ATLAS
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The ATLAS Detector Control System

H.J. Burckhart, J. Cook, F. Varela, B. Varnai, CERN, Geneva, Switzerland
V. Filimonov, V. Khomoutnikov, Y. Ryabov, PNPI, St.Petersburg, Russia

- Introduction
- Organization
- Front-End
- Back-End
- Read-out Chain
- Interaction with DAQ
- Operations
- Conclusions

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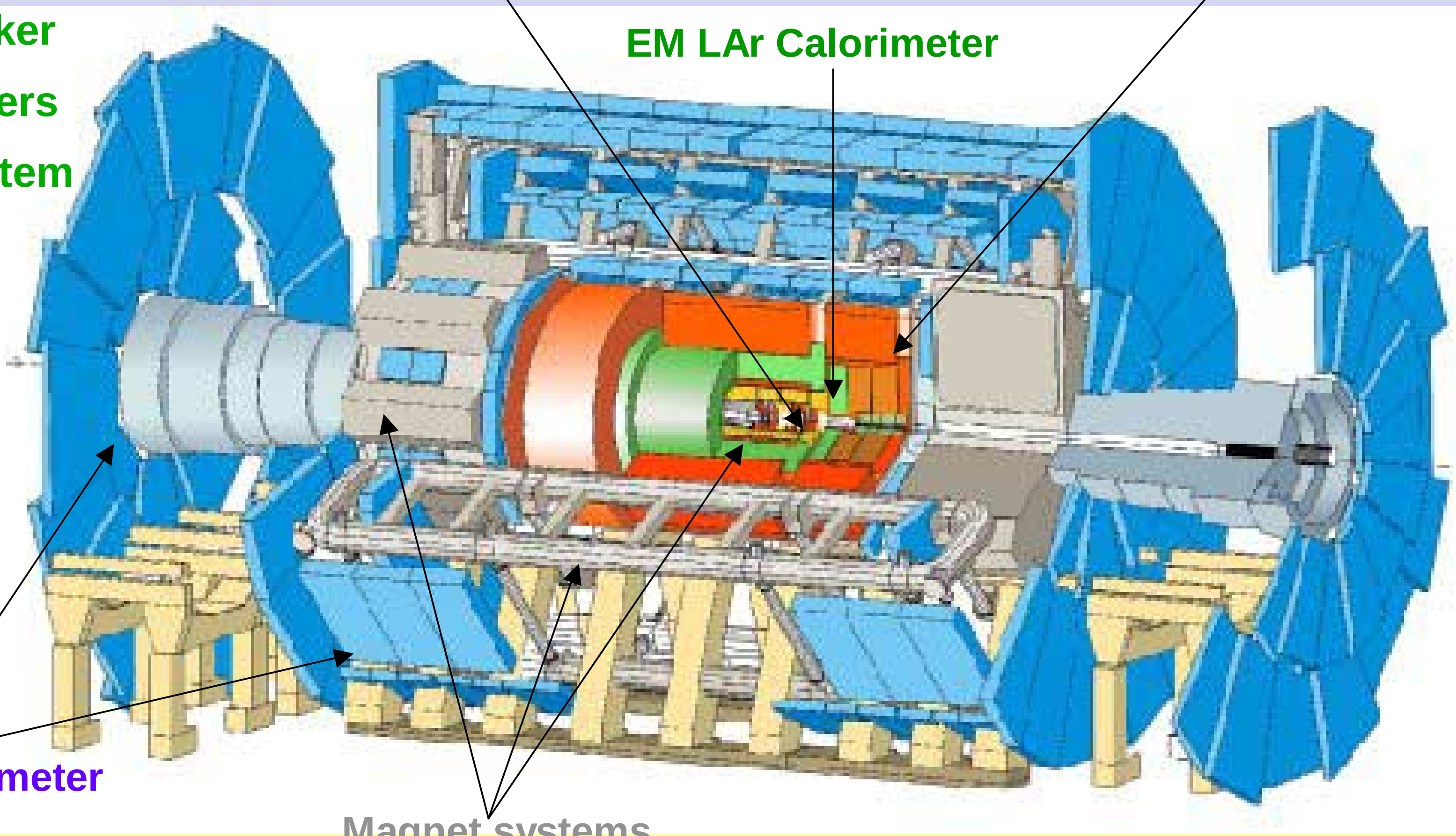
ATLAS (A Toroidal Lhc ApparatuS)

- General-purpose particle detector for the p-p collider LHC starting operation in 2007
- 1500 physicist, 150 institutes in 35 countries
- Length 45 m and diameter 25 m.
- Classical structure:
  - Inner tracker
  - Calorimeters
  - Muon System



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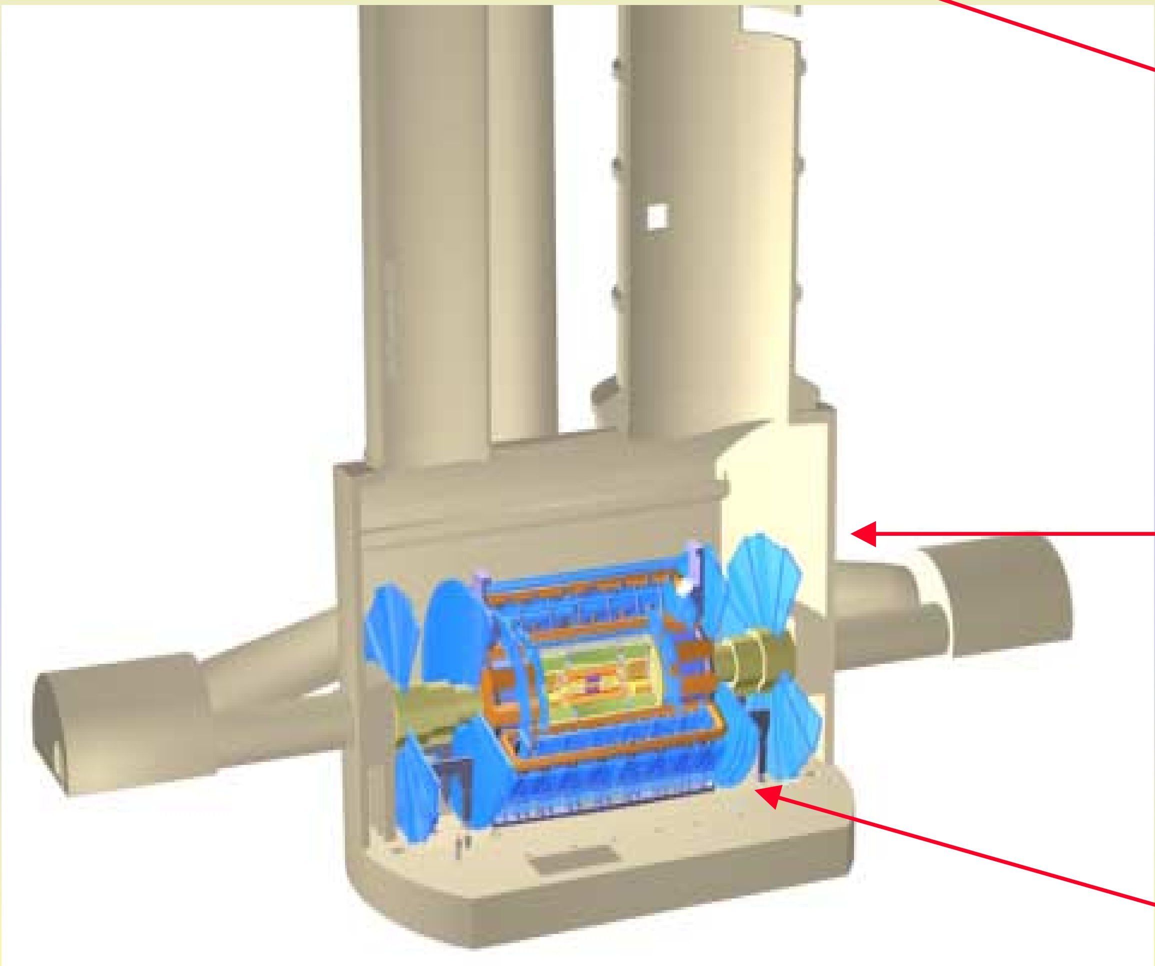
Experiment Cavern



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… the „real“ size …

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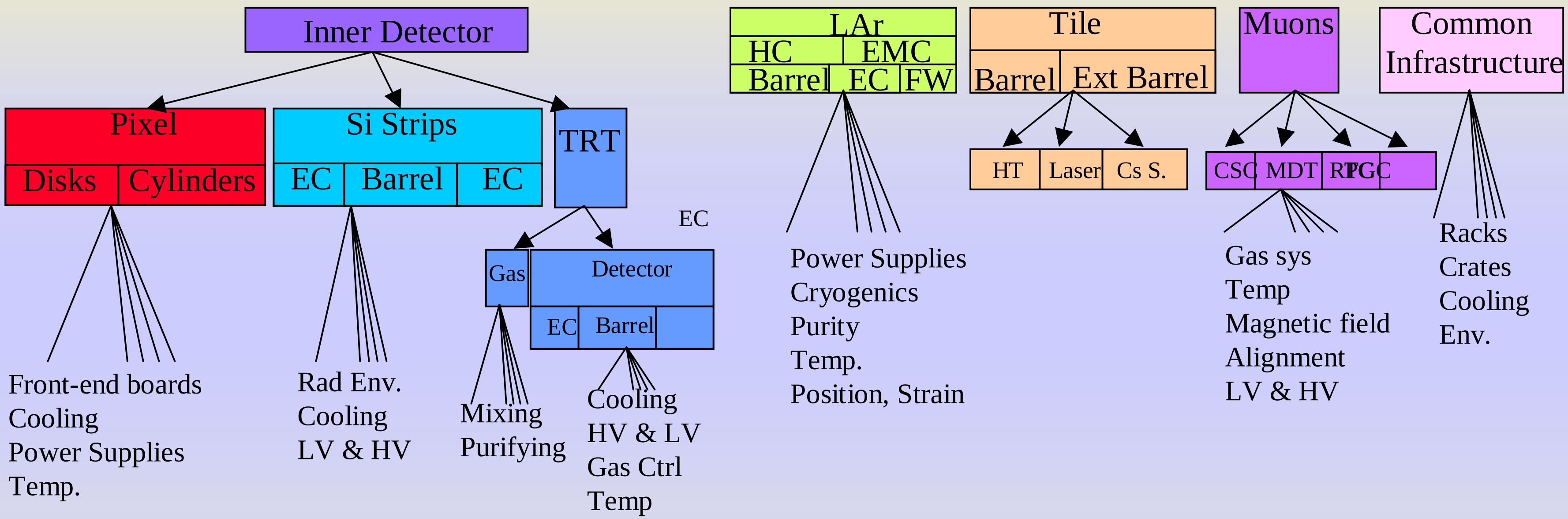
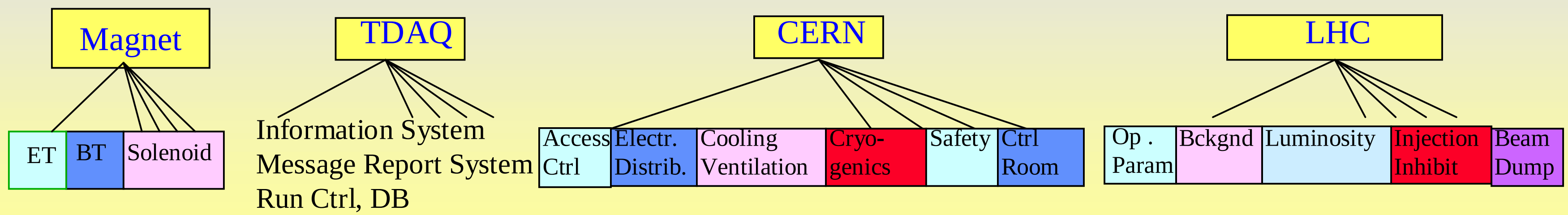
Logical Structure

Detector



External Systems



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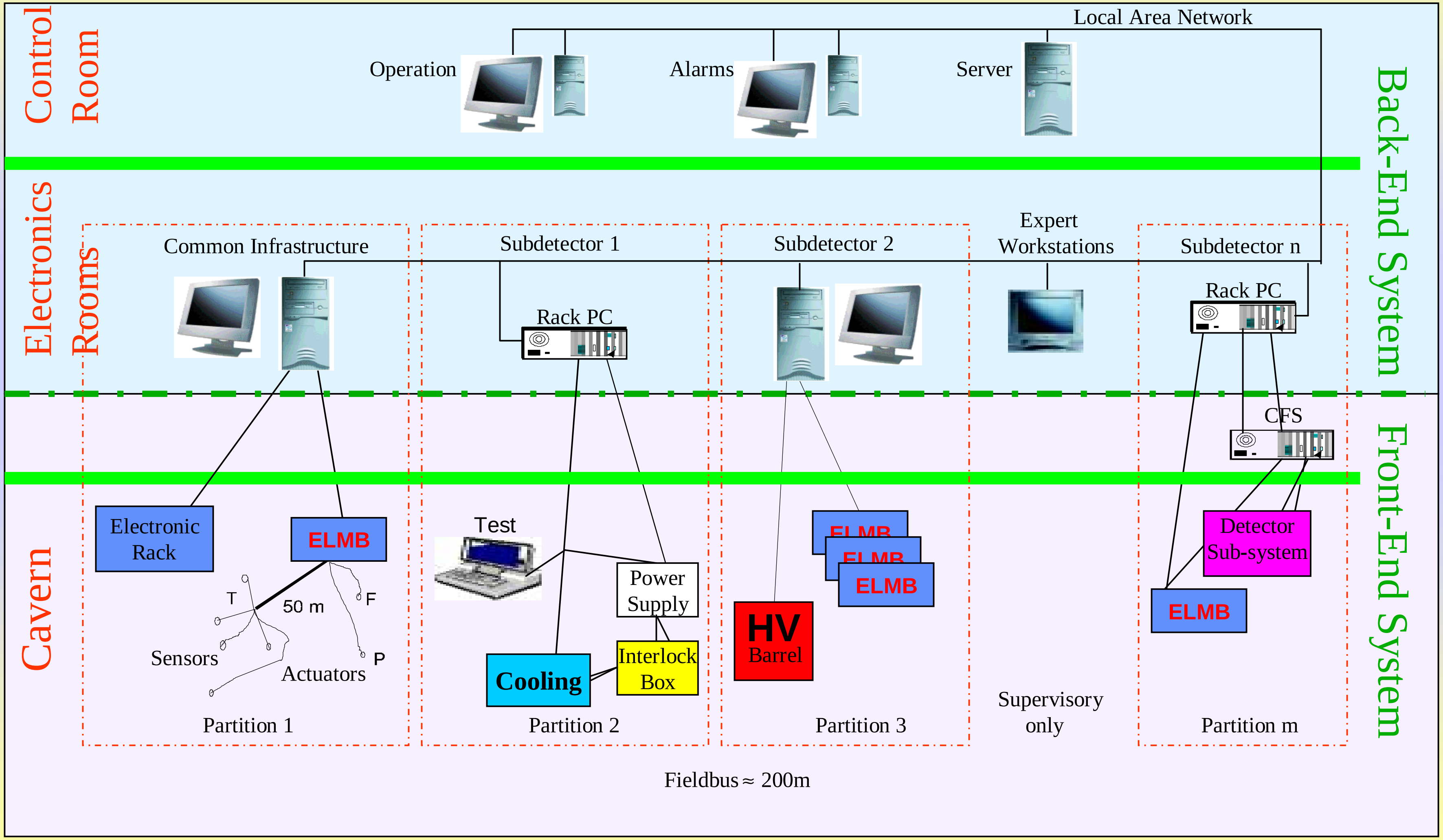
Physical Deployment

Implemented by SCADA PVSS-II (selected by the Joint COntrols Project)



From sensors/actuator up to complex computer-based systems e.g. VME, PLC

Specific and general purpose fieldbus I/O modules e.g Embedded Local Monitor Board

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Special Requirements

- **Development at different places**
- **Large variety of equipment**
  - **Homogeneity**
  - **Flexibility**
- **Types of operation**
  - Stand-alone for prototype development
  - **Stand-alone sub-detector, sub-system**
  - **Integrated operation as detector**
  - **Data taking**
- **Adaptability to operational procedures (which are still only partly known to date) Requirements!!!**

Strategy: **Use commercial HW and SW components and JCOP tools to build the control system**

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Front-End Systems

Positioning of Front-End electronics:

Difficulties in cavern:

Ionizing radiation

Magnetic field up to 1.5 T

No access during operation

Limited space available

Difficulties outside cavern:

Cabling

Standardization

- **Industrial devices: outside cavern**
  - Define read-out protocol to Back-End (OPC)
- **Purpose-built equipment: in cavern**
  - Use Embedded Local Monitor Board (ELMB) for controls
  - Connect to Back-End via CAN field bus

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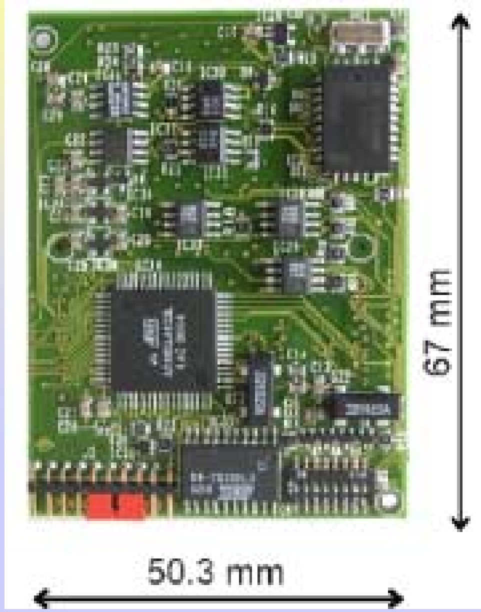
ELMB

Applications:

- Monitoring of environment
  - Temperature (Pixel, SCT,TRT)
- Control of power supplies
  - High Voltage (SCT, TRT)
  - Low Voltage (LAr)
- Supervision of cooling
  - Pixel, SCT, Tile,TRT
- Control of detector elements
  - MDT (custom firmware)
  - TGC (custom firmware)
- Control of infrastructure
  - Racks (all LHC exp.)
  - Gas (all LHC exp.)



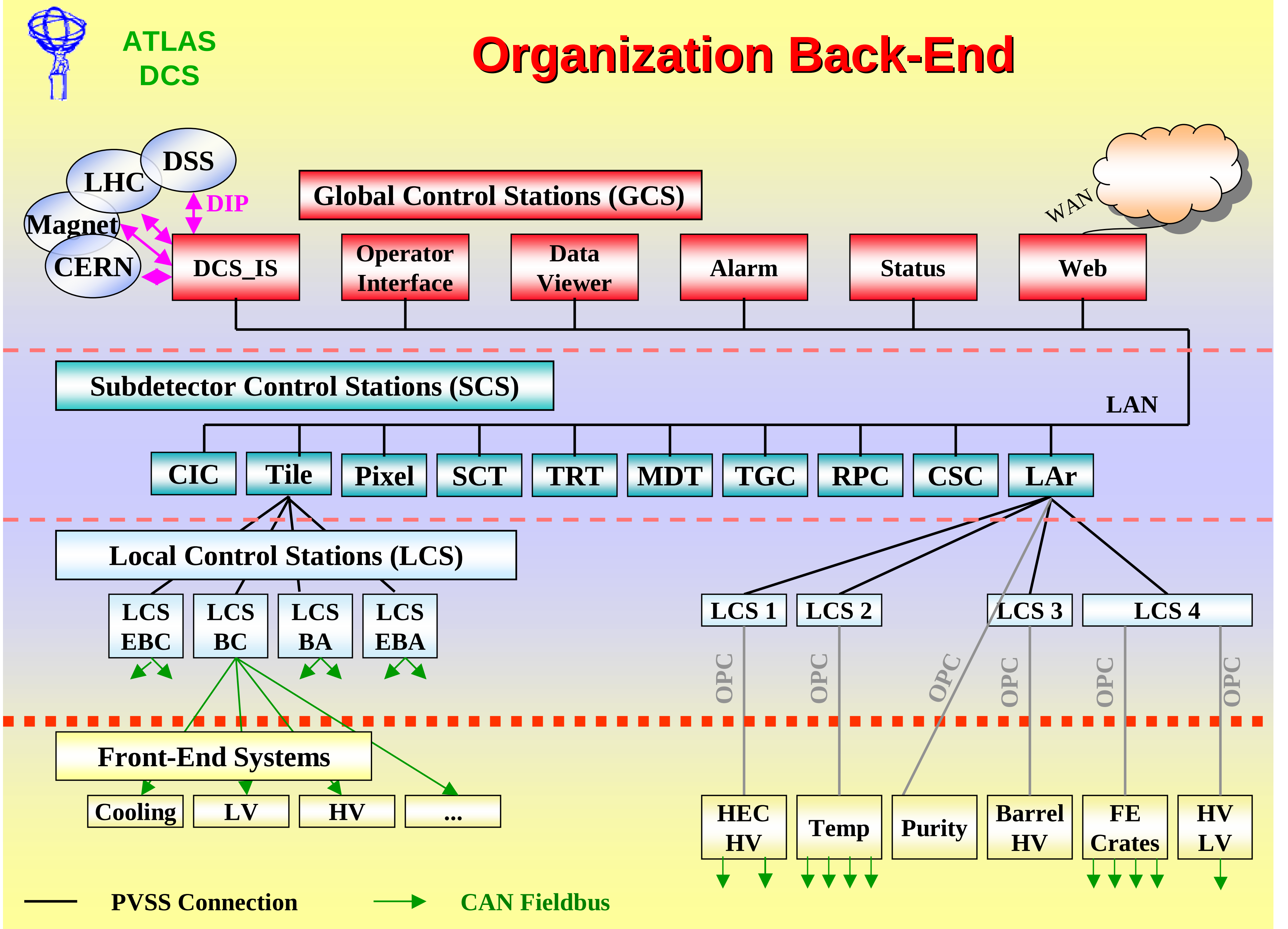
Features:

- 64 channels 16-bit ADC
- 24 digital I/O ports
- add-ons via SPI
- Radiation tolerant HW and SW
- Read-out conform to CANopen protocol

5000 ELMBs used in ATLAS = 400.000 channels

(10.000 pieces presently being produced)

Organization Back-End



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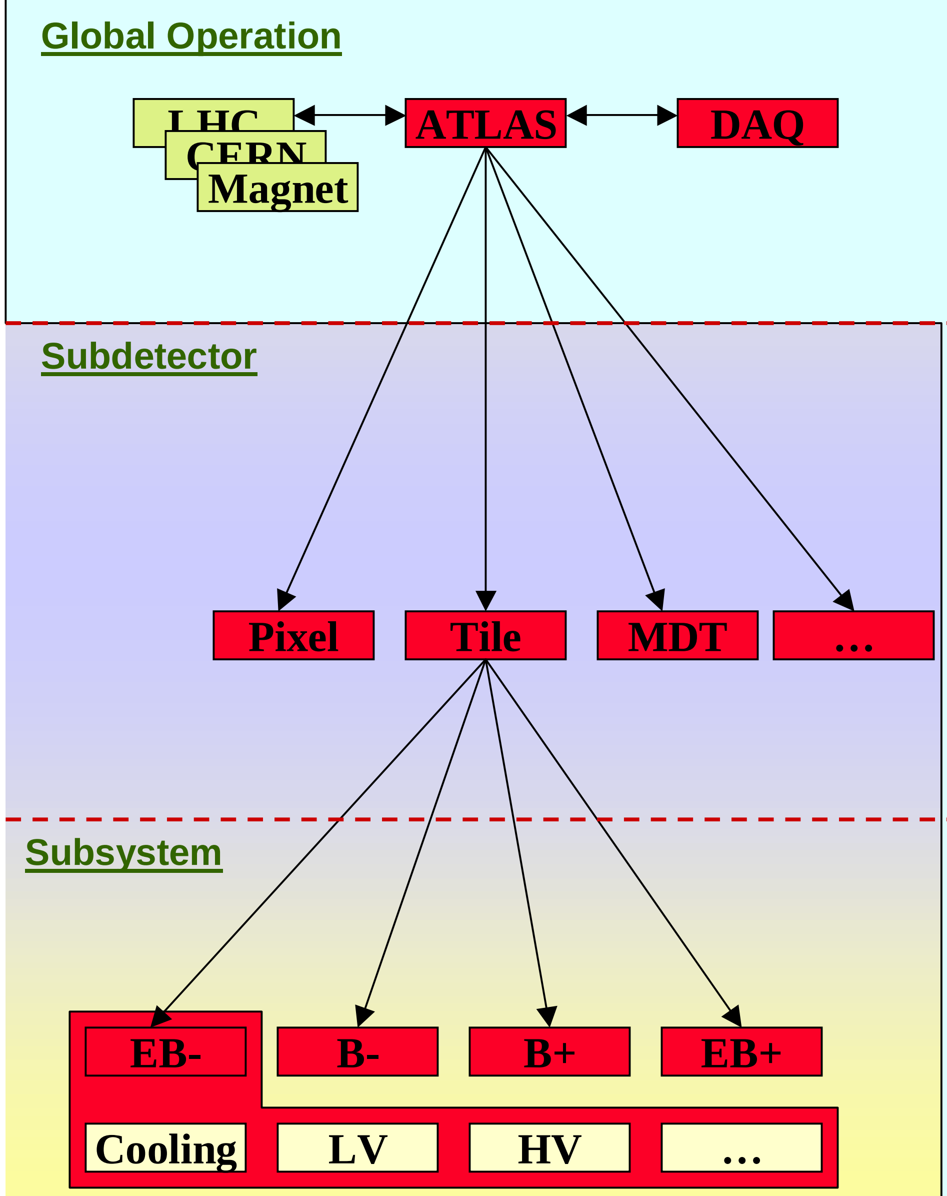
Functions GCS



1) Operator interactions (Main Control Room)

- Send commands
- Logging (Cmds, Incidents, system errors)
- Browse log files
- High level monitoring of:
  - subdetectors
  - external systems
- Display (permanently) critical data
- Alarms (display and acknowledge)
- Plot any data on request
- Change parameters (settings)
- Dis/enabling and masking of any channel
- Connection to DAQ
- Export and import data

2) Services

- Interface to Data Bases
- Logging
- Web service
- Interface to GSM
- Communication to external systems
  - LHC
  - CERN services
  - Magnet
- Alarms
- *Name server*

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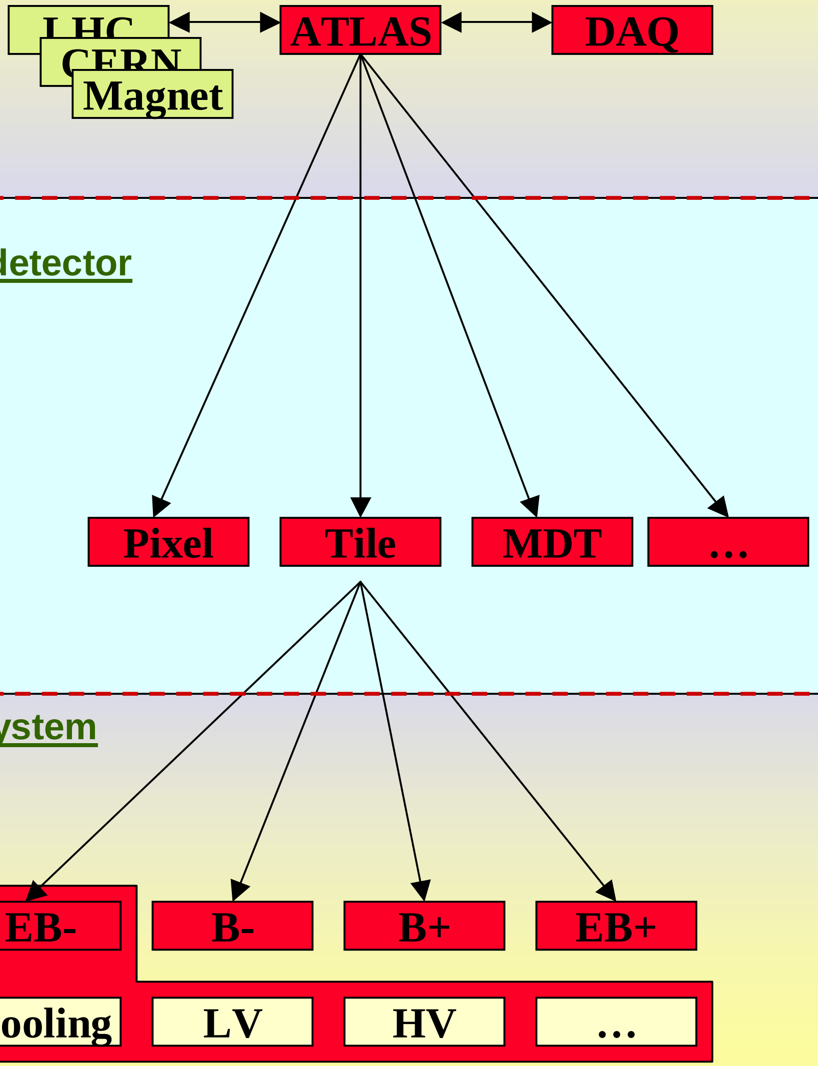
Functions SCS

Global Operation



Subdetector

Subsystem

Subdetector Operation (electr. room or surface)

All actions for this subdetector, which are possible from the Global Control Stations, must also be possible from the SCS

- Summary status of this sub-detector
- Archiving of summary information
- Full operation of this sub-detector
- Coordination and synchronization of services or sections of the detector
- Verification of commands
- Logging of commands
- Execution of automatic procedures or actions
- Receive commands from DAQ
- Export data to DAQ
- Send messages to DAQ
- Connect to services in the layer above

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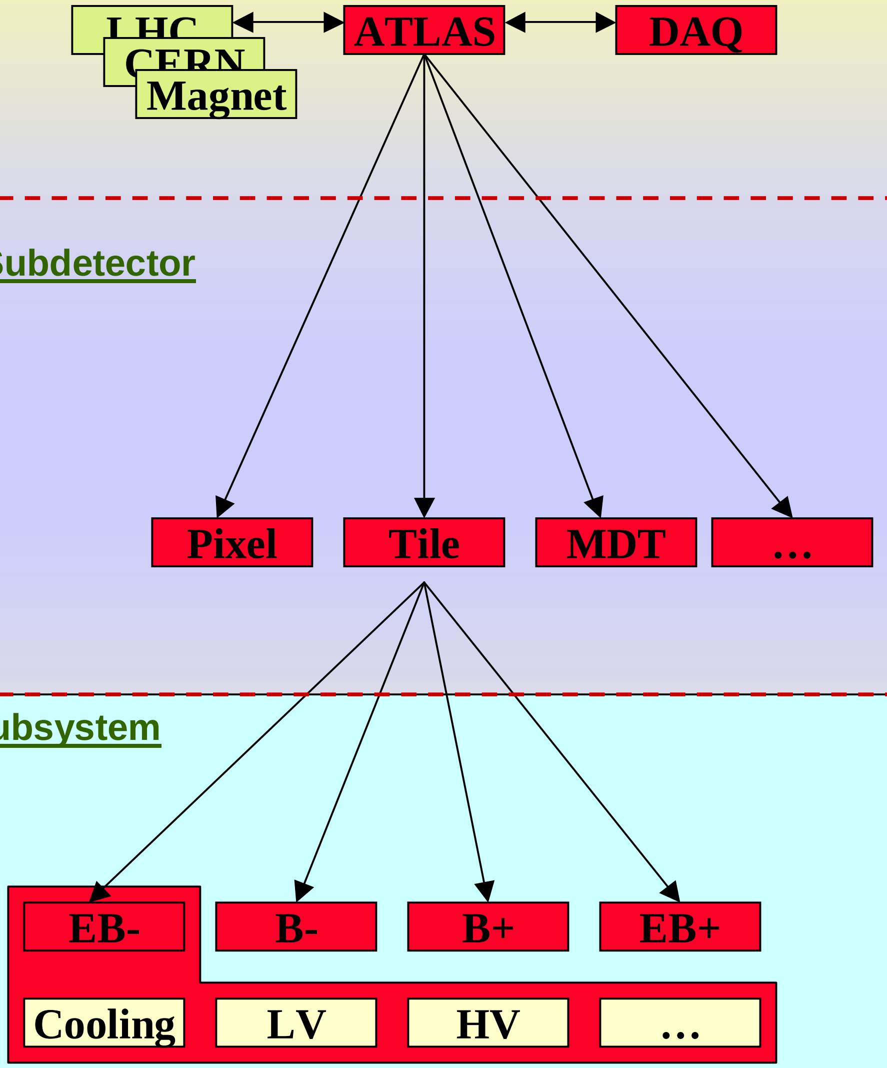
Functions LCS

Global Operation

Subdetector

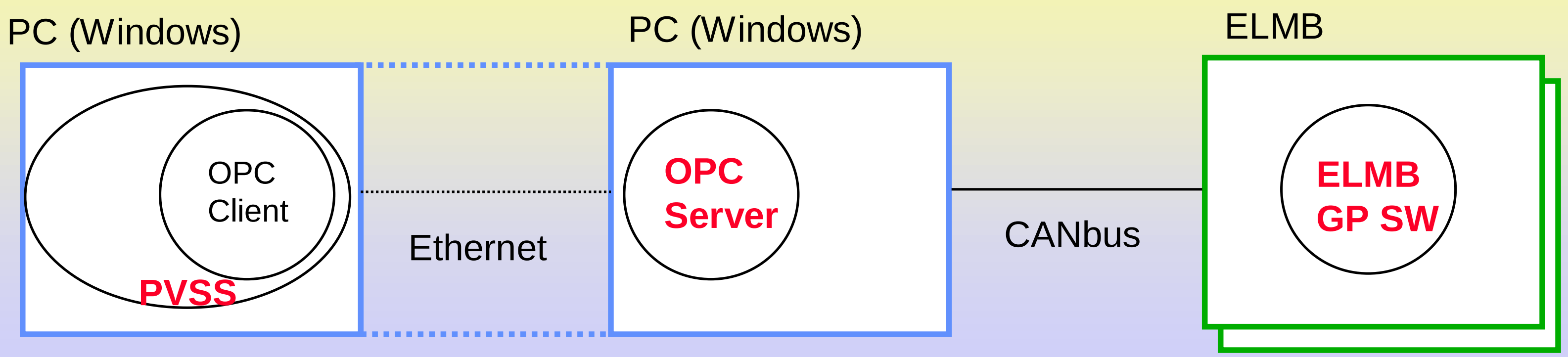
Subsystem



Sub-system Operation (electronics room)

- Hardware monitoring and control
- Readout/Write data from/to the front-end
- Calculations (calibration, conversions, etc.)
- Triggering of automatic actions (inc. feedback)
- Archiving of raw data into the PVSS DB

Read-out Chain

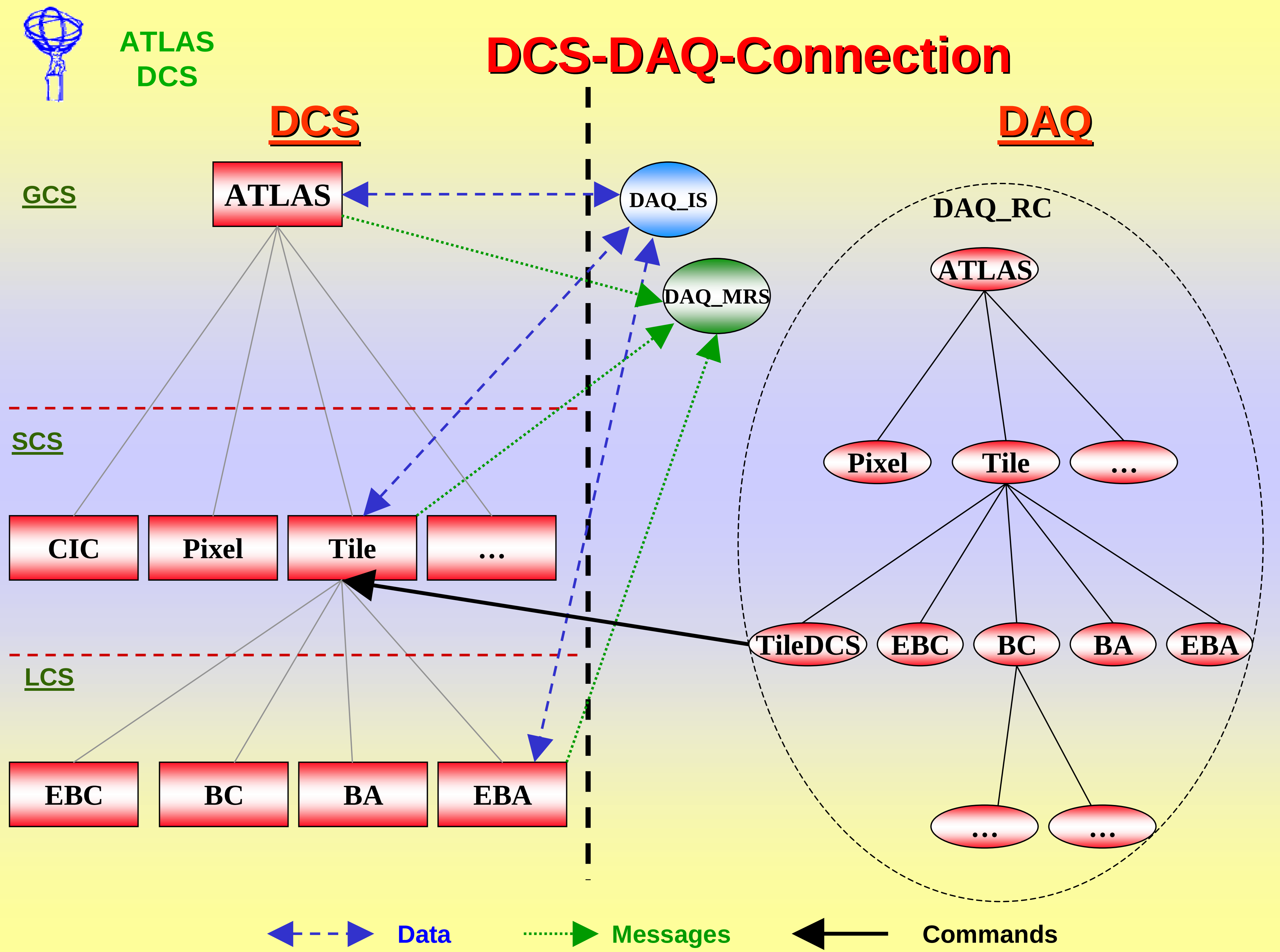


- **PVSS**
  - **Fine calibration**
  - **Calculations**
  - **Detects threshold crossing**
    - Warnings, alarms
    - Automatic actions
  - **Archiving**
  - **Data visualization**
  - **Data exchange with DAQ**

- **OPC**
  - **Conversion to physical units**
  - **Data filtering**

- **ELMB**
  - **Parameter setting**
  - **Calibration** (<1%)
  - **Read-out modes**
    - Polling
    - Periodic
    - On change

DCS-DAQ-Connection



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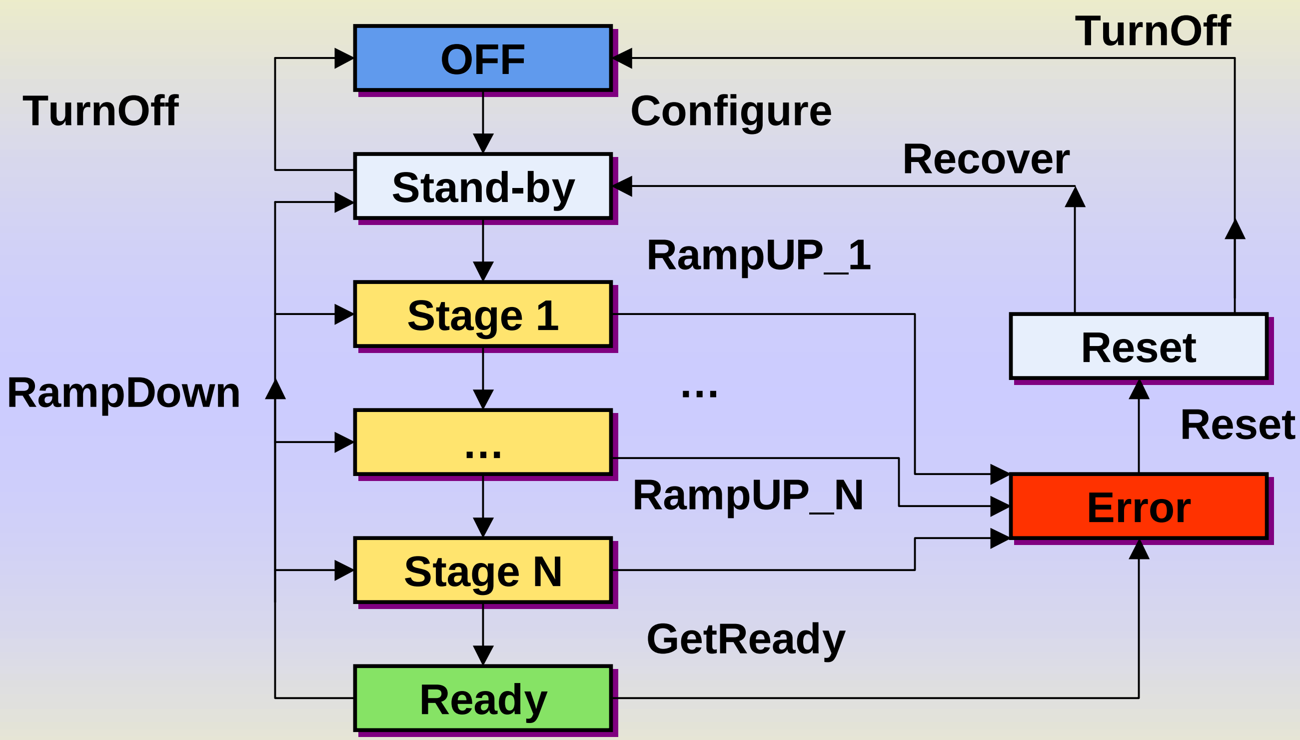
FSM of Sub-Detector



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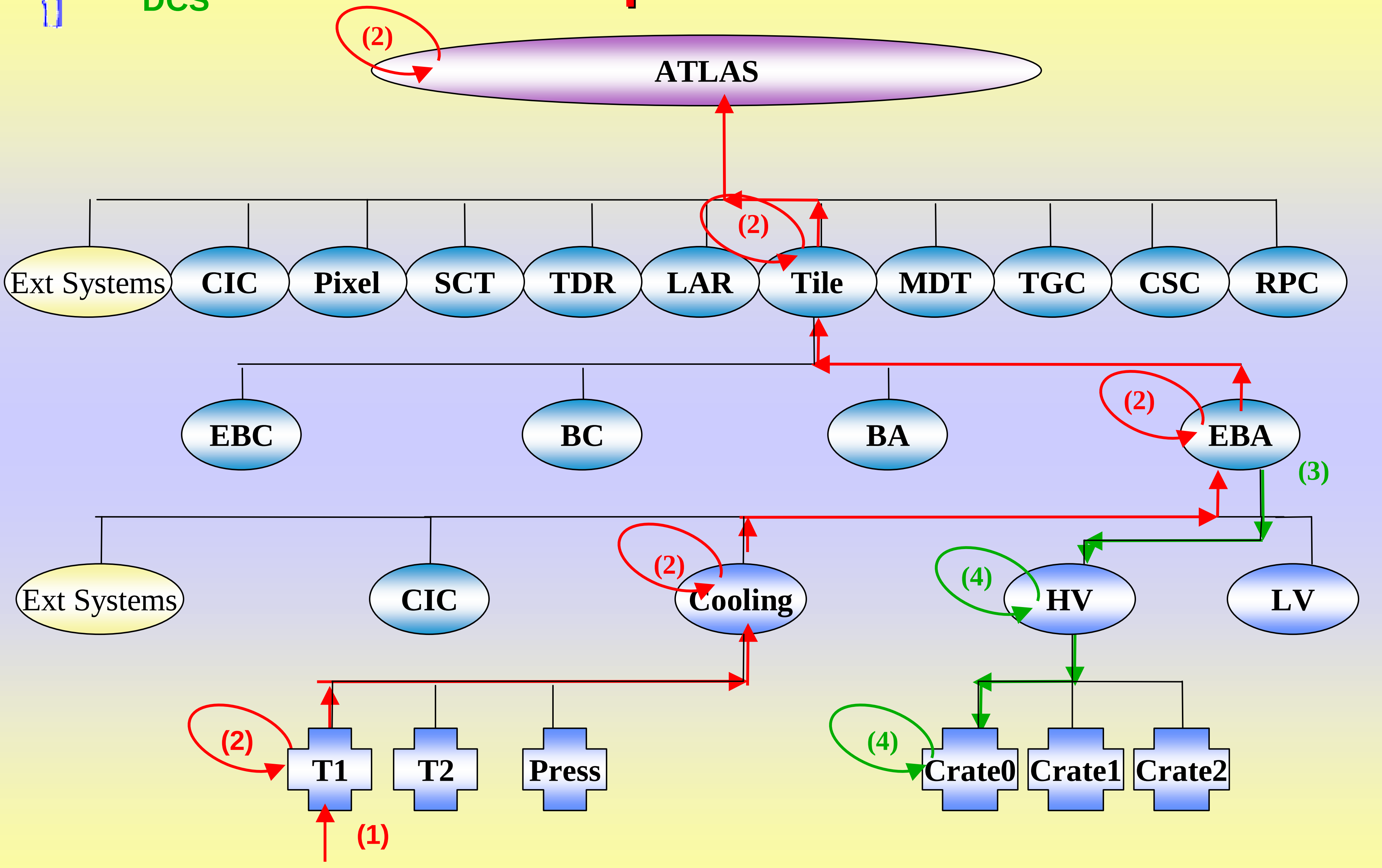
Operation as FSM



(1) Detector overheating

(2) State transition (READY -> Error)

(3) Automatic action on the HV system

(4) State transition (ON -> OFF)

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Conclusions

- **DCS models the hierarchical organization of the ATLAS detector**
- **The control of the Front-End is standardized**
  - Protocol for industrial devices
  - ELMB for purpose-built equipment
- **The Back-End is implemented with PVSS-II**
  - Provides interconnection between stations
  - JCOP adds tools and devices
- **DCS and DAQ independent systems, but seamless interconnection**
- **FSM approach very useful**
  - Allows to model the hierarchy
  - Flexible rules for operation