

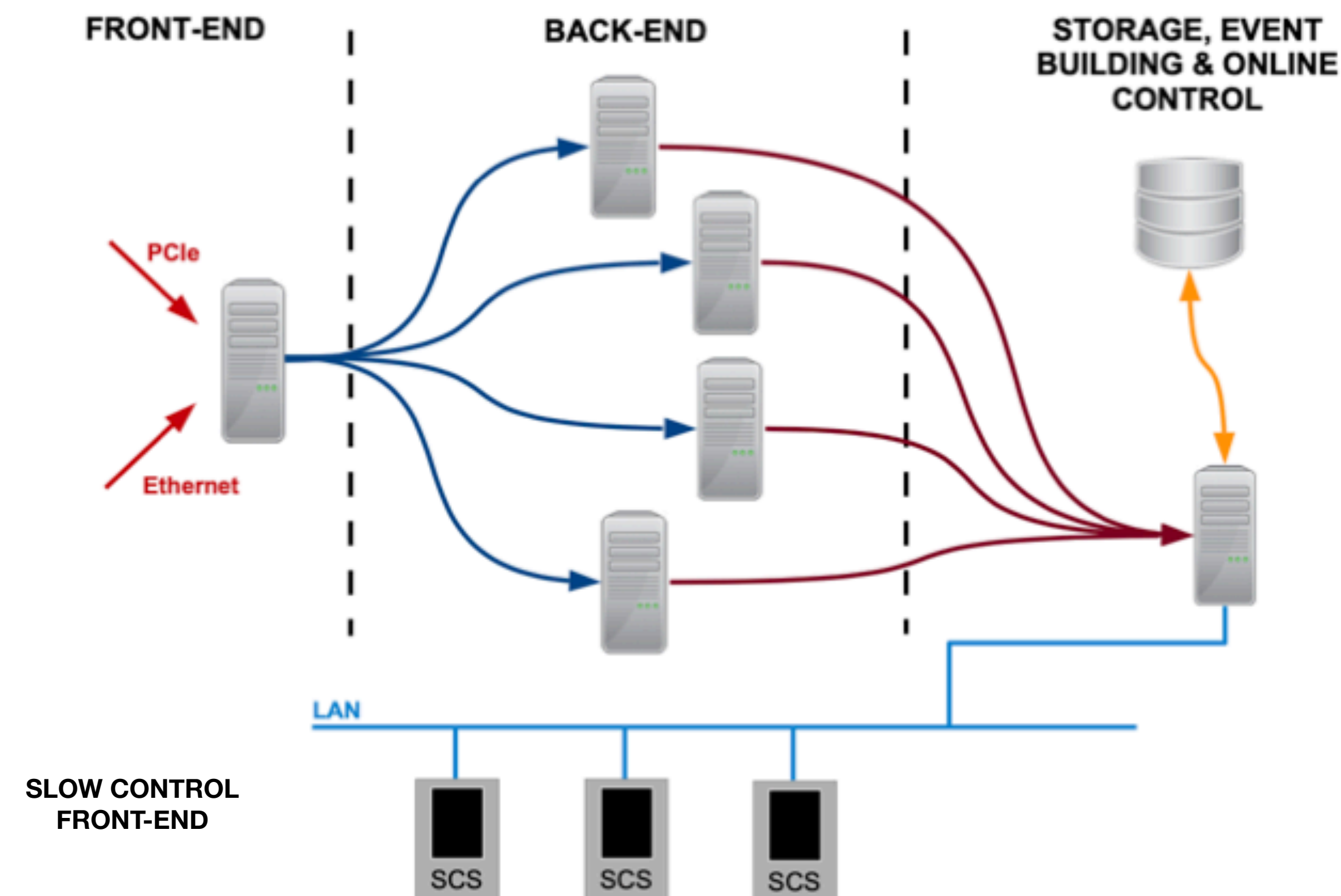
# Status and plans of DAQ system

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**CYGNO Collaboration Meeting**

**LNF, 06/12/2023**



# Introduction

- In this contribution we present the status of LIME DAQ and the plans of the CYGNO **DAQ system**
- Modification to **LIME's** setup
  - ➡ Trigger logic by the Brazilian module
  - ➡ Readout of the GEMs signals
  - ➡ Future improvements?
- Plans for **CYGNO\_04**:
  - ➡ Development of a custom board for the acquisition of the photodetectors
  - ➡ Use a frame grabber to acquire the camera
  - ➡ Development of a software preprocessing of the images on GPUs and possible use the output for a software trigger

# LIME: Acquisition of the GEMs signals

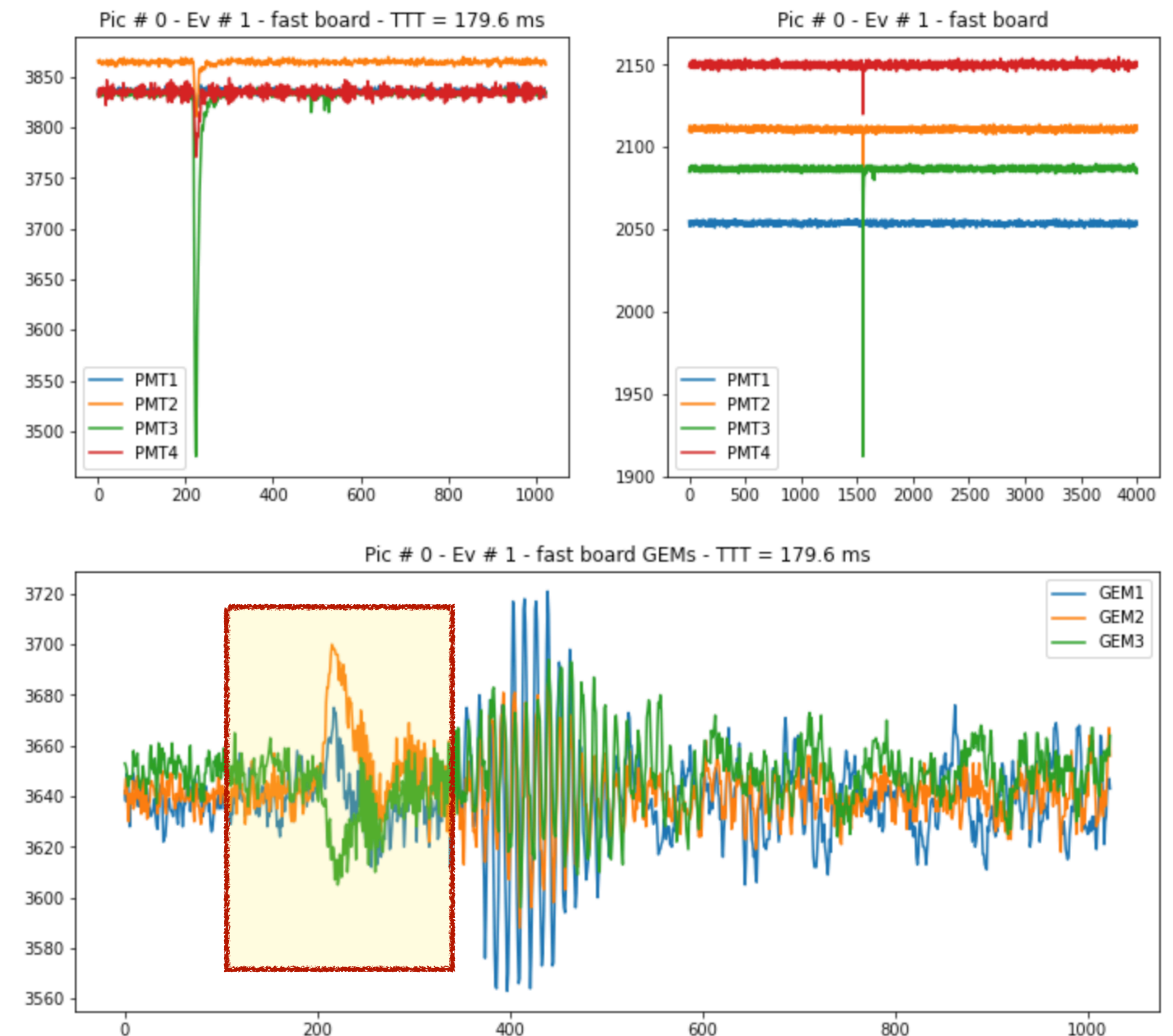
- GEMs signal now acquired with an amplification of a factor of 10, since 13th July 2023
- They are acquired via the fast board on:

A. CH5  $\leftrightarrow$  GEM1

B. CH6  $\leftrightarrow$  GEM2

C. CH7  $\leftrightarrow$  GEM3

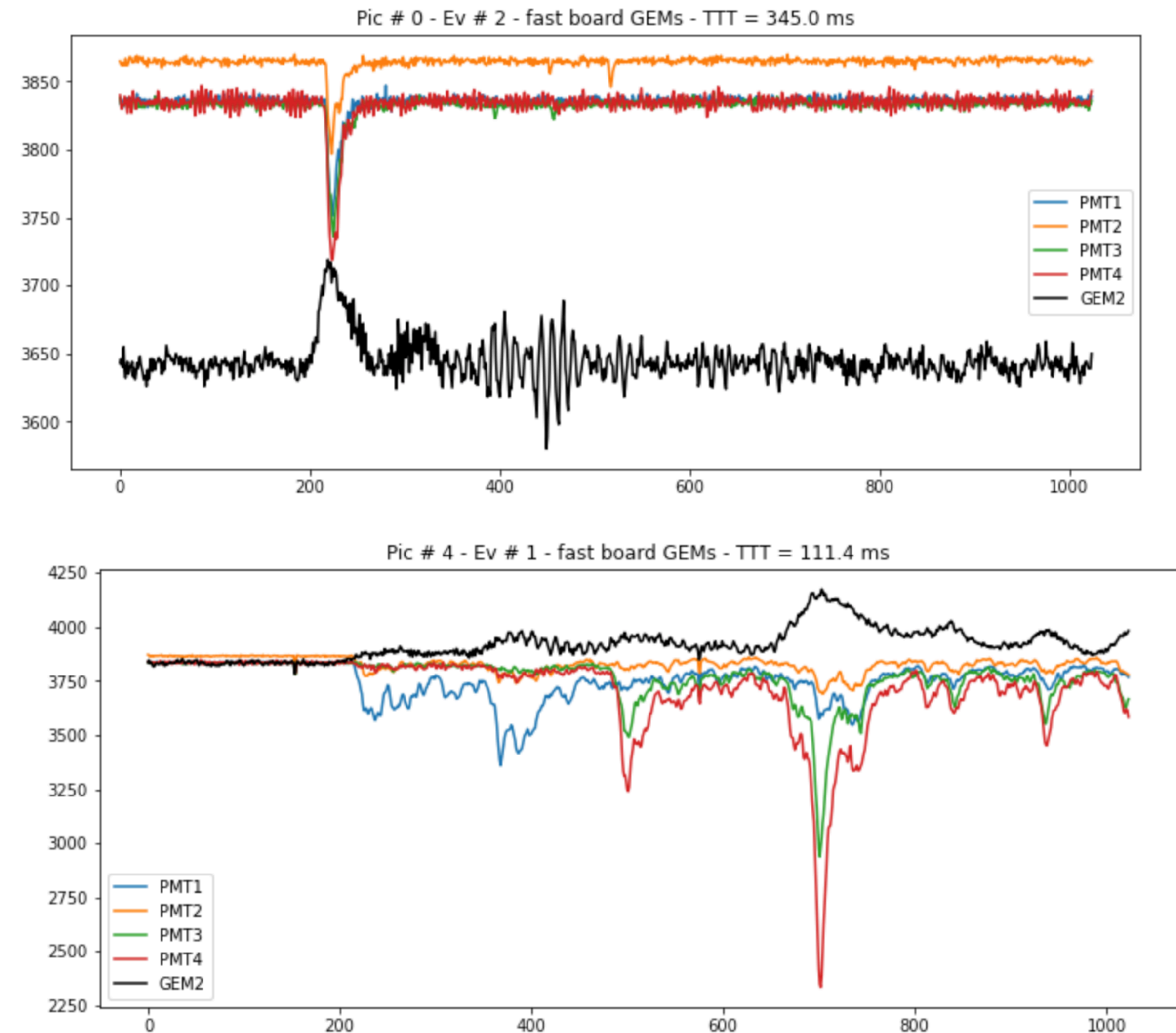
- Quite noisy, and we should plan the development of a dedicated readout system in future





# LIME has therefore a triple readout!

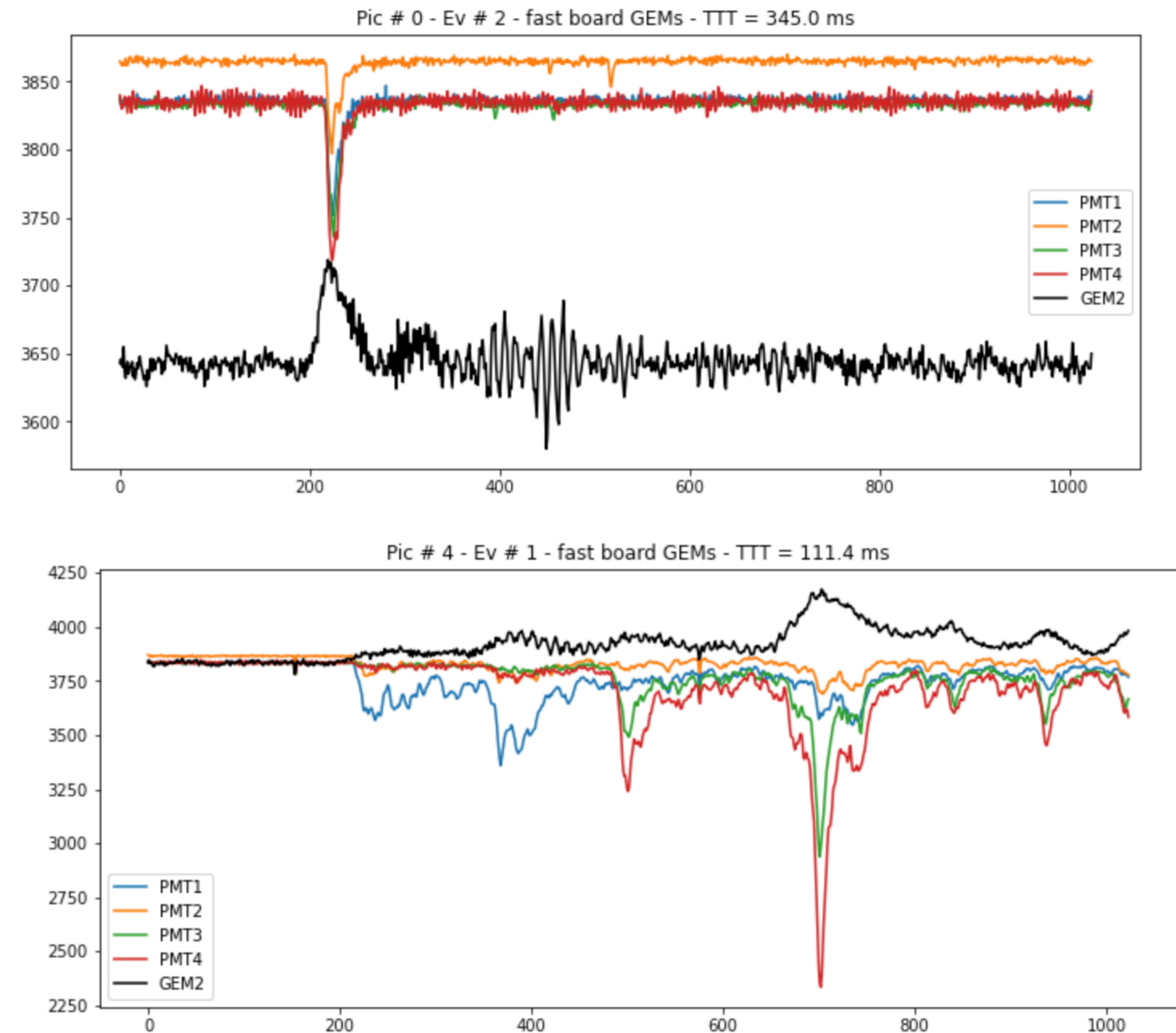
- With the exception of non-uniformities of the GEM gain, the intensity does not depend on the xy position (as the PMT signals do)
- Properly calibrated, this could be very helpful during the PMT xy position reconstruction, reducing the uncertainty on the original light intensity



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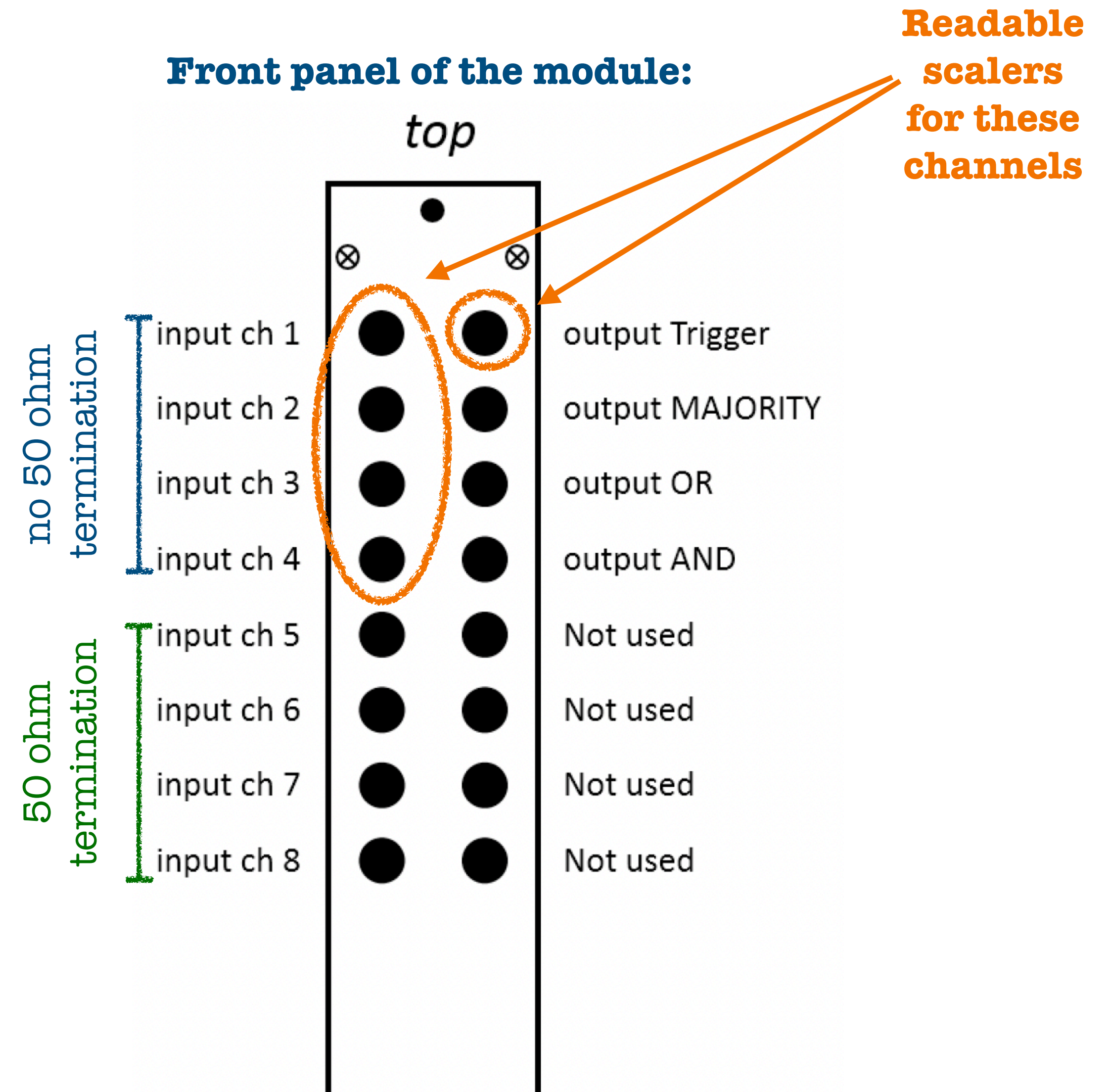
P.S. Nobody has properly looked at this data, yet.  
Volunteers are welcome!





# LIME: Logic with the trigger module

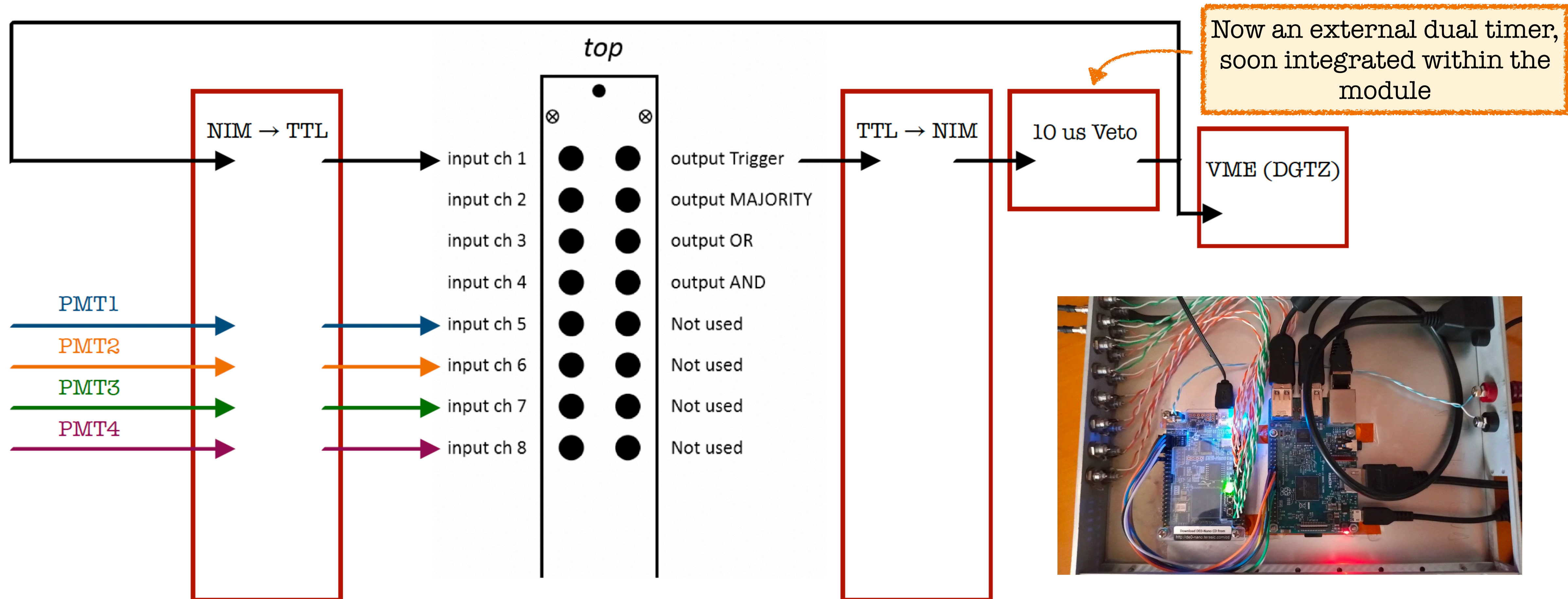
- Trigger Module designed by our Brazilian colleagues
- Contains an FPGA card and a Raspberry Pi
- Standalone and programmable Trigger electronics
- Accessible remotely via Ethernet connection (SSH)
- All inputs and outputs are TTL and LVTTTL compatible





# CygnosTrigger module

- The module is now completely integrated in the LNGS DAQ system since 13th July 2023





# Future improvements of current scheme

- The **major deficit** of the current LIME acquisition scheme is the **deadtime between two subsequent pictures**:

‣ **Result:** tracks acquired by PMTs are absent or cut in the correspondent image

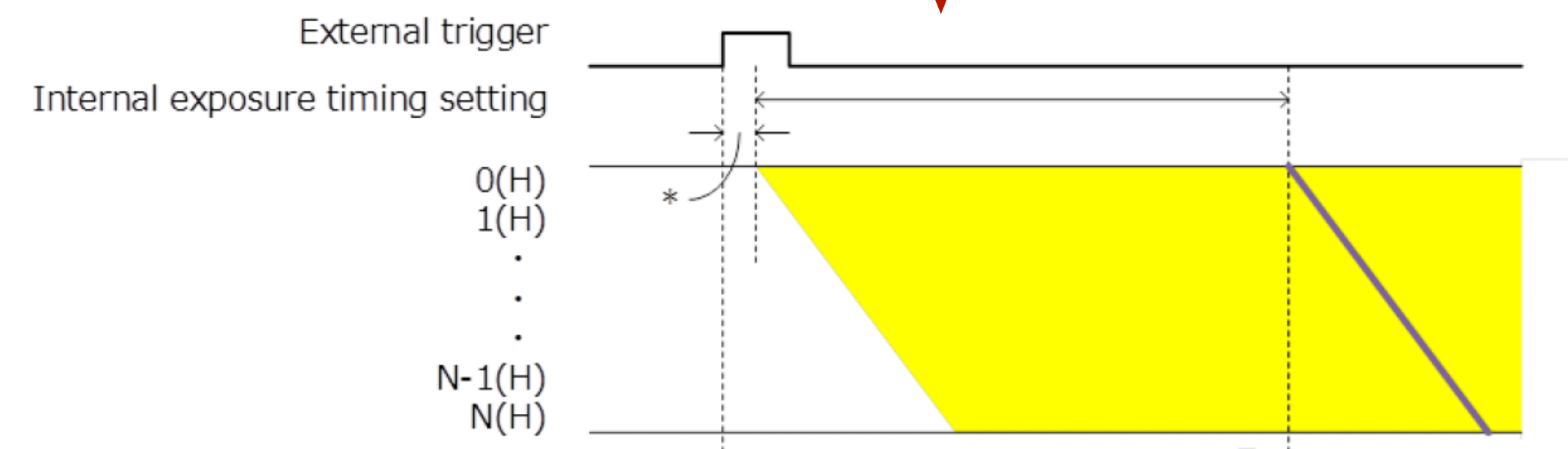
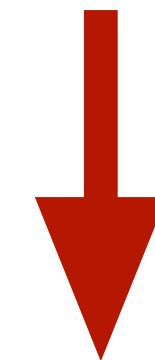
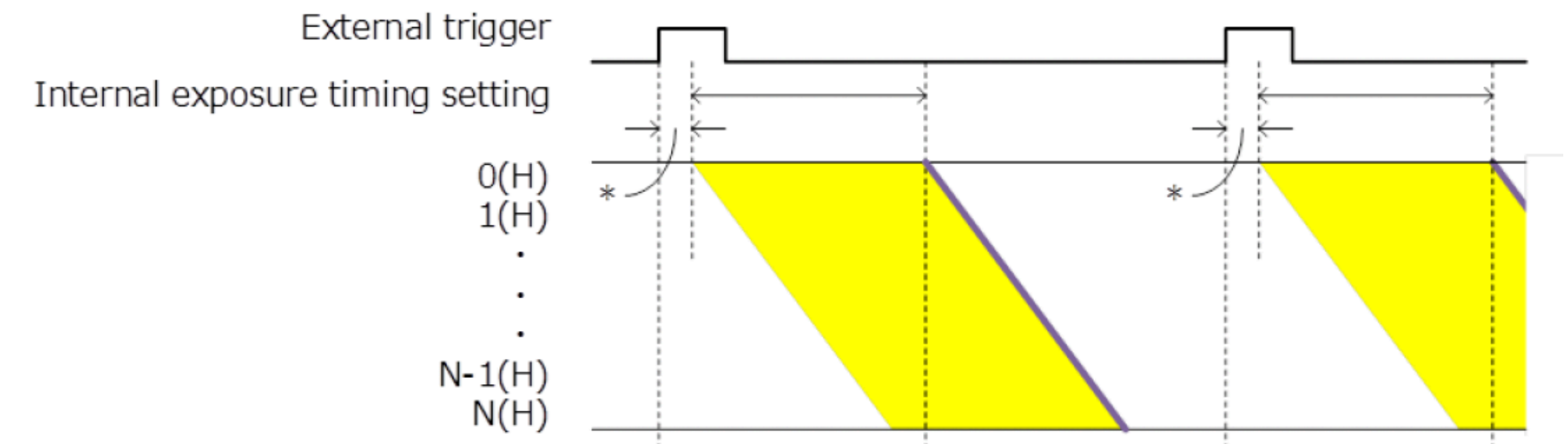
‣ **Solution:** start trigger mode

● After RUN4, tests on the at LNF with GIN

● Delicate synchronization with PMTs:

‣ Is TTT enough?

‣ Shared clock?





# Trigger and DAQ for CYGNO\_04

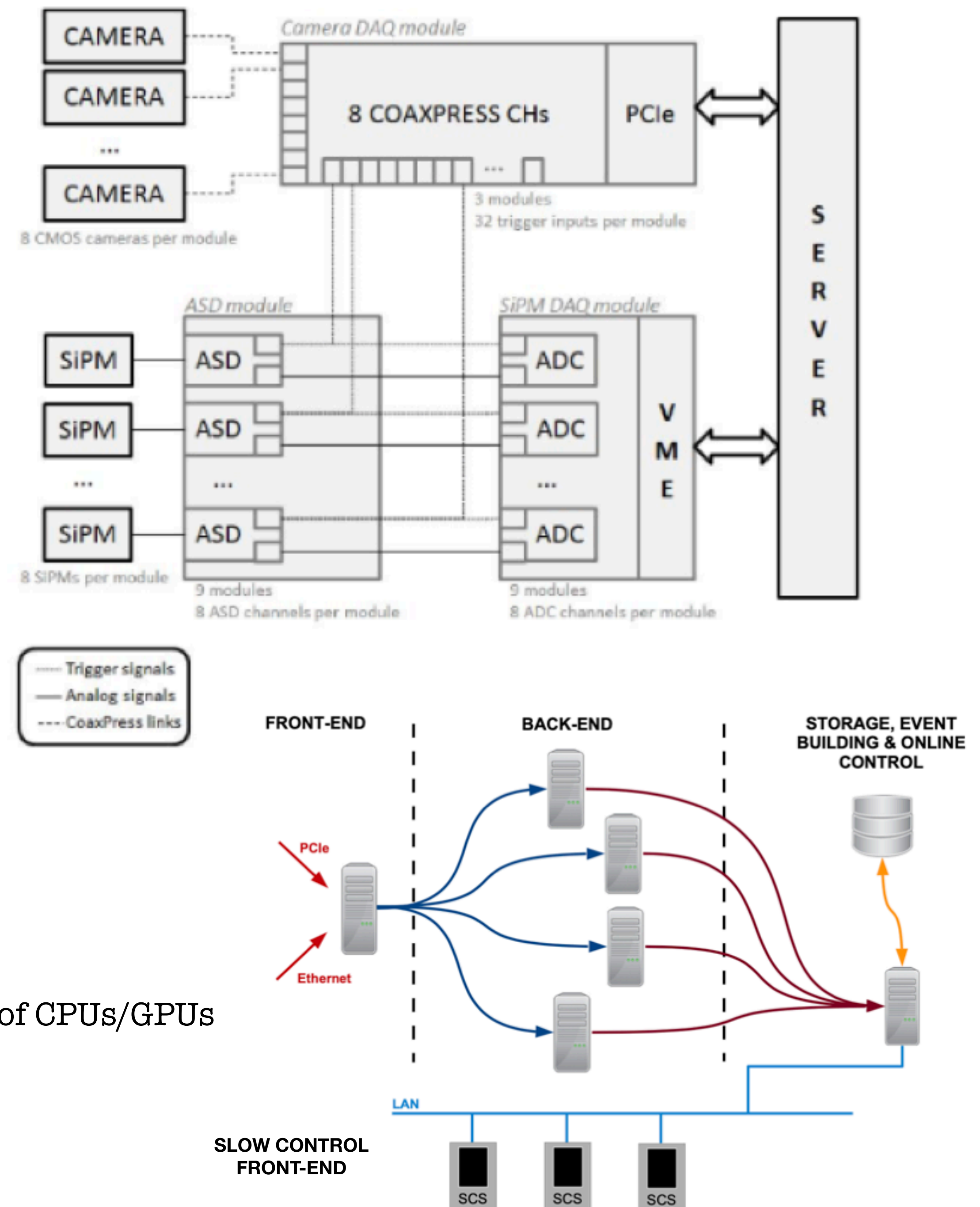
## Two readout path:

- **camera (4 Hamamatsu Orca-Quest):**
  - exposure 0.3 s/pic/cam @ 18 MB/pic/cam  
→ 60 MB/s/cam → 240 MB/s with 4 cameras → SSD local storage
  - CameraLink PCIe frame grabber @ 2.5 GB/s
- **photodetector (8 channels per side):**
  - Assuming a trigger rate of 10 Hz, a 12-bit digitization @ 750 MS/s,  $\lesssim 1 \mu\text{s}$ ,  $\sim 0.2 \text{ MB/s}$
  - Assuming a trigger rate of 10 Hz, a 12-bit digitization @ 250 MS/s,  $\lesssim 10 \mu\text{s}$ ,  $\sim 0.6 \text{ MB/s}$

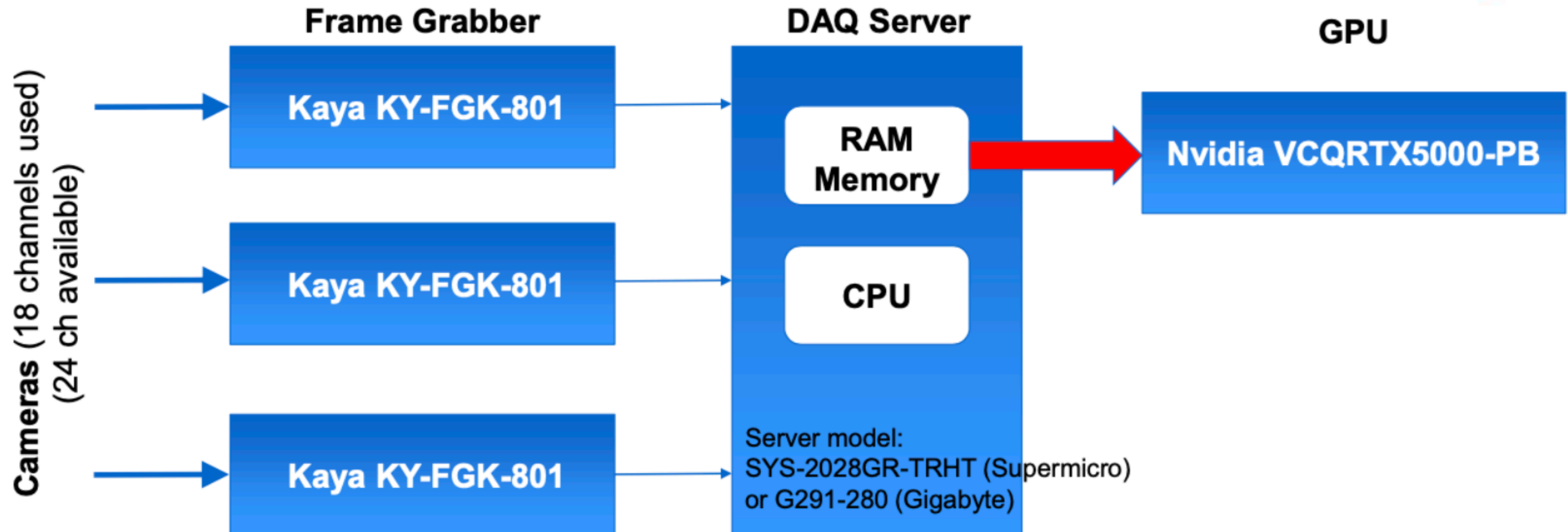
## Two possible trigger levels:

- **HW trigger:** photodetector with minimal logic (e.g. majority)
- **Software trigger:** reconstruction of images and waveforms on a farm of CPUs/GPUs and based on interesting features (eg. clusters)

**MIDAS** used for Readout, Trigger and slow control



# Camera readout system





# Ongoing: software and hardware

- The development of the DAQ system for CYGNO\_04 is a **high priority task**: the DAQ team needs **manpower** and **help** from the technical point of view.
- **Software** development:
  - Image acquisition and synchronization with boards: it should be developed in synergy with the reconstruction and all related services (middleware etc.)
  - Software trigger to reduce the data throughput
  - Evolution towards a more complex and general data structure
- **Hardware**:
  - How many and which **board**: with 2 V1742 (32 ch, 750 MS/s  $\rightarrow$  1 sample = 1.3 ns, 1  $\mu$ s time window) we can safely cover the CYGNO\_04 needs
  - Evaluate with the PMT team if the 750 MS/s board is really needed
  - There's no time for us to develop a custom board
- We will have to **procure of the hardware** (boards, framegrabbers, etc.) and start the tests with the multi-LIME configuration at LNF

# Ongoing: overall system design

- The **Trigger Module** will have to be updated and adjusted to be included in CYGNO\_04
- **Synchronization**: to not lose correlations between events in the different sub-detectors, the 4 LIME-like TPCs will have to be synchronized
- Define an **inter-calibration** procedure of the sub-detectors
- **Data flow** from each submodule: definition of where and how the data are collected and locally stored
- **Since CYGNO\_04 is the demonstrator of a bigger detector, the architecture will have to be modular and therefore scalable**



**Thanks for the attention**