DGM001482 (Service Manual Fiber Dust) REVISION HISTORY

Revision	Description	Prepared by:	Date
00	First release	M. Merigo	04/11/2020
01	PCC#210524TD FiberDust FW-SW New Functionalities	A. Luoni	05/07/2021

Fiber Dust

Service Manual

DGM001482.01

Rev. date 05/07/2021

 In order to avoid risks of dangerous faults, please **be sure that you carefully read this Service Manual completely before starting any operation.**

NOTE: Quanta System reserves the exclusive right to make changes and improvements at any time without prior notice, in case it was considered useful for the improvement of the product and/or of its use.

Yours,

Quanta System S.p.A.

www.quantasystem.com
quanta@quantasystem.com

Please direct all inquiries about this manual to:

Quanta System S.p.A.
Technical Support

Please fill in the following Installation Report and send it back to Quanta System Service Dept.:

via e-mail at service@quantasystem.com (scanned version),
or fax it to +39 0331 367815.

FIRST START-UP FORM

Model of the laser system: **Fiber Dust**

Serial number: _____

Nominal Line Voltage _____ **V**, _____ Hz

Checks	***Put x if performed***	***Comments***
Visual check of the laser system		
Integrity and presence of the Accessories		
Integrity and presence of the Power cord		
Functioning of the Touchscreen		
Presence of the Aiming beam out of the delivery system		
Absence of warnings or alarms		

General comments after the installation: _____

_____

_____

Distributor Company Name: _____

Country: _____

Check performed by: _____

Date / Signature: _____

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DISCLAIMER

Quanta System service manuals are written specifically for use by Quanta System Service Engineers who have received formal training in the servicing of Quanta System equipment and by customers who have taken and passed a Quanta System Certification Service Training Course for the equipment being serviced. Information on certification service training courses program offered to customers can be obtained by contacting the Technical Service Training Coordinator by phone at +39-0331-376797 (Central European time 8:30am-5:30pm) or by e-mail at *service@quantasystem.com*.

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Any servicing of Quanta System equipment by persons who have not passed a current Quanta System certification service training course for that equipment will void Quanta System's product warranty.

Content of the Service Manual

This Service Manual provides service engineers/technicians with information on the following topics:

- Safety Instructions
- Laser System Description and Installation instructions
- Operating instructions
- Laser system
- Electronic system
- Replacement instructions
- Preventive maintenance
- Troubleshooting
- Special Service Tools
- Customer Service
- Appendices

Service personnel are encouraged to familiarize themselves with the laser system and its operation. Make sure that all components within the laser can be identified. Follow the Troubleshooting Chapter to restore the performance of the laser if it does not meet or even exceeds the defined criteria.
The service manual includes the detailed descriptions of all the relevant components and procedures needed for the correct way of using this laser system along with additional electrical schematics and technical illustrations.
Upon request, Quanta System will provide additional circuit diagrams, component part lists, descriptions, calibration instructions, or other information not already contained within the technical guide, to assist the qualified technical personnel in resolving the issues.

 **Warning:** *Use of any controls, adjustments or performance procedures other than those specified herein may result in hazardous radiation exposure.*

 In order to avoid any risks of dangerous faults, please **be sure that you carefully read this Service Manual before starting any operation.**

Yours,

Quanta System S.p.A.

Tel.: +39 0331 376797
Fax.: +39 0331 367815
www.quantasystem.com
quanta@quantasystem.com

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Quanta System S.p.A.
Technical Support

1 GENERAL INFORMATION

The *Fiber Dust* is a Thulium fiber laser device emitting at a wavelength of 1940 nm, which is used by physicians as a tool in surgical procedures.

Model	**Fiber Dust**
Category of the device	Laser for medical use
Class	II b
Produced by	**Quanta System S.p.A.** Via Acquedotto, 109 21017 - Samarate (VA) ITALY Tel.: +39 0331 376797 Fax.: +39 0331 367815 www.quantasystem.com quanta@quantasystem.com

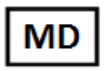
WARNING!
Equipment not suitable for use in the presence of flammable substances.

IMPORTANT!
For shipment and storage below +5°C, the cooling system must be drained.

NOTE!
To prevent damage during transport or shipment of the products we recommend using the original packaging material.

1.1 Symbols

Glossary of Symbols and abbreviations used in this Service Manual:

Symbol	Description
	Read the enclosed documentation label
	CE label
	Symbol of applied part type (i.e. optical fiber) BF According to standard 60601-1
	Symbol indicating that the device cannot be disposed of as municipal waste, but must be separated in accordance with the WEEE (Waste Electrical and Electronic Equipment)
	Manufacturing date
	Serial Number
	Medical Device Symbol
	Manufacturer
NOHD	Nominal Ocular Hazard Distance
MPE	Maximum permissible exposure
µm	Units, micrometer
s	Units, Second
mrad	Units, milliradiant
W	Units, watt
J	Units, Joule
J/cm^2	Units, Joule for centimeter square
cm	Units, centimeter
OD	Optical Density
D	Continuous laser according to EN207
L	Glasses protection degree

KV	Units, Kilovolt
A/m	Units, Ampere for metro
Vrms	Effective supply voltage
KHz	Units, Kilo Hertz
GHz	Units, Giga Hertz
WEEE	Waste Electrical and Electronic Equipment
CW	Continuous laser pulses
Vac	Volt AC
A	Units, Ampere
T	Slow blow fuse
I	Electrical Protection Class
nm	Units, Nanometre
mm	Units, millimetre
EO	Sterilization Method
Ø	diameter
SMA	Optical Fiber connector type
mW	Units, milli Watt
T on	Pulse duration laser on
T off	Pulse duration laser off
Bar	Units, Pressure
°C	Units, Celsius degree
kg	Units, Kilogram
%	Percentage
	A label that indicates the key switch off
	A label that indicates the key switch on
	Pushing Prohibited

2 SAFETY INSTRUCTIONS

As with any electrical equipment, there are potential hazards involved with the operation and servicing of this laser system. Before using the laser, operators and technicians should be aware of the following types of hazards: optical, electrical and fire. This section of the Service Manual describes these potential hazards and suggests precautions in order to avoid them.

2.1 General Safety Information

- For a safe use of the device it is necessary to know all the safety rules according to the international standards.
- This manual contains important information about the safe use of the device
- All the persons operating with this equipment have to know the operation instructions and the safety instructions specified in this manual.
- Only authorized individuals with appropriate laser training and knowledge should service the laser system.
- The laser device has to be closed. Only authorized personnel can open the external covering panels.
- Only authorized personnel providing technical service can have access to the internal components of the system.
- All the warning labels have to be continually in good condition.

2.2 Laser Classification and Working Area

This Laser System is a therapeutic device classified as a Class 4 laser following the International Standard IEC 60825-1.

This Laser has to be used in a specific working area defined and delimited following the international standards (IEC 60825-1):

 **Warning:** RESTRICTED ACCESS TO THE WORKING AREA.

The external personnel/visitors should:

- Be guided by internal personnel;
- Always wear the protective goggles inside the working area when the laser system is turned on.

2.3 Interference with other devices

This Laser Device does not include any type of direct connection with other external or internal device. This Laser Device can be disturbed by the interference of external electromagnetic fields generated by other electrical devices in the closest proximity of the laser device.

 **Warning:** *Mobile phones and similar electrical devices must be switched off when the laser device is working.*

2.4 Potential hazards

2.4.1 *Eye hazard*

The Fiber Dust laser generates laser light at a wavelength of 1.94 µm delivered by the optical fiber. Higher energy values can be generated from the laser head especially during service operations. At this wavelength and energy levels, serious and permanent eye damage can occur in cases when there is a direct or even indirect optical exposure.

The laser beam emitted by this Laser Device can cause vision loss. Any energy transmitted by this Laser Device that enters the eye will be focused directly to the retina. Direct absorption of laser energy by retina can result in temporary clouded vision clouds, retinal lesion, long-term scotoma and long-term photophobia.

A risk exists in any case of:

- Direct laser radiation
- Reflected laser radiation
- Diffused laser radiation

Following the Standard IEC 60825-1, the MPE (Maximum Permissible Exposure), NOHD (Nominal Ocular Hazard Distance) and OD (Optical Density) are calculated.

MPE (W/m²)	1000
Exposure time (s)	100
NOHD (m)	0.62
OD	2
Googles	1940 D LB2

Warning: *All the personnel present in the laser working area must wear the protective goggles in order to avoid serious eye injuries.*

Avoid direct look into the fiber or handpiece, even while wearing protective goggles.

End user and Service personnel must use protective goggles with the specifications according to the EN 207:

1940 D LB2

Always check the goggles condition.

Before wearing the protection goggles make sure that the goggles protection glass is in good condition.

Warning: *These lasers emit laser light each time the flashlamp fires. Do not look directly at laser resonator during the time the flashlamp fires, otherwise severe and permanent eye damage may occur. Make sure to wear the correct protective laser eyewear for the specified wavelength.*

Please adhere to the following precautions in order to avoid eyes damage during the operations with the laser:

- Make sure that everyone who is present during service procedures to wear the appropriate protective eyewear recommended by Quanta System.
- Never look directly into the laser light, even while wearing protective eyewear.
- Label the service rooms clearly to avoid unexpected entries during service operations.
- Limit entry to the treatment or service room only to trained employees
- Cover windows and other openings in the service room
- Take off reflective objects, such as jewelry, bracelets, rings or watches, which could reflect the laser beam to an area other than the intended service area.
- Put the laser into the Standby mode when the laser is not in use.
- Ensure that everyone present during service procedures knows how to shut down the laser system in case of an emergency.

2.4.2 *Skin hazard*

The skin can resist the higher values of laser energy but also the skin can be burned by a laser beam. If there is a need, the special protection clothing should be used.

If somebody is hurt from the laser beam:

- Turn off the laser device
- Immediately ask for a physician's assistance
- Inform the responsible person in charge of laser maintenance and safety

 **Warning:** *The Fiber Dust laser radiation is invisible to the human eye and can cause the third degree burns.*

2.4.3 *Electrical hazard*

 **Warning:** *Even when the laser is turned off and the AC line cord is disconnected, High DC Voltages on various laser components, such as capacitors bank may exist. This can present a potentially fatal electrical hazard during service procedures. Proceed with caution!*

Take the following precautions to avoid an electrical shock during the service:

- Always turn the laser off and disconnect the AC line cord from the receptacle before removing the protective cover of the laser system.
- With the laser turned off, allow the dump resistors to dissipate the energy in the capacitor bank to a safe level, approximately 45 seconds. Monitor the voltage on the capacitors bank with a DVM probe to ensure the safe level and check if HV charging indicator, close to capacitor bank, is still blinking. Wait for its complete power off. If you are still not sure, ground the capacitor bank with a shorting stick for at least five seconds.

 **Warning:** *Do not attempt to short it directly (i.e. with a screwdriver) or a potentially fatal electrical shock can occur.*

- If it is necessary to test or adjust any electrical component while the system is on, be careful not to touch any electrical components with bare fingers. Use only appropriate probes, insulated tools or insulating HV gloves.

- Become familiar with the electrical schematics and layouts of the system before attempting to provide the technical service.
- If the AC must be connected during the service routines, be very cautious around mains connected components, such as power supply feeds, circuit breakers, key switches, etc.

 **Warning:** *In case that the laser system must be tested opened, take care that hands or metals are not placed inside the system. After testing the system, make sure that all the panels are appropriately closed.*

2.4.4 *Fire hazard*

The laser radiation of this device is able to melt, burn or vaporize almost all the materials.
Fire hazard can occur due to the nature of the laser treatment. The absorption of emitted laser energy, no matter how shallow, may raise the temperature of any material. Certain precautions are required against the risk of combustible materials in and around the working area (ex. alcohol, gasoline, drapes or any other ignitable materials, etc.). It is recommended that a fire extinguisher is present in the proximity of the laser system.

When the laser beam contacts any exterior surface, the surface absorbs the laser energy, which raises the surface temperature, whether the surface is skin, hair, clothes or any flammable substance. Service personal must take the following precautions:

- Keep a minimum amount of any combustible materials (e.g. alcohol) in the service room. If it is possible, stock them away from the operating area during the technical service.
- Always keep a small fire extinguisher and water in the service room.
- Never direct the laser beam onto any surface except a power meter or an appropriate beam dump.

2.4.5 *Emission of toxic gas or vapor*

 **Warning:** *The laser radiation emitted by this laser device can melt, burn or vaporize all type of materials.*

2.5 Environmental precautions

Follow the environmental requirements to properly maintain the laser system.

 **Warning:** *Warm air may adversely affect the performance of the cooling unit.*

- Most of the heat dissipated by the laser exits on the right part. If the laser is used in conjunction with air-cooling, place the cooling unit away from the right part of the laser.
- Make sure that any warm air that may deflect from the laser is kept away from the cooling unit as well.
- Keep the air free of corrosive substances, such as salts and acids. These pollutants may damage electrical wirings and optical surfaces.
- Keep dust and hair particles to a minimum possible level. Shave patient's skin in a separate room.
- Dust and hair particles can cause permanent damage to optical components.
- Keep humidity in the laser room in the range 30% -85%.
- Keep the operating room temperature from 15° to 25°C: use of the laser at maximum power and room temperature higher than 25 °C can lead to immediate stop of operations due to over temperature interlock or inner components' damage.
- Do not place the laser unit close to heating vents or other sources of temperature variation.

3 LASER SYSTEM DESCRIPTION AND INSTALLATION

3.1 System Overview

The Fiber Dust laser system is a fiber laser system with output wavelengths at 1940 nm. The delivery system is an optical fiber. The laser device is cooled by fans and it is controlled by the control electronics with PC embedded and touchscreen display.

OPTICAL SYSTEM (See Chapter 5)		ELECTRONICS SYSTEM (See Chapter 6)	
Laser Sources	**Delivery System**	**Power Electronics**	**Control Electronics**
The laser source is composed by **fiber lasers at 1.94 µm.** The laser source integrates a fiber resonator and a delivery fibre with SMA connector.	The optical delivery system transmits the laser energy to the patient via an **optical fiber**. The fiber is connected to the laser source via a SMA905 connector. The **fiber presence sensor** and **RFID recognizer system** enable automatic detection of the presence and of the type of the fiber. If the fiber is not connected, the laser cannot operate and an “Unconnected fiber” warning appears on the screen.	The power electronics is basically composed of a **power supply module** to charge a capacitor bench that supplies the fiber laser with the necessary energy and power.	Composed by the **touchscreen display** with **control electronics**, **PC embedded, a microcontroller** and **sensors**. It regulates the functions of the laser and allows parameter selection by the User.

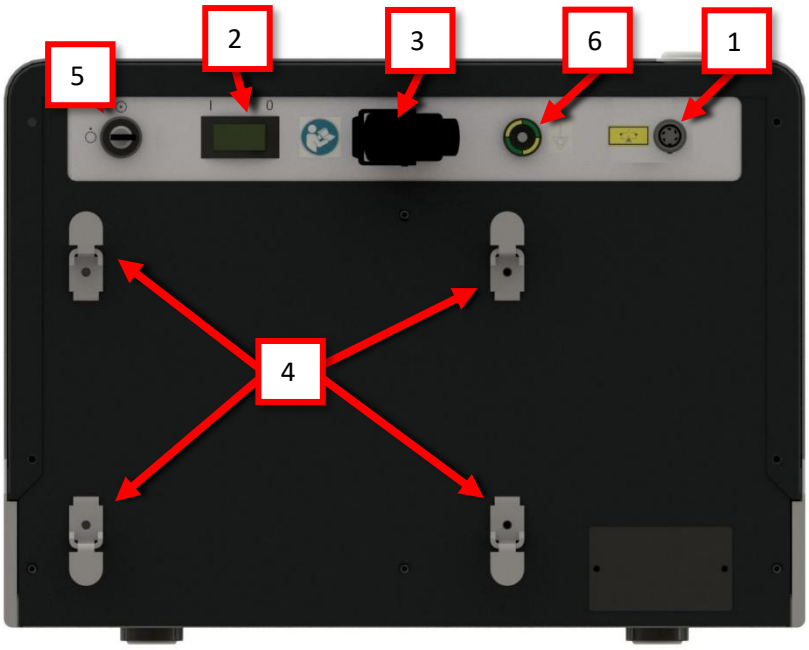
The Software functions and Operating Instructions are described in Chapter 4.

3.2 Device Components

3.2.1 *Front view*

1 Touch screen Display (control panel)
2 Emergency red push button
3 Footswitch connector
4 Optical fiber connector *(WARNING: this is a laser aperture)*
5 Hand Presence Sensor
6 RFID Antenna
7 Led indicator
8 External protection shutter
9 Frontal Button ON/OFF
10 Handle
11 USB port for Service
12 Blast Shield access
13 Air exhaust

3.2.2 *Rear panel*



1 Interlock connector
2 Power/mains switch
3 Power cable socket
4 Support for footswitch and power cord
5 Key switch
6 Equipotential connector

3.3 Power controls

The Device power controls include a main switch, the key switch and the emergency red push button.

Mains switch:

The main switch feeds the device. There are two positions on the switch: **I** and **O**.

- To switch the device ON, make the switch to **I** position.
- To switch the device OFF, make the switch to **O** position.

Key switch:

The key switch turns the device on. There are two positions on the switch: ⊙ and ○.

- To switch the device ON, insert the key and turn to ⊙ position.
- To switch the device OFF, turn the key on the ○ position and remove key.

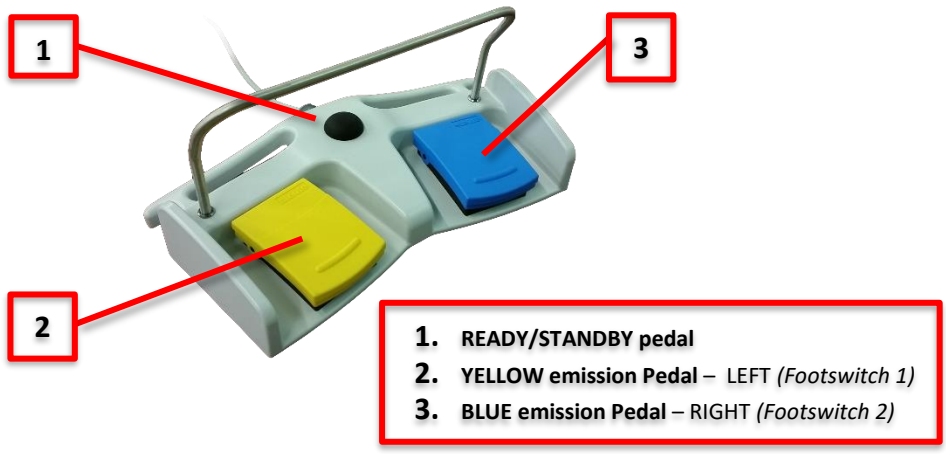
Emergency red push button:

The emergency red button is designed for emergencies or if the operator must immediately turn the device off.

- To switch off immediately, press the button.
- To reset the emergency red push button turn the knob clockwise.

3.3.1 *The double footswitch*

The double footswitch allows to change the system status (**1**) and to activate laser emission (**2-3**).



The central pedal switch (**1**) toggles between Standby and Ready status.
The two lateral pedal switches (**2-3**) activate laser emission in one of the selected treatment parameters, depending on the User choice via software.

Warning: *Do not wrap the footswitch with any plastic (or other material) film or cover bag, unless authorized by the manufacturer. The unauthorized use of wrapping bags/films may block the pedal in pressed position and cause unwanted laser emission.*

3.1 Transportation

Caution: *In order to transport the laser device, it must be gripped on both sides using the proper grooves, by at least two people, and positioned on a trolley.*

While transporting the laser, the fittings, fiber, power cord, the pedal and remote locking must be disconnected from it. Finally, the laser and the accessories should be stored in slots inside the packaging.

3.2 Installation procedure

WARNING!
The technical assistance of Fiber Dust is restricted to qualified personnel only. It is recommended that all the external staff that are in contact with the device is informed about all the safety standards.

The installation procedure must be performed each time the device is installed for the first time or after being transported by means of cars, elevators, trucks, air cargo, etc.
During installation the device must be checked for proper operation and possible malfunctions after transportation of the laser device must be corrected.
The installation procedure includes also a training course from the distributor to the user concerning the use of the medical device.
The first turn on procedure typically takes several hours, during this time the access to the installation site is forbidden. The case is normally shipped to the distributor.
It is extremely important that the packed materials be checked immediately upon their arrival, if possible, in the presence of the shipper's delivery employee, as follows:

- Open the packaging and put the laser device in a proper site for a general check.

- Execute the following operations for the general check:
    - Check the labels of the device
    - Connect the remote door interlock (rear panel)
    - Connect the footswitch (front panel of the device)
    - Connect the laser device to the power supply
    - Turn on the system
    - Check the system and verify if alert messages are displayed
    - Connect the RFID Fibers and wait that the laser system recognizes type and the number of uses of employed fibers
    - Check the system and verify if alert messages are displayed
    - Change the status of the laser system in Ready
    - Check the system and verify if alert messages are displayed
    - Change the status of the laser system in Standby
    - Turn off the system

- After the general check:
    - Remove the optical fiber
    - Remove the footswitch
    - Remove the interlock
    - Remove the key

    Note: Quanta System advises wrapping the device with a large quantity of protective plastics.

    Note: *The shipment of device to the final destination of the customer is under the responsibility of the distributor. Quanta System is not responsible for possible damage caused during this phase.*

    - Install the device in the room indicated by the customer in the following way:
        - Connect the device to the power supply
        - Connect the interlock connector
        - Connect the footswitch
        - Check the laser device

    - Perform a training to the end user on the following items:
        - Proper fiber attachment
        - Operation of the device

WARNING:

Do not start any action with the laser device before the official personnel have performed the installation procedure. The warranty is not comprehensive of any damage to the laser device before the installation.

NOTE!
Arrange the connection lines for power supply, footswitch, door contact and laser fibers in such a way that they do not represent a risk of stumbling or any other potential hazard.

WARNING!
To avoid risk of electric shock, this equipment must only be connected to a supply main with protective earth.

3.2.1 *Main device connection*

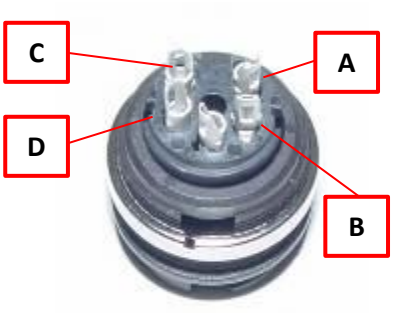
Once all the checks are made and after placing the laser device in its final position in the working area, you can connect the device to the mains. Use the cable provided. Such cable can suffer wear over time. The operator or anyone involved in the ordinary maintenance of the device after the installation must take care of monitoring the state of maintenance of the power cable.

The device must be connected to the mains in compliance with electrical safety regulations. The laser system can be connected to a power socket that provides 100-240VAC, 50/60Hz, 10A .

Caution: *Before starting to use the device, be sure that the cable lock is fixed and the cable cannot be removed.*

3.2.2 *Remote interlock connection*

According to IEC EN 60825-1 all laser devices must be equipped with a remote block connector, connected to the room access door, which prevents laser emission when the door is opened. An appropriate micro-switch shall be wired to the remote door interlock cable and mounted on the doorframe so that a contact closure is activated when the entrance door to the treatment area is closed. Before operation, please check if the remote door interlock cable leading to the door-mounting micro-switch is connected to the rear panel of the laser unit. As shown in the picture, a lamp should be mounted at the entrance of the operating room, on the door frame. The lamp should light when the laser is turned on and the entrance door to the working area is closed.
The connection, or the sequence of connections, has to be wired with a suitable cable to the interlock connector during the device installation. The interlock connector is wired on the laser side in the following way:



Interlock male movable connector
(inner view)

The external door microswitch has to be connected to pins A and B.
Contacts C and D close the signal lamp circuit (max current 1A, 24Vdc).

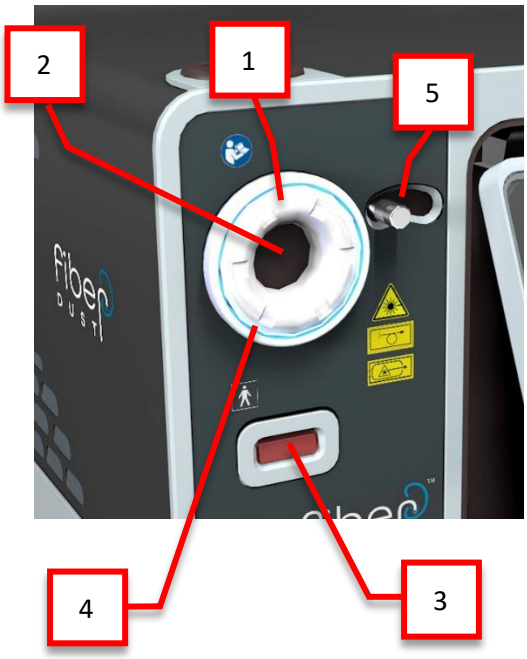
3.2.3 *Footswitch connection*

The light emission is controlled by the external **footswitch**.

Double pedal

To connect it, put the footswitch connector to the dedicated device socket (frontal panel).

3.2.4 *Optical fiber connection*



The fiber is connected to the device through the cable connector on the front.
A dedicated sensor recognizes the presence of your hand, opening the external shield of the fiber connector.
The device accepts fiber with SMA905 connector and with RFID Recognition System (only with Quanta System internal code). The fiber connector has an additional ring which facilitates the clamping of the fiber to the connector on the device. Furthermore, this ring enables the automatic detection of fiber status (present / absent), its diameter and its type (single use / reusable). If the fiber is not connected to the device, an error message is displayed when the device is switched on.

N°	Component description
1	RFID Antenna
2	Optical fiber connection location
3	Hand Presence Sensor
4	Led indicator
5	External protection shutter

3.3 Laser first start-up

Check the laser device, calibration and standard operation:

- Follow procedure given in **Chapter 4** for start-up the laser;
- Check the correct operation of key-switch and emergency button;
- Check the laser operation as follows:
    - Wait few seconds till the main screen will appear. In case of Alarm, please refer to Troubleshooting Chapter. Be sure also that the aiming beam is present out of the optical fiber;
    - If the aiming beam is not visible, the fiber may not be well inserted or it may be damaged. If damaged, the fiber should not be used anymore;
    - Select the 365 µm optical fiber;
    - Select the desired laser settings;
    - Enter in Ready mode;
    - Place the in fiber in front of a suitable power meter
    - Press the footswitch and check the laser emission from the optical fiber.
    - Do not fire the laser immediately at the maximum power but check emission starting from lower output power levels and increasing step by step.
    - If energy warning HIGH or LOW is displayed, go to troubleshooting Section;

- If everything is OK, use the external power meter indicated as tool in Chapter 8, to compare the power settled on the display with the one coming out from the optical fiber. As reference, perform the power measurements reported in the Optical test of the Product Sheet of the system:

  Example

Optical test **Test fiber: 365 µm**	
CW mode	**Displayed Power**
	20 W
	Measured Power

If the measured powers are low or do not match with the displayed ones (±20%), go to troubleshooting Section

- If everything is OK, turn off the system and complete the *Installation Report.*

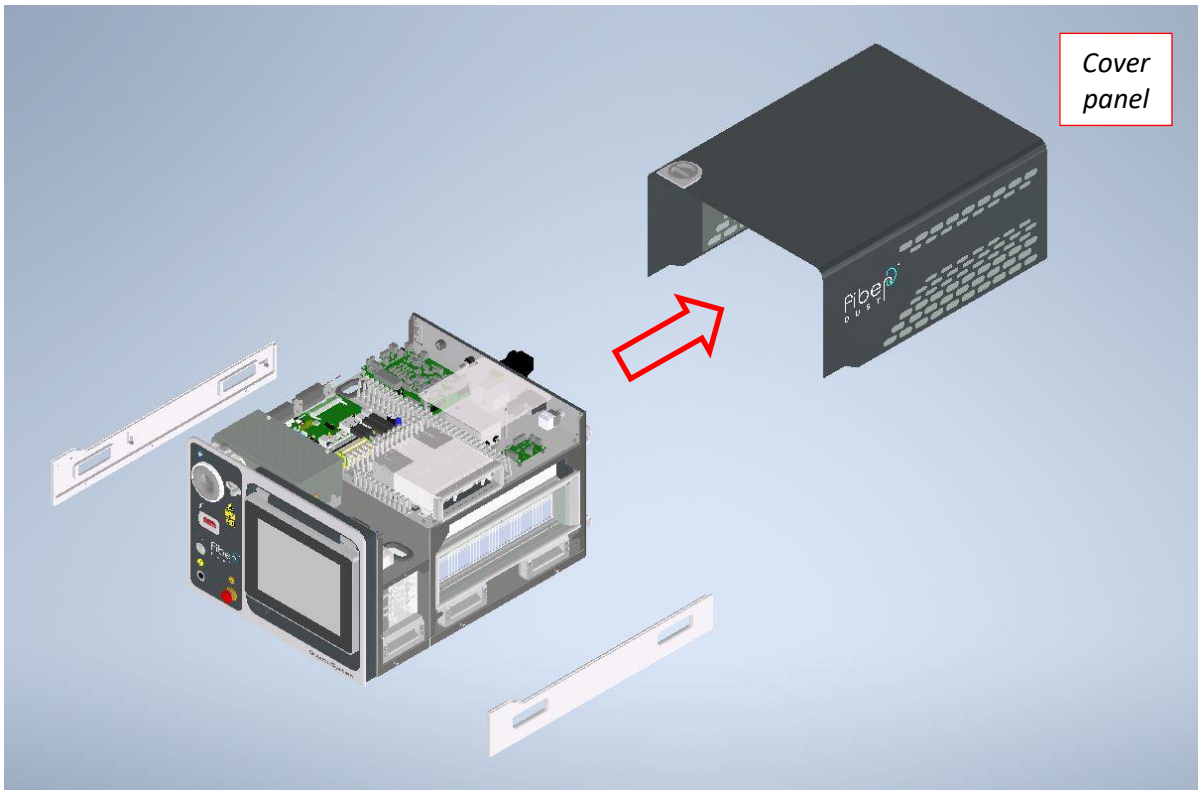
NOTE: *Contact Quanta System Service Department, or the authorized distributor if performance results cannot be obtained for any of the steps, or if it is noticed during the installation.*

IMPORTANT: Fill out an Installation Check Sheet during the installation process.
A sample form is reported at the pag. 4.
Return the completed form by fax or e-mail to Quanta System Service Department.

3.4 Removing the system covers procedure

Whenever necessary to access internal part of laser system, follow below procedure to remove the system covers; please, refer to the figures below.

- Switch the system off and unplug the mains cable
- Remove the optical fiber from the front panel
- Unscrew the 4 fixing screws of the cover panel on the back of the device
- Slide the cover panel toward the back of the device and pull it out
- If necessary, remove the lateral covers by unscrewing their 6 fixing screws.



4 OPERATING INSTRUCTIONS

For *Fiber Dust* operating instructions in USER Mode, refer to the proper Section of the User Manual.

In this Chapter functions, settings and Service general parameters, accessible by entering in the SERVICE area, are described.

4.1 Startup procedure

Before proceeding with the startup procedure of the device, verify the correct connection of the following parts:

- Power supply cable
- Interlock connector
- Key switch
- Footswitch
- Optical fiber

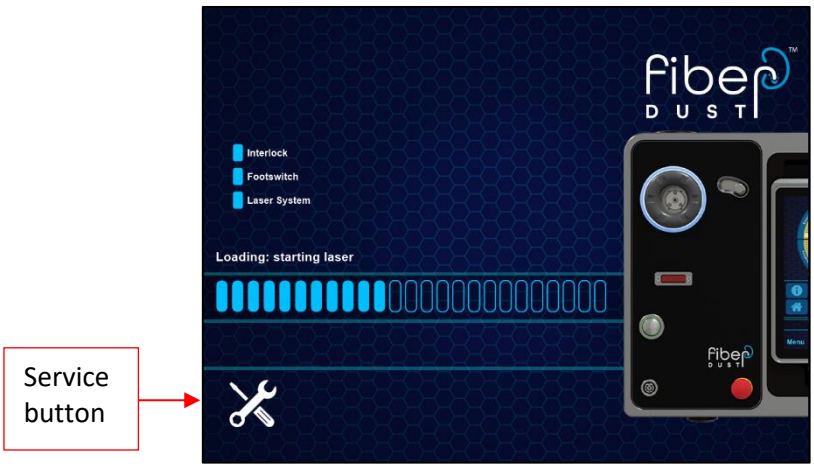
Also, make sure the emergency red button is not pushed.

To turn the device on:

- Switch the mains switch on **(1)**
- Insert the key switch **(2)** and turn clockwise, towards the ⊙ symbol. Press the ON/OFF button on the frontal panel. If the laser fails to start, check the emergency push button is not pressed. If the emergency push button is unpressed, twist to the right to release the button and turn the key to start the laser.

4.1.1 *The Touchscreen PC panel – Startup*

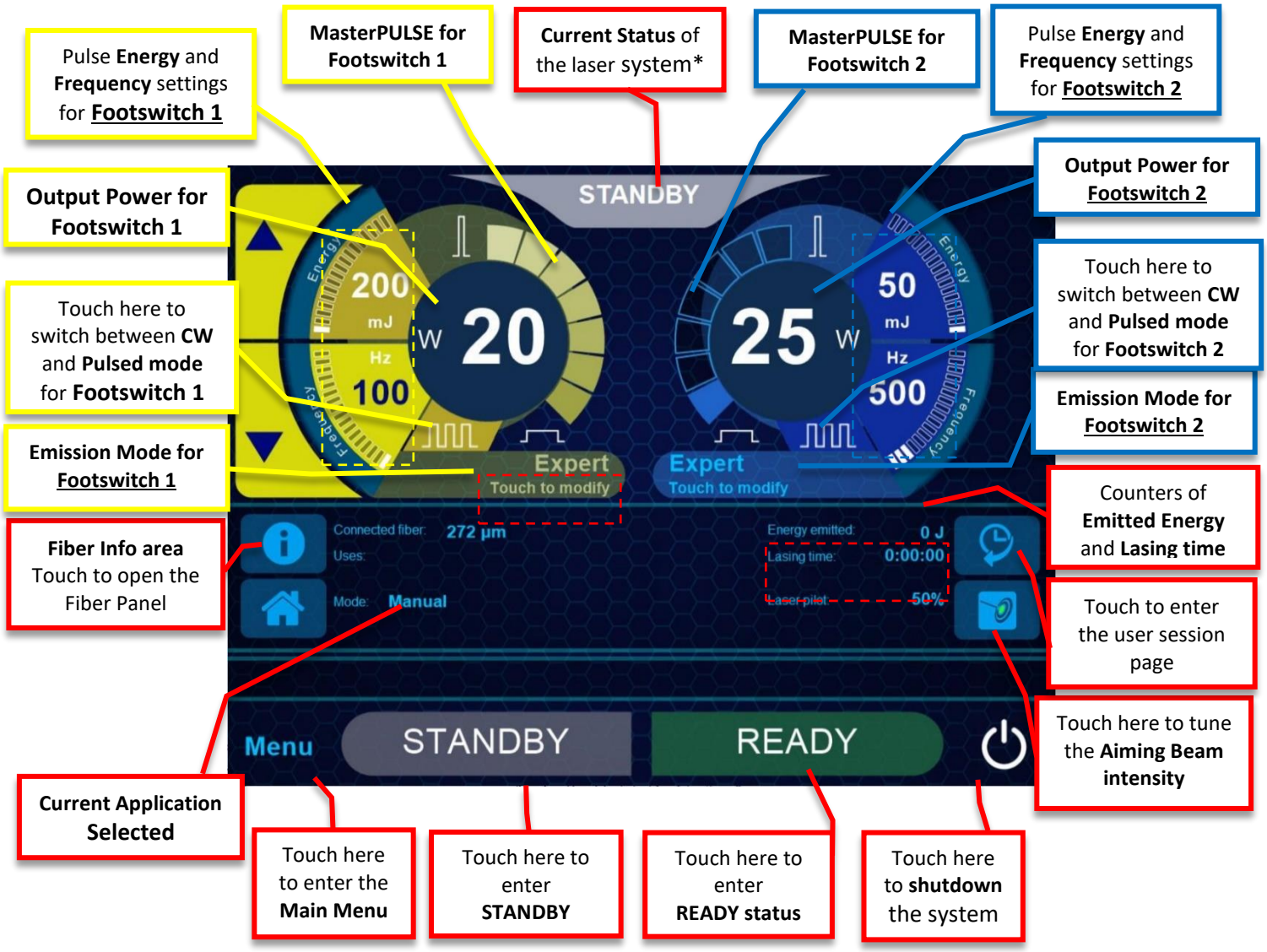
When the laser starts up, checks safety and auto-calibration.
The touchscreen panel displays the status of the controls check:



From this screen it is possible to enter in SERVICE mode (from its button) or wait until the system completes the warmup and enter from the Main Menu→Device settings→Service.

4.1.2 *Main User Screen*

The Main User Screen contains the controls and displays the settings for operating and monitoring the laser. It is essential that operators understand and use these controls properly.



<u>For further details on operating instructions in USER Mode, refer to the proper Section of the User Manual.</u>

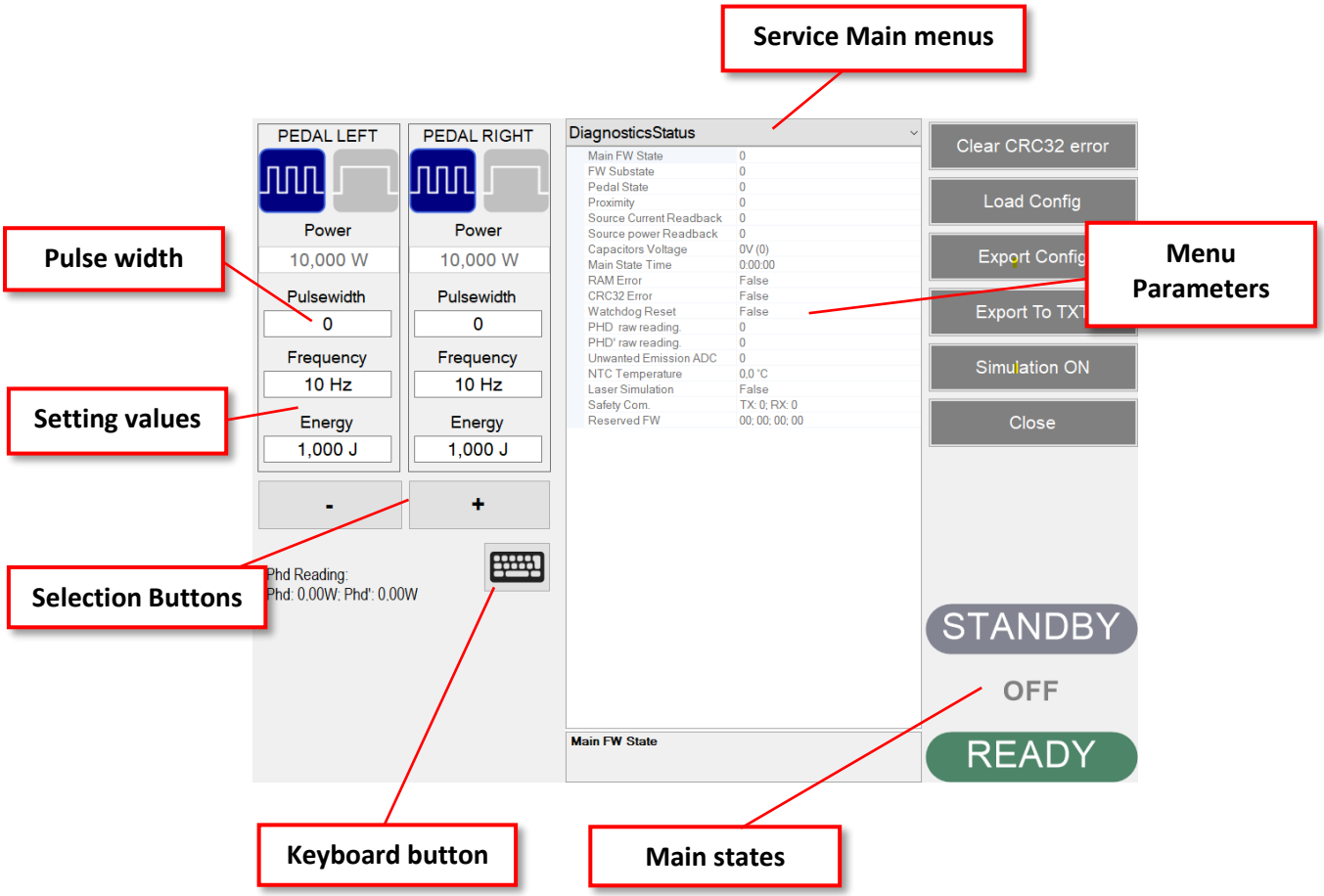
4.2 SERVICE Mode (for Technical Service only)

From the SERVICE screen it is possible to have access to the Diagnostic area and setting area.

Enter the password “Q-SERVICE” to access to the Service functions.

Press “←” to return to the Main Screen.

In the main service page it is possible to see the status machine, the pedals settings, the photodiode values, the number of pulses and all the parameters.



4.2.1 *Main state*

0 OFF
1 Debug – not for service use
2 ERROR (message status)
3 Wait 1(temporary status)
4 Wait 2(temporary status)
5 Wait 3(temporary status)
6 STANDBY
7 Wait to ready (temporary status)
8 READY
9 LASING
10 **STOP (temporary status, footswitch press too early)**

The technician can force a stable status; the displayed value will be updated as soon it is really reached.

4.2.2 *Setting values*

- **Pulse width**
- **Frequency**
- **Energy**

The setting values are used to set the laser parameter for each footswitch, the left column for the left pedal, the right column for the right one.

4.2.3 *Service Main Menus*

*A drop-down menu is present at the top right screen.
You can choose the following menus:

- **DiagnosticsIO32**
- **DiagnosticsStatus**
- **DiagnosticsSource**
- **Errors**
- **General parameters**
- **SourceCalibration_CW**
- **SourceCalibration_PulseShort**
- **SourceCalibration_PulseMedium**
- **SourceCalibration_PulseLong**
- **FinalCalibration_PulseShort**
- **FinalCalibration_PulseMedium**
  FinalCalibration_PulseLong
- **DiagnosticRFID**
- **SoftwareSettings**
- **FiberSettings**
- **VersionInfo**

Note: only the grey cell values can be changed.

4.2.3.1 *DiagnosticsIO32*

The diagnostic OUTS32 menu shows the digital signal outputs of the Microcontroller board; they are factory-use:

0 TFL_REMOTE_START_OUT
1 TFL_KEY_OUT
2 TFL_ERROR_RESET_OUT
3 ENABLE_78V
4 CW_ENABLE
5 OUT_C15
6 OUT_C14
7 OUT_DOOR
8 OUT_SHUTTER1
9 OUT_C9
10 OUT_POINTER
11 OUT_C7
12 OUT_C6
13 TFL_EMISSION_ENABLE_OUT
14 OUT_FIBERCK
15 OUT_EXT_RELAY
16 OUT_LED_BLUE
17 OUT_LED_GREEN
18 OUT_LED_RED
19 OUT_19
20 OUT_20
21 OUT_21
22 OUT_22
23 OUT_23
24 OUT_BUZZER
25 OUT_LED_LD3
26 OUT_26
27 OUT_27
28 OUT_28
29 OUT_29
30 OUT_30
31 OUT_31

4.2.3.2 *DiagnosticStatus*

The diagnostic INS32 menu shows the digital signal inputs of the Microcontroller board; they are factory-use:

0 IN_BLAST_ILK
1 IN_FIBER_ILK
2 IN_EXTINT
3 IN_FTSNC
4 IN_FOOTREADY
5 IN_FTS2NO
6 IN_FTSNO

7 **IN_FTS2NC**
8 **POWER_SUPPLY_ACTIVE**
9 **TFL_POWER_ON_IN**
10 **TFL_EMISSION_ON_IN**
11 **TFL_ERROR_READY_IN**
12 **IN_A16**
13 **IN_A15**
14 **IN_A14**
15 **IN_A13**
16 **IN_SHUTPOS1**
17 **IN_17**
18 **IN_THERMO_SW**
19 **IN_10**
20 **IN_NOT_ENACC_MON**
21 **IN_AL_OVT_CH**
22 **IN_PREAL_OVT_CH**
23 **IN_EOC**
24 **IN_24**
25 **IN_25**
26 **IN_26**
27 **IN_27**
28 **IN_28**
29 **IN_29**
30 **IN_30**
31 **IN_31**

4.2.3.3 *Diagnostics*

In the Diagnostics menu you can see the parameters and the analogic signals; the parameters are:

- **MainState**
- **pedal_state**
- **CurrentError**
- **Proximity**
- **SourceReadback (Current, Power)**
- **AverageVoltage**
- **effective_v1000**
- **Sub State**
- **mode_pulsing**
- **MainState Time**
- **CurrentSettingIndex**
- **fiber_index**
- **laser_mask**
- **beam_index**
- **Frequency**
- **PulseEnergy**
- **Pmax**
- **Power**
- **TreatmentEnergy**
- **UserCounter**
- **TreatmentTime**
- **applied_v1000**
- **qwErrorBits**

- **RAM error**
- **Program CRC32 error**
- **StartedFromWatchdogReset**
- **effective_ton_0**
- **phd_energy_0**
- **phd_raw_0**
- **phd_energy_1**
- **phd_raw_1**

Parameters main explanation:
Main State: it shows the present status.
Pedal_state: it shows the pedal status.
CurrentError: it shows the present error.
Proximity: current value of the hand sensibility of the fiber actuator.
Frequency: current frequency value.
PulseEnergy: current Pulse energy value.
Pmax: Maximum power value.
Power: current Power value.
TreatmentEnergy, UserCounter, **TreatmentTime** are counters that can be reset by the user at the treatment end.
applied_v1000: it is the applied voltage expressed in bit.
Program CRC32 error is a debug signal.
effective_ton_(n): it means the lighting delay time expressed in us.
phd_energy_(n): current photodiode energy expressed in mJ.
phd_raw_(n): current photodiode energy expressed in bit.
Parameters not mentioned are factory-use.

4.2.3.4 *Diagnostics: settings*

In the Diagnostics settings menu you can set the following factory parameters; they are:

- **Frequency**
- **PulseEnergy**
- **default i**
- **default t**
- **current i**
- **current t**

4.2.3.5 *Errors*

The Errors menu shows the error present; an asterisk means an active alarm; they are:

- **Blast Shield not present**
- **Remote interlock open**
- **Unconnected Fiber**
- **Unconnected Pedal**
- **Pressed pedal in standby**
- **Low Energy**
- **Calibration table error**
- **High Energy**

- **Very Low Energy**
- **Very High Energy**
- **Energy Sensor ERROR**
- **PC Timeout**
- **Unwanted Emission**
- **Watchdog Error**
- **Laser Source ERROR**
- **Discharge Resistor Overtemperature**
- **Charge Cap Error**
- **Shutter not Closed: ERROR**
- **Shutter not Open: ERROR**
- **Both pedals pressed**
- **Source current set ERROR**
- **Charge current error**
- **Source Fiber Interlock error**

Main parameters explanation:
Blast shield not present: it indicates the blast shield is not in the correct position.
Remote interlock open: it indicates that the remote interlock is not connected
Unconnected Fiber: it indicates that the optical fiber is not connected
Pressed pedal in standby: it indicates that one of the pedals is pressed in the standby state**Unwanted Emission:** it indicates photodiodes detect emission without footswitch pressed.**Watchdog Error:** it indicates that the FW on the microprocessor stopped working properly.
Laser Source ERROR: generic alarm from the Fiber laser
Discharge Resistor Overtemperature: it means high temperature of the power resistors.
Charge Cap Error: it means the capacitor voltage is under the threshold.
Low Energy (n): the detected energy is <20%.
High Energy (n): the detected energy is > 20%.
Very Low Energy (n): the detected energy is less than 20% of the setting power.
Very High Energy (n): the detected energy is more that the double of the setting power.
Energy Sensor ERROR (n): it means there is a wrong data coming from the photodiodes.
Shutter not closed/open: it means that the shutter is not in the set position.
Both pedal pressed: both pedals are pressed simultaneously

4.2.3.6 *General parameters*

The Service general parameters menu shows the following parameters:

- **Footswitch Type**
- **Source type**
- **Phd Integration Time**
- **Dinamic Threshold_mj**
- **Frequency Threshold**
- **Power button presence**
- **Proximity Threshold**
- **T min**
- **T max**
- **Power Max**
- **H20_thermistor_r25 (NA)**
- **H20_therimistor_beta (NA)**

- **Charge Voltage Max**
- **Charge Voltage Threshold**
- **Fiber Source Interlock Presence**
- **Autostendby time [10s]**
- **Serial Number**
- **Phd Mode 0**
- **Main Phd Offset**
- **Main Phd Calibration**
- **Secondary Phd Offset**
- **Secondary Phd Calibration**
- **Phd Mode 1**
- **Main Phd Offset**
- **Main Phd Calibration**
- **Secondary Phd Offset**
- **Secondary Phd Calibration**
- **Phd Mode 2**
- **Main Phd Offset**
- **Main Phd Calibration**
- **Secondary Phd Offset**
- **Secondary Phd Calibration**

Main parameters explanation:
SN: machine serial number.
ReadyAlwaysPulsing: in Ready status pulses are emitted if this parameter is set to 1; otherwise the laser source is turned off.
Tmin and **Tmax** are the pulse duration absolute limits.
Autostanby_secx10 is the waiting time to enter in standby mode expressed in seconds with a x10 factor.
The **proximity_threshold** refers to the hand sensibility threshold for the fiber actuator.
The **phd_offset (n)** refers to the initial photodiode reading; please refer to section 7.3.1.
The **phd_calibration (n)** represents the saturation values at high energy; please refer to section 7.3.1.
Parameters not mentioned are factory-use.

4.2.3.7 *Single/Final calibration table regime "n" Short/Medium/Long pulse*

The SINGLE CALIBRATION TABLE REGIME shows the settings of a **single cavity** for a kind of application.
The values are:

- **Hz**
- **Emin**
- **Emax**
- **I@Emin**
- **t@Emin**
- **I@Emax**
- **t@Emax**

Here below their explanation:

- **Frequency** [Hz].
- **Emin**: Energy minimum [J]; the value represents the real value with a x10 factor.
- **Emax**: Energy maximum [J]; the value represents the real value with a x10 factor.
- **I@Emin**: Current for minimum energy [0..1024].
- **t@Emin**: Pulse for minimum energy [0..1024].
- **I@Emax**: Current for maximum energy [0..1024].

- **t@Emin**: Pulse for maximum energy [0..1024].

Note: in case of a frequency not in the table, an interpolation will calculate the Energy and time values.

4.2.3.8 *RFID*

The RFID menu shows the Diagnostics RFID parameters; they are:

- **Tag Data**
- **RFID Reader connected**
- **RFID Reader FW Version**
- **RFID Tag Status**
- **RFID Reader error**

4.2.3.9 *Fiber Settings*

The Fiber menu shows the Diagnostics parameters about the fiber connections; they are:

- **Policy**
- **Policy change Allowed**
- **10x Allowed**
- **Fiber Session Extension**
- **Fiber Session Extension time**
- **RFID timeout**
- **Fiber policies**

4.2.3.10 *Software Settings*

In the SOFTWARE SETTINGS menu, there are the software settings; they are:

- **System Name**
- **Demo Mode**
- **Chiller type (NA)**
- **Laser COM Port**
- **RFID COM Port**
- **Chiller COM Port**
- **Source Port/Ip**
- **Part Number**
- **Treatment Session Max**
- **Max Power**
- **Surgical Factory Preset**

4.2.3.11 *Source Calibration_CW*

- **I Set**
- **Power [mW]**
- **Phd0 (NA)**
- **Phd1 (NA)**

In the column “Power” the calibrated power values are available. In the same row but in the column “PWM” the relative laser source current are available.
The values in “Power” are factory presets, while the PWM values can be modified in order to calibrate the CW emission.

4.2.4 *Selection buttons*

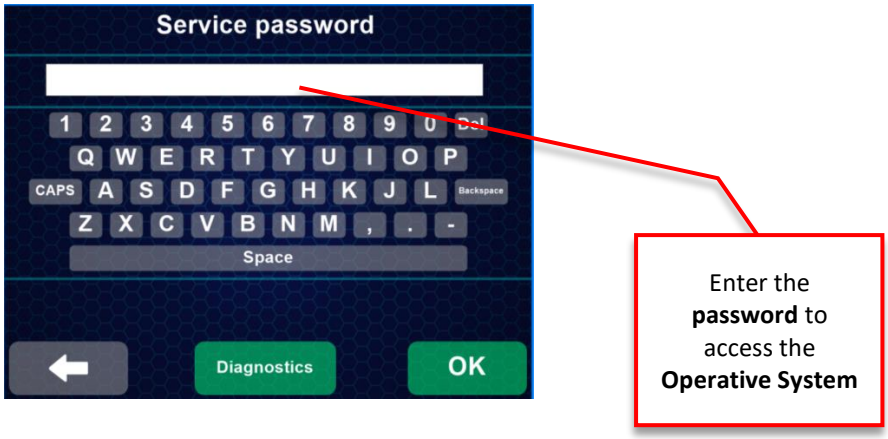
In the bottom of the Service screen there are the following buttons:

- **Clear CRC32 error** to reset the CRC32 microcontroller error or after a FW update.
- **Simulation** (0= Demo mode OFF; 1= Demo mode ON).
- **Export Config** to save the parameters in a file.
- **Load Config** to load the parameters from a saved file.
- **Export to TXT** to write the parameters in a .txt file in the Data directory in the folder sw application.
- **Close** to exit from the Service menu to the User menu.
- **Keyboard opens a on-screen keyboard that can be used to type values.**

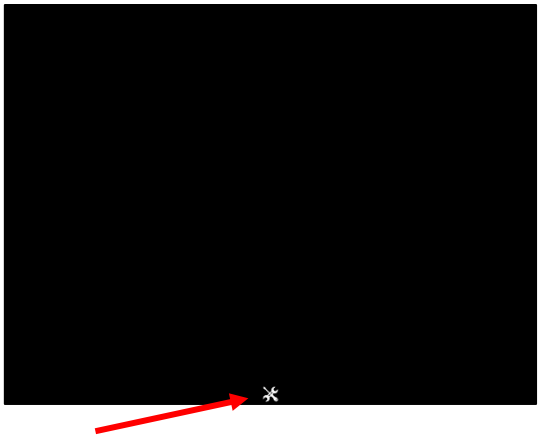
4.3 Firmware and Software updates

4.3.1 *Firmware update*

From the SERVICE screen it is possible to close the Laser SW GUI and have access to the Operative System by entering the password “EXIT”:



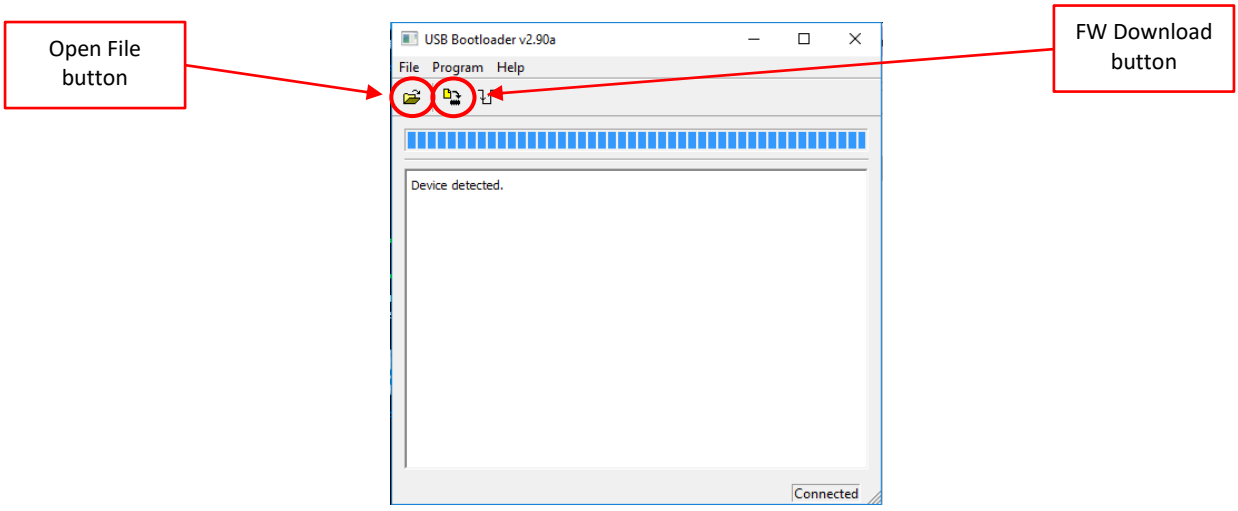
The following image appears:



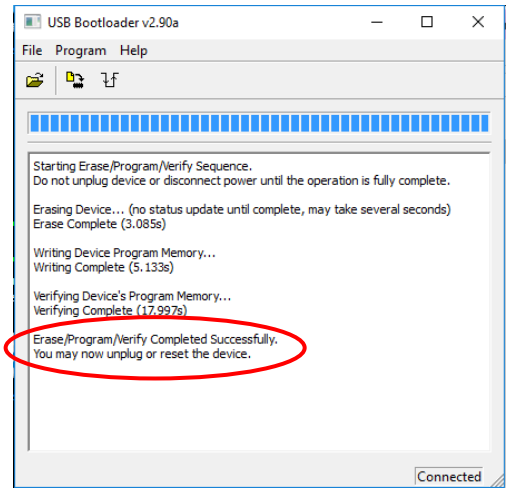
Click on the “tool” icon on the bottom center side of the display. The Operative system will start, with the task-bar “hidden”:

Then connect to the rear left PC USB port the USB stick memory where the new Firmware is stored and save it locally (on the pc desktop).
Remove the USB stick memory and restart the unit.
Connect a USB bridge between two USB ports.

Enter in the service menu and digit the password “BOOTLOADER”; in this way the USB Bootloader SW starts automatically.
On the USB Bootloader main window, they should appear: “Device detected” and “Connected” label in the bottom right corner.



Then import the file “.hex” using the Open File button and pointing to the file.hex saved on the pc desktop.
After that download the Firmware by clicking on the “FW Download button”.
During the process 5 beeps are emitted.
At the end of the process on the USB Bootloader main window it should appear the indication of “Verify Completed Successfully”, see next image;
After that you should restart the machine and remove the USB bridge.



As alternative, it is possible to directly connect a notebook to the USB right rear port and follow the procedure; to reset the microcontroller board turn off, then on the machine from the rear main switch.

After a FW update, restart the system and clear the FW CRC32, if the alarm “Critical error: FW CRC32” appears. To reset this alarm, digit service password and press diagnostics button (not OK button).
Then scroll the page and search the line FW CRC32, press the red line on the side, a pop-up will appear, confirm it; after this the system restart and delete the error.

<u>In case of both FW and SW updates</u>, follow these steps:

1) FW update
2) SW update
3) FW CRC32 reset(*)

(*)For only SW update, the FW CRC32 reset is not necessary.

4.3.2 *Software Update*

Execute the procedure described in the Service Instruction **IS_00015_rev** (contact Quanta System Service Dept.).

4.3.3 *Restore User preset*

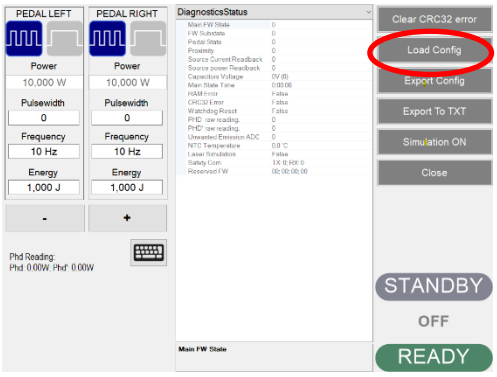
Copy “Data” folder from path:

D:\QuantaSystemYYYYMMDD\LaserApp*
into
D:\QuantaSystem\LaserApp

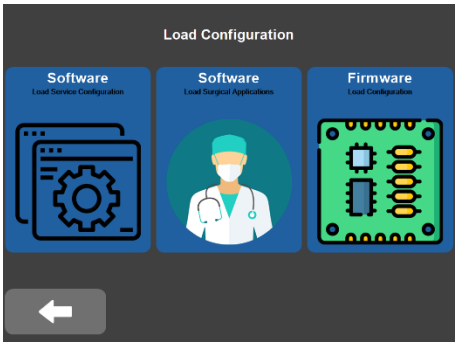
*: *YYYYMMDD refers to the actual date of the SW update.*

4.3.4 *Configuration loading*

In the Service screen, press “Load Config” to load the configuration files.



The following screen is displayed; select the default file to be loaded, by clicking on "Load Database Configuration" the windows browse window opens and you have to open the folder with the machine code required in the SD card. Repeat the action with the "Load Firmware Configuration" button.



5 OPTICAL SYSTEM

5.1 Optical System layout

The *Fiber Dust* **Opto-Mechanical system** comprises one Fiber laser module and an optical bench to launch into the delivery fiber.

The Fiber laser module is located in the bottom part of the laser system, to replace it, refer to §7.1.
The optical bench is in the top part, under the cover; see Figure 5.1.

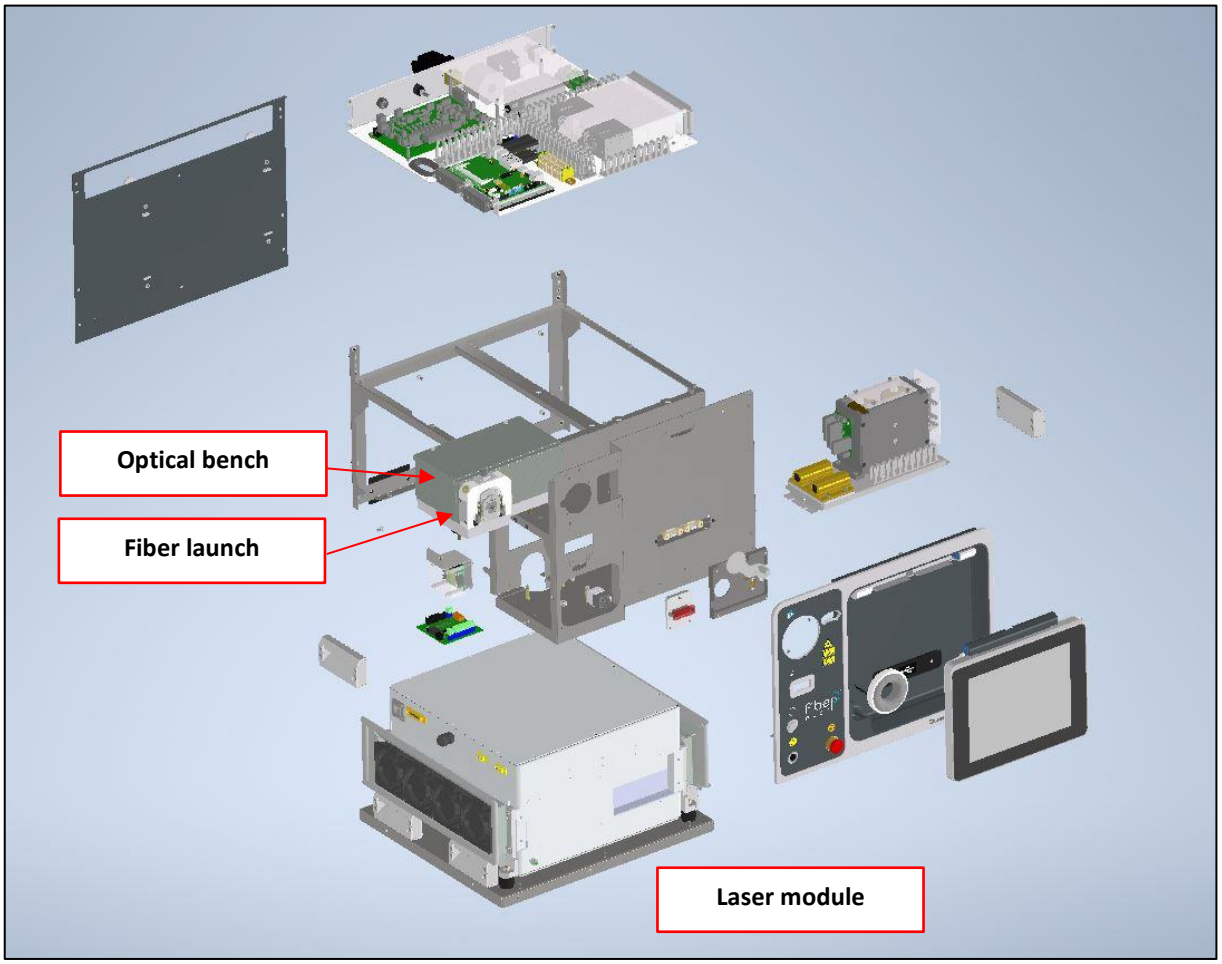
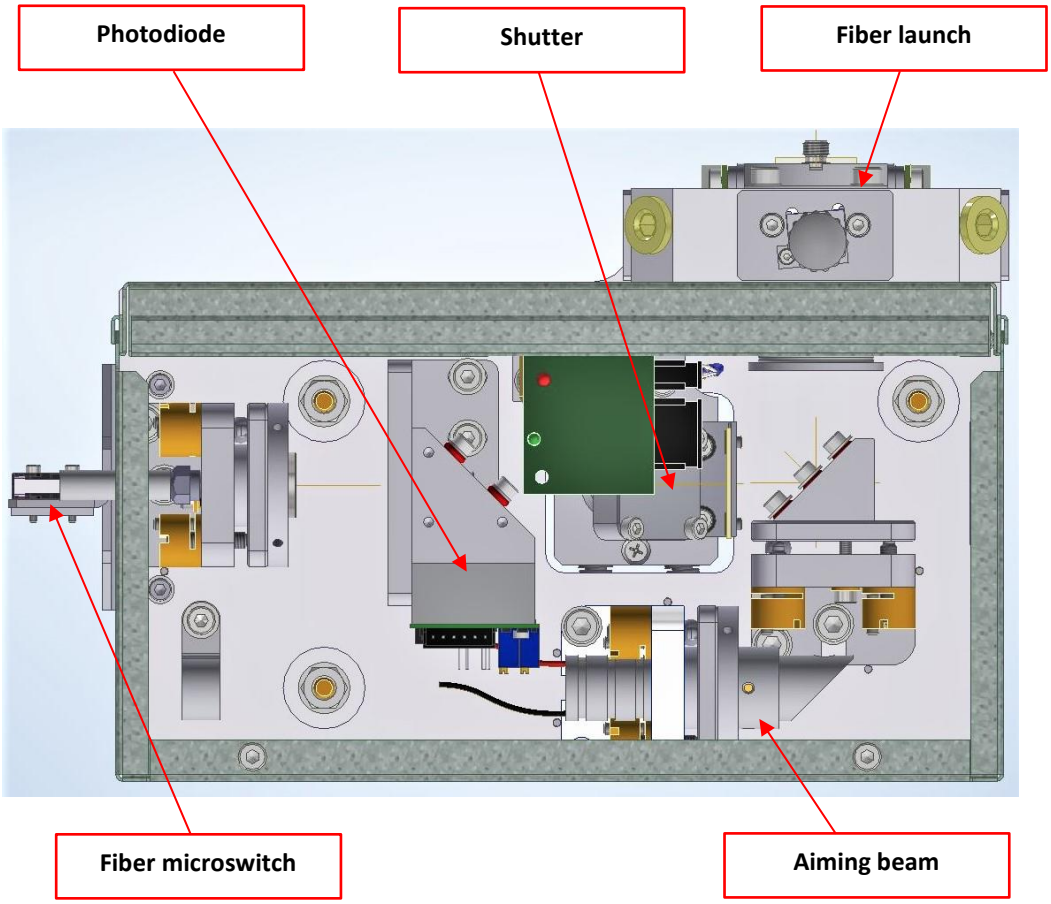


Figure 5.1: Optical module location and RFID antenna**.**

5.1.1 *Optical bench*

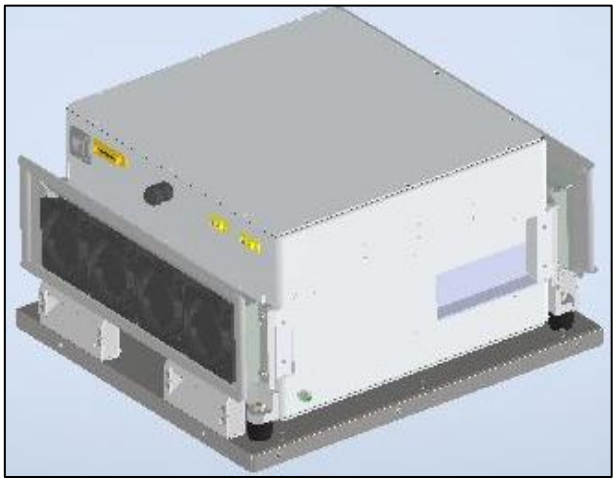
The optical bench contains the photodiodes, shutter, aiming beam and fiber launch with RFID antenna.
A metal cover is mounted over the optical bench to protect the optics from dust contamination. It also protects the operator/service technician from optical hazards. See § 7.2.



Warning: *Unless required for servicing procedures, the laser should not emits with the cover removed.*

5.1.2 *Fiber laser module*

The fiber laser module is a compact block in the bottom part of the unit.
In case of trouble, replace all the block, please refer to chapter 7.



6 ELECTRONICS SYSTEM

6.1 Introduction

The electronics of the *Fiber Dust* laser system is composed of three distinct subsections:

1. **Control electronics:** including I/O interface and all low-level logics which are used to process signals from the laser sensors and to produce commands to operate the system.
   Specifically, the control electronics provides:
   - Control of human interface: touchscreen display, buzzer and footswitch
   - Control of power supply
   - Monitoring of safety interlocks: external interlock, fiber optic sensor
   - Interfacing with internal power meter (photodiode)

   In particular, the control electronics subsystem contains the following main boards:
   - Display touchscreen TFT 10.4''
   - PC embedded
   - Controller board
   - Signal routing board

2. **Power electronics**: containing all devices involved to produce and deliver voltage to all electronics components.

   The Power electronics provides following features:
   - Supply Vac line voltage, through line input loop (emergency button and key switch)
   - Supply low voltages to all electronic devices

   The power electronics contains the following parts:
   - Voltage power supply 24V and 20V modules.

3. **Sensors:** including all sensors displaced inside the machine:
   - Fiber sense interlock
   - Fiber RFID
   - Proximity sensor

6.1.1 *Electronics system overview*

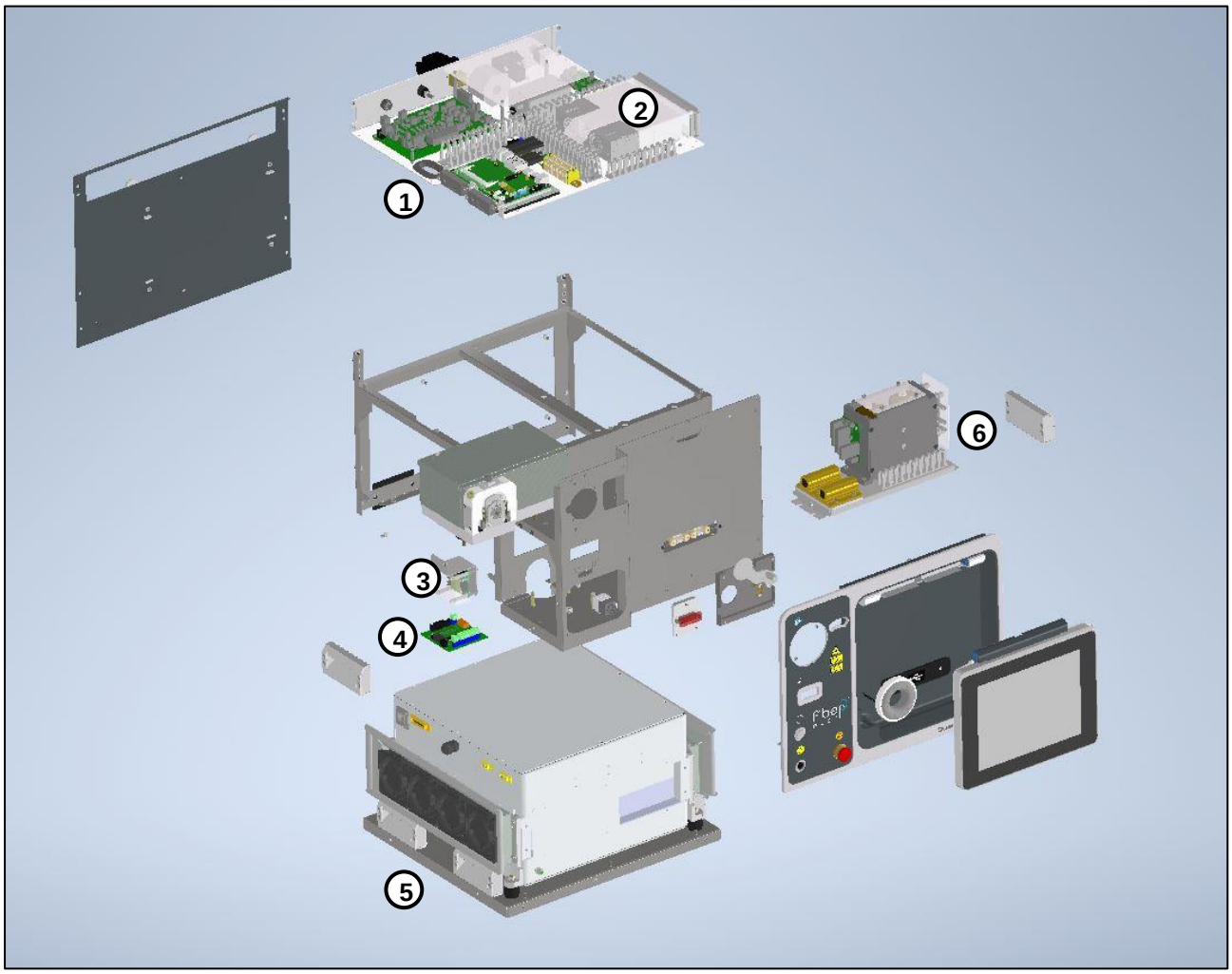
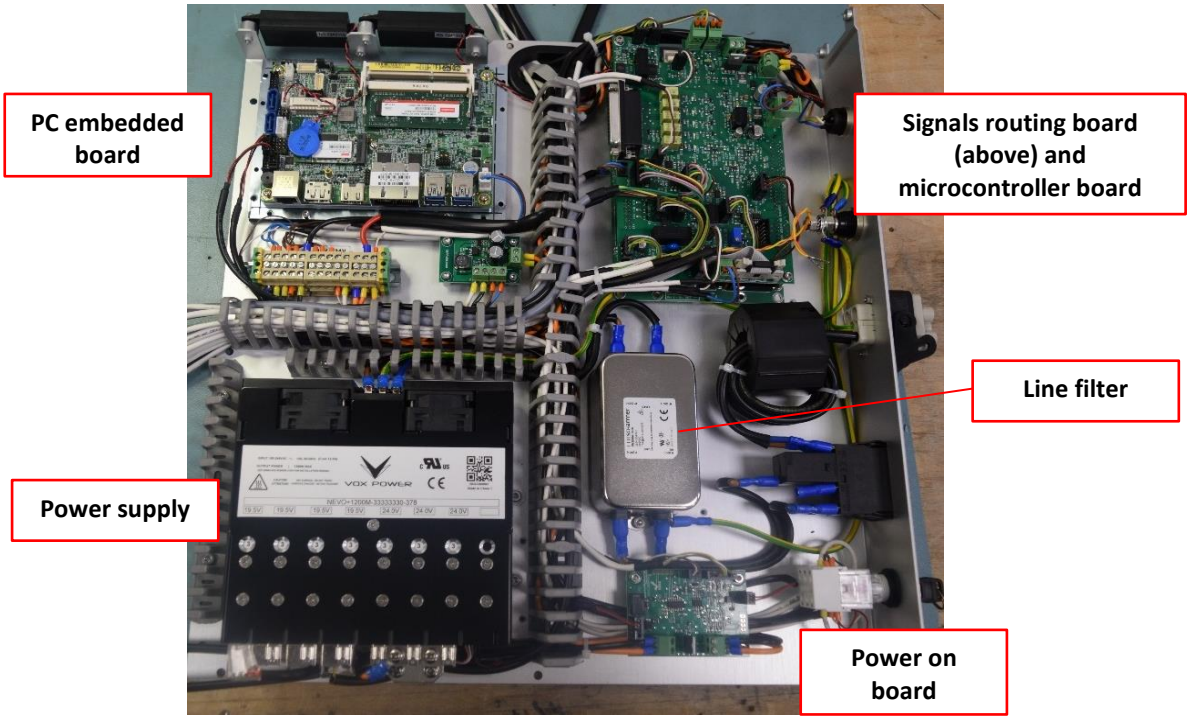


Figure 6.1: Electric system with Power and Control electronics components.

Item	Description	Item	Description
1	Electronic board group	**4**	Insulation board
2	Power supply	**5**	Fiber laser module
3	RFID board	**6**	Capacitor group

6.2 Electronic boards

On the top of the device, the electronic boards are located. To have access to them, the main cover should be removed.



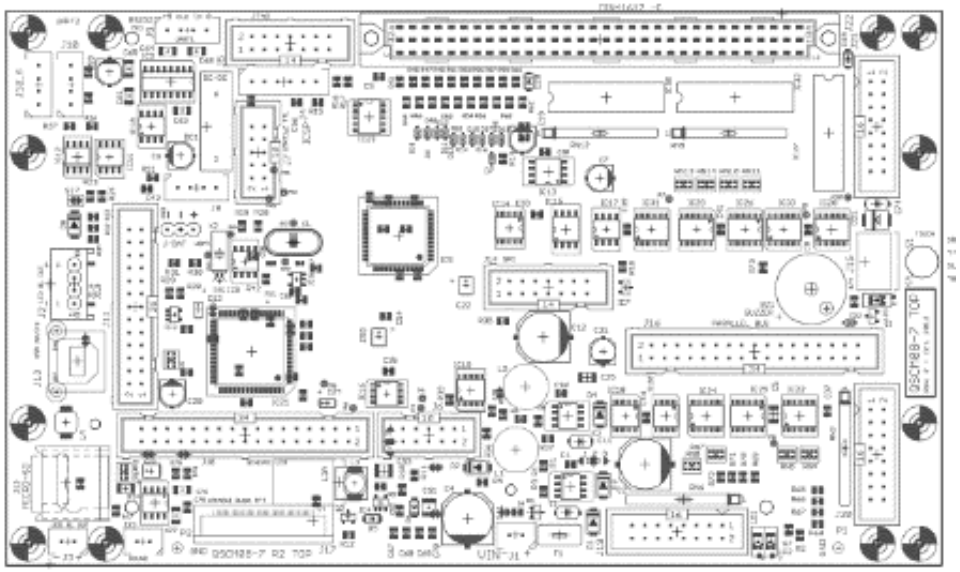
6.2.1 *PC embedded board*

The PC embedded is located on the side of the device, together with the other boards.

Figure 6.2: PC embedded.

6.2.2 *Microcontroller board*

The Microcontroller board is located on the side of the device, together with the other boards, under the Signal routing board and, in order to access it



The **Microcontroller board** (QSCM080-7) is the logic core of the control electronics and contains the following parts mounted on it:

- A Microchip Pic32MX460F512L microcontroller with internal watch-dog, internal flash memory with resident software (firmware)
- An external EEPROM memory storing service calibration parameters and application protocols (sets of user parameters both pre-set and user saved)
- A flash memory storing presentation images
- Driver ICs for graphic and touch-panel interface
- Switching power supply for graphic LCD display
- Analog inputs and digital I/Os

The Pic is programmed with the operative firmware. Accordingly, with conditions of external sensors, it provides correct sequence to operate the system or to display error messages and stop the machine.

The Microcontroller does not communicate directly with all parts of the system. It is interfaced through an **interface board** (QSMK1701), plugged into J22 (64 pin female connector).

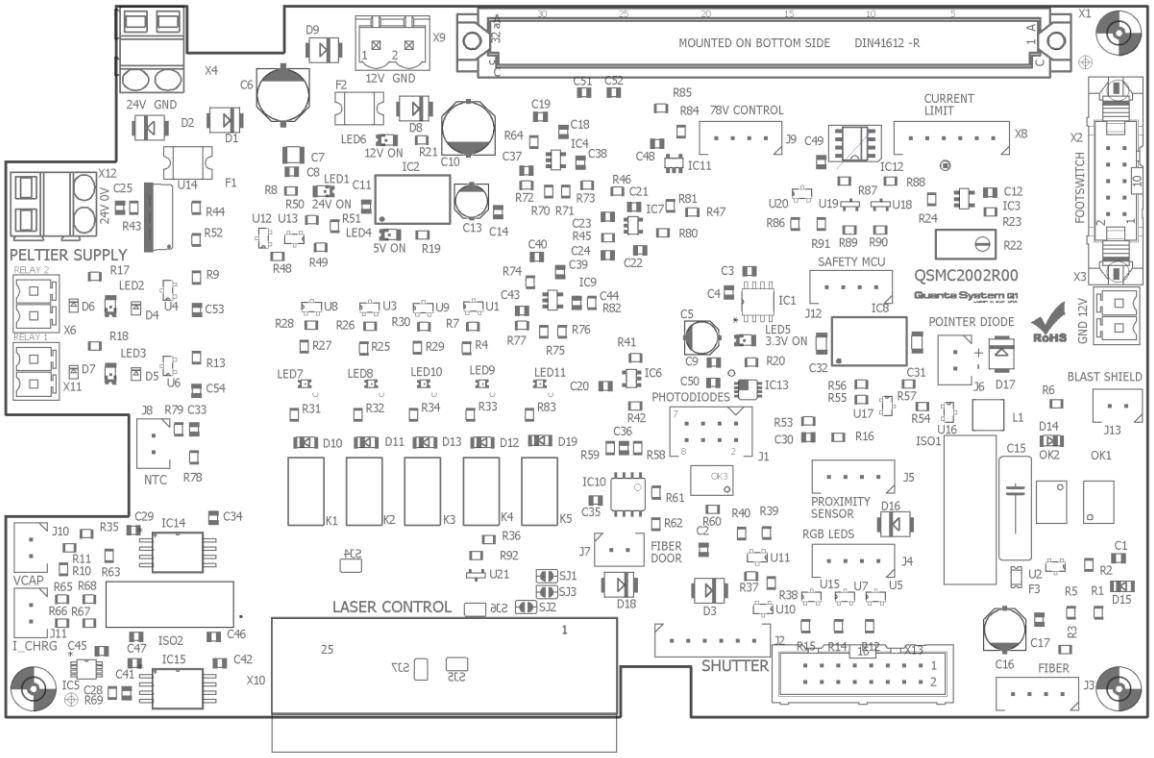
There are four diagnostic LEDs to indicate operating conditions of the board:

- LD1, green, (Board power supply) is **ON** when +12Vdc is supplied to the controller board
- LD2, green, (Microcontroller and Display power supply) is **ON** when 3.3Vdc is supplied to the microcontroller and touchscreen LCD
- LD3, green, (Microcontroller power supply) is **ON** when 5.0 Vdc is supplied to the microcontroller
- LD4, yellow, (Software installed) is:
    - ***FLASHING*** when software has been successfully installed and is running properly
    - ***OFF*** when software has not been correctly installed or there is a failure in the board.

Microcontroller board connector pinouts:

J1 (2 pins)	supply +12V (GND pin 2)
J2 (4 pins)	Backlight LED 12V 84 mA display
J4 (6 pins)	Programming bootloader with PicKit3 MCLR
J9 (4 pins)	Serial connector
J13 USB-B	HEX file uploading via HIDBootloader.exe Images files upload via HidTest.exe.
J15 (4 pins)	Touch panel display
J17 (40 pins)	Display led connection
J19 (16 pins)	QSMK1701 signals
J20 (16 pins)	QSMK1701 dischargers signals
J22 DIN41612	QSMK1701 routing
J23 (2 pins)	Speaker connector

6.2.3 *Signals routing board*



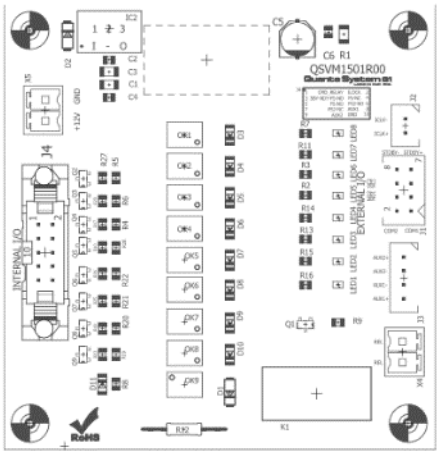
The **Signals routing board** (QSMC2002) provides signal connections: the 64-pin male connector DIN41612 (X1), interfacing with the µP board; here below the connectors list:

The board connector pinouts include:

X1 DIN41612	QSCM08-7 routing
X2 (10 pins)	Signals from insulation board
X3 (2 pins)	12V to insulation board

X4 (2 pins)	24V
X6 (2 pins)	24V relay enable
X8 (6 pins)	CAN signals
X9 (2 pins)	12V
X10 (25 pins)	Fiber laser signals
X11 (2 pins)	24V relay enable
J1 (8 pins)	Photodiode signals
J2 (6 pins)	Shutter signals
J3 (4 pins)	Fiber presence signals
J4 (4 pins)	Strip led signals
J5 (4 pins)	Proxy signals
J6 (2 pins)	Pointer signals
J7 (2 pins)	Solenoid signals
J8 (2 pins)	NTC signals
J9 (4 pins)	Emergency contacts
J10 (2 pins)	Relay1 monitor
J11 (2 pins)	Relay2 monitor
J12 (4 pins)	Power startup board signals
J13 (2 pins)	Blast shield contacts
PL2 (16 pins)	Signals from micro board

6.2.4 *Insulation board*



The **Insulation board** (QSVM15_01) makes the interconnection between microcontroller and the external interlock and footswitch. It is localized on the side of the laser, in the control electronics area (Figure 6.5).

The board connector pinouts include:

X5 (2 pins)	12V power supply (pin 2 GND)
X4 (2 pins)	Output relay contacts
J1 (8 pins)	Footswitch contacts
J2 (2 pins)	Interlock contacts
J4 (10 pins)	Input/Output signals

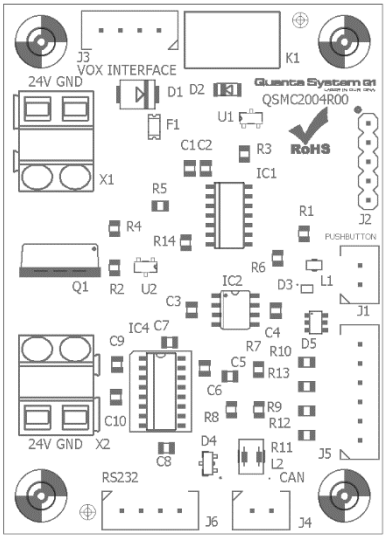
6.2.5 *RFID driver board*

This Laser System is provided with an RFID (Radio Frequency Identification) technology for the automatic identification of the optical fibers. **The RFID system keeps record of the number of uses (correlated with the required sterilization cycles) that the fiber undergoes.**
The board is located close to the fiber launch assembly, as shown in the figure below:

J3 (2 pins)	12V Power supply connector
J4 (4 pins)	Serial Connector

6.2.6 *Power startup*

The power supply (QSMC2004) manages the system ignition.

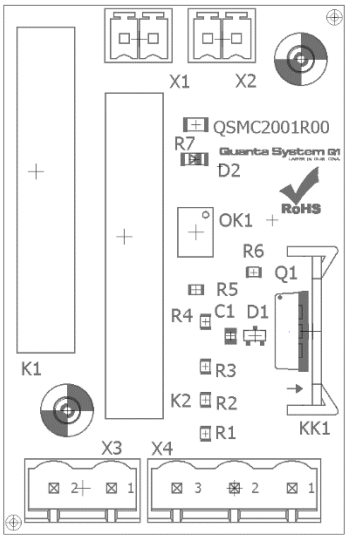


The board connector pinouts include:

J1 (2 pins)	Pushbutton contacts
J3 (4 pins)	Key and emergency contacts
J4 (2 pins)	CAN pins
J5 (6 pins)	Signal pins
J6 (4 pins)	RS232 pins

6.2.7 *Relay board*

There is a relay board to manage the capacitor voltage.

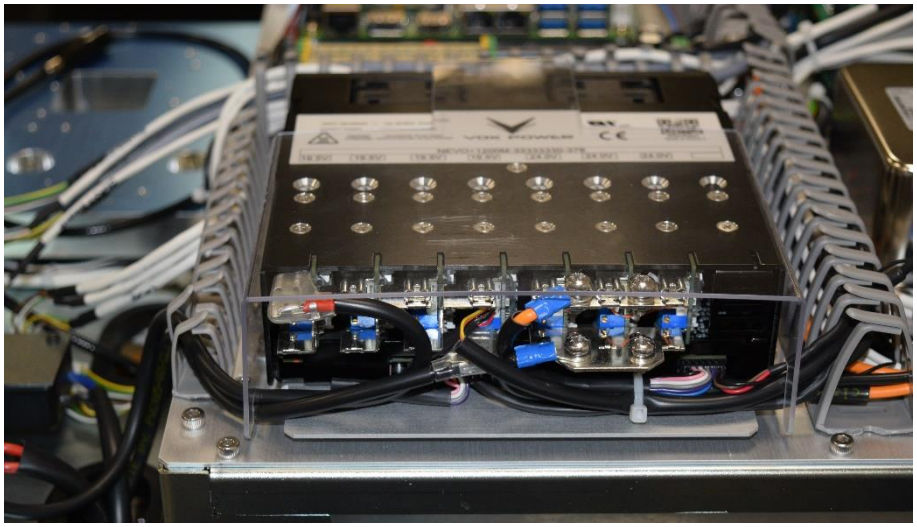


The board connector pinouts are:

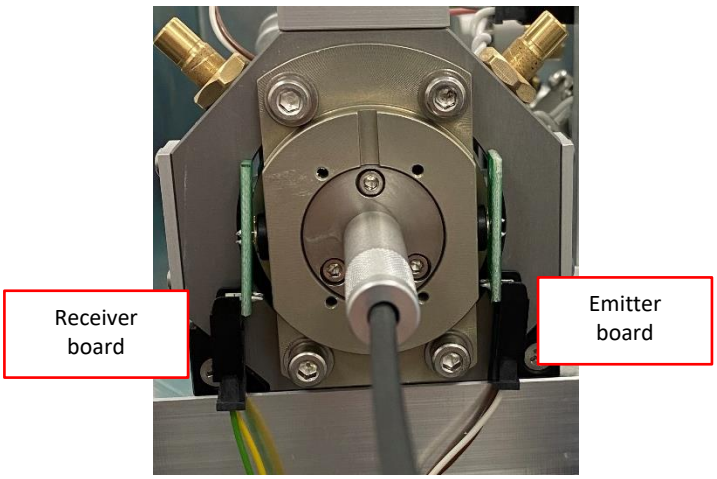
X1 (2 pins)	24V input1
X2 (2 pins)	24V input2
X3 (2 pins)	High Voltage1
X4 (3 pins)	High Voltage2

6.3 **Power supply**

The power supply is a AC/DC converter to supply 24V (3 modules in parallel) and 78V (4 modules 19,5V in series).
Each module is enabled/disabled from the control electronic.



6.4 Fiber sensor interlock



The fiber sense interlock is directly mounted on the optical fiber receptacle. It is composed of an emitter (diode) and a receiver (phototransistor). Basically, the transmitter emits some light that is captured by the receiver.

Once an optical fiber is inserted, this light beam is interrupted and a “fiber in” signal is sent to microcontroller. The fiber sense interlock assembly is normally setup at the factory in order to provide “fiber in” signal ONLY when the optical fiber is correctly inserted into receptacle.

7 REPLACEMENT AND SETTING INSTRUCTIONS

Caution: The access to the control electronics is restricted to the authorized and trained personnel only.

Warning: Use of controls, adjustments or demonstration of procedures other than those specified herein may result in hazardous radiation exposure.

Warning: Switch the system off and disconnect the power supply cable before opening the laser unit.

Warning: *All the personnel present in the laser working area must wear the protective goggles in order to avoid serious eye injuries.*

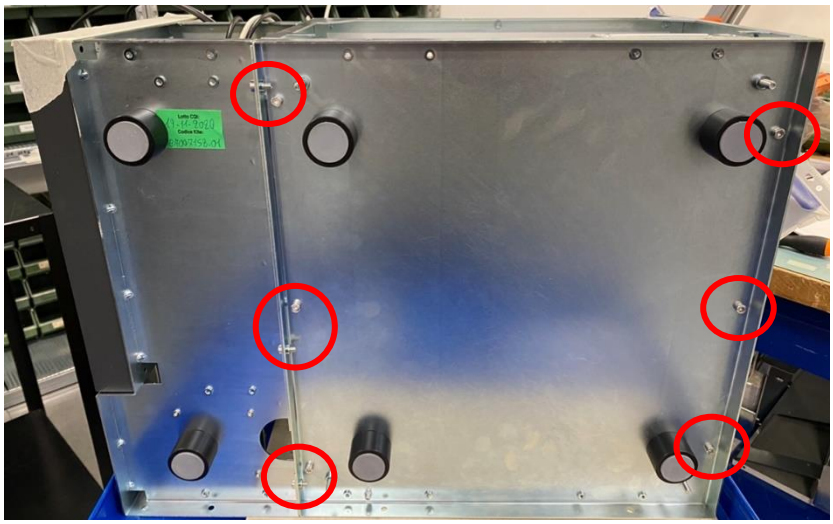
Remove the main cover to have access to any internal parts, see section 3.5.

7.1 Fiber Laser module replacement

To replace the fiber module, follow these steps:

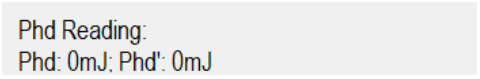
- disconnect the line cable
- disconnect the fiber laser power and signal cables
- disconnect the fiber laser optical fiber from the optical bench
- put the laser on the left side and unscrew the group from the main structure by unscrewing its bottom fixing screws
- slip away the fiber laser being careful to its fiber and its path
- then unscrew the fiber module from its support by unscrewing the nuts at the corners.

To assemble the new fiber module, follow the previous steps in reverse order.



After a fiber laser source replacement, turn on the system, verify the optical bench alignment (see next paragraph) and the photodiode calibrations.
Be careful: optical delivery fiber must be checked, then connect to the optical bench collimator, see next paragraph.

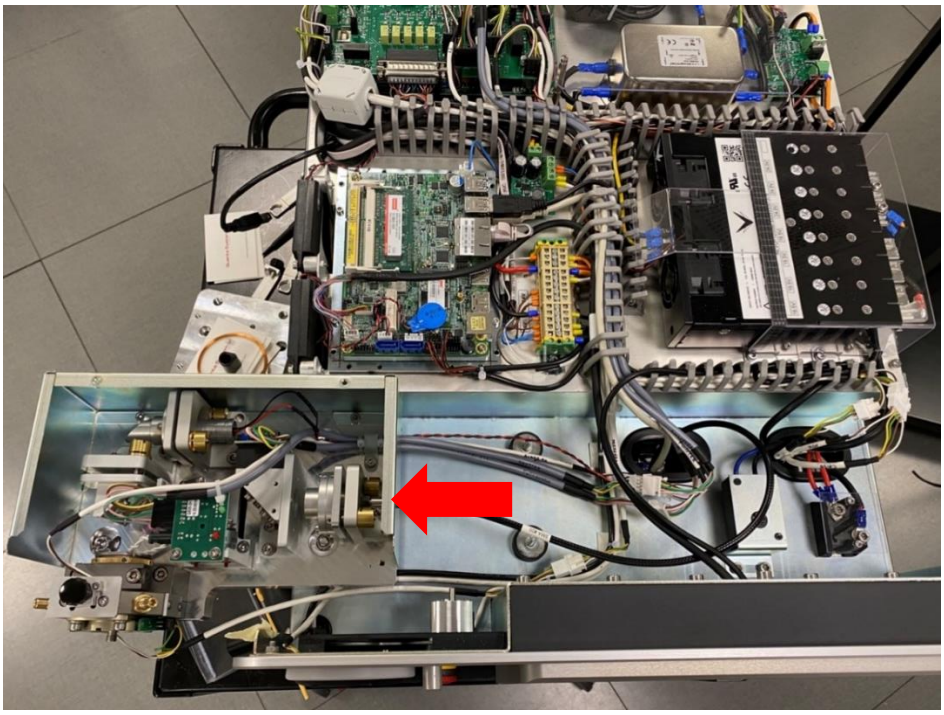
- Set frequency, energy and pulse index values as reported in the final test document.
- Connect an optical fiber and put a power meter in front of it.
- Emit laser radiation at the maximum power and take note of it, of the current and photodiode values.



Photodiode values from the Service main page

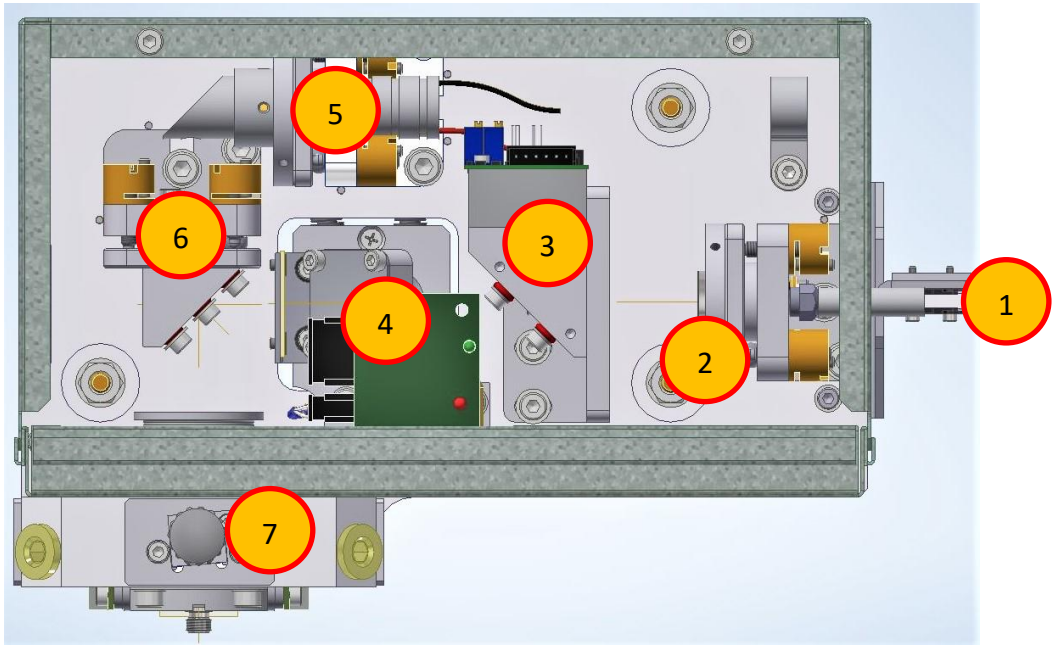
- Verify energy, current and pulses for every frequency reported in the final test document.

7.2 Optical bench alignment



To align the optical bench, unscrew it and fix it shift on the left, as the picture above.
Follow this procedure in case of alignment check or optic component replacement.

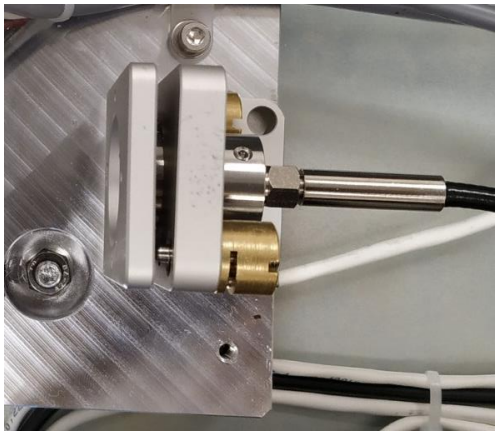
Optical layout:



1. Delivery TFL fiber
2. Collimator group with SMA connector
3. Photodiodes group
4. Shutter group
5. Aiming beam group
6. 45° folding mirror
7. Fiber launch

1. Remove the protection cup of the delivery fiber and verify the quartz in the ferrule is clean and intact, otherwise all the fiber laser source should be replaced.
   Be careful to do not damage the quartz.

2. Connect the delivery fiber to the collimator.
   Note: collimator grub screws will be used to regulate the collimation.



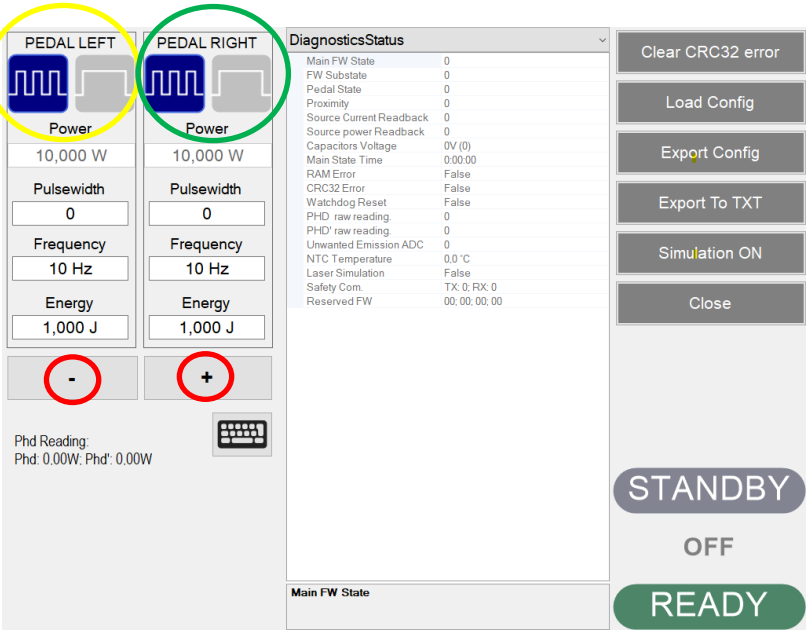
3. Turn on the system, enter in the Service menu; from the drop-down menu, select "**Errors**" window and disable the following errors by adding a "1" in the "Masked" column. Later, to replace errors, click on "C" by the keyboard.

   - Energy low
   - Energy high
   - Energy very low
   - Energy very high
   - Energy sensor error
   - Unconnected fiber
   - Unwanted emission

Errors

Name	Active	Masked
00 - Blast Shield not present		
01 - Remote interlock open		
02 - Unconnected Fiber		
03 - Unconnected pedal		
04 - Pressed pedal in standby		
05 - Low Energy		
06 - Calibration table error		
09 - High Energy		
13 - Very Low Energy		
17 - Very High Energy		
21 - Energy Sensor ERROR		
25 - PC Timeout		
28 - Unwanted Emission		
29 - Watchdog Error		
44 - Laser Source ERROR		
45 - Discharge Resistor Overtemp.		
46 - Charge Cap Error		
47 - Shutter not Closed: ERROR		
48 - Shutter not Open: ERROR		
51 - Both pedals pressed		
52 - Source current set ERROR		
53 - Charge current error		
54 - Source Fiber Interlock error		

4. In the main window, setting parameters for each pedal are circled in yellow (left pedal) and green (right pedal). **Pulse index** shows the pulse duration and setting current system: from 0 (high current and short pulse) till 6 (low current, long pulse). **+** and **–** button (red circles) allows to change the status (**standby**/**ready**).



5. Set left footswitch as following:

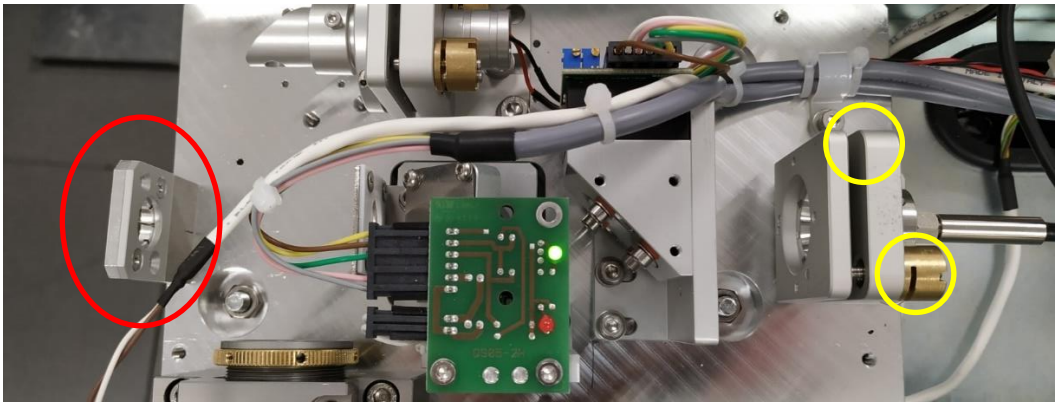
   - Frequency: 10Hz
   - Energy: 0.5J
   - Pulsewidth: 0

   Then switch to **ready** status.

<u>BE CAREFUL: check fiber delivery is well connected with the collimator.</u>

6. Emit laser radiation by clicking on the left footswitch, check the beam with thermal paper at a distance of 5 and 30 cm, shapes should be with the same diameter, in case regulate the collimator.

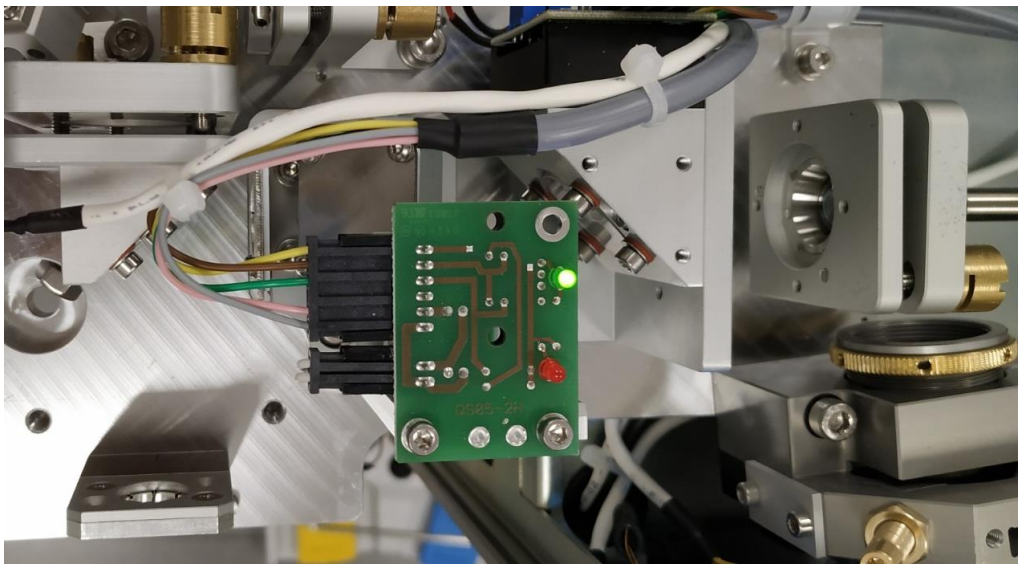
7. Remove the folding mirror and mount the pin hole.



8. Check the shapes on the thermal paper after the pin hole; if necessary, regulate the collimator support by acting on its screws (yellow circles).

Samples on a thermal paper

9. Replace the folding mirror support, disassembly the fiber launch and mount the pin hole as following picture.



10. Repeat emission on a thermal paper after the pin hole, if necessary, regulate the folding mirror.

11. Regulate the aiming beam alignment by regulating the screws of its support. Aiming beam and laser beam must be overlap.

12. Replace the fiber launch with its optic and blast shield; connect an optical fiber and place a power meter in front of it (5 - 10 cm distance).

13. With low power and frequency 10Hz, align the fiber position by acting on the launch fiber screws. Align the fiber launch lens by acting on its ferrule.
14. Step by step increase the energy and verify the fiber launch alignment.
15. Replace the optical bench in the original position.

7.3 Calibration procedure

Follow this procedure after an alignment check or optic component (or laser unit) replacement.

1. Enter in the Service menu and select "**Source calibration_PulseShort**" from the drop-down menu.
   In the table there are group parameters for each available frequency.
   - **EMin**: minimum available energy [mJ]
   - **IMin**: setting current at minimum energy (express in bit numbers from 0 to 1023)*
   - **TMin**: pulse duration at minimum energy, in [us]
   - **EMax**: maximum available energy [mJ]
   - **IMax**: setting current at maximum energy (express in bit numbers from 0 to 1023)*
   - **Tmax**: pulse duration at maximum energy, in [us]

   ** 950 corresponds to 95% of the maximum pump diode current*

   Intermediate values are obtained by linear interpolation.

SourceCalibration_PulseShort

F [Hz]	EMin	IMin	TMin	EMax	IMax	TMax
1	100	950	200	1000	950	2000
3	50	950	100	3000	950	6000
5	50	950	100	6000	950	12000
10	50	950	100	6000	950	12000
20	50	950	100	3000	950	6000
100	50	950	100	600	950	1200
250	50	950	100	240	950	480
500	50	950	100	100	950	200
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

2. Set the values on the tebale and verify them with a power meter.
   Regulate the setting current or the pulse duration to get the correspondent output power.

   The following limits must be respected:
   Minimum pulse duration: 100us
   Maximum pulse duration: 13000us
   Maximum current: 950

3. Repeat the previous step for "**Source calibration_ PulseMedium**" and "**Source calibration_ PulseLong**".
   Generally, in the short pulse calibration table (pulse index 0) the current is the maximum available. Increasing the pulse duration till "pulse index 6" current decreases.

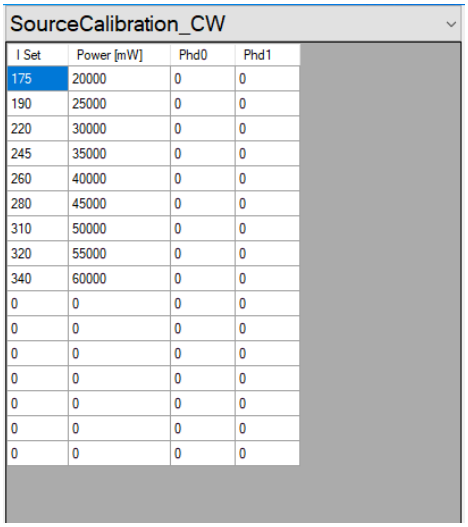
SourceCalibration_PulseMedium

F [Hz]	EMin	IMin	TMin	EMax	IMax	TMax
1	100	600	270	1000	600	3000
3	50	600	130	2000	600	6000
8	50	600	130	4000	600	12000
10	50	600	130	4000	600	12000
20	50	600	130	2000	600	6000
100	50	600	130	500	600	1400
500	50	600	130	100	600	270
1000	25	500	100	25	500	150
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

SourceCalibration_PulseLong

F [Hz]	EMin	IMin	TMin	EMax	IMax	TMax
1	100	600	600	1000	300	6000
3	50	300	300	1500	300	7500
5	50	300	300	2400	300	12000
10	50	300	300	2400	300	12000
20	50	300	300	2000	300	12000
100	50	300	300	500	300	2600
120	20	300	100	500	300	2600
500	20	300	100	100	300	500
2000	20	300	100	25	300	125
2500	20	300	100	20	300	100
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

4. Select "**CW Calibration Table**"



I Set	Power [mW]	Phd0	Phd1
175	20000	0	0
190	25000	0	0
220	30000	0	0
245	35000	0	0
260	40000	0	0
280	45000	0	0
310	50000	0	0
320	55000	0	0
340	60000	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

- **PWM**: setting current (express in bit numbers from 0 to 1023)
- **Power**: corresponding power [mW]

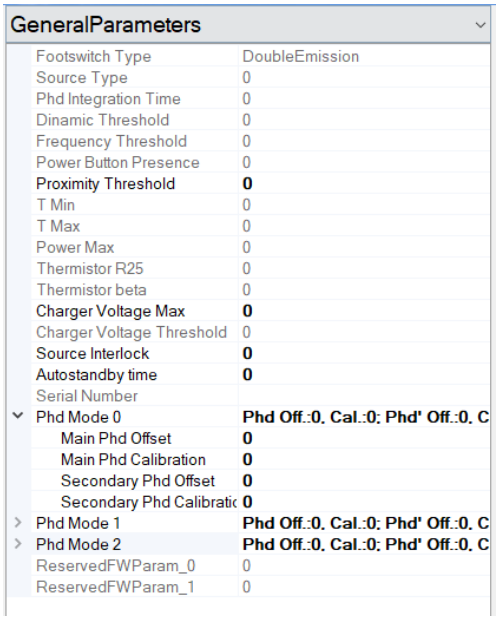
Set the CW mode and emit laser; verify the output power and if necessary, change the corresponding PWM value.

Note: *To change the PMW parameters you need to connect an external keyboard.*

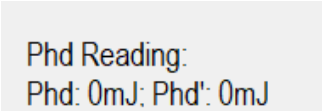
7.3.1 *Photodiode calibration*

Photodiode calibration is required for the calibration procedure reasons and also in case of mismatching readings.

Select "**Service general parameters**"; on the bottom, the following parameters are present:



There are two photodiodes, shown on the main page as “Phd”, in the table identified with and without apostrophe respectively.



“**offset**” values are for minimum readings, “**calibration**” values are for full-scale readings.

Both photodiodes work with 3 different modalities:

- Frequency < 170Hz, set energy < 250mJ → “**phd 0**” section (full-scale: 520mJ)
- Frequency < 170Hz, set energy > 250mJ → “**phd 1**” section (full-scale: 6.5J)
- Frequency > 170Hz or CW mode → “**phd 2**” section (full-scale: 65W)

For each photodiode there is a gain trimmer on the photodiode board.
Set a frequency 10Hz, short pulse (pulsewidth 0) and maximum energy 6J, regulate the trimmers in such a way the photodiode screen values correspond to the output power.
Set a frequency 10Hz, short pulse (pulsewidth 0) and minimum energy 50mJ and verify again the photodiode screen values, if necessary correct the PHD0 (or PHD0’) offset values.

7.4 Blast shield check / replacement

A blast shield is present at the output of the optical bench.

Any detection of efficiency decrease in laser emission or frequent failures of the connected optical fibers must be followed by an immediate check of the condition of the Blast Shield; if black spots are present on the blast shield, it must be replaced.

It is recommended to use cleanroom environment for replacement of protection glass holder.
Please wear cleanroom gloves, any contamination will lead to burn-in-destruction of the protection glass.

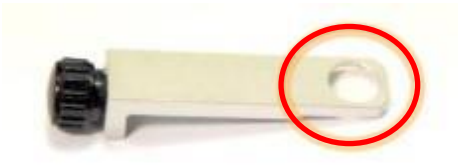
The protection glass must fit with the wavelength of your fiber laser module.
Therefore check delivered AR number with installed one before installing the new protection glass holder.

WARNING:
This operation must be done with clean hands and extreme caution to avoid optical damage of the device.

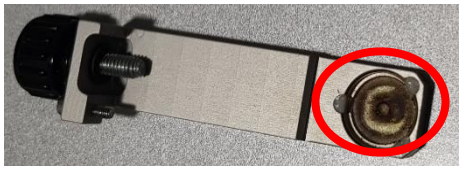
The blast shield replacement must be executed in the following way:

1. Turn the device off, disconnecting the equipment from mains.
2. Open the blast shield protective door on the side of the device unscrewing the doorknob.
3. Remove the blast shield unscrewing the knob:

4. In case of damage, substitute the whole blast shield paying attention not to touch the protective glass with hands.
5. Close the protective door screwing the doorknob:



Example of new blast shield



Example of damaged blast shield

6. Reinsert the blast shield and firmly screw the knob.

7. Close the protective door by screwing firmly the doorknob:

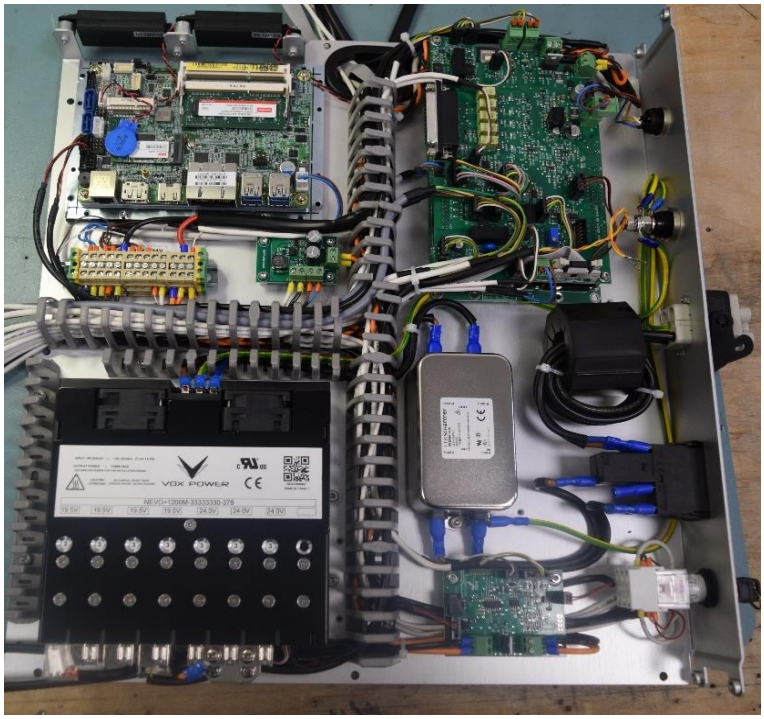
Warning: *In case of damage of the optical fiber, check the status of the focusing lens: laser sputtering from the SMA fiber connector can in principle reach the lens, leading to the optical damage of the lens.*

Warning: *Frequently check the status of the input face of the optical fiber used for the alignment. Power measurement made with a damaged fiber can be misleading during the alignment procedure.*

Warning: *in case of blast-shield damage, also check the optical fiber. If the optical fiber is damaged is shall not be used for further operation.*

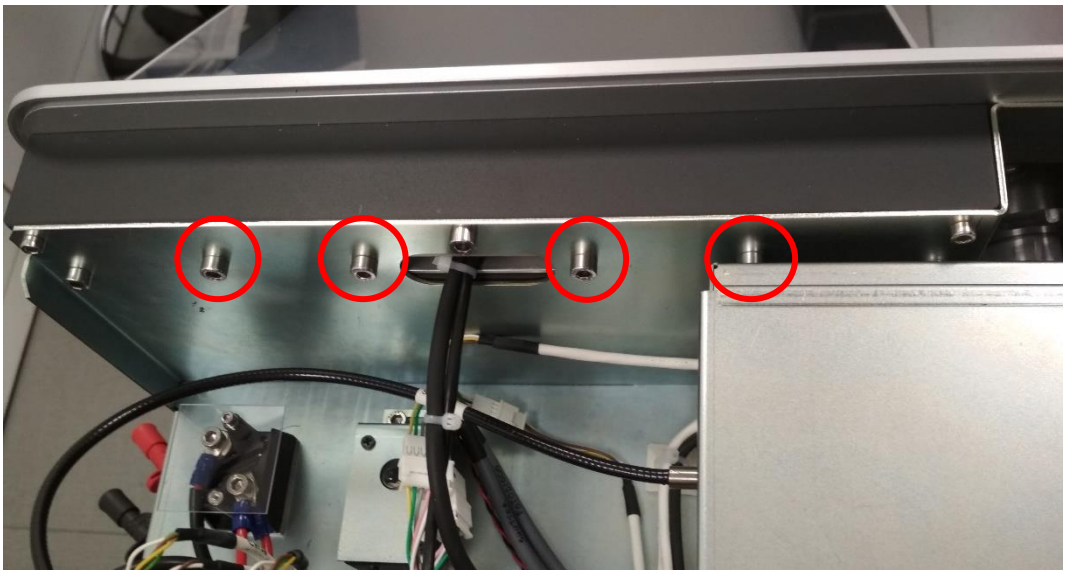
7.5 The electronic components replacement

The main electronic components are located on the top part; to have access to them, disconnect the wiring and unscrew the suspected part; see the chapter 6 for the details.



7.6 The touchscreen display replacement

To have access to the display, unscrew the frontal panel by unscrew its screws; then lay down the panel, unplug the display cables and remove it by unscrewing the four screws.



To reassemble repeat this procedure in reverse order.

7.7 The RFID board replacement

To have access to the RFID board, unscrew the frontal panel by unscrew its screws; then lay down the panel, disconnect the connectors, then remove the board by unscrewing the 4 screws.

To reassemble repeat this procedure in reverse order.

To test the RFID see section 8.3.

8 PREVENTATIVE MAINTENANCE

8.1 Basic inspection checks

8.1.1 *Check the power laser*

Power laser should be checked periodically, at least every 12 months.

8.1.2 *Check the blast shield*

Blast shield should be checked periodically, at least every 12 months.

8.1.3 *Check the cooling system*

Keep free and clean the cooling air flow; check it periodically, at least every 12 months.

8.1.4 *Check the line cable*

Line cable can be subject to deterioration over time and therefore it is necessary to check periodically the status of the line cable, at least every 12 months.

8.1.5 *Check the labels*

It is necessary to replace all the labels which are in poor condition; check them at least every 12 months.

8.1.6 *Check the covers*

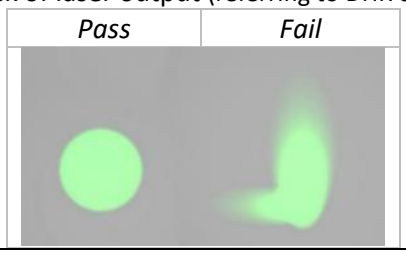
Check periodically the cover and main structures are in good condition, at least every 12 months.

8.1.7 *Check the touchscreen*

Check periodically the touchscreen works properly and it is in good condition, at least every 12 months.

Warning: It is the owner's responsibility to keep the laser system in a good condition and verify the periodic maintenance are executed.

8.2 Maintenance form module

Basic Recommended Actions	*Done*	*Pass / Fail*
• Check the power laser *(see DHR document)*		☐ ☐
• Visual inspection of optical fibers (using the aiming beam) and check of laser output (referring to DHR document):  •		☐ ☐
• Inspection of the integrity of blast shield optic		☐ ☐
• If the result is FAIL, replace the blast shield optic (refer to the instructions in section 7.2)	☐	
• Cleaning of cooling air flow	☐	
• Check the line cable	☐	
• Check the labels	☐	
• Check the covers	☐	
• Check the display	☐	
• Check of general system's operation (without displaying error or warnings)		☐ ☐

Note: *The preventive maintenance operations on the laser system and relevant accessories shall be performed at least every 12months in case of standard use and environmental conditions.*
Please note that intensive use and/or harsh environment conditions may require additional maintenance operations in order to ensure the proper functioning of the devices.

8.3 Calibration verification of the RFID

8.3.1 *RFID test*

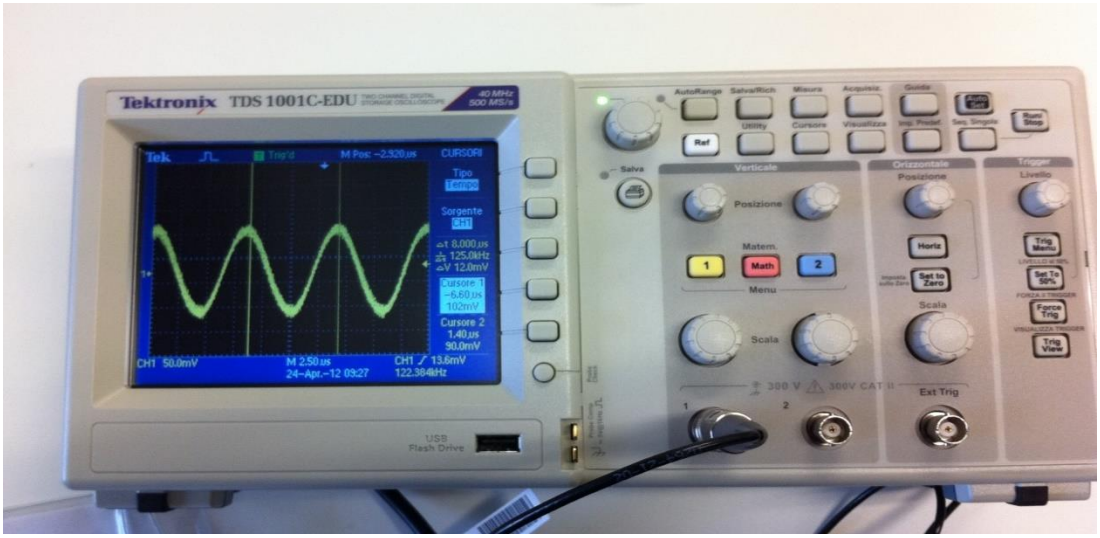
Frequency is the rate of recurrence of a cyclic or periodic event. For a digital waveform, can be inverted the signal period to obtain the frequency. The smaller is the period, the higher the frequency and vice versa. The frequency resonance of the RFID antenna is 125kHz or a period of 8.00µsec.

To test if the RFID signal is working, verify signal using an oscilloscope with probe.

Switch on the laser system, without connecting a fibre, following the standard start up procedure of your system. Set the system in STAND-BY MODE.

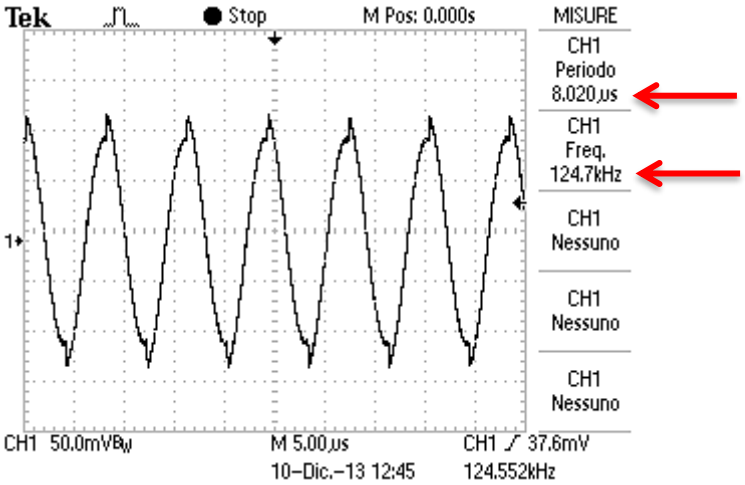
Connect the probe to the oscilloscope and set it as follow:

- Time scale: 2.5 – 5 µs/div
- Voltage scale: 5 – 100 mV/div (see below)
- Channel coupling and trigger coupling: DC mode
- Use the frequency measure tool of the oscilloscope if any



- Close the probe on its ground and put it close to the fibre aperture as in the next figure.

The amplitude of the signal strongly depends on the position of the probe, thus you need to adjust the voltage scale.
The resonance frequency of the RFID antenna is **125kHz** (period of 8.00 µs). To obtain a stable communication with the RFID tag, the measured frequency have to be between **124kHz** and **126kHz** (±1kHz tolerance) alternatively the period have to be between 8.1µs and 7.9µs.



The image above shows the waveform measured with the oscilloscope with the settings described above.
If the signal is unstable press the STOP button on the oscilloscope to freeze the screen and measure the period between two peaks.
If the frequency is absent or out of range, check the connections from the RFID board to the RFID antenna and verify the 12V to J3 of the RFID board is present.
In case RFID board and antenna should be replaced.

ATTENTION: be careful not to short circuit or touch the exposed terminals of the antenna.

9 TROUBLESHOOTING

9.1 Alarm list

When an alarm occurs, a relative message appears on the display; here below the visualized strings and the possible solutions:

Error Message / Trouble	Type	Issue related	Solution
Pressing the ON/OFF button is not producing any detectable effect	***Error***	• Plug not connected • Main switch not turned on • ON/OFF key not turned in ON position • Emergency LASER STOP activated	• Check for main input • Deactivate Emergency LASER STOP switch • Turn the key on the ON position
Energy error	***Error***	Fluctuation of energy parameter during laser radiation	• Wait a few seconds for stabilization. • Measure the output power • Check the fiber laser power
Serial port communication fault	***Error***	• This warning appears when the serial communication from PC to microprocessor fails	• Restart the system • Check the connections
Capacitor voltage error	***Error***	• Power supply error or broken • Relay board failure • Damaged capacitors	• Check the power supply • Check the power connections • Check the relays board
No correspondence between displayed energy and treatment effects and/or decrease of laser efficacy	***Error***	•Fiber damaged • Blast shield optic broken	• Check fiber • Check the blast shield
Shutter not closed	***Error***	• Incorrect shutter position	• Check the shutter and its connection
Shutter not open	***Error***	• Incorrect shutter position	
The remote interlock contacts are open	***Error***	• The ext. Interlock is not connected or is poorly connected	• Control ext. Interlock connections
Pedal not connected	***Error***	• Wrong pedal connections	• Check connections
Pedal pressed in STANDBY	***Error***	• Pedal(s) should be pressed at the right moment	• Enter in Ready mode and press the footswitch
Blast shield wrong installation	***Error***	• Wrong blast shield installation	• Check Blast shield

Error Message / Trouble	Type	Issue related	Solution
Fiber not present/connected	***Error***	• Wrong fiber installation	• Check the fiber connection
Fiber not identified by RFID	***Error***	• Wrong fiber installation • Wrong fiber type	• Check the fiber connection • Change fiber
RFID warning	***Error***	• Wrong fiber type	• Change fiber
RFID warning	***Error***	• Wrong fiber code	• Check or change fiber
RFID warning	***Error***	• The fiber is expired	• Change fiber
FW error	***Warning***	• Message after new FW release installation • FW issues	• Shut down and restart
FW error	***Warning***	• FW issues	• Shut down and restart

9.2 Alarm descriptions

The possible failures can be related to optical, electronic or cooling system. If an alarm has been shown on touchscreen it will help the service engineer/technician to focus his attention on a particular part of the system. If necessary, the laser system should be opened and checked.
In this paragraph, some common failures are listed.

WARNING: When an electrical adjustment is required:

- **put on the protective gloves**
- **switch OFF the system**

9.2.1 *Energy error*

This error message appears when the integrated energy sensor detected value is out of tolerance range.
A possible cause may be a temporary accidental fluctuation of the photodiode response integrated in the laser source. In this case, the error will not appear at the next laser emission.
If the error persists, it is possible that it is due to an irregularity of the optical fiber used, in this case replace it.
If the error occurs again after changing the optical fiber, it is possible that there is a malfunction in the laser. In this case, please contact the service department for replacement of the laser source

9.2.2 *Fiber interlock*

This error message appears when switching from standby to ready and the sensors in the source do not detect the presence of the optical fiber.
Make sure that the optical fiber is installed correctly with the fully screwed pawl, the fiber presence sensors are not activated if the fiber is only partially screwed.
Check that the threads on the fiber optic and laser source connectors are intact and do not prevent the complete threading of the fiber.
If the threads are damaged, replace the fiber and / or contact the service department for laser replacement.

9.3 Troubleshooting

Error message / Trouble	Possible cause	Solutions
The system doesn't switch on	• Power line is not connected • Emergency red push button is pressed • Main line input or low voltage connections are not proper • Low voltages power supply is damaged • Microprocessor or embedded PC boards damaged	• Check power cord connection • Check main line breaker (room and machine) • Release the emergency push button • Check main line filter I/O voltage • Check key, emergency push button, ON-OFF button and I/O voltage • Check low voltage PS I/O voltages • Check low voltages on microprocessor board and embedded PC • Substitute damaged parts
No correspondence between displayed energy and treatment effects and/or decrease of laser efficacy	• Fiber damaged • Blast shield mirror broken • Misalignment of optical components inside optical bench or fiber module	• Change the fiber • Substitute blast shield • Check the optical bench component • Substitute Fiber laser module
Ext. Interlock error	• The ext. Interlock is not properly connected • The external door safety switch is open • Faulty internal boards	• Check ext. Interlock connection • Check internal connections • Substitute internal damaged parts
Fiber Interlock error	• Wrong connection of the fiber • Faulty interlock sensor	• Connect the fiber properly • Verify the fiber status • Change the fiber • Substitute fiber module
Fiber not identified by RFID	• Wrong fiber installation • Wrong fiber type • Wrong fiber code • RFID antenna board not working	• Check the fiber connection • Change fiber • Substitute RFID antenna • Substitute RFID board
Footswitch Unconnected	• Footswitch not connected • Insulation board not properly working • Microcontroller not properly working	• Connect the footswitch • Verify its external and internal connections • checks the behaviour of the LEDs according to the pressure of the pedals • Substitute insulation board • Substitute microcontroller board

Error message / Trouble	Possible cause	Solutions
System Over Temperature	• Environment temperature out of specification • Insufficient ventilation of the device	• Check environment condition • Position the device so that there is sufficient free space around it at the air vents openings and check heat sink fans
Laser emission interruption due to the simultaneous pressure of both pedals	• Involuntary pressure of both pedal by laser operator • Unintended pressure of the second pedal due to accidental external causes	• Release pedals and restart application with by pressing only one pedal • Remove the external/accidental cause of unintended pressure
Energy Low/High Warning	• Temporary output power fluctuation • Energy sensor noise	• Adjust photodiode calibration
Pedal pressed	• Footswitch pressed in STANDBY mode	• Release the footswitch • Enter READY mode before pressing the footswitch

In case the device must be sent back to the company fill the RMA request enclosed in Appendix C and send it to the Quanta System Service Department.

10.1 Service tools

A full complement of tools is required to service this laser system. It is expected that service personnel carry at least the following tools to an installation or laser repair call.

9.1.1 *Hand tools*

- Flat blade screwdrivers set: metric size 2, 4, 6 mm
- Phillips screwdrivers set: PH0, PH1, PH2
- Allen Wrench or Hex Head Ball Driver set: metric size 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10 mm
- Spanners and wrenches set: metric size 5, 5.5, 6, 7, 8, 10 mm
- Nut screwdrivers set: metric size 5, 5.5, 6, 7, 8, 10 mm
- Adjustable wrenches
- Wire cutters
- Wire strippers
- Long Needle nose pliers

10.1.1 *Electrical equipment*

- Digital multimeter
- Oscilloscope (≥ 40MHz) with probe

10.1.2 *Optical equipment*

Basic tools:

- Test fibers:

Fiber info	Code
200 µm Fiber for Service (Not sterile)	OAF092099
272 µm Fiber for Service (Not sterile)	OAF092799
365 µm Fiber Precision for Service (Not sterile)	OAF793619
550 µm Fiber for Service (Not sterile)	OAF095599
800 µm Fiber for Service (Not sterile)	OAF098099

- Appropriate protective laser eyewear
- Laser energy/power meter calibrated for NIR operation. Other models may not be adequate. Check with Quanta System Technical Support for meter compatibility
- Pin-holes
- Thermal paper

10.1.3 *Miscellaneous equipment*

- Test Report documents
- Notebook with installed USB Bootloader SW
- USB cable (male A – male B)

11 CUSTOMER SERVICE

11.1 Warranty and Manufacturer's responsibilities

Quanta System S.p.A. will disclaim any responsibility about a misuse of the system.

The Manufacturer is not responsible for any damage or failure deriving from the wrong use of the device.

A correct use consists of:

- Following the instructions described in this manual
- Following a proper maintenance program of the system
- Complying with international safety standards

The device is warranted against any defects in material and workmanship for a period of one (1) full year from its delivery.

Repairs needed in case of natural disasters, accidents, electrical circuit failures, negligence, improper use or misuse of the device, or repairs or servicing carried out by persons not authorized by Quanta System are not covered by warranty.

Quanta System S.p.A. staff must be allowed with a free access to the device.

Any repair which cannot be carried out on site will be performed in Quanta System labs.

Warranty and responsibility of the Manufacturer will also expire for any of the following reasons:

- Use of the device is not according to the procedures and instructions reported in the user manual.
- Incorrect installation and maintenance.
- Use of the out-of-order safety system, not correctly installed or damaged.
- Noncomplying the transportation, storage, installation, and maintenance instructions.
- Arbitrary alteration of the device.
- Incorrect repairs.
- Accidents caused by external elements.
- The protective goggles are not used while operating the device, while the device is in any mode, including the STAND BY mode.

Customers can not be entitled to claim compensation for any damage resulting from the machine being out of operation.

On demand, the manufacturer will provide all technical information including electrical drawings, list of components and suggested protocols.

11.2 Repairs and modifications of the device

- Only authorized service personnel can execute repairing and maintenance
- It is recommended to follow the standard maintenance program
- It is recommended to replace all the damaged components
- Use only original spare parts
- Constructive modifications are not permitted

11.3 Contacts

Quanta System S.p.A. provides its clients with email and telephone troubleshooting, apart from the on-site customer trainings, repairs and maintenance.

Please contact Quanta System Service Department through the contacts reported here below. Please keep on hand the Serial Number of your device.

Quanta System Service Department

Tel.: +39 0331 376797
Fax.: +39 0331 367815
www.quantasystem.com
service@quantasystem.com

APPENDIX A: ELECTRIC SCHEMES

See/Require Electric Schemes: **SE_TFL_*rev*** [1].

[1] *"rev" means the release version.*

APPENDIX C: RMA REQUEST

SERVICE/ASSISTANCE REQUEST
RICHIESTA DI ASSISTENZA TECNICA
RMA NR:

FROM/DA:

TO: Quanta System Service Department +390331367815
DATE:
DEVICE MODEL:
S/N:
MALFUNCTIONS DESCRIPTION:

DETAILED LIST OF THE RETURNED SPARE PARTS/ DEVICE/ ACCESSORIES

Please contact Quanta System to report the malfunctions, manufacturing defects and not conformities of your device. If you need to send back goods or medical devices to Quanta System, send this document by fax and wait to ship the goods until the Service Department assign a RMA number.