

Data Quality Monitoring of the CMS Tracker

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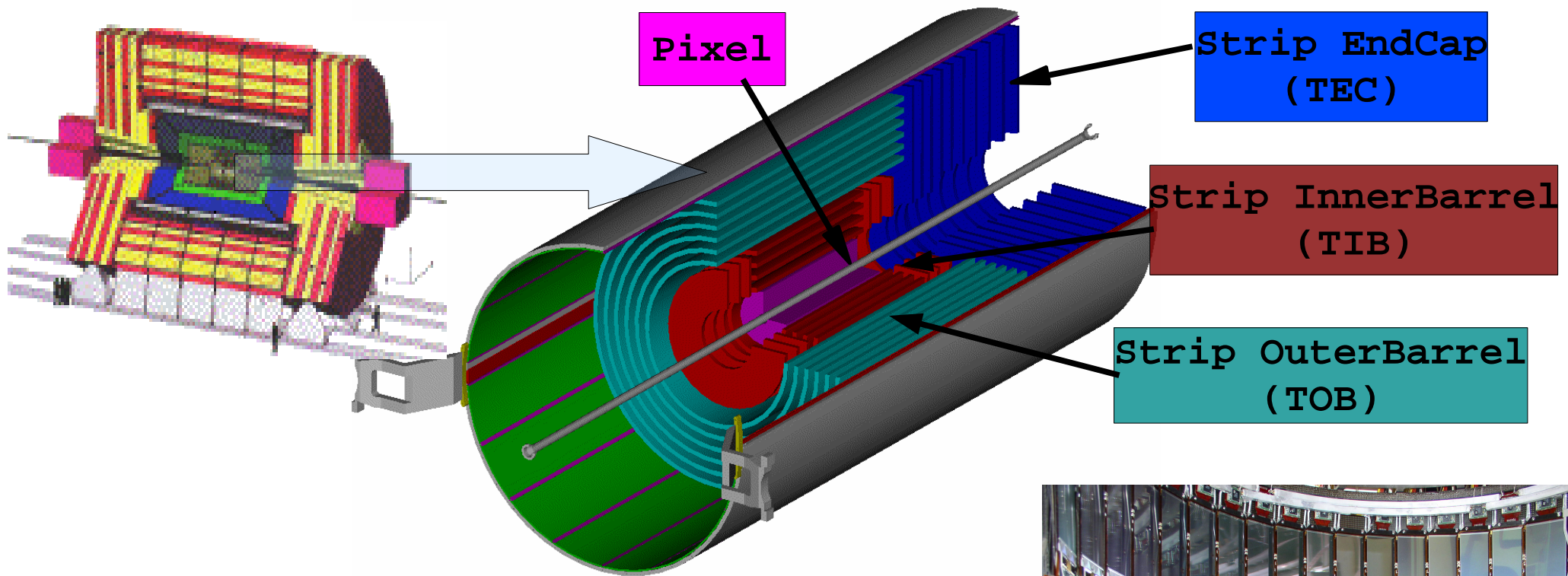
On behalf of CMS Tracker Monitoring Group

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Outline

- Introduction
- The Tracker Data Quality Monitoring(DQM) System
 - Monitoring Element “**Producer**” application
 - Monitoring Element “**Consumer**” application
- Graphical User Interfaces
- Summary & Outlook

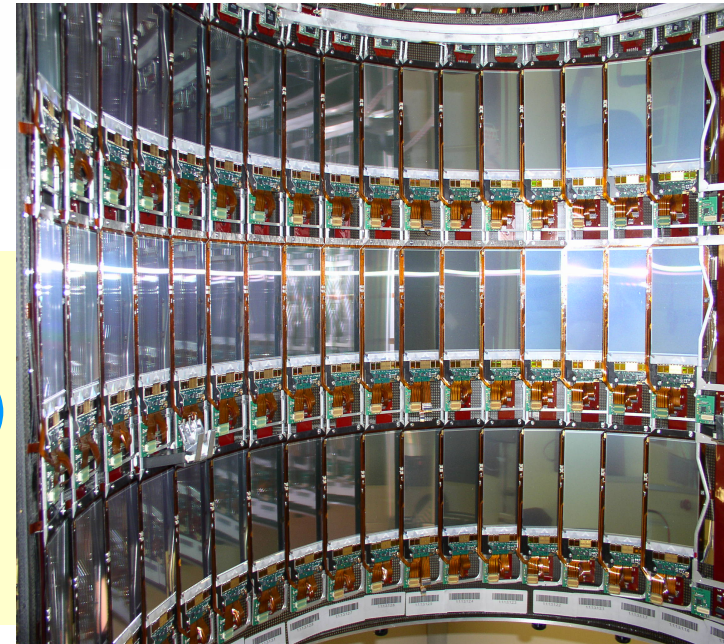
The CMS Tracker



The Challenge

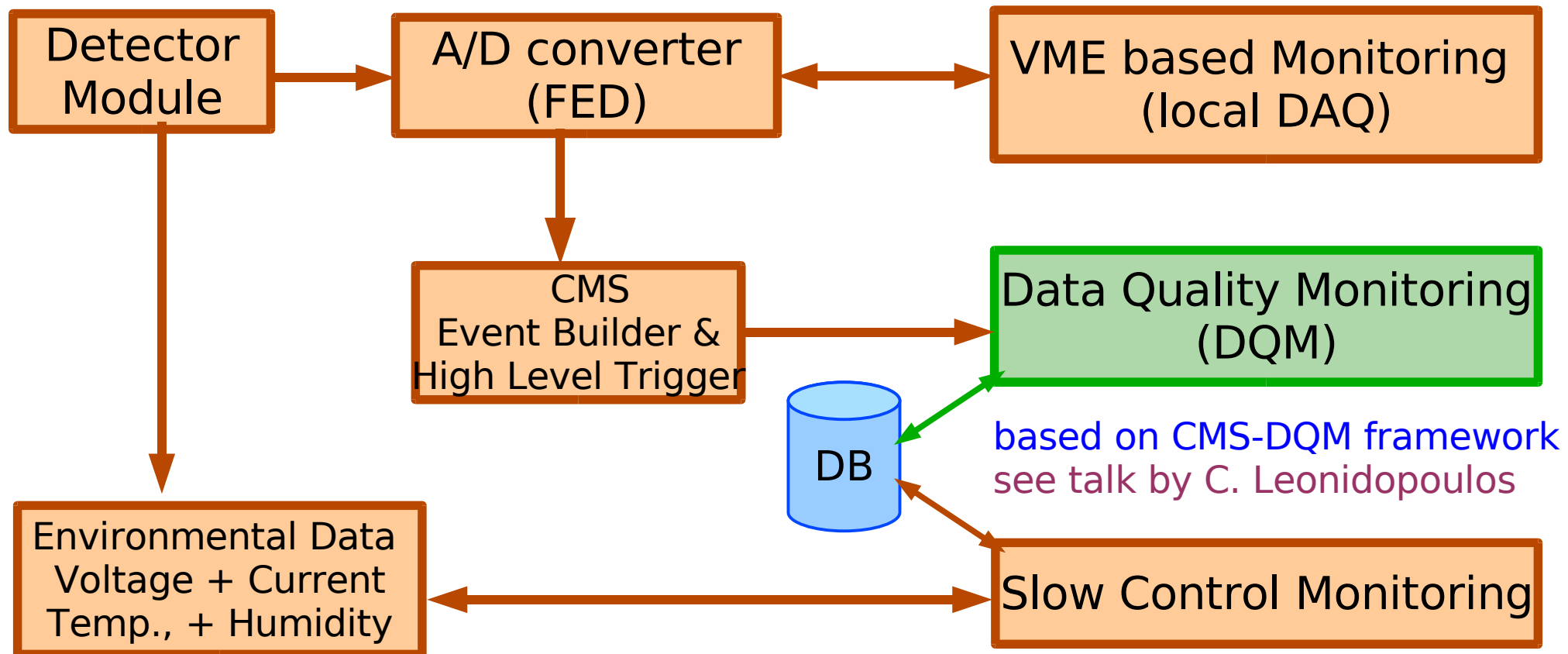
16915 detector modules (pixel+strip)

75 million readout channels



Tracker Monitoring

- monitor detector performance
- ensure smooth running
- fast problem detection
- quick feed back to hardware & reconstruction



How do we Monitor

- **Online**

- runs on Filter Farm (FF)
- shortest delay
- overhead on Filter Unit (FU) nodes

- **Event Consumer**

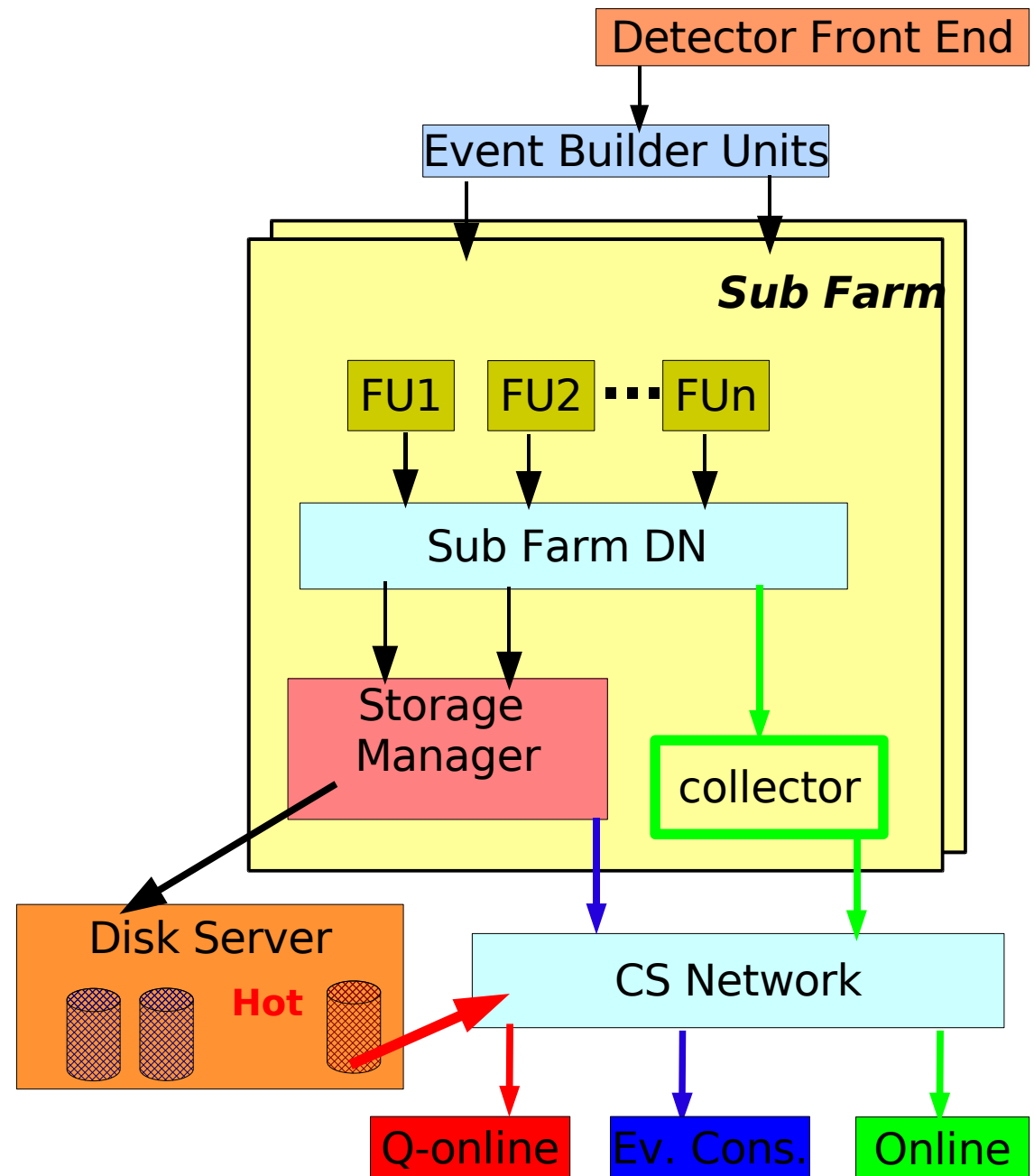
- selected events shipped to dedicated processors by storage manager

- **Quasi Online**

- events are accessed from the Hot buffers

- **Offline**

- data access from file



Tracker Monitoring Elements

.....divided according to the tasks

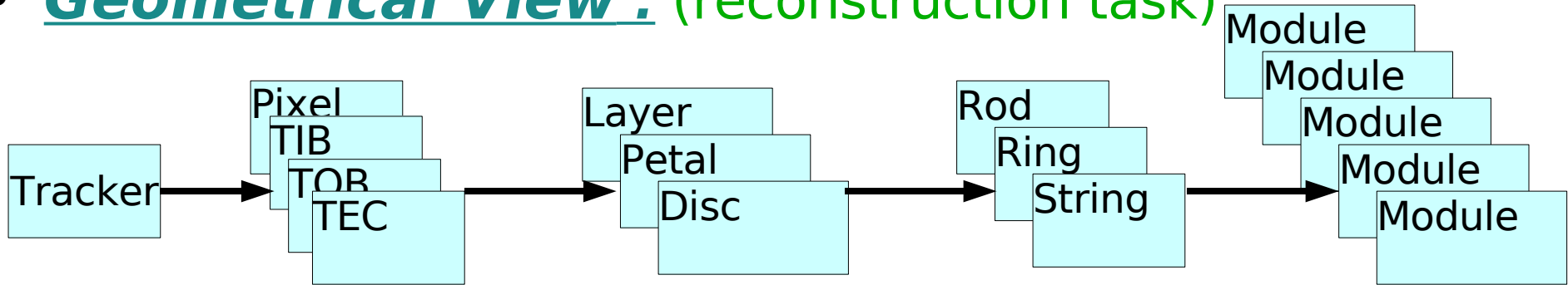
- ✓ Commissioning : detector tuning before data taking
- ✓ Zero suppression : pedestal, noise etc. during non-zero suppressed mode of Front End Drivers (FED) [strip only]
- ✓ Digitized and Reconstructed Hits : occupancy charge and position
- ✓ Local Tracking : e.g. seeds, tracks and vertex from pixel system alone
- ✓ Global Tracking : track quality, #of hits, residuals etc
- ✓ Radiation Damage Effects: signal trapping, Lorentz deflection etc.

Tracker DQM Producer

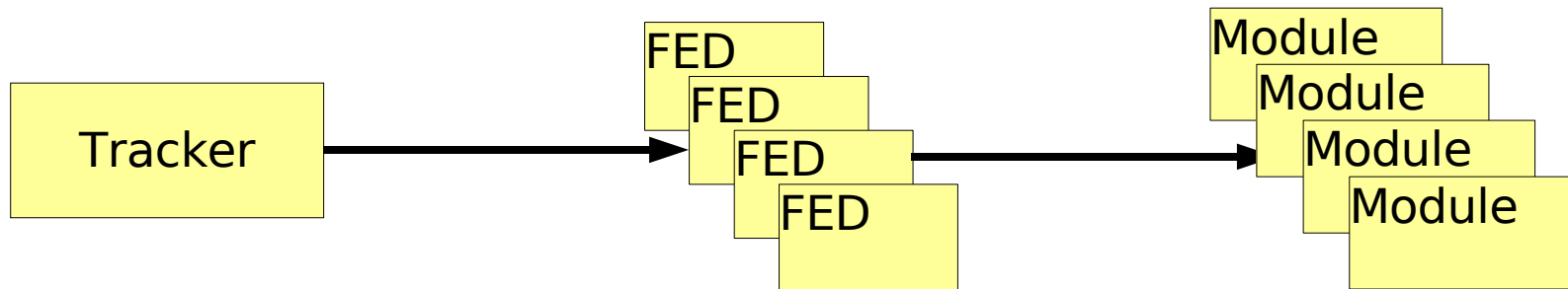
- Defines and fills Monitoring Elements (MEs)
 - Histogram, integer, float, string....
- Publish them
- Separate **Producers** deployed for individual tasks
 - independent of each other
 - can be initialized individually
 - easily pluggable through configuration file
- ME(s) from ~17k detectors must be arranged in a **hierarchical structure**

Tracker DQM Producer

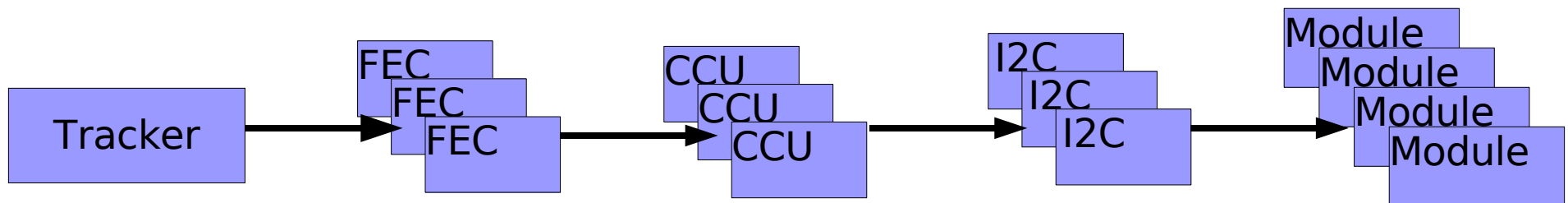
- **Geometrical View** : (reconstruction task)



- **Readout View** (commissioning task)[strip]

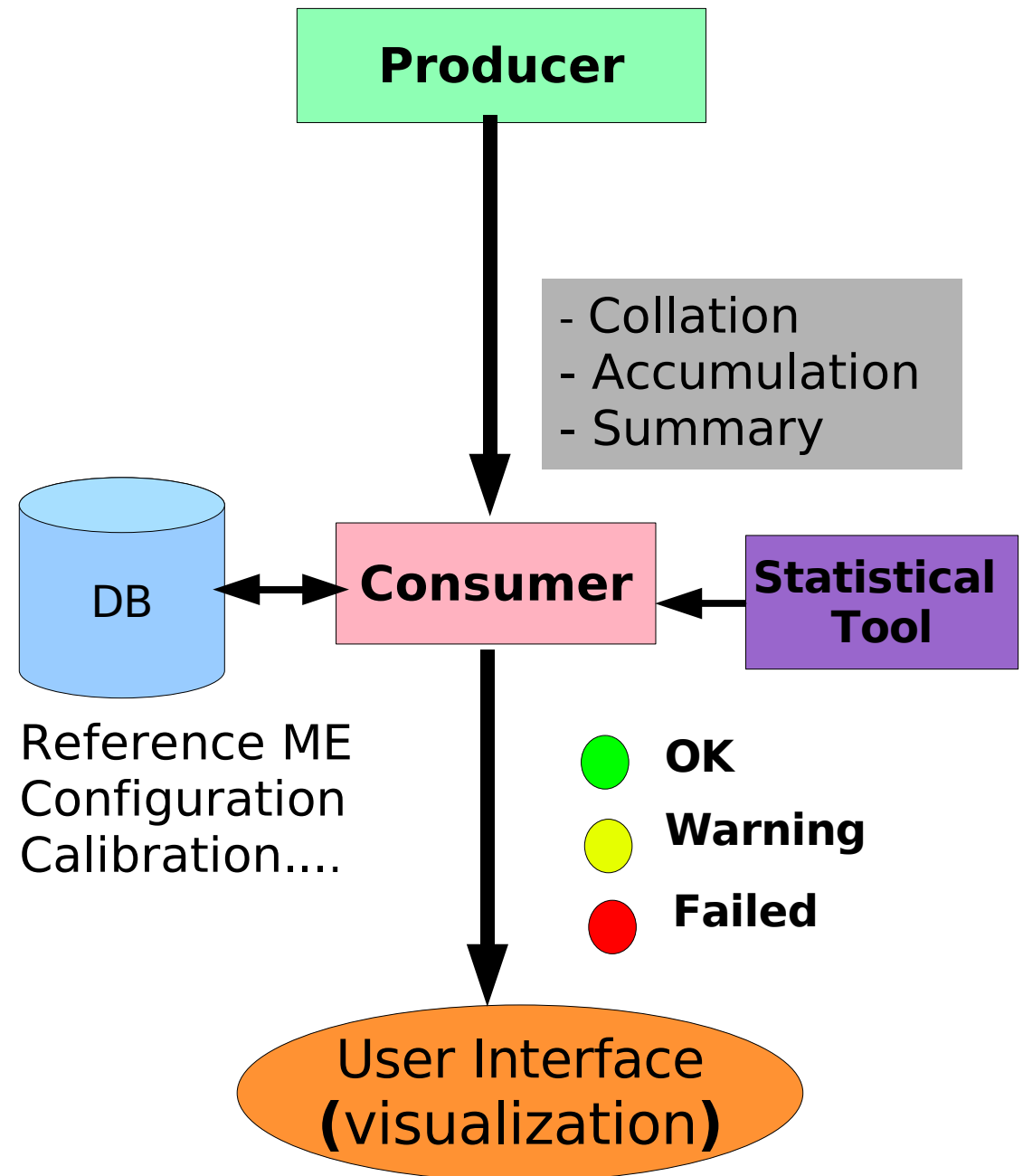


- **Control View** (commissioning task)[strip]

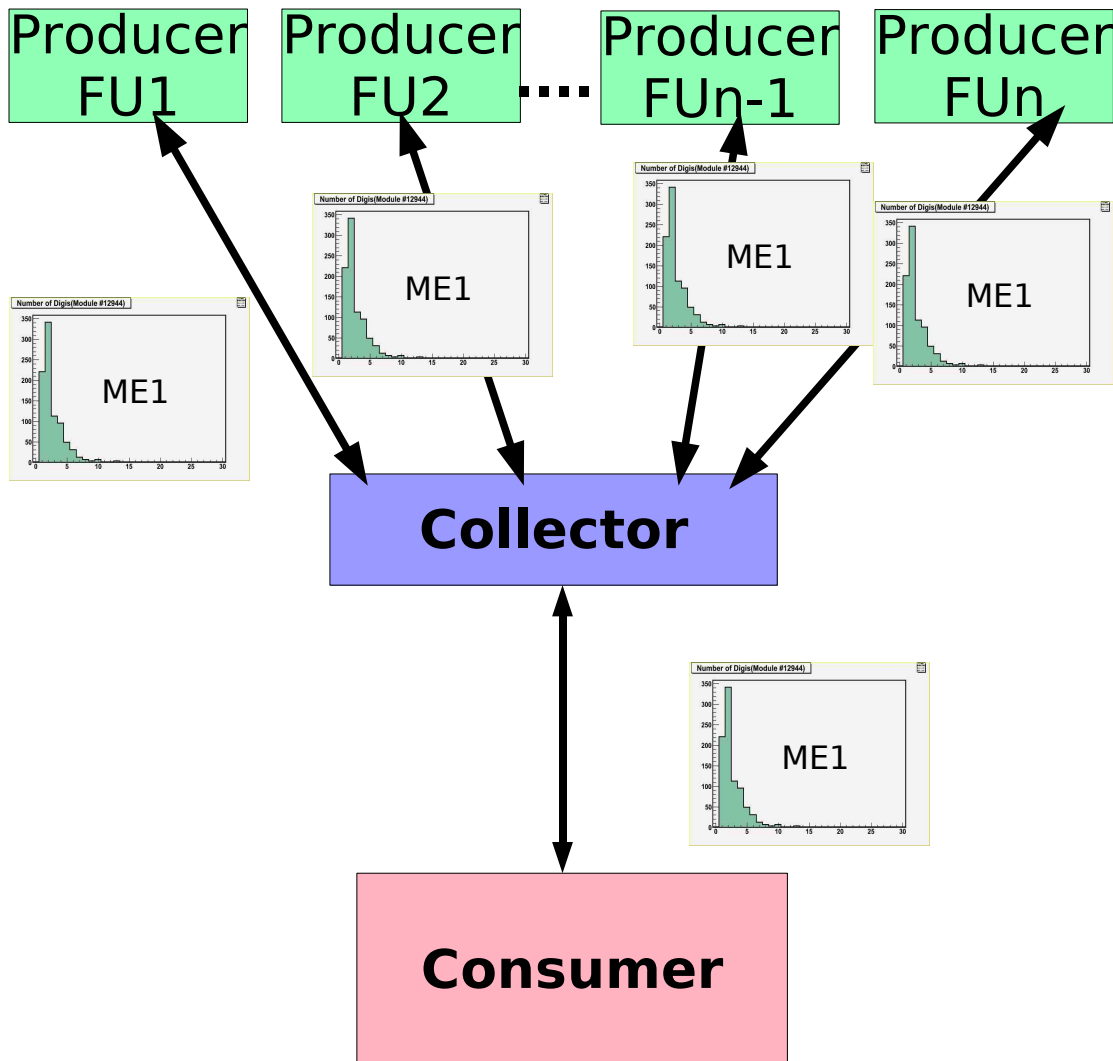


Tracker DQM Consumer

- Subscribes and retrieves ME(s)
- **Collates** ME(s) from multiple sources
- Creates **summary** information
- **Compares ME with reference**
 - Statistical, exact match, qualitative
- Generates **alarms**
- **Cross-check** results with slow control data from DB



Consumer Task (Collation)

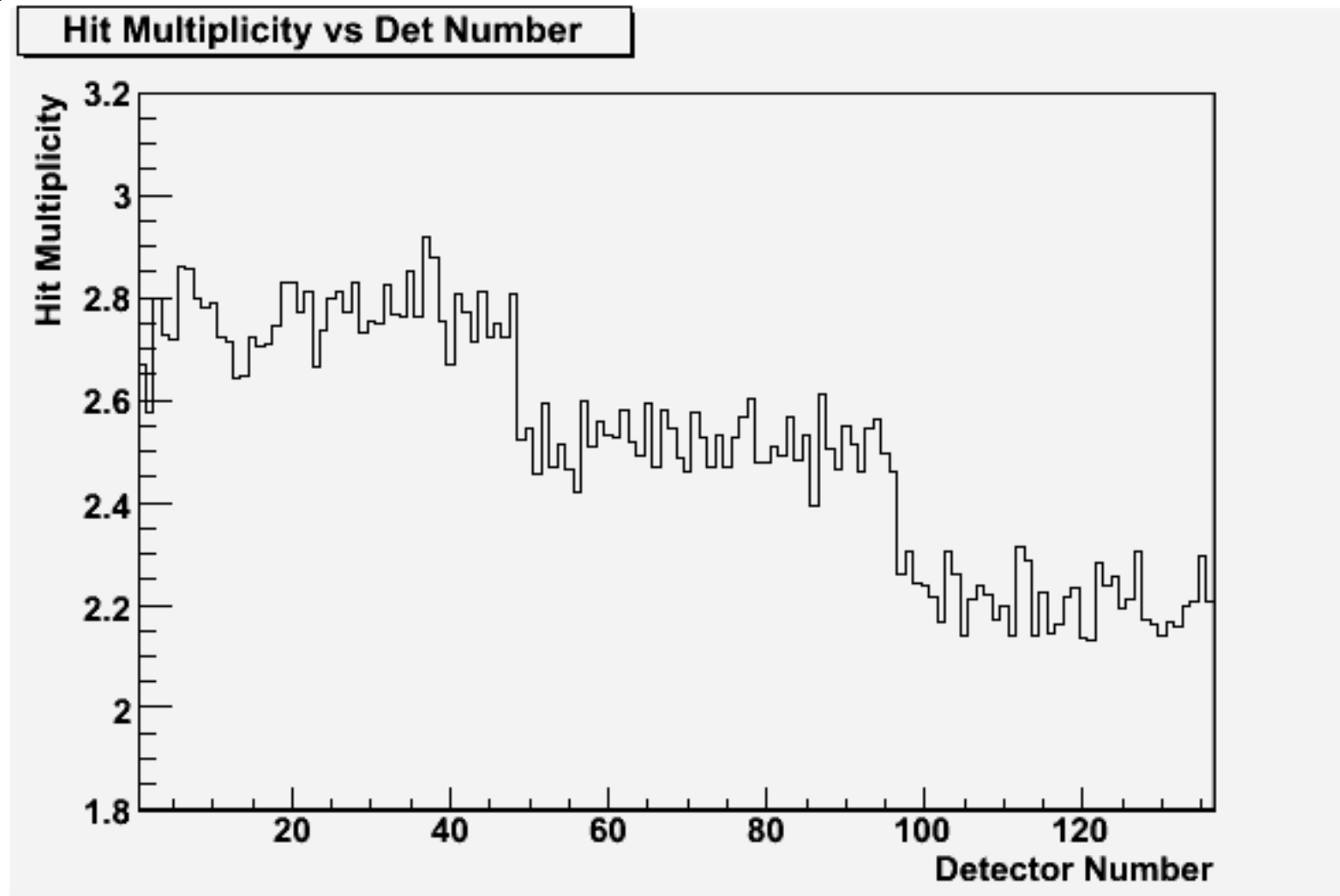


- Same ME produced by multiple sources on several FU nodes
- Computes the complete ME collating individual ones

$$FU0/ME1 + FU2/ME1 + \dots + FUn/ME1 = ME1$$

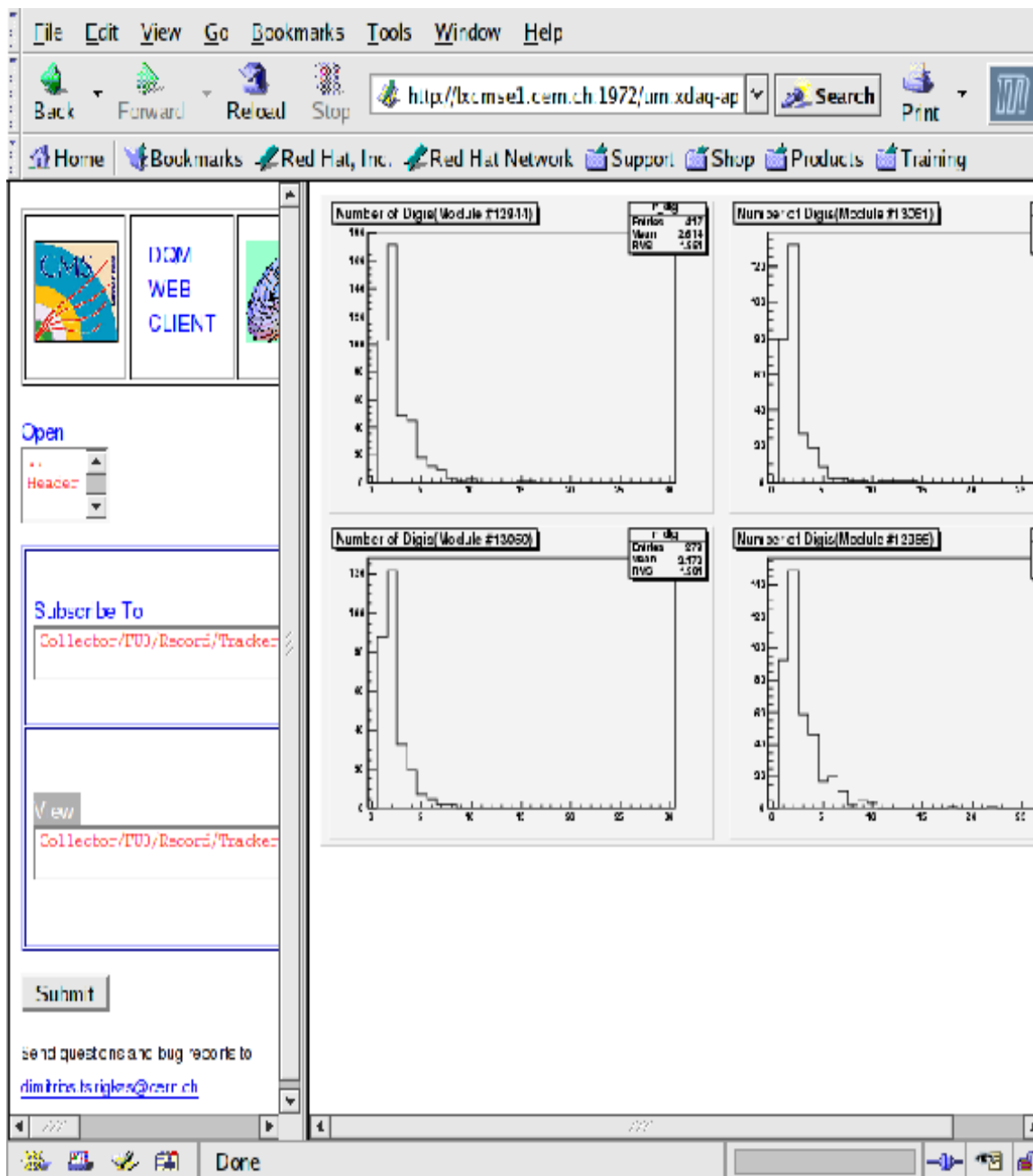
Consumer Task (Summary)

...created from a group of MEs received from source fetching their **Mean, RMS, #of entries** etc.



Average Hit multiplicity for all detectors in a layer

The Web GUI



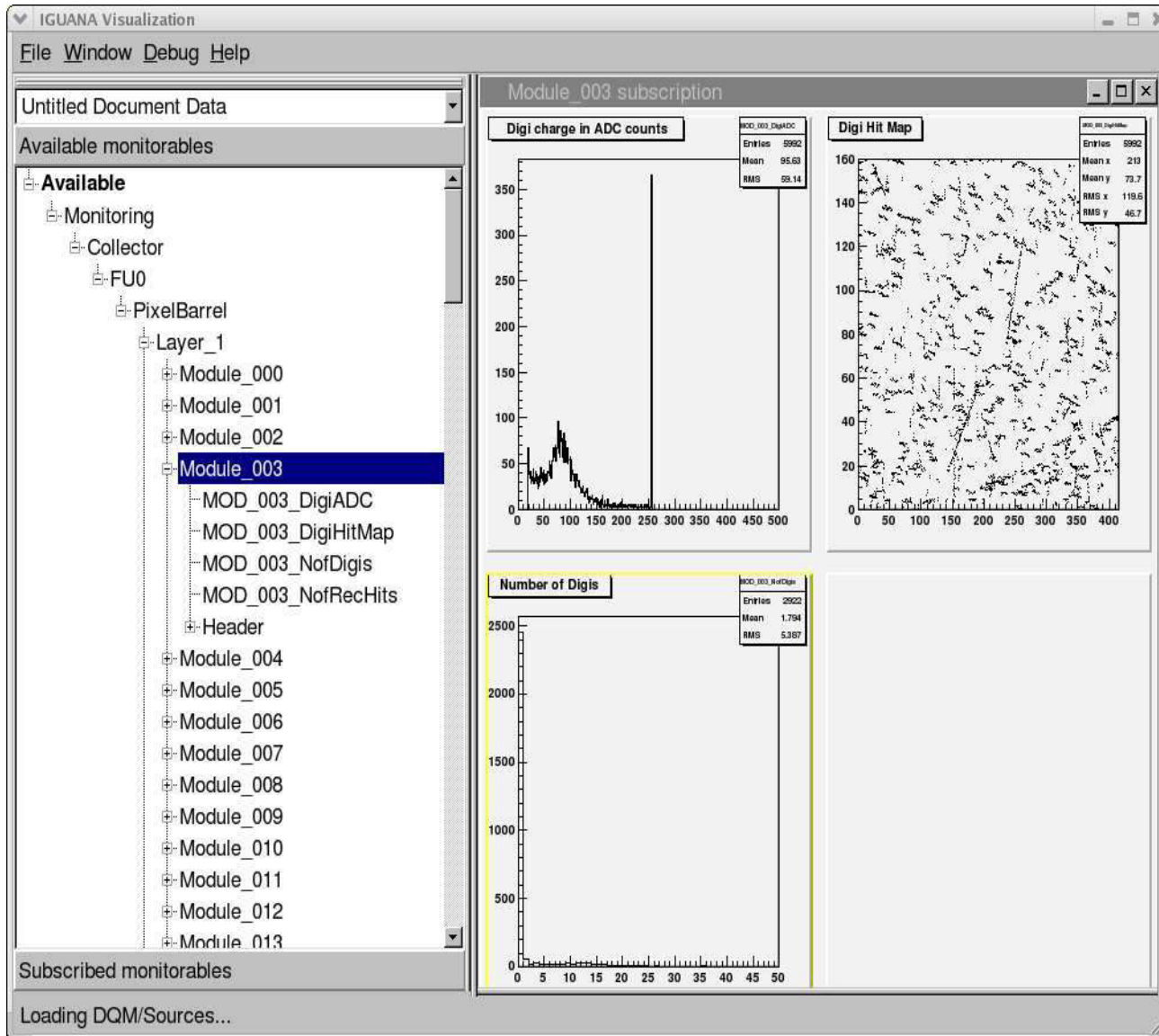
- Allows to subscribe and visualize MEs through web browser
- Easy access of MEs from any platform
- A set of widgets allows to customize detector specific web interface

IGUANA-CMS GUI

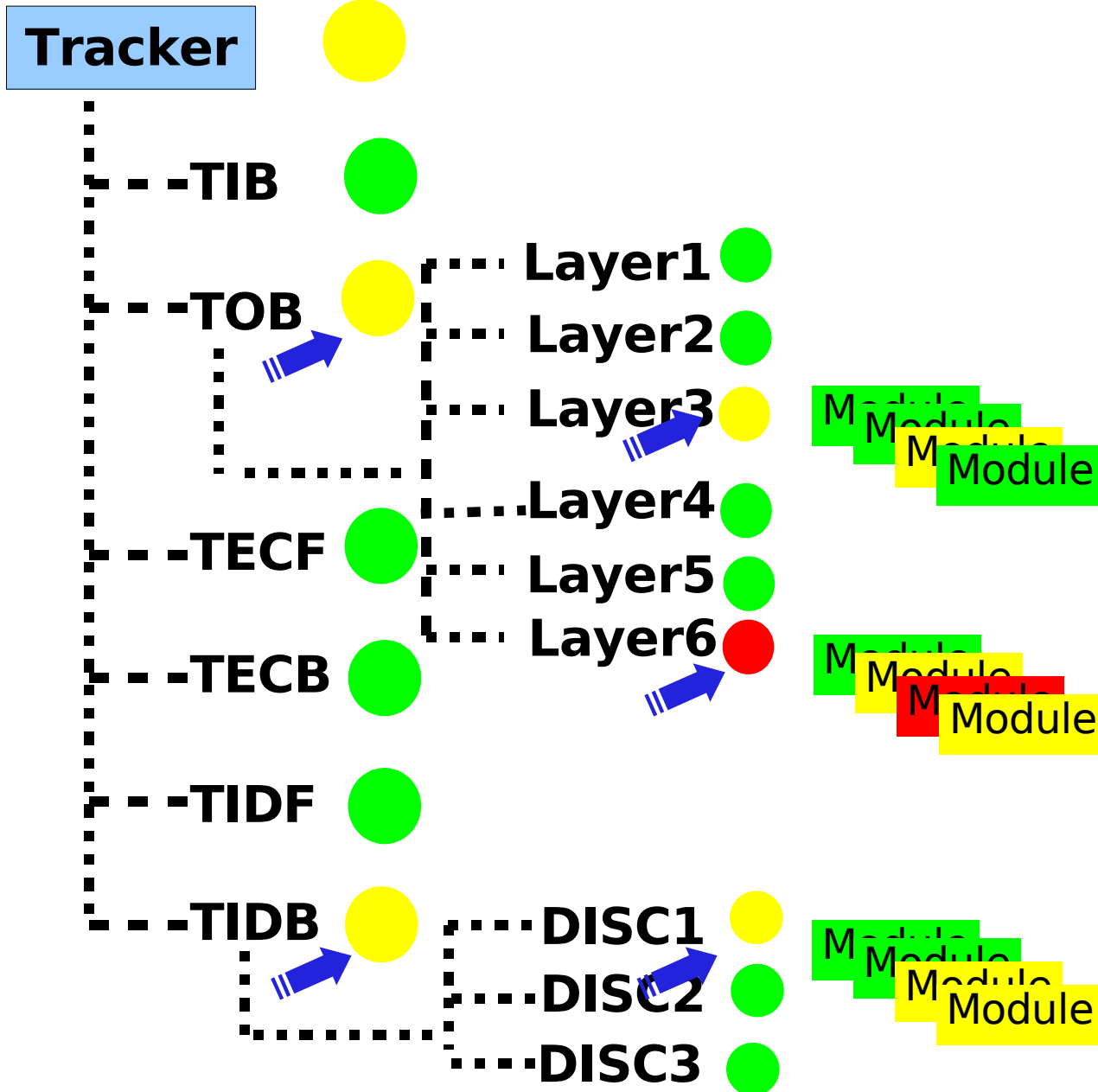
A pixel Detector unit with hit information

Based on Qt-Root
Main features:

- browsing of MEs
- subscription on demand
- visualization of multiple canvases
- interaction with canvas
- start/stop updates
- soft reset



Alarm Navigation

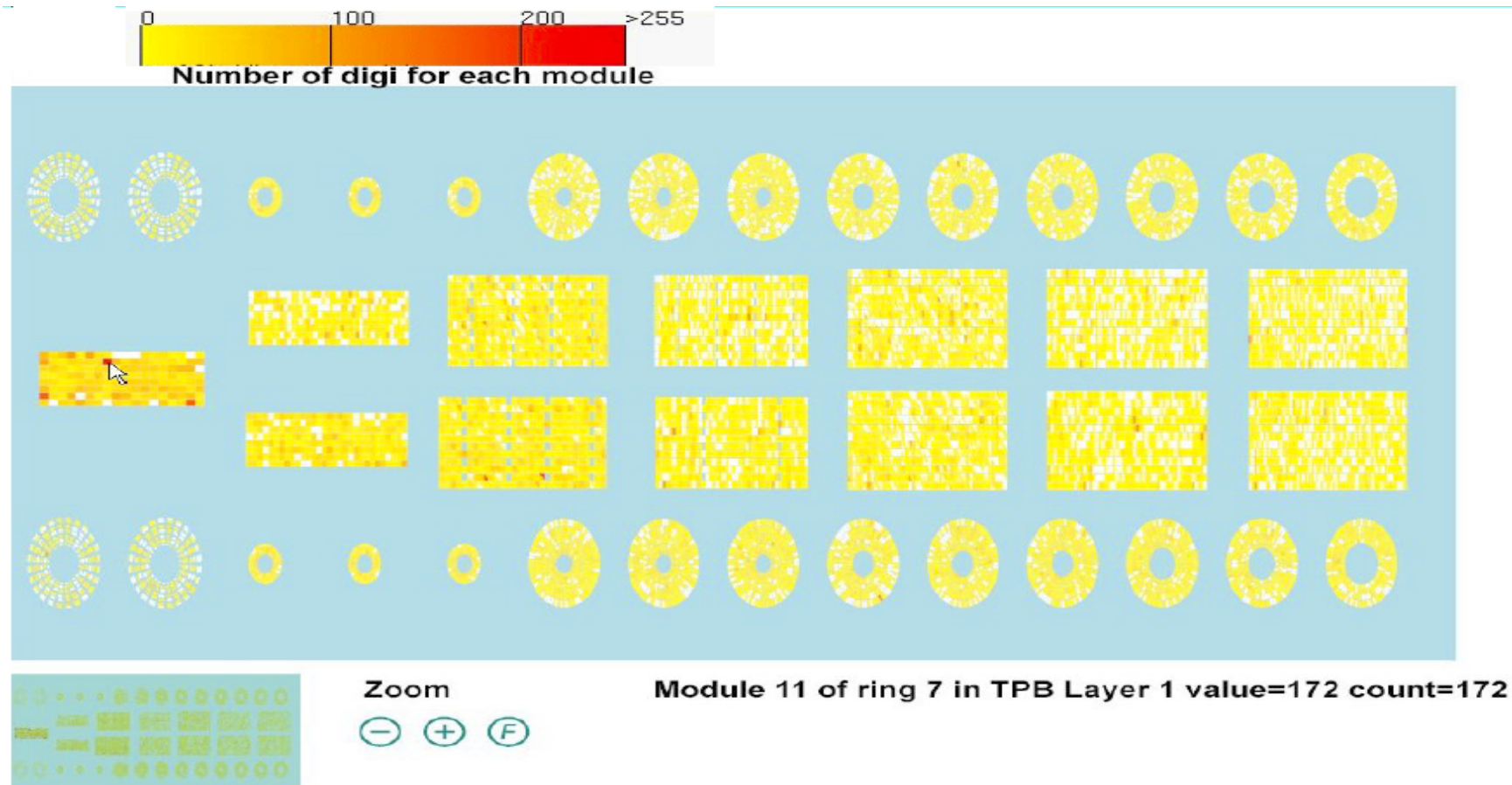


Detector Summary (histograms+comments)

The Detector Summary panel for Detector #10 displays four histograms and a text box. The histograms are: 'Number of Digits/Module #12944' (a histogram showing the distribution of digits per module), 'Digi with Det Number' (a line plot showing digit counts versus detector number), 'Digi charge in ADC counts' (a histogram showing the distribution of digit charges), and 'Digi Hit Map' (a 2D map showing the distribution of digit hits). The text box at the bottom contains the message: 'Detector #10 Error in Task#1 Warning in Task#5'.

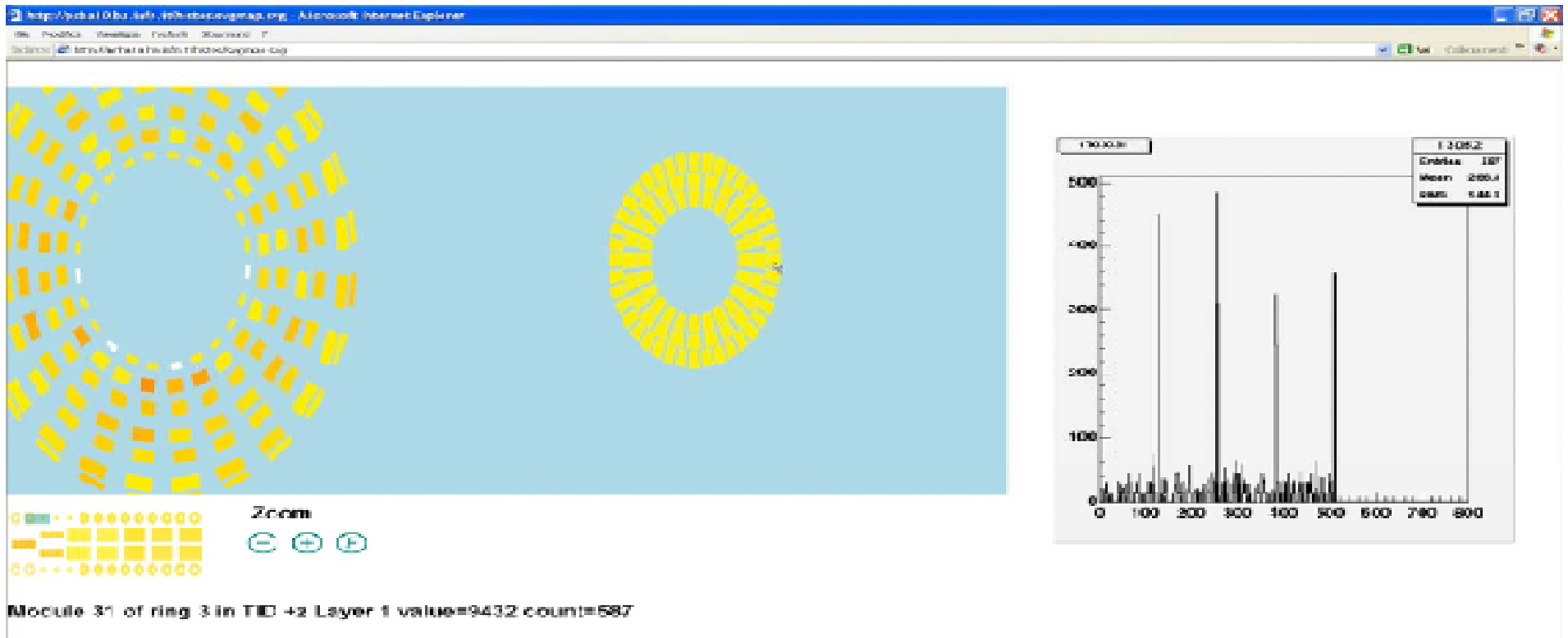
Tracker Map GUI

- Full tracker viewed at once in two dimensions
- Can be visualised with web browser globally using SVG plug-in
- ME from each detector coded in color map



Tracker Map GUI

- holes or hot spots pin point problem
- dead channels can be superimposed from DB
- result of comparison with reference
- single detector can be zoomed in and information can be obtained



Summary & Outlook

- DQM for CMS Tracker is very challenging due its size and complexity
 - Tracker DQM software exists with basic functionality of the **producer** and **consumer**
 - A simple and very useful tracker specific visualization tool, **TrackerMap** exists along with a couple of generic graphical user interfaces
 - Important milestones in 2006
 - Cosmic Challenge (CMS slice test with Cosmics)
 - 25% tracker readout test (before installation)
- **An opportunity to evaluate and improve Tracker DQM before CMS data taking**