The upgrade and re-validation of the Compact Muon Solenoid Electromagnetic Calorimeter Control System

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On behalf of the CMS ECAL group

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**

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

Precision temperature monitoring (PTM) upgrade

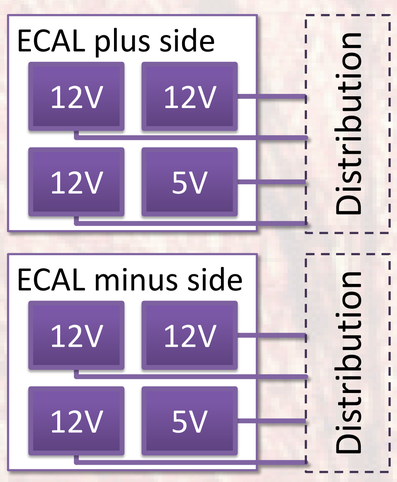
Embedded Local Monitor Board (ELMB) based monitoring

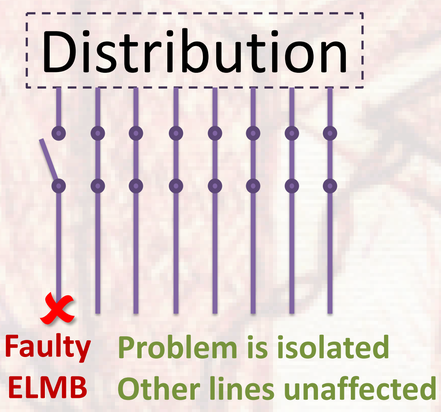
Measures EB & EE temperatures with high precision

- 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

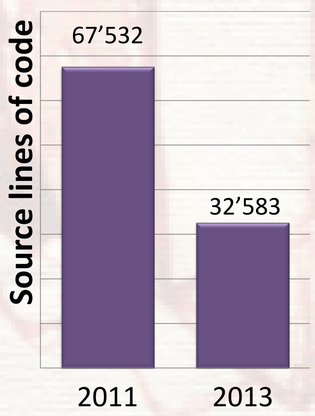
Problems can be isolated from the rest of the system

Software consolidation and merging

Legacy elements of the code removed

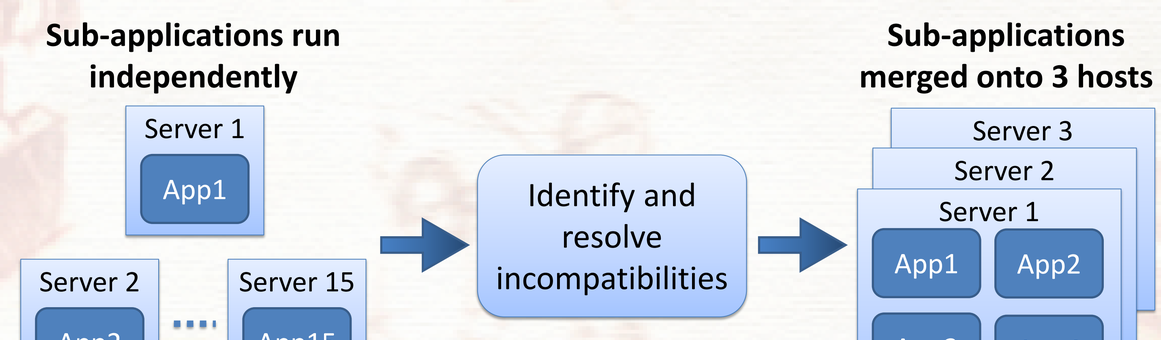
Duplicated code and implementations removed

→ 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



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

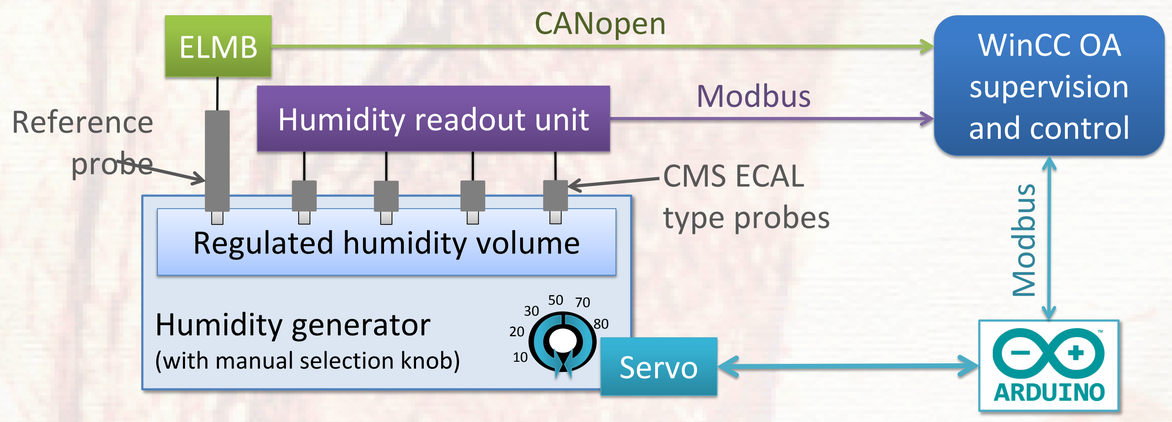
EB & EE humidity monitoring upgrade

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%

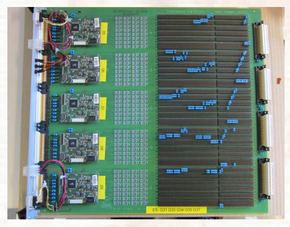
Fully calibrated units have been installed in CMS

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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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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