Improving the Compact Muon Solenoid Electromagnetic Calorimeter Control and Safety Systems for the Large Hadron Collider Run 2

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On behalf of the CMS Collaboration

The CMS ECAL Detector Control System

- Based on the WinCC Open Architecture software package
- Uses Joint Controls Project (JCoP) and CMS frameworks
- 3-level access control (MONITOR / OPERATOR / EXPERT)
- Applications archive / retrieve data from central databases
- Alerts and protective automatic actions at all system levels

Remote reset of CAEN mainframes

- Arduino Ethernet with Modbus-TCP implementation
- 14 ports per unit, providing TTL output signals
- Heartbeat to ensure the unit availability
- Adjustable pulse length for available reset modes
- Easy integration with the detector control system
- Reduction of intervention time from >30min to <10min
- Proven effectiveness in production environment

Improved PTM ELMB power distribution

- ELMB-based readout of 516 NTC thermistors
- Original ELMB powering scheme:
  - Single set of 3x 12V power supplies for all ELMBs
  - No easy way to disconnect an individual power line
  - Single failure could degrade the complete system

- Improved power distribution:
  - Two sets of 3x 12V power supplies, one for each detector half
  - Terminal blocks with switches and fuses per power line
  - Failures can be easily isolated at the CMS service cavern level

*) 4x dual-channel 16-port MUX for serial line switching
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* Arduino Yún with Modbus-TCP implementation
* SIEMENS PLCs
* Arduino Ethernet with Modbus-TCP implementation
* Arduino Ethernet with Modbus-TCP implementation

ES BV monitoring

- Largest ELMB-based system in the CMS ECAL (80 ELMBs)
- Monitors currents of 2216 individual bias voltage lines
- Readout of currents based on simple resistor networks
- Readout channels calibrated for precision better than 2%
- Important for identifying individual increases of currents
- Easy integration with the detector control system
- Problem when working in a multiple ground configuration

Safety system preparation for Run 2

- Preventive maintenance performed regularly
- Protection to prevent users from setting unsafe thresholds
- Annual interlock tests for complete system verification
- CPUs replaced by newer models to ensure support until 2022
- Software mechanism for recovering communication to readout units

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