FocalSpec 3D Line Confocal Scanner UULA

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Contents

1 UULA Installation Manual

This chapter contains the *UULA Installation Manual*.

The UULA User Manual is integrated into the software and can be opened by selecting Help from the header.

1.1 Safety Instructions

Please read the manual carefully and observe the safety instructions before you begin working with the system. If you are unsure or have any questions, please contact the supplier.

Table 1: Warnings

Warning sign	Warning
	**Danger of collision!** UULA is designed to offer open work space and easy access. Operator has the responsibility to prevent sensor colliding on anything when moving the sensor down with Z-move or during the measuring when the table moves in X/Y direction or sensor moves in Z-height between the jobs. Special attention must be paid to prevent the sensor from colliding with the calibration mirror, sample or fixture - especially when starting new work and making any adjustments.

Table 2: Warnings

Warning sign	Warning
	**Danger of crushing!** Keep your hands away from the measurement table area during the measuring operation.
	Danger of crushing! Be careful when opening the Z axis locking handle so that the sensor will not slide down with its own weight. (U_XY only)
	Danger of crushing! Mind the gap to enable Z axis movement and do not place fingers or any items into the openings between the sensor and the scanner frame.
	Danger of crushing! Do not put fingers or any items on the bellows cover between the measurement table and the scanner frame.
	Danger of injury! UULA scanner weighs approximately 120 kg / 265 lbs.
	Danger of injury! The sensors are heavy. Two persons are required to handle the LCI1200, LCI1201 and LCI1600 sensors.
	Danger of injury! The calibration mirror weighs 8 kg / 18 lbs.
	**Electrical shock!** The electrical cabinet must be opened only by a certified professional.

Table 3: Cautions

Warning sign	Warning
	Do not unplug the sensor cable connectors when the power is on.
	Handle the calibration mirror with care.
	Do not touch the calibration mirror surface (see Cleaning the Calibration Mirror on page 78).

Warning sign	Warning
	This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments. EN 61326–1:2013.

Notices

This machine must be operated, maintained and repaired only by persons who are properly trained and qualified. Make sure unauthorized persons cannot operate the machine.

The machine must only be operated by one person at a time.

The machine table moves during operation: ensure a safe area around the machine, a minimum of 0.5 m

(20"). Keep the measurement table surroundings clear of items in order not to block the table movement.

Clear the measurement table of any loose and unnecessary items before operating the machine.

Check the performance of the Emergency Stop button regularly.

Use this machine only for its intended purpose.

Operate this machine only in environments designed and permitted for its use.

Maintenance and service operations must be done regularly and in due time.

Any changes to the safety circuit are strictly forbidden. Changes may cause unexpected start-up or shutdown, or automatic repetition of cycles, which may lead to serious injuries.

If damage or malfunction occur, shut down the system without delay. Correct the issue immediately. If correcting the issue is not possible, turn off the system and make sure it cannot be started up before the issue is fixed.

Check that all the power supplies and wires are in good condition. Do not operate the machine if any cracks, worn out cables or connections are detected.

Make sure all cables are in place and arranged so that there is no risk of tripping.

1.2 Measurement Table

It is recommended to install the UULA measurement system on a stone table or firm worktable, which is suitable for the scanner weight (120 kg / 265 lbs) and does not wobble underneath the scanner. It is advisable to:

1. Level the table horizontally.
2. Set the scanner in place.
3. Level the scanner using the adjustable legs.

The scanner dimensions are 600 * 880 * 950 mm / 24 * 34.6 * 37.4 inches (D*W*H).

The measurement operation requires using the computer, and a good view of the measuring table. Thus, convenient access to both the scanner and computer is needed. It is recommended to place both the computer and the scanner on the same table, which is at least 160 cm (63”) wide.

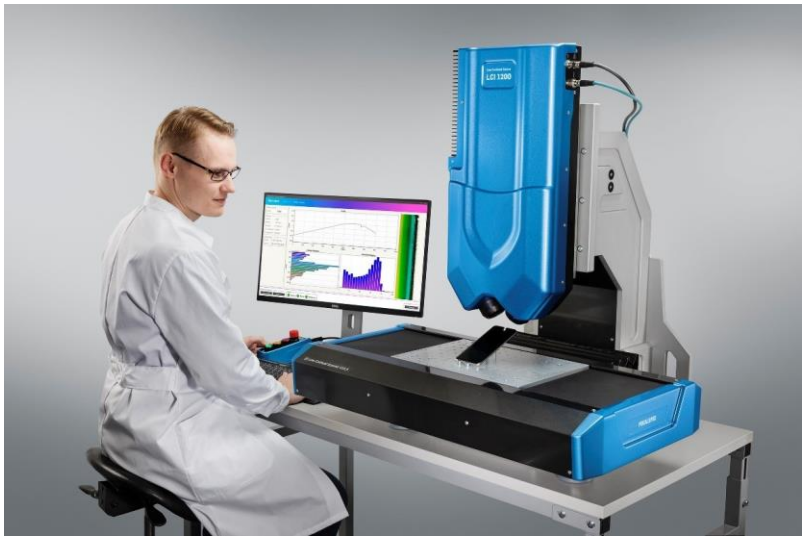


Figure 1. UULA Measurement System

1.3 Delivery Package Contents

The UULA delivery contains the following items:

- Scanner frame (1).
- Controller (2).
- Z-axis adjustment knob (3).
- Lifting strap (4) with screw pin anchor shackles (5).
- Calibration mirror (6).
- Measurement table (7).
- Power cable (8).
- Sample fastening kit (9).
- Display adapter cable in case the graphic card does not have HDMI.
- Fastening strips and pins.
- Plywood package and pallet. Keep the package and pallet for future device transportation.
- Printed UULA user manual and UULA installation manual.
- Map / Mountains Map USB dongle.

The installation code needed for FocalSpec Map installation will be delivered separately by LMI technical support.

The sensor will be delivered in a separate package.

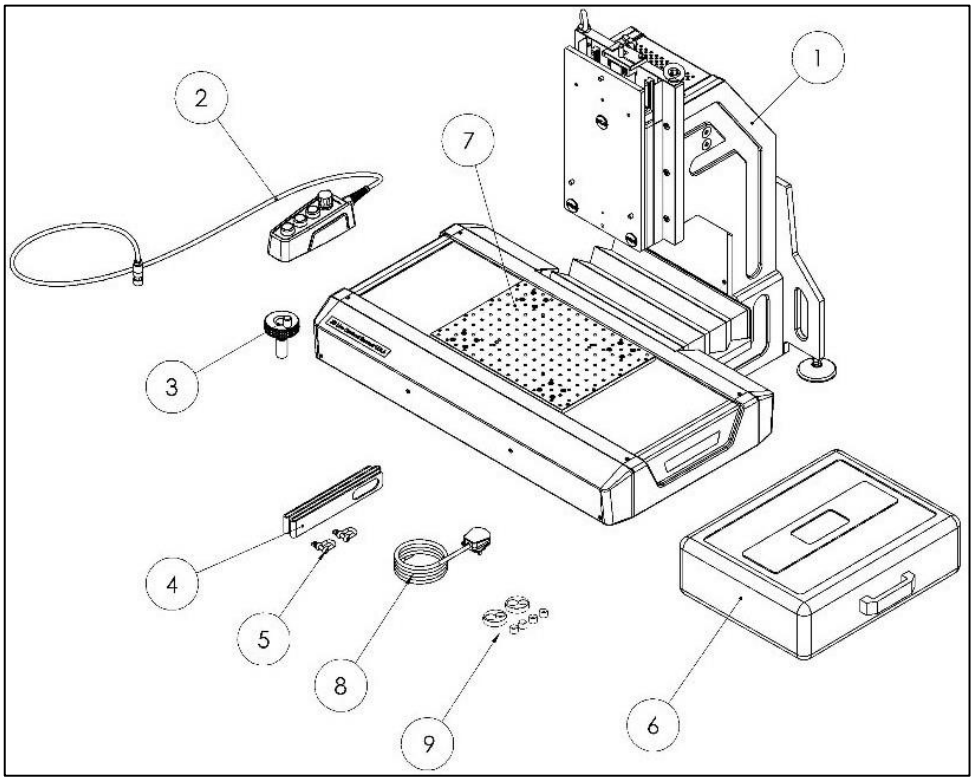


Figure 2 Delivery Package Contents

1.4 Computer and Ethernet

Note: If you use LCI1220 or LCI1620, see 1.8 UULA with sensors LCI1220 and LCI1620

If the delivery does not include a computer, the items below are required:

- A computer. The minimum requirements are:
  - CPU — Intel i7 6th generation or newer
  - RAM — 32 GB or more
  - GPU — Intel HD Graphics 530
  - Data Storage — SSD 256 GB or bigger
  - Ethernet Adapter — Intel Gigabit adapter, 9 Kbytes Jumbo packets enabled
  - Operating system — English Windows 10 (Tested on build 10.0.15063)

  o For production and lab environments, the recommended computer model is Advantech MIC-7500B-U8A1E with NVIDIA GPU, English Windows 10. For office environment, also HP Z2 Mini G5 WKS I7 8700 / 32GB / 512GB / P600 / 2xLAN / W10P / 4YNBD can be used.
- Ethernet cable to connect the scanner to the computer.

  Note: UULA requires its own dedicated Ethernet port. Do not use a switch.

  - SF/UTP double shielded cable (CAT-5)

The delivery does not include a display, keyboard or mouse. A 27" full HD (1920 x 1080) display with a DVI cable is recommended.

1.5 Unpacking and Assembling UULA

This section describes how to unpack and assemble the UULA hardware.

Before you start, make sure that you have:

- A PH2 screwdriver or a cordless drill.
- A pump lift.
- A 2 mm Allen key.
- Phoenix Contact tool TSD 04 SAC (1208429) and SAC BIT M12-D15 (1208432) 0.4 N m.

At least two persons are required to install the device.

Proceed as follows:

1. Place the plywood package in such a way that you can walk around it.
2. Unfasten the screws (PH2) on the package lid.
3. Remove the lid (number 1 in the figure below) of the plywood package.

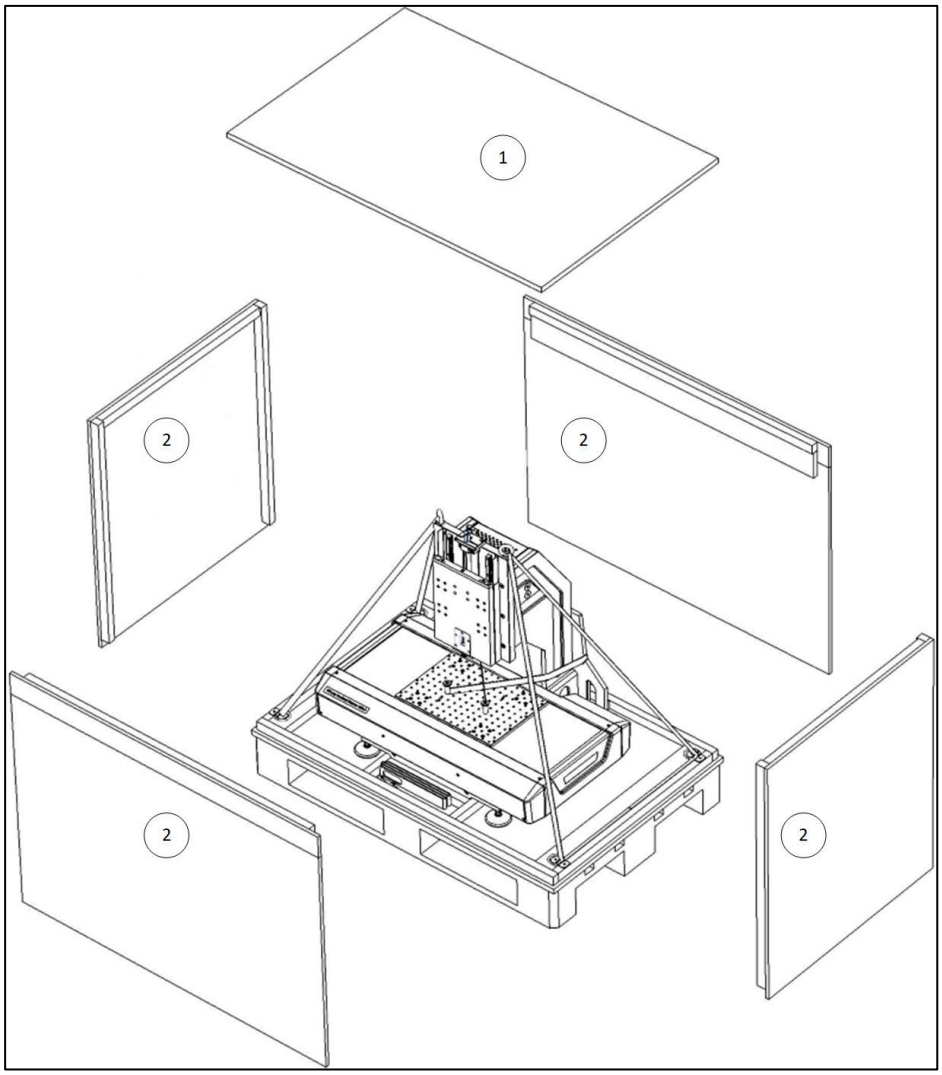


Figure 3 Plywood Package and Calibration Mirror

4. Remove the calibration mirror box and computer (if included) from the end plates.
5. Unfasten the screws on the vertical corners and at the bottom edges of the package.
6. Remove the sides (number 2 in the figure above).

7. Remove the corrosion protection paper.
8. Remove the envelope containing a USB memory stick with UULA software installer and a FocalSpec Map USB dongle.
9. Remove the fastening strips, which run through the screw pin anchor shackles and secure the device to the pallet.
10. Ensure that the device is ready for lifting.

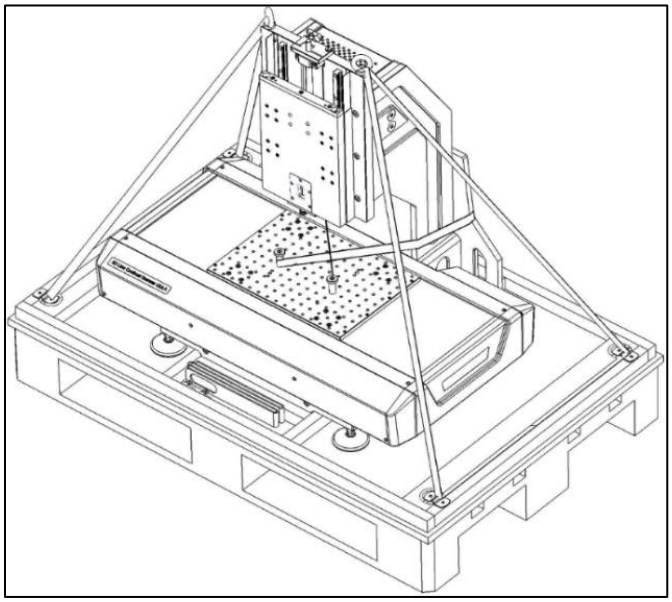


Figure 4 Removing the Fastening Strips

The device must only be lifted by using the two lifting eyebolts on top of the device. Use the screw pin anchor shackles and the lifting strap, which you can find in the pocket located at the front of the pallet.

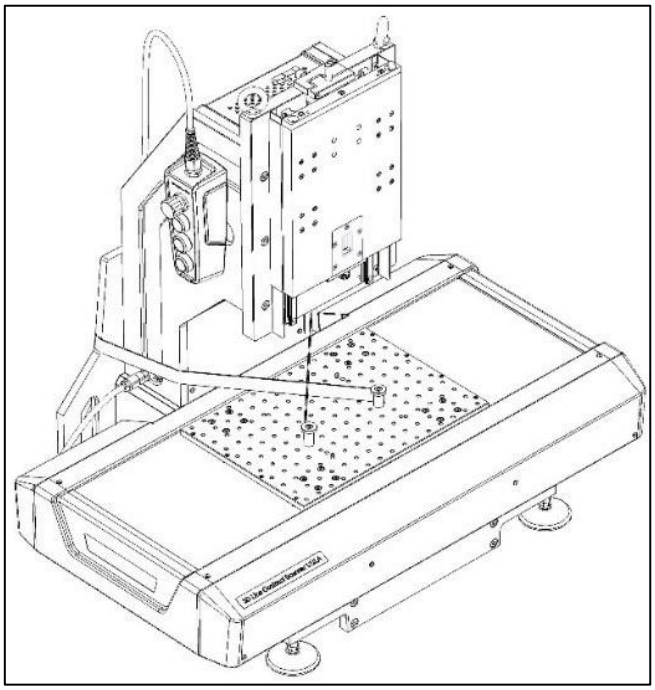


Figure 5 Table Locked

11. Using a pump lift, lift the device onto the worktable.

Warning: Danger of crushing! The UULA scanner weighs approximately 120 kg / 265 lbs. A pump lift is required to handle the scanner.

12. Remove the fastening strips around the sensor, and the fastening pins from the measurement table.
13. Remove the lifting eyebolts by unscrewing them.

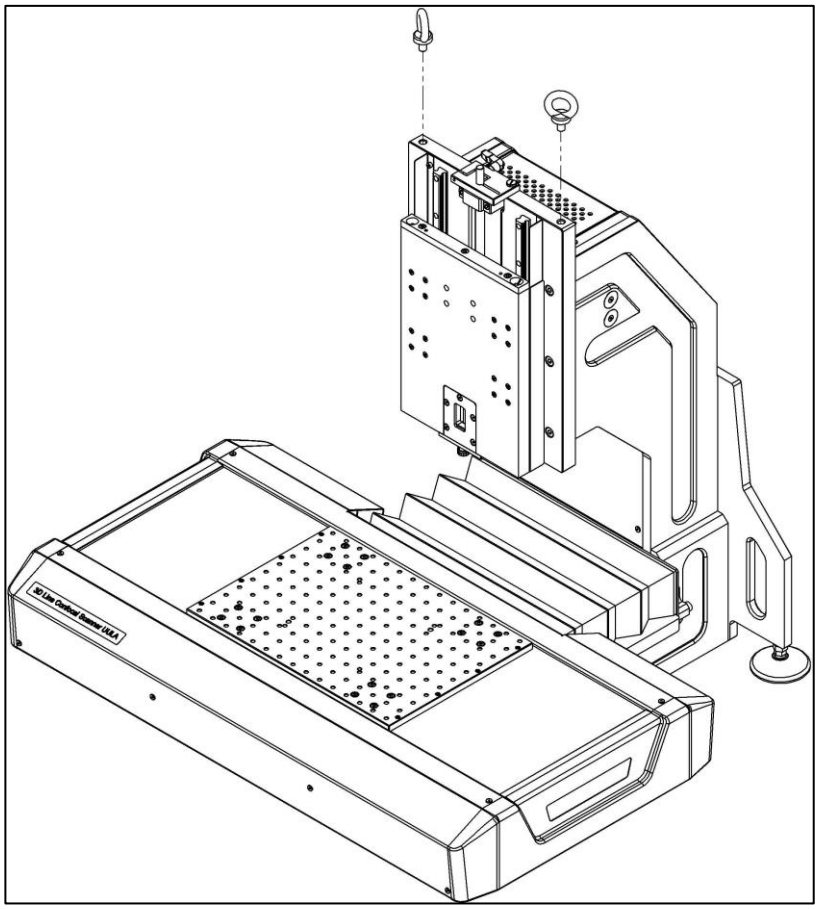


Figure 6 Removing the Lifting Eyebolts

Note:

It is extremely important that you remove the lifting eyebolts, as they will collide with the Z-axis protection plate when the sensor mounting plate is raised.

14. Fasten the Z-axis adjustment knob delivered with the package.

Fasten the locking screw in such a way that it enters the cavity on the axle.

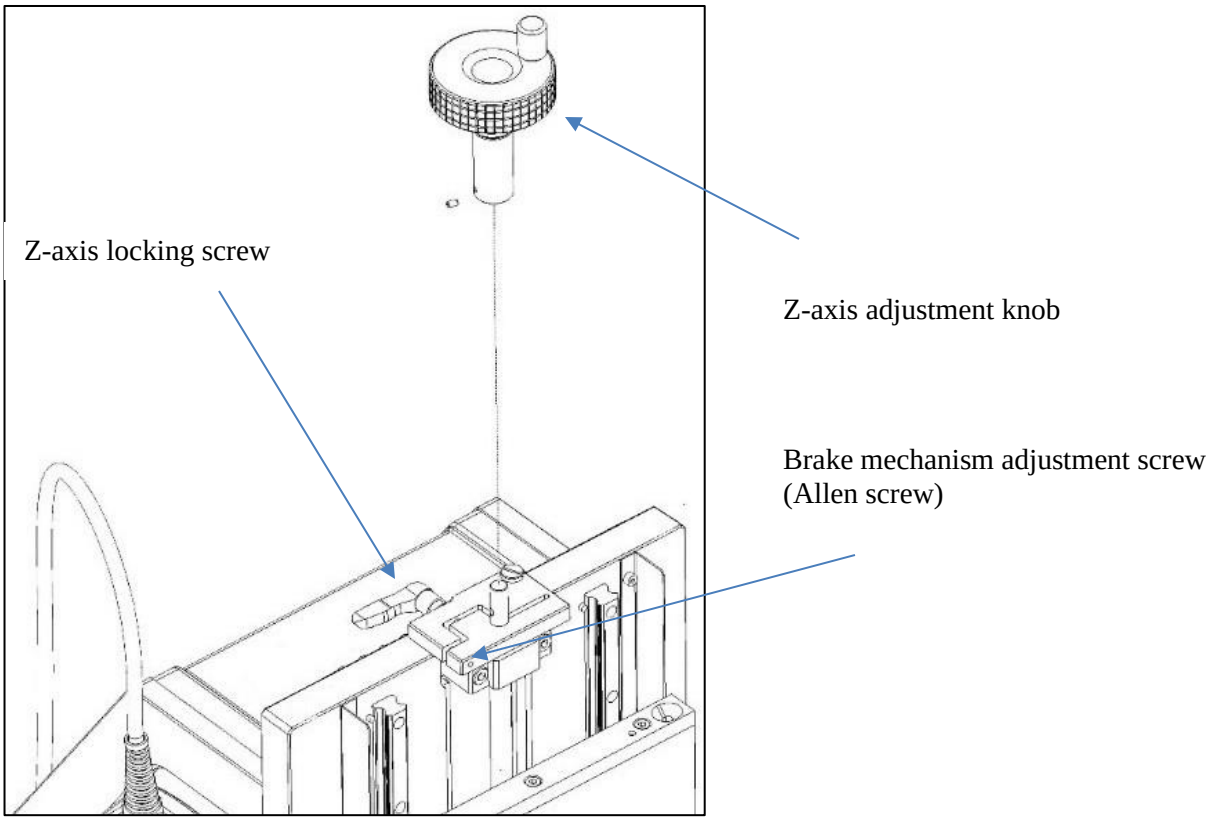


Figure 7 Fastening the Z-axis Adjustment Knob (with Z-axis locking screw)

15. Open the sensor mounting finger by unscrewing thumbscrew until the sensor head locking pin is no longer visible.
16. Connect the controller, delivered with the package, to its connector on the left side of the scanner frame.

    Push the connector in place (approximately 5 mm / 0.2") and tighten the nut by turning it clockwise with Phoenix Contact tool TSD 04 SAC (1208429) and SAC BIT M12-D15 (1208432).

    You can place the controller onto a magnetic holder. There is one magnetic holder on each side of the device.

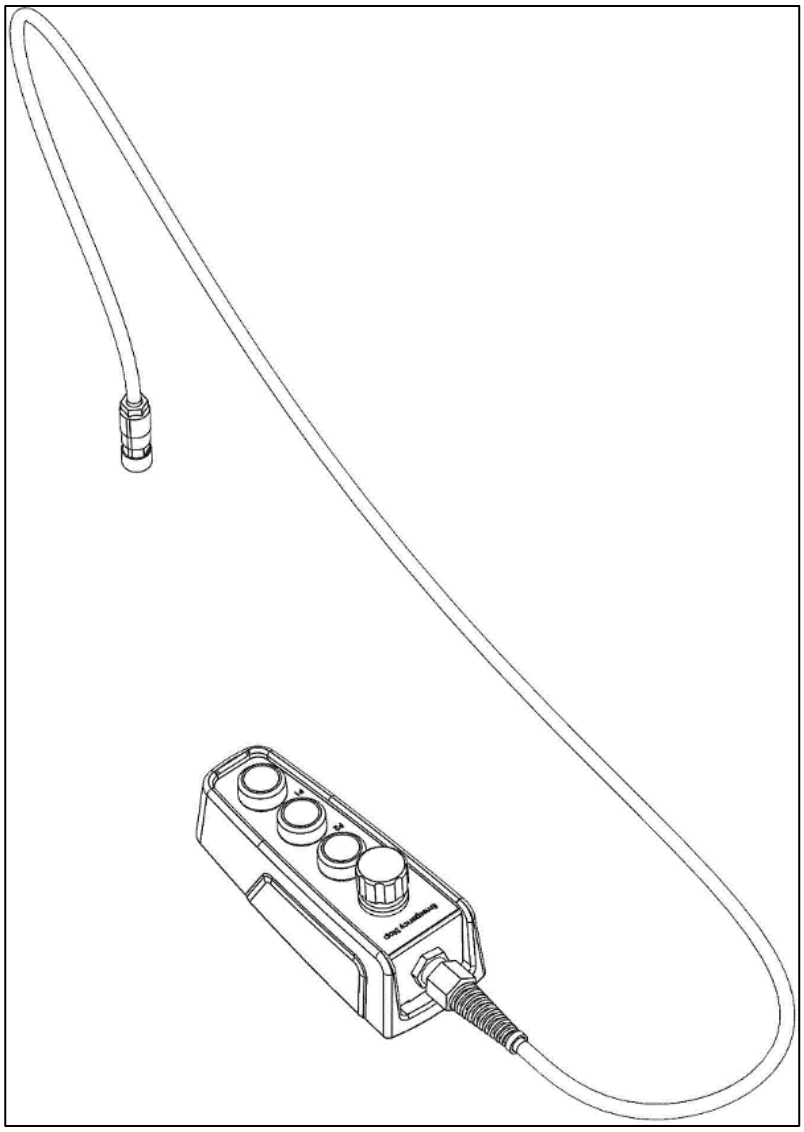


Figure 8 The Controller

17. Remove the sensor from its package.

Warning: Danger of crushing! The sensor weighs approximately 30 kg / 66 lbs. Two persons are required to handle the sensor.

Before you continue, ensure that the lens cover is in place:

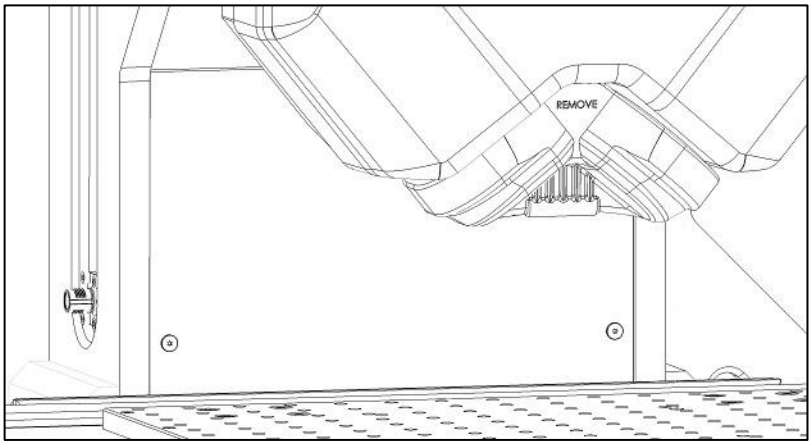


Figure 9 Lens Cover

18. Lower the sensor into its place in a slightly tilted position.

Before you start, check that the Z-axis has been raised enough, so that the sensor fastening plate is level with the device chassis, and that the Z-axle locking handle is locked (applies to the non-motorized version, U_XY).

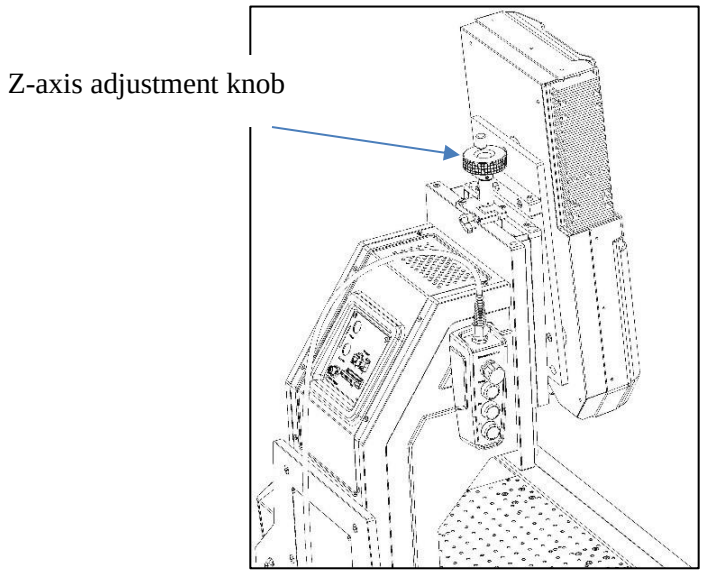


Figure 10 Lifting the Sensor in Place — 1

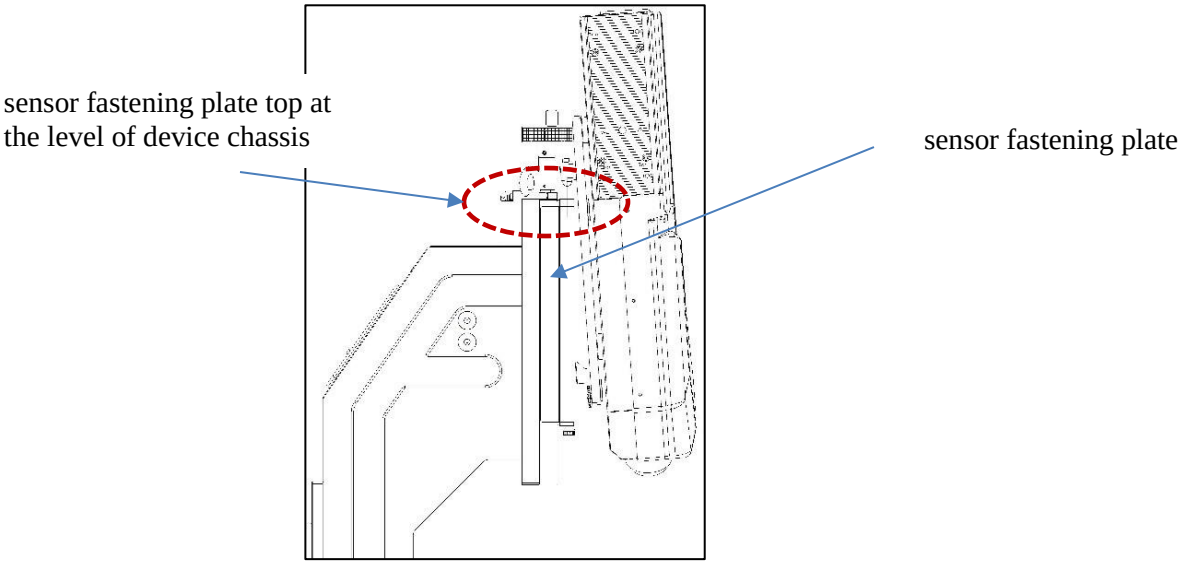


Figure 11 Lifting the Sensor in Place — 2 (sensor fastening plate top at the level of device chassis)

19. Ensure that the spherical guide pins in sensor back plate enter the conical cavities at the upper part of the Z-axis mechanism. (See Figure 11.)

20. Lock the sensor in place by using the thumbscrew at the lower part of the Z-axis mechanism. Use approximately 1 Nm torque.

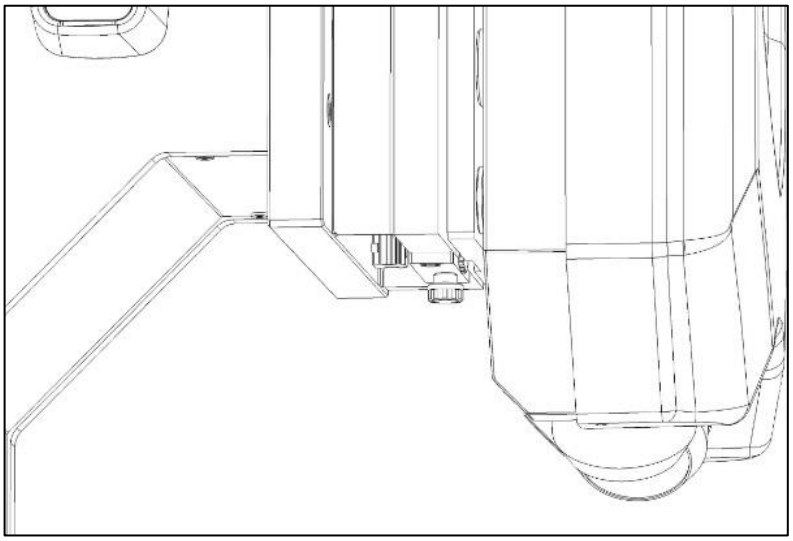


Figure 12 Locking the Sensor in Place

Note: If you are installing a motorized Z version (U_XYZ), make sure that the Z-axis locking handle is left loose.

21. Adjust the sensor height.

Hold the Z-axis adjustment knob by hand when opening the Z-axis locking handle, to prevent the sensor from moving downward due to gravity. When you turn the Z-axis adjustment knob downward, you should feel resistance. If not, tighten the brake mechanism adjustment screw (Allen screw), which is located next to the locking handle (non-motorized Z version U_XY). (See illustrations above for details.)

In the case of the motorized Z version (U_XYZ), make sure that the Z-axis locking handle remains loose.

22. Connect Phoenix Contact NBC-MSY (1407491) power/trigger cable between the scanner and the connector panel at the back on the frame.

Push the connector in place (approximately 5 mm / 0.2") and tighten the nut by turning it clockwise with the Phoenix Contact tool TSD 04 SAC (1208429) and SAC BIT M12-D15 (1208432).

23. Connect Phoenix Contact NBC-MS (1407414) Ethernet cable between the scanner (M12) and the connector panel position Ethernet 1 (RJ-45).

At the scanner end, push the connector in place (approximately 5 mm / 0.2"), and tighten the nut by turning it clockwise with the Phoenix Contact tool TSD 04 SAC (1208429) and SAC BIT M12-D15(1208432).

24. Ensure that the measurement table has enough room to move, by pulling the table outward.

25. Check that the main switch is in the Off (“0”) position.

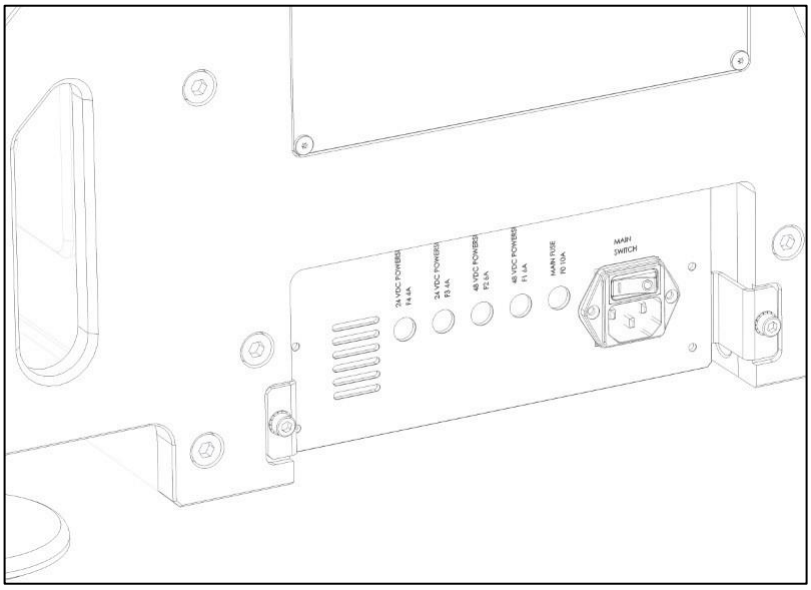


Figure 13 Power Main Switch at the Back of the UULA Frame

26. Connect the power cable to a grounded outlet.
27. Connect the Ethernet cable between the scanner and computer.

Note: UULA requires its own dedicated Ethernet port. Do not use a switch.

28. Remove the lens cover.
29. Switch on the power.

1.5 Installing UULA Software

This section describes how to install the UULA software.

Proceed as follows:

30. Copy setup.exefrom the USB memory stick or download it from LMI support site to the C drive.
31. Double-click setup.exeto run it.
32. Read and accept the license agreement.
33. Select Next.
34. Select the network adapter that is connected to UULA (on Windows 10).

    You can also check all the adapters if you are not sure, which one to choose. If you want to manually configure settings or if you are using Windows 7, choose **Manual configuration**. For manual configuration instructions, see chapter Manual Network Interface Configuration .

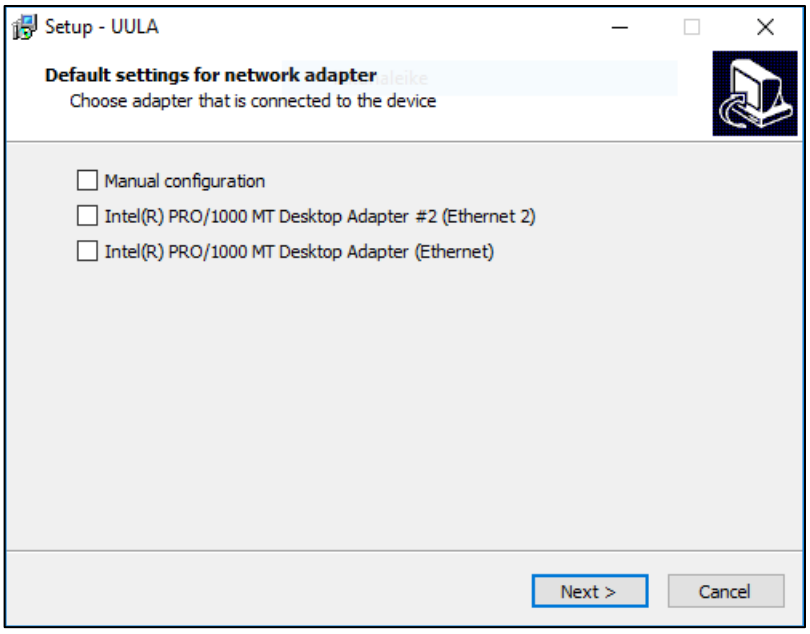


Figure 14 Selecting the Network Adapter

35. Select **Next >**.
36. Select the PilotCore.licenselicense file from the USB stick.
37. Select **Next >**.
38. Allow installer to create a desktop shortcut and select Next >
39. Select Install
40. Install **CloudCompare** (only if not yet installed).
41. In the **FocalSpec VEVO Filter Driver** setup window:
    a) Select **Install**.
    b) Select **Yes** to the network adapter parameters question.
42. Disable the drivers on interfaces not used with UULA, by unchecking them.

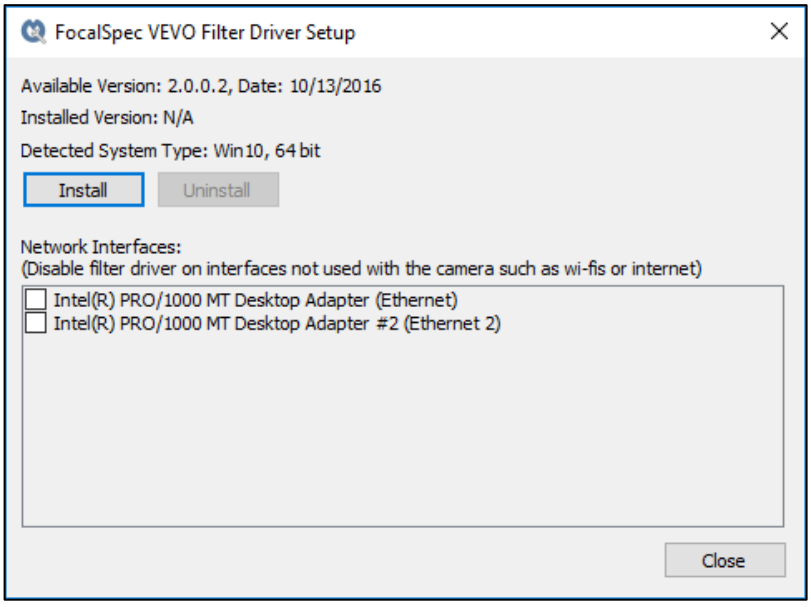


Figure 15 Installing FocalSpec VEVO Filter Driver

43. Select **Close**.
44. Select **Finish** to end the installation.

1.5.1 Manual Network Interface Configuration

This section describes how to manually configure the network interface.

Proceed as follows:

1. Open the settings for the network adapter connected to UULA.
2. In Windows 10, select **Network and Sharing Center**.

   Depending on the Windows version, you may have to select **Network & Internet settings**.
3. Select **Change adapter options**.
4. Double click the network adapter that is connected to UULA.
5. Select **Properties**.
6. Select **Internet Protocol Version 4 (TCP/IPv4)** > **Properties**.
7. Select **Use the following IP address**. Enter the details below:

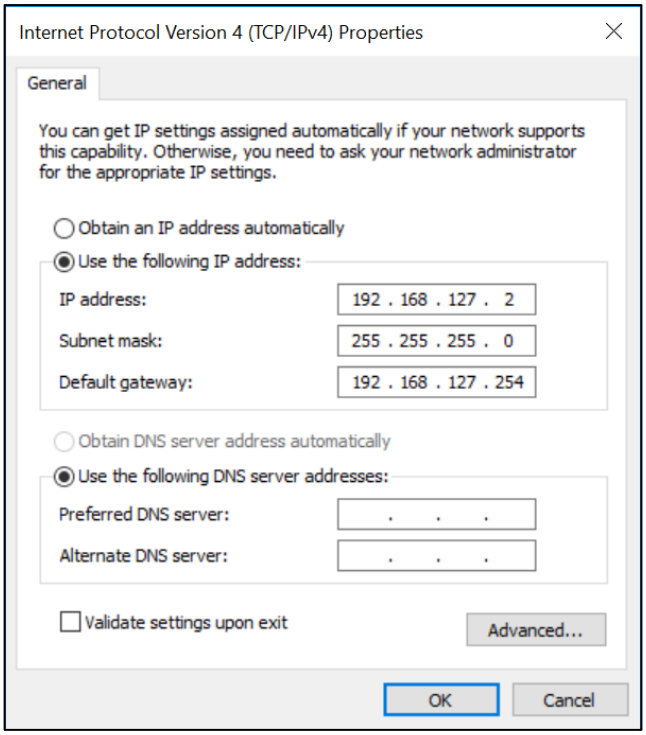


Figure 16 Network Adapter Settings

8. Select **OK**.

   Reboot your computer if needed.

1.6 Installing Focalspec Map

This section describes how to install the Focalspec Map software. Proceed as follows:

1. Copy setup.exe from the USB memory stick or download it from LMI support site to the C drive.
2. If you have purchased FocalSpec Map and have a license dongle, insert it into the USB drive prior to installing.
3. Extract the zip package and based on your operation system run either Setup32.exe in Install folder or Setup64.exe in Install 64 folder.
4. After starting the install below window opens

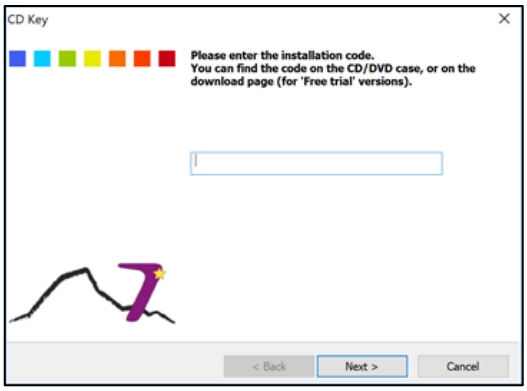


Figure 17 License key window

5. Type in the installation code you have got from LMI Support.
6. Follow the instruction to complete the installation

Activation of evaluation version

You can use the evaluation version 72 hours without activation. During that time, you can go to the "Help" tab and activate the software with the code you have got from LMI.

After activation your evaluation version may be used for 30 days. The evaluation period cannot be renewed. If you encounter any difficulty during the process, please contact the LMI support.

1.7 Installing Mountains Map v8

This section describes how to install the Mountains Map software. Proceed as follows:

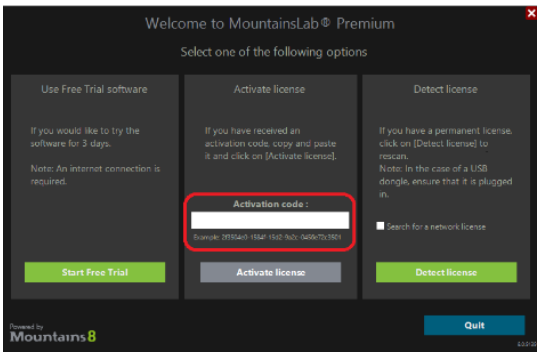
1. Before installing a new version of the software:

- Uninstall all previous versions, also Focalspec Map software (in Add or Remove programs)
- Make sure you have Administrator rights
- Insert the license dongle to USB port

2. Download the software installation file from: https://downloads.lmi3d.com/mountainsmap-imaging-topography-windows-installer-version-8
3. Unzip the file then double click on Autorun.exe to begin the installation process
4. Enter your 6-digit installation code and follow the installation steps

- Code can be found in the email you received or on the product packaging. If in doubt, please contact LMI support.

5. Once you have completed the installation process, launch MountainsMap V8
   - The following dialog is displayed



- Copy the “Activation code” (received by email) into the field in the second column. Make sure that you have entered the correct code. An “Activation code” is composed of 33 numbers/letters in this format: XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX

1.8 UULA with sensors LCI1220 and LCI1620

There are two options to connect LCI1220/1620 sensor to UULA:

- 10 Gbit optical Ethernet directly to desktop PC having additional network adapter with SFP+ interface. This is recommended option
- Switch with SFP+ between UULA and desktop PC or laptop without SFP+ interface. This option has limited maximum scanning frequency.

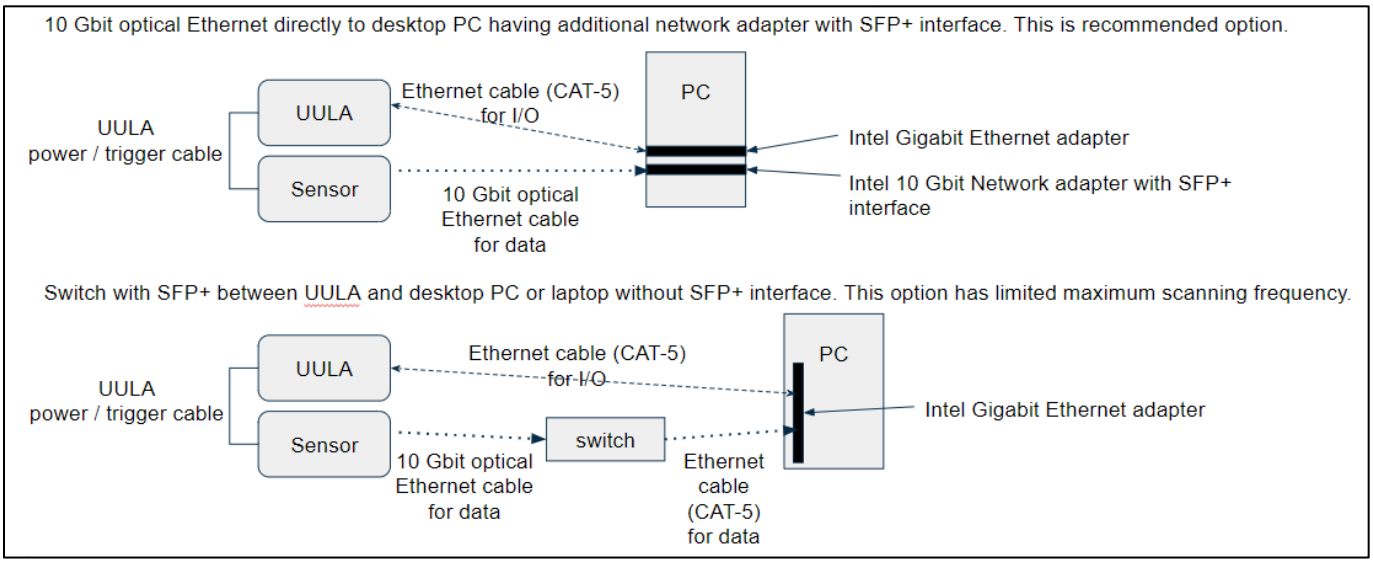


Figure 18 Connecting LCI1220 or LCI1620 to UULA

1.8.1 UULA LCI1220/1620 sensor set up cables

- Special UULA power / trigger cable - needs to be ordered separately from LMI
- Push Pull type optical Ethernet cable (5 m) with two SFP+ modules to connect sensor to PC, included in LMI sensor sales package

- In addition, Ethernet cable will be needed to connect Uula to PC, this is not provided by LMI.

Note 1: UULA I/O requires its own dedicated Ethernet port. Do not use a switch. SF/UTP double shielded cable (CAT-5) recommended.
Note 2: In order to connect the PC to company LAN, another Ethernet port (card or USB) is needed.

Also needed if not included in the sales package: PC, display, keyboard or mouse. A 27" full HD (1920 x 1080) display with DVI cable is recommended

1.8.2 Recommended UULA LCI1220/1620 sensor set up

Desktop computer, recommendation below

- CPU — Intel i7 6th generation or newer (for fast speed processing: i9 9900K)
- RAM — 32GB or more (min 16 GB)
- GPU — NVIDIA Quadro (min Inter HD Graphics 530)
- Data Storage — SSD 256GB or bigger
- Ethernet Adapter — Intel Gigabit adapter, 9KBytes Jumbo packets enabled
- Operating system — English Windows 10 (Tested on build 10.0.15063)

10 Gbit optical Ethernet connection with SFP+ interface requires additional network adapter to above mentioned desktop computer

- Recommended network adapter is Intel Ethernet Converged Network Adapter X520 - DA2 model

1.8.3 UULA LCI1220/1620 using through switch

If LCI1220/1620 sensor want to be used in UULA with PC or laptop without SFP+ connection, a switch is needed. With switch the maximum scanning frequency for continuous measuring is about 8000 Hz measuring one surface. With multiple surfaces the frequency is respectively lower.

QNAP network switch is recommended. The 8-port (QSW-804-4C-US) version is enough.

Install first DSU (device search utility)
https://moxa.com/Moxa/media/PDIM/S100000211/moxa-device-search-utility-v2.2.exe
Open DSU
Ethernet port TCP IPv4 setting can be on automatic
Run Search
After search completed, you may close the DSU and start Uula SW

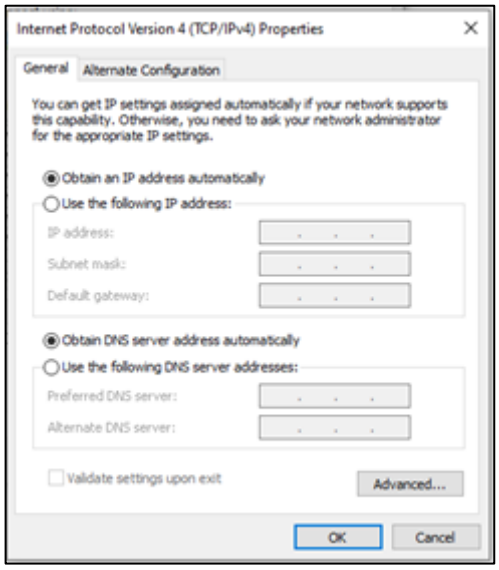


Figure 19 Network Adapter Settings for switch configuration

1.9 Disposal and Recycling of Packaging Materials

UULA plywood package, package papers and cushion foams can be disposed of according to the local recommendations for energy waste.

The EURO pallet and fastening strips can be recycled for another use.

2 UULA User Manual

The UULA User Manual is integrated into the software and can be opened by selecting Help from the header.

FocalSpec 3D Line Confocal Scanner UULA is an optical 3D imaging and metrology system for accurate sub-micron measurements on any material. It provides:

- Automated, high speed and high precision analysis of challenging surfaces and shapes, such as mirror-like, curved or multi-layered transparent objects.
- Easy, accurate and repeatable measurements.

The applicable measurement standards are:

- ISO 25178 3D height and functional bearing ratio parameters
- ISO 4287 2D primary and roughness parameters
- ASME B46.1 3D and 2D parameters
- EUR 15178 amplitude and area & volume parameters
- DIN (Germany), JIS (Japan), GB/T (China), NF (France), BSI (UK), UNI (Italy), UNE (Spain) equivalents of ISO parameters

Analysis and data editing:

- Full set of surface roughness/waviness filters including Gaussian (ISO 16610-61), cubic spline filter (ISO 16610-62), robust Gaussian filter (ISO 16610-71).
- PDF, RTF, screen and print quality bitmaps, Excel-compatible numerical results for compatibility with quality management and other systems.

This manual covers both machine versions: an earlier model without the motorized Z stage (referred to as "U_XY") and the current model with motorized Z stage (referred to as "U_XYZ"). Please refer to the section of the manual which reflects your machine version.

This manual also covers the operation of the optional rotary table. If the delivered content does not include the rotary table, those parts of the manual are not valid.

2.1 Recommendations

2.1.1 Measurement Table

It is recommended to install UULA measurement system on a stone table or firm worktable, which is suitable for the scanner weight (120 kg / 265 lbs) and does not wobble underneath the scanner. It is advisable to:

1. Level the table horizontally.
2. Set the scanner in place.
3. Level the scanner using the adjustable legs.

The scanner dimensions are 600 * 880 * 950 mm / 24 * 34.6 * 37.4 inches (D*W*H).

The measurement operation requires using the computer, and a good view of the measuring table. Thus, convenient access to both the scanner and computer are needed. It is recommended to place both the computer and the scanner on the same table, which is at least 160 cm (63”) wide.

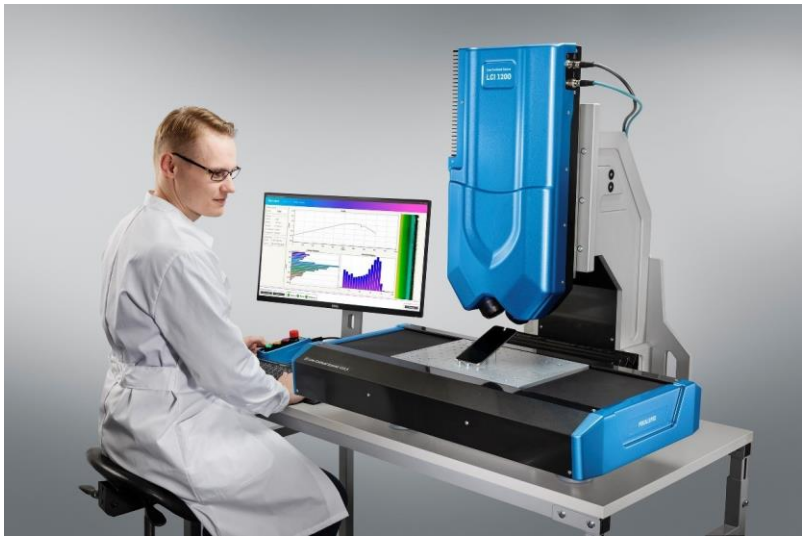


Figure 20 UULA Measurement System

2.1.2 Computer and Ethernet

Note: If you use LCI1220 or LCI1620, see 1.8 UULA with sensors LCI1220 and LCI1620

If the delivery does not include a computer, the items below are required:

- A computer. The minimum requirements are:
  - CPU — Intel i7 6th generation or newer
  - RAM — 32 GB or more
  - GPU — Intel HD Graphics 530
  - Data Storage — SSD 256 GB or bigger
  - Ethernet Adapter — Intel Gigabit adapter, 9 KBytes Jumbo packets enabled
  - Operating system — English Windows 10 (Tested on build 10.0.15063)

  o For production and lab environments, the recommended computer model is Advantech MIC-7500B-U8A1E with NVIDIA GPU, English Windows 10. For office environment, also HP Z2 Mini G5 WKS I7 8700 / 32GB / 512GB / P600 / 2xLAN / W10P / 4YNBD can be used.
- Ethernet cable to connect the scanner to the computer.

  Note: UULA requires its own dedicated Ethernet port. Do not use a switch.

  - SF/UTP double shielded cable (CAT-5)

The delivery does not include a display, keyboard or mouse. A 27" full HD (1920 x 1080) display with a DVI cable is recommended.

2.2 UULA User Interface

2.2.1 Access Right Levels

Users on different user levels have different access rights to the program. The access right levels are:

• Administrator

- User access control
- Calibration
- Editing recipes
- Scanning

• Advanced operator

- Editing recipes
- Scanning

• Operator

- Scanning

2.2.2 Logging in

When UULA software is started, the program asks you to login. When you have given the correct username and password, the program execution can continue.

Proceed, as follows:

1. Start UULA.

   The screen below is opened:

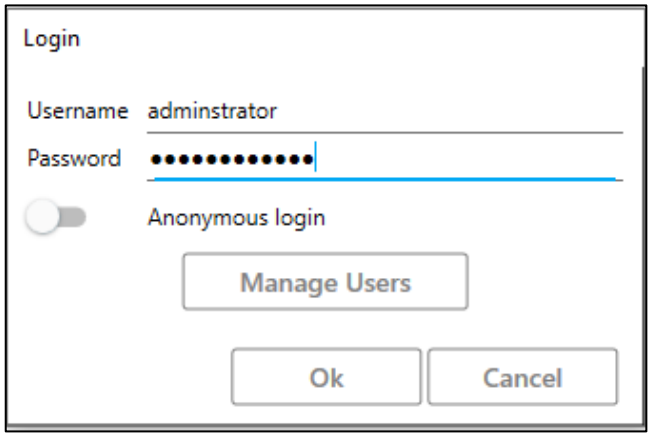


Figure 21. Login

   If the administrator has allowed anonymous logins for a particular user level, you can login without writing a username and password, by selecting **Anonymous login**.

   The **Manage Users** button is only visible for Administrators.

2. Enter your username and password.

   If the administrator has allowed anonymous logins for a particular user level, you can login without writing a username and password, by selecting **Anonymous login**.

   The **Manage Users** button is only visible for Administrators.

3. Select **OK**.

2.2.3 Managing users

This chapter describes how to add and remove users, and how to define anonymous login.

Adding users

Important:

The **Manage Users** button is visible when the software is used for the first time. Always create a new administrator user account at this time. The default *fsadmin* account is only for possible remote support from FocalSpec.

Proceed, as follows:

1. Start UULA.

   The screen below is opened:

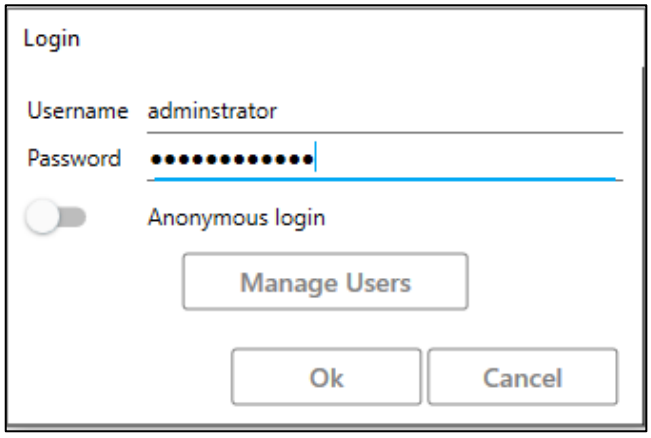


Figure 22. Login

2. Select **Manage Users**.

   The screen below is opened:

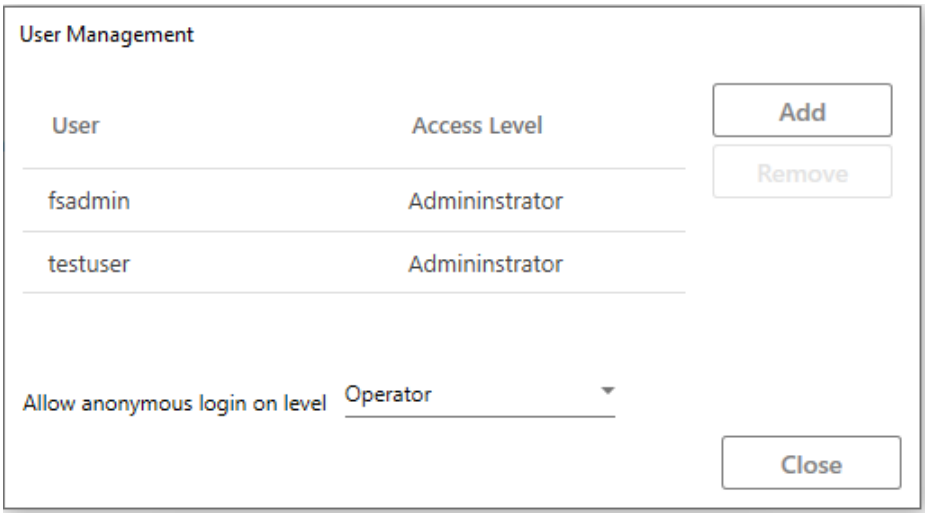


Figure 23. User Management

3. Select **Add**.

   The screen below is opened:

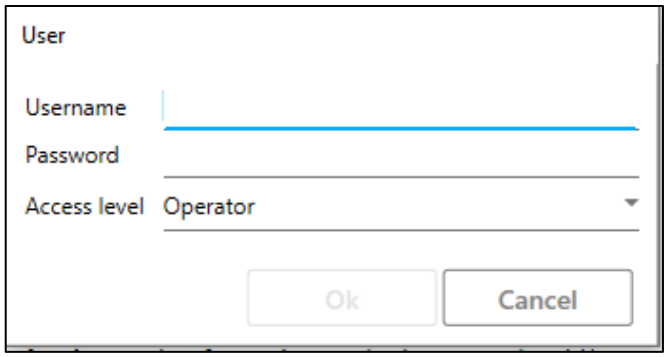


Figure 18. User window

Enter information, as follows:

- **Username** – Enter the username of the new user.
- **Password** – Enter the password of the new user.
- **Access level** – Enter the access right level of the new user.

4. Select **OK**.

Removing users

Proceed, as follows:

1. Start UULA.

   The screen below is opened:

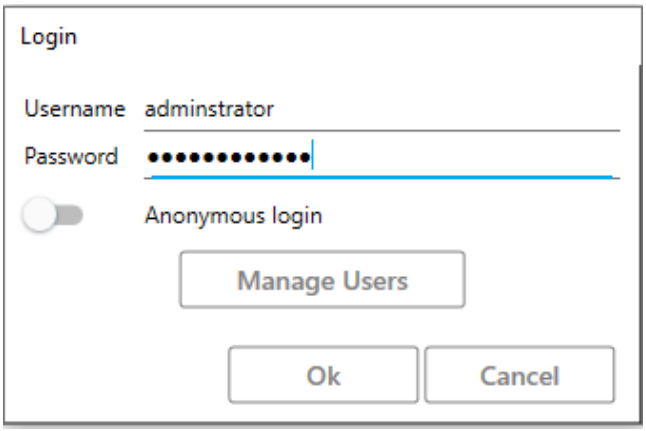


Figure 19. Login

2. Select **Manage Users**.

   The screen below is opened:

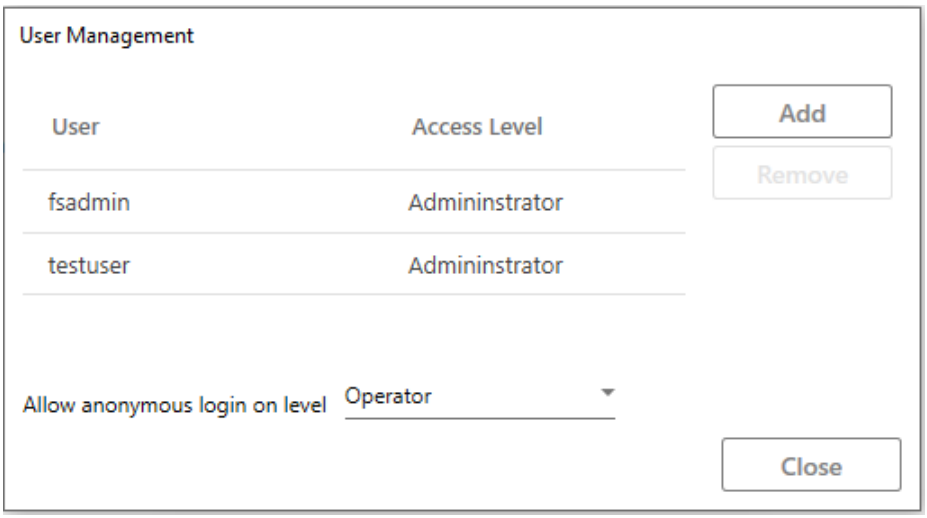


Figure 20. User Management

3. Select the user you want to remove.
4. Select **Remove**.

Defining anonymous access

An administrator can allow users to login anonymously, without writing a username and password.

Proceed, as follows:

1. Start UULA.

   The screen below is opened:

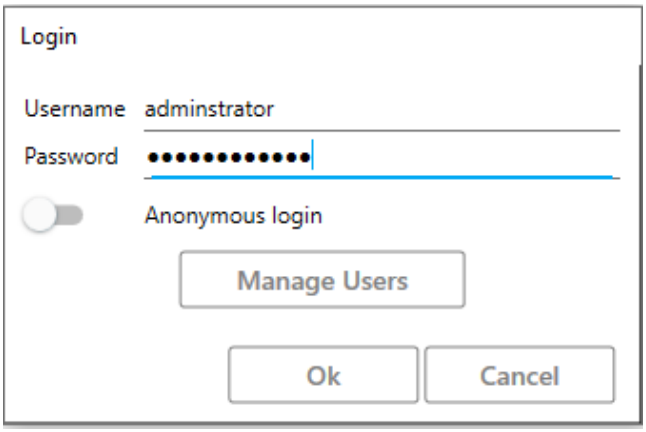


Figure 21. Login

2. Select **Manage Users**.

   The screen below is opened:

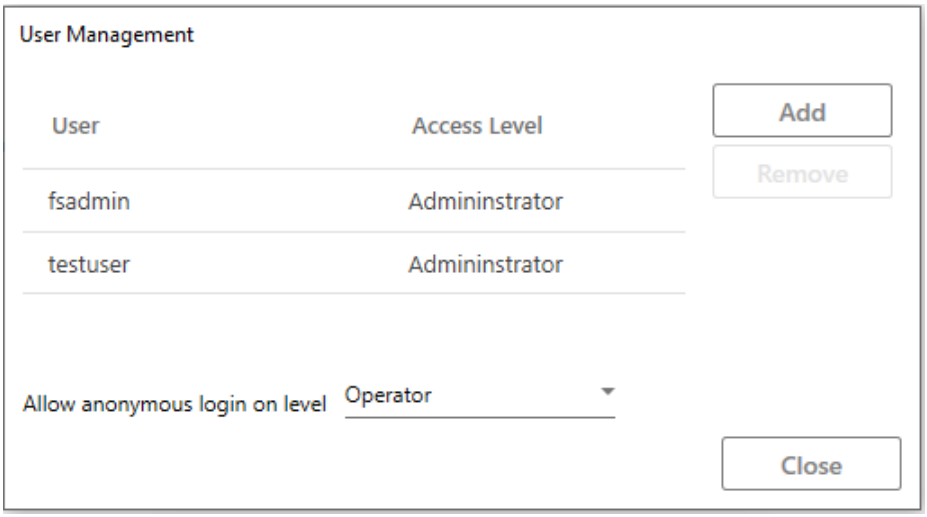


Figure 22. User Management

3. From the **Allow anonymous login on level** drop-down menu, select the anonymous access level, which you want to use.

   For example, if you set the access level to *Operator*, the anonymous user can only carry out scanning. If you set the level to *None*, anonymous login is not allowed.

4. Select **OK**.

2.2.4 Main Window

UULA main window consists of header and footer and four main tabs:

- Measurement (See chapter Measurement)
- Analysis (See chapter Analysis)
- Recipes (See chapter Recipes)
- Calibration (See chapter Calibration)

The header area is depicted in the figure below:

Figure 23. Header

The settings on the header are:

- **Help** — Press this to open the main view of the Help.
- **About** — Press this to open an information window which lists 3rd party software licenses, UULA software version and found firmware versions.

The footer area is depicted in the figure below:

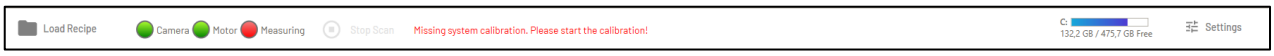


Figure 30. Footer

The settings on the footer are:

- **Load Recipe** — Press to open **Select Recipe** window, to select a recipe for scanning.
- **Status** — Indicator lights related to the physical machine status.
  - **Camera** — The possible statuses are:
    - Green — The camera has been found and the connection to it has been established.
    - Red — No connection to the camera.

      If there is no connection to the camera, proceed as follows:

      1. Restart the software.
      2. Restart UULA.
  - **Motor** — The possible statuses are:
    - Green — The motor has been found and the connection to it has been established.
    - Red — No connection to the motor.

      If there is no connection to the motor, proceed as follows:

      1. Restart the software.
      2. Restart UULA.
  - **Measuring** — The possible statuses are:
    - Green — The measurement is running.
    - Red — No measurement is running.
- **Disk** — This area indicates the amount of available hard disk space.
- **Stop scan** — When scanning is ongoing, scanning can be halted.
- **Settings** — A pop-up window will be opened.

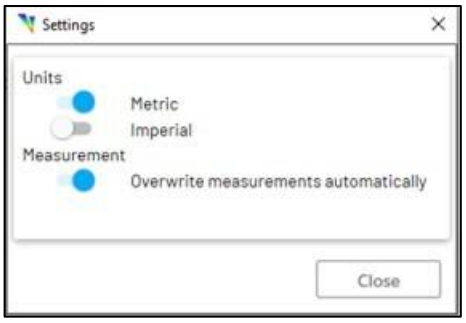


Figure 31. Settings Window

The options are:

- **Units**
  - Metric — Use the metric system units.
  - Imperial — Use the imperial system units.
- **Measurement**
  - Overwrite measurements automatically — If this option is selected, the measurement on the same name will be overwritten with a warning. If this option is not selected, the measurement on the same name will be renamed with a warning.
- **Manage Users** — User management is available on administrator level.

Note: Restart the system to make the changes effective.

2.2.5 Measurement

On the **Measurement** tab, you can define measurement-related parameters. The **Measurement** tab is depicted in the figure below:

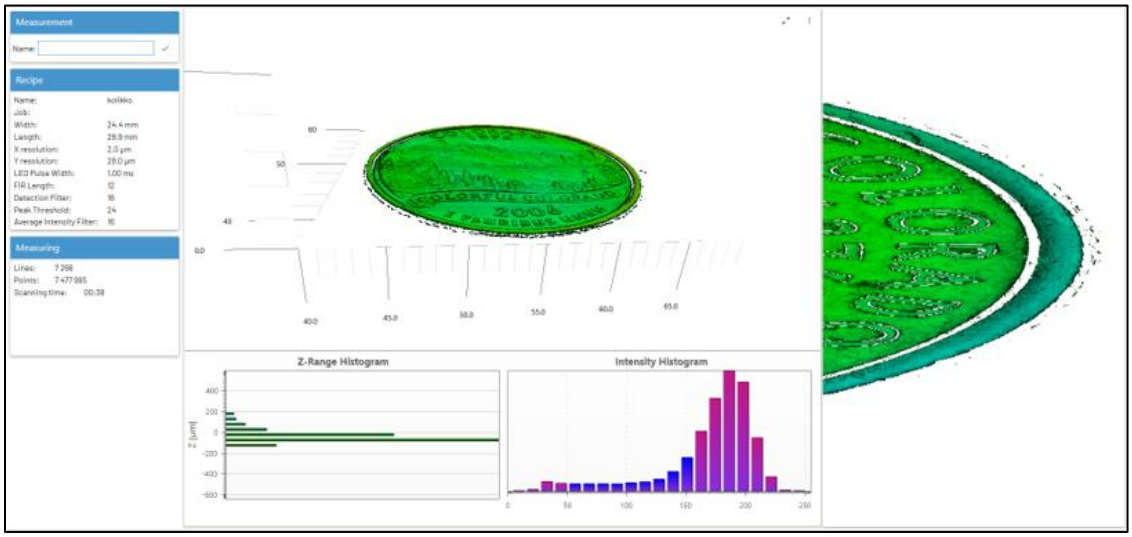


Figure 24. Measurement tab

The settings on the **Measurement** tab are:

- **Measurement** — Settings related to the measurement name.
  - **Name** — Enter the name of the measurement in this field.

    The name is used in the output files, when saving the measurement results.
- **Recipe** — Information related to the selected recipe.
  - **Name** — The recipe name.

- **Job** — The job selected for the selected recipe.
- **Width** — The measurement width.
- **Length** — The measurement length.
- **X resolution** — The X resolution length.
- **Y resolution** — The Y resolution length.
- **LED Pulse** — LED pulse width.
- **FIR Length** — FIR length in use.
- **Detection Filter** — Detection filter in use.
- **Peak Threshold** — Peak threshold in use.
- **Average Intensity Filter** — Average intensity filter in use.

- **Measuring** — Settings related to the measurement process.
  - **Lines** — The number of measurement lines.
  - **Points** — The number of measurement points.
  - **Scanning time** — The time it took to scan the image.
- **3D view** — The XYZ work area of the measurement table.
- **Z-Range Histogram** — The height distribution of the current work, which helps to see if height adjustment is needed.
- **Intensity Histogram** — The intensity distribution of the current work, which helps to see if intensity adjustment is needed.

  Typically, an intensity level of 100-150 is recommended, as it is high enough to produce good picture quality, and low enough not to cause saturation.

2.2.6 Analysis

On the **Analysis** tab, you can define analysis-related parameters. The **Analysis** tab is depicted in the figure below:

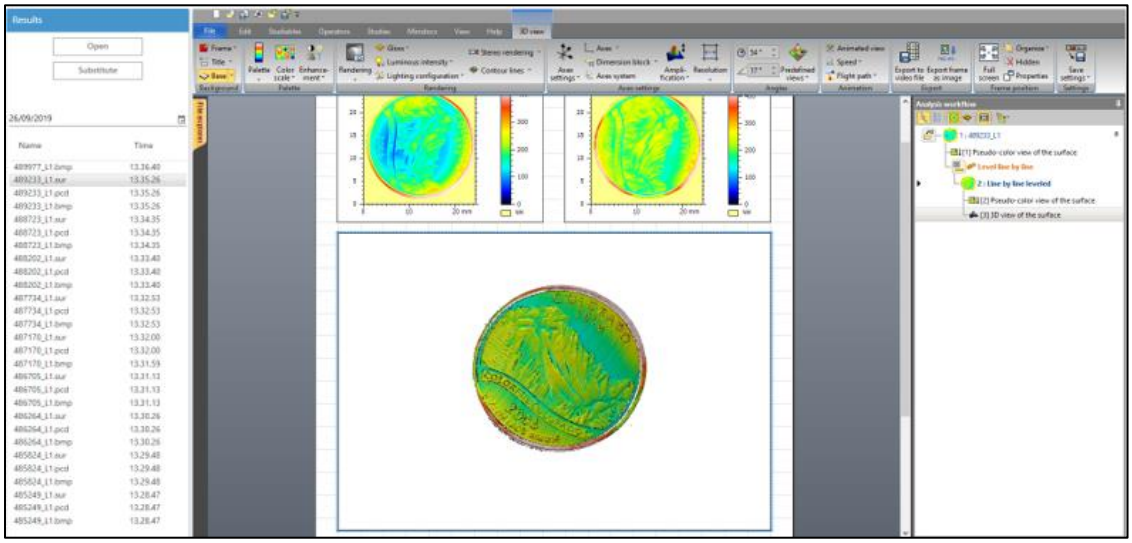


Figure 33. Analysis Tab

The settings on the **Analysis** tab are:

- **Results** — Buttons related to the scanning results.
  - **Open** — Open the file selected in the result file list.
  - **Substitute** — Replace the currently opened results with the selected result file.
  - **Calendar** — Open a calendar view, to open result files from the selected day.

See also Viewing scanning results.

2.2.7 Recipes

On the **Recipes** tab, you can define recipe-related parameters. The **Recipes** tab is depicted in the figure below:

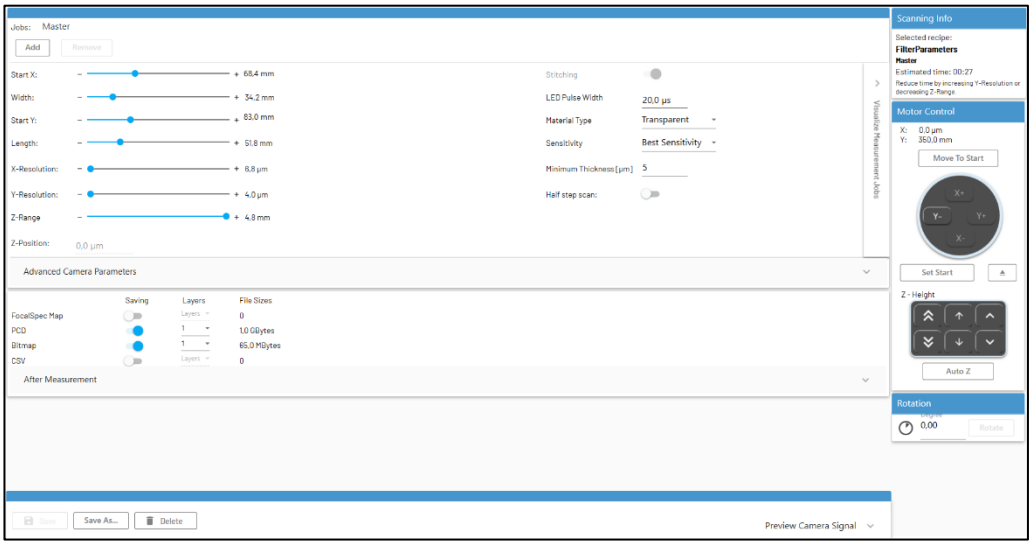


Figure 34. Recipes Tab

The settings on the **Recipes** tab are:

- **Recipe settings** — Settings related to the selected scanning recipe.
  - **Jobs** — The name of the selected job. The buttons are:
    - **Add** — Add a new job.
    - **Remove** — Remove the selected job.

      Note: You cannot remove the Master job.
  - **Start X** — Define the starting X coordinates.

    The X axis scan line interval depends on the sensor, as follows:

    - On LCI1200, the interval is 11 mm (0.43”).
    - On LCI1201, the interval is 11 mm (0.43”).
    - On LCI1600, the interval is 16.4 mm (0.65”).
    - On LCI401, the interval is 4.3 mm (0.17”).

    The table coordinates are depicted in the figure below:

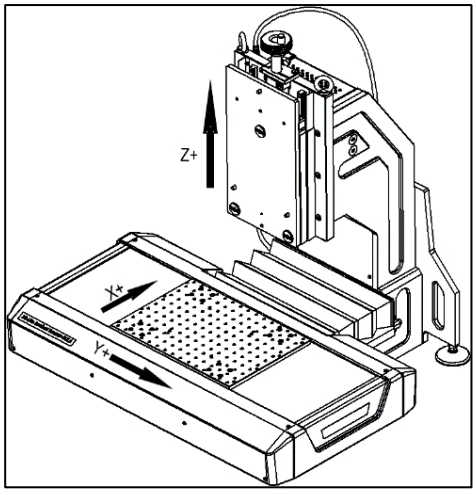


Figure 25. Measurement Table Coordinates

- **Width** — Defines the scan width, that is, how many sweeps will be used. One sweep width is the same as the sensor profile length, which is equal to the scan line interval above.
- **Start Y** — Defines the starting Y coordinates.

  The Y axis adjusting step is 1 mm (0.04").

  For measurement table coordinates, see the **Start X** definition above.
- **Length** — Scan length in the Y direction.
- **X-resolution** — Resolution in the profile width direction.
- **Y-Resolution** — Profile-to-profile pitch.
- **Z-Range** — The height of the measurement window. The smaller the Z-range, the faster the scanning. It is recommended to use the maximum value when a shorter measurement cycle time is not a priority.
- **Z-Position** — Z-Position height of a job compared to Master.
- **Stitching**

  Stitching combines the scanning sweeps, according to the calibration path.

  To enable more flexible X direction adjusting, you can switch stitching off, in which case the recipe can only be one sweep wide (LCI1201: 11 mm / 0.43”).

  Note: After turning stitching ON or OFF, check the **Start X** parameter.

  - When stitching is ON, the X axis scan line interval is as explained above.

    By default, stitching is on.
  - When stitching is OFF, the **Start X** step is 0.1 mm.

- For Led Pulse Width, Material Type, Minimum Thickness [µm] and Half step scan, see Main Parameters.

- **Visualize Measurement Jobs** — View the scan area in a 3D view.

The **Visualize Measurement Jobs** view is depicted in the figure below:

Figure 26. Visualize Measurement Jobs

In the view:

- Red marker: current position of the sensor.
- Green area: master scanning job, based on the **Scanning Jobs** values. After the scanning, this area also shows a preview of the scanned job.
- Blue area: second and later scanning jobs, based on the **Scanning Jobs** values.

Note:

If the Job is below the Master, the blue area is not visible.

- For Advanced Camera Parameters, see Advanced Parameters.

- **Output** — Settings related to the measurement output. The **Output** parameters screen is depicted in the figure below:

The file format parameters are:

- **SUR** — Use the .surfile format.
- **PCD** — Use the .pcdfile format.
- **Bitmap** — Use the .bmpintensity file format.
- **CSV** — Use the .csvfile format to present XYZ intensity in the ASCII format.

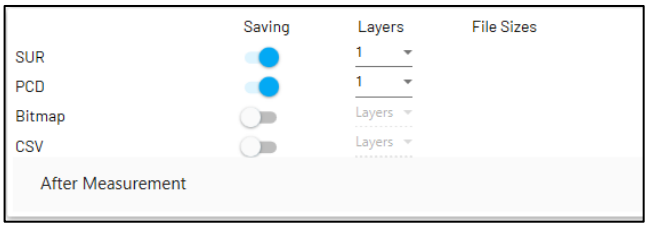


Figure 27 Output Parameters

Regardless of the file type selection or selections, always select the **Layers**, from which data will be saved. Lower layers are applicable in the case of transparent materials.

File Sizes indicates the size of the desired output file.

- **After measurement** — The actions to be carried out after the measurement has been completed. The **Output** parameters screen is depicted in the figure below:

Figure 28 After Measurement

The **After Measurement** parameters are:

- **Open with** — Select the program that will open the scan result once the scanning is completed. The options are:
  - None
  - PCD viewer
  - CloudCompare
  - FS/MM Map
  - Bitmap Viewer
- **Start the next measurement by using none recipe** — Select **Change Recipe** to select a different recipe for the next scan. See also chapter Multiple Scans with Different Rotation Angle .
- **After measurement unload sample to** — Select **Select position** to automatically return the table to the position selected with the **Load / Unload** function in the **Motor moving** area after the measurement has been completed.

- **Scanning Info** — This area indicates the estimated remaining scanning time. This area also provides tips for improving the currently used recipe.
- **Motor Control** — In this area, you can set the table X and Y coordinates. The **Motor Control** window is depicted in the figure below:

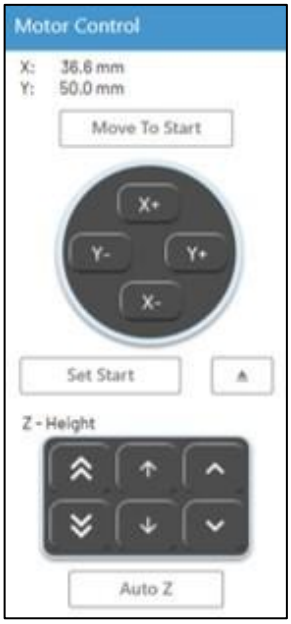


Figure 39. Motor Control

The buttons are:

- **Move to Start** — Move the table to the set start position.
- **X+, X-, Y+, Y-** — Move the measurement table step-by-step so that the sensor moves to the indicated direction – the scanning line moves on the sample to the indicated direction. The step in X direction is 11 mm

and the step in Y direction is 5 mm.

- **Set Start** — Set the current table position as the start position.

  This also refreshes the **Start X** and **Start Y** values after the axes have been moved with the X/Y buttons.

- **Load / Unload (button next to Set Start)** — Move the table out so that you can

  load or unload the sample. When you select **Load / Unload**, a pop-up window

  below is opened:

Figure 40. Move Table to Loading Position

The options are:

- Move the table to the left.
- Move the table to the middle.
- Move the table to the right.

If you enable the **Show selection if footer** slider, an arrow icon appears in the bottom bar, with which you can move the table to the selected position and back to the measurement start position.

- **Z-Height** (U_XYZ model only) — In this area, you can set parameter Z by enabling the **Preview Camera Signal** toggle button. When enabled, you can see live preview of the Z-range. The **Z-Height** parameters screen is depicted in the figure below:

Figure 41. Z-Height

Note:

Adjusting Z with the arrow buttons requires pressing the Shift key. Releasing the Shift key stops the Z-axis move.

You can:

- Fine-tune the height with the buttons in the **Z-Height** area. The buttons are:
  -  — 10 mm up.
  -  — 1 mm up.
  -  — 0.1 mm up.
  -  — 10 mm down.
  -  — 1 mm down.

-  — 0.1 mm down.

- Select **Auto Z** to automatically move the scanner down to the focus height.

  Note:

  Before you select **Auto Z**, make sure that the sensor is above the focus height. The

  Auto Z function detects possible objects in the sensor focus area only.

  Tip:

  The Z scale of the camera preview window is adaptive. You can adjust the scale with the mouse wheel, as follows:

  - Down, if adjusted below the green line.
  - Up, if adjusted above the green line.

  To zoom in, left click the mouse and drag down to the left. To return to full view, double left-click.

- **Rotation (only visible if rotation unit is installed)** — Enter the desired rotation table angle in the **Angle** field.

The **Camera Preview Signal** mode is depicted in the figure below.

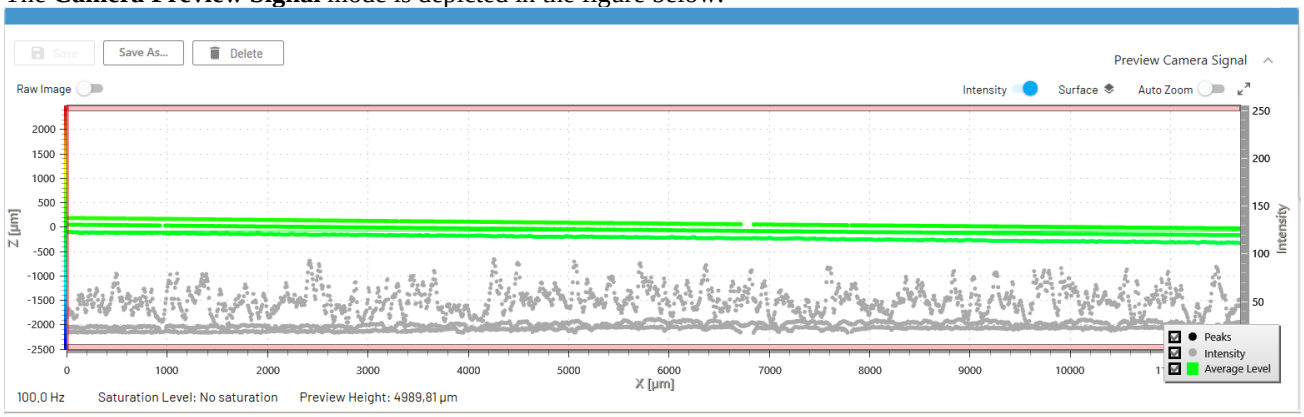


Figure 42. Camera Preview Signal

The settings on the **Recipes** tab in the camera preview mode are:

- **Intensity** — Displays intensity graph.

- **Surface** — All or Layers. If Layers is selected multiple layers are displayed based on Surface Mode selection in Advanced Camera Parameters

- **Auto Zoom** — When adjusting the Z-range manually, enabling **Auto Zoom** makes the adjusting easier.

The recipe management buttons are:

- **SAVE** — Save the recipe.
- **SAVE AS...** — Save the recipe with another name and in another location.
- **DELETE** — Delete the current recipe.

At the top right-hand corner of the preview camera signal window is the **Maximize View** arrow button to open the preview in a bigger window.

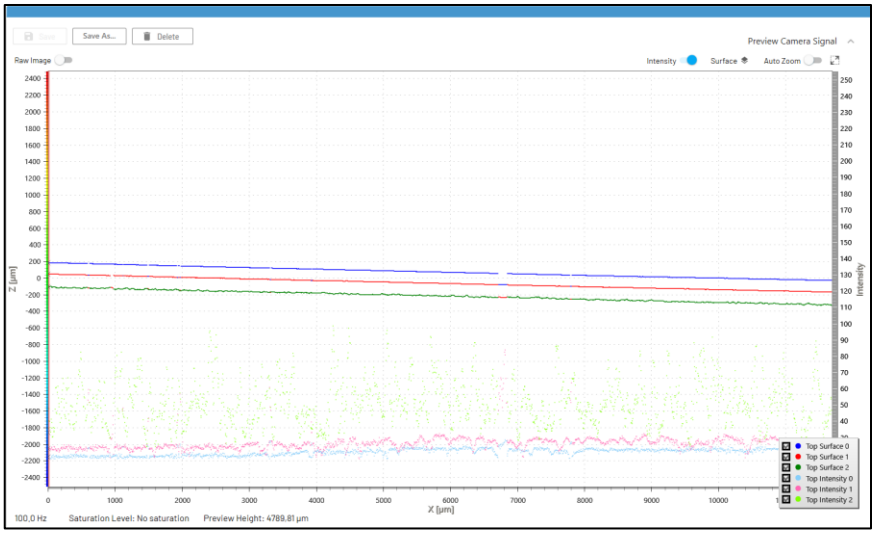


Figure 43. Camera Preview Signal Maximized. In the figure surface selection is Layers 3 (Surface Mode Top) and Intensity is on.

When it is maximized, the camera preview also shows, in the Y direction, the intensity at the cursor position. The horizontal axis of the intensity graph is the height in the Z direction.

Raw image selection displays actual raw image data from the sensor. The image can be zoomed with the mouse wheel to view more details. When the cursor is over the image, the intensity diagram is displayed on the chart below the image. When the image is zoomed more, the pixel level intensity values are shown.
Raw image view has three options on the top right corner:

- Maximize/minimize intensity diagram: The intensity diagram can also be enlarged by mouse dragging from the area between the raw image and the intensity chart.
- Pseudo image: Displays the image filtered by a threshold value.
- Freeze mode: Clicking the image freezes the intensity diagram on the selected position. Re-clicking frees the cursor.

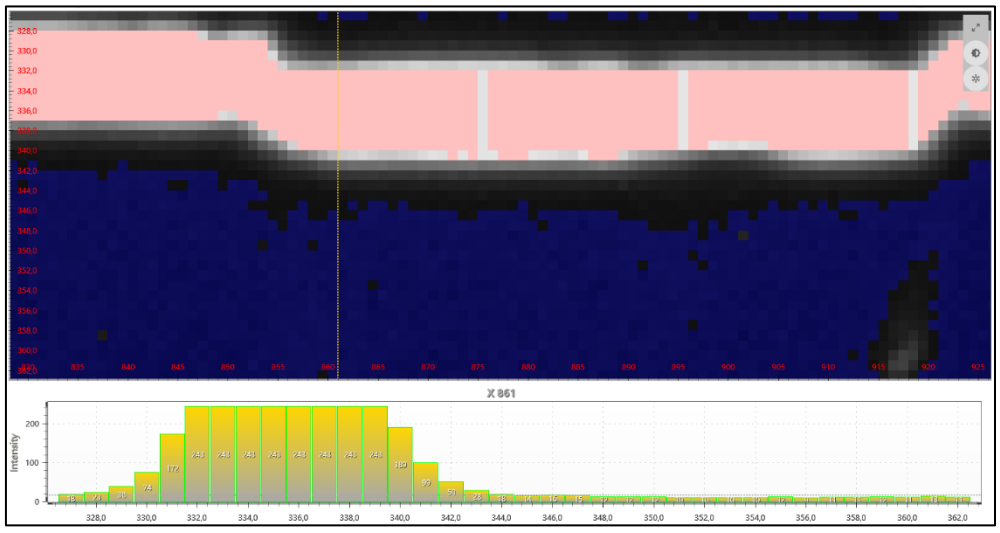


Figure 29 Raw Image Details

2.3 Calibration

This chapter describes how to calibrate UULA.

2.3.1 Instructions for calibration

Make sure that the mirror and all measured areas are clean; usually compressed air is enough. If any dirt remains, use common optics cleaning agents: do not use any aggressive, corrosive or abrasive agents.

Make sure the mirror is properly in place and leveled. If one end of the mirror is even slightly lifted, it will cause problems in calibration.

2.3.2 Calibrating UULA

This section describes how to calibrate UULA hardware.

Proceed as follows:

1. Place the calibration mirror onto the UULA measurement table.

   There are two guide pins that help you position the mirror

   correctly.

   The calibration mirror stands on three pins. There is one pin at the front and two pins at the back of the calibration mirror bottom surface.

   Warning: Danger of injury! The calibration mirror weighs 8 kg / 18 lbs.

   Caution: Do not touch the calibration mirror surface.

   The three calibration samples (number 1 in the figure below) must be on the right-hand side of the calibration mirror when looking from the front.

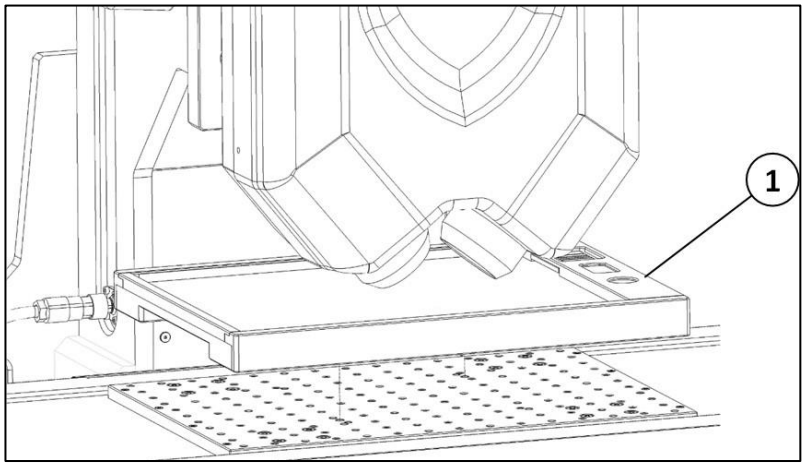


Figure 30 Calibration Mirror

If you have LCI1600 or LCI1620, add a paper (such as a Post-it Note) to hide the left side of the groove specimen, as seen in the picture below:

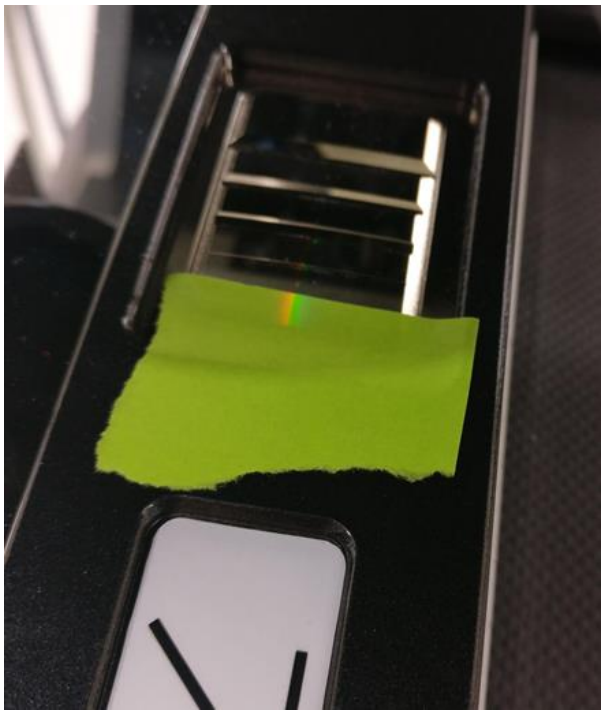


Figure 31. Paper on the groove specimen

2. Select **Calibration** in the header.
3. If the calibration block is certified, enter the specified groove heights in the **Certified Groove Height 30** and **Certified Groove Height 1000** edit boxes. If the calibrated depth is not known, use values 30 and 1000.
4. Select **Z-Calibration**.

   The **Set Groove Position** window opens, and the table moves so that the small groove is below the sensor.

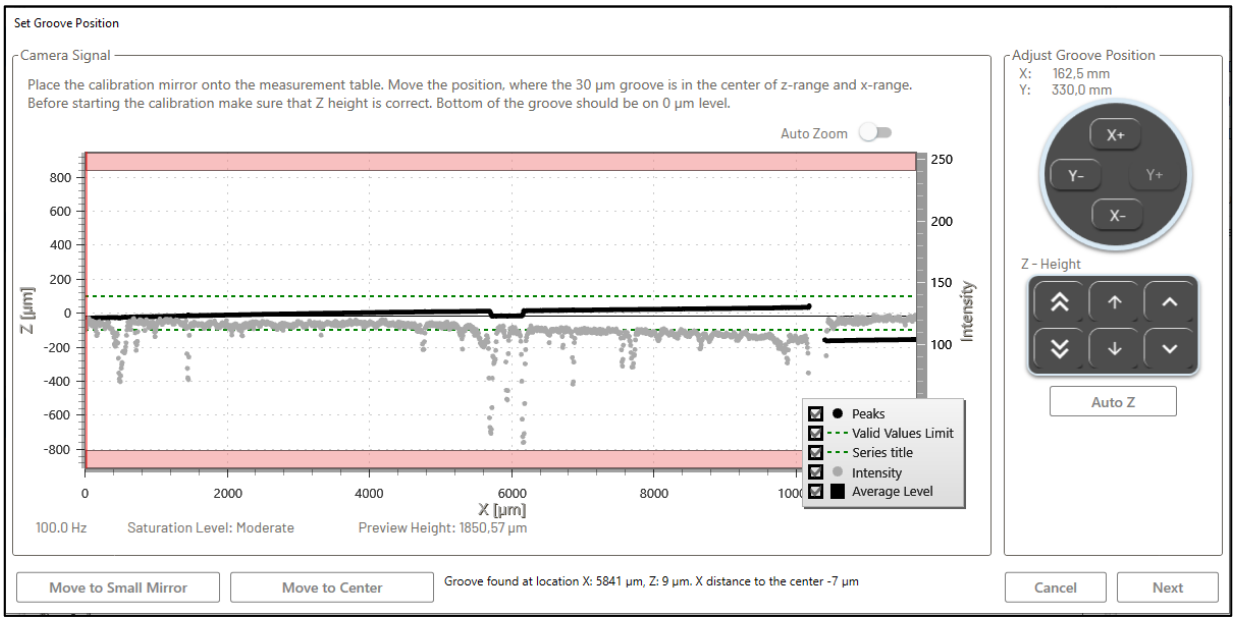


Figure 32 Set Groove Position

Use the **Auto Z** or Z arrows to adjust the sensor height to get the groove specimen visible.

The software remembers previously used X and Y positions, and the following two steps are typically only needed when the sensor is changed:

- Use the Y arrows to move the beam to the center of the groove sample, as depicted in the picture below.

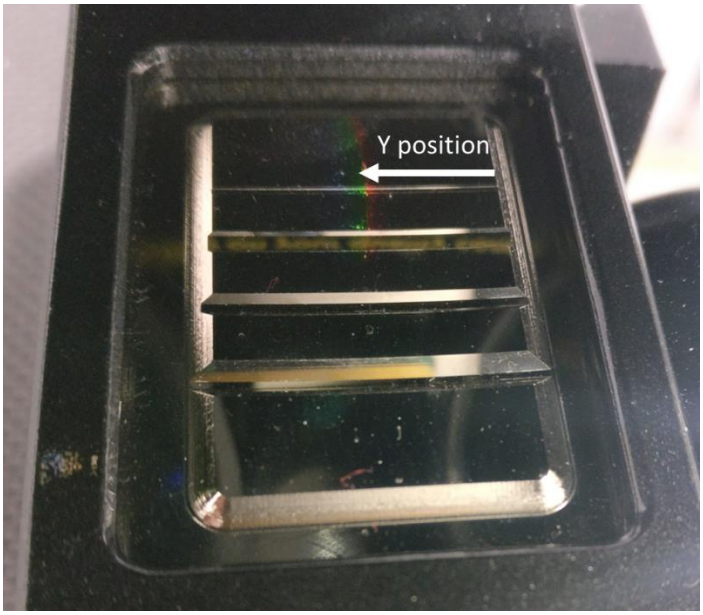


Figure 33. Y-Position for the beam

- Use the X arrow to adjust the X-position so that the small groove is visible in the profile view.

When the groove is visible in the profile view, select **Move to Center** to move the groove automatically to the center.

5. Adjust the mirror position.

   Select **Move to Small Mirror**. The table moves to the round flatness calibration mirror.

6. Adjust the sensor angle.

   Adjust the sensor angle to horizontally level the profile. Turn on **Auto Zoom** above the profile window.

   You can adjust the sensor angle by opening the lock screw (B) and turning the tilt angle screw (A) clockwise or counterclockwise. Adjust/level the profile so that both ends are on the same level within 10 µm range. After adjusting, tighten the locking screw.

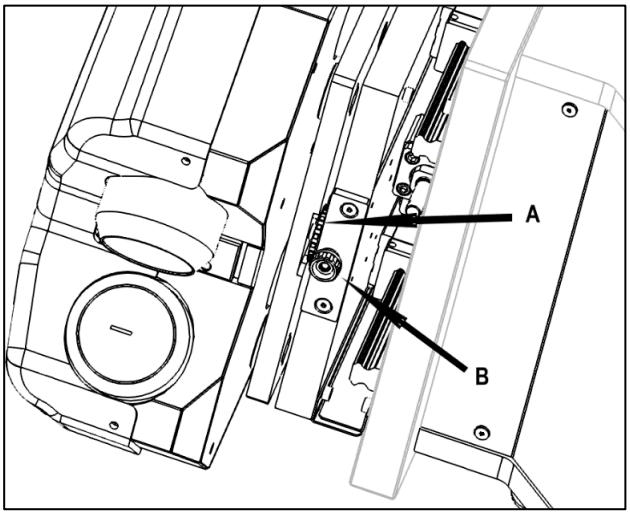


Figure 49. Adjusting the sensor angle

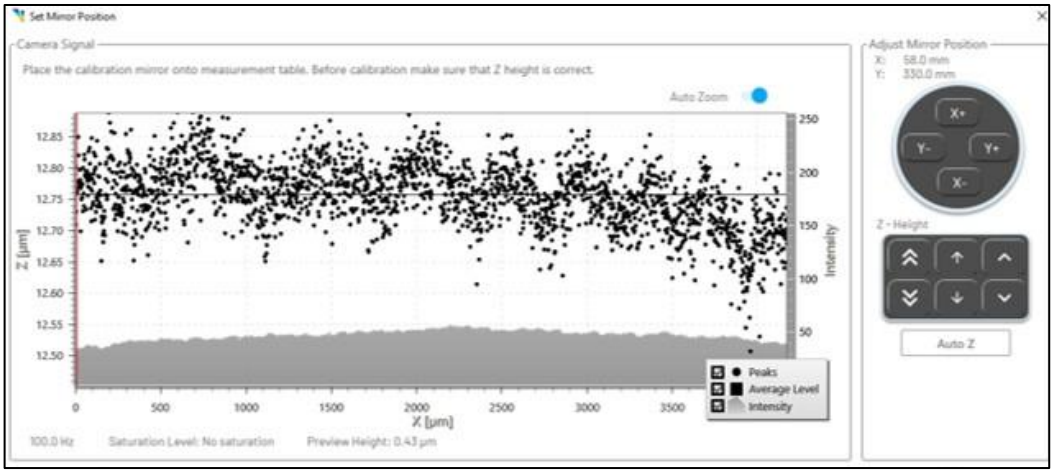


Figure 50. Adjust Mirror Position

7. Verify the groove position.

   Select **Move Back to Groove**. The table moves to the small groove. The Z value and X distance to the center should be as close to 0 as possible. If needed, use the **Move to Center** button to adjust the groove position. When the position is correct, select **Next**.

8. Select **Next**

   Z-Calibration starts by scanning the groove over the sensor's Z-range. After that, the table automatically moves to the small mirror and the mirror is scanned over the sensor's measurement area.

   Z-Calibration calculates linearity and flatness indicators to illustrate calibration accuracy. Indicators are visible in the top-right corner of the view, in the **Working Data** column.

Calibration Statistics

	Saved	Working Data
Calibrated	12/5/2019 11:30:21 AM	12/9/2019 9:53:01 AM
Z-Linearity [µm]	0.60	0.62
Flatness [µm]	0.47	0.38
Z-Repeatability [µm]	0.15	0.15
1000 µm Average [µm]	994.49	0.00
30 µm Average [µm]	30.03	0.00
30 µm Max-Min [µm]	0.55	0.00
30 µm StdDev [µm]	0.11	0.00
Rotation [degrees]	0.08	0.00

Figure 51. Z-Calibration statistics

Z-linearity is the maximum Z-calibration error within the Z-range.

Flatness is the maximum Z-error compared to the flat surface over the measurement area.

Z-repeatability is the standard deviation of Z measurements averaged over the measurement area.

After the Z-Calibration, the software asks whether the scaling check should be run or not.

9. Optionally, select **Check Scaling.**

   You can check the scaling by measuring the 1 mm groove. This option is not available with the LCI401 sensor.

If the measurement indicates a large difference compared to the given 1000 µm groove height, the software proposes a new **Groove Height** value for the Z-Calibration. If the new value is accepted, Z-Calibration is done again.

This step is usually needed at the first run, when the specimen is not certified and the original estimate for the **Groove Height** was incorrect.

After measurement the value is shown on the **1000 µm Average** row.

10. Optionally, select **Verify**.

You can optionally perform a Z-calibration verification. In this step, a 30 µm groove is measured over the measured area. This step is recommended, but it takes few minutes.

The verification process starts with the 'Groove Position' dialog to make sure that the motor has not moved since the last calibration step.

The following values are calculated:

- 30 µm Average is averaged groove height over the measurement area
- 30 µm Max-Min is maximum difference calculated over the measurement area
- 30 µm StdDev is averaged standard deviation over all the measurement points

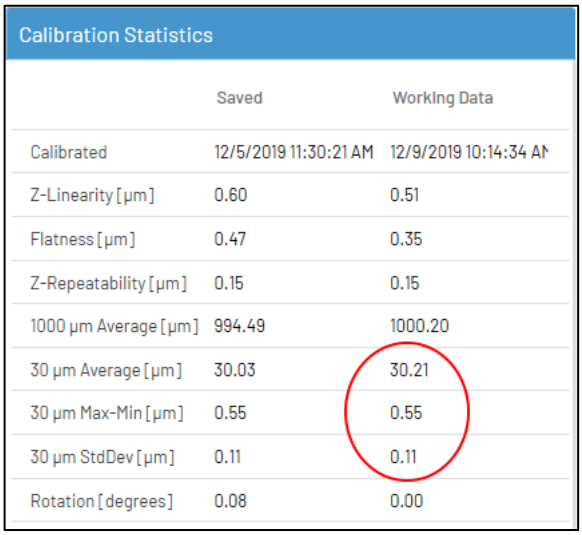


Figure 52. Calibration verification statistics

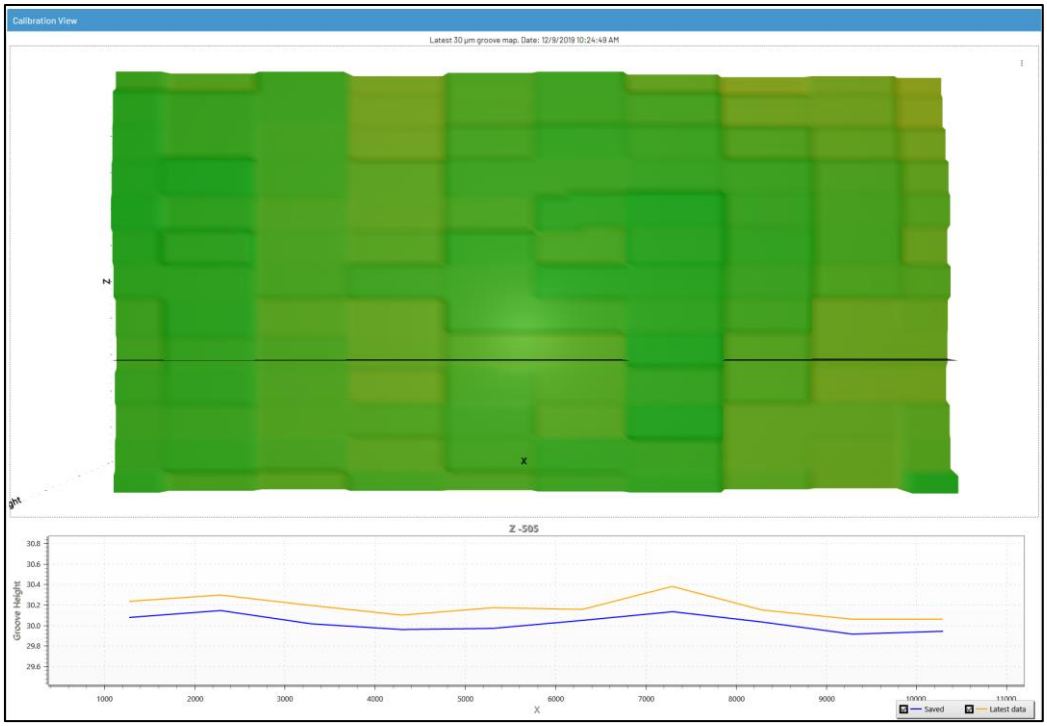


Figure 53. Verification result

Calibration View visually shows the result of the verification measurement with the groove map. The groove map is a 3D model, and you can view the details by zooming and turning it with the mouse. By placing the mouse cursor over the map, you can see the **Groove Height** profile from the specified Z-location, in a chart below the map.

From the options on the top right corner of the map, you can choose either the latest or the saved data, so you can compare the results.

The calibration statistics show the numerical data from the last saved calibration and the current working data.

11. Select **System Calibration**.

    The system calibration starts with head rotation and automatically continues with large mirror scanning.

12. Select **Accept and Save**.

    If you are satisfied with your calibration, select **Accept and Save** to finish the procedure. The system is now ready for scanning. The measured statistics values are moved from the **Working Data** column to the **Saved** column. The calibration process can also be performed by using **Automated Sequence**, which runs Z-Calibration, and then **Check Scaling**, **Verify** and **System Calibration** in succession. Again, select **Accept and Save** to finish the calibration.

13. Optional: Select **Intensity Calibration**.

    The **Set Sensor Height** window opens. Use the **Auto Z** or Z arrows to adjust the sensor height. Average level must be between the green lines at the top of the sensor's Z-range.

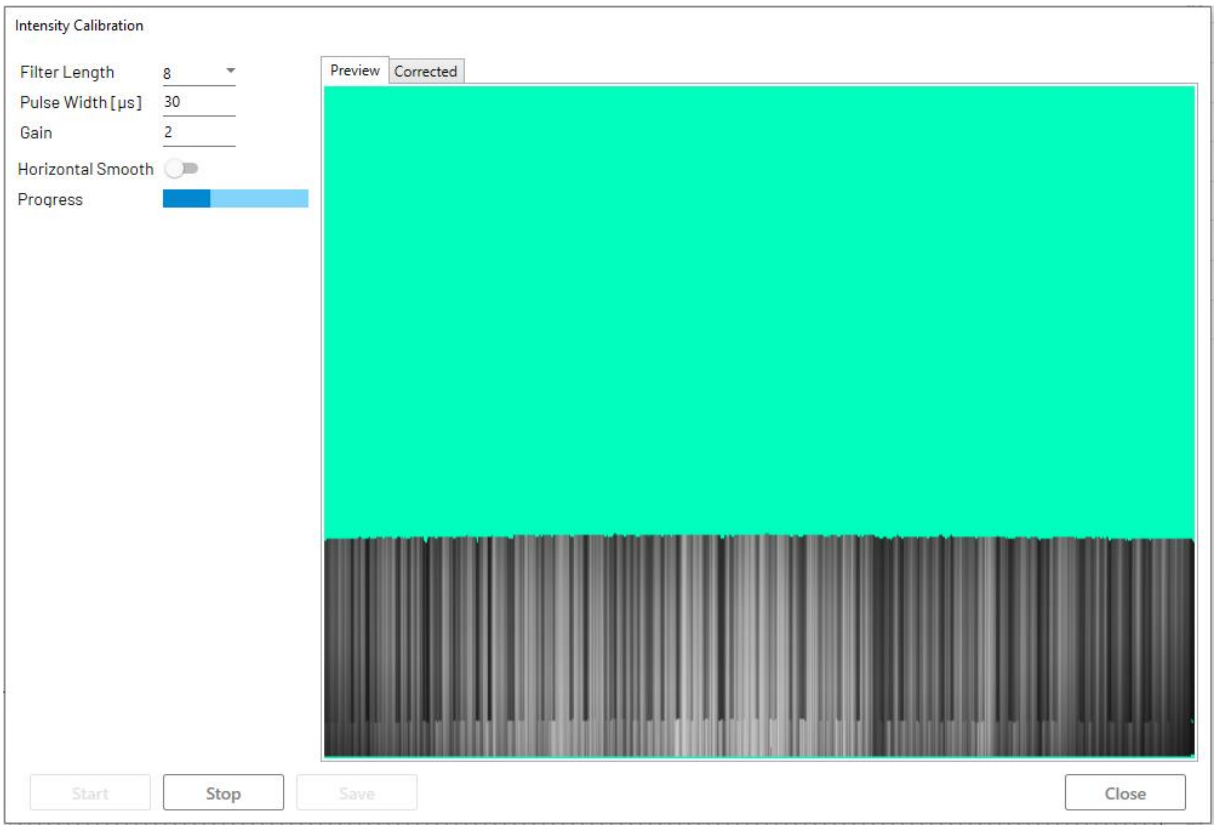


Figure 54. Intensity Calibration

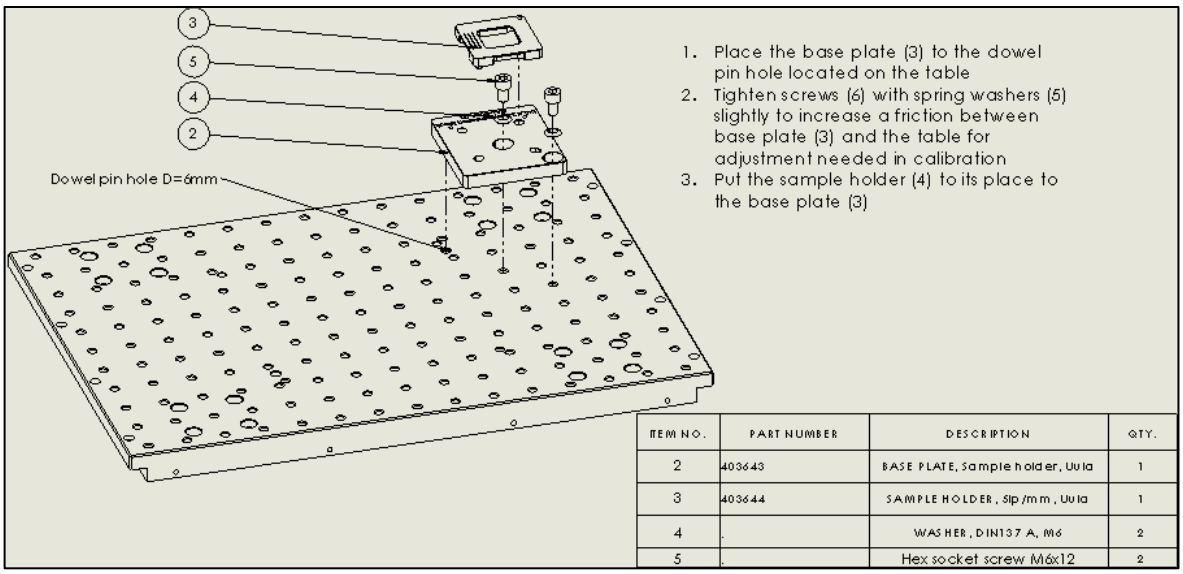
Set Filter Length, Pulse Width, Gain and Horizontal Smooth settings to be used in calibration. When calibration is started, current calculated correction is displayed in Preview window. Progress bar displays a percentual status of the correction. When calibration is finished, the final image is displayed in Corrected window. Save the final intensity calibration.

14. Optional: **Z-Compensation Calibration**

A strong surface texture may cause edge artifacts in Z values. To reduce edge artifacts, the sensor can be calibrated for Z-Compensation. Z-compensation is done with known flat specimen with texture causing intensity variation. Possible higher Z height coming from intensity variation is compensated with algorithm. Compensation is done on

the whole sensor Z-range and separately in sensor X and Y directions.

a. Install a Z-Compensation calibration block on the table, as shown below:



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
2	403643	BASE PLATE, Sample holder, Uula	1
3	403644	SAMPLE HOLDER, Slp/mm, Uula	1
4	.	WASHER, DIN137 A, M6	2
5	.	Hex socket screw M6x12	2

Figure 34.1. The calibration block installation

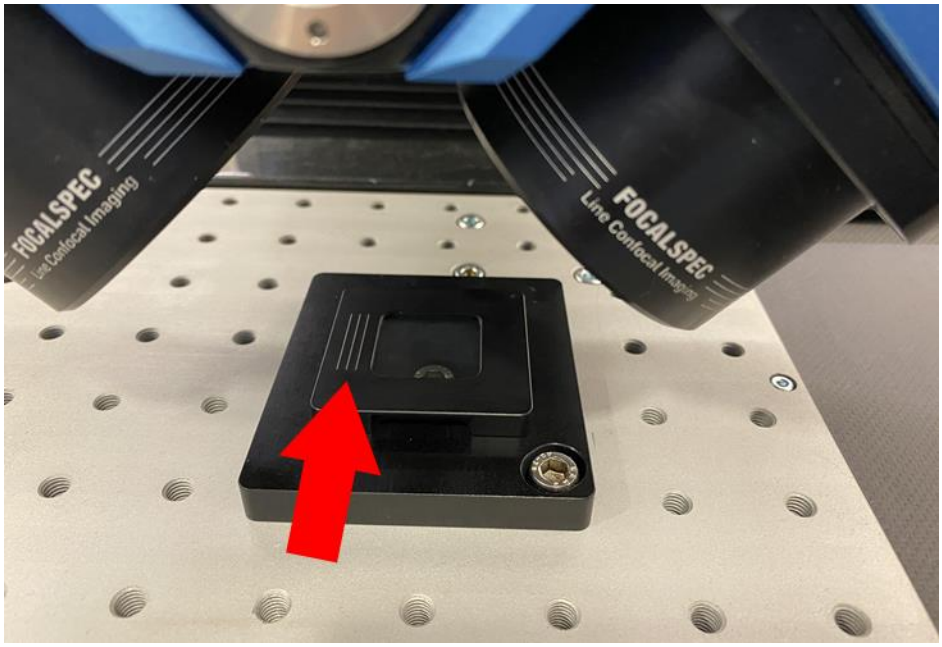


Figure 35.2. The calibration block for X-Direction scans

a. Select **Z-compensation Calibration** on calibration view, Set Sensor Height window opens.

c. Adjust the sensor.

Use the **Auto Z** and Z-height arrows to adjust the sensor height. Use the Adjust Position X and Y arrows to move the sensor to the center of Z-compensation calibration block.

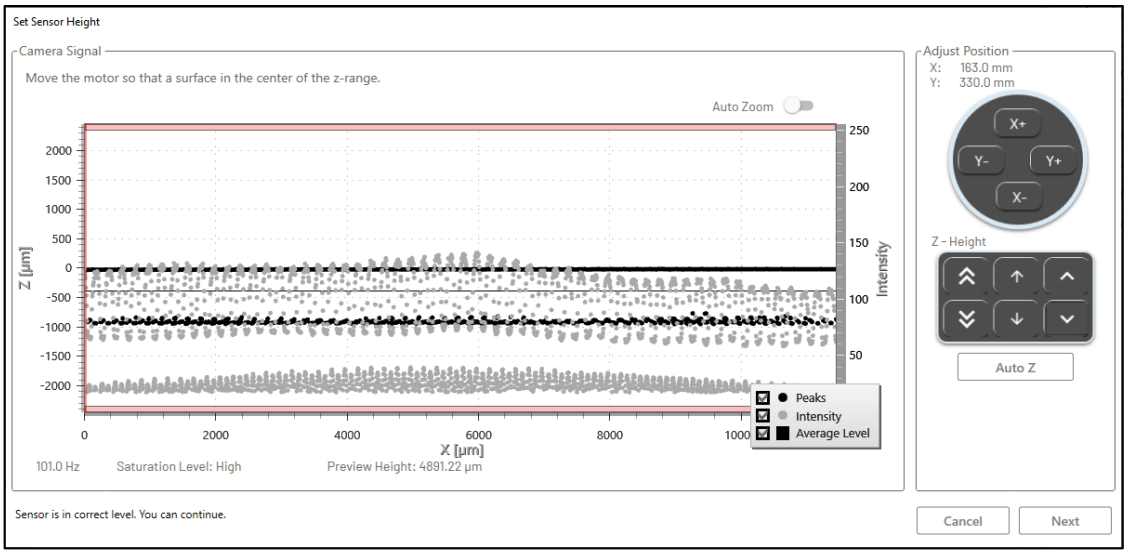


Figure 56. Z-compensation target surface is on 0-level

d. When the surface Z-coordinate is at the center, press the **Next** button to open the Z-Compensation Calibration view.

e. Press the **Start X-Direction** button.

UULA starts automatic measuring over the Z-range. When in progress, the following view is visible:

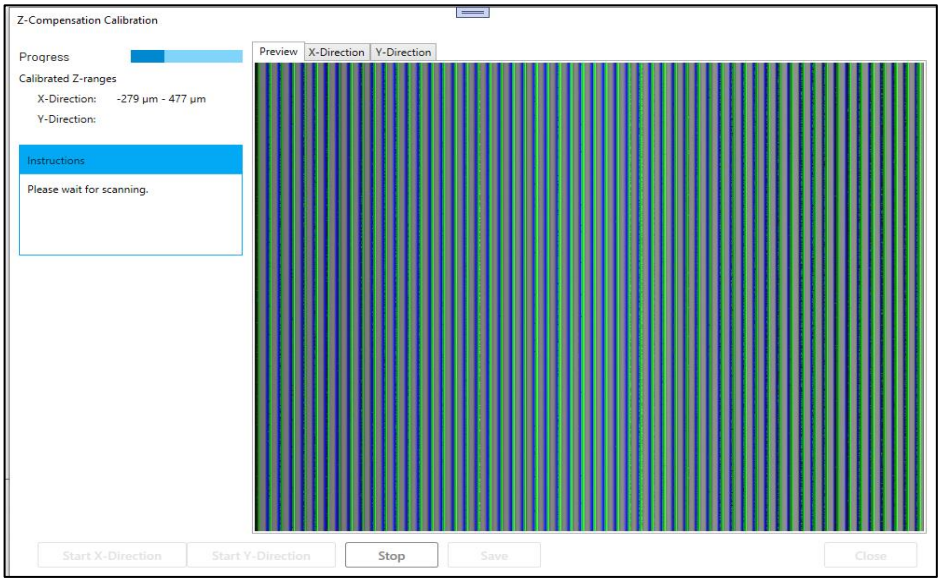


Figure 57. Scanning is on-going in X-direction

Wait until the whole Z-range is measured.

f. When the measuring is completed, turn the sample holder 90 degrees to the Y-Direction position, as shown in the picture below:

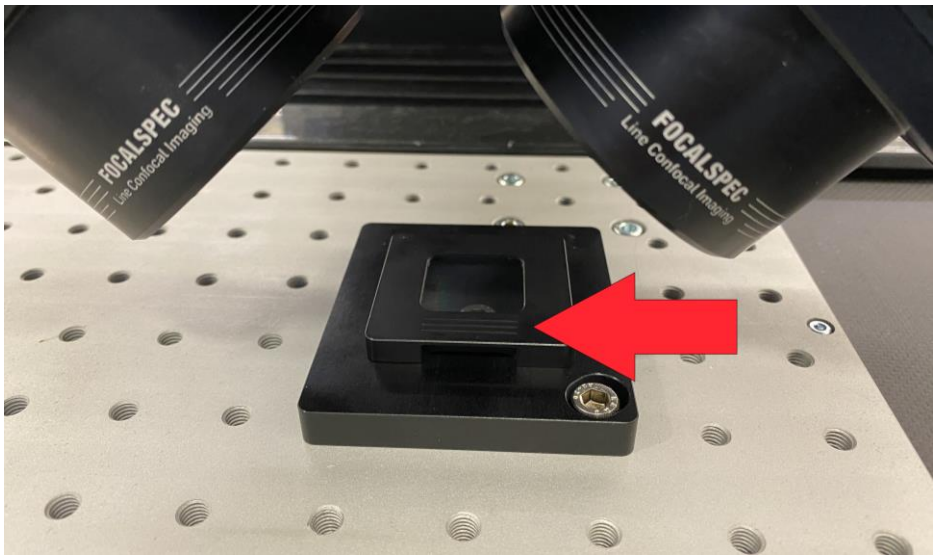


Figure 58. The calibration block in Y-Direction scan position.

g. Press the **Start Y-Direction** button.

When the scanning is in progress, the following view is visible:

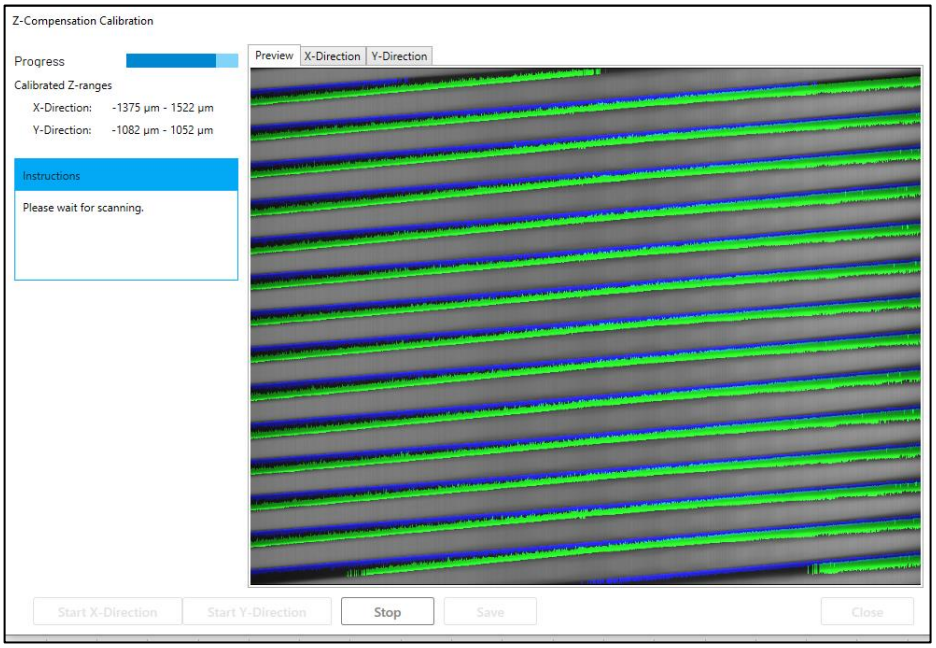


Figure 59. Scanning preview in Y-direction

Calibration is not sensitive to sample angle. If the lines are not horizontal (worse than in the picture above), press **Stop**, adjust the rotation of the block and Start Y-Direction again.
Wait until the whole Z-range is measured.

h. When completed, press the **Save** button to accept calibration and you may **Close** the window.

After the calibration has been saved, Use Z-Compensation can be enabled to the recipe in the Advanced Parameters section.

2.3.3 Using Calibration Files on Another PC

During UULA calibration, the sensor calibration files are internally updated for UULA usage. The calibration files can be copied by selecting **Copy Files…** in Calibration view. Window opens to enable user to define the destination folder and then pressing **Copy Files** copies the files to selected folder. The files below are copied:

- X-calibration
- Z-calibration
- Intensity calibration, if it exists
- Z-compensation calibration, if it exists

Saved calibration files can be copied to another PC. This feature is useful when UULA is used as calibration station for the sensor used by the FSSDK, and the customer application on another PC. FSSDK automatically finds the calibration files at startup, if the files are in folder C:\Focalspec\Calibration on the PC.

2.4 Scanning

This section describes how to make the first scan of a new sample.

See also chapters UULA User Interface and Parameter Guide .

Proceed as follows:

1. Select **Load Recipe** from the footer.
2. Select the recipe called **Recipe**.
3. Save the recipe with a new name, using the “Save as” button.
4. Use the X and Y sliders or the Motor Control window to move the sensor approximately over the sample.
5. Adjust the LED pulse width and use the full Z-range.

   LED Pulse Width depends on the reflectivity of the sample. The possible range is from 0 to 5000 µs.

   Exposure is controlled with the LED pulse width. The width is given in microseconds and based on the sample surface reflectivity. Typical values are shown below. In general, shiny and mirror-like surfaces require a short pulse width and low-gloss surfaces a high pulse width.

   For LCI1200:
   - Mirror — 2-4 µs
   - Glass — <10
   - Paper — ~100
   - PCB — ~600 (dark green solder mask)

   For LCI1201 and LCI1600, led pulse widths are close to the LCI1200 values.

   For LCI401, led pulse widths are typically three times higher than the LCI1200 values.
6. Select if **Half step scan** is used.

   If **Half step scan** is enabled, the step between the scan lines is only half of the scan line width: the entire surface will be scanned effectively twice.

   If **Remove the uncertain points** is selected, the areas which are scanned only once will be discarded: the first half of the first scan and the last half of the last scan line, as well as small areas in the scan start and end areas in cases of curved surfaces.
7. Select if **Stitching** is used.

   By default, stitching is ON and the scanning sweep interval on the X axis and the step of **Start X** are equal to the length of the sensor profile.

   When scanning only one sweep, stitching can be turned OFF to make adjusting easier and then the **Start X** step is 0.1 mm.

   Note:

   After turning stitching ON or OFF, check the **Start X** parameter.
8. Open the preview camera.
9. Use the **Z-Height** window to adjust sensor height Z so that the surface is visible to the camera.

   Caution:

   When adjusting Z, you must have a clear view of the gap between the sensor and the sample. Ensure that the sensor does not collide with the sample or the fixture.
10. Adjust X and Y if needed.
11. Adjust Z to fine-tune the sample surface until it is on 0-level in the camera preview.
12. Fine tune **LED Pulse width**.

    Adjust **LED Pulse width** so that intensity (the gray area in camera preview) is at the level of 100 - 150.

    The **Preview Camera Signal** window also has an option called **Raw Image**. This view may help in adjusting the **LED Pulse width**. Saturated areas on a surface are displayed in light red.

Only **LED Pulse width** and **LED current** have an effect on the raw image.

13. Move the table X and Y to the measuring start position.
14. Select **Set start**.
15. Adjust scanning width and length.
16. Adjust X and Y resolution.

    X-Resolution — Resolution in profile width direction.

    Y-Resolution — Profile-to-profile pitch.

    Reducing X-resolution reduces the output file size, which can be especially useful when scanning large areas.
17. Adjust Z range.

    Z-Range — The height of the measurement window. The smaller the Z-range, the faster the scanning. It is recommended to use the maximum value when a shorter measurement cycle time is not a priority.
18. **Select Material Type** — Simplified peak detection configuration based on material type. Available material types are Opaque, Mirror and Transparent. If user selects Custom type, customizable Peak Detection values become available.
19. **Select Sensitivity** — Best Sensitivity or Best Accuracy used in simplified peak detection.
20. Open Advanced Camera Parameters.

    See 2.7.2 Advanced Parameters
21. Select the output file formats.

    The output file formats are:

    - SUR — Use the .sur file format for FocalSpec Map / Mountains Map.
    - PCD — Use the .pcd file format.
    - Bitmap — Use the .bmp intensity file format.
    - CSV — Use the .csv file format to present XYZ intensity in the ASCII format.

    Regardless of the file type selection or selections, always select the Layers from which data will be saved. Lower layers are applicable in the case of transparent materials.

    File Sizes indicates the size of the desired output file.
22. Open **After Measurement**.

    After measurement — The actions to be carried out automatically after the measurement has been completed.

    Open with— Select the program, with which the scan result will be opened, once the scanning is completed. The options are:
    - None
    - PCD viewer
    - CloudCompare
    - FS/MM Map
    - Bitmap Viewer

    Start the next measurement by using none recipe — Use **Change Recipe** to select a different recipe for the next scan.

    After measurement unload sample to — use **Select position** to automatically return the table after the measurement to the position selected with the **Load / Unload** function in the **Motor Control** window.
23. Save the Recipe.
24. Open the **Measurement** page.
25. Give the measurement a name.
    Enter a name for the measurement into the field.
    The name is used in the output files, when saving the measurement results.
26. Start the measurement with the green button on the Controller.

    When the measurement is completed, you can find your results on the **Analysis** tab with the name that you have given to the measurement.

2.5 Viewing scanning results

The analysis supports the following file types:

- **.pcd** files are opened in an internal pcd viewer. pcd files can be opened also in an external CloudCompare utility from the popup menu. For more information, see chapter CloudCompare User Manual.

  The internal pcd viewer is set as default to open pcd files.

Figure 60. PCD Viewer

- **.bmp** files are opened in an internal bmp viewer.
- **.csv** files are opened in an external csv viewer, such as Microsoft Excel.

Optional, if FocalSpec Map is installed:

- **.sur** files are opened in the FocalSpec Map component (see chapter FocalSpec Map User Manual). For help in the FocalSpec Map, click an empty space on the tab and press the F1 button.

Proceed, as follows:

1. Select the **Analysis** tab.
2. Double-click the desired scanning result or right-click to open a context menu.
   The results are opened in the Pcd viewer.
   There are seven sliders in the top left corner of the pcd viewer:
   - **Rotation**. The sliders are alternatives for moving with the mouse. Notice that viewpoint set up effects the rotation.
     - **Pitch** — Rotates around the X-axis
     - **Yaw** — Rotates around the Z-axis
     - **Roll** — Rotates around the Y-axis
     - **Distance** — Zooms in / out
   - **View Point**
     - **X** — Moves the viewpoint in the X direction
     - **Y** — Moves the viewpoint in the Y direction
     - **Z** — Moves the viewpoint in the Z direction

   There are six icons in the top right-hand corner of the pcd viewer:

   - Options for height
     - **Pixel size** — This selection is stored to the settings file.
     - **Point limit** — This selection is stored to the settings file. Point limit selection requires a data reload. For large images and a large point limit, this operation is time consuming.
     - **Color scheme**

- **Distance measurement** — Lets you select two points to measure the distance between them.
- **Coloring mode** — Applies colors to points to represent height , intensity or height coloring with intensity.. Height coloring can be customized in a color scheme editor. Custom color scheme is stored to the settings file.
- Resets rotation and distance to original values.
- Sets predefined inclined view.

2.6 Table and Controller

This chapter describes the tools and procedures required to make measurements.

2.6.1 Measurement Table

The measurement table dimensions are 380 x 270 mm / 14.96 x 10.63 inches. The sample or the fixture should not extend beyond the table edges. If this is the case, pay special attention not to obstruct the table movement. The total weight of the sample and the fixture should not exceed 10 kg / 22 lbs.

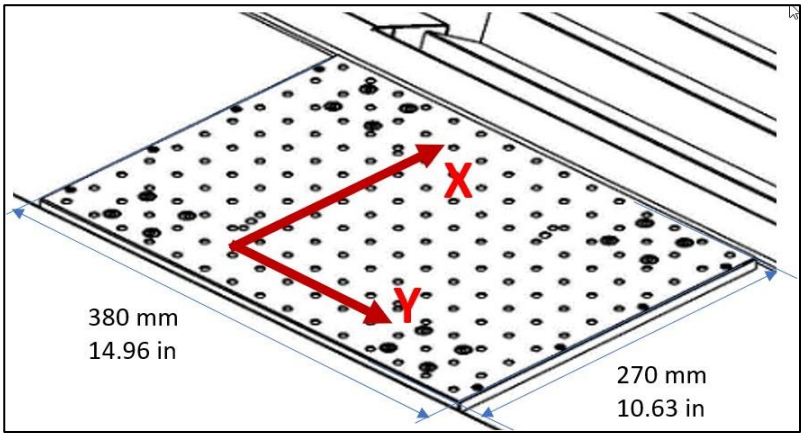


Figure 61. Measurement Table

Accurate measuring is based on completing calibration. Calibration creates precise compensation data to the points on the calibration path. Therefore, the sample measuring must travel the same path that the calibration has created.

Sample measuring start point, end point, and the points in between them, must be on the predefined path. As the distance of the scan path is fixed, the sample scanning line location in the X direction is only possible at the same intervals. If finer adjusting is required, move the sample and/or fixture. You can adjust the single scan line location in the **Motor Control** area of the user interface.

Table 4: Measurement Area Dimensions

Sensor	Width of the scan line	Measurement work area length	Measurement work area width
LCI1200	11.26 mm (0.433 in)		220 mm (8.67 in)
LCI1201	11.26 mm (0.433 in)	305 mm (12.0 in)	219 mm (8.63 in)
LCI1600	16.4 mm (0.646 in)	310 mm (12.2 in)	216 mm (8.5 in)
LCI401	4.3 mm (0.169 in)	310 mm (12.2 in)	218 mm (8.60 in)

Tip: Design the fixtures to enable adjustment in the X direction. The M6 fixing holes in the measurement table are in a 25 x 25 mm grid.

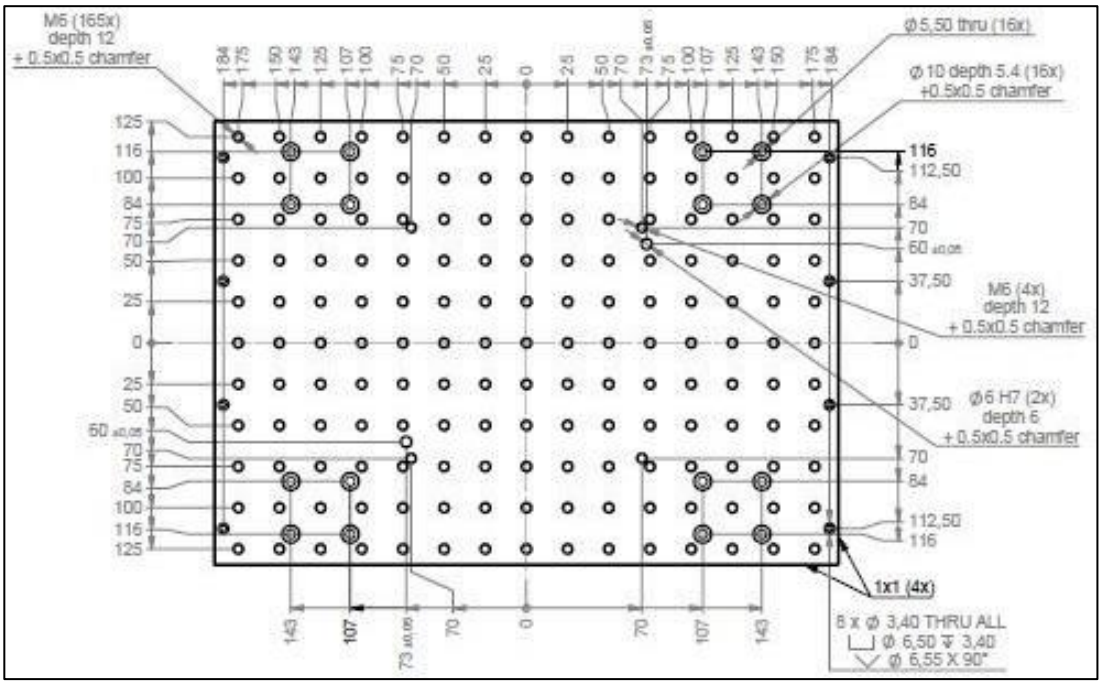


Figure 62. UULA measurement table

2.6.2 Controller

The Controller is used to operate the scanner. The Controller is depicted in the figure below:

Figure 36. Controller

The Controller buttons are:

- **Emergency stop** — Switches off the power from the table XY motors. Turn the button to release it.
- **Reset** — Red reset button. Press the button to reset the emergency stop and to switch the motor power back on.
- **P2** — When there is a light on the yellow P2 button, there is an error. Pressing the button resets the error, and the table will return to the home position.

  Note: After resetting, you must reload (select) the recipe.

- **P1** — Press the green button to start scanning. The light indications are:
  - Blinking — The table movement is controlled by the FocalSpec software from the PC.
  - On — The table is on the manual control mode.
  -

2.7 Parameter Guide

2.7.1 Main Parameters

This chapter contains the main parameters of UULA.

2.7.1.1 LED Pulse Width

Set LED Pulse Width based on the reflectivity of the sample. The possible range is from 0 to 5000 µs.

LED Pulse Width controls exposure, which is given in microseconds (µs). Typical values are shown below.

In general, shiny and mirror-like surfaces require a short pulse width and low-gloss surfaces a high pulse width.

• For LCI1200, in microseconds (µs):
- Mirror 2-4
- Glass <10
- Paper ~100
- PCB ~600 (dark green solder mask)

• For LCI1201 and LCI1600, LED pulse widths are close to the LCI1200 values.

• For LCI401 the LED pulse widths typically need to be three times higher than the LCI1200 values.

2.7.1.2 Material Type

Material Type contains a number of simplified peak detection configurations, based on material type.

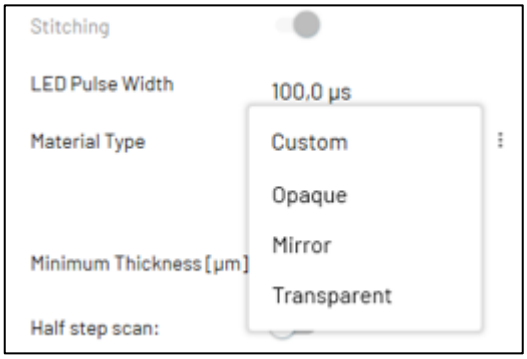


Figure 37. Material Type

The available predefined material types are:
• Opaque — Opaque is the most commonly used material type. It is used when the top surface has opaque areas.
• Mirror — Use Mirror for highly reflective surfaces.
• Transparent — Use Transparent for materials having transparent surfaces. Minimum thickness of each layer is used for parameter calculation.

Material	FIR Length	Signal detection filter length	Average intensity filter	Threshold
Opaque, best accuracy	16	16	16	17
Opaque, best sensitivity	16	2	16	10
Mirror	10	10	2	17
Transparent, best accuracy	Calc	Calc	Calc	17
Transparent, best sensitivity	Calc	2	Calc	10

Calc means that the value is automatically calculated to the maximum, which fits within the minimum thickness given in the user interface.

If you select the Custom type, a customizable Peak Detection dialog become available.

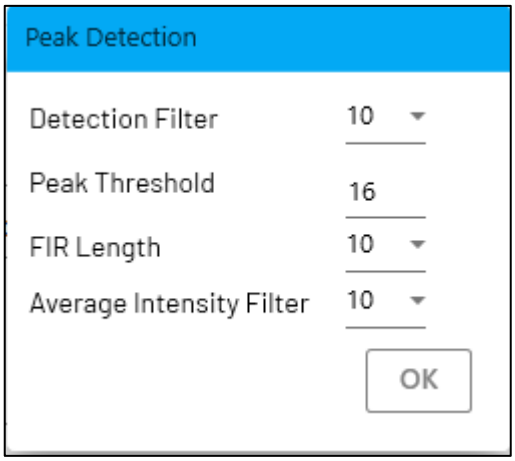


Figure 38: Peak Detection

The values are:

• Detection filter — Detection filter value defines the length (in number of pixels) used to calculate the average intensity. The peak is detected if the calculated average is greater than the threshold.

• Peak Threshold — Set the minimum intensity for surface detection. The minimum and a typically used value is 16. As a rule, the threshold should be as low as possible. Increasing the threshold lowers possible noise. Increasing it too much, however, increases the risk of losing small amounts of data.

• FIR Length — Finite impulse response is a filter function, which has a typical value of 10. The value range is even numbers from 2 to 16.

With thin transparent films, lower FIR helps to detect the both surfaces of the film. In these cases, use a FIR value lower than the film thickness in micrometers divided by 6. With non-transparent materials, higher FIR may help to reduce noise.

• Average Intensity Filter — Average Intensity Filter value defines the length (in number of pixels) used to calculate the average intensity value, which is then reported as peak intensity.

2.7.1.3 Peak Threshold

The LCI sensor detects the surface and provides a Z height reading and an Intensity reading when the Intensity value measured exceeds the Peak Threshold value. The range of the Peak Threshold is from 0 to 240.

The Peak Threshold should be as low as possible and as close to the Background signal level as possible, to get the maximum sensitivity.

Note: The threshold is used before intensity calibration.

See 3D and Intensity Profile vs Peak Threshold for more information on the effect of Peak Threshold.

2.7.1.4 3D and Intensity Profile vs Peak Threshold

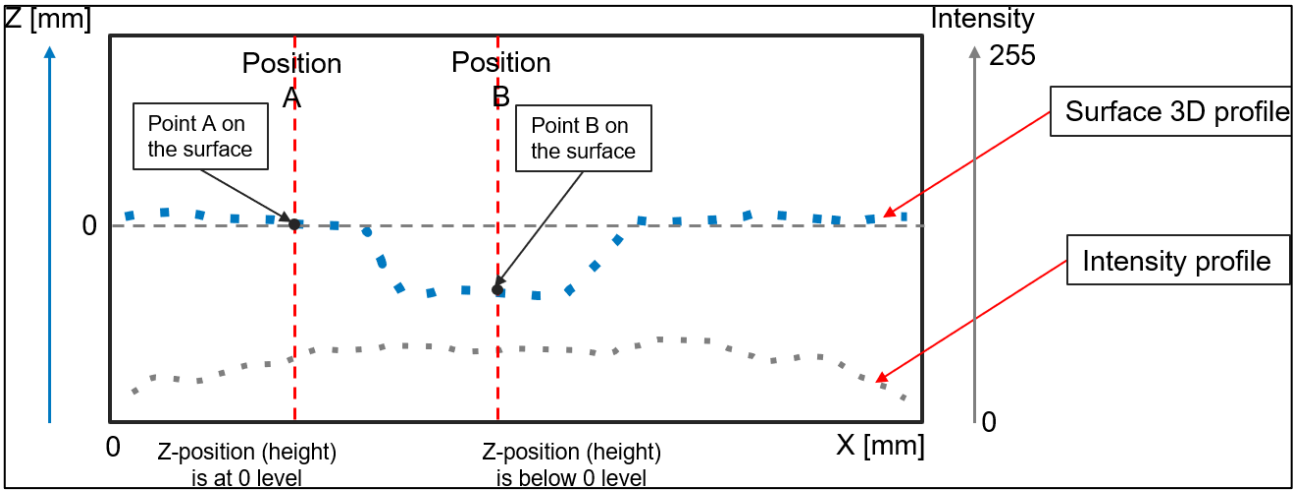


Figure 66. Sample Surface 3D Profile with Intensity Profile

Note: The Intensity of the signal must be over the Peak Threshold to get a point to the 3D and intensity profile. Peak Threshold filters out points with lower intensity.

Points A and B have the same higher than Peak Threshold intensity, both points are seen.

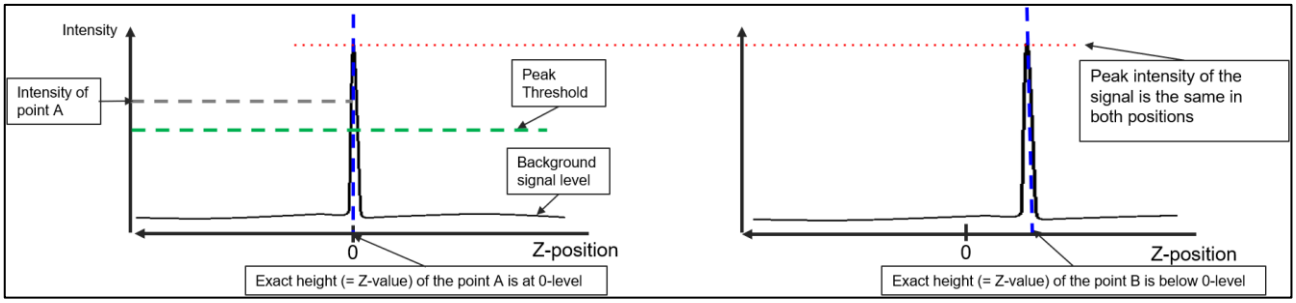


Figure 67. Positions A (left) and B (right) from the figure Above

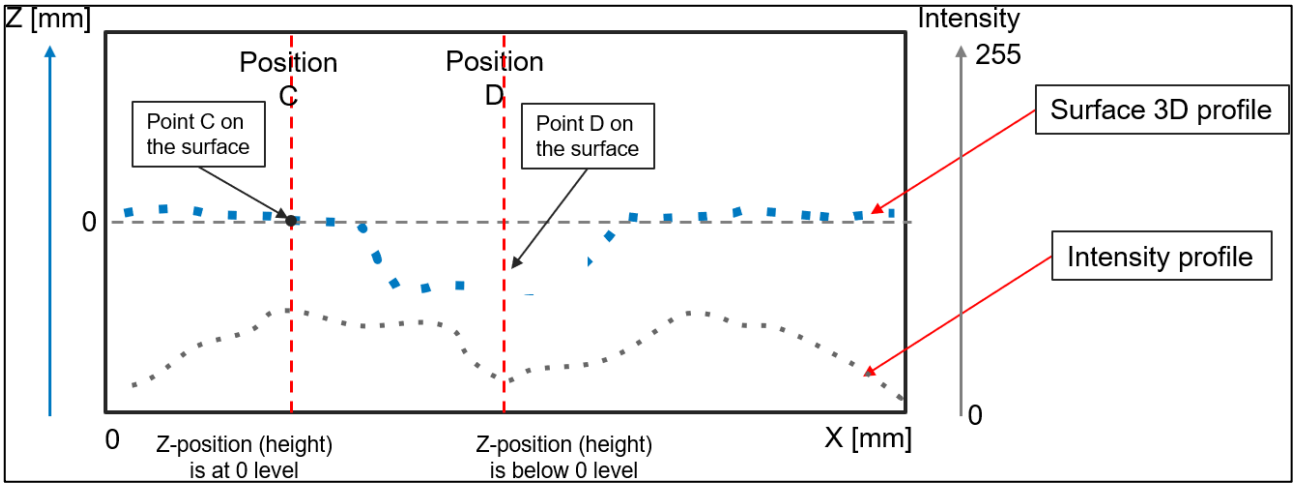


Figure 68. Sample Surface 3D Profile with Intensity Profile

Note: The Intensity of the signal must be over the Peak Threshold to get a point to the 3D and intensity profile. Peak Threshold filters out points with lower intensity.

Point C intensity is above the Peak Threshold, so it is seen at 0-level in Z height. Point D intensity is below Peak Threshold, so it is not seen.

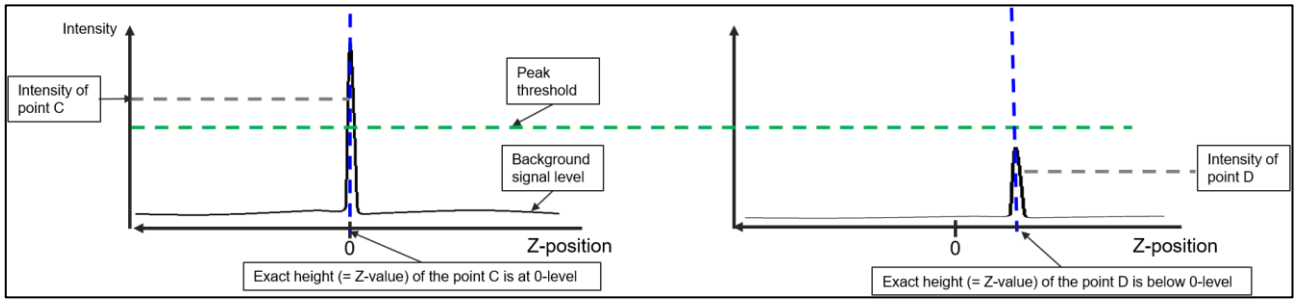


Figure 69. Positions C (left) and D (right) from the Figure Above

2.7.1.5 Peak Detection

The Peak Detection Filter length should normally be as high as possible, for example, 16.

High values of Peak Detection Filter are useful when the image is noisy, for example, due to strong reflections.

Decreasing the Peak Detection Filter value improves sensitivity to get a signal also from low-reflective surfaces.

2.7.1.6 Peak Detection Filter and Intensity

The Intensity is defined as an average signal height within the Z-range defined by the Peak Detection Filter length.

Case 1

Intensity value is high and close to the peak value of the signal when the Peak Detection Filter length is short.

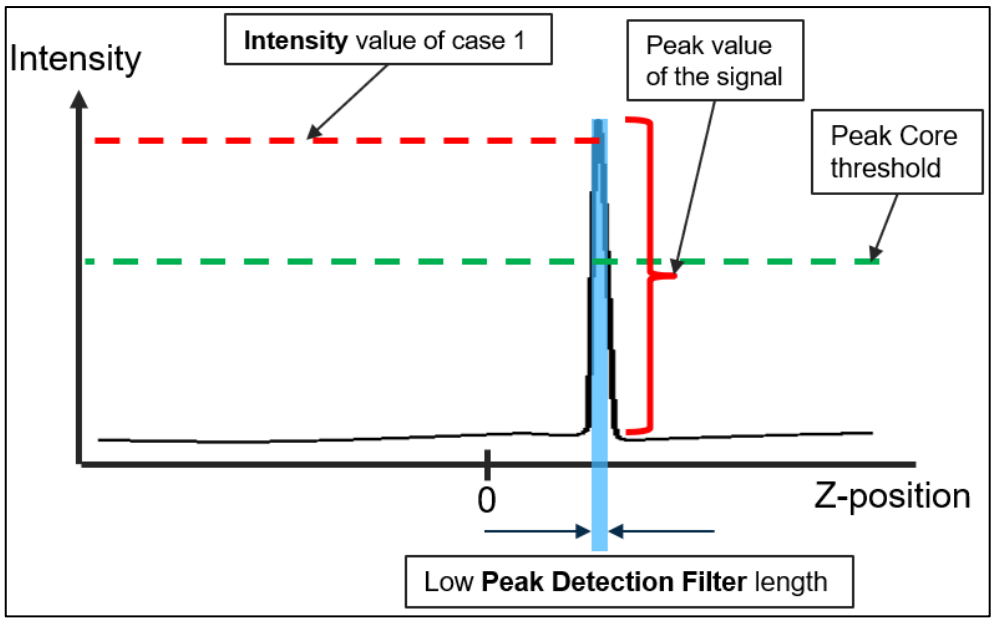


Figure 70. Low Peak Detection Filter Length

Case 2

The Intensity value is lower than the peak value, as it is an average of a wider range in the Z direction, that is, most of the signal is just background.

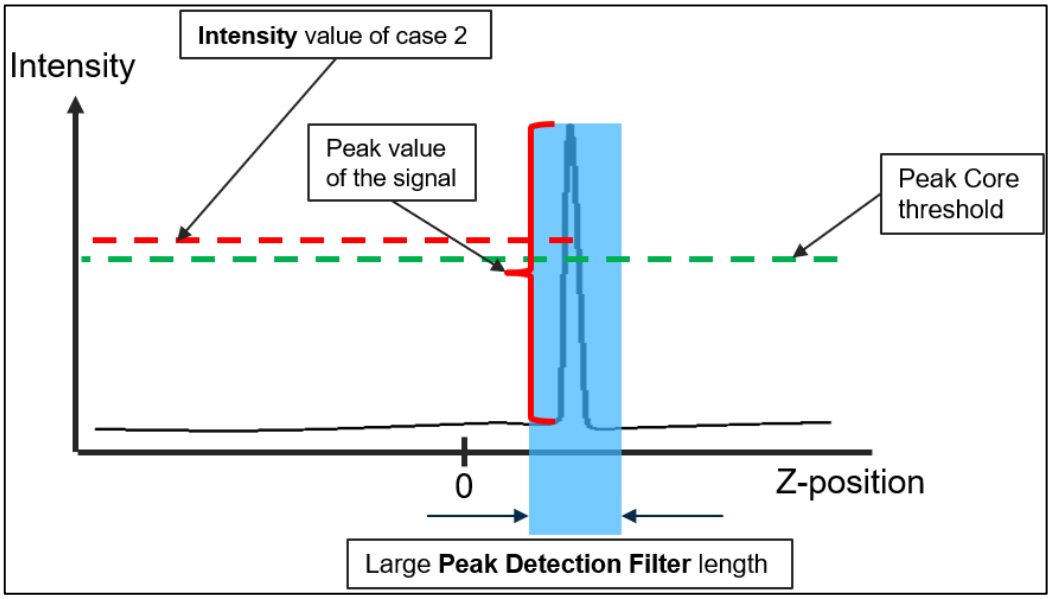


Figure 71. Large Peak Detection Filter Length

2.7.1.7 FIR

Finite Impulse Response (FIR) is a filter function, which has a typical value of 10. The value range is even numbers from 2 to 16.

The FIR Length parameter is used to calculate the exact Z position of the surface. When the FIR Length is large (=16) the Z- measurement accuracy is the best.

When the surfaces are not transparent, use FIR Length = 16.

2.7.1.8 FIR Length Setting for Thin Transparent Films and Coatings

A large FIR Length value reduces the capability to distinguish surfaces of thin material layers. Use a low FIR Length value to distinguish the surfaces of layers in thickness range 40 µm — 100 µm.

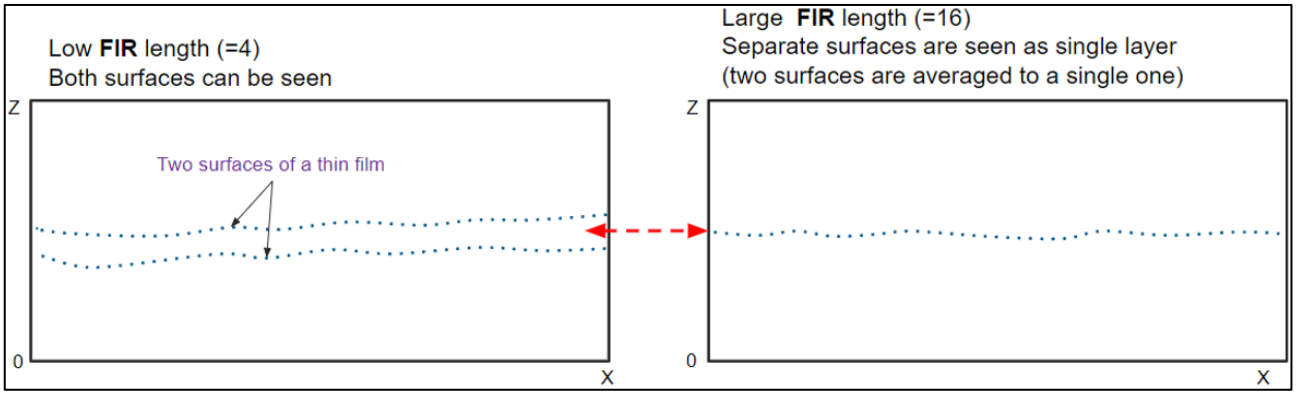


Figure 39. Effect of FIR Length

NOTE: When the film thickness is below 40 µm, LCI1201 sees the bottom and top surfaces as a single layer.

2.7.1.9 Average Intensity Filter

The Average Intensity Filter value defines the length (in number of pixels) used to calculate the average intensity value, which is then reported as peak intensity.

Average intensity is the mean value of intensities for all points that have intensity value over the Peak Threshold, and are therefore seen in the profile.

When the Average Intensity Filter length is large (for example, 16) the intensity value gets lower due to averaging.

When the Average Intensity Filter length is large, the noise in the intensity image is minimized.

The maximum signal intensity value must not exceed 240, to get a high quality non-saturated signal.

The maximum value can be determined by setting the Average Intensity Filter length to 2.

The maximum signal intensity is the maximum intensity when average intensity length is 2.

Note: Use the Intensity view to tune the intensity level to optimum for the surface area that is the most important (Intensity with Average Intensity Filter length = 2 setting is in the range 150-240).

2.7.1.10 Minimum Thickness

Minimum Thickness specifies the minimum thickness for the layer in micrometers (µm).

Minimum thickness is used with:

• The predefined material type Transparent. See Material Type.

• The Fill Gap Max function. See Fill Gap Max.

2.7.1.11 Half Step Scan

Half step scan toggles the half step scan mode ON/OFF. This parameter affects the UULA operation by halving the scan step between the scan passes in the X-direction.

When you select Half step scan, the Remove uncertain points option becomes available. Uncertain points are those, which have been covered by one scan only.

2.7.2 Advanced Parameters

This chapter contains the advanced parameters of UULA.

2.7.2.1 HDR

The High Dynamic Range (HDR) mode enhances the sensor capability to image objects with large contrast variation, by suppressing pixel saturation.

The effect of HDR can easily be seen on raw images. Use the Preview Camera Signal to switch Raw Image on.

In case of large contrast variation on a surface, the optimal HDR value for the specific measurement is best found experimentally.

2.7.2.2 LED Current

LED Current controls the LED brightness.

The current can be between 0.1 and 1 A. A typical value is 1 A, which hardly ever needs adjusting. Current is given in amperes, and used together with pulse length, to fine-tune the exposure. Higher current enables the use of a shorter pulse length, which is important with fast-moving surfaces. Alternatively, if a high current is used, the pulse length should be short.

2.7.2.3 X-filter

Effectively suppresses noise, allowing for use of a lower threshold.

The X-filter functionality can be used to smoothen the image in the X direction, before peak detection.

Valid values are 0 (disabled), 3, 5, or 7 pixels.

The filter function averages (moving average) the raw image signal in the X direction using the given number of pixels. As a result of filtering, the first in maximum 3 pixels at left and right edges of the image are darker.

The optimal X-filter value for a specific measurement is best found experimentally.

2.7.2.4 Gain

Sets the amplification of the camera signal:

• The range of the Gain = 1.0 (default) ... 3.2 for LCI401, LCI1200, LCI1201 and LCI1600.

• The range of the Gain = 2.0 (default) ... 8.0 for LCI1220 and LCI1620.

Note: The default setting is the most suitable for almost all applications.

Increasing Gain also increases noise and the background signal level.

Use a higher Gain setting only when the signal is very weak and a very short LED Pulse Width is possible, for example, due to high measurement frequency.

Note: Changing the Gain setting may also require changing the setting of Peak Threshold, as the background signal level also increases as Gain increases.

2.7.2.5 Average Z / Average intensity

Both Average Z and Average intensity are moving average filter functions for measured areas, unit is micrometers (µm).

Each surface is separately calculated.

2.7.2.6 Median Z / Median intensity

Both Median Z and Median Intensity are moving median filter functions for measured areas. The unit is pixels.

Each surface is separately calculated.

2.7.2.7 Fill Gap Max

Defines the maximum gap of missing measurement points filled by interpolation. The unit is micrometers.

The given Minimum Thickness parameter defines the maximum Z difference for interpolated points.

2.7.2.8 Trim Edges

The Trim Edges filter removes artificial points detected at the edge of the surfaces.

The filter works optimally for edges, which are clearly visible. However, it may remove real points, if the edges are gradually disappearing. Therefore, it is recommended to only use the filter for profiles, which have clear edges. Additionally, it might be useful to use the Fill Gap Max parameter to fill unmeasured areas on the edge.

Filtering is separately done for each profile, which means that only horizontal edges are trimmed.

The following two issues are handled with the filter:

Issue 1 - Artificial Points at the Profile

Due to the point spread function (PSF) of the optics, the top surface is continued after the real edge.

This effect may produce artificial points in the profile.

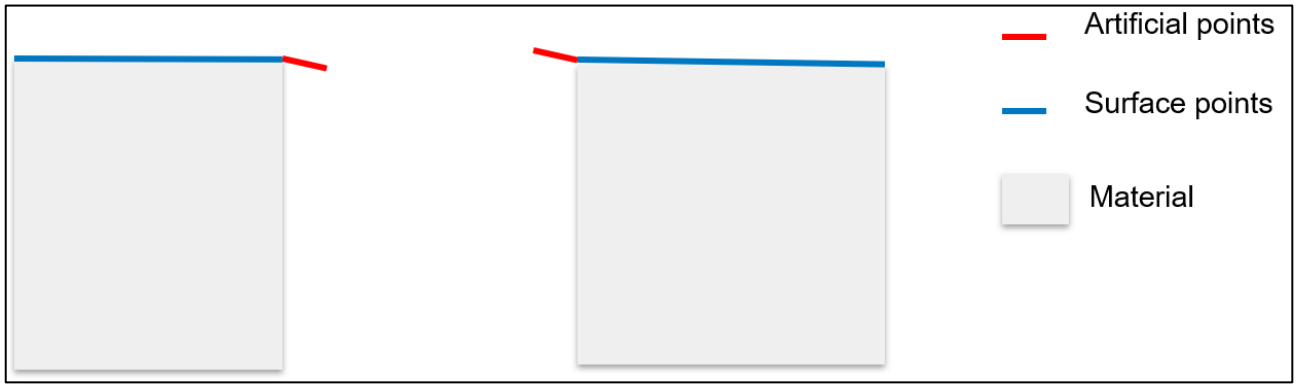


Figure 40. Artificial Points at the Profile

Issue 2 — Sharp Edge in Z-direction

Due to the point spread function (PSF) of the optics, the top surface is continued after the real edge.

This effect would produce artificial points to the higher step and missing points at the lower step. See the section below.

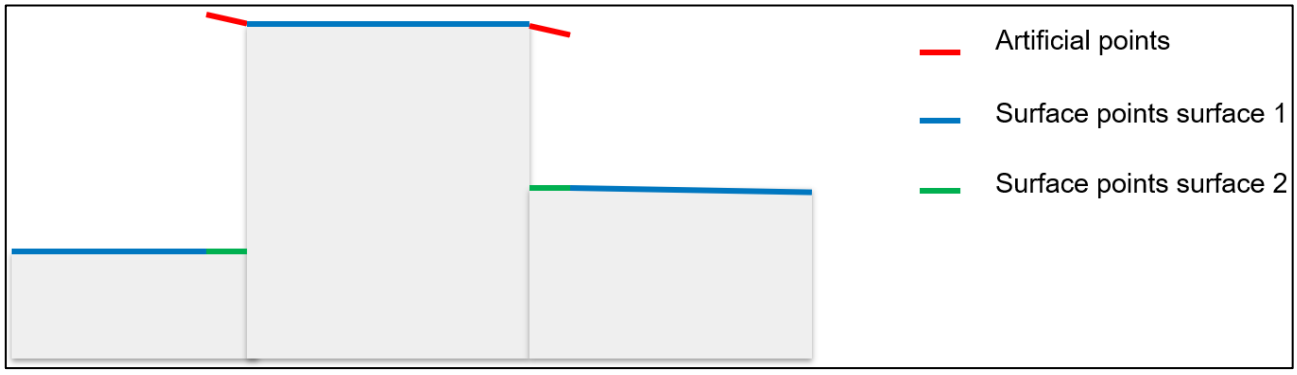


Figure 74. Sharp Edge in Z-direction

Algorithm for Trim Edges Filter

The filter removes tails of profiles, if no neighboring 3D points are found. The removal algorithm uses the intensity values of 3D points.

Surface reordering is done, if points are removed.

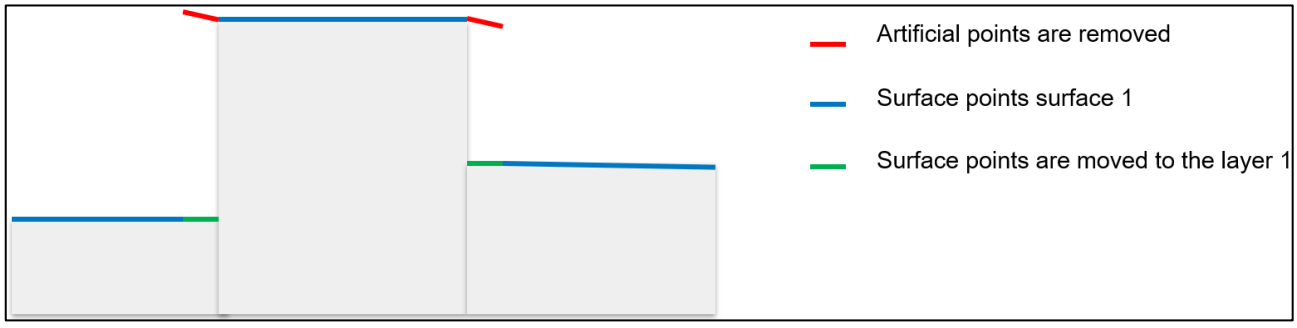


Figure 75. Algorithm for Trim Edges Filter

2.7.2.9 Noise Removal X

Connectivity analysis function that is done on a single frame basis. The frame contains all points acquired at a single moment / location.

Noise filter suppresses the noise and allows you to use lower threshold, which improves data acquisition.

Noise filter removes single data points that do not have adjacent data points.

2.7.2.10 Noise Removal Y

Connectivity analysis is done for the three previous frames (scanned profiles). The central point is removed, if it does not have any near neighbors at the same height level. An interpolated point is added, if neighbors are found from adjacent frames.

Layer reordering is done, if points are removed.

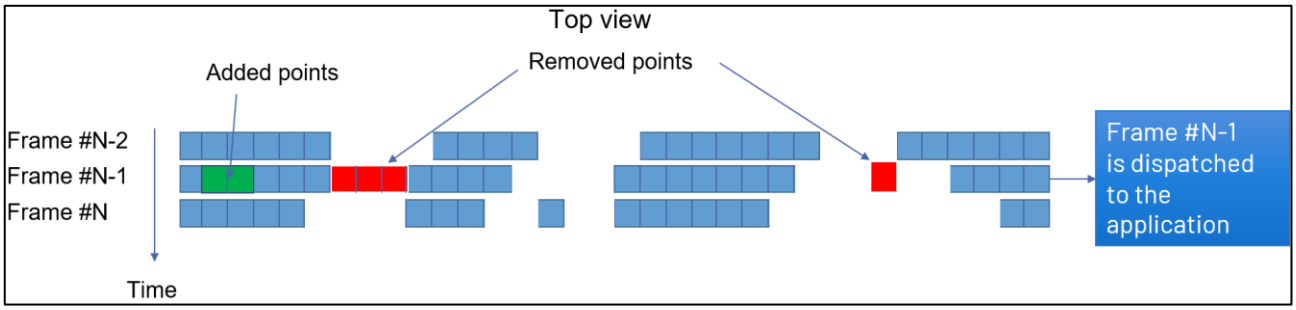


Figure 76. Noise Removal Y

2.7.2.11 Clustering Distance X (µm) and Z (µm) / Minimum Length for Cluster (µm)

This method removes clusters, which are shorter than the defined threshold.

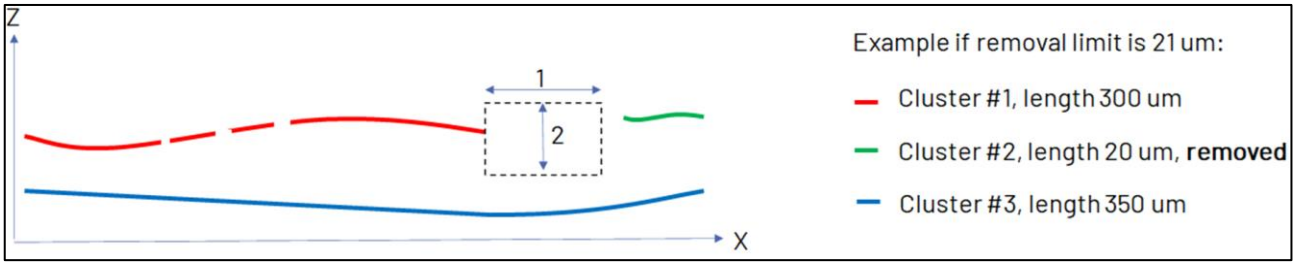


Figure 77. Clustering Distance

The maximum distance between two points in on cluster is defined by:

1. X-coordinate distance in micrometers

2. Z-coordinate distance in micrometers

2.7.2.12 Detect Missing First Layer

This feature improves surface classification, by using prior information about the surfaces.

Points in transparent surfaces are sorted to different surfaces according to Z-coordinate. The challenge is that if the first surface point is missing, the second surface point is detected as a first surface point.

The missing first surface is detected by setting the parameters below, in UULA:

1. Missing First Layer Distance (µm) — This parameter defines the minimum height distance between two surfaces, in micrometers. A typical value is 30 -100 µm.

2. Missing First Layer X Distance (µm) — This parameter defines the maximum X-coordinate distance between two

points, in micrometers. A typical value is 100 µm.

3. Missing First Layer Min Length (µm) — This parameter defines the minimum length, in micrometers, for a surface which is detected as the first surface. This is useful to filter small defects (like dust) from the first surface classification. The value can be relatively long, such as 1000 µm for flat surfaces.

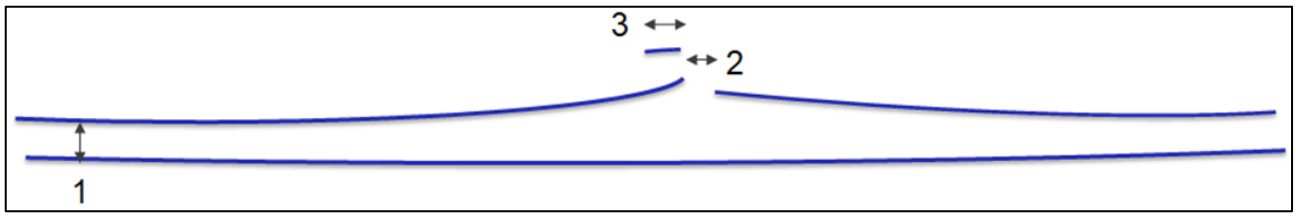


Figure 78. Detecting Missing First Layer

2.7.2.13 Use Intensity Calibration

To use this feature in UULA, see the UULA User Manual.

Calibration reduces intensity variation in grayscale bitmap imaging. You can use any sample for the intensity calibration, and intensity compensation is done real-time.

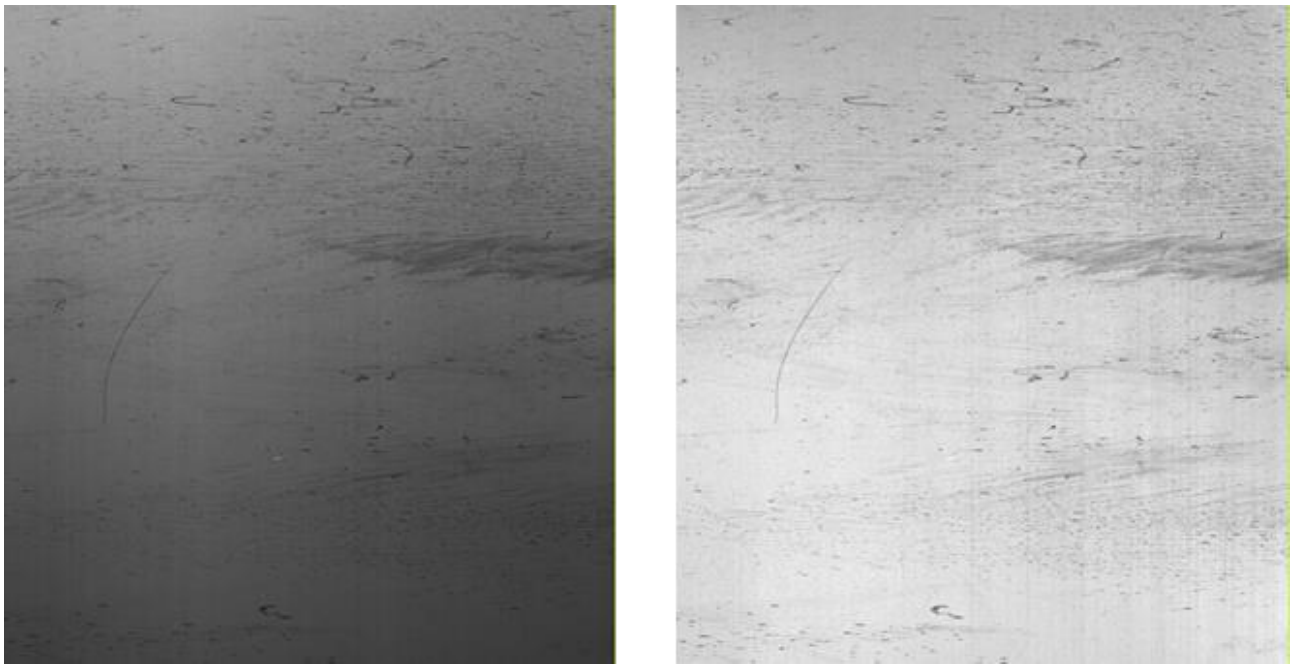


Figure 79. Intensity Image Scanned before Intensity Calibration and after the Calibration

2.7.2.14 Surface Mode

This preprocessing is done in the sensor and used to limit the number of surfaces to one, and so reduce the amount of data transferred from the sensor.

Sorts peaks and filters out top, bottom or brightest surface.

- Top — The first surface detected from the top direction.
- Bottom — The first surface detected from the bottom direction.
- Brightest — The surface that gives the highest intensity value over the Peak Threshold.
- Disabled — Transfers all the surfaces.

2.7.2.15 Layer Sorting Order

Layer sorting from top to bottom, from bottom to top or from max intensity top down.

- Top — The first surface detected from the top direction.
- Bottom — The first surface detected from the bottom direction.
- Brightest top — The surface that gives the highest intensity value from top down.

2.7.2.16 Layer Specific Parameters

If Layer Specific Parameters is enabled, the camera parameters below can be modified per layer:

- Effective Refractive Index — Specifies the effective refractive index of a material.
- Max Thickness — Specifies maximum thickness for the layer. Used for missing surface detection.
- Intensity Type — Average Intensity or Peak Detection.

2.7.2.17 Layer

Use this drop-down menu to select the surface for the layer-specific parameters.

2.7.2.18 Z-Compensation

Z-Compensation calculation can enabled/disabled, if the Z-Compensation calibration is done. The parameters below are used to fine-tune the compensation:

• X Bright To Dark Mul — Z-Compensation multiplication factor for X-edges, from bright to dark. The direction is from left to right.

0 — No compensation

1.0 — The default value

• X Dark To Bright Mul — Z-Compensation multiplication factor for X-edges, from dark to bright. The direction is from left to right.

0 — No compensation

1.0 — The default value

• Y Bright To Dark Mul — Z-Compensation multiplication factor for Y-edges, from bright to dark. The direction is from top to bottom.

0 — No compensation

1.0 — The default value

• Y Dark To Bright Mul — Z-Compensation multiplication factor for Y-edges, from dark to bright. The direction is from top to bottom.

0 — No compensation

1.0 — The default value

• Threshold — You have an option to remove points, where the calculated Z-Compensation is big. This is a useful feature, if the material has a strong texture and compensation is suboptimal for those points.

This method removes all Z-coordinates, where the calculated Z-Compensation would be greater than the specified threshold. Intensity values are not removed.

• Interpolation — If the Threshold parameter is set and points are removed, empty areas can be interpolated by using neighboring points. Interpolation can be enabled with this parameter.

2.7.3 Example Multi-Scan Use Cases

2.7.3.1. Multiple XYZ Scans

This section describes how to carry out multiple XYX scans one after another.

Note: The Z scan is only available for the U_XYZ model.

Proceed as follows:

a. Select the **Recipes** tab.
b. Select **Add** in the **Scanning Jobs** area.

The **Add a new job** screen is opened:

Figure 80. Add New Job

c. Add the desired jobs.

You can add as many jobs as you need.

To combine the jobs, they must be within the Master area.

The jobs are combined if the output file format allows it:

- The PCD and CSV file formats combine all jobs.
- The SUR file format combines all jobs, if the dimensions are equal or if the jobs are within the master job and use the same Y resolution.
  a. Adjust the scanning parameters for the master job.
  b. Adjust the scanning parameters for the other jobs. When adjusting the parameters:
- The **Start X**, **Start Y** and **Z** positions are relative to the master job.
- Separately adjustable parameters are: **Width**, **Length**, **Y-resolution**, **LED pulse width**, **Z-range** and advanced camera parameters.
- X-resolution of the jobs is the same as in Master and cannot be adjusted.
  c. Save the recipe.

The measurement begins in the master job and continues through the additional jobs in job order.

Tip: To optimize the system performance for job order using different Z height, start the master job with the lowest Z height, and move upward with the following jobs.

2.7.3.2. Multiple Scans with Different Rotation Angle

This section describes how to carry out multiple scans with a different rotation angle.

This feature requires an optional rotation table.

For this use case, you need two or more recipes.

Proceed as follows:

d. Select a recipe for the first scan from **Load Recipe** in the footer.

e. Select the **Recipes** tab.

f. Adjust the sensor height with the auto Z function.

g. Adjust the parameters.

Tip: Use the visualization or preview camera signal to make adjusting starting points easier.

h. Adjust the **After Measurement** parameters:

a) Adjust the rotation angle of the next scan.

b) Enable **Start the next measurement by using none recipe**, and select a recipe for the next scan.

c) Give a name for the measurement in the **Name for the measurement** field.

i. Save the recipe.

j. Select the second recipe from the recipe view.

k. Rotate the table to the angle in which the second measurement is to be scanned.

l. Adjust the parameters as with the first recipe.

m. Repeat the above steps for all recipes to be chained.

n. Make sure that the sample is rotated to the starting position, select the first recipe and start scanning.

Tip: Use the Rotate by __ degrees setting of the last recipe to get the sample to the same position as at the start of the first recipe.

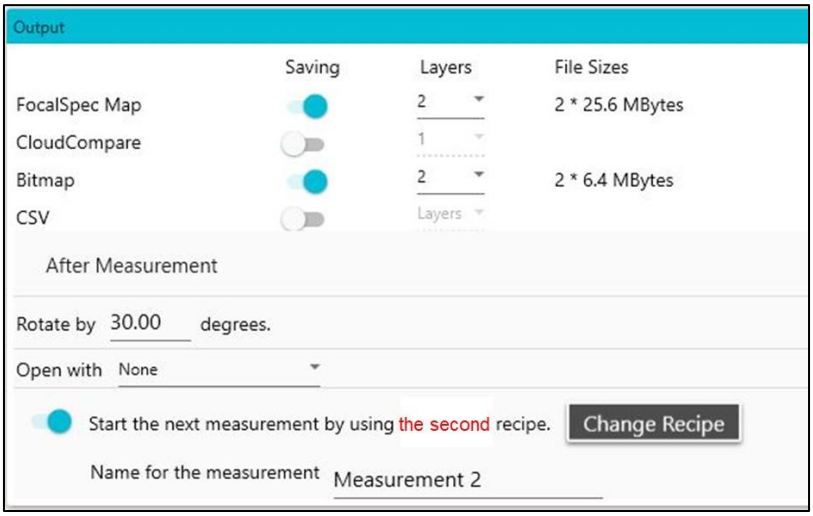


Figure 81. Output Settings 1

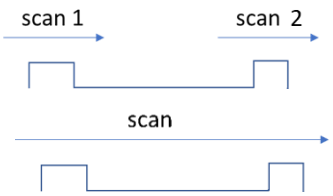
Figure 82. Output Settings 2

2.8.Troubleshooting

Table 5: Troubleshooting

Description	Effect	Possible cause	Recovery
XY table is stopped by external force.	XY table stops. Yellow button in controller turns on.	XY table movement is blocked by a mechanical obstacle.	Verify whether there is a mechanical obstacle and if so, remove it. Press the yellow P2 button to drive the table first back to the home position and then to measurement start position. To continue, press the green P1 button to start measuring.

Description	Effect	Possible cause	Recovery
XY table is stopped by pressing the emergency stop button.	XY table stops. Red and yellow buttons in the controller turn on.	Emergency stop is activated.	1. Release the emergency by turning the emergency stop button. 2. Press the red button to reset the emergency. Z-axis moves up. (Only in U_XYZ) 3. Press the yellow P2 button to drive the table back to the home position. To continue, drive the sensor back to correct height (only U_XYZ) and to measurement start XY position. Then press the green P1 button to start measuring.
Camera preview Z scale is not symmetrical and zero is not in the center.	It is difficult to see the surface level.	Software error.	Adjust the Z-Range to the minimum and back to 3.0 mm or to the originally set value.
Scan result not saved in FocalSpec Map .sur format.	There is no .sur result file.	The selected recipe is **Calibration**. There are no calibration files or calibration files are defective.	Do not use the **Calibration** recipe for measuring, select another recipe.
Scan result only saved in .bmp format.	Only a .bmp file is saved.	Calibration is missing.	Run the calibration.
Cannot find scan result output files.	Cannot find scan result output files.	An incorrect day is selected in the **Results calendar**.	Select the current date from the calendar.
Measuring does not work.	No camera or motor connection, the indicator(s) at the bottom bar is/are red.	Error in connection.	Try to reset the connection(s) with the Reconnect button. If this does not help, close the UULA software on the PC, turn the UULA device’s power off and then back on, and launch the software again.

There is long gap in scanning, during which the scanner does not see the object.	It is possible that the data will not be saved.	The scanner does not see the object.	Decrease the length of the scan. Separate short scans to two different recipes. 

2.9. CloudCompare User Manual

CloudCompare is a 3D point cloud (and triangular mesh) processing software package. It was originally designed to perform comparisons between two dense 3D points clouds, such as the ones acquired with a laser scanner, or between a point cloud and a triangular mesh. It relies on a specific octree structure dedicated to this task. More recently, it was extended to perform more generic point cloud processing, including many advanced algorithms (registration, resampling, color/normal/scalar fields handling, statistics computation, sensor management, interactive or automatic segmentation, display enhancement, and so on).

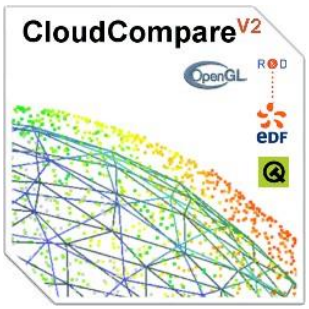


Figure 83. CloudCompare

For a list of CloudCompare functionalities, see the documentation page and the wiki:

- http://www.cloudcompare.org/documentation.html
- http://www.cloudcompare.org/doc/wiki/index.php?title=Main_Page

i. License

The license of the CCLib library (containing the core algorithms) is LGPL version 2.0.

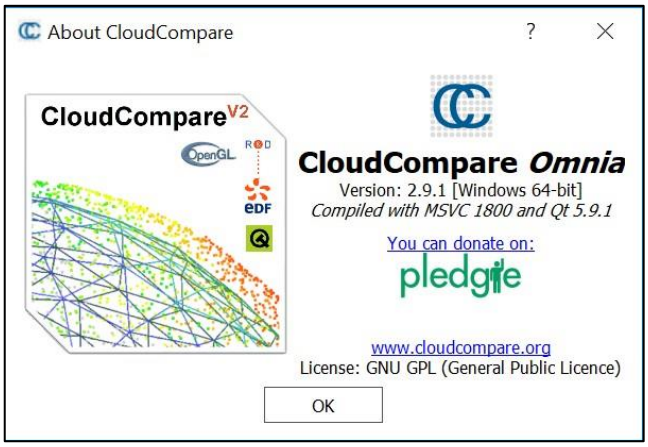


Figure 84. CloudCompare License

Due to its LGPL license, CCLib can be integrated in any commercial or non-commercial project. You just must share any modification of the code with the authors.

The license of the other components is GPL (version 2.0). The components are:

- qCC_db (database library)
- qCC_io (file I/O library)
- qCC_gl (OpenGL based 3D display library)
- CloudCompare and ccViewer (standalone applications)

Only GPL-compatible (which means open-source, but not necessarily free) projects can use the other components.

2.9.1. Using CloudCompare

This chapter contains examples on how you can use CloudCompare to view measurement data.

Opening a File

You can open a *.pcdfile by selecting **File** > **Open**.

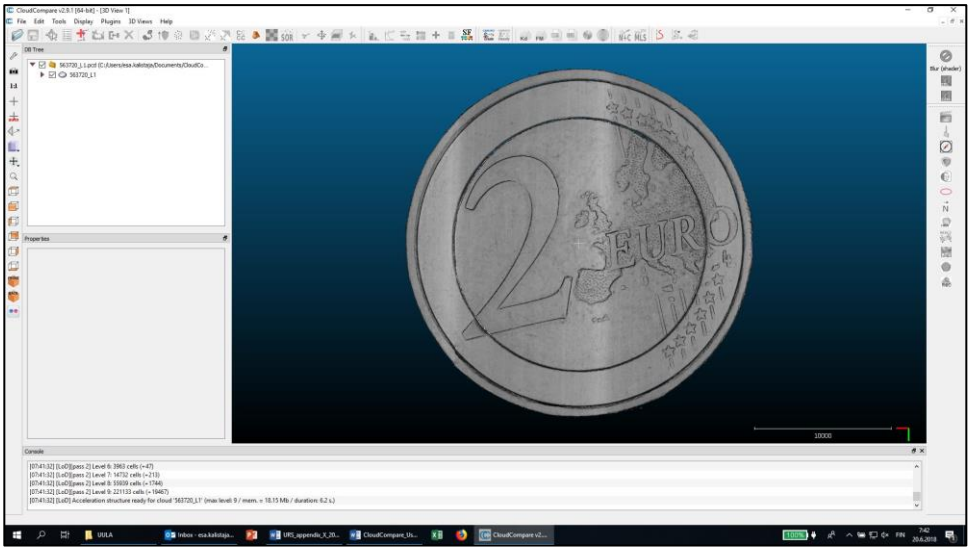


Figure 85. Opening a File

Select the object in **DB Tree** window.

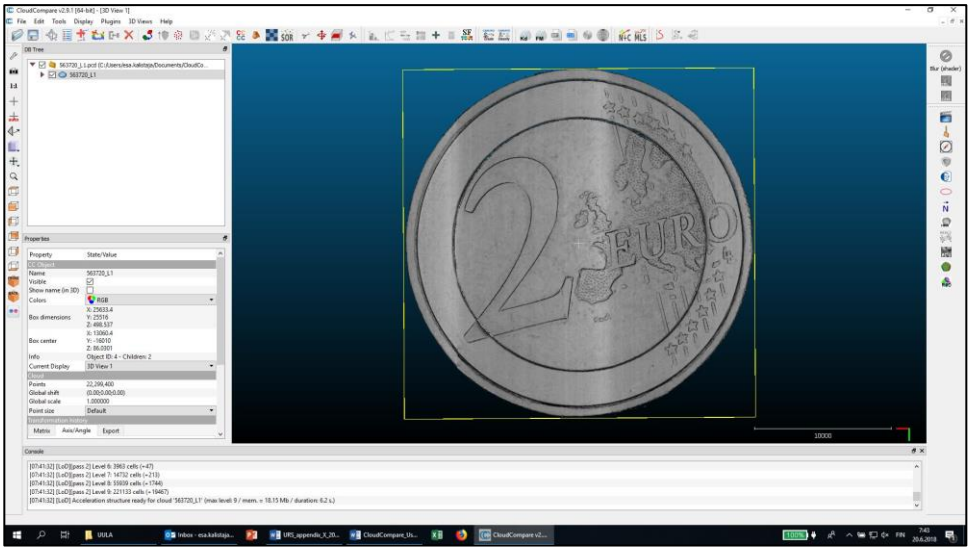


Figure 86. Selecting an Object

Editing Colors and the Height Ramp

Edit first height coloring with **Default** selected.

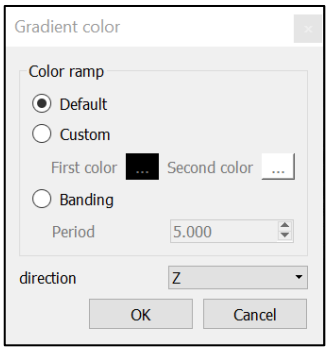


Figure 87. Editing Colors and the Height Ramp - 1

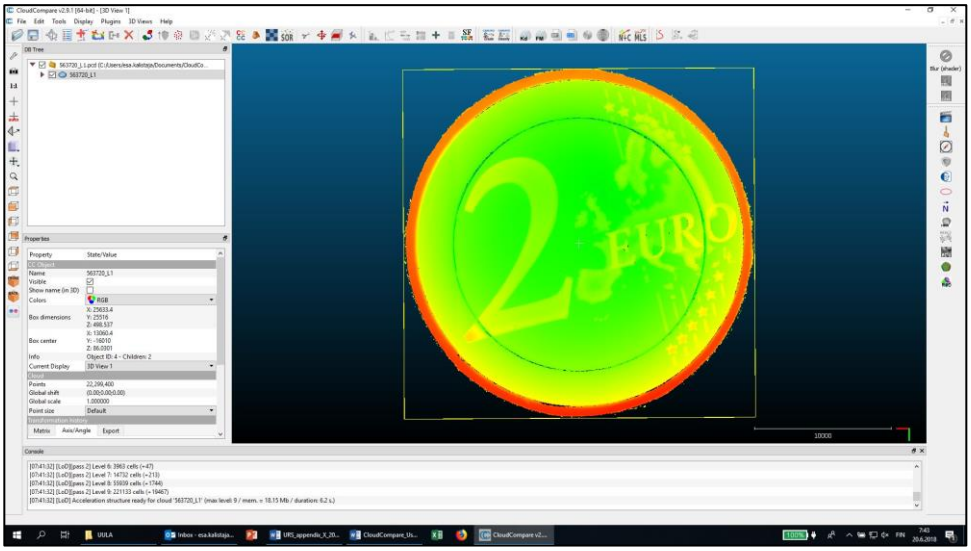


Figure 88. Editing Colors and the Height Ramp - 2

Banding

In **Banding**, you can set the banding period in micrometers. The color scale covers each defined banding period.

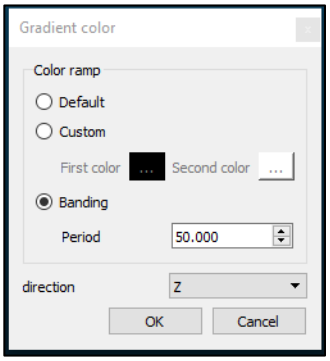


Figure 89. Banding - 1

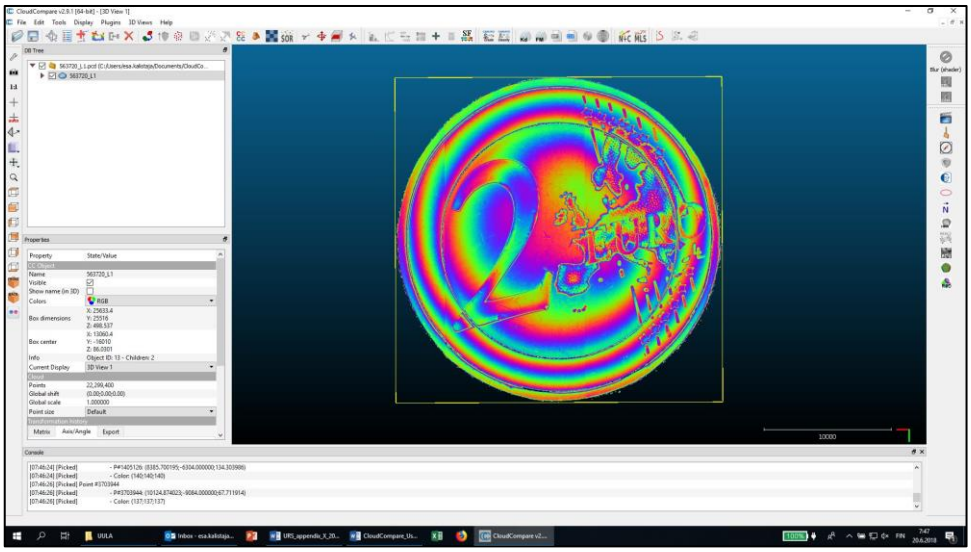


Figure 90. Banding - 2

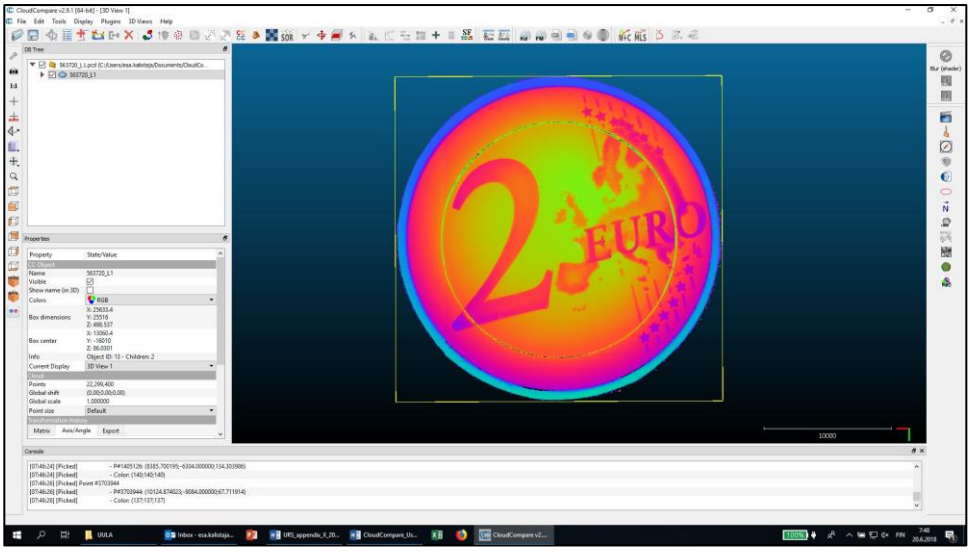


Figure 91. Banding Period 300 µm

Zooming

You can zoom in to view more details.

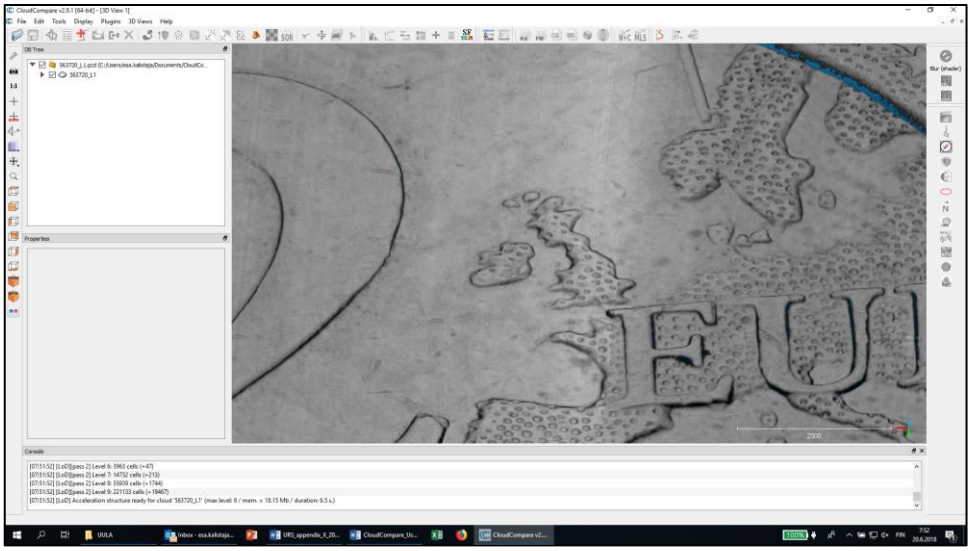


Figure 92. Zooming

Saving a File

You can save the screen view as a BMP picture by selecting **Display** > **Render to file**.

Figure 93. Saving a File

2.10. FocalSpec Map User Manual

FocalSpec Map is a comprehensive analyzing platform, which has an extensive help section assisting in software use. Using FocalSpec Map is introduced to customers during the initial machine installation, which gives new UULA users the confidence to explore the software.

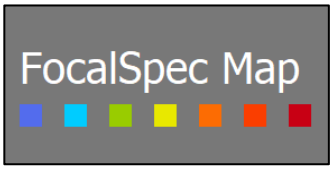


Figure 94. FocalSpec Map

In this manual, we provide simple examples of possible studies for beginners. The actual use cases depend on the scanner customer's industry, and LMI is happy to assist with possible questions.

It is recommended to keep the software up to date. You can check the availability of updates by selecting **Help** > **Check for updates**.

2.10.1. Analyses

This section contains example analyses made with FocalSpec Map.

2.10.1.1 Sample 1 – FocalSpec Business Card Logo

Open the *.surfile by selecting **Studiables** > **Load a studiable**.

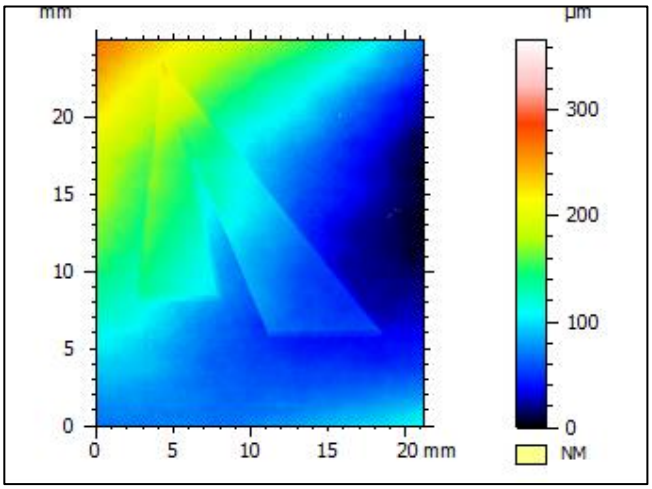


Figure 95. Opening a File

To rotate the picture, select **Operators** > **Adjust position group** > **Rotate**.

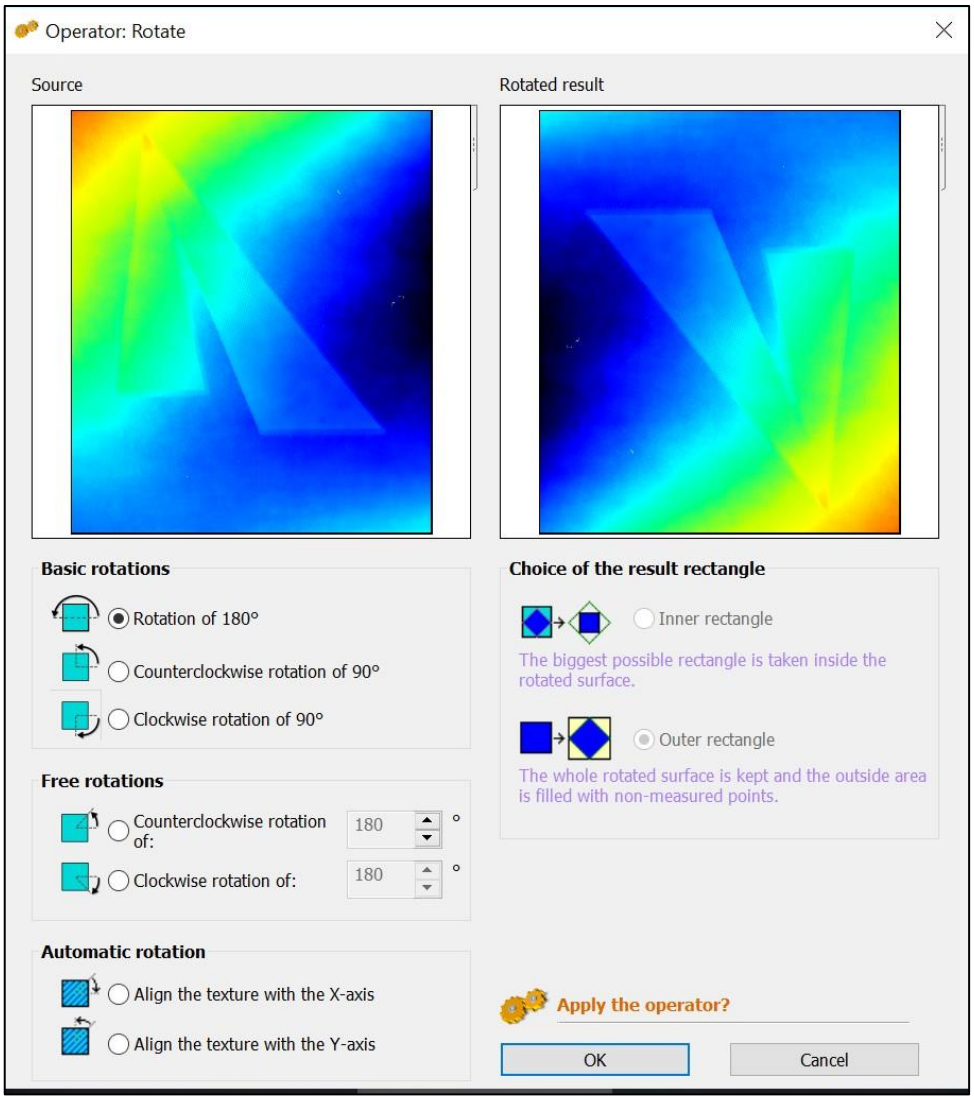


Figure 96. Rotating a Picture

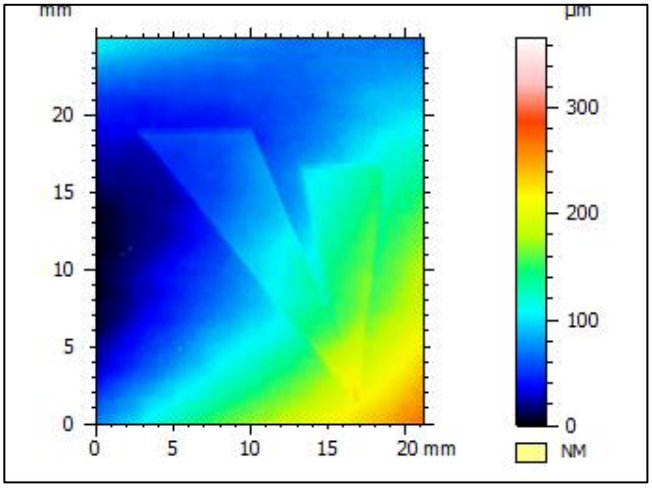


Figure 97. Rotated Picture

To open the 3D view, select **Studies** > **View group** > **3D View**.

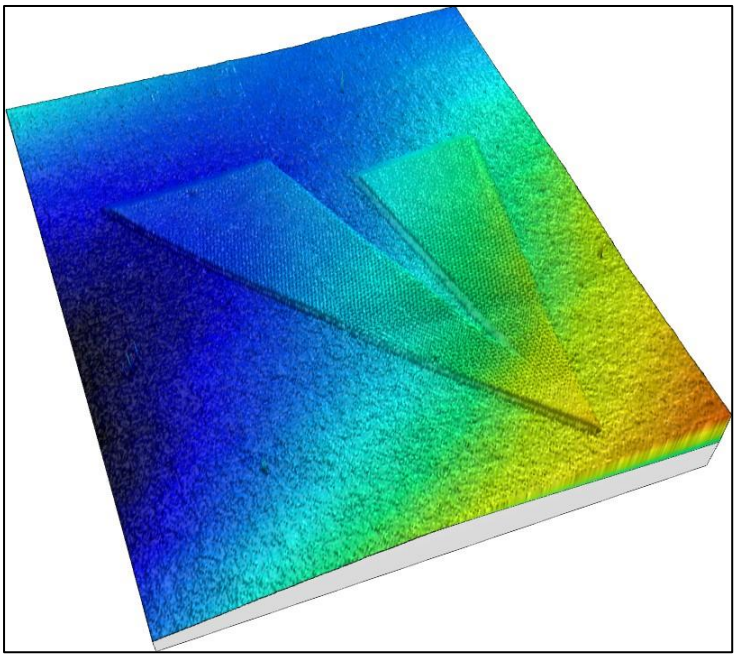


Figure 98. 3D View

To level the measured result, select **Operators** > **Adjust position group** > **Level**.

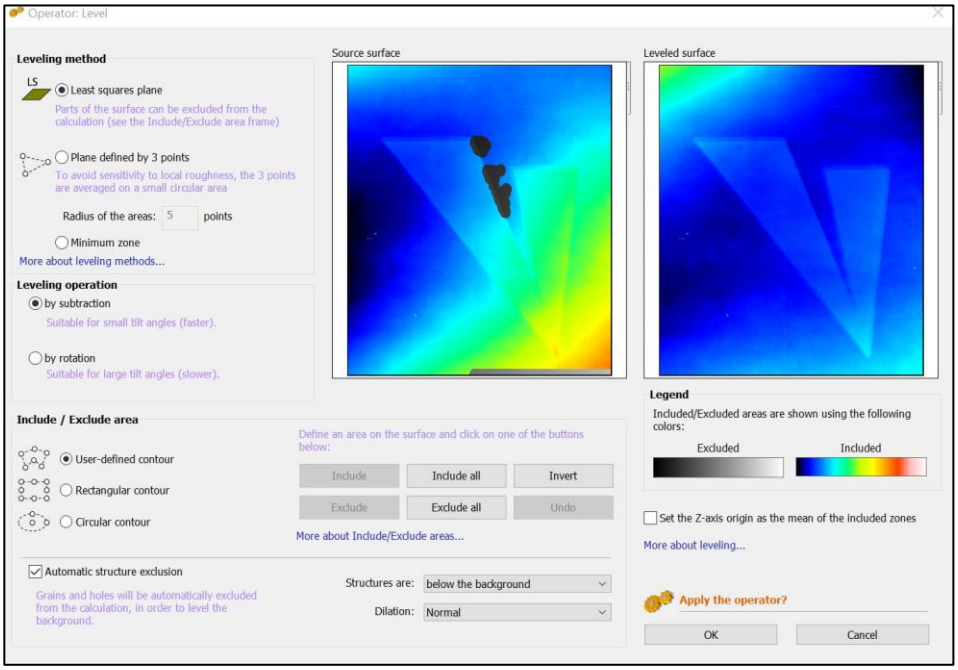


Figure 99. Levelling a Surface

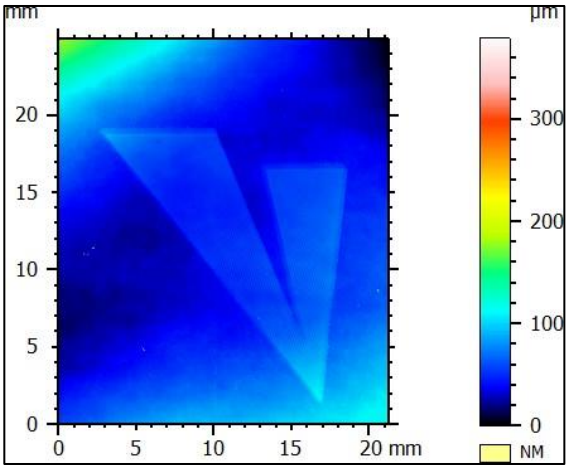


Figure 100. Levelled Surface

To measure dimensions, select **Studies** > **Geometry group** > **Distance measurement**.

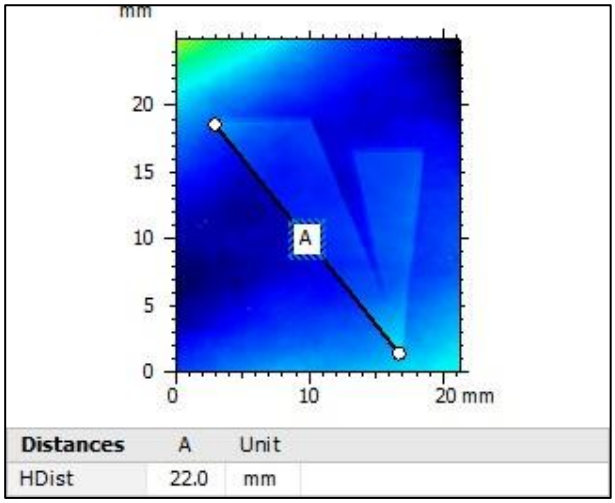


Figure 101. Measuring Dimensions

To study the profile, select **Operators** > **Extract group** > **Extract profile**.

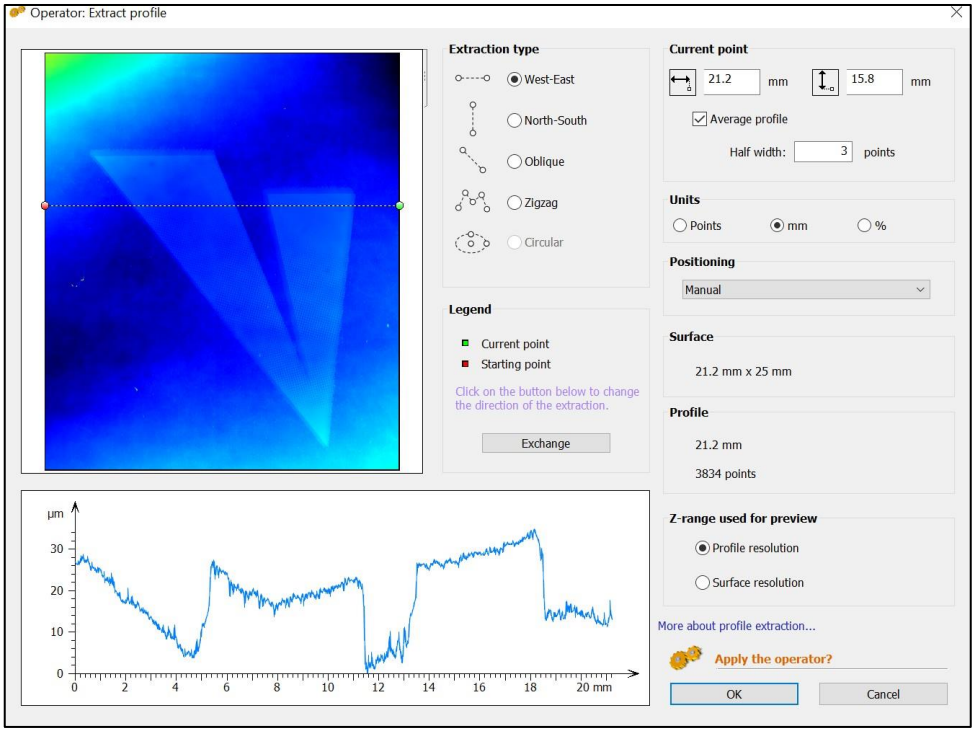


Figure 102. Studying the Profile

Note: In the top right-hand corner you can select **Average** and the number of points. When, for example, defining surface roughness Ra, this may give a more reliable figure.

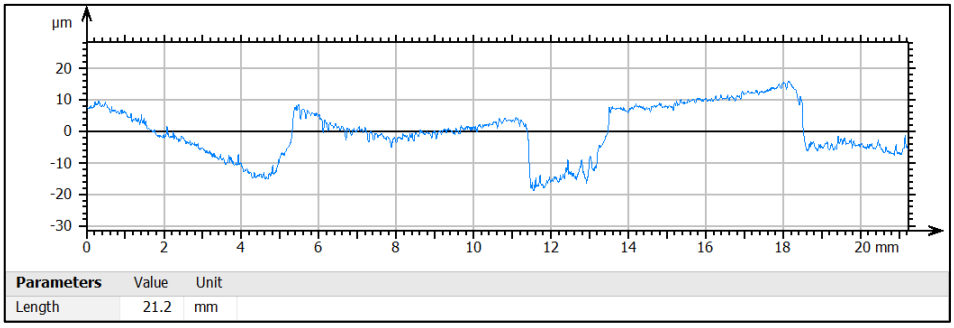


Figure 103. Extracted Profile

To study the surface in more detail, select **Operators** > **Extract group** > **Extract area**.

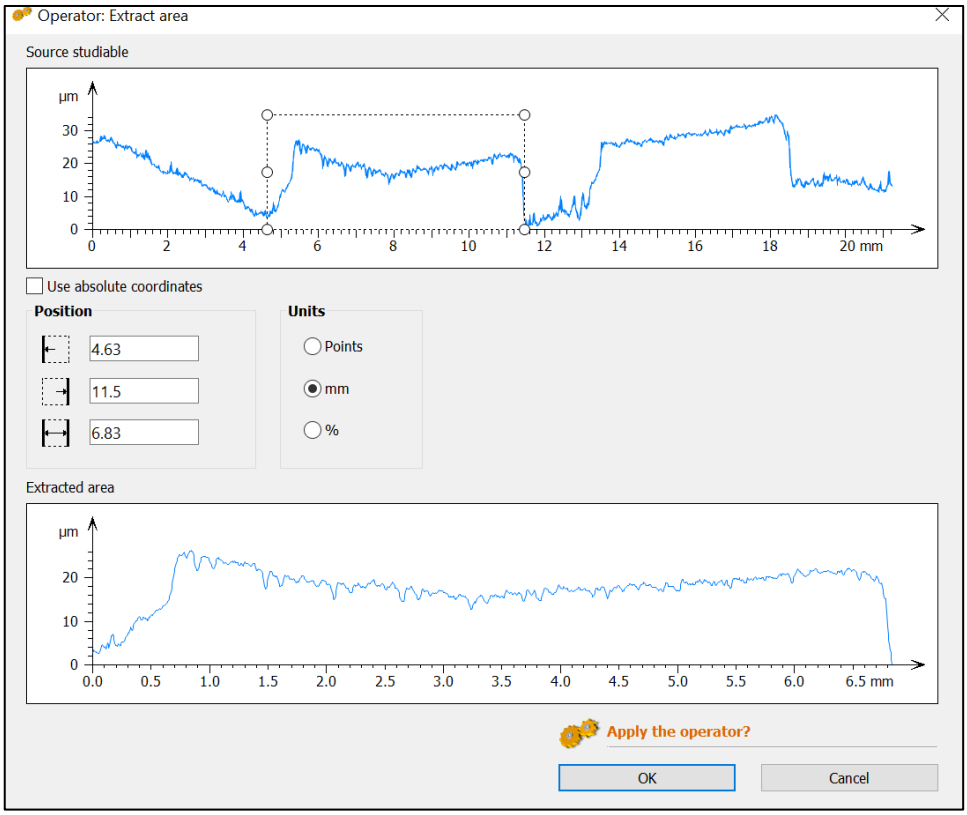


Figure 104. Studying the Surface

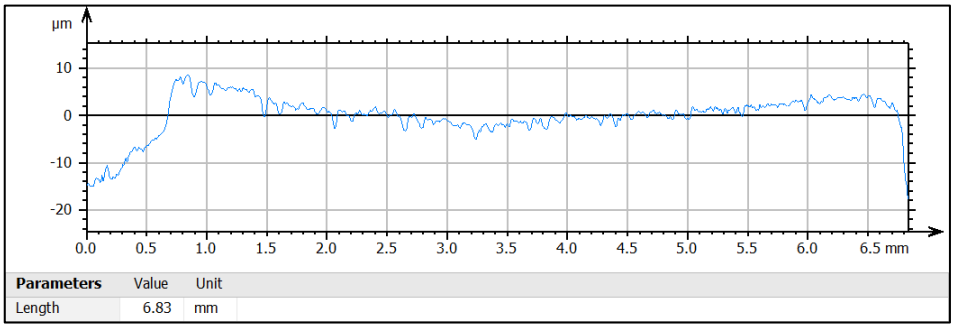


Figure 105. Extracted Area

To get a set of numeric roughness parameters, select **Studies** > **Parameters group** > **Parameter table**.

ISO 4287			
Amplitude parameters - Roughness profile			
Rp	1.74	µm	*Gaussian filter, 0.8 mm*
Rv	2.58	µm	*Gaussian filter, 0.8 mm*
Rz	4.32	µm	*Gaussian filter, 0.8 mm*
Rc	2.08	µm	*Gaussian filter, 0.8 mm, ISO 4287 w/o amendm..*
Rt	8.37	µm	*Gaussian filter, 0.8 mm*
Ra	0.689	µm	*Gaussian filter, 0.8 mm*
Rq	0.925	µm	*Gaussian filter, 0.8 mm*
Rsk	-1.05		*Gaussian filter, 0.8 mm*
Rku	4.57		*Gaussian filter, 0.8 mm*
Material Ratio parameters - Roughness profile			
Rmr	1.28	%	*c = 1 µm under the highest peak, Gaussian filte...*
Rdc	1.10	µm	*p = 20%, q = 80%, Gaussian filter, 0.8 mm*

Figure 106. Parameter Table

2.10.1.2 Sample 2 – 2 € Coin

Open the *.surfile by selecting **Studiables** > **Load a studiable**.

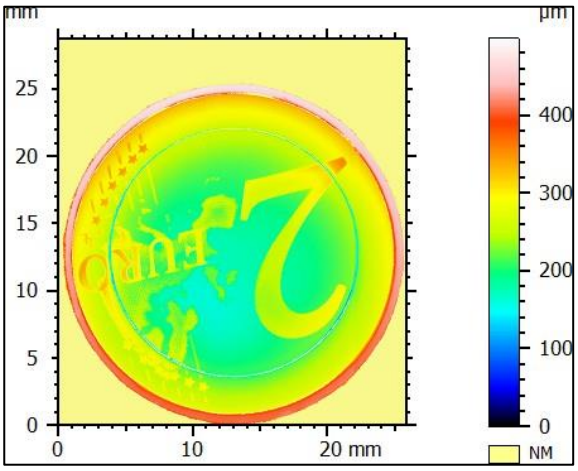


Figure 107. Opening a File

To rotate the picture, select **Operators** > **Adjust position group** > **Rotate**.

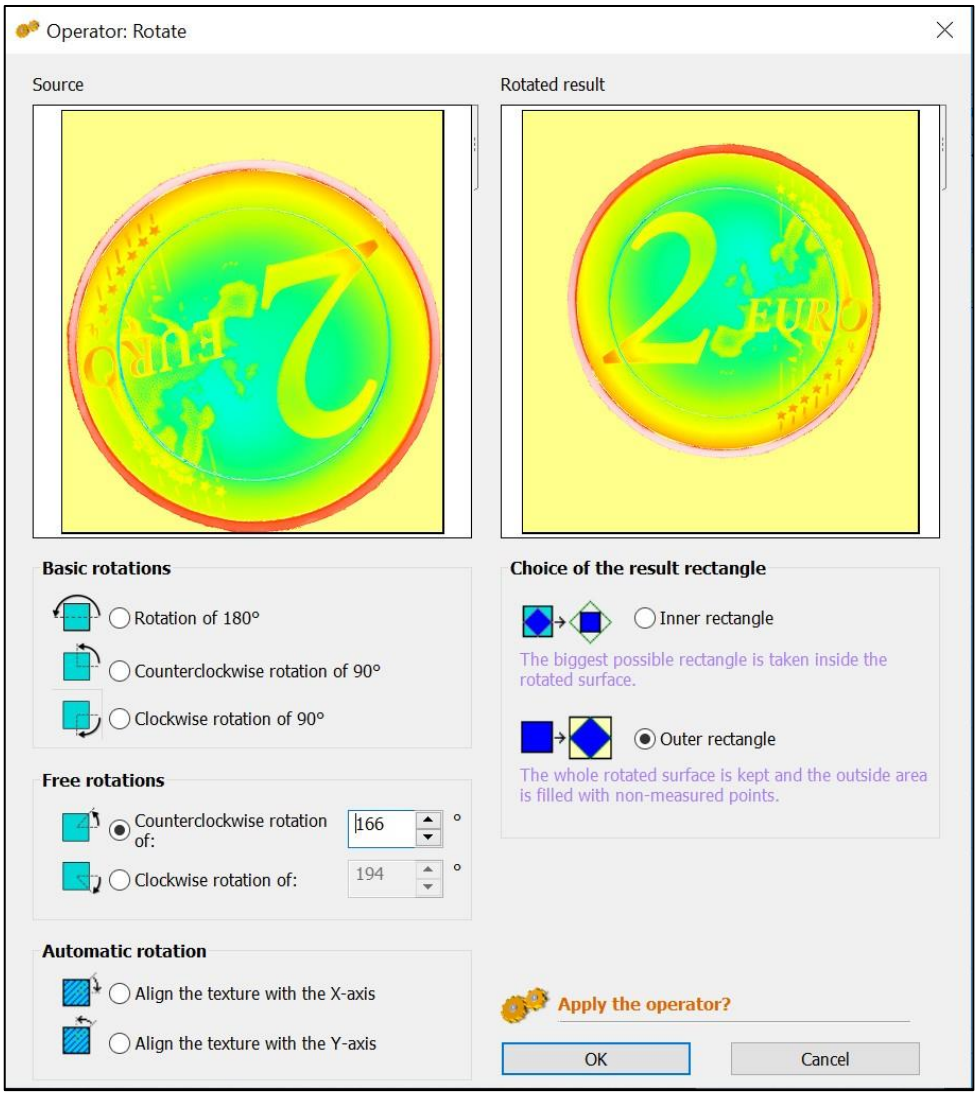


Figure 108. Rotating a Picture

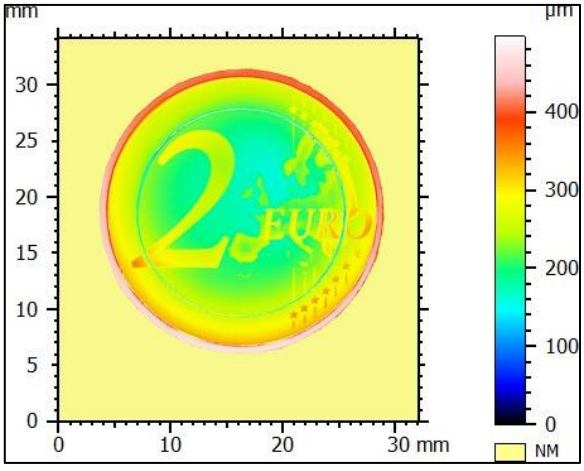


Figure 109. Rotated Picture

To open the 3D view, select **Studies** > **View group** > **3D View**.

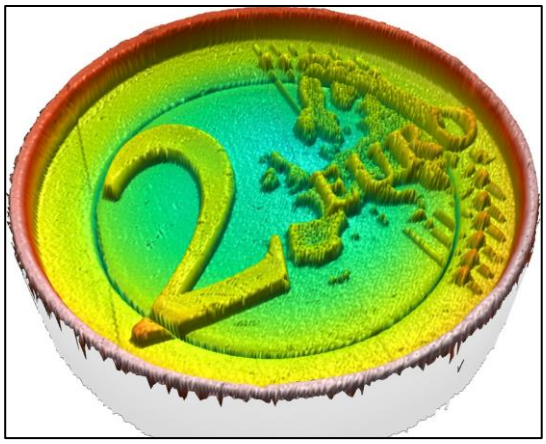


Figure 110. 3D View

To level the measured result, select **Operators** > **Adjust position group** > **Level**.

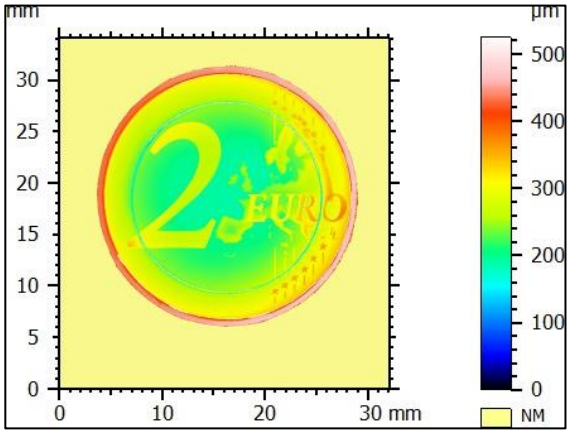


Figure 111. Levelling a Picture

To measure dimensions, select **Studies** > **Geometry group** > **Distance measurement**.

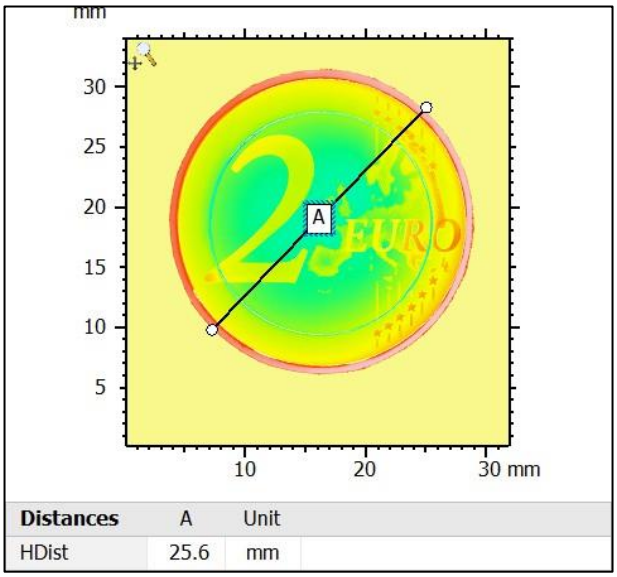


Figure 112. Measuring Dimensions

To study the profile, select **Operators** > **Extract group** > **Extract profile**.

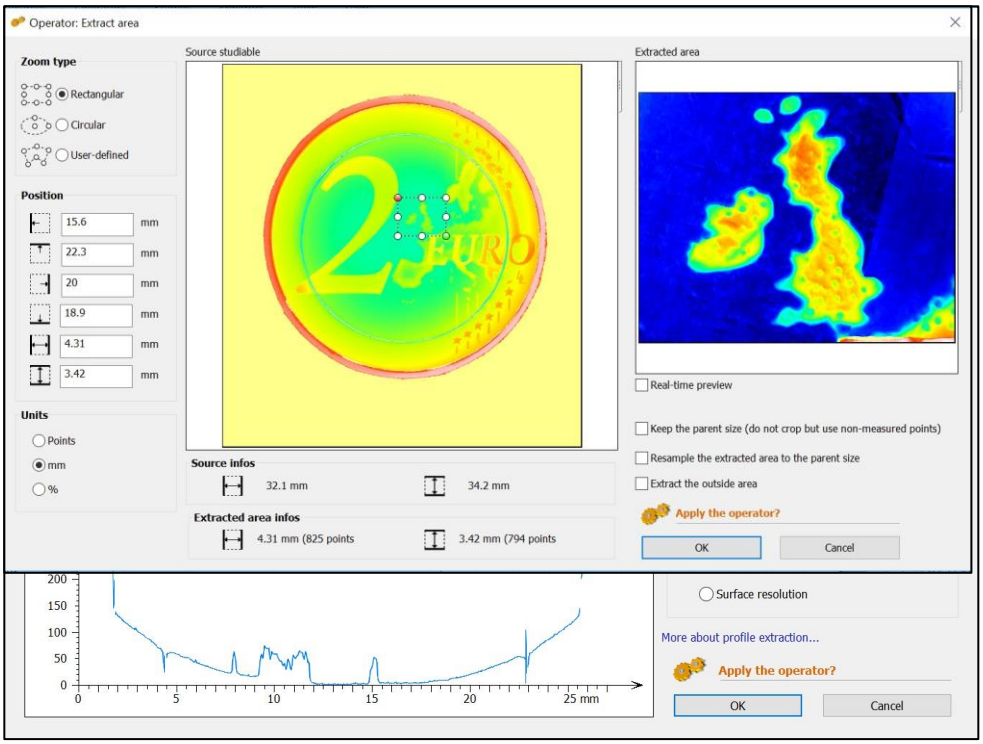


Figure 113. Studying the Profile

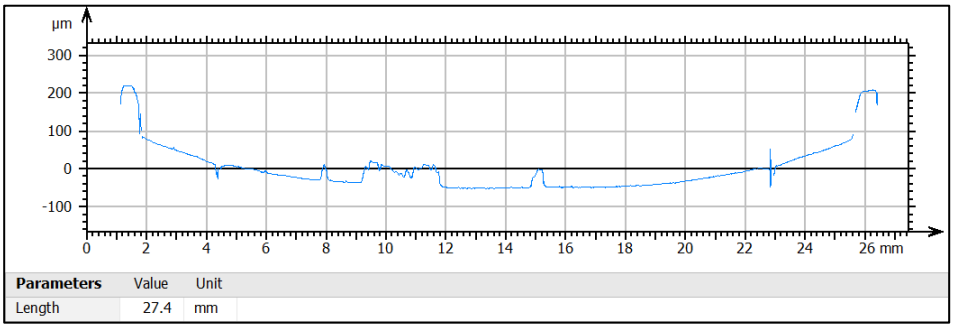


Figure 114. Extracted Profile

To study the surface in more detail, select **Operators** > **Extract group** > **Extract area**.

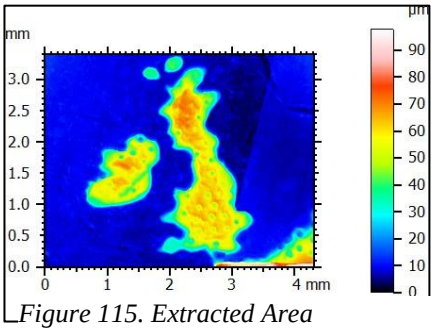


Figure 115. Extracted Area

To filter the roughness to study the sample form, select **Operators** > **Filter group** > **Standard filter**.

Figure 116. Studying the Surface

Figure 117. Filtering the Picture

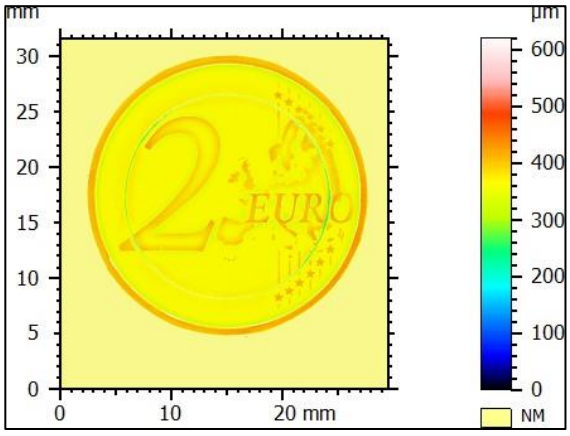
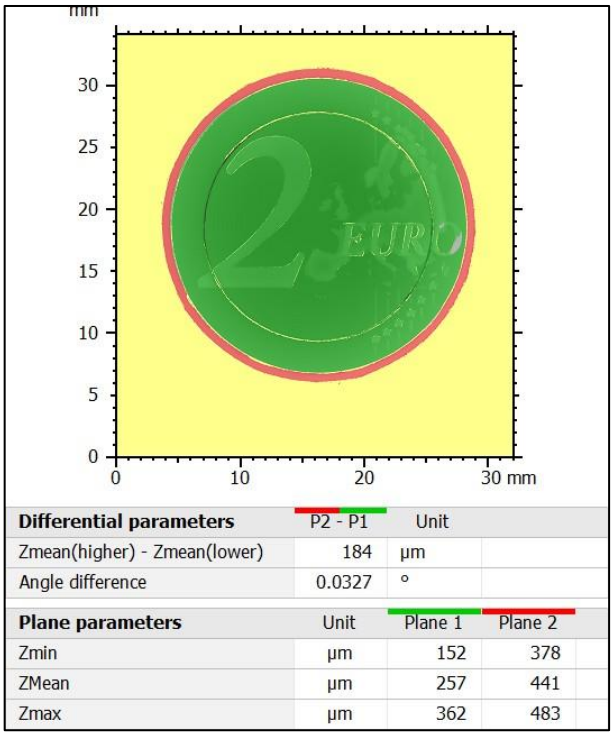


Figure 118. Filtered Picture

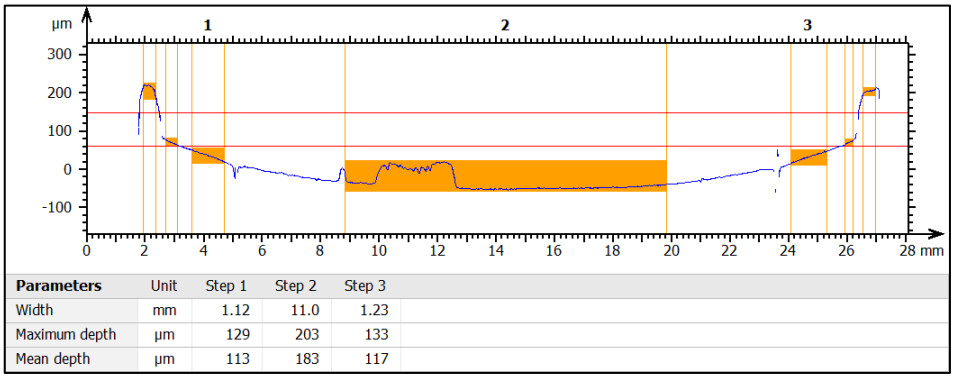
To set the step height, select **Studies** > **Step height**.



Differential parameters	P2 - P1	Unit
Zmean(higher) - Zmean(lower)	184	µm
Angle difference	0.0327	°

Plane parameters	Unit	Plane 1	Plane 2
Zmin	µm	152	378
ZMean	µm	257	441
Zmax	µm	362	483

Figure 119. Setting the Step Height



Parameters	Unit	Step 1	Step 2	Step 3
Width	mm	1.12	11.0	1.23
Maximum depth	µm	129	203	133
Mean depth	µm	113	183	117

Figure 120. Step Height

2.10.2 Startup and Help

The **Startup** dialog provides links to tutorials, examples and your recent documents and studiables.

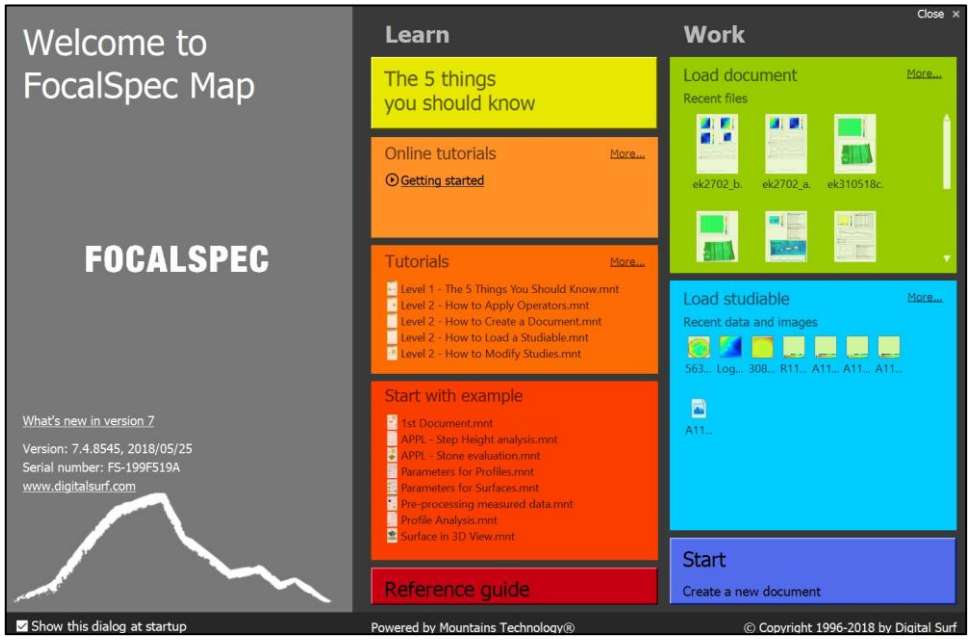


Figure 121. Startup

Many Operators also provide a quick line to **Help** with **More on...** in the right-hand bottom corner of the **Operator** window.

A reference guide has extensive contents, including well visualized instructions. The search function is handy to find more information on the subject.

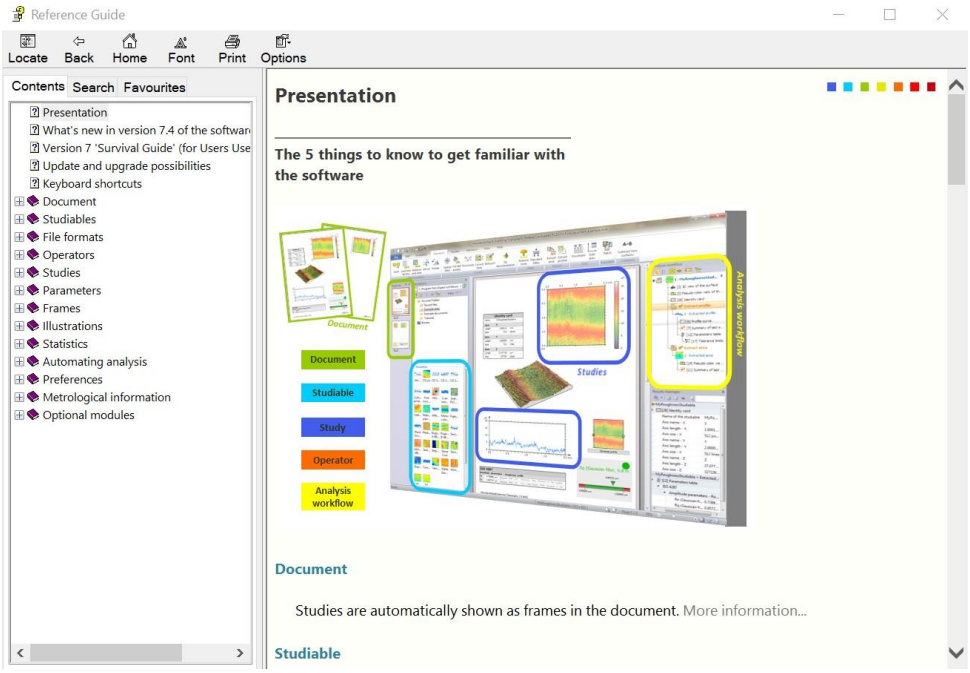


Figure 122. Help

2.10.3 FocalSpec Map Versions

There are three different FocalSpec Map versions, described in the sections below.

FocalSpec Map Standard

The standard package contains a wide range of tools, which allow a comprehensive analysis of UULA scanning results.

FocalSpec Map Extended

This package includes three of the most useful additional modules to extend the software's capability:

- 2D Advanced Surface Texture
- Contour Analysis and
- Statistics

FocalSpec Map Premium

In addition to what is included in the standard version, this package provides the following modules:

- 2D Advanced Surface Texture
- Contour Analysis
- Statistics
- 2D Automotive
- 3D Advanced Surface Texture
- 3D Fourier & Wavelets Analysis
- 4D Series Analysis
- Grains & Particles

2.10.3.1 FocalSpec Map Extended Version

This section describes the modules in the FocalSpec Map extended version.

2D Advanced Surface Texture

Figure 123. 2D Advanced Surface Texture

Everything that you need for advanced 2D surface texture analysis

- **Advanced 2D filtering techniques** - remove form and apply roughness/waviness filters from 2RC to ISO 16610 - apply morphological filters using a straight or round structuring element - filter noisy profiles directly by editing the FFT plot within selected upper and lower bounds.
- **MATLABTM compatibility** - load or write MATLABTM scripts and execute them to carry out custom operations including filtering.
- **Correct measurement anomalies** - use data correction tools (thresholding, retouching, resampling) to eliminate anomalies and improve resolution prior to analysis.
- **Assess surface functionality** - study the bearing area curve and depth distribution histogram to evaluate surface functionality - subtract profiles to assess wear.
- **Use FFT-based tools to analyze process-surface interactions and other surface characteristics** - show

frequency spectrum and power spectrum density plots - carry out autocorrelation and intercorrelation studies.

- **Fractal analysis** - analyze the fractal dimension of a profile using the enclosing boxes and morphological envelope methods.
- **Overcome measurement limits virtually** - join overlapping profiles to overcome physical measurement limits virtually, with automatic calculation of the overlap zone.
- **Statistical analysis of series of profiles or multiple profiles extracted from the same surface** - load a series profiles measured by 2D profilometers or load surfaces measured by 3D profilometers and extract one or more profiles for analysis - analyze series of profiles or multiple profiles extracted from the same surface statistically (trend plots, scatter plots, histograms) for process control or to achieve more reliable results.

Contour Analysis

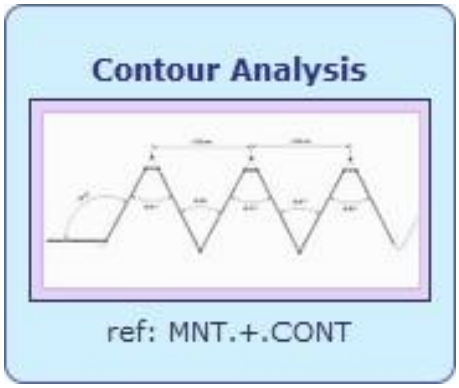


Figure 124. Contour Analysis

All the essential tools for geometric dimensioning & tolerancing of profiles

- **Calculate dimensions of profiles using interactive tools** - calculate dimensions including distances, radii, diameters and angles.
- **Define & display pass/fail criteria with tolerances for any dimension**
- **Save time & increase productivity with automation features** - save your contour analysis steps and reapply them on other profiles

Statistics

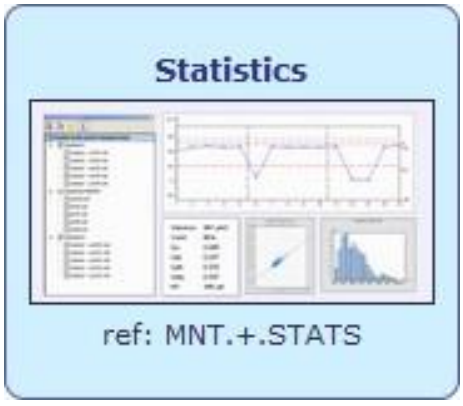


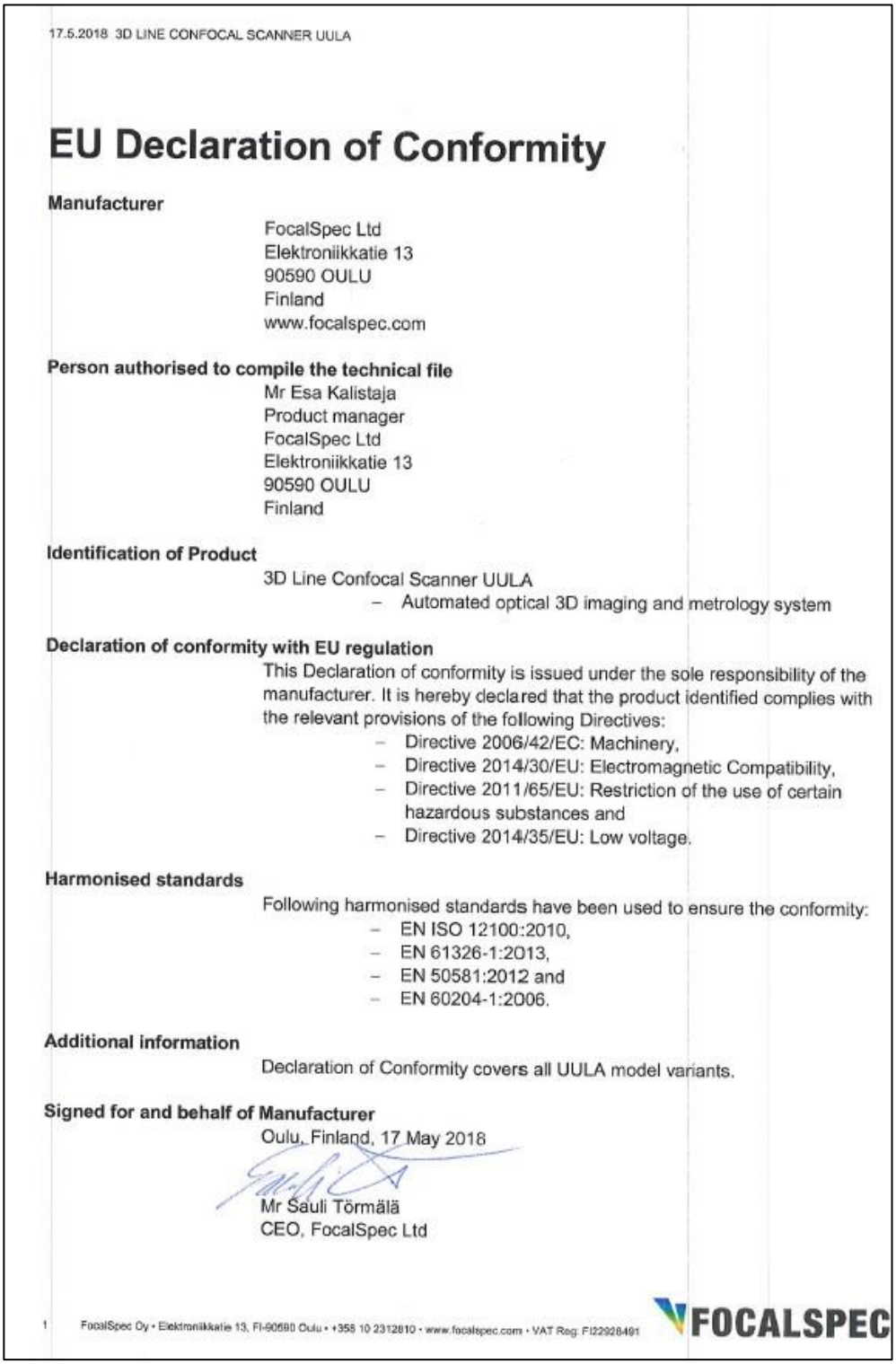
Figure 125. Statistics

Automated easy to use statistics for multiple measurement populations

- **Automated data preparation** – apply a template to analyze each measurement in a population automatically and generate one analysis document per measurement containing all of the parameters for statistical analysis.
- **Multiple populations** - define multiple populations for statistical analysis by simply selecting the analysis documents corresponding to each measurement population or by specifying the folder where they are located - calculate statistics for one or more populations including dimensions (distances, areas, volumes, step heights, angles) and parameters (e.g. ISO 4287 or ISO 25178 parameters).

- **Dynamic and static populations -** declare whether a population is static (all measurements are done) or dynamic (measurements are ongoing) - new measurements in a dynamic population are analyzed automatically and statistics are refreshed to take new data into account.
- **Control your process -** show control charts for an instant picture of whether or not a parameter is out of limits, together with histograms, box plots and scatter plots.
- **Evaluate manufacturing system capability** – calculate capability parameters (Cp, Cpk, Cpkl, NT and ET) to evaluate the capability of the manufacturing system to repeat itself.
- **Data export** – export results to quality management systems in Excel-compatible format.

2.11 Declaration of Conformity



17.5.2018 3D LINE CONFOCAL SCANNER UULA

EU Declaration of Conformity

Manufacturer

FocalSpec Ltd
Elektroniikkatie 13
90590 OULU
Finland
www.focalspec.com

Person authorised to compile the technical file

Mr Esa Kalistaja
Product manager
FocalSpec Ltd
Elektroniikkatie 13
90590 OULU
Finland

Identification of Product

3D Line Confocal Scanner UULA
- Automated optical 3D imaging and metrology system

Declaration of conformity with EU regulation

This Declaration of conformity is issued under the sole responsibility of the manufacturer. It is hereby declared that the product identified complies with the relevant provisions of the following Directives:
- Directive 2006/42/EC: Machinery,
- Directive 2014/30/EU: Electromagnetic Compatibility,
- Directive 2011/65/EU: Restriction of the use of certain hazardous substances and
- Directive 2014/35/EU: Low voltage.

Harmonised standards

Following harmonised standards have been used to ensure the conformity:
- EN ISO 12100:2010,
- EN 61326-1:2013,
- EN 50581:2012 and
- EN 60204-1:2006.

Additional information

Declaration of Conformity covers all UULA model variants.

Signed for and behalf of Manufacturer

Oulu, Finland, 17 May 2018

Mr Sauli Törmälä
CEO, FocalSpec Ltd

1 FocalSpec Oy • Elektroniikkatie 13, FI-90590 Oulu • +358 10 2312810 • www.focalspec.com • VAT Reg: FI22928491 FOCALSPEC

Figure 126. Declaration of Conformity

3. Maintenance and Service

If there are any questions on maintenance and service, please contact LMI by submitting a technical support request through https://support.lmi3d.com (recommended) or by email at support@lmi3d.com.

The system is nearly maintenance-free and does not need daily or weekly maintenance other than keeping the system clean.

3.1 Continuous Maintenance

It is a good practice to monitor the machine operation during daily use. Any abnormal function, movement, smell, sound or incorrect performance should be noted and addressed immediately.

The machine and its surroundings should be kept clean. For safe use the measurement table surroundings must be kept clear of anything that may block the table movement and the table should be kept free of any items not needed in the current measurement work.

3.2 Monthly Maintenance

Monthly maintenance includes visual, mechanical and electrical checking of the machine components and cleaning all surfaces. Monthly service should be recorded in the service log.

Wipe off oil residue on the Z axis rail ends monthly. The rail ends are indicated with arrows, in the figure below:

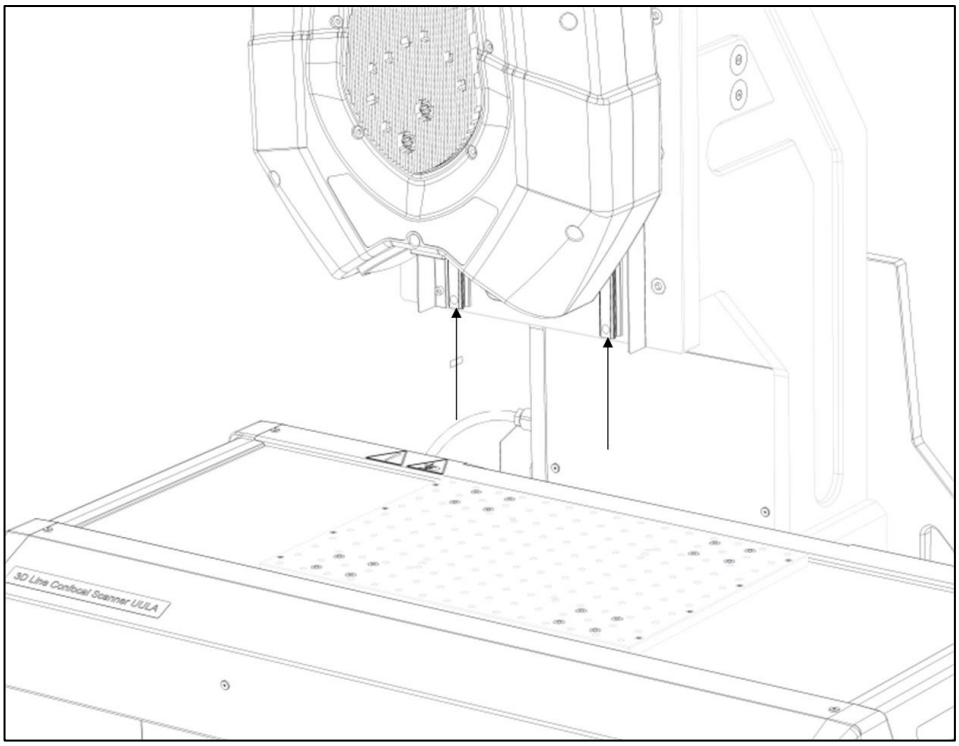


Figure 127. Rail Ends

Note:

Electrical checks involving access to the electrical cabinet must only be performed by a certified electrician.

3.3 Cleaning the Calibration Mirror

This section describes how to clean the calibration mirror.

Occasionally, the calibration mirror may require cleaning. If this is the case, use compressed air to blow away any dust or debris on the calibration mirror. The compressed air must be clean and oil-free; otherwise oil may end up on the calibration mirror.

Caution:

Do not use air flow that is too high.

Important:

Use only oil-free compressed air.

If you wipe the calibration mirror, for example, to remove greasy stains, use a lens-cleaning fluid such as isopropanol.

Proceed as follows:

1. Tip a small amount of isopropanol on a lint-free cloth.
2. Rub the calibration mirror with the cloth in a circular motion to remove the stains.
3. If necessary, use a dry lens cloth to remove residual cleaning fluid.

4 What Is New in the Latest SW Version

What's New in UULA Version 2.3.1

Calibration file saving has been added.

User manual parameter guide has been rearranged and more information on the parameters has been added. Z-compensation Calibration section has been updated.

What's new in UULA version 2.3.0

With version 2.3.0 of the UULA software, it is recommended to use version 290319020 of the motor firmware and version 60818010 of height firmware (in XYZ models only) or newer. The recommended camera firmware version is for LCI401, LCI1200, LCI1201 and LCI1600 sensors is 4.9.1 and for LCI1220 and LCI1620 sensors 1.4.0.

Updated Windows Driver

The device driver is updated for LCI401, LCI1200, LCI1201 and LCI1600 sensors. The update is mandatory for Windows 10 build 2004 and later.

Find Saturation Limit

Maximum LED pulse width without saturation for the current camera signal can be found by pressing ‘Saturation Limit’-button from the Preview Camera Signal view.

Z-compensation (optional)

A strong surface texture may cause edge artifacts in Z values. In order to reduce edge artifacts, the sensor can be calibrated for Z-Compensation. In this case, a Z-compensation block is used and available from LMI as a new UULA accessory.

What's new in UULA version 2.2.0

With version 2.2.0 of the UULA software, it is recommended to use version 290319020 of the motor firmware and version 60818010 of height firmware (in XYZ models only) or newer. The recommended camera firmware version is for LCI401, LCI1200, LCI1201 and LCI1600 sensors is 4.9.1 and for LCI1220 and LCI1620 sensors 1.3.2.

Uula support for sensor LCI1220 and LCI1620

FocalSpec Map not included in installer.

- Focalspec Map / Mountains Map software is recommended analysis tools for Uula scanner. Uula 2.2.0 installation package does not include before mentioned programs, but those need to be installed separately.

Intensity calibration

- User can use any sample for the intensity calibration and intensity compensation is done real-time.

Multiple layers displayed in Camera Preview window.

- Surface selection by top, bottom or brightest.

Simplified peak detection configuration based on material type

- Available material types are Opaque, Mirror and Transparent.

Advanced camera parameters

- Average Z
- Average Intensity
- Median Z
- Median Intensity
- Fill Gap Max
- Trim Edges
- Noise Removal X and Y
- Clustering Distance X and Z
- Minimum Length for Cluster
- Missing First Layer Distance
- Missing First Layer X Distance
- Missing First Layer Min Length
- Use Intensity Calibration
- Surface Mode
- Layer Sorting Order
- Effective Refractive Index
- Max Thickness
- Intensity Type

Height coloring with intensity in Pcd Viewer.

Known issues and problems

- Old recipes, which are using Half Step Scan, need to be saved with Uula 2.2.0 before they are used for scanning.

- If you have LCI1600 or LCI1620, add a paper (such as a Post-it Note) to hide the left side of the groove specimen, see user manual 2.3.2 Calibrating UULA.

- Parameters of old Recipes with Jobs are advised to be checked before scanning. If parameters are not right, it is recommended to recreate the Jobs from the start.

5 Technical Specifications

The specifications are subject to change without notice.

Technical Summary

This manual and the features described within are compatible with the following software and firmware versions:

Table 5: Technical Summary

UULA SW	Version 2.3.1
Camera FW	LCI 401, LCI1200, LCI1201 and LCI 1600: 4.9.1 LCI1220 and LCI1620: 1.4.0
Motor firmware	Version 290319020
Height firmware (in motorized Z models only)	Version 60818010

Technical Specifications

You can check the software and firmware versions from the **About** dialog in the UULA software header.

The technical specifications for the FocalSpec 3D Line Confocal Scanner UULA are presented in the table below:

Table 7: Technical Specifications

UULA scanner	
XY motion system	
X and Y encoder resolution	1 µm (0.0393 mil)
Maximum scanning area (X * Y)	225 mm * 305 mm / 8.86 * 12 inches
Maximum sample height (Z)	200 mm / 7.874 inches
Scanning Path Programming	Configurable scanning area
Electrical	
Power	230/110 VAC
Connectivity	Ethernet LAN RJ45 **Note:** UULA requires its own dedicated Ethernet port. Do not use a switch.
Computer requirement	OS Win 10, 64-bit, RAM min 16 GB
Mechanical	
Scanner weight	120 kg / 265 lbs.
Scanner dimensions (depth*width*height)	600 * 880 * 950 mm / 24 * 34.6 * 37.4 inches
Acquisition software	

Language	EN
FocalSpec Map analysis software	
3D data output	3D point cloud data
3D data format	.sur, .pcd, .bmp, .csv
2D data output	2D intensity data
2D data format	.bmp
Reporting	PDF, RTF, Excel compatibility
Language versions	EN, FR, DE, ES, IT, PL, JP, CN, KR, BR

LCI1200 sensor	
Sensor	High Precision Line Confocal Sensor
Measurement method	Optical
Scanning method	Line
Number of points/line	2048
Optical profile length	11.3 mm
Pixel size X	5.50 µm
Pixel size Y	25.0 µm
Z repeatability	0.11 µm
Stand-off distance	16.16 mm
Depth of field	2.80 mm

LCI1201 sensor	
Sensor	High Precision Line Confocal Sensor
Measurement method	Optical
Scanning method	Line
Number of points/line	2048
Optical profile length	11.5 mm
Pixel size X	5.6 µm
Pixel size Y	10 µm

Z repeatability	0.13 µm
Stand-off distance	20.58 mm
Depth of field	3.00 mm

LCI1600 sensor	
Sensor	High Precision Line Confocal Sensor
Measurement method	Optical
Scanning method	Line
Number of points/line	2048
Optical profile length	16.6 mm
Pixel size X	8.1 µm
Pixel size Y	36.0 µm
Z repeatability	0.24 µm
Stand-off distance	64.0 mm
Depth of field	5.50 mm

LCI401 sensor	
Sensor	High Precision Line Confocal Sensor
Measurement method	Optical
Scanning method	Line
Number of points/line	2048
Optical profile length	4.30 mm
Pixel size X	2.1 µm
Pixel size Y	4.0 µm
Z repeatability	0.11 µm
Stand-off distance	8.0 mm
Depth of field	1.1 mm

Operational conditions	
Ambient temperature	22 °C ± 2 °C (68–75 °F)
Humidity	30–50 %
Environment	Minimum: Class ISO 9 (ISO 14644-1) / Room air (FED STD 209E)

6 Legal and Safety Information

This section contains safety information, a disclaimer and the *UULA End-user License Agreement*.

6.1 Disposal and recycling

At the end of their life cycle, the LCI sensor and UULA scanner can be disposed according to the local recommendations for electronic and metal waste.

6.2 End-User License Agreement

FocalSpec XY Scanner UULA software– LMI Technologies Inc. – English

Acceptance

Please read this document carefully. Before installing this Product, you need to accept the terms of this End-User License Agreement (EULA). By installing or using the FocalSpec XY Scanner UULA software you agree that you have read all of the terms of this EULA and that you fully accept to be bound by these terms.

Definitions

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Contact

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END OF THE END-USER LICENSE AGREEMENT

6.3 Disclaimer

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