Compact Muon Solenoid (CMS) Electromagnetic Calorimeter (ECAL) Detector Control System (DCS)

CMS ECAL consists of 3 partitions:
- Barrel (EB) – scintillation crystals
- Endcap (EE) – scintillation crystals
- Preshower (ES) – silicon sensors

Each partition has two halves:
- Plus side
- Minus side

Precision temperature monitoring (PTM) upgrade
Embedded Local Monitor Board (ELMB) based monitoring
- Measures EB & EE temperatures with high precision
- System has been running successfully for several years
- Weaknesses identified in powering system

New powering architecture designed and installed
- Independent powering for Plus and Minus side
- Individual switching of power lines after distribution

Minimizes impact of single failures
- Problems can be isolated from the rest of the system

Software consolidation and merging
Legacy elements of the code removed
- Duplicated code and implementations removed
- Code base reduced in size by over 50%

Migration to Dell M610 Blades
- DCS can run on fewer, more powerful servers
- Independent sub-applications must run side-by-side
- Compatibility issues were identified and removed

Sub-applications run independently
Sub-applications merged onto 3 hosts

Removing all incompatibilities enabled any merging scheme to be adopted
- Optimal merging schema chosen to minimize I/O complexity
- Software maintenance load is reduced
- Reduced from 15 to 3 hosts with application merging

Operational activities
During LHC data taking and short technical stops:
- 24/7 on-call support
- Only minor software and hardware upgrades
- R&D for upgrades

During long LHC shutdown:
- Reduced support load
- Only short periods of detector powering
- Opportunity for major system upgrades

EB & EE humidity monitoring upgrade
New front-end designed and built by CMS Belgrade Group
- 4 units to excite and monitor all EB & EE humidity probes
- Modbus protocol to interface with supervision software

Readout unit calibration performed at CERN
- Commercially calibrated reference probe
- Humidity generator to set humidity levels
- Automated control and data acquisition
  - Arduino open-source hardware platform
  - WinCC Open Architecture (OA) control software
- 4th order polynomials convert raw data to humidities

Readable detector humidity range extended to 10-70%
- Fully calibrated units have been installed in CMS

ES bias voltage monitoring
16 new distribution boards deployed in 2012
- 80 ELMBs to monitor current in distributed channels
- ELMB reads voltage from passive resistor networks

Unexpected relationship between bias current & ELMB readings
- Circuit should be linear, but nonlinearities are seen
- More laboratory studies required to characterize each channel

Deploying upgrades
Step-by-step deployment following laboratory testing
- Validation period in production environment
- Essential to avoid disruption to other CMS ECAL test activities

Upgrade Status
- EB & EE humidity monitoring upgrade: Calibrated & deployed
- ES monitoring upgrade: Calibration in progress
- Consolidated and merged software: Deployed, validation in progress

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References
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2) University of Belgrade: Faculty of Physics and VINCA Institute of Nuclear Sciences
3) University of Wisconsin-Madison, U.S.A.

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