

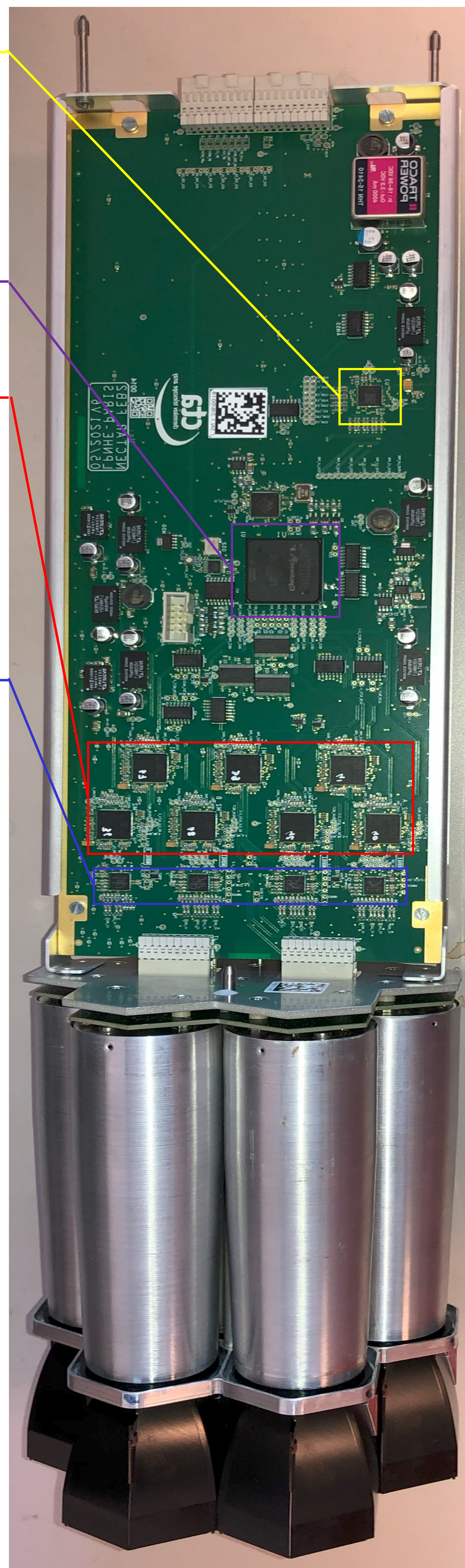
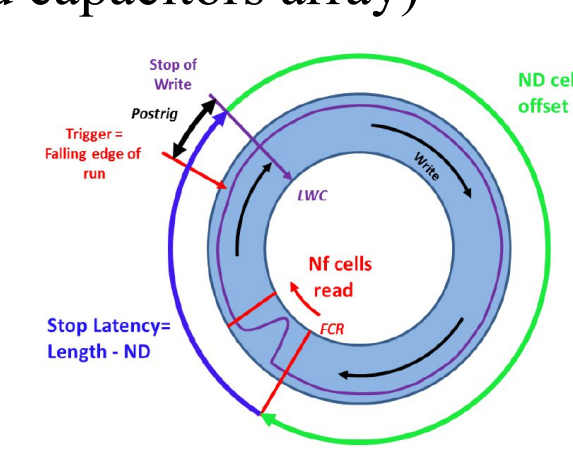


NectarCAM Front End Board (FEB)

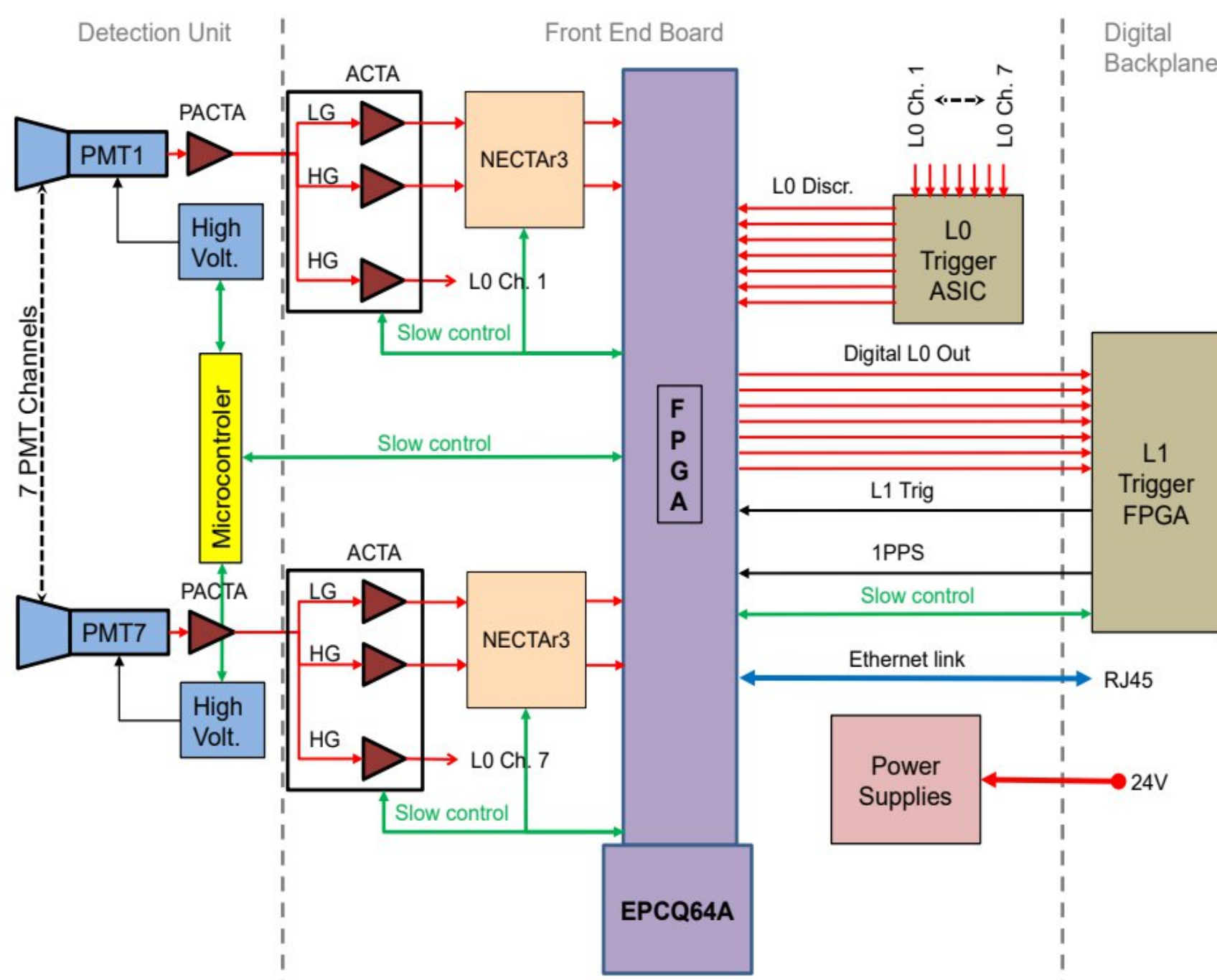
NectarCAM is a camera designed for the Medium Size Telescopes (MST) which will be implemented on the Northern site of the CTA observatory. It consists in 265 detection modules where the Front End Board (FEB) is the central part and is integrated between the Interface Board (IB) and the Digital Trigger Back Plane (DTBP).

FEB is aiming at amplifying, storing and digitizing the signal of each photomultiplier (PMT), formatting and transferring data to the camera server via a gigabit ethernet link, and providing inputs to the trigger system.

- 1 L0 ASIC
 - Level 0 trigger
 - 7 trigger channels from ACTA ASICs
 - 7 digital discriminators outputs for digital trigger
 - Remote control per channel (SPI)
 - Enable/disable, threshold, attenuation, ...
 - Designed by ICC-UB and UCM
- 1 INTEL FPGA Cyclone V, central component of FEB, configured by specific firmware (see firmware part)
- 7 NECTAr ASICs
 - Differential inputs
 - 2*512 cells SCA (switched capacitors array)
 - Sampling up to 2GS/s
 - 12 bits ADC
 - Ping Pong readout mode
 - 300 MHz typ. bandwidth
 - Xtalk < 0,5%
 - Designed by CEA/Irfu
- 4 ACTA ASICs
 - 2 amplifiers with 3 channels
 - High Gain 484 MHz bandwidth
 - Low Gain 417 MHz bandwidth
 - Trigger 361 MHz bandwidth
 - Fully differential input/output
 - Adjustable gain and offset (via SPI)
 - Low power consumption : 462mW
 - Pulsar for verification test
 - Designed by ICC-UB (Barcelona)



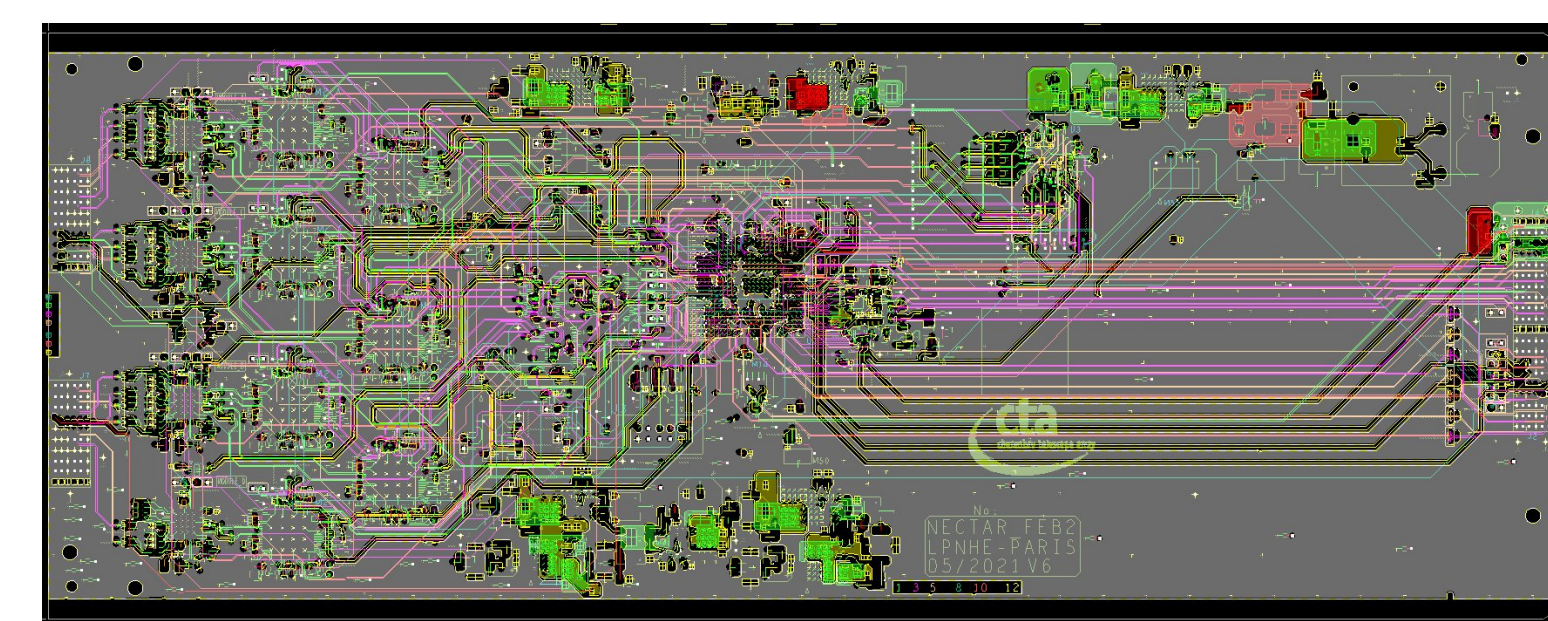
NectarCAM detection module



NectarCAM Qualification Model completely equipped with last version of FEB @ Irfu

FEB layout

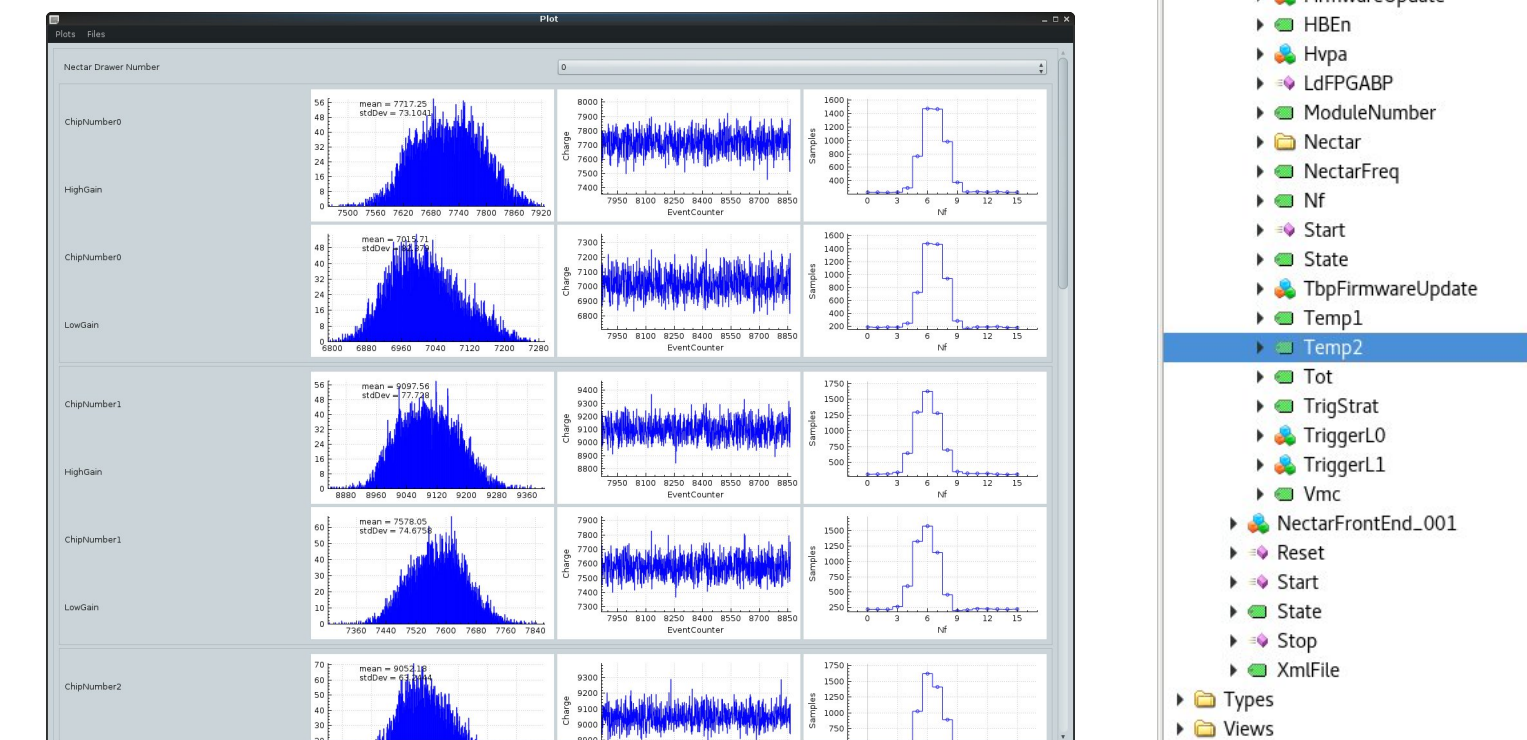
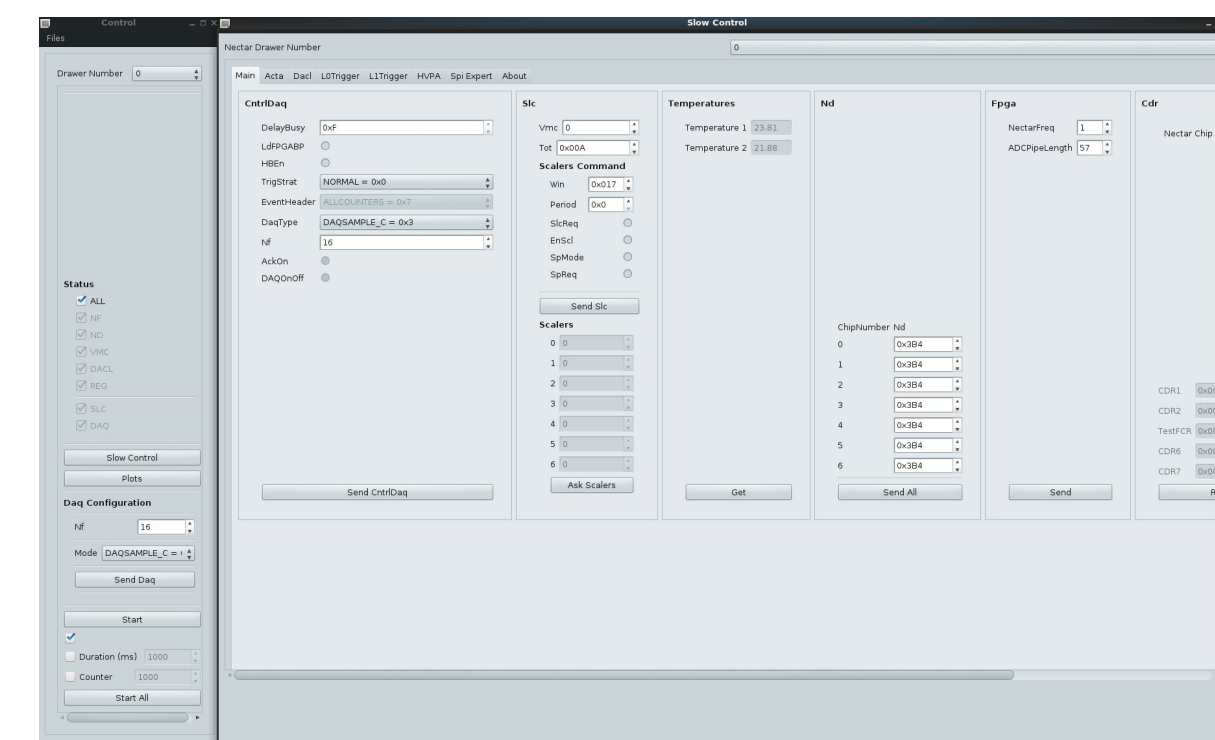
- Printed Circuit Board (PCB) is designed and routed by LPNHE, respecting IPC standards.
- 12 layers
- Matched impedances
- The production of FEB is running @ OUESTRONIC, the FEB manufacturer. It includes PCB manufacturing and CMS wiring.



FEB software

FEB associated software is provided along, allows to configure and monitor most of the module parameters and take data, namely:

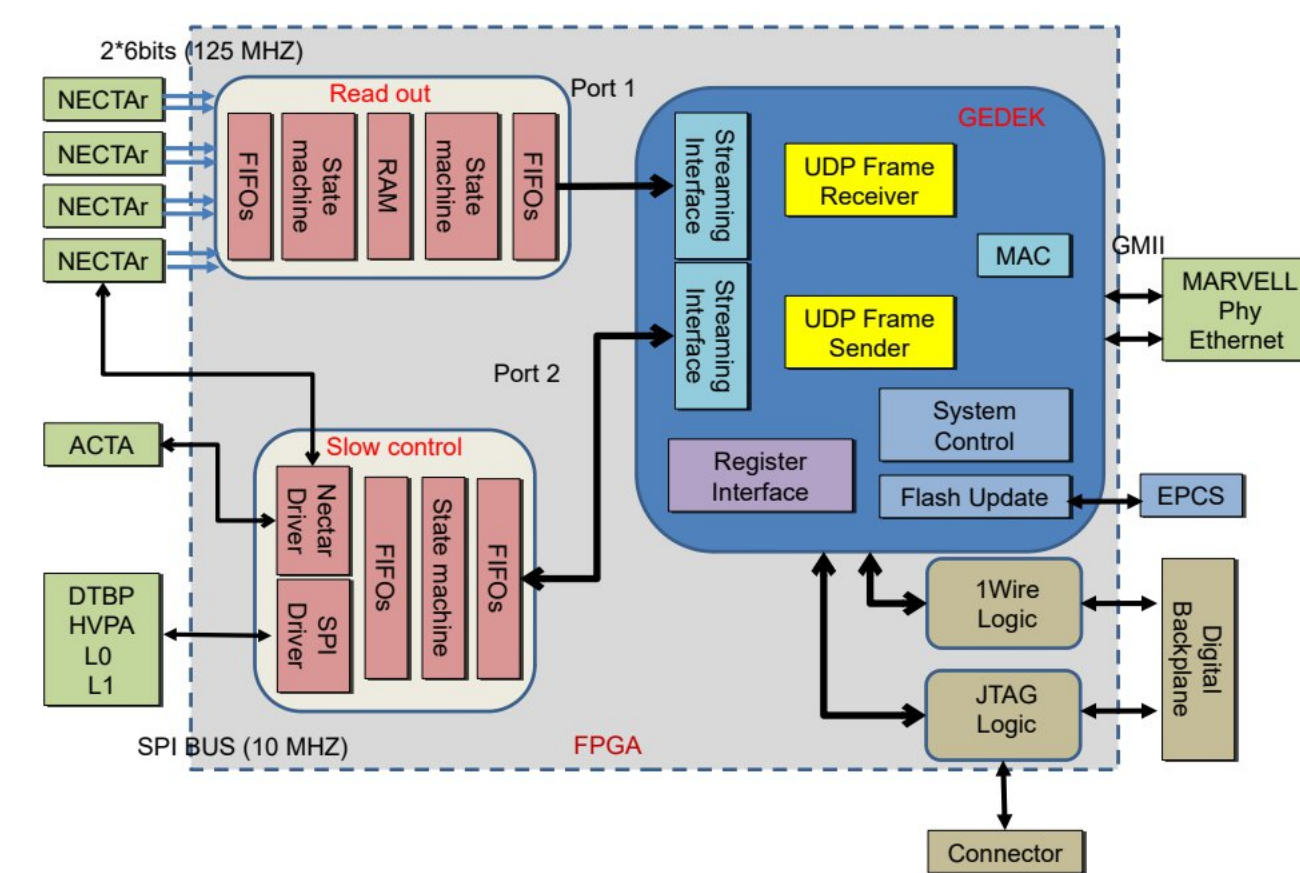
- The Graphical User Interface (GUI) qNectarCAM, used to debug and test the FEB.
- The NMC OPC-UA server which allows to integrate the FEB in CTA software environment.



FEB Firmware

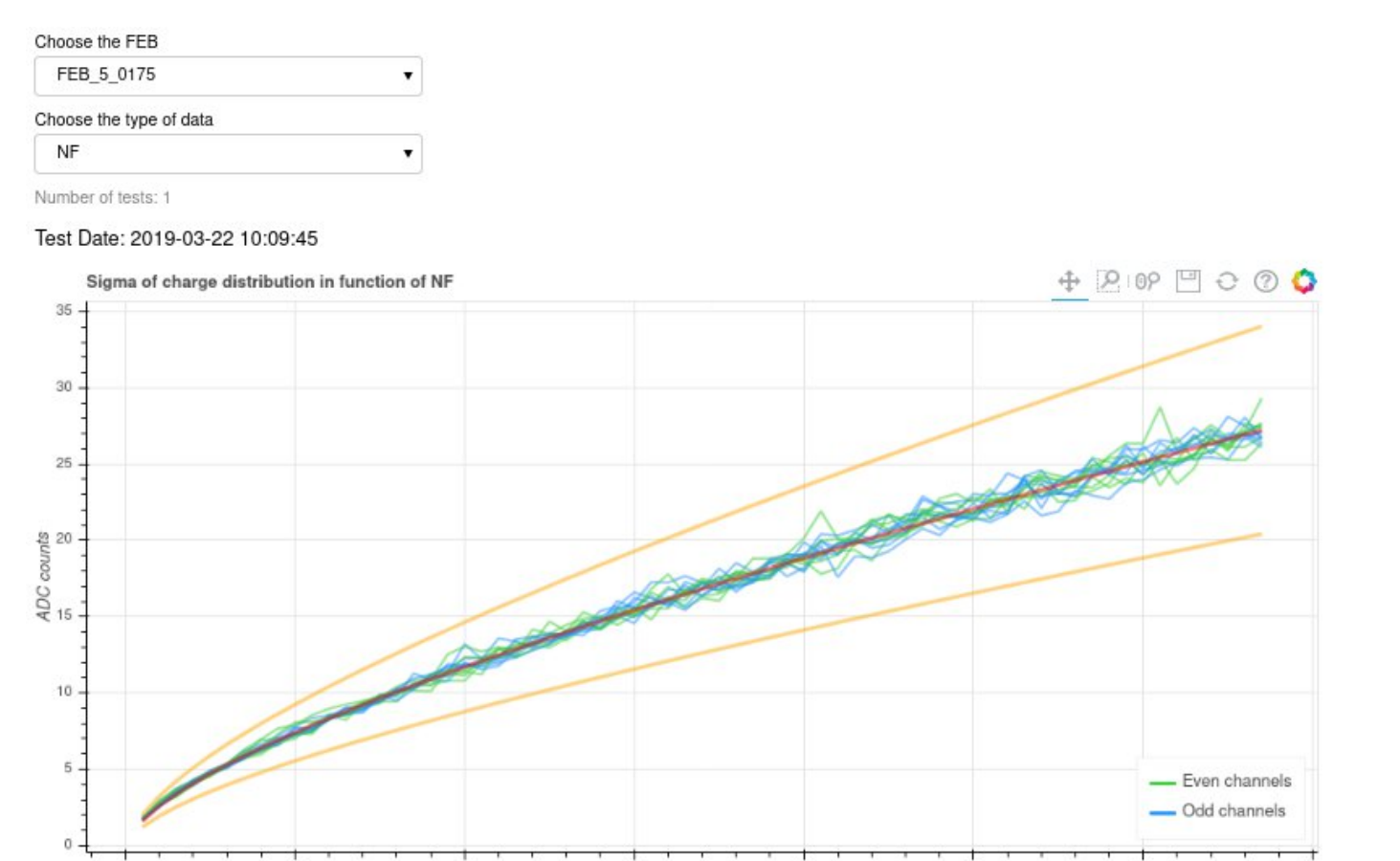
FEB firmware is designed by LPNHE and uploaded in FPGA INTEL cyclone 5. It consists in:

- Readout control & samples or integrated charge data format
- Data transfer to camera server via Gigabit UDP link
- Slow control & monitoring via SPI of ACTA, Nectar, L0, FPM & DTBP
- Remote FEB, DTBP & IB firmwares upload



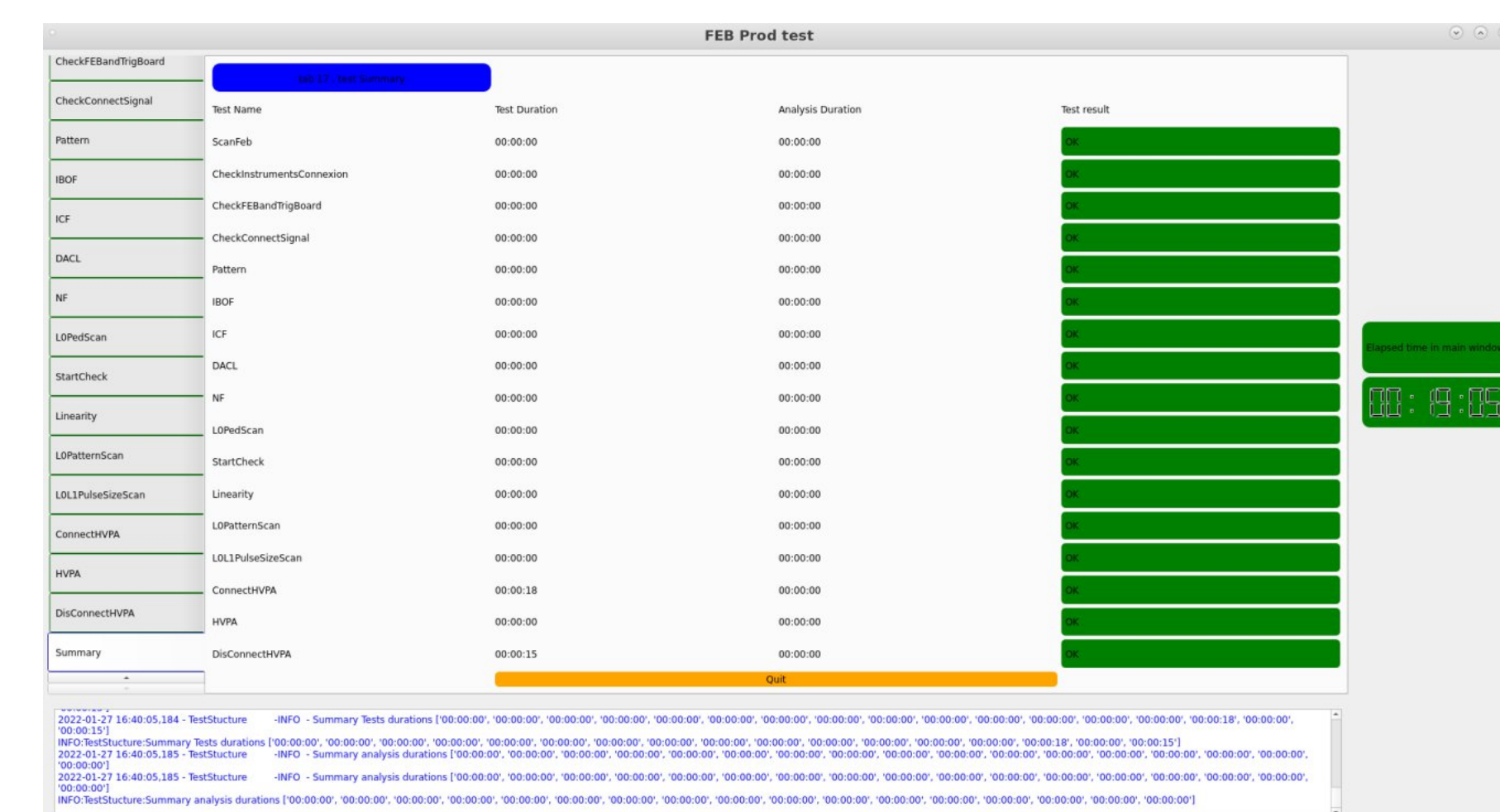
Production quality monitoring tool

This tool allows to easily visualize the production quality of the FEBs. It is based on the Python library Bokeh and accessible via a website. All tests made during production can be tested, as Pattern, Startcheck, ICFAadjust, IBOF, LOPedScan, LOLIPulseSizeScan, Linearity, DACL, NF, which has been saved on a dedicated database.



FEB Production automated test bench

The FEB production test bench is installed in the FEB manufacturer buildings for large production phase since September 2022. The associated software "TestAutoFEB" had been designed in Python and deployed as Docker container. It allows to configure, monitor and take data in order to verify all the functionalities of FEB.



Key figures:

- 9 cameras will be built and installed @ La Palma (Spain)
- 2560 FEBs are currently in production.