The AFP Detector Control System

A Tracking and Timing Detector in the ATLAS Experiment at CERN

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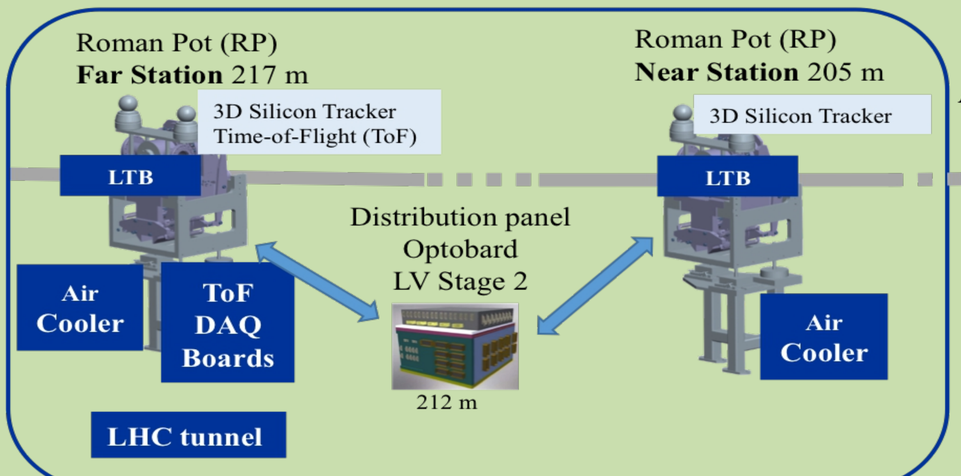
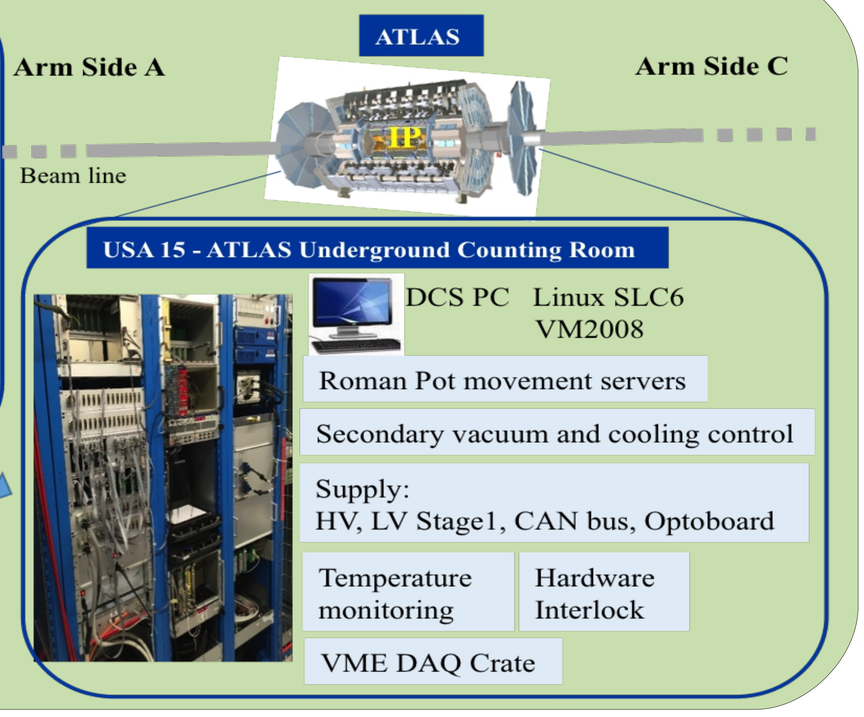
ATLAS Forward Protons (AFP) [1] tagging detector:

- **Tagging and measuring the momentum and emission angle of very forward protons**
- **Composed by four stations:**
  - Silicon tracking detectors (SiT)
  - Time-of-Flight detectors (ToF)
  - Roman Pots (RP)
- **Large variety of components:**
  - Near the AFP stations
  - In the ATLAS service cavern (USA15)





HV is provided by an ISEG power supply crate equipped with two modules with 16 channels each

Two-stage LV power supply system

Interlock Matrix Crate (IMC) monitors temperature and provides protection to the detectors and electronics

Embedded Local Monitor Boards (ELMBs) [2] monitor temperature, IMC behavior and perform current measurements in LV

330 m distance

Health parameters from front-end electronics will be collected by DAQ and transferred to DCS

Detector Control System (DCS)

Control and monitoring of components to ensure the safe detector operation for good data quality

Supervisory Control And Data Acquisition (SCADA), WinCC OA

The DCS [3] provides tools:

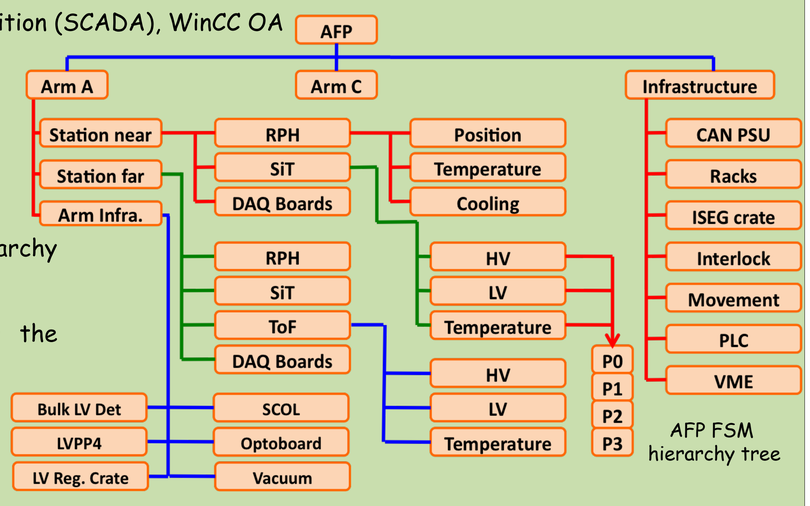
- Finite State Machine (FSM)
- Archiving
- Alerts
- Graphical user interfaces (GUI)

DCS back-end is mapped into a hierarchy of FSM elements

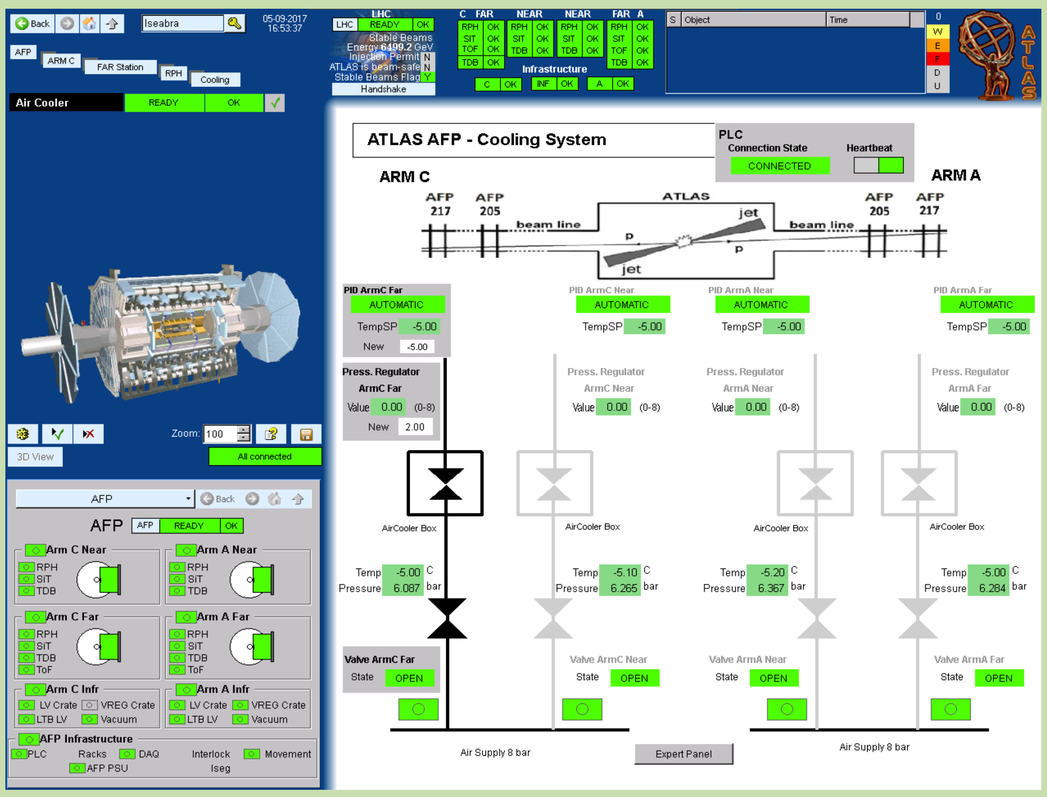
Large variety of subsystems for the detector operation

The AFP DCS server:

- Linux SLC6 as native OS
- Windows Server 2008 as VM



AFP FSM hierarchy tree



FSM GUI for cooling system

Secondary Vacuum System

Protection against the LHC high vacuum and icing inside the RP

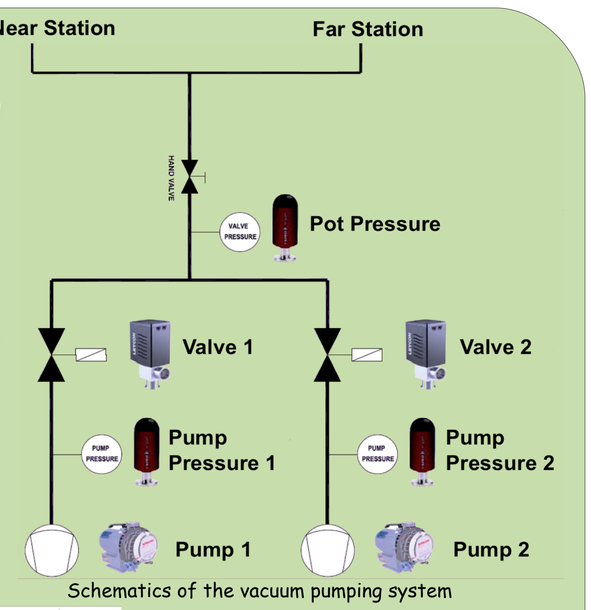
Independent vacuum system in each arm: 10-40 mbar

Control and Monitoring through a Programmable Logic Controller (PLC) S7-1200 from Siemens

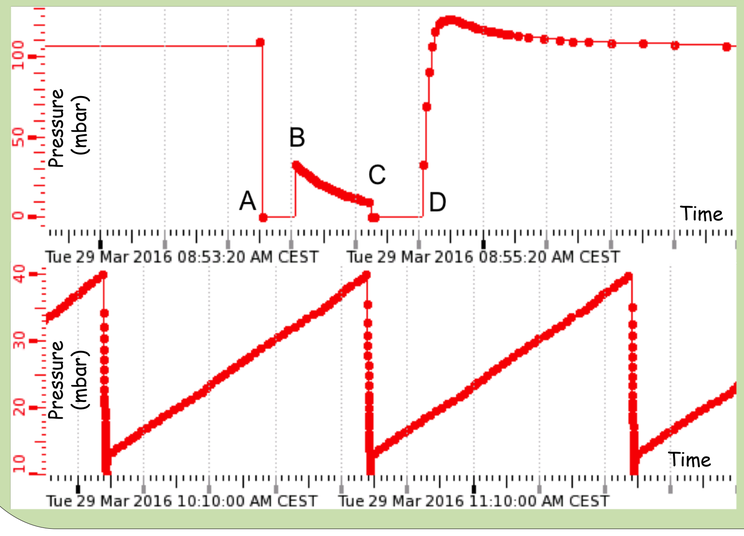
Communication between the PLC and the DCS through the WinCC OA S7 driver via TCP/IP

AFP DCS in the secondary vacuum system:

- Monitors pressure at Pump and RP
- Monitors Pumps and Valves states
- Selects the mode in which the PLC will work
- Allows full system control if in Manual mode



Schematics of the vacuum pumping system



Notification via e-mail and SMS in case of pressure alarm or loss of communication with the PLC

Pumping rate monitored

Top: Pressure in Pump side. (A) Pump ON, (B) Eletrovalve OPEN, (C) Electrovalve CLOSE and (D) Pump OFF. Bottom: Pressure in RP

Cooling System

Cooling of the electronics and detectors

Heat conducted to a Heat exchanger

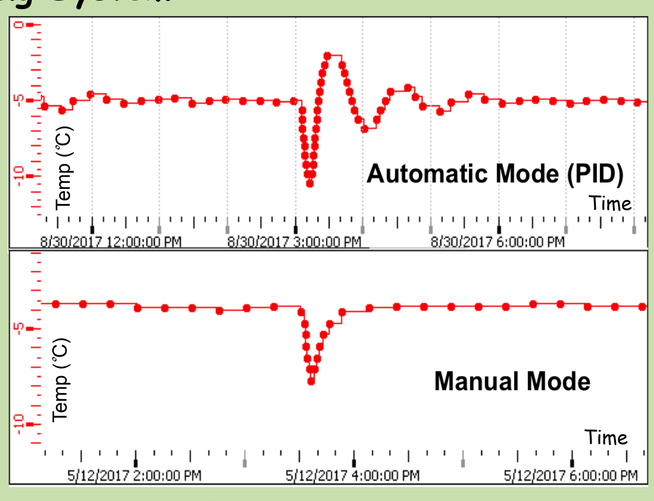
Cold air provided by Dry Air Vortex Cooling System (AirCooler) controlled and monitored through the PLC

AFP DCS in the cooling system:

- Controls and monitors electrovalves
- Monitors temperature (PT 1000)
- Monitors air pressure before AirCooler
- Sets operation mode (Automatic/Manual)

Manual mode: full operator control

Automatic mode: PLC control through a PID (Proportional Integral Derivative)



Behaviour of temperature perturbation in both modes

Movement / Position System

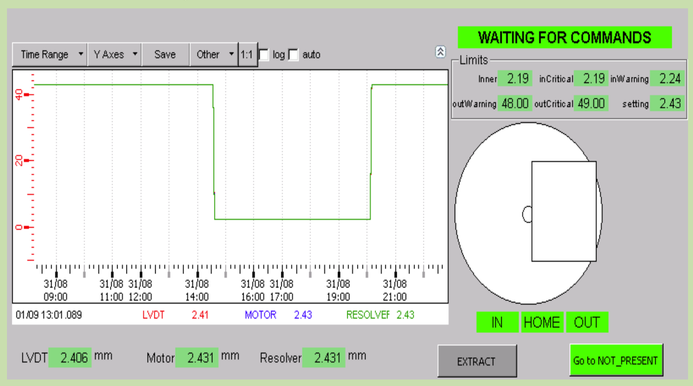
AFP DCS monitors the RPs positions inside the LHC beam pipe

Independent horizontal movement of 5 μm step

Toggle switches for movement range/limits and electrical stop switch for calibration

Two systems involved:

- National Instruments PXI for motors
- FESA (Front-End Software Architecture) server for DIM DNS host



Part of the position FSM panel showing the pot position inside the beam pipe and a position plot

AFP DCS in the movement system:

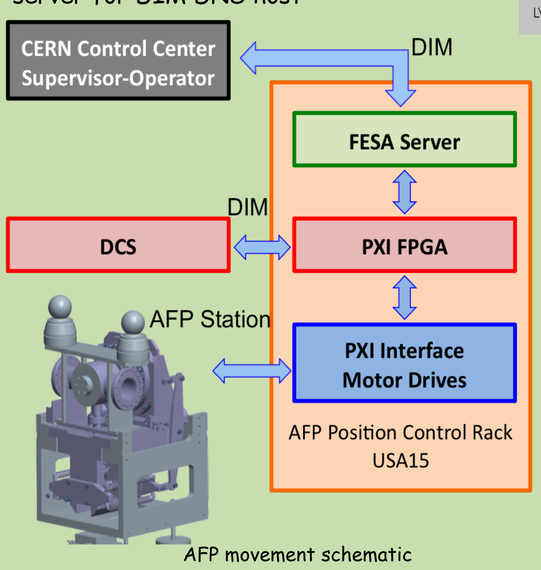
- Monitors RPs positions and states
- Disables movement
- Extracts RPs with springs in case of emergency
- Reboots FESA or PXI server through PLC

Position information given by:

- LVDT (Linear Variable Differential Transformer)
- Step motor
- Resolver

Mismatch alarms are triggered if different position measurement systems give different readings

Good position for physics data tagged by DCS and passed to DAQ



AFP movement schematic

Conclusions

AFP detector is under commissioning, participating in several physics runs, taking data successfully

AFP DCS includes a large variety of different systems and is successfully integrated in the ATLAS detector

All AFP DCS subsystems are concurrently under developments and are capable to fulfil all the detector requirements on monitoring and control including the Vacuum, Cooling and Movement systems

References

[1] AFP TDR: CERN-LHCC-2015-009, ATLAS-TDR-024 https://cds.cern.ch/record/2017378/
[2] Hallgren, B. et al., The Embedded Local Monitor Board (ELMB) in the LHC front-end I/O control system, Proc. Of the 7th
[3] Bariuso Poy, A. et al., The Detector control system of the ATLAS experiment, JINST 3, P05006, 2008

Acknowledgments

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