Operating Manual

Nitrogen Laser MNL100

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Dear customers

With the purchase of a laser from the MNL 100 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 100.

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

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

The MNL is mainly used in

- MALDI-TOF-Mass spectroscopy
- Laser-induced fluorescence spectroscopy
- Time-resolved spectroscopy
- laser-induced plasma spectroscopy
- Laser ablation
- Micro-structuring
- Cell dissection under the microscope
- Laser acoustics
- Calibration of fast sensors
- Pump source of dye lasers
- Amplification of ultra-short laser pulses
- Technological processes like laser-induced bonding, hardening and cleaning
- Special applications in the environment and biotechnology

The laser operates on the principle of transversal excitation. The energy is stored in a capacitor arrangement at about 12 kV. A fast high-current discharge will be triggered by means of a solid-state high-voltage switch thus generating laser radiation. All laser functions are controlled and monitored by an internal laser controller.

Your laser has been carefully tested for all operating states with LTB's end test program and left the firm in a good condition.

LTB wishes you much success in working with the laser on your projects. If this operation manual does not answer all your questions, please do not hesitate to contact us.

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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 radiation

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 non-inflammable materials in your set-up.

Always follow the safety regulations.

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 laser. Therefore, observe the protected earth connection of the mains. The earth conductor connection from the laser housing to the input of the LTB power supply of the laser is ensured.

Do not open the laser due to occurring dangerous high voltages in the interior of 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. No noxious gases are used in the laser. The cartridge has a pressure-safe sealing.

Please observe that the laser operating room is sufficiently ventilated.

1.4 Liability, Replacement parts

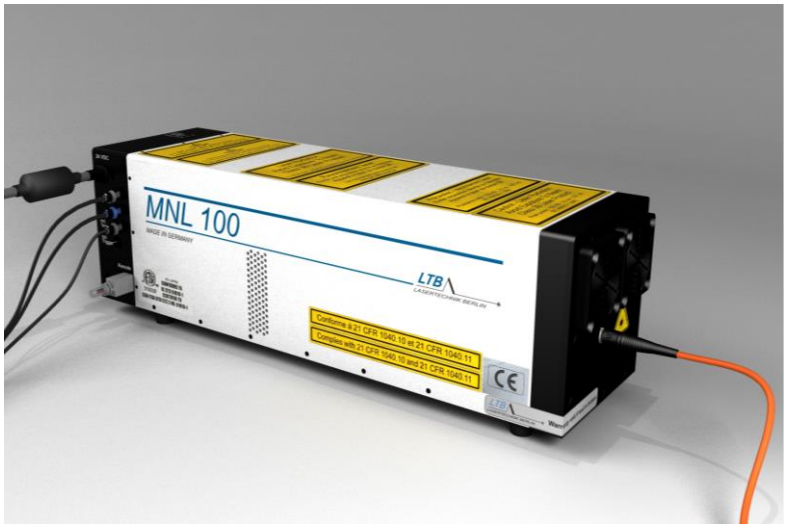
Any modification of the laser, replacement of components or adjustment of the laser must be done by authorized service staff.

Only components tested by LTB must be used.

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 and way of installation



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

Operation temperature	°C	+15 ... +38
Storage temperature	°C	-10 ... +60
Max. rel. humidity	%	85
Air pressure	mbar	750 ... 1300

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

Moreover observe that the air inlet is on the side of the beam output of the laser and must not be blocked. We advice to replace the air inlet filters of the laser every 6 to 18 months depending on the dust concentration of the cooling air (See also 8.3 S.40).

The air outlet openings on both sides of the laser cover must stay free.

Mounting the laser may only be realized via the base plate with the red-marked threaded holes. (See Dimensions and interfaces, appendix 8.7)

The laser may be used in a standing position or hanging with the beam output downwards. Other positions can be checked on request.

2.2 Electric requirements

The laser is supplied with a low voltage of 24 V DC 2.4 A. A power supply unit providing the low voltage from the mains is part of the delivery as standard.

The mains connection values are:

100 to 240 V, 47/63 Hz, 1.1 A (see type label).

Connect the laser power supply unit only to a mains that corresponds to the values stated on the type

The laser power supply unit has an earthed conductor connection that is connected to the laser housing via the connection cable. The low voltage is off-earth, the minus line is connected to the frame ground.

Using another power supply requires the written consent of LTB Lasertechnik Berlin.

Please observe: only a mains that provides an earthed conductor is to be used.

2.3 Fuses

The laser is equipped with resettable fuses. Their replacement is not necessary in case of an error.

2.4 Laser control, computer

Using a RS 232 interface connected to a PC or Notebook, the laser can be operated with all functions and settings. The last settings are stored when the laser is switched off and are provided again as basic settings when the laser is switched on again.
You receive with the laser an optic-electronic interface converter to realize the connection between laser and PC.

PC requirements:

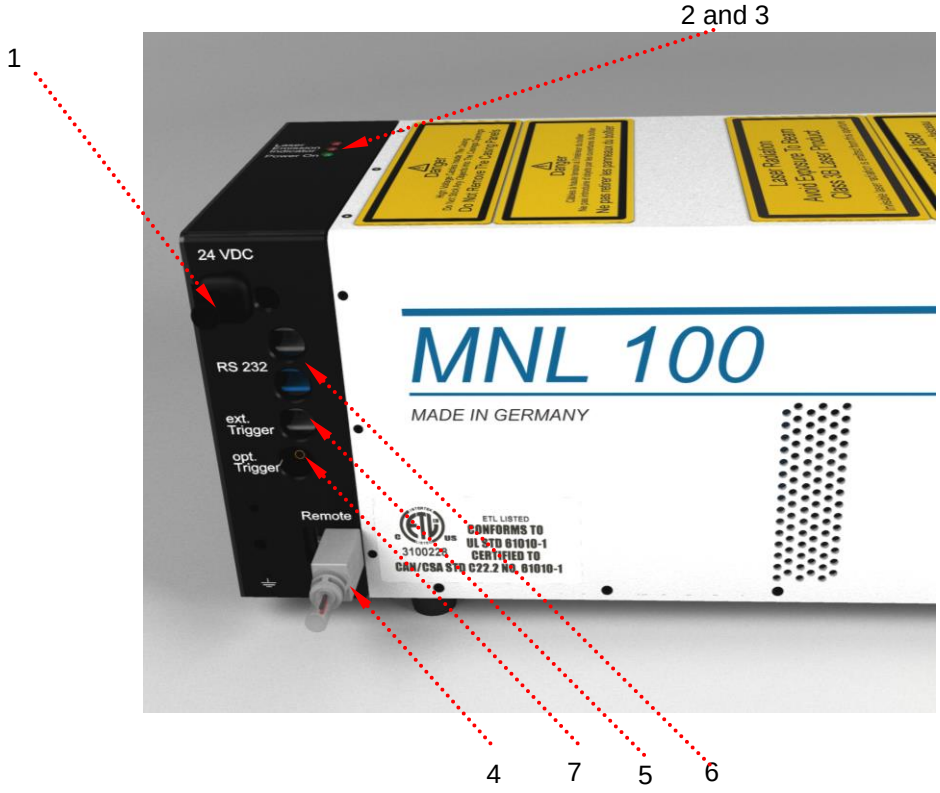
- IBM-compatibility, Pentium
- 128 MB RAM
- 20 MB free hard disk storage
- WINDOWS 9x, WINDOWS NT, WINDOWS XP, WINDOWS VISTA, WINDOWS 7
- Mouse
- Free serial interface, 9-pin
- Or USB interface (USB adapter necessary – option)
- CD-ROM drive

For integrating the MNL 100 in a system control, the interfaces of the MNL 100 are described in detail in the Interface Manual

Alternatively to the operation via the optical PC interface, the lasers of the MNL 100 series can be operated without computer (see 6. OEM – Applications).

3 Installation

1 Device cord
2 Power On LED (1 x green)
3 Laser emission indicator LED's (2 x red)
4 Remote socket
5 External trigger input, optical (HP OWG)
6 RS 232 interface (optical, HP OWG, TX-grey, RX-blue)
7 Sync Out (SMB) (optional)



3.1 Acclimatizing the laser

We recommend that the laser is acclimatized before it is switched on in the operating room for 1 hour, if it was exposed to ambient temperatures outside the allowable operational temperature range before.

3.2 Installing the connection between laser and computer

A Duplex-OWG is used to establish the connection between the laser and your computer or a notebook.

The interface in the laser has already been integrated. Plug and fix the interface adapter onto a free 9-pin serial port of your computer.

If you have only USB interfaces at your disposal, you need an adapter USB-RS 232 (optionally available).

Turn on your PC. The transmitter line (blue connector) of the duplex cable must emit red light. Put the OWG connectors – blue below, grey above – in the sockets of the optical interface RS 232 at the laser. Thus, the connection between the laser and the PC is established.

3.3 Installation of the user program MarathonControl

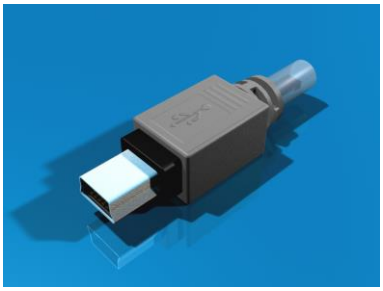
1. The laser is operated and monitored via its serial interface. The user program MarathonControl allows the comfortable operation via PC or Laptop.

   Put the CD with the title MarathonControl (delivered in the utility bag) in the drive of your computer.

2. Choose the CD drive by means of the file manager or MS explorer and execute the file **install.exe**.

   The laser control software is installed automatically then.

3.4 Remote key and remote socket



The remote socket (see page 10, [4]) is provided for:

- Closing the external remote circuit with the remote key
- Integrating external applications in the remote circuit of the laser

The remote key assures the laser against unauthorized use and serves the additional safety during laser operation.

Always remove the remote key after switching off the laser and keep it safe.

With an open remote circuit, the laser cannot be operated!

3.4.1 The external remote circuit

The external remote circuit is closed, if the remote key is plugged into the remote socket (Mini-USB) of the laser.

3.4.2 Connecting external applications

For additional protection against laser radiation, the position switch of the laser beam guidance and the sample chambers of a laser application can be incorporated into the external remote circuit.

With the opening of the beam guidance or of the sample chamber the laser will be automatically switched off.

The necessary cables can be obtained from LTB.

4 Operating the laser

4.1 Establish the readiness for operation

Connect the power supply unit via the device cord with the mains.
Connect the Mate-N-Lok connector to the laser.

The Power On LED (green) of the laser must be lightening. (please see 8.1 LED Codes)

4.1.1 Remote key

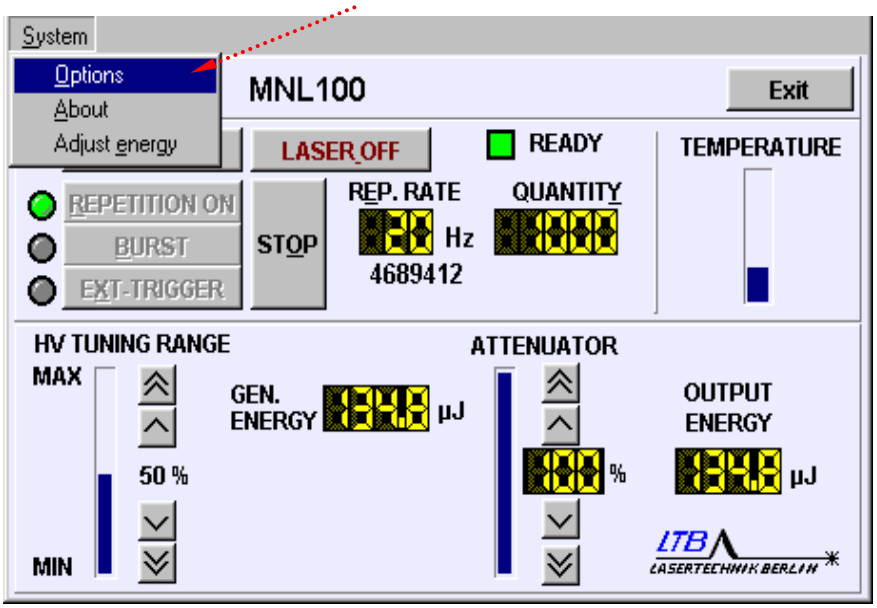
Plug the remote key or remote adapter in the remote socket of the laser. The green Power ON LED on the top of the laser should light permanently.

4.1.2 Connection establishment

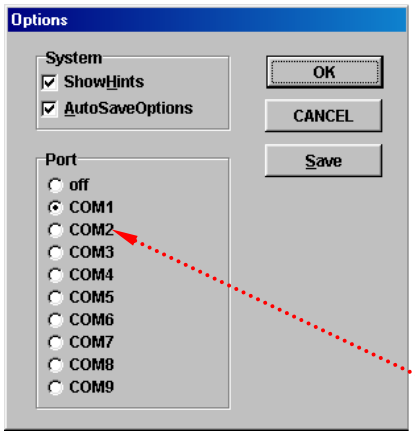
Start the MarathonControl program.

The laser controller automatically switches into the ONLINE mode. The laser-computer-communication is electronically monitored. Laser and computer are properly connected, if the blue and the green triangles in the MarathonControl user interface flash alternately.

If however NO CONNECTION flashes, the COM-port must be changed in the user interface.



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



Choose the appropriate port (COM 1 … 9).

4.2 Starting the laser operation

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

After the warm-up period is completed you can take the laser into operation.

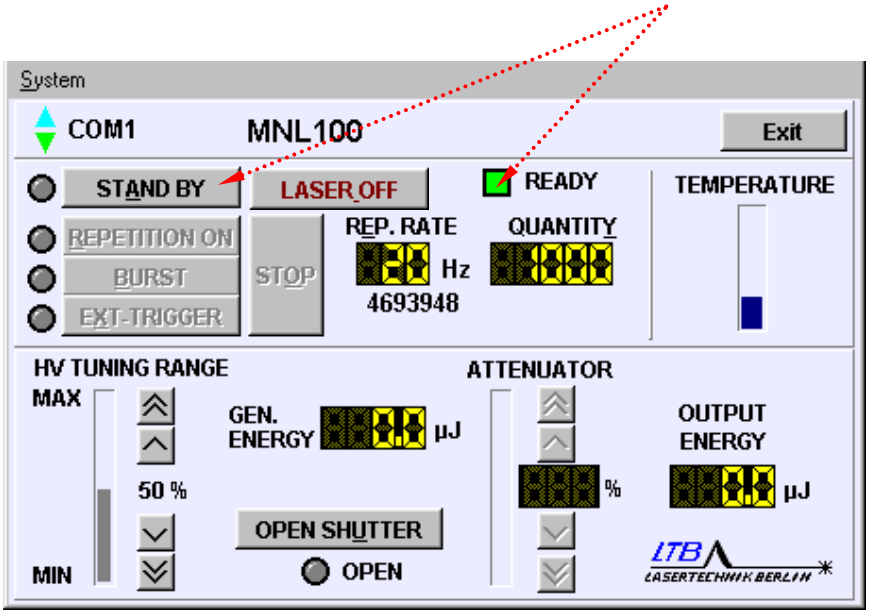
4.2.1 Switching on the readiness for operation

By clicking the button

STAND BY

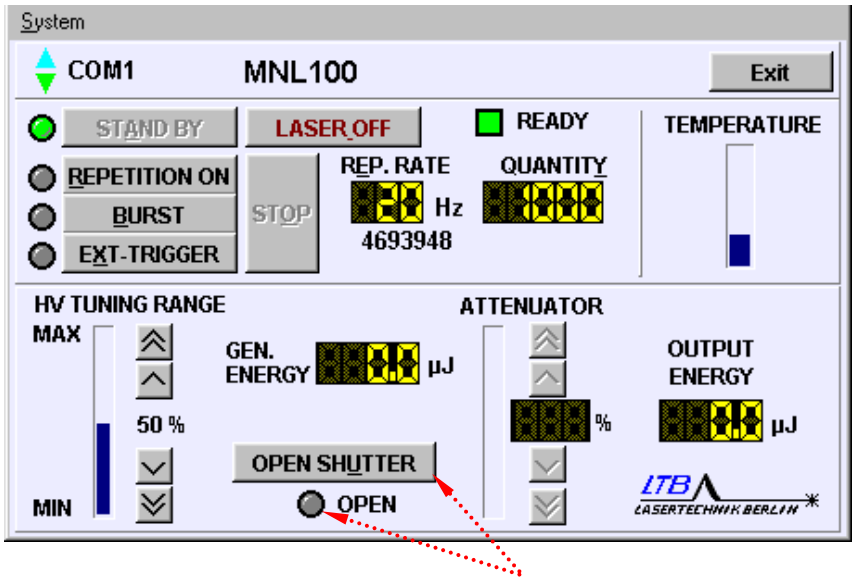
(or “A“ on the keyboard)

you activate the readiness for operation.



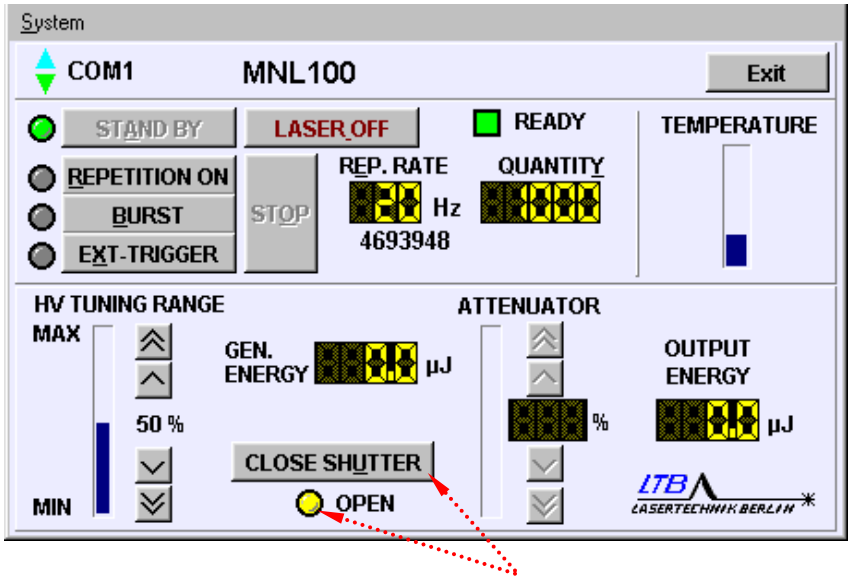
4.2.2 Beam Shutter

The laser is equipped with a motor-driven beam shutter which is activated via the interface of the laser.
As standard the beam shutter is closed.
It can be opened by a software command and is automatically closed again when the laser operation is interrupted.



When the laser is in the STAND BY mode, the shutter can be opened with the button „open shutter“.

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



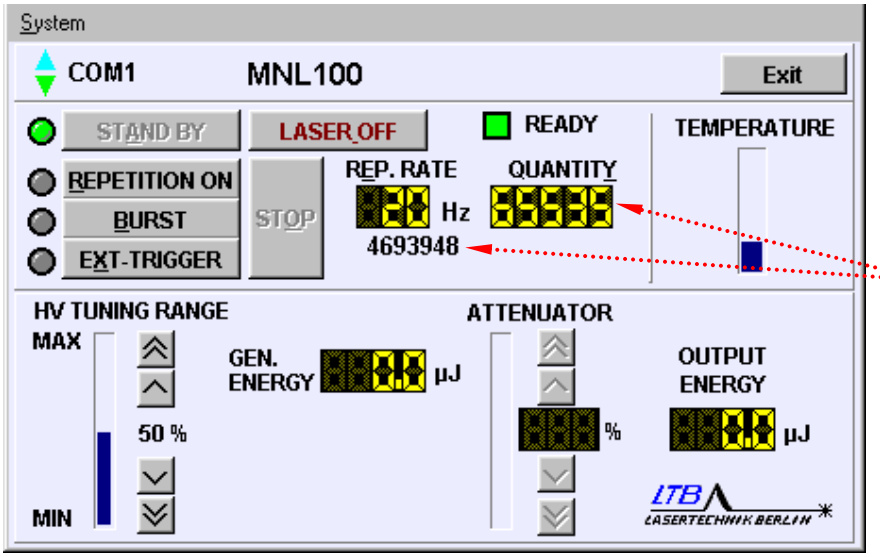
4.2.3 Set the repetition rate and the number of pulses

In the field **REP.RATE**

you see the required pulse repetition rate.

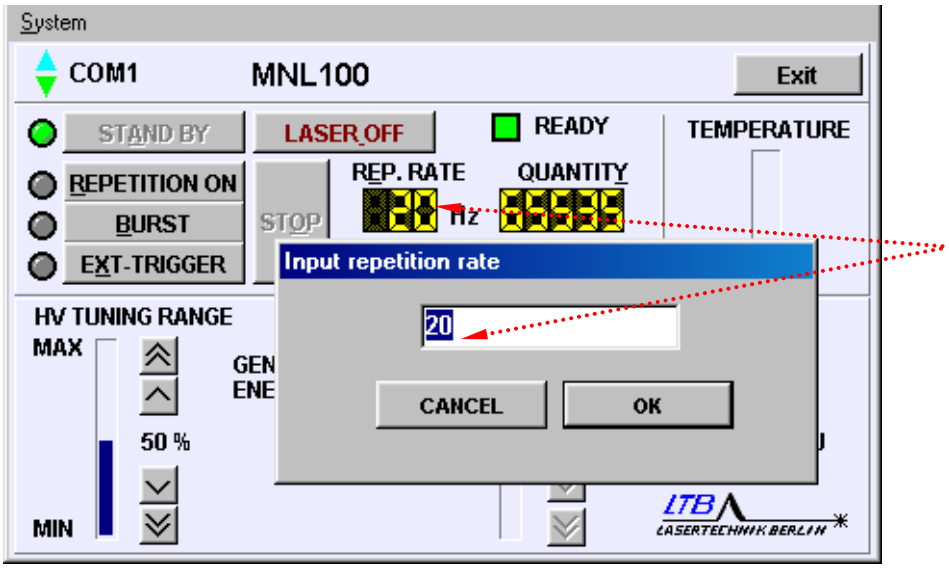
In the field **QUANTITY**

you see the current pulse number (refers only to *Burst* mode).



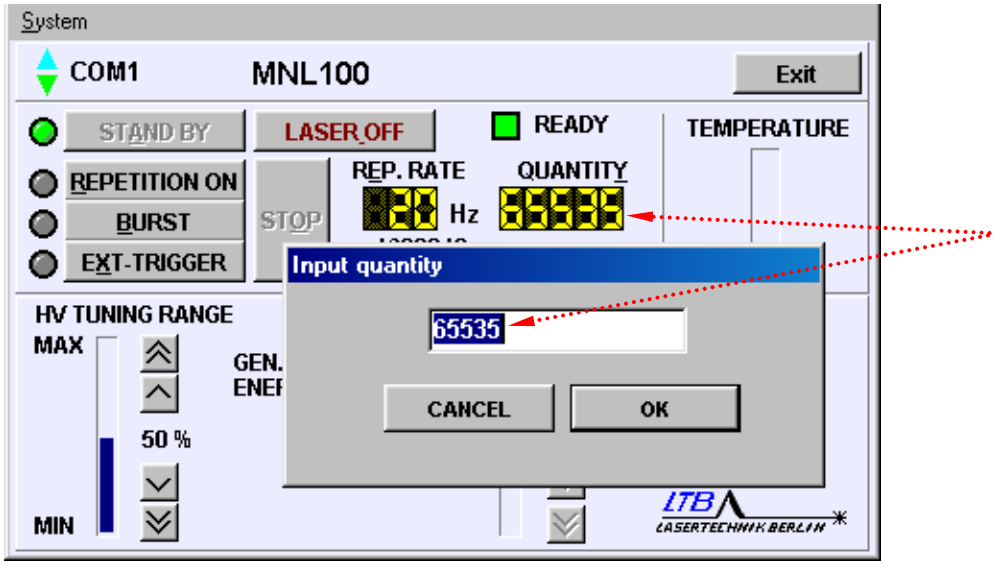
For changing the value of the repetition rate or quantity, click into the respective display:

The input window **INPUT REPETITION RATE** appears



or

INPUT QUANTITY



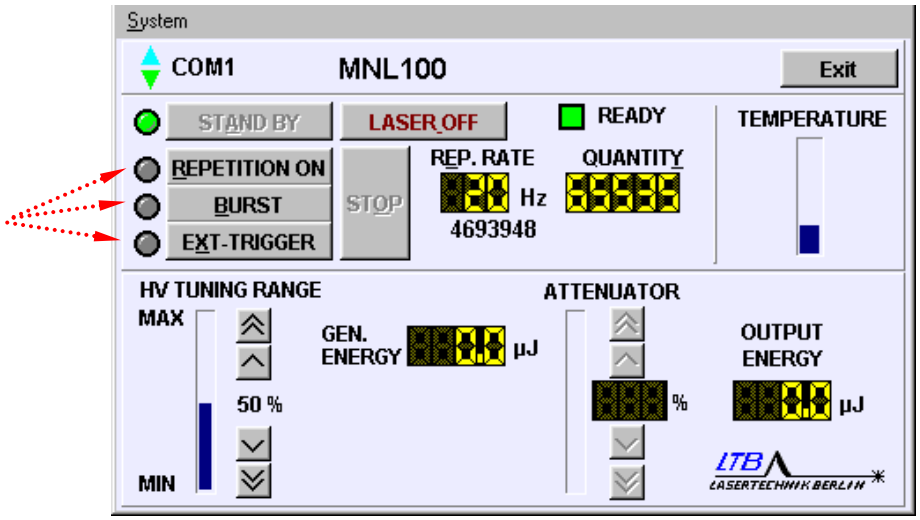
There you can key in your required values (in integers up to 65535) and confirm them.

You can call the input windows by entering "E" (for repetition rate) or "Y" (for quantity) on the keyboard.

4.2.4 Choosing your operation mode

Approximately ten seconds after you pushed the STAND BY button, the following buttons become active:

Here, you can choose the required operation mode.



After pushing one of these buttons, the high voltage is automatically 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") via the keyboard.

Please observe!

In the operation mode EXT-TRIGGER the optical trigger input of the laser is active, incident stray light can cause malfunctioning.

Please close the input with the enclosed HP dummy plug.

4.2.4.1 REPETITION ON

The laser runs continuously with the repetition rate between 1 and 60 Hz (depending on the laser type, internally limited) set by you.
The required repetition rate can be modified when the laser is running.

4.2.4.2 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.

4.2.4.3 EXT-TRIGGER

If you choose this mode, you must provide the laser an external optical trigger signal.

The respective input socket (S.10; [5]) is directly positioned below the interface input.
The trigger converter cable (electric – optic) converts electrical pulses into the corresponding trigger pulses (the cable is part of the utility bag)

If you use the trigger converter cable, please observe the following requirements:

Amplitude:	5 Volt (TTL, without OFFSET)
Driver current:	≥ 10 mA
Pulse width:	2 - 60 µs

If you use your own optical trigger source, please observe:

The laser is equipped with a HP OWG receiver system for ∅ 1 mm POF fibers and requires the following specifications:

- Pulse width of the light impulse 2-60 µs
- light power ≥ 100µW @ 660 nm

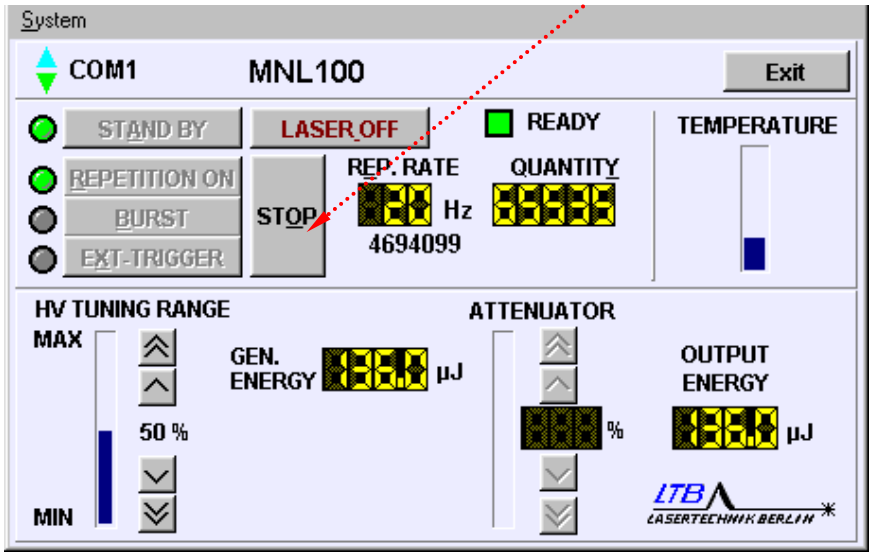
The possible maximum repetition rate of the laser is internally limited.

4.3 Switching off the laser

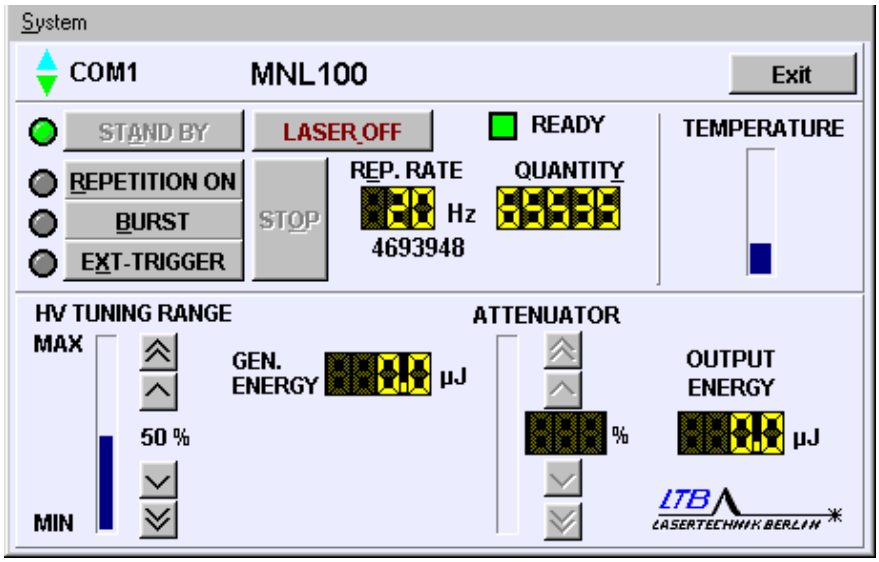
4.3.1 Stopping the laser operation

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

(or "O" on the keyboard).



The laser activity will be switched off but the laser remains in the STAND BY mode. From this mode the laser activity can be reactivated at any time.

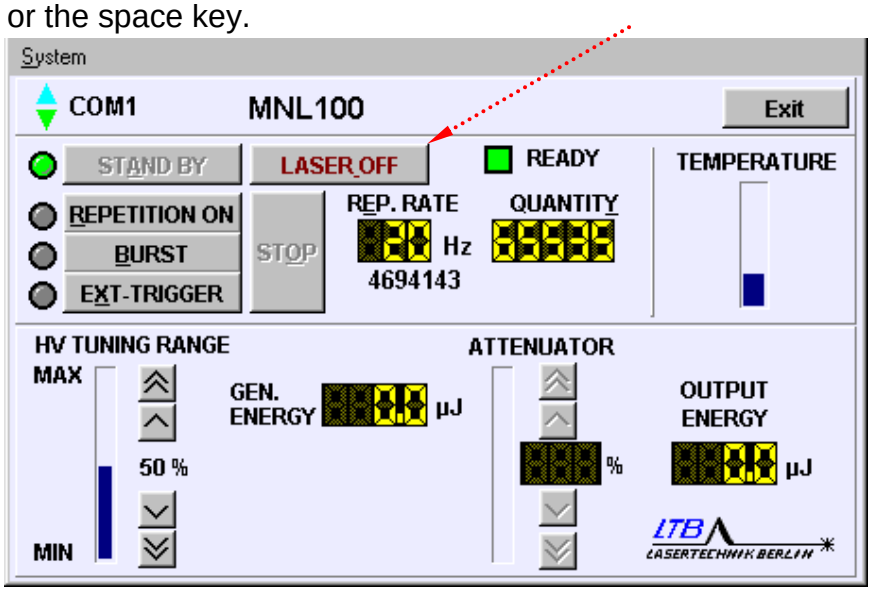


4.3.2 Switching off the laser

If you want to switch off the laser completely, press the button

LASER_OFF

or the space key.

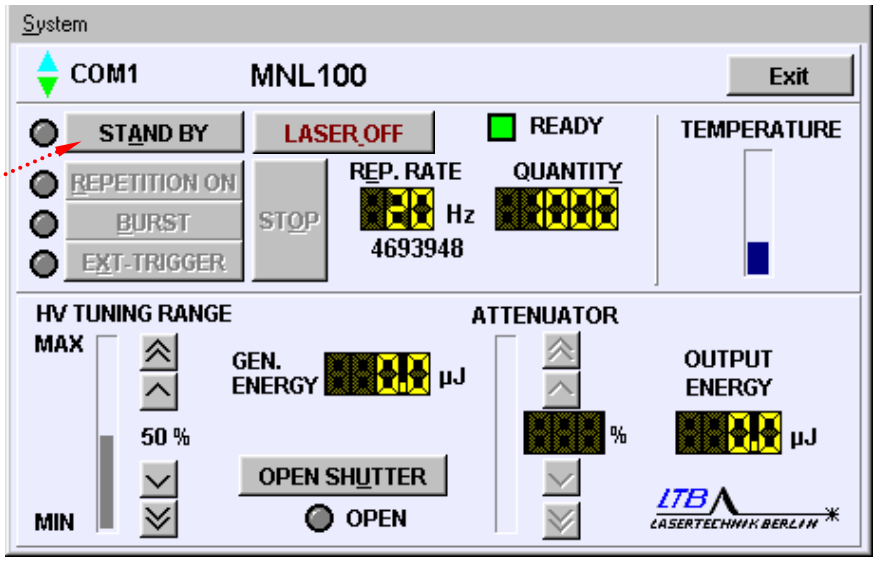


Now the laser is switched off.

If you wish to start the laser activity again you have to set the laser in the ready-to-operate state again by pressing the button

STAND BY

The delay time between LASER OFF and STAND BY is approx. 10 s.



4.3.3 Break time automatic

The laser has two independent break timers (BT1 and BT2). After a pre-set time between 30 and 9999 seconds, the laser is switched back in the STAND BY (BT1) and LASER OFF (BT2) mode, if no internal or external trigger signal is registered.
These reactions correspond to activating the STOP or LASER OFF button.
By pressing the respective button the laser will be set to the required operation mode again.

As standard the two timers are set as follows:
After 5 minutes interval, the laser automatically switches in the STAND BY mode and after another two hours interval in the LASER OFF mode.

4.3.4 Closing the beam shutter

With the command LASER OFF, the beam path regardless of the chosen mode of operation closes automatically.

4.3.5 Protecting the laser

If you remove the remote key from the remote connection after switching off the laser, the laser cannot be switched on by unauthorized persons.

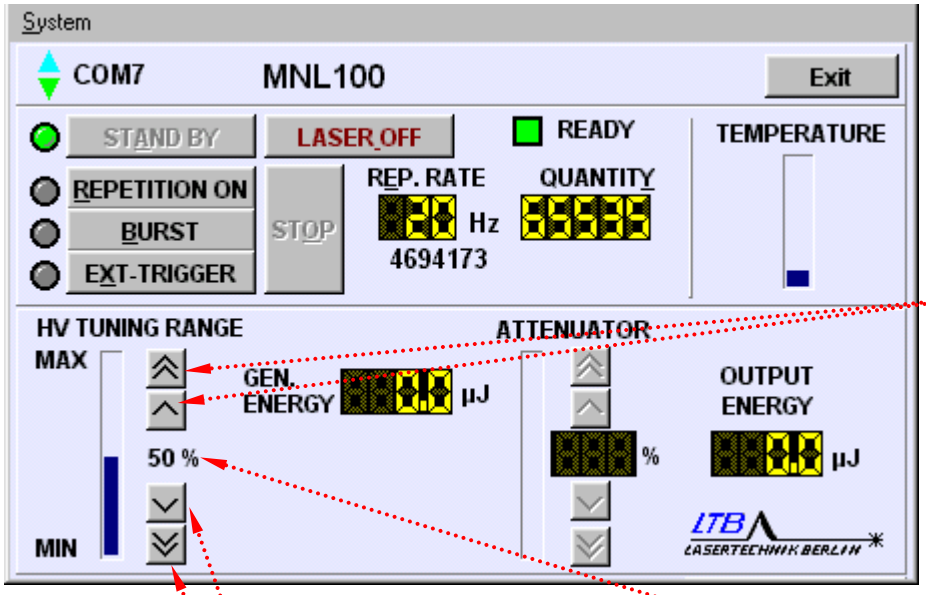
5 Optional Features

5.1 High voltage control

You can change the energy output by varying the high voltage within a range from 100 – 80%.

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

In the MarathonControl window, 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.



Increase of the high voltage

Decrease of the high voltage in steps of 1 per cent

Display of the high-voltage tuning range in per cent

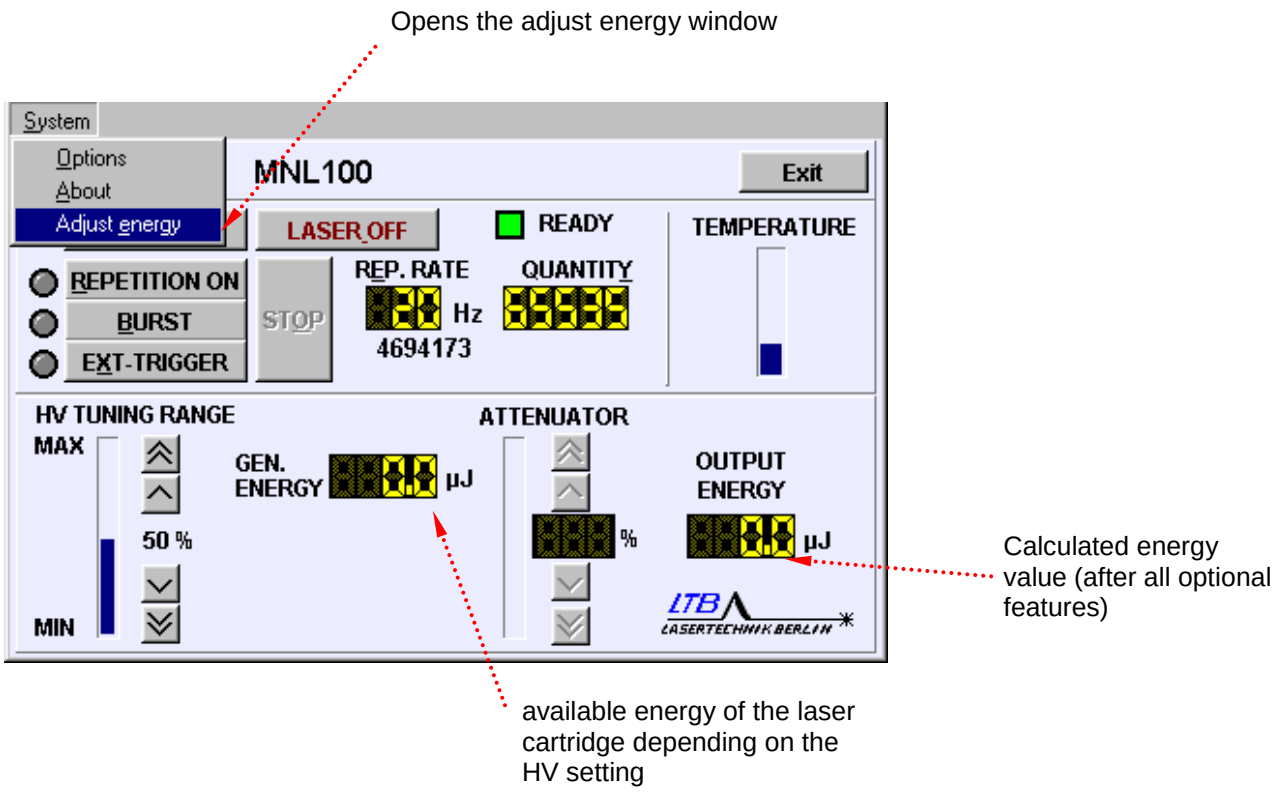
Decrease of the high voltage in steps of 10 per cent

5.2 Energy measurement

Optionally, the laser can be equipped with an energy monitor. With this monitor, the energy output can be displayed on your user interface, the energy measuring values are provided as 8-bit values at the laser interface.

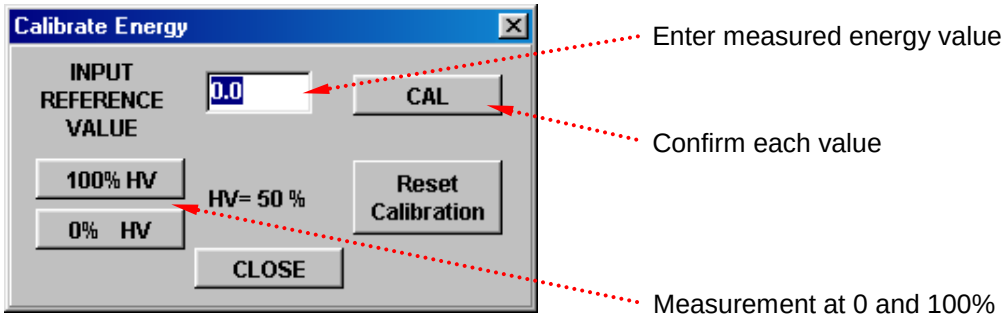
The energy monitor is adjusted in the factory and should be checked after one year at the latest and if necessary re-adjusted. For this purpose, you need a calibrated energy measuring device for the wavelength 337.1 nm (e. g. the PEM of LTB).

5.2.1 Calibration of the energy monitor



The calibration should be carried out at operating state temperature of the laser and with the frequency the laser is normally used.

At first click the **100% HV** button. The measured energy value is entered in the window and confirmed with the **CAL** button. As a second step the **0% HV** button is clicked and the now measured value is confirmed with the **CAL** button as well.



5.3 Attenuator module (in connection with energy monitor)

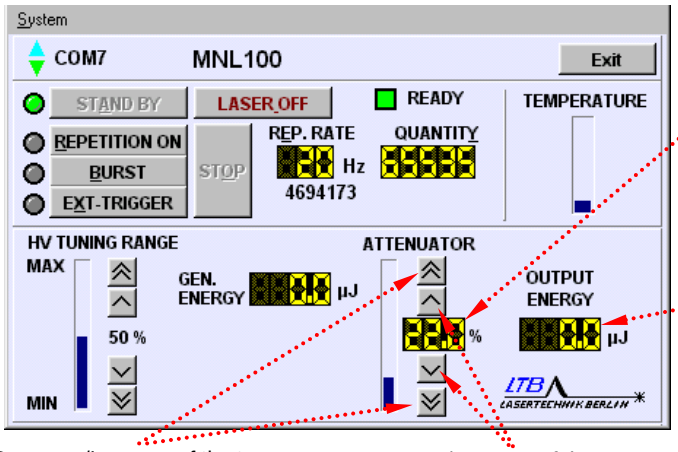
Via the attenuator module, the laser output energy can be adjusted continuously in a large range.

The attenuation is realized before the beam output and the coupling into a fiber. The adjustment can be carried out through both the MarathonControl software panel and the interface.

The required transmission of the attenuator can be set with 1 % resolution (via the arrow buttons) or the output energy can be entered directly with 0.5 µJ resolution via double click in the display field OUTPUT ENERGY.

When using the laser interface, the position of the attenuator can additionally be parameterized, so partially even better resolutions are achieved. A special firmware module realizes the linearization and short response times.

In connection with the energy monitor, you can directly enter the required output energy value, optionally the one after the fiber output. After switching on the supply voltage the zero point of the filter is always determined and the transmission curve is provided out of the laser controller memory.



Please observe:
Even when the attenuator is completely opened, it causes a transmission loss of 10 % of the laser energy.
The integration of attenuator **and** beam shutter is not possible. As a protection against laser radiation, the attenuator is set to the range of lowest transmission by the firmware when the laser is switched on. The user has to sign an OEM agreement, since a residual risk exists. The regulations of IEC 60825-1(laser safety) are to be observed.

5.4 Fiber coupling

The generated laser light is coupled into a quartz fiber behind the shutter or attenuator. The fiber diameter is 200, 600 or 1000 µm. The numerical aperture NA is 0.22.

Fibers with a diameter smaller than 600 µm are connected non-detachable to the laser and can therefore not be replaced by the user.

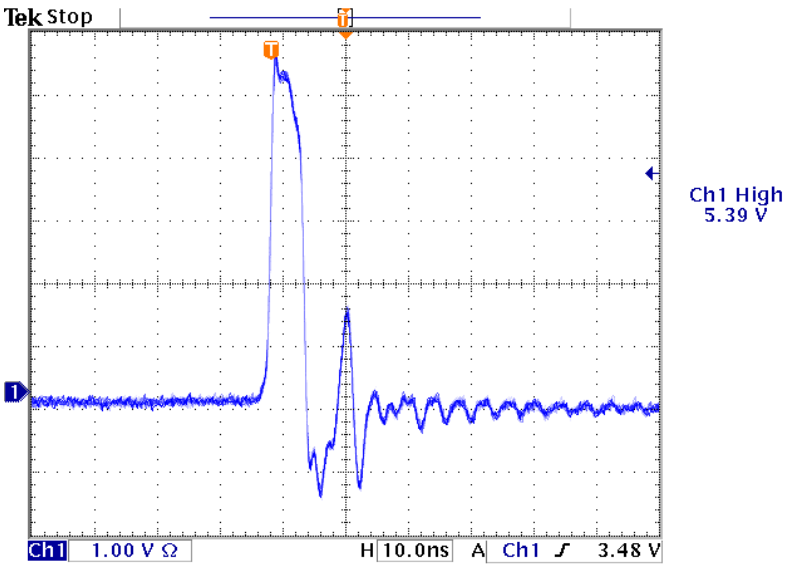
The transmission of the fiber coupling is 70 % (200 µm) and approx. 90 % (1000 µm).

5.5 Optical trigger with electrical output

The current rise of the solid-state switch is analyzed and converted into an electrical trigger signal (SMB output).

Amplitude:	5.0 ... 6.5 Volt (50 Ohm)
Delay:	approx. 3.5 ns before the laser pulse
Jitter:	< 0.2 ns (related to the laser pulse)
Rise time:	< 800 ps

(incl. adapter cable SMB to BNC)



6 OEM – Applications

6.1 AUTOMODE operation

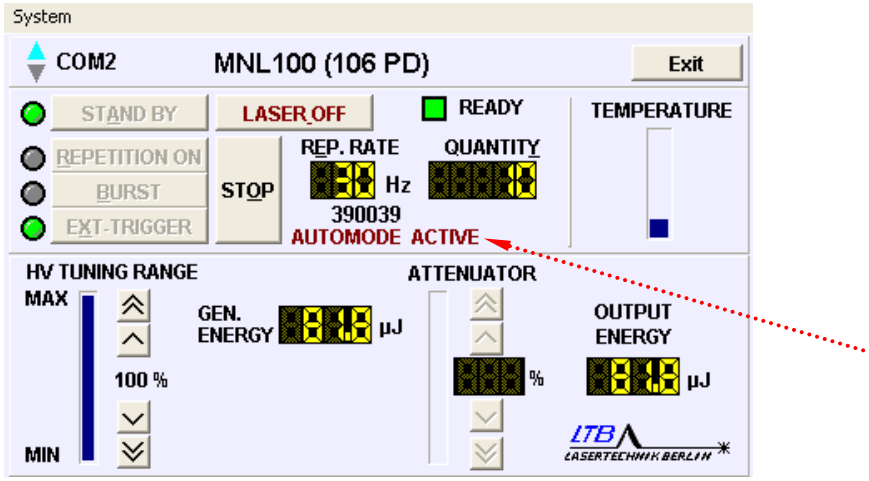
Alternatively to the operation via the optical PC interface, the lasers of the MNL 100 series can be operated without computer. The laser runs in the AUTOMODE with the stored presettings then.

Since the beam shutter does not fulfill the safety requirements of system redundancy, the customer has to sign an OEM agreement. The user has a higher responsibility for the compliance with laser safety when using the AUTOMODE. The regulations of the IEC 60825-1 (laser safety) are to be observed.

The decision to operate the laser in the AUTOMODE must be made before dispatch. The settings can only be made at the factory.

A laser monitoring is possible via the interface also in this mode. The *Automode* is indicated in the MarathonControl window. Only the shut-down functions (STOP und LASER OFF) are enabled.

If the shut-down functions are used during the Automode operation, the laser goes into a safe state. Only after a reset (separation from the mains for min. 30 s), the laser can be activated via a trigger signal again.



The two versions of AUTOMODE

6.1.1 AutoStandBy

After applying the operation voltage, the laser is in the **StandBy** mode.
The first external trigger pulse activates the **ext. trigger mode** after 8 milliseconds. All further trigger pulses generate laser pulses. Breaks between trigger signals longer than the time set in the break timer BT1 make the laser switch back to **StandBy**. BT2 is inactive.

6.1.2 TrgStandBy

After applying the operation voltage, the laser is in the **LaserOff** mode.

The first external trigger pulse activates the **StandBy** mode after 10 s. The second external trigger pulse activates the **ext. trigger mode** after 8 milliseconds. All further trigger pulses generate laser pulses. Breaks between trigger signals longer than the time set in the breaktimers BT1 and BT2 make the laser switch back to **LaserOff**.

The settings of the Breaktimers should be made in a way that a switching back during operational intervals of measuring processes is excluded.

Description of the operation modes of the laser in AUTOMODE

If your measuring process comprises longer intervals between the measurements, we recommend to choose the TrgStandBy mode, since the running time of the laser ventilation has a major impact on the maintenance cycles (internal contamination).

sleeping mode (LaserOff)
operation voltage is on
ventilation is off
high voltage is off

standby mode (StandBy)
preionisation of laser channel is running
ventilation is on
high voltage is off

operation mode (Ext.Trigger)
preionisation of laser channel is running
ventilation is on
high voltage is on
every trigger pulse generates a laser pulse

from	to	AutoStandby	TriggerStandby	delay
sleeping mode	standby mode	after switching on (operation voltage)	first trigger pulse	always 10 s
standby mode	sleeping mode	Hardware switch-off (safety key)	break timer BT2	no
standby mode	operation mode	first trigger pulse (next pulse triggers laser pulse)	first trigger pulse (next pulse triggers laser pulse)	no
operation mode	standby mode	after lapse of break timer BT1	after lapse of break timer BT1	no
sleeping mode	operation mode	impossible	impossible	----------
operation mode	sleeping mode	Hardware switch-off (safety key) **→ only for emergency !** Switching off the operation voltage **→ only for emergency !**	Hardware switch-off (safety key) **→ only for emergency !** Switching off the operation voltage **→ only for emergency !**	no

The order ***sleeping*** → ***standby*** → ***operation*** is not changeable.

The shut down of the laser should be done in the reversed order.

Quitting the *operation mode* by safety features (safety key etc.) or interrupting the operation voltage are emergency cutoffs and should be avoided.

6.2 Difference between AutoStandby and TriggerStandby

In ***AutoStandby*** operation the ***standby mode*** will be started directly after switching on the operation voltage and is active after 10 s switch-on delay. The laser remains in ***standby mode*** until switching off the operation voltage. To activate the ***operation mode*** (high voltage ON) one trigger pulse is necessary. Each following trigger pulse will generate laser light. Breaks between the shots longer than BT1 will switch back the laser to ***standby mode***.

Pro: - only the first trigger pulse (of every burst) is necessary for starting, all the other pulses generate laser light

Con: - preionisation of the laser cartridge is permanently running (stressing the laser gas)

- ventilation is permanently running (increased contamination of the laser)

In ***TriggerStandby*** operation the ***standby mode*** will be activated by the first trigger pulse and will be reached after 10 s switch-on delay. The red laser warning LED's flash simultaneously in short intervals.
If there are no following trigger pulses after reaching the ***standby mode***, the laser remains in ***standby mode*** up to the BT2 time is reached and switches back to sleeping mode then.
To activate the ***operation mode*** (high voltage ON), one trigger pulse is necessary. Each following trigger pulse will generate laser light. Breaks between the shots longer than BT1 will switch back the laser to ***standby mode***.

Pro: - preionisation and ventilation are only running if required

Con: - trigger breaks longer than 60 s will switch off the ***standby mode***

- for returning to the ***standby mode*** , the 10 seconds switch-on delay when no laser light is generated must be considered

6.3 Description of the Break Timers BT1 und BT2

- automatic shut down of the laser (to preserve the material)

- when using the laser in the AUTOMODE (without PC) only possibility to shut down the laser regularly

- also used in PC mode (laser controlling via interface), as additional safety function. The switching on and off is conducted via interface commands.

BT1 (AutoStandby and TriggerStandby mode)
- is active in the ***operation mode***
- can be preset from 30 to 60 s
  (PC mode up to 9999 s)
- monitors the time between the laser pulses and switches back to the ***standby mode,*** when it is exceeded
- for return to operation mode 1 Trigger pulse is necessary

BT2 (only for *TriggerStandby* operation)
- is active in the ***standby mode***
- can be preset from 30 to 9999 s
- monitors the time between the laser is in the ***standby mode*** and switches back to the ***sleeping mode*** when it is exceeded
- for return to ***standby mode*** one trigger pulse is necessary (+ 10 s switch-on delay)

6.4 Description of the auto open and auto close functions

auto close: When the laser is switched off (LASER_OFF) the shutter closes automatically, or the attenuator moves to the position of lowest transmission.
→ Standard setting, can be disabled for OEM applications

auto open: When the laser is switched in the StandBy mode, the shutter opens automatically, or the attenuator moves to the position of the last set transmission value.
→ only for OEM applications

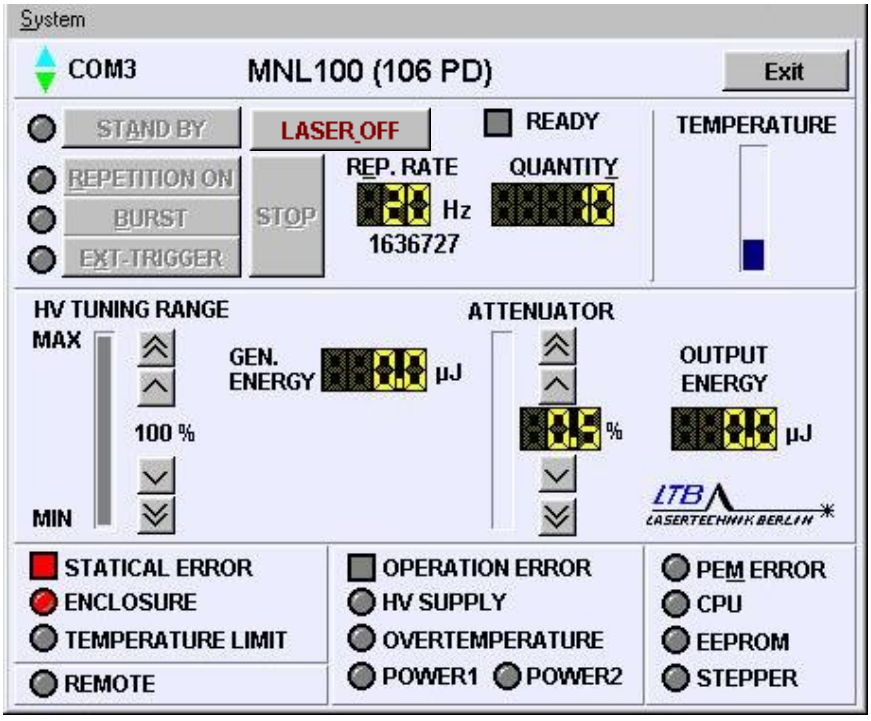
7 Safety functions

To ensure a safe laser operation, a number of monitoring functions has been set up.

They comprise:

- External remote circuit (Remote)
- Supervision of the casing, protection against contact
- Temperature monitoring inside the laser (advance warning)
- Monitoring of the high-voltage circuit and HV generation
- Monitoring of the output energy

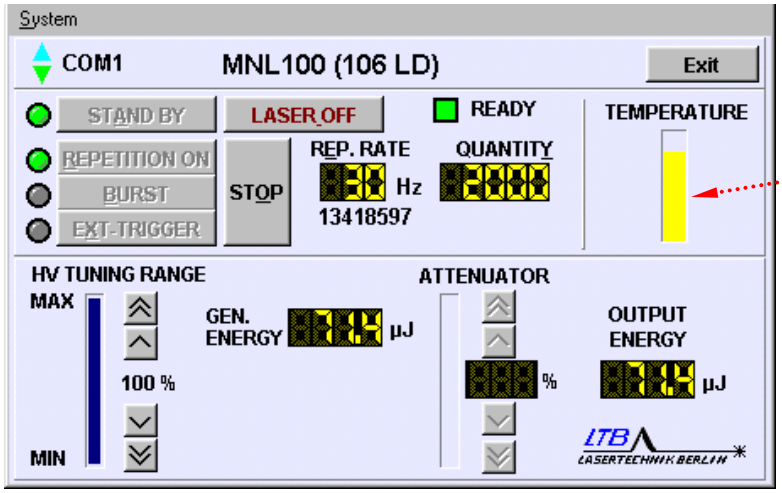
In case of an error, an additional window will appear on the MarathonControl user interface indicating the type and cause of the error. Errors are split into static errors and dynamic errors. Except for the EEPROM error and PEM error the laser will cease operating promptly.



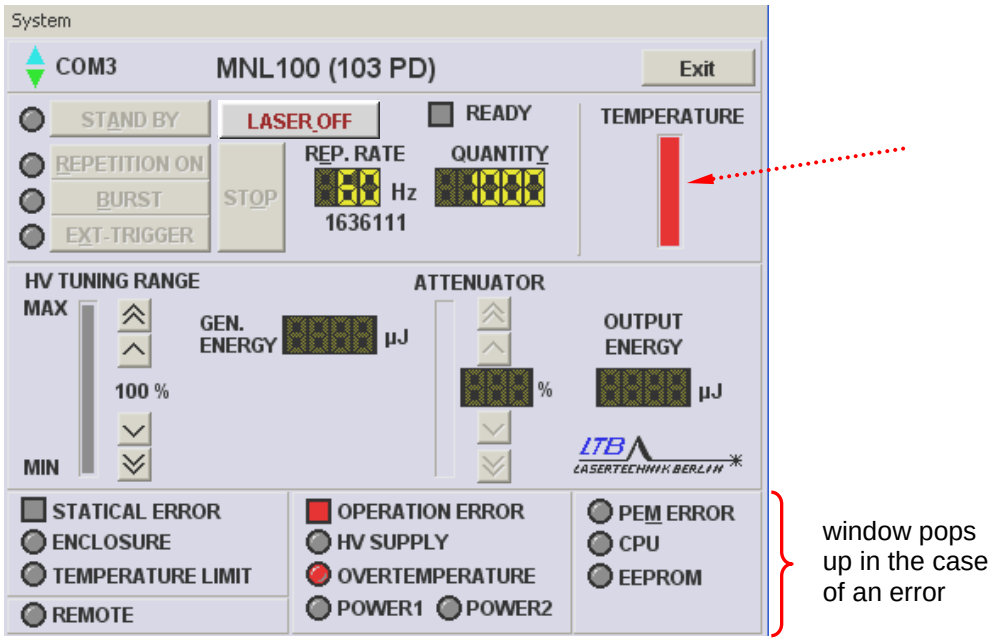
7.1 Temperature monitoring

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

The laser and the surrounding temperature need to be checked.



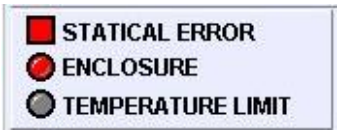
If the temperature continues to rise, the color of the bar changes to red and the laser will stop operating.



An additional window appears indicating the failure origin.

7.2 Error messages

7.2.1 Static errors



- Indication **"No Connection"**
  - The Laser-PC connection does not work stable or is interrupted
  - (erratically blinking triangles)
  - 30 second after missing or interrupted communication the laser switches off automatically (Polling).
  - USB-adapter usage in Windows XP (+higher): If the user logs out or the USB connection to the PC is cut, the used USB-port is disconnected from the PC as well and needs possibly to be set again via System\Options in the MarathonControl user interface after a new log-in.

- Indication "**TEMPERATURE LIMIT**"
  - The temperature in the laser is too high.

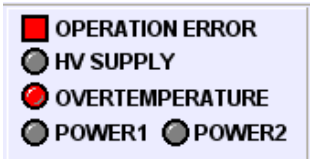
- Indication "**ENCLOSURE**"
  - The laser casing is still open or the parts are not properly screwed.

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

Static errors are signaled directly at the laser by slow flashing of the green LED.

Missing connection to the PC is not signaled at the laser.

7.2.2 Dynamic errors (operation errors)



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

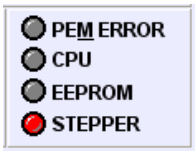
- Indication "**OVERTEMPERATURE**"
  - The temperature in the laser head is recurrently too high
- Indication "**HV SUPPLY**"
  - The high voltage in the excitation circuit is too high or the recharging of the storage capacitors takes too long).
- Indication "**POWER1**"
  - Internal voltage monitoring
- Indication "**POWER2**"
  - Recurrent voltage drops below the operation voltage of 24 V (error in the external power supply)

Dynamic errors are signaled directly at the laser by fast flashing of the green LED.

Separate the laser from the power supply unit and wait at least 10 seconds before connecting it again.

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

7.2.3 Other messages



EEPROM , STEPPER, CPU and PEM errors are not signaled by indicator light at the laser.

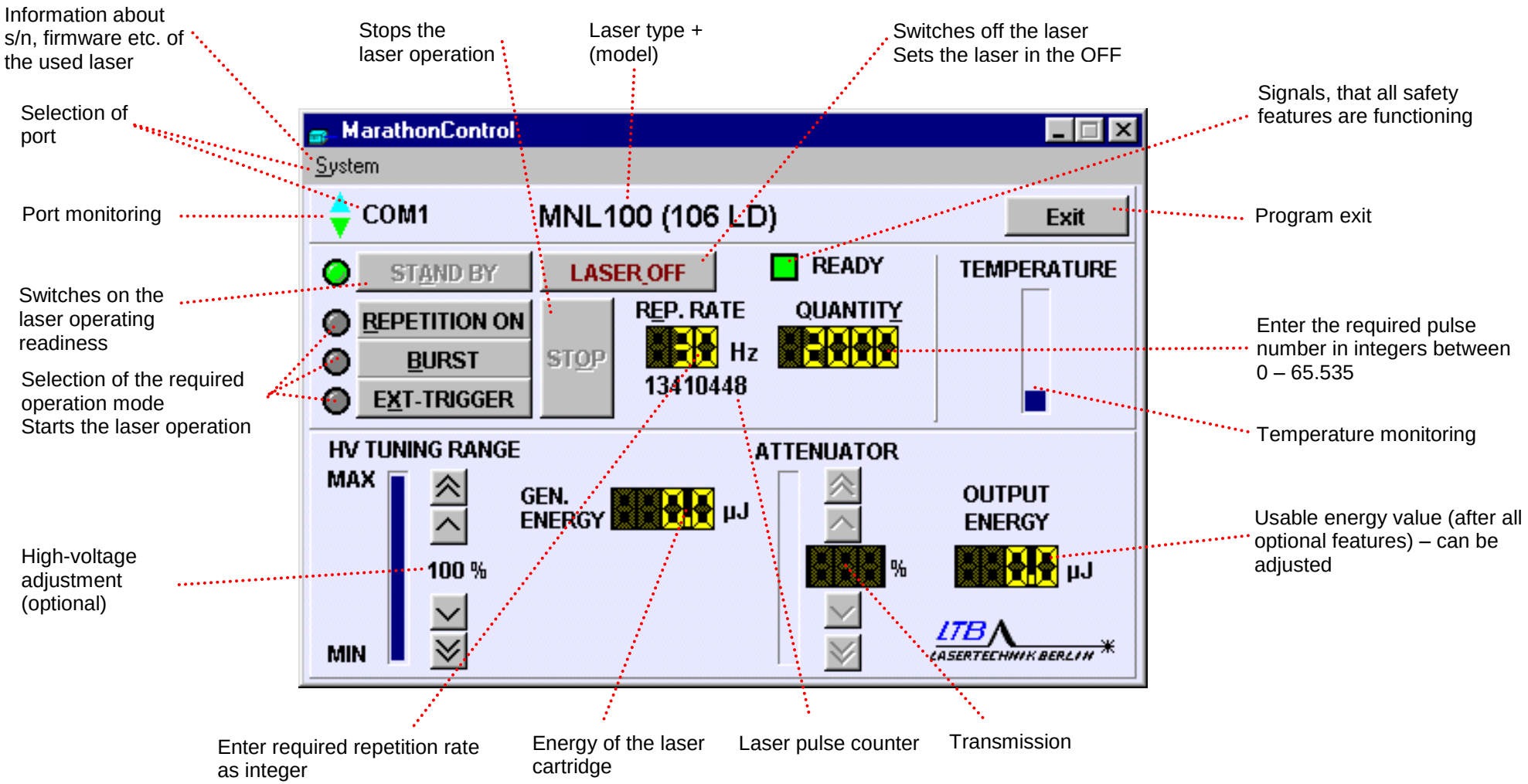
- Indication "**PEM ERROR**"
  - Measuring error of the energy monitor
- Indication "**CPU**"
  - Firmware program error
- Indication "**EEPROM**"
  - Check sum or storage error (EEPROM)
- Indication "**STEPPER**"
  - Zero point determination of the attenuator failed
- Indication **"REMOTE“**
  - The external remote circuit is not closed

8 Appendix

8.1 LED Codes

	Power on **Laser OFF**
0,4 / 0,4 s	Power on **statical error is displayed**
0,1 / 0,1 s	Power on **operation error is displayed**
0,1 / 1,0 s	Power on **Laser in AUTOMODE "TrgExtTrg"** **waits for a trigger für Stand By**
1,0 / 1,0 s	Power on **Laser in Stand By (STOP)** **HV is OFF**
0,4 / 0,4 s	Power on **OPERATION MODE** **HV is ON**

8.2 User interface of Marathon Control

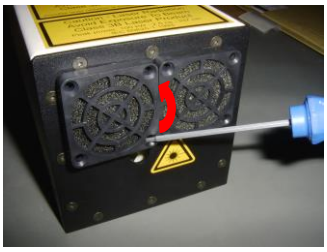


8.3 Inspection and maintenance

After the laser has run 2 years or 60 million pulses, the laser should be sent for inspection and cleaning to LTB.

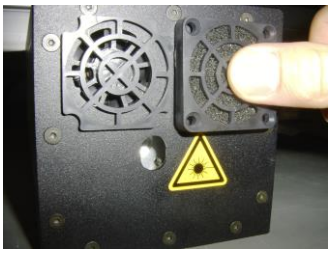
Depending on the dust concentration in the cooling air, the air inlet filters of the laser have to be replaced every 6 to 18 months (The filter mat dirties. The laser may indicate the error OVERTEMPERATURE).

1. Remove the covers



2. Replace the filter mats (Replacement mats are in the accessory kit).

3. Affix and snap in the covers



8.4 Optional components

The following components and devices are optionally available with the MNL 100:

- TWE 40
  Trigger converter for the exact optical external triggering, if only an electrical trigger source is available
  Input: TTL level 50 Ohm
  Output: Optical waveguide fitting the trigger input of the laser
  Time jitter: < 1 ns

- Trigger converter cable
  [electrical (BNC female)/ optical (HP)]
  Usage and connections like TWE4 40, but for standard requirements:
  Time jitter: 5 ns,
  Amplitude: 5 Volt (TTL, without OFFSET)
  Driver current: ≥ 10 mA
  Pulse width: 2 - 60 µs

- Energy meter µ-Joule Meter PEM 250 or PEM 500

- Remote adaptor (customized)

- USB-serial adaptor

8.5 Warranty

The MNL 100 comes with a warranty of two years from the date of invoice or 6 x 10^7 pulses, whichever comes first.

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

Wear parts, consumables and maintenance items are excluded.

Check-up table on maintenance works carried out

Date	Activities	Signature

8.6 Specifications, Technical Data

General

MNL 100		103-PD / 106-PD	103-LD / 106-LD
Wavelength	nm	337.1	
Spectral bandwidth	nm	0.1	
Pulse halfwidth FWHM, typ.[1]	ns	3	
Guaranteed pulse energy (90 % after 60 mill.)[2]	µJ	**≥ 140 / ≥ 120**	**≥ 80 / ≥ 60**
Typ. pulse energy (typ. 70 % after 100 mill.)[2]	µJ	**≥ 155 / ≥ 130**	**≥ 90 / ≥ 70**
Pulse power, typ.	kW	51 / 43	30 / 23
Repetition rate	Hz	**1...30 / 1...60**	**1...30 / 1...60**
Energy stability SD/<E> (for all rep. rates)	%	**≤ 2**	**≤ 2**
Beam dimensions, vertical x horizontal, typ.	mm	3 x 4	4 x 2.5
Beam divergence, vertical x horizontal[3]	mrad	≤ 3.5 x ≤ 3	≤ 0.5 x ≤ 0.3
Focus stability[4]	µm	< 15	< 25
Beam exit angle, vertical / horizontal, typ.	grad	+0.5 (±0.2) / 0±0.1	0±0.1 / 0±0.1
Trigger In		Optical or electrical (TTL)	
Jitter: ext. trigger ↔ laser pulse	ns	± 2.5	
Pulse delay: ext. Trigger ↔ laser pulse	ns	1300 ± 10%	
Sync Out (optional):		Typ. 3.5 ns before the laser pulse (U>4V)	
Jitter: electr. Trigger exit ↔ laser pulse	ns	< 0.2	
Warm-up time	s	< 20	
Control		AUTOMODE or software (DLL) via integrated controller	
Warranty[5]		**Mind. 90% from specified start energy (after 60 mill. pulses or 2 years)**	
Certifications		CE, ETL (UL, CSA, VDE, Semco), FDA	
Laser class		3B / IIIb	

Electrical interface

Power supply[6]	V DC	24
Power consumption	A	2.4
Maximum / (average) power consumption	VA	60 / 40

Environment and conditions of use

Operating temperature	°C	+15 ... +38
Storage temperature	°C	-10 ... +60
Max. relative humidity (non-condensing)	%	85
Air pressure	mbar	750 ... 1300
Dimensions of the laser (L x B x H)[7]	mm	321 x 95 x 95
Weight of the laser	kg	3.5
Dimensions of the power supply (L x B x H)	mm	180 x 80 x 50
Weight of the power supply	kg	0.6

[1] *reduction of request*
[2] *higher energies on request*
[3] *at max. rep.rate; measuring at 5m distance*
[4] *based on focusing of 60mm*
[5] *extension to 3 years optional*
[6] *via external wide-range power supply (90...260 V AC) (part of the delivery)*
[7] *with attenuator module 335x95x95 mm*

Subject to technical changes.

Additional components

Energy monitor

- display accuracy: ± 8 %
- with calibration function

Attenuator

- only in combination with an energy monitor
- transmission max. 90 %
- attenuation up to approx. 1 % of the laser output energy possible
- Please note modified external dimension
- no beam shutter possible (OEM agreement necessary)

Fiber coupling

- transmission approx. 90 %
- only for PD-type
- SMA-connector
- fibers with diameters < 600 µm cannot be replaced by the user

Fiber 200 µm

- length: 150 cm
- transmission approx. 70 %

Fiber 600 µm

- length: 150 cm
- transmission approx. 90 %

Fiber 1000 µm

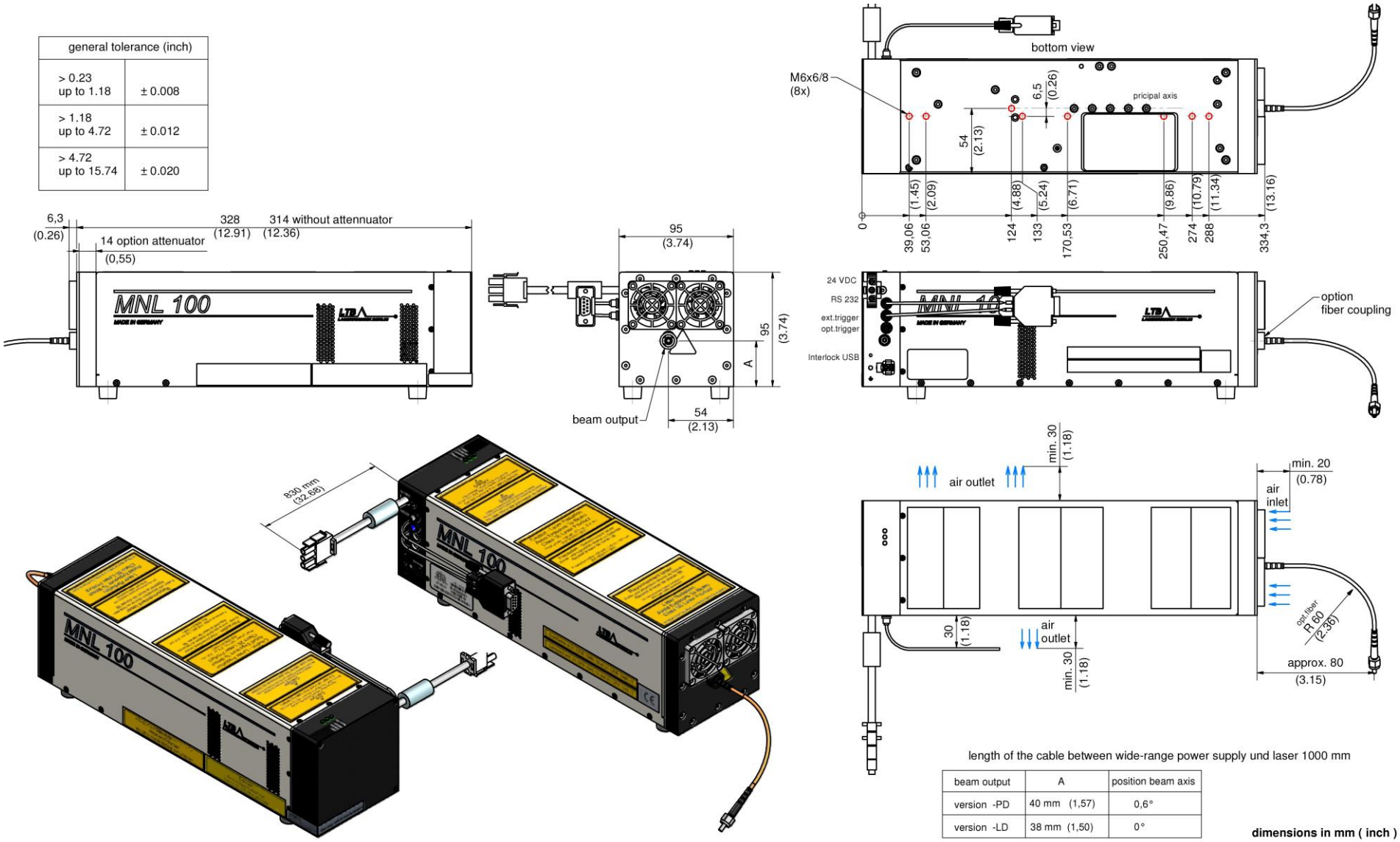
- length: 150 cm
- transmission approx. 90 %

Optical trigger with electrical output

- pretrigger
- Delay: approx. 3.5 ns (electr. trigger output ↔ laser pulse)
- Amplitude: 5.0 ... 6.5 Volt (50 Ohm)
- Jitter: < 0.2 ns (related to the laser pulse)
- Rise time: < 800 ps FWHM
- incl. adapter cable SMB to BNC

8.7 Dimensions and interfaces

general tolerance (inch)	
> 0.23 up to 1.18	± 0.008
> 1.18 up to 4.72	± 0.012
> 4.72 up to 15.74	± 0.020

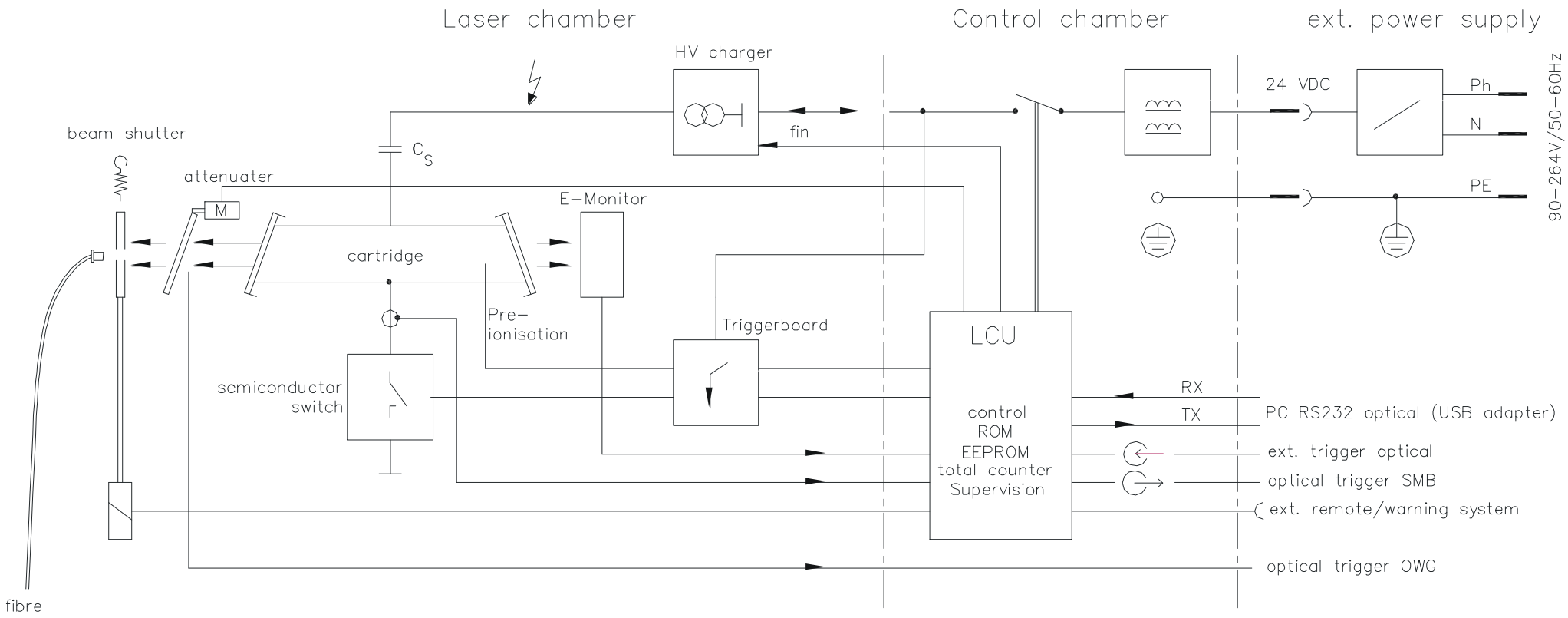


length of the cable between wide-range power supply und laser 1000 mm

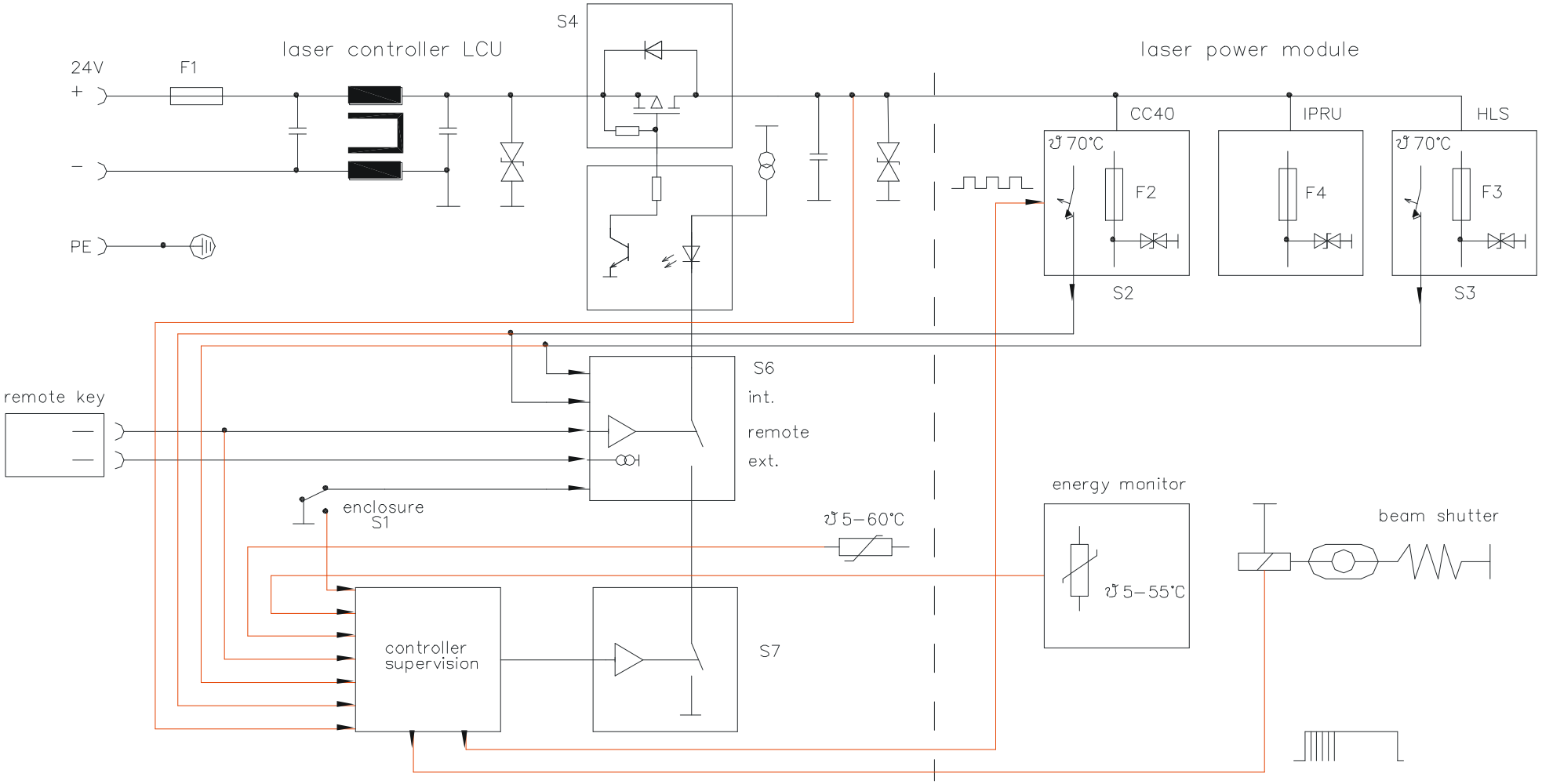
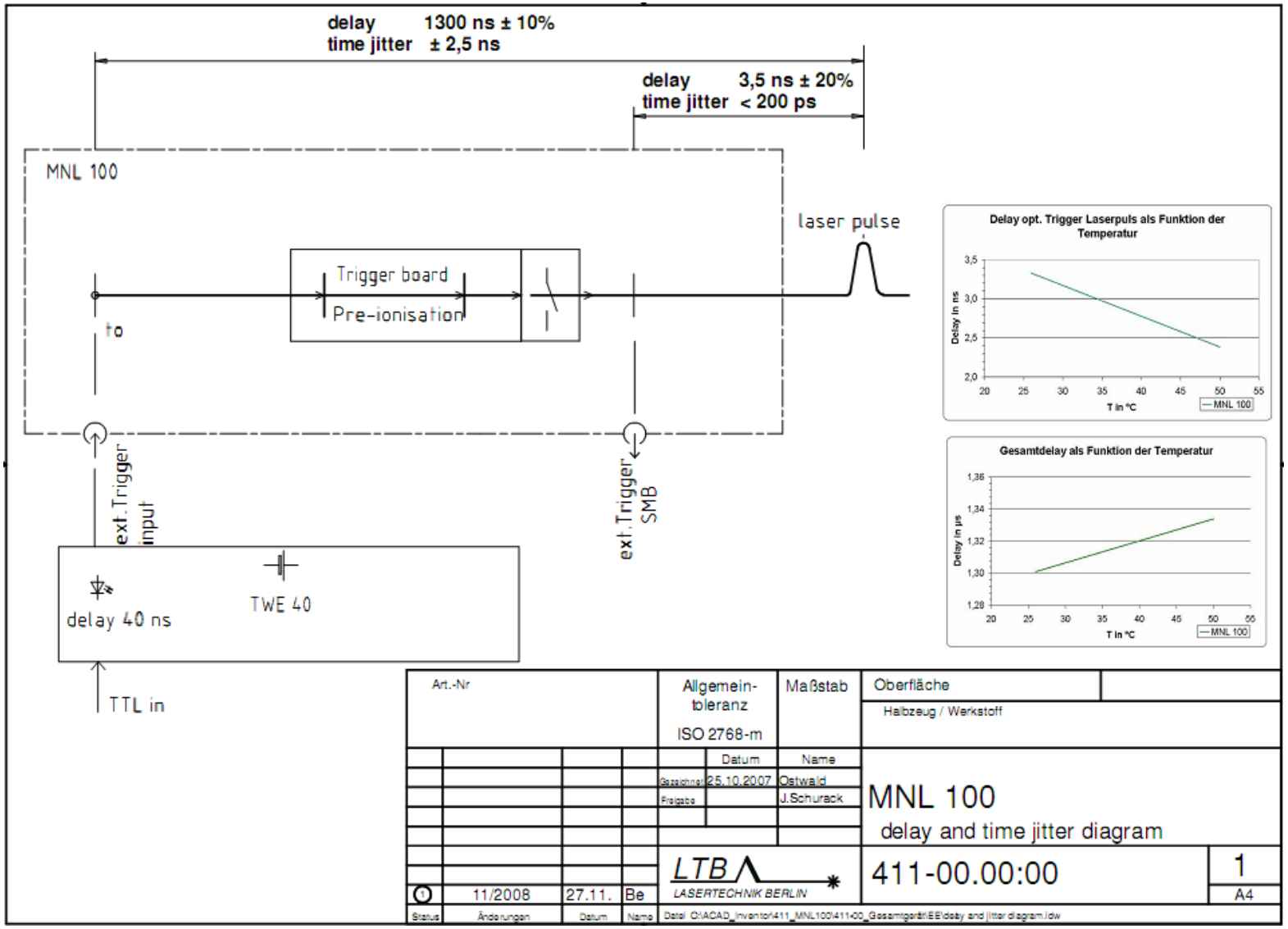
beam output	A	position beam axis
version -PD	40 mm (1,57)	0,6°
version -LD	38 mm (1,50)	0°

dimensions in mm (inch)

8.8 Functional block diagram



8.9 Safety functions



8.10 Delay and time jitter