New neutron sensitive Beam Loss Monitor (nBLM)

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nBLM purpose and features

A new neutron sensitive Beam Loss Monitoring system has been designed for fast and accurate measurement of number of neutrons produced when beam particles hit the accelerator material. It is crucial for the accelerator equipment safety and for locating the beam loss.

nBLM system features

- The firmware continuously detects and counts neutrons
- Each detector is individually configurable
- A smart scope helps to configure the neutron detection (possibility to trig on raw or interpreted data)
- The acquisition system stores and provides data on demand around the trigger
- nBLM system monitors the beam line activation
- Different trigger sources are available (timing system, analog input, software)
- Event statistics help to validate settings
- A beam permit signal which can trigger a stop in beam production is continuously transmitted to the Fast Beam Interlock System

ESS-nBLM Project

- 84 nBLM modules: 42 "slow", 42 "fast"
- Installation by the beginning of 2020

Detector and Control System

The nBLM detectors are powered with high and low voltages and filled with gas, the acquisition continuously detects and counts neutrons. All COTS devices are remotely controlled and monitored by EPICS.
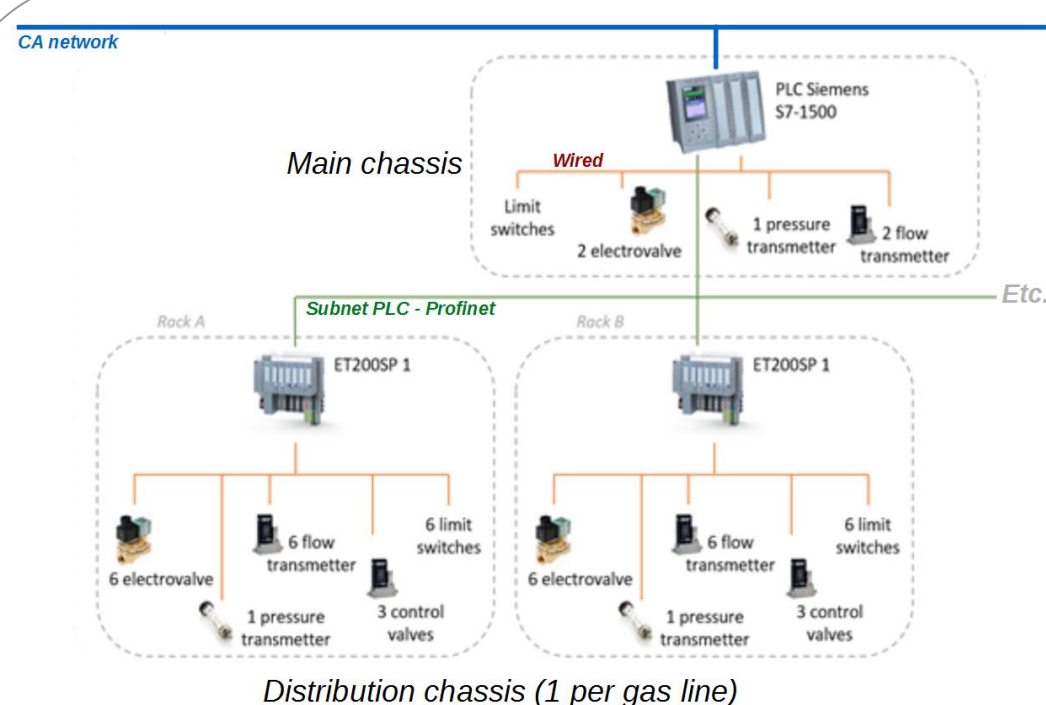
MTCA BEE

- IOxOS ADC3111 FMC: 8 inputs at 250 Ms/s
- IOxOS IFC1410: 2 FMC slots, Xilinx Kintex UltraScale FPGA, PowerPC
- mTCA-EVR-300(U)
- IOxOS RCC_1466 and FBI_1482

CAEN SY4527

- 16 slots
- A7030 (HV): 48 channels, 3kV/1mA
- A2519 (LV): 8 channels, 15V/5A
- Embedded EPICS IOC

nBLM detector: based on Micromegas gaseous detector with FEE based on the FAMAS current amplifiers

- Detection of fast neutrons
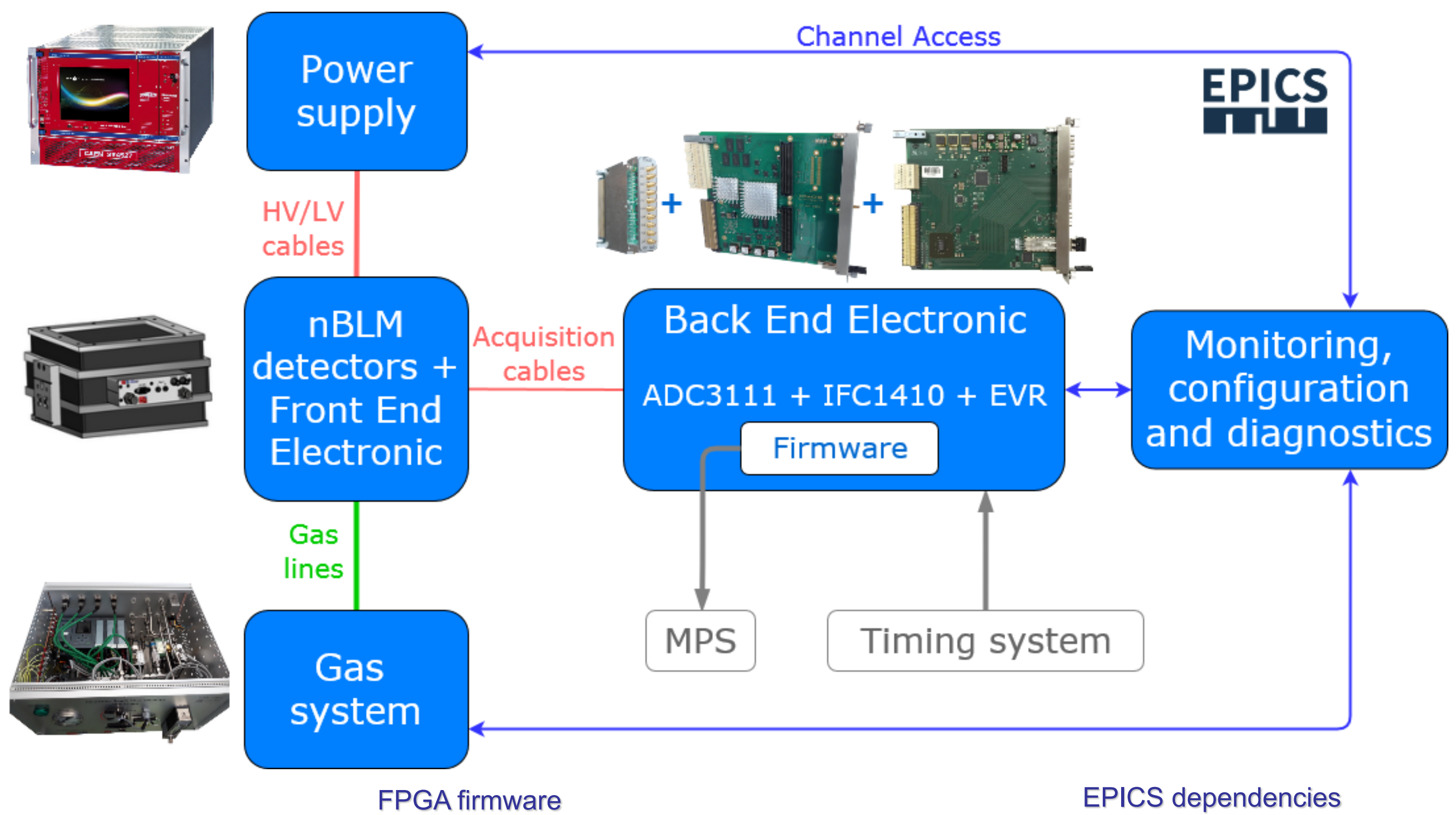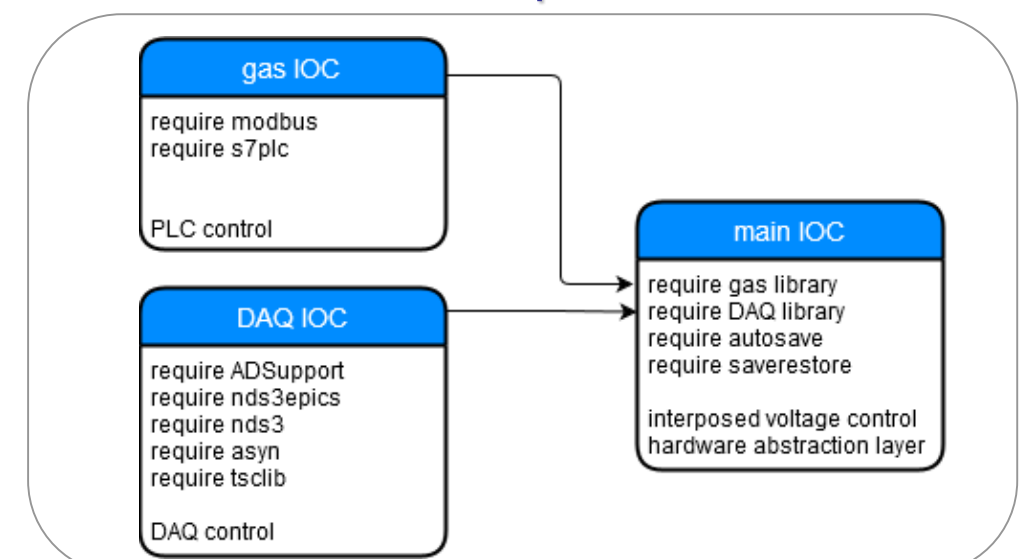- Low sensitivity to thermal neutrons, gammas and X-rays

Gas chassis architecture: A PLC Siemens S7-1500 is inside the main chassis

Distribution chassis (1 per gas line)

- Gas flow regulation
- Gas pressure and flow interlocks

Channel Access

Power supply

HV/LV cables

nBLM detectors + Front End Electronic

Acquisition cables

Back End Electronic
ADC3111 + IFC1410 + EVR
Firmware

Monitoring, configuration and diagnostics

Gas lines

Gas system

MPS

Timing system

FPGA firmware

- Detector signal processing
- Trigger management
- Neutron detection and counting
- Data monitoring for EPICS
- Machine protection functionality and communication to FBIS
- Data on demand
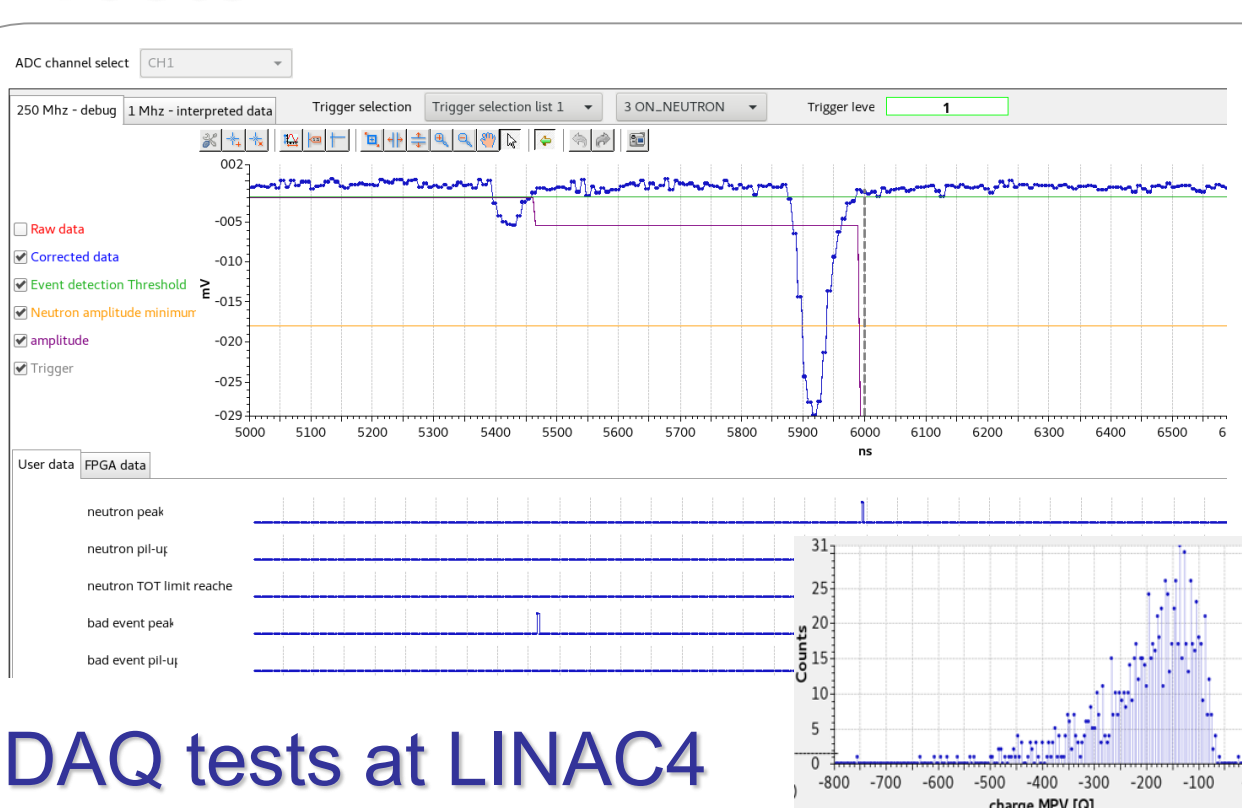- Acquisition status
- Input file reading

EPICS dependencies
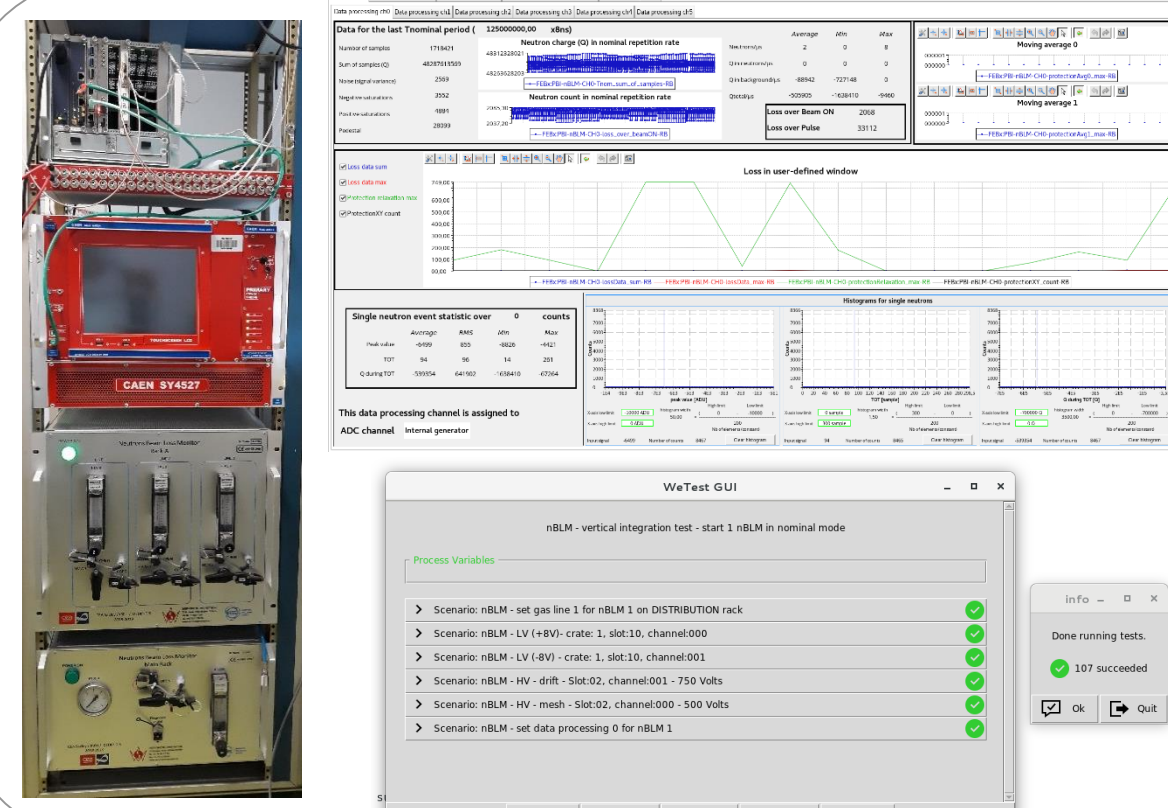

Algorithm for neutron detection and counting

Typical event shape expected in a Micromegas detector

Decision tree to identify event(s)
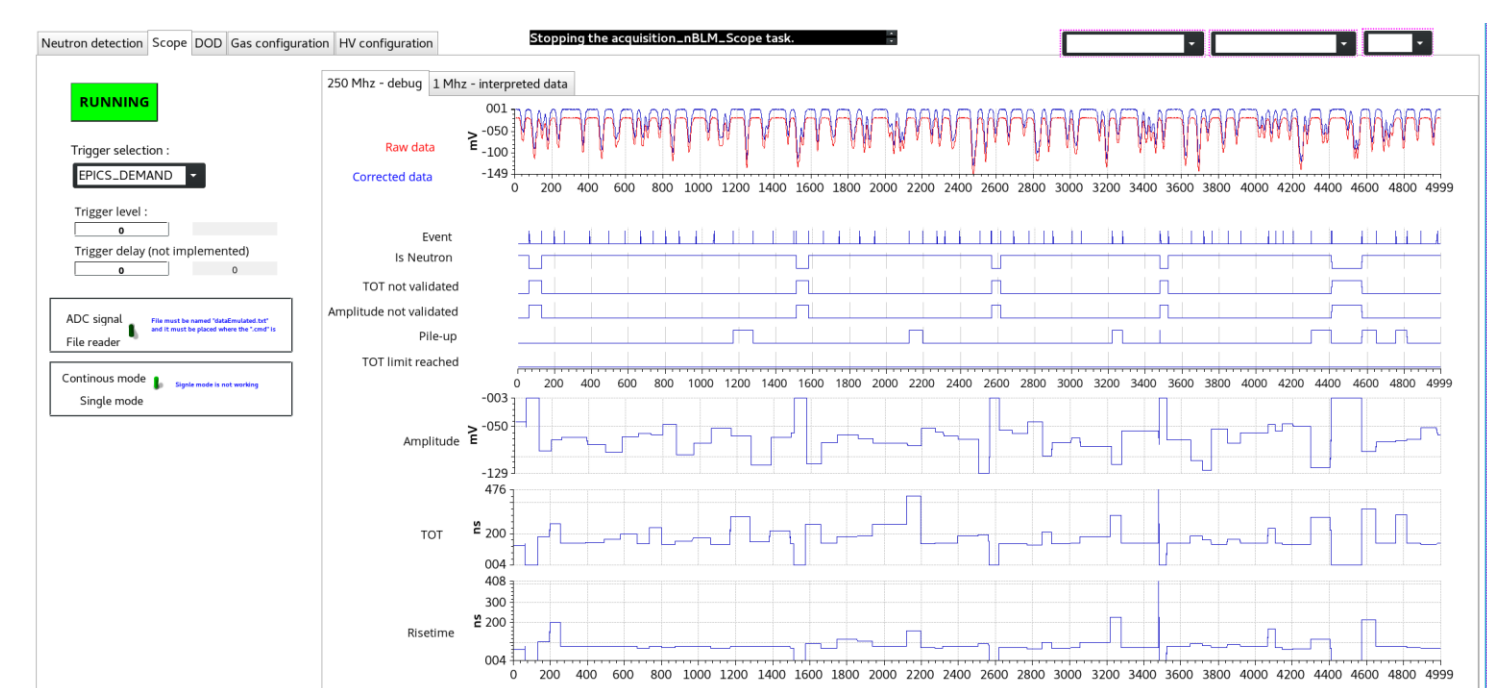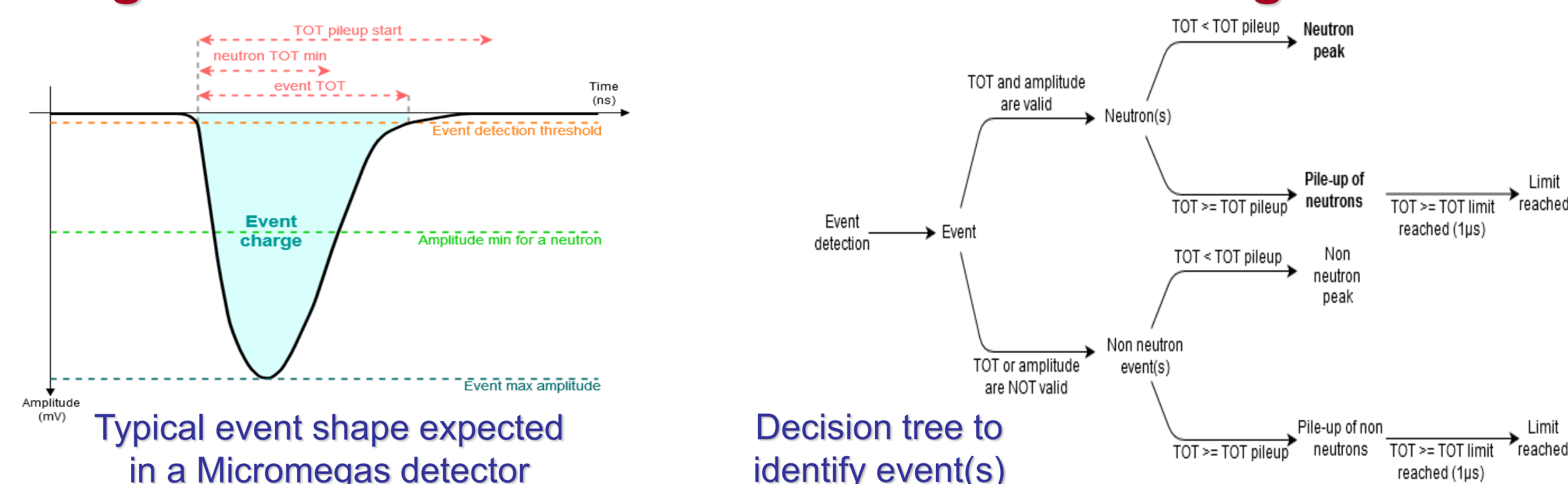
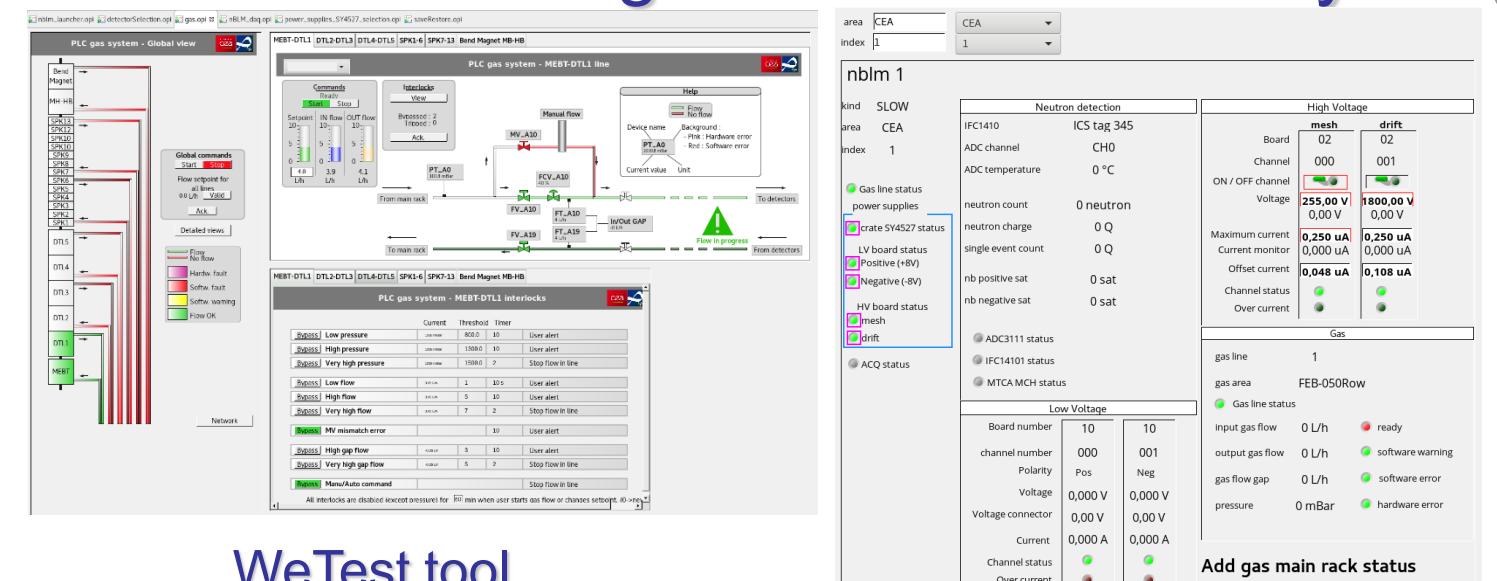CS-Studio view of event analysis of an input file

Tests

DAQ tests at LINAC4

WeTest tool

Vertical integration tests at Saclay

- Unit tests: check process variable ranges and limits
- Functional tests: starting one nBLM in nominal mode