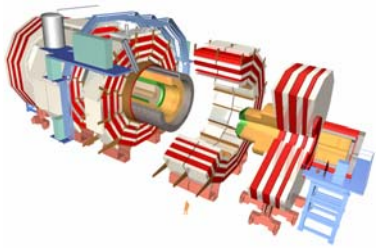


Data Quality Monitoring for the CMS Electromagnetic Calorimeter

Giuseppe Della Ricca

Università di Trieste & INFN – Trieste, Italy

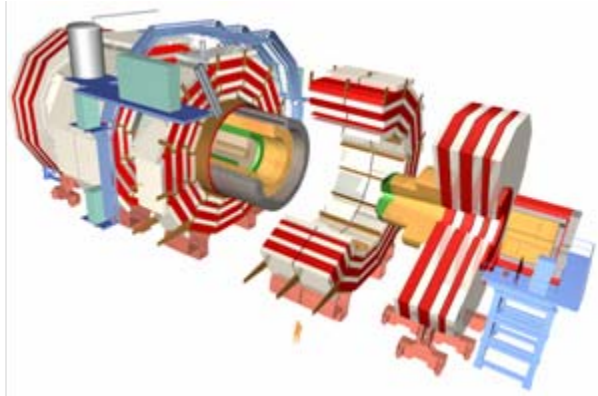
on behalf of the CMS Collaboration - ECAL Group

10th Topical Seminar on

Innovative Particle and Radiation Detectors

1-5 October 2006, Siena (Italy)

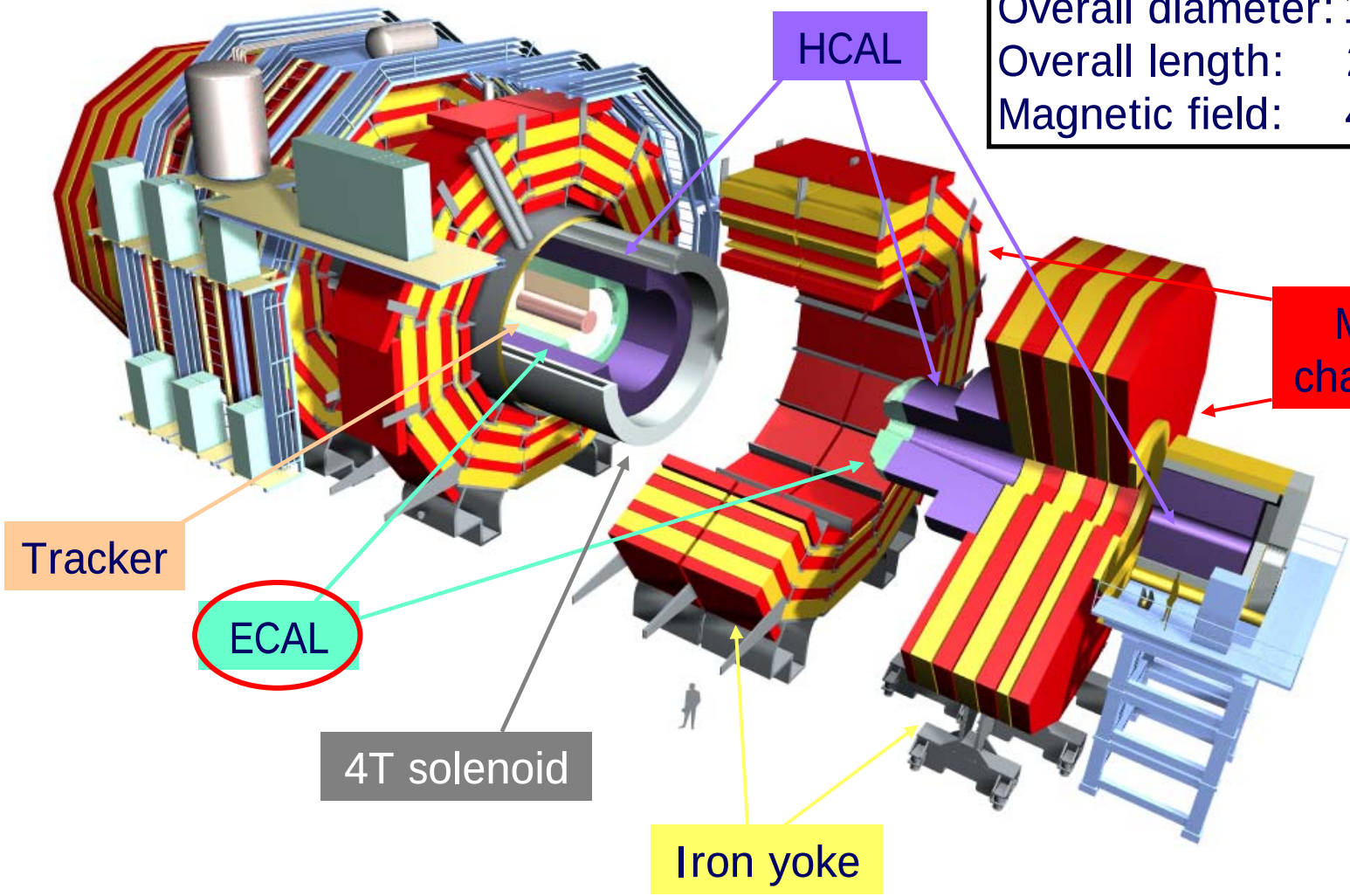
Overview



- the CMS ECAL detector
- the CMS Data Quality Monitor framework
- the ECAL Data Quality Monitor tasks
- future developments and conclusions

The Compact Muon Solenoid

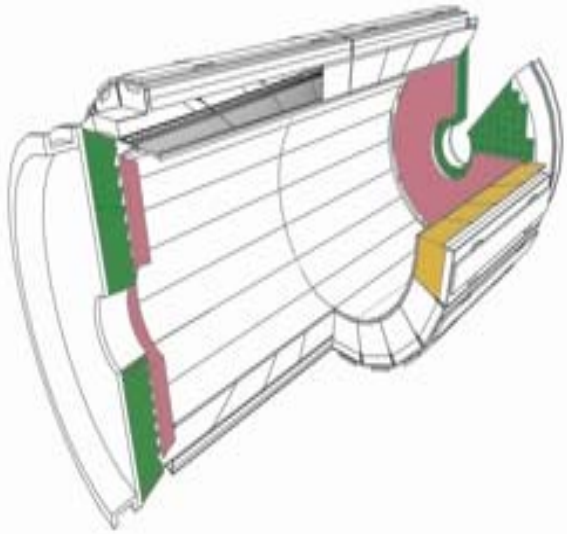
Total weight:	12,500 t
Overall diameter:	15 m
Overall length:	21.6 m
Magnetic field:	4 T



The ECAL Barrel Detector of CMS

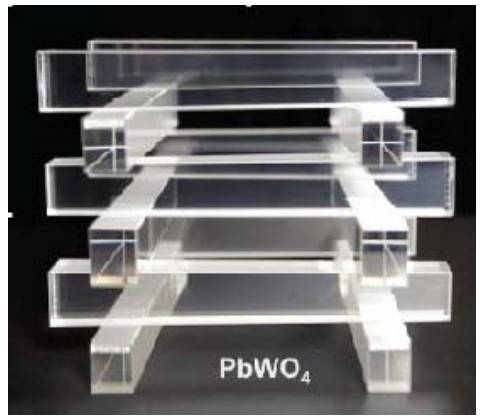
The CMS electromagnetic calorimeter (ECAL) is a compact detector designed to operate in a challenging environment:

- 4T magnetic field
- high radiation environment of 1-2 kGy/year
- at the LHC bunch crossing rate of 40 MHz.



The Barrel part of ECAL consists of 61,200 lead-tungstate ($PbWO_4$) crystals optically coupled to twice as many Avalanche Photo-Diodes (APD):

- short radiation length of 8.9 mm and small Moliere radius of 22 mm
- fast scintillator
- radiation-hard (do need monitoring of transparency)



Resolution design goal:

$$2.5\% / \sqrt{E} \oplus 0.55\% \oplus 0.2 / E$$

Calibrating and maintaining the calibration at this level will be very challenging → MONITORING

The CMS DQM

Filter Farm (High Level Trigger)

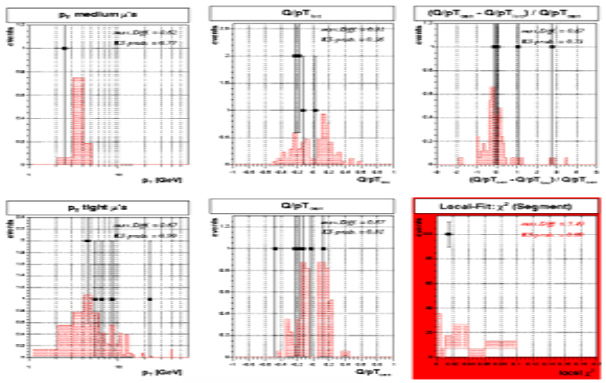
CPU CPU CPU CPU CPU CPU CPU CPU

Monitoring producers

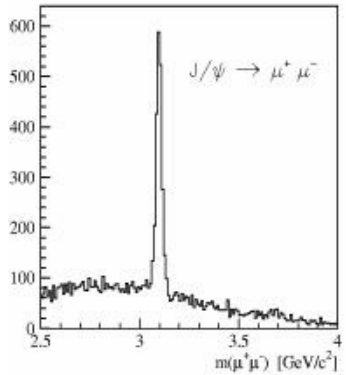
DQM infrastructure:
Collectors/Servers

DQM principle: use same code to serve different customers (DQM, analysis)

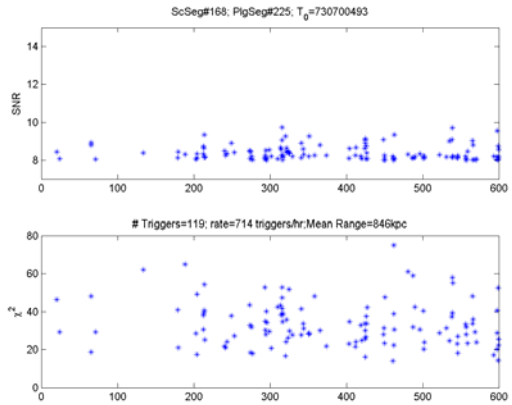
Inputs



Physics objects



Triggers etc...

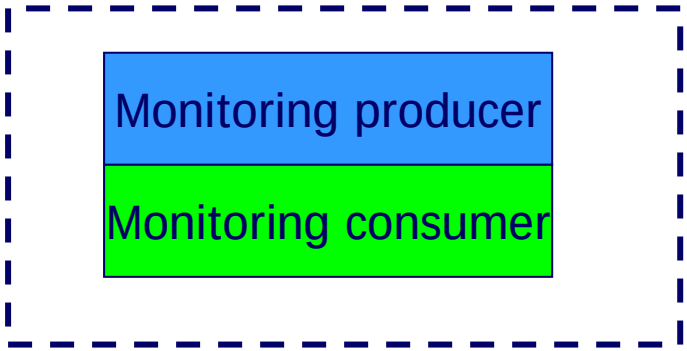




Monitoring consumers (clients)

The CMS DQM Architecture - 1

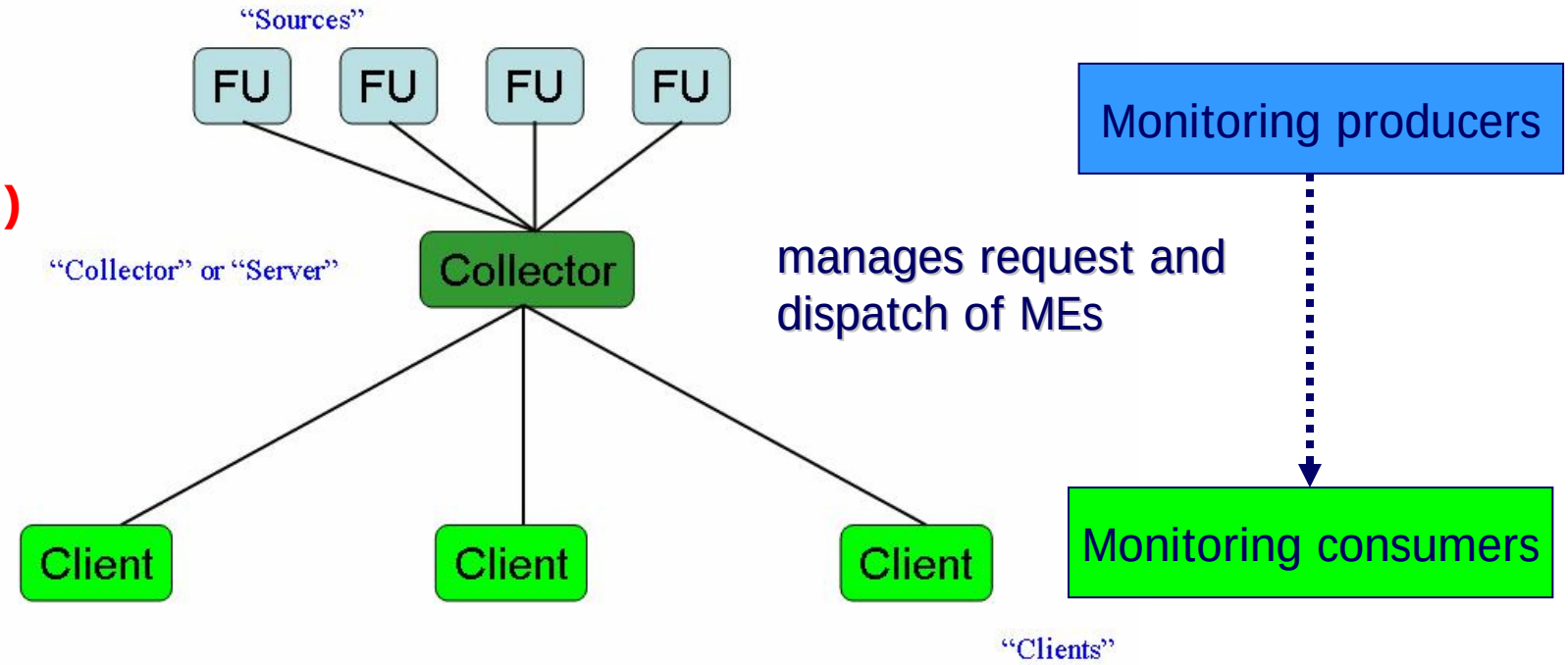
(1)



single program/node:

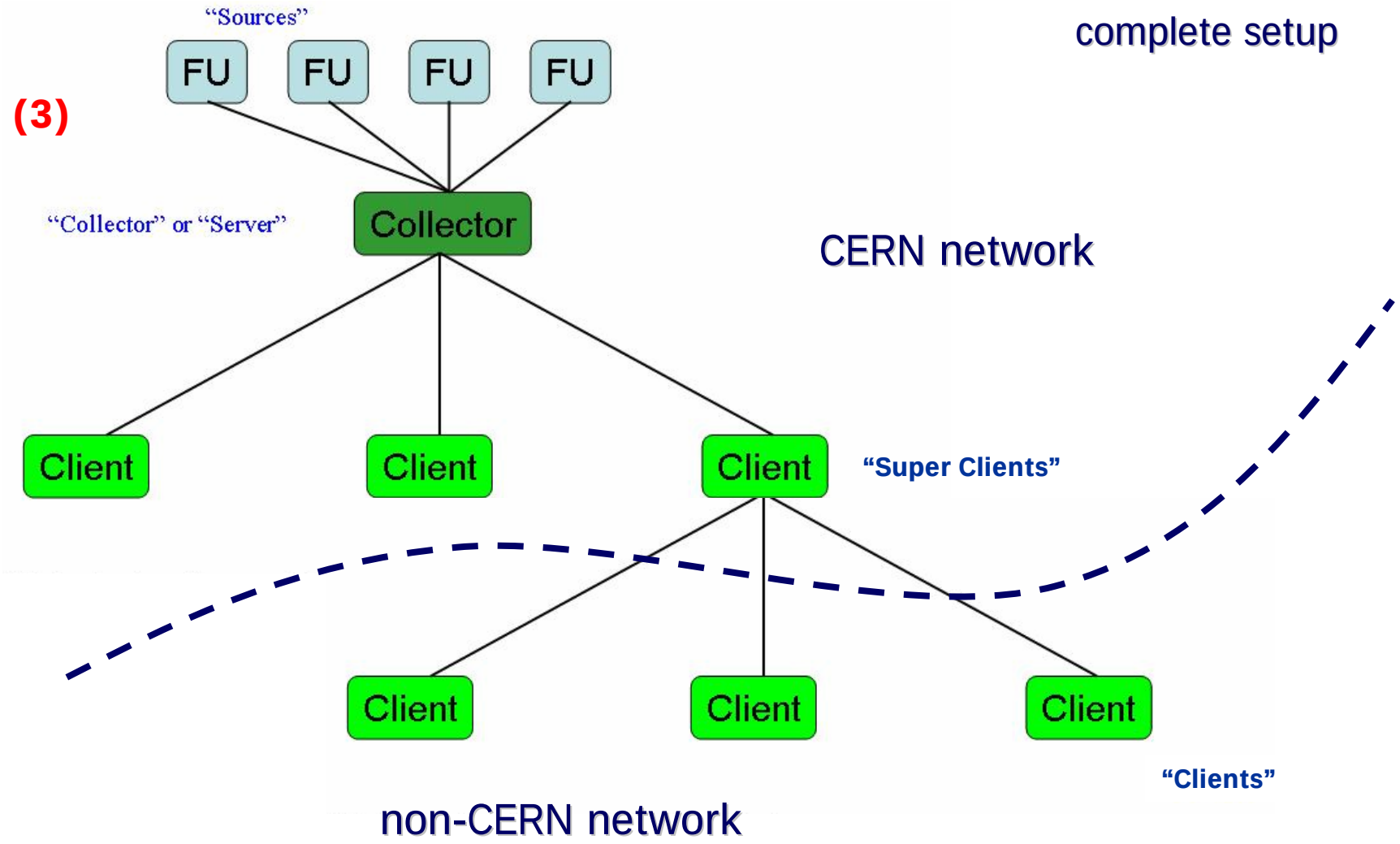
- defines and fills monitoring elements (MEs)
- subscribes and receives MEs and periodic updates

(2)



clear separation of production and processing of monitoring information

The CMS DQM Architecture - 2



CMS ECAL DQM use cases

ECAL Data Quality Monitoring is under development and continuous update/ upgrade/improvements since mid 2005, and is currently in use in several test-beams and integration sites:

1. at the ECAL cosmic test-beam site
2. at the ECAL test-beam site
3. at the ECAL-HCAL combined test-beam site
4. at the CMS DAQ integration test site

Low/High level ECAL DQM tasks

- most of the monitoring tasks give access to low level information:

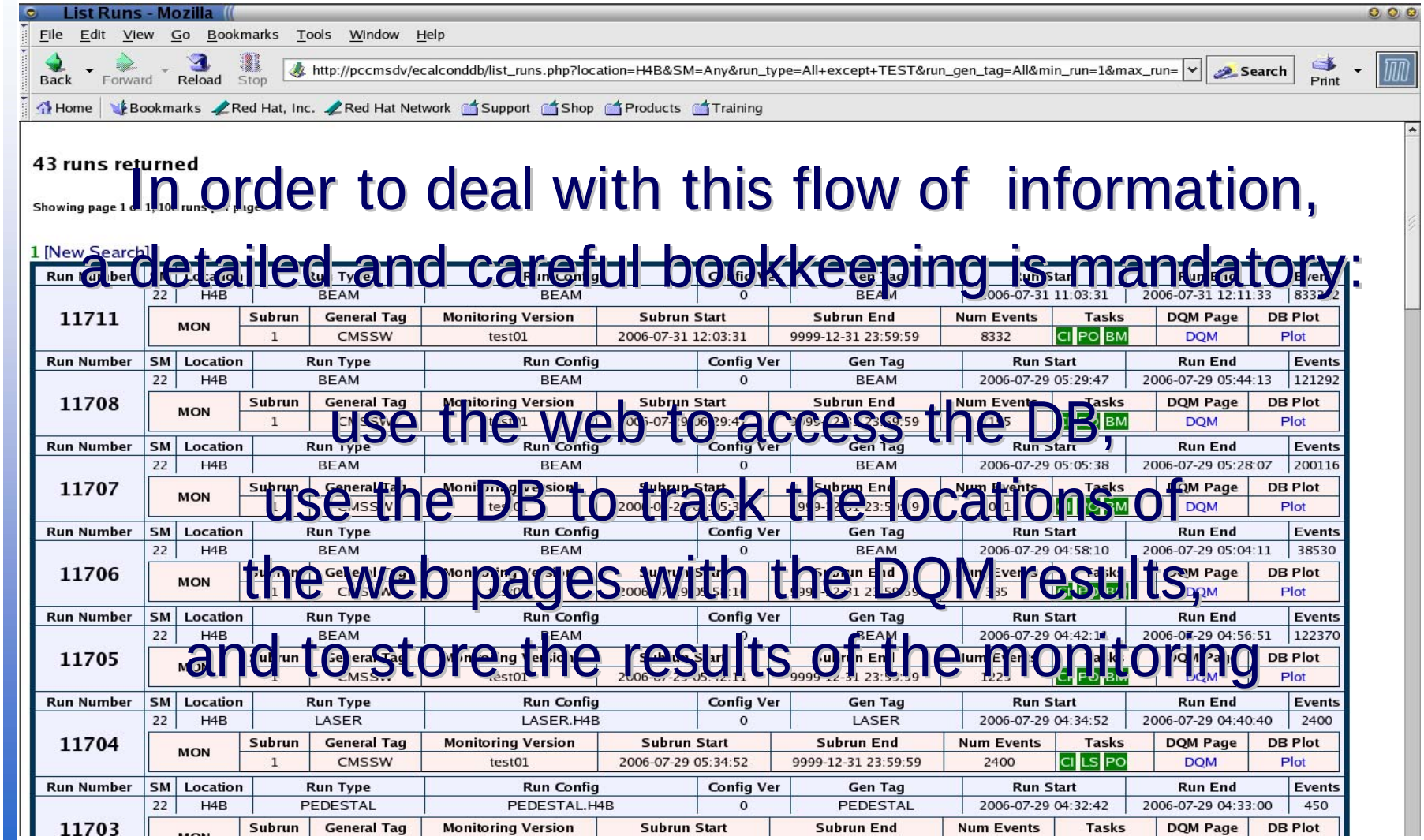
  1. data integrity
  2. pedestal mean/noise
  3. laser/testpulse amplitude & timing response
  4. trigger primitives activity

  basic diagnosis for noisy/dead channels comes first

- other monitoring tasks look at high level information ("physics"):

  – cosmic rays per crystal and energy spectrum distributions
  – electrons beam energy deposit (max E crystal, 3x3 crystal E matrix)
  – laser signal pulse shape
  – electrons beam profiles as measured by beam-line hodoscope
  – electrons energy deposit vs. beam position

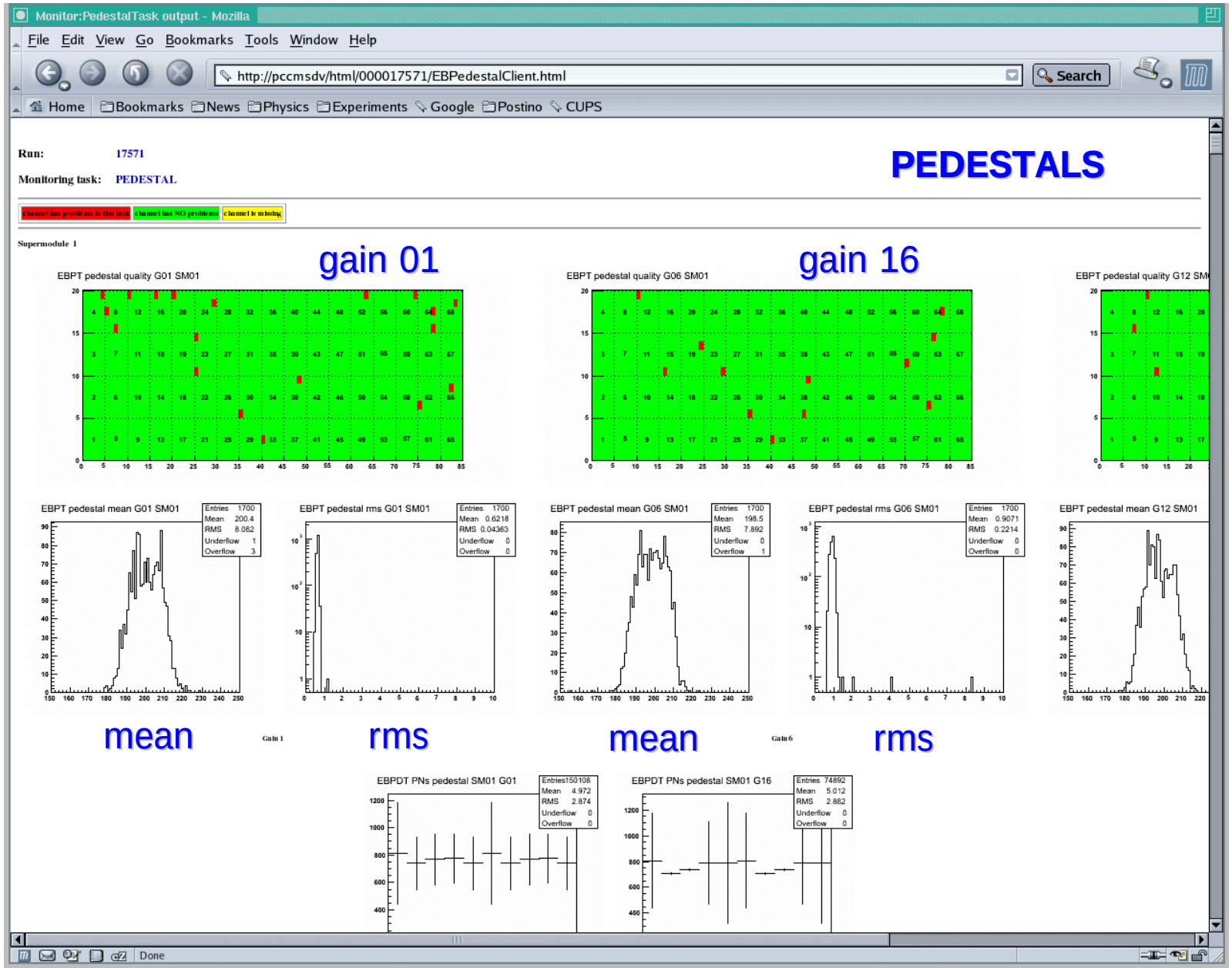
ECAL DQM-DB web interface



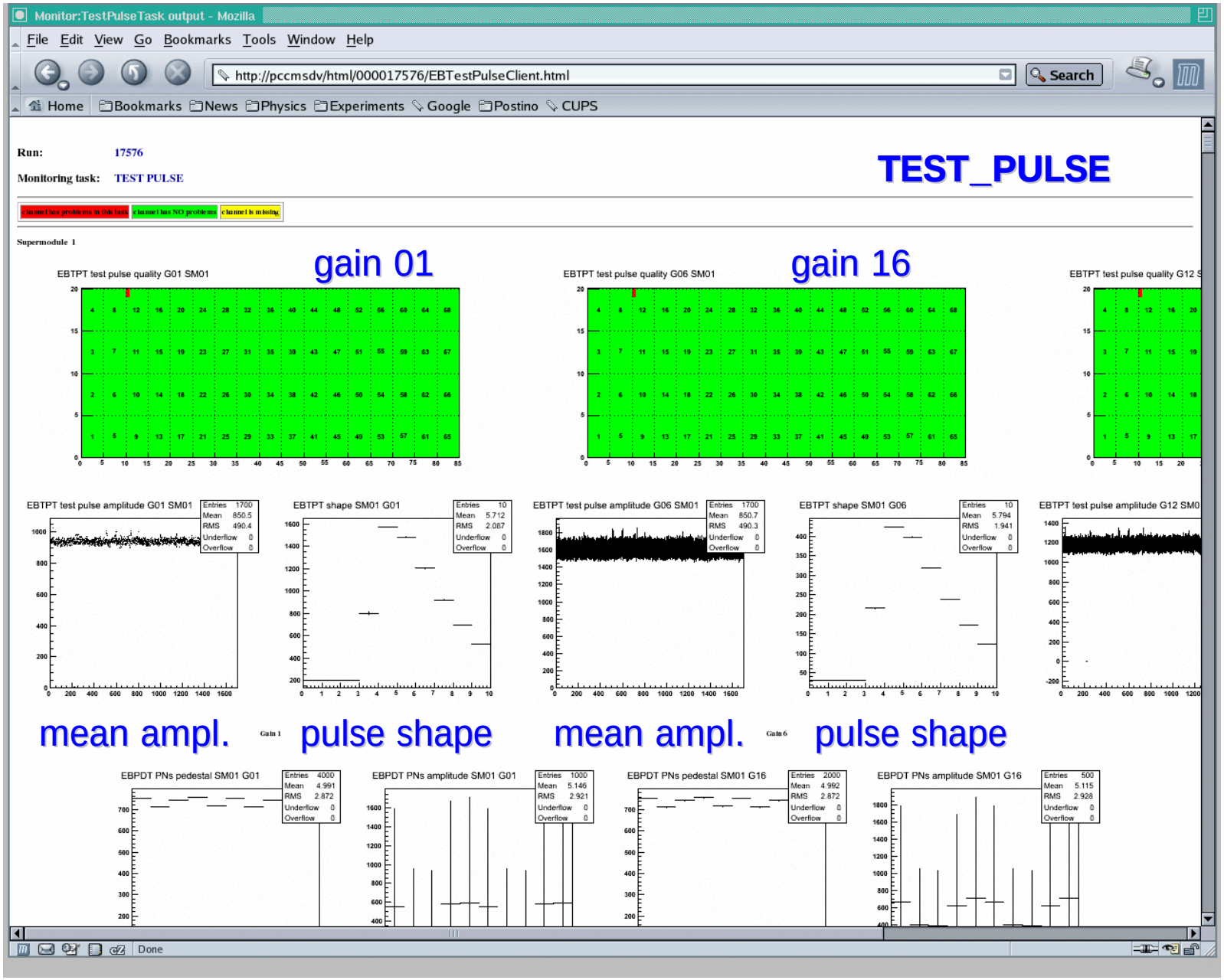
In order to deal with this flow of information, a detailed and careful bookkeeping is mandatory: use the web to access the DB, use the DB to track the locations of the web pages with the DQM results, and to store the results of the monitoring

CMS ECAL DQM
gallery of selected screenshots

ECAL DQM - web static pages



ECAL DQM - web static pages



ECAL DQM - web static pages

Monitor:CosmicTask output - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://pccmsdv/html/000017577/EBCosmicClient.html

Search

Home Bookmarks News Physics Experiments Google Postino CUPS

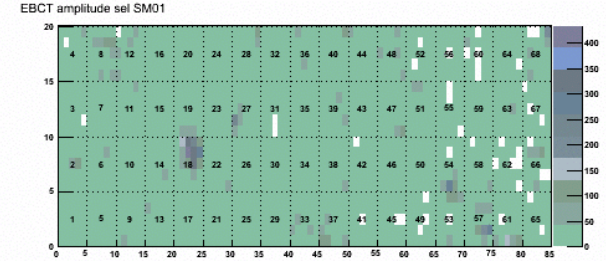
Run: 17577

Monitoring task: COSMIC

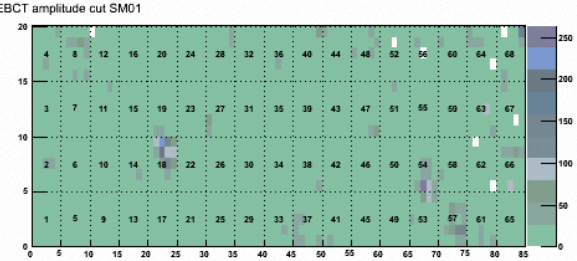
COSMICS

Supermodule 1

EBCT amplitude sel SM01

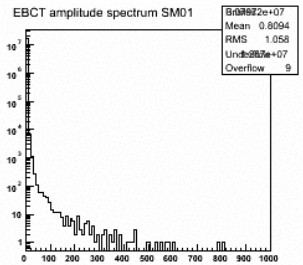


EBCT amplitude cut SM01



effect of cosmic rays
θ dependence

EBCT amplitude spectrum SM01

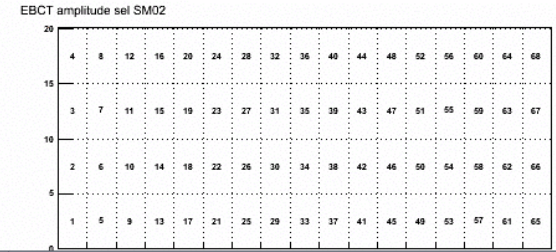


cosmic rays per crystal

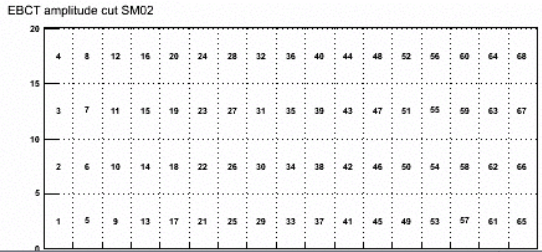
deposited energy spectrum

Supermodule 2

EBCT amplitude sel SM02

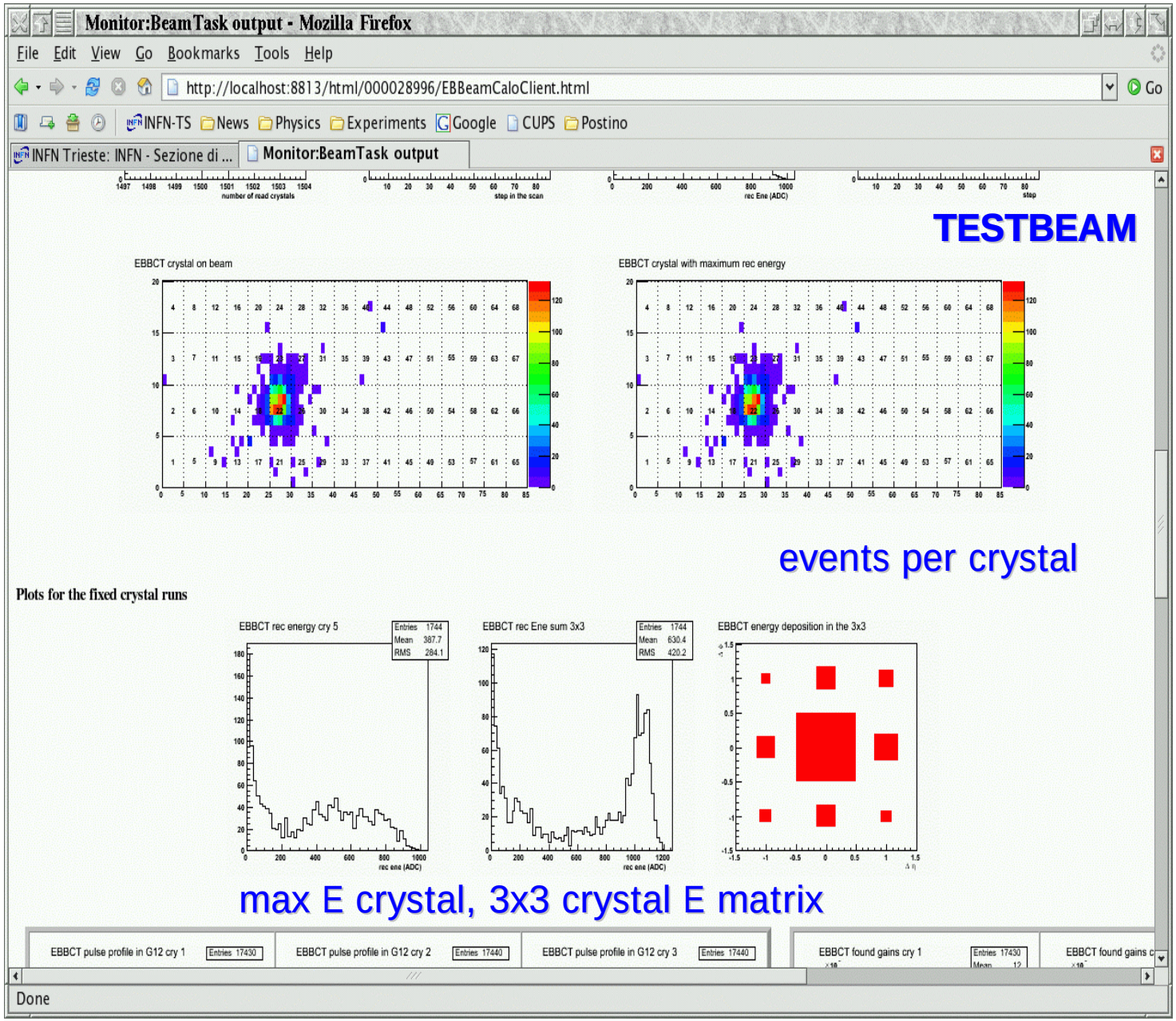


EBCT amplitude cut SM02



Done

ECAL DQM - web static pages



ECAL DQM - web static pages

file:///home/daq/shots_tmp/000011697/EBBeamHodoClient.html

Run: 11697

Monitoring task: BeamHodo

TESTBEAM

Hodoscope raw

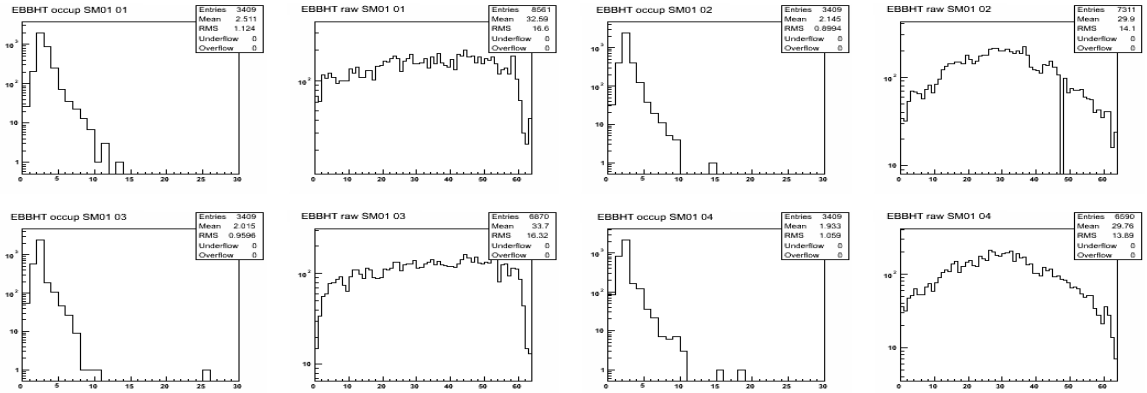
Hodoscope reco

Hodo-Calo

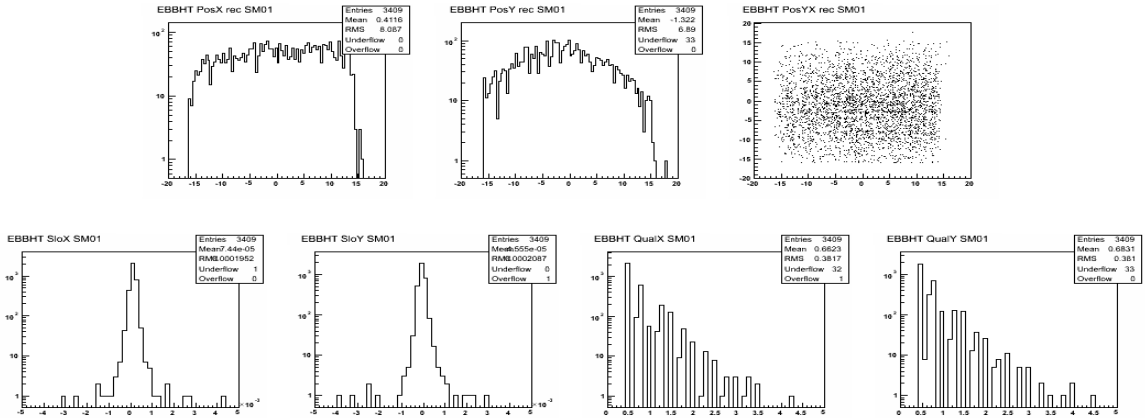
Energy vs position

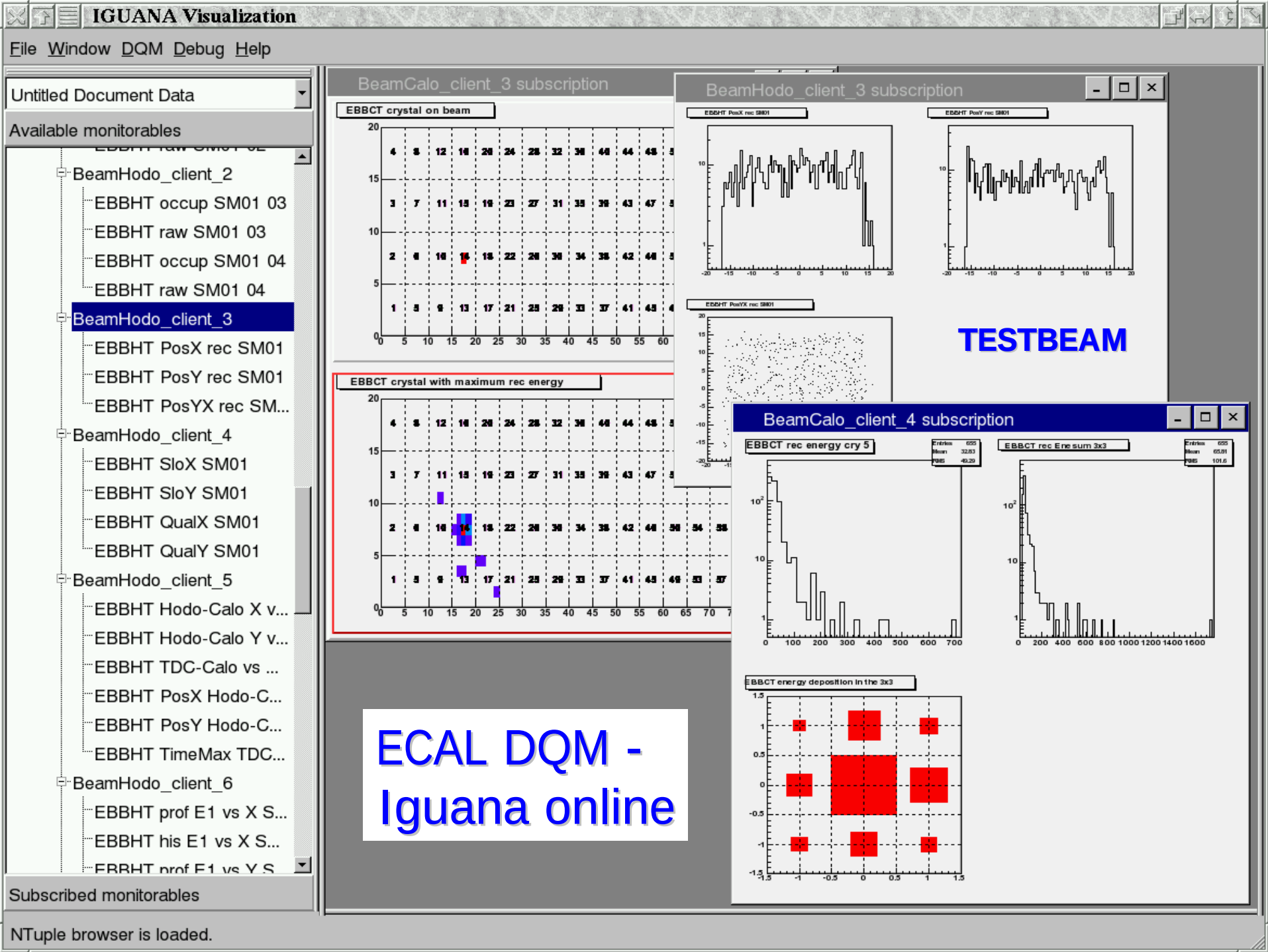
beam hodoscope
x-y profiles, timing, quality

Hodoscope raw plots



Hodoscope reco plots




IGUANA Visualization
File Window DQM Debug Help
Untitled Document Data
Available monitorables
BeamHodo_client_2
EBBHT occup SM01 03
EBBHT raw SM01 03
EBBHT occup SM01 04
EBBHT raw SM01 04
BeamHodo_client_3
EBBHT PosX rec SM01
EBBHT PosY rec SM01
EBBHT PosYX rec SM...
BeamHodo_client_4
EBBHT SloX SM01
EBBHT SloY SM01
EBBHT QualX SM01
EBBHT QualY SM01
BeamHodo_client_5
EBBHT Hodo-Calo X v...
EBBHT Hodo-Calo Y v...
EBBHT TDC-Calo vs ...
EBBHT PosX Hodo-C...
EBBHT PosY Hodo-C...
EBBHT TimeMax TDC...
BeamHodo_client_6
EBBHT prof E1 vs X S...
EBBHT his E1 vs X S...
Subscribed monitorables
NTuple browser is loaded.
BeamCalo_client_3 subscription
EBBCT crystal on beam
EBBCT crystal with maximum rec energy
BeamHodo_client_3 subscription
TESTBEAM
BeamCalo_client_4 subscription
EBBCT rec energy cry 5
EBBCT rec Ene sum 3x3
EBBCT energy deposition in the 3x3
ECAL DQM -
Iguana online

Conclusions

- the CMS ECAL DQM is in good shape for detector specific monitoring, under real-life stress-test conditions
- simple access to all high-level products used in analysis, thanks to the re-use of standard CMS framework/code
- ready to include more "physics" stuff
  - jet multiplicity, occupancy, size, energy flow

CMS-ECAL DQM Team

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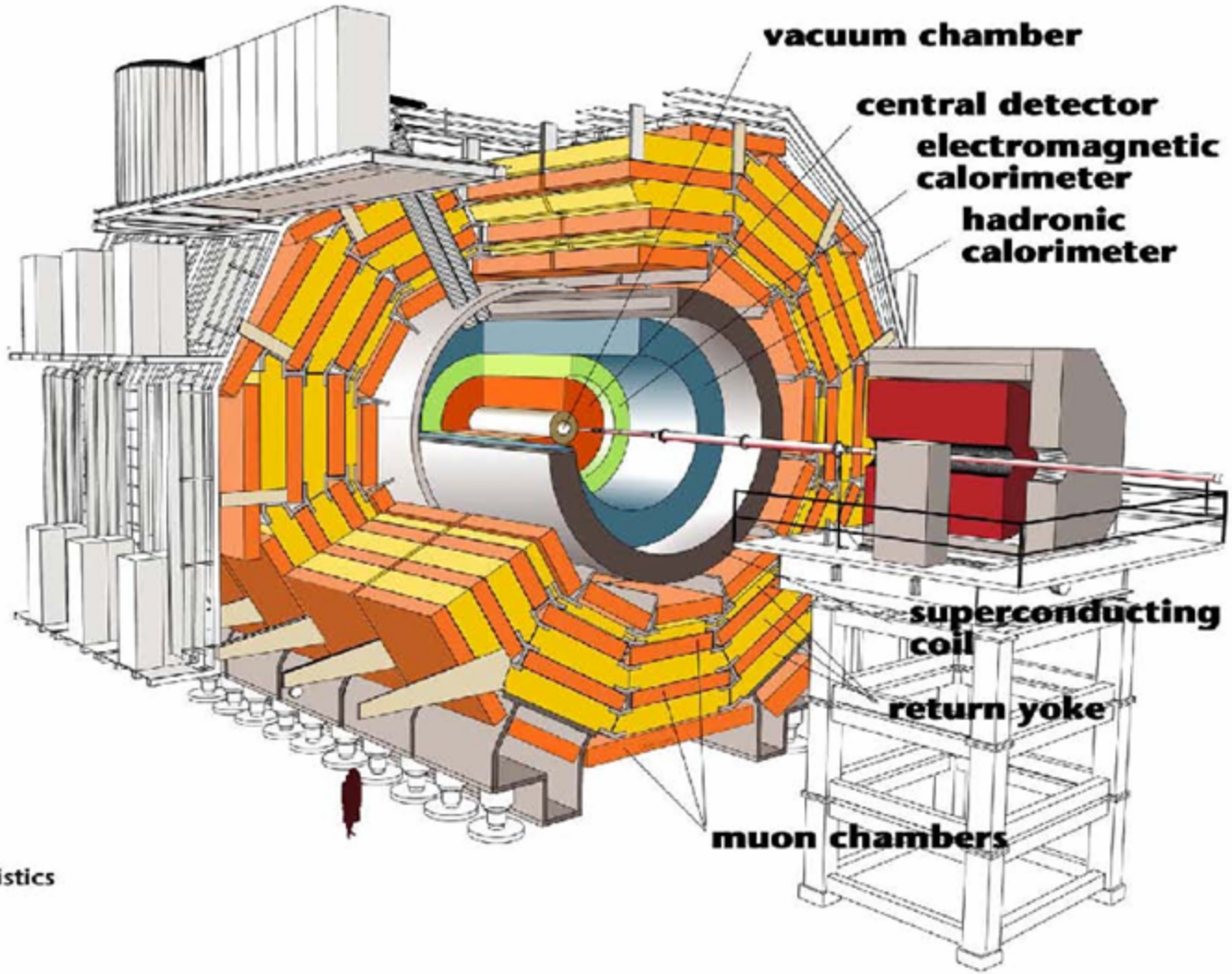
G. Franzoni (University of Minnesota)

A. Ghezzi (Università di Milano Bicocca & INFN-MiB & ETH Zurich)

B. Gobbo (INFN-Ts)

backup slides - begin

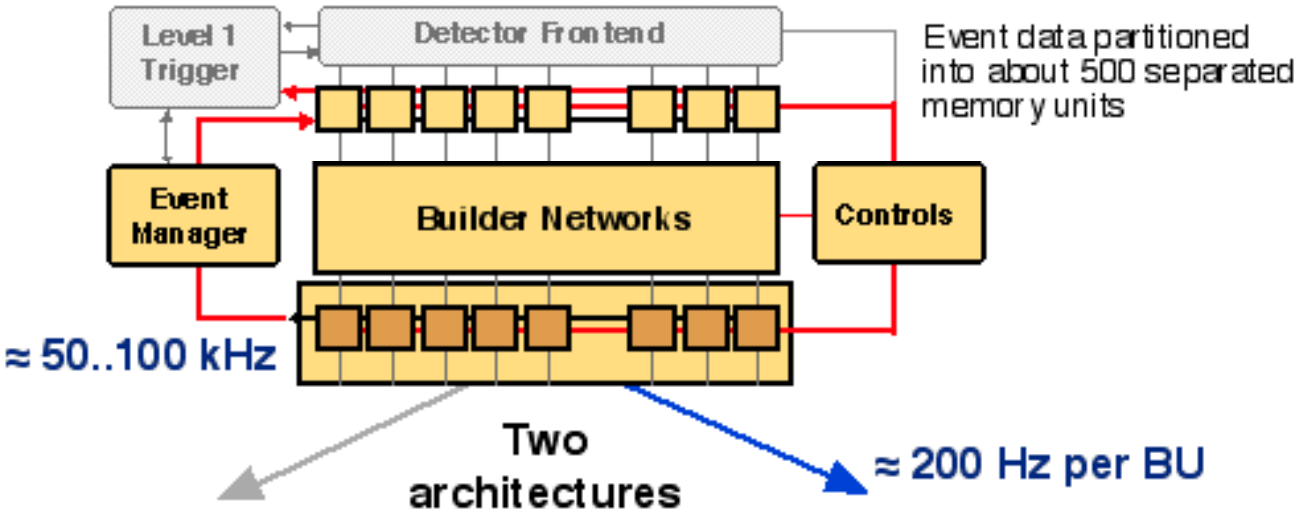
The Compact Muon Solenoid

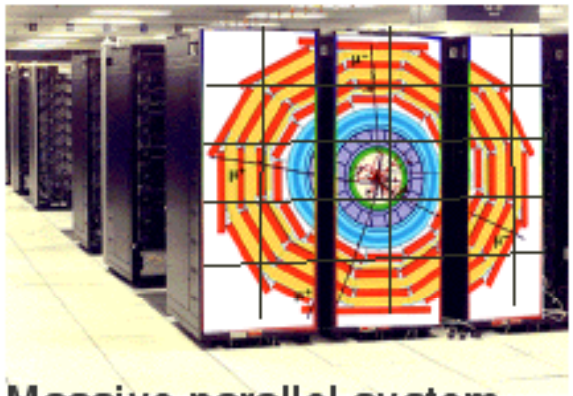


Detector characteristics

Width: 22m
Diameter: 15m
Weight: 14'500t

High Level Trigger: Event Filter Farm

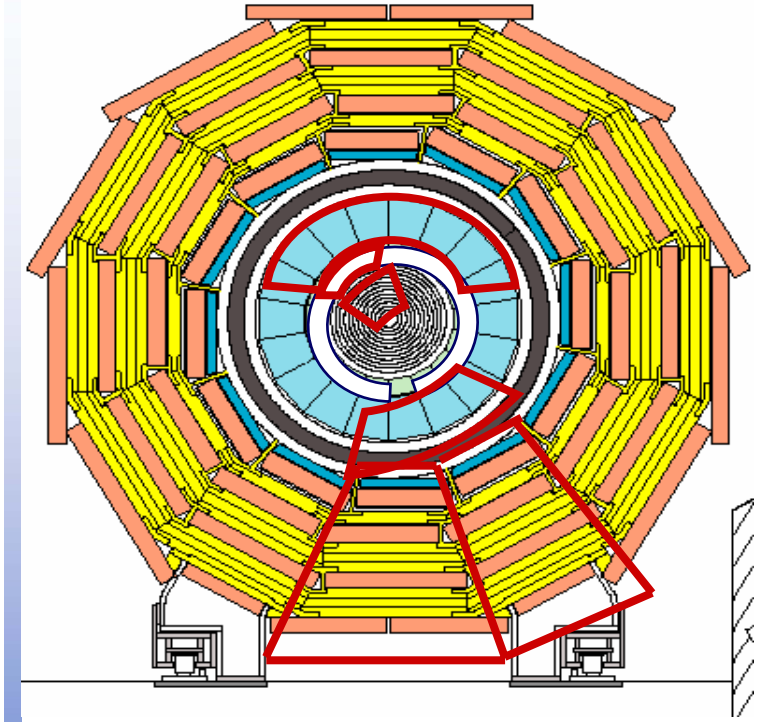


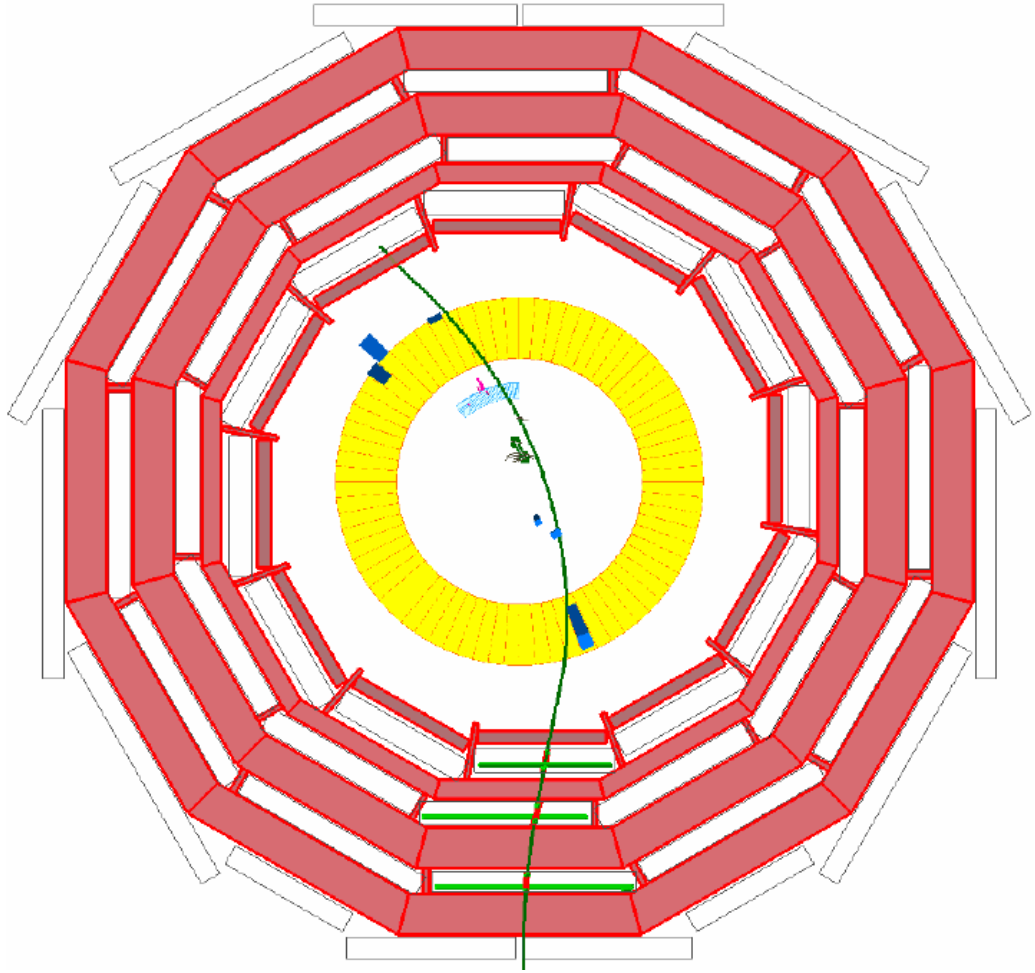


Massive parallel system
ONE event, ALL processors
- Low latency
- Complex I/O
- Parallel programming

Farm of processors
ONE event, ONE processor
- High latency (larger buffers)
- Simpler I/O
- Sequential programming

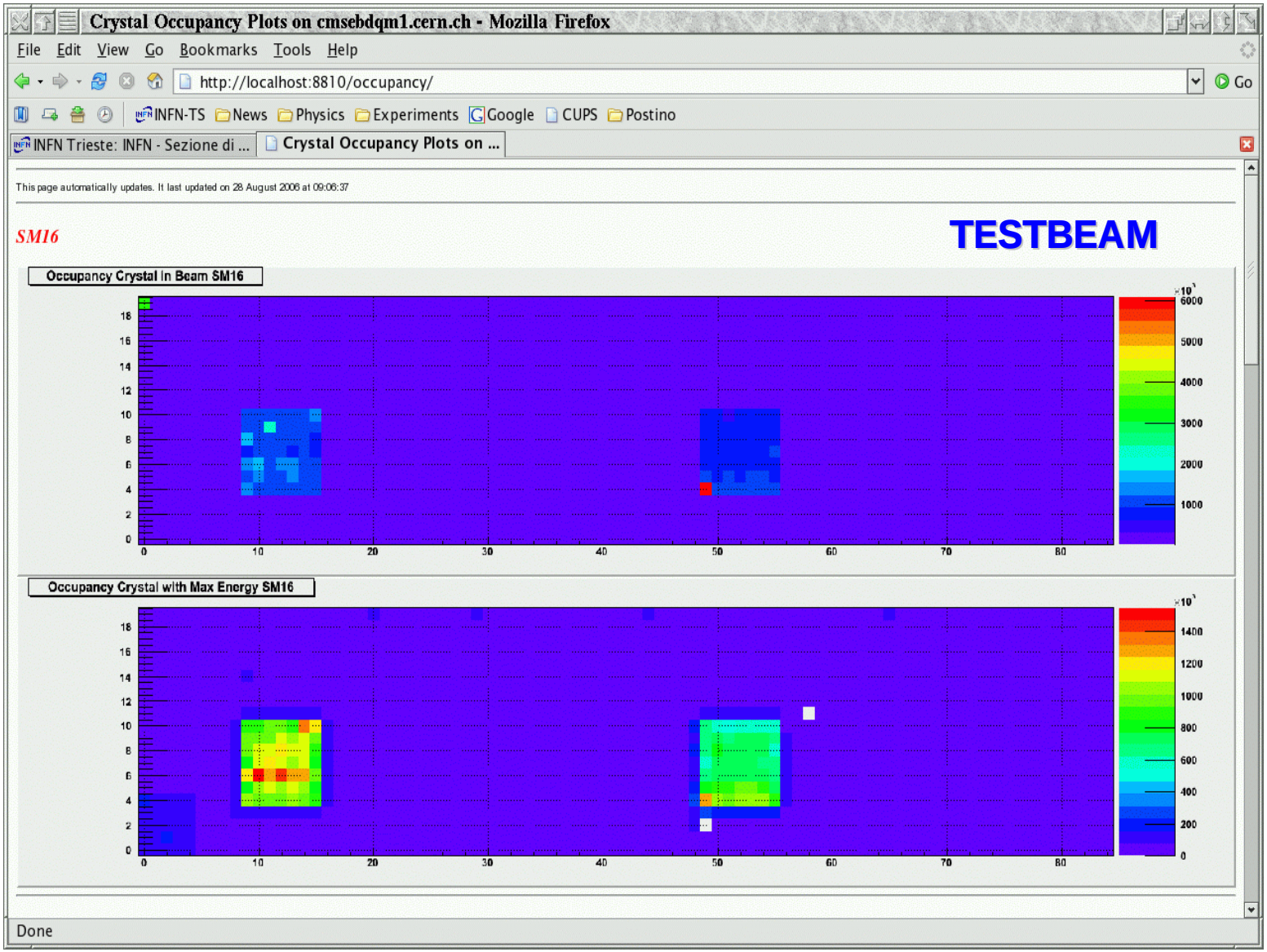
CMS event display





CMS DAQ integration test
Run 2605
Event 3981
B 3.8 T
27.08.06

ECAL DQM-DB - web pages



events per crystal distributions, extracted from ECAL CondDB

backup slides - end