

Operating manual



ScanFieldMonitor SFM 2D

LaserDiagnosticsSoftware LDS

IMPORTANT!

READ CAREFULLY BEFORE USE.

KEEP FOR FUTURE USE.

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PRIMES - The Company

PRIMES is a manufacturer of measuring devices for the analysis of laser beams.

These devices are used for the diagnostics of high-power lasers. This ranges from CO₂ lasers to solid-state and fiber lasers to diode lasers and the wavelength ranges from UV to IR.

A wide range of measuring devices is available to determine the following beam parameters:

- Laser power
- Beam dimensions and position of an unfocused beam
- Beam dimensions and position of a focused beam
- Beam quality factor M²

Development, production and calibration of the measuring devices is performed at PRIMES. This guarantees optimum quality, excellent service, and a short reaction time, providing the basis for us to meet all of our customers' requirements quickly and reliably.



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1 Basic safety instructions

Intended use

The device has been designed exclusively for measurements within the beam of high-power lasers.

Use for any other purpose is considered as not intended and is strictly prohibited. Furthermore, intended use requires that all information, instructions, safety notes and warning messages in this operating manual are observed. The specifications given in chapter 14 „Technical data“ on page 48 apply. Any given limit values must be complied with.

If not used as intended, the device or the system in which the device is installed can be damaged or destroyed. In addition, there is an increased risk to health and life. Only use the device in such a way that there is no risk of injury.

This operating manual is an integral part of the device and must be kept in the immediate vicinity of the place of use, accessible to personnel at all times.

Every person who is responsible for the installation, start-up or operation of the device must have read and understood the operating manual and, in particular, the safety instructions.

If you still have questions after reading this operating manual, please contact PRIMES or your supplier for your own safety.

Observing applicable safety regulations

Observe the safety-relevant laws, guidelines, standards and regulations in the current editions published by the state, standardization organizations, professional associations, etc. In particular, observe the regulations on laser safety and comply with their requirements.

Necessary safety measures

The device measures direct laser radiation, but does not emit any radiation itself.

However, during the measurement the laser beam is directed at the device. This produces scattered or directed reflection of the laser beam (laser class 4). The reflected beam is usually not visible.

Protect yourself from direct and reflected laser radiation while working with the device by taking the following measures:

- Never leave the device unattended when taking measurements.
- Wear **safety goggles** adapted to the power, power density, laser wavelength and operating mode of the laser beam source in use.
- Wear suitable **protective clothing** or **protective gloves** if necessary.
- If possible, also protect yourself from direct laser radiation and scattered radiation by using separating protective devices that block or attenuate the radiation.
- If the device is moved from its aligned position, increased scattered or directed reflection of the laser beam occurs during measuring operation. Mount the device in such a way that it cannot be moved unintentionally, i.e. by bumping or pulling the cables.
- Install safety switches or emergency safety mechanisms that allow the laser to be switched off immediately.
- Use suitable beam guidance and beam absorber elements which do not emit any hazardous substances when irradiated.

Employing qualified personnel

The device may only be operated by qualified personnel. The qualified personnel must have been instructed in the installation and operation of the device and must have a basic understanding of working with high-power lasers, beam guiding systems and focusing units.

Conversions and modifications

The device may not be modified in terms of design or safety without the explicit consent of the manufacturer. The same applies to unauthorized opening, dismantling and repair. The removal of covers is only permitted within the scope of the intended use.

Liability disclaimer

Manufacturer and distributor exclude any liability for damages and injuries which are direct or indirect consequences of using the device not as intended or modifying the device or the associated software without authorization.

2 Symbols and conventions

Warning messages

The following symbols and signal words indicate possible residual risks in the form of warnings:



DANGER

Means that death or serious physical injuries **will** occur if necessary safety precautions are not taken.



WARNING

Means that death or serious physical injuries **may** occur if necessary safety precautions are not taken.



CAUTION

Means that minor physical injuries **may** occur if necessary safety precautions are not taken.

NOTICE

Means that property damage **may** occur if necessary safety precautions are not taken.

Product safety labels

The following symbols are used on the device itself to indicate imperatives and possible dangers:



Read and understand the operating manual before using the device!



Labeling according to WEEE directive:

The device must not be disposed of with household waste, but in a separate WEEE collection in an environmentally friendly way.

Further symbols and conventions in this operating manual



Here you can find useful information and helpful tips.

- ▶ Indicates a single instruction. If several of these instructions appear one below the other, the order in which they are executed is irrelevant or they represent alternative courses of action.
- 1.
2.
...
▶ A numbered list identifies a sequence of instructions that must be executed in the specified order.
- ▶ Indicates the result of an action to explain processes that take place in the background.
-  Indicates an observation prompt to draw attention to visible feedback from the device or the software. Observation prompts make it easier to check whether an instruction was executed successfully. Often they also guide to the next instruction.
-  Points to a control element that is to be pressed / clicked.
-  Points to an element described in the text (for example an input field).

3 Transport and storage

Warning messages

NOTICE

Damage/Destruction of the device

Hard hits or falls may damage the device.

- ▶ Handle the device carefully when transporting it.

Shipping the device

If the power bank is enclosed with the SFM 2D, the power bank is to be considered as hazardous good.

- ▶ Please observe the valid regulations for shipping.

Particularly in case of a damaged battery, special regulations must be observed:

Damaged batteries can cause fire! These batteries must be checked by qualified personnel and, if necessary, sorted out or repacked!

Battery details for shipping:

Cell/battery type: Lithium Ion

Cell or battery: Battery

LC or Wh rating: 73 Wh

Cell/battery weight: 515 g

UN-Classification: UN 3481: Lithium ion batteries contained with equipment

Storing the power bank

Store the power bank in a cool, dry place. Keep a minimum distance of 3 m from combustible materials. Do not expose the device to direct sunlight.

Check the battery charge level at least once every three months; it should be between 30% and 70%.

4 About this operating manual

This manual describes the installation and operation of the ScanFieldMonitor SFM 2D and how to perform measurements using the LaserDiagnosticsSoftware LDS version 4.2.1 or higher

The abbreviations SFM 2D and LDS are used in this operating manual.

For measurement operation the LDS included in the package must be installed on a PC.

This manual includes a brief introduction on using the LDS for measurements. For a detailed description refer to the separate LDS manual or the built-in online help.



This operating manual describes the software version valid at the time of writing.
Check whether a newer version is available using the QR code or at
www.primes.de/en/support/downloads/software.



5 Device description

5.1 Scope of delivery and optional accessories

The scope of delivery includes:

- SFM 2D
- PRIMES USB flash drive
- USB cable (A to C connector)
- Alignment tool cover
- Bellows
- Screwdriver TX 6
- Transport and storage case

The following accessories are optional:

- Power bank

5.2 Functional description

The SFM 2D meets the demands of scanner specific measuring tasks, including aspects such as surface evenness, pincushion distortion, focal point shift, or precision of the position and marking speed.

The device operates by detecting the scattered laser light on a structured glass plate and is therefore independent of the optical power.

The measuring principle allows to reconstruct the travel path taken by the light and calculate the beam width at multiple positions across the working area. All of the variables mentioned above can be measured with high resolution and reproducibility.

Complex relations such as pincushion distortion, the merging of overlapping scanning fields, and delays in laser activation and deactivation can be analyzed using special measuring schemes. This can be used to synchronize the laser with its scan unit. Using the 3D machine construction platform to move along the z-axis makes it possible to measure the caustic and determine the evenness of the scanning plane.

5.3 Measuring principle

The general SFM 2D measurement principle is based on a glass plate with a small scattering structure embedded in its center. As the laser beam passes over the scattering structures, a portion of the laser light is scattered and detected by a photodiode as a time signal ("Time Track"). The LDS evaluates this signal and uses it to calculate the following parameters:

- Beam radius along the vector's scan direction
- Scan speed
- Vector position (start and end points, angle, and length)

Unlike the standard SFM, which has a single central scattering structure, the SFM 2D is equipped with a 15 x 15 matrix of these structures. These are evenly distributed across the entire measurement area and enable highly efficient characterization of the measurement field without physically moving the device.

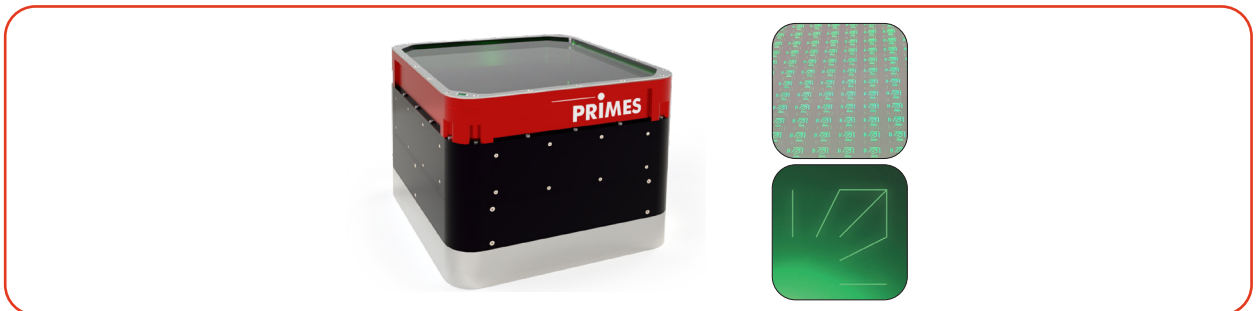


Fig. 5.1: SFM 2D

To measure the caustics of the laser beam along the direction of beam propagation, the SFM 2D must be raised or lowered along the z-axis of the system being measured. By moving the SFM 2D in the z-direction, beam diameters can be measured in different planes. This provides all the important propagation parameters of the entire caustic of the laser beam:

- Focus Position and Focus Diameter
- Diffraction Measure M^2
- Rayleigh Length z_R
- Divergence and Angle of Incidence

both centrally and peripherally within the measurement field. By analyzing all measurements, one can also obtain derived parameters, such as the focus position across the entire processing field.

In addition, a separate measurement mode allows for the measurement of the laser's turn-on and turn-off delays.

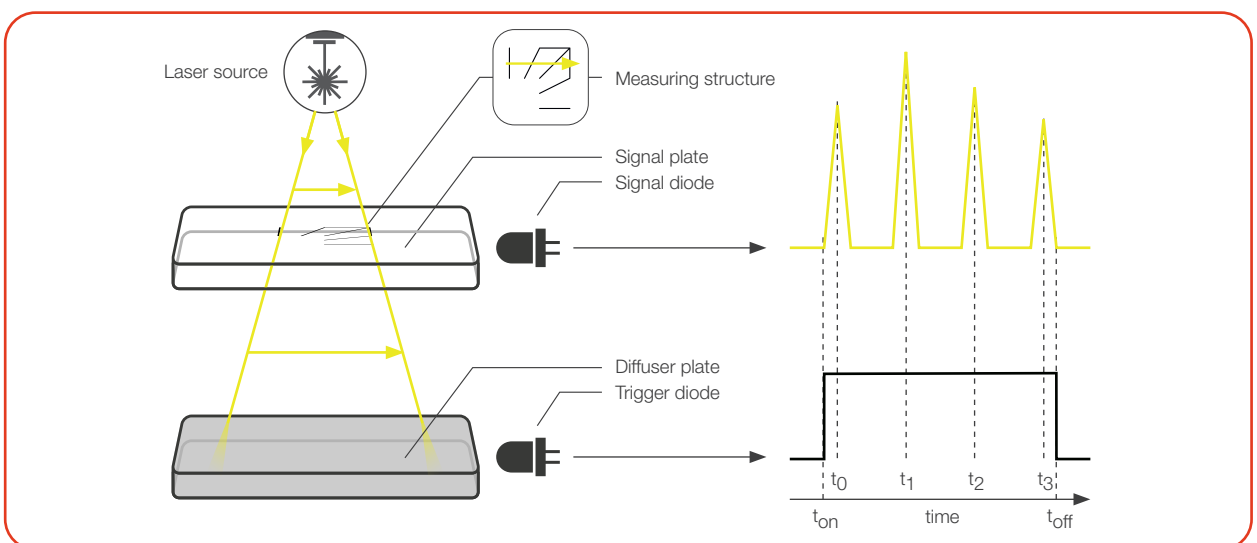


Fig. 5.2: Measuring principle of the SFM 2D

6 Connection

6.1 Power supply



Please note that the SFM 2D is switched off when the USB cable is pulled out.

The SFM 2D features a USB-C port that is used to power the SFM 2D.

The SFM 2D starts up automatically when the USB cable is plugged in.

Please use only the supplied power bank and connection cables.

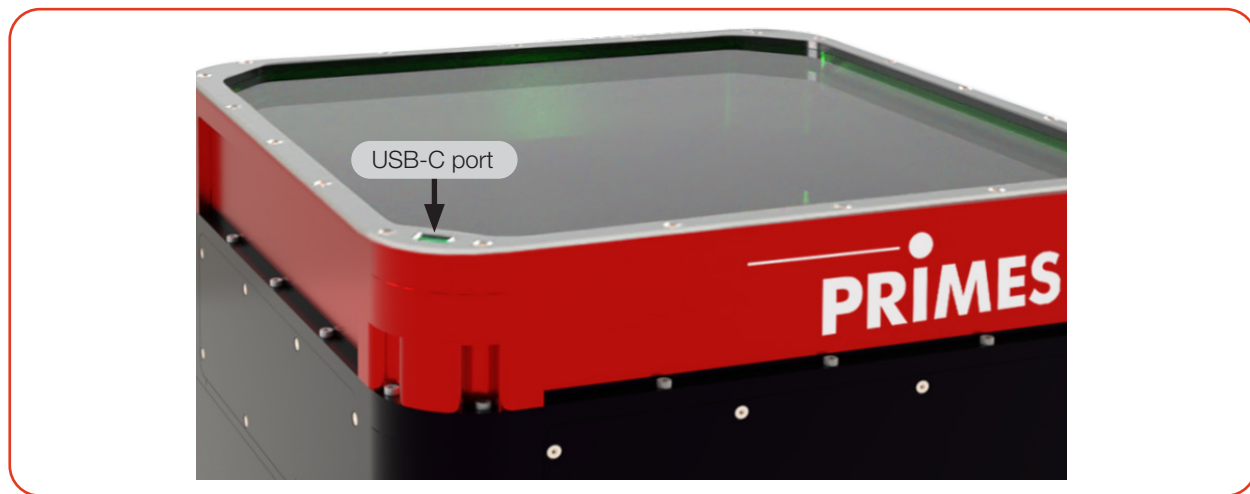


Fig. 6.1: USB-C port

Charge the power bank

Connect a compatible charger to a power bank's USB port. Do not charge the power bank using a laptop's or computer's USB port. PC ports usually provide too little power for large batteries and significantly increase the charging time.

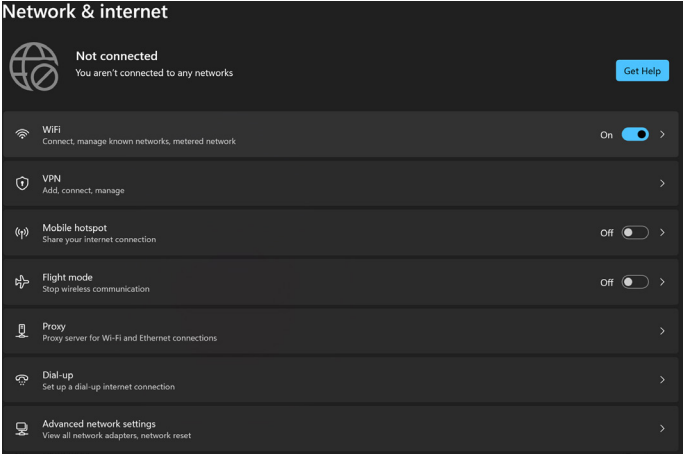
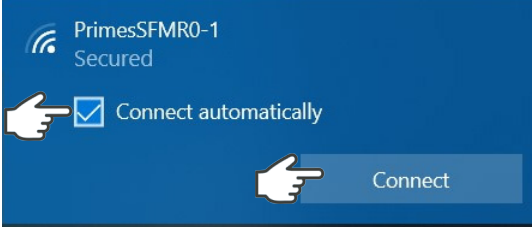
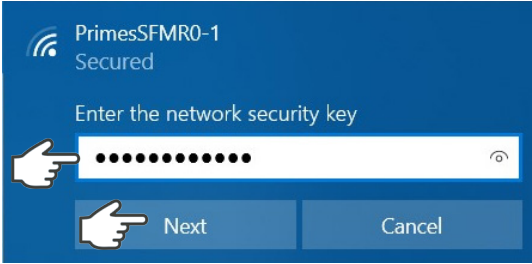
- Charge accumulators only under supervision and on a heat-resistant surface.
- Explosion hazard near open flames.
- Never open rechargeable batteries.
- Never allow rechargeable batteries to come into contact with liquids.
- Never short-circuit or bring rechargeable batteries into contact with metal

Dangers to health and the environment in the event of damage to the power bank

In general, contact with leaked power bank components may pose a risk to health and the environment:

- When the power bank is damaged, fluids (electrolytes) may leak out. These are flammable, contact with the eyes or skin may cause irritation.
- Vapors may irritate the eyes, respiratory organs, and skin.
- Fire or intense heat may cause violent bursting. Heating or fire may release toxic gases. Burning produces irritating smoke.

6.2 Connect to a PC via Wi-Fi

<div>1. Switch on the SFM 2D.</div> <div>2. Open the WiFi menu on the PC via Start > Settings > Network & internet.</div> <div> The Network & Internet settings window opens.</div> <div>3. Set the WiFi switch to the On position.</div> <div>4. Click on WiFi.</div> <div>5. Click on Show available networks.</div> <div>6. Click on the desired device. In this example: PrimesSFMRO-1:</div> <div><ul style="list-style-type: none">The designation corresponds to the SSID specification on the identification plate.</div>	
<div>7. Click on the Connect button.</div> <div> Activate the check box Connect automatically, if you want the SFM 2D to connect to the PC automatically the next time.</div>	
<div>8. Enter the password:</div> <div><ul style="list-style-type: none">The password is on the identification plate.A user specific password can also be set, see chapter 9.2.4 „Change password“ on page 20</div> <div>9. Click on the Next button:</div> <div> The SFM 2D is connected to the PC.</div>	
<div>10. To disconnect the WiFi connection, click on the Disconnect button.</div>	

7 Mounting

7.1 Prepare installation

NOTICE

Damage/Destruction of the device

Powder residues or contamination on the device lead to burn-in during measuring operation. Burn-ins disturb the measurement and can cause the protective window to shatter or splinter. The movement of the coater (scraper) can damage the SFM 2D.

- ▶ Only operate the device in a cleaned laser system.
- ▶ Deactivate or remove the coater (scraper).

1. Turn the laser source off.
2. Ensure that moving parts are at a standstill and that they cannot be set in motion unintentionally.
3. The overall height of the SFM 2D, including the protective window, is 161 mm. To prevent collisions, ensure there is sufficient clearance above the build platform.
4. Clean the build platform of the laser system. There must be no powder residues and contamination left on the build platform.
5. Deactivate or remove the coater (scraper).

Preheating and Inert Gas



It is recommended to disable the inert gas supply. This minimizes wait times during device alignment, as it eliminates the need for lengthy purging cycles.

- The system's preheating function must be turned off.
- The temperature of the build platform must be less than 30 °C.

7.2 Installation position



Since the laser beam is emitted downward from the device during measurement, a suitable surface, such as the base plate of the LPBF system, must be used.

The SFM 2D is mounted upright on the build platform.

7.2.1 Alignment to the laser beam

The SFM 2D is installed vertically and must be aligned to the laser beam. The SFM 2D is positioned in the focal plane. Make sure that the allowed power density at the beam entrance/protective window and in the area of the measuring structure is not exceeded.

- In the first step, the SFM 2D is positioned in the focal plane.
- The measurement structure is located approximately 109.3 mm (Tool Center Point, TCP) above the mounting surface/base plate; the SFM 2D must be lowered by this amount.
- The square entrance aperture measures 225 mm x 225 mm. The scattering patterns within, measures 7.5 mm x 7.5 mm.
- During the measurement, the laser must scan a scattering structure pattern in a straight line at a constant speed.

Vectors and Geometry

- Use a standard vector length of 10 mm. Note that the main point of the structure (x/y; 0/0) is not symmetrical within the scattering element (see Fig. 7.1).
- PRIMES recommends 4 vectors in the x, -x, y, and -y orientations for each scattering structure.
- Using the pilot laser is recommended for quick positioning of the vectors.

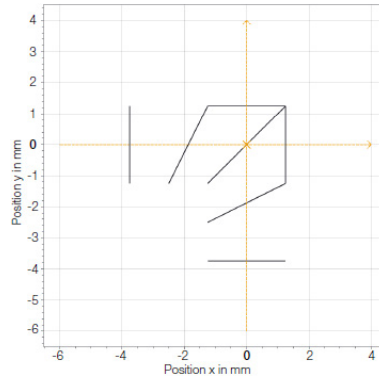


Fig. 7.1: Vectors over a scattering structure

7.2.2 Aligning the SFM 2D using the alignment tool

NOTICE

Damage/destruction of the alignment tool

The exposure with laser radiation will destroy the alignment tool.

- Remove the alignment tool before turning on the laser.

Using the alignment tool and a pilot laser beam you can align the device to the laser beam.

1. Insert the SFM 2D into the build platform.
2. Place the alignment tool on the SFM 2D.
3. Turn on the pilot laser and align the SFM 2D.
4. Draw a large cross over the SFM 2D and align the device precisely with the arrows in the center and at the edge.

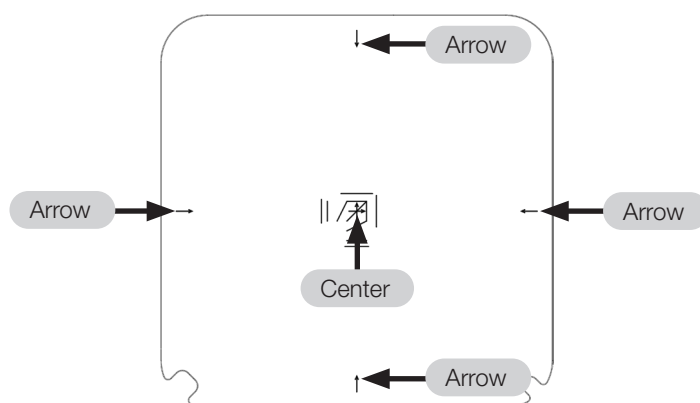


Fig. 7.2: Alignment tool

7.2.3 Preparation and Programming of the Vectors

The plant operator must program the required construction jobs for the measurement process.

Delay Time Measurement

To determine the laser's power-on and power-off behavior (power-on and power-off delay), prepare a job with identical vectors at the following speed levels:

- 0,01 m/s
- 0,5 m/s
- 1,0 m/s
- 2,0 m/s
- Maximum process speed

7.2.4 Caustic Measurement

To measure beam propagation, either the system's z-axis must be movable or a z-shifter must be available.



Under no circumstances should the coater be moved while the platform is in operation! There is a serious risk of damage to the device and the system.

Recommended Workflow

1. Aligning the SFM 2D, see chapter 7.2.2 „Aligning the SFM 2D using the alignment tool“ on page 15.
2. Take an initial measurement at the center of the field.
- Reduce the offset/angle.
3. 3 x 3 structures in the center: Detailed inspection of the central area. Fine-tuning to prevent damage to the edges.
4. Full-frame: Final validation of field homogeneity across the relevant measurement field.
The SFM 2D is intended for targeted measurements in edge areas, which requires precise knowledge of and setup for the system and its controls.

9-Point Quick Check

Practical experience has shown that it is advantageous to work with only 9 measurement points instead of 13 x 13 or 15 x 15. Especially with uncalibrated scanners or when the initial state is unclear, this approach is initially more efficient than full-frame measurement. Not doing so with uncalibrated scanners may result in damage or destruction of the SFM 2D. The 9 measurement points now comprise a 3 x 3 array:

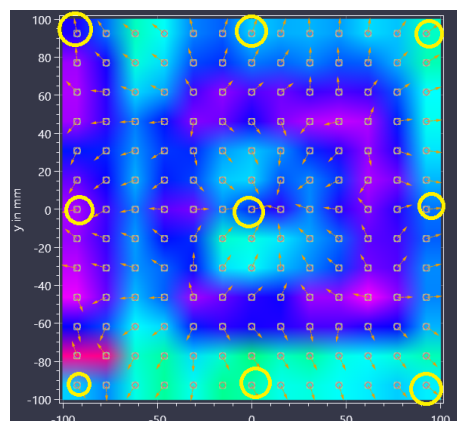


Fig. 7.3: 9-Point Quick Check

8 Software installation

8.1 Install LDS

1. Please ensure:
 - System requirements are met.
 - You have administrator rights.
 2. Close all programs on your PC.
 3. Insert the PRIMES USB flash drive into your PC and open the directory.
 4. Double-click the **LDS_Setup.exe** file to start the installation.
 5. Follow the instructions on the screen.
- ➔ The default storage location is:
C:\Programs\Primes\LaserDiagnosticsSoftware.

System requirements:

- Intel Pentium Core i3 or better
- Windows 10/11 (64-bit version)
- At least 4 GB RAM; 8 GB RAM recommended
- Display resolution: Full HD (1 920 x 1 080)
- Wi-Fi

9 Measuring

9.1 Warning messages



DANGER

Serious eye or skin injury due to laser radiation

During the measurement the laser beam is guided on the device. This causes scattered or directed reflection of the laser beam (laser class 4). The reflected beam is usually not visible. The device must not be operated without taking the following precautions:

- ▶ Wear **safety goggles** adapted to the power, power density, laser wavelength and operating mode of the laser beam source in use.
- ▶ Wear suitable **protective clothing** and **protective gloves**.
- ▶ Protect yourself from laser radiation by separating protective devices (e.g. by using appropriate shielding).



DANGER

Serious eye or skin injury due to laser radiation

If the device is moved from its aligned position, increased scattered or directed reflection of the laser beam occurs during measuring operation (laser class 4).

- ▶ Mount the device so that it cannot be moved by an unintended push or a pull on the cables or hoses.



DANGER

Fire hazard

If the power bank is damaged by the laser beam, it may catch fire.

- ▶ Before measuring, check that the power bank is not positioned in the beam path of the laser.

NOTICE

Damaging/Destruction of the device

The alignment tool will be destroyed by laser radiation.

- ▶ Remove the alignment tool before switching on the laser.

NOTICE

Damage/Destruction of the protective window

Contamination and fingerprints on the protective window can lead to damage or shattering or splintering of the protective window during measuring operation.

- ▶ Do not touch the protective window.
- ▶ Only operate the device with a clean protective window.

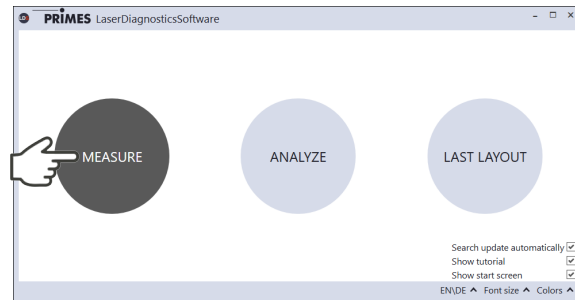
9.2 Measuring with the LDS

9.2.1 Connect the SFM 2D with the LDS

1. Observe chapter 9.1 „Warning messages“ on page 18
2. Switch on the SFM 2D.
3. Connect the SFM 2D via Wi-Fi with a PC (see chapter 6.2 „Connect to a PC via Wi-Fi“ on page 13) .
4. Start the LDS by double-clicking on the program icon .

 The start screen is displayed.

5. Select the operating mode **Measure**.

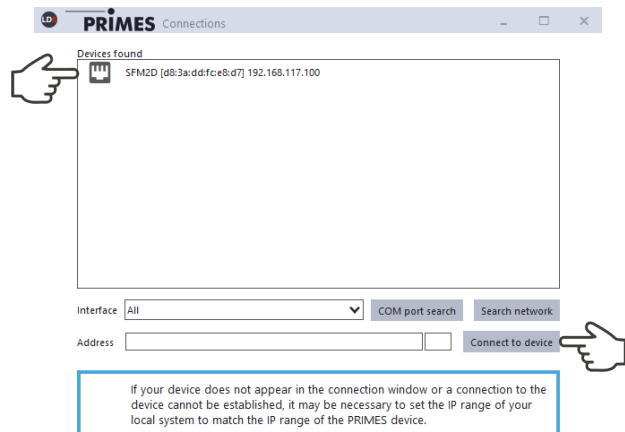


 The **Connections** window is displayed.

6. Click on the desired SFM 2D.
7. Click the **Connect to device** button.

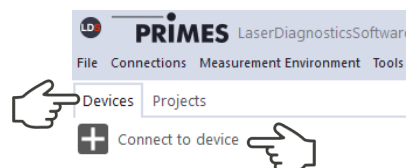
If the SFM 2D does not appear:

- Check chapter 10.2 „Connection failures and other errors“ on page 43.



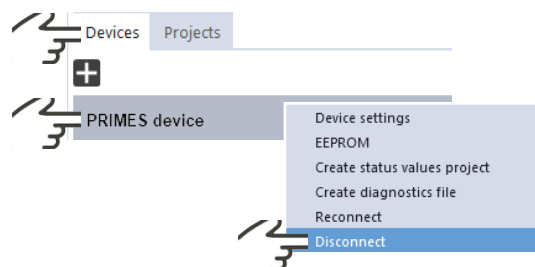
If the **Show start screen** option is disabled or the window **Connections** is closed:

- Click the **Devices** tab and then the **+ Connect to device** button.



9.2.2 Disconnect the SFM 2D from the LDS

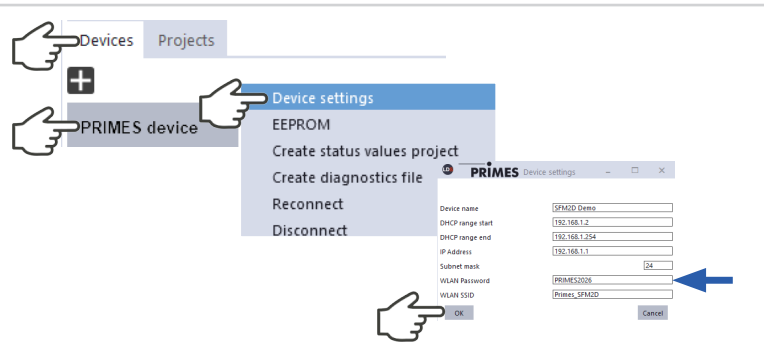
1. Click the **Devices** tab.
 2. Right-click the SFM 2D and select **Disconnect**.
- The SFM 2D is disconnected from the LDS.



9.2.3 Change password

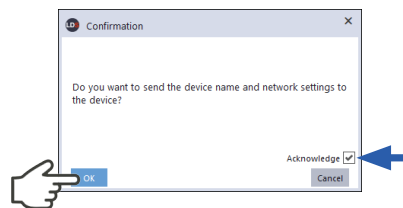
Change the password of a device as follows:

1. Click on the **Devices** tab.
2. Right-click on the PRIMES device and select the **Device settings** menu.
3. Enter the desired password in the **WLAN Password** input field.
4. Confirm the entry with **OK**.



👁 The **Confirmation** window appears.

5. In the **Confirmation** window, place a check mark at **Acknowledge** and click **OK**.
6. Power cycle the device.



9.3 Preparing measurement readiness

1. Observe the warning messages according to chapter 9.1 „Warning messages“ on page 18.
 2. Connect the device to the power supply.
- 👁 Have all protective covers been removed?
- ➔ The SFM 2D is ready for measurement.

9.4 General procedure for measuring

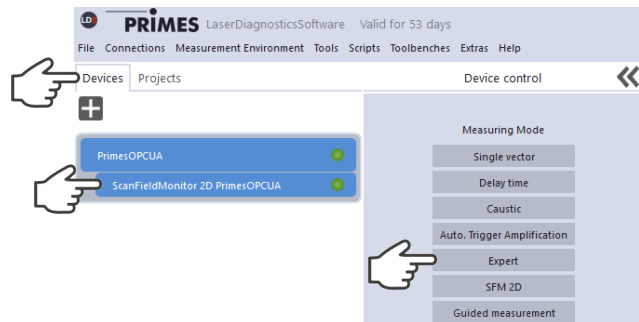
This chapter contains general information about the LDS, regardless of the specific measuring task. Read this general information before turning to the following chapters on the various measurement modes.

9.4.1 Open the Device control menu

Immediately after connecting the device, open the **Device control** menu:

1. Click on the **Devices** tab.
2. Click on **SFM 2D**.
3. Click on the required measurement mode.

👁 The **Device control** menu with the measuring modes is opened.

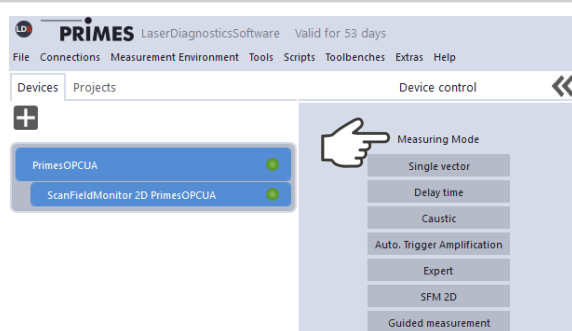


9.4.2 Open a measuring mode

The desired measuring mode is selected in the **Device control** menu. The following measuring modes are available:

- **Single vector** (see chapter 9.6 „Single vector“ on page 23)
- **Delay time** (see chapter 9.7 „Delay time“ on page 27)
- **Caustic** (see chapter 9.8 „Caustic“ on page 30)
- **Auto Trigger Amplification** (see chapter 9.9 „Auto Trigger Amplification“ on page 35)
- **Expert** (see chapter 9.10 „Expert (Basic settings for all measuring modes)“ on page 37)
- **SFM 2D** (see chapter 9.11 „SFM 2D“ on page 38)
- **Guided measurement** (see chapter 9.12 „Guided measurement“ on page 39)

- After selecting a measuring mode for the first time, you can switch to another measuring mode at any time using the drop-down list in the upper section of the **Device control** menu, e.g. from **Expert** to **Single vector**.



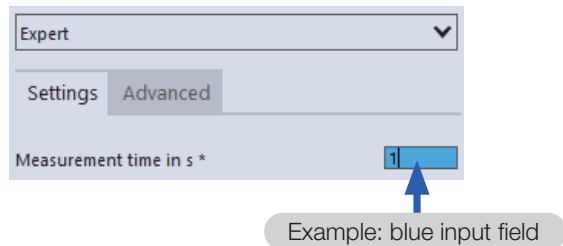
9.5 Settings that apply to all measurement modes

When configuring a measurement mode, please note that some parameters are also transferred to other measurement modes. If, for example, parameter entries are made in **Expert** measuring mode, these are automatically transferred to all other measurement modes.

9.5.1 Enter parameters and activate

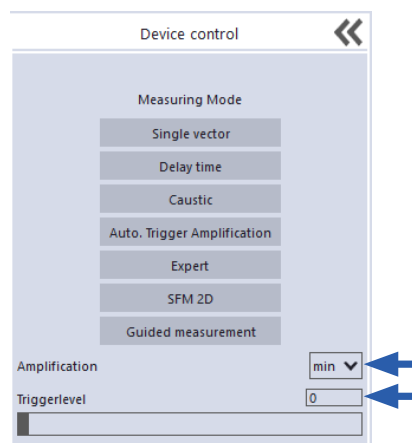
Transfer an entered parameter value with the Enter key:

1. Enter the desired value in the input field.
- 👁 The background color of the input field changes to blue.
2. Confirm the entry by pressing the Enter key.
- 👁 The field returns to its original background color.



9.5.2 Configuring the settings

1. Choose an Amplification:
 - The signal amplification is designed to avoid overdriving the detector and to reduce the measured signal amplitude.
 - ▶ min: > 1.000 W laser power
 - ▶ mid: 100 - 1.000 W laser power
 - ▶ max: 10 - 100 W laser power
2. Enter a Trigger level.
 - The trigger level depends on the laser power and the angle of incidence, i.e. on the position of the SFM 2D within the scan field. PRIMES recommends initially setting the trigger level to 0.



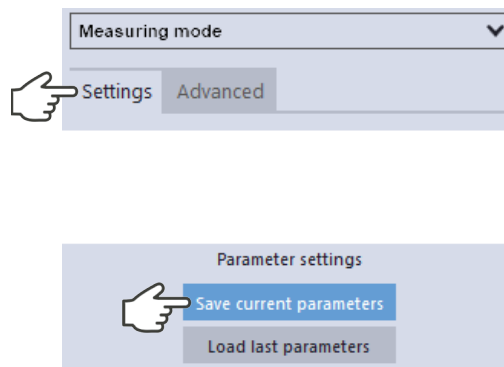
9.5.3 Saving options

When saving/loading a configuration, note that the command is called in a certain measurement mode, but the saved/loaded data set also includes the settings of the other measurement modes.

Save data with asterisk (*) on the PC:

All data marked with an asterisk in the **Device control** menu can be saved to a preset file with the extension **.pre** on the PC. The storage is made device-related in the local installation of the LDS.

1. Click on the **Settings** tab.
2. Use one of the following options:
 - ▶ Click the **Save current parameters** button to save the settings of the connected device.
 - ▶ Click on the **Load last parameters** button to load the last saved settings.



9.6 Single vector

Measurement mode for measuring at a single position within exactly one measurement structure.

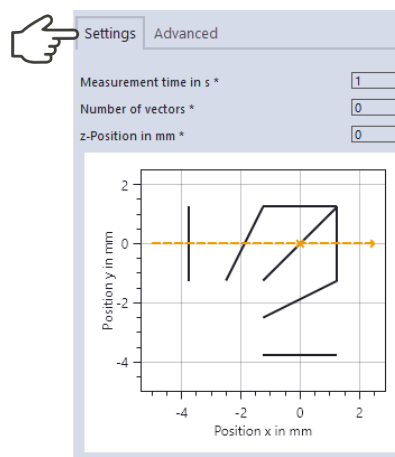
Please note that some settings are set in the **Expert** menu according to chapter 9.10 „Expert (Basic settings for all measuring modes)“ on page 37.

9.6.1 Configuring the settings

1. Click on the **Settings** tab.
2. Enter the **Measurement time in s**.
3. Enter the **Number of vectors**.
4. Enter the **z-Position in mm** according to your machine coordinate system.

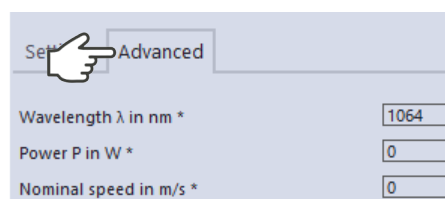
Vector direction

The vector direction of the measured beams is automatically detected. Thus, beams can be measured in all directions (x, y, -x, -y) simultaneously.



9.6.2 Configuring the advanced settings

1. Click on the **Advanced** tab.
- Specifications of the laser**
2. Enter the **Wavelength in nm** of the currently used Laser.
 3. Enter the **Power P in W** during your measurement.
 4. Enter the **Nominal speed in m/s** during your measurement.



9.6.3 Starting a measurement

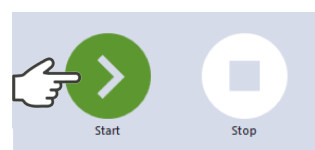
1. Follow the safety instructions in chapter 9.1 on page 18.
2. Click on the **Start** button:
3. Switch on the laser / start marking a vector.

Measurement is running

The measurement is performed with the selected measurement time.

Measurement is finished

The measurement is finished.



Status

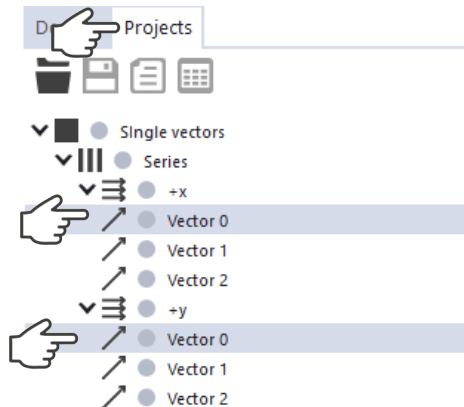
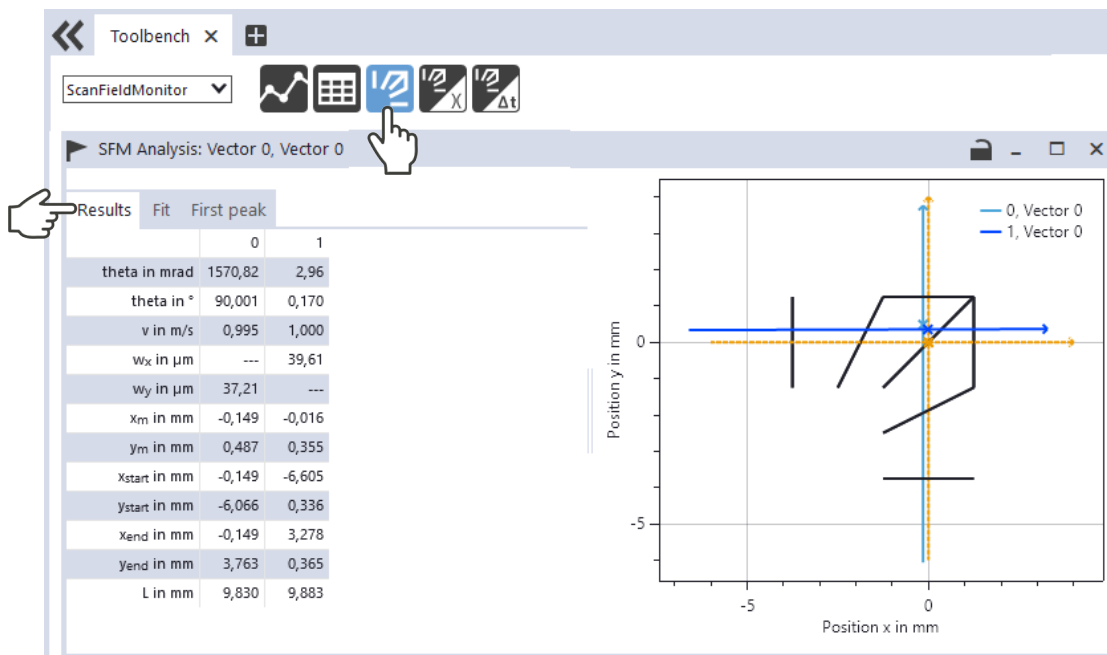
- Ready for measurement
- Measurement is running
- Measurement finished

9.6.4 Displaying measurement result

1. Click on the **Projects** tab:
 - All measurements are listed in the file structure.
 - ▶ For information on project management, please refer to the separate LDS operating manual.
2. Right-click on the measurement or measurements to be displayed.
3. Click on the selection **Show**:
 - The selected measurement is displayed in the **SFM Analysis** tool.

As an alternative, you can click on the **SFM Analysis** tool in the toolbench.

4. Drag and drop one or more selected vectors into the **SFM Analysis** tool.
- In the **Results** tab, the measured values and the vector direction are displayed.

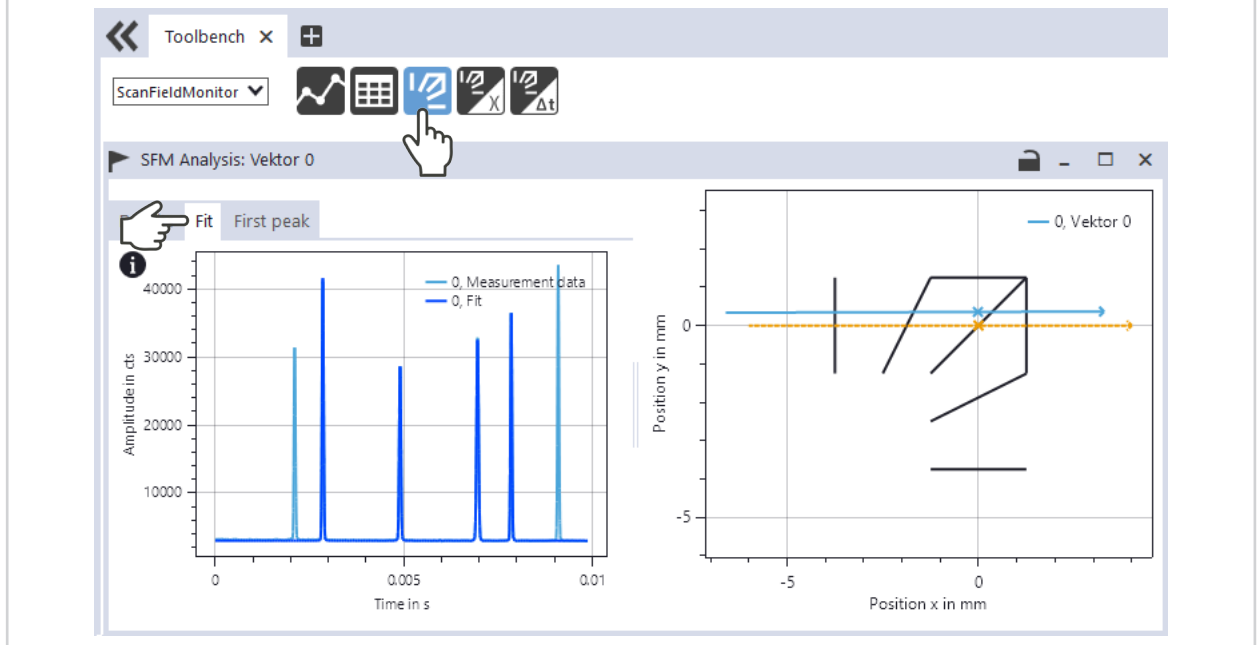


The vector direction of the measured beams is automatically detected.

Thus, beams can be measured in all directions (x, y, -x, -y) simultaneously.

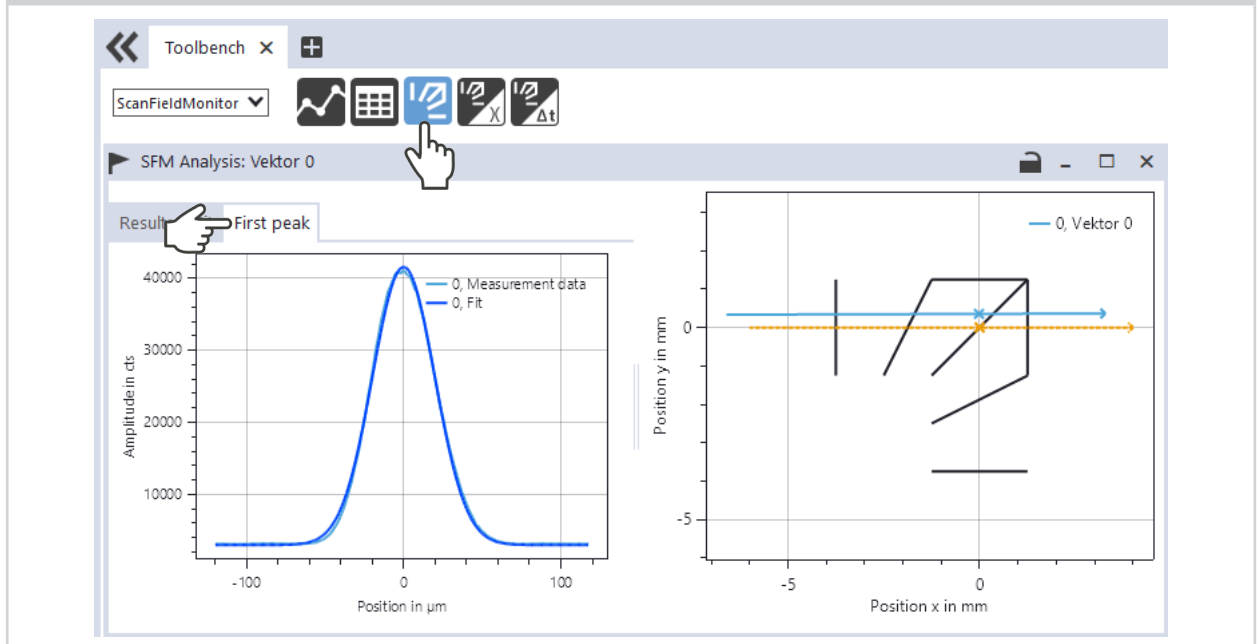
5. Click on the **Fit** tab.

- The first and last light blue peaks are used to determine the vector direction.



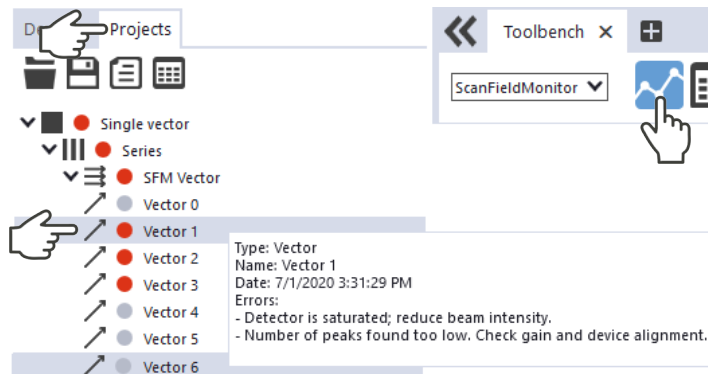
6. Click on the **First peak** tab:

- Here are more details about the first peak.
- The Gaussian fit over the first peak is the basis for the measured value w_x/w_y .

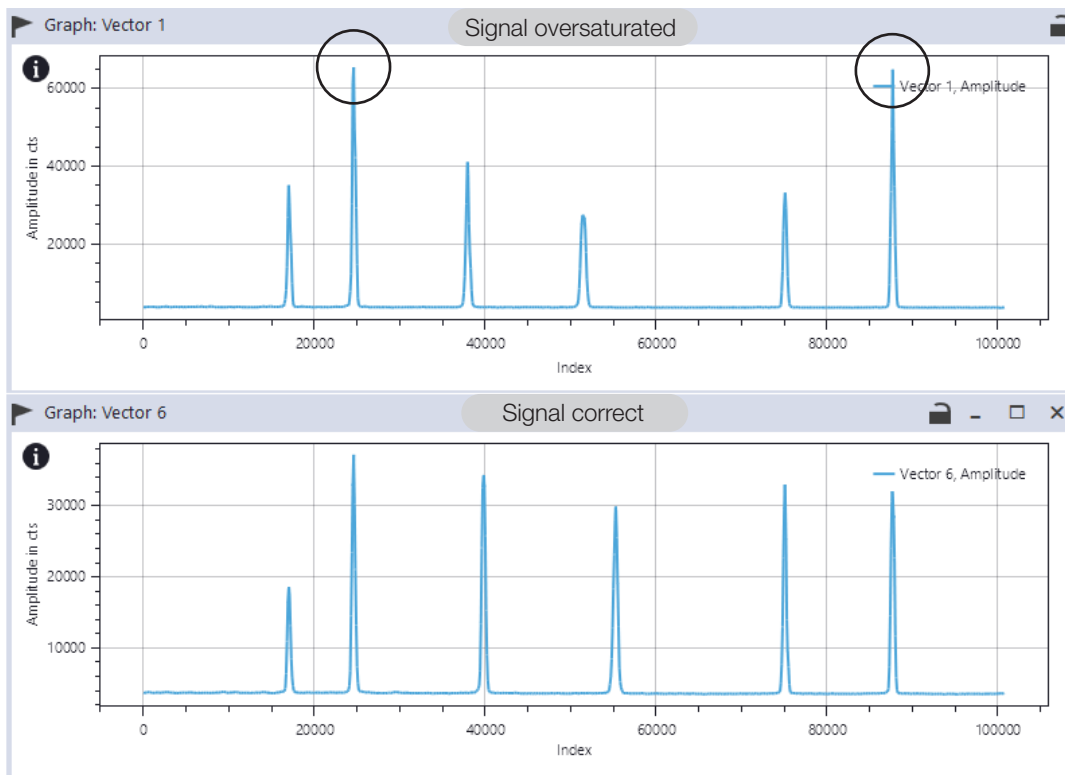


9.6.5 Displaying measurement errors in the LDS

1. Click on the **Projects** tab:
 - ➔ All measurements are listed in the file structure.
 - If the point in front of the measured vector is red, this indicates an incorrect measurement.
2. Position the mouse over the red dot:
 - ➔ An information about the measurement error is displayed.
 - In the example shown, the measurement is invalid due to an overload of the signal.
 - Looking at the raw measurement data can provide a clue for the cause of the error.



3. Click on the **Graph** tool.
4. Drag and drop the measurement result from the project tree into the **Graph** tool:
 - Check if all six peaks are visible and no peaks overlap or are cut off. If a peak exceeds 65535 cts, the signal is considered oversaturated
 - You can estimate the level of the necessary adjustment of the signal amplification on basis of the amplitudes.
5. Set the **Amplification** in the menu **Device control > Settings** (see chapter 9.6.1 on page 23).



9.7 Delay time

Measurement mode to synchronize the laser's on and off times with the scanner.

Please note that some settings are set in the **Expert** menu according to chapter 9.10 „Expert (Basic settings for all measuring modes)“ on page 37.

9.7.1 Procedure for measuring the delay time

The following overview gives a short description of the procedure. This can also be found in the LDS in the menu **Delay time > Device control > Settings: Instructions**.

Programming of vectors

- At a single measurement position, several vectors are measured; these have identical lengths, orientations, and delay settings, but differ in their velocities.
- For a reliable analysis at least five different marking speeds should be measured.
- It is possible to increase the overall statistical significance of the measurement result by repeating vectors.
- The vectors (different marking speeds and repetitions) can be measured separately or in one measurement sequence.
- Measuring in a plane close to the focal plane is recommended but not strictly necessary.

LDS settings

- The measurement duration must be longer than the sequence's marking time.
- Check positioning and photo diode gain with a single test measurement.
- For further analysis enter wavelength λ , laser power P and plane position z and the measurement position on the building platform.
- Start measurement.
- For analysis all vectors belonging to the delay time measurement must be saved in the same measurement sequence.

Data analysis in the LDS

- Open measurement sequence with the SFM Delay Time tool.

9.7.2 Configuring the settings

For a delay time measurement, several identical vectors with different speeds must be written.

Instructions

Click on **Instructions** to view information about the measurement.

1. Click on the **Settings** tab.
2. Enter the **Measurement time in s**.
 - The measurement duration must be longer than the sequence's marking time.
3. Enter **z-Position in mm** according to your machine coordinate system.

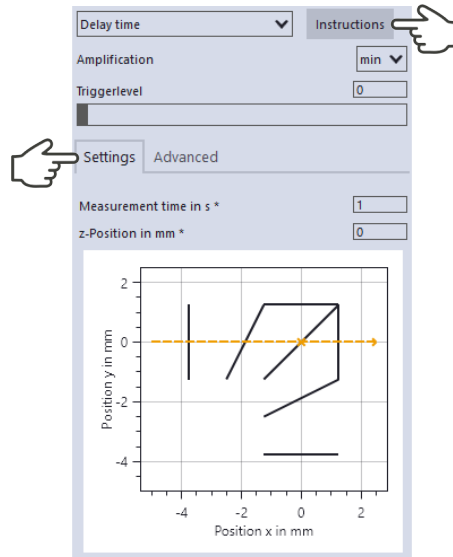
👁 The **Measurement time in s** is preset to 1 s.

Vector direction

The vector direction of the measured beams is automatically detected. Thus, beams can be measured in all directions (x, y, -x, -y) simultaneously.

The delay time results for each direction are displayed separately.

When measuring in all four directions, four results are displayed accordingly.

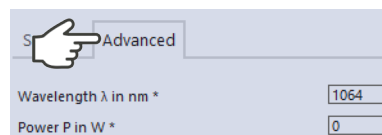


9.7.3 Configuring the advanced settings

1. Click on the **Advanced** tab.

Specifications of the laser

2. Enter the **Wavelength in nm** of the currently used Laser.
3. Enter the **Power P in W** during your measurement.



9.7.4 Starting a measurement

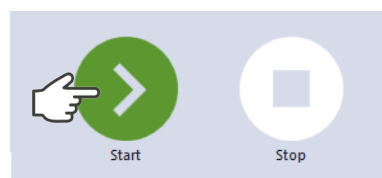
1. Follow the safety instructions in chapter 9.1 on page 18.
2. Click on the **Start** button:
3. Switch on the laser / start marking a vector.

Measurement is running

The measurement is performed with the selected measurement time.

Measurement finished

The measurement is finished.



Status

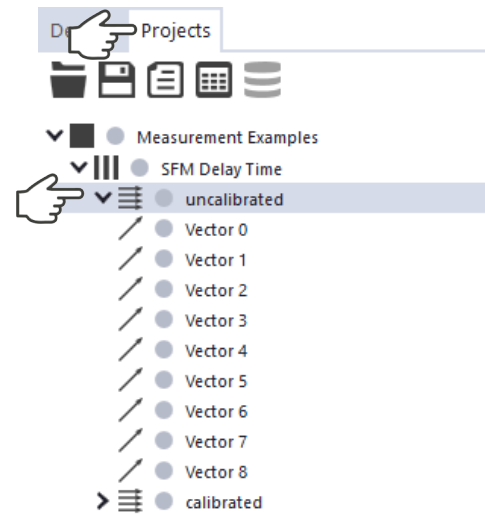
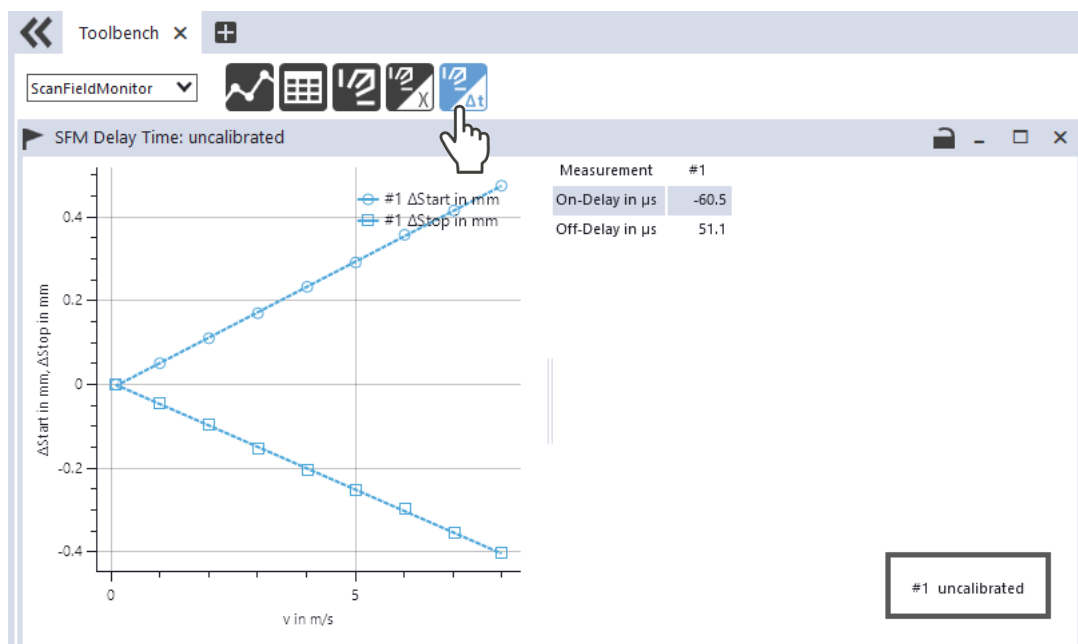
- Ready for measurement
- Measurement is running
- Measurement finished

9.7.5 Displaying the measurement results

1. Click on the **Projects** tab:
 - The delay time measurement and all of its single vectors are listed in the file structure.
 - ▶ For information on project management, please refer to the separate LDS operating manual.
2. Right click on the complete Delay Time sequence to be displayed.
3. Click on the selection **Show**:
 - The selected measurement is displayed in the **SFM Delay Time** tool.

As an alternative, you can click on the **SFM Delay Time** tool in the toolbench.

4. Drag and drop the complete Delay Time sequence into the **SFM Delay Time** tool.



9.8 Caustic

The Caustic measuring mode describes and enables measurements along the laser axis to determine the beam quality of your laser source.

Please note that some settings are set in the **Expert** menu according to chapter 9.10 „Expert (Basic settings for all measuring modes)“ on page 37.

9.8.1 Procedure for measuring a caustic

When performing a caustic measurement, the 2D tool is also open, and at least one structure must be selected before starting.

The following overview gives a short description of the procedure. This can also be found in the LDS menu **Caustic > Device control > Settings: Instructions**.

Programming of vectors and measurement procedure

- A vector is measured at one single building platform position for different z-positions.
- It is possible to measure vectors in x- and y-direction in one measurement sequence.
- The marking settings for the vectors must be kept the same for the whole measurement sequence.
- It is possible to increase the overall statistical significance of the measurement result by repeating vectors.
- For a reliable analysis it is recommended to measure at least 21 different z-planes, covering a range of $\pm 3 z_R$ around the focal position at z_0 .
- In measurement positions with large beam incidence angles the vector might leave the scattering structure for certain z-positions, which limits the maximum z-range for this position.

LDS settings

- The measurement duration must be longer than the sequence's marking time.
- Check positioning and photo diode gain with a single test measurement.
- Enter the z-position for the first measured plane.
- Enter the step size in z-direction and the number of measurement planes.
- "Interval between measurements" is a waiting duration between the end of one measurement and the start of the measurement in the next z-plane
- By checking "Confirm next measurement" this waiting time is ignored and the measurement in the next plane must be started manually.
- For further analysis enter laser power P and measurement position on the building platform.
- Start measurement.
- For analysis all vectors belonging to the caustic measurement must be saved in the same measurement sequence.

Data analysis in the LDS

- Open measurement sequence with the SFM Caustic tool.
- Caustic measurements for different building platform positions can be opened in the same tool.

9.8.2 Configuring the settings

Instructions

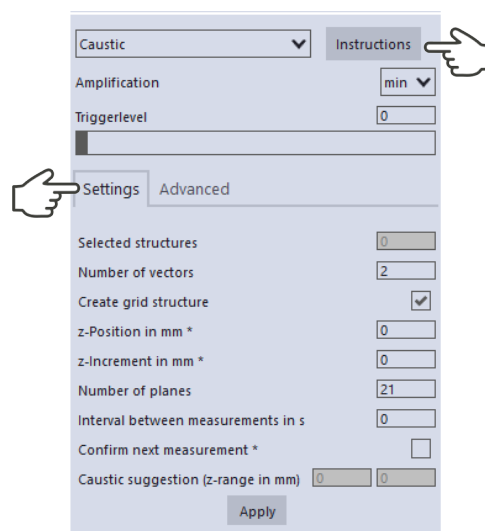
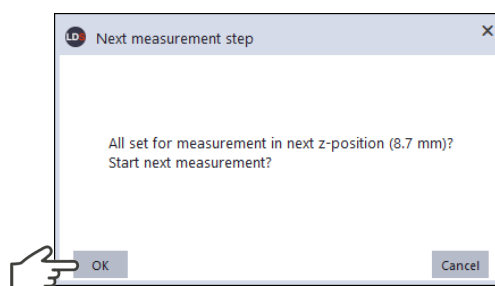
Click on **Instructions** to view information about the measurement.

1. Click on the **Settings** tab.
2. Enter **Number of vectors** per structure.
3. Enter the **z-position in mm** according to your the coordinate system. This is the starting point of the measurement.

Note

To improve the statistical evaluation, several vectors with identical parameters can be measured at each z-position.

- Adjust the height of the building platform after the first measurement.
 - With the input of the **z-position in mm**, the new z-position is automatically stored for the next measuring position in the LDS.
4. Enter the **z increment in mm**.
 - This corresponds to the distance on the z-axis until the next measurement. The step size can be both positive and negative.
 5. Enter the **Number of planes**.
 - For a reliable analysis it is recommended to measure at least 21 different z-planes, covering a range of $\pm 3 z_R$ around the focal position at z_0 .
 6. Enter the **Interval between measurements in s**:
 - If 0, the device is always ready to measure.
 - This value indicates the delay between the end of one measurement and the start of the measurement in the next z-plane.
 7. Activate the **Confirm next measurement** check box to ignore the automatic start of the next measurement.
 - The next measurement needs to be started manually.

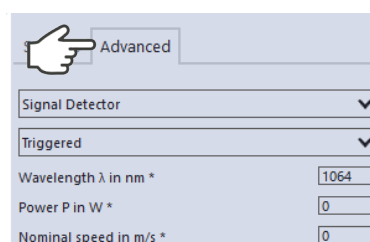



9.8.3 Configuring the advanced settings

1. Click on the **Advanced** tab.

Specifications of the laser

2. Enter the **Wavelength in nm** Laser.
3. Enter the **Power P in W** during the measurement.
4. Enter the **Nominal speed in m/s** during the measurement.



9.8.4 Starting a measurement

1. Follow the safety instructions in chapter 9.1 on page 18.
2. Click on the **Start** button:
3. Switch on the laser / start marking a vector.

Measurement is running

The measurement is performed with the selected measurement time.

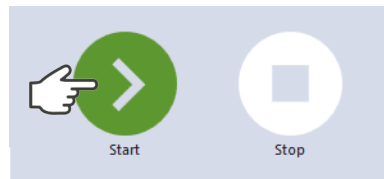
Measurement finished

The measurement is finished.

Vector direction

The vector direction of the measured beams is automatically detected. Thus, beams can be measured in all directions (x, y, -x, -y) simultaneously.

The results are displayed separately in x- and y-direction.



Status

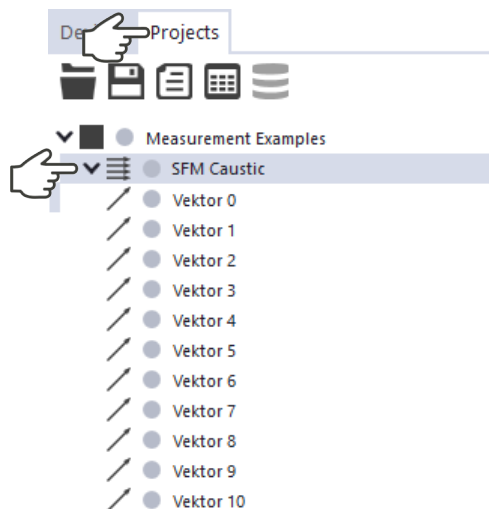
- Ready for measurement
- Measurement is running
- Measurement finished

9.8.5 Displaying the measurement results

1. Click on the **Projects** tab:
 - ➔ The caustic and all of its single vectors are listed in the file structure.
- For information on project management, please refer to the separate LDS operating manual.
2. Right click on the complete caustic sequence to be displayed.
3. Click on the selection **Show**.
 - ➔ The selected measurement is displayed in the **SFM Caustic** tool.

As an alternative, you can click on the **SFM Caustic** tool in the toolbench.

4. Drag and drop the complete caustic sequence into the **SFM Caustic** tool.



Algorithms for evaluating the beam geometry

The SFM 2D with the possibility to measure laser beams with an angle of incidence of $\pm 20^\circ$ is a special feature in the field of laser beam characterization, which is usually limited to the vertical beam incidence. In doing so, it must be considered how the laser beam is imaged by the device.

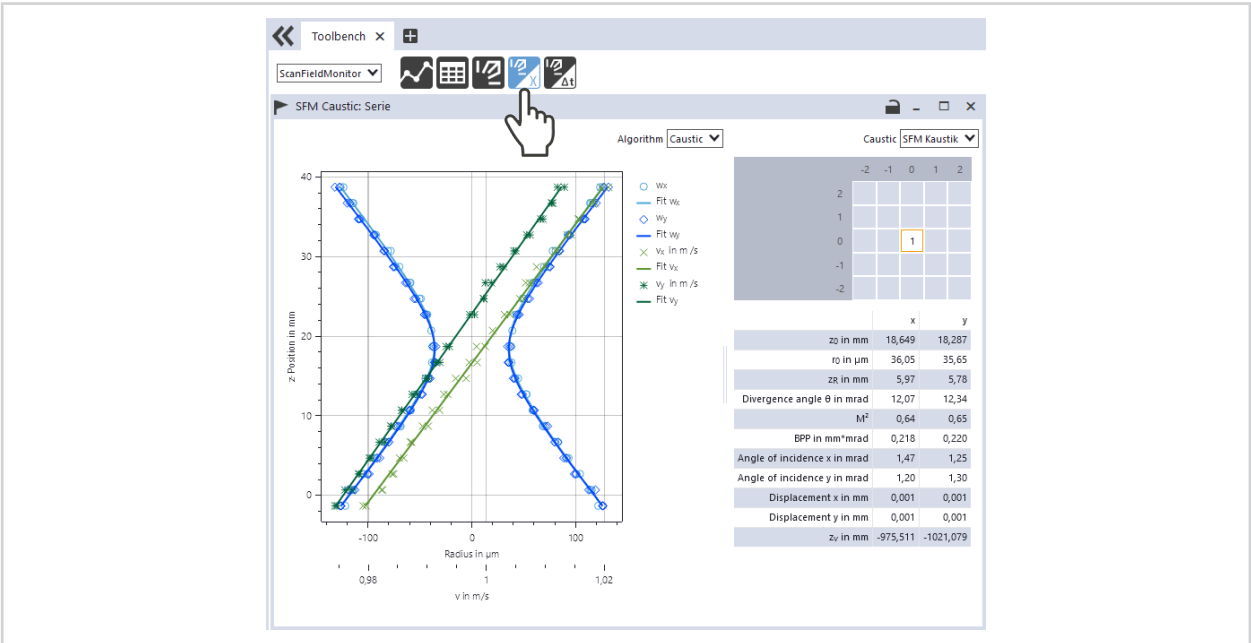
The SFM 2D is designed with the scattering structure parallel to the base plate. This means that the inclined incidence of the laser deforms the beam geometry on the glass surface. This form of projection images a round intensity profile along the propagation axis of the laser elliptically on the device surface. This applies equally to the surface of the SFM 2D and to the scattering structure.

A characterization according to the standard is only possible in the strict sense for vertical beam incidence. For inclined beam incidence, the measured beam geometry always represents a projection at the current angle of incidence. As a consequence, beam diameters are determined too large along the tilted axis. Note, that this projection can also apply to the laser process if it is influenced by the angle of incidence of the beam. For this reason, the LDS also offers two evaluation methods.

Caustic

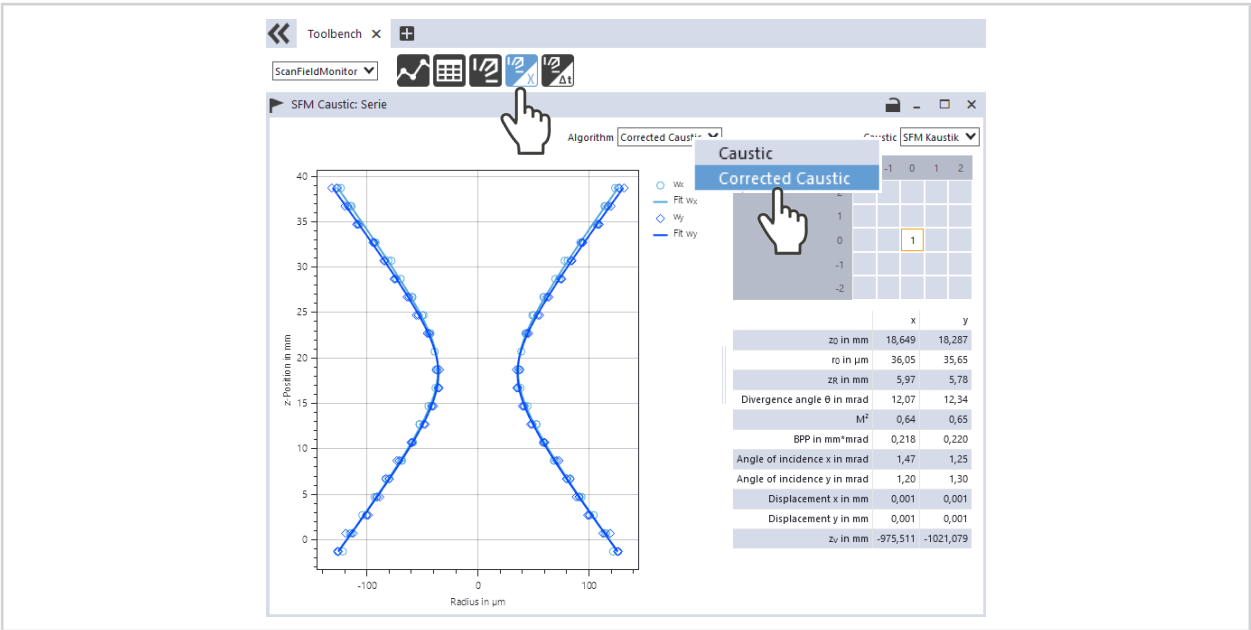
The caustic is shown on the basis of the measured radii in combination with the measured scanner speeds. The corresponding caustic parameters are given in the result table. All values reflect the geometry of the laser as a projection on a surface, parallel to the base surface. The beam looks exactly the same in the processing plane of a laser system.

The position of the nominal speed z_v in mm indicates at which z-position the expected/specified nominal speed was determined by the SFM 2D.



Corrected caustic

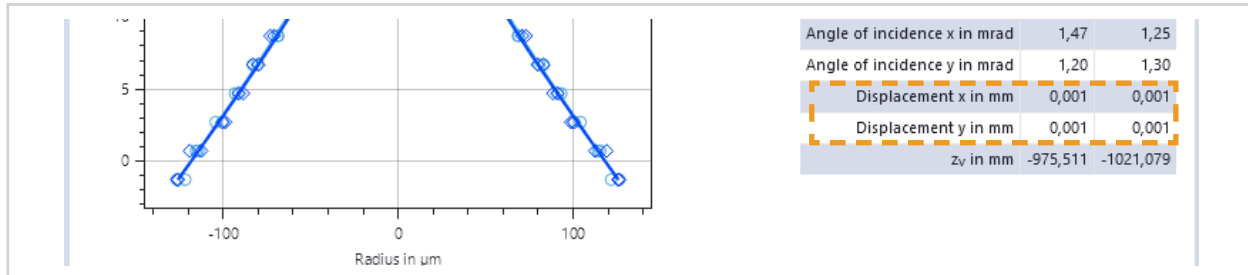
With the caustic measurement, the angle of incidence of the laser to the SFM 2D is determined at the same time. Taking the angle of incidence into account, the beam radii and their z-positions are corrected by calculation as if they were recorded perpendicular to the beam direction. The focus position serves as a reference and remains constant. The rayleigh length, the divergence angle, the beam quality factor M^2 and the beam parameter product BPP can vary as a result of the correction. The option "Corrected caustic" thus enables an evaluation of the caustic measurement according to the standard.



Note on beam position (beam displacement)

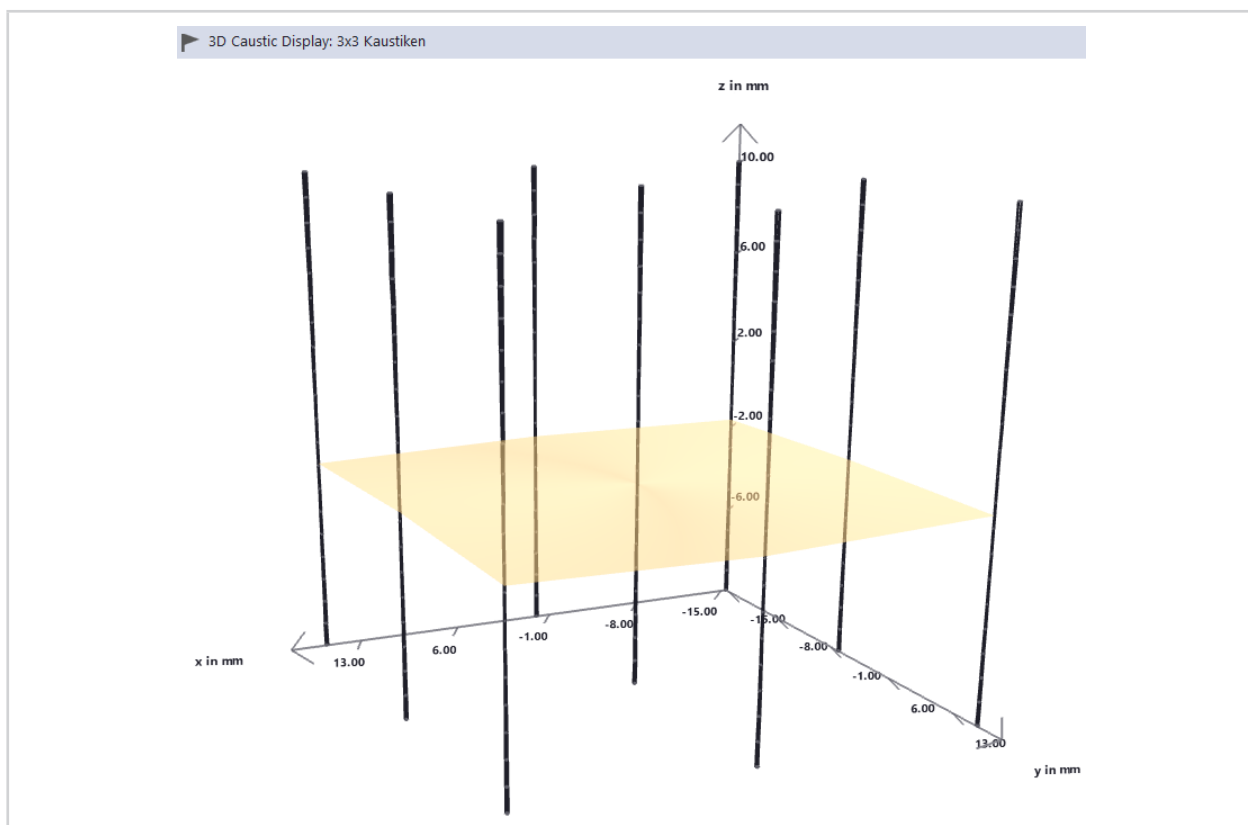
Due to the inclined beam incidence, the laser at the protective window of the SFM 2D is subject to a parallel offset. In the process of the caustic measurement, the angle of incidence of the laser is determined.

The resulting beam displacement on the scattering structure is indicated in the measurement result of the caustic measurement as displacement in x and y.



Multi Caustic

If more than one structure is selected, the **3D Caustic Display** tool shows each individual caustic within the scan field. The focus plane can be displayed.



9.9 Auto Trigger Amplification

To determine the optimum trigger amplification, the trigger amplification is automatically determined once in the **Auto. Trigger Amplification** measuring mode.

In general, the trigger amplification to be selected depends on the laser power and the angle of incidence, i.e. on the position of the SFM 2D within the scan field. If you change one of these parameters, you should determine the trigger amplification again.

9.9.1 Procedure for automated setting of the trigger diode

The following overview gives a short description of the procedure. This can also be found in the LDS menu **Auto. Trigger amplification > Device control > Settings: Instructions**.

Programming of the laser

- We recommend switching on the laser at a steady position within the SFM 2D measurement window.
- For the automatic trigger adjustment a vector can also be moved with low speed within the SFM 2D measurement window. The laser does not necessarily have to pass the scattering structure.
Example: vector length $L = 10.0$ mm; scanner speed $v = 20$ mm/s

LDS settings

- Choose measurement mode “Auto. Trigger Amplification”.
- The measurement duration is automatically preset to 5 s.
- We recommend initially setting the trigger amplification to 0.
- The signal amplification and z-position cannot be set, as these values do not affect the trigger amplification.
- For further analysis, the wavelength λ , the laser power P and the position on the building platform can be set in the advanced settings section.
- Start measurement.

Data analysis in the LDS

- The result of the automatic trigger adjustment is stored in “Auto. Trigger Amplification” in the project tree.
- Display the determined value of the trigger amplification in the table module.
- For subsequent applications PRIMES recommend to save the result of the automatic trigger adjustment.

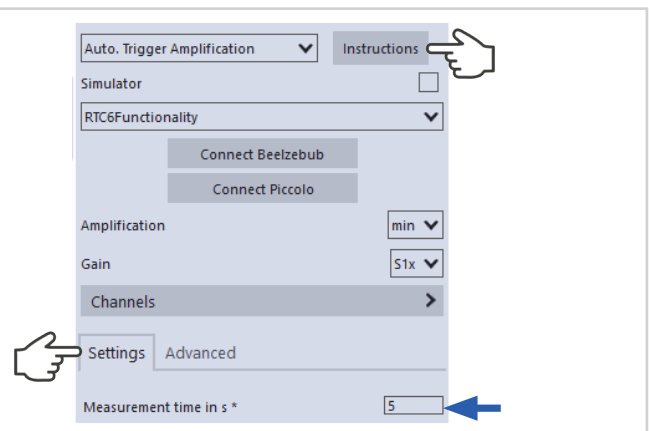
9.9.2 Configuring the settings

Instructions

Click on **Instructions** to view information about the measurement.

1. Click on the **Settings** tab.
2. Enter the **Measurement time in s**.

 The **Measurement time in s** is preset to 5 s.

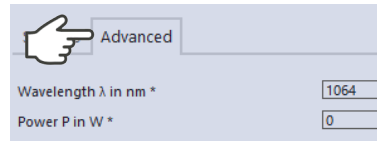


9.9.3 Configuring the advanced settings

1. Click on the **Advanced** tab.

Specifications of the laser

2. Enter the **Wavelength λ in nm** of the currently used Laser.
3. Enter the **Power P in W** during your measurement.



9.9.4 Starting a measurement

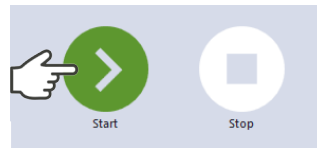
1. Follow the safety instructions in chapter 9.1 on page 18.
2. Click on the **Start** button:
3. Switch on the laser/start marking a vector.

Measurement is running

The measurement is performed with the selected measurement time.

Measurement is finished

The measurement is finished.



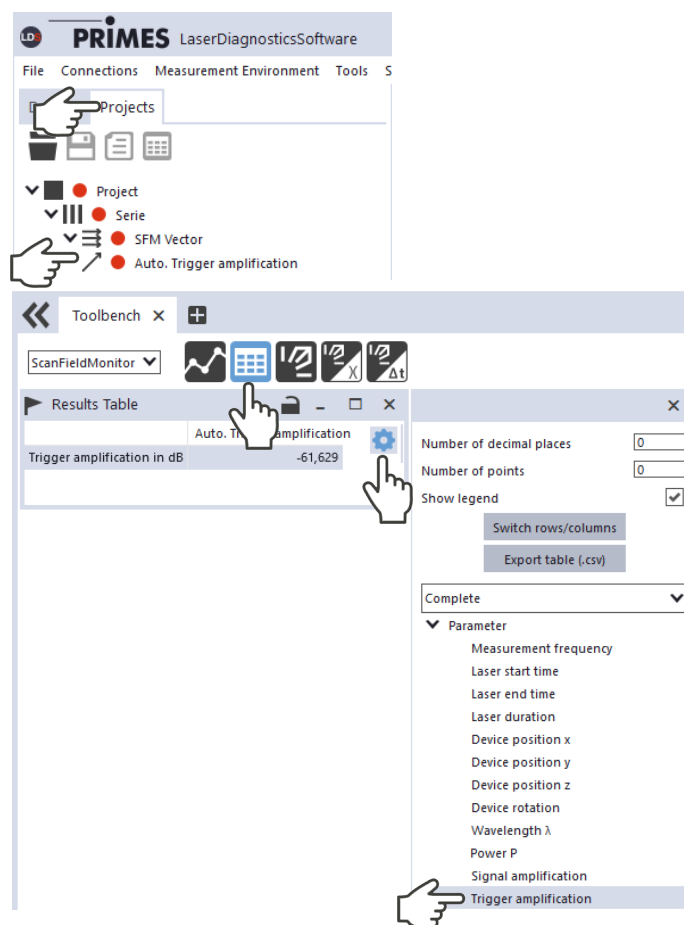
Status

- ☐ Ready for measurement
- ☐ Measurement is running
- ☐ Measurement finished

9.9.5 Displaying the determined trigger amplification in the project tree

For documentation purposes, the determined trigger amplification is saved in the project tree.

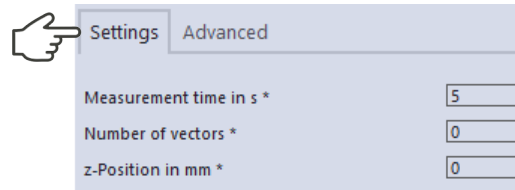
1. Click on the **Projects** tab:
 - ➔ The determined trigger amplification is listed in the file structure.
 - For information on project management, please refer to the separate LDS manual.
 2. Click on the **Results Table** tool.
 3. Drag and drop the **Auto. Trigger amplification** from the measurement to the **Results Table**.
 4. Click the **gear icon** and select the **Trigger amplification** selection.
- 👁 The **Results Table** displays the measured **Trigger amplification in dB**.



9.10 Expert (Basic settings for all measuring modes)

9.10.1 Configuring the settings

1. Click on the **Settings** tab.
2. Enter the **Measurement time in s**.
3. Enter the **Number of vectors**.
4. Enter the **z-Position in mm** according to the machine coordinate system.



9.10.2 Configuring the advanced settings

1. Click on the **Advanced** tab.

Drop-down list Trigger detector

- Choose between signal or trigger detector measurement recording.

Drop-down list Triggered

- **Triggered:** This is the default mode for a SFM 2D measurement. The structure is passed over with the laser switched on. The laser is switched off for jumping back to the start position.
- **Monitor:** When starting a measurement with the **Start** button, the measurement is started immediately. All data recorded during the measurement are saved.

Specifications of the laser

2. Enter the **Wavelength in nm**.
3. Enter the **Power P in W**.
4. Enter the **Nominal speed in m/s**.

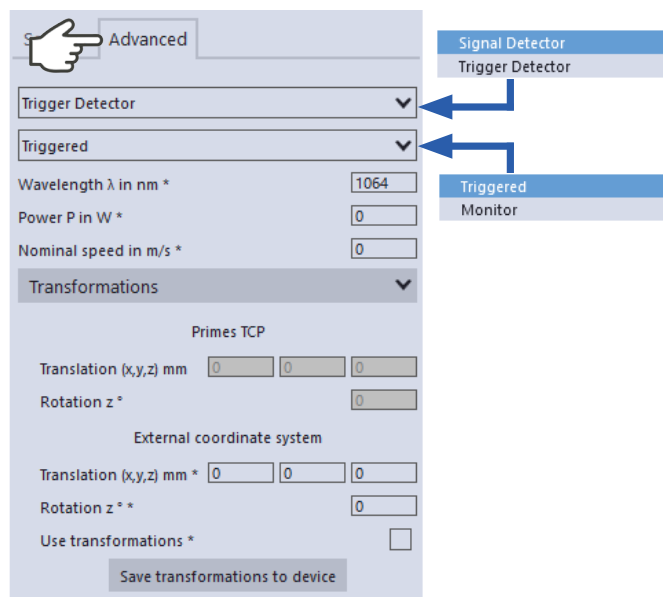
Transformations

Enter values for coordinate transformation. This allows to display the measured data in the device coordinate system or in an external coordinate system.

5. Enter the **Translation (x,y,z) mm** distances and the **Rotation z °** around the z-axis of the device coordinate system to the external coordinate system.
6. Select the **Use transformations** check box to apply the entered distances when evaluating all subsequent measurements.

Save transformation parameters

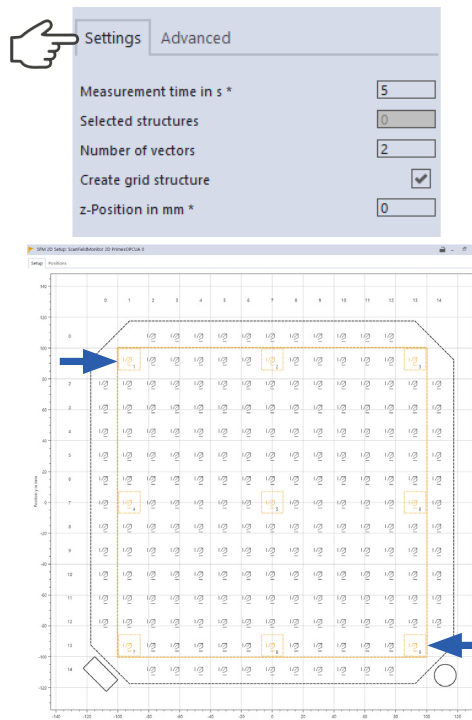
7. Click on the **Save transformation to device** button:
- ➔ The entered values of the transformation are available after a restart of the device.



9.11 SFM 2D

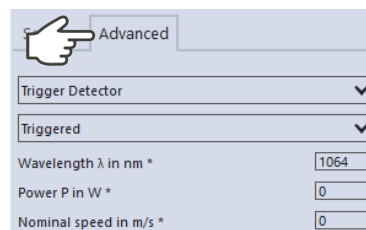
9.11.1 Configuring the settings

1. Click on the **Settings** tab.
2. Enter the **Measurement time in s**.
 - 👁 The **Measurement time in s** is preset to 5 s.
3. Enter **Number of vectors** per structure.
 - The number of vectors corresponds to the number of vectors selected per structure. The structures themselves and their order are selected via the 2D measurement bank.
 - The structures must be selected in the order in which they are exposed. Otherwise, misinterpretations may occur.
 - Click on a structure to select it. To deselect a structure, clicking on it again. Additionally hold leftclick to select or deselect an area of structures. Selecting and deselecting a structure will automatically change the order of the remaining selected structures.
 - Measurement sequences can be saved and reloaded using **Save As** and **Open**.
4. Enter the **z-Position in mm** according to your machine coordinate system.



9.11.2 Configuring the advanced settings

1. Click on the **Advanced** tab.
- Specifications of the laser**
2. Enter the **Wavelength in nm** of the currently used Laser.
 3. Enter the **Power P in W** during your measurement.
 4. Enter the **Nominal speed in m/s** during your measurement.



9.11.3 Starting a measurement

1. Follow the safety instructions in chapter 9.1 on page 18.
2. Click on the **Start** button:
3. Switch on the laser / start marking a vector.

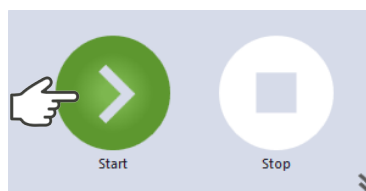
Measurement is running

The measurement is performed with the selected measurement time.

Measurement is finished

The measurement is finished.

- 👁 The indication shows the number of vectors expected and how many have already been measured.



Status
SFM 2D

- Ready for measurement
- Measurement is running
- Measurement finished

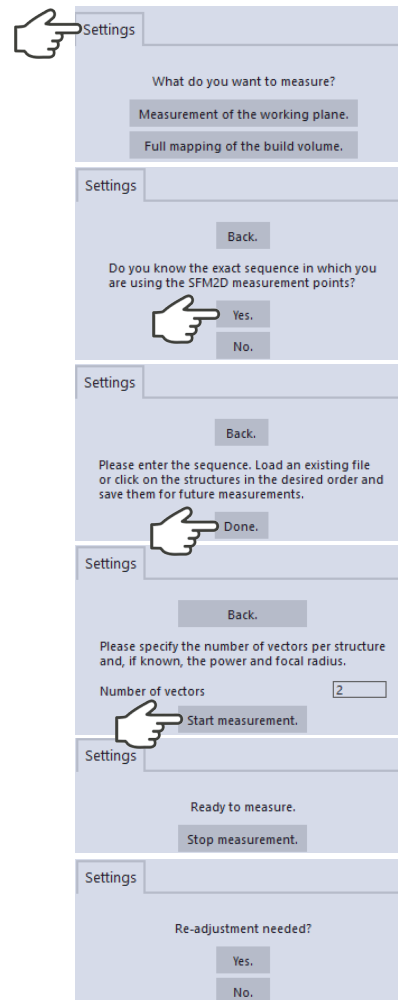
18 / 18

9.12 Guided measurement

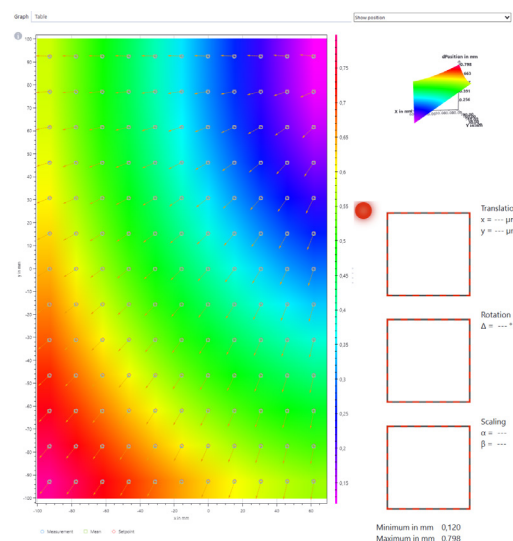
If the order of vectors is unknown, use the guided measurement mode. The guided measurement mode helps to find the appropriate measurement mode for characterizing the scan field. The mode will guide you through the process. Afterward, you can save the order for use in future measurements.

9.12.1 Configuring the settings

1. Click on the **Settings** tab.
2. Follow the instructions for a pre-configured measurement.

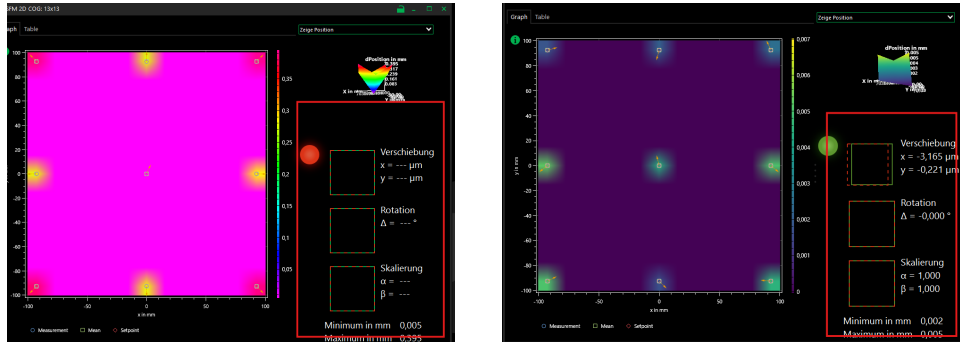


3. Based on the evaluation, determine whether readjustment is necessary.

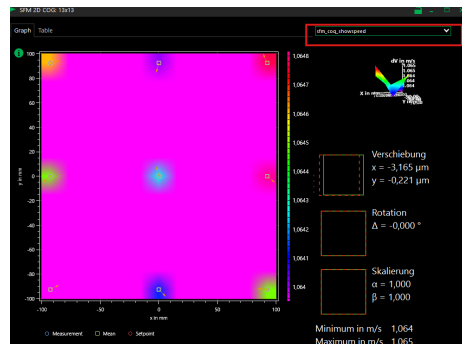


9.13 COG Control Module

The module displays the deviation of the measured vector positions from the target values. This is shown both in a 3D graph and in an optional heat map:



You can choose between position, speed, and radius as the parameters to display. If individual data points from the measurement cannot be evaluated, they can be interpolated:



The most important aspect is the protective glass correction. This corrects the x/y offset caused by the protective glass. The angle for the correction at this point is calculated based on the distance that needs to be determined.

The threshold value is a value used to define the corresponding maximum deviation; this determines the evaluation traffic light.

Clicking on “Target/Actual Values” opens a table that can be exported directly as a CSV file:

Target	Target	Measurement	Measurement
-92.50000	92.50000	-92.57500	92.54074
0.00000	92.50000	0.00266	92.57815
92.50000	92.50000	92.54217	92.54241
-92.50000	0.00000	-92.58103	-0.00236
0.00000	0.00000	0.00266	0.00446
92.50000	0.00000	92.54709	-0.00302
-92.50000	-92.50000	-92.57239	-92.57747
0.00000	-92.50000	0.00433	-92.54097
92.50000	-92.50000	92.57059	-92.57946

The calculated theoretical scanner correction values can be enabled or disabled and applied directly to measured values.

If the target/actual table is accessed with the correction values enabled, it will contain the values that have already been corrected.

9.14 Discussion of the measuring results and error analysis

For the correct interpretation of the measured values and the evaluation of the calculated results, the specific characteristics of the SFM 2D must be taken into account.

Both the color coding and the spatial extent of the measurement results directly correspond to the alignment quality of your scanner. A perfectly aligned scanner produces only a green, flat surface.

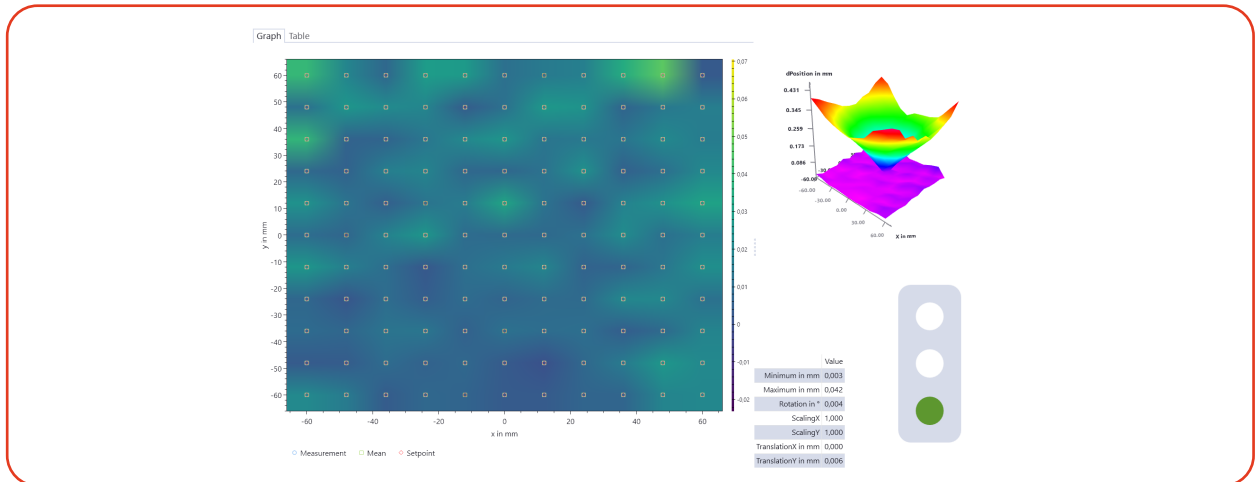


Fig. 9.1: Perfectly aligned scanner

Gaussian fit method

The measuring signal of the SFM 2D consists of the time track of the photodiode. The characteristic six peaks are generated when the laser passes over the lines of the scattering structure. This means that a one-dimensional integrated measurement signal is generated. The beam radius is calculated using a Gaussian fit to this power density distribution. This method provides valid results exclusively for the observation of Gaussian laser beams.

Beam position in the measuring window

If the laser is incident at an angle, the protective window above the scattering structure causes a beam shift. The position of the measured vector is thus subject to an offset. By measuring a caustic, the exact angle of incidence, the resulting beam shift in both directions and the corrected beam parameters can be determined.

Constant marking speed

A constant marking speed of the laser is assumed for the calculation of all measured variables. Acceleration and/or deceleration within the written vector influence the value and accuracy of all measured variables.

Contaminated protective window

Contamination, fingerprints and burn-ins on the protective window can cause additional stray light. If this stray light is misinterpreted as a measurement signal, this will lead to incorrect results.

Fluctuations of the laser power

The detector of the SFM 2D can resolve laser power fluctuations in the range of several 10 kHz, especially at low marking speeds. Therefore, the beam distribution sometimes appears unstable, which can also influence the measurement accuracy of all measured variables.

10 Troubleshooting

10.1 Messages in the LDS during measurement

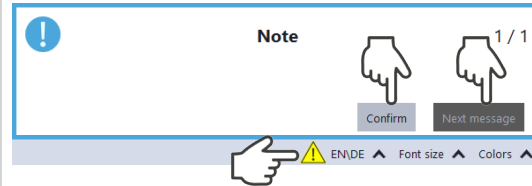
If problems occur during a measurement, the LDS displays them in different categories and colors.

Note

Notes provide assistance in interpreting the measurement results and are displayed in a blue window.

Use one of the following options:

- ▶ Click on the warning triangle in the footer to display / hide the window.
- ▶ If applicable, click the **Next message** button to display more messages of the same category.
- ▶ Click the **Confirm** button to remove the displayed message.



Warning

Non-safety-critical problems that influence the quality of the measurement results, for example, are displayed in a yellow window.

Use one of the following options:

- ▶ Click on the warning triangle in the footer to display / hide the window.
- ▶ If applicable, click the **Next message** button to display more messages of the same category.
- ▶ Click the **Confirm** button to remove the displayed message.



Device error

Device errors that can result in damage of the device are displayed in an orange window.

In this case, proceed as follows:

1. Fix the problem.
2. Click the **Confirm** button to remove the message.
- 👁 The message disappears. If the problem is not fixed, then the message appears again shortly afterwards.
3. Do not proceed with the measurement until the problem is solved.

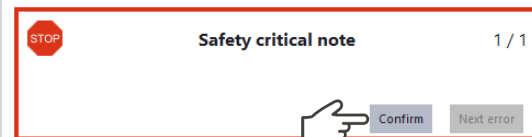


Safety critical note

Safety-critical problems that can result in damage/destruction of the device are displayed in a red window.

In this case, proceed as follows:

1. Fix the problem immediately.
2. Click the **Confirm** button to remove the message.
- 👁 The message disappears. If the problem is not fixed, then the message appears again shortly afterwards.
3. Do not proceed with the measurement until the problem is solved.



10.2 Connection failures and other errors

Error	Possible cause	Remedy
No connection between SFM 2D and PC.	The connection may be blocked by the firewall.	In Windows > Control panel > Firewall , enable the UDP port 20034.
Error during a measurement	<ul style="list-style-type: none"> Data transmission error Processor crash in the measuring system Program execution error 	<ol style="list-style-type: none"> Turn the SFM 2D off and on again. Disconnect the Wi-Fi connection and reconnect the device to the PC. Restart the PC. Restart the LDS.
Apart from the ambient noise and zero offset, no measuring signal is available.	The device is not aligned correctly.	Check the device alignment to the laser beam according to chapter 7.2.1 „Alignment to the laser beam“ on page 14.
	The signal amplification is too low.	Increase the signal amplification.
No vector is written during a triggered measurement.	The trigger amplification is too low.	Set the maximum trigger amplification or perform an automatic determination of the trigger amplification according to chapter 9.9 „Auto Trigger Amplification“ on page 35.
The measurement signal of a vector contains less than six peaks.	The device is not aligned correctly.	Check the device alignment to the laser beam according to chapter 7.2.1 „Alignment to the laser beam“ on page 14.
The measurement signal of a vector contains more than six peaks.	The protective window or signal plate is contaminated.	Clean the protective window or the signal plate.

Tab. 10.1: Troubleshooting

11 Maintenance and service

11.1 Maintenance intervals

The operator is responsible for determining the maintenance intervals of the measuring device.

PRIMES recommends a maintenance interval of 12 months after initial operation for inspection and validation.

If the device is used sporadically (less than once a day), the maintenance interval can be extended up to 24 months.

Please note that the safety and warning functions must be checked regularly.

11.2 Cleaning



CAUTION

Burns due to hot components

The protective window is hot after a measurement.

- ▶ Do not clean or change the protective window directly after a measurement.
- ▶ Let the device cool down for an adequate period of time.

NOTICE

Damaging/Destruction of the device

Contamination and fingerprints on the protective window can cause damage or cracking respectively splintering of the protective window during measuring operation.

- ▶ Only clean or change the protective window in a dust-free environment.
- ▶ Do not touch the protective window with bare hands, wear suitable gloves.



The coating of the protective window is particularly sensitive to scratches. Use cloths suitable for cleaning protective window.

Cleaning the device surface

1. After a measurement, let the device cool down for an adequate period of time.
2. Clean the device surface with clean and oil-free compressed air.
3. For further cleaning, use a mixture of distilled water and isopropanol in a ratio of approx. 5:1.
Use lint-free cleaning cloths that do not cause scratches.
4. If these steps are not sufficient, please contact PRIMES or your PRIMES distributor.

Cleaning the Protective window

To ensure consistently high measurement performance, PRIMES recommends checking the protective window for contaminants, such as dust or metal powder, before each measurement series or construction job and cleaning it if necessary.

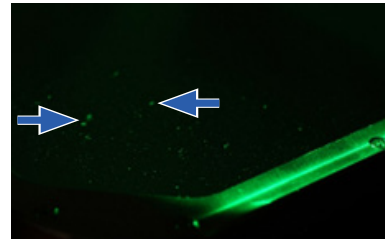
Residue from metal powder can cause burn marks on the protective window. These can have a measurable impact on the measurement results, resulting in significant deviations.

If the protective window is cracked, depending on the severity of the crack, you should either exclude the measurement structures in that area or replace the protective window.

(If you have any questions, please contact technical support at: support@primes.de)

1. Check the cleanliness of the protective window regularly.

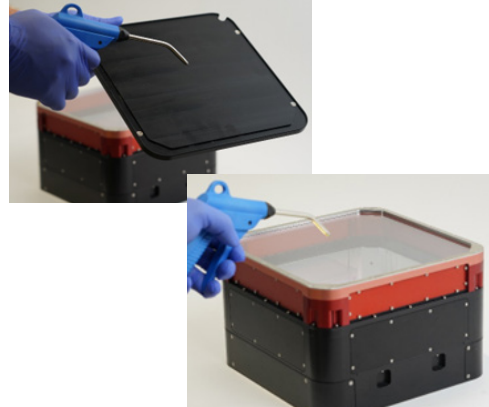
► If you look at the protective window under a green LED light, dirt and smudges become particularly visible.



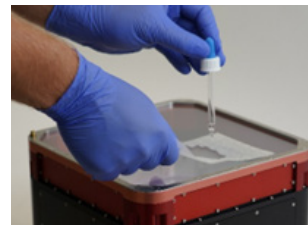
2. Clean the protective window cover with clean compressed air before removing it.

Clean the protective window in an environment that is as clean as possible and free of dust and particles.

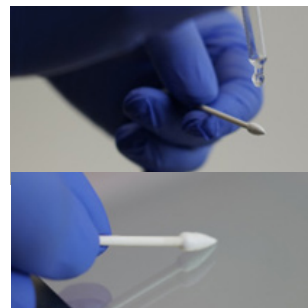
3. First, remove any dust or metal powder deposits with clean compressed air.



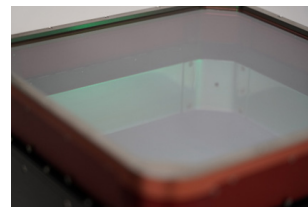
4. To remove streaks or stubborn deposits, apply a few drops of cleaning solution (acetone or isopropyl alcohol) to the protective window, place a lens cleaning cloth over it, and wipe in one direction (without applying pressure!). Check the cleanliness of the glass again and, if necessary, repeat the cleaning process with a new, clean cloth.



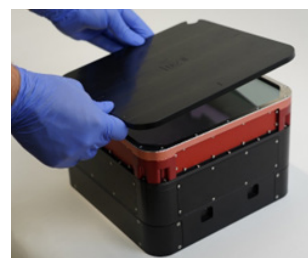
5. To remove localized dirt, you can use cleaning swabs designed for optical lenses. To do this, apply a few drops of cleaning solution (acetone or isopropyl alcohol) to the swab and remove the dirt from the protective window using light pressure and a rolling motion.



6. Check the cleanliness of the protective window regularly to prevent long-term damage to the protective window.



7. Keep the protective window free of dirt, and replace the lid when not in use.



12 Measures for the product disposal

This PRIMES measuring device is subject to the Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE) and the corresponding national laws.

The WEEE obliges the operating company to dispose of the device in an environmentally sound manner, not with household waste, but in a separate WEEE collection.

PRIMES gives the opportunity to return PRIMES measuring devices for free disposal within the scope of the WEEE. This service does not include shipping costs.

PRIMES measuring devices to be disposed of within the EU can be send to the following address:

PRIMES GmbH
Max-Planck-Str. 2
64319 Pfungstadt

Germany

If you are located outside the EU, please contact your local PRIMES distributor to discuss the disposal procedure for your PRIMES measuring device.

PRIMES is registered with the german „stiftung elektro-altgeräte register“ foundation (stiftung ear) as a manufacturer under the number: WEEE Reg. No. DE65549202.



To process your return as efficiently as possible, please fill out our return form. You can find the form using the QR code opposite or at www.primes.de/en/create-rma-online.



Caution battery included!

The power bank must be disposed of in accordance with applicable national and international laws if the device is not returned to PRIMES.

13 Declaration of Conformity



EU Declaration of Conformity

The manufacturer: PRIMES GmbH, Max-Planck-Straße 2, 64319 Pfungstadt, Germany hereby declares, that the device with the designation:

ScanFieldMonitor SFM 2D

is in conformity with the following EU Directives:
Radio Equipment Directive 2014/53/EU
RoHS Directive 2011/65/EC

The safety objectives of the Low-voltage directive 2014/35/EU and EMC Directive 2014/30/EU comply with article 3.1 of the Radio equipment directive.

Following harmonized standards have been applied:

DIN EN ISO 12100:2011-03	Safety of machinery - General principles for design - Risk assessment and risk reduction
DIN EN 61010-1:2020-03	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
DIN EN IEC 6100-16-2:2019-11	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
DIN EN IEC 6100-16-4:2020-09	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

Authorized for the documentation:
PRIMES GmbH, Max-Planck-Str. 2, 64319 Pfungstadt

Pfungstadt, September 3, 2026

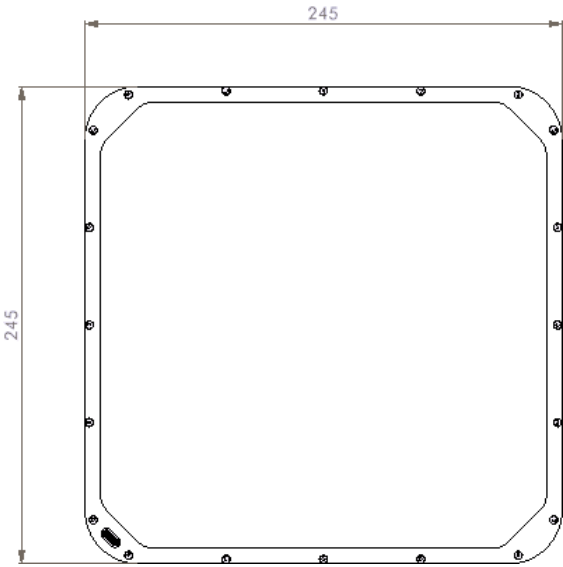

Dr. Reinhard Kramer, CEO

14 Technical data

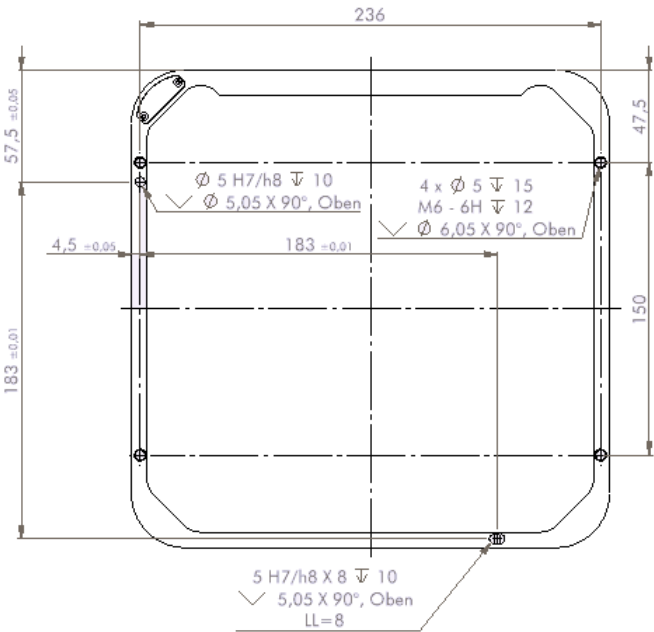
Measurement parameters	
Power range	10 – 1 000 W
Wavelength range	1 000 – 1 100 nm
Beam diameter	50 – 300 µm
Max. power density (1 000 – 1 100 nm)	100 MW/cm ²
Determined parameters	
Focus position x, y, z	yes
Focus radius x, y	yes
Beam quality factor M ²	yes
Beam parameter product BPP	yes
Divergence angle	yes
Marking speed	yes
Focus shift in z	yes
Angle of incidence	yes
Delay time	yes
Device parameters	
Angle of incidence perpendicular to inlet aperture	0 – 20 degree
Marking speed	0.1 – 10 m/s
Dimension of the scattering structure	7.5 mm x 7.5 mm
Number of structures (at 235x235mm)	213
Supply data	
Power supply	5 V = 3A; Power bank or USB-C power supply
Capacity	20 100 mAh
Energy	73 Wh
Weight power bank	515 g
Dimensions power bank (L x W x H)	168.5 x 80 x 23.2 mm
Communication	
Interfaces	Wi-Fi
Dimensions and weight	
Dimensions (L x W x H)	245 x 245 x 161 mm
Weight (ca.)	7.5 kg
Environmental conditions	
Operating temperature range	10 – 30 °C
Storage temperature range	10 – 45 °C
Reference temperature	22 °C
Permissible relative humidity (non-condensing)	10 – 80 %

15 Dimensions

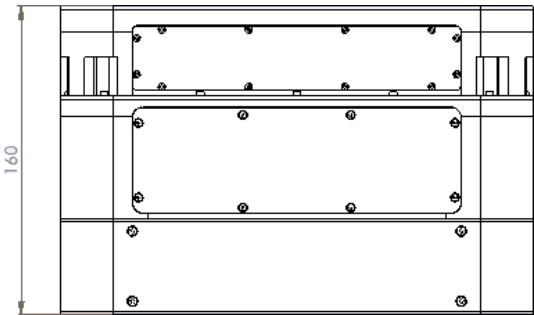
All dimensions in mm



Top view



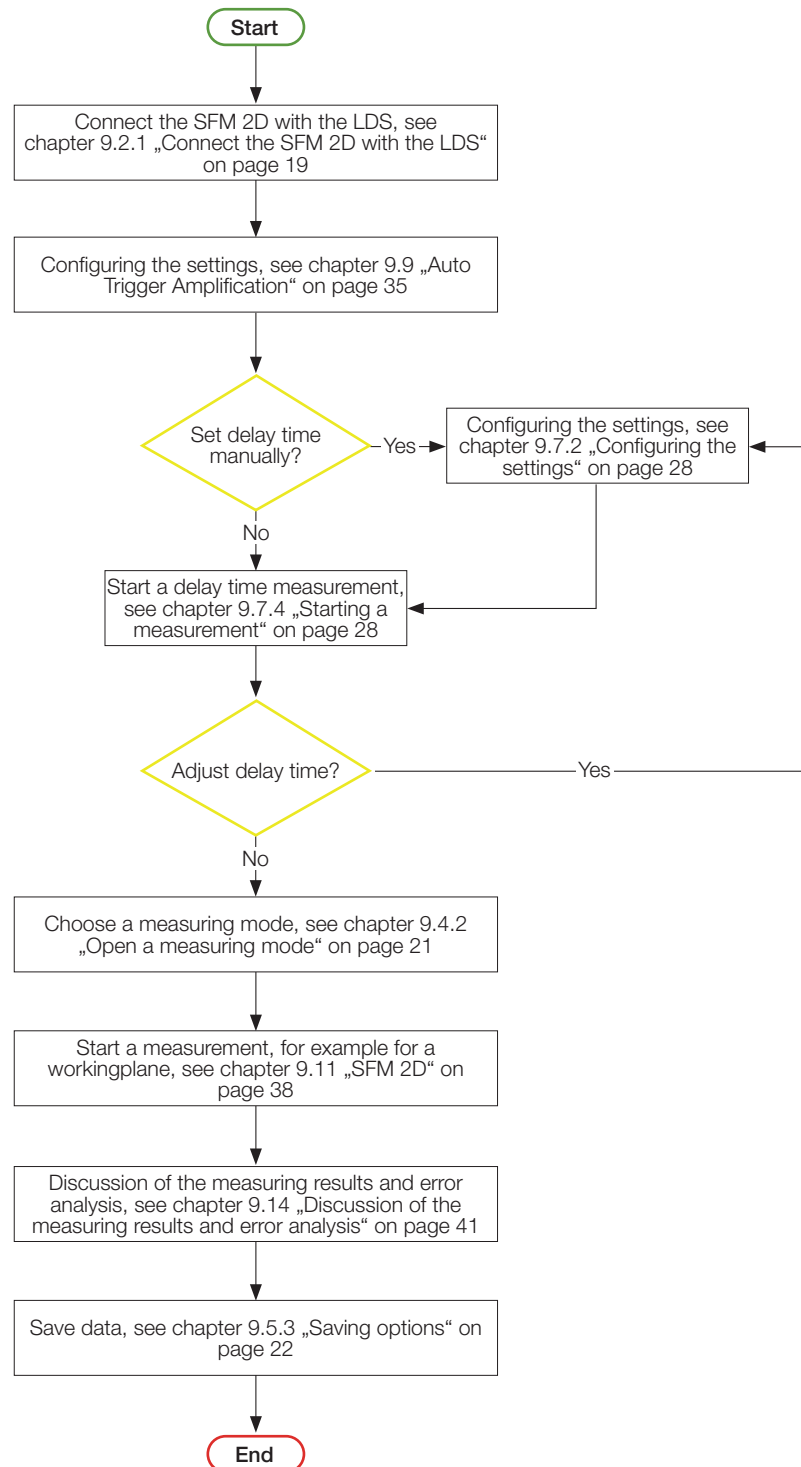
Bottom view



Side view

16 Appendix

A Flowchart of a measurement



B Patent notice

PRIMES is the owner of US patent 10,184,828 which protects a method for determining properties of a laser beam. The SFM 2D is a sophisticated tool that makes it easier for you to implement this method.

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