Corresponding author: david.bailleux@cern.ch
On behalf of the Caltech group
California Institute of Technology, Pasadena, CA 91125, USA

ECAL LASER MONITORING SYSTEM

Table of Contents

David BAILLEUX *Review 2015*

This manual contains general user information for the ECAL laser system

This manual is a supported for any laser on call shifters how have already received training directly on laser itself thus it is only used as a supported.

CAUTION
LASERS CLASS 4

Used eyes protection when operating laser

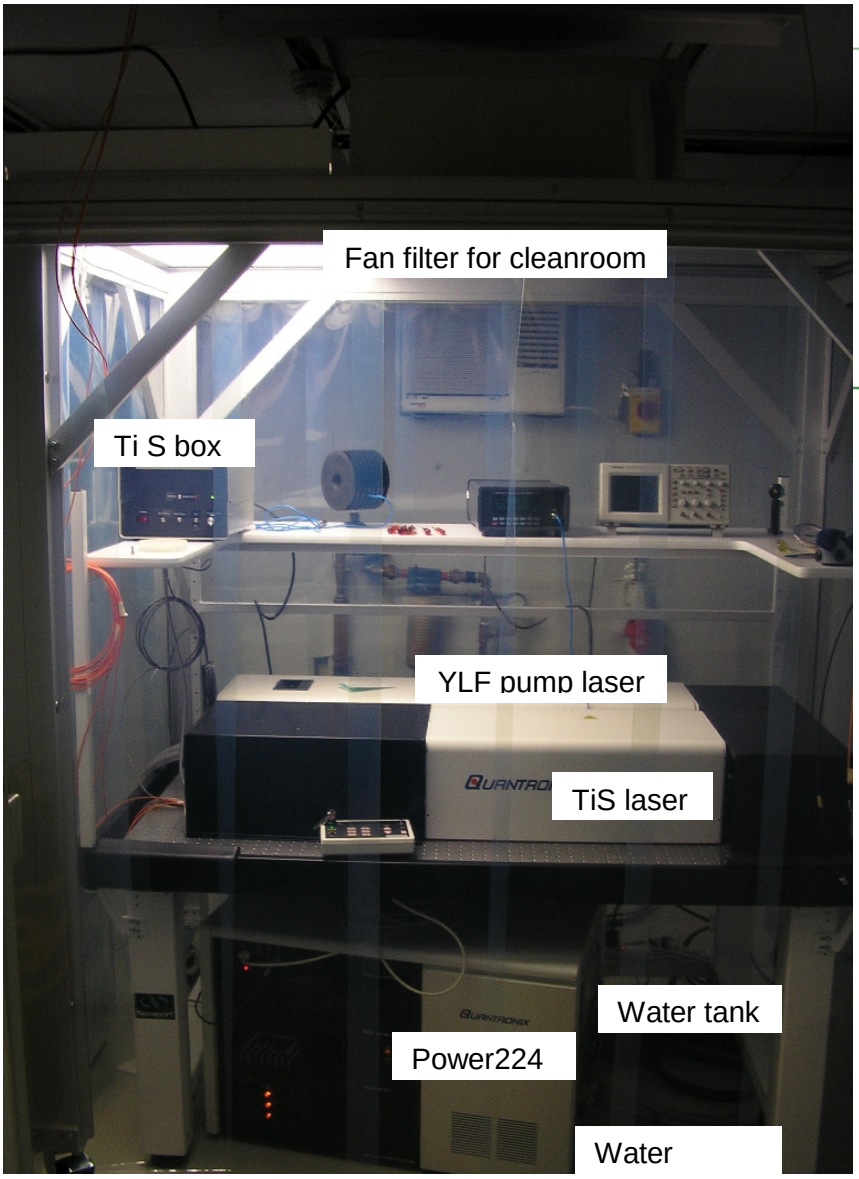
If you don't know what you are doing,
Ask experts !

Risk of Electrical SHOCK
Do not remove any cover

I. Setup

1. Laser description

The ECAL laser room in USC55 is organized as followed:
1 control room for racks, PCs and equipement;
1 room for old Quantronix laser, blue;
1 room for Quantronix IR laser + green + 2 Photonics DP2-447 lasers.



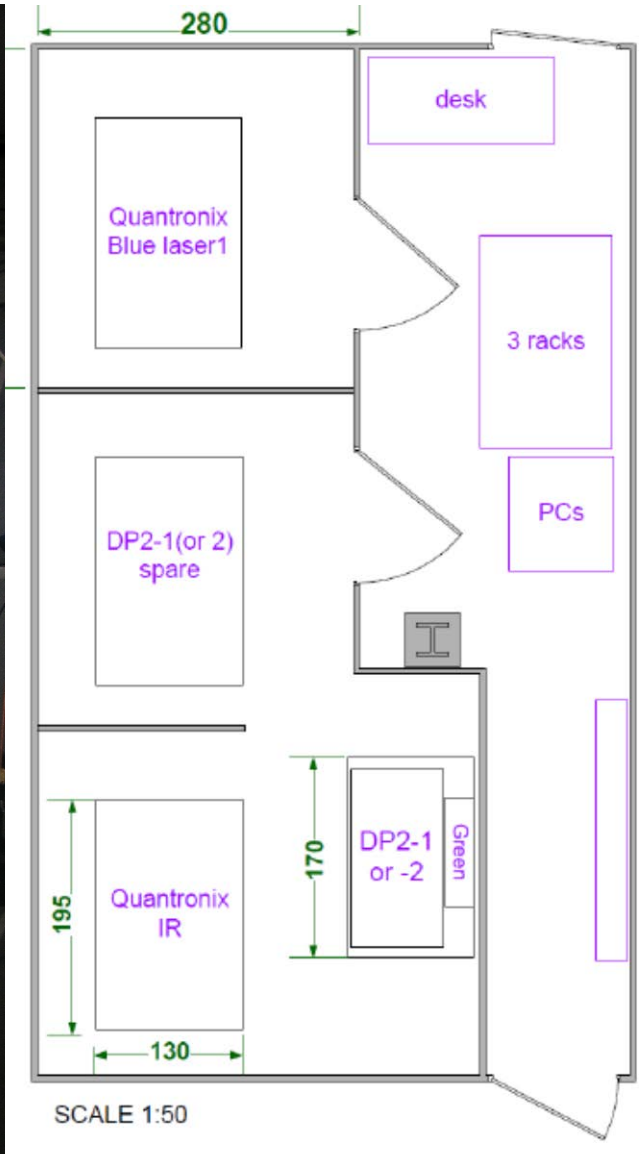


Fig.1: Laser system for Quantronix and scheme of the entire ECAL laser room

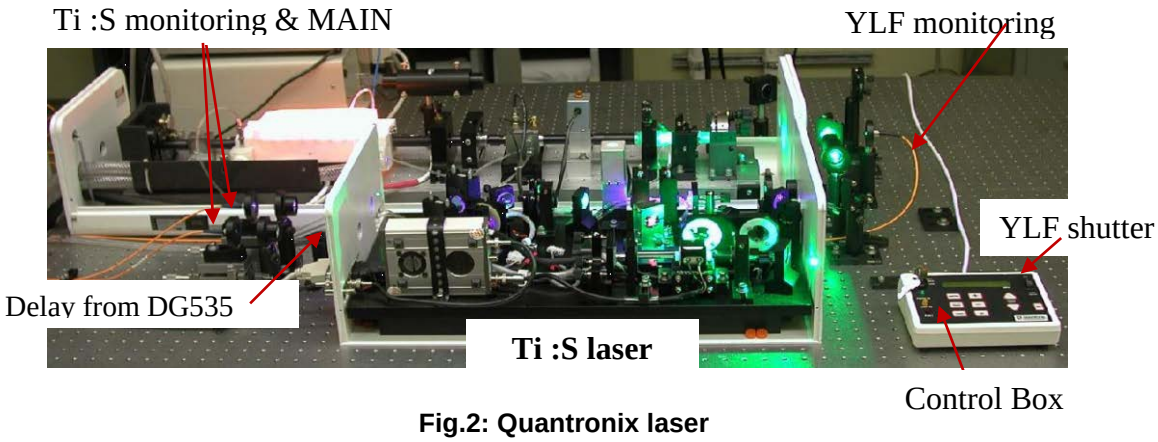


Fig.2: Quantronix laser

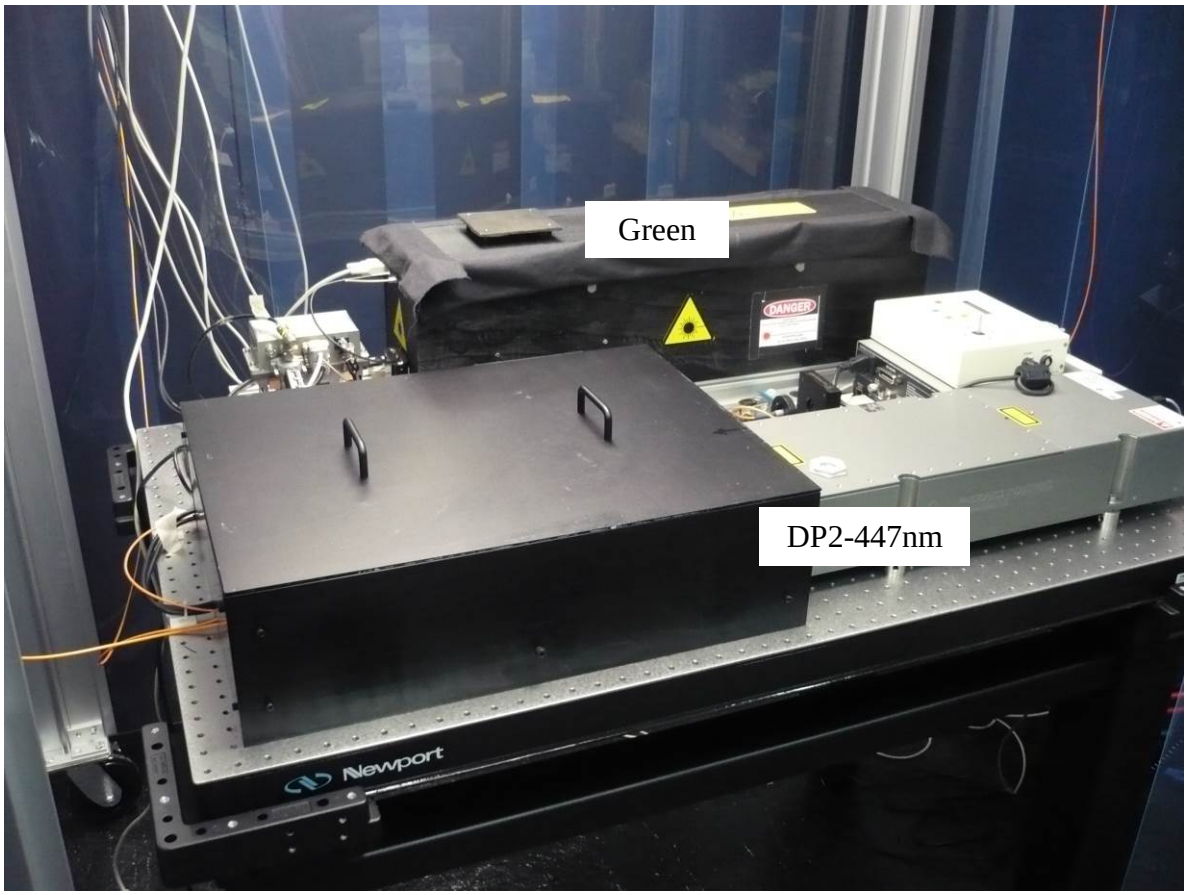


Fig.3: Green + DP2-440 lasers

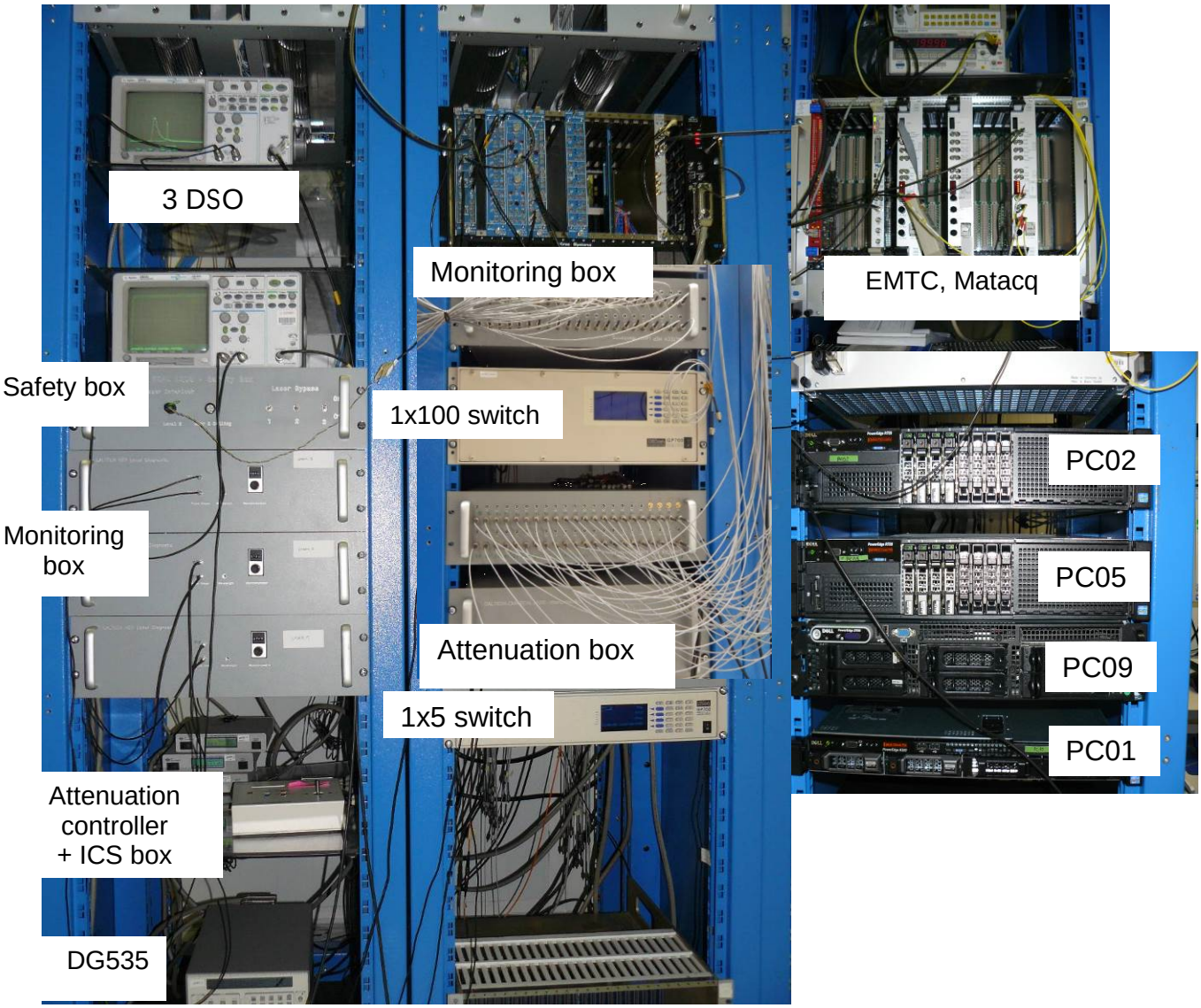


Fig.4: rack system

List of common Devices:

ecal-laser-room-02.cms: slow monitoring, laser control.
ecal-laser-room-03.cms: Saclay's PC for the lightChecker
ecal-laser-room-05.cms: fast monitoring with Acqiris DP210, DIM server. Spare PC of PC02

vmepc-ecal-laser-01 : alias ecalod-laser-xdaq :rack PC ecal supervisor (VME for EMTC)
ecal-laser-room-09.cms: spare of vmePC

Safety Box:
Input: All the doors interlock
Output: shutter

SHOT102 controller:
Stepper controller for linear and logarithmic attenuation.

Monitoring box (laser 1, 2, 3):
Input: monitoring fibre YLF and TiS or DP2.
Output: signal from pin diode for slow monitoring (DSO);

Optical Switch 1x5
Input: Main TiS fibre from the 3 lasers
Output: 1 fibre to the attenuation box

Attenuation box
Neutral density filters : 0, -10, -20, -30, -40, -50 dB;
Linear attenuation: 0 to 100% *(0.4dB to 27dB loss)*;
Pin diode for Acqiris DP210 and Matacq (VME splitter)

Optical Switch 1x100
Input: fibre from the attenuation box
Output: 88 fibres to the monitoring box

Monitoring box
Input: fibre from the 1x100 switch
Output: main fibres to ECAL
Box with pin diode for the Matacq.

EMTC board (*Ecal Monitoring Trigger Card***)**
Input: 4 TTCci's input fibres. EE +- and EB+-
Output: 2 NIM signals for laser and Matacq trigger

Matacq
Input: pulse from attenuation box – triggering by EMTC
Data on *http://ecal-laser-room-03.cms/laser-fastcheck*

Devices for Quantronix lasers:

ICS device, Serial RS232 to GPIB interface:
Input: TiS, Power224, Neslab RS232
Output: 1 GPIB

DG535 digital delay:
Ext trigger: Come from EMTC through a fan in/out unit for distribution.
NIM (threshold -4V)
T0: Connected to DSO trigger.
A: Connected to YLF external trigger input.
B: Connected to Ti:S laser (input delay of HV pulser on laser)
C: Not in used.
D: Connected to Acqiris trigger through coincidence unit.

Devices for Photonics laser:

DG535 digital delay:
Ext trigger: Come from EMTC through a fan in/out unit for distribution.
NIM (threshold -4V)

RS232 to USB box interface: x2
Manage the RS232 devices of the DP2:
DP2 controller, shutter, attenuator and temperature sensor.

ICS device, Serial RS232 to GPIB interface:
For the scope slow monitoring and optical switches.

The figure 5 below show the layout of 3 lasers. One photonic is the main BLUE laser while the second one is the spare. The spare is always connected and fully operational in order to be ready in case of failure. The 3rd laser shown is the infrared Quantronix. By default it is not online and need to setup in advance before use it.
The 4th laser is the green one but it is not included here on this chain because it is not controlled by the same PC: it is connected to vmepc-ecal-laser-01 and not ecal-laser-room-02. There is no slow monitoring as well. Nevertheless its main fibre is well connected to the 5x1 optical switch and the switch selection is done on laser program.

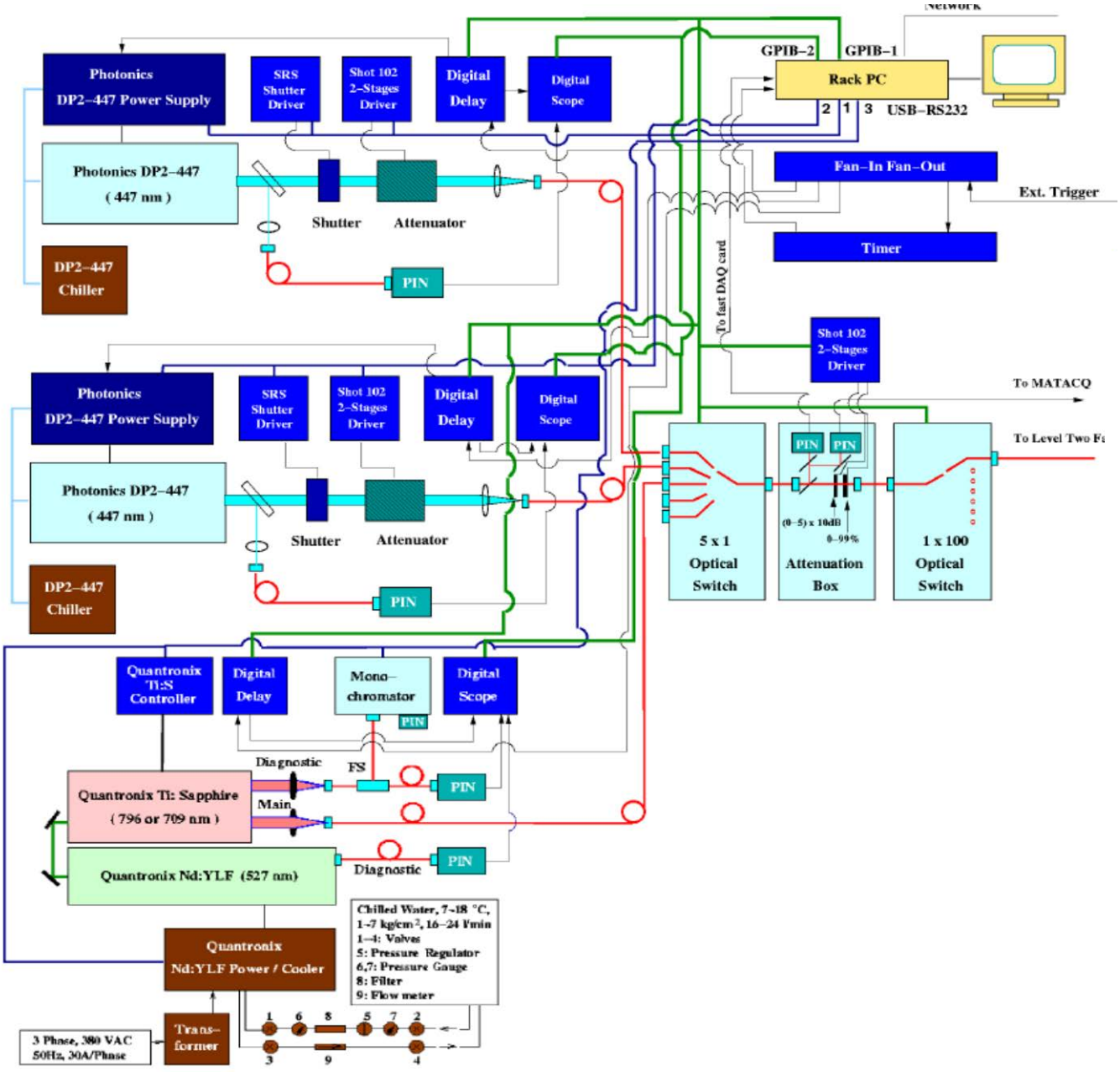


Fig.5: 3 lasers system

2. Laser control and slow monitoring

The full laser control system is described on the schematic 4 below:

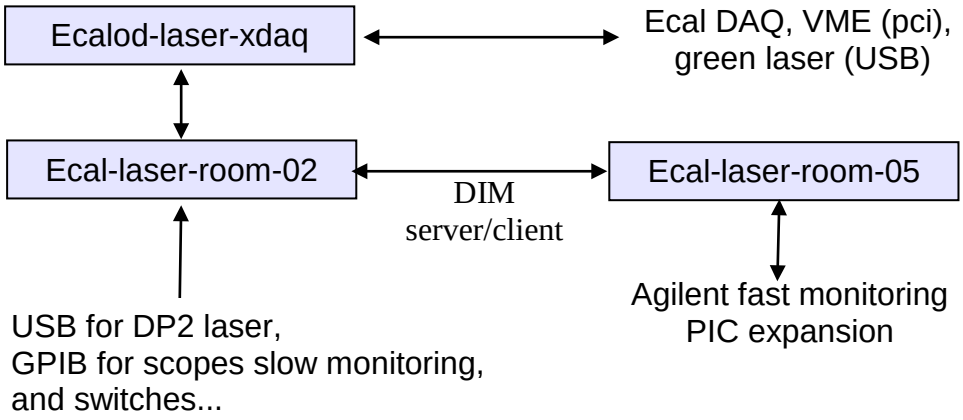


Fig.6: Laser control schematic

Main laser control is running under **ecal-laser-room-02.cms :**

#home/laser/dp2n~ ./run

Logfile.txt is created automatically with ./run. Else used #./laser

Running ./run open the GUI laser control and a second windows with the 3 DSO display for the 3 lasers pulses as shown figure 7.

This script is used to control the lasers with their data acquisition (slow monitoring), and communicate with ECAL DAQ.

The laser setting commands are controlled manually and most of them remotely by ECAL DAQ: when ECAL DAQ take the hand of the lasers, the selected laser, the channel, the attenuation value are changing according to the configuration file.

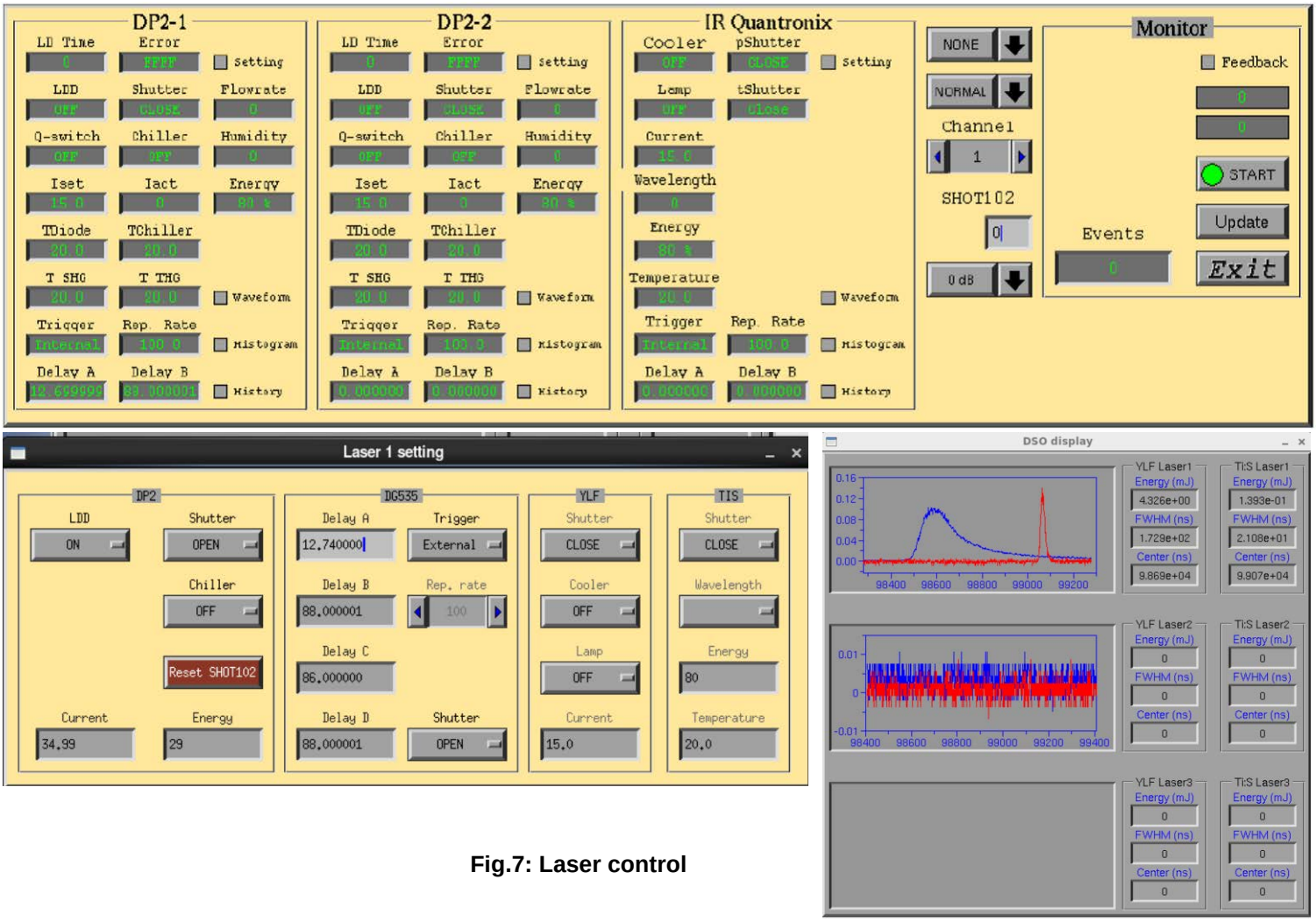


Fig.7: Laser control

Laser control main panel:

. DP2-1 // DP2-2 // IR Quantronix
→ Status of each laser: trigger, rate, cooler, lamp, current, shutters, wavelength, attenuation % (Energy) and Delay A. (temperature Neslab not in used), room temp…

→ Setting button:
.Control of the shutter: internal shutter of laser (under dp2 windows) and safety shutter outside laser (under Dg535 windows)
.energy = internal attenuation
. LDD, Qswitch, Chiller
.DG535:trigger (internal or external), delay A B C D.
.YLF and TIS windows: for IR laser only, laser 3.

. Right side Monitor:

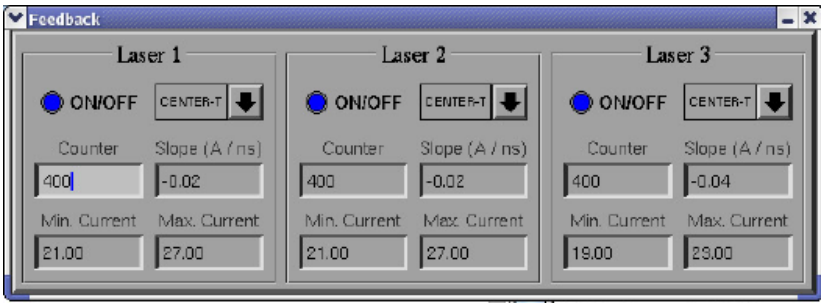
Laser online:	switch 1x5 selection.
Normal button:	not in used
Channel:	switch 1x100, 1 to 88 for ECAL.
SHOT102:	attenuation linear and logarithmic
Events:	number of events received

RUN/STOP button:
start and stop the monitoring acquisition.
On ”DSO display”, be sure that pulses are display and parameters are OK.

Data are saved into .dat file and hbook file for the current month.
update: refresh hardware/display value.
DSO display:
3 scope acquisitions for the 3 lasers:
DP2-1, DP2-2, IR laser.
For the IR laser there is 2 pulses: the YLF pump laser and the TiS laser.

Feedback:

Feedback is used to increase laser current automatically to compensate aging of the lamp (quantronix)
Or stabilize DP2 in case of temperature variation but because of DP2 is stable, it is not yet activated.



Current incremental step: 0.1A

For Quatronix:

Looking for variation of selected TiS pulse parameter over a defined period; Trim the YLF current according to the measured average values of the selected parameter according to the corresponding slope.

Parameter: Energy – FWHM – Center
Counter: number of events required to calculate average values for the selected parameter .
slope: value define by calibration
current limit: min and max for laser protection.

Slope:
TiS center = -0.02 A/ns
TiS Energy = 11.1 A/mJ
TiS FWHM= 0.6 A/ns

Feedback is not activated all the time: we need to be quite confident that laser is stable over a long time (few days), that the normal condition of operation will be respected.

Then feedback can be activated: since a long time it is used the TiS Center value as reference to get pulse always visible by ECAL, on the good range.

How to activated it:

- stop the data acquisition after few days to get the pulse timing average (histogram).

Put this value on laser_h.cfg file, on the corresponding line (original_value)

- stop and restart ./laser control software to take into account this new value
- open the feedback windows and enable the laser ON/OFF button.

More the smaller counter value is small, more the current may changed rapidly.
Counter = number of event to compare the 2 average pulse timing (file and histogram)

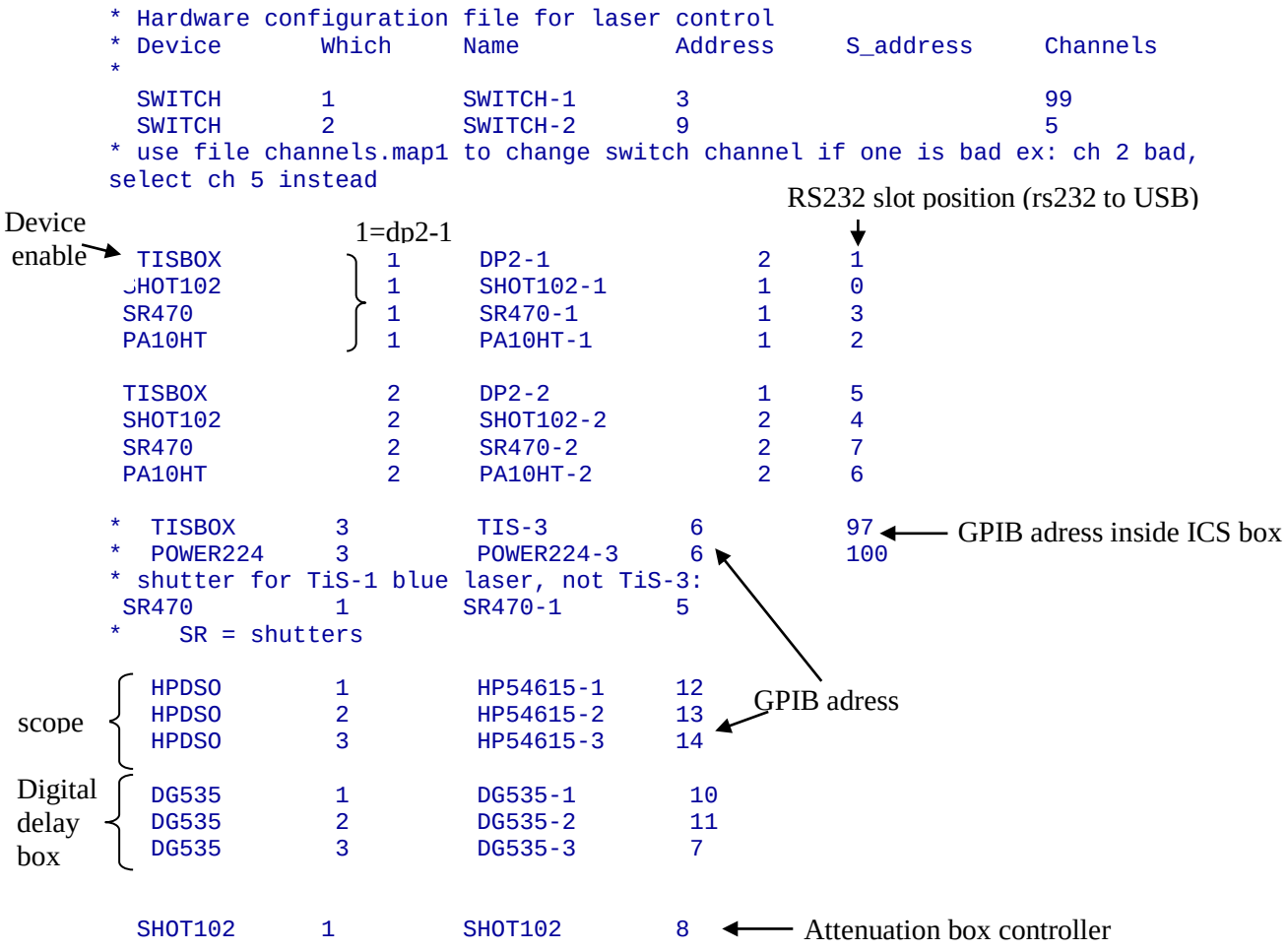
Associated to the laser control ./run, there is a **configuration file** attached to it: **laser_h.cfg.**
This is the running configuration for the 3 lasers which deal with all hardware address and settings.

This file allow to

1. enable or disable one laser from the program: put a * in front of devices.

One this example quantronix laser is disable from the GPIB chain:TISBOX and POWER 3 are *

2. select which laser DP2 is online or spare
3. store setting of each devices (delay for DG535)
4. enable or disable the communication with ECAL ("H4DAQ")



```
* LASER, which, set, wl, da, db, dc, dd, ecy, ect, al, po, spare(spare=1)
* set: set 1 of 2 wavelength for each laser
* wl:  wavelength
* da, db, dc, dd: delay A, B, C, D of DG535
* ecy: calibration of YLF laser
* ect: calibration of TIS laser
* al:  attenuator limit
* po:  pcm offset
 LASER  1  1  440  8.195 3.00  0.00  3.00  21.8   7.5  99  0 1
 LASER  1  2  500  7.74  1.00  2.75  3.45  21.8   1.0  40  0 1
 LASER  2  1  440  7.560 3.70  0.00  3.50  21.8   9.6  99  0 0
 LASER  2  2  500  7.74  4.00  2.00  2.00  21.8   1.0  40  0 0
 LASER  3  1  800  7.74  3.10  0.10  3.41  1.00   1.0  99  0 0
 LASER  3  2  700  7.74  1.00  3.20  3.39  29.7   86.4  99  0 0
```

Limit for TiS attenuation (%)

Spare laser = 1

Online laser = 0

Delay A, B, C, D (µs)

Calibration histogram

```
*mode YLF_E:1, YLF_W:2, YLF_C:3, TiS_E:4, TiS_W:5, TiS_C:6
*which on/off  mode   count_N  slope   current_min   current_max original_value
  FEEDBACK    1     0   6     2000    -0.02   21            25         11750
  FEEDBACK    2     0   6     100     -0.02   21            25         11750
  FEEDBACK    3     0   6     400     -0.02   19            23         11750
```

6 = TiS center

Value for feedback corresponding to the Mode (ns here)

```
************************************
*Interlock B field  ON/OFF (1/0)

INTERLOCK    1     0
INTERLOCK    2     0
INTERLOCK    3     0
************************************


* H4 DAQ 0/1 -> off/on
H4DAQ 1
```

H4 DAQ: enable or disable remote control by laser supervisor.

Configuration file : **laser_s.cfg**

This file allow to change the mode of this laser program.
By default it is in RUN mode: scanning and communicating with all the devices.
The second mode is the DAQ mode: it is to process FILE .dat and create the associated Hbook file and ps plots for the defined run.

Change DAQ_mode 0 or 1 ,
Change Filename.

```
Daq_mode: 1
Mode: 1
Events: 100
Filename: dso20524.dat
Timer: 100.00 0.10 0.10
```

The simplest way is to press "CRTL+P" on the program itself → open new dialog box.
Configuration file : **Channels_maps1(2)** For optical switch configuration.

This file associate the switch laser selection on the program to the channel of this switch.

Useful in case of faulty channels (associate faulty channel to another one) because like this we can changed the channel associated to one laser.

When the DAQ is running : "START" button RED in data acquisition mode, the raw data are saved into a hbook file. An associated ps file is created as shown the figure bellow.

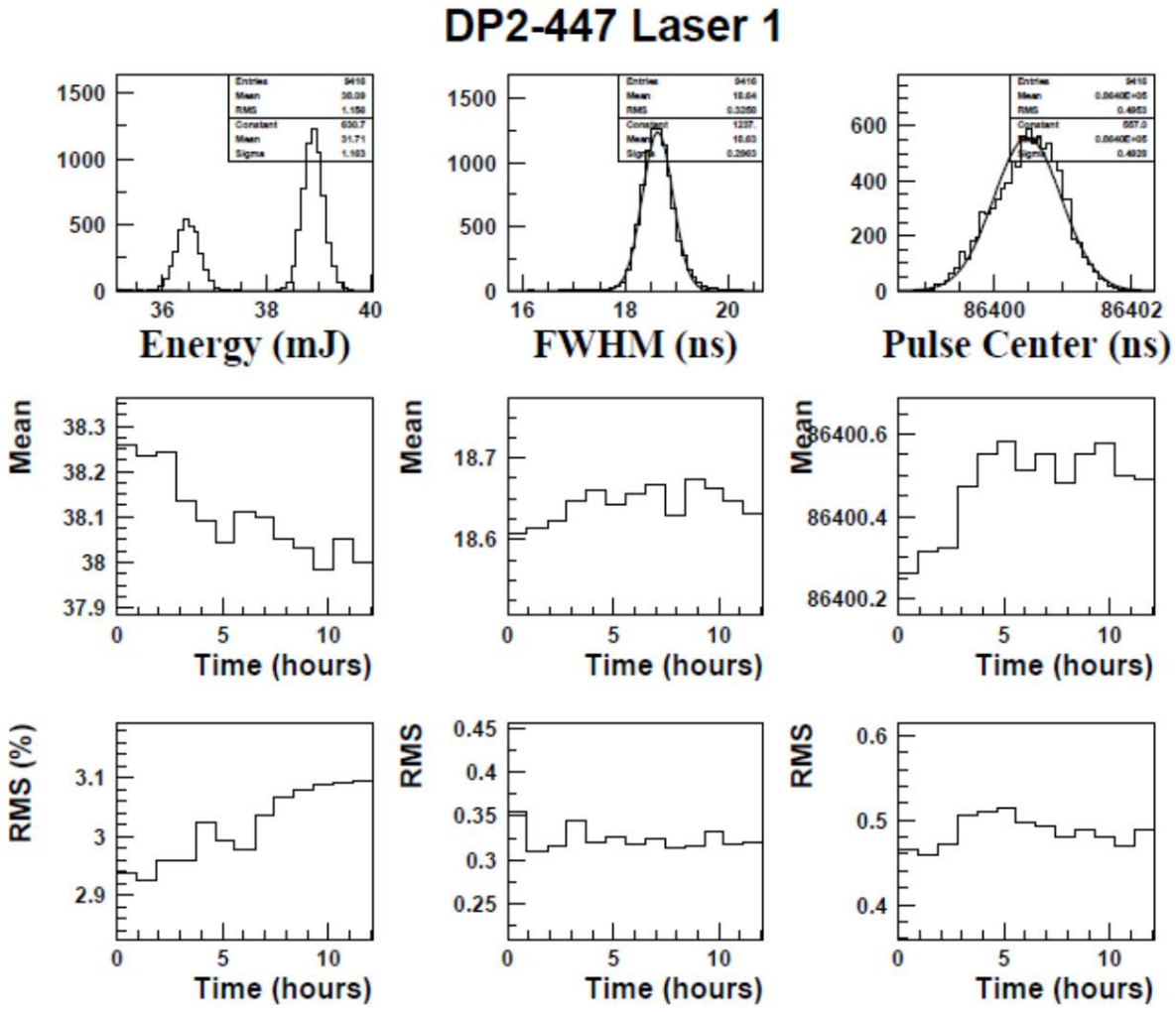


Fig.8: DP2 histogram

The double peak for the energy come from the first ~10 triggers of each burst, which have less intensity. This is a temp. effect and it is not critical for ECAL because those first events are removed for the calibration analysis.

3. Fast monitoring

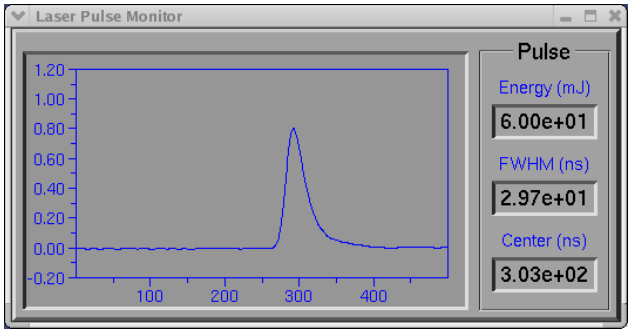
Fast monitoring allow to record all laser pulses, unlike the slow monitoring which is a 1Hz data acquisition.

Running on ecal-laser-room-05.cms : #monitor/src> ./monitor 99150

99150 correspond to the delay to match the overall laser delay and to get the pulse visible on the display.
Running ./monitor create a hbook file. Once the limited size is reached a new file is automatically created.

PCI board DP210 U1071A , Acqiris board from Agilent, 2Gs/sec to record all pulse events.

#laser/monitor/src > **./disp**



The fast monitoring allow 2 things:
- record all data and get a redundancy system with the Matacq,
- control the light of the main chain, just before detector side.

The signal arriving to the Acqiris is coming from a pin diode inside the monitoring box, as shown the fig.8. The monitoring box is placed just before the 1x100 switch which send the light to ECAL. In this way we can check the light of the main chain unlike the slow monitoring (fig.5): the slow take the light directly on the laser output so this is not informed about the optical chain status.

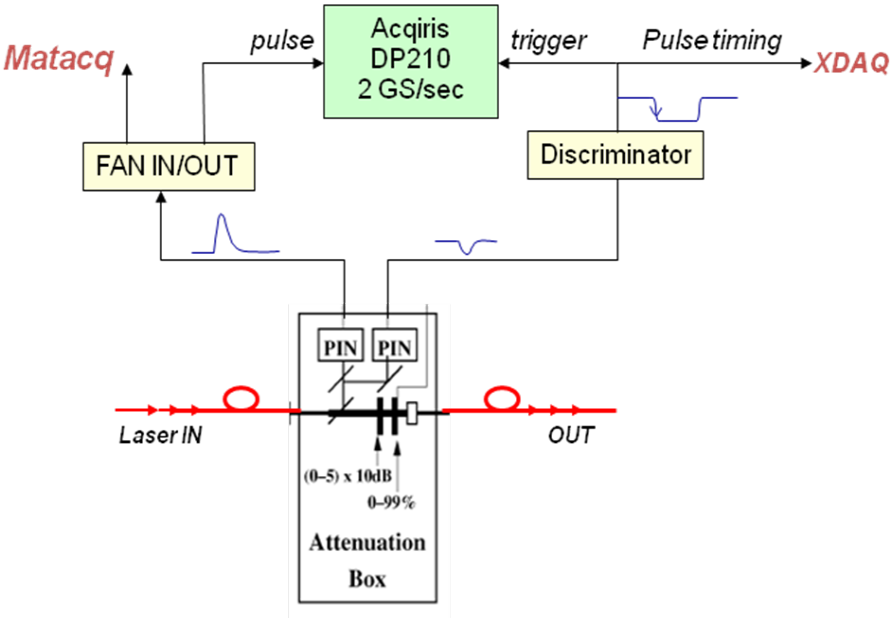


Fig.9: schematic of the fast monitoring

4. EMTC Ecal Monitoring Trigger Card

The EMTC receives the trigger and clock signal issues from the TTCci's, one per ECAL partition, through optical link.

- it merges the 4 signals;
- it decodes the signal and extract:
  - the warning test enable: used to trigger the laser
  - the trigger type and laser setting (switch, λ)
- it sends 2 NIM signal : trigger laser and Matacq
- it provides the decoded trigger information. Laser setting is known 4s in advance when changing switch and more when changing wavelength.

Firmware safety: can't send trigger rate >100Hz

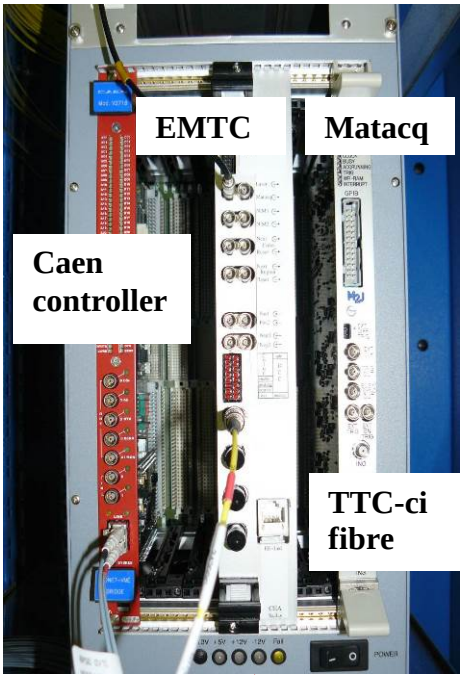


Fig.10: laser supervisor controller, EMTC, Matacq

EMTC is deal with ECAL and thus we don't have to control and get access to it.
For information:
Running on **ecal-laser-room-05.cms** →
#nfshome0/ecalpro/DAQ/ECAL/ECAL_0_8/ecal/ecalLaser/emtccons/caen/emtccons 17 (17 slot number maybe not necessary)

But starting ./emtccons anywhere under .cms – under user “ecalpro” ou “ecaldev” is OK

Maybe necessary before to be under ECAL environment:
source ~ecaldev/utiles/bashrc

The protocol between EMTC-XDAQ and laser DAQ is the following:

The XDAQ send a wavelength command to the laser DAQ which will select the corresponding laser according to the configuration files.
Now the new config is the following:
0 is 440 nm old laser
1 is the green,
2 is the DP2-1
3 is the IR laser3.
4 is the DP2-2

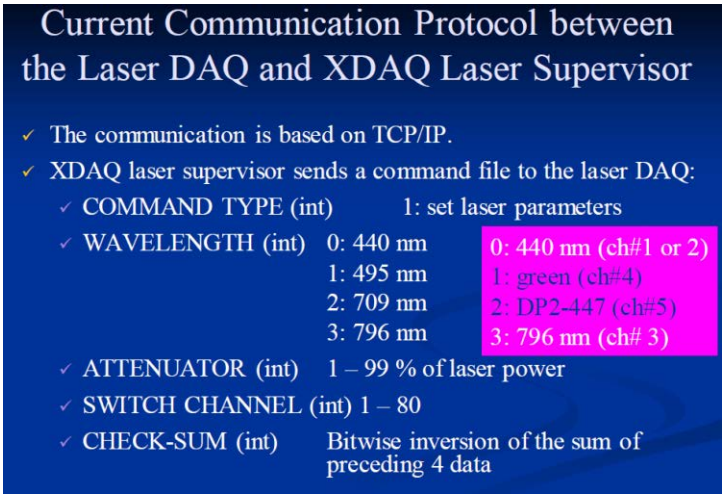


Fig.11: example of old communication protocol

The other control are the attenuation and channel.
On the laser DAQ , the following hardware part is thus involved:
Optical swith 1x5, optical switch 1x100, Shot102 attenuator.
All others are not remotely control by ECAL and remain local setting.

II. Turn on the laser system

1. Quantronix laser

Hardware:
Control room:
- All flash lamps should be ON;
- All corresponding devices on the laser_h.cfg should be ON.

Laser room:
- Cooling water: OUT valve and IN valve should be opened. The pump outside should be running.
- Neslab: ON , 30 degees.
- Power 224: 3 switches 0/1 ON; light should be there on power distribution;
- TiS box: ON, on computer mode ;

Turn ON the laser with control box (fig.7):

- laser power supply (under the table) : 3 switch should be ON

- YLF shutter should be 0, closed.
- turn the key from OFF to ON;
- turn the key to COOLER position. The pump from power224 should start. Green LED on. Wait 1-2min.
- Control box: turn the key to LASER position. The shutter position should be 0, CLOSED. After few seconds, lamp should be ON: orange LED on and current 10A. Click on INFO up to the current display information.

Usual error message*: "Control unit time out".* Go back to OFF position and restart.
- Control box: open YLF shutter. Noise of the shutter operation may be audible.

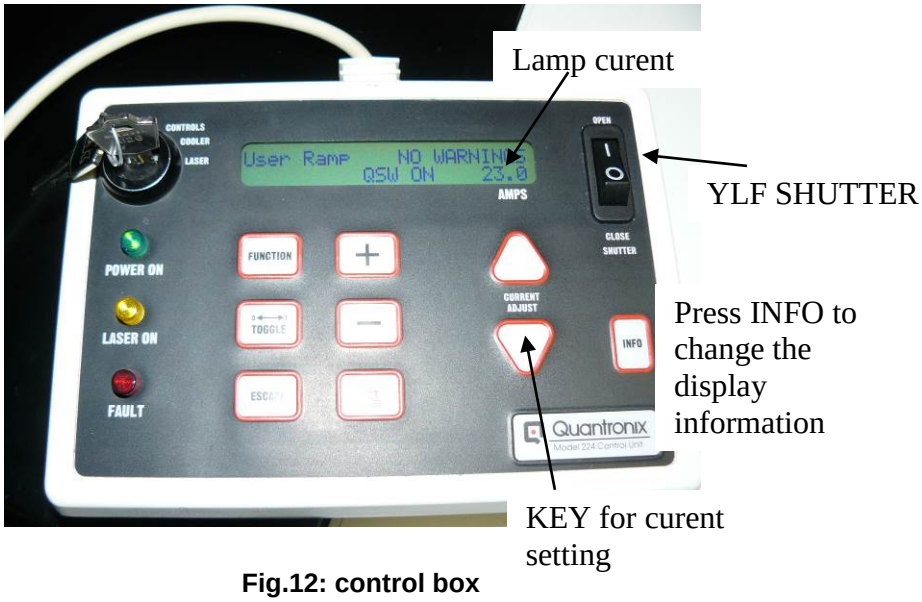


Fig.12: control box

At this stage, laser light is likely to be produced depending of trigger setting.
Any cover has to be removed and non expert should be there.

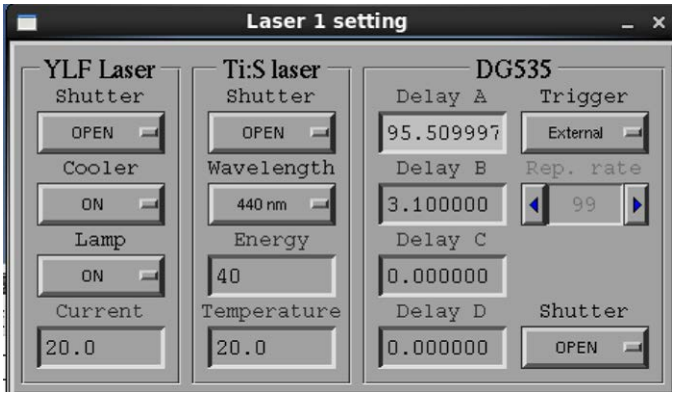
In principle, Laser trigger mode is in EXTERNAL mode so no light should be visible – else some diffused green light may be seen through the laser cover.

At this stage, laser is ready to be put ONLINE instead of the second Quantronix laser.
On the laser control you can check that the laser configuration is correct.

Turn ON the laser remotely through laser control GUI:

One of the spare Quantronix laser is ready to be put online at any time, in case the main one failed: the control box key is keep in power position and the shutter is OPEN to enable remote control.

- Open the setting of the defined laser
- Cooler: OFF -> ON
- wait 1 min
- Lamp: OFF - > ON
- Current display: need some refresh : click update button or restart the script.
This is also true time to time for the cooling.
- current value is 10A if laser succeed to switch on. If there is gpib error or cooler go OFF, laser is in error and the laser has to be turn off by the control key directly.
- Set the current to working point.
- Set the current 'energy' = internal attenuation.



2. DP2-447 laser

a) Hardware:

To turn on the laser from scratch, using the power supply, please refer to the laser operating manual directly.

Figure 11 show the laser controller. Refer to the laser manual to operate.
Figure 12 is the rack chiller. The water pipes are going through chiller, laser head and as well laser controller to cool down the diodes inside. The working temperature is defined on the chiller directly: 25Deg for DP2-1 and 27.8Deg for DP2-2. The laser diode temperature display on the laser GUI reflect directly if the chiller is ok or not.

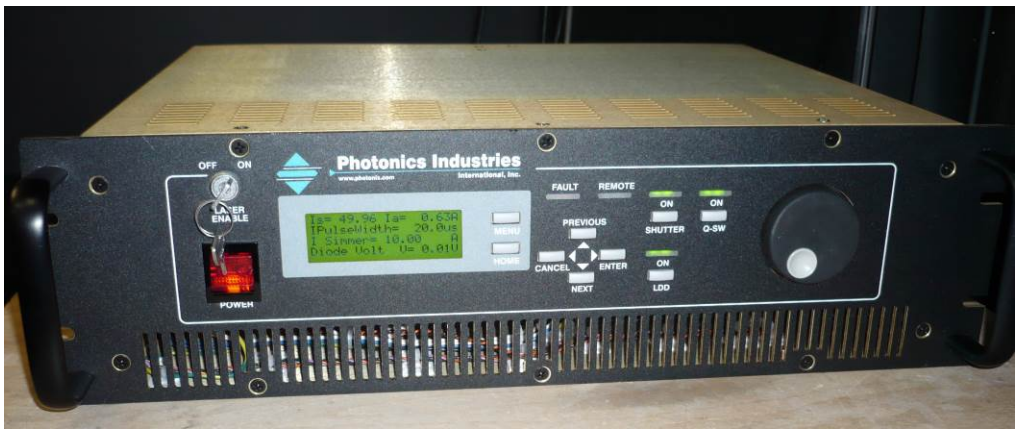


Fig.13: DP2-447 diodes with power supply

Fig.14: DP2-447 cooling

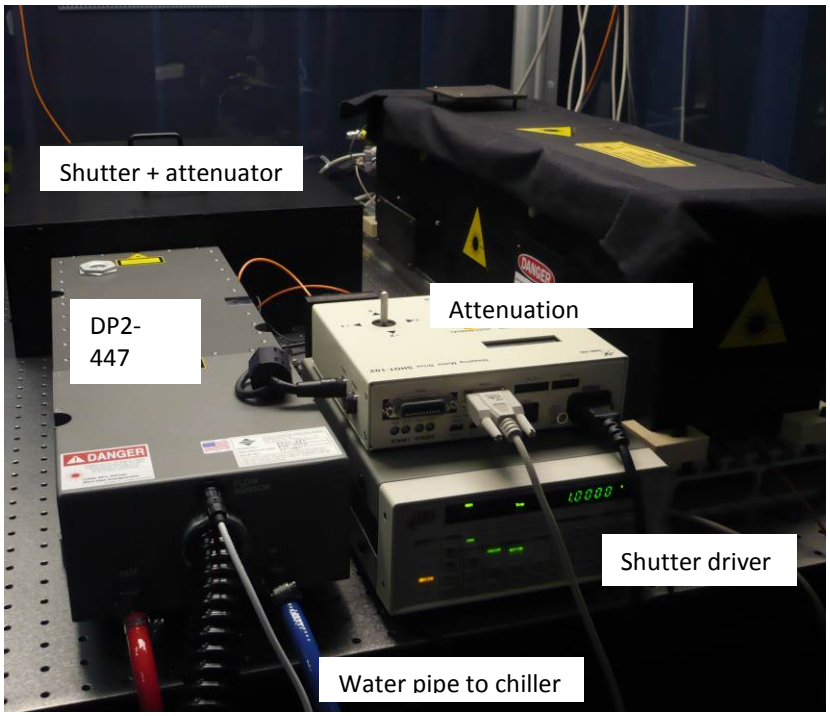


Fig.15: DP2-447 optical table

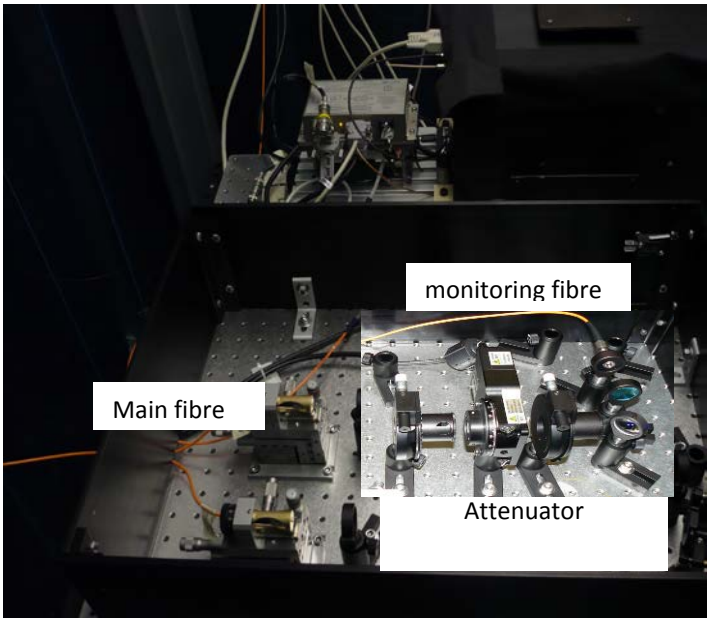


Fig.16: DP2-447 ancillaries optics

The left hand side picture shown DP2-1 laser , and the green laser on the back. The main light coming out of the DP2 is passing through some ancillaries optics inside black boxe shown on figure 14>
This is to :

i. Split the light to get some signal for the slow monitoring fibre, removing as well some IR harmonics wavelength,
ii. Attenuate the pulse with a remote control attenuator
iii. Protect the optical chain with a fast shutter between each optical switch operation

The control of the attenuation is done by an active optical system. This system is based on 2 polarizers and a custom wave plate.
The schematic is the following:

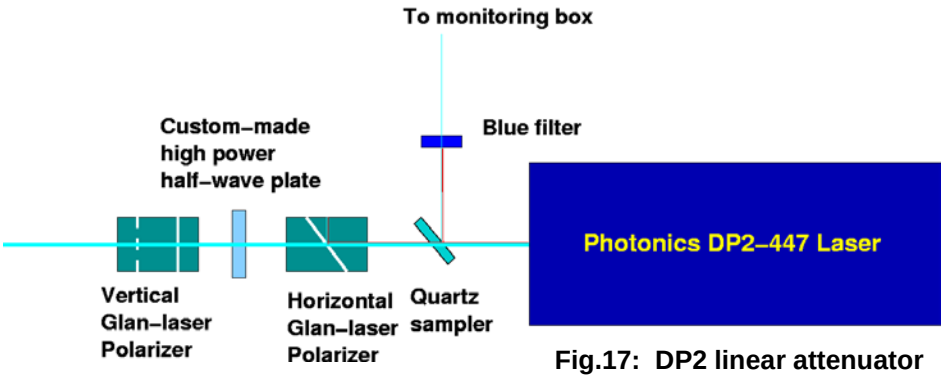


Fig.17: DP2 linear attenuator

The second polarizer allow as well to remove the second harmonic from DP2, since its polarization is perpendicular to that of third harmonic (447 nm). Therefore no blue filter is needed in main beam.

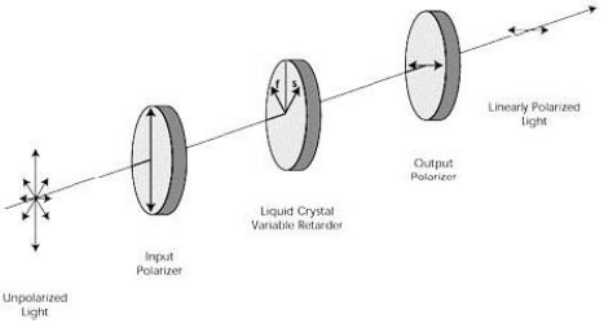


Fig.18: Principle of attenuator

The wave plate is control by a rotary mini stage with the SHOT-102 driver. The calibration is done through the software in order to get a full range from 0 to 100% of light. The total insertion loss of the new attenuator is measured to ~ 85%.

The DP2-447 has 2 trigger inputs:

DIODE TRIGGER: the rise/fall edge turns

ON/OFF the pumping diode

Q-SWITCH TRIGGER: the rise edge turns on the Q-switch.

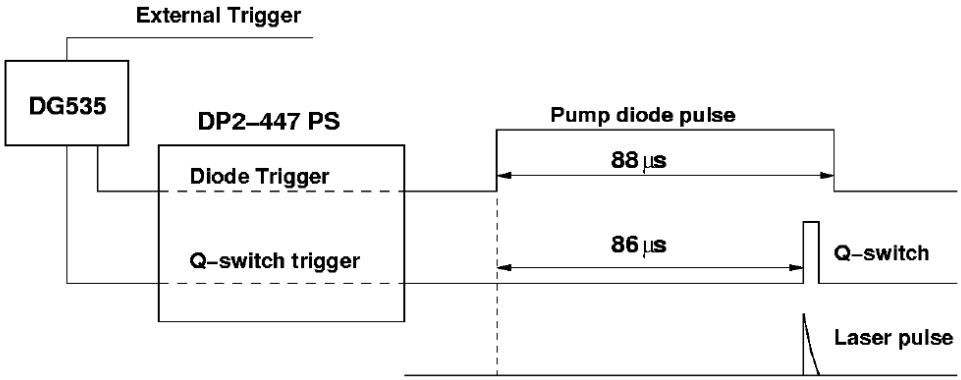


Fig.19: DP2 trigger system

These 2 delay are managed by the DG535 box (figure 4) . The 3rd delay, the main one (A) is calculated to have the pulse in the good period linked to LHC: figure below. It is also associated to a delay managed by the EMTC.
On the laser settings as shown in fig. 7 we have thus 3 delays to control the laser : A, B, C.
D is for the scope.

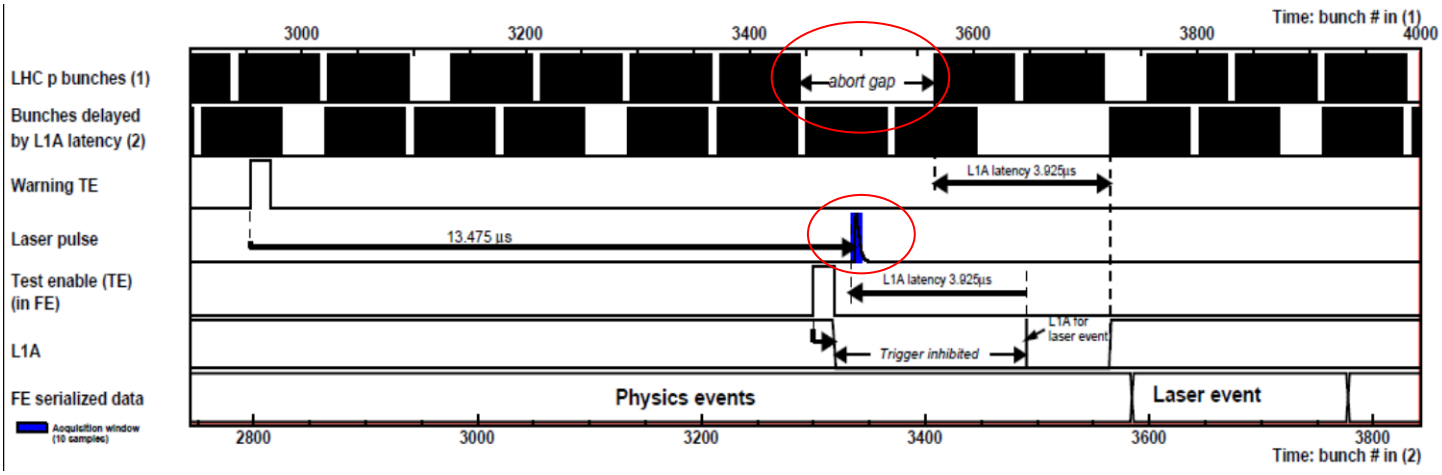
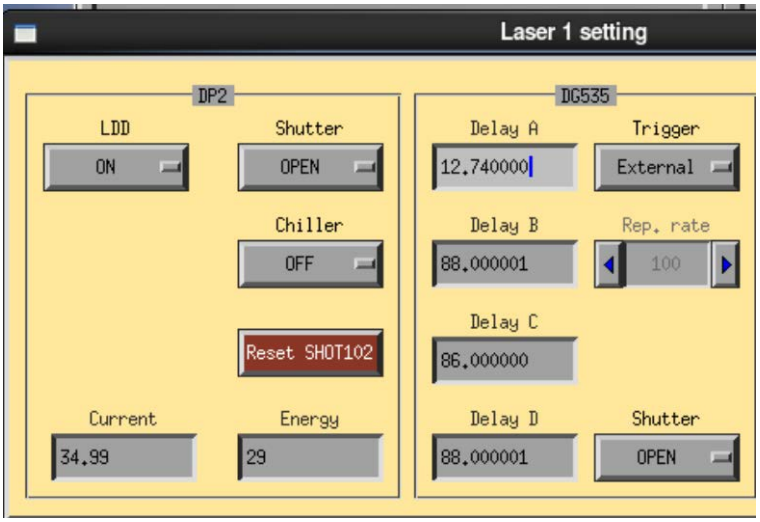


Fig.20: ECAL laser calibration trigger

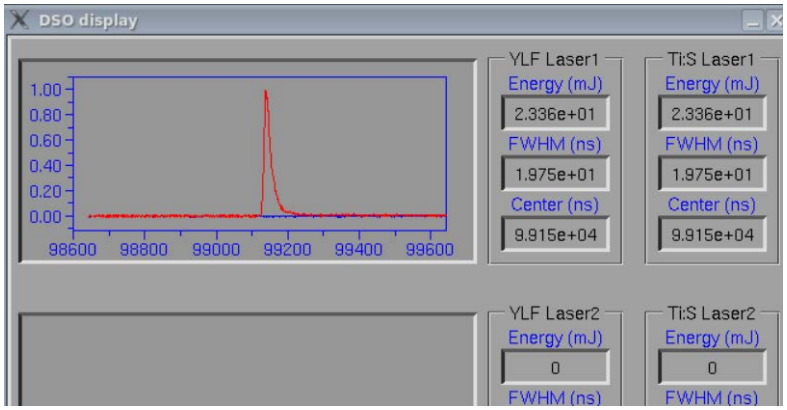
When you start ./laser or ./run be sure there is no error on the terminal and laser display correspond to the real laser state.

Normal status for the laser is the following:

1. LDD ON
2. Q-switch ON
3. Shutter OPEN
4. Current= 35A. If needed changed it: the current will increase step by step slowly automatically, you can see the evolution on the terminal windows.
5. Energy = 29% for Dp2-1 and 35% for Dp2-2
6. Trigger = Externe



If you'd like to check the laser operation while ECAL is running, **it is needed to disable the H4DAQ from laser_h.cfg** to avoid remote operation which could interfered with your operation (Else light can be sent during physics…)



Once the H4DAQ is disable:
Choose a channel > 88 to not send light to ECAL (and put 'none' as laser selection to be safer) and you can put internal trigger mode: pulse should be there.
If not, all settings and hardware have to be checked one by one: shutter ? trigger DG box ? error somewhere ?

b) Program on ecal-laser-room-05

Start server : /laser/dim/linux# ./Dns
/laser/monitor# ./h4daq

Start fast monitoring: /laser/monitor# ./monitor 99150, then ./Disp

c) Switch to the spare laser:

Switch to the spare laser:

The second laser is in principle ON all the time but with current = 0A.
Laser ON mean ready to fire, with LDD and Qswith ON and shutter open.
If not, it is needed to go underground and follow laser manual itself to switch it on.

By default, laser DAQ is running all the time and one blue laser should be already online.

1) Edit the configuration file: **laser_h.cfg**

- Enable the device of the corresponding laser you want to control (* or no *)
- change 0 to 1 SPARE number to put the good laser online:
LASER1 = DP2-1, LASER2= DP2-2

2) Stop current run and exit DAQ.

3) Restart DAQ . Communication with new laser ON should be there.

4) Setting: increase current to 35A, attenuation : 29% for DP2-1, 35 for DP2-2

5) Check if pulse is there with internal trigger mode. Exit program. On laser_h.cfg change back DAQ mode: **H4DAQ = 1 = ONLINE.**
Start again laser DAQ.

6) To be sure the communication through the server : check the access (server) on same PC with :
/dp2n# ./client ecal-laser-room-02.cms
Type 0 (REQUEST) → DAQ should start. And or SET :
Optical switch may changed according to the selected wavelength.

Each time you change the trigger source to INTERNAL TRIGGER : be sure the main channel is > 88 and the laser_DAQ is disable .

3. Check laser output on the main chain

For various reason it is necessary to check if the laser pulse which reach ECAL is OK.
This is needed when ECAL does not see light or before ECAL, if there is optical chain issue like to much attenuation.
→ light pulses may not achieve specifications
- Energy too low or not stable (>3%),
- Pulse center: far from mean value (defined by ECAL readout) or as it should be in configuration file or pulse jitter >3ns

Energy and FWHM specifications are only linked to laser tuning itself and or optical chain: fibres.

Pulse center:
Jitter is also linked to the laser tuning but the mean value is controllable thanks to **delay A** (main delay).
Delay B,C,D are fixed !

To check the main chain, it should be done with the fast monitoring:
The fast Acqiris is not working with internal trigger mode because in this case the board is not triggered.
So it is needed to send external trigger to the laser with a DG535 box (at 100Hz) and selected the good laser online on external mode. This external trigger replace in fact the ECAL trigger from EMTC.
The pulse should be visible on fast Acqiris.

Each time you change the trigger source to INTERNAL TRIGGER : be sure the main channel is > 88 and the laser_DAQ is disable .

When laser is (are) online the laser plots"sequence validation" on the Matacq should be GREEN. The figure 19 show a Matacq example where the green laser was faulty time to time because of Amplitude=0: the sequence is such red at the same time.

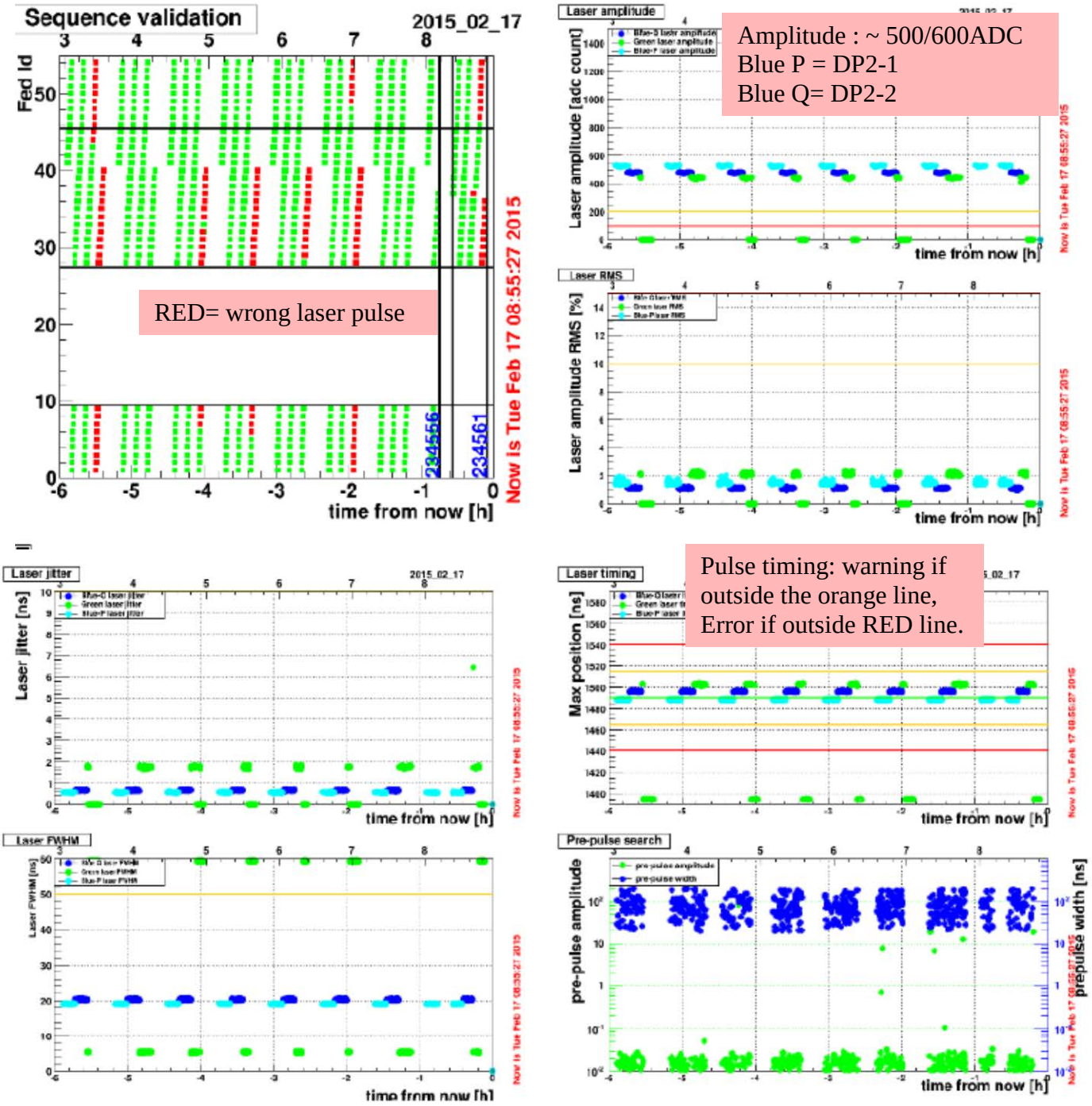


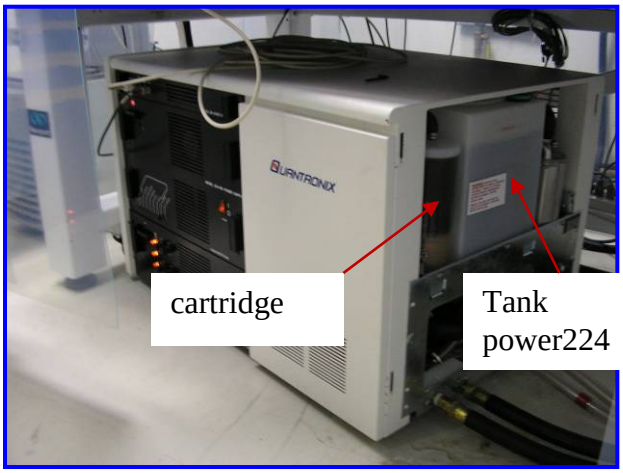
Fig.21: Matacq plot

III. Regular maintenance and services

1. Quantronix and DP2

Quantronix:

- Check the pulses evolution with histogram and history;
- Check the water level in Neslab chiller (TiS);
- Check the main cooling circuit;
- Check the water level inside tank on power224; Fill the distilled water to the line;
- Periodically (90days), change the deionizing cartridge and clean or change particle filter in the internal cooling tank;
- Every ~1000- 1500hrs, **change YLF lamp**.



→ If laser not in used: closed VALVES of the water supply – switch OFF laser power supply – switch OFF Neslab.
Remove the water from the YLF chamber by disconnecting one pipe.

Photonics:
Check everyweek the water level,
Changed the distilled water every 3 months,
Check the filter on the water pipe.
Room temperature, ect.
Refer to the laser manual for full details.

In case of short or long break the laser controller should remain on the 220V all the time (Xmas time, ect.)

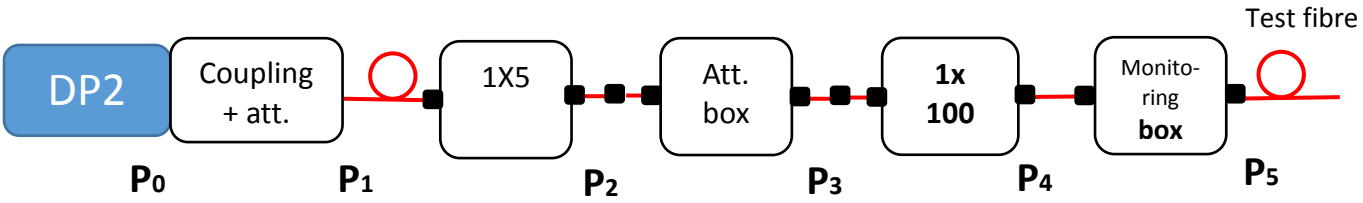
2. Attenuation of the optical chain

One of the main reason for a power degradation come from the optical quality. Over time some dust or damage on optical fibre reduce the amount of light at the end of the chain.

Here is the setup and the reference measurement of the full optical chain.
The power is measured after each crucial optical device to estimate the insertion loss.
The reference is P0, the DP2 output. P1 is measured after the optical attenuator system (at 100%) and after the 20m test fibre. The optical attenuator at 100% has a minimal effect so this measurement allow to check the coupling (x-y-z position) and the 20m fibre in used to get the power after each device. This test fibre is connected in order on the optical chain up to the last 1x100 switch.
The attenuation is given by the insertion loss:

$$IL(dB) = 10 \log (P_{out}/P_{in})$$

For each connector, the expected IL is 0.5dB and for the optical switch itself it is 2 dB.
The fibre coupling from the main DP2 is 0.7dB and the fibre is 0.025dBm/m.



<u>The expected overall attenuation for our optical chain is:</u>

$\sum_{loss\ (447nm)} = 0.7 + 0.025x33 + 0.5 + 2\ (1x5switch) + 0.5x6 + 2(1x100switch) + 0.5x3$

$\sum_{loss\ (447nm)} = 10.5\ dB$

<u>Example:</u>
For P0 = 40 mW, we have P5 = 2.2 mW
Total IL = 10. Log (2.2/40) = 12.6 dB which is basically OK.

IV. Quick start up from scratch

What need to be ON:

- DP2-1 (or2) laser system, chiller
- shot102 controller (laser table)
- shutter controller (laser table)
- scopes, crates, optical switch, ect.
- PC: ecal-laser-room-02 and 05

ecal-laser-room-02:
login with root cms account in order to get the privilege :
. home/laser/software/linux…/lib/gpib_config# sudo gpib_config minor –0 (and 1)

Laser account:
.home/laser/dp2n# ./run

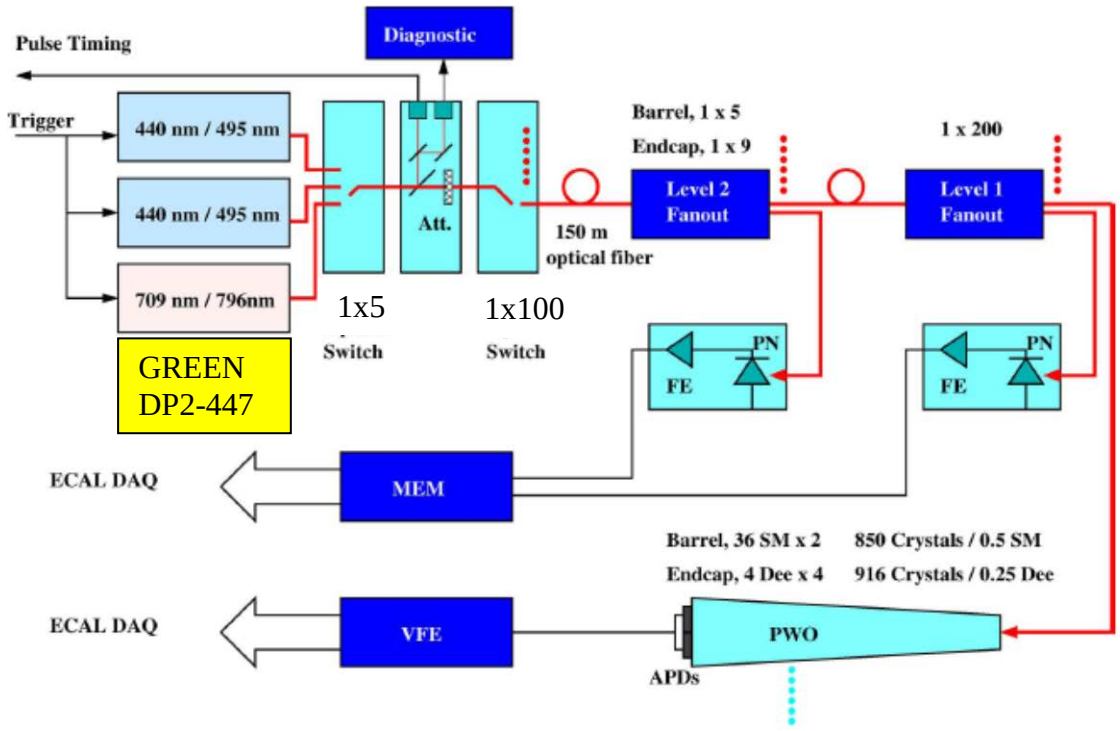
-> Laser GUI interface .

ecal-laser-room-05, laser account:

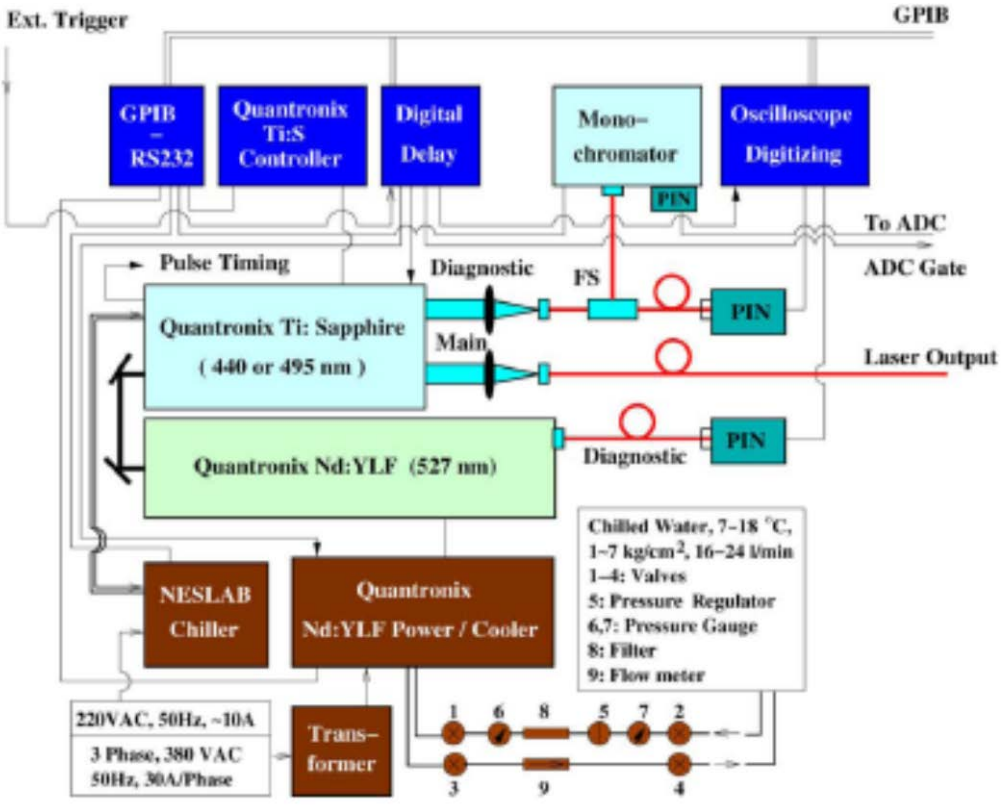
start the server :	home/laser/monitor/dim/linux# ./dns
start the comm:	home/laser/monitor# ./h4daq
start the fast Acqiris:	home/laser/monitor# ./monitor 99150
start the display:	home/laser/monitor# ./disp

V. Annexes

1) Design of the ECAL laser monitoring system:



3) Design of one Quantronix itself (the blue one):



4) Laser safety:

All the safety is controlled by the safety box:

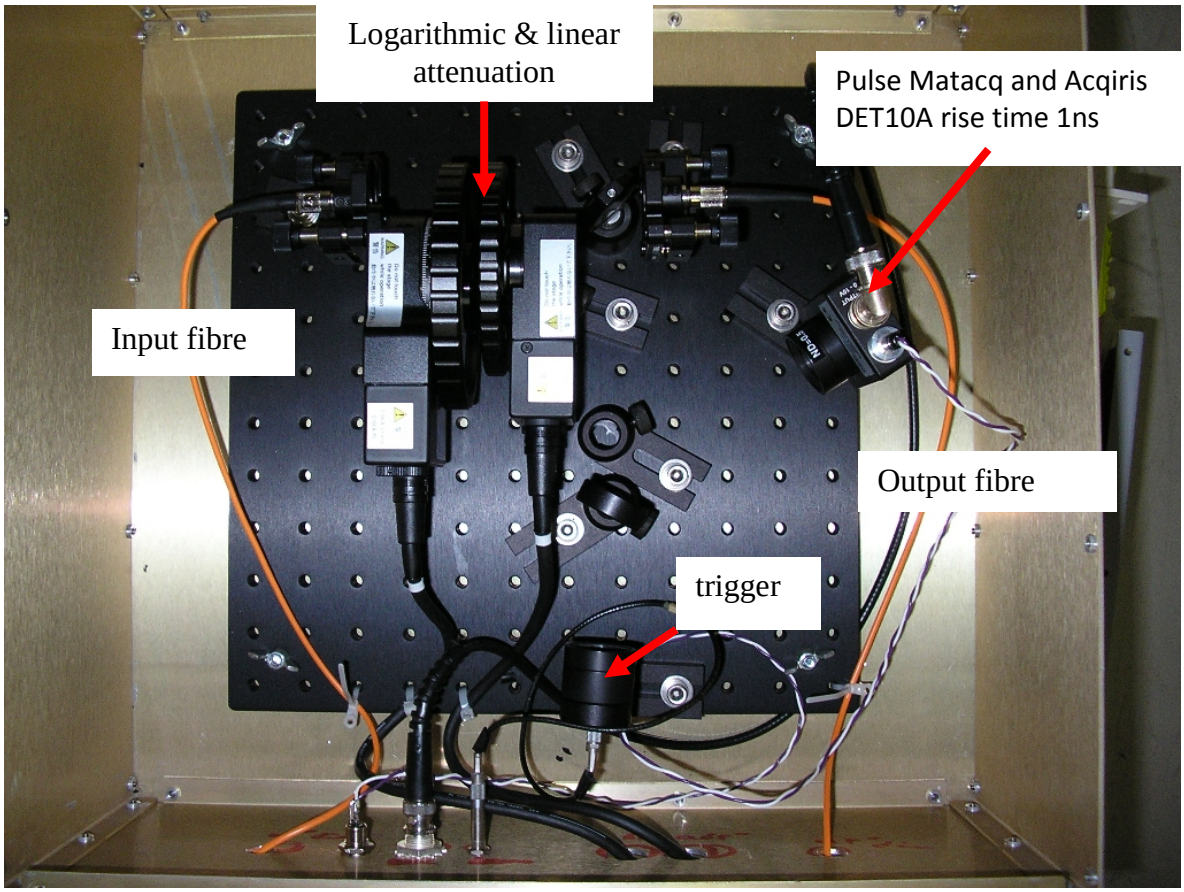
- **Outer door** : - interlock
- **Inner doors** : - interlock

!!!!! If the 2 doors are opened → DP2 shutter is closing, no more light. !!!!!!
At least one of the main door or the inner door should be always closed to get laser operation

To enable it again only local operation on laser controller is possible:

- Decrease current to 0A,
- Open shutter again,
- Put back 35A

1) Attenuation box:



Neutral density filters:
0-10-20-30-40-50 dB

+

Variable Reflective Neutral Density Filters 

⇩

Optical Density from 0.04 - 2.7

Remote control (XDAQ): 1% by 1%

0% = min. power (27 dB loss)
100% = max power (0.4 dB)