S neox

Five Axis

SENSOFAR METROLOGY

# SYSTEM MANUAL

IFU93-01-EN, E
Software version: 7.4

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CHAPTER

# 1

# WELCOME TO SENSOFAR!

The **S neox Five Axis 3D optical profiler** combines a high-accuracy rotational module with advanced inspection and analysis capabilities. This makes it possible to take automatic 3D surface measurements at defined positions, which combine to create full 3D volumetric measurements. Alternatively, it is possible to perform automatic 3D surface measurements at specific positions around the sample to be analyzed individually, to evaluate the surface texture, for example. Three measurement techniques cover a wide range of scales, including form (Ai focus variation), sub-nanometric roughness (interferometry) or critical dimensions that require both high lateral and vertical resolution (confocal).

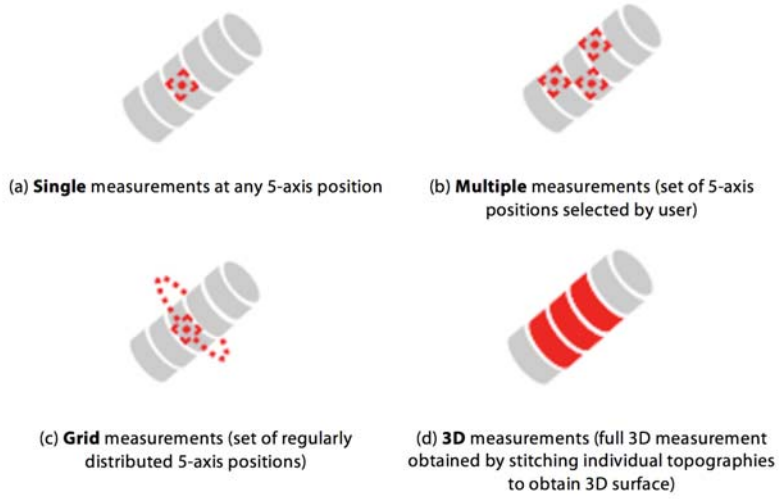


Figure 1.1 Examples of possible measurements

**SensoFIVE** is the software dedicated to controlling the hardware and managing the data obtained by the optical profiler. **SensoFIVE** manages **SensoSCAN** to control the S neox Five Axis system, its XYZ axis, light source, and measurement capabilities, such as image and topography.

This system manual will provide you with guidelines on how to use the Five Axis module, perform a calibration routine, command the different options to make a full 3D measurement, and to display the final topography or compile a set of 3D surface measurements and analyze them individually. Nevertheless, the use of this manual requires basic knowledge of **SensoSCAN**'s functionality. Thus, if there are any doubts or questions regarding **SensoSCAN**, please refer to the corresponding system manual.

# 1.1 Software Introduction

The **SensoFIVE** software has two different user interface modes: Inspection & Acquisition and Configuration & Alignment. **SensoSCAN**'s interface changes accordingly when entering one of these modes.

**SensoFIVE** has no Display & Analysis mode, it offers the Merge window for creating full 3D volumetric measurements from 3D surface measurements. However, these results should be displayed and analyzed in external software such as **Geomagic Control X**, GOM or **SensoMAP**.

## 1.1.1 Inspection & Acquisition

After starting up, the software always opens in Inspection & Acquisition mode. This mode is used to:

- Place the sample in the right position and focus on it using the Central Viewer
- Select measurement parameters in preparation for a measurement
- Control the system's motorized stages
- Manage measurement recipes

## 1.1.2 Configuration & Alignment

This mode can be accessed by clicking on the icon  , by selecting *Configuration / Calibration* from **SensoSCAN**'s menu bar or *Calibration / Go Calibration Screen* from **SensoFIVE**'s menu bar.

**NOTE** Configuration & Alignment is only visible / accessible to administrators of the system.

Configuration & Alignment is used to:

- Select software options
- Align and calibrate the rotational module

Configuration & Alignment procedures are carried out using a high-quality cylinder with a diameter of 10 mm, a λ/8 mirror and an Ai focus variation specimen.

## 1.1.3 The "Merge" Window

The "Merge" window opens after a new 3D volumetric measurement has been acquired, or when it is opened from the **SensoFIVE** toolbar.

This window has a simple 3D viewer in the center, which is able to display clouds of points or polygons and all the tools required to merge 3D surface measurements into a full 3D volumetric measurement, including point density, filters and a contour display. From this window, you can transfer data directly to external 3D analysis software, such as **Geomagic Control X** or **GOM**.

# 1.2 Service & Support

## Contact

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

The contact details for Sensofar's 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 any authorized distributor can supply all components and spares for the system and perform 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 to a new major version.

## Locating the SN

To locate your SN, open the **SensoSCAN** software. Click on Help > About… The About panel will open displaying your SN and version. It can also be found on the controller label.

# 1.3 Important Safety Information

This section provides important information regarding safety procedures, routine maintenance, and general considerations for using your S neox Five Axis.

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 injuries or damage.**

**WARNING**

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

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

## Operating mode in case of accident

In case of accident follow the risk prevention plan implemented by your company or contact the emergency services by calling your country's emergency number.

## 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.

## Power Specifications

- AC input line
- Voltage range: 100–240 V alternating current (AC), 3.0 A Max
- Frequency: 50–60 Hz single phase
- Power: 270 W
- Fuse rating: 4 A
- Fuse model: S501-4-R 250 V 5x20 mm

**WARNING**

**In 220 V connections a protective earth (PE) conductor is required.**

**WARNING**

**The only intended use for this power output is to connect the Five Axis power supply. Do not connect other devices.**


The only way to disconnect the power completely from your S neox Five Axis is to unplug the power cable from the main and electronic controller power supplies. To disconnect your display completely, unplug its power cable from the power outlet.

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

Use a CO2 fire extinguisher in case of a fire.

**WARNING**

**In order overheating and burning, a fan has been added to the electrical controller and a heat sink to the sensor head. In case of fire, do not block the air access and heat flow.**

Do not carry out repairs by yourself and do not attempt to open your system. If your system needs servicing, contact your local distributor or support service.

**WARNING**

**If you open your equipment or install other items, you run the risk of damaging it. Such damage is not covered by the limited warranty on your S neox Five Axis.**

## Important Handling Information

**NOTE** Personal Protective Equipment (PPE) is not a requirement to use the Five Axis system.

### Operating environment

- *Temperature*: 10 °C to 35 °C (recommended 20 ± 1 °C)
- *Relative humidity*: 5 to 80%
- *Altitude*: < 2000 m
- *Vibration*: required for vibration isolation frequencies in the range of 1 to 120 Hz

- *Acoustic noise*: should not exceed 75dBC

**NOTE** The noise emitted by the system while it operates is 68 dBC

## Placing the S neox Five Axis

We recommend placing the system on a surface located 90 cm above ground level, including the breadboard table in the configuration.

**WARNING**

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

## Moving the S neox Five Axis

Before lifting or re-positioning your S neox Five Axis, shut it down and disconnect all cables.

**NOTE** The system can not be moved from one place to another with the Five Axis module and the table assembled; they must be disassembled.

## General Maintenance

Please refer to the section Annex IV: Maintenance Procedures of this user manual for detailed maintenance recommendations.

### Cleaning 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 lenses 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.

**WARNING**

**Eye damage may be caused while looking directly through the lens.**

### Clean the reference mirror

If you need to clean the reference mirror, follow these instructions:

- Place optical paper over the reference mirror
- Use one or two drops of acetone
- Slide the optical paper smoothly across the mirror, wiping up the dust particles. Never rub hard, as this can scratch the mirror.

# 1.4 Copyright

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## Regulatory Compliance Information

Sensofar-Tech, S.L. declares that the system complies with the requirements of the Low Voltage Directive 2014/35/EU, the EMC Directive 2014/30/EU, the Machinery directive 2006/42/CE and the RoHS Directive 2011/65/EU, and carries the CE marking accordingly.

## Registration or update of this manual: October 2020

SENSOFAR

# CE Declaration of Conformity

*We, Sensofar Tech S.L., declare under our sole responsibility that the product*

| | |
|---|---|
| ***Product type:*** | Non-contact 3D Optical Profiler |
| ***Product name and model:*** | S neox 090 Five Axis |

*is in accordance with the essential requirements of the following directives:*

*Low Voltage Directive 2014/35/EU*

*EMC Directive 2014/30/EU*

*Machinery Directive 2006/42/CE*

*RoHS directive 2011/65/EU*

*The following standards have been applied:*

**EMC** IEC 61326-1:2012 (EN 61326-1:2013)
*Electrical equipment for measurement, control and laboratory use - EMC requirements*

**Emission**
UNE-EN 55011:2011+A1:2011
UNE-EN 61000-3-3:2009
UNE-EN 61000-3-2: 2006+A1:2010+A2:2010

**Immunity**
UNE-EN 61000-4-2:2010
UNE-EN 61000-4-3:2007+ A1:2008+A2:2011
UNE-EN 61000-4:2005+A1:2010+CORR:2011
UNE-EN 61000-4-5:2007+CORR:2010
UNE-EN 61000-4-6:2009
UNE-EN 61000-4-8:2011
UNE-EN 61000-4-11:2005

**Safety** IEC 61010-1:2010/Corr.1:2011 (UNE-EN 61010-1:2011)
*Safety requirements for electrical equipment for measurement, control and laboratory use.*

IEC 60204-1:2016 (UNE-EN 60204-1:2007+CORR:2010+A1:2009)
*Safety of machinery - Electrical equipment of machines*

*and carries the CE marking accordingly:* CE 0370

**Manufacturer:**

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Terrassa, April 22, 2020

CHAPTER

# 2

# ACCESSORIES INSTALLATION

# 2.1 Holders installation

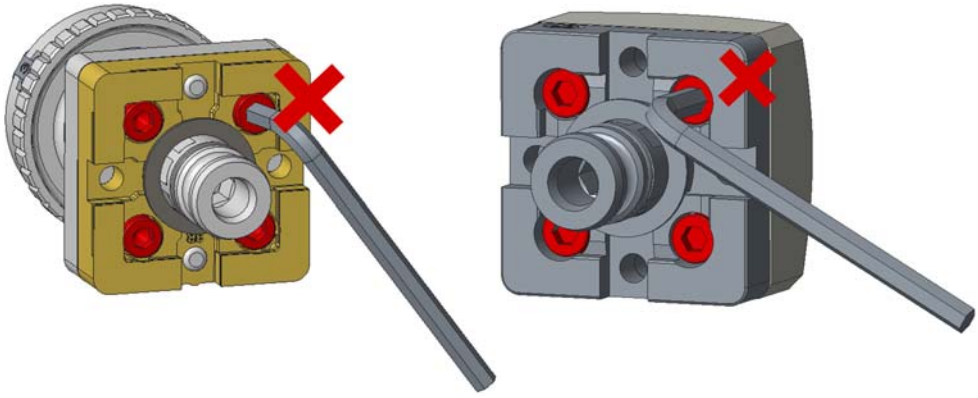
Different types of holders should be used depending on the shape of the sample. At the moment, the **SensoFIVE** software differentiates between the following types of holders:

- **Collet holders**: for samples that have a cylindrical handle. There are four types of collet holders available:
  - ER11 allows samples with diameters from 1 mm to 7 mm
  - ER16: allows samples with diameters from 1 mm to 10 mm
  - ER25: allows samples with diameters from 2 mm to 16 mm
  - ER32: allows samples with diameters from 2 mm to 20 mm
- **3 Jaw Chuck DBF34**: This holder is reversible; able to handle samples with outer diameters up to 14 mm (shaft) and inner diameters from 11 mm to 23 mm (bore).
- **3 Jaw Chuck DBF55**: This holder is reversible; able to handle samples with outer diameters up to 16 mm (shaft) and inner diameters from 13 mm to 28 mm (bore).
- **3 Jaw Chuck DBF100**: This holder is reversible; able to handle samples with outer diameters up to 40 mm (shaft) and inner diameters from 20 mm to 60 mm (bore).

Figure 2.1 Mirror holder, three collet holders, a 3 Jaw Chuck DBF34 and the collet chucks in their respective boxes

**WARNING**

**Do not disassemble in any case the pallet from the rest of the holder. Manufacturing tolerances will be lost and the accessory warranty will be void.**



- **Flat holder**: for samples that do not have a cylindrical handle.

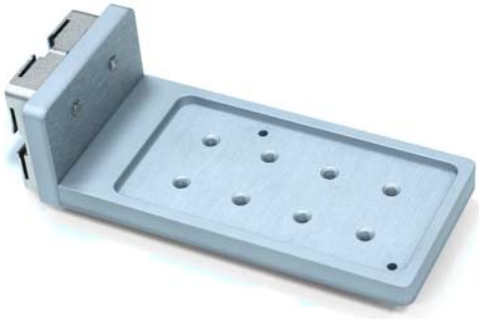


Figure 2.2 Flat holder

- **Mirror holder**: for the calibration mirror and the Ai focus variation specimen. This is only intended for calibration.

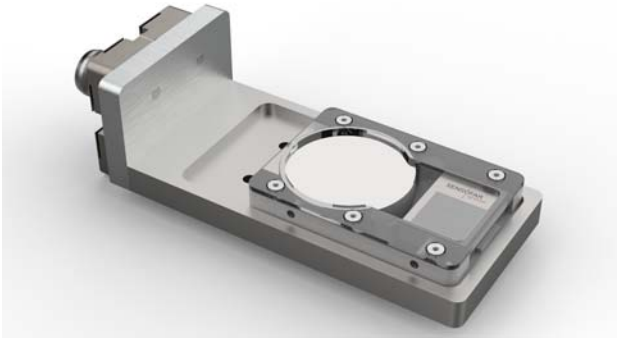


Figure 2.3 Mirror holder

The *mirror holder* consists of the flat holder and a plate on top of the flat base. This plate is designed to contain a 2" diameter mirror and the Ai focus variation calibration specimen. This plate is fixed to the bottom of the flat holder. Two thumbscrews have to be installed in the marked holes (red circles).

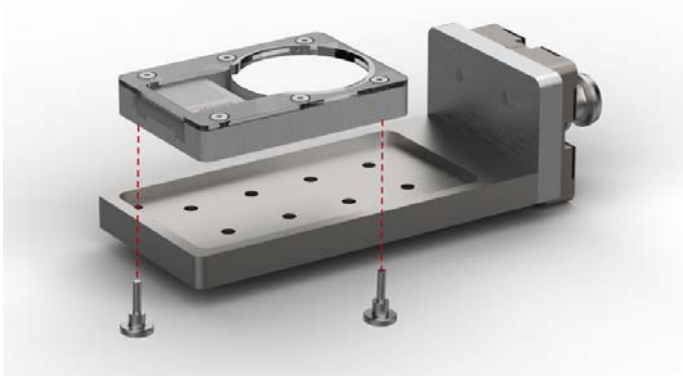


Figure 2.4 Diagram of how to prepare the mirror plate in the flat holder

**NOTE** The holders can be added and deleted through the System Preferences > Holders menu in **SensoFIVE**

## 2.2 Start-up

The following power-up procedure must be followed before the start of each Five Axis session:

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

1. Press the power button on the main controller (PC). Wait until Windows displays the login window and log in
2. Press the power button on the S neox Five Axis electronic controller
3. Switch on the Five Axis controller power switch

**WARNING**

**Wait approximately 20 s between switching on the electronic controllers and starting up the software**

4. Right-click on the **SensoFive** icon and choose "Open file location**"**. Inside the folder, right-click again on "SensoFive.exe" and choose "Properties". In the Compatibility tab, make sure that the option "Run this program as an administrator", is selected. Repeat this process with **SensoSCAN** (SensoSCAN_7.exe)

**WARNING**

**Five Axis users must have administrator rights on Windows**

5. Double-click on the **SensoFIVE** software icon. After starting **SensoFIVE**, the login window prompts the user to enter a username and a password. To log in with administrator rights, the username is **Administrator** and the password is **adm1234**.

**WARNING**

**If the login window does not display this prompt, it means that SensoSCAN is not embedded in SensoFIVE. Refer to the troubleshooting section to resolve this issue**

**WARNING**

**If at any time you only use the SensoSCAN software (without SensoFIVE) together with the Five Axis hardware, we recommend changing the turret from motorized to coded. Using a motorized turret with this hardware may cause a crash. Go to the System Preferences menu in SensoSCAN and select "Force coded turret instead of motorized"**

## 2.3 Preparing Samples

In order to prepare the sample, you need to select the proper holder. Afterwards, attach it to the Five Axis module.

**WARNING**

**The rotator's current must be OFF. You can disable the rotator's current by clicking on (located in the SensoFIVE toolbar), or by changing the type of holder in the 5MR section**

Once the current is off, you can proceed to mount the holder. Look for the screw (red circle) in the rotator and loosen it using a 5 mm hex key:

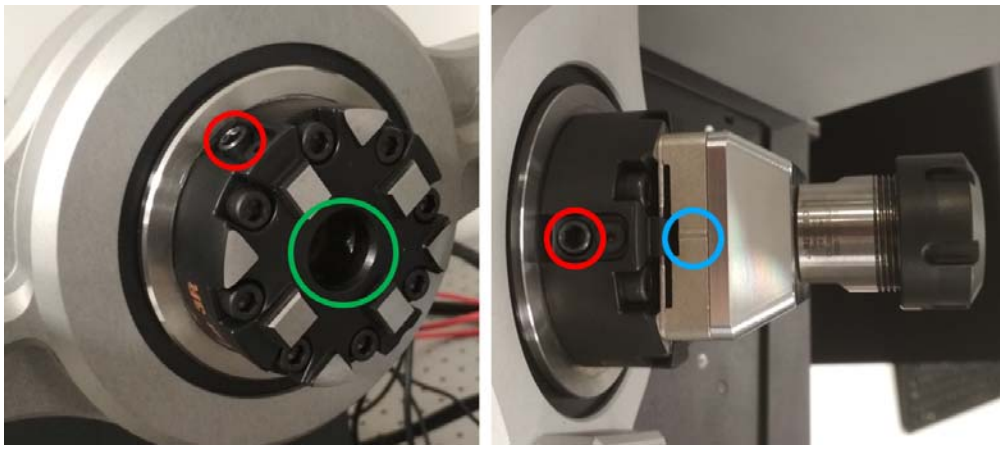


Figure 2.5 Five Axis rotator without any holder attached (left) and with a collet holder (right)

Insert the drawbar clamp into the center of the rotator (green circle) and once it has been positioned correctly, retighten the screw. The line mark in the pallet should coincide with the chuck clamping screw (Figure 2.5).

In the case of the **collet holder,** as each collet only has 1 mm rank, you will need to select the proper chuck from the supplied set to fit the diameter of the sample (handle).

Figure 2.6 Collets ER16 & ER32 with diameters ranging from 0.5 mm to 20 mm

Once selected, insert the collet ER25 into the thread of the holder and then screw the nut into the holder:

Figure 2.7 Steps to mount the different parts comprised in the collet holder

The ER8 collet is available upon request, which allow samples with diameters from 1 mm to 5 mm.

**WARNING**

**Once the rotator current is enabled again, an automatic homing will be done. Pay attention to the distance between the objective and the sample/holder. We recommend moving the Z scan position up for safety purposes. Also consider that samples may fall from the flat holder as a result of the rotation**

**WARNING**

**Do not screw the holder with the sample clamped. The sample must be placed in the holder after screwing**

# 2.4 SensoFIVE

## Motor Connections

System status of **SensoFIVE** (at bottom left of screen) displays the motor connections status. If both are OK, the status is "Ready" (green). If any of them are not connected, the status is "Warning" (orange).

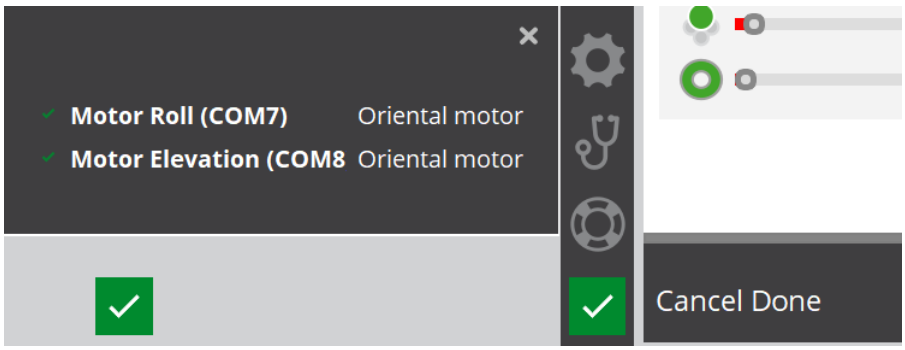



Figure 2.8 Motor connections

## Homing Actions

Every time the motor controller is restarted, a motor homing has to be performed for both axes. **SensoFIVE** displays a message on the screen to let the user know that a motor homing action will take place.


Figure 2.9 Message that appears when the controller is restarted

Users can also start the homing at any time from the "Calibration" screen (see Calibration Steps).

**WARNING**

**Make sure that the trajectories are free to prevent the objectives from crashing**

**WARNING**

**Rotation homing might cause the sample to fall. When the flat sample holder is mounted it is recommended to remove the sample before the homing**

We recommend moving coarse Z position up for safety purposes.

## Shutdown

The following shutdown procedure must be followed at the end of each Five Axis session:

1. Close **SensoFIVE**
2. Shut down the PC
3. Press the S neox Five Axis controller power button (the controller light will turn off)

CHAPTER

# 3

# QUICK START GUIDE

# 3.1 User interface

When **SensoFIVE** is launched, the user interface has two modes: Inspection & Acquisition and Configuration & Alignment. After the login, the software enters the Inspection & Acquisition mode.

Here we will explain the Inspection & Acquisition layout. The **Five Axis screen** is on the left side of the interface. Next to the Five Axis screen there is the common **SensoSCAN**, space which includes the main **Toolbar**, the **Sample Inspection** settings with the **System Status** below, the **Central Viewer** area, and finally the **Acquisition Settings** on the right**.** An expand icon is located on the toolbar, which changes the visualization mode, expanding or contracting the Five Axis screen.

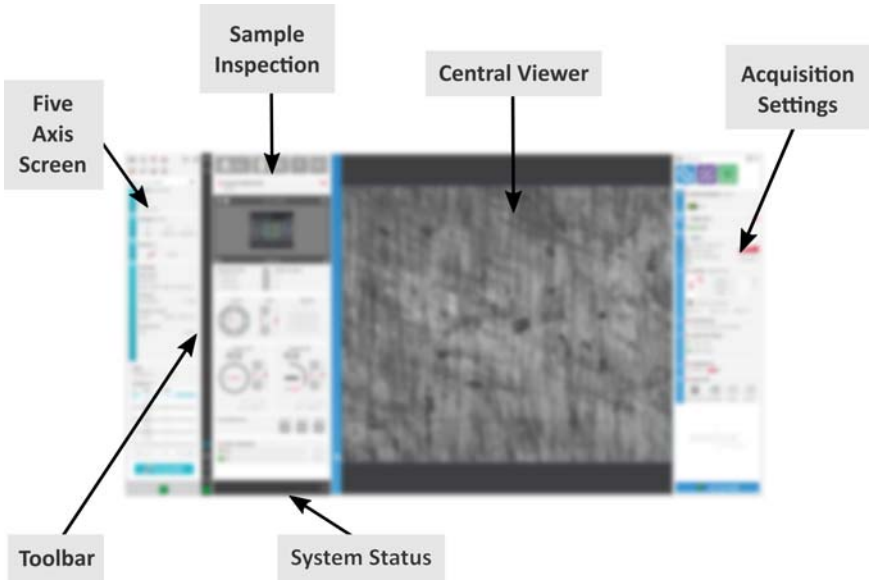



Figure 3.1 Inspection & Acquisition mode interface

The **SensoFIVE** Menu includes:

- **Toolbar**

  The toolbar allows the user to use basic features to: open result, load sample, enable/disable safe movements, automatically correct the tilt, disable the rotator current, open **System Preferences** and open the menu. One of the options included in the menu opens the Merge window.

- **5MR**

  The 5MR (Five Axis Multiple Recipe) is made up of different sections that define in the recipe how to measure the desired points or regions of the sample: Recipe, Holder, Sample, Result, Settings, INFO and ACQUIRE button

- **Hardware control (integrated into SensoSCAN)**

  The hardware control allows the user to move the rotation and elevation axes (A and B) in order to manipulate the sample and measure the desired region. This hardware control can be complemented with the **SensoSCAN**'s hardware control to manipulate the X, Y, Z axes.

## Status

The Status bar shows the current system status.

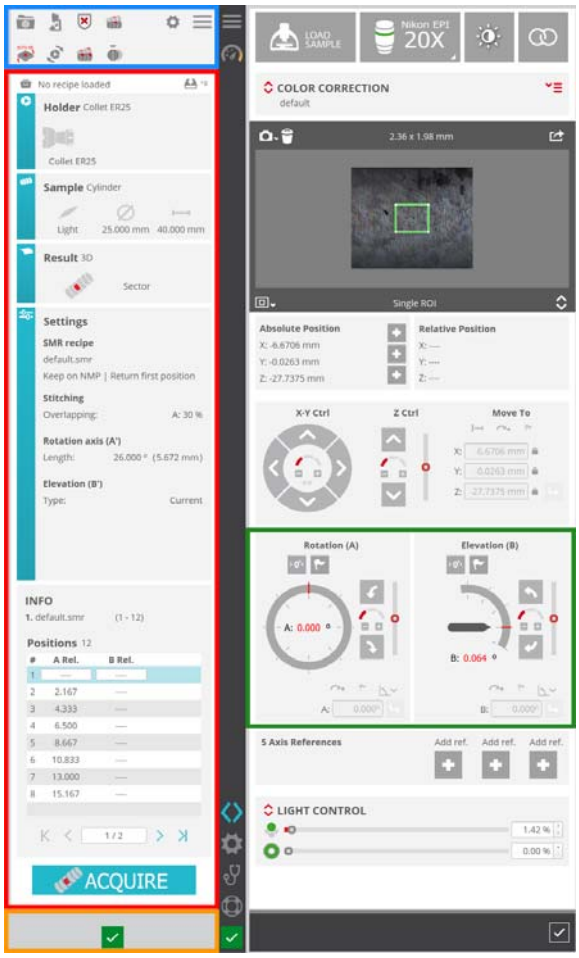



Figure 3.2 SensoFIVE menu interface

## 3.2 System Axes

The system's axes are defined as X, Y, Z, A, and B. There are two Z stages: Z coarse (manual, 350 mm travel range) and Z (motorized, metrological, 40 mm travel range).

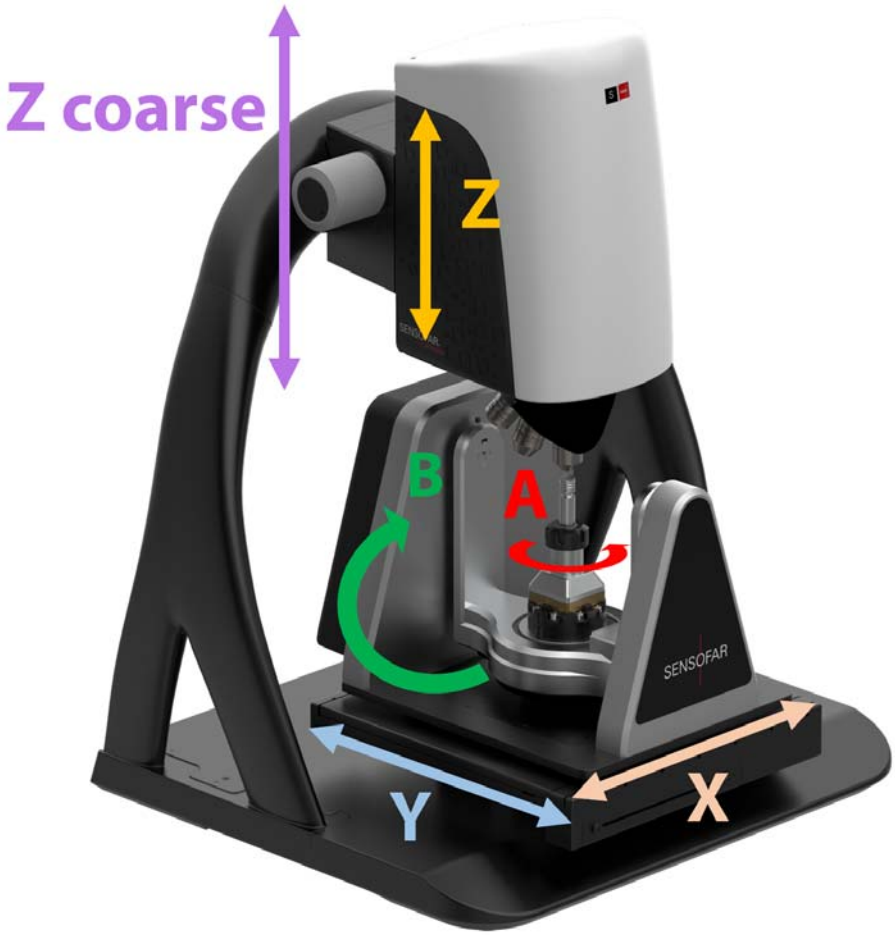



Figure 3.3 Scheme of the different axes. X, Y, Z are the Cartesian axes, while A is the rotation axis and B the elevation axis

Rotation axis (**A**) rotates 360° limitlessly. The rotation is performed around the axis going through the center of a cylindrical sample. The rotation axis can be tilted by the elevation (**B**) motor. Elevation rotates around the Y-axis. In the Figure 3.3, B is positioned at 90°.

**WARNING**

**When the program executes a Z stage movement, be careful not to trap your fingers between the moving parts.**

The rotation point corresponds to the point where the A and B axes intersect. Elevation rotation is performed around this point.

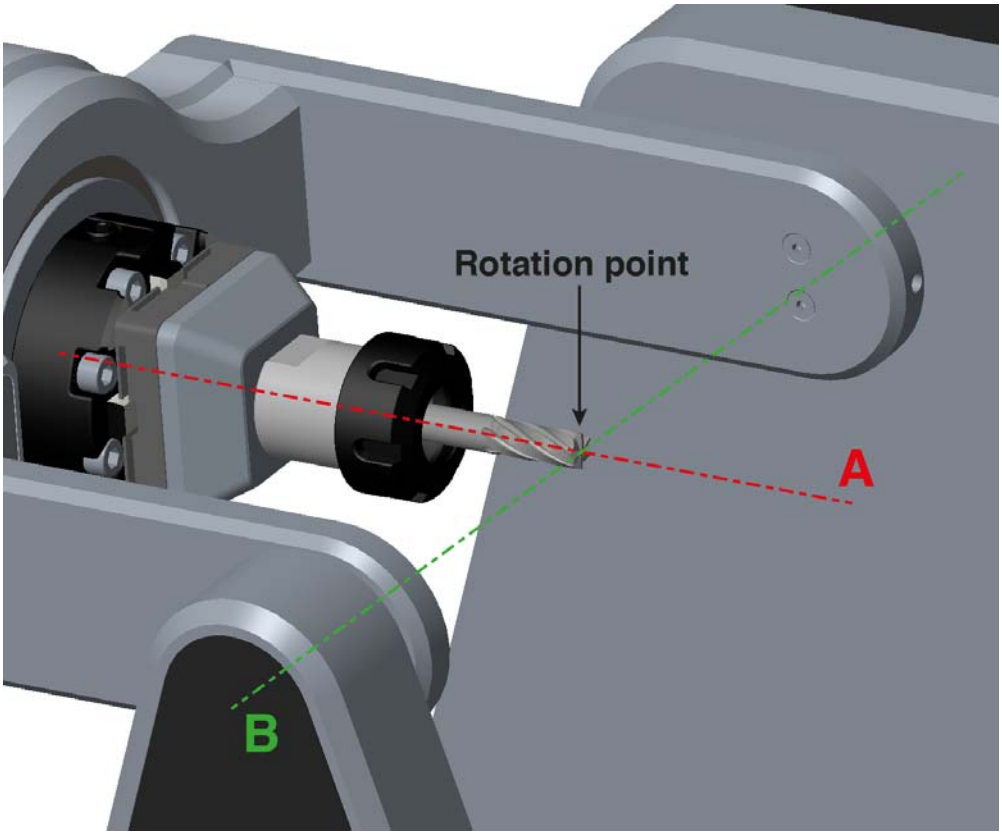



Figure 3.4 Diagram of the rotation point. A=0°, B=0°

**WARNING**

**Be careful not to trap your fingers with the 5-axis module when a movement is being executed.**

CHAPTER

# 4

# ROTATION (A) & ELEVATION (B) MOTORS

The Five Axis module relies on the ability to move the rotation axis and the elevation axis, which are designated as A and B, respectively.


Figure 4.1 Rotation and elevation motors widget

Both motor controls have the same structure:

- **Define positions**

  This function makes it possible to define a new zero position (left button), thus recalculating the value of the positions; or a new reference position for that axis. When a new zero or reference is

defined, the buttons turn red. Clicking on the buttons again overwrites the zero/ reference for the current position or deletes the defined value.

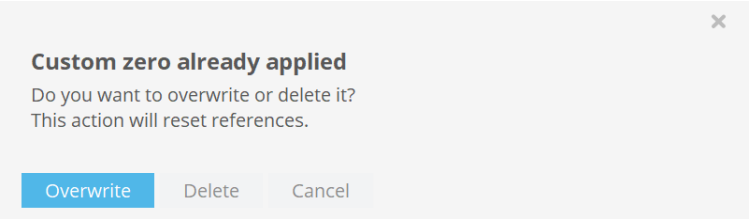
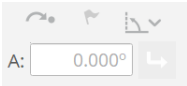
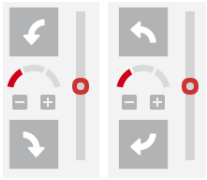



Figure 4.2 Warning message that appears when attempting to overwrite the existing zero

- **Move to** 


This part of the widget allows the user to move automatically to the absolute position defined in the box (left icon), to the reference, if it is already defined (central icon), or to a predefined positions of [0°, 120°, 240°] for rotation and [0°, 90°] for elevation (right icon). In all cases, pressing the "enter" key executes the movement.

- **Move manually** 

The arrows rotate the motors in opposite directions at the velocity defined by the +/- buttons. The slider allows for a more precise movement.

CHAPTER

5

# CALIBRATION PROCEDURE

A calibration is required in order to ensure that the Five Axis module functions properly.

To access the calibration screen, click on the Calibration icon in the **SensoSCAN** menu. Alternatively, click on *Configuration / Calibration* from **SensoSCAN**'s menu bar or *Calibration / Go Calibration Screen* from **SensoFIVE**'s menu bar.

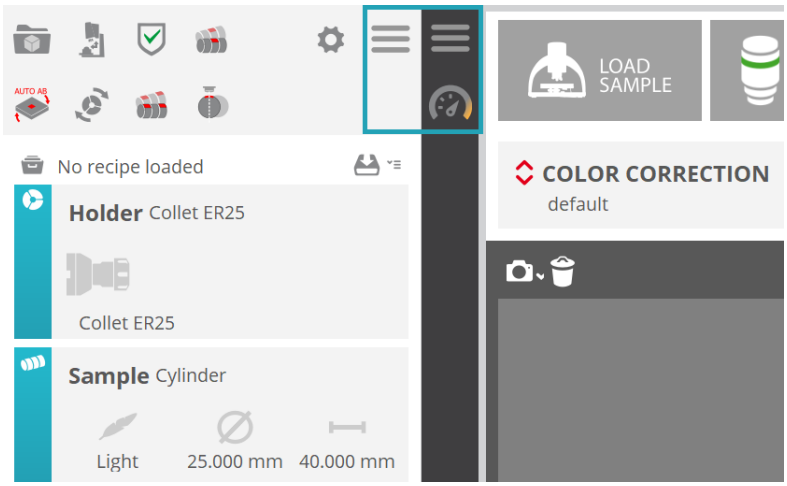



Figure 5.1 SensoSCAN path to enter Calibration

Both the **SensoFIVE** and **SensoSCAN** screens switch to their respective calibration screens.

# 5.1 Calibration screen

There are five calibration sections on the left side in **SensoFIVE** (Figure 5.2).

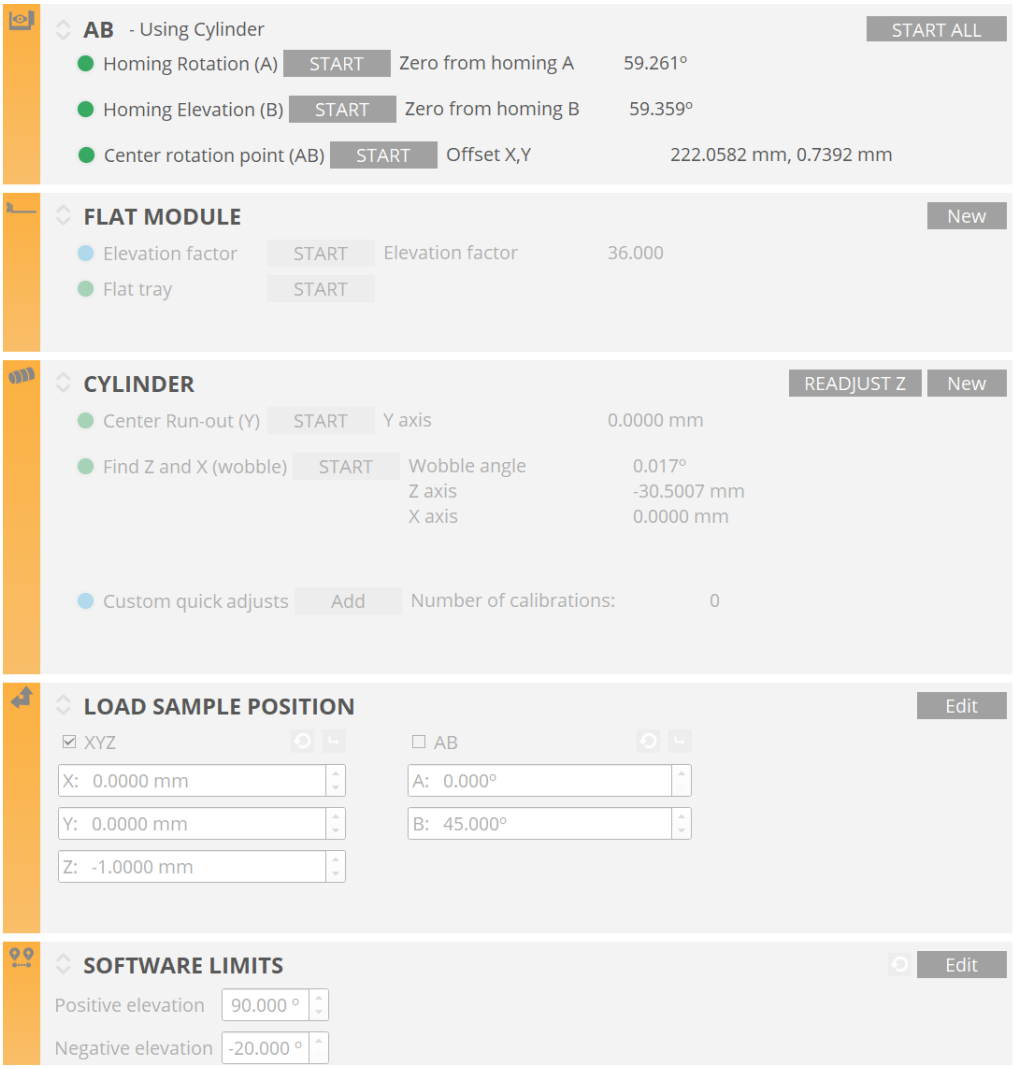



Figure 5.2 SensoFIVE calibration screen

The status of the parameter/procedure to calibrate is represented by a colored circle to the left of the parameter/procedure. Green stands for OK, red for NOT OK, blue indicates that the parameter/procedure is optional but not calibrated, and yellow indicates that the calibration is required but still missing.

## AB

The homings are needed by the system to find references in the hardware in order to position the different motors correctly, because the system loses its references if the motor or table is moved while the power is off or the controller is shut down. The center rotation point moves X and Y to a position close to the rotation point.

## FLAT MODULE

The elevation factor ensures that the distance moved by the motor matches the distance commanded by **SensoFIVE**.

The flat tray calibrates the position of 0° for when perpendicularity to the optical axis is needed.

## CYLINDER

This section searches for the coordinates (X, Y, Z) of the rotation point more accurately.

## LOAD SAMPLE POSITION

This section defines the absolute coordinates for where the holder will move when using the Load sample option.

## SOFTWARE LIMITS

This allows the user to limit the elevation movement in the software.

# 5.2 Five Axis Calibration

S neox Five Axis calibration requires the S neox 20X EPI objective to be available and calibrated so that it can be used for autofocus and topography measurements. If other objectives need to be calibrated, do so after completing the center rotation point (AB) step.

## 5.2.1 Calibration Specimens

- Mirror holder with:
  - Calibration mirror
  - Calibration specimen (Ai Focus variation & Confocal fusion)
- Calibration cylinder, 10 mm diameter

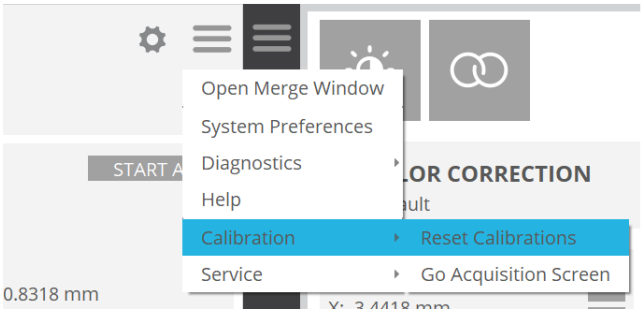
For more information about the different types of holders see Holders installation.

## 5.2.2 Calibration Steps

We will describe the process to perform a complete calibration. Some steps use **SensoFIVE** tools and some use **SensoSCAN** tools.

The full calibration procedure for the Five Axis includes the following steps:

1. **SensoFIVE** → **Reset Calibrations** to avoid any errors caused by previous calibrations. Go to the calibration menu in the Quick Bar:




2. **SensoFIVE** → **Homing A & B** (automatic after starting **SensoFIVE** if Five Axis controller has been reset or manually in "Calibration" screen)
3. **SensoSCAN** → **Home search Z** in the XYZ section
4. **SensoFIVE** → **Center rotation point (AB)** in the AB section

**NOTE** Alternatively, the user can perform the A & B homings and the center rotation point (AB) calibration simultaneously using the "Start all" option.

5. **SensoSCAN** → S neox Five Axis calibration (optional: only needed when S neox Five Axis is not calibrated)

   5.1 Position the mirror holder as follows:

   5.1.1 Screw the mirror plate into the flat holder

5.1.2 Disable the rotator current . A message will appear prompting you to select a holder. Do **NOT** click on "*Apply*".

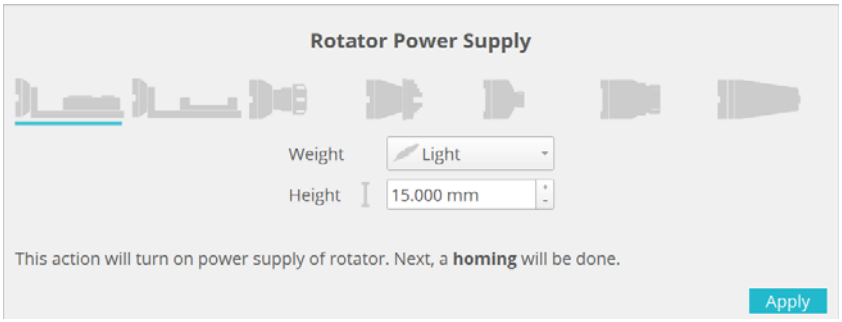



Figure 5.3 Holder selection pane

5.1.3 Remove the collet holder and insert the mirror holder

Figure 5.4 Mirror holder

5.1.4 Click "*Apply*"

**WARNING**

**Homing rotation (A) will be applied. Pay attention to the distance between the objective and the holder to avoid collisions**

**WARNING**

**If the holder rotation position is not close to where the mirror surface is perpendicular to the objective, the homing may fail and you will need to perform a manual "Homing Rotation (A)"**

5.2 **SensoFIVE** → Move elevation to 0°

5.3 **SensoFIVE** → Rotate the mirror until it is perpendicular to the objective. In subsequent steps, you will be able to level the mirror more accurately

5.4 **SensoSCAN** → Place and select 20X EPI objective

5.5 **SensoSCAN** → Focus the mirror surface with Z position around -25 mm. Move Z coarse adjustment to achieve this. This position is suitable for measuring most common samples.

5.6 **SensoSCAN** → Move X and Y to focus the center of the mirror

5.7 **SensoSCAN** → **Slit Position**

5.8 **SensoFIVE** → Click on  to level the mirror correctly *(around 3 min)*

5.9 **SensoSCAN** → Repeat **Slit Position**

5.10 **SensoSCAN** → **Light Balance** *(around 2 min)*

5.11 **SensoSCAN** → **Image Filters**

5.12 **SensoSCAN** → Calibrate the objective using the mirror

5.12.1 Select objective (add it to the turret position if the objective is not in the list)

5.12.2 Calibrate **Flat** *(around 1 min)*

5.12.3 Calibrate **Confocal Flat** *(around 2 min)*

5.12.4 Calibrate **Aberration** *(around 2 min)*

5.12.5 Check objective calibration by measuring the same point twice and subtract the measurements to obtain the system noise

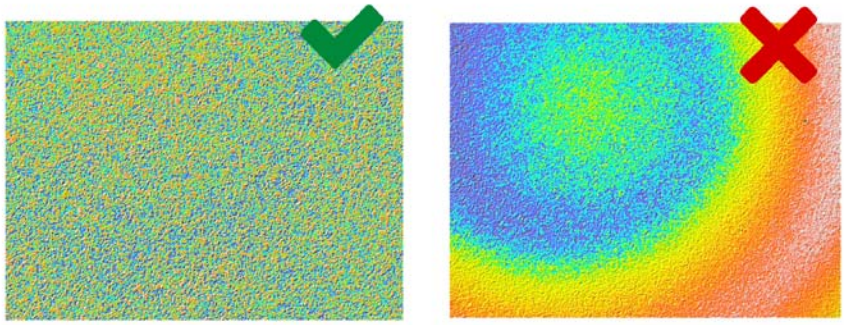


Figure 5.5 Examples of correct/incorrect aberration calibration

**NOTE** Optionally, if interferometric objectives will be used for aquisition, select the corresponding objective and calibrate **Flat** and **Calibration Mirror**.

5.13 **SensoSCAN** → Calibrate 20X EPI objective using the calibration specimen

5.13.1 Focus the calibration specimen

5.13.2 Calibrate **Ai Focus variation** *(around 6 min)*

5.13.3 Calibrate **Fusion** *(around 1 min)*

5.13.4 Check the Ai focus variation calibration by measuring an extended topography 2x2

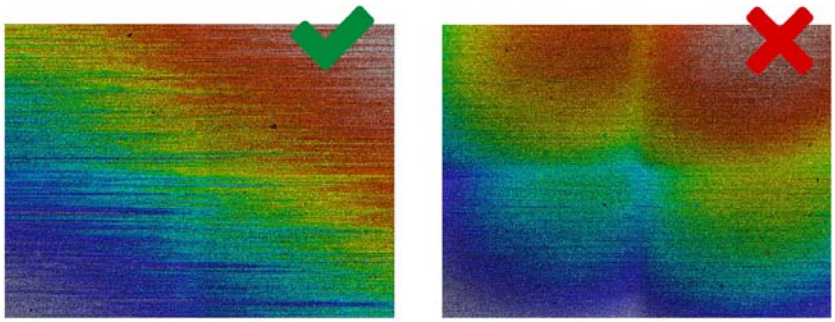


Figure 5.6 Examples of correct/incorrect Ai focus variation calibration

6. **SensoFIVE** → Perform **new** *Flat Module* calibration

   6.1 (Optional) **Elevation factor** *(around 2 min)*. This calibration requires the following steps to be taken:

      6.1.1 Move the elevation to 0°

      6.1.2 Focus at the mirror center using XY table

      6.1.3 Focus the mirror surface with Z position between -30 and -35 mm. Move Z coarse adjustment if required to achieve this. The Z position is different because an elevation homing is performed when the elevation factor calibration is complete, so that the motor moves up in order to avoid a collision between the objective and the holder

      6.1.4 When finished, accept the dialog to perform an elevation homing

**WARNING**

**Elevation homing moves Z up and X to the right. As a result, it may be necessary to compensate the elevation movements**

   6.2 **Flat Tray** *(around 2 min)*. This calibration requires the following steps to be taken:

      6.2.1 Move the elevation to 0°

      6.2.2 Focus at the mirror center using XY table

      6.2.3 Focus the mirror's surface with Z position between -30 and -35 mm. Move Z coarse adjustment if required to achieve this.

**WARNING**

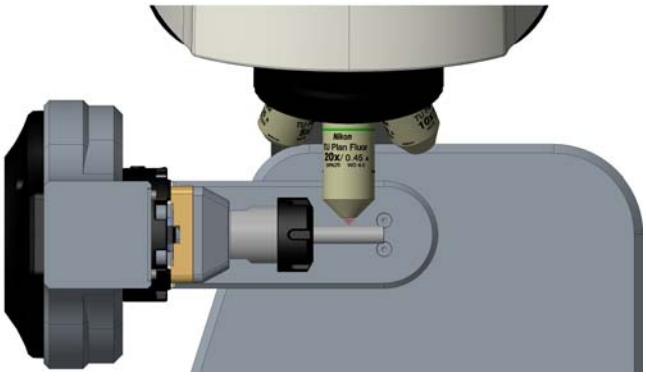
**We recommend emptying the nosepiece slot next to the objective (clockwise) in order to avoid a collision during the flat tray calibration, as seen in the image:**


7. **SensoFIVE** → Insert the calibration cylinder with a diameter of 10 mm. Move the Z position up in order to change the holder

7.1 Disable current in rotator. A message will appear prompting you to select the collet holder. Do **NOT** click on "*Apply*"

7.2 Remove the mirror holder and insert the collet holder with the (9-10 mm) collet

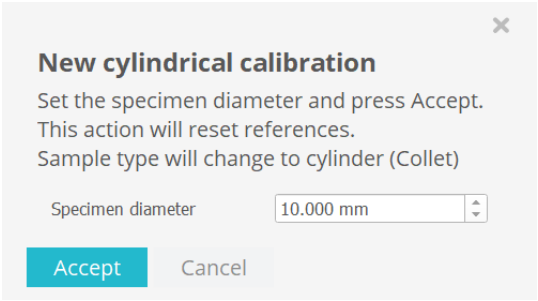
7.3 Place the cylinder into the collet leaving 40 mm outside the holder and focus in the middle of the cylinder (20 mm):



7.4 Click on "*Apply*"

8. **SensoFIVE** → Perform **new** *Cylinder* calibration

8.1 Make sure that the cylinder diameter in the dialog is 10 mm:




8.2 **Center Run-out (Y)** *(around 5 min)*. This calibration requires the following steps to be taken:

8.2.1 Move the elevation to 0°

8.2.2 The cylinder in the collet must have 40 mm clearance outside the holder. Focus in the middle of the cylinder (20 mm)

8.2.3 Focus the cylinder surface with Z position between -25 and -30 mm. Move Z coarse adjustment if required to achieve this. The value of Z position changes because the height of the mirror holder and the cylinder are different

8.3 **Find Z and X (wobble)** *(around 4 min)*. This calibration requires the following steps to be taken:

8.3.1 Move the elevation to 0°

8.3.2 The cylinder in the collet must have 40 mm clearance outside the holder. Focus in the middle of the cylinder (20 mm)

8.3.3 Focus the cylinder surface with Z position between -25 and -30 mm. Move Z coarse adjustment if required to achieve this

8.3.4 Press "Yes" to go to the new calibrated center

8.4 **Custom quick adjustments** *(around 2 min).*

This calibration is used to fine tune the calibration in order to measure at different elevations.

Multiple "Custom quick adjustments" calibrations can be performed. The number of performed calibrations will be stored and displayed in the calibration menu. The user can access these calibrations in the Merge screen, in Acquisition Settings.

This calibration can be done with any objective. The sample must be a cylinder, but the diameter may vary, as well as the slope (elevation). This calibration requires the following steps to be taken:

8.4.1 Move the elevation to the measurement position

8.4.2 The cylinder in the collet must have 40 mm clearance outside the holder. Focus at least 10 mm from the cylinder's edge

8.4.3 Focus the cylinder surface with Z position between -25 and -30 mm. Move Z coarse adjustment if required to achieve this

8.5 Click **End** to apply the calibration to the system

**WARNING**

**Avoid moving Z coarse adjustment after performing the calibration to maintain the calibration of the Z position on the rotation axis. In the event a sample requires the Z coarse position to be changed, the Z position on the rotation axis will need to be readjusted. Click on the READJUST Z button to do this (in the "Cylinder" section of the "Calibration" screen). This option is only available for cylindrical samples. An automatic rotation around the A axis is performed, which could crash against the objective with non-cylindrical samples.**

**WARNING**

**After a READJUST Z procedure we recommend performing a Custom Quick Adjustments calibration. This will correct any errors in the calibration that could have appeared after the change in the Z coarse position.**

CHAPTER

# 6

# FIVE AXIS MULTIPLE RECIPE (5MR)

The widgets and buttons that relate to the 5MR are grouped together on the left side of the screen.

To create a new 5MR from scratch, the user will need to define the settings in this order:

- Holder
- Sample
- Result
- Settings
- INFO

Each setting will be explained in detail in this chapter.


Figure 6.1 5MR section

# 6.1 Holder

Depending on the sample's handle, the user will need to use different types of holders. The available holders are:

- **Mirror**: holds the mirror and Ai focus variation specimen samples.
- **Flat**: for samples that have no cylindrical handle.
- **Collet**: for cylindrical samples, or ones that have a cylindrical handle. There are four different collets: ER11, ER16, ER25 and ER32.
- **3 Jaw Chuck**: for cylindrical samples or samples with cylindrical handle.There are three different types: DBF34, DBF55 and DBF100.

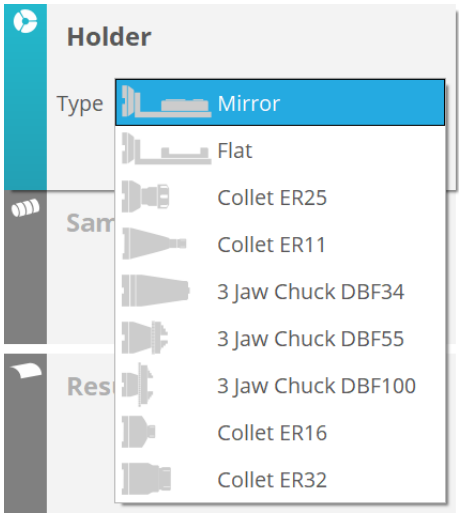



Figure 6.2 Holder type selection

See Holders installation for more information about the available holders.

## 6.2 Sample

Once the holder is selected, the software needs to know if the sample is *ligh*t (<2 kg) or heavy (>2 kg). Depending on the holder, the user will also need to specify different dimensions for the sample:

- **Collets and 3 Jaw Chuck holders**: the sample's diameter and length. The length corresponds to the distance between the edge of the holder and the edge of the sample).

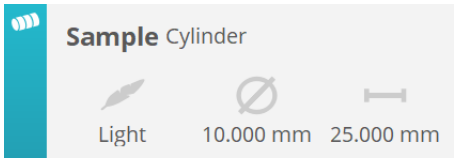



Figure 6.3 Sample parameters when using a collet holder

- **Flat and Mirror holders**: none (*sample* section is disabled for these holders).

**NOTE** The sample's diameter is limited by the FOV height. It is not possible to acquire if the diameter is smaller than 1/4 of the FOV's height.

## 6.3 Result

The three different types of results you can measure with the Five Axis module are: Manual, Grid and 3D.

- The **Manual** result is suitable for the samples that need to be measured at a very specific position so that they can be defined manually.
- The **Grid** measurement is used to obtain equally spaced measurements inside a defined region.
- The **3D** measurement is used to obtain a full 3D volumetric measurement. It can be used to define how to acquire equally spaced measurements inside a defined region with a certain overlap between measurements so that they can be merged.

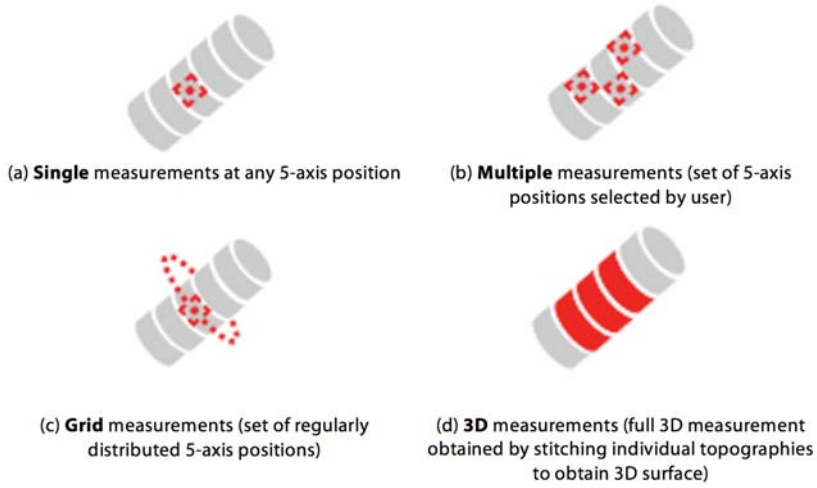



Figure 6.4 Example of manual (a) and (b), Grid (c) and 3D (d) measurements

The software automatically calculates both the grid and 3D positions, depending on the values configured in the **Settings** section.

### 6.3.1 Manual (Available for all Holders)

Two different types of measurements are available for this type of result:

- **Single**: only the current position will be measured
- **Multiple**: a set of positions will be measured. To add a new position, move to the desired position and click on ⊞ in the INFO section. All the coordinates will be loaded into the list of positions. To delete a position click on ×.

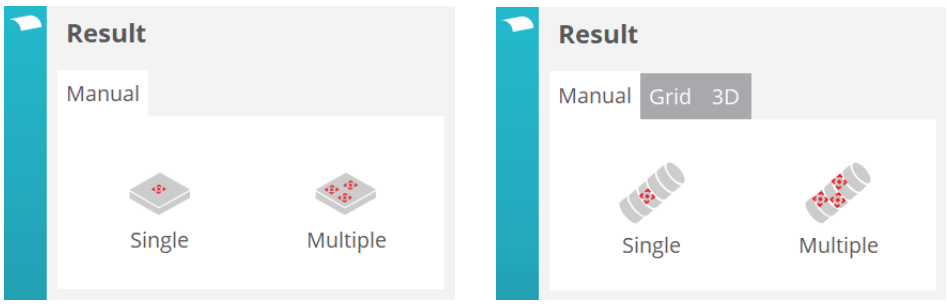



Figure 6.5 Type of result available for flat (left) or collet (right) holders

### 6.3.2 Grid and 3D (Only Available for Collet and 3 Jaw Chuck Holders)

Four different types of measurements are available for these types of results:

- **Sector**: defined region where the only the rotation axis changes. In the "Settings", you can change how many points are needed and the angular spacing between the points.
- **Extended**: same as the sector option, but the length of the sample that needs to be measured is also defined in addition to the rotational sector. The starting point is the one closest to the clamp (on the sample's axis).
- **Circle**: a 360º Sector.
- **Cylinder**: A circle extended lengthwise. The starting point is the one closest to the collet (on the sample's axis).

For 3D, when the full 5MR has finished, the *Merge* window opens automatically.

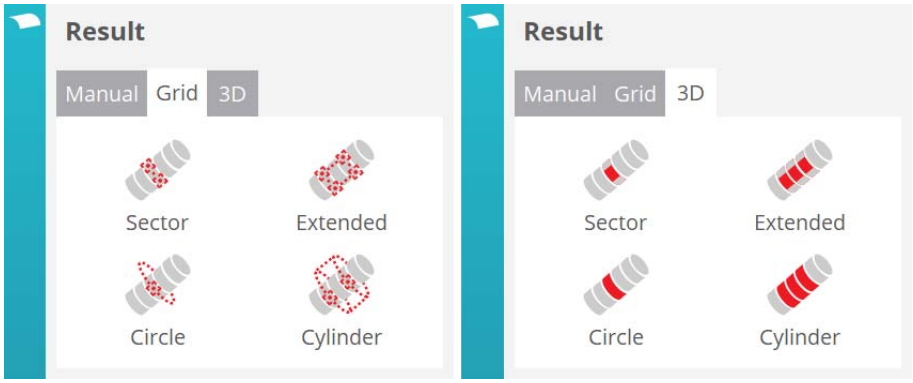



Figure 6.6 Type of result for the collet holder

## 6.4 Settings

Depending on the result and measurement type selected, you will need to configure several settings. The common setting will be to determine which Single Measurement Recipes (SMRs) are going to be used. If you want to use more than one SMR, add them by clicking on the ⊞ button. In **3D**, however, you can only select one SMR.

**WARNING**

**The order of the SMRs will determine the acquisition order of the different positions**

Define where to save the 5MR results by choosing a root folder and a base name.

The common settings include the following checkboxes:

- Continue measuring even if one of the positions is a "Non Measured Point"
- Early rotation after scan speeds up the measuring process by performing a rotation to find the next position while the last scan is being processed. It is not available for a single manual measurement.
- Return to the initial position (from the *Positions* list in *INFO*) when the full 5MR is finished
- Retract Z before each movement a distance set by the user
- Force the use of automatic turret movement

### 6.4.1 Manual

For the manual result type, you do not have to adjust any additional settings.

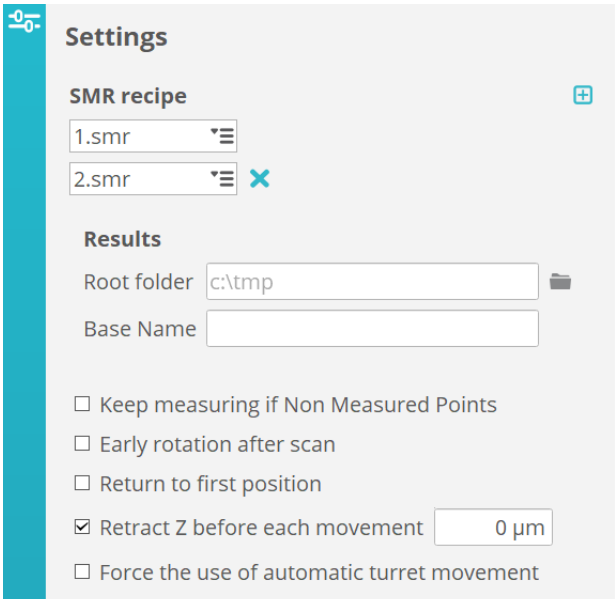



Figure 6.7 Manual settings pane

## 6.4.2 Grid

If the type of measurement result is grid, always specify the direction of rotation (clockwise/ counter-clockwise) in the settings along with the number of measurements required on the rotation axis. Other settings depend on the measurement type.

In the case of **Sector** or **Extended**, you will also need to specify the spacing between these measurements. The software will calculate the rotational angle covered by the measurements.

There are two options available for the elevation: Current and Absolute. In the latter case, you need to specify the absolute angle at which you want the sample to be measured.

In the case of **Extended** or **Cylinder**, you will also need to define the number of measurements in length (along the rotation axis) and the spacing between the measurements.

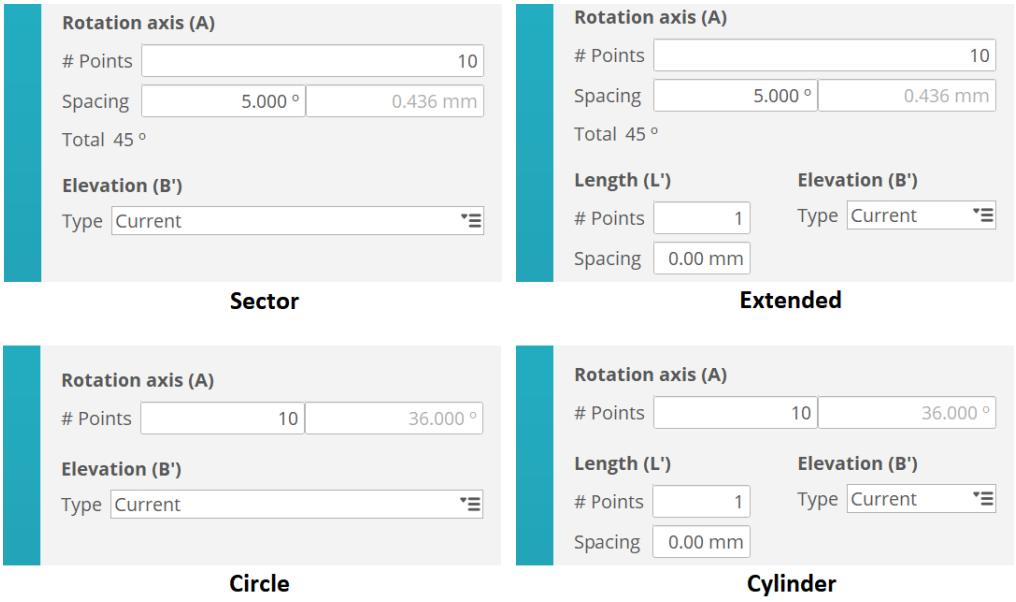



Figure 6.8 Settings for a Grid measurement

## 6.4.3 3D

The common setting for all 3D result types is the overlapping factors, which we recommend setting to 20-30% for cylindrical samples, 40-50% for more complex samples, and 70-80% for very complex samples.

There are three options available for the elevation: *Current*, *Absolute*, and *Dual*. In *Absolute* you will need to specify the absolute angle at which you want the sample to be measured. The *Dual* elevation mode performs the full measurement at one given angle of elevation and afterwards it repeats the full measurement at the second given angle. It is useful for samples that have steep angles and need to be measured from different points of views.

Figure 6.9 Example of the two elevations (-15° and 15°)
used in dual mode to measure a milling tool

For the **Sector** and **Extended** measurements, the software requires that you define the rotational length that is going to be measured.

For the **Extended** and **Cylinder** modes, you need to specify the length (along the rotation axis) of measurement.

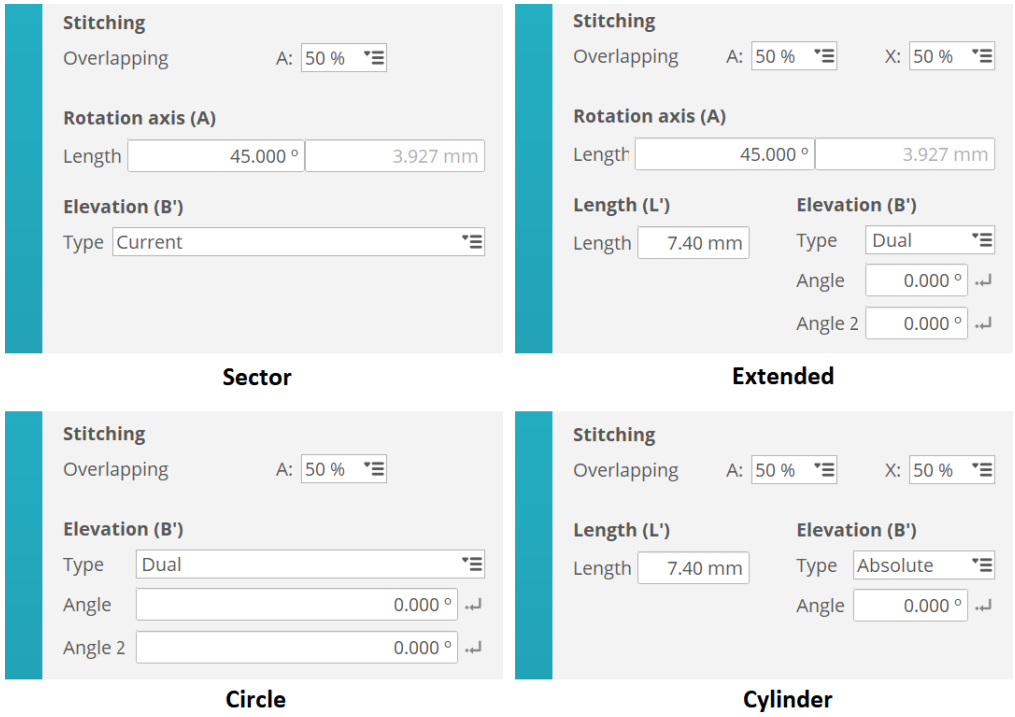



Figure 6.10 Settings for a 3D measurement

# 6.5 INFO

This section lists all of the positions that will be measured and the SMRs used for each position.

For the **Manual > Multiple** measurement, the positions have to be added by moving to the desired position and clicking on ⊞. For the **Manual > Single measurement,** the measured position is the current one. For **Grid** and **3D**, all of the positions are calculated automatically from the current position.

A summary of all SMRs added in *Settings* (for Manual and Grid) will appear. The user can define which positions are to be measured with each SMR. The same position can be measured more than once with a different SMR.

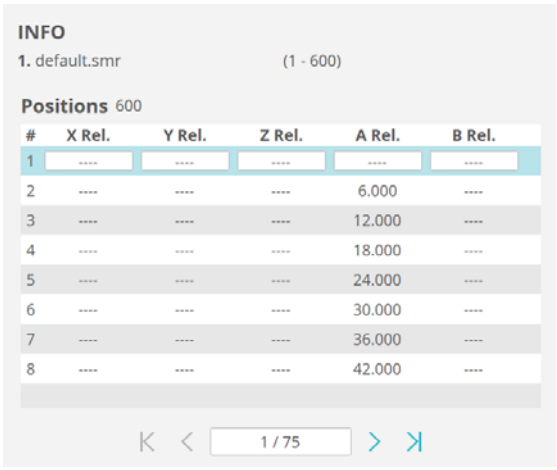



Figure 6.11 List of positions to be measured during the 5MR

Using the example of the Figure 6.11, there are 600 positions in total. Therefore, we need to assign at least one SMR to each of the 600 positions.

In the Figure 6.12 the SMR recipe settings show that the positions from 1 to 40 have at least one SMR assigned (positions 6 to 10 have both "default" and "1" SMR assigned). Nevertheless, not all positions from the 5MR have a SMR assigned, specifically position 41 to 600, so the warning icon appears.

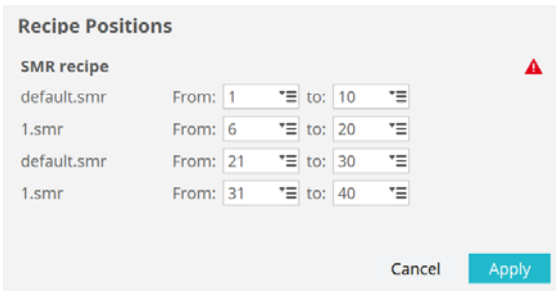



Figure 6.12 Recipe Position settings. The warning icon means that the current configuration is invalid, because not all positions have a SMR assigned.

**WARNING**

**All positions need to be assigned to one SMR, otherwise a warning icon will appear and the settings cannot be applied**

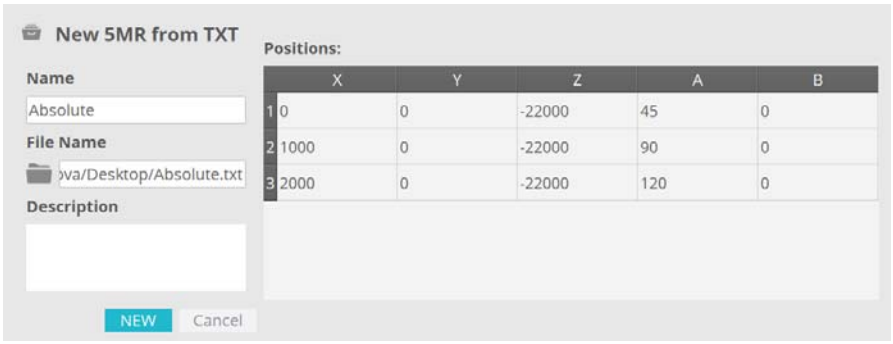
## 6.6 Save and Load 5MR

Once all of the settings have been defined for the 5MR in the previous steps, you can click on to save the settings in the current recipe. If there is no recipe or you want to save the settings in a different recipe, click on (next to the save button), select "Save as" and name the recipe. In the same menu, you also have the option of deleting a recipe, creating a new 5MR, importing the positions through a TXT file and unloading the current recipe.

To load a saved 5MR, simply click on the button and select the desired recipe.

### 6.6.1 New 5MR from TXT

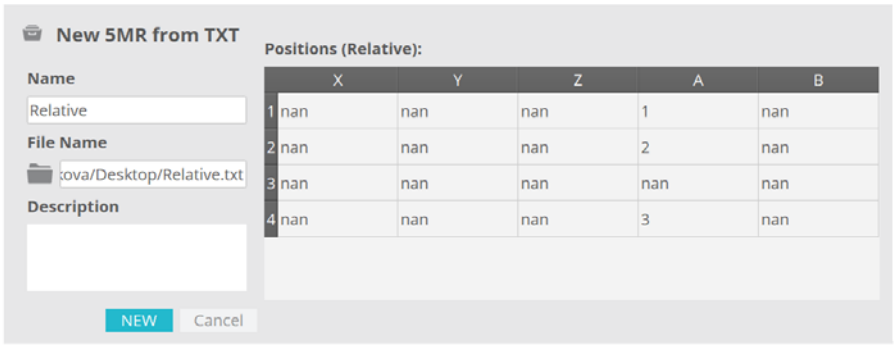
The positions of a 5MR can be imported from a TXT file. Choosing this option from the menu leads the user to the following pane:




In this pane the user can name the new 5MR, write an optional description and see a preview of the TXT file that has been chosen. This file must consist of five columns, all separated by a space. The first three columns correspond to XYZ positions, all expressed in µm. The last two columns correspond to the absolute rotation (A) and elevation (B) angles.

Positions can be imported in a relative coordinate system by adding a [Relative] tag at the start of the file:

```
[Relative]
-    -    -    1.0    -
-    -    -    2.0    -
-    -    -    -      -
-    -    -    3.0    -
```




If a value is not set ( - ) in relative coordinates it will be translated to nan, which means that the measurement will be done at the starting position. Thus, taking as an example the image shown above, taking A=10 as a starting position the measurements will be made at A=11, A=12, A=10 and A=13.

## 6.7 5MR completion

Once a 5MR has finished, a menu will appear on the screen showing a summary of the acquisition. This summary shows the total acquired measurements, both successful and unsuccessful. The total time is also shown, as well as the status of the acquisition.

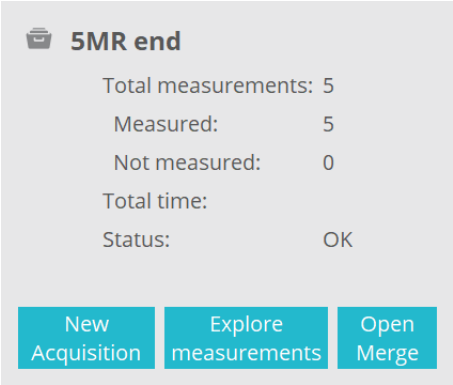



Figure 6.13 5MR end menu

There are three options available:

- New acquisition: closes the menu and allows the user to keep interacting with the **SensoFIVE** user interface.
- Explore measurements: opens the folder where the measurements have been saved.
- Open Merge: opens the merge menu. The settings of this menu will be explained in the next section.

CHAPTER

# 7

# MERGE

# 7.1 Merge User Interface

Once the 5MR has finished, all plux files for each measurement are saved and a single window appears. This window allows the user to define how to merge all of the measurements, change individual settings, visualize the full 3D result, and apply several filters. Data output options are: STL, IGES, STEP, PCD, XYZ or PLY.

There are three options for accessing this window:

1. After finishing the 3D measurements, this window appears containing all generated plux files to merge.
2. In the **SensoFIVE** menu, select **Open Merge Window**.
3. Click on the **Open result** button  located in the toolbar. In this last case, it is not possible to merge the measurements in the window. It is only possible to open existing merged items.

If you use options one or two, you will need to choose the folder containing all of the 3D surface measurements from the 5MR.

The merge window is divided into three parts: the left side is used for post-processing and exporting the full 3D result, the central area is used for displaying the data and the right side for merging settings and tools. If you use option three, the merge tools section will not appear because you will first have to upload an existing STL or PCD file. The elements pane is the only exception, it will appear even if option three is chosen.

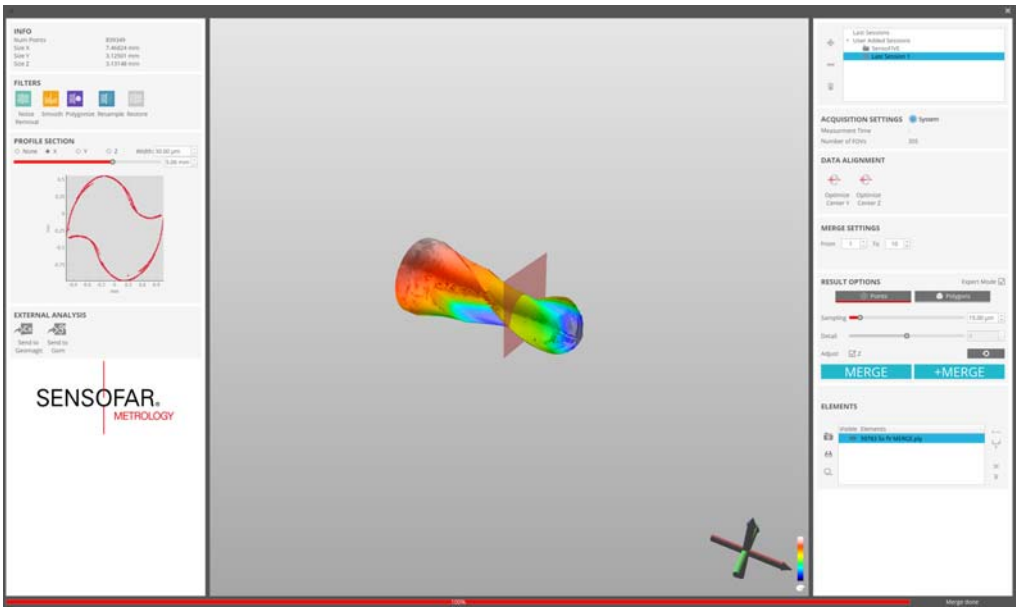


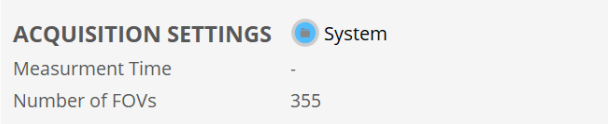

Figure 7.1 Merge user interface

## 7.2 Merging settings and tools

These settings define how to merge all of the different plux files.

The "**Last sessions menu**" shows the last five sessions to load and merge. It is also possible to add and remove sessions from the list, one by one, or clear the whole list.

The "**Acquisition settings**" pane displays the time required to perform the full displayed measurement and the number of FOVs that compose the measurement:




If more than one "Custom quick adjustments" calibration has been performed, the user can choose between these calibrations in the "System" drop-down menu. The elevations of the different calibrations will be displayed, as well as the objective used.

Once all of the 3D surface measurements have been loaded, you can select from which single measurement to which target measurement you want to perform the merge in "**Merge Settings**". A graphical representation of the selected FOV acts as a guide, visually reflecting any change in the number of selected FOVs:


Then, in the "**Result Options**", you can choose if you want to merge the full measurement into a point cloud or to polygonize the point cloud in order to obtain a mesh. We recommend selecting points results to start with, as it is more time efficient than selecting polygons.

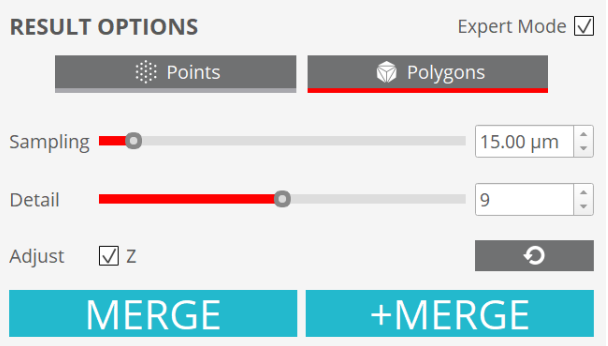



Figure 7.2 Result options

- **Points**: Specify the *Sampling* between points. The software will only consider points spaced apart at the selected distance. To expedite the merge, select a high sampling spacing, or choose a low spacing between points for higher accuracy but slower computation. For topographies acquired with 5X, 10X, and 20X objectives, 15 µm is the recommended value. If you want to work with all measured points, it should be set to 0 µm.

**WARNING**

**If the sampling is set to 0 µm, the calculation time will increase**

- **Polygons**: Besides the *Sampling* between points, a value also needs to be assigned to the *Detail* parameter. As the name suggests, this parameter determines the degree of detail. Thus, a higher value results in a more resolved 3D, but the merge will last longer. A compromise should be struck between the detail and the sampling.

The user can choose between Expert and Basic mode. Expert mode allows you to fine tune all the settings, while in Basic mode you can only customize the sampling. Basic mode works with a detail of 9 and the result is a polygonized mesh.

The default settings, which correspond to the basic mode with the sampling set to 15 µm, can be restored with the icon .

Now that all settings have been defined, you can click the "Merge" or the "Merge +" button:


Both generate an Element shown in the display section and "Elements" list. The former replaces the merged element if there is one already in the list, while the latter adds a new element to the "Elements" list below. This last tool is useful to combine/merge two full 3D measurements to create the final full 3D measurement. The result will be added to the list of elements in the "Elements" menu and displayed in the central viewer.

The merge may fail. One possible cause for this failure is the miscalibration of the system. If the calibration is incorrect, the user can optimize the calibration values. There are two tools in **"Data Alignment"** that modify the calibration values:

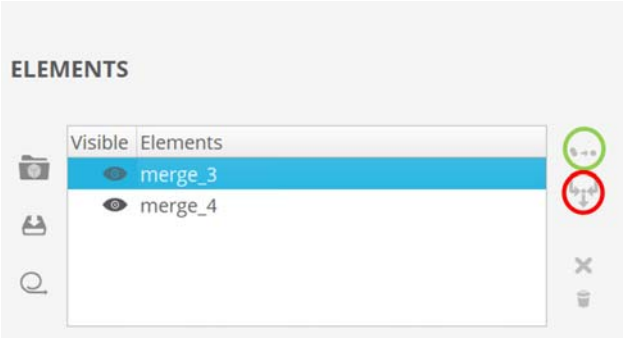
- "**Optimize Center Y**" makes it possible to improve the center of calibration for the Y axis within a range specified by the user. It works for most types of measurements, not only cylindrical.
- "**Optimize Center Z**" makes it possible to improve the center of calibration for the Z axis within a range specified by the user. It works only for cylindrical measurements that have an overlapping > 50%.

### 7.2.1 Merging Elements

One feature in the post-processing section allows you to merge two elements from the same sample. This may be necessary to measure the sample from different angles or with a different SMR. To do so, open two different elements, or merge one element and "Merge +" the second.

The current elements will be arranged in the "*Elements*" list. The system only allows two elements to be merged, but this process can be repeated many times. Thus, in order to merge three elements, for example, you can merge element 1+2 and then the new element called "Merge all" with element 3. Each time you merge elements, the result is a new element containing the information from both elements.

The procedure for merging two elements is to first **Register** them (green). This action moves the elements until their points coincide. Then, you can **Merge** them (red), which combines the two elements into a single element containing the information from both elements:




**NOTE** The merge can be performed without the registration.

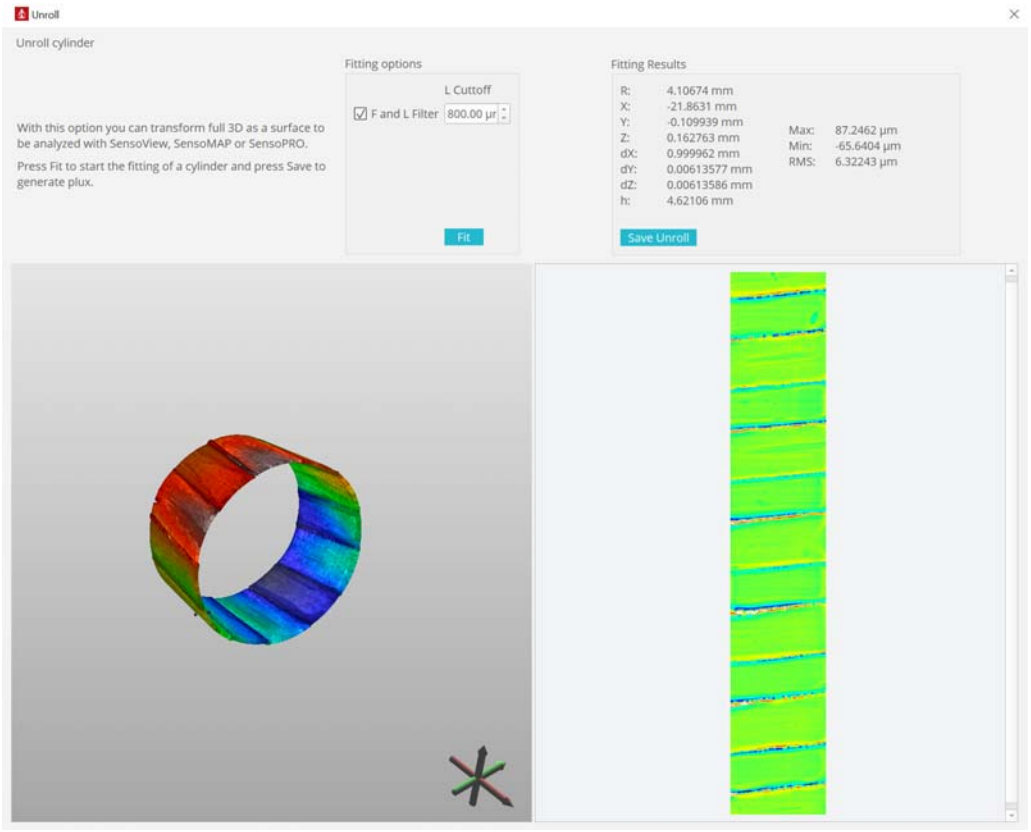
In the list, you can also:

- hide/show the corresponding element double-clicking on the icon
- delete the currently selected element with the icon
- delete all elements with the icon

### 7.2.1.1 Unroll 3D

The unroll option from the elements pane allows the user to transform a 3D measurement into a plane surface.

Select an element from the list and click on the icon. The following menu will open:




An F-filter will be applied to the 3D measurement to remove the main form and an L-filter to remove unwanted waviness. The L filter cutoff value is customizable; input the desired value and click Fit.

The fitting results will be shown on the right part, including all necessary fitting values such as the RMS as well as a 2D preview. Click on Save Unroll to generate a *.plux file, which can be opened with **SensoVIEW** or other external analysis software.

**NOTE** The Unroll process is most useful for cylindrical measurement. It may fail if the 3D measurement does not resemble a cylinder.

## 7.3 3D Display

In the 3D display section, you can visually analyze the element. Hold down the right mouse button and move the mouse to rotate the element and use the scroll wheel to zoom in and out. To determine the element's orientation, refer to the reference axis arrows (red for X, green for Y, blue for Z).

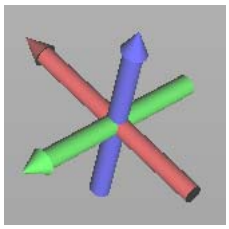


Figure 7.3 Cartesian axes (red = X, green = Y, blue = Z)

In addition, it is possible to change the rendering and scale options by clicking on  and choosing between false color and stack image, to change the color palette and the range. Notice that the color assignation criterion can be changed based on the distance to the axis (Cylinder), or distance in Z, X or Y and to modify the value of gamma (illumination).

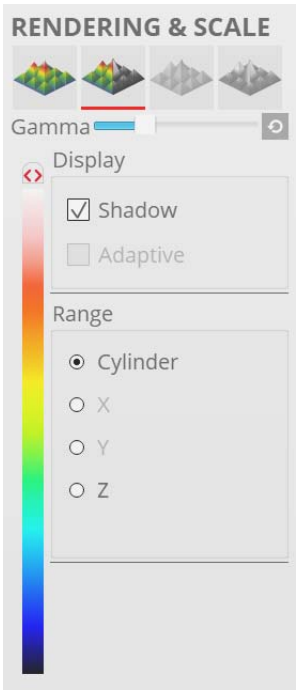



Figure 7.4 Rendering options

## 7.4 Post-Processing and Exporting

In this section, you can perform post-processing on the recently merged measurements or you can open a saved merged file (.stl, .pcd, .iges, .step, .stp, .ply, .xyz) by clicking on . You can also save the current element by clicking on the save button .

Under "**INFO**", you will see the information about the number of points (or triangles in case it is merged using polygons) and the real size in each direction.Filters

You can apply different filters to the currently selected item in the *Element list*:

- **Noise Removal**

You can remove the noise from the element using three different algorithms:

1. **Mesh** (valid only for polygons): removes the areas that are smaller than the indicated percentage of the total surface area. The recommended value is 10%.
2. **Statistical**: Used both for points and polygons.
   - Mean K points: number of K neighbor points that surround another point in order to create a plane.
   - Std. deviation threshold: if the point is at a higher distance from the plane than a defined standard deviation (σ), that point is removed.
3. **Radius**: similar to statistical, but instead of looking for a number of neighbors, it considers all of the neighbors within a given radius.
   - Radius search: select the radius to calculate the number of points that can fit inside.
   - Min. neighbors in radius: if the number of points is lower than the selected value, these points will be eliminated.

**WARNING**

**If both Noise Removal and Polygonize are to be applied, apply Noise Removal first**

- **Smooth**

This option smooths out the element as many times as the number of iterations defined by the user.

There are two algorithms to choose from:

1. **Neighbors**
   - Iterations: the number of times the smoothing will be done. The recommended value is 5.

- Neighbors: represents the amount of neighbors that will be considered for each point. The recommended value is 50.

2. **Radius**

- Iterations: the number of times the smoothing will be done. The recommended value is 5.
- Radius: defines the neighbors region to be used in this operation. Depending on the point spacing, it will include more or less points.

## Polygonize

This filter creates a mesh from a point cloud, converting a result merged with points to a result merged with polygons.

- Detail: higher values correspond to higher detail.
- Restoration: determines how detailed is the surface created from the points. It can have the following values: minimum, normal, high (recommended) and maximum (covers everything).

**NOTE** This filter is specially designed for point clouds. When applying this to a mesh, each vertex of each triangle is converted into a point cloud and then the polygonize algorithm is applied.

## Resample

This filter changes the total number of points in the point cloud by removing the ones that are closer than a minimum distance between points.

If the resample option is applied to a mesh, the algorithm will convert it into a point cloud, apply the resample and then the result will remain a point cloud. If a mesh is required, apply the polygonize option after resampling.

## Restore

This filter only works for polygons. It fills the holes in the surface using interpolation. The user can define the percentage of the "BB diagonal" (the major diagonal of an imaginary box enclosing the mesh or point cloud). If the hole's dimensions are smaller than the "BB diagonal" percentage, it will be filled.

Once a filter is applied, the user can undo the effect of the VERY LAST filter, not the previous filters. The user only needs to click on the  icon, which appears after applying a filter.

### 7.4.1 Profile Section

You can inspect a section of the element in the "**Profile Section**" along the X, Y and Z axes. This generates a plane with a defined width perpendicular to the selected axis and the software plots the points that are located inside the plane. The plane can be moved along the axis using the slider or by introducing a particular value in the box at the right of the slider.

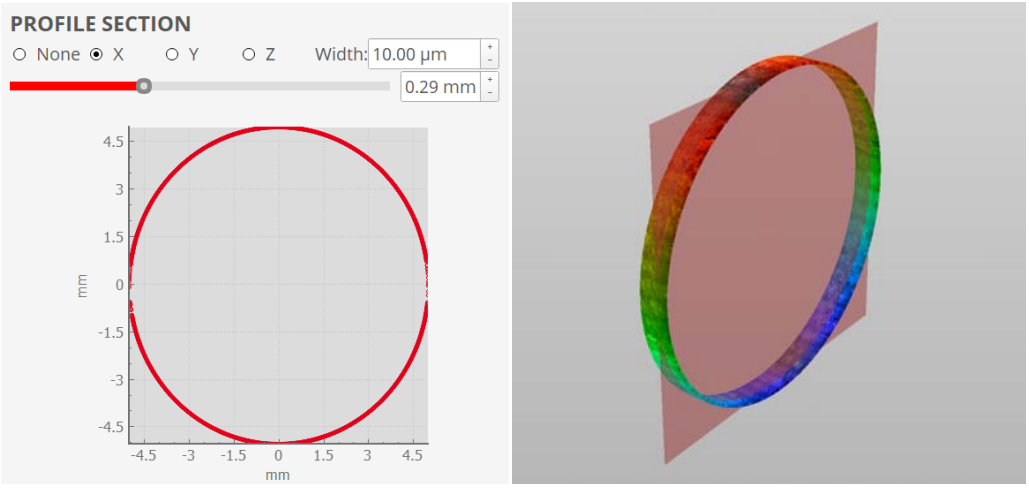



Figure 7.5 Profile section of the sample. You can modify the plane position and which axis you need to section (left). The software generates the plane that sections the sample for simple visual inspection (right)

The user can change the width of the profile, which will generate the plane using an average of the points. This width change is not reflected on the 3D display.

### 7.4.2 External Analysis

It is possible to send the currently loaded element to an external analysis software by clicking on the corresponding software icon. The path to each software must be defined in System Preferences > General.

The currently available external analysis software are **Geomagic Control X** and **GOM**. A connection to other 3D analysis software can be provided upon request.

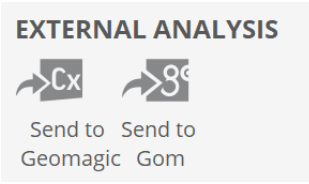



Figure 7.6 External analysis software

CHAPTER

# 8

# USERS STORIES

# 8.1 Story 1: Full 3D Volumetric Measurement of Cylindrical Samples

The aim of this user story is to obtain a full 3D volumetric measurement of a cylindrical sample. To obtain this result, several 3D surface measurements will be performed around the cylindrical surface and then merged.

## 8.1.1 Prepare the sample

To prepare the sample, you need to have the collet holder and follow the steps below:

1. Select the proper collet chuck (clamp) to match the holding diameter of the sample to the collet's diameter. Consider that each clamp has a tolerance of 1 mm. Insert the collet into the holder
2. Insert the sample into the holder
3. Measure the length and diameter of the sample. Length is measured from the collet edge to the tip of the sample

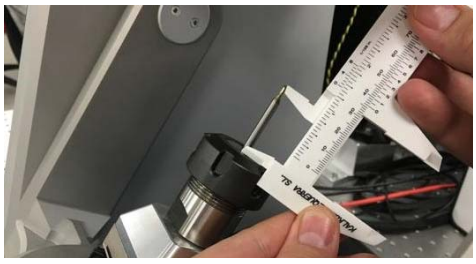
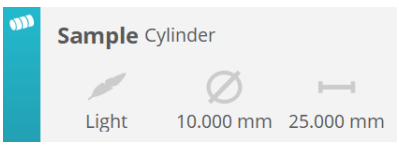


Figure 8.1 Image showing how to measure the length of the sample

The diameter of the object should be measured at the position you will measure, not at the position used to hold the sample

Figure 8.2 Image showing how to measure the diameter of the sample correctly and incorrectly

4. Enter the values in the "**Sample**" section:




5. Inspect the sample moving manually and focus at a position that will allow you to adjust the acquisition settings. Enable **Safe Movement Manager** to minimize the risk of crashing the objective against the sample

## 8.1.2 Define the SMR

In this step, you will define the settings for each individual measurement (technique, objective, Z scan, etc.). To acquire a full 3D volumetric measurement, the same SMR will be used for all measurement positions.

The recommended measurement technique is *Ai Focus Variation* with HDR for obtaining the shape of the sample and *Continuous Confocal* for shiny samples or samples with very small radii. Normally 5X, 10X, and 20X objectives are used, but depending on the local slopes you might need to use a 50X objective. For the scan's Z range, a default/recommended value cannot be provided because it depends greatly on the sample's dimensions.

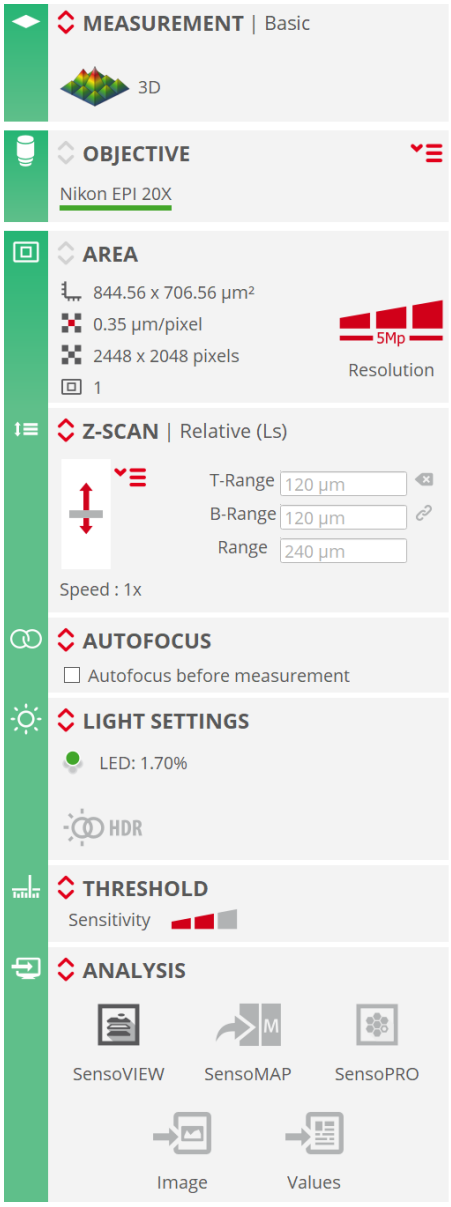



Figure 8.3 Example of an SMR configuration

**WARNING**

**Remember to save the SMR configuration by using the button or saving it as a new SMR**

Make sure that the acquisition results with this SMR are as expected by acquiring the data with **SensoSCAN** (press the ACQUIRE button at the bottom right of the screen).

### 8.1.3 Acquisition

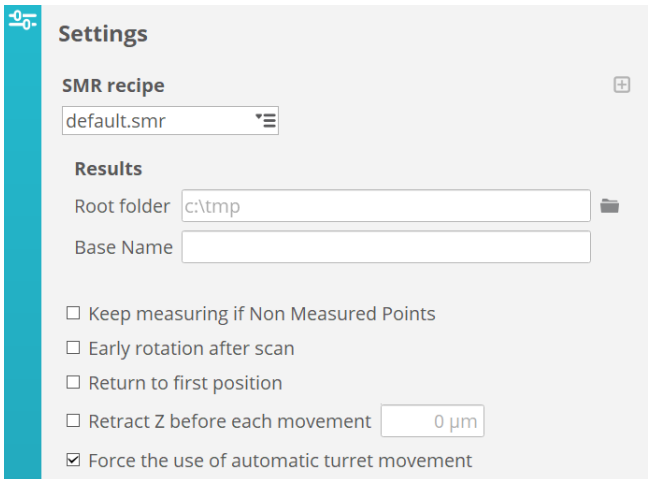
The next step is to configure the surface around the cylinder to be measured by creating a Five Axis Multiple Measurement recipe (5MR). This is done in the 5MR section:

1. Select 3D result and measurement mode: Sector, Extended, Circle or Cylinder:


2. If the measurement mode is Sector or Extended select the length of the rotation axis (A'). If the mode is Extended or Cylinder the length along the cylinder (L') must also be set

3. Select the SMR

4. Once SMR is selected a broad list of options will appear in the 5MR menu. Select the necessary settings such as "Force the use of automatic turret movement", if you want to use the system with a motorized nosepiece:




5. Select the overlappings. For an easy sample these values can be 20% and for complex samples the values can be increased to up to 90%:


6. To execute the measurement, press ACQUIRE on the left side of the screen

### 8.1.4 Merge

The window to merge the 3D surface measurements appears right after the acquisition has finished with the 5MR results. It allows you to merge preloaded data. It is also possible to load the results manually using the **Load Merge** tool. In this case, select the folder containing the 5MR recipe and all of the 3D surface measurement files (plux).

There are two options for creating and saving the full 3D results: point cloud or mesh. **SensoFIVE** calls this points and polygons. It is preferable to start by merging using points because this method is faster and later, when the merging settings are deemed successful, to convert the results to polygons.

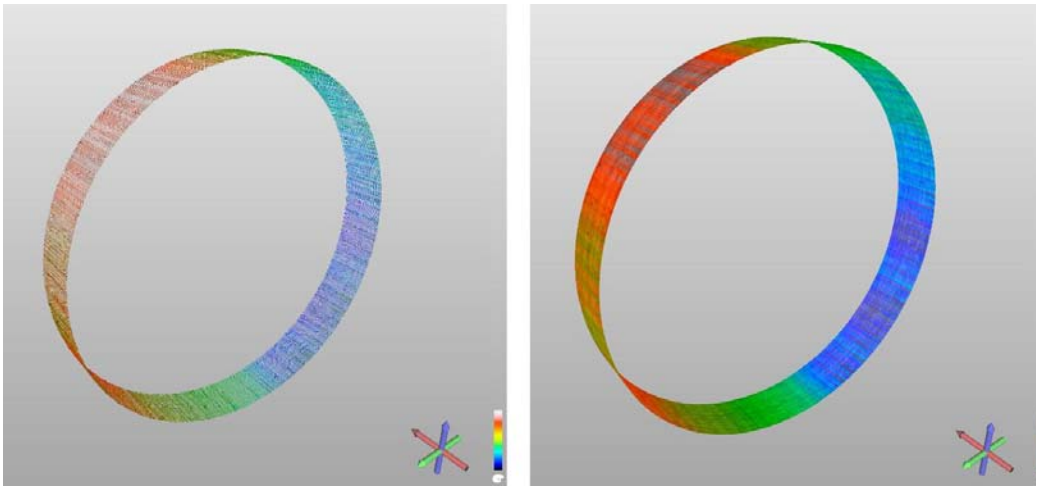


Figure 8.4 Points (point cloud) / Polygons (mesh)

The SW interface for the merge function is divided into three parts: the left side is used for post-processing and exporting the full 3D results, the central area is used to display the results, and the right side is for merging settings and tools.

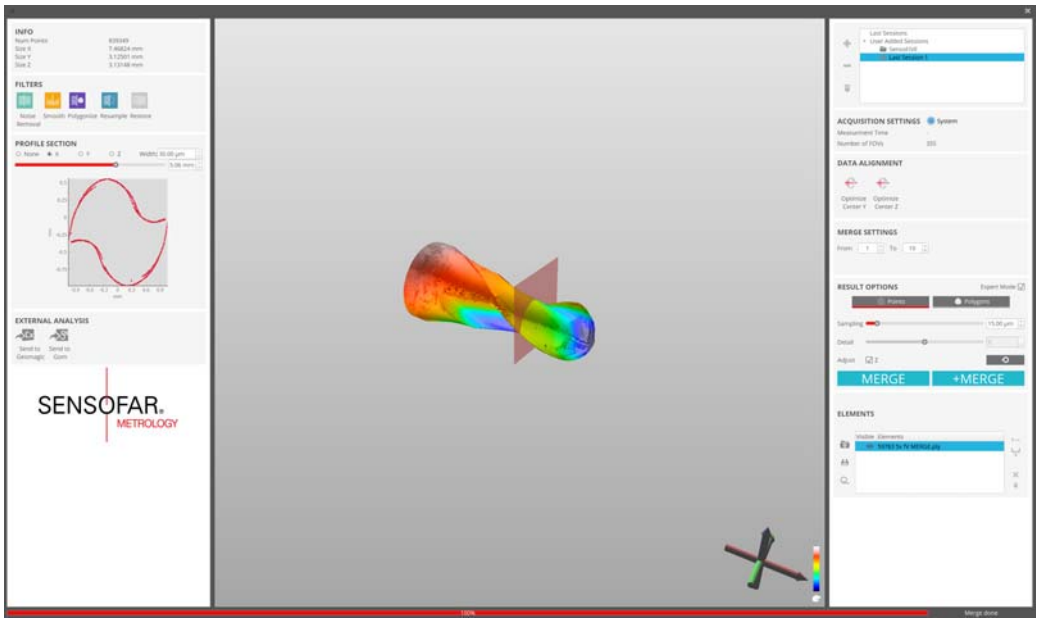
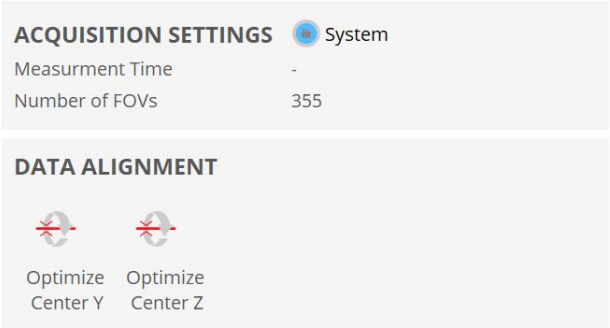



Figure 8.5 Merge screen interface

## Merge

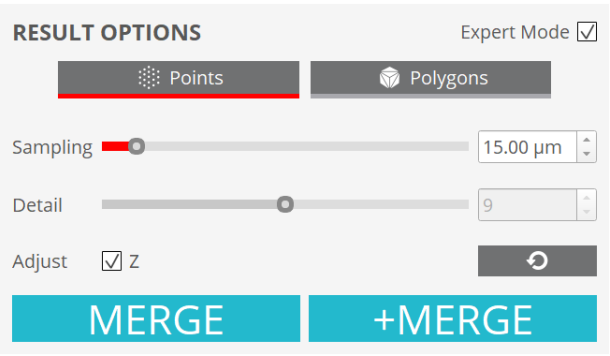
1. **Last sessions menu.** Here the user has available the last five sessions to load and merge. It is also possible to add and remove sessions from the list one by one or clear the whole list.

2. **Acquisition settings** and **data alignment** sections are pre-loaded with information provided by the acquisition and do not need to be modified. These options are useful for advanced users in case the merging results are not optimal:




3. The **merge settings** make it possible to select which individual 3D surface measurements will be used to create the final full 3D measurement:


4. **Result options**. We recommend selecting points instead of polygons to start with, as it is more time efficient




5. **Sampling**. This defines the spatial sampling. For topographies acquired with 5X, 10X, and 20X objectives, 15 µm is the recommended value. If you want to work with all measured points, this setting should be set to 0 µm.

6. **Detail**. Only used for polygons. Higher values correspond to higher detail. We recommend working between 8 and 10.

7. Press "**Merge**" or "**Merge +**" if you want to add the merged acquisition as a new element to the "Elements" list at the bottom right of the GUI. Both merge options will display the acquisition in the central viewer.

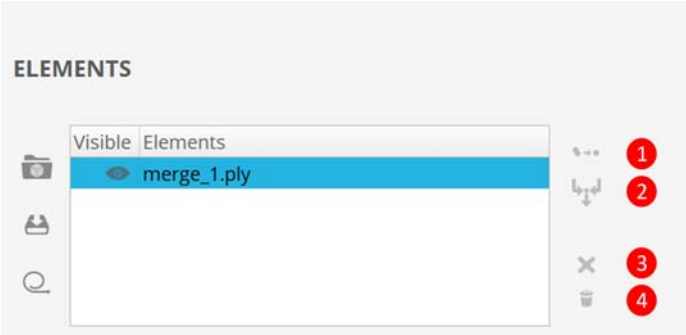
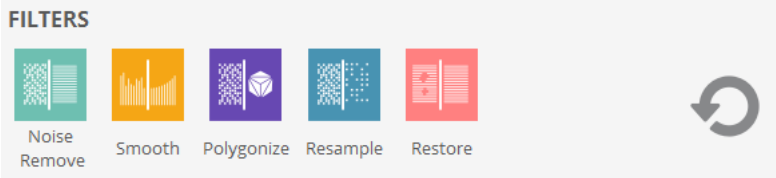



Figure 8.6 1) Register two elements, 2) Merge two elements, 3) Delete selected element, 4) Delete all elements.

## Post-processing and exporting

1. **Info**. Information related to the acquisition. Number of points/triangles and X, Y, Z size.
2. **Filters**. The user can apply any of the available filters.




**NOTE** See Post-Processing and Exporting for additional information about the filters.

**a.** Apply Noise Removal to eliminate any unwanted spikes present on the surface. Some of the settings available for this filter can only be applied to a mesh.

**b.** Apply Smooth to achieve a smoother surface.

**c.** If the merge has been made with the points option, you can apply Polygonize to convert the result to polygons. If you have more than one element, it is possible to convert several surfaces to polygons at the same time.

**d.** Apply Resample to change the distance between the points in the point cloud. It is not possible to set a lower minimum distance than the current one.

**e.** The Restore filter fills holes in a mesh.

### 8.1.5 Analysis

**SensoFIVE** offers the option of visualizing the data and a profile cut to check the merge result and to decide on which merging settings and post-processing actions to use.

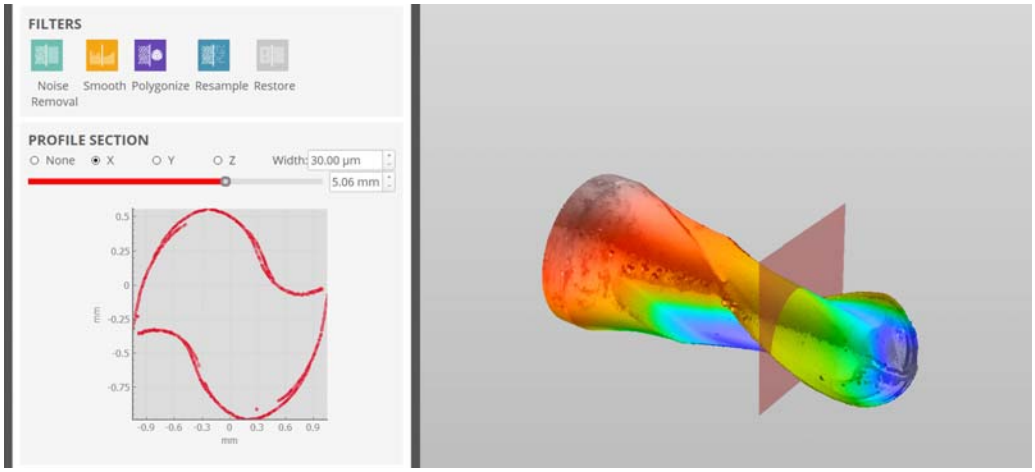



Figure 8.7 Example of a profile cut

The shape and dimension analysis has to be carried out in an external 3D analysis software such as **Geomagic Control X** or **GOM**:


A connection to other 3D analysis software can be provided upon request.

## 8.2 Story 2: Five Axis Multiple Recipe (5MR)

The aim of this user story is to obtain a sequence of multiple measurements for a sample. It is useful if you want to measure several critical positions for the sample but you do not need to measure the rest of it.

### 8.2.1 Prepare the sample

To prepare the sample, you need to have the collet holder and follow the steps below:

1. Select the proper chuck (clamp) collet to match the holding diameter of the sample to the collet's diameter. Consider that each clamp has a defined tolerance. Insert the collet into the holder.
2. Insert the sample into the holder.
3. Measure the length and diameter of the sample. Length is from the collet edge to the tip of the sample.

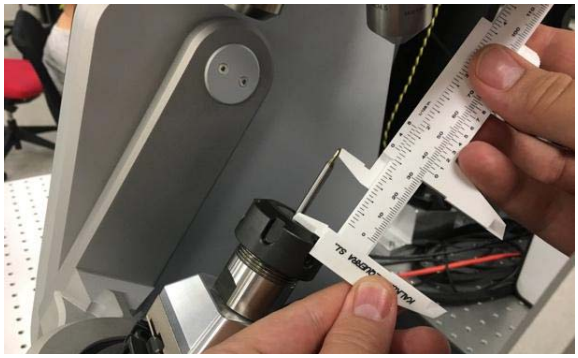


Figure 8.8 Image showing how to measure the length of the sample

Diameter is of the object at the position you will measure, not the position used to hold the sample.

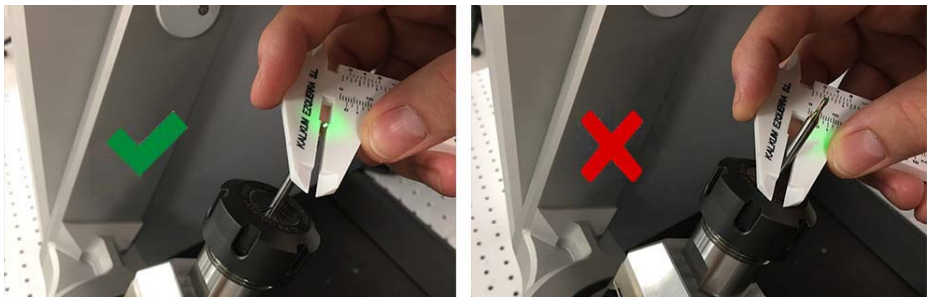
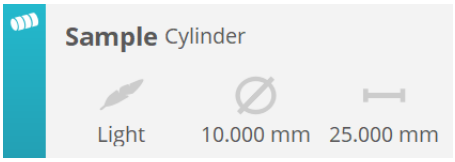


Figure 8.9 Image showing how to measure the diameter of the sample correctly and incorrectly

4. Enter the values in the "**Sample**" section



5. Inspect the sample moving manually and focus at a position that will allow you to adjust the acquisition settings. Enable **Safe Movement Manager** to minimize the risk of crashing the objective against the sample.

## 8.2.2 Define the SMR

In this step, you will define the settings of each individual measurement (technique, objective, Z scan, etc.). One SMR may be valid for several locations. If not, you should create an SMR for each feature that you wish to characterize.

The recommended measurement technique is *Ai Focus Variation* for obtaining the shape of the sample and *Continuous Confocal* for shiny samples or samples with very small radii. Normally, 5X, 10X, and 20X objectives are used, but depending on the local slopes you might need to use a 50X objective. For the scan's Z range, a default/recommended value cannot be provided because it depends greatly on the sample's dimensions.

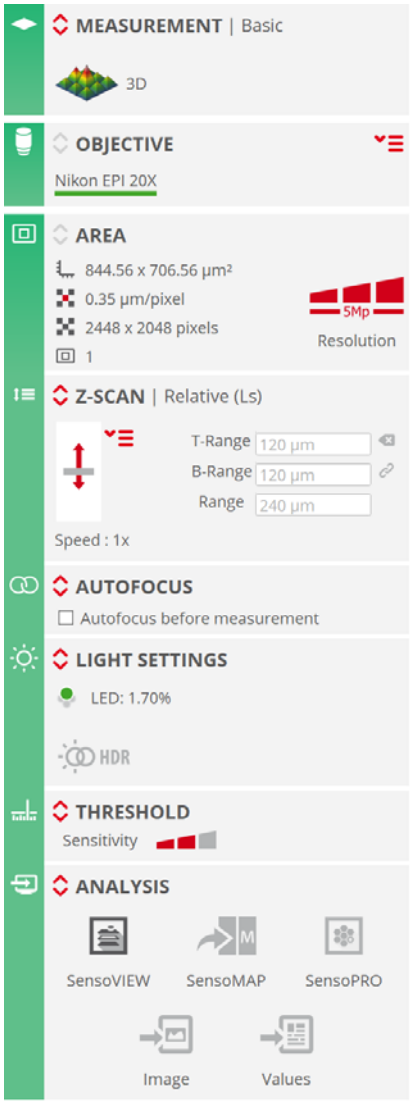



Figure 8.10 Example of an SMR configuration

**WARNING**

**Remember to save the SMR configuration by using the button or saving it as a new SMR**

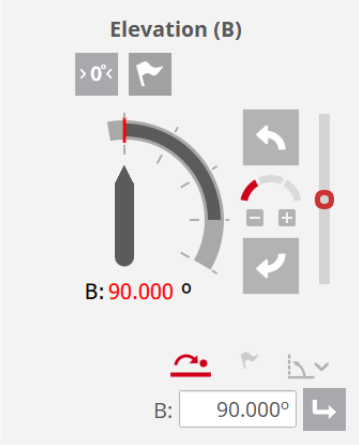
Make sure that the acquisition results with all SMRs are as expected by acquiring the data with **SensoSCAN** (press the ACQUIRE button at the bottom right of the screen).

## 8.2.3 References

If you want to measure a set of samples or the same sample several times and you want to make sure that the measurements are taken at the same locations, it is necessary to reference the samples before the acquisition. Do this by ensuring that the position along the X-axis is the same and then defining the 0° position for the rotation (A).

These are the steps for referencing a sample such as a milling tool:

1. Ensure that the length is the same for all samples. Measure it as described in the sample preparation section and adjust the sample position to have exactly the same length each time you insert a new sample from the set of samples to be measured with the same acquisition recipe.
2. Move the elevation to 90 degrees:




3. Focus the sample using a low magnification objective. For example, a 5X or 10X.

4. Look for the fiducial or a representative part of the sample. In this case, the cutting edges were matched to the central cross of the image. Remember that this cross can be enabled or disabled by pressing F9.

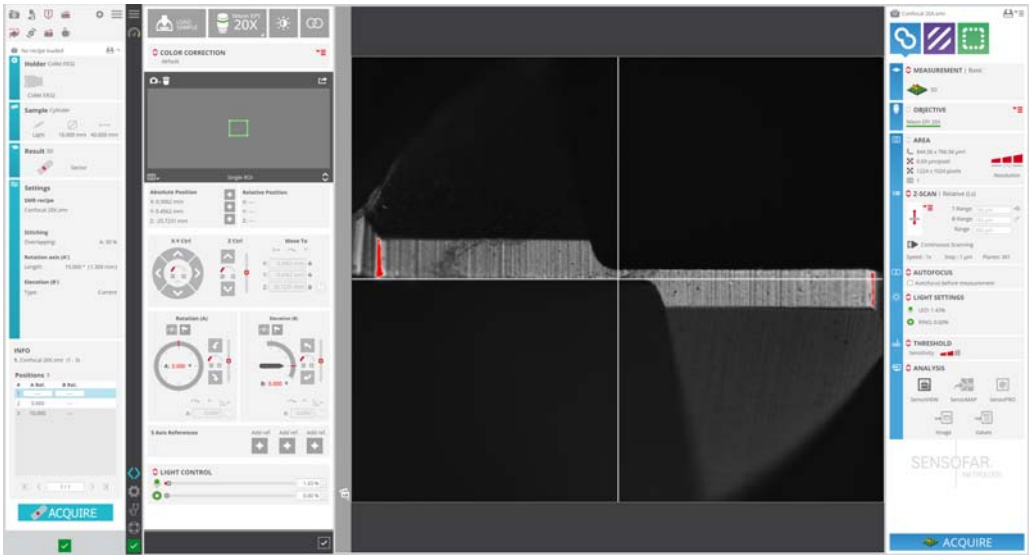
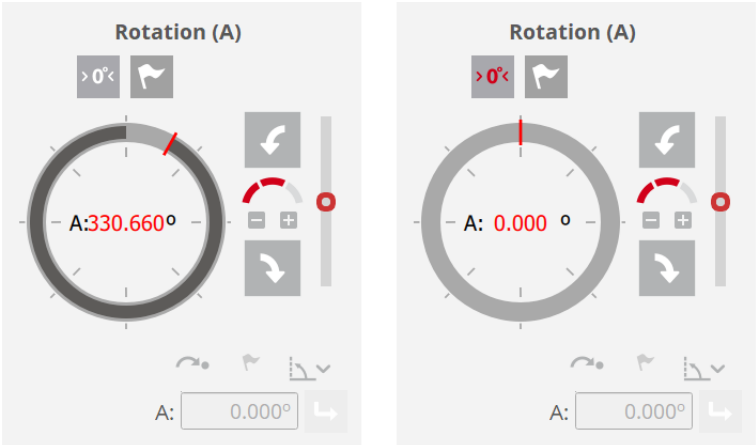



Figure 8.11 Example of how to use a reference system to always measure the same region for different identical samples

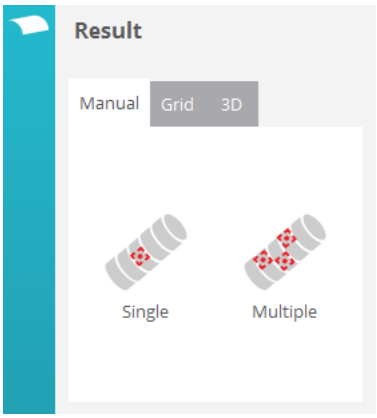
5. Define the new "> 0°<" for rotation:



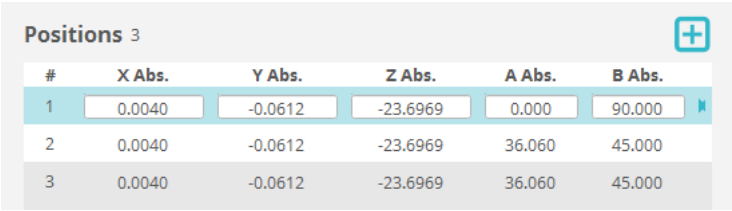
## 8.2.4 Acquisition

Next step is to configure the list of positions and the measurement to be taken at each position by creating a Five Axis Multiple Measurement Recipe (5MR). This is done in the 5MR section:

1. Select the 3D result manual or grid and the measurement mode. For example, select the "Multiple" option in the *Manual* tab. This will allow you to manually define the list of positions and the SMR to be used.




2. Go to each location where you wish to perform an acquisition and click "+" to save/add the location: X, Y, Z, A and B:




| # | X Abs. | Y Abs. | Z Abs. | A Abs. | B Abs. |
|---|---|---|---|---|---|
| 1 | 0.0040 | -0.0612 | -23.6969 | 0.000 | 90.000 |
| 2 | 0.0040 | -0.0612 | -23.6969 | 36.060 | 45.000 |
| 3 | 0.0040 | -0.0612 | -23.6969 | 36.060 | 45.000 |

**WARNING**

**Please make sure to use the same objective and ring light (if necessary) as in the SMR at each of these locations. If not, there may be a risk of collision between the objective or the ring light and the sample**

We strongly recommend grouping/arranging the locations during this task to define the position to be measured consecutively within the same SMR

3. Add/Select the SMRs in the 5MR **Settings** section
4. Assign the SMR to each group of locations. It is possible for each location to use a different SMR, as shown in the image below, or for the same location to be measured using several SMRs.


5. Save the 5MR so that it can be reused later
6. To execute the measurement, press ACQUIRE on the left of the screen

## 8.3 Story 3: Steep Angles

The aim of this user story is to obtain full 3D volumetric measurements for samples containing features with steep angles. In these samples, shadowing effects make it impossible to obtain a complete measurement with a single acquisition. It is necessary to tilt the sample in order to measure it from two different positions and combine the result to obtain the final measurement.

As an example, we will measure a thread with a flank higher than 90°. These pictures show the two elevation positions.

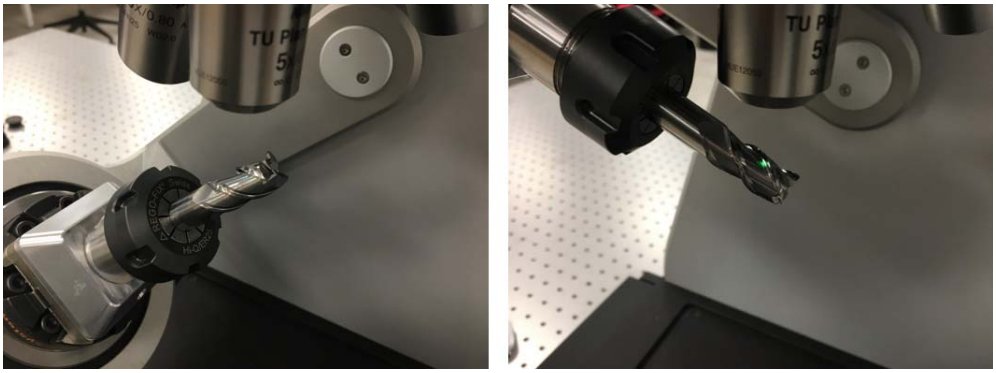


Figure 8.12 When the sample has regions with slopes higher than 90°, depending on the elevation, not all surfaces of the sample are measured.Thus, for a full 3D without non-measured points, these regions have to be measured with different elevations

### 8.3.1 Prepare the Sample

To prepare the sample, you need to have the collet holder and follow the steps below:

1. Select the proper collet chuck (clamp) to match the holding diameter of the sample to the collet's diameter. Note that each clamp has a tolerance of 1 mm. Insert the collet into the holder
2. Insert the sample into the holder
3. Measure the length and diameter of the sample. Length is measured from the collet's edge to the tip of the sample

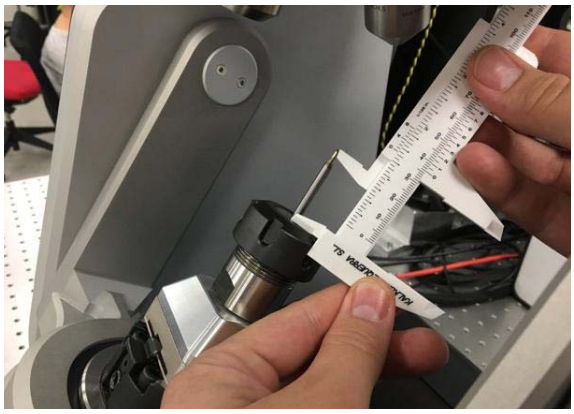
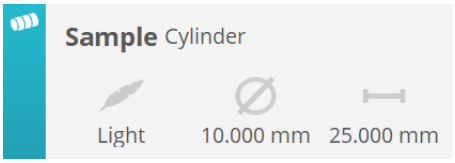


Figure 8.13 Image showing how to measure the length of the sample

The diameter must be measured of the object at the position you will acquire, not at the position used to hold the sample.

Figure 8.14 Image showing how to measure the diameter of the sample correctly and incorrectly

4. Enter the values in the "**Sample**" section




5. Inspect the sample moving manually and focus at a position that will allow you to adjust the acquisition settings. Enable **Safe Movement Manager** to minimize the risk of crashing the objective against the sample.

## 8.3.2 Define the SMR

In this step you will define the settings for each individual measurement (technique, objective, Z scan, etc.).

The recommended measurement technique is *Ai Focus Variation* for obtaining the shape of the sample and *Continuous Confocal* for shiny samples or samples with very small radii. Normally, 5X, 10X, and 20X objectives are used, but depending on the local slopes you might need to use a 50X objective. For the scan's Z range, a default/recommended value cannot be provided because it depends greatly on the sample's dimensions.

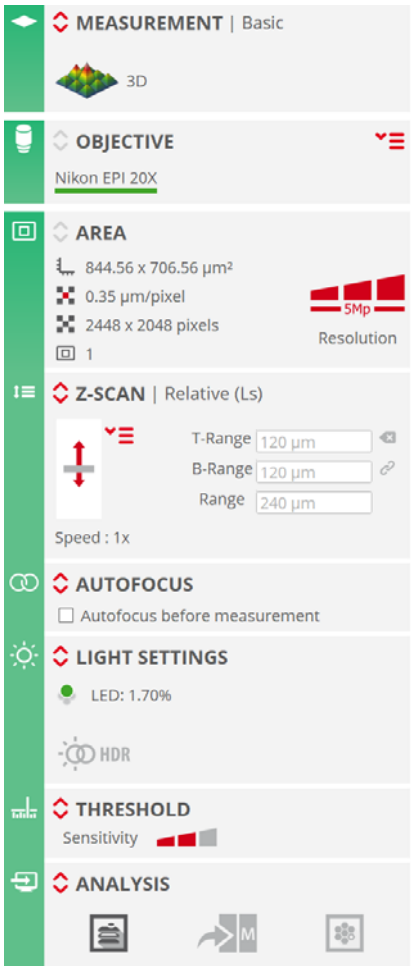



Figure 8.15 Example of a SMR configuration

**WARNING**

**Remember to save the SMR configuration by using the button or saving it as a new SMR**

Make sure that the acquisition results with this SMR are as expected by acquiring the data with **SensoSCAN** (press the ACQUIRE button at the bottom right of the screen)

### 8.3.3 Acquisition

The next step is to configure the surface section to be measured by creating a Five Axis Multiple Measurement recipe (5MR). This is done in the 5MR section.

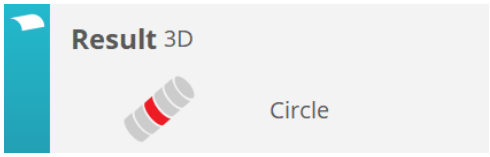
Depending on the sample, there are two different approaches:

- Manual positioning of two elevations
- Using dual elevation in the 5MR settings

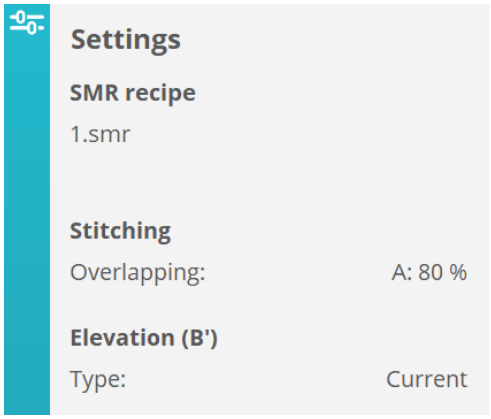
The second approach requires two different elevations as inputs and the software will acquire the full 3D measurements at both elevations.

For the manual positioning approach, the steps are as follows:

1. Select 3D result and measurement mode: Sector, Extended, Circle or Cylinder




2. If the measurement mode is Sector or Extended select the length of the rotation axis (A'). If the mode is Extended or Cylinder the length along the cylinder (L') must also be set
3. Select the SMR
4. Select the overlapping. For an easy sample these values can be 20% and for complex samples the values can be increased to up to 90%



5. Save the 5MR so that it can be reused later
6. To execute the measurement, press ACQUIRE on the left side of the screen
7. Save the result
8. Move to the complementary elevation position
9. Repeat the acquisition

### 8.3.4 Merge

The window to merge the 3D surface measurements appears right after the acquisition has finished with the 5MR results in order to merge the preloaded data. It is also possible to load measurements manually using the **Load Merge** tool. In this case, select the folder containing the 5MR recipe and all the 3D surface measurement files (plux).

There are two options for creating and saving the full 3D results: point cloud or mesh. **SensoFIVE** calls these points and polygons. It is preferable to start by merging using points because this method is faster and later, when the merging settings are deemed successful, to convert the results to polygons.

The SW interface for the merge is divided into three parts: the left side is used for post-processing and exporting the full 3D result, the central area is used for displaying the results and the right side for merging the settings and tools.

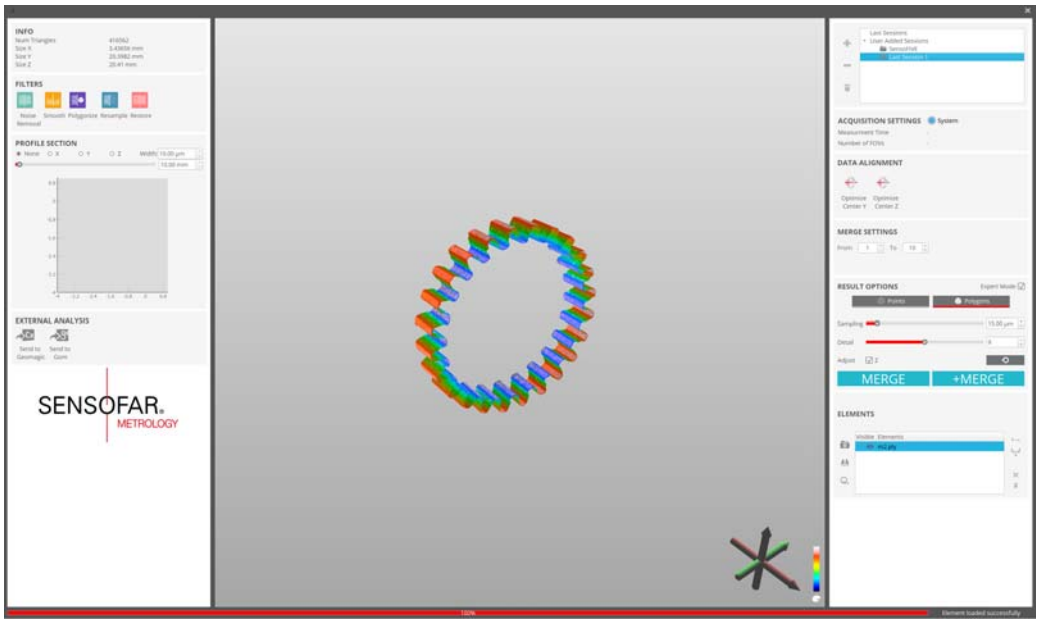
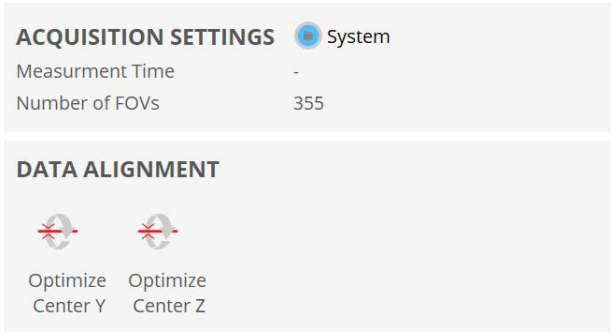



Figure 8.16 Merge window

## Preparing the Data

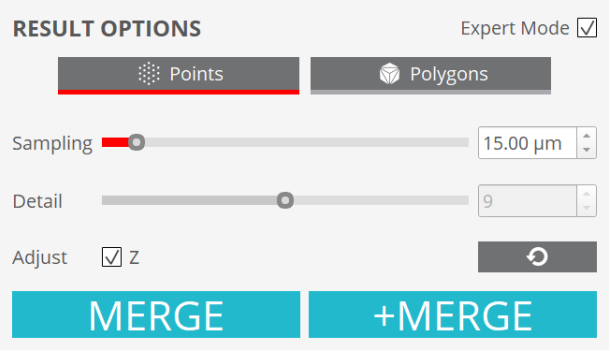
In order to merge the two acquisitions, first merge all of the acquisitions for the same elevation. These are the steps to follow for each elevation acquisition:

1. **Load the merge**. Select the folder containing all the measurement for the first elevation on the merge screen
2. **Acquisition settings** and **acquisition values** and data alignment do not need to be modified. These options are useful for advanced users




3. **Merge settings** make it possible to select the FOV to be worked on


4. **Result option**. We recommend working with points




5. **Sampling**. Defines the spatial sampling. If you want to work with all measured points, it should be set to 0 µm. For topographies acquired with 5X, 10X, and 20X objectives, 15 µm is the recommended value
6. **Detail**. Just for polygons. Higher values correspond to higher detail. We recommend working between 8 and 10
7. Press "**Merge**"

8. Repeat the steps for the second elevation acquisition and click on "**Merge +**" to add the second acquisition to the first one in the list. Once you have both elements, they need to be combined:

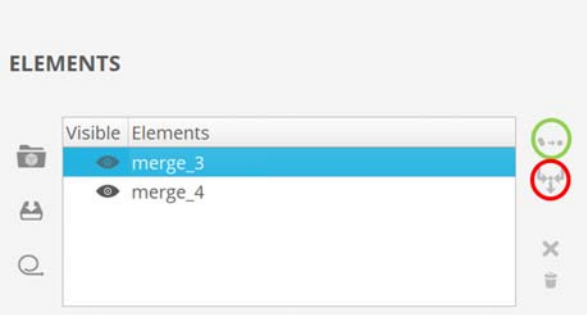
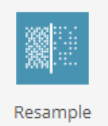
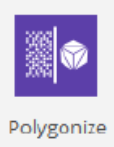



Figure 8.17 1) Register two elements, 2) Merge two elements.

9. Clicking on the register button (green) moves the elements until the points coincide
10. Clicking on the merge button (red) merges the two elements into a single one
11. Apply a *Resample* filter with a sampling of 15 µm




12. Apply *Polygonize* if a triangle mesh is needed instead of a point cloud



CHAPTER

# 9

# ADDITIONAL SETTINGS AND FEATURES

# 9.1 Additional Settings

## 9.1.1 Load Sample Position (Calibration Screen)

This section allows the user to define the coordinates for the XY table, Z motor and Five Axis module to open after clicking on the button to comfortably and safely load a sample. The user can choose to define XYZ coordinates, AB coordinates or all. The software can be given the exact value for each coordinate, the current coordinates (by clicking on the button) or the default coordinates (by clicking on the button).

The default coordinates are (X, Y, Z, A, B) = (0, 0, -1.0, 0°, 45°).

**WARNING**

**Using Load Sample is dangerous during the homing actions if the system is NOT calibrated**

## 9.1.2 Software Limits (Calibration Screen)

This section allows the user to define the elevation limits. The default values are 95° to -15°, which can be restored anytime by clicking on . The user can provide the software with limit values of up to 120° and down to -20°. However, although it is possible to move the elevation to further values in the software, the system stops once it reaches the hardware limits.

## 9.1.3 Safe Movement Manager (Inspection Screen)

This feature prevents the sample from colliding with the system according to the sample's dimensions and the objective selected. There are three modes:

**Enabled**: the system slows down and sends a warning if the user's movement is close to causing a crash. The movement is stopped and a message is generated, in which the user can choose whether to continue the movement or cancel. If the movement is made by entering coordinates, the software will deny the movement.

**Disabled**: no safe movement is applied.

**Disabled until restart**: safe movement is disabled until the next time the software is restarted.

**WARNING**

**Safe movements are always disabled in the calibration menu**

### 9.1.4 5 Axis References (Inspection Screen)

This feature allows the user to set up to three different reference points by adding the current coordinates when clicking on . Once the reference point is added, the icon will change to , which also contains the information about the time the reference was added. Hovering on this icon shows the 5MR position coordinates. By left-clicking on this new icon, the user can:

- Set a new reference by overwriting the previous one
- Go to the defined reference
- Clear the saved reference

### 9.1.5 Correct Tilt and Center Y

Once you have calibrated the Five Axis module, you have the option of correcting the tilt of a sample to leave it flat. When using the *Flat* or *Mirror* holder, you have the icons for using a single FOV and for correcting the tilt using multiple FOVs, to obtain a more accurate tilting correction. When using the *Collet* holder, the icons will change to for a single FOV and for multiple FOVs.

Also, when using the *Collet* holder, you can center a cylindrical sample along the Y-axis (so that the top of the cylinder is at the center of the image) by clicking on the button.

### 9.1.6 Automatic AB tip tilt

This setting offers another way to correct the sample's tilt. It is available for any holder and it can be performed with both EPI and DI objectives of all magnifications.

After clicking on "Start", a scan of a single FOV is performed, showing a preview of the topography.

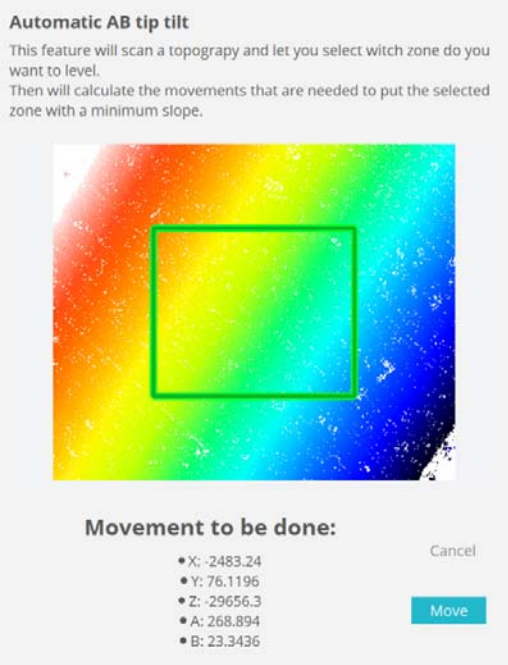



Figure 9.1 Automatic AB tip tilt menu

The preview shows how the sample is leveled. The user can choose a particular region as reference for leveling with the green, rectangular overlay.

Below the preview there are coordinates which correspond to the calculated positions at which the sample is perfectly leveled. The absolute coordinates for the X, Y and Z axes are expressed in microns while the coordinates for A and B are expressed as degrees. Once "Move" is clicked, the system will move to that position and the sample will be leveled.

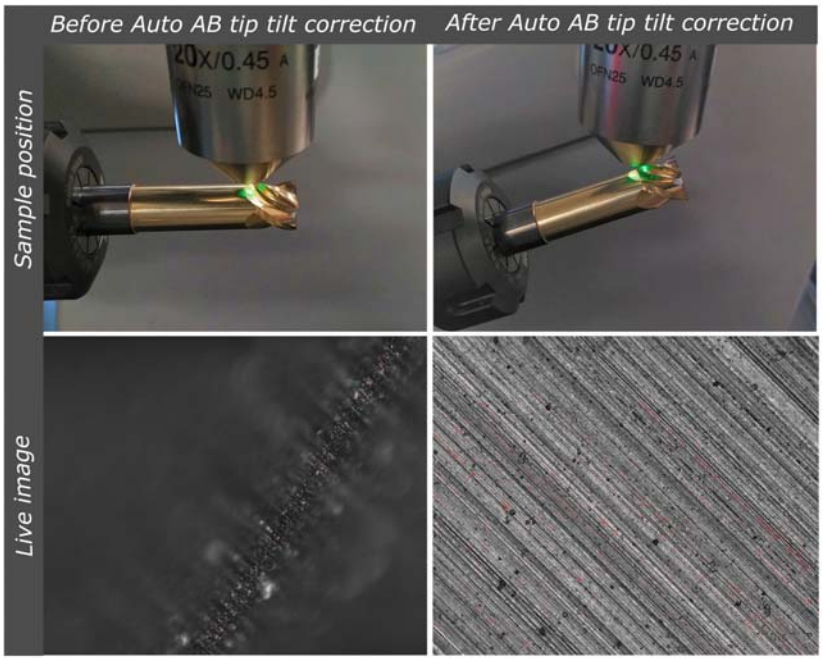



Figure 9.2 Example of a leveled sample using the Automatic AB tip tilt procedure.

## 9.2 Troubleshooting

### SensoSCAN is not embedded into SensoFIVE

If **SensoSCAN** does not start, check the **SensoSCAN** path in the **SensoFIVE** System Preferences menu.

If **SensoSCAN** starts but is not integrated into the **SensoFIVE** GUI, make sure that:

1. SDK is enabled in **SensoSCAN** HCF
2. Run as Administrator all exes (**SensoFIVE** and **SensoSCAN**)

CHAPTER

# 10 ANNEXES

# 10.1 Annex I: System Preferences

System Preferences can be accessed by clicking the icon in the **SensoFIVE** Toolbar or through the Menu icon. Different settings are organized in tabs.

## General

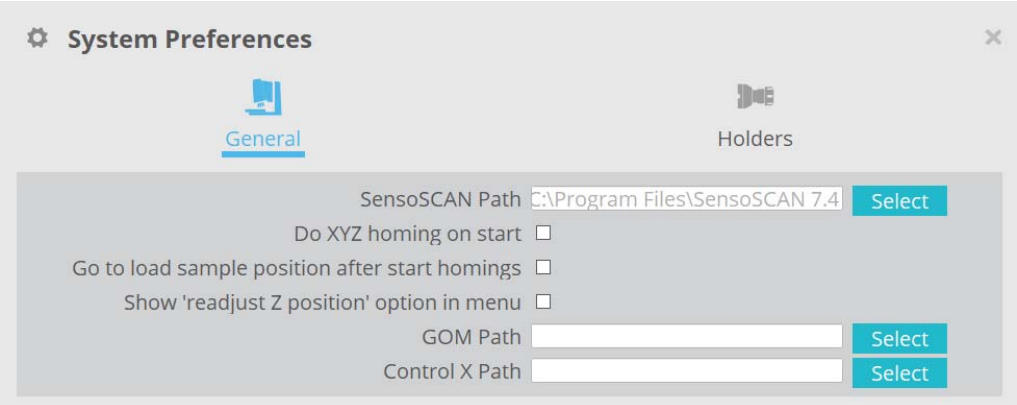



Figure 10.1 System Preferences menu displaying General settings

The options here allow you to set:

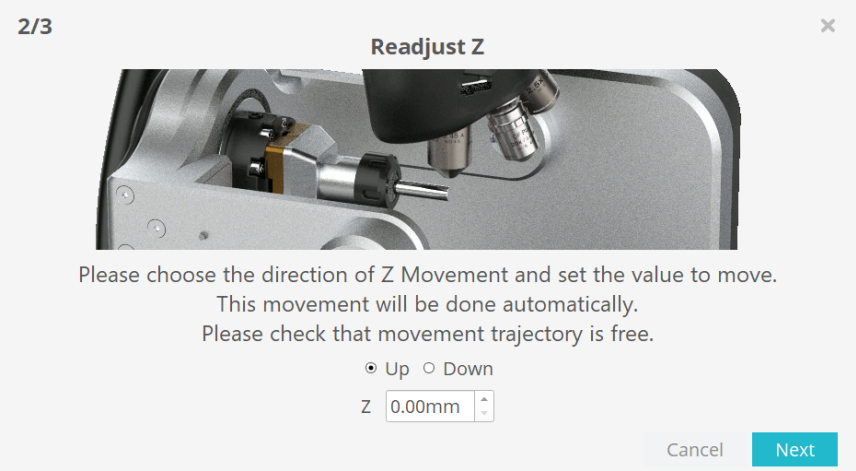
- **SensoSCAN** path: define the executable path to **SensoSCAN**. The default path is C:\Program Files\SensoSCAN 7.x
- Do XYZ homing on start
- Go to load sample position after starting homings

**WARNING**

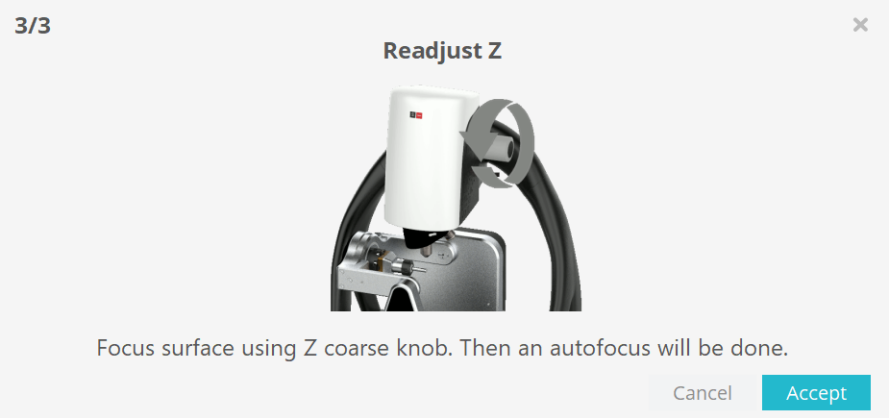
**Using Load Sample is dangerous during the homing actions if the system is NOT calibrated and Safe Movements are not active**

- Show "readjust Z position" option in menu, on the **SensoFIVE** toolbar. This option allows the user to adjust the Z coarse position without reseting the calibration. It is available for all samples, not only cylinders
- GOM path: define the executable path to GOM
- Control X path: define the executable path to Control X

After clicking on this icon the user must choose the direction of Z movement, input the desired distance, and click on next:




Once the movement is complete, the user must focus on the surface by changing the Z coarse position manually. Click on accept to finish the process with an autofocus:




**WARNING**

**Z coarse movements are usually locked. To readjust Z you need to manually unlock Z coarse by turning the handle. Remember to lock it again once the movement is done. Not locking the Z coarse position may result in metrological instability.**

## Holders

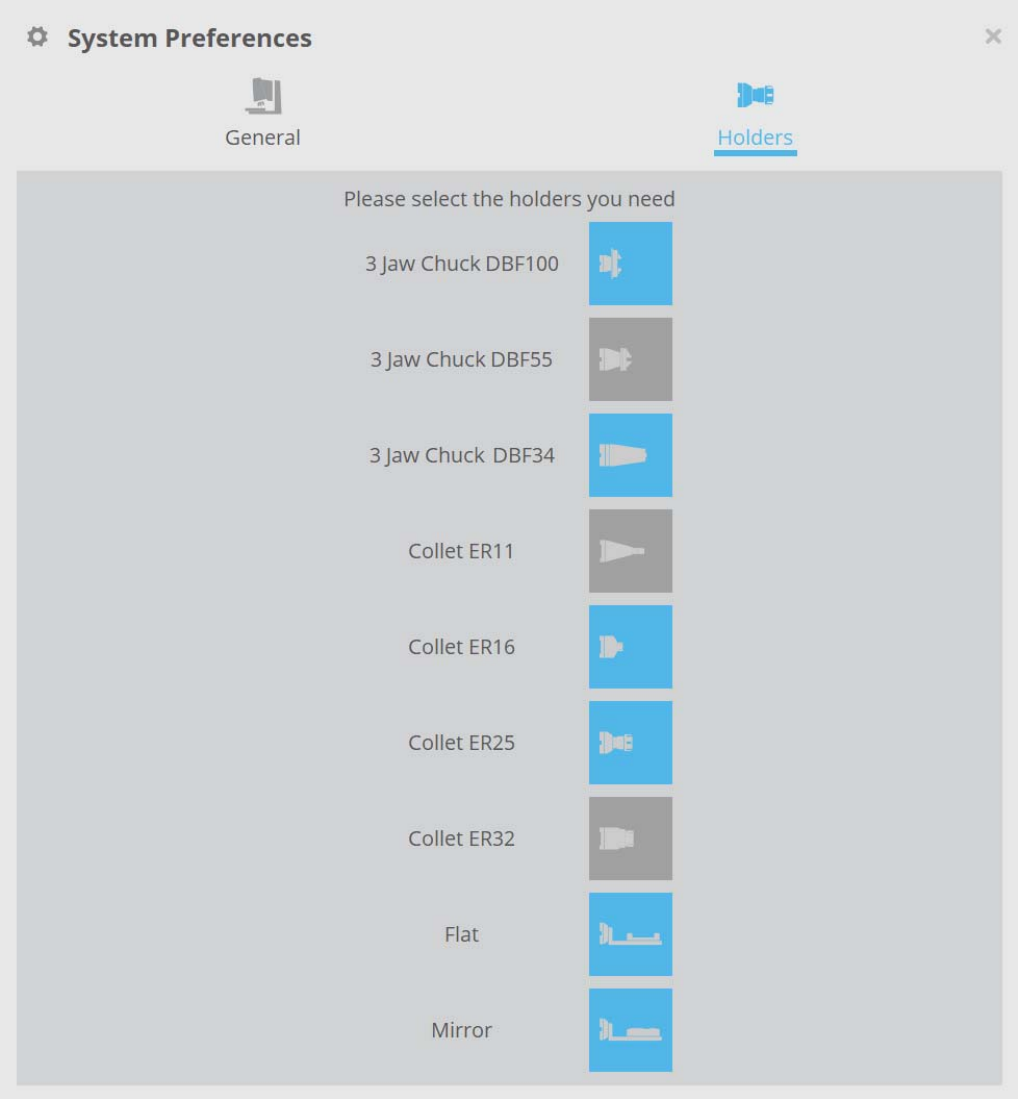



Figure 10.2 System Preferences menu displaying Holders settings

Holders can be added and deleted from the **SensoFIVE** interface through this menu by clicking on the icons. Enabled holders display a light-blue icon while disabled holders are shown in gray.

# 10.2 Annex II: Measurement Techniques

S neox Five Axis system offers several techniques within the same sensor head. Each technique presents certain advantages over the others depending on the sample and required data.

## Interferometry

interferometry can not offer color information but it has the highest vertical resolution of any optical technique. Different interferometry techniques have different strengths and weaknesses dependent upon the measurement task.

**NOTE** Interferometric techniques are very sensitive to vibrations.

### PSI (Phase Shift Interferometry)

This is the most accurate technique in terms of vertical resolution. S neox Five Axis in PSI mode can resolve up to 0.01 nm. It is commonly used in optics and semiconductors for measuring subnanometer roughness.

Its main limitation is the vertical range; it is only suitable for very smooth surfaces with low local slopes. It provides high repeatability for low magnification objectives, perfect to acquire large FOVs on very flat regions.

### CSI (Coherent Scanning Interferometry)

This technique is more versatile than PSI as the vertical range is limited by the working distance of the objective, not by the technique itself. Its vertical resolution is very good, 1 nm regardless of the objective's numerical aperture. It works best on smooth to moderately rough, discontinuous and varying surfaces (e.g. due to tilt, structuring, step heights greater than 120 nm, etc.). However, it has some limitations:

- Lateral resolution is limited to 500 nm
- Difficult to measure steep angles. Limited to 40° on smooth surfaces
- Limited selection of objectives. For some applications, it is necessary to use a large working distance objective or a higher numerical aperture
- Because of the limitation on steep angles, it is preferable to place the sample perpendicular to the optical axis. Thus, a tip-tilt is needed

Application range is vast: semiconductors, microelectronics, optics, medical devices, etc. It can also be used to perform thickness measurements from 1.5 µm to 100 µm.

### ePSI (Extended Phase Shift Interferometry)

ePSI is a variation of PSI that is best used only on very smooth surfaces that also feature step heights greater than 120 nm. ePSI profiling provides sub-nanometer vertical resolution for all numerical apertures (NA) - thus, very low magnifications (2.5X) can be employed to measure a large field-of-view with no sacrifice in vertical resolution. Note that, compared to CSI, the technique is relatively slow and there also are some memory limitations, so ePSI is only advantageous for the case mentioned and when sub-nm resolution is required.

## Confocal

This is the most versatile technique. It solves all of the limitations inherent in interferometry:

- Excellent lateral resolution, up to 300 nm
- Steep angles of up to 72° on smooth surfaces. Up to 86° on scattering surfaces using high numerical apertures
- Color information
- Wide range of available objectives in terms of magnification, working distance and numerical apertures. Confocal microscopy uses standard bright field objectives used in microscopy
- No need for sample preparation or tip-tilt
- Continuous Confocal is available, with speeds comparable to Ai Focus Variations while maintaining the details provided by the Confocal technique

The main disadvantage compared to interferometry is the vertical resolution, as it depends on the numerical aperture. Objectives with a low NA (usually low magnification) result in noisy measurements. With a high numerical aperture, a vertical resolution of 1 nm can be achieved, while the vertical resolution is close to 100 nm with a low numerical aperture.

## Ai Focus Variation

This technique relies on the surface texture's vertical and lateral resolution, the image contrast and the objectives' depth of focus. Therefore, it is not a useful technique for measuring roughness and has many difficulties with highly reflective surfaces.

On the other hand, it is a great technique for measuring steep angles (slopes up to 86°) with any objective. Therefore, it is suitable for measuring shape on large samples. Its most common application is tooling, where imaging large working distances and steep angles is required.


Figure 10.3 Effectiveness of the measurement techniques for different sample types

## 10.3 Annex III: Software Installation

This section should be used if you need to reinstall the **SensoFIVE** software.

To correctly install **SensoFIVE**, you need to install both **SensoFIVE** and **SensoSCAN**. Therefore, one installer (msi file) is required for each piece of software. The names of the installers are "SensoFIVE.msi" and "SensoSCAN.msi", respectively.

Installation steps:

1. Install **SensoSCAN** and make sure the software is working properly
2. Install **SensoFIVE**

**WARNING**

**SensoSCAN 7.1 or later is required**

**SensoSCAN SDK module and SensoFIVE link have to be enabled in SensoSCAN HCF to allow SensoFIVE to command it**

**SensoSCAN and SensoFIVE software must be "Run as Administrator" (see Start-up)**

**C:\ProgramData\Sensofar\SensoFIVE7.x\Configuration\System Preferences.xml exists and contains the correct configuration for the SensoSCAN path. If it does not exist, you will have to create it manually or copy it to this folder**

3. Close **SensoSCAN** and open **SensoFIVE**

Now both pieces of software are installed, but they need to be linked to work properly. When configured correctly, **SensoFIVE** opens **SensoSCAN** automatically. After the user enters the username and password to log into **SensoSCAN**, **SensoFIVE** displays it embedded on the right of the **SensoFIVE** screen. When the **SensoSCAN** link is not defined, the right side of the **SensoFIVE** screen is empty. In this case, perform step 4 to set up the link.

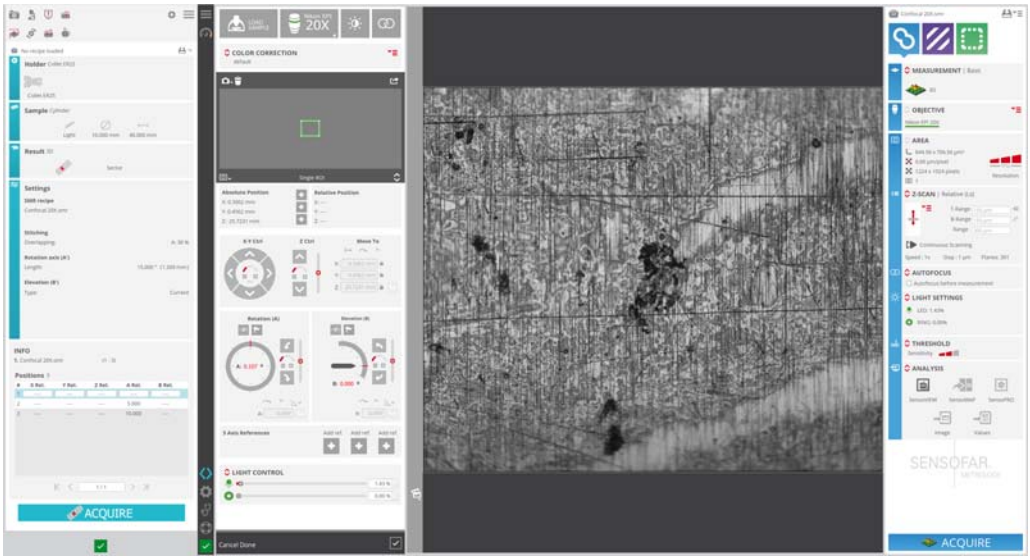
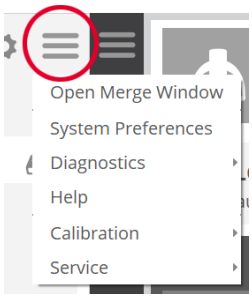



Figure 10.4 SensoSCAN embedded into SensoFIVE

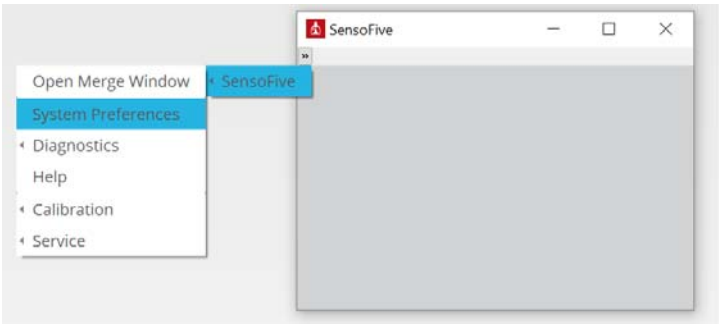
4. Link **SensoSCAN** to **SensoFIVE**

   **a.** Open **SensoFIVE**

   **b.** Click on the System Preferences icon from **SensoFIVE**, or go to the **SensoFIVE** menu and select "System Preferences":




   **c.** It is possible that in a new installation the link between **SensoSCAN** and **SensoFIVE** is not properly established. As a consequence the **SensoFIVE** menu may appear empty when opened. In that case click on the two arrows on the top left corner and select "System Preferences":




   **d.** In the dialog that then opens, click on "Select" the **SensoSCAN** path. Navigate to the folder containing **SensoSCAN** and select it. If it is not specified in a specific directory during the installation, the default directory for **SensoSCAN** will be: "*C:\Program Files\SensoSCAN 7.X*"

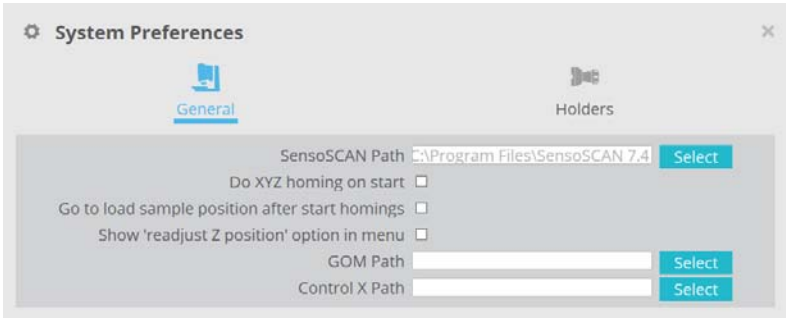



Figure 10.5 System Preferences general menu

   **e.** Restart **SensoFIVE**

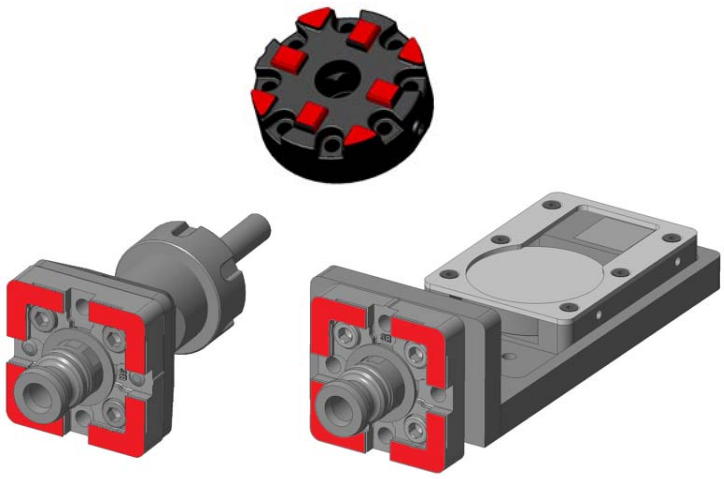
   **f.** **SensoFIVE** opens **SensoSCAN**

   **g.** Closing **SensoFIVE** automatically closes **SensoSCAN** as well.

# 10.4 Annex IV: Maintenance Procedures

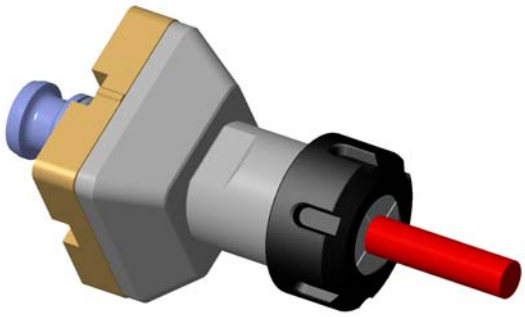
It is important to keep lubricated some areas of the Five Axis Components.

- **Daily**: inspect and clean the chucks
- **Weekly**: clean and lubricate with WD-40 or similar all ground reference surfaces marked in red:



- **When not in use for a long period of time**: clean and protect with the following recommended anti-rust greases
  - Shell Gadus S5 U150X 1.5
  - Shell Cassida XTS
  - Klüber Barrierta L 55/2

## Calibration cylinder



Lubricate the sample periodically with WD-40 or similar to prevent the appearance of rust and follow these general maintenance steps:

- **Before use**: clean the cylinder with a cleaning cloth so no imperfections are shown on the surface during acquisition or calibration
- **After use**: lubricate again before storing it in its protective case to reduce the exposure to air moisture

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