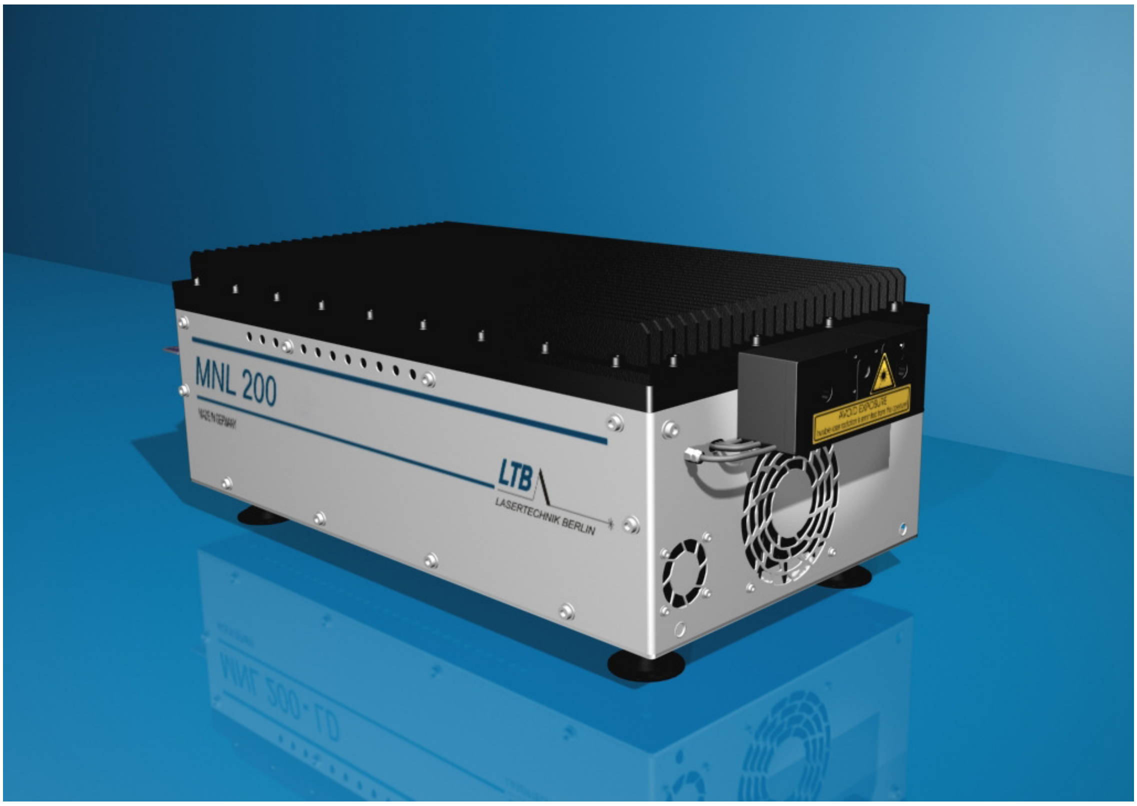
Manual

Nitrogen Laser MNL



July 2004

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Dear customers

With the purchase of a laser from the MNL series, you have selected a state-of-the-art Nitrogen laser.

The laser satisfies sophisticated needs and demanding goals in various applications within the industrial area. The following properties reveal the advantages of the MNL.

- High pulse power
- Minimal beam divergence
- Minimal time jitter
- Pulse halfwidths in the sub-nanosecond range
- Long life
- Low costs

These properties make the laser attractive for applications where high quality, stable output and cost-effectiveness are required.

The MNL is used in optical spectroscopy, micro-structuring, calibration of fast sensors and contactless quality control of thin layers as well as in certain applications within the environmental and biotechnological areas.

The laser operates on the principle of transversal excitement at atmospheric pressure (TEA laser). The energy is stored in a decoupled capacitor/strip conductor arrangement at about 10kV. The laser radiation is generated by a fast high-current discharging in the laser channels, which is triggered by a power switch (Thyratron or spark gap). All laser functions are controlled and monitored by an internal laser control.

Your laser has carefully been tested in an endurance test of more than 1 million pulses. The results of the test are included in the end test protocol accompanying the laser.

LTB wishes you much success in working with the laser on your projects. If there are any questions in working with the laser or suggestions how to improve the laser, please do not hesitate to contact us.

CONTENT

1. SAFETY PRECAUTIONS

MNL Lasers are 3B class lasers (IEC 60825-1).

Improper treatment and operation of the laser can cause damage to your health.
Please follow carefully all the instructions in this manual.

1.1 Invisible laser light

The laser emits intensive invisible laser radiation in the UV range.

Do not look into the laser beam!

Please always wear laser safety goggles appropriate to the wavelength of 337 nm and ensure that all persons in the vicinity of the laser also wear laser goggles during laser operation.
For MNL lasers, you need class L6 laser goggles

Always close the beam shutter when the laser is not in operation.

Please observe that there are no reflecting materials in the beam path by which the laser beam could unintentionally be directed towards persons or sensitive materials.

Always use beam shutters made of inflammable materials in your set-up.

Always follow the safety regulations.

In case of any unexpected events (fire, water or other things), you can stop the laser operation by using the SPACE key on your keyboard

1.2 High voltage up to 12 kV

A high voltage of up to 12kV is generated in the laser. Perilously high energy amounts are also accumulated in the capacitors of the strip-conductor. Therefore, always ground the laser sufficiently.

Do not open the laser!

Because of high voltage circuits, the laser should never be opened nor should any objects be put into the laser casing openings.

1.3 Dangerous gases

The high-energetic UV radiation causes ozone and nitrogenic gases.

Please observe that the laser operating room is sufficiently ventilated.

1.4 Pressure up to 4.5 bars

The laser works at a slight overpressure. The gas flow is controlled by a throttle with a pre-pressure of up to **4.5** bar (abs.).

Never exceed the Nitrogen pressure of 4.5 bars.

In case of an error, the pressure will be limited by a pressure control valve to **4.5** bar **absolute**. Nevertheless, there is a risk that the output window will be damaged.

For regulating the nitrogen supply, use a pressure reducer at any rate.

1.5 Liability

Any tampering with the laser or its adjustment must be done by authorized service staff.

Any liability and warranty lapses with the opening of the laser or any modifications without LTB's explicit written consent.

2. SYSTEM REQUIREMENTS

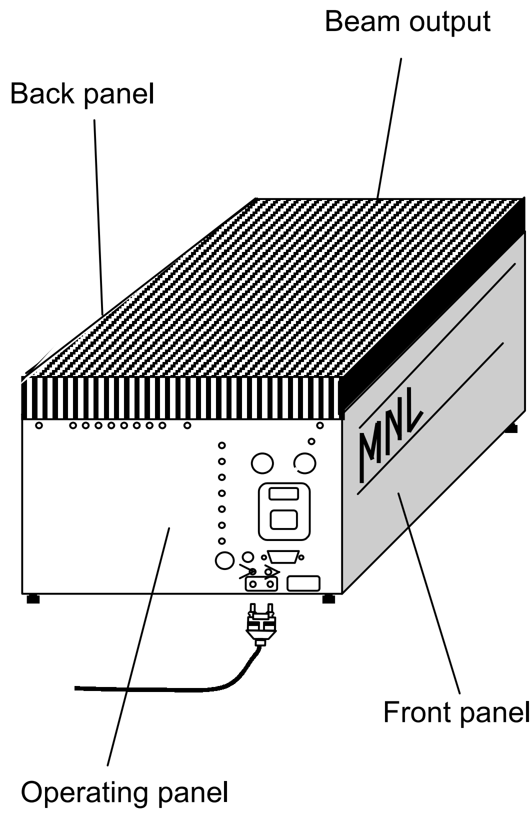
2.1 Place of Installation

The laser has to be operated and stored in a dry, dust-poor and well-ventilated area.

	temperature	humidity
Storage and operation	+5 … +35 °C	65 %

Please observe that the laser is not placed close to any heat sources.

Moreover, ensure that there is no blockage of ventilation fans or other air vents on the laser casing. These include side panels, the back panel and the bottom of the casing.



2.2 Electric requirements

You need a grounded contact socket with a protective conductor connection (protection class 1) protected with at least 6A. The appropriate values for the power input are:

230 V, 50/60Hz
115 V, 50/60Hz

Please only connect the laser to mains that matches the given values on the specification label on the operating panel of the laser.

2.3 Fuses

The fuses are located above the main plug on the operating panel of the laser. The fuses' nominal values are:

230 V – 2 x 3.15 AT
115 V – 2 x 6.30 AT

2.4 Nitrogen supply / Pressure-reducing valve

For the Nitrogen supply, you will need:

- Nitrogen with a purity of 99.996%
  (Quality **4.6**) **or better**
- A **pressure-reducing valve** when using a nitrogen bottle
  low-pressure side -- 0 … max. 10 bar
  high-pressure side -- bottle pressure
- A **Polyurethane-hose** (∅ 4mm), delivered with the laser and directly connectable to the laser and the pressure-reducing valve.

The following details may help in calculating your Nitrogen requirements:

- the approximate nitrogen consumption is 5l/h – 7l/h
- usually, the pressure of a nitrogen gas bottle is 150 bars minimum.
- The usable amount of gas is calculated by:
  bottle volume x bottle filling pressure

Therefore, a 10 l bottle, filled with 150 bar nitrogen, contains 1500 l nitrogen and will last for about 300 hours of laser operation. The nitrogen supply is automatically stopped by turning off the laser.

→ **Gas generators are a safe alternative to gas bottles or central gas supplies.**

2.5 Control/Computer

To operate the laser a PC is required.
You will find an opto-electronic interface adapter that is used to complete the connection between the laser and the PC in the utility bag. If you would rather work with a notebook, a special adapter is available from LTB.

PC requirements:

- IBM-compatibility 386 or higher
- 4 MB RAM, 1 MB free hard-disk storage
- WINDOWS 9x, WINDOWS NT, WINDOWS XP
- A mouse
- A serial COM interface, 9-pin
- CD-ROM drive
- free slot in the PC-casing (for internal current supply)

3. INSTALLATION

3.1 Operation Panel

1 Main fuses

2 Mains plug

3 Key switch

4 INTERLOCK socket

5 POWER ON ("Laser ON" lamp)

6 LASER EMISSION INDICATOR (warning lamp signals operational readiness and operation)

7 Optical external trigger input

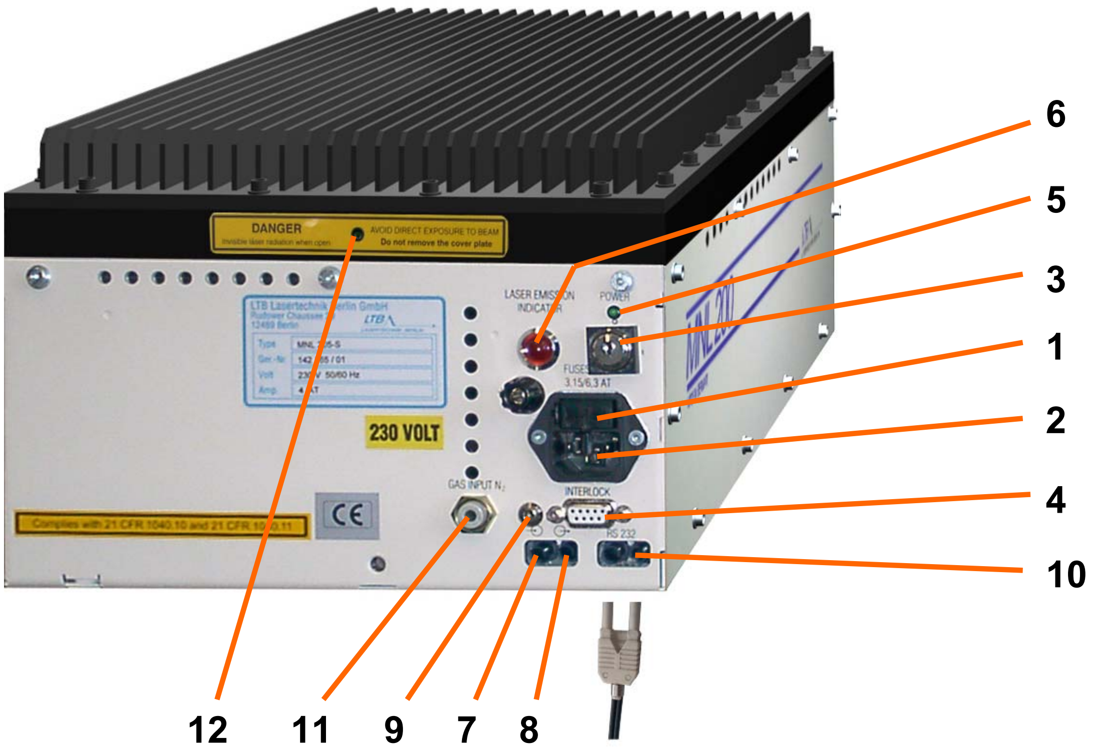
8 Optical PRE-trigger output

9 Electrical output of the optical trigger module with SMB connector (optional)

10 Optical RS 232 interface

11 Nitrogen inlet

12 Mirror



3.2 Acclimatising the laser

We recommend that the laser is acclimatised in the operating room for at least an hour after transport or after moving or changing the operating location.

3.3 Installation of the optical interface RS 232

The laser can only be operated and monitored via its serial interface. The user program WINLAC allows the comfortable operation via PC or Laptop.

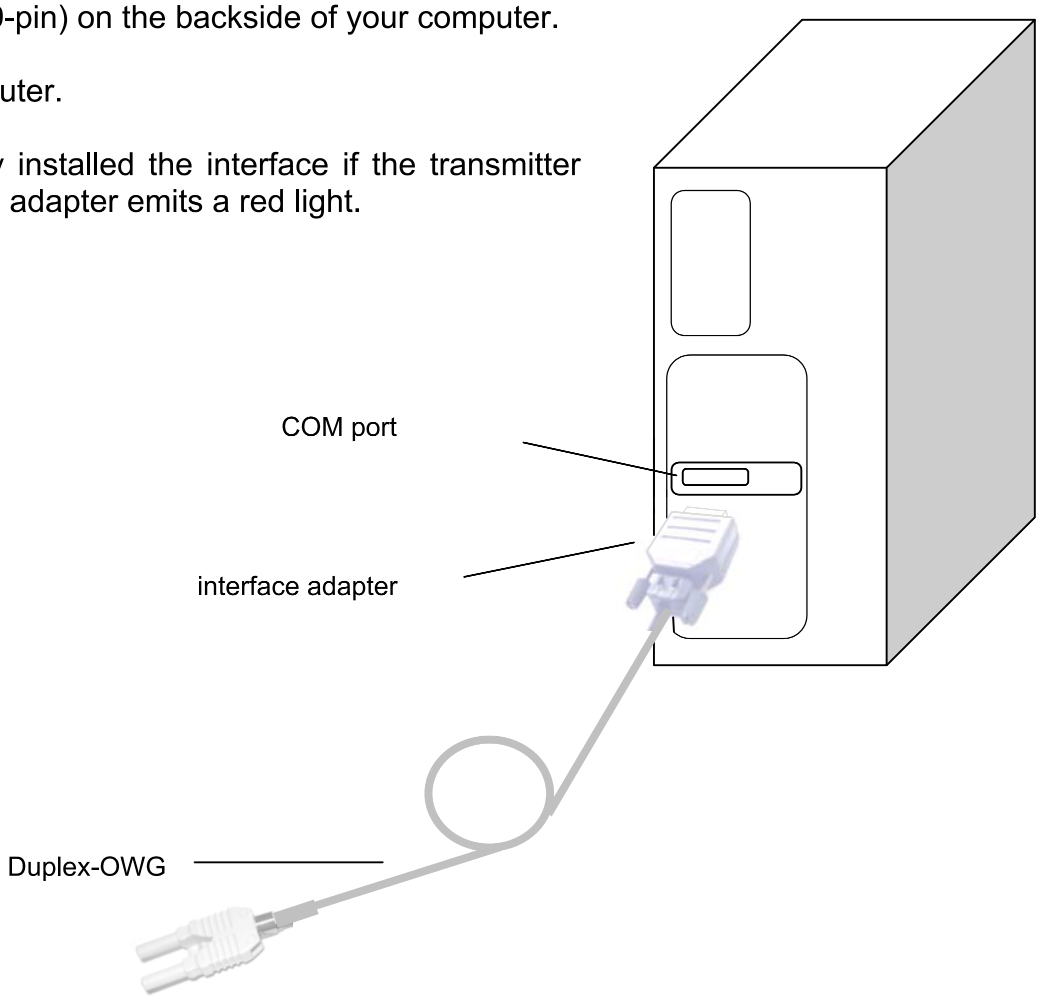
A Duplex-OWG and two optical interfaces, one in the laser and the other one in the PC or Laptop, effect the connection between the laser and the computer.

The interface in the laser is already mounted, but the interface in the computer needs to be installed.

Screw the interface adapter (LWL/232-IF) onto a free serial port (e.g. COM 2, 9-pin) on the backside of your computer.

Turn on your computer.

You have correctly installed the interface if the transmitter line of the interface adapter emits a red light.



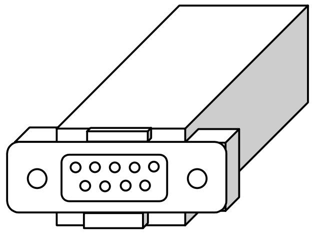
3.4 The Interlock plug

The interlock plug is an important safety feature during laser operation

It is provided for:

- closing the external safety circuit
- integrating external applications in the safety circuit of the laser
- connecting external warning devices

The safety circuit is supplied from a safety extra-low voltage of 12 V / 20 mA.



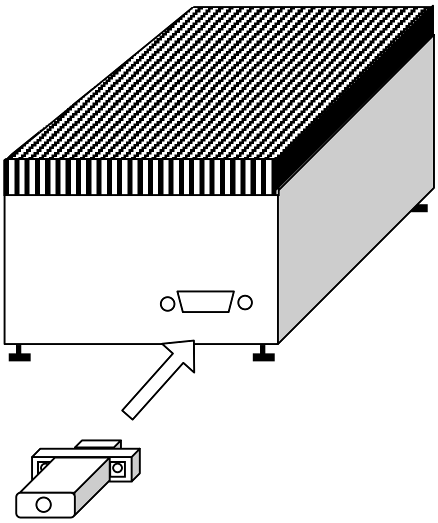
Without the interlock plug, you cannot operate the laser!

3.4.1 The external safety circuit

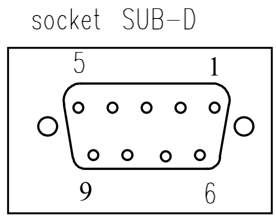
For operating the laser, the external safety circuit always has to be closed.

Put the interlock plug into the interlock socket on the operating panel of the laser and fix it in place with the screws.

The external safety circuit is now closed and laser operation is possible.



3.4.2 *Connecting external applications*



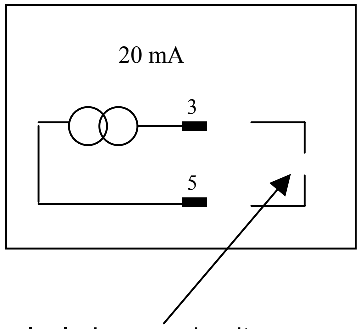
view of the solder side

For protection against laser radiation, the position switches of any lasers or other devices or the main safety switch of your laboratory can be connected together to one external safety circuit. The laser and its accompanying apparatus can then be turned off from this interlock plug.

In the interlock plug, the PINs 3 and 5 are connected.
You can integrate your equipment in the interlock circuit as follows:

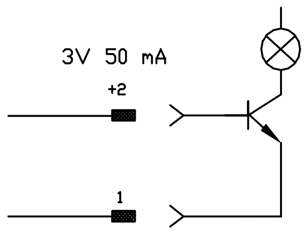
1. Open up the interlock plug with a screwdriver and loosen the connection between PIN 3 and PIN 5.

2. Solder the endings of your circuit on PIN 3 and PIN 5 and close the interlock plug.



Include your circuit here

3.4.3 *Connecting external warning devices*



Additionally, you can integrate an external warning device (electronic relay or warning lamp) connecting it to PIN 1 and PIN 2.

An interlock relay can be obtained from LTB.

3.5 Mains supply

Please find your power cord in the utility bag.
The power plug is on the operating panel of the laser.

3.6 Gas supply

3.6.1 Instructions for compliance with the gas hygiene

Operate your laser only with nitrogen of the quality 4.6 or better. We recommend the mini gas generator MNG 100 or compressed gas cylinders filled with the specified gas.
Central supply lines for technical nitrogen are not suited, even not with additional filter equipment.

The gas discharge in the laser is particularly perturbed by an augmented O_2 or H_2O portion in the ppm range.
They cause irreversible damages in the laser head.

1. Before connecting the gas supply line and taking into operation the laser make sure that the complete nitrogen gas supply system, from the generator or pressure reducer up to the gas input connector at the laser is flushed carefully, so that no air is in the lines.

2. Only after having pressed all air out of the lines (flush with nitrogen for a few seconds), you may remove the blind plug from the gas inlet of the laser and replace it with the gas hose, which is still flown through with nitrogen.
Lasers equipped with a gas generator carry these flushing routines out automatically when taken into operation.

3. Before the first operation of the laser we recommend by all means to have the switched-on laser flushed at least 30 minutes without operating it. The set gas pressure should be approx. 2500 mbar. (The pressure is displayed in the WINLAC software.)

4. Please see to it that the whole gas equipment is leak-proof.
When the laser is switched off, its inlet valve is closed; a pressure drop in the gas supply line is a certain indication of a leak. Via leaky lines, impurities get into the laser head and lead to a long-lasting energy loss and increased electrode wear. Heavy impurities cause high-voltage spark-overs in the laser head.

Lasers that have been operated with non-specified laser gas by accident should at any rate be sent to LTB for laser head cleaning.

3.6.2 Connecting the laser to the nitrogen generator

This procedure is comprehensively described in the Manual of the N_2 generator.

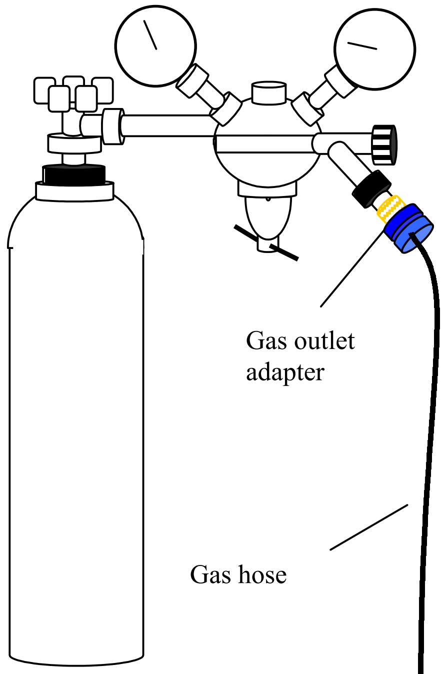
3.6.3 Connecting the laser to the nitrogen supply

1. Remove the gas outlet nipple from the pressure-reducing valve on your gas bottle.

2. Screw the gas connection adapter from the utility bag onto the pressure reducer. (Pressure reducers normally have a ¼" thread on the gas outlet)

3. Now, plug one end of the gas hose into the gas connection adapter on the pressure reducer.

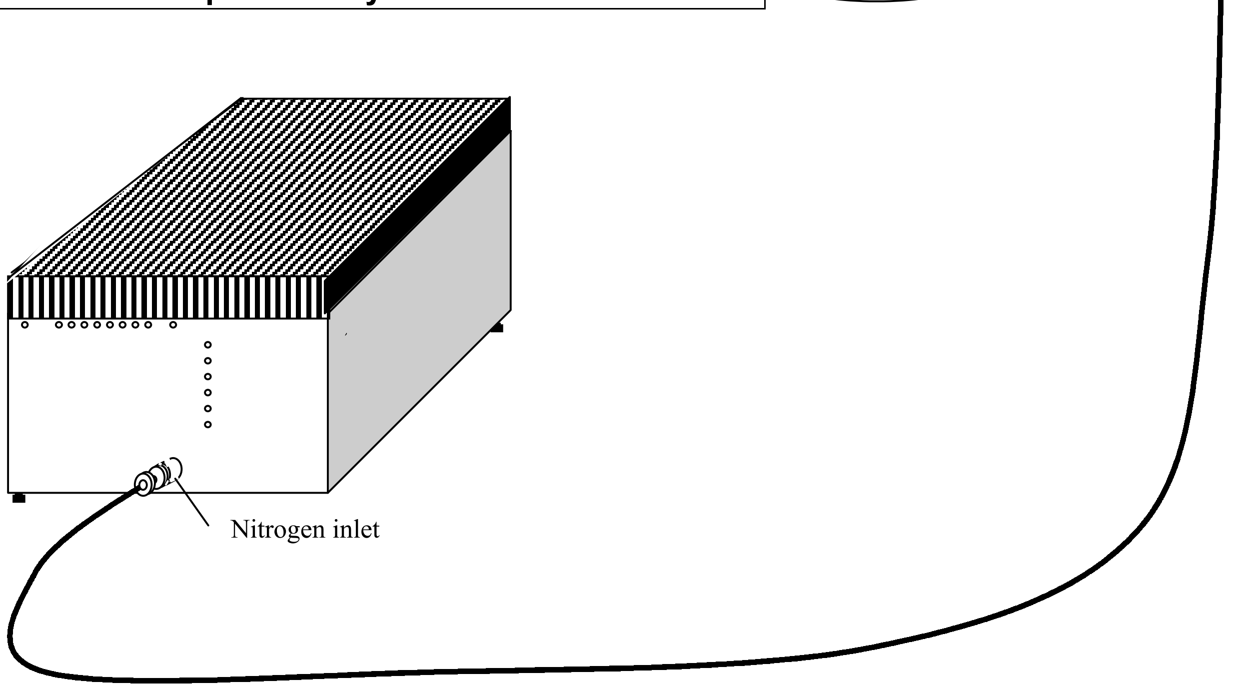
   If you want to remove the hose again, press the blue plastic ring of the adapter and pull out the simultaneously.



Before you connect the gas hose with the nitrogen inlet of your laser, please make sure that the rules for the gas hygiene acc. to point 3.7 are observed!

If there are any problems in preparing the nitrogen supply, please call our customer service.

Do not improvise any connections!



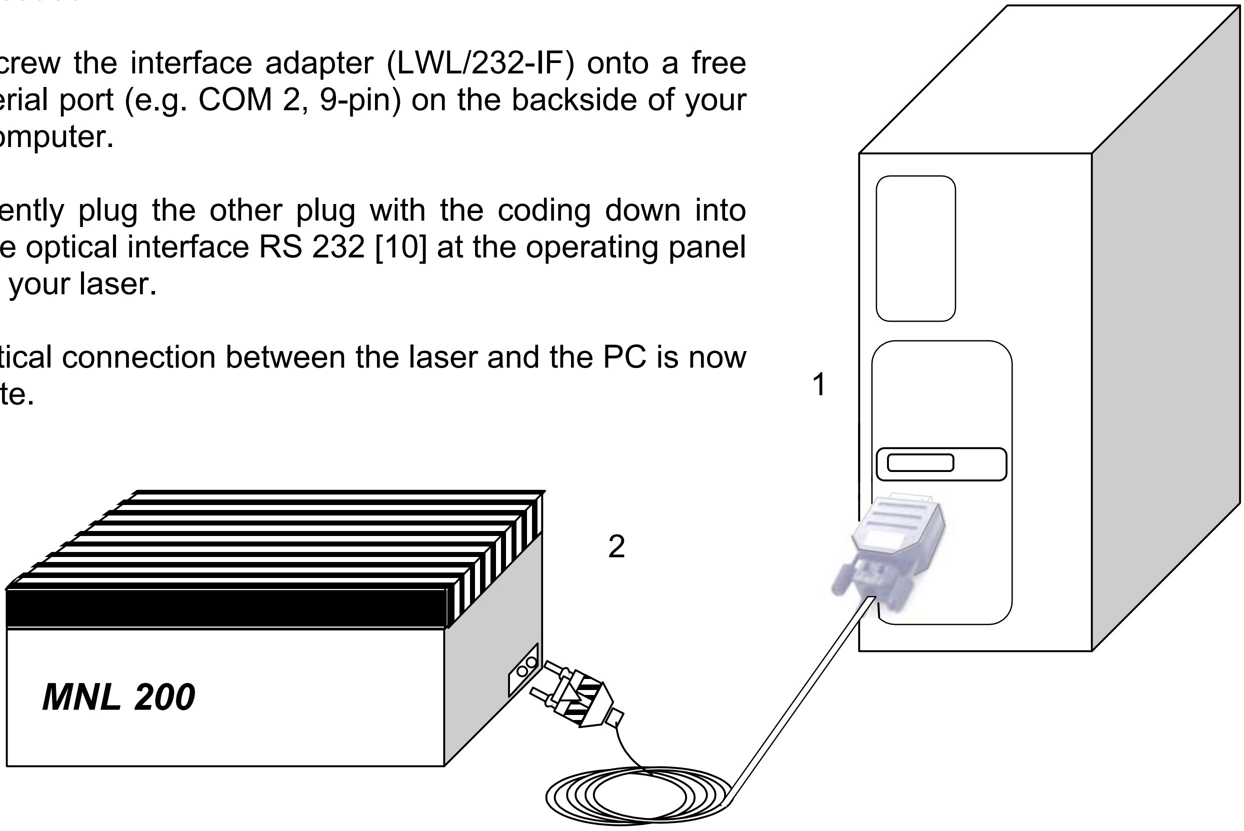
3.7 Laser - Computer - Communication

The laser now needs to be connected to your computer.
In the utility bag, you will find an electric/optical interface adapter with an OWG-Duplex cord. Please observe that the plug is coded.

1. Screw the interface adapter (LWL/232-IF) onto a free serial port (e.g. COM 2, 9-pin) on the backside of your computer.

2. Gently plug the other plug with the coding down into the optical interface RS 232 [10] at the operating panel of your laser.

The optical connection between the laser and the PC is now complete.



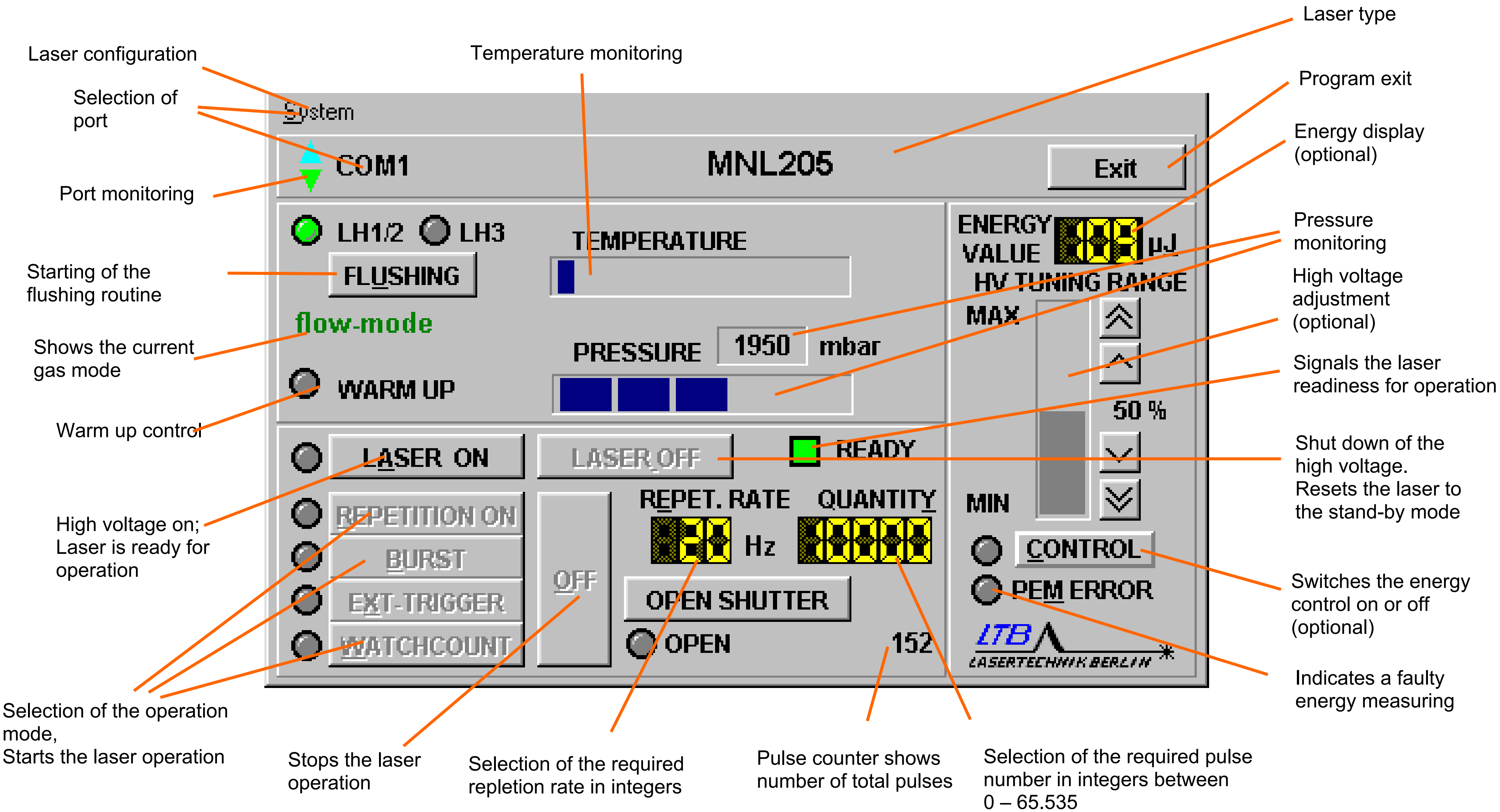
3.8 Installing the user program WINLAC

1. Put the CD with the name WINLAC in the CD-ROM drive of your computer.

2. Carry out the **install.exe**. The program will be automatically copied on the hard disk drive of your computer.

Start the program WINLAC and familiarise with the user interface.

3.9 User interface of the WINLAC program

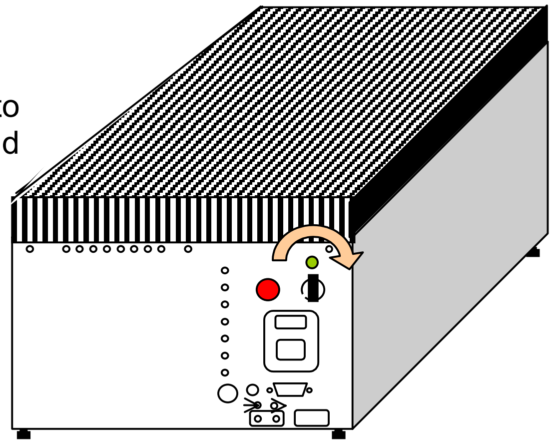


4. OPERATING THE LASER

4.1 Switching on the laser

4.1.1 Key switch

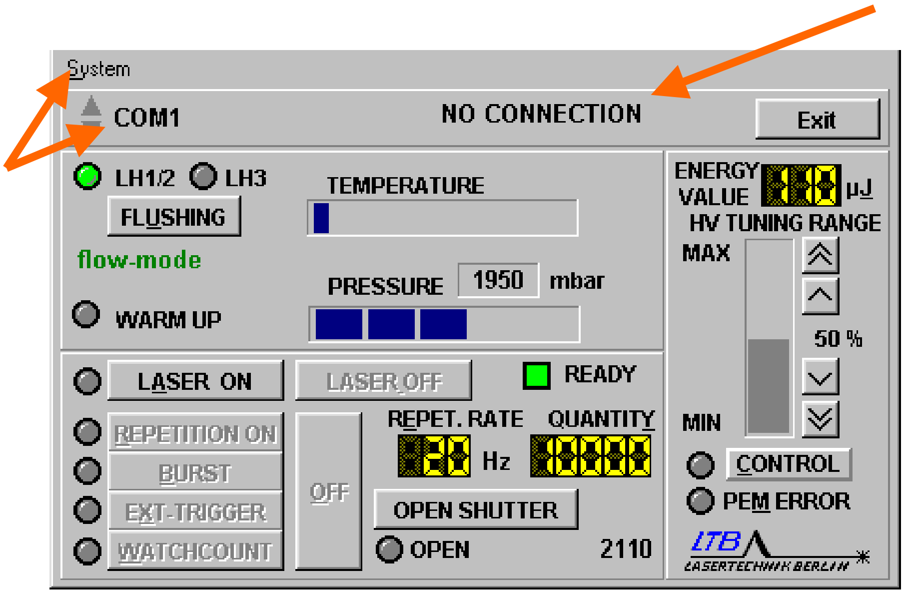
Turn the key switch on the operating panel of the laser to position I. The green diode above the key-switch should now light up.

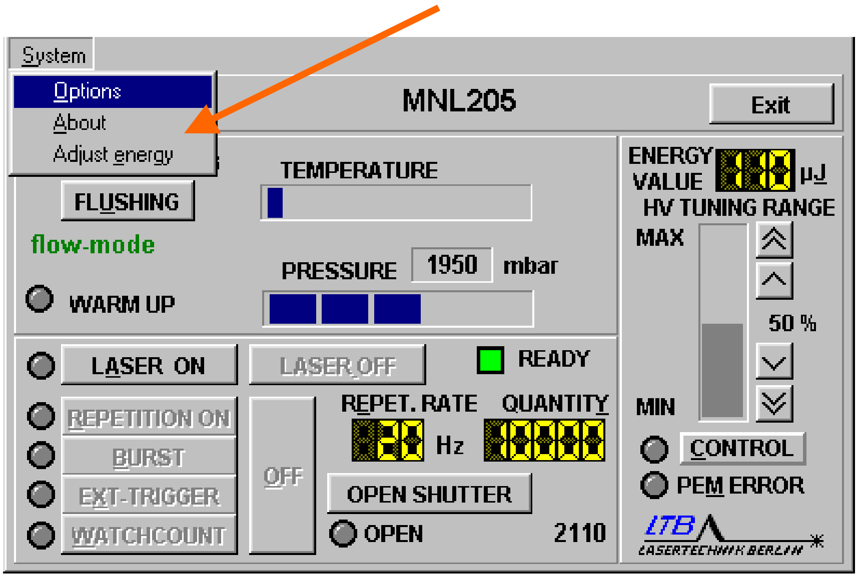


The laser switches automatically into the ONLINE mode.
The laser-computer-communication is electronically monitored. It is operating correctly if the blue and the green triangles in the left corner of the user interface flash alternately

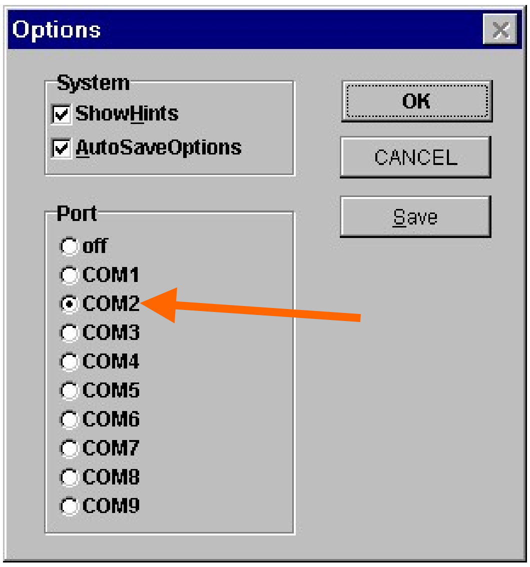
If the connection is not correct, a NO CONNECTION message will flash. Then you should change the COM port in the user interface.

Click *System* in the drop down menu and then go to *Options* or click directly on *COM*.

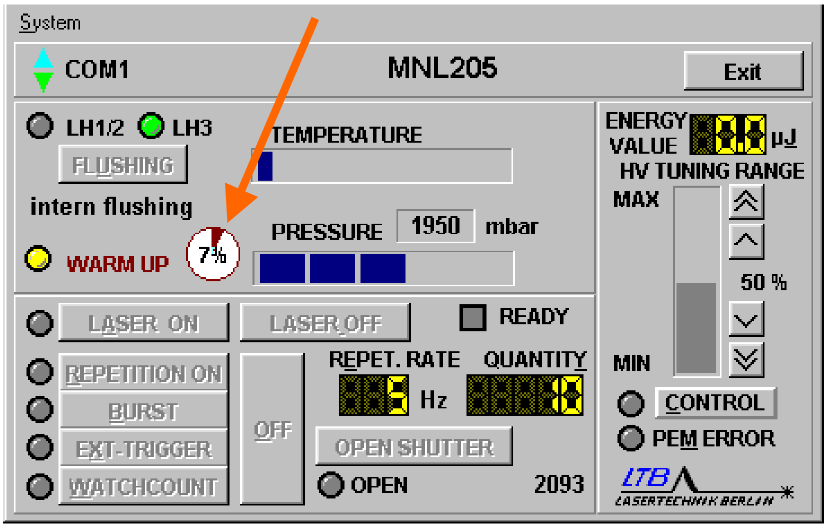




Select the appropriate port (COM 1 … 9)



After turning the key switch, the 10-minute flush-warm-up and conditioning phase of the laser begins that lasts approx. 25 minutes. This phase is displayed in per cent. The steps are displayed separately.

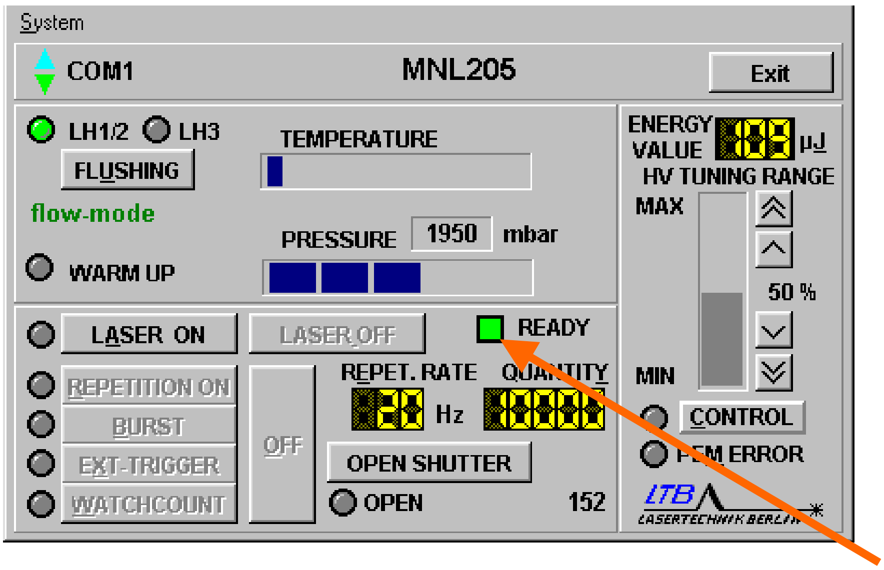


During this time you cannot operate or internally flush the laser.

The laser is ready for operation, when the box

READY

lights up in green.



4.1.2 Adjustment of nitrogen supply

When using the N_2 generator MNG 100, the pressure and the gas quantity is adjusted automatically.

When using a gas cylinder, you can adjust the nitrogen pressure with the pressure-reducer on the cylinder, and thus choose between semi-sealed or flow mode.

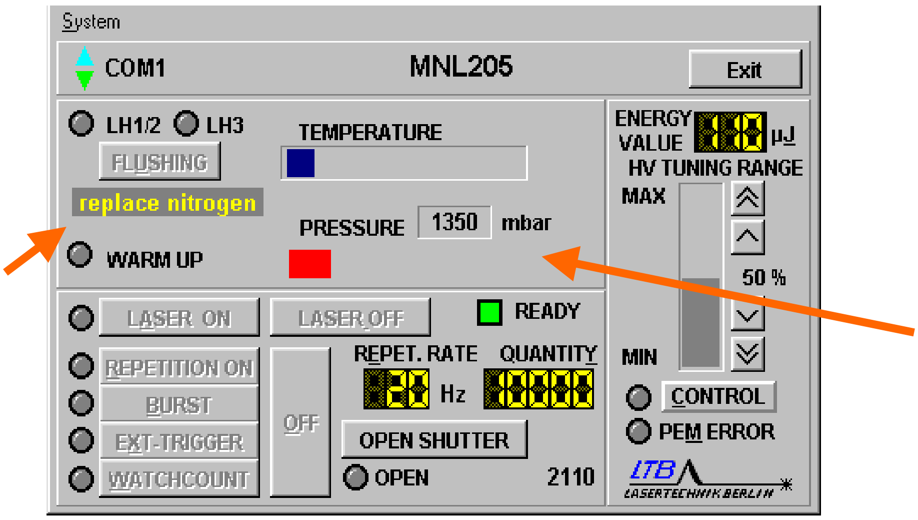
The monitoring of the adjustment is depicted on the monitor graphically and numerically.

The number of visible segments of this bar display (totalling 5) gives clues for the adjustment of the gas pressure.

1 segment	Low or no pressure: semi-sealed-mode
2 segments	Switch-over range (hysteresis) semi-sealed / flow-mode
3 segments	Economical gas consumption, flow-mode ≤ 5 l/h
4 segments	Increased gas consumption, flow-mode 10 - 20 l/h
5 segments	Overpressure: hazard to the laser; error message

The Semi-Sealed mode

At a pressure below 1400 mbar, the laser switches automatically into the semi-sealed mode.



Please observe, that the laser has to be flushed after 200,000 pulses after working in the semi-sealed mode. Otherwise, the laser will stop operating after a warning period.

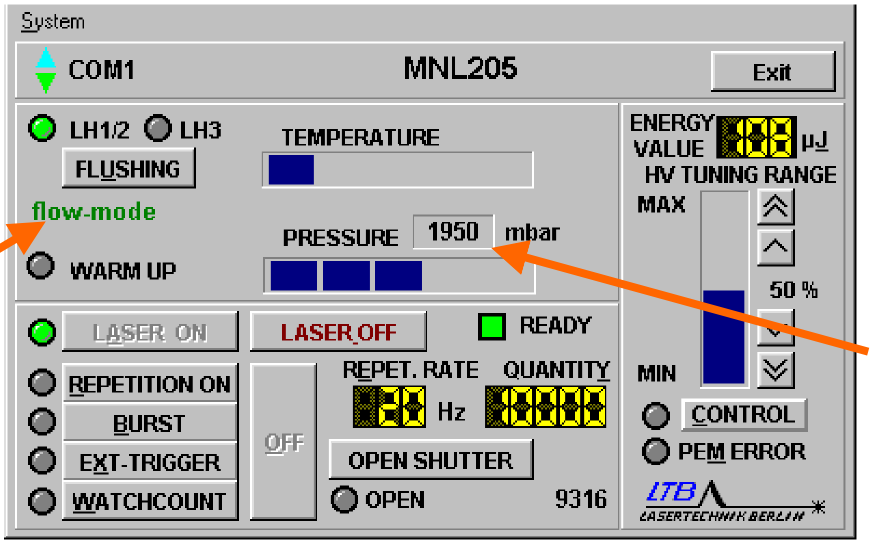
Please see section 5.3 for more specific description.

The Flow Mode

If the pressure is adjusted to above 1600 mbar, the laser automatically switches into the flow mode.

The optimum adjustment is at 2.0 bar.

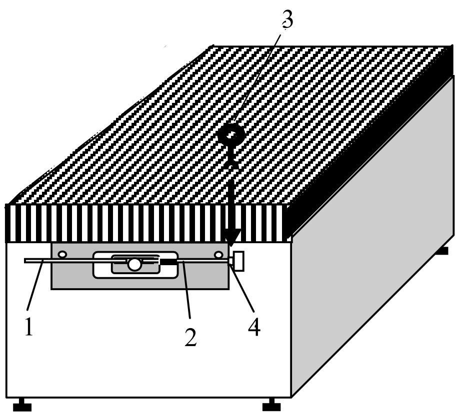
The gas consumption is ≤ 6.5 l/h.



4.1.3 Open the beam shutter

To open the beam shutter on the beam output side of the laser,

1. push the pin marked [1] to the right
2. thereby, the beam exit will open and the pin marked [2] is pushed out
3. fix the pin [2], using the key marked [3], sticking it into the groove marked [4] in pin [2].

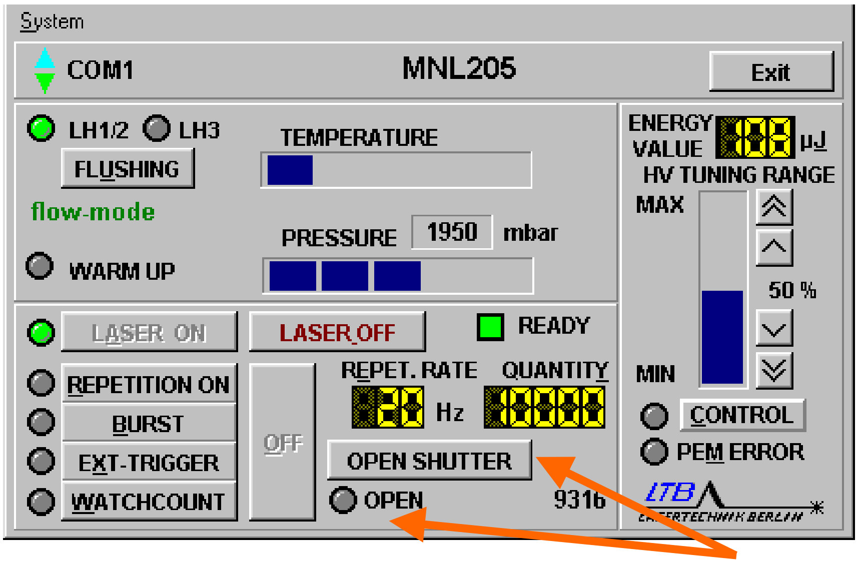


The beam path is now opened.

Please follow the safety precautions on the pages 4 - 5 in this manual before you turn on the laser.

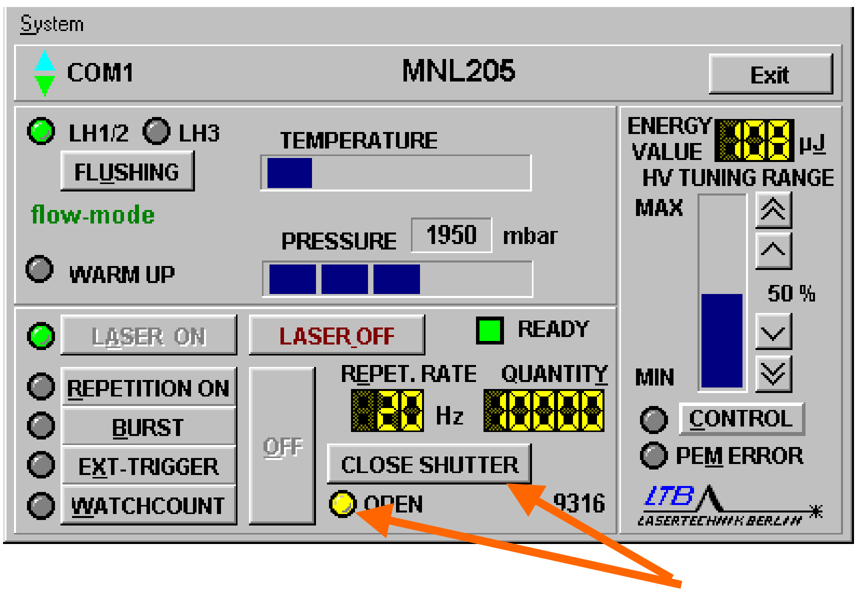
From 4 / 2002 20 Hz lasers are equipped optionally and 50 Hz lasers as standard with a motor-driven beam shutter. The beam shutter is incorporated into the energy monitor.

During an internal warm up and conditioning burst of the laser over a few thousand pulses until the laser has reached operational readiness, the control of the beam shutter is blocked



After operational readiness of the laser is indicated, the beam shutter can be opened by actuating the button “open shutter” in the software.

When the shutter is open, the button changes to “close shutter” and the display “Open” under the button gleams yellow.



If the button is actuated again, the shutter is closed.
By actuating the button "Laser off" or when the laser operation is interrupted, the shutter is closed automatically.

4.2 Operating the laser

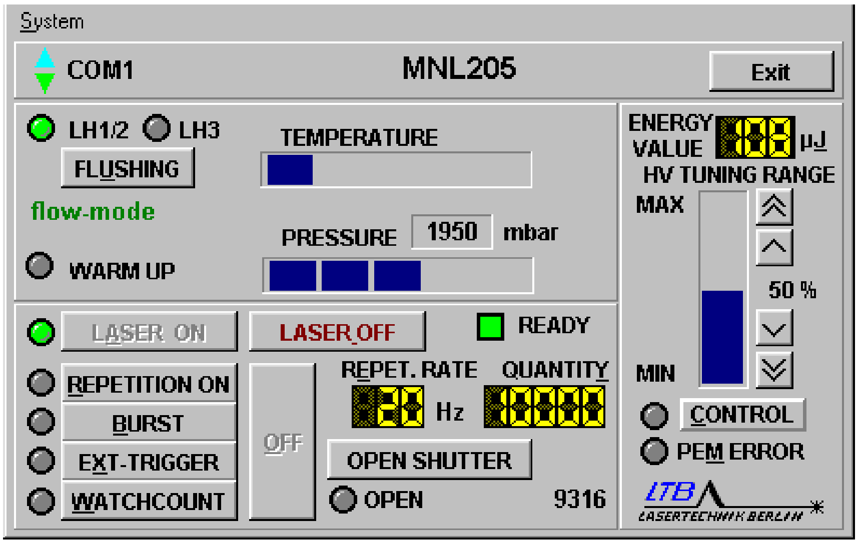
You can change all parameters via the mouse on the user interface or by using the respective underlined letters in the menu bar.

4.2.1 Switching on the operational readiness

The laser is ready for operation, after pushing the button

LASER ON

(or pressing "A" on the keyboard.



The laser emission indicator on the operating panel [6] starts flashing.

4.2.2. Set the repetition rate and the number of pulses

In the window

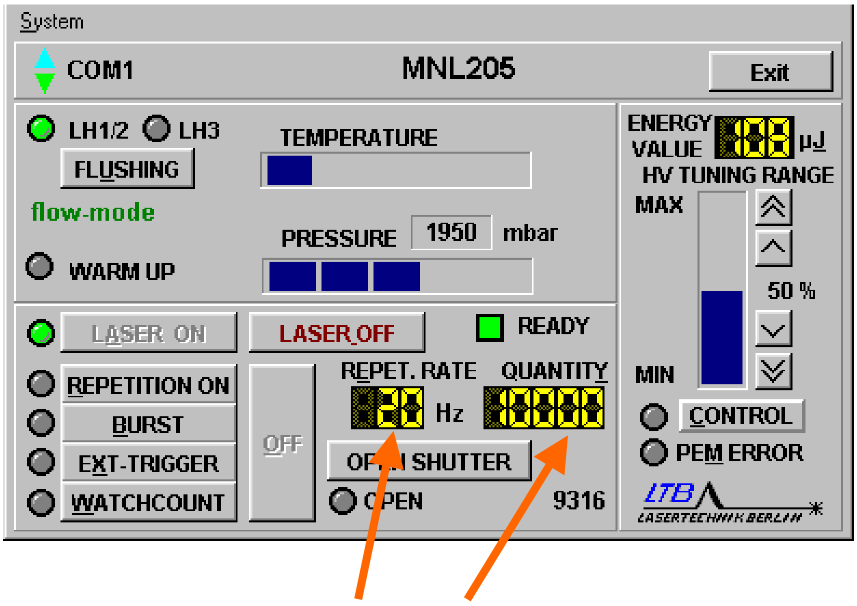
REPET. RATE

you can key in the required pulse frequency as an integer number.

In the window

QUANTITY

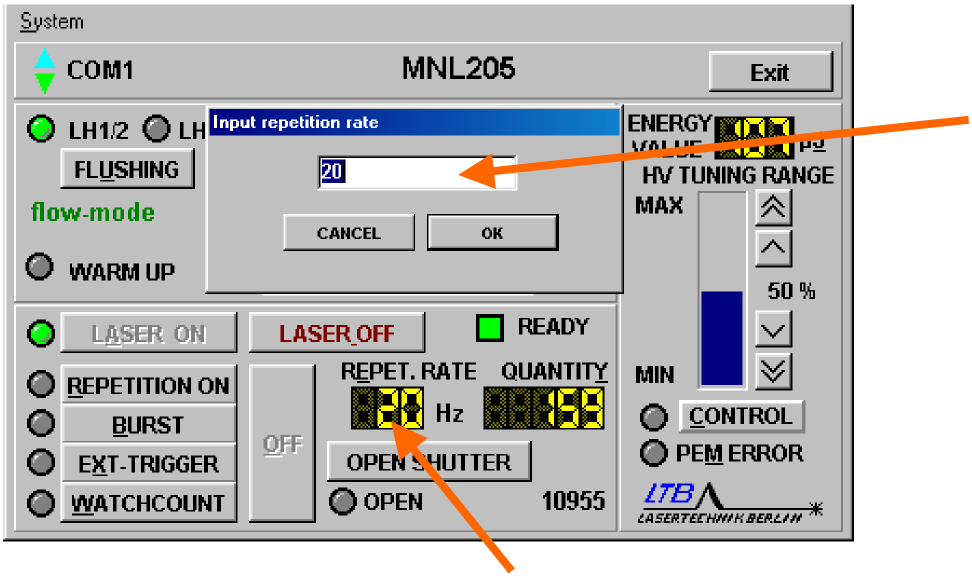
you can key in the required pulse number up to 65 535 as an integer number (refers only to *Watchcount* and *Burst* mode).



For changing the value of the repet. rate or quantity, click into the respective display:

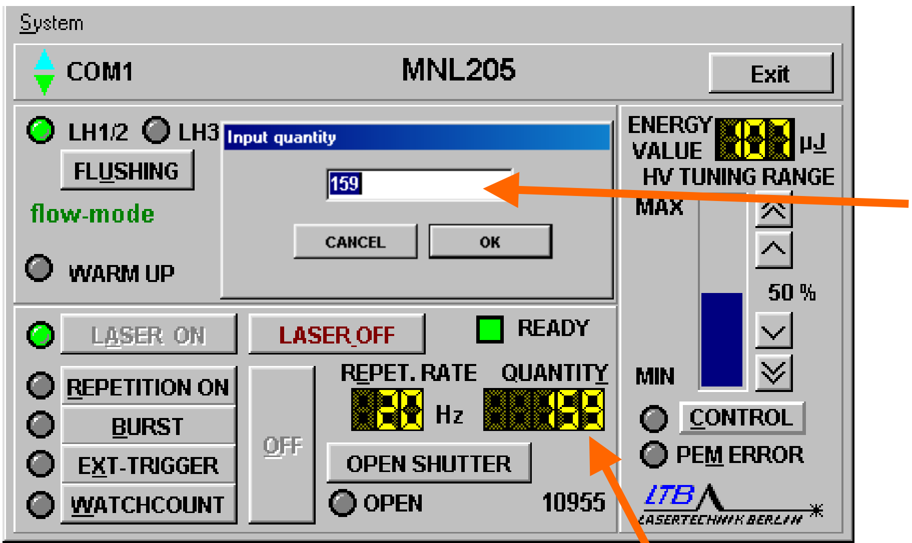
The following input window appears:

INPUT REPETITION RATE



respectively

INPUT QUANTITY



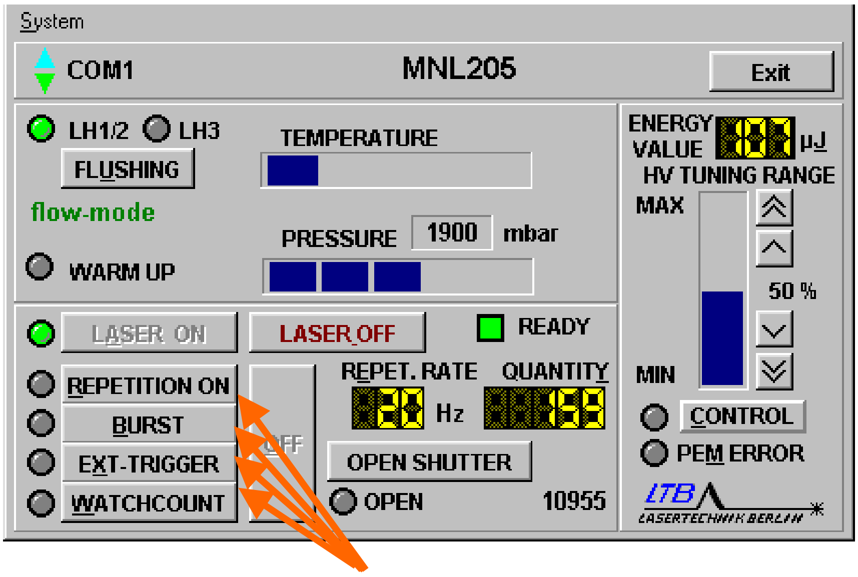
There you can key in your required values and confirm them.
You can call the input windows by entering "E" or "Y" on the keyboard.

4.2.3 Choosing your operation mode

Five seconds after you pushed the LASER ON button, the following buttons become active:

REPETITION ON
BURST
EXT-TRIGGER
WATCH COUNT

Here, you can choose the required operation mode.



After pushing one of these buttons, the high voltage is switched on and the laser starts in the selected mode.

This choice can also be made by entering the respective underlined letter ("R", "B", "X" or "W") via the keyboard.

Please note!

The external optical trigger signals are directly conducted to the trigger board of the laser.
If you use the internal operation modes "REPETITION ON" or "BURST", the external trigger source must be switched off. Or, the external trigger input must be closed optically tight to avoid malfunctions.

REPETITION ON

The laser runs continuously with a frequency of 1 – 10 / 20 / 50 Hz depending on your chosen frequency and your laser type.

BURST

Besides the frequency, you can also choose the pulse quantity in this mode. Starting with the total number, the laser counts down the pulses to zero. You can set the pulse number (Quantity) when the laser is already working.

Ext. TRIGGER

If you have an external trigger signal, you choose the *EXT TRIGGER mode*. Make sure that the signal has a maximum frequency corresponding to the maximum frequency of the laser. The trigger signal input is the No. [7] on the operating panel.

WATCHCOUNT

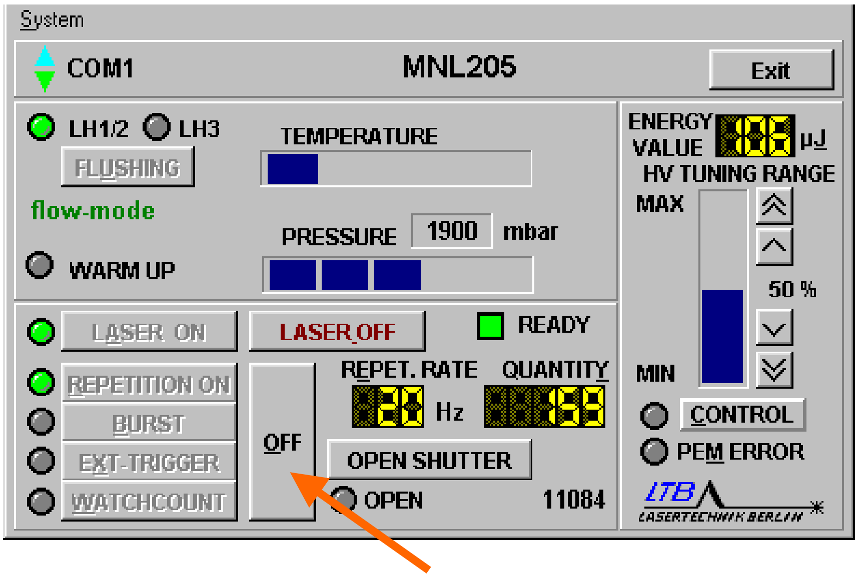
The watchcount mode can be used if you are working with an external trigger signal. The number of pulses emitted is monitored internally.
You can set the required laser pulses in the Quantity window. Starting with the total number, the laser counts down the pulses to zero and stops, although the triggering is continuing.

4.2.4 Changing the parameters

If you want to change the parameters, you can key in your new values in the quantity and repetition rate display windows at any time. The new values are flashing then in the respective window. However, in order for them to become valid, the laser must be first switched off on the control panel.

OFF

(or key "O")



It is now in the stand-by mode.

You can turn it on again by pushing one of the following buttons:

REPETITION ON
BURST
Ext. Trigger
WATCHCOUNT

The laser will now run with your new parameters immediately.

If you are working with the *EXT TRIGGER* or *WATCHCOUNT* mode, you must change the repetition rate of your external trigger signal.

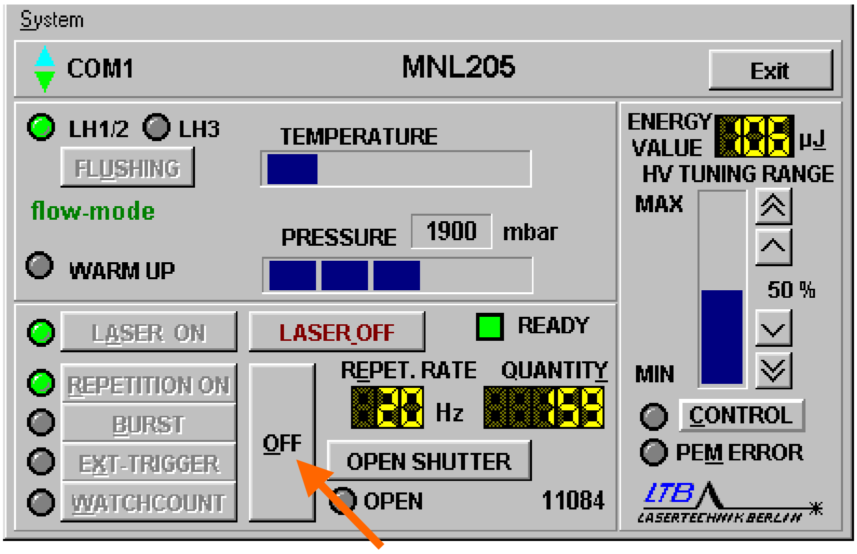
4.3 Switching off the laser

4.3.1 Stopping the laser operation

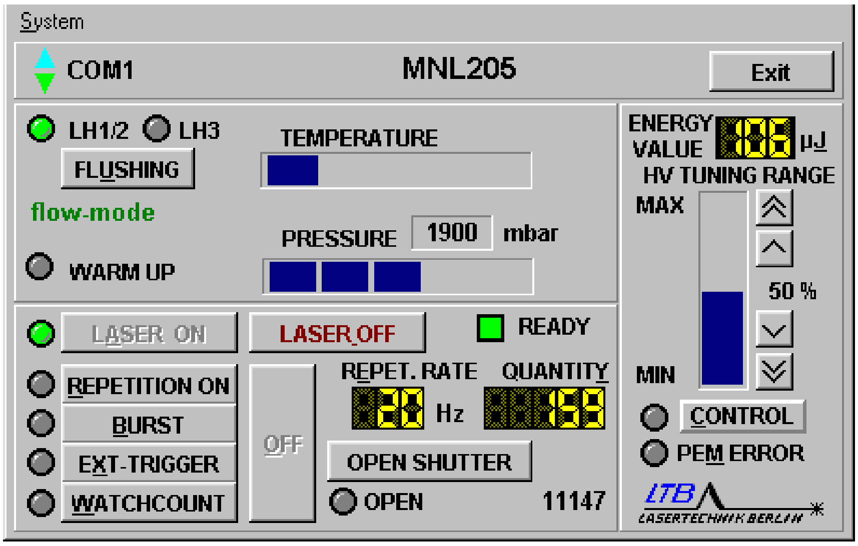
If you do not want to operate the laser for some time, you can put it in the stand-by mode by pushing the button

OFF

(or "O" on the keyboard)



From the stand-by mode, you can continue the laser operation again at any time or even change the operation mode.



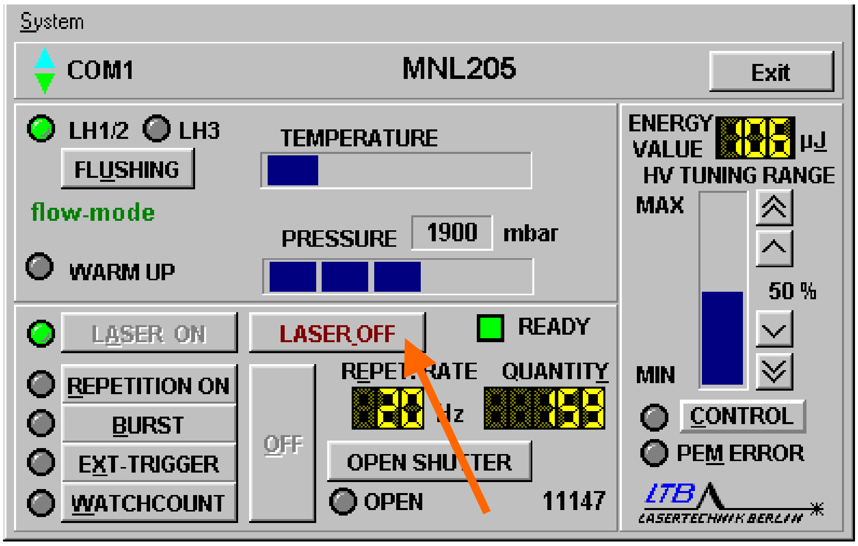
If the laser is not triggered internally or externally within the next 10 minutes, the high voltage module is automatically turned off. (This corresponds to the reaction to the "LASER OFF" command, please see following page.)

4.3.2 Turning off the laser

You turn off the laser completely when you press the following button

LASER_OFF

(or the space key).

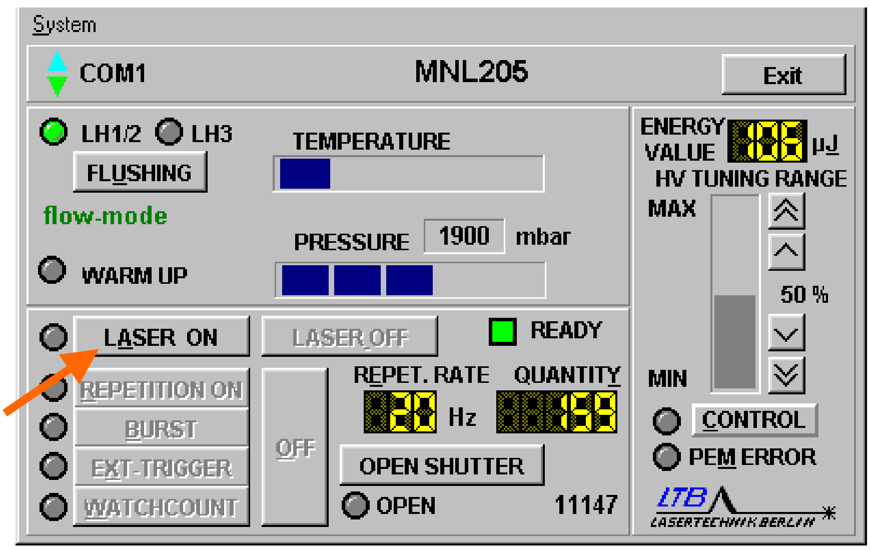


Now, the high voltage module is turned off.

If you wish to start the laser activity again, you have to press again the following button:

LASER ON

(see 4.2.1)



4.3.3 Closing the beam shutter

To close the beam path, pull the key out of the beam shutter. The beam shutter closes automatically.

4.3.4 The key switch

Turn the key switch to position 0. The gas flow is automatically shut off. For safety reasons, pull out the key.

4.3.5 The Interlock plug

Remove the interlock plug from the interlock socket.

5. LASER MONITORING / WARNINGS

The following functions are set up to monitor:

- the warranty cycle
- the temperature in the laser casing
- the nitrogen adjustments
- the output energy (option)

If, during laser operation, differences are detected in these parameters, you will be warned and eventually the laser's operation stops after a warning period.

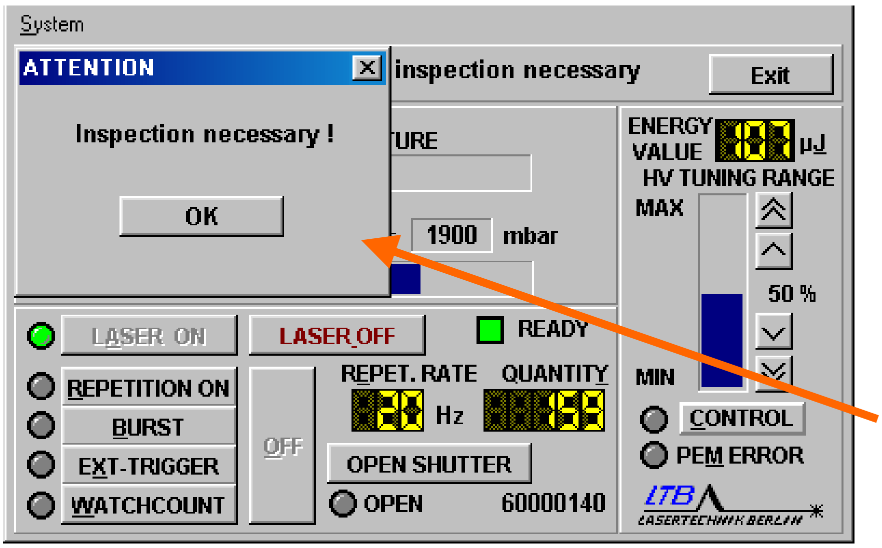
5.1 Inspection necessary

If the warning message, *Inspection necessary,* appears on the monitor, you will know that a default pulse number was passed and that the laser needs to be checked by our service.

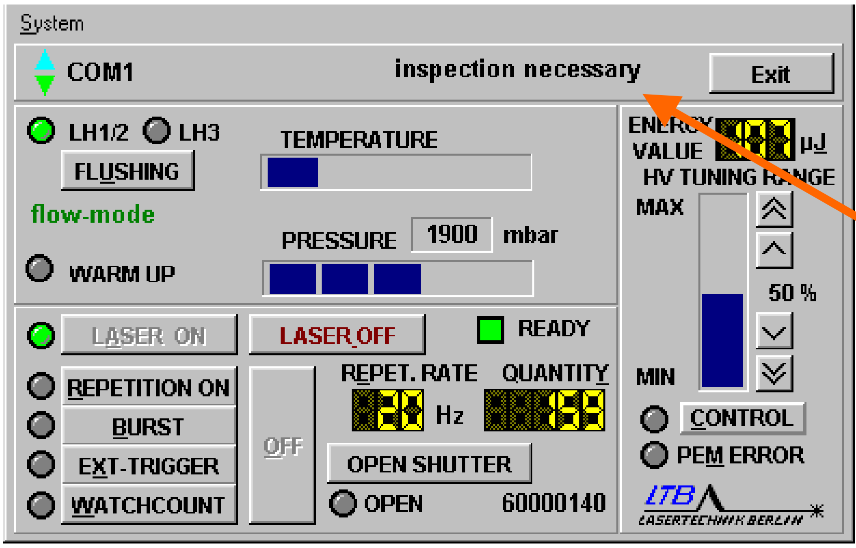
The window,

INSPECTION NECESSARY

appears once, when this number of pulses was achieved.



Afterwards, this message will continuously flash in the Laser type field:

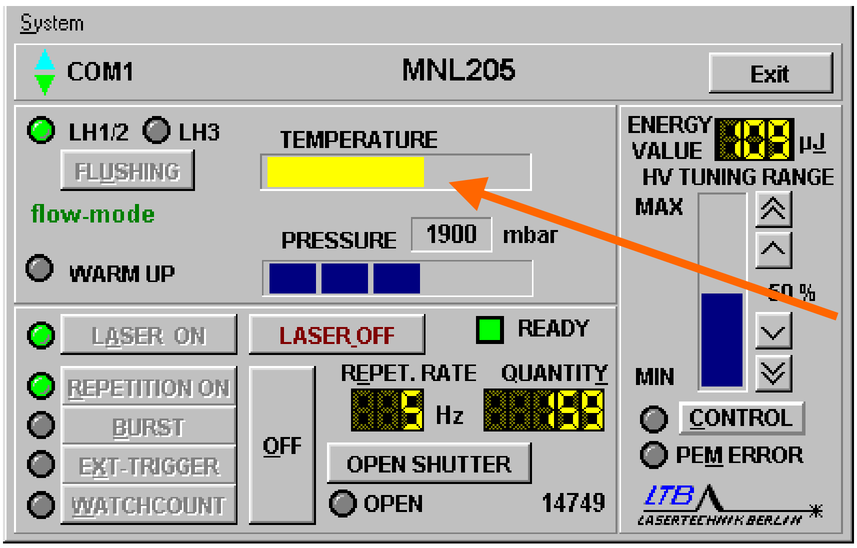


Please contact LTB to make an appointment for the inspection of the laser.

5.2 The temperature monitoring

The temperature monitoring is depicted as a bar on the software control panel. If the internal laser temperature exceeds a limit value, the colour of the bar will change to yellow. The laser will still operate, however.

The laser and the surrounding temperature need to be checked.

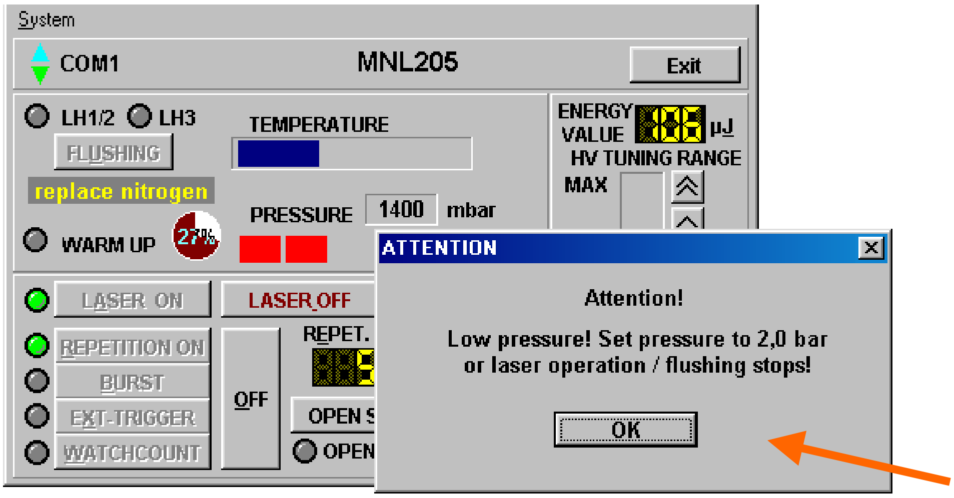


If the temperature continues to rise, the colour of the bar changes to red and the laser will stop operating.

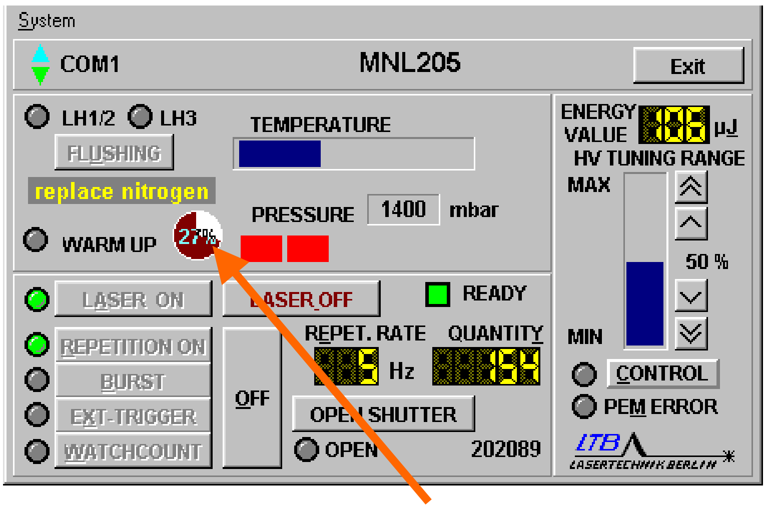
5.3 Monitoring the nitrogen flow

You can operate the laser for 1 million pulses in the ***Semi-Sealed Mode***. After 1 million pulses, the laser has to be flushed for at least 10 minutes. If you do not flush the laser, a warning will appear requesting that you flush the laser.

If the laser is not flushed after 1 million pulses, it will turn off automatically after 10 minutes.

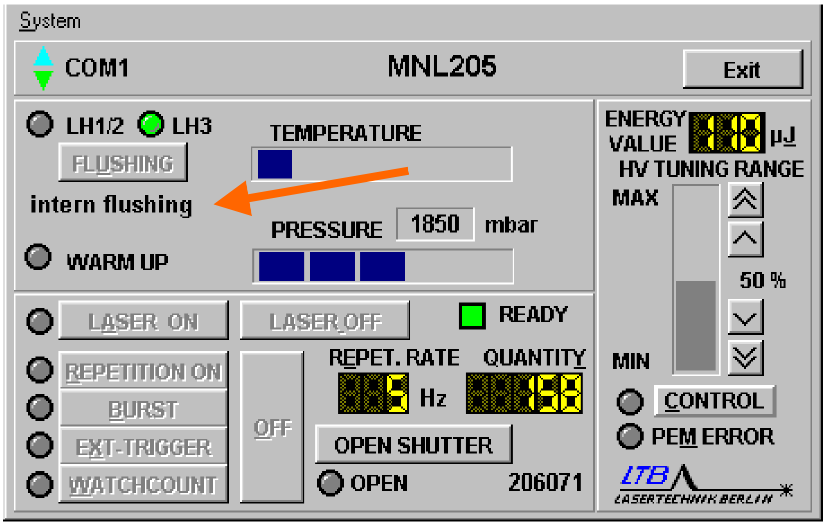


The time until the laser turns off is depicted on the monitor as a percentage.



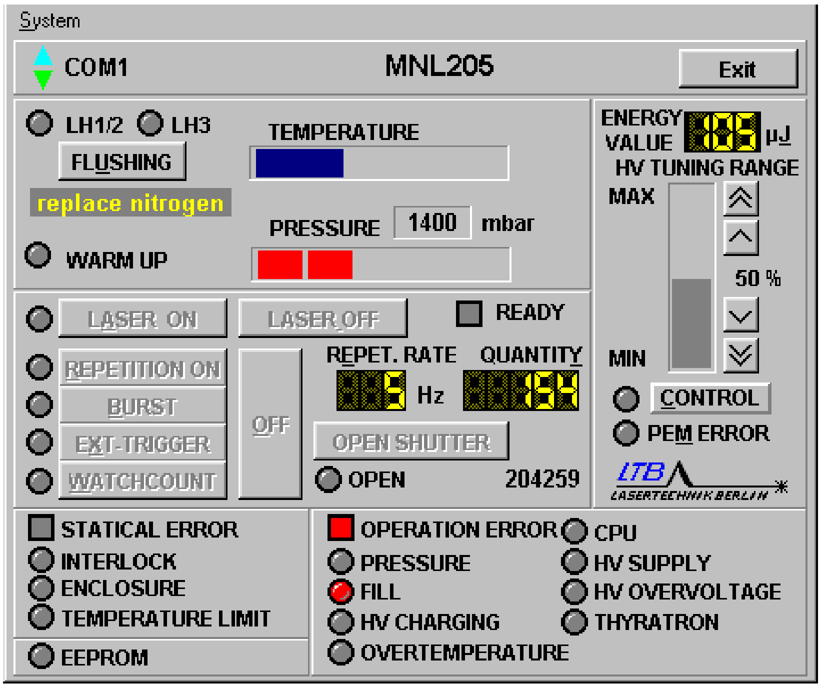
For laser flushing, you just need to increase the pressure on your pressure-reducing valve. You do not need to turn the laser off.

The laser will automatically switch into the ***flow mode*** and will be flushed with nitrogen for ten minutes. The time remaining until the flushing is completed is displayed as a percentage.



After the flushing is completed, you can either continue working in the ***flow mode*** or switch back to the ***semi-sealed mode*** by decreasing the nitrogen pressure again.

If the laser is not put in the ***flow mode***, the laser goes in the state "OPERATION ERROR" showing "FILL ERROR". The laser operation is interrupted then.

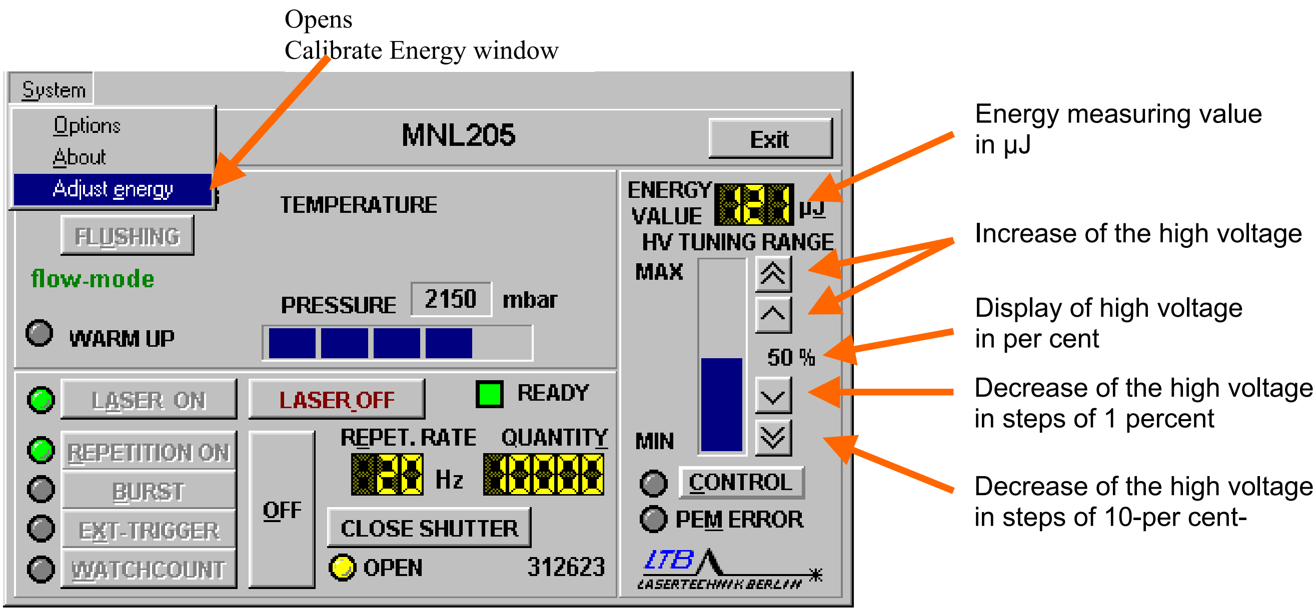


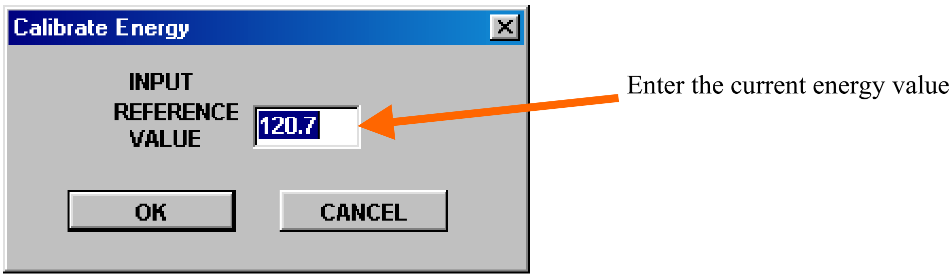
5.4 Energy measurement (optional)

Optionally, the laser can be equipped with an energy monitor. With this monitor, the energy output can be displayed and monitored on your user interface.

The data transfer is carried out via an OWG to the laser-internal controller. The information is available as an 8bit value at the laser interface.

The energy value is measured ONLINE and is depicted in the WINLAC window.





The energy monitor is adjusted in the factory, after one year the energy monitor should be checked and readjusted, if necessary. For this purpose, you need a calibrated energy measuring device for the wavelength 337.1 nm (e. g. LTB 's PEM 100). The energy monitor is disposed at the beam output in a way that the complete detector area is illuminated.

A mean value over approx. 20 pulses is determined, which is entered in the „energy adjust window“ and confirmed. The adjustment is thus completed.

Please conduct the adjustment on a warmed-up laser only, in order to avoid errors (only the last figure may change constantly).

5.5 The high voltage control (optional)

You can change the energy output by varying the high voltage within certain limits.

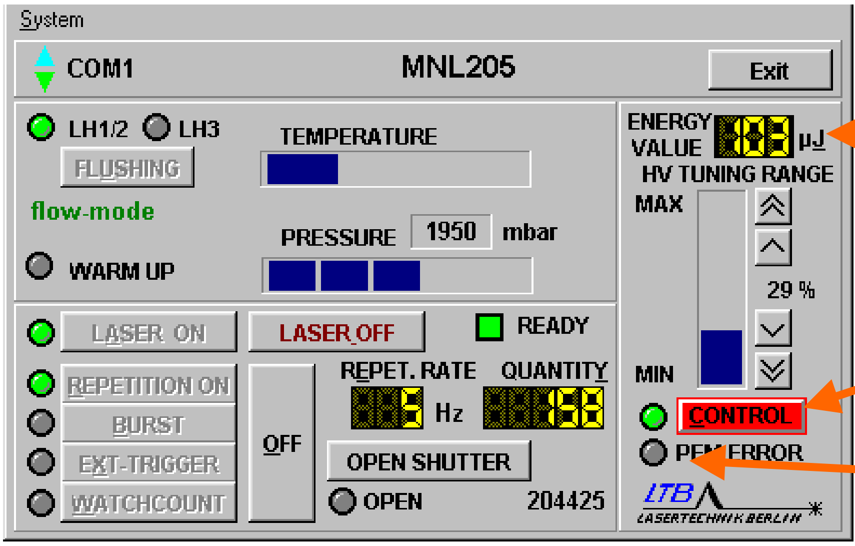
The adjustment can be carried out through both the WINLAC software panel and the interface.

In the WINLAC user menu, you can change the high voltage in steps of one or ten percent referring to the adjustment range by clicking either the up or down pointing arrows.

5.6 Energy control (optional)

The laser can be run in the ***Energy-Constant-Mode.*** The high voltage is tracked via a control circuit, thus keeping the laser output energy independent of outside influences.
The switching-on is carried out via the button

CONTROL



Energy display

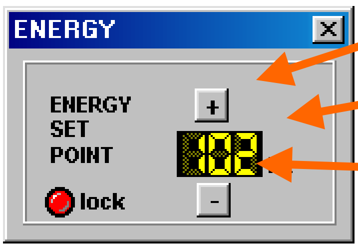
Switching-on / -off of the Energy-Constant-Mode

Display of a faulty energy measurement

The set point of the energy can be adjusted in different ways:

a) After clicking the energy display window, the energy input window opens

   The energy set point is displayed and the energy value can be incremented or decremented in 5-µJ-steps.



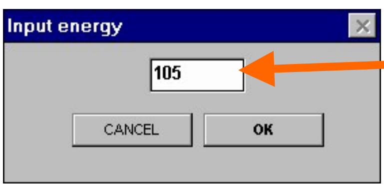
Increment set point

Display of the energy set point

Decrement set point

b) A further click on the display of the energy set point opens another input window

   Here, the set point can be entered directly via the key board



Input window for energy set point

c) If the high voltage value is changed (see 5.5) while the laser is running and the control button is active, the new value is automatically adopted as new energy set point.

5.7 Adjustment of the Spark Gap (optional)

Lasers equipped with a spark gap are subject to a higher wear. That is why the pulse number for the service interval was reduced.
When this pulse number is achieved, the message

Inspection necessary

appears.

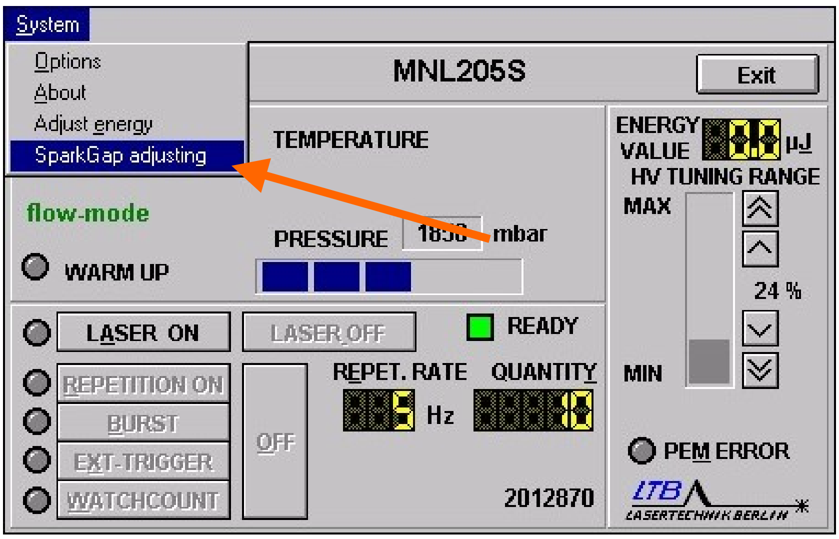
This monitoring function is described on page 32 under 5.1.

A service by LTB is necessary.

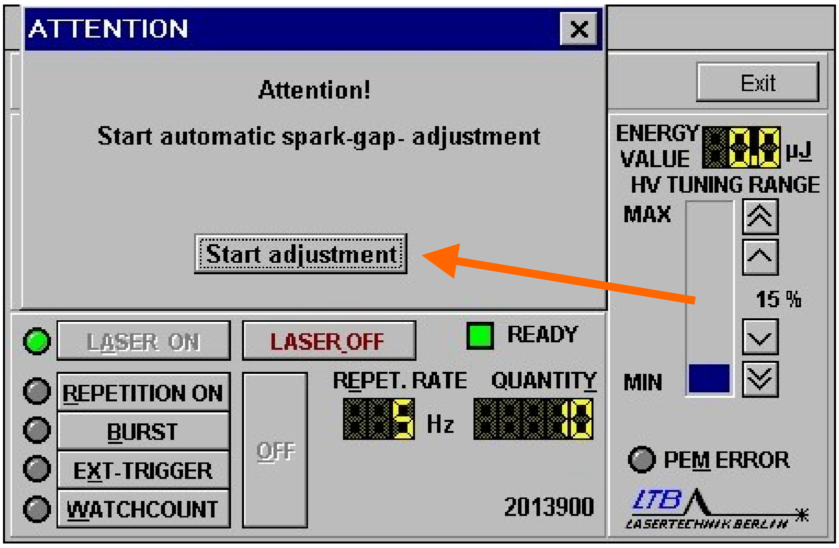
If a spark gap breakdown occurs frequently during a service interval (laser triggers itself), an adjustment of the spark gap becomes necessary.

For this purpose, you find under "System" the menu

Spark Gap adjusting



The following window opens



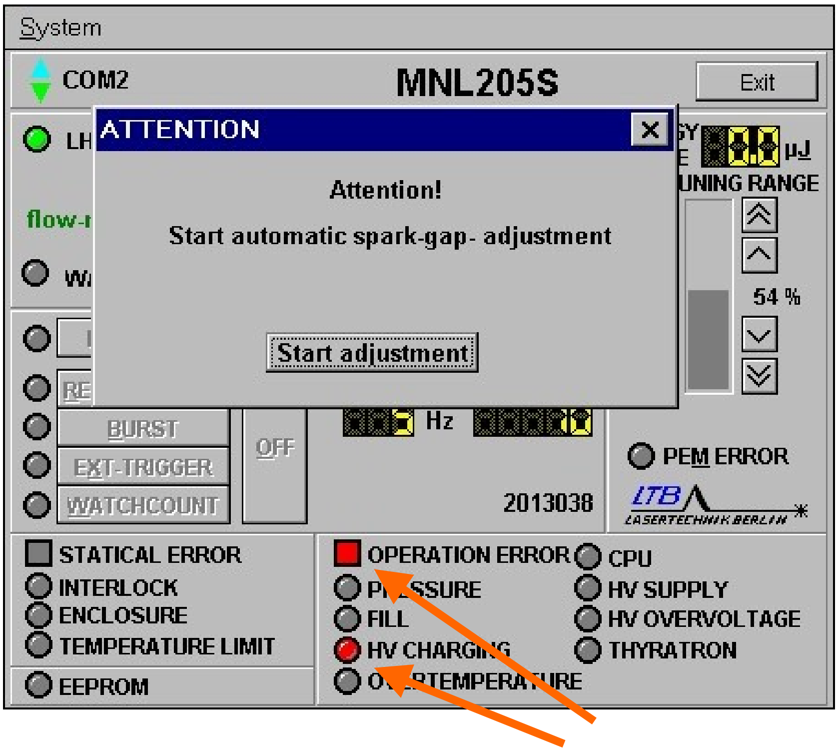
When this function is started, the laser starts operating automatically. The high voltage is incremented in 1 % steps beginning at 0. The optimum value is searched for. This value is saved and kept after the laser was switched off.

Please take appropriate measures before starting this function, in order to avoid endangering people or work equipment,
e.g. close the beam path with the beam shutter

Please observe the safety precautions under point 1, page 4 and 5.

The spark gap breakdown can also be avoided by manually decrementing the high voltage. The chosen value is saved then as well.

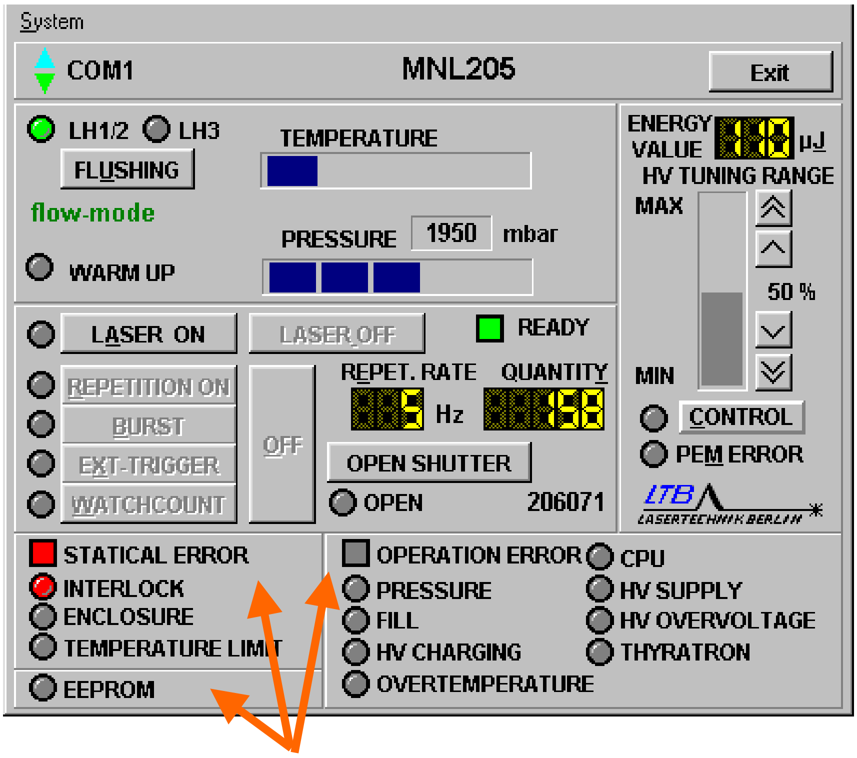
If the breakdown occurs very often, the laser can respond with "OPERATION ERROR“, "HV CHARGING“.



To reset the "OPERATION ERROR“ the laser must be switched off. After approx. 20 s the laser can be switched on again. When the "Warm UP" is completed, the adjustment can be started.

6. Error messages

In case of an error, an additional window will appear on the WINLAC user interface indicating the type and cause of the error. Errors are split into static errors, dynamic errors and the EEPROM error. Except for the latter, the laser will cease operating if any of these errors occur.



6.1 Static errors

Static errors can easily be remedied, if the cause is identified, e.g.:

- a break in the connection between the laser and computer (flashing display "No Connection" instead of the laser type display)
- the temperature is too high ("Temperature Limit")
- the laser casing is still open ("Enclosure")
- the external safety circuit is not closed ("Interlock")

The laser remains in the stand-by mode and can be switched on immediately after removing the cause of the error.

6.2 Dynamic errors (Operation errors)

Dynamic errors indicate that the tolerance level of the monitored operating limits or components has been exceeded. These include:

- the strip conductor;
- the high voltage module;
- the thyratron or spark gap switch;
- the internal laser software.

Turn off the laser by turning the key to position 0. Wait for approximately ten seconds and turn the laser on again by turning the key to position I.

After the warm-up of ten minutes, the laser should be ready for operation.

If the error message still appears on the screen, you should contact LTB and ask for further instructions.

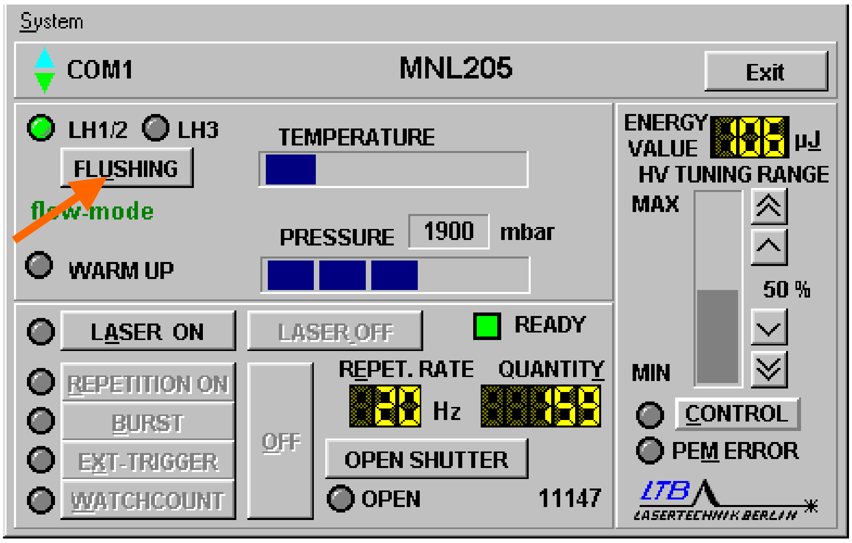
6.3 EEPROM error

An EEPROM error is displayed, if an incorrect data set was recorded even after five writing cycles.
The laser operation is not interrupted. We recommend to inform the LTB Service Dept. , in order to remove the cause of error and to avoid increased wear.

6.4 Troubleshooting

The following tables will help in troubleshooting and error elimination.

If the laser does not indicate any errors and yet no stable laser operation is achieved, a contamination of the laser operating gas might be the reason (bad gas quality, humidity, air inlet or the like).
Starting from the type series 143 a push of a bottom makes a quick gas exchange possible, an increased wear of the laser is avoided.



Static errors

Error	***Cause***	***Removal***
The POWER lamp is not on Even if the key is on position I, there is no voltage applied.	The power cord may not be properly attached or the fuses are defective. As well, the power supply may not match the laser specification voltage (i.e., 230 V vs. 115V).	Check the mains connection values and the fuses. If necessary, change the fuses: Open the cover lids of the fuse holders with a screw driver and replace the defective fuses.
Error message "NO CONNECTION“	The connection between the laser and the computer is not complete.	Check, if the plugs in both the laser and the PC are properly inserted. Check, if the interfaces are supplied with power. Check, if the COM occupancy is correct.
Error message "INTERLOCK“	The safety circuit is interrupted.	Check, if the interlock plug is in the socket or if the safety circuit is open.
Error message "TEMPERATURE LIMIT“	The temperature in the laser is too high	Ensure, that the laser is sufficiently ventilated or that other objects around the laser do not block the vents. Decrease the surrounding temperature to below 35°C
Error message "ENCLOSURE"	The laser casing is open	Check, if the laser casing is closed and if the screws are properly screwed in. Replace or tighten screws as necessary.
If you cannot clear an error, please contact LTB and ask for further instructions.		

Dynamic errors

a) influenceable by the user

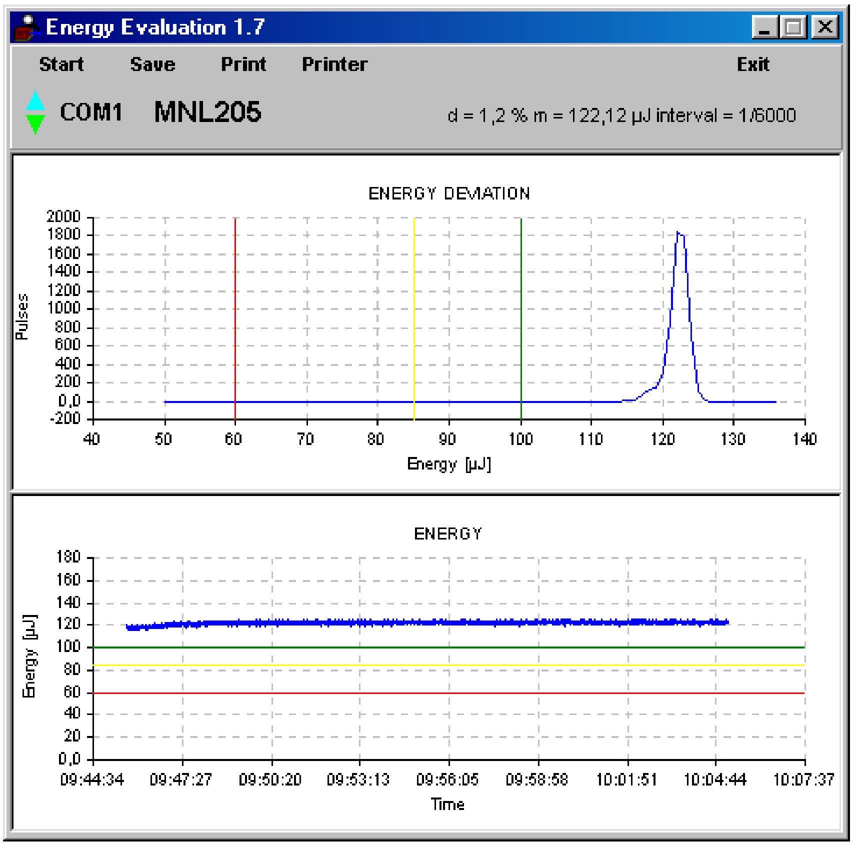
Error	***Cause***	***Removal***
error message: "Pressure“	Gas pressure improperly high	Reduce the nitrogen pressure on the pressure reducer so far that only 3 of the 5 segments of the pressure bar display flash. Afterwards a restart of the laser is necessary. (Deleting of the error message)
error message: "Fill“	The request for flushing the laser was ignored more than 10 min. (see chapter 5.3)	Increase the nitrogen pressure on the pressure reducer (until 4 or at least 3 segments of the pressure bar display flash). Afterwards a restart of the laser is necessary. (Deleting of the error message)
error message: "Overtemperature“	Overheating of the laser. The error occurs when the temperature exceeds the limit value. Prior warning by changing of the bar colour to yellow	Remove the heat accumulation by sufficient ventilation. Decrease the surrounding temperature to below 35°C Check if the fans function properly. After a cooling interval a restart of the laser is necessary. (Deleting of the error message)

b) Hardware errors

<table>
<tr><th>Error</th><th>Cause</th><th></th></tr>
<tr><td>Error message
"HV CHARGING“</td><td>The charging time for the high voltage charge is exceeded.

-The thyratron is defective.
-The strip conductor is defective
-The charging filter is defective.</td><td rowspan="5"></td></tr>
<tr><td>Error message
"HV Overvoltage"</td><td>The high voltage module is defective.</td></tr>
<tr><td>Error message
"CPU“</td><td>Error in the internal laser software (firmware)</td></tr>
<tr><td>Error message
"HV SUPPLY“</td><td>The high voltage module is defective.
The thyratron is defective.</td></tr>
<tr><td>Error message
"THYRATRON“</td><td>The heating or reservoir voltage of the thyratron is beyond the tolerance range or there is none.</td></tr>
<tr><td colspan="3">With dynamic errors occurring repeatedly, please always contact LTB and ask for further instruction.</td></tr>
</table>

7. Energy Evaluation Tool



7.1 Functional description

By using the DLL interface of the laser MNL 200, the energy evaluation program "**energy evaluation 1.x**" allows the the laser light parameters to be monitored without additional appliances and parallel to the controlling software WINLAC from version 7.02-b.

The laser energy in µJ and the energy distribution within a burst that is determined by the program are evaluated. The pulse-to-pulse stability is evaluated and possible side maxima are represented.

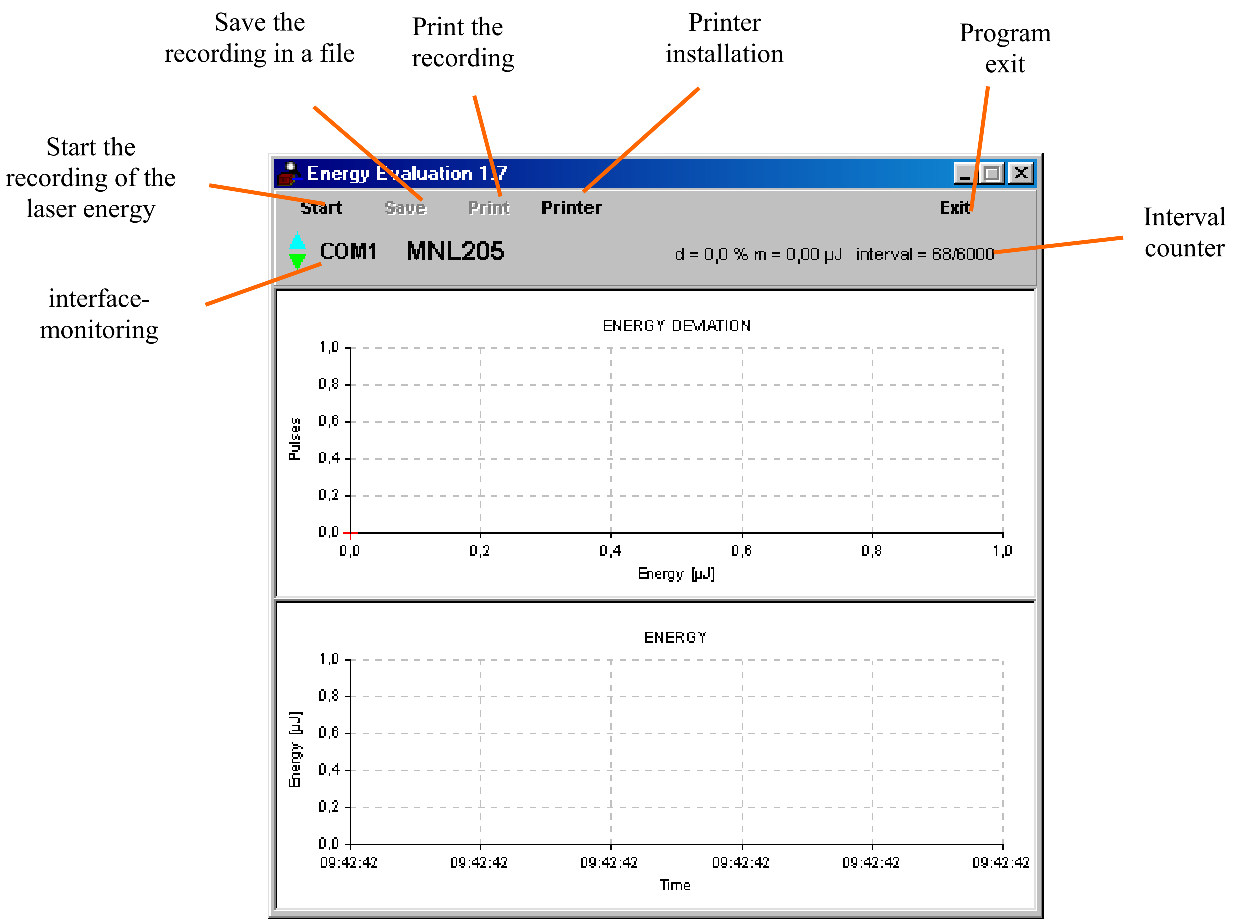
The laser does not need to be dismantled from the device system or measuring set-up.

To ensure that you receive comparable measuring results, defaults are determined that must not be changed.

The monitoring should only be conducted, when the laser has already run for some time (approx. 20 min operation time after warm up time). If the laser shows an energy stability worse than 6 %, the monitoring should be repeated after a laser flushing.
(Device manual page 15, user interface)

Within an “evaluation run“ the laser runs 35,000 to 45,000 pulses at 50 % HV and 50 Hz Rep. Rate. The burst is slightly dependent on the pull rate of the PC; 6000 pulses statistically distributed are considered for evaluation from this burst.

Please find the user interface of this program as follows.



The program is included in the laser software package Winlac 7.02-b.
After proper installation and program start, the laser monitoring can be started by clicking on „Start“:

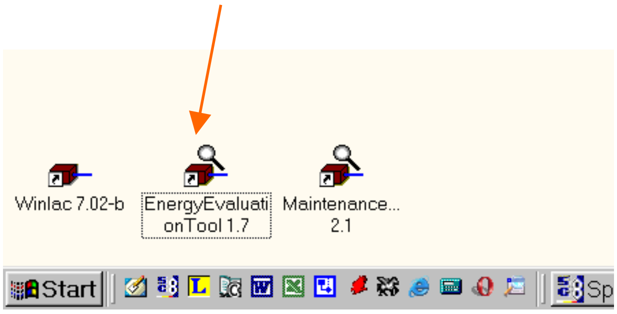
- The laser is automatically started with the program settings, the beam exit remains closed (no danger).

- The result is represented and can be directly compared with the plot of a properly functioning laser.

- The results can be saved as pdf file, electronically sent to LTB or printed. Besides the measuring values, the serial number of the laser and the date is stored in the documentation.

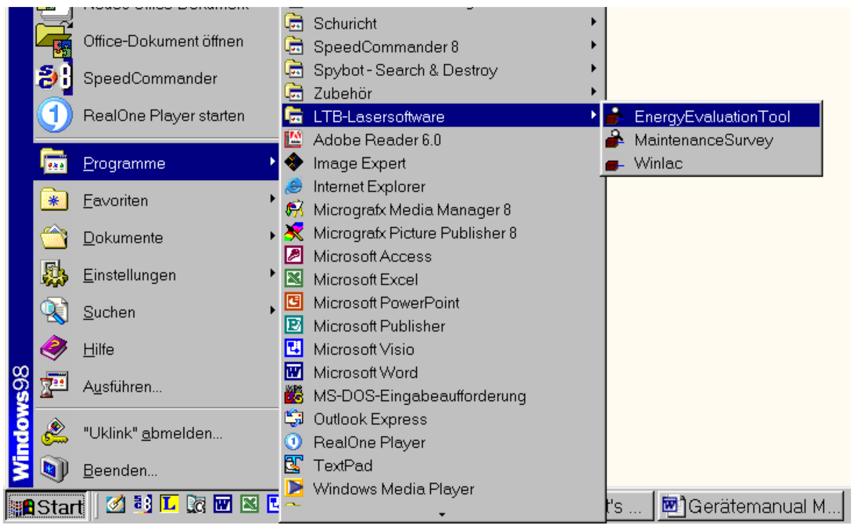
7.2 Starting the program

Das Energy Evaluation Tool is started by double clicking the program icon on the Windows desktop.



or

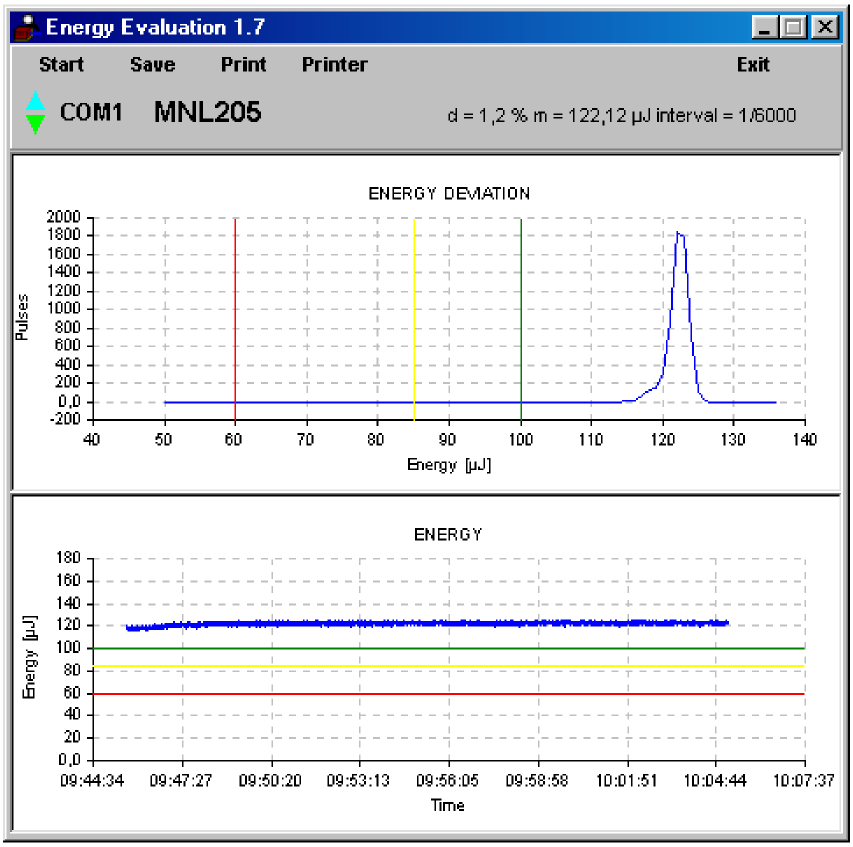
via “Start”, “Programs”, “LTB- Lasersoftware”, “EnergyEvaluationTool”.



7.3 Starting the energy recording

By clicking the “Start“ button in the Energy Evaluation Window, the recording of the laser energy is started over 6000 intervals.
Clicking the “Start“ button again restarts the laser.

The upper diagram “Energy Deviation“ will not be displayed before the end of the measurement.
The recording of the energy over the time in the lower diagram is displayed on-line.



Three cursors exist in each diagram. They conduce to evaluate the gradient:

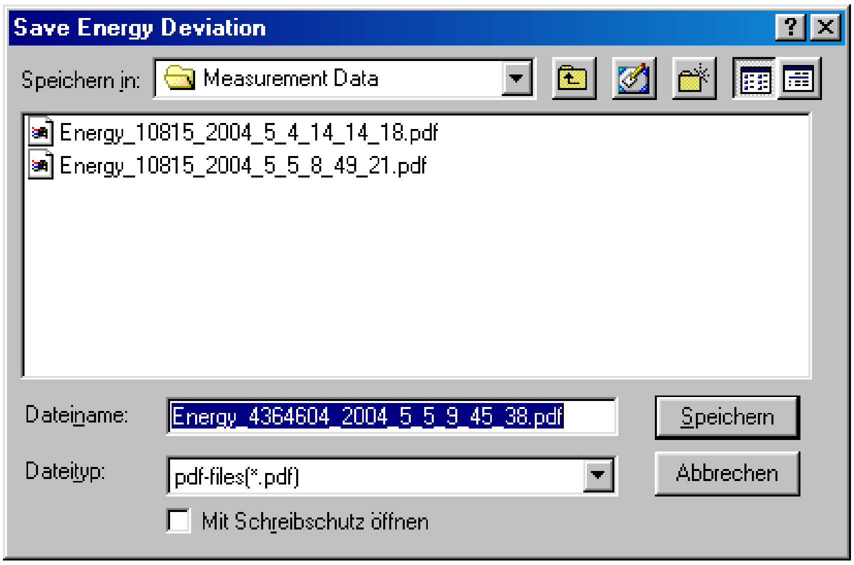
green — Is the gradient above this line, the laser is alright.

yellow — Is the gradient between the yellow and the green line, a minor fault is existing.
An internal flushing should be carried out and the monitoring should be repeated.

red — Is the gradient below the red line, a major problem exists.
The laser should be presented to the service.

7.5 Saving the recording in a file

Clicking the “Save“ button saves the recording as pdf file.



The file name consists of:

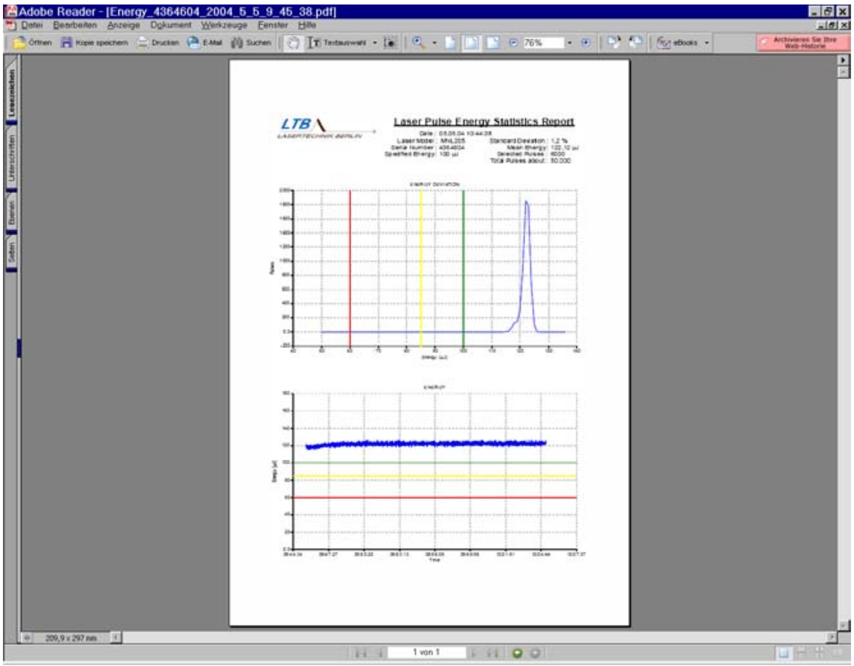
„Energy“_
S/N of the laser_
Year_
Month_
Day_
Hours_
Minutes_
Seconds
.pdf

The default for the saving location of the file is the directory

C:\Winlac 7.02_b\Measurement Data\ .

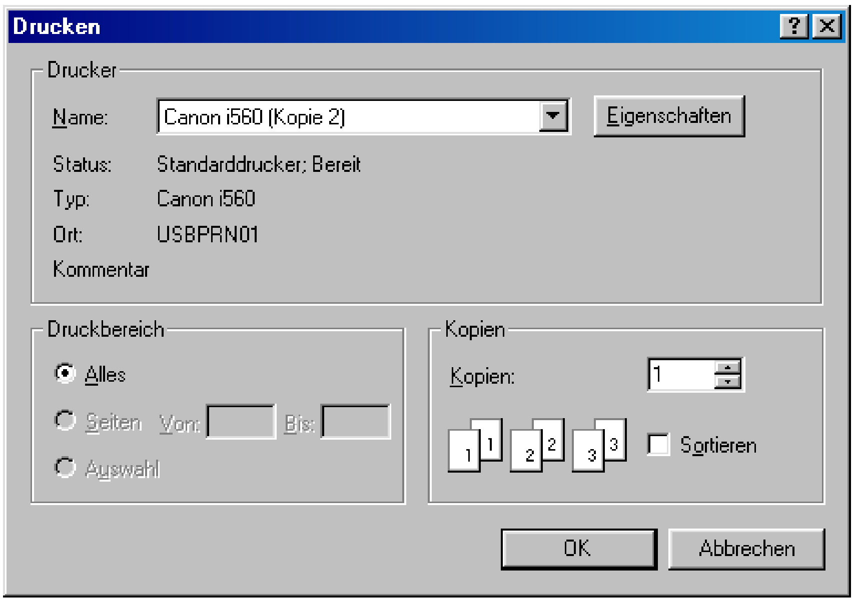
The directory is created during the installation of the laser controlling software.

The saved file can be viewed again with the Adobe Reader (Viewer).



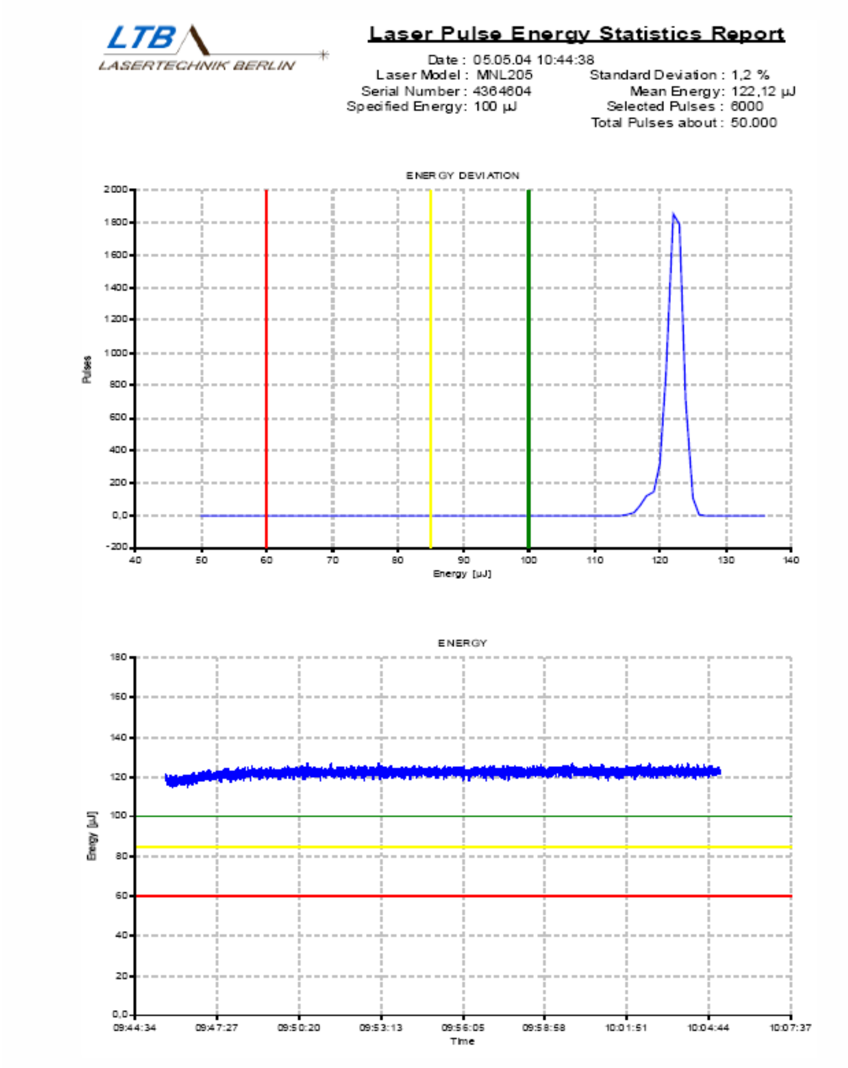
7.5 Printing the recording

After clicking the “Print“ button, a window opens for printing the recorded energy gradient.



Clicking “OK“ starts the print process.

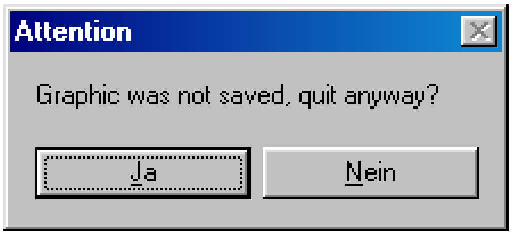
Printed energy gradient:



7.6 Quitting the program

The program is left with a click on the Exit button.

Is a complete, but not yet saved recording existing, you are asked to save it.



Is no or no complete recording existing, the program module is left directly. The Energy Evaluation window is closed.

Important!

If the “Exit“ button is clicked during laser operation, the laser operation is not interrupted necessarily.

The laser may continue running for another 30 seconds.

8. APPENDIX

8.1 The options

With the MNL, you can order additional devices:

- a TWE Trigger Converter for optical external triggering, if you have an electric trigger source only. The TWE additionally contains a fast opto-electric converter, by means of which an electric trigger impulse can be generated from the pre-trigger signal of the laser.
- an optical trigger Module (TM) that allows to derive a time-accurate trigger signal from pulsed laser radiation. A small portion of the intensity of the laser beam is converted by a fast photodiode with a subsequent impedance converter into a trigger signal.
- an Interlock Relay for switching a warning device
- a Mini Gas Generator

8.2 Warranty

The MNL lasers come with a warranty of one year from the date of invoice or $5x10^7$ pulses for thyratron lasers or 5×10^6 pulses for spark gap lasers, whichever comes first.

The warranty includes all parts and labour to repair or replace defects in materials or workmanship.

For spare parts and optics, the warranty is 3 months / 90 days.

Consumables and maintenance items are excluded.

8.3 Regular inspection and maintenance

A check-up inspection by LTB is necessary after $6x10^7$ pulses. A reminder will appear on the software menu.

8.4 Technical parameters

Parameter	Unit	MNL 200	MNL 800
Wavelength	nm	337.1	
Spectral bandwidth	nm	0.1	
Energy	µJ	≥100	≥400
Pulse duration	ps	700	800
Mains supply	V	115/230	
	Hz	50/60	
Power consumption (at 10Hz)	VA	200	300
Gas requirements	l/h	5-7	
Dimensions (width x depth x height)	mm	450x250x168	538x338x168
Weight	kg	22	30
Adjustable beam height	mm	125+20	

8.5 Service

The number of generated pulses is registered and displayed. The software will indicate when a check-up is necessary.

Check-up table

Date	Activities	Signature