structure. At the end of the acquisition of all measurements, the measurements that have been selected to be analyzed using **SensoPRO** are sent to **SensoPRO** folder by folder.

**WARNING**

**Configuration of SensoPRO options has to be done in the SMR. That is, an MMR will only send the results obtained using the SMRs that have SensoPRO enabled.**

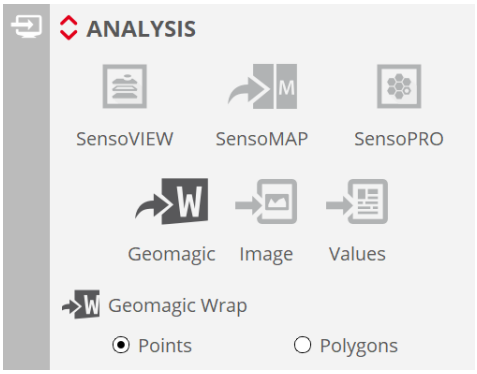
Options for how the measurement is handled together with **SensoPRO** follows exactly the same description as for Analysis of MMR measurements with **SensoMAP**.

### Document naming rules

The documents are saved in the same folder as *.*plux* files (the folder structure for the MMR results).

The *.*csv*/*.*xlsx* file name will be the SMR name. One single *.*csv*/*.*xlsx* file will be created for each folder of *.*plux* files that is analyzed.

### 5.7.4 Geomagic

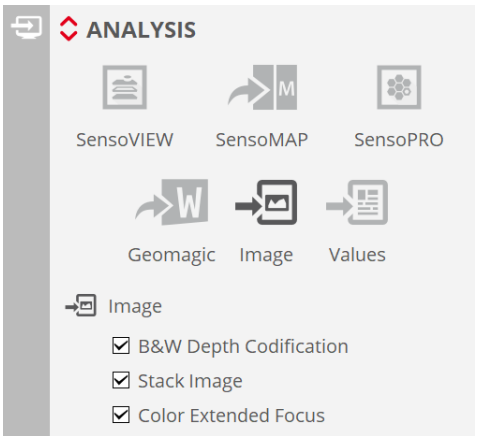



Analysis settings selecting Geomagic

The user can choose the wrap that will be used to represent the measurement in Geomagic. The two options are:

- Points: faster process but shows less detail
- Polygons: slower than Points but shows more detail

### 5.7.5 Export Image




Analysis settings selecting Image to export

Export Image allows the user to export a pixel map from **SensoSCAN** with maximum resolution.

| Measurement type | Exportable Images |
|---|---|
| **Single & Extended Image** | Full Image |
| **Single & Extended 3D topography** | B&W Depth Codification Image Stack Image Color Extended Focus Image |

Each selection saves two files – an image file and a calibration file (*.cal*). The image file has different tags depending on the chosen image format (selectable between **.tif, *.tiff, *.png, *.bmp* and **.jpg* in System Preferences / General).

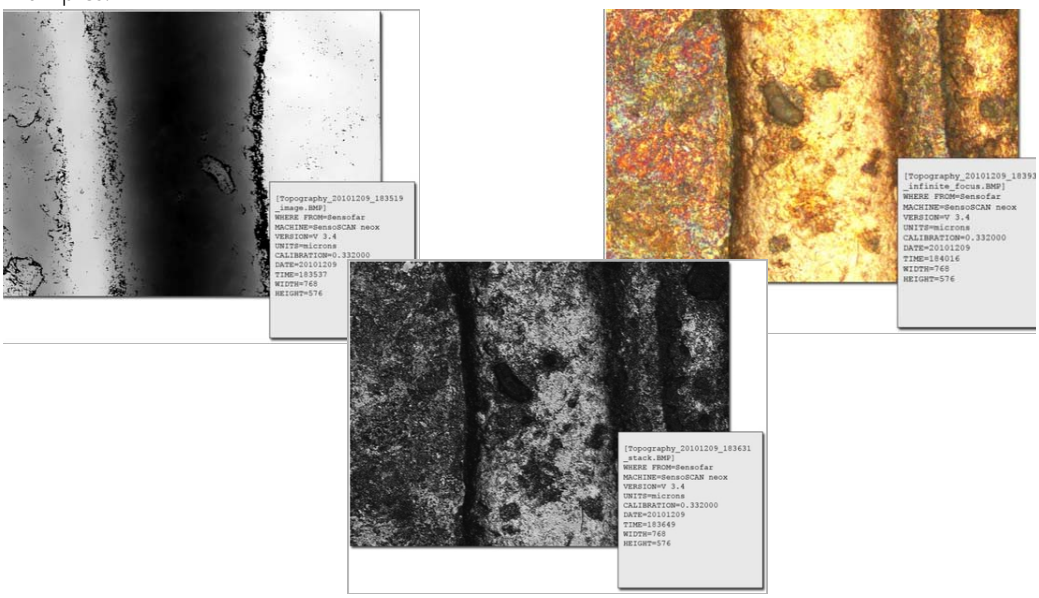
| Images | File |
|---|---|
| **B&W Depth Codification image** | *_z.* |
| **Stack** | *_stack.* |
| **Color Extended Focus** | *_image.* |

The calibration file contains the following fields:

| Field Name | Description | Example |
|---|---|---|
| **WHERE FROM** | Acquisition application name | SENSOSCAN |
| **MACHINE** | Acquisition machine name | S wide |
| **VERSION** | Application version | 1.0 |
| **UNITS** | Units in the XY axis [microns or nanometers] | microns |
| **CALIBRATION** | XY distance per pixel | 14.197531 |
| **DATE** | Day of measurement | 30/03/2020 |
| **TIME** | Time of measurement | 19:14 |
| **WIDTH** | Image width | 2448 |
| **HEIGHT** | Image height | 2048 |
| **ZUNITS** | **Units in the Z axis [microns or nanometers]** | **microns** |
| **ZCALIBRATION** | **Z distance per level of gray** | **0.007843** |
| **ZLOWER** | **Z lowest point** | **-4687.406738** |
| **ZUPPER** | **Z highest point** | **5586.268555** |

The bold fields are only visible for B&W depth codification images.

Examples:



B&W Depth Codification, Stack and Color Extended Focus images (left to right)

Follow these steps to use this feature:

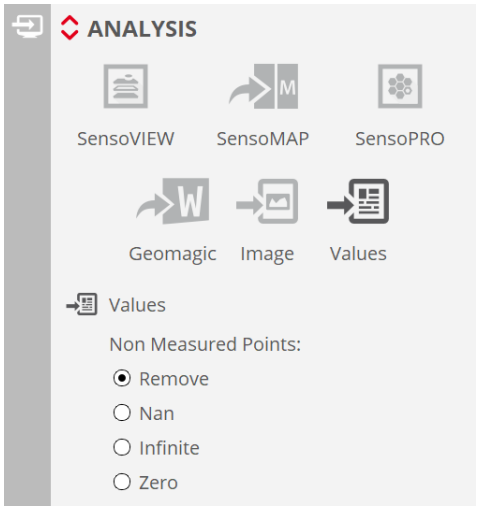
- Enable Export Image in the Analysis pane
- Click on the red up/down arrows ⇕ to reveal the options and select the desired image type

After acquisition, the image and **.cal* file will be saved automatically to the current path (the default path is C:\TMP, or the user-selected measurement folder).

Images can also be exported from **SensoVIEW**'s Quick Bar / Export, where the *Export Image* and *Export Full* options are available.

## 5.7.6 Export Values

Export Values option in analysis pane allows the user to export the DAT file automatically when an SMR or an MMR is used. It is also possible to define how the non-measured points should be displayed: remove, nan, infinite or zero.

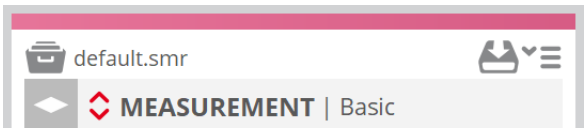



Analysis settings selecting Values to export

CHAPTER

# 6 RECIPES

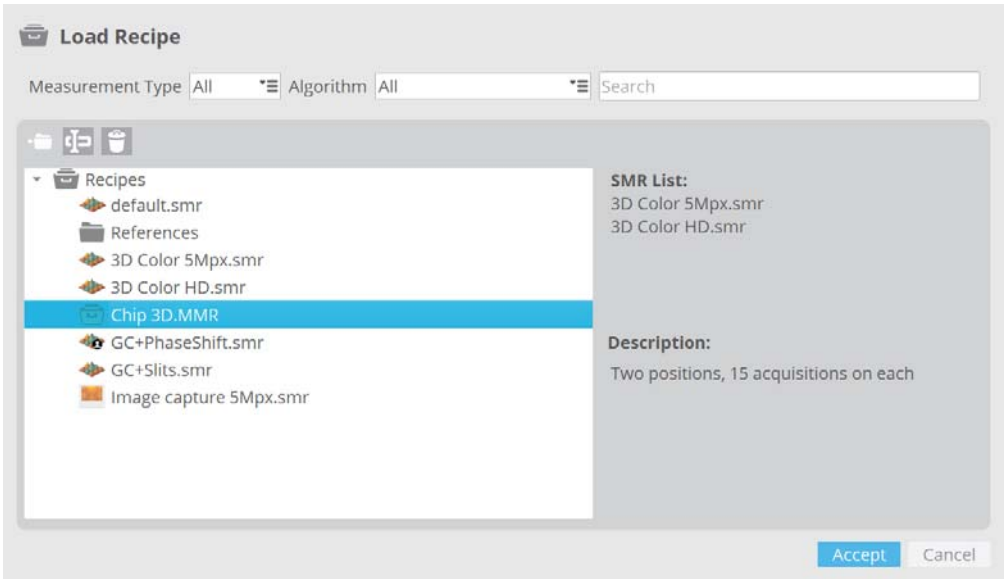
Recipes allow the user to select predefined scanning parameters that typically optimize a given application (Single Measurement Recipe, SMR) and/or that are used to automate an extensive measurement process (Multiple Measurement Recipe, MMR). They are available if the system configuration includes the optional Automation Procedure Module (APM).




Access to Recipes is via icons at the top of the Acquisition Settings pane

## Recipes: SMR & MMR

The icon  opens a dialog that allows the user to load either single (SMR) or multiple measurement recipes (MMR):




Load Recipe

Any recipe from the list can be searched for by name in the search bar. Folders can be created to organize the recipes by dragging and dropping them in the corresponding folder. It is also possible to rename and delete any recipe except "default.smr".

**NOTE** The default recipe is updated every time **SensoSCAN** is closed. The Acquisition Settings at the time of closing the software overwrite the settings of the recipe.

By choosing a recipe from the list a description will be displayed on the right part of the dialog. If there is an error with the recipe, it will be displayed above the description. For the case of an MMR, the full list of SMRs that it contains will be shown.

When choosing an SMR, the corresponding Acquisition Settings will become visible. The name of any loaded recipe will be visible at the top of the Acquisition Settings pane.

## Default

The Default recipe is used to load the measurement default settings (i.e. image acquisition). This measurement can be carried out right after system setup.

Depending on their needs, users can redefine the default SMR. For example, if the user usually measures similar samples that require the same level of illumination this setting can be saved as the default.smr using the Save as command (see drop-down menu  ).

## Single Measurement Recipe (SMR)

The Single Measurement Recipe (SMR) is used to load the measurement settings from a stored file. This function is useful for automating processes when the user needs to take a large number of measurements under the same conditions.

## Multiple Measurement Recipe (MMR)

This function is useful for automating a measurement process. For example, MMRs can be used to acquire measurements from different XY locations. At each XY location, several measurements can be acquired by simply utilizing a list of SMRs. MMRs can also be used to repeat measurements in the same position, for example to assess evolution or to obtain average measurements.

**WARNING**

**The system uses the fastest XY trajectory to move between two coordinates. Therefore, trajectories between the Positions listed in a MMR must be free of obstacles. See MMR set-up.**

**NOTE** The MMR can be canceled during the measurement by pressing the Esc key.

At the end of the measurement, a report is displayed. The report shows how many files have been measured (or not), the time required and the status. If the user clicks on Explore Measurements, the software opens the path to the measurements to be displayed.

## Managing recipes

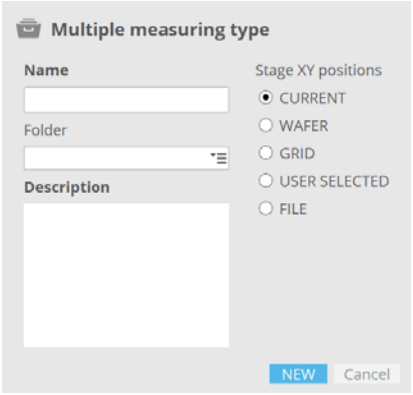
Recipes (SMRs and MMRs) can be created via the recipes drop-down menu :

- Through the *Save* option, the current Acquisition Settings overwrite the previous recipe.
- The *Save as* option opens the Save Recipe dialog. The available options in this dialog are similar to the options in the Load Recipe dialog; the user can filter, organize, rename and delete recipes. Additionally, the user can write an optional description for a new recipe.
- MMRs can be created with the *New MMR* option.

When saving an SMR, all the current parameters selected for a measurement – the Measurement type, settings for Area, Projection, Light Settings, Processing options as well as Analysis settings – are saved in the recipe.

**NOTE** Before defining an MMR, all the required SMRs must first be created.

When creating an MMR, the MMR must initially be given a name, a brief description and a position system must be chosen (all of these can be changed in the subsequent dialog after confirming with *New*):

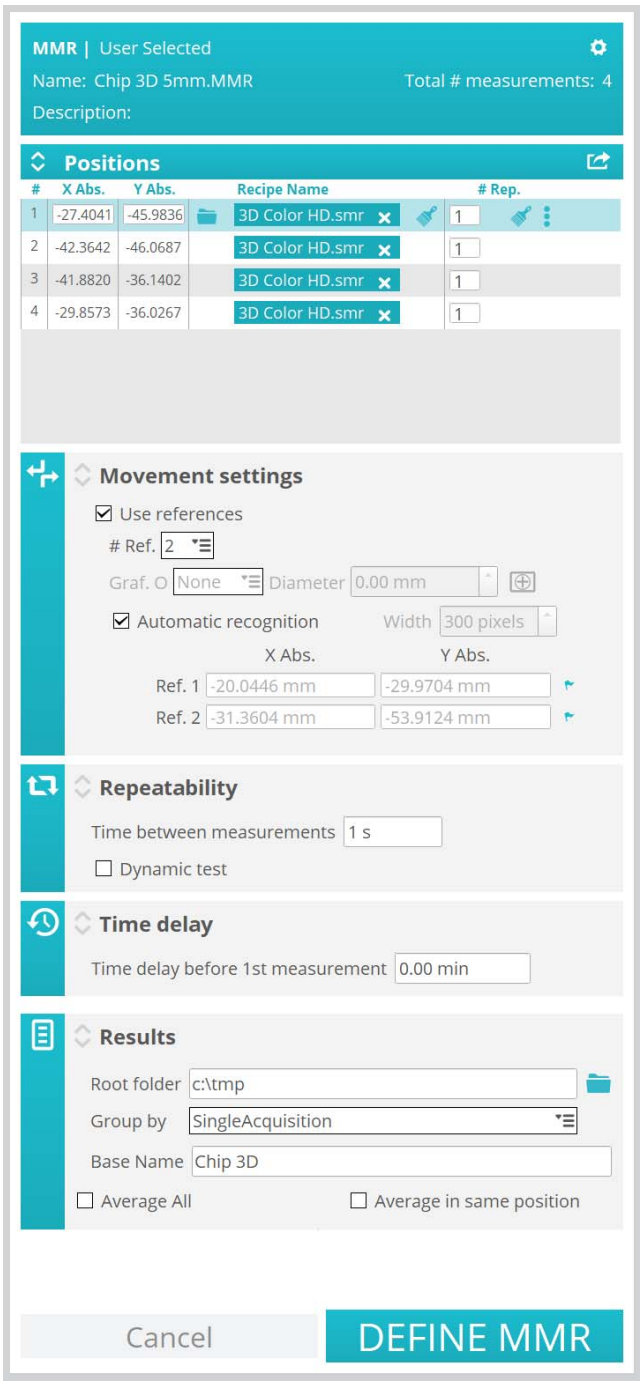



Multiple measurement create positions dialog

Confirming with New then reveals the define MMR pane (see next section).

# 6.1 Creating an MMR

The MMR configuration dialog contains all the tools required to create an MMR.




MMR settings

The following outlines the steps needed (see MMR set-up for individual step details):

- if necessary, click on the icon to redefine the name, change the description and/or re-select the type of MMR given previously

- define measurement locations under Positions (if not already specified by the choice of MMR):
  - define absolute X & Y position values
  - click on the icon to select an appropriate SMR and specify the number of repetitions
  - repeat for any other necessary measurement Positions – if necessary, parameters can be copied to any other Positions using the paste tool
  - deletions can be made using the icon
- under Bind Positions and Sample IDs (only visible if *Use Sample ID* has been activated in System Preferences / Sample ID):
  - define the total number of Sample ID's
  - tie (bind) one or more Positions to each Sample ID. It is possible to assign more than one position to each Sample ID. In case of multiple positions, separate them by commas.

    Example:

    Id #1 – positions: 1-4, 6, 8-10

    Id #2 – positions: 5, 7
- under Movement settings enable or disable the following:
  - Use references: when selected, the Movement settings pane extends to enable user-defined reference positions

**NOTE** Movement Settings is not available for all position systems, in which case this section of the pane will be disabled.

- under Repeatability:
  - set the parameter Time between measurements
  - enable or disable Dynamic Link
- under Time delay insert a value for Time delay before 1st measurement (in minutes)
- under Results define Root folder, Group by and Base Name, as well as enable or disable Average all and Average in same position

Finally, upon completion of the settings, confirm by clicking Define MMR.

A report, summarizing the MMR will be displayed. By choosing Edit, the parameters of the MMR can be adjusted. To return to the standard Inspection & Acquisition interface choose Exit.

If Use references is enabled, when the user clicks the Acquire button the software asks for the defined References to be set. If the XY start position is not the current position, the software asks for confirmation before movement.

### 6.1.1 MMR set-up

In creating an MMR, the user must consider a number of points and options – these are described below.

#### Recipe naming

The following characters are not allowed:

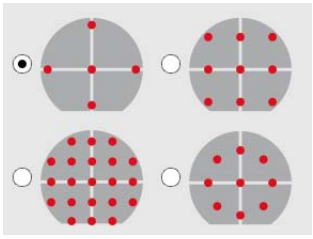
- \ in recipe names
- & < > in the recipe description

#### Positions

Different measurement locations (Positions) can be defined when creating or editing the MMR. The options are:

- *Current*: the current stage values are used.
- *Wafer*: the measurement locations are defined by the predefined distributions of measurement locations relative to the center of the wafer (0,0). It is assumed that the wafer is placed at the center of the XY stage.

  There are four options with different layouts and numbers of points:



  The distance between two points must be set in the die pitch edit box. The positions are automatically loaded into the table. The final list is comprised of absolute XY coordinates.
- *Grid*: the measurement locations are defined by entering the number of columns and rows of the measurement positions and their spacing. The user must enter the spacing in X and Y between the center of the FOVs. The positions will be automatically loaded into the table.
- *User selected*: the XY stage movements can be used to manually define the measurement locations (absolute coordinates) and add these positions to the MMR with the add button + ADD POSITION. It is also possible to add or delete a position by clicking the right button ⋮. When adding a new position, the position is automatically cloned and the user is able to edit its values.
- *File*: the measurement locations can be loaded from an ASCII file. This is a plain text file that has two sections – the reference positions are in the section labeled References and the measurement locations in the section Measures. The positions can be absolute or relative. It must be tagged as [References Relative] or [Measures Relative] for relative positions and [References] or [Measures] for

absolute positions. In order to convert a relative position to an absolute one, it is necessary to define the center (0, 0) of these coordinates. That is why the first action after clicking the acquire button is to ask the user where this center position is placed. References and Measures consist of 2 values – X and Y, in millimeters and up to 4 decimal places – separated by spaces. When the user defines References (up to 3) they will appear in the Use references option.

Here is a sample file with reference positions:

```
[References]
 18.0000   -46.0000
-22.0000    32.0000
[Measures]
 7.9835     13.2266
-41.7320   -21.7928
 8.4372     -32.9694
```

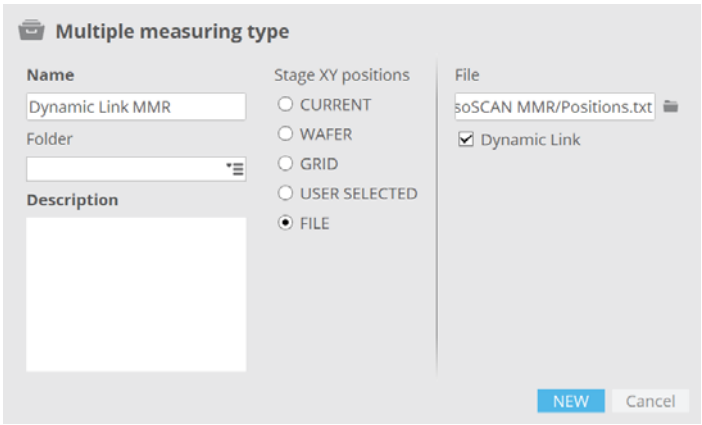
Here is a sample file without reference positions:

```
[References]
[Measures]
 7.9835     13.2266
-41.7320   -21.7928
 8.4372     -32.9694
```

**NOTE** These are all converted to absolute positions by adding the actual XY coordinate of the system when Acquire is triggered.

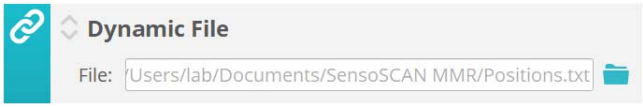
### Dynamic Link

This option allows the user to change the positions and references through a file linked to a MMR. The usual File MMR loads positions and references from a file, if these positions are to be changed, another file has to be loaded. Dynamic Link MMR connects the values shown in **SensoSCAN** and the values in the **.txt* file.




Dynamic Link MMR creation dialog

The path of the file is shown in a widget called "Dynamic File". The user can select another file with positions and references, or change the values of the current file editing the **.txt* file.

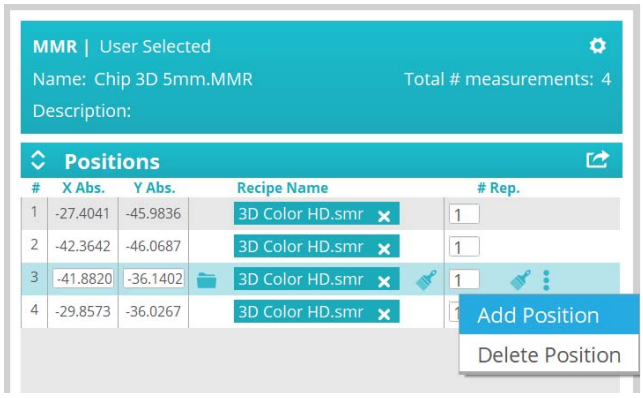



MMR Dynamic File

For this type of MMR only the first row of the table can be modified. All changes will be automatically applied to the rest of the table, this includes recipes and repetitions. Editing the **.txt* file will not erase the recipes and repetitions. If references were defined, they are maintained.

Defining the MMR refreshes the values. Once defined, in the MMR summary screen, the file can also be updated through the icon . Starting the acquisition refreshes the file as well.

By clicking on the export button , the software generates a **.txt* file with the positions introduced in the MMR with the format **SensoSCAN** accepts to import the XY positions.




MMR positions list with Export button

MMR log files contain exportable relative coordinates from MMR.

There is a menu to the right of each position enabling the possibility to delete or add a position. When you add a position it is automatically cloned and the user is able to edit its values.

## Bind Positions and Sample IDs

This pane is only visible if Use Sample ID has been activated in System Preferences / Sample ID. When activated, proceed as follows to tie Positions (measurement locations) to specific Sample ID's:

- Unlock the padlock by clicking, define the total number of Sample ID's, and re-lock the padlock by clicking again – a corresponding number of text fields appears.
- Tie (bind) one or more the Positions to each Sample ID – hover the cursor over a text field to reveal a tip overlay with possible examples and the required syntax. Naturally, all measurement locations used here must exist in the Positions listing in the pane above when Acquire is selected.

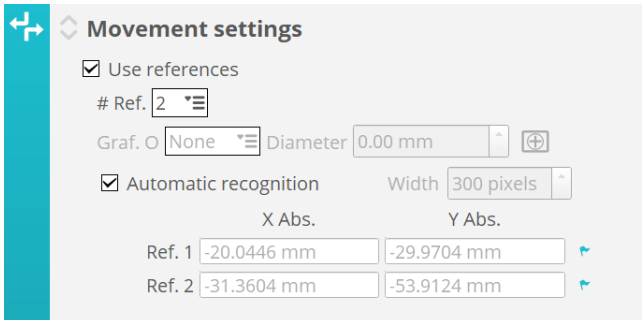
## Movement settings

- Use references: these are fixed points (or markers) on a sample. The Positions can be related to these markers.
- Automatic recognition: enabling this option, the user does not need to do a manual operation when the MMR starts. **SensoSCAN** will move to each of the nominal positions, by applying the recognition pattern learned before. In case of a successful match, the software will correct the positions automatically. Ideal for automation of the fiducial recognition and correction without any human interaction.

The user must apply a two-steps procedure:

- Introduce the width/height of the ROI in which the reference will be enclosed
- Move the stage to place the reference inside the defined ROI and click to the reference definition button. It is necessary to repeat this step for each reference. **SensoSCAN** will individually save each image to recognize them in future processes.

**NOTE** The reference must be inside the FOV of the nominal position.




MMR movement settings

References are useful when a sample has been removed from the system and is then replaced to take another measurement. Usually, the sample is not replaced in exactly the same position and the system does not measure the proper positions. If References have been defined for the original measurement, they can be used to properly re-locate the measurement points. This is also useful when you are measuring different samples of the same type.

**NOTE** Samples rotated with an angle higher than 10º will not be detected

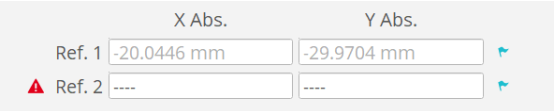
Before measurement, the system will go to these reference positions and ask the user to center them. From the corrections introduced by the user, the system determines the error in the sample position and corrects it.

To use this feature, simply enable Use references.

**NOTE** Use references is not available if the selected Positions option for the MMR is Current or Grid

Before the reference positions can be defined (by clicking the flag), the user needs to select some options:

- # Ref.: either 2 or 3 References can be used. The use of 2 References corrects the shift, rotation and scale (but assumes that the scale is the same in X and Y). The use of 3 References enables the system to determine X and Y scaling errors individually. References can either be set at the origin or be user-defined. Incomplete definitions are indicated with a warning triangle:




- Graf. O.: an alignment aid can be overlaid on the image to help center the References. The options are None, Cross and Circle. When None is selected, the usual cross-hair will be displayed. When Circle is selected, a circle of the diameter defined in the edit box (in mm) will be displayed. When Cross is selected, a width of the cross defined in the edit box (in mm) is displayed.

## Repeatability

The Repeatability options are used for repetitive measurements in the same XY position.

- Time between measurements: a time delay between measurements to help reduce the effect of instabilities
- Dynamic test: enabling this option will move the system a given distance D in XY after each measurement and return to the starting point before the next one.

## Time delay

A time delay before the first measurement can be defined. This can be used to let the system settle from any environmental vibrations. It is also particularly useful if an MMR must be launched automatically at a programed time, without a system administrator being present to start it.

## Results

The results of MMR measurements are the measurement files (*.*plux*) and a report file (MMR.log) that contains information about the measurement. The following settings tell the system where to save the files – Root folder and Base Name. The user can also select how to group the measurements by SingleAcquisition, Day, Weekdays, Week, Month or AllTogether.

Each time an MMR measurement completes, a new folder is created in the root folder. This is the MMR folder. The name of the MMR folder consists of the Base Name and a time stamp.

Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**MMR Folder:** C:\Sensofar\Measure_26_May_2020_18_28_17

**WARNING**

**If the MMR folder already exists, the system asks whether it should be overwritten.**

If the Group by option is not SingleAcquisition, the folder name will additionally be composed as follows:

- Group by Day will generate Basename + _Day_Month_Year
- Group by Weekdays will generate Basename + _Weekday_Month_Year
- Group by Week will generate Basename + _YearWeek_Year
- Group by Month will generate Basename + _Month_Year
- Group by AllTogether will generate Basename

Result files are organized inside this folder according to the following rules:

- If the total number of SMR is one:
  - If the number of positions is one, the files are saved in the MMR folder. No sub-folder is created.
    - **a** If the number of repetitions of the SMR is one, the file name consists of the SMR name.

    Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR:** Topo.SMR **Positions:** 1 **Repetitions:** 1
**Files:** C:\Sensofar\Measure_26_May_2020_18_28_17\ Topo.plux

    - **b** If the number of repetitions of the SMR is more than one, the file name consists of the SMR name and the repetition tag.

    Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR:** Topo.SMR **Positions:** 1 **Repetitions:** 3
**Files:**
C:\Sensofar\Measure_26_May_2020_18_28_17\ R0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ R0002_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ R0003_Topo.plux

  - If the number of positions is more than one:
    - **a** If the number of repetitions of the SMR is one, the file name consists of a position tag (PXXXX) and the SMR name.

    Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR:** Topo.SMR **Positions:** 2 **Repetitions:** 1
**Files:**
C:\Sensofar\Measure_26_May_2020_18_28_17\ P0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ P0002_Topo.plux

**b** If the number of repetitions of the SMR is more than one, a sub-folder is created for each position. The name of the sub-folder consists of P and a number between 1 and 9999 (PXXXX). The files are saved in the sub-folder according to the position in which they were measured. The file name consists of the SMR name and the repetition tag.

Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR:** Topo.SMR **Positions:** 2 **Repetitions:** 2
**Files:**
C:\Sensofar\Measure_26_May_2020_18_28_17\ P0001\R0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ P0001\R0002_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ P0002\R0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ P0002\R0002_Topo.plux

- If the total number of SMR is more than one:
  - If the number of positions is one:

    **a** If the number of repetitions of a SMR is one, the files are saved in the MMR folder. The file name consists of the SMR name.

Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR1:** Topo.SMR **Positions:** 1 **Repetitions:** 1
**SMR2:** Image.SMR
**Files:**
C:\Sensofar\Measure_26_May_2020_18_28_17\Topo_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\Image_Image.plux

**b** If the number of repetitions of a SMR is more than one, a sub-folder is created for the SMR. The name of the sub-folder is the name of the SMR. The file name consists of the SMR name and the repetition tag.

Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR1:** Topo.SMR **Positions:** 1 **Repetitions:** 2
**SMR2:** Image.SMR
**Files:**
C:\Sensofar\Measure_26_May_2020_18_28_17\TopoR0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\TopoR0002_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ImageR0001_Image.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\ImageR0002_Image.plux

  - If the number of positions is more than one, a sub-folder is created for the SMR. The name of the sub-folder is the name of the SMR.

**a** If the number of repetitions of a SMR is one, the files are saved in the SMR sub-folder. The file name consists of a position tag (PXXX_) and the SMR name.

Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR1:** Topo.SMR **Positions:** 2 **Repetitions:** 1
**SMR2:** Image.SMR
**Files:**
C:\Sensofar\Measure_26_May_2020_18_28_17\Topo\TopoP0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\Topo\TopoP0002_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\Image\ImageP0001_Image.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\Image\ImageP0002_Image.plux

**b** If the number of repetitions of a SMR is more than one, a sub-folder is created for each position. The name of the sub-folder consists of P and a number between 1 and 9999 (PXXX). The files are saved in the sub-folder according to the SMR used in each position. The file name consists of the SMR name and the repetition tag.

Example:

**Root folder:** C:\Sensofar
**Base name:** Measure **Date:** 26 May 2020 **Time:** 18h 28m 17s
**SMR1:** Topo.SMR **Positions:** 2 **Repetitions:** 2
**SMR2:** Image.SMR
**Files:**
C:\Sensofar\Measure_26_May_2020_18_28_17\P0001\Topo\TopoR0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\P0001\Topo\TopoR0002_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\P0001\Image\ImageR0001_Image.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\P0001\Image\ImageR0002_Image.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\P0002\Topo\TopoR0001_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\P0002\Topo\TopoR0002_Topo.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\P0002\Image\ImageR0001_Image.plux
C:\Sensofar\Measure_26_May_2020_18_28_17\P0002\Image\ImageR0002_Image.plux

The system can additionally be set to save the average of each SMR recipe in the same position, and in all positions:

- Average All: the average of all the individual data measured with the same recipe in all positions will be saved in the corresponding Recipe MMR folder.
- Average in same position: the average of all the individual data measured for each location with the same recipe will be saved in the corresponding position MMR folder.

### 6.1.2 MMR performance

- If the MMR's list of Positions has:
  - One single undefined XY coordinate, the system measures at the current coordinate when Acquire is triggered.
  - Relative XY coordinates, the system adds to every XY coordinate the actual XY coordinate of the system when Acquire is triggered.
- If the MMR makes use of References:
  - The system asks for confirmation to move to the first Reference position. Press accept or use the Enter key.
  - The stage moves to the nominal position for Reference 1 and waits for the user to center Reference 1. Press Accept once it is centered.
  - The same process will be repeated for Reference 2 and 3 (if 3 References are used).
  - When all References have been centered, the system uses the actual reference positions to correct the XY positions in the MMR list. XY coordinates are corrected for translation and rotation if two References are used and also for scale if 3 References are used.
  - Finally, the stage moves to the measuring position and starts the measurement of the first SMR.
- If MMR does not make use of References:

  The system checks whether the actual position matches the first position in the MMR list. If not, the software asks for confirmation before moving to the first position.
- If SMR includes Autolight, the system will execute Autolight before each measurement.

#### Further Notes

- If an MMR does not make use of References, the Center references steps are not required.
- Asking for confirmation steps is not required if the system is remotely controlled or a Control of Production system is used.
- Center references is a manual operation and is required even in production control and remotely controlled systems.

CHAPTER

# 7

# ERRORS & DIAGNOSTICS

This chapter briefly addresses errors associated with acquisition and diagnostics for the hardware system.

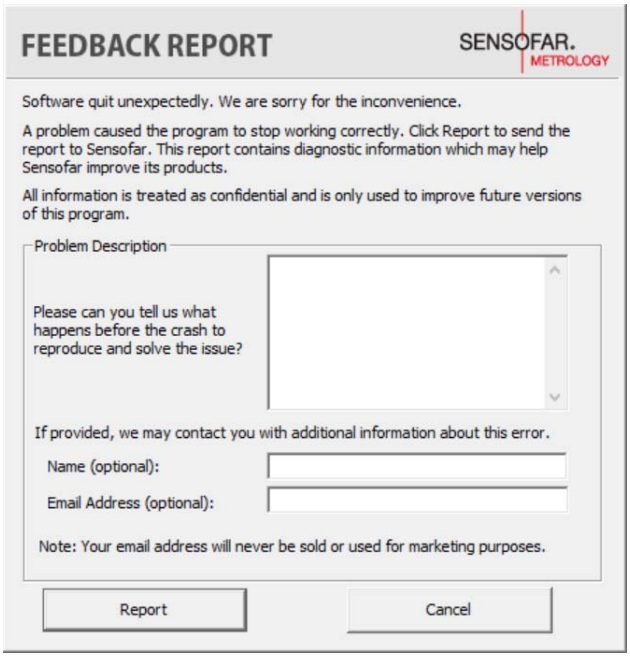
In general, non-solvable acquisition errors and repetitive hardware issues that are not easily fixed should be reported to Service & Support.

# 7.1 Crash report

If the software fails unexpectedly it will allow the user to automatically send the failure to Sensofar. The information sent will help identify the root cause of the failure and pro actively fix the issue in our next **SensoSCAN** versions.

Once a report is submitted a "Crash Id" will be assigned and then automatically sent to our software team, the report will include all basic information to evaluate and try to fix any reported software crash. Fixes, if available, will be included in the next software versions.

Please fill in the feedback report form.




Crash report dialog

Additionally, a zip file is generated and stored in the folder C:\tmp\CrashReports. It contains information that technical service support may request in order to perform a proper diagnostic.

The user can always manually generate a report zip and/or a backup zip through the file menu, **Help / Diagnostics**.

**NOTE** Connection to the Internet is required to send a Crash report.

## 7.2 Restoring or re-installing the main controller

If you have software or hardware problem with your S wide, Acronis provides repair and restore services that may eliminate problems and can even restore your software to its original factory settings.

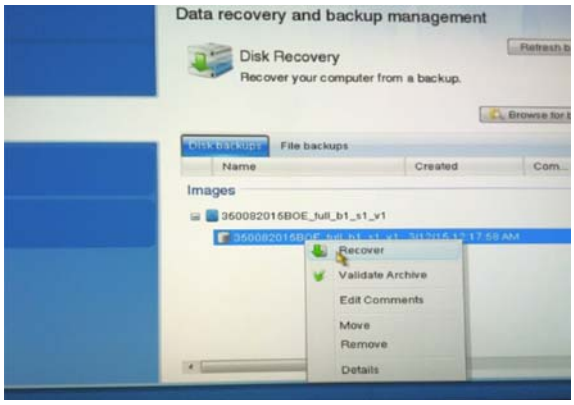
**WARNING**

**Do not restore or reinstall the main controller without contacting your Distributor beforehand.**

**WARNING**

**This process will delete all calibrations and configurations, as well as created recipes and measurements.**

1. Switch on the main controller (PC). Note that you may have to access the Start up menu pressing "*Esc*" at the start up sequence to select the USB as the boot unit.
2. Boot up from Sensofar's USB memory stick provided with the system.
3. The Acronis software will start.
4. On the Home panel, click Recover.
5. On the Data recovery and backup management panel, select "*Browse for backup…*" button.
6. Select the Acronis partition (fixed disk drive) and click OK.
7. Select the file corresponding to the system that needs to be restored which is identified with its serial number. Then, click OK.
8. Select the file of the system that has to be restored from the list.
9. Click on the right button and select the Recover option:

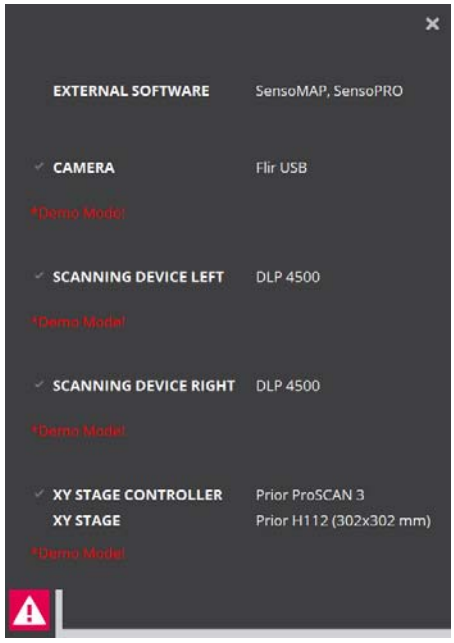



10. When the recovery process is finished, remove the USB dongle and restart the computer.

# 7.3 Hardware configuration

## Problem 1 – Hardware configuration not found

Check the system status panel to display the error messages:



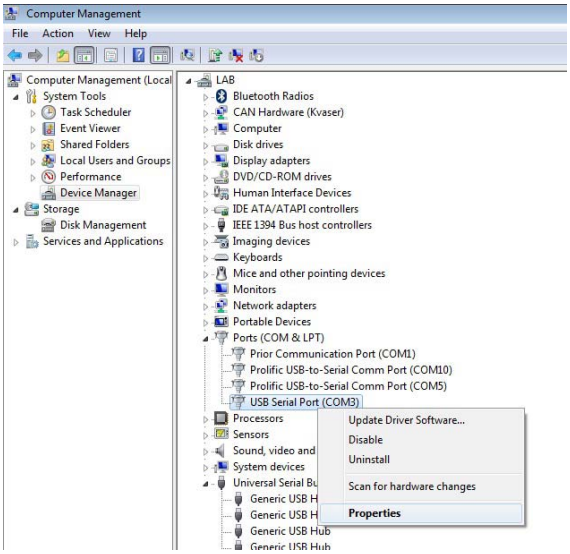

System Status panel

### Cause A – Ports need to be configured

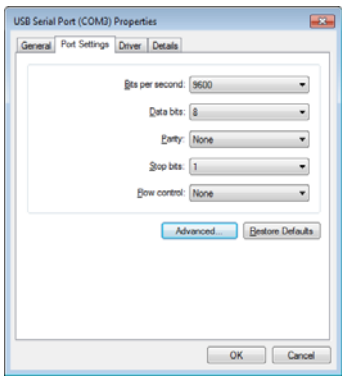
1. Check the ports configuration in device manager panel. The configuration must be as follows:

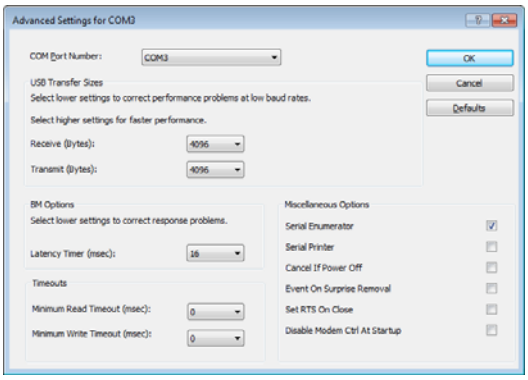
| Hardware device | Ports (COM) |
|---|---|
| **Prior ProScan III, XY Stage Controller** | COM2 |

2. Click onto START icon and go to Control Panel > System and Security > System > Device Manager.
3. If not, right click onto the port and select Properties.




4. In the 'Port Settings' tab, select 'Advanced…'.




**WARNING**

**Check that COM2 has latency timer set to 1.**

5. Select the correct port number in 'COM Port Number' and click on OK button.

CHAPTER

# 8 APPENDIX

All globally relevant information as well as background topics from other chapters are collected here.

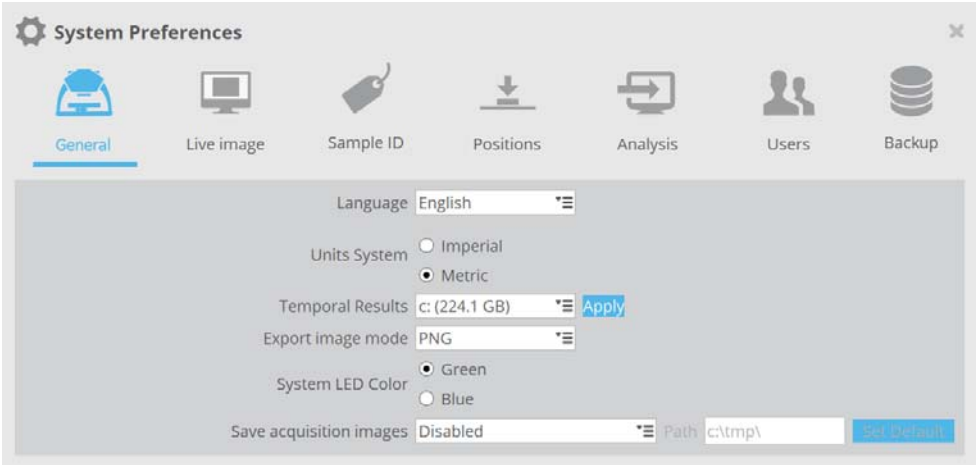
# 8.1 System Preferences

System Preferences can be accessed by clicking the icon in the Quick Bar when in Inspection & Acquisition mode, or choosing Configuration / System Preferences from the Menu icon.

The Quick Bar bottom area with System Preferences icon

The System Preference categories are organized as tabs.

## General




System Preferences menu displaying General settings

The options here allow setting of:

- Language: the user interface language for **SensoSCAN**.
- Units System: select between imperial or metric system.
- Temporal Results: the software saves measurements in the C:\tmp folder, except for measurements acquired with MMR that are saved in the root folder defined in the MMR. This allows linking to external analysis software tools such as **SensoVIEW** for display and analysis of individual measurements.

  By default, the temporal results folder is "C:\tmp" but for computers with small SSD "C:\" drive this may not be optimum. When the software is run for the first time the user selects the drive where this temporal folder is created. It is possible to modify the drive by selecting another drive. The software does a backup of the current temporal results folder in "oldtmp" folder in the same drive before creating the temporal results folder in the new drive.

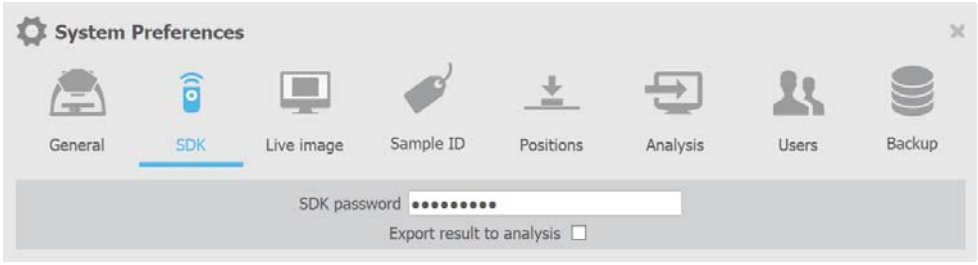
- Export image mode: set the file extension for the exported images. Choose between **.tif, *.tiff, *.png, *.bmp* and **.jpg*.
- System LED color: allows to choose whether a Green or a Blue LED will be used during acquisitions.

**WARNING**

**The choice of LED is an important step, as all acquisitions should be done with the same LED to be consistent. Changing the LED implies performing a new calibration.**

- Save acquisition images: it is possible to save each image taken during the acquisition. The path where these images will be saved must be defined here. The default path is "C:\tmp\". Image format is **.png*.

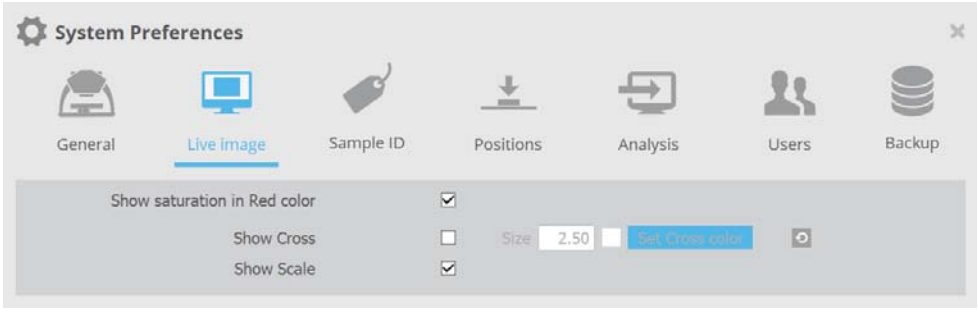
## SDK




SDK settings in System Preferences

This is where to enter the password to activate the SDK link. The user can also enable the option to send the results to an external analysis software.

## Live Image




Live Image settings in System Preferences

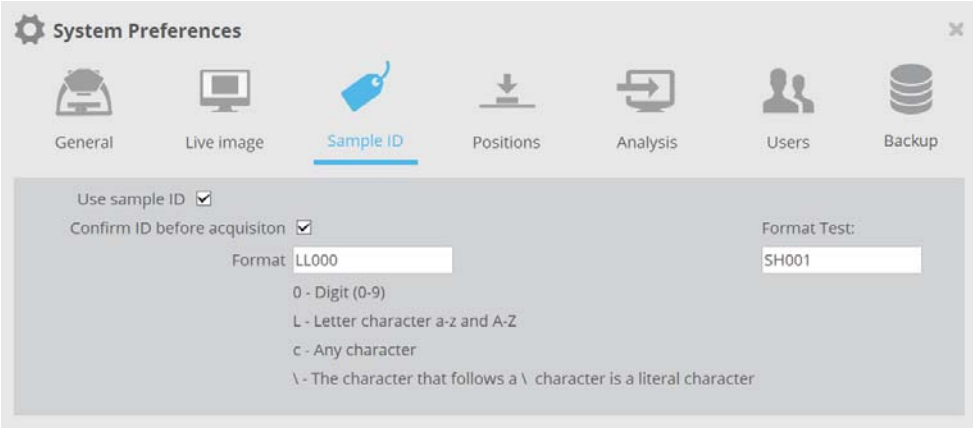
The options here determine which viewer options are shown in the Central Viewer:

- *Show saturation in RED color* highlights the saturated pixels in red.
- *Show Cross* places a small cross-hair on the center of the Central Viewer. The cross-hair is user-customizable in width (0.5 - 5.0 pixels) and in color (default is white). Note that the F9 keyboard shortcut can be used to toggle to a large cross-

hair at any time, regardless of whether none, or a small cross-hair is selected here (see Keyboard Shortcuts).

- *Show Scale* enables a scale value on the bottom right corner of the Central Viewer.

## Sample ID




Sample ID settings in System Preferences

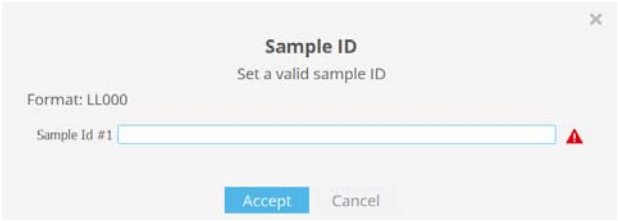
The Sample ID feature allows the user to label the measurement according to an identification. The subsequent measurement will exhibit the ID inside the file as well as in the file name.

When the user is programming an MMR, the MMR can be used with only a single Sample ID or with multiple IDs by mapping the positions with their specific identification.

Sample ID options are as follows:

- Use Sample ID toggles the option of using a specific Sample ID. On activation, either the existing Sample ID is shown at the top of the Sample Inspection pane or the 'No Id.' name tag icon can be clicked to reveal a pane where a new name can be entered using the keyboard (i.e. user-defined), or scanned from a list or from the sample by using a barcode reader.


Note that, until a valid name has been given, a small red warning triangle is shown:



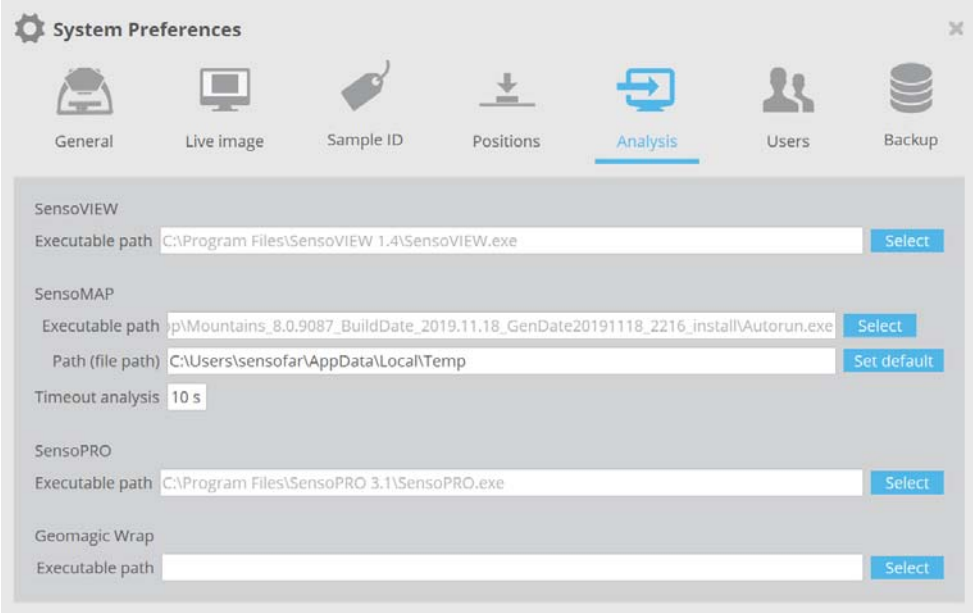
- Confirm ID before acquisition allows the user to check the Sample ID once more before acquisition.
- Format options allow a specific nomenclature strategy to be implemented. That is, the nomenclature is nominally freely selectable, but it can be restricted to a specific alphanumeric format by entering the corresponding definition into the Format field (see example in the System Preferences Sample ID pane above).

## Positions


Positions settings in System Preferences

- *XY1 – load position* is where XY stage moves at the first step of Load Sample process. The default value is X center (0) and Y front (Y travel range/2). It can be edited or set to the current XY position.
- *XY2 – measurement position* is where the XY stage moves at the last step of Load Sample process. The default value is X center (0) and Y center (0). It can be edited or set to the current XY position.
- *Back to start position* is an alternative way to define XY2 measurement position. It is not enabled by default. When it is enabled XY2 measurement position defined in previous item is not used, instead the system uses the XY position where the user starts Load Sample process.
- *Set All defaults* resets default position settings.

## Analysis




Analysis settings in System Preferences

- The executable path for **SensoVIEW**, **SensoMAP**, **SensoPRO** and **Geomagic** can be defined here. When these are correctly given, **SensoSCAN** can automatically call the external analysis software when required.
- **SensoMAP**

  The file path for measurement files to be processed in **SensoMAP** can be defined here.

  When **SensoSCAN** is configured to push measurements to **SensoMAP** for analysis, **SensoSCAN** must wait until **SensoMAP** has finished processing the last measurement before **SensoSCAN** can push over the next. Normally **SensoSCAN** poles **SensoMAP** for the status, and makes the next acquisition as soon as **SensoMAP** is ready. The Time analysis duration determines the maximum dwell time per measurement file that **SensoSCAN** waits before posting a warning message. Time analysis should thus be set to be greater than the nominal time required by **SensoMAP** to analyze each measurement in the users particular configuration.

## Users

Administrators of the system can manage the users and their associated rights through the Users tab.

### Managing user profiles

In order to help organizations that have acquired a system to administer the use and maintenance of the system, **SensoSCAN** distinguishes between three different levels of users and their associated rights:

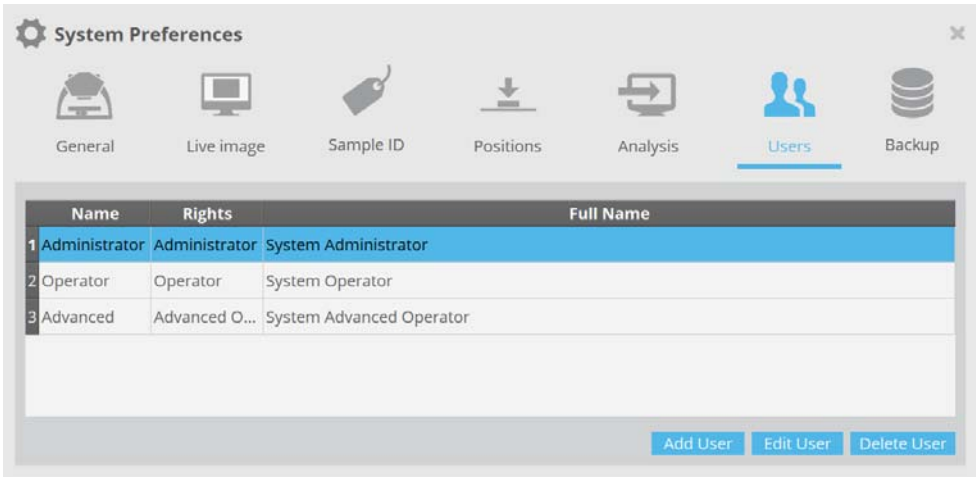
- **Administrator**: can manage System Preferences, can perform Configuration & Calibration tasks and has all the rights of an Advanced Operator.
- **Advanced**: can configure measurement and create recipes, and has all the rights of an Operator.
- **Operator**: can load recipes, acquire and save/load data and perform analysis.

After initial installation (and also following re-installation) the user list contains by default one user of each type. The table below shows the three default users, their rights and the associated default password:

| User | Rights | Default Password |
|---|---|---|
| Administrator | System Preferences | adm1234 |
| | Calibration & Alignment | |
| Advanced | Save Recipes | adv1234 |
| | Configure Acquisition | |
| Operator | Load Recipes | ope1234 |
| | Acquire Data | |
| | Perform Analysis | |
| | Save/Export Data | |

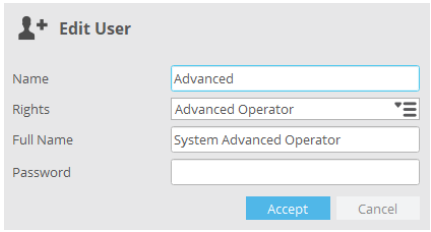
User rights and the default passwords after initial installation (and following re-installation)

The default users can be used 'as is', or they can be edited as required, or new users can be added. An Administrator can access the users tab in order to manage all users of the system (*Add* / *Edit* / *Delete*):




Users tab in System Preferences

Clicking *Add User* or *Edit User* reveals a drop-down dialog, in which the details and rights for a new user can be given, or where those for an existing user in the list can be changed, respectively:




Using the Edit User dialog to edit the details for Advanced Operator user

After adding a new user or after making any changes to a user profile, simply click Accept to confirm the changes and return to the user profiles dialog.

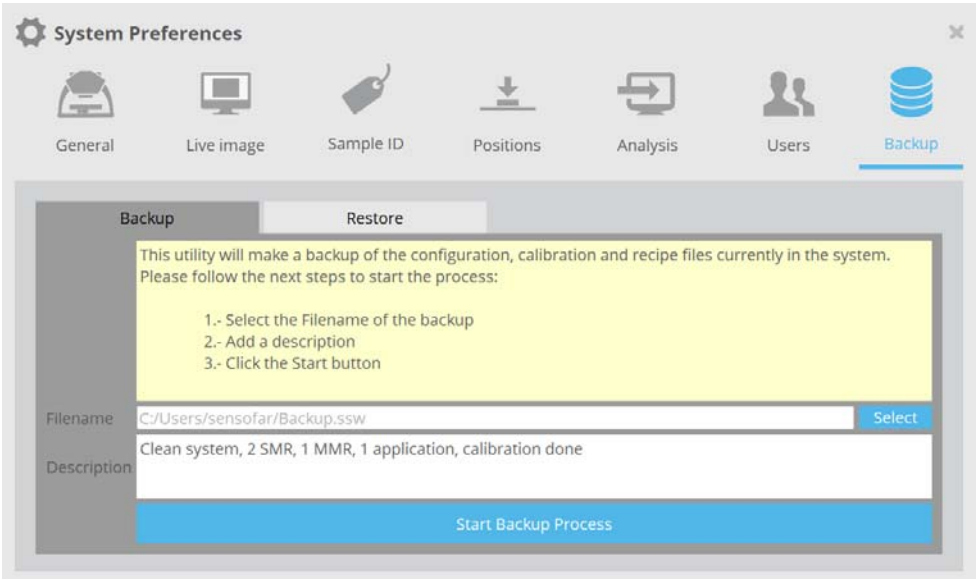
**NOTE** The user name and password may contain any combination of available symbols, numerals and upper/lower case type.

**NOTE** In the event that a user profile can no longer be loaded by the system, the profile should simply be deleted and then recreated by an Administrator.

Clicking *Delete User* reveals a drop-down dialog with which the chosen profile can be deleted:


Using the Delete User option to delete the profile for the user Operator

## Backup




Backup settings in System Preferences

This option allows the user to save the system configuration through a backup, to be restored in the future. The backup file is a compressed zip file with a *.ssw extension.

- Backup

  To perform a backup the user must select the folder where the backup will be saved and write a description (optional). During the backup process the following files are copied:

  - Applications and Recipes
  - Calibrations
  - Configurations
  - SNXXX.hcf file

- Restore

  To retrieve the files the user must choose the path where the backup was saved. Once the backup file is selected, some relevant information saved in the backup file will be shown on the screen, such as user, date, version, description and serial number.

**NOTE** **SensoSCAN** must close to apply the changes. It will be done automatically, after the restore process a dialog will appear, informing the user.

The Backup/Restore process is useful when the user wants to uninstall and install the current version without having to repeat the calibration and keeping the recipes.

**NOTE** Repeating the calibration is strongly recommended in order to achieve the most metrologically accurate results.

Another useful application for the Backup/Restore process consists of maintaining the configuration whenever a version upgrade has to be done. The user can back up all the relevant files and restore them in the new version without having to repeat the calibration. However, a new version could have changes in the calibration, which is why it is recommended to perform another calibration process.

**WARNING**

**The restore process can delete information of the current installation, such as recipes and configurations. A backup before a restore is recommended.**

# 8.2 Offline Extended Topography

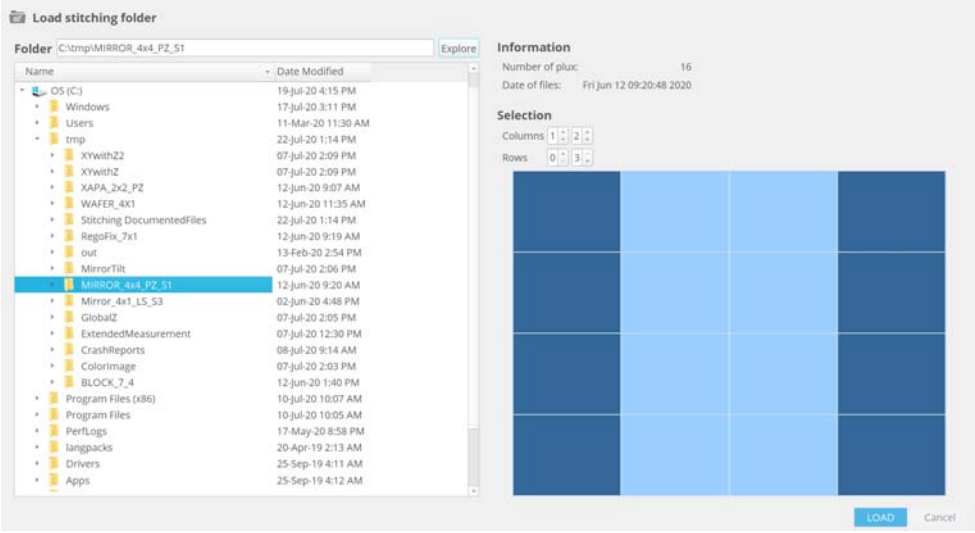
To access this window select File / Offline Extended Topography on the Quick Bar. The window allows the user to choose which FOVs to stitch, and to apply the appropriate settings before obtaining the final result.

## 8.2.1 Quick Bar


The following actions can be performed by clicking on the icons from the Quick Bar:

- opens the path of the currently loaded folder
- loads a folder with files to stitch
- closes the offline stitching window

## 8.2.2 Load stitching folder window

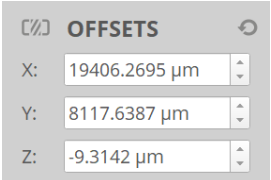



Load stitching folder window

This window allows the user to choose the files to stitch. On the left side of the pane the user can choose the folder where the files are located. By default, the tmp folder is expanded.

The right side of the pane displays basic information such as the number of plux files and the date the measurements were acquired, as well as controls to select which rows and columns will be stitched. The FOVs that will be used are represented by a lighter shade of blue.

## 8.2.3 Offsets



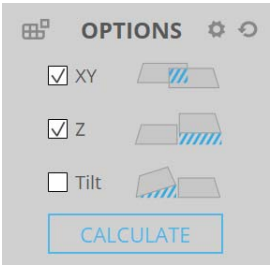

Offsets pane

Select any FOV to see its current XYZ offset, which corresponds to the distance from the center of the FOV to the center of the axis located in the middle.

The FOVs can be manually moved to change the offset by clicking and dragging or by using the keyboard arrows.

The icon restores the default offsets.

## 8.2.4 Options




Options pane

There are three correction options to choose from:

- **XY** – FOVs are stitched using the best fit in the XY plane, as if seen from above, without considering the changes in Z (height).
- **Z** – stitching done by considering the height differences between two consecutive FOVs.
- **Tilt** – works best for large area acquisitions (high number of measured FOVs or low magnification objectives). It corrects the tilt that may appear on the FOVs near the edges of the acquisitions as a result of the XY table movement.

**WARNING**

**Tilt is not enabled by default because it can have negative effects on the stitching of smaller areas, as it can remove a tilt that does not exist.**

Multiple correlations can be selected at the same time by checking the corresponding checkbox. By not checking any boxes the result will be shown without any adjustment. Additional options are available by clicking the icon.

**NOTE** The default settings work on most cases and usually there is no need to alter the additional options. These options are complex and should only be altered by very experienced users who know what to expect when applying each setting.

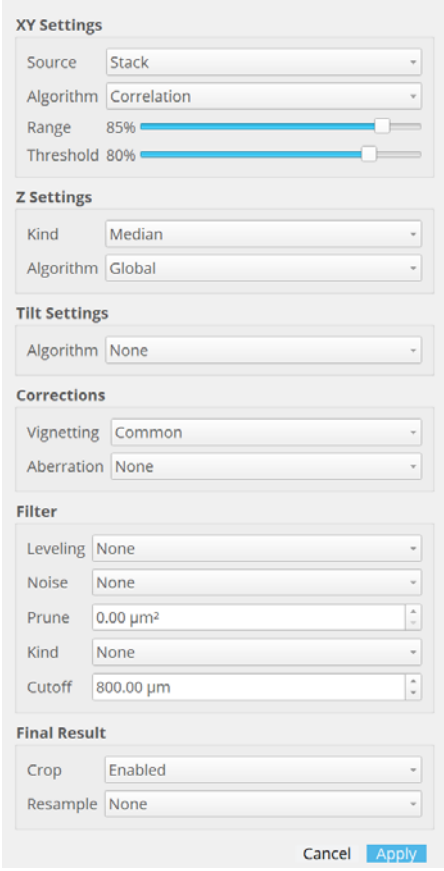
Once the necessary settings are adjusted click on CALCULATE to preview the final result. Each time CALCULATE is clicked the selected settings are applied to the original FOVs, as to not apply the same settings twice. The only exception is the XY offset, which is always applied to the last offset performed. To apply the options to the original XY offset restore the default offsets before clicking CALCULATE.

If there is a problem during the analysis a warning icon will appear; hover the mouse over the icon to see a brief description of the error:


In this case use the advanced settings to adjust the configuration. The advanced settings can help solve those cases that could not be solved with the standard settings. If the warning is related to a particular correction option disable it to see if the stitching adjustment improves.

Use the icon to return to the default settings.

## Advanced settings




Advanced settings pane

The settings available in this pane should only be changed in those cases when the default settings do not provide the desirable results. For most cases it is not necessary to adjust the advanced settings. The user must be aware of the effect of each setting before changing them.

### XY Settings

- **Source**: corresponds to the data layer that will be used to perform the XY correction. The options are Stack, Color, DataZ and Nan. The final stitching will be applied to all data layers.
  - Stack is selected by default because it works for most cases and it is the fastest; the others can be chosen for those cases where the performance using Stack is not ideal.
  - If the individual FOVs have been acquired in color this information can be used by choosing Color.
  - DataZ works best if there are distinct structures present on the surface which can be used to correlate two different FOVs.
  - Nan uses non-measured points to correlate FOVs, which is useful when there are many non-measured points or large holes.
- **Algorithm**: the kind of mathematical analysis to be applied. The options are None, Correlation, Features and Median Correlation.
  - Correlation is the default option; images are correlated by using a Fourier Transform to analyze every pixel.
  - None leaves the FOVs invariant, it is the same as not enabling the XY option outside the advanced settings.
  - Features looks for very distinct structures that are repeated in consecutive FOVs to stitch them together.
  - Median Correlation does the correlation of all FOVs, finds the median displacement, and applies it.
- **Range**: this setting only has an effect if the chosen algorithm is Correlation or Median Correlation (Features always uses range 100%).

  The higher the range, the higher the displacement (error) that can be detected within the overlapping region but with less accurate results. Lower range values mean smaller search regions, achieving more accurate displacement results. Nevertheless, if the search region is too small the results will not be correct. Set low values only for those cases where the misalignment is known to be small.
- **Threshold**: all previous options have a quality degree, meaning that they can improve or worsen the final result. If the quality threshold is not surpassed, a warning icon will appear to inform the user and the XY correction will not be applied. It is counterproductive to apply a correction that worsens the original information, so this warning appears when that may be the case. By decreasing the threshold the quality degree will become lower, thus the correction will be more tolerant but the results could be incorrect.

### Z settings

- **Kind**: how the Z offset is calculated for each region of overlapping. To calculate the offset choose:
  - Mean, which finds the mean of the overlapping
  - St. Dev., which finds the mean of the overlapping but discards those points that are farther away than the standard deviation
  - Median (default), which finds the median of the overlapping
  - Histogram, which looks at the highest point of the histogram
- **Algorithm**: The options are None, Grow and Global.
  - None does not correct the Z, this is the same as not enabling the Z option outside the advanced settings.
  - Global (default): a system of equations is used to minimize the offset differences, by moving all FOVs up and down until the error is the smallest possible.
  - Grow: the stitching is done one by one in a sequence; one neighbor is stitched to a FOV, then another, and so on.

### Tilt Settings

- **Algorithm**: The options are None and Global.
  - None does not correct the tilt, this is the same as not enabling the tilt option outside the advanced settings.
  - Global (default): a system of equations is used to minimize the offset differences, by moving all FOVs up and down until the error is the smallest possible.

### Corrections

- **Vignetting**: corrects the Stack image using measured data. This setting usually improves the Stack image result because the flat calibration of each objective is done on a mirror, which can result in some vignetting effects to be left without correcting for samples of different reflectivity. The options are None, Common, Median and Mean.
  - None: the Stack image is not corrected.
  - Common (default) searches for the vignetting of all FOVs and finds the best correction.
  - Mean calculates the mean of the Stack image, works better on smooth samples.
  - Median calculates the median of the Stack image, works better on smooth samples.
- **Aberration**: used to achieve a better result on smooth samples that have not been measured correctly. The options are None, Mean and Median.

- None: no calibration is subtracted.
- Mean: the mean calibration is subtracted from each FOV.
- Median: the median calibration is subtracted from each FOV.

### Filter

These options are applied to each individual FOV before the stitching.

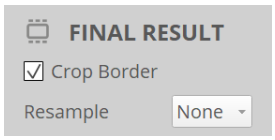
- **Leveling**: choose whether to remove the main plane from each FOV before the stitching by selecting Plane or keep the original tilt by selecting None.
- **Noise:** choose whether to remove the noise present on each FOV or not (None) and the intensity of the filter (Low, Medium, or High).
- **Prune:** surfaces surrounded by non-measured points and that are smaller than this value will be deleted.
- **Kind**: choose the output surface. None leaves the surface as it is, Roughness generates an S-L surface and Waviness an S-F surface.
- **Cutoff**: set the cutoff wavelength which separates the roughness from the waviness. Wavelength above the cutoff are assigned to waviness, and below to roughness.

### Final Result

These options are also available outside the advanced settings menu. For more information, see the section below.

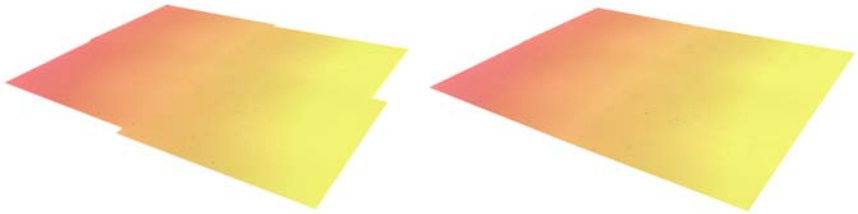
- **Crop**: choose if the stitched result should have its edges cropped or not.
- **Resample**: if wanted, the topography can be resized to achieve a different resolution. The different options are None (no resampling), HD, 2K, 4K and 8K.

### 8.2.5 Final Result




Final result pane

When FOVs are being stitched, the end result may be such that the borders are not uniform. Enable this setting to trim the borders, leaving a straight edge.

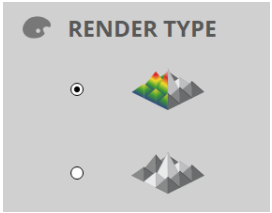


Crop disabled (left) and enabled (right)

Resample the result to a user selected resolution. This is done by taking the largest side of the topography - it can either be the horizontal or the vertical side - and it resizes it to the selected resolution. The other side is resized accordingly to maintain the original aspect ratio. The options are:

| Resolution | Largest side |
|---|---|
| **None** | As is |
| **HD** | 1080 |
| **2K** | 2048 |
| **4K** | 4096 |
| **8K** | 8192 |

### 8.2.6 Render Type




Render pane

Choose between the following ways to visually present the result:

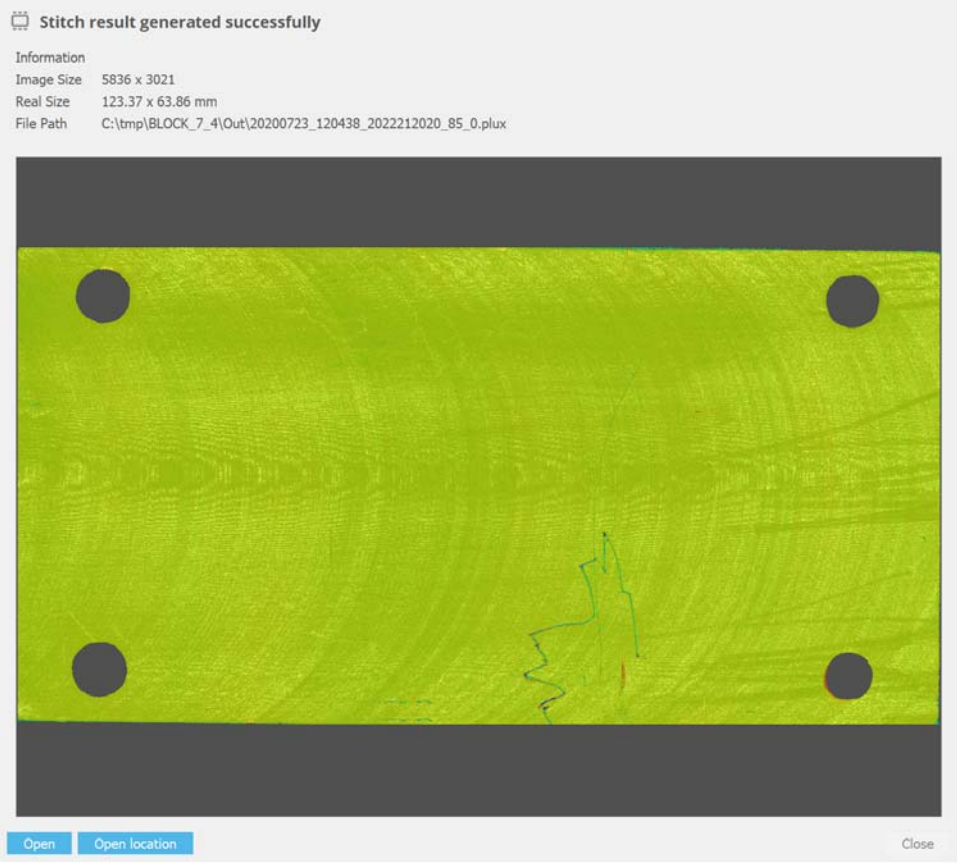
- False Color + Stack. This is the default option
- Stack / Real Color. If the topography has been acquired with a color camera the true color can be displayed. Otherwise select this option to see only the Stack without the False Color representation.

This pane is only for visual purposes and it does not affect the stitching result.

## 8.2.7 Stitch

When all settings have been adjusted, click on stitch to join all the FOVs. A pop-up window will appear showing the preview of the final result, as well as the image size and path. The user can choose to open the file, to open the location where the file is saved or to close the window.

**NOTE** Clicking on "Stitch" merges the data but clicking on "Calculate" does not, it applies the correction options and advanced settings.




Stitch result preview window

Every stitch result is saved in a folder named "Out", located inside the folder with the files used to perform the stitching. As a result, the user does not have to repeat the stitching process to see the final result.

## 8.3 Configuration Files

This section outlines the initialization settings which are determined by the contents of **.xml* configuration files.

These files can be found in the following folder: "C:\ProgramData\Sensofar\SensoSCAN S wide 1.x\Configuration". Their settings are usually configured during system installation. They can be edited using any text editor.

**WARNING**

**To restore the configuration files, close the program and delete the existing ones. When SensoSCAN is re-opened, it will generate default configuration files.**

The StageX.xml and StageY.xml files configure these options for the X / Y stages (files contain more fields but only these are used by the system):

| Section | Description |
|---|---|
| **MIN_VALUE** | Sets the minimum X/Y position in microns.<br>Default is -TravelRange/2. |
| **MAX_VALUE** | Sets the maximum X/Y position in microns.<br>Default is TravelRange/2 |
| **MAX_SPEED** | Sets the maximum stage speed in microns/second.<br>Default is 20000. |
| **REVERSED** | Invert axis values. Not inverted (false) or inverted (true).<br>Default value for X stage is true.<br>Default value for Y stage is false. |
| **STABILITZATION_TIME** | Sets a wait time to let the system settle (stabilize) before acquiring a new FOV in Extended Measurements.<br>Default depends on the XY stage type. |

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