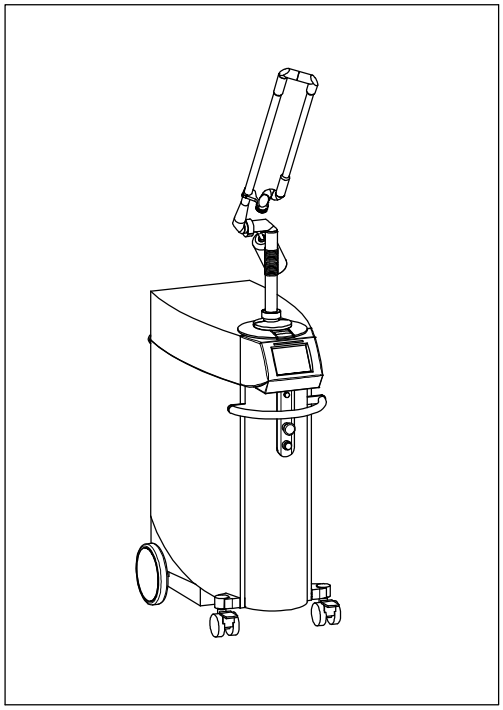
RUBYSTAR

SERVICE MANUAL



Version 1.4

EPILATION & Q-SWITCH

Contents

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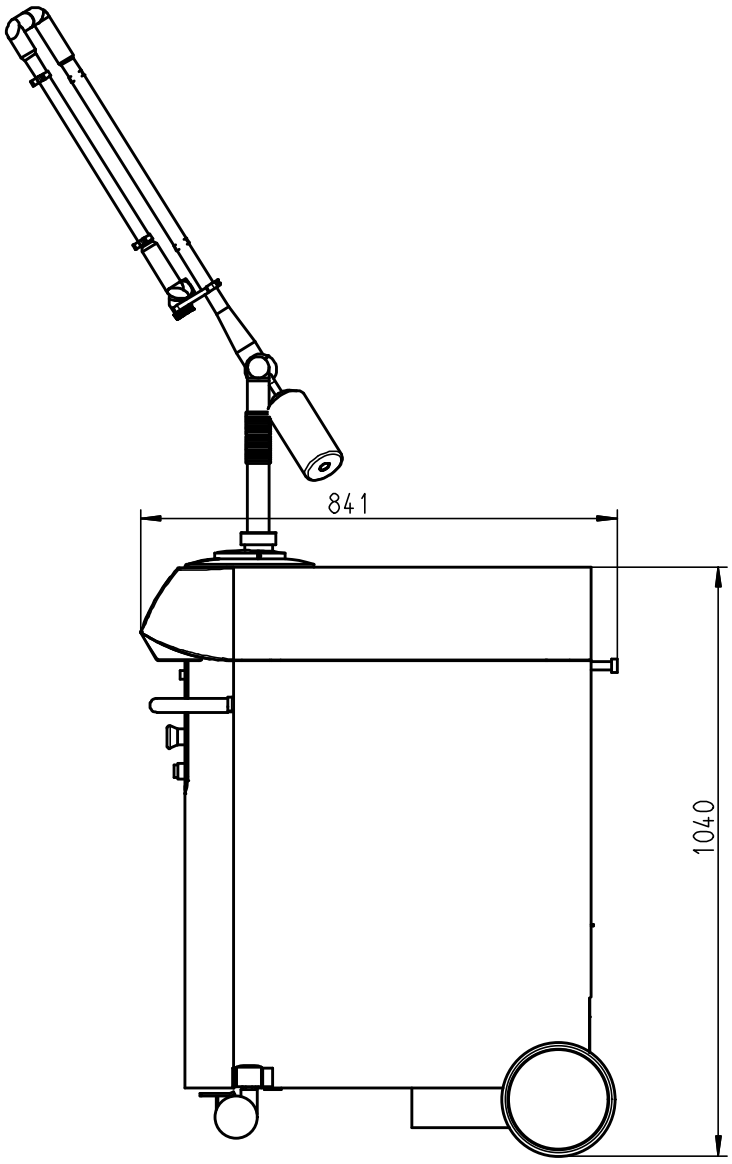
List of illustrations

1 Technical data

System	Microprocessor-controlled laser system
Therapeutic laser	Pulsed ruby laser (Cr: Al_2O_3) Class 4 laser device as per IEC 825
Wavelength	694 nm
Pulse duration EPIL-Mode **Pulse duration Q-Switch-Mode**	about 2 ms about 40 ns
Pulse energy EPIL-Mode **Pulse energy Q-Switch-Mode**	max. 10 J max. 1 J
Pulse rate	Single shot or 1 Hz
Treatment spot size (EPIL-Mode) **Treatment spot size (Q-Switch-Mode)**	Variable up to 14 mm Variable up to 5 mm
Aiming laser	Diode (intensity adjustable) Class 2 laser device as per IEC 825
Wavelength	635 nm
Output power	3 mW
Optical System	Articulated mirror arm with handpiece
Spot diameter (EPIL-Mode) **Spot diameter (Q-Switch-Mode)**	8, 10, 12 and 14 mm 3.5, 4 and 5 mm
Display	LCD display
Operation	Touch screen
Ambient requirements	Temperature: 15 ... 30 °C Humidity: 0 ... 85 % Atmospheric pressure: 70 ... 106 kPa
Transportation and storage	Temperature: 15°C to +70°C
conditions	Rel. air humidity: 10% to 95% (no condensation)
Laser head	Flashlamp, ruby rod, pockels cell
Cooling	Distilled water through heat exchanger and external coolant supply (ext. water temp. = 20° +/- 5°C, ext. Water pressure = 200 to 400 kPa (2 to 4 bar), water flow rate at least 5l/min)
Dimensions	841x446x1040 (LxWxH)
Weight	appr. 150 kg (incl. dist. water)
Floor space (required)	appr. 0,3 m^2
Electrical safety	Acc. to VDE 0750 Part 1, Part 226 DIN VDE 0837 IEC 601-1-1; 601-1-2; 601-2-22
Power requirements	220 ... 240 VAC, P+N+PE, 50/60 Hz
Power consumption	max. 16 A

2 Dimensions and parts



High with articulated mirror arm: apr. 2000 mm

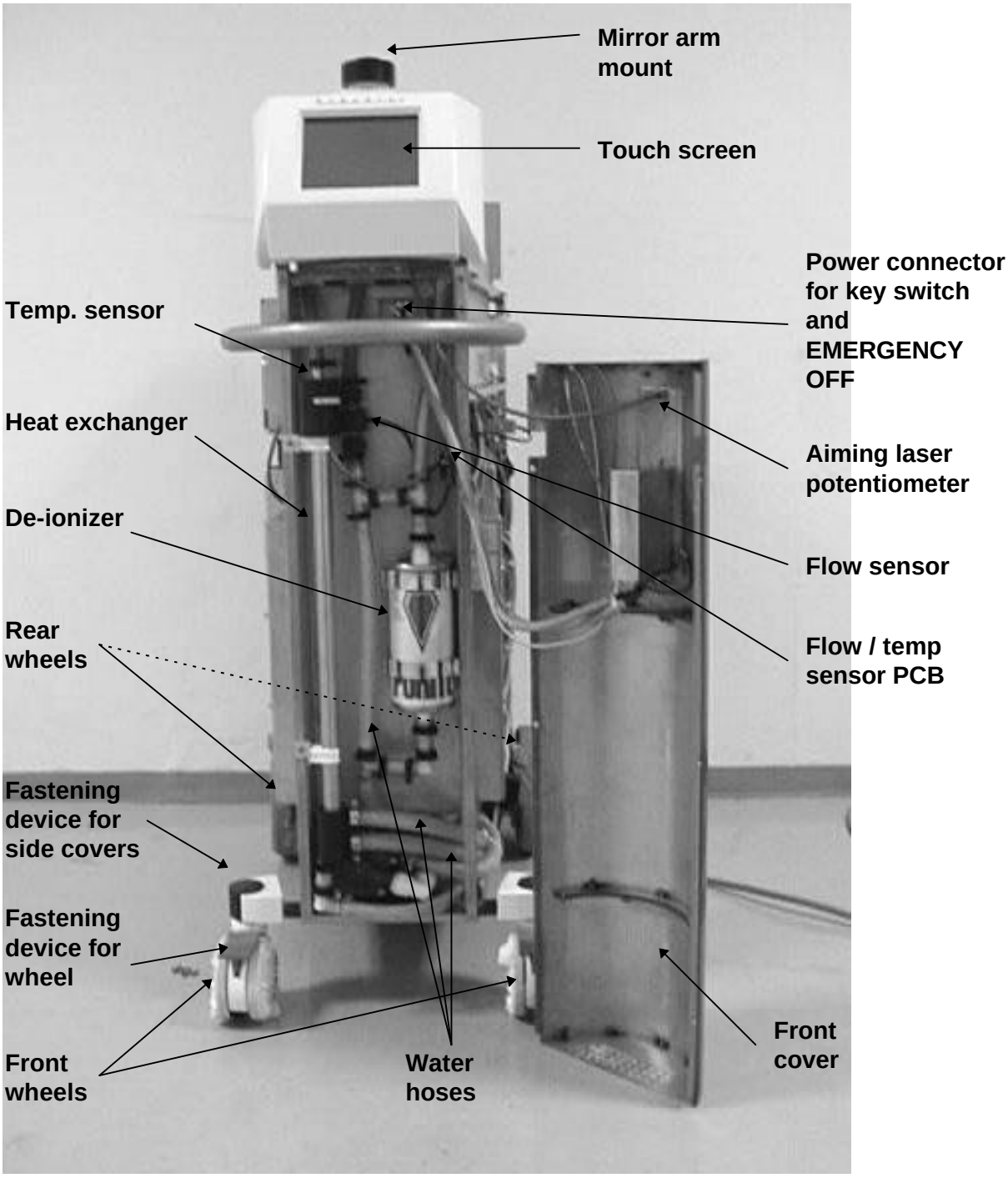


Fig. 1: RubyStar – front view
(Cooling system see Fig. 36 on page 66).

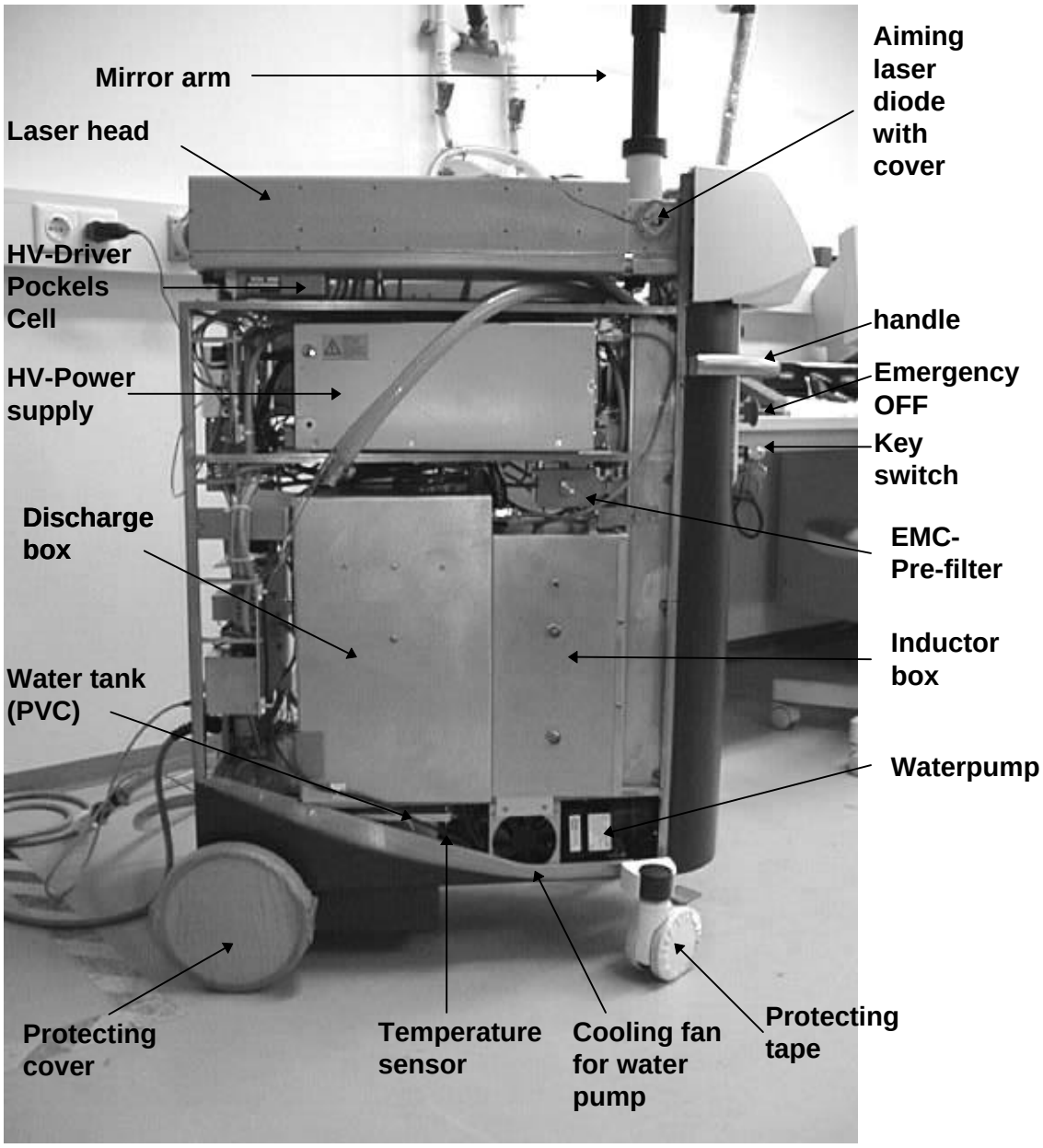


Fig. 2: RubyStar – left-hand view

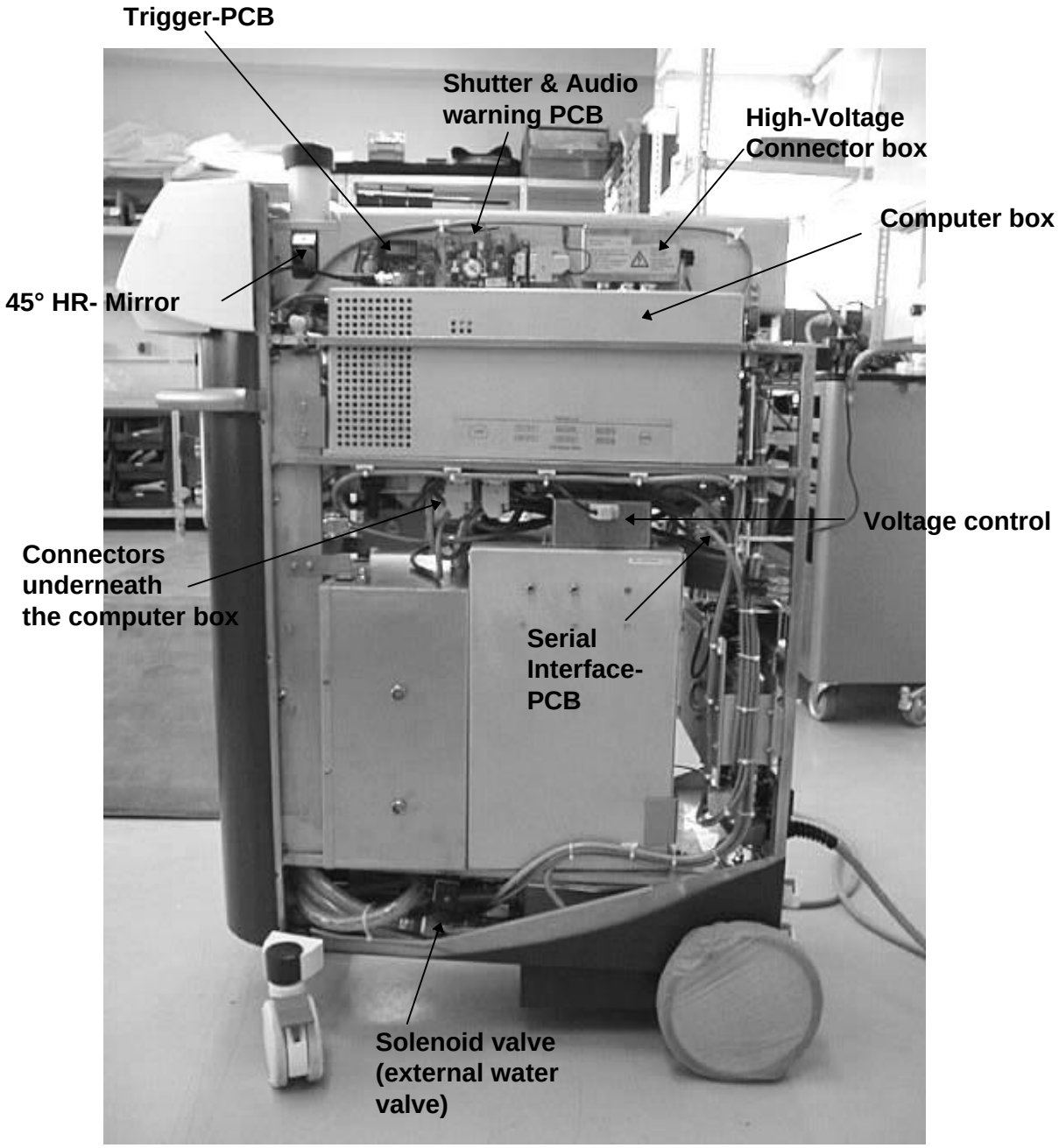


Fig. 3: RubyStar – right-hand view

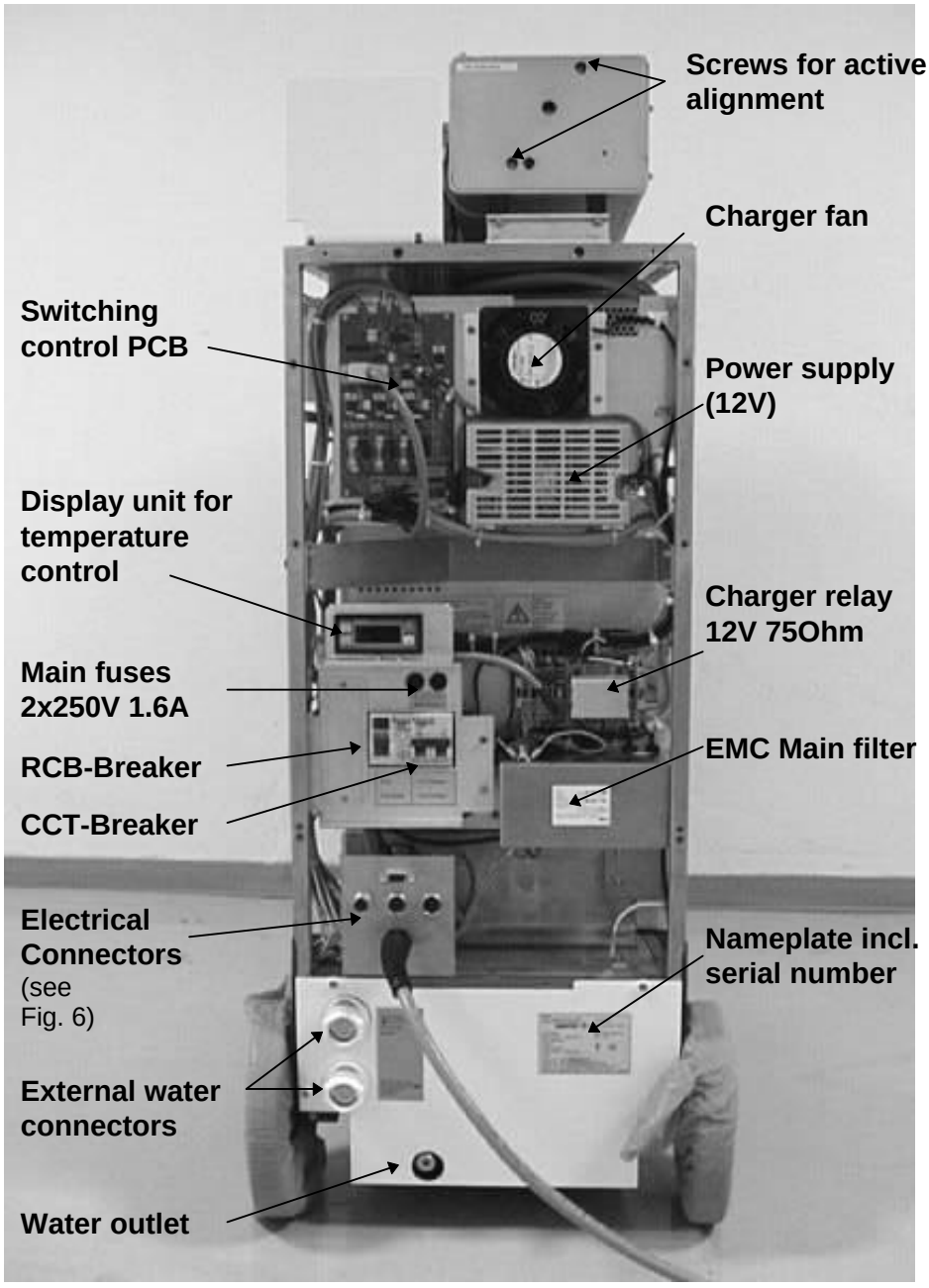


Fig. 4: RubyStar – rear view (EPIL ONLY)

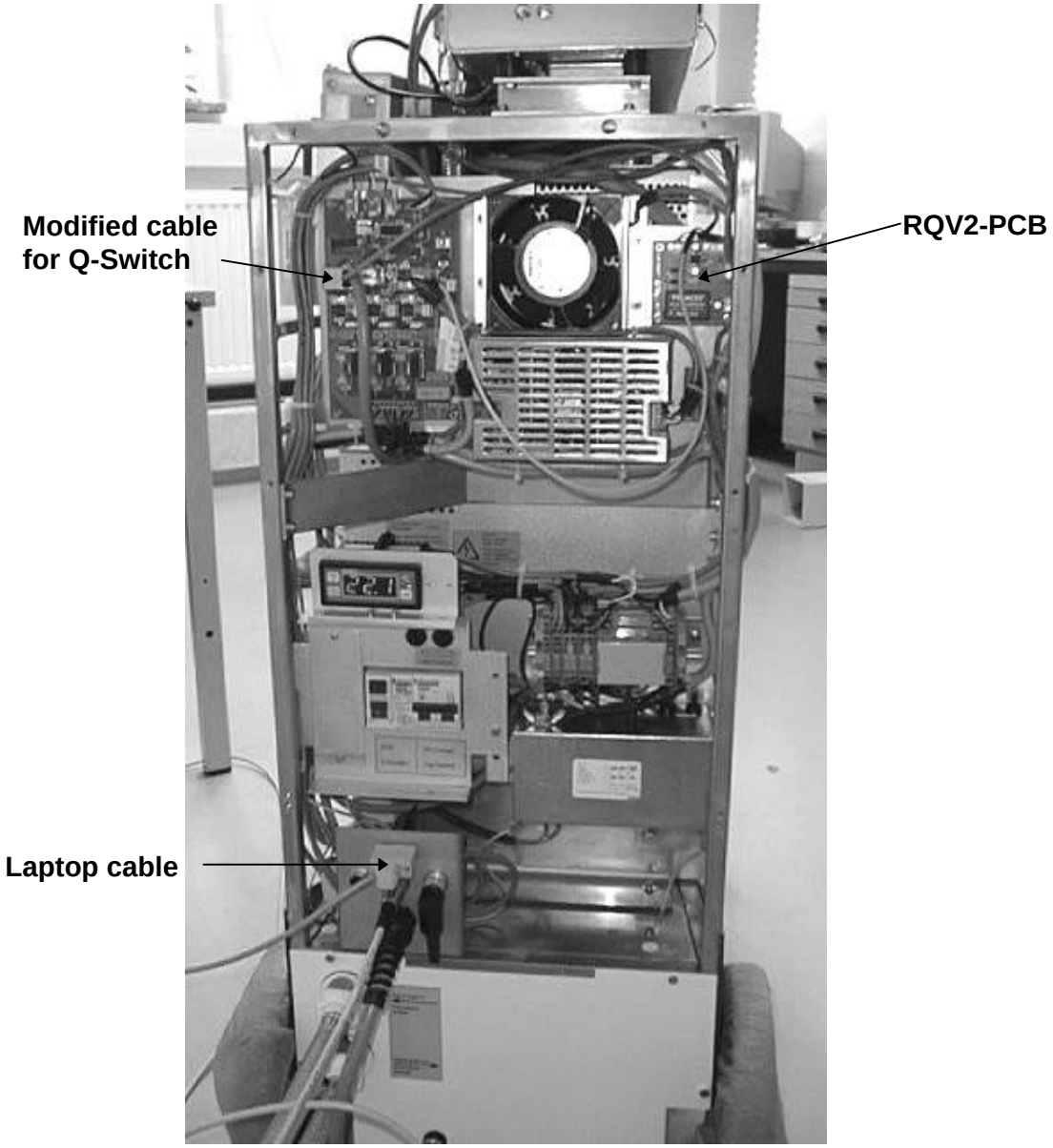


Fig. 5: RubyStar – rear view (Q-SWITCH)

3 Tools and Aids

No.	Designation	Item No.
1	Laptop IBM compatible (WIN 95/98 recommended)	
2	"TELIX" Interface Software	660209025
3	Null modem cable	160101011
4	Adapter for null modem cable	550201132
5	Service box RubyStar vst.	163006801
6	Ophir NOVA display unit	660209022
7	Ophir 30(150)A-HE1 measuring head	660209027
8	Adapter for energy meter	163001903
9	Autocollimator AK 50	661106001
10	Jack for autocollimator RubyStar	163006803
11	Support for autocollimator jack RubyStar	163006804
12	Cross-hairs target	160806801
13	Centering target with glass plate	163001901
14	Centering target for arm exit[1]	163001902
15	Discharge cable RubyStar	163001804
16	Vice	163001803
17	Alcohol (f.ex. Isopropanol, Fishwater[2]) for optics cleaning	660208006
18	Wooden sticks with cotton swab	660205002
19	Photographic paper, developed DINA7 LITEX L720RC	660209001
20	Lens cleaning tissue	660205001

[1] a piece of tape will do it as well
[2] a mixture of 60% Spirit + 40% Ether

4 Installation

4.1 Notes on installation

Caution

The laser system must be installed only by qualified persons who have been trained by Asclepion-Meditec AG.

4.1.1 Preparing for Operation

Caution

After each transfer of the *RubyStar* from a location with cold ambient temperatures to another warmer place, i.e. with temperature differentials above 10°C, the product must be allowed to adjust to the new temperature level over at least 5 hours (!!!) before operation (laser session) can be resumed. The same care has to be taken for the articulated miorror arm.

Disregarding this recommendation may destroy the *RubyStar*!

4.1.2 Preparing the laser

- Unpack the device and the supplied accessories. The packing contains a ramp (international shipment only), over which you can roll the device from the pallet onto the floor.
- Check the delivered parts for completeness (see table, p. 13).
- Check the labels on the laser device. Normally the labels are in German. If necessary, replace them with the english labels included in the delivery package.
- Connect the power cable to the wall outlet.
- Connect footswitch and door interlock connector.

4.1.3 Scope of delivery

- Articulated mirror arm with counterweight
- Handpiece set (EPIL + Q-SWITCH)
- Footswitch
- Door interlock plug
- Key (2)
- Coolant hoses (two 4 m (½ inch) water tubes with quick-release fittings on laser end

- Laser safety goggles
- EpiCheck
- Cooling set
- Skin protection film
- Marker
- Hair Counting Loupe
- Protective cream
- Set of stamps and special inkpad
- Manuals
- Option: Kryo cooling unit

4.1.4 Safety

Distance from wall:	RubyStar basic unit: Keep a clearance of at least 15 cm to the rear panel for cable connections.
Floor quality:	Smooth and even surface (e.g. PVC covering, floor tiles).
General requirements:	Keep flammable and volatile substances and materials away from the laser aperture. Do not operate the laser without the articulated mirror arm being mounted.
Labeling of entrances:	Warning lamps must be installed above all entrances to the laser room. Post laser warning signs to the doors. Two sets of warning labels will be provided with every device.
Door interlock:	Observe any relevant national regulations.

Explanation:

By opening an external contact you can prevent laser radiation from being emitted. This contact must not get in touch with a power cable and not be accommodated in a connector or any other connecting element carrying line voltage. To be able to operate the laser, this contact must be closed. Our connector for the door interlock is therefore fitted with a shorting bridge. Remove this bridge and connect your door interlock to the same terminals. If you do not use a door interlock, make sure to keep the connector with shorting bridge connected.

Laser emission will be shut off instantaneously when the door is opened during treatment. On the one hand, this will protect the person entering the laser room; on the other hand, the therapeutic success will be uncontrollably affected. The user should therefore consider this precaution thoroughly and, if necessary, another precaution be taken for this case. As with all building facilities and according to the Medical Device Directive, it is the responsibility of the owner/operator to decide about this.

The door interlock must be set up as potential-free break contact (5 V, 20 mA). To install the door interlock, remove the factory-mounted wire bridge from the connector. The connecting lead should be a shielded stranded conductor (2 x 0,25 mm^2).

4.1.5 Electrical connections

1 - External enable

2 - Foot switch

3 - Door interlock

4 - Serial port (RS 232) for laptop

5 - Power cable

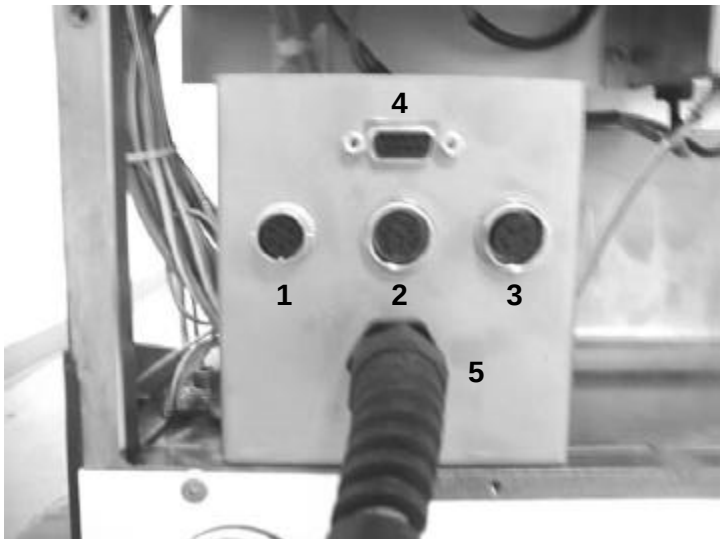
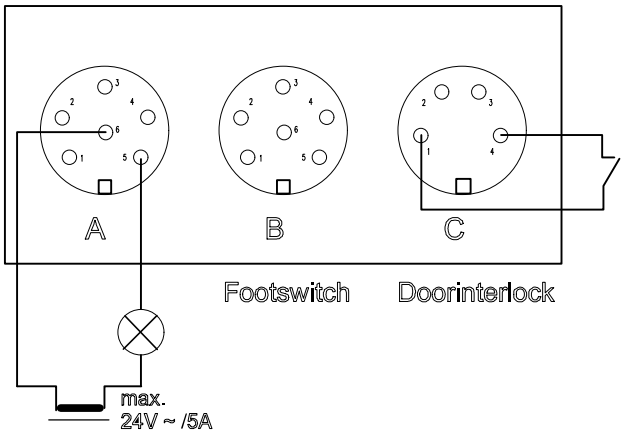


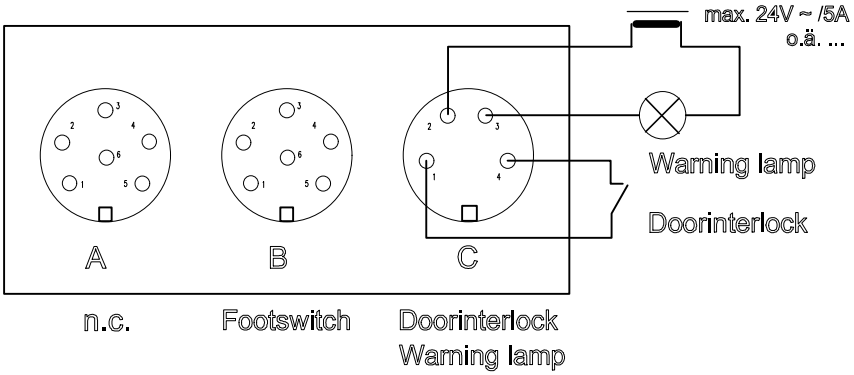
Fig. 6: Electrical connections

4.1.6 External enable

Old version



New version



The external enable contact is providing a voltage of 24 V AC (5 A) for a warning lamp. If the laser is switched on, the connected lamp will be shine.

4.1.7 Connection of the door interlock

Warning

At each entry point to the laser zone (typically the room where laser treatment takes place), a warning lamp must be installed in addition to the prescribed warning signs. This lamp must light (or flash), as long as laser action is going on.

A male port is located at the back of the laser for connection of an external door contact to ensure that the treatment beam of the laser is immediately switched off on opening the entrance door to the laser zone. The delivered connector is bridged inside for using without a connection to the door.

4.1.8 AC Power Supply

To operate the laser, a single-phase socket with at least 16 A (T) protection is required.

Caution

Check line power supply and specified power requirements for compatibility before connecting the *RubyStar* to the mains supply.

Proceed in accordance with VDE 0107 (=*Association of German Electrical Engineers*).

4.1.9 Fuses

1 - FI - Switch (RCB)

2 - Double Fuse (CCT-Breaker) for the charger

3 - Main fuses (2x1,6A)

4 - Display unit for temperature control

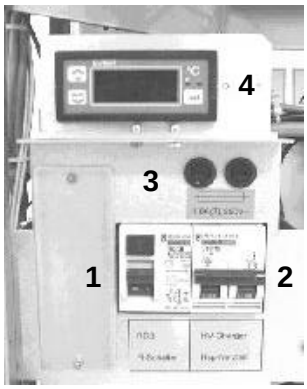


Fig. 7: Double fuse and FI switch

It is useful to switch on only the FI switch for test purposes. This will power the pump, the electronics system and the aiming beam. The capacitor charger is switched on with the double fuse thus applying voltage to the flash lamps.

4.1.10 Water Supply

To cool the laser, one water inlet and one water outlet facility is needed (with siphon trap if desired). Each water tube must allow for the following specifications:

Water flow rate:	at least 5 l/min
Water pressure:	200 to 400 kPa (2 to 4 bar)
Water temperature:	20° +/- 5°C (temperature ≤ 15°C is not dangerous)

1 - External water inlet

2 - External water outlet

3 - Internal water drain

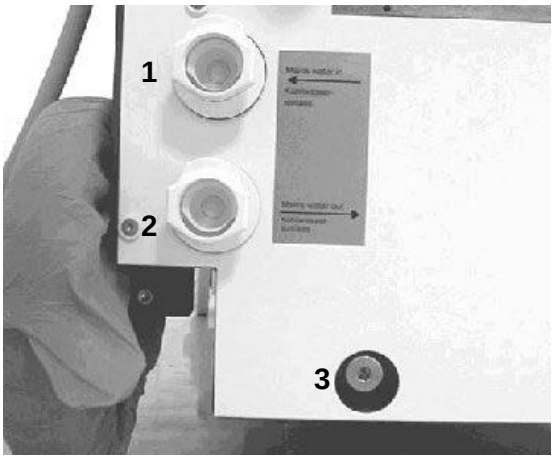


Fig. 8: Water connections

Connection to water supply is via two 4 m (½ inch) tubes (included in scope of delivery). The connection points for water inlet and outlet are clearly marked. Make sure that the two tubes are also properly connected to the local water supply net. Install a shut-off valve with ½ inch tube ports in the water inlet line. Close this valve when a longer break in operation can be foreseen.

If there are questions or problems it's possible to order a special „Installation report" for the RubyStar.

The *RubyStar* may also be operated without external water supply. However, you should be aware that it will have a limited service life in this case, depending on the room temperature and the selected operating parameters.

We don't recommend to use the laser without the external water supply especially during longer treatments.

If you decide for an external "Elite" cooler (optional delivery item), you should try to avoid installing it in the laser room, if possible, because the cooler dissipates heat, thus, unnecessarily raising the room temperature.

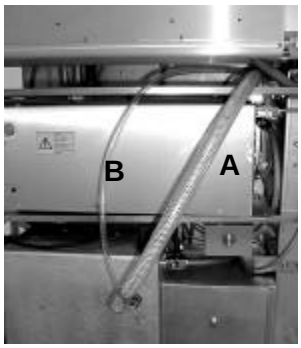
4.2 Advice on installation

Make sure that there is a free space of at least 15 cm between the back panel of the laser cabinet and the wall when you install the *RubyStar.* This is required for electrical and water supplies. For service work, a free space of approximately 80 cm should be kept on all sides of the *RubyStar*.

4.2.1 Fill up internal cooling water

- Remove coverplate and cover from laser device.

- Underneath of the laser head 2 hoses are located: a thick one **(A)** for filling the reservoir and a thin one **(B**) as air vent. Both hoses must be opened.



- Use a funnel or pump to fill up distilled water (10 l / 2.8 gal) until water leaks from the air venting hose (place a vessel underneath).
- Shut the air venting hose. Fill up the thick hose and shut it also.
- Use key switch to turn on the device (FI on, Double fuse off). Let pump run for 1-2 minutes.
- Turn off the device using the key switch. Open the thick hose (keep the thin one closed!) and refill water. Fill hose up to the top and remove any air bubbles by lifting and shaking the filling hose. Shut the hose.
- Turn on the device using the key switch (FI on, Double fuse off). Let pump run once again for 1-2 min.
- Turn off the device. If there are still air bubbles in the thick hose (you can hear it) refill it in the same way. (sometimes you have to do this whole procedure for several times, sometimes you will need only one try).
- Secure thick hose with a hose clamp and thin hose with a cabel strap.

4.2.2 External cooler / Coolant connection:

The using of an external water supply (tap water) or an external cooling device is absolutely required to make successful treatments.

Connection of external cooler:

Cut hoses to required length using the material provided. Fix quick-action couplings to hose ends and secure them by hose clamps. Turn in the quick action couplings to the external cooler by using of a little strap of teflon. Then, connect the hoses to the fasten connectors and secure them with hose clamps. Make sure that there is not a leackage. Fill up water (tap water possible) in the filling hole on the top of the cooler until the level indicator at the lower side of the cooler shows a level between min. and max. Switch on the cooler for check.Then, connect the external cooler to the laser device.
Do not mix-up inlet and outlet connectors !!!

4.2.3 Draining water

Drain the cooling water from the system for transportation or storage of the device at temperatures below 0° C.

- Remove cover from laser device. Open the filling hose and the air venting hose (underneath the laser head).
- Loosen drain screw (on rear panel to drain the water (lift up the RubyStar). Finally, screw in the drain screw.
- Shut the two hoses. Reattach the cover.

4.3 Starting up the device

4.3.1 Switching on the laser unit and checking the display

Make sure that the cables are connected and the fuses are switched on. Turn on the device using the key switch. After switch on the company logo will appear and, few seconds later, the standby screen with a short beep. After this audible sound it is possible to use the touch panel.

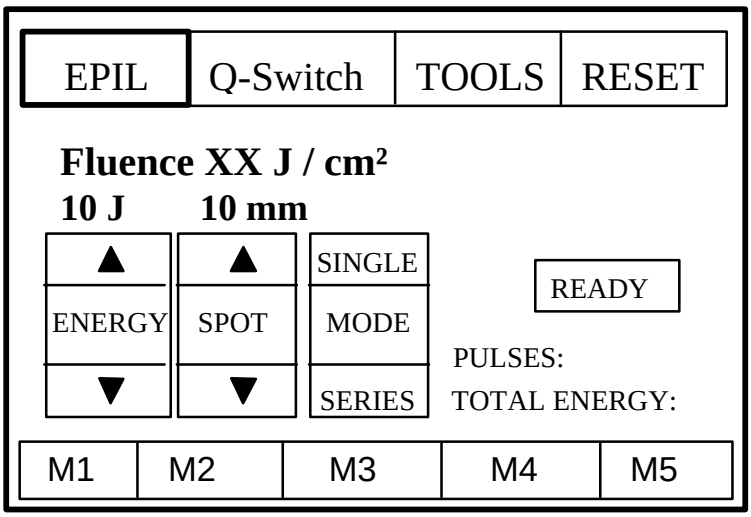


Fig. 9: Display (Standby mode)

Press the energy selector keys to step through all energy levels from 3 J to 10 J and press the spot selector keys to vary the spot size. While doing so, the "Fluence" display must vary accordingly. The laser must allow switching between „SINGLE" and „SERIES", „EPIL“ and „Q-SWITCH“. When the „EPIL“-button will pressed after „Q-SWITCH“ the main functions of the touch panel are disabled for approx. 10 sec. The „RESET“ button is used to reset the pulses and the energy counter. Keep pressed the „RESET“ button for a few seconds. Press „READY“ to leave the standby mode. If the CCT breaker at the rear side (behind small aperture) is switched on, the fan of the charger unit should start now. By pressing the footswitch it is possible to release laser energy now. If the laser is working in standby mode for more than 20 minutes, a short beep will be heard.and the charger will switch off automatically. Please also check whether tha aiming beam is vissible. The brightness of the aiming beam diode can be changed by the potentiometer located near the handle at the front cover.


Warning

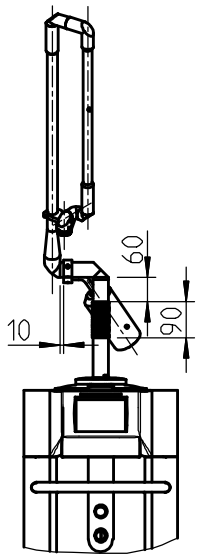
By pressing the footswitch, Class 4 laser radiation is emitted from mirror arm mount. Observe all regulations for the protection against unintentional irradiation by the laser.

4.3.2 Mounting the articulated mirror arm

- Take the mirror arm out of the package and remove the dust protection at both sides of the arm.


Caution

If you fail to remove the dust protection, this will cause destruction of the articulated mirror arm in laser operation.



Mounting the articulated mirror arm:

Standing in front of the device, turn the arm so that its second element points to the left. Fasten the arm by means of the 3 delivered screws provided (included in the package).

Attaching the counterweight:

Screw down the counterweight between the first and the second knuckle. It is important that the second element of the arm points to the left and the counterweight is at the right behind it! Take the weight and first mount the delivered parts of the weight to the weight holder. Then attach the weight with several turns to the holder and fasten it.

Detachment:

To be performed in reverse order (First, remove the counterweight, then take off the arm).

Caution

The elements of the articulated mirror arm are screwed and glued against each other. If you fail to mount the counterweight correctly, the screw connection of the second arm element will come loose and the arm will be irreparably damaged!

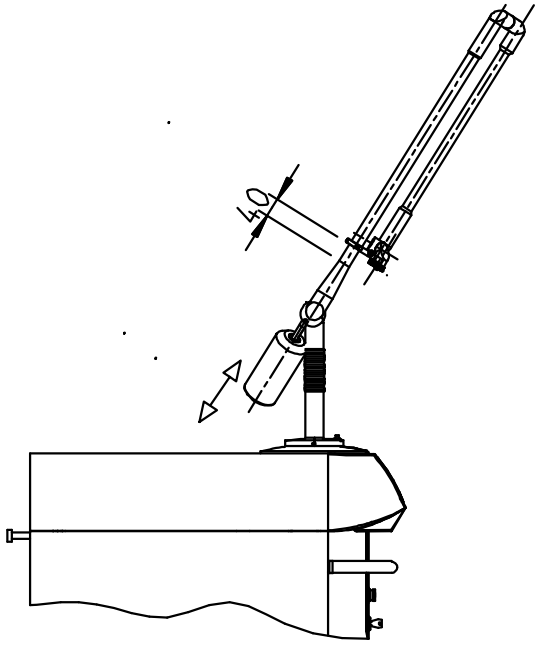


Fig. 10: Mounting the articulated mirror arm

Balancing the arm:

Mount the counterweight so that the arm can be moved conveniently.

Rotary weight:

Turn the weight on its guide until it is in balance with the arm including the handpiece. Secure it against loosening with the mounted holder.

Old: Screw-type weight:

The counterweight is screwed down with two hexagon screws that are visible beneath the counterweight.

Sliding the rubber rings:

The arm contains 24 rubber rings. They must be seated so that the weight in no position will knock against the arm.

Mounting the handpiece holder:

One end of the holder can be used for clamping the handpiece, the other one serves for hanging it in. Screw the holder to the lower thicker end of the articulated mirror arm 40 mm above the 2nd knuckle.

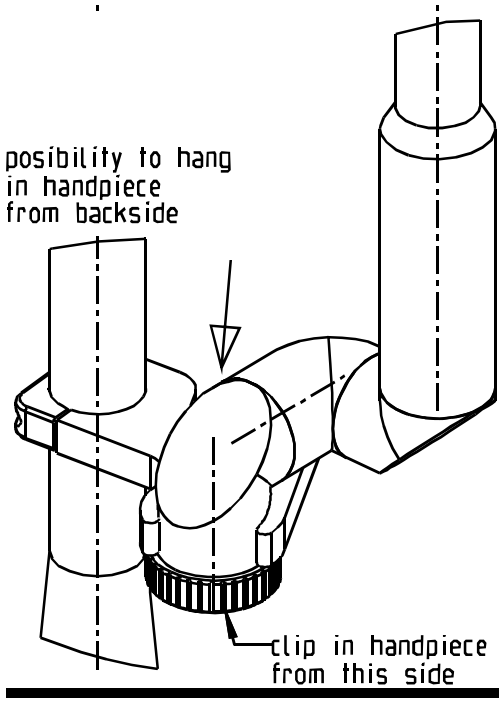


Fig. 11: Handpiece holder

Checking the centration of the aiming beam (EPILATION MODE ONLY):

Before the device is started up, you must verify that the aiming beam / laser beam remain centered when turning the arm.
Turn on the laser (key switch, double fuse may remain off, FI on). Screw "Centering target for mirror arm exit" (see 3 on p. 12) to the handpiece flange of the arm (a piece of adhesive and transparent tape will do it as well) to make the reflection of the aiming beam visible.
For turning the arm, hold it in the position illustrated in Fig. 12 (right angle). Hold the end of the arm in your hand while going around the device. Use only the 180° area in front of the laser (treatment area).
It is important that only the first knuckle of the arm is being turned while all the other knuckles remain stationary!
If the position of the aiming beam spot changes more than is permissible (center ± 1 mm) while you turn the arm, readjust the 45° mirror (far field mirror, see Fig. 3 on p. 9) until the beam is centered and remains stationary when you move the articulated mirror arm as described above.

If it is not possible to readjust the position of the aiming beam with the 45° mirror there are two causes:

The aiming beam is not correct aligned.

Problems ? ***Please have a look to 9.3 on page 79.***

The articulated mirror arm is defective.

Problems ? ***Please exchange the articulated mirror arm.***

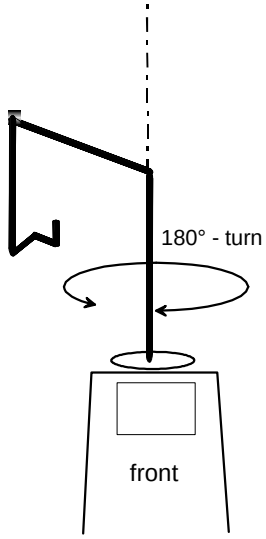


Fig. 12: Checking the centration of the aiming beam

4.3.3 Checking the laser beam

- Clamp the end of the articulated mirror arm in a vice.
- Fix a sheet of photo-paper at a distance of approx. 20 cm in front of the end of the articulated mirror arm.
- On the control console set an energy of 3 J and switch the laser to „READY“ mode. Press the footswitch to fire a test shot onto the photo-paper.
- Switch laser to Standby. Check whether the treatment beam is cutted obscure and the aiming beam is in the center of the spot on the photo-paper.

- Cutted beams may be identified by a precisely circular edge of the spot and concentric rings visible at this edge. If the beam is cutted, carefully correct the beam path at the 45° HR mirror. When doing this, observe the movement of the aiming beam on the photographic paper. Check the adjustment by firing further trial shots. If the alignment is o.k. please make another test shots with an energy of 5 and 10 J.
- The beam profile at 10 J may be round or square (depends on the rod). If the beam profile is irregular, check the optics incl. the ruby rod for damages and waterdrops on the end sides. In the case of unsolvable problems please contact the manufacturer.
- If the aiming beam is not in the center small adjustments at the 3 adjusting screws (far field) could help (see page 79).

4.3.4 Check of the energy with the handpiece

- Mount the handpiece with a 10 mm tip on the mirror arm exit. Place the energy meter directly in front of the handpiece (distance should be appr. 1 mm to the measuring head surface).
- Use the OPHIR NOVA measuring instrument with the measuring head 30(150)A-HE1 SH:

⇒ Connect measuring head to display. If possible: line powered mode, battery-powered operation is however possible.

⇒ Turn on measuring instrument, switch to **ENERGY, RANGE: 30 J, MORE: THRESHOLD: MED.**

⇒ When taking the measurement, always wait (2-4 s). until READY is displayed! Otherwise, the shown values will be wrong.

- Set energy levels from 3 to 10 J and check by firing a trial shot each. If one value should be outside the range specified in the table below, the laser must be readjusted with the laptop (see following pages). The energy loss caused by handpiece is between 15-20%, and, caused by the mirror arm approx. 10%.

EPIL Mode:

Set value	Meas. value	Meas. value
3 J	2.6 J	3.4 J
4 J	3.4 J	4.6 J
5 J	4.3 J	5.7 J
6 J	5.1 J	6.9 J
7 J	6.0 J	8.0 J
8 J	6.8 J	9.2 J
9 J	7.7 J	10.3 J
10 J	8.5 J	11.5 J

In case of not enough energy see 9.4 on page 81 !

Q-Switch-Mode:

Change the handpiece !!!

Warning

By using the EPIL handpiece in the Q-Switch Mode the handpiece will be destroyed definitely! If you use the Q-Switch handpiece in the EPIL-Mode the patient will be burned by the laser beam!

Select the „Q-Switch"-Option on the display.

In the Q-Switch-Mode place the measuring head at least 20 cm in front of the mirror arm exit **(measuring without handpiece!!!)**. Hold a piece of photopaper between mirror arm exit and measuring head and release a shot to check the spot size. Beware of sparks during the shots. Release a shot with 0.5 J. If the spot homogeneous and symmetrical start with the energy measurement.

Software-Version up to V. 3.06 / 3.2:
For the energy measuring procedure you have to place an absorber between the mirror arm exit and the measuring head. Select on the display the „Serial-Mode". Because the energy and the spot size will change after 1-2 shots, you have to use this absorber. Press the footswitch and take out the absorber out of the beam after the 4th shot and measure the 5th shot.

Take care with your measuring head !!!

Software-Version from V. 3.10 / 3.3:
Included in this software-version is a prepulse procedure. That means only the third shot (preseted by the production team, modifications possible) will be released to the measuring head. In this case it is not necessary to use the absorber.

Fig. 13: Absorber

Check the several energy settings by using following table:

Set value on display	Meas. value minimum	Meas. value maximum
0.5 J	0.4 J	0.5 J
0.75 J	0.6 J	0.75 J
1 J	0.8 J	1.0 J

Start with 0.5 J. If the energy at this level is much too high please coonect the laptop and decrease all energy levels in Q-Switch mode (0.5, 0.75 and 1.0) accordingly. Beware that the energy at 1.0 J does not exceed 1.2 J. If the energy is higher you may destroy the laser rod.

Problems: *Please have a look to 9.5 on page 82.*

5 Laser calibration


Warning

When the laser efficiency decreases with increasing temperature, calibrate the laser energy when the device is cold! Before starting the installation connect the external water supply to the laser!


Warning

Adjust energy values only with screwed on handpiece!

5.1 Tools

		Item No.
1	Laptop, IBM compatible	
2	Interface software „TELIX„ **(Windows Hyper Terminal recommended)**	660209025
3	Null modem cable RS 232 crossed	160101011
4	Sub-D Adapter for null modem cable, 9pol 2- male	550201132
5	Display unit Ophir NOVA	660209022
6	Measuring instrument Ophir 30(150)A-HE1	660209027
7	Safety goggles	

5.2 Requirements

- Door interlock plug and footswitch are connected to the device.
- Coolant has been filled up (external water connection is recommended), the device has been installed completely with articulated mirror arm and EPIL-Mode“ - handpiece.
- Energy measurement as in Section 4.3.4. The end of articulated mirror arm (with handpiece!!!) has been clamped and the measuring head has been placed in front of the handpiece.
- The laptop computer has been connected to the device (null modem cable to COM1 on laptop and with adapter to serial port of laser device).

5.2.1 Operation of TELIX software (HYPERTERMINAL / WINDOWS 95/98)

Start corresponding software on the laptop. This software is used to enter the SERVICE-MODE.

WINDOWS 95:	When running TELIX on Windows 95 troubles will arise. To avoid them, you can run Windows 95 in DOS mode and start TELIX from the DOS prompt, or you might as well configure Windows Hyper Terminal accordingly for communication with the device.

TELIX parameters: ***9600 Baud, 8 Data Bits, No Parity, 1 Stop Bit, (on COM 1)***

5.3 Parameter adjustment in Service mode

Requirements:

⇒ Cleaness of all optics has been checked
⇒ Active alignment on the HR-mirror has been done.


Warning

In energy measurement, Class 4 laser radiation is emitted. Observe all regulations for the protection against unintentional irradiation by the laser!

- **Turn on the laser using the key switch.**

5.3.1 Software up to EEPROM (Master) version 2.xx

5.3.1.1 Start-up

Type in @ on the laptop to start the Service mode of the laser.
The following menu will appear:

```
Aesculap Meditec-Service Monitor for RubyStar Laser System

  Select Service Option   :          ENERGY          -- E
                          :          Frequency       -- F
                          :          Exit            -- X
```

After you have selected Energy (E) or Frequency (F), a warning will appear. After you have taken all necessary precautions, press "c" to exit this warning message. Then, you can change the drive values. When you select the 'E' option, the following menu will appear:

```
  Options :               Increase              'I'
                          Decrease              'D'
                          Exit                  'X'
                          Save and exit         'S'
  DAC value = 200
```

Increase	:	Increase DAC value for energy by 1.
Decrease	:	Decrease DAC value for energy by 1.
Exit		Exit program without saving.
Save and exit	:	Save new DAC value and exit the program.

Successful saving is confirmed by a message.

The DAC (**D**igital **A**nalog **C**onverter) value stands for the maximum charging voltage of the capacitor charger. This voltage in turn determines the pump energy in the laser head.

5.3.1.2 Energy calibration

To change the individual drive values for the energy levels, perform the following operations:

1. On the laptop, start the Service mode and activate the Increase / Decrease menu.
2. On the laser display, set the energy level whose drive value shall be changed.
3. Activate the Single shot mode and release a trial shot onto the measuring head.
4. Compare the measured value with the tolerances specified in the table below (cf. Check of the energy Check of the energy). If necessary, change the DAC value by 'I' or 'D' commands. The new value appears on the laptop: e.g. "New DAC-Value = 185"

Set value on display	Meas. value minimum	Meas. value maximum
3 J	2.6 J	3.4 J
4 J	3,4 J	4.6 J
5 J	4.3 J	5.7 J
6 J	5.1 J	6.9 J
7 J	6.0 J	8.0 J
8 J	6.8 J	9.2 J
9 J	7.7 J	10.3 J
10 J	8.5 J	11.5 J

5. Release a shot onto the measuring device. If necessary, repeat Step 3.
6. If the desired energy has been reached, type in 'S' to save the new value to the table of drive values and exit the program.
7. Change the energy level on the touch screen of the ruby and start the telix software with @ again.

This procedure must be repeated for every energy level. Please note that after the save command the laser will always exit the service mode so that you must always start the adjustment with the first step.
After every step you have to note the new values to the table delivered inside of the top cover.

5.3.1.3 Frequency adjustment

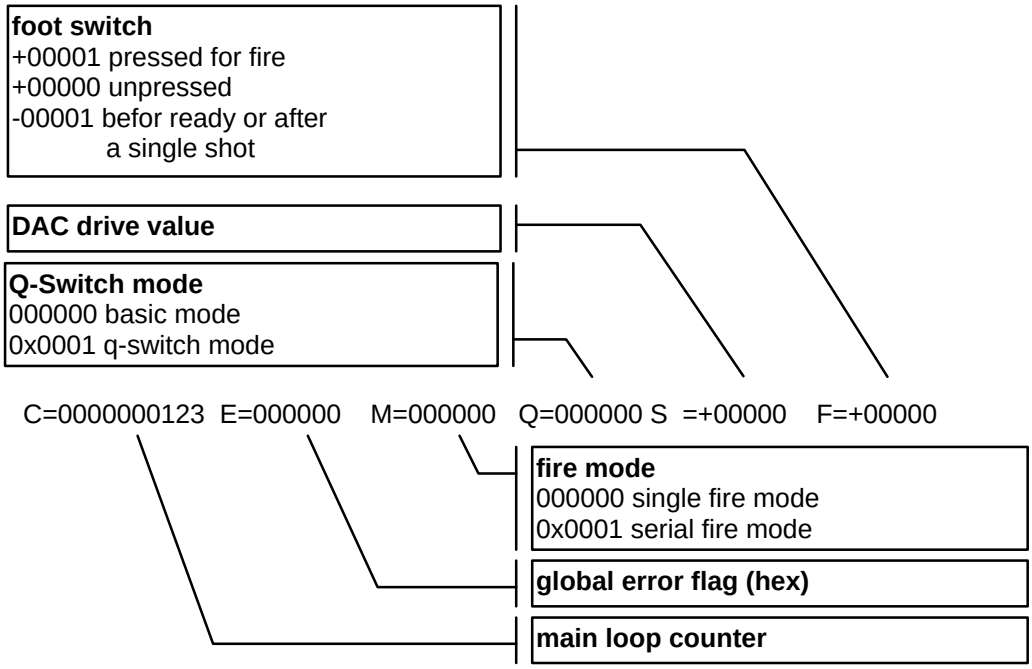
It is not necessary and not allowed to change the frequency !!!

5.3.2 Software up to EEPROM (Master) version 3.04 (partly with Q-Switch option)

Please connect the laptop to the service connector. Start a terminal program (Telix, Hyperterminal) and turn on the machine with the keyswitch.

If the main processor works, then you can see the prints at the service computer. A comma stands for an inquiry to the display unit and a asterisk stands for an unnecessary sent byte from the display unit. Necessary byte received from the display unit will show separately. The display unit sends four bytes sometimes five bytes.
The structure is: start byte, instruction byte, low data byte, high data byte [, stop byte]

For a communication check will sent back the necessary bytes to the display unit. Necessary bytes are the start byte, the instruction byte and, if exist, the low data byte.



Example for the normally service screen:

,C=0000000121 E=000000 M=0X0001 Q=000000 S=+00000 F=+00000	*basic & repeat mode, standby*
,C=0000000122 E=000000 M=0X0001 Q=000000 S=+00000 F=-00001	*foot switch pressed*
,C=0000000123 E=000000 M=0X0001 Q=000000 S=+00000 F=-00001	*still pressed*
,Receive from Display = aa 30	*ready on (armed)*
Send to Display = aa 30	*send back*

,C=0000000124 E=000000 M=0X0001 Q=000000 S=+00157 F=-00001	*still pressed, no fire*
,C=0000000125 E=000000 M=0X0001 Q=000000 S=+00157 F=-00001	*still pressed, no fire*
,C=0000000126 E=000000 M=0X0001 Q=000000 S=+00157 F=-00001	*still pressed, no fire*
,C=0000000127 E=000000 M=0X0001 Q=000000 S=+00157 F=+00000	*unpressed*
,C=0000000128 E=000000 M=0X0001 Q=000000 S=+00157 F=+00001	*pressed again - fire*

5.3.2.1 Start-up

Type in @ on the laptop to start the Service mode of the laser.
The following menu will appear:

```
Aesculap Meditec - Service Monitor for Ruby Star Laser System
Aesculap Meditec - [version number]

C -- OPEN SHUTTER
D -- DATA INPUT
E -- ENERGY
I -- Standard Init
K -- Touch panel calibration
L -- LED Setting
M -- DAC MIN / MAX
Q -- Q-SWITCH
W -- Watchdog test
X -- Exit
```

C----Shutter

To improve the alignment of the optical elements, this function allows the shutter to be opened until the next key is being pressed.

D----Data Input

This function is to facilitate troubleshooting. Some signals may be tested online.
(in using this function, however, not all the error messages will be generated.)

```
+------------------
|+------------------ +30 degrees C (Valve)
||+----------------- +45 degrees C (critical)
|||+---------------- Shutter Sense 2
|||| +-------------- +35 degrees C (Warning)
|||| |+------------- IntLock
|||| ||+------------ Water Level
|||| |||+----------- Shutter Sense 1
|||| |||| +---------
|||| |||| |+-------- EOC (End of charge)
|||| |||| ||+------- Foot2
|||| |||| |||+------ Foot1
|||| |||| |||| +----
|||| |||| |||| |+---
|||| |||| |||| ||+--
|||| |||| |||| |||+-
|||| |||| |||| ||||
0000.0000.0000.0000
```

E----Energy

```
Options:  Increase DAC     'I'
          Decrease DAC     'D'
          Increase ENERGY  '+'
          Decrease ENERGY  '-'
          Q-SWITCH ON/OFF  'Q'
          SINGLE PULSE     'FOOT SWITCH'
          Save and exit    'S'
          Exit             'X'

     Basic Values :
```

With ‘I’ and ‘D’ the DAC value is being changed. ‘+’ and ’-‘ change the energy stage. The ‘Q’ command switches alternately between Q-Switch and Basic tables. The current setting will always be displayed. If you exit this function with ’X’, the old values will be kept. With ‘S’ all values will be saved.
It is not necessary to save every value separately. Release the laser pulse using the footswitch. The display is inactive.

I----Standard Init

This function serve to reset the Basic / Q-Switch drive values to predefined values.

Joule	DAC (Basic)
3	157
4	164
5	170
6	175
7	179
8	184
9	188
10	193

Joule	DAC (Q-Switch)
0.50	142
0.75	145
1.00	148

This menu option will be activated automatically, if the system detects a memory error during initialization after switch on (version number, ROM checksum, table checksum).

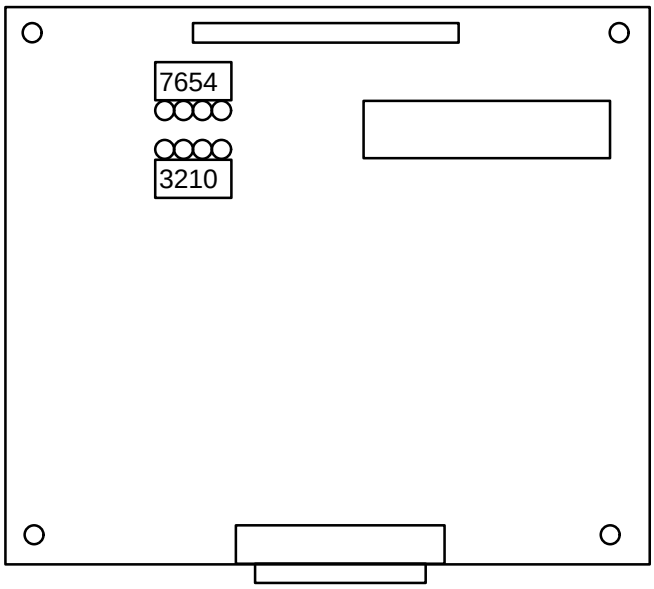
K----Touch panel calibration (Master Version 3.04)

This function allows the adjustment of the touch panel. Due to variations in touch panel manufacture, the active areas may be shifted. If there is such a deviation, the system must be informed of it once.

L----LED Setting

```
1 -- error flag 1
2 -- error flag 2 (unused)
3 -- water flow counter (binery value, < 12 the pump will switch off)
4 -- Port A of PPI
X -- Exit without changes
```

To improve troubleshooting, you can use the LED's in the computer. Four LED's are available:



- error byte 1

bit 0	water flow error
bit 1	water level error
bit 2	remote interlock error
bit 3	shutter error
bit 4	temperature level 1 30°C
bit 5	temperature level 2 35°C
bit 6	temperature level 3 45°C
bit 7	watch dog error

- error byte 2 is unused until now
- flow counter value shows the count value from the IC9 on the 72-1028 board
- PPI online

bit 0	shutter sense 1
bit 1	water level
bit 2	remote interlock
bit 3	temperature level 1 30°C
bit 4	shutter sense 2
bit 5	temperature level 2 35°C
bit 6	temperature level 3 45°C
bit 7	

M---- DAC MIN / MAX

```
Press any key for count up or count down !
Press X for exit !
Charger off !
DAC value :   0
DAC value : 255
```

Pressing a key automatically increases the control voltage by one digit up to 255 or from 255 to 0. Press ‘X’ to exit this function.

Q----Q-Switch

The display needs the information if the device contains the Q-Switch option or not. This function serves to inform the display accordingly. After the setting, an error is being generated. Switch the device off and on again to make the change effective.

W----Watchdog test

It is a check of the correct jumper settings (displayed with a supervised shutdown).
This function serves to test the on-board watchdog. After a few seconds the system must perform a restart. On the laptop computer you may identify a restart by the print of the version number etc. The display shows System Error 1. After a few further seconds, System Error 3 will appear.

X----Exit

Press 'X' to exit the Service Mode.

5.3.3 Software up to EEPROM (Master) version 3.06 / 3.2 (Slave)

In addition to the older version there are following tools:

P---- Read & Show slave version & check sum again

Press 'P' to check the Slave EPROM version without removal of it.

R---- Reset the long time pulse counter

Press 'R' to reset the long time pulse counter.
The Reset will be immediately without warning! Only reset this counter after a flashlamp replacement!

I----Standard Init

This function serve to reset the Basic / Q-Switch drive values to predefined values.
The values below are improved compared with the former software versions!

Joule	DAC (Basic)
3	154
4	160
5	165
6	170
7	176
8	181
9	186
10	190

Joule	DAC (Qswitch)
0.50	140
0.75	142
1.00	144

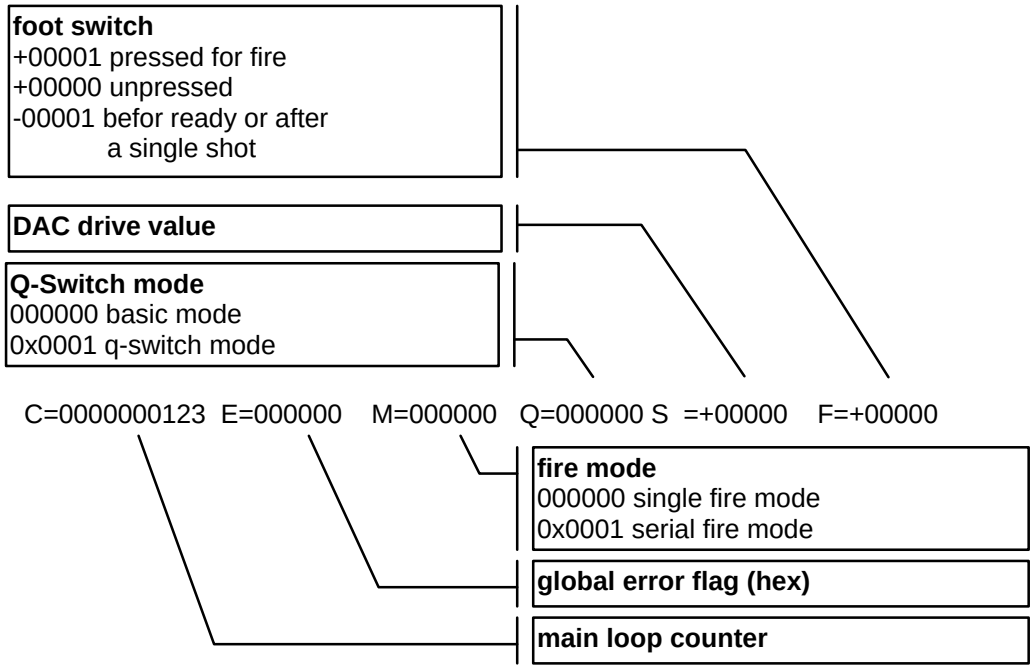
5.3.4 Software from EEPROM (Master) version 3.10 / 3.3 (Slave)

The newest software version at the moment is 3.10c / 3.3 incl. the RMST 1.17c in the display unit.

Please connect the laptop to the service connector. Start a terminal program (Telix, Hyperterminal) and turn on the machine with the keyswitch.

If the main processor works, then you can see the prints at the service computer. A comma stands for an inquiry to the display unit and a asterisk stands for an unnecessary sent byte from the display unit. Necessary byte received from the display unit will show separately. The display unit sends four bytes sometimes five bytes.
The structure is: start byte, instruction byte, low data byte, high data byte [, stop byte]

For a communication check will sent back the necessary bytes to the display unit. Necessary bytes are the start byte, the instruction byte and, if exist, the low data byte.



Example for the normally service screen:

,C=0000000121 E=000000 M=0X0001 Q=000000 S=+00000 F=+00000	*basic & repeat mode, standby*
,C=0000000122 E=000000 M=0X0001 Q=000000 S=+00000 F=-00001	*foot switch pressed*
,C=0000000123 E=000000 M=0X0001 Q=000000 S=+00000 F=-00001	*still pressed*
,Receive from Display = aa 30	*ready on (armed)*
Send to Display = aa 30	*send back*

,C=0000000124 E=000000 M=0X0001 Q=000000 S=+00157 F=-00001	*still pressed, no fire*
,C=0000000125 E=000000 M=0X0001 Q=000000 S=+00157 F=-00001	*still pressed, no fire*
,C=0000000126 E=000000 M=0X0001 Q=000000 S=+00157 F=-00001	*still pressed, no fire*
,C=0000000127 E=000000 M=0X0001 Q=000000 S=+00157 F=+00000	*unpressed*
,C=0000000128 E=000000 M=0X0001 Q=000000 S=+00157 F=+00001	*pressed again - fire*

5.3.4.1 Start-up

Type in @ on the laptop to start the Service mode of the laser.
The following menu will appear:

```
Aesculap Meditec - Service Monitor for Ruby Star Laser System
Aesculap Meditec - [version number]

A –- CHARGER ON/OFF
C -- OPEN SHUTTER
D -- DATA INPUT
E -- ENERGY
I -- Standard Init
K -- Touch panel calibration
L -- LED Setting
M -- DAC MIN / MAX
P –- Read & Show slave version & check sum again
Q -- Q-SWITCH
R –- Reset the long time pulse counter
W -- Watchdog test
V –- Adjust pre-pulses
X -- Exit
```

A----Charger ON / OFF

This function switches the charger by using the charger relay ON or OFF.

C----Open Shutter

To improve the alignment of the optical elements, this function allows the shutter to be opened until the next key is being pressed.

D----Data Input

This function is to facilitate troubleshooting. Some signals may be tested online.
(in using this function, however, not all the error messages will be generated.)

```
+------------------
|+----------------- +25 degrees C (Valve)
||+---------------- +45 degrees C (critical)
|||+--------------- Shutter Sense 2
|||| +-------------- +35 degrees C (Warning)
|||| |+------------- IntLock
|||| ||+------------ Water Level
|||| |||+----------- Shutter Sense 1
|||| |||| +---------
|||| |||| |+-------- EOC
|||| |||| ||+------- Foot2
|||| |||| |||+------ Foot1
|||| |||| |||| +----
|||| |||| |||| |+---
|||| |||| |||| ||+--
|||| |||| |||| |||+-
|||| |||| |||| ||||
0000.0000.0000.0000
```

E----Energy

```
Options:  Increase DAC     'I'
          Decrease DAC     'D'
          Increase ENERGY  '+'
          Decrease ENERGY  '-'
          Q-SWITCH ON/OFF  'Q'
          SINGLE PULSE     'FOOT SWITCH'
          Save and exit    'S'
          Exit             'X'
```

With ‘I’ and ‘D’ the DAC value is being changed. ‘+’ and ’-‘ change the energy stage. The ‘Q’ command switches alternately between Q-SWITCH and EPIL tables. The current setting will always be displayed. If you exit this function with ’X’, the old values will be kept. With ‘S’ all values will be saved.
It is not necessary to save every value separately!
Release the laser pulse using the footswitch. The display is inactive.
After the change from Q-Switch to EPIL mode there is a delay of approx. 10 sec to discharge the Pockels cell unit. For future use the software is also prepared for ½ Joule energy steps.

I----Standard Init

This function serve to reset the Basic / Q-Switch drive values to predefined values.

Joule	DAC (Basic)
3	157
4	164
5	170
6	175
7	179
8	184
9	188
10	193

Joule	DAC (Q-Switch)
0.50	142
0.75	145
1.00	148

This menu option will be activated automatically, if the system detects a memory error during initialization after switch on (version number, ROM checksum, table checksum).

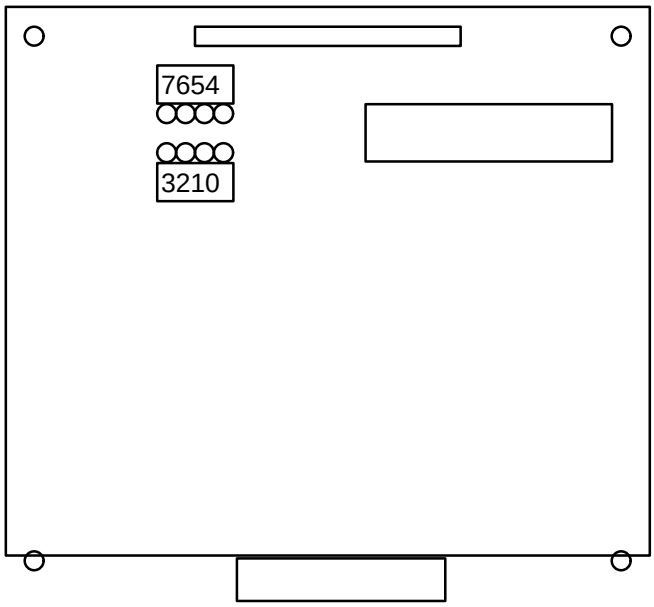
K----Touch panel calibration

This function allows the adjustment of the touch panel. Due to variations in touch panel manufacture, the active areas may be shifted. If there is such a deviation, the system must be informed of it once.

L----LED Setting

```
1 -- error flag 1
2 -- development
3 -- water flow counter
4 -- Port A of PPI
X -- Exit without changes
```

For a better error search you can use the LED's. Four LED modes are available:



- **error byte 1**
  - bit 0 water flow error
  - bit 1 water level error
  - bit 2 remote interlock error
  - bit 3 shutter error
  - bit 4 temperature level 1 30°C
  - bit 5 temperature level 2 40°C
  - bit 6 temperature level 3 55°C
  - bit 7 watch dog error

- **development**
  - bit 0 Armed / Standby
  - bit 1
  - bit 2
  - bit 3
  - bit 4 Shutter state
  - bit 5 1 Hz repeat timer
  - bit 6 toggle bit for measurement (slave main loop)
  - bit 7 service on/off

- flow counter value shows the count value from the IC9 on the 72-1028 board
- **PPI online**
  bit 0 shutter sense 1
  bit 1 water level
  bit 2 remote interlock
  bit 3 temperature level 1 30°C
  bit 4 shutter sense 2
  bit 5 temperature level 2 40°C
  bit 6 temperature level 3 55°C
  bit 7

M----DAC MIN / MAX

```
Press any key for count up or count down !
Press X for exit !
Charger off !
DAC value :   0
DAC value : 255
```

Pressing a key increases the control voltage automatically by one digit up to 255 or from 255 to 0. Press 'X' to exit this function.

P----Read & Show slave version & check sum again

Press 'P' to check the Slave EPROM version without removal.

Q----Q-Switch

The display needs the information if the device contains the Q-Switch option or not. This function serves to inform the display accordingly. After the setting, an error is being generated. Switch the device off and on again to make the change effective.

R----Reset the long time pulse counter

Press 'R' to reset the long time pulse counter.
The Reset will be immediately without warning! Only reset this counter after a flashlamp replacement!

V----Adjust pre-pulses

This software version allows to program pre-pulses for a better spot quality. The number of pre-pulses can be setted between 0 and 9 pulses and is different between EPILATION and Q-SWITCH.

W----Watchdog test

It is a check of the correct jumper settings (displayed with a supervised shutdown).
This function serves to test the on-board watchdog. After a few seconds the system must perform a restart. On the laptop computer you may identify a restart by the print of the version number etc. The display shows System Error 1. After a few further seconds, System Error 3 will appear.

X----Exit

Press 'X' to exit the Service Mode.

6 Instructions for software update V 3.06 / 3.2 → V 3.10c / 3.3

6.1 Requirements

Basic equipment of the computer box with a Master / Slave Version 3.06 / 3.2

6.2 Display modifications

As the software version **3.10c** (EEPROM, Master) / **3.3** (EPROM, Slave) is working perfectly only in combination with the display version **1.17c** (2 EPROM's, **RMST 1.17c / RGR 1.17**), you have to remove the display and to replace both EPROM's shown below (1 EPROM per board, Figure 1).

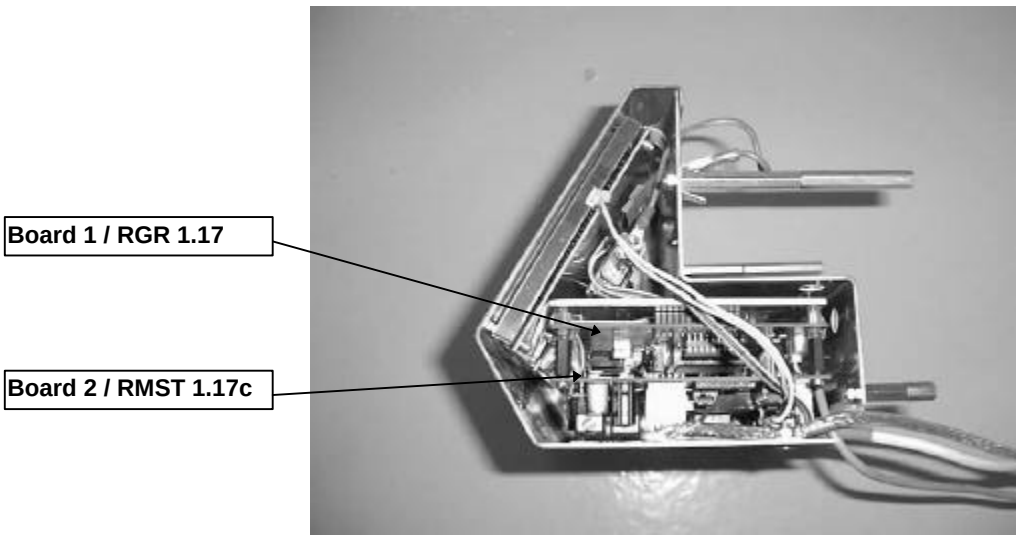


Fig. 14: Display

⇒ Make sure the device is switched off.
⇒ Remove the top cover and the right-hand side panel, remove the holding strut for the side panel, loosen the fastening screws of the computer box, loosen the screws of the computer box cover and remove it.

6.3 Computer box modifications

It is necessary to bridge a few (8) pins on the serial interface PCB AIM104-SER4 located at the right hand side of the computer box. Loosen the 4 nuts and take out this PCB (Fig. 16).
Use a soldering iron and bridge following pins:

7 → 8
9 → 10
17 → 18
19 → 20
27 → 28
29 → 30
37 → 38
39 → 40

⇒ The numbering on the PCB is clear visible(see the pictures).

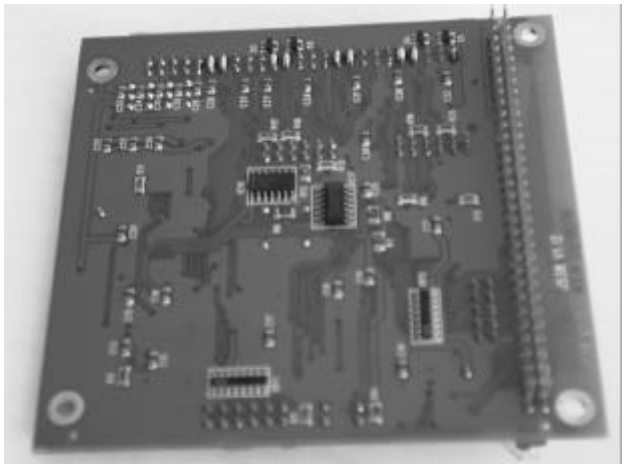


Fig. 15

Fig. 16

⇒ Fit the PCB to it's former position and connect all cables like before.
⇒ Slightly turn the round cable at the underside of the computer box (12V supply for the computer unit) to remove it.
⇒ Plug the programming unit SVIF1 into PL3 of the ARCOM CPU board (top right, see Fig. 17) .

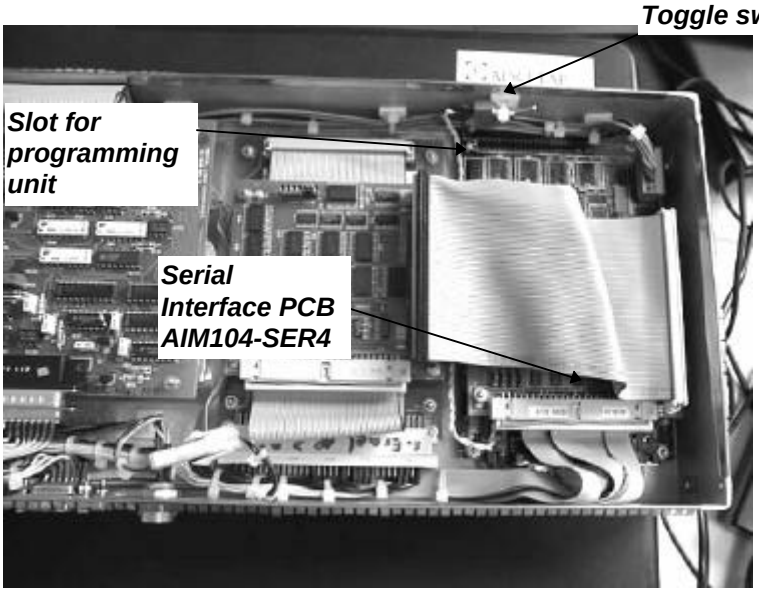


Fig. 17: PCB

⇒ Switch toggle switch (top right) over (the toggle switch is fixed to the case by a cable clip).
⇒ Connect 9pol SubD connector (from the programming unit, channel B) to the laptop (COM 1 or ...).
⇒ ***Start HyperTerminal under Windows 95/98*** (it's not recommended to use Telix) with the following settings: 19200 baud, 8 data bits, no parity and a stop bit, ANSI emulation (status bar at the bottom: ***ANSI 19200 8-N-1*** or ***ANSI automatic detection***).
⇒ Switch on the device. The system generates an acoustic warning, which is usual.

⇒ On the laptop display the following information appears:

<<TMON386 TARGET MINI-MONITOR>>
Version 1.03
Copyright © Arcom Control Systems 1996

0100>

⇒ Type in **<H>** on the laptop. This will bring up a help screen (communication test).
⇒ Type in **<P>** on the laptop.
⇒ From the "Transfers' menu, select 'Text files'.
⇒ Select the text file (Intel HEX format) contained on the provided disk (A:\) or hard disk and confirm your choice.
⇒ Wait for 1'30'' to 5'30'' depending on the processor type of the laptop, until

0100>Download complete

appears on the display.
⇒ Next, the software must be transfered to the memory (which is done very quickly).
⇒ Please type in:

0100>C 1000_8000_F00 (_ → means „Press Space")

The download is now complete. Switch off the device, remove the programming unit SVIF1 and switch over the toggle switch again.

⇒ If necessary, replace the EPROM (Slave) of the Z86.
⇒ For this, remove the board (see Fig. 18).

Fig. 18: PCB

Fig. 19 shows the lower board with the EPROM (Slave) to be replaced.

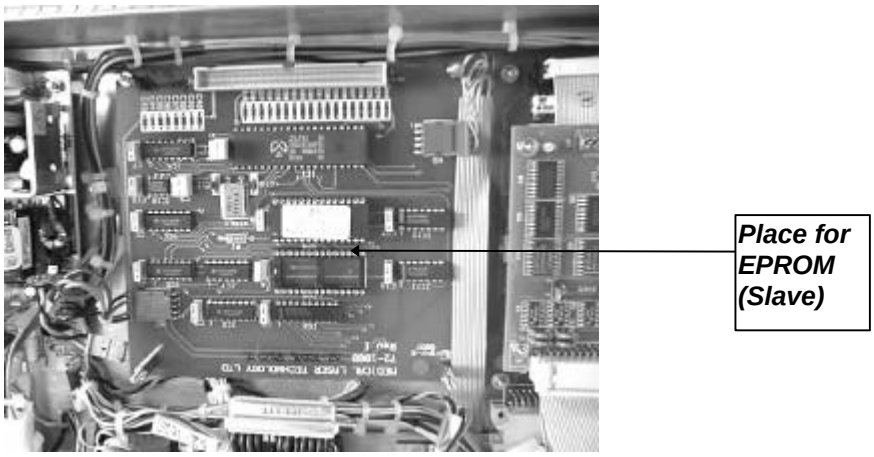


Fig. 19: PCB

⇒ Replace the EPROM, connect and refit the upper board (Fig. 19).
⇒ Connect the 12 V connector.
⇒ Connect the laptop (Com 1, 9600 Baud, 8 Data Bits, No Parity, 1 Stop Bit) to the RS 232 port of the laser using a null modem cable, switch on the device and follow the instructions on the display of your laptop. Start with „Y“ the standard initialization procedure. After conclusion of the standard initialization switch off the laser. Switch on the laser again and start the service utility with „@„.
⇒ If there wasn't a message on the display to start the standard initialisation procedure, please start it now with „I“ on your keyboard.
⇒ In the Service Utility press „E“ for „Energy„, then „c„ and „Q„ to activate the „Q-Switch Mode„. Next, decrease the driving values (DAC's) to 130 (0.5 J), 131 (0.75 J) and 132 (1.0 J) to avoid that the laser rod is being damaged caused by too high energy settings in Q-Switch Mode. Save this values with „S“.
⇒ Start the Service Utility again and press „R - Reset long time puls counter“to reset the counter to zero.

Temperature threshold

⇒ Remove the front cover („tower“).
⇒ To simulate the temperature change, disconnect the upper connector of the temperature sensor on the small „Flow & Temperature PCB“ and connect the potentiometer (SERVICETOOL).
⇒ Adjust the digital multirange meter to „Volt“ or „Millivolt“.
⇒ Find the earthing contact (black cable, see Fig. 20) and connect it.

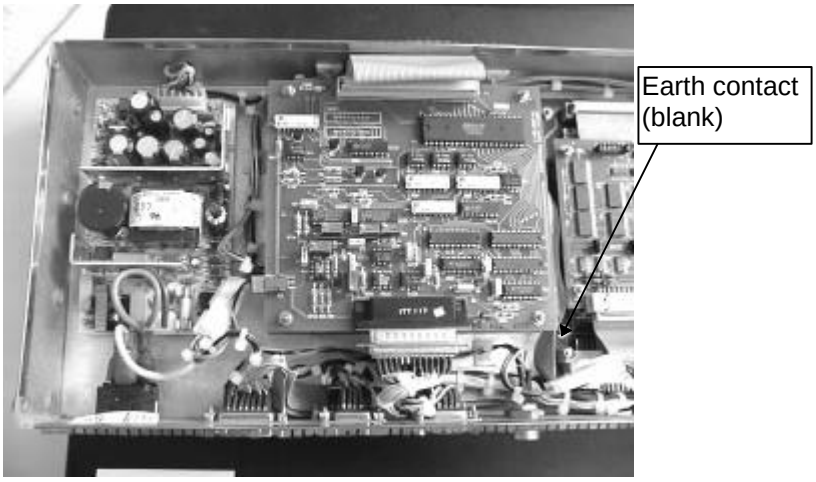


Fig. 20: PCB

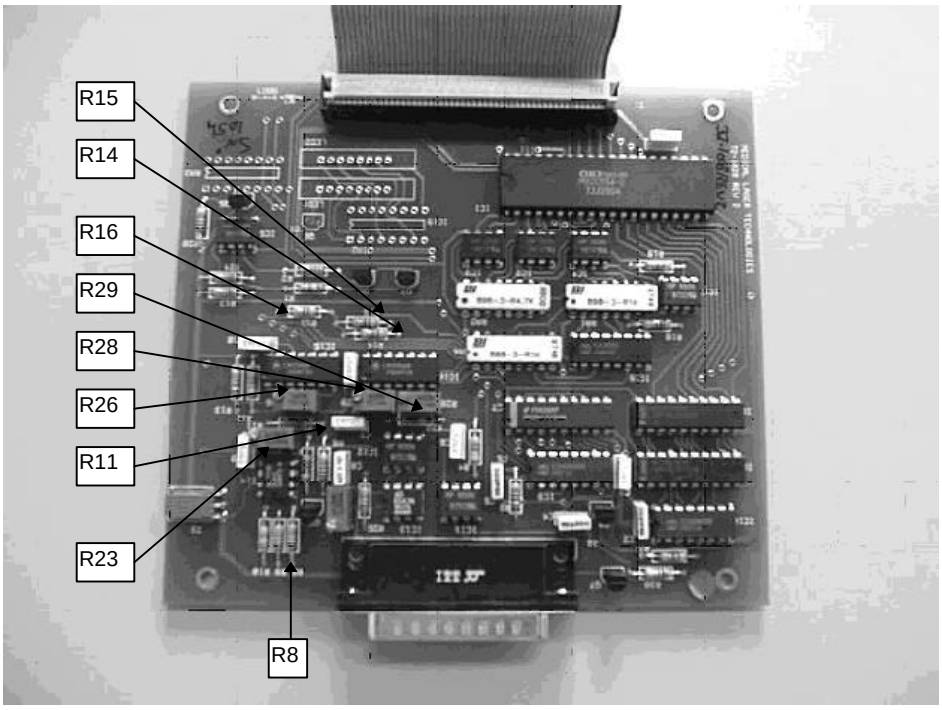


Fig. 21: Potentiometer and resistors

⇒ Measure the pre-amplification at R8 (bottom) and adjust it with the potentiometer (Input for sensor) → 200 mV ≅ 20°C (Figure 6, please check labeling on the board)

⇒ Measure the voltage at R11 (right) and turn R23 to adjust the follow-up amplification to 1250 mV. In this way, defined conditions for threshold value adjustment have been set.
⇒ To adjust the first threshold value at 25°C (opening the external water valve), measure at R8 (bottom) and use the potentiometer to adjust 250 mV ≅ 25°C. Next, measure at R16 (left) and find the switching threshold with R26. You have found the threshold, if you hear the corresponding relay clicking on the Switching Ctrl. PCB. Don't stop adjusting the potentiometer before the click sound but just after it, i.e. when the valve is already open.
⇒ Measure the voltage at R8 (bottom) and adjust it to 350 mV ≅ 35°C using the potentiometer. Measure the voltage at R15 (right) and turn R28 to find the switching threshold. Proceed as described above. If the switching threshold has been reached, a temperature warning is heard and shown on the display.
⇒ Measure the voltage at R8 (bottom) and adjust it with the potentiometer to 460 mV ≅ 46°C (45°C is not possible due to the used resistor). Measure the voltage at R14 (right) and turn R29 to find the switching threshold. If the charger goes out, slightly turn back the screw and switch the device off and on again. Then turn the adjusting screw again until the charger switches off because of supposed overheat.
⇒ Switch off the device and step down the voltage using the potentiometer.
⇒ Switch on the device. Measure the voltage at R8 (bottom) and turn the potentiometer in order to pass and check all switching thresholds.
⇒ To check the digital/analog converter, activate the service utility and select "M" to let the driving values run up to 255. Then, simply put the measuring probe onto the "measuring eye" of R4 as described in Fig. 22 and measure the voltage. If the voltage deviates from 8 ± 0.05 V, readjust it with R4.

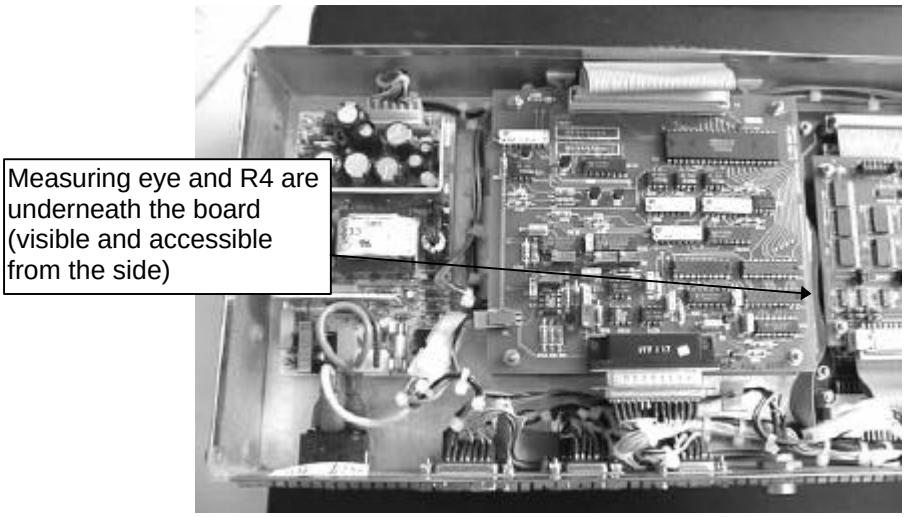


Fig. 22: Measuring eye

⇒ Remove the rear cover of the laser device and check the adjustment of the monitoring unit of the external water valve. Press „SET“ once and adjust the value to **+45°C** (switch-off value of charger). Press „SET" once more to activate the adjustment of the switching point for opening the external water valve. Adjust this value to **+23°C**. The new values will be saved automatically.
⇒ Complete the device (covers, etc.).
⇒ Perform energy calibration by selecting all energy steps and modifying the driving values (DAC’s) until you obtain the desired energies at the end of the handpiece.

7 Controlling the Laser with the Service Box

The service box is an additional device allowing operation of the laser independent of its own control system. The service box includes a power supply (12 V + 220V) and a set of cables.

7.1 Connecting the Service Box

- Remove top cover, side panels and rear panel from laser device. The front panel with Emergency Stop and key switch can remain attached to the device!!!
- Connect service cables (Fig. 23) to test box and laser device. For this, first disconnect the connectors on the device and replace them with those of the service box (Fig. 24 - Fig. 26)
- Connect the power supply of the service box to a power outlet.

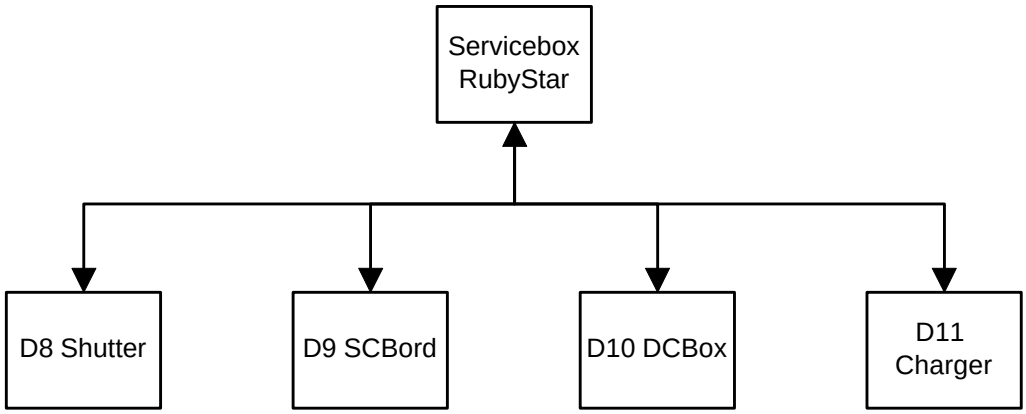


Fig. 23: Service box cables

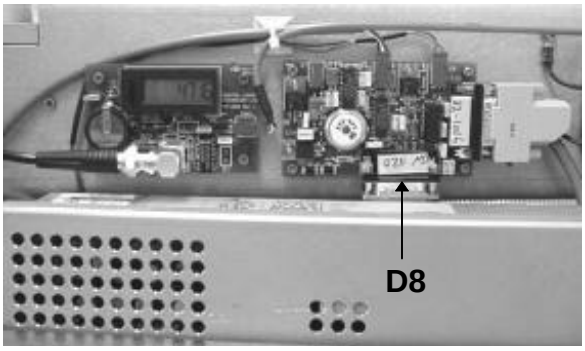


Fig. 24: Connection of service cable to Shutter & Audio Warning PCB → **D8**
(right-hand side of the laser head)

Fig. 25: Connection of service cable to Switching Control PCB → **D9**
(rear panel of the device)

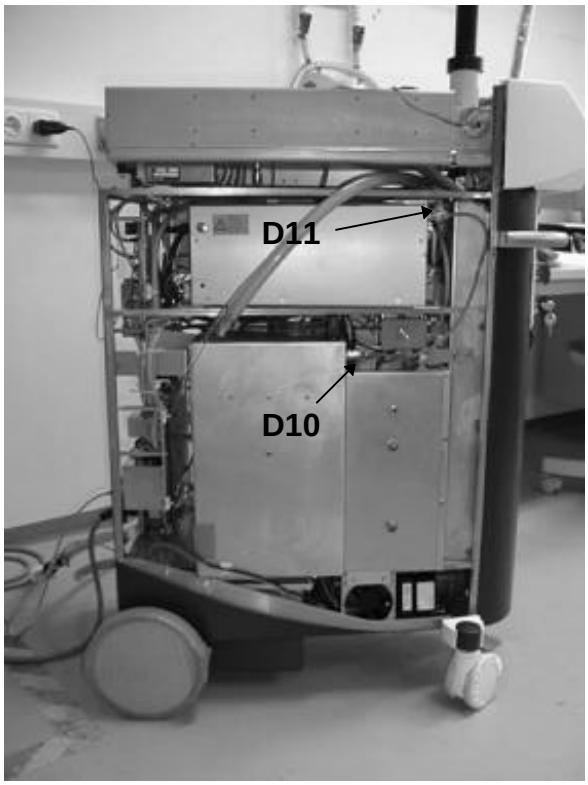


Fig. 26: Connection of service cables → **D10 and D11**
(right-hand side of the device)

7.2 Operation of the Service Box

The RubyStar service box allows you to test several functions of the laser.
The section below describes the functions of the display elements and the operation of the controls of this box.

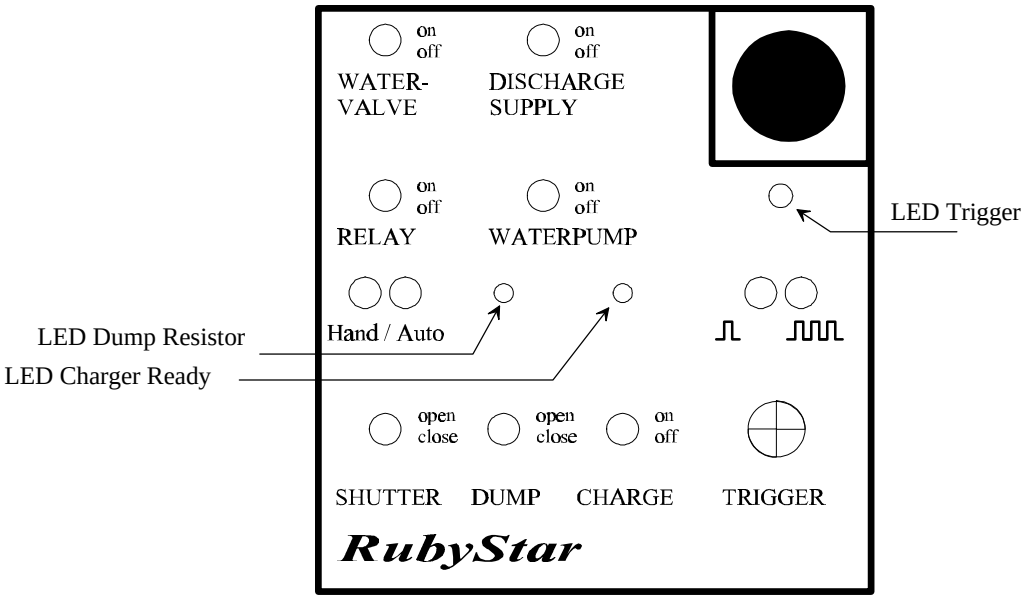


Fig. 27: Control panel of service box

7.2.1 Brief Description of Service Box

The service box allows you to test individual components of the laser and simulate laser operation. The 4 switches in the top area of the panel serve for testing the internal WATER PUMP, SOLENOID VALVE FOR THE EXTERNAL COOLING CIRCUIT, DISCHARGE BOX AND CAPACITOR CHARGER. With the two slide switches below you can switch between HAND and AUTOMATIC MODE or SINGLE SHOT and 1 HZ SERIES MODE.
The switches DUMP and CHARGE in the lower part are used in HAND MODE only; the SHUTTER CONTROL switches the shutter in all operating modes. TRIGGER is a key for triggering the laser pulse (release a shot). If you started series operation by means of the TRIGGER key, switch to Single pulse mode to stop it again.


Warning

The test box controls the laser <u>independent</u> of its safety systems and error messages! If errors occur in test mode, <u>the system will not switch off automatically</u>!

The laser will operate also if errors such as excess temperature or Coolant Flow Errors appear.

Hence, the service technician himself must take care that the device is not damaged when being controlled via the test box.

Typical Test Procedure:

1. General functions

- All switches are in their bottom position: HAND/AUTO set to Hand, Single shot mode  .
- Turn on the device. Actuate the upper switches to check the individual functions acoustically (WATERVALVE: valve clicks, DISCHARGE SUPPLY: relay clicks, RELAY: capacitor charger is being started, WATERPUMP: water pump starts running).

  SHUTTER ON / OFF: Check visually.

2. Laser operation in Auto Mode


Warning

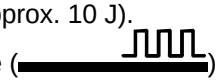
In energy measurement, Class 4 laser radiation is emitted. Observe all regulations for the protection against unintentional irradiation by the laser!


Warning

When the test box has been set to Auto, you can instantly release laser radiation by pressing the Trigger key!

You will not be alerted acoustically!!!

- Set up the measuring device (see Section 4.3.4) for operation of the measuring device. Align it using the aiming beam.
- Switch service box to AUTO (Single shot). Set 1,200 V; the upper 4 switches must be set to their upper position (on), SHUTTER CLOSED.

- Open the SHUTTER: Trigger a trial shot (at 1,200 V the energy will be approx. 1-2 J, at 1,600 V the energy will be approx. 10 J).
- Switch to 1 Hz mode (). Press the TRIGGER key to release laser pulses. Then, switch to Single shot mode to stop laser emission. The laser must operate evenly at approx. 1 Hz.

3. Hand mode

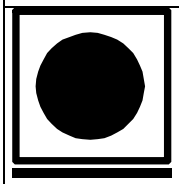
- Switch service box to HAND mode and Single shot (). Set 1,200 V; the upper 4 switches must be set to their upper position (on), SHUTTER closed.
- Then, operate the laser using the DUMP and CHARGE switches in the bottom part of the box.
- Open the SHUTTER.
- DUMP open (left-hand LED lights green)


Caution

The Dump Resistor shorts the charging circuit. If you charge for a longer period (Charge = 'ON') with the charging circuit being closed (Dump = 'OPEN'), the capacitor charger will be overloaded.

- Switch CHARGE shortly (!!!) to 'ON' until the right-hand LED lights up. Then, switch to 'OFF' immediately and release the laser by pressing TRIGGER.
- Switch to DUMP 'CLOSE', close the SHUTTER.

7.2.2 Detailed Description of Service-Box Operation

Display	Displays the set charging voltage U in Volt: U = 0 ... 2000V The input energy may be calculated from the charging voltage using the formula $E = U^2 \times 0.00075$ (at 1,600 V the energy will be approx. 10 J).
	Set the charging voltage by turning the control knob at the top right corner of the box. The voltage appears on the display.
LED Trigger	Lights up yellow when the box outputs a signal.

LED Dump-Resistor	Green: Dump Resistor open — Laser operation possible Yellow: Dump Resistor closed — Discharge circuit shorted Laser operation impossible **Caution**: In Auto Mode, laser operation is possible also when yellow LED is lighting!!
LED Charger	Lights up yellow when capacitors are charged.
WATER-VALVE	on / off: Operates solenoid valve that activates the external cooling circuit.
DISCHARGE SUPPLY	Switches the operating voltage for the discharge box. In off-state, the system can charge the capacitors, but not generate laser pulses. In on-state, the system can generate laser pulses.
RELAY	Switches the operating voltage for the capacitor charger (Charger) either on (charging possible) or off (charging impossible).
WATERPUMP	Switches the water pump on / off.
Hand / Auto	Selector for Hand or Automatic control Hand: The Dump and Charge switches are effective Auto: the Dump and Charge switches are ineffective: a laser pulse may be released instantly by pressing Trigger key.
Switch 	Selector for Single pulse / 1 Hz Series pulses In 1 Hz Series pulse mode, switch to Single mode to stop laser emission.

SHUTTER	Opens / closes the shutter.
DUMP	Switches the Dump Resistor (short-circuit impedance in laser circuit) Open: LED green Laser operation possible Closed: LED yellow Discharge circuit shorted Laser operation impossible
CHARGE	This switch turns on the capacitor charger. **Caution:** **Turn on only shortly (until LED "Charger ready" lights yellow)!!!** **Caution:** **Must be set to Off while triggering the laser!!!**
TRIGGER	Key: Starts the trigger pulse (laser pulse).

8 Replacing Defective Components

8.1 Tools and Aids

DO NOT USE ACETON FOR OPTICS CLEANING (Aceton will damage the coating of the optics) !!!
RECOMMENDED ARE SOME KINDS OF COMBINATIONS WITH PURE ALCOHOL FOR EXAMPLE ISOPROPANOL OR FISHWATER (60%-SPIRIT, 40%-ETHER).

8.2 Replacement of laser head components

Warning

Before opening of the laser head:

SHORT EACH END OF THE FLASHLAMPS TO EARTH.

NEVER TOUCH THE LAMPS WHEN THE LASER IS ON! CONTACT LEADS TO DEATH IMMEDIATELY !!!

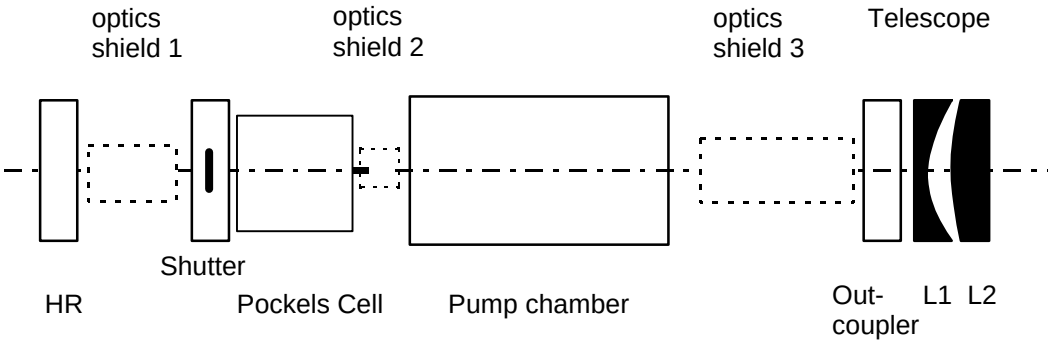


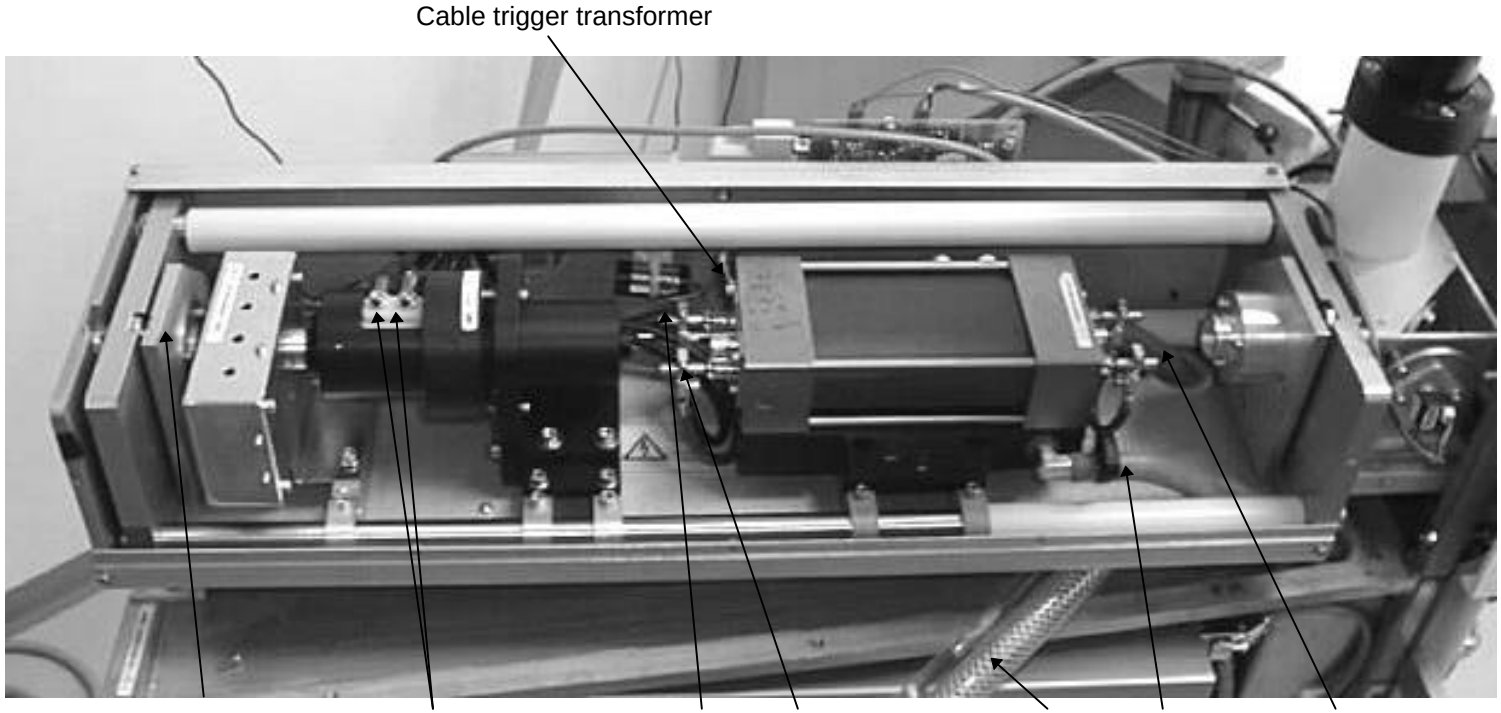
Fig. 28: Optical scheme of laser head

8.2.1 Replacing the pump chamber

1. Open fill tube, drain some water if necessary.
2. Open laser head.
3. **Short the two lamp cables, at first to earth ground (one by one), then with each other !!! Short both terminals of the Pockel's cell (2KV !!!).**
4. Remove dust shields 2 and 3.
5. Loosen lamp cables and pull cables off lamp terminals (left-hand side).
6. Loosen trigger transformer cable at the pump chamber.
7. Remove four screws in pump chamber base plate.
8. Release clamp of inlet tube (back end) at pump chamber with pliers and pull tube cautiously off. Remove outlet tube in the same way.
9. Take out pump chamber and remove right lamp cable.
10. (Replace Rubyrod and flash lamps if necessary. Rubyrod pointer must be on "12 o'clock" and should show to the Q-Switch side.)
11. Reinstall lamp cable for connection of lamp contacts (right-hand side) and fix cable with screws.
12. Install new pump chamber, reconnect the inlet and outlet tubes and fix the pump chamber with four screws (do not tighten them).

13. Slide two lamp cables (left-hand side) onto lamp contacts and fix with screws. Mind correct polarity. Front end is "Red", back end is "Black". A colour dot is provided at each lamp contact end for control.
14. Refill water and close fill tube.
15. **Turn off CCT-breaker at the back of the laser !!!**
16. Turn on power, connect laptop and start service program. Use "C" to open the shutter.
17. Unhang HR-mirror cautiously in order to be able to unequivocally identify reflexes from the outcoupler mirror and Rubyrod with the help of an autocollimator (autocollimating telescope/ACT).
18. Remove sticker label on left side of laser head and install autocollimator in this place. Move pump chamber to identify reflexes from Rubyrod and outcoupler mirror. Close the laser head if there is too much interfering light around the laser head.
19. Align both reflexes so they are one above the other. This can be achieved by shifting the pump chamber and tightening the four screws. In some cases it may be necessary to put a slip of aluminium foil or gauging paper below the pump chamber for better adjustment.
20. Looking through the ACT to see a cloud of dots. These are generated by reflections inside the Q-switch unit. In this cloud, greenish dots (3x2) can be discerned (2x2 from the two windows inside of the Pockels Cell unit, 1x from the pockels Cell itself). They form some type of circular figure. Move the ACT a few centimeters away from it's normal position until two of the significant points become smaller and darker. Use the three adjustment screws (**B**, see section "**Problems with Q-switch energy"**) until the reflexes from Rubyrod and outcoupling mirror are positioned between this 2 points.
21. Cover up pilot beam diode with a business card (or a similar aid).
22. Look through opening (left-hand side) of the laser head and check for centricity of Rubyrod and Q-switch unit.
23. Suspend HR-mirror in its former position.
24. Look through laser head opening again (with ACT) and turn the two adjustment screws as necessary to align the second brightest reflex of the HR-mirror with the reflex from the outcoupler mirror (left-hand side of laser head).
25. Close shutter and install dust shields.
26. Close laser head and remove cover from pilot beam diode.
27. Perform active alignment to achieve a maximum in energy (see section **„Active alignment of the output energy“** under **„Problems“**).
28. Check alignment of near and far field. Perform balancing in EPIL mode.
29. Check extinction and compare energy (see section **"Problems with Q-switch energy"**).
30. Perform complete balancing procedure in Q-SWITCH mode.

After the exchange of a complete new pump chamber (new flashlamps, new rod) it will be necessary to „warm-up“ the flashlamps. To realize this procedure please first check the output energy in the „Epilation-Mode“ without handpiece at the mirror arm exit. The energy should be in a range of approximately 12 J. Set to „Serial-Mode“ on the display, place a piece of paper (e.g. business-card) into the laserbeam (in the laserhead) and fix the footswitch in the down position. Let the laser run for about 30 minutes.


Cable trigger transformer
HR-mirror
Lamp cables of the pockels cell
Black end (black cable)
Red end (red cable)
Fill tube
Outlet tube
Inlet tube

8.2.2 Replacing the shutter

1. Open the laser head.
2. **SHORT FLASHLAMPS TO EARTH!**
3. Loosen screws at the slide bar of the shutter
4. Remove optics shield 1.
5. Disconnect cable from Audio/Shutter PCB.
6. Loosen screws on shutter.
7. Remove the old shutter.
8. Screw new shutter, but do not tighten it.
9. Connect new shutter to Audio/Shutter PCB.
10. Align the shutter so that is laterally flush with the HR mirror (shutter aperture exactly coincides with HR mirror mount). Open the shutter with the service program or the service box and check the position.
11. Fasten the shutter to the shutter slide bar.
12. Replace optics shield and fasten the shutter slide bar.
13. Close the laser head.

8.2.3 Replacing the flashlamps

(Refer to sketch Fig. 29)

Warning

When you replace the flashlamp, take care not to touch the bulb with bare fingers. You should therefore wear appropriate gloves.

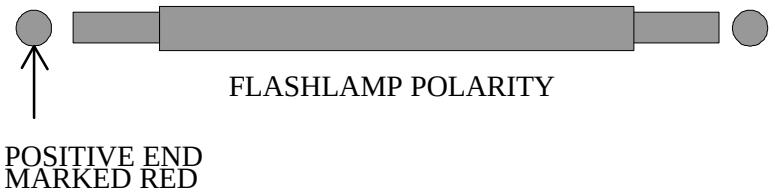


Fig. 29: Flashlamp

Both flashlamps are connected with a serial connection.
Please always exchange both flashlamps!

1. Open the fill hose.
2. Open the laser head.
3. **SHORT EACH END OF THE FLASHLAMPS TO EARTH!**
4. Remove optics shields 2 and 3.
5. Gently remove the lead clamps at both ends of the lamp by using Allen keys.
6. Release the clamp plate on either side of the lamp.
7. Loosen the 4 screws of the pump chamber and disconnect the inlet and outlet tubes.
8. Take out the pump chamber until it is possible to remove the flashlamps.
9. Remove the lamp. (Initially a gentle rotation of the lamp will help in breaking the seal and allow air into, and water out of, the laser head in a controlled way.)
10. Take a new lamp.
11. Place a new 'O' ring around the new lamp 1cm from one end and slip the other end into and through the pump chamber.
12. Place the other 'O' ring at the other end.
13. **ENSURE THAT THE NEW LAMP WHEN INSERTED WILL HAVE THE CORRECT POLARITY (You should see one red and one black lamp end on each side of the pump chamber).**
14. Replace both plates and lightly tighten them.
15. Ensure that the lamp is positioned symmetrically in the chamber.
16. Reattach the electrical leads **(take care for the right polarity)** and clamp firmly in place.
17. Unhang HR-mirror cautiously in order to be able to unequivocally identify reflexes from the outcoupler mirror and Rubyrod with the help of an autocollimator (autocollimating telescope/ACT).
18. Reattach the pump chamber, reconnect the inlet and outlet tubes and fill up water if necessary.

19. **CLOSE THE FILL HOSE.**
20. Switch on the laser and check for leackages.
21. Align the rod to the outcoupling mirror with an autocollimator.
22. Align the rod to the Pockels cell (see section „Replacing the pump chamber“)
23. .
24. Suspend HR-mirror in its former position
25. Look through the laser head aperture again (with ACT) and turn the two adjustment screws as necessary to align the second brightest reflex of the HR-mirror to the reflex of the outcoupler mirror.
26. Reattach optics shield 2.
27. Refit optics shield 3
28. Close the laser head.

8.2.4 Replacing the Ruby Rod

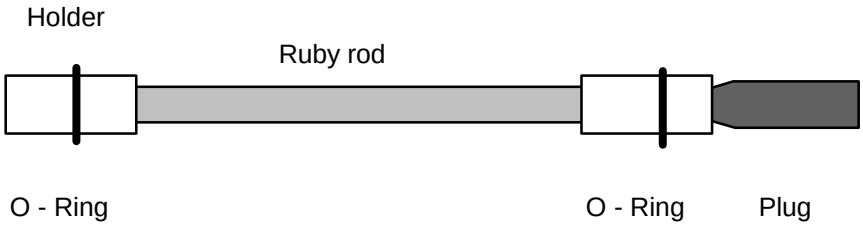


Fig. 30: Ruby rod with holder

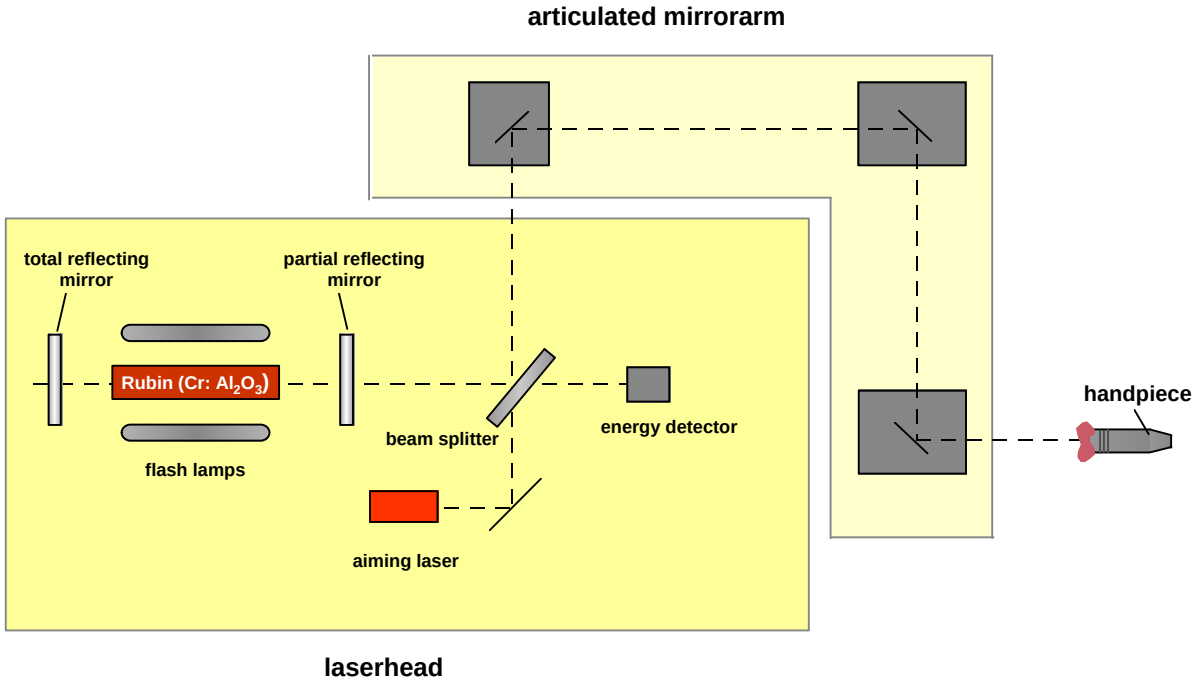
This procedure follows closely that of flashlamp replacement:

Before removal of the rod mount the plug (SERVICETOOL) to beware the endplates for waterdrops.

8.3 Replacing the Mirrors

The resonator mirrors (HR mirror and output coupler) are retained within removal mirror holders with delrin clamp rings. The mirror holders are designed to be removed and replaced with sufficient accuracy to maintain minimal lasing following a mirror replacement.

8.3.1 Overview



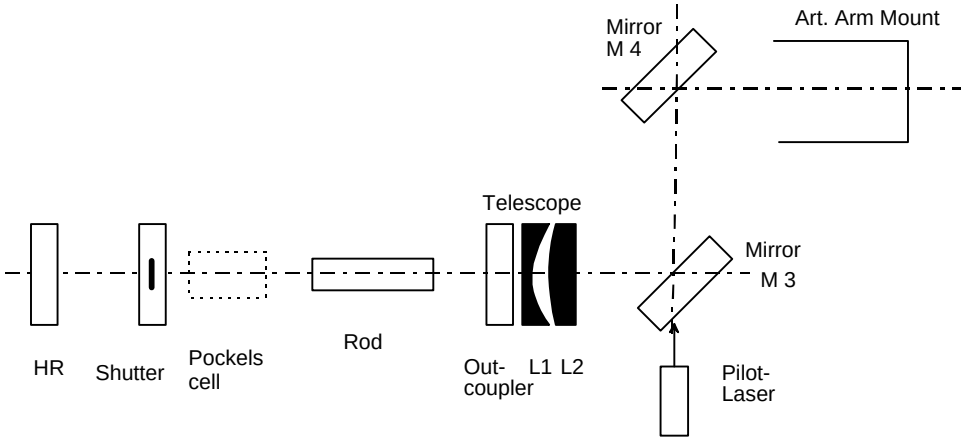


Fig. 31: Optical path

Complete alignment is performed in the following order:

1. ***Alignment of outcoupling mirror with AKF to ruby rod.***
2. ***Alignment of ruby rod with AKF to pockels cell.***
3. ***Alignment of HR mirror with AKF to outcoupling mirror.***
4. ***Mirror M3 will not be aligned.***
5. ***Active resonator alignment on HR mirror.***
6. ***Near field alignment on insulated adapter (below articulated arm mount) with cross-hairs target.***
7. ***Alignment of aiming laser in near field / far field.***
8. ***Far field alignment with fixed articulated arm and centering target for arm exit.***

8.3.2 Replacing the HR mirror

1. **SHORT EACH END OF FLASHLAMPS TO EARTH!**
2. Remove the optics shields 1.
3. Remove the three retaining bolts on the mirror holder and withdraw it.
4. Unscrew the delrin retaining ring. The spacer ring and mirror will then come out if the holder is carefully inverted.
5. Insert the mirror, replace the spacer and retaining ring.
6. Replace the mirror holder on the mounting plate and reaffix the three bolts.
7. Replace optics shield 2, retighten the shutter mount and refit shields 1.
8. Pre-alignment: Align the mirror to the outcoupling mirror using the autocollimator.
9. Turn on the laser and make small adjustments to the HR mirror alignment to optimize the output.

8.3.3 Replacing the output coupler / lens assembly

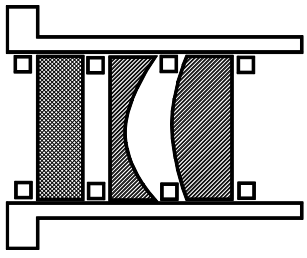


Fig. 32: Output coupler / Lens assembly

1. **SHORT EACH END OF FLASHLAMP TO EARTH!**
2. Check the position of rod and outcoupling mirror with the AKF. Notice this configuration.
3. Remove optics shield 3.
4. Remove the three retaining bolts on the mirror holder and withdraw it.
5. Unscrew the delrin retaining ring.

6. Carefully remove the set pair of lenses, spacers and mirror. The lenses MUST be replaced in the same sequence as originally fitted so note this carefully on removal.
7. Insert the new mirror, replace the spacer, lens pair with separating spacer and retaining ring.
8. Replace the mirror holder on the retaining plate and reaffix with the three bolts.
9. Use the AKF to check the position of rod and outcoupling mirror. Restore the former position how noticed by using the 2 screws of the outcoupling mirror. The adjusting screws are located at the end of the laser head. The lower screw is accessible through a permanently plugged key, the top one is illustrated in Fig. 33.
10. Replace optics shield 3.
11. Turn on the laser and make small adjustments to the HR mirror alignment to optimize the output.

Caution	**Do never adjust the output coupler to optimize the laser energy !!!**

8.3.4 Beam Combiner (Mirror 3)

Warning	**Replacement of the Beam Combiner should never occur in the field !!!**

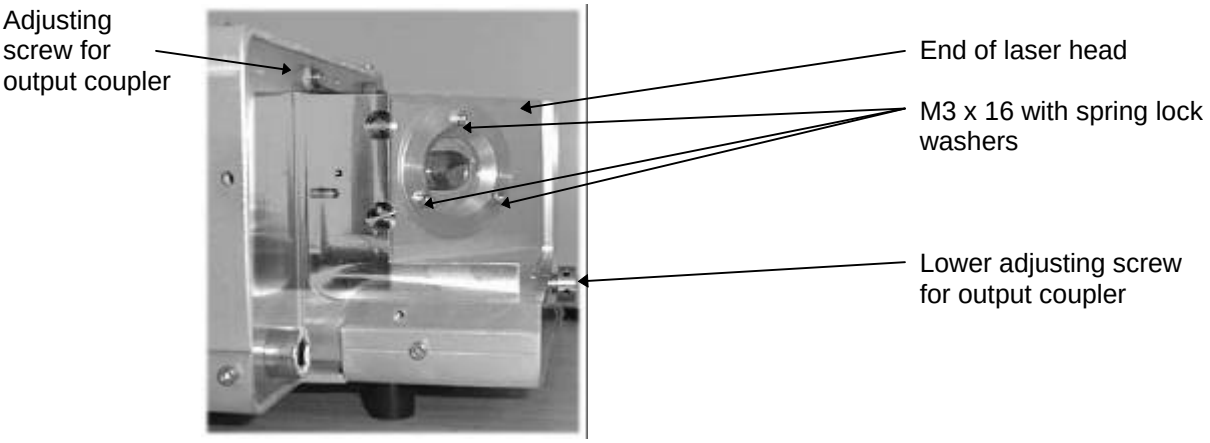


Fig. 33: Beam combiner (Mirror 3)

The beam combiner is located at the end of the laser head between laser head and display on the left-hand side behind the aiming laser.

1. Remove cover, side panels and display.
2. Remove protective plate from aiming laser.
3. Remove top cover plate of aiming laser.
4. Remove angular support with aiming laser.
5. Put glass plate onto arm flange. With the AKF autocollimating telescope verify that the reflection of the output coupler (large, red) and the reflection of the glass plate coincide. If necessary, readjust mirror 4 (if there should be several small reflections, the reflection that remains stationary while adjusting mirror 4 is the one produced by the glass plate).
6. Loosen the 3 screws at the mirror holder and remove the mirror assembly.
7. Fix new mirror assembly so that the flange is approximately parallel with the mounting surface (distance. approx. 0.5 mm).
8. Align beam combiner using the 3 screws until, in the AKF, the reflection of the output coupler (large, red) coincides with that of the glass plate.
9. Replace angular support with aiming laser.
10. Check alignment of aiming laser (see Section Replacing the aiming laser Replacing the aiming laser)
11. Screw down cover plate over aiming laser.
12. Screw down protective plate in front of the aiming laser.

8.3.5 Replacing the 45° HR mirror (Mirror 4)

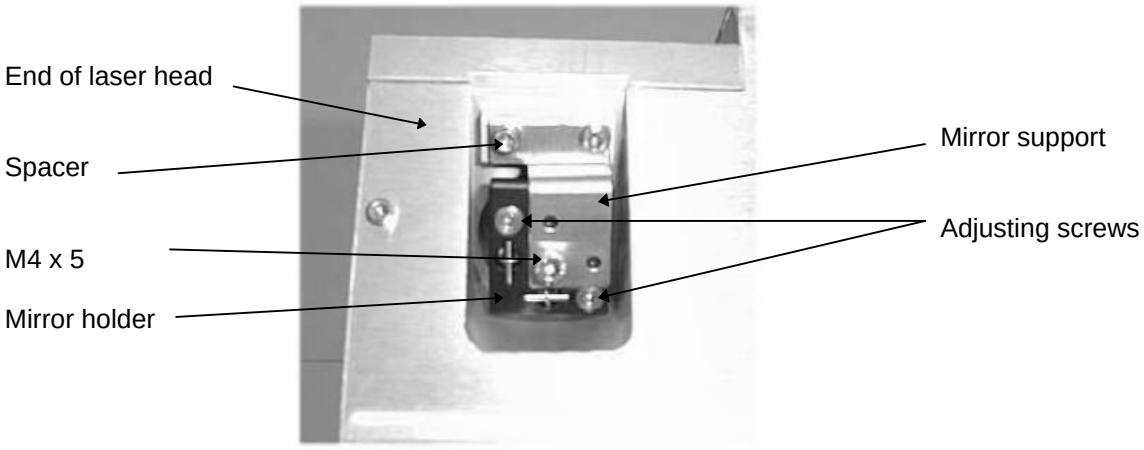


Fig. 34: 45° HR mirror (Mirror 4)

The 45° HR mirror (Mirror 4) is located at the end of the laser head on the right-hand side between laser head and display. It is fixed to a mirror holder (see Fig. 34) that is screwed to the end of the laser head through a mirror support. A spacer is arranged between angular support and end of laser head.

1. Remove cover and side panels.
2. Unscrew mirror support with mirror holder from coupling block (at the two screws visible on top in Fig. 34).
3. Unscrew mirror with mirror holder from mirror support (one screw in the middle).
4. Screw down new mirror to mirror support.

8.3.6 Replacing the aiming laser

Caution

When a glass plate has been placed on the flange of the arm and the laser is operated, the aiming laser must be covered. Otherwise, the aiming laser will be destroyed.

Position of aiming laser:

1. Remove cover and articulated mirror arm.
2. Remove protective plate from aiming beam diode.
3. Remove top cover plate of aiming beam diode.
4. Remove support plate with aiming beam diode (2 screws left and right of the aiming laser).
5. Loosen nut on aiming laser (15 mm jaw spanner).
6. First, adjust the beam profile on the aiming laser with the provided special spanner or a screw driver:
   - Turn on the device.
   - Disconnect the plug from the old laser diode and plug it into the new one.
   - Direct the beam of the laser diode onto a wall that is approx. 2 m away. Turn the spanner until the laser light forms a spot.
7. Install aiming beam diode in support plate by using the nut.
8. Fix the support plate with the 2 screws.f the Align the aiming laser (see next page).
9. Reattach top cover plate of aiming beam diode.
10. Reattach protective plate to the aiming beam diode.

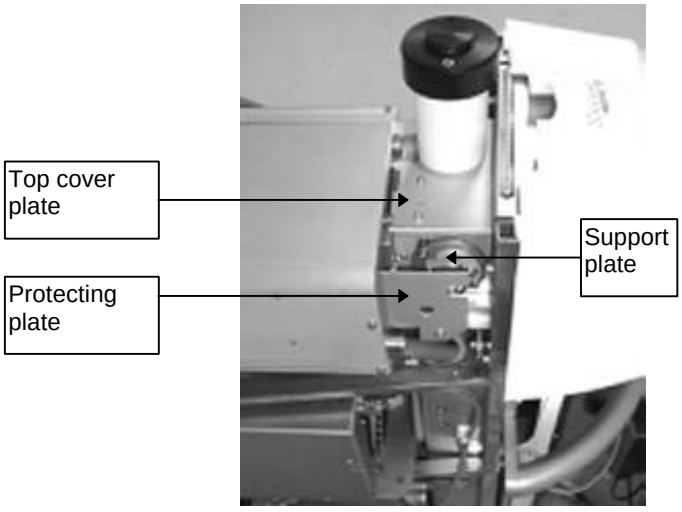
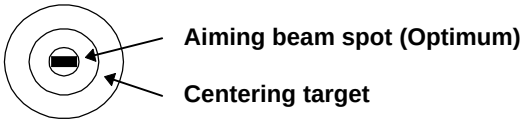


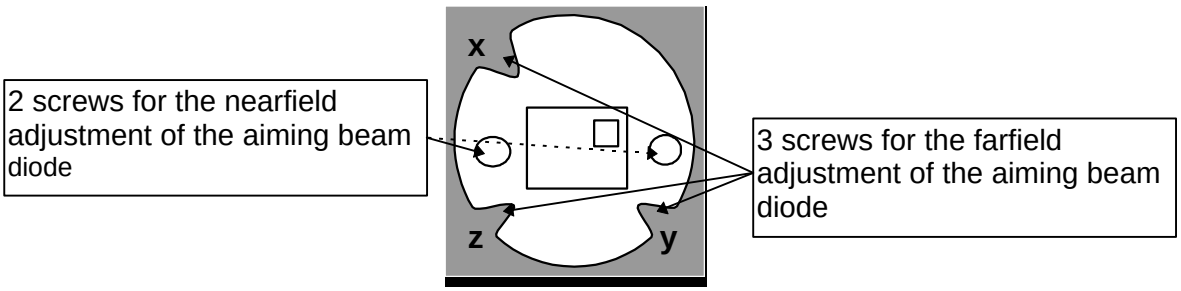
Fig. 35: Aiming beam diode

Alignment of the aiming laser:

1. Turn on the device.
2. Put centering target with glass plate for mirror arm mount onto arm flange.
3. Loosen **2** adjusting screws on aiming laser and move the aiming beam diode until the spot is in the center of the centering target (near field alignment). Tighten the **2** screws.



4. Remove centering target.
5. Fix photographic paper to the ceiling.
6. **Wear protective goggles!!!**
7. Release a test shot of 10 J onto the ceiling.
8. With the **3** adjusting screws on the aiming laser **(x, y, z)** align the aiming beam until it is concentric with the spot onto the photo paper (far field alignment).
9. Repeat Steps 3 ... 8 until in near field the aiming beam is in the center of the centering target, and in far field, the aiming beam is in the center of the spot onto the photo paper.



8.4 Replacing components of the cooling system

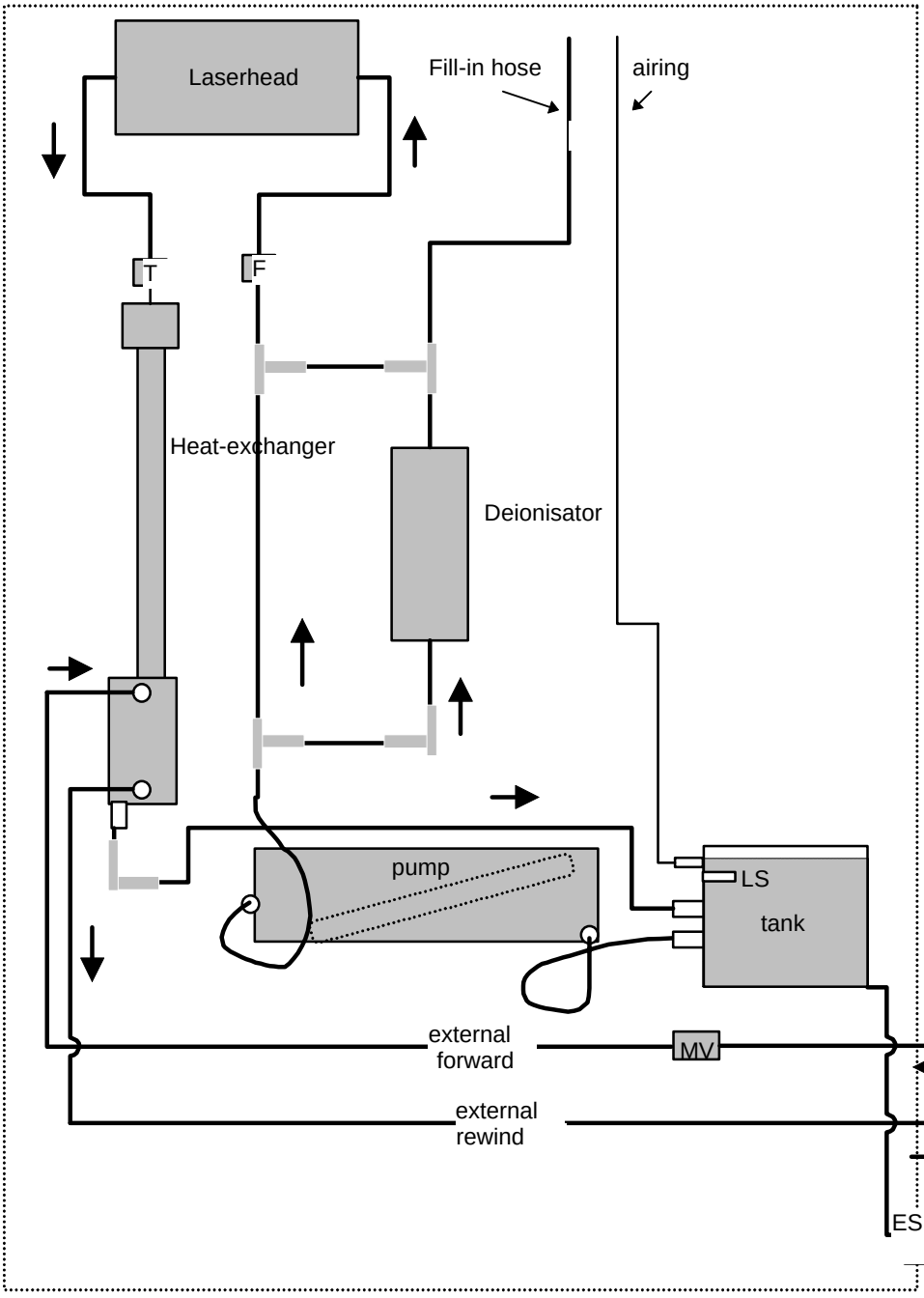


Fig. 36: Schematic diagram of cooling system

MV: Solenoid valve
ES: Draining screw
T: Temperature Sensor
F: Flow Sensor
LS: Level Sensor

8.4.1 Pump

Pump and water reservoir are located on a common base plate. This base plate is arranged in the bottom part of the device and fixed to the device with screws 1 ... 3. The pump rests on 3 rubber pads and a glued in piece of rubber on the base plate.

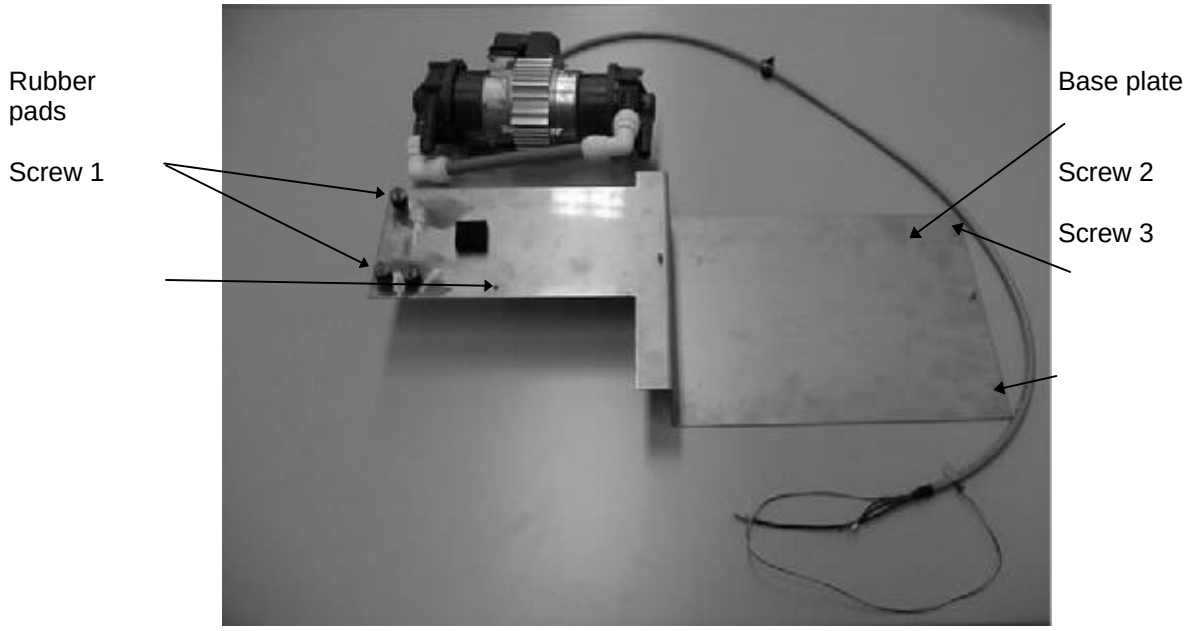


Fig. 37: Pump and base plate

1. Remove covers completely.
2. Drain water.
3. External cooling circuit: Disconnect the lower hose from the heat exchanger and the other hose from behind the solenoid valve.
4. Internal cooling circuit: Disconnect the one hose located under the heat exchanger; then, disconnect the other hose located below the T-piece at the bottom right beside the heat exchanger.
5. Disconnect the white plug from the level sensor (between reservoir and pump).
6. Remove rear panel from the device (bottom).
7. Loosen screws 1 ... 3 on the base plate (Screw 1: at the bottom in the middle; Screws 2 and 3 accessible from the rear).
8. Pull out base plate with reservoir and pump.
9. Unscrew pump from base plate.
10. Disconnect cable from pump and connect it to the new pump.
11. Disconnect hoses from old pump and connect them to the new one.
12. Glue rubber strip at the bottom onto the new pump.
13. Screw new pump onto base plate. (Orientation as shown in Fig. 37)
14. Slide base plate into the device and screw it down.
15. Reconnect the level sensor.
16. Reconnect the hoses as shown in Fig. 36.
17. Reattach rear panel (at bottom rear).
18. Fill up cooling water.

8.4.2 Heat exchanger

1. Remove the top cover, both side covers and the tower (front cover).
2. Drain water.
3. Disconnect the water hoses from heat exchanger.
4. Loosen the holder of the temperature sensor (including the temperature sensor) and disconnect the cable at the „Flow & Temperature PCB“.

5. Replace the heat exchanger.
6. Screw in the temperature sensor holder and re-connect the cable.
7. Reconnect the water hoses.

8.4.3 Flow sensor

1. Remove the top cover, both side covers and the tower (front cover).
2. Disconnect sensor connector on Flow & Temp. PCB.
3. Squeeze off the hose above the sensor by means of a surgical clamp.
4. Loosen hose clamps.
5. Replace the sensor.
6. Tighten the hose clamps.
7. Connect sensor cable to Flow & Temp. PCB.

8.4.4 Water tank (V4A)

The procedure for replacing the water tank is similar to that for replacing the pump (see 8.4.1). Pump and water tank are located on a common base plate. This base plate is arranged in the bottom part of the device and fixed to the device with screws 1 ... 3 (Fig. 37). The pump rests on 3 rubber pads and a glued in piece of rubber on the base plate.

1. Remove covers completely.
2. Drain water.
3. External cooling circuit: Disconnect the lower hose from the heat exchanger and the other hose from behind the solenoid valve.
4. Internal cooling circuit: Disconnect the one hose located under the heat exchanger; then, disconnect the other hose located below the T-piece at the bottom right beside the heat exchanger.
5. Disconnect the white plug from the level sensor (between tank and pump).
6. Remove rear panel from the device (bottom).
7. Loosen screws 1 ... 3 on the base plate (Screw 1: at the bottom in the middle; Screws 2 and 3 accessible from the rear).
8. Pull out base plate with tank and pump.
9. Unscrew tank from base plate.

10. Remove level sensor from old tank and install it in the new one.
11. Disconnect hoses from old tank and connect them to new one.
12. Screw down new tank on base plate.
13. Slide the base plate into the device and screw it down.
14. Reconnect the level sensor.
15. Reconnect the hoses as shown in Fig. 36.
16. Reattach rear panel (at bottom rear).and perform function test.

8.4.5 Water tank (PVC)

1. Place the device to a highboard or a special ramp to get a better position for working
2. Remove the top cover
3. Remove the sidecovers and the front cover
4. Open the two hoses which are lay under the laserhead (water fill-up hose and airvent)
5. Loosen the screw for the drain on the backside of the laser and drain the water
6. Remove the screws of the lower cover on the backside
7. Remove the power supply cable of the magnetic valve (Fig. 3)
8. Remove the hose on the right side of the magnetic valve (direction to the waterinlet of the external water, Fig. 3)
9. Remove the hose mounted at the heat exchanger (lower metal hose clamp, Fig. 2)
10. Remove the lower back cover
11. Remove the 2 hoses mounted at the water tank (Fig.1, use a hot air fan)
12. Remove the airvent (Fig.1, use a hot air fan)
13. Disconnect the cable of the levelsensor (Fig.1)
14. Remove the temperature sensor (Fig.1)
15. Remove the holders on the front and the back of the water tank (Fig.1)
16. Exchange the tank
17. Mount the 2 holders
18. Mount the hoses to the tank connectors and secure them with cable straps
19. Put some heat conducting compound into the connector for the temperature sensor
20. Reconnect the cable for the level sensor
21. Reconnect all the remaining cables and hoses

8.4.6 Programming the switching unit of the external coolant valve

The programming unit drives the inlet valve for external coolant supply directly with U = 220V. The temperature is measured by means of a sensor fixed to the water reservoir (old version) or inside the reservoir (new version). At a temperature of 27°C in EPIL Mode and 23°C in Q-switch Mode, the module opens the valve. Thus, in counterflow mode, the external coolant can cool down the internal coolant via a heat exchanger.

Fig. 38: Programming unit

8.4.6.1 Programming of the external temperature control „BÜRKERT“ ***(OLD-VERSION)***

Follow these steps:

1. Press the <SET> button for more than 5 seconds to reach the programming level. The first setting value is shown.
2. The other parameters you will get by using the <UP> or the <DOWN> button.
3. To change the individual parameters use the <SET> button and the <UP> or <DOWN> button together.
4. The saving of the changed values will follow after changing to the next parameter or after 10 seconds.

Follow parameters you have to check:

Parameter	**Settings**	**Dimension**
HC	*C*	*state*
d	*-3*	*°C*
LS	*+10*	*°C*
HS	*+50*	*°C*
CA	*0*	*°C*
rP	*on*	*state*
PS	*0*	*Nr.*
Pt	*0*	*sec. / min.*

USING:

With pressing the <SET> button for one time the set value is shown. There is a range of 5 seconds to change the set value by using the <UP> or the <DOWN> button. After 5 seconds once more the value will be saved automatically.

Set value = +27°C for the „EPIL-ONLY Device“
+23°C for the „Q-Switch Device“

8.4.6.2 Programming of the ext. temperature control „BÜRKERT 2“ ***(NEW-VERSION)***

Follow these steps:

1. Press the <SET> button for more than 5 seconds to reach the programming level. The first setting value is shown.
2. The other parameters you will get by using the <UP> or the <DOWN> button.
3. To change the individual parameters use the <SET> button and the <UP> or <DOWN> button together.
4. The saving of the changed values will follow after changing to the next parameter or after 10 seconds.

Follow parameters you have to check:

Parameter	Settings	Dimension
HC2	*C*	*state*
d1	*-2 (hyst. charger)*	*°C*
d2	*-3 (hyst. magnetic valve)*	*°C*
LS1	*0.0*	*°C*
LS2	*0.0*	*°C*
HS1	*99.9*	*°C*
HS2	*99.9*	*°C*
CAL	*0*	*°C*
Ft	*on*	*state*
rP1	*ro*	*state*
rP2	*rc*	*state*

USING:

With pressing the <SET> button for one time the set value to prevent a overheating is shown (45°C). Press the button twice and the temperature settings for the external water valve will shown.There is a range of 5 seconds to change the set value by using the <UP> or the <DOWN> button. After 5 seconds again the value will be saved automatically.

Set value 2 = normally open contact (magnetic valve = external water supply enable)
Set value 1 = normally closed contact (disconnect the connection to the relay of the laser charger = switch off the laser automatically)

Open the magnetic valve: ***+27°C for the „EPIL-ONLY Device“(set value 2)***
+23°C for the „Q-Switch Device“
Switch off the laser
(If there is a fault in the switch off circuit controlled by software): ***45°C (set value 1)***

8.4.7 Exchange of the Discharge PCB

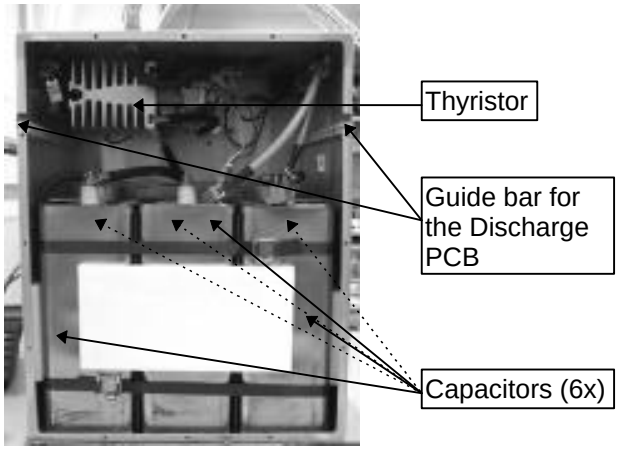


Fig. 40: Opened Discharge box

Fig. 39: Discharge PCB

1. Remove the top cover and the left hand side cover.
2. Unscrew all screws which fix the cover of the capacitor box.
3. Remove the cover.
4. **Short the capacitors by using the discharge cable (SERVICETOOL)!!!**
5. Loosen the 2 screws fixing the small cover located at the opposite side of the capacitor box.
6. Pull off the orange connector on the Discharge PCB.
7. Go back to the former position and lpull off the other connectors.
8. Take out the Discharge PCB.
9. Replace the PCB and fix all connectors, covers and screws. If possible please secure any connector with a cable strap.

8.5 Fuses

No.	Fuse	Rating	Location
1	FI switch	230 V 16 A	Rear side, left
2	Autom. circuit breaker for charger	230 V 16 A	Rear side, left (beside FI)
3	Instrument fuse Si 1	T1,6A *	Rear side above FI
4	Instrument fuse Si 2	T1,6A *	Rear side above FI
5	Main fuse LV1	F3, 15A *	On 5V power supply in control computer 1111
6	Main fuse LV2	F3, 15A *	In 12V power supply at rear side beside Switching Ctrl Board
7	F1 - water pump	T1A *	Switching Ctrl Board
8	F2 - Discharge Control Board	T1A *	Switching Ctrl Board
9	F3 - water valve	T1A *	Switching Ctrl Board

* Fine-wire fuse

9 Error Codes and Fault Findings

9.1 Error Codes

During operation of the system there are certain errors that may occur. Below is a quick reference for the error codes and possible sources of the errors.

Error messages	Source of error	Cause	Action
COOLANT TEMPERATURE TOO HIGH,CHECK EXTERNAL WATER SUPPLY!	Internal coolant temperature increases above 45°C.	Failure of external water supply.	Check if external water supply is connected and switched ON.
		Solenoid valve for the external water supply.	Check the solenoid valve. The valve should open when the internal coolant temperature (in the water tank) gets 23°C. Replace control unit.
		Failure of temperature sensor.	Replace temperature sensor attached at the top end of the heat exchanger and, if necessary, the Flow & Temp. PCB.
INTERNAL COOLANT FLOW ERROR! RESET SYSTEM!	The flow sensor has detected a stop of the internal coolant flow.	Failure of internal water pump.	Check operation of the water pump (e.g. use the testbox)
		Water pump fuse has failed.	Check the water pump fuse located on the Switching Control PCB (T250V 1A).
		Water flow sensor failed.	Check the water flow sensor operation. See section „LOW FLOW“.
		Flow & temp. PCB failed.	Exchange PCB.
		Insufficient coolant in the tank, which has a capacity of approx. 10ltrs.	Add coolant to the tank.

Error Codes and Fault Findings

Error messages	Source of error	Cause	Action
INTERNAL COOLANT LEVEL TOO LOW! RESET SYSTEM!	Coolant level in the tank is too low.	Insufficient coolant in the tank, which has a capacity of approx. 10 ltrs.	Add coolant to the tank.
		Leak in internal coolant system.	Check for leakages in the internal coolant system, particularly in the laser head.
		Failure of level sensing switch. The level sensing switch is usually closed when the reservoir level is correct.	Check the connectors at the Switching Control PCB.
EXTERNAL INTERLOCK IS OPEN, CLOSE INTERLOCK!	External interlock has been detected as open.	No interlock plug in place.	When the interlock is not in, short Pin 1 and 4 to have the same effect.
		A disconnection of the interlock connector.	Check the interlock connector.
SYSTEM ERROR! RESET SYSTEM!	Communication error of the control system.	Internal communication error has occured in the control unit.	Replace the control unit.
SAFETY SHUTTER FAILURE! RESET SYSTEM!	Shutter failure.	Shutter jams.	Check shutter function with test box, replace shutter, if necessary
		Shutter connector failed.	Check shutter cabling.
		Shutter control failed.	Replace Shutter & Audio Warning PCB.
FAULT MESSAGE 1 (+3)!	Computer failed (hardware fault).	No communication between master and slave processor.	Replace the computer box.

Error Codes and Fault Findings

Error messages	Source of error	Cause	Action
FAULT MESSAGE 5!	Communication error.	Internal communication error has occured in the control unit (software problem).	Update the device with the newest software version.
CHARGER NOT READY!	Internal temperature is too high.	Problems with the external water supply. The computer or the independent control unit at the rear side of the laser switched off the charger unit.	Check the external water supply; let the laser cool down.
	Charger has failed.	Charger unit failed.	Replace the charger unit.

9.2 Fault Findings

1. System fails to switch ON with key switch.

- Check emergency OFF switch is pulled out.
- Check the RCB breaker behind the rear panel is in ON position.
- Test fuses in the fuse holders on the rear panel are intact (2xT250V 1.6 A).

2. Display fails to switch ON at start up.

- Check cable connection between display and serial interface board (D13).
- Check cable connection between serial interface board (D7) and control unit (D1).
- Connect the laptop, start the service program and choose the option „Touch panel calibration“.
- Replace display unit.
- Replace control unit and re-test.

3. System fails to respond the touch screen.

- Check cable connection between display and serial interface board (D13).
- Check cable connection between serial interface board (D7) and control unit (D1).
- Ensure control unit mains supply is plugged in.
- Test fuses in the fuse holders on the rear panel are intact (2xT250V 1.6A).
- Check the position of the EPROM’s.
- Replace control unit.
- Replace display unit.

4. Footswitch is pressed in Ready On Mode and the charger does not respond.

- Ensure the circuit breakers behind the rear panel are in the ON position.
- Check the cable connection between the control unit and the charger.
- Ensure that RELAY 1 is closed and mains is being supplied to the charger.
- Test the correct operation of the charger. This can be tested on the Switching Control PCB where the footswitch connects. Both switches must be closed to allow the laser to begin the firing sequence.
- Check the cable connection between the Switching Control PCB and the control unit.
- Check the temperature settings at the control unit of the solenoid valve. Check the temperature inside of the system (see the display of the control unit)
- Replace the charger.
- Replace the computer unit.

5. System fails to discharge.

- Test by pressing keys on the touch panel. If the panel fails to respond then the computer unit has failed to complete the charge/discharge cycle. This indicates that it is waiting for the end of charge signal but has not received it. Carry out tests in point 4.
- If the charger is operating correctly but the system is not discharging, check the cable connections between the control unit and the capacitor box.
- Ensure the main inlet socket to the capacitor tray is in place.
- Check the fuse for the capacitor box supply on the switching control board.
  (Note: The main supply to the capacitor box is only enabled when the unit is in Ready ON mode.)
- Remove the main supply to the charger by switching the circuit breakers in the rear panel to the OFF position. Disconnect the mains signal harness connector to the capacitor box and connect the service box. Switch on the system and select Ready On mode.
- Open the laser head and observe whether the flash lamps are cracked.

Warning

NEVER TOUCH THE LAMPS WHEN THE LASER IS ON!

CONTACT LEADS TO DEATH IMMEDIATELY!!!

- Trigger the laser with the service box and ensure that the lamps are flashing.
- If the lamp fails to flash then replace the Discharge PCB.
- If the unit operates with the external service box, but not with the computer box unit, then replace the computer unit.
- If there are some pulses are hidden or it seems that after a couple (e.g. 1000) of shots the output energy decreases to zero, please check the voltage control. Remove the cable direct at the voltage control and the two cables underneath at the computer box. If the system now running very well, there is a dry joint at the voltage control PCB. In this case please replace the voltage control PCB.

6. Low flow.

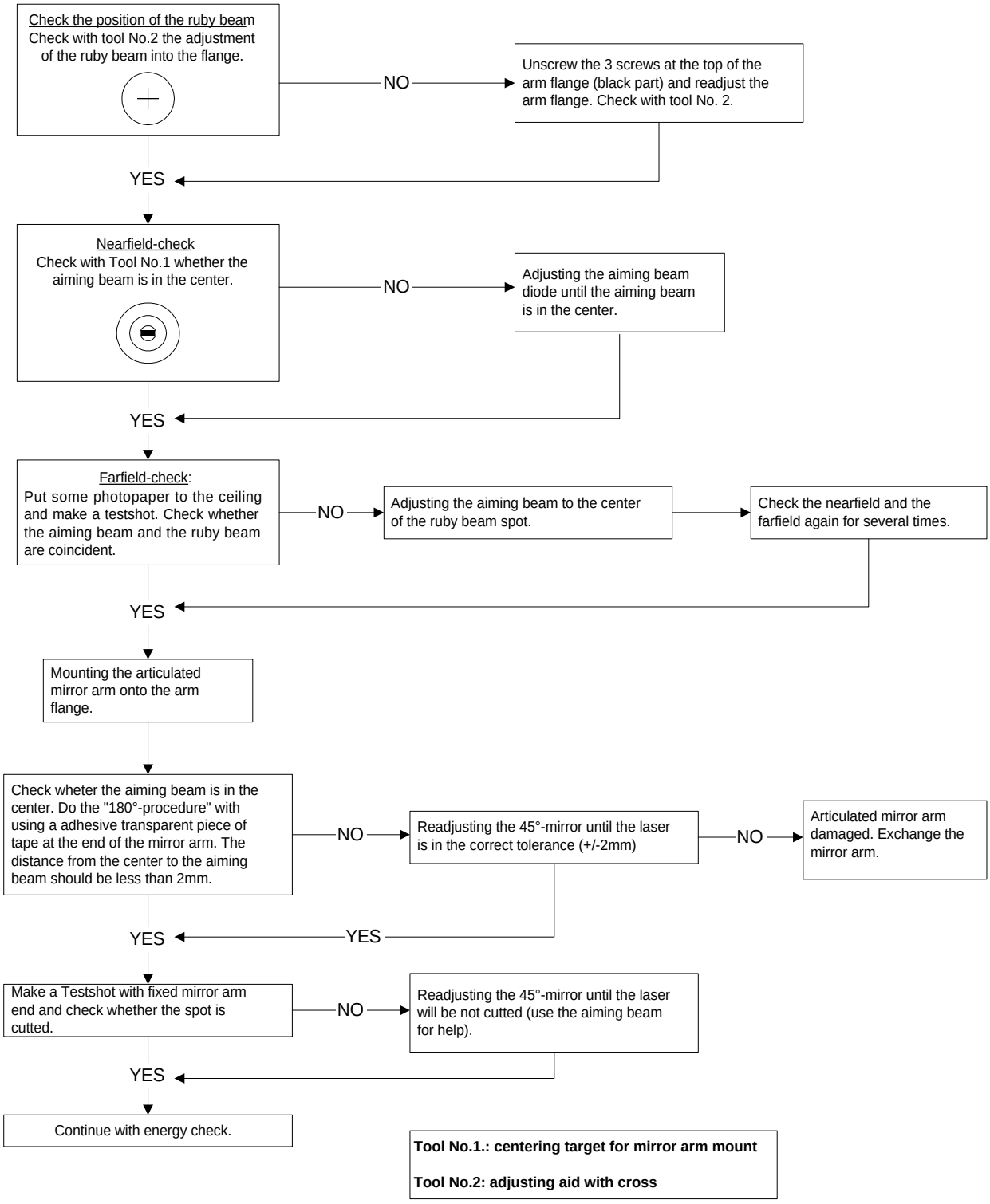
- Check the water flow sensor operation. The signal is a frequency proportional to the water flow. It can be measured on the Flow & Temp. PCB. Check on plug S1 on cable 163001585 (Do not pull out the plug!): pin 1 red and pin 4 green. Take probes and a device like Voltkraft VC 506 for frequency-measurement. Do the laser has a software upgrade it is possible to check the flow by using the LED's located underneath the 6 holes at the cover of the computer assembly. If the flow rate lower than 12Hz the system switches off automatically.

Flow l/min	1	2	3	4	5	6	7
Signal Frequency Hz	12	24	36	48	60	72	84

7. Energy output is low.

- First Check optics (mirrors, rod) for damages or contamination! Clean or replace if necessary. Make new alignment according to the replaced optics.
- Optimize optical alignment of the laser head (Minor adjustments to HR mirror may be made to optimize the output).
- Correct energy settings. For this, follow the instructions in section „Laser calibration".

9.3 Procedure of near- and farfield-check (laser- and aiming beam):



Problems:

If there are any problems with the centering of the laser- and the aiming beam please do the following steps:

Near and farfield check

Do the following procedures only in the „EPIL-Mode“ !!!

Check the position of the ruby beam in the near field

Check with the cross-hair target the adjustment of the ruby beam. For this procedure put a glass plate (e.g. micro slides) into the mirror arm mount and protect the aiming beam diode with a piece of paper or your business card (open the top cover of the aiming beam diode), else the aiming beam diode will be damaged. Does the mirror arm mount consist of a protecting glass, which is glued into, please fix the glass plate into the cross-hair target e.g. with double sided self-adhesive tape.

Put the cross-hair target onto the mirror arm mount and hold a piece of photo-paper with the black side to the target. Make a test shot with 10 J and check whether you can see a symmetric cross.
If you can't see a symmetric cross, you have to change the position of the mounted part of mirror arm flange by using the 3 screws inside. Do this procedure again until the cross at your photo-paper is symmetric. Also it's possible to move the white ceramic distance holder underneath.
Now you can be sure that the ruby beam is in the center of the flange.

Near-field check for the aiming beam (coincidence check)

You have to check the coincidence of aiming beam and ruby beam. Check with the centering target for mirror arm mount the adjustment of the aiming beam in the near field. To align the aiming beam diode use the 2 screws for the near field (see section 8.3.6 on p. 64 ff).

Far-field check

See section 8.3.6. on on p. 64 ff.

9.4 Active alignment of the output energy

Problems:

Too high energy ?

a) Check whether the handpiece is mounted.

Too low energy ?

a) Check whether the orange plugs are removed from the two exits of the articulated mirror arm.
b) Check whether the optic parts are clean (open the laser head; **SHORT EACH ENDS OF THE FLASHLAMPS TO THE EARTH**).
c) Turn the 2 screws at the backside of the laserhead to optimize the output energy (see page 10).

---

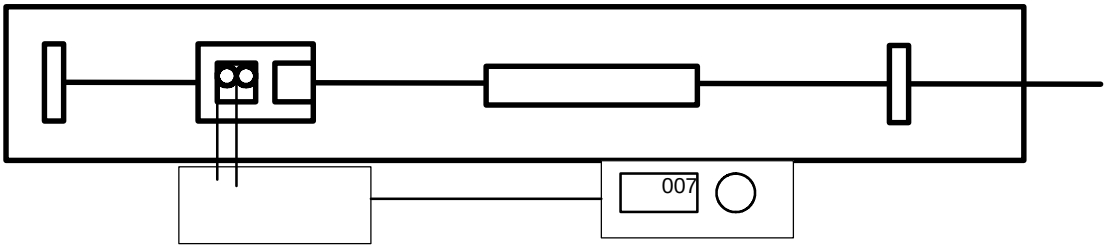
c)

For this procedure put a glass plate into the mirror arm mount (don't use the glass plate in the case of a modified mirror arm mount with included glass plate) and protect the aiming beam with a piece of paper or your business card (open the top cover of the aiming beam diode).
Put the measure-head of the OPHIR-NOVA energy-meter (see 4.3.4 on p. 24) onto the mirror arm mount and use an Allen-key for turning the first of the 2 HR-mirror screws. Make test shots with about 3-5 J. Turn the Allen-key and measure the output energy again until you have reached the maximum energy. Do the same procedure for the other screw. Do this until you are sure to be at the point of the highest energy. Now change to 10J and try to optimize the output energy again in the same way. **Check the near and farfield (see 9.3 on p. 79) !**

9.5 Problems with Q-Switch energy

If you should encounter any problems with too low energy in Q-Switch Mode, check the window inside of the handpiece for dirt and , if necessary, clean it with any kind of alcohol. The next step are adjustments on the Q-Switch unit.

How does the Q-Switch work?



HR - HR mirror, PC - Pockels cell, BP - Brewster pack, OC output coupler mirror

Terms:

Q-Switch	an electrooptical switch (EOS) an electrooptical modulator (EOM), = Pockels cell
Brewster Pack	Is a polarizer consisting of windows arranged at Brewster angle
Brewster angle	Arranged at Brewster angle, glass lets through 100% of light of one polarization direction while reflecting most of the light of the other polarization direction
Pockels cell	Is an electrooptical crystal that rotates the polarization of incident light when high voltage is applied to it (here: by 45°)
Q-switch unit	Brewster pack + Pockels cell
Extinction	Indicates how good the Q-Switch closes or how much energy it lets through.

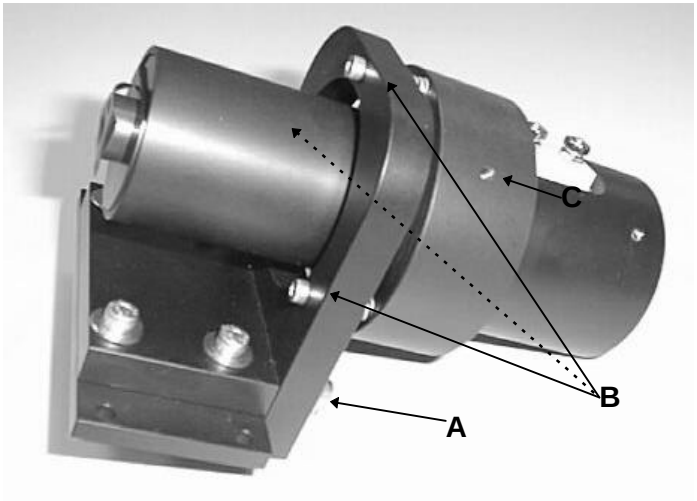


Fig. 41: Q-Switch unit

Difference between EPIL Mode and Q-Switch Mode

EPIL-Mode	**10J, 2ms**	Intensity = 5kW per pulse
Q-Switch	**1J, 40ns**	Intensity = 50MW per pulse (higher than 10000 times)

The difference is audible (Q-Switch is louder) and visible: Everytime there is a yellow spot (Q-Switch) by way of contrast with a grey or white spot (EPIL). The stress for the laser is accordingly higher. Therefore damages at the optics (also in the mirror arm) could happen more rapidly.

In **EPIL Mode**, a standing wave is being built up in the resonator, which continuously removes the inversion in the rod.
In **Q-Switch Mode** no standing wave can be built up, the inversion in the rod is continuously increasing and the energy being stored. If the switch is opened then, a standing wave is building up and the total energy is being delivered all at once. High voltage (U ≈ 2kV) is applied to the Pockels cell. Ruby radiation is emitted from the rod through the polarizer (Brewster Pack). The radiation transmits the Pockels cell. With voltage being applied, the Pockels cell rotates the laser radiation by 45°. After reflection by the HR mirror, the polarization is rotated again by 45°. Now the radiation is being reflected off by the polarizer. The trigger PCB detects the flashlamp pulse, and 2 ms later it will send a pulse to the HV driver. The high voltage will then be switched off for a few microseconds, the polarization is not rotated any more and the switch is open. The switching behaviour of the Pockels cell can be measured (Extinction, see next pages). If the switch lets through too much energy (E ≥ 200 mJ) although being closed, mostly the polarizer is not correctly positioned and must carefully be readjusted (3 screws, B → Fig. 41).

Adjustment of Q-switch

Requirements: - Shutter opened through software, test box or dismantled
- Laser switched off
- Autocollimating telescope (AKF, autocollimator)

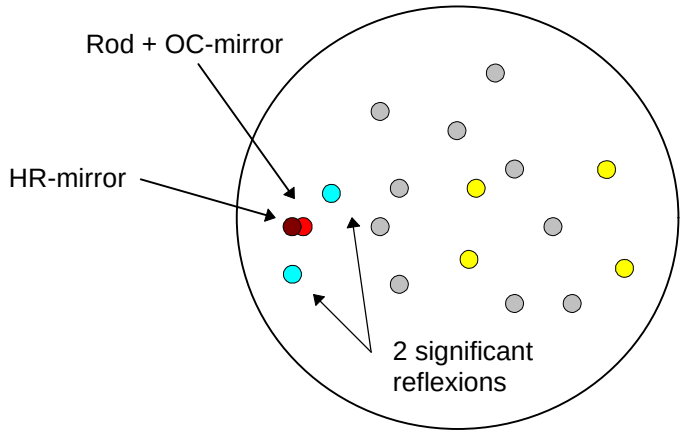


Fig. 42: Q-switch - image in AKF

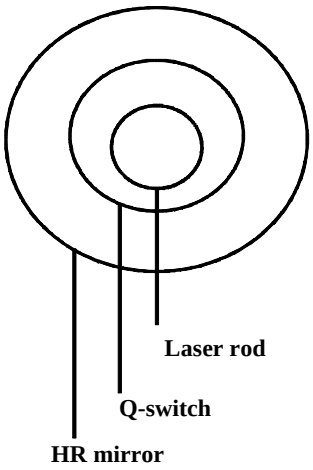


Fig. 43: Centering

When you look with the AKF to the aperture at the left hand side of the laser head (through the HR mirror) you will see many reflections including 6 blue / yellow ones produced by the Pockels cell unit (2x2 → 2 windows; 1x2 → Pockels cell). They form some type of circular figure. Besides, there are strong red reflections produced by the HR mirror and a weak one caused by the laser rod. In addition, many faint reflections produced by the Brewster pack are visible. Unhang HR-mirror cautiously in order to be able to unequivocally identify reflexes from the outcoupler mirror (red colored) and rubyrod (bright blue colored) with the help of an autocollimator (autocollimating telescope/ACT). Remove sticker label on left side of laser head and install autocollimator in this place. Close the laser head, if there is too much interfering light around the laser head. Move the ACT a few centimeters away from it's normal position until two of the significant points become smaller and darker. Use the three adjustment screws (**B**, see section "**Problems with Q-switch energy"**) until the reflexes from Rubyrod and outcoupling mirror are positioned between this 2 points. Cover up pilot beam diode with a business card (or a similar aid) and switch off the CCT breaker. Look through opening (left-hand side) of the laser head and check for centricity of Rubyrod and Q-switch unit (see Fig. 43).Suspend HR-mirror in its former position. Look with ACT through laser head opening again and turn the two adjustment screws as necessary to align the second brightest reflex of the HR-mirror with the reflex from the outcoupler mirror (left-hand side of laser head). Close shutter and install dust shields.

Centration: When looking with the eye through the HR mirror in the resonator, the Q-switch should not clip the beam (see Fig. 43). At the bottom of the Q-switch holder there are 2 screws (see **A** in Fig. 41) which are used to re-adjust the position of the Q-switch unit.

Procedure:

1. Open laser head, **discharge flashlamps!**
2. Open the shutter.
3. Check the marks on ruby rod and Q-Switch unit; if incorrect, turn ruby rod or Q-Switch unit (loosen screw **C** in Fig. 41). If the unit is unmarked use a air level to align the unit horizontal.
4. Look through HR mirror and check centration as per Fig. 43.
5. If centration is not correct, loosen the 2 screws (see **A** in Fig. 41) at the bottom of the Q-Switch holder and move the Q-Switch until centration is correct.
6. Use AKF to look through HR mirror and and check angular adjustment according to the sketch.
7. If necessary, turn the three adjusting screws on the Q-switch holder.
8. Check centration (Repeat step 4).
9. Close laser head, turn on the device, and test the extinction (see next page). If values are too high ($E \geq 200$ mJ), repeat steps 1 and 5.

Extinction measurement

Requirements

- Device has been adjusted in EPIL Mode.
- Q-Switch pre-adjusted
- Mirror arm flange mounted; if available
- Measuring device installed (see 4.3.4 on page 24)
- Display menu Q-Switch being active, single shot mode
- Device connected to laptop, service program being active.

Note: The laser cannot produce Q-Switch pulses without trigger pulses! Residual radiation that the switch lets through in closed state is not q-switched!

No.	Test	Result
1.	***Energy measurement in EPIL Mode (with Laptop)*** - Choose **EPIL Mode.** - Activate Service Program and set 3 J in EPIL Mode. - Determine control variables (DAC) for 3J by increasing („I“) or decreasing („D“) the DAC's. Do the same for 2 J and note them down.	**Value table**
2.	***Extinction test of Q-switch*** - **Remove BNC cable** at the trigger PCB on the left side of the laser head (thus permanently applying HV to the Q-Switch, switch is closed) **(IMPORTANT !!!)** - On Laptop, switch to Q-Switch mode („Q“). - Set control value for 3J and 2J (see 1.), release a shot and note down the energy. - The control variable for 2J should yield an energy of E ≤ 200 mJ. - **Re-connect the BNC cable!!!** - If the energy is E ≥ 200 mJ with the 2J control variable, carefully change the tilt angle of the Q-Switch (3 screws, see **B** in Fig. 41); do the **active alignment** (see p. 81) of output energy at the 2 screws of the HR mirror in **EPIL Mode**. **Then, don't forget to check the near- and far-field!!!. Repeat the extinction test (2.).**	**Value table**

Energy comparison: EPIL / Q-Switch

Caution: The settings (Service Mode) for Q-Switch are lower than those for the EPIL-Mode. If you operate the Q-Switch with settings normal for EPIL Mode, the laser rod will be destroyed.

1. Screw meter either onto auxiliary device (flange) or set it up at a distance of at least 30 cm behind the arm exit aperture.
2. **Observe laser safety regulations !!!**
3. On laptop, start service program and start the device.
4. Set EPIL Mode.
5. Determine the control variables for 0.5 J , 0.75 J and 1 J by trial and note down these values (control variables and energy values, see example table below)
6. In Service Program, set Q-Switch and start the adjustment using the control variables (DAC's) found in Step 5 and set them until 0.5, 0.75 und 1.0 (see also Section "Q-Switch Mode")
7. Compare found values with standard values (EPIL-Mode). If deviation exceeds 5 units (DAC's), check optical system for cleanness, remove Q-Switch unit and test the laser head in normal EPIL Mode. If the energy is significantly higher, the Q-Switch will mask the beam and must be readjusted accordingly.

Example table

Control variable	143	145	147
Energy EPIL Mode	0.54 J	0.78 J	1.02 J
Energy Q-switch	0.56 J	0.66J	0.88 J

10 Wiring and electronic circuits

	KIND OF DIAGRAM	TITLE	PCB No	DRAWING No
1	BLOCK DIAGRAMM	SIGNAL WIRING		163 00 - 4508
2	BLOCK DIAGRAMM	MAIN CIRCUIT		163 00 - 4002
3	BLOCK DIAGRAMM	POTENTIAL DIAGRAM		163 00 - 4003
4	CIRCUIT DIAGRAM	DISCHARGE CONTROL		163 00 - 4504
5	CIRCUIT DIAGRAM	RSH		
6	CIRCUIT DIAGRAM	TEMP.-CONTROL (1-P.-REGLER)		
7	CIRCUIT DIAGRAM	TEMP.-CONTROL (2-P.-REGLER)		
8	BLOCK DIAGRAM	DISCHARGECIRCUIT		163 00 - 4005
9	BLOCK DIAGRAM	DISCHARGECIRCUIT WITH ENERGY CONTROL		163 00 - 4007
10	CIRCUIT DIAGRAM	TEMP./ FLOW		163 00 - 4503
11	CIRCUIT DIAGRAM	DISPLAY AND KEYBOARD PCB		
12	CIRCUIT DIAGRAM	SHUTTER ASSEMBLY	163 42-1015	163 00 - 4505
13	CIRCUIT DIAGRAM	SWITCHING CONTROL		163 00 - 4502
14	CIRCUIT DIAGRAM	SERIAL INTERFACE		163 00 - 4501
15	CIRCUIT DIAGRAM	SHUTTER DIAGRAMM		163 00 - 4506
16	CIRCUIT DIAGRAM	SHUTTER CONTROL PCB	163 42-1016	163 00 - 4507
17	CIRCUIT DIAGRAM	SUPERVISOR CONTROL PCB	163 42-1008	
18	CIRCUIT DIAGRAM	CONTROL INTERFACE PCB	163 42-1012	
19	CIRCUIT DIAGRAM	V-CONTROL		163 00 - 4008
20	BESTÜCKUNG	V-CONTROL		
21	LAYOUT	V-CONTROL		
22	VOLTAGE MONITORING			