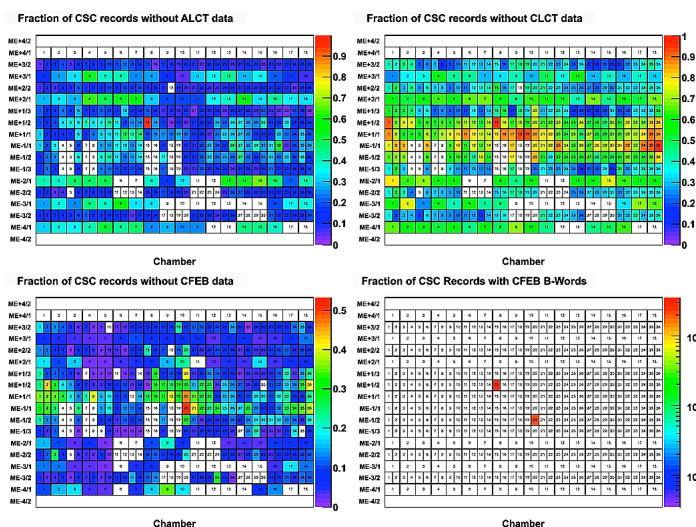


CMS data quality monitoring: systems and experiences



On behalf of the CMS collaboration

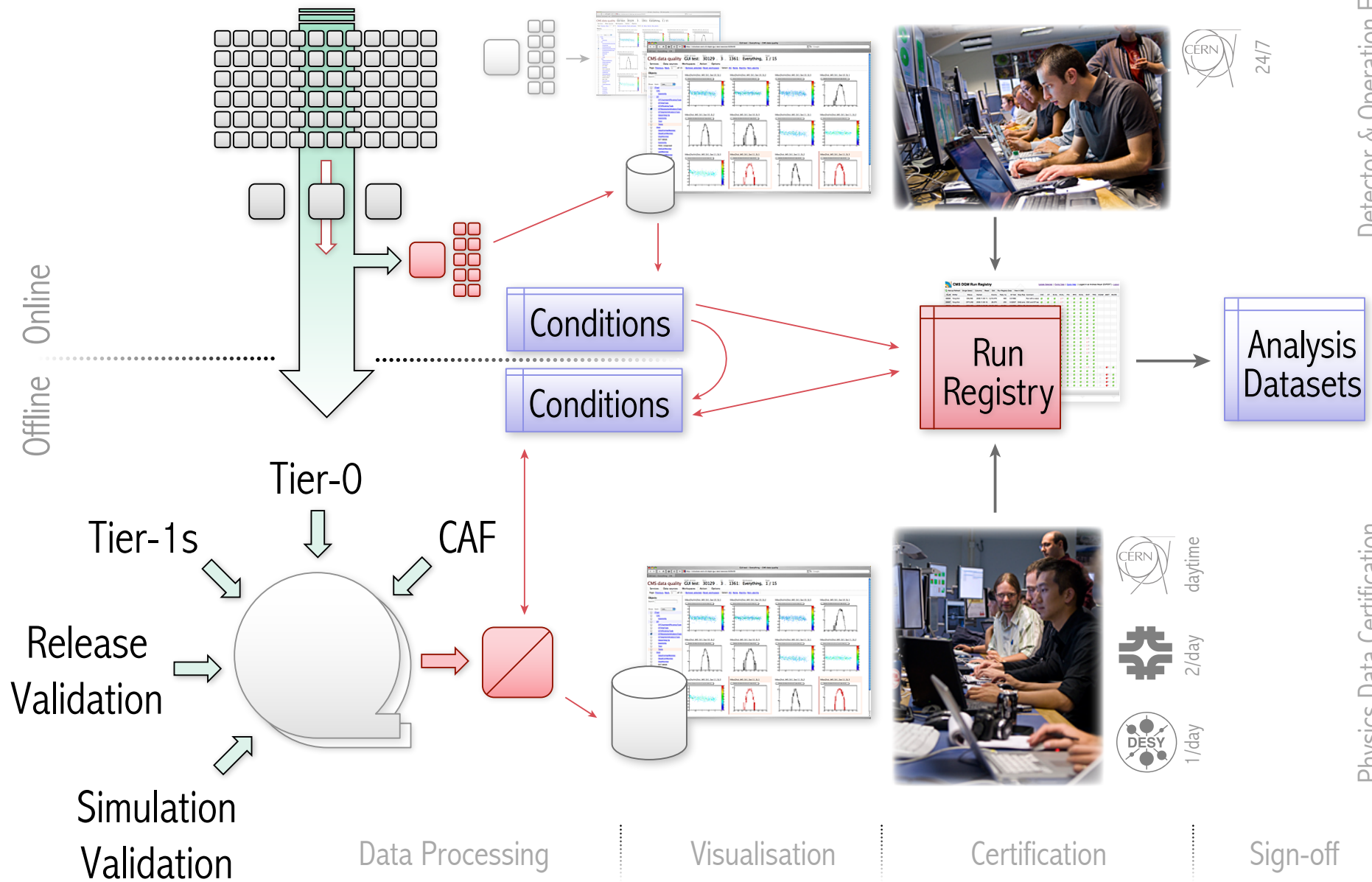
Lassi Tuura, *Northeastern University*

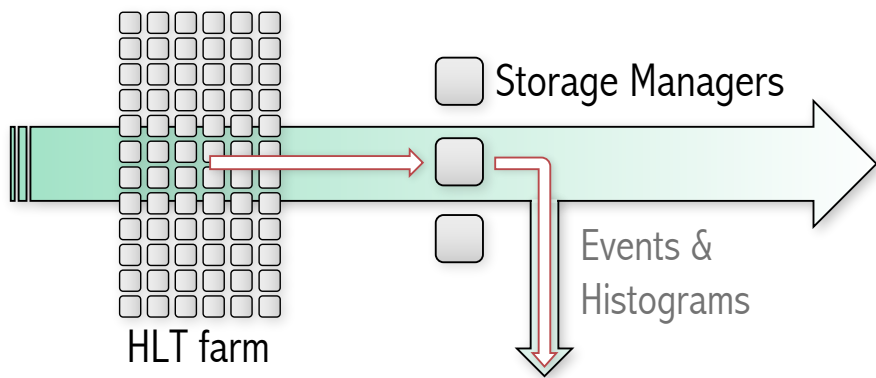
Andreas Meyer, *DESY* – Ilaria Segoni, *CERN*

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.

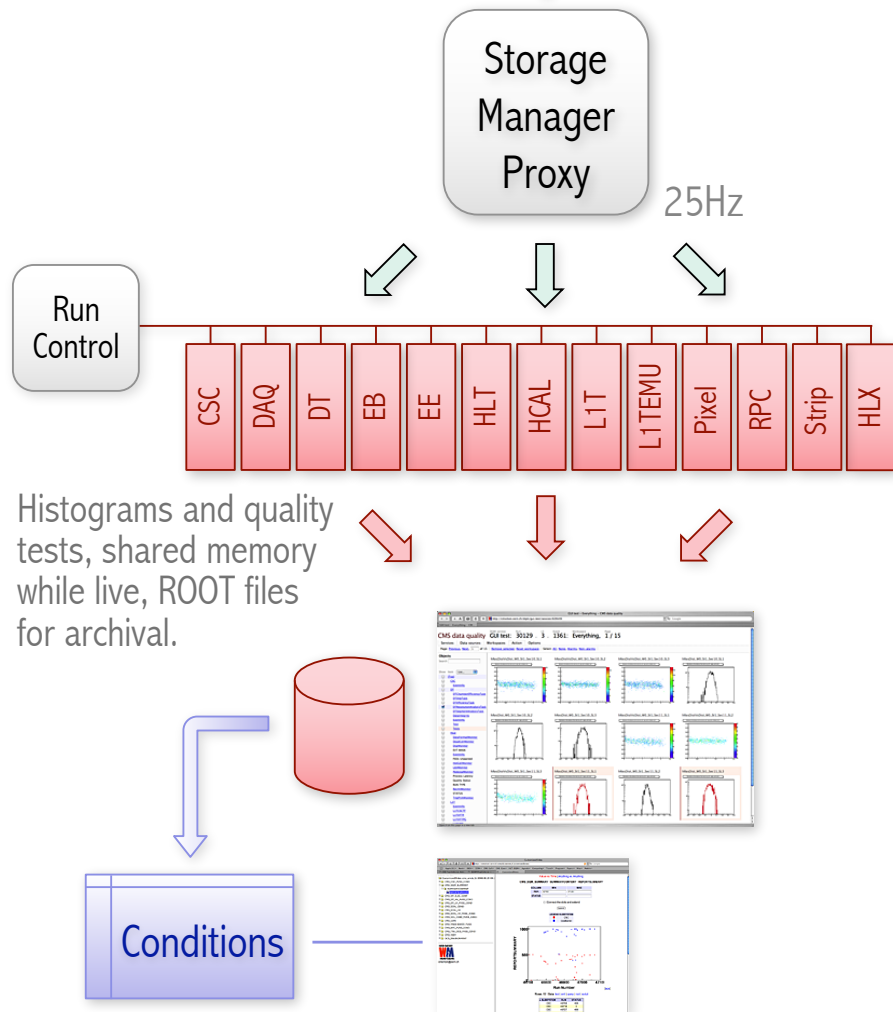
Live display at $\Delta t \sim$ seconds plus **ITB** space for the **archive** of recent runs accessible to the entire CMS in real time.

~300k histograms produced on DQM cluster, ~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.

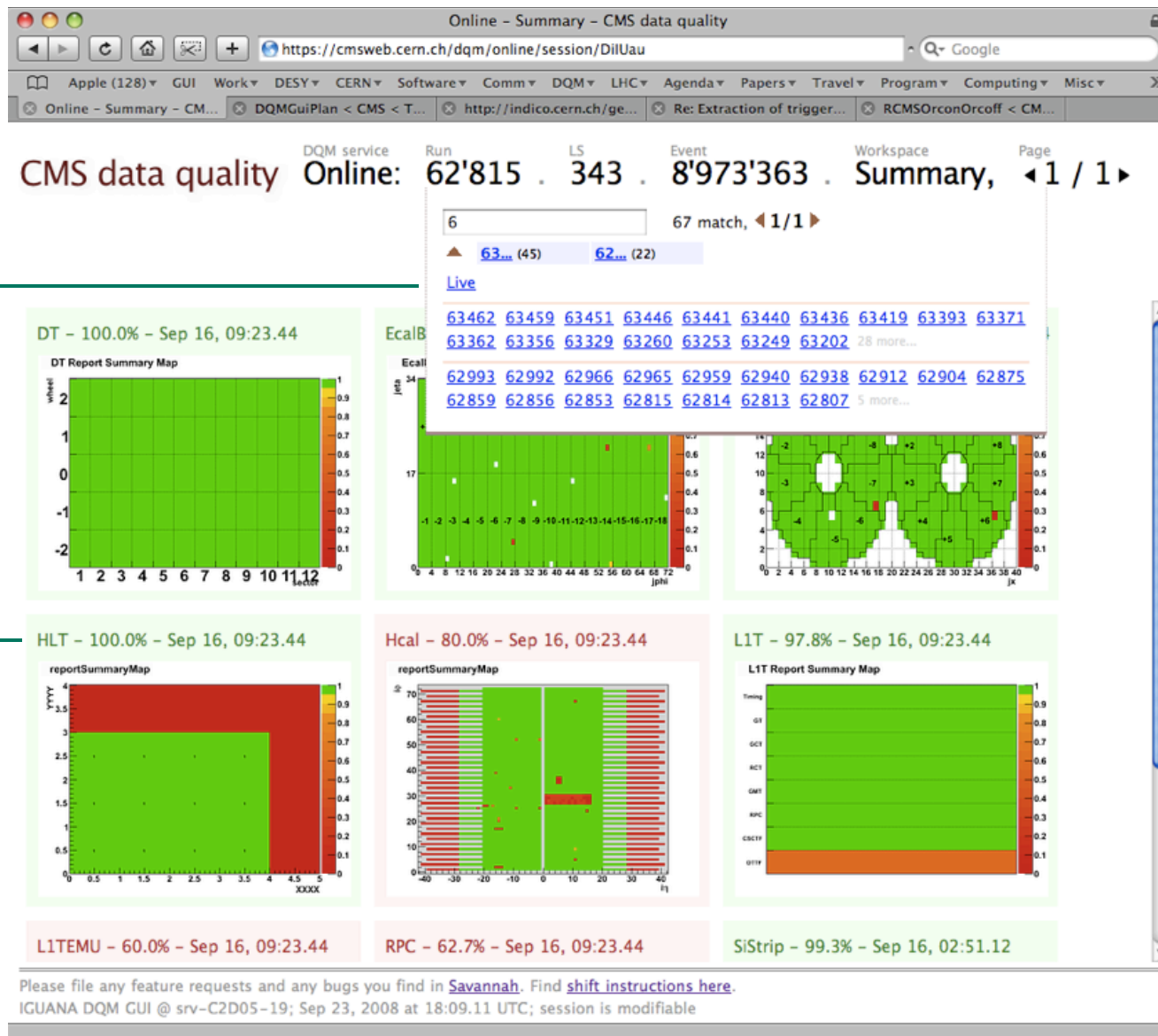
Includes online detector quality summary and other key values in conditions database.



Standard high-level overview

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

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

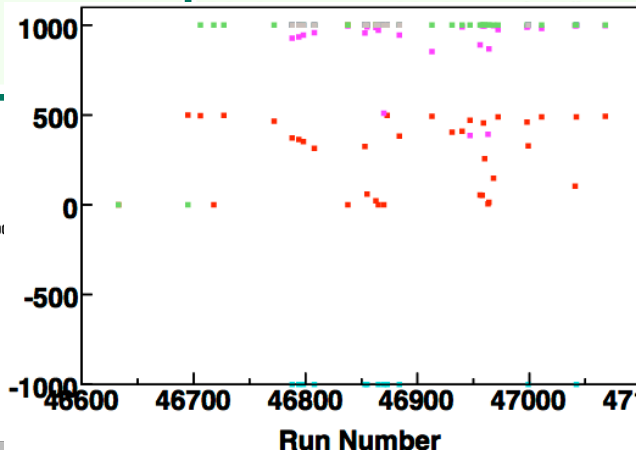
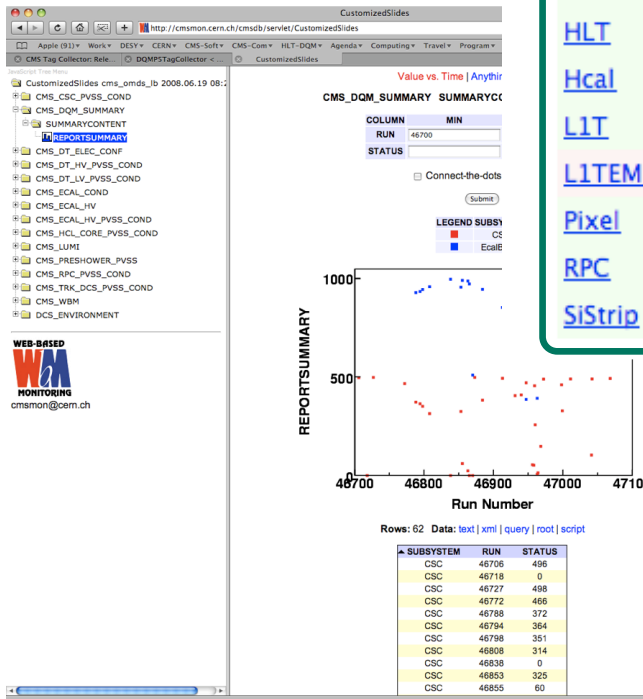


Standard high-level reports

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 Run LS Event Workspa
Online: 62'959 . 7 . 195'394 . Rep

Subsystem	Summary	Lumi				Processed Event		Monitor
		Run	section	Event	Last update	Last event	events rate	
CSC	100.0%	52959	7	194690	1' 26" ago	1' 26" ago	10331 17.66	813
DAQ	N/A	1	1	35	1' 26" ago	(Never)	35 0.05	401
DT	100.0%	52959	7	192202	1' 26" ago	1' 26" ago	13571 24.61	6312
EcalBarrel	99.8%	52959	7	191012	1' 26" ago	1' 26" ago	3876 8.27	3393
EcalEndcap	99.6%	52959	7	193665	1' 26" ago	1' 26" ago	2865 4.8	1829
HLT	100.0%	52959	7	194284	1' 26" ago	1' 26" ago	14029 24.51	604
Hcal	99.7%	52959	7	192200	1' 26" ago	1' 26" ago	2934 4.82	930
L1T	97.2%	52959	7	195394	41" in future	41" in future	13902 24.45	3487
LITEMU	59.5%	52959	7	192046	1' 26" ago	1' 26" ago	3637 6.5	648
Pixel	100.0%	52959	7	194350	1' 26" ago	1' 26" ago	12106 24.46	10200
RPC						1' 26" ago	13750 24.62	14657
SiStrip						1' 26" ago	587 2.35	1103



320: WBM/ECAL

Standard shift views

CMS data quality Online Playback: 47041 . 4 . 312'035 . Everything, Page 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

+ DDUs

+ EventInfo

+ Layouts

+ Summary

- DT

+ DataIntegrity

+ Digi

+ EventInfo

+ Layouts

+ LocalTrigger

+ Segments

- EcalBarrel

+ EBClusterTask

+ EBCosmicTask

DQM service

Run

LS

Event

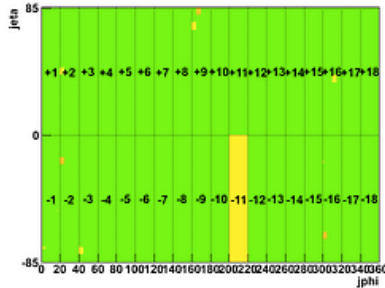
Workspace

Page

Small Large 12 per page Play; rate 5 sec Reset workspace

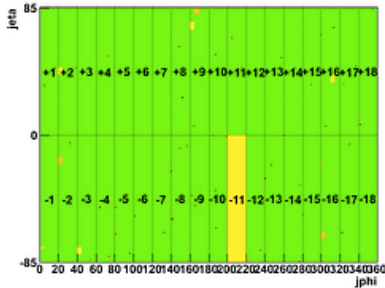
01-Integrity

EBIT integrity quality summary

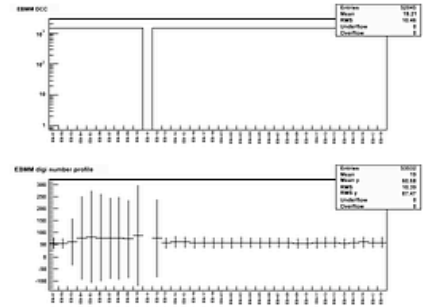


02-PedestalOnline

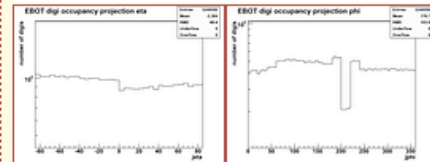
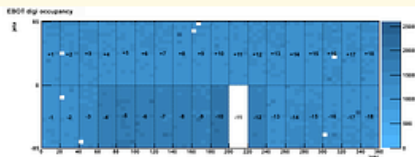
EBPOT pedestal quality summary G12



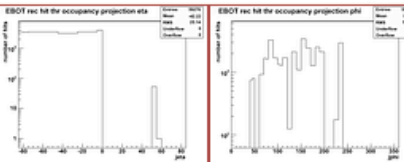
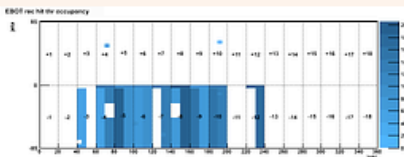
03-DCCOccupancy



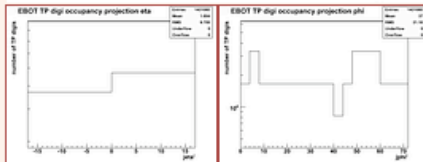
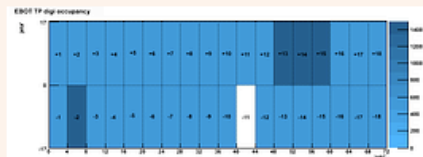
04-DigiOccupancy



05-RecHitOccupancy



06-TPDigiOccupancy



07-RecHitAndTPProfiles

2D digis occupancy map - [DQMShiftEcal](#)

08-Cosmics

09-Timing

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

Shift operation

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.*

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]%

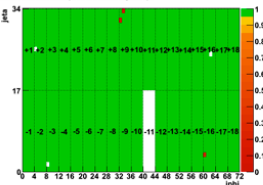
red : status = [0-85]%

white: not being readout (not in DAQ)

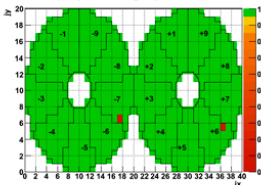
Evaluation criteria: The overall % of the subsystem should be more than 98% and different regions in the 2D plot should be Green. Red or Yellow regions in the histogram would represent problems

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%.

ECAL Barrel Report Summary Map



ECAL Endcap Report Summary Map



01-Integrity

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

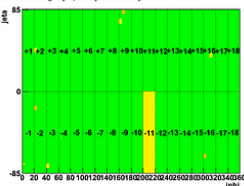
green : good; **red** : bad; **yellow** : no entries.

Evaluation criteria: It should be all green.

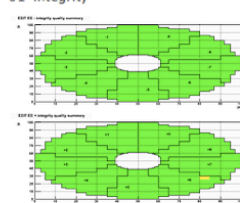
Subsystem Evaluation: a single crystal (a pixel in this scale) with integrity errors is not a problem. This will be skipped in reconstruction. Regions with concentrated red spots are problems because entire trigger towers are badly formatted.

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

EBIT integrity quality summary



01-Integrity



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).

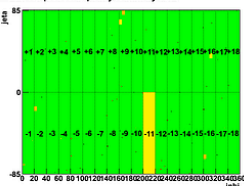
green : good; **red** : bad; **yellow** : no entries.

Evaluation criteria: It should be all green.

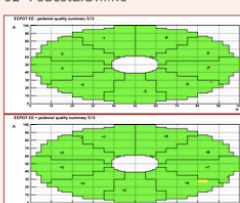
Subsystem Evaluation: a single crystal (a pixel in this scale) noisy is not a problem in a certain run. Diffuse noise in all the barrel is a problem.

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.

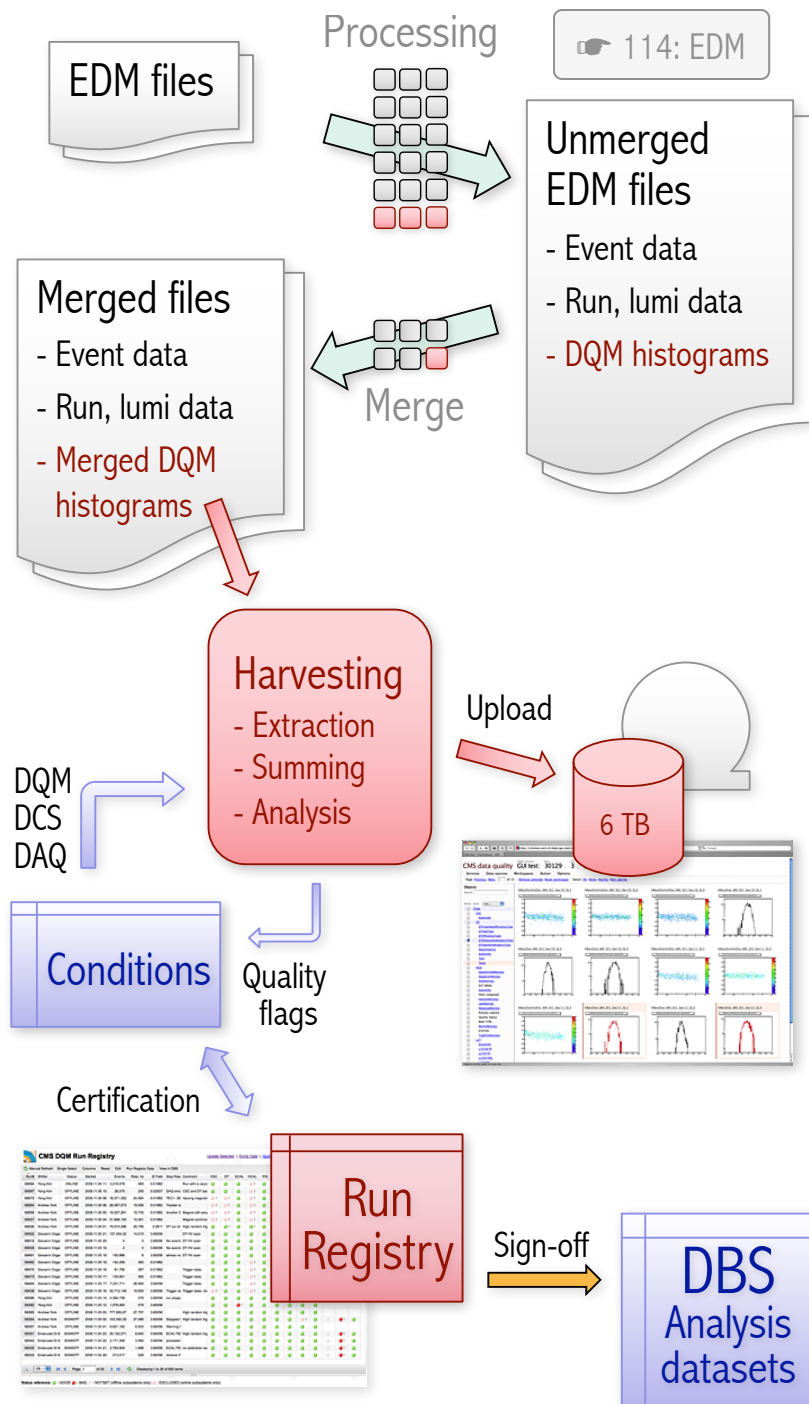
EBPOT pedestal quality summary Q12



02-PedestalOnline



64, 67: CMS centre



Offline DQM

Prompt, Al-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 Al-Ca entities. Validation verifies MC data.



CMS DQM Run Registry

[Update Selected](#) | [Dump Data](#) | [Quick Help](#) | Logged in as Andreas Meyer (EXPERT) - [Logout](#)

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 11:00	3,219,478	465	0.01882		Run with a varying magnet												
69587	Yong Kim	OFFLINE	2008.11.06 10:00	26,075	255	0.02007	DAQ error	CSC and DT back												
69573	Yong Kim	OFFLINE	2008.11.06 08:00	18,371,352	24,994	0.01882	TEC+: 26	Varying magnet												
69564	Andrew York	OFFLINE	2008.11.06 06:00	28,267,073	19,556	0.01882	Tracker is													
69559	Andrew York	OFFLINE	2008.11.06 05:00	19,527,261	19,733	0.01882	Another C	Magnet still ramp												
69557	Andrew York	OFFLINE	2008.11.06 04:00	51,898,183	15,561	0.01882		Magnet continue												
69536	Andrew York	OFFLINE	2008.11.06 01:00	79,574,286	25,756	2.0811	DT out of	High random trig												
69522	Giovanni Orga	OFFLINE	2008.11.05 21:00	137,404,02	14,015	3.80056		DT HV scan												
69515	Giovanni Orga	OFFLINE	2008.11.05 20:00	4	0	3.80056	No events	DT HV scan												
69509	Giovanni Orga	OFFLINE	2008.11.05 19:00	4	0	3.80056	No events	DT HV scan												
69491	Giovanni Orga	OFFLINE	2008.11.05 19:00	155,886	6	3.80056	almost no	DT HV scan												
69482	Giovanni Orga	OFFLINE	2008.11.05 18:00	142,259	363	0.01882														
69475	Giovanni Orga	OFFLINE	2008.11.05 18:00	81,756	367	0.01882		Trigger tests												
69473	Giovanni Orga	OFFLINE	2008.11.05 17:00	135,851	362	0.01882		Trigger tests												
69464	Giovanni Orga	OFFLINE	2008.11.05 17:00	7,231,711	28,465	3.80056		Trigger tests												
69438	Giovanni Orga	OFFLINE	2008.11.05 16:00	32,712,148	18,855	3.80056	Trigger ra	Trigger tests: ch												
69396	Yong Kim	OFFLINE	2008.11.05 14:00	4,364,738	576	3.80056	run stopp													
69382	Yong Kim	OFFLINE	2008.11.05 12:00	1,578,483	576	3.80056														
69365	Andrew York	OFFLINE	2008.11.05 03:00	777,850,67	27,757	3.80056		High random trig												
69364	Andrew York	SIGNOFF	2008.11.05 02:00	103,593,35	27,085	3.80056	Stopped t	High random trig												
69357	Andrew York	OFFLINE	2008.11.05 01:00	6,621,162	6,933	3.80056	Warning f													

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 10 Result page: 1 [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [Next »](#)

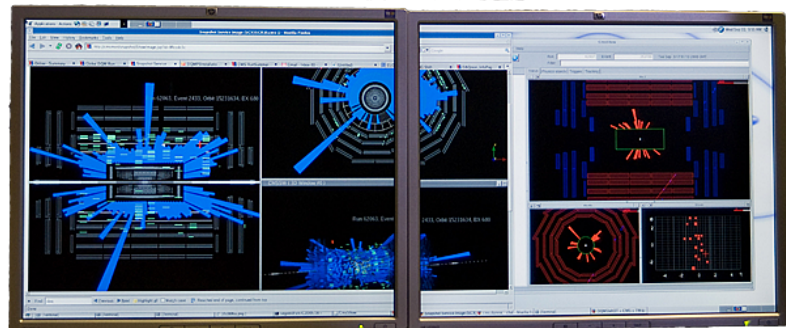
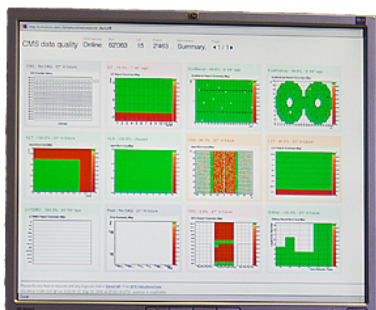
found 36 run(s). Run range: 70000-70687. Show PhEDEx [info](#). Jump to run range: - Go

Run	Type	Events	Store	Start of run	End of run	dataset	# Files	Size	LFNs	Transfer	Data Quality	Run Summary
70687 DQM	data	0	0	1226390992	0	/Calo /Commissioning08-PromptReco-v2 /RECO	1	3.0MB	cff plain details wParents pv wParents	cmssrm.fnal.gov srm-cms.cern.ch gridka-dCache.fzk.de	<input checked="" type="checkbox"/> -Pixel_Global <input checked="" type="checkbox"/> -L1T_Global <input checked="" type="checkbox"/> -JetMET <input checked="" type="checkbox"/> -Muon	
						/Calo /Commissioning08-v1 /RAW	1	1.1MB	cff plain details wParents pv wParents	cmssrm.fnal.gov gridka-dCache.fzk.de srm-cms.cern.ch	<input checked="" type="checkbox"/> -Pixel_Global <input checked="" type="checkbox"/> -L1T_Global <input checked="" type="checkbox"/> -JetMET <input checked="" type="checkbox"/> -Muon	
						/Cosmics /Commissioning08-PromptReco-v2 /RECO	3	946.5MB	cff plain details wParents pv wParents	ccsrm.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"/> -Pixel_Global <input checked="" type="checkbox"/> -L1T_Global <input checked="" type="checkbox"/> -JetMET <input checked="" type="checkbox"/> -Muon	
						/Cosmics /Commissioning08-v1 /RAW	3	393.9MB	cff plain details wParents	srm-cms.cern.ch cmssrm.fnal.gov ccsrm.in2p3.fr cmsdcache.nl.infn.it	<input checked="" type="checkbox"/> -Pixel_Global <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 defined **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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Giuseppe Della Ricca

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