ECAL LED Monitoring System

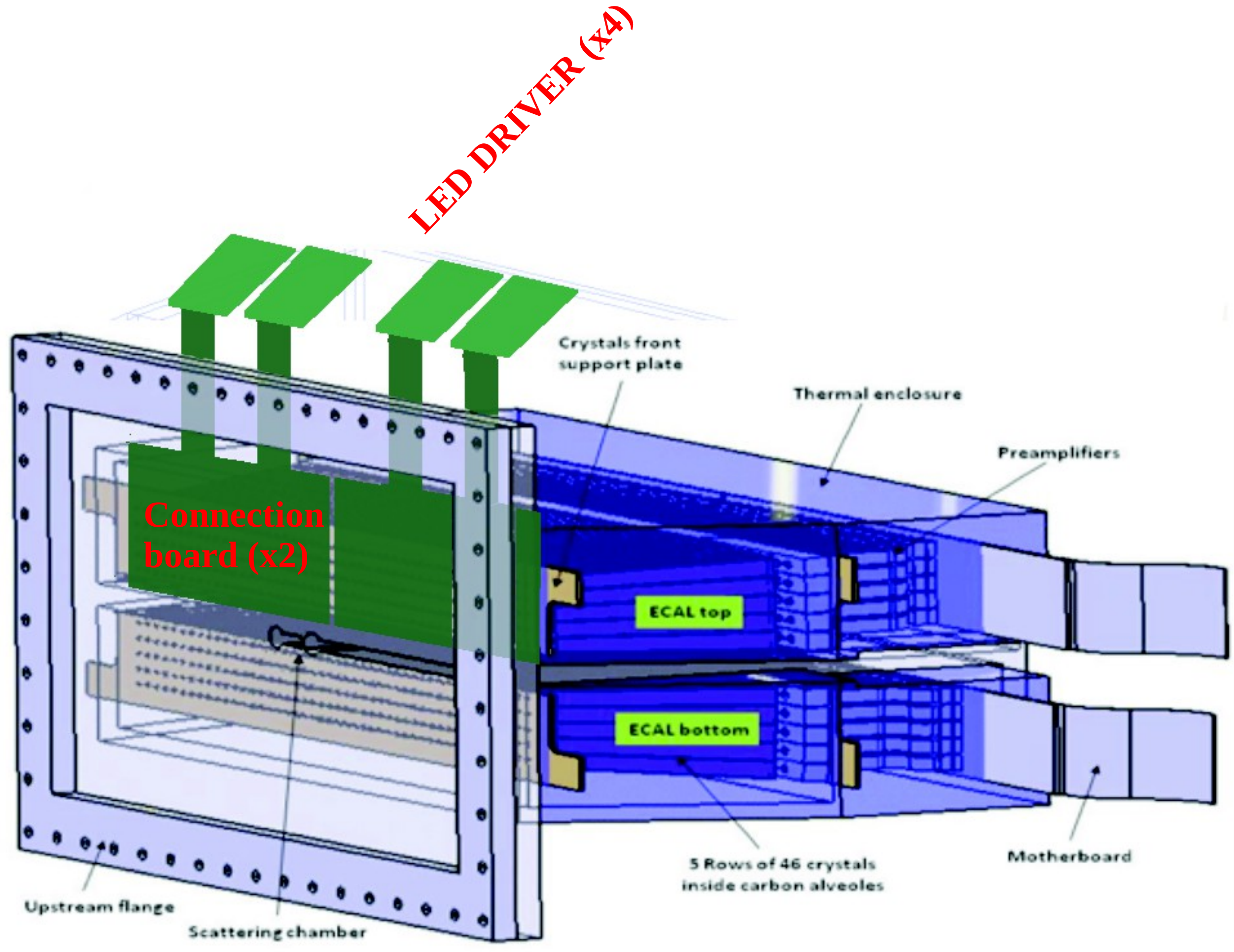
A. Celentano

LED monitoring system design

Design: LEDs mounted in front of $PbWO_4$ crystals.
Use wires to connect LEDs to a connection board, mounted in front of ECal

Components:

- Main controller (2 x)
- Driver Boards (8 x)
- Connection boards (4 x)
- LEDs (442 x)



Main controller

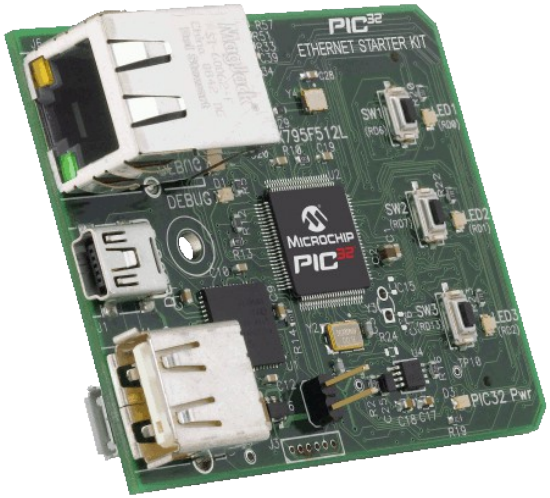
The main controller

- Provides communication with the system through Ethernet/USB interfaces.
- EPICS compliant.
- Mounted in a crate, ~10 m from the calorimeter (1U/controller)
- Handles up to 6 driver boards.
- **Both ready and tested**

2 independent controllers, one for ECAL TOP, one for ECAL BOTTOM.
Clock is propagated from the first to the second for syncronization (feature already tested)

The controller communicates with the driver boards trough I^2C bus.

- **USB port:** gives direct connection with I^2C bus: **debug only.**
- **Ethernet:** communication handled through PIC32 Ethernet starter kit (32-bit MCU), connected to the I2C bus as master.



PIC32 firmware written and tested

- Uses Microchip TCP-IP stack (supports DHCP/static IP address)
- Implements a TCP server listening for incoming connections
- A connected client can interact with the system sending string commands

Full documentation: Wiki page

Main controller: EPICS integration

Ken Livingstone is developing the EPICS-side software to interact with the Led Monitoring System

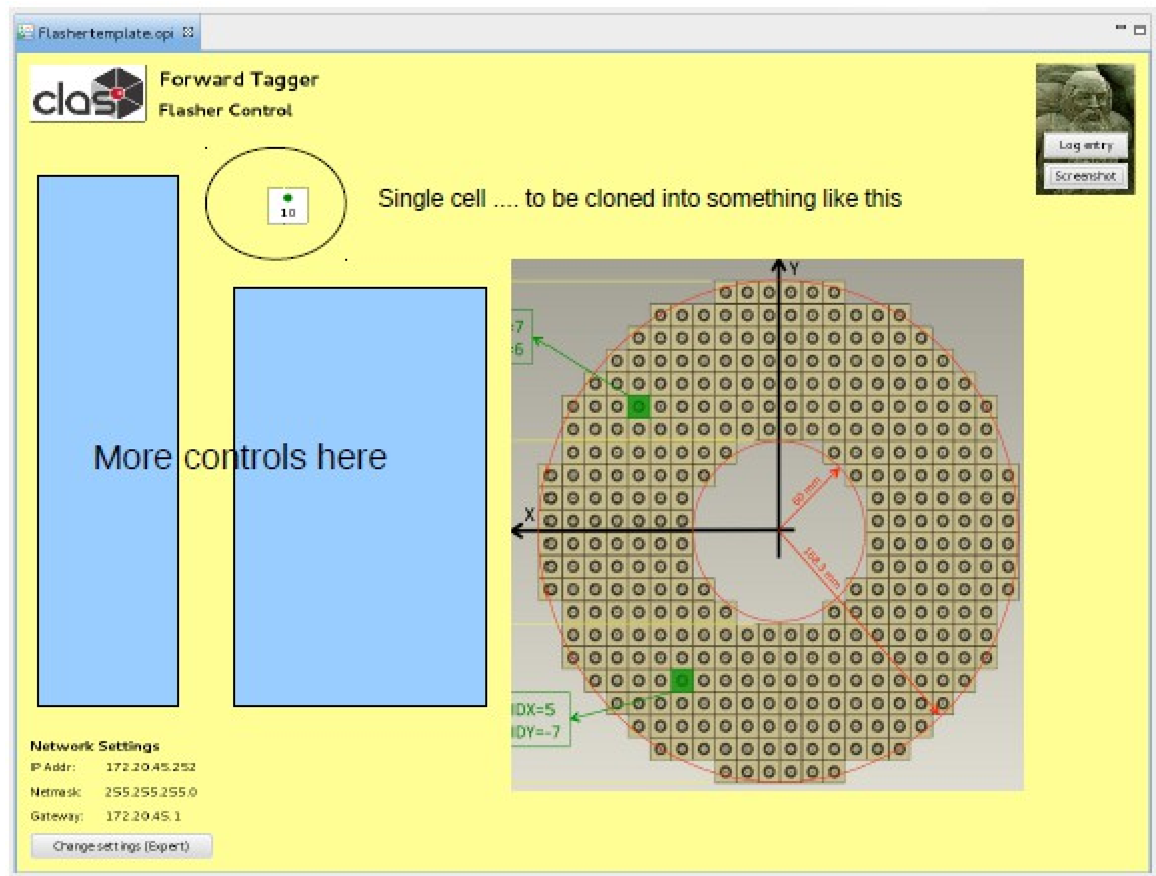
- SoftIOC running on a PC, communicating with the controller through the StreamModule module
- GUI for users interaction

Status:

- SoftIOC ready
  - Employs streamDev module
- GUI under development
  - Try to have a common effort between HPS and CLAS12
  - Discussion in progress to check compatibility

Operations:

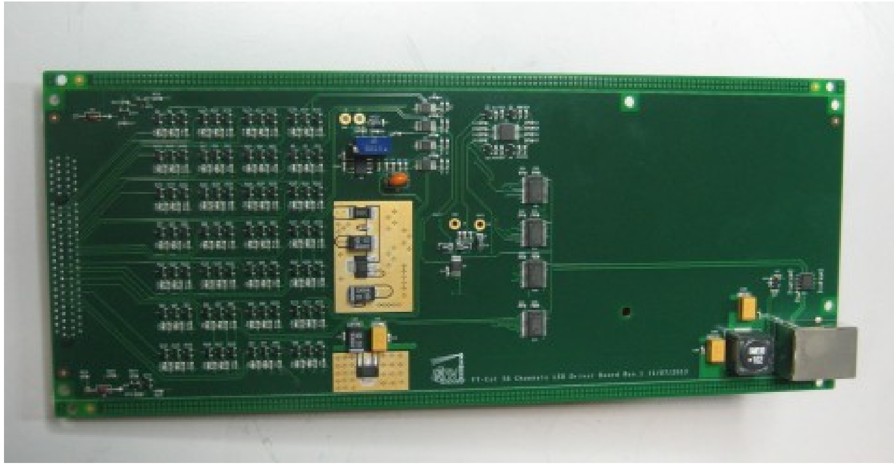
The system can be used immediately after installation in the ECAL, even without GUI.



Driver board

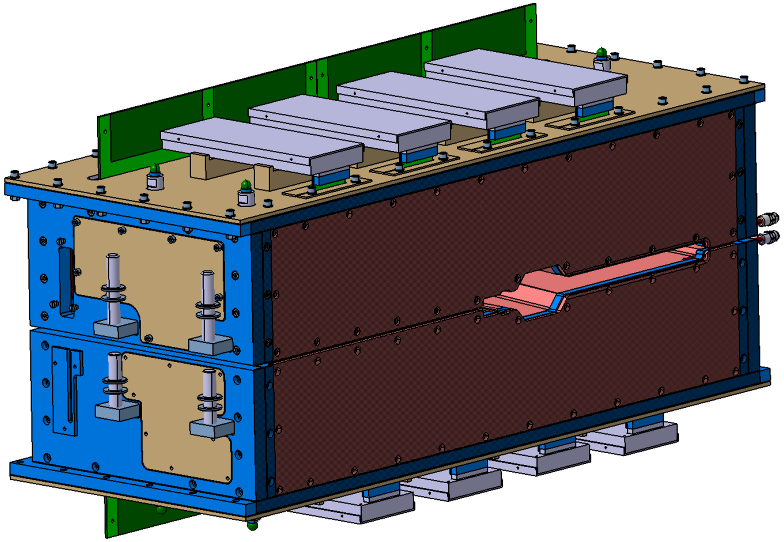
The driver board

- Hosts **56** independent LED pulser circuits.
- Communicates via I^2C with the main controller , through Ethernet-like cable
- Mounted out of the calorimeter enclosure, it is connected to the LED board.
- **During tests, one minor project error found and corrected (bad LVPECL twisted pair termination).**
- **10 boards ready and tested (8+2 spares)**



Connection board

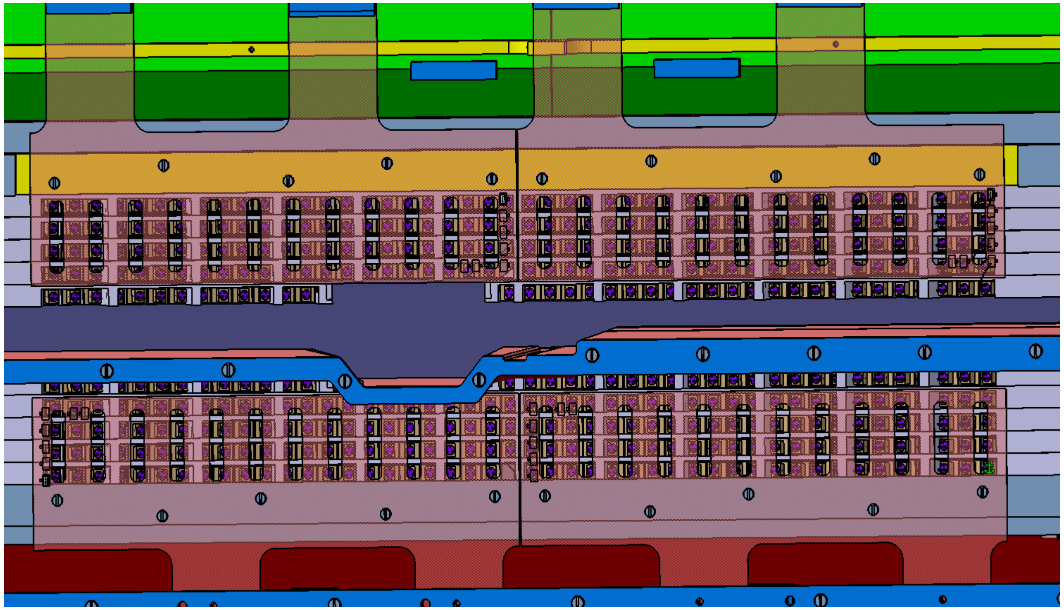
Mechanics



- ECAL enclosure has to be modified to support drivers and let the connection boards exit.
- Iterative process to match mechanical and electronic requirements, now completed.
  - All details were discussed between Orsay (mechanics), INFN-TO (connection board design), INFN-GE.

Connection board design

- Connectors mounted on the upstream face.
- Long holes to route wires to crystals.
- Single design for the 4 boards.
- **Mechanical design completed.**
- **Electrical design completed.**
- **Boards ready and tested.**



Connection board

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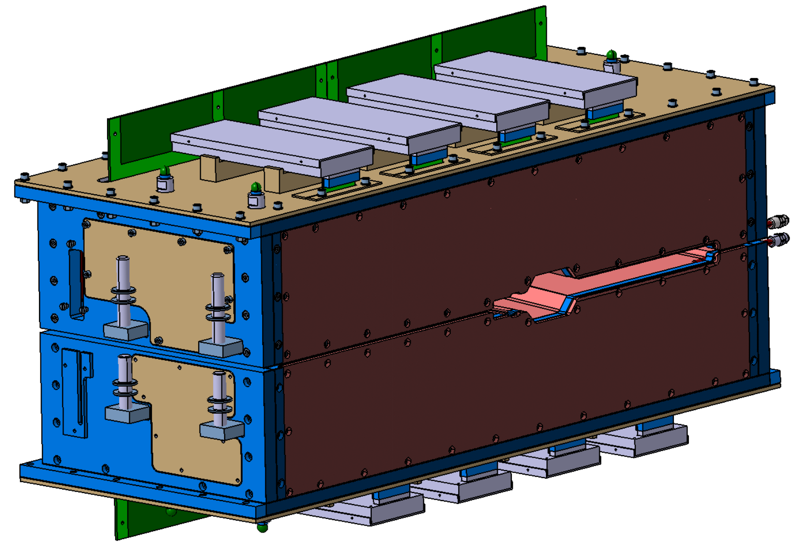

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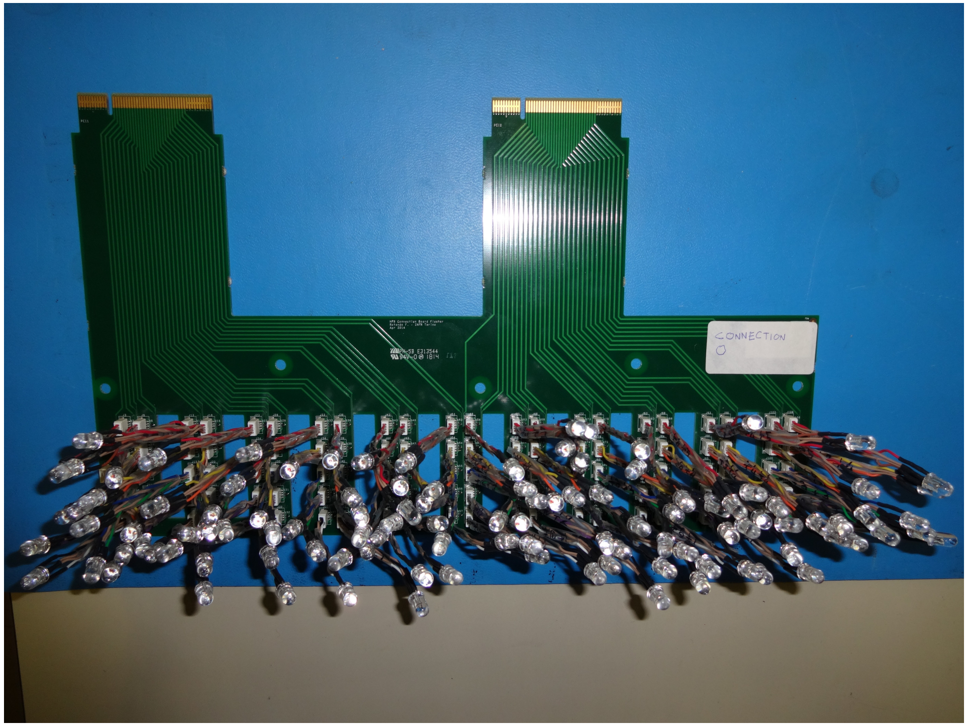

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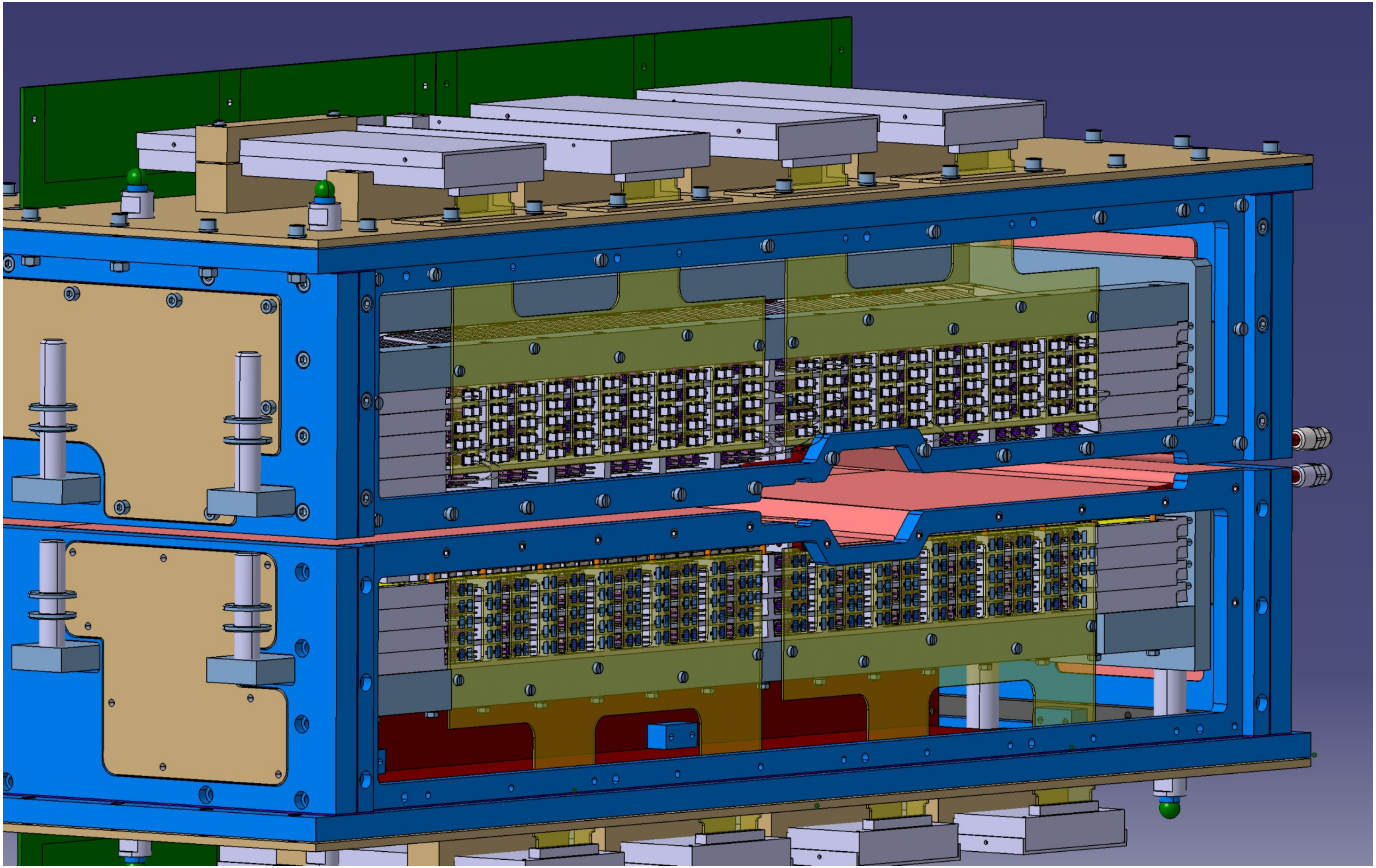
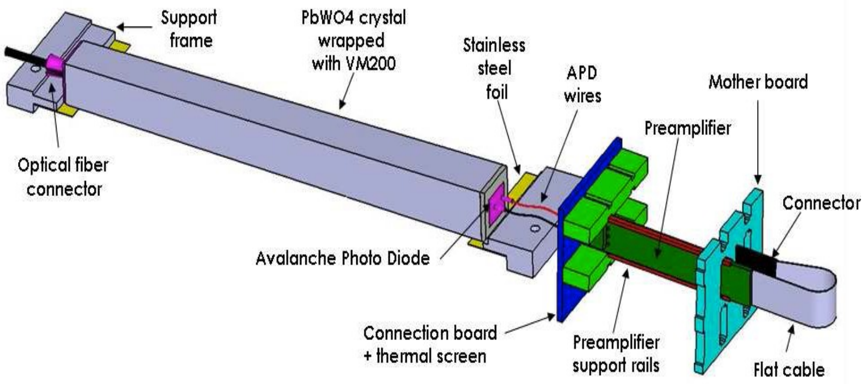


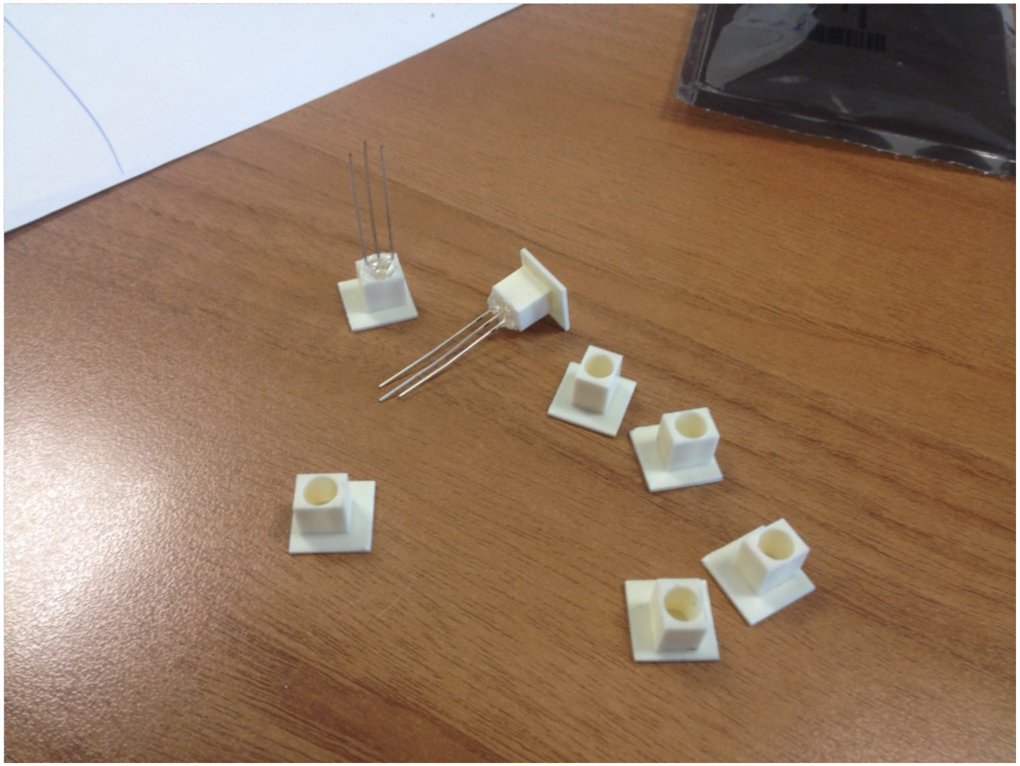
Crystal Assembly

The single crystal assembly was re-designed

- Front PEEK nose changed to accommodate LED.
- LED "embedded" in the PEEK nose, becomes part of the crystal assembly.
- Non-central geometry due to ECal mechanical structure (vertical pillars).
- **LED holders design done (Orsay)**.
- **LED holders production completed (Catania).**
- **LED holders currently at Jlab, ready to be mounted on the crystals.**

Old crystal assembly

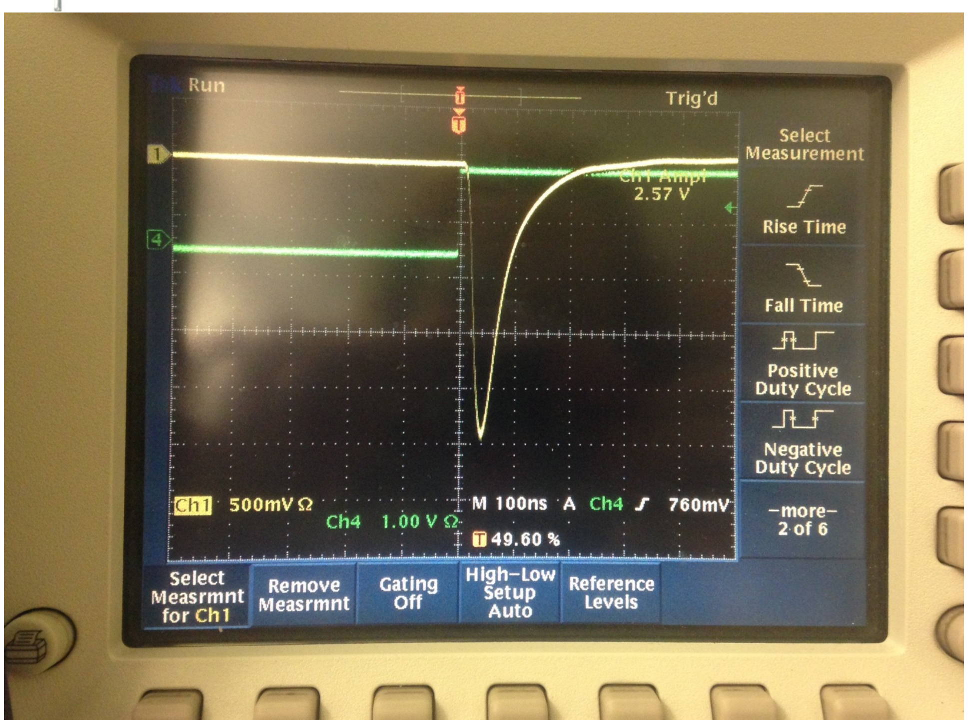


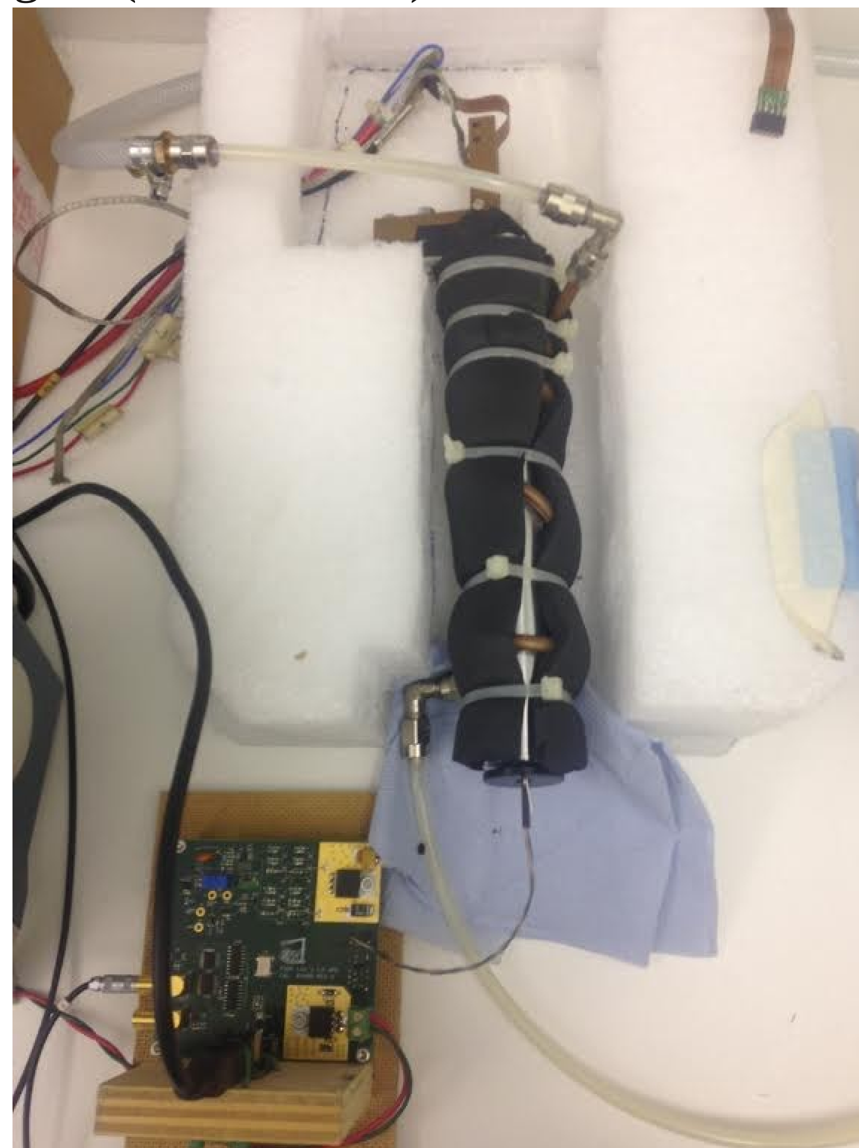


LEDs

RAPID 56-0352 blue/red LEDs are used in the ECal LED monitoring system

- All LEDs were individually tested in Glasgow (E. Buchanan)
  - Dynamic range 2.5 V
  - Pulse width < 150 ns
- LEDs were soldered to wires in Orsay.
  - All LEDs ready to be mounted in the connection board.

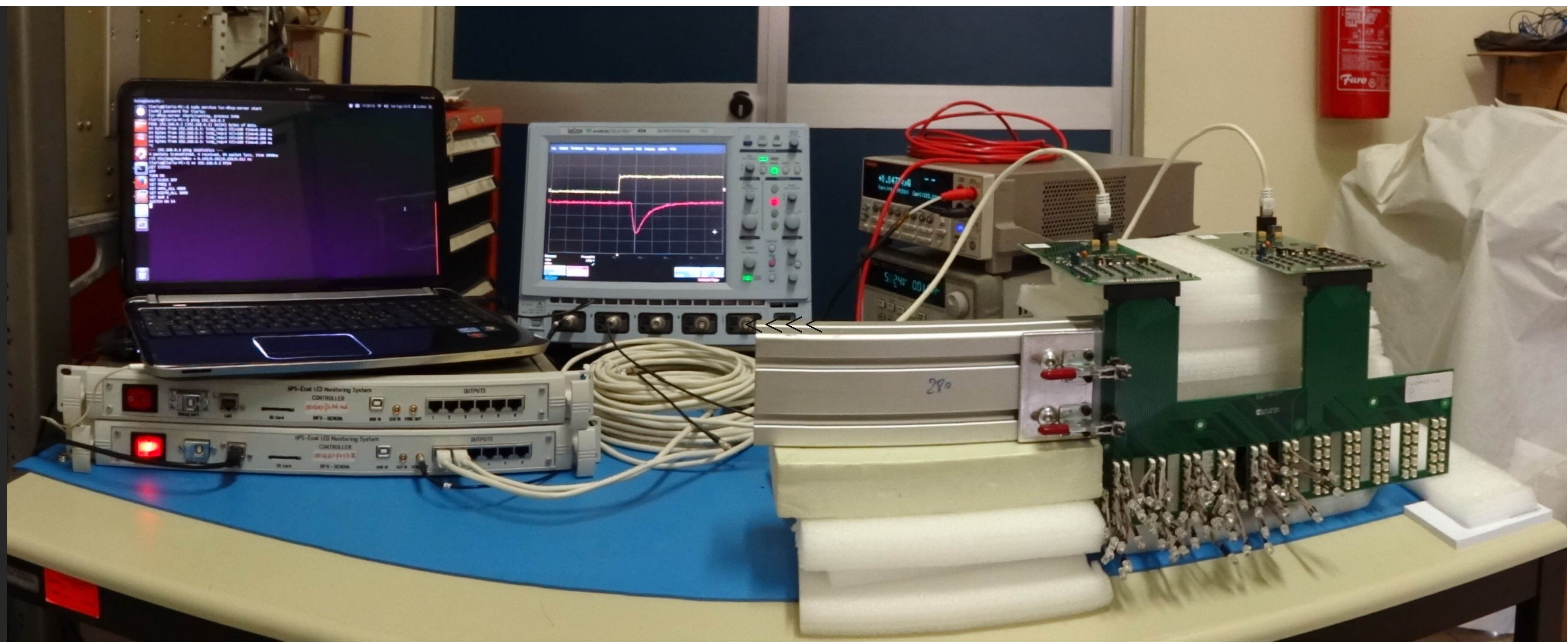




System test

The whole system, in the final setup, has been tested in Torino (I. Balossino), using the same measure system to characterize LEDs.

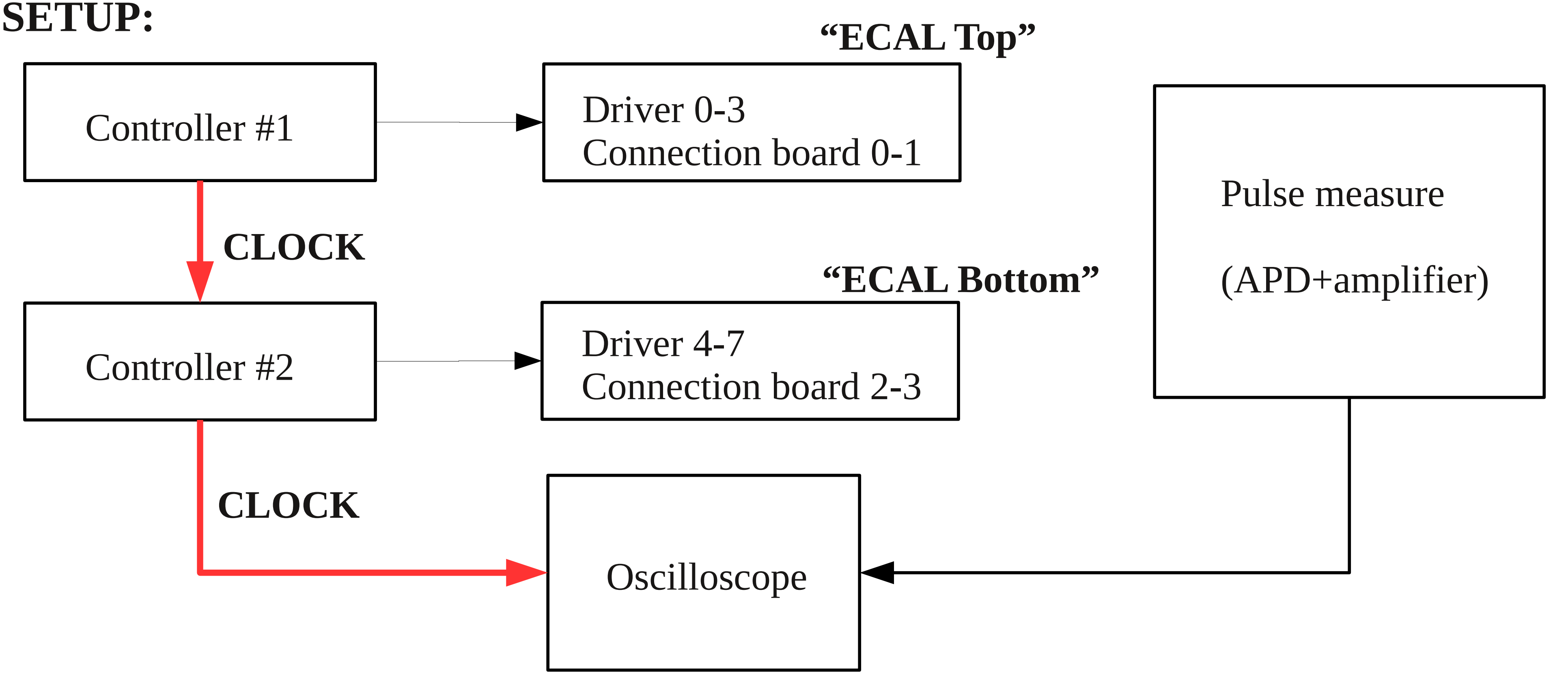
- Final matching drivers – connection boards – LEDs
- Verify all LEDs are properly working.
- Map the LED response vs the programmed amplitude for few samples
- **Measure the relative time delays**



System test

The measure of relative time delays is required for later timing equalization of different ECAL channels.

SETUP:



PROCEDURE:

- Keep all the cable lenghts constant
- Measure the time difference between the CLOCK and the LED signal, for all 442 LEDs

Operations during HPS run

(Fast) in-lab commissioning, before ECAL moved to the Hall:

- Switch on individually each LED, check proper signal cabling from the detector, even just with an oscilloscope.
- Verify the amplification chain is working properly for each channel.
- Check the channel mapping.

Time required: three days (very conservatively).

ECAL in-hall (fast) commissioning:

- Switch on individually each LED.
- Check again channel matching.
- Test the DAQ chain for every channel
  - Verify cable mapping.
  - Align channels in time.

Time required: one week (very conservatively).

Operations during HPS run

ECAL first installed in HPS:

- Acquire data with cosmic-rays, for energy calibration.
- Cross-calibrate the LED system, channel-by-channel, to the cosmics reference point.
  - Record the settings required to produce a cosmic-like energy deposition.
  - Determine the set-point for ~ 1 GeV energy deposition.

Time required: one week (from the experience of single crystal measure in Genova).

At the end of a run, before a "medium" stop:

- Switch on individually each LED, at the work-point found before, verify again proper equalization.
- Acknowledge any drift in the channels working points.
  - Need to introduce a "threshold" in the working point change (CLAS-IC experience)

Time required: 1 h (1 minute/LED, 8 boards/time, 56 LEDs/board).

At the end of a run, before a long stop:

- Switch on LEDs in CONTINUOUS mode, to recover EM-induced radiation damage.