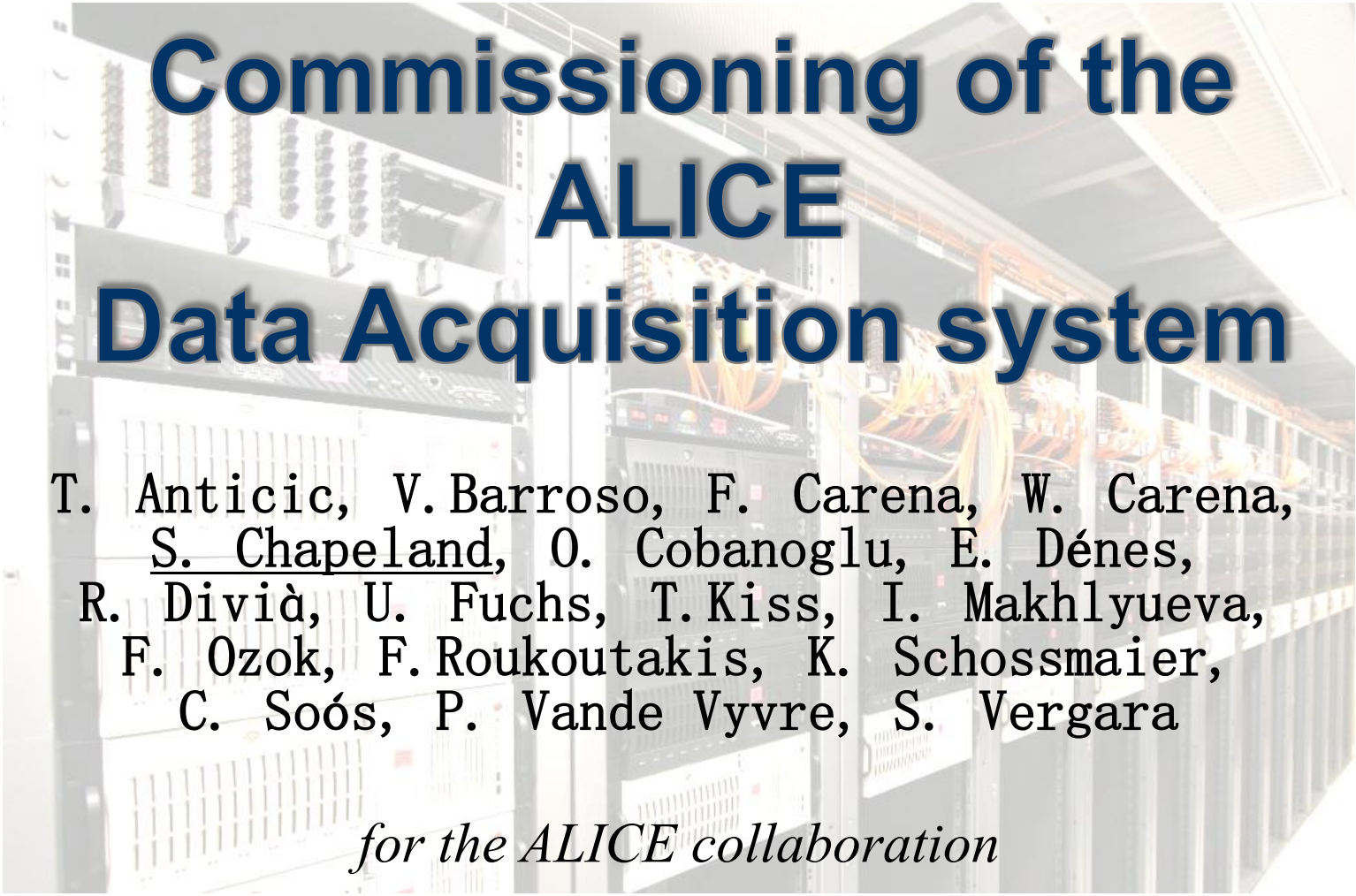


Commissioning of the ALICE Data Acquisition system

T. Anticic, V. Barroso, F. Carena, W. Carena, S. Chapeland, O. Cobanoglu, E. Dénes, R. Divià, U. Fuchs, T. Kiss, I. Makhlyueva, F. Ozok, F. Roukoutakis, K. Schossmaier, C. Soós, P. Vande Vyvre, S. Vergara

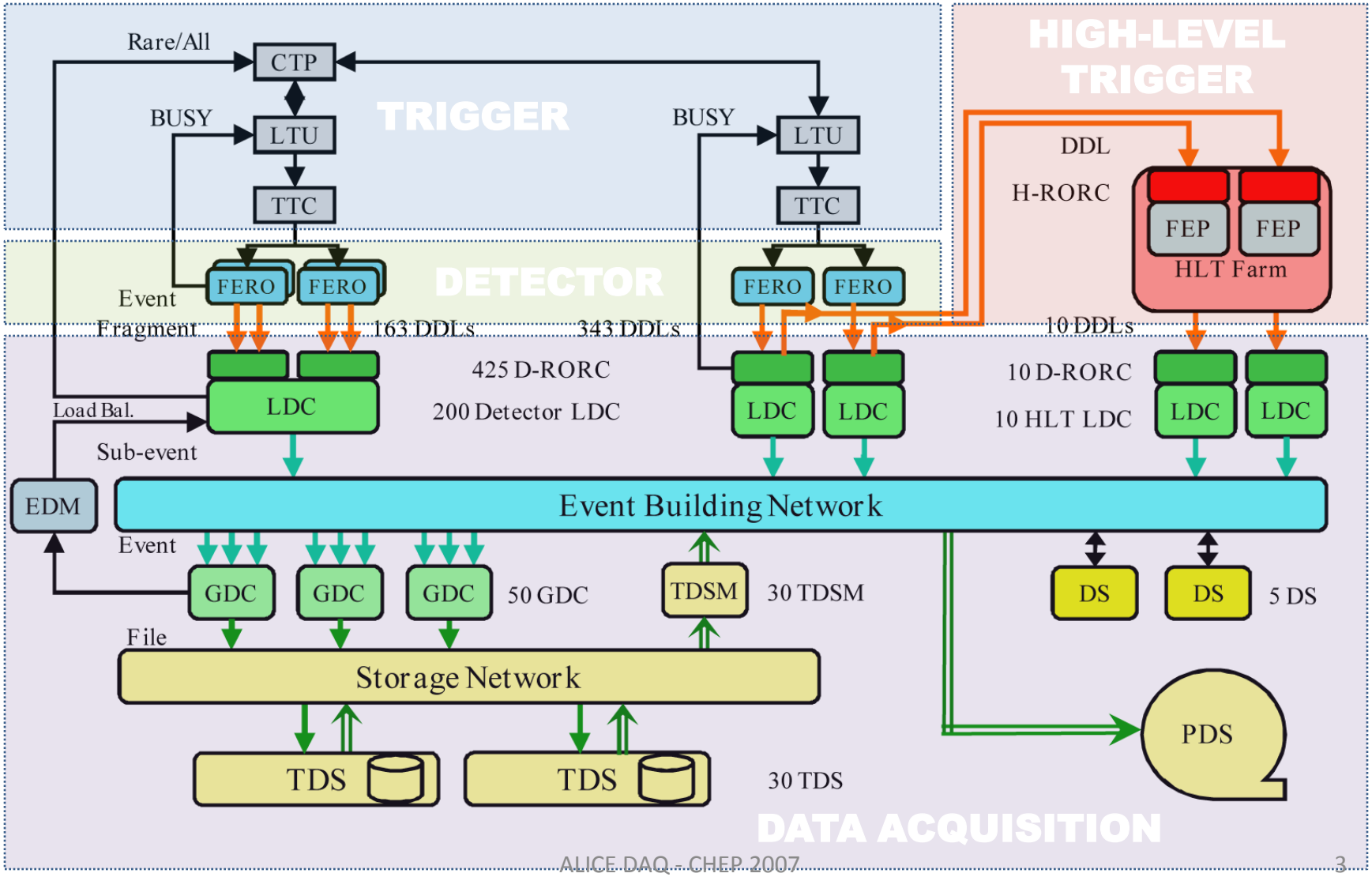
for the ALICE collaboration

ALICE DAQ needs

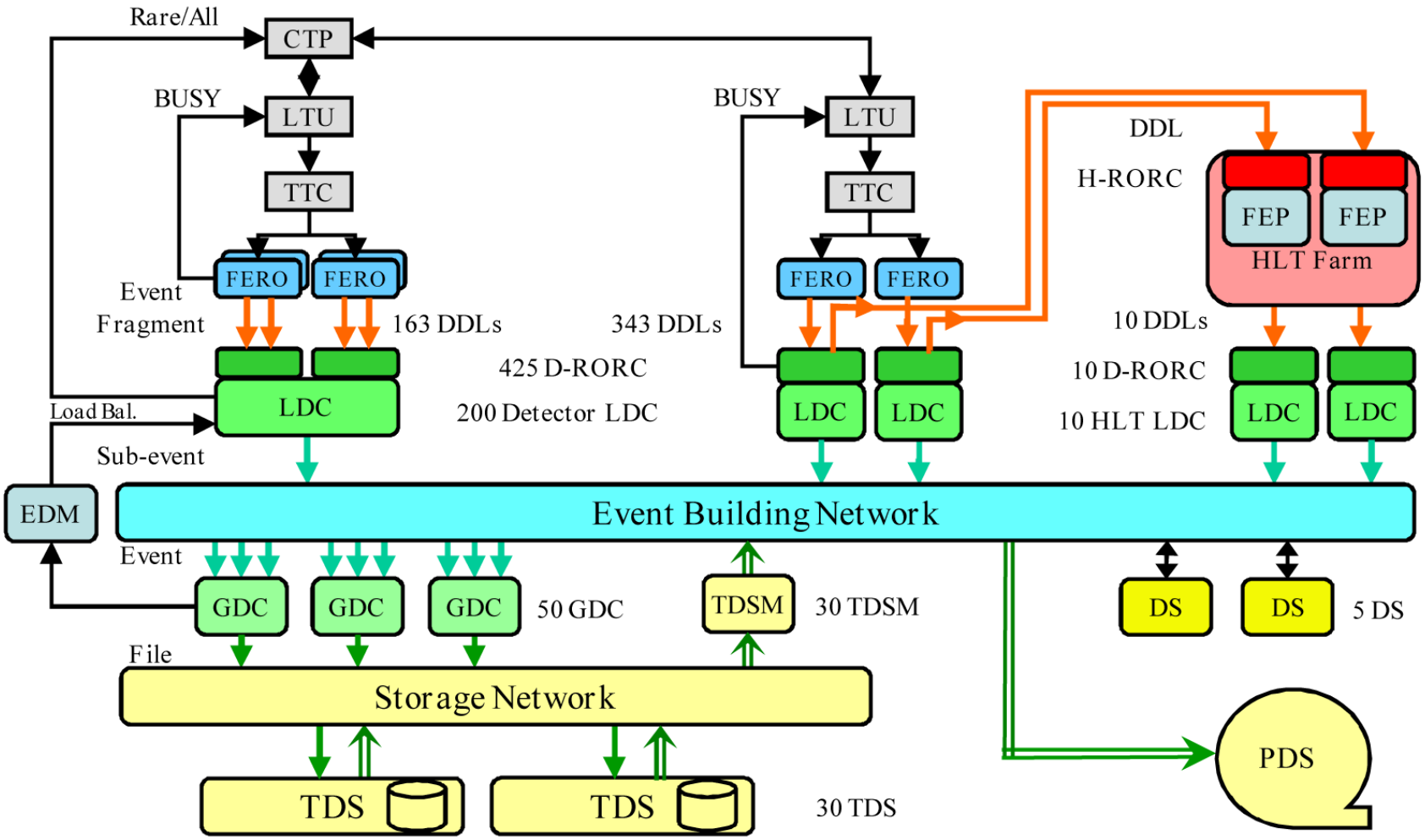
Number of detectors	18	
Input throughput	25 GB/s	
Collision type	p-p	Pb-Pb
Event size	86.5 MB	2.5MB
Trigger rate	10 KHz	200 KHz
Bandwidth to mass storage	1.25 GB/s	200 MB/s

- Two data flow patterns, depending on collision type:
  - big events, low interaction rate, complex triggers with different sets of detectors in each event, large bandwidth to tape (few weeks per year)
  - small events, high interaction rate, simpler triggers, less bandwidth
- Flexibility to allow detector operation standalone or in groups
  - All 18 standalone + up to 6 partitions in parallel

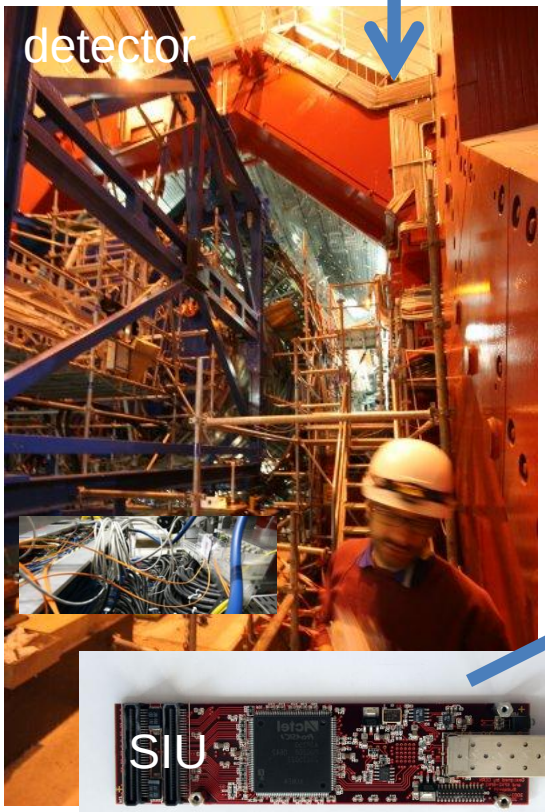
Online data flow

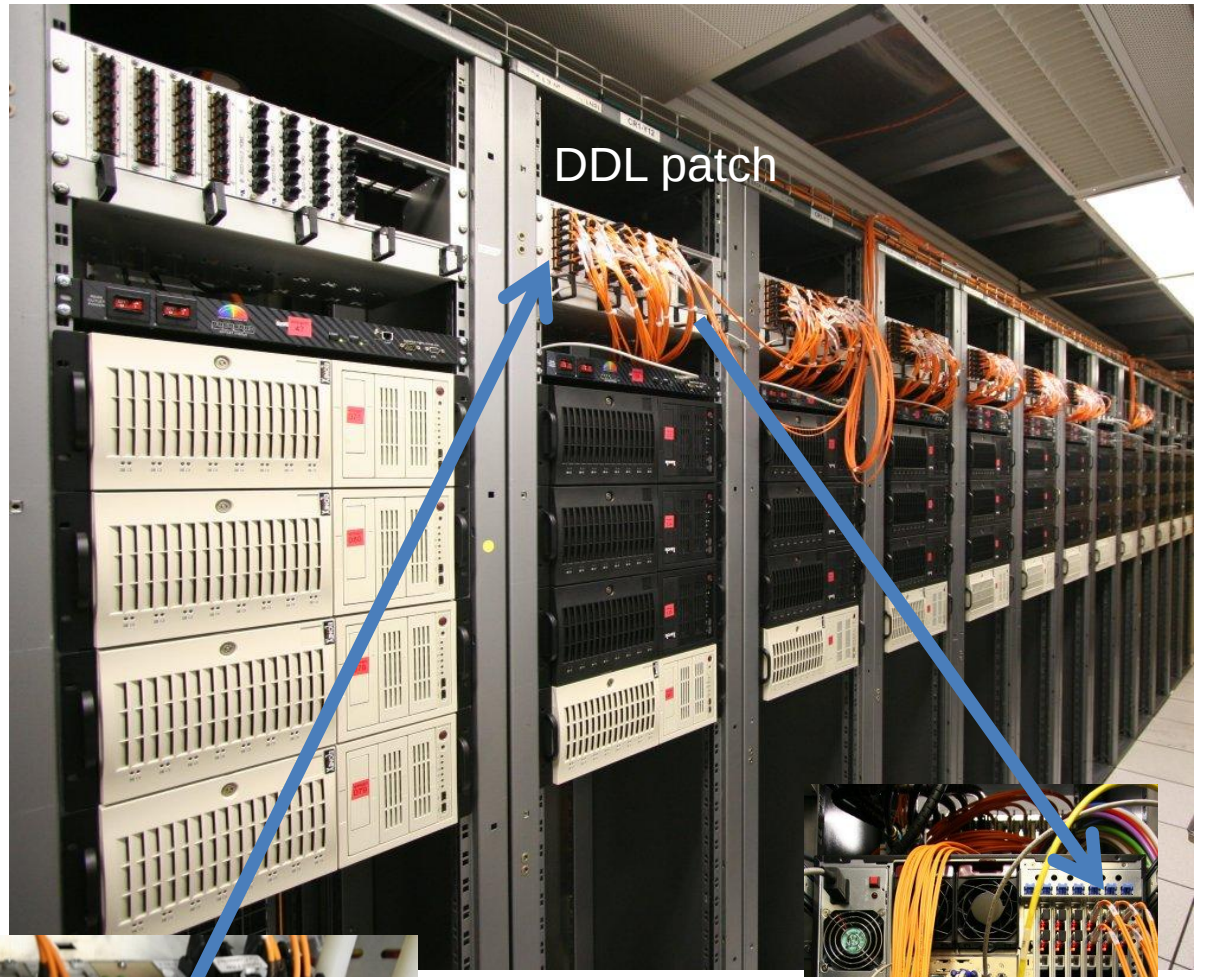


Online data flow

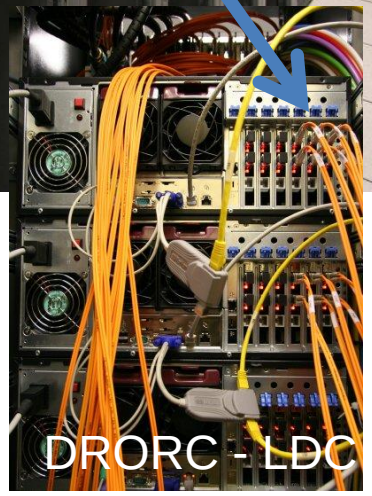



trigger


detector


DDL patch

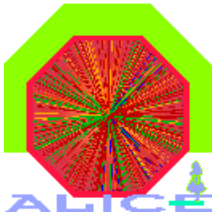

DDL patch


DRORC - LDC

SIU

Implementation Highlights

- Detector Data Link
  - More than 200 MB/s, full duplex
  - 500 optical fibers to detector
  - Radiation tolerant sender unit, FPGA based
  - 100 MHz PCI-X readout board, DMA, 2 channels per card
- Local data concentrators (readout) – 110 PCs
  - 6 PCI slots, dual processors, 4G memory, 4U box
- Global data concentrators (event Building) – 15 PCs
  - Dual processors, Cluster File System mounted by FC 4G *(c.f. poster)*
- Transient data storage
  - Disk arrays – 20 x 3 TB Raid 5
- Gigabit router
  - Force10 E1200, 336 x 1Gb ports (max 14x48) + 4 x 10Gb uplink



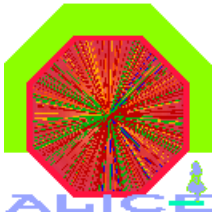
Implementation Highlights

- MySQL database + GUI
  - Configuration (roles, memory banks, detector files, environment)
  - Log messages
  - Experiment logbook (run, events recorded, …)
  - File Exchange Server (interface to other online / offline systems)
- Network services: DHCP, DNS, NTP, syslog, SNMP, PXE/Kickstart
- YUM repository for RPMs:
  - SLC4 base + updates + DAQ software (DATE, ECS, dependencies, drivers)
- Monitoring
  - AFFAIR : integrated DAQ performance monitoring
  - Lemon : general fabric health monitoring
  - MOOD : online monitoring
  - AMORE : data quality monitoring, automatic histogram *(c.f. talk)*

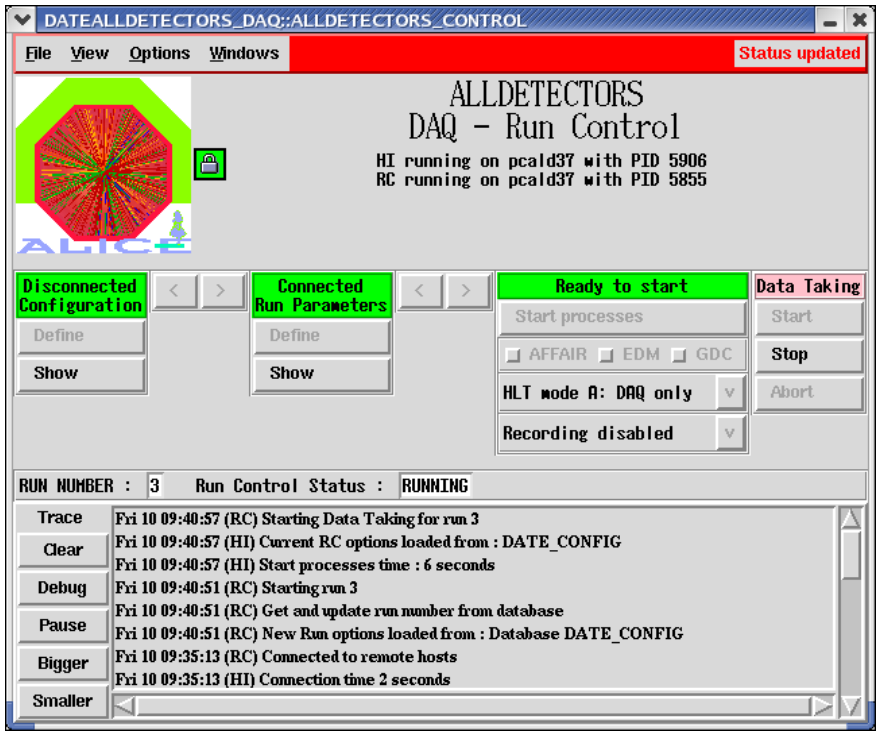
Deployment and Operation

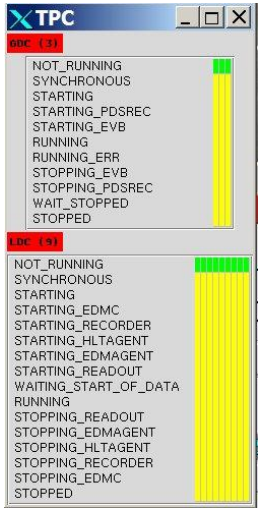
- Rack-mounted commodity PCs + software layer
- Experiment Control System
  - High level status and control of the online systems

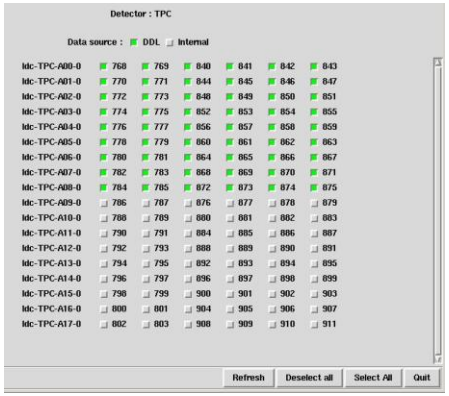
    DCS, DAQ, HLT, TRG
  - Distributed Finite State Machine: DIM/SMI
- DATE software
  - Handling of the data flow
  - Process synchronization
  - Push data, back-pressure control from detector front-end to transient storage
- Common central application logging mechanism
  - Run, time, host, pid, user, subsystem, message
- Full remote operation from surface control room

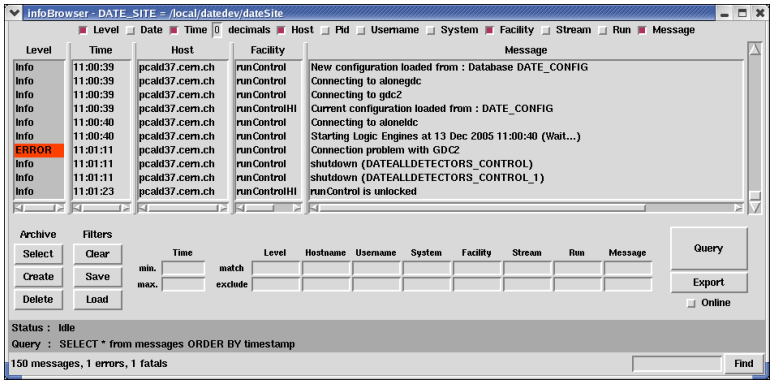

ALICE

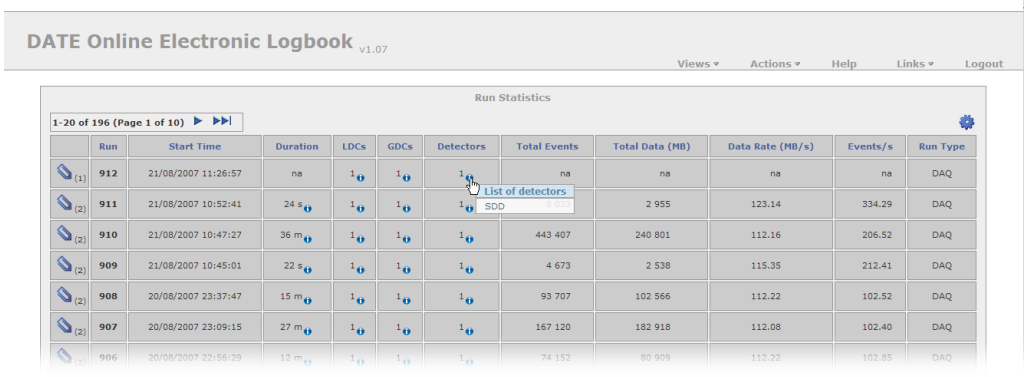

CERN

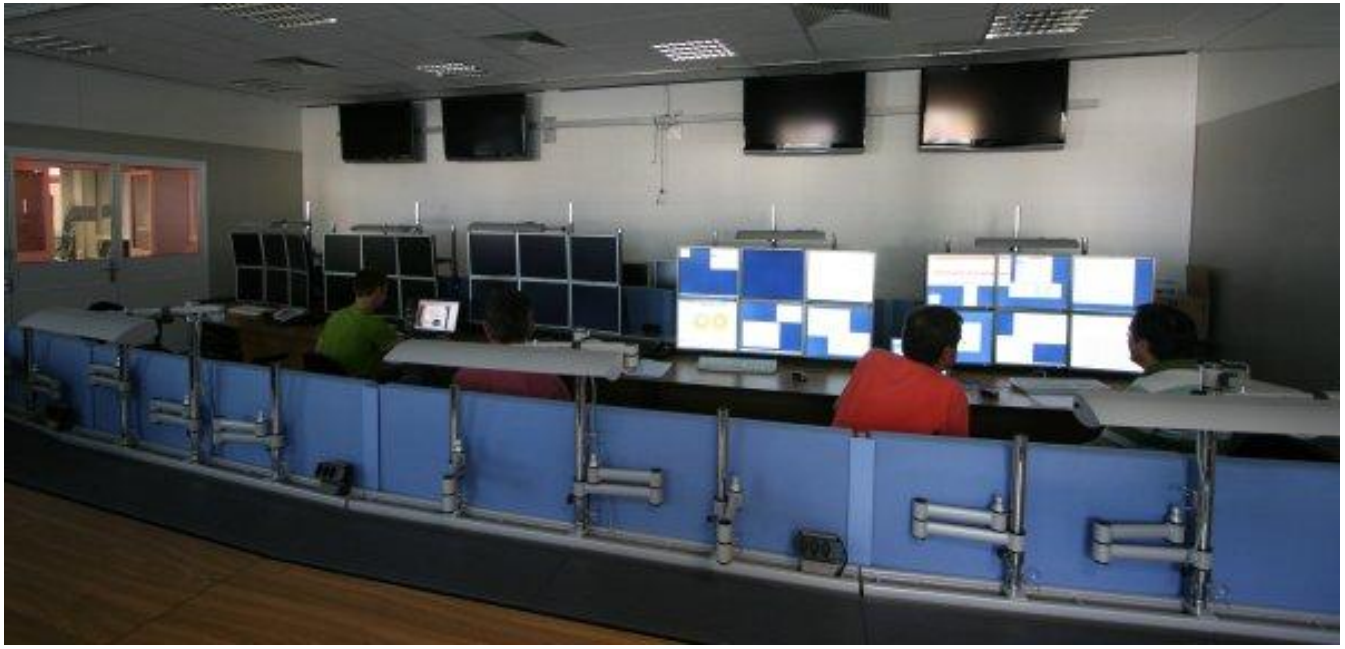

DATEALLDETECTORS_DAQ::ALLDETECTORS_CONTROL
File View Options Windows
Status updated
ALLDETECTORS
DAQ - Run Control
HI running on pcald37 with PID 5906
RC running on pcald37 with PID 5855
Disconnected Configuration
Define
Show
Connected Run Parameters
Define
Show
Ready to start
Start processes
AFFAIR EDM GDC
HLT mode A: DAQ only
Recording disabled
Data Taking
Start
Stop
Abort
RUN NUMBER : 3
Run Control Status : RUNNING
Trace
Clear
Debug
Pause
Bigger
Smaller
Fri 10 09:40:57 (RC) Starting Data Taking for run 3
Fri 10 09:40:57 (HI) Current RC options loaded from : DATE_CONFIG
Fri 10 09:40:57 (HI) Start processes time : 6 seconds
Fri 10 09:40:51 (RC) Starting run 3
Fri 10 09:40:51 (RC) Get and update run number from database
Fri 10 09:40:51 (RC) New Run options loaded from : Database DATE_CONFIG
Fri 10 09:35:13 (RC) Connected to remote hosts
Fri 10 09:35:13 (HI) Connection time 2 seconds

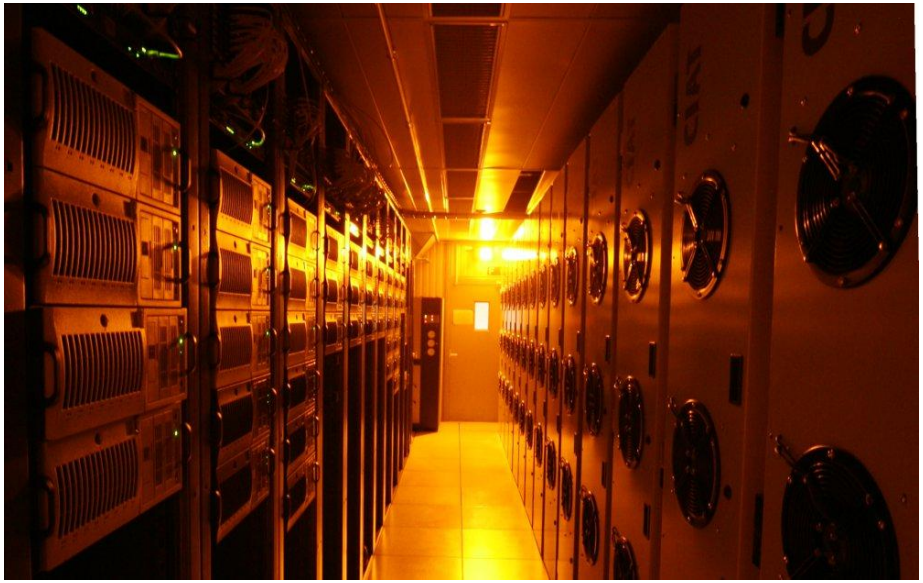

TPC
GDC (3)
NOT_RUNNING
SYNCHRONOUS
STARTING
STARTING_PDSREC
STARTING_EVB
RUNNING
RUNNING_ERR
STOPPING_EVB
STOPPING_PDSREC
WAIT_STOPPED
STOPPED
LDC (9)
NOT_RUNNING
SYNCHRONOUS
STARTING
STARTING_EDMC
STARTING_RECORDER
STARTING_HLTAGENT
STARTING_EDMAGENT
STARTING_READOUT
WAITING_START_OF_DATA
RUNNING
STOPPING_READOUT
STOPPING_EDMAGENT
STOPPING_HLTAGENT
STOPPING_RECORDER
STOPPING_EDMC
STOPPED


Detector : TPC
Data source : DDL Internal
Refresh
Deselect all
Select All
Quit


InfoBrowser - DATE_SITE = /local/datedev/dateSite
Level Date Time decimals Host Pid Username System Facility Stream Run Message
Level Time Host Facility Message
Info 11:00:39 pcald37.cern.ch runControl New configuration loaded from : Database DATE_CONFIG
Info 11:00:39 pcald37.cern.ch runControl Connecting to alonegdc
Info 11:00:39 pcald37.cern.ch runControl Connecting to gdc2
Info 11:00:39 pcald37.cern.ch runControlHI Current configuration loaded from : DATE_CONFIG
Info 11:00:40 pcald37.cern.ch runControl Connecting to alonehldc
Info 11:00:40 pcald37.cern.ch runControl Starting Logic Engines at 13 Dec 2005 11:00:40 (Wait...)
ERROR 11:01:11 pcald37.cern.ch runControl Connection problem with GDC2
Info 11:01:11 pcald37.cern.ch runControl shutdown (DATEALLDETECTORS_CONTROL)
Info 11:01:11 pcald37.cern.ch runControl shutdown (DATEALLDETECTORS_CONTROL_1)
Info 11:01:23 pcald37.cern.ch runControlHI runControl is unlocked
Archive
Select
Create
Delete
Filters
Clear
Save
Load
Time Level Hostname Username System Facility Stream Run Message
min. match
max. exclude
Query
Export
Online
Status : Idle
Query : SELECT * from messages ORDER BY timestamp
150 messages, 1 errors, 1 fatals
Find

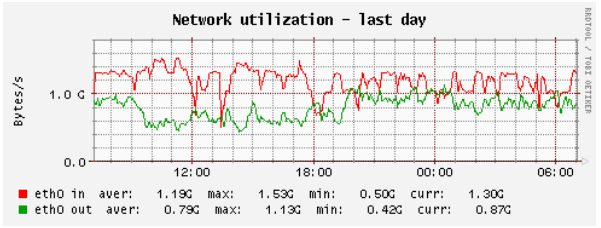

DATE Online Electronic Logbook v1.07
Views
Actions
Help
Links
Logout
Run Statistics
1-20 of 196 (Page 1 of 10)
Run Start Time Duration LDCs GDCs Detectors Total Events Total Data (MB) Data Rate (MB/s) Events/s Run Type
912 21/08/2007 11:26:57 na na na na na DAQ
911 21/08/2007 10:52:41 24 s 2 955 123.14 334.29 DAQ
910 21/08/2007 10:47:27 36 m 443 407 240 801 112.16 206.52 DAQ
909 21/08/2007 10:45:01 22 s 4 673 2 538 115.35 212.41 DAQ
908 20/08/2007 23:37:47 15 m 93 707 102 566 112.22 102.52 DAQ
907 20/08/2007 23:09:15 27 m 167 120 182 918 112.08 102.40 DAQ
List of detectors
SDD

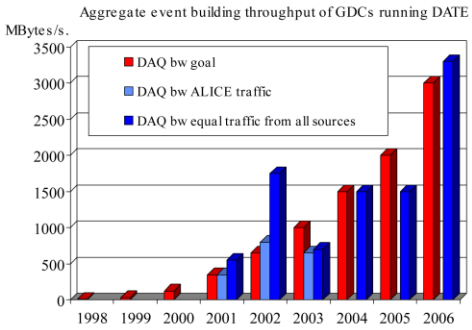


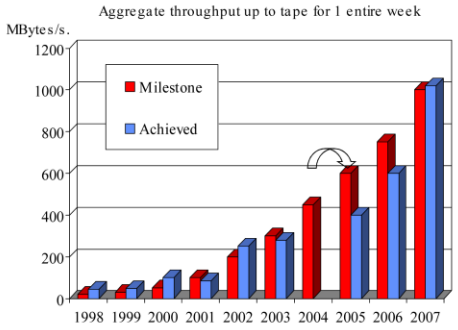


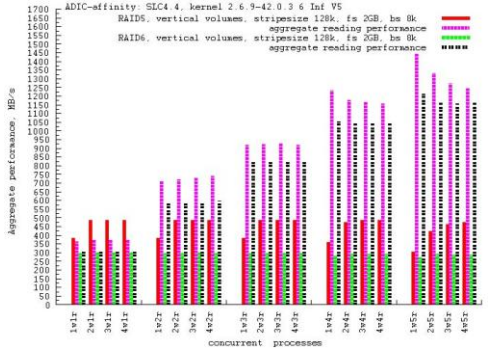
Testing

- DAQ standalone evaluation
  - Emulation hardware (DDL Data Generator)
  - Data Challenges
  - Test beams, detector setups
  - Reference system (including storage)
  - Code releases: usually once a month, more often when needed









- Interfaces: physical connections + high-level functionality

Interfaces and tests

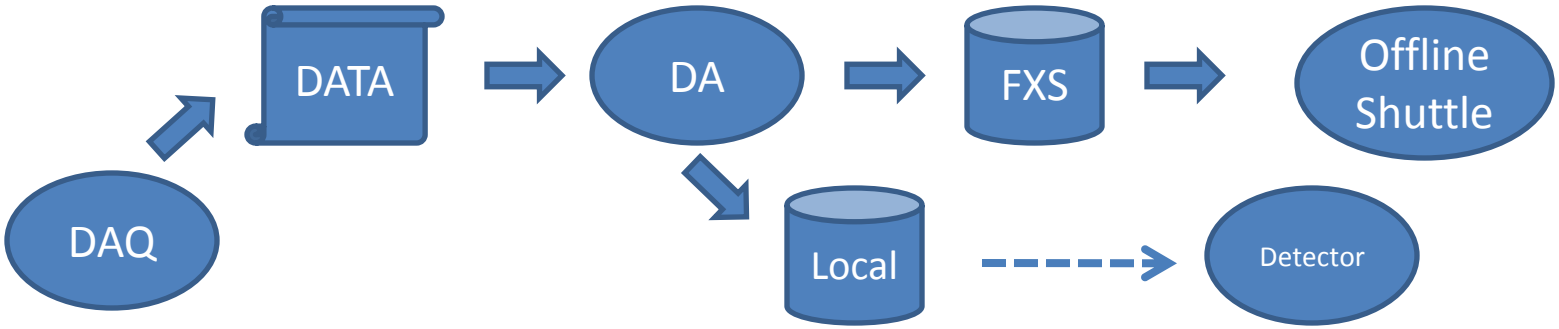
- Front-end electronics : DDL + Trigger (x 18 !)
  - Independent small test setups
  - Local Trigger Unit in emulation mode
  - DAQ + TRG controlled by ECS
  - Burn-in tests with all software checks enabled
    - validation of data format (event headers, start/stop of data)
    - stability
  - Commissioning in experimental area

Interfaces and tests

- Trigger
  - ECS control
  - Central Trigger Processor readout
- High-Level Trigger
  - Standalone DAQ setup with emulated trigger decisions
  - Real hardware (including full connectivity) in experimental area, ECS controlled (synchronization + configuration)
- Offline interface
  - DAQ / Offline fully decoupled at run time
  - File storage + GRID registration
  - Data challenges, test beams, detector commissioning runs

Interfaces and tests

- Detector calibration algorithms (DA)
  - Data taking + online processing on DAQ nodes
  - Strict rules for user code (I/O, configuration, deployment, interfaces, footprint, dependencies, packaging, documentation)
  - Validation on standalone setup with data files
  - Central server to build DA releases from Offline code
  - File Exchange server to export results to Offline (tested)



Current and future activities

- Standalone detector development setups
  - Including full data recording and archiving
- Detector integration and commissioning at experimental area
  - Real DAQ and detector hardware, standalone runs
  - Electronics interface validated for most detectors (TPC, SPD, SSD, SDD, …)
  - Operation from control room: ECS/DAQ/TRG/HLT/DCS control, monitoring, logbook
  - Full chain stability from electronics to CASTOR
  - DAQ group support 24/7 + shifts
- Next steps: physics production
  - Cosmics runs with combined detectors starting fall 2007
  - Beam in 2008

Conclusions

- Distributed system
  - Large number of components
    - General purpose and ad-hoc solutions
  - Top-level control and configuration
    - Complete yet simple mechanisms to hide low-level complexity
  - Individual tests for base functionality
  - Extensive interface validation procedures
- DAQ ready for operation
  - Detector commissioning runs ongoing, cosmics starting this fall
- Scale up gradually