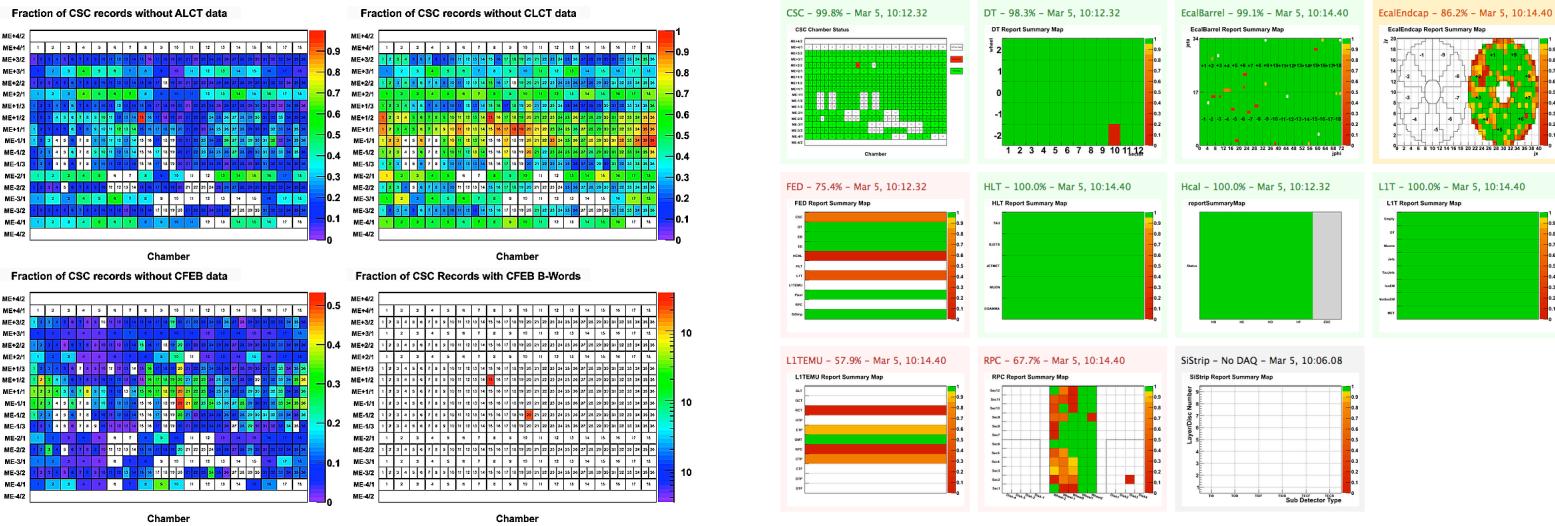


CMS data quality monitoring: systems and experiences



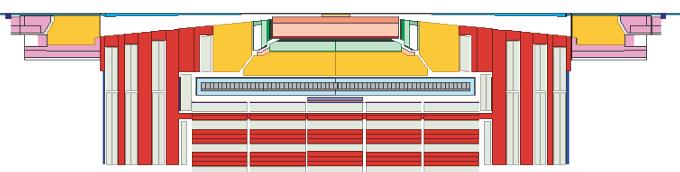
On behalf of the CMS collaboration

Lassi Tuura, Northeastern University

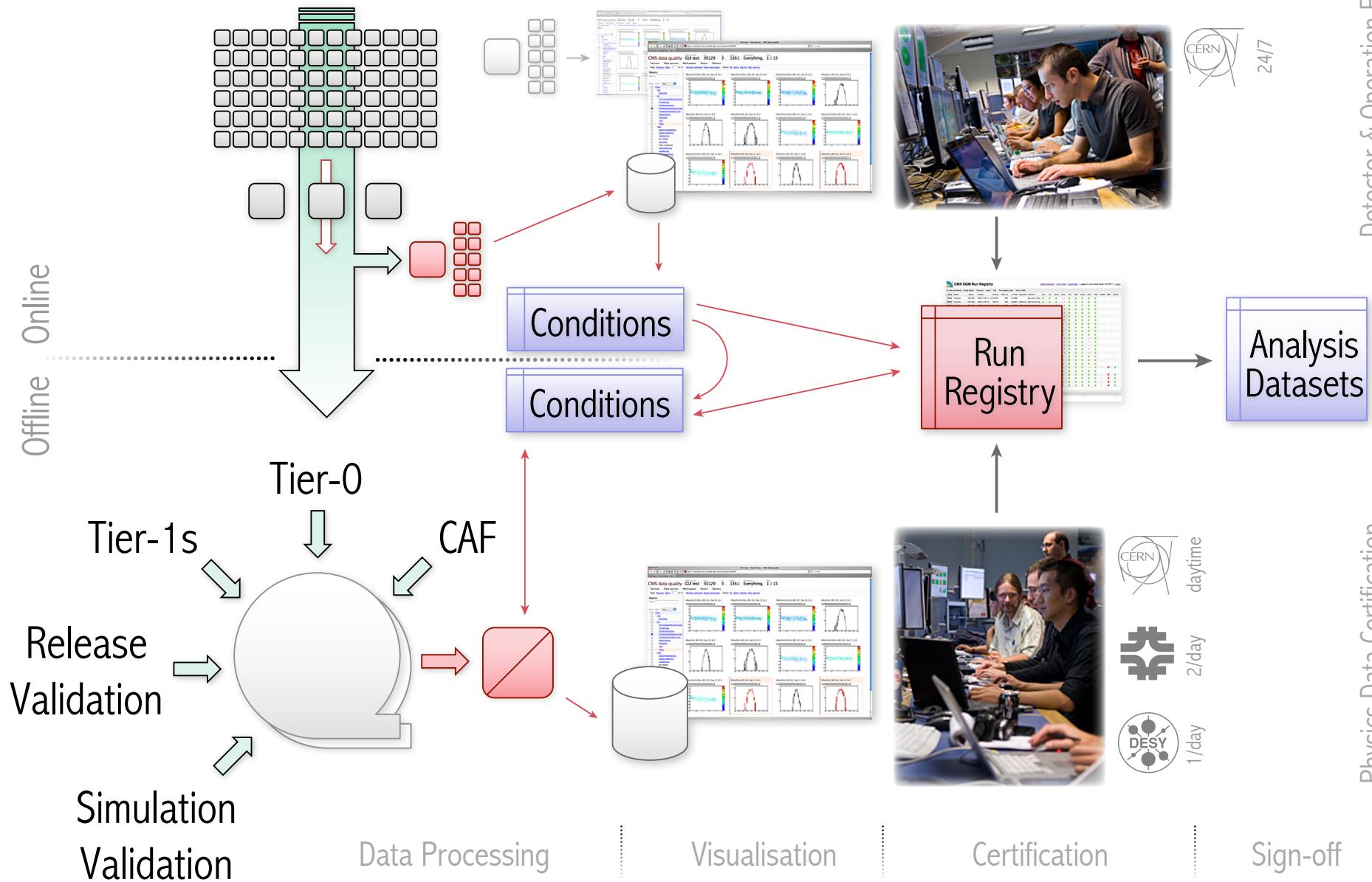
Andreas Meyer, DESY – Ilaria Segoni, CERN

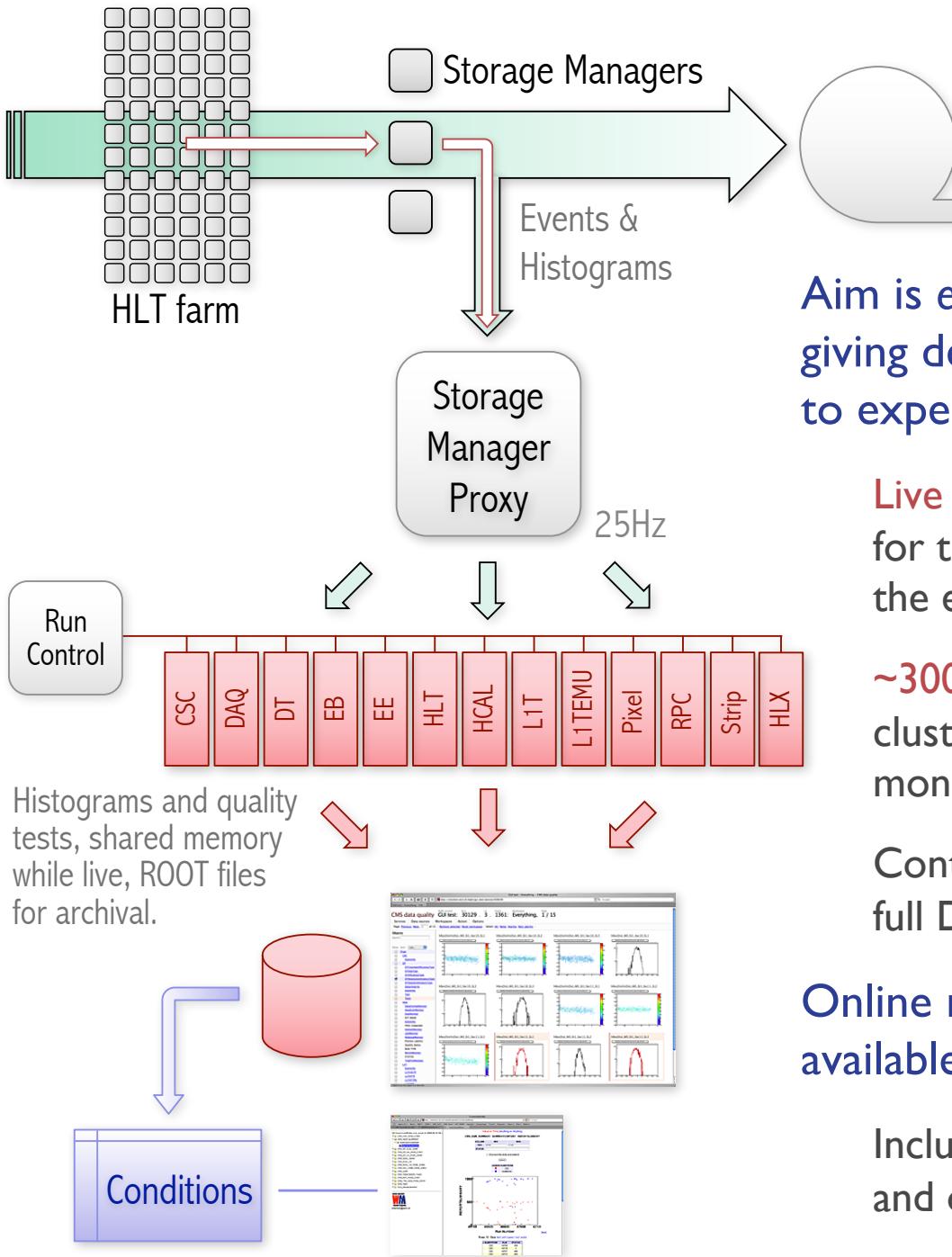
Giuseppe Della Ricca, INFN Sezione di Trieste; Università di Trieste

CHEP'09 – Prague – 21-27 March 2009



DQM end to end





Online DQM

Aim is *efficient detector and operation* by giving detector and trigger status feedback to experts and shifters.

Live display at $\Delta t \sim$ seconds plus **ITB** space for the **archive** of recent runs accessible to the entire CMS in real time.

~300k histograms produced on DQM cluster, \sim 50k shown in GUI. HLT: 15 trigger monitoring, 3x8 FED subsystem histograms.

Continuous, **dead-line free integration** of the full DQM chain in a replica playback system.

Online results, initial run summary made available to offline analysis and processing.

Includes online detector quality summary and other key values in conditions database.

Standard high-level overview

Access to live and archived runs in a central web GUI.

Standard high-level subsystem summary as a 2D map.

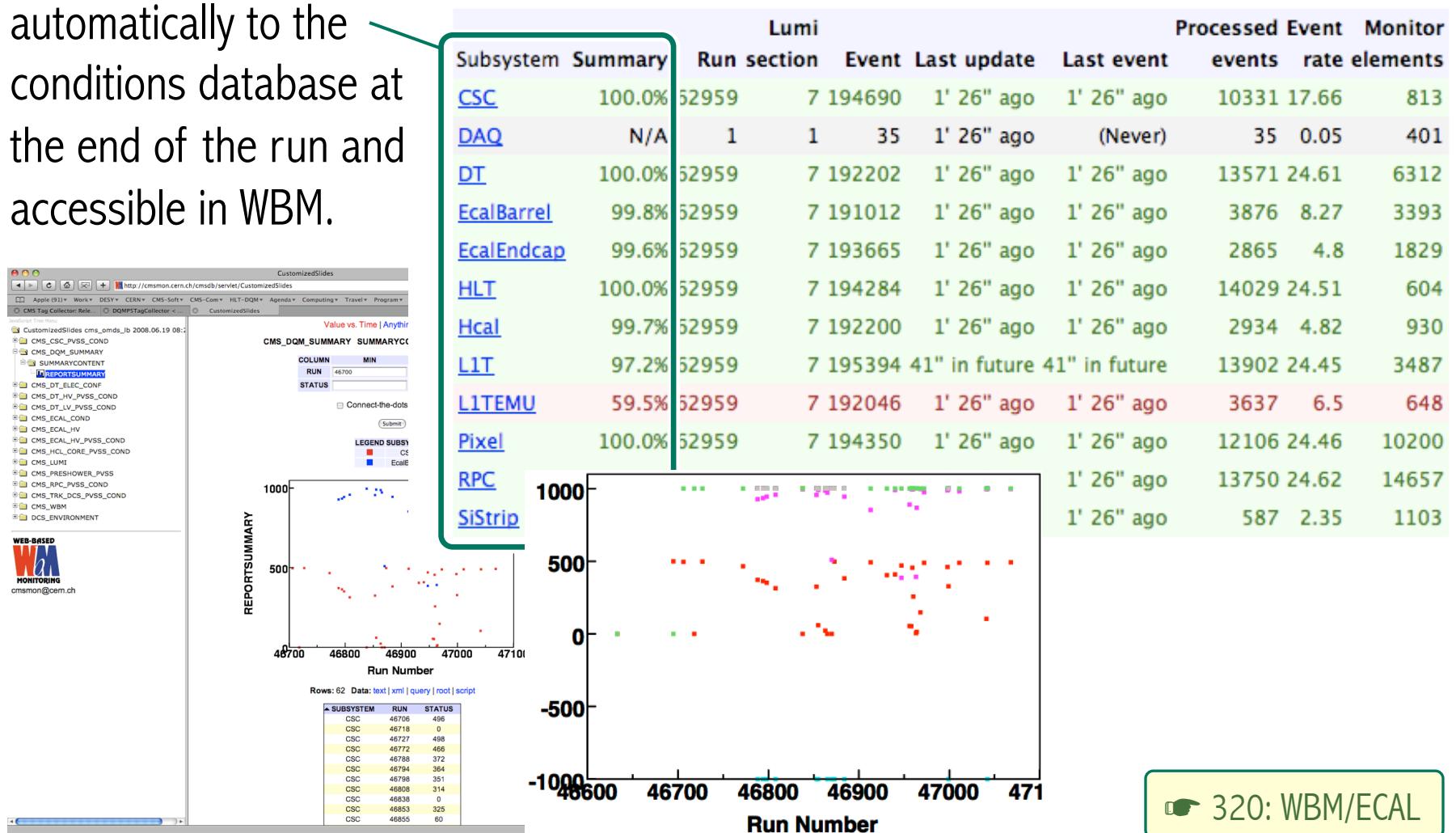


234: DQM GUI

Standard high-level reports

Per system quality summary, copied automatically to the conditions database at the end of the run and accessible in WBM.

CMS data quality DQM service Online: Run 62'959 . LS 7 . Event 195'394 . Workspace Rep



320: WBM/ECAL

Standard shift views

CMS data quality

DQM service Run LS Event Workspace Page
Online Playback: 47041 . 4 . 312'035 . Everything, ▶ 1 / 1 ▶

Objects

Dataset **/Global/Online/ALL**

Step **Global run**

Filter **Show all**

Search
(16142 objects)

Quick collection

- (Top)

- 00 Shift

- + CSC
- + DT
- + EcalBarrel**
- + Hcal
- + L1T
- + Pixel
- + SiStrip**

- CSC

- + DDU
- + EventInfo
- + Layouts
- + Summary

- DT

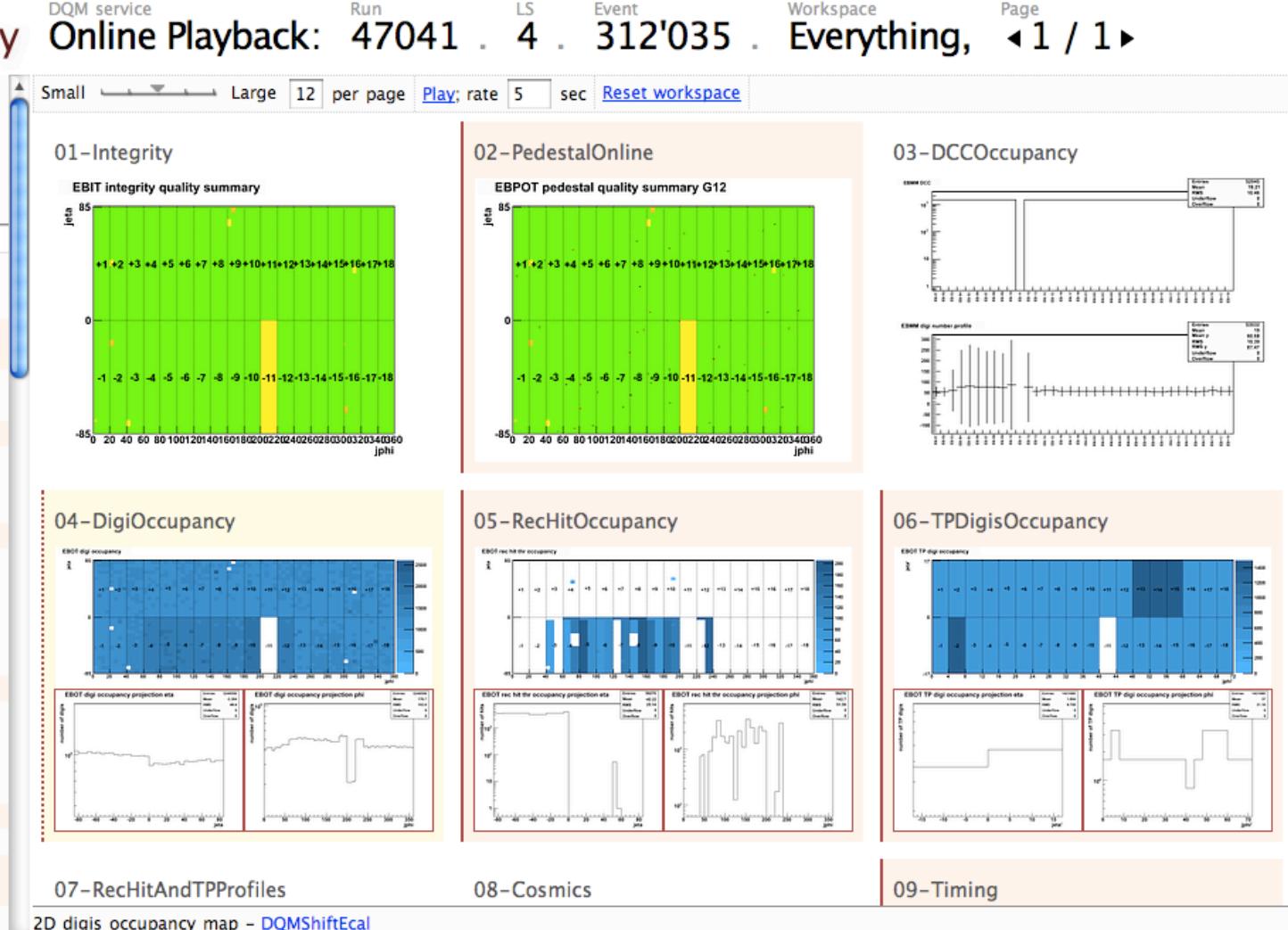
- + DataIntegrity
- + Digi
- + EventInfo
- + Layouts

+ LocalTrigger

- + Segments

- EcalBarrel

- + EBClusterTask
- + EBCosmicTask



Standard per-subsystem shift views
with links to the shift documentation

See also [draft shift instructions](#).
session is modifiable

Tested on playback system!



List of Shift Histograms

ECAL DQM report summary

Description: the histogram shows, for each 5x5 crystals matrix, the fraction of good channels / 25. The goodness of the crystal is decided based on the results of many analysis on it. The grid with numbers delimit different readout units (supermodules in barrel, sectors in endcap). They are known as FEDs

Legend:

- green : status = [95-100)%
- yellow : status = [85-95)%
- red : status = [0-85)%
- white: not being readout (not in DAQ)

Evaluation criteria: The overall % of the subsystem should be more than 98% and different regions in the 2D plot should be Green. Red or Yellow regions in the histogram would represent problems

Subsystem Evaluation and Action: if one FED has a % less than 95%, the reason has to be identified in the plots below and a commented. If it is lower than 85%, the expert should be contacted. The same if the overall status of the subsystem is lower than 85%.

01-Integrity

Description: quality summary checking that data for each crystal follows all the formating rules and all the constraints which are dictated by the design of the electronics.

green : good; **red :** bad; **yellow :** no entries.

Evaluation criteria: It should be all green.

Subsystem Evaluation: a single crystal (a pixel in this scale) with integrity errors is not a problem. This will be skipped in reconstruction. Regions with concentrated red spots are problems because entire trigger towers are badly formatted.

Action Items: In presence of red regions, call the ECAL DAQ experts.

02-PedestalOnline

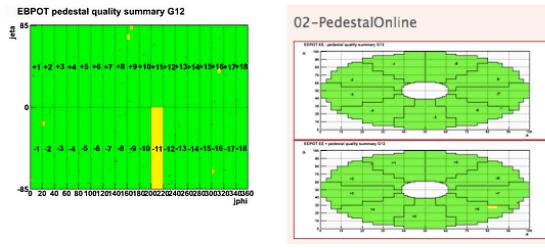
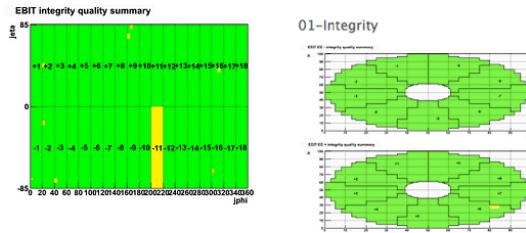
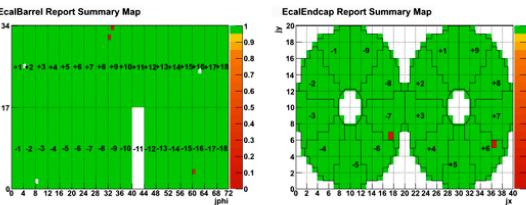
Description: quality summary checking the level of noise of ECAL. The pedestals are evaluated from the first three pre-samples of the pulse shape. Mean of the pedestal is checked to be in the expected range (sensitive to the magnetic field) and RMS below threshold (sensitive to the noise).

green : good; **red :** bad; **yellow :** no entries.

Evaluation criteria: It should be all green.

Subsystem Evaluation: a single crystal (a pixel in this scale) noisy is not a problem in a certain run. Diffuse noise in all the barrel is a problem.

Action Items: 2 adjacent Trigger Towers red (rectangular areas red) probably means a HV channel off (call ECAL HV expert). L-shaped red bars in a supermodule means probably laser events polluting physics events. Call the ECAL laser expert.



Online DQM shifts operated at *Point-5*, with remote assistance from remote centres.

Offline DQM shifts operated from the CMS centres at *Meyrin, FNAL and DESY*.

Standard shift instructions have been fully exercised. Perpetual effort to optimise histograms to maximise sensitivity to problems, to standardise the look and feel and to improve efficiency through better documentation.

Offline DQM

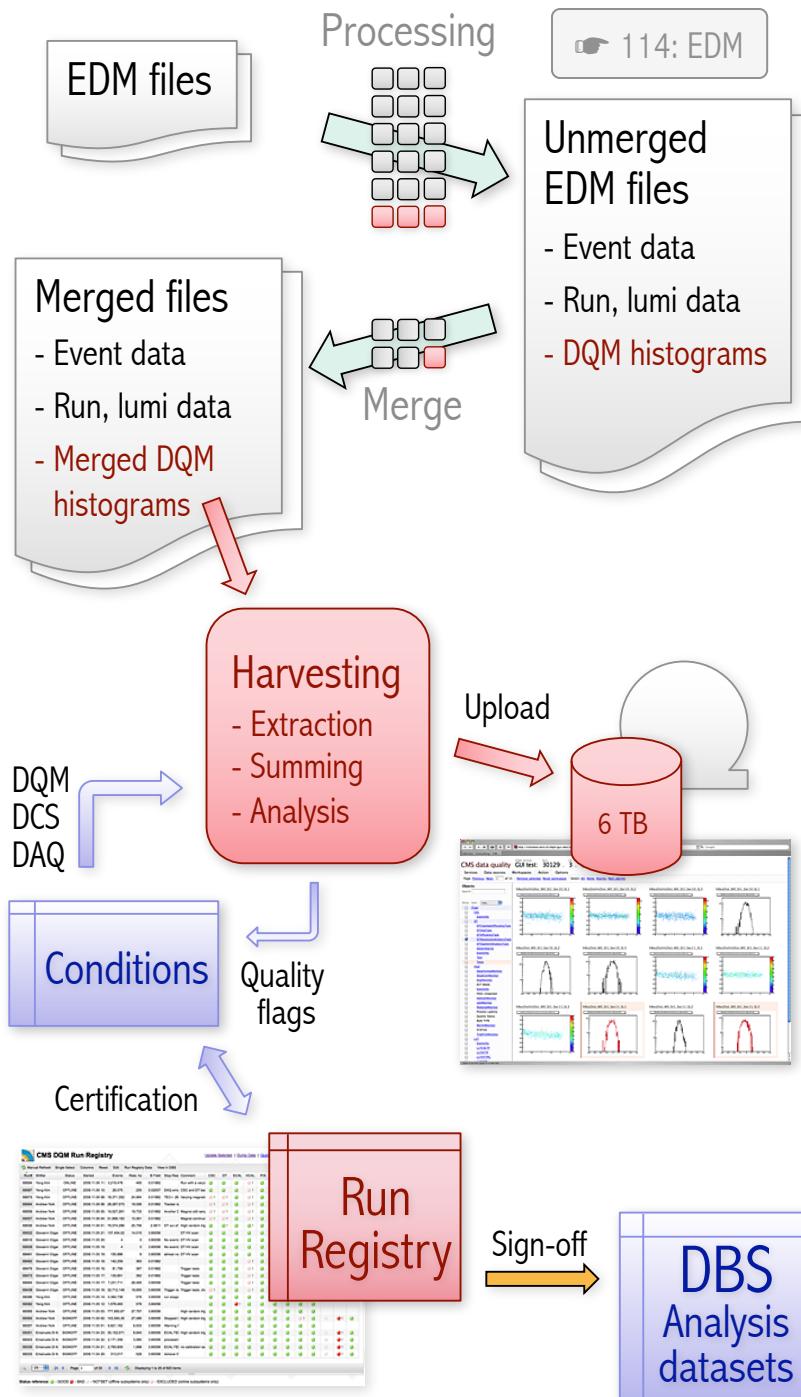
Prompt, AI-Ca and re-reconstruction, and simulation, release validation all use the same processing model.

Histograms created in jobs, saved in normal data files, harvested periodically and merged into full statistics with DAQ, DCS info and finally tested for quality and summarised.

Resulting histograms are uploaded to the GUI web server hosted at CERN, backed up to MSS and recent files copied to AFS.

Final quality summary flags are stored into condition database for *certification*.

Differences are in content and timing. Tier-0, Tier-1s re-determine detector status using full event statistics, full reconstruction, plus add monitoring for physics objects; Tier-0 $\Delta t \sim$ one day, Tier-1s days+. CAF Δt hours to days on AI-Ca entities. Validation verifies MC data.





	Manual Refresh	Single Select	Columns	Reset	Edit	Run Registry Data		View in DBS													
Run#	Shifter	Status	Started	Events	Rate, hz	B Field	Stop Reason	Comment	CSC	DT	ECAL	HCAL	PIX	RPC	SCAL	SIST	TRG	EGAM	JMET	MUON	
69594	Yong Kim	ONLINE	2008.11.06 11:30:00	3,219,478	465	0.01882		Run with varying magnetic field	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
69587	Yong Kim	OFFLINE	2008.11.06 10:45:00	26,075	255	0.02007	DAQ error	CSC and DT bad	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
69573	Yong Kim	OFFLINE	2008.11.06 08:45:00	18,371,352	24,994	0.01882	TEC+/- 26%	Varying magnetic field	✗ !	✗ !	✓	✗ !	✓	✓	✓	✓	✓	✓	✓	✓	✓
69564	Andrew York	OFFLINE	2008.11.06 06:45:00	28,267,073	19,556	0.01882	Tracker issues		✗ !	✗ !	✓	✗ !	✓	✓	✓	✓	✓	✓	✓	✓	✓
69559	Andrew York	OFFLINE	2008.11.06 05:45:00	19,527,261	19,733	0.01882	Another DQM run	Magnet still ramping	✗ !	✗ !	✓	✗ !	✓	✓	✓	✓	✓	✓	✓	✓	✓
69557	Andrew York	OFFLINE	2008.11.06 04:45:00	51,898,183	15,561	0.01882		Magnet continuing to ramp	✗ !	✗ !	✓	✗ !	✓	✓	✓	✓	✓	✓	✓	✓	✓
69536	Andrew York	OFFLINE	2008.11.06 01:45:00	79,574,286	25,756	2.0811	DT out of range	High random trigger rate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69522	Giovanni Organtini	OFFLINE	2008.11.05 21:45:00	137,404,02	14,015	3.80056		DT HV scan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69515	Giovanni Organtini	OFFLINE	2008.11.05 20:45:00	4	0	3.80056	No events	DT HV scan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69509	Giovanni Organtini	OFFLINE	2008.11.05 19:45:00	4	0	3.80056	No events	DT HV scan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69491	Giovanni Organtini	OFFLINE	2008.11.05 19:45:00	155,886	6	3.80056	almost no events	DT HV scan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69482	Giovanni Organtini	OFFLINE	2008.11.05 18:45:00	142,259	363	0.01882			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ !	✓
69475	Giovanni Organtini	OFFLINE	2008.11.05 18:45:00	81,756	367	0.01882		Trigger tests	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ !	✓
69473	Giovanni Organtini	OFFLINE	2008.11.05 17:45:00	135,851	362	0.01882		Trigger tests	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ !	✓
69464	Giovanni Organtini	OFFLINE	2008.11.05 17:45:00	7,231,711	28,465	3.80056		Trigger tests	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ !	✓
69438	Giovanni Organtini	OFFLINE	2008.11.05 16:45:00	32,712,148	18,855	3.80056	Trigger rate	Trigger tests: changing	✗ !	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ !	✓
69396	Yong Kim	OFFLINE	2008.11.05 14:45:00	4,364,738	576	3.80056	run stopped		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69382	Yong Kim	OFFLINE	2008.11.05 12:45:00	1,578,483	576	3.80056			✓	✓	✓	✗ !	✓	✓	✓	✓	✓	✓	✓	✓	✓
69365	Andrew York	OFFLINE	2008.11.05 03:45:00	777,850,67	27,757	3.80056		High random trigger rate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69364	Andrew York	SIGNOFF	2008.11.05 02:45:00	103,593,35	27,085	3.80056	Stopped test	High random trigger rate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗ !	✓
69357	Andrew York	OFFLINE	2008.11.05 01:45:00	6,621,162	6,933	3.80056	Warning flag		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Run registry is our central workflow tool which both steers the process and tracks certification and quality knowledge, including manual notes. It interfaces with the conditions databases and the dataset bookkeeping system. Online and offline shifters add initial notes, detectors and physics groups add certification from DQM, and the final results are confirmed in weekly sign-off meetings.

DBS discovery :: Run search :: Results :: Run information
Physicist

For run range 70000-70687 found 724 run,dataset entries

Number of rows per page

Result page: [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [Next »](#)

found 36 run(s). Run range: 70000-70687. Show PhEDEx [info](#).

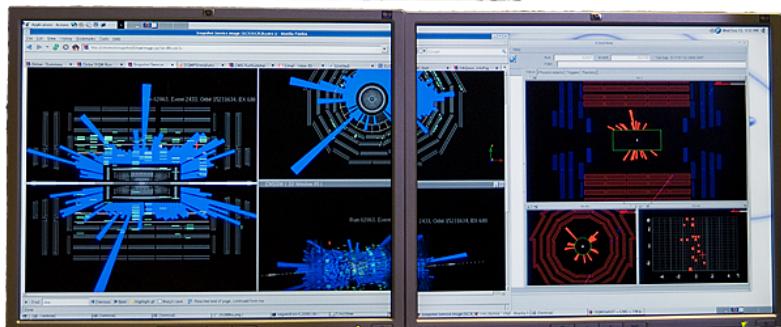
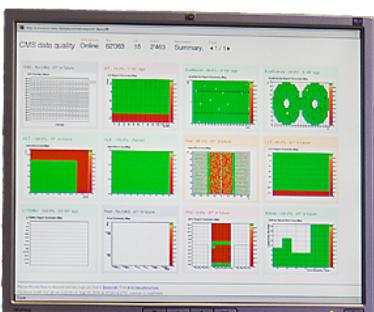
Jump to run range: -

Run	Type	Events	Store	Start of run	End of run	dataset	# Files	Size	LFNs	Transfer	Data Quality	Run Summary
70687	DQM		data	0	01226390992	/Calo /Commissioning08-PromptReco-v2 /RECO	1	3.0MB	cff plain details cff wParents py wParents	cmssrm.fnal.gov srm-cms.cern.ch gridka-dCache.fzk.de	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
						/Calo /Commissioning08-v1 /RAW	1	1.1MB	cff plain details cff wParents py wParents	cmssrm.fnal.gov gridka-dCache.fzk.de srm-cms.cern.ch	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
						/Cosmics /Commissioning08-PromptReco-v2 /RECO	3	946.5MB	cff plain details cff wParents py wParents	ccsrn.in2p3.fr srm-cms.cern.ch srm.ciemat.es srm.ihepa.ufl.edu cmssrm.fnal.gov t2-srm-02.lnl.infn.it	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
						/Cosmics /Commissioning08-v1 /RAW	3	393.9MB	cff plain details cff	srm-cms.cern.ch cmssrm.fnal.gov ccsrn.in2p3.fr cmsdcache.ni.infn.it	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	

Quality flags uploaded to the dataset bookkeeping system are available for in the data discovery and query interfaces and are also used to define **analysis datasets**. The flag assignments are versioned in case revisions are needed.



↑ CMS centre at CERN Meyrin site, 10 Sept 2008.
Dozens of screens visualise DQM histograms live.



← One of the DQM and
event display stations.

→ 61: LHC first beam

Experience and Summary

CMS has commissioned a full end to end data quality monitoring system in tandem with the detector over the last two years.

Online DQM has been in production for about a year and the full offline chain has now been commissioned. We have just recently completed the first full cycle of certification and sign-offs. DQM for the less structured alignment and calibration at CAF exists but a fair amount of work remains.

In our experience **it takes about one year to commission a major component** such as online DQM to production quality.

Shift organisation, instructions, tutorials and supervision are major undertakings in their own right.

We have so far focused on commissioning a common first order DQM system throughout the entire experiment.

Second order features will come later.

Modest amounts of code for DQM core. The time goes into developing DQM algorithms, standardisation and integration of workflows, procedures, code, systems and servers.

Very modest manpower for DQM itself, a truly collaborative effort with a lot of people from numerous other projects: trigger, detector subsystems, offline and physics software, production tools, operators, etc.

We are pleased with DQM visualisation served using web technology and operating shifts from the CMS centres. These have been practical enabling factors.

For more information...

Unfortunately details beyond the talks and posters at this conference are limited to CMS collaborators only due to the September 2008 security breach. We think e-mail might not be cut off, you can try to reach us at:

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