ALICE subsistems

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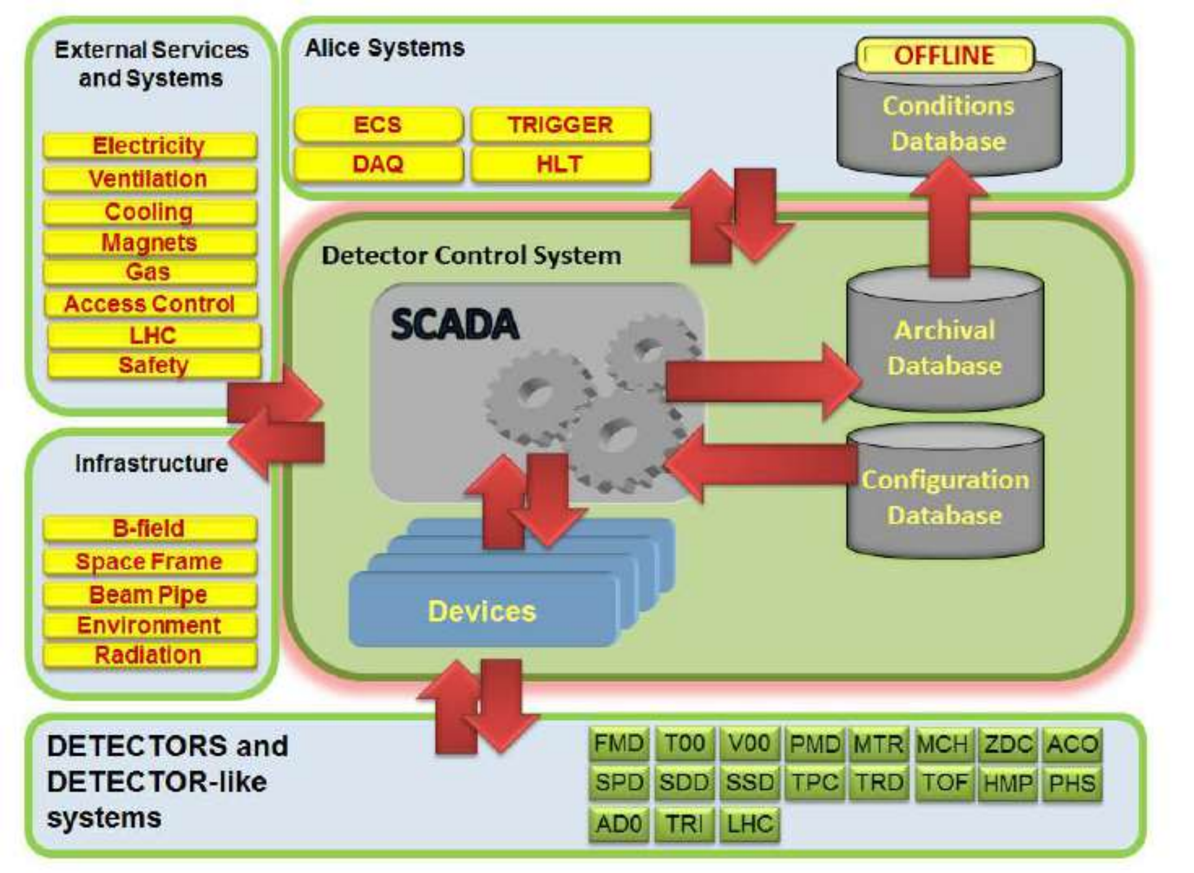
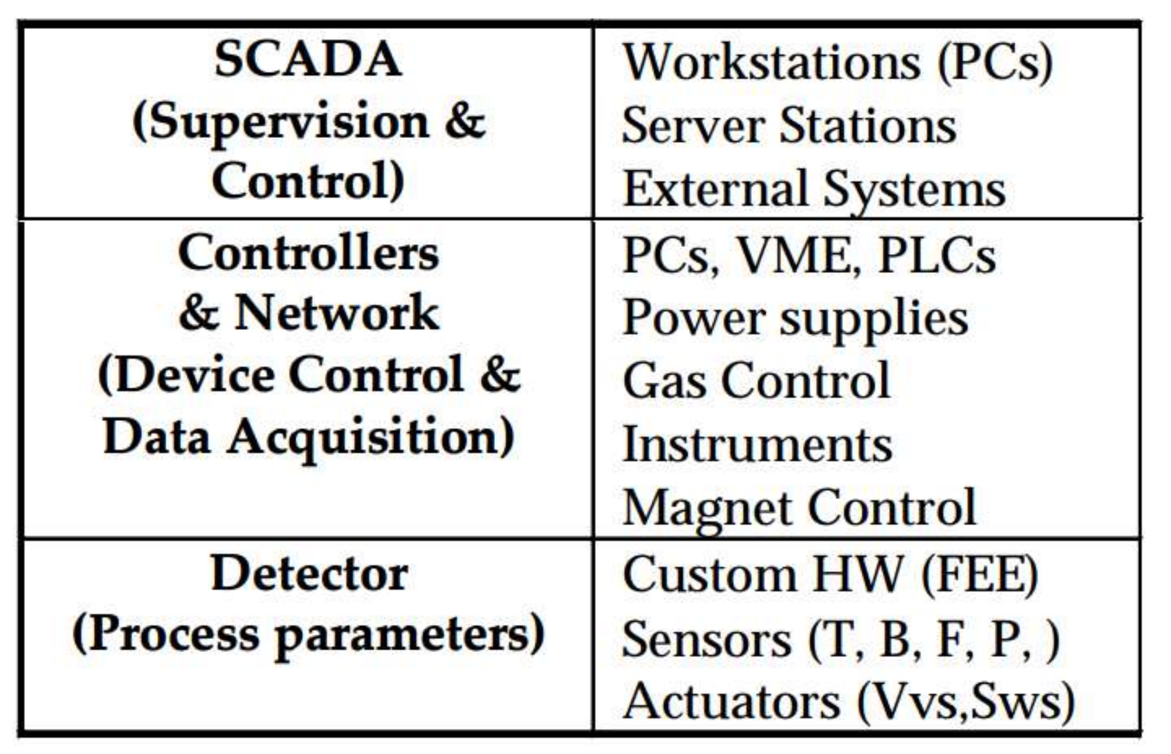
Overview and Operational Modes of ALICE DCS

- Let's start with an introduction to the ALICE detector control system, which plays a key role in integrating more than ten different detectors, each utilizing unique technologies and operational conditions. The primary goal of the DCS is to ensure coordinated operation and control across all subsystems.



Detailed Architecture of ALICE DCS

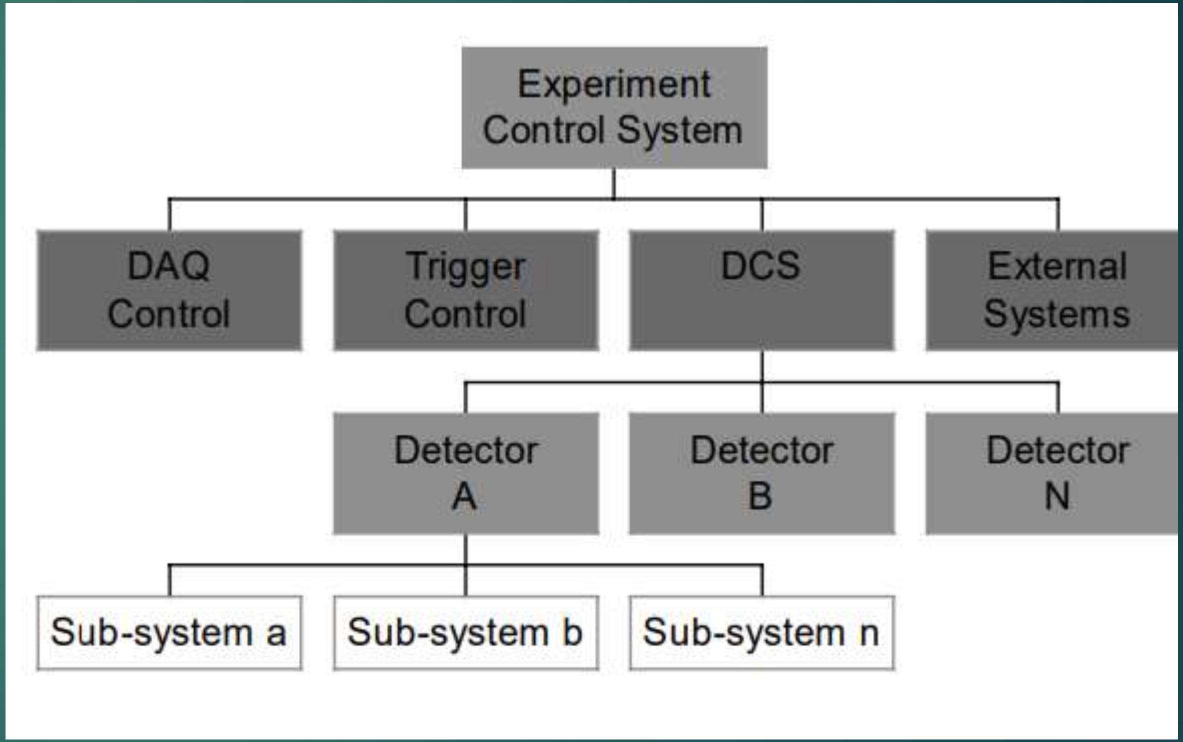
- Next, we will delve into the detailed architecture of the detector control system, emphasizing its importance for achieving modularity, scalability, and distributed intelligence. The description of each layer: The process layer includes field instrumentation, such as sensors and actuators, adapted to meet the needs of individual detectors. The control layer consists of multi-purpose control computers or PLCs, which manage the complex network of field instrumentation and ensure precise operation. The supervisory layer includes workstations that manage configuration data, control alarms, log activities, and facilitate communication and data exchange throughout the experiment. I will conclude the overview by emphasizing the strategic importance of this architecture for providing a unified and efficient control environment for the experiment.



SCADA (Supervision & Control)	Workstations (PCs) Server Stations External Systems
Controllers & Network (Device Control & Data Acquisition)	PCs, VME, PLCs Power supplies Gas Control Instruments Magnet Control
Detector (Process parameters)	Custom HW (FEE) Sensors (T, B, F, P,) Actuators (Vvs,Sws)

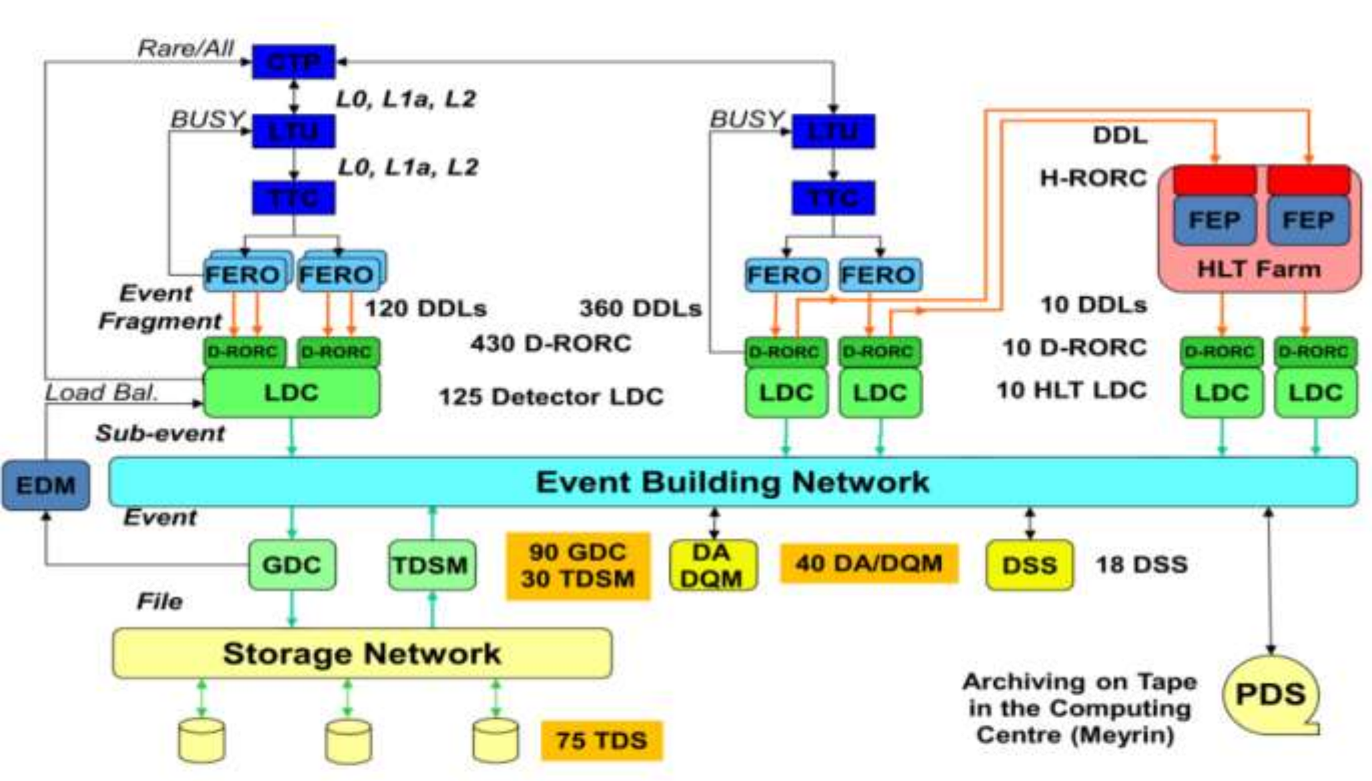
Communication and Software Integration in ALICE DCS

- Let's move on to the communication infrastructure underlying the ALICE DCS and examine how it ensures reliable and secure data exchange and remote access capabilities. We will detail the various communication layers and protocols used, such as LAN, TCP/IP, and fieldbuses, and their role in supporting the DCS. Then, we will discuss the aspect of software integration, focusing on the use of industry standards such as OPC for interoperability and flexibility, and how this software layer facilitates connections between various control equipment, SCADA systems, and user interfaces, ensuring a responsive and adaptable control system.

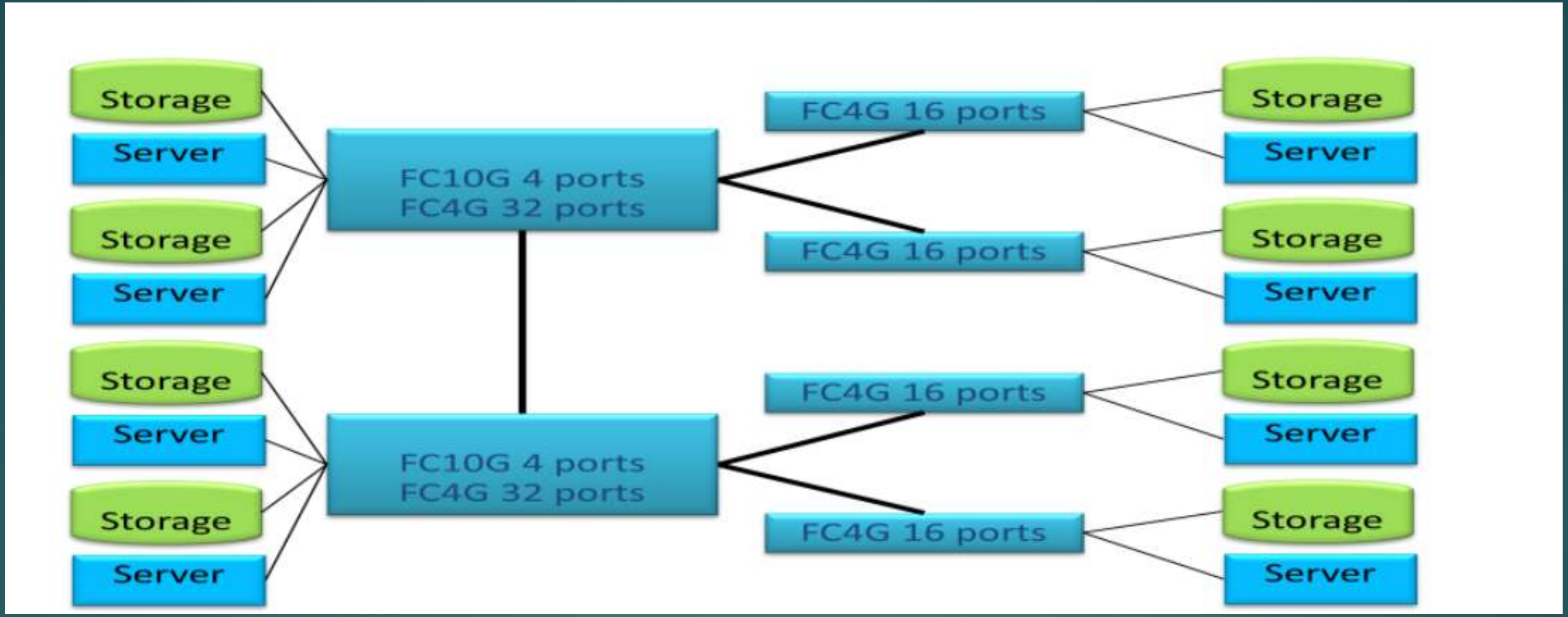


Architecture of ALICE Online Systems

- ALICE includes five online systems that provide integration and management of various aspects of the experiment. The Central Trigger Processor (CTP) manages data readout decisions from the sub-detectors, the High-Level Trigger (HLT) provides a data filtering mechanism, and the Data Acquisition system (DAQ) manages the data flow from the detector to permanent data storage. The Detector Control System (DCS) controls the sub-detectors and their services, while the Experiment Control System (ECS) provides a simplified view of this complex experiment to the personnel

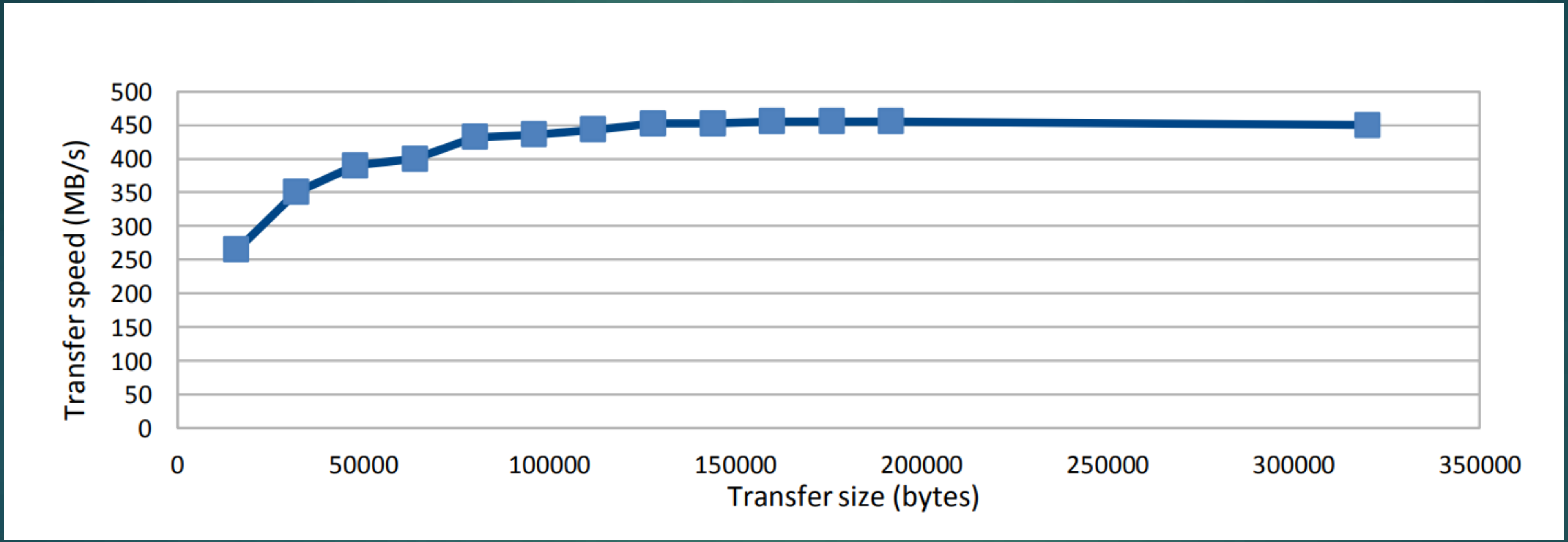


ALICE DAQ Local Data Storage



- One of the unique features of the ALICE DAQ system is its high bandwidth and local data storage located at the experimental site, providing several hours of data storage autonomy. The storage is organized around a storage network based on a Fibre Channel Storage Area Network that connects servers and storage devices. A commercial file system is used to provide consistent access to all storage devices

Experiment Upgrade and Data Readout System



- Different upgrades are considered for the ALICE detector, which may include modifications or the creation of a new Inner Tracking System (ITS), the addition of a Forward Calorimeter (FOCAL), or a Very High Momentum Particle Identification system (VHMPID). These upgrades will require new data readout solutions, and the DAQ team has already started research and development to propose new solutions and upgrade the DAQ system itself.

Overview of ALICE Central Trigger System (CTS)

- The ALICE experiment is undergoing a significant update to adapt to high-speed data collection during LHC Run 3, significantly increasing interaction rates. A new Central Trigger System (CTS) is being introduced, utilizing advanced technologies such as Passive Optical Network (PON) and GigaBit Transceiver (GBT). This update allows ALICE to transition to a continuous data readout system, eliminating the need for hardware trigger selection and enabling real-time data processing. This slide details the motivations for the CTS update, its key components, and the expected improvements in data collection capabilities.

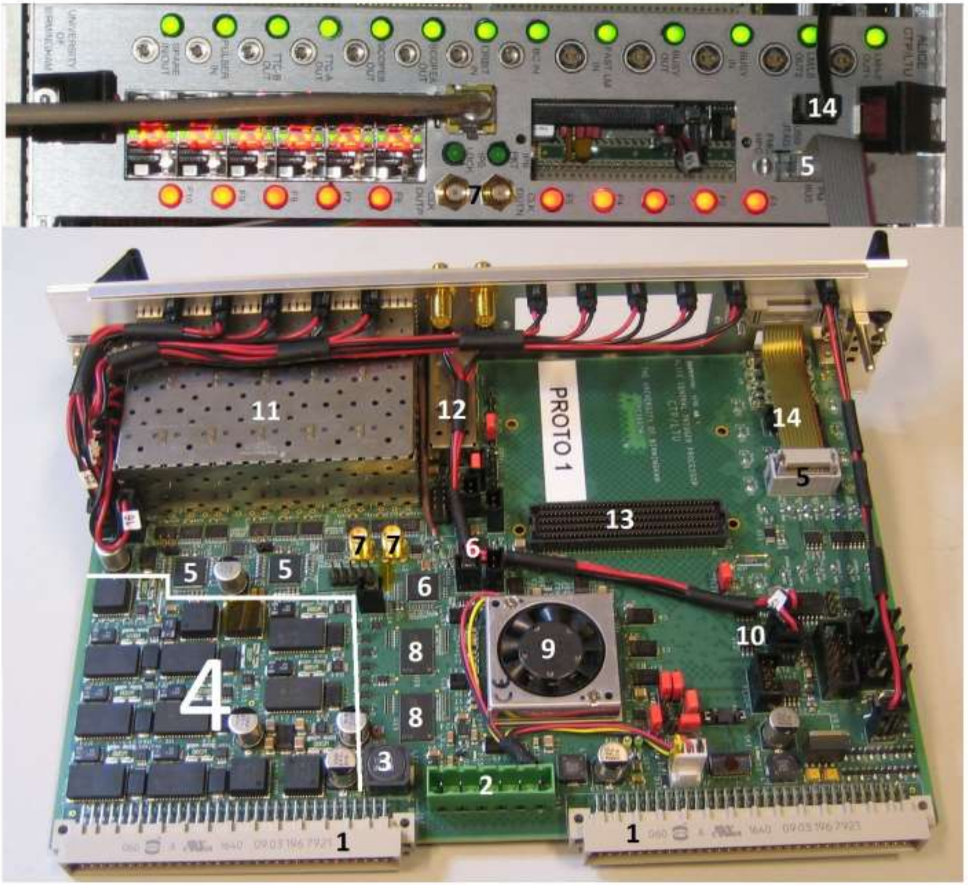


Figure 3. Front and side view of ALICE Trigger Board (ATB). The followin components are visible (see in the text for details).
1: VME 6U power supply connector
2: ELMAbox power supply connector
3: power decoupling - inductance
4: DC-DC converter
5: PMbus
6: PLL
7: Clock from PLL
8: DDR4
9: FPGA
10: Flash memory
11: two six-fold SFP+
12: single-fold SFP+
13: FMC
14: JTAG-microUSB

Time and Trigger Distribution in ALICE

- With ALICE's transition to continuous data readout, a new approach to time and trigger distribution is introduced, corresponding to the increased interaction rates for different types of collisions. This new methodology requires sophisticated synchronization between ALICE detectors, ensuring accurate data correlation. This slide explores the complex trigger distribution mechanisms, the role of software filters in data selection, and how ALICE manages this transition, emphasizing seamless integration of continuous and trigger readout modes to maximize data integrity and efficiency.

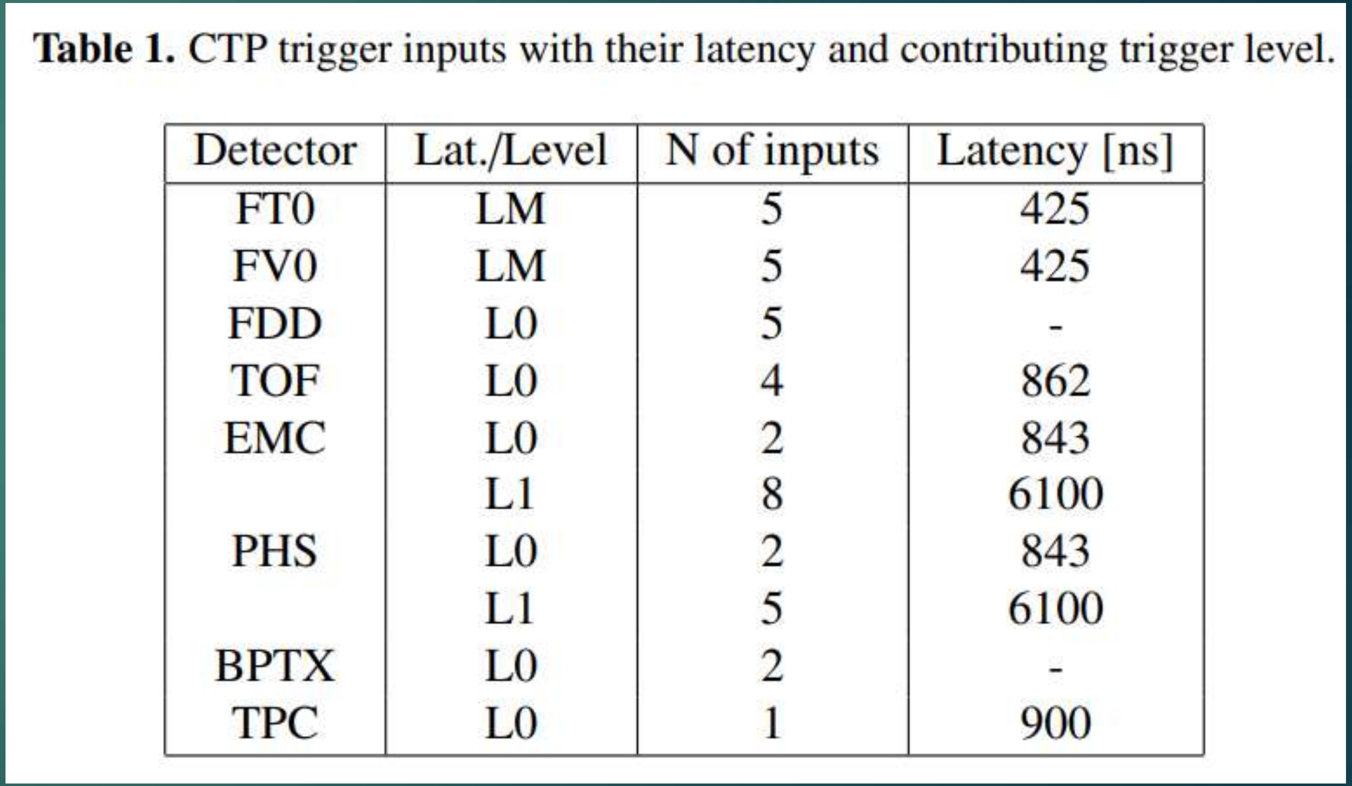
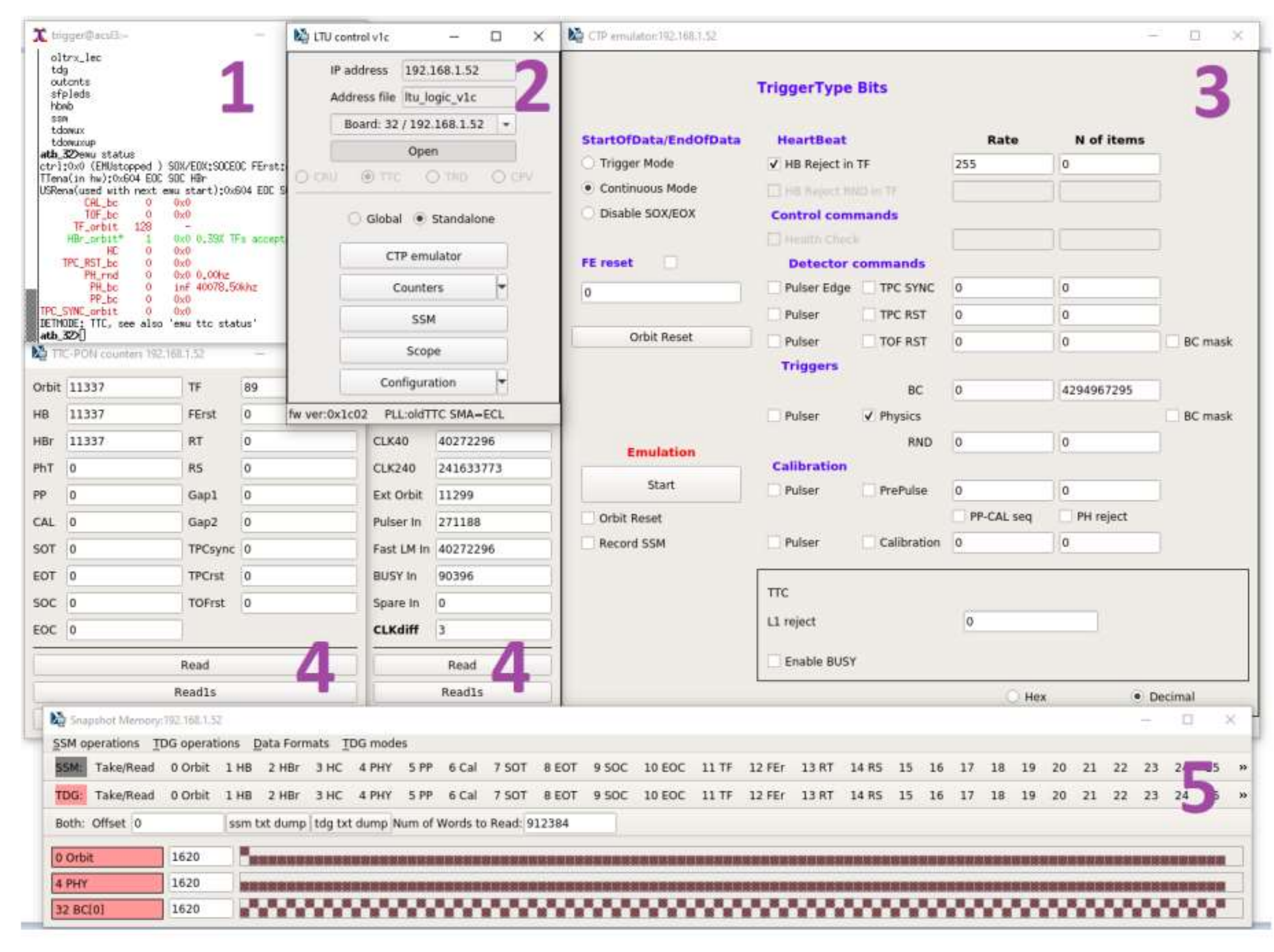


Table 1. CTP trigger inputs with their latency and contributing trigger level.

Detector	Lat./Level	N of inputs	Latency [ns]
FT0	LM	5	425
FV0	LM	5	425
FDD	L0	5	-
TOF	L0	4	862
EMC	L0	2	843
	L1	8	6100
PHS	L0	2	843
	L1	5	6100
BPTX	L0	2	-
TPC	L0	1	900

Technical Implementation of CTS and ALICE Trigger Board

- In the new Central Trigger System, advanced trigger protocols and transceivers are utilized, including the development of the ALICE Trigger Board (ATB), which is a key component of the system. Based on Xilinx FPGA, ATB provides the flexibility and power needed for trigger processing and time stamping. The system supports two modes of operation, ensuring compatibility with both modern and legacy detectors. With respect to the further development of CTS, emphasis is placed on integration with the overall ALICE data readout infrastructure, anticipating improvements and adaptations necessary to maintain ALICE's leadership in high-energy physics research.



```
  oltrx_lec
  tdg
  outcnts
  sfpleds
  hbmb
  ssm
  tdomux
  tdomuxup
atb_32>emu status
ctrl:0x0 (EMUstopped ) SOX/EOX:SOCEOC FErst:
TTena(in hw):0x604 EOC SOC HBr
USRena(used with next emu start):0x604 EOC S
       CAL_bc     0    0x0
       TOF_bc     0    0x0
     TF_orbit   128     -
    HBr_orbit*    1    0x0 0.39% TFs accept
           HC     0    0x0
   TPC_RST_bc     0    0x0
       PH_rnd     0    0x0 0.00hz
        PH_bc     0    inf 40078.50khz
        PP_bc     0    0x0
TPC_SYNC_orbit    0    0x0
DETMODE: TTC, see also 'emu ttc status'
atb_32>
```

IP address 192.168.1.52
Address file ltu_logic_v1c
Board: 32 / 192.168.1.52
○ CRU ● TTC ○ TRD ○ CPV
○ Global ● Standalone
fw ver:0x1c02 PLL:oldTTC SMA–ECL

Orbit	11337	TF	89
HB	11337	FErst	0
HBr	11337	RT	0
PhT	0	RS	0
PP	0	Gap1	0
CAL	0	Gap2	0
SOT	0	TPCsync	0
EOT	0	TPCrst	0
SOC	0	TOFrst	0
EOC	0		

CLK40	40272296
CLK240	241633773
Ext Orbit	11299
Pulser In	271188
Fast LM In	40272296
BUSY In	90396
Spare In	0
CLKdiff	3

TriggerType Bits

StartOfData/EndOfData
○ Trigger Mode
● Continuous Mode
○ Disable SOX/EOX

FE reset ☐
0

Emulation
☐ Orbit Reset
☐ Record SSM

			Rate	N of items	
HeartBeat					
☑ HB Reject in TF			255	0	
☐ HB Reject RND in TF					
Control commands					
☐ Health Check					
Detector commands					
☐ Pulser Edge	☐ TPC SYNC		0	0	
☐ Pulser	☐ TPC RST		0	0	
☐ Pulser	☐ TOF RST		0	0	☐ BC mask
Triggers					
		BC	0	4294967295	
☐ Pulser	☑ Physics				☐ BC mask
		RND	0	0	
Calibration					
☐ Pulser	☐ PrePulse		0	0	
			☐ PP-CAL seq	☐ PH reject	
☐ Pulser	☐ Calibration		0	0	

TTC
L1 reject 0
☐ Enable BUSY

○ Hex ● Decimal

SSM: Take/Read 0 Orbit 1 HB 2 HBr 3 HC 4 PHY 5 PP 6 Cal 7 SOT 8 EOT 9 SOC 10 EOC 11 TF 12 FEr 13 RT 14 RS 15 16 17 18 19 20 21 22 23 24 25 »
TDG: Take/Read 0 Orbit 1 HB 2 HBr 3 HC 4 PHY 5 PP 6 Cal 7 SOT 8 EOT 9 SOC 10 EOC 11 TF 12 FEr 13 RT 14 RS 15 16 17 18 19 20 21 22 23 24 25 »
Both: Offset 0 Num of Words to Read: 912384

0 Orbit	1620
4 PHY	1620
32 BC[0]	1620

THANK YOU!