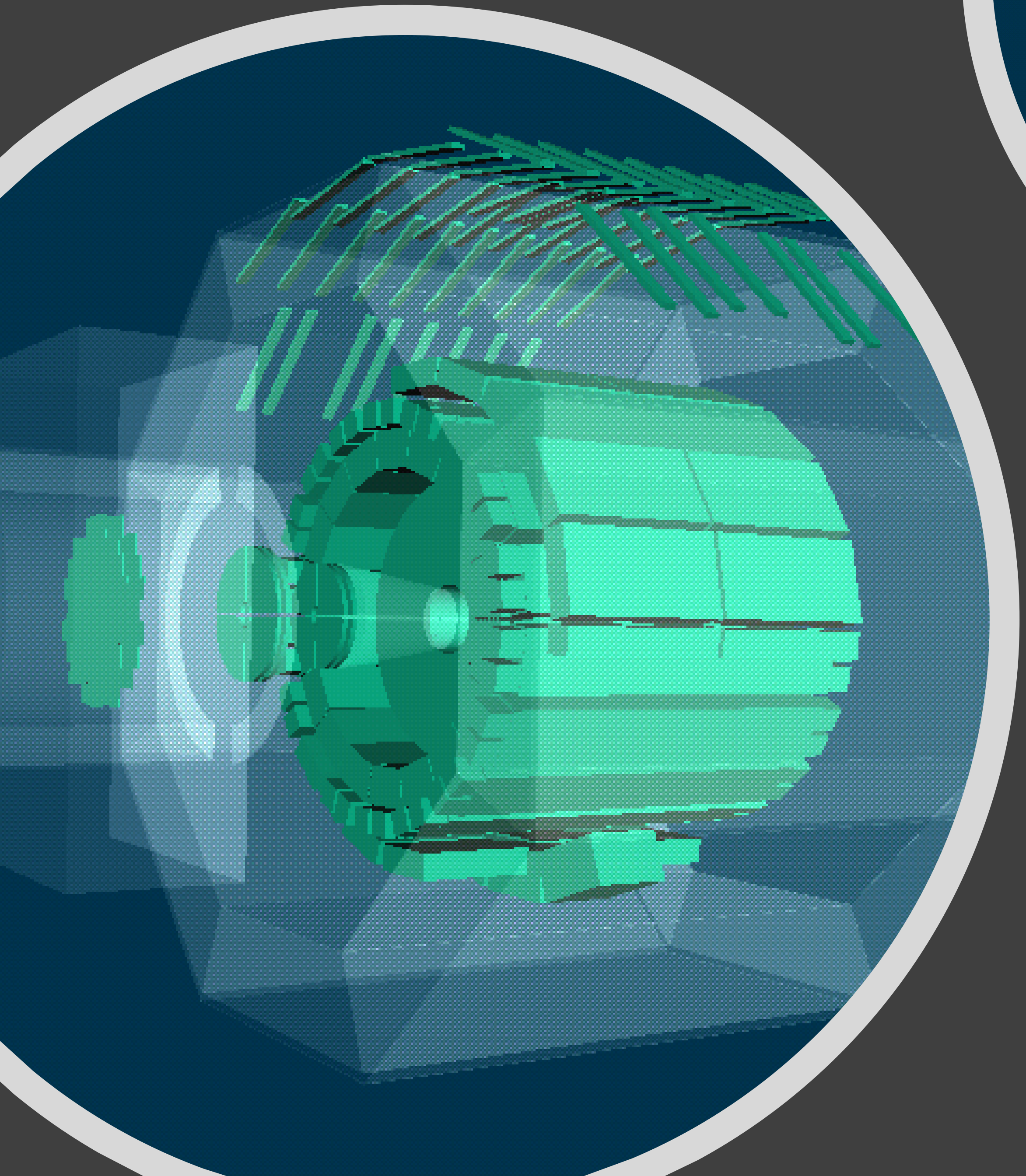
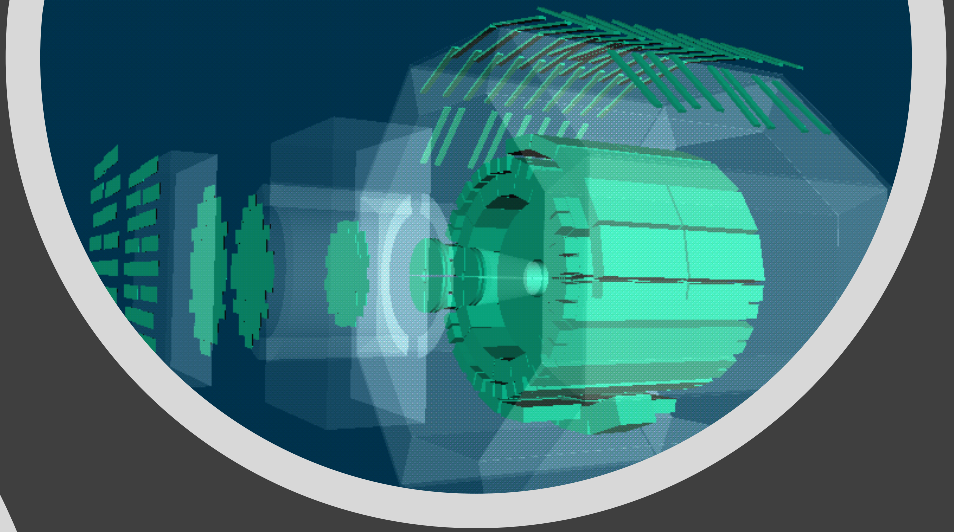




The 12th ALICE ITS Upgrade and MFT, O2 Asian Workshop ,

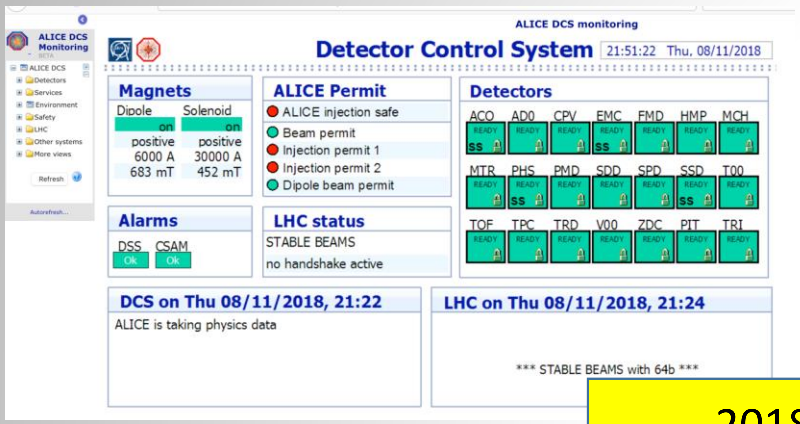
November 2018, Incheon Korea

Peter Chochula , CERN

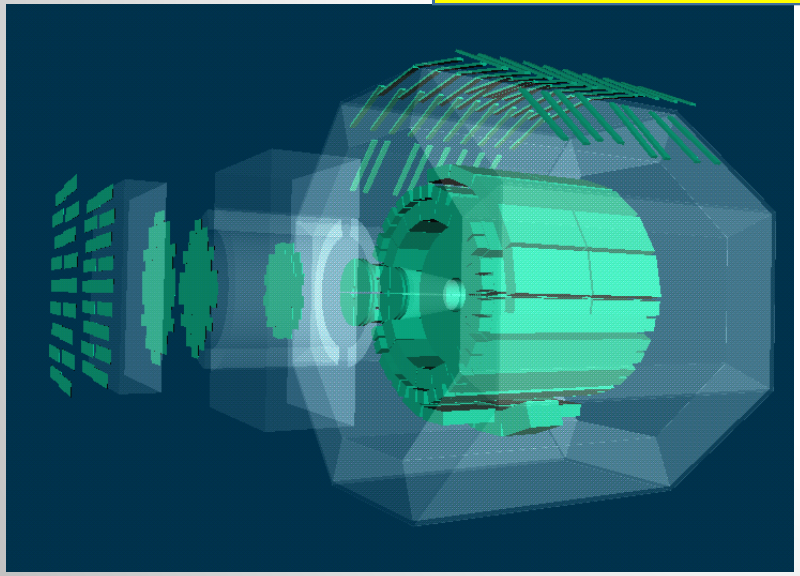
DCS Status and Plans

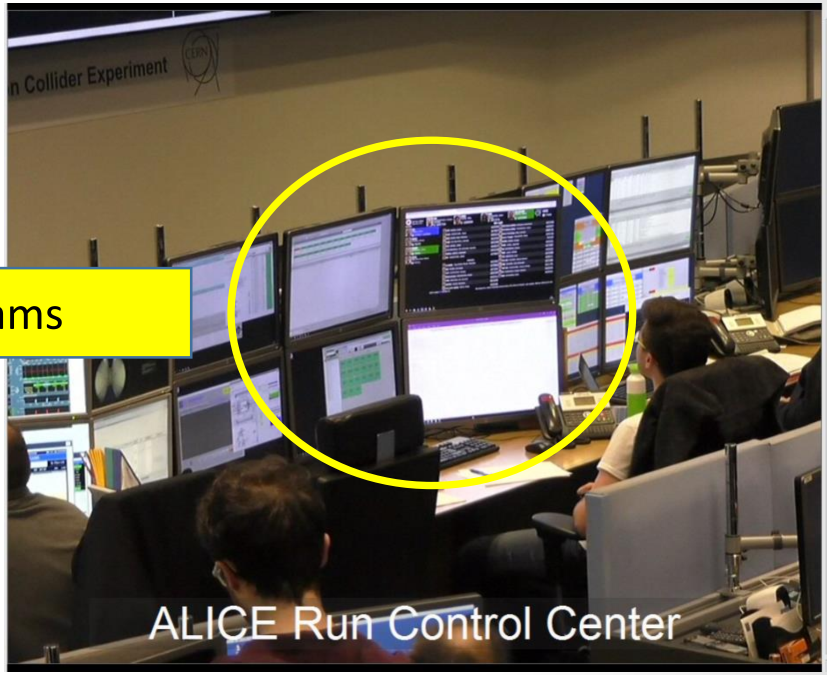
Few keywords to start with

DCS is reliable



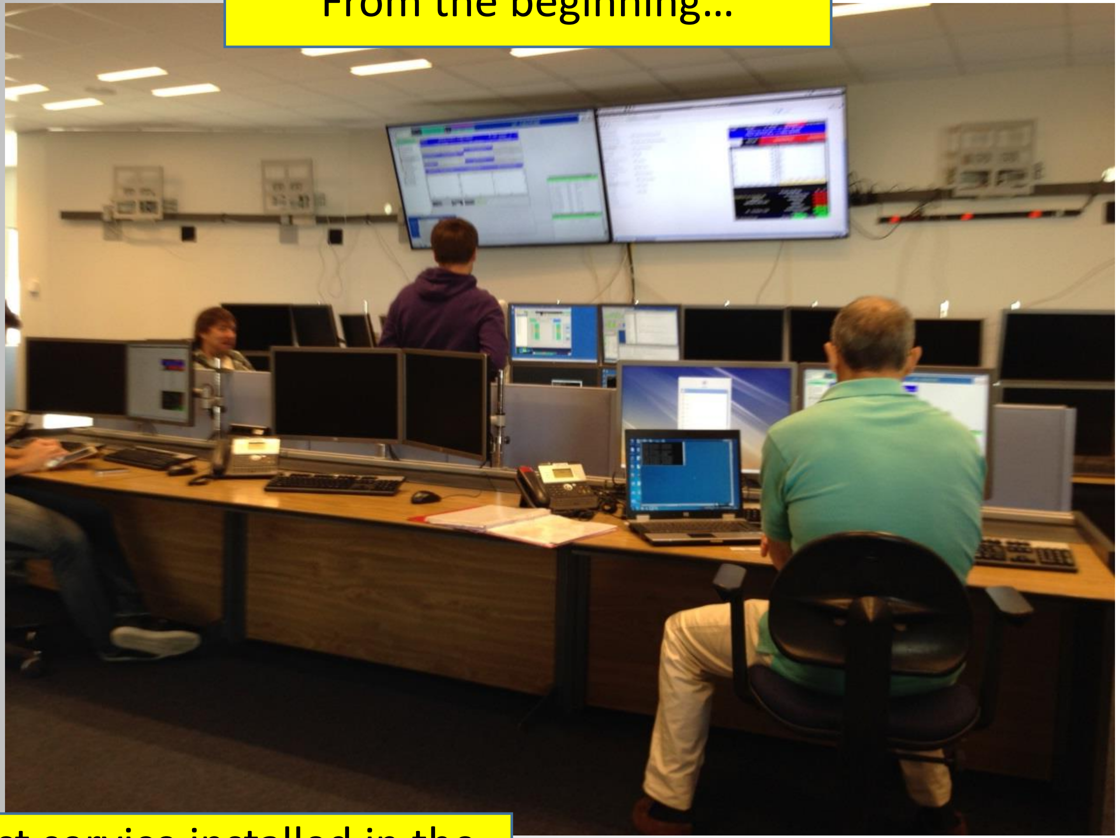
2018 first ion beams





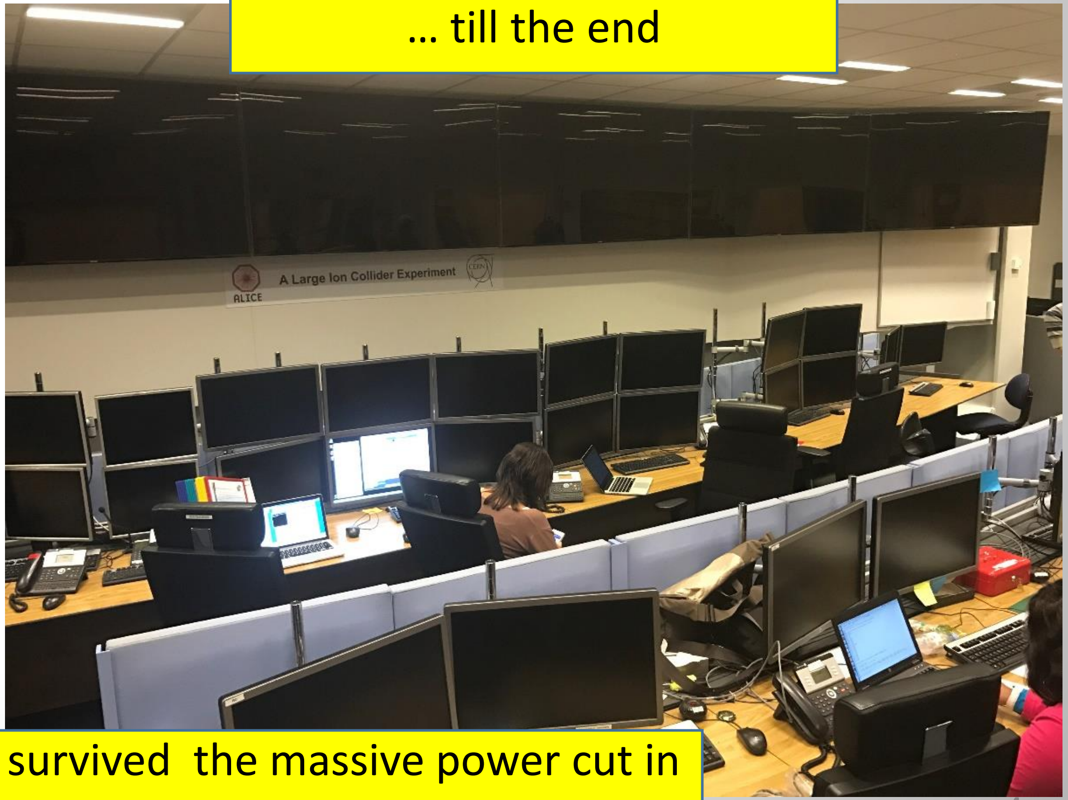
DCS is always with you

From the beginning…



First service installed in the ARC

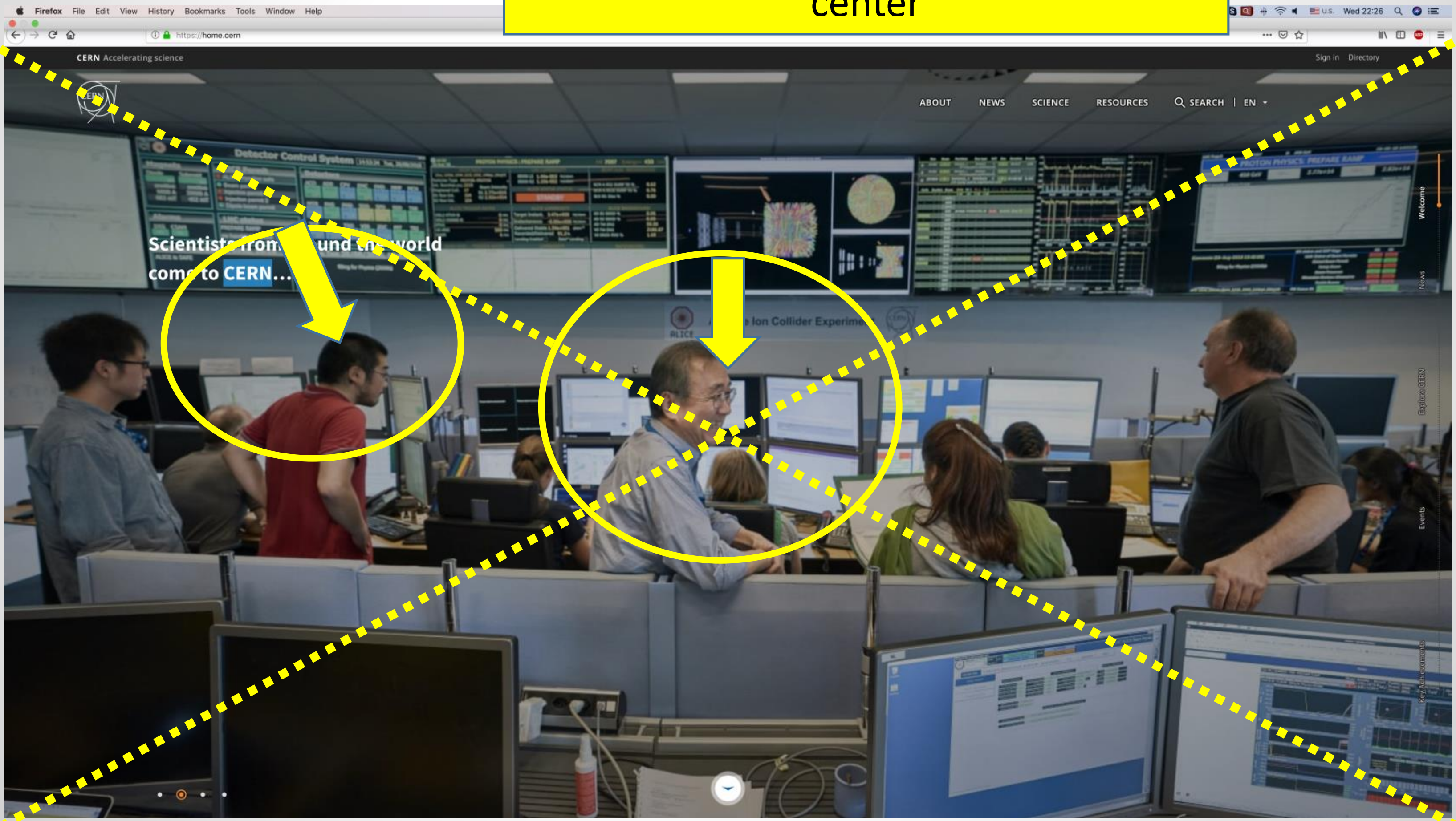
… till the end



Only DCS survived the massive power cut in ALICE in 2016

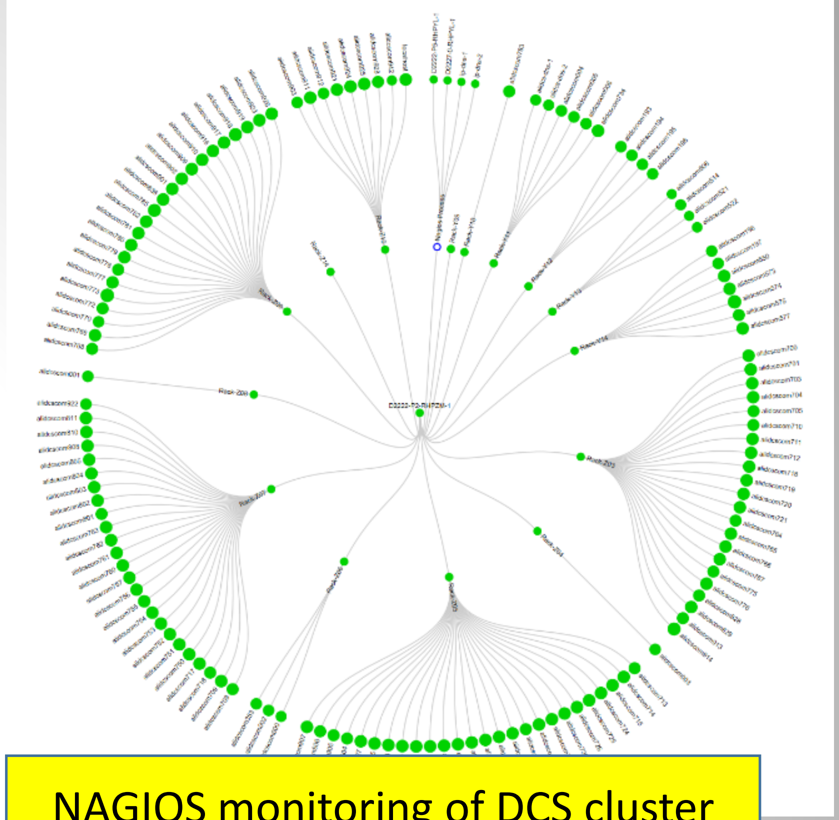
DCS is visible

New official CERN home page with NOT ONLY the DCS in main screen the center

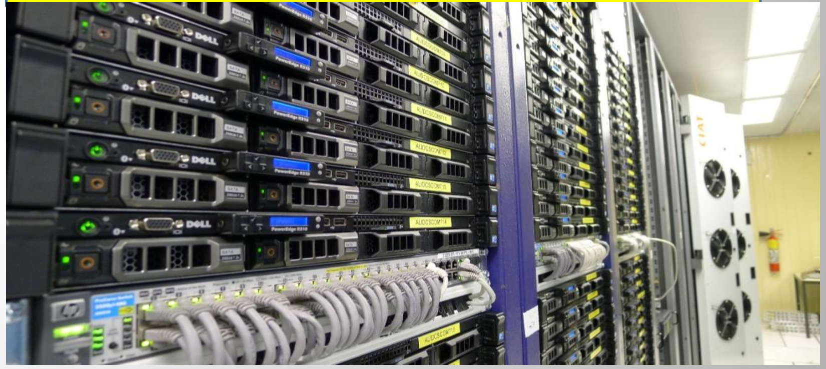


DCS RUN2 performance

- DCS scale:
  - 200 servers
  - 1200 network attached devices
- Excellent stability
  - No Data loss due to DCS
- In 2018, the DCS uptime is so far 99.95%
  - Downtime caused by maintenance and safety tests
- Operational incidents in 2018
  - Replacement of 2 disks in the shadow of other activities – no data loss
  - Replacement of TOF operator node mainboard, not affecting ongoing datataking
  - Replacement of 2+1 storage disks – transparent



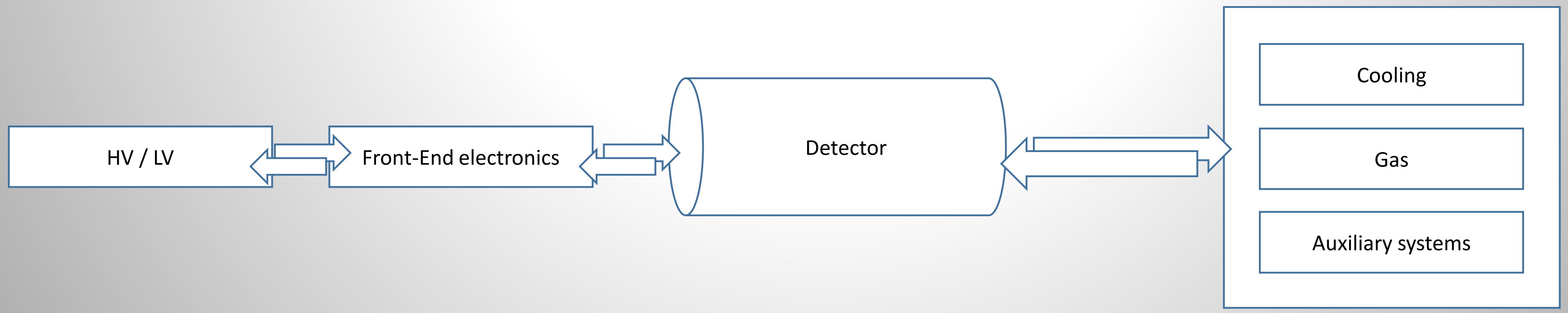
NAGIOS monitoring of DCS cluster



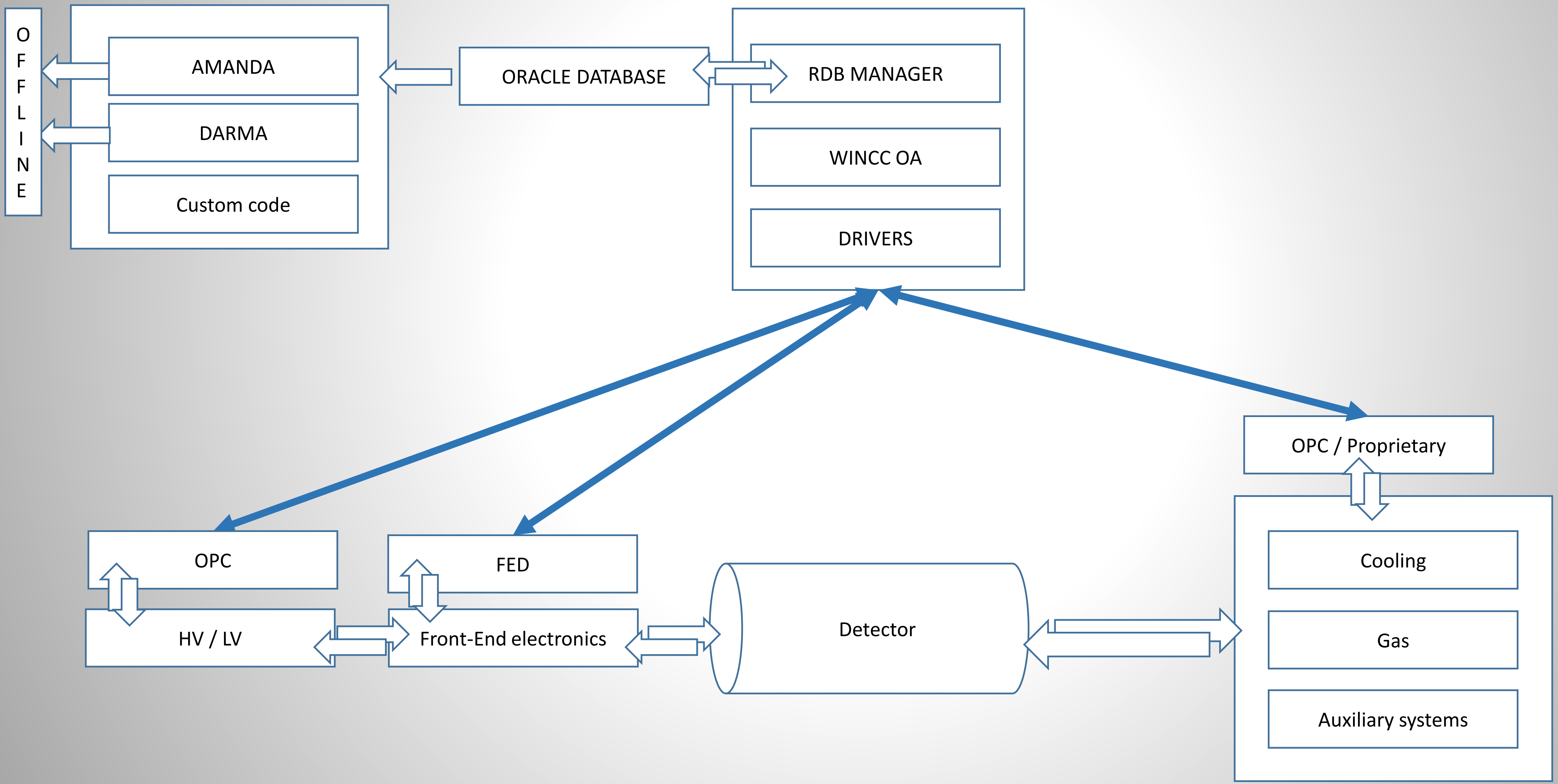
Why shall we then touch such a stable system?

- DCS architecture defined more than 10 years ago (first proposal in 2002)
  - Infrastructure in place since 2007!
  - The RUN1 and RUN2 operation proved, that the technology choice and system design was:
    - correct
    - based on solid components and tools
    - scales very well
- RUN3 does not require major changes in the conservative system architecture, evolution would be sufficient
  - Device control strategy remains the same
  - Controls logic and implementation (FSM based on SMI++) will not change
- BUT…. there are 2 exceptions triggering a major upgrade:
  - Need for data streaming to O2
  - Need for new front-end access mechanism for GBT based detectors

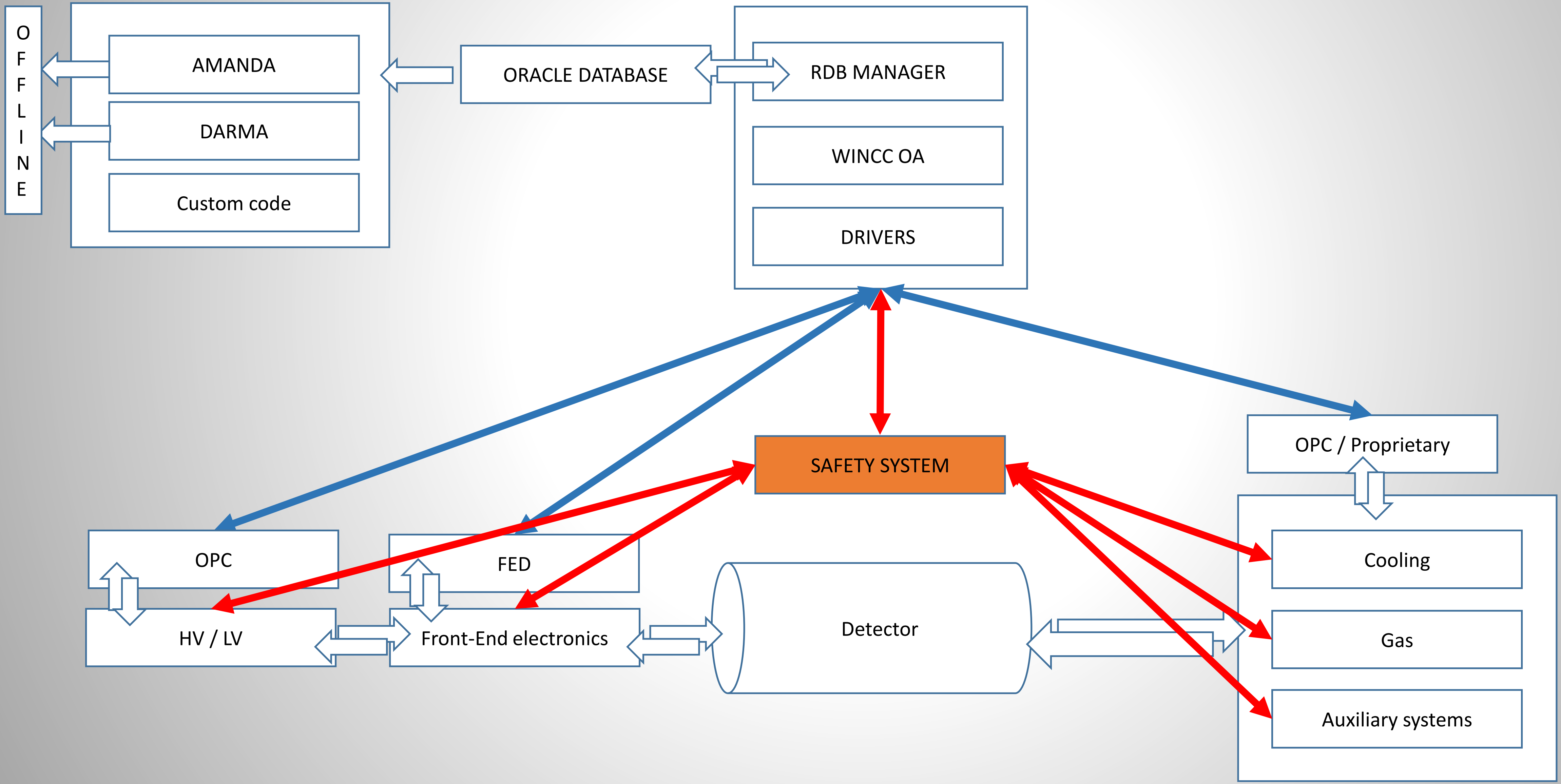
ALICE DCS architecture: RUN 2



ALICE DCS architecture: RUN 2

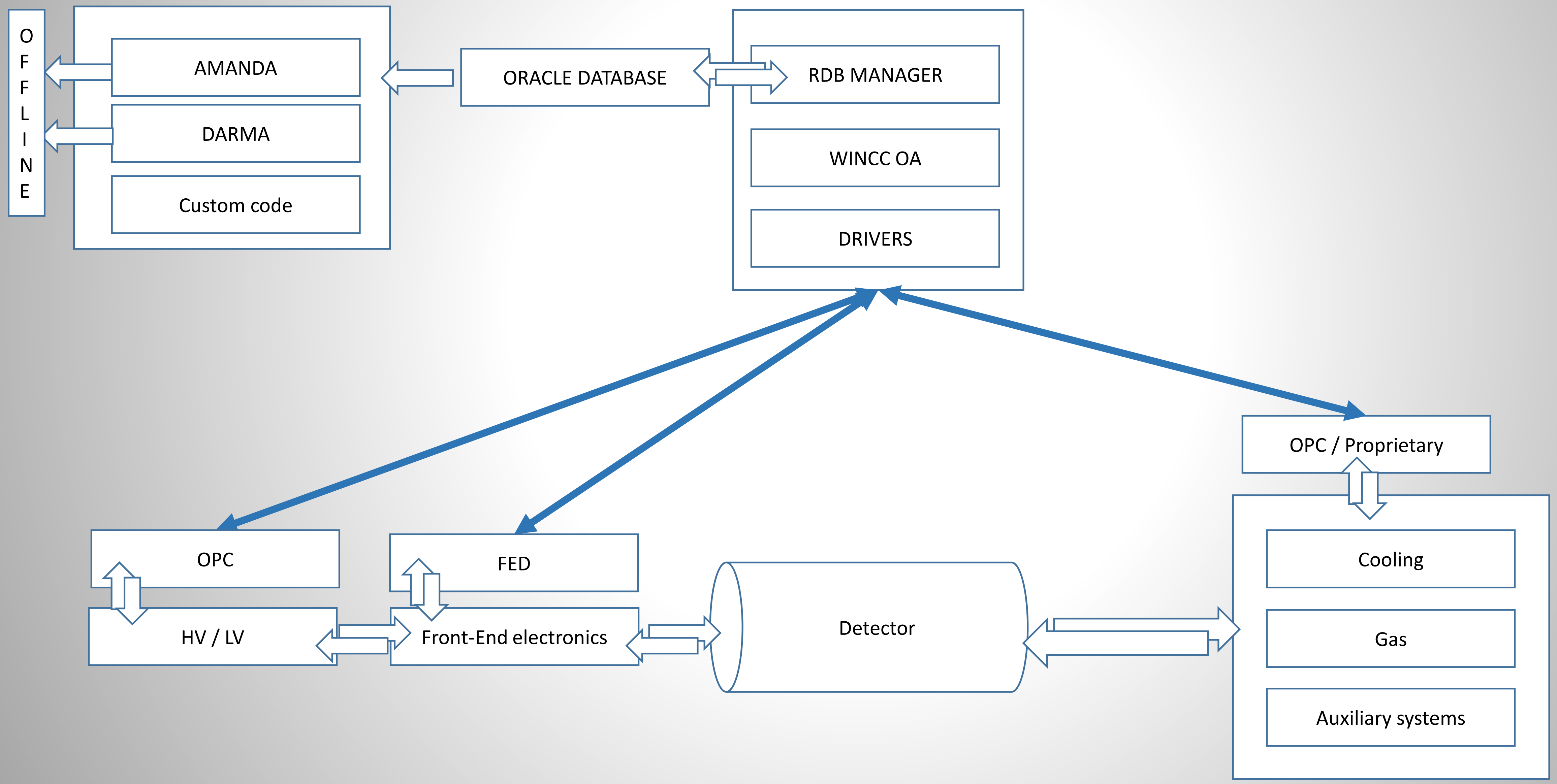


ALICE DCS architecture: RUN 2

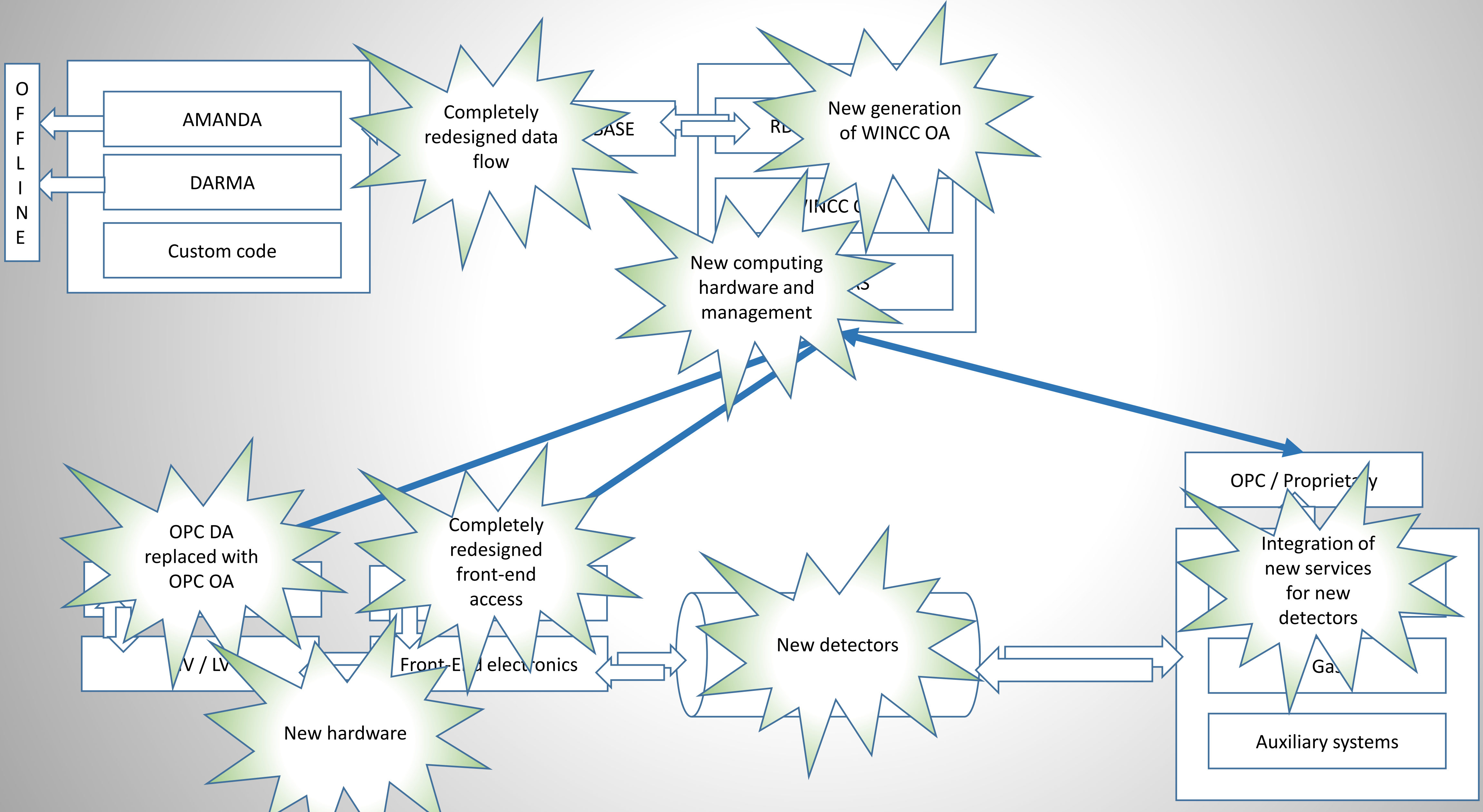


What will change?

ALICE DCS architecture: RUN 2

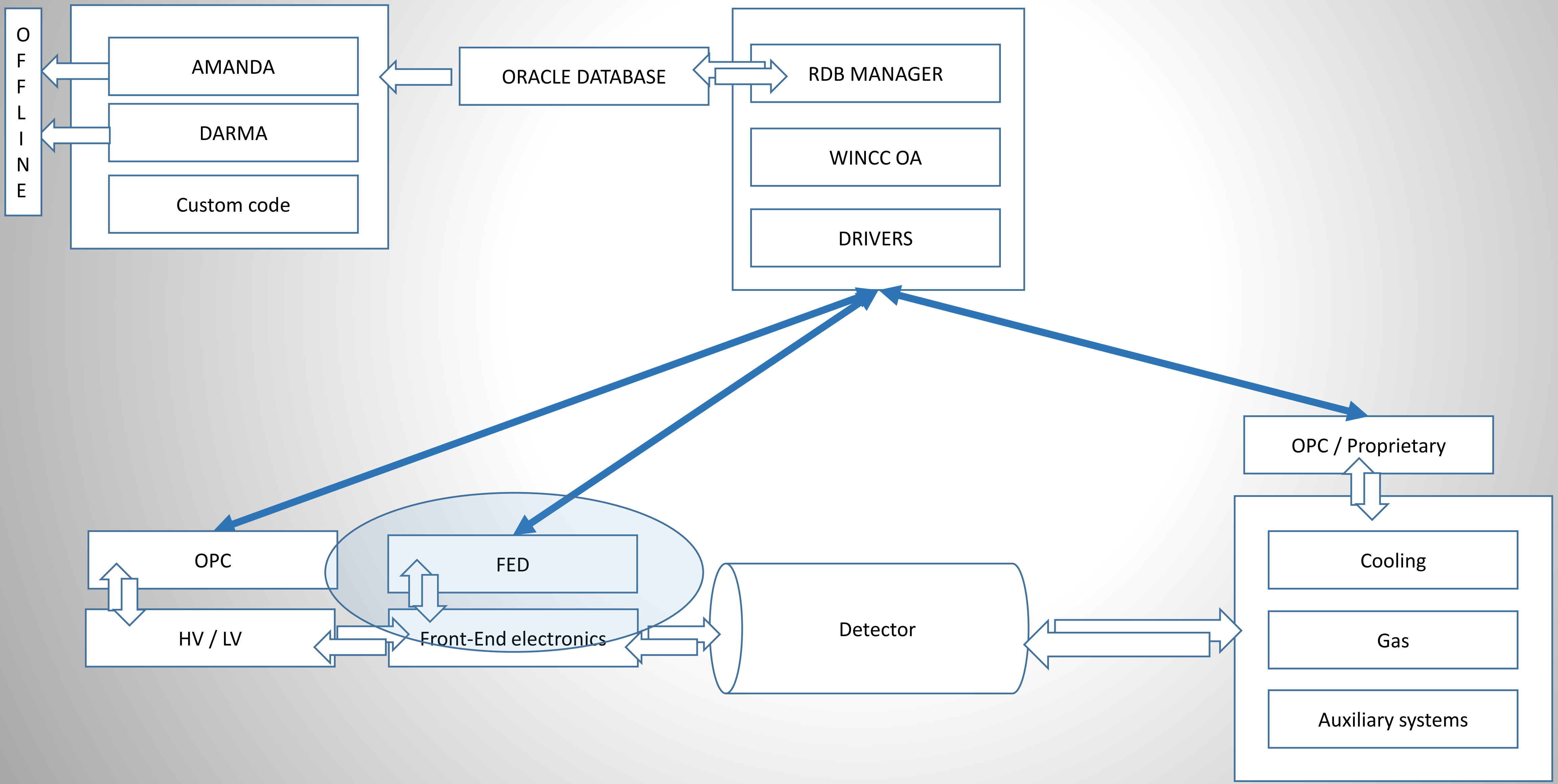


ALICE DCS architecture: RUN 3

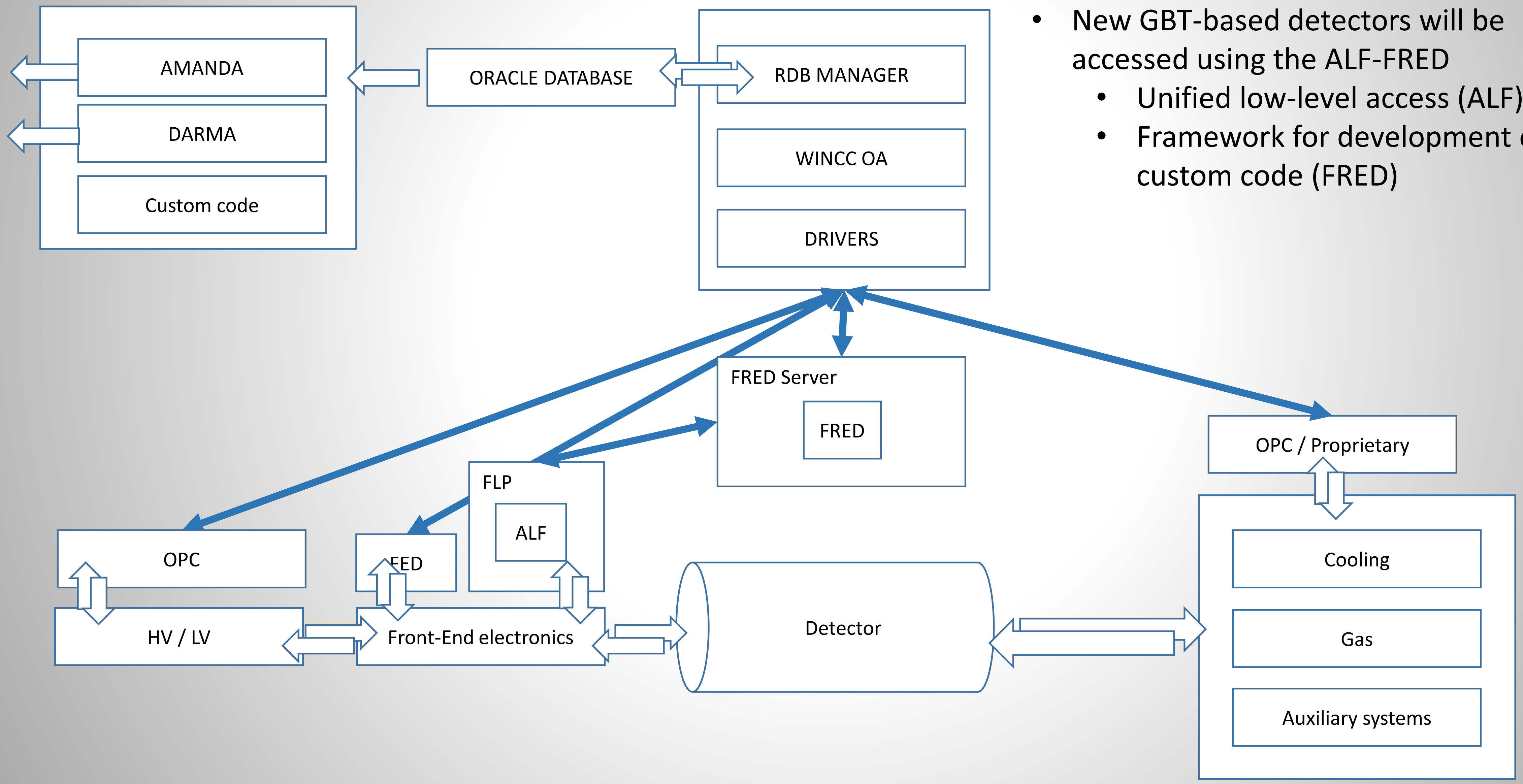


Some upgrade highlights

Redesigned Frontend Access for RUN3



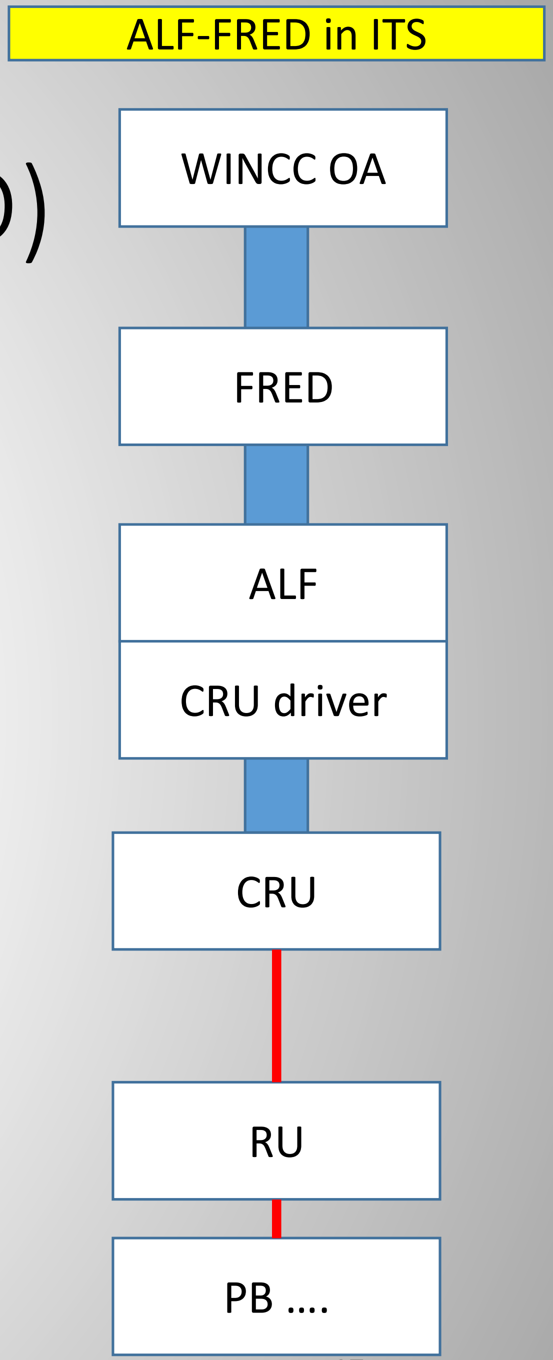
Redesigned Frontend Access for RUN3



- New GBT-based detectors will be accessed using the ALF-FRED
  - Unified low-level access (ALF)
  - Framework for development of custom code (FRED)

Redesigned frontend access (**ALF**-FRED)

- ALF
  - Low level detector-independent device access
  - runs on FLP
  - Capable of scanning SCA/SWT sequences
  - Can create services with periodic execution
- FRED
  - Flexible framework customizable by detectors
  - Runs on dedicated DCS server
  - Translates low level sequences to WINCC compatible format (services)
  - Can perform specialized tasks (like monitoring) and take fast action



ALF status

- Taken over by Kosice team in summer 2018
- SWT support added
- Release (code+documentation) available on GIT
- Easy installation (already tested by independent users)

- TODO
  - Depending on HW availability
    - Implement CRU addressing (use ID instead of PCI address)
    - Test with multiple CRUs in a single FLP
    - ADD CAN interface for ITS ALF

Sequence can be specified in service config or taken from a file/database
Repetitive sequences can be generated ‘on fly’ following a recipe

```
SERIAL = 0
LINK = 1

TYPE = SCA        #SCA or SWT message type
FILE = ./commands/its_pb_initialize.sqc
MESSAGE = 140100D1,1 @ v

IN_VAR = PU #0/1
OUT_VAR = v
EQUATION = v * 2 +
```

Raw messages can be manipulated by the service by applying an equation (like calibration constant)

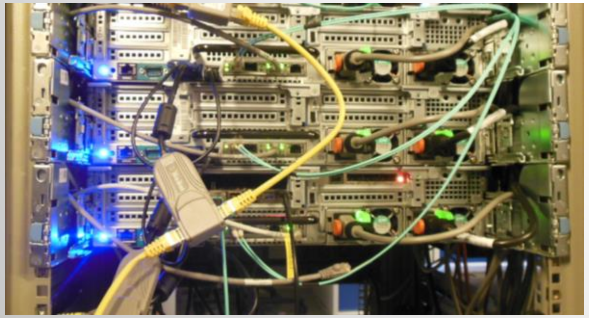
Redesigned frontend access (ALF-**FRED**)

- Massive modification in summer 2018
  - Support for SWT
  - Configuration moved to external files
  - Multiple ALF supported by 1 FRED
  - WINCC OA interface completed
  - Release on GIT including documentation and examples
  - Example WINCC project available

- ALF-FRED kit installed in:
  - DCS lab – reference and development system
  - ITS lab in bldg. 167 – installed remotely by Kosice, ITS and DCS teams
  - MID setup, MFT setup – unbiased testers (Roni and Kosei, help of Ombretta)

Reference DCS setup in photos

FLP with CRU



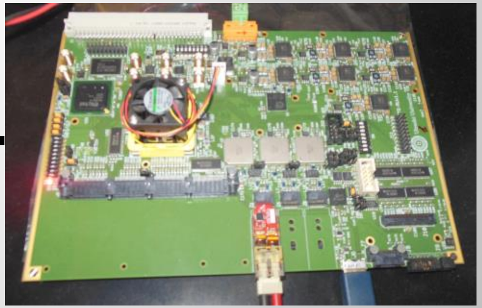
Rack with power supply and boards

MID

TPC

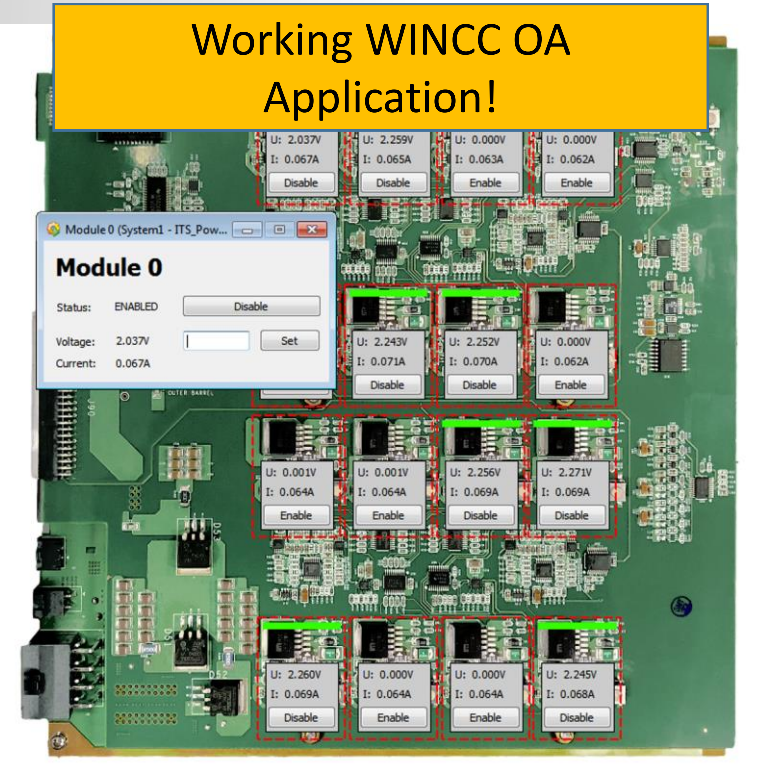
VLDB

ITS



ITS test bench

- Full chain from WINCC to PB
  - Uses SWT
  - Installed in DCS lab and bldg. 167



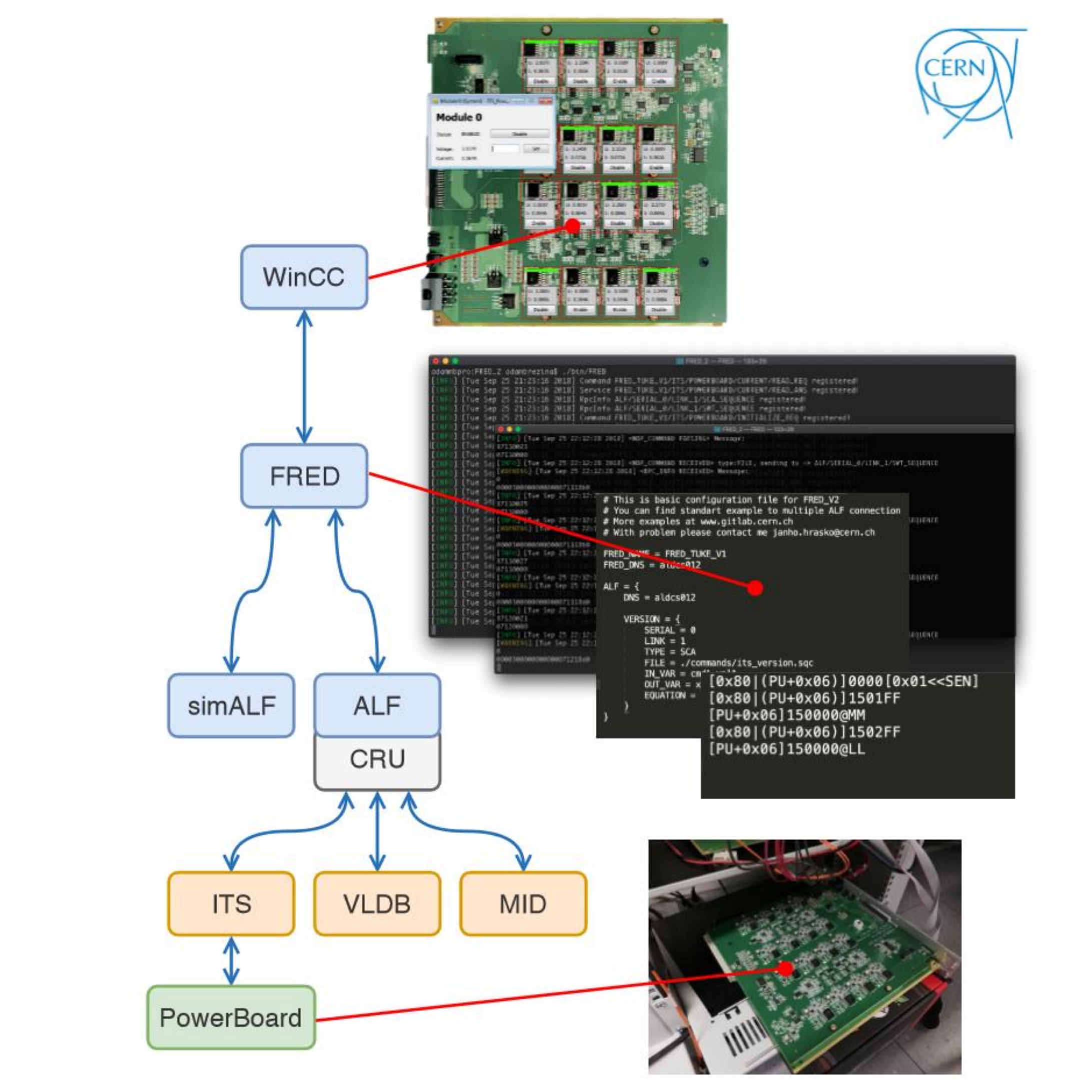
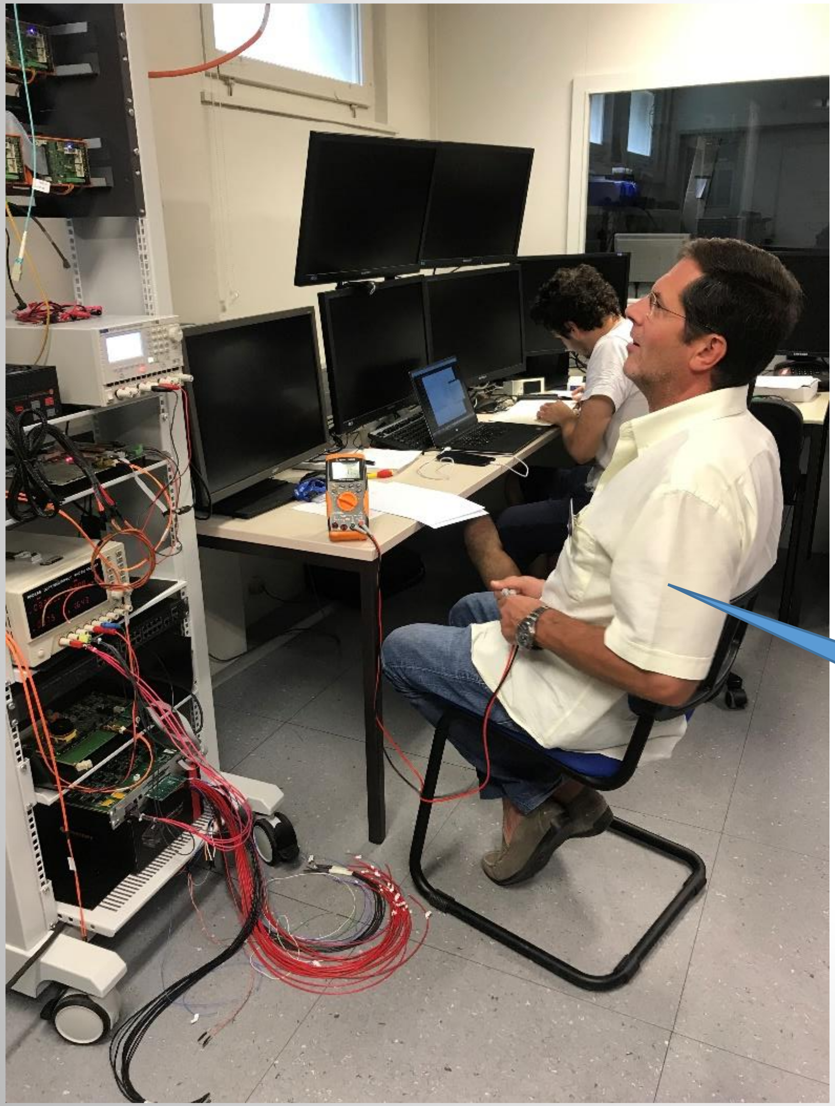


Figure 1: Actual State of ALFRED server

ITS progress



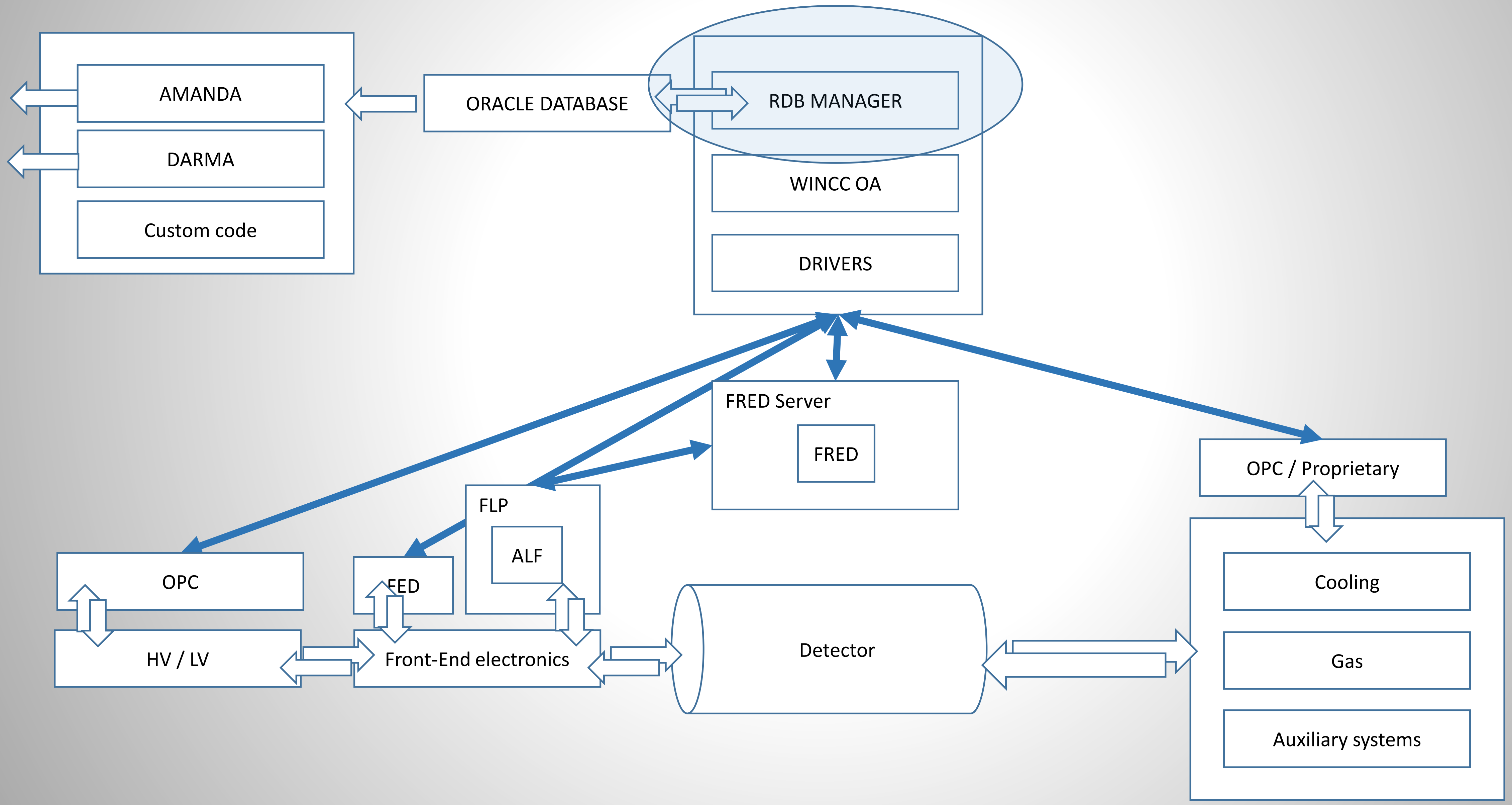
- First successful test of ALF-FRED using the Power board in the DCS lab
- Due to the lack of detector hardware , we controlled Paolo

PMD: Paolo as a Measuring Device

ALF-FRED next steps

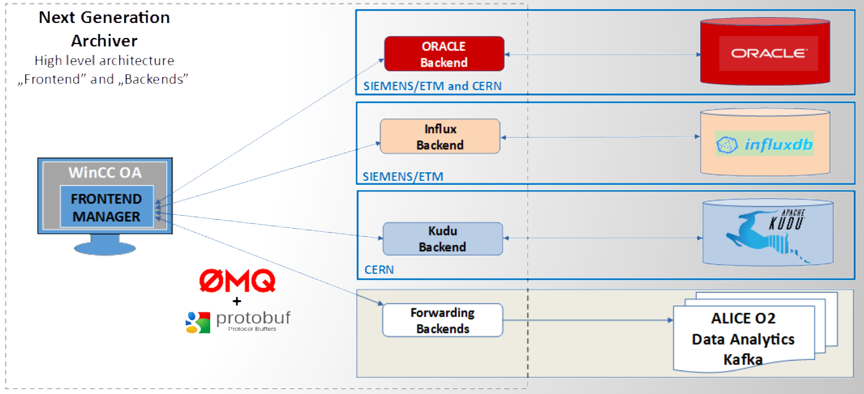
- Modifications foreseen to accommodate the monitoring mechanisms implemented by ITS
- Tests with realistic configuration sequences are needed
  - Functional tests
  - Performance
  - Optimization – caching config on FLP, database management
- Implementation of complex operations : i.g. ITS scan

Redesigned Data flow

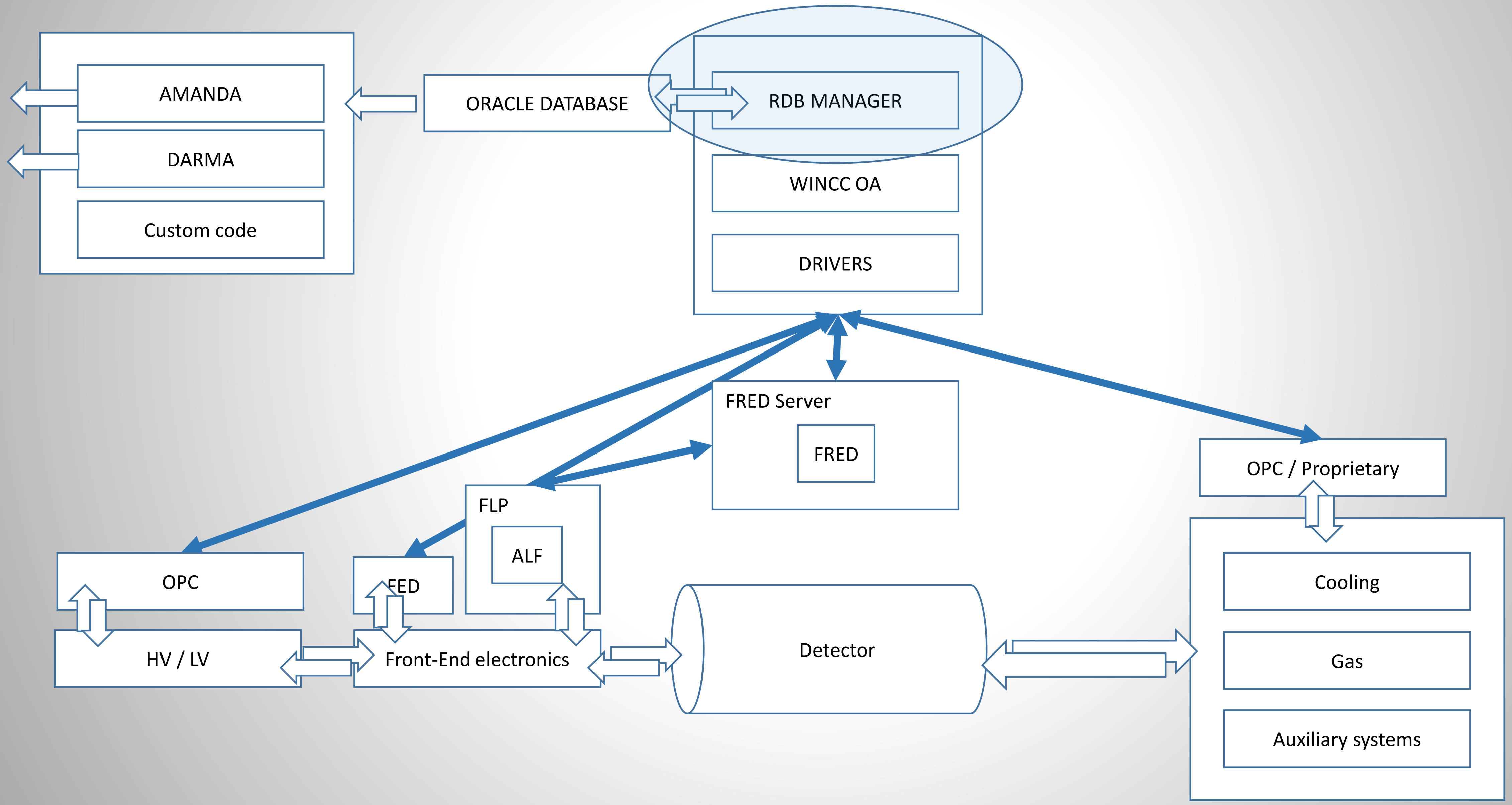


The Next Generation Archiver - NGA

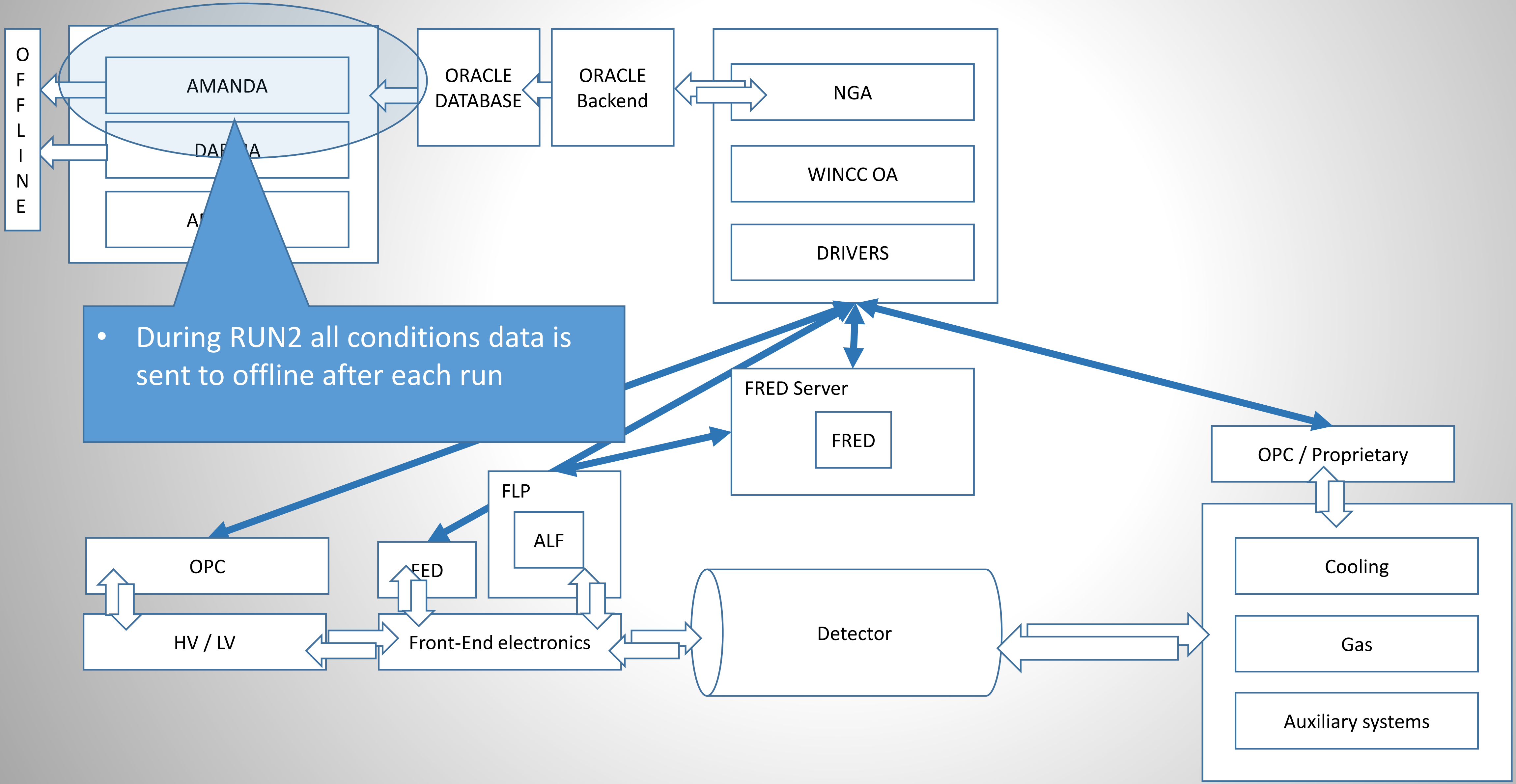
- Completely redesigned dataflow component provided by SIEMENS
  - Acts as a fanout, allowing for splitting the data stream into multiple configurable data channels
- Backend plugins
  - Custom modules written in C++
  - Receive data from NGA
  - INFLUX DB plugin developed by Siemens
  - ORACLE plugin developed at CERN by BE ECS and OPENLAB (will be handed over to Siemens)
  - ADAPOS plugin developed in ALICE to interface with the O2



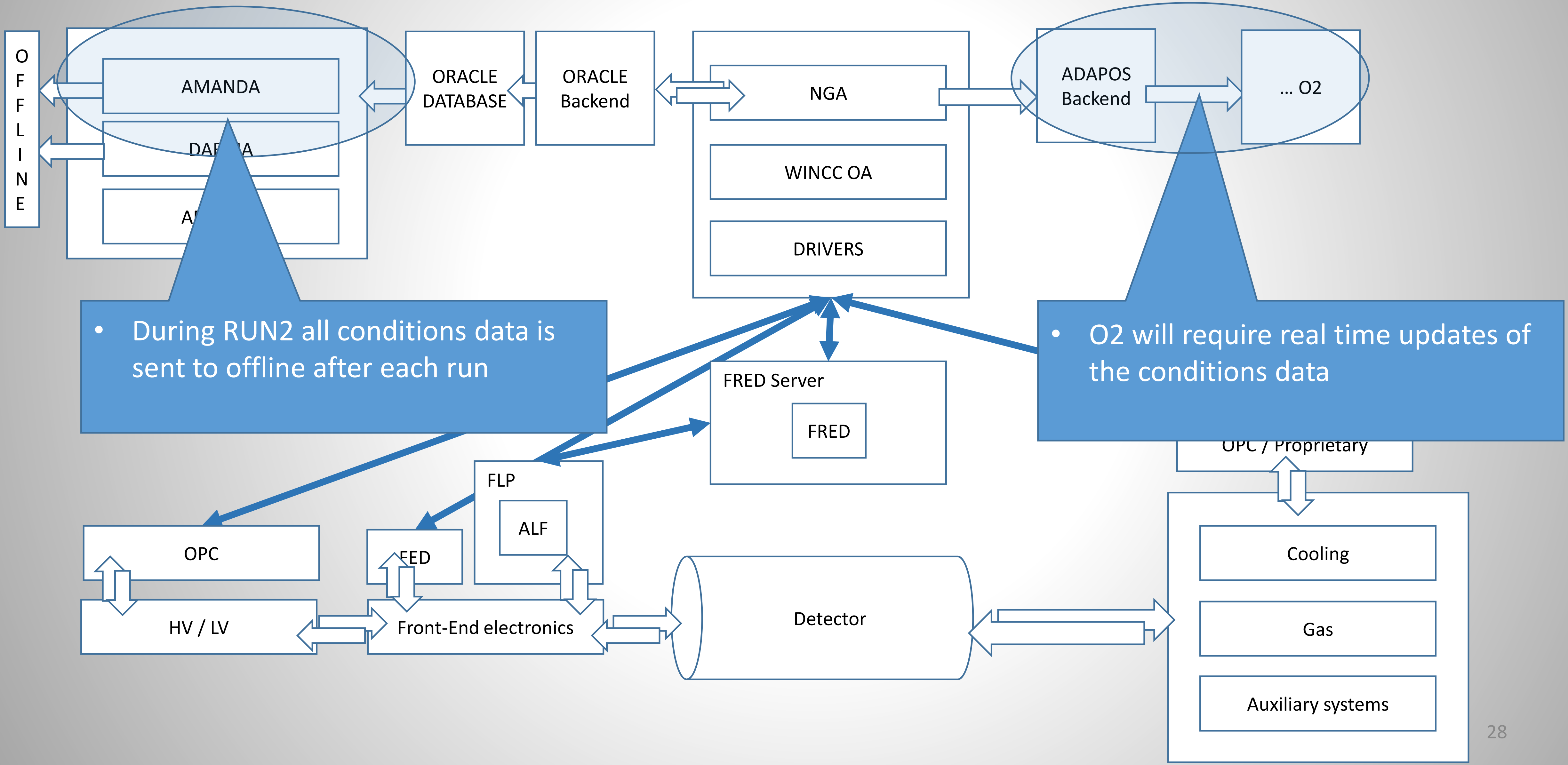
Redesigned Data Flow



RUN2 Conditions data flow



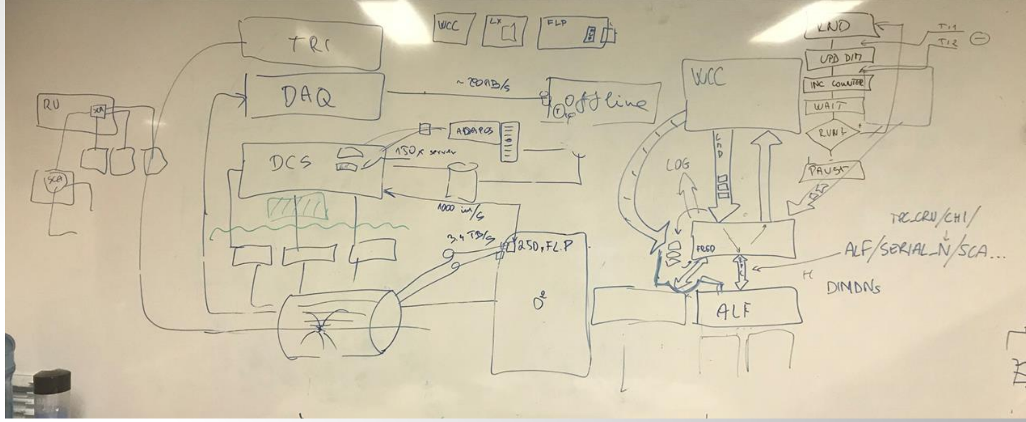
RUN3 Conditions data flow



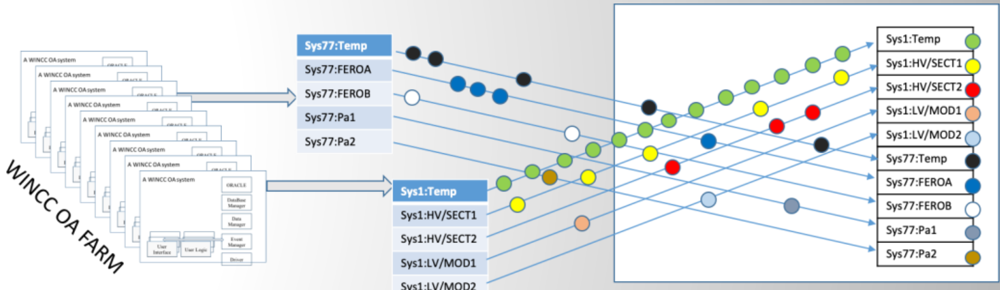
- During RUN2 all conditions data is sent to offline after each run

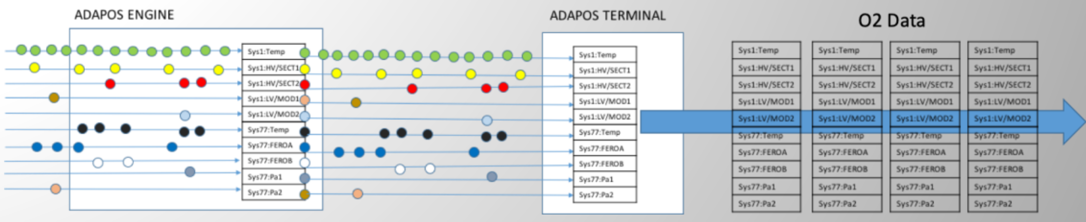
- O2 will require real time updates of the conditions data

ADAPOS

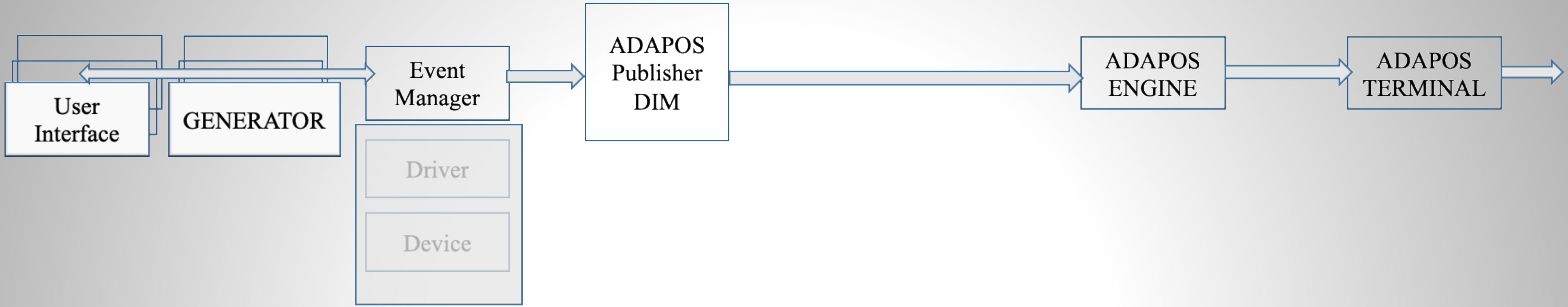


- Data streaming mechanism from DCS to O2
- ALL DCS data is collected in a buffer
    - The buffer contains full snapshot of all current DCS parameters
- The Buffer is sent to O2 each 50ms to DCS FLP and from there to EPNs
- New values overwrite old ones in the buffer
- Designed and tested for continuous streaming of 100k parameters by 1 ADAPOS server
    - Current O2 requirements dropped from 100k to 20k parameters
    - New request to deliver conditions data also to detector FLP (TPC)



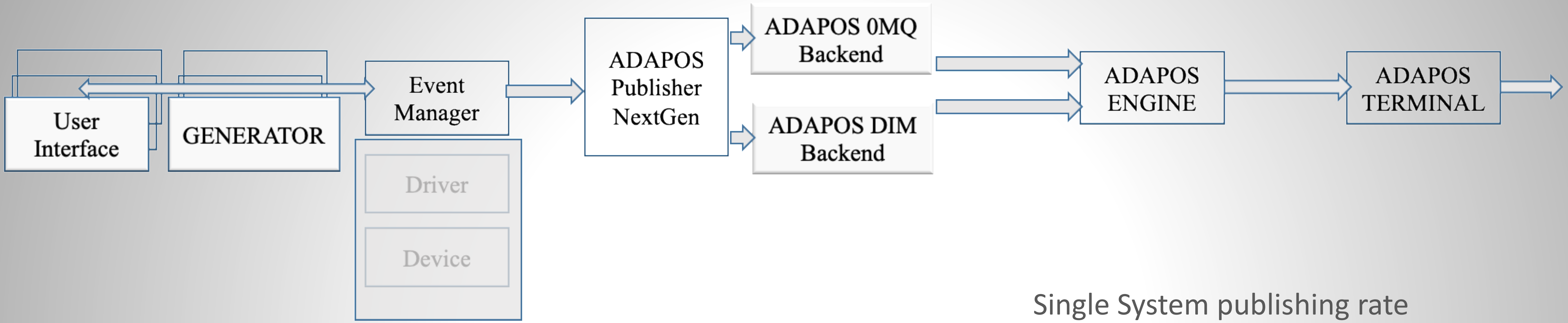


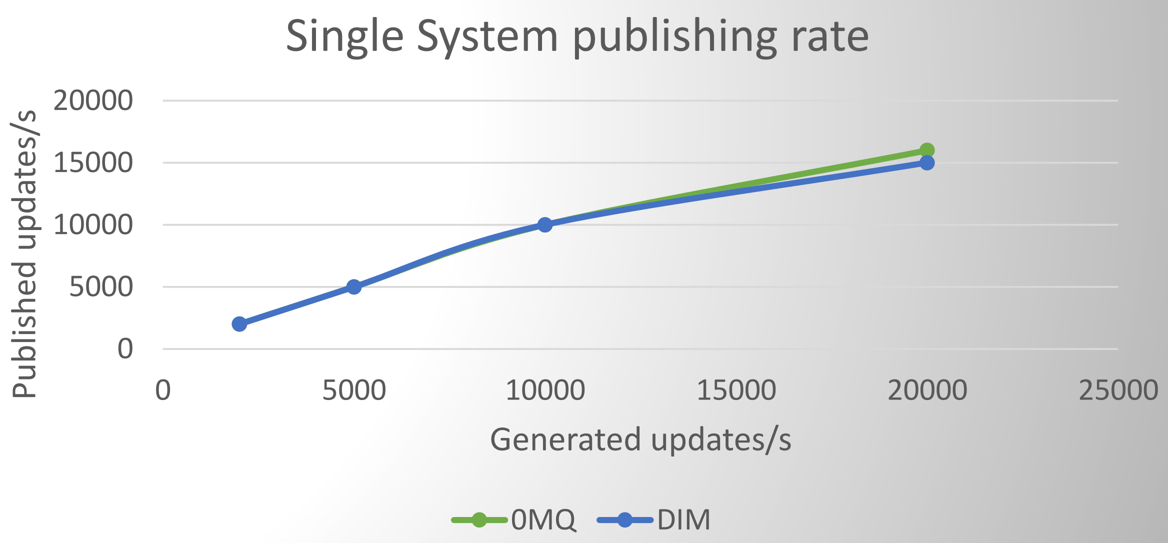
ADAPOS and NextGen tests in ALICE



- Conservative setup compatible with present system
  - If anything else fails, this will do the job!
- Successful large scale tests – 150 systems running in parallel
- Successful long-term tests – several weeks of running (reproducing all DCS data produced since 2007)
- Tested performance better by 2 orders of magnitude compared to requirements
  - But…. There is a risk of ADAPOS overflow due to the lack of smoothing in the WINCC publisher

ADAPOS and NextGen tests in ALICE





- Test setup based on NGA beta release
  - Single DCS system with heavy data generation
- Long-term tests – several weeks of running
  - Measured performance limited only by WINCC capabilities
    - NGA can digest all what WINCC can produce
- TODO: large scale tests after the ion run
  - test setup is ready, waiting for the end of ions

ADAPOS in Education

- ADAPOS and ADAPRO framework is used as a model example at Utrecht University in academic year 2018-2019
  - Course on Program Semantics and Verification
  - Proposed and carried out by our former ADAPOS developer and technical student John Larry Lang
- Thesis on ADAPOS defended by our technical student Kevin Cifuentes Sallaz won the price for the best master final project at Bilbao University in 2018

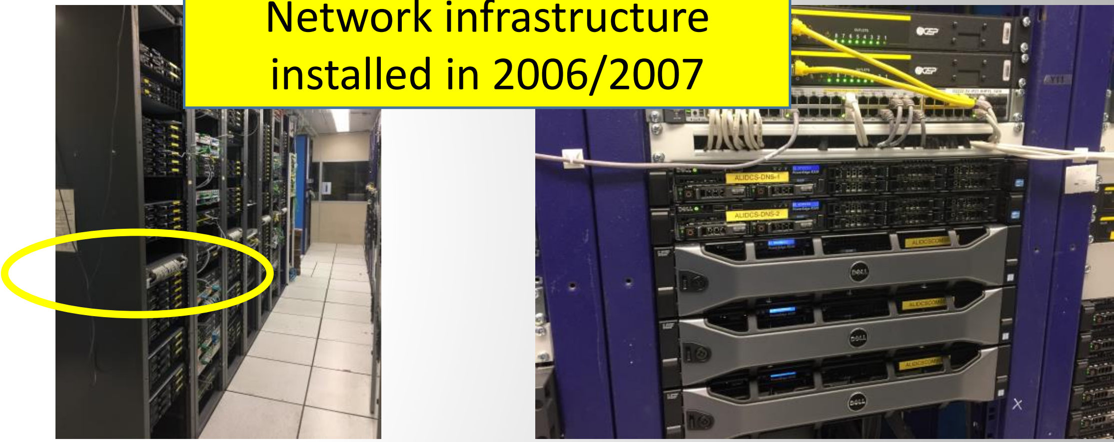
DCS Cluster upgrade

- Cluster designed in 2007 and extended to cope with ALICE needs
- Today we run 200 computers
  - Most of the servers are more than 5 years old
    - Warranty recently expired or expiring in early 2019
- Network infrastructure
  - Reliable
  - Managed by IT
  - But… installed in 2007 reusing older switches…

- Currently we run 3rd generation of the DCS cluster consisting of
  - 150 servers (100 running the central SCADA system)
  - ORACLE database service
  - Redundant file servers
  - Other servers and network equipment supervising 1200 network attached devices

Very first DCS server (2006)

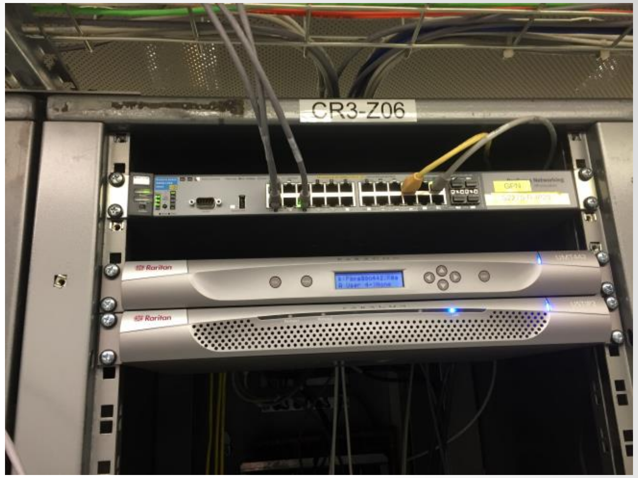
Network infrastructure installed in 2006/2007



DCS computers today

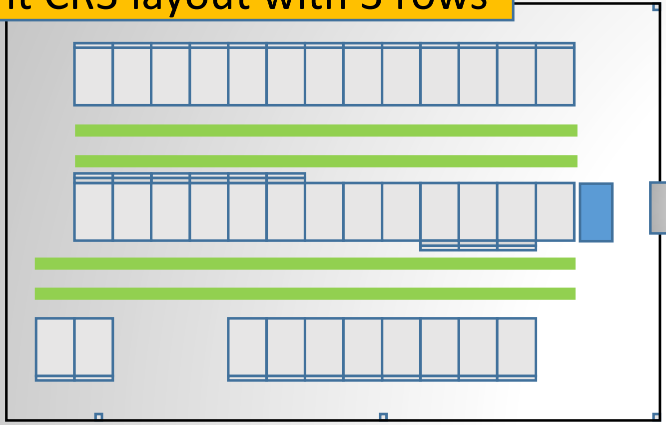
Racks need resuscitation

- Installed in the previous millennium (1980-ies)
  - A little bit tired by now
- Mechanically deformed
- Cannot host big servers
- Incompatible with rails
- Cooling doors develop leaks

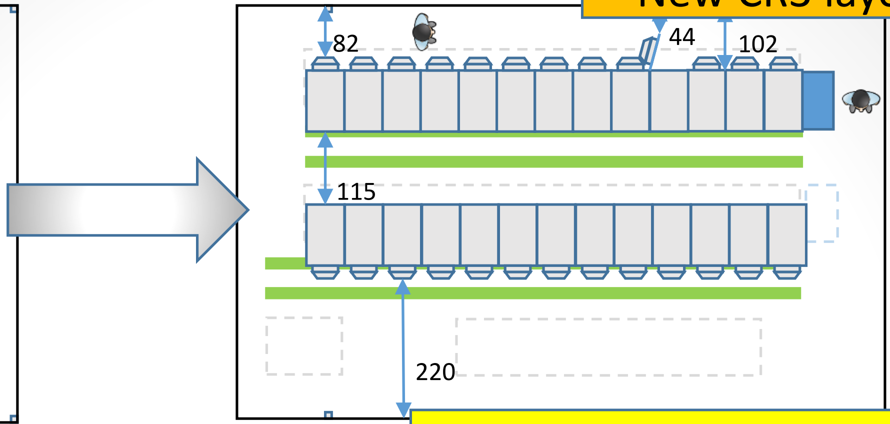


New CR3 layout

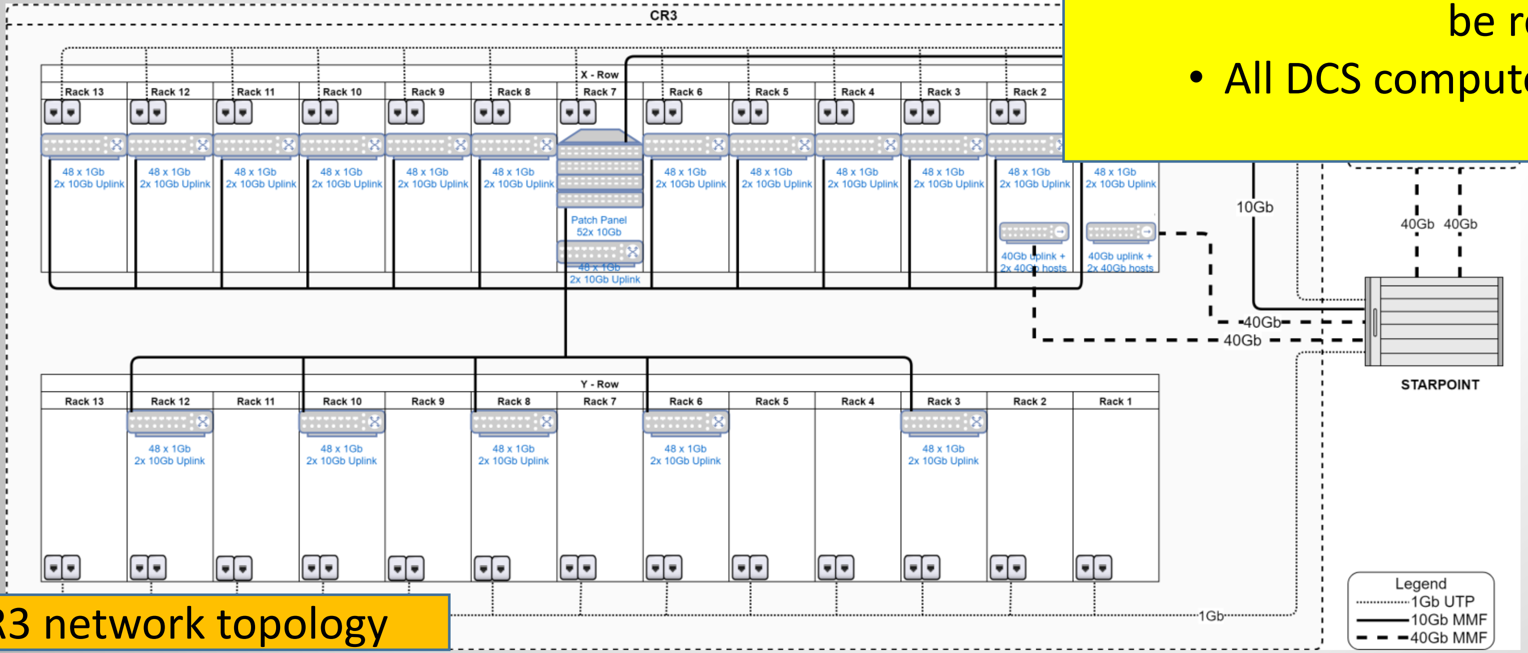
Current CR3 layout with 3 rows



New CR3 layout with 3 rows



- ALL DCS racks and network infrastructure will be replaced
- All DCS computers will be replaced



New CR3 network topology

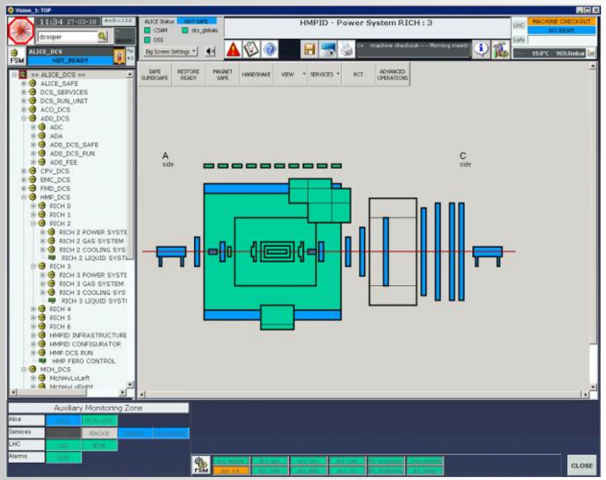
“Standard” Central DCS evolution

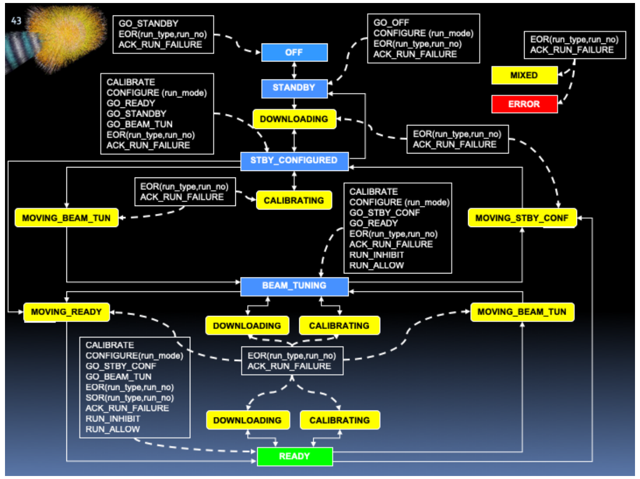
- DCS computers, including the ORACLE service will be replaced
- OS upgrades
  - Centos (ALICE O2 brew)
  - Windows Server 2019 as a preferred target
    - Windows Server 2016 as a conservative target

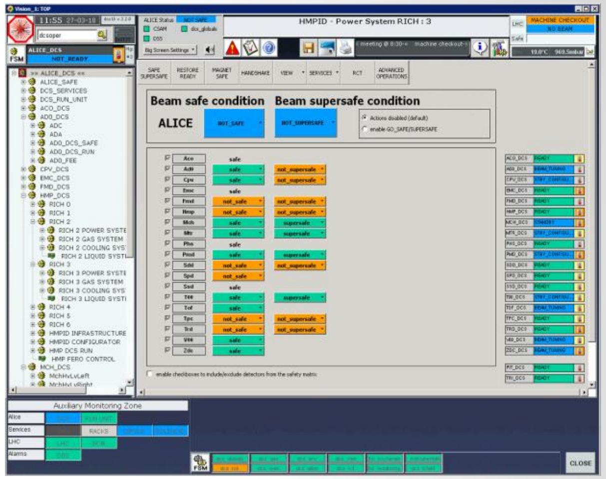
- WINCC OA upgrade to latest version
- JCOP FW upgrade
- OPC servers, drivers upgrade

- Reconsolidation of DCS monitoring (using JCOP farm monitoring suite)
- Revision of software deployment procedures

ALICE framework upgrades







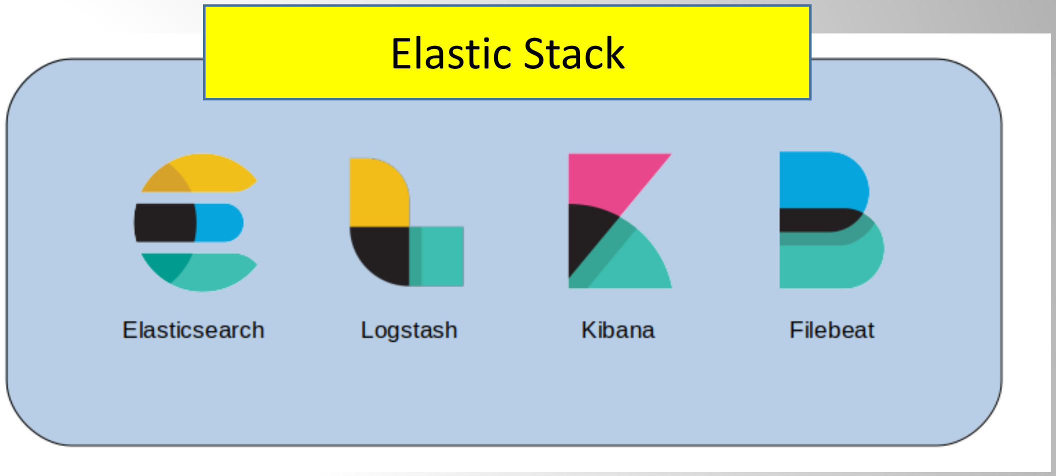
- New/lighter User Interface
- Improved Web publishing tools
- Enhanced logging of operator actions

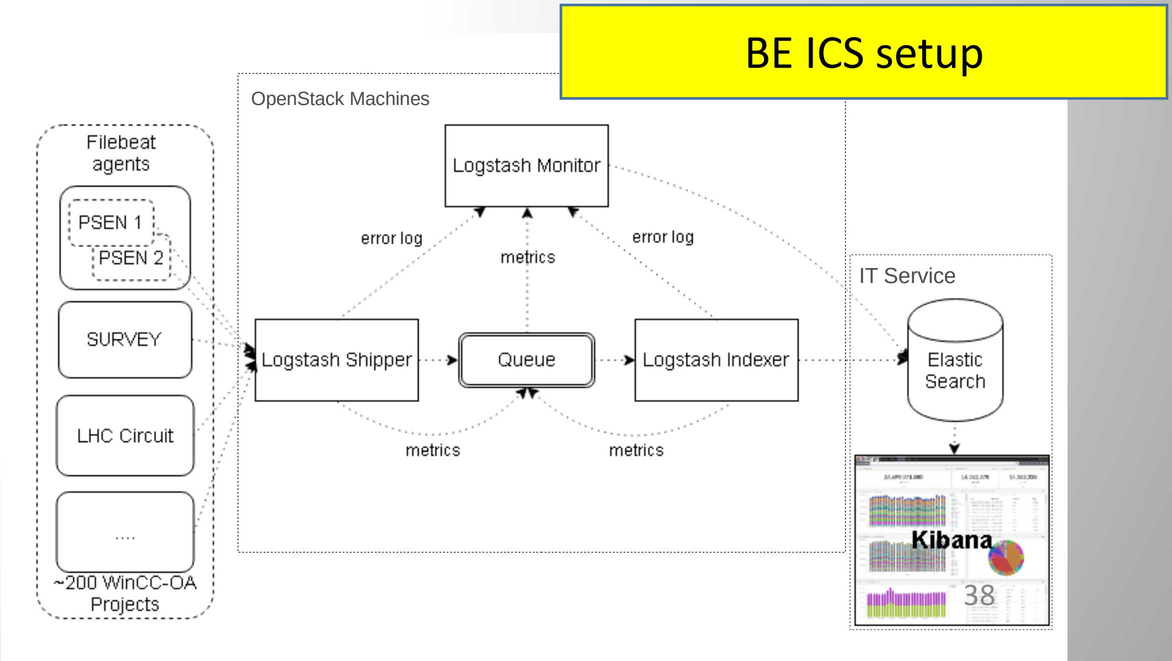
- Cleanup of FSM
- Simplified top level FSM
- New O2 interface not based on FSM needs to be developed

- Improved advanced procedures (GO SAFE…)
- Clear reporting of progress during the transition

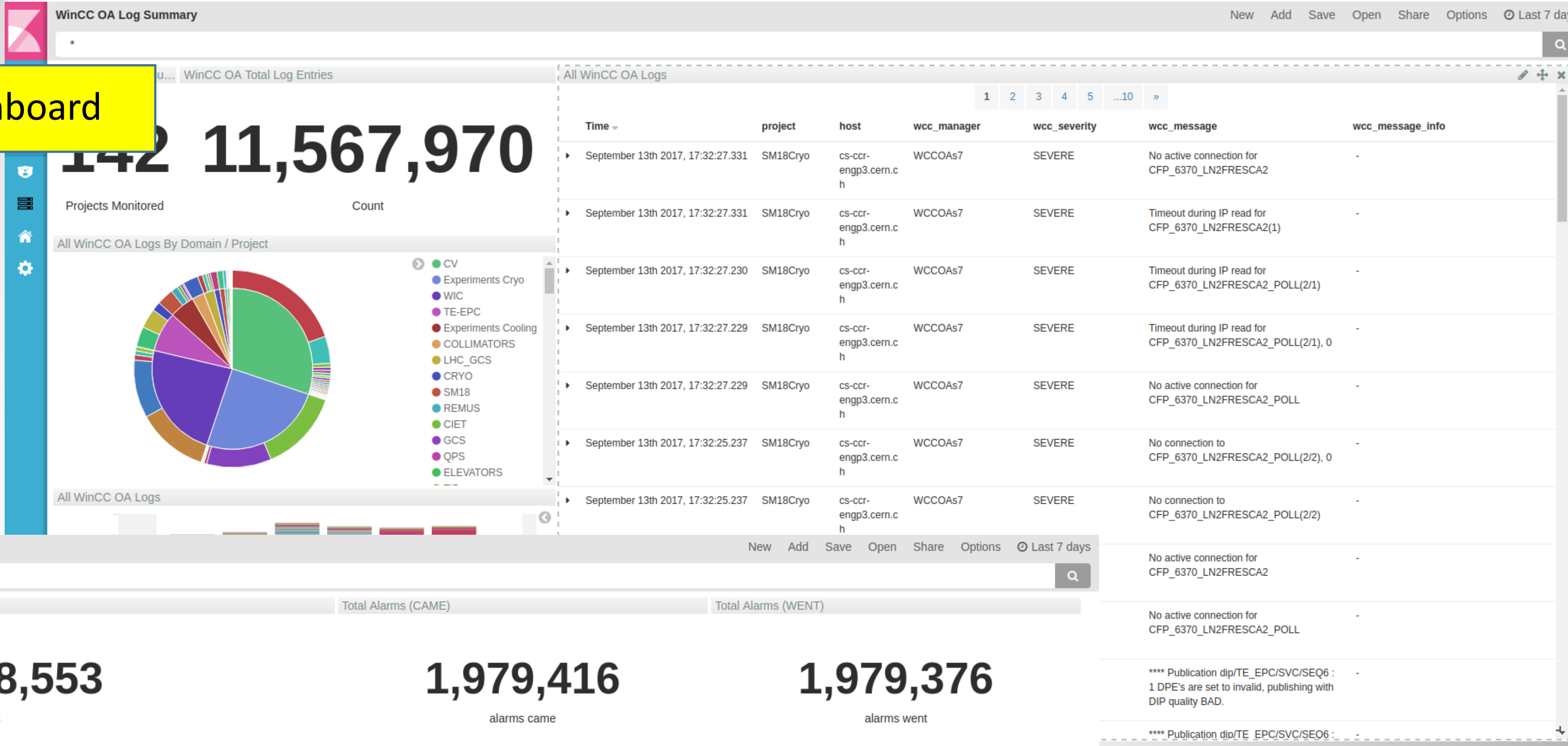
Advanced system diagnostics based on logfile analytics

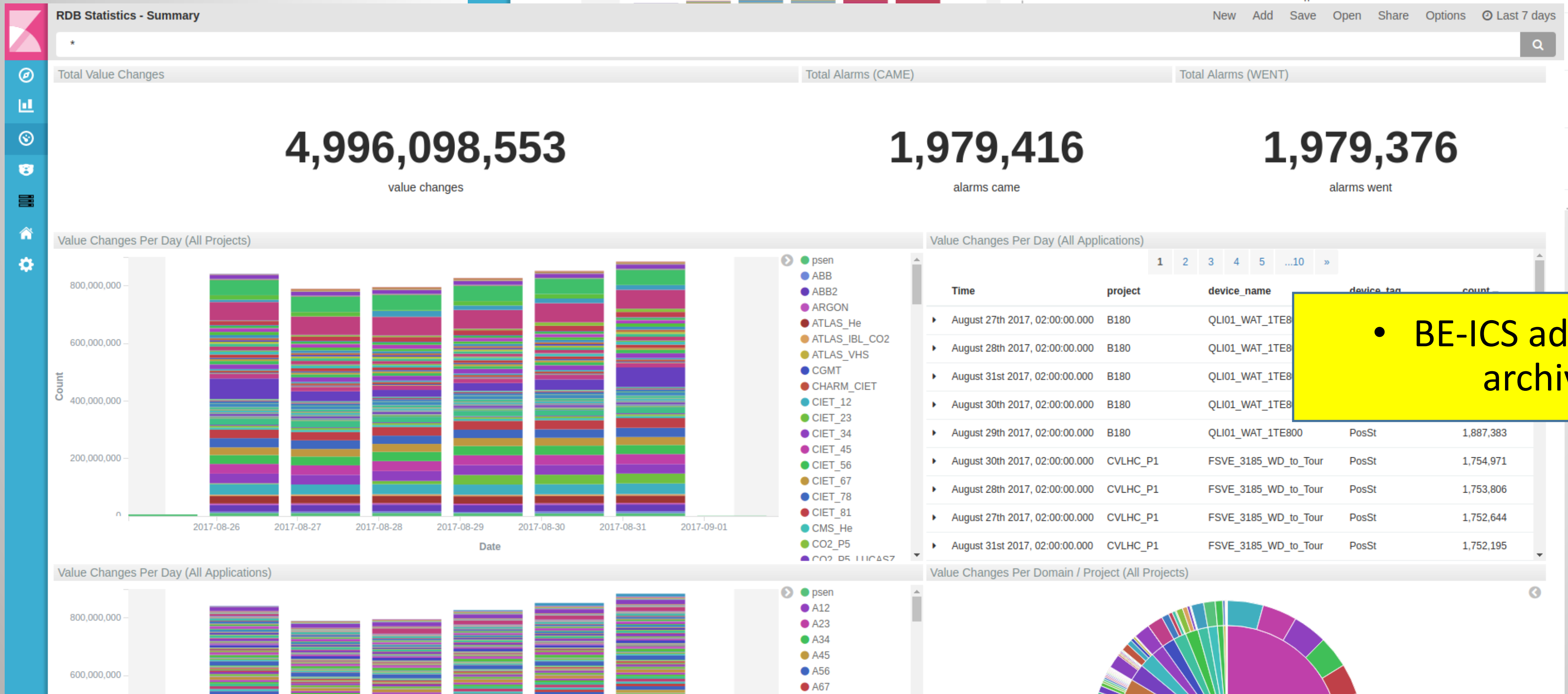
- New project for log analysis launched in collaboration with BE ICS
- Based on Elastic Stack
- Aim: logfile analysis and early problem detection





- BE-ICS WINCCOA dashboard



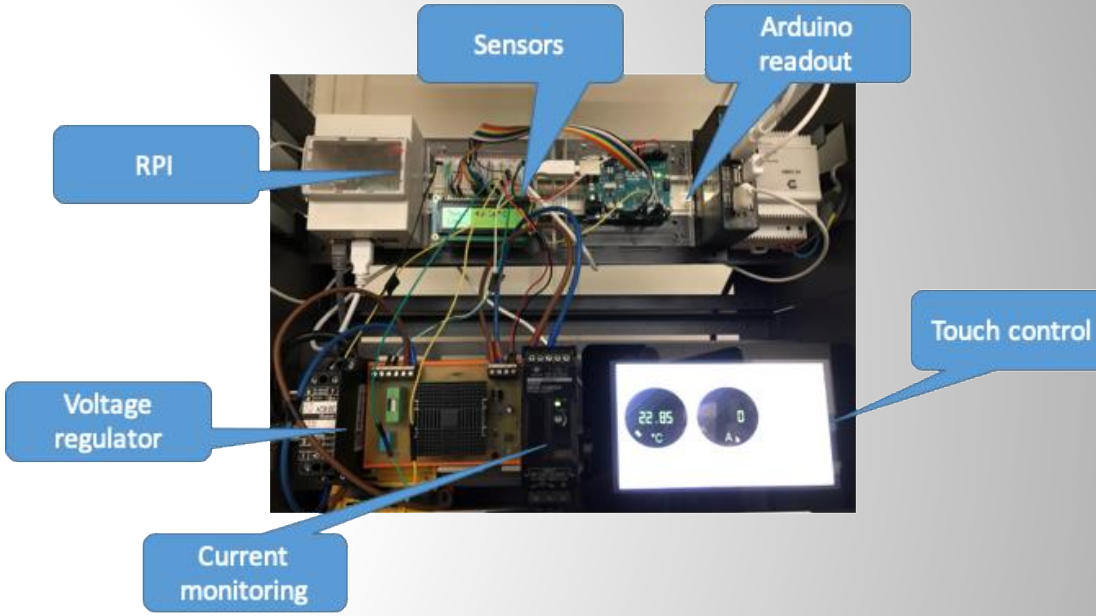


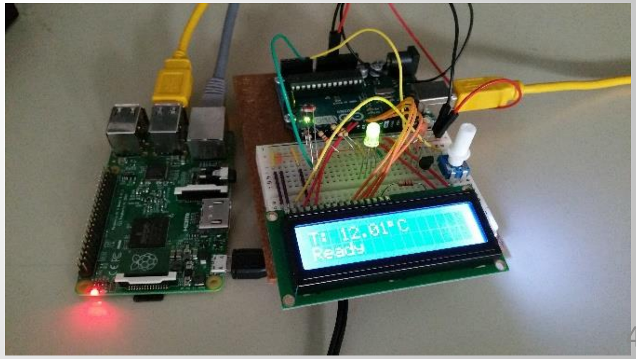
- BE-ICS advanced ORACLE archival analysis

IOT components in the DCS

IOT components in the DCS

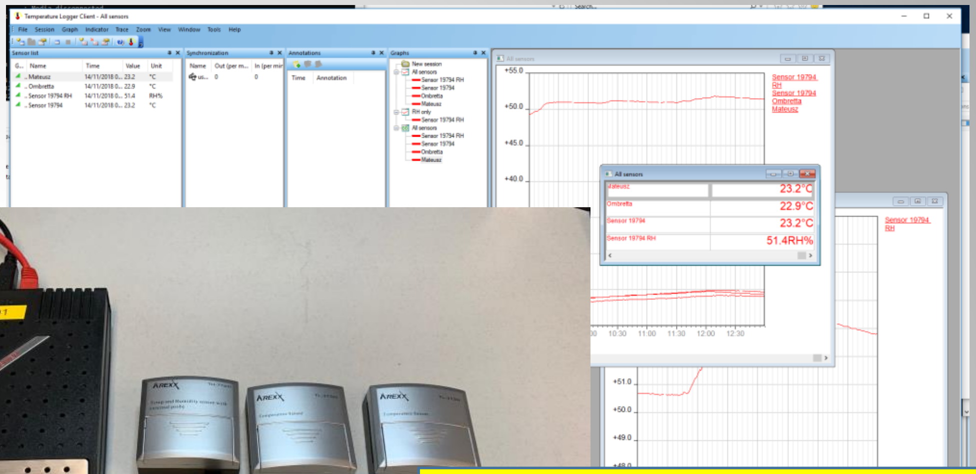
- Pioneering work in DCS to integrate cheap IOT components:
  - Readout prototyping
  - Environment control
  - Student training and education
- Price of the IOT setup significantly lower than the traditional ELMB based solution





Industrial IOT components

- … meanwhile the industry followed
- Cheap sets available
- DCS investigates 2 candidates for rack monitoring based on industrial kits
  - Price comparable to RPI setups
  - Significant savings on cabling cost and efforts if Zigbee modules are used



- AREX test setup

- DIGI test setup

Important dates for DCS computing

- DCS computing infrastructure will remain operational until late summer 2019
  - Upgrades will start in Q1 2019
  - Flexible to adopt detector requirements
  - ‘reversible’ upgrades
- September – November 2019
  - DCS NOT AVAILABLE
    - But still awesome
- November 2019
  - NEW DCS
  - start of reintegration and system commissioning

DCS Milestones in 2019

December 2018

- WINCC OA backups
- DCS operational

January 2019

- WINCC OA upgrades v 3.16 on central systems

February-March2019

- WINCC OA upgrades on detector systems
- ORACLE schemas upgraded to NGA compatible version

April 2019

- RDB manager replaced by NGA and ORACLE backend
- Point of no return!
- ADAPOS backend deployed to detector systems

DCS Milestones in 2019

Summer 2019

- New dataflow commissioning, stability tests

September 2019

- CR3 dismantled

November 2019

- New DCS in P2

Conclusions

- We will now disassemble an unprecedentedly stable system to make it more stable