Detector Control System for Forward Diffractive Detector

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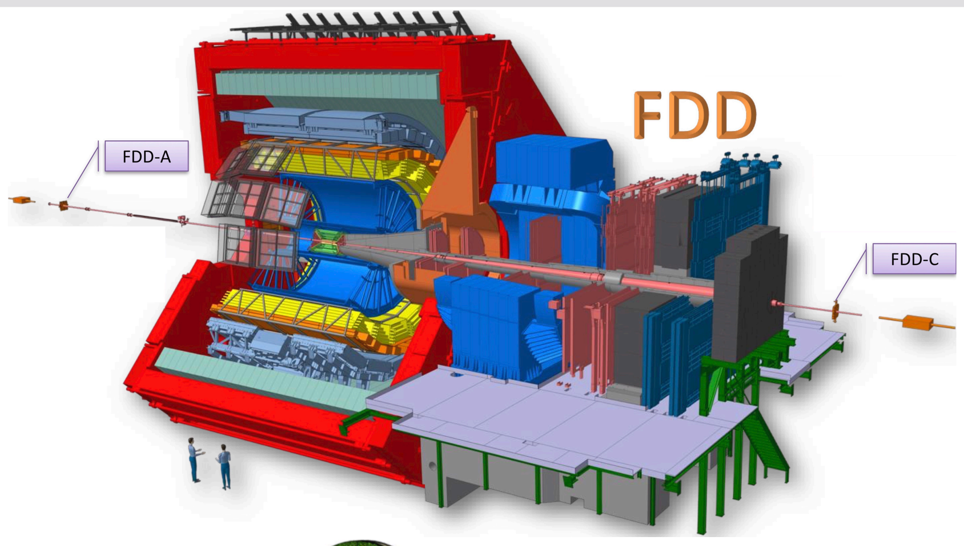
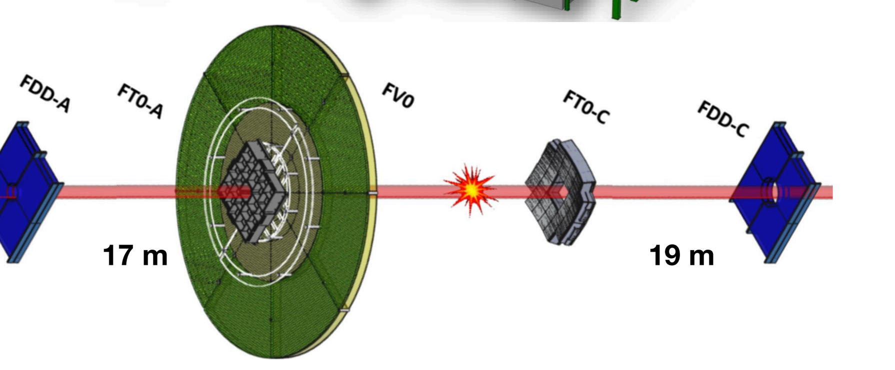
FIT - FDD

FDD location in ALICE

The Forward Diffractive Detector (FDD) will be located at ends A and C of the ALICE cavern for operation during Run-3 of the Large Hadron Collider (LHC).



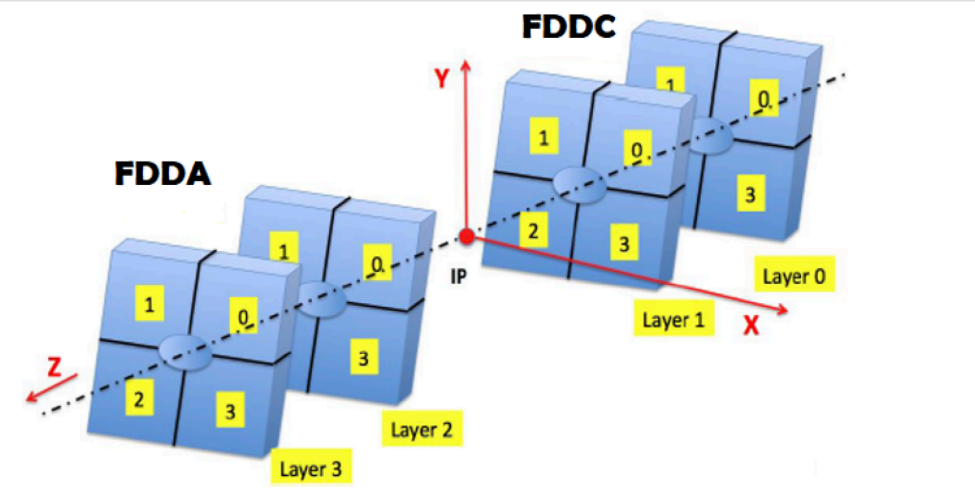


Fast Interaction Trigger

- The Fast Interaction Trigger (FIT) serves as an interaction trigger, online luminometer, initial indicator of the vertex position, and the forward multiplicity counter [1].
- The FDD detector is part of one of the three subdetectors that make up ALICE's Fast Interaction Trigger (FIT) project, together with FT0 and FV0 detectors.
- FDD will contribute with the measurements of the time and the luminosity of collisions.
- It will also be used for the study of diffractive physics.

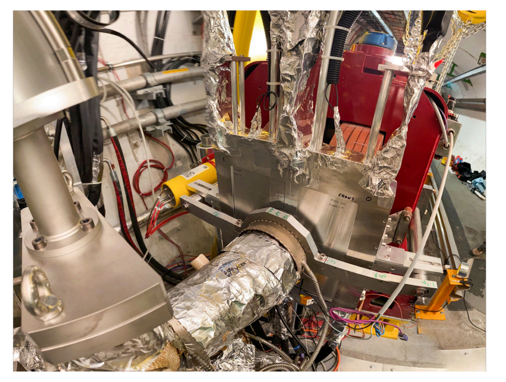
Forward Diffractive Detector

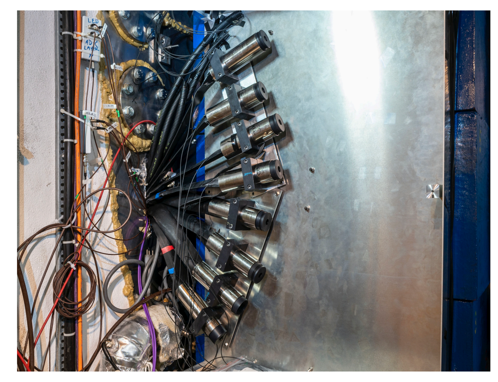
- The FDD detector consists of two subdetectors called FDDA and FDDC.
- Each of them includes two detector layers, and each layer consists of four scintillator modules arranged around the LHC beam pipe.
- The FDDA and FDDC designations refer to the installation positions at both ends of the ALICE site concerning the interaction point (IP).



FDD installation in ALICE

- The subdetector FDDC was already build and it was installed in ALICE cavern side C [2].
- The 8 photomultipliers required to collect the light from the subdetector FDDC were installed as well.
- FDDA was build as well and it will be installed in mid-2021.

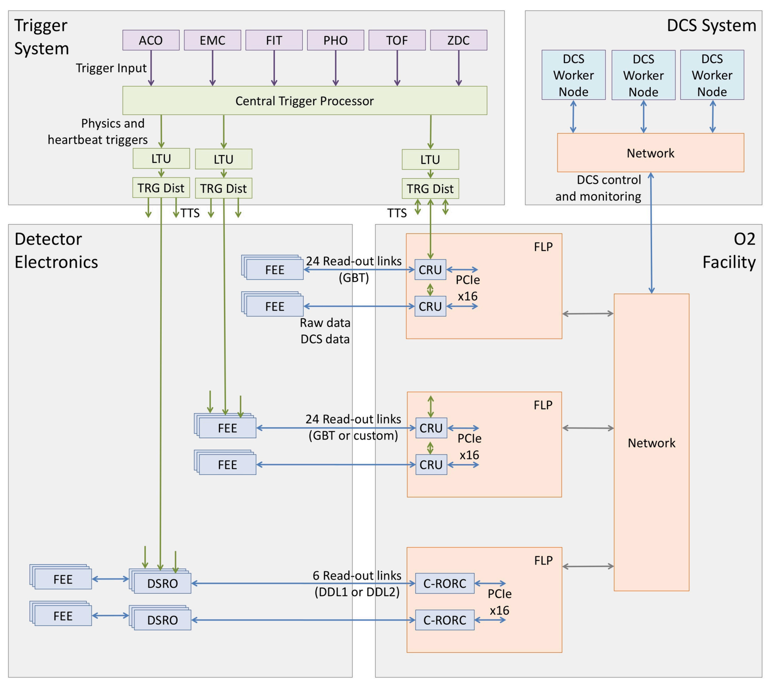




FDD - DCS

Online-Offline

One of the main updates that is being carried out at the LHC during the Long Shutdown number 2 (LS2) is the Online-Offline infrastructure that will be used in Run 3, since the high-precision measurements that will be carried out in the detectors of ALICE, CMS, ATLAS and LHCb experiments will be at a higher speed than the previous runs (Runs 1 and 2). Therefore, the data from the detectors must be processed immediately online during collisions to reduce the costs and requirements of the computer systems to process and archive such data generated during collisions [3].

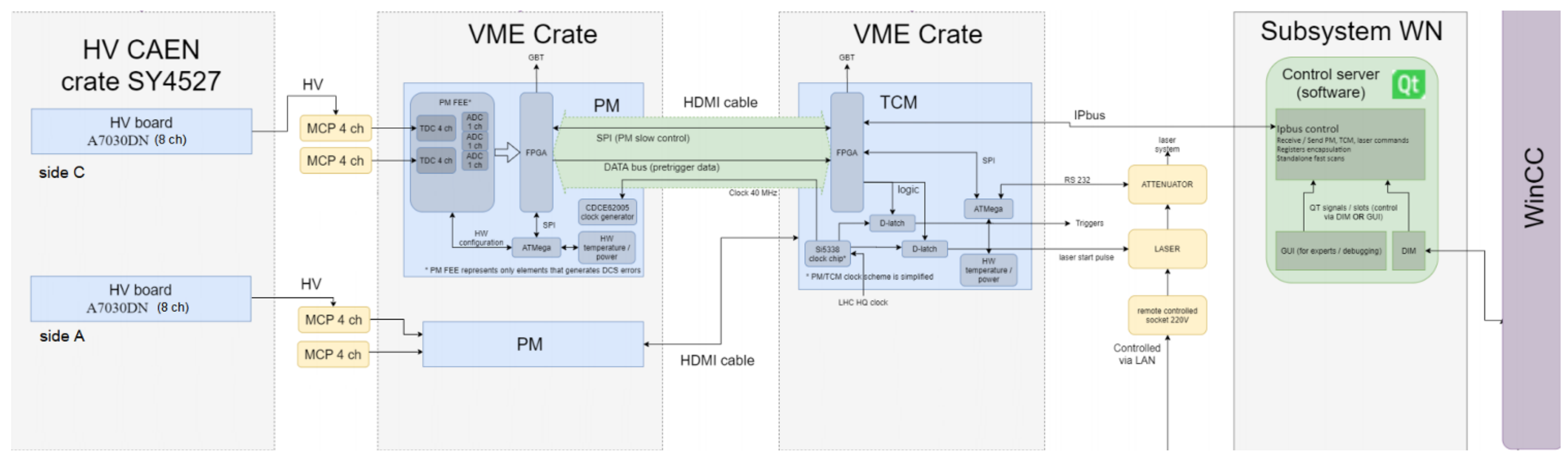


Detector Control System

- The DCS is one of the most critical software systems that allows the operation of high energy physics experiments (HEP) [4].
- All equipment and devices that make up detectors' subsystems must be integrated into DCS's software to allow their control, monitoring, and configuration [5].
- Upgrading the existing detectors or installing new detectors with online-offline processing capacities implies to develop new DCS.

FDD Electronics

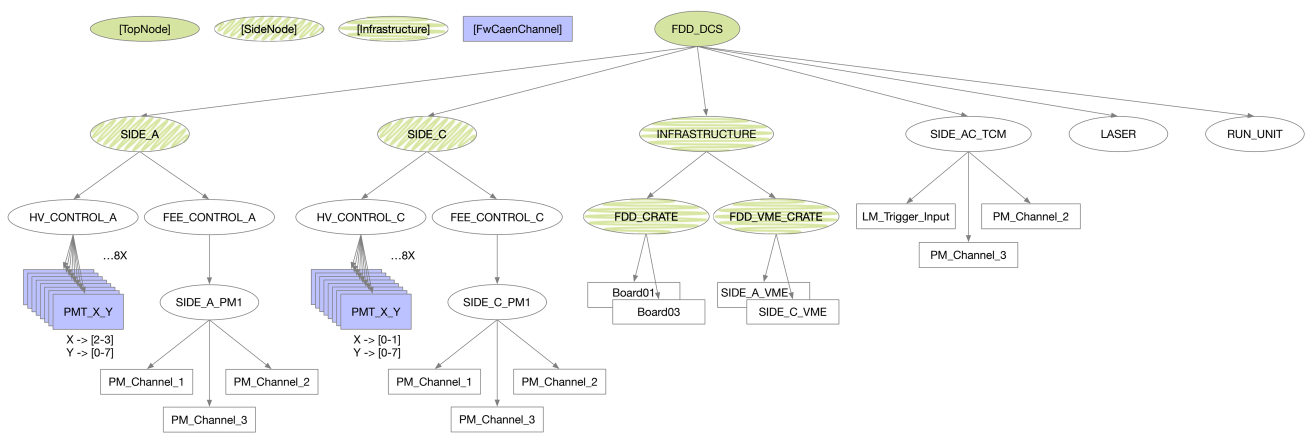
- For FDD, two A7030 high voltage boards are used to power the 16 photomultipliers that will transform the optical signals that comes from FDDA and FDDC to analog electrical signals. Two PMs are used for FDD, one for each subdetector (FDDA and FDDC), which processes the analog signals from the photomultipliers.
- FDD has only one Trigger and Clock Module (TCM) that enables the reading of data from the two PMs. Each PM is connected to the dedicated TCM via an HDMI cable to transmit "pre-trigger" data, slow-control data and LHC clock distribution. The commands, configuration data, and status data are sent from the ALICE control system to the TCMs via a 1 Gb Ethernet optical link using an IPbus (UDP based protocol) [6].
- Laser pulses are used for time and amplitude calibration, as well as monitoring of aging and radiation damage of the FDD subdetectors. Finally, ControlServer passes control and status parameters between each FIT subsystem's TCM and WinCC-OA as a part of Detector Control System [7].



Control Hierarchy for the FDD

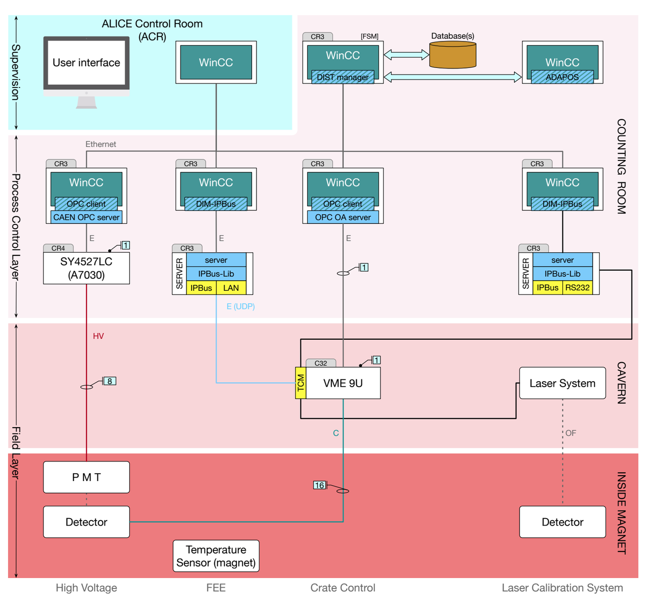
Software architecture

The Detector Control System:
- It will monitor the status of the FDDA and FDDC subdetectors.
- It will also take a reading of the electronics present in such experiment, for example: Processing Modules (PM), Trigger and Clock Module (TCM), and the Infrastructure of the experiment, such as the power supply devices and the temperature of the CRATES where various electronic devices are located.



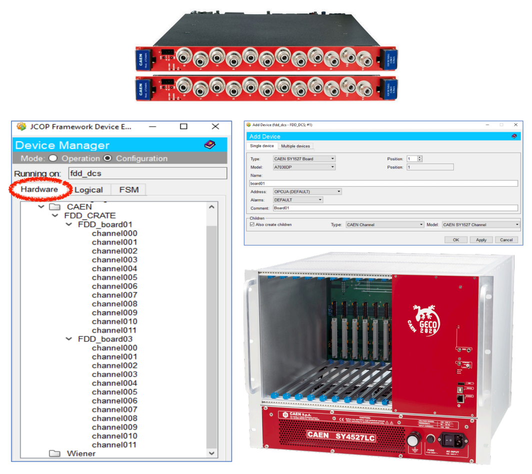
Hardware architecture

The FDD DCS has the following hardware architecture:
- The supervision layer consists of Operator Nodes (ON) that provide the user interfaces to the operators and it is located in ALICE control room.
- The process control layer consists of Worker Nodes (WN), PLCs and PLC-like devices that interface to the experiment equipment. It is located in the Counting Room.
- The field layer comprises field devices such as power supplies, field bus nodes, sensors, actuators, and more. This is located in the ALICE Cavern and Magnet.



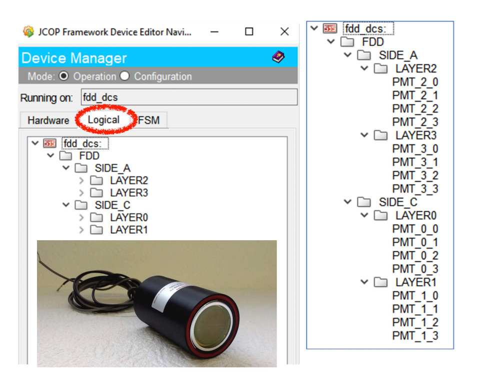
Hardware FDD-DCS

Regarding the state of development of the Control System for the FDD Detector:
- Using the WinCC-OA software, the hierarchy of the CAEN A7030 high voltage boards used to power the photomultipliers was configured.
- Such CAEN boards are inserted in the CAEN_CRATE SY4527LC that is going to be located in Counting Room 4 (CR4).



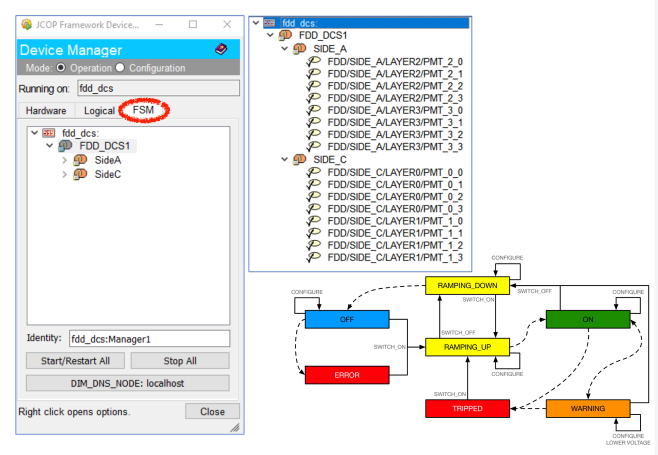
Logic FDD-DCS

- Another part of the development of the control system that was done is to configure the logical hierarchy corresponding to the photomultipliers of the FDD detector on side A and side C of the cavern of the ALICE experiment.
- This is necessary for the control system to identify the 16 photomultipliers and read the data from such photomultipliers during collisions.



Finite State Machine FDD-DCS

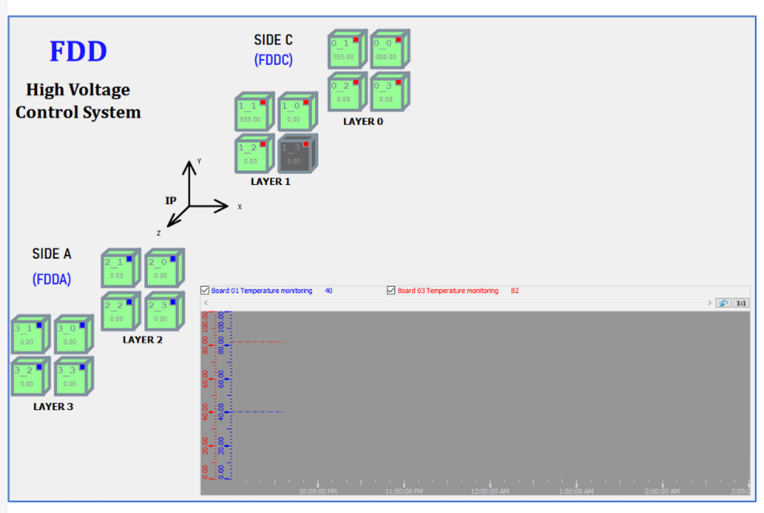
- The hierarchy of Finite State Machines (FSM) was defined for the upper node and the control nodes of the FDD detector on both sides, A and C, as well as that of the photomultipliers.
 This is required for the control system to monitor the status of the FDDA and FDDC detectors, as well as send ON (SWITCH_ON) or OFF (SWITCH_OFF) commands to the 16 photomultipliers.



User interface / Alarms

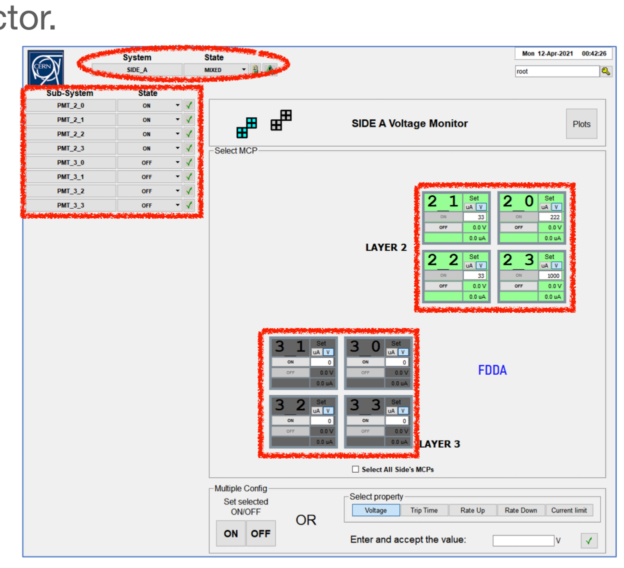
FDD-DCS main panel

Using the WinCC-OA software, the first version of the main panel of the FDD-DCS has been developed.
The DCS must have a main control panel to be managed by the operator who is in the shift at the central control system of the ALICE experiment. In such a way that the operator will be able to monitor the general status of the detector during collisions



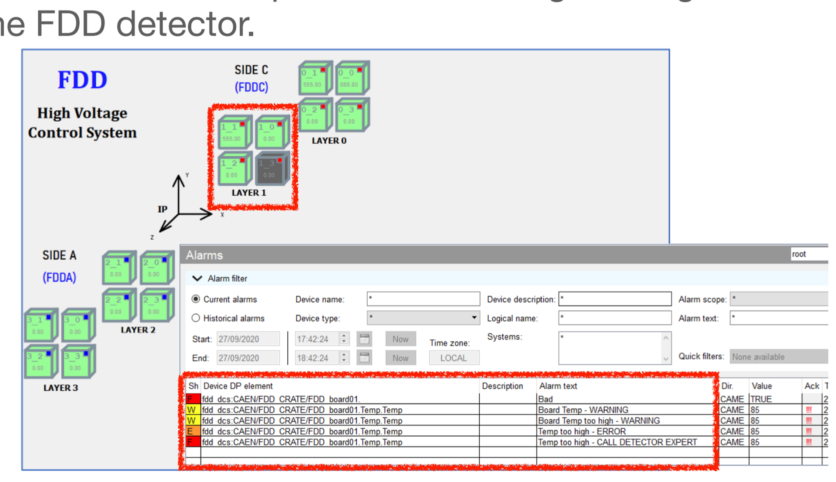
FDDA and FDDC subpanels

The first version of the panel to monitor and control the A and C side of the FDD detector was also developed.
The main panel of DCS must have subpanels of control that allow the operator to obtain in more detail the status of the different parts of the detector, as well as to be able to control such parts. For example:
- In the FDDA subpanel, the operator can set and read the voltage and current applied by the high voltage boards to the photomultipliers.
- It can also monitor and control the status for each photomultiplier of the FDDA detector.



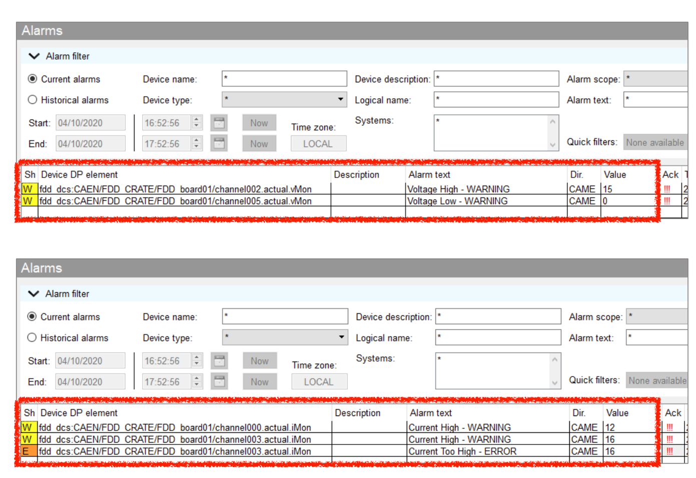
CAEN Boards temperature

Alarms were defined in such a way that the DCS operator can identify on the main panel if any of the sides of such FDD detector has any type of problem:
- For example, layer 1 of side C of the detector has a gray background, while layers of side A has a green background. This indicates that the detector on side C has a problem, while side A is working properly.
- The operator can obtain more detail of the problem by accessing the alarm panel. In this case the problem has to do with the temperature of the high voltage board for the FDD detector.



Voltage and current for PMTs

Another example of an alarm that was defined is the voltage level received by the photomultipliers connected to the FDD detector on side A and side C.
- The alarm is triggered either when the voltage level is above or below the set value.
- The same applies to the current level received by the photomultipliers.



Comments and outlook

The construction of the FDD detector is on time and it is expected to be successfully constructed and commissioned during 2021. The FDD detector will increase the time resolution compare with ALICE Diffractive Detector (AD) used in Run-2 (2015-2018), and it will provide triggers at level zero for ALICE [8].

The development of Detector Control System for FDD is going good as well. The software and hardware architecture already proposed will allow to release a fully operative DCS for the FDD detector to comply with the new Online-Offline infrastructure requirements of ALICE experiment. Finite State Machine testing is currently on going with WinCC-OA and high voltage boards. Finally, it is expected to have the DCS ready for commissioning during 2021.

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