

RSM PowerLine E/EL (IR and SHG)

Repair Manual

Version 1.1

rofin

THE MARK OF EXCELLENCE

Contents

1	General Information	1
1.1	Identification data	1
1.2	Customer data	1
1.3	Introductory information	2
1.3.1	Explanation of symbols	2
1.3.2	Scope of the repair manual	2
1.3.3	Contact addresses	3
2	Safety	7
2.1	Operation according to regulations	7
2.2	Operation of the laser	8
2.3	General safety instructions	8
2.4	Safety notices for the laser system	10
2.4.1	Beam path	11
2.4.2	Alignment laser	12
2.5	Safety instructions for maintenance and setup tasks	13
2.6	Electrotechnical safety instructions	14
2.7	Components at risk of static electricity (ESD)	15
2.8	Emergency stop mechanisms and safety equipment	16
2.8.1	Emergency stop mechanisms	16
2.8.2	Safety equipment	17
2.9	Other dangers	19
2.9.1	Ultraviolet radiation	19
2.9.2	Hazardous materials	19
2.10	Personal protective measures	19
2.11	Administrative precautions	20
2.12	Waste disposal information	20
2.13	Labelling	20
3	Required tools, measuring devices and aids	23
4	Cleaning optical components	37
4.1	Galvo head	38
4.1.1	Galvo head with protective glass slide	38
4.1.1.1	Protective glass	38
4.1.1.2	Focusing lens	39
4.1.2	Galvo head with protective glass screwed into the optics	42
4.2	Deflecting mirror	48
4.2.1	Deflecting unit	48
4.2.1.1	Deflecting unit with adjusting screws on the side of the cover	48
4.2.1.2	Deflecting unit with adjusting screws on the beam output side	50

4.2.2	Alignment laser	53
4.3	Beam expander	54
4.4	Beam attenuator	55
4.5	Glass fiber lines	56
4.6	Resonator module	56
5	Troubleshooting	59
5.1	Image errors	59
5.2	Marking errors	64
5.2.1	Vector marking	64
5.2.2	Grayscale marking	65
5.3	Emergency stop circuit	66
5.4	Measurement of the laser power	67
5.4.1	Measuring points	67
5.4.2	General information	70
5.4.2.1	Performing the measurement	70
5.4.2.2	Assessment of the measurement	72
5.4.3	Power measurement on the galvo flange	74
5.4.3.1	Performing the measurement	74
5.4.3.2	Assessment of the measurement	75
5.4.4	Power measurement at the output of the deflecting unit	75
5.4.4.1	Performing the measurement	75
5.4.4.2	Assessment of the measurement	76
5.4.5	Power measurement at the output of the resonator module	76
5.4.5.1	Performing the measurement	76
5.4.5.2	Assessment of the measurement	77
5.4.6	Measurement of the diode power	78
5.4.6.1	Performing the measurement	78
5.4.6.2	Assessment of the measurement	81
5.5	Measurement of the HF power	83
5.5.1	Performing the measurement	83
5.5.2	Assessment of the measurement	84
5.6	Measuring the diode voltage	85
5.6.1	Performing the measurement	85
5.6.2	Assessment of the measurement	85
5.7	Measuring the diode current	86
5.7.1	Performing the measurement	86
5.7.2	Assessment of the measurement	86
5.8	Temperature measurement of the diodes	87
5.8.1	Performing the measurement	87
5.8.2	Assessment of the measurement	87
5.9	Loading a new configuration	88
5.9.1	System with operating panel	88
5.9.2	System without operating panel	91
5.9.2.1	With MCT software	92
5.9.2.2	Without MCT software	93
5.10	Loading a new ALI configuration	94
5.11	Checking the ALI system settings	96

6	Adjustment tasks	99
6.1	Pre-adjustment check	99
6.1.1	LaserControlPanel (LCP)	99
6.1.2	MCT software	100
6.2	Adjusting the laser head	100
6.3	Adjusting the laser beam	102
6.3.1	Main laser	102
6.3.1.1	Beam expander mount without angle adjustment	102
6.3.1.2	Beam expander mount with angle adjustment	109
6.3.2	Focal point	119
6.3.3	Alignment laser	122
6.4	Adjusting the beam attenuator	124
6.5	Adjustment of the internal power measurement device	126
7	Repair work	129
7.1	Changing the optical components	129
7.1.1	Galvo head	129
7.1.1.1	Galvo head with protective glass slide	129
7.1.1.2	Galvo head with protective glass screwed into the optics	134
7.1.2	Protective glass	140
7.1.2.1	Galvo head with protective glass slide	140
7.1.2.2	Galvo head with protective glass screwed into the optics	140
7.1.3	Beam expander	141
7.1.4	Deflecting mirror	142
7.1.4.1	Deflecting unit	142
7.1.4.2	Alignment laser	145
7.2	Changing the shutter module	146
7.3	Changing the resonator module	150
7.4	Changing the diode module	157
7.5	Changing glass fiber lines	170
7.6	Changing the HF generator	176
7.6.1	HG -24	176
7.6.2	HG-25	178
7.6.3	Changing from HG-25 to HG-24	179
7.6.4	Setting the operating voltage of HG-24	181
7.6.5	Setting the HF power of HG-24	184
7.6.6	Setting the HF power of HG-25	187
7.7	Changing the alignment laser	191
7.8	Changing the MICO controller	195
7.9	Changing the HN80x power supply unit	199
7.10	Changing the internal power measurement device	201
7.11	Changing the beam attenuator	203
7.12	Changing the ALI board	204
7.13	Changing the filter mats	206
7.14	Changing the particle filter and the deionizer bag	206
7.15	Calibration of the motor valve in the cooling circuit	207

7.16	Changing the cooling unit	208
8	Adjustment and repair of SHG models	211
8.1	Installation and adjustment of SHG components	211
8.1.1	Installing the SHG resonator module	211
8.1.2	Installing the SHG deflecting unit	215
8.1.3	SHG software settings	216
8.1.4	Leakage check	217
8.1.5	Power adjustment and checking of the SHG laser	218
8.1.6	Installing the SHG alignment laser	219
8.1.7	Installing the SHG beam expander	220
8.1.8	Installing the SHG galvo head	221
8.1.9	Fine adjustment of the SHG	224
8.1.10	Power adjustment for the SHG HG-24	225
8.2	Removing SHG components	226
9	Checklist - Power Line E	235

1 General Information

1.1 Identification data

Identification data	
Machine type:	
Model designation:	
Serial number:	
Order number:	
Parts list number:	
Manufactured on:	

1.2 Customer data

Customer data	
Inventory number:	
Location:	

1.3 Introductory information

1.3.1 Explanation of symbols



Attention: This symbol appears in all safety instructions in the repair manual. Possible risks are thus specially marked.

Non-observance of these safety instructions can lead to severe injury (including death) and/or to considerable property damage!



Note: This symbol indicates information and advice regarding operation and maintenance in the repair manual.

1.3.2 Scope of the repair manual



Attention: This repair manual is intended solely for repair personnel trained and authorized by ROFIN-SINAR for PowerLine E/EL series lasers.

This repair manual is valid for lasers of the ROFIN-SINAR PowerLine E/EL series.

This repair manual must be read, understood and observed by the competent repair personnel. ROFIN-SINAR Laser GmbH shall not be liable for damage and operating failure resulting from the non-observance of the repair manual. The copyright on this repair manual is exclusively reserved to ROFIN-SINAR. This manual is only entrusted to the owner of the laser for his/her personal use.

No part of this repair manual nor technical regulations nor drawings may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without the prior consent of Rofin-Sinar.



Note: We reserve the right to make technical changes in the information in this repair manual in order to improve the laser system.

1.3.3 Contact addresses

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2 Safety

This laser system may only be installed, operated, serviced and repaired by specially trained personnel who have received instruction concerning the hazards involved in its operation. This includes reading this repair manual and especially this chapter.

Please contact ROFIN-SINAR Laser or the system manufacturer if you have questions regarding this chapter or the safety of the laser system in general.



Attention: The safety instructions in the other laser system documents (operating instructions, maintenance manual) and the peripheral component documents must also be observed! These documents remain valid without limitations!

2.1 Operation according to regulations

The laser system has been designed to mark workpieces. The use of the laser for applications other than the intended ones are considered misuse and the laser manufacturer is not liable for any damage thereby caused. In this case, the user assumes the entire responsibility.

The laser manufacturer is not liable for damage caused by modifications made to the machine without consulting the manufacturer.

ROFIN-SINAR lasers are manufactured in accordance with the following safety regulations:

- EN ISO 12100
- EN 60204
- EN 60825
- VDE 0837 (IEC 825)
- UVV BGV B2
- BGI 832
- VDE 0100
- VDE 0105
- 21 CFR - National Center for Devices and Radiological Health - CDRH No. 0121857-01



ROFIN-SINAR lasers comply with valid EU guidelines:

- 2006/95/EG (Low Voltage Directive)
- 2004/108/EG (EMC Directive)
- 98/37/EC, Appendix IIA (Machinery Directive [if there is machine status])

2.2

Operation of the laser

The rules for the prevention of accidents by laser radiation (UVV) BGV B2 (formerly VBG 93) must be observed when operating the laser in the area within which these rules and relating instructions are valid. The implementation of the accident prevention regulation UVV BGV B2 "Laser Radiation" can be found in BGI 832 - Operation of Laser Equipment. Under UVV BGV B2, a person must be appointed to take charge of laser safety, and the professional association and the appropriate work safety authorities for lasers from class 3B or 4 must also be informed.

Outside the area within which the BGV B2 is valid, the national regulations of the user's country must be observed with regard to the rules for prevention of accidents by laser radiation.

The laser system may only be operated by trained and authorized personnel. Training courses are offered by:

- ROFIN-SINAR Laser GmbH (maintenance, repair application, operation)
- OEM suppliers (operation)
- Professional Association of Precision Mechanics and Electronic Technique (UVV)
- PTB Physical and Technical Federal Institute Braunschweig (UVV)
- Technical Supervisory Associations (UVV)

2.3

General safety instructions

- The plant owner must make sure that no unauthorized personnel work on the laser system or in its vicinity.
- The laser system may be operated only by qualified personnel. The plant owner is responsible for the selection and training of the personnel. The personnel must have annual training on laser-specific risks. This training must be documented. The personnel must be taught to handle the laser system at set intervals, for which a written record must be kept.
- The laser system may be operated only in a malfunction-free state. Safety equipment may be neither dismantled nor deactivated, not even upon instruction.
The machine's own safety technology should be checked at regular intervals for proper function and effectiveness.
- In case of changes to the laser system that impair safety, the laser system must be shut down. Before turning the laser system on again, the faults have to be remedied.
- Due to a possible risk of injury, the laser system should be clearly surveyable and clean.
- The personnel is obliged to wear the required personal protective equipment. E. g., this includes protective goggles with the corresponding protective class and adaptation to the wavelength of the laser (see BGI 5092 "Selection and use of laser protection and adjusting glasses").
- Every manner of working that impairs the safety of the laser system or people is prohibited. Improper use of the laser system must be ruled out.
- Operating the system under the influence of drugs, alcohol or medications that influence perception and reactions is prohibited!
- When switched on, the laser system must be monitored by operating personnel. Personnel must refrain from any manner of working that impairs safety.
- The plant owner is obliged to check the system for visible damage and faults at least once a shift. Changes that appear that impair safety must be eliminated immediately.
- During operation, you absolutely may not reach into the working range of the laser system with your hand or tools; safety equipment may not be evaded. A risk of injury exists!

- The laser system may only be operated using the provided controls. In this case, the use of tools (screwdrivers, etc.) is prohibited.
- Adjustment tasks may only take place during the setup mode. Personnel must take special care. These adjustment tasks may be performed only by qualified personnel using the provided controls.
- If unexpected risks arise during the operation of the laser system, operation must stop until the risks have been eliminated.
- The responsibilities for the various tasks within the scope of the operation of the system must be clearly defined. This applies particularly for work on electrical equipment and on beam-guiding components.
- Electrically unsecured doors or covers that can be opened or removed only with tools may be opened or removed only when the main switch is turned off.
- Before powering up the laser system, all tools and aids must be removed from the working area to exclude an endangerment of people and property.
- When the laser system is shut down, the main switch should be shut off and secured.
- In case of unexpected risk situations, the laser system must be shut down immediately using the emergency stop button.
- Emergency stop mechanisms may not be used as off switches in normal situations.
- After the emergency stop is pressed or after a serious fault, a safety check is required.
- Work in the electrical switch cabinet or on the control panel or electrical system may only be performed by qualified personnel. Control and switch cabinets must always be kept closed.
- Wet and compressed-air cleaning of the laser system is prohibited and only permitted under the following conditions:
 - Wet exterior cleaning with mild soapy solution or mild cleaning agent.
 - Compressed air from a can (water-free and oil-free), Nitrogen (1-2 bar).



Attention: *There is a risk of suffocation in case the nitrogen concentration in the ambient air is too high! Never exceed the permissible limit values!*

- Supply lines for the laser system (electrical power, cooling water) are to be laid in cable seats so that no one can trip over them.
- During work performed on additionally purchased function parts, the technical documents of the manufacturers must be observed.
- All safety notices and warnings attached to the laser system may not be removed and must always be legible. Damaged or illegible safety symbols must be exchanged immediately.

2.4 Safety notices for the laser system



Attention: Laser radiation is very hazardous for the eyes. Radiation of the skin can cause severe burns. Diffuse, secondary (reflected) radiation is also dangerous. Laser radiation can cause fire risk or risk of explosion. Avoid any exposure to direct or secondary laser radiation at all times during installation, operation, maintenance or service of the laser. Never look into the laser beam directly or with optical devices. The organizational and personal protective measures must be observed!



Attention: Laser radiation can lead to permanent eye damage and skin burns!



Attention: Warning against laser radiation!

A laser without any special protective unit corresponds to hazard class 4. A laser beam is invisible at a wave length of 1064 nm. With activated alignment lasers (wavelength 675 nm, red laser beam, safety class 2) and with SHG models (wavelength 532 nm, green laser beam, safety class 4), the laser beam is visible.



Laser class 1

Lasers that are safe under reasonably predictable conditions; this includes the use of optical instruments for the direct observation of the beam.
The accessible laser radiation is classified as safe.



Laser class 2

Lasers that emit visible radiation in the wavelength range of 400 nm to 700 nm; here, eye protection is usually effected by defensive reactions, including the eyelid closure reflex (up to 0.25 s).

It is to be expected that this reaction offers appropriate protection under reasonably predictable operating conditions.



Laser class 4

Lasers that can also generate dangerous, diffuse reflections. They can lead to skin injuries and the risk of fire. Their use requires extreme caution.
"Invisible laser radiation" is present if the emitted radiation lies outside of the visible radiation (wavelength range between 400 nm and 700 nm).
These areas are to be labeled with the corresponding warning symbol and the additional text "INVISIBLE LASER RADIATION – avoid irradiation of eyes and skin by direct or scattered radiation – LASER CLASS 4."



Attention: The beam is emitted, depending on the layout of the laser marker, at the optics of the marking head. The optics of these beam guide systems can point in any direction (360°).



Attention: If no galvo head is attached, the laser beam is emitted out of the front of the laser head.

- The owner of a laser system of laser class 3B or 4 is obliged to name a laser protection officer for the operation of the plant.
- With completely mounted protective housing, the machine has laser protection class 1. This means that no dangerous radiation can escape from the protective paneling and thus no risk exists for the machine operator or other people in the vicinity.



Attention: If the machine is serviced and the protective paneling is removed, the machine has laser protection class 4. In this condition, all corresponding laser protection measures must be complied with.



Attention: The protective goggles used must be adapted to the wavelength of the laser and have the corresponding protection class.

- To counteract potential malfunctions arising from inadvertent laser radiation, we remind you to comply with the proper use of the safety shutter.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.

2.4.1 Beam path

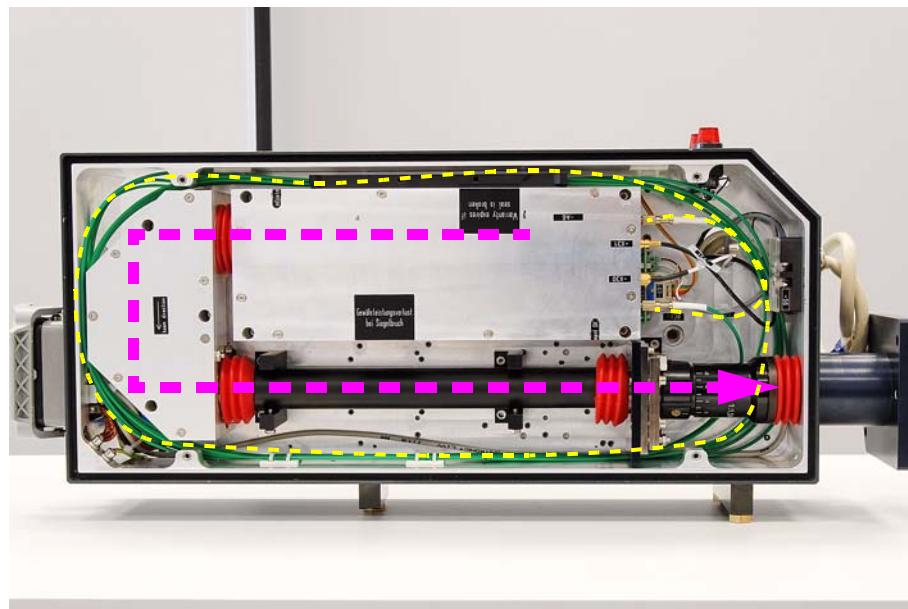


Figure 2.1 Beam path RSM PowerLine 20E/EL

The dashed line designates the beam path of the main laser. The beam path of the diode lasers is marked in yellow.

2.4.2 Alignment laser¹

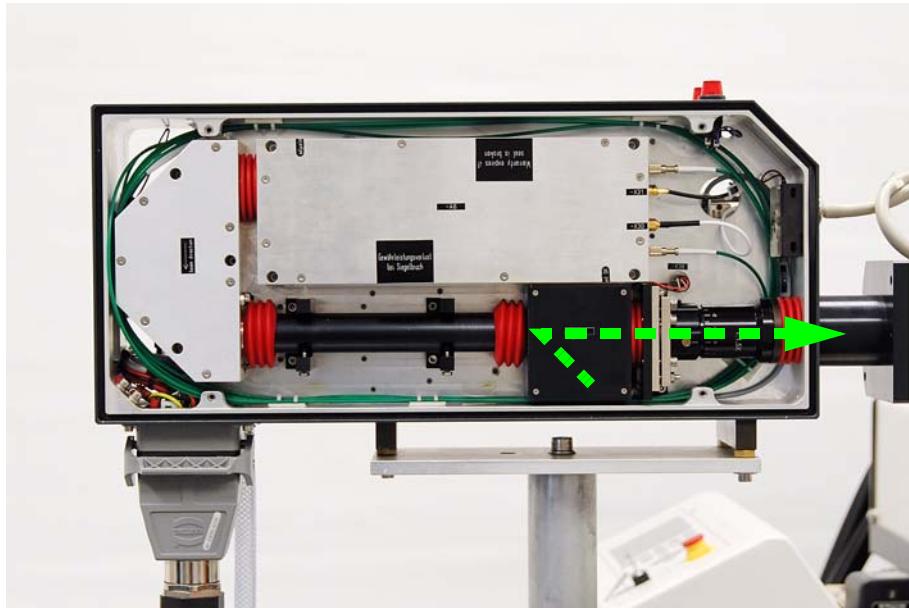


Figure 2.2 Beam path of the alignment laser

The dashed line indicates the beam path of the alignment laser.

The alignment laser is a laser diode of hazard class 2. According DIN EN 60825, the eyes are usually protected by defensive reactions, including the eyelid closure reflex. The alignment laser radiation is not dangerous to the skin.



Attention: Never look into the beam of the alignment laser directly or with optical devices.

1. Installation depends on the respective laser type

2.5 Safety instructions for maintenance and setup tasks



Attention: During the performance of maintenance, repair, setting, and monitoring tasks, the system must be shut down and secured against restarting. The warning sign "System shut down - activation prohibited!" must be attached to the laser system.



Attention: For the observance of laser protection class 1, the operation of the system with partially or completely dismantled protective housing is fundamentally prohibited.

- After installing electrical systems or servicing, the function of the existing protective devices must be checked and the protective measures tested.
- Electrically unsecured doors or covers that can be opened or removed only with tools may be opened or removed only when the main switch is turned off.
- Work in the electrical switch cabinet or on the control panel or electrical system of the machine may only be performed by qualified personnel. Control and switch cabinets must always be kept closed.
- If safety devices are removed during repair work, the machine may not be restarted until all safety devices have been attached and checked for proper function.
- During maintenance work, make sure that electrical and media lines are not damaged or crushed.
During this work, the main switch should be shut off and secured.



Attention: Danger from laser radiation: If parts of the protective housing are removed for work on beam-guiding units, operation of neighboring systems must be shut down. Authorized personnel located in the vicinity of the laser system during this work must wear protective goggles according to DIN 207. The working area must be labeled (laser class 4) (see Section 2.4, page 10).



Attention: The mechanical processing (grinding, drilling, separating, etc.) of parts of the laser system must strictly take place outside of the working area! **The processing of supporting components and assemblies is strictly prohibited!**

2.6

Electrotechnical safety instructions

- Wiring, electrical connection, commissioning, maintenance, and repair may only be performed by qualified electricians.
- Work may not be performed on live parts under any circumstances. The system or parts of it must be electrically disabled and secured against unintentional reactivation.
- When working on the electrical systems, turn off and secure the main switch.

**Attention: High voltage! Extreme danger!**

The devices marked with lighting bolts signs in the switch cabinet (main switch, repair socket, mains connection terminals) remain live after the main switch is turned off.

The switch cabinet may only be opened by electricians for repair purposes.

**Attention:** Additional devices connected to the laser system may have their own mains supply line and thus be live when the main switch of the system is turned off.

- The control and main power lines are to be laid separately from each other.

Non-observance may result in the following:

- Failure of the machine function
- Endangering malfunctions
- Destruction of electrical and mechanical components
- Electrical equipment must be checked regularly. Loose connections must be retightened. Damaged lines or cables should be exchanged immediately.
- The switch cabinet and all electrical supply units must always be kept locked. Access is permitted only to authorized personnel with a key or special tool.
- PCBs or plug connection may be removed only when the system is shut down. Do not mix up PCBs or plug connections. The label or coding must be observed.
- In case of measurements on live subassemblies or lines, a second person must always be present who can turn off the main switch in case of an emergency.
- When working with grounded measuring devices (oscilloscope), make sure that the ground bushing of the measuring device is always connected with the ground point of the control system (measuring cable). According to requirements, isolation amplifiers should be used for perfect measurements.

**Attention:** Never clean electrical equipment with water or other liquids.

2.7 Components at risk of static electricity (ESD)



Attention: The diode modules are components sensitive to electrostatic (ESD)! In case of work on and with the diodes, you must take protective measures!

Protective measures to be taken:

- Make sure the equipotential bonding is constant!
- Make sure personnel are grounded using wrist and shoe grounding!
- Make sure clothing is conductive and closed!
- Avoid electrostatically chargeable materials such as normal PE, PVC, styrofoam, etc.!
- Avoid electrostatic fields > 100 V/cm!
- Only use marked and defined packaging and transport materials!



Attention: The required disconnection of the power supply prior to opening system components will also disconnect the grounded conductor! This also applies to the disconnection of the plug on the laser head (e. g. only required when removing the laser head for space reasons; do not damage pins in the connection plug)!

The laser head must be grounded with suitable measures before working on diodes! The external grounding must be performed at a marked PE clamp of the laser head and a marked PE clamp in the system area! The correct equipotential bonding must be checked using measuring technology! The ESD wrist band must then be connected to a PE clamp of the laser head!

Before that, the diode modules may not be disconnected!



Attention: All persons working on diode modules must comply with the measures for the protection of electrostatic sensitive devices (ESD)! The work area must be secured!



Attention: When the connecting lines are removed, touching the connecting terminals can lead to the destruction of the diode! This also applies to disconnecting the connecting lines on the power supply unit! Immediately after disconnection, diodes must be short-circuited by a person equipped in accordance with the relevant ESD regulations!

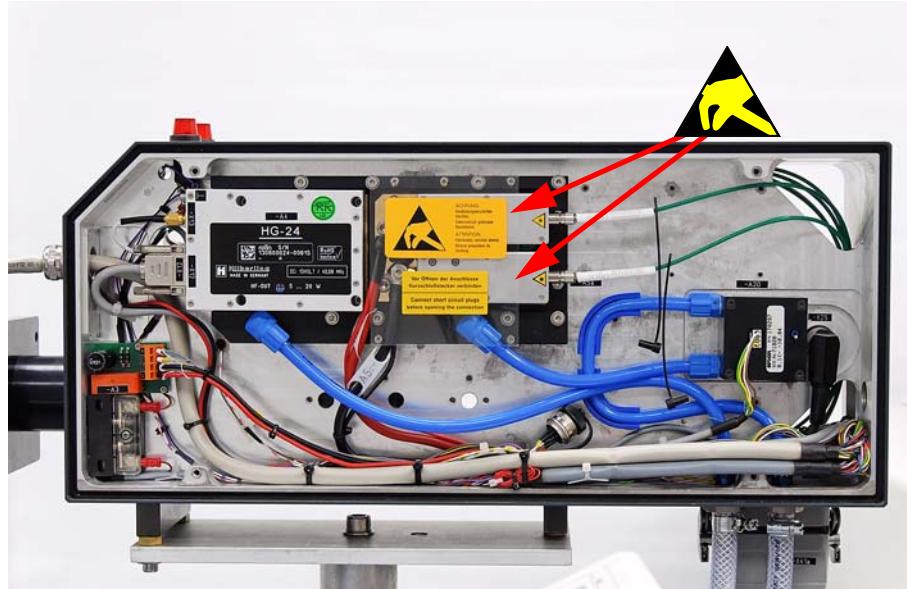


Figure 2.3 Diode modules RSM PowerLine 20E/EL

2.8 Emergency stop mechanisms and safety equipment

2.8.1 Emergency stop mechanisms

The emergency stop is caused by operating the red emergency stop push button. The emergency stop switches off the laser as quickly as possible and stops all movements of the operation process and is used to prevent injury to persons, or damage to the machine or workpiece.

Depending on the system layout, the emergency stop push button is on the control panel or on the supply plug-in or it is available as an external emergency stop push button.



Figure 2.4 Emergency stop push button on control panel

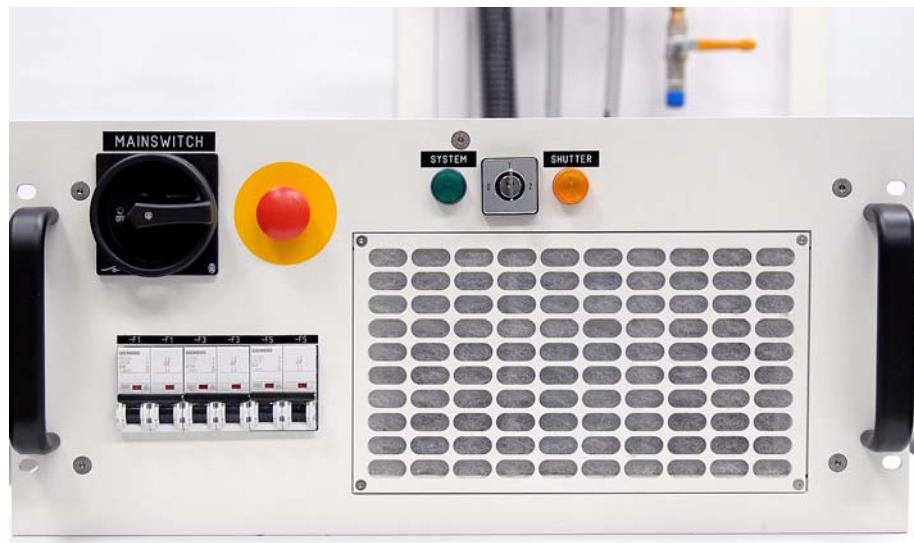


Figure 2.5 Emergency stop push button supply plug-in unit



Figure 2.6 External emergency stop push button



Note: The emergency stop should not be used to end a normal working cycle.

2.8.2 Safety equipment

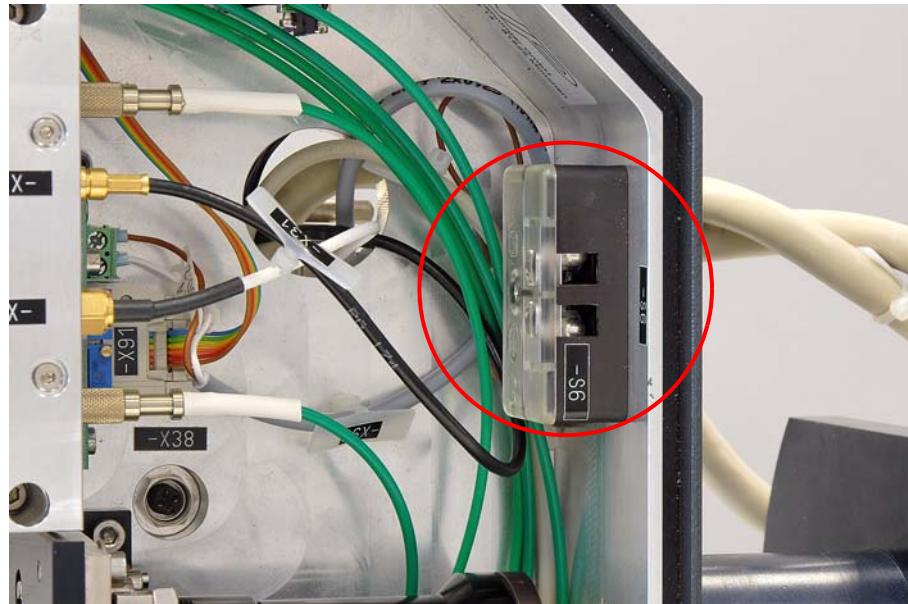


Figure 2.7 Interlock switch for laser head

An interlock switch has been mounted for both lateral covers of the laser head.



Note: As required, the laser system can be equipped with a connection for an external interlock -X28 (see the "Shutter, shutter interlock" page of the circuit diagram). This installation set can be obtained from ROFIN-SINAR.

For mounting, the cover of the installation opening (Figure 2.8) should be removed. The electrical connection is made on Plug -X28 on the diode side of the laser head (Figure 2.9).



Figure 2.8 Installation opening of the external interlock

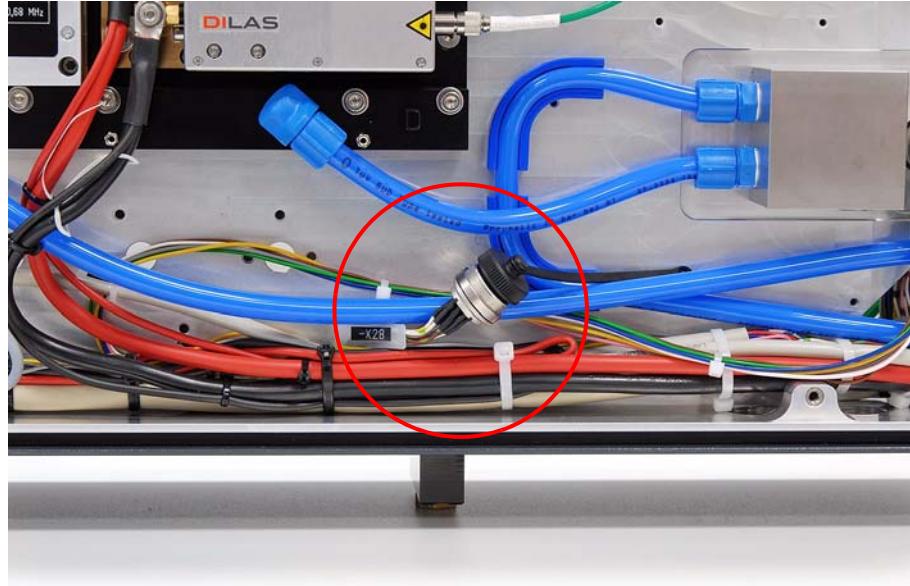


Figure 2.9 Connecting plug -X28 in the laser head

2.9 Other dangers

2.9.1 Ultraviolet radiation



Attention: The metal vapor plasma which emerges when welding and marking certain metals with a laser beam emits intense invisible ultraviolet radiation which can cause severe damage to the eyes and the skin!



Note: The protective goggles shown in Figure 3.1 and Section 3.2, page 23 also provide eye protection from UV radiation.



Attention: If goggles other than those shown are used, it will be necessary to check in each case that adequate protection against UV radiation is provided. Furthermore, the necessary protective measures (e. g. face mask, use of sun screen agents) must be arranged by the owner's occupational safety specialist.

2.9.2 Hazardous materials



Attention: Hazardous fumes and dust may be given off during the marking process or when carrying out service tasks (e.g. replacing contaminated filters). The regulations of the supplier in regard to safety must be observed. When handling hazardous materials, a suitable breathing mask and protective gloves shall be used.

2.10 Personal protective measures



Attention: Laser radiation is very hazardous for the eyes. Radiation of the skin can cause severe burns. Diffuse, secondary (reflected) radiation is also dangerous. Laser radiation can cause fire risk or risk of explosion.

- Avoid any exposure to direct or secondary laser radiation at all times during installation, operation, maintenance or service of the laser. Never look into the laser beam directly or with optical devices. The organizational and personal protective measures must be observed!
- In the laser area, wear suitable protective goggles conforming to DIN EN 207 and EN 208 – eye protection against laser radiation at a wavelength of 1064 (532) nm.
- The interlock circuits which act as safety devices must not be removed or bypassed during the operation of the laser system; if they are bypassed they will not operate in accordance with regulations. No liability whatsoever is assumed by the manufacturer if the safety devices are removed or bypassed.

2.11 Administrative precautions

The following regulations must be observed. The detailed organizational protective measures and guidelines of DIN EN 60825, Classification VDE 0837 (IEC 825), must be observed.

- The operators must be instructed in safety regularly.
- Attach warning signs to warn against laser radiation.
- Deny access to the laser system to anybody not working on it.
- The laser area must be sufficiently labeled.
- Due to a possible risk of fire and explosion, no flammable or easily flammable gases, liquids, or solids may be brought into the laser area.
- Toxic decomposition products may develop when certain materials (e.g. metals or plastics) are processed. Information on possible risks that can appear should be obtained, e.g. from professional organizations.
- Objects that can endanger people through the uncontrolled reflection of the laser radiation must be removed from the laser area.
- Have authorized and purposely appointed persons check the effectiveness of integrated safety equipment (e.g. emergency stop) according to defined test cycles. All relevant national safety regulations and guidelines must be observed (see "Operation according to regulations" on page 7).

Existing safety equipment must be actuated during operation. Any endangering functions must immediately be stopped or interrupted. Before renewed powering up the laser system, the corresponding displays or error messages must be acknowledged. Make sure that the laser system can be restarted. If this is confirmed the safety equipment is in proper working order.

- Make sure that the warning lamps regarding laser radiation function properly. A defective lamp must be replaced immediately. The laser radiation warning lamps are located on top of the laser head.

2.12 Waste disposal information

Comply with all national and regional regulations regarding waste disposal.

2.13 Labelling

All locations which, under certain circumstances (such as when protective covers are opened), represent a potential risk, are labeled with the required warning labels. The location of the individual signs are marked in the Safety chapter in the user manual.



Attention: These labels must not be removed.

Notes

Notes

3 Required tools, measuring devices and aids

In addition to a standard tool set, the tools, measuring devices, and aids listed in the following are required for performing repair work on lasers of the RSM PowerLine E/EL (IR and SHG) series:



Note: Listed here are the tools, measuring devices and aids that can be purchased from ROFIN-SINAR. If other tools, measuring devices or aids are used, these must have the appropriate characteristics.



Figure 3.1 Protective goggles

- Protective goggles*



Attention: The protective goggles must be adapted to the wavelength of the laser that is used.



Note: The protective goggles shown in Figure 3.1 are suitable for all the wavelengths that may appear in the RSM PowerLine E/EL (IR and SHG) (180 nm through 532 nm; 800 nm through 1080 nm). If goggles that do not cover the full range of wavelengths are used, several appropriate sets will be required and will have to be changed according to the wavelength in use.



Figure 3.2 Protective goggles (version for wearers of eyeglasses)

- Protective goggles (version for wearers of eyeglasses)*



Attention: The protective goggles must be adapted to the wavelength of the laser that is used.



Note: The protective goggles shown in Figure 3.2 are suitable for all the wavelengths that may appear in the RSM PowerLine E/EL (IR and SHG) (180 nm through 532 nm; 800 nm through 1080 nm). If goggles that do not cover the full range of wavelengths are used, several appropriate sets will be required and will have to be changed according to the wavelength in use.



Figure 3.3 ESD wrist band with spiral cable

- ESD wrist band with spiral cable*



Figure 3.4 Diode power measurement parts set

- Diode power measurement parts set PL-E*



Figure 3.5 Cross wires with seat

- Cross wires with seat D=16 mm, cross wires D=25 mm*

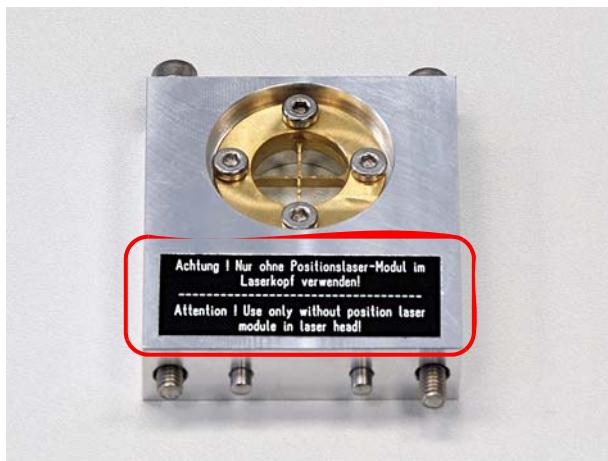


Figure 3.6 Cross wires with seat for systems without a pilot laser (1)

- Cross wires with seat for systems without a pilot laser*

i Note: Figure 3.6 shows the label on the front.



Figure 3.7 Cross wires with seat for systems without a pilot laser (2)

- Cross wires with seat for systems without a pilot laser*

i Note: Figure 3.7 shows the marking on the top, including the direction of the beam.



Figure 3.8 Cross wires with seat for systems with a pilot laser (1)

- Cross wires with seat for systems with a pilot laser*

i Note: Figure 3.8 shows the label on the front.



Figure 3.9 Cross wires with seat for systems with a pilot laser (2)

- Cross wires with seat for systems with a pilot laser*

i **Note:** Figure 3.9 shows the marking on the top, including the direction of the beam.



Figure 3.10 Adjusting aperture for beam expander

- Adjusting aperture for beam expander*



Figure 3.11 Adapter for cross wires

- Adapter for cross wires, flange for galvo head, E-Line*



Figure 3.12 Adjustment tube of galvo head with base plate

- Adjustment tube of galvo head with base plate*



Figure 3.13 Transducer disk

- "Beam catcher" transducer disk*

! **Attention:** The transducer disk must be suitable for all wavelengths that may occur with the corresponding model (IR or SHG).

! **Attention:** When the transducer disk is used, protective goggles adapted to the wavelength of the laser must be used!



Figure 3.14 Transducer disk with cross wires

- "Beamcatcher" transducer disk with cross wires*

! **Attention:** The transducer disk must be suitable for all wavelengths that may occur with the corresponding model (IR or SHG).

! **Attention:** When the transducer disk is used, protective goggles adapted to the wavelength of the laser must be used!



Figure 3.15 IR transducer screen LDT-007

- IR transducer screen LDT-007*

Attention: When the IR transducer screen is used, protective goggles adapted to the wavelength of the laser must be used!

Note: The IR transducer screen is only required for IR models.



Figure 3.16 Power measurement device

- Power measurement device including sensor and fitting for power measurement head LM 200*

Attention: When the power measurement device is used, protective goggles adapted to the wavelength of the laser must be used!



Figure 3.17 Multimeter

- Multimeter

- Clamp-on ammeter



Figure 3.18 Clamp-on ammeter



Figure 3.19 Precision thermometer

- Precision thermometer

Attention: An additional watertight measuring tip is required for measurements in the cooling water container.



Figure 3.20 HF power and standing wave measuring device

- HF power and standing wave measuring device including HF measuring cable for PWL-E 1xBNC and 1xSMA*



- Fine measuring tips

i **Note:** Various measuring points cannot be reached with standard measuring tips.

Figure 3.21 Fine measuring tips



- Measuring adapter for galvo voltage*

Figure 3.22 Measuring adapter for galvo voltage



- Measuring adapter HG-24 signals, SubD9*

Figure 3.23 Measuring adapter HG-24 signals, SubD9



Figure 3.24 Scotch tape # 6877 50 x 66

- Scotch tape # 6877 50 x 66*

Attention: Only tape that can be completely removed without residue may be used!



Figure 3.25 Torque wrench

- Torque wrench (min. 20 through 120 Ncm)

- Torque wrench (min. 1 through 12 Ncm)

Figure 3.26 Torque wrench



Figure 3.27 Precision level gauge



Figure 3.28 Lens cleaning paper pack



Figure 3.29 Isopropyl alcohol

- Precision level gauge

- Lens cleaning paper pack*

- Isopropyl alcohol for the cleaning of optical components*



Figure 3.30 Compressed air can

- Compressed air can



Figure 3.31 Rubber gloves and dust protection mask

- Rubber gloves and dust protection mask for cleaning tasks*

i **Note:** To prevent contamination, the gloves must not be powdered.



Figure 3.32 Poly-Stretch gloves

- Poly-Stretch gloves*

i **Note:** For use when cleaning optical components.



Figure 3.33 High vacuum grease

- High vacuum grease*



Figure 3.34 E-Line measurement head cooling adapter

- E-Line measurement head cooling adapter *

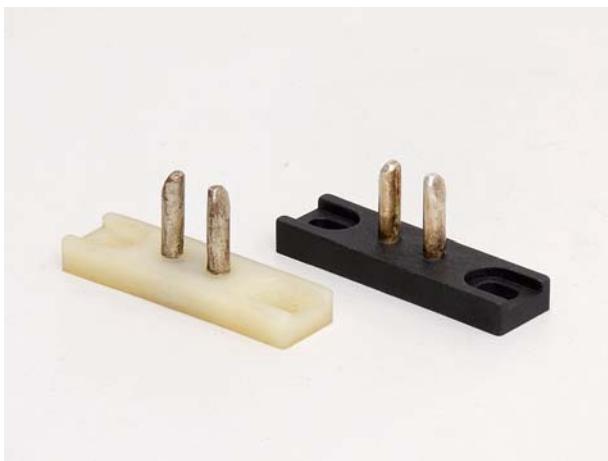


Figure 3.35 Bridging contact for interlock switches

- Bridging contact for interlock switches*

 **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

 **Attention:** The owner of the laser system must keep the bridging contacts in such a way that no use by unauthorized persons is possible!

*. For the order number, see the ROFIN-SINAR measuring and adjusting device catalog

Optionally available exchange components



- Warning lamp exchange set

i **Note:** The filament bulbs in the warning lamps can be replaced by LEDs (right). These LEDs guarantee a longer life and thus greater reliability.

Figure 3.36 Warning lamp exchange set

4 Cleaning optical components



Note: The surfaces of the optical components are to be cleaned according to the maintenance schedule.



Attention: For cleaning, lens cleaning paper and water-free isopropyl alcohol or purified compressed air should be used! Water in the isopropanol causes surface streaks.



Attention: Isopropyl alcohol basically has special dangers. It may basically only be used by accordingly trained personnel with the necessary care.

The substance is highly inflammable. It irritates the eyes. Fumes can cause sleepiness and a dazed state. The safety data sheet absolutely must be observed!

Cleaning of the optical components:

1. Dismantle optical components as described below.
2. Blow fine dust particles off the surfaces using purified compressed air.
3. Clean optical components using lens cleaning paper and isopropyl alcohol.



- With a pipette, apply 1-2 drops of isopropyl to the surface to be cleaned.



- Apply lens cleaning paper and carefully remove or wipe off the isopropyl alcohol.

Figure 4.1 Cleaning optical components (1)

Figure 4.2 Cleaning optical components (2)



Attention: Always work with clean, grease-free hands, so as not to soil the optical components! Use Poly-Stretch gloves (see Chapter 3) to prevent contamination of the optics!

- Repeat the cleaning procedure until the surface of the optics is clean.



Attention: Do not damage optical components during cleaning! Do not apply pressure! Remove the lens cleaning paper only in one direction. Use a new piece of lens cleaning paper each time you clean!

- Always clean both sides of lenses or partially two-way mirrors. In the process, make sure that both previously cleaned surfaces are not soiled further.

4.1 Galvo head

4.1.1 Galvo head with protective glass slide

4.1.1.1 Protective glass

1. Remove the protective glass mount from the protective glass slide.
2. Loosen the respective fastening of the protective glass and remove it.
3. Clean it (see page 37).



Note: Always use a new piece of lens cleaning paper each time you clean!



Note: Both sides of the protective glass must always be cleaned. In the process, make sure that the previously cleaned surface is not soiled further or comes into contact with isopropyl alcohol.

1. Put and fix the protective glass back in place.
2. Push the protective glass mount into the protective glass slide.



Note: Make sure that the protective glass and protective glass mount are installed on the right side. The arrow on the side of the protective glass must point toward the resonator module.

4.1.1.2 Focusing lens



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

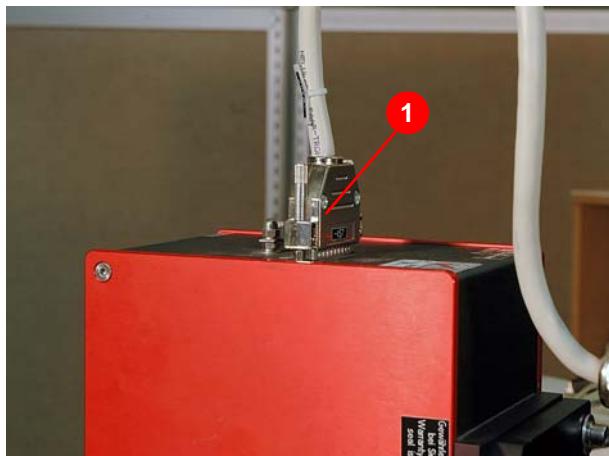


Figure 4.3 Galvo head connecting plug

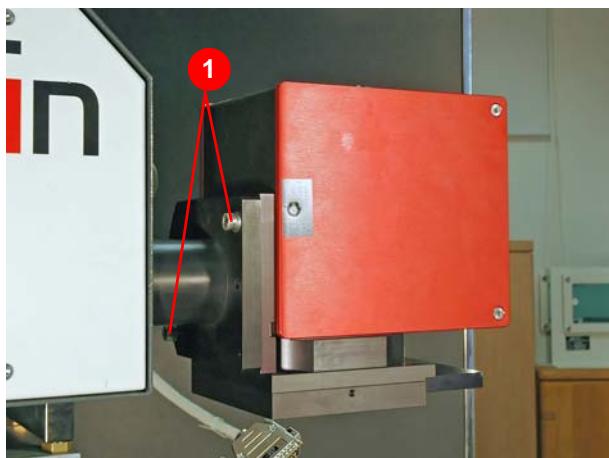


Figure 4.4 Dismantling the galvo head

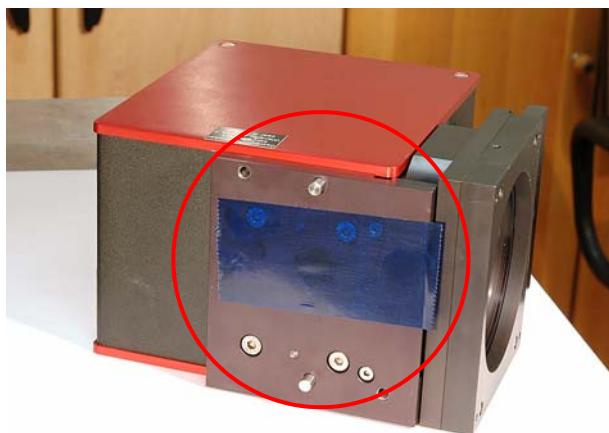


Figure 4.5 Covering the entry openings

Attention: Remove or insert the connecting cable of the galvo head only without tension! In case of non-observance, the galvo head can be damaged!

1. Loosen and remove the connecting plug of the galvo head (1) (Figure 4.3).

2. Loosen the fastening screws (1) (Figure 4.4).
3. Remove the galvo head.

4. Cover the entry opening with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the galvo head.
5. Cover the laser beam exit opening on the laser head with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the laser head.

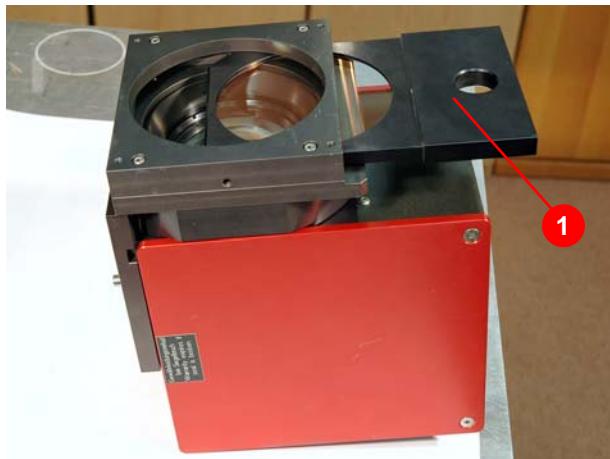


Figure 4.6 Removing the protective glass



Figure 4.7 Dismantling the guide plate



Figure 4.8 Removing the focusing optics

6. Remove the protective glass (1) (Figure 4.6).

! **Attention:** Take care that the protective glass does not fall out.

i **Note:** If the protective glass is damaged, it must be exchanged (see Section 7.1.2, page 141).

i **Note:** All parts must be marked for reinstallation with suitable tools.

7. Clean the protective glass (see page 37).

8. Loosen the screws (Figure 4.7) of the guide plate for the protective glass.

9. Unscrew the focusing optics (1) (Figure 4.8).

10. Clean it (see page 37).



Figure 4.9 Removing the distance ring

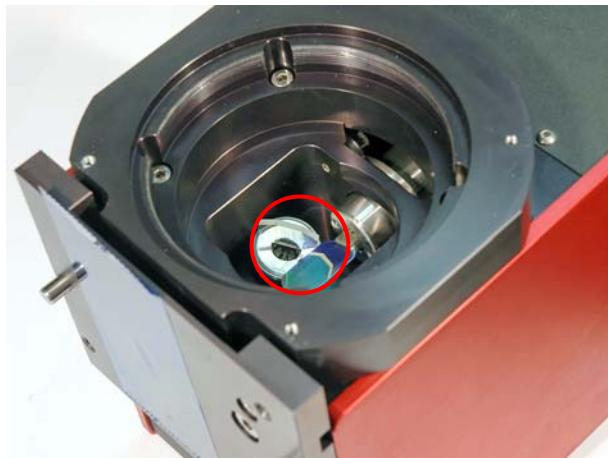


Figure 4.10 Checking to see if the deflecting mirror is clean

11. Removing the distance ring (1) (Figure 4.9).

12. Check to see if the deflecting mirror is clean (Figure 4.10) and clean it if necessary (see page 37).
 13. Remove the adhesive tape from the galvo head and the laser head.
 14. Mount the galvo head in the reverse order.
- i Note:** When mounting the galvo head, pay attention to the correct position of the distance ring (see Figure 4.9).
15. Remount the galvo head to the laser and connect it.
 16. Commission the laser system.

4.1.2 Galvo head with protective glass screwed into the optics



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Figure 4.11 Galvo head connecting plug

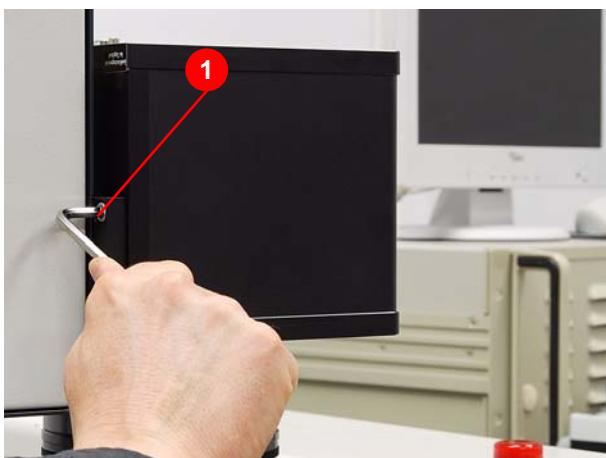


Figure 4.12 Dismantling the galvo head



Figure 4.13 Covering the entry openings

Attention: Remove or insert the connecting cable of the galvo head only without tension!
In case of non-observance, the galvo head can be damaged!

1. Loosen and remove the connecting plug of the galvo head (1) (Figure 4.11).
2. Loosen the two fastening screws (1) (Figure 4.12).
3. Remove the galvo head.

4. Cover the entry opening with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the galvo head.
5. Cover the laser beam exit opening on the laser head with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the laser head.



Figure 4.14 Removing the focusing optics



Figure 4.15 Unscrewing the protective glass



Figure 4.16 Set the focusing optics to one side and fit a protective cap

6. Unscrew the focusing optics (1) (Figure 4.14).

Note: In the process, take note of the aluminum distance ring that may be present.

7. Clean it (see page 37).

8. Unscrew the protective glass (1) (Figure 4.15) from the focusing optics.

Note: If the protective glass is damaged, it must be replaced.

Note: All parts must be marked for reinstallation with suitable tools.

If the protective glass cannot be unscrewed:

- a) Lay the focusing optics on a foam rubber mat (e. g. a reversed mouse mat) with the protective glass facing down.

Attention: The mat must be absolutely free of foreign objects, in order not to damage the protective glass.

- b) Fit a protective cap (1) (Figure 4.16) to the rear of the focusing optics.

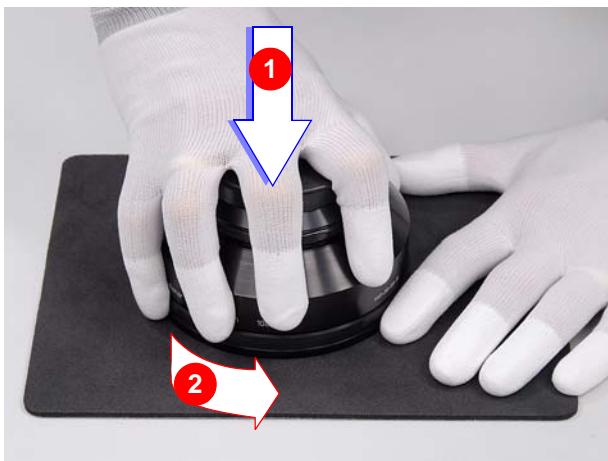


Figure 4.17 Unscrewing a seized protective glass



Figure 4.18 Cleaning the protective glass (1)



Figure 4.19 Cleaning the protective glass (2)

- c) Apply axial pressure (1) to the focusing optics and unscrew the protective glass (2).

9. Remove the protective glass from the guide ring.
10. Lay the lens cleaning paper on the protective glass.
11. Soak the lens cleaning paper with isopropyl alcohol.

12. Pull the soaked lens cleaning paper slowly and at a slight downwards angle from the protective glass.
13. Repeat the cleaning procedure until the entire surface of the protective glass is clean.

i *Note:* Always use a new piece of lens cleaning paper each time you clean!

i *Note:* Both sides of the protective glass must always be cleaned. In the process, make sure that the previously cleaned surface is not soiled further or comes into contact with isopropyl alcohol.

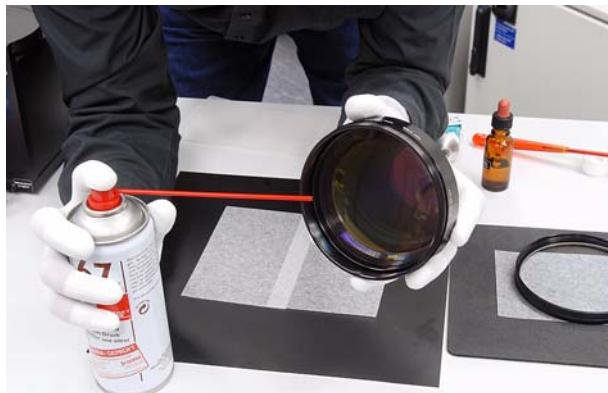


Figure 4.20 Cleaning the focusing optics

14. Remove any dust from the area to be cleaned with clean, dry, oil-free air.

15. Clean the external lenses of the focusing optics in the same way as for the protective glass.

! **Attention:** Take care that the cleaning fluid does not get into the inside of the lens. In such a case, the optics will have to be sent to ROFIN-SINAR for internal cleaning.



Figure 4.21 Fitting the protective glass (1)

16. Before fitting the protective glass, apply high vacuum grease to four points on the thread of the focusing optics to prevent the protective glass from seizing.

! **Attention:** Apply the grease extremely sparingly to prevent contamination of the focusing optics and the protective glass.



Figure 4.22 Fitting the protective glass (2)

17. Insert the protective glass in the guide ring.

i **Note:** Do not contaminate the protective glass while inserting it! Note the correct position of the protective glass in the guide ring!



Figure 4.23 Fitting the protective glass (3)



Figure 4.24 Set the focusing optics down

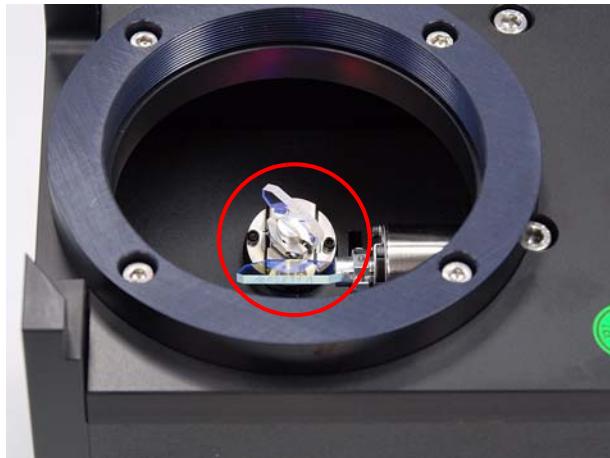


Figure 4.25 Checking to see if the deflecting mirror is clean

18. Screw the protective glass on to the focusing optics.

i **Note:** To check for correct seating of the protective glass, it must be ensured that there is no gap between the glass and the F-theta objective. "Rock" the focusing optics carefully. If there are any rattling noises, the protective glass is still loose.

19. Attach protective caps to the focusing optics and set them down.

20. Check to see if the deflecting mirror is clean (Figure 4.25) and clean it if necessary (see page 37).



Figure 4.26 Fitting the focusing optics (1)



Figure 4.27 Fitting the focusing optics (2)



Figure 4.28 Protective cap for the focusing optics

21. Before fitting the focusing optics to the galvo head, apply high vacuum grease to four points on the thread of the focusing optics to prevent the optics from seizing.

Attention: Apply the grease extremely sparingly to prevent contamination of the focusing optics and the interior of the galvo head.

22. Screw the focusing optics back into the galvo head.

Note: In the process, reinsert the aluminum distance ring that may be present.

23. Remove the adhesive tape from the galvo head and the laser head.
24. Remount the galvo head to the laser and connect it.

Attention: Before starting up the laser system, check that the protective cap on the focusing optics (Figure 4.28) has been removed. If the laser system is switched on with the protective cap fitted, the cap will be damaged or destroyed!

25. Commission the laser system.

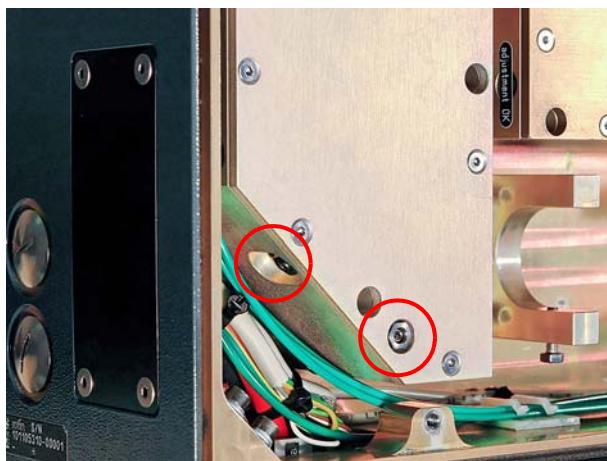
4.2 Deflecting mirror

4.2.1 Deflecting unit



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

4.2.1.1 Deflecting unit with adjusting screws on the side of the cover



i **Note:** This method must be used for laser systems where a deflecting unit is fitted in accordance with Figure 4.29.

Figure 4.29 Adjusting screws for the lower deflecting mirror

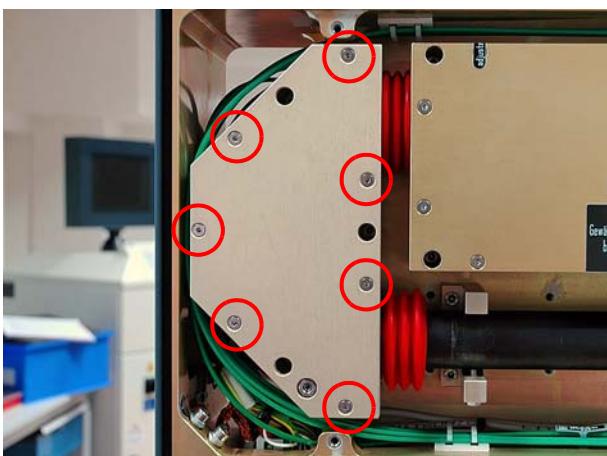


Figure 4.30 Cover of deflecting unit

1. Open the lateral cover of the resonator side of the laser head.
2. Loosen the seven fastening screws on the cover of the deflecting unit.
3. Remove the cover.

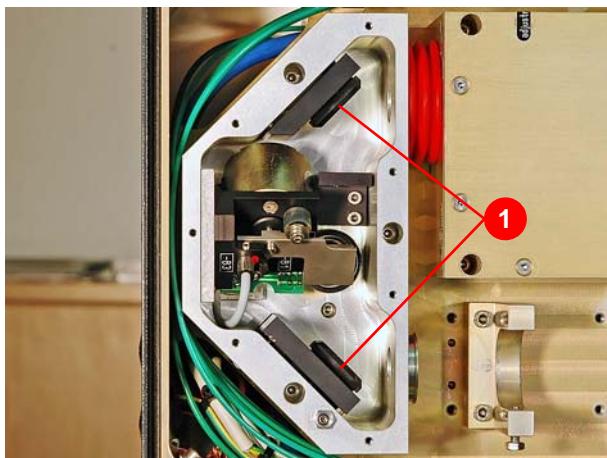


Figure 4.31 Removing the deflecting mirror

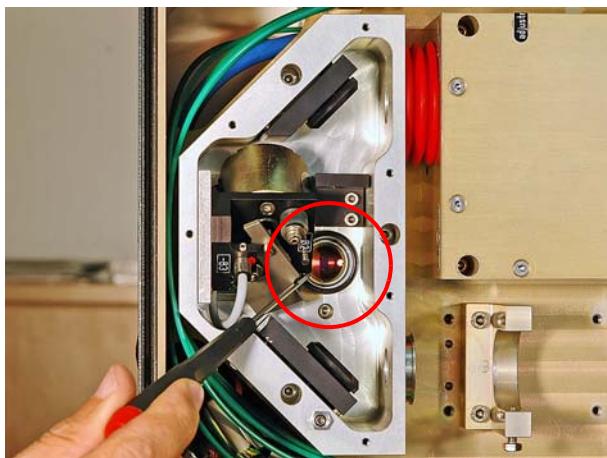


Figure 4.32 Lens in front of the internal power measurement unit or in front of the absorber

4. Unscrew the deflecting mirror (1) (Figure 4.36) and lay it on a clean foundation.

 **Attention:** Do not use a tool to unscrew the deflecting mirror! A risk of damaging the deflecting mirror exists!

5. Swivel back the shutter mirror carefully to check the degree of soiling of the lens in front of the internal power measurement unit or in front of the absorber.
6. If cleaning is necessary, the complete deflecting unit and shutter module must be disassembled (see Section 7.2, page 147).

 **Attention:** If the shutter module is installed during the lens cleaning procedure, there is a risk of damage to the electronic or optical components of the shutter module!

7. Unscrew the lens in front of the internal power measurement unit or in front of the absorber and lay it on a clean foundation.
8. Clean the deflecting mirror, the lens, and the shutter mirror (see page 37).
9. Reinstall the lens, shutter module, and deflecting mirror into the deflecting unit.

 **Attention:** Note the direction of installation of the deflecting mirror! The gold-colored ring on the deflecting mirror must point in the direction of the laser beam! The deflecting mirror will be destroyed if it is installed incorrectly!

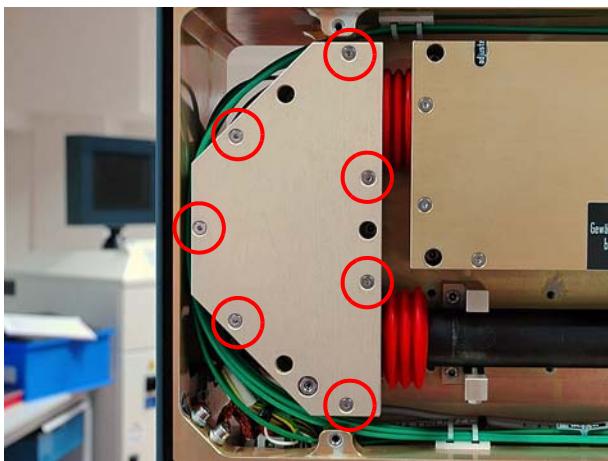


Figure 4.33 Cover of deflecting unit

10. Mount the cover of the deflecting unit and install the deflecting unit into the laser head.
11. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.1, page 102).
12. Mount the cover on the resonator side of the laser head.
13. Commission the laser system.
14. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

4.2.1.2 Deflecting unit with adjusting screws on the beam output side



Figure 4.34 Adjusting screws for the lower deflecting mirror

i **Note:** This method must be used for laser systems where a deflecting unit is fitted in accordance with Figure 4.34.

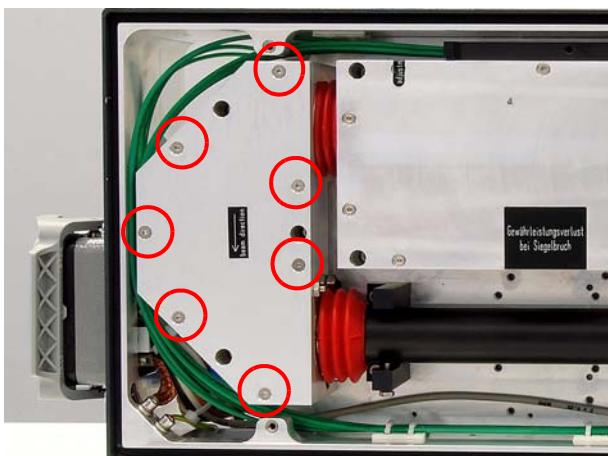


Figure 4.35 Cover of deflecting unit

1. Open the lateral cover of the resonator side of the laser head.
2. Loosen the seven fastening screws on the cover of the deflecting unit.
3. Remove the cover.

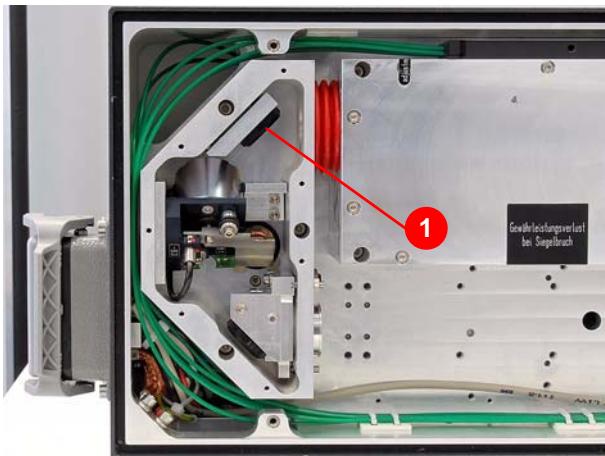


Figure 4.36 Removing the upper deflecting mirror

4. Unscrew the upper deflecting mirror (1) (Figure 4.36) and lay it on a clean surface.

Attention: Do not use a tool to unscrew the deflecting mirror! There is a risk of damaging the deflecting mirror!

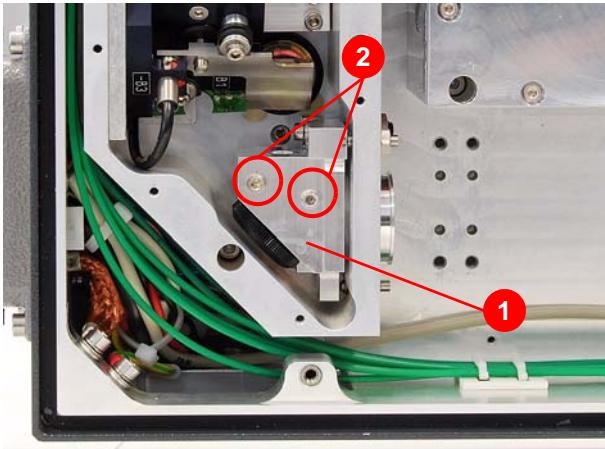


Figure 4.37 Removing the lower deflecting mirror (1)

5. Dismantle the retaining block (1) (Figure 4.37) for the lower deflecting mirror after first loosening the two fastening screws (2).

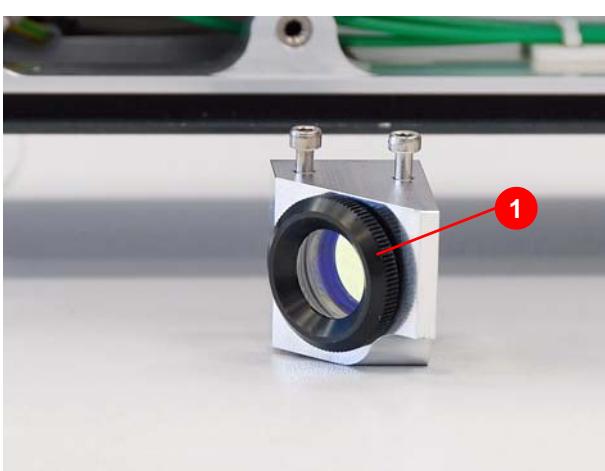


Figure 4.38 Removing the lower deflecting mirror (2)

6. Unscrew the upper deflecting mirror (1) (Figure 4.38) from the retaining block and lay it on a clean surface.

Attention: Do not use a tool to unscrew the deflecting mirror! There is a risk of damaging the deflecting mirror!

Note: After the mirror has been cleaned and reinserted, the retaining block must be pressed against the two milled edges and the screws tightened again.

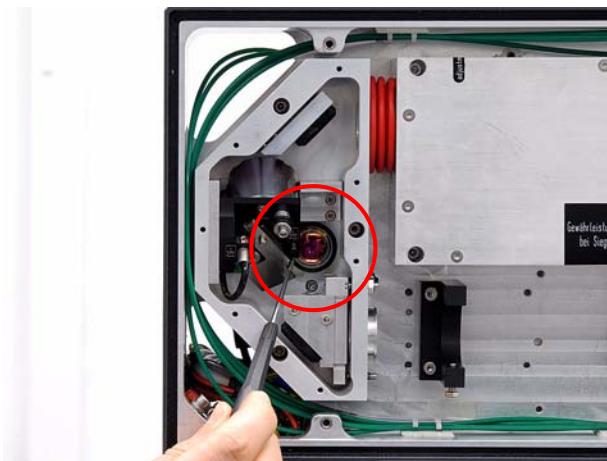


Figure 4.39 Lens in front of the internal power measurement unit or in front of the absorber

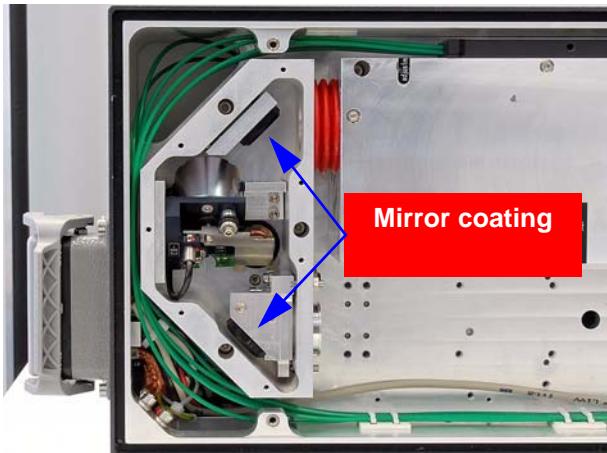


Figure 4.40 Installing the deflecting mirror

7. Swivel back the shutter mirror carefully to check the degree of soiling of the lens in front of the internal power measurement unit or in front of the absorber.
8. If cleaning is necessary, the complete deflecting unit and shutter module must be disassembled (see Section 7.2, page 147).

 **Attention:** If the shutter module is installed during the lens cleaning procedure, there is a risk of damage to the electronic or optical components of the shutter module!

9. Unscrew the lens in front of the internal power measurement unit or in front of the absorber and lay it on a clean foundation.
10. Clean the deflecting mirror, the lens, and the shutter mirror (see page 37).
11. Reinstall the lens, shutter module, and deflecting mirror into the deflecting unit.

 **Attention:** Note the direction of installation of the deflecting mirror (see Figure 4.40)! The gold-colored ring on the deflecting mirror must point in the direction of the laser beam! The deflecting mirror will be destroyed if it is installed incorrectly!

12. Mount the cover of the deflecting unit and install the deflecting unit into the laser head.
13. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.1, page 102).
14. Mount the cover on the resonator side of the laser head.
15. Commission the laser system.
16. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

4.2.2 Alignment laser¹



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

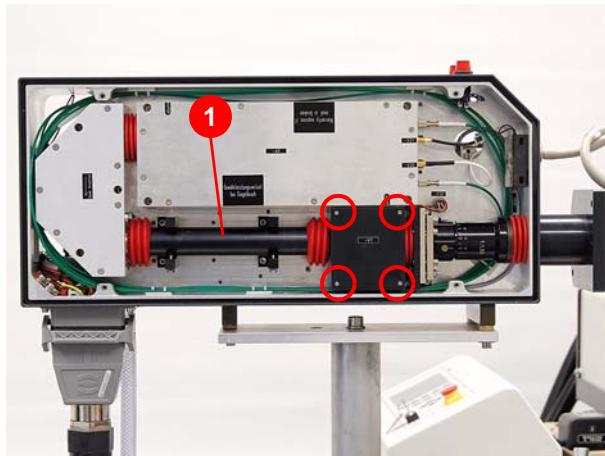


Figure 4.41 Dismantling the beam guide

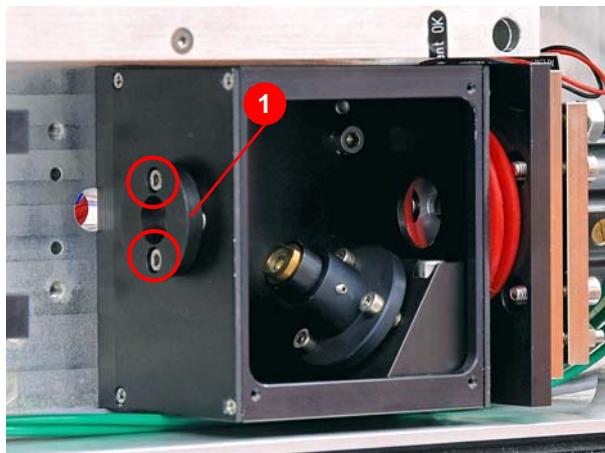


Figure 4.42 Housing for the alignment laser/
coupling mirror

1. Open the lateral cover of the resonator side of the laser head.
2. Remove the beam guide (1) (Figure 4.41) of the laser head.
3. Loosen the four fastening screws on the cover of the alignment laser.
4. Remove the cover.
5. Clean the inside of the positioning laser housing.
6. Remove the coupling mirror (1) (Figure 4.42).
7. Clean the coupling mirror (see page 37).
8. Reinstall the coupling mirror.
9. Install the beam guide and pay attention to the correct position of the bellows.
10. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.3, page 122).
11. Mount the cover of the alignment laser housing.
12. Mount the cover on the resonator side of the laser head.
13. Commission the laser system.

1. Installation depends on the respective laser type

4.3 Beam expander



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

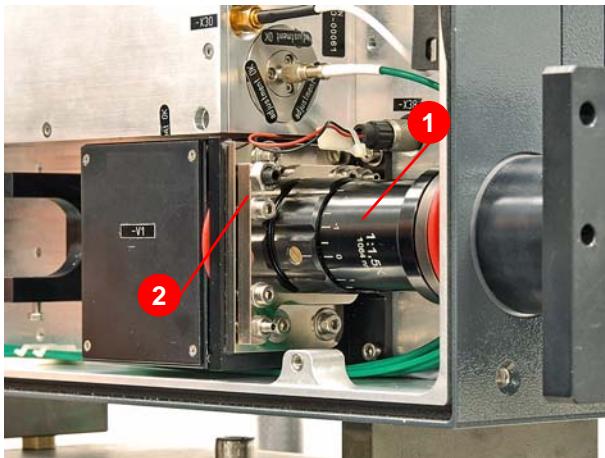


Figure 4.43 Dismantle the beam expander.

1. Remove the beam expander (1) (Figure 4.43) and the mount (2).



Note: The current adjustment of the beam expander should be noted so that the correct focal distance can be reset after any false adjustment of the beam expander.

2. Unscrew the beam expander from the mount.
3. Clean it (see page 37).
4. Screw the beam expander into the mount and reinstall the mount.



Attention: Do not crush or jam the cables and lines inside the laser head during installation!

5. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.1, page 102).
6. Check the adjustment of the beam expander; set the value read before cleaning if necessary.
7. Mount the cover on the resonator side of the laser head.
8. Commission the laser system.
9. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

4.4 Beam attenuator¹



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

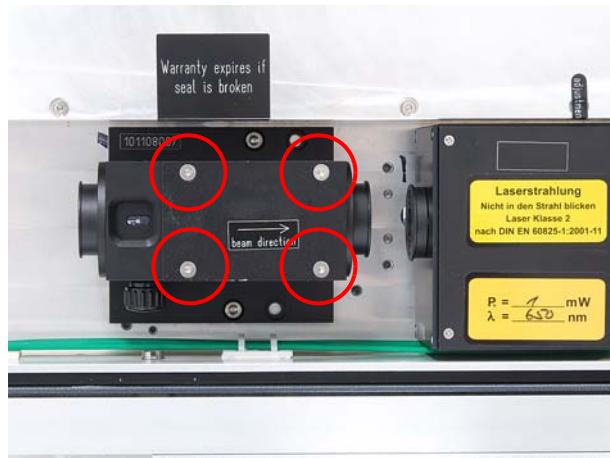


Figure 4.44 Beam attenuator

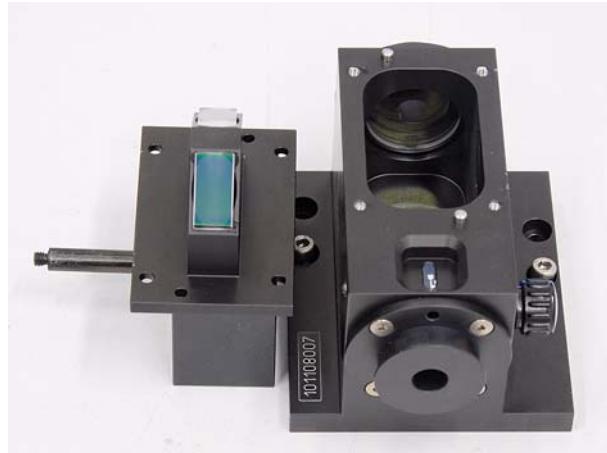


Figure 4.45 Optical components in the beam attenuator

1. Open the resonator side of the laser head.

Note: The current adjustment of the beam attenuator should be noted so that the correct value can be reset after any misadjustment of the attenuator.

2. Loosen the four fastening screws on the cover of the beam attenuator.
3. Remove the cover.
4. Clean the optical components (see page 37). Inspect the cleaned surface with a magnifying glass.

Attention: If there are burn marks, the complete beam attenuator must be replaced.

5. Fit the cover of the beam attenuator.
6. Check the setting of the beam attenuator.
7. Mount the cover on the resonator side of the laser head.
8. Commission the laser system.
9. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

1. Installation depends on the respective laser type

4.5 Glass fiber lines



Attention: *The connections of glass fiber lines should be cleaned only with purified compressed air or water-free isopropyl alcohol! The 'draw-off' method taught during training must be used for this!*

4.6 Resonator module



Attention: *No cleaning work is required on and in the resonator module. The resonator module may be replaced as a complete unit as needed. Repair and cleaning inside the resonator module may be performed only by ROFIN-SINAR. In case of non-observance, the warranty is no longer valid.*

Notes

Notes

5 Troubleshooting

5.1 Image errors



Note: For the precise assessment of the image errors, a measuring magnifier or microscope is required.

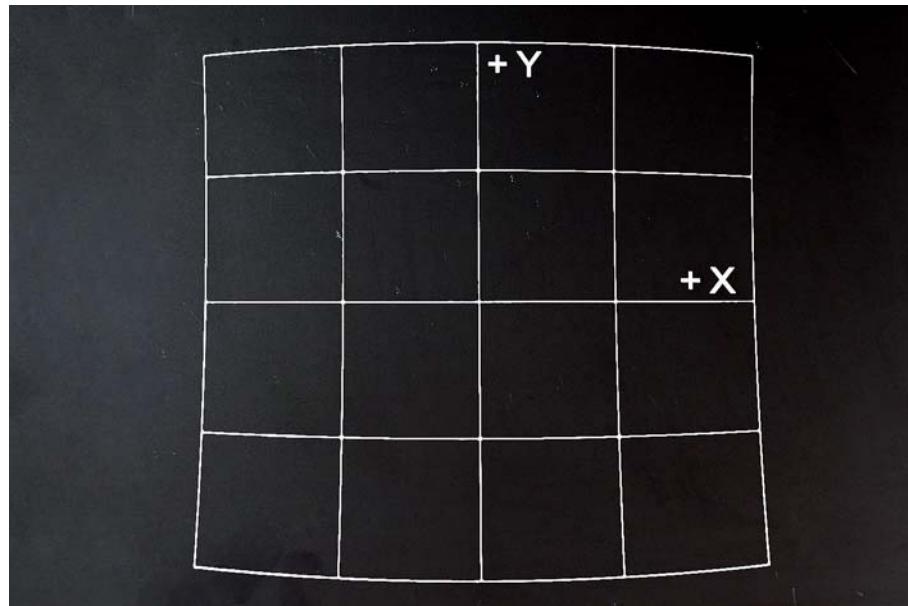


Figure 5.1 Barrel and pincushion distortion

Fault	Remedy
Barrel and/or pincushion distortions in the X and Y directions	Load the compensation file belonging to the optics.

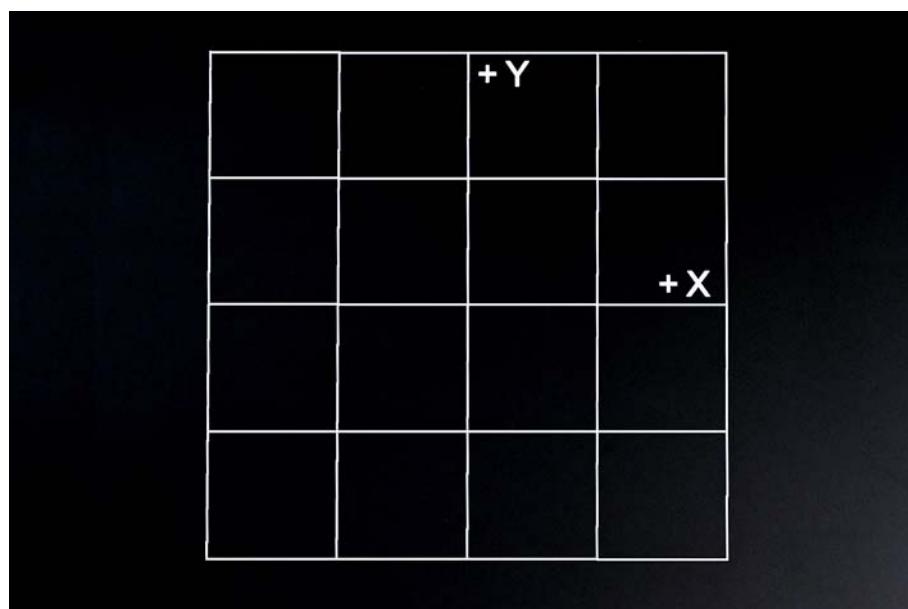


Figure 5.2 Compensation file loaded

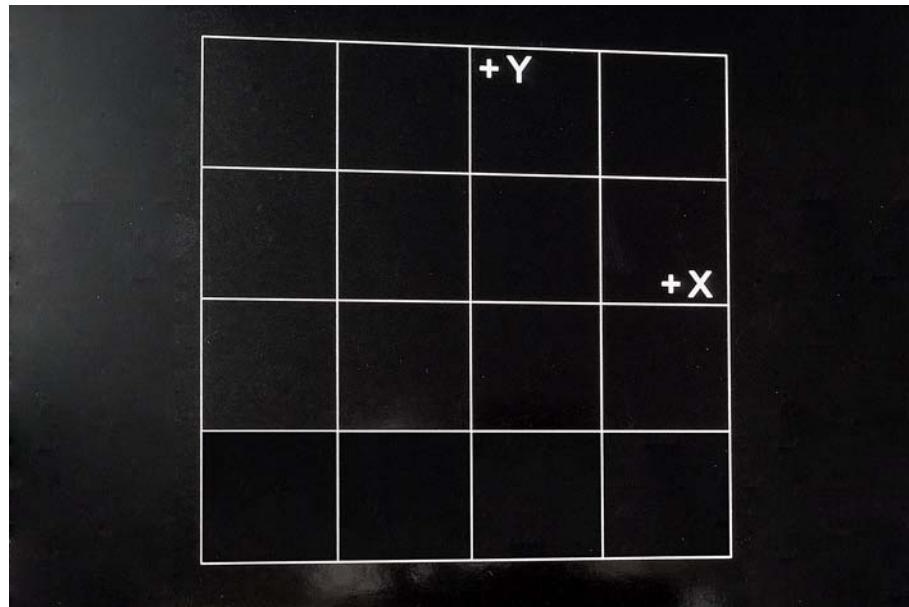


Figure 5.3 Trapezoidal distortion

Fault	Remedy
Trapezoidal distortions in the X and Y directions	Check the adjustment of the workpiece support plate and the galvo head (see Section 6.2, page 100).

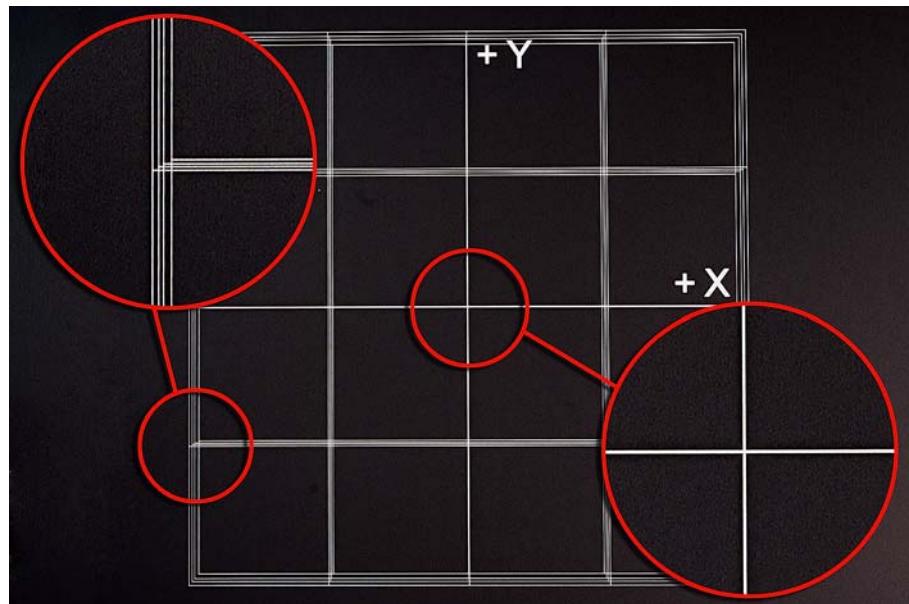


Figure 5.4 Focusing errors

Fault	Remedy
Focusing error (center point okay, deviation at edge)	Check the focal distance of the galvo head (see Section 6.2, page 100).

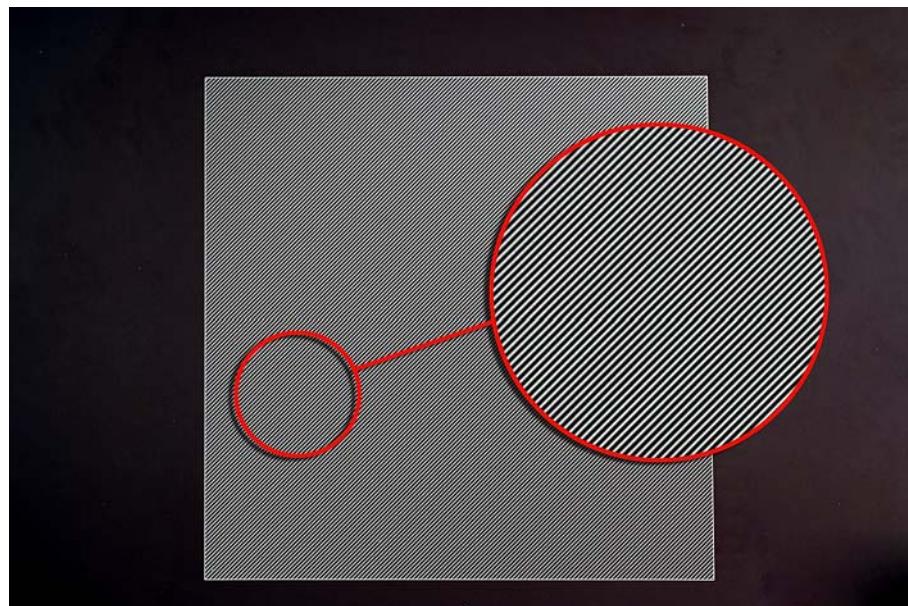


Figure 5.5 Correct image



Note: A test program should be created to test the image (see the VLM user manual).

Sample settings for the test program:

- Square 120 mm x 120 mm (congruent to the maximum marking field of the laser)
- Hatching 45°
- Hatching distance approx. 0.5 mm to 2.0 mm
- Speed, current, and frequency should be adapted to the material to be marked (e. g. for steel/anodized aluminum: 400 m/s, 30 A, 20 kHz)

The image of the lines must be clean and have a high acutance.



Attention: The laser system and the workpiece support plate must be absolutely vibration-free! The suction system must be switched on since vapors obstruct/weaken the laser radiation!



Note: To prevent errors due to the material being marked, let the test program run through several test patterns.



Note: For the precise assessment of the image errors, a measuring magnifier or microscope is required.

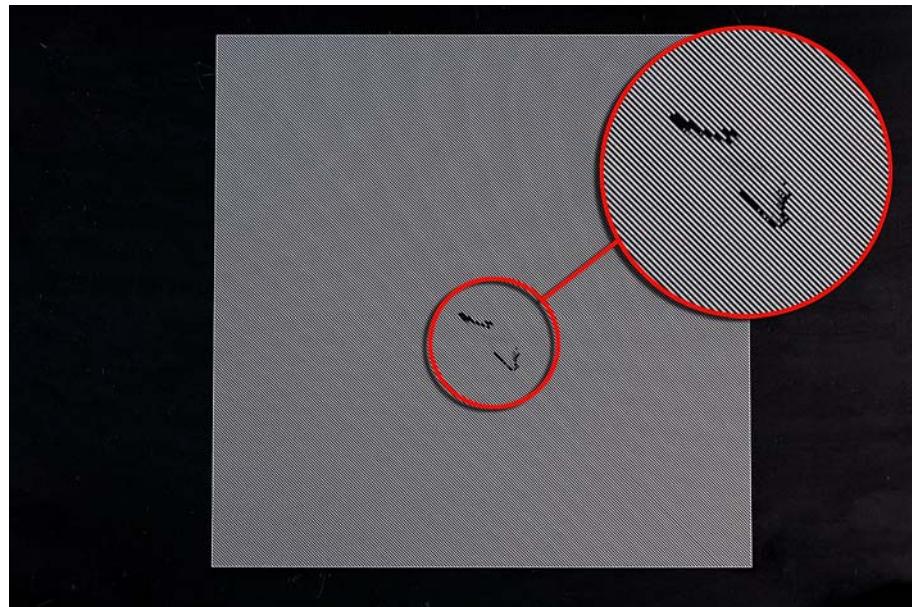


Figure 5.6 Irregular power fluctuations

Fault	Remedy
Irregular power fluctuations	Check the optics for soiling and burning (see Chapter 4).

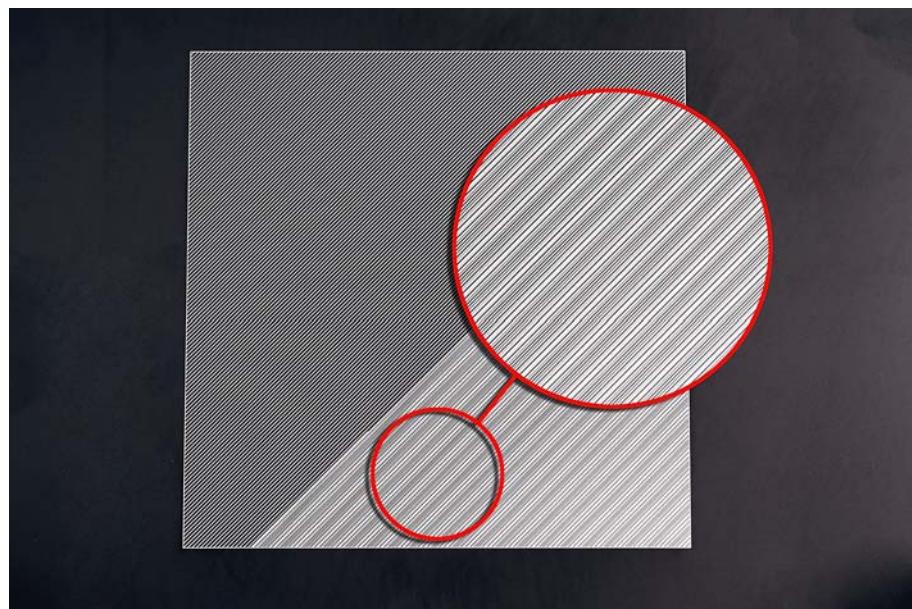


Figure 5.7 Regular power fluctuations

Fault	Remedy
Regular power fluctuations due to internal or external influences	Check and/or exchange the power supply unit, resonator, and Q-switch. Check system for vibrations.

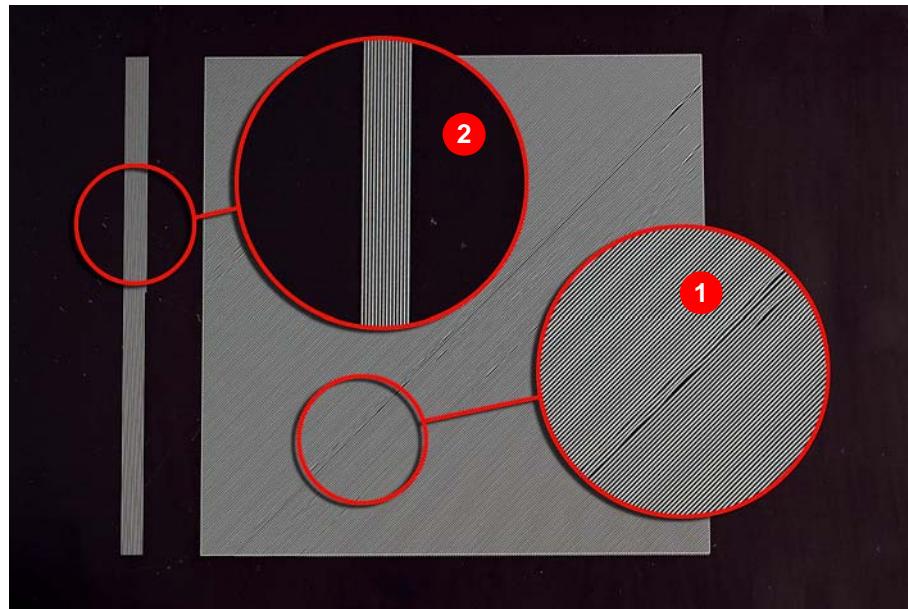


Figure 5.8 Positioning error of galvo head

Fault	Remedy
Positioning error of galvo head (1) (X or Y direction)	Check/exchange the galvo head or ALI board. Check the system for vibrations.



Note: If the test matrix is not hatched in a 45° angle, errors will possibly not be recognized (2).

5.2 Marking errors

5.2.1 Vector marking

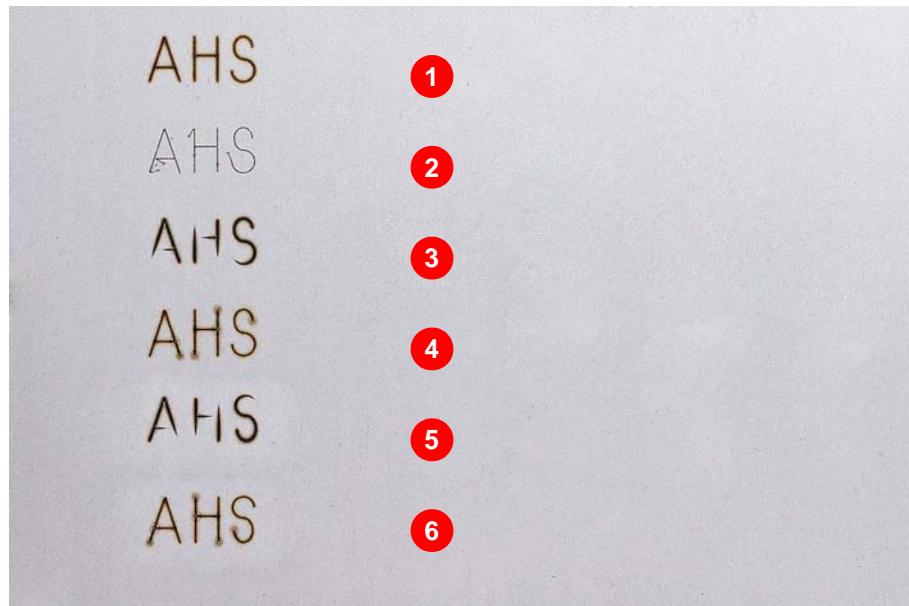


Figure 5.9 Marking errors

No.	Fault	Remedy
1	No error	—
2	Distortions	<ul style="list-style-type: none">Check the parameters and hardware.
3	The first pulse is too strongly attenuated.	<ul style="list-style-type: none">Check the parameters and hardware.
4	LASER-OFF-DELAY too long	<ul style="list-style-type: none">Check the parameters and hardware.
5	LASER-OFF-DELAY too short	<ul style="list-style-type: none">Check the parameters and hardware.
6	The first pulse is not attenuated enough.	<ul style="list-style-type: none">Check the parameters and hardware.

5.2.2 Grayscale marking



Note: SHG models are not suitable for grayscale marking.

Fault	Remedy
In case of correctly set parameters, an image of a black rectangle appears.	Check the setting of the -S4 switch (EXT.). Check software parameters using LCP/MCT software > E.5.1 OPTIONS - first pulse suppression "deactivated" by pulse suppression card.

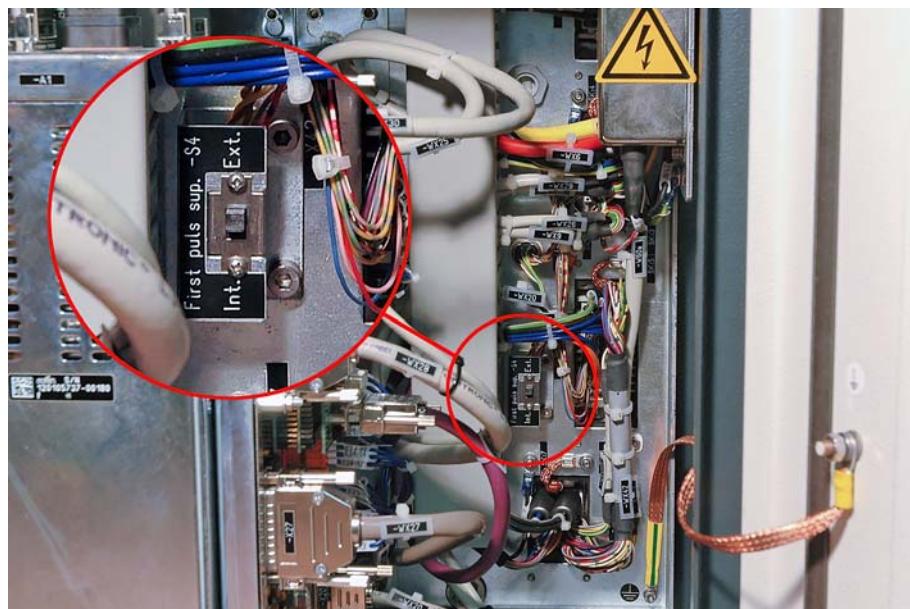


Figure 5.10 -S4 switch in supply cabinet

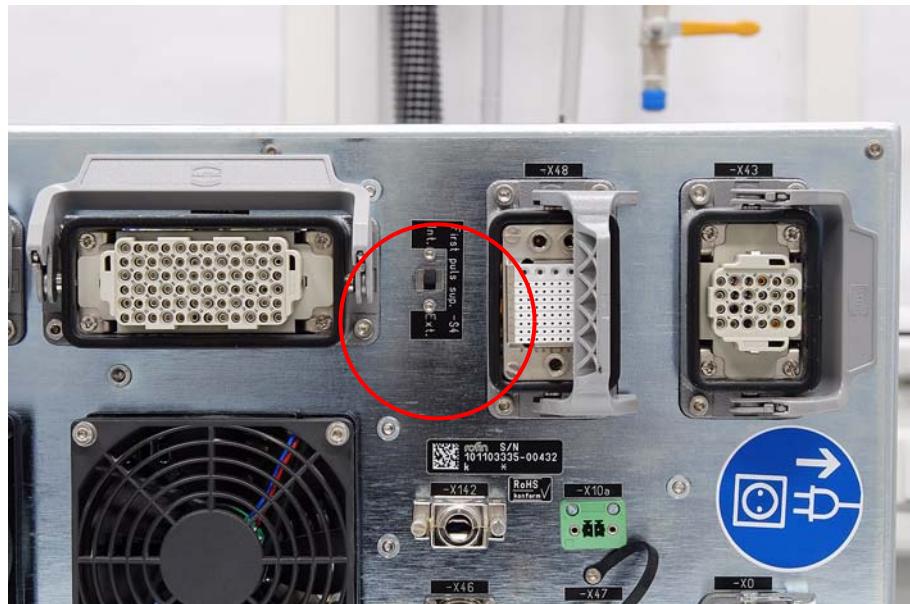


Figure 5.11 -S4 switch on 19" plug-in

5.3 Emergency stop circuit



Attention: The peripheral components of the laser system should be shut down and secured against reactivation.

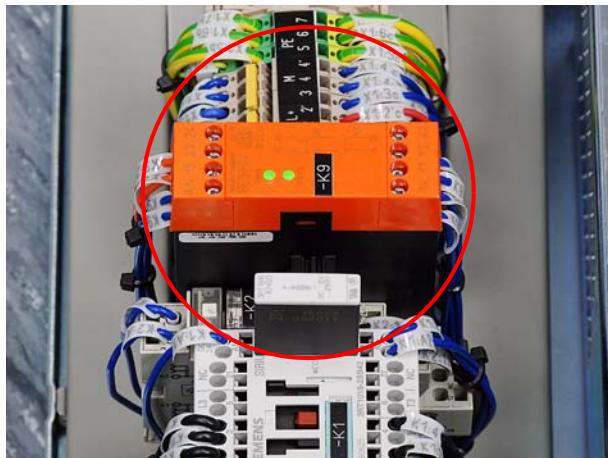


Figure 5.12 Emergency stop relay – OK

- Emergency stop circuit OK

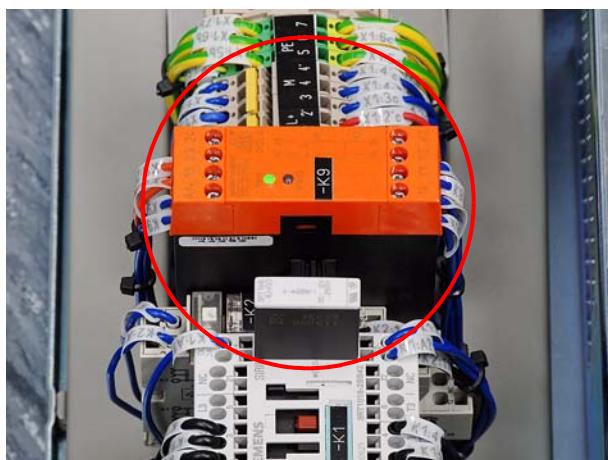


Figure 5.13 Emergency stop relay – Fault 1

- Keyswitch not in zero position.
- No reset of the emergency stop relay performed

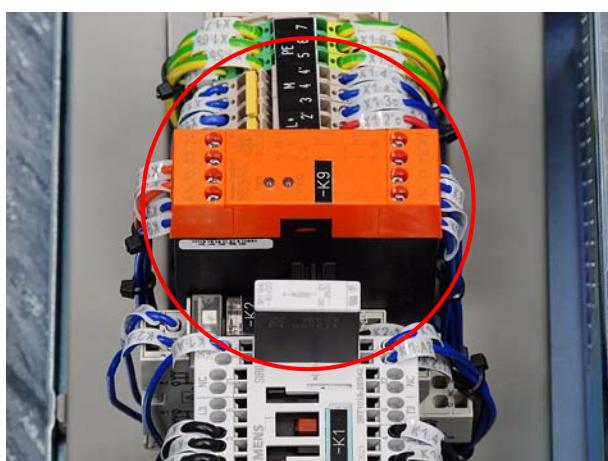


Figure 5.14 Emergency stop relay – Fault 2

- Emergency stop circuit triggered

5.4 Measurement of the laser power



Attention: For the measurement of the laser power, a power measurement device with a measuring adapter for the respective laser type is required (see Chapter 3). The operating instructions of the measuring device absolutely must be observed!



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.



Attention: During the measurement of the laser power, a second person must always be present to press the emergency stop button/main switch of the laser system in case of an emergency.



Attention: The peripheral components of the laser system should be shut down and secured against reactivation.



Note: To achieve reproducible measurement results and to prevent overheating of the measurement head, we recommend using the "Measurement Head Cooling Adapter" (see Chapter 3), which is available as an accessory. 30 seconds' settling time for the measuring equipment must be observed!

5.4.1 Measuring points

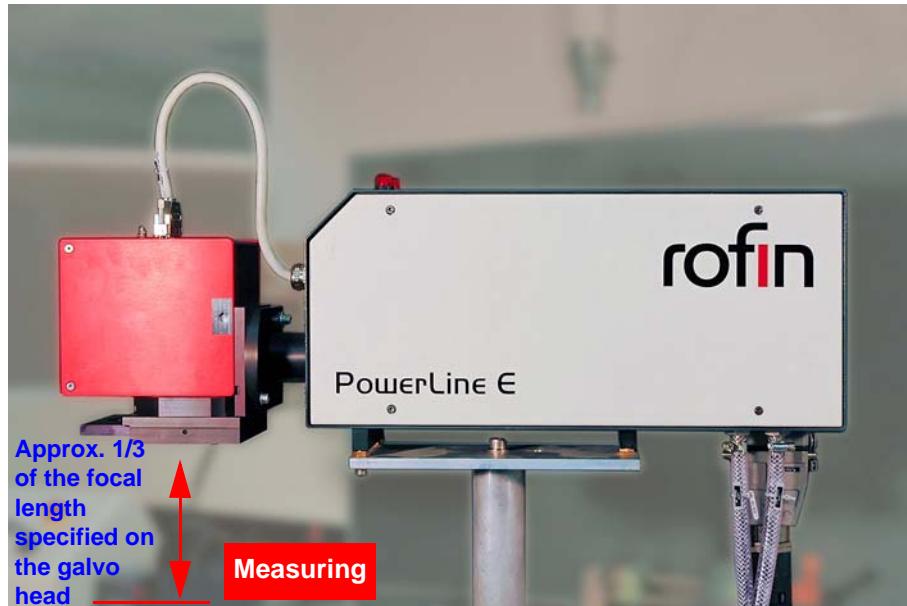


Figure 5.15 Laser power after the galvo head



Attention: The laser power after the galvo head must fundamentally be measured outside of the focus to prevent burning or other damage to the measurement head! At a focal length of 160 mm, for example, measure a maximum of 60 to 70 mm below the protective glass!

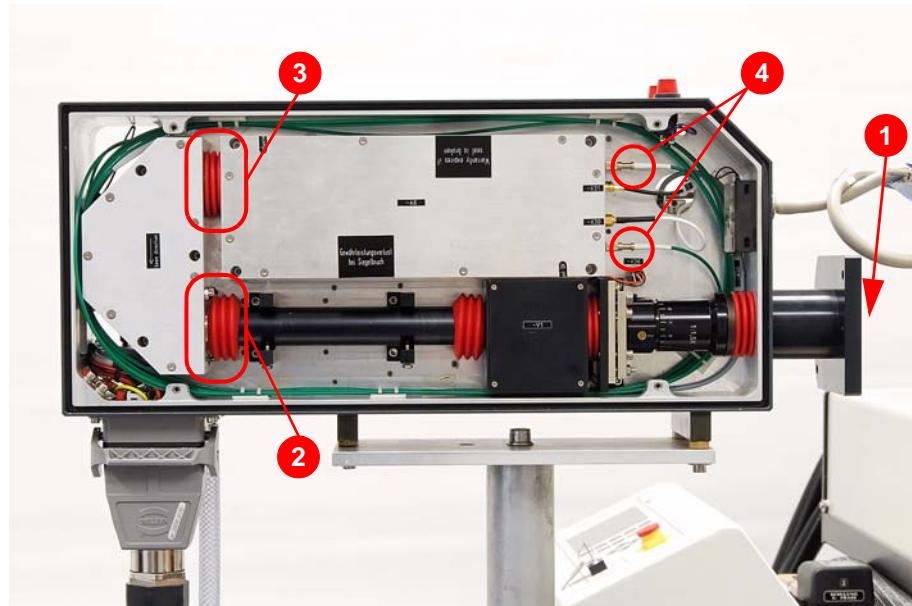


Figure 5.16 Laser power measuring points

No.	Measuring point
1	Galvo flange*
2	Output of the deflecting unit
3	Output of the resonator module
4	Diode power of the fiber end

*: Perform the measurement with and without the installed beam expander.

Laser source	Wavelength
IR laser	1024 nm
SHG laser	532 nm
Pump diodes	806 nm



Attention: The diode current must be set such that the power at the end of the glass fiber does not exceed 30 W! This value must be measured before any troubleshooting, setup or adjustment work, or determined from the logbook (logbook entry). When replacing diodes or fibers, this value must always be determined again. **Under no circumstances may this current be exceeded during setup! If the current is exceeded, there is a risk of damaging the resonator module!**



Note: The values in the following table are based on the maximum diode current at a diode module output power of 30 W. These values are the minimum values (IR models) or maximum values (SHG models), measured in front of the galvo flange.



Attention: If, with the **SHG model**, the laser power at approximately **30 A** and **50 kHz** does not reach at least **2 W**, contact ROFIN-SINAR for consultation.

Laser type	Power
HP/HQ - 1064 nm for RSM PowerLine 10E/ EL	<ul style="list-style-type: none"> CW HP: 10 W CW HQ: 8,5 W
532 nm with RSM PowerLine 12E/SHG	<ul style="list-style-type: none"> 50 kHz, max. 6 to 7 W <p> Attention: 7 W may never be exceeded! A risk of damaging or destroying the resonator module exists!</p>
1064 nm for RSM PowerLine 20E/25E/30E	<ul style="list-style-type: none"> CW 20E: min. 16.5 W, max. 18.5 W CW 25E: min. 24 W, max. 25 W CW 30E: min. 25 W, max. 27 W
532 nm with RSM PowerLine 20E SHG	<ul style="list-style-type: none"> 50 kHz, max. 12.0 to 12.5 W <p> Attention: 13 W only short-term for adjustment purposes!</p>
532 nm with RSM PowerLine 25E SHG	<ul style="list-style-type: none"> 50 kHz, max. 18.0 to 18.5 W <p> Attention: 19 W only short-term for adjustment purposes!</p>

5.4.2 General information

5.4.2.1 Performing the measurement



Attention: Before powering up the laser for measuring purposes, the measurement head should be positioned at the measuring point!



Attention: Do not move the measurement head through the activated laser beam! There is a risk of an uncontrolled deflection of the laser beam!

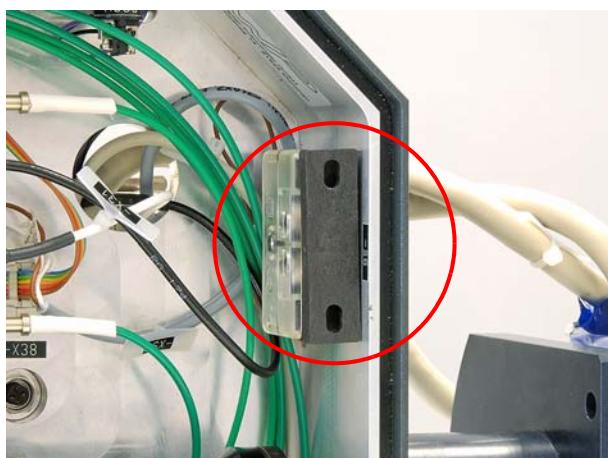


Figure 5.17 Interlock switch bridged

1. Open the cover of the resonator side of the laser head (slanted corner located on the right).
2. Bridge the interlock switch (Figure 5.17).

Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

Note: Bridging contacts to be used: see Chapter 3.

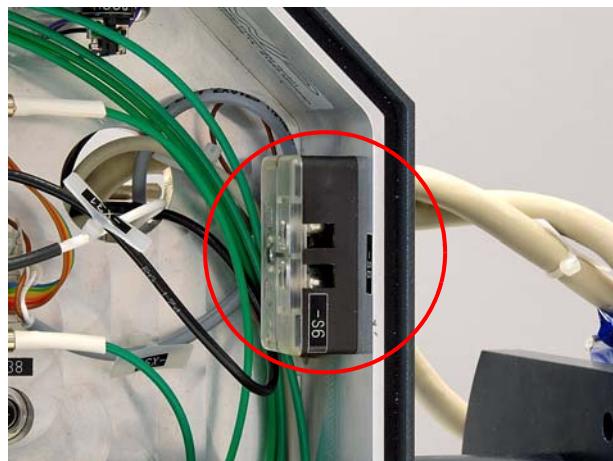
3. Secure the laser system against being switched on (remove the key from the keyswitch).

Attention: Take measures for protection against laser radiation (see page 67)!

4. Position the measurement head.

Attention: Set the measuring device to the wavelength of the laser! Observe the operating instructions of the measuring device!

Note: When making output measurements without a measurement head adapter (freehand), take care that the measurement head does not move. This can result in incorrect measurements.

**Figure 5.18** Interlock switch

5. Activate the main switch of the laser system.

! ***Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.*

6. Switch on the laser system.
7. Open the shutter.
8. Perform the measurement.
9. Close the shutter.
10. Set the keyswitch to the zero position and switch off at the main switch.
11. Remove the measurement head.
12. Remove the bridge from the interlock switch.
13. Completely mount the components.
14. Mount the cover on the resonator side of the laser head.
15. Commission the laser system.

5.4.2.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
Power okay, marking result faulty	Focal distance incorrectly adjusted	<ul style="list-style-type: none"> • Adjusting
	Focal point incorrectly adjusted	<ul style="list-style-type: none"> • Adjusting
	Optical components have changed their properties	<ul style="list-style-type: none"> • Perform further power measurements
	Handling system faulty	<ul style="list-style-type: none"> • Check it. • Adjusting
Power too low	Voltage and current supply	<ul style="list-style-type: none"> • Check HN80x.
	Diode module, glass fiber	<ul style="list-style-type: none"> • Check the diode power.
	HF generator	<ul style="list-style-type: none"> • Check the HF power. • Adjustment of the residual level of the hardware or software • Check the wiring for the residual level. • Check laser blocking
	Laser beam	<ul style="list-style-type: none"> • Power Measurement resonator module • Check the beam adjustment. • Check the optical components.
	Cooling system	<ul style="list-style-type: none"> • Check the temperatures. • Check the flow. • Check the filter. • Check the calibration of the motor valve. • Check the coolant level.

Fault	Possible Reasons	Remedy
Power fluctuations	Voltage and current supply	<ul style="list-style-type: none">• Check HN80x.
	Vibrations	<ul style="list-style-type: none">• Check it.
	Diode module, glass fiber	<ul style="list-style-type: none">• Check the diode power.• Check the attachment of the glass fiber.
	HF generator	<ul style="list-style-type: none">• Check the HF power.• Check the wiring for the residual level.
	Heating unit SHG module	<ul style="list-style-type: none">• Check the heating unit of the SHG module (current flow 170 mA in cold condition, 80-100 mA in regulated condition (model-dependent reference values); cold environment = high current, warm environment = low current)
	ALI board	<ul style="list-style-type: none">• Check the ALI board
	Measurement	<ul style="list-style-type: none">• Check that the measurement head is in a stable position• Wait until the measuring equipment settles (30 seconds)• Connect the water cooling system for the measurement head

5.4.3 Power measurement on the galvo flange

5.4.3.1 Performing the measurement

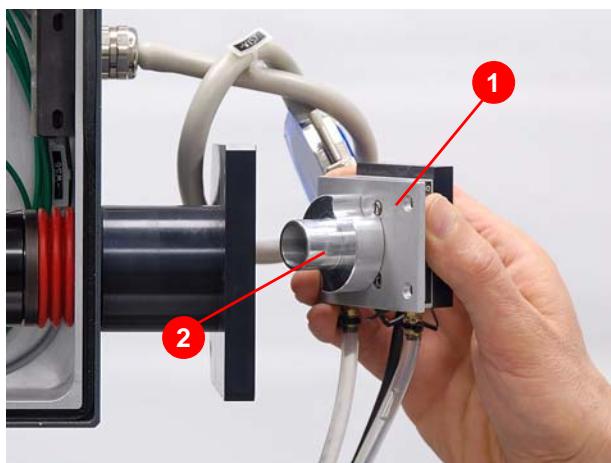


Figure 5.19 Complete the measurement head.

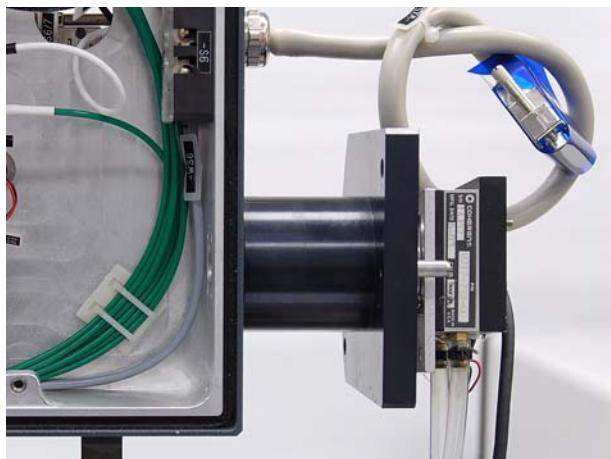


Figure 5.20 Measurement on the galvo flange

1. Dismantle the galvo head.
2. Attach the fitting (1) (Figure 5.19) on the power measurement head.
3. Insert the cross wire adapter (2) to the fitting.

i Note: Fittings and adapters to be used: see Chapter 3.

4. Insert the measurement head into the galvo flange.
5. Perform the measurement (see Section 5.4, page 67).

i Note: Observe the 30 second settling time for the measuring equipment!

i Note: Compare the measured power with the power after the galvo head to detect any power losses. The measurement should be performed with and without an installed beam expander to detect any power losses due to the beam expander.

! **Attention:** Perform the measurement only for a short time since damage may occur to the measurement head when the water cooling system is not connected to it! Follow the instructions in the operating instructions of the measuring device! The use of the optionally available cooling adapter (see Chapter 3) is recommended.

5.4.3.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
Power loss	Soiling, protective glass damage, focusing lens, beam expander, galvo mirror	<ul style="list-style-type: none"> • Clean, exchange <p>i Note: In case of damage to the galvo head, the complete head must be exchanged.</p>
	Galvo head voltage supply fault	<ul style="list-style-type: none"> • Measure the voltage and adjust it if necessary • Check HN80x.
	Defective galvo head	<ul style="list-style-type: none"> • Check its function • Exchange the galvo head or the ALI board for the optics if necessary.

5.4.4 Power measurement at the output of the deflecting unit

5.4.4.1 Performing the measurement

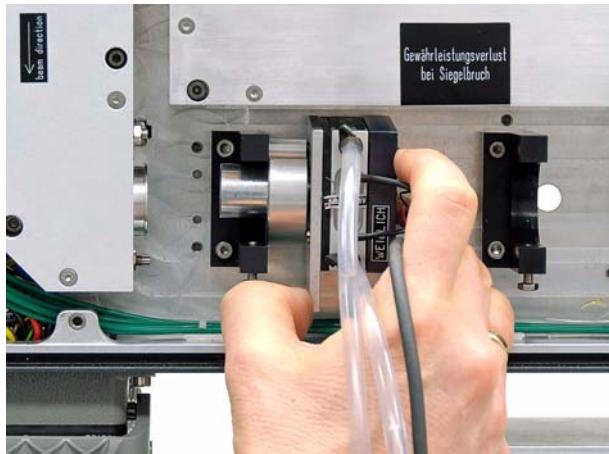


Figure 5.21 Positioning the measurement head

1. Dismantle the beam guide between the deflecting unit and the beam expander or alignment laser housing (optional).
2. Position the measurement head at the output of the deflecting unit.
3. Perform the measurement (see Section 5.4, page 67).

i Note: Observe the 30 second settling time for the measuring equipment!

i Note: Compare the measured power with the power at the galvo head to detect any power losses due to the beam expander or coupling mirror of the alignment laser.

5.4.4.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
Power loss	Soiling of the beam expander	<ul style="list-style-type: none">• Clean it.
	Soiling of the coupling mirror of the alignment laser	<ul style="list-style-type: none">• Clean it.
	Defective coating on the deflecting mirror in the beam deflector	<ul style="list-style-type: none">• Replace the component

5.4.5 Power measurement at the output of the resonator module

5.4.5.1 Performing the measurement

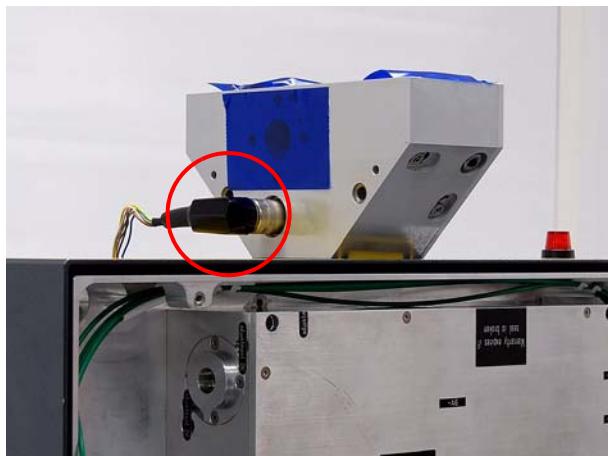


Figure 5.22 Connecting plug (-X25)

1. Dismantle the deflecting unit (see Section 7.2, page 147).
2. Turn off the deflecting unit on the laser head and reinsert the connecting plug (-X25).

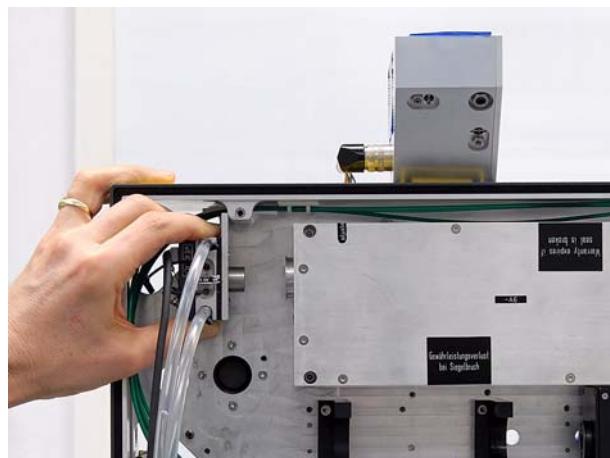


Figure 5.23 Positioning the measurement head

3. Position the measurement head at the output of the resonator module.

! **Attention:** Be careful not to damage the fibers in the interior of the laser head with the laser beam! Use beam protection plates if necessary! Under no circumstances may the measurement head be removed while the laser beam is switched on!

4. Perform the measurement (see Section 5.4, page 67).

i **Note:** Observe the 30 second settling time for the measuring equipment! To avoid incorrect results, do not move the measurement head during measurements.

! **Attention:** The laser beam cannot be deflected by the shutter. Shut down the laser system via the emergency stop in case of emergency!

i **Note:** Compare the measured power with the power at the output of the deflecting unit to detect any power losses due to the deflecting unit.

5.4.5.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
Power loss	Soiling of the deflecting mirror	<ul style="list-style-type: none"> • Clean it.
	Defective coating of the deflecting mirror	<ul style="list-style-type: none"> • Exchange the deflecting mirror.
	Defective shutter module	<ul style="list-style-type: none"> • Exchange the shutter module
	Defective resonator module (if the diode power, HF/QS, and fiber are OK)	<ul style="list-style-type: none"> • Exchange the resonator module
	Fault in the residual level of the hardware/software	<ul style="list-style-type: none"> • Check the resonator module • Check the setting of the HF generator (residual level, setting, cable) • Check the software setting.

5.4.6 Measurement of the diode power

5.4.6.1 Performing the measurement



Attention: The peripheral components of the laser system should be shut down and secured against reactivation.



Attention: When working with open fiber ends, ensure utmost cleanliness.

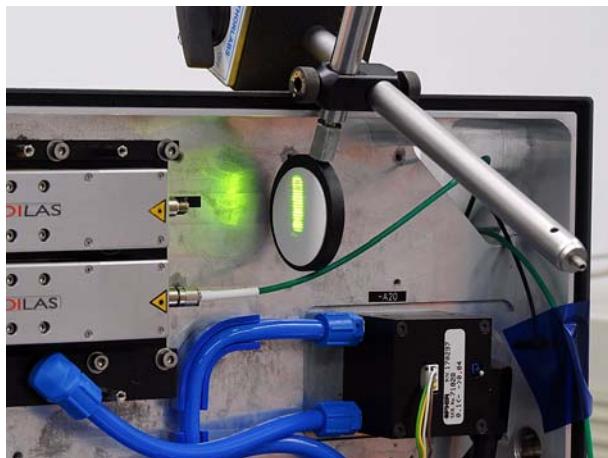


Figure 5.24 Checking the diode module

It is possible to position the measurement head directly after the diode module:

1. Disconnect the glass fiber line from the diode module.
2. Using suitable means, fix the transducer disk to the output of the diode module (Figure 5.24).



Attention: Under no circumstances operate the laser system without the transducer disk fitted! The fiber(s) behind it might otherwise be damaged!

3. Remove the dust caps from the diode module and the fiber.
4. Fix the fiber with adhesive tape so that it points downwards and place material below the fiber to absorb the laser radiation.



Attention: The laser beam (wavelength 806 nm) must be prevented from harming persons or irradiating flammable materials.



Attention: Wear protective goggles that guarantee protection at wavelengths of 532 nm/806 nm/1064 nm.

5. Operate the laser system at a current of approx. 10 to 12 A.
6. The diode module must project 18 lines on to the transducer disk.
7. Reduce the diode current to 6 A and remove the transducer disk.



Attention: To prevent the laser beam from causing damage to the interior of the laser head, the diode current must be reduced to 6 A before the transducer disk is removed!



Figure 5.25 Diode module output measurement

8. Measure the output of the diode module (see Section 5.4, page 67).

! **Attention:** Hold the measurement head at slight angle when doing this (see Figure 5.25), to prevent reflections and hence damage to the diode module.

i **Note:** Observe the 30 second settling time for the measuring equipment! To avoid incorrect results, do not move the measurement head during measurements.

9. Reduce the diode current to 6 A and remove the measurement head.

! **Attention:** To prevent the laser beam from causing damage to the interior of the laser head, the diode current must be reduced to 6 A before the measurement head is removed!

10. Check the fiber end for contamination after the measurement and clean if needed. Mount the fiber immediately.

It is not possible to position the measurement head directly after the diode module:

1. Mount the measurement head of the power measuring device at the measuring adapter for the diode power (see Chapter 3).
2. Disconnect the glass fiber line from the resonator module.
3. Connect the glass fiber line to the measuring adapter.

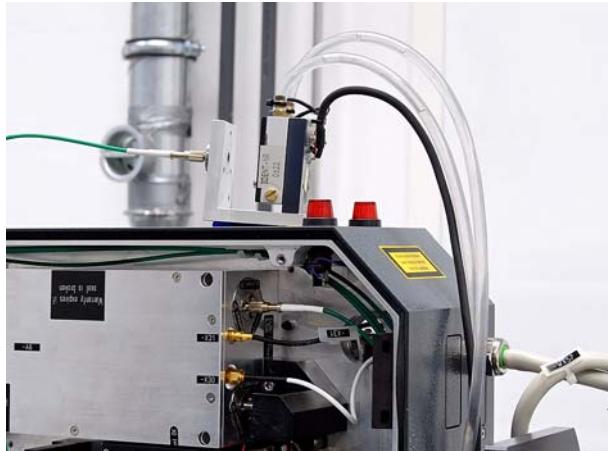


Figure 5.26 Measuring adapter for diode power

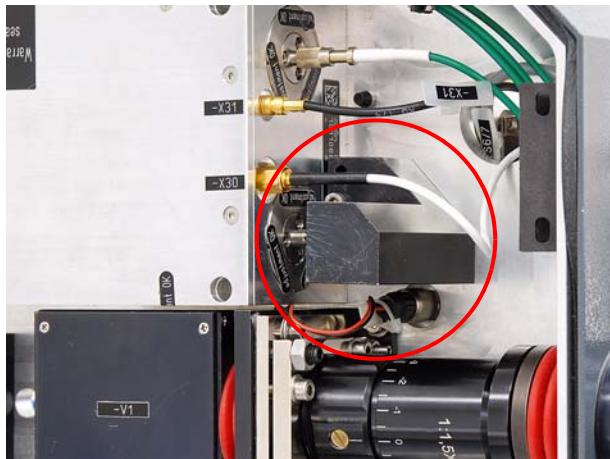


Figure 5.27 Install the absorber

4. **PowerLine E/EL with two diodes/two fibers:** Mount the absorber in front of the respective connection of the removed glass fiber on the resonator module to shield any transmitted residual laser radiation.

⚠ **Attention:** Never close the connection of the resonator module using dust protection caps! A risk of damaging the resonator module exists!

⚠ **Attention:** Use the laser protection goggles to guarantee protection from wavelengths between 750 and 900 nm (wavelength of the radiation after the fiber) and 532 nm/1064 nm.

5. Perform the measurement (see Section 5.4, page 67).
6. **PowerLine E/EL with two diodes/two fibers:** Perform the measurement at the second fiber.
7. Check the fiber end for contamination after the measurement and clean if needed. Mount the fiber immediately.

5.4.6.2 Assessment of the measurement

RSM PowerLine 10E/EL:

Fault	Possible Reasons	Remedy
Power loss (in comparison with the logbook entry)	Declining diode power	<ul style="list-style-type: none"> • Readjust the laser power using the current limiter (e. g. LCP/MCT) <p> Attention: The output power must not exceed 30 W under any circumstances!</p>
	Diode module or glass fiber defective	<p>Check the temperature of the coupling points on the diode and resonator modules (< 60 °C)</p> <ul style="list-style-type: none"> a) Temperature okay > diode module defective b) Temperature too high > check the state of the fiber ends <ul style="list-style-type: none"> – In case of soiling/damage > exchange the fiber – Fiber okay > exchange the diode module
	Power supply fault	<ul style="list-style-type: none"> • Check the diode voltage • Check HN80x.
	Diode current fault	<ul style="list-style-type: none"> • Measuring the diode current • Check HN80x. • Replace the MICO board
No power	Power supply fault	<ul style="list-style-type: none"> • Check the diode voltage • Check HN80x.
	Diode current fault	<ul style="list-style-type: none"> • Measuring the diode current • Check HN80x. • Replace the MICO board
	Diode module defective	<ul style="list-style-type: none"> • Exchange the diode module

RSM PowerLine 20E/EL:

Fault	Possible Reasons	Remedy
Power loss at the end of a fiber	Declining diode power	<ul style="list-style-type: none"> • Readjust the laser power using the current limiter (e. g. LCP/MCT)
	Diode module or glass fiber defective	<ul style="list-style-type: none"> • Exchange the fiber and repeat the measurement. <p>a) Fault occurs in another diode module > glass fiber defective</p> <p>b) Fault occurs in the same diode module > diode module defective</p>
Power loss at both fiber ends	Declining diode power	<ul style="list-style-type: none"> • Readjust the laser power using the current limiter (e. g. LCP/MCT)
	Power supply fault	<ul style="list-style-type: none"> • Check the diode voltage • Check HN80x.
	Diode current fault	<ul style="list-style-type: none"> • Measuring the diode current • Check HN80x. • Replace the MICO board
No power	Power supply fault	<ul style="list-style-type: none"> • Check the diode voltage • Check HN80x.
	Diode current fault	<ul style="list-style-type: none"> • Measuring the diode current • Check HN80x. • Replace the MICO board
	Diode module defective	<ul style="list-style-type: none"> • Exchange the diode module

5.5 Measurement of the HF power

5.5.1 Performing the measurement



Attention: The peripheral components of the laser system should be shut down and secured against reactivation.



Figure 5.28 Connect the HF power and standing wave measuring device.



Attention: Do not bend the HF lines, as this will alter the impedance of the line!

1. Disconnect the HF line -X13 from the HF generator and connect it to the "ANT" connection of the HF power and standing wave measuring device (see Chapter 3).
2. Connect the "TX" connection of the HF power and standing wave measuring device and the HF connection -X13 of the HF generator with a measuring line.
3. Perform the measurement.
4. Reassemble the system.



Note: No marking program may be run during the measurement.

5.5.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
	<p>Measurement OK</p> <ul style="list-style-type: none"> The measured value lies between 12 and 15 W. 	–
	<p>HF power too low</p> <ul style="list-style-type: none"> Measured value < 10 W 	<ul style="list-style-type: none"> Check the voltage at -X8 of the HN80x Check the setting of the HF generator.
	HF fault, no power	<ul style="list-style-type: none"> Check the voltage at -X8 of the HN80x Check the setting of the HF generator. Check the MICO controller Check the ALI board
	HF power okay, reflection of Q-switch	<ul style="list-style-type: none"> Check that the HF line is free of bends or kinks (replace damaged lines) Check the connecting cable between the HF generator and resonator module Exchange the resonator module (Q-switch defective)

5.6 Measuring the diode voltage

5.6.1 Performing the measurement



Attention: The peripheral components of the laser system should be shut down and secured against reactivation.



Figure 5.29 Voltage measurement of both diodes

1. Check the voltage at -X6 of the HN80x.
2. **PowerLine E/EL with one diode:**
Measure the voltage on the diode.
PowerLine E/EL with two diodes:
Measure the voltage across both diodes.

Measured values (at maximum current):

- in case of one diode ~1.7 V to ~2.0 V
- in case of two diodes ~3.4 V to ~4.0 V

5.6.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
Voltage fault	Cable defective	<ul style="list-style-type: none">• Check the cable
	Contact point faulty	<ul style="list-style-type: none">• Check the contact points (measure the voltage on the diode(s) and on the HN80x; maximum difference: 0,2 V)
	Power supply fault	<ul style="list-style-type: none">• Check HN80x.
	One/both diodes defective (short circuit)	<ul style="list-style-type: none">• Exchange the diode module(s)
No voltage	Power supply fault	<ul style="list-style-type: none">• Check HN80x.

5.7 Measuring the diode current

5.7.1 Performing the measurement



Attention: The peripheral components of the laser system should be shut down and secured against reactivation.



Figure 5.30 Measuring the diode current

1. Measure the diode current using the clamp-on ammeter.
2. Compare the current value with the programmed current value. The deviation may amount to a maximum of ± 0.5 A.



Note: The clamp-on ammeter used for this measurement must have the appropriate accuracy. I. e. the measurement error of the measuring device must not be greater than the tolerance.

5.7.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
Reduced current flow	Power supply fault	<ul style="list-style-type: none">• Measure the nominal voltage from the MICO to the HN80x (10 V corresponds to 80 A)• Check HN80x.• Replace the MICO board
	Contact point faulty	<ul style="list-style-type: none">• Check the contact points (measure the voltage on the diode(s) and on the HN80x; maximum difference: 0,2 V)
No current flow	Power supply fault	<ul style="list-style-type: none">• Check HN80x.
	Cable defective	<ul style="list-style-type: none">• Check the cable
	Contact point faulty	<ul style="list-style-type: none">• Check the contact points and repair them

5.8 Temperature measurement of the diodes

5.8.1 Performing the measurement



Attention: The peripheral components of the laser system should be shut down and secured against reactivation.



Figure 5.31 Temperature measurement of the diode

1. Commission the laser system for about ten minutes at maximum current (see page 69).
2. Check the temperature at the coupling between the diode module/resonator module and the glass fiber (max. 60 °C).

5.8.2 Assessment of the measurement

Fault	Possible Reasons	Remedy
Temperature too high	Diode module or glass fiber defective	<p>Check the state of the fiber ends</p> <ul style="list-style-type: none"> • In case of soiling/damage > exchange the fiber • Fiber optically okay > check/exchange the diode module <p>Exchange the fiber and repeat the measurement.</p> <p>a) Fault occurs in another diode module > glass fiber defective</p> <p>b) Fault occurs in the same diode module > diode module defective</p>

5.9 Loading a new configuration

5.9.1 System with operating panel



Figure 5.32 Status LEDs – "OK" display



Figure 5.33 Status LEDs – "Error" display

1. After the MICO controller is exchanged (see Section 7.8, page 196), switch on the laser system and check the status LEDs on the MICO controller.

- OK: The red LED (Figure 5.32) lights up, while the green LED flashes at a frequency of 1 Hz.

- Fault: The red and yellow LEDs light up; no LED lights up.

2. In the event of a fault: Call the configuration mode.



Figure 5.34 Configuration mode

Troubleshooting

Loading a new configuration



Figure 5.35 Service

3. Press Service.



Figure 5.36 Page through.

4. Select page 25.



Figure 5.37 Selecting "NEW CONFIGURATION"

5. Select "NEW CONFIGURATION" using the left arrow key.

Troubleshooting

Loading a new configuration



Figure 5.38 Selecting "YES"



Figure 5.39 Confirming the selection



Figure 5.40 Startup mode

6. Select "YES" using the up arrow key.

7. Confirm the selection with "ENTER".

8. The startup mode is called.
9. Check the status LEDs on the MICO controller.

5.9.2 System without operating panel



Figure 5.41 Status LEDs – "OK" display

1. After the MICO controller is exchanged (see Section 7.8, page 196), switch on the laser system and check the status LEDs on the MICO controller.
 - OK: The red LED (Figure 5.41) lights up, while the green LED flashes at a frequency of 1 Hz.



Figure 5.42 Status LEDs – "Error" display

- Fault: The red and yellow LEDs light up; no LED lights up.

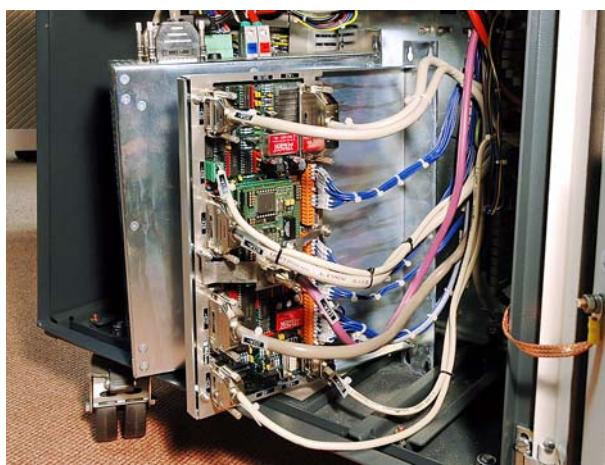


Figure 5.43 Connecting plug -X20

2. Remove the -X20 connecting plug from the MICO controller.
3. Connect connecting socket -X20 with the COM1 port of the laser PC using a cable.

5.9.2.1 With MCT software

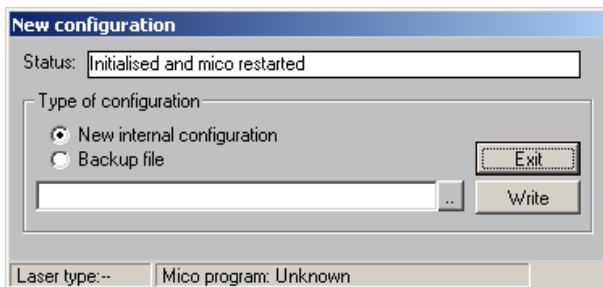


Figure 5.44 Starting the MCT software

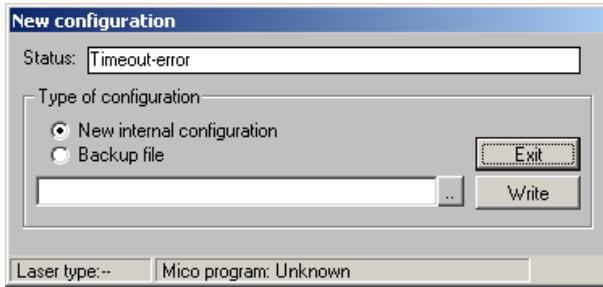


Figure 5.45 Error message

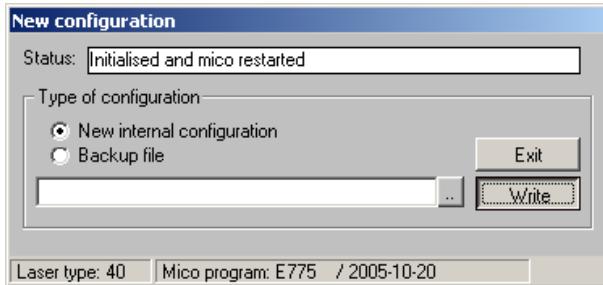


Figure 5.46 Starting the configuration

1. Call the MCT software on the laser PC.

Note: The MCT tried to establish a connection but received no answer because the program/card has not yet loaded-initialized.
The MCT waits a certain time (typically 5 seconds); if it receives no reply by then, a timeout results.
The MIKO program should be initialized (see Figure 5.46).

2. Start the configuration with the "WRITE" button.

3. Confirm the end of the confirmation.



Figure 5.47 Confirming

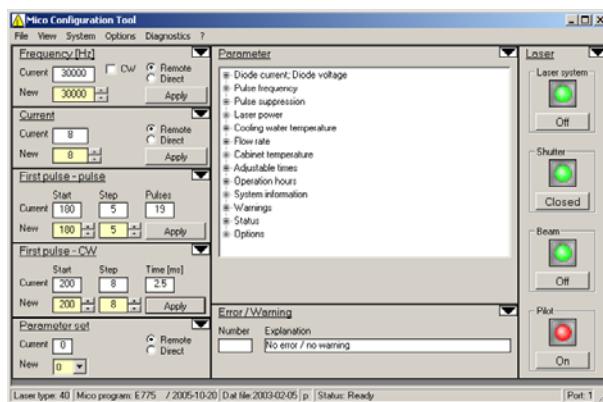


Figure 5.48 MCT software

5.9.2.2 Without MCT software

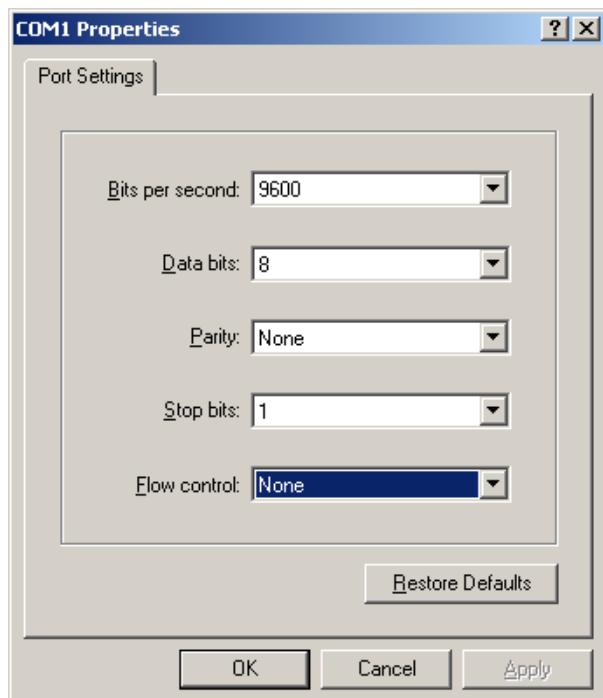


Figure 5.49 Hyperterminal

4. The MCT software starts.
5. Remove the connecting cable from -X20 on the MICO controller.
6. Insert connecting plug -X20 into the MICO controller.

5.10 Loading a new ALI configuration

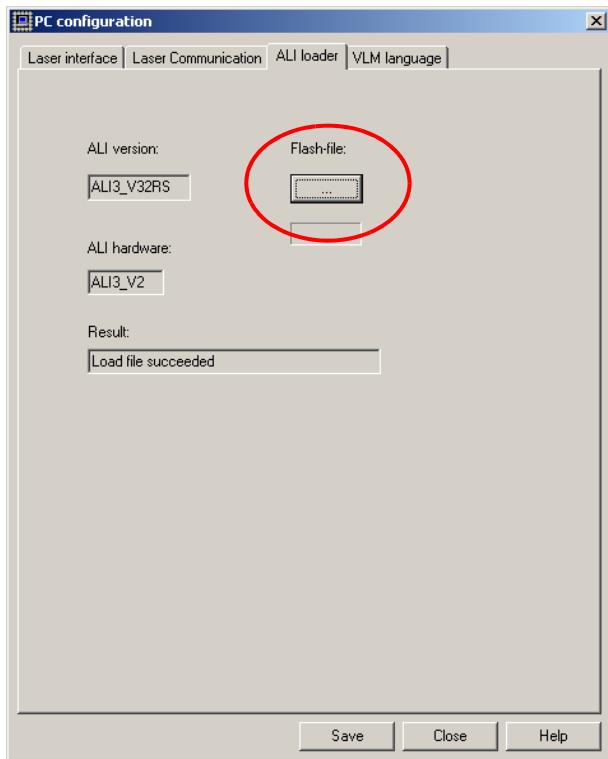


Figure 5.50 VLM PC configuration

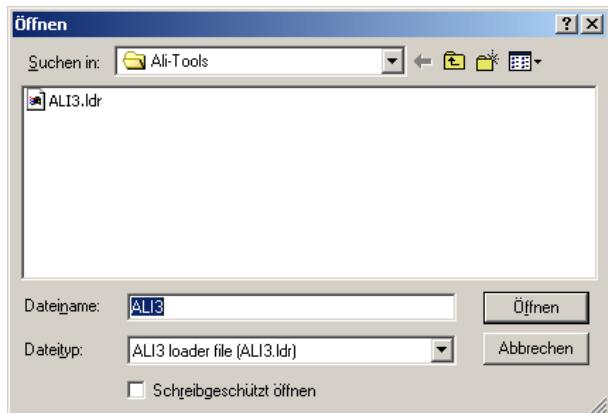


Figure 5.51 Selecting the ALI loader file

Note: The "New Hardware Found" dialog is called if the version difference between the old and new ALI card is too great (e.g. Version 1 to Version 3).

1. After the change of the ALI board on the laser PC, call the VLM PC configuration (VisualLaserMarker > Configuration > PC Configuration).
2. Call the ALI loader.
3. Press the "FlashFile" button

4. Select and open the corresponding ALI loader file.

Troubleshooting

Loading a new ALI configuration

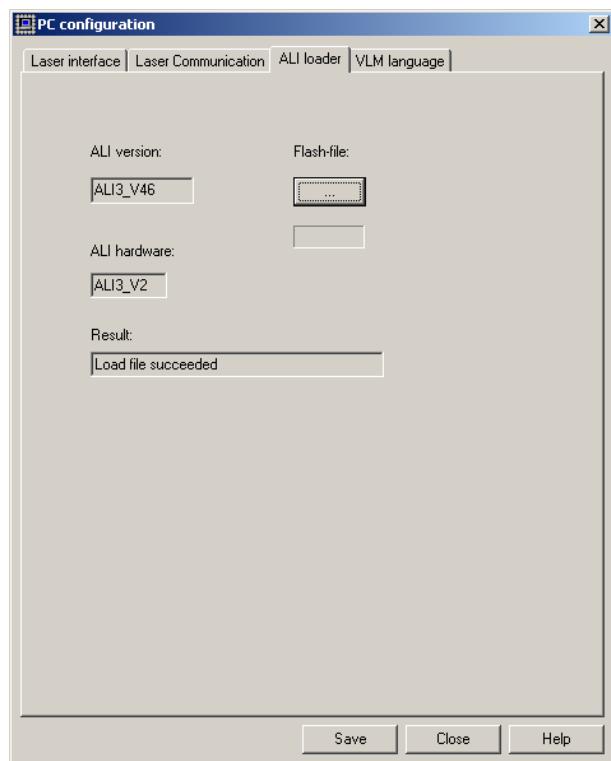


Figure 5.52 Installation ended

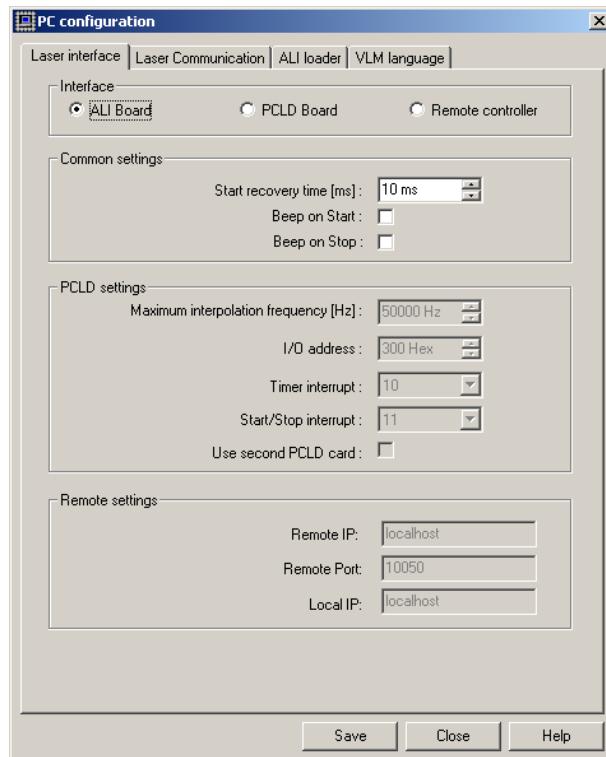
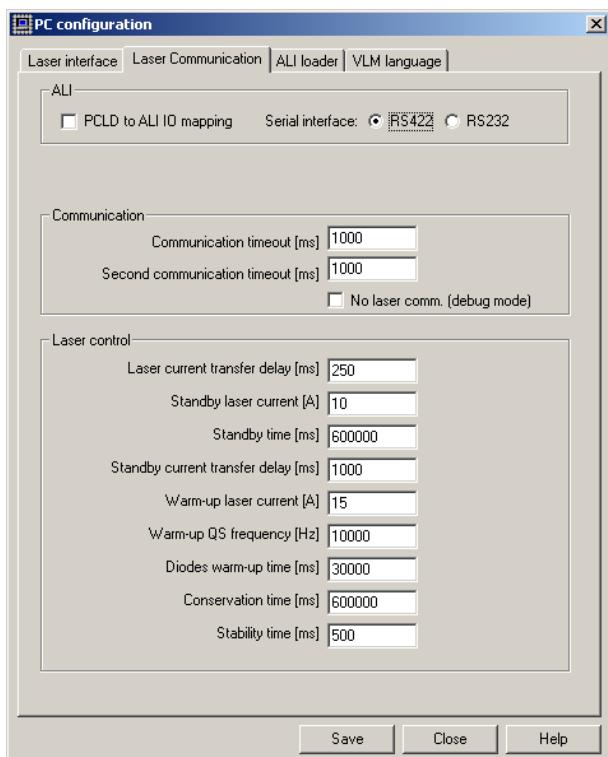


Figure 5.53 Laser interface

5. Wait until the installation of the FlashFile is complete.

Note: In this way, any test program on the ALI card is overwritten.

6. Adapt the settings in the laser interface.

**Figure 5.54** Laser communication

7. Adapt the settings in the laser communication.

5.11 Checking the ALI system settings

**Figure 5.55** Call the computer administration

1. Call the computer administration (right click on My Computer > Administer).

Troubleshooting

Checking the ALI system settings

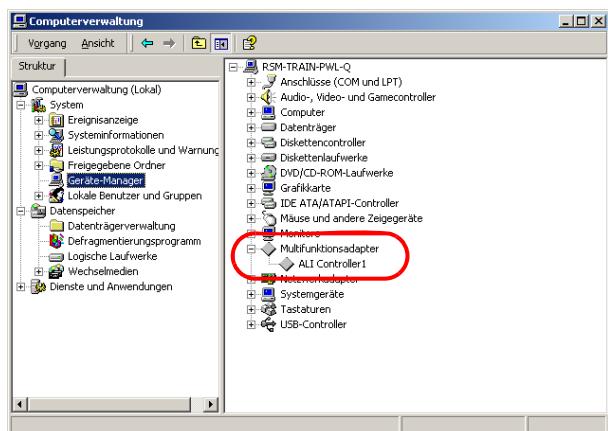


Figure 5.56 Device Manager

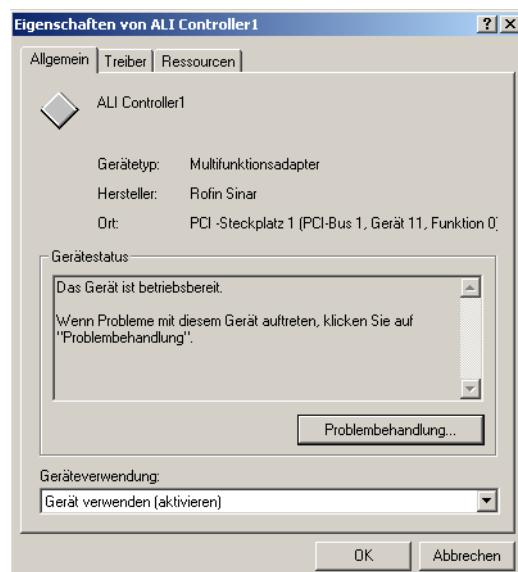


Figure 5.57 Device properties

2. Open the Device Manager.
3. Under "Multifunction Adapters," check whether the ALI controller exists.

4. Check the device properties.

Notes

6 Adjustment tasks

6.1 Pre-adjustment check



Note: Before starting any adjustment work, the setting of the beam protection time in the LCP/MCT software must be checked and deactivated if necessary. If the beam protection time is activated, the laser will be switched off after a programmed time has elapsed and an error message will be generated.

6.1.1 LaserControlPanel (LCP)

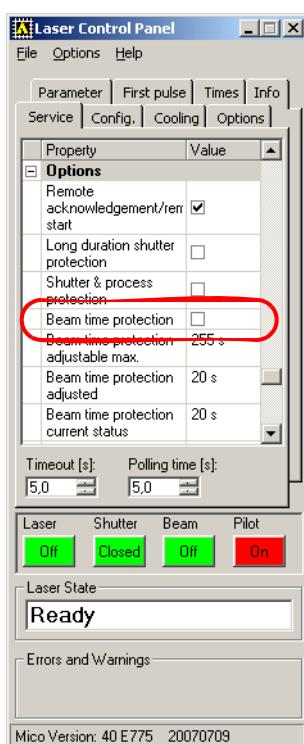


Figure 6.1 LaserControlPanel

1. Start the PC and load WINDOWS®.
2. Start LaserControlPanel.

Note: The start time for the LaserControlPanel is approx. 15 seconds.

3. Under "Service", check the activation of the beam protection time and deactivate the "Beam time protection" parameter if necessary (see Figure 6.1).

Note: Reactivate the setting after completion of the adjustment work (if previously active).

6.1.2 MCT software

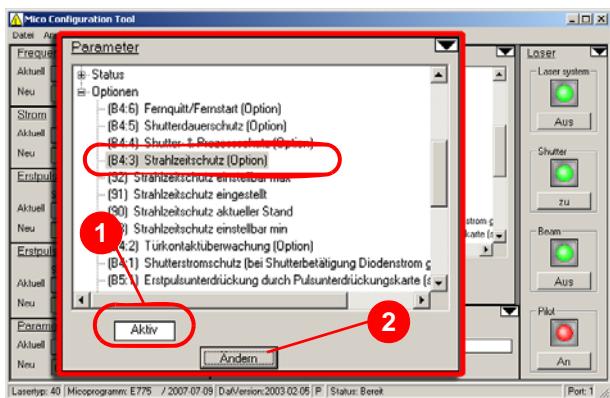


Figure 6.2 MCT software

1. Start the PC and load WINDOWS®.
2. Start the MCT software.
3. Under "Options", check the activation of the beam protection time (1) (Figure 6.2).
4. If necessary, deactivate the setting by pressing the "Change" button (2).

i Note: Reactivate the setting after completion of the adjustment work (if previously active).

6.2 Adjusting the laser head



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.



Figure 6.3 Checking the position of the workpiece support plate

1. Check the X and Y directions of the position of the workpiece support plate using a level gauge.
2. Perform an adjustment if necessary.



Figure 6.4 Checking the position of the galvo head



Figure 6.5 Adjusting the laser head

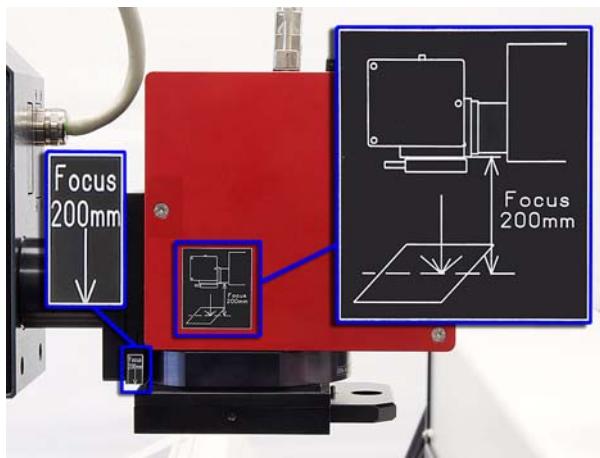


Figure 6.6 Adjusting the focal distance

3. Check the X and Y directions of the position of the galvo head using a level gauge.

4. Adjust the position of the galvo head using the three-point support plate of the laser head if necessary.

Note: If the workpiece support plate cannot be aligned to be absolutely straight, the galvo head must be adjusted in parallel at the value measured under 1.

5. Check the focal distance using the stickers on the galvo head and the logbook entries and adjust it if necessary.

6.3 Adjusting the laser beam

6.3.1 Main laser



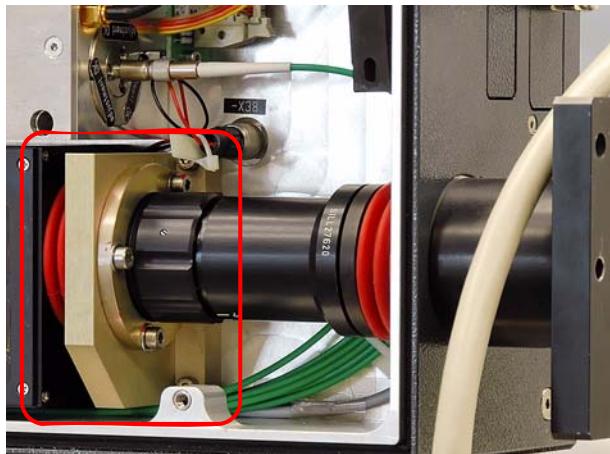
Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.

6.3.1.1 Beam expander mount without angle adjustment



Note: This method must be used for laser systems where a beam expansion mount is fitted in accordance with Figure 6.7.

Figure 6.7 Mount for beam expansion without angle adjustment

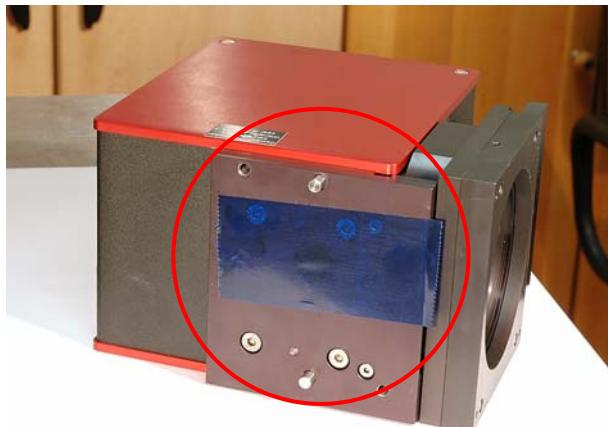


Figure 6.8 Dismantling the galvo head

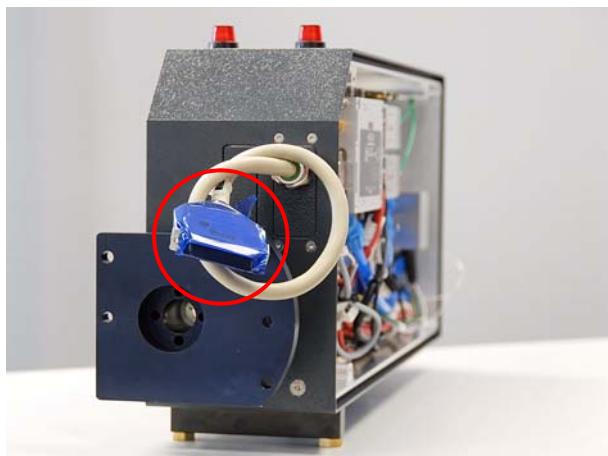


Figure 6.9 Galvo head connecting plug

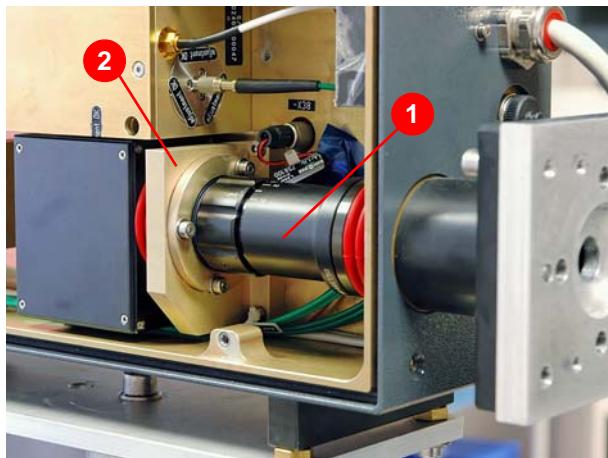


Figure 6.10 Dismantle the beam expander.

1. Remove the galvo head, put it to one side and cover the entry opening with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the galvo head.
2. Open the cover of the resonator side of the laser head (chamfered corner located on the right).

3. Cover the connecting plug of the galvo head with adhesive tape (tape to be used: see Chapter 3), to eliminate the risk of short circuits on the open plug during adjustment work.

i *Note:* Before starting the adjustments, the positioning laser and the beam expansion must be checked for holes, dirt, etc. If necessary, components must be cleaned or replaced.

4. Remove the beam expander (1) (Figure 6.10) and the mount (2).

i *Note:* The current adjustment of the beam expander should be noted so that the correct focal distance can be reset after any false adjustment of the beam expander.

5. Unscrew the beam expander from the mount.
6. Reinstall the mount.

! *Attention:* Do not crush or jam the cables and lines inside the laser head during installation!

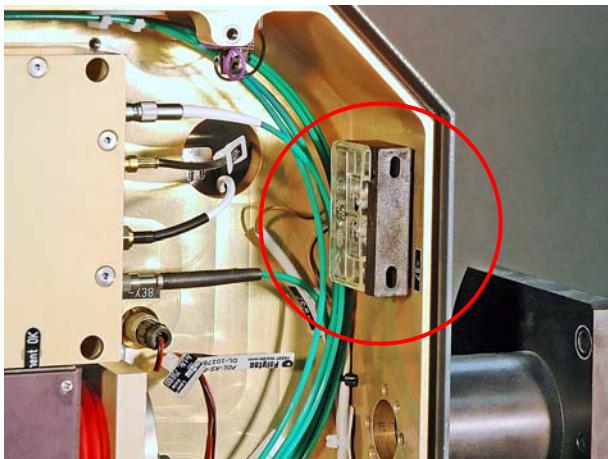


Figure 6.11 Interlock switch bridged

7. Bridge the interlock switch (Figure 6.11).

Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

8. Secure the shutter against activation.

Attention: Take measures for protection against laser radiation (see page 102)!

9. Insert the mains plug of the laser system and switch on the main switch.

Attention: If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

10. Using suitable means, mount a transducer disk (see Chapter 3) opposite the galvo flange on a surface that absorbs laser beams.

Attention: Under no circumstances may the absorbing surface be made of flammable materials!

11. Activate the laser system and set low power (IR at 7-8 W, CW; SHG at 2 W, 50 kHz).

12. Open the shutter and check the emission of the main and alignment lasers on the transducer disk.



Figure 6.12 Mounting the transducer disk

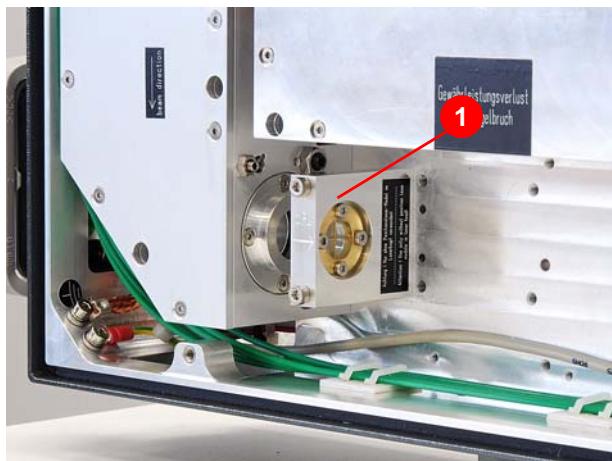


Figure 6.13 Mounting the adjusting aperture

13. Close the shutter.
14. Mount the adjusting aperture (1) (Figure 6.13) after the deflecting unit.

Attention: Use the appropriate adjusting aperture for the laser system (with or without pilot laser)! Note the direction of installation! The adjustment cannot be performed correctly if this is not observed.

Note: In the following steps, make sure that the cross wires are always in the same installation position.

Attention: Careful handling of the adjusting aids must be guaranteed! Damaged adjusting aids lead to imprecise adjusting results!

Note: Adjusting aids to be used: see Chapter 3.

15. Open the shutter and check the image of the laser on the transducer disk. Figure 6.14 shows examples for possible images:
 - Adjustment OK (1)
 - Emission too low (2)
 - Emission too far to the left (3)
 - Emission too far to the right (4)

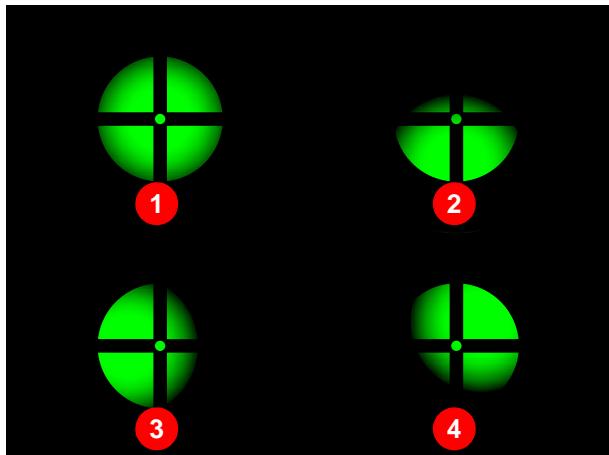


Figure 6.14 Checking the beam adjustment

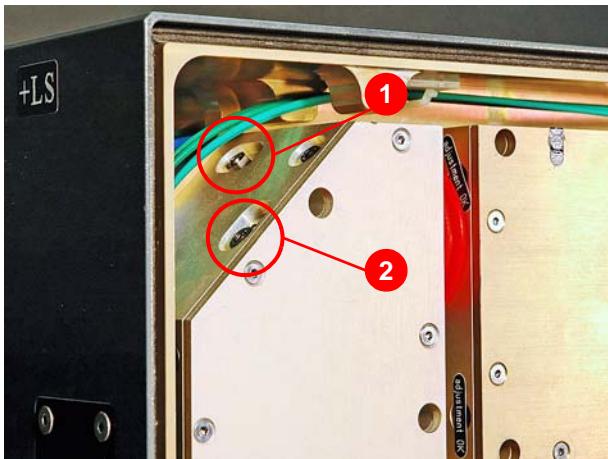


Figure 6.15 Beam adjustment of the upper deflecting mirror



Figure 6.16 Mounting the cross wires

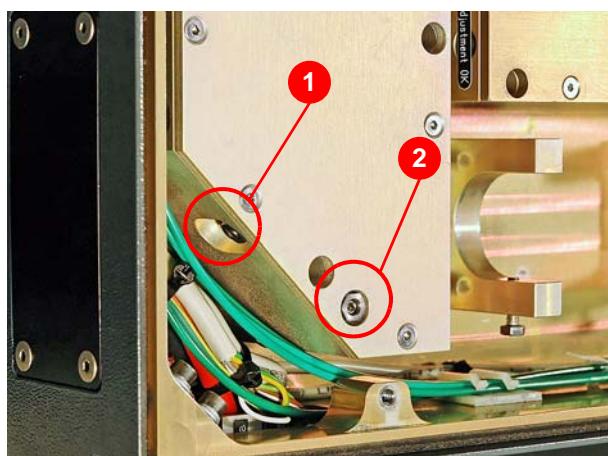


Figure 6.17 Beam adjustment of the lower deflecting mirror

16. Adjust the beam by adjusting the upper deflecting mirror of the deflecting unit.

- Horizontal adjustment (1) (Figure 6.15)
- Vertical adjustment (2) ()

17. Close the shutter after adjustment.

18. Remove the adjusting aperture (1) (see Figure 6.13, page 105) after the deflecting unit.

19. Insert the cross wires and their seat into the adjustment hole in the laser head from the inside.

i Note: Make sure the cross wires are always installed in the same position.

! **Attention:** Careful handling of the adjusting aids must be guaranteed! Damaged adjusting aids lead to imprecise adjusting results!

20. Open the shutter and check the image of the laser on the transducer disk (see Figure 6.14).

21. Adjust the beam by adjusting the lower deflecting mirror of the deflecting unit.

- Horizontal adjustment (1) (Figure 6.17)
- Vertical adjustment (2) ()

i Note: If the deflecting unit has been replaced by a newer model, the setting must be carried out according to Section 6.34, page 113.

22. Close the shutter after adjustment.

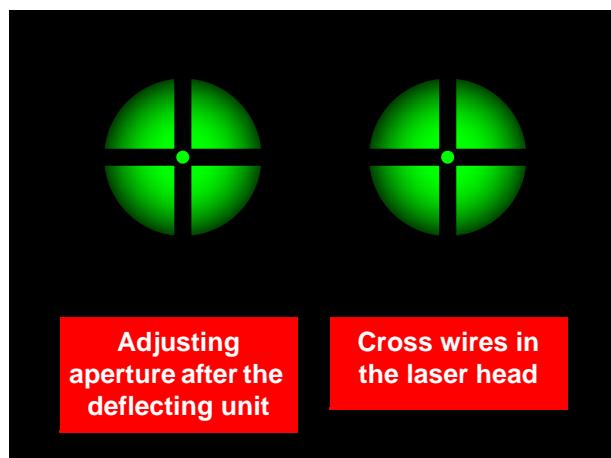


Figure 6.18 Beam adjustment OK

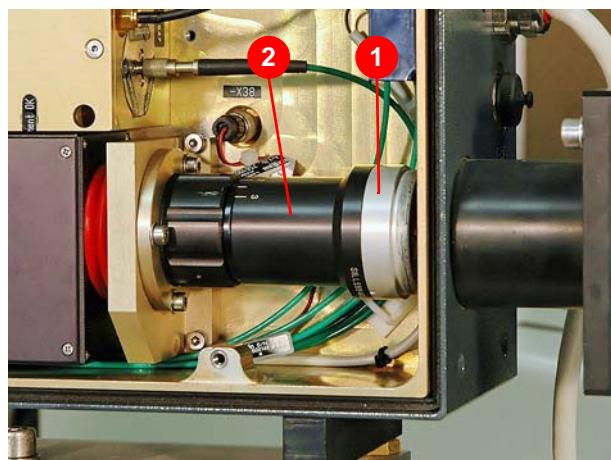


Figure 6.19 Beam expander with adjusting aperture



Figure 6.20 Beam adjustment of the beam expander

Note: Repeat Steps 13 through 22 until no more deviations can be determined in the image after the installation position changes.

23. If no more deviations in the image can be determined, the adjustment is okay (see Figure 6.18).

24. Measure the power in front of the beam expander or alignment laser housing (optional) and on the galvo flange (see Section 5.4, page 67).

Note: If a power difference can be determined, the adjustment should be performed again. Visually inspect the components closely once more and clean or replace them as necessary.

25. Screw the adjusting aperture for beam expander (1) (Figure 6.19) onto the beam expander (2).
26. Remove the beam expander mount, screw the beam expander into the mount, and reinstall the mount.

Attention: Do not crush or jam the cables, fibers, and lines inside the laser head during installation!

27. Open the shutter and check the image of the laser on the transducer disk. Figure 6.20 shows examples for possible images:

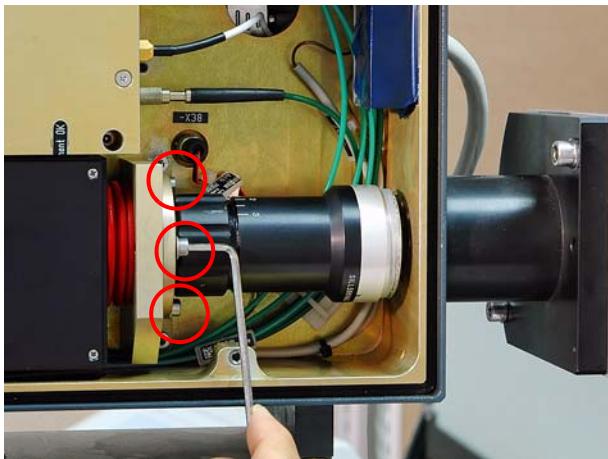


Figure 6.21 Adjustment of the beam expander

28. Adjust the beam expander after loosening the three clamping screws and tighten the three screws again after completing the adjustment.

i **Note:** Take care not to alter the position of the beam expander when tightening the screws.

29. Close the shutter; Switch off the system and secure it against reactivation.
30. Remove the beam expander and mount and unscrew the adjusting aperture from the beam expander.
31. Install the beam expander and the mount again; pay attention to the correct position of the bellows.

! **Attention:** Do not crush or jam the cables, fibers, and lines inside the laser head during installation!

32. Check the adjustment of the beam expander; if necessary, set to the value read before the adjustment procedure and check the focal point (see Section 6.3.2, page 119).
33. Measure the power in front of the beam expander or alignment laser housing (optional) and on the galvo flange (see Section 5.4, page 67).

i **Note:** If a power difference can be determined, the adjustment should be performed again.

34. Mount the galvo head.
35. Perform an adjustment if necessary (see Section 6.3.3, page 122).
36. Remove the bridge from the interlock switch.
37. Mount the cover on the resonator side of the laser head.
38. Commission the laser system.
39. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

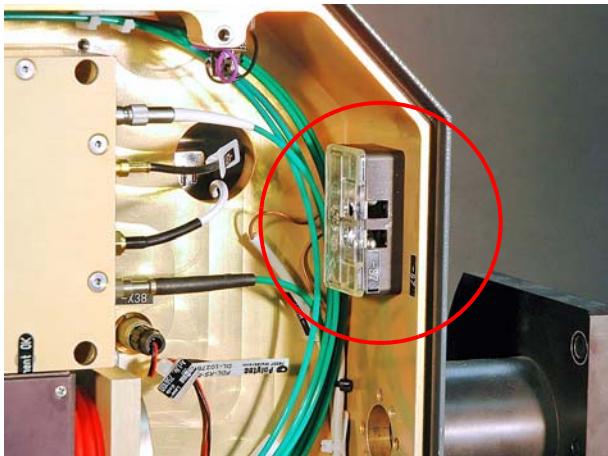


Figure 6.22 Interlock switch

6.3.1.2 Beam expander mount with angle adjustment

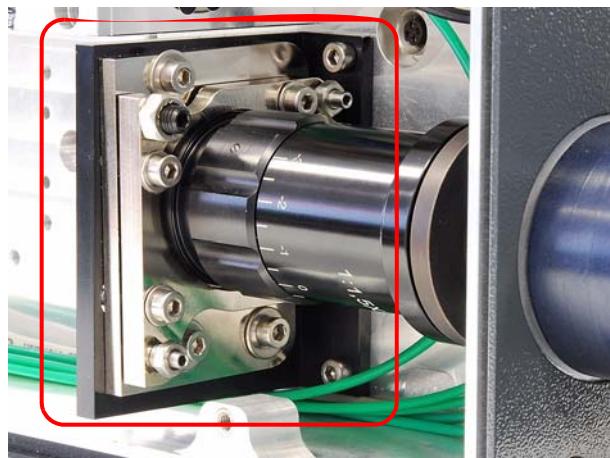


Figure 6.23 Mount for beam expander with angle adjustment

i Note: This method must be used for laser systems where a beam expansion mount is fitted in accordance with Figure 6.23.



Figure 6.24 Dismantling the galvo head

1. Remove the galvo head, put it to one side and cover the entry opening with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the galvo head.
2. Open the cover of the resonator side of the laser head (chamfered corner located on the right).

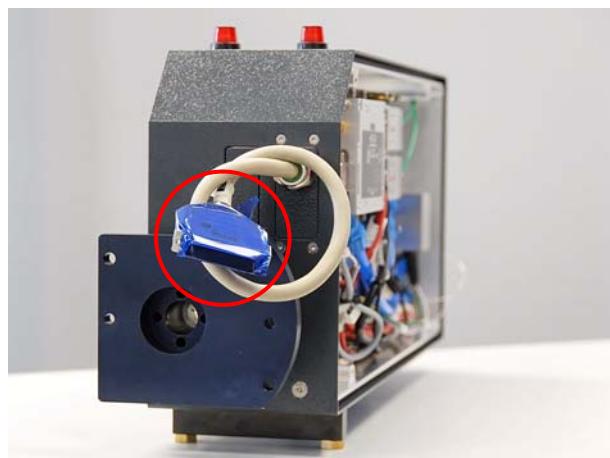


Figure 6.25 Galvo head connecting plug

3. Cover the connecting plug of the galvo head with adhesive tape (tape to be used: see Chapter 3), to eliminate the risk of short circuits on the open plug during adjustment work.

i Note: Before starting the adjustments, the positioning laser and the beam expansion must be checked for holes, dirt, etc. If necessary, components must be cleaned or replaced.

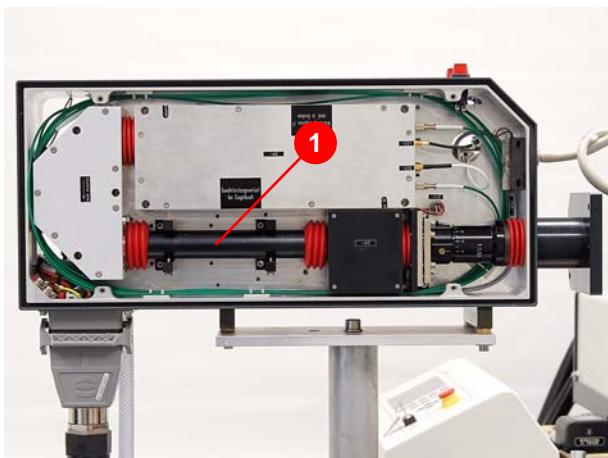


Figure 6.26 Dismantling the beam guide

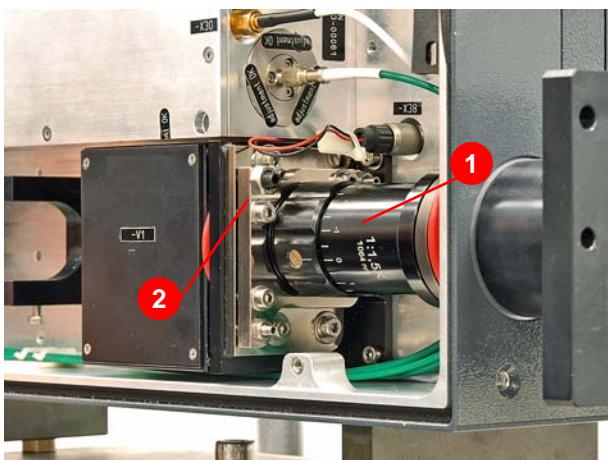


Figure 6.27 Dismantle the beam expander.

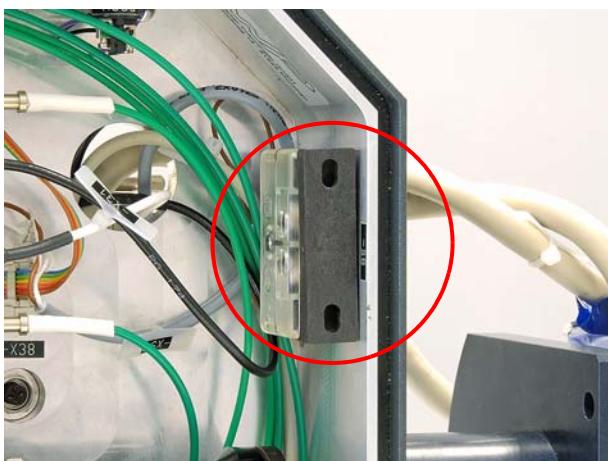


Figure 6.28 Interlock switch bridged

4. Dismantle the beam guide (1) (Figure 6.26).

5. Remove the beam expander (1) (Figure 6.27) and the mount (2).

i Note: The current adjustment of the beam expander should be noted so that the correct focal distance can be reset after any false adjustment of the beam expander.

6. Unscrew the beam expander from the mount.

7. Reinstall the mount.

! **Attention:** Do not crush or jam the cables and lines inside the laser head during installation!

8. Bridge the interlock switch (Figure 6.28).

! **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

9. Secure the shutter against activation.

! **Attention:** Take measures for protection against laser radiation (see page 102)!

10. Insert the mains plug of the laser system and switch on the main switch.



Figure 6.29 Mounting the transducer disk

! **Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

11. Using suitable means, mount a transducer disk (see Chapter 3) opposite the galvo flange on a surface that absorbs laser beams.

! **Attention:** Under no circumstances may the absorbing surface be made of flammable materials!

12. Activate the laser system and set low power (IR at 7-8 W, CW; SHG at 2 W, 50 kHz).
13. Open the shutter and check the emission of the main and alignment lasers on the transducer disk.
14. Close the shutter.
15. Mount the adjusting aperture (1) (Figure 6.30) after the deflecting unit.

! **Attention:** Use the appropriate adjusting aperture for the laser system (with or without pilot laser)! Note the direction of installation! The adjustment cannot be performed correctly if this is not observed.

i **Note:** In the following steps, make sure that the cross wires are always in the same installation position.

! **Attention:** Careful handling of the adjusting aids must be guaranteed! Damaged adjusting aids lead to imprecise adjusting results!

i **Note:** Adjusting aids to be used: see Chapter 3.

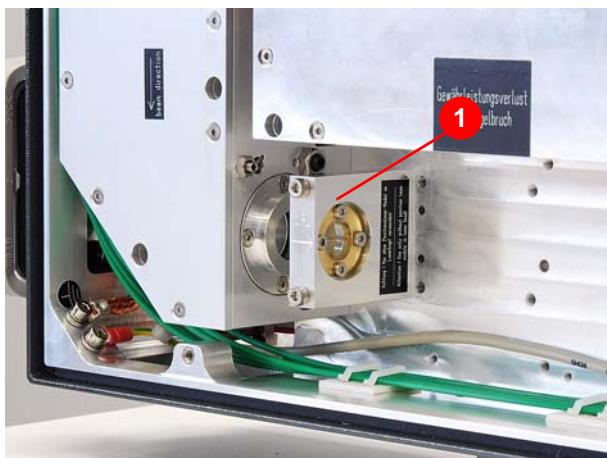


Figure 6.30 Mounting the adjusting aperture

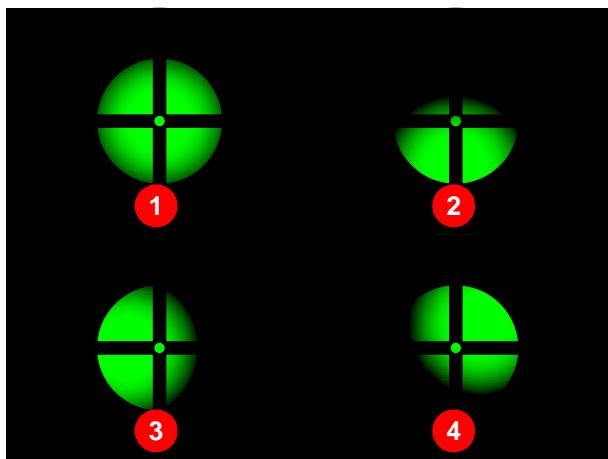


Figure 6.31 Checking the beam adjustment

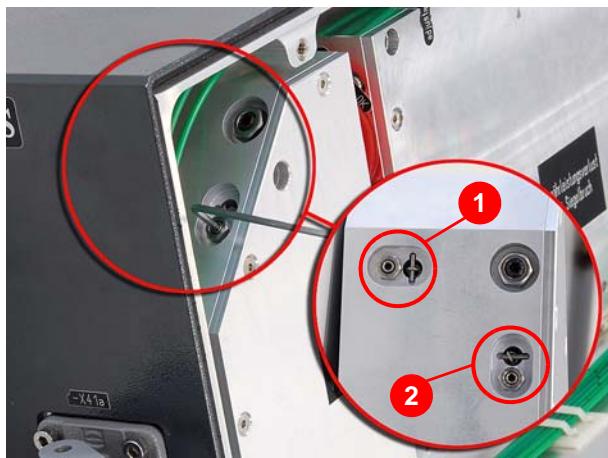


Figure 6.32 Beam adjustment of the upper deflecting mirror



Figure 6.33 Mounting the cross wires

16. Open the shutter and check the image of the laser on the transducer disk. Figure 6.31 shows examples for possible images:
 - Adjustment OK (1)
 - Emission too low (2)
 - Emission too far to the left (3)
 - Emission too far to the right (4)

17. Adjust the beam by adjusting the upper deflecting mirror of the deflecting unit.
 - Horizontal adjustment (1) (Figure 6.32)
 - Vertical adjustment (2) ()
18. Close the shutter after adjustment.

19. Remove the adjusting aperture (1) (see Figure 6.30, page 111) after the deflecting unit.

20. Insert the cross wires and their seat into the adjustment hole in the laser head from the inside.

i **Note:** Make sure the cross wires are always installed in the same position.

! **Attention:** Careful handling of the adjusting aids must be guaranteed! Damaged adjusting aids lead to imprecise adjusting results!

21. Open the shutter and check the image of the laser on the transducer disk (see Figure 6.31).

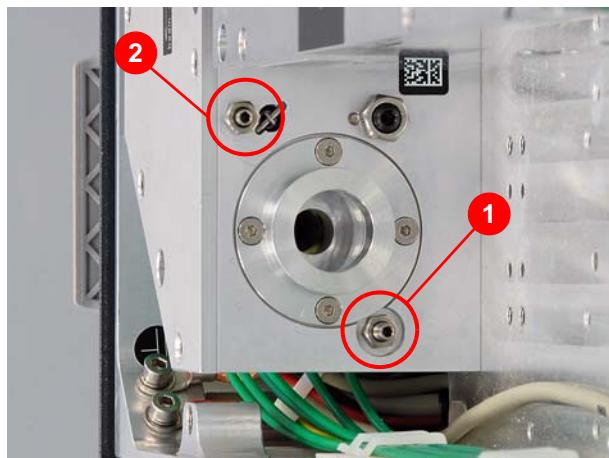


Figure 6.34 Beam adjustment of the lower deflecting mirror

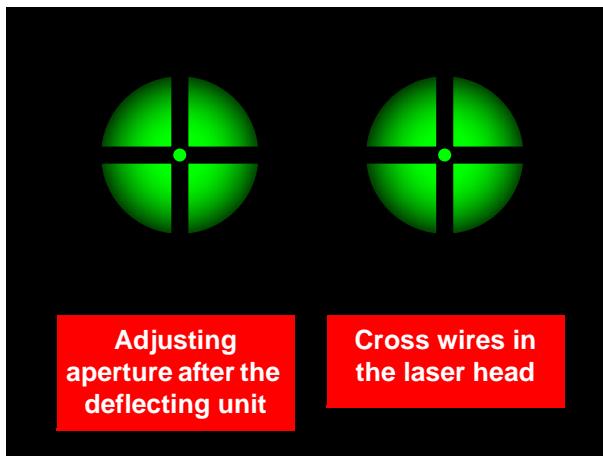


Figure 6.35 Beam adjustment OK

! **Attention:** Do not reach into the laser beam during the adjustment!

22. Adjust the beam by adjusting the lower deflecting mirror of the deflecting unit.
 - Horizontal adjustment (1) (Figure 6.34)
 - Vertical adjustment (2) ()
23. Close the shutter after adjustment.
24. Remove the cross wires and insert the adjusting aperture again.

i **Note:** Repeat Steps 15 through 24 until no more deviations can be determined in the image for either cross wire.

25. If no more deviations in the image can be determined, the adjustment is okay (see Figure 6.35).
26. Insert the cross wires and their seat into the adjustment hole in the laser head from the inside.
27. Carefully tighten the adjusting screws on the deflecting unit.

Adjustment tasks

Adjusting the laser beam



Figure 6.36 Aligning the transducer disk to the laser beam

28. Using suitable means, mount a transducer disk (see Chapter 3) opposite the galvo flange on a surface that absorbs laser beams.

! *Attention: Under no circumstances may the absorbing surface be made of flammable materials!*

29. Align the transducer disk parallel to the galvo flange.
30. Set the distance from the transducer disk to the galvo flange to at least 200 to 300 mm.
31. Open the shutter. Align the marking or the cross wires on the transducer disk to the laser beam.
32. Fix the transducer disk in this position.

! *Attention: For the remaining work, the transducer disk and the laser head must remain in the same positions!*

33. Close the shutter.
34. Check the basic setting for the beam expansion mount and readjust if necessary.
 - The distance between the two silver-colored plates must be 1 to 1.5 mm. The plates must be aligned parallel to each other.
 - To adjust, loosen screws (1) (Figure 6.37) and set the distance using the support screws (2 and 3).
 - Tighten the screws (1) hand-tight again.

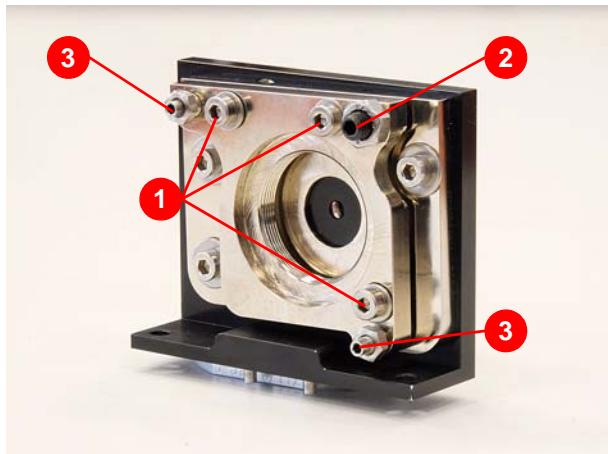


Figure 6.37 Basic setting for beam expansion mount

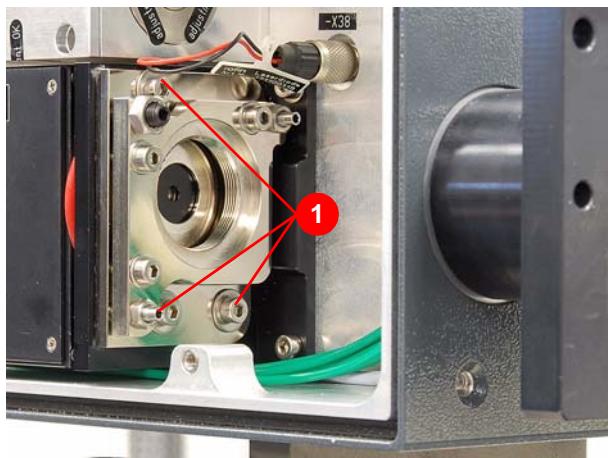


Figure 6.38 Fitting the beam expander mount

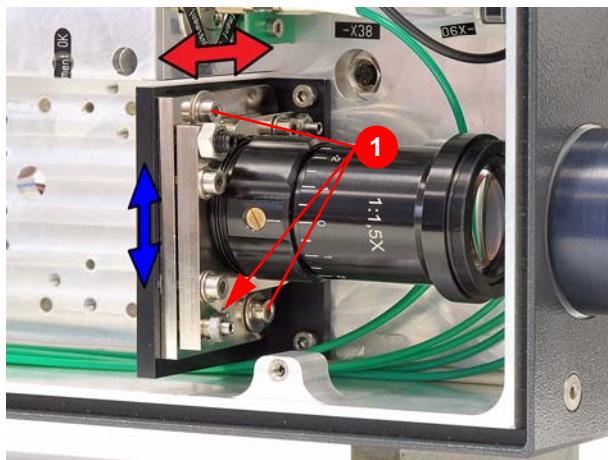


Figure 6.39 Mounting the beam expansion and X/Y adjustment



Figure 6.40 Beam adjustment of beam expander in X/Y direction

35. Fit the beam expander mount.

i Note: If there is a lens in the mount for reducing the beam divergence, this must be removed before the basic settings are made.

! **Attention:** Do not crush or jam the cables, fibers, and lines inside the laser head during installation!

36. Loosen the screws (1) (Figure 6.38).

37. Set the divergence of the beam expansion to zero.

38. Screw the beam expansion into the mount.

39. Open the shutter and check the position of the beam (beam centered through the cross wires and seat) (see Figure 6.40). If the beam is centered, continue with item 40. If the beam is off-center, loosen screws (1) and move the beam expansion in the X and Y directions until the beam passes centrally through the cross wires. Carefully tighten the screws (1) afterwards.

i Note: Take care not to alter the position of the beam expander when tightening the screws.

40. Close the shutter.

Adjustment tasks

Adjusting the laser beam



Figure 6.41 Mounting the adjustment tube

41. Mount the adjustment tube on the galvo flange.
42. Insert the cross wires into the adjustment tube.
43. Open the shutter and check the position of the beam.

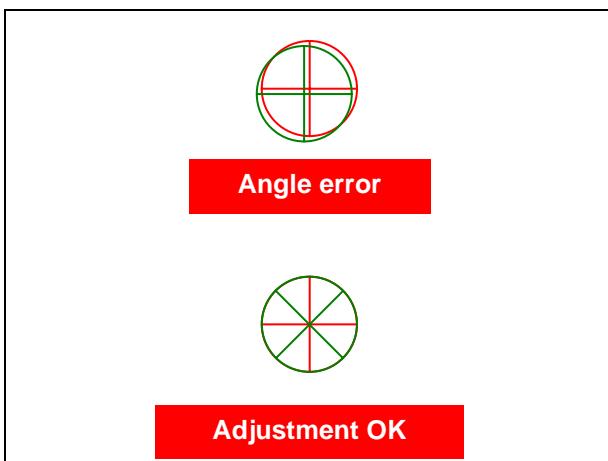


Figure 6.42 Checking the beam position at the galvo flange (1)



Note: For the best setting, the two cross wires must be adjusted so that there is no angular offset between them.

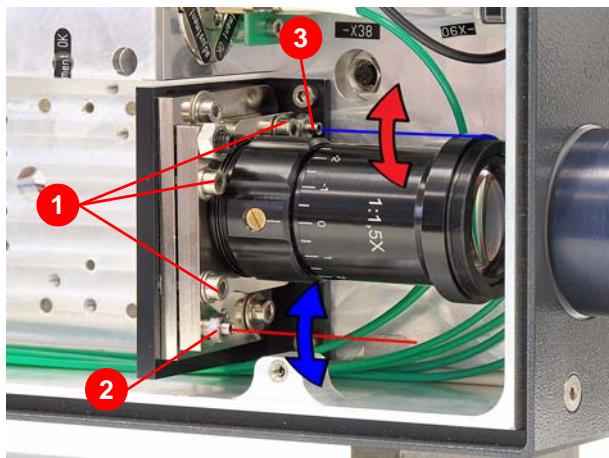


Figure 6.43 Angular setting of the beam expander

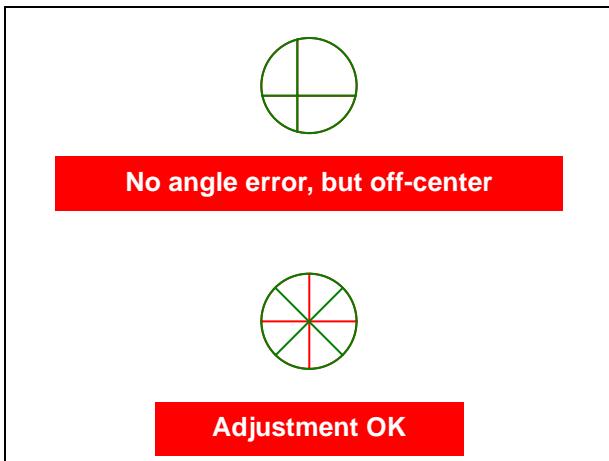


Figure 6.44 Checking the beam position at the galvo flange (2)

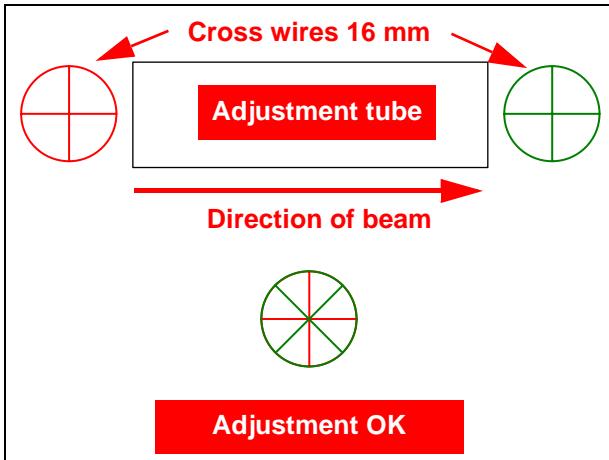
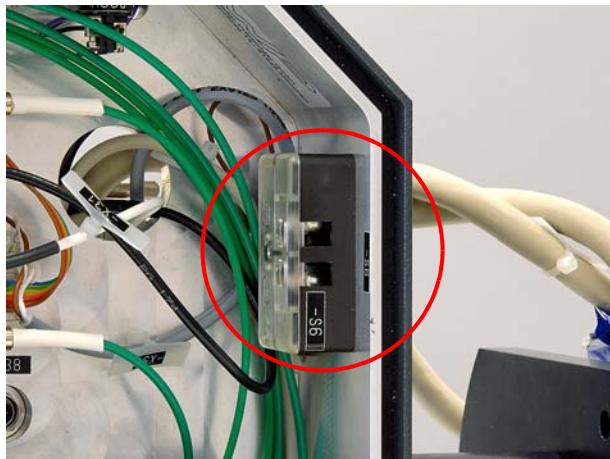


Figure 6.45 Checking the beam position at the galvo flange (3)

44. Loosen screws (1) (Figure 6.43) and adjust the angle of the beam expander using screws (2) in the horizontal direction and (3) in the vertical direction.
45. After the adjustment, tighten screws (1) by hand and carefully tighten screws (2) and (3).
46. Open the shutter and check the position of the beam (beam centered through the cross wires and seat) (see Figure 6.40). If the beam is off-center, loosen screws (1) (Section 6.39, page 115) and move the beam expansion in the X and Y directions until the beam passes centrally through the cross wires. Carefully tighten the screws (1) afterwards.
47. Close the shutter.
48. Repeat points 44 through 47 until the centering of the laser beam through the adjusting aperture on the beam expander (X/Y setting) and the angle setting are correct.

49. Open the shutter and check the position of the beam. To do this, rotate the cross wires in the adjustment tube by 45°. If the displayed crosses are congruent (see Figure 6.45, bottom), the adjustment is OK (then continue with point 51).
50. Remove the adjustment tube.
51. When the adjustment is complete, the galvo head must be fitted and connected to the galvo cable.

Attention: Remove or insert the connecting cable of the galvo head only without tension!
In case of non-observance, the galvo head can be damaged!

**Figure 6.46** Interlock switch

52. Switch on at the main switch, start the system and set the current so that a laser power of approx. 6 to 7 watts is produced.
53. The VLM software must then be started and the galvo mirrors brought into a defined starting position by means of the "Hardware initialize" symbol.
54. The centered image of the adjusting aperture must be checked at approx. 1/3 of the focal length specified on the galvo head.

i **Note:** If the image after the galvo head is not correct (e. g. eccentric, laser beam not round), the galvo head and the ALI board must be checked.

55. Check the adjustment of the beam expander; if necessary, set to the value read before the adjustment procedure and check the focal point (see Section 6.3.2, page 119).
56. Measure the power in front of the beam expander or alignment laser housing (optional) and on the galvo flange (see Section 5.4, page 67).

i **Note:** If a power difference can be determined, the adjustment should be performed again.

57. Refit the beam guide and bellows.
58. Perform an adjustment if necessary (see Section 6.3.3, page 122).
59. Switch off the laser system.
60. Remove the bridge from the interlock switch.
61. Mount the cover on the resonator side of the laser head.
62. Commission the laser system.
63. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

6.3.2 Focal point



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

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Attention: To adjust the focal point, the distance between the galvo head and workpiece may not be changed as the field size otherwise shifts!

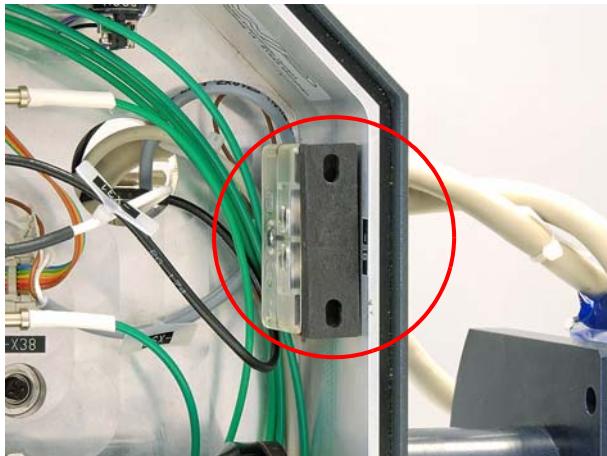


Figure 6.47 Interlock switch bridged

1. Open the cover of the resonator side of the laser head (chamfered corner located on the right).
2. Bridge the interlock switch (Figure 6.47).

Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

3. Secure the shutter against activation.

Attention: Take measures for protection against laser radiation (see page 119)!

4. Insert the mains plug of the laser system and switch on the main switch.

Attention: If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

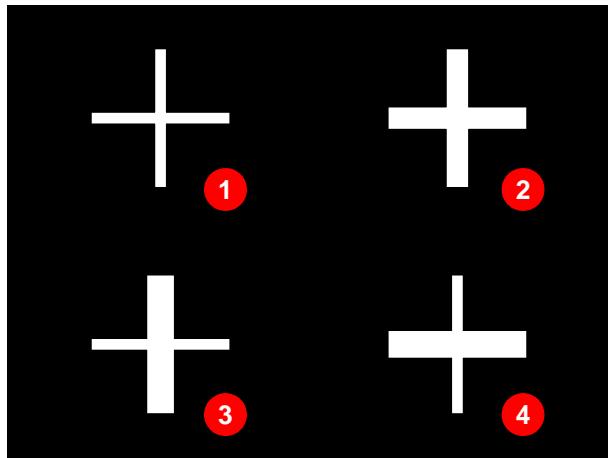


Figure 6.48 Checking the focus setting

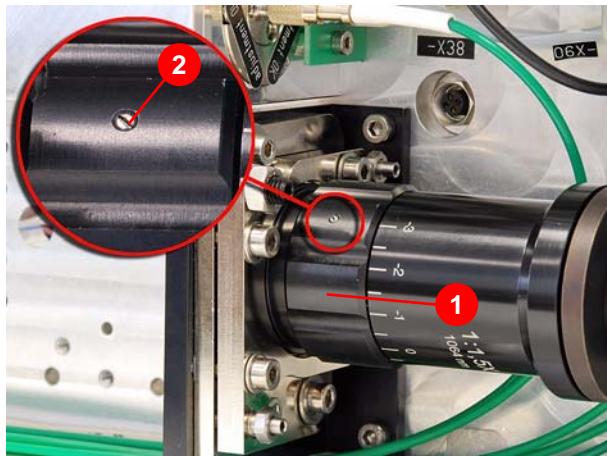


Figure 6.49 Setting the focal point

5. Lay material (an anodized metal sheet, coated paper) under the galvo head.
6. Switch on the laser system using the key switch.
7. Open shutter; the emission of the laser beam is blocked by the Q-switch.
8. Let the program for the cross in the middle of the field with the material run according to the laser parameters.
9. Close the shutter.
10. Check the image of the cross. The focal point is correctly set when both laser lines in the X and Y direction have the same dimensions at the smallest possible width.
 - Adjustment OK (1) (circular cross-section)
 - Too wide (2) (circular cross-section)
 - Y dimension too wide (3) (cross-section elliptical, x axis > Y-axis)
 - X dimension too wide (4) (cross-section elliptical, X axis < Y-axis)
11. If necessary, change the focal point by adjusting the adjusting ring (1) (Figure 6.49).

i **Note:** Only alter the focus with the beam expander. Should that not be possible, it will be necessary to contact ROFIN service.

Under no circumstances should the distance between the galvo head and the workpiece be altered as the field geometry will be changed and a new field correction will be necessary!

12. Move material under the galvo head, open the shutter, and let the program run.
13. Check the image of the cross.
- i** **Note:** Repeat Steps 7 through 13 until the focal point is correctly set.
14. Fix the position of the beam expander using the locking screw (2).

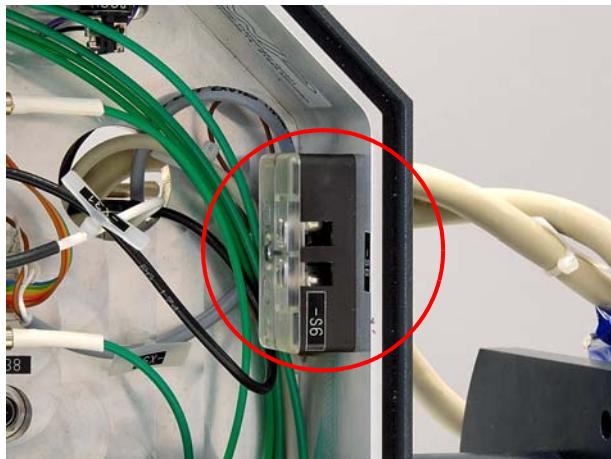


Figure 6.50 Interlock switch

15. Remove the bridge from the interlock switch.
16. Mount the cover on the resonator side of the laser head.
17. Commission the laser system.

6.3.3 Alignment laser¹



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.

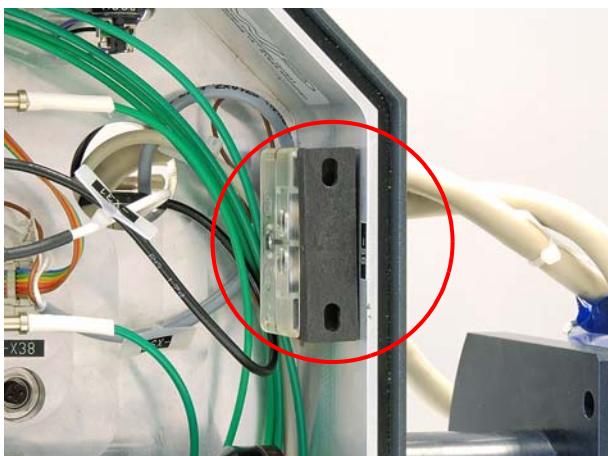


Figure 6.51 Interlock switch bridged

1. Open the cover of the resonator side of the laser head (chamfered corner located on the right).
2. Bridge the interlock switch (Figure 6.51).

Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

3. Secure the shutter against activation.

Attention: Take measures for protection against laser radiation (see page 122)!

4. Insert the mains plug of the laser system and switch on the main switch.

Attention: If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

1. Installation depends on the respective laser type

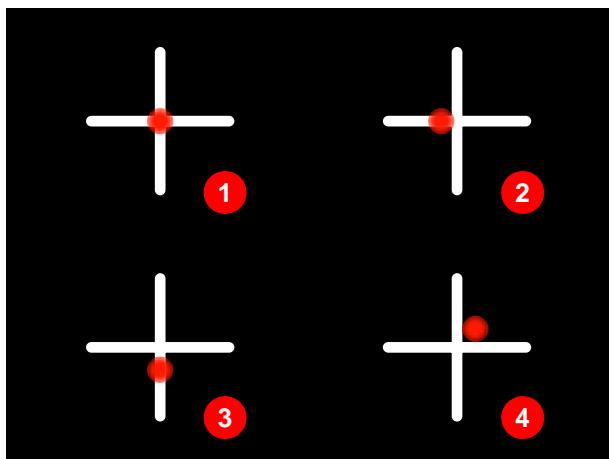


Figure 6.52 Checking the adjustment of the alignment laser

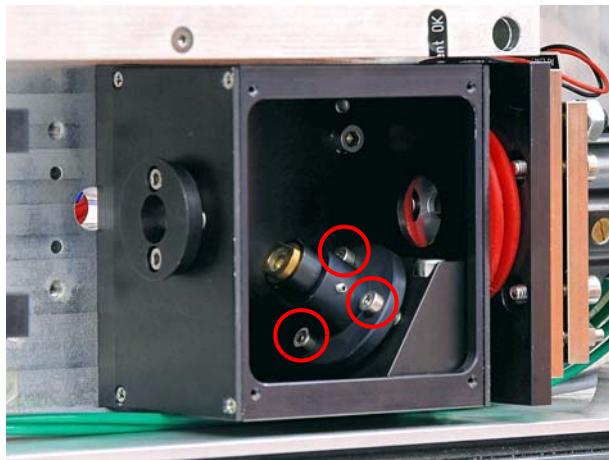


Figure 6.53 Adjustment of the alignment laser

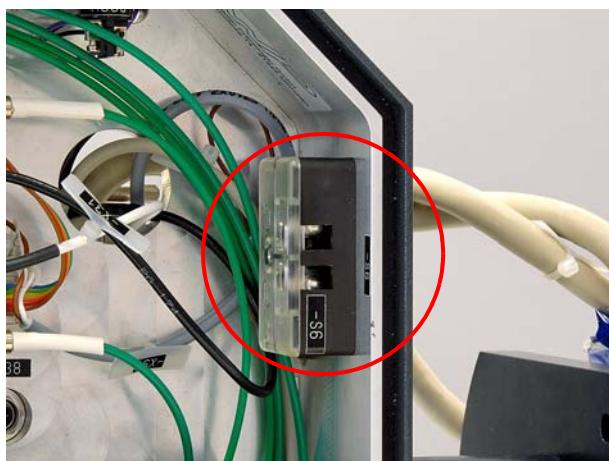


Figure 6.54 Interlock switch

5. Fix material (an anodized metal sheet, coated paper) into place in the focus under the galvo head using tape.
6. Switch on the laser system using the key switch.
7. Open shutter; the emission of the laser beam is blocked by the Q-switch.
8. Let the program for the cross in the middle of the field with the material run according to the laser parameters.
9. Close the shutter.
10. Switch off the laser system; leave the main switch in the "On" position.
11. Check the position of the alignment laser in relation to the image of the cross hairs. Figure 6.52 shows examples for possible images:
 - Adjustment OK (1)
 - Emission too far to the left (2)
 - Emission too low (3)
 - Emission too far to the right (4)
12. Open the housing of the alignment laser.
13. Adjust the alignment laser to the center of the marked cross hairs using the three adjusting screws (Figure 6.53).
14. Close the housing of the alignment laser.
15. Remove the bridge from the interlock switch.
16. Mount the cover on the resonator side of the laser head.
17. Commission the laser system.

6.4 Adjusting the beam attenuator¹



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.

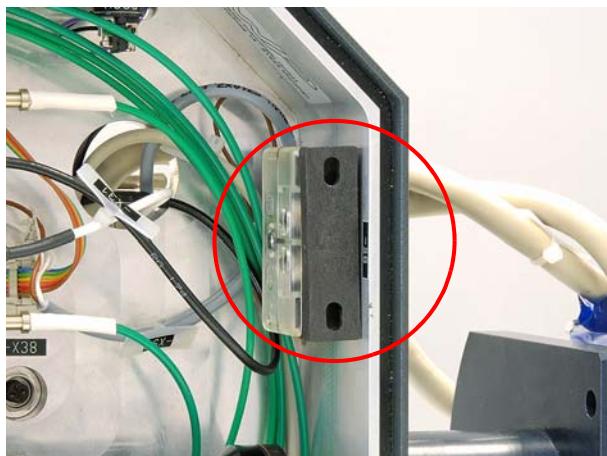


Figure 6.55 Interlock switch bridged

1. Open the cover of the resonator side of the laser head (chamfered corner located on the right).
2. Bridge the interlock switch (Figure 6.51).

Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

3. Secure the shutter against activation.

Attention: Take measures for protection against laser radiation (see page 122)!

4. Insert the mains plug of the laser system and switch on the main switch.

Attention: If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

1. Installation depends on the respective laser type

Adjustment tasks

Adjusting the beam attenuator

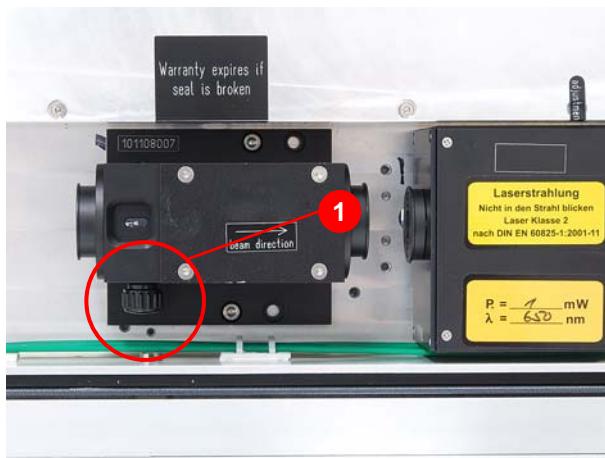


Figure 6.56 Beam attenuator



Figure 6.57 Adjusting lever

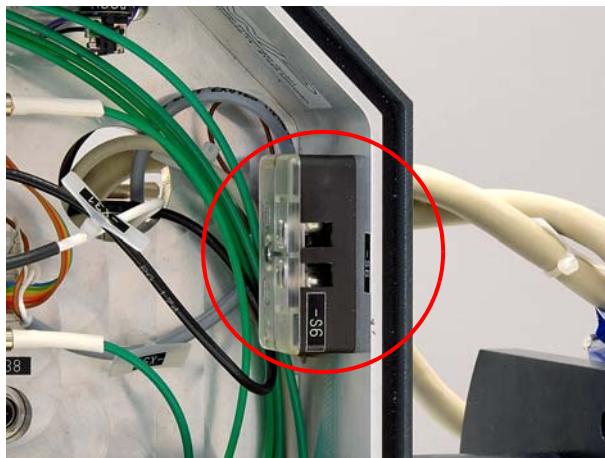


Figure 6.58 Interlock switch

5. Loosen the clamping screw (1) (Figure 6.56).
6. Switch on the laser system.
7. Open the shutter and perform a power measurement.

8. Set the required laser power at the specified current and frequency by adjusting the beam attenuator with the lever (1) (Figure 6.57).
9. Clamp the beam attenuator again after the adjustment is complete.
10. Close the shutter.
11. Switch off the laser system.

12. Remove the bridge from the interlock switch.
13. Mount the cover on the resonator side of the laser head.
14. Commission the laser system.

6.5 Adjustment of the internal power measurement device

1. Measure the laser power after the deflecting unit (see Section 5.4.4, page 75).



Note: 30 seconds' settling time for the measuring equipment must be observed! To avoid incorrect results, do not move the measurement head during measurements.

1. Close the shutter, use the same parameters as under Section 1, switch on the laser beam, and read the power display of the internal measurement head.
2. In case of deviations, adapt the display in the LCP/MCT software.

Notes

Notes

7 Repair work



Note: The "Maintenance Schedule" chapter in the RSM PowerLine E/EL (IR and SHG) user manual must also be observed. The necessary aids are listed in Chapter 3 of this repair manual and in the "Spare Parts" chapter of the RSM PowerLine E/EL (IR and SHG) user manual.

7.1 Changing the optical components



Attention: When changing the optical components, make sure that the surfaces of the new components are always free of grease and dust.

7.1.1 Galvo head



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Note: The necessary spare parts of the galvo head can be ordered individually from ROFIN-SINAR. To observe the field geometry/correction after the change of the galvo head and/or focusing optics, we recommend that you order the components with a compensation file created by ROFIN-SINAR.

7.1.1.1 Galvo head with protective glass slide

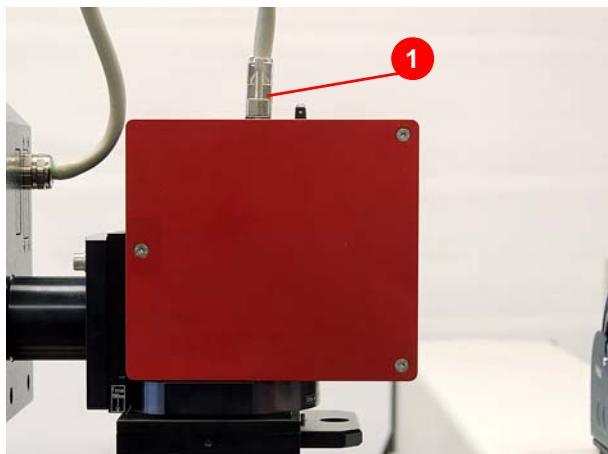


Figure 7.1 Galvo head connecting plug

1. Loosen and remove the connecting plug of the galvo head (1) (Figure 7.1).



Attention: Remove or insert the connecting cable of the galvo head only without tension!
In case of non-observance, the galvo head can be damaged!

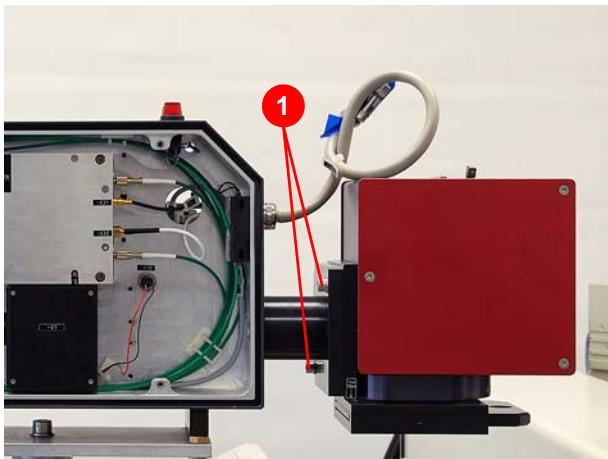


Figure 7.2 Dismantling the galvo head

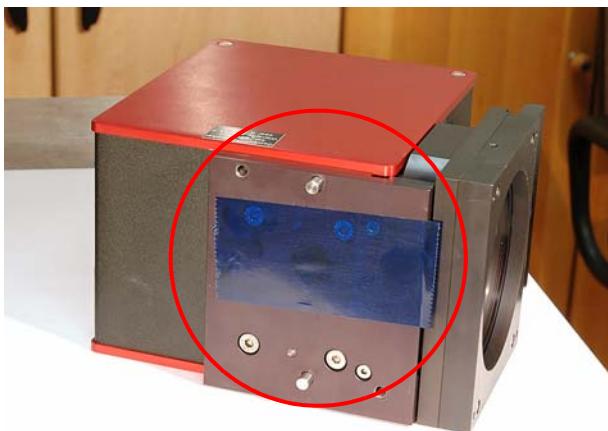


Figure 7.3 Covering the entry openings

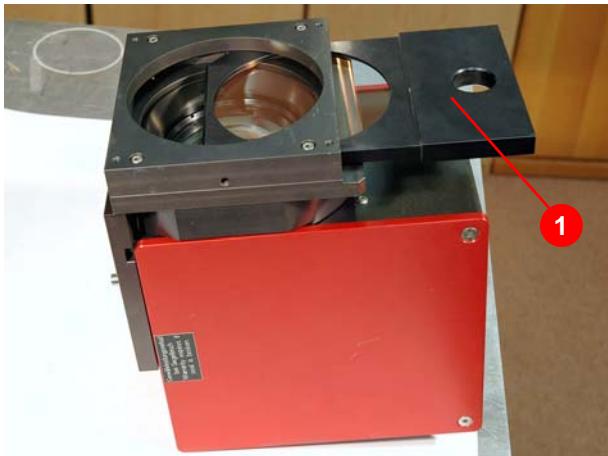


Figure 7.4 Removing the protective glass

2. Loosen the fastening screws (1) (Figure 7.2).
3. Remove the galvo head.

4. Cover the entry opening with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the galvo head.
5. Cover the laser beam exit opening on the laser head with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the laser head.

6. Remove the protective glass (1) (Figure 7.4).

Attention: Take care that the protective glass does not fall out.

i Note: If the protective glass is damaged, it must be exchanged (see Section 7.1.2, page 140).

i Note: All parts must be marked for reinstallation with suitable tools.



Figure 7.5 Dismantling the guide plate

7. Loosen the screws (Figure 7.5) of the guide plate for the protective glass.



Figure 7.6 Removing the focusing optics

8. Unscrew the focusing optics (1) (Figure 7.6).



Figure 7.7 Removing the distance ring

9. Removing the distance ring (1) (Figure 7.7).

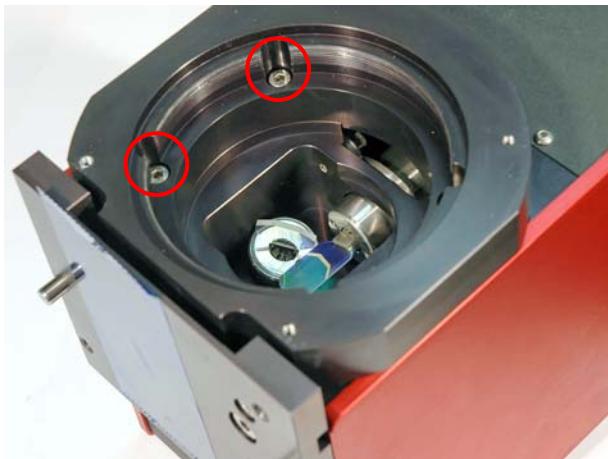


Figure 7.8 Removing the optics mount

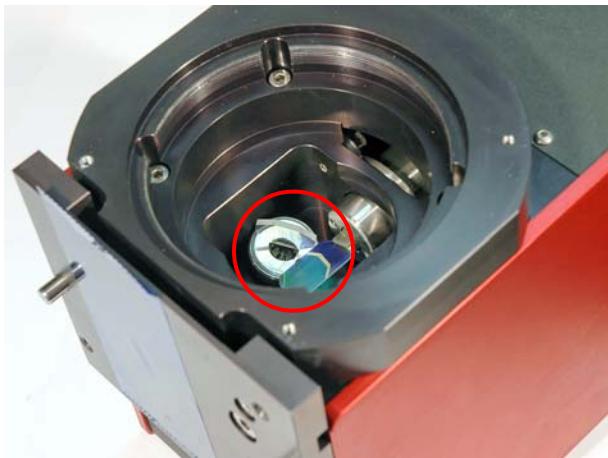


Figure 7.9 Checking the cleanliness condition



Figure 7.10 Setting the operating voltage (1)

10. Loosen the four fastening screws (Figure 7.8) of the optics mount and remove it.

11. Check to see if the deflecting mirror (Figure 7.9) is clean.
12. Clean (see Section 4.1, page 38) if necessary.
13. Mount the galvo head in the reverse order.

i *Note:* When mounting the galvo head, pay attention to the correct position of the distance ring (see Figure 7.7).

14. Remove the adhesive tape from the galvo head and the laser head.
15. Remount the galvo head to the laser.

16. Mount the measuring adapter (see Chapter 3) between the galvo head and the connecting cable.

! *Attention:* Remove or insert the connecting cable of the galvo head only without tension!

In case of non-observance, the galvo head can be damaged!

17. Commission the laser system.
18. Measure the voltage (+15.5 V).



Figure 7.11 Setting the operating voltage (2)
(supply cabinet)

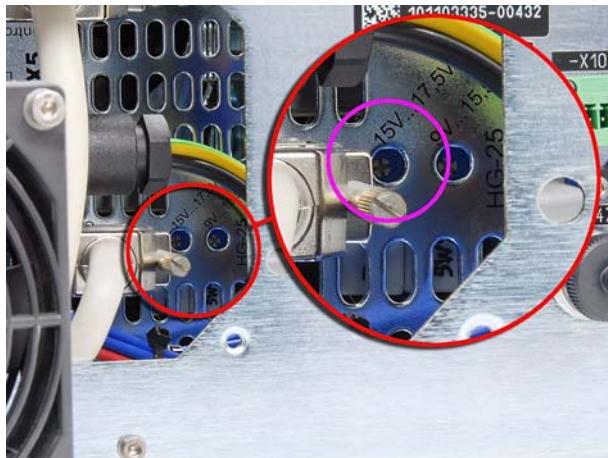


Figure 7.12 Setting the operating voltage (2)
(19"-plug-in)



Figure 7.13 Setting the operating voltage (3)

19. Set the operating voltage (+15.5 V) on the HN 80x using a small screwdriver. Setting precision: ± 0.2 V.

i Note: The position of the potentiometer on the HN80x power supply is similar to Figure 7.11.

20. Measure the voltage (-15.5 V).

i Note: The display of the minus value can have an offset to the set plus value.

21. Switch off the laser system.
22. Remove the measuring adapter.

! **Attention:** Remove or insert the connecting cable of the galvo head only without tension!
In case of non-observance, the galvo head can be damaged!

23. Commission the laser system.
24. Check the focal point of the laser and adjust it if necessary (see Section 6.3.2, page 119).
25. Check the field geometry/correction and load a new compensation file if necessary.

7.1.1.2 Galvo head with protective glass screwed into the optics

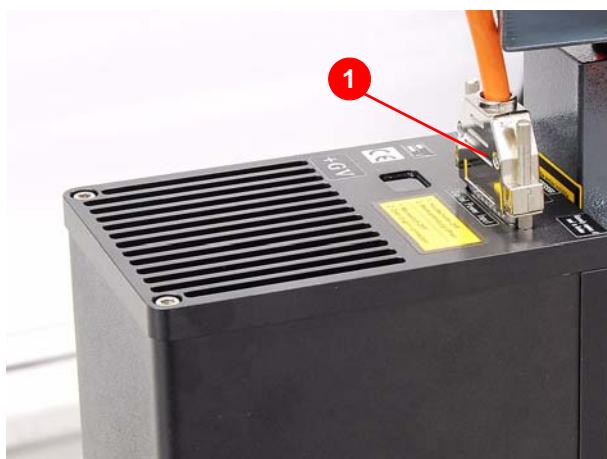


Figure 7.14 Galvo head connecting plug

1. Loosen and remove the connecting plug of the galvo head (1) (Figure 7.14).

Attention: Remove or insert the connecting cable of the galvo head only without tension!

In case of non-observance, the galvo head can be damaged!

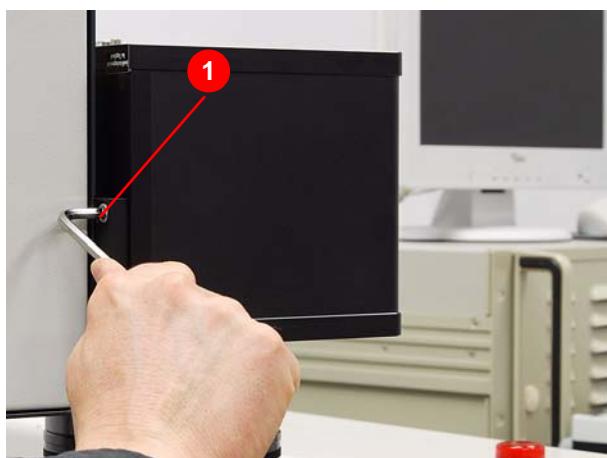


Figure 7.15 Dismantling the galvo head

2. Loosen the two fastening screws (1) (Figure 7.15).
3. Remove the galvo head.



Figure 7.16 Covering the entry openings

4. Cover the entry opening with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the galvo head.
5. Cover the laser beam exit opening on the laser head with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the laser head.



Figure 7.17 Removing the focusing optics



Figure 7.18 Unscrewing the protective glass



Figure 7.19 Set the focusing optics to one side and fit a protective cap

6. Unscrew the focusing optics (1) (Figure 7.17).

Note: In the process, take note of the aluminum distance ring that may be present.

7. Unscrew the protective glass (1) (Figure 7.18) from the focusing optics.

Note: If the protective glass is damaged, it must be replaced.

Note: All parts must be marked for reinstallation with suitable tools.

If the protective glass cannot be unscrewed:

- a) Lay the focusing optics on a foam rubber mat (e. g. a reversed mouse mat) with the protective glass facing down.

Attention: The mat must be absolutely free of foreign objects, in order not to damage the protective glass.

- b) Fit a protective cap (1) (Figure 7.19) to the rear of the focusing optics.

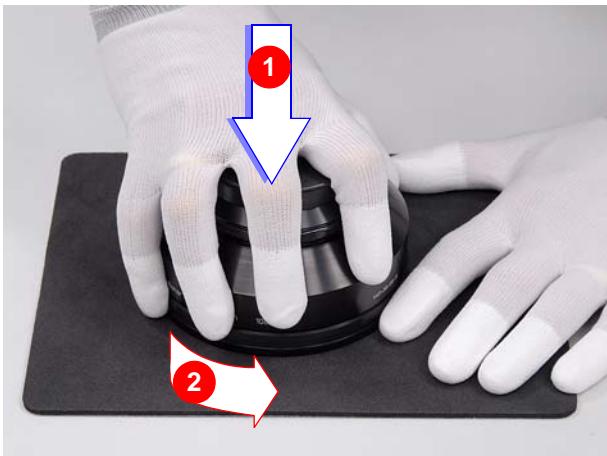


Figure 7.20 Unscrewing a seized protective glass



Figure 7.21 Fitting the protective glass (1)



Figure 7.22 Fitting the protective glass (2)

- c) Apply axial pressure (1) to the focusing optics and unscrew the protective glass (2).

8. Clean the individual components (see page 37).

Attention: Take care that the cleaning fluid does not get into the inside of the lens. In such a case, the optics will have to be sent to ROFIN-SINAR for internal cleaning.

9. Before fitting the protective glass, apply high vacuum grease to four points on the thread of the focusing optics to prevent the protective glass from seizing.

Attention: Apply the grease extremely sparingly to prevent contamination of the focusing optics and the protective glass.

10. Insert the protective glass in the guide ring.

Note: Do not contaminate the protective glass while inserting it! Note the correct position of the protective glass in the guide ring!



Figure 7.23 Fitting the protective glass (3)



Figure 7.24 Set the focusing optics down

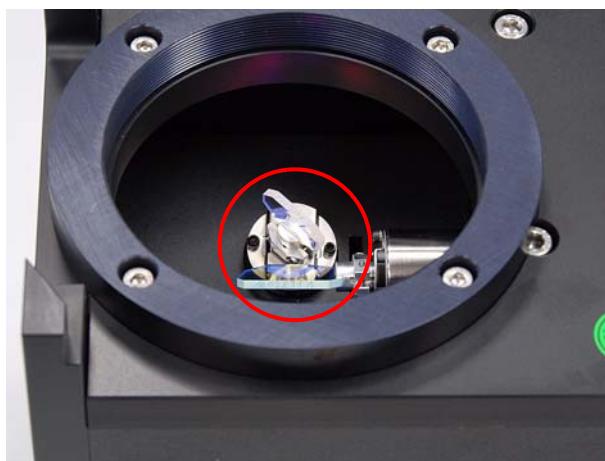


Figure 7.25 Checking to see if the deflecting mirror is clean

11. Screw the protective glass on to the focusing optics.

i **Note:** To check for correct seating of the protective glass, it must be ensured that there is no gap between the glass and the F-theta objective. "Rock" the focusing optics carefully. If there are any rattling noises, the protective glass is still loose.

12. Attach protective caps to the focusing optics and set them down.

13. Check to see if the deflecting mirror (Figure 7.25) is clean. Clean it if necessary (see page 37).



Figure 7.26 Fitting the focusing optics (1)



Figure 7.27 Fitting the focusing optics (2)



Figure 7.28 Protective cap for the focusing optics

14. Before fitting the focusing optics to the galvo head, apply high vacuum grease to four points on the thread of the focusing optics to prevent the optics from seizing.

Attention: *Apply the grease extremely sparingly to prevent contamination of the focusing optics and the interior of the galvo head.*

15. Screw the focusing optics back into the galvo head.

i Note: *In the process, reinsert the aluminum distance ring that may be present.*

16. Remove the adhesive tape from the galvo head and the laser head.
17. Remount the galvo head to the laser and connect it.

Attention: *Before starting up the laser system, check that the protective cap on the focusing optics (Figure 7.28) has been removed. If the laser system is switched on with the protective cap fitted, the cap will be damaged or destroyed!*



Figure 7.29 Setting the operating voltage (1)



Figure 7.30 Setting the operating voltage (2)
(supply cabinet)

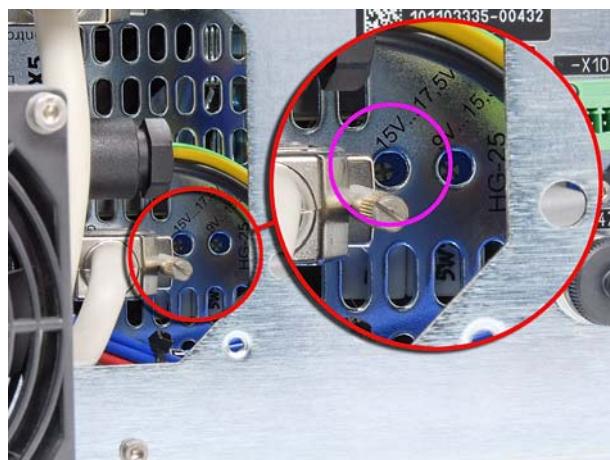


Figure 7.31 Setting the operating voltage (2)
(19"-plug-in)

18. Mount the measuring adapter (see Chapter 3) between the galvo head and the connecting cable.

Attention: Remove or insert the connecting cable of the galvo head only without tension!
In case of non-observance, the galvo head can be damaged!

19. Commission the laser system.
20. Measure the voltage (+15.5 V).

21. Set the operating voltage (+15.5 V) on the HN 80x using a small screwdriver. Setting precision: ± 0.2 V.

Note: The position of the potentiometer on the HN80x power supply is similar to Figure 7.30.



Figure 7.32 Setting the operating voltage (3)

22. Measure the voltage (-15.5 V).

i Note: The display of the minus value can have an offset to the set plus value.

23. Switch off the laser system.

24. Remove the measuring adapter.

! **Attention:** Remove or insert the connecting cable of the galvo head only without tension!

In case of non-observance, the galvo head can be damaged!

25. Commission the laser system.

26. Check the focal point of the laser and adjust it if necessary (see Section 6.3.2, page 119).

27. Check the field geometry/correction and load a new compensation file if necessary.

7.1.2 Protective glass

7.1.2.1 Galvo head with protective glass slide

1. Remove the protective glass mount from the protective glass slide.
2. Loosen the respective fastening of the protective glass and remove it.
3. Put and fix new protective glass in place.
4. Push the protective glass mount into the protective glass slide.



Note: When changing the protective glass, make sure that the new protective glass is installed on the right side.

7.1.2.2 Galvo head with protective glass screwed into the optics

1. Dismantle the galvo head.
2. Unscrew the focusing optics from the galvo head.
3. Unscrew the protective glass from the focusing optics.



Note: If the protective glass cannot be unscrewed: see page 135.

1. Insert a new protective glass and screw it on to the focusing optics.
2. Screw the focusing optics on to the galvo head.
3. Mount the galvo head.

7.1.3 Beam expander



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.

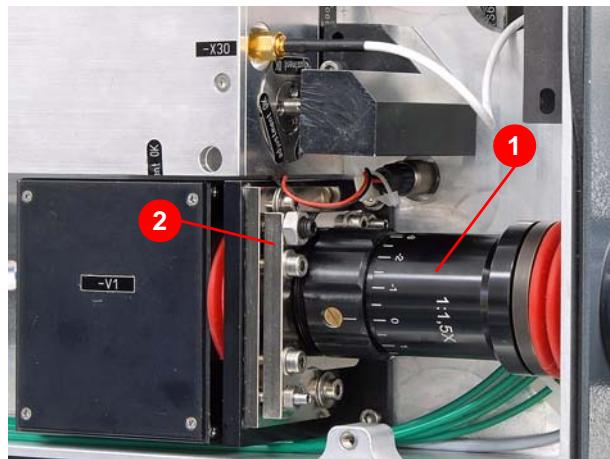


Figure 7.33 Dismantle the beam expander.

1. Open the lateral cover of the resonator side of the laser head.
2. Remove the beam expander (1) (Figure 7.33) and the mount (2).
3. Unscrew the beam expander from the mount.
4. Screw a new beam expander into the mount.
5. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.1, page 102).
6. Install the beam expander and the mount again; pay attention to the correct position of the bellows.



Attention: Do not crush or jam the cables and lines inside the laser head during installation!

7. Check the focal point of the laser and adjust it if necessary (see Section 6.3.2, page 119).
8. Mount the cover on the resonator side of the laser head.
9. Commission the laser system.

7.1.4 Deflecting mirror

7.1.4.1 Deflecting unit



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

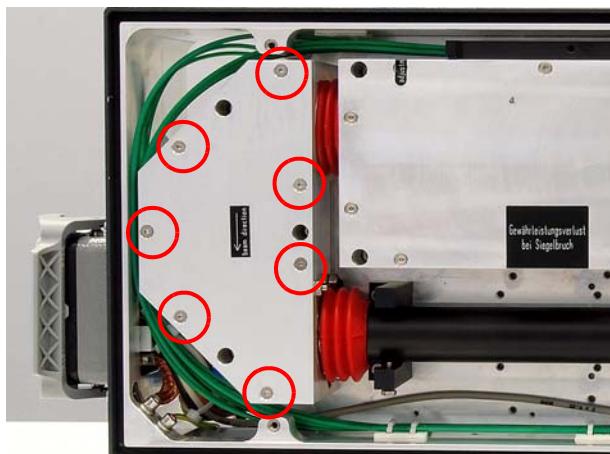


Figure 7.34 Cover of deflecting unit

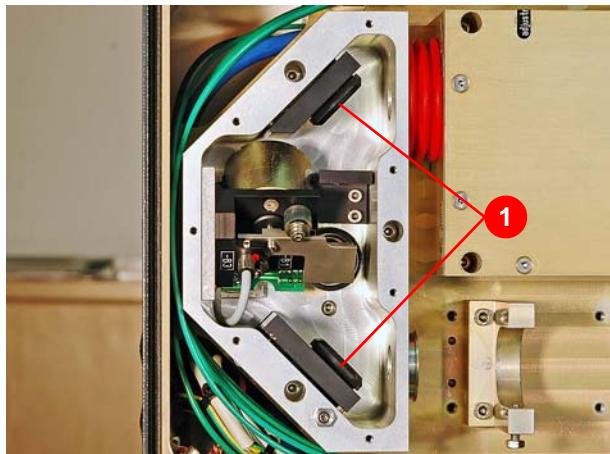


Figure 7.35 Removing the deflecting mirror

1. Open the lateral cover of the resonator side of the laser head.
2. Loosen the seven fastening screws on the cover of the deflecting unit.
3. Remove the cover.
4. Note the installation position of the mirror.

Note: An arrow on the mirror side indicates the side that is coated. The coating must always point toward the laser beam.

Deflecting unit with adjusting screws on the side of the cover

5. Unscrew the deflecting mirror (1) (Figure 7.35) and lay it on a clean foundation.

Attention: Do not use a tool to unscrew the deflecting mirror! A risk of damaging the deflecting mirror exists!

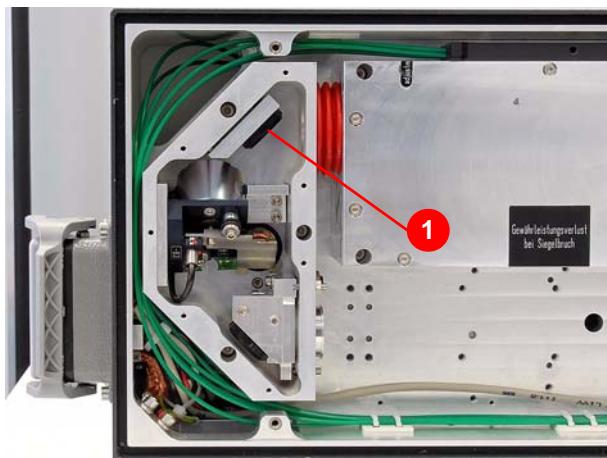


Figure 7.36 Removing the upper deflecting mirror

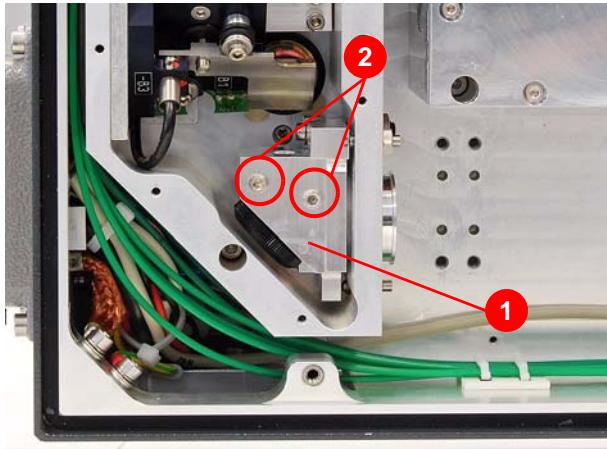


Figure 7.37 Removing the lower deflecting mirror (1)

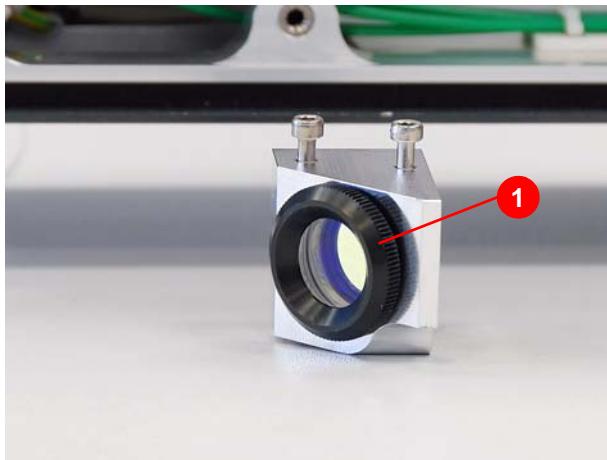


Figure 7.38 Removing the lower deflecting mirror (2)

Deflecting unit with adjusting screws on the beam output side

- Unscrew the upper deflecting mirror (1) (Figure 7.36) and lay it on a clean surface.

Attention: Do not use a tool to unscrew the deflecting mirror! There is a risk of damaging the deflecting mirror!

- Dismantle the retaining block (1) (Figure 7.37) for the lower deflecting mirror after first loosening the two fastening screws (2).

- Unscrew the upper deflecting mirror (1) (Figure 7.38) from the retaining block and lay it on a clean surface.

Attention: Do not use a tool to unscrew the deflecting mirror! There is a risk of damaging the deflecting mirror!

Note: After the mirror has been cleaned and reinserted, the retaining block must be pressed against the two milled edges and the screws tightened again.

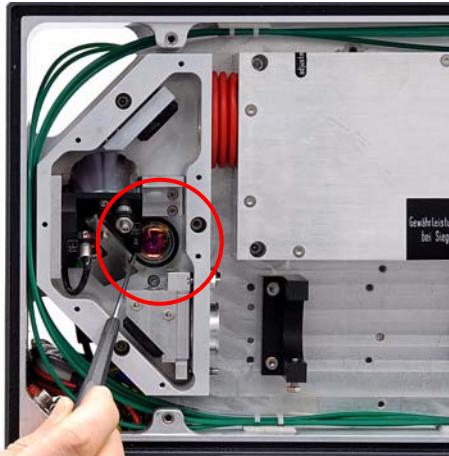


Figure 7.39 Lens of the measuring head or absorber

6. Swivel back the shutter mirror carefully so that you can reach the lens of the measuring head or absorber.

7. Unscrew the lens and lay it on a clean foundation.

i **Note:** If necessary to remove the lens, the complete deflecting unit and shutter module must be disassembled (see Section 7.2, page 146).

8. Clean the deflecting mirror, the lens, and the shutter mirror if necessary.

9. Reinstall the deflecting mirror and lens. Mount the cover of the deflecting unit.

i **Note:** An arrow on the mirror side indicates the side that is coated. The coating must always point toward the laser beam.

10. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.1, page 102).

11. Mount the cover on the resonator side of the laser head.

12. Commission the laser system.

13. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

i **Note:** Observe the 30 second settling time for the measuring equipment!

7.1.4.2 Alignment laser¹



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

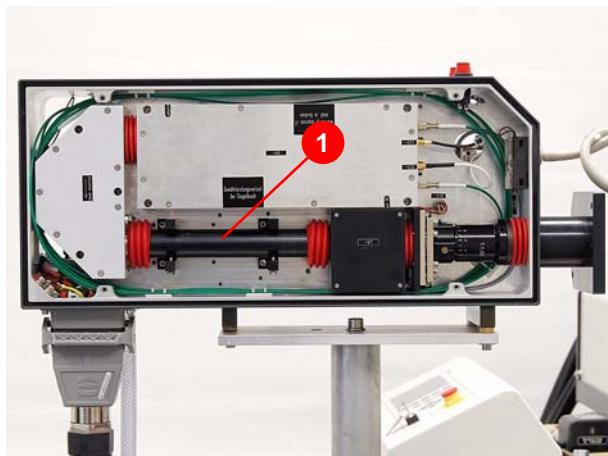


Figure 7.40 Dismantling the beam guide

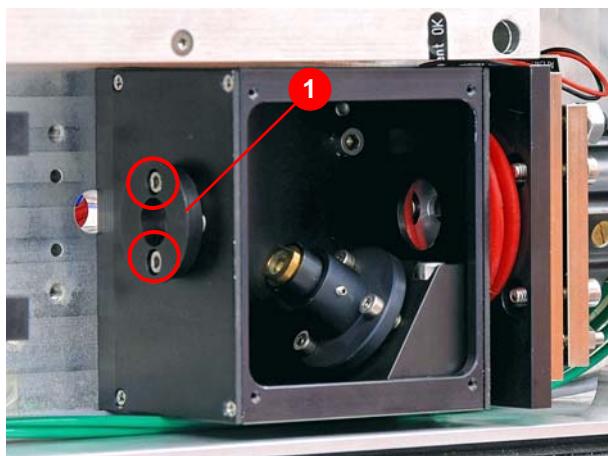


Figure 7.41 Alignment laser housing

1. Open the lateral cover of the resonator side of the laser head.
2. Remove the beam guide (1) (Figure 7.40) of the laser head.
3. Loosen the four fastening screws on the cover of the alignment laser.
4. Remove the cover.
5. Remove the coupling mirror (1) (Figure 7.41).
6. Clean the coupling mirror if necessary.
7. Clean the inside of the positioning laser housing.
8. Reinstall the coupling mirror.
9. Install the beam guide and pay attention to the correct position of the bellows.
10. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.3, page 122).
11. Mount the cover of the alignment laser housing.
12. Mount the cover on the resonator side of the laser head.
13. Commission the laser system.

1. Installation depends on the respective laser type

7.2 Changing the shutter module



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Note: After changing the shutter module, check the adjustment of the laser beam.

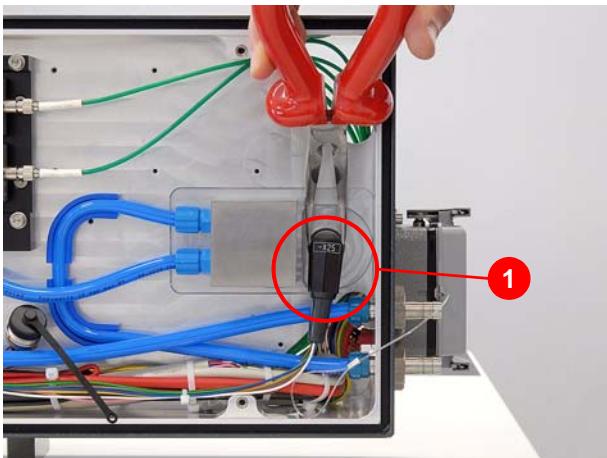


Figure 7.42 Shutter module connecting plug

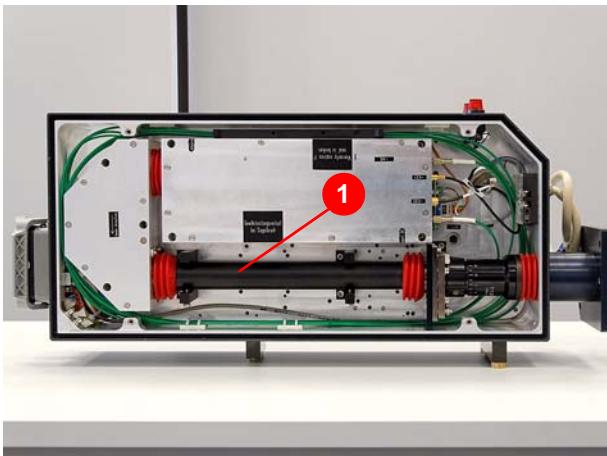


Figure 7.43 Dismantling the beam guide

1. Open both lateral covers of the laser head.
2. Remove the connecting plug (-X25) of the shutter module (1) (Figure 7.42) on the diode side of the laser head.

Attention: If the use of tools is necessary, do not apply force! Do not damage the connecting plug!

3. Remove the beam guide (1) (Figure 7.43) on the resonator side of the laser head.

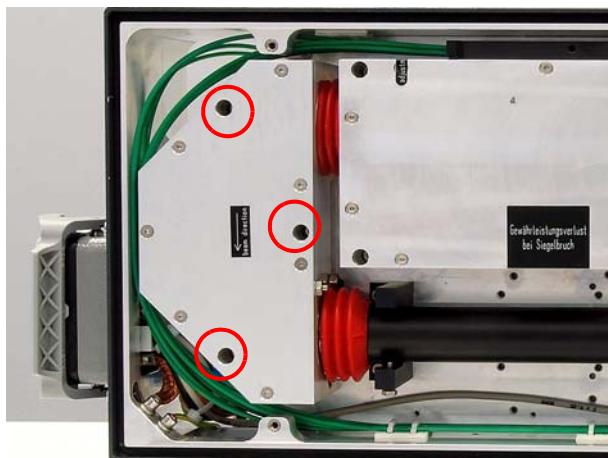


Figure 7.44 Deflecting unit fastening screws



Figure 7.45 Beam aperture of the resonator module



Figure 7.46 Cover of deflecting unit

4. Loosen the three fastening screws of the deflecting unit.
5. Pull the deflecting unit forward off the alignment pins and remove it.

6. Remove the bellows from the resonator module.
7. Cover the beam aperture of the resonator module with adhesive tape (tape to be used: see Chapter 3) to prevent the antireflection-coated outlet window of the resonator module from getting dirty.

8. Lay the deflecting unit on a clean foundation.

! **Attention:** Do not apply any pressure to the deflecting unit, to avoid damaging the connector on the underside.

9. Loosen the seven fastening screws on the cover of the deflecting unit.
10. Remove the cover.

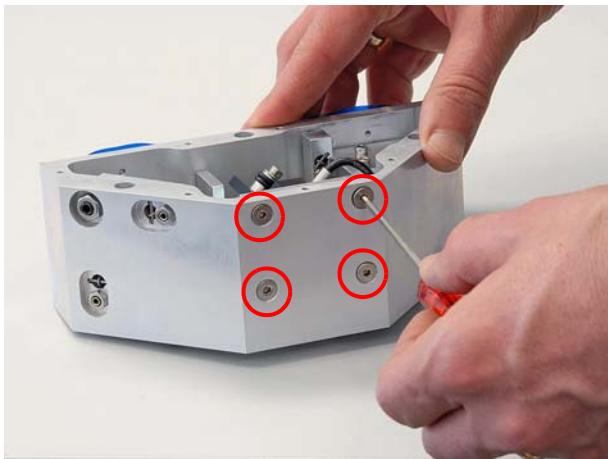


Figure 7.47 Loosening the shutter module

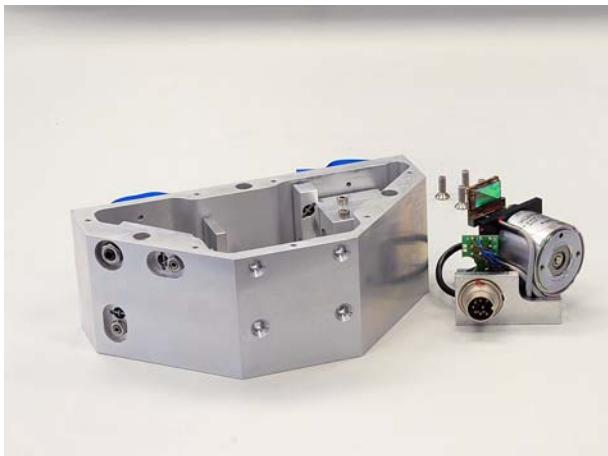


Figure 7.48 Removing the shutter module

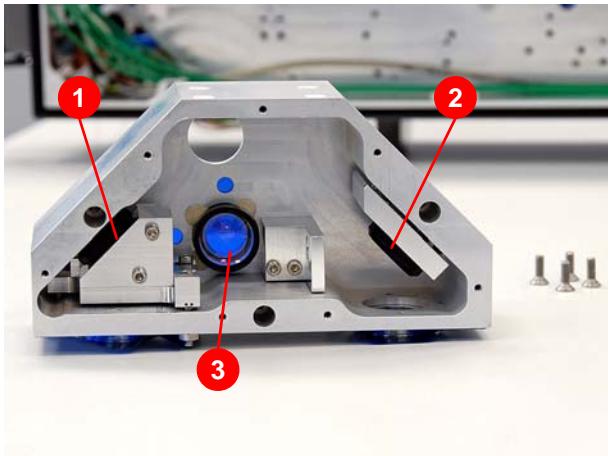


Figure 7.49 Deflecting mirror/lens in front of the internal power measurement or absorber

11. Loosen the four fastening screws of the shutter module.

12. Remove the shutter module.

13. Check the cleanliness of the deflecting mirrors (1 and 2) (Figure 7.49) and lens in front of the internal power measurement or absorber (3) in the deflecting unit. Clean as needed.

Note: To dismantle the deflecting mirror (1) it will first be necessary to remove its mount after loosening the two fixing screws.

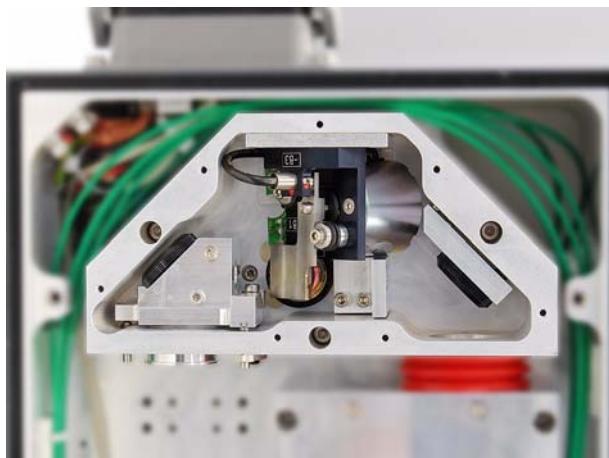


Figure 7.50 Inserting the shutter module

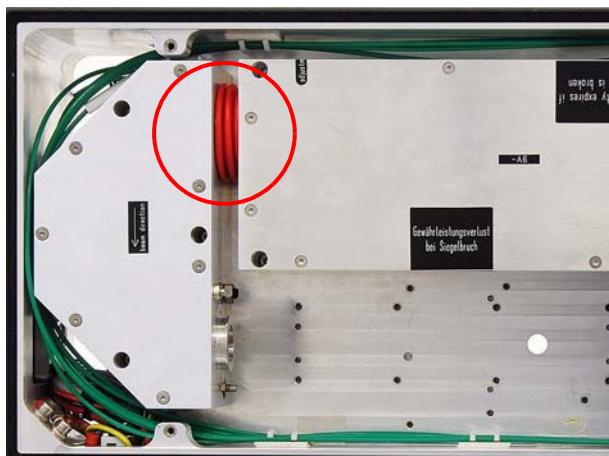


Figure 7.51 Installation of the deflecting unit

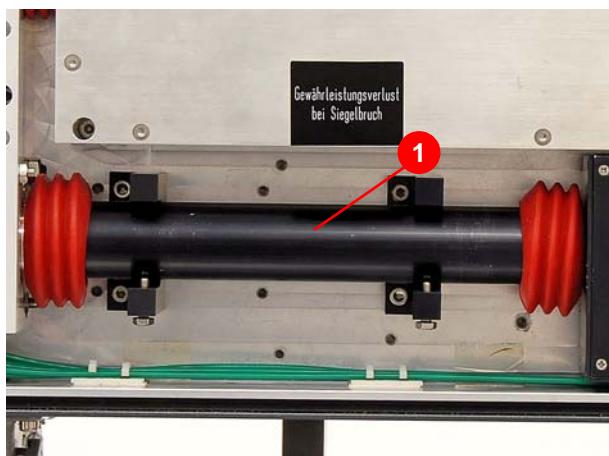


Figure 7.52 Installing the beam guide

Note: Before installation, check how clean the shutter mirror is. Clean it if necessary.

14. Insert a new shutter module into the deflecting unit and screw it into place.
15. Mount the cover of the deflecting unit.

16. Remove the tape from the beam aperture of the resonator module.
17. Insert the bellows between the deflecting unit and the resonator module, place the deflecting unit onto the alignment pins, and make sure the bellows are in the correct position.
18. Screw the deflecting unit into place; then insert the connecting plug (-X25) of the shutter module on the diode side of the laser head and screw it into place.

Attention: Tighten the connecting plug only by hand to prevent any damage to the thread due to the use of tools!

19. Check the adjustment of the laser beam (see Section 6.3, page 102)
20. Install the beam guide (1) (Figure 7.52) on the resonator side of the laser head and pay attention to the correct position of the bellows.
21. Mount both lateral covers of the laser head.
22. Commission the laser system.

7.3 Changing the resonator module



Note: The replacement of the resonator module for IR models is described below. Please observe the special messages for SHG models in Chapter 8.



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.



Note: The resonator module should be exchanged as a complete unit. Repair inside the resonator module may be performed only by ROFIN-SINAR. In case of non-observance, the warranty is no longer valid.



Note: After changing the resonator module, check the adjustment of the laser beam.



1. Open both lateral covers of the laser head.
2. Push highly absorbent paper (e. g. paper towels) underneath the resonator module to absorb any leaking cooling water.

Figure 7.53 Resonator module

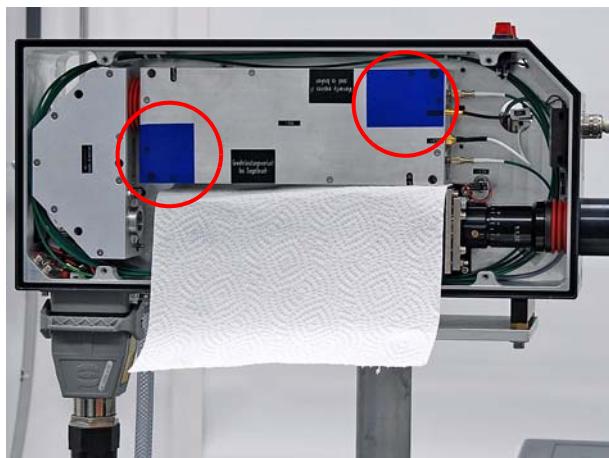


Figure 7.54 Loosen the fastening screws

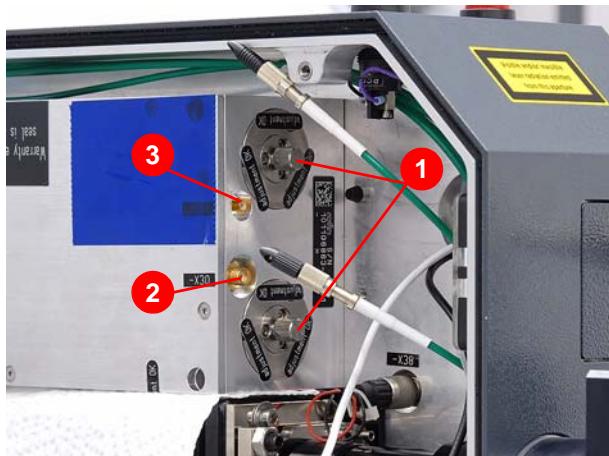


Figure 7.55 Disconnecting the resonator module

3. Loosen two fastening screws.
4. Fix adhesive tape (tape to be used: see Chapter 3) over the screw holes to prevent the screws from falling out during removal.

5. After first loosening the swivel nut **slowly withdraw** the glass fiber line(s), as dust particles might otherwise get on to the optical surfaces as a result of the suction arising.

Attention: In the process, do not use tools! Risk of damage!

Note: In the case of the PowerLine E/EL with two diodes, which has two glass fiber lines, mark the socket at which the respective glass fiber was connected. In this way, the lines are not mixed up, which can lead to malfunctions.

6. Attach dust protection caps to the glass fiber(s) and the connections on the resonator module (1) (Figure 7.55).

Note: A bag with dust protection caps and short-circuit bridges is located on the diode side of the laser head (Figure 7.56). Reattach the bag with dust protection caps and short-circuit bridges there when work is completed.

7. Disconnect the SMA plug of the HF line (2) (Figure 7.55) and the SMB plug of the Q-Switch interlock line (3).

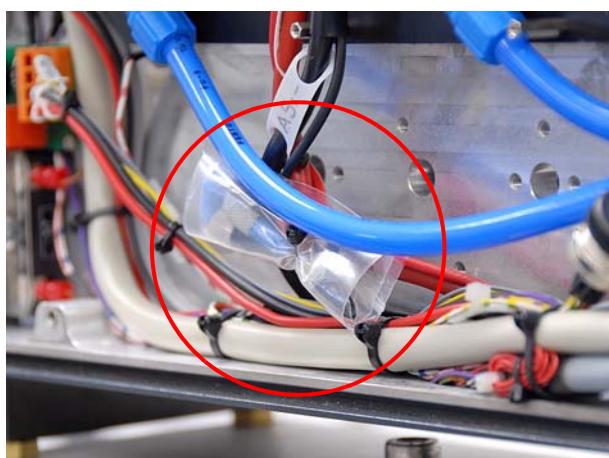


Figure 7.56 Dust protection caps and short-circuit bridges

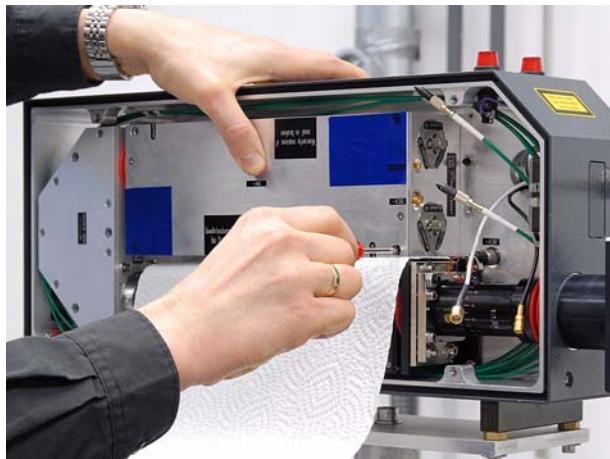


Figure 7.57 Loosening the resonator module



Attention: With systems that have a cooler that is installed **above** the laser head, take measures in advance to ensure that the water cycle is interrupted at the laser head (e. g. by installing the corresponding stainless steel valves, etc.) to prevent cooling water from continuing to flow.

8. Loosen the remaining two fastening screws of the resonator module. Tip the resonator module 1 to 2 mm to the rear in a slanted manner so that the module is aerated (a suction noise occurs).



Note: Hold the resonator module securely to prevent it from tipping out and thus losing cooling water in an uncontrolled manner.

9. Pull the resonator module off the alignment pins and then tip it out as shown in Figure 7.58 to prevent the cooling water remaining in the resonator module from spilling. In the process, secure the fastening screws from falling out as well.



Note: Clean up any cooling water that leaks with highly absorbent paper (e. g. paper towels). In the process, check the diode side of the laser head for leaking cooling water as well.

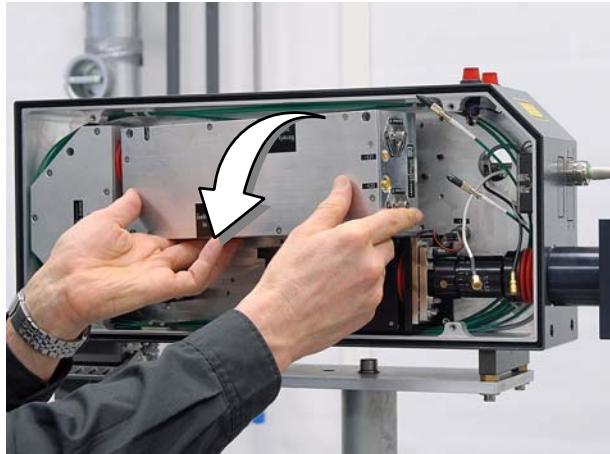


Figure 7.58 Removing the resonator module

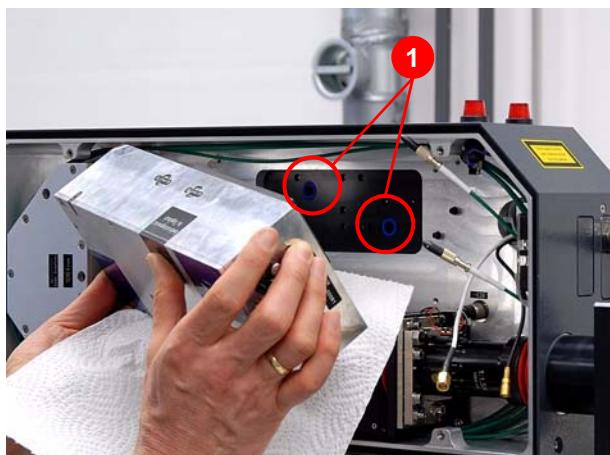


Figure 7.59 O-rings

10. Remove the O-rings (1) (Figure 7.59).

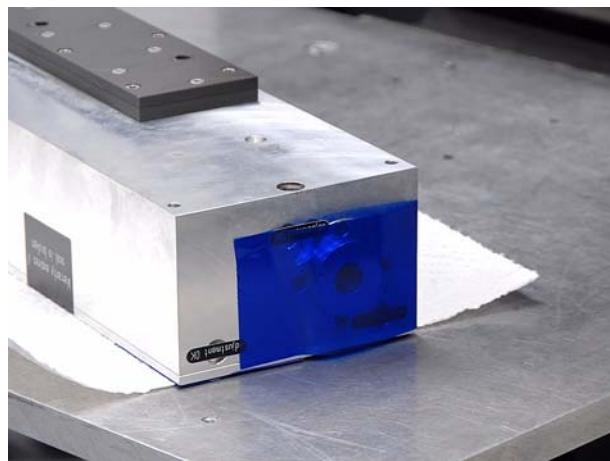


Figure 7.60 Beam aperture of the resonator module

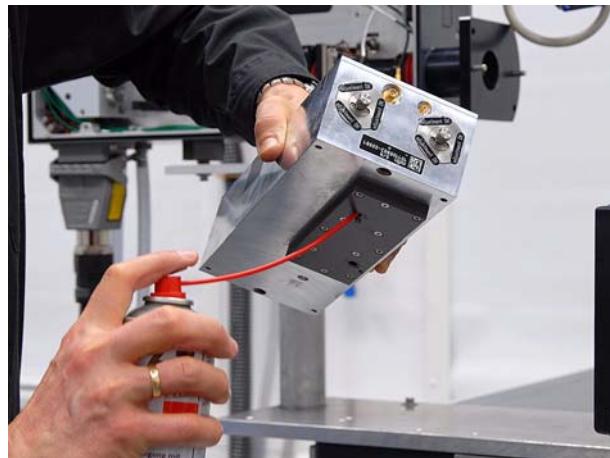


Figure 7.61 Blowing out the cooling water line

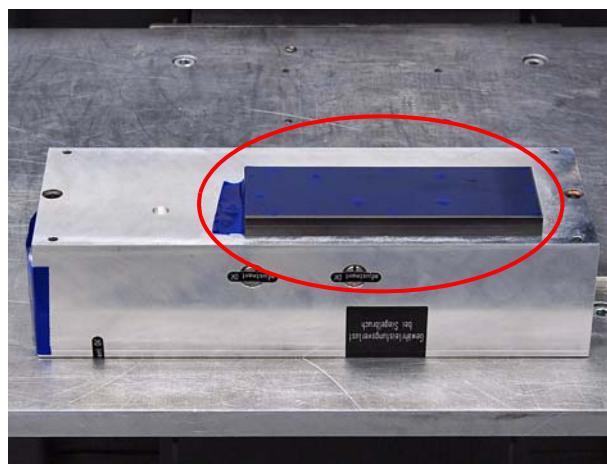


Figure 7.62 Closing the cooling water connection

11. Cover the beam aperture of the resonator module with adhesive tape (tape to be used: see Chapter 3) to prevent the antireflection-coated outlet window of the resonator module from getting dirty.

12. Blow out the cooling water line using purified, oil-free compressed air (**1 - 2 bar**), compressed air from a can or nitrogen (N_2) (**1 - 2 bar**). Cooling water remaining in the resonator module can lead to corrosion or, e. g. in case of transportation during freezing weather, damage.

Attention: There is a risk of suffocation in case the nitrogen concentration in the ambient air is too high! Never exceed the permissible limit values!

13. Cover the cooling water connection with adhesive tape (tape to be used: see Chapter 3), to prevent the inside of the resonator module from getting dirty.

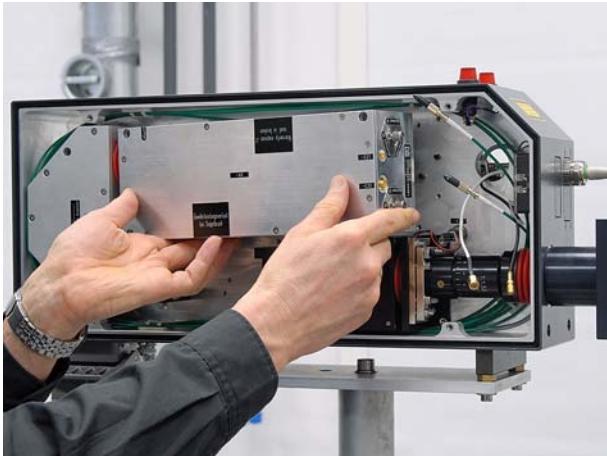


Figure 7.63 Inserting the resonator module

14. Insert new O-rings (provided together with the new resonator module) into the cooling water connections in the laser head.

Attention: Contamination of the "O-ring seats" / "O-ring grooves" and the O-rings themselves must be avoided. Make also sure the o-rings are positioned correctly.

Attention: Before the installation of the resonator module make sure that all tape (beam aperture, cooling water inlet) is removed again. In case of non-observance, severe damage to the laser (risk of fire, blocked cooling water flow) may result.

Attention: When installing the new components, make sure that the fibers and the lines to the pilot laser are not pinched!

15. Push the resonator module onto the alignment pins.
16. Fit the fixing screws enclosed with the new resonator module and tighten them crosswise to a torque of **2 Nm (200 Ncm)**.
17. Remove the dust cap(s) from the resonator module and the glass fiber line(s) and connect the glass fiber(s) (1) (Figure 7.64).

Attention: In the process, do not use tools! Risk of damage!

Note: In the case of the PowerLine E/EL with two diodes, pay attention to the correct connection of the respective glass fibers. The glass fibers must be remounted as they were connected prior to replacing the resonator module (serial number, identification). Reattach the bag with dust protection caps and short-circuit bridges to the diode side of the laser head when work is completed (see Figure 7.56, page 151).

18. Connect the SMA plug of the HF line (2) and the SMB plug of the Q-switch interlock line (3).

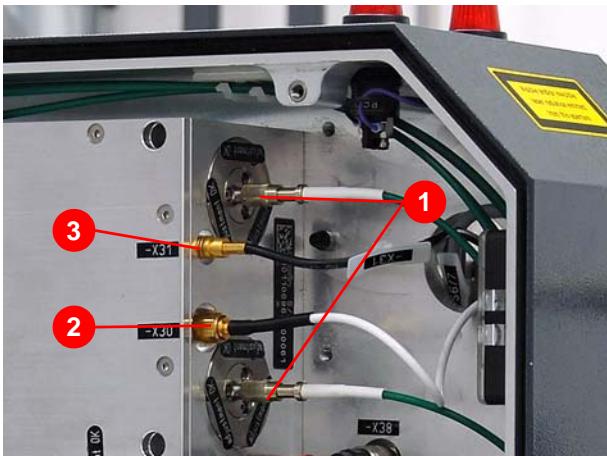


Figure 7.64 Connecting the resonator module



Figure 7.65 Interlock switch bridged

19. Bridge the interlock switch (Figure 7.65).

! Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

20. Secure the shutter against activation.

! Attention: Take measures for protection against laser radiation (see page 150)!

21. Insert the mains plug of the laser system and switch on the main switch.

! Attention: If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

! Attention: With systems where the cooler is installed **above** the laser head, open the water cycle.

22. Switch on the cooling unit for about a minute and perform a leakage check of the cooling circuit in the vicinity of the resonator module and on the diode side.

! Attention: Take measures for protection against laser radiation (see page 150)!

! Attention: In case of cooling water leakage, the laser system must be shut down immediately using the emergency stop button/main switch.

i Note: In addition to a visual inspection, the use of highly absorbent paper is recommended when checking for leaks.

23. Turn off the main switch and eliminate the leaks if necessary.

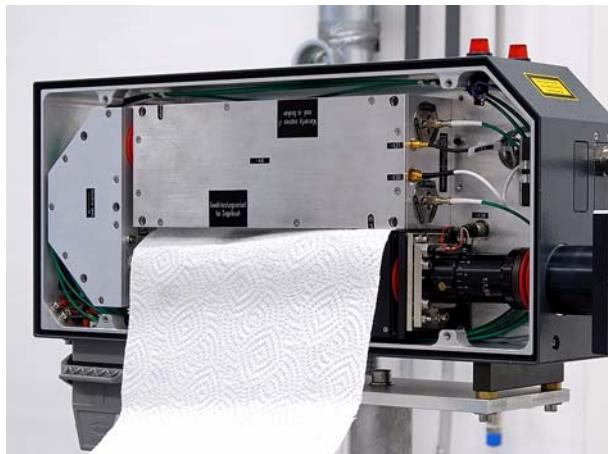


Figure 7.66 Leakage check

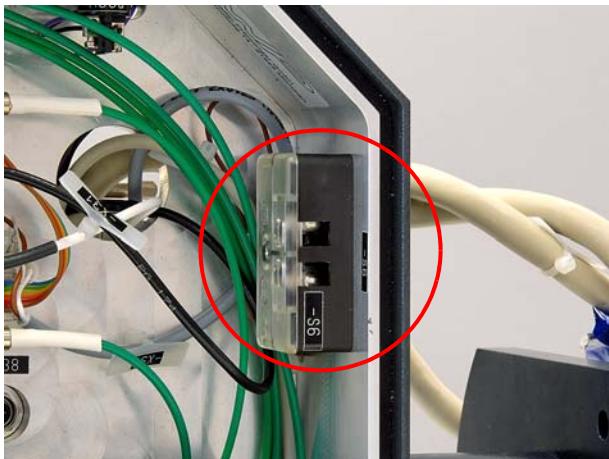


Figure 7.67 Interlock switch

24. Check the adjustment of the laser beam (see Section 6.3, page 102)
 25. Remove the bridge from the interlock switch.
 26. Mount the cover on the resonator side of the laser head.
 27. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.
- i** *Note: Observe the 30 second settling time for the measuring equipment!*
28. Commission the laser system.
 29. After an hour's operation of the laser system, shut down the system, open both lateral covers of the laser head, and perform another leakage check.
 30. Check the laser leakage power of the HF generator (see Section 7.6.5, page 184 or Section 7.6.6, page 187).

7.4 Changing the diode module



Attention: Switch off the laser system and secure it against reactivation. **Pull the mains plug only if the correct grounding of the laser system continues to be guaranteed.** The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: The required disconnection of the power supply prior to opening system components will also disconnect the grounded conductor! This also applies to the disconnection of the plug on the laser head (e. g. only required when removing the laser head for space reasons; do not damage pins in the connection plug)!
The laser head must be grounded with suitable measures before working on diodes! The external grounding must be performed at a marked PE clamp of the laser head and a marked PE clamp in the system area! The correct equipotential bonding must be checked using measuring technology! The ESD wrist band must then be connected to a PE clamp of the laser head!
Before that, the diode modules may not be disconnected!



Attention: All persons working on diode modules must comply with the measures for the protection of electrostatic sensitive devices (ESD)! The work area must be secured!



Attention: When the connecting lines are removed, touching the connecting terminals can lead to the destruction of the diode! This also applies to disconnecting the connecting lines on the power supply unit! Immediately after disconnection, diodes must be short-circuited by a person equipped in accordance with the relevant ESD regulations!



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.
The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.



Note: The new diode module is sent when ordered. The transport container is to be used for the return of the old diode module.



Note: If it is still possible, measure/check the laser power after the protective glass of the galvo head using the power measurement device before changing the diode module (see Section 5.4, page 67). Enter the measured value in the logbook.

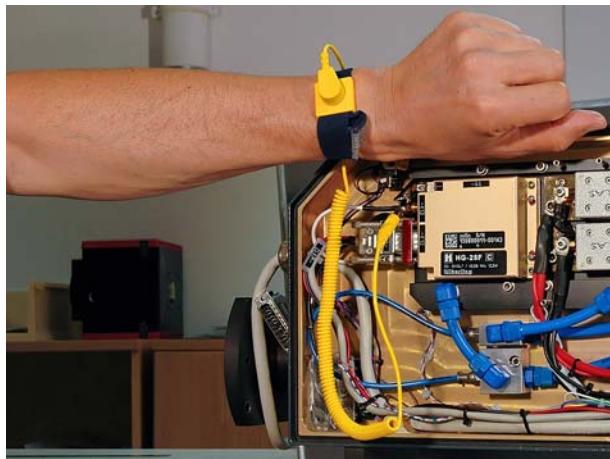


Figure 7.68 Performing equipotential bonding

Preparatory tasks

! *Attention: Pull the mains plug and connecting plug on the laser head only if the correct grounding of the laser system continues to be guaranteed.*

Procedure in case the mains plug cannot be pulled:

- Secure the main switch against reactivation with a padlock, for example.

Changing the diode module

! *Attention: Components at risk from static electricity (ESD)! The diode module may be changed only after equipotential bonding has been performed!*

1. Open the cover of the diode side of the laser head (slanted corner located on the left).
2. Put on the grounding strap and securely fasten the terminal of the ground cable to a port in the laser head marked with \oplus .

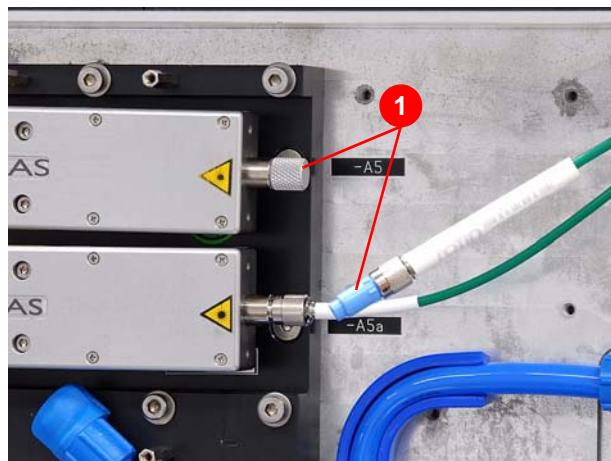


Figure 7.69 Disconnecting the glass fiber line from the diode module

3. Remove the protective cover on the diode module(s).
4. After first loosening the swivel nut **slowly withdraw** the glass fiber line(s), as dust particles might otherwise get on to the optical surfaces as a result of the suction arising.

! **Attention:** In the process, do not use tools! Risk of damage!

i **Note:** In the case of the PowerLine E/EL with two diodes/two glass fiber lines, mark the socket to which the respective glass fiber was connected. In this way, the lines are not mixed up, which can lead to malfunctions. **In the case of the PowerLine E/EL with two diodes, the diode modules must always be replaced in pairs.**

5. Attach dust protection caps to the glass fiber(s) and the sockets on the diode module (1) (Figure 7.69).

! **Attention:** It is essential to remove the dust cap from the fiber before switching on, as the fiber will otherwise be damaged during the power measurement.

i **Note:** A bag with dust protection caps and short-circuit bridges is located on the diode side of the laser head (Figure 7.70). Reattach the bag with dust protection caps and short-circuit bridges there when work is completed.

6. Remove the short-circuit bridge from the bag and keep it at hand.

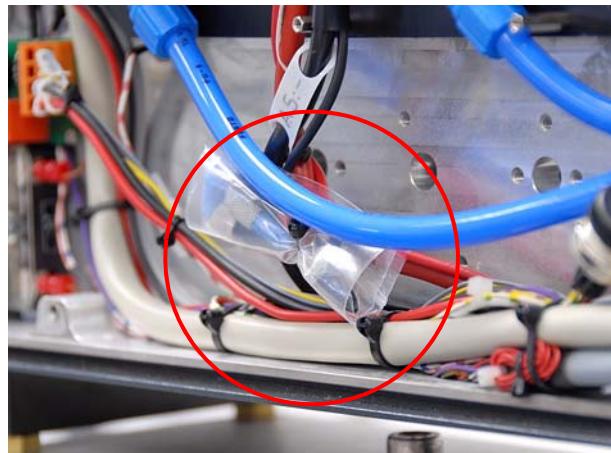


Figure 7.70 Dust protection caps and short-circuit bridges



Figure 7.71 Short-circuit bridge on the housing

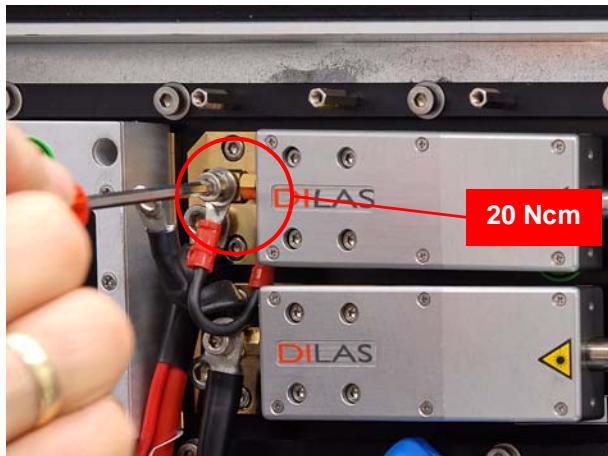


Figure 7.72 Short-circuit bridge on the connecting terminal



Figure 7.73 Loosen the fastening screws

7. Screw the short-circuit bridge to the housing of the diode module (maximum torque: **20 Ncm**).

8. Disconnect the diode module and screw the short-circuit bridge to the connecting terminal (maximum torque: **20 Ncm**).

Attention: In the case of the PowerLine E/EL with two diodes, touching the connecting terminals of the second diode without applied equipotential bonding can lead to the destruction of the diode!

9. Loosen the fastening screws of the diode module.

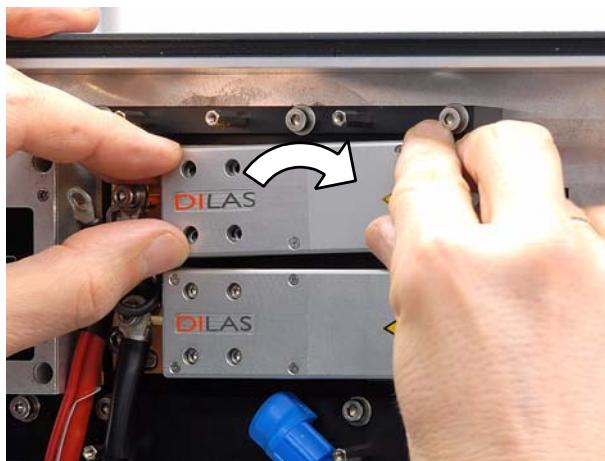


Figure 7.74 Loosening the diode module



Figure 7.75 "Diode module" exchange set

10. Loosen the diode module by turning it.

11. Keep the "Diode module" exchange set (Item No. depends on the laser type) at hand.
Contents:
 - Plastic scraper (plastic card)
 - Graphite film
 - Diode module
 - Short instruction
 - Diode module data sheet
 - Plastic bag with 4 M 2.5 x 18 screws
 - Plastic bag with 4 M 2.5 x 20 screws (labeled with an "L" sticker)
 - Cable binding strip

i **Note:** The exchange set will be provided by ROFIN-SINAR depending on your system. Compare the article number of the dismantled module with the new one. Contact ROFIN-SINAR in case of any questions.

! **Attention:** The user instructions for the exchange set – the safety instructions in particular – must be followed without exception!

12. Remove the plastic scraper.

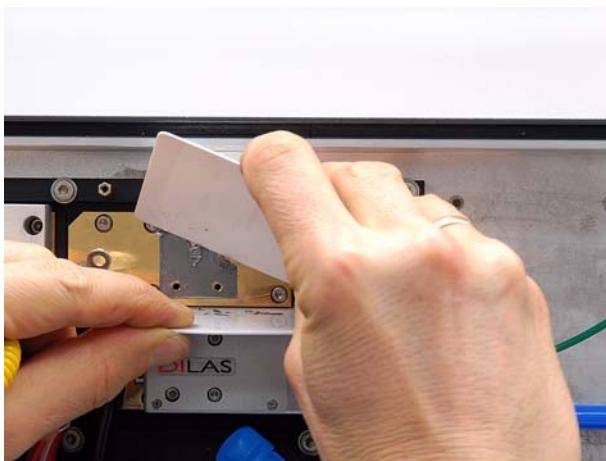


Figure 7.76 Removing the residual graphite



Figure 7.77 Isopropyl alcohol/lens cleaning paper

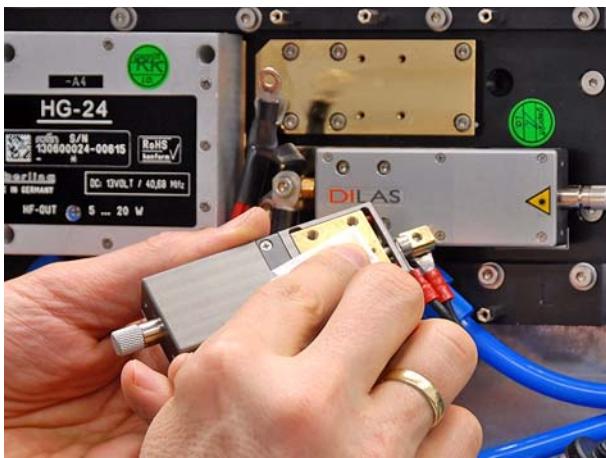


Figure 7.78 Cleaning the cooling surface of the diode module

13. Clean residual graphite off the cooling surface with plastic and collect the rubbings.

Attention: Only use a plastic scraper to remove the residual graphite! Do not scratch the cooling surface!

14. Clean the cooling surface in the laser head using lens cleaning paper and isopropyl alcohol. This makes a later adhesion of the graphite film more difficult.

15. Clean the cooling surface of the new diode module in the same way.

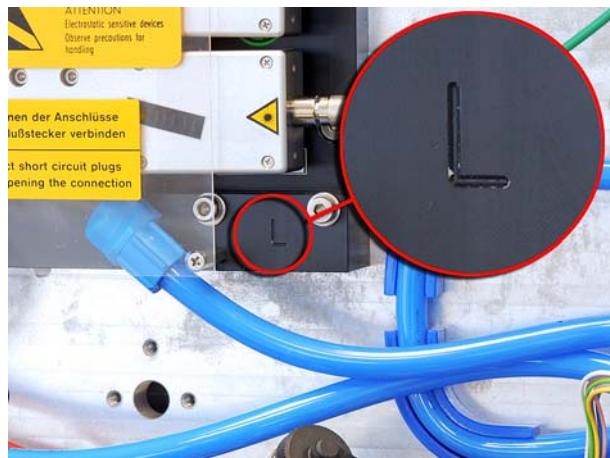


Figure 7.79 Cooling block identification



Figure 7.80 Applying graphite film



Figure 7.81 Inserting the diode module/
positional control of the graphite film

Attention: **M 2.5 x 20 mm**
fastening screws must always be used on
cooling blocks identified with "D" or "L".
On cooling blocks **without any**
identification, **M 2.5 x 18 mm** fastening
screws must always be used!
Longer screws can damage the cooling
surfaces in the laser head, which can lead
to water escaping, while shorter screws
will result in inadequate fastening!

16. Apply the graphite film on the right side using tweezers.

Attention: Do not bend the graphite film! In case the film is bent, electrical and thermal contact may be insufficiently established!

17. Fix the position of the graphite film using two fastening screws.

Attention: Always use fastening screws that correspond to the identification on the cooling block (see page 163)! Longer screws can damage the cooling surfaces in the laser head, which can lead to water escaping, while shorter screws will result in inadequate fastening!

18. Insert the diode module and slightly tighten the fastening screws.

19. Make sure that the graphite film does not slip during the insertion of the diode module.

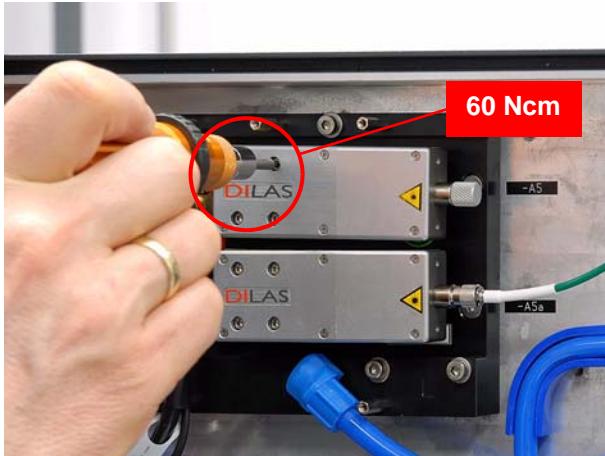


Figure 7.82 Screwing the diode module tight

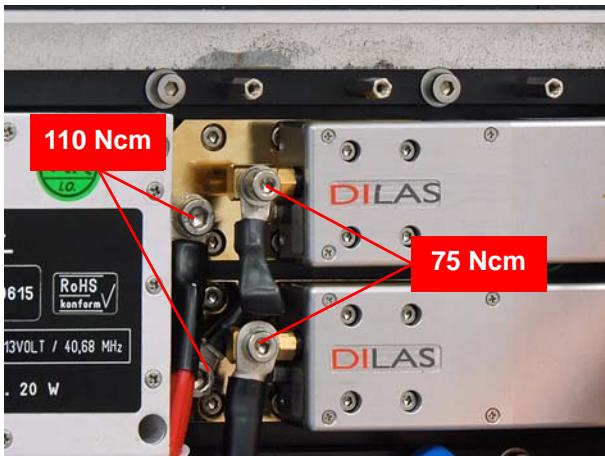


Figure 7.83 Connecting the diode module

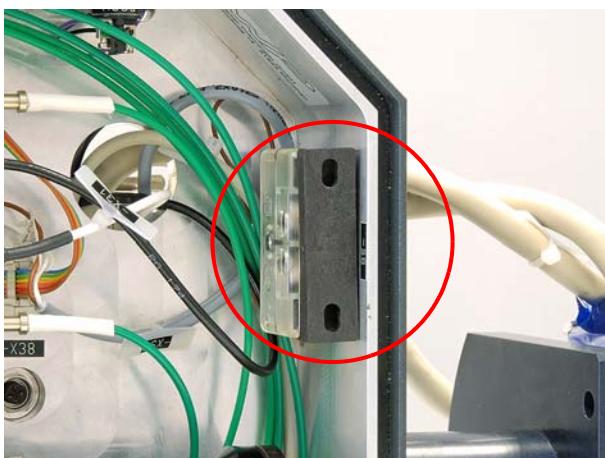


Figure 7.84 Interlock switch bridged

20. Insert the remaining two fastening screws.

21. Tighten the fastening screws crosswise with a maximum tightening torque of **60 Ncm**.

22. Remove the short-circuit bridge from the connection and connect the diode module (maximum torque: minus contact on diode module **75 Ncm**). Use a lock washer to secure against loosening.

Attention: Loose connections result in high contact resistance and can cause damage.
Due to contact resistance, do not use washers or other materials between the cable lug and the cooling plate/connection.

23. Unscrew the short-circuit bridge from the housing of the diode module and retighten the fastening screw slightly.

24. Bridge the interlock switch (Figure 7.84).

Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision!
Production while the interlock switch is bridged is fundamentally prohibited!

25. Secure the shutter against activation.

Attention: Take measures for protection against laser radiation (see page 157)!

26. Insert the mains plug of the laser system, mount the shaft of the main switch if necessary, and switch on the main switch.

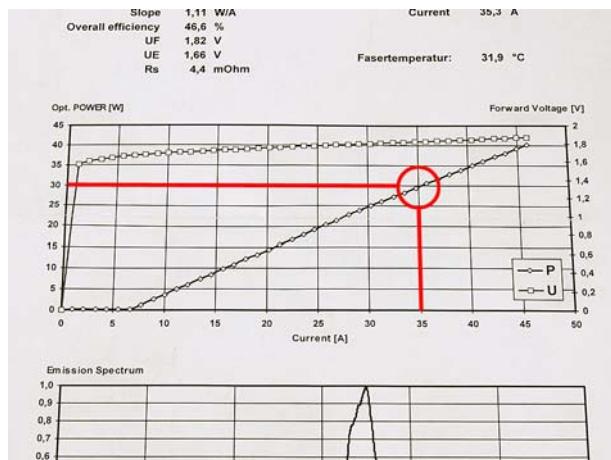


Figure 7.85 Diode module characteristic (example)

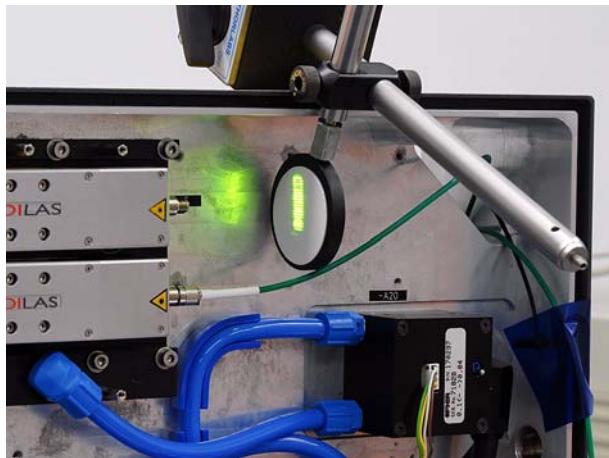


Figure 7.86 Checking the diode module

27. From the graph accompanying the diode module, read off the current at which a diode power of 30 W is achieved.

Attention: Under no circumstances may this current be exceeded during setup! A risk of damaging the resonator module exists!

Attention: If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

28. Using suitable means, fix the transducer disk to the output of the diode module (Figure 7.86).

Attention: Under no circumstances operate the laser system without the transducer disk fitted! The fiber(s) behind it might otherwise be damaged!

29. Remove the dust caps from the diode module and the fiber.
30. Fix the fiber with adhesive tape so that it points downwards and place material below the fiber to absorb the laser radiation.

Attention: The laser beam must be prevented from harming persons or irradiating flammable materials.

Attention: Wear protective goggles that guarantee protection at wavelengths of 532 nm/806 nm/1064 nm.

31. Operate the laser system at a current of approx. 10 to 12 A.
32. The diode module must project 18 lines on to the transducer disk.
33. Reduce the diode current to 6 A and remove the transducer disk.

Attention: To prevent the laser beam from causing damage to the interior of the laser head, the diode current must be reduced to 6 A before the transducer disk is removed!



Figure 7.87 Diode module output measurement

34. Measure the output of the diode module.

! **Attention:** Hold the measurement head at slight angle when doing this (see Figure 7.87), to prevent reflections and hence damage to the diode module.

i **Note:** Observe the 30 second settling time for the measuring equipment! To avoid incorrect results, do not move the measurement head during measurements.

i **Note:** If there is not sufficient space to position the measurement head in front of the diode modules, it will be necessary to proceed according to Section 5.4.6.2, page 81 (replacing the fibers).

35. Switch off the laser system.

36. Remove the bridge from the interlock switch.

37. Connect the glass fiber line (Figure 7.88).

! **Attention:** In the process, do not use tools! Risk of damage!

i **Note:** In the case of the PowerLine E/EL with two diodes, pay attention to the correct connection of the respective glass fibers. The glass fibers must be remounted as they were connected prior to replacing the diode module (serial number, identification). Reattach the bag with dust protection caps and short-circuit bridges to the diode side of the laser head when work is completed (see Figure 7.70, page 159).

38. **Applicable only to the PowerLine E/EL with two diodes:** Replace the second diode module.

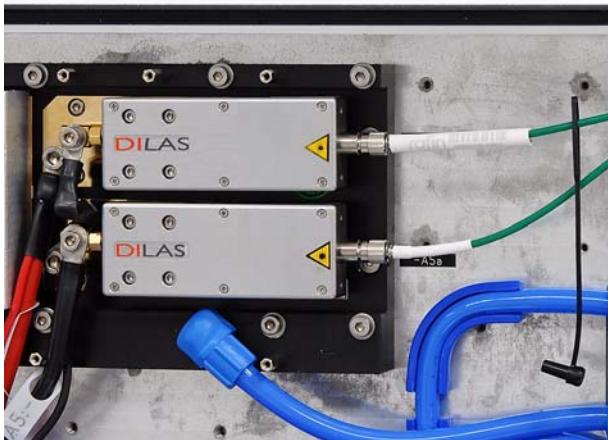


Figure 7.88 Connecting the glass fiber



Figure 7.89 Interlock switch bridged

39. Bridge the interlock switch (Figure 7.89).

! **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

40. Secure the shutter against activation.

! **Attention:** Take measures for protection against laser radiation (see page 157)!

41. Insert the mains plug of the laser system, mount the shaft of the main switch if necessary, and switch on the main switch.

! **Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

42. Commission the laser system for about ten minutes at maximum current.

43. Measure the power after the deflecting unit in CW mode.

i **Note:** Observe the 30 second settling time for the measuring equipment!

i **Note:** Limit the output according to the "Laser Type - Output" table on Page 69.

! **Attention:** The current limit for an output power of 30 W from the diode module must not be exceeded! Should it not be possible to achieve the power for the particular laser type using the appropriate current, the power must be checked after the fiber (see Section 5.4.6.1, page 78).

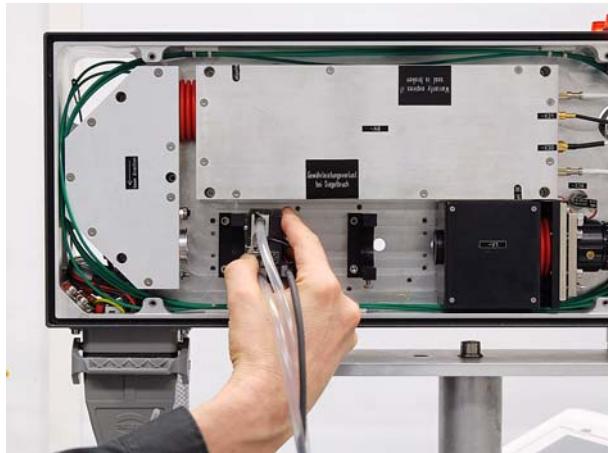


Figure 7.90 Measuring the power after the deflecting unit

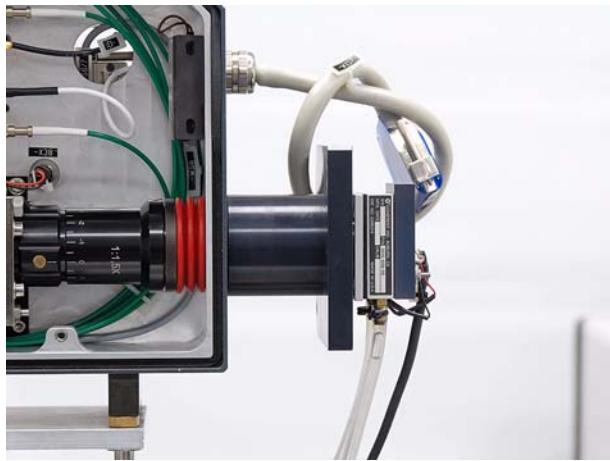


Figure 7.91 Power measurement at the galvo flange

44. Measure the output at the galvo flange.

i Note: Observe the 30 second settling time for the measuring equipment!

i Note: The loss of power should not be more than 1 W compared to the previous measurement point. If the losses are greater, the optical components must be checked.

45. If the loss in power is within tolerance, the current should be increased carefully until the output power at the galvo flange is correct.

! **Attention:** The current limit for an output power of 30 W from the diode module must not be exceeded!

46. Set the laser power (e. g. LCP/MCT) (see "Laser type - output" on Page 69).

47. Check the temperature at the coupling between the diode module and glass fiber (max. **60 °C**).

i Note: When the maximum temperature is exceeded, check the connection of the glass fiber. It is possible that the diode module must be replaced or the glass fiber exchanged.



Figure 7.92 Temperature check

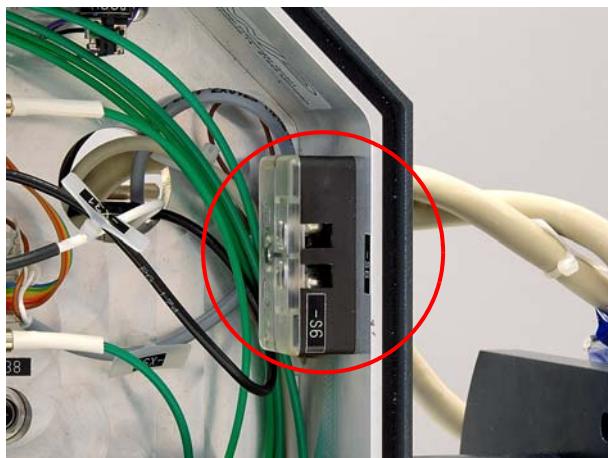


Figure 7.93 Interlock switch

48. Remove the bridge from the interlock switch.
49. Mount the cover on the diode side of the laser head.
50. Enter the operating hours of the laser system and the time of the diode change in the logbook.
51. Commission the laser system.
52. Measure the laser power after the galvo head.

i **Note:** Observe the 30 second settling time for the measuring equipment!

i **Note:** The loss of power should not be more than 0.5 W compared to the measurement point at the galvo flange. If the losses are greater, the galvo head must be checked.

i **Note:** After the change of the diode module, perform a comparative measurement of the laser power with the same laser parameters as before the change at the same measuring point. A power increase should be able to be determined.
With a new diode module, functioning glass fibers, a functioning resonator module, and perfect optical components, the following power values should be reached according to the "Laser type - power" table on Page 69. Enter the measured values in the logbook.

i **Note:** If no power increase is determined, the power of the laser diodes should be measured at the end of the fiber (see Section 5.4.6, page 78).

7.5 Changing glass fiber lines



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.



Attention: When working with open fiber ends, ensure utmost cleanliness.



Note: An inspection device for the fiber end surfaces is available from ROFIN-SINAR.



Note: Before changing glass fiber lines, measure/check the laser power behind the protective glass of the galvo head using the power measurement device (see Section 5.4, page 67). Enter the measured value in the logbook.

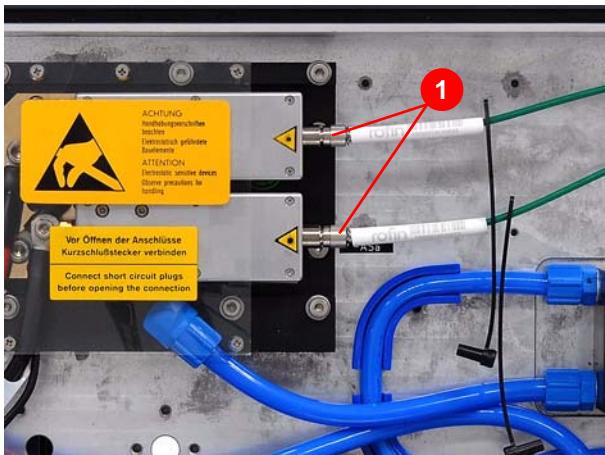


Figure 7.94 Disconnecting the glass fiber line from the diode module

1. Open both lateral covers of the laser head.

i Note: In the case of the PowerLine E/EL with two diodes/two glass fiber lines, mark the socket to which the respective glass fiber was connected. In this way, the lines are not mixed up, which can lead to malfunctions. Both glass fiber lines should be removed if necessary since the lines are laid in common holding clamps.

2. Disconnect the glass fiber line from the diode module (1) (Figure 7.94).
3. After first loosening the swivel nut **slowly withdraw** the glass fiber line(s), as dust particles might otherwise get on to the optical surfaces as a result of the suction arising.

! **Attention:** In the process, do not use tools! Risk of damage!

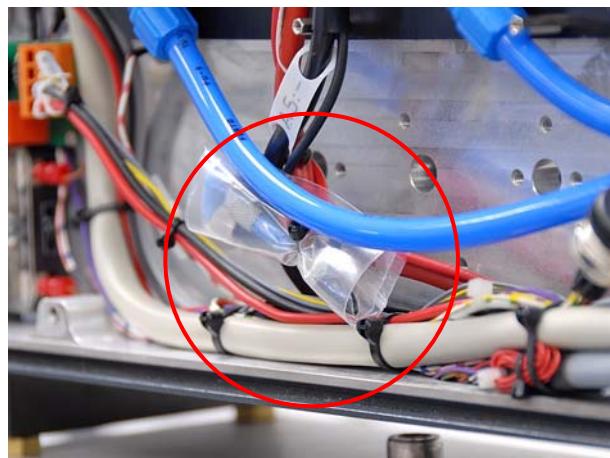


Figure 7.95 Dust protection caps and short-circuit bridges

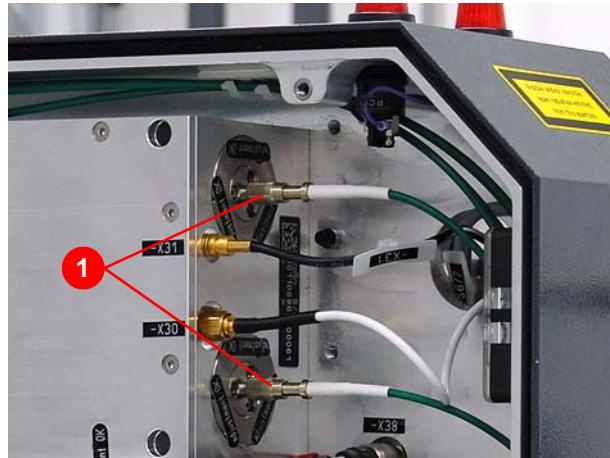


Figure 7.96 Disconnecting the glass fiber line from the resonator module

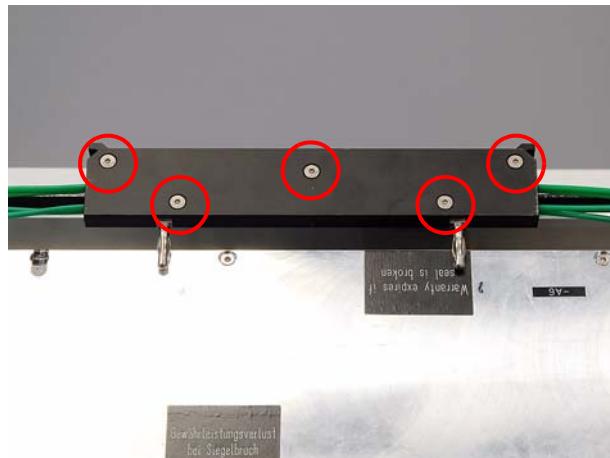


Figure 7.97 Fiber anchor

i **Note:** A bag with dust protection caps and short-circuit bridges is located on the diode side of the laser head (Figure 7.95). Reattach the bag with dust protection caps and short-circuit bridges there when work is completed.

4. Attach dust protection caps to the glass fiber(s) and the sockets on the diode module.

5. Disconnect the glass fiber line from the resonator module (1) (Figure 7.96).
6. After first loosening the swivel nut **slowly withdraw** the glass fiber line(s), as dust particles might otherwise get on to the optical surfaces as a result of the suction arising.

! **Attention:** In the process, do not use tools! Risk of damage!

7. Attach dust protection caps to the glass fiber(s) and the sockets on the resonator module.
8. Pull back the glass fiber lines from the diode side of the laser head to the resonator side.
9. If fitted, pull the fiber anchor (Figure 7.97) from the mounts above the resonator module, open it and take out the fibers.
10. Remove the glass fiber lines from the holding clamps and roll them up.

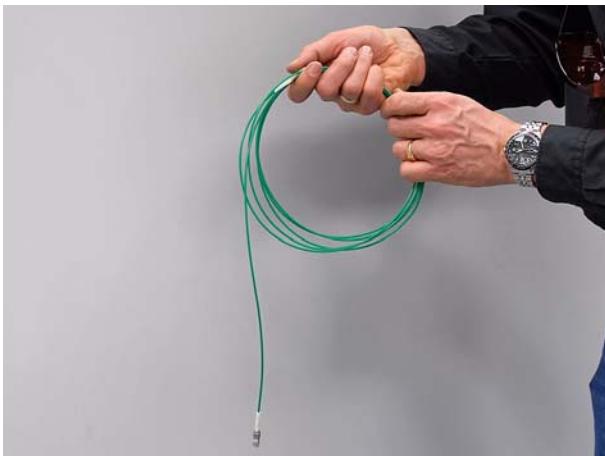


Figure 7.98 Rolling up the glass fiber line



Figure 7.99 Glass fiber line in transport bag

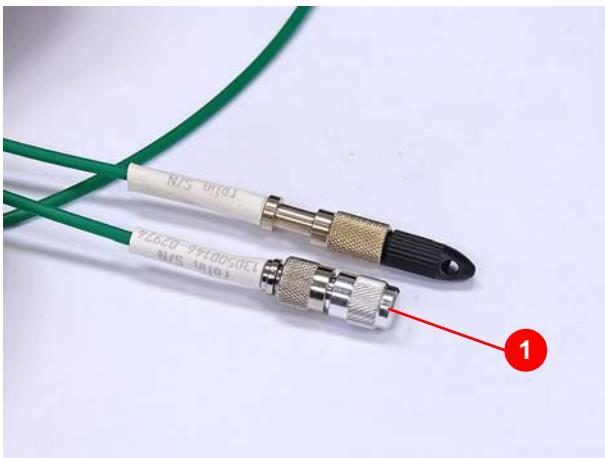


Figure 7.100 Dust protection caps of the glass fiber line

Attention: Be careful when handling glass fiber lines! Do not bend glass fiber lines, roll them up without twisting and do not subject the fibers to shocks or tensile stresses. Do not get glass fibers dirty (prevent contact with dust and do not let them get on the floor)!

11. Remove the new glass fiber from the sealed transport bag.

Note: The color of the glass fiber varies depending on the length of the glass fiber.

12. Push the diode connection of the glass fiber (1) (Figure 7.100) through the passage from the resonator side of the laser head to the diode side (1) (Figure 7.101).

13. Remove the dust protection cap from the diode connection of the glass fiber.
 - Keep the fiber end pointing downward.
 - Remove the cap by turning it downward slowly to prevent underpressure (particles can deposit on the glass fiber).

Note: Prevent soiling of the dust protection caps.

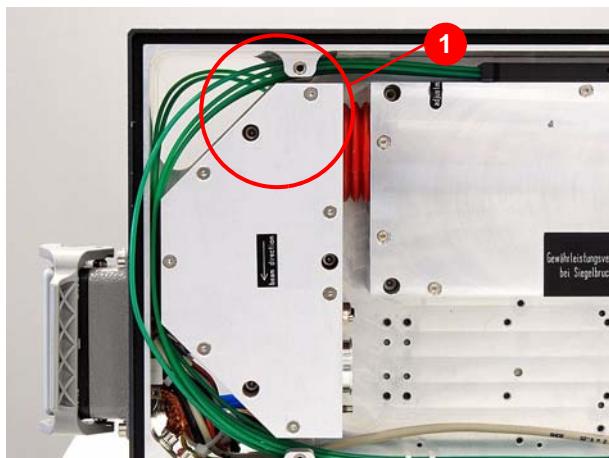


Figure 7.101 Inserting the glass fiber

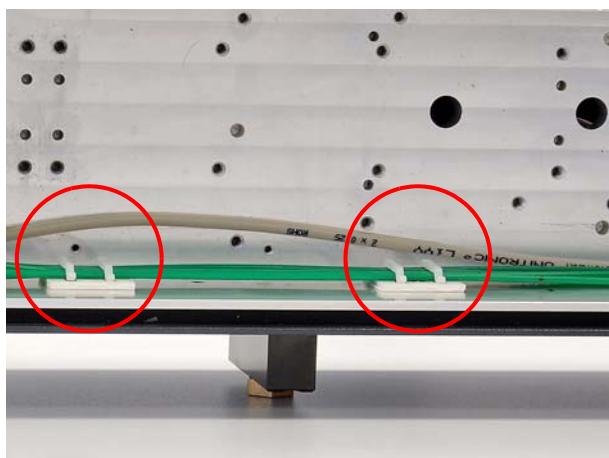


Figure 7.102 Holding clamps of the glass fiber

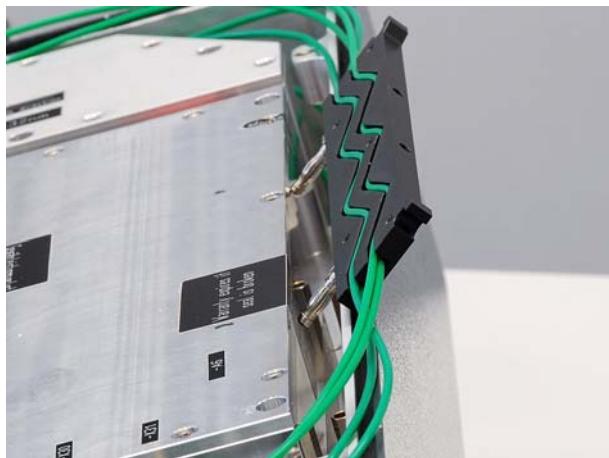


Figure 7.103 Inserting the fibers in the anchor

14. Connect the glass fiber to the diode module. Tighten it by hand.

! **Attention:** In the process, do not use tools! Risk of damage!

15. Insert the glass fiber into the holding clamp.

! **Attention:** Do not bend the glass fiber when inserting it and do not lay radii that are too small.

i **Note:** The line length of the glass fiber determined by technical reasons. A corresponding number of coils should be laid within the laser head.

i **Note:** Lay the glass fiber line flatly in the holding clamps. At tight places, open the holding clamps using a suitable screw driver.

! **Attention:** Do not damage the glass fiber line with the screwdriver!

16. In the case of the PowerLine E/EL with two diodes, insert the second glass fiber.

17. If fitted, insert the fibers into the anchor as shown in Figure 7.103, close the anchor and plug it into the mounts above the resonator module.

! **Attention:** Do not damage the fibers when inserting them into the anchor! Do not subject the fibers to any kind of tensile force or twisting!

18. Remove the dust caps from the end of the fiber and the resonator module and insert the fiber into the socket on the resonator module.

i **Note:** Take care that the guide on the fiber is inserted cleanly into the slot in the socket.

19. Tighten the swivel nut by hand.

! **Attention:** In the process, do not use tools! Risk of damage!

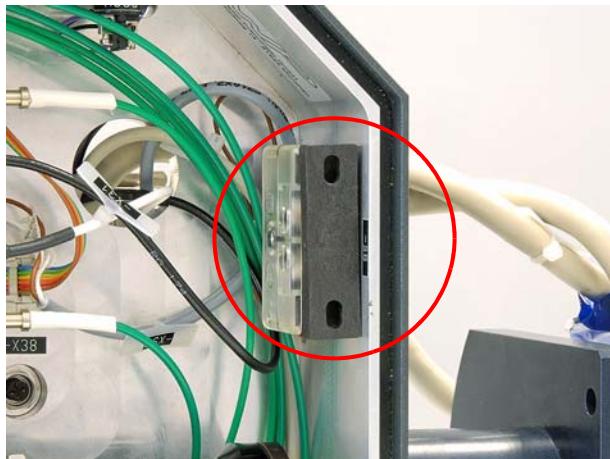


Figure 7.104 Interlock switch bridged

20. Bridge the interlock switch (Figure 7.104).

! **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

21. Secure the laser system against being switched on (remove the key from the keyswitch).

! **Attention:** Take measures for protection against laser radiation (see page 170)!

22. Insert the mains plug of the laser system and switch on the main switch.

! **Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

23. Commission the laser system for about ten minutes at maximum current (see the "Laser Type - Power" table on Page 69).

24. Check the temperature at the coupling between the diode module and resonator module and glass fiber (max. 60 °C).

i **Note:** When the maximum temperature is exceeded, check the connection of the glass fiber. It is possible that the diode module must be replaced or the glass fiber exchanged.



Figure 7.105 Temperature check

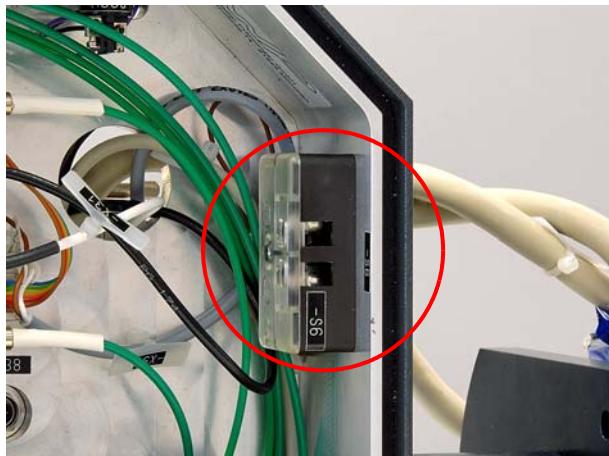


Figure 7.106 Interlock switch

25. Switch off the laser system.
26. Remove the bridge from the interlock switch.
27. Mount the cover of the laser head.
28. Enter the operating hours of the laser system and the time of the change in the logbook.
29. Commission the laser system.
30. Send the removed glass fiber to ROFIN-SINAR for repair.



Note: After having changed the glass fiber lines, perform a comparative measurement of the laser power with the same laser parameters as before the change at the same measuring point. A power increase should be able to be determined.
With a new diode module, functioning glass fibers, a functioning resonator module, and perfect optical components, the following power values should be reached according to the "Laser type - power" table on Page 69. Enter the measured values in the logbook.



Note: If no power increase is determined, the power of the laser diodes should be measured at the end of the fiber (see Section 5.4.6, page 78).

7.6 Changing the HF generator



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

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7.6.1 HG -24

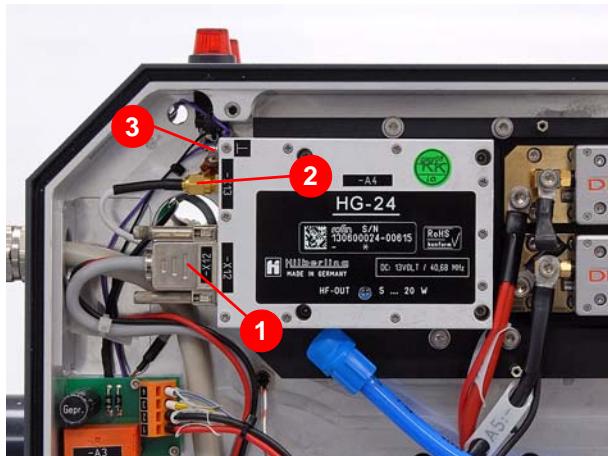


Figure 7.107 Removal of the HG-24

1. Open the cover of the diode side of the laser head (slanted corner located on the left).
2. Disconnect the connecting plug -X12 (1) (Figure 7.107), HF line -X13 (2), and ground line (3).



Note: Leave the ground line connected to the laser head for further use.

3. Loosen four fastening screws and remove HG-24.
4. Clean the cooling surface and bottom of the new HG-24 with isopropyl alcohol.
5. Connect the ground line to the HG-24.
6. Screw the HG-24 tight using four fastening screws (without washers).
7. Connect the HF line -X13.

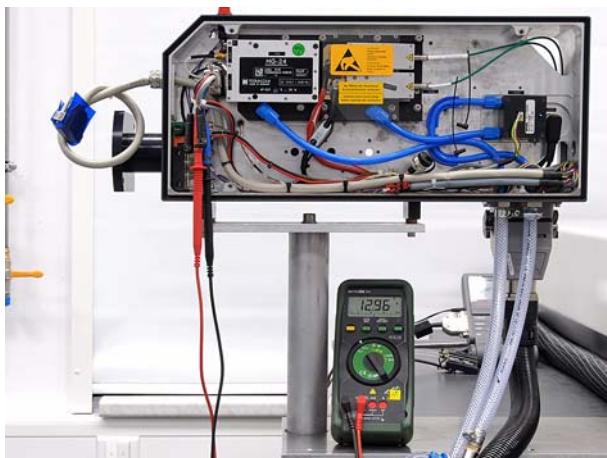


Figure 7.108 Measuring adaptor of the operating voltage



Figure 7.109 Connecting HG-24

8. Plug the measuring adaptor (see Chapter 3) into -X12 of HG-24.
9. Plug the connecting plug -X12 into the measuring adapter.
10. Connect the voltmeter to Pin 1 (-) and Pin 5 (+) of the measuring adapter.
11. Set the operating voltage (see Section 7.6.4, page 181).

12. Remove the measuring adapter and connect the connecting plug -X12 to HG-24.
13. Set the HF power (see Section 7.6.5, page 184).
14. Enter the operating hours of the laser system and the time of the change in the logbook.
15. Mount the cover of the laser head.
16. Commission the laser system.

7.6.2 HG-25



Note: An SHG laser may not be fitted with an HG-25.



Note: Depending on the production period, the appearance of the HG-25 may deviate from the HF generator shown here.

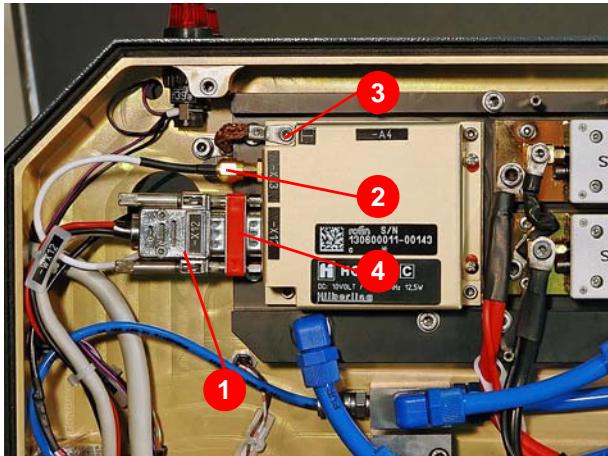


Figure 7.110 Removal of the HG-25



Figure 7.111 Installation of the HG-25

1. Open the cover of the diode side of the laser head (slanted corner located on the left).
2. Disconnect the connecting plug -X12 (1) (Figure 7.110), HF line -X13 (2), and ground line (3).
3. Loosen four fastening screws and remove HG-25.
4. Remove the plug-in filter (4) from HG-25.
5. Clean the cooling surface and bottom of the new HG-25 with isopropyl alcohol.
6. Screw the HG-25 tight using four fastening screws.

i **Note:** Leave the ground line connected to the laser head for further use.

7. Plug the plug-in filter into X12 of HG-25.
8. Plug the connecting plug -X12 into the plug-in filter.
9. Connect the HF line -X13.
10. Set the HF power (see Section 7.6.6, page 187).
11. Enter the operating hours of the laser system and the time of the change in the logbook.
12. Mount the cover of the laser head.
13. Commission the laser system.

7.6.3 Changing from HG-25 to HG-24



Note: New systems are always delivered with the HG-24. The conversion of existing systems is described here.

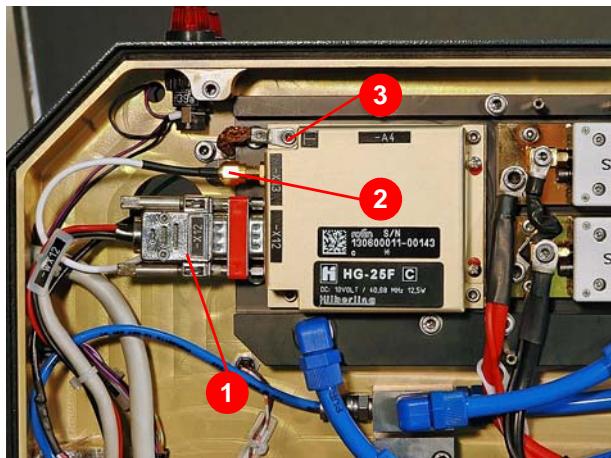


Figure 7.112 Removal of the HG-25

1. Open the cover of the diode side of the laser head (slanted corner located on the left).
2. Disconnect the connecting plug -X12 (1) (Figure 7.112), HF line -X13 (2), and ground line (3).



Note: Leave the ground line connected to the laser head for further use.

3. Loosen four fastening screws and remove HG-25.
4. Clean the cooling surface.
5. Connect the ground line to the HG-24.



Note: Do **NOT** use the plug-in filter of HG-25 with HG-24.

6. Screw the HG-24 tight using four fastening screws (without washers).
7. Connect the HF line -X13.
8. Plug the measuring adaptor (see Chapter 3) into -X12 of HG-24.
9. Plug the connecting plug -X12 into the measuring adapter.
10. Connect the voltmeter to Pin 1 (-) and Pin 5 (+) of the measuring adapter.
11. Set the operating voltage (see Section 7.6.4, page 181).

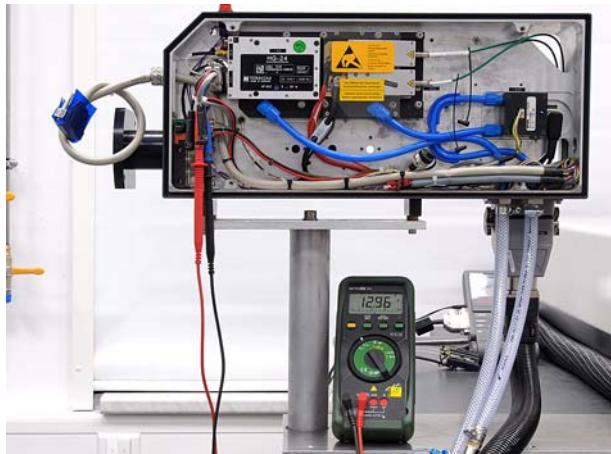


Figure 7.113 Measuring adaptor of the operating voltage



Figure 7.114 Connecting HG-24

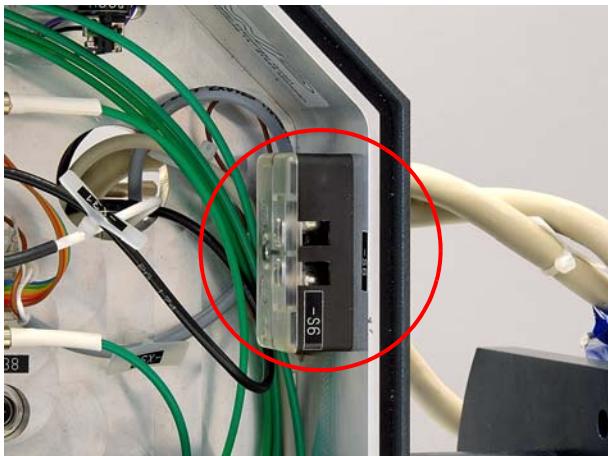


Figure 7.115 Interlock switch

12. Remove the measuring adapter and connect the connecting plug -X12 to HG-24.

13. Set the HF power (see Section 7.6.5, page 184).

14. Enter the operating hours of the laser system and the time of the change in the logbook.

15. Mount the cover of the laser head.

16. Commission the laser system.

17. Remove the bridge from the interlock switch.

18. Mount the cover of the laser head.

19. Commission the laser system.

20. Adjust the parameters in VLM.

- First pulse suppression: upper limit = 90 (see Chapter 9 of the "VLM User Manual")

- Grayscale bitmap:
Standard minimum DAC value = 200; standard maximum DAC value = 1000 (see Chapter 5.11 of the "VLM User Manual").

7.6.4 Setting the operating voltage of HG-24

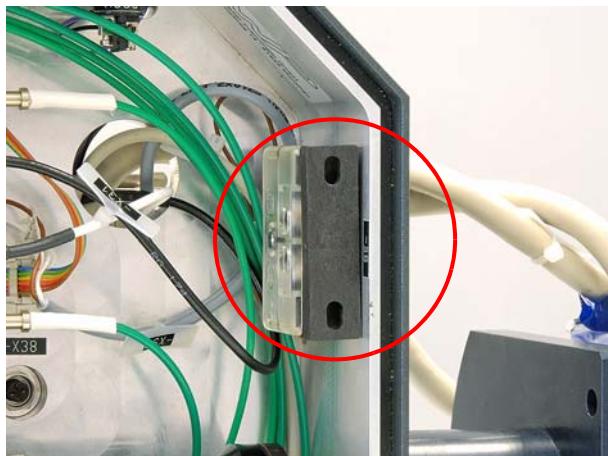


Figure 7.116 Interlock switch bridged

1. Bridge the interlock switch (Figure 7.116).

! **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

2. Secure the shutter against activation.

! **Attention:** Take measures for protection against laser radiation (see page 176)!

3. Insert the mains plug of the laser system.

! **Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

Supply cabinet

- a) Open the supply cabinet.
- b) Turn on the main switch using the main switch shaft (1) (Figure 7.117).



Figure 7.117 Main switch in the supply cabinet

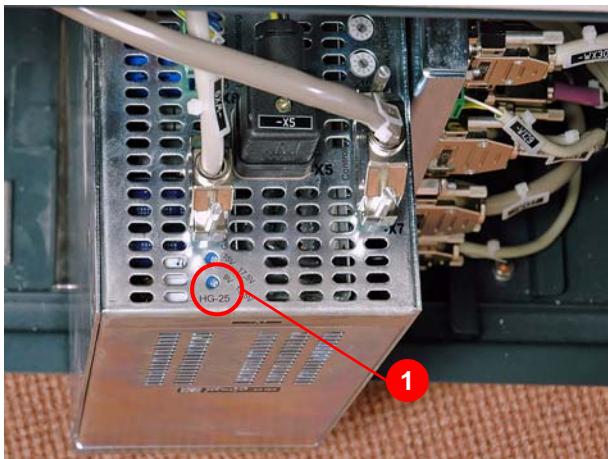


Figure 7.118 Potentiometer for operating voltage

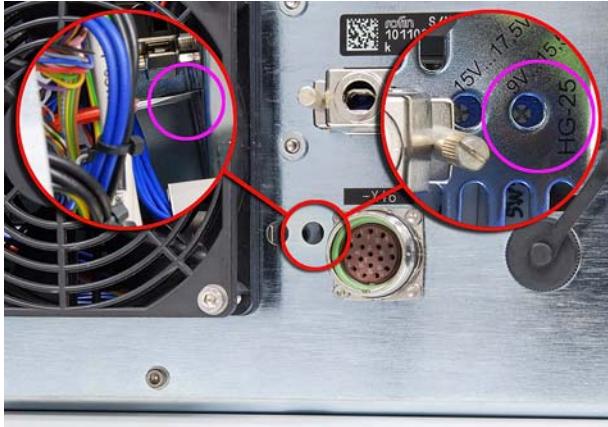


Figure 7.119 Adjustment holes on 19"-plug-in



Figure 7.120 Rear view of 19" plug-in

- c) Using a small screwdriver, turn the HG-25 potentiometer (1) (Figure 7.118) until $13.0\text{ V} \pm 0.1\text{ V}$ is measured at HG24/-X12.
- d) Switch off the main switch and close the supply cabinet.

19" plug-in

- a) Make access possible at the rear of the plug-in unit.
- b) Push a suitable screwdriver into the right-hand hole in the plug-in unit.
- c) Turn on the main switch.
- d) Using the screwdriver, turn the HG-25 potentiometer until $13.0\text{ V} \pm 0.1\text{ V}$ is measured at HG-24/-X12.
- e) Turn off the main switch.

19" plug-in (alternative)

- a) Make access possible at the rear of the plug-in unit.
- b) Disassemble the fan on the right so that you can reach the potentiometer.
- c) Turn on the main switch.
- d) Using a small screwdriver, turn the HG-25 potentiometer until $13.0\text{ V} \pm 0.1\text{ V}$ is measured at HG-24/-X12.
- e) Turn off the main switch and mount the blower.

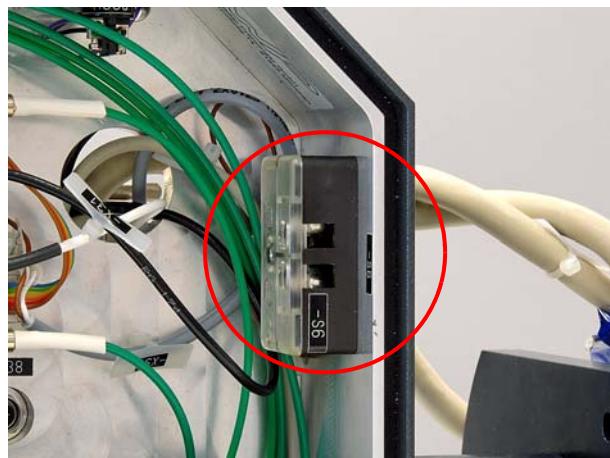


Figure 7.121 Interlock switch

4. Remove the bridge from the interlock switch.
5. Mount the cover of the laser head.
6. Commission the laser system.

7.6.5 Setting the HF power of HG-24

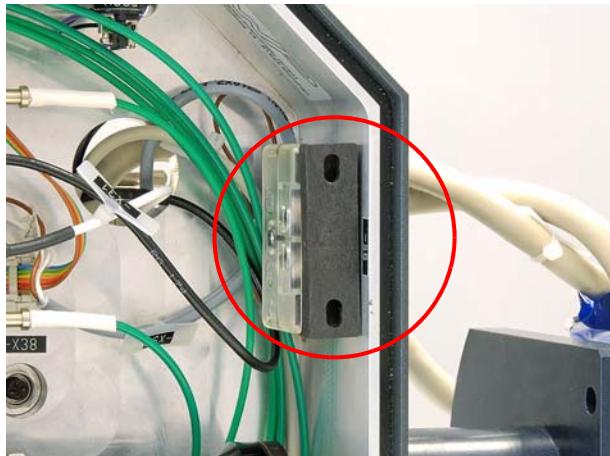


Figure 7.122 Interlock switch bridged

1. Bridge the interlock switch (Figure 7.122).

! **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

2. Secure the shutter against activation.

! **Attention:** Take measures for protection against laser radiation (see page 176)!

3. Insert the mains plug of the laser system.

! **Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

i **Note:** The HF generator must be in operation for 15 min. to correctly set the HF output.

If the HF output is set too soon, problems may occur during the blocking behavior or quality may be lost during marking.

4. Set the operating voltage of 13.0 V ± 0.1 V as described in Section 7.6.4, page 181.
5. Open the shutter.
6. Switch off the laser beam.
7. Set the current to the maximum value typical for this system (see the "Laser Type - Power" table on Page 69).
8. Open the shutter.
9. Using the transducer disk (see Chapter 3), search for laser radiation outside of the focal point.

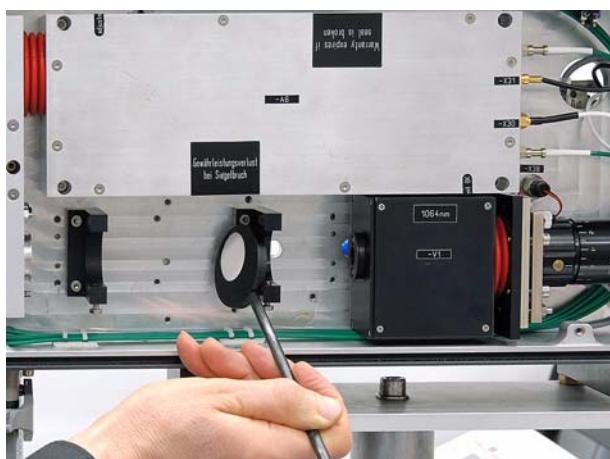


Figure 7.123 Transducer disk



Figure 7.124 HG-24 potentiometer



Figure 7.125 IR transducer screen

Laser radiation present

- Increase the RF power by slowly turning the potentiometer to the right (clockwise) until the laser radiation disappears.

i Note: With the **IR model**, turn the potentiometer of the HG-24 completely to the left and slowly increase the output by turning it clockwise.

With the **SHG 12E/25E model**, turn the potentiometer on the HG-24 completely to the left and then turn it to the right until the output is minimal (check visually or with a measuring device). The **SHG 20E model** must be adjusted according to Section 8.1.10, page 225.

10. Using the IR transducer screen (see Chapter 3), search for laser radiation outside of the focal point as follows:

i Note: When using the IR transducer screen, keep it moving to guarantee a constant display. After about 10 to 15 seconds, "charge" the IR transducer screen at a light source (approx. 1 to 2 seconds).

! **Attention:** Take measures for protection against laser radiation. Danger of deflecting the laser beam through the reflecting surface of the IR transducer screen.

i Note: This measurement is only performed with IR models.

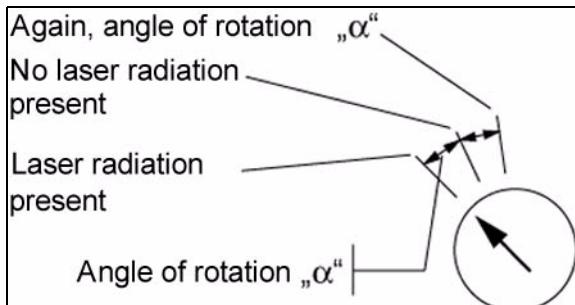


Figure 7.126 Setting the HF power of HG-24

Laser radiation present

- a) Increase the RF power by slowly turning the potentiometer to the right (clockwise) until the laser radiation disappears. Proceed with b).

No laser radiation present

- b) Decrease the HF power by slowly turning the potentiometer to the left (counterclockwise) until the laser radiation emerges.
- c) Turn the potentiometer to the right (clockwise) until the laser radiation disappears. The two positions of the potentiometer (laser radiation present/not present) describe the "α" angle of rotation (Figure 7.126).
- d) Turn the potentiometer by this angle of rotation to the right (clockwise) again. This guarantees that the value of the HF power is sufficiently high.

i *Note:* If the adjustment is carried out with a power measurement device, the residual laser power should not exceed 0.15 W.

11. Remove the bridge from the interlock switch.
12. Mount the cover of the laser head.
13. Commission the laser system.
14. Adjust the parameters in VLM.
 - First pulse suppression: upper limit = 90 (see Chapter 9 of the "VLM User Manual")
 - Grayscale bitmap: Standard minimum DAC value = 200; standard maximum DAC value = 1000 (see Chapter 5.11 of the "VLM User Manual").

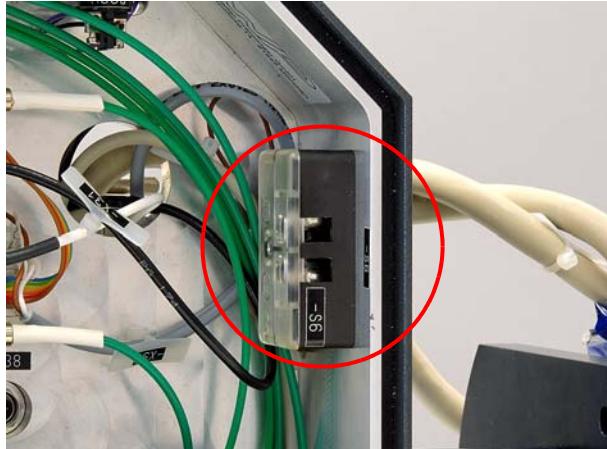


Figure 7.127 Interlock switch

7.6.6 Setting the HF power of HG-25



Attention: Due to the structure of the laser system, the following activities should be performed by two people. These people must make sure that they can communicate with each other at all times!

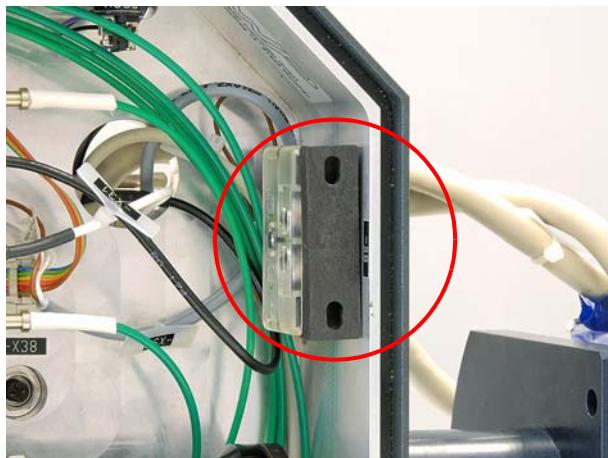


Figure 7.128 Interlock switch bridged

1. Bridge the interlock switch (Figure 7.128).

Attention: When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

2. Secure the shutter against activation.

Attention: Take measures for protection against laser radiation (see page 176)!

3. Insert the mains plug of the laser system.

Attention: If the emergency stop button/main switch of the laser system is out of safe reach of one of the two people during the task to be performed, a third person must always be present who can press the emergency stop button/main switch in case of an emergency.

Note: The HF generator must be in operation for 15 min. to correctly set the HF output. If the HF output is set too soon, problems may occur during the blocking behavior or quality may be lost during marking.

Access to the "HG-25" potentiometer for the supply cabinet

- a) Open the supply cabinet.
- b) Turn on the main switch using the main switch shaft (1) (Figure 7.129).

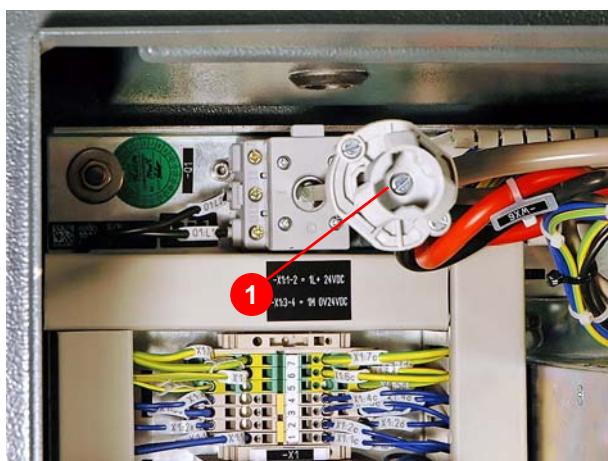


Figure 7.129 Main switch in the supply cabinet

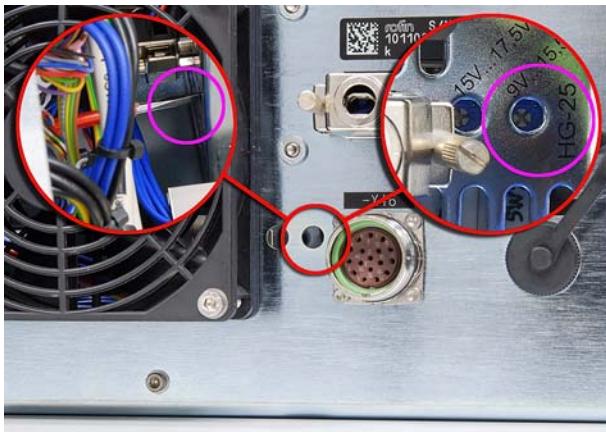


Figure 7.130 Adjustment holes on 19"-plug-in



Figure 7.131 Rear view of 19" plug-in

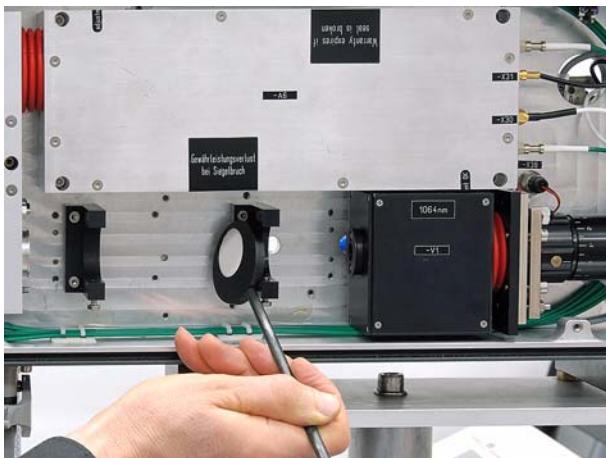


Figure 7.132 Transducer disk

Access to the "HG-25" potentiometer for the 19" plug-in

- Make access possible at the rear of the plug-in unit.
- Push a suitable screwdriver into the right-hand hole in the plug-in unit.

Access to the "HG-25" potentiometer for the 19" plug-in (alternative)

- Make access possible at the rear of the plug-in unit.
- Disassemble the fan on the right so that you can reach the potentiometer.

- Set the current to the maximum value typical for this system (see the "Laser Type - Power" table on Page 69).
- Open the shutter.
- Using the transducer disk (see Chapter 3), search for laser radiation outside of the focal point.

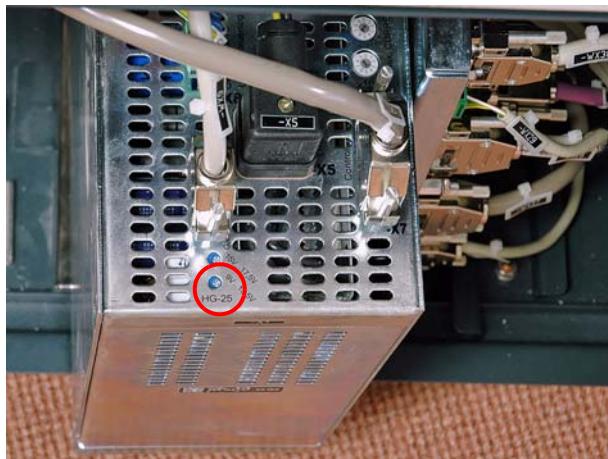


Figure 7.133 HG-25 potentiometer



Figure 7.134 IR transducer screen

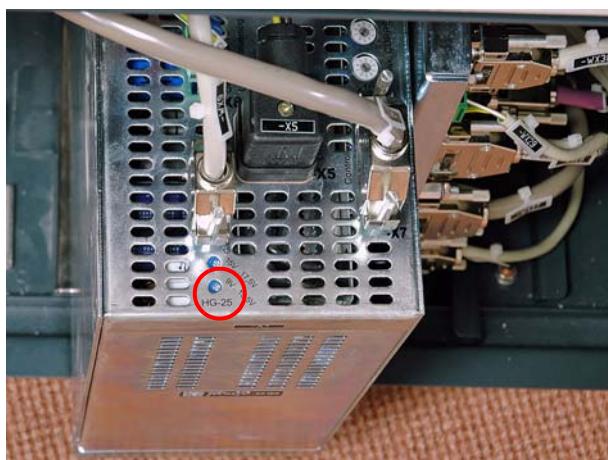


Figure 7.135 HG-25 potentiometer

Laser radiation present

- Increase the HF power by slowly turning the potentiometer to the right (clockwise) with a small screwdriver until the laser radiation disappears.

i *Note:* Turn the potentiometer completely to the left and slowly increase the output by turning it clockwise.

7. Using the IR transducer screen (see Chapter 3), search for laser leakage radiation outside of the focal point.

i *Note:* When using the IR transducer screen, keep it moving to guarantee a constant display. After about 10 to 15 seconds, "charge" the IR transducer screen at a light source (approx. 1 to 2 seconds).

! *Attention:* Take measures for protection against laser radiation. Danger of deflecting the laser beam through the reflecting surface of the IR transducer screen.

8. Turn the HG-25 potentiometer to the right (clockwise) until the laser leakage radiation disappears.



Figure 7.136 Voltage measurement

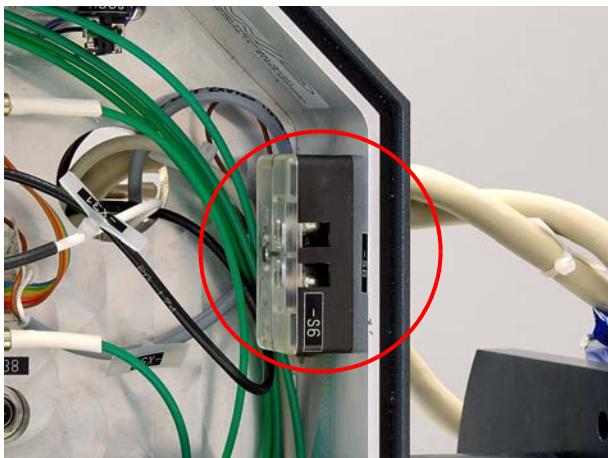


Figure 7.137 Interlock switch

9. Measure the voltage at plug -X8 of HN80x, Pins 1 and 2.

i *Note:* The measuring points can only be reached with fine measuring tips (see Chapter 3).

10. Increase the measured voltage at the potentiometer by 0.2 V.

i *Note:* If the adjustment is carried out with a power measurement device, the residual laser power should not exceed 0.15 W.

11. Switch off the main switch and close the supply cabinet or mount the fan (19" plug-in).

12. Remove the bridge from the interlock switch.

13. Mount the cover of the laser head.

14. Commission the laser system.

15. Adjust the parameters in VLM.

- First pulse suppression: upper limit = 130 (see Chapter 9 of the "VLM User Manual")
- Grayscale bitmap:
Standard minimum DAC value = 200; standard maximum DAC value = 1400 (see Chapter 5.11 of the "VLM User Manual").

7.7 Changing the alignment laser¹



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.

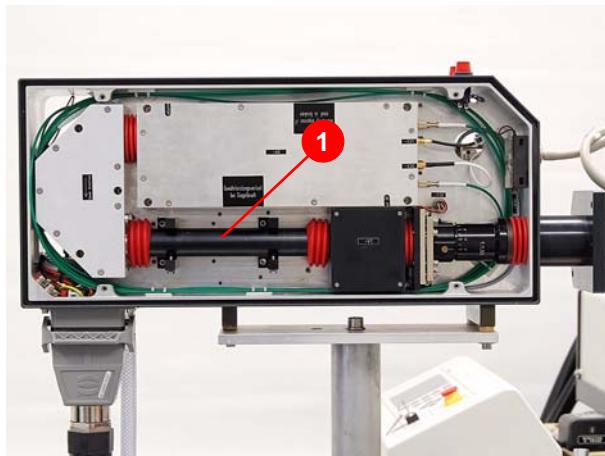


Figure 7.138 Dismantling the beam guide

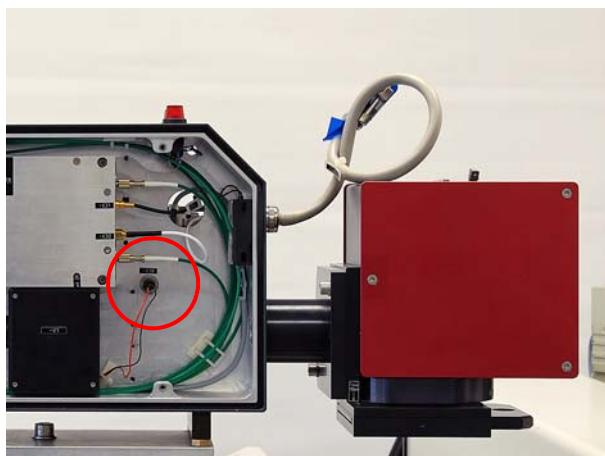


Figure 7.139 Connecting plug of the alignment laser

1. Open the lateral cover of the resonator side of the laser head.
2. Remove the beam guide (1) (Figure 7.138) of the laser head and beam expander (2).
3. Remove the connecting plug of the alignment laser (-X38) (see Figure 7.139).

1. Installation depends on the respective laser type

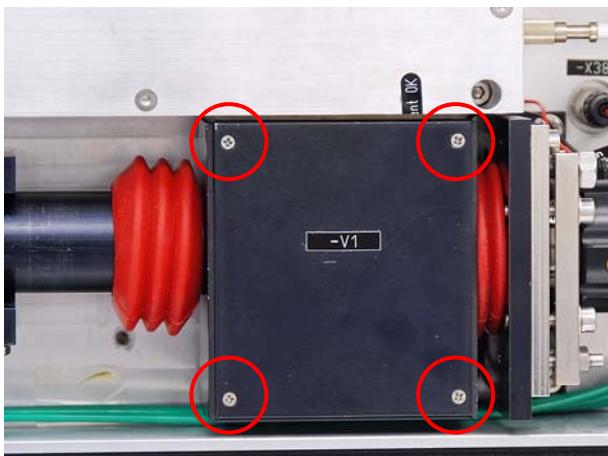


Figure 7.140 Alignment laser cover

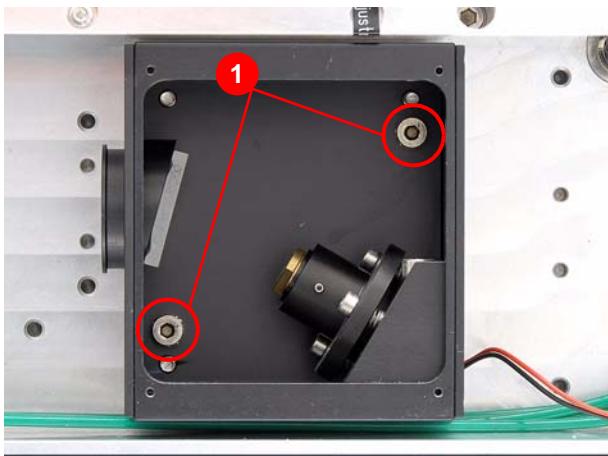


Figure 7.141 Attachment for the alignment laser housing

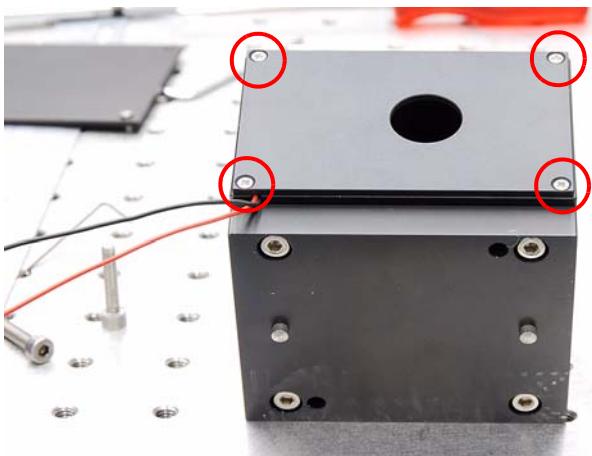


Figure 7.142 Alignment laser housing

4. Loosen the four fastening screws on the cover of the alignment laser (see Figure 7.140).
5. Remove the cover.

6. Loosen the fastening screws (1) (Figure 7.141) for the alignment laser housing; remove the housing.

7. Remove the side cover of the alignment laser housing after loosening the four fastening screws (Figure 7.142).

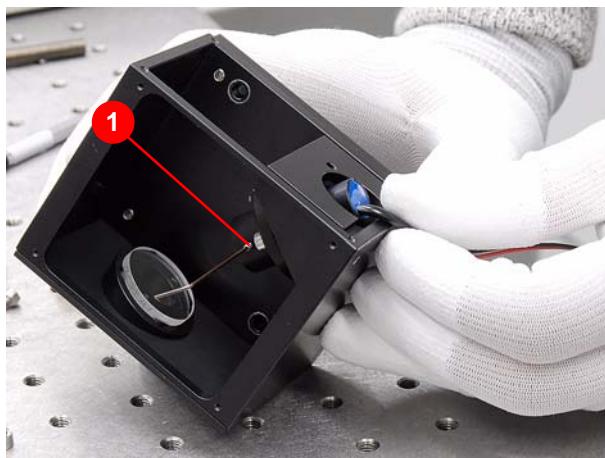


Figure 7.143 Removing the alignment laser

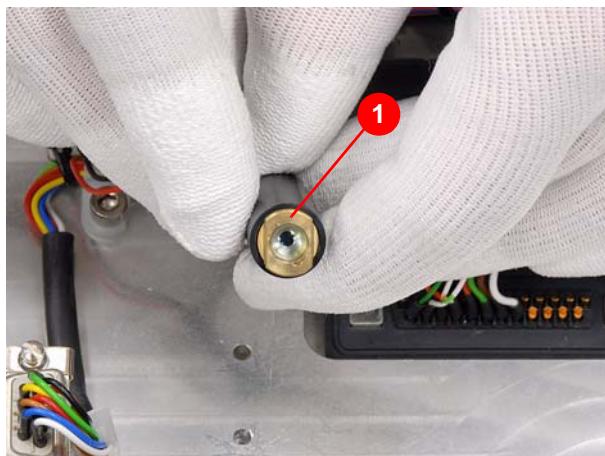


Figure 7.144 Adjustment of the alignment laser

8. Carefully withdraw the alignment laser after loosening the headless screw (1) (Figure 7.143).

9. Plug the new alignment laser into the connecting plug (-X38).
10. Switch on the system, start up the software (LaserConsole) and switch on the alignment laser.
11. Using the brass screw (1) (Figure 7.144), align the red laser beam to a white surface that is about 1.5 m to 2 m and turn the brass screw until the minimum diameter of the laser beam is reached.

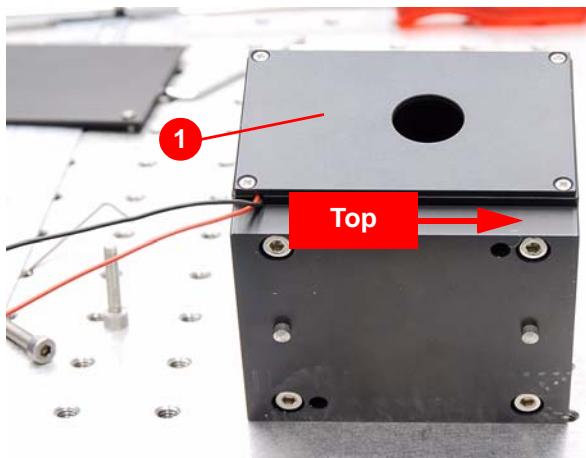


Figure 7.145 Alignment laser housing

12. Insert the new alignment laser in the housing and screw it tight.
13. Screw on the side cover (1) (Figure 7.145).

i **Note:** Make sure that the cover is fitted on the correct side. The laser beam will be shadowed if it is installed incorrectly!

14. Fit the alignment laser housing in the laser head.

! **Attention:** Do not crush, jam, or abrade the connecting lines of the alignment laser during installation! Make sure that the connecting lines are fixed (e. g. with adhesive tape) so that they cannot be damaged by the laser beam.

15. Check the adjustment of the laser beam and adjust it if necessary (see Section 6.3.3, page 122).
16. Mount the cover of the alignment laser housing.
17. Install the beam guide and pay attention to the correct position of the bellows.
18. Install the beam expander and the mount again; pay attention to the correct position of the bellows.

! **Attention:** Do not crush or jam the cables and lines inside the laser head during installation!

19. Check the setting of the beam expander.
20. Mount the cover on the resonator side of the laser head.
21. Commission the laser system.

7.8 Changing the MICO controller



Note: Before changing the MICO controller, read out the operating values with LCP or MCT and note them down (see Chapter 9, page 235).



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.



Figure 7.146 MICO controller for supply cabinet



Figure 7.147 MICO controller for 19"-plug-in

1. Switch off the laser system and the PC and pull both mains plugs.

Supply cabinet

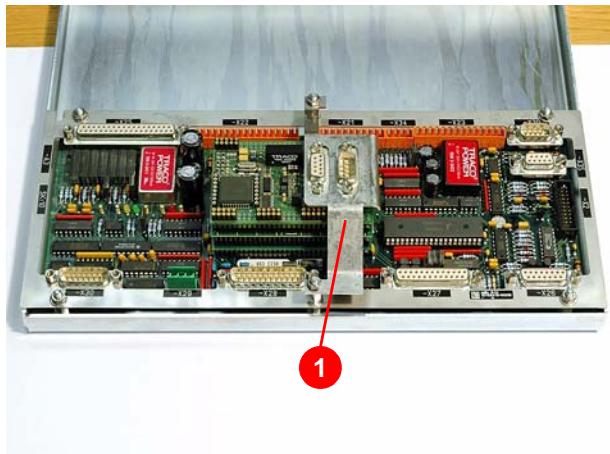
- a) Open the supply cabinet.
- b) Loosen the fastening screws for the MICO controller mounting plate.
- c) Lift the MICO controller mounting plate and withdraw it towards the front.

19" plug-in

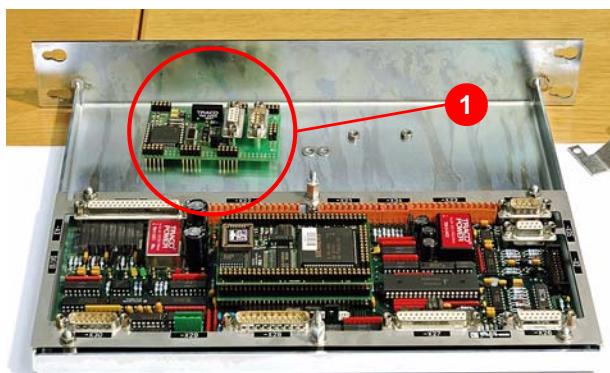
- a) Loosen the fastening screws of the plug-in.
 - b) Pull out the plug-in toward the front.
2. Remove all plug connections from the MICO controller.

Repair work

Changing the MICO controller



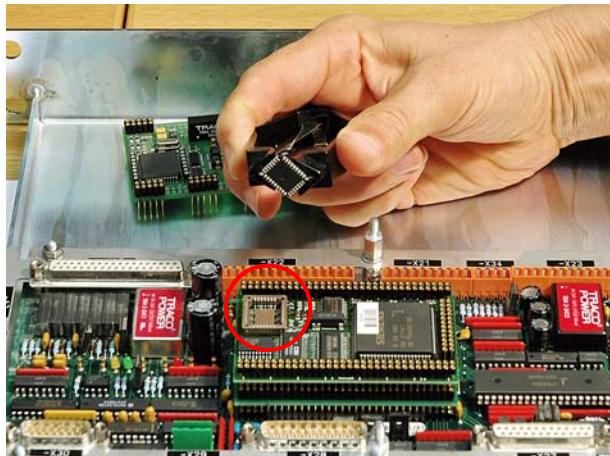
3. Dismantle the mounting plate (1) (Figure 7.148).



4. Carefully remove the CAN bus module (1) (Figure 7.149).

Attention: Exercise care while working! Do not bend connecting contacts!

Figure 7.149 Removing the CAN bus module



5. Remove the EPROM from the socket carefully using the PROM removal tool.

Figure 7.150 Removing the EPROM

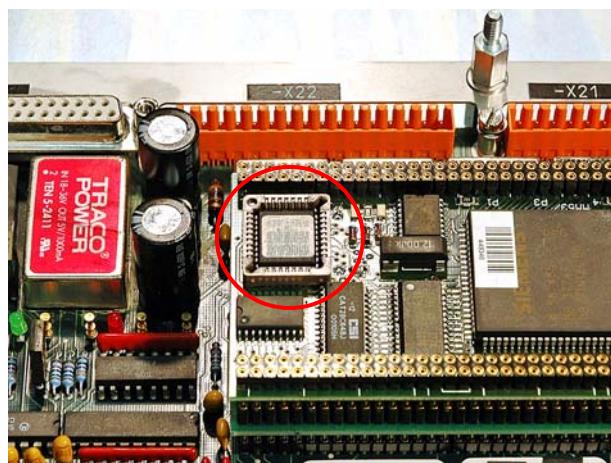


Figure 7.151 Inserting the EPROM



Figure 7.152 MICO controller for supply cabinet



Figure 7.153 Status LEDs – "OK" display

6. Insert the EPROM carefully into the socket of the new MICO controller and then press it downwards evenly.
 7. Carefully place the CAN bus module on top of it.
- Attention:** Exercise care while working! Do not bend connecting contacts!
8. Mount the mounting plate.
 9. Mount the MICO controller with the base plate.
 10. Plug all connectors into the MICO controller.

Supply cabinet

- a) Lift the MICO controller with the base plate and hook it on to the loosened fastening screws.
 - b) Tighten the fastening screws.
11. Insert the mains plug of the laser system and the PC and switch on both components.

12. Check the status LEDs on the MICO controller after activation.
 - OK: The red LED (Figure 7.153) lights up, while the green LED flashes at a frequency of 1 Hz.



Figure 7.154 Status LEDs – "Error" display

- Fault: The red and yellow LEDs light up; no LED lights up.

13. **In the event of a fault:** Perform trouble-shooting according to Section 5.9, page 88.
14. If no fault appears, close the supply cabinet or reinsert the 19" plug-in and fix it into place.
15. Commission the laser system.

7.9 Changing the HN80x power supply unit



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.

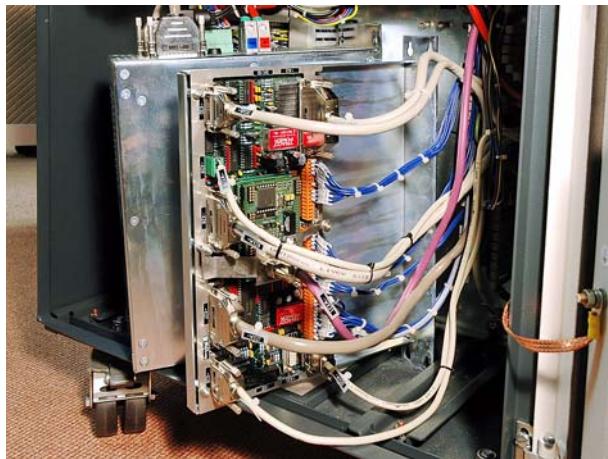


Figure 7.155 HN80x supply cabinet

Supply cabinet

- Open the supply cabinet.
- Loosen the fastening screws of the HN80x.
- Lift the HN80x and pull it out toward the front.
- Disconnect the connecting lines of the HN80x.
- Remove the HN80x.
- Mount it in reverse order.



Figure 7.156 19"-plug-in of the HN80x

19" plug-in

- Loosen the fastening screws of the plug-in.
- Pull out the plug-in toward the front.
- Remove all plug connections from the MICO controller.
- Disassemble the MICO controller
- Disconnect the connecting lines of the HN80x.
- Remove the HN80x.
- Mount it in reverse order.

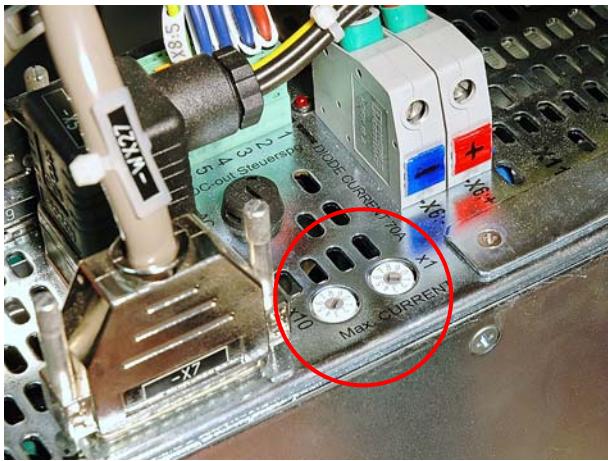


Figure 7.157 Setting the limiting current

Perform the following checks/settings:

1. Check/set the operating voltage of HG-24 (see Section 7.6.4, page 181).
2. Check/set the HF power of HG-24 (see Section 7.6.5, page 184) or HG-25 (see Section 7.6.6, page 187).
3. Check/set the operating voltage of the galvo head (see page 132).
4. Check the setting of the limiting current (X10 = 4; X1 = 6). The limiting current is thus set to 46 A.

7.10 Changing the internal power measurement device¹



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.

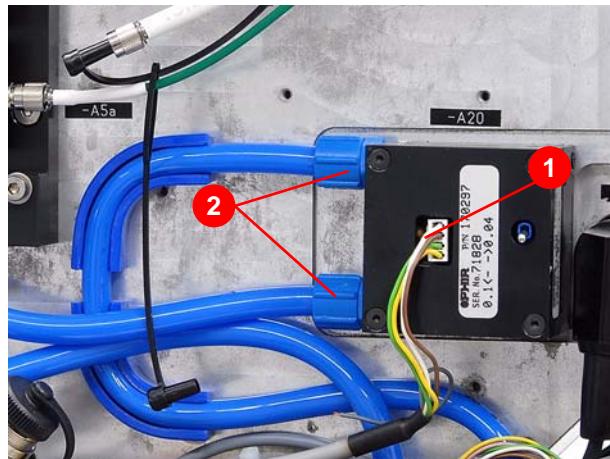


Figure 7.158 Connecting plug/cooling water lines of the power measurement device

1. Open both lateral covers of the laser head.
2. Remove the deflecting unit (see Section 7.2, page 146).
3. On the diode side of the laser head, remove the connecting plug (1) (Figure 7.158) from the internal power measurement device.
4. Unscrew the swivel nuts of the cooling water lines (2).

i **Note:** Check the hose ends for damage (tears, expansions, etc.). Damaged hoses must be replaced!

1. Installation depends on the respective laser type

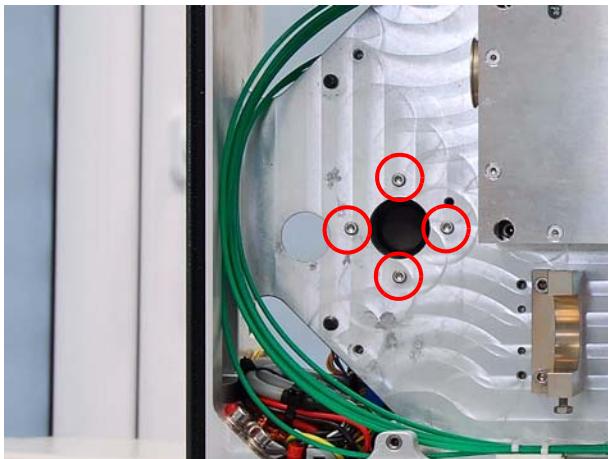


Figure 7.159 Fastening screws of the power measurement device

5. Hold the power measurement device firmly and loosen the four fastening screws of the power measurement device on the resonator side of the laser head.
 6. Insert the new power measurement device and screw it tight.
 7. Attach the hose.
- !** **Attention:** Do not twist the screwed connection!
8. Tighten the swivel nut by hand.
- !** **Attention:** Prevent twisting the connection in the measuring head. Especially when twisting back!
9. Mount the deflecting unit (see Section 7.2, page 146).
 10. Commission the laser system.
 11. Check the cooling water cycle for leaks after switching the laser system back on.
 12. Mount the cover of the laser head.
 13. Adjust the power measurement device (see Section 6.5, page 126).

7.11 Changing the beam attenuator¹

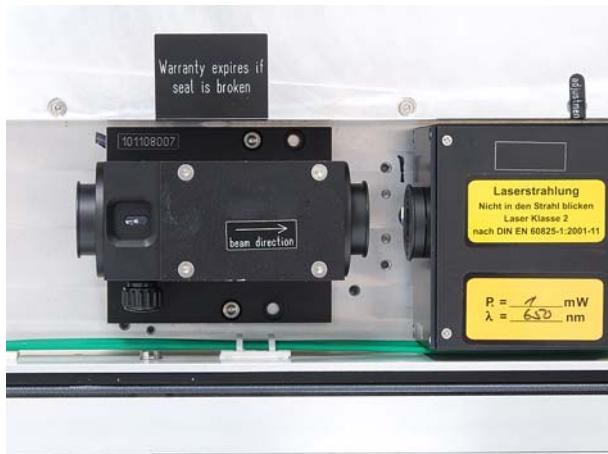


Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.



1. Open the cover of the resonator side of the laser head (chamfered corner located on the right).
2. Loosen the fastening screws on the beam attenuator.
3. Remove the beam attenuator and replace it.
4. Check the adjustment of the beam attenuator and adjust it if necessary (see Section 6.4, page 124).
5. Mount the cover on the resonator side of the laser head.
6. Commission the laser system.

Figure 7.160 Beam attenuator

1. Installation depends on the respective laser type

7.12 Changing the ALI board



Attention: Switch off the laser system and secure it against reactivation. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: When the mains connection is disconnected as required before the plug-in unit is opened, the protective conductor connection is also disconnected!

Before working on electronic components, ground the plug-in unit using suitable means! The external grounding line must be implemented on a marked PE terminal of the plug-in unit and on a marked PE terminal in the vicinity of the plant! The correct equipotential bonding must be checked using measuring technology! The ESD wrist band must then be connected to a PE clamp of the module!

Before that, no work may take place on electronic components!



Attention: All persons working on electronic components must comply with the measures for the protection of electrostatic sensitive devices (ESD)! The work area must be secured!



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.



Figure 7.161 Plug-in PC unit

1. Take out the plug-in PC unit and remove the top cover.
2. Loosen all connecting lines from the back side of the plug-in PC unit.

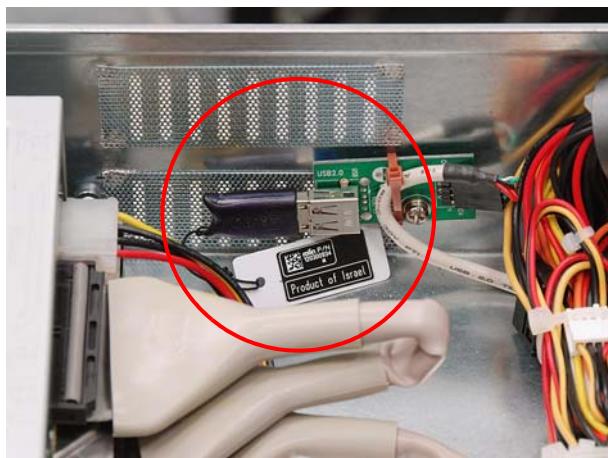


Figure 7.162 USB dongle for VLM software

Attention: A USB dongle for the VLM software is located on the left side of the plug-in PC unit (see Figure 7.162). This does not have to be removed for the exchange of the ALI board! The USB dongle may not be exchanged with a USB memory stick!

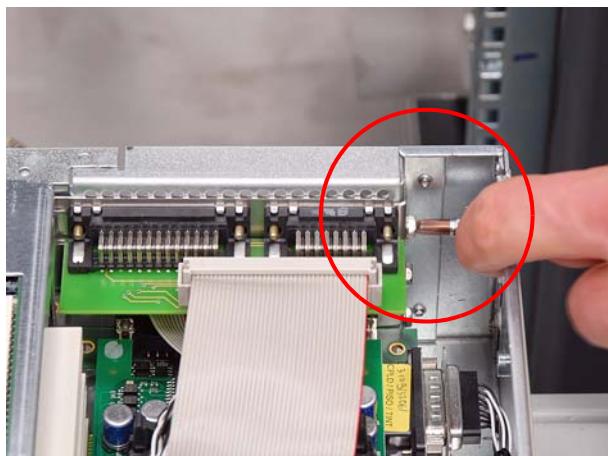


Figure 7.163 Loosening boards

3. Loosen the attachment of the top board.



Figure 7.164 Removing boards

4. Remove the board from the side.
5. Pull the plug of the board.

Attention: Do not pull out the plug by the cables!

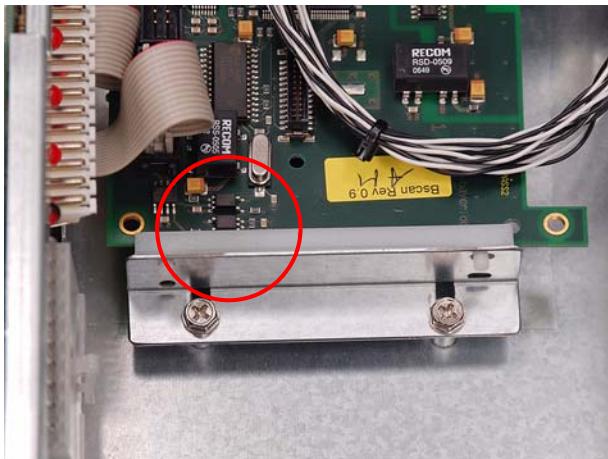


Figure 7.165 Attaching the board

6. Insert new boards and fix them into place.
 **Attention:** Do not damage the boards and structural elements with fastening elements (see Figure 7.165)!
7. Connection of new cards according wiring diagram.
8. Connect all connecting lines on the back side of the plug-in PC unit.
9. Mount the cover of the plug-in PC unit.
10. Push back the plug-in PC unit and attach it.
11. Load the new ALI configuration (see Section 5.10, page 94 and Section 5.11, page 96).

7.13 Changing the filter mats



Note: The changing of the filter mats is described in Chapter 2 of the ROFIN-SINAR Maintenance and Integration Manual.

7.14 Changing the particle filter and the deionizer bag



Note: The changing of the particle filter and deionizer bag is described in Chapter 2 of the ROFIN-SINAR Maintenance and Integration Manual.

7.15 Calibration of the motor valve in the cooling circuit



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825-4 Safety of Laser Products: Laser Guards) standards must be observed.

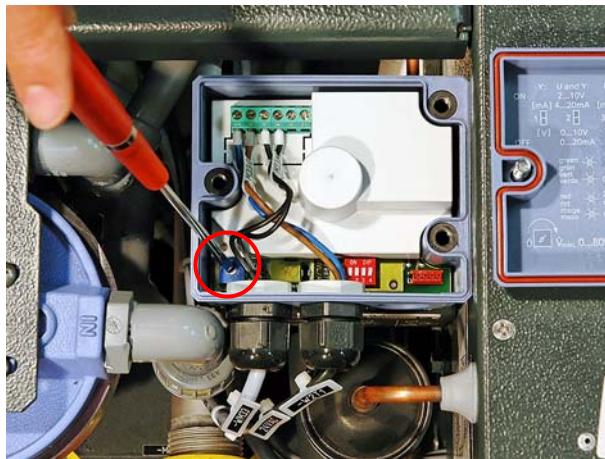


Figure 7.166 Calibrating the motor valve (1)

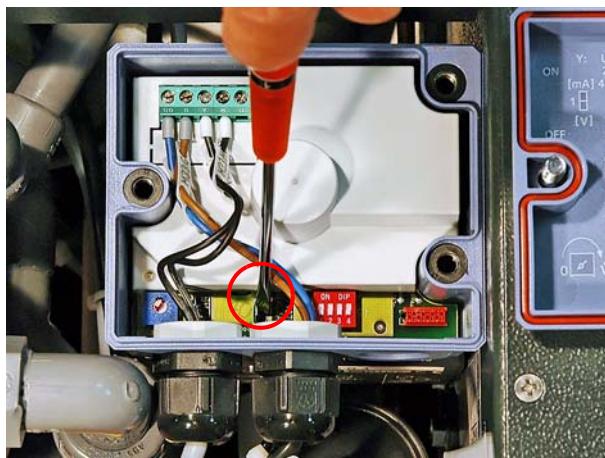


Figure 7.167 Calibrating the motor valve (2)

1. Remove the cooling unit from the supply cabinet or pull out the plug-in (see Section 7.16, page 208).
2. Turn the potentiometer completely to the left using a suitable screwdriver.

3. Use a suitable screwdriver to bridge the calibration contacts until the green LED is flashing. Then repeat the procedure twice after a short break.

i **Note:** Take a break between the individual calibration cycles. During calibration, the green LED flashes and then lights continuously when the procedure is completed.

4. Close the cover of the motor valve.
5. Mount the cooling unit.

7.16 Changing the cooling unit



Attention: Switch off the laser system and secure it against reactivation. Pull the mains plug. The peripheral components of the laser system should also be shut down and secured against reactivation.



Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.



Figure 7.168 Cooling unit in supply cabinet – rear fastening



Figure 7.169 Cooling unit in supply cabinet – front fastening

Supply cabinet

- a) Open the cooling unit cover on the supply cabinet.
- b) Loosen the rear fastening screw of the cooling unit.

- c) Loosen the front fastening screw of the cooling unit.



Figure 7.170 Lifting out the cooling unit

- d) Lift out the cooling unit from the supply cabinet toward the front.

! **Attention:** Do not damage the supply lines when removing them! To guarantee the circulation of cooling air during the test operation, the cooling unit must be placed on a suitable foundation!

- e) Disconnect the connecting lines.
f) Change and connect the cooling unit.
g) Check the cooling water level and refill if necessary.
h) Calibrate the motor valve (see Section 7.15, page 207).
i) Mount the cooling unit.

! **Note:** Do not damage the supply lines! Perform a leakage check!

19" plug-in

- a) Loosen the fastening screws of the plug-in.
b) Lift out the plug-in toward the front.

! **Attention:** Do not damage the supply lines when removing them! To guarantee the circulation of cooling air during the test operation, the cooling unit must be placed on a suitable foundation!

- c) Disconnect the connecting lines from the plug-in.
d) Change and connect the complete plug-in.
e) Check the cooling water level and refill if necessary.
f) Calibrate the motor valve (see Section 7.15, page 207).
g) Mount the plug-in.

! **Note:** Do not damage the supply lines! Perform a leakage check!



Attention: Drain the cooling water in the dismantled cooling unit completely! Cooling water remaining in the cooler can lead to corrosion or, e. g. in case of transportation during freezing weather, damage.

Notes

8 Adjustment and repair of SHG models



Note: The "Maintenance Schedule" chapter in the RSM PowerLine E/EL (IR and SHG) user manual must also be observed. The necessary aids are listed in Chapter 3 of this repair manual and in the "Spare Parts" chapter of the RSM PowerLine E/EL (IR and SHG) user manual.

8.1 Installation and adjustment of SHG components



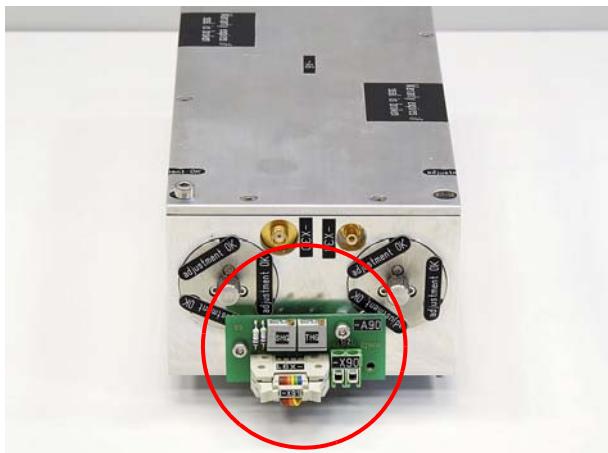
Attention: If the laser system has to be switched on for testing/measuring purposes, measures for protection against laser radiation must be taken (use of protective goggles, setup and positioning of partition walls, attachment of warning signs and barriers, etc.). These measures must be coordinated with the laser protection officer.

The DIN EN 207 Filter und Augenschutzgeräte gegen Laserstrahlung (BS EN 207 Filters and Eye-Protectors Against Laser Radiation (Laser Eye-Protectors)), DIN EN 60825-1 Sicherheit von Lasereinrichtungen (BS EN 60825-1 Safety of Laser Products), and DIN EN 60825-4 Sicherheit von Laserschutzwänden (BS EN 60825- 4 Safety of Laser Products: Laser Guards) standards must be observed.



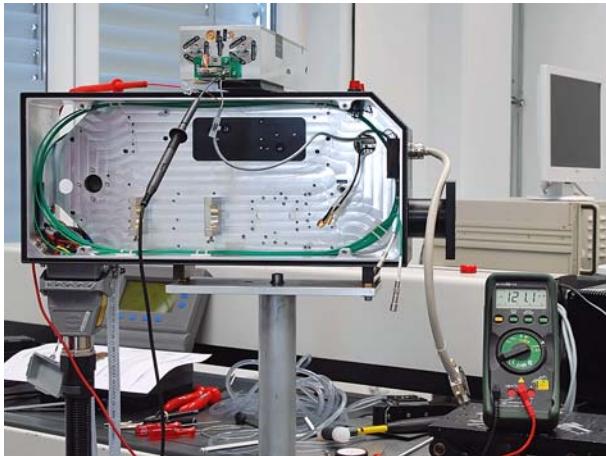
Note: The following steps for installing SHG components must be performed in the order specified here.

8.1.1 Installing the SHG resonator module



Note: The SHG version of a resonator module is shown on the connection side of the PCB.

Figure 8.1 Resonator module SHG version

**Figure 8.2** Relay PCB**Figure 8.3** Check the current of the heating element

1. Connect the connecting line for the heating element that is supplied with the SHG resonator module on the diode side of the laser head.

! **Attention:** Note wiring diagram! Reversing the polarity of the connections will result in the destruction of the heating element in the resonator module! This will result in instability of the laser system (irregular power variations)! Never operate the SHG resonator module without having the connecting line connected, not even short-term.

2. Push the line through to the resonator side.
3. Safely place the resonator module onto the laser head.
4. Connect the multimeter to measure the current of the heating element on the -X90 connection.

! **Attention:** Note wiring diagram! Reversing the polarity of the connections will result in the destruction of the heating element in the resonator module! This will result in instability of the laser system (irregular power variations)!

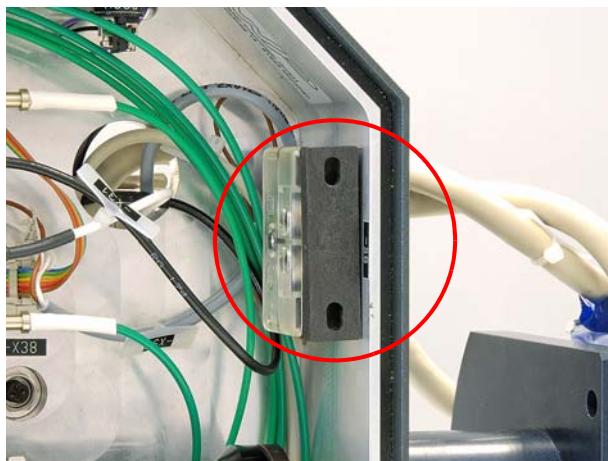


Figure 8.4 Interlock switch bridged

5. Bridge the interlock switch (Figure 8.4).

! **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

6. Secure the shutter against activation.
7. Insert the mains plug of the laser system and switch on the main switch.

! **Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

8. Current of the heating element during the heating up phase:
 - Approx. 170 mA while heating up,
 - Approx. 80 mA after the operating temperature (model specific guideline values) has been reached (see page 73),
 - Cold environment = high current, warm environment = low current.

i **Note:** The operating temperature is reached after approx. 10 minutes. If it has not been reached after 15 minutes, contact ROFIN-SINAR for consultation.

9. Remove the bridge from the interlock switch.
10. Pull the mains plug.
11. Remove the measuring device and connect lines directly to -X90.

! **Attention:** Note wiring diagram! Reversing the polarity of the connections will result in the destruction of the heating element in the resonator module! This will result in instability of the laser system (irregular power variations)!

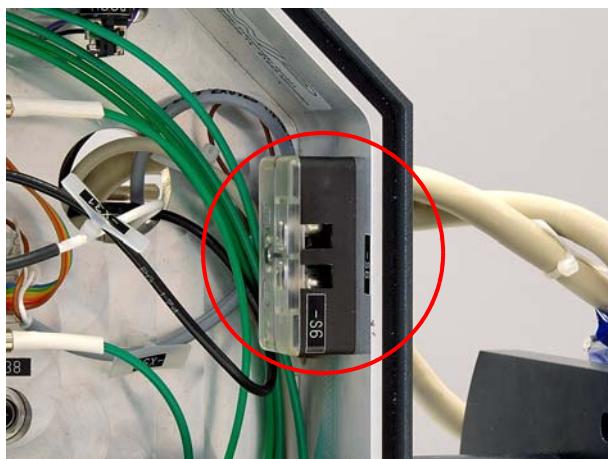


Figure 8.5 Interlock switch

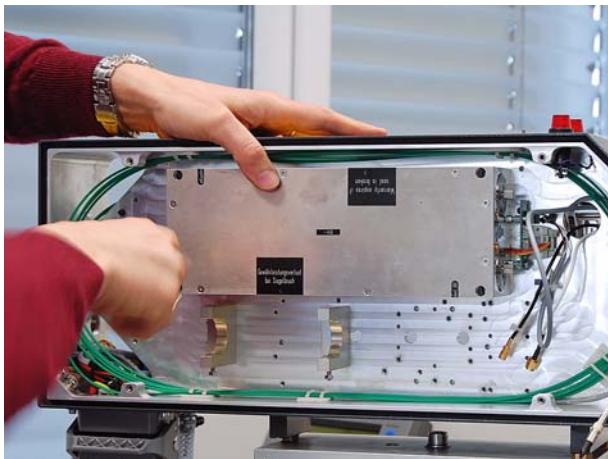


Figure 8.6 Inserting the resonator module

12. Insert new O-rings (provided together with the new resonator module) into the cooling water connections in the laser head.

Attention: Contamination of the "O-ring seats" / "O-ring grooves" and the O-rings themselves must be avoided. Make also sure the o-rings are positioned correctly.

Attention: Before the installation of the resonator module make sure that all tape (beam aperture, cooling water inlet) is removed again. In case of non-observance, severe damage to the laser (risk of fire, blocked cooling water flow) may result.

Attention: When installing the new components, make sure that the fibers are not pinched!

13. Push the resonator module onto the alignment pins.
14. Insert the fastening screws provided with the new resonator module and tighten them crosswise.
15. Remove the dust cap(s) from the resonator module and the glass fiber line(s) and connect the glass fiber(s) (1) (Figure 8.7).

Attention: In the process, do not use tools! Risk of damage!

Note: In the case of the PowerLine E/EL with two diodes, pay attention to the correct connection of the respective glass fibers.

16. Connect the SMA plug of the HF line (2) and the SMB plug of the Q-switch interlock line (3).

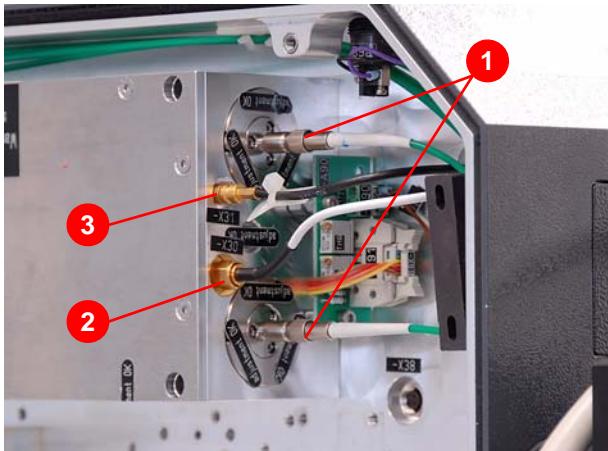


Figure 8.7 Connecting the resonator module

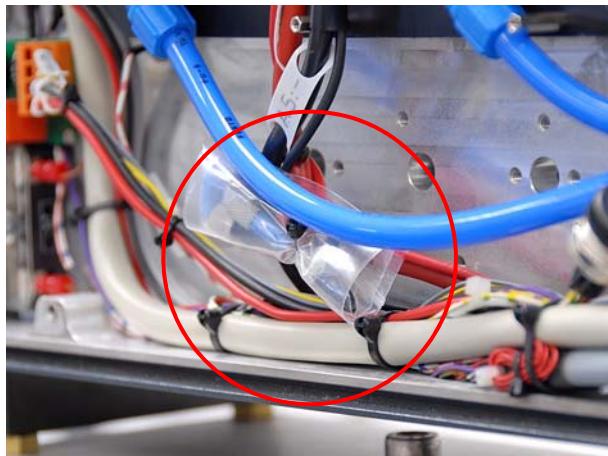


Figure 8.8 Dust protection caps and short-circuit bridges

i **Note:** Reattach the bag with dust protection caps and short-circuit bridges to the diode side of the laser head when work is completed (see Figure 8.8).

8.1.2 Installing the SHG deflecting unit

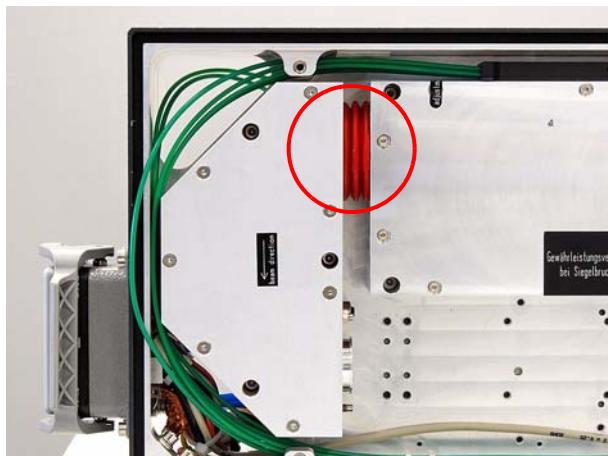


Figure 8.9 Installation of the deflecting unit

1. Remove the tape from the beam aperture of the resonator module.
2. Insert the bellows between the deflecting unit and the resonator module, place the deflecting unit onto the alignment pins, and make sure the bellows are in the correct position.

! **Attention:** Before installing the deflecting unit, check the labeling of the wavelength (Label "532 nm")! Changes will result in damage to the optical components!

3. Screw the deflecting unit into place; then insert the connecting plug (-X25) of the shutter module on the diode side of the laser head and screw it into place.

! **Attention:** Tighten the connecting plug only by hand to prevent any damage to the thread due to the use of tools!

8.1.3 SHG software settings

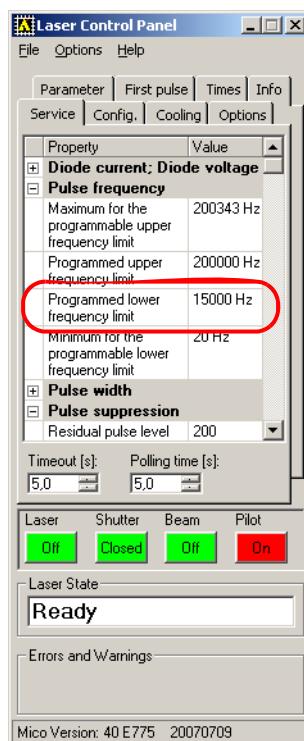


Figure 8.10 LaserControlPanel (1)

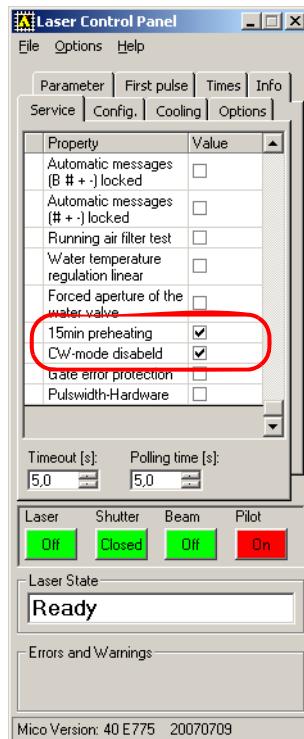


Figure 8.11 LaserControlPanel (2)

1. Start the PC and load WINDOWS®.
 2. Start LaserControlPanel.
- i Note:** The start time for the LaserControlPanel is approx. 15 seconds.
3. Enter a password and then set the "Programmed lower frequency limit" value under "Service" to **15,000 Hz**.

4. Set the options "**15 min preheating**" and "**CW-mode disabled**" under "Service".

! **Attention:** If these two options are not set, the resonator module will be destroyed!

8.1.4 Leakage check

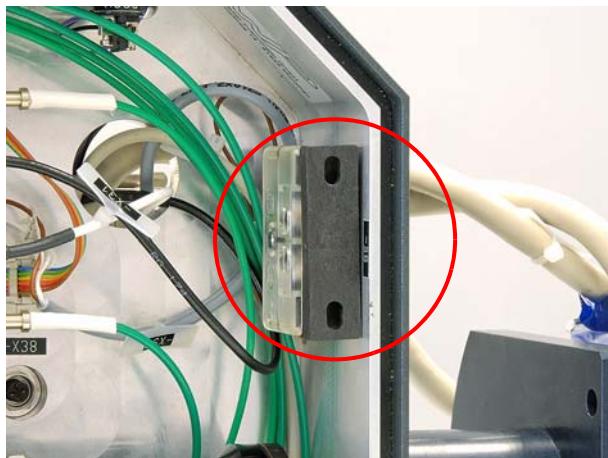


Figure 8.12 Interlock switch bridged

1. Bridge the interlock switch (Figure 8.4).

! **Attention:** When the interlock switch is bridged, the laser system may be switched on for testing/measuring purposes only under supervision! Production while the interlock switch is bridged is fundamentally prohibited!

2. Secure the shutter against activation.

! **Attention:** Take measures for protection against laser radiation (see page 211)!

Use protective goggles that are suitable for the wavelength of the SHG laser (532 nm)!

3. Insert the mains plug of the laser system and switch on the main switch.

! **Attention:** If the emergency stop button/main switch of the laser system is out of reach, a second person must always be present who can press the emergency stop button/main switch in case of an emergency.

! **Attention:** With systems where the cooler is installed **above** the laser head, open the water cycle.

4. Switch on the cooling unit and perform a leakage check of the cooling circuit in the vicinity of the resonator module and on the diode side.

! **Attention:** In case of cooling water leakage, the laser system must be shut down immediately using the emergency stop button/main switch. Correct leaks!

i **Note:** In addition to a visual inspection, the use of highly absorbent paper is recommended when checking for leaks.



Figure 8.13 Leakage check

8.1.5 Power adjustment and checking of the SHG laser

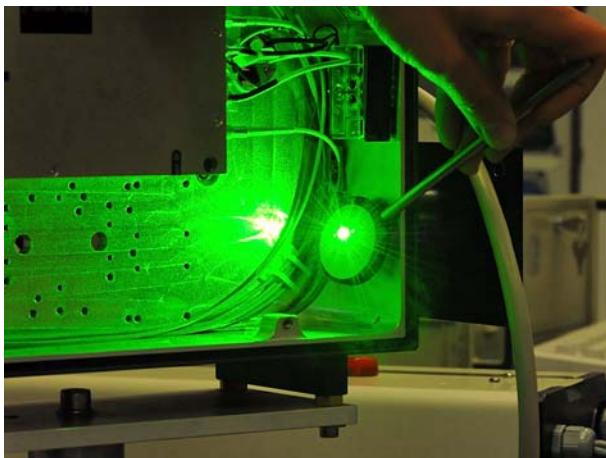


Figure 8.14 Check the laser beam

1. Wait for a preheating phase of 15 minutes.
2. Open the shutter, set the frequency to 50 kHz and slowly increase the current from 8 A and check the exit of the laser on a transducer disk (see Chapter 3).

! **Attention:** Use the transducer disk that is set up for the wavelength of the SHG laser (532 nm)!

i **Note:** The laser threshold is approximately **10 A** (green laser light visible).

! **Attention:** If the laser output does not reach at least **2 W** at approximately **30 A** and **50 kHz**, contact ROFIN-SINAR for consultation.

3. Close the shutter.

! **Attention:** Check to make sure the shutter closes correctly with the transducer disk!

i **Note:** When the main switch is switched off, waiting for the preheating phase of 15 min. is again required prior to additional work.

8.1.6 Installing the SHG alignment laser

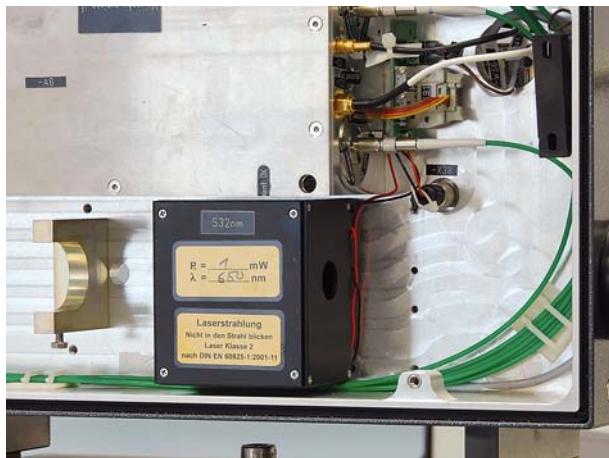


Figure 8.15 Mount the alignment laser housing.

1. Remove the tape from the beam entry and exit of the alignment laser housing.

Attention: Before installing the alignment laser, check the labeling of the wavelength (Label "532 nm")! Changes will result in damage to the optical components!

2. Mount the alignment laser housing and insert the connecting plug (-X38).

Attention: Do not crush, jam, or abrade the connecting lines of the alignment laser during installation!

3. Check the adjustment of the main laser (see Section 6.3.1, page 102) and the alignment laser (see Section 6.3.3, page 122) and correct as needed.
4. Close the shutter.

8.1.7 Installing the SHG beam expander

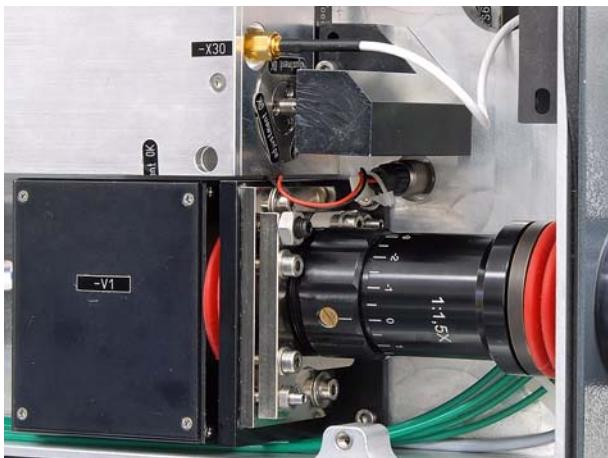


Figure 8.16 Mount the beam expander



Attention: Before installing the beam expander, check the labeling of the wavelength (Label "532 nm")! Changes will result in damage to the optical components!

1. Install the beam expander and the mount again; pay attention to the correct position of the bellows.



Attention: Do not crush or jam the cables and lines inside the laser head during installation!

2. Check the beam adjustment of the laser expander and adjust it if necessary (see Section 6.3.1, page 102).



Note: The adjustment must be performed with a frequency of 50 kHz and a current at which an output of 2 W is reached.

3. Check the focal point of the laser and adjust it if necessary (see Section 6.3.2, page 119).
4. Completely mount the bellows on the beam expander.
5. Turn off the main switch.

8.1.8 Installing the SHG galvo head



Figure 8.17 Mount the galvo head

Attention: Remove or insert the connecting cable of the galvo head only without tension!

In case of non-observance, the galvo head can be damaged!

Attention: Before installing the galvo head, check the labeling of the wavelength (Label "532 nm")! The same applies to optical components mounted on the galvo head (field optics). Changes will result in damage to the optical components!

1. Mount and connect the galvo head.
2. Check the focal distance using the stickers on the galvo head and adjust if necessary.
3. Secure the shutter against activation.
4. Switch on the main switch, wait for a preheating phase of 15 minutes.
5. At the same time, start the machine configuration.

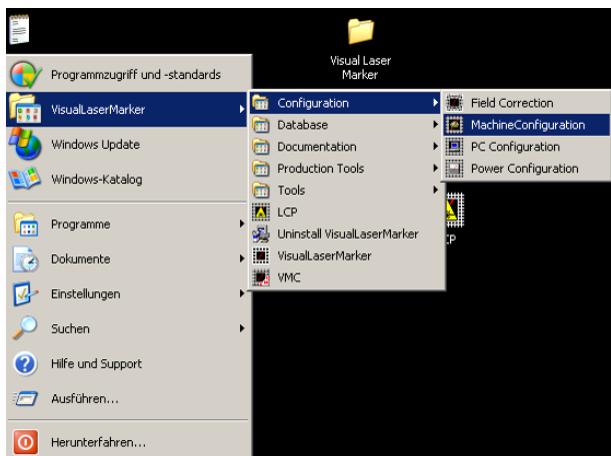


Figure 8.18 Start machine configuration

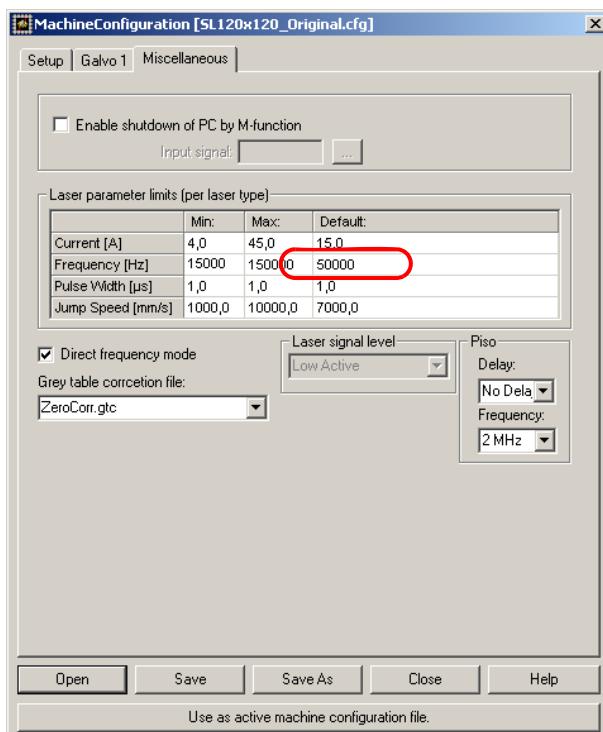


Figure 8.19 Setting the machine configuration for the SHG-model (1)

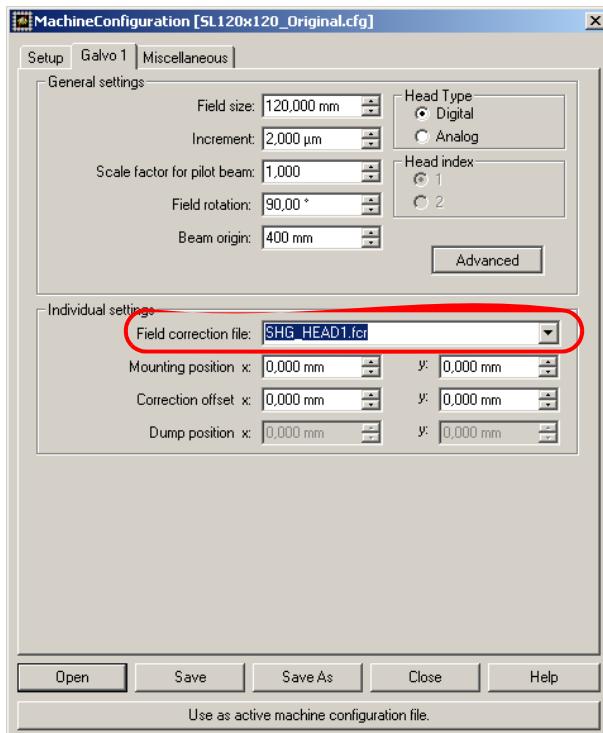


Figure 8.20 Setting the machine configuration for the SHG-model (2)

- 6.** Under "Miscellaneous", set the value "Default Frequency" to **50,000 Hz** and the value for "Min. Frequency" to **15,000 Hz**.

- 7.** Load the field correction file for the galvo head that is used and **532 nm** field optics.

i Note: Because of the different wavelength, the field correction for 1064 cannot be used!



Figure 8.21 Power measurement



Attention: Before measuring the laser output, check the settings of the measuring device for the correct wavelength ("532 nm")! Do not overheat the measuring head during the measuring procedure! The use of the separately available cooling adapter (see Chapter 3) is recommended.

8. After the preheating time has elapsed, position the output measuring device outside of the focus.
9. Set maximum output according to the "Laser Type - Output" table on Page 69.



Attention: Take measures for protection against laser radiation (see page 211)!
Use protective goggles that are suitable for the wavelength of the SHG laser (532 nm)!
If, at approximately 30 A and 50 kHz, a minimum laser output of 2 W is not reached, contact ROFIN-SINAR for consultation.

8.1.9 Fine adjustment of the SHG

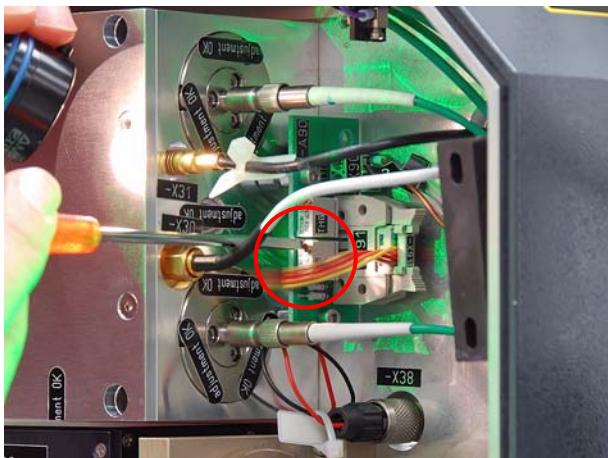


Figure 8.22 Fine adjustment

1. Open the shutter.
2. Performing a fine adjustment on the SHG potentiometer:
 - Turn the potentiometer max. 45° into one direction,
 - wait 2 to 3 minutes until a stationary condition has been reached.
 - and repeat setting and measurement until the maximum laser output is reached.

i **Note:** Note the angle by which the potentiometer was turned and in which direction to be able to reset the original position if necessary. If the laser output does not increase in one rotation direction, the potentiometer must be turned in the other direction after resetting the original position. The maximum laser power should be within one revolution of the potentiometer.

! **Attention:** Do not overheat the measuring head during the measuring procedure! The use of the separately available cooling adapter (see Chapter 3) is recommended.

3. Limit the maximum output according to the "Laser Type - Output" table on Page 69.
4. Close the shutter.
5. Setting the locking behaviour of the Q-switch:

i **Note:** The procedure for setting the locking behavior of the Q-switch varies according to the different laser types.

! **Attention:** Take measures for protection against laser radiation (see page 211)!
Use protective goggles that are suitable for the wavelength of the SHG laser (532 nm)!

8.1.10 Power adjustment for the SHG HG-24

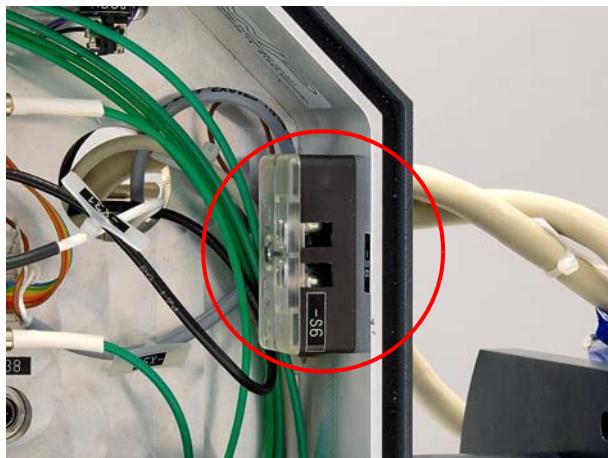


Figure 8.23 Interlock switch

RSM PowerLine 20E/EL SHG:

i Note: Owing to the system design, this SHG model always exhibits leakage power. The procedure described above will set the best locking point with open shutter and activated laser beam.

- Preset the operating voltage according to Section 7.6.5, page 185.

i Note: The check for leakage power with an IR transducer screen is not performed with SHG models.

- Set **20 kHz** and a current for approximately **8 W**.
- Open the shutter.
- Turn on the laser beam.
- Adjust the potentiometer of the HF driver until the maximum laser power is reached.
- Wait 2 to 3 minutes until a stationary condition has been reached.
- and repeat setting and measurement until the maximum laser output is reached.
- Close the shutter.

RSM PowerLine 12E/25E SHG:

- Perform the setting according to Section 7.6.5, page 185.

i Note: If there is leakage power for these SHG models, troubleshoot according to Section 5.5, page 83.

1. Turn off the main switch.
2. Pull the mains plug.
3. Remove the bridge from the interlock switch.
4. Mount the cover of the laser head.
5. Commission the laser system.
6. Check the laser power behind the galvo head (on the workpiece) using the power measurement device and perform a test marking procedure. Enter the measurement values in the logbook.

8.2 Removing SHG components

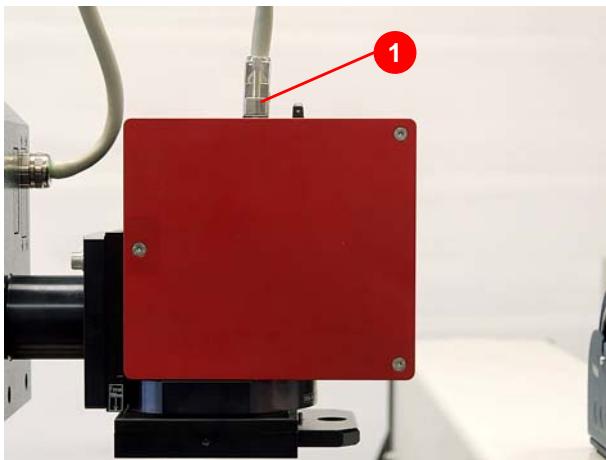


Figure 8.24 Galvo head connecting plug

1. Loosen and remove the connecting plug of the galvo head (1) (Figure 8.24).

Attention: Remove or insert the connecting cable of the galvo head only without tension!

In case of non-observance, the galvo head can be damaged!

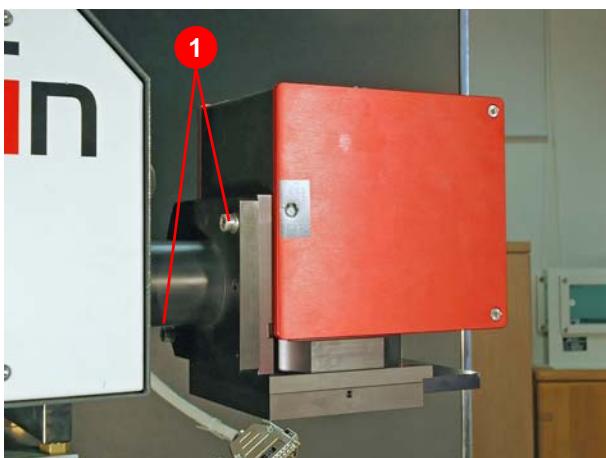


Figure 8.25 Dismantling the galvo head

2. Loosen the fastening screws (1) (Figure 8.25).
3. Remove the galvo head.

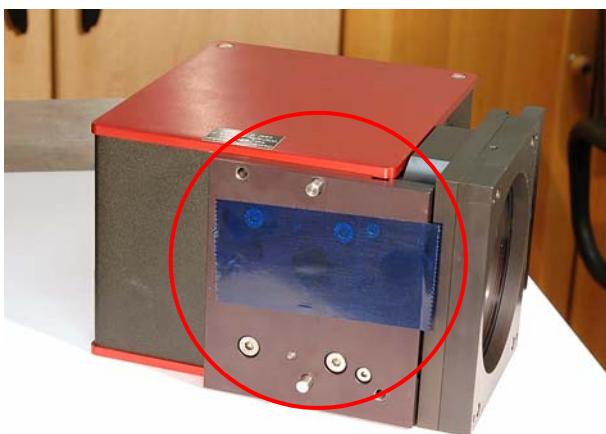


Figure 8.26 Covering the entry openings

4. Cover the entry opening with adhesive tape (tape to be used: see Chapter 3), to prevent contamination of the inside of the galvo head.

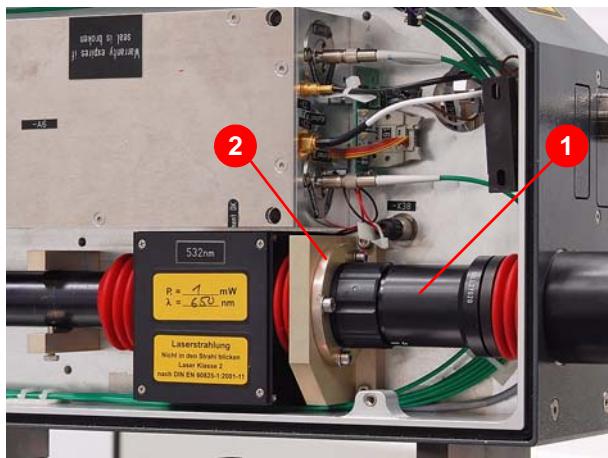


Figure 8.27 Dismantle the beam expander.

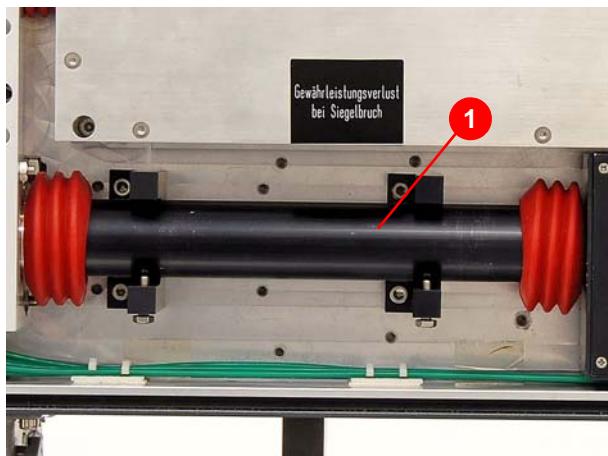


Figure 8.28 Dismantling the beam guide



Figure 8.29 Open the alignment laser housing.

5. Open both lateral covers of the laser head.

Attention: Before removing the beam expander, check the labeling of the wavelength on the beam expanders and attach a new label as needed (Label "532 nm")! Changes will result in damage to the optical components!

6. Remove the beam expander (1) (Figure 8.27) and the mount (2).
7. Unscrew the beam expander from the mount.
8. Close the beam expander with covers to prevent contamination.
9. Remove the beam guide (1) (Figure 8.28) of the laser head.

Attention: Before opening the alignment laser housing, check the labeling of the wavelength and attach a new label as needed (Label "532 nm")! Changes will result in damage to the optical components!

10. Open the alignment laser housing.

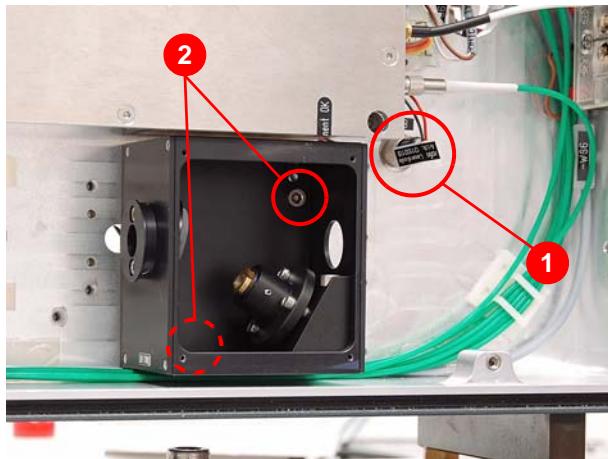


Figure 8.30 Disconnect the alignment laser and remove the housing



Figure 8.31 Close the alignment laser housing

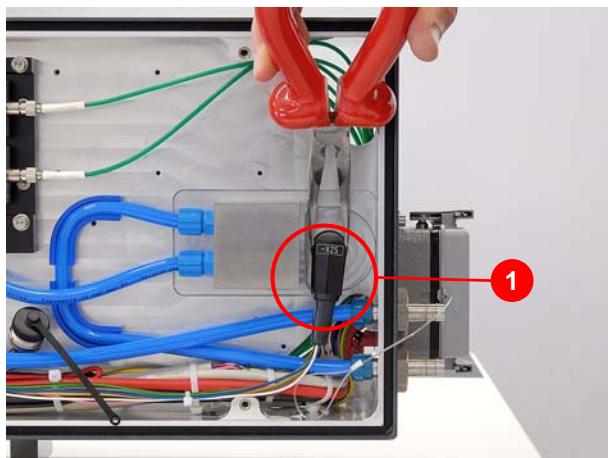


Figure 8.32 Shutter module connecting plug

11. Remove the connecting plug -X38 (1) of the alignment laser (Figure 8.30).

Attention: Before removing the alignment laser housing, check the labeling of the wavelength and attach a new label as needed! Mix-ups will result in damage to the optical components (Label "532 nm")!

12. Loosen the fastening screws of the alignment laser housing (2); remove the housing.

13. Seal the alignment laser housing with the fitting cap (labeling of wavelength).
14. Cover the beam entry and exit of the alignment laser housing with adhesive tape (tape to be used: see Chapter 3) to prevent contamination.

15. Remove the connecting plug (-X25) of the shutter module (1) (Figure 8.32) on the diode side of the laser head.

Attention: If the use of tools is necessary, do not apply force! Do not damage the connecting plug!

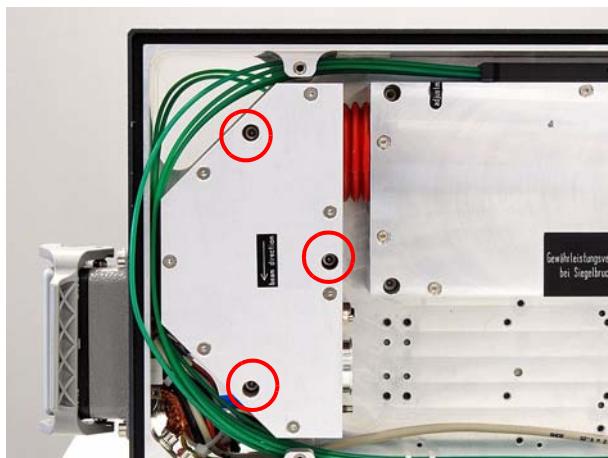


Figure 8.33 Deflecting unit fastening screws

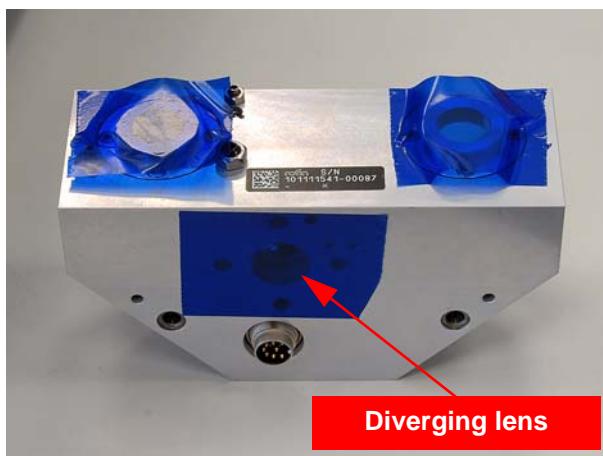


Figure 8.34 Close the deflecting unit

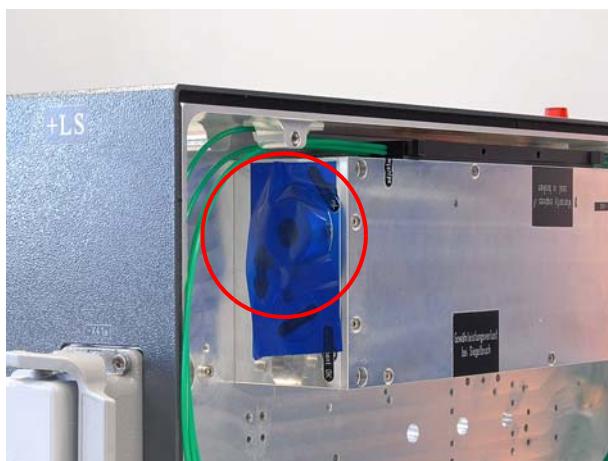


Figure 8.35 Beam aperture of the resonator module

16. Loosen the three fastening screws of the deflecting unit.

Attention: Before removing the deflecting unit, check the labeling of the wavelength and attach a new label as needed! Mix-ups will result in damage to the optical components (Label "532 nm")!

17. Pull the deflecting unit forward off the alignment pins and remove it.

18. Cover the beam entry and exit and also the diverging lens on the bottom of the deflecting unit with adhesive tape (tape to be used: see Chapter 3) to prevent contamination.

19. Remove the bellows from the resonator module.
20. Cover the beam aperture of the resonator module with adhesive tape (tape to be used: see Chapter 3) to prevent the antireflection-coated outlet window of the resonator module from getting dirty.

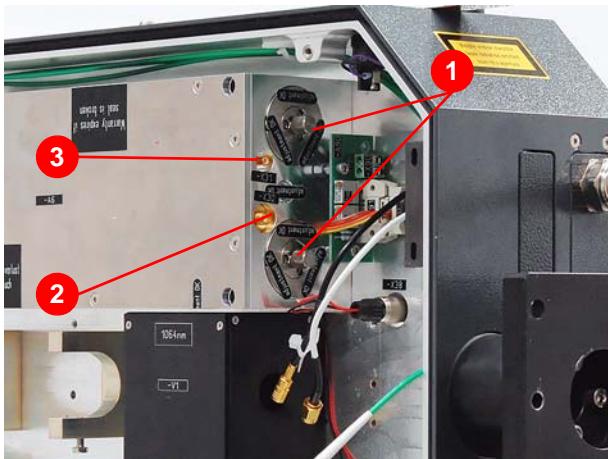


Figure 8.36 Disconnecting the resonator module

21. Loosen the swivel nut and remove the glass fiber line(s).

Attention: In the process, do not use tools! Risk of damage!

Note: In the case of the PowerLine E/EL with two diodes/two glass fiber lines, mark the socket to which the respective glass fiber was connected. In this way, the lines are not mixed up, which can lead to malfunctions.

22. Attach dust protection caps to the glass fiber(s) and the connections on the resonator module (1) (Figure 8.36).
23. Disconnect heating elements from connection -X90.

Note: A bag with dust protection caps and short-circuit bridges is located on the diode side of the laser head (Figure 8.37). Reattach the bag with dust protection caps and short-circuit bridges there when work is completed.

24. Disconnect the SMA plug of the HF line (2) (Figure 8.36) and the SMB plug of the Q-Switch interlock line (3).

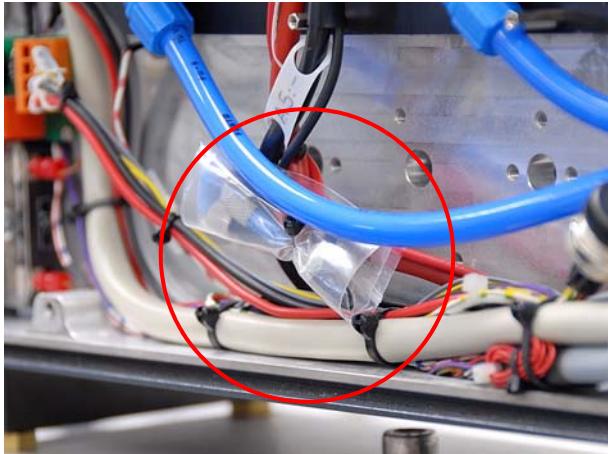


Figure 8.37 Dust protection caps and short-circuit bridges



Figure 8.38 Loosening the resonator module



Attention: With systems that have a cooler that is installed **above** the laser head, take measures in advance to ensure that the water cycle is interrupted at the laser head (e. g. by installing the corresponding stainless steel valves, etc.) to prevent cooling water from continuing to flow.

25. Push highly absorbent paper (e. g. paper towels) underneath the resonator module to absorb any leaking cooling water.
26. Loosen the fastening screws of the resonator module. Tip the resonator module 1 to 2 mm to the rear in a slanted manner so that the module is aerated (a suction noise occurs).



Note: Hold the resonator module securely to prevent it from tipping out and thus losing cooling water in an uncontrolled manner.

27. Pull the resonator module off the alignment pins and then tip it out as shown in Figure 8.39 to prevent the cooling water remaining in the resonator module from spilling. In the process, secure the fastening screws from falling out as well.



Note: Clean up any cooling water that leaks using a cloth. In the process, check the diode side of the laser head for leaking cooling water as well.

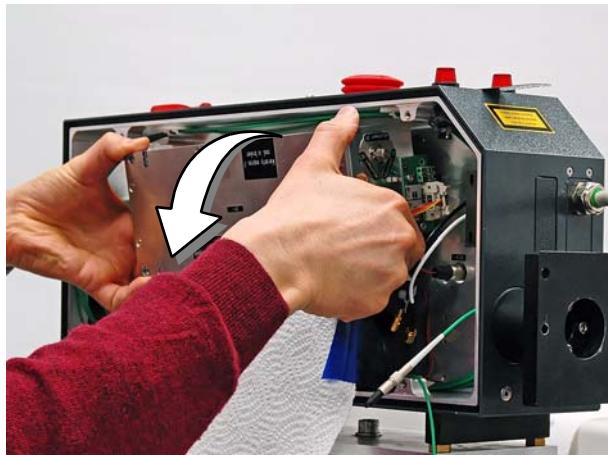


Figure 8.39 Removing the resonator module

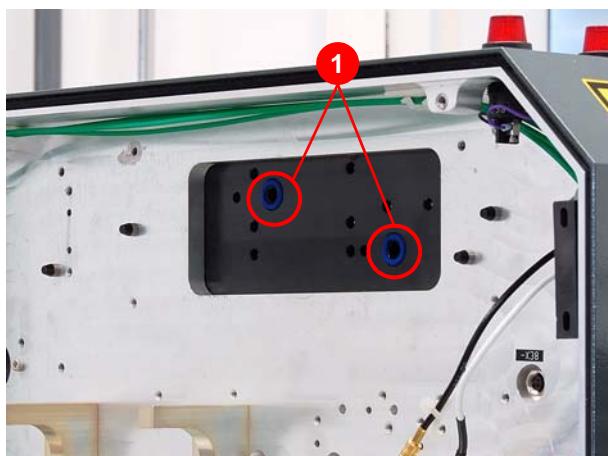


Figure 8.40 O-rings

28. Remove the O-rings (1) (Figure 8.40).

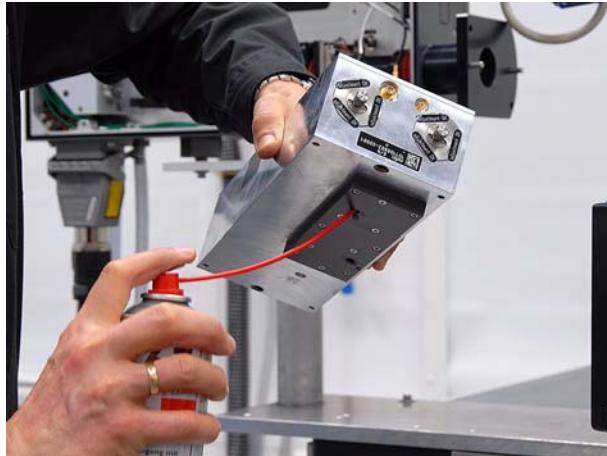


Figure 8.41 Blowing out the cooling water line

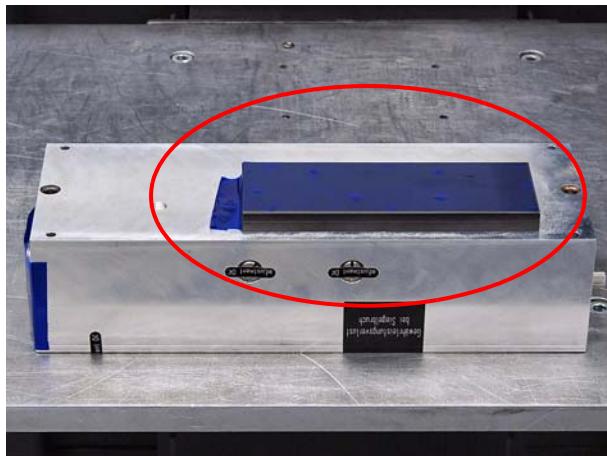


Figure 8.42 Closing the cooling water connection

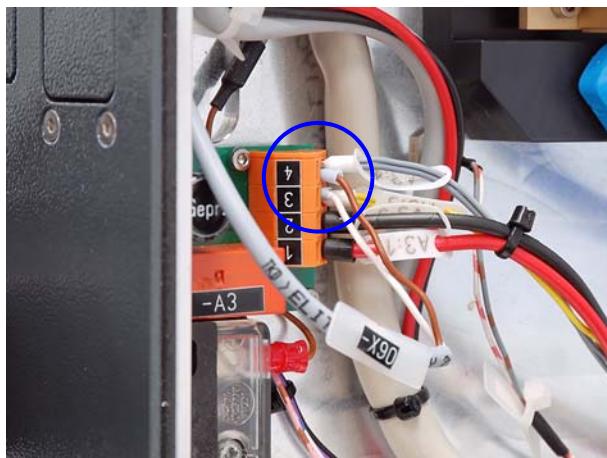


Figure 8.43 Relay PCB

29. Blow out the cooling water line using purified, oil-free compressed air (**1 - 2 bar**), compressed air from a can or nitrogen (N_2) (**1 - 2 bar**). Cooling water remaining in the resonator module can lead to corrosion or, e. g. in case of transportation during freezing weather, damage.

Attention: There is a risk of suffocation in case the nitrogen concentration in the ambient air is too high! Never exceed the permissible limit values!

30. Cover the cooling water connection with adhesive tape (tape to be used: see Chapter 3), to prevent the inside of the resonator module from getting dirty.

31. Disconnect the connecting line for the heating element on the relay PCB from the diode side of the laser head.
32. Pull the line through to the diode side and place the line with the removed SHG resonator module.
33. Retighten terminals of the relay PCB.

Notes

9 Checklist - Power Line E

Adr.*	Parameter	Pw-M**	Default value	SHG II and THG	Set value
Diode current; diode voltage					
(03)	Programmed upper current limit	PW	(refer to the explanations)	(refer to the explanations)	
(05)	Programmed lower current limit	PW	6,0 A	6,0 A	
(0D)	Error threshold: Diode voltage crit. high	PW	9,5 V diode voltage	9,5 V diode voltage	
(0E)	Error threshold: Diode voltage too low	PW	0,5 V diode voltage	0,5 V diode voltage	
Pulse frequency					
(12)	Programmed upper frequency limit	PW	200 kHz	200 kHz	
(14)	Programmed lower frequency limit	PW	20,0 Hz	15 kHz	
Pulse suppression					
(2A)	Residual pulse level minimum	PW	20	20	
(2D)	Pulse step maximum	PW	100	100	
(32)	Residual cw level minimum	PW	1	1	
(35)	Cw step maximum	PW	100	100	
Laser power					
(56)	Registry	free	0	0	
(53)	Programmable factor	free	10 W/V	10 W/V	
Cooling water temperature					
(64)	Programmed nominal value for the water temperature	PW	25,0 °C	25,0 °C	
(67)	Offset for the temperature (PT100 cable length offset)	PW	100 0,01 °C	100 0,01 °C	
(B5:7)	Water temperature PID control (AKA P-regulation)	PW	active	active	
Flow rate					
(6E)	Programmable error threshold: Flow rate too low	PW	2,0 l/min	2,0 l/min	
Times					
(9B)	Resetable operating time meter (for the laser diode):	PW	min	min	

Adr.*	Parameter	Pw-M**	Default value	SHG II and THG	Set value
(81)	Lead time set at the moment	free	40 sec	40 sec	
(89)	Warm-up time set at the moment	free	10 sec	10 sec	
(8D)	After-running time set at the moment	free	20 sec	20 sec	
(95)	After-running time warning set at the moment	free	120 sec	120 sec	
Options					
(B4:6)	Remote acknowledgement/remote start	free	inactive	inactive	
(B4:5)	Long duration shutter protection	free	active	active	
(B4:4)	Shutter & process protection	free	active	active	
(B4:3)	Beam time protection	free	active	active	
(91)	Beam time protection adjusted	free	20 sec	20 sec	
(B4:2)	Door contact check	free	inactive	inactive	
(B4:1)	Shutter current protection (when activating the shutter the current will be lowered)	free	inactive	inactive	
(B5:0)	Lead time 15 min. from mains on	PW	inactive	active	
(B5:1)	First pulse suppression with pulse suppression board	PW	inactive	inactive	
Pulse suppression board					
(B5:2)	Flow rate maximum monitoring	PW	inactive	inactive	
(B5:4)	Monitoring the H2 sensor (cavity)	PW	inactive	inactive	
(B5:5)	Fiber_Break_Ctrl	PW	inactive	inactive	
(B5:6)	Monitoring the cooling water level	PW	active	active	
(BE:0)	CW mode blocked	PW	inactive	active	
(BE:1)	Gate monitoring	free	inactive ***	inactive ***	

Explanations

* Address. The individual parameters are defined by their "Address", with the two-digit hexadecimal number in brackets. The address (nn:m) defines individual bits in registers, nn is the register address, n is the bit number (0 ... 7).

** Password mode. PW: Parameters with permanent settings, requiring a password (customer password or service password); Free: free parameters, can be freely set at any time

*** If the system is loaded with a compatible VLM version, gate monitoring must be set to 'active'.

Index

A

Adapter for cross wires
 Flange for galvo head, E-Line 26
 Adhesive tape 31
 Adjusting aperture for beam expander 26, 107
 Adjusting the angle of the beam expander 117
 Adjusting the beam expansion in the X and Y directions 115, 117
 Adjustment and repair of SHG models 211
 Adjustment tasks 99
 Alignment laser 122
 Beam attenuator 124
 Beam expander 108
 Focal point 119
 Internal power measurement device 126
 Laser beam 102
 Laser head 100
 Main laser 102
 Beam expander mount with angle adjustment 109
 Beam expander mount without angle adjustment 102
 Adjustment tube of galvo head 27
 Aids 23
 ALI
 Checking the system settings 96
 Loading a new ALI configuration 94
 ALI board
 Exchange 204
 Grounding the PC plug-in unit 204
 Alignment laser
 Adjustment 122
 Connection
 Retrofitting for the SHG model 219
 Exchange 191
 Preadjustment 193
 Safety instructions 12

B

Basic setting for beam expansion mount 114
 Beam attenuator
 Adjustment tasks 124
 Cleaning 55
 Exchange 203
 Beam expander
 Adjustment 108
 Cleaning 54
 Exchange 141
 Beam protection time 99

C
 Calibration
 Cooling circuit motor valve 207
 CE guidelines 7

Checklist - Power Line E 235
 Clamp-on ammeter 29, 86
 Cleaning
 Beam attenuator 55
 Beam expander 54
 Deflecting mirror 48
 Deflecting mirror of the alignment laser 53
 Deflecting mirror of the deflecting unit 48
 with adjusting screws on the beam output side 50
 with adjusting screws on the side of the cover 48
 Galvo head 38
 Galvo head with protective glass screwed into the optics
 Protective glass and focusing lens 42
 Galvo head with protective glass slide
 Focusing lens 39
 Galvo head with screwed-in protective glass
 Focusing lens 44
 Glass fiber lines 56
 Optical components 37
 Protective glass
 Galvo head with protective glass slide 38
 Resonator module 56
 Cleaning tasks
 Rubber gloves and dust protection mask 33
 Components at risk of static electricity ESD) 15, 158, 204
 Compressed air can 33, 153, 232
 Contact addresses 3
 Cooling circuit motor valve
 Calibration 207
 Cooling unit
 Changing the 19" plug-in 209
 Changing the supply cabinet 208
 Exchange 208
 Cross-wires 24
 for systems with a pilot laser 25, 26
 for systems without a pilot laser 25
 Current measurement heating element 212

D

Deflecting mirror
 Cleaning 48
 Exchange 142
 Lower unscrew 51, 143
 Unscrewing 49, 142
 Unscrewing upper 51, 143
 Deflecting unit
 Installation 149
 Retrofitting for the SHG model 215
 Removal 147
 Retrofitting for the IR model 229
 Diode module
 Connection 164
 Disconnection 159
 Exchange 157
 Exchange set 161

-
- Insertion 163
Removal 160
Short-circuiting 160
- Diode power
Diode power measurement parts set 24
Measurement 78
- Diode power measurement parts set 24
- Dust protection mask
for cleaning tasks 33
- E**
- E-Line measurement head cooling adapter 34
- Emergency stop circuit
Troubleshooting 66
- Emergency stop mechanisms 16
- Equipotential bonding 15, 157, 204
During the change of the diode module 158
- ESD
See Components at risk of static electricity
- ESD wrist band 204
with spiral cable 24
- Exchange
ALI board 204
Alignment laser 191
Beam attenuator 203
Beam expander 141
Cooling unit 208
Deflecting mirror 142
Deflecting mirror of the alignment laser 145
Deflecting mirror of the deflecting unit 142
Diode module 157
Filter mats 206
Galvo head 129
Galvo head with protective glass screwed into the optics 134
Galvo head with protective glass slide 129
- Glass fiber lines 170
HF generator 176
HN80x power supply unit 199
Internal power measurement device 201
MICO controller 195
Optical components 129
Particle filter and deionizer bag 206
Protective glass 140
Resonator module 150
Shutter module 146
- Explanation of symbols 2
- F**
- Fiber anchor 171, 173
- Filter mats
Exchange 206
- Fine measuring tips 30, 190
- Focal point
Adjustment 119
- Focusing lens
- Cleaning
Galvo head with protective glass slide 39
Galvo head with screwed-in protective glass 44
- G**
- Galvo head
Cleaning 38
Disassembly 130
Exchange 129
Galvo head with protective glass screwed into the optics 134
Galvo head with protective glass slide 129
Galvo head with protective glass screwed into the optics
Cleaning of the protective glass and focusing lens 42
- Galvo head with protective glass slide
Cleaning 38
Galvo head with screwed-in protective glass
releasing a seized protective glass 43, 135
- mount and connect
after changing the optical components 132
after cleaning optical components 41, 47, 138
after laser adjustment 108, 117
Retrofitting for the SHG model 221
- Setting the operating voltage 132, 139
- Galvo head with screwed-in protective glass
Unscrewing a seized protective glass 44, 136
- Glass fiber lines
Cleaning 56
Disconnection 170
Exchange 170
Insertion 173
- Grounding
Plug-in PC unit 204
- H**
- HF generator
Exchange 176
Installation of the HG-25 178
Removal of the HG-24 176
Removal of the HG-25 178, 179
Setting the HF power of HG-24 184
Setting the HF power of HG-25 187
Setting the operating voltage of HG-24 181
- HF power
HF power measuring device 29
Measurement 83
- HG-25 potentiometer
19" plug-in 182, 188
Supply cabinet 182, 187
- High vacuum grease 34
- HN80x power supply unit
Changing the 19" plug-in 199
Changing the supply cabinet 199
Exchange 199
- I**
- Image errors
Barrel and pincushion distortion 59

Focusing errors 60
 Irregular power fluctuations 62
 Marking fault 64
 Positioning error of galvo head 63
 Regular power fluctuations 62
 Trapezoidal distortion 60
 Troubleshooting 59
 Installation and adjustment of SHG components 211
 Interlock switch 17
 Connecting plug -X28 for external interlock 18
 External interlock 18
 Internal power measurement device
 Adjustment tasks 126
 Exchange 201
 IR transducer screen LDT-007 28
 Isopropyl alcohol 32, 37
 Dangers 37

L

Labeling 20
 Laser
 Operation of 8
 Safety instructions 10
 Laser beam
 Adjustment 102
 Laser head
 Adjustment 100
 Laser radiation
 Measures for protection against 11, 67, 100, 102, 119, 122, 124, 141, 150, 157, 170, 176, 195, 199, 201, 203, 204, 207, 208, 211
 Laser system
 Safety instructions 10
 LaserControlPanel
 Pre-adjustment check 99
 LCP
 See LaserControlPanel
 Lens cleaning paper pack 32, 37
 Level gauge
 See precision level gauge
 Loading the configuration 88
 System with operating panel 88
 System without operating panel 91
 With MCT software 92
 Without MCT software 93

M

Main laser
 Adjustment 102
 Beam expander mount with angle adjustment 109
 Beam expander mount without angle adjustment 102
 Maintenance and setup tasks
 Safety instructions for 13
 Marking fault
 Grayscale marking 65

Vector marking 64
 MCT software
 Pre-adjustment check 100
 Measurement head cooling adapter 67
 Measuring adapter
 Galvo voltage 30
 HG-24 signals, SubD9 30
 Measuring devices 23
 Measuring the diode current 86
 Measuring the diode voltage 85
 MICO controller
 Changing the 19" plug-in 195
 Changing the supply cabinet 195
 Exchange 195
 Mounting the SHG components
 Fine adjustment of the SHG 224
 Installing the SHG alignment laser 219
 Installing the SHG beam expander 220
 Installing the SHG deflecting unit 215
 Installing the SHG galvo head 221
 Installing the SHG resonator module 211
 Leakage check 217
 Power adjustment and checking of the SHG laser 218
 Power adjustment for the SHG HG-24 225
 SHG software settings 216
 Multimeter 28

N

N₂
 See Nitrogen
 Nitrogen 9, 153, 232

O

Operation according to regulations
 Safety instructions 7
 Optical components
 Cleaning 37

P

Plug-in PC unit
 Grounding for work on the ALI board 204
 Poly-Stretch gloves 33, 38
 Positioning of laser measurement head
 After the galvo head 67
 At the output of the deflecting unit 75
 At the output of the resonator module 76
 Diode power 78
 On the galvo flange 74
 Power measurement
 Diode power 78
 HF power 83
 Laser power 67
 Assessment of the measurement 72
 Performing the measurement 70
 Laser power measuring points 67

Laser power values 69	Laser class 2 10
Power measurement device 28	Laser class 4 10
Pre-adjustment check 99	Laser system 10
Precautions	Maintenance and setup tasks 13
Administrative 20	Operation according to the regulations 7
Personal 19	Other hazards 19
Precision level gauge 32	Ultraviolet radiation 19
Precision thermometer 29, 168, 174	Scope of the repair manual 2
Protective glass	SHG potentiometer 224
Cleaning	SHG resonator module 212
Galvo head with protective glass slide 38	Connection for heating element 212
Exchange 140	Shutter module
Galvo head with screwed-in protective glass	Connection 149
Unscrewing a seized protective glass 44, 136	Retrofitting for the SHG model 215
Protective goggles 23, 217, 223, 224	Disconnection 146
Version for wearers of eyeglasses 23	Retrofitting for the IR model 228
R	Exchange 146
Removing the SHG components 226	Insertion 149
Repair work 129	Removal 148
Resonator module	Switch -S4
Cleaning 56	19" plug-in 65
Connection 154	Supply cabinet 65
Retrofitting for the SHG model 214	
Disconnection 151, 230	T
Exchange 150	Temperature measurement of the diodes 87
Insertion 154	Thermometer
Retrofitting for the SHG model 214	See precision thermometer
Leakage check of the cooling circuit 155, 217	Tools 23
Removal 152	Torque wrench 31, 164
Retrofitting for the IR model 231	Transducer disk 27
View of SHG version 211	- fixing to the output of the diode module 78, 165
Rubber gloves	aligning to the laser beam 114
for cleaning tasks 33	Mounting 104, 111
Rules for prevention of accidents 8	Transducer disk with cross wires 27
S	Troubleshooting 59
Safety equipment 17	Emergency stop circuit 66
Interlock circuits 19	Image errors 59
Interlock switch	Marking fault 64
External interlock 18	
Safety instructions 7	W
Alignment laser 12	Warning lamp exchange set 35
Beam path 11	Waste disposal information 20
Beam path of the pilot laser 12	Wavelength
Components at risk of static electricity ESD) 15	1064 nm 10
Electrical components 14	532 nm 10, 217, 218, 223, 224
General 8	675 nm 10
Hazardous materials 19	Alignment laser 10
Isopropyl alcohol 37	IR laser 10
Laser class 1 10	SHG laser 10