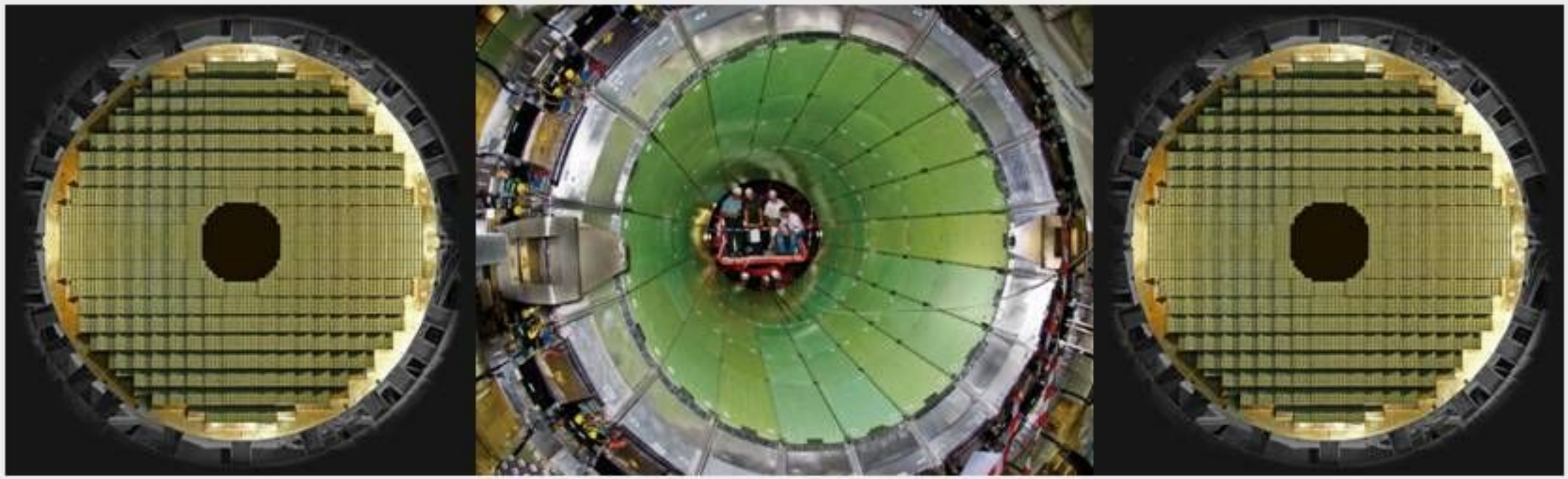
ICALEPCS 2009

The CMS ECAL Detector Control System



Diogo Di Calafiori
ETH Zurich
(on behalf of the CMS ECAL DCS group)

ETH Institute for Particle Physics

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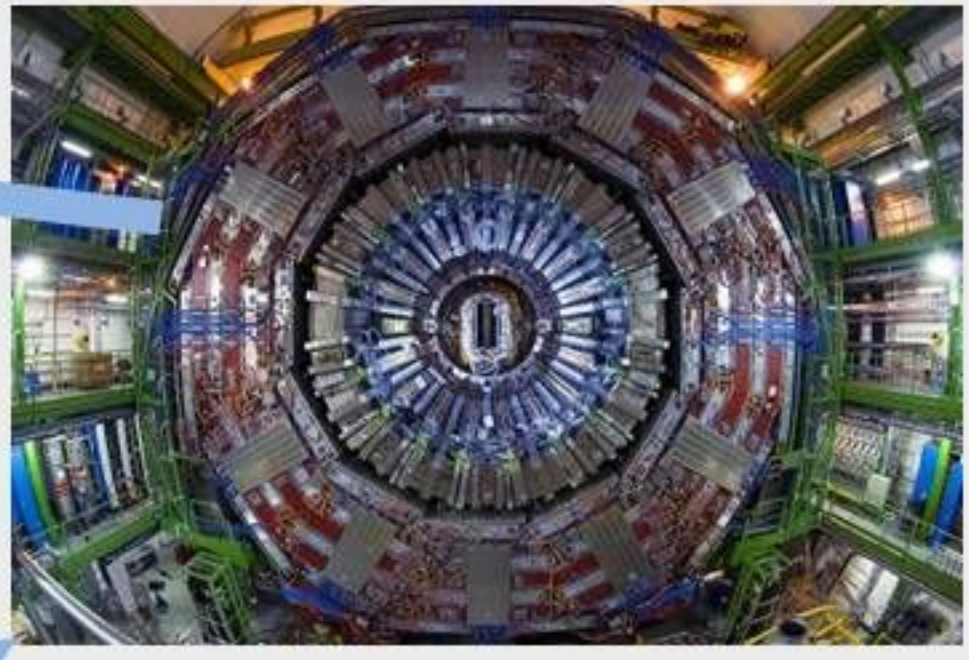
OUTLINE

- *Introduction*
- *The CMS ECAL DCS Layout*
- *The DCS Hardware*
- *The DCS Software*
- *The DCS/ESS Action Matrix*
- *The Operational Experience*
- *Next Steps*
- *Conclusion*

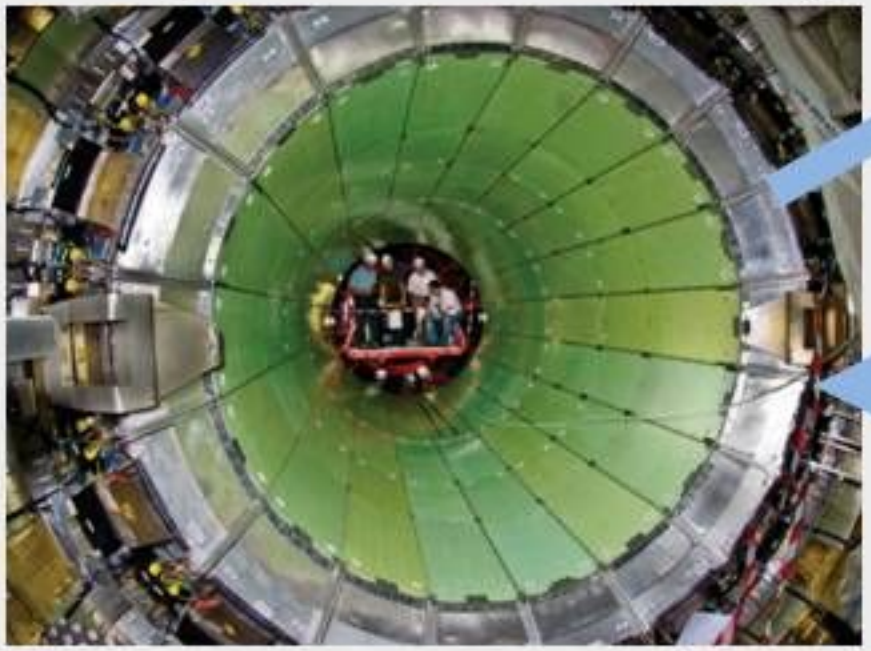
INTRODUCTION

Large Hadron Collider (LHC)

Compact Muon Solenoid (CMS)

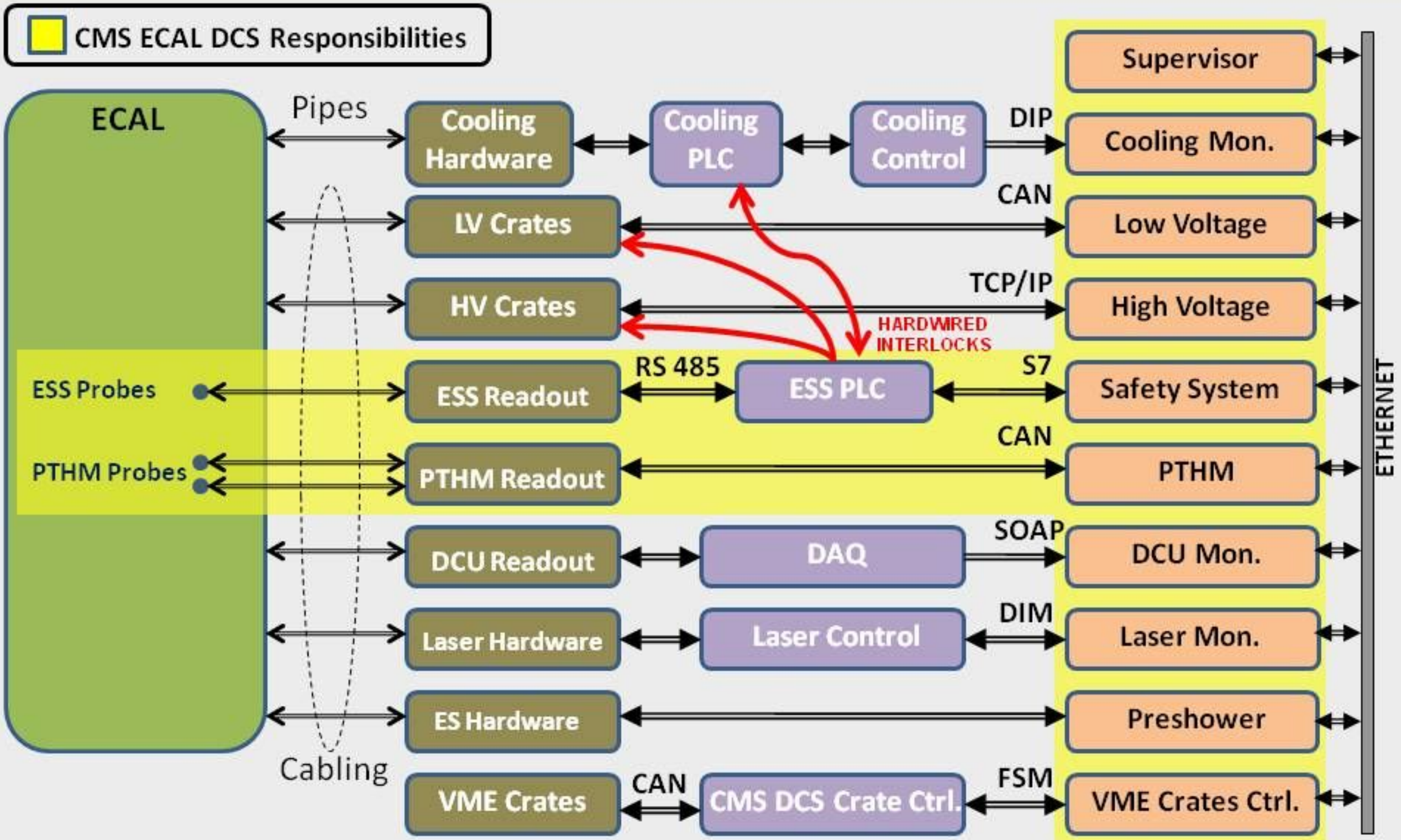


Electromagnetic Calorimeter (ECAL)



ECAL Detector Control System (DCS)

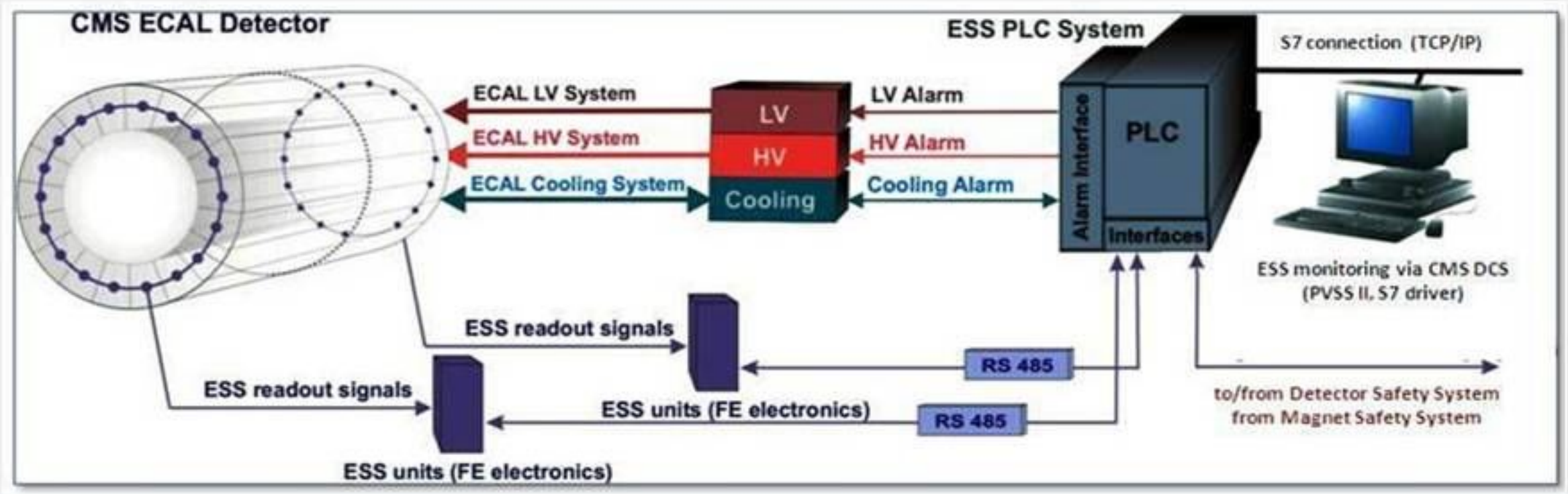
CMS ECAL DCS LAYOUT



THE DCS HARDWARE

ECAL Safety System:

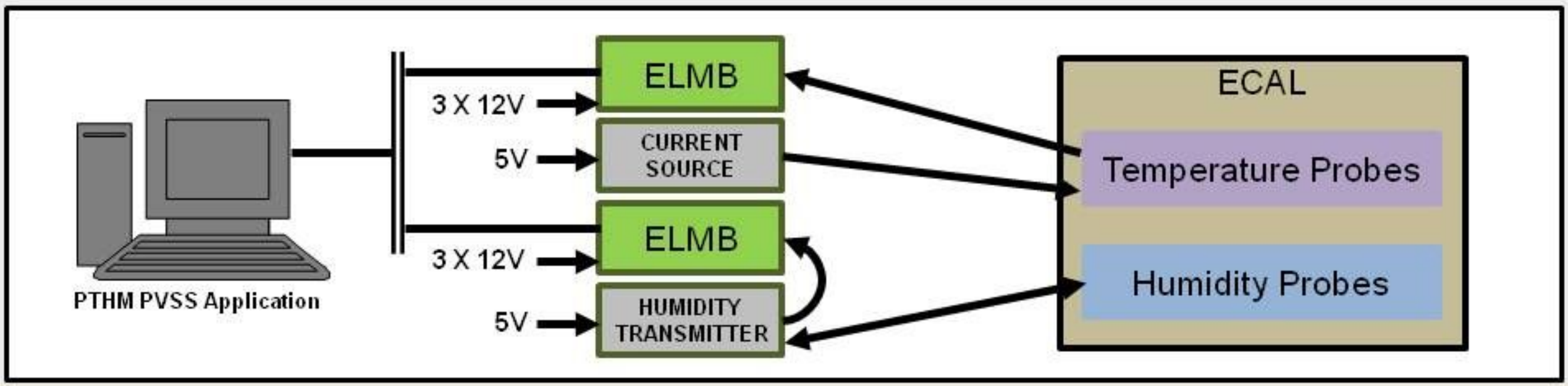
- Fully installed and operational during all the commissioning and running periods;
- No issues concerning the readout systems;
- Hardware problems, their sources and corrections:
  - *2 defective CP341 communication modules + 1 active backplane – replaced (under investigation by SIEMENS);*
  - *1 defective interlock unit – metallic dust – replaced / rack door to be installed;*
  - *WLD sensors installation issues – short to ground – solution under investigation.*



THE DCS HARDWARE

Precision Temperature and Humidity Monitoring;

- Fully installed and operational during all the commissioning and running periods;
- No issues concerning the temperature readout system;
- Humidity readout system affected by cables capacitance – reliable measurements only for RH > 60%;
- Hardware problems, their sources and corrections:
  - *7 out of 516 temperature sensors working out of specifications – masked;*
  - *1 out of 516 temperature sensor broken (since the installation) – masked;*
  - *10 out of 164 humidity sensors presenting high noise levels – masked.*



THE DCS SOFTWARE

Composed by 11 subsystems:

- Supervisor
- Low Voltage
- High Voltage
- SM/DEE Air Temperatures
- Cooling Monitoring
- PTHM
- ECAL Safety System
- Preshower Ctrl. & Mon.
- VME Crates Control
- Laser Monitoring
- DCU

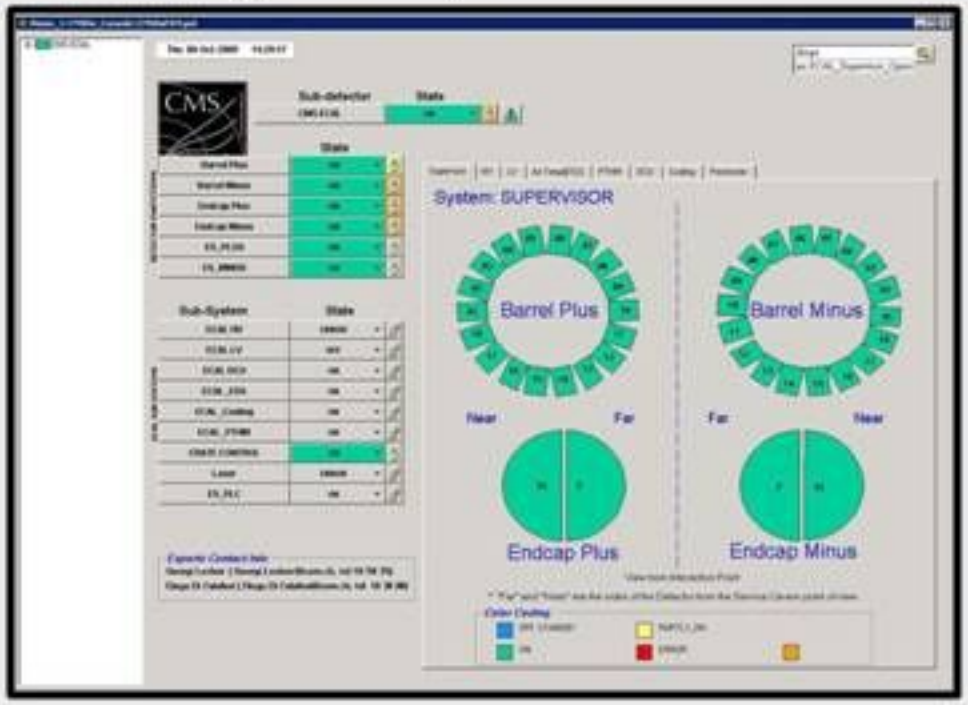
Overview of the system:

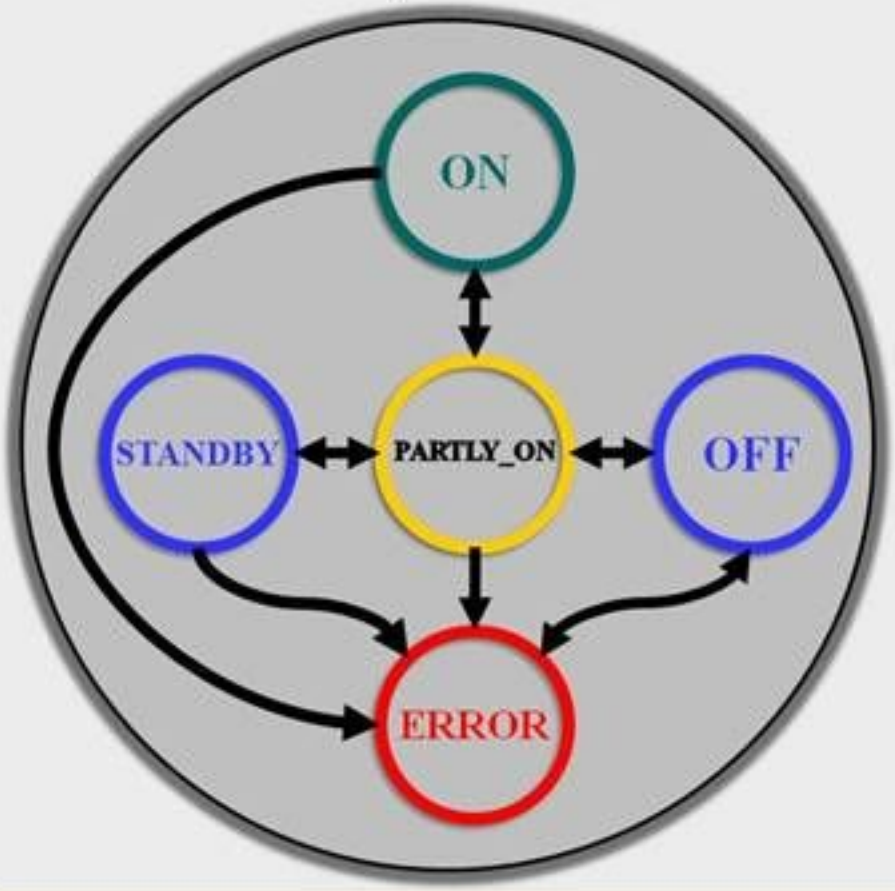
- Fully integrated to the CMS DCS, operated locally by ECAL shifters or centrally by CMS shifters;
- Two–level role–based access control: operator / expert;
- EB/EE control and monitoring of:
  - *860 low voltage channels*
  - *1240 high voltage channels*
  - *20 VME crates*
- Monitoring of:
  - *516 precision temp. sensors*
  - *56 ES temp. sensors*
  - *352 ESS temp. sensors*
  - *40 cooling control temp. sensors*
  - *164 humidity sensors*
  - *40 water leak det. sensors*
  - *55 laser parameters*
  - *8 magnet parameters*
  - *> 160.000 DCU parameters*

THE DCS SOFTWARE

The ECAL DCS Supervisor:

- ✓ Handles the interactions between all CMS ECAL DCS subsystems;
- ✓ The main panel allows the user to:
  - Monitor the overall status of all subsystems;
  - Instantly find the source of possible problems;
  - Control the power to the LV, HV and VME crates;
  - Manually shutdown the detector or its partitions.





- ✓ State diagram based on the CMS DCS standard;
- ✓ PARTLY_ON summarizes all transitions and unexpected states;
- ✓ Controlled ON/OFF switching sequence (OFF ↔ STANDBY ↔ ON);
- ✓ Automatic controlled shutdown via software.

THE DCS/ESS ACTION MATRIX

SOFTWARE LAYER (DCS)

- COOLING MONITORING
- SM/DEE AIR TEMPERATURE
- PTHM

→ ERROR → **SM / DEE Controlled Shutdown**: ON → STANDBY → OFF

HARDWARE LAYER (ESS)

- DSS SHUTDOWN
- MAGNET UNSTABLE
- ESS PLC PROBLEMS
- COOLING PLC PROBLEMS
- SM/DEE OVERHEATING
- SM/DEE COOLING FAILURE [2]
- LVRACKS COOLING PROBLEMS [1]
- ESS READOUT PROBLEMS [1]
- SM/DEE WATER LEAK

GRANULARITY: ECAL → **HARDWIRED FAILSAFE INTERLOCKS**

GRANULARITY: SM/DEE → **HARDWIRED FAILSAFE INTERLOCKS**

GRANULARITY: SM/DEE → **HARDWIRED FAILSAFE INTERLOCKS**

→ **High Voltage crates**
Low voltage crates
LV crates inputs (OPFC)

→ **ECAL Cooling [2]**
High Voltage crates
Low voltage crates
LV crates inputs (OPFC)

[1] Granularity per group of SM (readout units, racks, etc)
[2] The Cooling Control has granularity per EE instead of DEE

OPERATIONAL EXPERIENCE

- All ESS actions on MSS and DSS signals have proven to be reliable;

- On a single occasion:

Scenario: ECAL fully powered + SM/DEE Cooling failure + Operational mistake
(no automatic reaction from the ESS)

Additional safety layers: Alerting system (SMS/Emails) + Fast expert intervention

Result: No damage to the detector!!!

- Automatic controlled shutdown via software has proven to be very efficient;

- Software applications were upgraded regularly according to user's feedback and additional components were developed and integrated;

- Permanent DCS expert on-call service has guaranteed the maximum availability of the detector.

NEXT STEPS

Hardware:

- Additional interlocks to be used by the OPFCs of the LV system;
- A new readout system for humidity monitoring is under consideration;
- Implementation of a setup, reproducing the current DCS configuration in a small scale, to be used for tests and further development;

Software:

- Automatic health check mechanisms to be implemented;
- Central database services to be improved and made more reliable;
- User interfaces to be improved;
- Finalize the documentation.

CONCLUSION

- ✓ The CMS ECAL DCS has achieved a reliable and stable configuration;
- ✓ The automatic controlled shutdown via software in addition to the safety system protection mechanisms enables an even safer operation of the detector;
- ✓ Still some room for improvements for both hardware and software;
- ✓ And the most important:

The ECAL control system is ready for the LHC startup!!!

(foreseen for November 2009)