PRIMES

Original Instructions

ScanFieldMonitor SFM

LaserDiagnosticsSoftware LDS

Revision 01 EN - 05/2021

IMPORTANT!

READ CAREFULLY BEFORE USE.

KEEP FOR FUTURE USE.

Table of contents

PRIMES - The Company

PRIMES manufactures measuring devices used to analyze laser beams. These devices are employed for the diagnostics of high-power lasers ranging from CO_2 lasers and solid-state lasers to diode lasers. A wavelength range from infrared through to near UV is covered, offering a wide variety of measuring devices 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 M^2

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 in 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 you observe all information, instructions, safety notes and warning messages in this operating manual. The specifications given in chapter 22 „Technical data“ on page 72 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.

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.
- If the device is moved from its aligned position, increased scattered or directed reflection of the laser beam occurs during measuring operation. Fix the device in such a way that it cannot be moved by unintentional bumping or pulling on 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.
- 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.

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 injury **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:

Warning of hot surface

Read and observe the operating instructions and safety guidelines before startup!

A lithium-ion battery (power bank) is located on the top of the Processing Unit. To avoid health and environmental damage, the power bank must be disposed of in accordance with the applicable national and international laws.

Further symbols and conventions in this operating manual

Here you can find useful information and helpful tips.

▶ Indicates a simple instruction.
If several such instructions appear one below the other, then the order of their execution is irrelevant or they are alternative procedures.

1. A numbered list identifies a sequence of instructions that must be executed in the specified order.
2.
...

→ Indicates the result of an action to explain processes that take place in the background.

Indicates an observation prompt that draws your attention to visible feedback from the device or the software.
Observation prompts make it easier to check whether an instruction was executed successfully and often also guide you to the next instruction.

Points to a control element that is to be pressed/clicked in images of the device/graphical user interface.

Points to an element described in the text (e.g. an input field) in graphical user interface images.

3 About this operating manual

This documentation describes the installation and configuration of the ScanFieldMonitor SFM and the execution of measurements with the PRIMES LaserDiagnosticsSoftware LDS.

The LaserDiagnosticsSoftware LDS and the plugin for the ScanFieldMonitor SFM must be installed on the PC for measuring operation of the ScanFieldMonitor SFM. The basic version of the LaserDiagnosticsSoftware LDS and the plugin for the ScanFieldMonitor SFM are included in the scope of delivery.

For a detailed description of the software installation, file management and evaluation of the measured data, please refer to the separate operating manual LaserDiagnosticsSoftware LDS.

4 Conditions at the installation site

- The device must not be operated in a condensing atmosphere.
- The ambient air must be free of organic gases.
- Protect the device from splashes of water and dust.
- Operate the device in closed rooms only.

5 Important notes on the lithium-ion battery (power bank)

A power bank is located on the upper side of the Processing Unit. Two different versions are distinguished:
- A Processing Unit with exchangeable power bank. For this Processing Unit the power bank can be pulled out and replaced.
- A Processing Unit with permanently installed power bank. For this Processing Unit the power bank cannot be removed.

Be aware that this power bank may ignite at high temperatures. For operation, storage and shipping, refer to the information according to chapter 22 „Technical data“ on page 72.

5.1 Charge the power bank

Charge the power bank completely before using it for the first time. The first complete charge requires approx. 5 hours. Only use the supplied USB cable and quick-charge plug-in power supply to charge the power bank. Recharge the power bank when the charge level reaches 20 percent. Do not charge the power bank unattended, e.g. overnight. Do not expose the device to direct sunlight.

5.2 Store the power bank

Store the device with power bank or the removed power bank in a cool dry place. Keep a minimum distance of 3 m from flammable materials. Do not expose the device to direct sunlight. Please recharge the power bank at least every three months.

5.3 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.

5.4 Shipping the power bank

The Processing Unit with inserted power bank or permanently installed power bank is a dangerous good in case of shipment and is classified as “lithium ion batteries contained in equipment”. If the power bank is enclosed with the Processing Unit, the power bank is classified as “lithium ion batteries with equipment”. Particularly in the case of a damaged power bank, special regulations must be observed. Please observe the requirements for shipping according to the valid regulations.

6 Device description

6.1 Functional description

The measuring system consists of the ScanFieldMonitor SFM and the Processing Unit with power bank. For stable installation of the ScanFieldMonitor SFM on the building platform of the laser system a device holder is supplied.

The device holder must be mounted stable in the laser system by the customer and holds the ScanFieldMonitor SFM at the respective measuring position. The laser radiation passes through the device during measurement and exits at the bottom of the ScanFieldMonitor SFM. For a secure operation the ScanFieldMonitor SFM may only be operated with a device holder that is able to absorb the exiting laser radiation. For exact alignment of the ScanFieldMonitor SFM to the laser beam an alignment tool is supplied.

The ScanFieldMonitor SFM is connected to the Processing Unit via the connecting cable.

The ScanFieldMonitor SFM is supplied with power:
- by the power bank in the Processing Unit or
- by the supplied USB cable with quick-charge plug-in power supply. This is plugged into the USB connection socket of the processing unit with the power bank.

Please note that the connected ScanFieldMonitor SFM is switched off when the USB cable is pulled out of the USB connection socket of the Processing Unit.

The power bank display shows the charge status in percent and the set output voltage (12 V).

Measurement data is transmitted either wirelessly via WLAN or with an Ethernet cable. This enables fast data transfer during the measurement. The PC used requires a WLAN module for wireless transmission.

The ScanFieldMonitor SFM is controlled and the measurement results evaluated using the LaserDiagnosticsSoftware LDS.

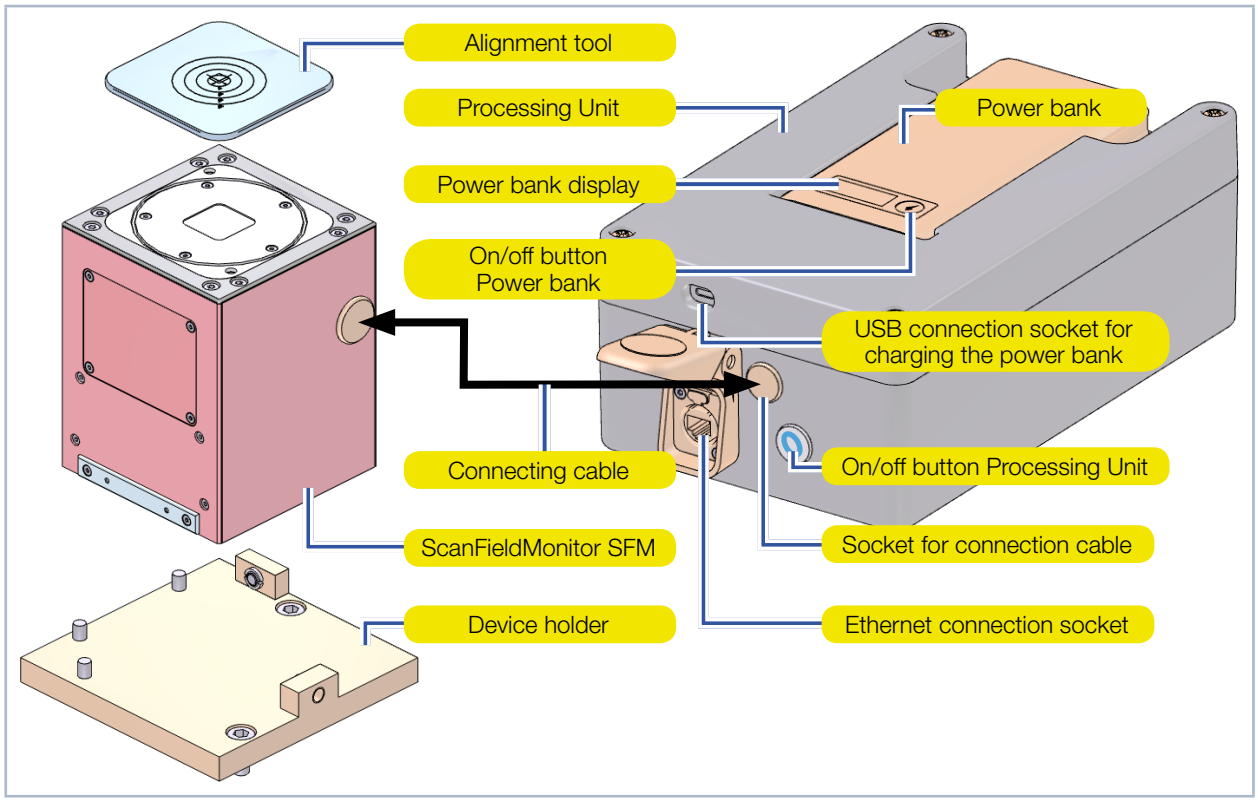


Fig. 6.1: Functional description of the ScanFieldMonitor SFM

6.2 Measuring principle

The ScanFieldMonitor SFM is equipped with a glass plate, in the middle of which is a small scattering structure. As the laser beam passes over the scattering structure, part of the laser beam is scattered along the lines of the scattering structure. This scattered light is detected by a photodiode in a time track. By knowing the exact position, angle and shape of the scattering structure, the laser path and the beam radius of the laser beam are determined by evaluating the time track in the LaserDiagnosticsSoftware LDS. When measuring at one position, the following quantities can be determined:

- Beam radius along the scan direction of the vector
- Scanning speed
- Position of the vector (start and end point, angle and length)

In order to measure the working plane, especially the corner areas of the closed scan field, the device is positioned at different positions within the scan field.
The ScanFieldMonitor SFM can also be used to measure a scan field with several lasers or to align adjacent scan fields.
The examination of the overlapping areas of these scan fields is particularly important because the two lasers must be precisely matched to each other in order to irradiate this region completely and, above all, uniformly. Since the ScanFieldMonitor SFM can also work with a large angle of incidence, this area can also be measured.

To measure the caustics of the laser beam along the beam propagation direction, the ScanFieldMonitor SFM is raised or lowered by the z-axis of the system to be measured. This allows the ScanFieldMonitor SFM to be moved in z-direction and the beam diameter to be measured in different planes. Thus, all important propagation parameters of the entire caustic of the laser beam are obtained:

- like focus position and focus diameter
- the beam quality factor M^2
- the Rayleigh length
- the divergence and the angle of incidence

not only in the center position but also for the deflected laser beam.

From the evaluation of all measurements, additional derived variables are obtained, such as the focus position over the entire processing field. Furthermore, measuring the switch-on and switch-off delay of the laser is possible via a separate measurement mode.

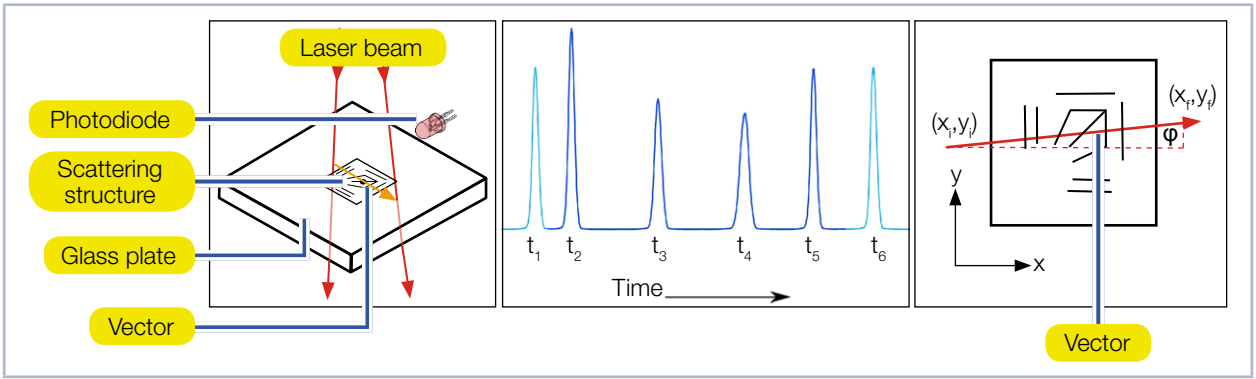


Fig. 6.2: Measuring principle of the ScanFieldMonitor SFM

7 Quick overview installation

1. Installing the LaserDiagnosticsSoftware LDS on the computer • The software is included in the scope of delivery.	See separate Operating Manual of the LaserDiagnosticsSoftware LDS
2. Taking safety precautions	Chapter 1 on page 8
3. Installing the plugin ScanFieldMonitor SFM on the computer • Software is part of the scope of delivery	Chapter 8 on page 15
4. Charge the power bank • Set output voltage • Check charge status	Chapter 10 on page 16
5. Installing the protective window spacer onto the ScanFieldMonitor SFM • For high power densities above 15 MW/cm² on the protective window of the ScanFieldMonitor SFM	Chapter 11 on page 18
6. Install device holder on the building platform of the laser system • Make preparations • Set installation position • Align the ScanFieldMonitor SFM with the device holder • Install the device holder	Chapter 12 on page 20
7. Electrical connection • Establish power supply • Connect the ScanFieldMonitor SFM to the Processing Unit • Establish WLAN or Ethernet connection with the PC	Chapter 13 on page 25
8. Switch ScanFieldMonitor SFM on/off	Chapter 14 on page 28
9. Position the ScanFieldMonitor SFM with the Processing Unit on the building platform of the laser system	Chapter 15 on page 29
10. Perform the measurement • Observe safety instructions • Perform measurements	Chapter 16 on page 30

8 Install/uninstall plugin

1. Close the opened LaserDiagnosticsSoftware LDS.
2. Double-click in the Windows start menu under Primes\LaserDiagnosticsSoftware on the file: ***Configuration Tool***.

3. Click on the ***Install Plugins*** tab in the window.
4. Click on the ***Search for Plugin*** button.
5. Choose the storage location where your installed plugins are saved:

➔ The plugin will be displayed. If there are multiple plugins, they will be listed together.

6. Check the box next to the plugin to be installed.
7. Click on the ***Install*** button:

➔ You will see the following message:
The plugin has been installed successfully / The plugins have been installed successfully.

➔ The plugin will then be available directly in the tool bar of the LaserDiagnosticsSoftware LDS.

Please note that after updating the LaserDiagnosticsSoftware LDS, the plugin must also be reinstalled. To do this, uninstall the old plugin and install the new plugin after updating the LaserDiagnosticsSoftware LDS.

To uninstall

1. Close the opened LaserDiagnosticsSoftware LDS.
2. Double-click in the Windows start menu under Primes\LaserDiagnosticsSoftware on the file: ***Configuration Tool***.

3. Click on the ***Uninstall Plugins*** tab in the window.
4. Place a check mark in the check box of the plugins you want to uninstall.
5. Click on the ***Uninstall*** button.

➔ You will see the following message:
The plugin has been uninstalled successfully / The plugins have been uninstalled successfully.

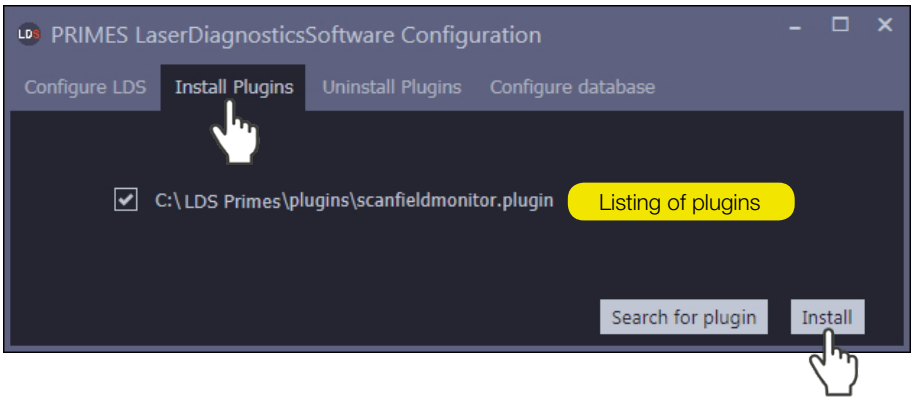


Fig. 8.1: Install plugin

9 Transport

NOTICE

Damage/destruction of the ScanFieldMonitor SFM or the Processing Unit

Hard impacts or dropping can damage the optical components of the ScanFieldMonitor SFM or the Processing Unit.

- ▶ **Handle the device carefully when transporting or installing it.**
- ▶ **To avoid contamination, close the inlet aperture of the ScanFieldMonitor SFM with the supplied alignment aid for transport and storage.**

10 Charge the power bank

A power bank is located on the upper side of the Processing Unit. Two different versions are distinguished:

- A Processing Unit with exchangeable power bank. For this Processing Unit the power bank can be pulled out and replaced.
- A Processing Unit with permanently installed power bank. For this Processing Unit the power bank cannot be removed.

Use only the supplied USB cable and quick-charge plug-in power supply to charge the power bank. Recharge the power bank when the charge level reaches 20 percent.

To charge the power bank, please proceed as follows:

1. Press the on/off button on the Processing Unit for at least five seconds:
➔ The ring light on the Processing Unit flashes and switches off.
➔ The ScanFieldMonitor SFM is switched off.
➔ The power bank switches off automatically after a few seconds.
2. Insert the plug of the quick-charge power supply unit into the charging socket of the Processing Unit. If the power bank is already removed, use its integrated socket for charging:
➔ The charge status is shown in percent in the power bank display.

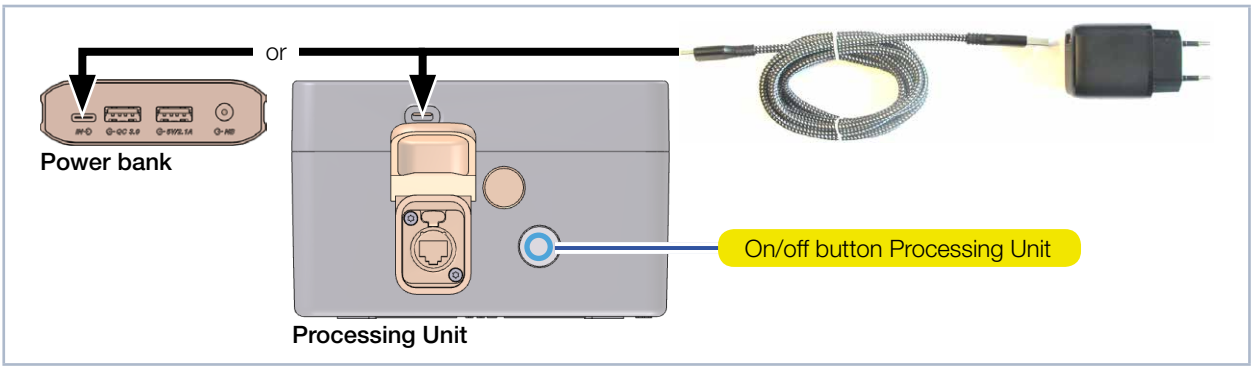


Fig. 10.1: Charge the Processing Unit with installed power bank or charge the removed power bank, both with the quick-charge plug-in power supply

During the charging process, further information can be shown in the display:

Display during charging	Meaning	Measure
Battery symbol flashes and alternates with the display of the charging power in W	The power bank is charging	---

Display during charging	Meaning	Measure
OV	Over voltage	The charging process is stopped automatically: • Activate the Processing Unit again by briefly pressing the on/off button.
UV	Under voltage	
OC	Charge current too high	
OT	Temperature too high	The charging process is stopped automatically: • Let the power bank cool down. Continue charging after the power bank has cooled down. • Activate the Processing Unit again by briefly pressing the on/off button.

Tab. 10.1: Displays during charging

10.1 Setting the output voltage on the power bank

The power bank offers the possibility to set the output voltage. The ScanFieldMonitor SFM can be operated with any output voltage of the power bank. However, the power consumption of the Processing Unit is lowest at 12 V output voltage.

To set the output voltage on the power bank, please proceed as follows:

1. Press the on/off button of the power bank for at least three seconds until the volt value in the power bank display flashes:

- Each time the on/off button is pressed again, the selected output voltage switches further (12 V, 15 V, 16.5 V, 19 V, 20 V, 24 V).
- Without further pressing, the displayed output voltage is set.
- You can check the set output voltage at any time by briefly pressing the on/off button.

10.2 Check the charging status of the power bank

The charge status of the power bank is displayed in percent. The accuracy of this display depends on various factors (e.g. temperature, age of the power bank, etc.). Recharge the power bank when the charge level reaches 20 percent.

When the power bank is fully discharged, the charging time with the supplied quick-charge plug-in power supply is approx. 5 hours. At 100% charge status, the possible operating time is approx. 6 hours.

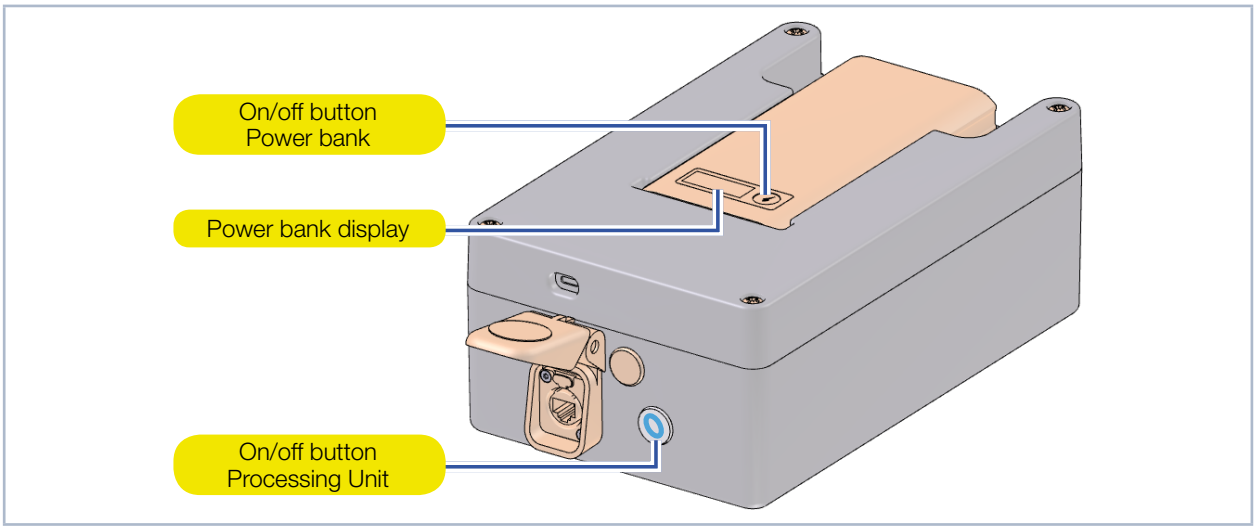


Fig. 10.2: Set output voltage on power bank and check charge status

11 Installing the protective window spacer on the ScanFieldMonitor SFM

For high power densities above 15 MW/cm² at the ScanFieldMonitor SFM protective window, we recommend operating the ScanFieldMonitor SFM with the protective window spacer.
With the spacer we enlarge the distances between measurement structure and protective window. Thereby the power density on the protective window is reduced to a noncritical range. Please note that when using the protective window spacer, the protective window in the ScanFieldMonitor SFM must be dismantled.

11.1 Removing the protective window and O-ring on ScanFieldMonitor SFM

1. Observe the safety instructions in chapter 19.1.1 on page 67.
2. Unscrew the 5 Torx screws M2 x 3 mm (Torx 6 screwdriver) at the protective window holder.
3. Put on powder-free latex gloves.
4. Remove the protective window holder carefully upwards.
5. Remove the protective window from the ScanFieldMonitor SFM. We recommend to use a suction cup to remove the protective window.
6. Remove the O-ring from the indentation.

7. Tighten the protective window holder with 5 Torx screws M2 x 3 mm.
8. Check for secure fit of the protective window holder. The protective window holder must lie flat against the housing of the ScanFieldMonitor SFM.

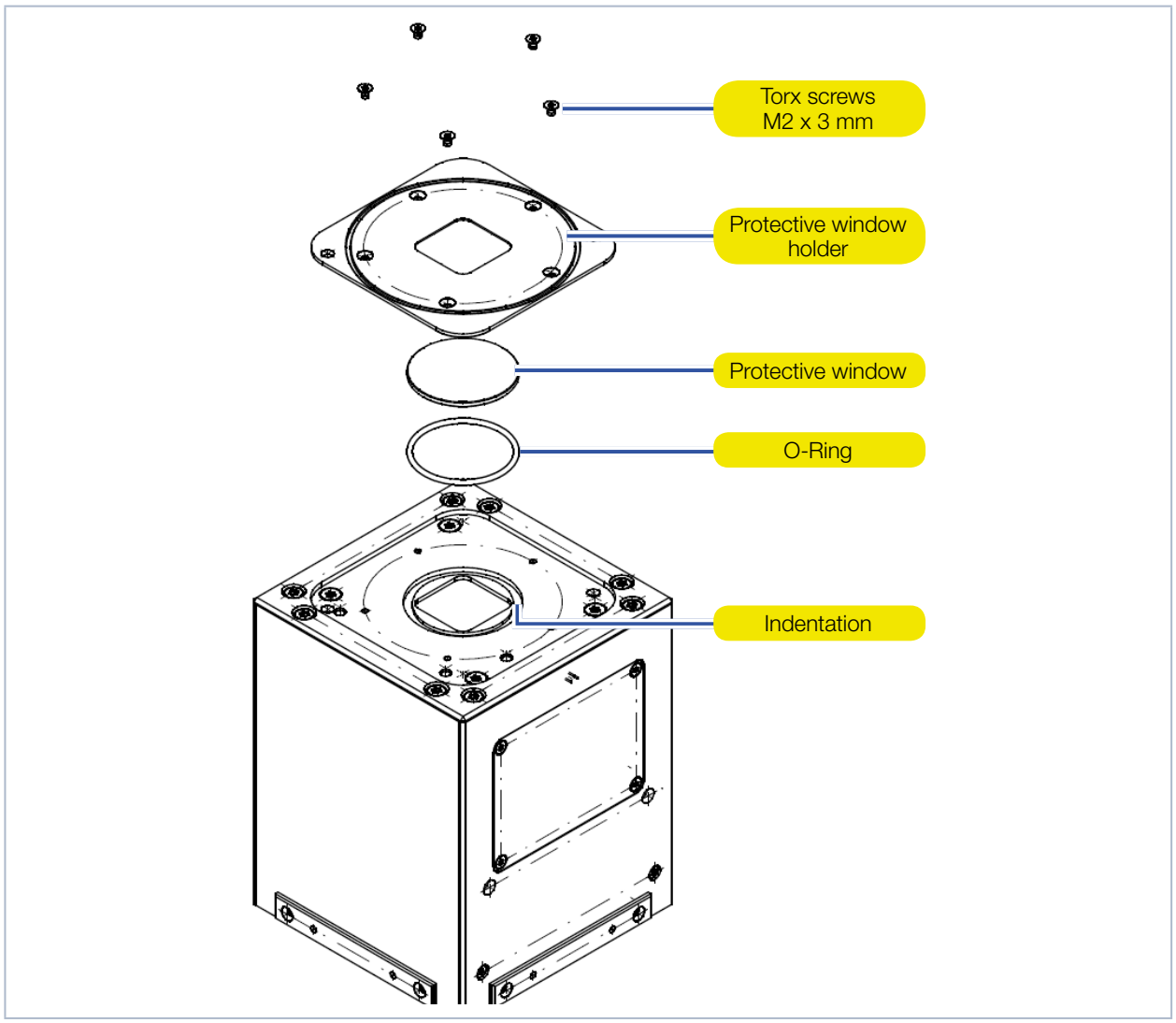


Fig. 11.1: Removing the protective window and O-ring on ScanFieldMonitor SFM

11.2 Installing the protective window spacer

1. Place the protective window spacer on the ScanFieldMonitor SFM.
2. Tighten the protective window spacer with 2 Torx screws M3 x 25 mm (Torx 10 screwdriver).
3. Check for secure fit of the protective window spacer. The protective window spacer must lie flat against the housing of the ScanFieldMonitor SFM.

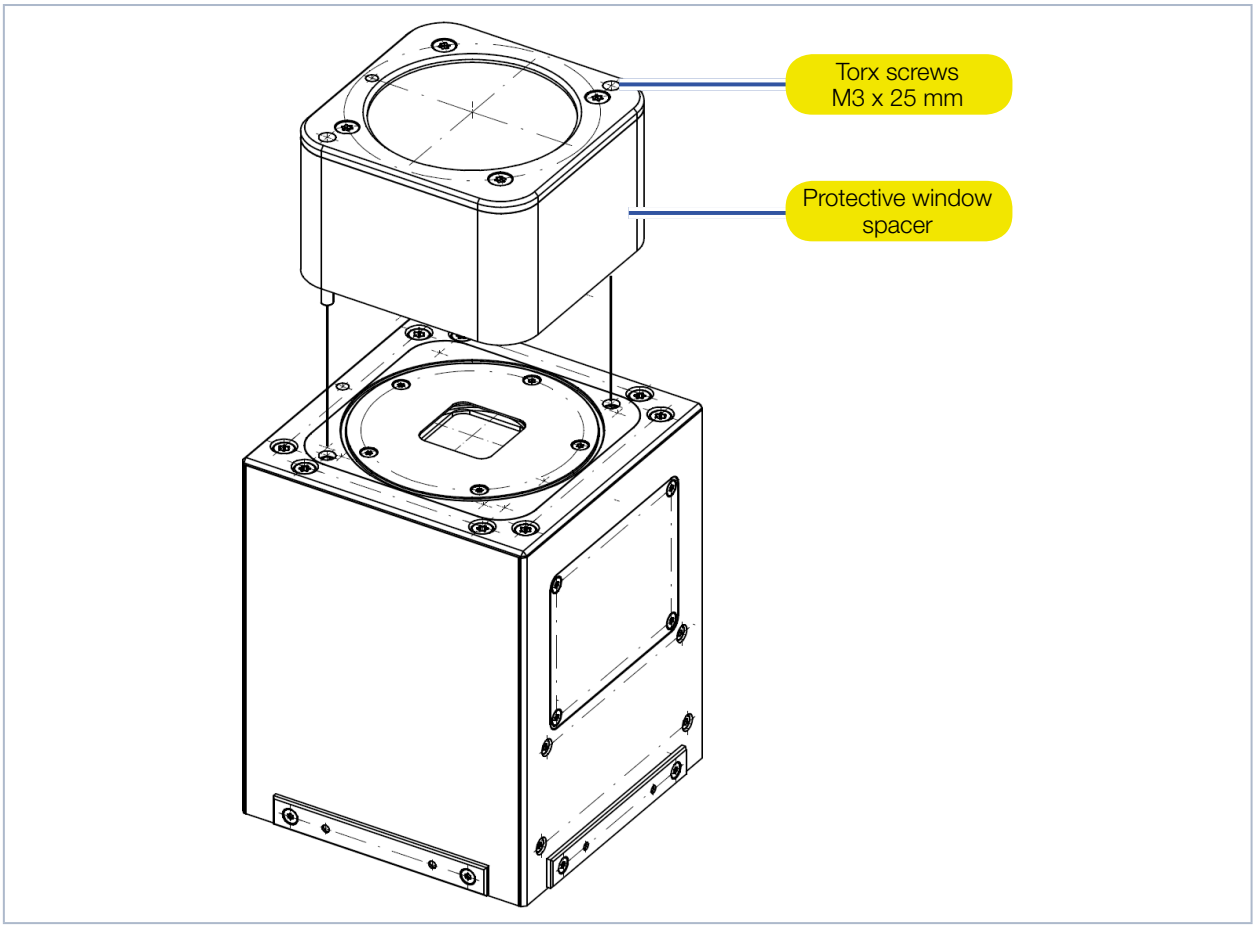


Fig. 11.2: Installing the protective window spacer

12 Install device holder on the building platform of the laser system

12.1 Prepare installation

1. Turn the laser source off.
2. Ensure that moving parts are at a standstill and that they cannot be set in motion unintentionally.

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 ScanFieldMonitor SFM.

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

3. Clean the building platform of the laser system. There must be no powder residues and contamination left on the building platform.
4. Deactivate or remove the coater (scraper).

12.2 Installation position

12.2.1 Alignment to the laser beam

The ScanFieldMonitor SFM is installed vertically and must be aligned to the laser beam. The ScanFieldMonitor SFM is positioned in the focal plane (see Fig. 12.1 on page 21). Make sure that the allowed power density at the beam entrance is not exceeded.

The ScanFieldMonitor SFM has a square inlet aperture of 20 mm x 20 mm. Within this area the laser radiation can enter the device. The scattering structure relevant for measuring amounts approx. 7.5 mm x 7.5 mm. We recommend to use vectors with a maximum length of 10 mm, i.e. 1.5 mm in front and behind the scattering structure.

The scattering structure can be crossed by the laser in x and y direction. During a measurement, the laser must pass over the scattering structure at a constant speed and always in one direction as a straight line.

If the housing is irradiated instead of the inlet aperture, it is usually damaged by the laser beam. Due to the absorption of the laser beam, the housing is also strongly heated, which leads to a considerable temperature increase. An over temperature of the device is displayed in the LaserDiagnosticsSoftware LDS. If the housing continues to be irradiated, the device may be damaged/destroyed.

To align the ScanFieldMonitor SFM under the laser, an alignment tool is supplied:
- ScanFieldMonitor SFM (see chapter 12.2.2 on page 22).
- ScanFieldMonitor SFM with protective window spacer (see chapter 12.2.3 on page 23).

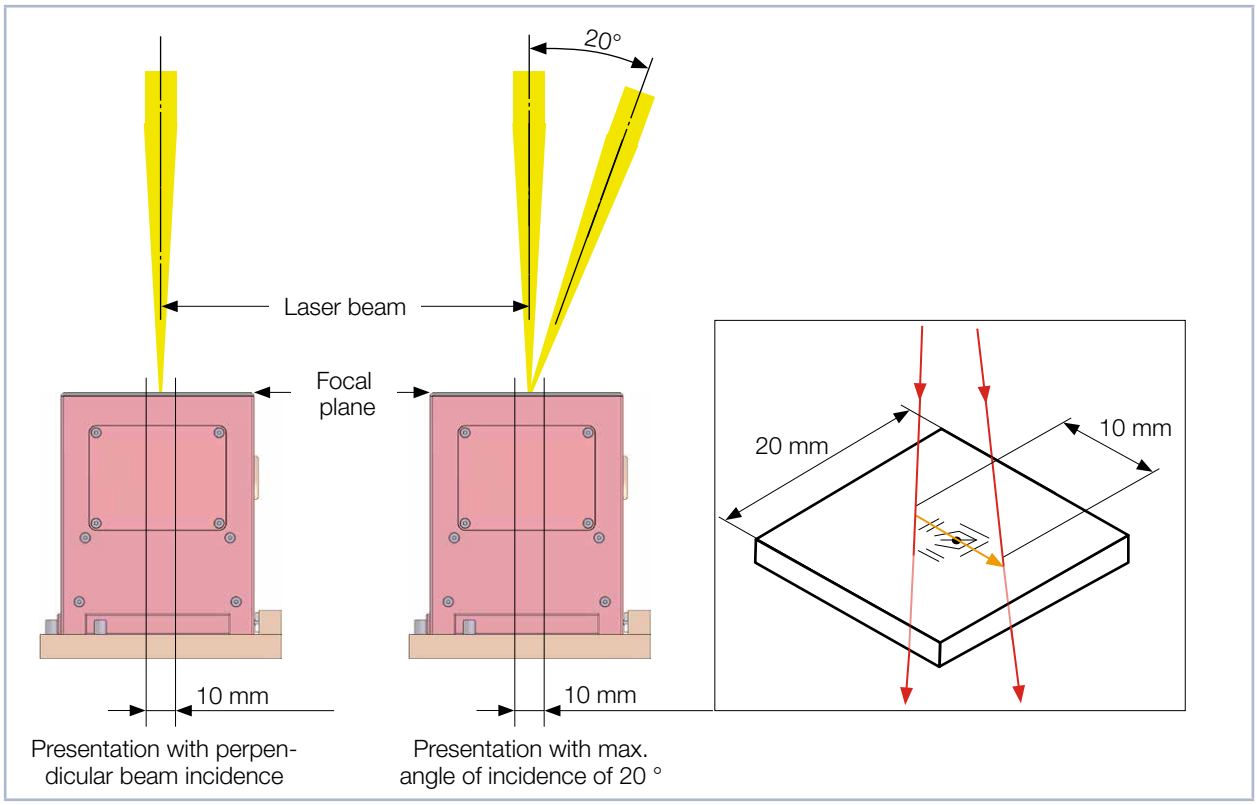


Fig. 12.1: ScanFieldMonitor SFM alignment to the laser beam

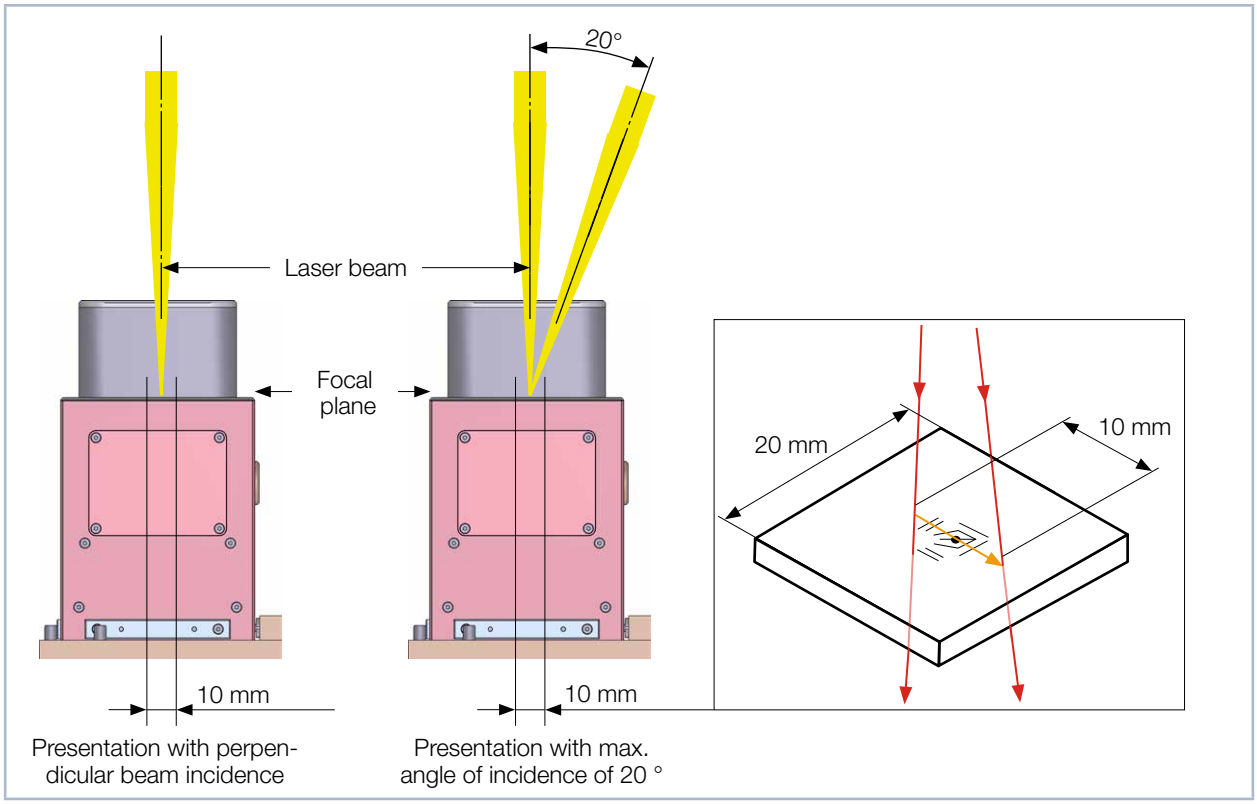


Fig. 12.2: ScanFieldMonitor SFM alignment to the laser beam with installed spacer

12.2.2 Aligning the ScanFieldMonitor SFM using the alignment tool

Using the alignment tool and a pilot laser beam you can align the device to the laser beam (see Fig. 12.3 on page 22).

1. Insert the ScanFieldMonitor SFM into the device holder:
2. Check the secure fit of the ScanFieldMonitor SFM in the device holder.
3. For an optimal fit, place the alignment tool on the provided drillings of the ScanFieldMonitor SFM.
4. Turn on the pilot laser and align the ScanFieldMonitor SFM.

With a perpendicular beam incidence from above or a lateral beam incidence, the laser beam of the pilot laser must move along the lines of the alignment tool along the vector direction (see also Fig. 12.1 on page 21).

1. Let the pilot laser move several times on the lines of the alignment tool along the x- and y-axis.
2. Align the device to the pilot laser exactly at the intersection of the cross hairs.

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.**

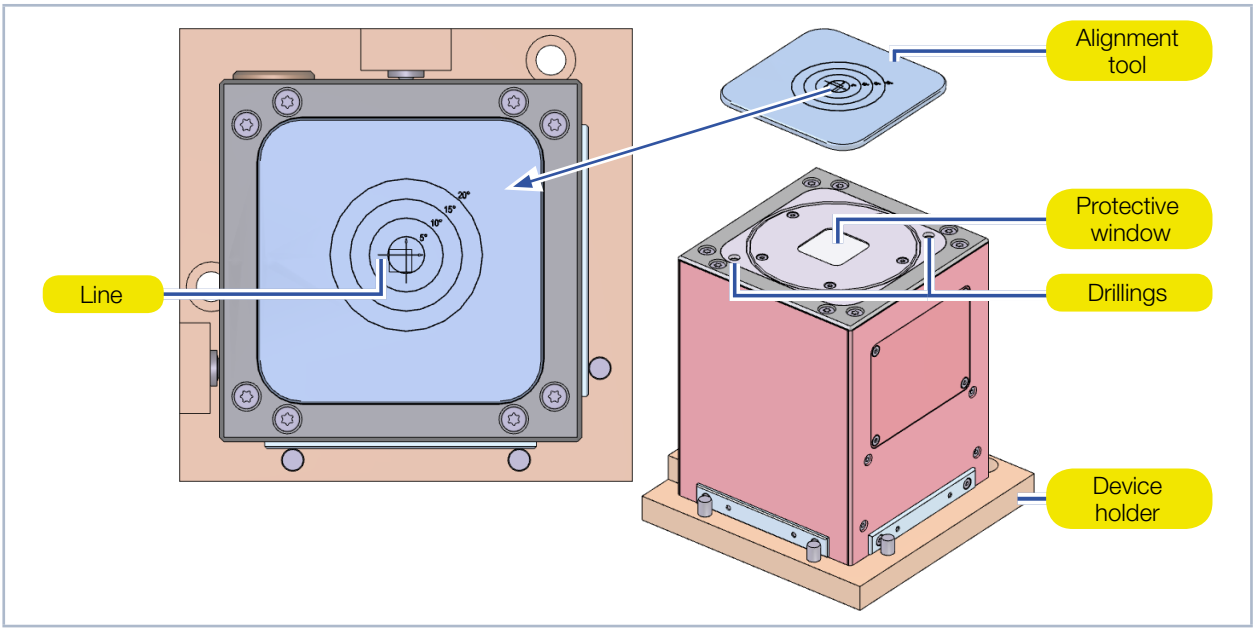


Fig. 12.3: Aligning the ScanFieldMonitor SFM using the alignment tool

12.2.3 Aligning the ScanFieldMonitor SFM with protective window spacer using the alignment tool

Using the alignment tool and a pilot laser beam you can align the device to the laser beam (see Fig. 12.4 on page 23).

1. Insert the ScanFieldMonitor SFM into the device holder:
2. Check the secure fit of the ScanFieldMonitor SFM in the device holder.
3. For an optimal fit, place the alignment tool on the provided drillings of the spacer.
4. Turn on the pilot laser and align the ScanFieldMonitor SFM.

With a perpendicular beam incidence from above

With a perpendicular beam incidence from above, the laser beam of the pilot laser must move along the lines of the alignment tool along the vector direction (see also Fig. 12.2 on page 21).

1. Let the pilot laser move several times on the lines of the alignment tool along the x- and y-axis.
2. Align the device to the pilot laser exactly at the intersection of the cross hairs.

With a lateral beam incidence

With a lateral beam incidence, the laser beam of the pilot laser must be aligned to a circle corresponding to the angle of incidence of the laser beam. On the alignment tool there are auxiliary lines with 5, 10, 15 or 20 degrees (see also Fig. 12.2 on page 21).

1. Let the pilot laser move several times on the lines of the alignment tool along the x- and y-axis.
2. Align the device to the pilot laser exactly at the intersection of the cross hairs.
3. Move the device along the propagation direction until the laser beam hits the desired circle of the alignment tool (Fig. 12.4 on page 23 shows an example for 15 degree).
   The propagation direction of the laser beam must run imaginary in the extension over the lines of the cross hairs.

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.**

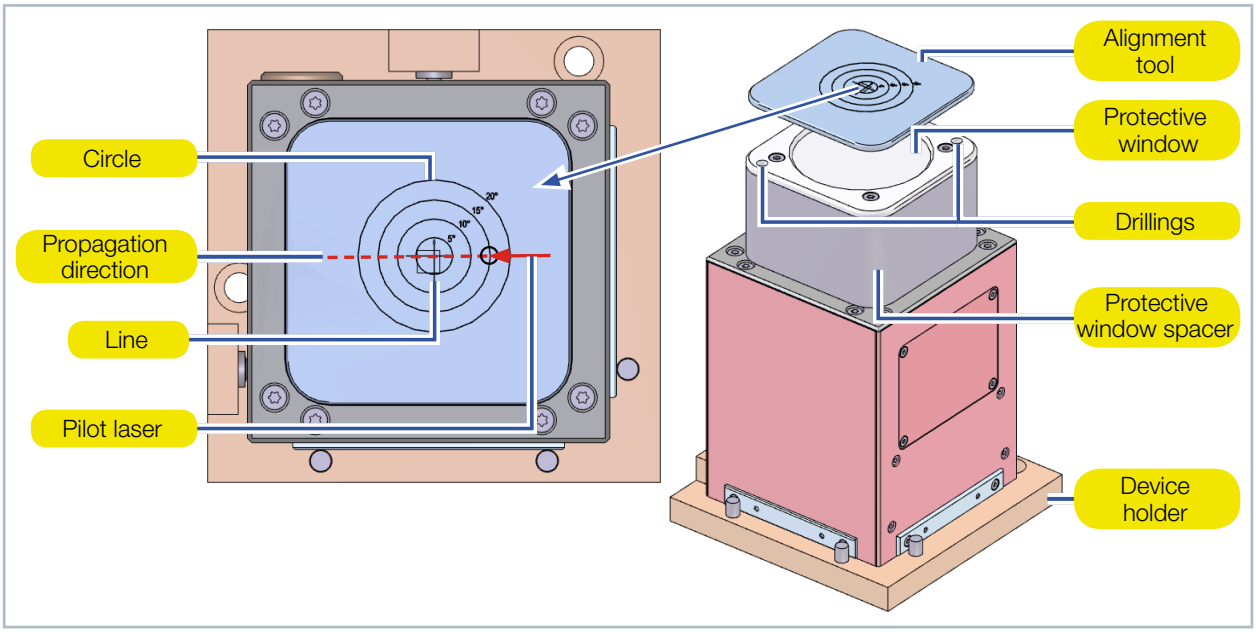


Fig. 12.4: Aligning the ScanFieldMonitor SFM with spacer using the alignment tool

12.3 Installation of the device holder on the building platform of the laser system

A device holder is supplied for installing the device at various positions on the building platform of the laser system. The laser radiation passes through the device during measurement and exits at the bottom of the ScanFieldMonitor SFM. For a secure operation the ScanFieldMonitor SFM may only be operated with a device holder that is able to absorb the exiting laser radiation.
If the ScanFieldMonitor SFM is mounted by a customer device holder, it must be ensured that this device holder can absorb the emitted laser radiation.

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 holder for the ScanFieldMonitor SFM in such a way that the device cannot be moved by an unintentional knock or cables being pulled accidentally.**

The installation of the device holder on the building platform of the laser system has to be carried out by the customer. The accuracy with which the position of the vector in the scan field can be measured is mainly determined by the accuracy of the customer's mounting plate.

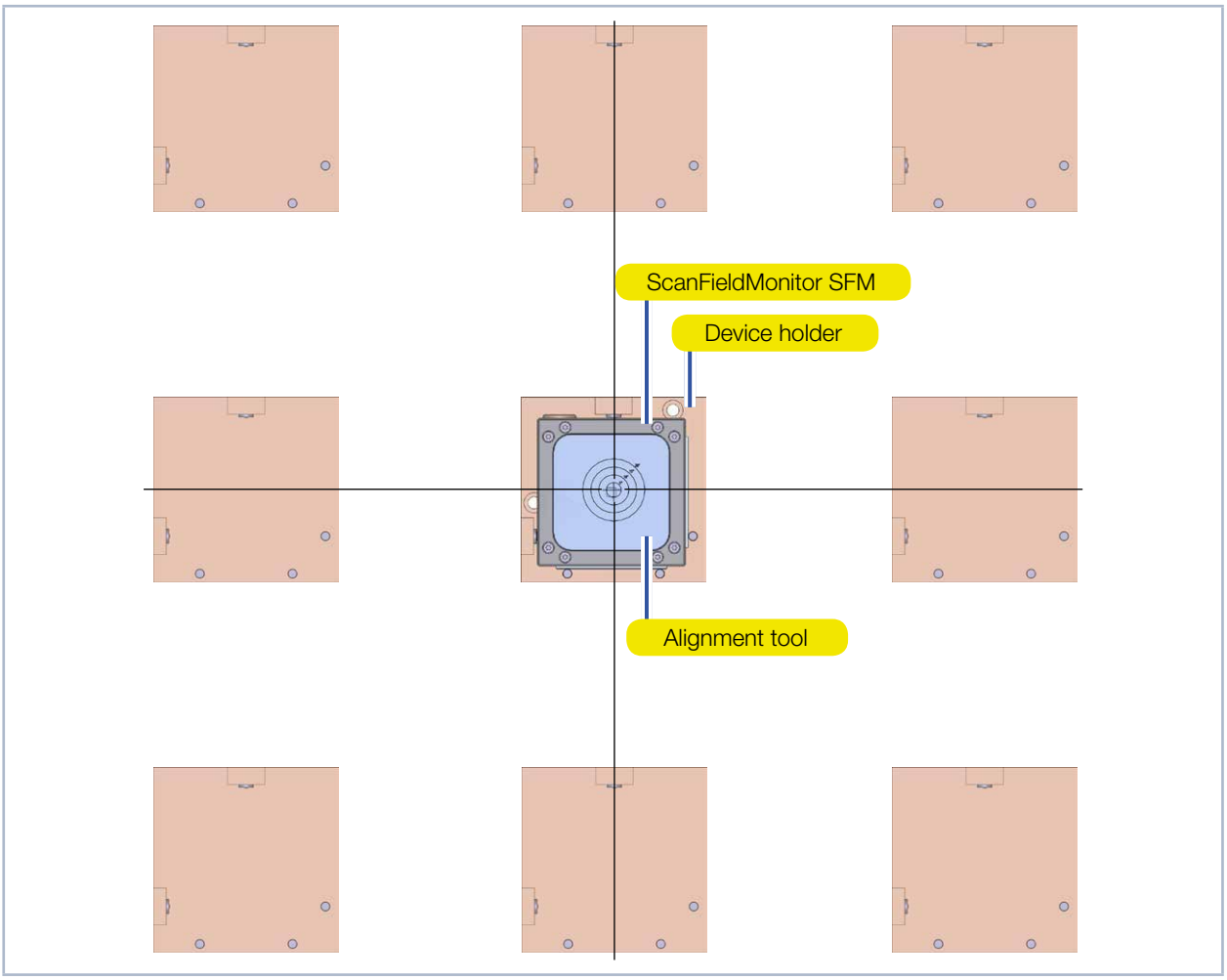


Fig. 12.5: Installation position on the building platform of the laser system

13 Electrical connection

Please use only the supplied connection cables, the USB cable and the quick-charge plug-in power supply.

13.1 Power supply of the ScanFieldMonitor SFM

The ScanFieldMonitor SFM is supplied with power:

- by the power bank in the Processing Unit or
- by the supplied USB cable with quick-charge plug-in power supply. This is plugged into the USB connection socket of the processing unit with the power bank.

Please note that the connected ScanFieldMonitor SFM is switched off when the USB cable is pulled out of the USB connection socket of the Processing Unit.

13.2 Connecting the ScanFieldMonitor SFM to the Processing Unit

1. Press the on/off button on the Processing Unit for at least five seconds to switch off the Processing Unit:

➔ The ring light on the Processing Unit flashes and switches off.

2. Connect the ScanFieldMonitor SFM to the Processing Unit using the connection cable.
3. If the power bank needs to be charged permanently, connect the quick-charge plug-in power supply unit with the Processing Units USB connection socket.

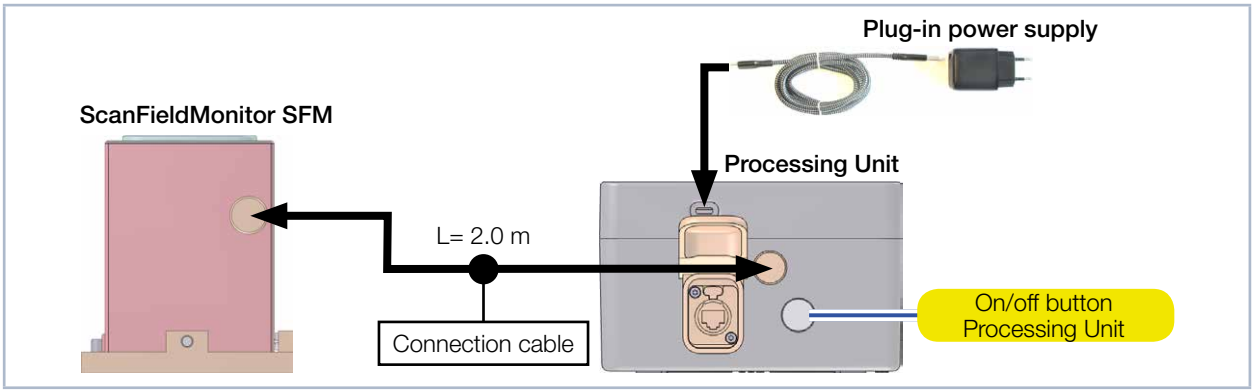


Fig. 13.1: Connecting the ScanFieldMonitor SFM with its Processing Unit

13.3 Connectivity options WLAN or Ethernet

13.3.1 For a WLAN connection with the Processing Unit

▶ Activate the WLAN connection according to chapter 13.4 on page 27.

13.3.2 For an Ethernet connection with the Processing Unit

NOTICE

Destruction of the network infrastructure

If the Processing Unit with ScanFieldMonitor SFM is directly connected to a network via Ethernet, the SFM DHCP protocol randomly assigns IP addresses in the network. Thus, even with a short plugging in of the Ethernet cable, the infrastructure of the network can be damaged/destroyed.

- **▶ Never plug the Ethernet cable of the Processing Unit directly into a Ethernet socket of a network.**
- **▶ Ethernet connection needs to be established always and exclusively between Processing Unit and PC.**

▶ Connect the Ethernet socket in the Processing Unit and the PC using the Ethernet cable.
➔ The Ethernet connection is established automatically when the Ethernet cable is plugged in (see chapter 16.3.1 on page 33).

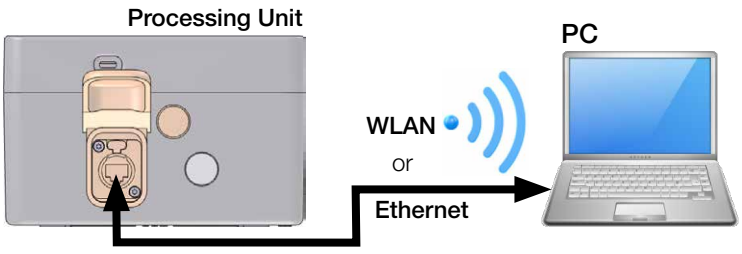


Fig. 13.2: Connecting Processing Unit to PC via WLAN or Ethernet

13.4 Establish/disconnect WLAN connection with the PC

1. Switch on the device according to chapter 14.1 on page 28.

2. Click on the WLAN Icon within the Windows taskbar.

The Network & Internet settings window opens.

3. Click on the desired device. In the example shown: ***PrimesSFMRO-1***:
- The designation PrimesSFMRO-1 corresponds to the SSID specification on the Processing Unit identification plate.
- The password on the identification plate of the Processing Unit is assigned to this SSID.

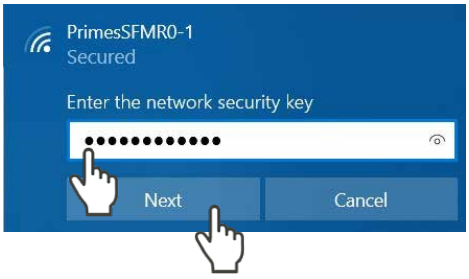
4. Click on the ***Connect*** button.

▶ Activate the check box ***Connect automatically***. This will establish connection next time automatically, SFM WLAN key is stored.
Suitable for the standard PC used for SFM measurements.

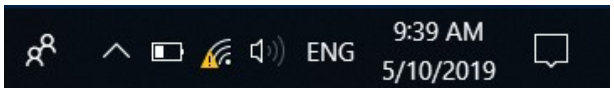
5. Enter the password:
- You will find the password on the identification plate of the Processing Unit.

6. Click on the ***Next*** button:

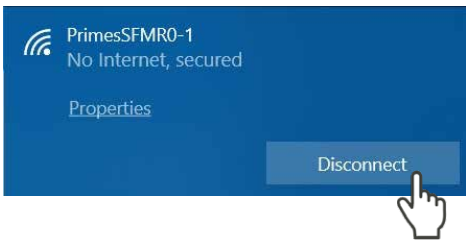
➔ The Processing Unit is connected to the PC.



Note
The yellow warning triangle in the Windows taskbar, only indicates that there is no Internet connection.
The function of the WLAN connection is not affected.



7. To disconnect the WLAN connection, click on the ***Disconnect*** button.



14 Switch the ScanFieldMonitor SFM on/off

14.1 Switch on the ScanFieldMonitor SFM

1. Switch on the power bank by briefly pressing the on/off button:
➔ The display in the power bank shows the charge status in percent and the set output voltage (12 V).
▶ If a different output voltage is displayed, you can set it according to chapter 10.1 on page 17.
2. Briefly press the on/off key on the Processing Unit:
➔ The ring light on the Processing Unit lights up.
➔ The display in the power bank shows the discharge power in W.
➔ The ScanFieldMonitor SFM is switched on.

14.2 Switch off the ScanFieldMonitor SFM

1. Press the on/off button on the Processing Unit for at least five seconds:
➔ The ring light on the Processing Unit flashes and turns off.
➔ The ScanFieldMonitor SFM is switched off.
➔ The power bank switches off automatically.

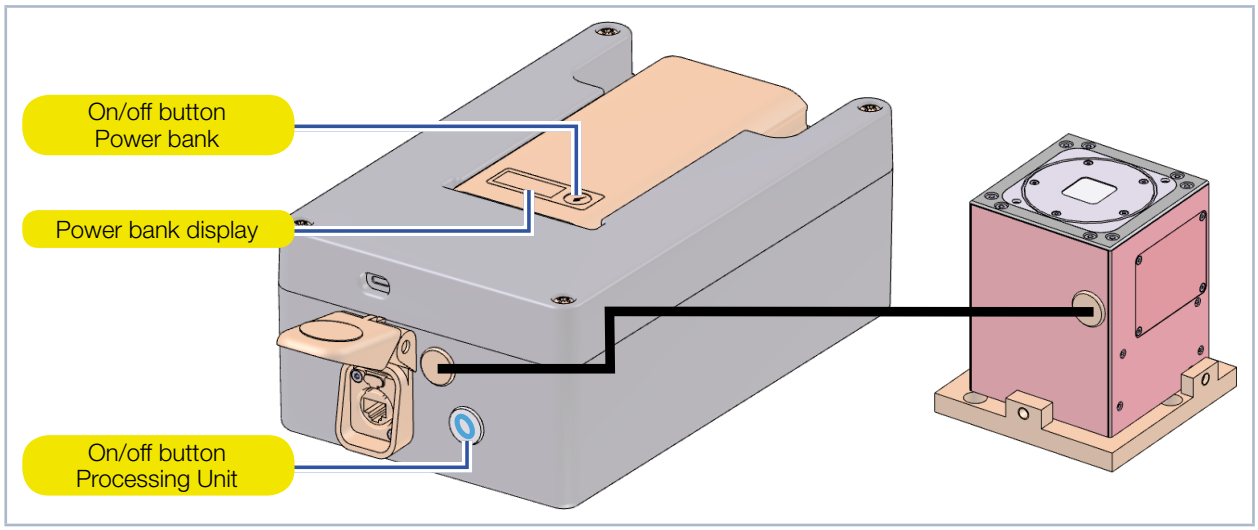


Fig. 14.1: Switch ScanFieldMonitor SFM on/off

15 Position the ScanFieldMonitor SFM with Processing Unit on the building platform of the laser system

15.1 Positioning the ScanFieldMonitor SFM and Processing Unit

During measurements, the Processing Unit transmits the data wirelessly via WLAN or via Ethernet connection to the PC.

1. Turn off the laser source.
2. Ensure that moving parts are at a standstill and that they cannot be set in motion unintentionally.
3. Clean the building platform of the laser system. All powder residues and contamination must be removed.
4. Deactivate the coater (scraper).
5. Switch on the ScanFieldMonitor SFM according to chapter 14.1 on page 28.
6. Insert the ScanFieldMonitor SFM into the device holder.

DANGER

Fire hazard

The Processing Unit is equipped with a power bank. If the power bank is damaged by the laser beam, it may catch fire.

- ▶ **Position the Processing Unit at a radiation-free location on the building platform.**

7. Position the Processing Unit at a radiation-free location on the building platform.

15.2 Removing the ScanFieldMonitor SFM from the building platform

1. Turn off the laser source.
2. Ensure that moving parts are at a standstill and that they cannot be set in motion unintentionally.

CAUTION

Hot surface – risk of burns

The device and especially the device holder heat up during a measurement.
An overtemperature of the device is displayed in the LaserDiagnosticsSoftware LDS.

- ▶ **Do not touch the device and the device holder directly after a measurement.**
- ▶ **Let the device and the device holder cool down for an adequate period of time. The cooling time varies depending on the laser power and the irradiation time.**

3. Remove the device from the laser system.
4. Switch off the ScanFieldMonitor SFM according to chapter 14.2 on page 28.
5. After using the ScanFieldMonitor SFM, check the optical components for damage.
6. To avoid contamination, cover the inlet aperture with the alignment tool.

16 Measuring

This chapter describes examples of measurements with the LaserDiagnosticsSoftware LDS and the plugin for the ScanFieldMonitor SFM to familiarize you with the ScanFieldMonitor SFM.

For a detailed description of the software installation, file management and evaluation of the measured data, please refer to the separate operating manual LaserDiagnosticsSoftware LDS.

16.1 Safety instructions

DANGER

Serious eye or skin injury due to laser radiation

During the measurement the laser beam is guided on the device, which causes scattered or directed reflection of the laser beam (laser class 4). The reflected beam is usually not visible.

- **Please wear safety goggles adapted to the power, power density, laser wave length 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

Fire hazard

The Processing Unit is equipped with a power bank. If the power bank is damaged by the laser beam, it may catch fire.

- **Before measuring, check that the Processing Unit is not positioned in the beam path of the laser.**

CAUTION

Hot surface – risk of burns

The device and especially the device holder become hot during a measurement.
An overtemperature of the device is displayed in the LaserDiagnosticsSoftware LDS.

- **Do not touch the device and the device holder directly after a measurement.**
- **Let the device and the device holder cool down for an adequate period of time. The cooling time varies depending on the laser power and the irradiation time.**

NOTICE

Damage/Destruction of the device

Residual powder or contamination on the device will cause burn-ins during measuring operation. Burn-ins can cause the protective window to shatter or splinter.
The movement of the coater (scraper) can damage the ScanFieldMonitor SFM.

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

NOTICE

Damage/Destruction of the device

If the housing is irradiated instead of the entrance aperture, it may become hot. An overtemperature of the device is displayed in the LaserDiagnosticsSoftware LDS. If the housing is irradiated further, the device may be damaged/destroyed.

- ▶ Finish the measurement and check the alignment of the device to the laser beam.

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. Parts of the protective window can get into the laser system and damage it.

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

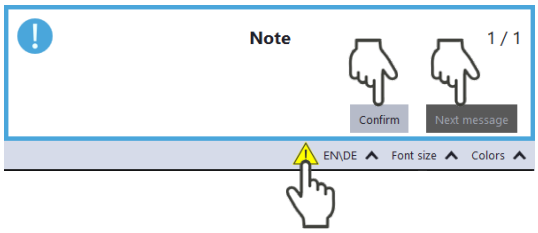
16.2 Consider the messages in the LaserDiagnosticsSoftware LDS during measurement

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

Notes

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

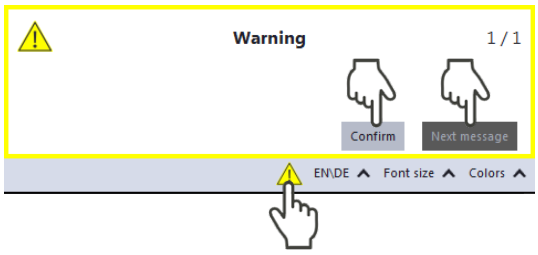
Use one of the following options:
- ▶ Click on the warning triangle in the footer to display/hide the window.
- ▶ If applicable, click the ***Next message*** button to display more messages of the same category.
- ▶ Click the ***Confirm*** button to remove the displayed message.



Warnings

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.



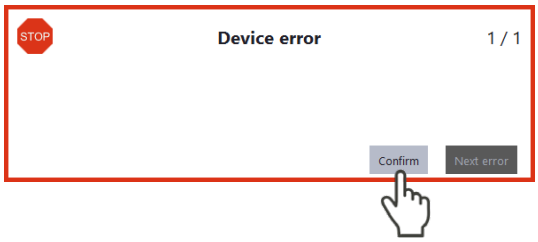
Safety critical device errors

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.



16.3 Connecting the ScanFieldMonitor SFM with the LaserDiagnosticsSoftware LDS

16.3.1 Connect device

1. Switch on the device according to chapter 14.1 on page 28.

Only for WLAN connection

▶ Start the WLAN connection according to chapter 13.4 on page 27.

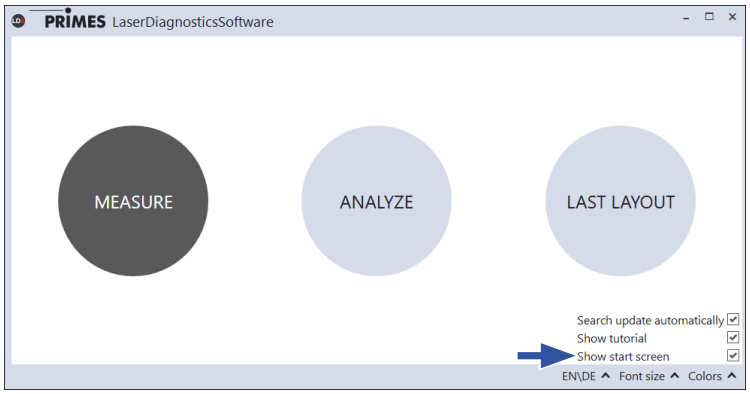
2. Start the LaserDiagnosticsSoftware LDS by double-clicking on the program icon in the start menu group or on the desktop icon.

👁 The start logo LDS appears for a short time.

Only if the *Show start screen* option is enabled:

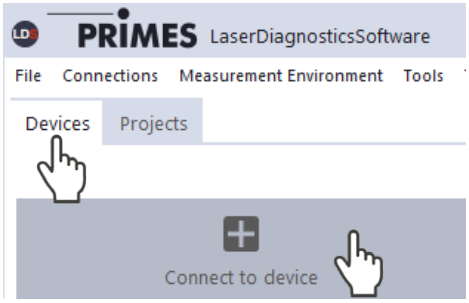
👁 The start screen appears.

3. Select the ***Measure*** operating mode.



Only if the *Show start screen* option is disabled:

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

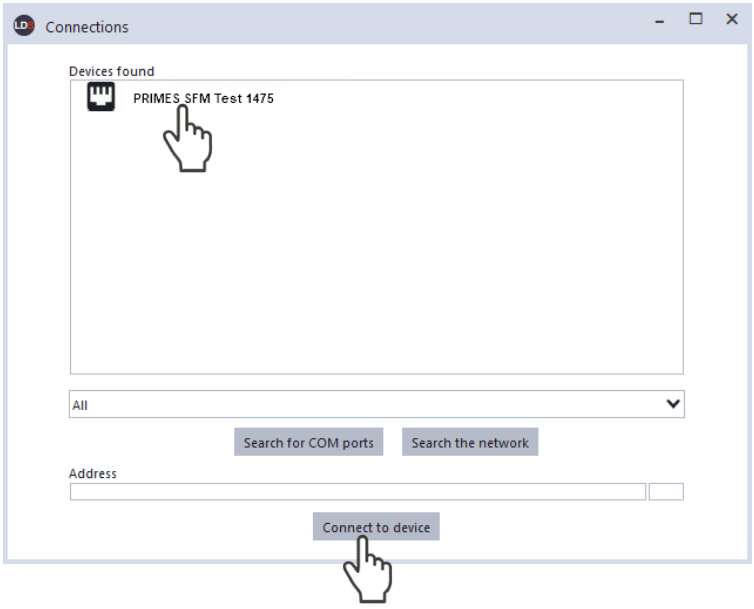


👁 The ***Connections*** window appears.

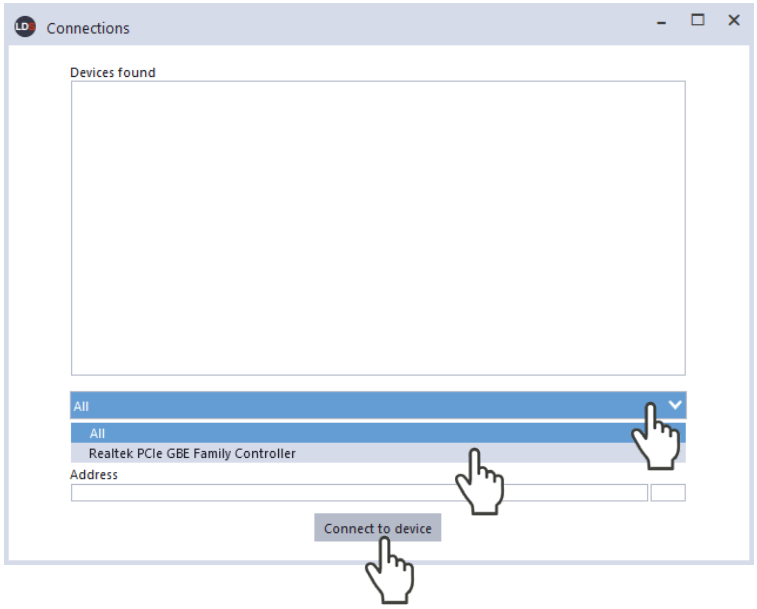
5. Click on the desired device.

▶ If the device does not appear in the ***Connections*** window, see chapter 16.3.2 on page 34.

6. Click on the ***Connect to device*** button.



16.3.2 The device does not appear in the connections window

The connection between device and LaserDiagnosticsSoftware LDS may be blocked by the firewall. ▶ In ***Windows > Control panel > Firewall***, enable the UDP port 20034.	The UDP port should be enabled by a system administrator.
The network address of the PC is not within the range of the ScanFieldMonitor SFM. ▶ In ***Windows > Control panel > Network and Sharing Center***, set the PC to DHCP (obtain IP address automatically).	The IP address should be entered by a system administrator.
If several Ethernet cards or a USB3-to-Ethernet card are installed in the PC, the connection between device and LaserDiagnosticsSoftware LDS may be blocked by the selection of the wrong Ethernet card. 1. Select the appropriate Ethernet card in the ***Connections > All*** window: 👁 The device is displayed in the ***Connections*** window 2. Click on the device. 3. Click on the ***Connect to device*** button.	

16.4 General procedure for measuring

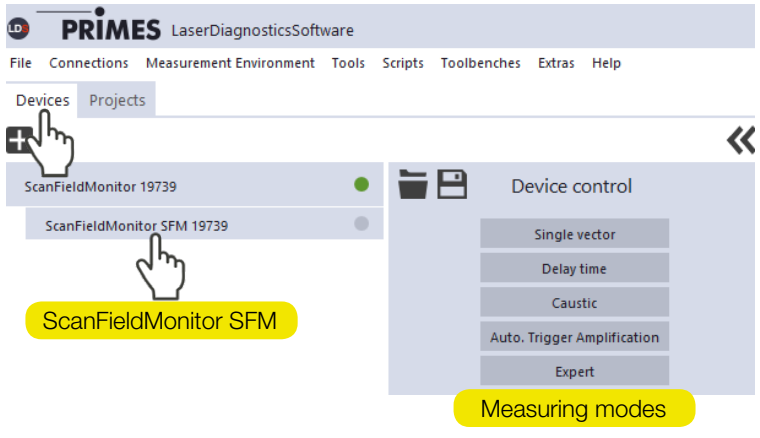
This chapter describes in general which steps are necessary to perform measurements after connecting your device to the LaserDiagnosticsSoftware LDS and what you should pay attention to. Read this general information before you turn to the following chapters on the different measurement tasks.

16.4.1 Open the Device control menu

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

1. Click on the ***Devices*** tab.
2. Click on ***ScanFieldMonitor SFM***.

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

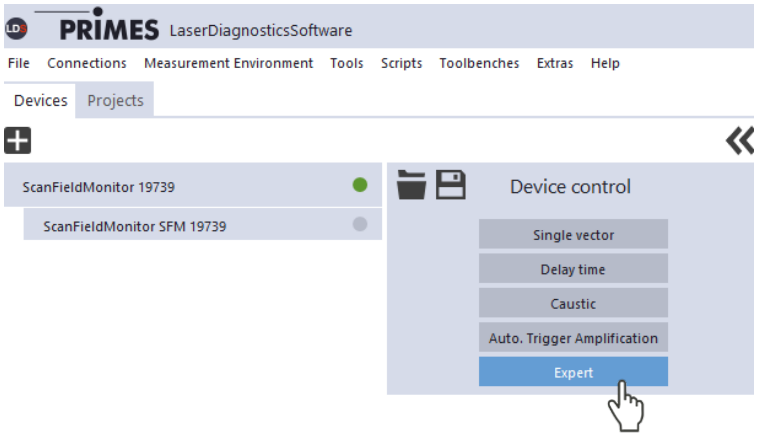


16.4.2 Select measuring mode

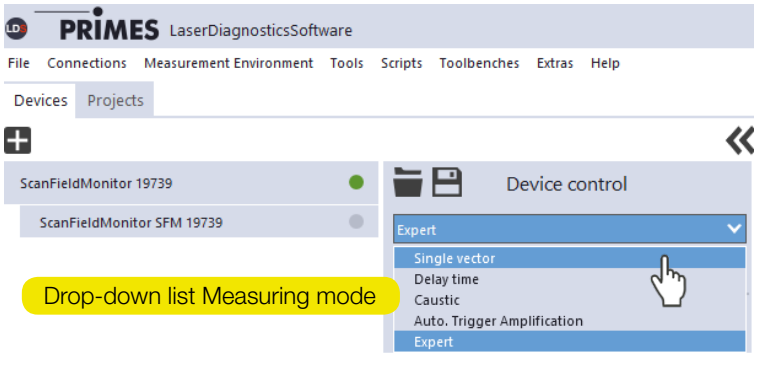
Select the measuring mode for your desired measuring task. You will find the Measuring modes in the ***Device control*** menu. In a measuring mode, all relevant setting options for a measuring task are clearly arranged in a menu.

▶ Click on the button of the desired measuring mode, e.g. ***Expert***.

👁 The ***Settings*** and ***Advanced*** tabs are displayed for the selected measurement mode.



👁 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***.



16.4.3 Configuring and saving measurement settings

After selecting a measurement mode, you can configure numerous measurement and device settings in the ***Settings*** and ***Advanced*** tabs of the ***Device Control*** menu. All available options and settings for SFM measurements will be described in the following chapters on every different measuring task. However, some operating steps in the Device control menu apply equally to all measuring modes. They are described in the following overview.

When configuring settings, especially in the Expert measuring mode, note that they are also applied in the other measuring modes.

When saving/loading a configuration, note that you call up the command from a specific measuring mode. At the same time, however, the saved/loaded data set also contains the settings of the other measuring modes.

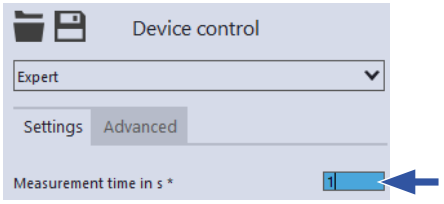
Entering and activating parameters
Accept an entered parameter value into the active configuration in the ***Device control*** menu. Confirm it with the enter key or by clicking outside the input field.

1. Enter the desired value in the parameter field.

👁 The background color of the parameter field changes to blue.

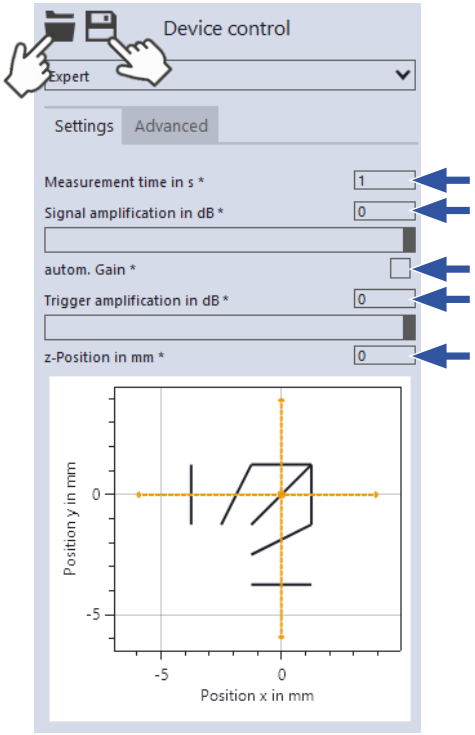
2. Confirm the input by pressing the Enter key or click outside the input field.

👁 The parameter field will return to its original background color.



Save a configuration to a file/ load from a file
All options marked with an asterisk in the ***Device Control*** menu can be saved to/ loaded from a preset file with the ***.pre*** extension.

- ▶ To save a configuration, click on the icon 💾.
- ▶ To load a configuration, click on the icon 📂.



16.5 Performing automatic determination of the 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 ScanFieldMonitor SFM within the scan field. If you change one of these parameters, you should determine the trigger amplification again.

16.5.1 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 LaserDiagnosticsSoftware LDS menu ***Auto. Trigger amplification > Device control > Settings: Instructions***.

Programming of the laser

- For the automatic trigger adjustment the laser must be switched on for ≥ 0,5 seconds.
- We recommend switching on the laser at a steady position within the SFM measurement window.
- For the automatic trigger adjustment a vector can also be moved with low speed within the SFM 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 set to 1 s.
- We recommend initially setting the trigger amplification to 0 dB.
- 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 we recommend to save the result of the automatic trigger adjustment.

The procedure in the menu of the LaserDiagnosticsSoftware LDS is described in the following chapters.

16.5.2 Selecting automatic trigger amplification measuring mode

1. Connect the device according to chapter 16.3 on page 33 with the LaserDiagnosticsSoftware LDS.

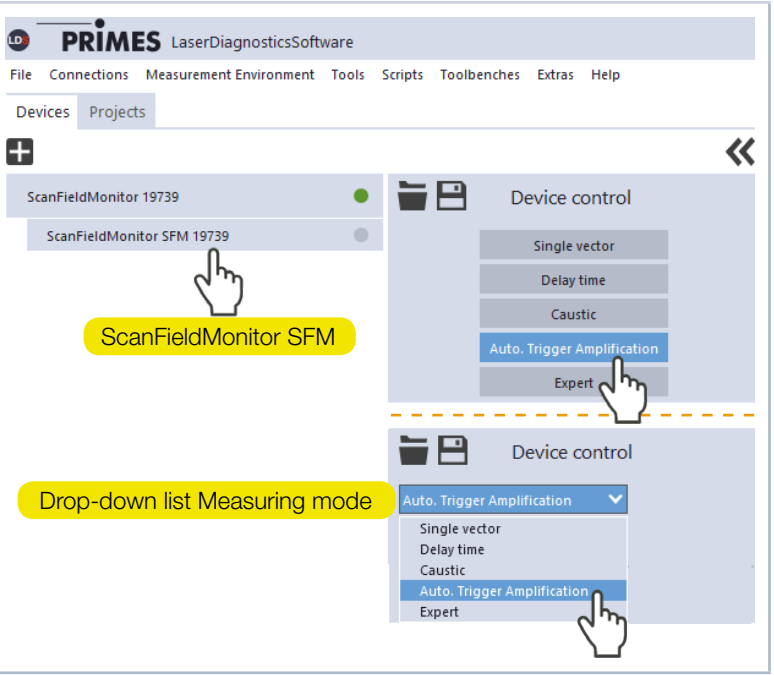
👁 The ScanFieldMonitor SFM is established as a connected device.

2. Click on ***ScanFieldMonitor SFM***.

👁 The ***Device control*** menu opens.

3. Click the ***Auto. Trigger amplification*** button
or
on the drop-down list Measuring mode and ***Auto. Trigger amplification***.

👁 The corresponding ***Device control*** opens.



16.5.3 Configuring the settings (*Device control* > *Settings*)

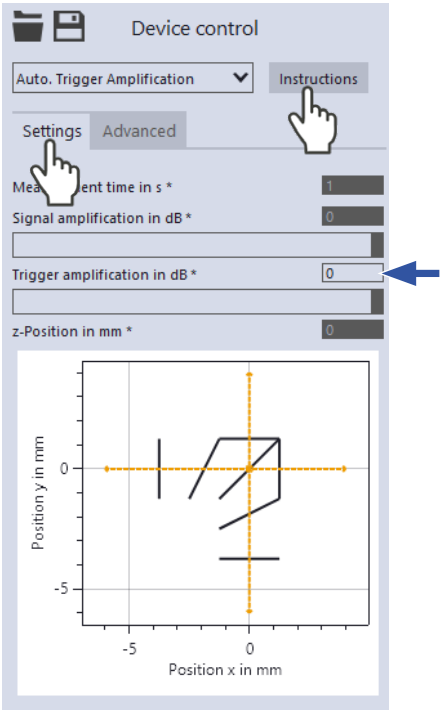
1. Click on the ***Settings*** tab.

Instructions
Click the ***Instructions*** button to get general information about the measurement.

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

👁 ***Signal amplification in dB*** and ***z-position in mm*** cannot be set, as these values have no influence on the trigger amplification.

2. Set the ***Trigger amplification in dB*** to 0 dB.



16.5.4 Configuring the advanced settings (*Device control* > *Advanced*)

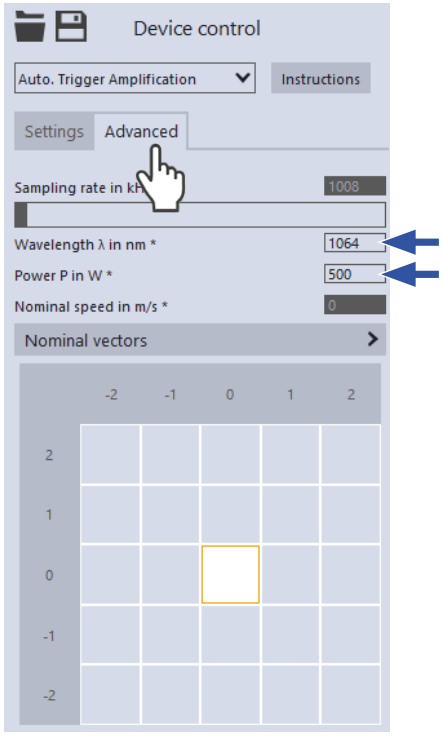
1. Click on the ***Advanced*** tab.

The ***Sampling rate in kHz*** is preset to the minimum value of 1008 kHz.

Specifications of the laser
The specifications for the laser are informative and serve only for the subsequent classification of the measurement.

2. Enter the used ***Wavelength in nm*** of the laser.
3. Enter the ***Power P in W*** during the measurement.
4. Enter measurement position on the building platform.

The ***Nominal speed in m/s*** cannot be set, as these values have no influence on the trigger amplification.



16.5.5 Starting measurement of the automatic trigger amplification

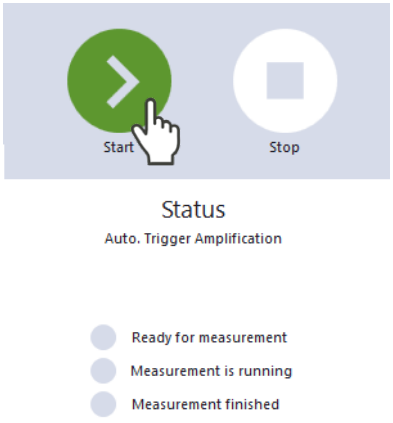
1. Follow the safety instructions in chapter 16.1 on page 30.

2. Click on the ***Start*** button:
➔ The ScanFieldMonitor SFM waits for 15 s for the laser.

3. Switch on the laser:
• The laser must be switched on for ≥ 0.5 seconds.

Measurement is running
The measurement is performed with the measurement time of 1 second.

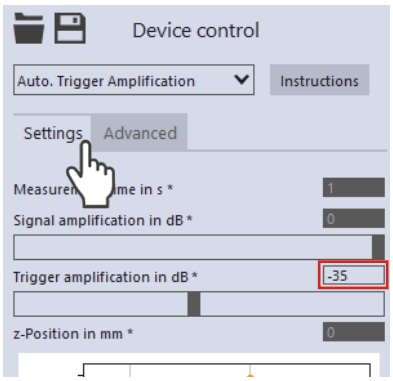
Measurement is finished
The measurement is finished.



16.5.6 Displaying the determined trigger amplification and transfer to all measuring modes

▶ Click on the ***Settings*** tab.

The determined value is displayed in the ***Trigger amplification in dB*** input field and is adopted in all measurement modes.
The trigger amplification can also be entered manually, e.g. from a previous measurement.



16.5.7 Displaying the determined trigger amplification in the project tree

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

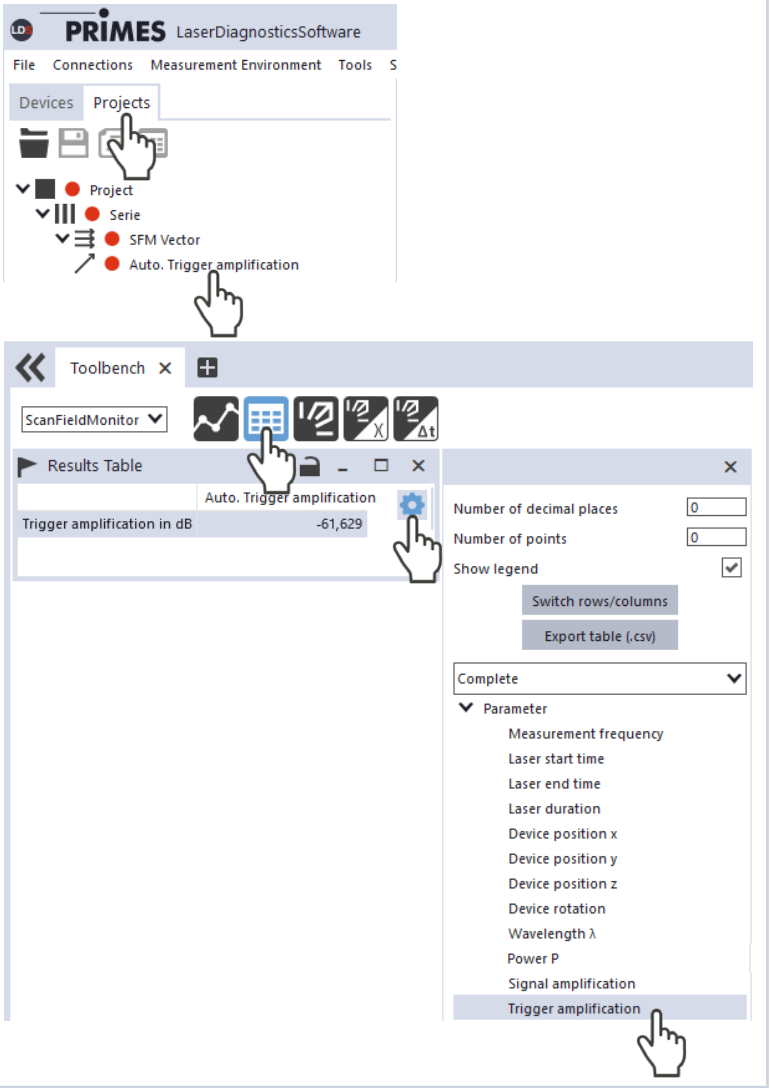
1. Click on the ***Projects*** tab:
➔ The determined trigger amplification is listed in the file structure.
▶ For information on project management, please refer to the separate LaserDiagnosticsSoftware LDS operating manual.

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***.



16.6 Basic settings for all measuring modes

16.6.1 Selecting the measuring mode Expert

1. Connect the device according to chapter 16.3 on page 33 with the LaserDiagnosticsSoftware LDS.

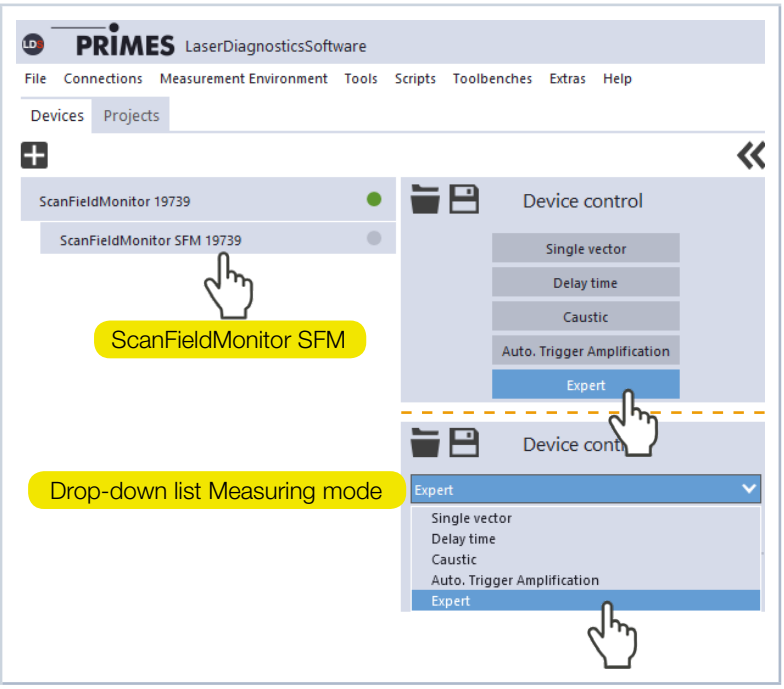
👁 The ScanFieldMonitor SFM is established as a connected device.

2. Click on ***ScanFieldMonitor SFM***.

👁 The ***Device control*** menu opens.

3. Click on the ***Expert*** button
or
on the drop-down list Measuring mode and ***Expert***.

👁 The corresponding ***Device control*** opens.



16.6.2 Configuring the settings (*Device control* > *Settings*)

1. Click on the ***Settings*** tab.

2. Enter the ***Measurement time in s***.

Signal amplification

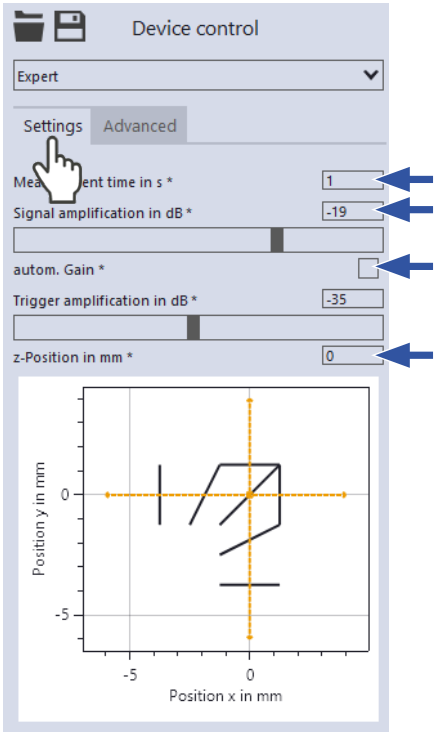
3. Enter the ***Signal amplification in dB***:

- The signal amplification is designed to avoid overdriving the detector and to reduce the measured signal amplitude (see also chapter 16.7.6 on page 49).
- By activating the checkbox ***autom. Gain***, the signal amplification is automatically adjusted to the optimal signal amplitude with each measurement.

Trigger amplification

The value obtained from the measurement of the automatic trigger amplification is displayed in the ***Trigger amplification in dB*** input field.
The trigger amplification can also be entered manually, e.g. from a previous measurement.

4. Enter the ***z-Position in mm*** according to your machine coordinate system.



16.6.3 Configuring the advanced settings (*Device control* > *Advanced*)

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

2. Set the desired ***Sampling rate in kHz*** to vary the number of measuring points:
- The sampling rate should be based on the marking speed.
- We recommend:
  $f\,[MHz] = 0.5 \cdot v_{max}\,[m/s]$.

Drop-down list Signal and Trigger detector

3. With the selection you can choose between signal or trigger detector measurement recording.

Selection for measured data recording

- ***Triggered:*** When a measurement is started with the ***Start*** button, the ScanFieldMonitor SFM is waiting for the laser for 15 s.
  This is the default mode for a ScanFieldMonitor SFM 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 period are saved.

Specifications of the laser

4. Enter the ***Wavelength in nm*** of the laser in use.
5. Enter the ***Power P in W*** during your measurement.
6. Enter the ***Nominal speed in m/s*** during your measurement.

Number of measuring positions

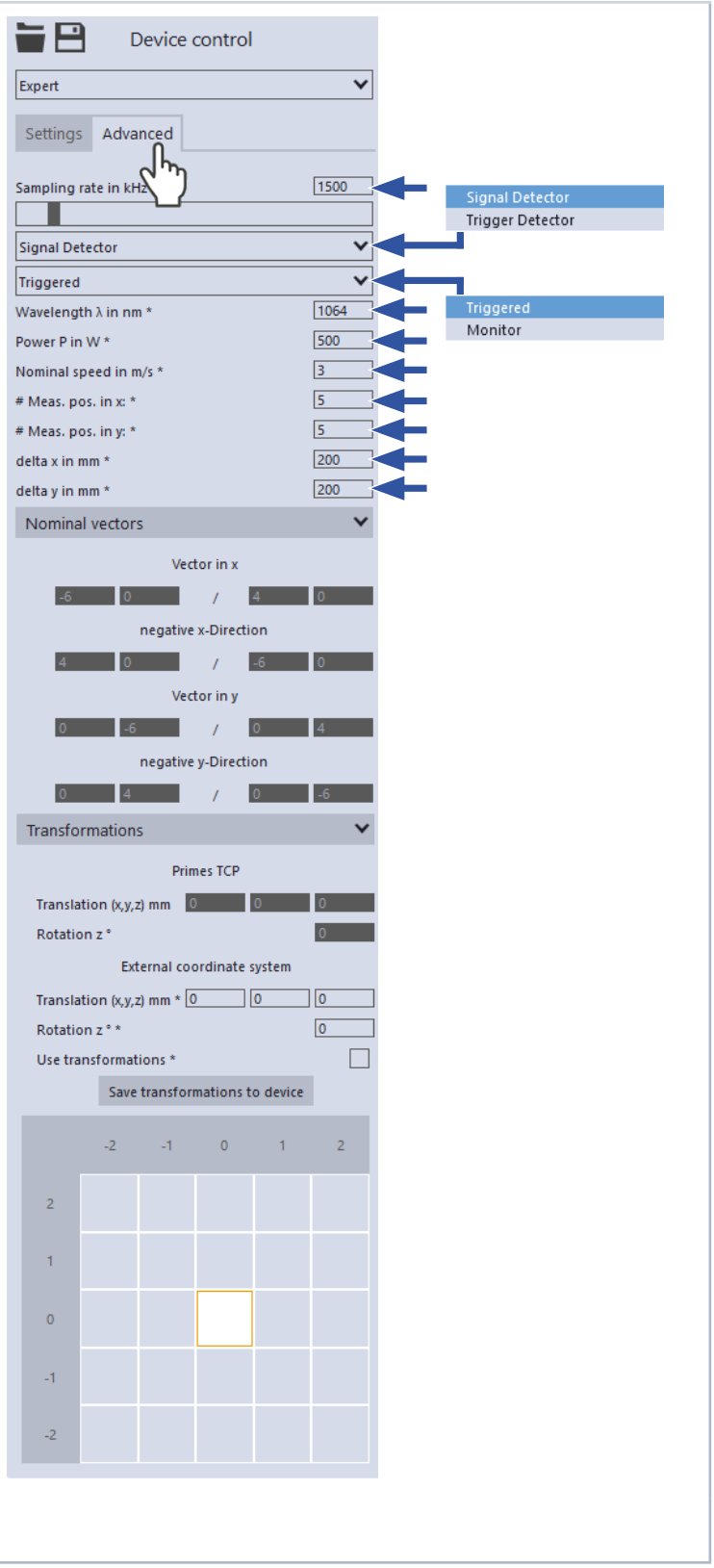
The number of measuring positions is shown in the bottom illustration.

7. Enter the number of measuring positions ***# Meas. positions in x +/-*** on the x-axis.
8. Enter the number of measuring positions ***# Meas. positions in y +/-*** on the y-axis.

Distance of the measuring positions

The distance between the measuring positions is determined by the position of the device holders on the building platform (see Fig. 12.5 on page 24).

9. Enter the distance ***delta x in mm*** on the x-axis.
10. Enter the distance ***delta y in mm*** on the y-axis.



Continued on the next page

Continuation

Nominal vectors

In the ***Nominal vectors*** drop-down menu, the possible travel distances are displayed depending on the position on the building platform and the TCP calibration.

Transformations

You can view and enter values for coordinate transformations in the Transformations area.
This allows the data measured by the ScanFieldMonitor SFM to be displayed in the device coordinate system or in an external coordinate system.

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

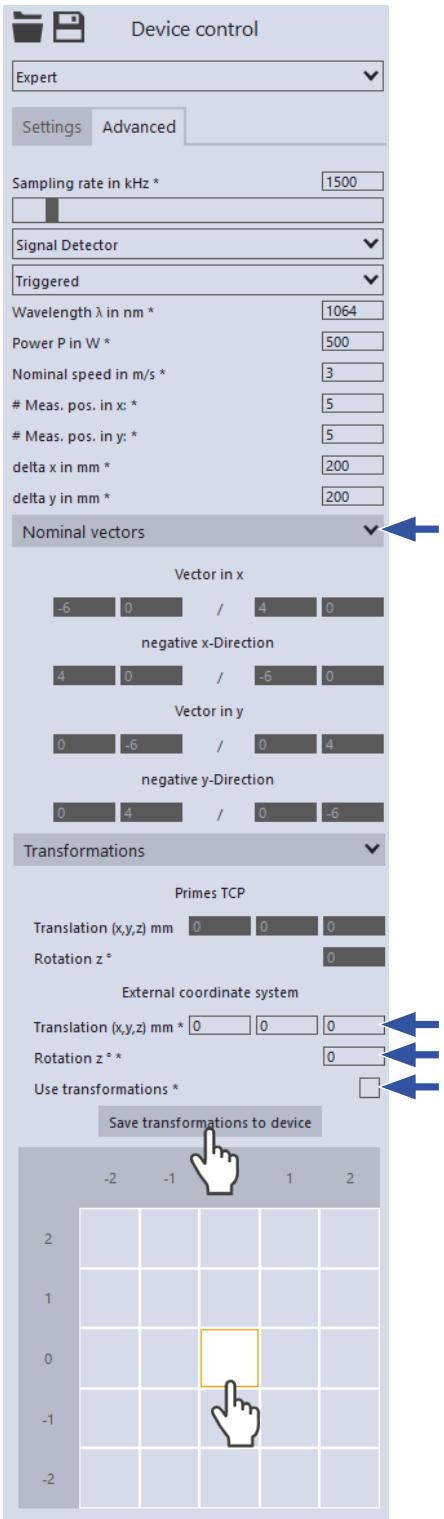
Save transformation parameters

13. Click on the ***Save transformation to device*** button:

➔ The entered values of the transformation are saved in the device and are thus also available after a restart of the device.

Determine measuring position

14. Use the selection area for documentation. Click on the position where the ScanFieldMonitor SFM is located on the building platform during the measurement.



16.7 Performing measurement of a single vector

Please note that some settings are set in the ***Expert*** menu according to chapter 16.6 „Basic settings for all measuring modes“ on page 41.

16.7.1 Selecting the measuring mode Single vector

1. Connect the device according to chapter 16.3 on page 33 with the LaserDiagnosticsSoftware LDS.

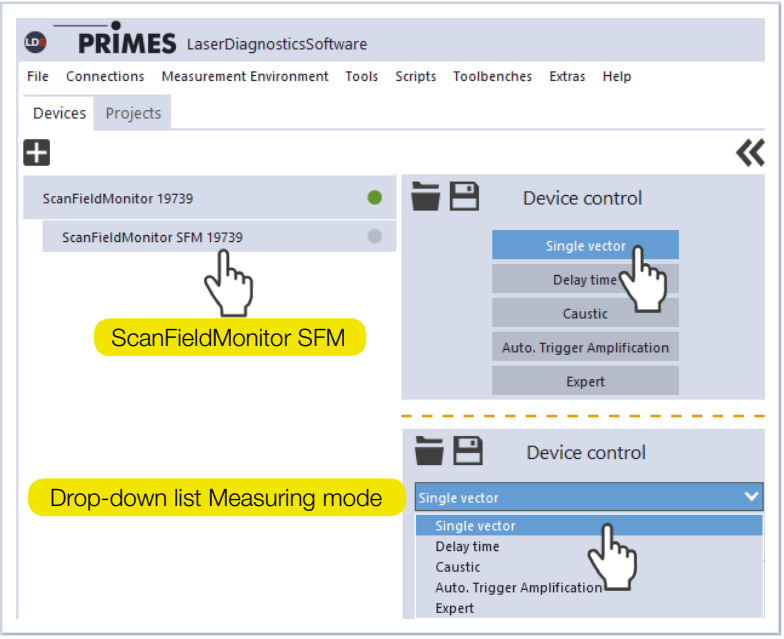
👁 The ScanFieldMonitor SFM is established as a connected device.

2. Click on the ***ScanFieldMonitor SFM***.

👁 The ***Device control*** menu opens.

3. Click on the ***Single vector*** button or on the drop-down list measurement mode and ***Single vector***.

👁 The corresponding ***Device control*** opens.



16.7.2 Configuring the settings (*Device control* > *Settings*)

1. Click on the ***Settings*** tab.

2. Enter the ***Measurement time in s***.

Signal amplification

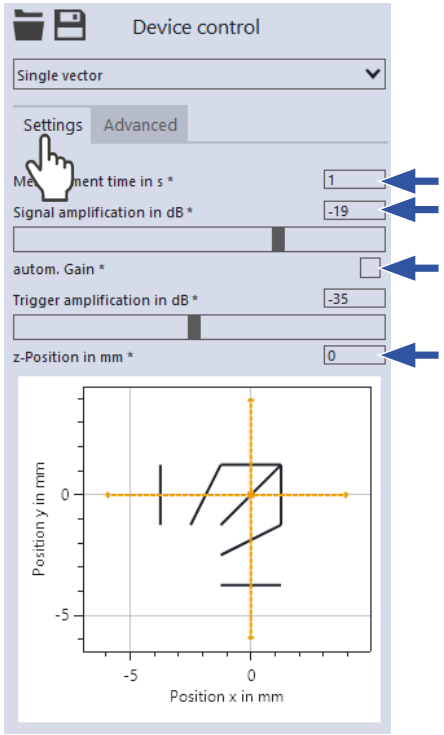
3. Enter the ***Signal amplification in dB***:

- The signal amplification is designed to avoid overdriving the detector and to reduce the measured signal amplitude (see also chapter 16.7.6 on page 49).
- By activating the checkbox ***autom. Gain***, the signal amplification is automatically adjusted to the optimal signal amplitude with each measurement.

Trigger amplification

👁 The value obtained from the measurement of the automatic trigger amplification is displayed in the ***Trigger amplification in dB*** input field. The trigger amplification can also be entered manually, e.g. from a previous measurement.

4. Enter the ***z-Position in mm*** according to your machine coordinate system.



16.7.3 Configuring the advanced settings (*Device control* > *Advanced*)

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

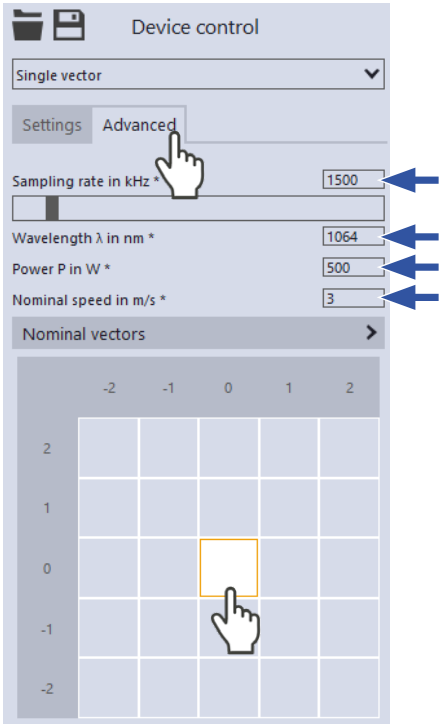
2. Set the desired ***Sampling rate in kHz*** to vary the number of measuring points:
- The sampling rate should be based on the marking speed.
- We recommend:
  f [MHz] = 0.5 · v_{max} [m/s].

Specifications of the laser

3. Enter the ***Wavelength in nm*** of the laser in use.
4. Enter the ***Power P in W*** during your measurement.
5. Enter the ***Nominal speed in m/s*** during your measurement.

Determine measuring position

6. Use the selection area for documentation. Click on the position where the ScanFieldMonitor SFM is located on the building platform during the measurement.



16.7.4 Starting a single vector measurement

1. Follow the safety instructions in chapter 16.1 on page 30.

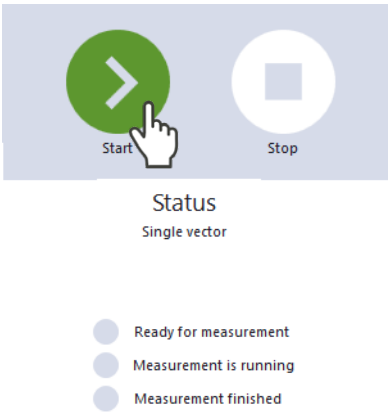
2. Click on the ***Start*** button:
➔ The ScanFieldMonitor SFM is waiting for the laser for 15 s.

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.

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 (see also chapter 16.7.5 on page 47).



16.7.5 Displaying single vector measurement result

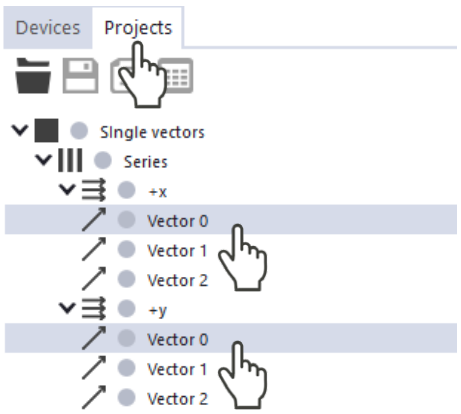
1. Click on the ***Projects*** tab:
➔ All measurements are listed in the file structure.
▶ For information on project management, please refer to the separate LaserDiagnosticsSoftware LDS operating manual.

2. Right-click on the measurement or measurements to be displayed.

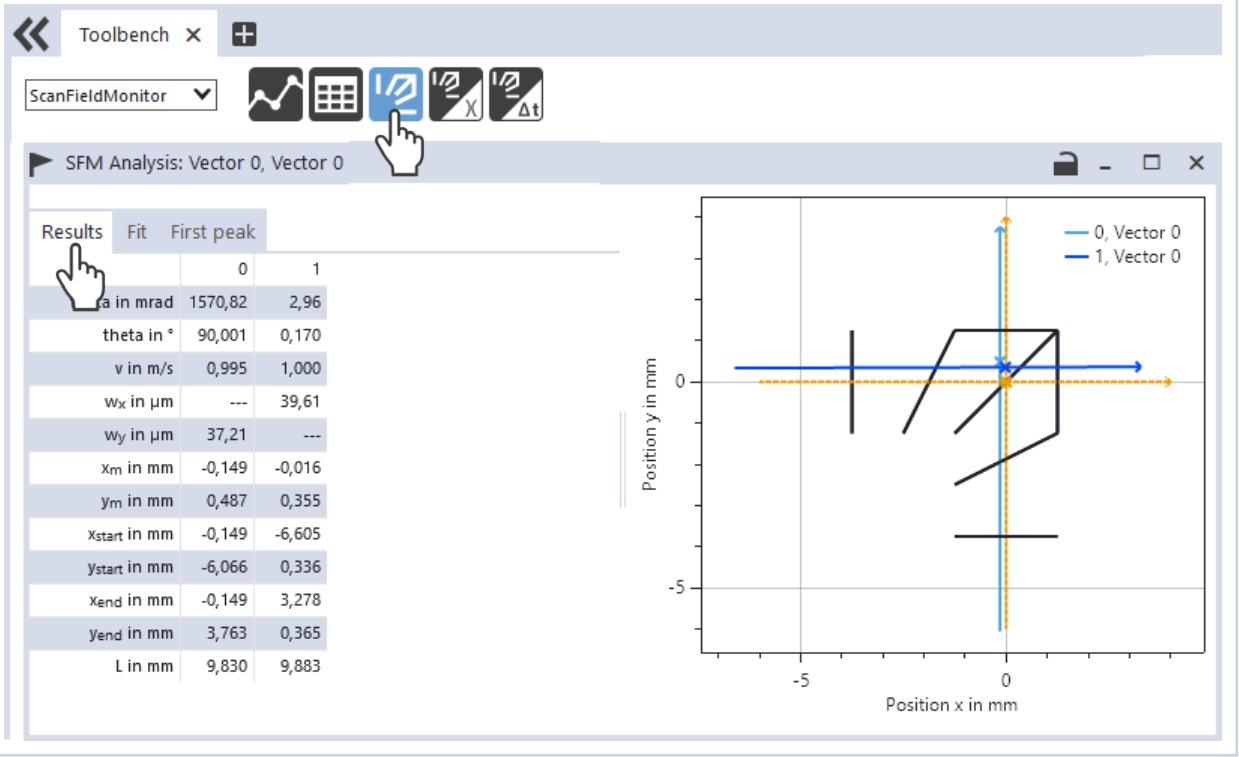
3. Click on the selection ***Show***:
➔ The selected measurement is displayed in the ***SFM Analysis*** tool.

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.



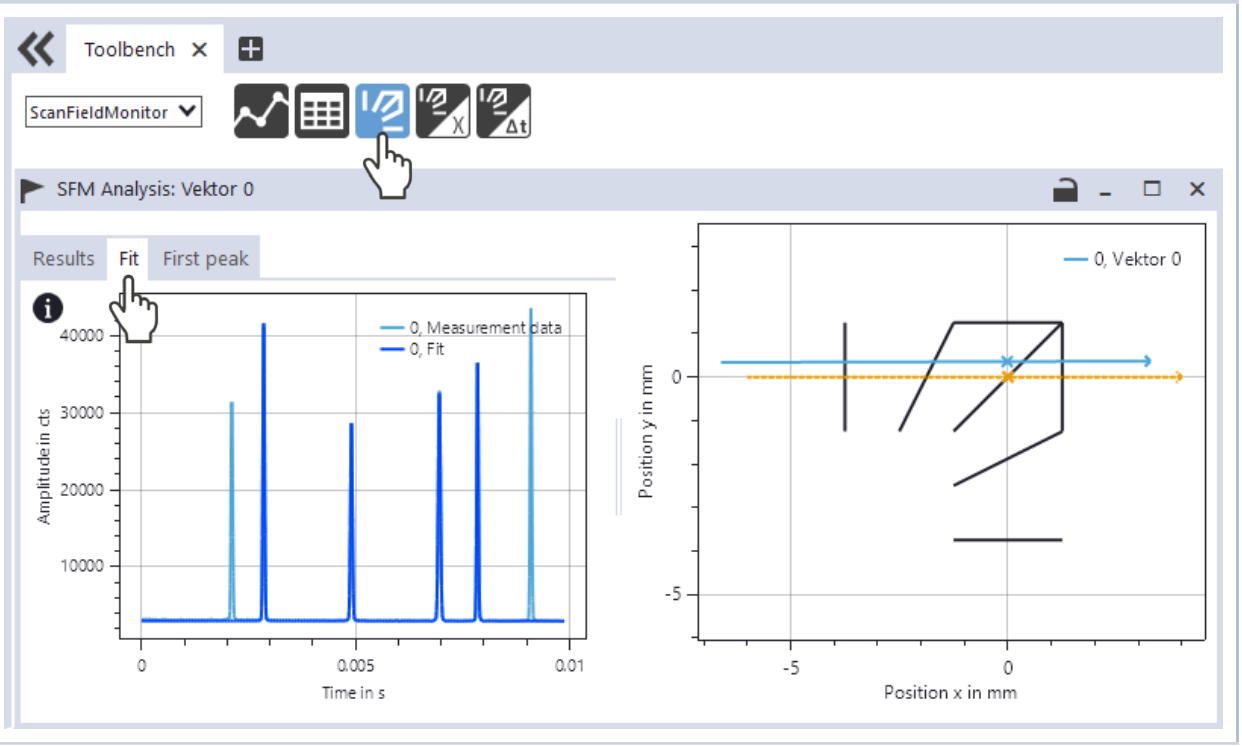
➔ In the ***Results*** tab, the measured values and the vector direction are displayed.



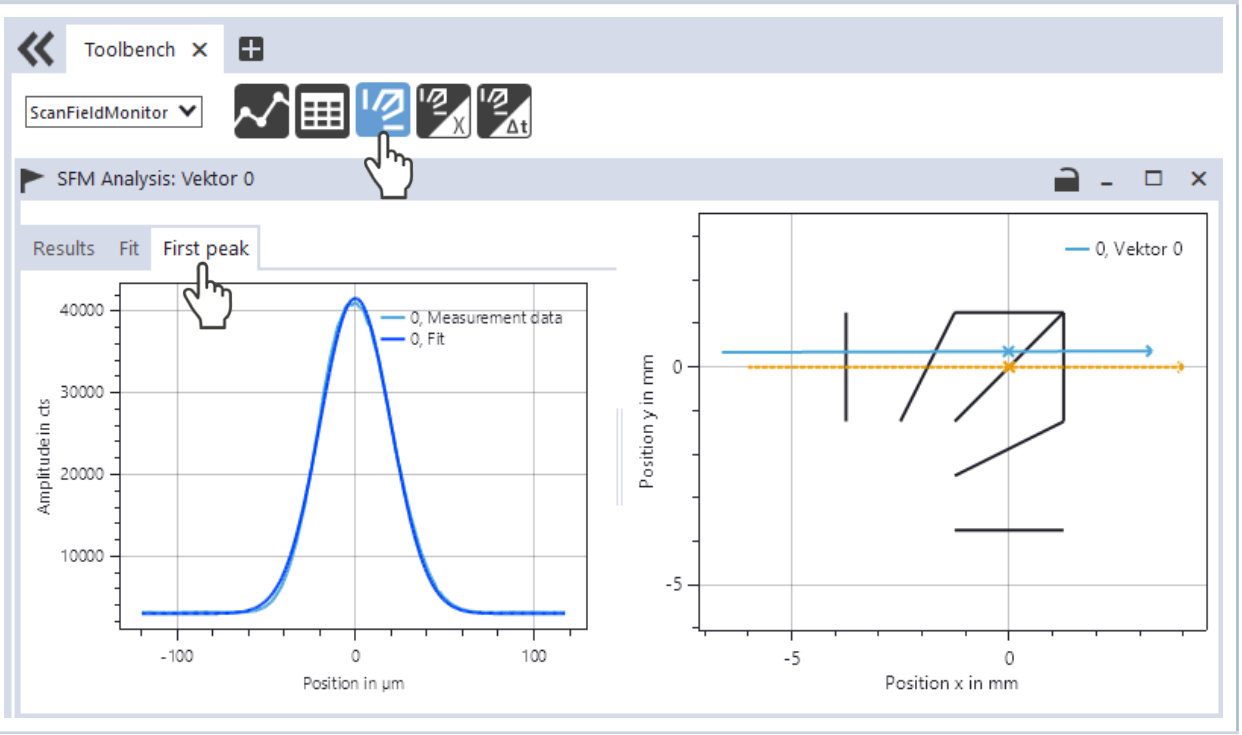
	0	1
a in mrad	1570,82	2,96
theta in °	90,001	0,170
v in m/s	0,995	1,000
w_x in µm	---	39,61
w_y in µm	37,21	---
x_m in mm	-0,149	-0,016
y_m in mm	0,487	0,355
x_{start} in mm	-0,149	-6,605
y_{start} in mm	-6,066	0,336
x_{end} in mm	-0,149	3,278
y_{end} in mm	3,763	0,365
L in mm	9,830	9,883

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.



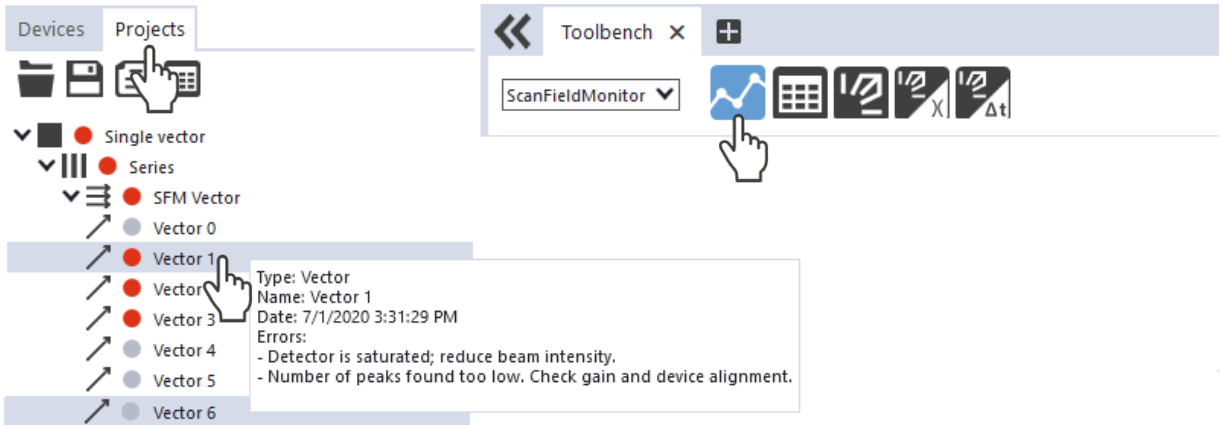
6. Click on the ***First peak*** tab:
- Here you can find detailed information about the first peak.
- The Gaussian fit over the first peak is the basis for the measured value wx/wy.



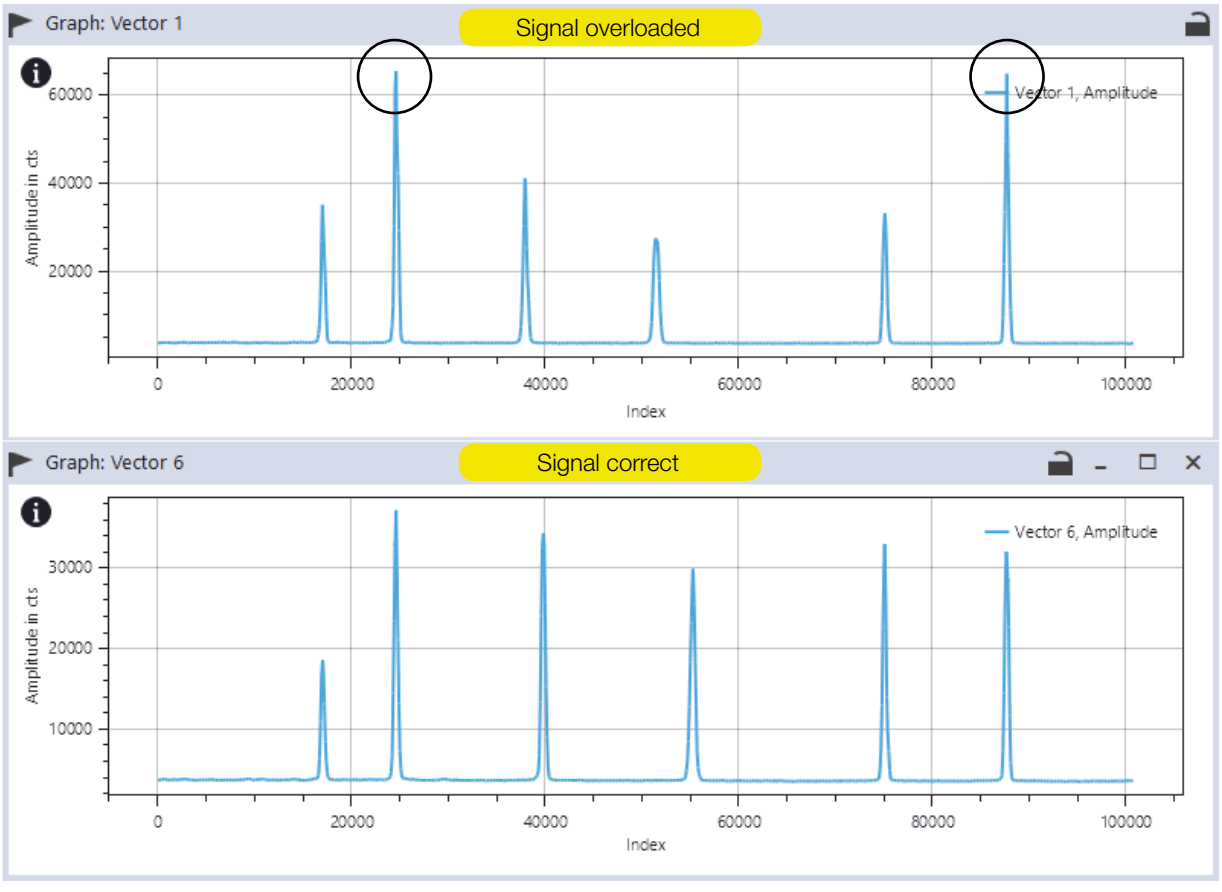
16.7.6 Displaying measurement errors in the LaserDiagnosticsSoftware LDS

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.
• You can estimate the level of the necessary adjustment of the signal amplification on basis of the amplitudes.
• The maximum value of the graph shall be between 40 000 cts and 60 000 cts.
5. Set the ***signal amplification in dB*** in the menu ***Device control > Settings*** (see chapter 16.7.2 on page 45).



16.8 Performing measurement of a caustic

Please note that some settings are set in the ***Expert*** menu according to chapter 16.6 „Basic settings for all measuring modes“ on page 41.

16.8.1 Procedure for measuring a caustic

The following overview gives a short description of the procedure. This can also be found in the LaserDiagnosticsSoftware 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 +/- 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 plane measured.
- 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.
- In the advanced settings section, the sampling rate, the wavelength λ, and the nominal velocity v_{nom} are entered. The sampling rate should be chosen based on the marking speed used.
  We recommend: f [MHz] = 0.5 * v_{max} [m/s].
- 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.

The procedure in the menu of the LaserDiagnosticsSoftware LDS is described in the following chapters.

16.8.2 Selecting the measuring mode Caustic

1. Connect the device according to chapter 16.3 on page 33 with the LaserDiagnosticsSoftware LDS.

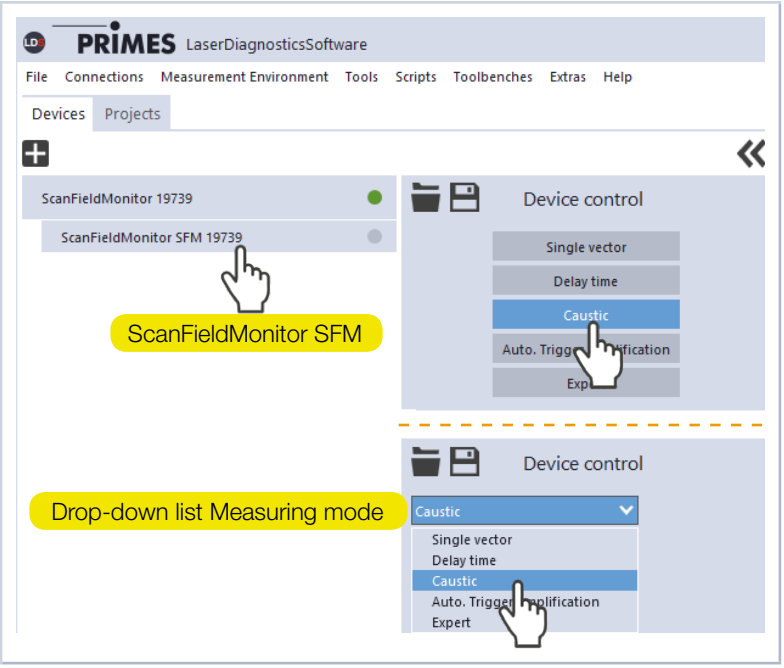
👁 The ScanFieldMonitor SFM is established as a connected device.

2. Click on the ***ScanFieldMonitor SFM***.

👁 The ***Device control*** menu opens.

3. Click on the ***Caustic*** button
   or
   on the drop-down list measurement mode and ***Caustic***.

👁 The corresponding ***Device control*** opens.



16.8.3 Configuring the settings (*Device control* > *Settings*)

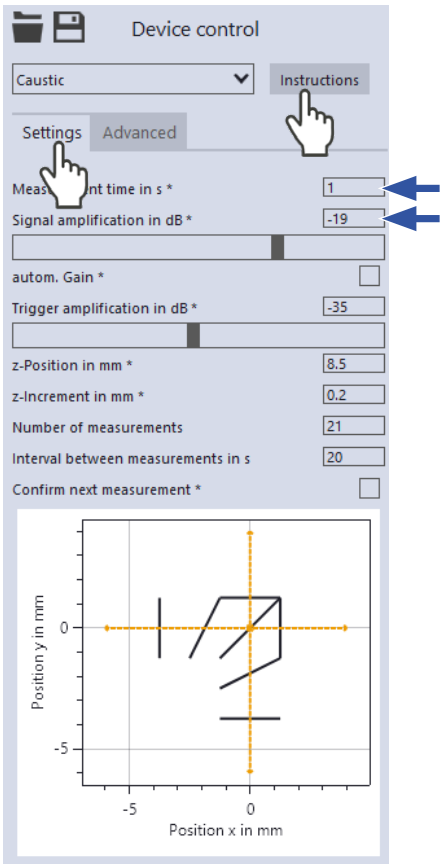
1. Click on the ***Settings*** tab.

Instructions
Click the ***Instructions*** button to get general information about the measurement.

2. Enter the ***Measurement time in s***.
- The measurement duration must be longer than the sequence's marking time.

Signal amplification
3. Enter the ***Signal amplification in dB***:
- The signal amplification is designed to avoid overdriving the detector and to reduce the measured signal amplitude (see also chapter 16.7.6 on page 49).
- By activating the checkbox ***autom. Gain***, the signal amplification is automatically adjusted to the optimal signal amplitude with each measurement.

Trigger amplification
👁 The value obtained from the measurement of the automatic trigger amplification is displayed in the ***Trigger amplification in dB*** input field.
The trigger amplification can also be entered manually, e.g. from a previous measurement.



Continued on the next page

Continuation

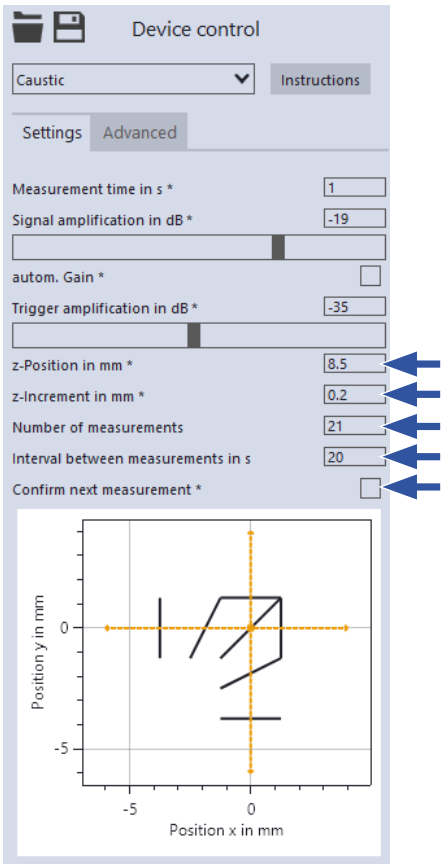
4. Enter the ***z-position in mm*** according to your machine coordinate system.

5. 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.

6. Enter the ***Number of measurements***:
- For a reliable analysis it is recommended to measure at least 21 different z-planes, covering a range of +/- 3 z_R around the focal position at z_0.

7. Enter the ***Interval between measurements in s***:
- This input corresponds to a waiting duration between the end of one measurement and the start of the measurement in the next z-plane.

8. Activate the ***Confirm next measurement*** check box to ignore the automatic start of the next measurement:
- The next measurement needs to be started manually.



16.8.4 Configuring the advanced settings (*Device control* > *Advanced*)

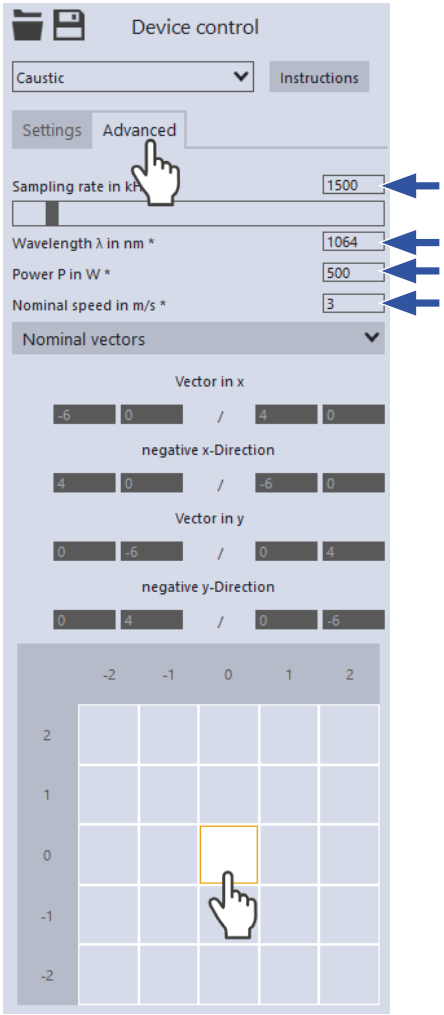
1. Click on the ***Advanced*** tab.

2. Set the desired ***Sampling rate in kHz*** to vary the number of measuring points:
- The sampling rate should be based on the marking speed.
- We recommend:
  f [MHz] = 0.5 · v_{max} [m/s].

Specifications of the laser
For a complete evaluation of the caustics, the following values must be entered:
3. Enter the ***Wavelength in nm*** of the laser in use.
4. Enter the ***Power P in W*** during your measurement.
5. Enter the ***Nominal speed in m/s*** during your measurement.

Nominal vectors
In the ***Nominal vectors*** drop-down menu, the possible travel distances are displayed depending on the position on the building platform and the TCP calibration.

Determine measuring position
6. Use the selection area for documentation. Click on the position where the ScanFieldMonitor SFM is located on the building platform during the measurement.



16.8.5 Starting a caustic measurement

1. Follow the safety instructions in chapter 16.1 on page 30.

2. Click on the ***Start*** button:
➔ The ScanFieldMonitor SFM is waiting for the laser for 15 s.

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 (see also chapter 16.7.5 on page 47).
The results are displayed separately in x- and y-direction.

Note
To improve the statistical evaluation, several vectors with identical parameters can be measured.

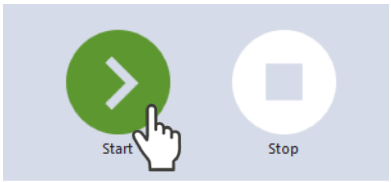
4. Adjust the height of the building platform after the first measurement.
5. With the input of the ***z-position in mm***, the new z-position is automatically stored for the next measuring position in the LaserDiagnosticsSoftware LDS.

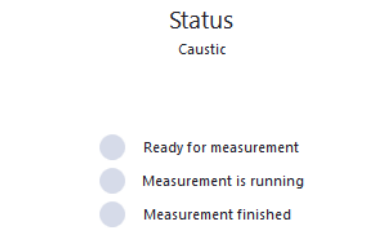
Next measurement
By selecting ***Interval between measurements in s*** the next measurement will start automatically.
With the selection ***Confirm next measurement*** the next measurement must be confirmed manually.

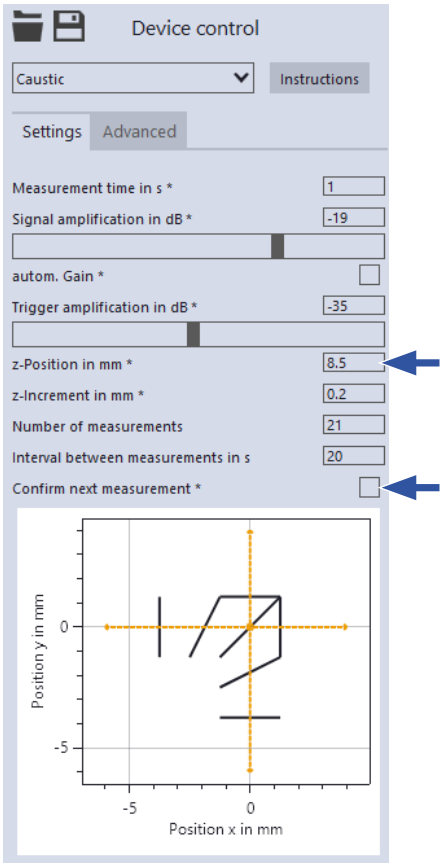
Signal amplification
The signal amplification is designed to avoid overdriving the detector and to reduce the measured signal amplitude (see also chapter 16.7.6 on page 49).
By activating the checkbox ***autom. Gain***, the signal amplification is automatically adjusted to the optimal signal amplitude with each measurement.

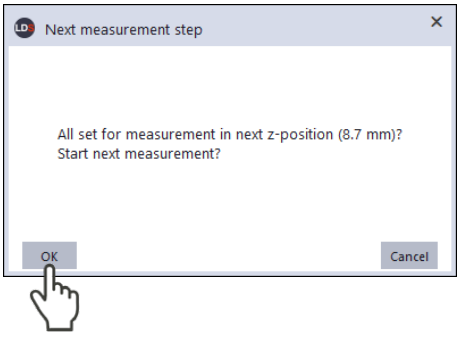
Only if the *Confirm next measurement* check box is activated

6. Click on the ***OK*** button.
➔ The next measurement is started.









16.8.6 Displaying the measurement results

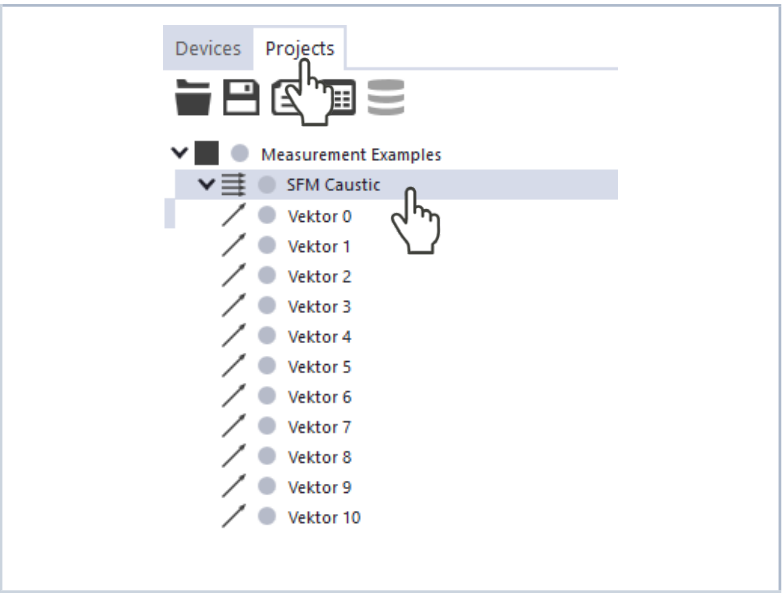
1. Click on the ***Projects*** tab:
➔ The caustic and all of its single vectors are listed in the file structure.
▶ For information on project management, please refer to the separate LaserDiagnosticsSoftware LDS operating manual.

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 (see figure on the next page).



Algorithms for evaluating the beam geometry

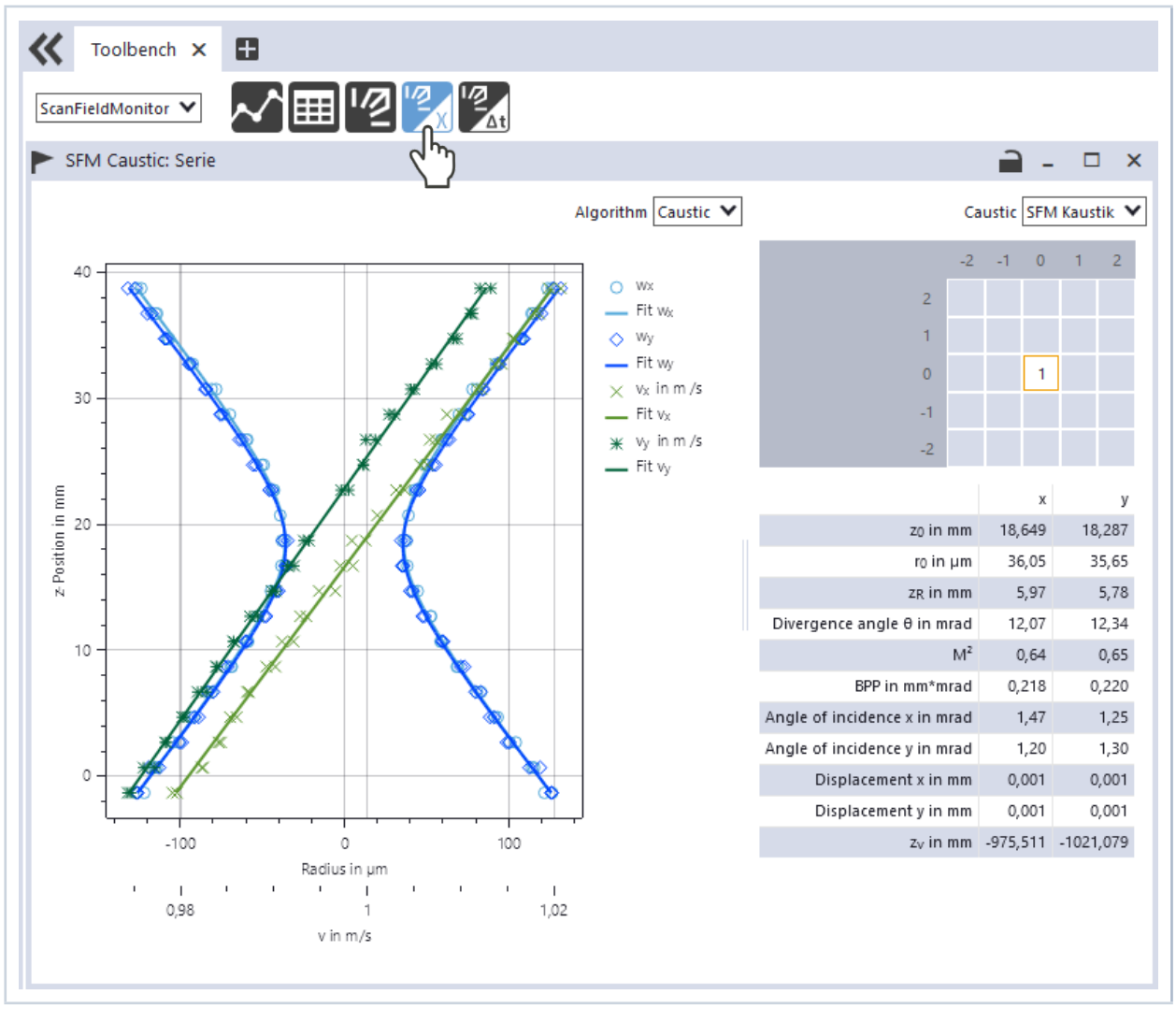
The ScanFieldMonitor SFM with the possibility to measure laser beams with an angle of incidence of +/- 20 ° is a special feature in the field of laser beam characterization, which is usually limited to the vertical beam incidence. In doing so, it must be considered how the laser beam is imaged by the device.

The ScanFieldMonitor SFM 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 ScanFieldMonitor SFM 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 LaserDiagnosticsSoftware 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.

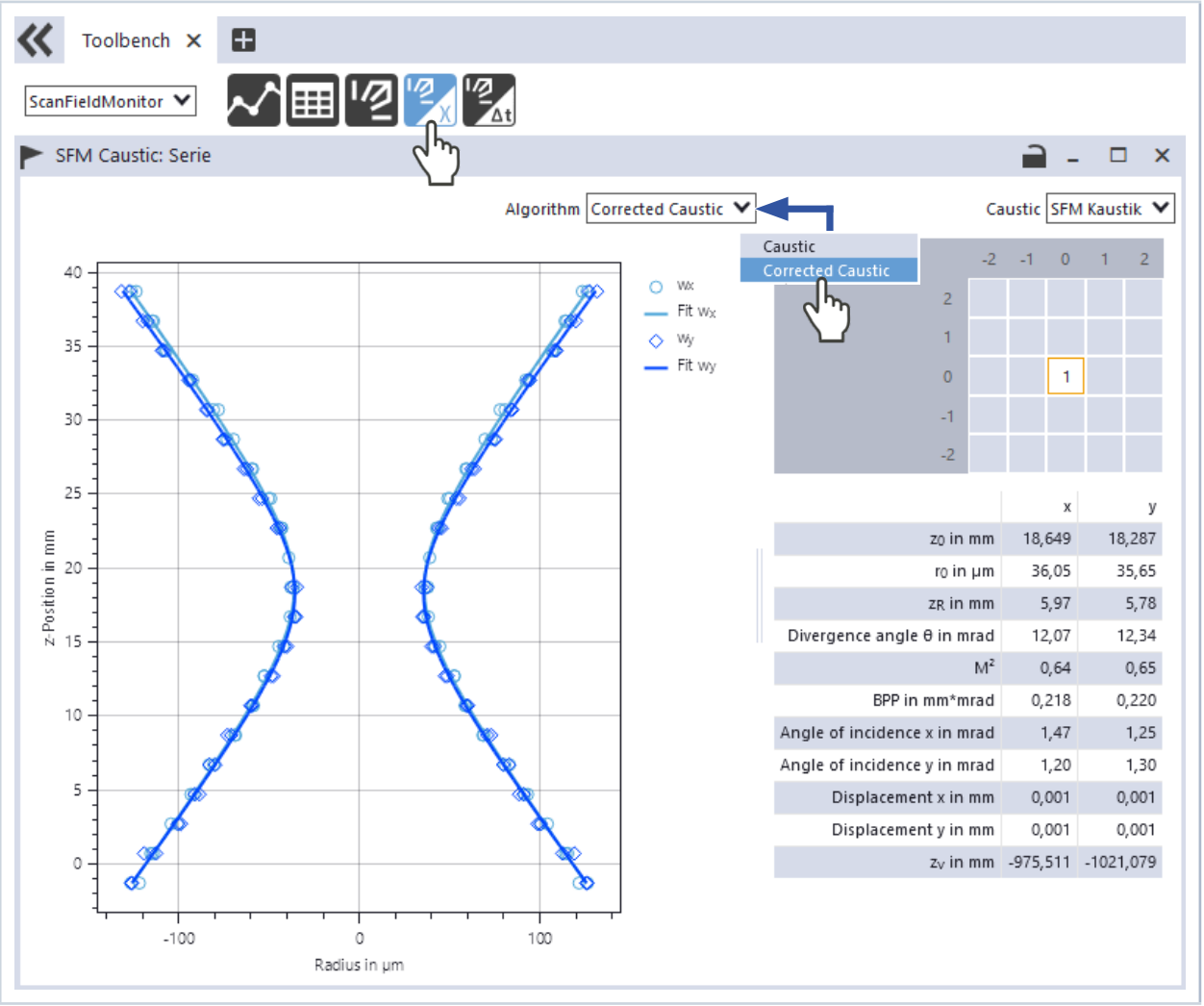


	x	y
z_0 in mm	18,649	18,287
r_0 in µm	36,05	35,65
z_R in mm	5,97	5,78
Divergence angle θ in mrad	12,07	12,34
M^2	0,64	0,65
BPP in mm*mrad	0,218	0,220
Angle of incidence x in mrad	1,47	1,25
Angle of incidence y in mrad	1,20	1,30
Displacement x in mm	0,001	0,001
Displacement y in mm	0,001	0,001
z_V in mm	-975,511	-1021,079

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

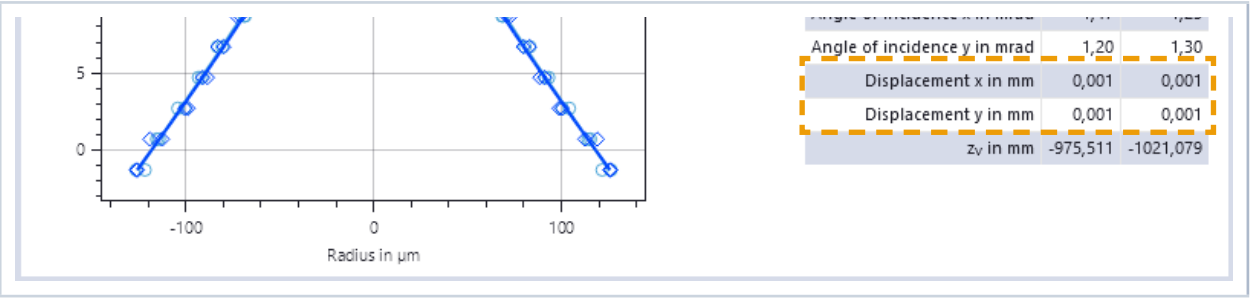
Corrected caustic

With the caustic measurement, the angle of incidence of the laser to the ScanFieldMonitor SFM 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 glass of the ScanFieldMonitor SFM 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.



16.9 Performing measurement of the delay time (laser on and laser off delay)

Please note that some settings are set in the ***Expert*** menu according to chapter 16.6 „Basic settings for all measuring modes“ on page 41.

16.9.1 Procedure for measuring the delay time

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

Programming of vectors

- Measurement of multiple vectors of identical length, orientation and delay time at different marking speeds.
- 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.
- Enter the sampling rate in the advanced settings section. The sampling rate should be chosen based on the highest marking speed used. We recommend: f [MHz] = 0.5 * v_{max} [m/s].
- 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.

The procedure in the menu of the LaserDiagnosticsSoftware LDS is described in the following chapters.

16.9.2 Selecting the measuring mode Delay time

1. Connect the device according to chapter 16.3 on page 33 with the LaserDiagnosticsSoftware LDS.

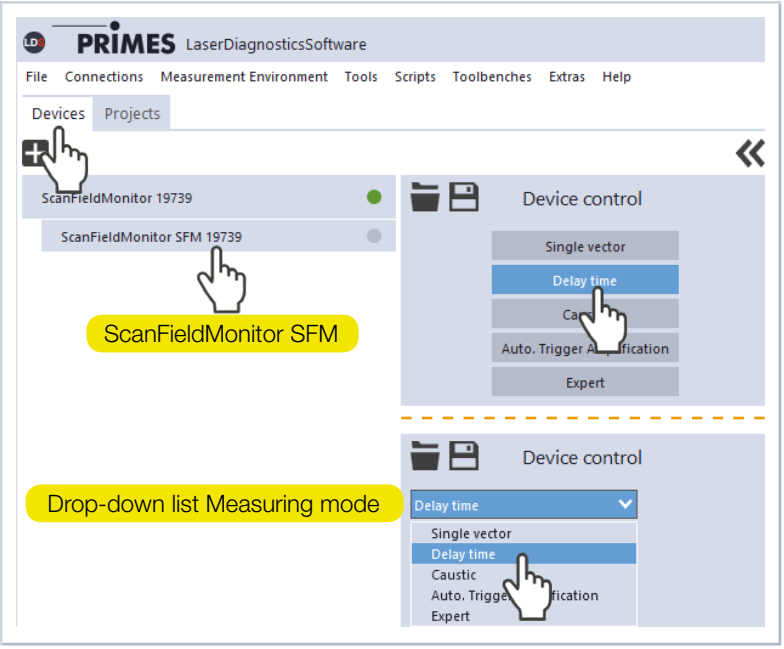
👁 The ScanFieldMonitor SFM is established as a connected device.

2. Click on the ***ScanFieldMonitor SFM***.

👁 The ***Device control*** menu opens.

3. Click on the ***Delay time*** button
or
on the drop-down list measurement mode and ***Delay time***.

👁 The corresponding ***Device control*** opens.



16.9.3 Configuring the settings (*Device control* > *Settings*)

1. Click on the ***Settings*** tab.

Instructions
Click the ***Instructions*** button to get general information about the measurement.

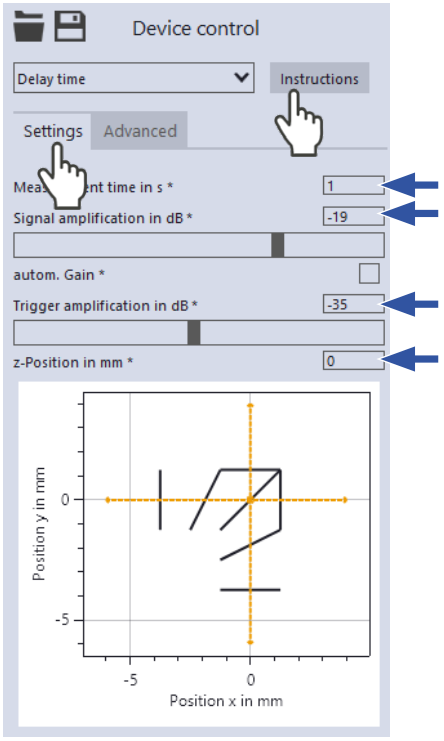
Note
For a delay time measurement, several identical vectors with different speeds must be written.

2. Enter the ***Measurement time in s***.
- The measurement duration must be longer than the sequence's marking time.

Signal amplification
3. Enter the ***Signal amplification in dB***:
- The signal amplification is designed to avoid overdriving the detector and to reduce the measured signal amplitude (see also chapter 16.7.6 on page 49).
- By activating the checkbox ***autom. Gain***, the signal amplification is automatically adjusted to the optimal signal amplitude with each measurement.

Trigger amplification
The value obtained from the measurement of the automatic trigger amplification is displayed in the ***Trigger amplification in dB*** input field.
The trigger amplification can also be entered manually, e.g. from a previous measurement.

4. Enter the ***z-Position in mm*** according to your machine coordinate system.



16.9.4 Configuring the advanced settings (*Device control* > *Advanced*)

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

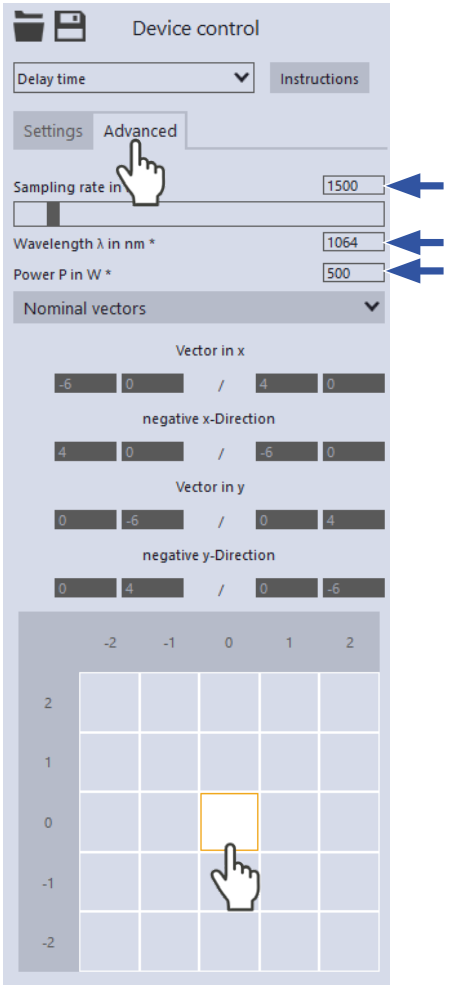
2. Set the desired ***Sampling rate in kHz*** to vary the number of measuring points:
- The sampling rate should be based on the marking speed.
- We recommend:
  f [MHz] = 0.5 · v_{max} [m/s].

Specifications of the laser
The following entries are informative and do not influence the measurement of the delay time.

3. Enter the ***Wavelength in nm*** of the laser in use.
4. Enter the ***Power P in W*** during your measurement.

Nominal vectors
In the ***Nominal vectors*** drop-down menu, the possible travel distances are displayed depending on the position on the building platform and the TCP calibration.

Determine measuring position
5. Use the selection area for documentation. Click on the position where the ScanFieldMonitor SFM is located on the building platform during the measurement.



16.9.5 Starting a delay time measurement

1. Follow the safety instructions in chapter 16.1 on page 30.

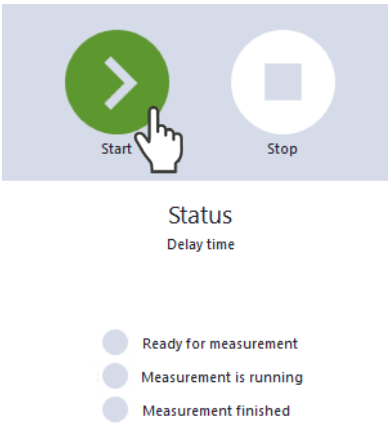
2. Click on the ***Start*** button:
➔ The ScanFieldMonitor SFM is waiting for the laser for 15 s.

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 (see also chapter 16.7.5 on page 47).
The delay time results for each direction are displayed separately.
When measuring in all four directions, four results for all directions are displayed accordingly.



16.9.6 Displaying the measurement results

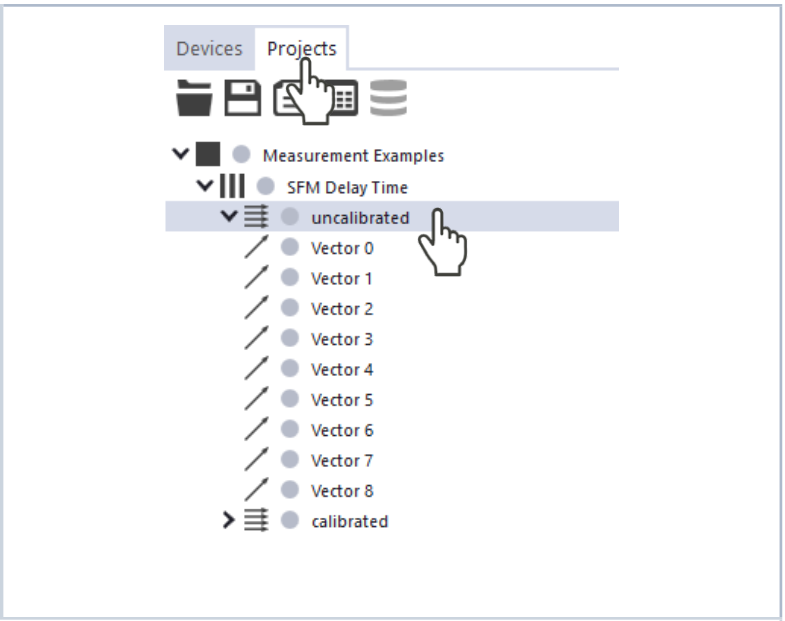
1. Click on the ***Projects*** tab:
➔ The delay time measurement and all of its single vectors are listed in the file structure.
▶ For information on project management, please refer to the separate LaserDiagnosticsSoftware LDS operating manual.

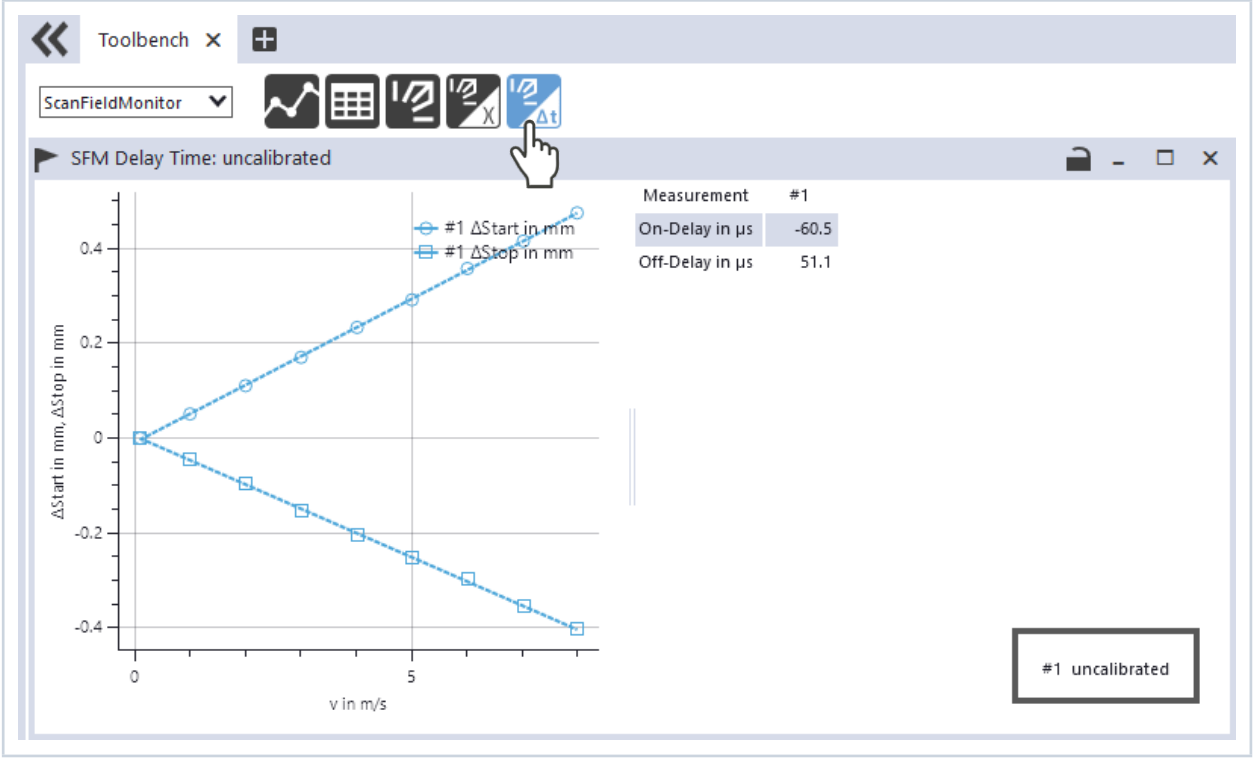
2. Right click on the complete Delay Time sequence to be displayed.

3. Click on the selection ***Show***:
➔ The selected measurement is displayed in the ***Delay Time*** tool.

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

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





17 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 ScanFieldMonitor SFM must be taken into account.
The LaserDiagnosticsSoftware LDS uses the Gaussian fit method for radius determination by default.

Gaussian fit method

The measuring signal of the ScanFieldMonitor SFM 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 ScanFieldMonitor SFM 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.

18 Troubleshooting

Error	Possible cause	Remedy
There is no connection between the ScanFieldMonitor SFM and the PC.	Network address of the PC is not within the range of the ScanFieldMonitor SFM.	In Windows > Control panel > Network and Sharing Center, set the PC to DHCP (obtain IP address automatically).
	The connection may be blocked by the firewall.	Enable the UDP port 20034 according to chapter 16.3.2 on page 34.
	An incorrect Ethernet card is selected.	Select the appropriate Ethernet card according to chapter 16.3.2 on page 34.
Error during a measurement	• Data transmission error • Processor crash in the measuring system • Program execution error	1. Restart the LaserDiagnosticsSoftware LDS. 2. Disconnect the Ethernet or WLAN connection and reconnect the device to the PC. 3. Restart the PC. 4. Turn the ScanFieldMonitor SFM off and on again. Disconnect the Ethernet or WLAN connection and reconnect the device to the PC.
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 12.2 on page 20.
	The power density is too low.	Increase the laser power.
	The signal amplification is too low.	Set the maximum 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 16.5 on page 37.
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 12.2 on page 20.
The measurement signal of a vector contains more than six peaks.	The protective window is contaminated.	Clean or replace the protective window.

Tab. 18.1: Troubleshooting

19 Maintenance and service

The operator is responsible for determining the maintenance intervals for the measuring device.
PRIMES recommends a maintenance interval of 12 months for inspection and validation.
If the device is used only sporadically, the maintenance interval can also be extended up to 24 months.

19.1 Exchanging the protective window on the device

The protective window in the beam entrance is a wearing part and can be replaced if necessary. Low levels of contamination of the protective window can be removed carefully with Isopropanol when cooled down (observe the manufacturer‘s safety instructions). In case of heavy, non-removable contamination or damage, the protective window must be replaced with a new one.

The protective window is coated with an antireflection coating and has low reflection values in the specified wavelength range of less than 1 %. To avoid increased reflection values, use only original PRIMES protective windows.

Protective window for ScanFieldMonitor SFM

Protective window diameter	30 mm
Glass thickness	1.5 mm
Order number	801-004-054 (1 piece); 410-011-022 (10 pieces)

Protective window spacer

Protective window diameter	55 mm
Glass thickness	1.5 mm
Order number	801-001-023 (1 piece)

19.1.1 Safety instructions

DANGER

Severe eye or skin injury due to laser radiation

If the protective window is not correctly positioned, reflections can cause directional laser radiation.

- ▶ Ensure that the new protective window is positioned evenly in the indentation.

CAUTION

Hot surface – risk of burns

The device and the protective window are hot after a measurement.

- ▶ Do not replace the protective window directly after a measurement.
- ▶ Let the device cool down for an adequate period of time. The cooling time varies depending on the laser power and the irradiation time.

NOTICE

Damage/Destruction of the device or the laser system

Contamination and fingerprints on the protective window can lead to damage or shattering or splintering of the protective window during measuring operation. Parts of the protective window can get into the laser system and damage it.

- ▶ Only replace the protective window in a dust-free environment.
- ▶ Do not touch the protective window with your bare hands.
- ▶ When exchanging the protective window wear powder-free latex gloves.

19.1.2 Exchanging the protective window on ScanFieldMonitor SFM and check O-ring

1. Observe the safety instructions in chapter 19.1.1 on page 67.
2. Unscrew the 5 Torx screws M2 x 3 mm (Torx 6 screwdriver) at the protective window holder.
3. Put on powder-free latex gloves.
4. Carefully remove the protective window holder upwards.
5. Remove the old protective window from the ScanFieldMonitor SFM and dispose it. Use a suction cup to remove the protective window.

6. If there is visible wear, remove the temperature-resistant O-ring from the indentation.
7. Insert a new temperature-resistant O-ring into the indentation.

8. Check the optical components for contamination.
9. Insert the new protective window into the ScanFieldMonitor SFM. Make sure that the protective window is flat in the indentation.
10. Place the protective window holder.
11. Tighten the protective window holder with 5 Torx screws M2 x 3 mm.
12. Check for secure fit of the protective window holder. The protective window holder must lie flat against the housing of the ScanFieldMonitor SFM.

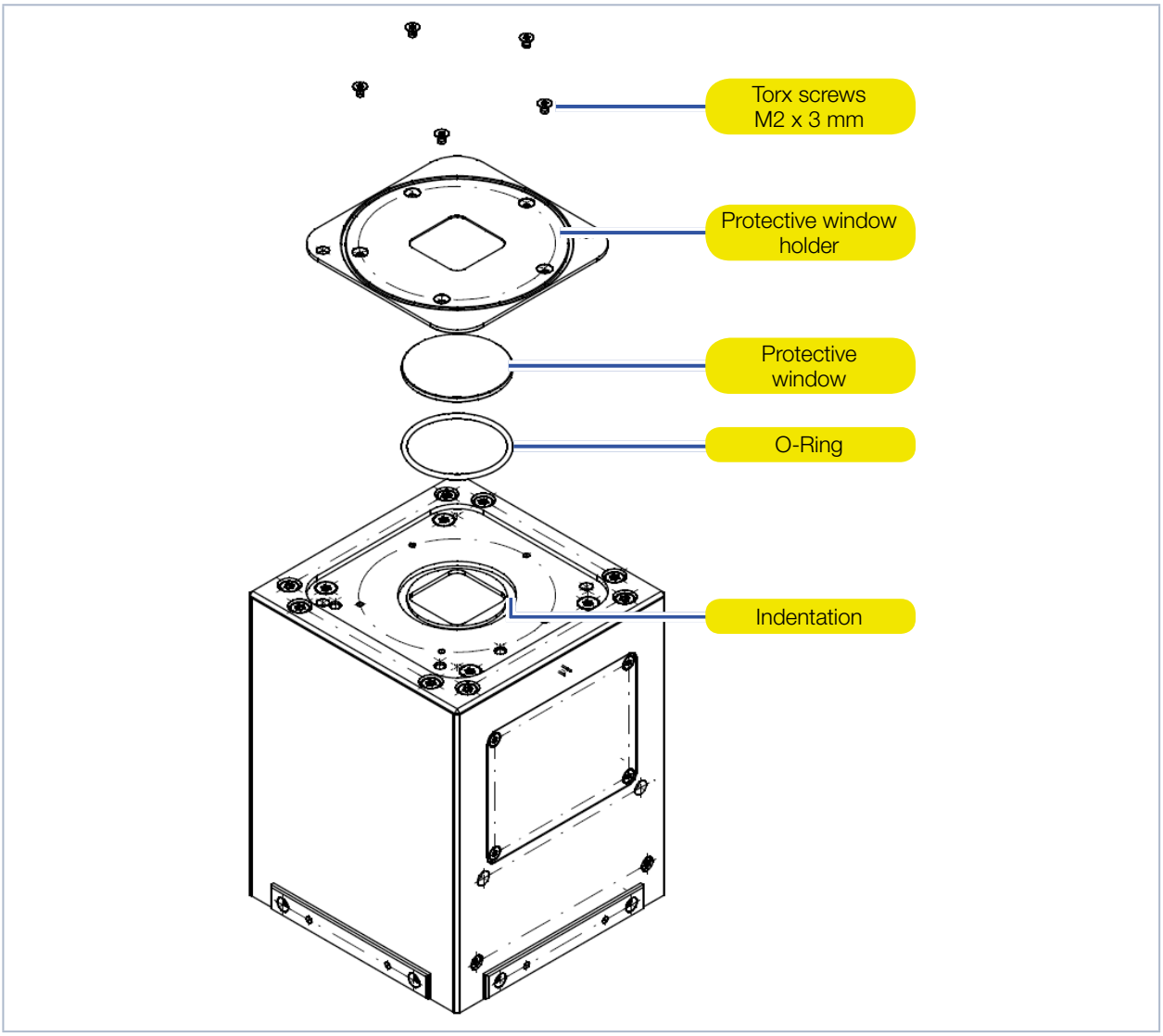


Fig. 19.1: Exchanging the protective window on the ScanFieldMonitor SFM

19.1.3 Exchanging the protective window on the protective window spacer and check O-ring

1. Observe the safety instructions in chapter 19.1.1 on page 67.
2. Unscrew the 4 Torx screws M3 x 6 mm (Torx 10 screwdriver) at the protective window holder.
3. Put on powder-free latex gloves.
4. Carefully remove the protective window holder upwards.
5. Remove the old protective window from the protective window spacer and dispose it. Use a suction cup to remove the protective window.

6. If there is visible wear, remove the temperature-resistant O-ring from the indentation.
7. Insert a new temperature-resistant O-ring into the indentation.

8. Check the optical components for contamination.
9. Insert the new protective window into the protective window spacer. Make sure that the protective window is flat in the indentation.
10. Place the protective window holder.
11. Tighten the protective window holder with 4 Torx screws M3 x 6 mm.
12. Check for secure fit of the protective window holder. The protective window holder must lie flat against the housing of the protective window spacer.

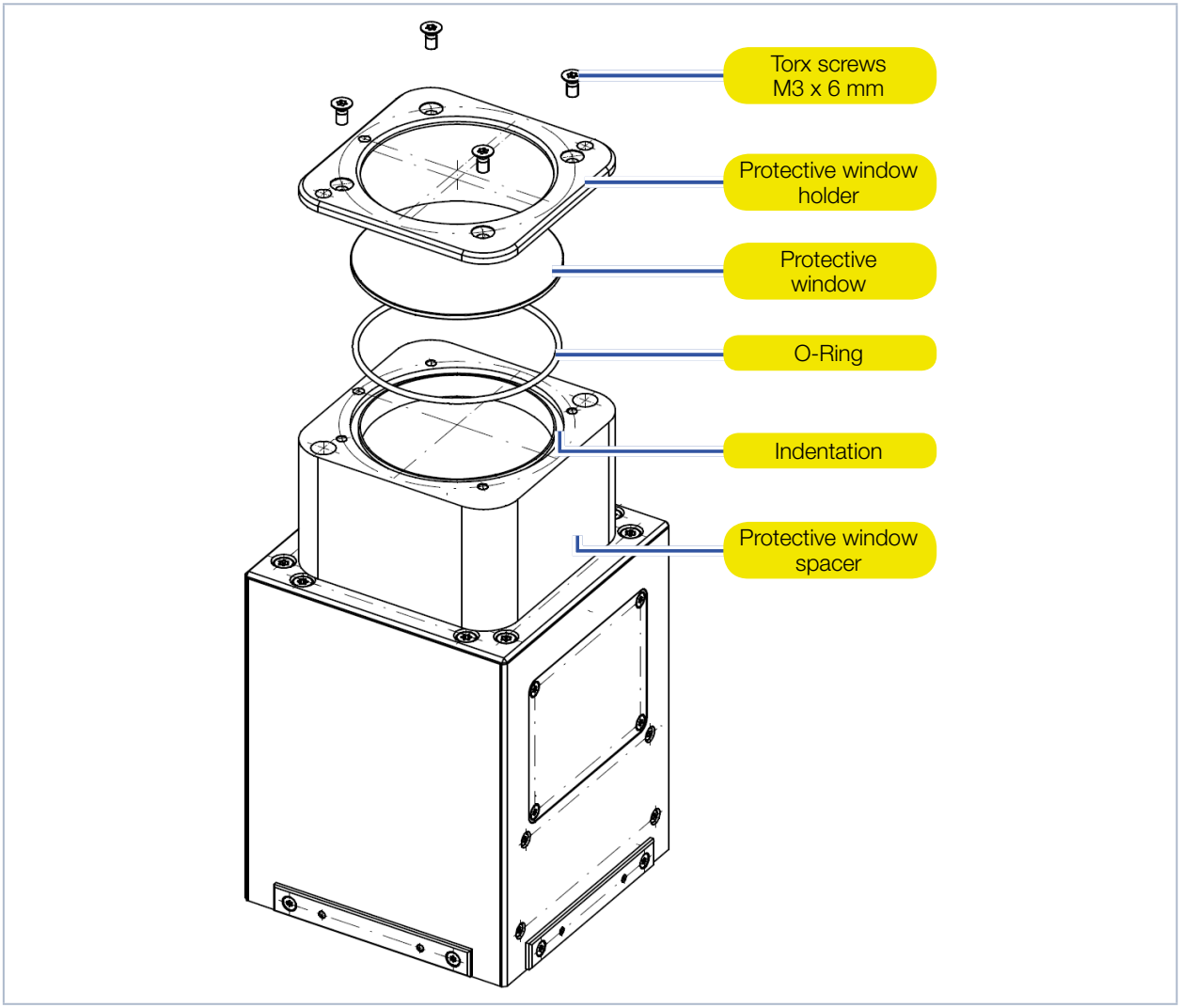


Fig. 19.2: Exchanging the protective window on the protective window spacer and check the O-ring

20 Measures for the product disposal

PRIMES gives you the opportunity to return your PRIMES measuring device for free disposal within the scope of the Waste of Electrical and Electronic Equipment (WEEE Directive). You can send PRIMES measuring devices to be disposed of within the EU (this service does not include shipping costs) to our 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 a registered manufacturer in the German “Used Appliances Register“ stiftung elektro-altgeräte register (stiftung ear) with the number WEEE-reg.-no. DE65549202.

21 Declaration of conformity

Original EG Declaration of Conformity

The manufacturer: PRIMES GmbH, Max-Planck-Straße 2, 64319 Pfungstadt, Germany,

hereby declares that the device with the designation:

ScanFieldMonitor

Types: SFM

is in conformity with the following relevant EC Directives:

- EMC Directive EMC 2014/30/EU
- Directive 2011/65/EC on the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment
- Radio Equipment Directive 2014/53/EU
- Directive 2014/32/EC on measuring instruments

Authorized for the documentation:
PRIMES GmbH, Max-Planck-Straße 2, 64319 Pfungstadt, Germany

The manufacturer obligates himself to provide the national authority in charge with technical documents in response to a duly substantiated request within an adequate period of time.

Pfungstadt, November 12, 2019

Dr. Reinhard Kramer, CEO

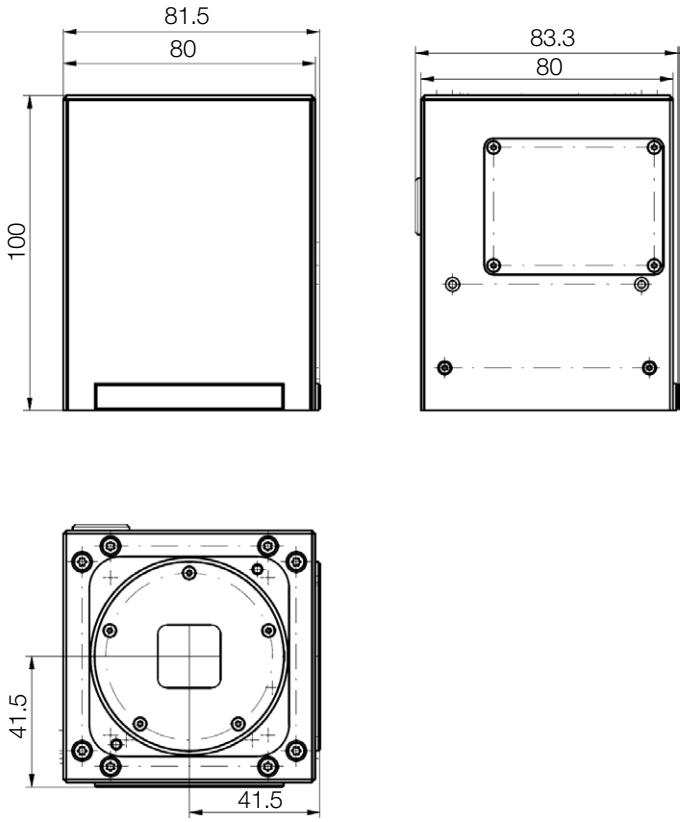
22 Technical data

Measurement parameters	
Power range	10 – 1 500 W
Wavelength range	1 000 – 1 100 nm
Beam diameter	50 – 500 µm
Max. power density (1 000 – 1 100 nm)	100 MW/cm²
Determined parameters	
Focus position x, y, z	yes
Focus radius x, y	yes
Beam quality factor M²	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
Supply data	
Power supply	Lithium-ion battery (power bank)
Output voltage power bank	Adjustable 12 V, 15 V, 16.5 V, 19 V, 20 V, 24 V
Operating voltage of the ScanFieldMonitor SFM	12 V
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
Shipping classification of the processing unit with inserted or permanently installed power bank	Lithium ion batteries contained in equipment
Shipping classification of the separate power bank	Lithium ion batteries with equipment
Temperature range for charging the power bank	0 – 45 °C
Communication	
Interfaces	Ethernet, WLAN

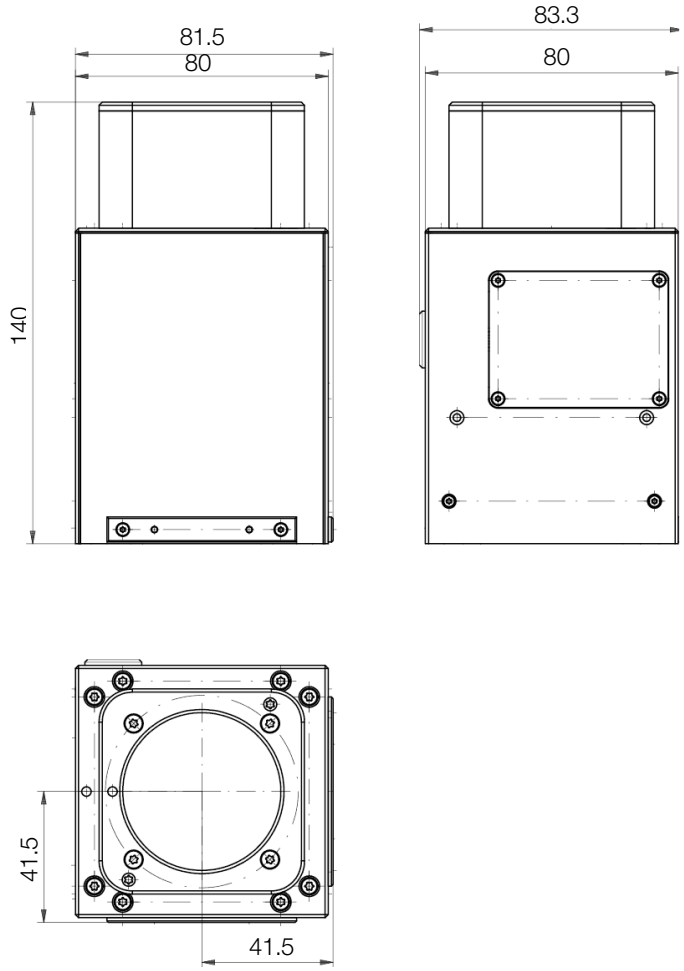
Dimensions and weight		
Dimensions (L x W x H)	ScanFieldMonitor SFM	80 x 80 x 100 mm
	Protective window spacer	65 x 65 x 40 mm
	Processing Unit	275 x 160 x 100 mm
Weight (ca.)	ScanFieldMonitor SFM	1.2 kg
	Device holder	0.8 kg
	Processing Unit	3.2 kg
Environmental conditions		
Operating temperature range	ScanFieldMonitor SFM	10 – 45 °C
	Processing Unit	10 – 45 °C
Storage temperature range	ScanFieldMonitor SFM	10 – 45 °C
	Processing Unit	10 – 45 °C
Reference temperature	22 °C	
Permissible relative humidity (non-condensing)	10 – 80 %	

23 Dimensions

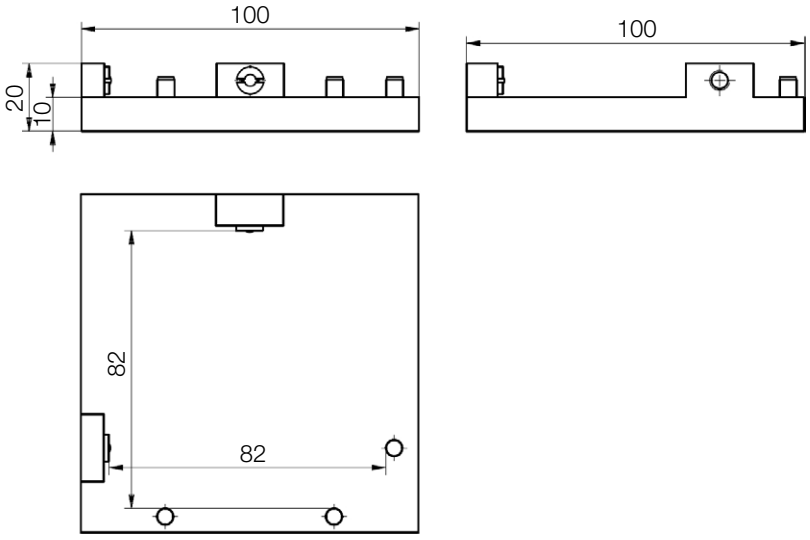
23.1 ScanFieldMonitor SFM



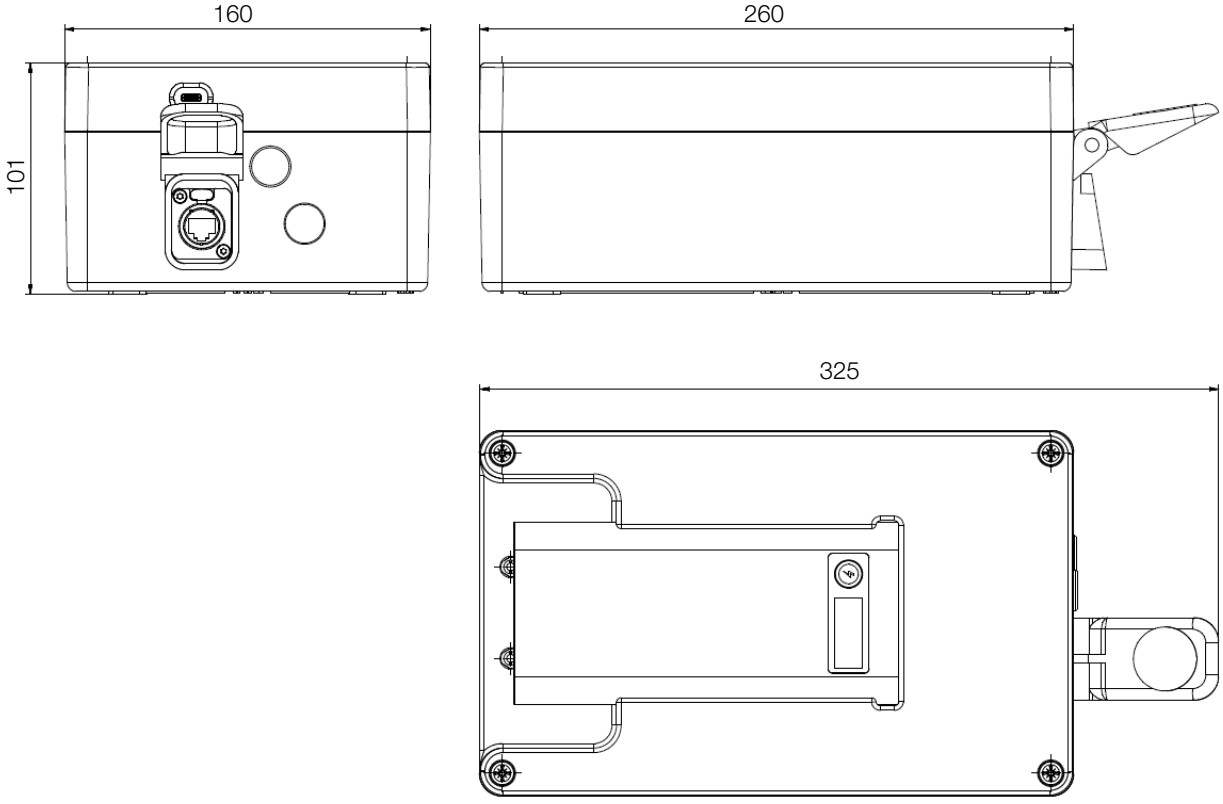
23.2 ScanFieldMonitor SFM with protective window spacer



23.3 Device holder



23.4 Processing Unit



24 Appendix

24.1 Patent notice

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

24.2 GNU GPL license notice

The software of this product contains software code that is licensed subject to the GNU General Public License (GPL) Version 2 or later. The license terms of the GNU GPL Version 2 or later are available on the following websites:

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- https://www.gnu.org/licenses/licenses.en.html

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