



Trigger Coordination Report

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CMS Trigger Coordinator

LHCC CMS Review

May 6, 2008

Outline:

Level 1 Trigger

DAQ & HLT Infrastructure

HLT Algorithm performance -- Christos Leonidopoulos



Calorimeter Trigger Primitives

HCAL:

- All installed, operating in Global Runs

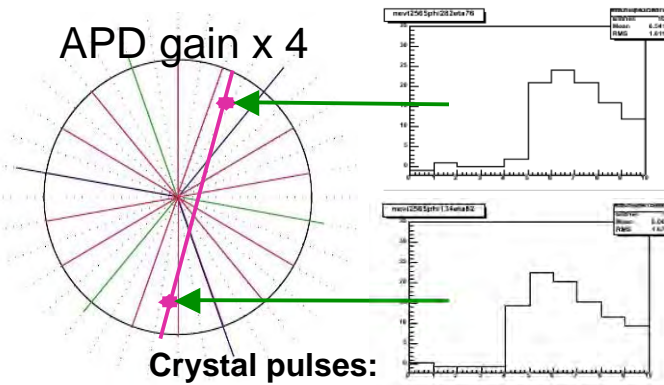
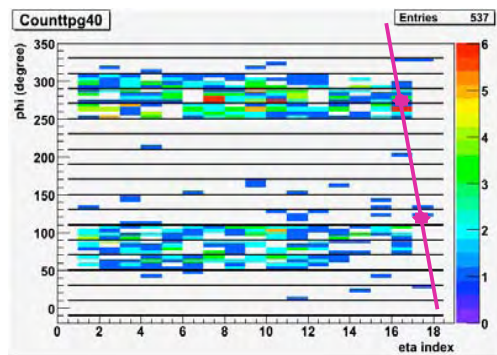
ECAL Barrel:

- All Trigger Concentrator Cards (TCC-68) installed
- Tests w/ Regional Cal. Trig.
 - patterns, timing
- Ready for operation in CRuZeT

ECAL Endcap:

- TCC-48 submitted for board manufacture
- Present schedule completes in Fall
 - under negotiation

ECAL MIP Triggers w/15 SM in Nov/Dec Run:



ECAL Barrel TCC's



ECAL Endcap TCC



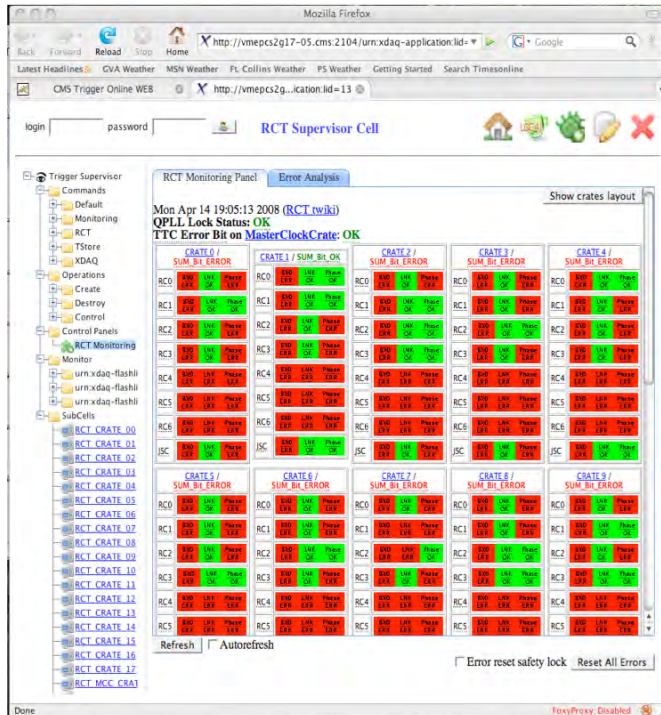
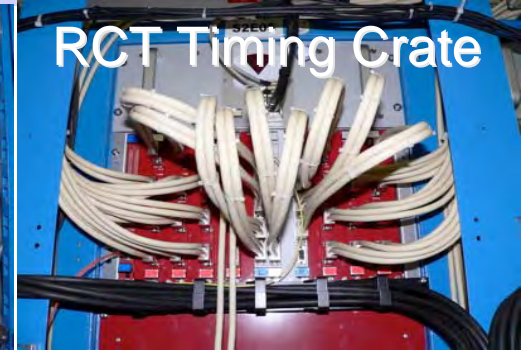
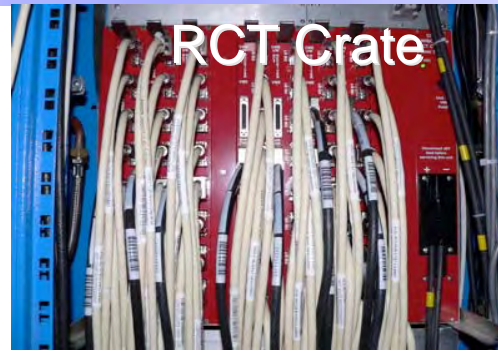
Regional Calorimeter Trigger

Hardware

- RCT is complete & ready for CRuZeT
- For CRAFT: Finalize timing

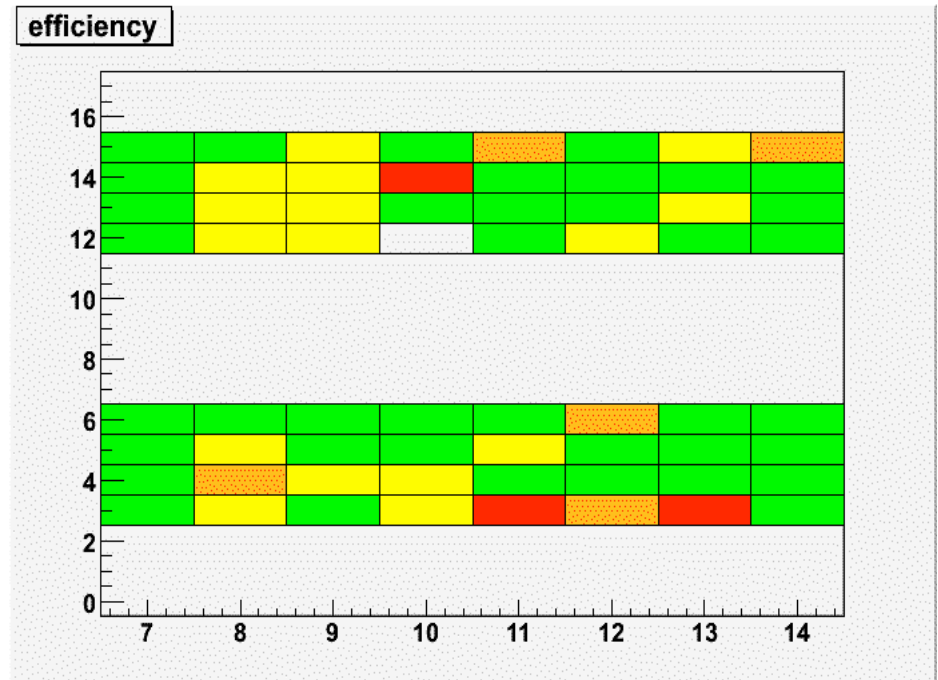
Monitoring:

- Link Status:



← Links off in order to test display

•Efficiency Status (GREN Data):

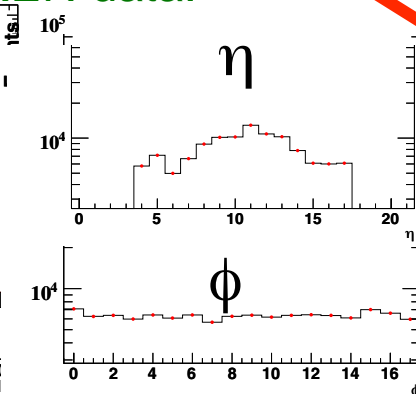
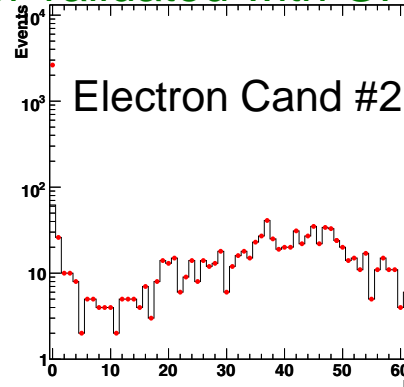
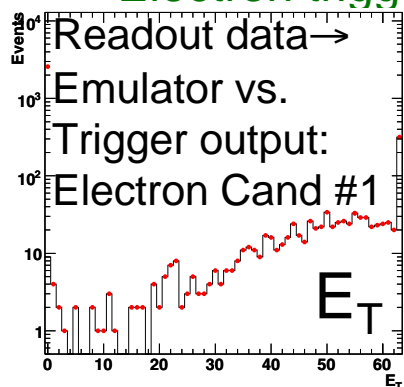




Global Calorimeter Trigger

Status:

- All 63 input (Source Cards) are in & debugged
- All Electron trigger cards installed & working
- Electron trigger validated with GREN data:

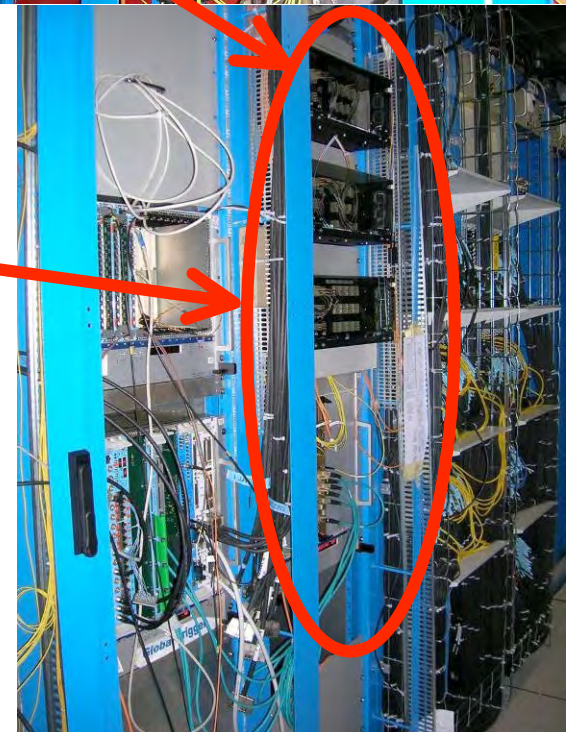
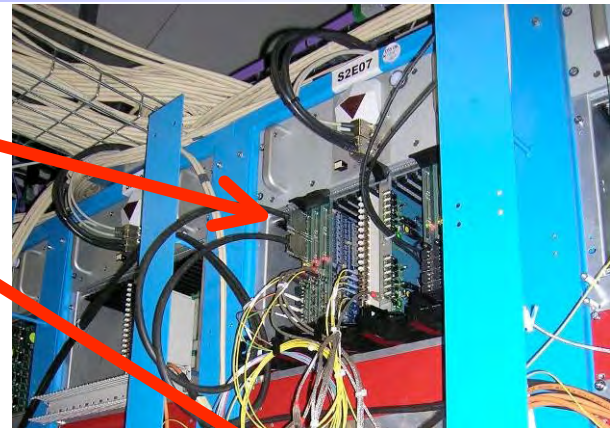


- Half of Jet trigger cards installed & under test

Available for May run:

- Electron Trigger.
- Positive Rapidity Jet Trigger Data
 - Use with emulator to study jet triggers
- All Hardware Integrated in Trigger Supervisor
 - Source Cards, Electrons and Jets

Available for June run: All Electron & Jet Triggers





Drift Tube Trigger

Local Trigger + Sector Collector ready (5 wheels)

- Phi Drift Tube Track Finder connection ready
- Eta connection being prepared

All DTFE Crates mounted

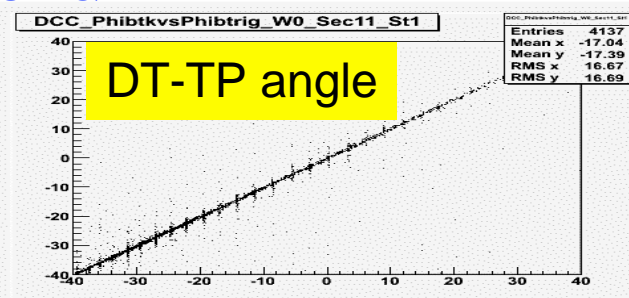
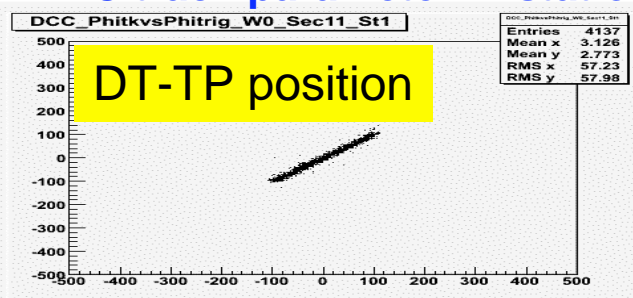
- All 72 Phi Track Finder Boards will be installed
- All Timing & Data Link Boards available

CSC connection: Cables in place & Transition boards installed

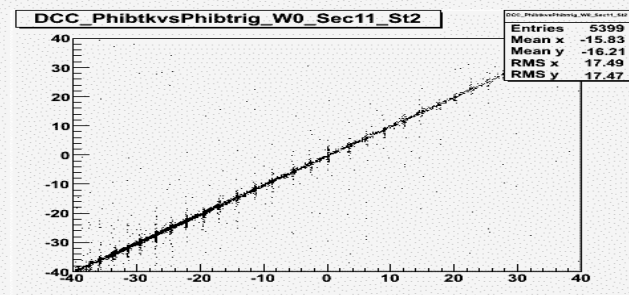
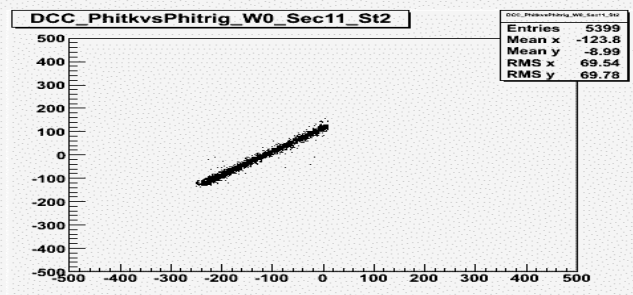
DT Trigger Validated in GREN:

- Position & angle of DT trigger primitives, as a function of the TDC track parameter in stations 1 & 2:

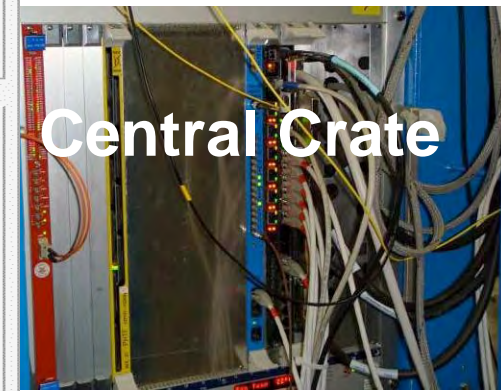
St. 1



St. 2



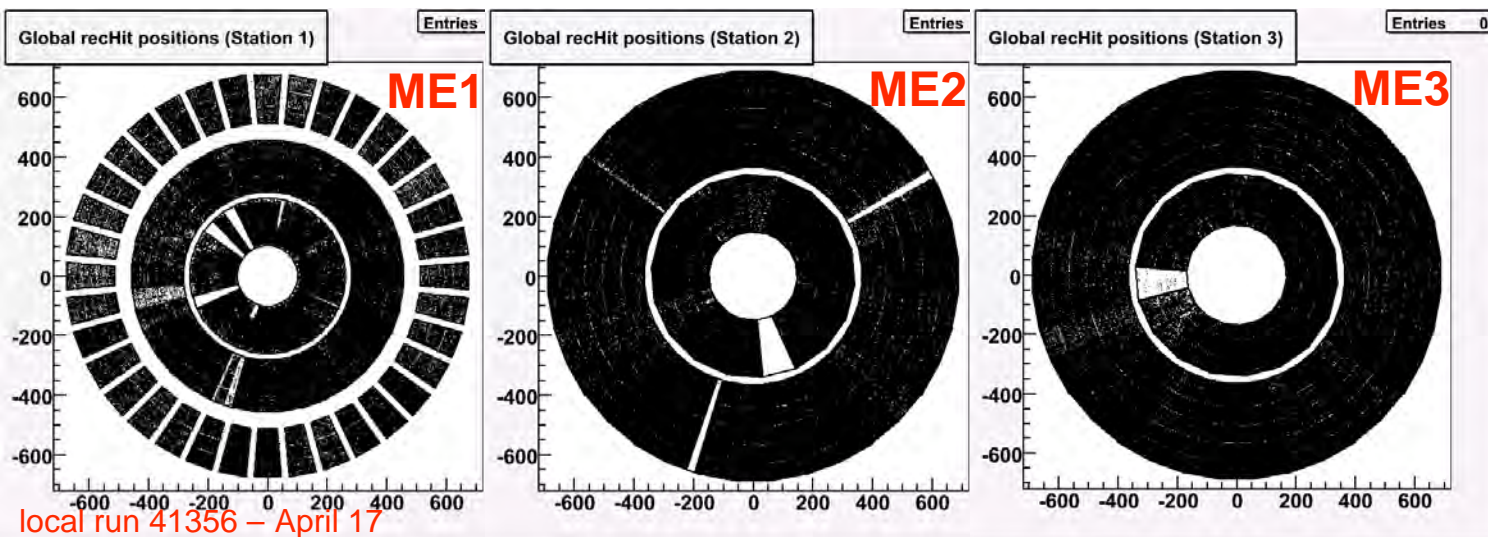
DTFE Crates



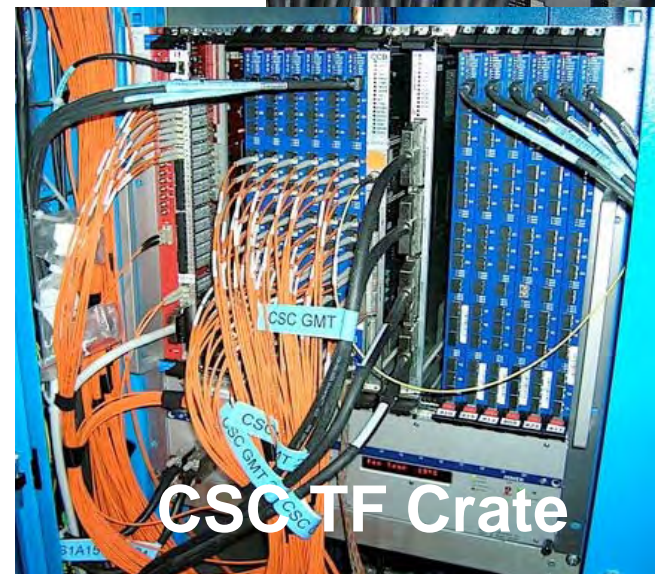
Central Crate



CSC Trigger



- Reconstructed positions from 3 CSC stations with CSC trigger (213/234 CSCs active)
- Trigger configuration: LHC pattern trigger (cosmic ray rate ~ 28 Hz)
- Single Crate, installed & operational since Spring '07
- Timed in with DTTF & GMT
- Integrated with Trigger Supervisor, Emulator Validated
- Monitoring data available, panel in development, DQM in use with plots available





RPC Trigger

Tested in Global Runs:

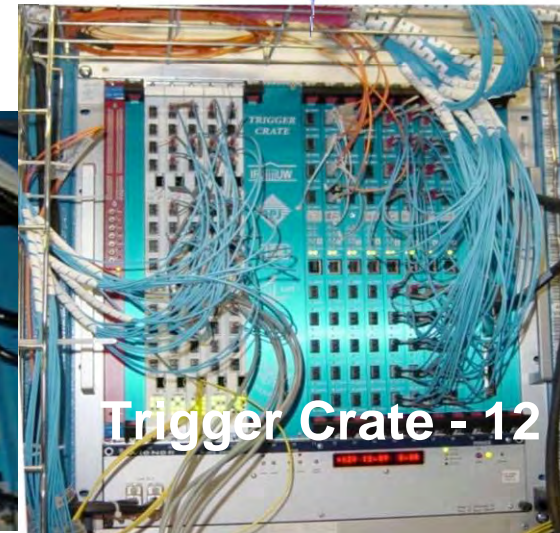
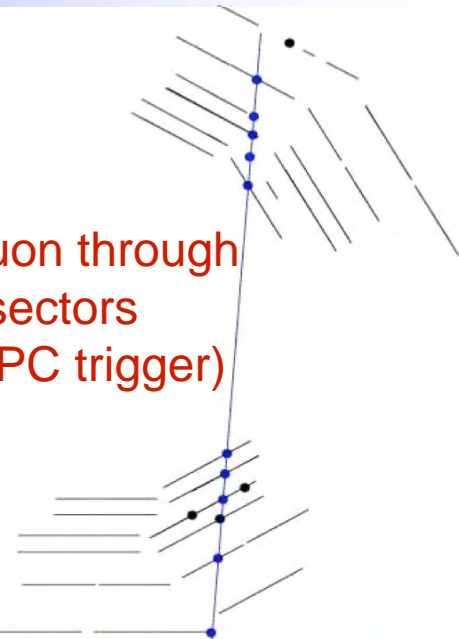
- Timing checked against DT, CSC

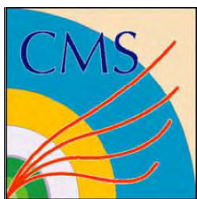
Link System (UX)

- Barrel system finishing commissioning
- Endcap system: YE+ installed, YE- starting
 - New production to complete YE-

Trigger System (US)

- Trigger Boards (64): full number at CERN
- Trigger Crates (12): half installed, rest in 1 month
 - Cabling keeping up
- Readout Mother Board
→ Data Concentrator Card OK
- Integrated with Trigger Supervisor

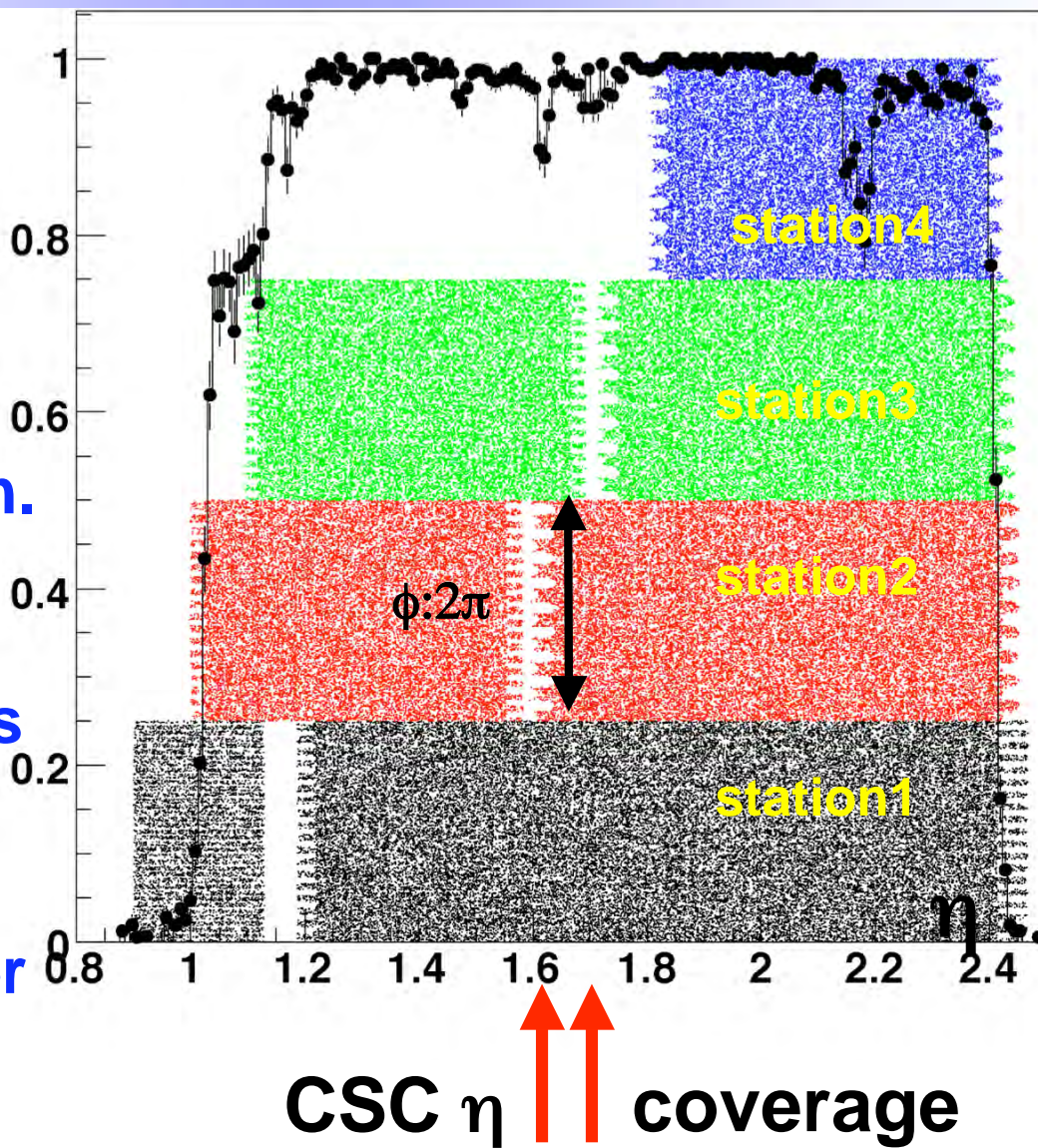




Global Muon Trigger

Accept 2-station μ triggers only for η where CSC coverage is missing

- Check with $\sim 6\text{M}$ min. bias for low lumi. thresh (3-10 GeV)
- Find rate increase is small
 - $< 1\text{ kHz}$
- Efficiency vs. η after modification \rightarrow





Global Trigger

All modules installed & in operation w/ final firmware

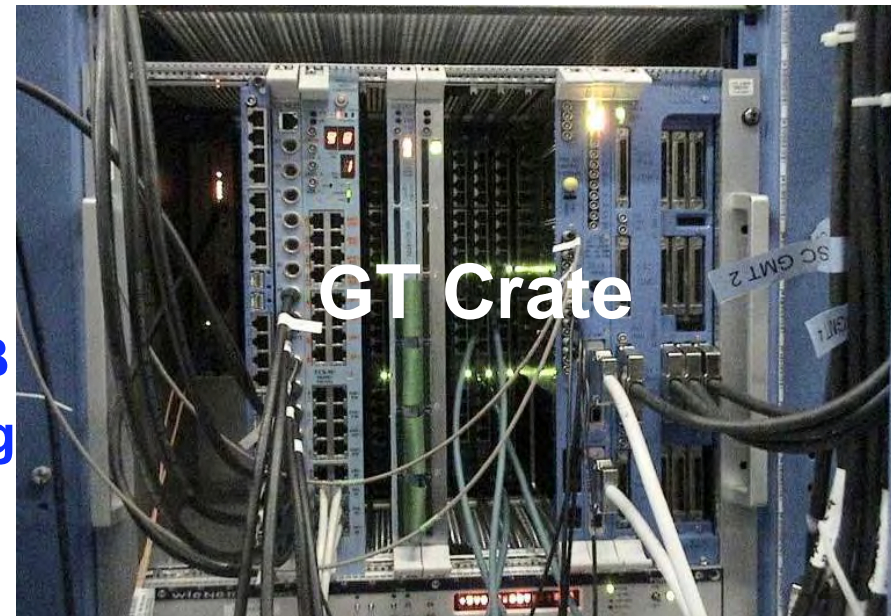
- Final Decision Logic Module commissioned w/muons, ECAL, HCAL

Installed a “hot spare” crate (GT2) in USC55

- on top of “production” crate (GT1)
- each crate is controlled via CAEN by a separate crate PC
- TTC clock/orbit signals fanned out to serve both crates
- can quickly switch between crates
- can test spare modules or upgrade software without interfering with normal operation of Global Trigger

Software:

- Integrated w/online configuration DB
- XDAQ/Trigger Supervisor monitoring
- Panels for monitoring, control, configuration





L1 Emulator Configuration

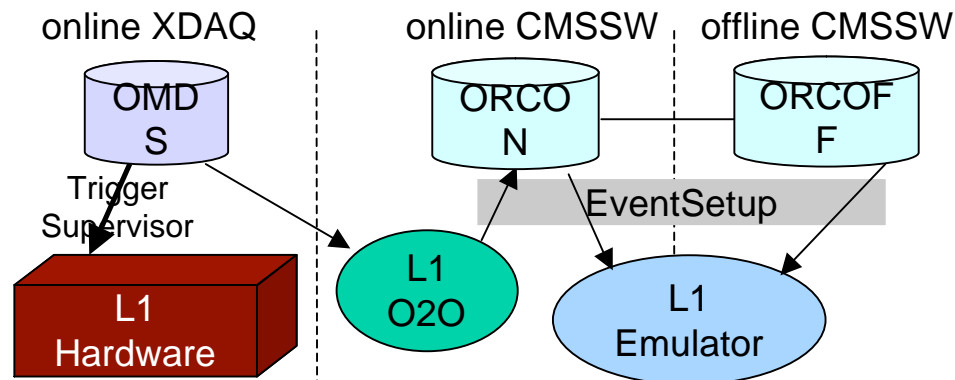
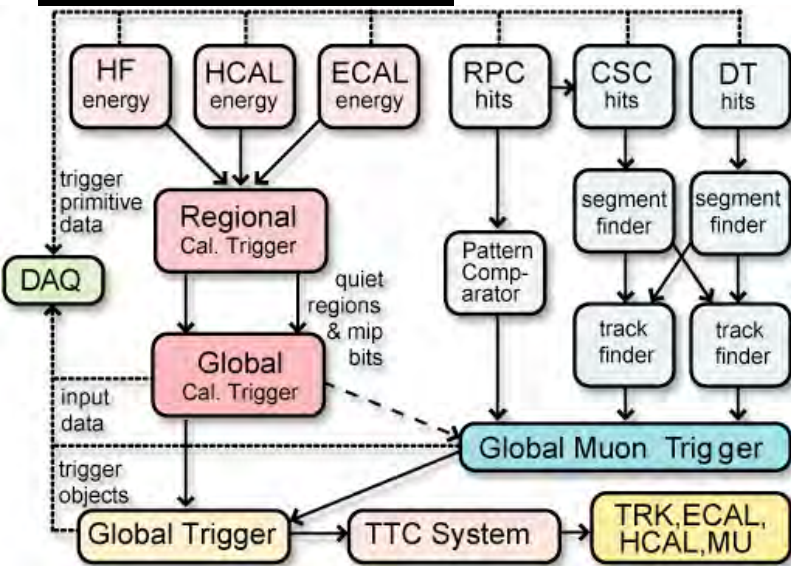
L1 emulator: bit-wise reproduction of trigger hardware in CMSSW:

- **Current use cases:**
 - Test hardware during commissioning (e.g. pattern tests).
 - Study triggers with MC (used in HLT exercise and CSA07).
- **Future:**
 - Run in filter farm at P5 for prompt hardware monitoring during data taking.
 - Stage new trigger algorithms before migration to hardware.

Current work: deploy emulator online.

- Emulator configuration must match hardware.
- Emulator modules configured from DB
- Online & Offline DB synchronized before each run.

L1 Trigger subsystems





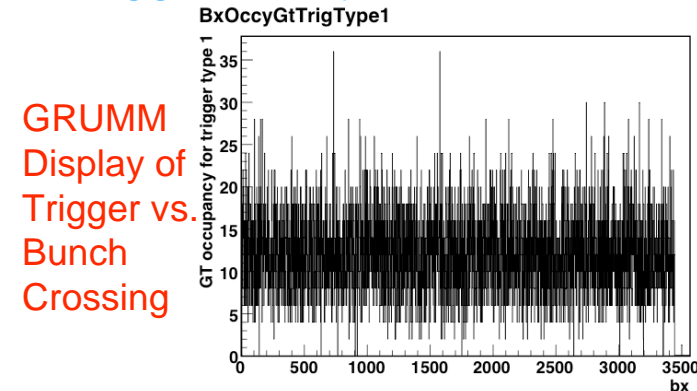
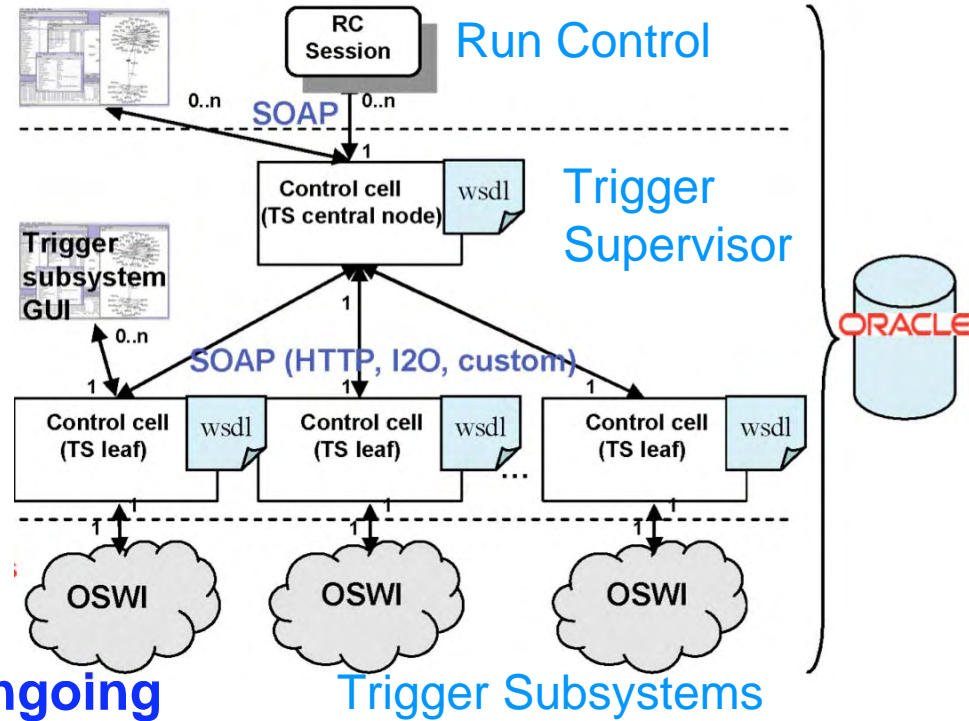
L1 Trigger Software

Trigger Supervisor

- Progress bar
- Integration with TTC
- Reporting, monitoring,
- handling of errors, alarms
- Integration with Configuration & Conditions Databases

Trigger DQM

- Histograms for almost all trigger systems run online for GRUMM
- Emulator-based data validation ongoing
- Plans:
 - Semi-automated procedure to run at CAF, (replica of the online DQM but on all events).
 - Run L1T DQM at Tier0 and FNAL Tier1.
 - Integrate with offline DQM workflow.
 - Run Emulator DQM in HLT.





DAQ Capability

100 kHz EVB (readout) installed

Use of EVB Farm as 25 kHz EVB + limited Filter Farm

- **With 100 ms/core (@2 GHz on EVB nodes): 14 kHz**
 - Summer 2007 “HLT exercise” menu measured 43 ms on 3 GHz
- **Operational Now**
 - Drop to 7 kHz during May-June (recable) & August (integrate new PCs)

Dedicated Nodes for Filter Farm

- **Purchase 900 PCs (dual quad-core @ 2.6 GHz)**
 - 720 HLT, 180 DAQ Services
- **Capacity 50 kHz (Phase 2 in 2009 → 100 kHz)**
 - Contingency in present rack space for 112 more PCs
- **Operational: expect end of summer**

Storage: (i.e. HLT accept rate)

- **Expect about 0.7 kHz peak, assuming 1.5 MB evt size (1 GB/s)**
- **Local Storage: Now: 120 TB (34 hours at 1 GB/s)**
- **Link to Tier-0 (1×10 Gb/s & one spare -- needs sustained throughput)**



Summary of DAQ Schedule

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50% EVB	Daq test	Daq test	Daq test	-	-	-	-	-	-	-	-
50% EVB	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR
HLT* @EVB kHz				~7	~7	~14	~7	~14	-	-	-
HLT* @FF kHz								~50	~50	~50	~50
				Cable 100% →			Integr				
CMS		GR		CR I B=0T	CR II B=0T	CR B=4T					
LHC beam					ready →						

*Will continue to operate HLT@EVB until HLT@FF is commissioned



DAQ Commissioning, Testing & Operating Plans

Complete:

- Tested Storage Manager
- Tested transfers to Tier-0 over CDR Link (120 MB/s so far)

Mar (GRUMM):

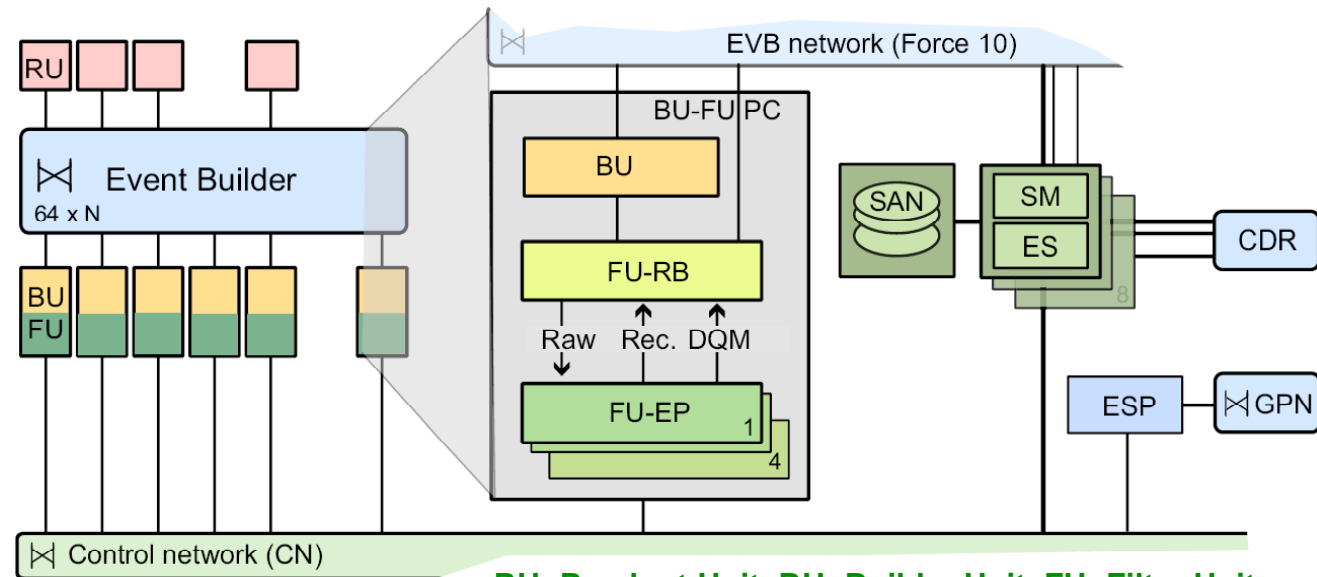
- Technical run: EVB farm (640 PCs) in SCX configured as EVB + limited HLT & transfer to CDR T0 link:
 - chain working

May & June:

- Cosmic Run: B=0

July:

- Cosmic Run: B=4T
- Ready for Beam



RU: Readout Unit, BU: Builder Unit, FU: Filter Unit

EVB: Event Builder, RB: Resource Broker, ES: Event Server

SM: Storage Manager, EP: Event Processor

CDR: Central Data Recording, SAN: Storage Area Network



HLT SW Infrastructure

Support for reduced-content streams (for calibration etc.)

- Ready and tested (since CMSSW 1_8_0)

Error event stream

- Filter Unit side done & Storage Manager side underway

Exception streams

- Collect all events generating (non-fatal) exception in at least one path
- Underway (not ready for CRuZeT)

Hard HLT Timeout

- Stop processing event in HLT if $T_p > T_c$
- Considered an “extreme” measure to supplement soft timeout

HLT “rate monitor”

- Scalers collected from Filter Units & summed up in HLT Scaler Gatherer (HLTSG) stored to online DB per lumi section
- Proof-of principle implementation in operation

Prescale Service

- Unique table of “working points” agreed between L1 and HLT



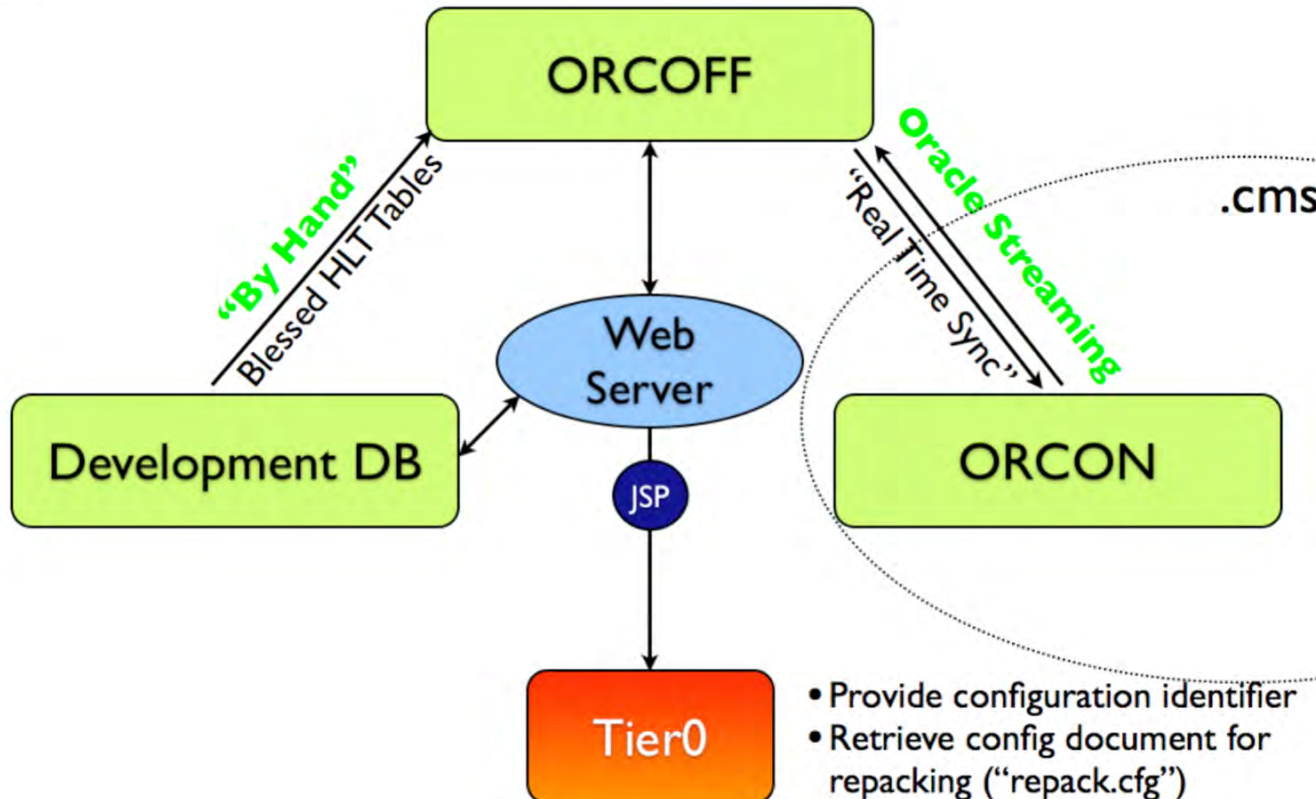
HLT Configuration

Offline/development switching to ConfDB

- Phase out of CVS menu will be completed with 2_1_0

Agreed scheme of link to production DB & relation to online

- Support offline access to HLT menus used for data-taking





HLT Validation Farm

(Higher Level Trigger online)

Currently: 20 DAQ PC (2x2GHz dual-core, 4GB)

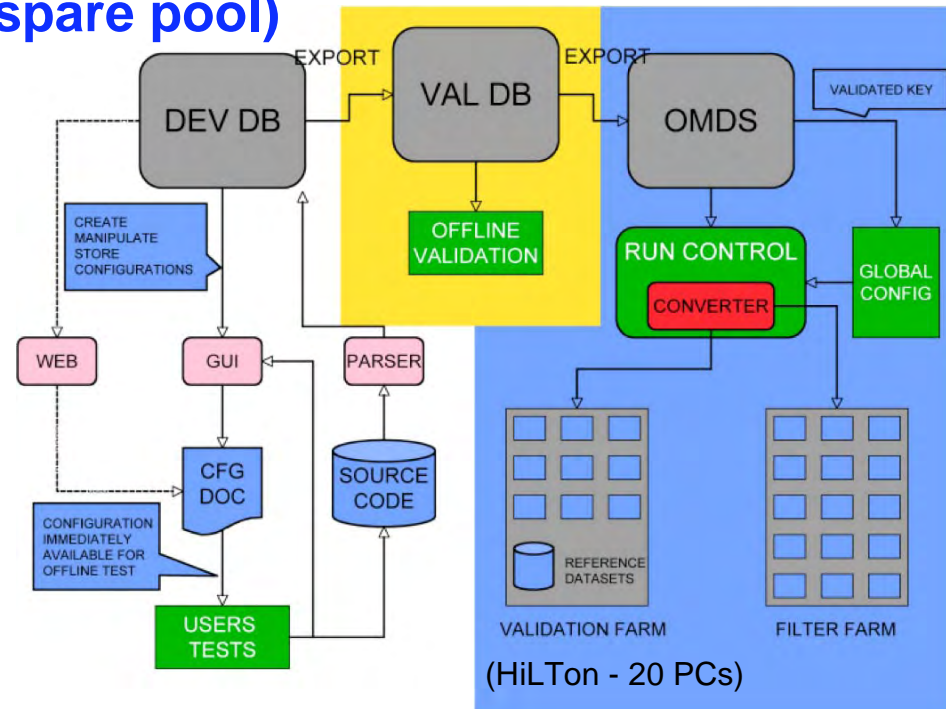
- Install 2TB disk on hilton01 to serve input data
 - Playback MC from CASTOR
 - Playback cosmics from SM

HiLTon Installation phase 1 (June)

- Replace current nodes with 25-30 1U PC (same as filter farm phase 1) (move current PCs back in DAQ spare pool)
- 0.5-1TB SATA disk each (playback input, test samples)

HiLTon Installation phase 2 (December)

- Duplicate system with second rack
- Introduce CDR relay via SM loggers for fast transfer from CASTOR





HLT Online Operations

Gear up for 24/7 operation of HLT in P5

Event Filter core team in charge of operations

- **Adding to experts team**

HLT Online Operations Forum to coordinate HLT online decisions with other stakeholders

- **Checkpoint validation of HLT menus for data-taking**
 - **CMSSW version and related issues**
- **Coordinate with offline reconstruction**
 - **Calibrations, configurations etc.**
- **Coordinate with Tier 0**
 - ***e.g.* number/content of online streams etc.**
- **Coordinate with sub-detector communities**



2008 HLT Status and Outlook

CMSSW_1_8_0: new HLT data model

- Started switch of HLT menu development to ConfDB

Storage Manager hardware:

- phased in for first time in GRUMM

GRUMM

- Special stream operations
 - Calibration, Express with specific event content

CMSSW_2_0_0: Ready for data taking

- Only minor refinements for monitoring remaining

CrUZeT:

- First operation with tracker
- Tests complete table online

CRAFT:

- Integrate all lessons learned for LHC startup

July-August Filter Farm Installation: DAQ @ 50 kHz

- Will continue to operate with EVB FF nodes until commissioned
 - 14 kHz capability (7 kHz during recabling)



Trigger Coordination Organization

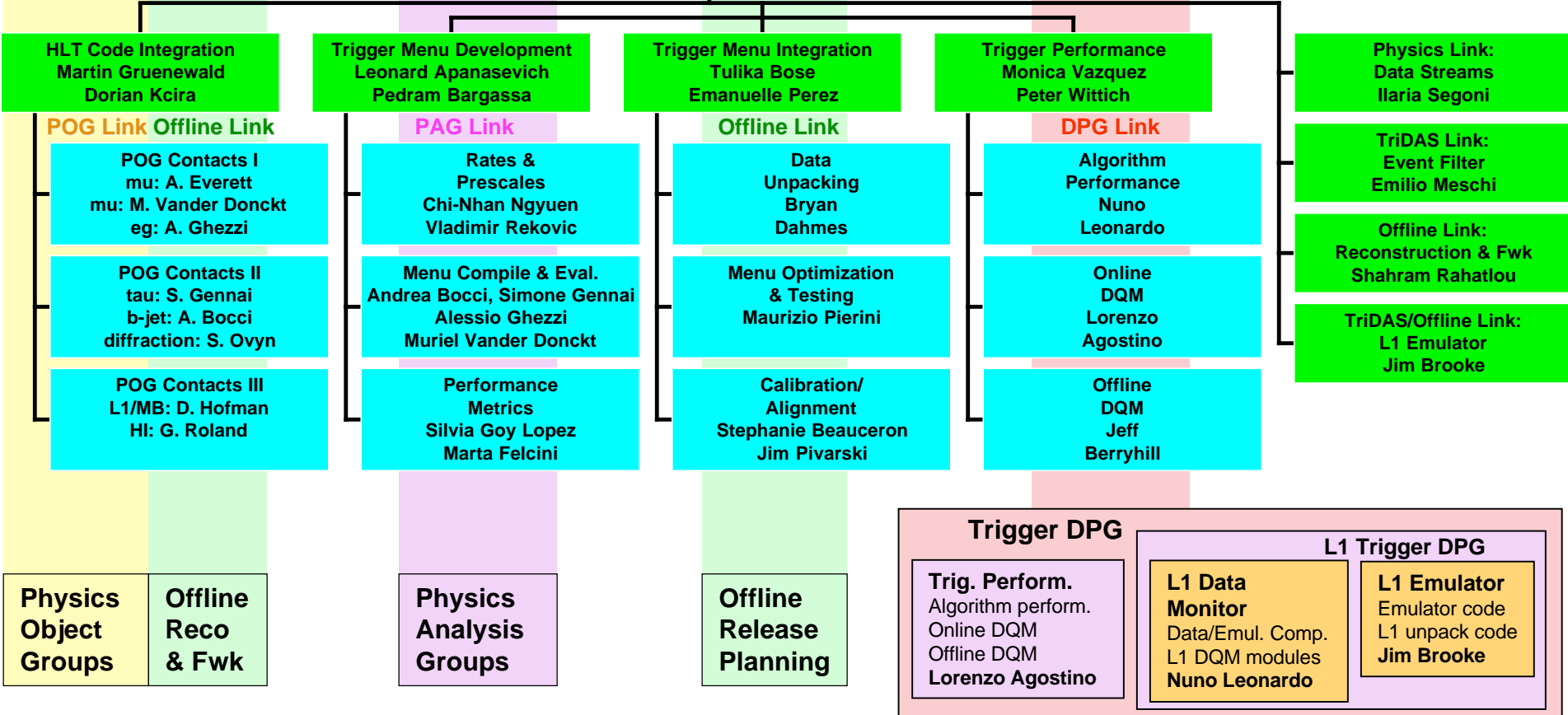
& LINKS

2008

Trigger Coordinator
Wesley Smith
Deputy
Christos Leonidopoulos

Trigger Study Group
Chaired by Dep. Tr. Cor.

Trigger Executive Board
Chaired by Tr. Cor.





Trigger Coordination Summary

- All trigger systems operating & have been used to trigger
- Global Calorimeter trigger is on fast track for full operation
- Manageable Delays: ECAL Endcap & RPC Endcap triggers
- L1 Trigger software is functional and maturing
- L1 Emulators are operational
- DQM available for all trigger systems
- 7 kHz DAQ operational now. 50 kHz DAQ by Sep. 1
- HLT infrastructure is mature and robust
- HLT validation Farm is working
- Plan in place for HLT operations
- Effective Trigger Coordination organization in place
- Next: Trigger Menus (talk by C. Leonidopoulos)