



Data Quality Monitoring for the CMS Silicon Strip Tracker

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CHEP 2009

**On behalf of the CMS Silicon Strip Tracker
Community**



Outline

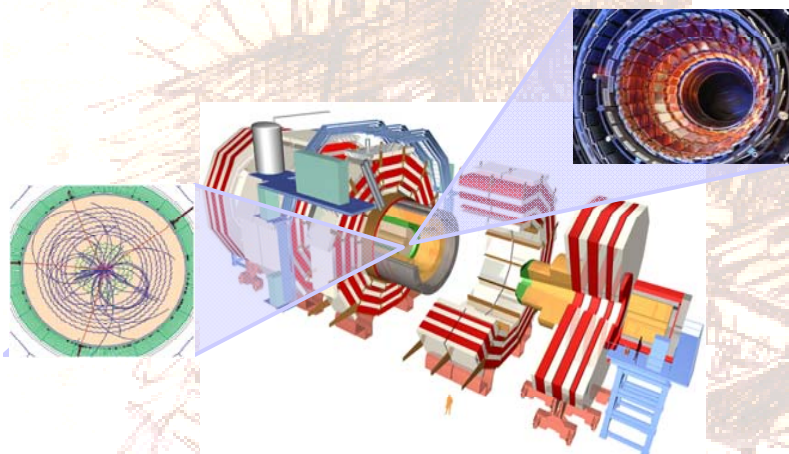
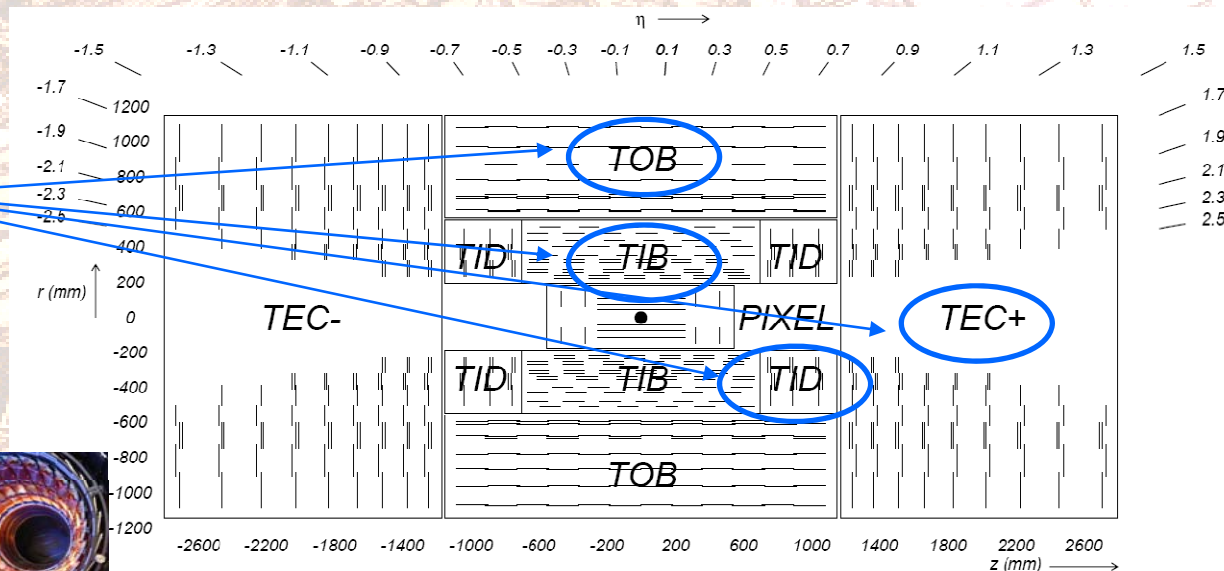
- **Introduction: the CMS Silicon Strip Tracker layout**
- **CMS Data Quality Monitoring (DQM) deployment**
- **DQM framework**
- **What and how the DQM monitors**
- **DQM tools**
- **Data certification**
- **Long term monitoring**
- **Performance**



The CMS Silicon Strip Tracker

➤ Tracking system in CMS is quite a complex object:

- ✓ ~200 m² of Si sensors
- ✓ 10 M channels
- ✓ 15148 modules
- ✓ 4 subsystems





The Data Quality Monitoring deployment

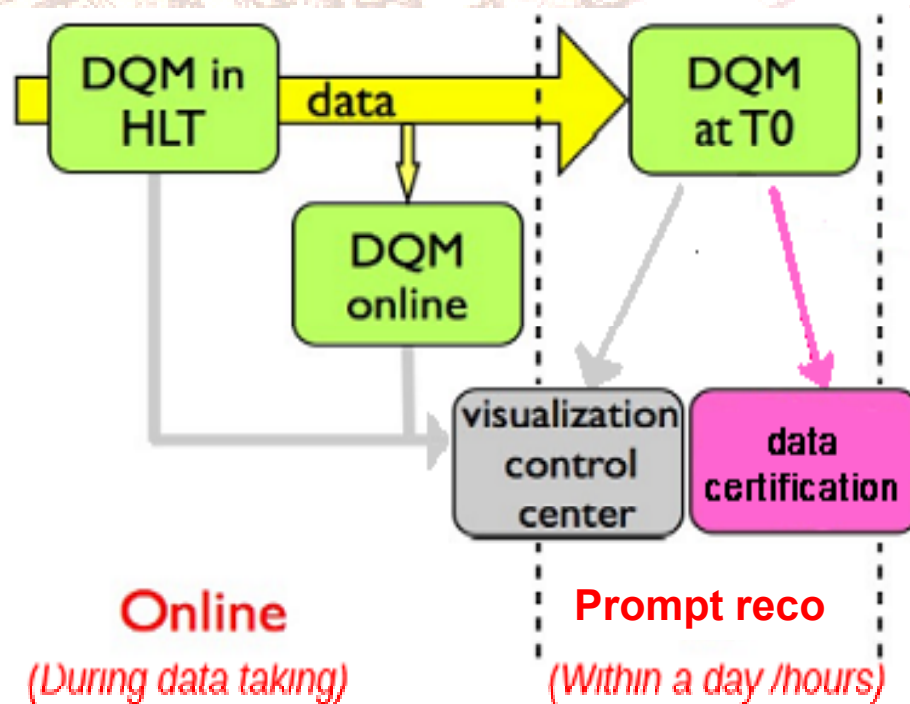


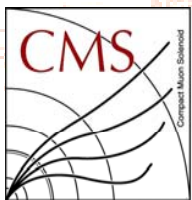
➤ Online DQM

- ✓ Real time and uses fraction collected events
- ✓ Monitors detector performance and efficiency

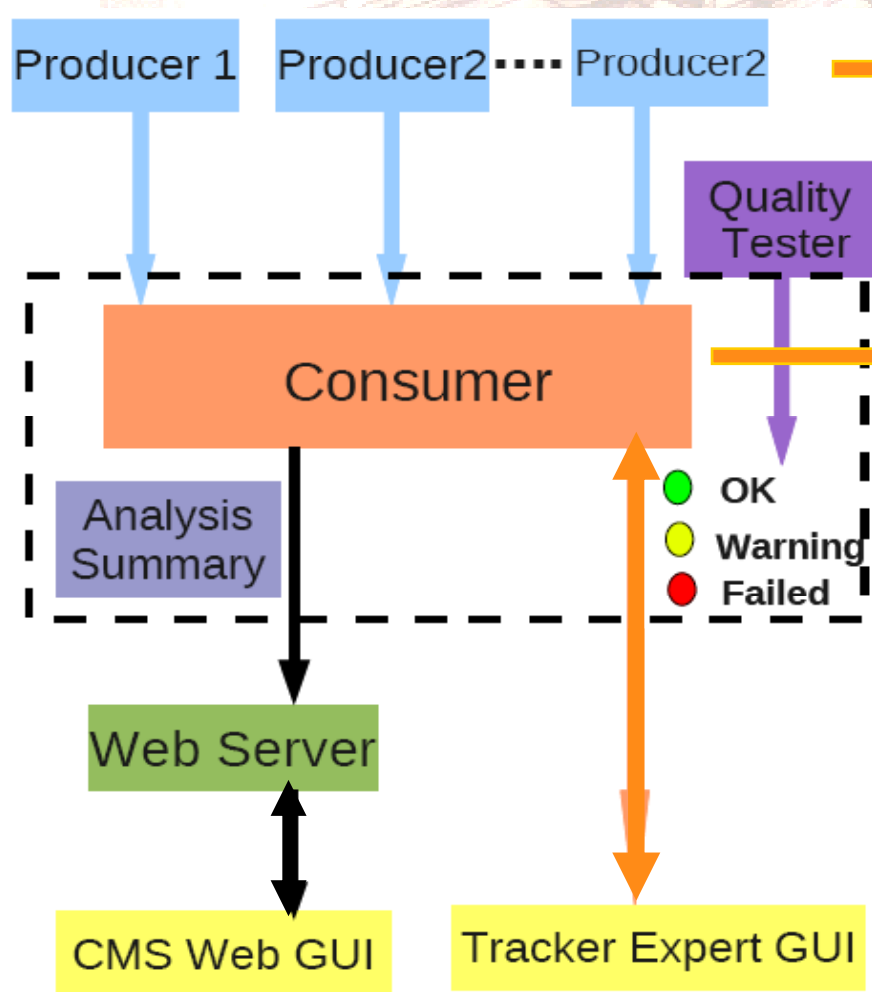
➤ Offline DQM (During prompt reconstruction)

- ✓ Full statistics within a few hours of latency, uses best calibration
- ✓ Detailed monitoring of detector performance and reconstruction algorithms
- ✓ Data certification





DQM framework

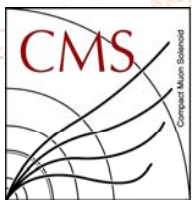


➤ **Books histograms in a tree structure and fill them accessing the events. Then it makes them available for the check by the shifter**

➤ **Accesses histograms from source and performs further analysis:**

- ✓ **Creates summary histos**
- ✓ **Defines and applies Quality Tests**
- ✓ **Writes out all results in output root files**

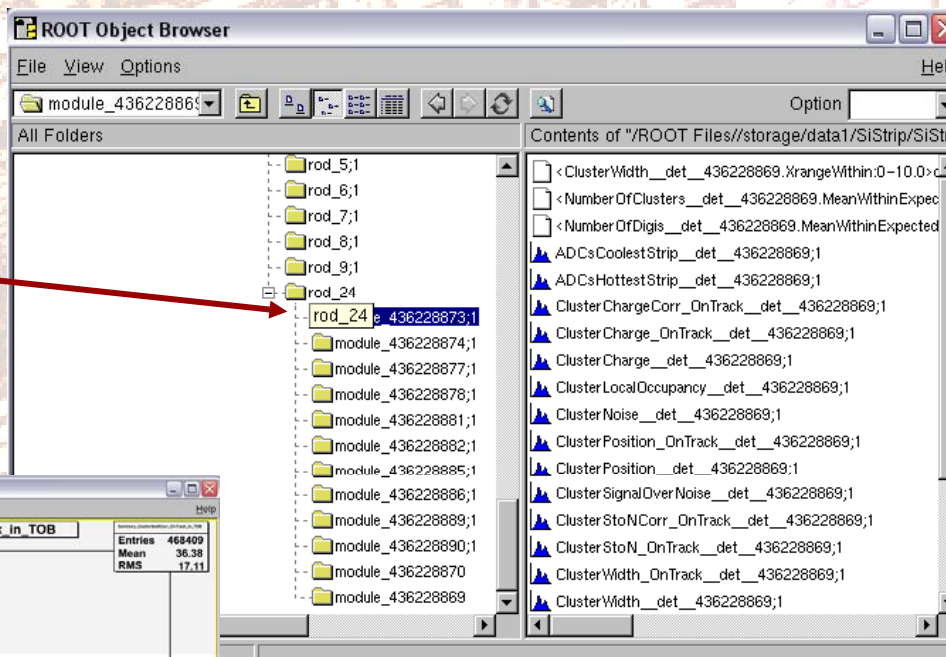
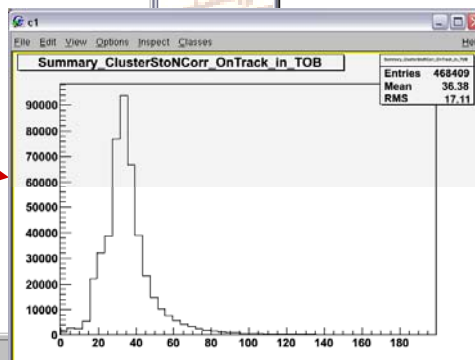
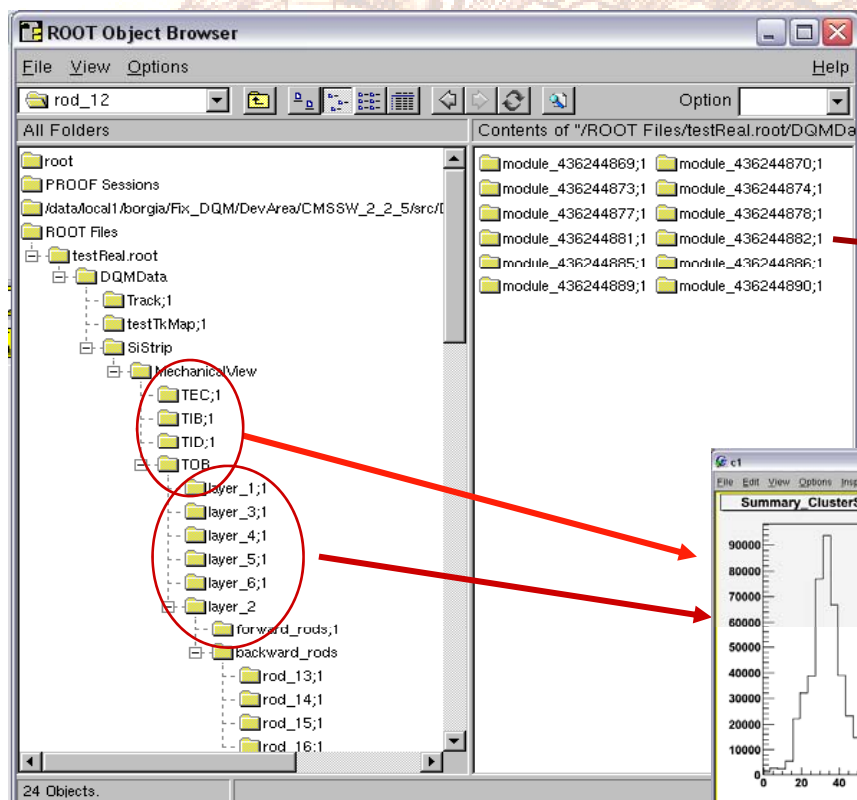
➤ **Visualization**

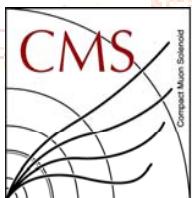


What the DQM monitors

- **The DQM Producers define the quantities to be monitored**
 - ✓ **Raw data (readout and unpacking errors)**
 - ✓ **Digi and Cluster properties (also related to the tracks)**
 - ✓ **Global track parameters**
 - ✓ **Residuals of hits**

30000 histograms





DQM tools: the web GUI



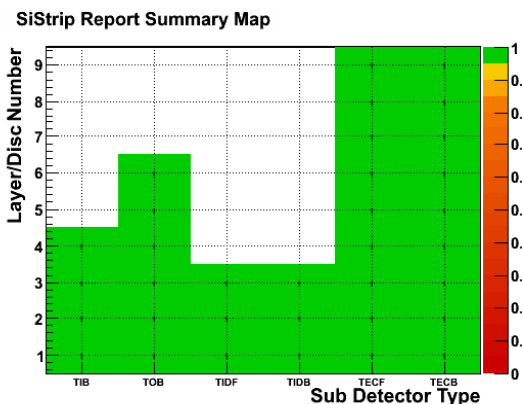
- **Graphical User Interfaces used by CMS DQM are web based**
 - ✓ **This means they are accessible from EVERYWHERE and there is no need of any software installation, but just a web browser**
- **On top of GUI, an additional tool: the Layout**
 - ✓ **Used to make the shifter's work more efficient**
 - ✓ **Histograms grouped by type**
 - ✓ **Easy to navigate, just by clicking**

The shifters don't need to navigate folders: the Layout does this work for them!

CMS data quality CERN Tier-0: 77'064 . 24 . 35'797'128 . Summary, <1 / 1>

SiStrip 100.0% / 77064 24 35'797'128 Mar 5, 02:16:48 Mar 5, 23:52:32 1469916 1.49 1111

SiStrip Part	Status
SiStrip_TECB	100%
SiStrip_TECF	100%
SiStrip_TIB	100%
SiStrip_TIDB	100%
SiStrip_TIDF	100%
SiStrip_TOB	100%



Please file any feature requests and any bugs you find in [Savannah](#). Find [shift instructions here](#).
 IGUANA DQM GUI @ vocms34.cern.ch; Mar 19, 2009 at 17:54:27 UTC; session is modifiable

X Trova: fault Successivo Precedente Evidenzia Maiuscole/minuscole

CMS data quality CERN Tier-1: 69'594 . 78 . 3'219'463 . Everything, <1 / 1>

Search (47436 objects)

Quick collection

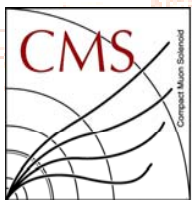
- (Top)
- 00 Shift
- + CSC
- + DT
- + EcalBarrel
- + EcalEndcap
- + Egamma
- + HLT
- + Hcal
- + JetMET
- + L1T
- + L1TEMU
- + Muons
- + Pixel
- + RPC
- + SiStrip
- CSC
- + CSCOfflineMonitor
- + DDUs
- + EventInfo
- FPDSebac...

04 OnTrackCluster

Signal-to-Noise (corrected for the angle) for On-Track clusters in TOB - [DQMShiftOfflineSiStrip](#)

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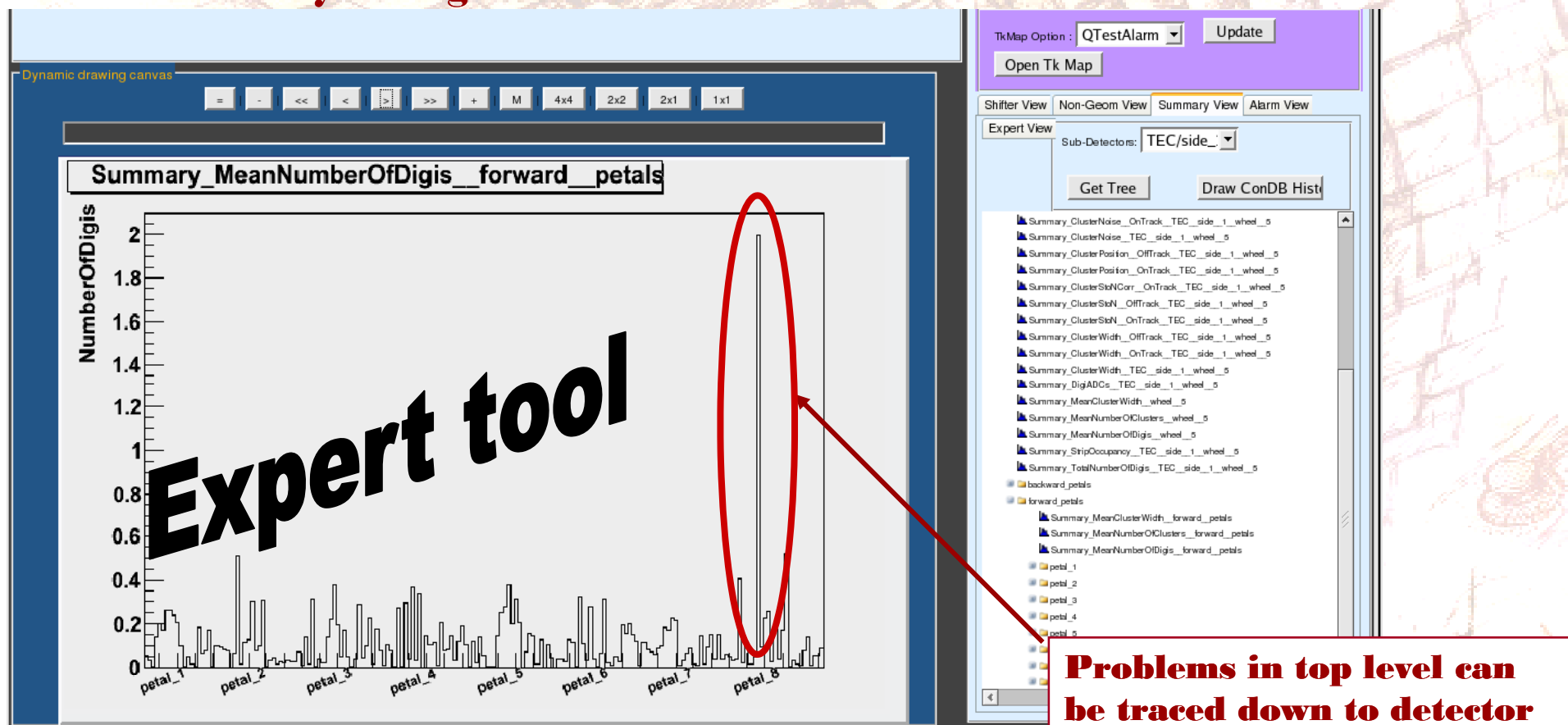


DQM tools: the Consumer

Summaries



- **The Consumer uses detector level histograms to create summaries**
 - ✓ **Mean/rms values from detector level histograms are used to create summary histogram**



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DQM tools: the Quality Tester

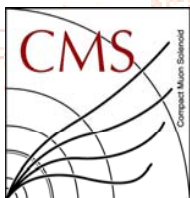
- **In order to let the shifter work efficiently, an automatic tool that allows the application of tests on histograms to check the quality quickly has been developed**
 - ✓ **Histograms compared with reference (sophisticated and simple statistical test)**
 - ✓ **Histograms are qualified: a label is attached to them with the result of the test**
 - ✓ **Finally alarms generated from test results**

OK

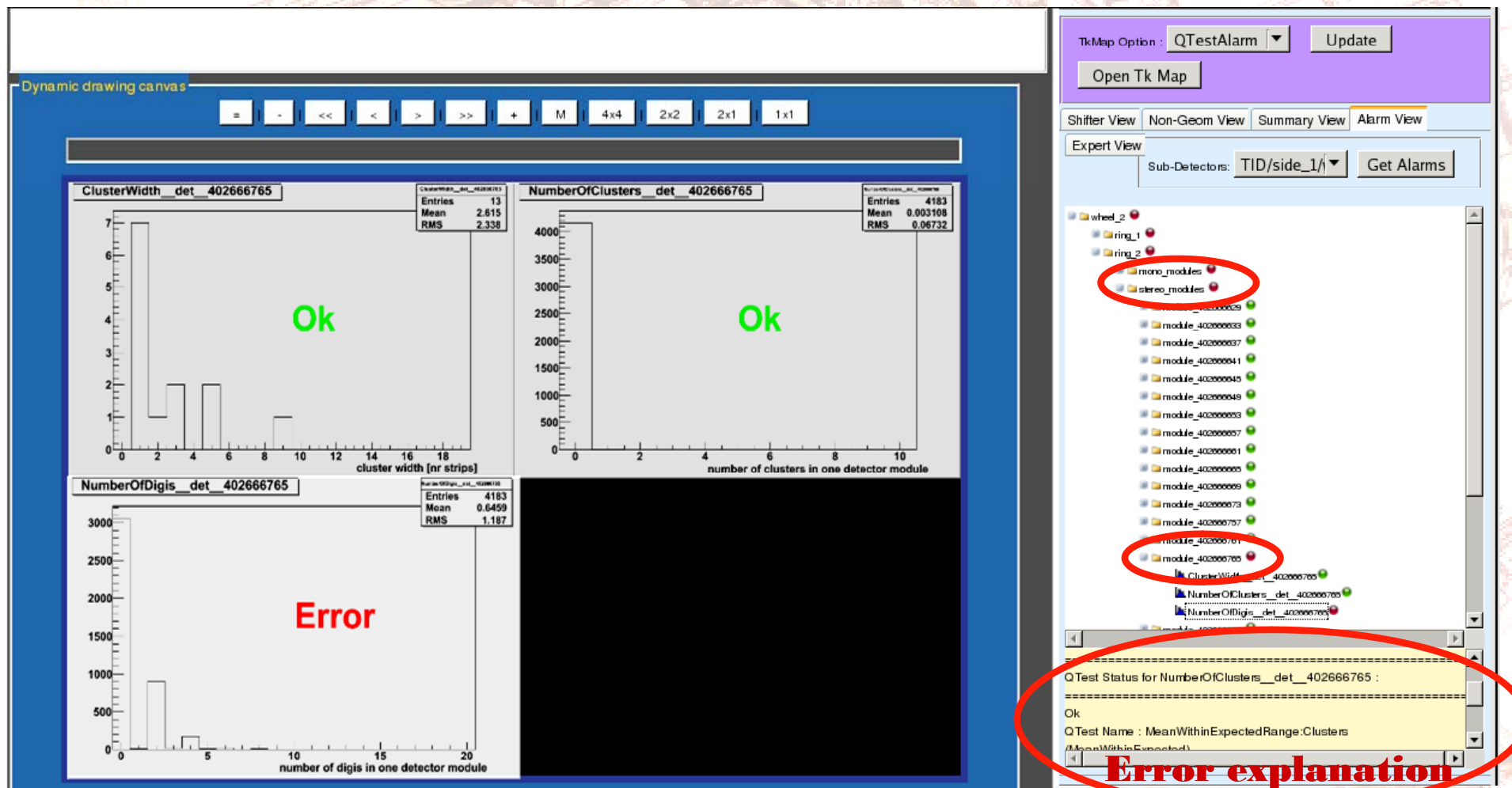
Warning

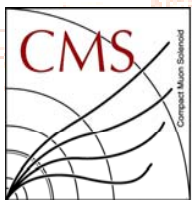
Error

- **The alarm levels can be adjusted depending on the need**
- **Quality tests (QTest) configured and attached to the histograms through xml files**
- **Automatic determination of histogram quality is a complex and difficult task in such huge system of histograms. The QTest tool in DQM allows to configure and use it in a simple way**



The QT results through the tracker GUI alarm view

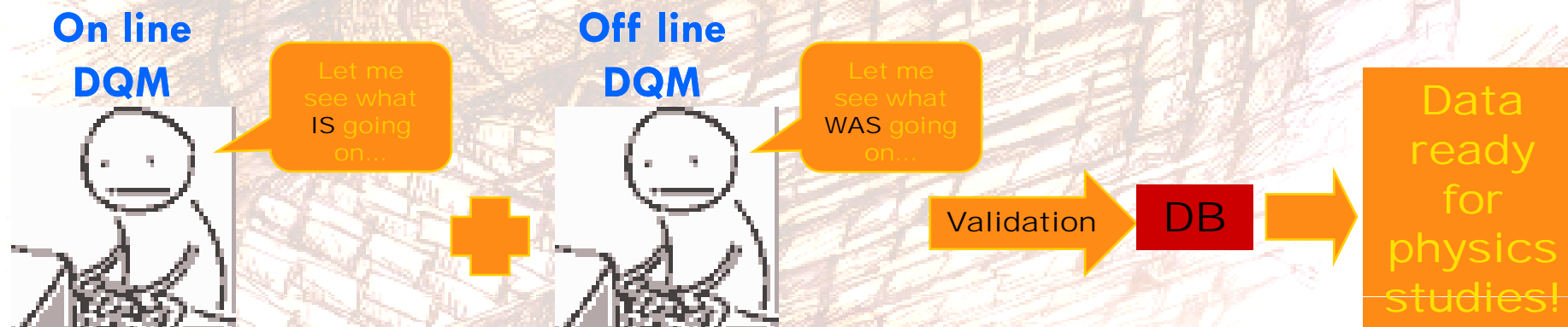




Data certification

➤ **DQM fundamental to define the goodness of data, but also to monitor detector and reconstruction conditions. This is done on a run by run basis through the Data Certification procedure**

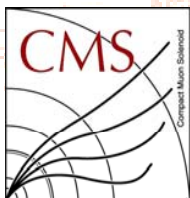
- ✓ **Two steps: on line + off line**
- ✓ **Two kinds of checks: some automatic (via scripts), some manually (direct view)**
- ✓ **Scripts check automatically if values are in an expectation range or if distribution shapes are consistent. If not → check manually**
- ✓ **Results stored in a Database**



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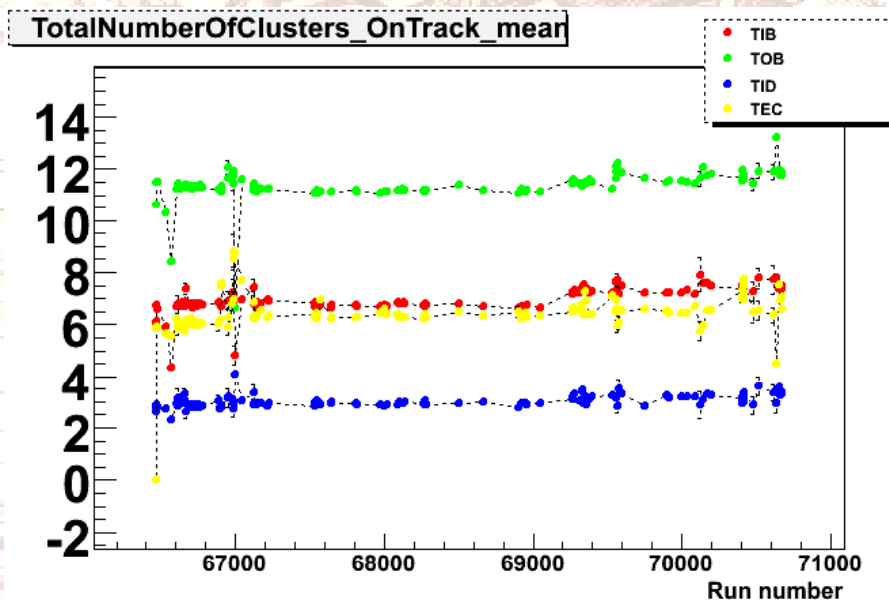
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Long term monitoring

➤ **Tool to study the stability in time of the detector behavior, in medium (few days) to long term (few weeks or months)**

- ✓ **Summary information from DQM histograms are stored in database corresponding to each run number**
- ✓ **They can be plotted later as a function of run number at any given interval**



DQM Histograms

Mean, RMS, Maximum, Minimum values...

Database

Flexible plotting methods

Standalone access using root

Access through web interface



Performance

- **DQM tool extensively used during the last months in cosmic data taking of CMS**
- **Stressed and tested deeply**
- **It was able to run stably even for runs that lasted more than 12 h on line, and always stably at Tier0 (offline)**
- **A total of 350 M events processed and used both for monitoring performance and for data certification**
- **Resources usage**
 - ✓ **On line, with full granularity, together with the reconstruction ~2GB of RAM**
 - ✓ **Off line, with a reduced granularity in order to share resources with the other processes, ~0.5 GB of RAM**



Summary

➤ **The DQM of the CMS Silicon Strip Tracker is a powerful tool to monitor and certify the data**

- ✓ **Versatile, as can run in different environment (on line, off line)**
- ✓ **Easy to use, even for non expert people**
- ✓ **Efficient in summarize information from so large an amount of detectors (~15000)**
- ✓ **Immediate to spot problems (clear alarms)**
- ✓ **Fundamental to monitor the detector and the reconstruction both in the short term and in long periods**
- ✓ **Proved functionality and reliability in first cosmic data taking**