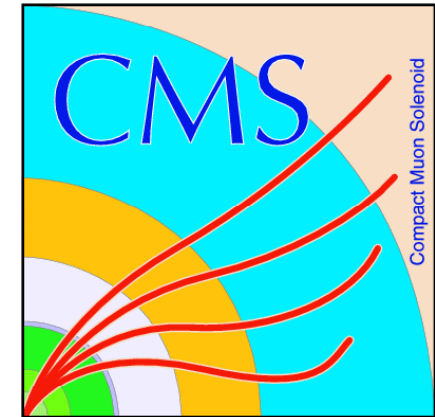


CMS pixel data quality monitoring



Petra Merkel, Purdue University
For the CMS Pixel DQM Group
Vertex 2008, Sweden

outline

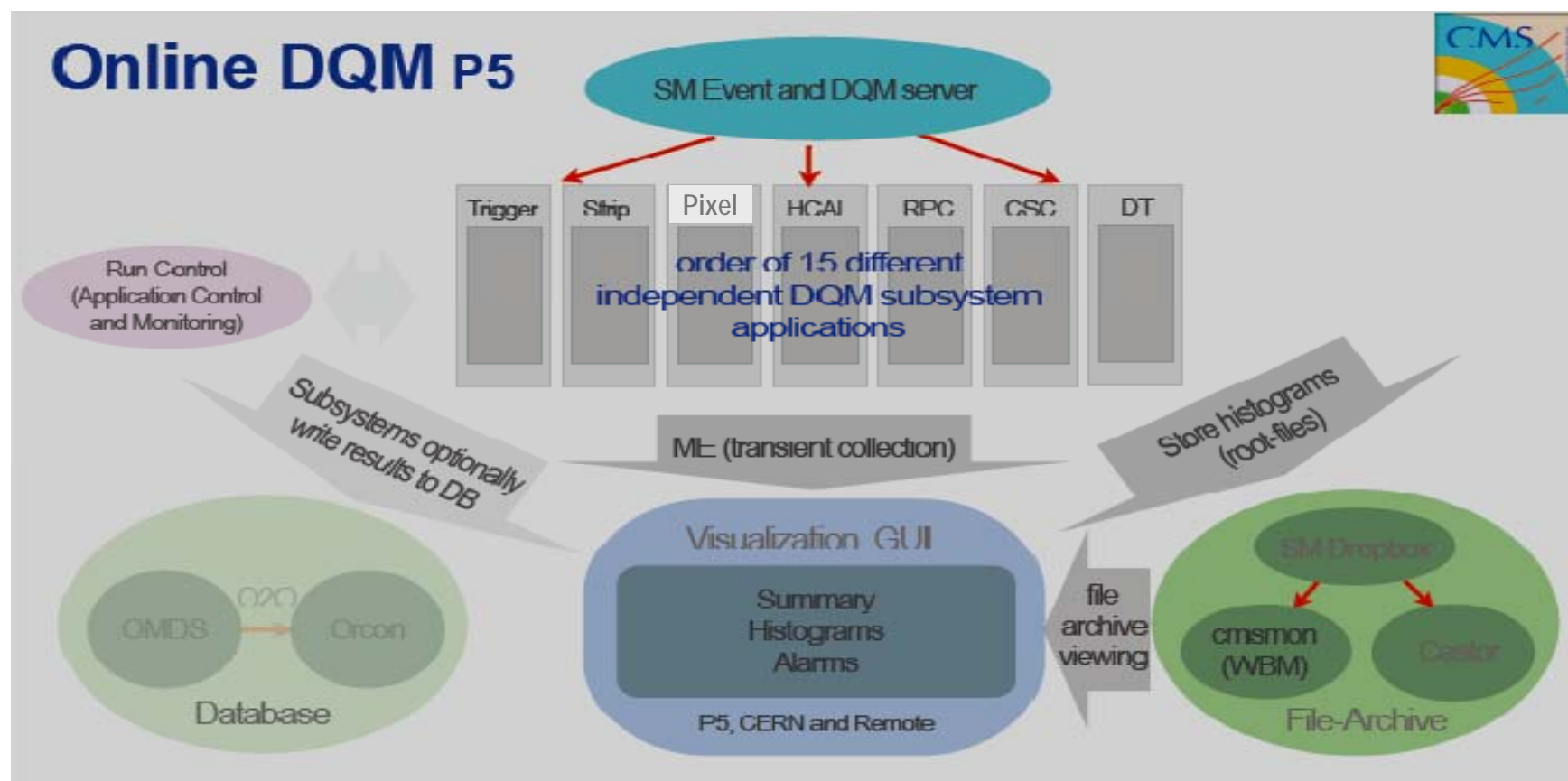


- DQM architecture in CMS
- Pixel specific DQM
- Pixel commissioning via DQM
- online experience: CMS global runs
- offline experience: processing at Tier-0
- summary

CMS DQM : overview



- DQM processes controlled through CMS RunControl (dedicated DQM data stream: fraction of all events: 5-10Hz)
- DQM sources fill histograms (monitoring elements – MEs)
- DQM clients pick up histos and analyze them:
 - create summary histos
 - define and apply quality tests
 - write out all results in root files
- subsystems can write results to DB
- central file archival
- global CMS GUI for shifter



pixel DQM : requirements



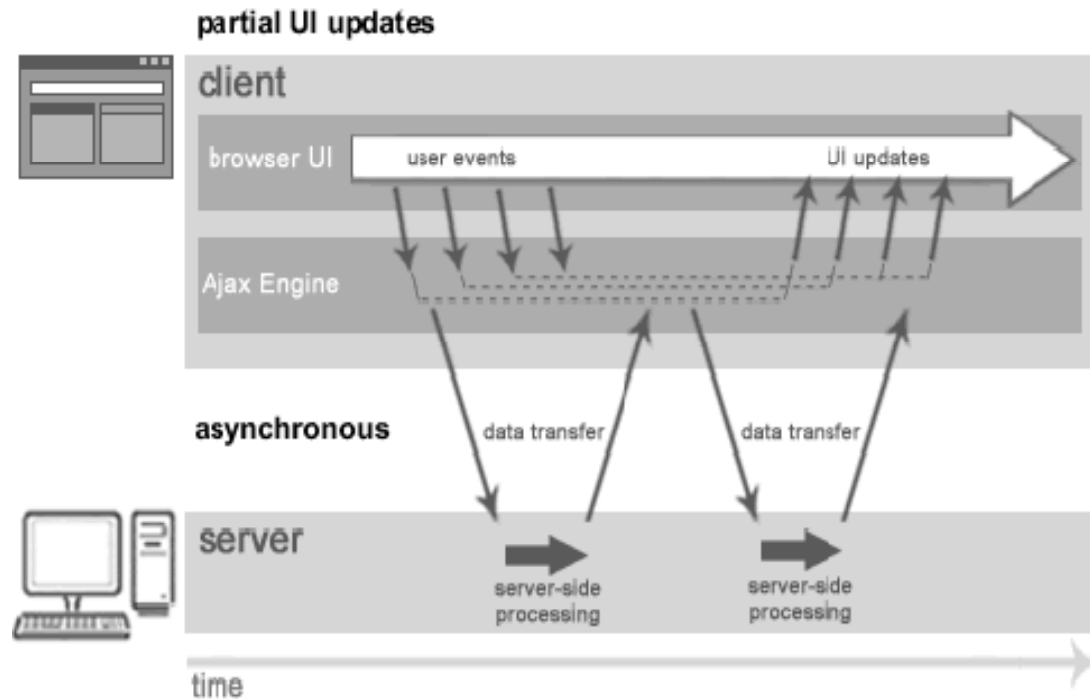
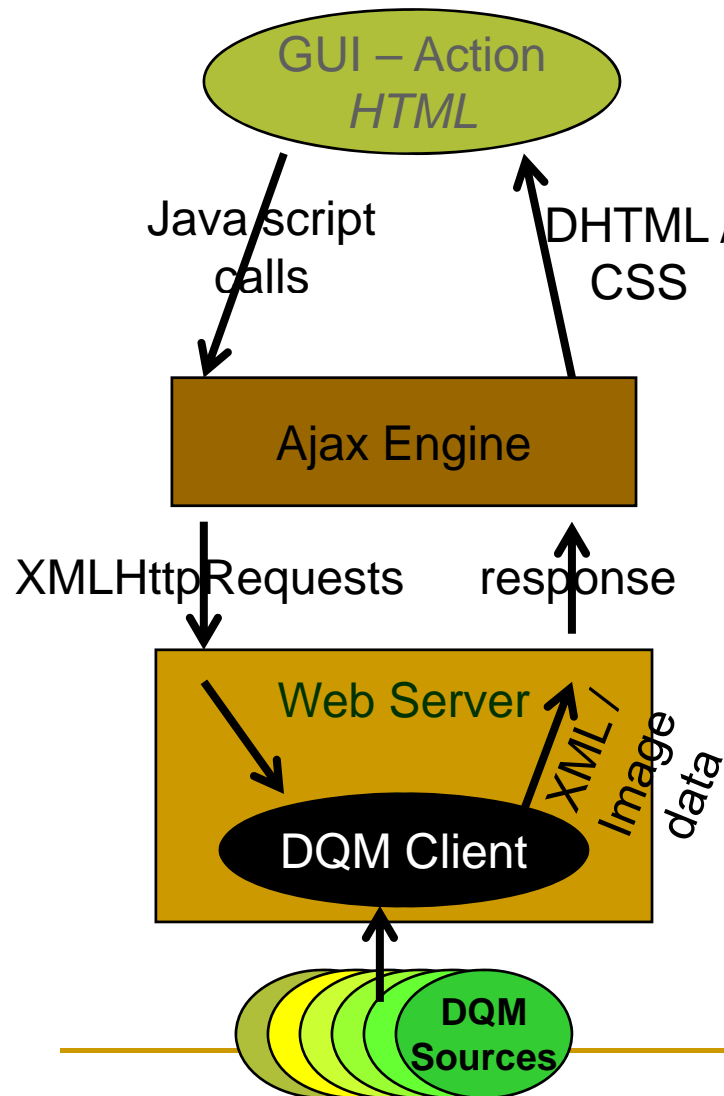
- Forward + barrel pixel ~67M pixels
- Basic monitoring unit: a module (8k - 66k pixels each): 1440 modules
- Need for highly automatized system for quality assurance
- Monitor detector performance, not physics
- Extremely fine detector granularity (a pixel: $100 \times 150 \mu\text{m}^2$)
 - high statistics needed
 - fast application (keep CPU and memory usage in online system low)
- Pixel DQM is versatile and powerful
 - one of the main tools during detector commissioning
 - monitors detector in real time during data taking (limited statistics)
 - and offline (full statistics, calibrations and reconstruction)
- Lots of tools in common with SiStrip DQM: close collaboration

pixel DQM : architecture



- DQM calibration & data sources:
 - **Gain**: measure gain for each pixel
 - **PixelAlive**: detect dead pixels
 - **SCurve**: measure threshold for each pixel
 - **RawData**: errors from FED's and data unpacking
 - **Digis**: charge (ADC) and pixel position
 - **Clusters**: charge (e^-), size and position
 - **RecHits**: position after Lorentz angle correction
 - **Residuals**: unbiased track residuals in x & y
- DQM client & GUI:
 - Run on data and calib sources
 - Perform frequent analyses (at lumi section and run end)
 - **Summary histos, quality tests, global DQM flags**
 - Pixel specific GUI interacts with client at run time (expert operation)
 - **Tree browsing, TrackerMap**
- Historic client:
 - Analyzes distributions and writes some key numbers to the DB
 - Retrieves numbers from DB and fills **historic trend plots**

html - java - ajax - xml - c++



- Asynchronous communication minimizes dead time in browser
- Only modified parts of browser updated

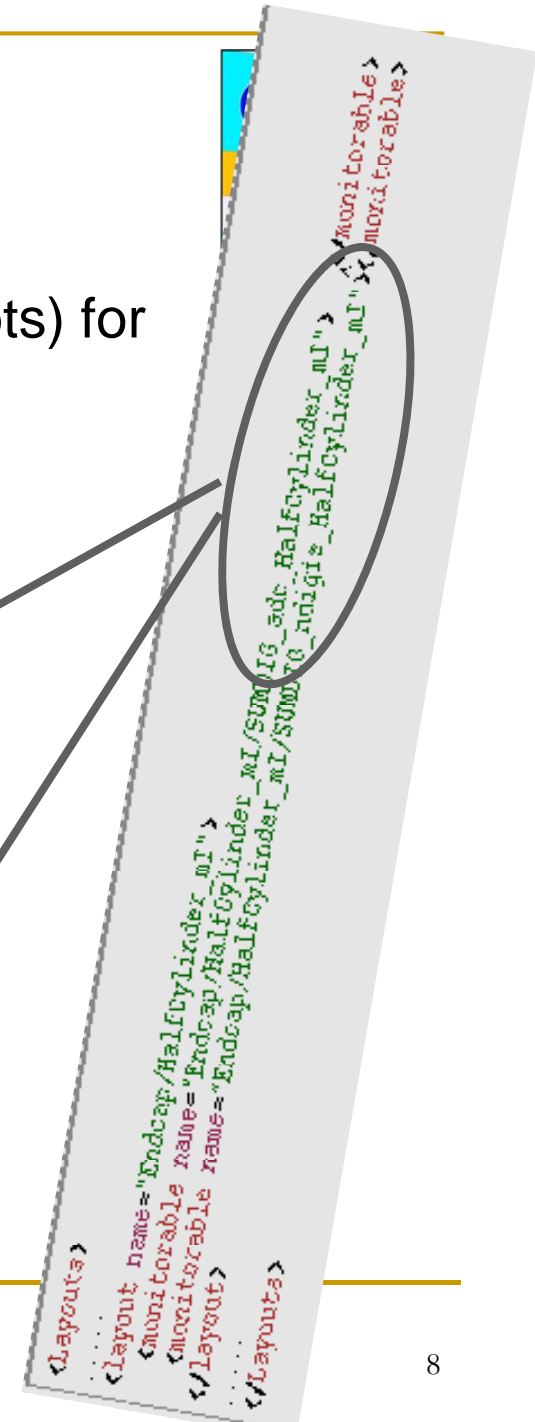
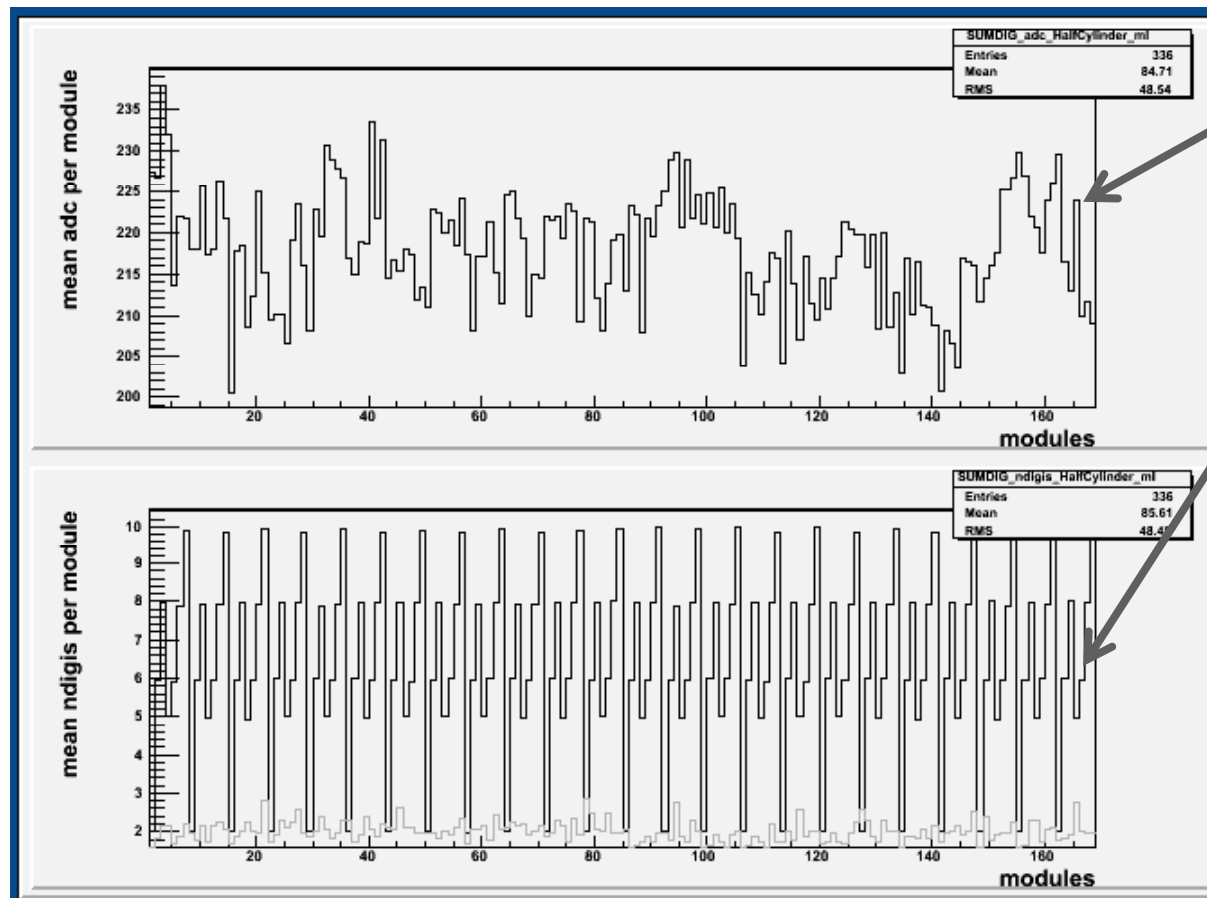
pixel commissioning via DQM



- Pixel commissioning inside CMS ongoing NOW!
- basic connectivity tests → basic DAC tuning → calibration data (Gain, PixelAlive, SCurve)
- analyze calib data with DQM suite
 - advantage of powerful tools:
 - summary histos, TrackerMap, reference histos, quality tests, detector hierarchy navigation, offline browsing
 - offline shifts at CERN and remote
- restricted to offline mode for now due to DB and DAQ slices:
 - calib analyzers need info from online DB in offline DB at run time; not automatized yet
 - calib runs taken in DAQ slices (per FED)
 - 40 FEDs; each connected to one storage manager
 - DQM only set up to run on one storage manager / data stream at the time

pixel DQM for pixel shifters

- Pre-defined non-expert views (static summary plots) for shifters
 - Defined in XML files

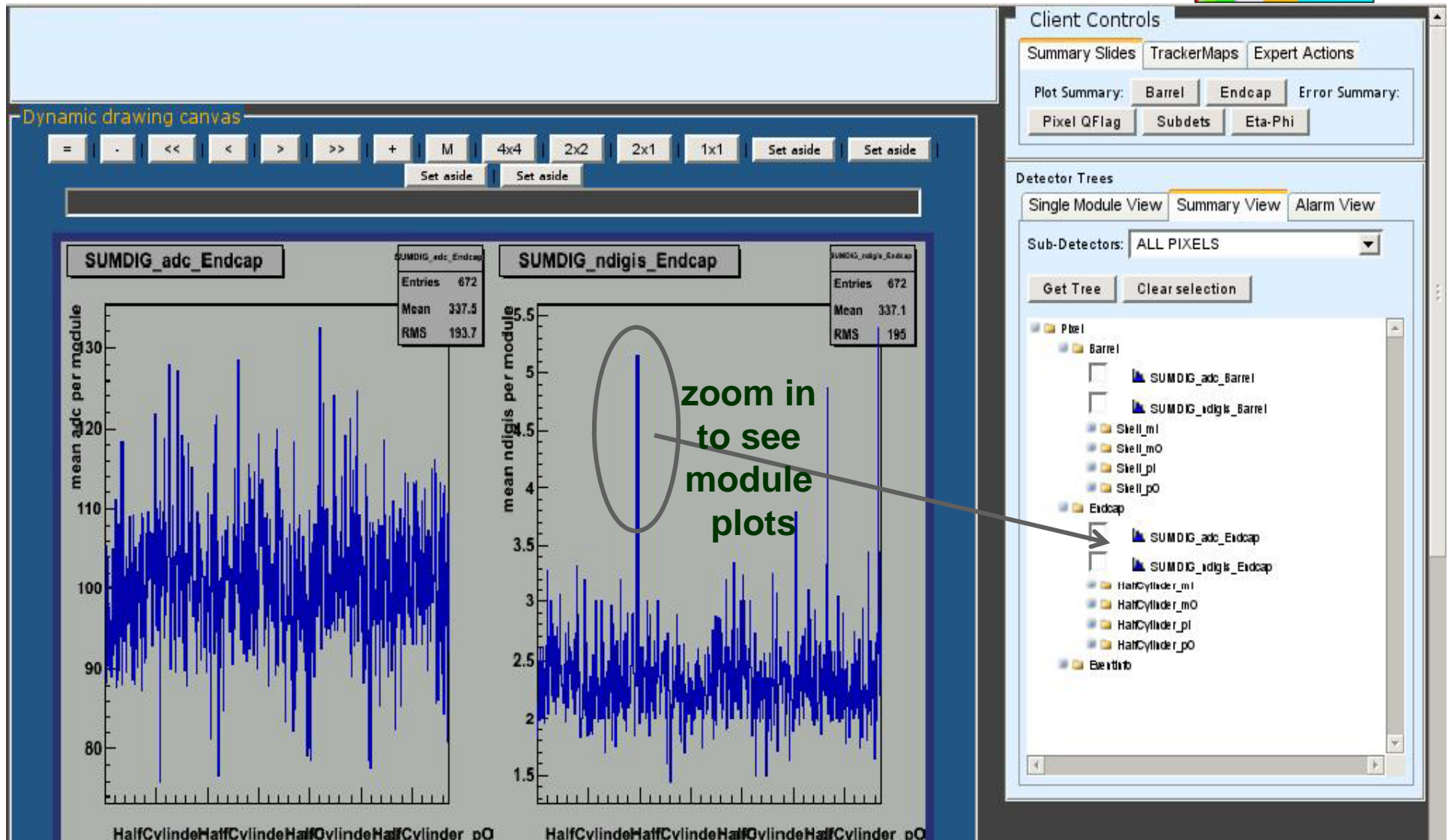


pixel DQM for pixel experts

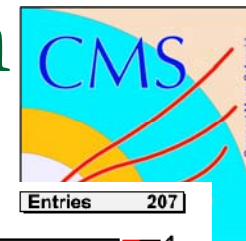


- Pixel specific GUI allows for easy switch between global overview plots and detailed histogram and alarm folder navigation for efficient debugging
 - Spot a problem on overview plots → navigate through detector hierarchy → plot single module distributions on demand
- One page overview in form of:
 - TrackerMap (geometric view)
 - Summary histos (monitor one variable for all modules simultaneously)

Pixel expert GUI

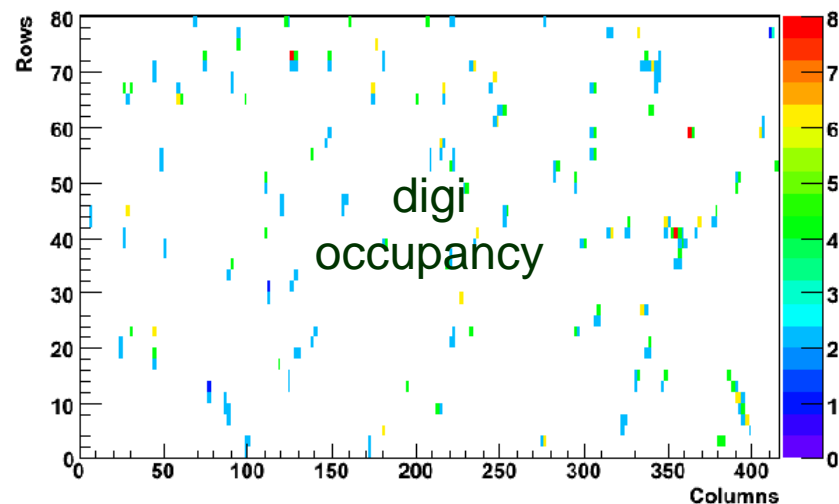


detailed module level information



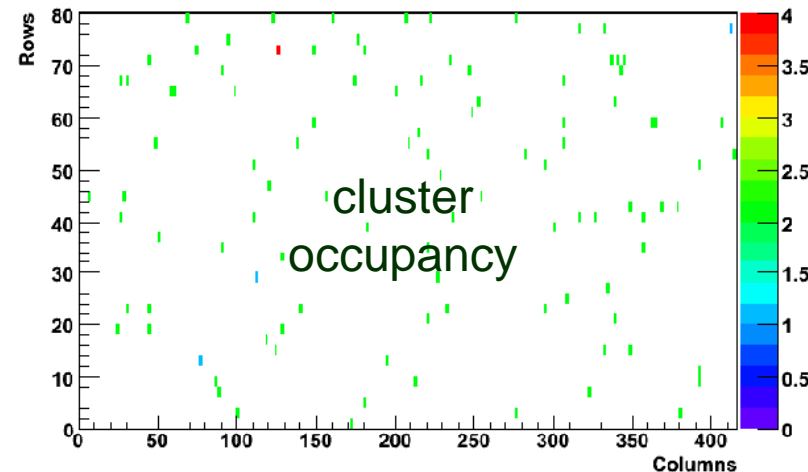
Number of Digits (1bin=four pixels)

Entries 668

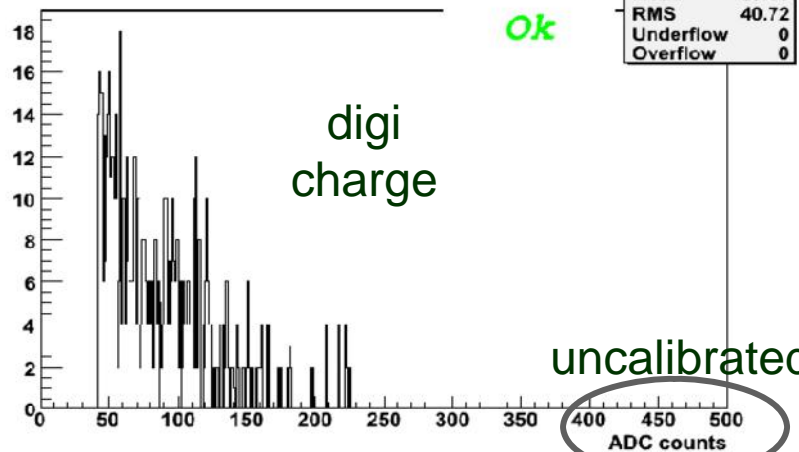


Number of Clusters (1bin=four pixels)

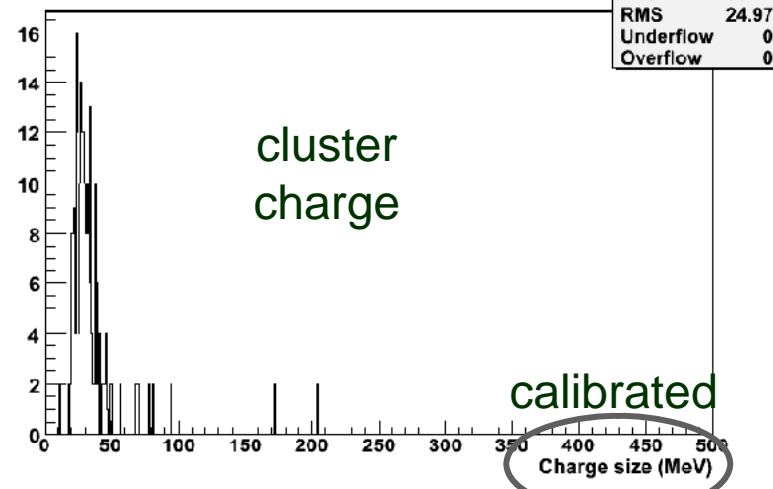
Entries 207



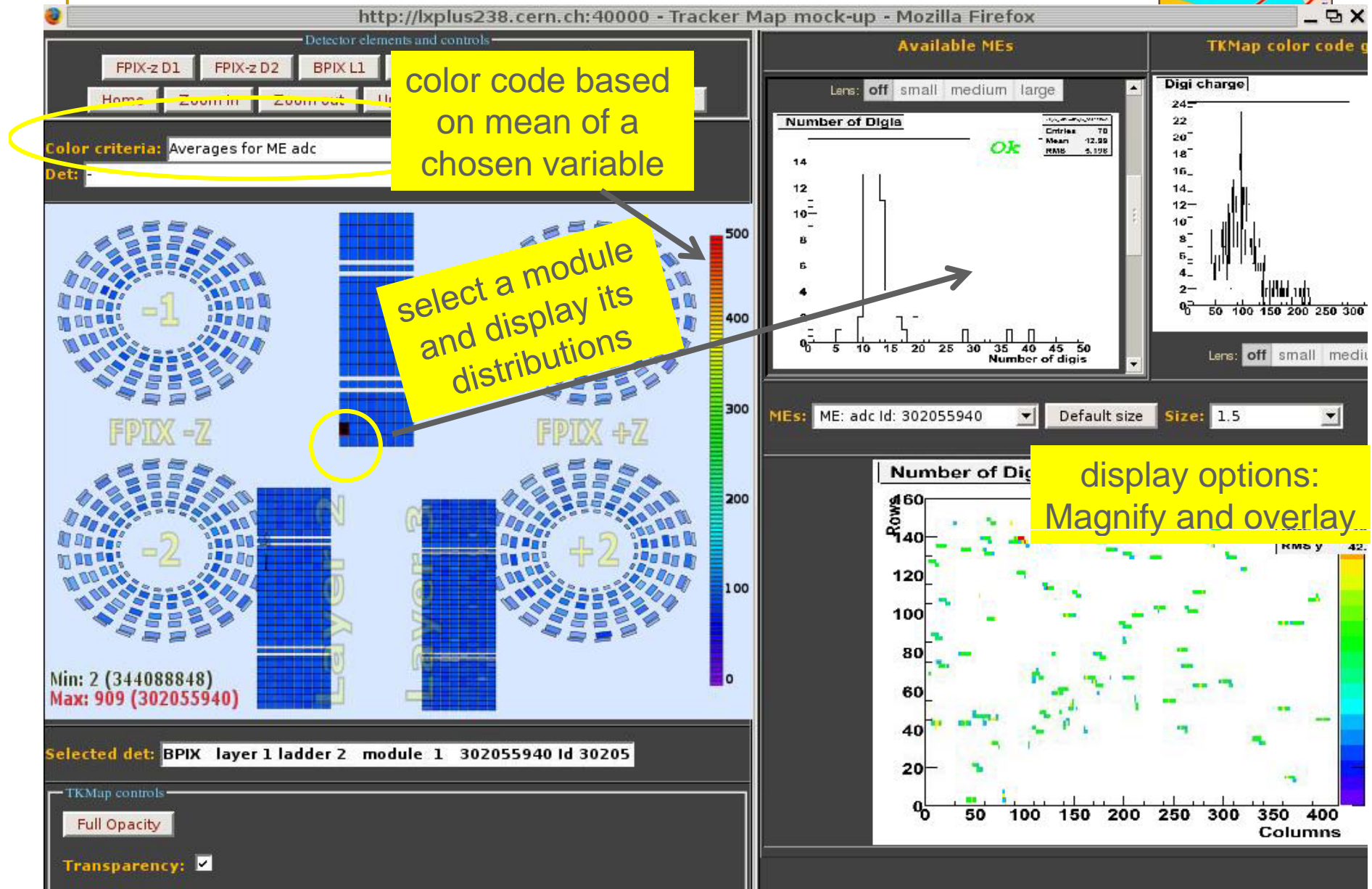
Digi charge



Cluster charge



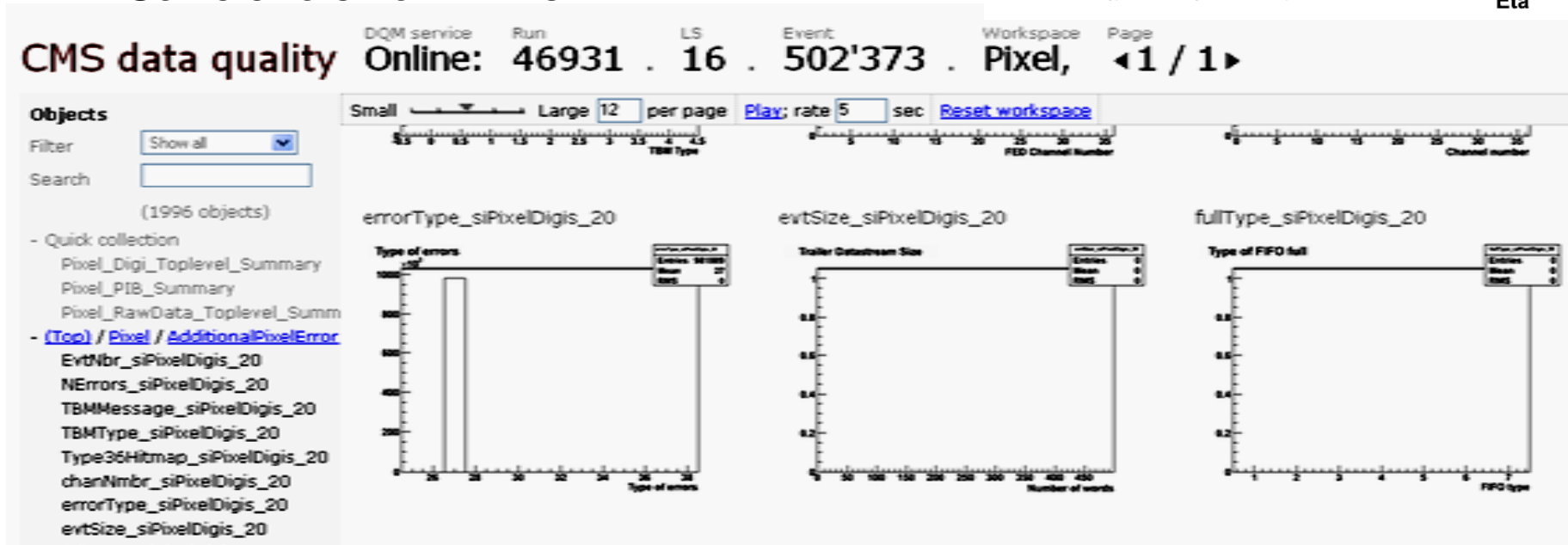
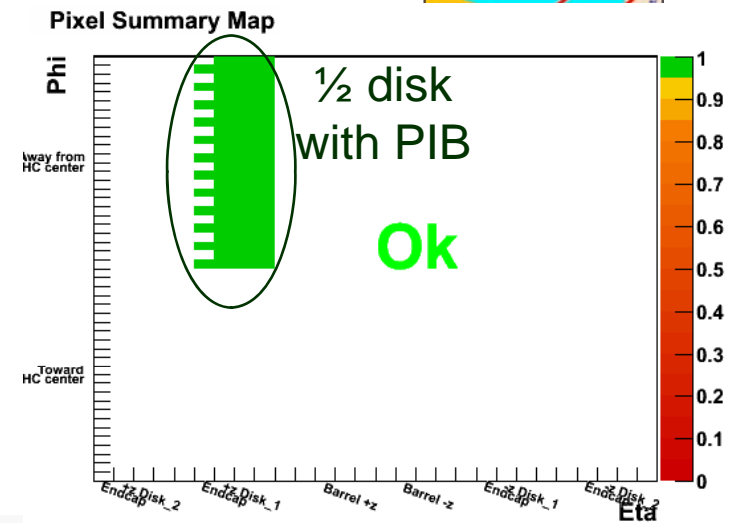
TrackerMap: synoptic view of pixel detector



online experience during global runs



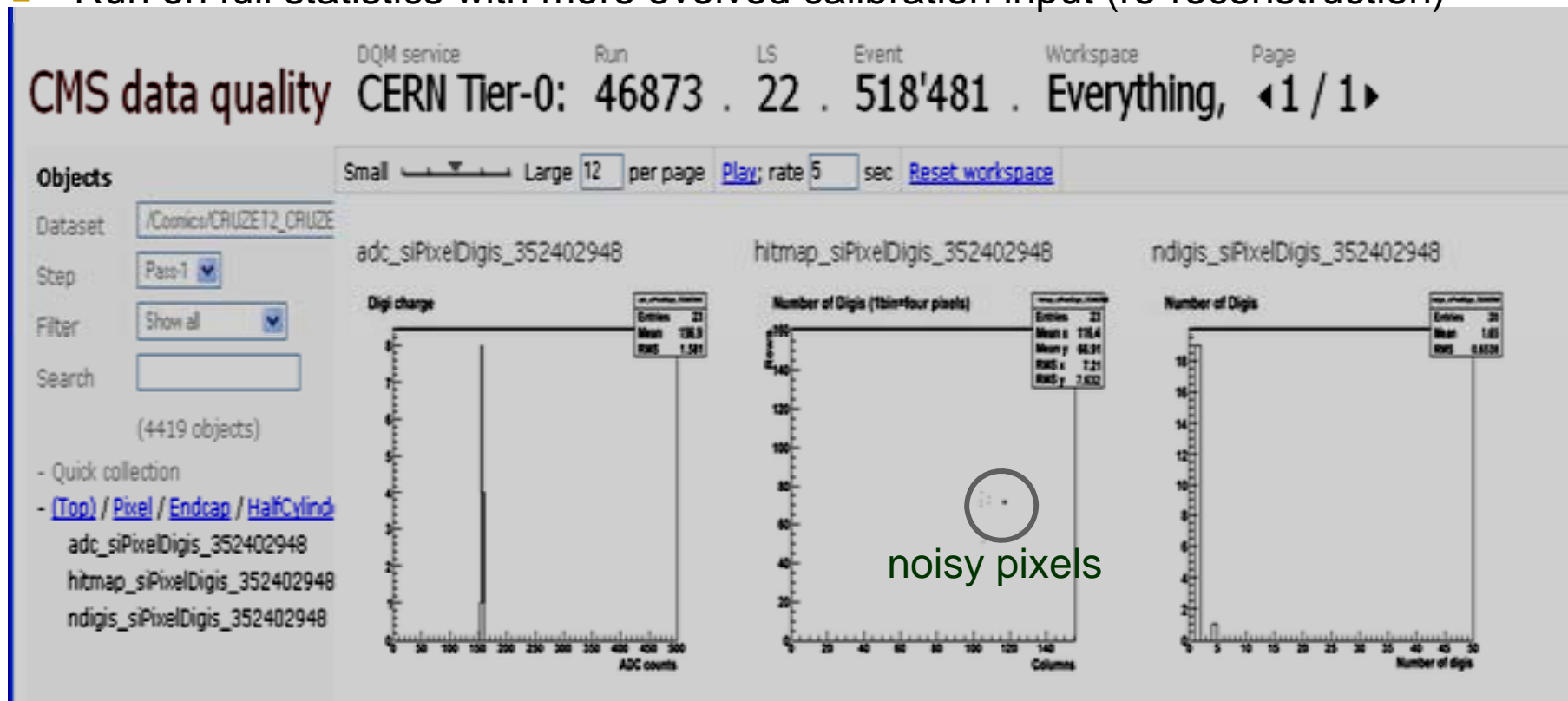
- Pixel DQM included in global data taking since June
- Pixel detector: 1 FPIX panel (3 modules) [Panel In a Box]
- Central GUI: predefined layouts for shifter view + shift instructions
- Some noisy pixels seen (digis)
- Some errors from FEDs



offline DQM



- At Tier-0: almost same code as online (but no XDAQ env. → not interactive)
- Histogram and bin number limitations (memory): switch off module level histos and group together at higher levels instead
- Run on full statistics with more evolved calibration input (re-reconstruction)



summary



- Pixel DQM embedded in common CMS DQM framework + sub-system specific additions (Pixel GUI, TrackerMap, offline browser)
- Heavily used for detector commissioning by experts
- Successfully included in CMS global runs
- Successfully included in offline processing at Tier-0
- Looking forward to real data in a few weeks!

Backup Slides



offline DQM result browsing



- Facilitate extensive result browsing offline:
- similar html – java – ajax – c++ code suite as online, but no interface with DAQ
- executable runs on apache web server (cgi-bin) continuously
- offline browser similar to online GUI allows to load any two DQM root output files:
 - study details on full statistics
 - compare with reference histos
 - study trends

Applications Actions

Pixel DQM Viewer - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://cmsfpix3.cern.ch/ajax/PixelDQMViewer.html

EMAIL JCO CMSSW HYNEWS CMSTC Babel Fish XWHO DBS

Pixel DQM Viewer

SUMDIG adc Barrel

mean adc per Module

Modules

Projection

Entries: 768

Mean: 95.45

RMS: 4.24

Developed by: S. Dutta, adapted for Pixels by P. Merkel

DQM Output Root File Access

choose input files

Type: Local

Update

Current: DQM_RawDigis_Run1.root

Reference: DQM_Gain_Run2445.root

Shifter View Summary View Alarm View Expert View

shifter + expert actions

Sub-Detectors: Barrel

Get Tree

SUMRAW_NErrors_Barrel

SUMRAW_PXId_Barrel

SUMRAW_ROCId_Barrel

SUMRAW_ROCNmbr_Barrel

SUMRAW_TBMTType_Barrel

SUMRAW_chanNmbr_Barrel

SUMRAW_errorType_Barrel

SUMRAW_evtSize_Barrel

SUMRAW_fullType_Barrel

SUMRAW_linkId_Barrel

Shell_ml

Shell_mO

Shell_pl

Shell_pO

detector hierarchy trees, quality test results, and display options

Find: default

Next Previous Highlight all Match case

merkel@cn

Pixel DQM V

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