CRAFT Experience – Operations, Monitoring, and Data Quality

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JTerm IV

Outline

- Overview of commissioning schedule and status
- Shift crew composition, and operations
- Introduction to Fermilab Remote Operations Center (ROC)
- Monitoring Tools:
  - Web Based Monitoring (WBM)
  - Runtime Logger
  - Run Registry
- How to keep informed and get involved

Commissioning Terminology

- Some terms you should know:

MWGR: Mid Week Global Run

- Typically 1 to 2 days
- Usually in the middle of the week
- With as many sub-systems as possible
- MWGR(NN), NN is the week # (1-52)

CRUZET: Cosmic RUn at ZEro Tesla

- Typically 4 or more days

CRAFT: Cosmic Run At Four Tesla

$4 \approx 3.8$

- Multiple weeks in duration
- Emphasis on stable running

As used in sentences:

"Dude, I was there all of Wednesday and Thursday for MWGR29, when CMS first ran with all detectors included!"

- A hardworking grad student

"That low p_T muon track is so straight. Is that an event display from CRUZET?"

- An inquisitive grad student

"Please redo your alignment study using the CRAFT09 data, so that it includes the full effect of the magnetic field."

- Grad student's supervisor

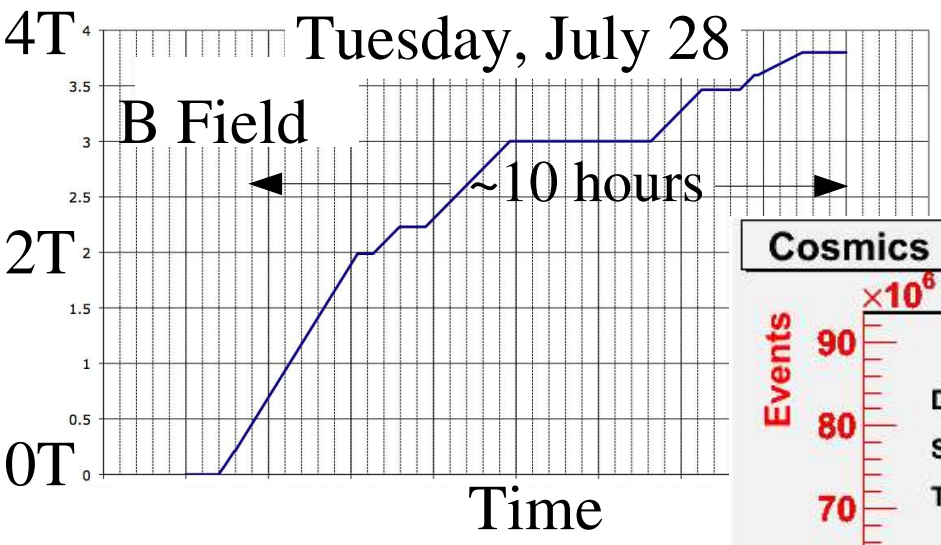
Commissioning History

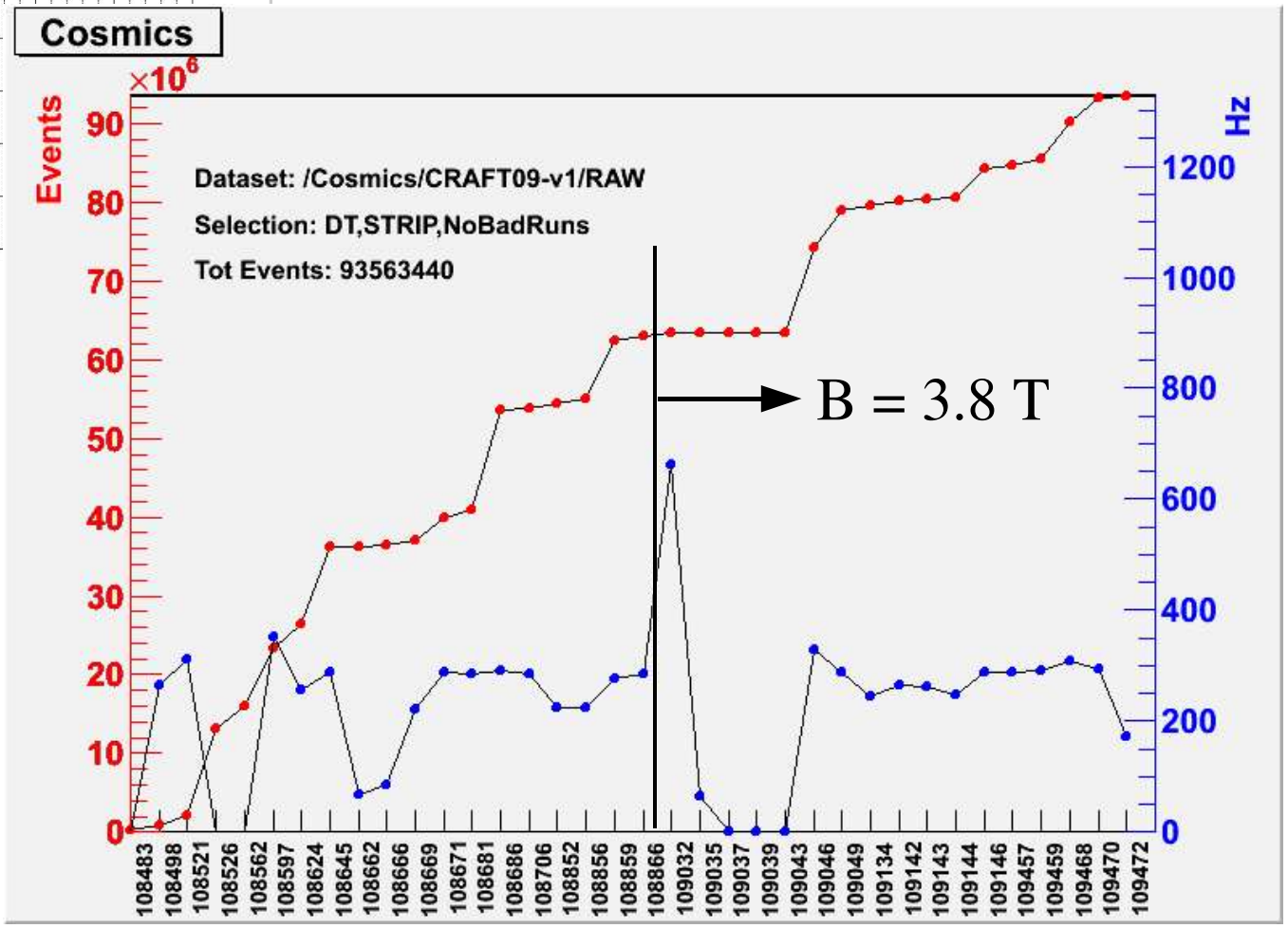
- Tremendous amount of work prior to CRAFT09
  - Series of Global Runs, each with many development and integration steps
  - 2007: At least 6 running periods, for a total of 32 days
  - 2008: ~25 running periods, for a total of 110 days
  - 2009: 16 running periods, for a total of 45 days so far
- Distribution for 2009, so far:

CRAFT09 Goals

- Collect ≥300 million triggers with drift tubes (DT), silicon strip tracker, pixel tracker, and full Level 1 Trigger (L1) and High Level Trigger (HLT)
  - On pace to achieve this before end of August, then surpass CRAFT08
  - More statistics will particularly help endcap alignment
- Stable running, with all/most sub-detectors
  - Restrict changes, such as to firmware and run configuration
- Include data workflows for alignment and calibration
  - 48 hour turn-around for tracker and DT calibrations
- Run with live time >85%
  - So far, appears achievable if infrastructure holds (power, cooling, network)
    → Need to improve recovery time for such problems
- Lots of individual sub-system goals

CRAFT09 Week 1

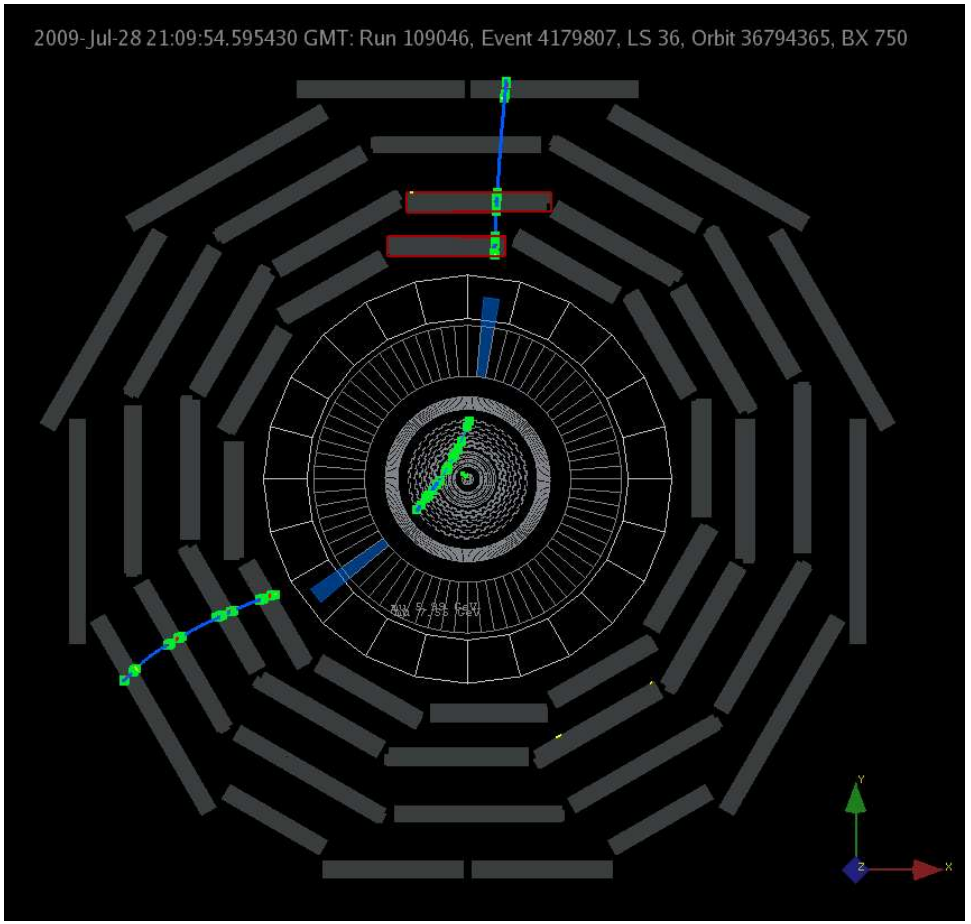




- 60 million events with B = 0 T
- 30 million events with B = 3.8 T

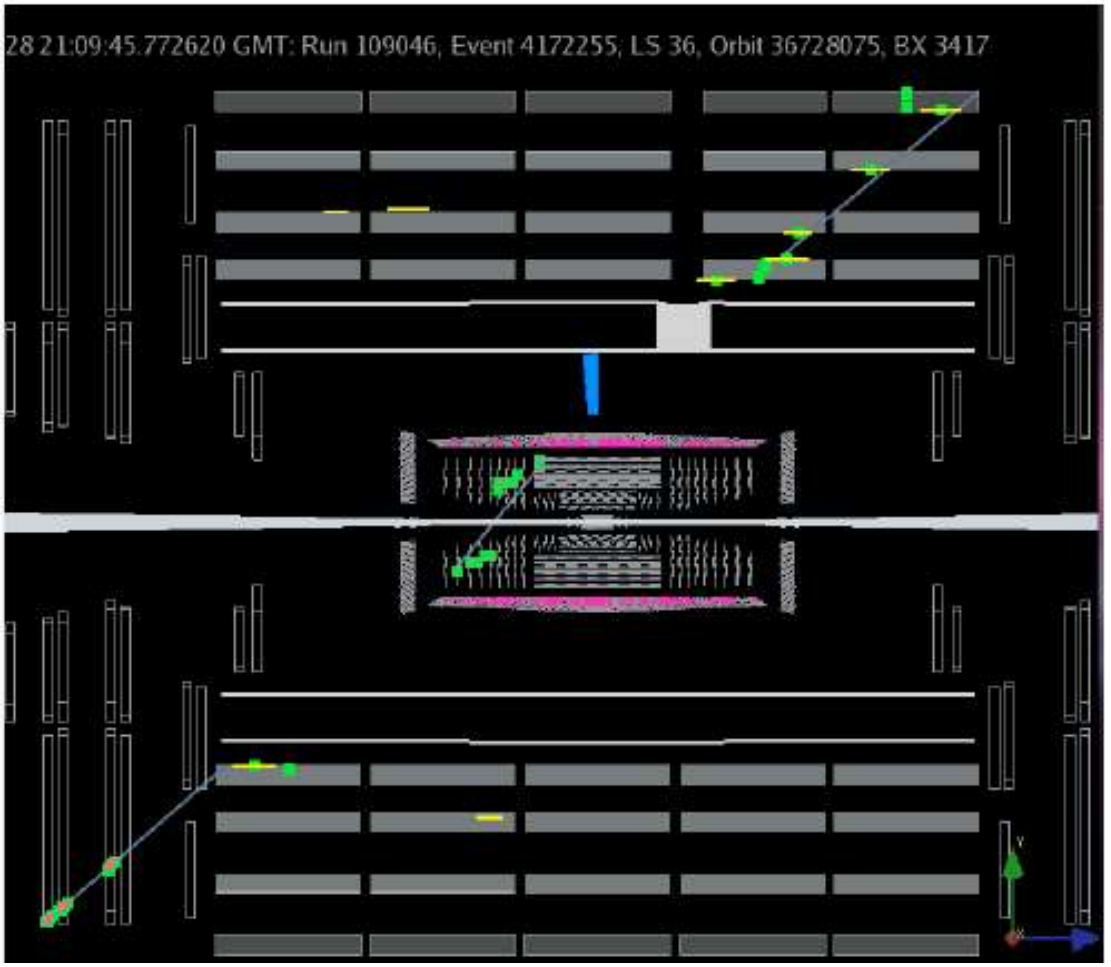
CRAFT09 Events

Run 109046, Event 4179807



r-ϕ view

Run 109046, Event 4172255



y-z view

Shift Crew

- 7 Central shifts ("central" means core, but not necessarily at P5)
  - Shift leader: coordination and personnel safety
  - DAQ
  - Trigger
  - DQM: 2 shift takers (one at P5 and one remote)
  - Central DCS (Detector Control Systems)
  - Detector Safety (when magnet or beam are on)
- Run Field Managers (2 at a time, for a 4 week period)
- Sub-detector shifts
  - Organized by each sub-system
  - Can include more than one per sub-system (e.g. DAQ expert, DQM expert)
  - Can be at P5, remote, or on-call
  - For sustainable operation, start moving these duties to "central" crew

Relation to Data Flow

- Many important steps involving shift crew before data is ready for analysis

Detector Safety CMS solenoid, radiation

DCS "slow controls": temperature, humidity, HV, LV, ...

Trigger
configuration,
"L1 key"

configuration, state machine
DAQ

Online DQM
real-time histograms,
detector performance

Tier0
Tier1s
...

Offline DQM
detector and phys.
objects

Validation

Analysis

Shift Leader
coordination, safety, logging downtimes

Run Field Manager
coordination, continuity of plan

Plus ~20 subsystem expert shift takers

DQM Shifts

- Goals of the DQM shifts:

  (1) Identify detector and data quality problems in real-time and report them to the shift crew for possible remediation

  - Monitor histograms (DQM GUI) and use Web Based Monitoring (WBM)
  - Communicate with shift crew and experts (in person, video, chat, phone, elog)

  (2) Determine quality of data and carry out bookkeeping for for later use in analyses

  - Monitor histograms (DQM GUI) and use Web Based Monitoring (WBM)
  - Use “Run Registry” for bookkeeping of data quality

DQM Shift Schedule

- An area that is particularly well suited to remote shifts
- Central Online DQM shift schedule (FNAL and DESY, in parallel with P5):

At P5	00:00-07:00 | 07:00-15:30 | 15:30-00:00	CERN time
At FNAL	17:00-00:00 | N/A | 08:30-17:00	FNAL time
At DESY	N/A | 07:00-15:30 | N/A	DESY time

- Central Offline DQM shift schedule (2 shifts per day during CRAFT09):

At Meyrin CC	09:00-16:00 | 14:00-21:00	CERN time

(with ~24 hour delay with respect to Online)

Remote Operations Center

- Fermilab Remote Operations Center (ROC)

- Flexible configuration (displays, network, lighting)
- Continuous hi-def video connection with other sites
- Conferencing equipment
- 5 projection screens
- High profile location

2005	2006	2007	2008	2009

First CMS ROC, at WH11 is ready

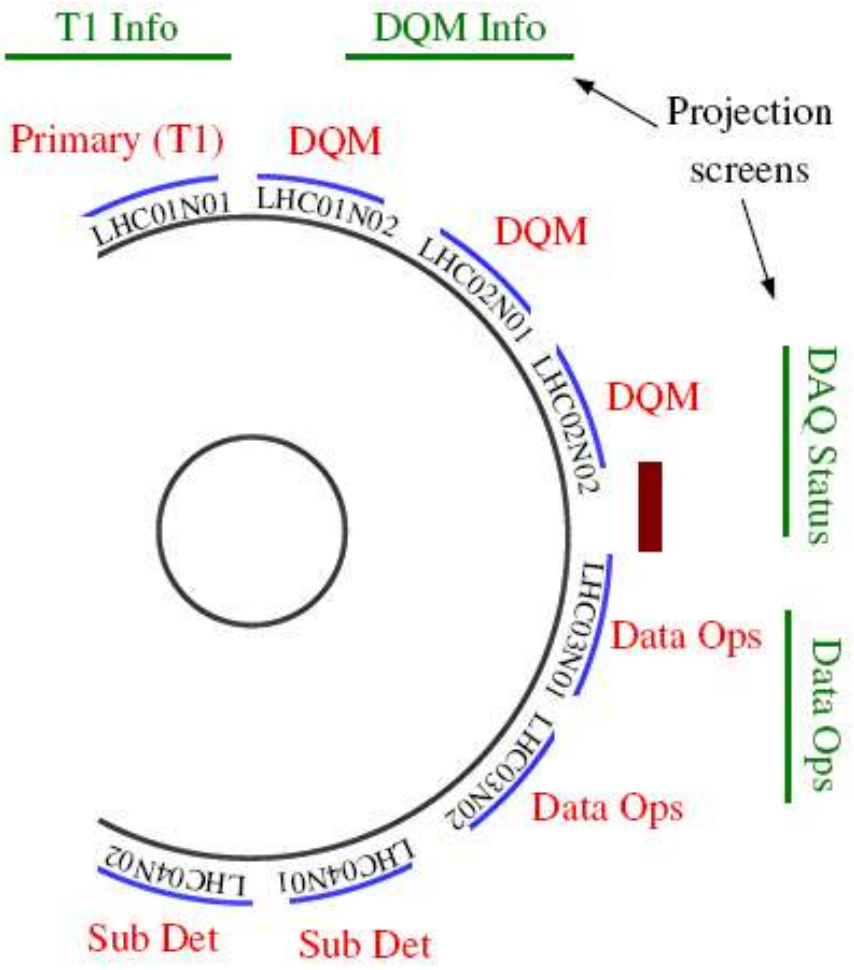
FNAL ROC at WH1 is available

CMS Center at Meyrin opens

ROC at DESY is available

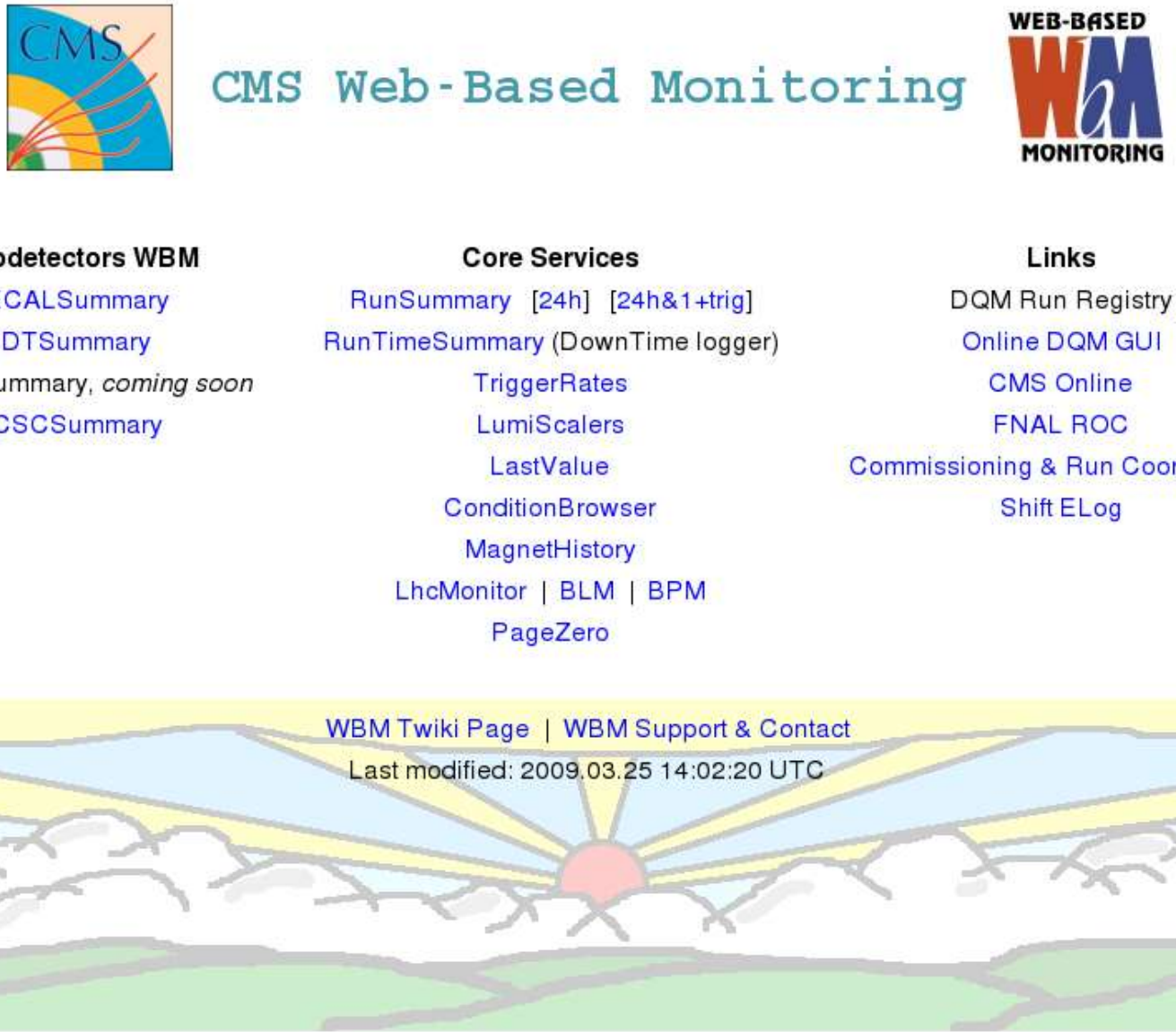
ROC Activities

- Active participation in MWGRs, CRUZETs, CRAFTs
- Shifts and development work
  - Central Online DQM
  - Data Operations
  - Tier-1 “primary”
  - Sub-detector
- Available for LHC machine activities
- Fermilab, CMS, and LHC outreach



Monitoring Tools: WBM

- Web Based Monitoring. Available at http://cmswbm.web.cern.ch



WBM Explained

- Wealth of CMS information is generated or available at P5
  - Online database contents; status of DAQ, lumi, trigger, LHC, etc.
  - Often not easily accessible, especially from outside of P5
  - Much of online database is not replicated offline (e.g. DCS histories)
- Information is only useful if we can access and view it conveniently
- WBM and DQM GUI both involve monitoring, but the conceptual difference relates mostly to the input source

  DQM GUI input: mostly event data (processed using cmssw)

  WBM input: online database, and real time information
- WBM is intended for a wide audience (not just shift crew)

WBM Example: PageZero

- Collection of mostly real time information about CMS and LHC
- Screen capture from Sept. 10, 2008:

CMS PageZero

All table times are in UTC
Contents of this table update every 20 seconds.

Collection Time in UTC:
2008.09.10 07:35:43
CERN: 09:36:04
Computer: 02:36:04

LHC	
Accelerator Mode	SETUP
Beam Mode	INJDUMP
Energy	450 GeV
Fill Number	827
Live Time	0
Ring 1	10×10^{10}
Ring 2	10×10^{10}

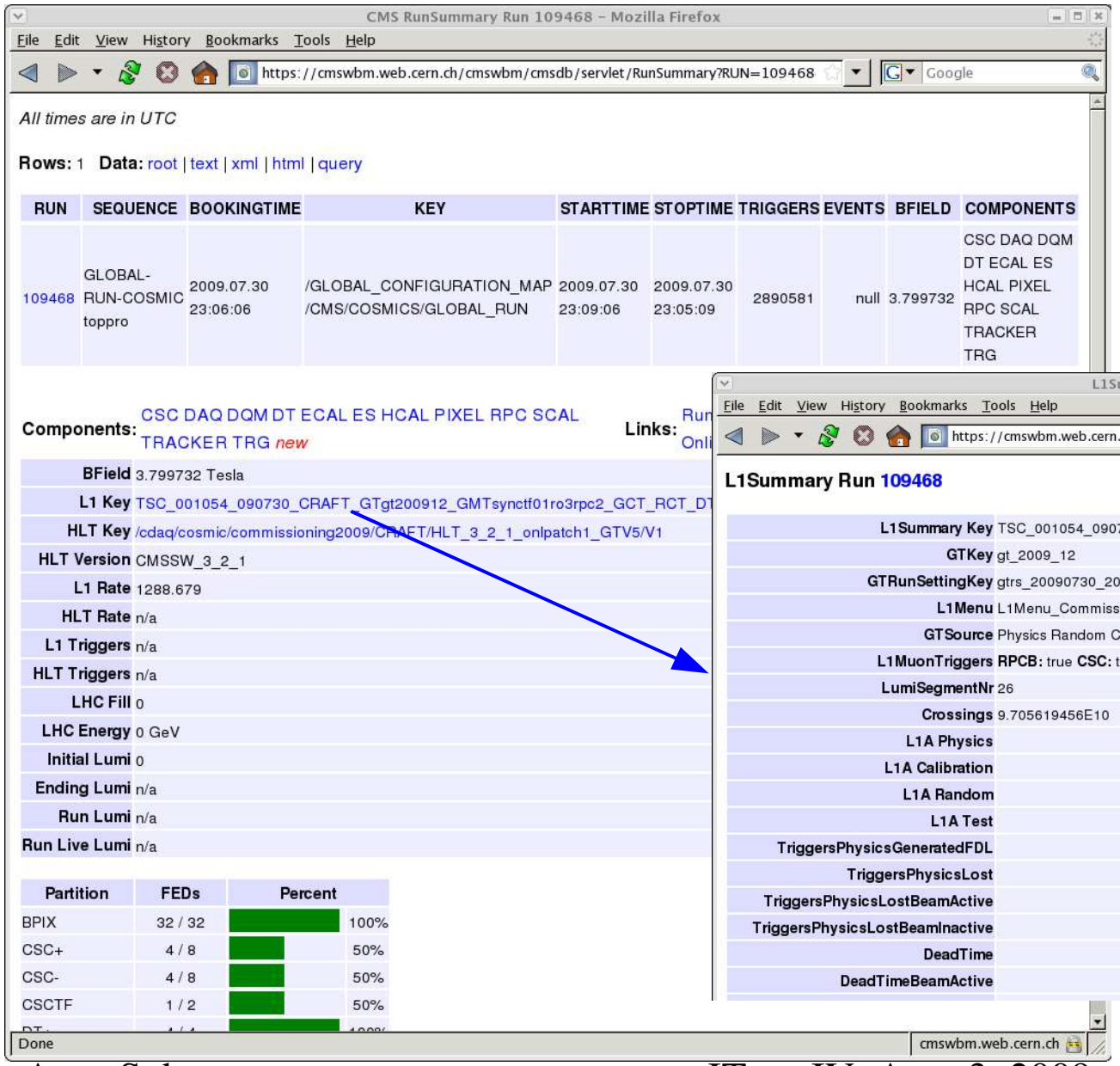
Magnet	
Magnetic Field	
Current	
Vaccum	
Temperature	

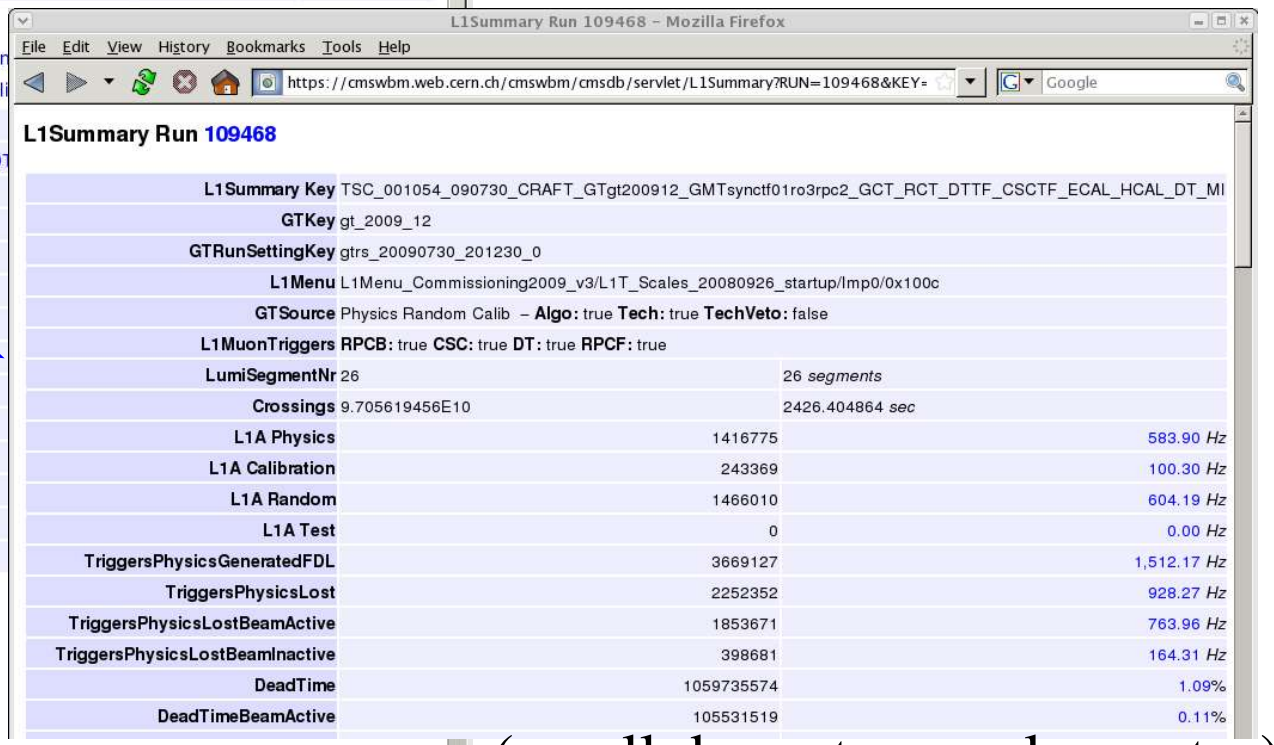
CMS DAQ/Trigger	
Run Number	62063
L1 Triggers	178
L1 Rate (Hz)	0.00000000
L1 Configuration	TSC_000301_080910_MIDW
HLT Triggers	0
HLT Rate (Hz)	0.00000000
HLT Configuration	/cdaq/physics /singleBeam /simple_bptx2_bsc/V2
State	RUNNING
Dectector Components	

Luminosity	
Lumi	86,384.00000000
∫ Lumi Fill	0.00000000
∫ Lumi Live Fill	0.00000000
∫ Lumi Run	0.00000000
∫ Lumi Live Run	0.00000000

Miscellaneous	
Beam Pipe Temperature	
Outside Temperature	
Storage Manager	
PhEDEx	
DCS Condition	

WBM: RunSummary





- RunSummary
- L1Summary

(scroll down to see algo. rates)

WBM: L1 Rate History

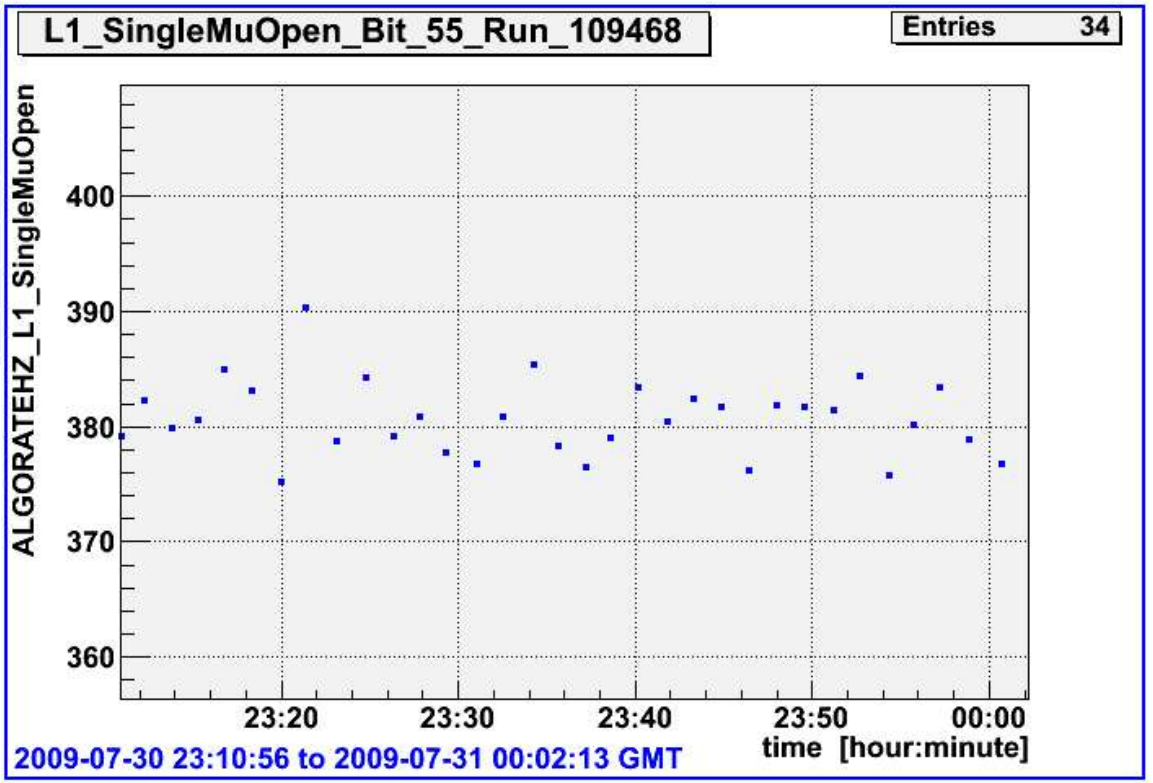
- Individual algorithm counts, rates, prescales

44	L1_SingleIsoEG15	68	0.02	1	1
45	**L1_SingleEG1**	252784	90.29		
46	L1_SingleEG2	10513	3.76		
47	L1_SingleEG5	633	0.23		
48	L1_SingleEG8	169	0.06		
49	L1_SingleEG10	123	0.04		
50	L1_SingleEG12	100	0.04		
51	L1_SingleEG15	75	0.03		
52	L1_SingleEG20	52	0.02		
53		0	0.00		
54	**L1_SingleMuBeamHalo**	1195	0.43		
55	**L1_SingleMuOpen**	1066621	380.98		
56	**L1_SingleMu0**	1057889	377.86		
57	**L1_SingleMu3**	1056825	377.48		

Column	min	max	clear
TIME_STAMP	2009.07.30 23:10:56	2009.07.31 00:02:13	☐
ALGORATEHZ	356.29528503417947	409.69142761230495	☐

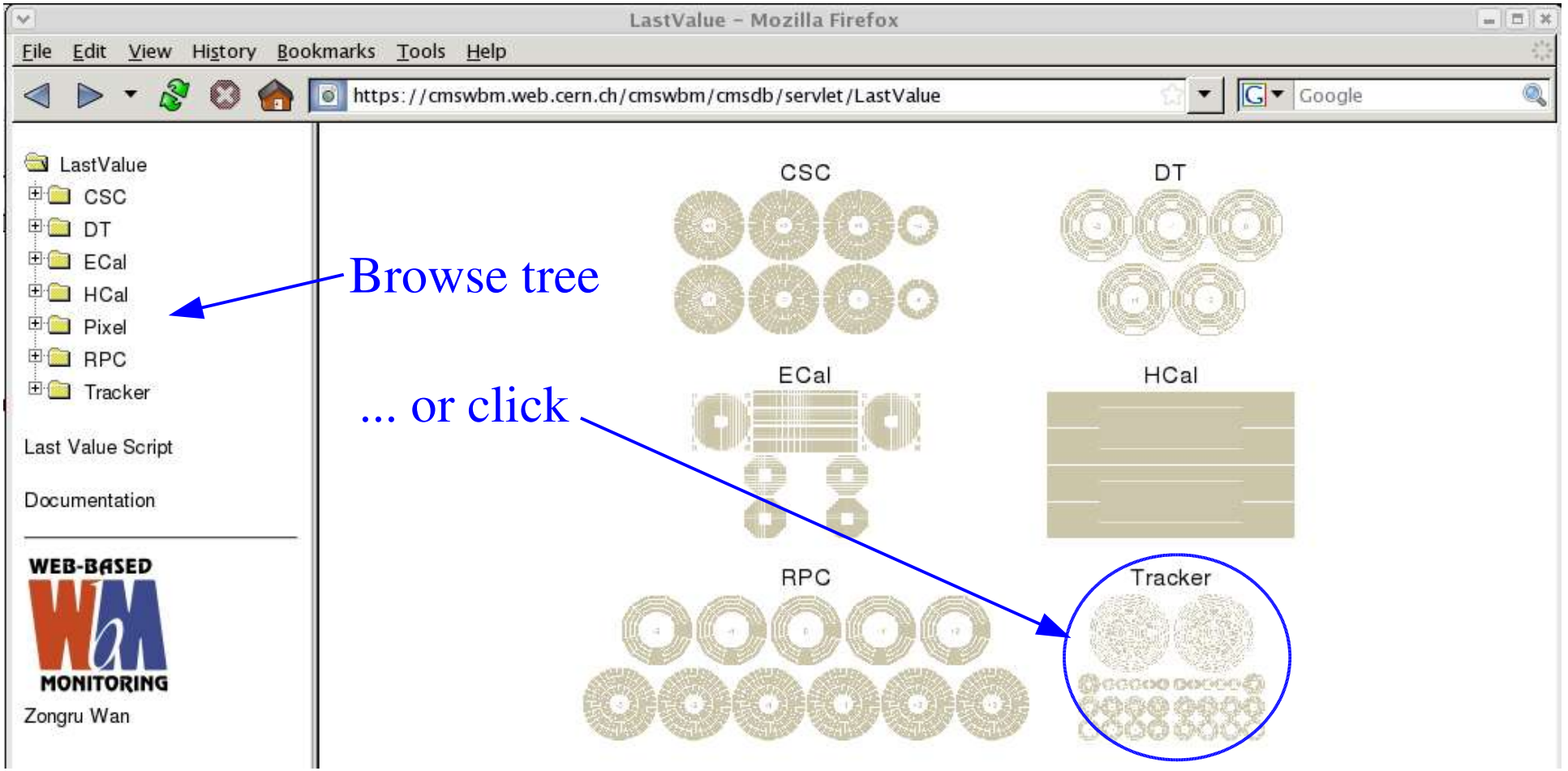
Submit

Click to plot

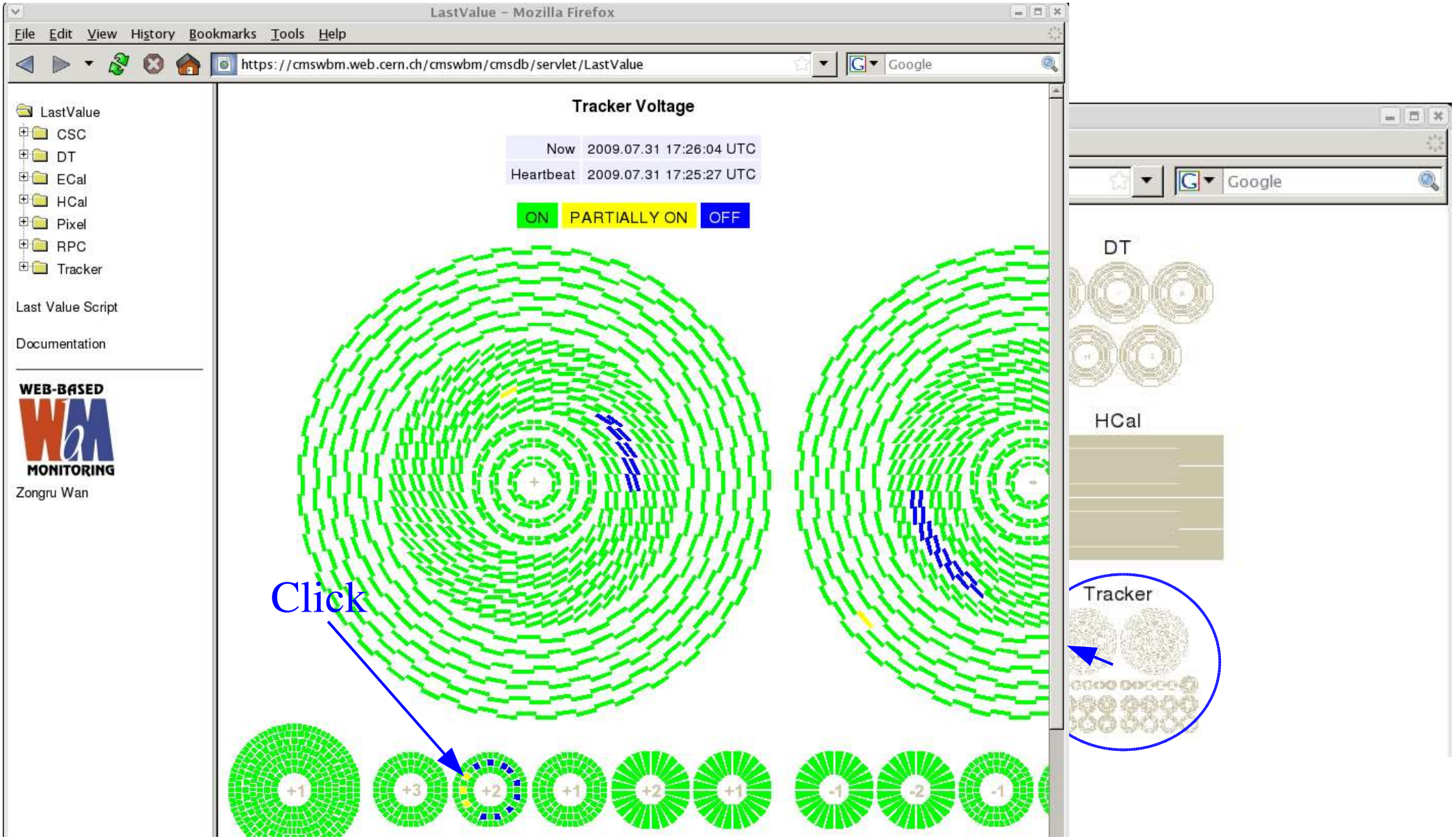


WBM: LastValue

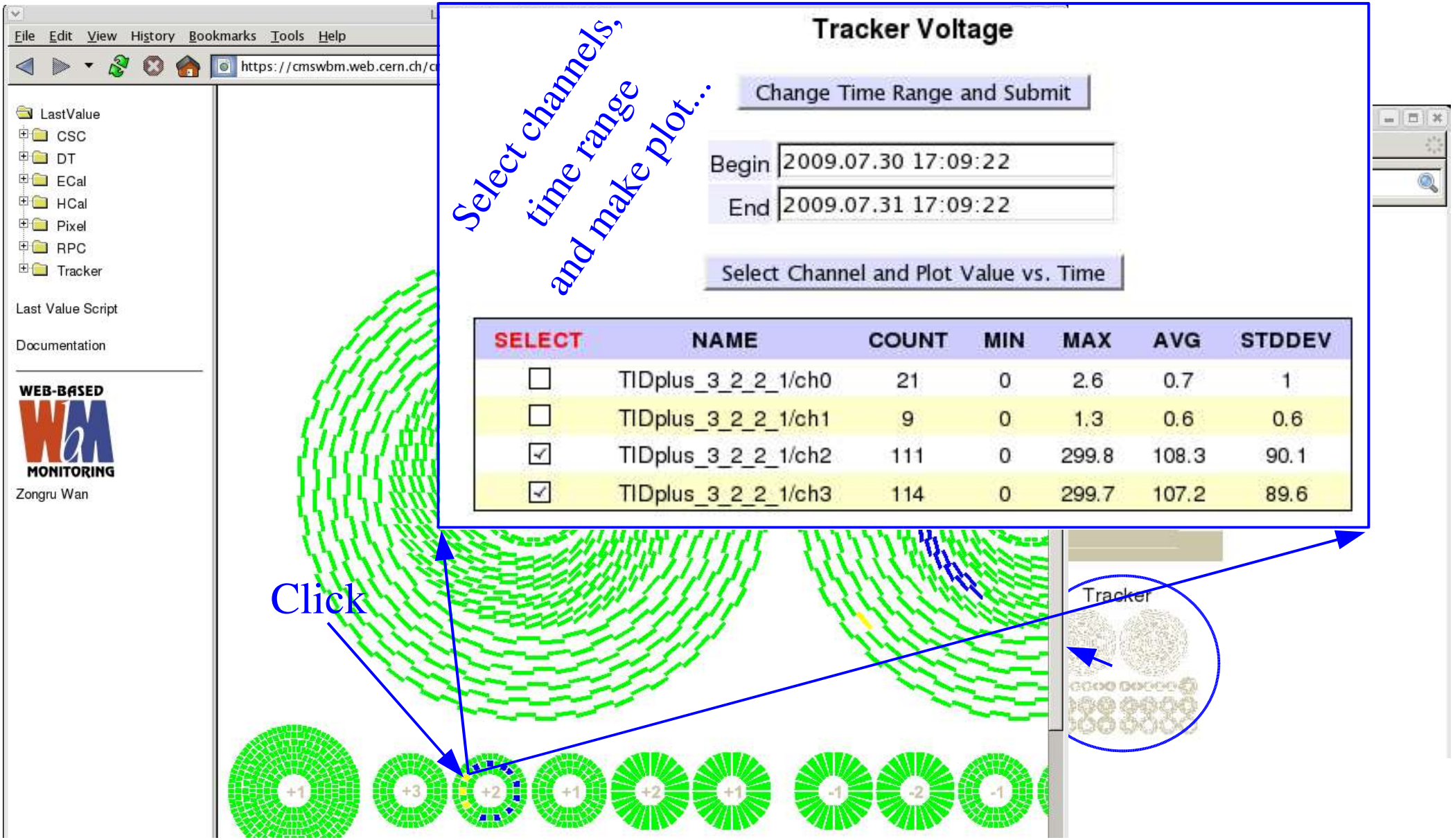
- Subsystem status: voltage, current, temperature, humidity, ...



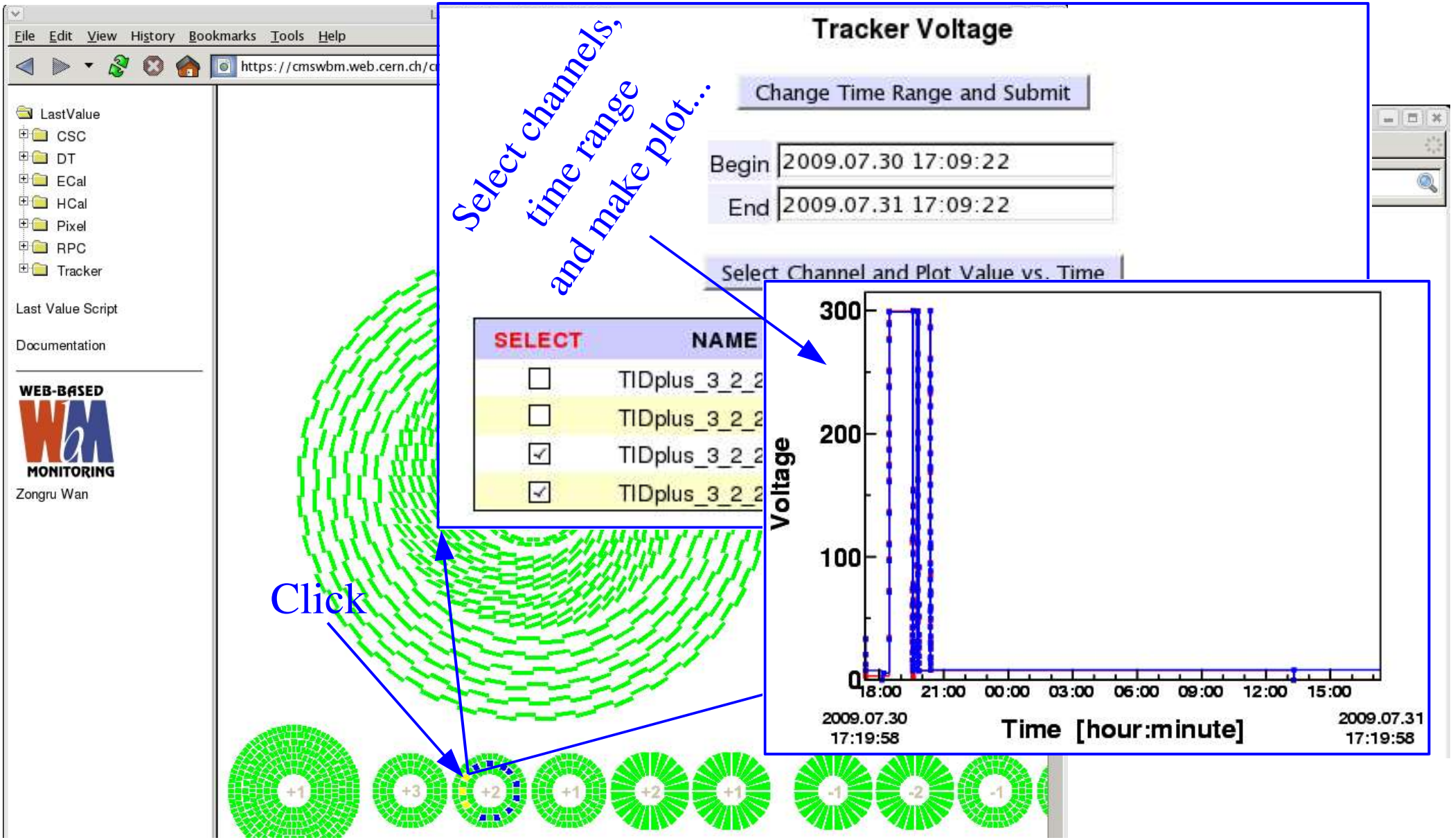
WBM: LastValue



WBM: LastValue



WBM: LastValue



More WBM

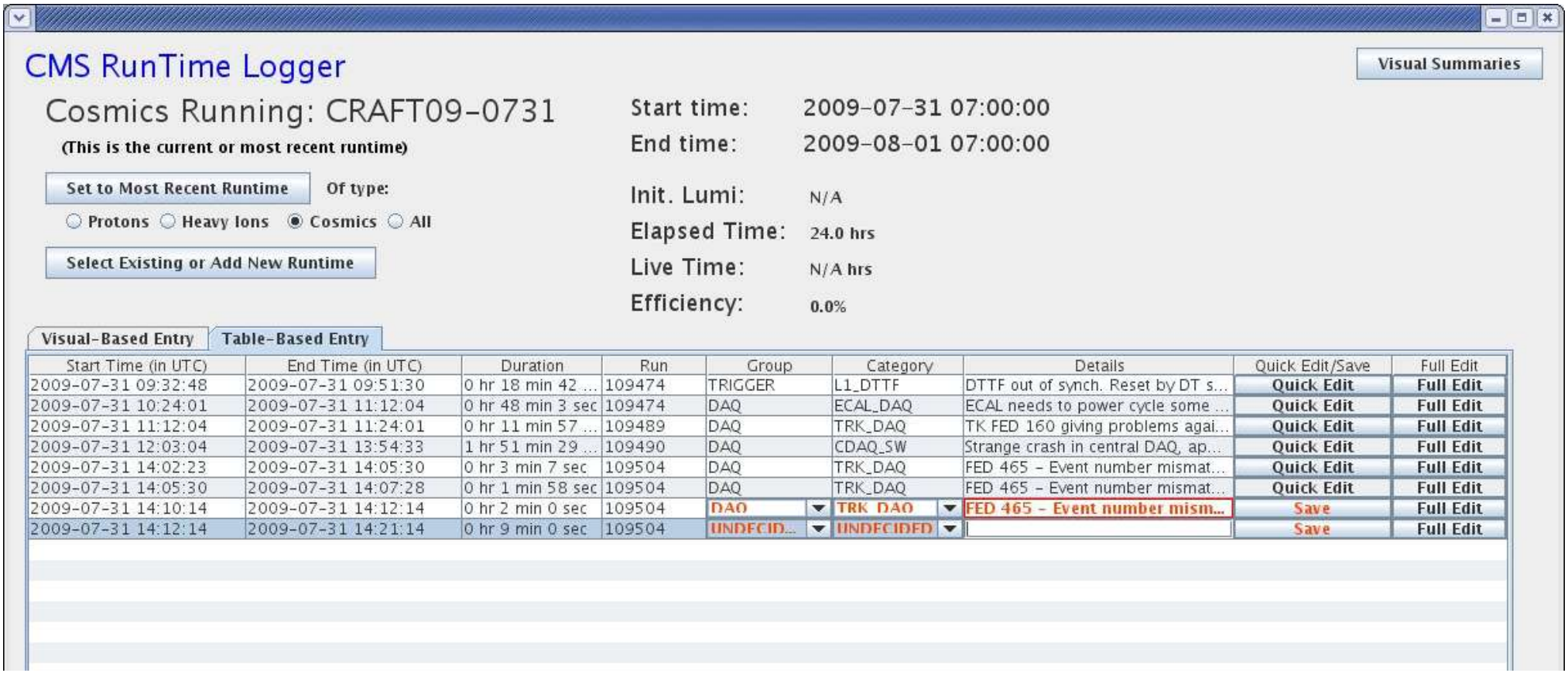
- ConditionBrowser:
  - Plot two variables against each other to look at history and correlations
- TriggerRates:
  - Live trigger rate plotting
  - Developing cross section and rate monitoring to check against expected ranges (as function of instantaneous luminosity) and alarm if discrepant
- MagnetHistory
- ECAL, DT, and CSC have contributed their own summaries
  - More coming soon

CMS Runtime Logger

- Primary goals:
  - Improve CMS operating efficiency
  - Report real time and history of operational efficiency (for use by shift crew, operations group, management, accelerator group, etc.)
- Keep track of down time and live time
- Identify sources of down time that have largest impact on data taking
  - Log by category, and sort based on integrated down time
  - Log sources of down time both between runs *and* during runs
  - Provide web-accessible reports and plots for analyzing down times

Runtime Logger GUI

- GUI displayed on Shift Leader console
  - Drop-down menus to select groups/categories, text fields for details
  - Additional GUIs for full editing, and selecting different running periods

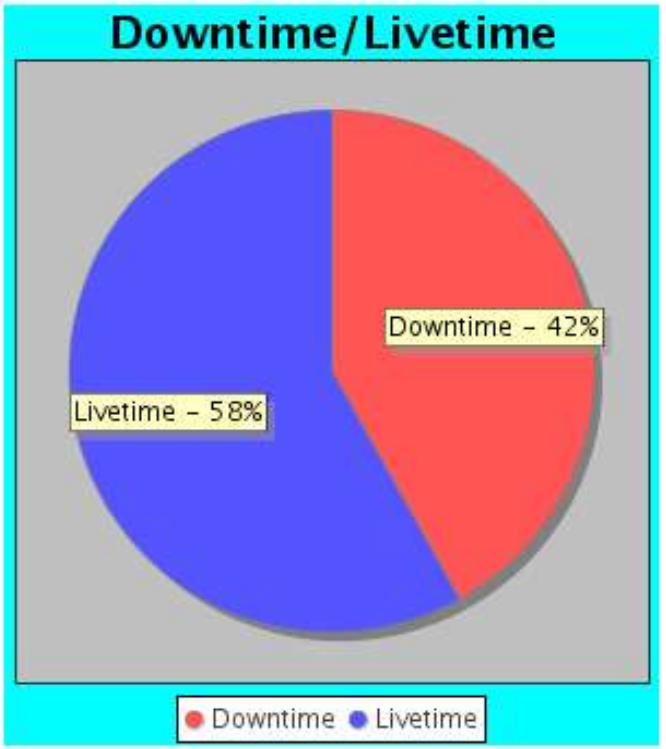


Start Time (in UTC)	End Time (in UTC)	Duration	Run	Group	Category	Details	Quick Edit/Save	Full Edit
2009-07-31 09:32:48	2009-07-31 09:51:30	0 hr 18 min 42 ...	109474	TRIGGER	L1_DTTF	DTTF out of synch. Reset by DT s...	Quick Edit	Full Edit
2009-07-31 10:24:01	2009-07-31 11:12:04	0 hr 48 min 3 sec	109474	DAQ	ECAL_DAQ	ECAL needs to power cycle some ...	Quick Edit	Full Edit
2009-07-31 11:12:04	2009-07-31 11:24:01	0 hr 11 min 57 ...	109489	DAQ	TRK_DAQ	TK FED 160 giving problems agai...	Quick Edit	Full Edit
2009-07-31 12:03:04	2009-07-31 13:54:33	1 hr 51 min 29 ...	109490	DAQ	CDAQ_SW	Strange crash in central DAQ, ap...	Quick Edit	Full Edit
2009-07-31 14:02:23	2009-07-31 14:05:30	0 hr 3 min 7 sec	109504	DAQ	TRK_DAQ	FED 465 - Event number mismat...	Quick Edit	Full Edit
2009-07-31 14:05:30	2009-07-31 14:07:28	0 hr 1 min 58 sec	109504	DAQ	TRK_DAQ	FED 465 - Event number mismat...	Quick Edit	Full Edit
2009-07-31 14:10:14	2009-07-31 14:12:14	0 hr 2 min 0 sec	109504	DAQ	TRK_DAQ	FED 465 - Event number mism...	Save	Full Edit
2009-07-31 14:12:14	2009-07-31 14:21:14	0 hr 9 min 0 sec	109504	UNDECID...	UNDECIDED		Save	Full Edit

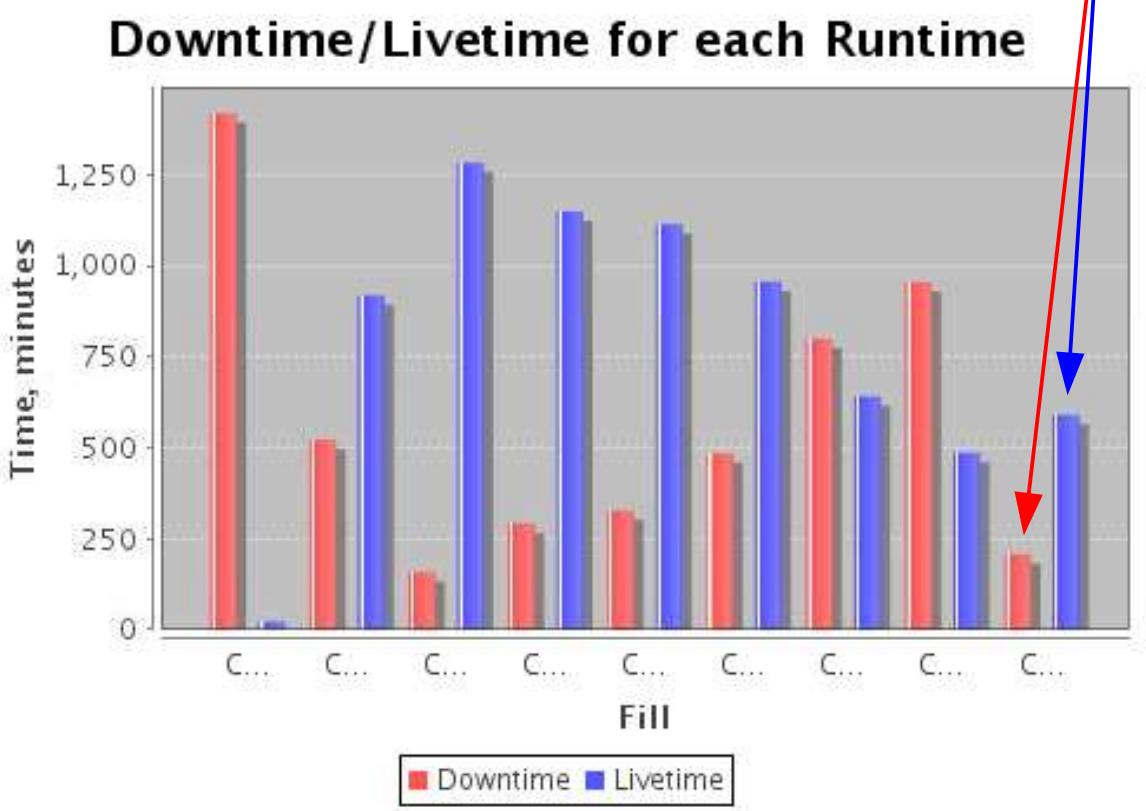
Runtime Logger Reports

- Select type, and time period or LHC Fill(s)

Runtime period type COSMICS
Begin date 2009.07.23 11:00:00 End date 2009.07.31 22:00:00
LHC FILL from to
Submit Query

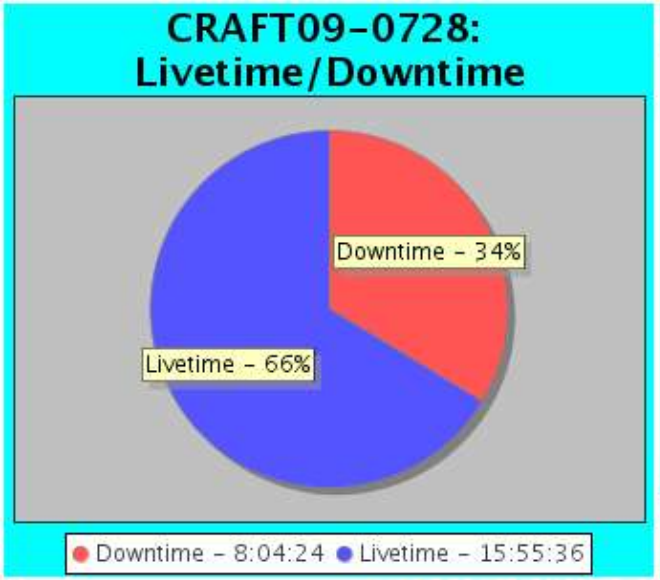


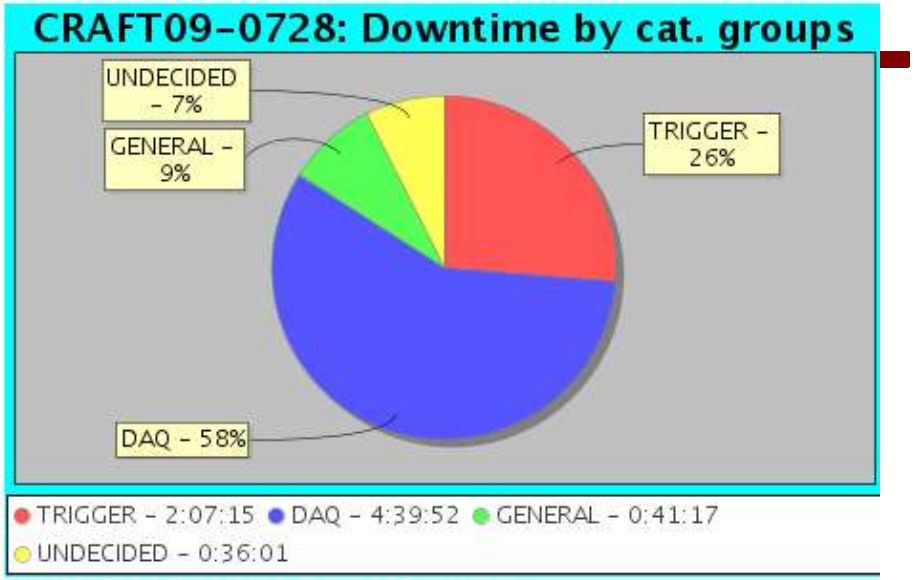
For CRAFT09, there is a pair of bars for each day

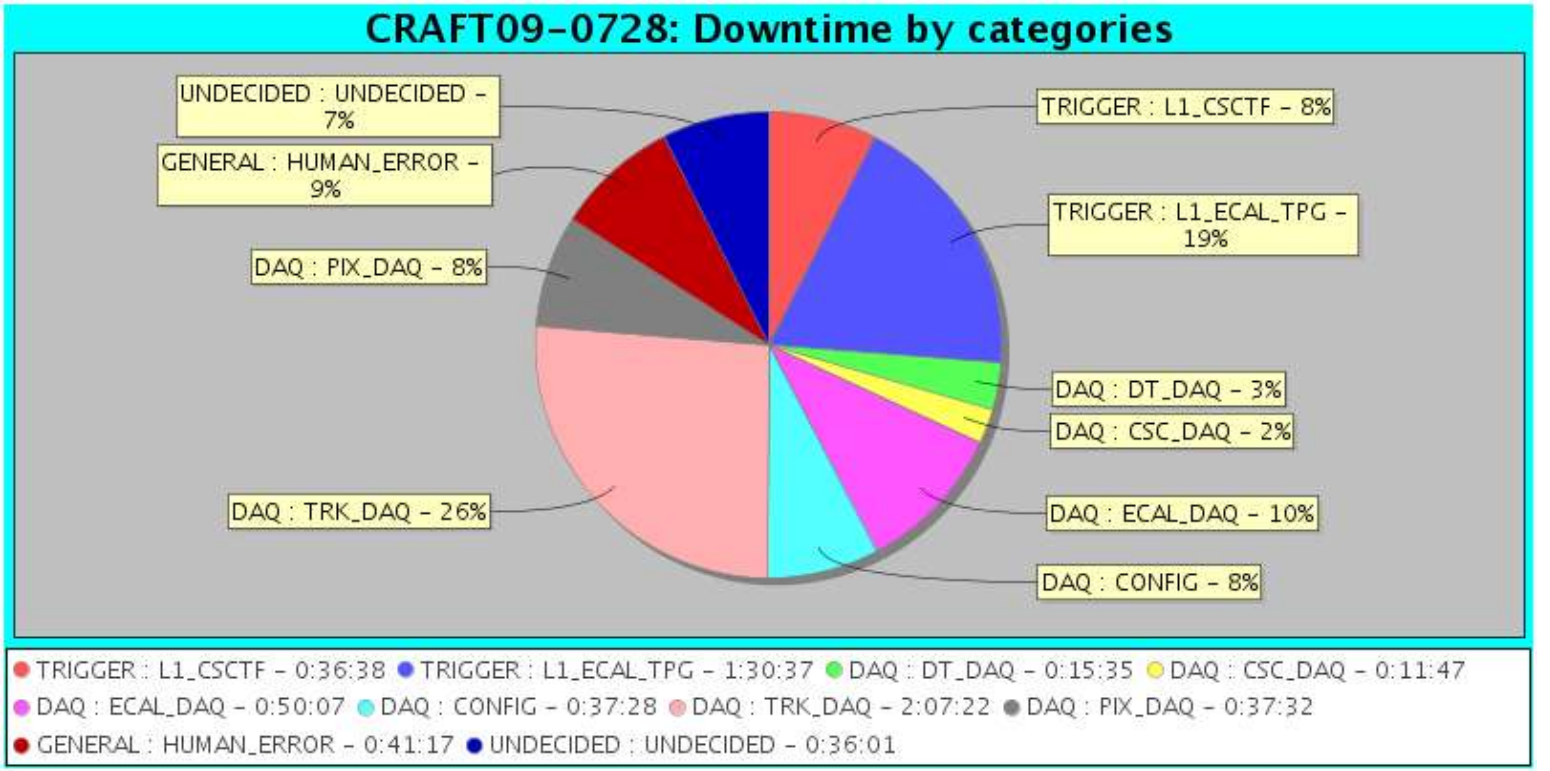


Runtime Logger Reports

For July 28:







Keeping in Touch

- Meetings of interest for commissioning and operations:
  - Daily planning, during active running: 11:00am CERN time at IP5
  - Weekly Run Coordination: Fri. 16:00 CERN time in 40-s2-a01
    9:00 FNAL time in WH11NW
  - All US CMS: Fri. 18:00 CERN time in 40-s2-a01
    11:00 FNAL time in Sunrise (WH11NE)
  - CMS Wednesday Plenary: Wed. 15:00 (varies) CERN time in 40-s2-a01
    10:00 FNAL time in Sunrise (WH11NE)
  - Many others: DQM, physics validation, etc.
- Hypernews (subscribe or browse):
  https://hypernews.cern.ch/HyperNews/CMS/login.pl
  - hn-cms-commissioning
  - hn-cms-global-runs
  - Many others

Getting Involved

- Signing up for shifts:

  - For FNAL ROC DQM -- look at the schedule and guidelines:
    https://twiki.cern.ch/twiki/bin/view/CMS/FNALROCDQMShiftList

  - For P5 DQM:
    https://twiki.cern.ch/twiki/bin/view/CMS/DQMShiftList

  - For all other shifts:
    - Contact your favorite detector subsystem leaders
    - This covers the central shifts and subsystem shifts
    - Projects leaders forward the central shift names to the run coordinators

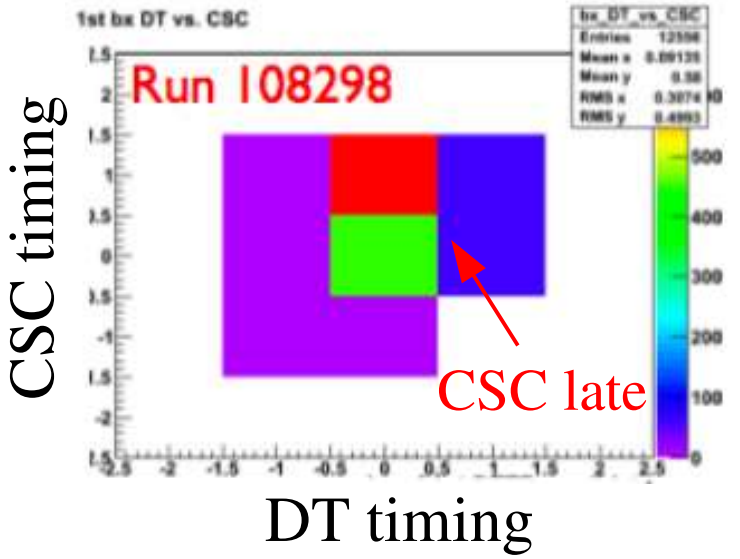
Conclusions

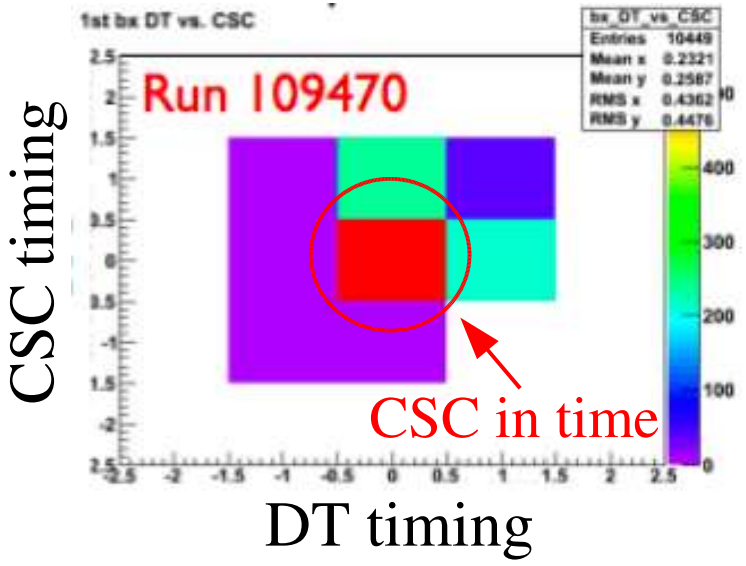
- CRAFT09 off to a good start
  - Benefit from previous global runs
  - On target to meet prioritized goals
- Shift crew & their activities are critical to producing high quality data
- Fermilab ROC is active in central and sub-system operations
- Monitoring tools are providing access to wealth of information, and helping to improve operating efficiency

Backup

CRAFT09 Examples

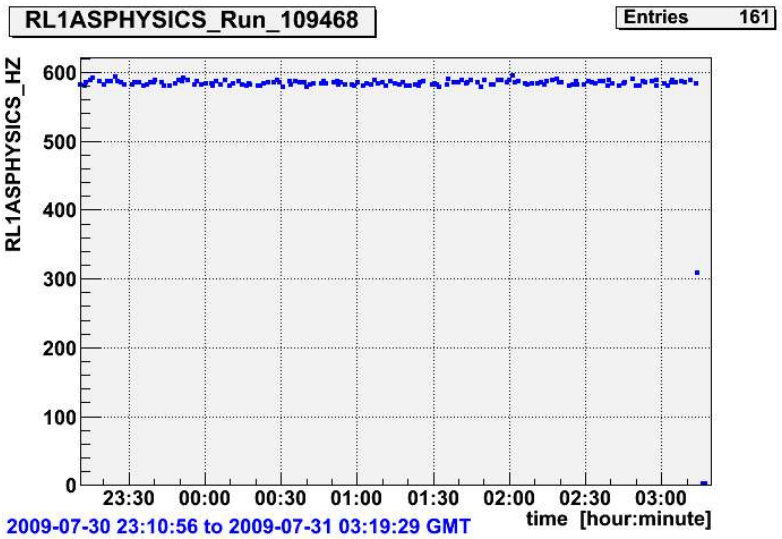
- Sub-detector activities include:
  - Adjust thresholds
  - Sub-detector readout relative timing
  - Tests of configuration and calibration mechanisms
  - Trigger rate stress tests
  - Gaining experience isolating problems (removing single front end electronics elements from DAQ rather than entire subsystems)

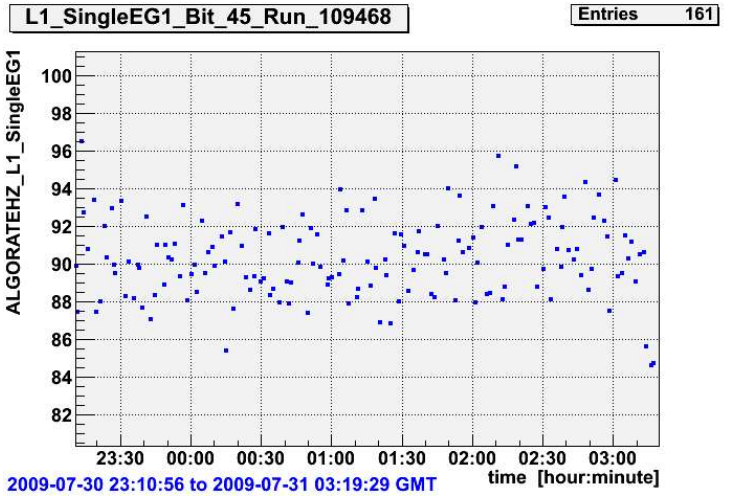




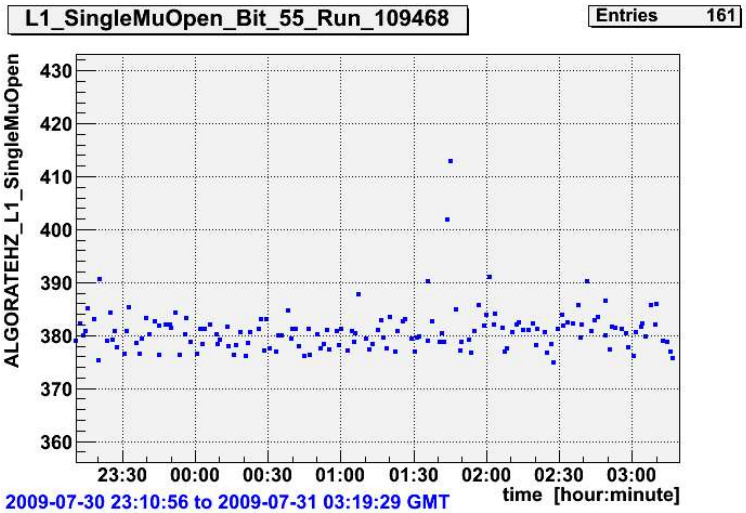
CRAFT09 Examples

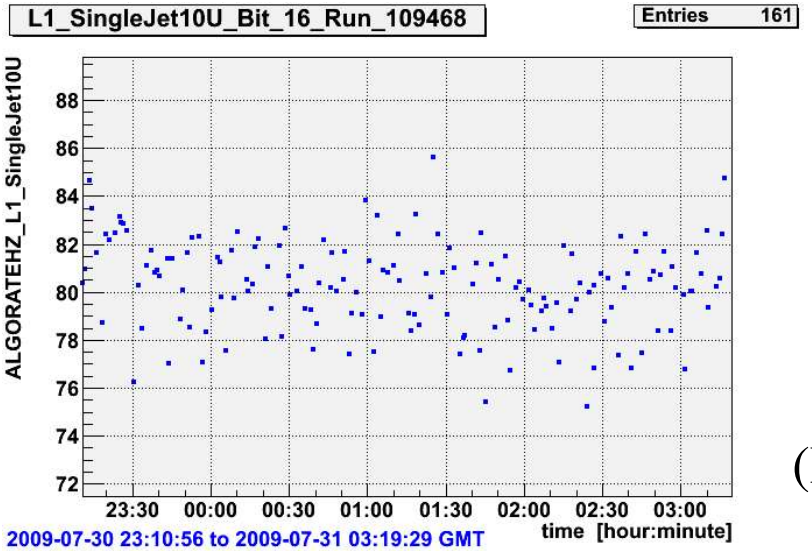
- Trigger rate stability:





All: ~600 Hz
Mu: ~380 Hz
EG1: ~80 Hz
Jet10: ~90 Hz





(Plots from WBM)

WBM: TriggerRates

CMS TriggerRates - Mozilla Firefox

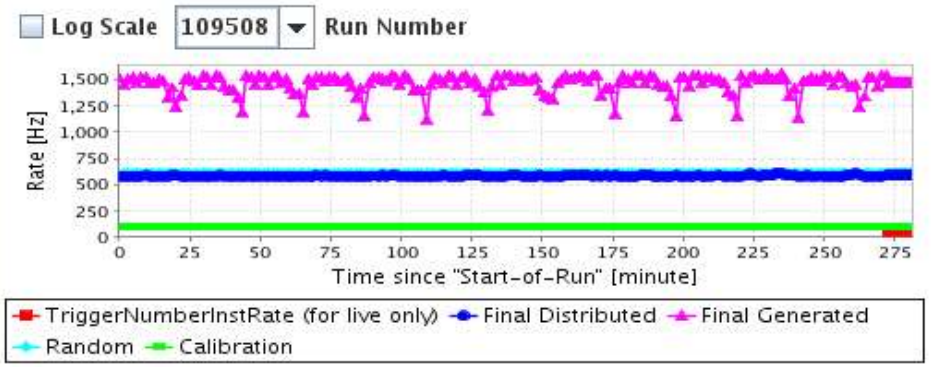
File Edit View History Bookmarks Tools Help

https://cmswbm.web.cern.ch/cmswbm/cmsdb/servlet/TriggerRates

Google

L1 TriggerRates

RunNumber	109508
TSCKey	TSC_001057_090731_CRAFT_GTgt200912_GMTsynctf(
GTKey	gt_2009_12
GTRunSettingsKey	gtrs_20090728_162356_0
L1Menu	L1Menu_Commissioning2009_v3/L1T_Scales_20080926_
GTSource	Physics Random Calib – Algo: true Tech: true TechVeto:
HLTConfiguration	/cdaq/cosmic/commissioning2009/CRAFT/HLT_3_2_1_or
TriggerState	RUNNING
CollectionTime	2009.07.31 18:40:53.996866000

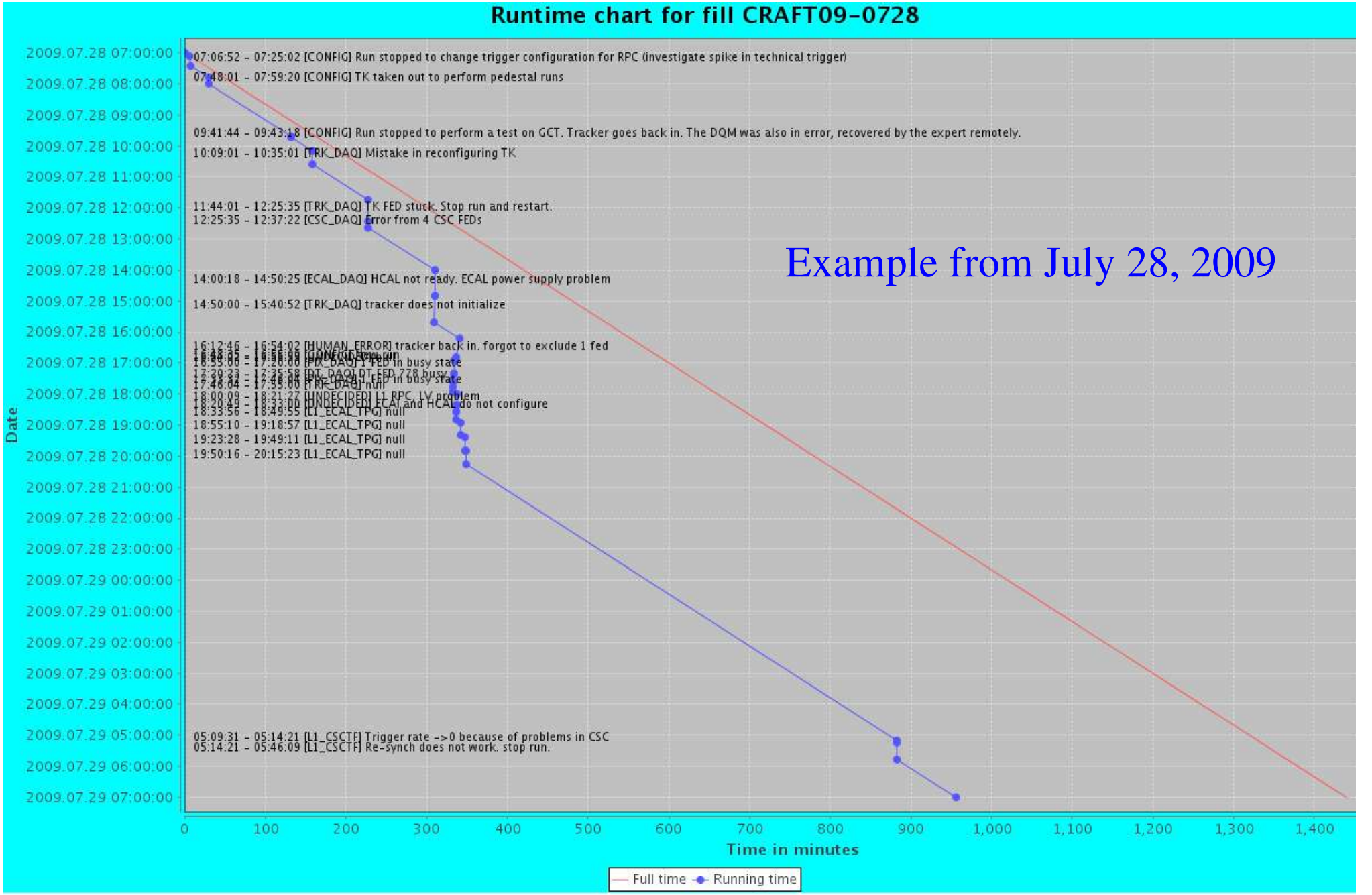


0 16 32 48 64 80 96 112 T0 T16 T32 T48

	Counts	Inst Rate
TriggerNumber	21598	15.92979836
EventNumber	21598	15.92979836
FinalTriggersDistributed	54910	587.72454224
FinalTriggersGenerated	136863	1,464.90154844
RandomTriggers	56375	603.40504587
CalibrationTriggers	9362	100.20537542
TotalTestTriggers	0	0.00000000

Index	TriggerName	Counts	Inst Rate
0	L1_ZeroBias	16777215	179,573.50220343
1	L1_MinBias_HTT10	16777215	179,573.50220343
2	**L1_SingleHfBitCountsRing1_1**	0	0.00000000
3	**L1_SingleHfBitCountsRing2_1**	4821	51.60116587
4	**L1_SingleHfRingEtSumsRing1_4**	0	0.00000000
5	**L1_SingleHfRingEtSumsRing1_200**	0	0.00000000
6	**L1_SingleHfRingEtSumsRing2_4**	0	0.00000000

Runtime Logger Plots



Example from July 28, 2009

Runtime Logger Tables

- Can sort by group, category, etc.

Example from July 28, 2009

Run (Filter: All)	Group (Filter: All)	Category	Downtime start	Downtime end	Lost Time (days hr:min:sec)	Details
108873	DAQ	CONFIG	2009.07.28 07:06:52	2009.07.28 07:25:02	0 00:18:10.0	Run stopped to change trigger configuration for RPC (investigate spike in technical trigger)
108878	DAQ	CONFIG	2009.07.28 07:48:01	2009.07.28 07:59:20	0 00:11:19.0	TK taken out to perform pedestal runs
108889	DAQ	CONFIG	2009.07.28 09:41:44	2009.07.28 09:43:18	0 00:01:34.0	Run stopped to perform a test on GCT. Tracker goes back in. The DQM was also in error, recovered by the expert remotely.
108919	DAQ	TRK_DAQ	2009.07.28 10:09:01	2009.07.28 10:35:01	0 00:26:00.0	Mistake in reconfiguring TK
108934	DAQ	TRK_DAQ	2009.07.28 11:44:01	2009.07.28 12:25:35	0 00:41:34.195794943	TK FED stuck. Stop run and restart.
108946	DAQ	CSC_DAQ	2009.07.28 12:25:35	2009.07.28 12:37:22	0 00:11:47.378910667	Error from 4 CSC FEDs
108959	DAQ	ECAL_DAQ	2009.07.28 14:00:18	2009.07.28 14:50:25	0 00:50:07.0	HCAL not ready. ECAL power supply problem