ECAL Front-End Monitoring in the CMS experiment

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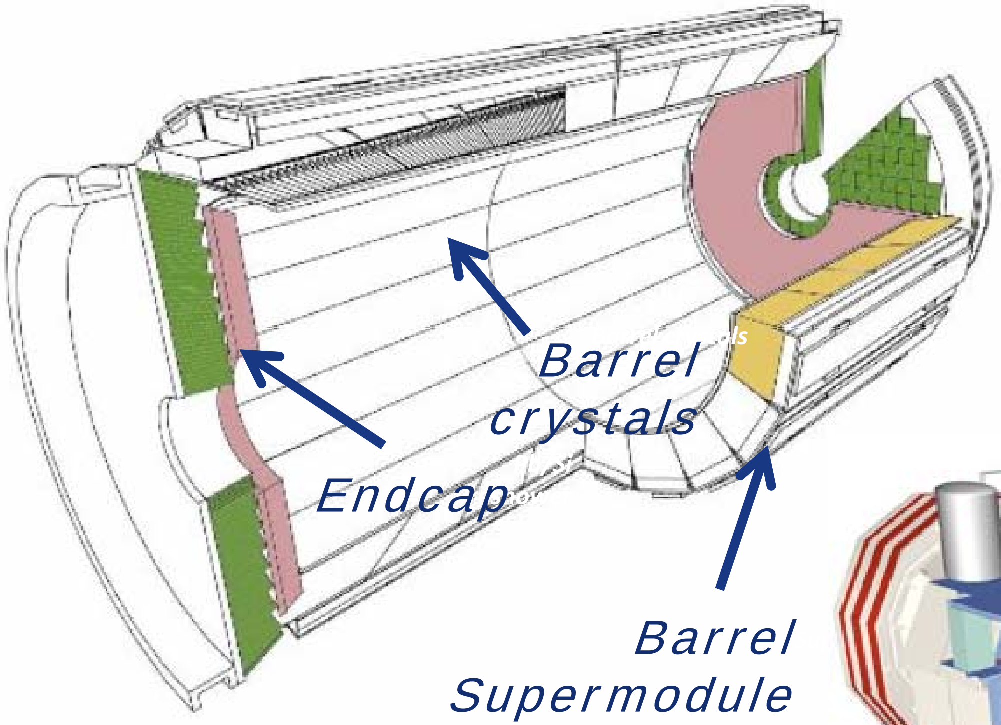
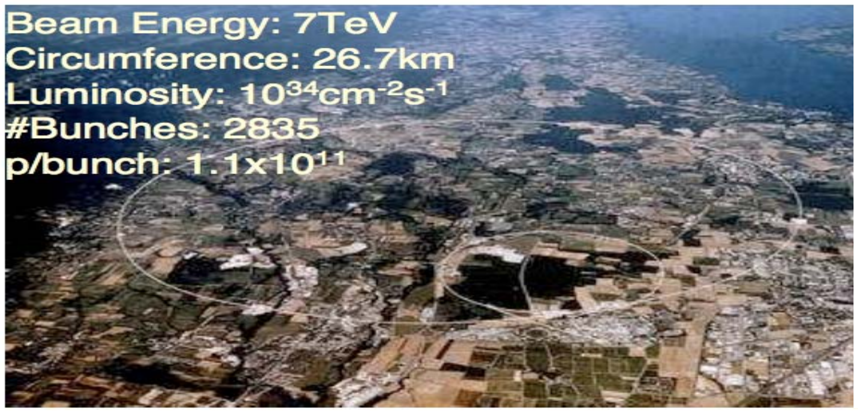
Outline

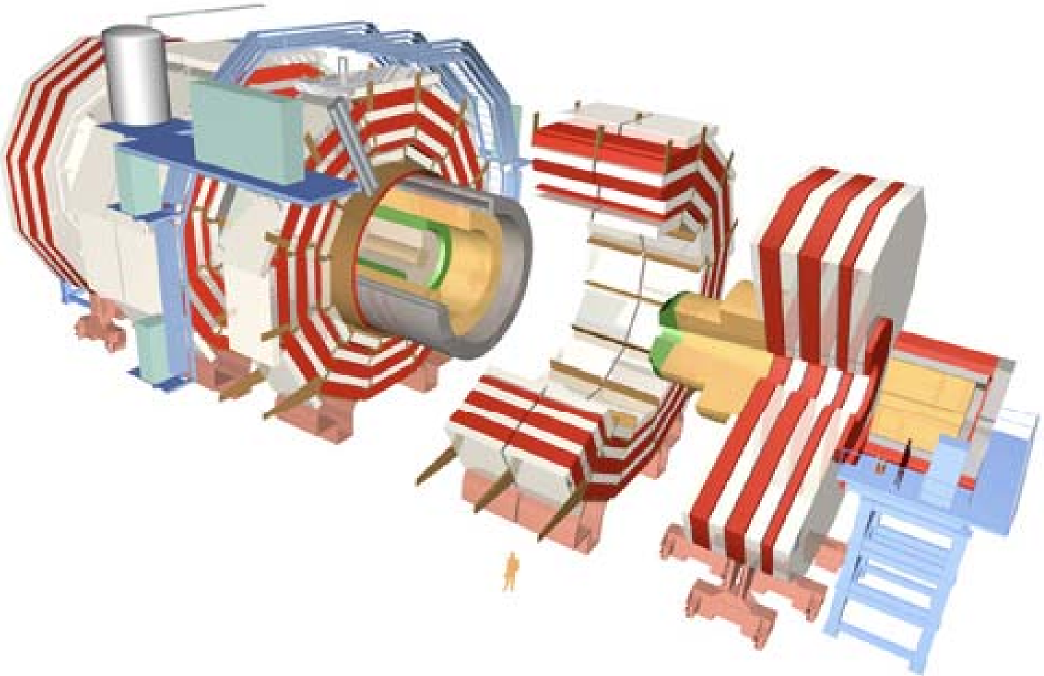
- CMS & ECAL
- Detector Control Unit (DCU)
- Online Readout Chain
- Framework & Software Architecture
- Integration with Conditions DB and Detector Control System
- Operational Experience

CMS/ECAL at LHC



- 36 Supermodules, 1700 Crystal each
- 4 Endcap Dees, 3662 Crystals each
- 8 meters long
- 90 Tons of Crystal
- More than 75000 channels





ECAL Requirements

$$\left(\frac{\sigma}{E}\right)^2 = \left(\frac{3.37\%}{\sqrt{E}}\right)^2 + \left(\frac{0.107}{E}\right)^2 + \left(0.25\%\right)^2$$

Stochastic — Noise — Constant

ECAL response sensitive to variations of:

- **Crystal transparency (irradiation)**
- **Temperature: $\partial(LY)/\partial T \sim -2\%/^{o}K$**
  $1/M(\partial M/\partial T) \sim -2\%/^{o}K$
- **High voltage: $1/M(\partial M/\partial V) \sim 3\%/V$**

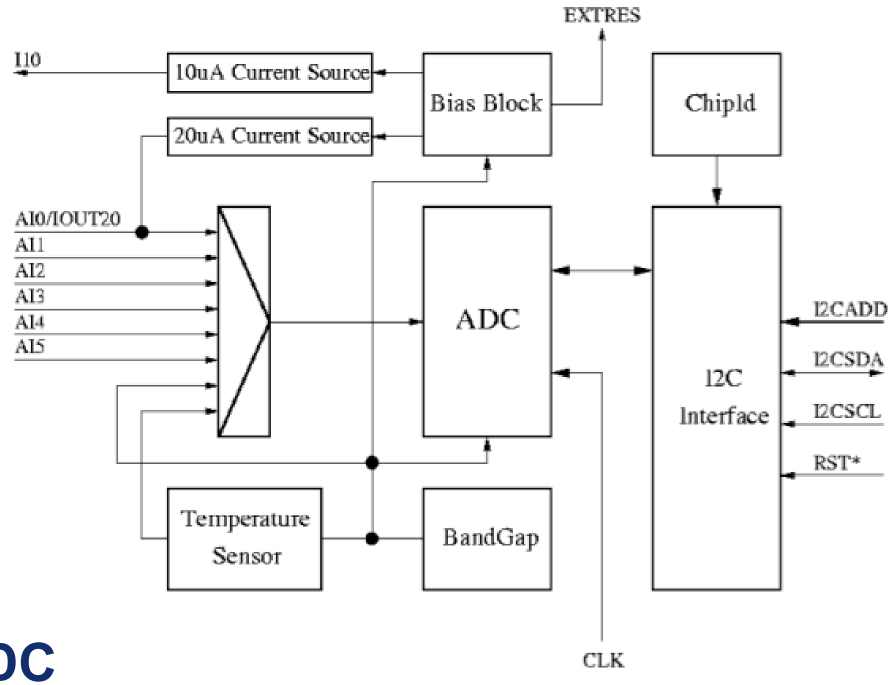
M= Photodetector gain
LY= Light Yeld

affect the resolution constant term

Temperature stability @ $0.1^{o}C$ level
HV stability at the 10 mV level

Detector Control Unit (DCU)

special ASIC used to monitor Front End electronics parameters:
- Currents
- Temperatures
- Voltages



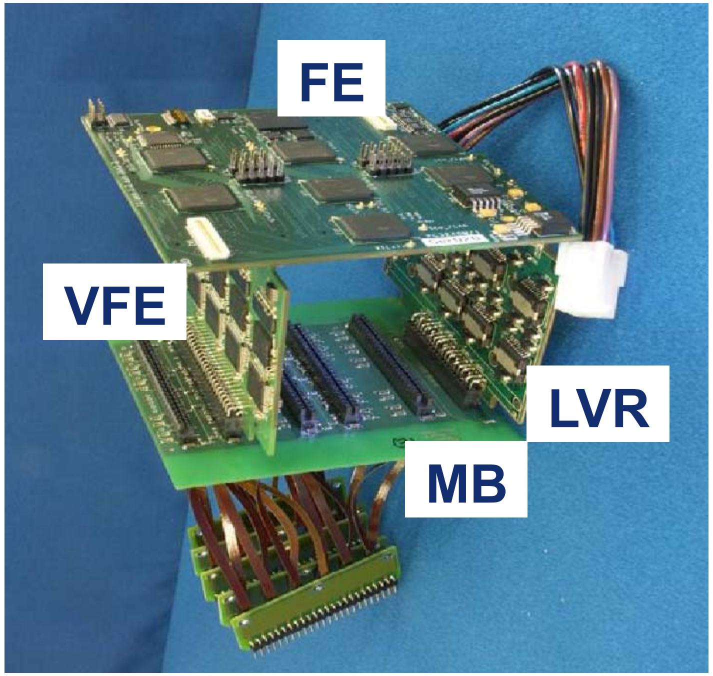
Quantities measured with 12 bit ADC
Sensitivity:

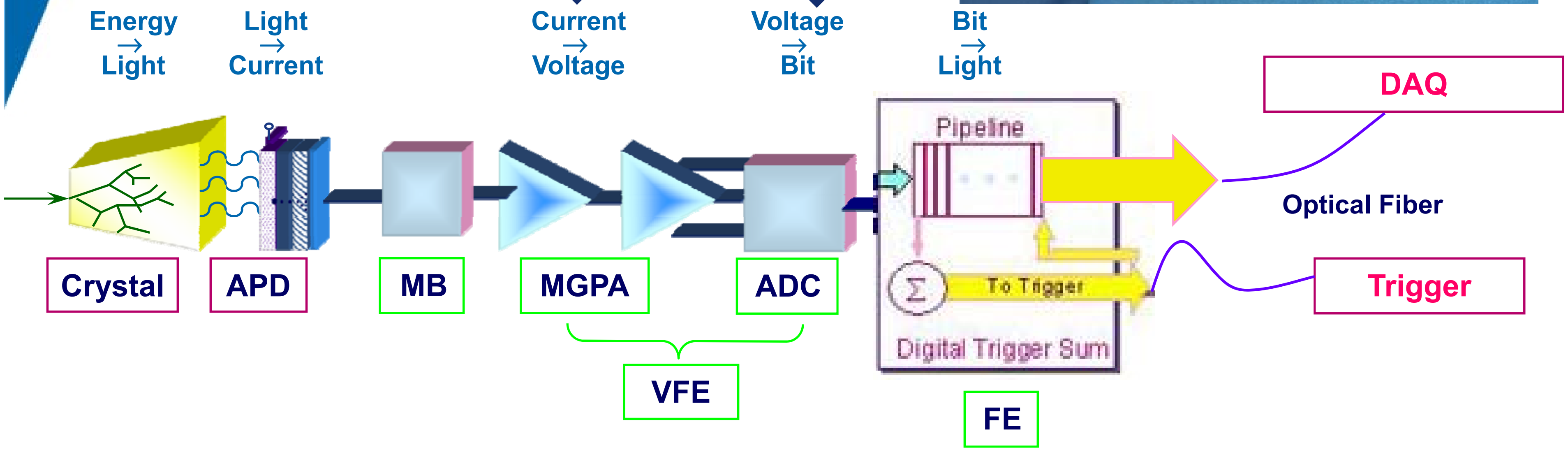
Temperature	0.012 °C
Currents	340 nA
Voltages	~ mV

Data retrieved via standard I2C protocol

On Detector electronics

1 DCU every VFE card
Basic Read-out Geometry:
5X5 crystals (TT)
8 DCUs per TT ~ 20000



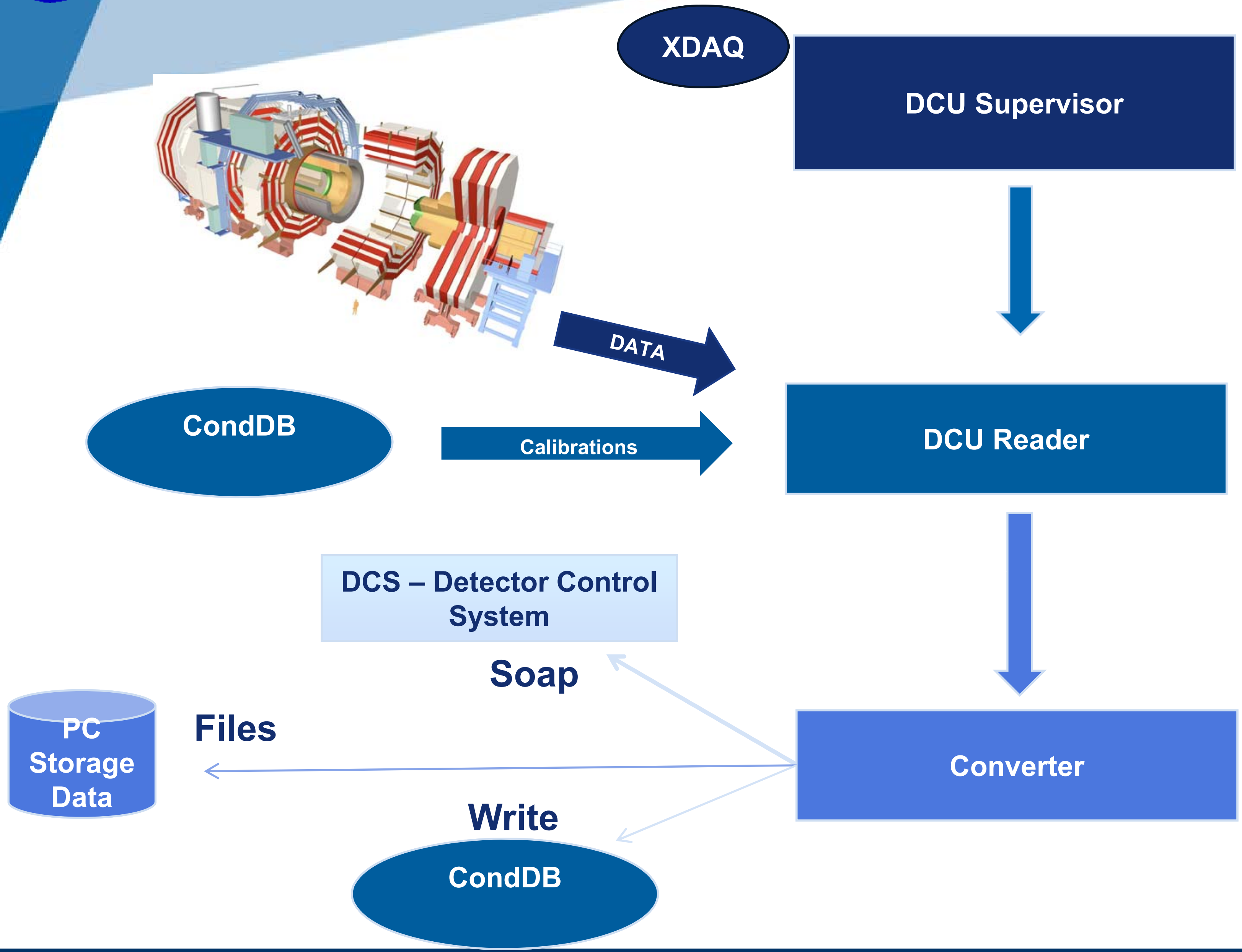


XDAQ

- CMS online software framework in which all the online applications are implemented (C++):
- Used for configuration, messaging, event handling
- Extensive use of XML
- Scalable: from small test stand to the CMS DAQ

- XDAQ user application is a collection of
  call-back functions, typically attached with FSM transitions
- SOAP messages drive application's call-back

DCU Software Architecture

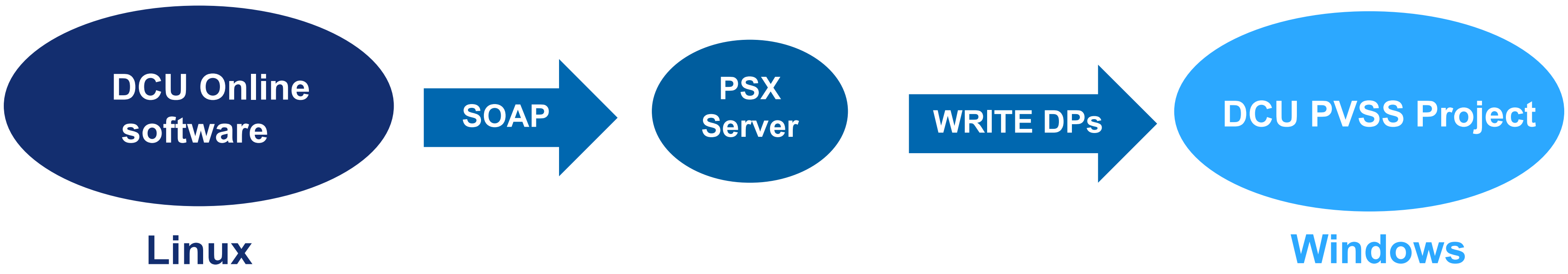


DCU to DCS (Detector Control System)

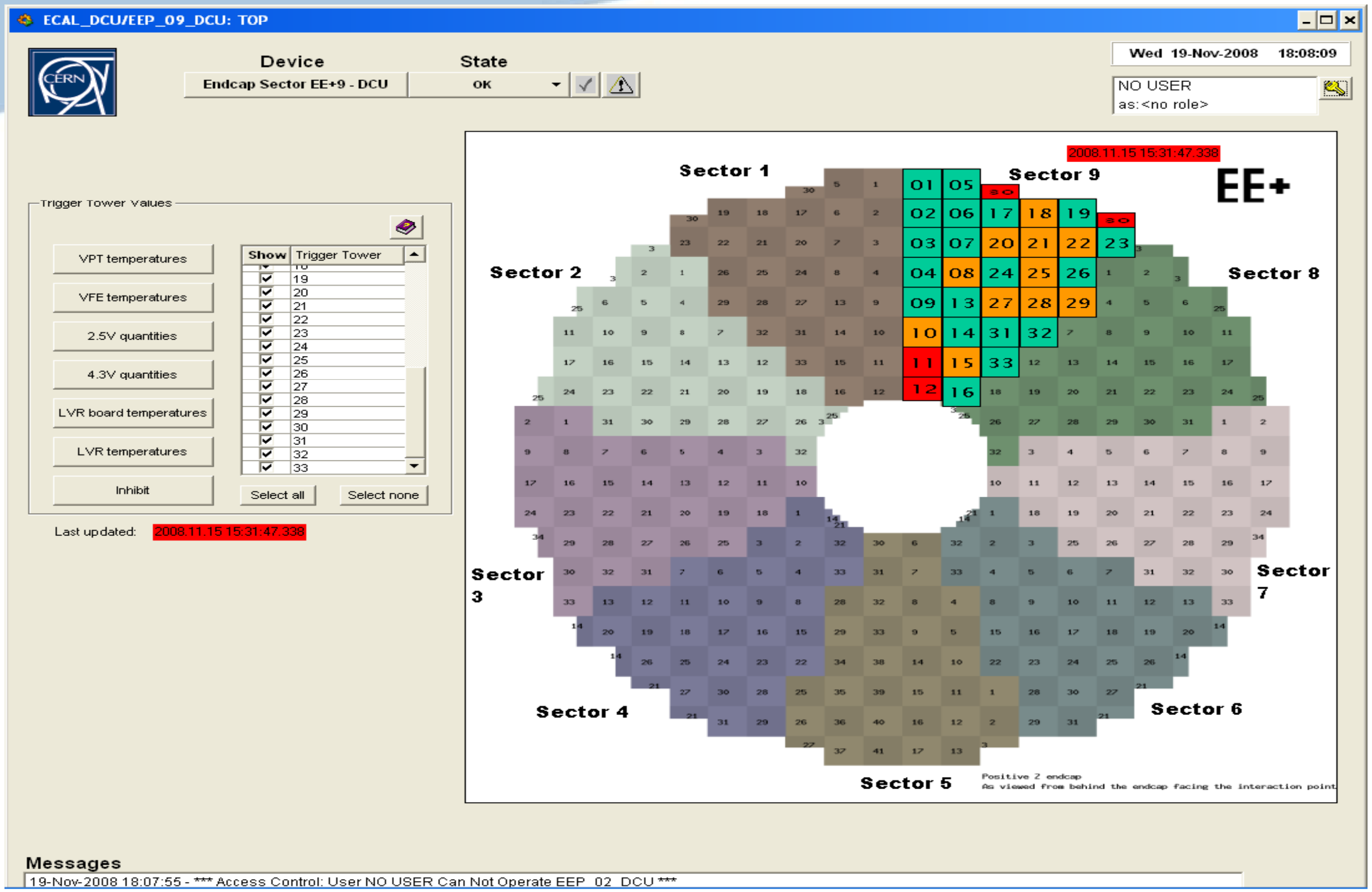
DCUSupervisor performs the read-out, builds the PVSS datapoints and sends them to DCS using the PSX interface

➢**DCS provides:**
•**early detection of abnormal conditions (issuing appropriate warnings and alarms)**
•**hard-wired interlocks**

All ECAL DCS applications have been developed using the commercial ETM SCADA (Supervisory Control And Data Acquisition) software PVSS 3.6 and standard Joint Control Project (JCOP) framework components



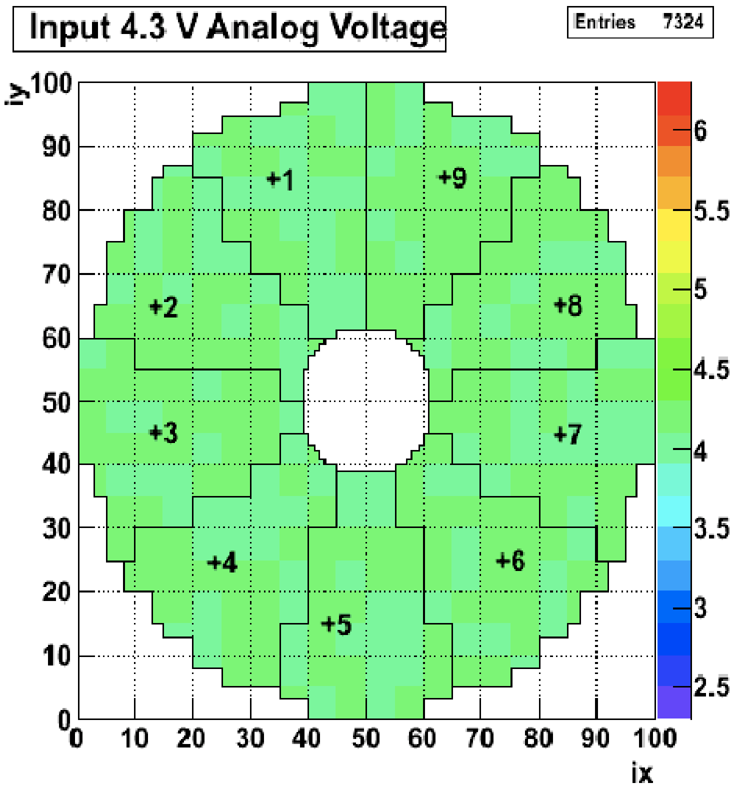
PVSS DCU Project

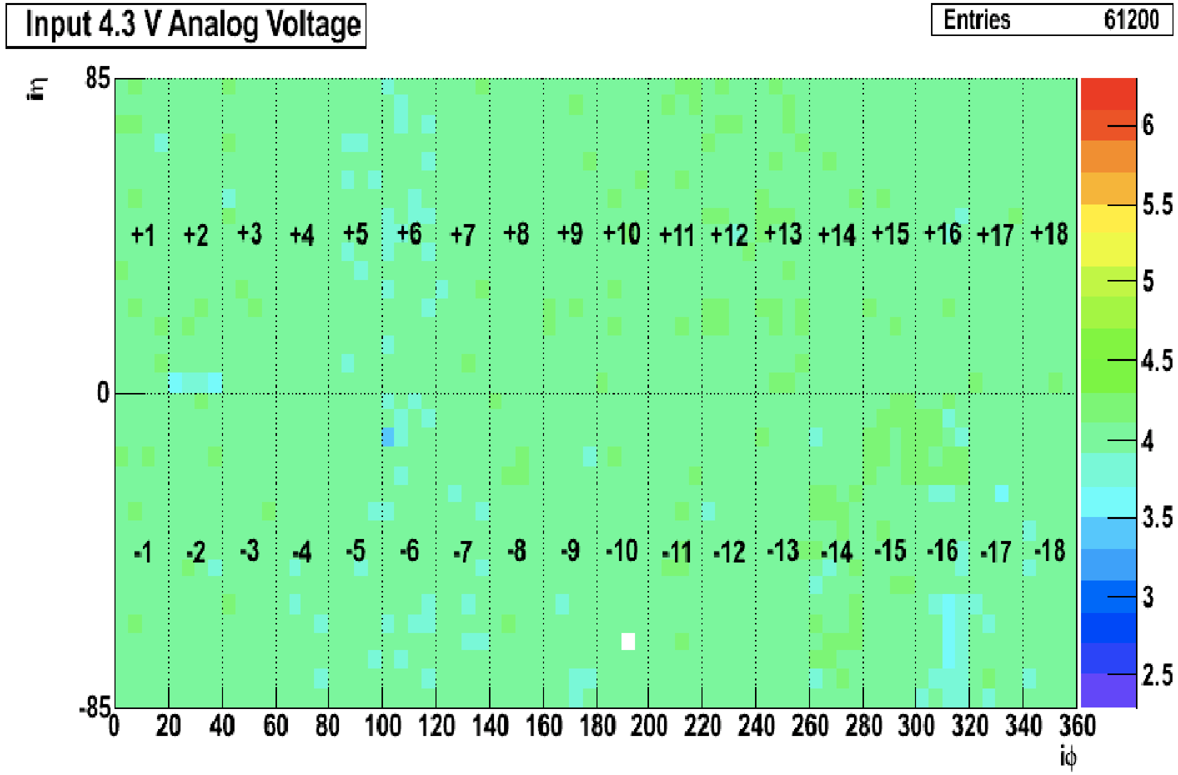


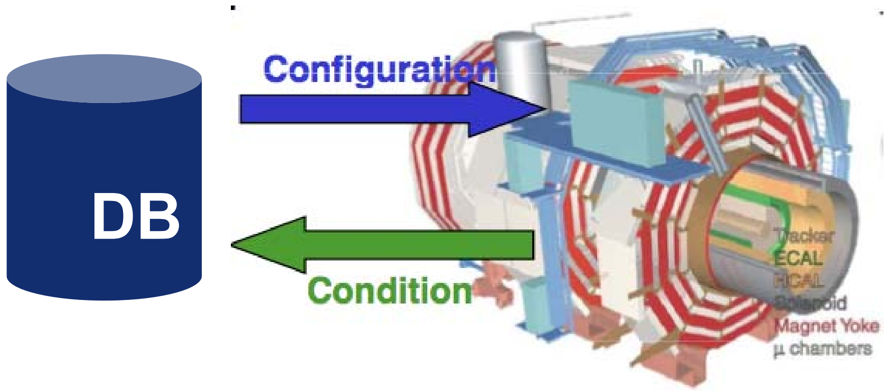
DCU final readout sequence foresees to send DCU data:

Changing values ~ 5 min
Whole ECAL ~ 20 min

Conditions Database



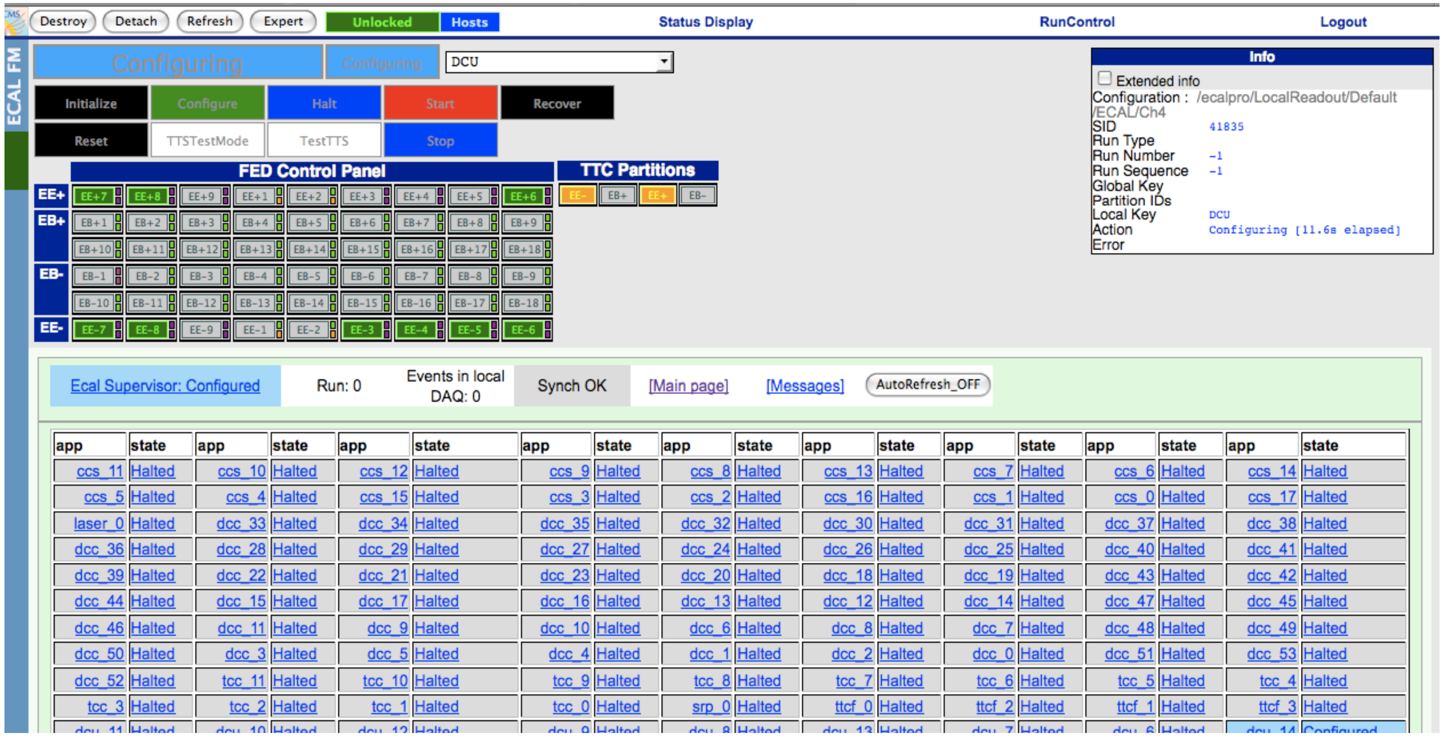




- The entire amount of data has been stored into the DB (so far)
- Data easily browsable through WEB

ECAL Run Control Web Interface

DCU runs are currently taken using the ECAL Run Control whenever needed/possible



- **A tree of finite state machines controls the data taking operation of the experiment (Function Manager)**
- **It has been used successfully during the global run**

Operational Experience

- DCU measurements have been used for :

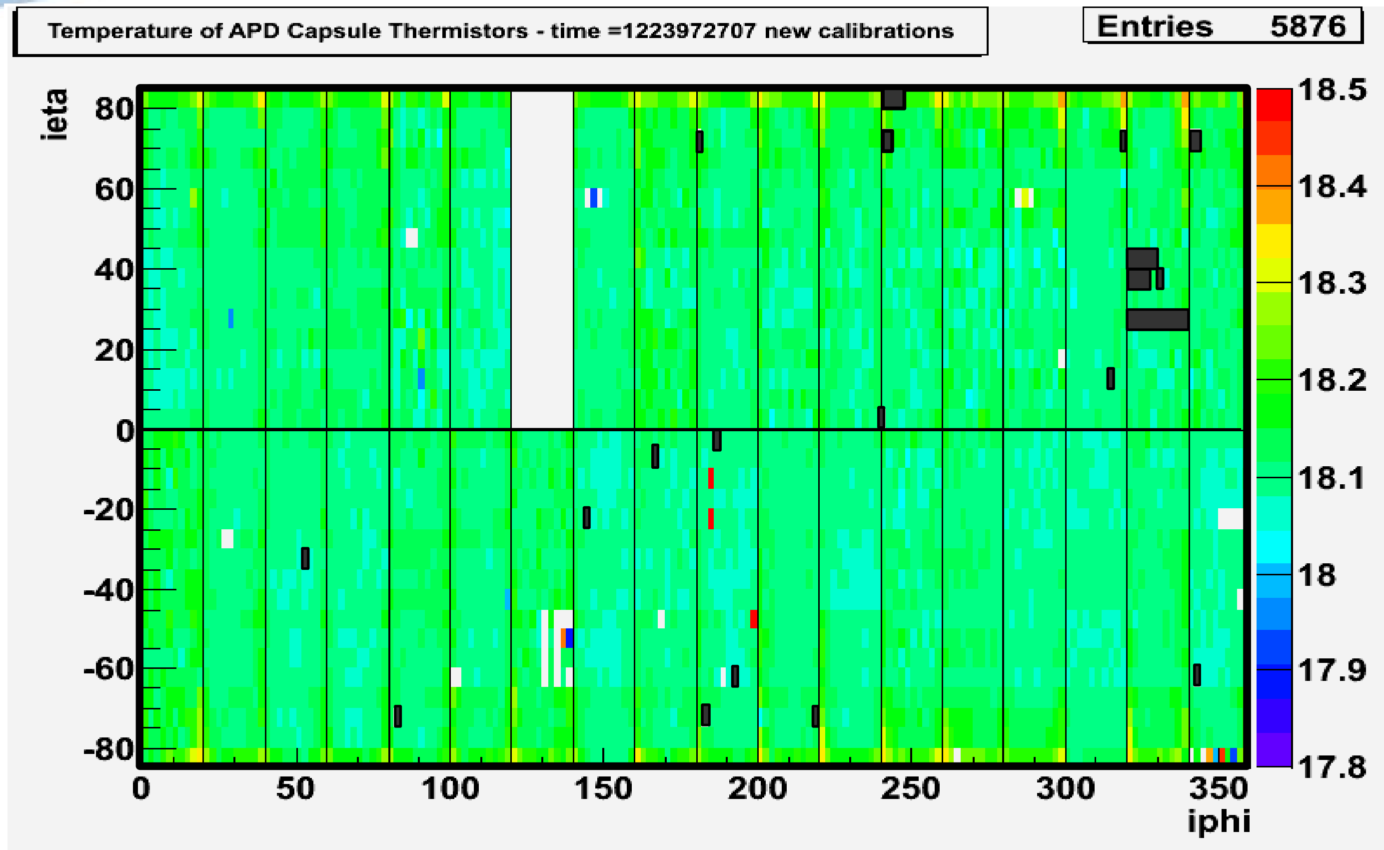
  - validating the detector thermal stability during operational periods

  - investigating sources of problems/dead channels

- More than 500 DCU runs during 2008 (150 runs in regular data taking)

- Foreseen to have DCU read-out automatically (daemon) in order to keep the detector monitored

Results(1):Barrel Temperatures



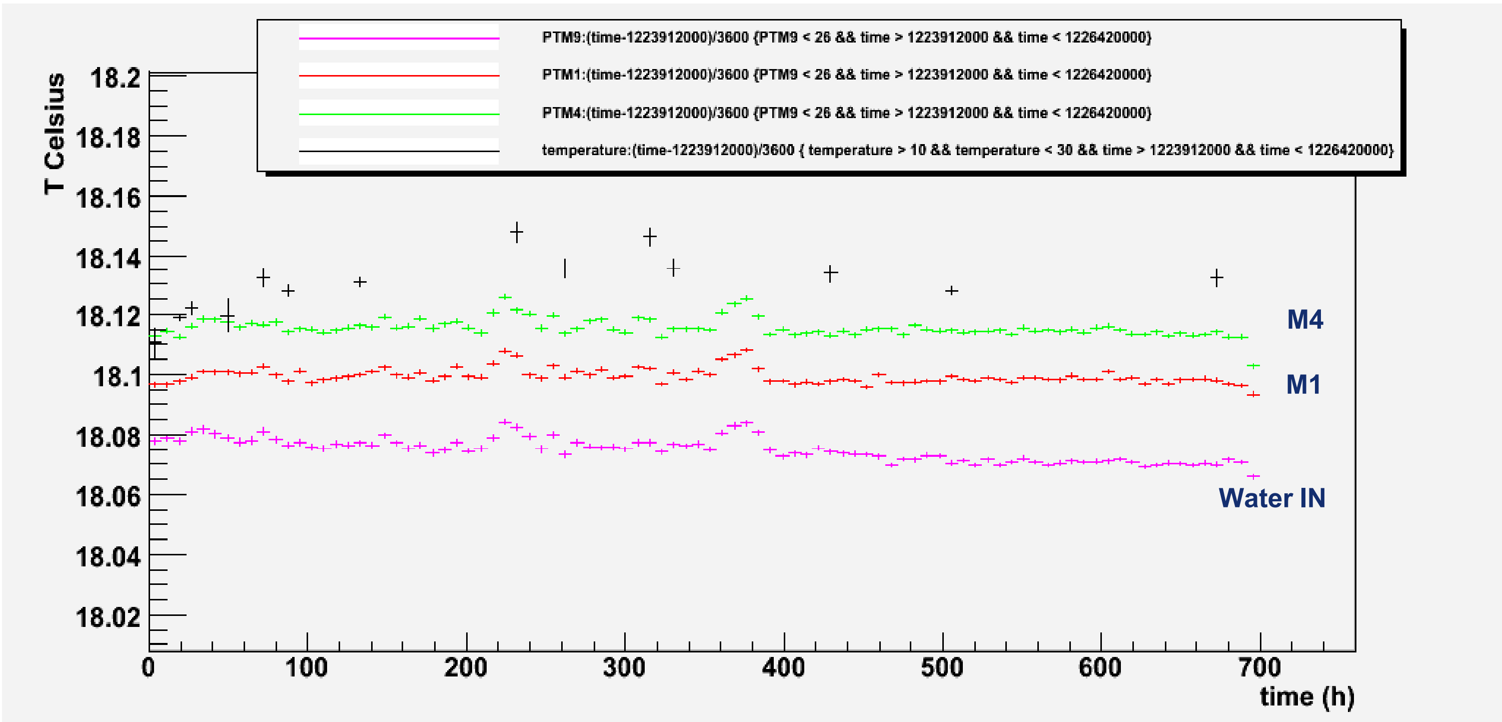
These data refer to a 4 weeks periods of global run

•41 Missing measurements (32 recoverable) – Black Spots

•33 Thermistors out of range (under investigation): White spots

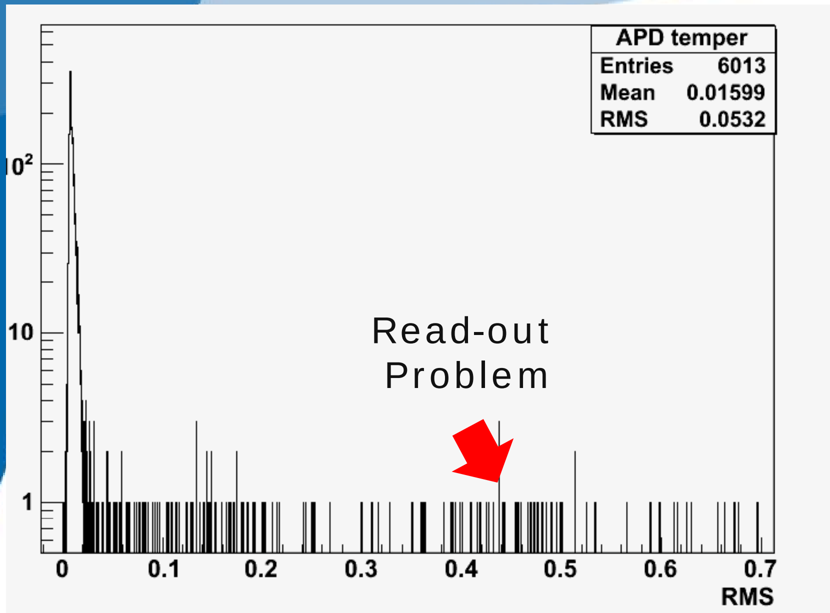
Results(2):Temperature

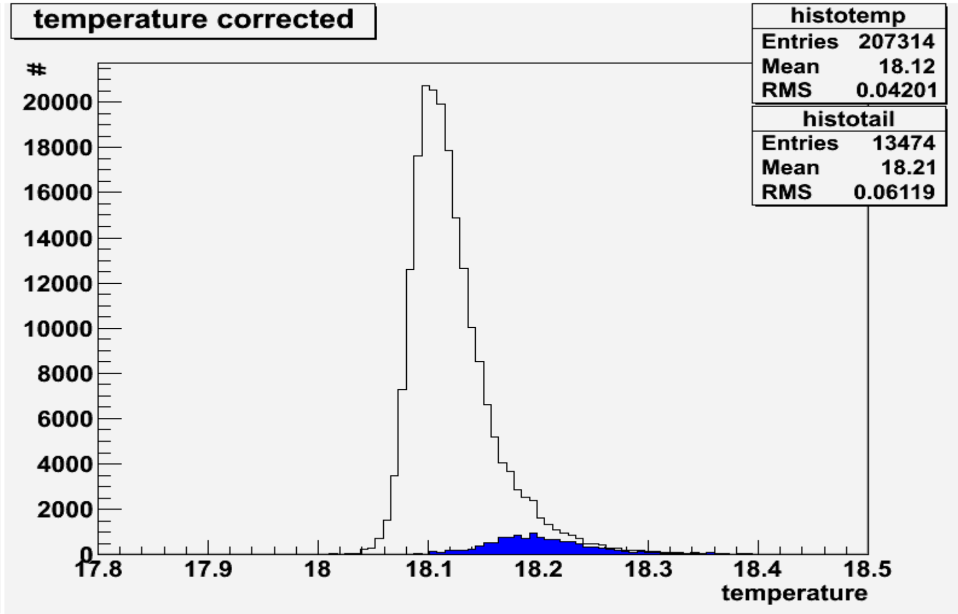
DCU measurements (in black) compared with an independent temperature measurement provided by a set of devices called PTM (Precision Temperature Monitoring)



PTM and DCU well correlated

Results(3):Temperature





Good temperature stability in time:
- **Mean fluctuation is ~0.016 °C**
- **Tail due to data misreading**

Good temperature homogeneity:
- **RMS ~ 0.04 °C**
- **Blue area corresponds to sensors close to the highest density of LV cables**

ECAL=(18.12±0.04) °C
PTM=(18.10±0.02) °C

Conclusions

- ✓ DCU read-out commissioned both for ECAL Barrel and Endcaps
- ✓ DCU integration in XDAQ framework has been successfully done
- ✓ Data communication with CondDB and PVSS achieved
- ✓ Validation of detector thermal stability and bad channels investigation have been carried out

DCU will help to ensure monitoring of the calorimeter during the LHC run

Spares

What is monitored in detail

✓**APD:**

currents (1 DCU for xtal = 1700/SM)

t3mperatures (1 DCU every 10 xtals = 170 values/SM):

✓**VFE & LVR:**

DCU internal temperatures (8x68 values /SM)

✓**MEM box:**

VDD_1, VDD_2, 2.5 V, Vinj (4X2 values / SM)

DCU internal temperatures (1x2 values /SM)

✓**LVR:**

3 thermistors

2.5 V (12x68 values / SM)

4.3 V (2X68 values / SM)

0.1 V – inhibit (1X68 values /SM)