# BRILLIANT AND BRILLIANT B MAINTENANCE MANUAL


**VERSION 1.00**

# TABLE OF CONTENTS

# GENERALITIES

# A. GENERALITIES

# I. HOW TO USE THIS MANUAL?

## I.1. WHO THIS MANUAL IS DEDICATED TO?

There are three versions of this manual:

- The maintenance manual
- The senior maintenance manual
- The expert maintenance manual.

**The maintenance manual** can be accessed by anybody, including the users. The aim of this maintenance manual is to improve the communication between QUANTEL's customers service and the person troubleshooting the system. The user of this manual won't be able to identify all the breakdowns on its own, only the most current ones. But it will give him a better basis to talk with QUANTEL's service engineers and repair the system in a shorter amount of time. No training is required to be able to use this manual.

**The senior maintenance manual** is for trained persons use only. Before receiving this manual you must follow the appropriated training and receive an accreditation from QUANTEL. If it is not your case and that you are in possession of such a manual, please contact QUANTEL service. For your own security and the good functioning of your system, do not attempt to repair it by yourself with the help of this manual. If you do, note that your system won't be covered by the warranty anymore. If you have the accreditation from QUANTEL, before using this manual, please DO read the "laser safety", "understanding and servicing" and "color codes" chapters.

**The expert maintenance manual** is for QUANTEL service engineers use only. Before receiving this manual you must follow the appropriated training and receive an accreditation from QUANTEL. If it is not your case and that you are in possession of such a manual, please contact QUANTEL service. For your own security and the good functioning of your system, do not attempt to repair it by yourself with the help of this manual. If you do, note that your system won't be covered by the warranty anymore. If you have the accreditation from QUANTEL, before using this manual, please DO read the "laser safety", "understanding and servicing" and "color codes" chapters.

## I.2. UNDERSTANDING AND SERVICING

This manual is separated into three main chapters:

- Generalities,
- Description,
- Maintenance.

The **"generalities"** chapter contains all the information needed to use correctly this manual: the laser safety indications, the color-codes...
In the **"description"** chapter you will find a description of the system, more or less precise depending on the level of manual you have. This chapter is as important as the maintenance one. You will not be able to troubleshoot correctly your system if you don't understand its functioning. **Please DO read this chapter before attempting any manipulation on the laser.**

The **"maintenance"** chapter gives you a method to troubleshoot your laser. It is divided into three parts. The first part of the chapter, "generalities", explains how to use correctly the second and third parts, "troubleshooting" and "procedure". Depending, on the level of manual you are using, you will be able to find which module or device is in fault and to repair them.

## I.3. COLOR CODES

In the power supply description chapters, two color codes are used to make its reading clearer.

The first one gives a color to each element of the system:

| | |
|---|---|
| CPU.BB | TCG.BB |
| VD.BB | QS.BR |
| PB.BR | Laser head |
| TS.BB | Front panel |
| REL.BB | Rear panel |
| SDTQ.BB | Dicharge network |

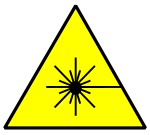
The second code gives a color to each connection between two boards and is used only in the interconnections schematics:

| | |
|---|---|
| TS.BB ↔ REL.BB | CPU.BB ↔ VD.BB |
| TS.BB ↔ PB.BR | CPU.BB ↔ PB.BR |
| TS.BB ↔ CPU.BB | CPU.BB ↔ Front panel |
| REL.BB ↔ PB.BR | CPU.BB ↔ Rear panel |
| REL.BB ↔ Front panel | VD.BB ↔ Front panel |
| CPU.BB ↔ REL.BB | Others |

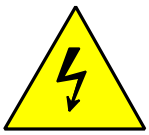
# II. LASER SAFETY

## II.1. PREAMBLE

The following symbols will be used along this document to warn the user from the different dangers that might occur while installing or repairing the laser.



CAUTION-LASER RADIATION, avoid eye or skin exposure to direct or scattered radiation. Permanent damage to the eyes may occur.



CAUTION-HIGH VOLTAGE, electrical shocks and burns resulting from power lines or capacitor discharge can cause serious injury or death.

CAUTION-DANGER, other than those above.

## II.2. GENERALITIES

Information concerning laser safety in this document is in compliance with chapters 6.1 and 6.2 of the publication 825-1 by the International Electro technical Committee concerning laser product radiation safety, published by the Central Office of the International Electro technical Committee, 3 rue Varembé, Geneva, Switzerland, 1993 Issue.

Other laser safety references may also be consulted in the following documents:

- European Standard and French standard: NF EN 60825-1 July 1994, classification index: C43-805.
- American National Standards for the "Safe Use of Lasers": ANSI Z136.1-1993 Laser Institute of America, 12424 Research Parkway, Suite 125, Orlando, FL, 32826.
- Compliance Guide for Laser Products: HHS Publication FDA 86-8260. U.S. Department of Health and Human Services. FDA. Center for Devices and Radiological Health. Rockville, Maryland 20857.

## II.3. CLASSIFICATION

Laser devices are divided into four general classes:

- Class 1: Lasers presenting no danger in all reasonably foreseeable use conditions.
- Class 2: Lasers emitting continuous visible light (within the 400 nm to 700 nm wavelength range) and carrying less than 1mW. The defense reflexes ensure eye protection.
- Class 3A: Looking directly into the beam is dangerous only if the exposition last more than 0.25 seconds or if looking through optical instruments.
- Class 3B: Looking directly into the beam of these lasers is dangerous, but diffused reflections presents no danger if the exposition last less than 10 s and is done at least 13 cm away from the diffusing surface.
- Class 4: Lasers producing dangerous specular and diffused reflections for the eyes. These lasers can induce severe damages to the skin and may ignite flammable and combustible materials. Their use requires extreme precautions.


**QUANTEL's lasers are class 4 lasers.**

## II.4. SAFETY INSTRUCTIONS

The following safety instructions are to be read and observed by anyone working with the laser:

- Before turning the laser on, make sure that everybody in the room is wearing appropriated protection goggles.
- Never look directly into the beam or its reflections. It can lead to severe damages to the eyes.
- If someone wants to enter the working area while the laser is on, turn it off and provide him protection goggles.

- Protect as much as possible all parts of your body and avoid direct exposure to the beam.
- Orient the laser so that the beam is not directed toward entry doors or corridors.
- Terminate the beam at the end of its useful path with a fire resistant and light absorbing material.
- Remove all shiny reflective surfaces and flammable materials from the working area
- Use a high intensity lamp to light up crowded and dimly lit areas.
- Make sure that the working area is clearly delimited and that its access is controlled.
- Visible lighting signs should be placed at the entrances of the working area.
- In order to prevent hazards due to electrical shocks, before starting any manipulation on the power central unit, make sure that the AC power is unplugged and the capacitors completely discharged.
- Only QUANTEL qualified personnel is authorized to perform maintenance operations on QUANTEL laser systems. These operators must have knowledge in optics and electronics and attended to a QUANTEL maintenance training.
- In case of accident, incident or doubt concerning the operation of the laser, please contact the safety officer.

## II.5. SAFETY LABELS

All laser devices are identified with labels. These identification labels must be permanent, legible and clearly visible during operation, maintenance, or adjustment. The operators should always be safe from laser light when reading them.

Several identification plates are placed on and inside QUANTEL's lasers. The operators are strictly forbidden to move, remove or cover these plates.

# BRILLIANT & BRILLIANT B DESCRIPTION

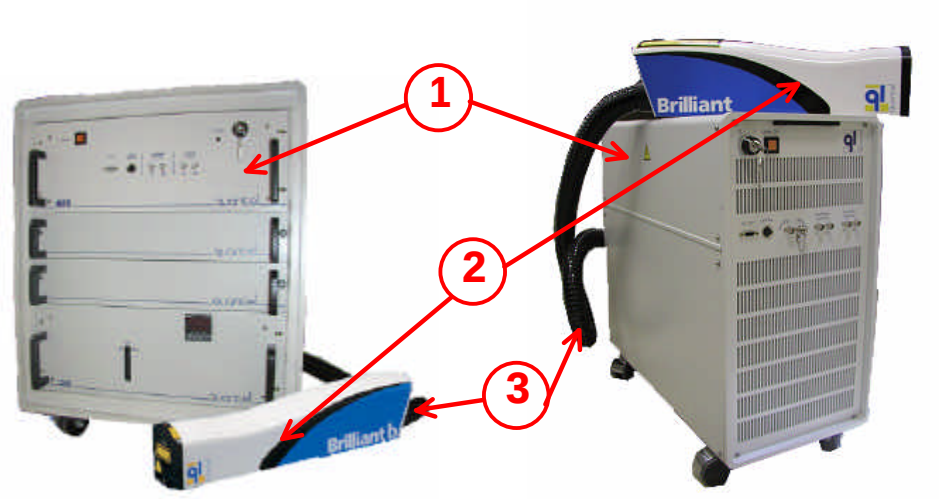
# B. BRILLIANT & BRILLIANT B DESCRIPTION

# I. THE BRILLIANT AND BRILLIANT B LASERS

## I.1. GENERAL DESCRIPTION

The Brilliant and Brilliant B lasers are two Nd:YAG Q-Switched lasers generating a gaussian laser beam at 1064 nm. They are made of (see picture B-1):

1. an electronic cabinet managing the pulse creation (flashlamp and Q-Switch), the interface with the user and the cooling of the system,
2. a laser head creating the laser pulse,
3. an umbilical containing the wiring and the water hoses going from the electronic cabinet to the laser head.




**Picture B-1. The Brilliant B 20Hz (left) and Brilliant (right) lasers**

One, two or three harmonic generators can be added to the laser head to change the output beam wavelength. Here are the possible combinations and the associated wavelength:

- SHG (second harmonic generator): 532 nm,
- SHG + THG (third harmonic generator): 355 nm,
- SHG + FoHG (fourth harmonic generator): 266 nm,
- SHG + FoHG + FiHG (fifth harmonic generator): 213 nm.

Of course, the specifications of the laser are different for each wavelength.

## I.2. SPECIFICATIONS

The Brilliant is set with a 6mm diameter rod and shows these performances:

| **Repetition rate (Hz)** | | **10** | **20** | **50** |
|---|---|---|---|---|
| **Energy per pulse (mJ)** | 1064nm | 360 | 350 | 150 |
| | 532 nm | 180 | 160 | 65 |
| | 355 nm | 65/100* | 60/70* | 20 |
| | 266 nm | 40 | 30 | 12 |
| | 213 nm | 8 | 6 | 2 |
| Measured with a calibrated wattmeter / *High energy UV option | | | | |
| **Energy stability - shot to shot (%)** | 1064nm | ±2 | ±2 | ±3 |
| | 532 nm | ±4 | ±4 | ±7 |
| | 355 nm | ±6 | ±6 | ±9 |
| | 266 nm | ±8 | ±8 | ±12 |
| | 213nm | ±12 | ±12 | ±16 |
| Peak to peak, 100% of the shots | | | | |
| **Power drift (%)** | 1064nm | ±3 | ±3 | ±3 |
| | 532 nm | ±3 | ±3 | ±3 |
| | 355 nm | ±3 | ±3 | ±3 |
| | 266 nm | ±6 | ±6 | ±6 |
| | 213nm | ±10 | ±10 | ±10 |
| Over 8 hours, without readjustment of phase-matching, 18°C<TO<28°C (10Hz/20Hz), 18°C<TO<25°C(50Hz), W/W exchanger or chiller option available | | | | |
| **Pulse duration (ns)** | 1064nm | ~5 | ~5 | ~6 |
| | 532 nm | ~4 | ~4 | ~5 |
| | 355 nm | ~4 | ~4 | ~5 |
| | 266 nm | ~4 | ~4 | ~5 |
| | 213nm | ~4 | ~4 | ~5 |
| FWHM, Hamamatsu photodiode and 1 GHz scope | | | | |
| **Linewidth (cm-1)** | 1064nm | 0.7 | 0.7 | 0.7 |
| | 532 nm | 1.4 | 1.4 | 1.4 |
| FWHM, measured by a grating spectrometer with a 0,045cm-1 resolution | | | | |
| **Jitter (ns)** | 1064nm | <0.5 | <0.5 | <0.5 |
| With respect to Q-Switch trigger, measured at half-width of 500 accumulated shots | | | | |
| **Pointing stability (urad)** | 1064nm | <50 | <75 | <75 |
| | 532 nm | <50 | <75 | <75 |
| | 355 nm | <50 | <75 | <75 |
| | 266 nm | <50 | <75 | <75 |
| Measured by SPIRICON LBA-100, RMS, on 200 pulses at the focal plane of a 2m focus lens | | | | |
| **Divergence (mrad)** | 1064nm | 0.5 | 0.5 | 0.7 |
| Full angle, on 200 pulses, at 1/e2 of the peak, 85% of total energy | | | | |
| **Polarization ratio (%)** | 1064nm | >90 | >90 | >80 |
| Horizontal polarization | | | | |
| **Focusability (times Diffraction Limit)** | 1064nm | <2 | <2 | <3 |
| At 1/e2 of the peak, by SPIRICON LBA-100 | | | | |
| **Spatial profile (fit to gaussian)** | | | | |
| **Near field** | 1064nm | 0.70 | 0.70 | 0.70 |
| At 1 m from the laser output. Least square fit to Gaussian (perfect fit = 1). | | | | |
| **Far field** | 1064nm | 0.95 | 0.95 | 0.90 |
| At focal plane of a 2m focus lens. Least square fit to Gaussian (perfect fit = 1). | | | | |

**Table B-1. Brilliant specifications**

The Brilliant B is set with a 9mm diameter rod and shows these performances:

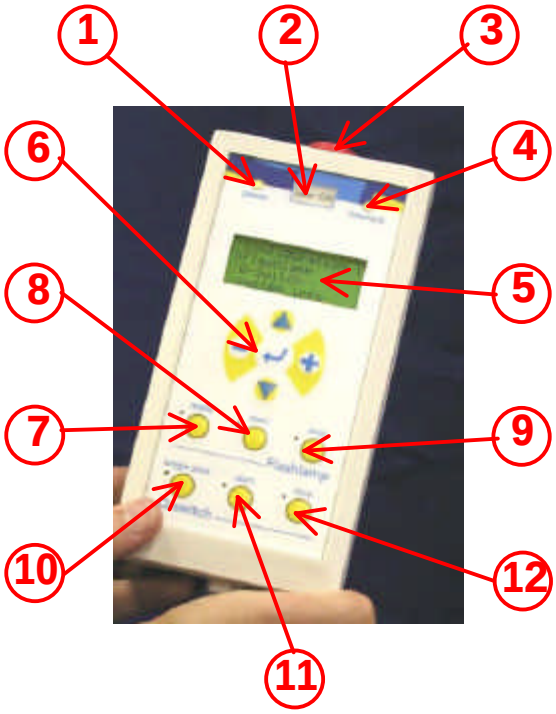
| Repetition rate (Hz) | | 10 | 20 |
|---|---|---|---|
| **Energy per pulse (mJ)** | 1064nm | 850 | 700 |
| | 532 nm | 400 | 300 |
| | 355 nm | 165/200* | 120/140* |
| | 266 nm | 90 | 60 |
| | 213 nm | 16 | 12 |
| Measured with a calibrated wattmeter / *High energy UV option | | | |
| **Energy stability - shot to shot (%)** | 1064nm | ±2 | ±2 |
| | 532 nm | ±4 | ±4 |
| | 355 nm | ±6 | ±6 |
| | 266 nm | ±8 | ±8 |
| | 213nm | ±12 | ±12 |
| Peak to peak, 100% of the shots | | | |
| **Power drift (%)** | 1064nm | ±3 | ±3 |
| | 532 nm | ±5 | ±5 |
| | 355 nm | ±5 | ±5 |
| | 266 nm | ±10 | ±10 |
| | 213nm | ±14 | ±14 |
| Over 8 hours, without readjustment of phase-matching, 18°C<TO<25°C (10Hz), 18°C<TO<35°C(20Hz), W/W exchanger or chiller option available | | | |
| **Pulse duration (ns)** | 1064nm | ~6 | ~6 |
| | 532 nm | ~5 | ~5 |
| | 355 nm | ~5 | ~5 |
| | 266 nm | ~5 | ~5 |
| | 213nm | ~5 | ~5 |
| FWHM, Hamamatsu photodiode and 1 GHz scope | | | |
| **Linewidth (cm-1)** | 1064nm | 0.7 | 0.8 |
| | 532 nm | 1.4 | 1.6 |
| FWHM, measured by a grating spectrometer with a 0,045cm-1 resolution | | | |
| **Linewidth with etalon-LNE (cm-1)** | 1064nm | <0.1 | <0.1 |
| FWHM, 15% energy reduction | | | |
| **Jitter (ns)** | 1064nm | <0.5 | <0.5 |
| With respect to Q-Switch trigger, measured at half-width of 500 accumulated shots | | | |
| **Pointing stability (urad)** | 1064nm | <50 | <50 |
| | 532 nm | <50 | <50 |
| | 355 nm | <50 | <50 |
| | 266 nm | <50 | <50 |
| Measured by SPIRICON LBA-100, RMS, on 200 pulses at the focal plane of a 2m focus lens | | | |
| **Divergence (mrad)** | 1064nm | 0.5 | 0.55 |
| Full angle, on 200 pulses, at 1/e2 of the peak, 85% of total energy | | | |
| **Polarization ratio (%)** | 1064nm | >80 | >70 |
| Horizontal polarization | | | |
| **Focusability (times Diffraction Limit)** | 1064nm | <2 | <2 |
| At 1/e2 of the peak, by SPIRICON LBA-100 | | | |
| **Spatial profile (fit to gaussian)** | | | |
| **Near field** | 1064nm | 0.70 | 0.65 |
| At 1 m from the laser output. Least square fit to Gaussian (perfect fit = 1). | | | |
| **Far field** | 1064nm | 0.9 | 0.9 |
| At focal plane of a 2m focus lens. Least square fit to Gaussian (perfect fit = 1). | | | |

**Table B-2. The Brilliant B specifications**

# I.3. REMOTE BOX PROTOCOL

The remote box allows you to control the entire system very easily. On the following pages, you will find the different functions accessible from the remote box. The remote box has the priority on the RS232 connection.

## I.3.i. DESCRIPTION




**Picture B-2. The remote box**

1. **The "power" led:** lights up when the laser is turned on.

2. **The "laser on" inscription:** lights up when the simmer current is on or the laser is flashing. Please follow the safety instructions when the inscription is lit up.

3. **The emergency stop push button:** When this button is pushed the power supply unit stops and the capacitor is grounded in less than 5s. Pull it before re-operating the system.

4. **The "interlock" led:** indicates if all the securities are OK (led lit up). If one of them fails, then it is blinking and a message is displayed on the LCD screen.

5. **The LCD screen.**

6. **The control pad:** to navigate inside the remote box menus and sub-menus, press:

   ▲ to go to the upper line of the menu,

   ▼ to go to the lower line of the menu,

   ✚ to increase the value of the variable parameters of the laser (such as the flashlamp discharge voltage or the Q-Switch-Flashlamp delay),

   ▬ to decrease the value of the variable parameters of the laser (such as the flashlamp discharge voltage or the Q-Switch-Flashlamp delay),

   ↵ to enter a sub-menu (such as “Flashlamp” or “Q-Switch) or go back to the main menu.

7. **The flashlamp “ready” button:** when pressed, turns on the simmer current in the flashlamp. The associated led lights up when the simmer current is established.

8. **The flashlamp “start” button:** when pressed, starts the firing operation of the flashlamp in internal or external mode, depending of what the user has selected. The associated led blinks when the lamp is flashing.

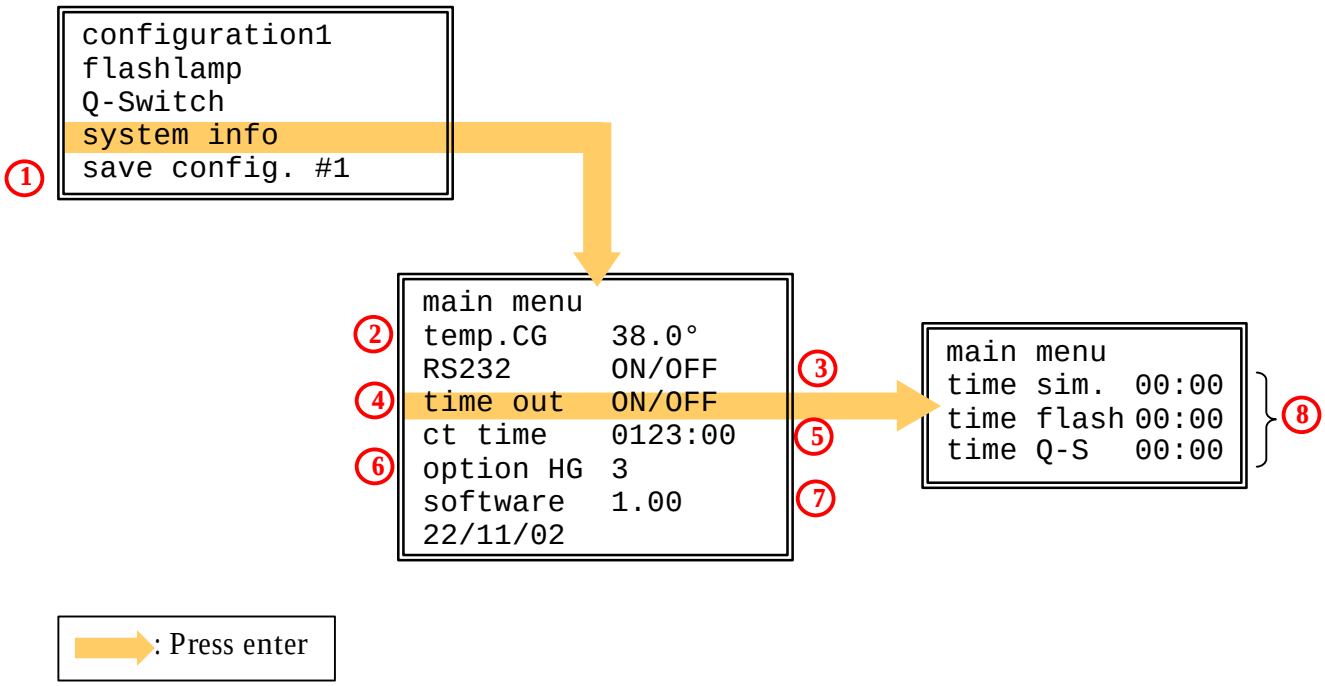
9. **The flashlamp “stop” button:** when pressed, stops the firing operation of the flashlamp and the simmer current.

10. **The Q-Switch “single shot” button:** when pressed, emits a single laser pulse if the laser temperature has reached the preset value and if the laser is not already operating continuously.

11. **The Q-Switch “start” button:** when pressed, emits a continuous burst of laser pulses (automatic mode) if the laser temperature has reached the preset value. The associated led blinks when the laser is emitting pulses.

12. **The Q-Switch “stop” button:** when pressed, stops the automatic Q-Switch operation.

## I.3.ii. THE "SYSTEM INFO" MENU




**Draw B-1. "System info" menu of the remote box**

The **"system info"** menu gives a general information about the state of the laser:

1. **save config. #1:** 4 configurations of the Brilliant operation can be saved. To choose under which number (#1, #2, #3 or #4) you want to save the current configuration, press the + / - buttons on the remote box. Then press the " ↵ " button on the remote box to save the parameters under the selected configuration.

2. **temp.CG:** indicates the real water temperature in the cooling group.

3. **RS232:** indicates if the laser is commanded or not through the RS232. To change the ON/OFF values, press the + / - buttons on the remote box.

4. **time out:** indicates if laser will operate until the user stops it through the remote box or the RS232 (time out OFF) or if it will operates according to the timing described in point 18 (time out ON). To switch from a mode to another, press the + / - buttons on the remote box.

5. **ct time:** indicates how long the laser has been on since its delivery.

⑥ **Option HG:** indicates the number of harmonic generators set on the laser head. It can take the following values:

**0, 1, 2 or 3:** when there is no harmonic generator or a second or third harmonic generator

**4:** where there is a fourth harmonic generators

To switch from one value to another press the + / - buttons on the remote box.

⑦ **ver 1.00:** indicates the reference of the software used to manage the laser system.

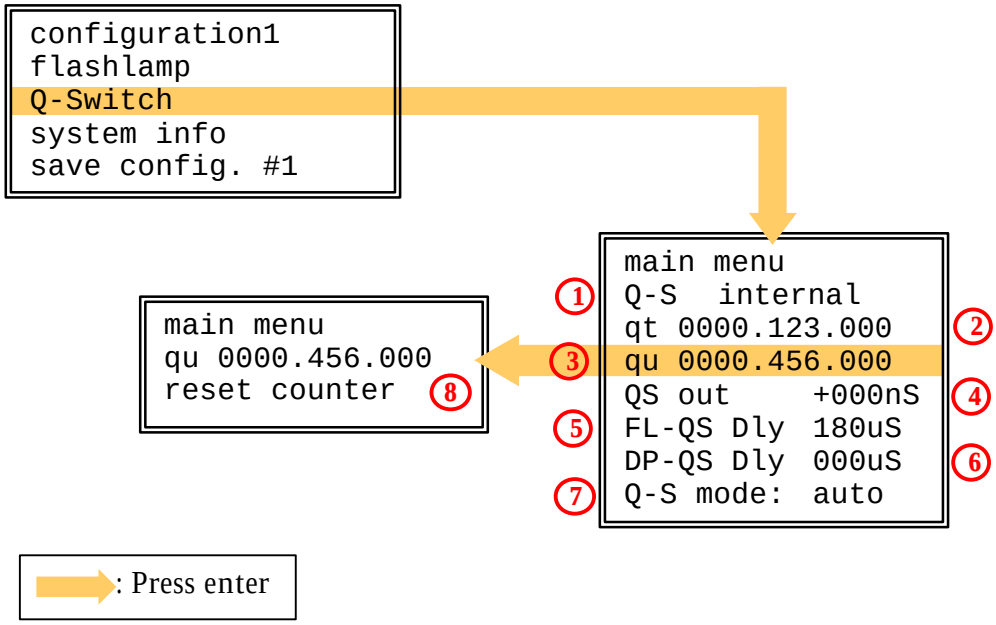
⑧ **time sim.:** indicates, in minutes and seconds, how long the simmer will last until the system stops it.

**time flash:** indicates, in minutes and seconds, how long the lamp will flash until the system stops it.

**time Q-S:** indicates, in minutes and seconds, how long the laser will Q-Switch until the system stops it.

Each of these values can be adjusted by pressing the + / - button on the remote box. This operation configuration has to be validated by the line “time out” (n°4).

### I.3.iii. THE "Q-SWITCH" MENU




**Draw B-2. "Q-Switch" menu of the remote box**

The **"Q-Switch"** menu gives information about the Q-Switch operation:

① **Q-S:** indicates if the Q-Switch is internally or externally synchronized. To switch from the internal to the external mode, press the "+/-" buttons of the remote box.

② **qt:** indicates the number of shot Q-Switched since the delivery of the system. This value cannot be reseted by the user.

③ **qu :** indicates the number of shot Q-Switched. This value can be reseted by the user.

④ **QS out:** indicates the value of the time delay between the signal used to synchronize the Pockells cell (thus to create the laser pulse) and the one sent to the user on the front panel (BNC Q-Switch OUT). This delay can be set between –500ns and +500ns. To adjust it, press the +/- buttons of the remote box.

⑤ **FL-QS Dly :** indicates the value of the time delay between the flashlamp shot signal and the Q-Switch signal. This value can be adjusted with the +/- button on the remote box.

⑥ **DP-QS Dly:** displayed only if the laser operates with the doublepulse option (option DP-QS = 1). Indicates the time delay between the two

pulses generated by the laser. The double pulse option will be valid only if this value is higher than 30 **m**S. This value can be adjusted with the + / - button on the remote box.

⑦ **Q-S mode :** indicates the operation mode of the laser: auto, burst or scan. To switch from one to another press the + / - buttons of the remote box. To set up these modes, press the "enter" button on the remote box.

- If the "auto" mode is selected, the following menu will appear on the remote box (after pressing "enter"):

```
Qswitch menu
QS mode:   auto
QS pulse:  F/01 (a)
```

ⓐ **QS pulse:** indicates the repetition rate of the laser pulses. The value F is the normal operation frequency of the laser. To divide the repetition rate value, press the + / - buttons of the remote box.

- If the "burst" mode is selected, the following menu will appear on the remote box (after pressing "enter"):

```
Qswitch menu
QS mode:   burst
QS pulse:  001   (a)
```

ⓐ **QS pulse:** indicates the number of laser pulse that will be generated. To increase or decrease the number of laser pulses generated, press the + / - buttons of the remote box.

- If the "scan" mode is selected, the followig menu will appear on the remote box (after pressing "enter"):

```
Qswitch menu
QS mode:      scan (a)
nb of burst:   99
active pulse:  01 (b)
passive pulse: 00 (c)
```

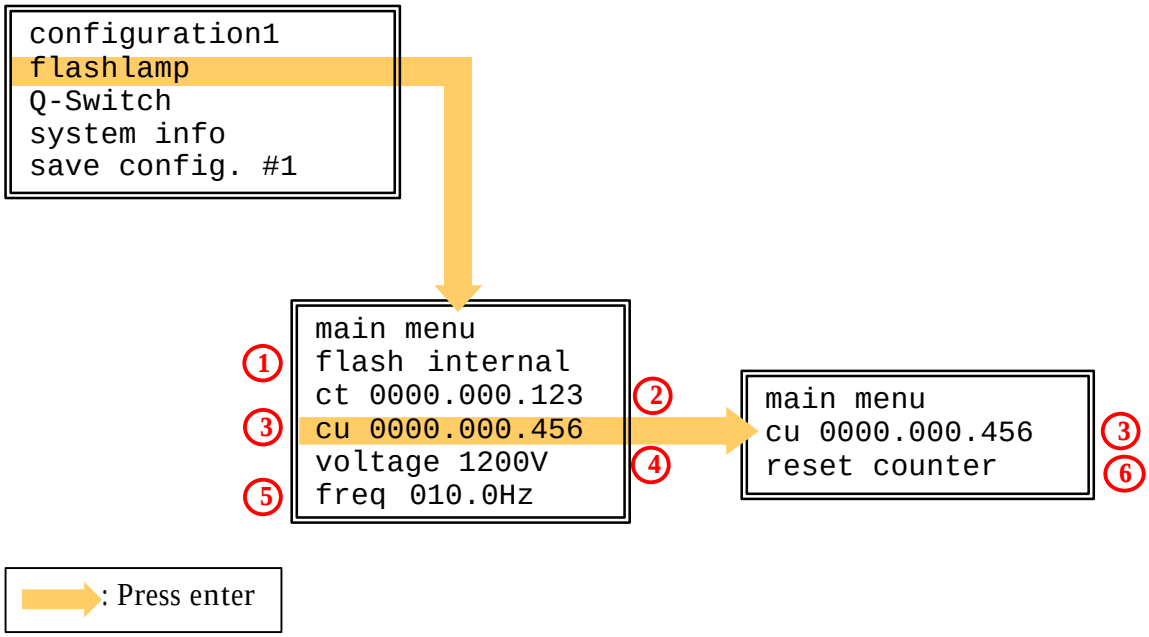
ⓐ **nb of burst:** when the laser is set in burst mode, indicates the number of times where the system is going to repeat the laser pulses configuration set on the two lines below. To increase or decrease the nb of burst, press the + / - buttons of the remote box.

ⓑ **active pulse:** indicates the number of active laser pulses in one burst. To increase or decrease the nb of active pulses, press the + / - buttons of the remote box.

ⓒ **passive pulse:** indicates the number of inhibited laser pulses in one burst. To increase or decrease the nb of inhibited pulses, press the + / - buttons of the remote box.

⑧ **reset counter:** reset the “qu” counter.

### I.3.iv. THE "FLASHLAMP" MENU




**Draw B-3. "flashlamp" menu of the remote box**

The **"flashlamp"** menu gives an information about the state of the flashlamp operation:

① **flash:** indicates if the flashlamp is internally (internal) or externally (external) synchronized. To switch from the internal to the external mode, press on the "enter" button of the remote box.

② **ct:** indicates the number of flashlamps shots since the delivery of the system. This value cannot be reseted by the user.

③ **cu :** indicates the number of flashlamp shots. This value can be reseted by the user.

④ **voltage:** indicates the value of the voltage discharged in the flashlamp. This value can be adjusted with the + / - buttons of the remote box.

⑤ **freq:** indicates the operation frequency of the laser.

⑥ **reset counter:** reset the "cu" counter.

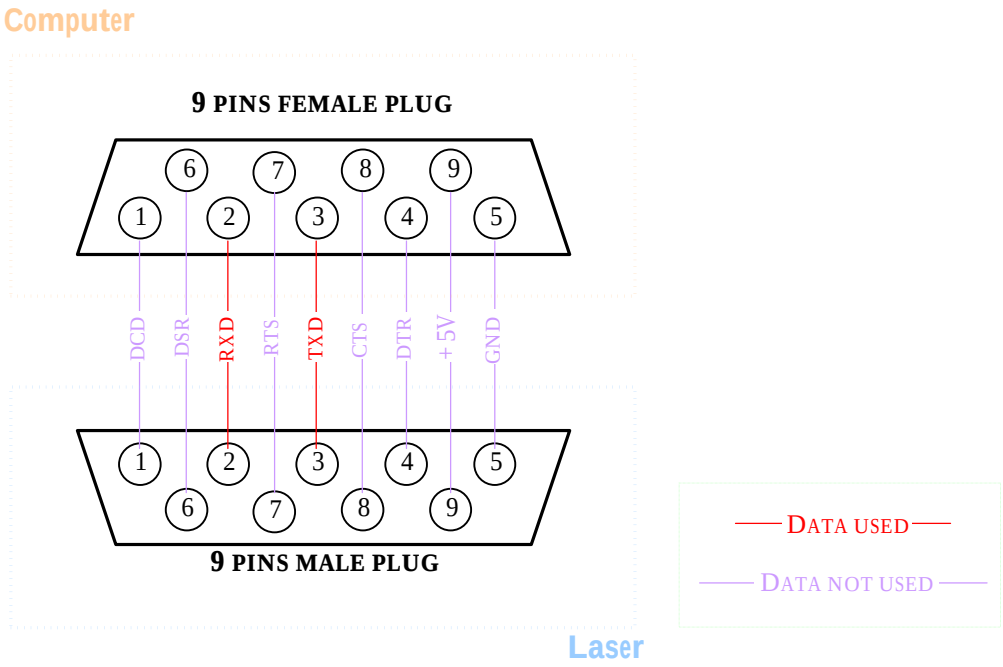
## I.4. RS 232

The RS 232 connection will allow you to manage the laser operation directly from your computer. To do so, the host computer has to incorporate an RS 232 command format, and the cable to the connector should not exceed 20 m.

The RS 232 communication parameters are:

- 9600 BAUD,
- 8 bit,
- 1 stop bit,
- no parity.

The standard wiring diagram is shown on the draw B-4.




**Draw B-4. RS 232 connection**

Commands are in ASCII string and must be terminated by the “CRLF” (**C**arriage **R**eturn **L**ine **F**eed) character. The answers are also composed of “CRLF” followed by 15 characters.

As a rule:

- the “uS” characters in the answer messages stand for “µS”,

- the " ° " character in the following RS 232 command and answer description stands for a space,
- the answer message "unknown char" appears when the computer doesn't recognize the characters sent,
- the answer message "overflow char" appears when, while programming a data, the number of figure exceeds the authorized one,

### I.4.i. CONFIGURATION

In the following table, you will find the command and answer messages to get some information about the laser configuration.

| RS 232 command | Function | Answer |
|---|---|---|
| **Configuration reading** | | |
| **X**"CRLF" | Soft version | **Brilliant°°x.xx** |
| **DAT**"CRLF" | Date of the soft version | **xx/ xx/ xx°°°°°°°** |
| **CG**"CRLF" | Cooling group temperature in °C | **temp.°CG°xx°d°°** |
| **CGF**"CRLF" | Cooling group temperature in °F | **temp.°CG°xx°F°°** |
| **NTP**"CRLF" | Unit of the temperature display (°C or °F) | **option°TP°°:°°x** |
| **CFG**"CRLF" | Current system configuration | **configuration°x** |
| **T**"CRLF" | Time counter | **ct°time°hhhh:mm** |
| **WOR**"CRLF" | Laser status (refer to the table B-5) | **I°a°F°b°S°c°Q°d** |
| **Configuration programming** | | |
| **CFG1**"CRLF" | Load a system configuration (from 1 to 4) | **configuration°x** |
| **SAV2**"CRLF" | Save a system configuration (from 1 to 4) | **Save°config.°°2** |
| **NTP**"CRLF" | Set the unit of the temperature display (0= °C, 1= °F) | **option°TP°°:°°x** |

**Table B-3. Configuration RS232 commands**

| Data \ Value | | 0 | 1 | 2 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| **a** | **Interlock** | All ok | Fail | | | | |
| **b** | **Flashlamp** | Internal synchronisation | | | External synchronisation | | |
| | | Stop | Single | Start | Stop | Single | Start |
| **c** | **Simmer** | Off | On | | | | |
| **d** | **Q-Switch** | Internal synchronisation | | | External synchronisation | | |
| | | Stop | Single | Start | Stop | Single | Start |

**Table B-4. "WOR" RS232 command values**

## I.4.ii. FLASHLAMP MANAGEMENT

In the following table, you will find the command and answer messages to get some information about the flashlamp state and to command it.

| RS 232 command | Function | Answer |
|---|---|---|
| **Flashlamp data reading** | | |
| **V**"CRLF" | Oscillator flashlamp voltage (V) | volt°fl1°----°V |
| **D**"CRLF" | Preset flashlamp repetition rate (Hz) | freq°°---.-°Hz |
| **F**"CRLF" | Flashlamp shot counter | ct°LP°-------- |
| **UF**"CRLF" | User flashlamp shot counter | cu°LP°-------- |
| **Flashlamp data programming** | | |
| **V1320**"CRLF" | Flashlamp discharge voltage (V) | voltage°°01320°V |
| **UF0**"CRLF" | Reset the user flashlamp shot counter | cu°LP°000000000 |
| **Flashlamp activation/ desactivation** | | |
| **M**"CRLF" | Establishes the simmer current in the flashlamp | simmer°°°°°°°°° |
| | | simmer°°°°°°°e° |
| **A**"CRLF" | Activate the internal automatic flashlamp shot mode | fire°auto°°°°°° |
| | | fire°auto°°°°e° |
| **E**"CRLF" | Activate the external automatic flashlamp shot mode | fire°ext°°°°°°° |
| | | fire°ext°°°°°e° |
| **S**"CRLF" | Stop the the automatic or external mode | standby°°°°°°°° |
| | | standby°°°°°°e° |

**Table B-5. Flashlamp RS232 commands**

## I.4.iii. Q-SWITCH MANAGEMENT

In the following table, you will find the command and answer messages to get some information about the Q-Switch state and to command it.

| RS 232 command | Function | Answer |
|---|---|---|
| **Q-Switch data reading** | | |
| **QSM**"CRLF" | QS mode | **QS°mode°:°°°-°°** |
| **QSF**"CRLF" | QS repetition rate in auto mode | **cycle°rate°F/ -** |
| **QSP**"CRLF" | Number of QS shots in burst mode | **burst°QS°°°°---** |
| **Q**"CRLF" | QS parameters in scan mode | **QS°°°--°°--°°--** |
| **FQ**"CRLF" | Q-Switched shots counter | **ct°QS°--------** |
| **UFQ**"CRLF" | User Q-Switched shots counter | **cu°QS°--------** |
| **W**"CRLF" | Flash-QS delay | **delay°°°°---°uS** |

**Table B-6. Q-Switch RS232 commands (1/ 2)**

| RS 232 command | Function | Answer |
|---|---|---|
| **Q-Switch data reading** | | |
| **WD** "CRLF" | Delay between the two Q-Switched shots in double pulse | **QS1-QS2°°---°uS** |
| **VQ**"CRLF" | QS synchro out variable delay (+/-500ns) | **Var.°QS°±---°nS** |
| **Q-Switch data programming** | | |
| **QI**"CRLF" | Set the Q-Switch operation in internal mode | **QS°synch°:°°int** |
| **QE**"CRLF" | Set the Q-Switch operation in external mode | **QS°synch°:°°ext** |
| **QSM1**"CRLF" | Set the QS mode (0= Auto, 1= Burst, 2= Scan) | **QS°mode°:°°°1°°** |
| **QSF10**"CRLF" | Set the QS repetition rate in auto mode | **cycle°rate°F/10** |
| **QSP50**"CRLF" | Set the number of QS shots in burst mode (from 1 to 999) | **burst°QS°°°°050** |
| **Q120455**"CRLF" | Set the QS parameter in scan mode | **QS°°°12°°04°°55** |
| **UFQ0**"CRLF" | Reset the user Q-Switched shots counter | **cu°QS°000000000** |
| **W225**"CRLF" | Set the flash-QS delay | **delay°°°°225°uS** |
| **WD100** "CRLF" | Set the delay between the two Q-Switched shots in double pulse | **QS1-QS2°°100°uS** |
| **VQ+250**"CRLF" | Set the QS synchro out variable delay (+/-500ns) | **Var.°QS°+250°nS** |
| **Q-Switch activation/desactivation** | | |
| **CC**"CRLF" | Start the QS operation in the preselected mode | |
| | Flashlamp and QS in internal mode | **fire°auto°°°qs°°** |
| | Flashlamp in internal mode, QS in external mode | **fire°auto°°°qse°** |
| | Flashlamp in external mode, QS in internal mode | **fire°ext°°°°qs°°** |
| | Flashlamp in external mode, QS in external mode | **fire°ext°°°°qse°** |
| **CS**"CRLF" | Stops the QS operation | |
| | Flashlamp and QS in internal mode | **fire°auto°°°°°°°** |
| | Flashlamp in internal mode, QS in external mode | **fire°auto°°°°°e°** |
| | Flashlamp in external mode, QS in internal mode | **fire°ext°°°°°°°°** |
| | Flashlamp in external mode, QS in external mode | **fire°ext°°°°°°e°** |
| **OP**"CRLF" | Single pulse QS operation in the preselected mode | |
| | Flashlamp and QS in internal mode | **fire°auto°°°qs°°** |
| | Flashlamp in internal mode, QS in external mode | **fire°auto°°°qse°** |
| | Flashlamp in external mode, QS in internal mode | **fire°ext°°°°qs°°** |
| | Flashlamp in external mode, QS in external mode | **fire°ext°°°°qse°** |

**Table B-7. Q-Switch RS232 commands (2/2)**

## I.4.iv. SECURITY

In the following table, you will find the command and answer messages to get some information about the securities.

| RS 232 command | Function | Answer |
|---|---|---|
| **Securities** | | |
| **IF1**"CRLF" | General securities test | IF1°°ab°cd°ef°00 |
| | All securities OK | IF1°°00°00°00°00 |
| | Low flow rate or cooling group temperature too high | a=1 |
| | Discharge button pushed on the power supply cabinet | b=1 |
| | Remote box emergency stop button activated | c=1 |
| | Protective housing not correctly set | d=1 |
| | Laser head temperature too high (>45°C) | e=1 |
| | External safety interlock (BNC) opened | f=1 |
| **IF2**"CRLF" | Flashlamp securities test | IF2°ab°cd°ef°g0 |
| | All securities OK | IO1°00°00°00°00 |
| | Repetition rate of the flashlamp in external mode below the low limit | a=1 |
| | Repetition rate of the flashlamp in external mode above the high limit | b=1 |
| | Capacitor charge failure | c=1 |
| | Simmer current initiation failure | d=1 |
| | Simmer stop | e=1 |
| | Water temperature below the low limit | f=1 |
| | Water temperature above the low limit | g=1 |
| **IQ**"CRLF" | QS securities test | IQS°°ab°c0°0f°g0 |
| | All securities OK | IQS°00°00°00°00 |
| | QS inhibited during the preset number of flashlamp shots | a=1 |
| | Water temperature below the low limit | b=1 |
| | QS stop | c=1 |
| | External safety interlock (BNC) opened (only with MPS electronic cabinet) | f=1 |
| | Shutter closed | g=1 |

**Table B-8. Security RS232 commands**

## I.4.v. "TIME OUT" FUNCTION

In the following table, you will find the command to manage the "time out" function. This function allows the user to program the stop of the simmer, flashlamp shots and Q-Switched shots after a preset amount of time.

| RS 232 command | Function | Answer |
|---|---|---|
| **"Time out" parameters reading** | | |
| **L**"CRLF" | "Time out" status (0= off, 1= on) | **time°out°°°°°°-** |
| **CLS**"CRLF" | Simmer time counter order | **con°SIM°= °--:--** |
| **CLC**"CRLF" | Flashlamp shots time counter order | **con°LF°°= °--:--** |
| **CLQ**"CRLF" | Q-Switched shots time counter order | **con°QS°°= °--:--** |
| **LS**"CRLF" | Simmer time counter state | **cpt°SIM°= °--:--** |
| **LC**"CRLF" | Flashlamp shots time counter state | **cpt°LF°°= °--:--** |
| **LQ**"CRLF" | Q-Switched shots time counter state | **cpt°QS°°= °--:--** |
| **"Time out" parameters programming** | | |
| **IF2**"CRLF" | Flashlamp securities test | **IF2°ab°cd°ef°g0** |
| **L1**"CRLF" | Set the "Time out" status (0= off, 1= on) | **time°out°°°°°°1** |
| **CLS6000**"CRLF" | Simmer time counter order | **con°SIM°= °60:00** |
| **CLC100**"CRLF" | Flashlamp shots time counter order | **con°LF°°= °01:00** |
| **CLQ500**"CRLF" | Q-Switched shots time counter order | **con°QS°°= °05:00** |

**Table B-9. "Time out" RS232 commands**

# II. POWER SUPPLY

## II.1. GENERAL DESCRIPTION

The Brilliant's power supply with the cooling group (water to air heat exchanger) is called the "ECB2K". The whole Brilliant family is using this kind of cabinet except the Brilliant B 20Hz whose using a MPS (Master Power Supply) with a separated cooling group (CGS, water to water heat exchanger).

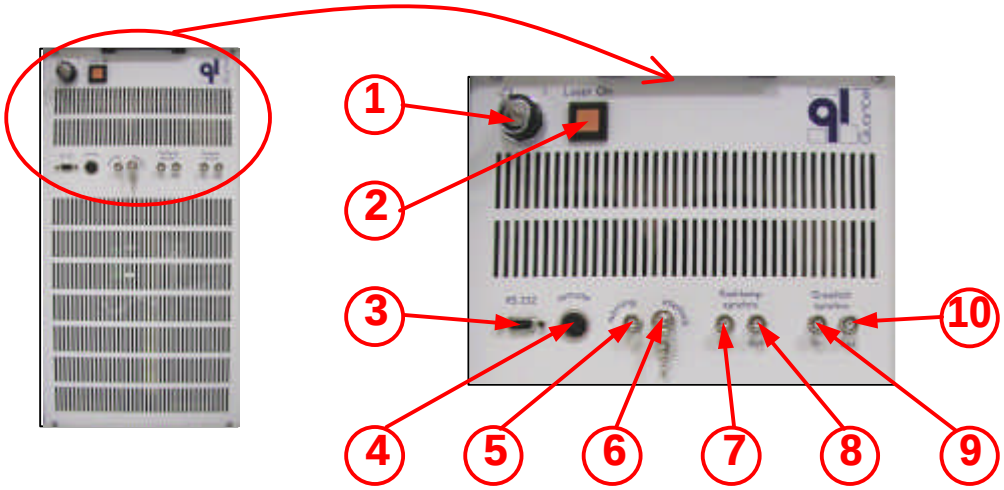
**Picture B-3. The "ECB2K"**

The "ECB2K" dimensions (height x depth x width) are 56.8 x 59.2 x 28.6 $cm^3$. It weights 43 kg. For the Brilliant B 20Hz, the MPS and the CGS are set in a cabinet whose dimensions are 74.5 x 80 x 55 $cm^3$. It weights 86 kg.

**Picture B-4. The Brilliant B 20Hz cabinet**

## II.1.i. FRONT PANEL

### II.1.i.a. THE "ECB2K"




**Picture B-5. The "ECB2K" front panel**

1. **On/ Off key.**

2. **Laser indicator:** lit up when the simmer current is established in the flashlamp

3. **Serial port (RS 232):** through this connector, all the laser data and command are accessible in ASCII code.

4. **Remote control:** the remote control is plugged on this connector so that the user can communicate with the laser.

5. **Warning:** turns on the external warning light as soon as the lamp is flashing.

6. **Interlock:** external security that can be used to shut down the laser in case of danger. If any security fault is detected, the capacitor is discharged.

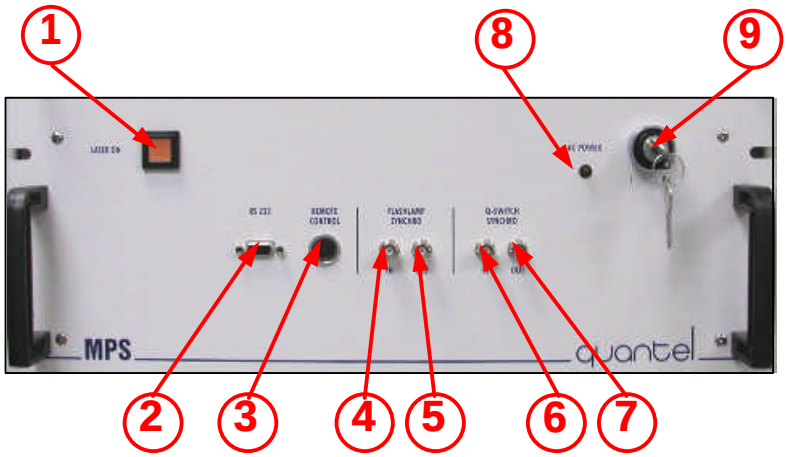
7. **Flashlamp external synchronization:** through this connector, the user can input its own signal to synchronize the flashlamp.

8. **Flashlamp internal synchronization:** through this connector, the user can access the flashlamp synchronization signal generated by the electronic cabinet.

9. **Q-Switch external synchronization:** through this connector, the user can input its own signal to synchronize the flashlamp.

10. **Q-Switch internal synchronization:** through this connector, the user can access the Q-Switch synchronization signal generated by the electronic cabinet.

### II.1.i.b. MPS FOR BRILLIANTB 20HZ




**Picture B-6. MPS front panel**

1. **Laser indicator:** lit up when the flashlamp is fed (simmer current on).

2. **Serial port (RS 232):** through this connector, all the laser data and command are accessible in ASCII code.

3. **Remote control:** the remote control is plugged on this connector so that the user can communicate with the laser.

4. **Flashlamp external synchronization:** through this connector, the user can input its own signal to synchronize the flashlamp.

5. **Flashlamp internal synchronization:** through this connector, the user can access the flashlamp synchronization signal generated by the MPS.

6. **Q-Switch external synchronization:** through this connector, the user can input its own signal to synchronize the flashlamp.

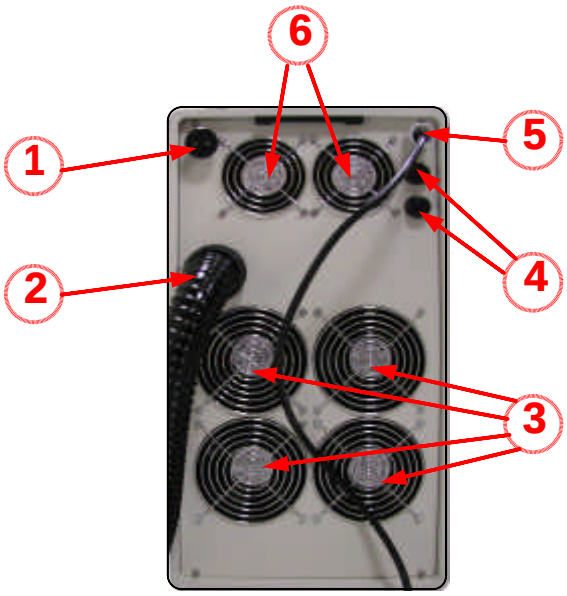
7. **Q-Switch internal synchronization:** through this connector, the user can access the Q-Switch synchronization signal generated by the MPS.

8. **Power indicator:** lit up when the key in on the I position.

9. **On/ Off key.**

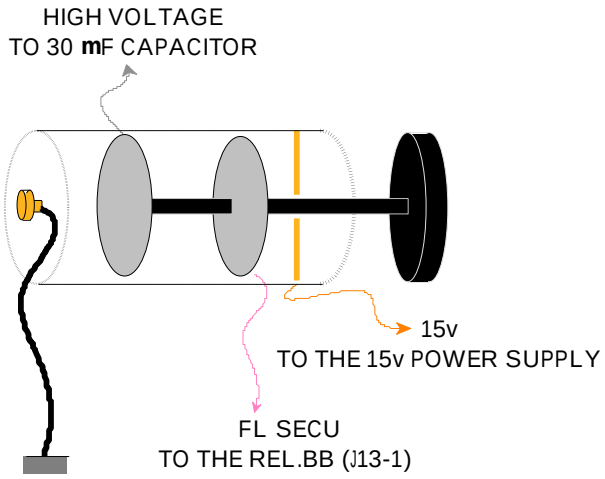
## II.1.ii. REAR PANEL

### II.1.ii.a. THE "ECB2K"




**Picture B-7. "ECB2K" rear panel**

1. **Discharge capacitor switch:** security switch that discharges the 30 µF capacitor of the power supply when pushed. **TO BE PUSHED BEFORE ANY MAINTENANCE OPERATION.**




**Draw B-5. The discharge capacitor switch**

2. **The umbilical:** it is a 3 meters hose connecting the power supply cabinet to the laser head. It includes the flashlamp high voltage wires, the water hoses, the safety wires, the synchronization wires, the 15V power supply, the ground and the 48V power supply for the harmonic generators.

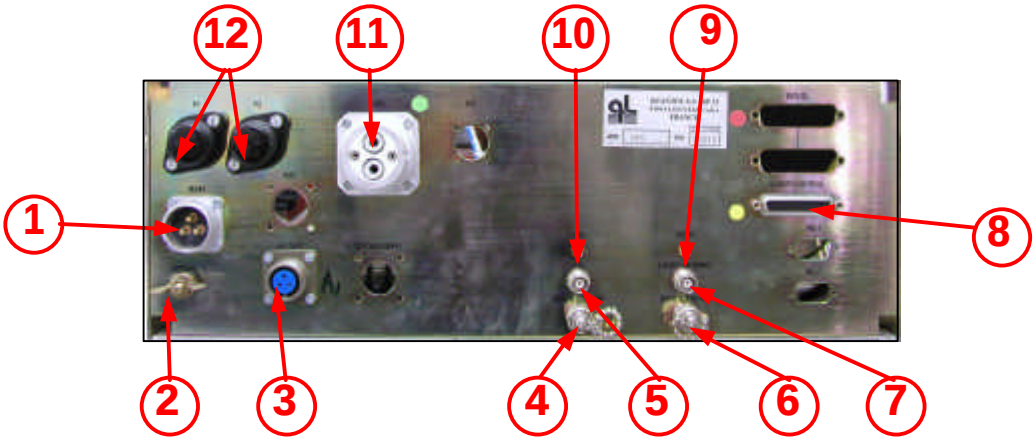
3. **Fans:** to cool the CG.

4. **Fuses:** two 10AT fuses to protect the system from the main instabilities.

5. **Main plug:** the main power supply feeds the electronic cabinet through this connector.

6. **Fans:** to cool the system power supply.

### II.1.ii.b. MPS FOR BRILLIANTB 20HZ




**Picture B-8. MPS rear panel**

1. **Main plug:** the main feeds the MPS through this connector.

2. **Ground:** connected to the ground of the rack.

3. **AC OUT:** through this connector, the MPS sends the main to the cooling group.

4. **Interlock QS:** external security that may be used to stop the Q-Switch in case of danger.

5. **CG:** connected to the cooling group to stop the MPS when a security fault has been detected in the CGS

6. **Interlock PS:** external security that may be used to shut down the laser in case of danger. If any security fault is detected, the capacitor is discharged.

7. **Laser warning:** turns on the external warning light as soon as the lamp is flashing.

8. **Laser control:** connected to the laser head for the MPS and the laser head to be able to communicate.

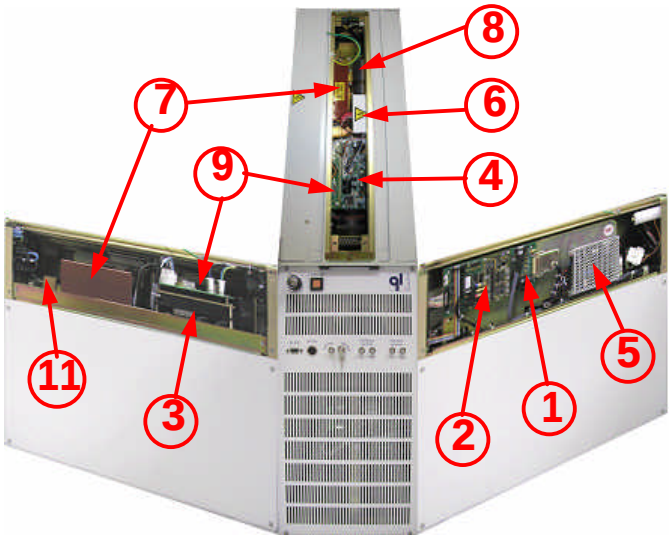
9. **STPK:** Copy of the QS output (n°10).

10. **QS:** Oscillator Pockells cell synchronization output.

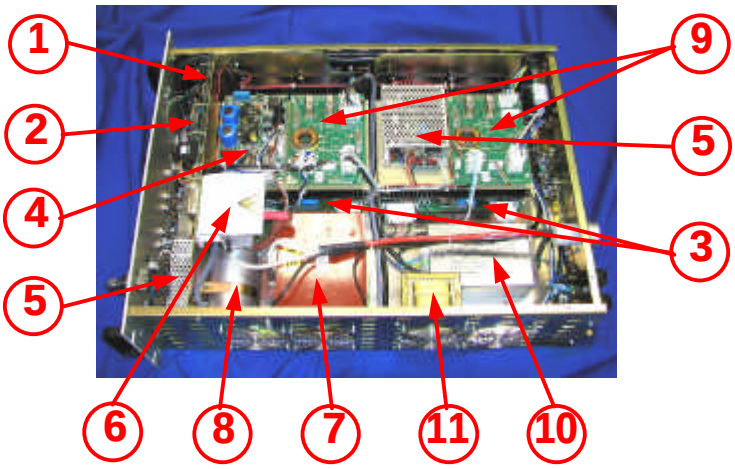
11. **CH:** connected to the laser head to send the high voltage to the oscillator flashlamp.

12. **F1 & F2:** fuses used to protect the MPS (F1= 10AT, F2= 10AT)

## II.1.iii. COMPOSITION




**Picture B-9. "ECB2K" description**




**Picture B-10. MPS for BrilliantB 20Hz description**

1. CPU.BB board (Central Processing Unit):
   - to control the charge timing and send the fire orders,
   - to monitor security interlocks (to switch the laser off when a malfunction is detected).

**2.** **VD.BB** board (Variable Delay unit):

- to control the timing of the Q-Switch delays,
- to operate the Q-Switch delays in Automatic, External or Internal mode.

**3.** **PB.BR** board (Power Board):

- to charge the capacitor bank that will be discharged in the flashlamp.

In the case of a BrilliantB 20Hz, there are two PB.BR that charge the capacitor at the same time.

**4.** **TS.BB** board (Trigger Simmer board):

- to maintain a low simmer current between the pulses in order to decrease the E.M.I. noise and improve the lifetime of the flashlamp,
- to send the order to the thyristor to discharge the capacitor bank.

**5.** **+15V power supply**:

- to supply the boards with + 15V.

In the case of a BrilliantB 20Hz, there are two 15V power supplies.

**6.** **Thyristor**:

- to discharge the capacitor in the flashlamp.

**7.** **Transformer trigger**:

- to establish the simmer current.

**8.** **Capacitor bank** (composed of a 30 µF capacitor):

- to stock the energy in the capacitor,
- to initiate the flashlamp with the TS.BB board,
- to discharge the energy in the flashlamp with the thyristor.

**9.** **REL.BB** board (RELay unit):

- to distribute the main to the different units,
- to control the current with 2 fuses.

In the case of a BrilliantB 20Hz, there are two REL.BB boards that distribute the main.

**10. Main filter**:

- to reduce the noise level coming from the main.

In the case of a "ECB2K", the main filter is set in the cooling group part of the cabinet (down right).

**11. SDTQ.BB:**

- To command the harmonic generators if there are some.

# II.2. OPERATION DESCRIPTION

## II.2.i. LEXICON

In the following lexicon, you will find the list and the definitions of the data managed by the Brilliant and BrilliantB power supplies:

- **230 VAC:** Main power supply.
- **3/ 4W CD:** Signal commanding the third and fourth harmonic generators crystals heating.
- **CAPACITOR VOLTAGE:** Reading of the voltage across the capacitor terminals (factor 200).
- **CG SECU:** Signal indicating if the cooling group is correctly operating.
- **CG TP:** Water temperature in the cooling group (only on "ECB2K").
- **COVER SECU:** Signal indicating if the cover of the laser is closed or opened.
- **ENABLE LOAD:** Signal synchronizing the charge of the capacitor.
- **ENABLE QS:** Signal allowing or not the VD.BB board to deliver the Q-switch signals.
- **ENABLE TS:** Signal allowing or not the TS.BB board to deliver the simmer current and to command the thyristor.
- **EXT QS SYNC:** External synchronization signal for Q-Switch operation.
- **EXT SECU:** Signal indicating if the external securities are all OK.
- **EXT SHOT CD:** External (user) signal synchronizing the capacitor discharge in the flashlamp.

- **FL SECU:** Signal indicating that the laser head is well plugged to the electronic cabinet through the CH connector.
- **HV:** Value of the voltage charging the capacitor.
- **INT QS SYNC:** Synchronisation signal for the Q-Switch operation.
- **LASER HEAD SECU:** Signal indicating if the laser head temperature is too high (thermopa).
- **LASER READY:** Signal indicating that the laser is flashing or that the simmer current is established in the flashlamp.
- **LED SHUTTER:** Signal which lights up the laser head led when the shutter is opened.
- **ON/ OFF:** Signal indicating if the key is on the ON or OFF position on the front panel.
- **PK CD:** Signal giving the order to open the Pockells cell and thus synchronizing the Q-Switch operation.
- **QS SECU:** Security signal sent by the user that can stop the Q-Switch operation in case of danger (only on MPS).
- **QS SYNC OUT:** Delayed (+/- 500ns) Q-Switch synchronization signal sent to the user.
- **RC SECU:** Signal indicating if the emergency push button on the remote box is pushed or pulled.
- **RELAY SECU:** Security signal sent to the user to command a security lamp.
- **RXD:** User data received through the RS232 connector.
- **SCL:** Clock needed to read the data carried by the SDA signal.
- **SDA:** Multiplexed data.
- **SHOT CD:** Signal synchronizing the capacitor discharge in the flashlamp.
- **SHUTTER REPORT:** Signal indicating if the shutter is closed or opened.
- **TS REPORT:** Signal indicating if the simmer current is established in the flashlamp.
- **TXD:** System data transmitted to the user through the RS232 connector.

## II.2.ii. BLOCK DIAGRAMS

The power supply cabinet is controlling the oscillator operation. To do so, the **CPU.BB** board treats the data coming from the users and the system. It also generates:

- the signals sent to the TS.BB to pre-ionize the flashlamp and establish the simmer current when the user presses the flashlamp "**READY**" button on the remote box.
- the signals sent to the PB.BR to charge the capacitor and to the TS.BB to discharge the capacitor in the flashlamp when the user press the "**START**" button on the remote box.
- the signals sent to the VD.BB to synchronize the Pockells cell for the Q-Switch operation when the user press the Q-Switch "**SINGLE SHOT**" or "**START**" button on the remote box.

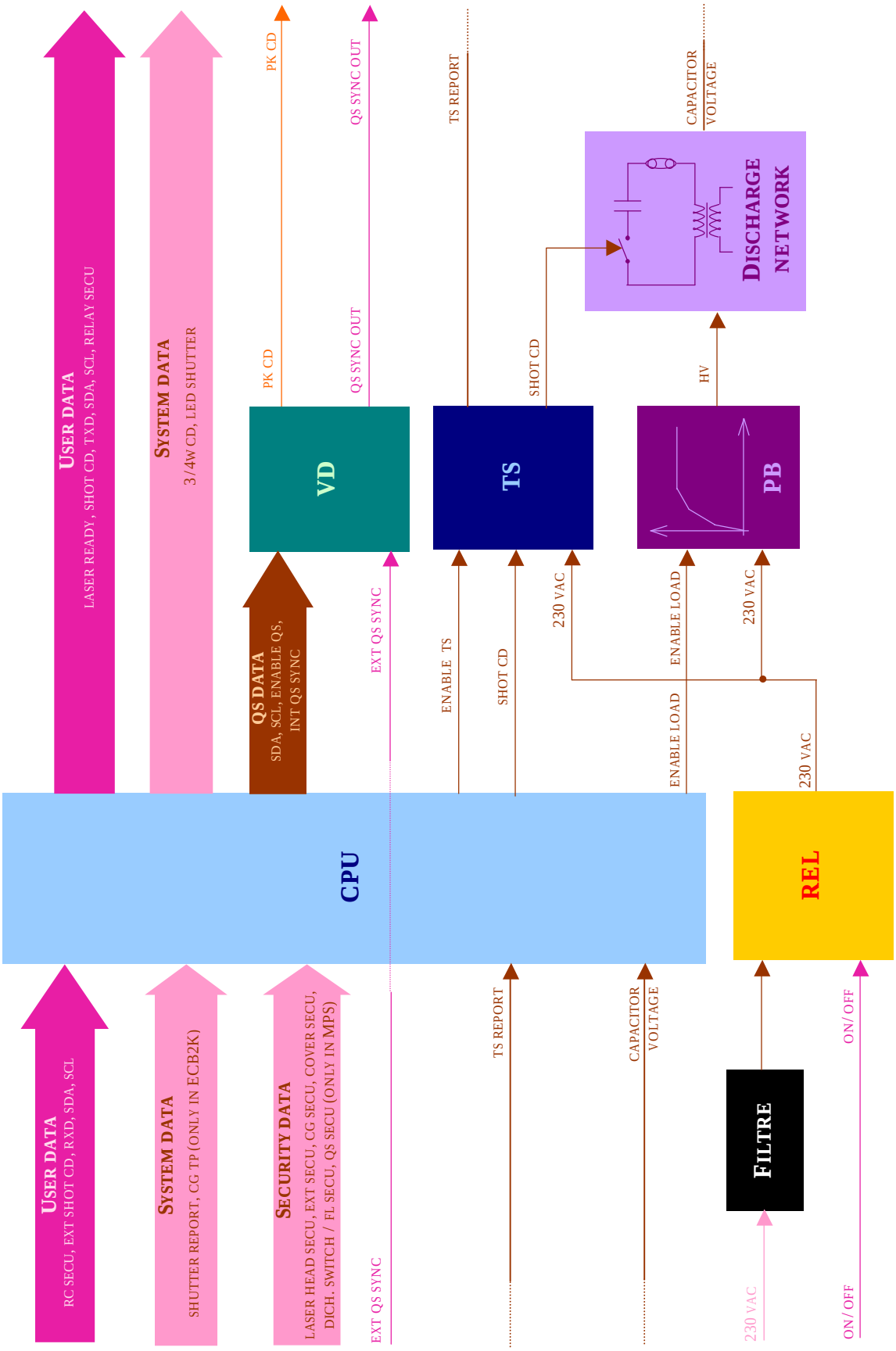
The **PB.BR** board receives the charge order from the CPU.BB and the energy to charge the capacitor from the REL.BB. It then charges the capacitor.

The **TS.BB** board receives the synchronization and command signals from the CPU.BB and treats them. It establishes the simmer current with the help of the transformer trigger. It then sends the order to the thyristor to discharge the capacitor in the flashlamp.

The **discharge network** is composed of:

- the thyristor, which receives the shot order from the TS.BB and discharge the capacitor in the flashlamp. It is the on/off switch of the network.
- the capacitor, which is charged by the PB.BR and stock the energy needed to release the flashlamp.
- the transformer trigger, which helps the TS.BB to establish the simmer current in the flashlamp by multiplying the voltage set across its terminals. Once the simmer current is established, the transfomer trigger is just a passive component of the network.

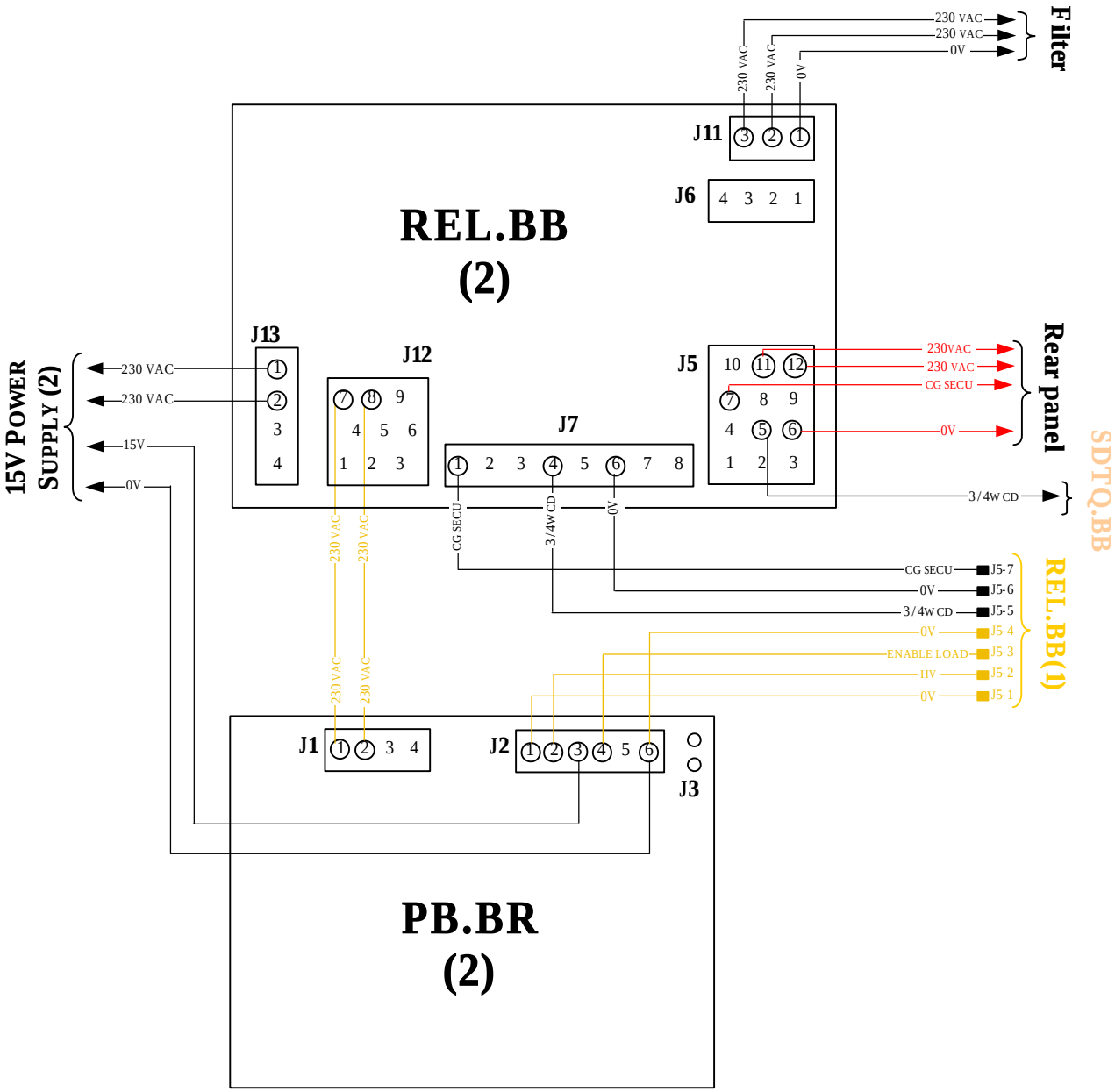
The **VD.BB** board receives the synchronization and command signals from the CPU.BB and treats them. It then generates the signal that will command the Pockells cell (to generate the laser pulse) and sends to the user the Q-Switch synchronization signal.




**Draw B-6. Power supply block diagram**

## II.3. BOARDS INTERCONNECTIONS

Here are the interconnections between the electronic boards of the Brilliant and BrilliantB lasers for the MPS and the “ECB2K”.




| BRILLIANT (AOC FOR MPS CABINET) INTERCONNECTIONS |
|---|
| DRAWN BY: SOPHIE AUVINET |
| CHECKED BY: |
| DATE: 17/12/2002 |

# BRILLIANT (MPS CABINET) INTERCONNECTIONS

DRAWN BY: SOPHIE AUVINET

CHECKED BY:

DATE: 17/12/2002

## TS.BB

## REL.BB (1)

## PB.BR(1)

## CPU.BB

## VD.BB

## FRONT PANNEL

## REAR PANNEL

## 15V POWER SUPPLY (1)

Discharge network

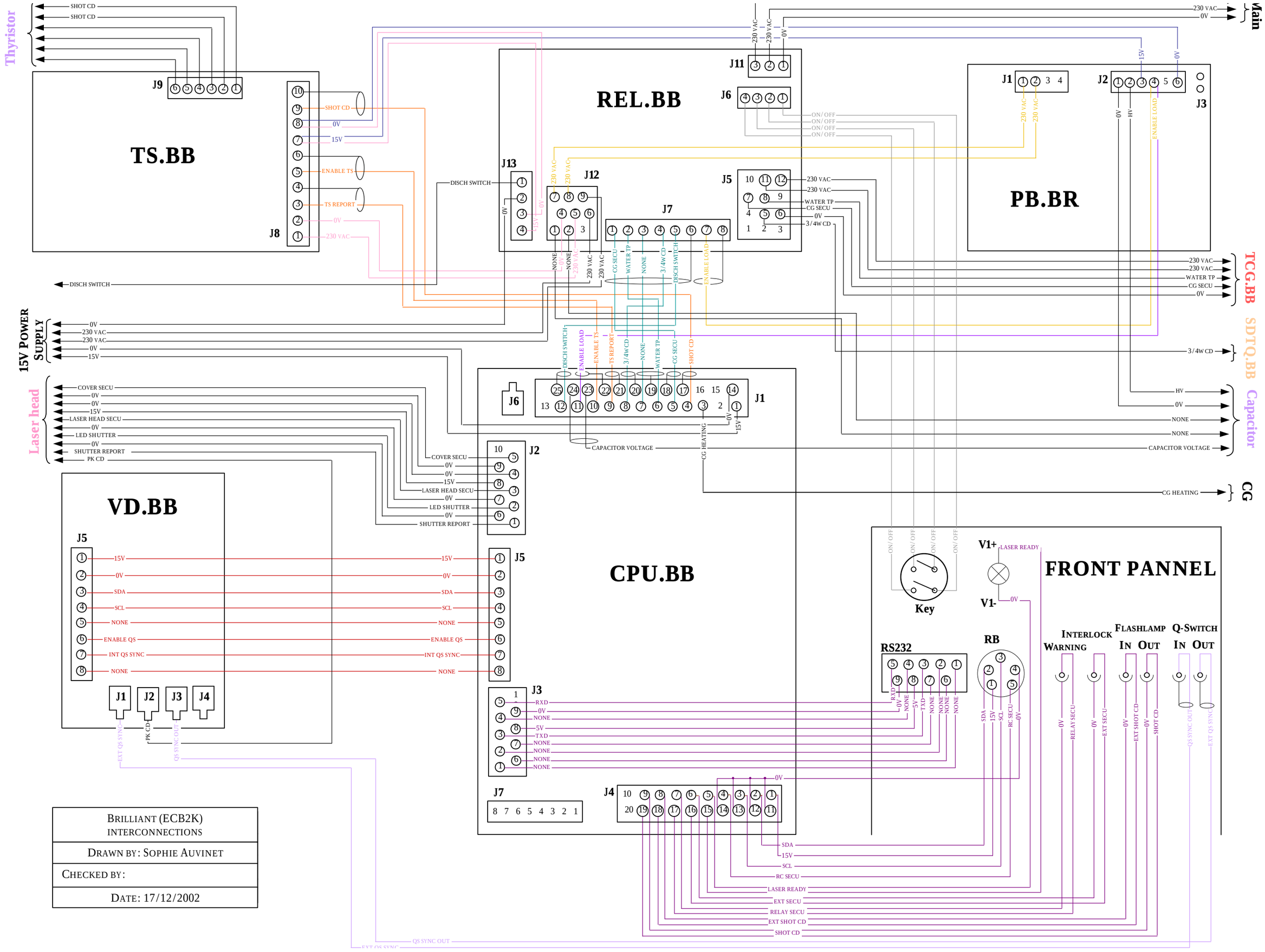
Filter

Capacitor

PB.BR(2)

REL.BB(2)

Thyristor

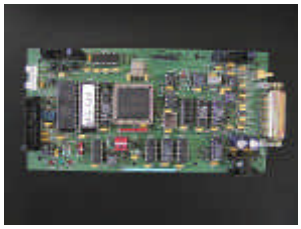



| |
|---|
| BRILLIANT (ECB2K)<br>INTERCONNECTIONS |
| DRAWN BY: SOPHIE AUVINET |
| CHECKED BY: |
| DATE: 17/12/2002 |

# III. ELECTRONIC BOARDS DESCRIPTION

# III.1. CPU.BB

The CPU.BB board (**Cental Processing Unit**) is the brain of the system. It receives the user orders and the system data (state and security). It then commands the other electronic boards of the system.



**Picture B-11. The CPU.BB board**

## III.1.i. LEXICON

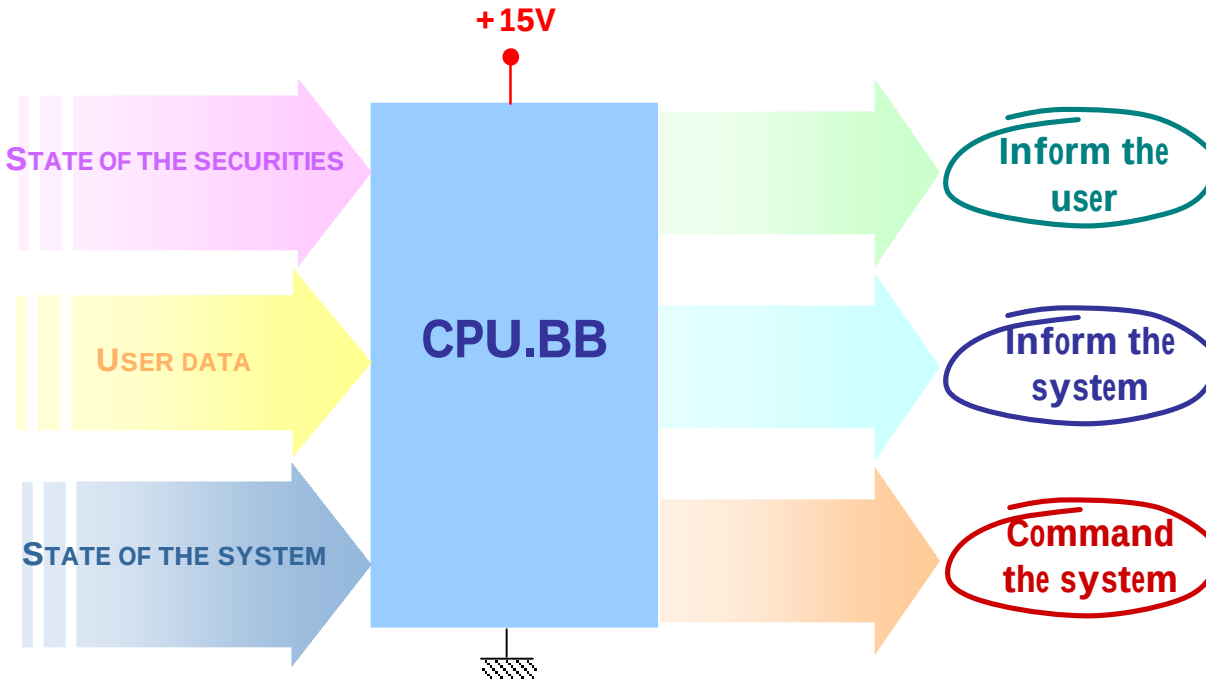
In the following lexicon, you will find the list and the definitions of the data managed by the CPU.BB.

- **3/ 4W CD:** Signal commanding the third and fourth harmonic generators crystals heating.
- **CAPACITOR VOLTAGE:** Reading of the voltage across the capacitor terminals (factor 200).
- **CG SECU:** Signal indicating if the cooling group is correctly operating.
- **CG TP:** Water temperature in the cooling group (only on “ECB2K”).
- **COVER SECU:** Signal indicating if the cover of the laser is closed or opened.
- **DISCH. SWITCH / FL SECU:** Signal indicating that the laser head is well plugged to the electronic cabinet through the CH connector.
- **ENABLE LOAD:** Signal synchronizing the charge of the capacitor.
- **ENABLE QS:** Signal allowing or not the VD.BB board to deliver the Q-switch signals.
- **ENABLE TS:** Signal allowing or not the TS.BB board to deliver the simmer current and to command the thyristor.
- **END OF CHARGE:** Signal indicating if the capacitor has reached the requested voltage.
- **EXT SECU:** Signal indicating if the external securities are all OK.

- **EXT SHOT CD:** External (user) signal synchronising the capacitor discharge in the flashlamp.
- **INT QS SYNC:** Synchronization signal for Q-Switch operation.
- **LASER HEAD SECU:** Signal idicating if the temperature of the laser head is too high (thermopa).
- **LASER READY:** Signal indicating to the user that the laser is flashing or the simmer current is on (front panel.
- **LED SHUTTER:** Signal lighting up the laser head led when the shutter is opened.
- **LOAD VALIDATION:** Signal provided by the micro controller to enable the next charge of the capacitor. It sets a dead time of 5ms after each shot.
- **QS SECU:** Security signal sent by the user that can stop the Q-Switch operation in case of danger.
- **RC SECU:** Signal indicating if the security button on the remote box is pushed or pulled.
- **RELAY SECU:** Signal sent to the user to command a security lamp when the system is flashing or the simmer current on (WARNING BNC on "ECB2K" or LASER WARNING BNC on MPS).
- **RXD:** User data received through the RS232 connector.
- **SCL:** Clock needed to read the data carried by the SDA signal.
- **SDA:** Multiplexed data.
- **SHOT CD:** Order to discharge the capacitor in the flashlamp.
- **SHUTTER REPORT:** Signal indicating if the shutter is closed or opened.
- **SUM SECU:** Signal indicating if all the securities are OK.
- **TS REPORT:** Signal indicating if the simmer current is established in the flashlamp.
- **TXD:** System data transmitted to the user through the RS232 connector.
- **VOLTAGE REQUESTED:** Charge voltage of the capacitor requested by the user.
- **WATER TP:** Temperature of the water in the cooling group.

## III.1.ii. DESCRIPTION AND OPERATION

The CPU.BB manages the messages coming from the other boards or the user and sends them back orders and data.

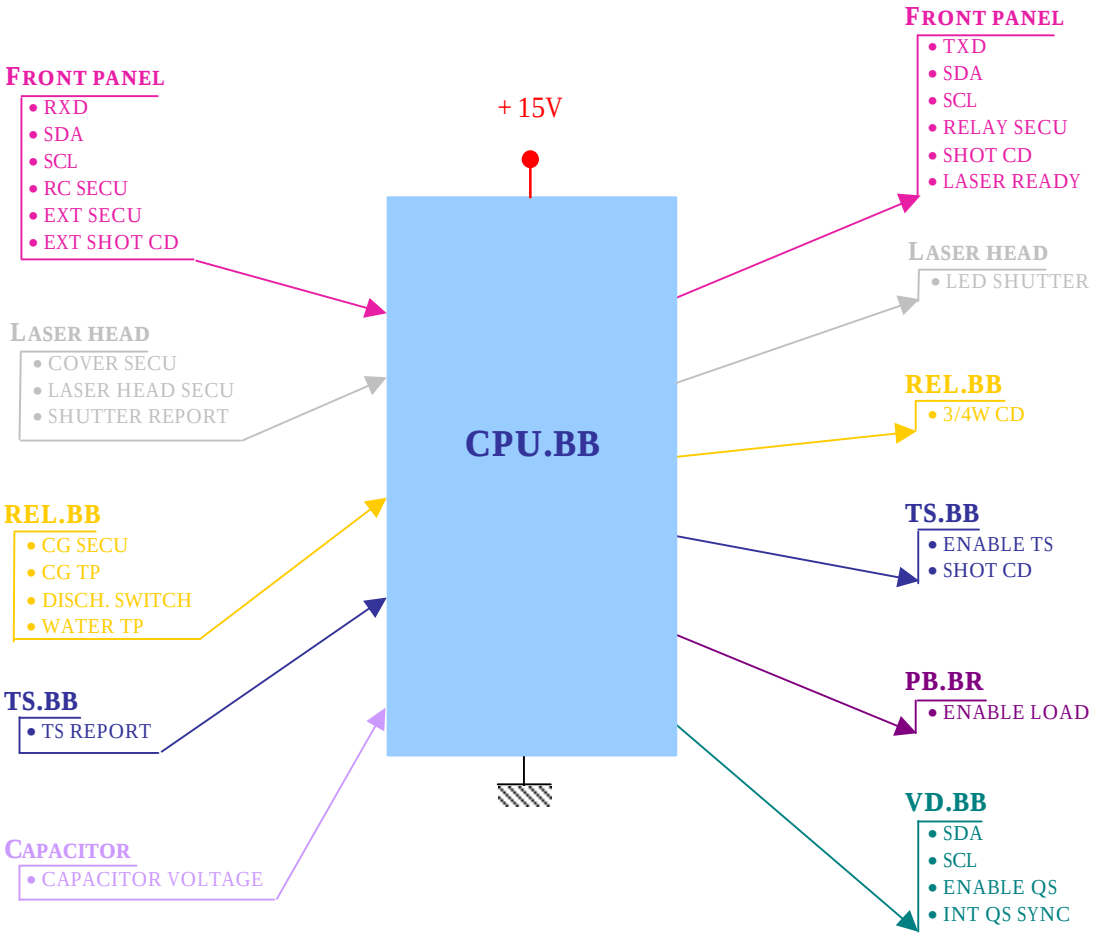



**Draw B-7. Operation principle of the CPU.BB board**

### III.1.ii.a. WIRING (FOR THE "ECB2K")

In the case of a "ECB2K", the CPU.BB is connected to:

- the front panel to exchange data with the user,
- the TS.BB to send the signal that command the thyristor and to check if the simmer current is well established in the flashlamp,
- the PB.BR to send the signal that charges the capacitor,
- the VD.BB to send all the data needed to operate the Q-Switch,
- the REL.BB to reorient some of the data,
- the capacitor to read the voltage across its terminals.
- the laser head to get its security data.




**Draw B-8. CPU.BB links (ECB2K)**

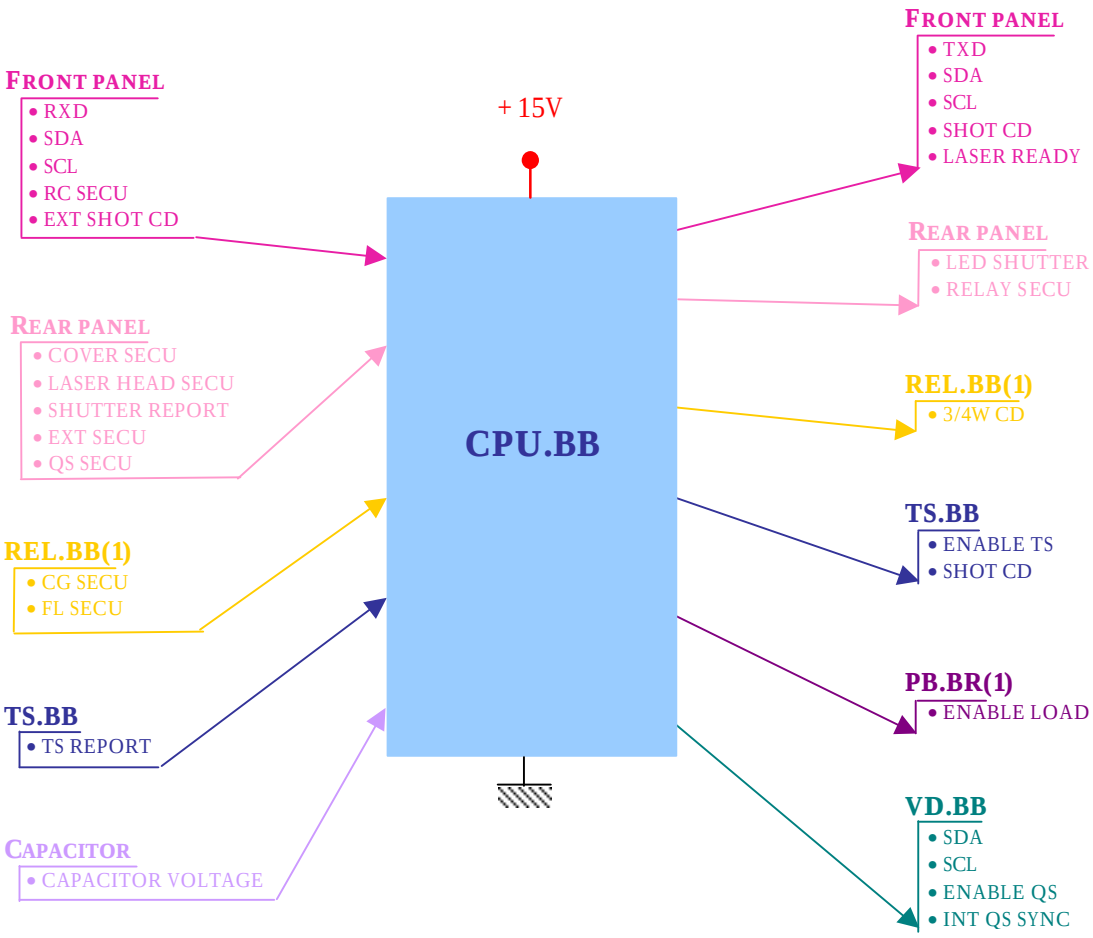
### III.1.ii.b. WIRING (FOR THE "MPS CABINET")

In the case of a "MPS cabinet", the CPU.BB is connected to:

- the front panel to exchange data with the user,
- the rear panel to exchange data with the user, the CGS and the laser head
- the TS.BB to send the signal that command the discharge thyristor and to check if the simmer current is well established in the flashlamp,
- the PB.BR(1) to send the signal that charges the capacitor,
- the VD.BB to send all the data needed to operate the Q-Switch,

the REL.BB(1) to reorient some of the data,

the capacitor to read the voltage across its terminals.

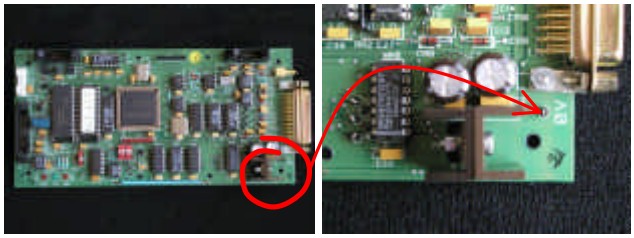



**Draw B-9. CPU.BB links (MPS cabinet)**

## III.1.iii. TEST POINTS

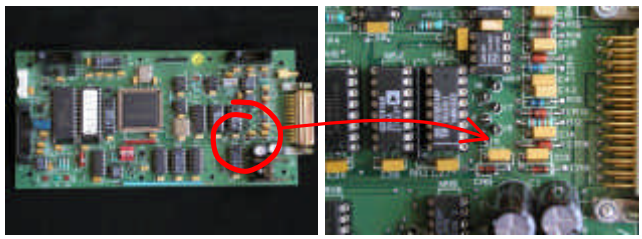
There are 20 tests points and 3 LEDs on the CPU.BB board that will help you to troubleshoot it.

- **TP1:** Ground



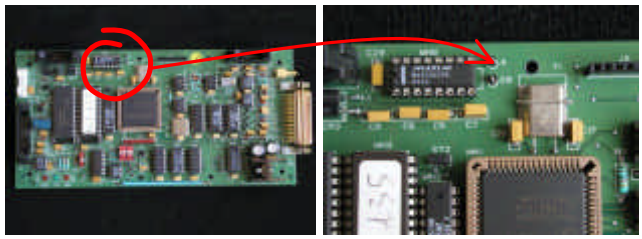
**Picture B-12. TP1 of the CPU.BB**

- **TP3:** SUM SECU
  - Set to 0V when the simmer current is on and none of the securities is wrong,
  - Set to 5V when the simmer current is off or one of the securities is wrong.



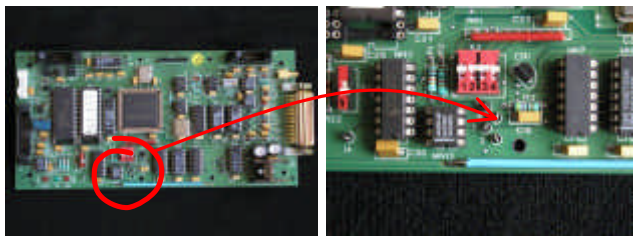
**Picture B-13. TP3 of the CPU.BB**

- **TP4:** DISCH. SWITCH / FL SECU
  - Set to 0V when the laser head is well plugged to the electronic cabinet through the CH connector.
  - Set to 5V when the laser head is disconnected from the electronic cabinet.



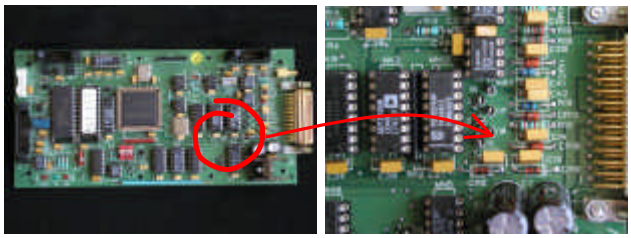
**Picture B-14. TP4 of the CPU.BB**

- **TP6:** LOAD VALIDATION
  - See timing diagram (Draw B-11).



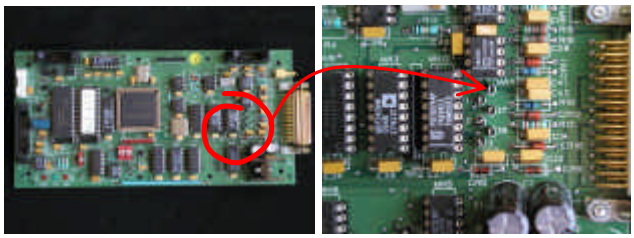
**Picture B-15. TP6 of the CPU.BB**

- **TP9:** ENABLE LOAD
  - See timing diagram (Draw B-11).



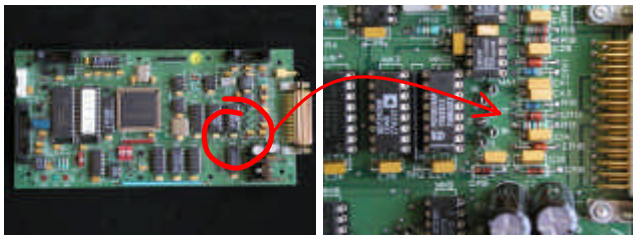
**Picture B-16. TP9 of the CPU.BB**

- **TP10:** VOLTAGE REQUESTED
  - Set to the capacitor charge value chosen by the user divided by 200 (i.e. 7V for 1400V).



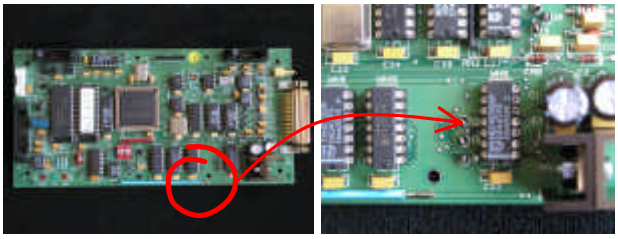
**Picture B-17. TP10 of the CPU.BB**

- **TP11:** END OF CHARGE
  - Set to 5V when the capacitor has not reached the voltage requested by the user
  - Set to 0V when the capacitor has reached the voltage requested by the user (see timing diagram draw B-11).



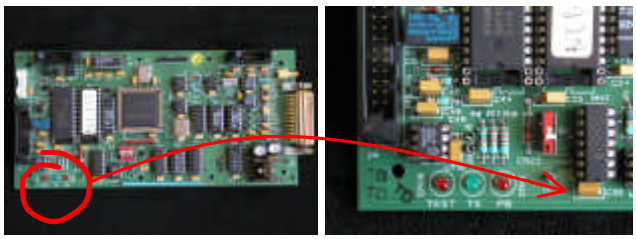
**Picture B-18. TP11 of the CPU.BB**

- **TP12:** SHOT CD
  - See timing diagram (Draw B-11).



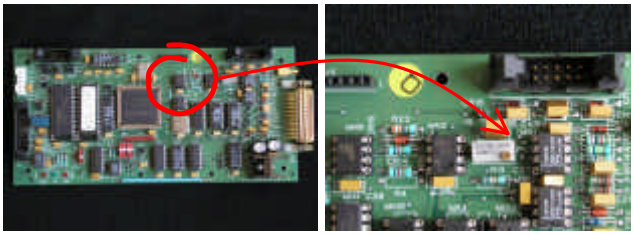
**Picture B-19. TP12 of the CPU.BB**

- **TP14:** ENABLE TS
  - Set to 0V when the simmer current is off,
  - Set to 5V when the simmer current is on.



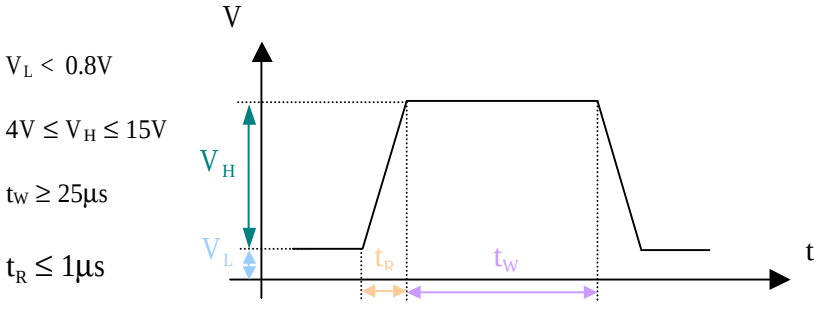
**Picture B-20. TP14 of the CPU.BB**

- **TP19:** CAPACITOR VOLTAGE
  - Voltage across the capacitor's terminals divided by 200 (i.e. 7V for 1400V).
  - See timing diagram (Draw B-11)

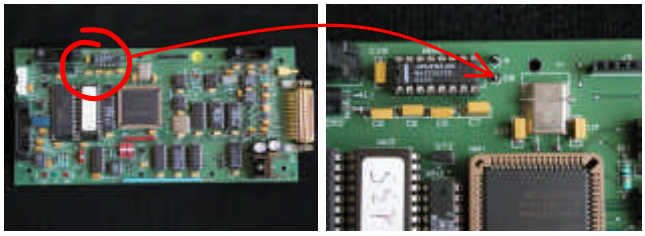


**Picture B-21. TP19 of the CPU.BB**

- **TP20:** EXT SHOT CD
  - See timing diagram (Draw B-10).

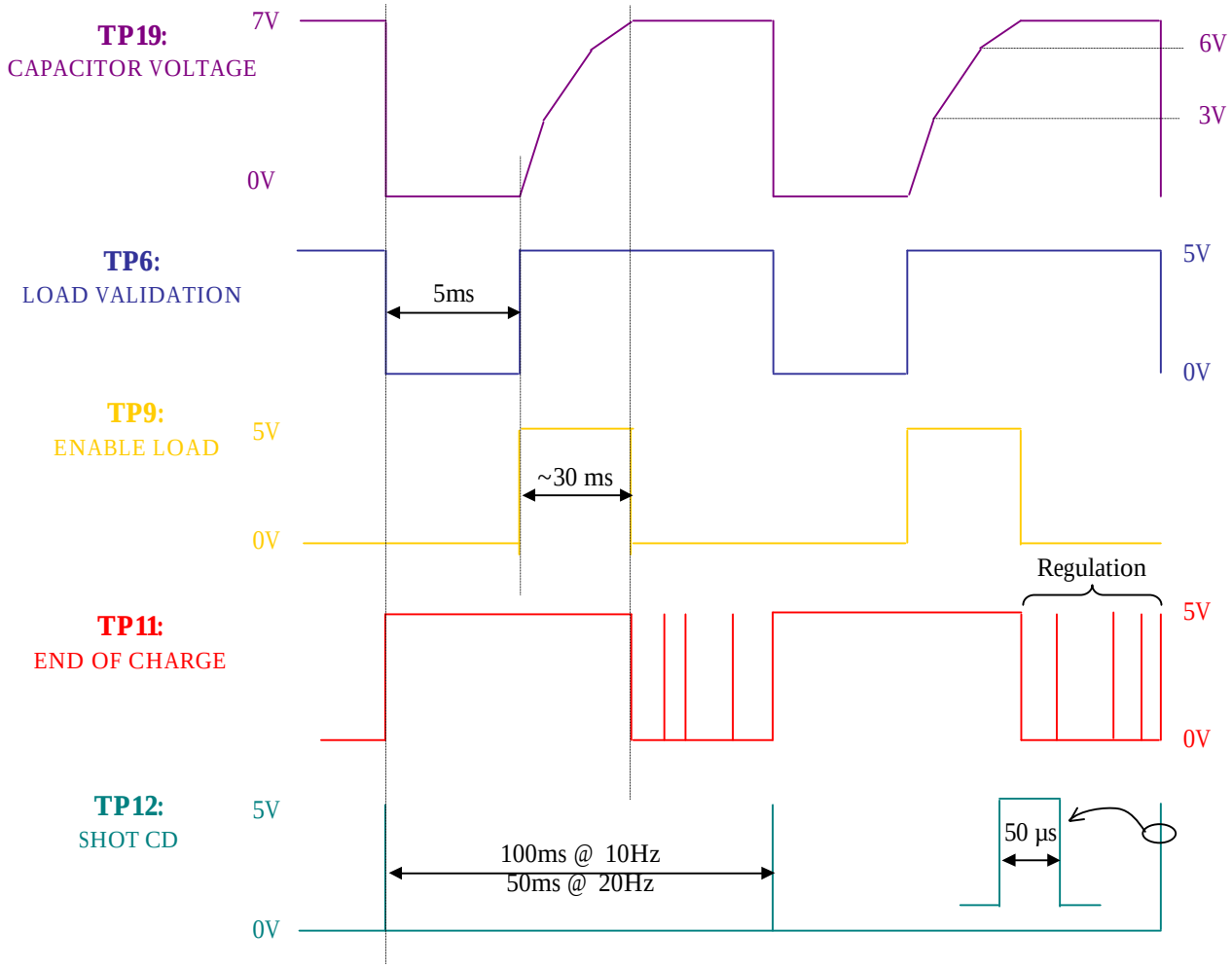



**Draw B-10. TP20 timing diagram**



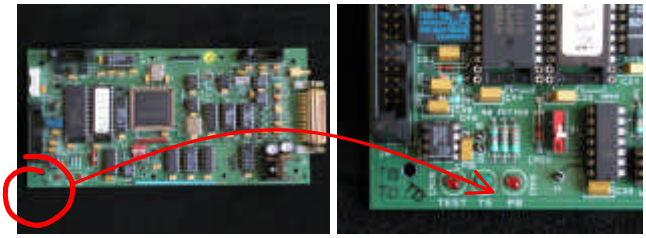
**Picture B-22. TP20 of the CPU.BB**

Some of these tests points can be described in one timing diagram as shown below:



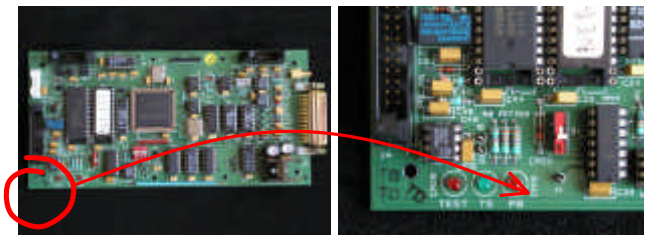

**Draw B-11. CPU.BB timing diagram**

- **CR18 (TS LED):** ENABLE TS
  - Lit up when the simmer current is on,
  - Off when the simmer current is off.



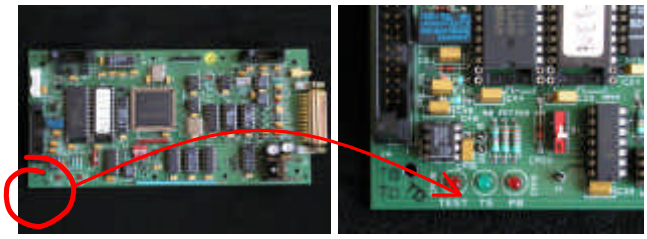
**Picture B-23. CR18 (green TS LED) of the CPU.BB**

- **CR19 (PB LED):** ENABLE LOAD
  - Blinking when the PB.BR is operating,
  - Off when the PB.BR is not operating or in fault.



**Picture B-24. CR19 (PB LED) of the CPU.BB**

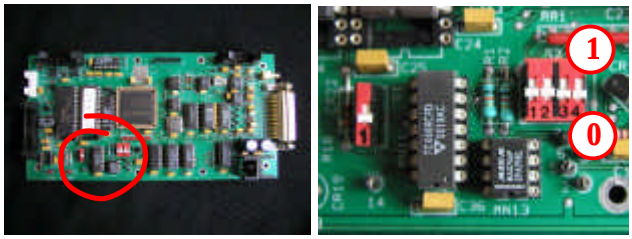
- **CR20 (TEST LED):**
  - Blinking when the CPU.BB is operating,
  - Off when the CPU.BB is not operating or in fault.



**Picture B-25. CR20 (TEST LED) of the CPU.BB**

### III.1.iv. SWITCH CONFIGURATION

When the laser is turned on, the system detects the position of the switch S2 that sets the repetition rate of the module (see table B-10).




**Picture B-26. Switches of the CPU.BB**

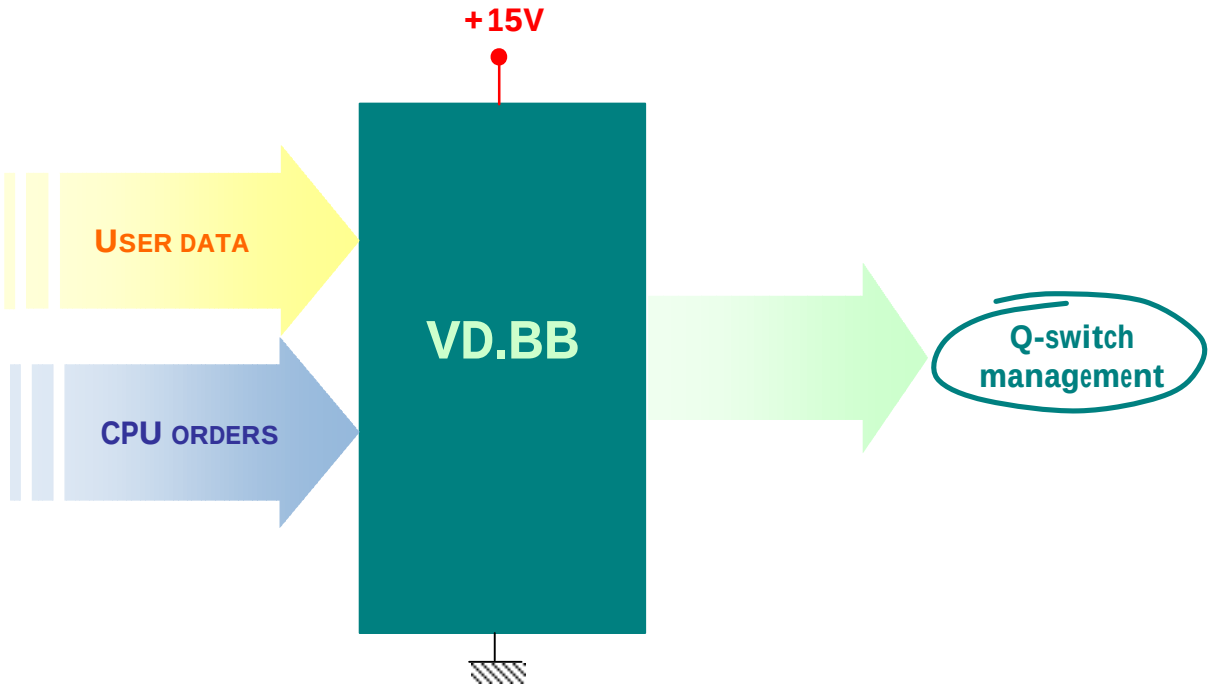
| Configuration | | | | Repetition rate (Hz) |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | |
| 1 | 1 | 1 | 1 | Free frequency |
| 0 | 1 | 1 | 1 | 10 |
| 1 | 0 | 1 | 1 | 20 |
| 0 | 0 | 1 | 1 | 30 |
| 1 | 1 | 0 | 1 | 40 |
| 0 | 1 | 0 | 1 | 50 |
| 1 | 0 | 0 | 1 | 60 |
| 0 | 0 | 0 | 1 | 12,5 |

**Table B-10. S2 switch configuration**

If the four switches are equal to 1, the repetition rate can be adjusted with the buttons + and – on the remote box.

# III.2. VD.BB

This is the Variable Delay board. It generates the delay between the signal used by the laser to synchronize the Q-Switch operation and the signal read by the user on the front panel (Q-Switch synchro out) to synchronize its experiment. This delay is set by the user between –500ns and 500ns.




**Draw B-12. Operation principle of the VD.BB board**

## III.2.i. LEXICON

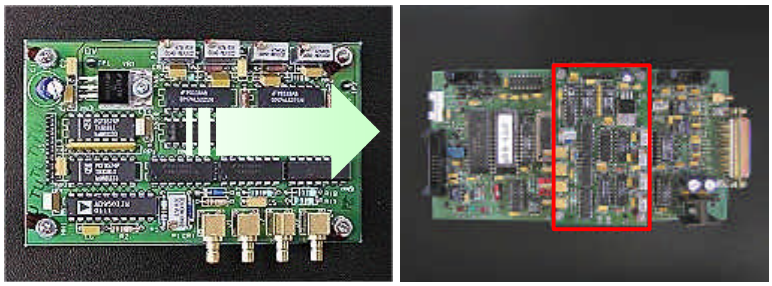
In the following paragraph, you will find the list and the definitions of the data managed by the VD.BB.

- **ENABLE QS:** Signal allowing or not the VD.BB board to deliver the Q-Switch signals.
- **EXT QS SYNC:** External synchronization signal for Q-Switch operation.
- **INT QS SYNC:** Internal Q-Switch synchronization signal.
- **PK CD:** Signal, sent to the QS.BR, giving the order to open the Pockels cell and thus synchronizing the Q-Switch operation.

- **QS SYNC:** Q-Switch synchronization signal, either the internal or the external one depending on the user's choice.
- **QS SYNC OUT:** Delayed Q-Switch synchronization signal sent to the user.
- **SCL:** Clock needed to read the data carried by the INT SDA signal.
- **SDA:** Signal provided by the micro controller containing the SDA EXT and the security data.

## III.2.ii. DESCRIPTION AND OPERATION

This board receives most of the data it needs from the CPU.BB. As we have said before, these two boards are operating closely together. We could nearly consider the VD.BB board as a block of the CPU.BB.

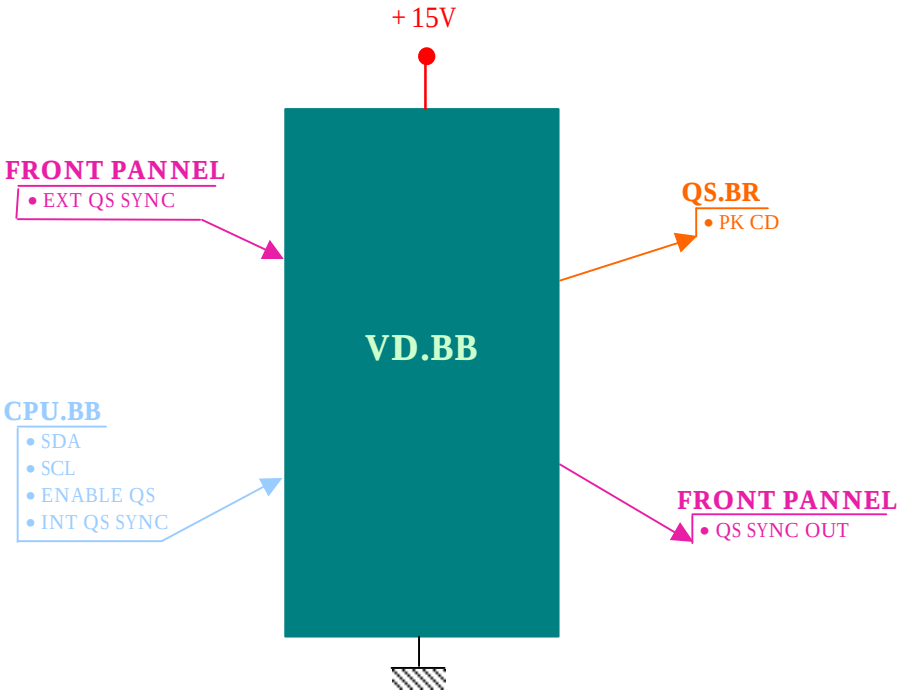


**Picture B-27.The VD.BB board**

### III.2.ii.a. OVERVIEW

The VD.BB is connected to:

- the front panel to receive the external Q-Switch synchronization signal from the user and to send to the user the internal Q-Switch synchronization signal with a delay of +/-500ns,
- the CPU.BB to receive all the data needed to operate the Q-Switch.
- the QS.BR to command the opening of the Pockels cell.

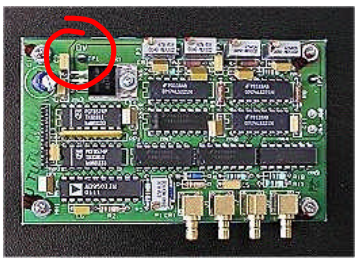



**Draw B-13. VD.BB links**

## III.2.iii. TEST POINTS

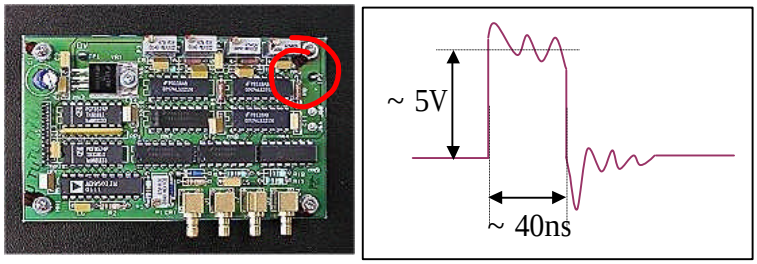
There are only two test points on the VD.BB.

- **TP1:** Ground



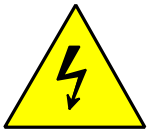
**Picture B-28. TP1 of the VD.BB**

- **TP2:** QS SYNC

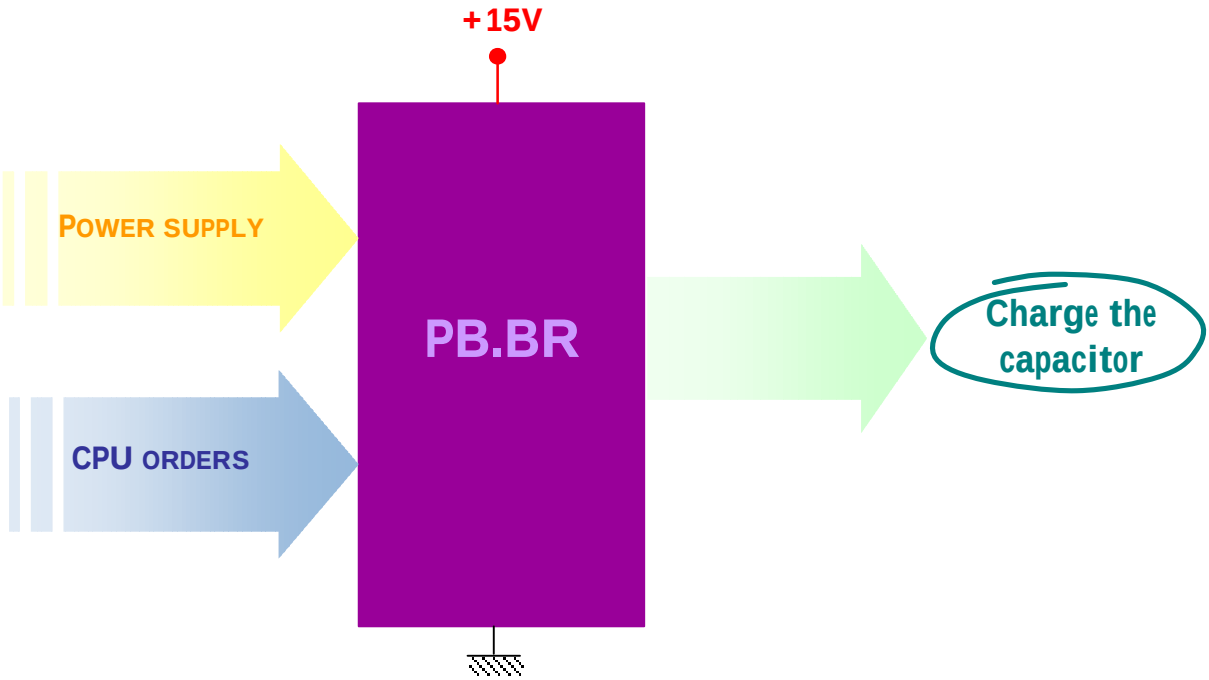



**Picture B-29. TP2 of the VD.BB**

# III.3. PB.BR



This is the Power Board. It delivers the voltage needed to charge the capacitor. It is thus using high voltage and must be handled with care. There is only one PB.BR in the “ECB2K” and two of them in a MPS cabinet.




**Draw B-14. Operation principle of the PB.BR**

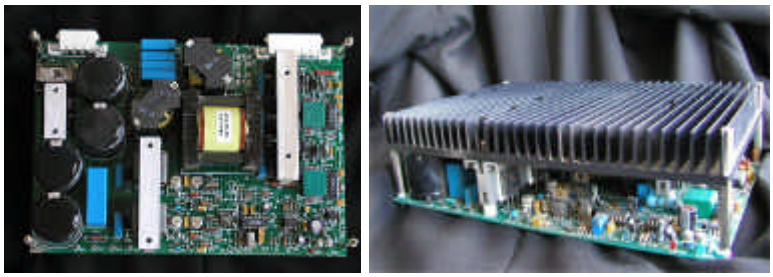
## III.3.i. LEXICON

In the following paragraph, you will find the list and the definitions of the data managed by the PB.BR

- **230 VAC:** Main power supply.
- **ENABLE LOAD:** Signal synchronizing the charge of the capacitor.
- **HV:** Value of the voltage charging the capacitor.

## III.3.ii. DESCRIPTION AND OPERATION

This board is fed the main through the REL.BB board. It then transforms this alternative voltage into a continuous one and send it to the capacitor when ordered by the CPU.BB.

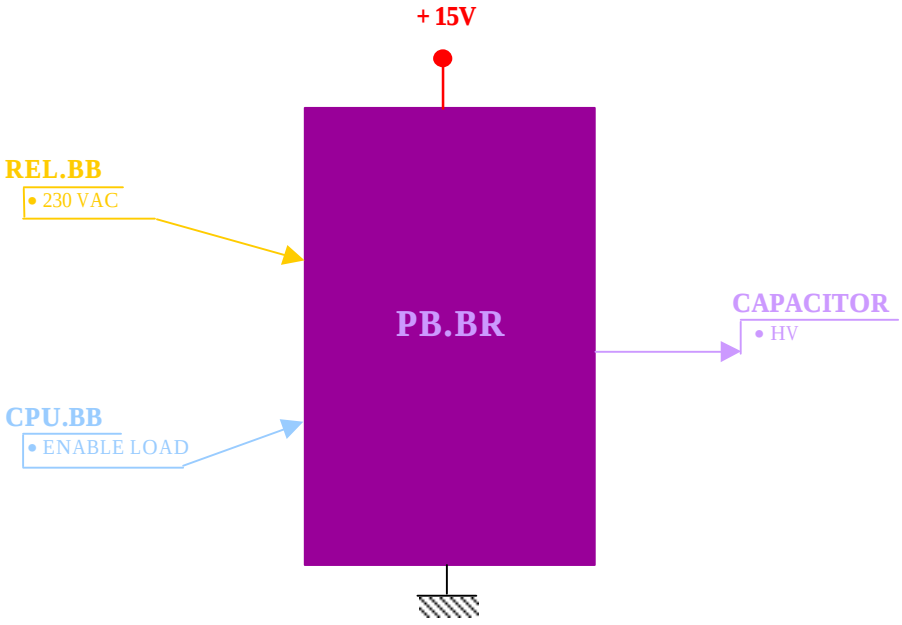


**Picture B-30. The PB.BR board**

### III.3.ii.a. OVERVIEW ("ECB2K")

In the case of a "ECB2K", there is only one PB.BR, which is connected to:

- the REL.BB to receive the main,
- the CPU.BB to receive the order to charge the capacitor,
- the capacitor to charge it.



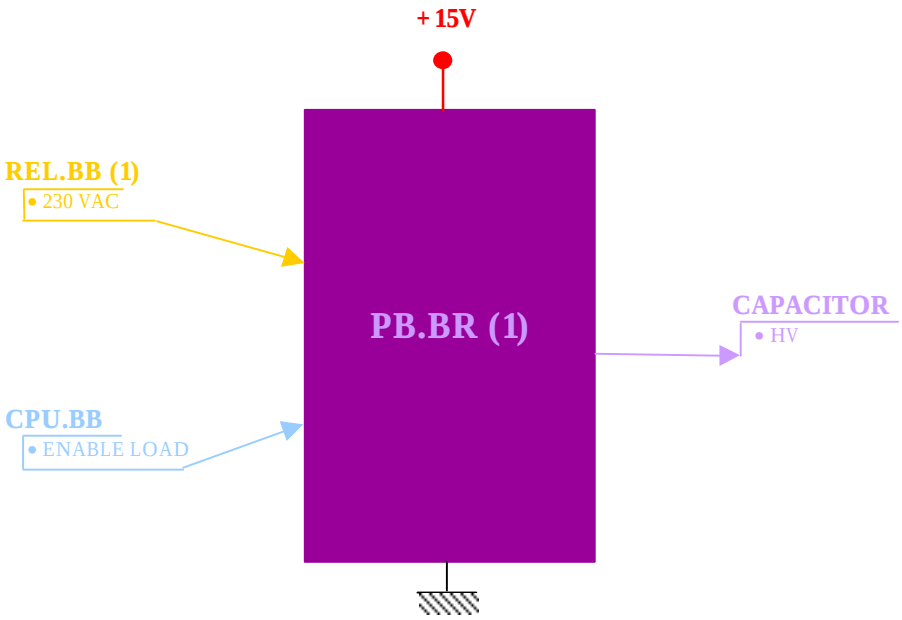

**Draw B-15. First PB.BR links**

### III.3.ii.b. OVERVIEW (MPS CABINET)

In the case of a MPS cabinet, there are two PB.BR. The first one is connected to:

- the REL.BB (1) to receive the main,

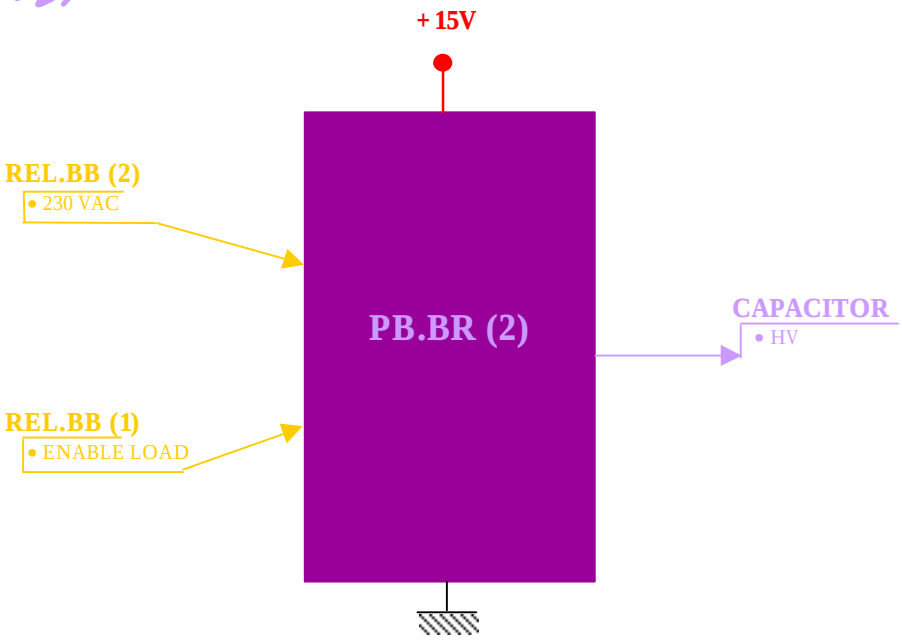
- the CPU.BB to receive the order to charge the capacitor,
- the capacitor to charge it.




**Draw B-16. First PB.BR links**

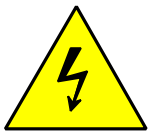
The second PB.BR is connected to:

- the REL.BB (1) to receive the order to charge the capacitor (coming from the first PB.BR),
- the REL.BB (2) to receive the main.
- the capacitor to charge it.




**Draw B-17. Second PB.BR links**

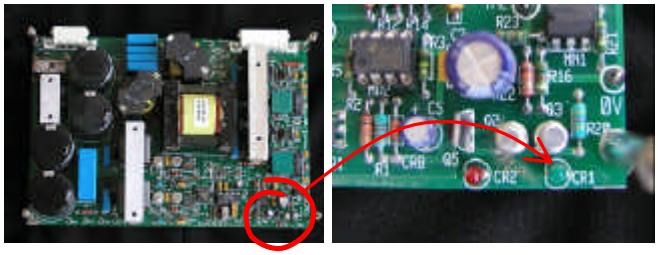
## III.3.iii. TEST POINTS



There are ten test points on the PB.BR. However most of them are hardly accessible when the board is set on the rack.

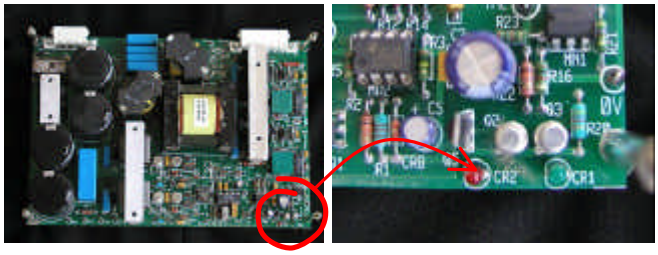
As the test points are not easily accessible, the best way to troubleshoot the PB.BR boards is to check the state of the green and red LED's:

- **CR1:** + 15V
  - Lights up when the board is correctly fed by the + 15V power supply.



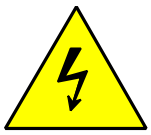
**Picture B-31. CR1 of the PB.BR**

- **CR2:** ENABLE LOAD
  - Blinks at the laser's frequency when a charge order is sent by the CPU.BB to the PB.BR.

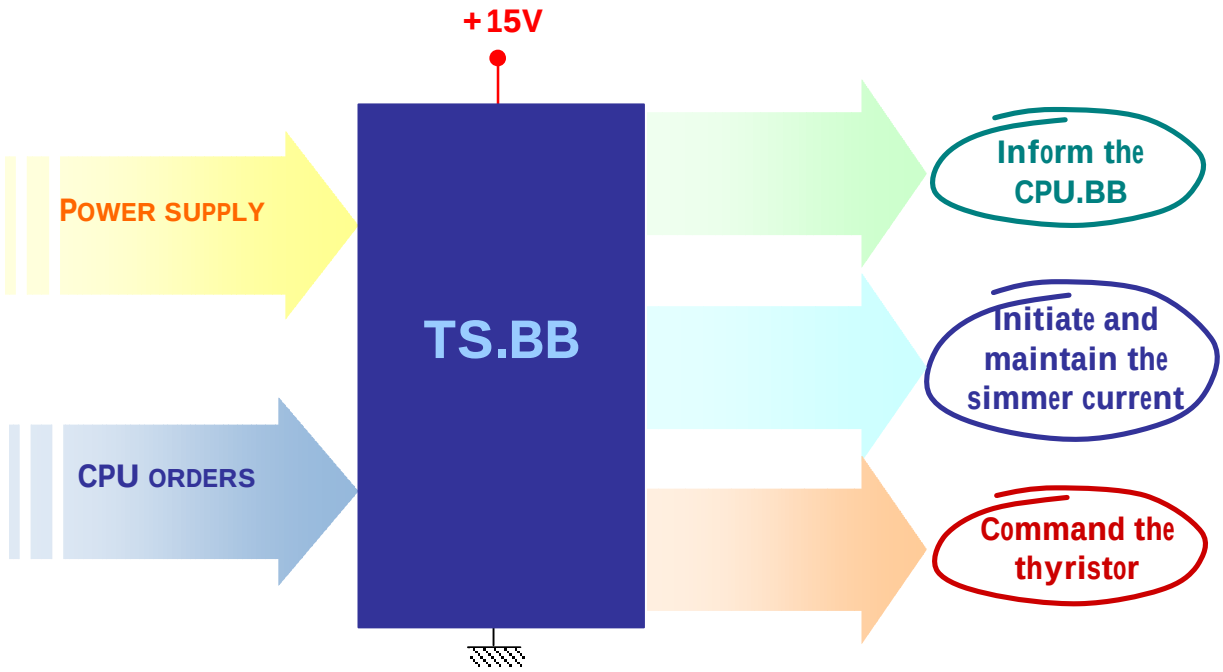


**Picture B-32. CR2 of the PB.BR**

## III.4. TS.BB



This is the **Trigger Simmer** board. It enables and maintains the simmer current and commands the thyristor that discharges the capacitor in the flashlamp. This board is using high voltage and, thus, must be handled with care.




**Draw B-18. Operation principle of the TS.BB**

### III.4.i. LEXICON

In the following paragraph, you will find the list and the definitions of the data managed by the TS.BB.

- **230 VAC:** Main power supply.
- **ENABLE TS:** Signal allowing or not the TS.BB board to deliver the simmer current and to command the thyristor.
- **SHOT CD:** Order to discharge the capacitor in the flashlamp.
- **TS REPORT:** Signal indicating to the CPU.BB if the simmer current is established in the flashlamp.

## III.4.ii. DESCRIPTION AND OPERATION

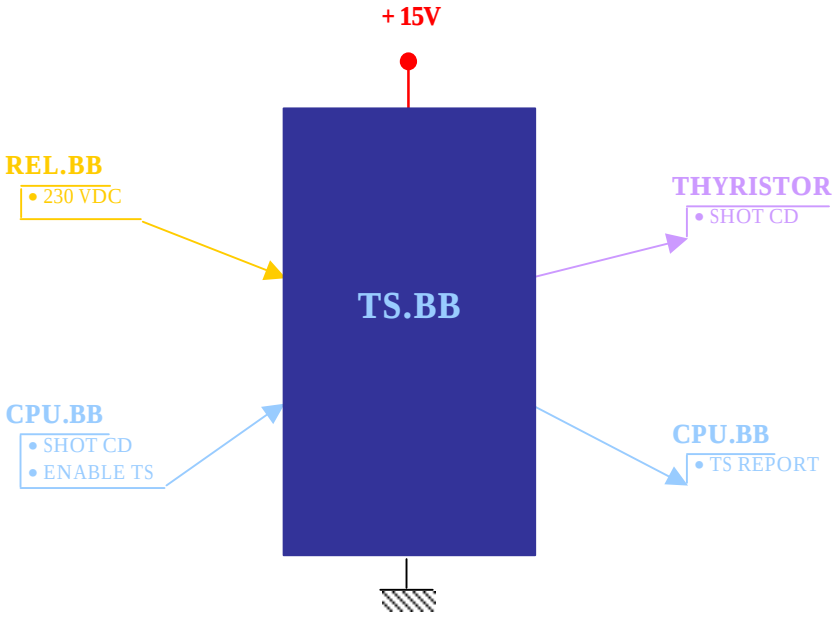
This board receives all its orders from the CPU.BB and power supply from the main through the REL.BB board.

**Picture B-33.The TS.BB board**

### III.4.ii.a. OVERVIEW

The TS.BB is connected to:

- the REL.BB to receive the main,
- the CPU.BB to receive the order to commend the thyristor and to send the state of the simmer current,
- the thyristor to send the discharge order,



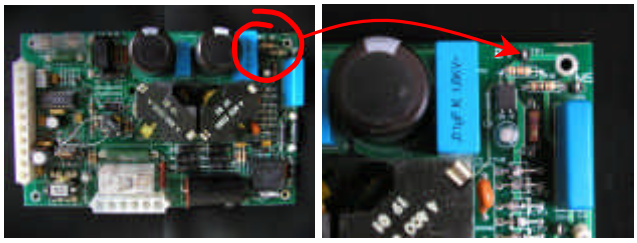

**Draw B-19. TS.BB links**

The TS.BB is also connected to the capacitor. Once the simmer current is stopped, the capacitor is connected to a 22kΩ resistor set on the TS.BB to ensure its discharge.

## III.4.iii. TEST POINTS

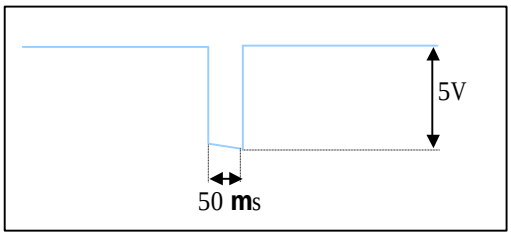
There are 11 test points on the TS.BB board that will help you to troubleshoot it.

- **TP1:** Ground

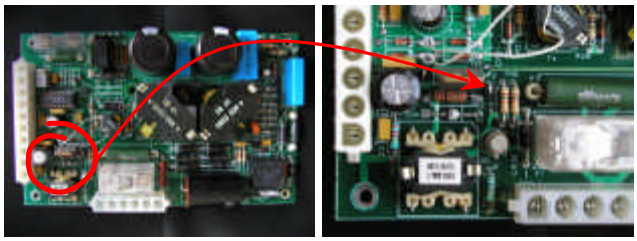


**Picture B-34. TP1 of the TS.BB**

- **TP2:** SHOT CD
  - See timing diagram (Draw B-20).

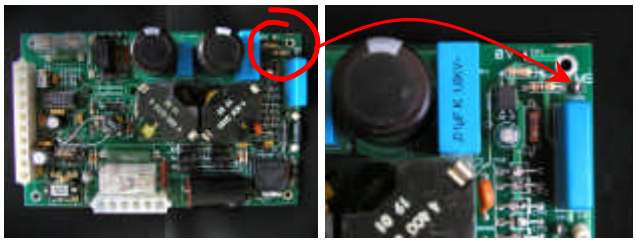



**Draw B-20. TP2 timing diagram**



**Picture B-35. TP2 of the TS.BB**

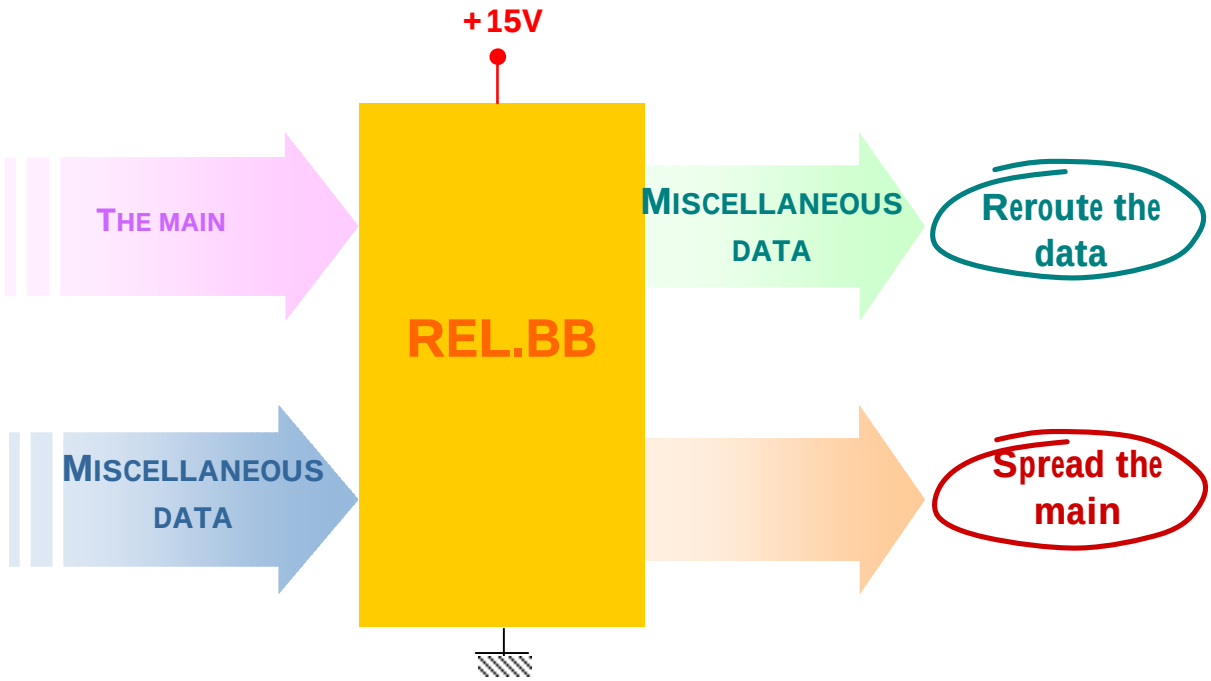
- **TP5:** SIMMER STATE
  - Simmer current value read through a 10Ω resistance (i.e.: 0.95V read represent a 95mA current)



**Picture B-36. TP5 of the TS.BB**

# III.5. REL.BB

This is the **Relay board**. It delivers the power supply coming from the main to the PB.BR and the TS.BB. It is thus dealing with high voltage and must be handled with care. There is only one REL.BB board in the “ECB2K” and two of them in a MPS cabinet.




**Draw B-21. REL.BB operation principle**

## III.5.i. LEXICON

In the following paragraph, you will find the list and the definitions of the data managed by the REL.BB.

- **230 VAC:** Main power supply.
- **3/ 4W CD:** Signal commanding the third and fourth harmonic generators crystals heating.
- **CG SECU:** Signal indicating if the cooling group is correctly operating.
- **DISCH. SWITCH:** Signal indicating if the capacitor discharge switch on the rear panel of the ECB2K is pushed or pulled.
- **ENABLE LOAD:** Signal synchronizing the charge of the capacitor.

- **FL SECU:** Signal indicating that the laser head is well plugged to the electronic cabinet through the CH connector.
- **HV:** Value of the voltage charging the capacitor.
- **ON/ OFF:** Signal indicating if the key is on the ON or OFF position on the front panel.
- **WATER TP:** Data indicating for the Brilliant and Brilliant B 10Hz, the temperature of the water in the tank of the CGU.

## III.5.ii. DESCRIPTION AND OPERATION

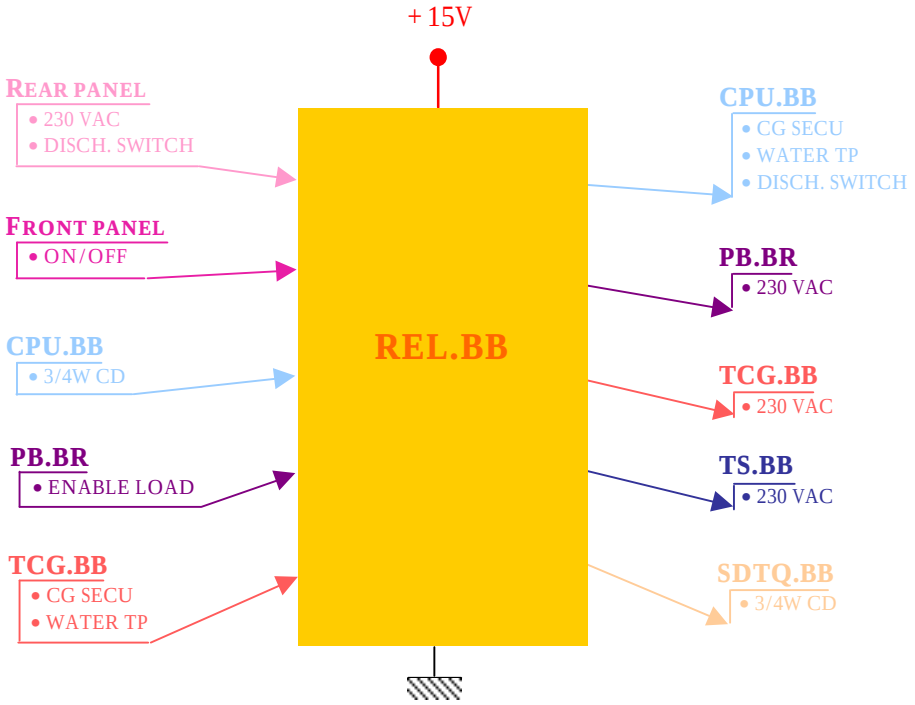
The REL.BB is the data interchange of the power supply.

**Picture B-37. The REL.BB board**

### III.5.ii.a. OVERVIEW ("ECB2K")

The REL.BB is connected to:

- the TS.BB, to distribute the main,
- the PB.BR, to distribute the main and get the charge order,
- the TCG.BB, to distribute the main and get the CGU data,
- the CPU.BB, to reroute some of its data,
- the rear panel, to get the main,
- the front panel, to get the key data,
- the SDTQ.BB, to give the harmonic generators configuration.




**Draw B-22. The REL.BB board links (for the ECB2K)**

### III.5.ii.b. OVERVIEW ("MPS CABINET")

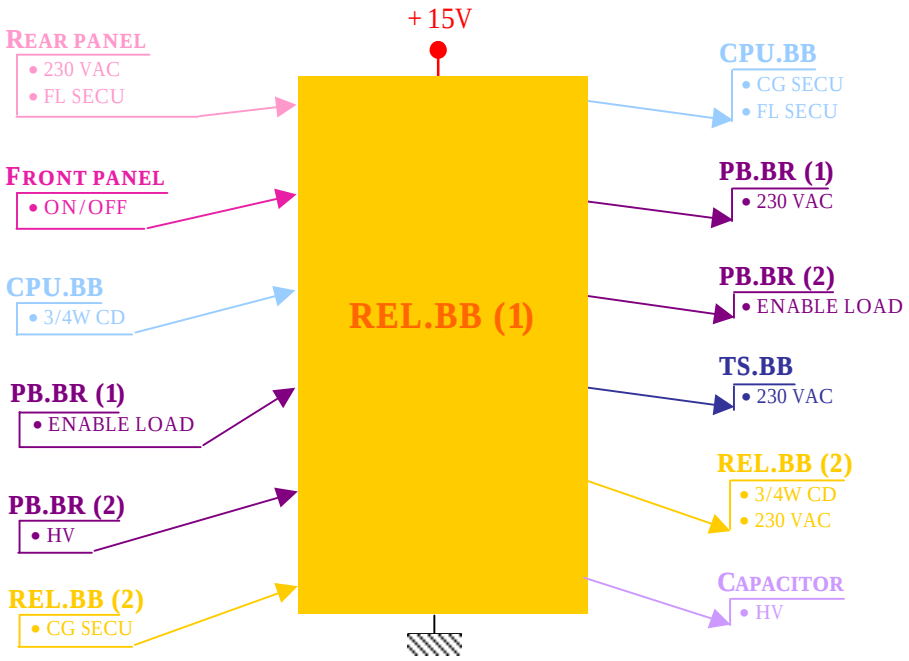
The REL.BB(1) is connected to:

- the TS.BB, to distribute the main,
- the PB.BR(1), to distribute the main and get the charge order,
- the PB.BR(2), to give the charge order and get the capacitor charge voltage,
- the CPU.BB, to reroute some of its data,
- the rear panel, to get the main,
- the front panel, to get the key data,
- the capacitor, to charge it with the voltage coming from the PB.BR(2),
- the REL.BB (2), to reroute some data and send the main.

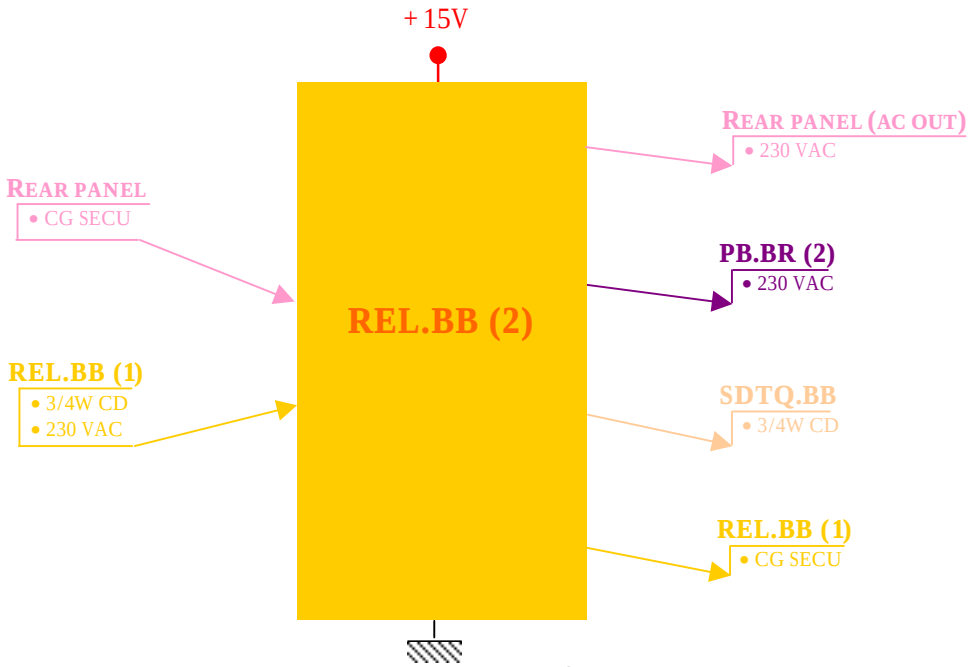
The REL.BB(2) is connected to:

- the PB.BR (2), to distribute the main,

- the rear panel, to give the main to the CGS and reroute some data,
- the front panel, to get the key data,
- the REL.BB (1), to get the main and reroute some data.
- the SDTQ.BB, to give the harmonic generators configuration.



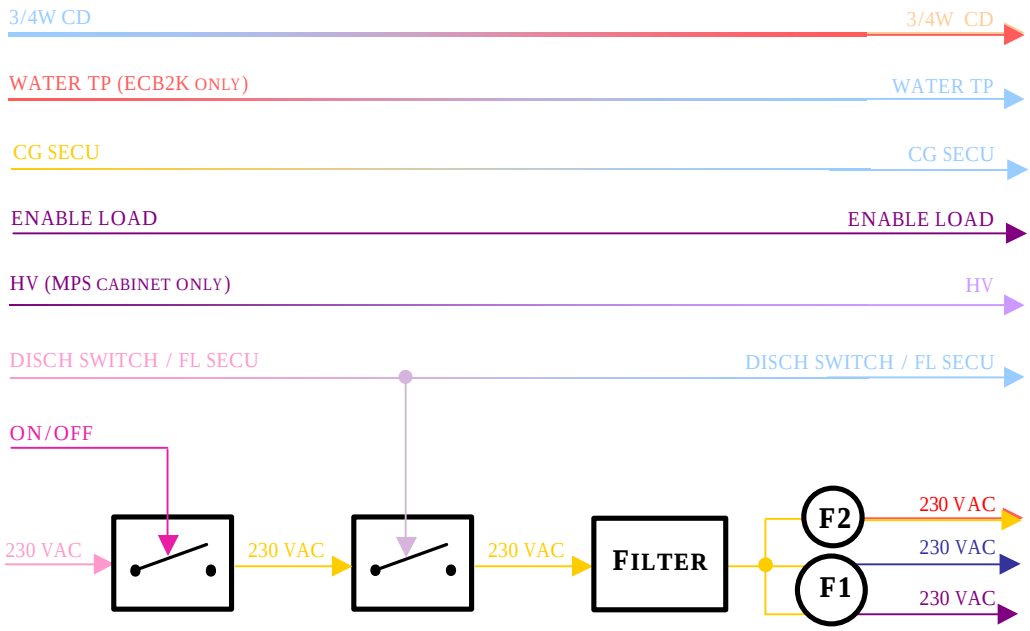

**Draw B-23. First REL.BB links (for the MPS cabinet)**




**Draw B-24. Second REL.BB links (for the MPS cabinet)**

### III.5.ii.c. BLOCK DIAGRAM

The operation of the first REL.BB board can be described with only one block diagram. It can be divided into five sub-blocks (see draw B-25): two switches, one filter and two fuses.




**Draw B-25. First REL.BB block diagram**

As you can see, the REL.BB card is mainly a distribution card. It reroutes a few data.

**The first switch** is commanded by the ON/OFF data. As long as the user has not turned the key on the I position, the main can't feed the system.

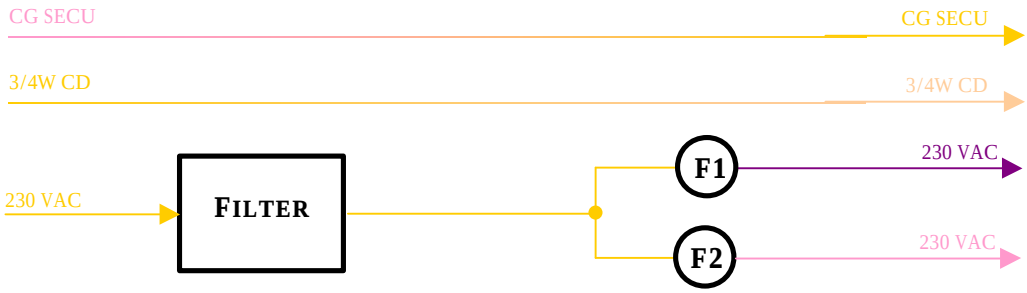
**The second switch** is commanded by the DISCH. SWITCH / FL SECU data. If the the capacitor discharge switch is pushed (for a "ECB2K") or the flashlamp cable is not plugged on the rear panels of the MPS cabinet, the main does not feed the PB.BR and the TS.BB boards.

**The filter** protects the boards fed from the main instabilities.

**The fuse F2** (10A time-lag) is protecting the line feeding the CGU (in the case of a "ECB2K") or the second REL.BB (in the case of a MPS cabinet).

**The fuse F1** (6.3A time-lag) is protecting the line feeding the TS.BB board and the first power board.

In the case of a MPS cabinet (for the Brilliant B 20Hz), there are two REL.BB boards. The operation of the second REL.BB board can be described with only one block diagram. It can be divided into three sub-blocks (see draw B-26): one filter and two fuses.




**Draw B-26. Second REL.BB block diagram**

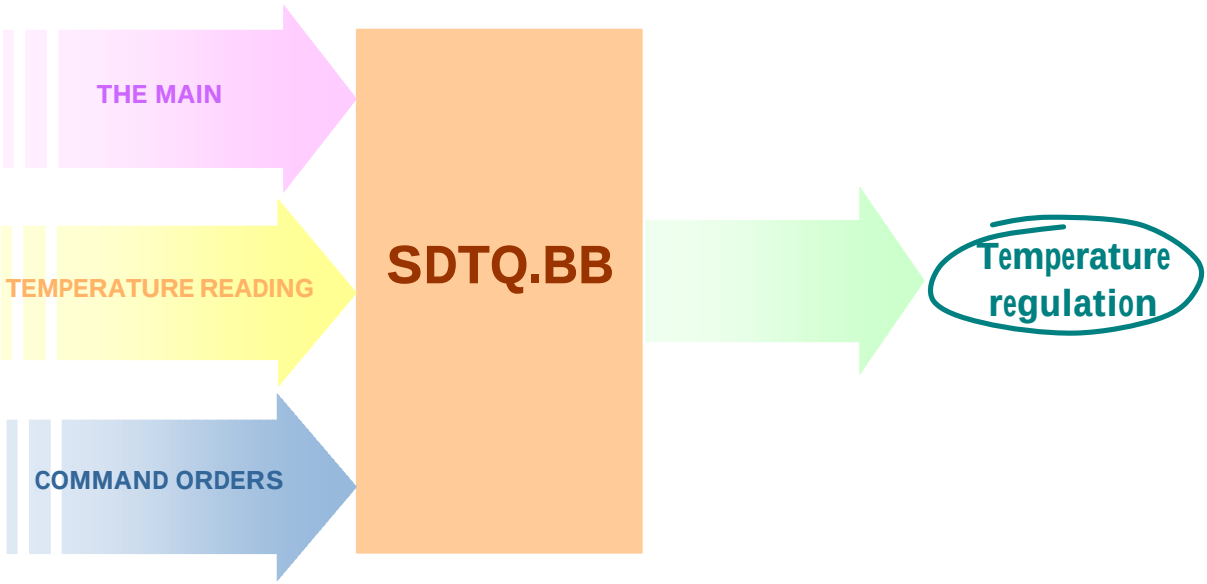
**The filter** protects the boards fed from the main instabilities.

**The fuse F1** (10A time-lag) is protecting the line feeding the PB.BR(2) board.

**The fuse F2** (6.3A time-lag) is protecting the line feeding the rear panel on the AC OUT output where the CGS is connected.

# III.6. SDTQ.BB

This is the **Single Double Third Quadruple** board. It commands the heating of the harmonic generators (HG). For the first, second and third harmonic generators, which are angle tuned, the SDTQ.BB board reads and regulates the temperature so that it stays constant. For the fourth harmonic generator, which is temperature tuned, the SDTQ.BB board also manages its tuning. Finally, for the fifth harmonic generator, there is no reading of its temperature, it is just regulated with the fourth HG temperature regulation signal.




**Draw B-27. Operation principle of the SDTQ.BB board**

## III.6.i. LEXICON

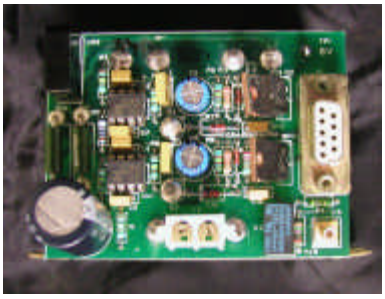
In the following paragraph, you will find the list and the definitions of the data managed by the SDTQ.BB.

- **230 VAC:** Main power supply.
- **2W HEATING CD:** Signal commanding the second harmonic generator heating.
- **2W TP:** Analogical signal indicating the temperature of the second harmonic generator.
- **3/4W CD:** Signal indicating if the laser is using a third or a fourth harmonic generator.

- **3/ 4W HEATING CD:** Signal commanding the third of the fourth harmonic generator heating.
- **3/ 4W TP:** Analogical signal indicating the temperature of the third or the fourth harmonic generator.
- **ERROR:** Analogical signal indicating the value of the difference between the temperature read and the setting.
- **TUNING:** Signal indicating the value of the tuning of the fourth harmonic generator set by the user.

## III.6.ii. DESCRIPTION AND OPERATION

The SDTQ.BB board is independent from the rest of the system. It only receives from the CPU the information indicating if the system is functioning with a third or a fourth harmonic generator.

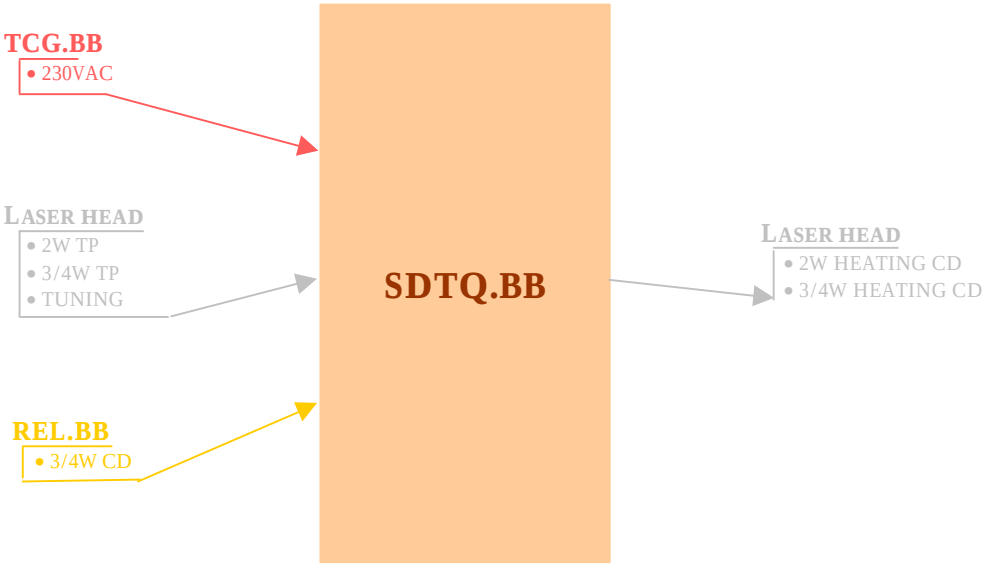


**Picture B-38. The SDTQ.BB board**

### III.6.ii.a. OVERVIEW

The SDTQ.BB is connected to:

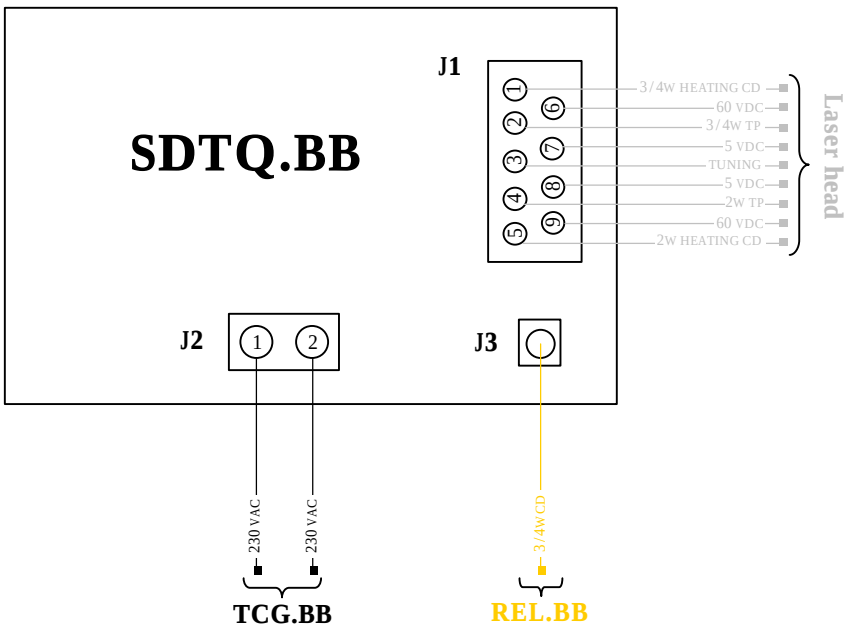
- the TCG.BB board, to receive the main. The fuse from the TCG.BB also protects the main line of the SDTQ.BB.
- the laser head, to read and command the temperature of the harmonic generators.
- the REL.BB board, to received from the CPU the information indicating if the laser is set with a third or a fourth harmonic generator.




**Draw B-28. SDTQ.BB links**

### III.6.ii.b. INTERCONNECTIONS

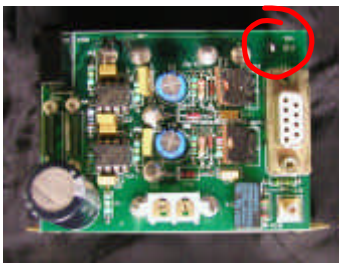
The following draw represents the SDTQ.BB board interconnections with the rest of the system.



## III.6.iii. TEST POINTS

There is only one test point on the SDTQ.BB board which is the ground.

- **TP1:** Ground

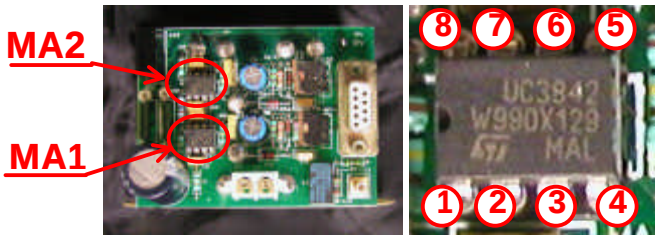


**Picture B-39. TP1 of the SDTQ.BB**

To be able to troubleshoot correctly this card, you will have to use an integrated circuit test clip (see picture B-40) that you will plug either on the MA1, if you have a problem with the second harmonic generator, or on the MA2, if you have a problem with the third or the fourth harmonic generator.

**Picture B-40. An integrated circuit test clip**

Then, you can look at the following pins to troubleshoot the board:



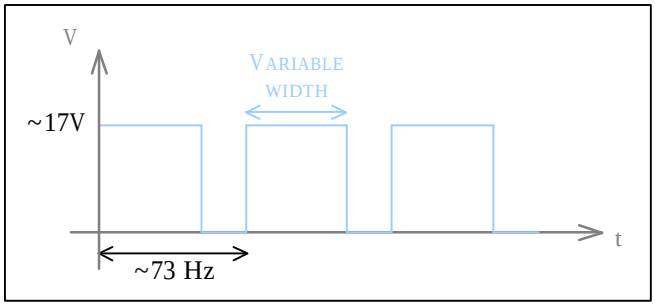

**Picture B-41. Pin numbers of the MA1 and MA2**

- **Pin n°2:** 2W TP (MA1) or 3/4W TP (MA2)
  - Should be set around 1.6V when the temperature is stable for a second or a third harmonic generator and between 1.6 and 2.1V for a fourth harmonic generator (see table B-11).

| °C | Volts | °C | Volts |
|---|---|---|---|
| 2 | 3,84 | 42 | 1,78 |
| 4 | 3,75 | 44 | 1,69 |
| 6 | 3,66 | 46 | 1,61 |
| 8 | 3,56 | 48 | 1,52 |
| 10 | 3,46 | 50 | 1,44 |
| 12 | 3,35 | 52 | 1,37 |
| 14 | 3,25 | 54 | 1,29 |
| 16 | 3,14 | 56 | 1,22 |
| 18 | 3,03 | 58 | 1,16 |
| 20 | 2,92 | 60 | 1,09 |
| 22 | 2,81 | 62 | 1,03 |
| 24 | 2,70 | 64 | 0,98 |
| 26 | 2,59 | 66 | 0,92 |
| 28 | 2,49 | 68 | 0,87 |
| 30 | 2,38 | 70 | 0,82 |
| 32 | 2,27 | 72 | 0,78 |
| 34 | 2,17 | 74 | 0,73 |
| 36 | 2,07 | 76 | 0,69 |
| 38 | 1,97 | 78 | 0,66 |
| 40 | 1,87 | 80 | 0,62 |

**Table B-11. Temperature and voltage correspondences**

- **Pin n°6:** 2W HEATING CD or 3/4W HEATING CD




**Draw B-29. Pin n°6 of the MA1 or MA2 timing diagram**

- **Pin n°8:** + 5V (power supply of the integrated circuit)

# III.7. SUMMARY OF THE POWER SUPPLY OPERATION

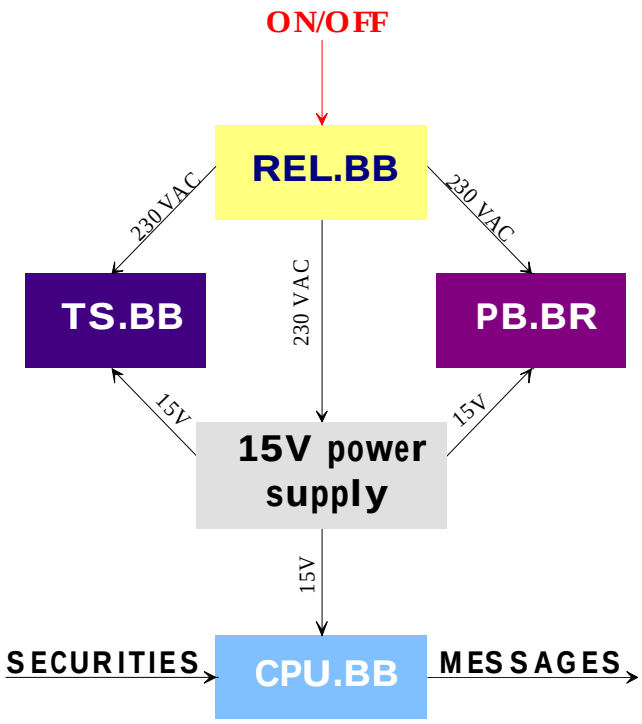
## STEP 1: TURN THE KEY

The ON/OFF data is sent to the REL.BB board. When the key is on the ON position, then the REL.BB board can spread the main to the TS.BB, the PB.BR and the 15V power supply.

The 15V power supply is then live and can spread the 15V to the TS.BB, the PB.BR and the CPU.BB so that they can generate their logic signals.

The CPU.BB gets the system securities and, depending on their states, generates or not the messages to display on the remote box. The CPU.BB treats the following securities:

- the cover switch,
- the laser head shutter report,
- the laser head thermal sensor,
- the remote control push button,
- the cooling group security,
- the interlock QS,
- the discharge switch (Brilliant and Brilliant B 10Hz)
- the flashlamp security (Brilliant B 20Hz),
- the interlock PS (Brilliant B 20Hz).




**Draw B-30. Power supply operation – step 1**

## STEP 2: PRESS THE START BUTTON (FLASHLAMP) ON THE REMOTE BOX

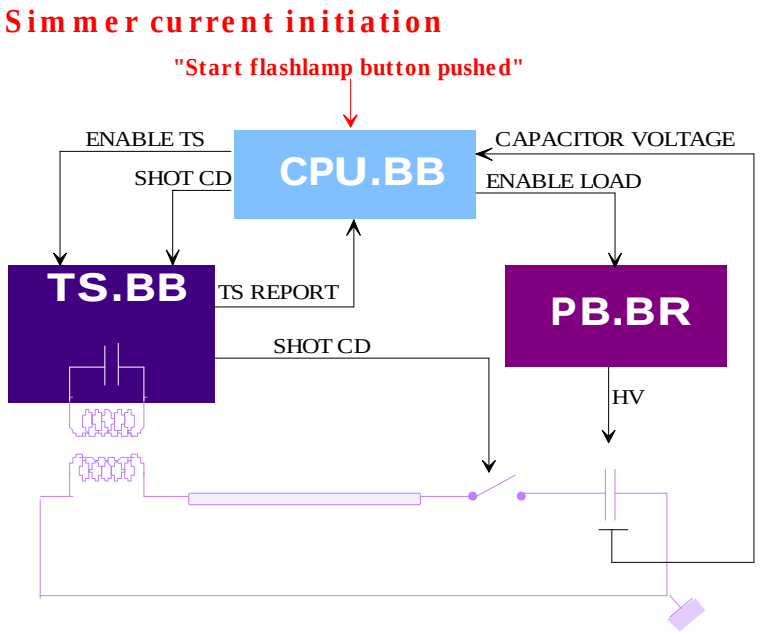
The CPU.BB first generates the ENABLE TS and ENABLE LOAD signals.

The ENABLE TS signal turns the TS.BB on and allows the charge of the capacitor C7 of the TS.BB. The ENABLE LOAD signal allows the charge of the 30µF capacitor by the PB.BR board.

The CPU.BB makes a direct reading of the capacitor state of charge. If it reaches the voltage required by the user (END OF CHARGE) in a shorter time than 1/f, the SHOT CD signal is sent to the TS.BB board to command the thyristor and thus close the discharge network. If the PB.BR fails to charge the capacitor up to the requested voltage, then the CPU.BB displays on the remote box: “PSU charge error”.

The capacitor C7 of the TS.BB and the 30µF capacitor are discharged into the flashlamp to initiate the simmer current. The C7 capacitor is discharged through the transformer trigger to give enough energy to reach the ionization level of the flashlamp.

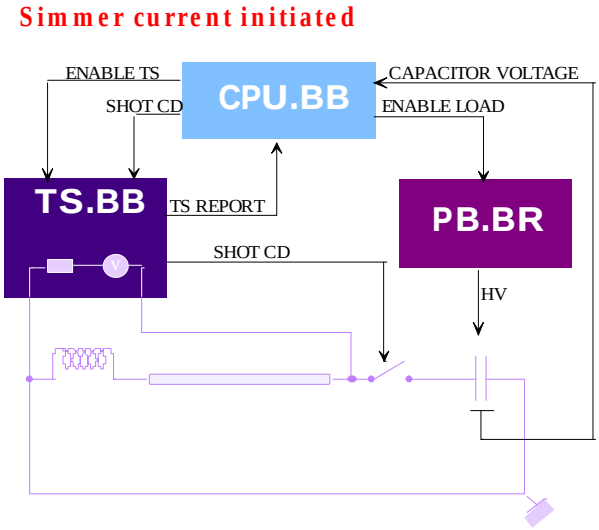
The TS.BB informs the CPU.BB if the simmer current in on or off thanks to the TS REPORT data. If the simmer current cannot be initiated (TS REPORT at 0V), then the CPU.BB displays on the remote box: “Simmer stop”.




**Draw B-31. Power supply operation – simmer current initiation**

Once the simmer current is initiated, the TS.BB will just maintain it and thus will just have a role of DC voltage power supply. It will also command the closing of the thyristor thanks to the SHOT CD signal.

Then, to make the flashlamp flash, the CPU.BB board sends the charge order to the PB.BR to charge the 30µF capacitor. There again, the CPU.BB makes sure that the capacitor is well charged up to the requested level and then sends the SHOT CD signal to the TS.BB board to discharge the capacitor in the flashlamp.

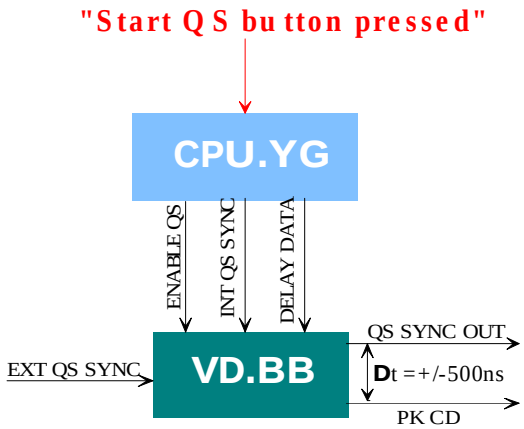



**Draw B-32. Power supply operation – simmer current initiated**

## STEP 3: PRESS THE START BUTTON (FLASHLAMP) ON THE REMOTE BOX

The CPU.BB board generates the internal synchronization signal (INT QS SYNC) and sends it to the VD.BB board with the data dealing with the delay between the signal sent to the laser head and the one sent to the user on the front panel.

The VD.BB board, depending on the user request, selects either the internal synchronization signal or the external synchronization signal. From this signal, it creates a second one with the variable delay (+ / -500ns) added. If the ENABLE QS signal is set at a high state, the first signal (PK CD) is sent to the laser head to synchronize the Pockels cell opening, and the second one (QS SYNC OUT) is sent to the user on the front panel.




**Draw B-33. Power supply operation – step 3**

# IV. THE COOLING GROUP

# IV.1. GENERALITIES

The Brilliant and Brilliant B lasers are using an air to water cooling group (CGU, Cooling Group Unit) set inside the ECB2K. In the case of a Brilliant B 20Hz, the cooling group is separated from the MPS and is using a water to water cooling group (CGS, Cooling Group Stabilized). They both cool the flashlamp and the rod using a close loop of deionized water and thus provide thermal stability of the oscillator structure.

# IV.2. THE CGU (COOLING GROUP UNIT)

The CGU is an air to water cooling group set inside the ECB2K which is used for the Brilliant and Brilliant B lasers (except the Brilliant B 20Hz).

## IV.2.i. PRINCIPLE

The operation principle of the CGU is shown on the draw B-34. The water is pumped from a 2l water tank and then is heated up by a heating resistance. This heating resistance is commanded by the CPU.BB board and will be activated when you turn the system on and when the laser is not flashing to compensate the heat generated by the flashlamp. This way, even if the laser is not flashing, the laser head stays at the same temperature and the beam profile of the laser is more stable at the next start.

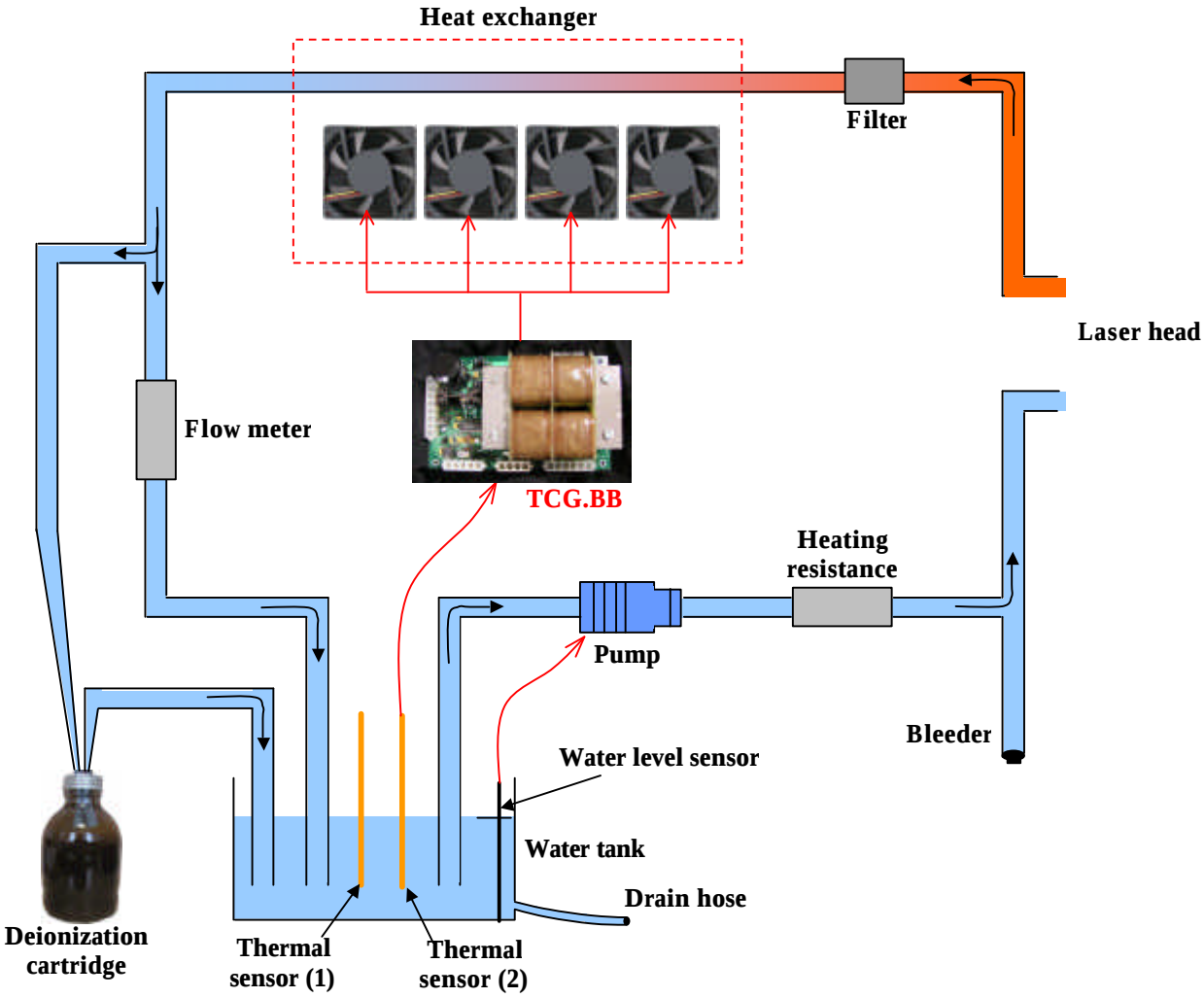
This water is then sent to the laser head to cool it and comes back to the CGU at a pretty high temperature. There, the water is filtered and cooled by an air to water heat exchanger. The ventilators are commanded by the TCG.BB board (see next paragraph) and will turn more or less quickly depending on the temperature of the water in the tank (thermal sensor (2)). The higher the temperature, the quicker they will turn.

A part of the cooled water is then sent through a flow switch into the water tank. The other portion first passes through the deionisation bottle before being sent back into the water tank. This deionisation cartridge is used to capture the ions that may appear in the water and thus to avoid the apparition of micro-organisms in the water circuit.

In the water tank, there are two temperature sensors and a water level sensor. The first thermal sensor (thermal sensor (1)) is set in serial with the flow meter. These three information will give to the CPU.BB the data CG SECU. If the water temperature is higher than the temperature set by the user with the “high

temperature" knob (see next paragraph) or the water flow lower than 2l/min then the CG SECU data is set to the high state and stops the system. The following message will be displayed on the remote box: "Interlock: CGU flow rate / thermal sensor, see instr. manual". The water level sensor stops the pump when water level is two low. Thus in this case, the message "Interlock: CGU flow rate / thermal sensor, see instr. manual" will also be displayed on the remote box as the flow switch will detect a water flow lower than 2l/min. The second thermal sensor is used by the TCG.BB for the regulation of the water temperature.

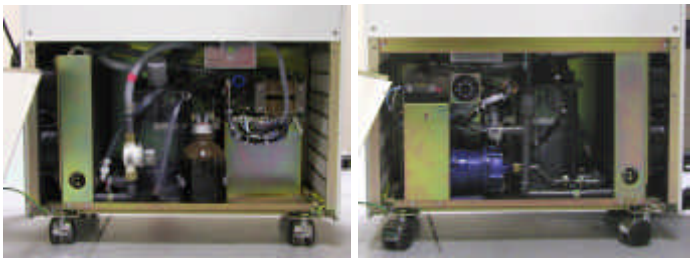
The drain hose plugged at the bottom of the water tank is to be used to empty it. Once this is done and the tank is filled back with clean water, the user might need to use the bleeder to help the pump to restart. The pump might be filled with air and in this case the user will have to evacuate it (and replace it with water) by pushing the button set at the end of the bleeder.




**Draw B-34. Operation principle of the CGU**

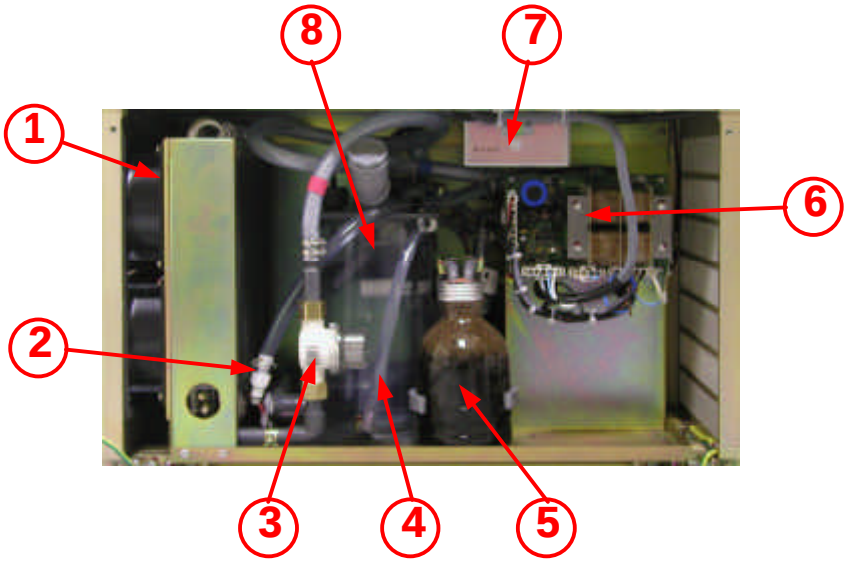
## IV.2.ii. DESCRIPTION

To access the cooling group unit , you have to unscrew the two lower panels of the ECB2K (see picture B-42).



**Picture B-42. Left and right hand side of the CGU**

On the left hand side you can access:




**Picture B-43. Left hand side of the cooling group**

1. **The air to water heat exchanger:** the water coming from the laser head is cooled down here with four ventilators. The rotation speed of these ventilators is commanded by the TCG.BB board and is proportional to the temperature of the water in the tank.

2. **The bleeder:** to restart the cooling group once the user has changed the water. By pushing the button at its end, the user empty the air that might have filled the pump to replace it by water.

3. **The water filter:** filters the impurity that can appear in the water. This filter should be cleaned regularly.

4. **The drain hose:** to empty the water tank.

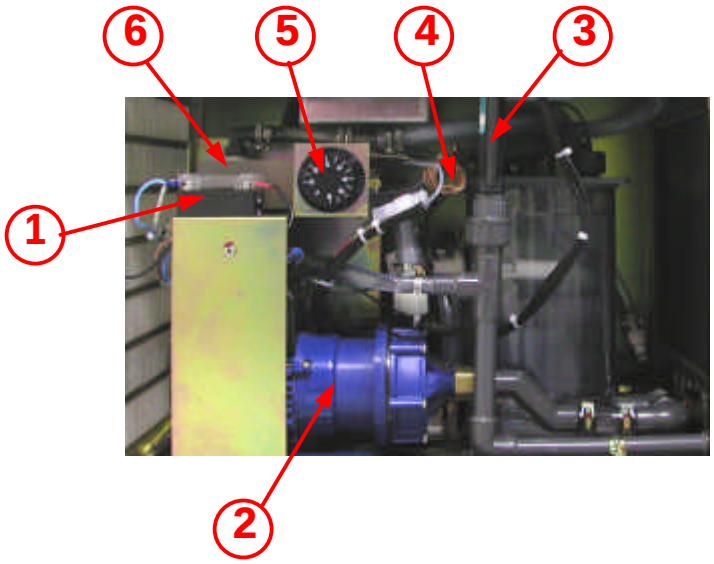
5. **The deionization bottle:** a part of the water goes through this bottle to be deionized and minimize the risk of apparition of impurities.

6. **The TCG.BB board:** manages the rotation speed of the ventilators according to the temperature of the water in the tank.

7. **The main filter:** reduces the noise coming from the main before feeding the power supply electronics boards and the TCG.BB.

8. **The water tank:** contains 2l of water that are used to cool down the laser head. Two thermal sensors are set in the water tank, one for the CGU security and one for the water temperature regulation. Inside the tank, there is also a water level sensor.

On the right hand side you can access:




**Picture B-44. Right hand side of the CGU**

1. **The heating resistance relay:** is commanded by the CPU.BB board and commands the heating resistance when the laser is not flashing to increase the stability of the beam.

2. **The pump:** manages the water flow in the group.

3. **The flow switch:** checks if the water is flowing. This security is set in serial with the temperature sensor (1) and water level sensor. It will activate the error message if the flow goes lower than 2l/min.

4. **The temperature sensor(1):** measures the water temperature. This security is set in serial with the flow meter. It will activate the error message if the temperature of the water in the tank is higher than the one set by the user with the temperature knob (n°5).

5. **The temperature knob:** sets the water temperature security level where the system will stop and display the error message.

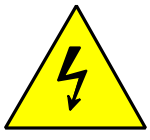
6. **The heating resistance:** keeps the water at the right temperature when the laser is not flashing. It compensates the energy dissipated by the flashlamp when it is not operating.

## IV.2.iii. PERFORMANCES

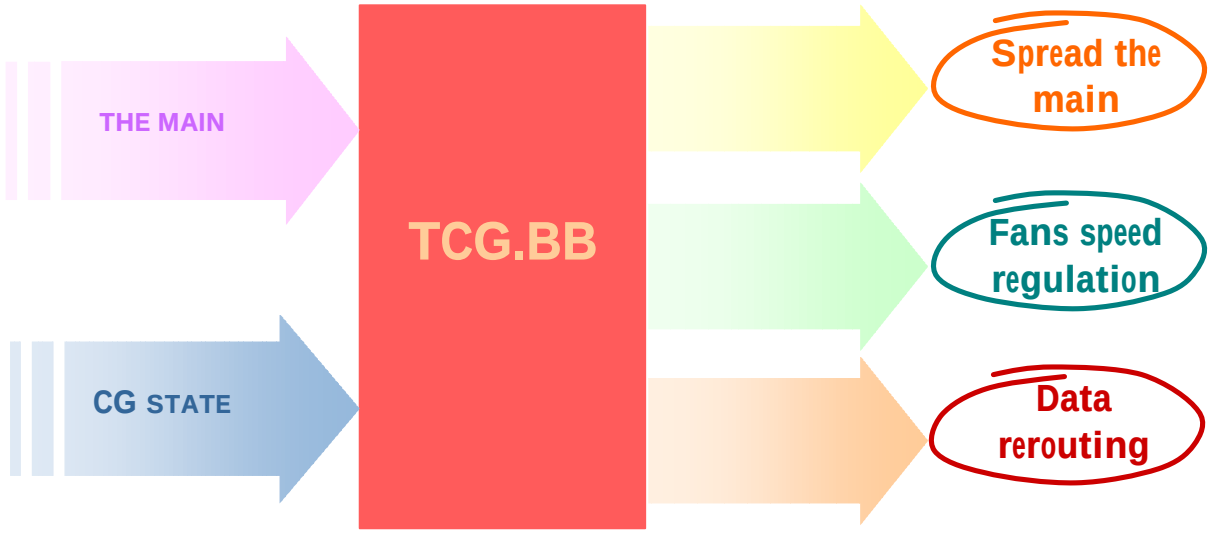
The performances of the CGU are the following:

- **Cooling power:** 600W
- **Water temperature:** 38°C (adjustable with the TCG.BB board potentiometer)
- **Temperature stabilization:** + / - 1°C
- **Stabilization time:** less than 10 minutes
- **Minimum temperature difference between the air and the water**: 10°C
- **Ambient air temperature range (Brilliant):** 18°C to 28°C.
- **Ambient air temperature range (Brilliant B):** 18°C to 25°C
- **Water tank capacity:** 2l

## IV.2.iv. THE TCG.BB BOARD



This is the **Temperature Cooling Group** board. This card can only be found in the CGU thus in a the Brilliant and Brilliant B using a ECB2K. According to the water temperature of the cooling group, it manages the speed of rotation of the ventilators.




**Draw B-35. Operation principle of the TCG.BB board**

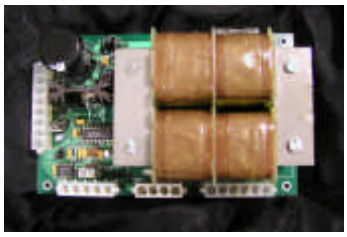
### IV.2.iv.a. LEXICON

In the following paragraph, you will find the list and the definitions of the data managed by the TCG.BB:

- **15 VAC:** 15V alternative voltage.
- **21 VDC:** 21V continuous voltage.
- **230 VAC:** Main power supply.
- **CG SECU:** Signal indicating if the cooling group is correctly operating. This data includes the temperature sensor data and the flow meter data.
- **ERROR:** Value of the difference between the temperature read and the reference.
- **FANS CD:** Signal commanding the fans rotation.
- **REF:** Reference value for the water temperature.
- **REGULATION:** Signal used to regulate speed rotation of the fans.
- **WATER TP:** Temperature of the water in the tank.

### IV.2.iv.b. OVERVIEW

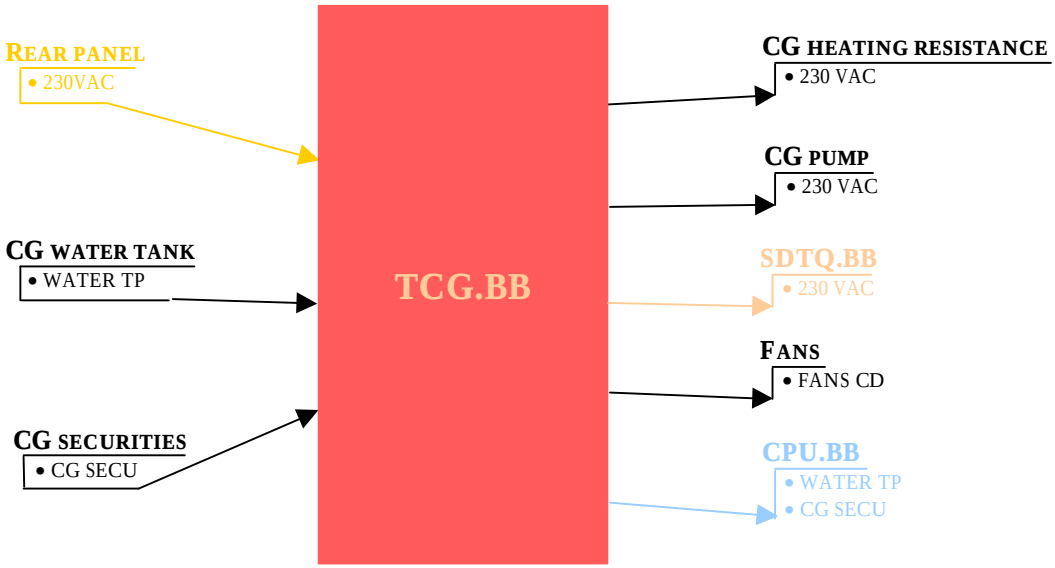
This board is completely independent from the power supply. It just sends to the CPU.BB board the data concerning the state of the cooling group.



**Picture B-45. The TCG.BB board**

The TCG.BB board is connected to:

- the REL.BB board, to receive the main,
- the rest of the cooling group, to distribute the main, get the water temperature and the security data and command the fans rotation speed.
- the SDTQ.BB board, to distribute it the main.
- the CPU.BB board, to send it the water temperature and the security data.

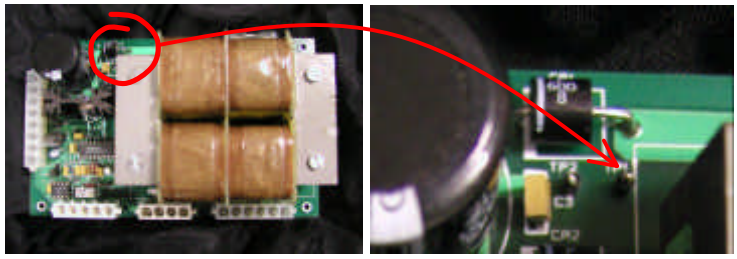



**Draw B-36. TCG.BB links**

### IV.2.iv.c. TEST POINTS

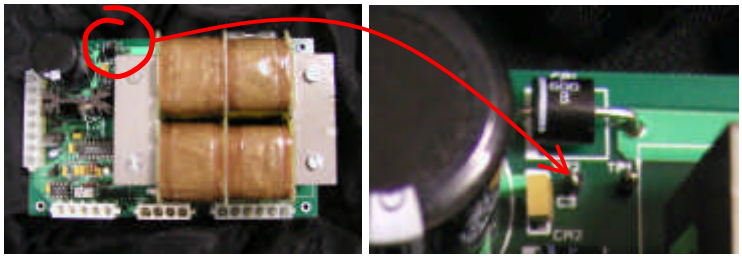
There are 8 test points on the TCG.BB board that will help you to troubleshoot it.

- **TP1:** Ground



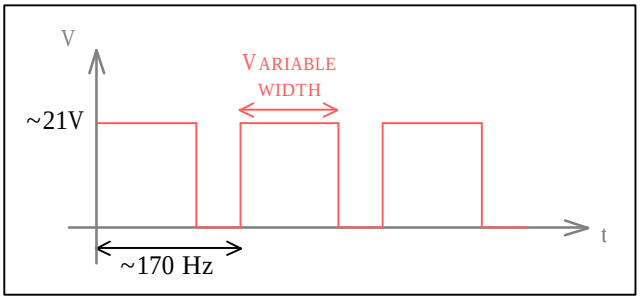
**Picture B-46. TP1 of the TCG.BB**

- **TP2:** 21 VDC

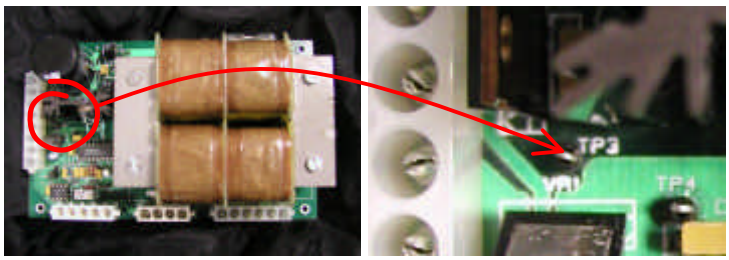


**Picture B-47. TP2 of the TCG.BB**

- **TP3:** FANS SPEED

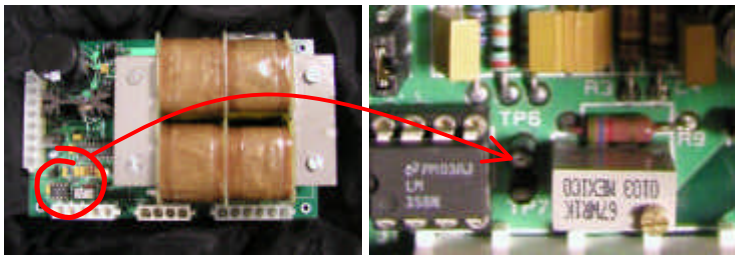



**Draw B-37. TP3 timing diagram**



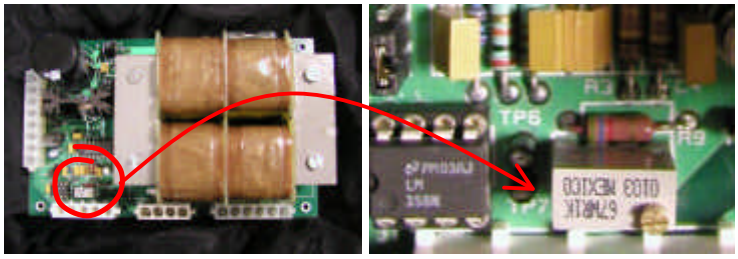

**Picture B-48. TP3 of the TCG.BB**

- **TP6:** REF
  - Set to 1,95V for a temperature of 38°C



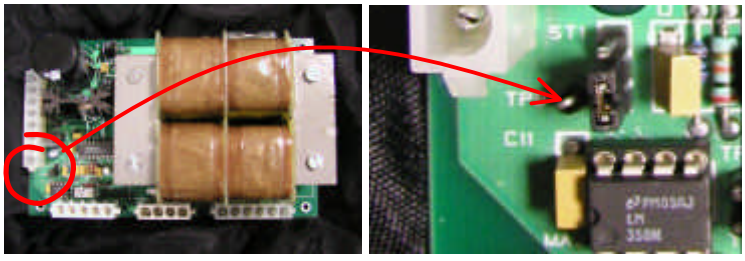

**Picture B-49. TP6 of the TCG.BB**

- **TP7:** WATER TP
  - Should be set at 1,95V when the water temperature is stabilized (see table B-11).




**Picture B-50. TP7 of the TCG.BB**

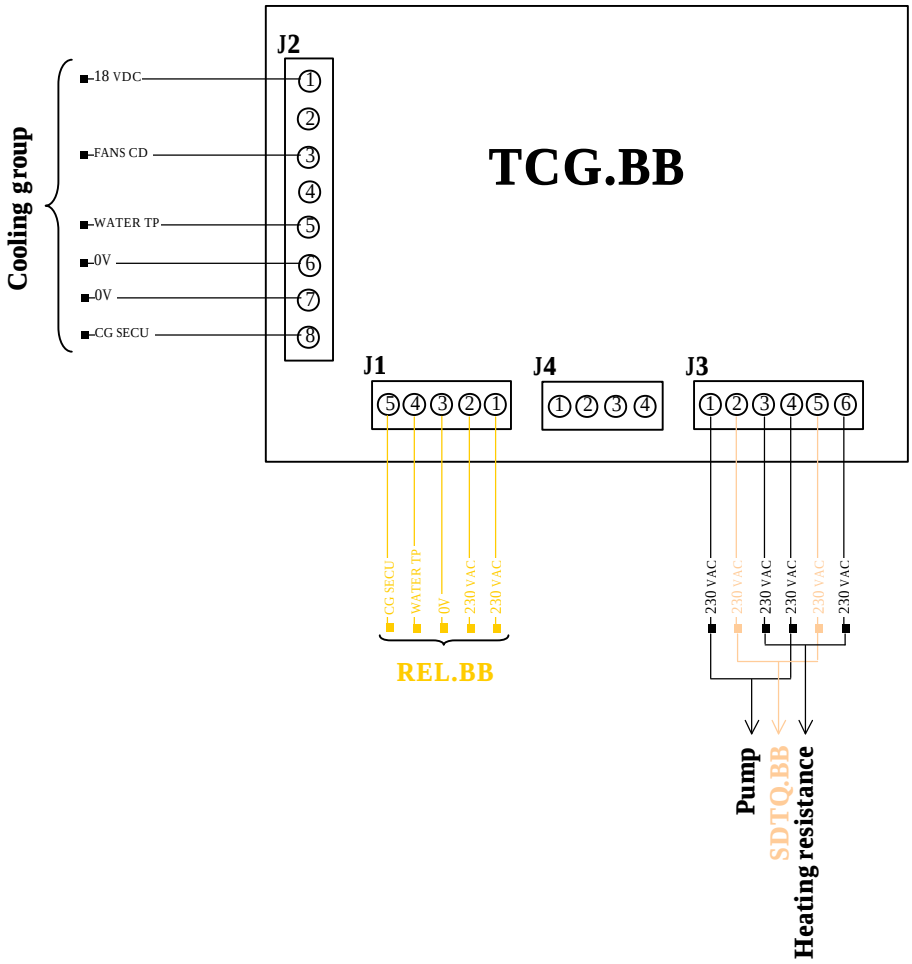
- **TP8:** WATER TP
  - Should be set at 1,95V when the water temperature is stabilized (see table B-11).




**Picture B-51. TP8 of the TCG.BB**

### IV.2.iv.d. INTERCONNECTIONS

The following draw represents the TCG.BB board interconnections with the rest of the system.



# IV.3. THE CGS (COOLING GROUP STABILIZED)

The CGS is a water to water cooling group which is used on the Brilliant B 20Hz.

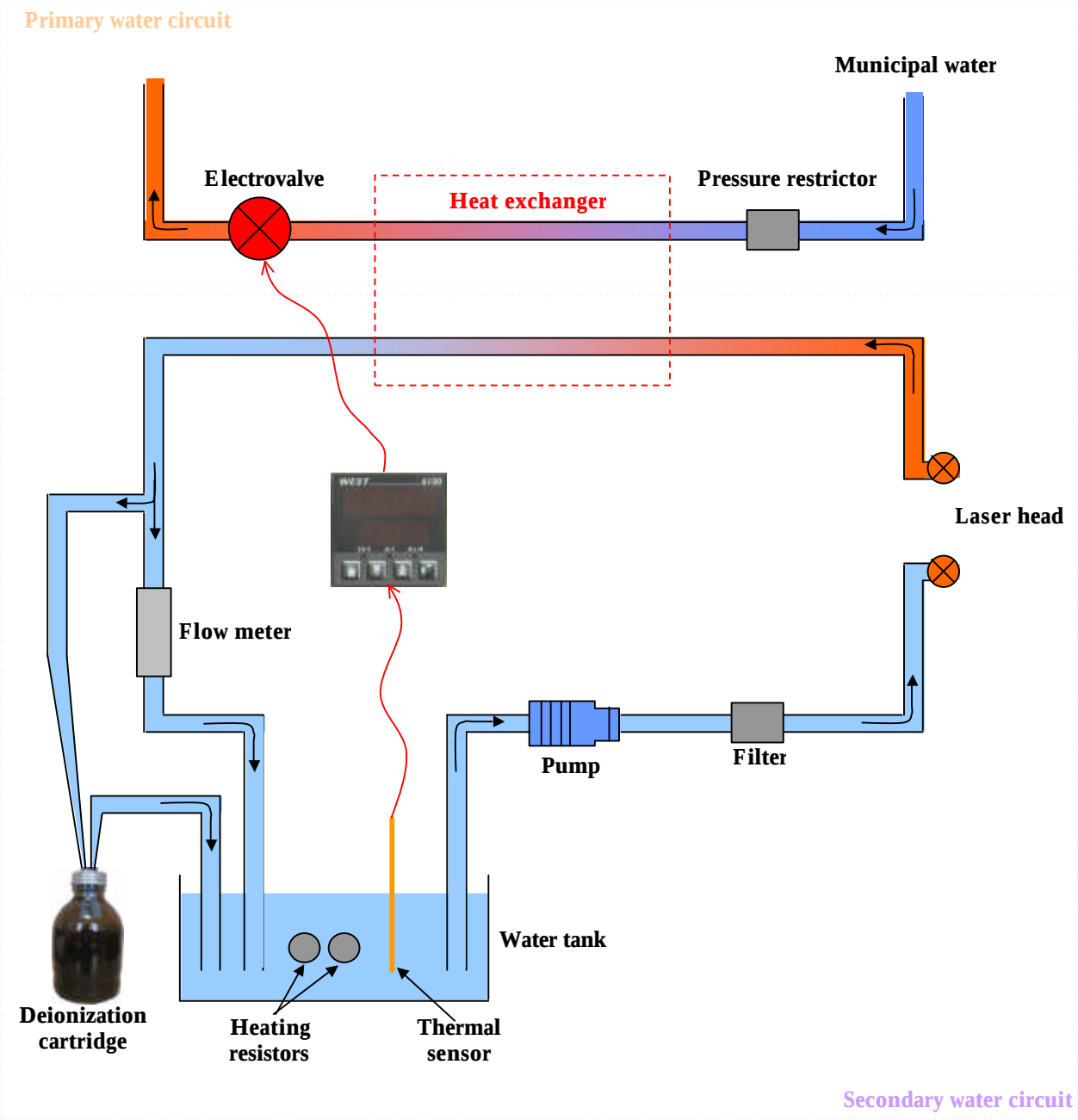
## IV.3.i. PRINCIPLE

The operation principle of the CGS is shown on the draw B-38. The secondary water is pumped from a 5l water tank. It is then filtered before being sent to the laser head. The water cools it and comes back into the cooling group at a pretty high temperature.

There, the water is cooled by a water to water heat exchanger. The secondary water circuit transfers its heat to the primary water circuit. The heat quantity that the secondary will be able to transfer depends on the primary flow rate. Thus, an electrovalve is set on the primary circuit and is commanded by an IPD (Integral Plus Derivative) to adapt its flow rate depending on the water temperature in the tank (in the primary water circuit). The higher the temperature, the higher the flow rate of the primary water circuit. As the electrovalve is operating normally for a given range of pressure of the municipal water, a pressure restrictor is set on the primary circuit.

On the secondary circuit, at the output of the heat exchanger, a part of the cooled water is sent through a flow switch into the water tank. The other portion of the water first passes through the deionisation cartridge before being sent back into the water tank. This deionisation cartridge is used to capture the ions that may appear in the water and thus to avoid the apparition of micro-organisms in the water circuit.

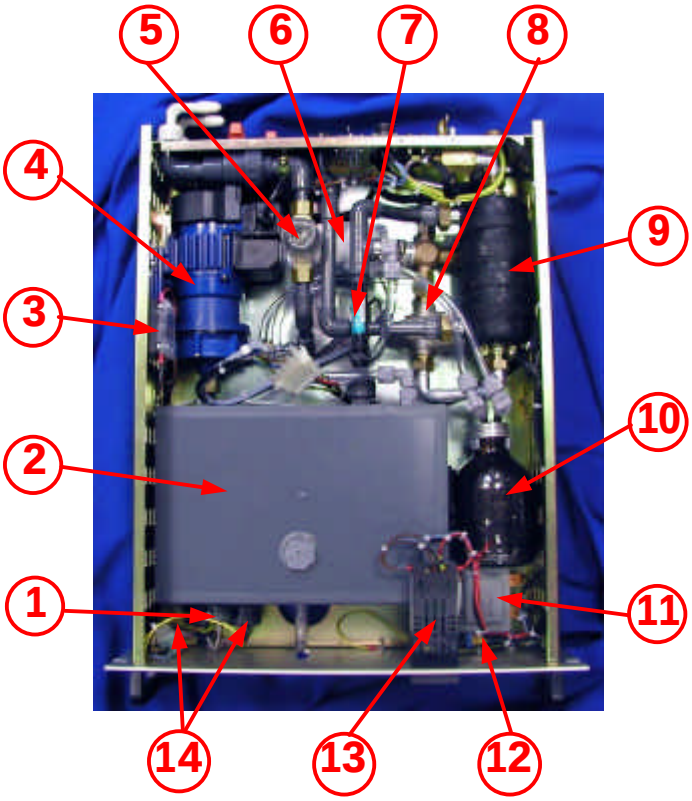
In the water tank, there are a thermal sensor and two heating resistors. The thermal sensor is managed by the IPD. The temperature value read will be used for the regulation and be compared with the low and high limit temperature set by the user on the IPD. The result of this comparison is set in serial with the flow switch. These two information will give the data CG SECU sent through the rear panel to the CPU.BB board of the MPS. If the water temperature is lower or higher than the limits or if the water flow is lower than 2l/min, then the CG SECU data is set to high state and stops the system. The following message is displayed on the remote box: “Interlock: CGU flow rate/thermal sensor, see instr. Manual”. The two heating resistors (700W each) are commanded by the IPD and are used mainly at the start of the cooling group to heat the water up to the temperature set by the user.




**Draw B-38. Operation principle of the CGS**

## IV.3.ii. DESCRIPTION

To access the CGS, you have to unplug the wires of the rear panel and unscrew the four screws of the front panel. Then, you can pull the rack out of the cabinet.




**Picture B-52. Inside of a CGS**

1. **The thermal sensor:** measures the water temperature for the regulation and to compare it to the low and high temperature settings. The result of this comparison is set in serial with the flow meter.

2. **The water tank:** contains 5l of deionised water used to cool down the laser head.

3. **The static relay (1):** receives the heating order from the IPD and sends it to the two heating resistors.

4. **The pump:** manages the water flow in the secondary circuit.

5. **The water filter:** filters the impurities that can appear in the water. This filter should be cleaned regularly.

6. **The electrovalve:** regulates the water flow in the primary circuit depending on the water temperature in the tank.

7. **The flow switch:** checks if the water is flowing. This security is set in serial with the temperature security coming from the IPD. It activates an error message on the remote box if the water flow goes lower than 2l/min.

8. **The pressure restrictor:** is set on the primary circuit to limit the municipal water pressure as the electrovalve is operating normally for a given range of pressure.

9. **The water to water heat exchanger:** the water coming from the laser head transfers its heat here to the municipal water.

10. **The deionisation cartridge:** a part of the water of the secondary circuit goes through this bottle to be deionised and minimize the risk of apparition of impurities.

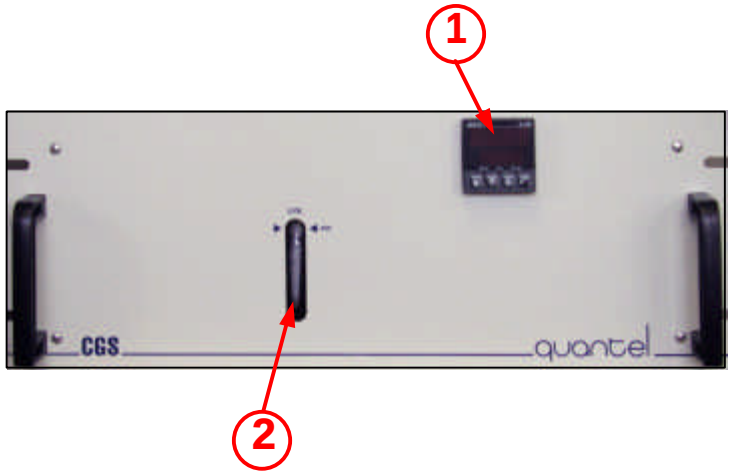
11. **The 24V transformer:** feeds the electrovalve.

12. **The static relay (2):** gets the state of the security loop (flow meter plus temperature) and transfers this data to the rear panel connector.

13. **The IPD:** is the brain of the cooling group. It manages the temperature regulation of the secondary water circuit by managing the electrovalve opening. It also gives the temperature security data.

14. **The two heating resistors:** (700W each) are commanded by the IPD and are used mainly at the start of the cooling group to heat the water up to the temperature set by the user.

### IV.3.iii. THE FONT PANEL

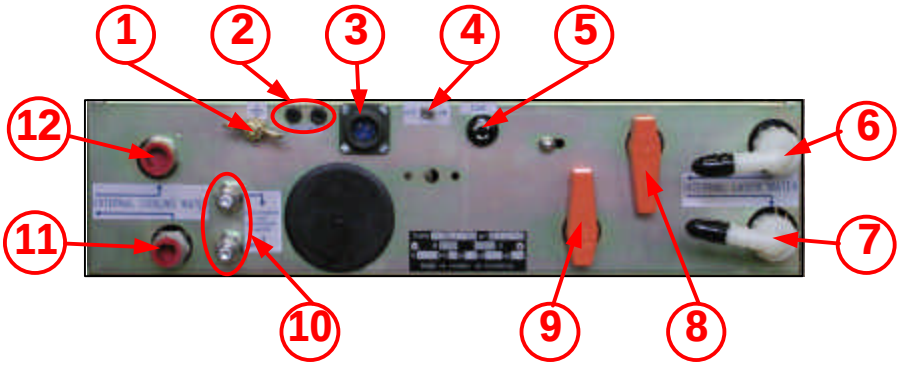



**Picture B-53. The front panel of the CGS**

1. **The IPD front panel:** through which the user can enter its settings for the cooling group operation.

2. **The water level indicator:** the water level should never be lower than the one indicated with the arrows labelled “mini”.

### IV.3.iv. THE REAR PANEL




**Picture B-54. The rear panel of the CGS**

1. **The Ground.**

2. **The CG SECU connector:** through this connector arrives the CG SECU data including the temperature and the flow securities. It is a dry contact commanded by the static relay (2).

3. **The main connector:** through this connector the CG receives the main from the MPS.

4. **The ON/OFF switch:** to turn on or off the cooling group. This switch should always stay on the ON position.

5. **The fuse:** (fast acting, 8A, 250V) protects the cooling group from the main power supply instabilities.

6. **Primary water circuit outlet:** port through which the secondary water leaves the cooling group to cool the laser head.

7. **Primary water circuit inlet:** port through which the secondary water gets back into the cooling group from the laser head. At this port, the water is pretty hot.

8. **Primary water circuit outlet valve:** close or open the outlet port.

9. **Primary water circuit inlet valve:** close or open the inlet port.

10. **Electronics heat exchanger water:** not used in QUANTEL's applications.

11. **Secondary water circuit inlet:** port through which the municipal water gets into the primary water circuit of the cooling group.

12. **Secondary water circuit outlet:** port through which the municipal water leaves the primary water circuit of the cooling group.

### IV.3.v. PERFORMANCES

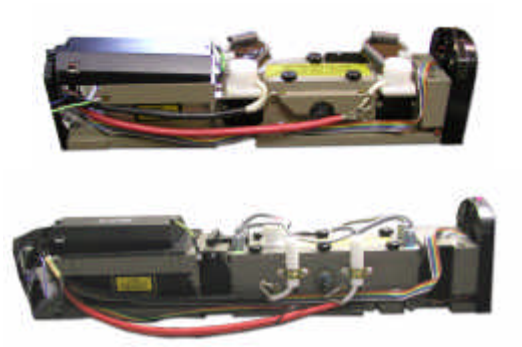
The performances of the CGS are the following:

- **Cooling power:** 3kW
- **Primary water temperature:** 5-20°C
- **Secondary water temperature:** 35-45°C
- **Temperature stabilization:** + / - 0.1°C
- **Stabilization time after the activation of the system:** around 15mn
- **Stabilization time after the activation of the laser power:** around 2mn
- **Temperature difference between the primary and the secondary water circuits**: 15°C
- **Water tank capacity:** 5l

# V. THE LASER HEAD

# V.1. GENERAL DESCRIPTION

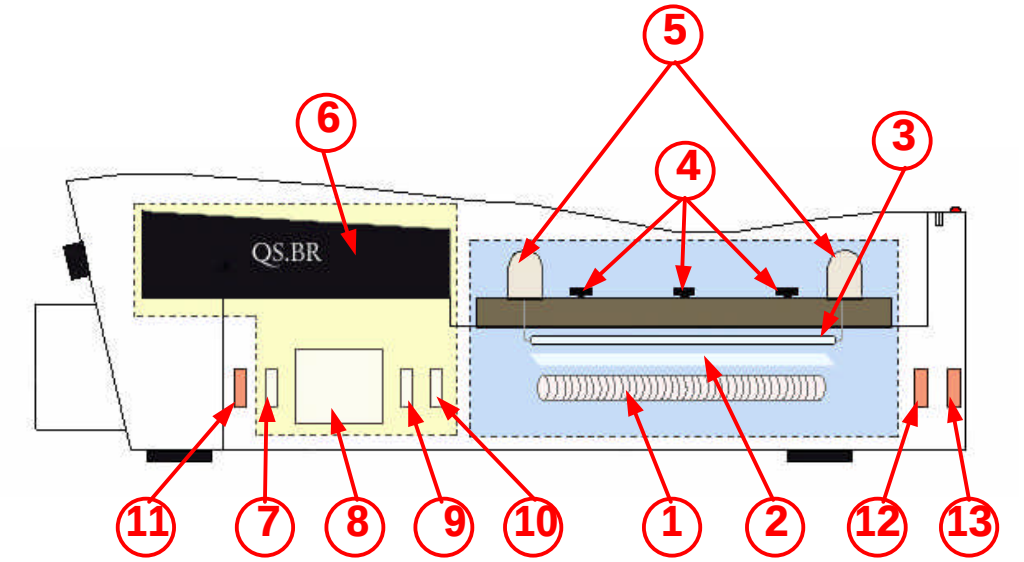
The Brilliant and Brilliant B laser heads are pretty similar. The main differences are the diameter of the Nd:YAG rod (6mm for the Brilliant and 9mm for the Brilliant B) and the number of flashlamp (1 for the Brilliant and 2 for the Brilliant B) set inside the pumping cavity. Moreover, you can easily recognize one from another thanks to the size of their mechanical block: the Brilliant is smaller than the Brilliant B.



**Picture B-55. The Brilliant (up) and Brilliant B (down) laser heads without their housing**

## V.1.i. OPTICAL DIAGRAM

The following draw gives a quick description of the cavity from the optical components point of view. Each of these components is described more in details in the following paragraphs.




**Draw B-39. Optical diagram of the Brilliant and Brilliant B lasers**

The Brilliant and Brilliant B laser heads can be separated into three main parts:

**The pumping cavity** where the energy to create the laser pulse is stocked. It is composed of:

1. A Nd:YAG rod with a 6mm (Brilliant) or 9mm (Brilliant B) diameter and a 115mm length which is the active medium of the laser (producing the laser emission).
2. A KSF filter that selects the wavelengths pumping the rod.
3. One (Brilliant) or two (Brilliant B) flashlamps receiving the high voltage from the electronics cabinet and transforming this energy into light to pump the Nd:YAG rod.
4. Five (Brilliant) or six (Brilliant B) screws to maintain the pumping cavity cover. This cavity is filled with water to cool down the flashlamps and the rod.
5. Two (Brilliant) or four (Brilliant B) flashlamps connectors to plug the flashlamp to the high voltage coming from the electronics cabinet.

**The Q-Switch cavity** where the impulsion is created thanks to the Pockels cell. It is composed of:

6. The QS.BR board which is controlling the opening of the Pockels cell.
7. A quarter wave plate changing a linear polarization into a circular one and vice versa.
8. A Pockels cell sets on its neutral lines. This cell is commanded by the QS.BR board. When no voltage is applied on the cell, it is equivalent to a neutral element. When a high negative voltage is applied, the Pockels cell is equivalent to a quarter wave plate.
9. A cylindrical diverging lens improving the beam shape (on some Brilliant B only).
10. A polarizer, which linearly polarizes the light in the cavity.

**The amplification**, which manages the laser pulse amplification. It is composed of:

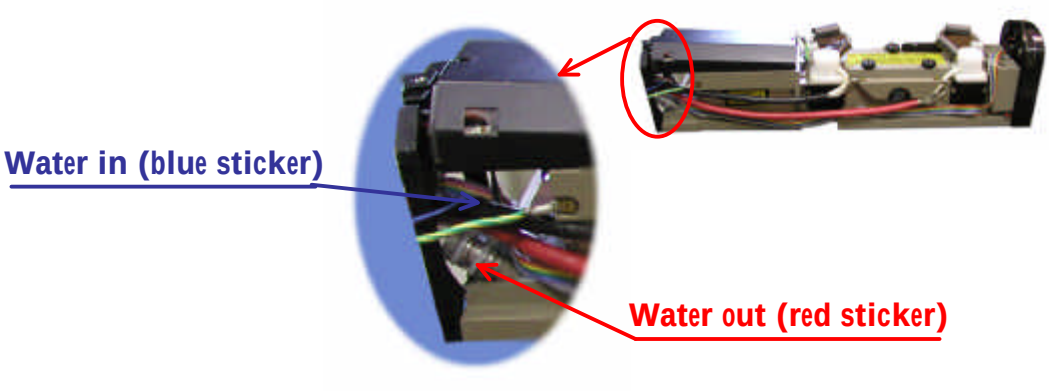
11. The rear mirror with a high reflectivity at 1064nm and whose radius of curvature is chosen to provide a low divergence output beam.

12. A quarter wave plate set only on the Brilliant B and the 50Hz lasers. This plate is used to improve the spatial quality of the laser beam in the near field.

13. The output mirror (or gaussian mirror) with a gaussian reflectivity mirror (at 1064nm) to improve the quality of the output beam.

## V.1.ii. WATER CONNECTIONS

The Brilliant and Brilliant B laser heads are cooled by a closed deionized water loop. Two water hoses coming from the CGU (for Brilliant and Brilliant B 10Hz) or the CGS (for Brilliant B 20Hz) are plugged to the laser head. The hose marked with a blue sticker is the incoming (cold) water. It should be connected to the left hand side input when looking at the back of the laser. The hose marked with a red sticker is the outgoing (hot) water. It should be connected to the right hand side input when looking at the back of the laser (see picture below).

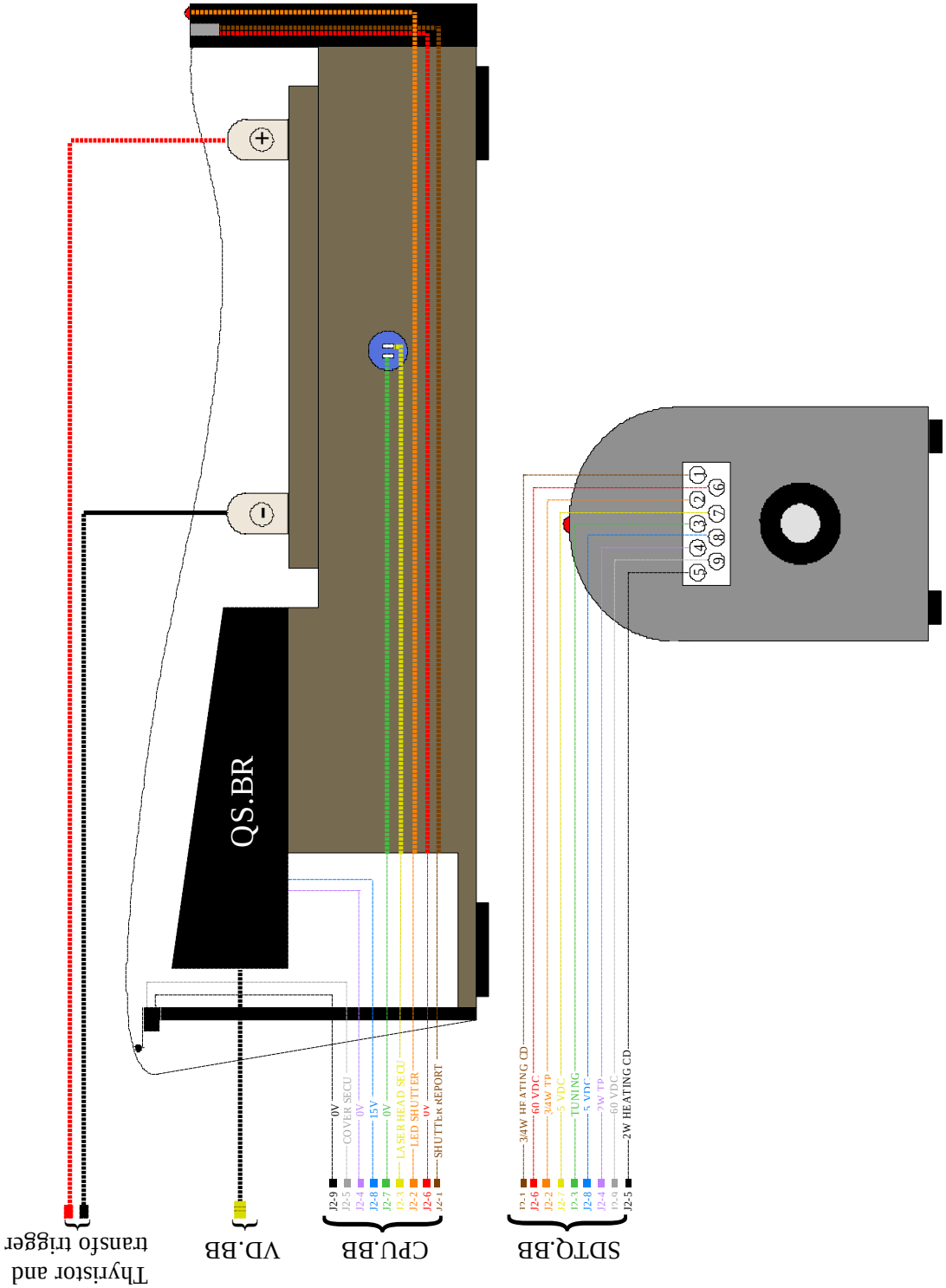



**Picture B-56. Brilliant water connections**

This water is used to cool down the pumping cavity. The flashlamp, the KSF filter and the rod (its body but not its faces) are under water. Thus the water hoses go under the Q-Switch cavity and then fill the pumping cavity. The screws on the top of it insure its tightness.

## V.1.iii. ELECTRICAL CONNECTIONS

The laser head sends to the electronic cabinet the data indicating its state and the electronic cabinet sends to the laser head the orders to command the laser head and the harmonic generators.




**Draw B-40. The Brilliant and Brilliant B laser heads electronics interconnections (external view)**

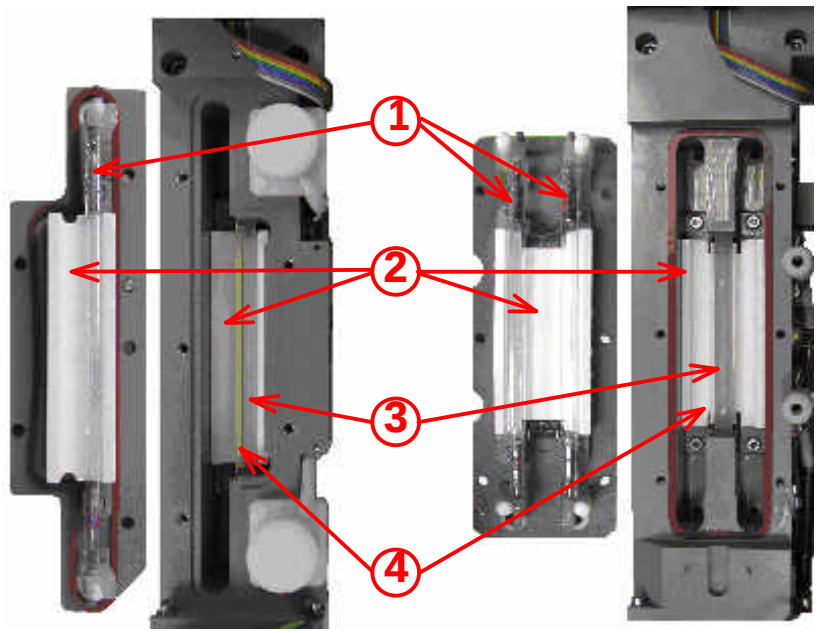
# V.2. THE PUMPING CAVITY

## V.2.i. DESCRIPTION

We have seen before that the Brilliant and Brilliant B pumping cavities are mainly composed of (see next picture):

1. one or two flashlamps
2. two blocks of ceramic
3. a 6 or 9mm Nd:YAG rod
4. a KSF filter

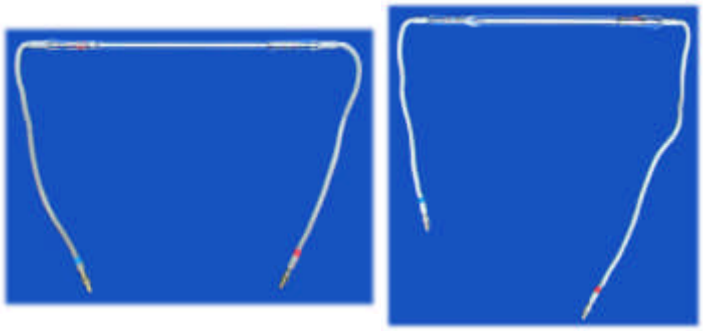
The flashlamps are ionized by the high voltage coming from the electronic cabinet and emit light. This light pumps the Nd:YAG rod and thus creates the inversion of population needed to observe the laser effect. To get the best efficiency, the light is filtered by the KSF plate whose absorption spectrum fit the Nd:YAG one. The ceramic is a diffuser that homogenizes the pumping of the Nd:YAG rod by the flashlamp light.




**Picture B-57. Brilliant (left) and Brilliant B (right ) pumping cavities**

### V.2.ii. THE FLASHLAMP

The flashlamp is ionized by the high voltage coming from the electronics cabinet (stocked in the capacitor) and emits light. This light pumps the Nd:YAG rod to realize the population inversion.



**Picture B-58. Brilliant (left) and Brilliant B (right) flashlamps**

The Brilliant laser is using the **SFL BR1-06** flashlamp referenced as **OPT349** in QUANTEL's service parts list.

The Brilliant B laser is using two **SFL BB1-09** flashlamps referenced as **OPT387** in QUANTEL's service parts list.

The lifetime of these two kinds of flashlamps is guaranteed up to 30 million shots. You can easily recognize one from another as the Brilliant B flashlamp positive cable is longer than the negative one and its tube is larger than the Brilliant's ones.

## V.3. THE Q-SWITCH CAVITY

### V.3.i. DESCRIPTION

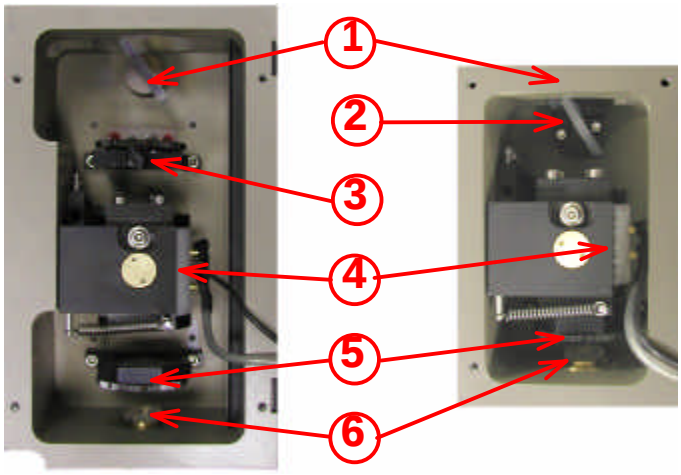
We have seen before that the Brilliant and Brilliant B Q-Switch cavities are mainly composed of (see next picture):

1. a polarizer
2. a compensating plate (on Brilliant only)
3. a cylindrical diverging lens (on some Brilliant B only)

**4.** a Pockels cell

**5.** a quarter wave plate

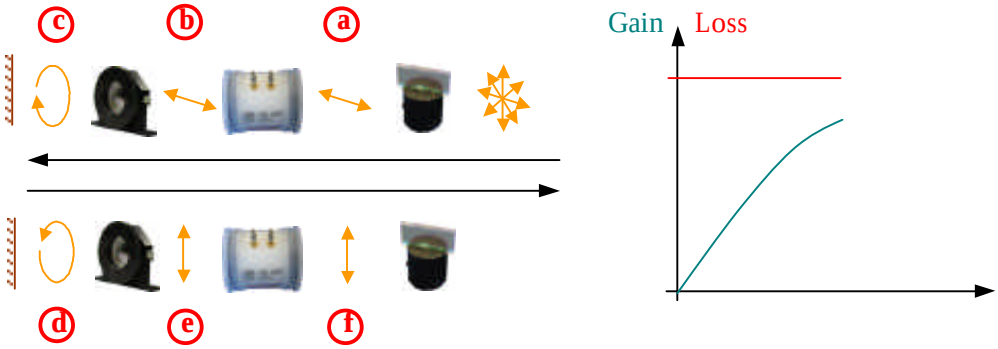
**6.** the rear mirror, which is described in the amplification paragraph.




**Picture B-59. The Brilliant (right) and Brilliant B (left) Q-Switch cavities**

The operation can be described in two phases: the opening and the closure phases of the cavity.

During the first phase (see draw next page), no voltage is applied on the Pockels cell, which, in this case, is equivalent to a neutral element. Thus, if we decompose the principle:




**Draw B-41. First phase of the Q-Switch operation**

**a.** the polarizer linearly polarizes the incident light: it rejects the vertical components of the polarization and let the horizontal ones pass,

b. then, the Pockels cell has no effect,

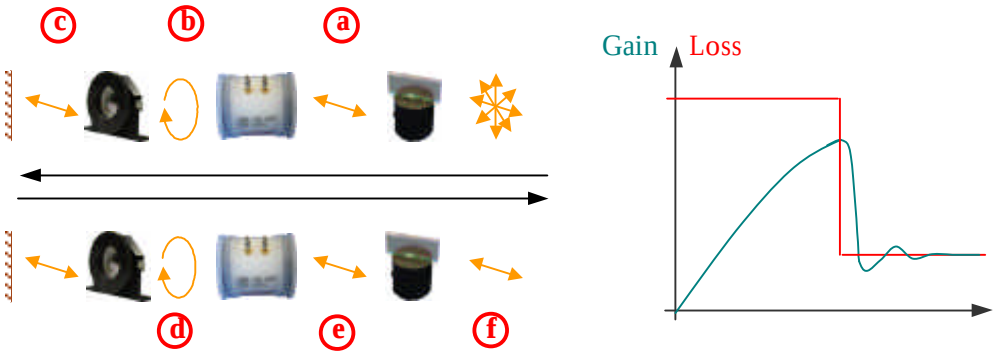
c. the quarter wave plate transforms the horizontal polarization of the light into a right hand circular polarization,

d. after bouncing on the mirror, the polarization turns to left hand circular,

e. then the quarter plate wave transforms the left hand circular polarization in to a vertical polarization,

f. thus when arriving on the polarizer, it is rejected: the light cannot be amplified.

During the second phase (see draw below), a high voltage (3500V) is applied on the Pockels cell, which is then equivalent to a quarter plate wave. Thus, if we decompose the principle:




**Draw B-42. Second phase of the Q-Switch operation**

a. the polarizer linearly polarizes the incident light: it rejects the vertical polarization and let the horizontal one pass,

b. then, the Pockels cell is equivalent to a quarter wave plate and thus transforms the horizontal polarization of the light into a right hand circular polarization,

c. the quarter wave plate transforms the right hand circular polarization into an horizontal polarization,

d. on its way back the polarization turns back to a right hand circular polarization when going through the quarter wave plate,

e. and then goes back to horizontal after the Pockels cell.

f. Thus when arriving on the polarizer, it can pass: the light is amplified.

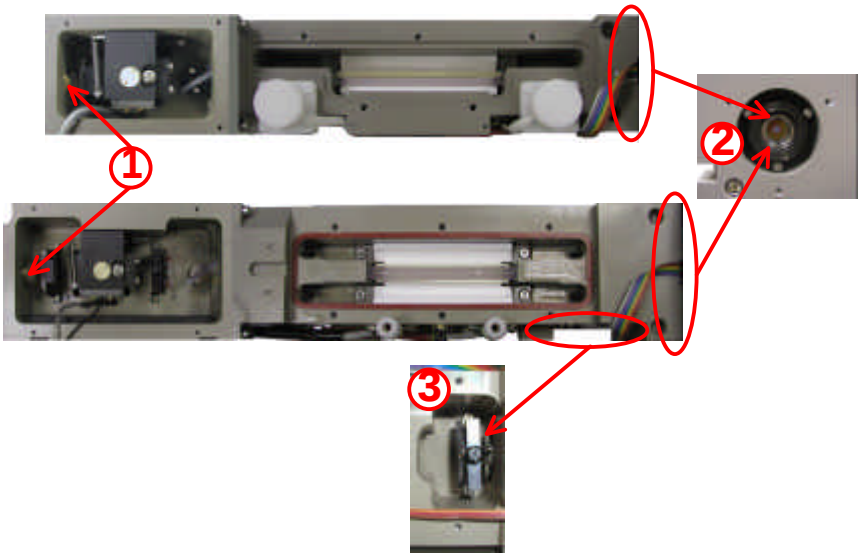
If during the first phase the light cannot be amplified, it also means that the energy is stocked inside the cavity and cannot get out. Thus the gain increases and the loss stays at its high level. During the second phase, the totality of the light stocked inside the cavity can be amplified. By feeding the Pockels cell, the loss is lowered and the gain liberated to create a laser pulse.

## V.4. AMPLIFICATION

### V.4.i. DESCRIPTION

We have seen before that the Brilliant and Brilliant B amplification part of the cavity is composed of (see next picture):

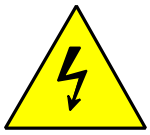
1. the rear mirror
2. the gaussian mirror
3. a quarter wave plate (on Brilliant B only)



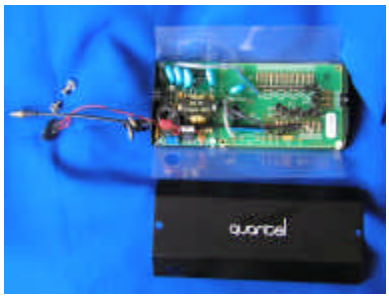

**Picture B-60. The Brilliant and Brilliant B amplification**

The light balances between these two mirrors and is amplified at each passage in the Nd:YAG rod. The rear mirror is totally reflective at 1064nm but the gaussian mirror is not so that a part of the light can get out of the cavity.

# V.5. THE QS.BR BOARD



The QS.BR board (**Q-Switch board**) is made of two boards: the AC.BR board and the HV.BR board. It transforms a 15 VDC voltage into a high voltage to command the Pockels cell.



**Picture B-61. The QS.BR board**

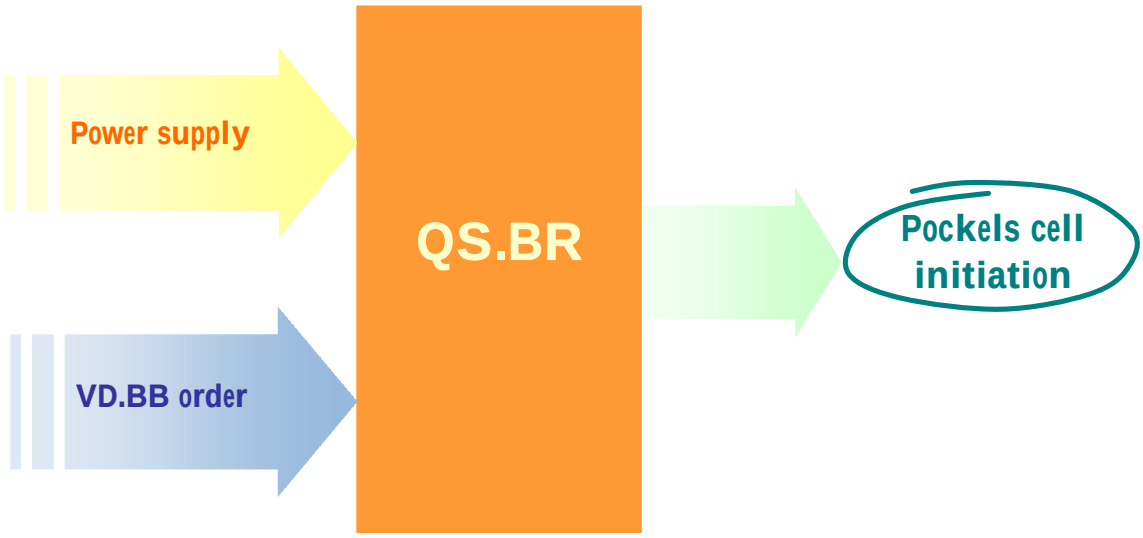
## V.5.i. LEXICON

In the following lexicon, you will find the list and the definitions of the data managed by the QS.BR.

- **15 VDC:** 15 Volts DC voltage.
- **0/-3500 VDC:** Ground brought down to –3500V when the Pockels cell is activated.
- **PK CD:** Signal giving the order to open the Pockels cell and thus synchronizing the Q-Switch operation.

## V.5.ii. DESCRIPTION AND OPERATION

The QS.BR board is managing the opening and the closing of the Pockels cell. It receives the order from the VD.BB board to close the Q-Switch cavity and then sends a high voltage signal to the Pockels cell.

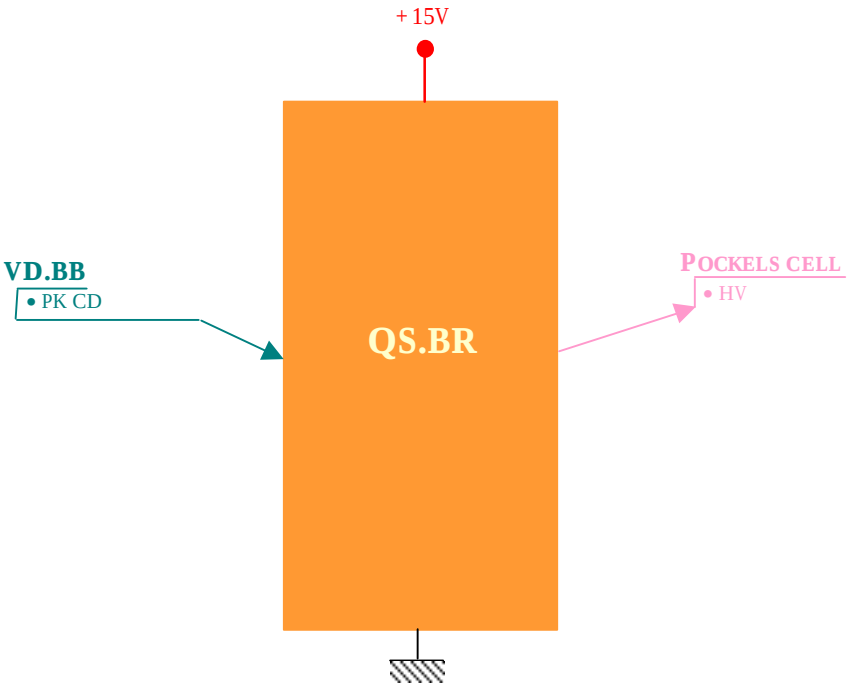



**Draw B-43. Operation principle of the QS.BR**

### V.5.ii.a. OVERVIEW

The QS.BR is connected to:

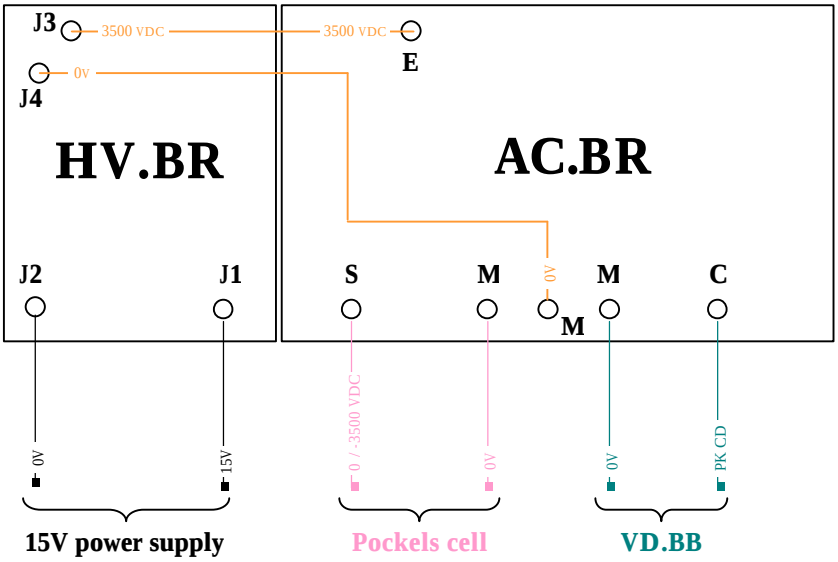
- the VD.BB to receive the order to close the Q-Switch cavity,
- the Pockels cell to send the high voltage that will change its optical properties and thus close the Q-Switch cavity.




**Draw B-44. QS.BR links**

### V.5.ii.b. INTERCONNECTIONS

The following draw represents the QS.BR board interconnections with the rest of the system.



# BRILLIANT AND BRILLIANT B SERVICING

# C. BRILLIANT AND BRILLIANT B SERVICING

# I. GENERALITIES

# I.1. ADVICES TO TROUBLESHOOT THE SYSTEM

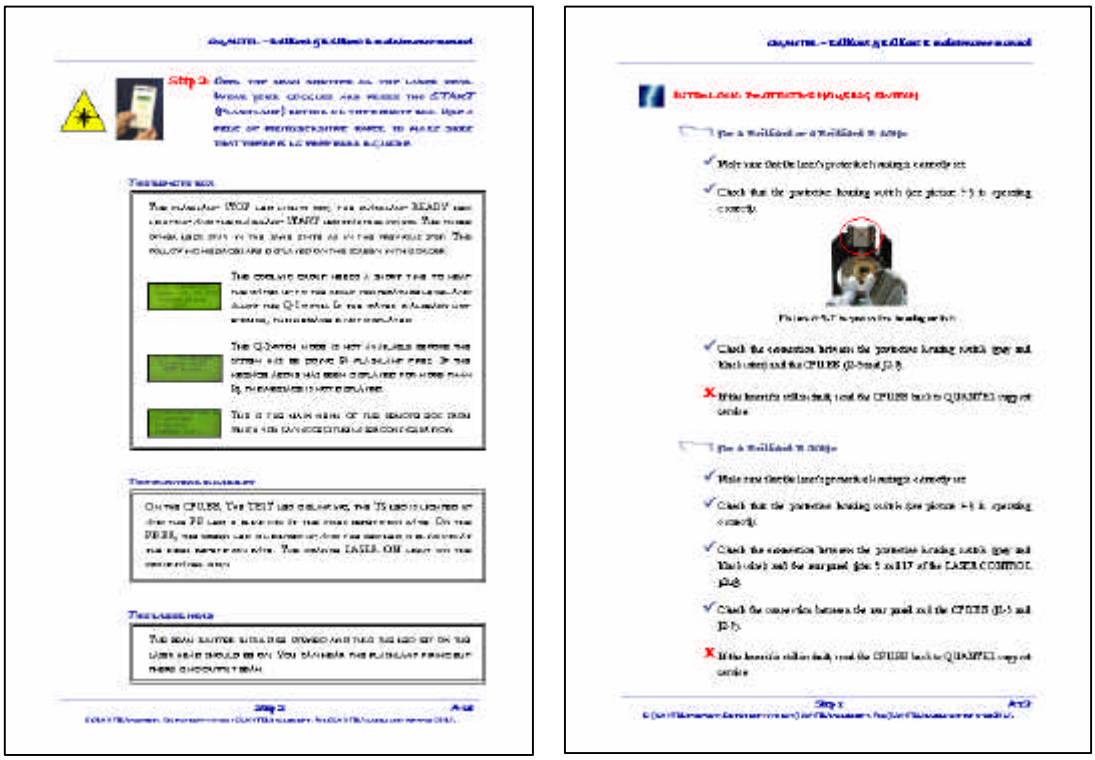
**Before starting any troubleshooting operation on the system, please always first check if the system is operating in the right conditions.**

This manual shows two different ways to troubleshoot your system:

- Thanks to the symptoms shown by your system,
- By following the different steps described in the chapter “Step by step troubleshooting”.

**If you choose the second solution, you must start from the first step, otherwise your diagnostic could be wrong.**

At each step of the “step by step troubleshooting”, the normal operation of the laser and the list of symptoms that can occurs are described. Once you have identified your symptom, realize the serie of tests associated. Some of these tests (the QUANTEL specific ones) are described in the “Procedure” chapter.



**Draw C-1. Description of the normal system operation (left) and troubleshooting of a symptom (right)**

Once you have identified the device in fault and exchanged it, start the “step by step” troubleshooting all over again to make sure that everything is going on normally and that your system is completely fixed.

**Please note that QUANTEL cannot be considered responsible if a breakdown appears due to a faulty exchange following a troubleshooting done by a customer or a representative thanks to this manual.**

## I.2. STANDARD TOOLKIT

To perform the maintenance tasks described in the troubleshooting, you will need the following tools:

- ☐ 1 pole
- ☐ 1 tuning screwdriver
- ☐ 1 cross screwdriver
- ☐ 1 flat screwdriver
- ☐ 2 tube wrenches (5 and 5.5mm)
- ☐ 1 multimeter (MHz)
- ☐ 1 Torx key
- ☐ 1 oscilloscope
- ☐ 1 x10 probe
- ☐ 1 x100 probe
- ☐ 1 antistatic bracelet
- ☐ 1 x1000 probe
- ☐ 1 powermeter
- ☐ 1 photodiode
- ☐ pieces of photosensitive paper
- ☐ pieces of polaroïd paper
- ☐ 1 torch
- ☐ 1 dentist mirror
- ☐ 1 set of Allen keys
- ☐ 1 deionised water tank
- ☐ 1 thermometer

**Please wear the antistatic bracelet (connected to the ground) before attempting any manipulation on the boards. If you do not, you might damage it irremediably.**

## I.3. REMINDER

### I.3.i. SYMBOLS

Each symptom is associated to a given type of failure :

 an electronics failure,

 an optical failure,

 a failure regarding the cooling group.

These symbols will be associated to the symptoms to help you to find your way through this part of the manual.

## I.3.ii. NORMAL OPERATION CONDITIONS

The laser head should be set on a solid work table.

For proper operation of the laser the ambient temperature ranges are :

- water/air heat exchanger (CGU):
  Brilliant : 18°C to 28°C
  Brilliant B 10 Hz : 18°C to 25°C

- water/water heat exchanger (CGS):
  Brilliant B 20 Hz : 18°C to 40°C

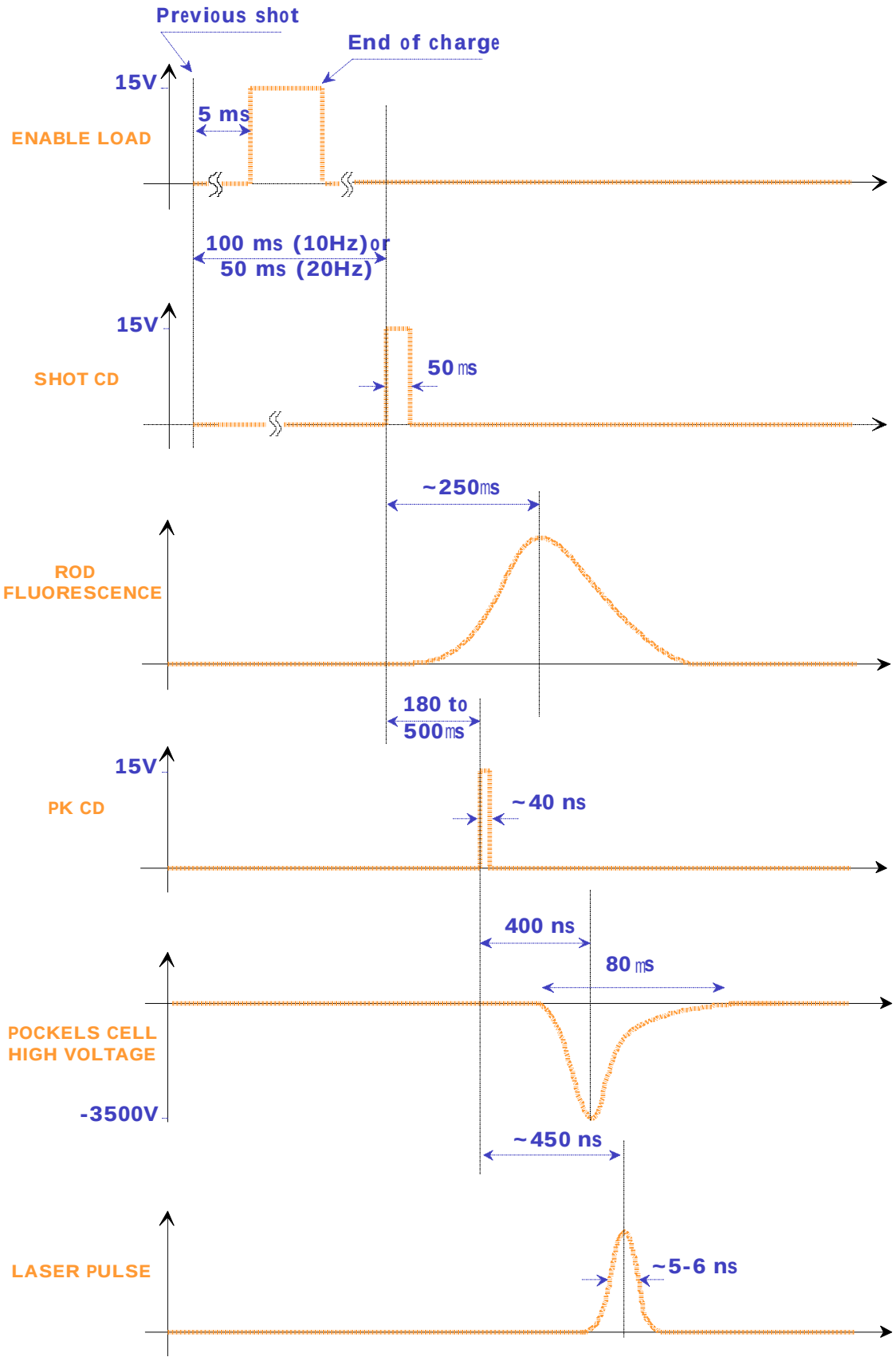
Choose a location for the electronic cabinet so that each side, the front and rear panels of the cabinet are not obstructed and are set at least 50 cm away from a wall or any other obstacle. For the Brilliant and Brilliant B 10 Hz, the air flow goes from the front to rear panel. For the Brilliant B 20Hz, looking at the front panel of the CGS, the air flow goes from the left to the right.

The main power must be 230 VAC or 110 VAC 50/60 Hz with available average current up to 10 A or 20 A respectively. This information is indicated on the label on the rear panel of the electronic cabinet. The wire colours are: blue for the neutral, black or brown for the phase, and yellow/green for the ground.

The CGS requires tap-water facilities with the following characteristics:

- when cooling is provided by industrial water, filtration of all particles greater than 100 µm diameter is required
- temperature must lie between 5° and 25°C
- input pressure ≤ 6 bars (88 PSI)
- output pressure ≤ 3 bars (44 PSI)
- input-output differential pressure ≥ 3bars (44 PSI)
- flow rate able to reach 750 l/h
- the water supply must be fitted with a stop cock and an electro-valve when the laser is controlled by an automatic system.

## I.3.iii. GENERAL TIMING DIAGRAM



## I.4. PARTS LIST

Here is the list of the Brilliant and Brilliant B parts available. The part number associated is the service department part number. Thus to order any of these parts, please contact QUANTEL's service department.

| Part No | DESIGNATION |
|---|---|
| OPT161 | 1/2 WAVE PLATE |
| OPT166 | 1/4 WAVE PLATE |
| OPT217 | GAUSSIAN MIRROR, BRILLIANT |
| OPT229 | REAR CAVITY MIRROR |
| OPT240 | DIELECTRIC POLARIZER |
| OPT289 | POCKELS CELL (Standard Exchange), BRILLIANT |
| OPT314 | POCKELS CELL (new), BRILLIANT |
| OPT349 | FLASHLAMP BRILLIANT |
| OPT350 | ND:YAG ROD, 6mm, BRILLIANT |
| OPT387 | FLASHLAMP BRILLIANT B |
| OPT389 | ND:YAG ROD, 9mm, BRILLIANT B |
| OPT390 | POCKELS CELL (new), BRILLIANT B |
| OPT391 | POCKELS CELL (Standard Exchange), BRILLIANT B |
| OPT392 | KSF FILTER, BRILLIANT B |
| OPT393 | CERAMIC DIFUSEUR WITH SUPPORT BRILLIANT B |
| OPT394 | KSF FILTER, BRILLIANT |
| OPT395 | CERAMIC DIFUSEUR WITH SUPPORT BRILLIANT |
| OPT396 | GAUSSIAN MIRROR, BRILLIANT B |

**Table C-1. Optics parts list**

| Part No | DESIGNATION |
|---|---|
| ELE136 | TRANSFO TRIGGER BRILLIANT |
| ELE229 | REMOTE RB07 |
| ELE234 | FLASHLAMP DISCHARGE CAPACITOR 30µF |
| ELE354 | PB.BR |
| ELE366 | QS.BR |
| ELE373 | CPU.BB |
| ELE375 | TS.BB |
| ELE377 | TCG.BB |
| ELE382 | SDTQ.BB |
| ELE395 | THYRISTOR |
| ELE415 | FLASHLAMP DISCHARGE CAPACITOR 60µF |
| ELE417 | REL.BB |
| ELE429 | TRANSFO TRIGGER BRILLIANT B |
| ELE430 | VD.BB |
| ELE448 | ALIM 15V |
| ELE463 | 115V TRANSFORMER BRILLIANT POWER SUPPLY |

**Table C-2. Electronics parts list**

| Part No | DESIGNATION |
|---|---|
| MEC4 | DEIONIZATION CARTRIDGE (0,5L) |
| MEC11 | INSTRUCTION MANUAL |
| MEC33 | COOLING GROUP FLOW SWITCH, 2 l/mn |
| MEC125 | COOLING GROUP PUMP |
| MEC136 | ST2000 CONTROLLER (for maintenance) |
| MEC164 | ROD RETAINER / PACKING RING BRILLIANT |
| MEC165 | ROD RETAINER / PACKING RING BRILLIANT B |
| MEC173 | DEIONIZED WATER (5 liters) |
| MEC185 | WATER FILTER FOR COOLING GROUP |
| MEC227 | LASER HEAD TEMPERATURE SECURITY SENSOR |
| MEC277 | THERMAL SECURITY SWITCH (for any CG) |
| MEC307 | CAPACITOR DISCHARGE SWITCH DC-BB |
| MEC321 | TOOL FOR TORX SCREWS |
| MEC350 | COOLING GROUP FLOW SWITCH, 1 l/mn |

**Table C-3. Mechanics parts list**

## I.5. RETURNS

Here are the general conditions for the return of a fault system or device to QUANTEL:

- The customer must obtain a written authorization from QUANTEL service manager about the product's return.

- The customer must prepay the freight and insurance charges (for the full value of the shipped goods). The customer is responsible for all risks of loss, damage or delay in shipment.

- After receipt of product, QUANTEL reserves the right of inspecting the product and determining the cause of failure and the warranty status. QUANTEL shall have no duty to perform a warranty repair where the product has suffered damage in shipment.

- If the product is found to be under warranty, it will be repaired or replaced free of charge in accordance with the terms of QUANTEL warranty. The warranty period on a repaired or replaced product shall be the balance of the warranty period remaining on the original product (i.e. no new warranty is created by such a repair).

- If the product is determined to be of a non-warranty status the customer will be advised. A written purchase order for repair or

service work will be required before the beginning of the repair. The cost and terms of non-warranty service shall be according to QUANTEL's then prevailing policies, which are subject to change without prior notice.

### I.5.i. RETURN OF A LASER

The laser must be properly packed in its original QUANTEL shipping container.

### I.5.ii. RETURN OF A BOARD

To return a board to QUANTEL's service department, proceed as follow:

1. Wrap the board with some anti-electrostatic film and adhesive tape.
2. Wrap the whole package with a piece of closed cell polyethylene.
3. Wrap the whole package with some polyethylene film with air bubbles.
4. Set the package in a rigid board case padded with dense foam.

### I.5.iii. RETURN OF AN OPTICS (NON HYDROPHOBIC)

To return a non hydrophobic optics to QUANTEL's service department, proceed as follow:

1. Wrap the optics with a piece of 20g white mousseline ("optical paper").
2. Wrap the whole package in a zipped platic bag.
3. Wrap the whole package with a piece of closed cell polyethylene.
4. Set the whole package in a rigid plastic case.

### I.5.iv. RETURN OF AN OPTICS (HYDROPHOBIC)

To return an hydrophobic optics to QUANTEL's service department, proceed as follow:

1. Wrap the optics with a piece of 20g white mousseline ("optical paper").
2. Wrap the whole package with a piece of closed cell polyethylene.
3. Set the whole package in a rigid plastic case.
4. Put a disiccant in the plastic case.
5. Set the whole package in an impermeable heatweldable envelop "Valsem S165" with SNEC 201

## I.6. QUANTEL CONTACT LIST

QUANTEL's service department:

- E-mail: service@ quantel.fr
- Phone: 00 33 (0)1 69 29 17 11
- Fax: 00 33 (0)1 69 29 17 12

QUANTEL's maintenance training department :

- E-mail: auvinet@ quantel.fr
- Phone: 00 33 (0)1 69 29 17 35
- Fax: 00 33 (0)1 69 29 17 06

Please send the systems back to this address (read §C.1.5 before sending back any system):

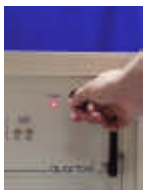
**SAV QUANTEL**
**17, avenue de l'Atlantique**
**Z.A. de Courtaboeuf**
**BP 23**
**91 941 Les Ulis Cedex**
**France**

# II. TROUBLESHOOTING

## II.1. MESSAGES AND SYMPTOMS

In this paragraph, you will be able to point out which symptom occurs on your system. The following list is not exhaustive. You might meet some breakdowns not listed here. In this case, please contact QUANTEL's support service. Once you have found the right symptom, please jump to the indicated page. If you find that several symptoms fit your failure, please follow the "step by step" troubleshooting.

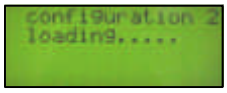
# II.2. STEP BY STEP TROUBLESHOOTING



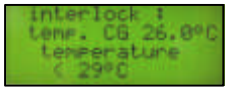
## Step 1: TURN THE O/I KEY OF THE FRONT PANEL ON THE I POSITION.

### THE REMOTE BOX

THE SIX LEDS OF THE REMOTE BOX LIGHT UP. THEN, ONLY THE FLASHLAMP AND Q-SWITCH STOP LEDS STAYS UP, THE FOUR OTHER ONES LIGHT OFF. THE FOLLOWING MESSAGES ARE DISPLAYED ON THE SCREEN IN THIS ORDER:

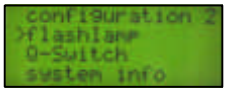



THE SOFTWARE (ON THE CPU.BB) IS LOADING THE CONFIGURATION OF THE LASER SYSTEM.




AT THE POWERING, THE COOLING GROUP NEEDS A SHORT TIME TO HEAT THE WATER UP TO THE RIGHT TEMPERATURE LEVEL. IF AT THE POWERING THE WATER IS ALREADY HOT ENOUGH, THIS MESSAGE IS NOT DISPLAYED.


THIS SCREEN INDICATES WHICH SYSTEM THE SOFTWARE IS MADE FOR (BRILLIANT) AND ITS VERSION (1.43).




THIS IS THE MAIN MENU OF THE REMOTE BOX FROM WHICH YOU CAN ACCESS THE LASER CONFIGURATION.

### THE ELECTRONIC CABINET

YOU CAN HEAR THE VENTILATORS AND THE PUMP OF THE COOLING GROUP OPERATING. THE TEST LED ON THE CPU.BB IS BLINKING AND THE GREEN LED ON THE PB.BR IS LIGHTED UP. FOR A BRILLIANT B 20HZ, THE AC POWER LED ON THE MPS FRONT PANEL IS LIGHTED UP.

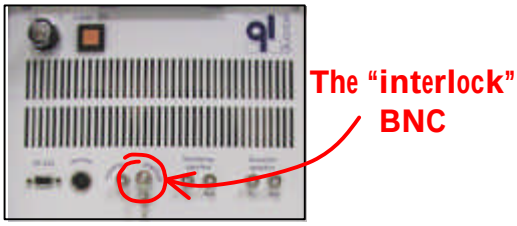
### THE LASER HEAD

THE BEAM SHUTTER SHOULD BE CLOSED AND THUS THE LED SET ON THE LASER HEAD SHOULD BE OFF.

# INTERLOCK: BNC CONNECTOR ON FRONT PANEL

## For a Brilliant or a Brilliant B 10Hz

✓ Check that the "interlock" BNC on the cabinet front panel is short circuited with the appropriated plug (see picture C-1).




**Picture C-1. The "interlock" BNC**

✗ If the laser if is still in fault, contact QUANTEL service department.

## For a Brilliant B 20Hz

✓ Check that the "interlock PS" BNC on the MPS rear panel is short circuited with the appropriated plug (see picture C-2).

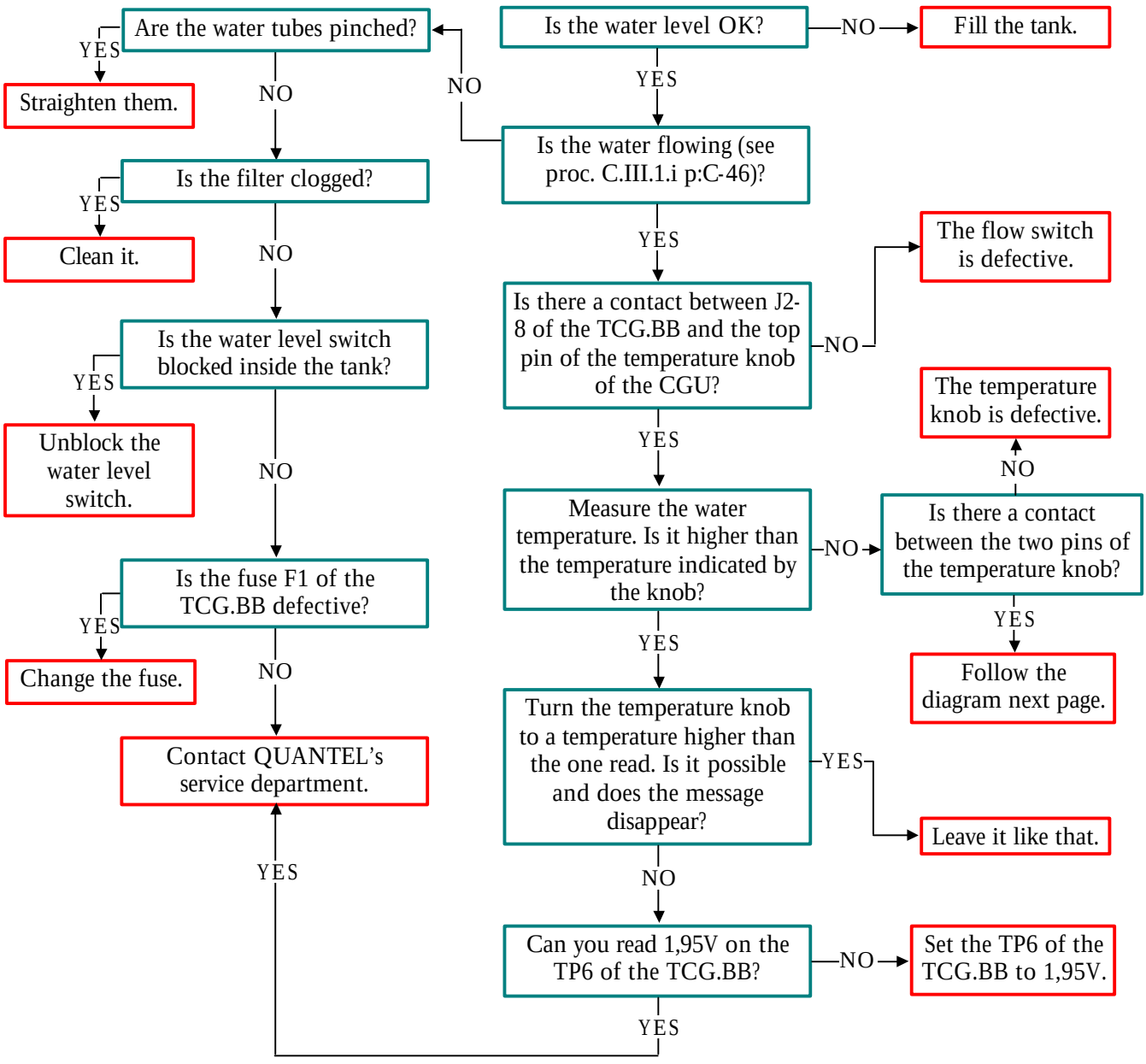

**Picture C-2. The "interlock PS" BNC**

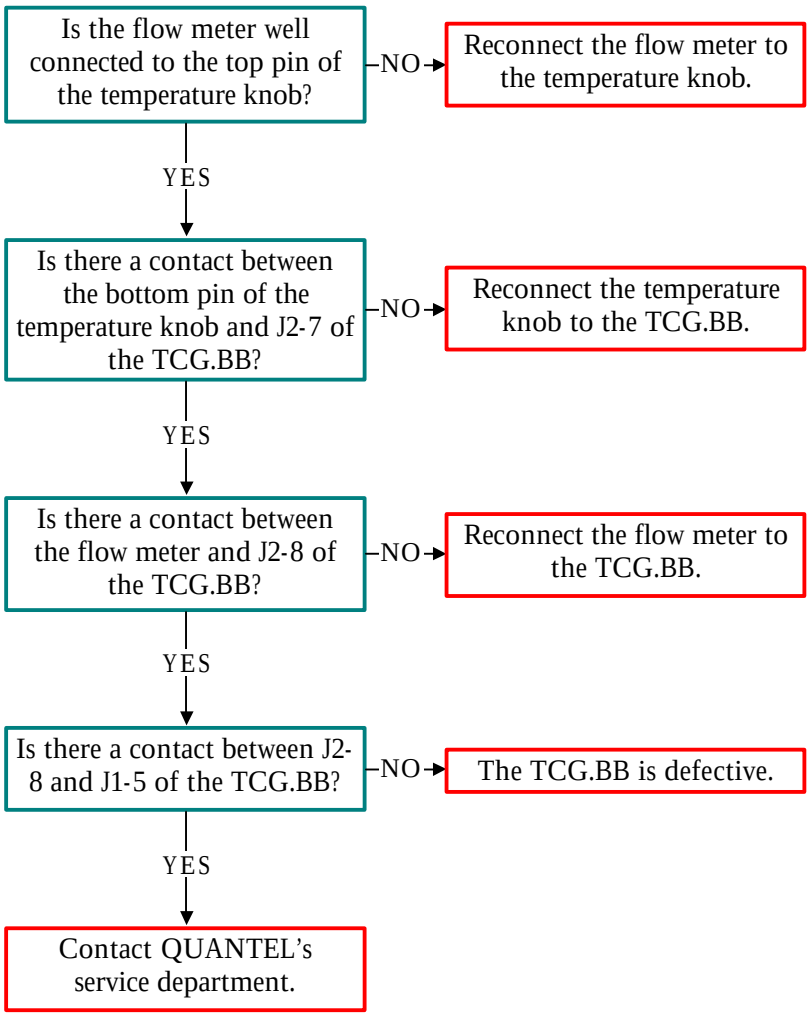
✓ Check the connection between the interlock PS BNC and the CPU.BB (J7–2, J7-1).

✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.

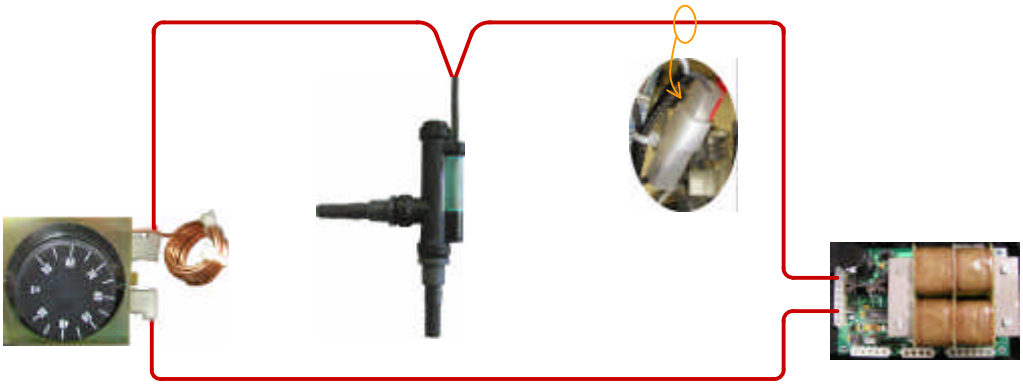
# INTERLOCK: CGU FLOW RATE / THERMAL SENSOR SEE INST MANUAL

## For a Brilliant or a Brilliant B 10Hz






The following draw represents the security loop generating the message "Interlock: CGU flow rate / thermal sensor see inst manual".



**Draw C-2. The CGU security loop**

The following table shows for a given temperature the corresponding resistance you should read across the probe terminals and the corresponding voltage you should read on TP7 and TP8 of the TCG.BB.

| Temperature (°C) | Resistance (KW) | Voltage (V) | Temperature (°C) | Resistance (KW) | Voltage (V) |
|---|---|---|---|---|---|
| 0 | 7,36 | 3,93 | 41 | 1,15 | 1,83 |
| 1 | 6,99 | 3,89 | 42 | 1,11 | 1,78 |
| 2 | 6,64 | 3,84 | 43 | 1,06 | 1,74 |
| 3 | 6,32 | 3,80 | 44 | 1,02 | 1,69 |
| 4 | 6,01 | 3,75 | 45 | 0,98 | 1,65 |
| 5 | 5,72 | 3,70 | 46 | 0,95 | 1,61 |
| 6 | 5,45 | 3,66 | 47 | 0,91 | 1,56 |
| 7 | 5,18 | 3,61 | 48 | 0,88 | 1,52 |
| 8 | 4,94 | 3,56 | 49 | 0,84 | 1,48 |
| 9 | 4,70 | 3,51 | 50 | 0,81 | 1,44 |
| 10 | 4,48 | 3,46 | 51 | 0,78 | 1,40 |
| 11 | 4,27 | 3,41 | 52 | 0,75 | 1,37 |
| 12 | 4,07 | 3,35 | 53 | 0,72 | 1,33 |
| 13 | 3,89 | 3,30 | 54 | 0,70 | 1,29 |
| 14 | 3,71 | 3,25 | 55 | 0,67 | 1,26 |
| 15 | 3,54 | 3,19 | 56 | 0,65 | 1,22 |
| 16 | 3,38 | 3,14 | 57 | 0,62 | 1,19 |
| 17 | 3,22 | 3,09 | 58 | 0,60 | 1,16 |
| 18 | 3,08 | 3,03 | 59 | 0,58 | 1,13 |
| 19 | 2,94 | 2,98 | 60 | 0,56 | 1,09 |
| 20 | 2,81 | 2,92 | 61 | 0,54 | 1,06 |
| 21 | 2,69 | 2,87 | 62 | 0,52 | 1,03 |
| 22 | 2,57 | 2,81 | 63 | 0,50 | 1,00 |
| 23 | 2,46 | 2,76 | 64 | 0,49 | 0,98 |
| 24 | 2,35 | 2,70 | 65 | 0,47 | 0,95 |
| 25 | 2,25 | 2,65 | 66 | 0,45 | 0,92 |
| 26 | 2,16 | 2,59 | 67 | 0,44 | 0,90 |
| 27 | 2,06 | 2,54 | 68 | 0,42 | 0,87 |
| 28 | 1,98 | 2,49 | 69 | 0,41 | 0,85 |
| 29 | 1,89 | 2,43 | 70 | 0,39 | 0,82 |
| 30 | 1,81 | 2,38 | 71 | 0,38 | 0,80 |
| 31 | 1,74 | 2,33 | 72 | 0,37 | 0,78 |
| 32 | 1,67 | 2,27 | 73 | 0,36 | 0,76 |
| 33 | 1,60 | 2,22 | 74 | 0,34 | 0,73 |
| 34 | 1,53 | 2,17 | 75 | 0,33 | 0,71 |
| 35 | 1,47 | 2,12 | 76 | 0,32 | 0,69 |
| 36 | 1,41 | 2,07 | 77 | 0,31 | 0,67 |
| 37 | 1,35 | 2,02 | 78 | 0,30 | 0,66 |
| 38 | 1,30 | 1,97 | 79 | 0,29 | 0,64 |
| 39 | 1,25 | 1,92 | 80 | 0,28 | 0,62 |
| 40 | 1,20 | 1,87 | 81 | 0,27 | 0,59 |

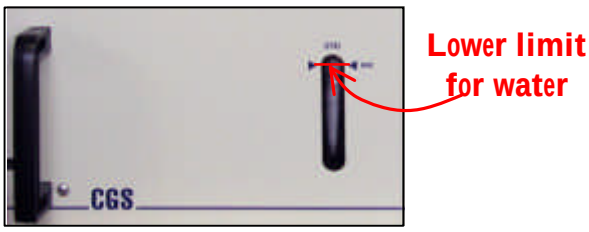
**Table C-4. Correspondence between the temperature, the resistance and the voltage values**

## For a Brilliant B 20Hz

✓ Check that the cooling group is well plugged to the MPS.

✓ Check that the municipal water tap is opened.

✓ Check that the water level is fine (see picture C-3).




**Picture C-3. Water level of the CGS**

✓ Check that the cooling group security connector (see picture C-4) is connected to the MPS.

**Picture C-4. The cooling group security connector**

✓ Check that the water is flowing inside the laser head (see procedure C.III.1.i p:C-46). If it is not then, check that the orange water taps are opened, that the water tubes are not pinched and that the filter is not clogged.

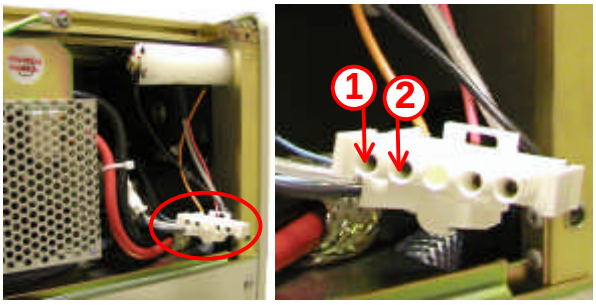
✗ If the laser if is still in fault, send the cooling group back to QUANTEL support service.

# INTERLOCK: CHECK CAPACITOR DISCH. SWITCH SEE INST MANUAL

## For a Brilliant or a Brilliant B 10Hz

✓ Pull the capacitor discharge switch on the rear panel of the electronic cabinet.

✓ Unplug the laser from the main and, with a multimeter, check that there is a contact between the two pins of the capacitor discharge switch connector shown on the picture below. If there is not, the discharge switch is defective. Contact QUANTEL's service department.

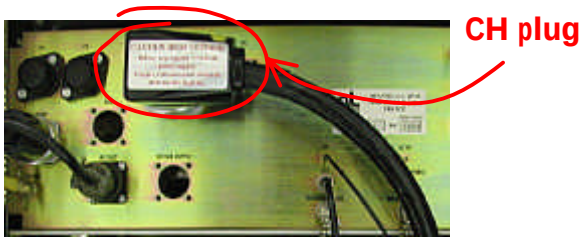



**Picture C-5. Pins of capacitor discharge switch connector**

✗ If the laser if is still in fault, contact QUANTEL's service department.

## For a Brilliant B 20Hz

✓ Check that the CH cable is plugged on the rear panel of the MPS (see picture C-6).




**Picture C-6. The CH plug**

✓ Check that the CH cable is well plugged to the laser head.

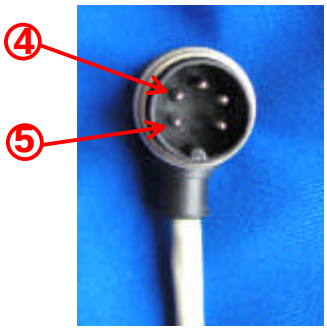
✗ If the laser if is still in fault, contact QUANTEL's service department.

# INTERLOCK: EMERGENCY STOP PUSH BUTTON PULL IT PLEASE

## For a Brilliant or a Brilliant B 10Hz

✓ Pull the emergency stop push button on the remote box.

✓ With a multimeter, check that the pins 4 and 5 of the male RB connector are at the same potential. If they are not, the emergency push button is defective thus send the remote box back to QUANTEL support service.




**Picture C-7. The male RB connector**

✗ If the laser if is still in fault, contact QUANTEL's service department.

## For a Brilliant B 20Hz

✓ Pull the emergency stop push button on the remote box.

✓ With a multimeter, check that the pins 4 and 5 of the male RB connector are at the same potential. If they are not, the emergency push button is defective thus send the remote box back to QUANTEL support service.

✓ Check the connection between the front panel (female RB connector, pins 4 and 5) and the CPU.BB board (J4-4 and J4-14).

✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.

# INTERLOCK: PROTECTIVE HOUSING SWITCH

## For a Brilliant or a Brilliant B 10Hz

✓ Make sure that the laser's protective housing is correctly set.

✓ Check that the protective housing switch (see picture C-8) is operating correctly.

**Picture C-8. The protective housing switch**

✗ If the laser if is still in fault, contact QUANTEL's service department.

## For a Brilliant B 20Hz

✓ Make sure that the laser's protective housing is correctly set.

✓ Check that the protective housing switch (see picture C-8) is operating correctly.

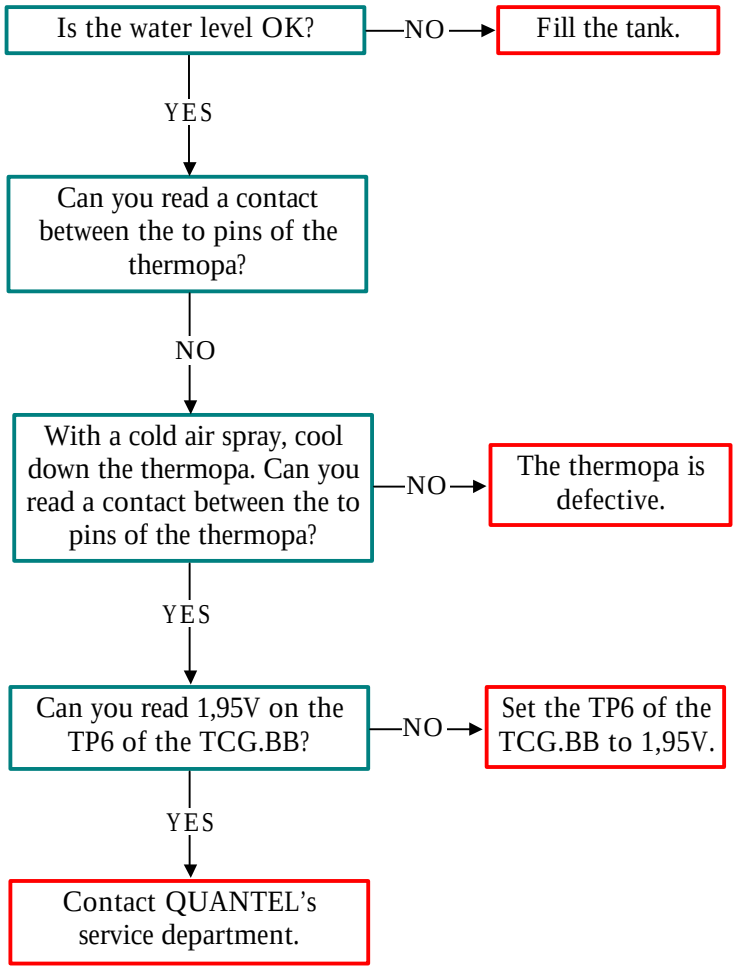
✓ Check the connection between the protective housing switch (grey and black wires) and the rear panel (pins 5 and 17 of the LASER CONTROL plug).

✓ Check the connection between the rear panel and the CPU.BB (J2-5 and J2-9).

✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.

# INTERLOCK: THERMAL SENSOR OPTICAL HEAD

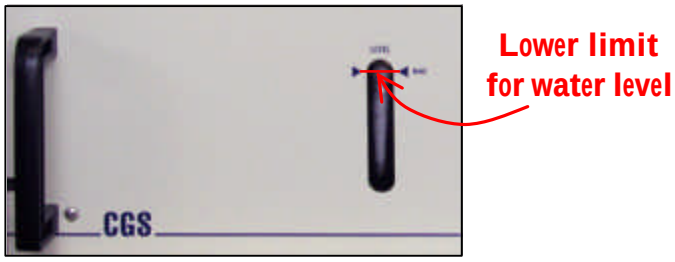
## For a Brilliant or a Brilliant B 10Hz




## For a Brilliant B 20Hz

- ✓ Check that the cooling group is well plugged to the MPS through the AC OUT connector.
- ✓ Check that the municipal water tap is opened.
- ✓ Check that the orange taps on the rear panel of the cooling group are opened.

✓ Check that the water level is acceptable (see picture C-9).




**Picture C-9. Water level of the CGS**

✓ With a cold air spray, cool down the thermopa and check that its two pins are at the same potential. If they are not, the thermopa is defective, thus send it back to QUANTEL support service.

✓ Check the connection between the laser head and the rear panel (pins 3 and 15 of the LASER CONTROL plug).

✓ Check the connection between the rear panel and the CPU.BB (J2-3 and J2-7).

✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.

# INTERLOCK: WATER TEMPERATURE < 20°C

## For a Brilliant or a Brilliant B 10Hz

- Wait 30 minutes and if the message doesn't disappear, contact QUANTEL's service department.

## For a Brilliant B 20Hz

- This message does not exist for the Brilliant B 20Hz.

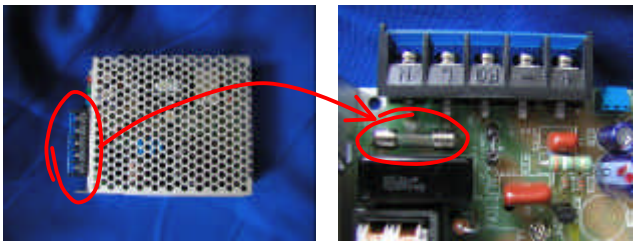
# NOTHING HAPPENS WHEN THE KEY IS ON THE I POSITION

## For a Brilliant or a Brilliant B 10Hz

- ✓ Check that the cabinet is correctly plugged to the main.
- ✓ Check the fuses F1 and F2 on the rear panel of the cabinet.
- ✗ If the laser if is still in fault, contact QUANTEL's service department.

## For a Brilliant B 20Hz

- ✓ Check that the cabinet is correctly plugged to the main.
- ✓ Check the fuses F1 and F2 on the rear panel of the cabinet.
- ✓ Check that the key connector is well connected to the connector J6 of the REL.BB.
- ✓ Check that the 15V power supply is well giving 15V.



**Picture C-10. The 15V power supply fuse**

- ✓ If there is no 15V at the output, check that its fuse (2,5 A time-lag fuses) is not defective (see picture C-10).
- ✗ If the laser if is still in fault, contact QUANTEL's service department.

# NOTHING IS DISPLAYED ON THE REMOTE BOX

## For a Brilliant or a Brilliant B

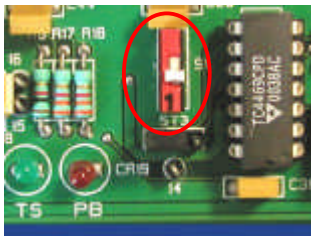
✓ Check that the remote box is plugged to the front panel of the electronic cabinet.

✗ If the laser if is still in fault, contact QUANTEL's service department.

## For a Brilliant B 20Hz

✓ Check that the remote box is plugged to the front panel of the electronic cabinet.

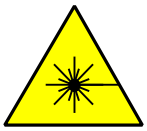
✓ Check that the switch S1 on the CPU.BB is on the correct position (see picture C-11).




**Picture C-11. The switch S1 of the CPU.BB**

✓ Check the connection between the RB connector on the front panel and the pins J4-1, J4-2, J4-3, J4-4 and J4-11 of the CPU.BB.

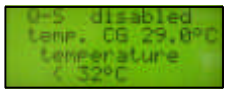
✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.



**Step 2: OPEN THE BEAM SHUTTER ON THE LASER HEAD. WEAR YOUR GOGGLES AND PRESS THE START (FLASHLAMP) BUTTON ON THE REMOTE BOX. USE A PIECE OF POLAROÏD PAPER TO MAKE SURE THAT THERE IS NO FREE RUNNING MODE.**

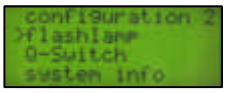
## THE REMOTE BOX

THE FLASHLAMP STOP LED LIGHTS OFF, THE FLASHLAMP READY LED LIGHTS UP AND THE FLASHLAMP START LED STARTS BLINKING. THE THREE OTHER LEDS STAY IN THE SAME STATE AS IN THE PREVIOUS STEP. THE FOLLOWING MESSAGES ARE DISPLAYED ON THE SCREEN IN THIS ORDER:




THE COOLING GROUP NEEDS A SHORT TIME TO HEAT THE WATER UP TO THE RIGHT TEMPERATURE LEVEL AND ALLOW THE Q-SWITCH. IF THE WATER IS ALREADY HOT ENOUGH, THIS MESSAGE IS NOT DISPLAYED.


THE Q-SWITCH MODE IS NOT AVAILABLE BEFORE THE SYSTEM HAS BE DOING 80 FLASHLAMP FIRES. IF THE MESSAGE ABOVE HAS BEEN DISPLAYED FOR MORE THAN 8S, THIS MESSAGE IS NOT DISPLAYED.




THIS IS THE MAIN MENU OF THE REMOTE BOX FROM WHICH YOU CAN ACCESS THE LASER CONFIGURATION.

## THE ELECTRONIC CABINET

ON THE CPU.BB, THE TEST LED IS BLINKING, THE TS LED IS LIGHTED UP AND THE PB LED IS BLINKING AT THE FIRES REPETITION RATE. ON THE PB.BR, THE GREEN LED IS LIGHTED UP AND THE RED LED IS BLINKING AT THE FIRES REPETITION RATE. THE ORANGE LASER ON LIGHT ON THE FRONT PANEL IS ON.

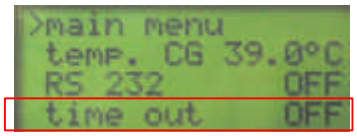
## THE LASER HEAD

THE BEAM SHUTTER SHOULD BE OPENED AND THUS THE LED SET ON THE LASER HEAD SHOULD BE ON. YOU CAN HEAR THE FLASHLAMP FIRING BUT THERE IS NO OUTPUT BEAM.

## INTERLOCK: END OF TIME OUT SIMMER SEE INST MANUAL

### For a Brilliant or a Brilliant B

✓ Check if you have set the simmer counter on (on the remote box go down the menu “system info”, line “time out”).




**Picture C-12. The “system info” menu**

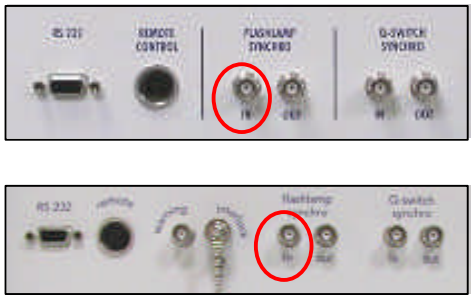
✗ If you have not, then the CPU.BB is defective. Send the it back to QUANTEL support service.

# INTERLOCK: FREQ HIGH SEE INST MANUAL

## For a Brilliant or a Brilliant B

✓ Check that the system is well set in external mode for the flashlamp firing. If it is set in internal mode, then the CPU.BB is defective.

✓ Check that you are well feeding the system with a signal on the front panel on the BNC connector tagged “FLASHLAMP IN”.



**Picture C-13. The flashlamp in BNC connector**

✓ Measure the frequency of your synchronization signal. It must be lower than 10.8Hz for the Brilliant and Brilliant B 10Hz and 21.6Hz for the Brilliant B 20Hz.

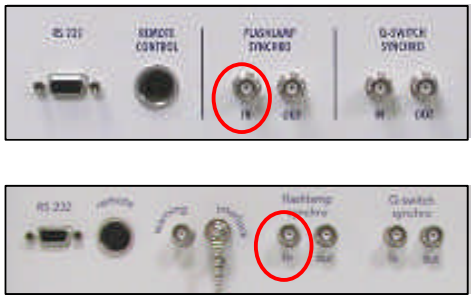
✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.

# INTERLOCK: FREQ LOW SEE INST MANUAL

## For a Brilliant or a Brilliant B

✓ Check that the system is well set in external mode for the flashlamp firing. If it is set in internal mode, then the CPU.BB is defective.

✓ Check that you are well feeding the system with a signal on the front panel on the BNC connector tagged “FLASHLAMP IN”.



**Picture C-14. The flashlamp in BNC connector**

✓ Measure the frequency of your synchronization signal. It must be higher than 9.2Hz for the Brilliant and Brilliant B 10Hz and 18.4Hz for the Brilliant B 20Hz.

✓ Make sure that the synchronization system does not miss a shot. No missing shot is permitted.

✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.

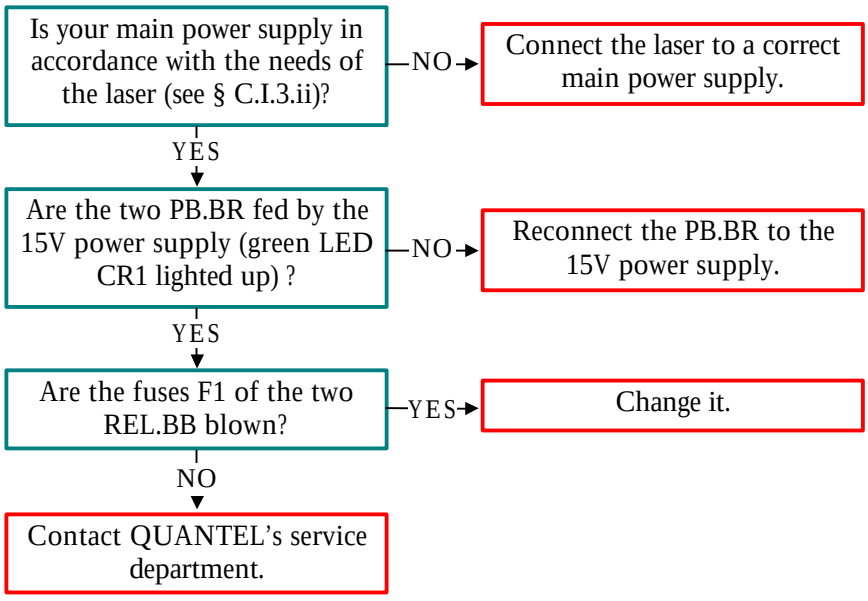
# INTERLOCK: PSU CHARGE ERROR SEE INST MANUAL

## For a Brilliant or a Brilliant B 10Hz

✓ Check that your main power supply is in accordance with the needs of the laser.

✗ If the laser if is still in fault, contact QUANTEL's service department.

## For a Brilliant B 20Hz




## INTERLOCK: SIMMER STOP SEE INST MANUAL

### For a Brilliant or a Brilliant B 10Hz

✓ Check the state of the flashlamp.

✗ If the laser if is still in fault, contact QUANTEL's service department.

### For a Brilliant B 20Hz

✓ Check the state of the flashlamp.

✓ Check that the fuse of the TS.BB board is not blown.

✓ Check that the fuse of the REL.BB board is not blown.

✗ If the laser if is still in fault, contact QUANTEL's service department.

# Q-S DISABLED CHECK INTERL QS ON REAR PANEL

## For a Brilliant or a Brilliant B 10Hz

✗ This message does not exist for the Brilliant or Brilliant B 10Hz.

## For a Brilliant B 20Hz

✓ Shut the “Interlock QS” BNC connector on the rear panel with the plug provided by QUANTEL. If the message disappears then the security you connected to this BNC is in fault.

**Picture C-15. The interlock QS BNC connector**

✓ Check the connection between the center of the “Interlock QS” BNC connector and the pin J7-3 of the CPU.BB.

✗ If the laser if is still in fault, send the CPU.BB back to QUANTEL support service.

## Q-S DISABLED PLEASE OPEN BEAM SHUTTER ON OPTICAL HEAD

### For a Brilliant or a Brilliant B

✓ Open the beam shutter on the optical head.

**Picture C-16. The beam shutter**

✓ Check that there is a contact between the brown and the red wires on the laser head. If there is not, then the shutter sensor is defective.

✗ If the laser if is still in fault, contact QUANTEL's service department.

## Q-S DISABLED WATER TEMPERATURE < 35°C

### For a Brilliant or a Brilliant B 10Hz

✕ Wait 30 minutes and if the message doesn't disappear, contact QUANTEL's service department.

### For a Brilliant B 20Hz

✕ This message does not exist for the Brilliant B 20Hz.


# THE FLASHLAMPS DON'T FIRE WHEN WE PRESS THE FLASHLAMP START BUTTON ON THE REMOTE BOX

## For a Brilliant or a Brilliant B 10Hz

✓ Check if the flashlamp START led turns on. If it does not, then the remote box is defective.

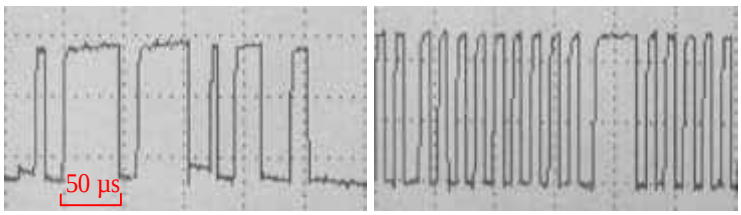
✗ Refer to the symptom on step 2, p: C-32, named "Interlock: simmer stop see inst manual".

## For a Brilliant B 20Hz

✓ Check if the flashlamp START led turns on. If it does not, then the remote box is defective.

✓ Check the connection between the remote box connector and the connector J4 of the CPU.BB.

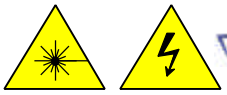
✓ Check if you can read a random 5V squared signal on J4-2 (SDA) and J4-3 (SCL) of the CPU.BB. If you cannot, then the remote box is defective.



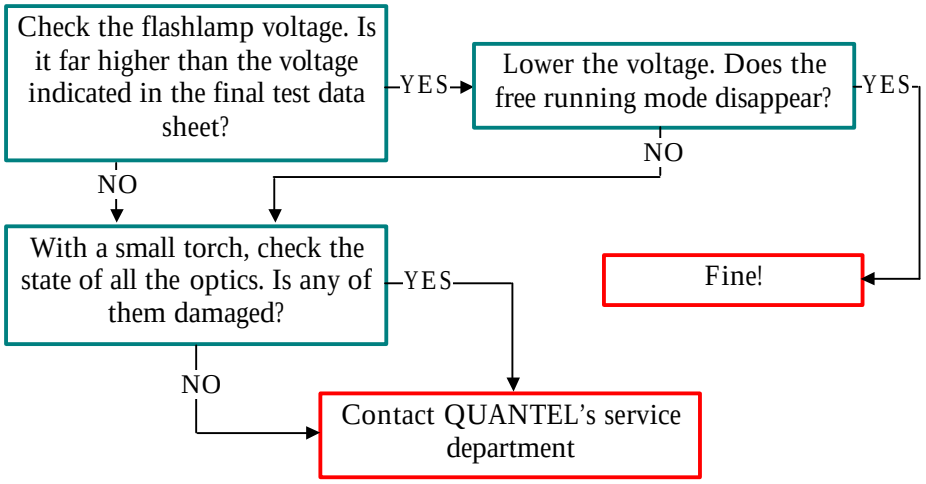

**Picture C-17. The SDA and SCL signals**

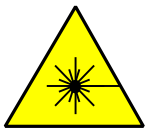
✗ Refer to the symptom on step 2, p: C-32, named "Interlock: simmer stop see inst manual".

## YOU CAN OBSERVE SOME FREE RUNNING MODE WHEN THE SYSTEM IS FLASHING



### For a Brilliant or a Brilliant B

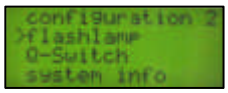




## Step 3: WEAR YOUR GOGGLES AND PRESS THE START (Q-SWITCH) BUTTON ON THE REMOTE BOX. USE A POWERMETER TO READ THE ENERGY OF THE OUTPUT BEAM AND A PIECE OF PHOTOSENSITIVE PAPER TO LOOK AT ITS SHAPE.

### THE REMOTE BOX

THE Q-SWITCH STOP LED LIGHTS OFF AND THE Q-SWITCH START LED STARTS BLINKING. THE FOUR OTHER LEDS STAY IN THE SAME STATE AS THE PREVIOUS STEP. THE FOLLOWING MESSAGE STAYS DISPLAYED ON THE REMOTE BOX:




THIS IS THE MAIN MENU OF THE REMOTE BOX FROM WHICH YOU CAN ACCESS THE LASER CONFIGURATION.

### THE ELECTRONIC CABINET

THE ELECTRONIC CABINET STAYS IN THE SAME STATE AS THE PREVIOUS STEP.

### THE LASER HEAD

THE LASER HEAD IS EMITTING AN OUTPUT BEAM WHOSE MAIN SPECIFICATIONS ARE SUMMARIZED IN THE FINAL TEST DATA SHEET SET INSIDE THE COVER OF THE USER MANUAL:

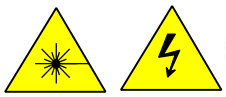

**BRILLIANT SPECIFICATIONS**
PULSE DURATION: ~5 ns
ENERGY PER PULSE : 360 mJ

**BRILLIANT B 10 HZ SPECIFICATIONS**
PULSE DURATION : ~6 ns
ENERGY PER PULSE : 850 mJ

**BRILLIANT B 20 HZ SPECIFICATIONS**
PULSE DURATION : ~6 ns
ENERGY PER PULSE : 700 mJ

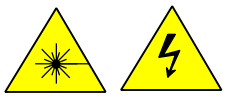
THE BEAM SHAPE SHOULD BE CLOSE TO  WITH A 6 mm DIAMETER FOR BRILLIANT AND A 9 mm DIAMETER FOR BRILLIANT B.


# NO PULSE IS EMITTED WHEN WE PRESS THE Q-SWITCH START BUTTON ON THE REMOTE BOX



## For a Brilliant or a Brilliant B 10Hz

- ✓ Check that the Q-Switch is set in internal mode.
- ✓ Check the flashlamp – Q-Switch delay on the remote box (~180µs).
- ✓ Check if the Q-Switch START led is blinking. If it is not, then the remote box is defective.
- ✗ If you still cannot get any energy, contact QUANTEL's support service.



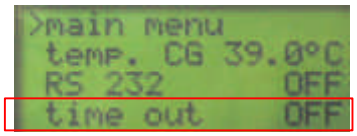
## For a Brilliant B 20Hz

- ✓ Check that the Q-Switch is set in internal mode.
- ✓ Check the flashlamp – Q-Switch delay on the remote box (~180µs).
- ✓ Check if the Q-Switch START led is blinking. If it is not, then the remote box is defective.
- ✓ Check the connection between the remote box connector and the connector J4 of the CPU.BB.
- ✓ Check if you can read a random 5V squared signal on J4-2 (SDA) and J4-3 (SCL) of the CPU.BB (see picture C-17). If you cannot, then the remote box is defective.
- ✓ Check if you can read the QS SYNC signal on J5-7 of the CPU.BB and the VD.BB. If you cannot, then the CPU.BB is defective.
- ✓ Check if you can read the QS SYNC signal on J2 of the VD.BB. If you cannot, then the VD.BB is defective.
- ✗ If you still cannot get any energy, contact QUANTEL's support service.

## Q-S DISABLED END OF TIME OUT Q-S

### For a Brilliant or a Brilliant B

✓ Check if you have set the Q-Switch time out on (on the remote box go down the menu “system info”, line “time out”).




**Picture C-18. The “system info” menu**

✗ If you have not, then the CPU.BB is defective. Send the it back to QUANTEL support service.

## THE BEAM PROFILE IS INCORRECT

### For a Brilliant or a Brilliant B

✓ On a piece of photosensitive paper, realize an impact and compare it to the pictures below:

The laser is aligned.

The rear mirror is misaligned.

There is an optical problem. You may also observe a combination of these beam shapes. Contact QUANTEL's service department.


## THE OUTPUT BEAM ENERGY EXPERIENCES A POWER DRIFT

### For a Brilliant or a Brilliant B 10Hz

✓ Make sure that the laser is operating in the right conditions (see § C.I.3.ii).

✓ Check that the TP6 of the TCG.BB is set at 1,95V. If it is not, turn the potentiometer P1 until you reach this value.

✗ If the system is still experiencing a power drift, contact QUANTEL's support service.

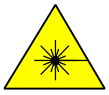
### For a Brilliant B 20Hz

✓ Make sure that the laser is operating in the right conditions (see § C.I.3.ii).

✓ Reset the CGS (see procedure C.III.1.ii p:C-47)

✗ If the system is still experiencing a power drift, contact QUANTEL's support service.

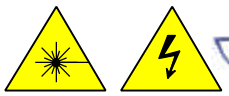

# THE OUTPUT BEAM ENERGY IS NOT STABLE



## For a Brilliant or a Brilliant B

- ✓ Check that the laser head is not set just under a ventilation.
- ✓ Check that the water hoses are connected the right way on the laser head.
- ✓ Check the state of the water and the deionization cartridge.
- ✓ Check the profile of the output beam. If it is incorrect, refer to the symptom on step 3, p: C-41, named “The beam profile is incorrect”.
- ✓ With a small torch, check the state of all the optics. If one is damaged, contact QUANTEL’s service department.
- ✓ Check that there is no free running mode. If there is, refer to the symptom on step 2, p: C-37, named “You can observe some free running mode when the system is flashing”.
- ✓ Make sure that the flashlamps are correctly tightened.
- ✗ If the energy stays unstable, contact QUANTEL’s support service.


# THE OUTPUT BEAM ENERGY IS TOO LOW



## For a Brilliant or a Brilliant B

✓ Check the flashlamp – Q-Switch delay on the remote box (~180µs).

✓ Check the state of the flashlamps.

✓ With a small torch, check the state of all the optics. If one is damaged, contact QUANTEL's service department.

✓ Check the alignment of the laser head.

✗ If you cannot get the correct energy, contact QUANTEL's support service.

# III. PROCEDURES

# III.1. TROUBLESHOOTING PROCEDURES

These procedures are specific to QUANTEL lasers and may be used only within the framework of their troubleshooting.

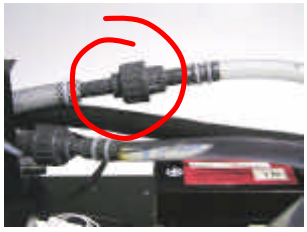
## III.1.i. IS THE WATER FLOWING INSIDE THE LASER HEAD?

**Toolkit needed**

- Standard toolkit

To check if the water is flowing in the laser head, proceed as follow:

1. Switch the laser system off.
2. Push the capacitor discharge switch.
3. Unplug the system from the main.
4. Remove the laser head housing.
5. Unscrew a little one of the two water tubes coming from the cooling group so as to make an air bubble inside and screw it back.



**Picture C-19. Water tube to unscrew**

6. Plug the system to the main.
7. Pull the capacitor discharge switch.
8. Turn the system on.
9. If the water bubble doesn't move inside the water tube, then the water is not flowing.
10. Set the laser head housing back.

## III.1.ii. RESET OF THE CGS

**Toolkit needed**

- Standard toolkit

To reset the CGS, proceed as follow:

1. Switch the laser system on.

2. Make sure that the CGS is not in AT mode (the AT LED must be off)

3. If the CGS is in AT mode, press on the ▼ and ▲ keys until the AT LED blinks once. Then, during 3s, press on the key ☞.


**Picture C-20. Steps to get out the AT mode**

4. Get in the SET mode by pressing the ▲ and ◙ keys. The SET LED lights up

5. The parameter ULoc is displayed on the screen. With the ▲ key, set it to 10 and press ◙.


**Picture C-21. The ULoc parameter**

6. Go through the parameters by pressing ◙. The following table shows an example of the values of the parameters you can read. Make sure that APt is well set to 0 on your system.

| Parameter | Value (i.e.) | Unit |
|---|---|---|
| Filt | 2 | s |
| OFFS | 0 | / |
| Out1 | variable | % |
| Out2 | variable | % |
| Pb1 | 8 | % |
| Pb2 | 8 | % |
| rSEt | 0.54 | min.s |
| rAtE | 0.13 | min.s |
| OL | 2 | % |
| biAS | 25 | % |
| SPhi | 31 | °C |
| SPLo | 31 | °C |
| OPhi | 100 | % |
| Ct1 | 1 | s |
| h_A1 | 40 | °C |
| LAEn | 0 | / |
| APt | 0 | / |
| PoEn | 0 | / |
| rPEn | 0 | / |
| SPSt | 1 | / |
| Loc | 10 | / |
| SP | 31 | °C |
| rP | nothing | / |

**Table C-5. The CGS parameters**

**7.** Set the parameters Pb1 and Pb2 to 0.

**8.** Go through the parameters, until you reach the screen displaying the real water temperature and its setting (see picture below).

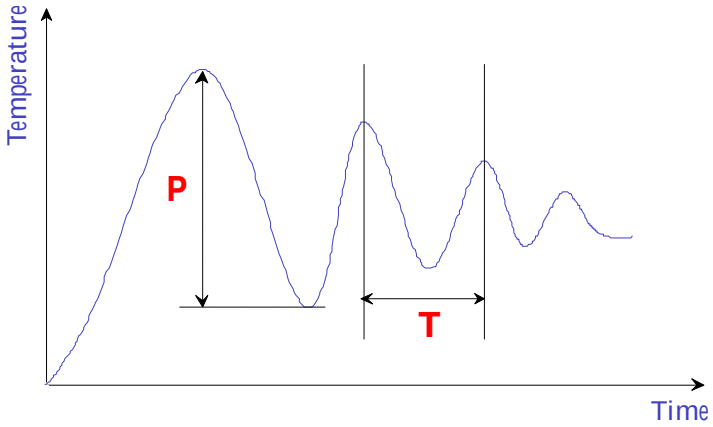

**Picture C-22. Water temperature and its setting**

**9.** Turn the flashlamps on.

**10.** During 3 minutes, every 15s read the temperature displayed on the screen.

**11.** Plot the temperature versus the time.

**12.** Measure the P and T values as shown on the draw below.




**Draw C-3. Temperature stabilization**

**13.** Go through the parameters by pressing until you reach Pb1.

**14.** With the key, set Pb1 to the value Px2.

**15.** Go through the parameters by pressing until you reach Pb2.

**16.** With the key, set Pb2 to the value Px2.

**17.** Go through the parameters by pressing until you reach rSEt.

**18.** With the and keys, set rSEt to the value T.

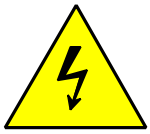
**19.** Go through the parameters by pressing until you reach rAtE.

**20.** With the and keys, set rAtE to the value T/6.

**21.** Press the key until you reach the screen displaying the real water temperature and its setting (see picture C-22).

**22.** Get out the SET mode by pressing the and keys. The SET LED lights off

# III.2. EXCHANGE PROCEDURES



**WARNING:** The Brilliant and Brilliant B laser systems are using high voltage. You must be very careful while handling them. Before exchanging any item, always unplug the rack from the main and push the discharge button. Moreover, when exchanging the quarter wave plate or the polarizer, always make sure that you tilt them a little bit from the optical axe.

## III.2.i. CPU.BB EXCHANGE FOR BRILLIANT B 20HZ

**Toolkit needed**

- Standard toolkit
- 1 new CPU.BB

To change the CPU.BB board, proceed as follow:

1. Turn the laser on and note the settings of the system.
2. Unplug the system from the main.
3. Unplug all the connectors on the rear panel.
4. Pull the rack out of the electronic cabinet.
5. With the pole, make sure that the capacitor is discharged.
6. Unscrew the front panel of the rack.
7. Unscrew and unplug the VD.BB board from the CPU.BB.
8. Unplug the connectors set on the CPU.BB.
9. Unscrew the CPU.BB from the electronic cabinet.
10. Screw the new CPU.BB to the electronic cabinet.
11. Plug back the connectors to the new CPU.BB.
12. Screw back the VD.BB to the new CPU.BB.
13. Make sure that the switch S1 of the new CPU.BB are set the same way than the old CPU.BB.

14. Screw the front panel of the rack back.

15. Put the rack back in the electronic cabinet.

16. Plug back all the connectors on the rear panel.

17. Plug the system to the main.

18. Turn the laser on.

19. Set the settings of the system like they were with the old board.

20. Turn the laser off.

## III.2.ii. VD.BB EXCHANGE FOR BRILLIANT B 20HZ

### Toolkit needed

- Standard toolkit
- 1 new VD.BB

To change the VD.BB board, proceed as follow:

1. Unplug the system from the main.
2. Unplug all the connectors on the rear panel.
3. Pull the rack out of the electronic cabinet.
4. With the pole, make sure that the capacitor is discharged.
5. Unscrew the front panel of the rack.
6. Unplug the connectors set on the VD.BB. Mark the wires to connect them on the right connectors on the new VD.BB.
7. Unscrew and unplug the VD.BB board from the CPU.BB.
8. Plug and screw the new VD.BB to the CPU.BB.
9. Plug back the connectors to the new VD.BB.
10. Screw the front panel of the rack back.
11. Put the rack back in the electronic cabinet.
12. Plug back all the connectors on the rear panel.
13. Plug the system to the main.

## III.2.iii. QS.BR EXCHANGE

**Toolkit needed**

- Standard toolkit
- 1 new QS.BR

To change the QS.BR board, proceed as follow:

1. Switch the laser system off.
2. Push the capacitor discharge switch.
3. Unplug the system from the main.
4. Remove the protective housing.
5. Unscrew the cover of the QS.BR box and open it.
6. Unscrew the four white plastic screws of the AC.BR board from the Q-Switch cavity of the laser head.
7. Unplug the connectors of the QS.BR board and remove it.
8. Unscrew the cover of the new QS.BR board and open it.
9. Screw the four white plastic screws of the new AC.BR board to the Q-Switch cavity of the laser head.
10. Screw the cover of the new QS.BR board back.
11. Plug back the connectors of the QS.BR board.
12. Set the protective housing back on the laser head.
13. Plug the system to the main.
14. Pull the capacitor discharge switch.

## III.2.iv. TCG.BB EXCHANGE

**Toolkit needed**

- Standard toolkit
- 1 tube wrench (7 mm)
- 1 new TCG.BB

To change the TCG.BB board, proceed as follow:

1. Switch the laser system off.
2. Push the capacitor discharge switch.
3. Unplug the system from the main.
4. Looking at the front panel of the electronic cabinet, unscrew the bottom left hand side panel.
5. Unscrew the four nuts fixing the TCG.BB to the electronic cabinet.
6. Unplug the connectors of the TCG.BB and remove it.
7. Screw the new TCG.BB to the electronic cabinet.
8. Plug back the connectors to the new TCG.BB.
9. Screw the panel of the electronic cabinet back.
10. Plug the system to the main.
11. Pull the capacitor discharge switch.

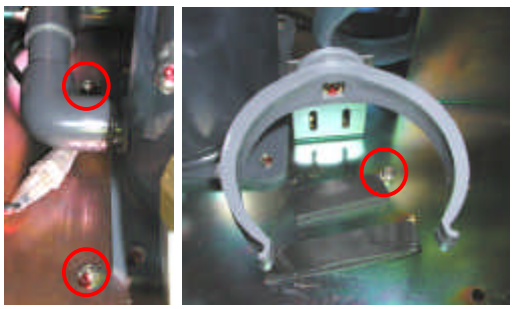
## III.2.v. EXCHANGE OF THE CGU WATER PUMP

**Toolkit needed**

- Standard toolkit
- 1 new water pump

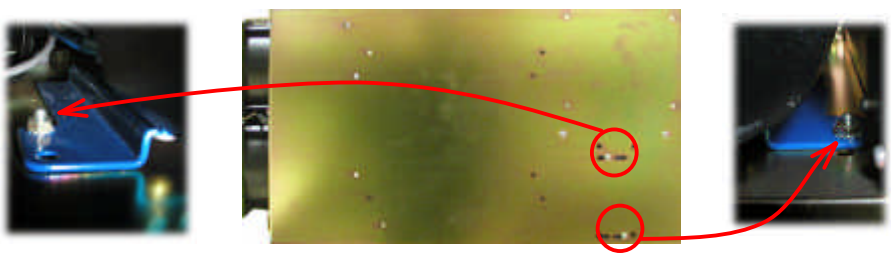
To change the water pump, proceed as follow:

1. Switch the laser system off.
2. Push the capacitor discharge switch.
3. Unplug the system from the main.
4. Unscrew the two bottom sides panels.
5. Unplug the connectors J1 and J3 of the TCG.BB.
6. Empty the water tank
7. Unscrew the three screws fixing the CGU to the electronic cabinet (see picture below).



**Picture C-23. The CGU fixing screws**

8. Pull the CGU out of the electronic cabinet.
9. Unscrew the screws fixing the pump to the CGU (see picture below).

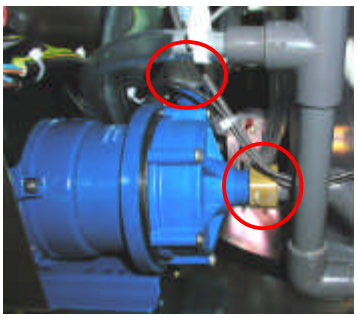


**Picture C-24. Water pump fixing screws**

**10.** Unplug the pump main cord from the relay (see picture below).

**Picture C-25. The water pump relay**

**11.** With an adjustable wrench, unplug the defective pump from the water circuit (see picture below) and remove it from the CGU.



**Picture C-26. The water pump**

**12.** Set the new pump in the CGU and plug it on the water circuit.

**13.** Plug the main cord of the new pump to the relay.

**14.** With the appropriated screws, fix the pump to the CGU.

**15.** Set the CGU back into the electronic cabinet.

**16.** Screw the CGU back to the electronic cabinet.

**17.** Reconnect the connectors J1 and J3 of the TCG.BB.

**18.** Fill the water tank.

**19.** Screw the panels of the electronic cabinet back.

**20.** Plug the system to the main.

**21.** Pull the capacitor discharge switch.

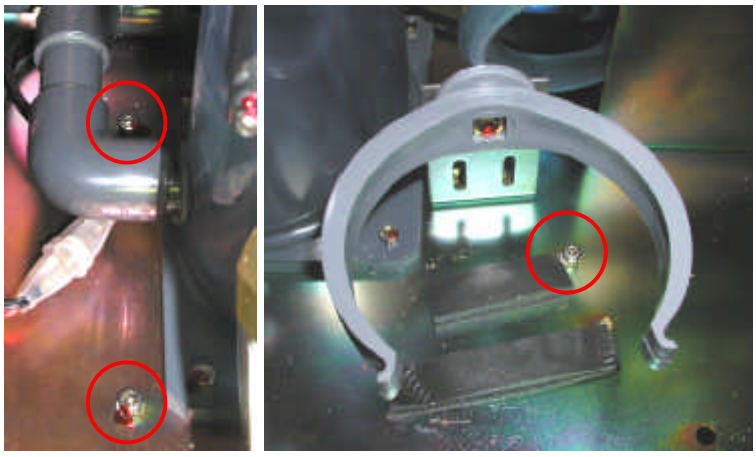
## III.2.vi. EXCHANGE OF THE CGU TEMPERATURE PROBE

**Toolkit needed**

- Standard toolkit
- 1 new temperature probe

To change the temperature probe, proceed as follow:

1. Switch the laser system off.
2. Push the capacitor discharge switch.
3. Unplug the system from the main.
4. Unscrew the two bottom sides panels.
5. Unplug the connectors J1 and J3 of the TCG.BB.
6. Empty the water tank
7. Unscrew the three screws fixing the CGU to the electronic cabinet (see picture below).



**Picture C-27. The CGU fixing screws**

8. Pull the CGU out of the electronic cabinet.
9. Unscrew the defective temperature probe and pull it out of the water tank.
10. Cut the two wires of the defective temperature probe.

11. Set the new temperature probe inside the water tank and screw it.

12. Connect the two wires of the new temperature probe to the one you cut before.

13. Set the CGU back into the electronic cabinet.

14. Screw the CGU back to the electronic cabinet.

15. Reconnect the connectors J1 and J3 of the TCG.BB.

16. Fill the water tank.

17. Screw the panels of the electronic cabinet back.

18. Plug the system to the main.

19. Pull the capacitor discharge switch.