desktop compact

Instructions for use

DENTAURUM

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Contents

1. General information

Thank you for choosing the Dentaurum laser welding unit. In order for you to enjoy your laser welding unit in the future, please take time to observe all the information in these operating instructions. According to the EC guidelines, the Dentaurum laser welding unit is a piece of working equipment specifically designed for use in the dental laboratory.

Unit identification

Product: Laser welding unit (Nd: YAG laser wave length 1064 nm)

Type: desktop Compact – REF 090-578-00

Company: Dentaurum GmbH & Co. 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 vapor is automatically extracted.

⚠ **Caution:** **The unit must be installed and put into operation by authorized, qualified personnel or Dentaurum service technicians.**
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.

2. Safety information

2.1 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.

2.2 Intended use

The desktop Compact 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.**

2.3 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 the laser, especially the safety precautions
- Improperly performed repairs.

2.4 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 (see the chapter "Confirmation of Instructions")
- 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 BGV B2 (VBG 93))
- Before using the unit for the first time, the relevant authorities must be informed

2.5 Personnel‘s obligation

Before starting to work all personnel who work with the unit must

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

2.6 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.

2.7 Protection of the eyes against laser radiation

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

Safety shutter

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

- when the feed flap is open
- if the laser parameters are changed
- if there is no control current at the safety shutter.

The laser pulse is only operational when

the feed flap is closed

- and no laser parameters are set
- and the charging of the energy reservoir has finished
- and the pedal switch has been pressed down to stage 2.

Other devices for eye protection

- The unit is equipped with a large observation window made from a laser protection polymer for safe and direct observation of the welding process
- The unit is equipped with an automatic glare protection in the optical path of the stereomicroscope, which is activated during welding
- The complete laser beam path is optically sealed.

The unit fulfils all stipulations for total eye protection!

This fulfils **part** of the stipulations of a class I laser.

The unit does **not** fulfil the second part of the stipulations for a class I laser, i.e. **skin protection** against laser radiation.

2.8 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 reticule or in the laser beam!
- Look through the stereo microscope and position the workpiece so that the welding point appears sharp within the reticule!
- 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 your 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.

2.9 Further important safety issues, laser emission extraction

- The operating instructions must always be kept with the unit
- This unit is designed to weld dental metals and alloys using laser pulses, it must not be used for any other purposes
- **Never** place flammable or explosive substances into the welding chamber!
- During the welding procedure, **health endangering vapours** may be produced!

Therefore, in order to maintain clean, breathable air, the trade association recommends the use of a suitable laser emission extractor during welding work with the laser.

The extraction unit, integrated in the desktop Compact is only permitted to extract laser emissions. It must not be used for any other purposes, e.g. the extraction of

- highly inflammable or explosive gases
- liquids of any kind
- organic substances (i.e. acrylics)

The vent slots must always be unrestricted. The compressed air outlet must always remain unrestricted. The welding emission extractor must only be used with the original spare filter and never without filter.

Emergency off button

The emergency off switch is situated next to the display (see fig. 2 on page 12). If a dangerous situation should occur, the desktop Compact laser can be switched off by pressing hard against this button. In order to re-start the unit, turn the switch in the direction of the arrow, it will automatically jump back into place.

Electrical Safety

⚠ The desktop Compact laser is driven by AC voltage 1-phase 200…240 V, 50..60 Hz, 10 A. In the laser there are voltages of up to 400 V.
The laser must be connected to a three-conductor mains cable with integrated protective earthing equipment.
In order to avoid a short circuit, only de-ionised cooling water with a conduction value of < 2.5pS/cm can be used.

⚠ **Caution: Make sure the mains plug is removed before opening the machine.**

2.10 Service activities

⚠ Caution: **When carrying out service and maintenance activities, never work alone!**
All work on electrical parts, optical components and structure of the machine may only be carried out by authorized, qualified personnel or by the Dentaurum service technicians.

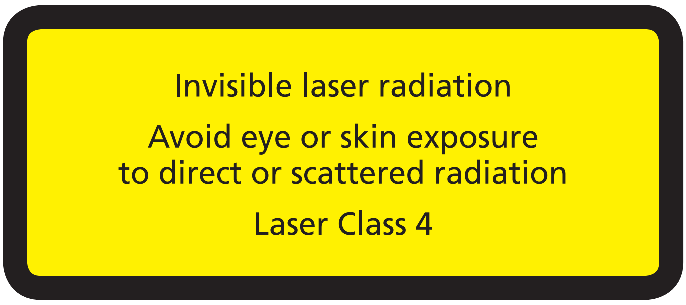
A second person, who should be at least familiar with the risks posed by laser radiation and high-voltage, should always be present during service and repair activities.

⚠ **Warning: Dangerous high-voltage!**

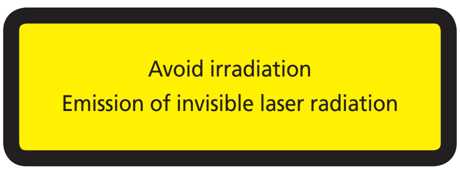
In order to ignite the flashbulb, this laser runs with high-voltage capacitors. For this reason, after having turned off or disconnected the device, current-carrying components could still be live.

2.11 Laser warning signs:

①



②



③

2.12 Position of the laser warning signs:

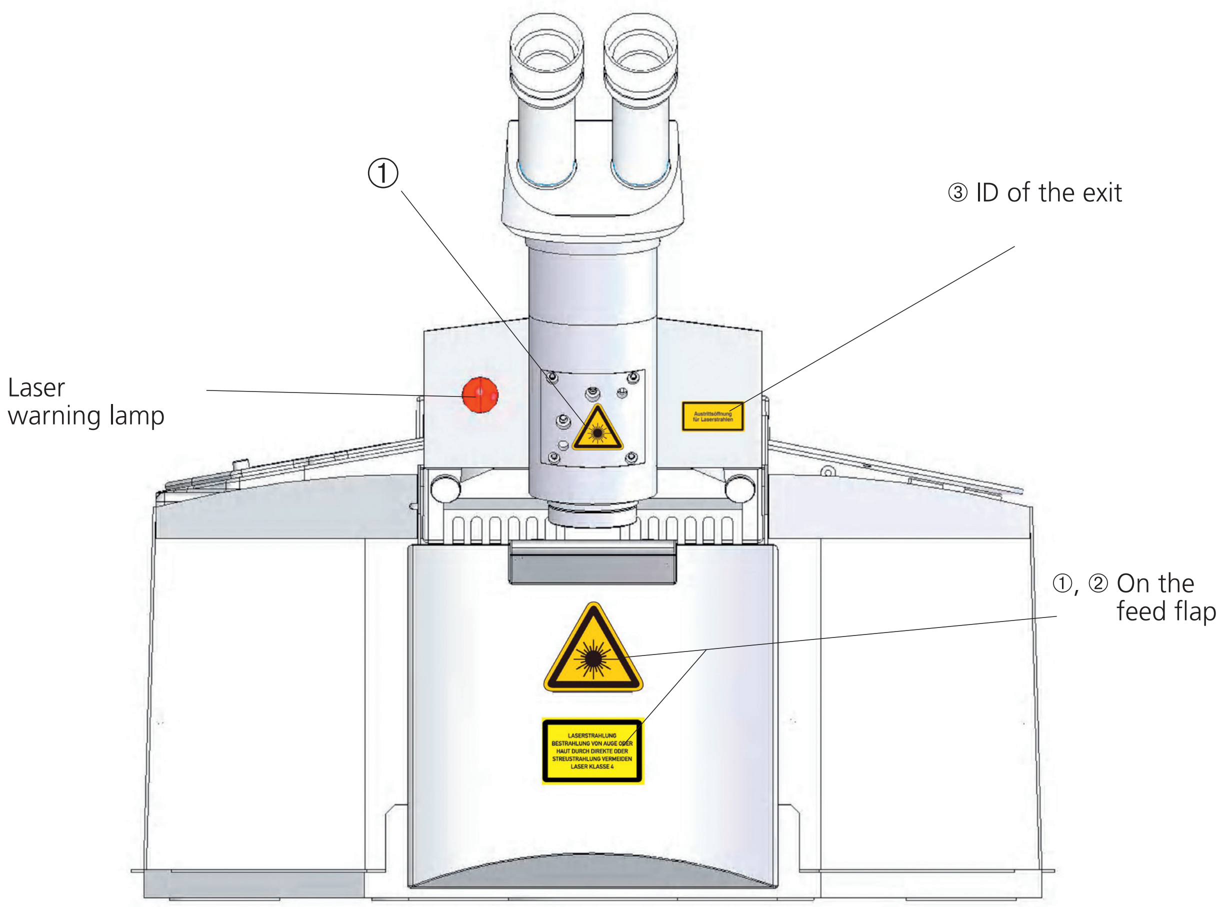


Fig. 1: Position of the laser warning signs

3. Basics of the laser and 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 so 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.

Thanks to 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.

4. Machine description

4.1 Overview

The desktop Compact laser welder is a very compact table-top unit for manual use. It supplies short, energy-rich invisible laser pulses at a wavelength of 1064 nm. Fig. 2: Front view of the desktop Compact shows a view of the device with all of the essential controls.

The workpieces are fed through the front feed flap into the integrated laser-safe working chamber (see fig. 3 on page 13). The workpiece is positioned manually under the stereomicroscope through the two side openings and held to be welded. When both of your hands are inserted into the leather cuff of the portal, the laser radiation cannot exit the device.

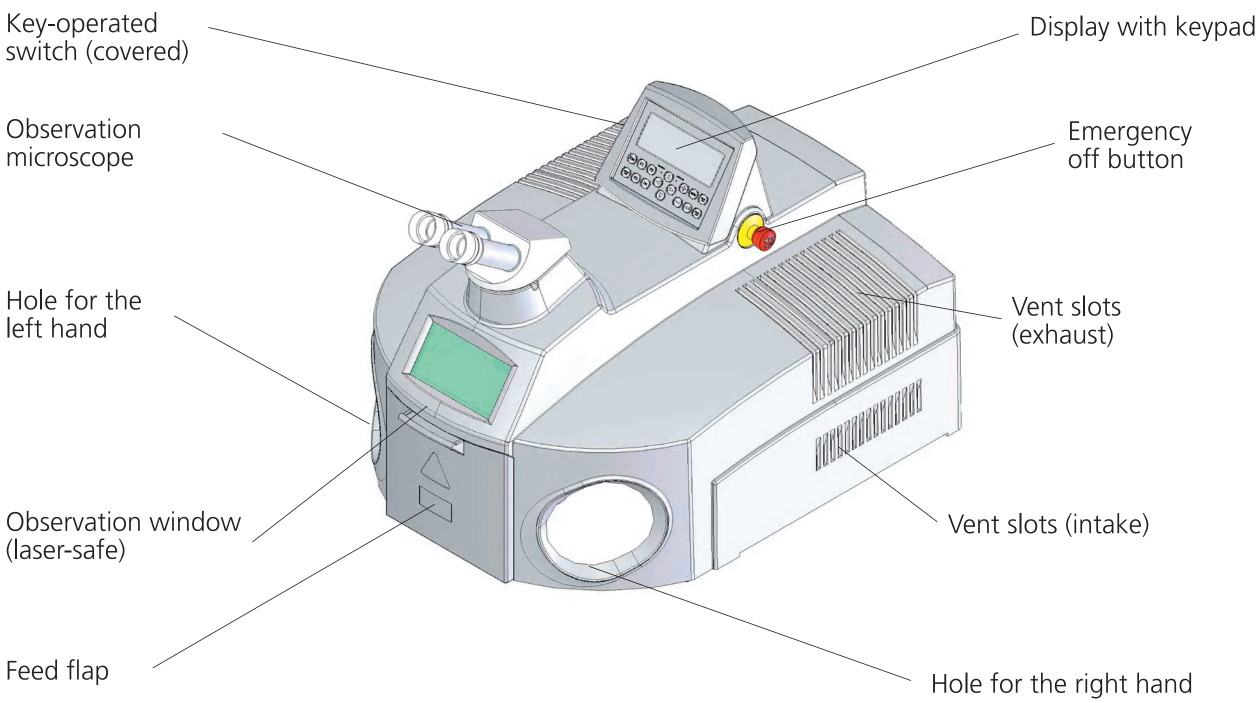


Fig. 2: Front view of the desktop Compact laser

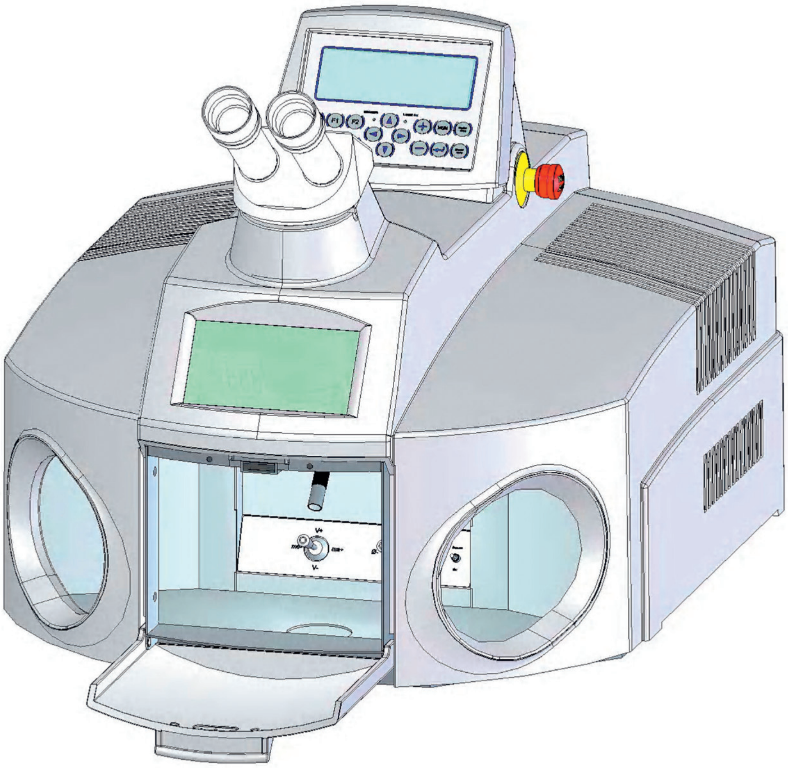


Fig. 3: desktop Compact with open feed flap

Any inert gas that may be required as well as the laser pulse are turned on and triggered using a two-level footswitch. During and after processing, the welding smoke is automatically drawn off and filtered.

All of the important functions and settings are shown on the display. The laser parameters are set on the keyboard underneath. Settings can also be made in the working chamber (see fig. 4 on page 14). Important laser parameters can be directly adjusted using the switches in the chamber without having to remove your hands out of the working chamber.

4.2 The working chamber

The desktop Compact working chamber contains all controls necessary for easy manual laser welding. To provide a view of all of them, the working chamber in fig. 4 is shown from below.

At the top middle, the laser beam leaves through a focusing lens protected by protective glass.

The working chamber and the workpiece are illuminated from the right and left side of the laser exit by two powerful halogen lamps.

The rigid nozzle for the inert gas can be swung forward and backward. When the nozzle is in its rear position, the flow of gas is interrupted. The height of the nozzle opening can be adjusted 5mm by turning the nozzle. The flexible nozzle on the left side is used to guide the inert gas precisely to the welding spot.

There is also a rigid nozzle on the right that can be used to cool the workpiece and the working chamber with compressed air.

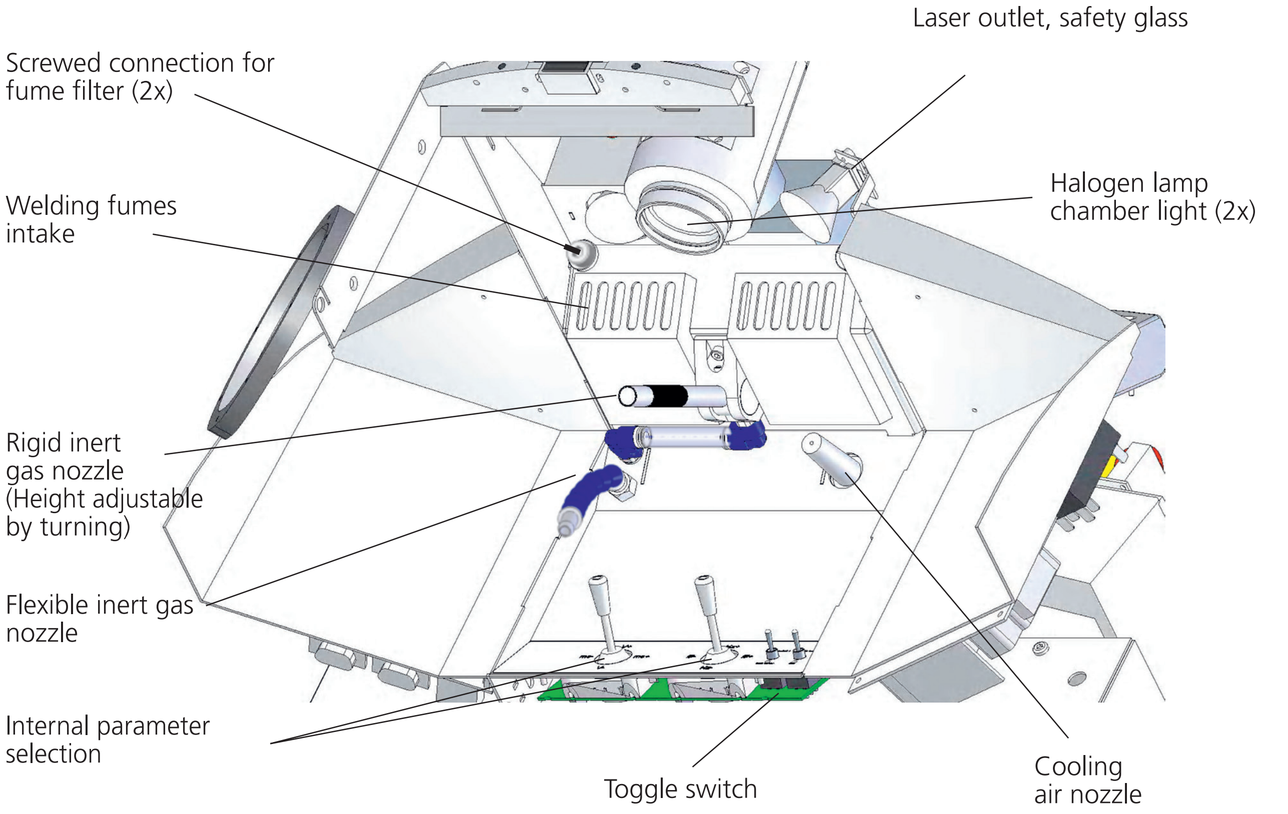


Fig. 4: View from below into the working chamber

The intake openings for the **welding fumes filter** are in the top of the chamber behind the laser exit.

The **controls** (2 joysticks and 2 toggle switches) are easily accessible at the bottom rear of the chamber, and they can be monitored through the observation window.

4.3 Design of the desktop Compact

All functions for operating the desktop Compact laser welder are integrated in the compact housing. Fig. 5: shows a block diagram of the construction.

The heart of the unit is a solid-state laser. It is pumped with a flash lamp operated by a power supply with a high electrical efficiency. The laser flash is guided along a carefully adjusted beam path through the observation microscope to the workpiece.

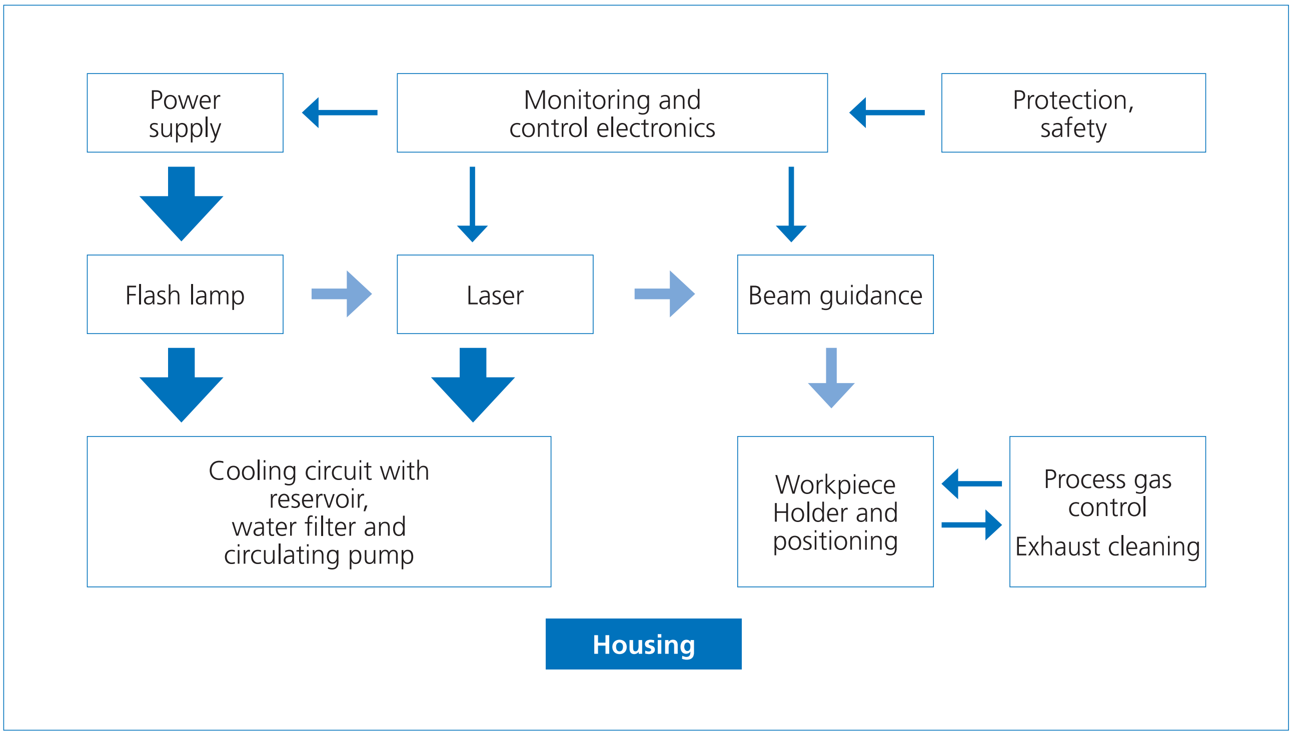


Fig. 5: Schematic layout of the desktop Compact

A newly developed control unit precisely manages the laser pulses and monitors all of the functions necessary for safe welding.

The filtered and purified cooling water is pumped in a closed circuit through the pumping chamber of the laser and thereby cools the flash lamp and laser rod. The arising heat is removed to the surrounding air by a heat exchanger and fan.

The inert gas (such as argon) necessary to protect the weld seam is supplied from the outside by a connection at the rear of the unit (see fig. 6 on page 16). The inert gas can be directly guided to the welding point via a rigid and flexible nozzle in the working chamber. The flow of gas is controlled by the footswitch.

The welding fumes arising during welding (see fig. 4 on page 14) are drawn out of the welding chamber and thoroughly filtered.

4.4 External connections

All of the external connections are at the rear of the unit (see fig. 6).

The rating plate shows the serial number of the unit as well as the properties of the laser source.

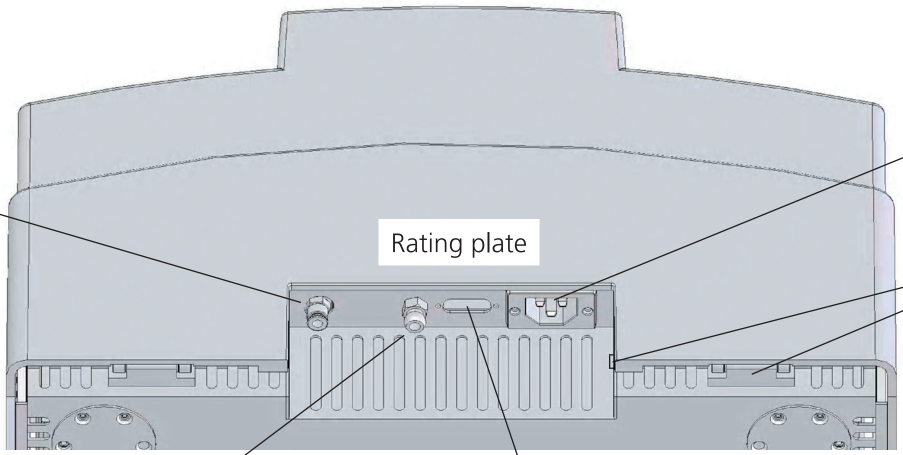


Fig. 6: Connections on the back of the desktop Compact

The gas connections have a connector for tubes with a diameter of 6 mm.

Inert gas:
For most applications, welding argon 4.6 according to ISO 14175:2008 (Welding consumables – Gases and gas mixtures for fusion welding and allied processes) is appropriate.

Cooling air nozzle:
The maximum permissible compressed air pressure is 6 bar.

Power connection:
The power is supplied through the provided standard power cable.
The unit is operated with 200 - 240 V 50/60 Hz 10 A, single-phase

Footswitch:
The provided footswitch is connected to the 15-pin sub D socket (female). When the footswitch is not or insufficiently connected, the LED Laser ok in the control panel will glow in red.

4.5 Installation and starting operation

Initial inspection

Check the packaging and the device for any visible damage. If the packaging is damaged, please report it immediately to the shipping agent. Document the damage for later claims.

The desktop Compact weighs 50 kg. It takes two people to move or transport the device.

Check the shipment for completeness.

Only undamaged units may be used.

Setup

The surface under the unit must be flat. Compensate for small unevenness with non-slip material.

The device should be placed in a dust-free location protected from direct sunlight.

Base: Width 560, depth - approximately 700 mm

Cooling water

De-ionized cooling water must be poured into the reservoir for the cooling circuit before initial startup. See chapter "Changing the cooling water and water filter" on page 36.

To prevent damage from leaking or freezing coolant water, drain the cooling water container each time you move the unit.

4.4 Electrical connections

Before connecting to the mains, make sure that the line voltage is appropriate for the desktop Compact. The unit is operated with 200-240 V 50/60 Hz 10 A, single-phase.

Connect the footswitch to the 15-pin socket next to the power connection. When the footswitch is not or insufficiently connected, the LED Laser ok in the control panel will glow in red.

4.6 Operating the desktop Compact

The desktop Compact was designed to be very easy to use. You will quickly achieve successful welding results when you observe the following points. The subsequent sections offer detailed descriptions of each step.

BEFORE YOU TURN THE UNIT ON you must read and understand the instructions for use, especially the safety instructions! ONLY THEN MAY YOU TURN ON THE UNIT!

Quick start for experienced users

1. Turn the **key operated switch** to start the laser. Once `"System OK"` is shown on the display (see fig. 7 on page 20), the laser is ready to use.
2. If you need **inert gas**, connect a bottle at the rear gas inlet, and set the proper gas flow on the pressure reducer. (Display shows "8 l/min")
3. Insert the workpiece into the **working chamber**, and close the feed flap.
4. Adjust the **microscope** to your personal preference.
5. Set the desired **parameters** for the welding process by using the external keys, or use the switches in the working chamber.
6. Open the safety shutter by pressing the **"Shutter open"** key (bottom line, far right). The green LED must shine when you press the key.
7. Through the microscope, visualize the site to be welded on the workpiece. The microscope cannot be moved. You need to move the workpiece into the line of vision and **adjust the sharpness** by changing the distance.
8. Direct the appropriate **inert gas nozzle** toward the welding site.
9. Press the **footswitch** to the first switching point, and the inert gas will flow. When you press the footswitch all the way down, the laser will emit pulses at the set value, and you can start welding.

Turning on the unit

Open the gas bottle.

Turn the key-operated switch to the front.

(If you have changed the lamp or cooling water, wait for approximately 1 minute until all the air bubbles leave the cooling water circuit)

Inert gas

The connection for the inert gas supply is on the back of the unit (see fig. 6 on page 16).

The flow of gas to the workpiece is turned on as long as the footswitch is pressed to the first level.

The inert gas can be directed to the welding point through both a rigid and flexible nozzle in the working chamber (see fig. 4 on page 14). The rigid nozzle for the inert gas can be swung forward and backward. When it is in the rear position, the gas flow is stopped. The height of the nozzle opening can be adjusted 5mm by turning the nozzle.

The flexible nozzle can be shut off with a turncock.

Please attend to these hints for the gas supply:

· Gas bottle 200 l or smaller (at least 10 l)

· The gas bottle can be placed in a lying position if it is secured from rolling away and the pressure regulator is protected

· Standing bottles must be secured in accordance with regulations

· The flow control valve for argon can be adjusted within a range of 1..10 l/min

· The gas hose diameter is 6 mm (outer ø)

· Do not forget: After you have finished working, close the valve on the gas bottle.

The footswitch

The footswitch is connected to the rear of the device (see fig. 6 on page 16). It switches in two levels.

In the first switching level, the inert gas is released.

In the second switching level, the laser pulses are released.

This allows the inert gas to displace the air around the welding point before welding starts to ensure an oxide-free weld seam.

4.7 The control panel

The control panel consists of the display field and the touch keypad. In fig. 7, the status of the display is shown directly after turning on the unit.

In the first line of the display, the pulse parameters are shown. See chapter 5 on page 23 for explanations.

Information on the saved parameter sets is displayed in the second line (see chapter 6 on page 26).

The third line displays messages on the status of the desktop Compact (see chapter 7 on page 30).

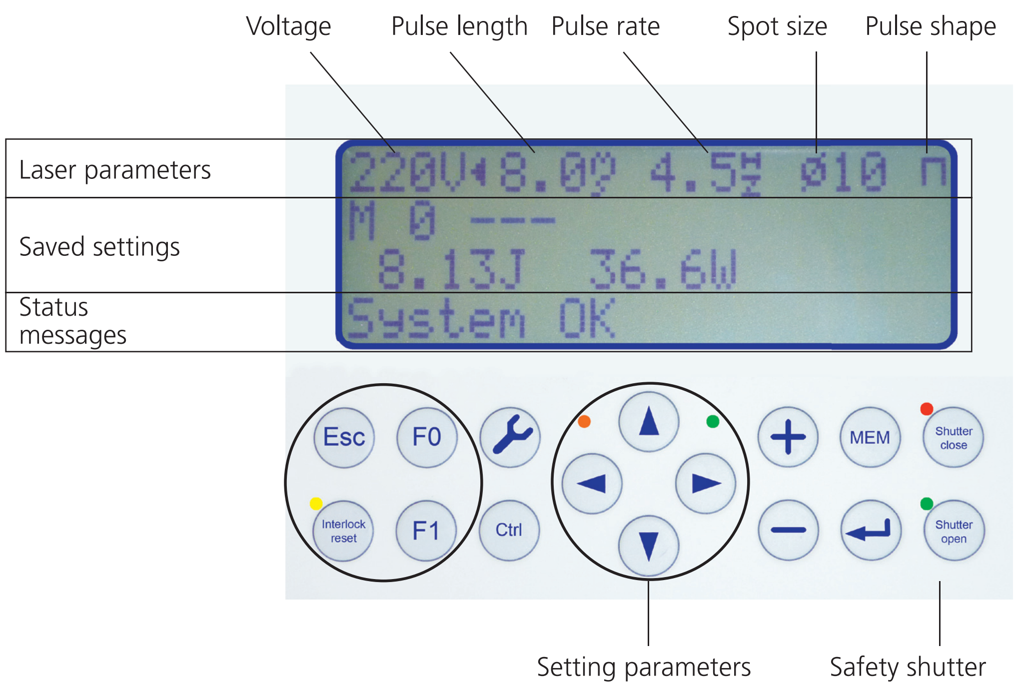


Fig. 7: Control panel

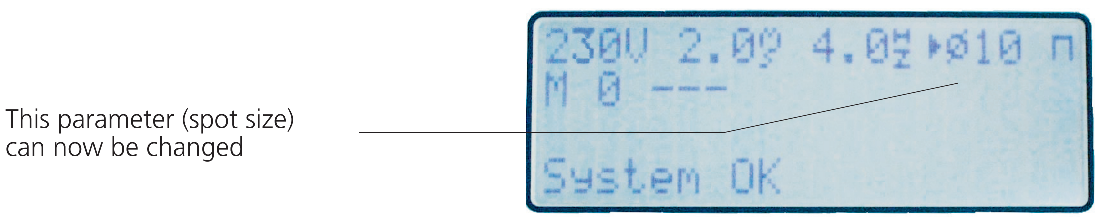


Fig. 8: In change mode, ▶ or ◀ identifies the changeable parameter

The touch keypad has 16 keys in two lines and five LEDs:

Left block:

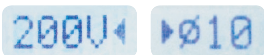
Esc	Back to main menu
F0	Not used
Ỵ (service)	Special parameters (see page 23)
F1	Not used
Interlock Reset mit gelber LED	This must be pressed after an error message has been eliminated (see chapter 7 on page 30)
Ctrl	Not used

Right block:

+	Increases the values for special parameters
-	Decreases the values for special parameters
Mem	Save or load parameter sets (see chapter 6 on page 26)
↵ (Enter)	For editing the names of parameter sets
Shutter close with a red LED	Closes the safety shutter.
Shutter open with a green LED	Opens the safety shutter.

Warning: A laser beam may exit!

Arrow keys:

←→ 	Switches between the parameters that can be changed. The first time you press the arrow key, the change mode is activated. A small triangle ▶ or ◀ indicates which value can be changed at the moment.
↑↓	Changes the active parameters; ↑ increases, ↓ decreases. When you hold down this key, the value changes quickly. After having pressed Ỵ, you switch between parameters in the service menu.
LED Laser ok	If this is green, a laser pulse can be emitted. When it is red, the laser is not ready to emit pulses. At fast pulse rates, the LED flashes between green and red; red indicates the recharging phase of the power supply. Only when the LED shines red continuously, the welding process has to be stopped.
LED Warning (orange)	Flickers while discharging ("Discharge"). Glows, if no operating is possible with actual adjusted parameter settings for voltage and pulse length (these parameters determine the pulse energy), e.g. because of too low supply voltage. In this case the pulse rate is taken back automatically so that the pulse energy remains constantly.

Press Y to go to a different menu level.
Press the arrow keys ↑ ↓ to switch to the display.
The + - keys change the respective value.
Press the Esc key to return to the normal menu.

Display	Description
Function 1/17 Fan speed n [%] 85	**Speed of the exhaust fan** Adjustable speed control range. (40 – 100 %)
Function 2/17 Fan Off Time [s] 10	**Exhaust follow-up time** Exhaust is starting when a laser pulse is released. When there are no more laser pulses exhaust continues for the selected time (0 – 30 s)
Function 3/17 New Filter Calibr.	Not active in this version.
Function 4/17 Language	Not active in this version.
Function 5/17 Get Pulse Cntr 123456	**Pulse counter** After pressing it displays of pulses since the last reset. Actual value is marked with "OK" (Resetting possible only in the service menu).
Function 6/17 Factory Param 1-10	
Function 7/17 U6	Not used.
Function 8/17 **** Service ****	These settings are only for service personnel.

Esc back

5. Setting the pulse parameters

For welding to be successful, the appropriate laser pulses must be used. The proper laser pulses depend on the joint partners and their thicknesses. The best values can only be found when fine adjustments are made on the work piece. Please ask your sales partners to get recommendations and empirical values. Here only a very general guideline can be offered. The following pulse parameters can be set:

· The pulse peak output by the voltage ①
· The pulse length ②
· The pulse rate ③
· The size of the laser spot on the work piece ④, and
· The time characteristic of the laser pulse ⑤.

This sequence corresponds to the sequence from left to right in the display (see fig. 7 on page 20).

The most important parameters may also be changed using the joysticks in the working chamber.
With the left switch on the control panel you can select parameter sets.

The figure below explains the relation between pulse parameters and actual form of the laser pulse:

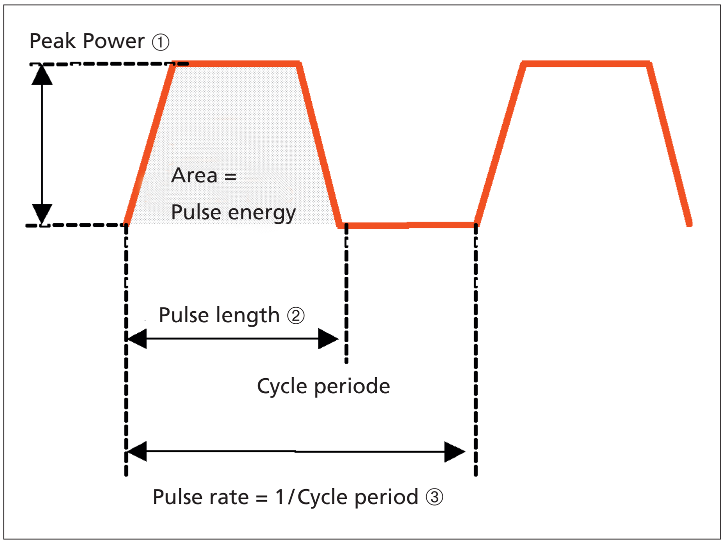


***Fig. 9 : Pulse Parameters* ① *to* ③**

The user sets the parameters on the control panel:

① The laser power is varied with the parameter "voltage" in Volts.

② The pulse length is set directly in ms.

③ The pulse rate is set directly in pulses/second (Hz).

The energy of the laser pulse is given roughly by the product of Power x Pulse length.

Additionally, there are the parameters

④ Size of the welding spot. It is set in 1/10 mm and

⑤ Shape of the laser pulse. Usually it is nearly rectangular, but it may be varied, see page 25.

Special note:

1. You cannot set both, high voltage and long pulses at the same time. In some cases the actual limit for the parameters voltage and pulse length can be lower than its maximum value.
2. In some cases, the pulse rate will be decreased automatically when the voltage or the pulse length are increased.

Voltage from 150 to 400 V

The voltage influences the peak pulse output. The voltage should be increased to accommodate the weld seam depth, the heat conductivity, and reflectivity of the material.

In addition to the arrow keys on the display, the voltage can also be controlled by pushing the left joystick in the working chamber up (V+) to increase it, and down (V-) to decrease it.

When the target voltage has been reduced, the flash lamp is actuated when the shutter is closed in order to lower the voltage at the charging capacitor to the target value. "`Wait for Discharge`" appears in the display. You can only continue working when the desired voltage has been reached.

Voltage from 0.5 to 20 ms

The energy of the pulse depends on the pulse length. Given an equivalent peak output, the longer the pulse lasts, the more energy is fed into the welding point and more material gets melted. The welding point tends to become wider as opposed to deeper.

In addition to the arrow keys on the display, the pulses can also be lengthened by pushing the left joystick in the working chamber to the right (ms+), and the pulse length can be lowered by pushing the joystick to the left (ms-).

Pulse rate from an individual pulse (0Hz) to 25 Hz

The pulse rate is limited by the performance of the laser device. When the pulses are energy-rich, the performance limit of 50 W will be exceeded after just a few pulses are emitted. Only when the pulses are short and weak, the pulse rate can be accelerated. The frequency that is chosen depends on the operator's experience.

In addition to the arrow keys on the display, the pulse rate can also be adjusted by using the right joystick in the working chamber; it can be raised by pushing the joystick up (Hz+) and lowered by pushing the joystick down (Hz-).

Spot size 0.2 – 2 mm

By means of an installed optical system, the diameter of the laser spot can be adapted to create weld seams of different widths. It should be noted that the laser output is distributed over a larger area when the spots are larger. To achieve comparable welding results, a correspondingly higher voltage must be used.

In addition to the arrow keys on the display, the spot size can also be increased by pushing the right joystick in the working chamber to the right (ø +), and the spot size can be decreased by pushing the joystick to the left (ø -).

Pulse shape:

Four different pulse shapes can be selected that are identified by symbols:

⊓ indicates an uninfluenced pulse,

◢ indicates a pulse that is weaker at the beginning,

◣ indicates a pulse that is weaker at the end, and

▙ indicates a pulse that grows weaker in steps.

Fig 10: Pulse shape at the setting „in steps“

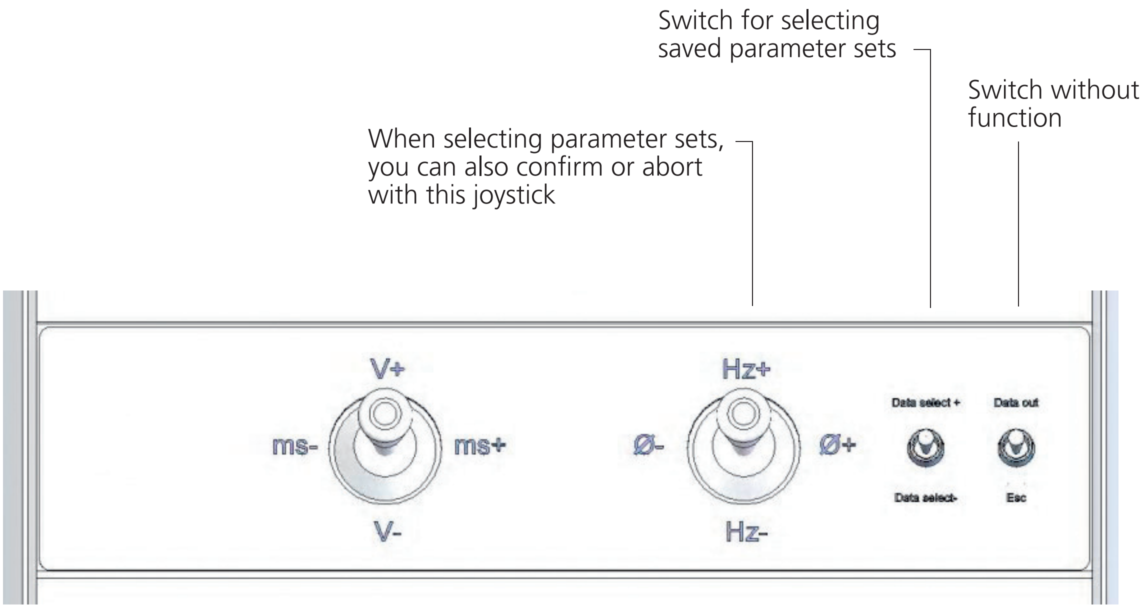


Fig. 11 : Controls in the working chamber

6. Saving the parameter data and loading

Up to 39 parameter data can be loaded and saved using the MEM ("Memory") button.

When the MEM button has been pressed, an arrow appears for 2 seconds 🡸 (this shows, the **values are being loaded**). By pressing the +/- button, the required parameter data is selected and loaded.

It is also possible to load the data by pressing the button **"Data select"** in the welding chamber (see fig. 11 on page 25) By pressing up or down, a higher or lower number is selected.

If the button MEM is pressed twice quickly, an arrow appears 🡺; this shows the **values are being saved**. The desired memory space is selected by pressing the +/- buttons, and then confirmed by pressing enter (↵)). If you do not wish to confirm the space, abort with the ESC button.

Press the enter (↵) button to edit the current **material name** (max. 16 digits). The cursor can be moved with the buttons ◀ / ▶ and the letters can be changed with the +/- buttons. The name is saved by pressing the enter button once more.

If the values in the memory are altered, the "M" (capital M) in the display will change to "m" (lower case m). The name of the memory space will remain in the display, so that the parameter can be easily updated.

The parameter can also be selected directly in the welding chamber (see fig. 11 on page 25). As soon as the changeover button confirms "data select" the control will automatically change into the parameter selection mode. In this mode the parameter data can be sequentially selected. The relevant parameter data is shown in the display .

In the parameter selection mode the "Hz+" and "Hz-" contact joystick is used to "abort" or "confirm". Once the user has decided upon a certain parameter data, the “Hz-“ will accept it. To leave the parameter selection mode move the push stick towards "Hz+".

6.1 The Stereo microscope

The viewing microscope is used to place the required area on the piece of work in the direct path of the laser. Protective filters are integrated in the microscope which protect the eyes against the laser radiation and intensive radiation which is always generated during welding processes. If the microscope is adjusted to suit the user correctly, then it is possible to position even the finest welding joints accurately.

To this, at first the **eye distance** is regulated.

6.2 Adjusting the reticule in the stereo microscope (Jenoptik)

- **Setting the eye distance**
  The eye distance is set correctly, when you see one round image with both eyes. If this is not the case, look through the eyepiece and adjust the ocular tubes by pushing them together or pulling them apart with both hands.

- **Setting the exit pupil**
  The distance between the eye and the eyepiece is about 22 mm. You have found the correct distance once you see the complete image area without any shadows. Slowly move your eyes towards the eyepieces.

- **Set the eye shells of the microscope**
  If you do not wear glasses and wish to have close contact with the eyepieces: Hold the dioptre ring and fold the rubber eye shells upwards. If you wear glasses fold the eye shells back down (see fig. 12).

- **Adjust oculars to individual visual acuity**
  Set the dioptre on both eyepieces to **"0"**. Place a flat test piece (i.e. a piece of metal) under the laser lens, using a titanium holder, until it can be seen sharply with the right eye. Turn the left dioptre in the left ocular until the test piece can be seen sharply. Do not move the test piece (see fig. 13 on page 28).

- **Adjust the reticule according to the division scale**
  For vertical adjustment, hold the ocular tightly with one hand and turn so that the reticule and the division scale are both vertical (see fig. 14 on page 28).

- Every operator should only need to adjust his setting once. He should note down his own personal values (number of lines in +/- in the left ocular). The operator simply needs to re-set these values before he works with the laser again. With this method it is possible to enable all laser operators to use the laser under the same focal settings and identical laser conditions.

Fig. 12: Ocular adjustment at the microscope

Fig. 13: Adjust the ocular to the correct individual visual acuity

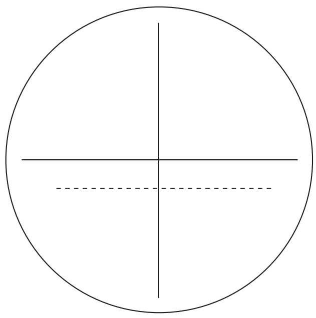
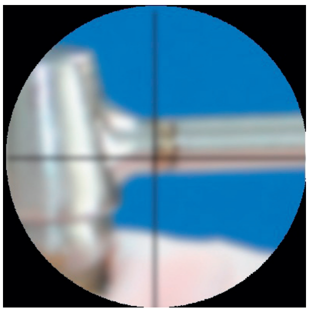
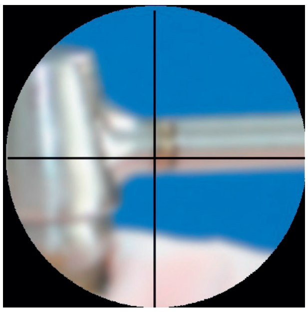


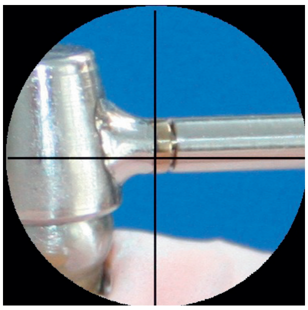
Fig. 14: Adjust the reticule according to the division scale



Everything unclear



First make sure the reticule is sharp using the adjustment ring,



then make sure the piece of work can be seen clearly

Fig. 15: Microscope adjustment

6.3 Welding

To weld, you need to open the safety shutter by pressing the "Shutter open" key (control panel, bottom line, far right). The green LED next to the key must shine, and the red LED above next to "Shutter close" goes dark.

Through the microscope, observe the site to be welded on the workpiece. The microscope cannot be moved. You need to move the workpiece into the line of vision and adjust the sharpness by changing the distance. The welding point should be precisely in the reticule. If this is not the case, the reflecting mirror needs to be adjusted (see chapter 8.7 on page 37).

Direct the appropriate inert gas nozzle toward the welding site. (see the description on p. 14)

Press the footswitch to the first switching level, and the inert gas will flow.

As long as you press the footswitch all the way down, the laser will emit pulses at the set value, and you can start welding. The motor for drawing off the welding fumes starts running. For your protection, the microscope becomes briefly dark during the laser pulse.

Move the workpiece under the laser beam to create a weld seam. Adapt the speed to the pulse rate so that the welding spots overlap sufficiently on the workpiece (approximately 80%).

After welding is finished, the exhaust will still operate briefly. Close the safety shutter by pressing the "Shutter close" key. The red LED next to the key must shine, and the green LED below next to "Shutter open" goes dark.

6.4 Turning off the system

Even when there are brief interruptions, close the safety shutter by pressing the "Shutter close" key.

After you are finished welding, let the cooling water pump run for approximately 5 minutes to provide additional cooling.

Turn the key-operated switch to the left.

Close the gas bottle.

7. Warning instructions

The following error messages (interlocks) are shown on the display, and cause the laser pulse to stop and turn off the lamp pulse generator:

Display text	Possible causes and remedy
In normal operation	
Box open LED Shutter Close is on LED Shutter open flashes	The feed flap is open. Close the flap.
Wait for Discharge LED Shutter Close is on LED Shutter open flashes	The target voltage was reduced. To adjust the voltage at the charging capacitor to the target level, the flash lamp is actuated when the shutter is closed until the target level is reached. Wait.
In the case of Errors	
System error LED Laser ok is red LED Interlock is on	Some unspecified system error occurred. Switch off the laser and call service.
Safety Shutter Ilck LED Laser ok is red LED Interlock is on	The electrical connection to the safety shutter has been interrupted. The safety shutter is jammed. The sensor for the safety shutter is defective. Check the cables, call service.
HEX Flow Ilck LED Laser ok is red LED Interlock is on	There is no cooling water. The cooling water flow in the laser circuit is too low. The pump is defective, the water particle filter is full, the flow monitor is defective. Investigate the coolant water flow and eliminate the problem.
Safety Loop Error	Feed flap contact misaligned or defect. Contact customer service.
Safety Loop Ilck	Feed flap contact misaligned or defect. Contact customer service.
HEX Level Ilck LED Laser ok is red LED Interlock is on	The level of coolant water in the water tank is too low. Add de-ionized water.
HEX Temperature Ilck LED Laser ok is red LED Interlock is on	The coolant water temperature in the laser circuit is too high. The internal temperature control is defective. Check the cooling water circuit, clean the water/air heat exchanger. Dust deposits on the heat exchanger lamella?

After eliminating the problem, press the "Interlock RESET" key.
The Laser okay LED shines green, and Interlock LED goes dark.

8. Maintenance advice

⚠ **Caution:** **Never work alone on any service or maintenance activities!**
Various work on electrical parts, optical components and structure of the machine may only be carried out by authorized, qualified personnel or by the Dentaurum service technicians.

Hotline: + 49 72 31 / 803 - 211

⚠ **Caution:** **Only skilled persons are allowed to perform maintenance work on the switched off laser!**

If maintenance or service work is required to be carried out on the laser whilst it is switched on, which requires the laser safety mechanisms to be put out of action, then the stipulations **according to laser class 4 applies**: All persons present in the same room must wear **protective eyewear** suitable for laser wave lengths. It is advisable to restrict the laser area with protective walls or curtains so that only persons within the laser area are required to wear protective goggles.

⚠ **Caution:** **All maintenance work which is carried out on the laser must comply with the accident prevention regulations, in particular**

- **BGV B2 Laser radiation**
- **BGV A2 Safety regulations on voltage-carrying parts**

⚠ **Caution:** Unplug the device before opening it!

8.1 Check lists 1, 2 and 3

Check list 1

Regular maintenance guarantees a long service-life for your dental laser – it is advisable to observe the following points!

The following laser modules are required to be checked every day before starting to work:

· Is the observation window scratched or soiled?

· Is the inert gaz nozzle positioned correctly?

· Do you have an unrestricted view through the stereo microscope or is the lens soiled?

· Do the indicator lamps for the laser radiation shutter switch from red to green without flickering?

· Does the pedal switch work correctly?

· Always maintain a clean extraction sieve in the extraction unit!

Check list 2

The following checks are required to be performed once a month:

· Are the hand opening cuffs damaged or are they no longer tight fitting?

· Are the holding cuffs fixed tightly?

· Is there enough de-ionised water in the supply container?

· Do the safety switches react after opening the side flaps?

· Does the key operating switch work properly and is it mounted correctly?

· Does the EMERGENCY OFF button function correctly?

Check list 3

Yearly examination:

The particle filter must be changed together with the de-ionized water **once a year** (see section 8.6 on page 36).

Failure to change the filter leads to a reduction in the cooling function and contamination of all parts which come into contact with the water. This could cause the laser crystal, the laser lamp or the lamp reflector to become irreparably damaged. The service life of the lamp could also be reduced.

A maintenance contract will take care of a large part of the above duties and serves towards the conservation value of your laser!

8.2 Test of laser adjustment and beam path

Check the laser adjustment once a week or when the welding results are unsatisfactory under normal laser settings.

Place laser photo paper on the floor of the working chamber over the round aluminum plate.

Set the spot size to 2.0, 300 V, 1 ms, and trigger a laser pulse.

Look at the image on the photographic paper:

Ideally, it should be round and only have a small, rough black edge and the black photographic layer should be evenly removed. If the edge is ragged or small, black dots are visible, change the protective glass for the lens.

If the spot is oval or not cohesive and asymmetrical, either objects are in the way of the laser beam, or the laser needs to be readjusted (contact service).

8.3 Changing the protective glass

If the safety glass (see fig. 16) is too dirty, it can be exchanged as follows:

Turn off the unit.

Open the feed flap.

With one hand grasp the bottom of the laser lens, and rotate the knurled retention ring to the left.

Remove the retention ring with the safety glass without changing its orientation.

Exchange the old safety glass with the new safety glass. Screw the retention ring with the new safety glass tight to the bottom of the laser output.

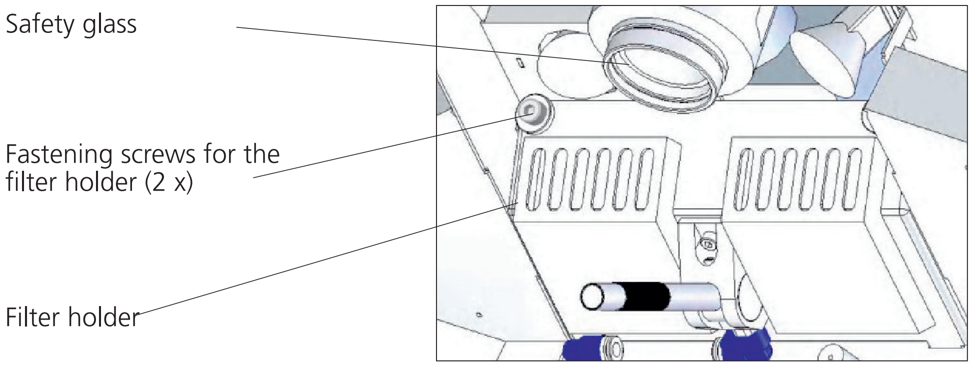


Fig. 16: Performing maintenance in the working chamber

8.4 Check and change the filter for welding fumes

To ensure that the welding fumes are completely drawn off, the filter has to be checked regularly and changed if necessary. The filter consists of a pre-filter fleece for larger particles and a particulate filter of class EU 13/K2. The filter is located at the upper rear of the working chamber.

Note: the particles in the filter can be **hazardous to health**. Wear gloves. Pack the filter right away in a plastic bag. **Dispose of the filter in accordance with local regulations.**

To change the filter, remove the two fastening screws (see fig. 4 on page 14), then the filter holder swings down and the filter can be removed through the flap.

When installing new filters, the pre-filter fleece is placed on the bottom of the filter holder.

The black seal for the particulate filter must be at the top and should be lubricated lightly for an easier installation.

Insert the filter holder towards the rear in the two guiding slots, and then screw it tight at the front.

8.5 Opening the desktop Compact

⚠ **Before opening the unit, pull the power plug!**

Many of the parts of the desktop Compact that need to be serviced are under the housing cover. To open it, you first need to remove the top part of the microscope:

The set screw on the right under the microscope is removed, and the microscope is lifted to the right out of the dovetail guide.

Note: Do not touch any optical surfaces. Protect the microscope from dirt.

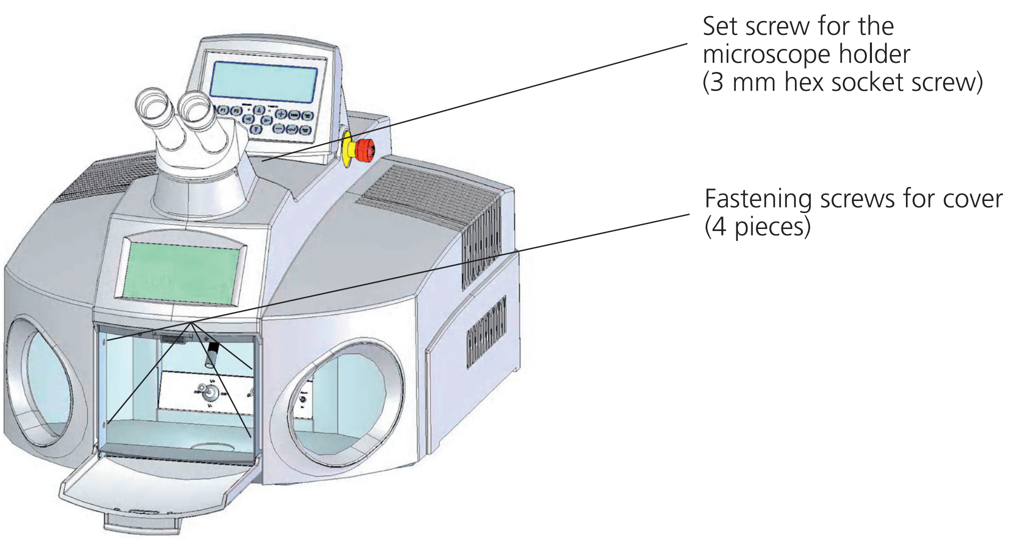


Fig. 17: Fastening points for the unit cover

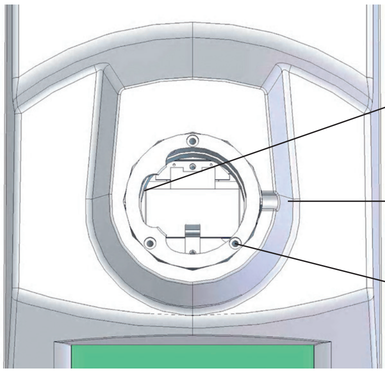


Fig. 18: Microscope flange (from above)

The microscope flange is attached with three screws (see fig. 18). Unscrew the screws, and pull out the flange upward.

The cover is fastened with four screws near the door flap (see fig. 17 on page 34). When these are unscrewed, you can open the cover flap to the rear. To avoide damage to the cover, take care that it can rest e.g. on a table.

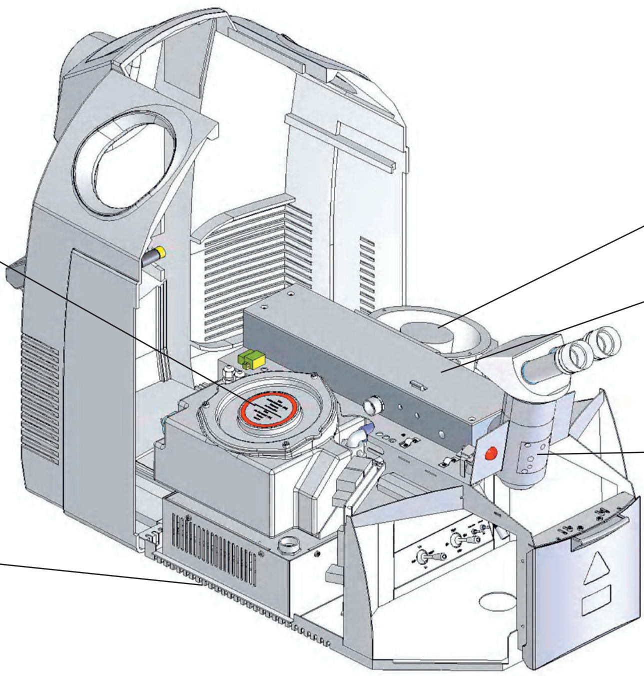


Fig. 19: Laser with open cover

8.6 Changing cooling water and water filter

Open the cover of the desktop Compact as described in section 8.5 (see page 34).

The cooling water container is on the left to the rear. It holds 4,5 l de-ionized water. To **open** it, unscrew three screws in the lid, and carefully lift the lid upward with a broad blade screwdriver. To **close** it, press the lid into the opening, and then screw it tight. Make sure that the seal is clean and undamaged. If it is hard to press in the lid, wet its seal or use a bit of grease.

Draining the cooling water:
The cooling water needs to be suctioned out of the container. A small pump is useful, otherwise carefully suck out the cooling water with a hose and then let it drain over the edge into a lower container.

Exchanging the particle filter:
The particle filter is a white, 100 mm long cylinder with a diameter of 70 mm that floats freely in the cooling water.

· Unscrew the particle filter to the feed hose,

· Remove the old filter

· Insert a new filter

· Screw on the feed hose, and make sure there are no kinks

· Add clean water, and let the filter fill up with water. Only use de-ionized water!

Add cooling water:
You need approximately 4,5 l de-ionized water with a conductance < 2.5 µS/cm. When you are adding water, make sure that no particles get in it.

Plug in the power plug, and turn the key-operated switch on.

Wait approximately 5 minutes until the air escapes from the cooling system, and add distilled or de-ionized water if necessary until the level monitor is completely under water.

Turn off the device, and pull the power plug.

Close the cooling water container, and affix the device cover.

8.7 Adjustment of laser welding point according to the reticule in the microscope

Using the directional mirror (see fig. 21) the laser beam can be easily brought into line with the reticule in the ocular of the microscope.

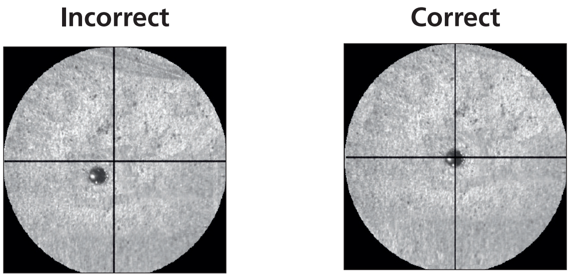


Fig. 20: adjustment of the laser welding point and reticule

With an angled allen key (3 mm) the adjustments can be carried out at closed hood.

Adjustment

- Put a small elevated platform (or similar) under the laser lens and place a pad of paper or a piece of flat metal on top. Bring the object into sharp focus under the microscope.
- Set the unit to 200 V 1 ms, the focal diameter to ø 0.8 mm and then release a single laser shot. An arc spot will appear on the object.
- By using the adjusting screws the bending mirror can be corrected (detail see in fig. 21) so that the arc spot is drawn into the reticule of the microscope.
- If the upper screw is turned to the right (left) the welding spot will move to the left (right).
- If the upper screw is turned to the left (right) the welding spot will move to the right (left).
- When the arc spot is central, set the parameter to 300 V, 5 ms, focal diameter of ø 2.0 mm, and release a laser shot. Now the focal impression should still be central in the reticule of the microscope.

If there are large discrepancies, check the laser adjustment. The laser beam axis could also be misaligned (service).

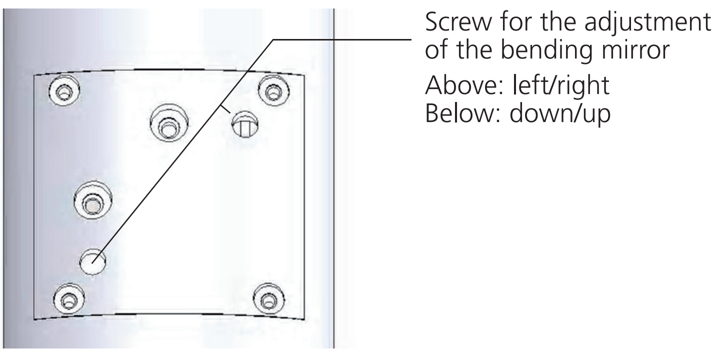


Fig. 21: Adjustment screws for the bending mirror

9. Possible faults, causes and elimination

Fault	Indication	Possible cause	Elimination
After having switched the machine on with the key switch			
Machine is quiet. Pump does not run. Extractor does not run. Illumination remains dark	Display is dark	Mains plug is not plugged in Socket is without electricity FI switch on the plug is activated Emergency off has been pressed Automatic fuse 15 A on back side of connection	Connect the plug in the socket Check lab safety fuse Check the fuse box, Customer service turn and pull out emergency off button
Display and illumination remain dark	Display is dark	24 V supply for control is defect	Customer service
Laser does not pulse	LED Laser OK = green	Flashlight defect	Customer service
	LED Laser OK = red (continually red)	Mains supply defect Flashlight defect * Charger switched off - Voltage charge too high - Thermal overload after frequent switching on/off * Foot pedal not switched on	Customer service Switch machine off using the key switch, wait approx. 10 minutes then use the key switch to switch back on again Connect foot pedal
		* Foot pedal not activated fully/not connected	Activate foot pedal fully
Laser does not pulse	LED laser ok = green		
	LED laser ok = green Shutter on = green	* Lamp defect	Customer service
	LED Laser OK = green LED Laser OK = red	* Fault function in machine Charger off	
	Button INTERLOCK = yellow and...		
	* „HEX Interlock“	Short fault in cool water flow, e.g. cool water level or circulation lies at the sensor level	Fill cool water to above the blue filter lid. If the cool water is ok, change particle filter
	HEX temperature Ilck	Cool water temperature less than 50 °C/122 °F	Check if the ventilator lamellae are clean. Run the ventilator and pump for approx. 10min without turning the laser on. If unsuccessful, call customer service
	HEX Flow Rate Ilck	Cool water flow too low * Bend in pipe * Pump defect * Filter blocked	Customer service Check pipe Customer service Change particle filter
	HEX level Ilck	Cool water level too low	Fill cool water to above the blue filter lid
	Safety shutter Ilck	Safety shutter defect	Customer service
	Safety Loop Error	Feed flap contact misaligned or defect.	Customer service
	Safety Loop Ilck	Feed flap contact misaligned or defect.	Customer service
Laser pulse energy appears to be too low at normal setting	Normal parameter	* Protective glass soiled	Change protective glass
		* Lamp aged * Laser misaligned	Customer service Customer service
Unable to focus laser in usual manner, laser beam too big	Normal parameter	* Protective glass soiled * Microscope ocular incorrectly set * Piece of work is incorrectly placed	Adjust the reticule in the right ocular until it is sharp Position piece of work higher until it can be seen clearly

Fault	Indication	Possible cause	Elimination
Laser welding spot and reticule are not aligned	Normal parameters in display	Directional mirror for the laser beam is misaligned	Adjust the directional mirror using the lower and right hand screw See page 37
Laser welding spot is uneven, sharp-edged, rough	Normal parameters in display	* Laser is misaligned * Laser beam is restricted by a shadow * Laser rod holder is loose, water is in the laser entrance	Customer service Customer service (after changing the lamp, do not leave cables lying in the path of the laser beam) Customer service
Laser welding spot is unevenly distributed	Normal parameters in display	* Protective glass is broken * Protective glass is soiled, welding splashes on glass surface * Laser is very misaligned	Change protective glass Change protective glass Customer service
Laser bores a hole, Material spatters	Normal parameters in display	* Focus too small, or performance too high * Alloy has a high percentage of low melting metal	Enlarge spot or reduce voltage Use zinc-free metal alloys
Laser melts a hole through thin sheet metal, even at low parameters	e.g. „150 V 2 ms“	Thermal contact to background is too low	Adapt and press sheet metal sufficiently
Welded joint has cracks		With chrome alloys the C content is higher than 0.3 %	C content < 0.3 % Pulse duration > 10 ms, Focus > 1 mm
When joining different materials by welding material A vaporises, material B melts		* Melting point of material A < material B * Material A has higher laser beam absorption than material B	Increase the spot on material B in comparison to material A, and select new parameter
The welding process distorts parts the pieces		Welding process creates stresses on the surface	1. Step: staple the two materials together using light pulses 2. Step: weld together tightly from two sides not just from one side

10. Spare part list

Spare parts	**REF**
Particle filter in water tank	908-231-50
Filter insert in the laser emission extraction	908-235-60
Prefilter for welding vapor exhauster	908-236-60
Laser lamp	908-232-55
Protective glass for the lens	908-234-00
Halogen lamp with cold light reflector	908-316-50
1 Cuff for the hand flap	907-490-20

Service – Accessories

Laser protective goggles	
1 sheet A4 format – detection paper for laser radiation	907-877-00

11. Technical Data

Laser:

Laser crystal	Nd: YAG
Wavelength	1064 nm
Max. average power	50 W
Pulse energy	50 J
Pulse peak power	5 kW
Pulse duration	0.5 - 20 ms
Pulse frequency	single pulse … 25 Hz
Pulse shape	4 pre-formed pulse shapes
Laser cooling	integrated water-air-heat exchanger. No external cool water connection necessary.
Cool water level	4.5 l de-ionised water (conductance < 2.5 µS/cm)

Electrical connection:

1-phase	200 V - 240 V/50 - 60 Hz/10 A
Max. power consumption	2.2 kW

External measurements:

Width x height x depth	510 x 430 x 645 mm (without microscope) Height with microscope: 485 mm
Weight	Approx. 50 kg

Welding chamber:

Flap, height x width	140 x 185 mm
Max. height	180 mm
Max. depth	240 mm
Max. width	480 mm
Max. height of work piece	60 mm
Welding spot diameter	0.2 - 2.0 mm
Observation	Stereo microscope magnification 16 x,
Field of view	ø 16 mm
Focus	120 mm
Inert gas inlet	2-part, 1 fixed and 1 flexible, individually lockable
Extraction	Integrated, with suspended particle filter
Cool air nozzle	integrated
Programme memory	space for 39 parameter data
Illumination	2 x 20 W halogen lamps, non-dimmable

Environmental requirements:

Environmental temperature	10 °C ... 30 °C/50 °F ... 86 °F
Transport and storage temperature	5 °C ... 45 °C/41 °F ... 113 °F
Max. rel. humidity	70 %
Max. mounting height:	3000 m

EC-Declaration of Conformity

DENTAURUM GmbH & Co. KG
Turnstraße 31
75228 Ispringen

hereby declares that the design and construction of the laboratory equipment described below, including the version marketed by us, comply with the basic regulations governing safety and health as stated in the EC Guidelines. This declaration will become invalid if the laboratory equipment is modified or altered in any way without our prior consent.

Description of unit:	**DESKTOP Compact Laser**	
REF:	**090-578-00**	
Type of unit:	Dental laser unit	
Start with No.:	00010208-07.08	
EC guidelines:	98/37/EC	Machinery Directive
	2006/95/EC	Electrical equipment used within certain voltage limits
	2004/108/EC	Electromagnetic compatibility
Applied unified standards:	EN 207 EN 60825-1,-4 EN 11553-2 EN 61000-3, -4, -6	
Applied national standards and technical specifications:	BGV B2 BGV A3	

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Turnstraße 31 · 75228 Ispringen · Germany
Telefon+497231/803-0·Fax+497231/803-295

Date and manufacturers signature: 01.01.2010 ---
Signatory: - i.V. Dipl.-Ing. (FH) Klaus Merkle -
Production Manager Mechanic

13. Confirmation of Instruction

The following list of persons confirm hereby with their signature that they have read the operating instructions and have been instructed about the regulations of use and the safety precautions:

Dentaurum laser welding unit desktop Compact, unit no: ______________________________

Family name	First name	Date	Signature

Prothetical instruction

Dentaurum Dental Laser desktop Compact

Contents Page

Prothetical instruction

Dentaurum Dental Laser desktop Compact

1. Preface

Laser welding in dental technology makes use of the infrared light spectrum. It creates a concentration of heat at the welding point which in turn causes local melting of the metal.

2. Advantages of laser welding technology

The increasingly widespread use of the laser in dental technology is due to the many advantages it offers. Among these are:

· efficient working = considerable time savings
· corrosion resistant solder-free joint technology
· homogeneous structure
· high mechanical strength
· small area affected by heat, low deformation
· work near plastic and ceramic materials
· easy connection, extension, repair
· suitable for practically all dental alloys and titanium

With its dental laser units, Dentaurum offers a technology which makes all the benefits of laser welding available to the laboratory. The laser units by Dentaurum have been especially developed for the requirements of the dental technician. They combine modern laser technology, safety, user-friendly design, simple operation and compact size.

3. Material characteristics and laser weldability

3.1 Physical properties

In view of the differing material characteristics such as melting point and thermal conductivity, a specific pulse power is required for each dental metal and alloy.

The following table shows important physical parameters for a number of important metals and alloying elements used in dental technology:

Base-metal	Thermal conductivity W/mK	Specific heat capacity (ref. 1 g) J/gK	Density P g/cm³	Specific heat capacity (ref. 1 cm³) J/cm³K	Melting-point °C/°F
Au	316	0.125	19.19	2.399	1064/1947
Pd	75	0.244	12.02	2.933	1554/2829
Ag	418	0.460	10.49	4.825	960/1760
Cu	393	0.385	8.96	3.450	1083/1981
Zn	113	0.380	7.14	2.710	419/786
Co	100	0.422	8.90	3.907	1493/2719
Ni	92	0.439	8.90	3.907	1455/2651
Cr	67	0.460	7.19	3.309	18903434
Ti	22	0.523	4.51	2.395	1668/3034

(based on Kappert, H, “Titanium as a Material for Dental Prosthetics and Implantology”, DZZ 49, 1994/8)

The importance of the physical parameters is based on the following considerations:

A low thermal conductivity concentrates the incident laser energy on the area of the weld and is therefore beneficial for laser welding.

Metals and alloys with low thermal conductivities such as titanium and cobalt-chromium alloys require lower welding energies than those with high conductivities such as gold alloys.

The specific heat capacity indicates the amount of energy required to heat 1 g of the material by 1 K (= 1 °C).

As a consideration of volume is more accurate for laser welding, the density (= specific gravity, mass per cm^3) should also be taken into account.

From both quantities, the energy required to heat 1 cm^3 of the material by 1 K can be calculated.

3.2 Surface quality of the metal

Visually, laser beams behave in the same way as light beams. Bright surfaces can reflect a large part of the laser beam, thus reducing the amount of energy available for welding. A sand blasted surface is therefore recommended. Highly reflective metals such as gold require much higher energy for welding.

3.3 Alloy composition

The composition of the alloy also affects the quality of the laser weld:

Precious metal alloys

In general, the laser weldability of precious metal alloys can be described as good. However, the violent reactions (evaporation) caused by alloying elements with high vapour pressures can adversely affect the welding process. This applies particularly to alloys with a high zinc content (from approx. 2 %).

Laser weldability can also be affected by alloys with a high silver content (from approx. 20 %) as well as by gold alloys containing titanium.

However, suitability for laser welding by laser does not generally depend on the gold or precious metal content.

Metals and alloys with no precious metal content

Titanium

As a pure metal, titanium is highly suited for welding by the laser process. To avoid brittleness through oxygen absorption, it must however be ensured that the welding point is well covered by a protective gas.

CoCr alloys

The laser weldability of CoCr alloys depends on their carbon content. The alloys used for CoCr crowns and bridges (e.g. remanium® 2000+, remanium® secura) are generally free of carbon and are easily welded.

With regard to the model casting alloys, those with low carbon contents are preferred in order to avoid brittleness. Alloys such as remanium® GM 900 (carbon-free), remanium® GM 800+ (0.2 % C) or remanium® GM 380+ (0.2 % C) are ideal. Filler material for CoCr alloys (e.g. Dentaurum CoCr laser welding wires ø 0.35 mm REF 528-210-00, ø 0.5 mm REF 528-200-50) should always be free of carbon. The carbon free CoCr crown and bridge alloys such as remanium® 2000+ are also suitable for use as filler materials, but alloys with higher carbon contents can also be laser welded.

CoCr wires such as Redur, Crozat or Wiptam are **not suitable** for use as filler materials.

If these are used as retaining wires, the welding is carried out using the filler materials given above.

Ni-Cr alloys

Ni-Cr-alloys, like remanium® CS, can also be laser welded. The ideal filler metal is the NiCr laser welding rod ø 0.5 mm, REF 528-200-00.

Material combinations

The large variety of dental alloys available on the market and the number of possible combinations makes it difficult to make a detailed statement with regard to individual alloys. Please consult the manufacturer of the alloy you intend to use.

The handbook DENTAL VADEMECUM (published by Deutscher Ärzteverlag Cologne, 1995, ISBN 3-7691-4058-3) gives a review of the composition of the various dental alloys.

The following table contains a more general summary of combinations which, in our experience show good or acceptable (X, x) or poor (–) welding quality:

	CoCr	Au-(high)	Au-(reduced)	PdCu	PdAg	Ti
CoCr	X	X	X	–	–	–
Au-(high)		X	X	X	x	–
Au-(reduced)			X	X	x	–
PdCu				X	x	–
PdAg					x	–
Ti						X

The above data is based on our experience and is intended to serve only as a guideline for selecting possible material combinations. No guarantee is given with regard to properties such as mechanical durability and corrosion resistance.

The danger of corrosion (e.g. the creation of local elements) should always be taken into account when joining different materials by means of laser welding. In case of doubt, consult the alloy manufacturer.

4. Laser terminology

Pulse energy

Every laser pulse has a certain energy content known as pulse energy. The pulse energy is stated in Joules = Watt seconds, e. g. 30 J.

Pulse power

Power means: energy per time unit. It is stated in J/sec = Watts (or kilojoules/sec = kilowatts, kW). The pulse power therefore indicates the pulse energy supplied for a certain time unit.

Pulse voltage, pulse time

In order to supply the pulse energies required for laser welding within very short intervals, (electrical) energy is stored. The storage takes place in a so-called condenser bank. The energy content of the condenser bank is a measure of the pulse energy. This energy can be supplied for welding purposes by means of the setting parameters voltage (in volts) and discharge time (in milliseconds).

An increase in voltage while keeping the pulse time constant increases the pulse energy supplied. An increase in pulse time for a constant voltage has the same effect.

The withdrawal of the same pulse energy in a shorter time increases the pulse power, as the same energy is only available within a shorter time by increasing the power.

Focus

The focus setting makes it possible to adjust the diameter of the laser beam. The diameter at the working point can be both increased and decreased.

At this point, the term „energy density" should be considered. Energy density means: energy per surface (e. g. J/cm^2). The diameter of the laser beam produces a circular surface, over which the energy of the laser beam is distributed. A reduction of the beam diameter produces a smaller surface, thereby transmitting the same energy at a higher energy density.

5. Procedure for dental laser welding

5.1 Alloy characteristics

As already described in section 3.3, the alloys used in dental prosthetics have different characteristics. These affect the quality of the laser weld, and, because of their differing conductive and reflective behaviour, require widely differing welding energies.

By contrast to „soldering", the energy used is not directly dependent on the melting temperature of the alloy.

For example, a low melting precious metal alloy requires much higher laser welding energies than CoCr or titanium, which both have a much higher melting temperature.

Practically all standard dental alloys can be welded by laser. However, the qualities with regard to strength and splash behaviour vary. For this reason, all the alloys commonly used in the dental laboratory must be compared with one another in order to assess their distinguishing characteristics with regard to welding behaviour.

When welding alloys whose composition is unknown, a trial weld has to be carried out. The strength and the welding depth is determined by fracturing the welding point.

5.2. Assessment of welding surfaces

When preparing a welding operation, it is essential to consider the casting quality of the surface to be welded. Especially in the case of repairs, the surface must first be assessed under the microscope of the laser welding unit.

Particularly negative features are:

· casting structure with shrinking cavities

· dark stains on the welding surface (carbide elimination)

· remains of solder on the border surfaces.

If any of these features are present, the surface must be ground to ensure that the base metal is free of defects. It may even be necessary to cut out a larger piece of the casting.

Shiny metal surfaces reflect part of the laser light beam. The surface of the metal must therefore be dulled by sand blasting or grinding.

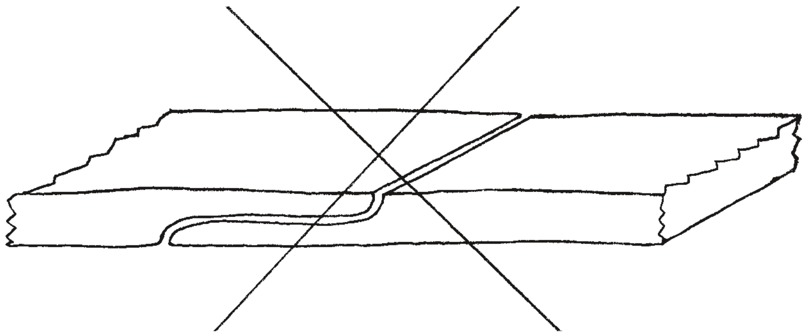
5.3. Preparation of the welding points

5.3.1 Preparation of joint contact

The preparatory work required for laser welding is very different from that required for soldering.

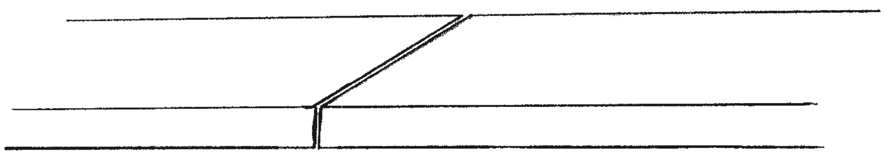
Overlapping of the workpieces which is necessary to increase the size of the soldering surface, is undesirable in the laser welding process.

Preparation for soldering:



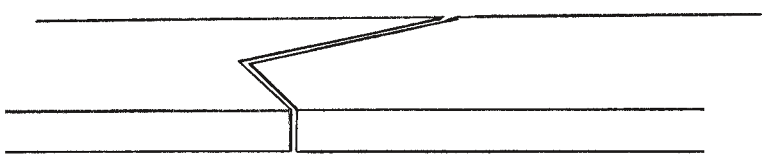
With laser welding, a butt-type contact should always be sought which allows welding from both sides, from above and below.

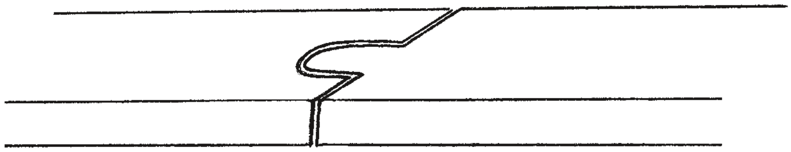
Preparation for laser welding:



In cases of high stressing or alloys of poor weldability, the contact surface may also be enlarged.

Examples:





Regardless of how the joint surface is shaped, it must always be possible to weld in the same direction from the opposite side. Only in this way is it possible to equalize any stresses created.

5.3.2 Quality of the joint contact

The more accurately the welded workpiece has to fit, the more exact the preparation required for the joint contact.

A gap of up to 0.2 mm can be bridged by the laser beam, but both parts will contract.

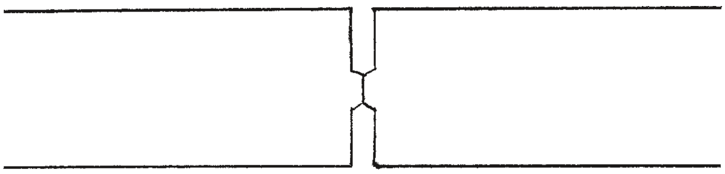
Important!

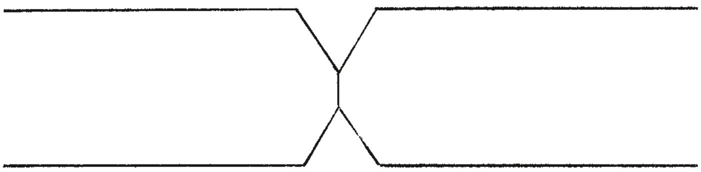
The greater the degree of accuracy required, the more attention must be paid to a gap-free contact.

5.3.3 Central joint contact

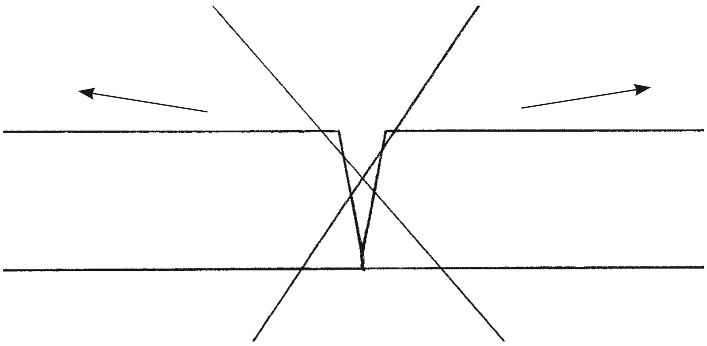
In practice, it is often difficult to create even joint contact over the entire welding surface. However, at least central contact must be ensured.

Possible preparation:





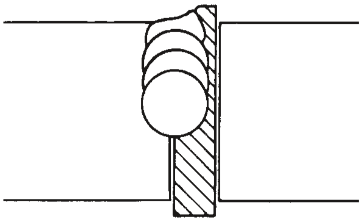
Incorrect joint contact:



This joint is certain to cause warping of the laser weld, as the gap at the top is larger and contracts more strongly.

5.3.4 Wide welding gap

With wide welding gaps, material of the same type must first be inserted and then welded only on one side. Then the actual joint is welded.



5.4 Filler material

The use of suitable filler material is essential for the quality of the joint.

5.4.1 Pre-fabricated filler material

For filler material in wire form, the ideal cross section is between 0.35 and 0.5 mm.

Dentaurum supplies suitable material of the following types:

CoCr	laser welding wire	ø 0.35 mm ø 0.5 mm	matt matt	REF 528-200-50 REF 528-210-00
Titanium	laser welding wire	ø 0.4 mm ø 0.7 mm ø 1.0 mm ø 1.2 mm		REF 528-039-50 REF 528-040-50 REF 528-041-00 REF 528-042-00
Titanium, rolled		0.25 x 3.0 mm 0.5 x 1.5 mm		REF 528-044-00 REF 528-043-00
NiCr	laser welding wire	ø 0.5 mm		REF 528-220-00
Precious metal (Au-Pt)	DentAurum C4 DentAurum B4 DentAurum LFC4	ø 0.4 mm ø 0.4 mm ø 0.4 mm		REF 102-521-00 REF 102-531-00 REF 102-541-00

Nowadays, most precious metal alloys are available from the manufacturers only as thin wire material.

Important!
Prefabricated material should always be preferred to self-cast material.

5.4.2 Cast filler material

If an alloy is not available in pre-fabricated form, it can (with certain limitations) be cast by the user.

Very thin wires with diameters of less than 0.6 mm are extremely difficult to cast.

For all standard laboratory alloys, rods of various diameters (0.6 to 3.0 mm) and small tablets of approximately the thickness of a cutting disk should be cast.

This considerable simplifies the preparatory work involved in closing a welding gap.

Important!
When casting CoCr filler material, an exception should be made to the rule of using the same alloy. Instead, a carbon-free alloy such as remanium® GM 900, remanium® 2000+ or remanium® secura should be used!

5.5 Preparing the laser welding unit

Before beginning work, always check the following parts of the laser welding unit:

5.5.1 Cleanness of the lens-protection glass

The lens-protection glass may be contaminated by welding fumes or even splashes of metal. It should therefore be cleaned regularly (with Kleenex and alcohol) or if necessary replaced. If the glass is dirty, the power of the laser beam is greatly reduced.

5.5.2 Inert gas covering

To avoid the uncontrolled absorption of oxygen during the laser welding process, it is generally recommended to flood the welding point with argon. This is especially important when using pure titanium or titanium alloys. The inert gas nozzle should be positioned approx. 5 mm in front of the workpiece (i.e. visible in the left-hand eyepiece of the microscope).

The correct distance of the argon nozzle opening is determined by using a titanium disk (reference sample supplied with the unit):

Setting parameters for laser welding unit: voltage 270 V, pulse duration 5 ms, argon flow 8 l per min.

Bring the titanium disk into focus and move the argon nozzle as close as possible to the welding point diagonally from above.

Before beginning the welding process, flush the area of the weld for approx. 3-5 secs by pressing the foot switch half way down. Then start the welding process (press the foot switch down fully). If the argon flush is optimum, the lasered point will have a bright silvery surface. If the surface is discoloured, move the argon nozzle closer to the workpiece and/or change its angle and repeat the process until the surface has the correct appearance. Do not alter this position of the argon nozzle but check it frequently!

Note: the lasered titanium disk can be used repeatedly simply by shot blasting it from time to time.

5.6 Setting welding parameters

5.6.1 Welding power for dental purposes

With reference to the physical terms explained in section 4, the welding „power“ of the laser unit can be varied by adjusting the four following parameters:

· **Voltage**
· **Pulse duration**
· **Interrelationship of voltage and pulse duration**
· **Focus position**

5.6.2 Voltage

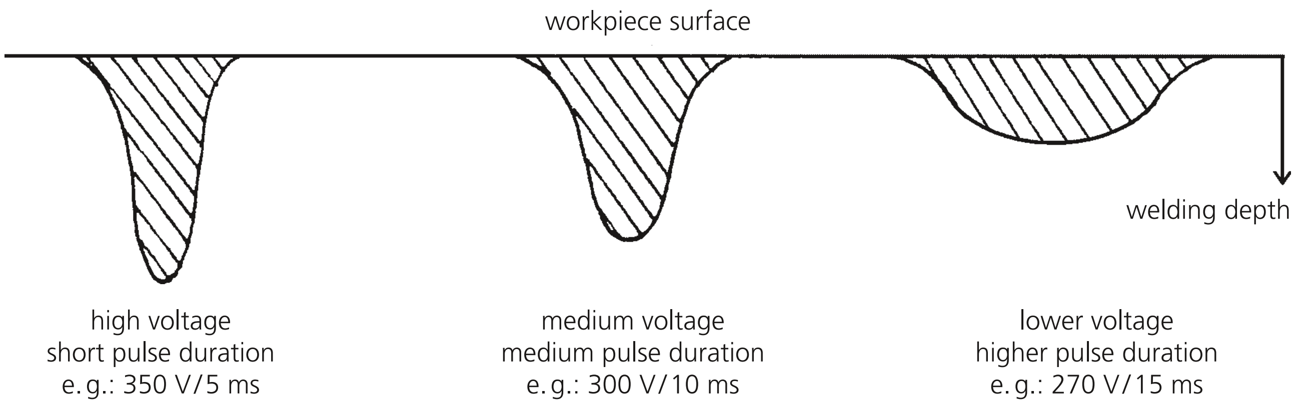
The voltage determines the welding depth. Increasing the voltage results in a greater welding depth. Reducing the voltage results in less welding depth.

5.6.3 Pulse duration

The pulse duration is determined by the time in which the laser pulse operates (0.5 - 20 ms). It affects both the diameter of the welding spot and the strength of the weld.

5.6.4 Interrelationship between voltage and pulse duration

The two parameters voltage and pulse duration are inter-related and must be selected to accommodate the material’s thickness, composition and welding task to be carried out. In general, large differences in the parameters should be avoided (e.g. very high voltage and very low pulse duration or very low voltage and very high pulse duration). The relationship is shown in the following diagram:



By adjusting the welding parameters, it is possible to join securely solid elements such as lower lingual bars or solid connecting elements, as material thicknesses of up to 4 mm can be welded through by working from both sides. On the other hand, very fine welds (e. g. on implants or precision attachments) can be carried out reliably by reducing the power.

Soft welding

Soft welding means: welding with a higher pulse duration and a lower voltage. A joint which is welded using the parameters 280 V / 12 ms (soft) has a better and more stable weld structure than one which uses a higher voltage and a lower pulse duration, even though the same depth of penetration is achieved.

For this reason soft welding should be used if enough space is available.

Depending on the alloy, a pulse duration of approx. 10 ms should be used if the wall thickness is large enough, e. g. with CoCr alloys the minimum duration should be 8 - 10 ms).

The voltage is adapted accordingly and if necessary set to a lower value.

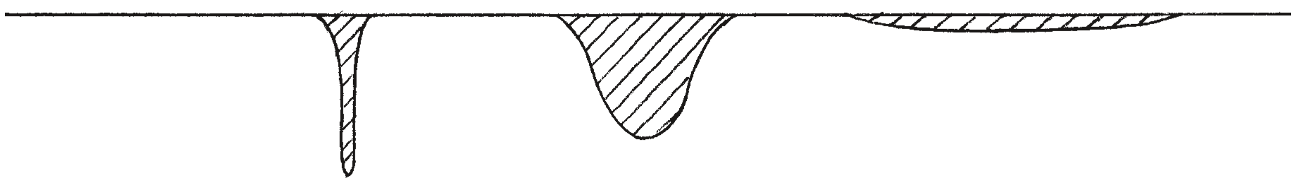
5.6.5 Focus position

The diameter of the laser beam at the focal point can be varied between 0.2 and 2.0 mm by adjusting the focus. This makes it possible to spot weld in very confined locations using a small focus diameter. The larger diameter on the other hand is used for flooding large areas.

A very tight setting of the focal point diameter brings the laser into a „drilling“ position. As a rule, this results in uncontrolled material ejection and poor joint strength.

On the other hand, a very wide setting simply causes melting at the surface of the metal, making in-depth welding impossible. It can however be used for smoothing or even polishing the metal.

For welding, the ideal focus diameter is around 0.6 to 0.8 mm, which can be altered according to the working conditions.



5.7 Welding process

Following the preparatory measures described in sections 5.1 and 5.6, the actual welding process can now begin.

5.7.1 Verification and assessment of the overall welding depth

The overall thickness of the required weld is assessed before fixing the workpiece onto the master model.

Certain welding parameters are set on the basis of the alloy, the gap still existing, and the welding depth.

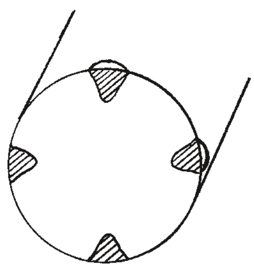
5.7.2 Tack welding

In order to avoid warping, not only is the correct preparatory work of importance, but also the correct location of the welding spots.

As a general rule:

the lower the welding energy, the less risk there is of warping.

For this reason, the workpiece is first fixed to the master model by tack welding.

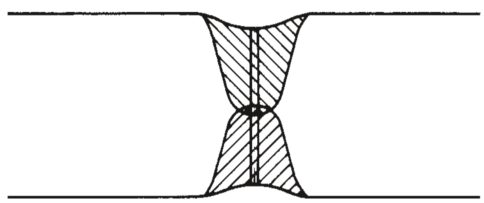


As shown in the diagram, four diametrically opposed welding spots are first applied at low energy. Depending on the application, the welding depth should be between 0.15 and 0.3 mm.

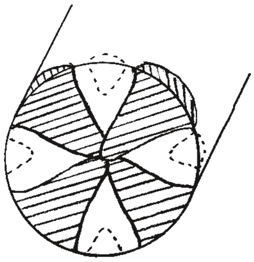
If possible, the first spots are applied at the points where the best joint contact is seen. Remove the workpiece from the model and check that it is free of stress.

5.7.3 Depth welding

Diagonally to the tack spots, weld in depth using an energy corresponding to the overall thickness of the weld. Always weld from both sides, ensuring that the root of the weld overlaps.



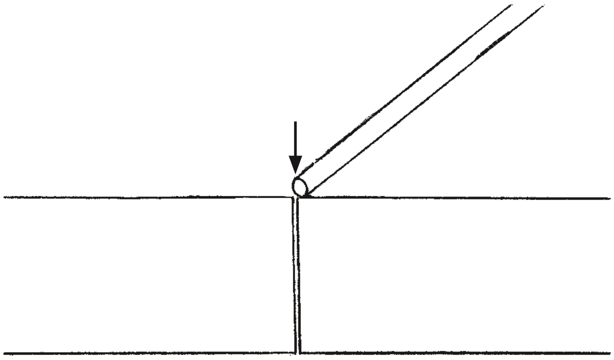
After applying the four diametrically opposed in-depth welding spots, weld the gaps which are still open, covering the tack spots.



5.7.4 Depth welding with filler material

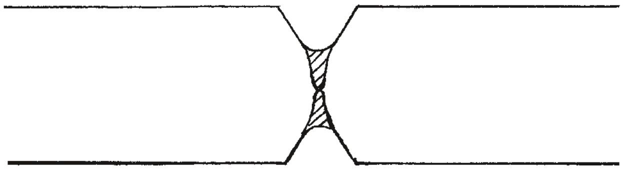
With many welding tasks, it is advisable to apply a suitable filler material (0.35 to 0.5 mm) to the welding gap during the depth-welding phase. This way, any material deficiency is made up immediately during the welding process.

This is especially important in the case of alloys with poor weldability, as it often improves the quality. When welding CoCr model casting alloys, a carbon-free CoCr laser welding wire must always be applied to the gap.

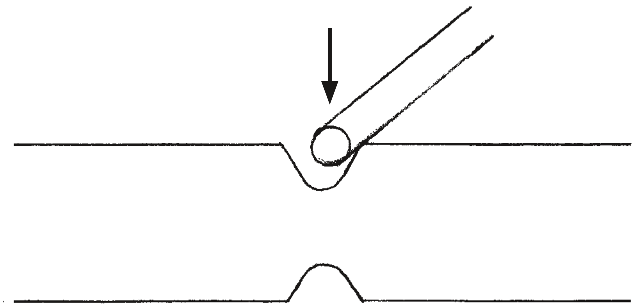


5.7.5 X-shaped welds

For preparatory work with central joint contact, it is generally possible to work with low welding energies.



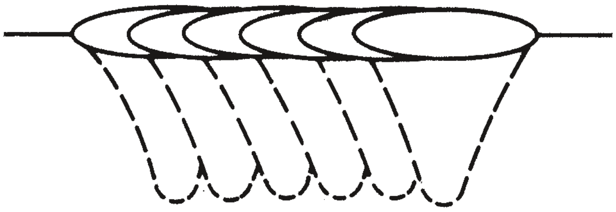
First of all, the centre of the contact surface is welded.



Filler material of the same alloy (wire diameter, 0.35 - 0.5 mm) is applied around the fillet with low welding energy. Sufficient material is added until the overall cross section of the original material is achieved.

5.7.6 Welds

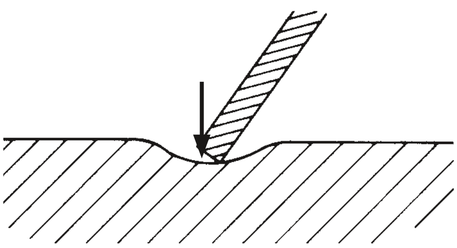
The weld is applied in the form of spots which overlap one another by about 2/3 of their surface area in order to assure complete welding to the desired depth.



5.7.7 Applying material

With restrictions in the weld, or where additional thickness is required (e.g. contact points), thin wire material is applied.

The material is „shot" off the tip onto the area being built up. This operation is carried out using a slightly softer setting, i.e. low voltage and higher pulse duration.



5.7.8 Laser beam alignment

As a rule, the laser beam is pointed vertically at the workpiece. The beam of laser light is exactly in the direction view through the microscope. If the beam is applied diagonally to the object, the superficially melted metal is pushed in the direction of the beam. This way, the material can be „driven" in any direction required.

5.7.9 Smoothing

With the help of the adjustable focus, a weld which has been applied can be smoothed by widening the focus.

The diameter of the focal point is considerably enlarged and the energy distributed over this surface. This causes the surface to melt and merge.

5.8 Weld cracking

Some alloys which are difficult to weld tend to form cracks in the weld.

These cracks are generally created after only a few spots have been applied and are normally only visible when enlarged under the microscope. They represent a weak point in the weld and must be avoided at all costs.

The best way to avoid them is to prepare a good joint contact and use suitable filler material. Under certain circumstances, the filler metal can be of a different composition. For example, the laser-welding characteristics of a „difficult" palladium-silver alloy can be improved by using gold wire as filler material.

5.9 Welding of different materials

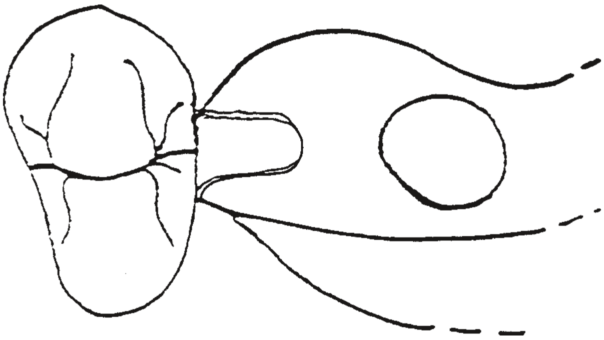
When welding different materials, slightly more energy should be applied to the alloy with the higher requirement in welding energy.

For example, when joining a gold alloy to a CoCr alloy, the focus (for example) is directed more towards the gold alloy.

When welding EM telescopes to a model-casting alloy, it is advisable to attach an appendix to the crown to achieve stable stress-free welds.

Recommendation: conical pin for laser welding, REF 111-901-00.

The fit between the crown appendix and the model casting should be as close as possible, i. e. with no gap whatsoever. Laser welding with CoCr wire or without filler material. If the contact between crown and model casting is over a larger surface, always use gold wire as filler. In order to achieve a better control of the fit, weld each secondary component in combination work separately. Apply the welding spots alternately at diametrically opposite positions and work alternately from above and below.



5.10 Welding close to plastic and ceramic material

Welds close to plastics can be made without difficulty. This is also the case with ceramic coatings. Ideally however, there should be a metallic border of about 1 mm in width.

To avoid excessive heating, the individual weld spots should be applied with longer intervals.

5.11 Frequency setting

The laser welding unit can be used both with single pulses (0 Hz) or with continuous pulses with adjustable frequency. However, even experienced users should not select frequencies of over 3 Hz. This means executing three weld spots per second, which is extremely difficult to do by hand. At a setting of 1 Hz, it is possible to work at a slow but continuous pulse rate either with the pedal permanently in the down position or by pressing the pedal to release single pulses.

5.12 Laser welding in the field of Orthodontics

Welding charts of Dentaurum Laser units

Fundamental hints to use the welding chart:

1. To weld small elements and appliances in the orthodontic field, the same general procedures and preliminaries are required as for general laser welding.
2. It is essential that the elements being welded are well prepared and that they provide an accurate fit without any gaps. This is the only way to ensure that thick parts such as wires can be properly welded to extremely thin parts such as bands.
3. To produce good orthodontic work, the parts being welded must be prepared lying flat against one another. In particular, industrially manufactured standard parts such as the pivots of a Herbst® Bite Jumping Hinge joint or the base of a buccal tube must be carefully ground in such a way that they lie flat against bands of different sizes and shapes. This is the only way to join elements of this kind without using welding filler material.
4. If the band and wire contact one another at points only, or if there is a slight gap between them, it is essential to use a suitable filler material such as remanium® wire ø 0.35 mm.
5. As a general rule, laser welding should always be carried out using Argon gas to avoid oxidation of the welds. This also has a positive effect on the strength of the joint. In most cases, the weld spots should have a metallic sheen.
6. The parts used in orthodontics often have a shiny metallic surface. This may cause reflection of the laser beam. In view of the amount of reworking required, the parts are not generally shot blasted with corundum. However, in order to obtain the desired result, it may be necessary to vary the angle of the laser beam on the joint area. In this case, the welding power has to be adapted to the circumstances in question. Under normal conditions, the power is increased and the angle of the laser beam selected should be guided from the "thick" to the "thinner" part.
7. The parameters stated in the following table refer to the experience gained in using Dentaurum products and application technology in orthodontics.

Welding Tables for Dentaurum Laser Welding Units
Field of Application: Orthodontics

Number	Task	Recommended materials	Welding parameters		
			Voltage (V)	Pulse duration ms	Focus position
1	Manufacture of a Herbst® appliance	a) Herbst® I molar bands Upper/Lower premolar bands Upper/Lower	225 - 230	2.5 - 3.5	0.6
2		b) Herbst® IV molar bands Upper/Lower premolar bands Upper/Lower	225 - 230	2.5 - 3.5	0.6
3	Manufacture of a Rapid Palatal Expansion	Hyrax® or Palex® screw, molar bands Upper, premolar bands Upper, remanium® wire, spring hard 0.9 oder 1.0 mm			
	Stage 1	Wire ø 0.9 mm on band	225 - 230	2.5 - 3.5	0.6
	Stage 2	Retention arm on wire ø 1.0 mm	270	6.0 - 7.0	0.6
	Stage 3	Reinforce with wire ø 0.35 mm	230	3.0	0.6
4	Quad Helix welding to bands	Quad Helix, pre-formed Molar bands, upper	225 - 230	3.0 - 3.5	0.6
5	Manufacture of an individual gap retainer	remanium® wire ø 0.8 mm Molar bands, Upper/Lower	225 - 230	3.0 - 3.5	0.6
6	Manufacture of a palatal/lingual sheath to bands	Orthorama® lingual/palatal bow remaloy® wire ø 0.9 mm remanium® wire, spring hard ø 0.9 mm Molar bands, lingual	225 - 230	3.0 - 3.5	0.6
7	Welding a lingual/palatal lock to a band	Palatal/lingual sheath, molar bands	230	3.0 - 3.5	0.6
8	Manufacture of a Crozat appliance				
	Stage 1	remaloy® wires ø 0.7 to 1.5 mm or	260 - 270	4.0 - 8.0	0.6
	Stage 1	remanium® wires, spring hard ø 0.7 to 1.5 mm	260 - 270	4.0 - 8.0	0.6
	Stage 2	Reinforcement with wire ø 0.35 mm	230	3.0	0.6
9	Manufacture of a Nance appliance	remaloy® wire ø 0.9 mm to palatal molar bands remanium® wire ø 0.9 mm	225 - 230 225 - 230	3.0 - 3.5 3.0- 3.5	0.6 0.6
10	Welding on a hook for dentalastics to a face bow or lip bumper				
	Stage 1	Button anchor 0.7 mm	240	4.0	0.6
	Stage 2	Reinforce with wire ø 0.35 mm	230	3.0	0.6

Welding Tables for Dentaurum Laser Welding Units
Field of Application: Orthodontics

Number	Task	Recommended materials	Welding parameters		
			Voltage (V)	Pulse duration ms	Focus position
11	Welding a stop to a round or square bow Stainless steel	Stop tube slotted, to round bow	225 - 230	3.0	0.6
		To square bow	230	3.0	0.6
12	Welding on a hook for dentalastics to a round or square bow	Pre-formed hook or button anchor ø 0.7 mm to round bow	225	2.5 - 3.0	0.6
		to square bow	230	3.0 - 3.5	0.6
13	Welding a cross tube to a round or square bow Stainless steel	Cross tube to round bow	225	2.5 - 3.0	0.6
		to square bow	230	3.0	0.6
14	Welding a round tube to an ADAMS-clasp for holding a face bow	Tubes – stainless steel e. g. ø 1.2 mm	225	3.0	0.6
15	Individual manufacture of a bonded retainer Manufacture of an individual lingual retainer	remaloy® wire ø 0.7 mm Mesh base, small	220	3.0	0.6
16	Individual manufacture of a hook to band or bonded bracket, buccal tube	Button anchor ø 0.7 mm	235	3.5	0.6
17	Manufacture of a Kahn Spur to a face bow				
	Stage 1	remanium® wire ø 0.9 mm, end to end	260	7.0	0.6
	Stage 2	Reinforce with wire ø 0.35 mm	230	3.0	0.6
18	Manufacture of a spike for bonding method	remanium® wire ø 0.9 mm on mesh base	220	3.0	0.6
	Stage 1	Lingual bow and remanium® wire ø 0.9 mm	250	3.0	0.6
	Stage 2	Reinforce with wire ø 0.35 mm	230	5.0	0.6
19	Manufacture of an individual spring to a labial bow	remanium® wire , ø 0.7 mm, spring hard	260	3.0	0.6
20	Manufacture of a hook for dentalastics to a face mask				
	Stage 1	Button anchor ø 0.9 mm	245	4.0	0.6
	Stage 2	Reinforce with wire ø 0.35 mm	230	5.0	0.6
21	Welding a nut for spring screws to a labial bow				
	Stage 1	Milled nut	230	3.0	0.6
	Stage 2	Reinforce with wire ø 0.35 mm	230	3.0	0.6

Welding Tables for Dentaurum Laser Welding Units
Field of Application: Orthodontics

Number	Task	Recommended materials	Welding parameters		
			Voltage (V)	Pulse duration ms	Focus position
22	Manufacture of additional retention to expansion screw for improved anchoring in acrylic	remanium® wire 0.9 mm	240	4.5	0.6
23 **24**	Welding of a wire to an expansion screw e. g. as a spring				
	Stage 1	remanium® wire 0.8 mm, end to end	260	6.0	0.6
	Stage 2	Reinforce with wire ø 0.35 mm or	230	3.0	0.6
		remanium® wire ø 0.8 mm, flat	260	6.0	0.6
25	Manufacture of an acrylic-free palatal or lingual expansion appliance	Hyrax® or Palex® srew, mini palatal/ lingual molar bands	225 - 230	3.0 - 3.5	0.6
26	Repair of a labial bow of an ADAMS-clasp etc.				
	Stage 1	remanium® wire ø 0.7 mm, end to end	260	6.0	0.6
	Stage 2	Doubling with wire ø 0.7 mm	260	4.0	0.6
27	Manufacture of a stop on face bow, lip bumper	Stop tube ø 1.15 mm	230	3.5	0.6
28	Manufacture of a post hook on palatal or lingual round or square bow Stainless steel	Button anchor ø 0.7 mm	225	3.0	0.6
29 **30**	Repair of Hyrax® or Palex® screw with broken retention arm				
	Stage 1	End to end	270	7.0	0.6
	Stage 2	Reinforce with wire ø 0.35 mm or	230	3.0	0.6
		weld on flat	270	7.0	0.6

Welding Tables for Dentaurum Laser Welding Units
Field of Application: Orthodontics

Number	Task	Recommended materials	Welding parameters		
			Voltage (V)	Pulse duration ms	Focus position
31	Buccal tube to molar band	Palatal/lingual molar band Buccal tube	230	3.0 - 3.5	0.6
32	Double hook to molar band	Palatal/lingual molar band Lingual/palatal hook	230	3.0 - 3.5	0.6
33	Modification of a palatal bow, Orthorama® system	remanium® wire, ø 0.5 mm, spring hard	230	3.0	0.6
34	Modification of two tension screws (Geller system)	Tension screw	260	6.0	0.6

5.13 Examples of application Prosthetics Settings for voltage and pulse duration

The following table shows typical settings for the voltage and pulse duration for common welding tasks and alloy systems.

Chosen reference setting for the focus is ø 0.7 mm.

It may be necessary to use different settings depending on the application, alloy and surface quality!

	Material system					
Welding task	**Ti (pur)**	**Co-Cr**	**Au-Pt**	**Au-Ag**	**Au-Pd**	**Pd-Ag**
Lower lingual bar	300/6-10	290-310/8-12	–	–	–	–
Bridge	280-300/4-8	290-310/8-12	300-340/ 8-10	300-340/ 8-10	290-330/ 8-10	290-320 8-10
Small connector	280-290/4-8	270-300/8-10	–	–	–	–
Framework	230-270/2-8	270-280/8-10	–	–	–	–
Crown hole	220-270/ 1-6	230-270/1-6	230-280/ 2-8	230-280/ 2-8	220-270/ 2-8	220-270/ 2-8
Plate weld	270-290/4-6	270-290/4-6	–	–	–	–
Friction pin	240-270 / 3-6	250-270 / 3-6	–	–	–	–