

Laser



DL 3000



Operating Instructions



DENTAURUM

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General information

The laser you have purchased complies with the EC directives for such equipment and has been developed especially for dental applications.

Unit identification

Product: Laser welding unit (Nd:Yag laser wave length 1064 nm)
Type: DL-3000
Company: Dentaorium J.P.Winkelstroeter KG
Turnstraße 31
D-75228 Ispringen
Germany

The parts to be welded are manually arranged, positioned and laser welded in the welding chamber using the stereo microscope.

The required inert gas and the laser pulse are switched on or activated via a two stage pedal switch. During and after the processing the welding vapors is automatically extracted.



Caution:

Before switching on the unit you must have read and understood the user's instructions! Switch on the device only after having done this! Before using the unit for the first time, the relevant authorities must be informed.



Caution:

Empty the cooling water tank before every change of the installation site.

Safety information

Danger symbols and information

The following symbols indicating danger are used in these operating instructions:

 **Warning:** Notes on possible threat to life and health of personnel. Failure to heed this can cause serious damage to health and even dangerous injuries.

 **Caution:** Note on a possibly dangerous situation. Failure to heed this can cause minor injuries or damage to property.

Correct usage

The DL 3000 is designed exclusively for welding metals. To use it for any other purpose or for anything beyond this is to use it improperly. DENTAURUM is not liable for damages caused by this. Proper use also includes heeding all information of this manual and regular inspections and maintenance work.

 **Caution:** Processing non-metallic materials, especially plastics, constitutes improper use.

Warranty and Liability

Our general terms and conditions of sale and delivery apply. Warranty and liability claims in the event of physical injury or damage to persons and property are invalid if they are caused by one or more of the following:

- Improper putting into operation, operating, mounting and maintenance of the laser welder
- Improper use of the laser welder
- Operating the laser with safety facilities that are defective or improperly installed or with inoperative safety and protective precautions
- Failure to heed the notes and information in this manual concerning the transport, storage, installation, operation and maintenance of this laser
- Lacking supervision of wearing parts
- Unauthorized structural modifications to this laser
- Improperly performed repairs

Employer's obligations

The employer will only allow personnel to work with this unit who

- are familiar with the basic regulations concerning safety at work and accident prevention and have been instructed in the use of this unit.
- have read and understood the safety information and the warnings in this manual and have confirmed this by their signature.
- have been instructed as to the dangerous effects of laser radiation in accordance with the valid regulations about accident prevention for laser radiation (decree of the trade association VBG 93).
- Before using the unit for the first time, the relevant authorities must be informed.

Personnel's obligation

All personnel who work with the unit must undertake before starting to work to

- heed the basic regulations concerning safety at work.
- read and understand the safety information and the warnings and confirm them by their signature.

Laser safety officers

Using a class 4 laser, a competent laser safety officer must be appointed in writing by the employer. The specialist should have training and experience in the field of laser radiation. The laser safety officer should fully understand the safety procedures and equipment used. He is responsible for the safe operation and safety measures of the unit.

The laser safety officer will receive appropriate training by the relevant trade associations or by DENTAURUM.

Protection of the eyes against laser radiation

The unit is equipped to protect the eyes of the operator and other personnel around the unit.

1. Safety shutter

The safety shutter prevents generation of laser pulses or the unintended emission of laser radiation from the laser source and is closed,

- if the arm sleeves are open.
- if the openings of the arm sleeves are not closed.
- if the laser parameters are changed.
- if there is no control voltage at the safety shutter.

2. The laser pulse is only operational when

- both arm sleeves are closed
- and both forearms of the operator are in the welding chamber
- and no laser parameters are set
- and the charging of the energy reservoir has been finished
- and the pedal switch has been pressed down to stage 2.

3. Other devices for eye protection

- The unit is equipped with a large observation window out of laser protective glass for a safe direct observation of the welding process.
- The unit is equipped with an automatic glare protection within the optical path of the stereo microscope that is activated during welding.
- The complete laser beam path is optically sealed.

THE UNIT FULFILLS ALL CONDITIONS FOR TOTAL EYE PROTECTION.

This meets one **part** condition for a class I laser.

The unit does **not** fulfill the second part condition for a class I laser, **skin protection** against laser radiation.

Protection of the skin against laser radiation

The unit has been developed for dental applications. Every workpiece is an individual part, the processes cannot be automated. The dental workpiece must be held **with the hands** as a large number of various materials with different measurements, appearances, surface compositions and fitting tolerances are connected together in various combinations or have to be processed at their surfaces. At the moment protective gloves against laser radiation technically cannot be realized and would hinder or even make impossible to work on the very small parts. The same problem exists for the use of holders, tweezers etc. Therefore this laser has to be classified as work equipment for the dental laboratory that bears the threat of minor injuries.

Due to the design of the unit the area of danger is reduced to the hands and arms of the operator. In case of false operation the tissue of the skin can slightly be burnt by laser influence. In case of severe burns the operator should seek medical treatment.

Caution: Invisible laser radiation!

You can avoid direct laser radiation to your hands:

- Do not position your hands directly under the crosshair or in the laser beam!
- Look through the stereo microscope and position the workpiece that the welding point appears sharp within the crosshair!
- Take care that the hands do not appear - if possible - in the field of view of the stereo microscope!
- Keep your hands calm while releasing the laser pulse with the footpedal switch!
- Always look through the stereo microscope and control the position of you hands and the position of the workpiece!

Caution: Scattered laser radiation

You can avoid scattered laser radiation to your hands:

Especially objects with shiny surfaces can scatter or deflect the laser radiation so that even in longer distances of the welding point there is a certain local danger of burning!

- If possible do not wear any jewelry on arms or fingers while working with laser radiation or do not hold any shiny surfaces directly into the laser beam.

Further important Safety Information, welding vapor exhauster

- The operating instructions must always be kept at the installation site.
- The device is a work equipment for welding dental metals and alloys with pulsed laser radiation. It must not be used for other purposes.
- NEVER put inflammable or explosive substances in the welding chamber!
- During the welding VAPORS DANGEROUS TO HEALTH may be produced!

To keep the breathing air clean the trade association requests a corresponding welding vapor exhauster for welding with the laser.

The exhauster integrated in the DL 3000 is only licensed for exhausting laser welding vapor. IT MUST NOT BE USED FOR OTHER PURPOSES, e.g. for exhausting of

- highly inflammable or explosive gases
- fluids of any kind
- organic substances (e.g. plastics)

The air outlet holes must always stay free. There must not be any damages at the suction hose and it must be properly connected to the suction filter and the exhauster!

The welding vapor exhauster must only be operated with the original spare filter and never without filter.

Maintenance activities

! Attention: For all service and maintenance activities never work alone!

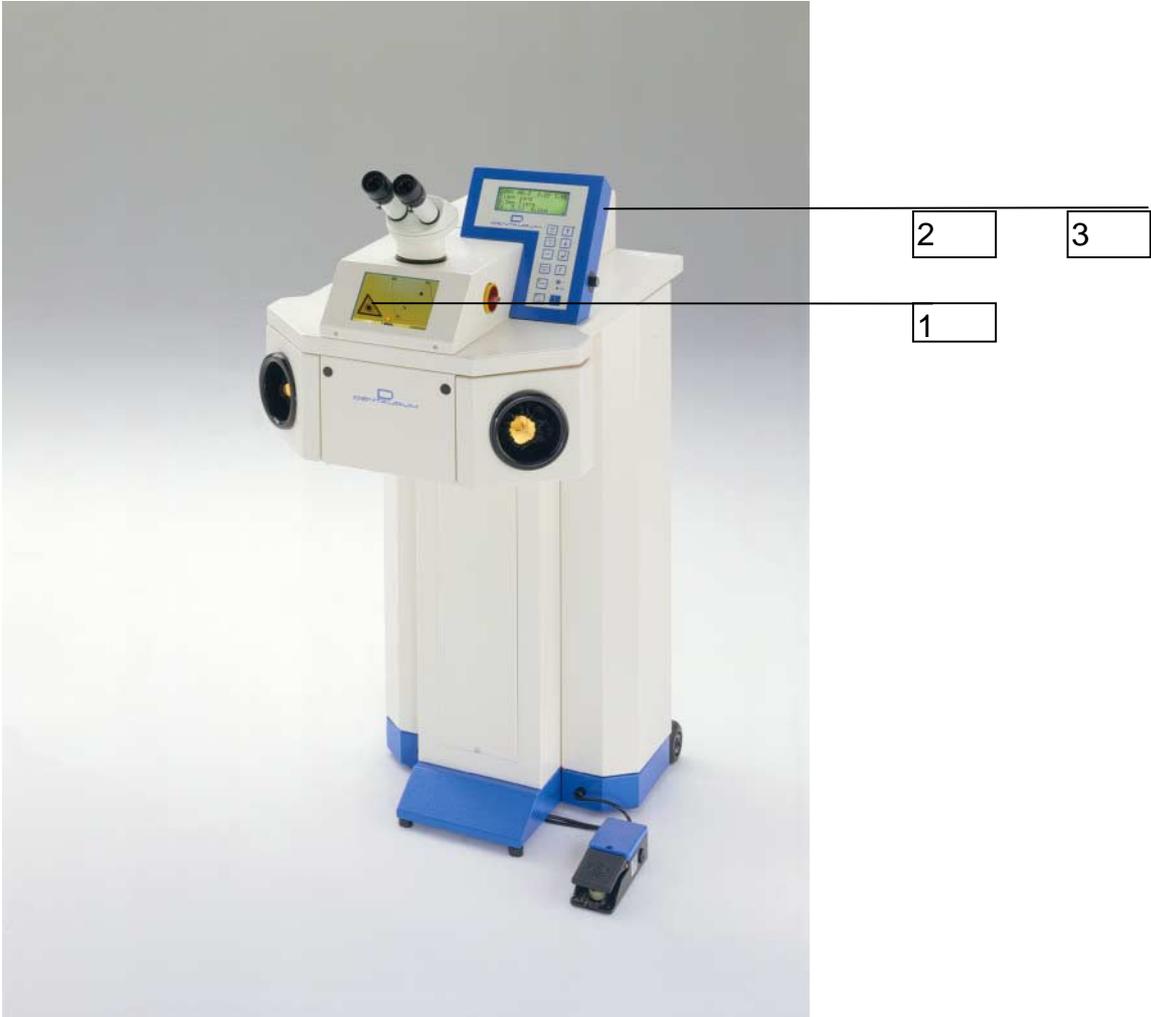
A second person, who should be at least familiar with the risks posed by laser radiation and high voltages, should always be present during service and repair activities.

All activities on electrical or electronic components of the device must only be performed by authorized qualified employees or by the Dentaurum service.

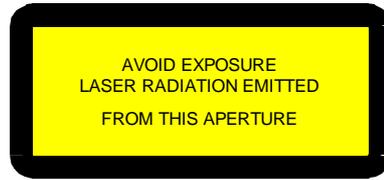
! Warning: Dangerous high voltage!

To ignite the flashbulb this laser is operated with high-voltage capacitors. After having turned off or disconnected the device current-carrying components can still be live.

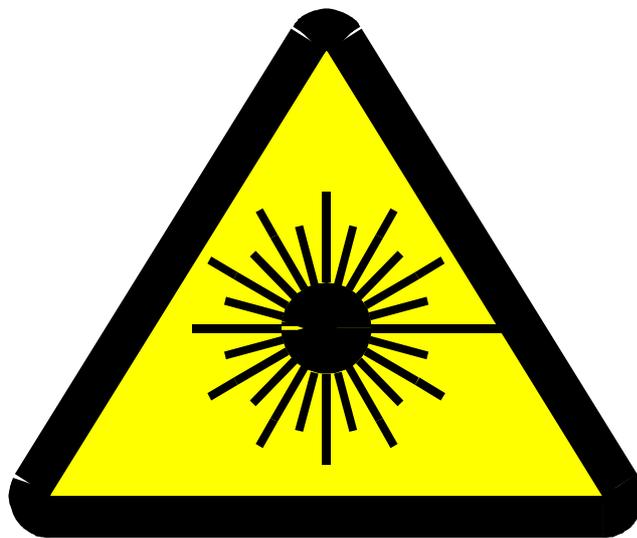
Position of the laser warning signs



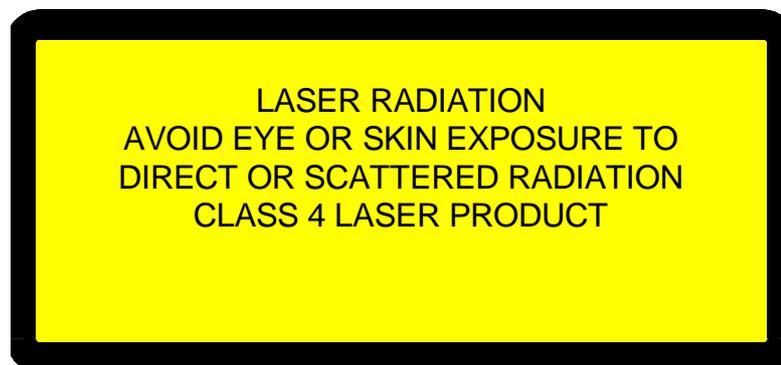
Laser warning signs



1



2



3

Basics of the laser and the welding process

LASER = Light Amplification by Stimulated Emission of Radiation

It is a light amplification caused by stimulated emission of radiation. The light amplifier of the laser is a rod shaped crystal of neodymium-doped yttrium aluminum garnet (Nd:YAG) stimulated by a light pulse from an external rod shaped flash bulb. A suitable high-performance reflector guarantees a high efficiency and coupling-in rate of the lamp light into the laser crystal. In order to send out amplified and directive laser light two mirrors are arranged outside the crystal that way that the light coming from the crystal is reflected in itself and back to the crystal (resonator). One of the mirrors is semi-reflecting and releases a strongly directive laser radiation from the resonator. The wave length range of this radiation is strongly limited to 1064 nm. Due to the strong directional dependence and the narrow wave length range the extreme concentration of the laser energy on the workpiece is possible (focusing via a suitable lens). This energy concentration exceeds the concentration of usual light sources many times.

The laser pulse facilitates welding by heating the workpiece in the focal area beyond the melting temperature and liquefying the materials that are to be connected. After a relatively short laser exposure time (0,5 ms to 20 ms) the melted materials solidify again and are tightly connected together.

By the high and short time concentration of the laser energy to a limited volume heat is only produced where it is needed. This feature makes the laser an excellent tool for the dental laboratory.

Technical description of the device

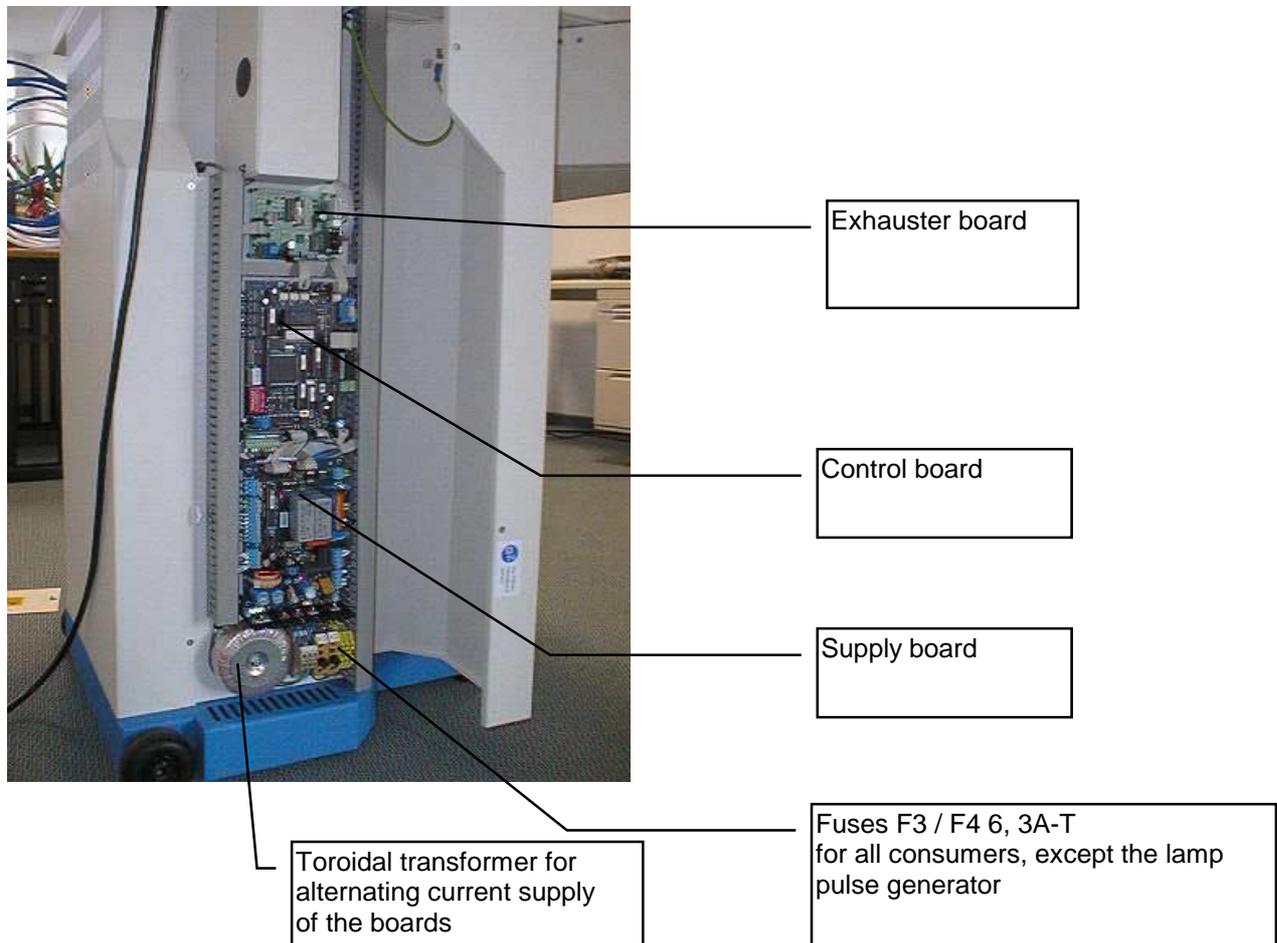
Fuses and current distribution

! Attention: Unplug the device before opening it.

The following modules are behind the left side door:

- The fuses F3 and F4 that are responsible for the cooling water pump for the remaining modules.
- A toroidal transformer for the power supply of the boards
- The supply board with further fuses responsible for various power supplies, the fan control of the heat exchanger, the connections to the interlock sensors, the control of the magnetic valve for the gas supply, the halogen lighting and for the control of the exhauster.
- The control board responsible for the control of the laser especially the lamp pulse generator, for the in- and output of the laser parameters, the display control and the evaluation of the safety circuits.
- The automatic circuit breaker for the lamp pulse generator is behind the right side door.

Left side door open



Lamp pulse generator

A converter with sinus shape current input connectable to almost all supply voltages loads the capacitor bank integrated in the lamp pulse generator. The stored energy is far higher than needed for one pulse. Therefore the voltage decreases only slightly after every pulse. Shortly before the main pulse itself a small ignition coil ignites and ionizes the lamp. This is the precondition for a reproducible and stable main discharging.

During the main discharging two parallel high-power transistors connect the capacitor bank to the flashbulb for an adjustable pulse duration (0.5 ms to 20 ms). The battery is automatically recharged after the end of the pulse.

The loader is connected to the control via the optical fibers (LWL sender and receiver).

Signals from the control to the loader

Loader ON/OFF

Charging voltage (PWM signal)

Laser pulse ON/OFF

Signal from the loader to the controller

Charging voltage reached / charging finished

The following safety functions are integrated in the loader:

- Forced rapid discharge of the capacitor bank after disconnecting the loader
- Disconnecting in case of overvoltage
- Disconnecting in case of overtemperature

From external via loader ON/OFF

- Disconnecting in case of malfunction of the laser (interlock)
(see controller)

Water - air heat exchanger

Each lamp flash produces dissipation heat in the laser head that must be dissipated to prevent overheating of the device.

In the lower shelf of the device a dipping pump sucks water from a tank and pumps it through the laser head past lamp and rod. There the water takes up the dissipation heat of the flashbulb. The heated water is circulated up to a water-air heat exchanger. The heat exchanger fins are efficiently ventilated by a fan. The water expels its heat to the air blown out upward.

The fan is continuously regulated depending on the temperature of the cooling water.

The cooled water flows back down through a particle filter into the tank.

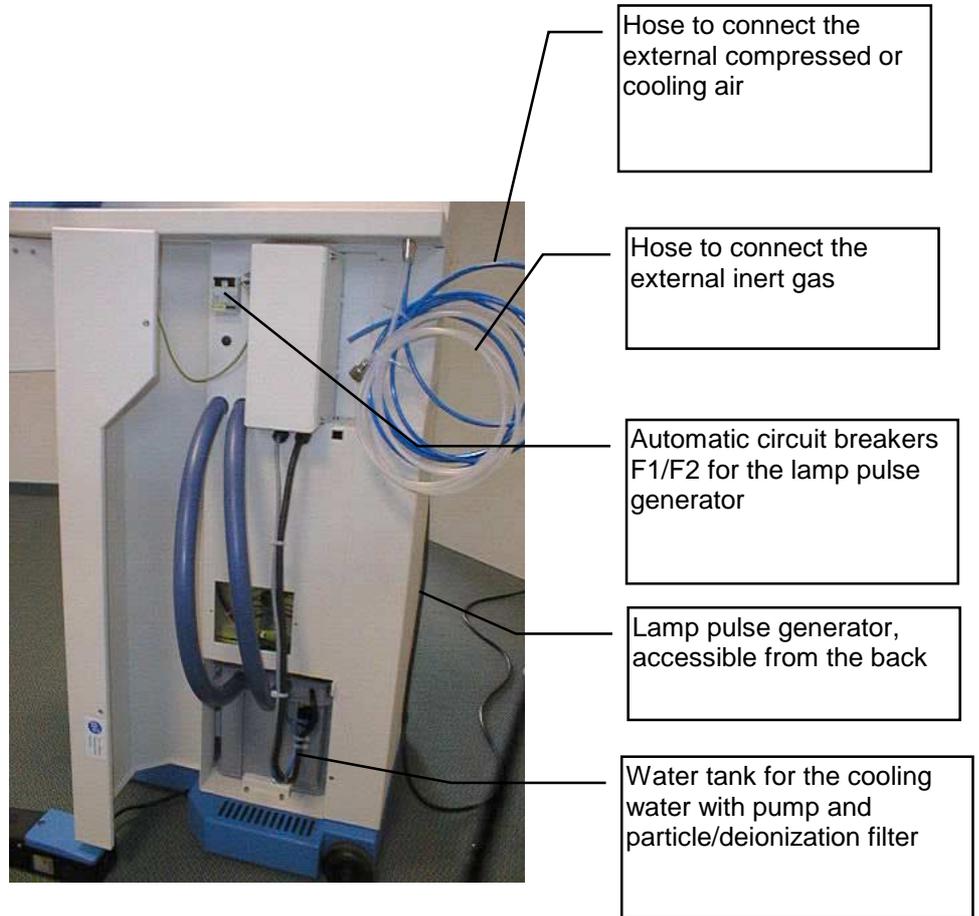
The following safety functions are integrated in the tank (in the water reflux):

- Flow sensor
- Level switch
- Overtemperature switch

In case of one or several malfunctions the loader is disconnected via the controller.

Also refer to page 15

Side view (right side door open)



Laser beam source, focusing and observation optics

A compact mechanically stable metal housing contains

- the laser beam source with the mirrors and the laser head
- the safety shutter to protect the eyes against unintended laser radiation
- the telescope to adjust the focal spot diameter

The housing protects the optical components against welding dust, mostly avoids electromagnetic disturbances to the outside and an unintended emission of laser radiation or scattered laser radiation.

A mechanical unit is flanged to the metal housing. It contains the following components:

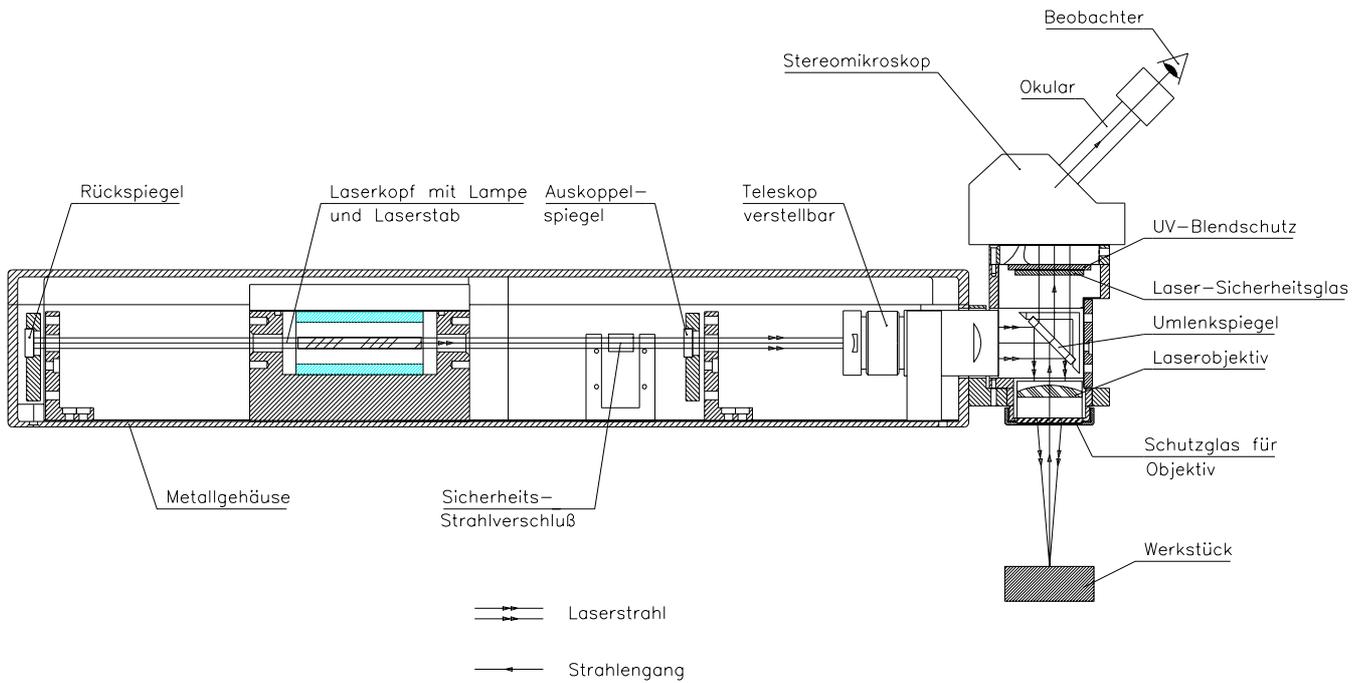
A deflecting mirror to deflect the laser beam for 90° downward.

- The laser and observation lens to bundle the laser beam on the workpiece and to observe it via the stereo microscope. The observation lens is equipped with a protective glass against welding dust and metal splashes.
- The observation window with its protective glass to protect the environment against scattered laser radiation.
- A stereo microscope to control the welding through the laser lens and via the deflecting mirror.
- An automatic glare protection for the eyes that closes the beam path to the stereo microscope during the laser pulse.

Also refer to page 17

Beam path (sectional drawing)

Laserstrahlquelle, Fokussierungs- und Beobachtungseinheit



Legende

- | | |
|-----------------------------------|------------------------------------|
| Rückspiegel | Rear mirror |
| Laserkopf mit Lampe und Laserstab | Laser head with lamp and laser rod |
| Auskoppelspiegel | Output coupler |
| Teleskop Verstellbar | Telescope adjustable |
| UV-Blendschutz | UV glare protection |
| Laser-Sicherheitsglas | Laser safety glass |
| Umlenkspiegel | Deflecting mirror |
| Laserobjektiv | Laser lens |
| Schutzglas für Objektiv | Protective glass for lens |
| Metallgehäuse | Metal housing |
| Sicherheits-Strahlverschuß | Safety shutter |
| Werkstück | Workpiece |

Welding chamber

For eye protection the complete laser path is shielded to the outside.

The workpiece is enclosed in a welding chamber that reduces the scattered laser radiation during welding to a level that is safe for the eyes. All openings for observation and positioning of the workpiece are closed with permitted protective glasses against laser radiation or controlled by sensors.

The chamber has a

- left and a right handflap through which the workpiece can be put into the chamber. At the handflaps there are safety limit switches that only permit the release of laser pulses if both flaps are closed. Furthermore there are sensors that only permit the release of laser pulses if both arms of the operator are within the hand openings.

At the operators side of the housing is

- a large-area laser protective window for direct pre-positioning of the workpieces

The following operating elements are mounted down at the rear side

- Down left: Rotary potentiometer to adjust the setting of the lighting
- Up left: Cooling air nozzle to cool the workpiece
- Down below: Two joysticks to set the laser parameters from the working chamber.
The joysticks have the following functions:
Moving the
left joystick up/down: Increase/reduce the focal diameter.
left joystick right/left: Increase/reduce voltage.
right joystick up/down: Increase/reduce frequency.
right joystick right/left: Increase/reduce pulse duration.
- Down below: Small joystick to select the parameter sets from the temporary memory
Moving the joystick downward: Select parameter set
Moving the joystick upward: Get parameter set from the temporary memory
- Down right: Rotary potentiometer to control the power of the exhauster

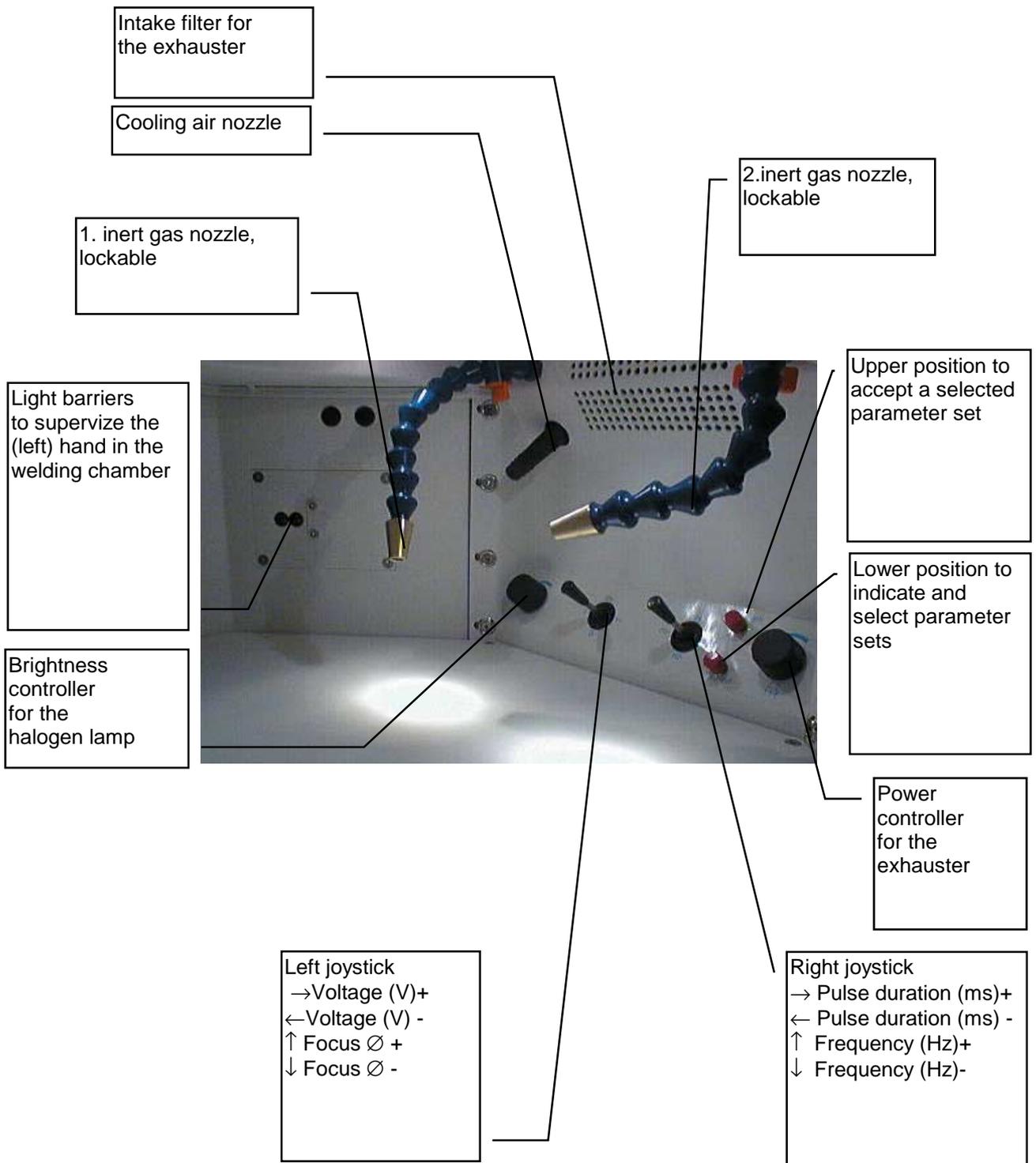
Left and right beside the laser lens are

- one halogen spot each to illuminate the workpiece in the focal spot area

At the laser aperture

- are mounted both inert gas nozzles with stopcock

Figure: Welding chamber



Main switch and key switch

- Main switch ON/OFF or EMERGENCY OFF switch for the complete device. It switches on/off the water pump and enables the power supply for the other components.
- Key switch Via the key switch of the control box the control and the loader are switched on or off.

The control box at eye level of the operator

The following indication and operating elements are at the control box (see figure on page 24):

- LED raster display The display shows the reference input value for voltage, focal diameter, pulse duration and frequency. It shows a possible cause of failure by plain text messages. Simultaneously the LED within the CLEAR key comes on. The loader then is switched off.
- LED ON It shines green if the control has been activated with the key switch
- LED The LED * shines red if the laser cannot pulse. This is the case if the loader has not yet finished loading or is not ready or if the loader has been cut off because of a malfunction (see interlock).

 The LED * shines green if the laser pulse can be released with the pedal switch.
- Shutter Close key The key closes the safety shutter, the LED shines red
- Shutter Open key This key enables the opening of the shutter: The LED **flashes** green. If both hands are within the hand openings the shutter opens and the laser can pulse. In this case the LED continuously shines green.

Also refer to page 25

Setting of the desired language on the display

The display at the control box can indicate the dental technical terms in five different languages. To select the desired language plug in the mains plug and switch on the mains switch on the right side. Now turn the key switch of the control box to „I“ and simultaneously press the **MEM IN** key of the control box for several seconds. Confirm the selection menu **language select** by pressing the **↵** key. Now select the desired language (German, English, French, Spanish or Italian) with the **↑/↓** keys and confirm with the **↵** key. Then leave the selection menu by pressing the **MEM OUT** key. After that the system performs its usual self check. The setting of the language is finished.

Display and key pad at the control box

The parameters voltage, focal diameter, pulse duration and pulse frequency (V, Ø, ms, Hz) can either be set with the key pad of the display or via the joystick in the welding chamber.

If a set parameter exceeds the loading capacity of the loader the laser pulses with its maximum frequency. The reduced frequency is indicated.

The following functions can only be set if no character flashes on the display and the parameters (V, Ø, ms, Hz) appear in the first line of the display (main menu).

1. Call parameter sets from data base / set laser data anew

The data base contains 8 material groups. A maximum of 16 entries (parameter sets) per material group is possible for the various kinds of processing. Predefined parameter sets are assigned to the first four groups.

1. To call one material group press the **MEM OUT** key.
A list of material groups appears. To select the desired material group press the \uparrow/\downarrow keys.
2. To call the parameter sets stored under the selected material group press the \downarrow key.
The first parameter set of this group is indicated:

1. Line	Name of the material group, parameter set no. [..]
2. Line	Welding depths (comment)
3. Line	The parameters (V, Ø, ms, Hz)
4. Line	Pulse shaping S, pulse energy (J), pulse peak power (kW)

To select the desired parameter set press the \uparrow/\downarrow keys.

3. To get the desired parameter set press the \downarrow key.
Press the **MEM OUT** key to adjust the laser to the previously used parameter set or to cancel the selection menu.

2. Program memory and pulse shaping

To make operation easier for the operator various welding programs have already been programmed in the DL 3000. The pulse shaping can compensate differences depending on various alloys. You will find a more detailed description of the user guide of these programs in the dental technical instructions.

3. Setting of individual parameters via the key pad at the control box

1. Press the **EDIT** key to activate the parameter setting function.
2. One of the changeable parameters - voltage (**V**), focal diameter (**Ø**), pulse duration (**ms**), pulse frequency (**Hz**) or pulse shaping (**S...**) - flashes.
3. Select the desired parameter with the \downarrow key and adjust the value of the desired parameter with the \uparrow/\downarrow keys. With these settings you can start working immediately.
4. Press the **EDIT** key to switch off the parameter setting function.

4. Save parameter sets in the data base

1. Set the parameter set that is to be stored.
2. Press the **MEM IN** key.
A list of material groups appears. Press the \uparrow/\downarrow key to select the material group where the parameter set is to be stored.
3. Press the \downarrow key. the set parameters are added to the selected material group.
4. Press the **MEM OUT** key. the set parameters will **not** be accepted.

5. Delete parameter sets from the data base

1. To call one material group press the **MEM OUT** key.
A list of material groups appears. To select the desired material group press the \uparrow/\downarrow keys.
2. To call the parameter sets stored under the selected material group press the \downarrow key.
The first parameter set of this group is indicated. Select the parameter set that is to be deleted with the \uparrow/\downarrow keys.
3. First press the **F** key and then additionally the **MEM-IN** key.
The selected parameter set is deleted from the data base.
Press the **MEM OUT** key: the selected parameter set will **not** be deleted.

6. Create texts and values in the memory and change them with the display key pad

Instead of the names *material A* of *material B* you can enter any name for the material groups and save them.

Moreover you can add individual comments to every stored parameter set, change stored parameter sets and define them anew.

Change name of the material group:

1. To call the name of a material group that is to be changed press the **MEM OUT** key.
A list of material groups appears. To select the desired material group press the \uparrow/\downarrow keys.
2. Press the **EDIT** key to activate the text editor.
The cursor flashes below the changeable character (= the text editor is active).
3. Set/indicate the desired text passage with the \downarrow key and with the \uparrow/\downarrow keys the desired character at this place.
4. Press the **EDIT** key to close the text editor.
The flashing cursor disappears and the changed name of the material group is saved.
5. To get to the parameter sets stored under the material group press the \downarrow key.

Enter/change comment to a stored parameter set anew and change parameter values in the stored parameter set:

1. Press the **MEM OUT** key to select the material group where a comment is to be added to the parameter set. A list of material groups appears.
To select the desired material group press the \uparrow/\downarrow keys.
Press the \downarrow key to indicate the first parameter set of this group. Select the desired parameter set with the \uparrow/\downarrow keys.
2. Press the **EDIT** key to activate the text editor.
The cursor flashes below the changeable character (= the text editor is active) in the second line.

3. Set/indicate the desired text passage with the \downarrow key and with the \uparrow/\downarrow keys the desired character at this place.
4. Press the **EDIT** key anew to change the values in a parameter set in line 3 and 4.
5. The changeable parameter (V, \emptyset , ms, Hz, S) in line 3 or 4 flashes.
Select the desired parameter with the \downarrow key and adjust the value of the desired parameter with the \uparrow/\downarrow keys.
6. Press the **EDIT** key to close the text editor.
The flashing cursor disappears and the changed data are saved.
7. Press the \downarrow key to activate the new parameter set for the laser.
Press the **MEM OUT** key to get to the previously used parameter set.

7. Form pulses with the display key pad

This function determines the time behavior of the laser power during a pulse. Altogether 4 different pulse shapes are programmed unchangeably (S1-S4). The user can freely program the pulse shapes S5 to S8.

1. Press the **SHAPE EDIT** key.
A list of five pulse shapes appears. To select the desired pulse shape press the \uparrow/\downarrow keys.
2. Indicate the desired pulse shape with the \downarrow key.
The selected pulse shape is indicate with 10 horizontally equal time segments and with a maximum of 8 height steps in every segment. A time segment corresponds to 1/10 of the set pulse duration, a height step corresponds to about 1/8 of the determined laser pulse power. If the voltage or the pulse duration is changed the shape of the pulse remains unchanged while the complete pulse duration or height is shrunk or stretched.
3. Select the desired time segment with the \downarrow key (horizontally, segment flashes) and set the heigth of the selected segment with the \uparrow/\downarrow keys.
4. Press the **SHAPE EDIT** key anew.
The changed pulse shape is stored.
„S_“ is the usual pulse without pulse shaping.

Joystick

Set parameters with the joystick

You can set the following parameters with the joysticks in the welding chamber:

- | | | | |
|---|----------------|--------------------------|---------------------------------|
| - | left joystick | \rightarrow/\leftarrow | voltage higher / lower |
| | left joystick | \uparrow/\downarrow | focal diameter bigger /smaller |
| | right joystick | \rightarrow/\leftarrow | pulse duration longer / shorter |
| | right joystick | \uparrow/\downarrow | frequency higher / lower |

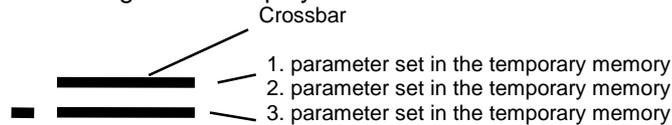
Store parameter sets temporarily and update them

To facilitate fast access to the last used data or quickly switch from one parameter set to the other the control is equipped with a temporary memory. You can save 4 parameter sets in the temporary memory. The contents of the temporary memory is automatically deleted after having switched off the controller.

A bar indication is at the right lower edge of the display. The crossbars indicate the number of parameter sets stored in the temporary memory. The dot in front of the crossbar indicates which parameter set of the temporary memory is just indicated (see sketch).

If the temporary memory is empty no indication is displayed (**status after switching on**).

Example: Indication at the lower edge of the display:



Example: The display just shows the values of the 2. parameter set

Copy a parameter set to the temporary memory

Press the ↵ key once to manually copy the presently used parameter set to the temporary memory (e.g. to quickly store a suitable parameter set for a new welding procedure). A bar indication appears at the right lower edge of the display. The crossbars indicate the number of parameter sets stored in the temporary memory. The dot in front of the crossbar indicates which parameter set of the temporary memory is just indicated.

To save a value from the *material data base* in the temporary memory first select the desired parameter set with **MEM OUT** and the ↑/↓ keys. Confirm the selection menu **language select** by pressing the ↵ key.

If there are already four sets in the temporary memory and an additional parameter set is to be added, the last parameter set down below (see bar diagram) is deleted.

Select and accept a parameter set from the temporary memory

The memory is organized as a *push-pop stack* i.e. you can first access to the last stored data. Fast access is possible with the small right joystick within the welding chamber.

If you push down the joystick (*Data switch*) you can select the three stored parameter sets. The dot in front of the bar indication moves downward. Push the joystick upward (*Data out*) to accept one of the parameter sets. Now the laser uses the values of this parameter set.

Delete a parameter set from the temporary memory

Push the small joystick downward (*Data switch*) to select a parameter set that is to be deleted. Now press the **F** and **MEM IN** key simultaneously to delete the parameter set. If this is done with all parameter sets the display shows the message **recall stack empty** and the temporary memory is empty.

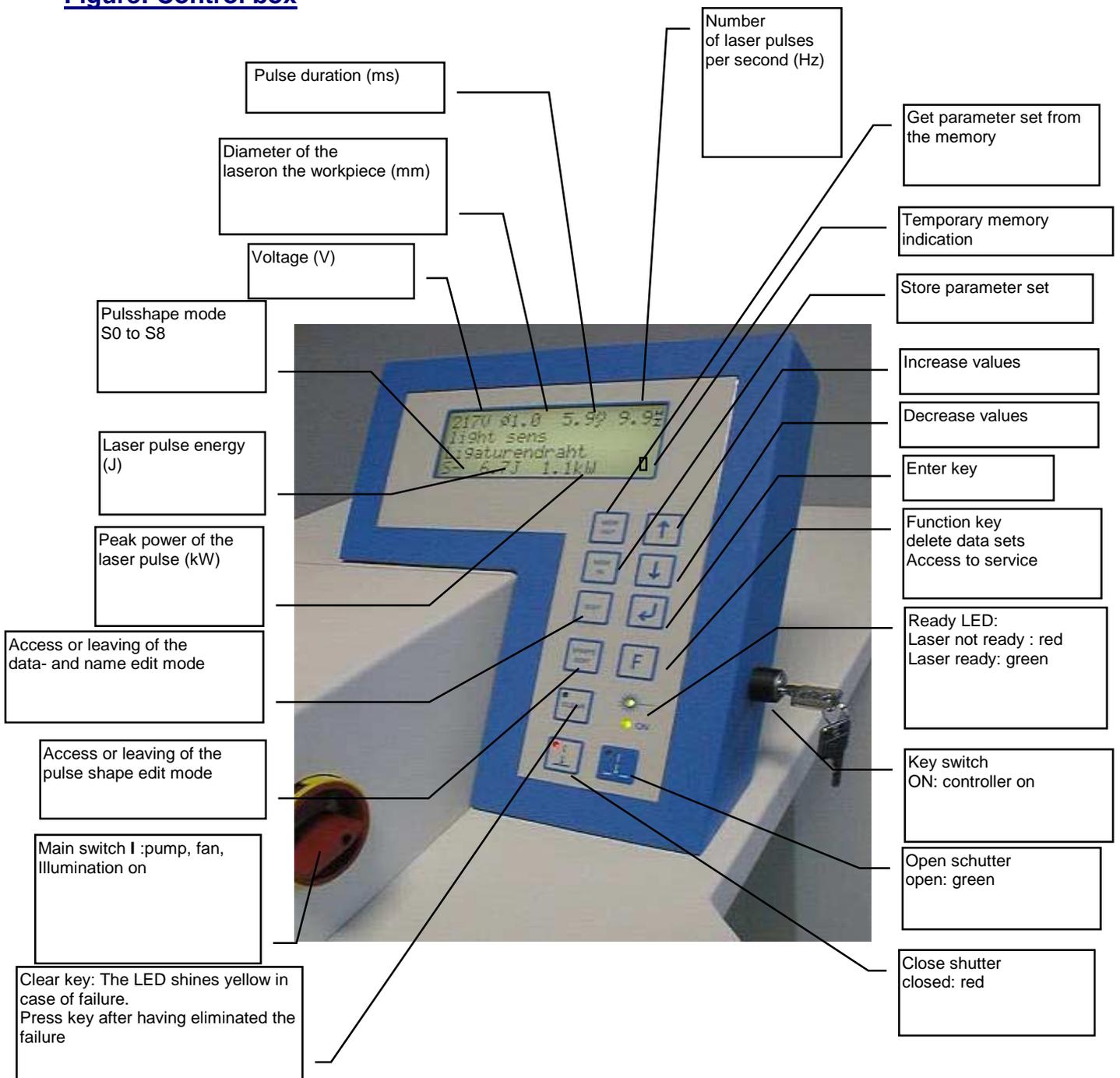
Reset the material data base to the factory default values

A maximum of 16 entries (parameter sets) per material group can be stored in the data base. Predefined parameter sets are assigned to the first four groups.

You can reset the device to the original factory default status if you want to delete self-made and useless parameter sets.

For this turn on the main switch on the right side. Now turn the key switch of the control box to „I“ and simultaneously press the **MEM IN** key of the control box for several seconds. Select the selection menu **Entry defaults** by pressing the **↑/↓** keys and confirm with the **↵** key. The display shortly shows the indication **defaults set**. Then leave the selection menu by pressing the **MEM OUT** key. After that the system performs its usual self check. The material memory again contains its original 8 material groups with the first 4 groups being occupied with predefined parameter sets.

Figure: Control box



Exhauster

The device is equipped with a welding vapor exhauster with filter elements to remove the polluted welding vapor from the welding chamber produced during the laser welding in order to keep the breathing air clean.

Via a coarse filter in the welding chamber and a flexible hose the sucked polluted air reaches a combifilter within the exhauster, consisting of a pre-filter and a suspended particle filter. This suspended particle filter can separate finest particles (filter class EU 13 / K 2).

The sucking turbine transports the cleaned air through the lateral blow opening to the room.

The exhauster is started after every laser pulse and automatically switches off again after about 15 to 30 s after the laser pulse.

Installation

Ambient conditions for a safe operation of the laser

Ambient temperature for operation	10°C 30°C
Transport and storage temperature	5°C 45°C
Max. rel. humidity	70%
Max. height of installation site above sea level:	3.000 m

Transport and connection of the device

You can move the device without any problems on both rear wheels.



Attention: Before any change of the installation site empty the cooling water tank.

Installation

The device is automatically blocked if it stands on the two break blocks mounted below the feet.

The floor on the installation site must be even. Level out possible slight unevenness only with non-slip material.

Suitable installation site:

The device has to be installed in a room as dust-free as possible, protected against direct sunlight.

It does not need much room. Place to stand: Width 600 mm times 815 mm depth plus place to sit.

To guarantee enough distance between the rear side of the device and the wall the rear side of the device is equipped with spacers. This guarantees that the cooling air can be blown out to the back without any problems and that the device cannot be overheated.

Electrical connection:

You can connect the device to a usual 230 V/50 HZ socket:

200 - 240V / 50 - 60 Hz / 16A

Inert gas connection:

Please note the following:

- Use argon 4.6 a inert gas (in case titan is processed argon 5.0 is recommended)
- Use a gas cylinder with a volume of a maximum of 200 l.
- Standing bottles have to be properly mounted to the walls with chains.
- The flow regulation valve for argon should be set to a flow of 8 l/min.
- The gas hose diameter is 6 mm.
- The gas hose is directly plugged in at the laser housing beside the mains connection.
- NEVER FORGET Close the valve of the gas cylinder after having finished working.



Attention:

Gas cylinders always must be properly secured for storing and during operation.

Connection of the integrated cooling air nozzle:

Connect the transparent fabric hose beside the mains cable and the inert gas connection to the cleaned compressed air. Max. pressure: 3 bar.

Fill cooling water into the tank of the heat exchanger

Filling the tank is described in the chapter notes on maintenance (page 38). During the first start-up procedure you will be made familiar with the filling of the tank by our service.

Operation



Attention: Before switching on you must have read and understood the user's instruction! Then you can switch on the device!

Switching On

- Open the argon gas cylinder.
- Turn the main switch to the right, position "I". After a lamp or cooling water exchange wait about 5 minutes until all air bubbles are removed from the cooling water circuit!
- Turn the key switch to the right. Now the control is switched on.
- After switching on the integrated micro processor performs a selftest to check important functions of the device. The test is finished after about 1 minute.
- After the selftest the LED *ON* shines green.
- Press the *Shutter open* key. Now the device is ready for operation.

Setting of the stereo microscope:

- Setting of the eye distance:
The eye distance is correct, if you can see with both eyes one single round image. Look into the eyepieces and move both tubes with both hands together or apart.
- Setting of the exit pupil:
The distance between the eye and the eyepiece is about 22 mm. You have got the correct distance if you see the complete image area without shadings. Slowly move the eyes towards the eyepieces
- Set the eye shells of the microscope:
If you do not wear goggles and wish to have close contact with the eyepieces: Hold the dioptic ring and turn the eye shell anti-clockwise until it is released. Lift up the eye shell. Hold the dioptic ring and tighten the eye shell clockwise. If you wear goggles move the eyeshell to the lowest position
- Adjust the eyepieces to your individual visual acuity.
Set the dioptics of both eyepiece to "0". Focus the crosshair in the right eyepiece by turning the right dioptic ring. Position a flat test item (e.g. a sheet) on the small lift under the laser lens that it appears sharp seen with the right eye. Focus the test item in the left eyepiece with the left dioptic ring without moving the test item.
- Every person who operates the laser only once has to adjust this setting. He should write down his personal values (number of lines in + / - direction of both eyepieces). He has to set these values again before working the next time with the laser. Only this way it is possible that all persons can operate the laser with identical beam conditions using the same focal settings.**

Welding

- Open the handflaps to put the workpiece into the welding chamber
- Close the handflaps
- Both forearms must be positioned in the openings of the handflaps in order to release a laser pulse.
- You should adopt a sitting position that allows you to work in a relaxed manner and comfortably prop your forearms on both hand openings.
- Position the nozzle for the inert gas supply that the workpiece or the area that is to be welded can be covered with argon.
- Adjust the laser parameters with both joysticks or at the controlbox (refer to page 21).
- Put the parts that are to be welded with both hand together and position them by observing them through the stereo microscope:
 - if you can see the workpiece exactly the vertical distance to the laser and observation lens is correct.
 - if the crosshair is precisely on welding spot the horizontal position of the workpiece is correct (the focal spot of the laser is identical with the crosshair)
- Always pay attention that your hands do not appear directly under the crosshair of the stereo microscope.

Attention: The laser beam can cause local burns!

- Keep the positioned welding parts calm
- If you touch the pedal switch the inert gas supply is released first (stage 1)
- Press the pedal switch to position 2 to release a laser pulse. The view area in the stereo microscope is shortly darkened during a laser pulse in order not to blind the eye by the plasma torch created during the welding.
- If more spots are to be welded keep the pedal switch pressed on stage 2. This way you can set several welding points to a welded seam.
- If no further spots are to be welded release the pedal switch
- The inert gas supply remains active as long as you keep the pedal switch pressed on stage 1
- If the welding is to be corrected or e.g. a seam is to be smoothed change the laser parameters with the joysticks or the control keys
- By positioning the black air nozzle you can cool a workpiece that has become too hot with compressed air.
- After the welding open the handflaps to remove the workpiece

 **Attention:** **Using other operation or adjusting elements as indicated in the user's instruction or other methods can cause dangerous exposure to radiation!**

What to do if you receive a burn by laser radiation

If a laser pulse or scattered laser radiation unintentionally has burnt your fingers or hand, you might get a slight local burn of the skin comparable to a burn by a hot soldering iron. Due to its wave length the invisible infrared laser radiation only causes local thermal damages i.e. it acts like "normal thermal radiation". Although a small burn of the skin by the laser pulse is not particularly critical, you should still make sure that no infection results. If necessary you should treat the wound with a disinfectant. Depending on the degree of the burn, you should undergo medical treatment.

Switching Off

- Turn the key switch to the left to switch off the controller.
- Then turn the main switch to the left, position "0". This disconnects the power supply and the remaining components of the device.
- Close the valve of the gas cylinder!



Attention:

To switch on the laser, always turn first the main switch to the position "I" before you turn the key switch!

To switch off the laser first turn the key switch and than the main switch to the position"0"!

Otherwise there´s the possibility that, the power supply will be damaged!



Attention:

Don`t turn on the main switch to often one behind the other. After switching off the laser by main switch, wait for 5 minutes, bevor you switch on the laser again!

Otherwise there´s the possibility that the power supply will be damaged!

Notes on Maintenance

! Attention: Only skilled persons are allowed to perform maintenance work at the switched off laser!

If maintenance or service work is necessary at the switched on laser that requires the laser safety mechanisms to be set out of operation it is **just a laser class 4** device. All persons being in the same room must wear **protective goggles** appropriate to the wave length of the laser. It is advisable to restrict the laser area by protective walls or curtains that only persons within the laser area have to wear protective goggles.

! Attention: For all laser maintenance work the accident prevention regulations have to be complied with, especially for Laser radiation and Safety rules for works with voltage-carrying parts.

! Attention: Unplug the device before opening it.

Check list 1

The following modules of the laser have to be checked every day before starting to work:

- Is the viewing window scratched or polluted?
- Do you have free view through the stereo microscope or is the lens protective glass polluted?
- Are the light barriers at the hand openings working correct and can you hear the laser beam shutter "switch".
- Do the indication lamps for the laser shutter change from *red* to *green* without flickering?
- Does the pedal switch work correctly?

Check list 2

The following checks are to be performed once a month:

- Are the hand opening cuffs damaged or aren't they tight any more? Are the holding cuffs fixed tightly?
- Do the safety switches react after opening the side flaps? Are the safety switches mounted tightly? Does the closing mechanism of the side flaps work correctly? Does the laser shutter close when the side flaps are opened?
- Does the key switch work properly and is it mounted correctly?
- Does the main switch work properly and is it mounted correctly?

Test of the laser adjustment and of the beam path

The laser adjustment should be checked once a week or if the welding results seem to be insufficient with the usual laser settings.

- Put the laser photo paper on the bottom of the welding chamber
- Set the focal diameter to $\varnothing 2,0\text{mm}$, the welding voltage to 290 V and the pulse duration 2 ms. Use no pulse shaping (S-). Release a laser pulse.
- Check the print on the photo paper:

The print should be round with a small roughened black edge.

The black photolayer should be removed uniformly. If the edge is frayed or if you can see small black dots you have to change the protective glass for the lens.

If the spot is oval or disjointed and asymmetrical any objects are in the laser beam or the laser has to be readjusted. Only the service is allowed to perform adjustment of the laser!

Adjustment of the laser welding spot to the crosshair in the microscope

With the deflecting mirrors you can easily make congruent the laser beam with the crosshair in the eyepiece of the microscope. Directly below the microscope within the welding chamber (beside the yellow warning sign) a vertical black plate is mounted. The deflecting mirror is mounted with its adjusting screws at this plate.

- Put a small lift on the bottom of the welding chamber and put a writing pad with squared paper on the lift. Focus the squares of the paper with the microscope.
- Set a voltage of 290 V and a pulse duration of 2 ms at the device. Set the focal diameter to 0,2 +
-
- mm and release a laser shot. Move the paper pad that the focal spot appears exactly in the intersection of the squares on the paper.
- You can incline the deflecting mirror directly from the welding chamber that the focal spot appears exactly in the crosshair of the microscope (see drawing):

If you turn screw A to the right the welding point also moves to the right

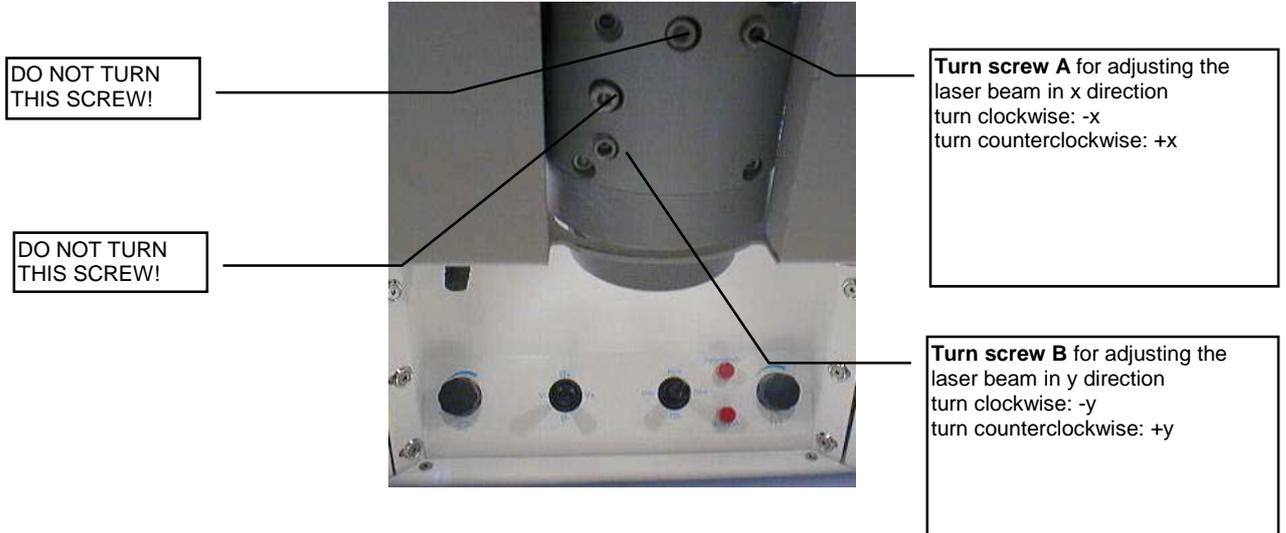
If you turn screw B to the right the welding point moves upward

- Release a laser shot with a new setting (voltage 360 V, pulse duration 5 ms, focal diameter 2.0 mm). Now you still must see the focal print in the center of the crosshair of the microscope. In case of greater differences check the laser adjustment. Also the axis of the laser beam might be misadjusted (please inform the service).

Also refer to page 37

Position of the adjusting screws of the deflecting mirror

View through the front laser protective window (after having removed the cover)



Filling the tank with cooling water

The tank of the heat exchanger must be always filled with sufficient deionized water (optimum water level about 2 cm above the level meter / floater).

To fill the tank proceed as follows:

- Switch off the device. Then unplug the power cord
- Unscrew the hexagon screw of the right side door and open the door backward.
- Loosen both screws of the supporting rail and remove it.
- Unplug the connector of the water tank from the socket (connector the pump and the interlock cable).
- Lift out the gray cooling water tank and put it down.
- Then open up the lid of the gray tank. Move both white bolts outward.
- Fill the water tank with fresh deionized water up to about 4 cm below the edge.
- Reconnect the lead-ins to the water tank.
- Plug the mains plug and then turn the keyswitch to *OFF*, and the main switch to *I*.
- Wait about 1 minute until the air has disappeared from the cooling system and the filter has sunk down. If necessary refill distilled or deionized water up to 2 cm above the particle filter.
- Switch off the device and unplug the power cord again.
- Bolt the lid and put the tank back into the device. Take good care that the hoses are not bent.
- Close the door again and lock it with the hexagon screw.

Change of the particle filter in the tank of the heat exchanger

The particle filter must be changed about all 12 months independent of the working hours of the device. At the same time the deionized water must be changed (about 5 to 7 l).

- Switch off the device. Then unplug the power cord
- Unscrew the hexagon screw of the right side door and open the door backward.
- Drag out the connections to the pump and to the interlock cable.
- Lift out the gray cooling water tank and put it down.
- Then open up the lid of the gray tank. Move both white bolts outward.
- Pour out the deionized water over one corner of the gray tank into a flat plastic vessel of about 10l capacity.
- Unscrew the inlet hose to the particle filter (white cylindrical vessel).
- Put out the old filter and replace it by a new one.
- Then connect the inlet hose
- Fill the water tank again with fresh deionized water up to about 4 cm below the edge.
- Plug the mains plug and then turn the keyswitch to *OFF*, and the main switch to *I*.
- Wait about 2 minutes until the air has disappeared from the cooling system and the filter has sunk down. If necessary refill distilled or deionized water up to 2 cm above the particle filter.
- Switch off the device and unplug the power cord again.
- Bolt the lid and put the tank back into the device. Take good care that the hoses are not bent.
- Close the door again and lock it with the hexagon screw.

Change of the filter in the welding vapor exhauster

If the display indicates the message *AIR FILTER* the filter in the welding vapor exhauster must be changed. In this case the filter is up to 80 % filled with particles.

You can delay the filter exchange if you increase the exhausting power with the rotary control in the welding chamber (see also page 19).

- Switch off the device at the mains switch and unplug the power cord.
- Unscrew one hexagon screw on top and on the bottom of the front cover of the device. Pull of the casing and disconnect the earth contact.
- Unlock the filter at the excentric screw and lift it up. Lift up the filter when taking it out of the filter chamber.
- Put down the new filter inset on the filter chamber bottom, fold it in and fix it with the excentric screw

- Connect the earth connection to the casing fix the casing again and screw it at the bottom and the top.

 **Attention:** The particle filter contains residues of the welding vapor! Do not clean and use the filter again but do expert recycle it.

Changing the lens protective glass

If the lens protective glass is polluted or defective you have to replace it by a new one.

- Switch on the device with the mains switch.
- Turn the hand flaps to the side
- Grasp the lower side of the laser lens with one hand and turn the knurled holding ring to the left
- Open the holding ring and take it out together with the protective glass
- Remove the old protective glass and put the new one into the holding ring Now screw it together with the new protective glass onto the lens.

Lamp change



Attention:

Mechanical tension can be applied to the lamp. Wear safety goggles when changing the lamp. Only our service or authorized qualified employees are allowed to perform the lamp change.

- Switch off the device at the mains switch and unplug the power cord.
- Wait at least 3 minutes until all parts are free of any voltage.
- Remove the upper cover behind the stereo microscope. For this loosen one hexagonal screw at the left and the right and two at the rear side. Lift up the casing and disconnect the earth cable.
- Completely unscrew both slotted head screws of the laser metal container. Slightly lift up the cover and remove it to the back.
- Loosen the four inner hexagon screws at the white lid of the laser head and slightly lift up the lid until you can hear the cooling water flowing out.
- Then take off the upper gold plated reflector bowl.
- Completely loosen the hexagon screw at the clamps of the two lamp contacts and remove the clamps.
- Screw off the red and the black lamp cable at the brown isolating clamps.
- Pull off the white pressure part and the O-ring from the cables.
- Then carefully pull out the old lamp from the laser head. If the lamp is exploded carefully remove all pieces of broken glass with tweezers.
- Carefully insert the new lamp.
- Replace the parts in opposite order and do not forget the O-rings!
- Make sure that the clamps and the hexagon screws are fixed tightly. The screws of the white lid of the laser head must be tightened regularly. The screws of the laser metal container should be **adjusted only slightly!**
- Plug in the power supply plug and **only** switch on the main switch.
- Leave the water pump switched on about 3 minutes and wait until the air is removed from the cooling water circuit!
- Switch off the device and unplug the power cord.
- After having switched off wait at least 3 minutes.
- Completely unscrew both slotted head screws of the laser metal container and remove the lid again.

- Check if the laser head and the water circuit are not leaky.
- Put back the lid of the laser metal container again and slightly adjust the slotted head screws.
- Remount the rear casing and connect the earth cable.
- Plug in the mains plug and let the device run another two minutes until the water circuit is finally deaerated.
- Having turned the key switch the device is ready for operation.

Possible failures, causes and fault clearance

Error	Indication	possible cause	Clearance
<i>The following error appears after having switched on the device with the main switch.</i>			
Device does not react	no indication	Mains plug not connected	C, plug in mains plug
Pump does not run		Socket without current	C, check laboratory fusing
Exhauster does not run		Fuse F3/F4 blown	Service
Illumination remains dark		(see page 12)	
<i>The following error appears after having switched on the device with the key switch.</i>			
Display and indication without function	no indication	Fuse F3/F4 blown	Service
		24 V supply for controller defective (see page 12)	
Display and indication are on After selftest the display does not show the last set parameter set.	e.g. "ROM TEST"	flat band plug for control board loose or not plugged flat band plug for exhauster board loose or not plugged	Service

Error	Indication	possible cause	Clearance
Laser pulses, however error message	AIR FILTER	air filter in the exhauster is filled up Indication despite new air filter: - control board of the exhauster is wrong calibrated	C, change filter Service
Laser does not pulse	LED ON = green	* Loader not loaded up to the set voltage	Service
	LED * = red	* Fuse F1/F2 blown	Service
	Interlock key = dark	* Loader has performed forced outage as - loading voltage too high - thermal overloading because of frequent switching on/off	Service C, key switch off and wait about 10 minutes then switch on device with key switch
	LED ON = green	* handflap(s) open	C, close handflaps
	LED * = red	* hands are not deep enough in the welding chamber.	C, totally insert hands
	Shutter open = flashes green.		
Laser does not pulse	LED ON = green	* pedal switch pressed not deep enough	C, press until the stop
	LED * = green		
	Shutter open = green.	* Lamp defective	Service, change lamp
	LED ON = green	* malfunction in the device, loader is switched off	
	LED * = red		
	INTERLOCK key = yellow and * „HEX Interlock“	short time disturbance in the cooling water circuit as e.g. the level of the cooling water or the flow is at the operate margin of the sensors!	C, fill up cooling water over and above the white lid If cooling water level is all right change particle filter
	* „Temp Interlock“	Cooling water temperature > 50°C	Service, turn off key switch let the exhauster and the pump run about 10 minutes and switch

* „Flow Interlock“	Cooling water flow too low	on anew Service
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Error	Indication	possible cause	Clearance
		* kink in the hose	Check hose run
		* Pump defective	Service
		* filter blocked	Change particle filter
	* „Level Interlock“	Cooling water level too low	C, fill up cooling water over and above the white filter lid
	* „Safety Shutter Interlock“	Safety shutter defective	Service
Laser pulse energy too low at normal settings	normal parameters	* protective glass polluted	C, change protective glass
		* focal diameter too big	C, reduce focal diameter
		* lamp aged	C, change lamp or increase voltage
		* laser misadjusted	Service, adjust laser
Laser cannot be focused as usual, beam diameter too big	normal parameters	* protective glass polluted	C, change protective glass
		* eyepieces of the microscope not correctly adjusted	C, focus the cross hair in the right eyepiece
		* workpiece in wrong position	C, position the height of the workpiece that you can see it clearly in the observation microscope
Laser welding spot and crosshair are not congruent	normal parameters	Bending mirror for the laser beam bending misadjusted	C, adjust bending mirror with the lowest right screw
Laser welding spot is not round, cornered or fringed	normal parameters	* laser misadjusted	Service
		* Shading by objects in the beam path	C, do not leave any cables in the beam path after having changed the lamp!
		* laser rod holders leaky	Service
		Water in the beam path	
		* protective glass polluted broken	C, change protective glass
Laser welding spot uneven spread	normal parameters	* protective glass polluted	C, change protective glass
		welding splashes on the glass surface	

Error	Indication	possible cause	Service Clearance
Laser deeply drills into the workpiece, material splashes	normal parameters	* laser strongly misadjusted * focal diameter too small or power adjusted too high	C, increase focal diameter or decrease welding voltage.
Despite low power laser melts a hole in a thin plate	e.g. 15 210 to 2 V	* Alloy with too high fraction of low melting material thermal contact to the ground too low, heat lag	C, chose other alloy C, exactly adapt and press on plate shaped material that heat can dissipate
Welding has cracks		A steel alloy with more than 0.3% Carbon has been used	C, chose a steel alloy with less than 0.3% carbon and set pulse duration to >10 ms and focal diameter >1 mm
Welding different materials: material A vaporizes, material B melts		* Melting point material A < material B * material A has a higher laser beam absorption than material B	C, increase part of the spot of material B relative to material B and select new parameters
Parts distort during welding		Welding point create tensile stress at the surface	1. step fix together material with several pulses 2. step alternately weld material from two sides, but do not weld to the depth from one side!

Spare part list

Spare Parts	Item No.
Particle filter in the water tank.....	908-231-00
Filter inset in the welding vapor exhauster	908-235-00
Prefilter for welding vapor exhauster	908-235-00
Laser lamp.....	908-232-00
Protective glass for the lens.....	908-234-00
Acrylic glass protection for laser protective window 200 x 100 mm	908-257-00
Halogen lamp with cold light reflector	908-316-00
1 Cuff for the hand flap	907-490-00

Service - Accessories

Laser protective goggles	090-512-00
1 sheet in A4 format - detection paper for laser radiation	

Technical Data

Mechanical dimensions:

Width x height x depth	1240 x 550 x 815 mm
Weight	Approx. 125 kg
Electrical connection:	200 V - 240 V / 50 Hz - 60 Hz / 16 A

Laser:

Laser crystal	Nd:YAG
Wavelength	1.06 μ m
max. average power	50W
Pulse energy	50mJ -55J
Pulse peak power	5kW
Pulse duration	0.5 - 20 ms
Pulse frequency	Single pulse max.10 Hz
Welding spot diameter	0.2 - 2.0 mm
Focal setting	integrated, motor driven

Optical Viewing System

Stereo microscope with eyepieces for persons who wear goggles, 15-fold magnification, diameter of the viewing area 16 mm.

Crosshair and indication of the most important laser parameters in the right eyepiece

Program memory:

Memory locations for 8 materials with 16 processing variants (parameter sets) each.

Exhauster:

integrated / with suspended particle filter class EU13/K2

Cooling air nozzle

integrated

Inert gas nozzle

2-fold / individually lockable and adjustable

Cooling

integrated / water-air heat exchanger

EEC declaration of conformity

complies with the EU Directive 89/655 EEC for Work Equipment

We, **Dentaurum**
J.P.Winkelstroeter KG
Turnstraße 31
75228 Ispringen

hereby declare that the work equipment named in the following complies with the relevant fundamental safety and health standards of the EU directive because of its conception and construction as well as in the version distributed by us.

This declaration loses its validity in case of any changes of the work equipment made without our consent.

Name: Craftsmanship laser welding device for use within residential and industrial areas.

Type: **DL 3000**

series no.: 106-001.01.00 - 106-099.12.01

Relevant EU directives:

EU Work Equipment Directive	(89/655 EEC)
EU Low Voltage Directive	(73/023 EEC)
EU Electromagnetic Compatibility Directive	(89/336 EEC)

Applied harmonized standards, especially:

EN 292-1	
EN 60825	Safety Instructions for Laser Radiation
EN 60204	Electrical Appliance of Machinery
EN 207	Lasers Protective Filter
EN 50081-1 Limiting class B	Noise Emission (tightened version, for household and light industrial area)
EN 50082-2	Jamming Immunity (tightened version, for industrial area)

Applied national standards, especially:

VBG 93 Accident Prevention Regulations for Laser Radiation
 VBG 4 Accident Prevention Regulations for Electrical Equipment and Operational Fund

Date / Signature of manufacturer

Personal details to signatory i.V. Dipl. Ing.(FH) K.Merkle
 Productionmanager Mechanic III