Preparing the hardware of the CMS Electromagnetic Calorimeter control and safety systems for LHC Run 2

O. Holme[1], P. Adzic[2], D. Di Calafiori[1], P. Cirkovic[2], G. Dissertori[1], L. Djambazov[1], D. Jovanovic[2], W. Lustermann[1], S. Zelepoukine[1,3]

On behalf of the CMS Collaboration

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

- Standard protocols: OPC, MODBUS and S7
- Hardware readout via CAN bus, RS485 and Ethernet
- Fieldbuses converted to Ethernet for connection to DCS

Redundant software runs on six Windows servers

WinCC OA DCS software

OPC Client → CANopen OPC Server → Embedded Local Monitor Boards (ELMBs) → Temperature Probes

(before 2014)

MODBUS Client → Humidity Readout Units → (since 2014) Humidity Probes

OPC Client → Wiener OPC Server → EB/EE Low Voltage

Wiener MARATON

OPC Client → CAEN OPC Server → ES Low Voltage; EB/EE/ES High Voltage

CAEN SY4527

S7 Client → Safety Systems

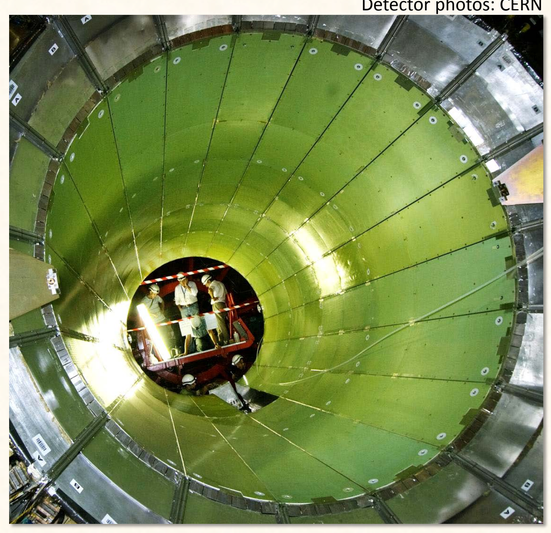
Siemens PLCs

External Systems

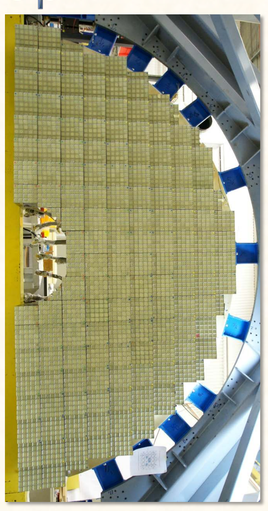
- ECAL Cooling Control Systems
- CMS Magnet Control System
- CMS Detector Control System

Barrel (EB)

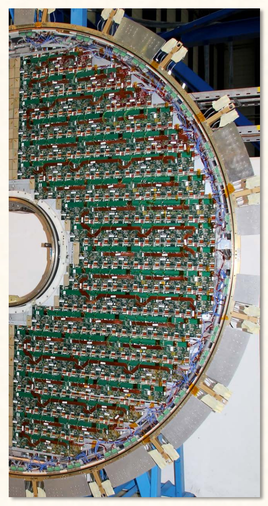
Detector photos: CERN



Endcap (EE)

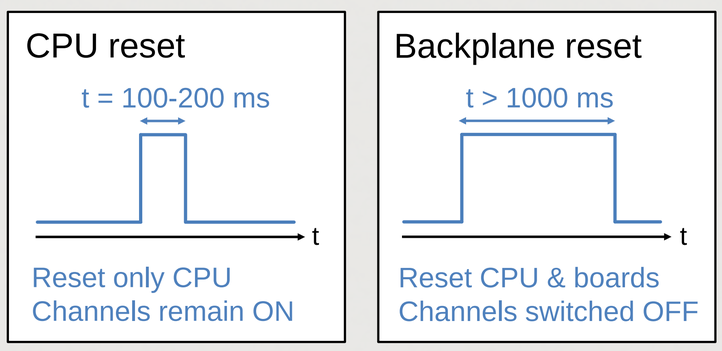


Preshower (ES)

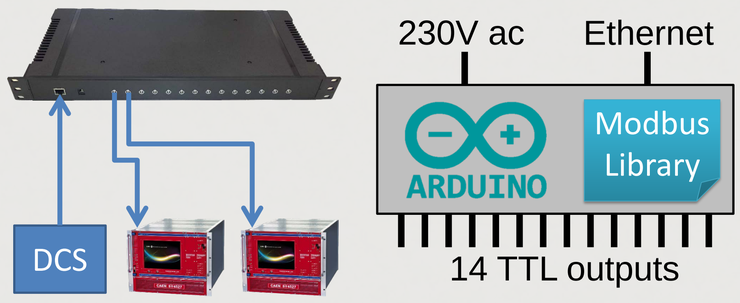


Remote power cycling of CAEN mainframes

- CAEN hardware needs rebooting sometimes
  - To recover from problematic situations
- Long travel times to intervene at CMS
- Remote reboot enables faster recovery
- CAEN SY4527 has a NIM/TTL reset input



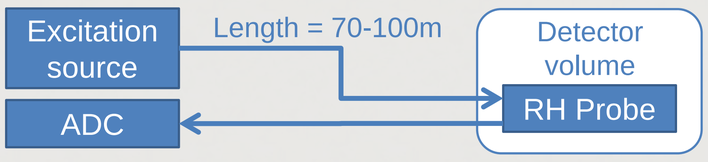
- Custom hardware based on Arduino
- Controls up to 14 SY4527s with TTL output
- Implements Modbus TCP protocol



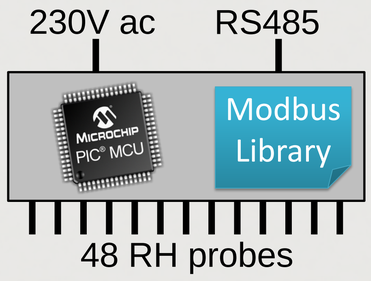
- Modbus TCP allows easy integration to DCS
- Outputs linked to Modbus registers
  - Register is written from DCS
  - Function code 6 (write single register)
  - Register value = pulse width (ms)

Enhanced EB/EE relative humidity (RH) monitoring

- 192 EB/EE resistive RH probes
  - Specified 33Hz-10kHz excitation signal



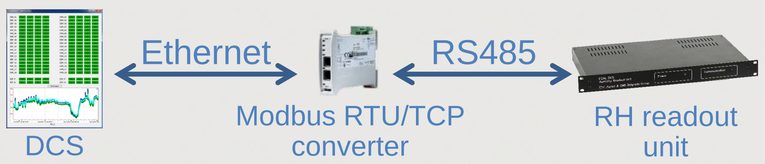
- Previous ELMB readout used 400Hz signal
  - At low RH, cable capacitance dominates
  - RH readout range limited to 60-80%
- New solution uses 1Hz excitation signal
  - Outside specs, but exhaustively tested
  - Achieves readout range of 10-70%
- New readout with PIC18F452 microcontroller
  - High precision excitation system
  - Logarithmic signal amplifiers
  - Built in temperature compensation
  - Implements Modbus RTU protocol



RS485 used as fieldbus

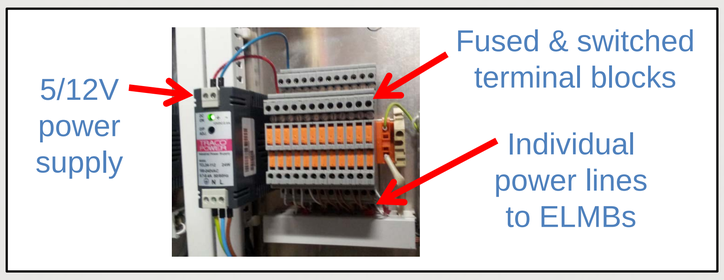
No Ethernet available at installation site

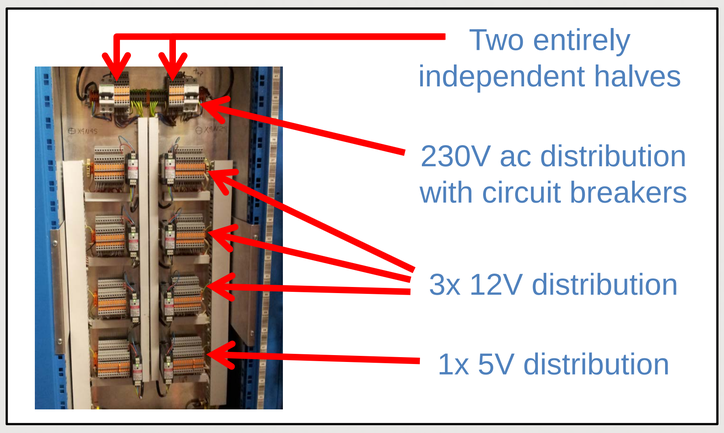
- Modbus RTU/TCP converters enable simple connection to DCS via Ethernet



Improved powering scheme for EB/EE temperature readout

- 516 EB/EE thermistors readout by 16 ELMBs
  - ELMBs require 3x 12V
  - Probe current sources require 1x 5V
  - Electronics installed in limited access area
- Old power distribution had limited granularity
  - Single failure could impact the full system
  - Electronics issues in limited access area may cause persistent degradation
- New solution has improved granularity
  - Minimized impact of problems due to individually fused ELMB power lines
  - Switched power lines enable ELMBs to be power-cycled or isolated for repair

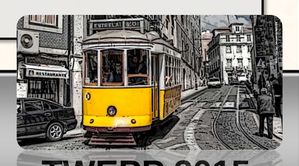




1) Institute of Particle Physics, ETH Zurich, Switzerland
2) University of Belgrade: Faculty of Physics and VINCA Institute of Nuclear Sciences
3) University of Wisconsin-Madison, U.S.A.

Acknowledgements

Swiss National Science Foundation, Switzerland
Ministry of Education, Science and Technological Development, Serbia



TWEPP 2015