

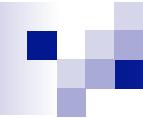
# CMS DAQ-2 Shifter Tutorial

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On behalf of the CMS DAQ group



# DAQ2 Tutorial Outline

- Part 1: Your tasks as a DAQ shifter
- Part 2: Overview of the DAQ-2 system
  - Change from DAQ-1 to DAQ-2
  - DAQ-2 hardware and data flow from the detector to storage / Tier 0
  - Flow control
  - Software
- Part 3: Controlling data taking through Run Control
- Part 4: DAQ monitoring tools

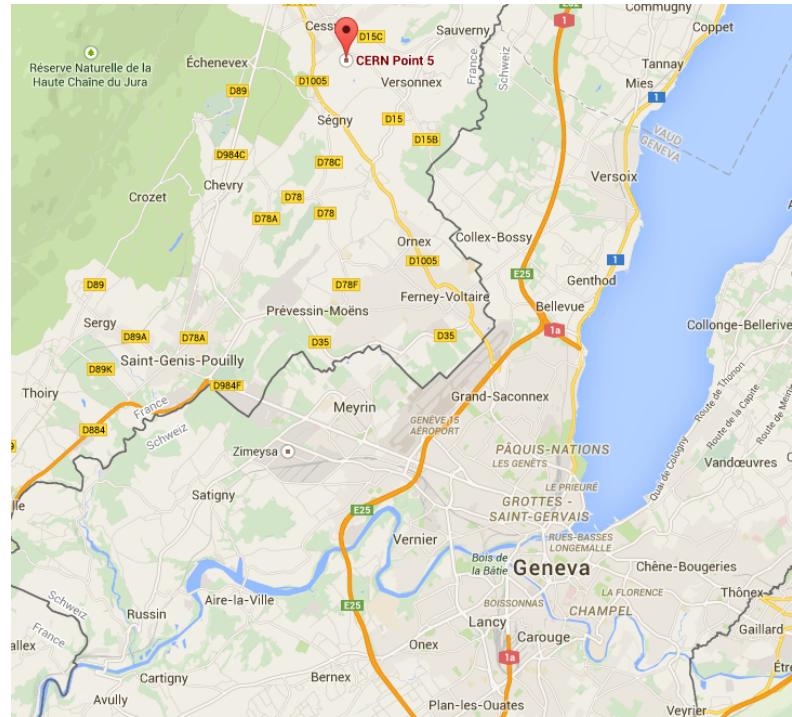


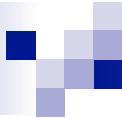
# Part 1: Your tasks as a DAQ shifter



# Context

- DAQ shifts take place at the CMS Control Room at Point 5 of the LHC in Cessy, France
  - Three shifts: 7-15, 15-23, 23-7
  - Five shifters
    - Shift leader: manage operations in line with daily plan, monitor data taking, communicate with LHC, safety
    - DCS shifter: slow control, access, safety
    - DAQ shifter: control, monitor & troubleshoot data taking
    - Trigger shifter: monitoring of the L1 trigger
    - DQM shifter: monitoring of data quality
- (the latter three shifts may get cancelled under certain circumstances)

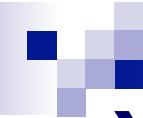




# Your responsibilities as a DAQ Shifter

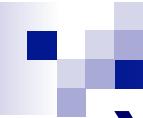
## ■ Main DAQ responsibilities:

- Monitor the DAQ
  - Make sure the DAQ is running smoothly and that CMS is collecting high quality data!
  - This means:
    - Monitoring all stages of the DAQ from FEDs -> data sent to Tier 0.
      - Data rate, dead time, back-pressure, CPU usage, problems
    - Interfacing with the shift crew
- Control data taking as the Shift Leader requests
  - Start / stop runs
  - Take in / out sub-detectors, FEDs
  - Manual re-syncs, hard resets, control random rate
- Troubleshoot the DAQ in case of problems
  - But don't hesitate to call the DAQ DOC (x76600) when you are stuck!
- Document your shift: use the ELOG!



# Your responsibilities as a DAQ Shifter

- ◆ You are the **main responsible** for efficient data taking of CMS
  - The CMS efficiency will depend to a high degree on your abilities
    - As a consequence you need to
      - ◆ Read and learn the necessary procedures
      - ◆ Keep yourself up-to-date
        - The run environment will evolve in time
        - Procedures will change
        - Monitoring systems will change
    - ◆ This means you have to dedicate some time outside of your shift period to study the online DAQ system and how to operate it.



# Your responsibilities as a DAQ Shifter

- ◆ During your shift you have to communicate continuously with the shift leader and other shifters/DOCs in order to keep running efficiently

- You are needed since the job CANNOT be done by a computer program or a robot !

- Since you are the key person which starts and stops the run, you also should be the key person to overcome or work around problems. This means:

- ◆ You should be able to localize where the problem is
  - In the central DAQ, or in a subsystem, or in the computing infrastructure
- ◆ You must communicate efficiently to the relevant experts and the shift leader in the control room
- ◆ You are involved in suggesting workarounds were you can
- ◆ You are co-responsible to solve problems in the DAQ and online system
  - This often means to efficiently communicate to the expert on call
  - You must be precise & concise when reporting problems on the phone



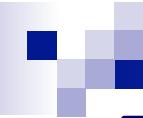
# Your responsibilities as a DAQ Shifter

- ◆ **Be active!** Do not just wait for instructions

- This will increase the data taking efficiency.
- If you think time is being wasted, talk to the shift-leader.
- If you think a specific sub-system is blocking for too long the data taking talk to the shift leader.
  - ◆ You as a cDAQ shifter probably have the best feeling which subsystem is blocking data-taking.
- When you are active, you learn more about the other systems, too. This makes shifting much more fun, and is a good thing for CMS!

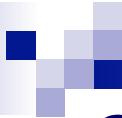
- ◆ **But always:** Do nothing without informing the shift leader

- In particular when subsystem experts contact you directly:  
Always involve the shift leader that he knows what is going on!
- Always make sure that either you or the shift leader have contacted the relevant sub-system expert (DOC) before deciding to remove subsystems or FEDs from the run



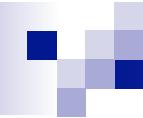
# E-Log

- Document your shift in the e-log
  - Your entries are essential to make CMS run efficiently. The e-log is a primary source of information for improving the system. With your entries in the e-log you are part of the team which tries to improve the online system to achieve “smooth operation”.
- There should be an e-log window already open. Logout the old shifter and log in yourself as soon as you start your shift
  - Use the Subsystems>DAQ>DAQ area – there is a link to it in the shifters guide
- Please “submit” comments in a timely manner
  - That way people offsite can monitor what’s going on
    - Many short entries are preferable to one long log entry at the end of your shift!
- Document any issues that come up or observations you have about the DAQ, e.g.
  - If you have to constantly restart or resync a subdetector, If the DAQ goes into error at any time, anything that seems funny or you don’t understand
  - Make sure to copy / paste any error messages that are relevant
    - From hotspot / RCMS / handsaw / etc.
  - Add context information to the errors
- Give a meaningful & correct subject to your log message
  - E.g.: “Run blocked due to HFLUMI FED 1122 sending events out of sequence”  
(instead of “DAQ crashed”)



# Shift Bulletin Board

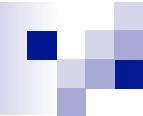
- Before each shift check the Shift Bulletin Board
  - This Twiki page contains
    - Procedures
    - Settings (e.g. sub-system RUN Keys, FEDs that are out for a period of time)
    - Known problems (and workarounds)
    - (temporary) instructions
  - If you do not fully understand, check with the previous shifter or the DAQ on-call **at the beginning of your shift**
- **You must** keep the Shift Bulletin Board up-to-date
  - The next shifter will rely on it



# General Rules and Policies

- ◆ **Security (computing):**

- Never write down passwords in public places where other people have access to (files in your home account, paper on your desk, etc)
- Do not give the passwords to other people
  - ◆ It is the on-call experts which give the relevant information to the shifters



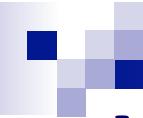
# General Rules and Policies

- ◆ **Take your work seriously:**
  - If you have time (during a long smooth run in the night):
    - ◆ Of course you may check your email on your portable
    - ◆ Of course you may write an email
    - ◆ You SHOULD eat and drink something during your shift...
  - BUT : You must continuously watch the screens to check that the data taking proceeds as it should.
- ◆ **It is unacceptable that the run stops due to some problem and you do not realize this for 5 minutes.**
- ◆ **Shifting is real work, and unfortunately not always exciting or breath-taking...**
- ◆ **If you manage to do efficiently other work during your shift, then you do not take the shifting seriously !**



# General Rules and Policies

- ◆ **In case you are in trouble:**
  - FIRST INFORM THE SHIFT LEADER
    - ◆ Tell him/her what you suggest to do next. (Sometimes he/she does not know what to do...)
- ◆ **You cannot get a run going and beam is there or imminent**
  - You have serious doubts that the data is taken correctly and/or there is a problem in the central DAQ
  - CALL THE DAQ ON-CALL EXPERT AT ANY TIME**
  - The experts are there to help you at any time. (This is why they do not need to do other shifts)
- ◆ **If you have a problem or question which **you are sure** is NOT critical to efficient data taking**
  - Document your problem in e-log
  - Call the expert at any time during the day/morning/evening.
  - The experts are also there in order to make you more expert!!



# Your shift outline

- Arrive 15 minutes early!
  - Discuss with previous shifter any problems / issues / requests
  - Read through the shift bulletin board and make sure you understand it
  - Log into the Elog and begin documenting your shift
- If a run is ongoing, check all the monitoring screens
  - Is the data flowing ok?
  - Do you understand the trigger rate? Is the trigger correct?
- Follow any requests from the shift leader
  - **Never** include / remove subdetectors or FEDs without talking to the shift leader
- When you have time, take a tour of both the central control room and the subdetector room
  - Introduce yourself to your fellow shifters!
- If questions/problems do not hesitate to call the DAQ DOC (x76600)



# Documentation and Resources

- DAQ2 shifters guide twiki page
  - <https://twiki.cern.ch/twiki/bin/view/CMS/ShiftPourNuls2014>
- The leftbar of the DAQ2 shifters guide has many valuable links:

**Shifting News**  
DAQ Expert on Call:  
76600  
HLT Expert on Call:  
165575  
Shift Bulletin Board  
DAQ shifter hypernews  
[\[link\]](#)

**Shifting Documentation**  
DAQ ELOG  
DAQ Shift Tutorial (not yet updated for DAQ2)  
Glossary of DAQ Terms

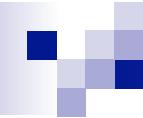
**Shift lists and phone numbers**  
Expert On Call Schedule  
[\[link\]](#)  
Expert List and General Phone Numbers  
DAQ Shift Schedule  
[\[link\]](#)  
P5 shuttle signup

DAQ shifter bulletin board: read before every shift.  
DAQ shifter hypernews: subscribe to this! All DAQ shift related announcements are sent here

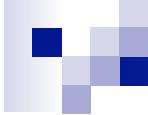
DAQ ELOG: Link to DAQ area of the ELOG  
DAQ Shift Tutorial: link to slides from shift tutorial  
Glossary of DAQ Terms: definition of all the DAQ acronyms.

Expert on call: link to DAQ DOC area of shift tool  
Expert List: link to list of DAQ and HLT experts  
DAQ shift schedule: link to DAQ shifters area of shift tool  
P5 shuttle: link to shuttle schedule

- Shifter bookmarks : <http://cmsdaqweb/daqpro/ShifterBookmarks.html>
- Questions about shifts: [cms-daqshift-office@cern.ch](mailto:cms-daqshift-office@cern.ch)



## Part 2: The central DAQ system

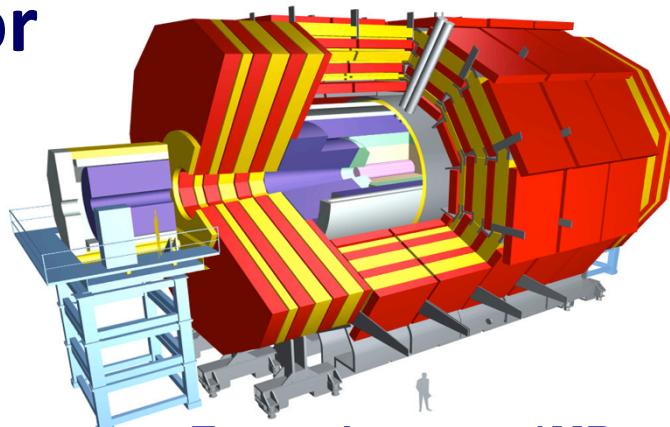


# The Central DAQ during Run-1 DAQ-1



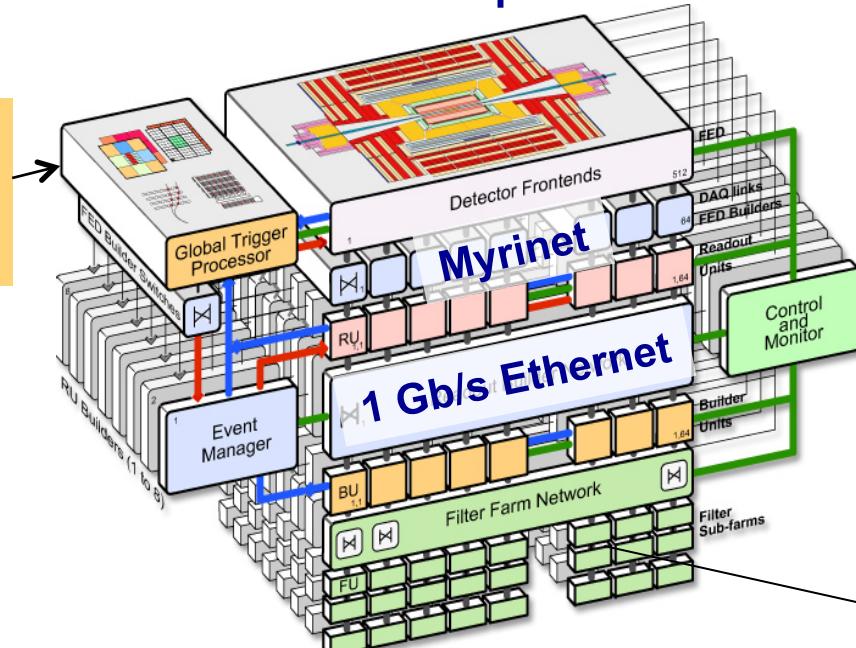
# CMS DAQ for LHC Run-1

Only 2 trigger levels in CMS



Event size up to 1MB

Level-1 Trigger accepting 100 kHz  
Custom electronics



99.6 % cDAQ availability  
(2010-2013 physics runs)

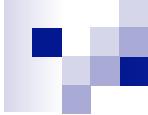
up to 1.2 GB/s to storage

Bunch crossing rate  
40 MHz nominal

DAQ: 100 GB/s bandwidth

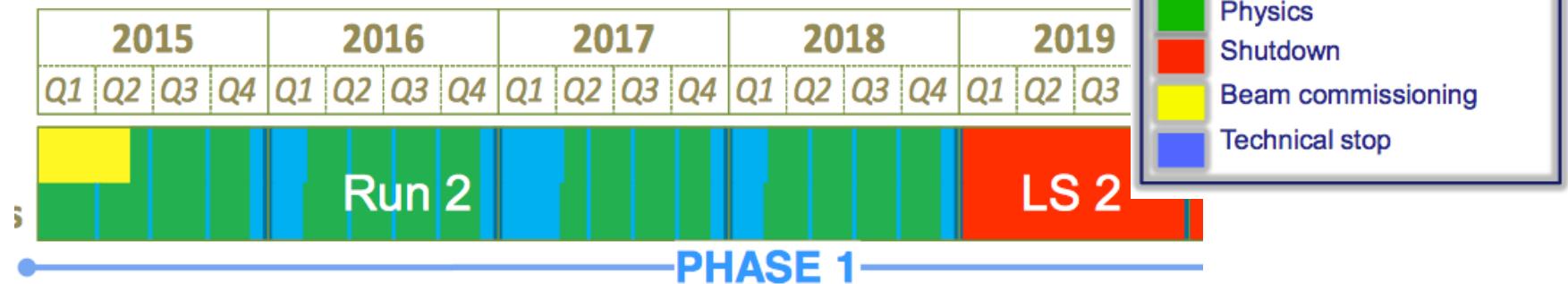
2-stage event builder  
Myrinet  
Gigabit Ethernet

High-Level Trigger working on full events  
13000 cores  
~500 Hz accept rate



# Why build a new DAQ?

# LHC plans



13 TeV center-of-mass energy  
40 MHz (25 ns) operation  
targeting  $40 \text{ fb}^{-1}$  / year  
higher pile-up

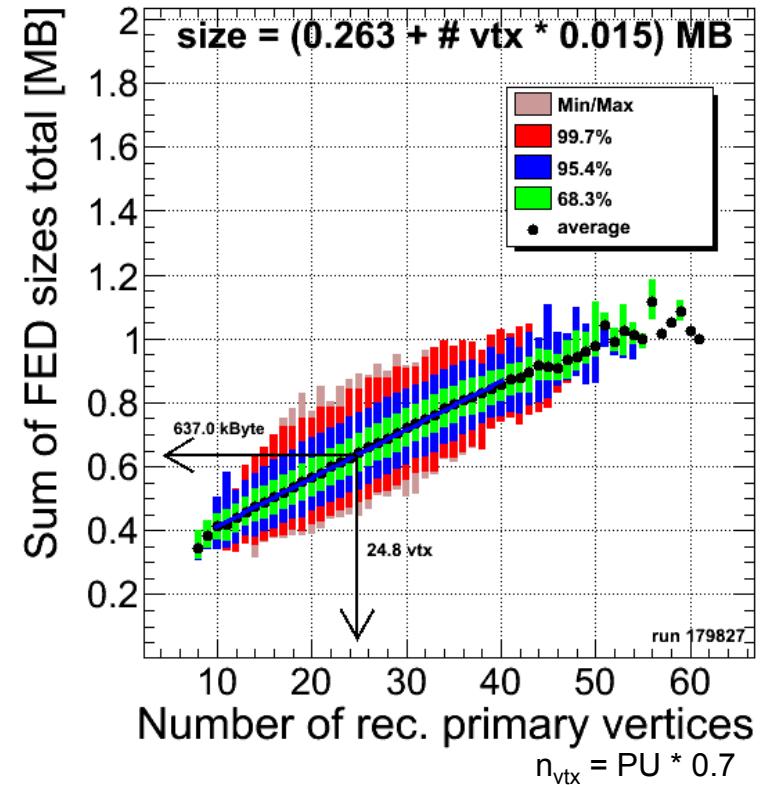
Plan for startup after LS1 (2015)



	BX spacing [ns]	Beam current [ $\times 10^{11} \text{ e^-}$ ]	Emittance [ $\mu\text{m}$ ]	Peak Lumi [ $\times 10^{34} \text{ cm}^{-2} \text{s}^{-1}$ ]	Pileup
2015	25	1.15	3.5	0.92	21
2016	25	1.15	1.9	1.6	43
2017	50	1.6	2.3	0.9-1.7	40-76 (*)
2018	50	1.6	1.6	2.2	108 (*)

## LHC run-2 pile-up scenarios

(\*) LHC will perform luminosity leveling to limit pile-up to 50



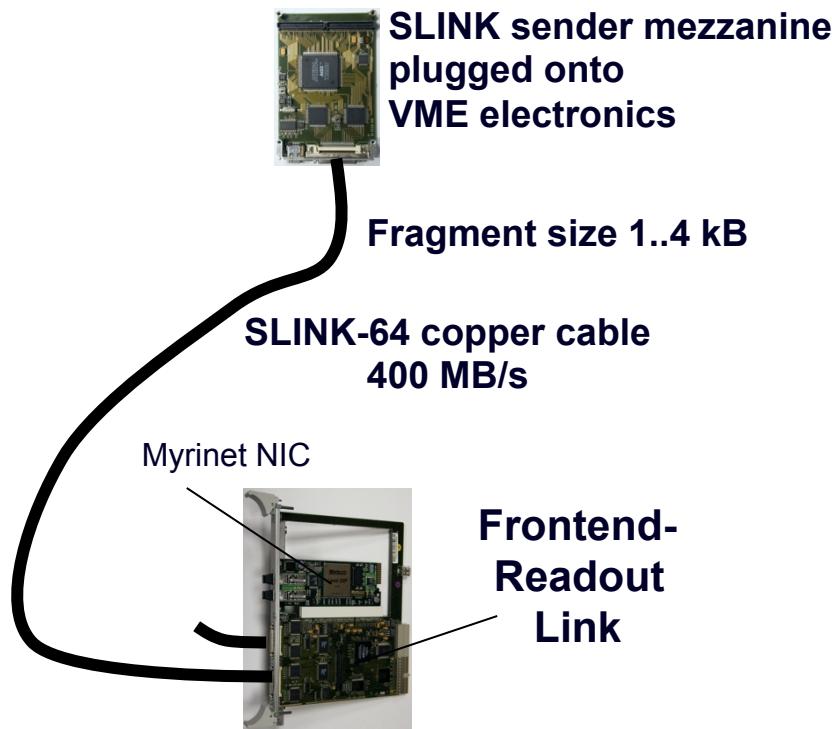
CMS event size  
(Run-1 subsystems)

$$n_{\text{vtx}} = \text{PU} * 0.7$$

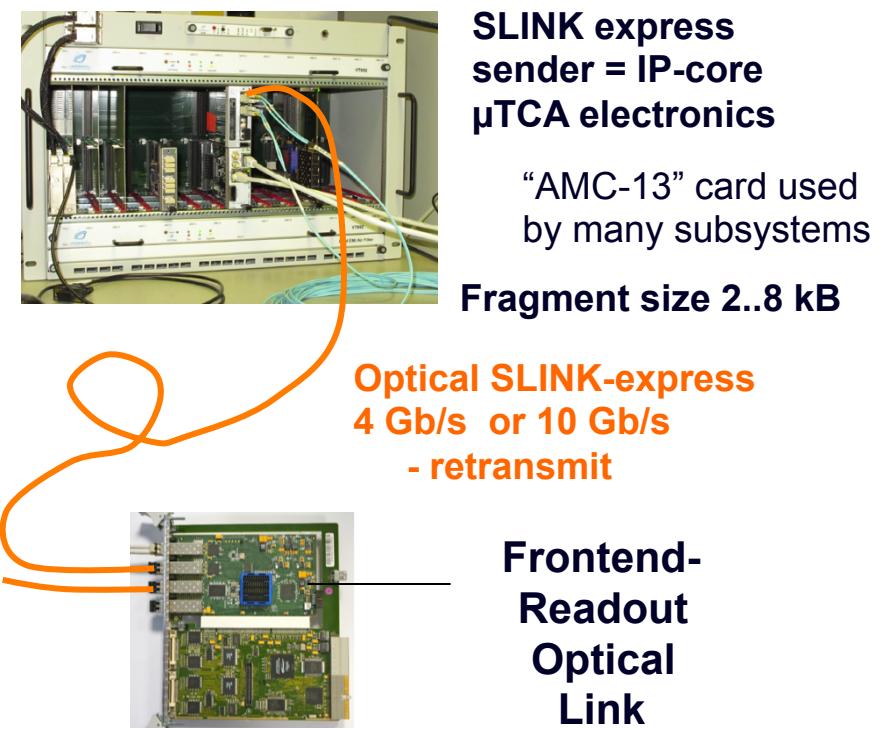
# New or upgraded detectors in CMS

- Several detectors / online-systems being upgraded to cope with higher luminosity
- Increase of event size
- Readout electronics of upgraded systems based on μTCA

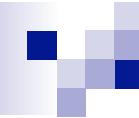
- 2014: New Trigger Control and Distribution System
- 2014: Stage-1 calorimeter trigger upgrade
- 2014/15: new HCAL readout electronics
- 2016: Full trigger upgrade
- 2017: New pixel detector and readout electronics



**640 Legacy Links: SLINK-64**  
(600 after pixel upgrade)



**+ 50 new Links: SLINK-express**  
(170 after pixel upgrade)



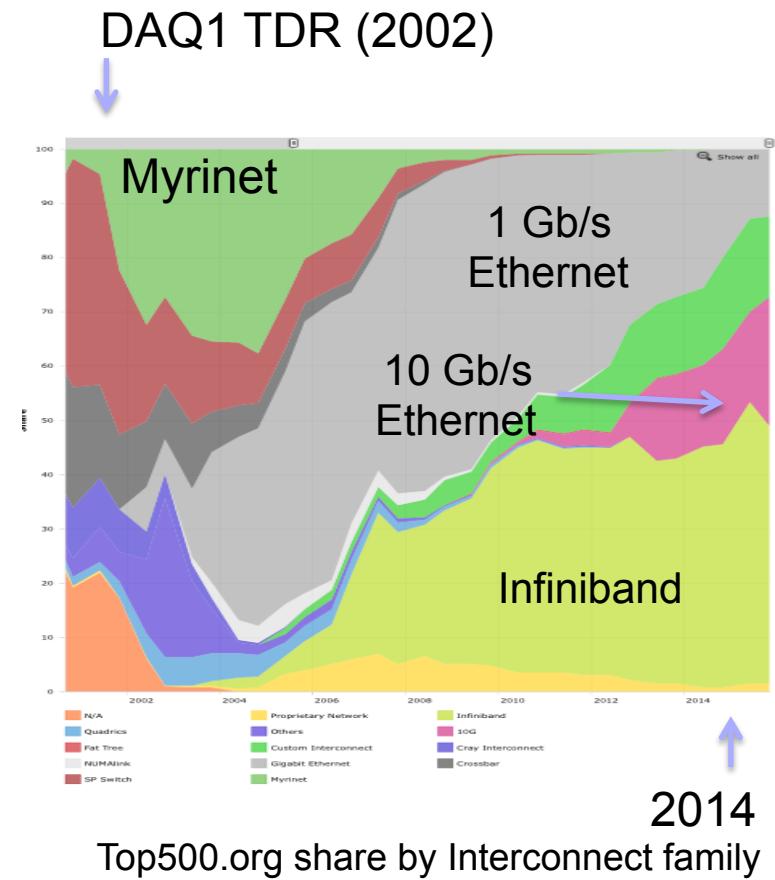
# Other reasons to upgrade

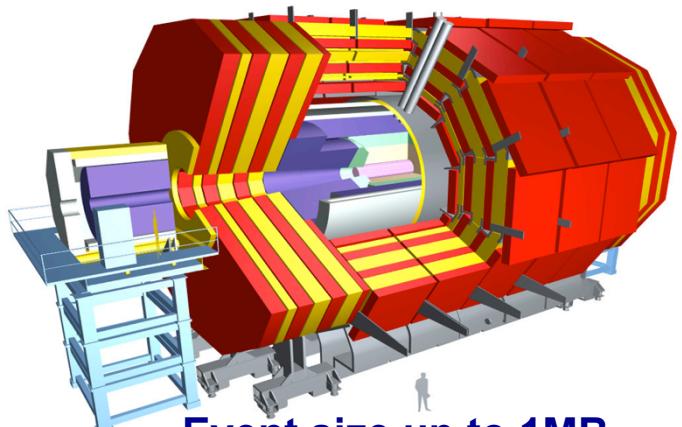
## ■ Ageing hardware

- Most PCs of Run-1 system at end of life cycle
- NICs of Run-1 based on PCI-X

## ■ New technologies

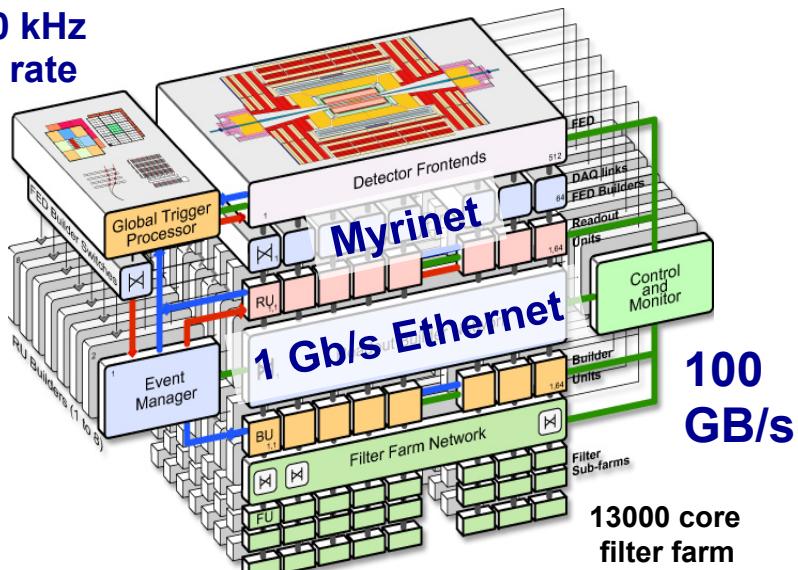
- Myrinet widely used when DAQ-1 was designed
- Today Ethernet and Infiniband dominate the Top-500 supercomputers





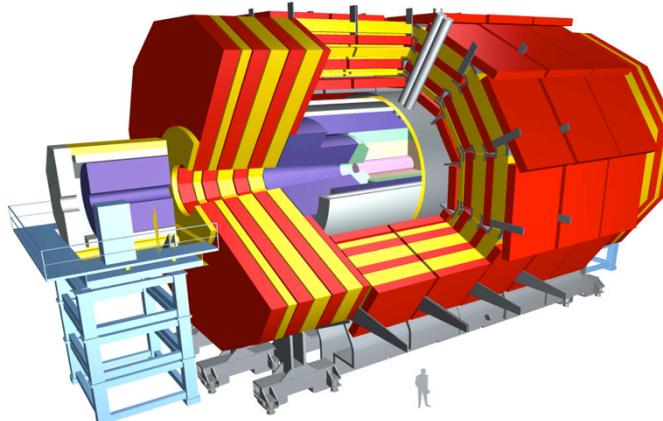
**Event size up to 1MB**

**100 kHz  
L1 rate**



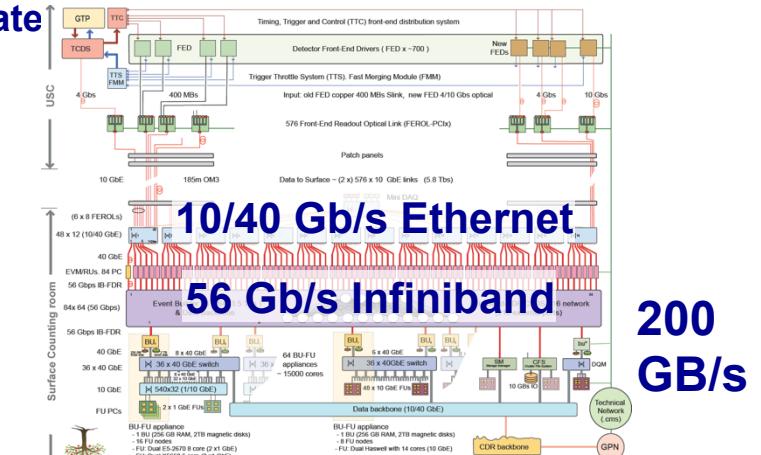
**13000 core  
filter farm**

**max. 1.2 GB/s to storage**



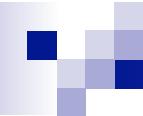
**Event size up to 2MB  
(large margin)**

**100 kHz  
L1 rate**

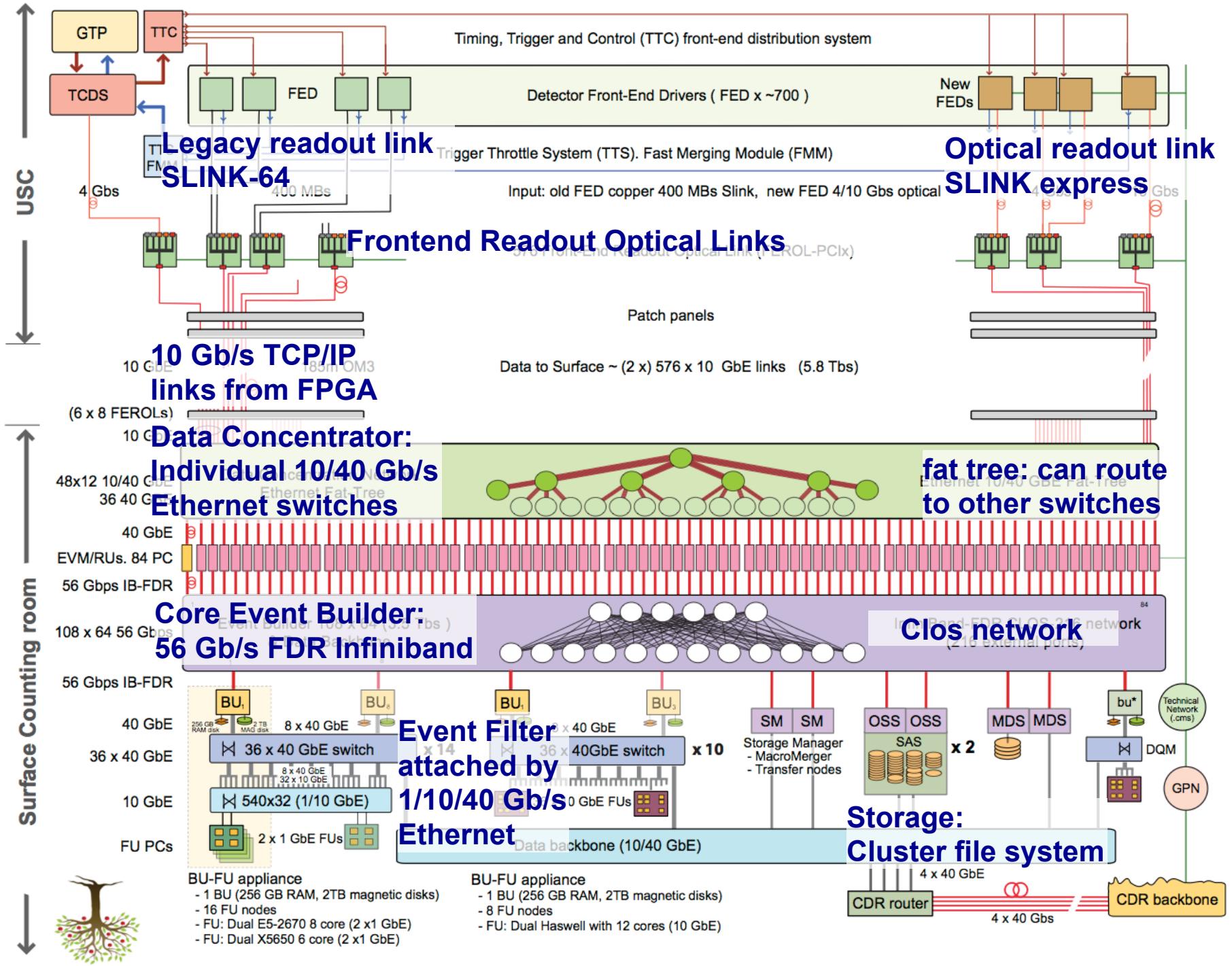


**16000+ core  
filter farm**

**~ 3 GB/s to storage**

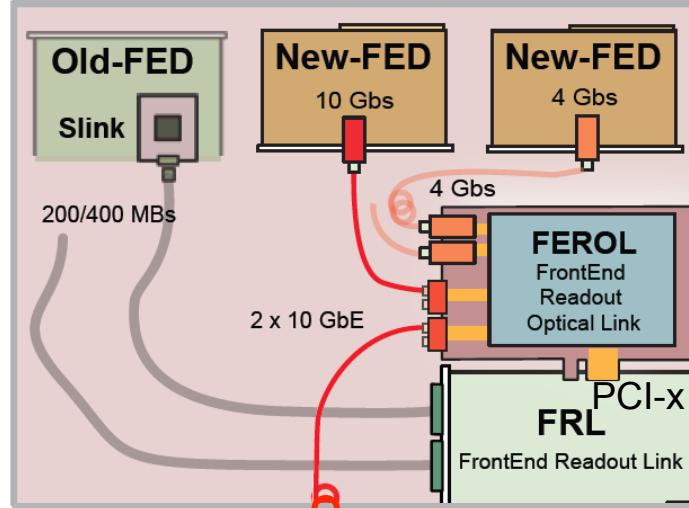


# The Central DAQ during Run-2 DAQ-2

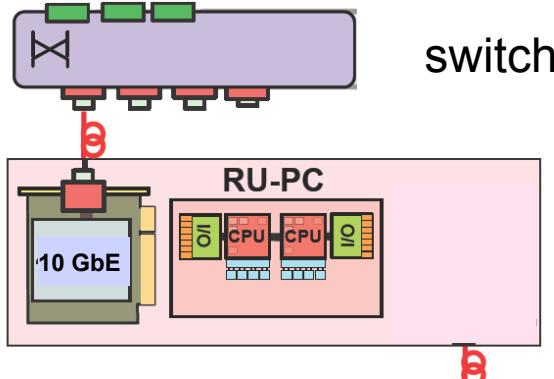




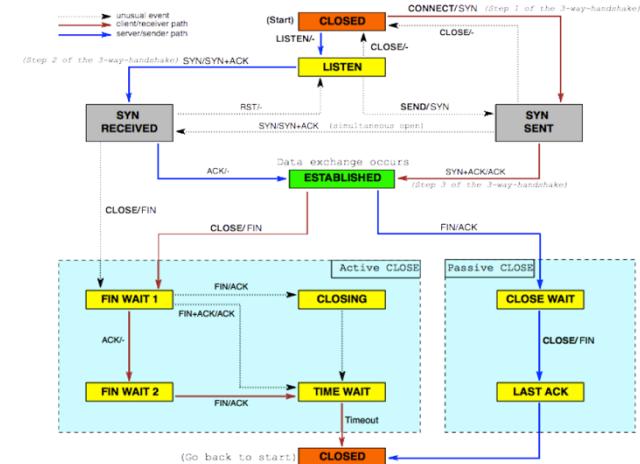
# Frontend-Readout Optical Link



10 Gb/s simplified TCP/IP  
from an FPGA

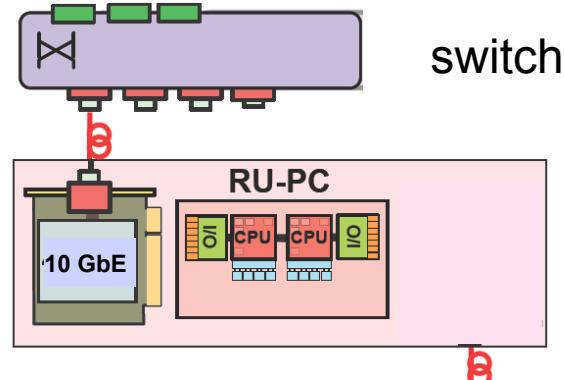
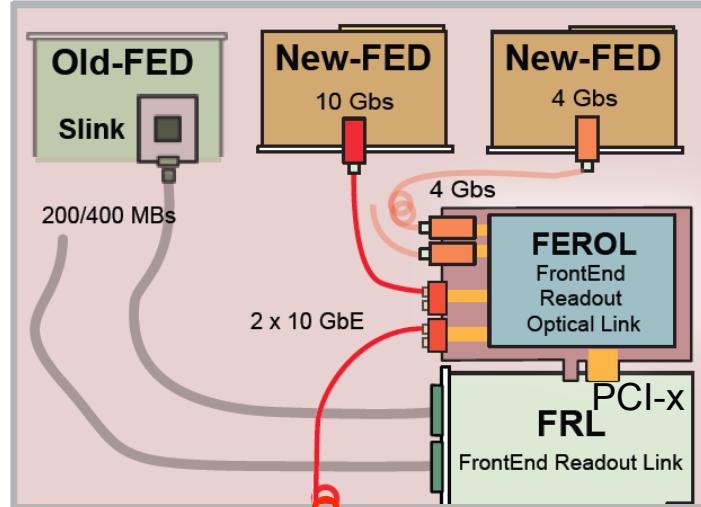


PC running standard  
TCP/IP Linux stack

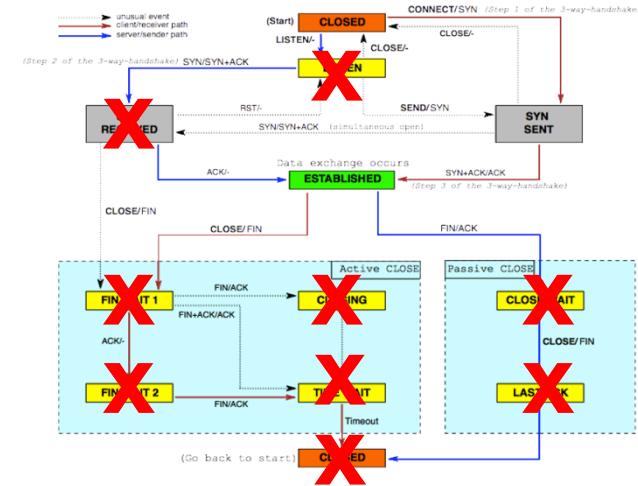


TCP/IP in principle difficult to implement in an FPGA ...

# Frontend-Readout Optical Link



PC running standard  
TCP/IP Linux stack



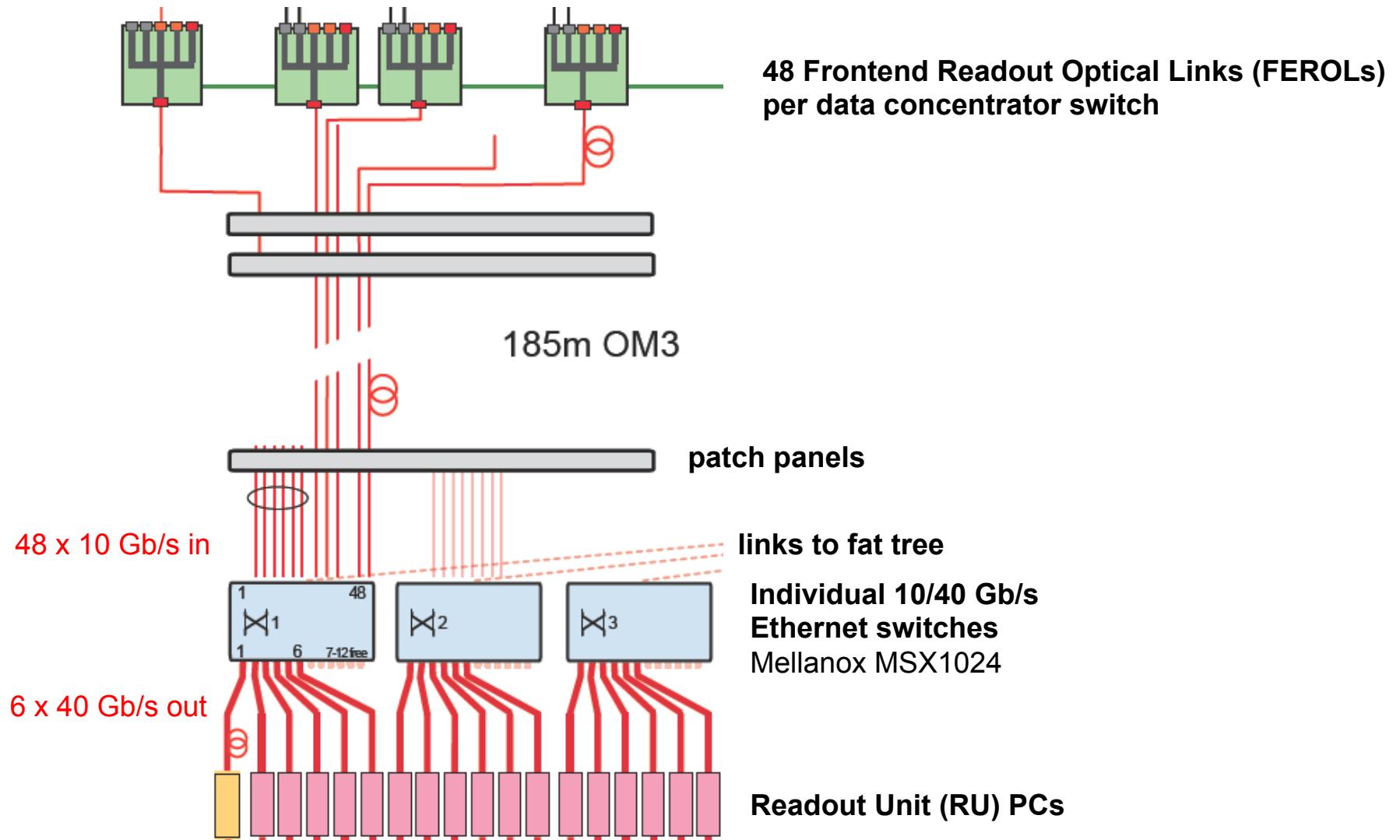
Simplified unidirectional TCP/IP  
only needs 3 states

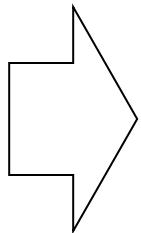
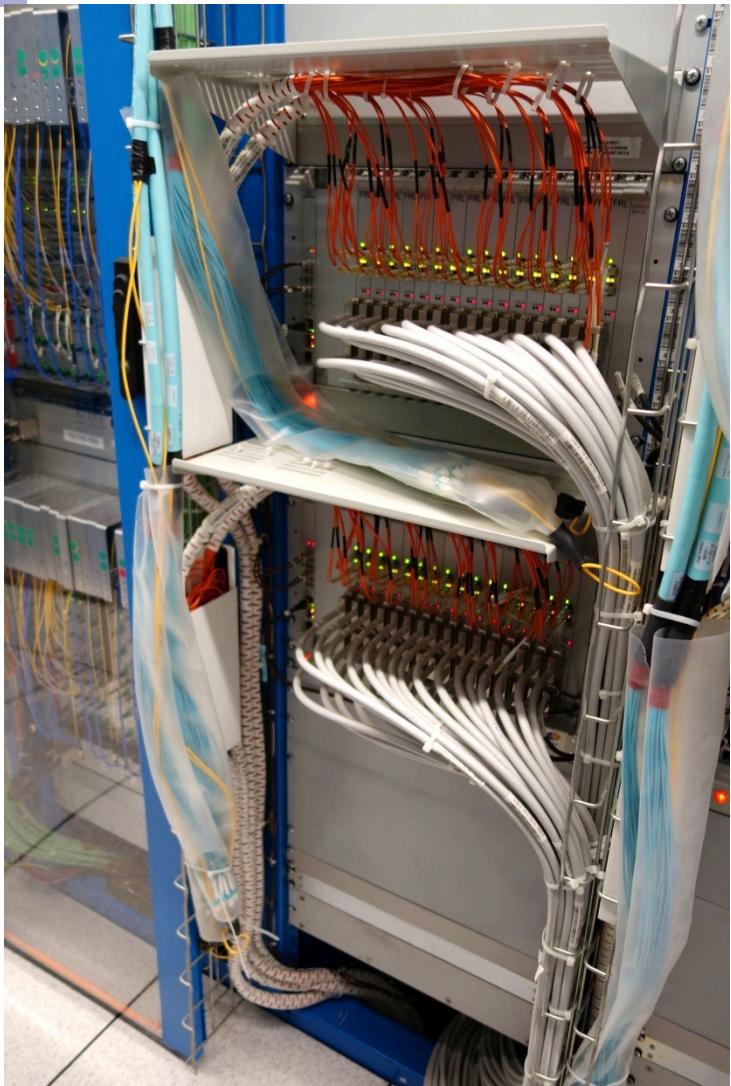
# New in 2017: FEROL 40 board



- 4x 10 Gb/s SLINK Express in
- 40 Gb/s (4x 10 Gb/s) TCP/IP to DAQ
- uTCA standard
- Used to read out Pixel Upgrade

# Data concentrator

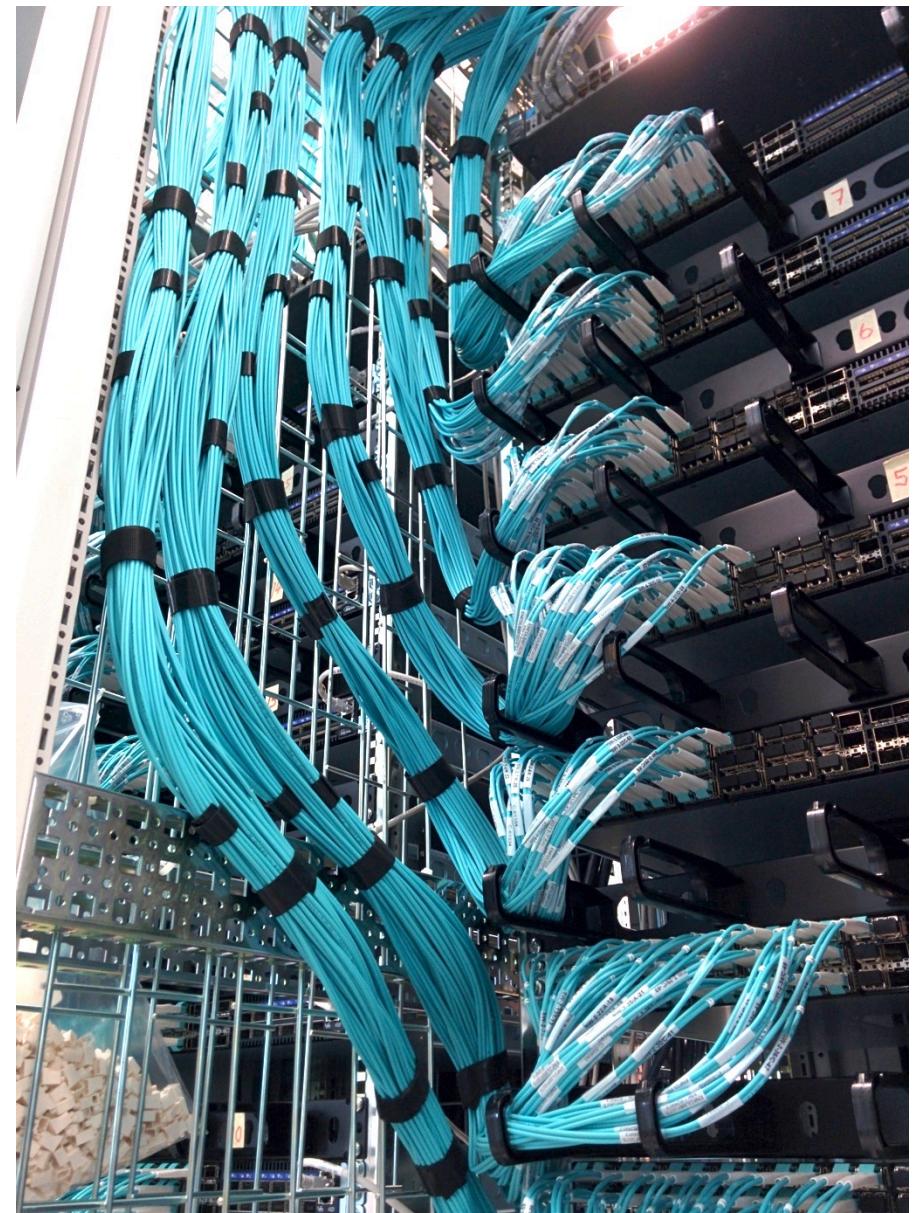




**DAQ-2: FRL/FEROL 10 Gb/s  
Ethernet**

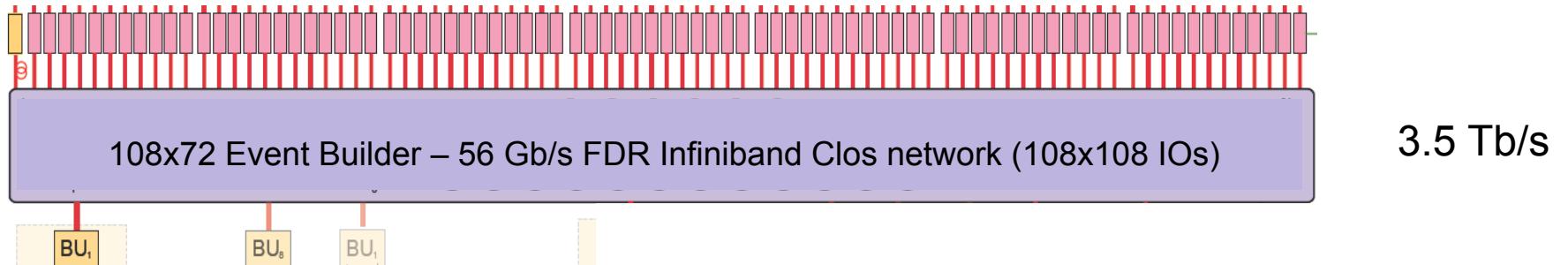
**DAQ-1: FRL/Myrinet**

**Switchover completed**



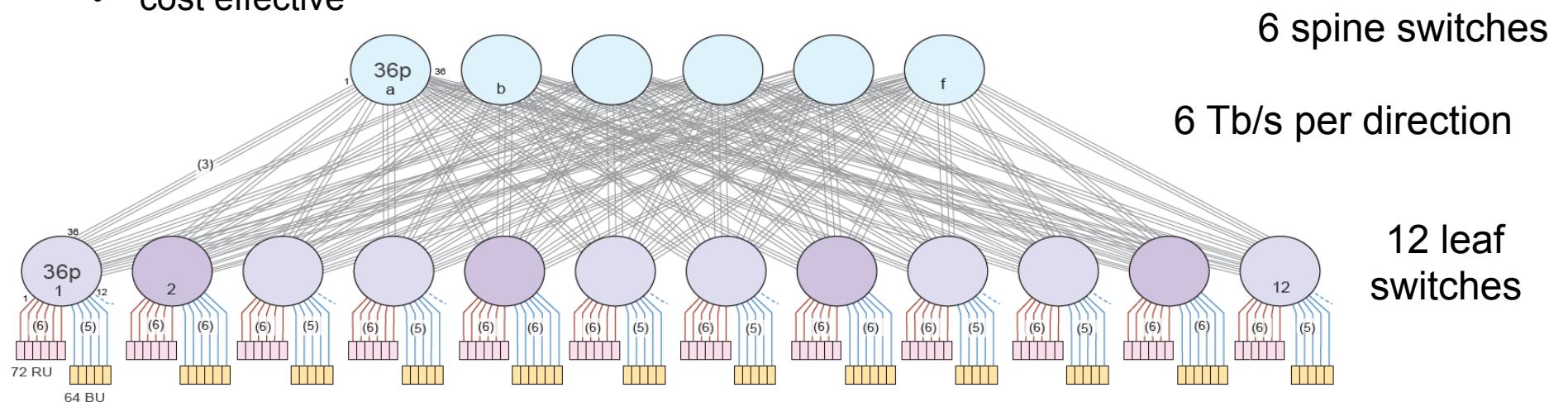
Data concentrator patch panels  
and switches

# Core Event Builder



## Infiniband

- reliable in hardware at link level (no heavy software stack needed)
- supports credit-based flow control
- switches do not need to buffer
- can construct large network from smaller switches
- cost effective



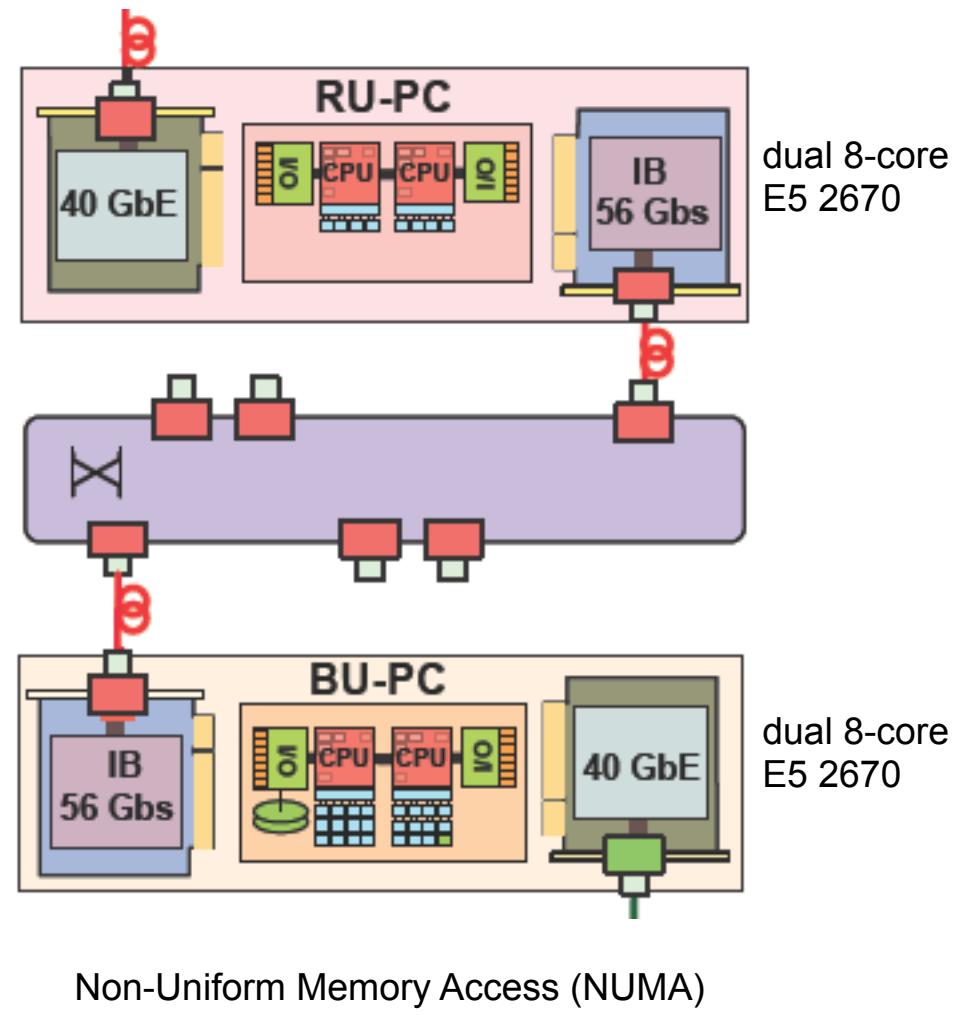
Inputs and outputs mixed on leafs to better utilize leaf-to-spine connections



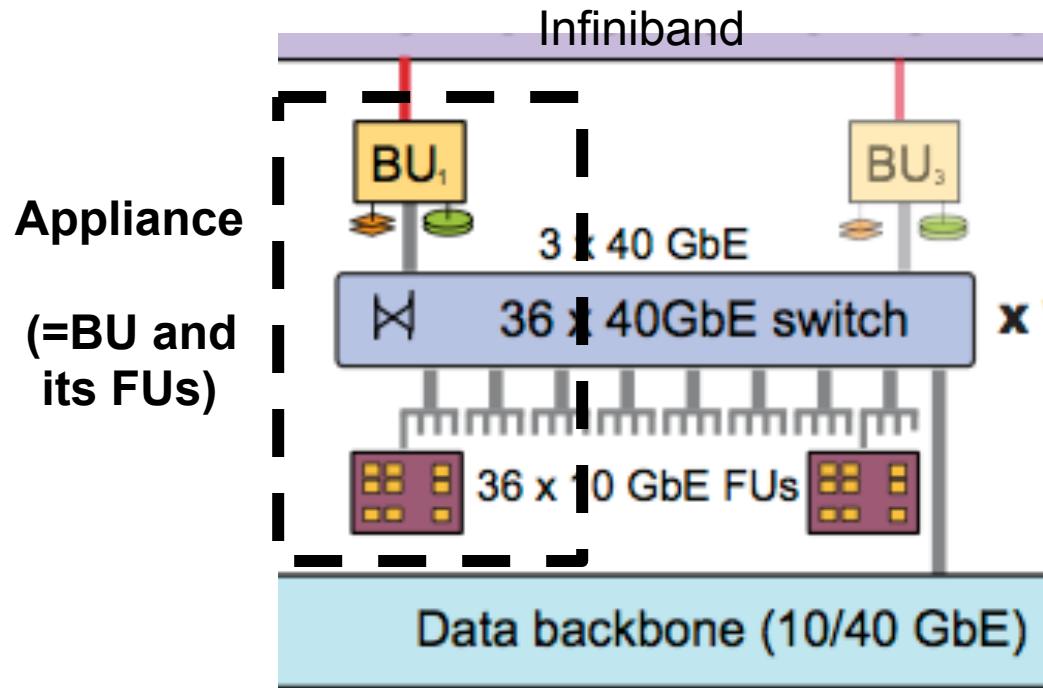
## Infiniband Clos network

# Core event builder performance tuning

- 40 Gb/s Ethernet
  - Linux stack with performance tuning
- 56 Gb/s Infiniband
  - Software based on Infiniband Verbs API
  - All data transport by RDMA
- In both cases:
  - Multiple threads for data reception and writing
  - CPU affinities tuned
    - threads
    - memory pools
    - interrupts



# Filter Farm



# HLT farm, DAQ2

2012

64x



2015

90x



2016

81x



May/June 2017

72 x



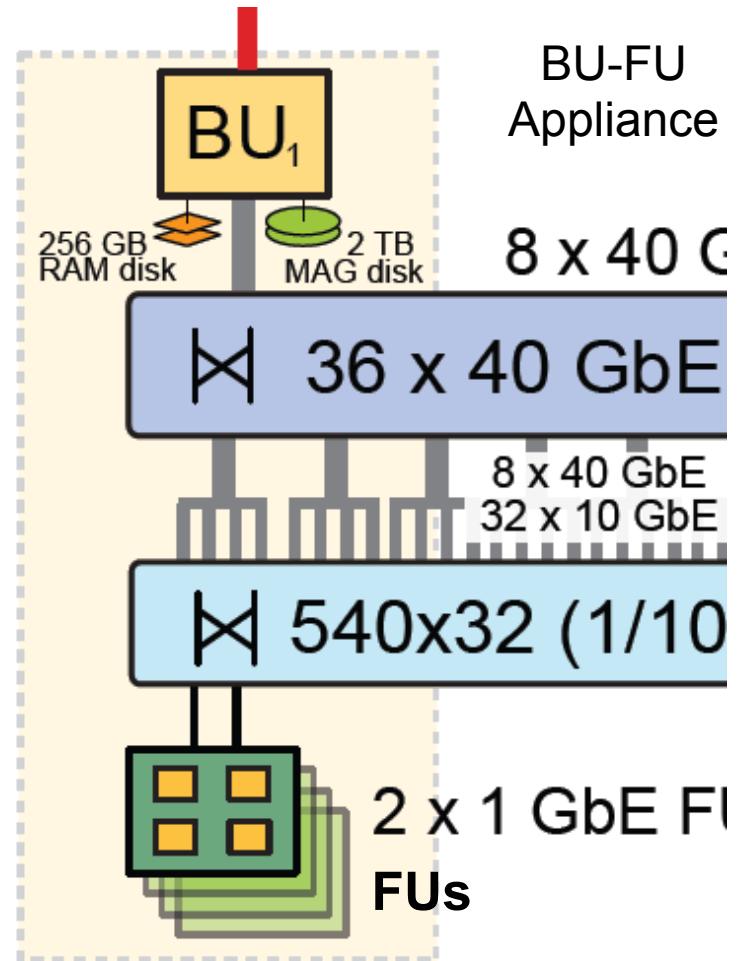
	2012 extension of DAQ-1 Dell Power Edge c6220	HLT PC 2015 Megware S2600KP	HLT PC 2016 Action S2600KP	HLT PC 2017 Huawei
Form factor	4 motherboards in 2U box	4 motherboards in 2U box	4 motherboards in 2U box	4 motherboards in 2U box
CPUs per motherboard	2x 8-core Intel Xeon E5-2670 <b>Sandy Bridge</b> , 2.6 GHz, hyper threading, 32 GB RAM	2x 12-core Intel Xeon E5-2680v3 <b>Haswell</b> , 2.6 GHz, hyper threading, 64 GB RAM	2x 14-core Intel Xeon E5-2680v4 <b>Broadwell</b> , 2.5 GHz, hyperthreading, 64 GB RAM	2x 14-core Intel Xeon E5-2680v4 <b>Broadwell</b> , 2.5 GHz, hyperthreading, 64 GB RAM
#boxes	64 (=256 motherboards)	90 (=360 motherboards)	81 (=324 montherboards)	72 (=296 motherboards)
#cores	4096	8640	9072	8288
Data link	2x 1Gb/s	1x 10 Gb/s, 1x 1Gb/s	1x 10 Gb/s, 1x 1Gb/s	1x 10 Gb/s, 1x 1Gb/s

Will soon be phased out

Total 2017: 26k cores on 980 motherboards

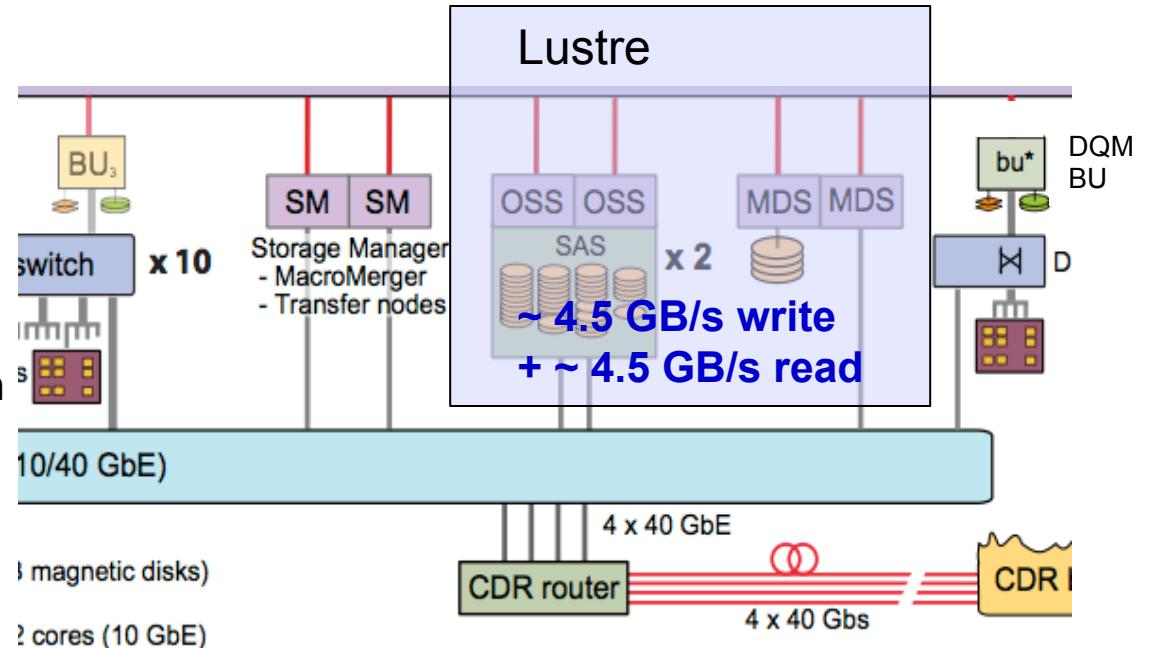
# File based Filter Farm Data Flow

- BUs build full events and write them to RAM disk
- Several FU machines per BU run CMSSW processes to reconstruct / filter the events
  - CMSSW input/output is file based
  - BU-FU data transfer uses file systems as a protocol
  - 8-16 FUs mount ram disk via NFSv4 over the BU-FU network :
    - 40 to 10 Gbit Ethernet  
(1 Gbit on legacy FU)
- The output files of the CMSSW processes are merged by the **Micro-Merger** on the FU and written back to a hard disk on the BU over NFS.



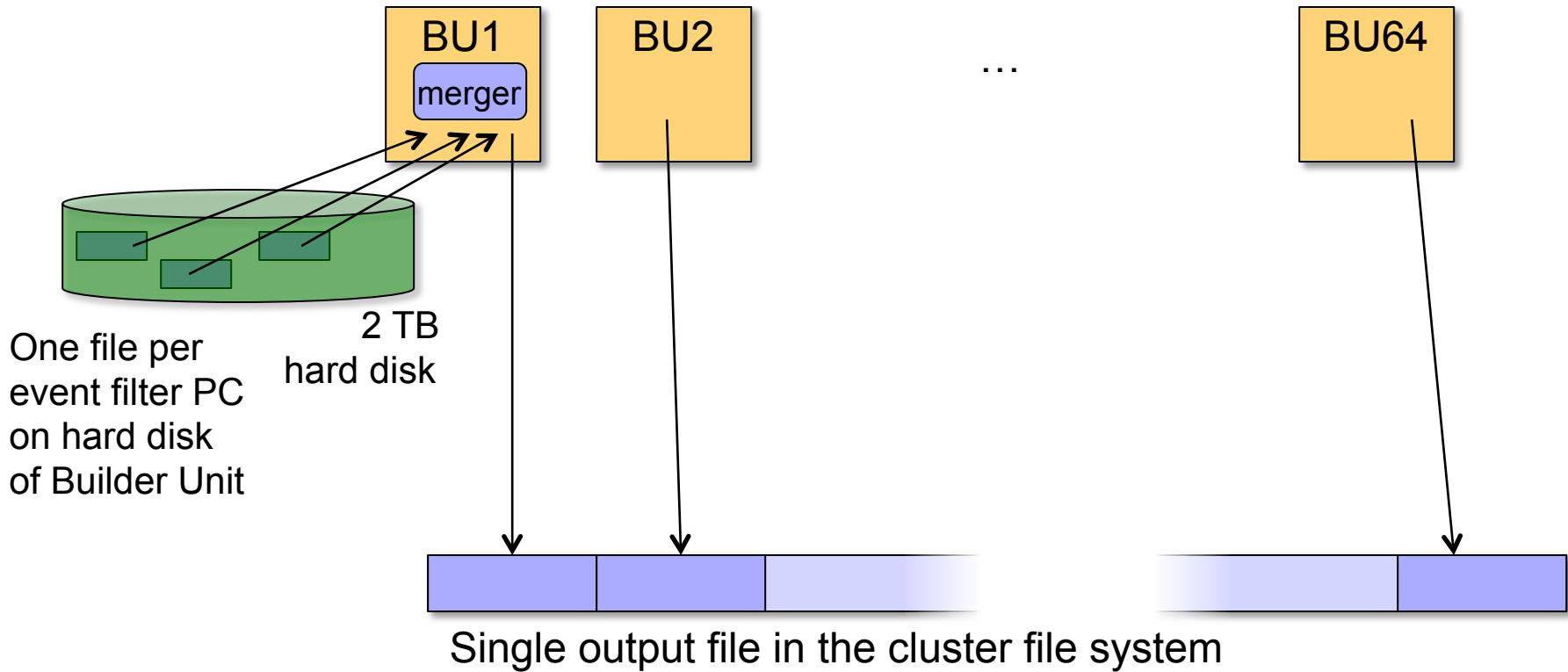
# Merging

- File-Based Filter Farm produces output files
  - After micro-merging on FU:  
1000 files x 10 streams per lumi section (23s)  
scattered over hard disks on 72 BUs
  - To be merged to 1 file per stream and lumi section in a central place



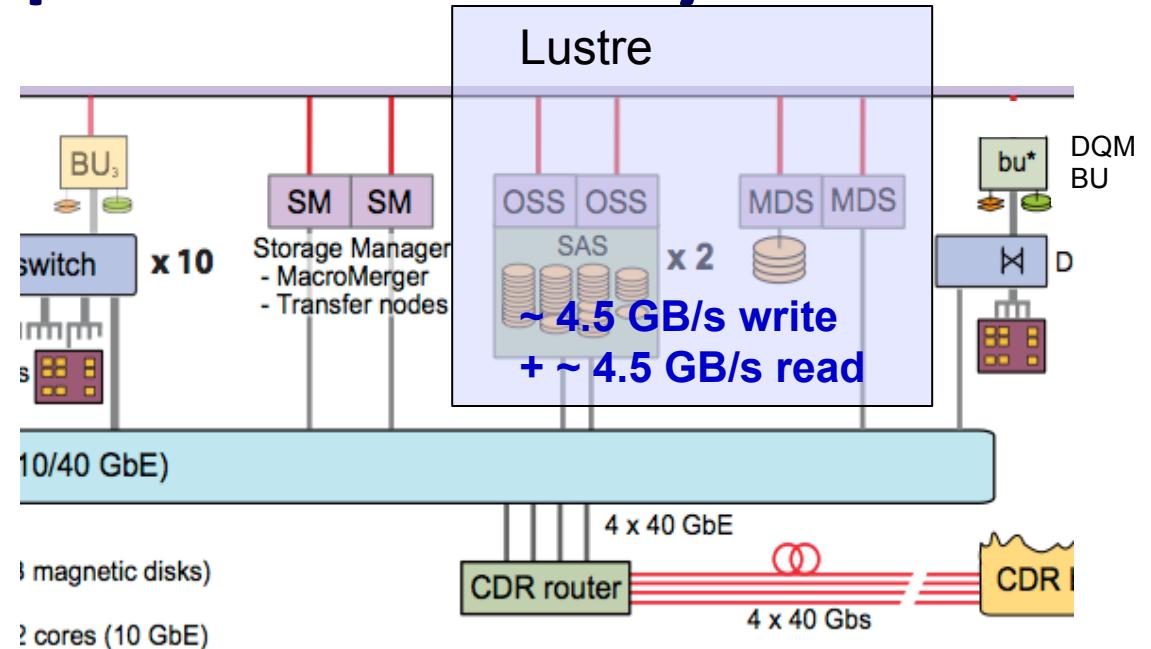
- Merging is done by a Global File System (Lustre)
  - Micro-merging on FU
  - Mini-Merging on BU
  - Macro-merging on dedicated merger nodes

# Mini-Merge step



- **Mini-Merge** step
  - Merger process on BU reads data from all FUs in the appliance
  - Data are written directly from the BUs to a single output file per stream in the global file system
    - Exception: DQM streams: One file per BU in the global file system

# Macro-Merge step and Transfer System

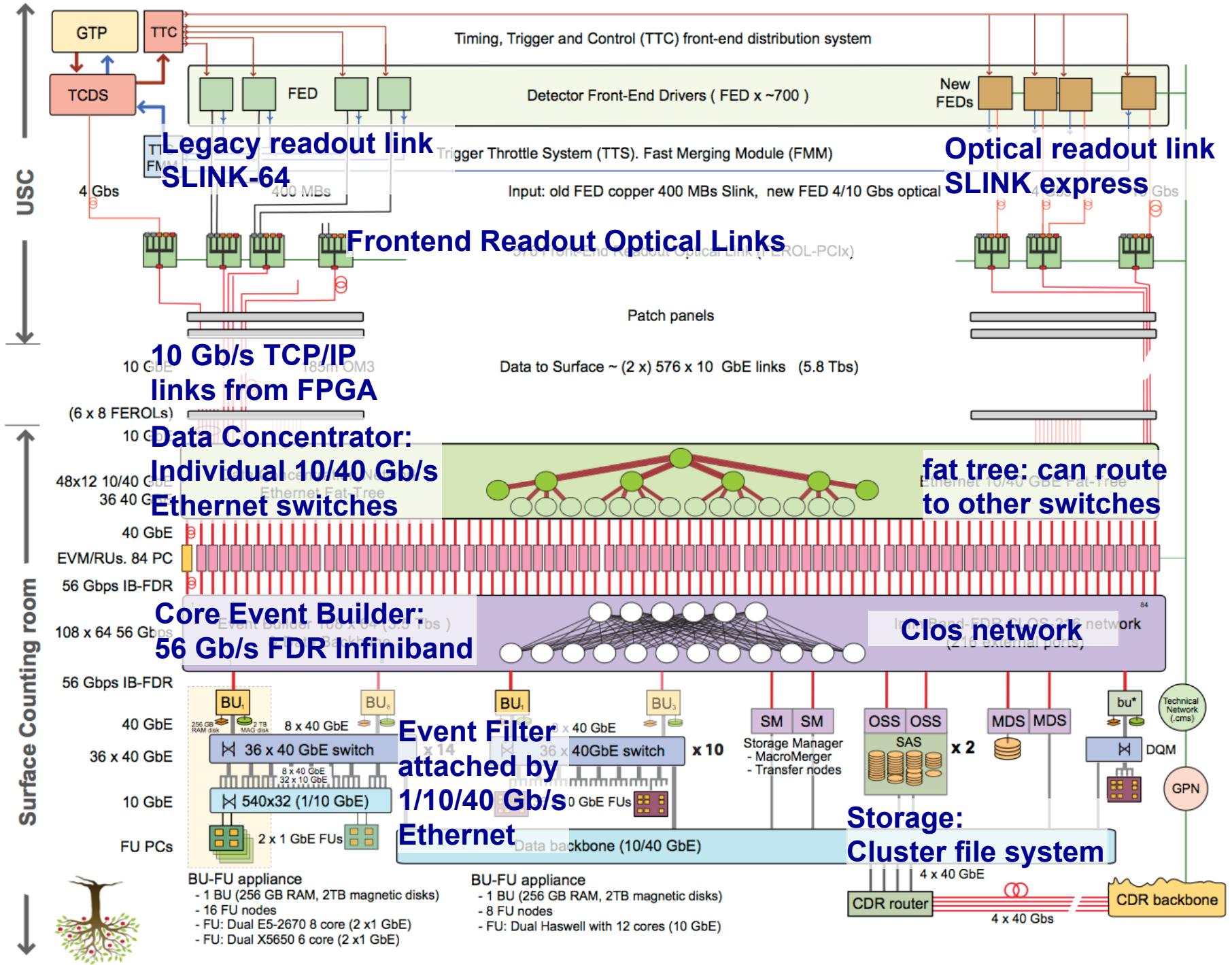


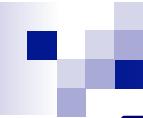
## ■ Macro-Merge step

- Single output file in Lustre is checked and resized
- Exception: DQM streams
  - Output files per BU are read from Lustre and written to single output
    - Cut on size (2 GB) and timeout of 15s to ensure DQM data gets to DQM in time
  - Histograms are added

## ■ Transfer

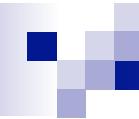
- Merged data are then transferred from Lustre to Tier 0 or to consumers (e.g. DQM/Event Display) at pt.5



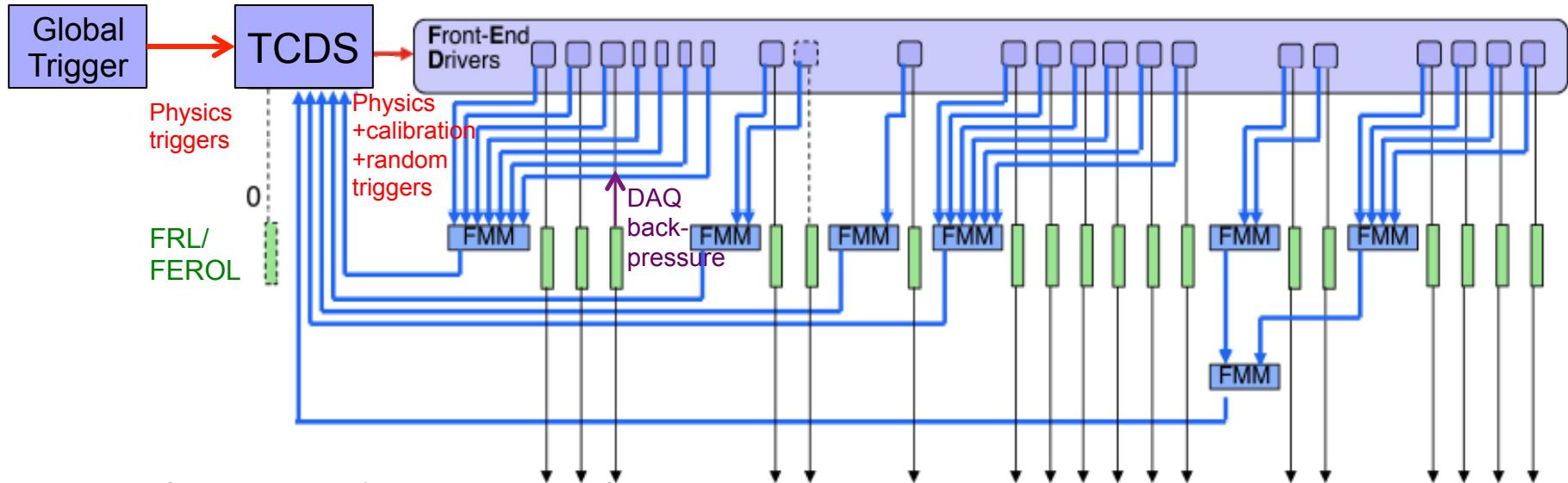


# Flow control

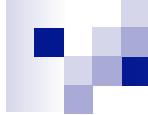
- The entire DAQ from detector to storage is loss-less
- If cDAQ cannot handle the data throughput, **back-pressure** is propagated all the way back to the FED
  - Bandwidth limitation in any part of CDAQ
  - CPU limitation in the filter farm
  - A failure / crash
- Buffers in the FED may fill up
  - If too much data is coming from the detector
    - Backgrounds, noise, high trigger rate, wrong settings
  - Or if the FED is back-pressured by CDAQ
- In this case the FED throttles the trigger
  - Through the Trigger Throttling System (TTS)
  - A tree of Fast Merging Modules (FMMs)



## Trigger, TCDS + flow control



- Each FED sends a TTS signal
  - Possible sTTS signals: Busy, Warning, OutOfSync, Error, Disconnected, Ready
- FEDs are grouped into partitions
- FMMs (Fast Merging Modules) merge sTTS signals from FEDs in each partition
- Merged signals sent to TCDS (Trigger Control and Distribution System) which reacts according to the signal
  - i.e. blocks triggers from Global Trigger for all states except Ready
- Special cases of TTS signals that are only seen by TCDS (not by the FMMs):
  - For tracker partitions also the emulated APV state is an input to the partition controller
  - New uTCA FEDs send their TTS status through the TTC Partition Interface to TCDS



# Software

# The online software

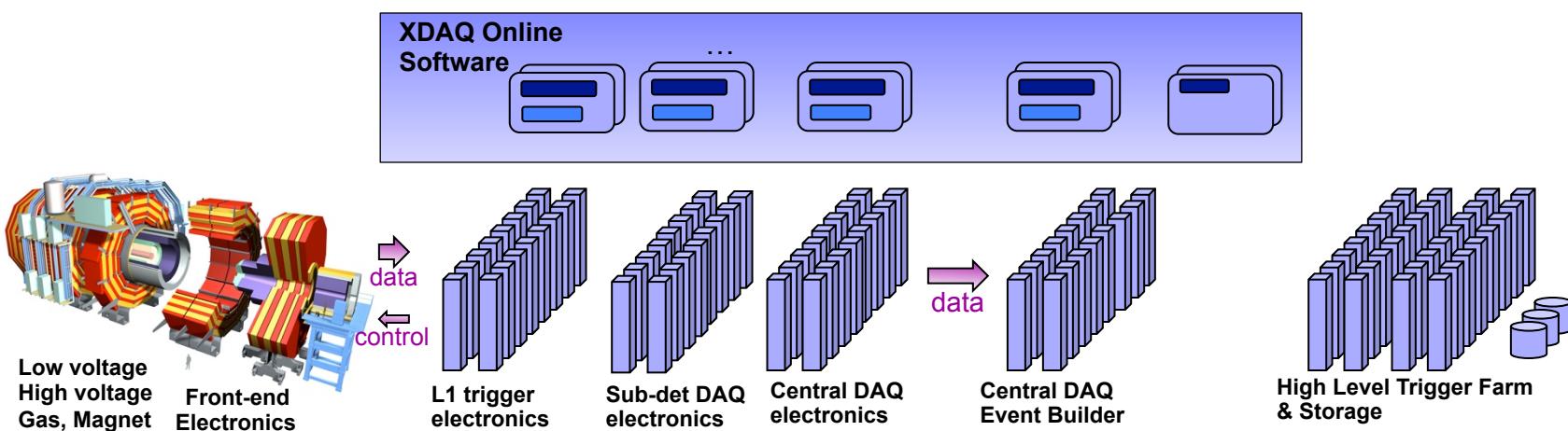
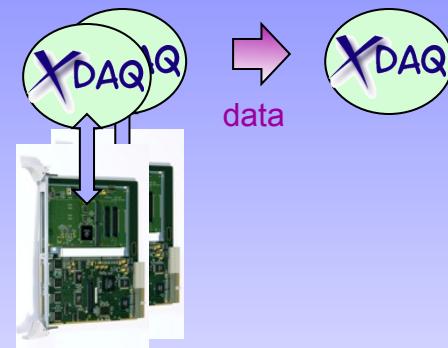
## XDAQ Framework – C++, XML, SOAP

XDAQ applications control hardware and data flow

**XDAQ** is the framework of CMS online software  
It provides Hardware Access, Transport Protocols,  
Services etc.

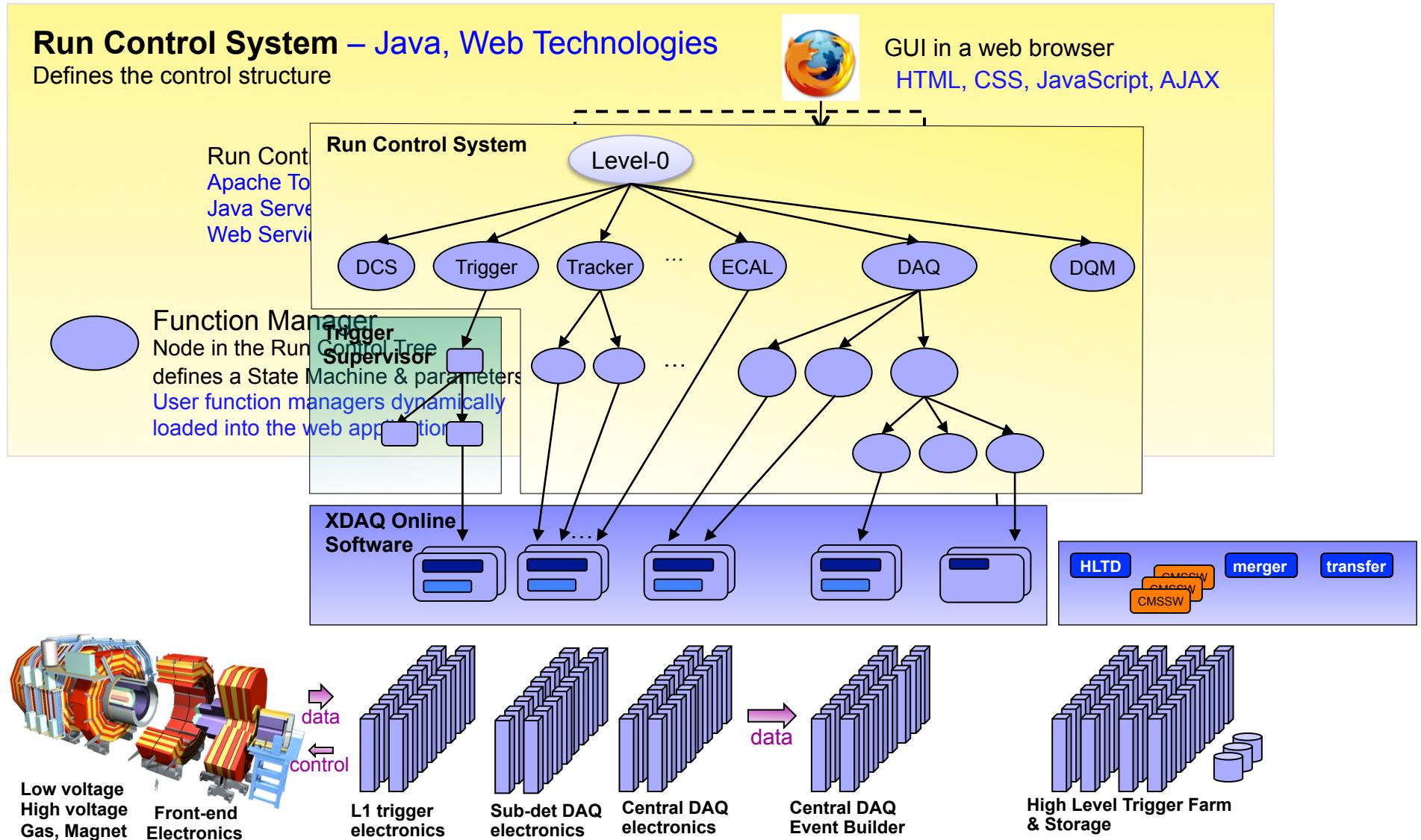


XDAQ Application

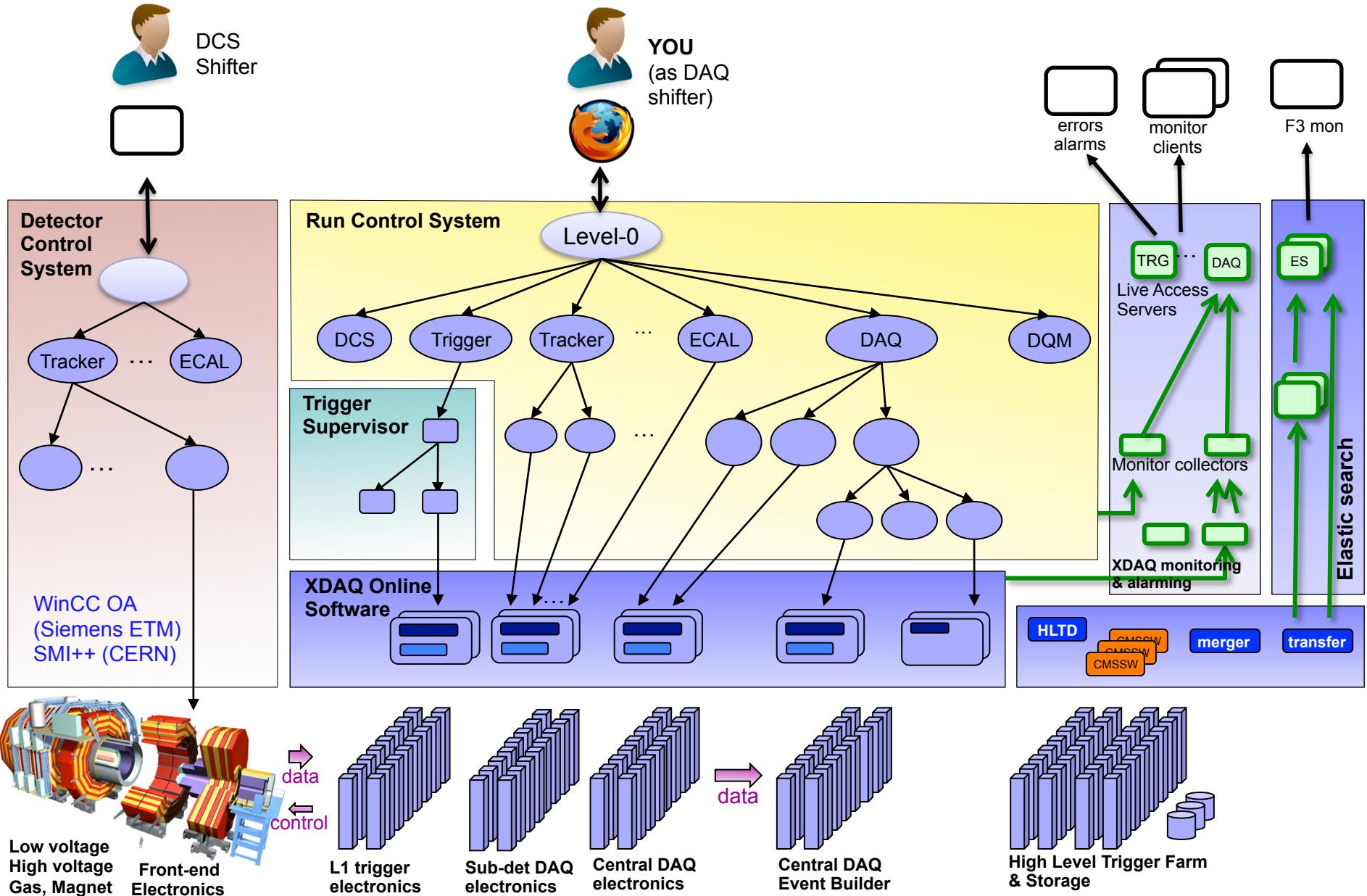


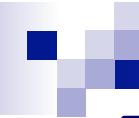


# The online software



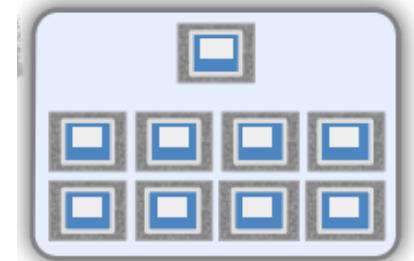
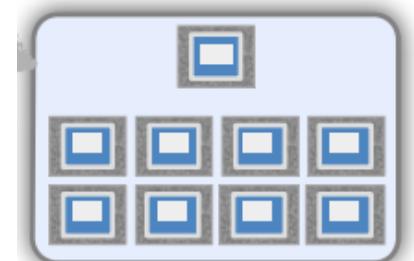
# The online software



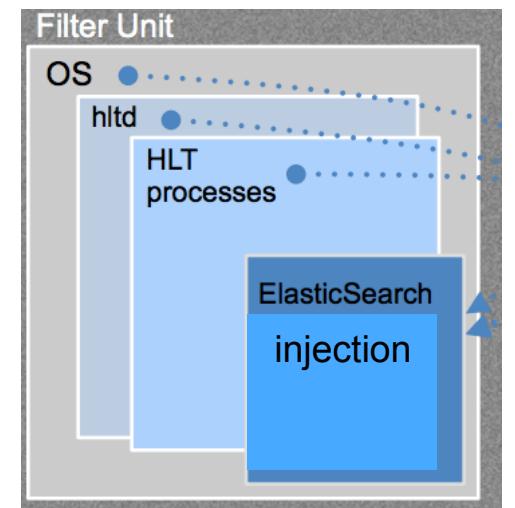


# File-based Filter Farm Software

- FFF on appliances is controlled by a service (hltd), asynchronous to Run Control
- hltd is running on BUs and FUs and responsible for:
  - Detecting a new run (run directory in ramdisk appears)
  - CMSSW runs as standard cmsRun jobs, process input files
  - Output bookkeeping and copying merged data files to BU
- Monitoring
  - Using elasticsearch (a search engine)
  - Data is indexed, searching for specific information is available in near-realtime
  - Running on central ES server clusters
  - Insertion of information by hltd or merger services
    - CPU usage, event processing statistics, merging completion, logs (more details later in F3Mon description)

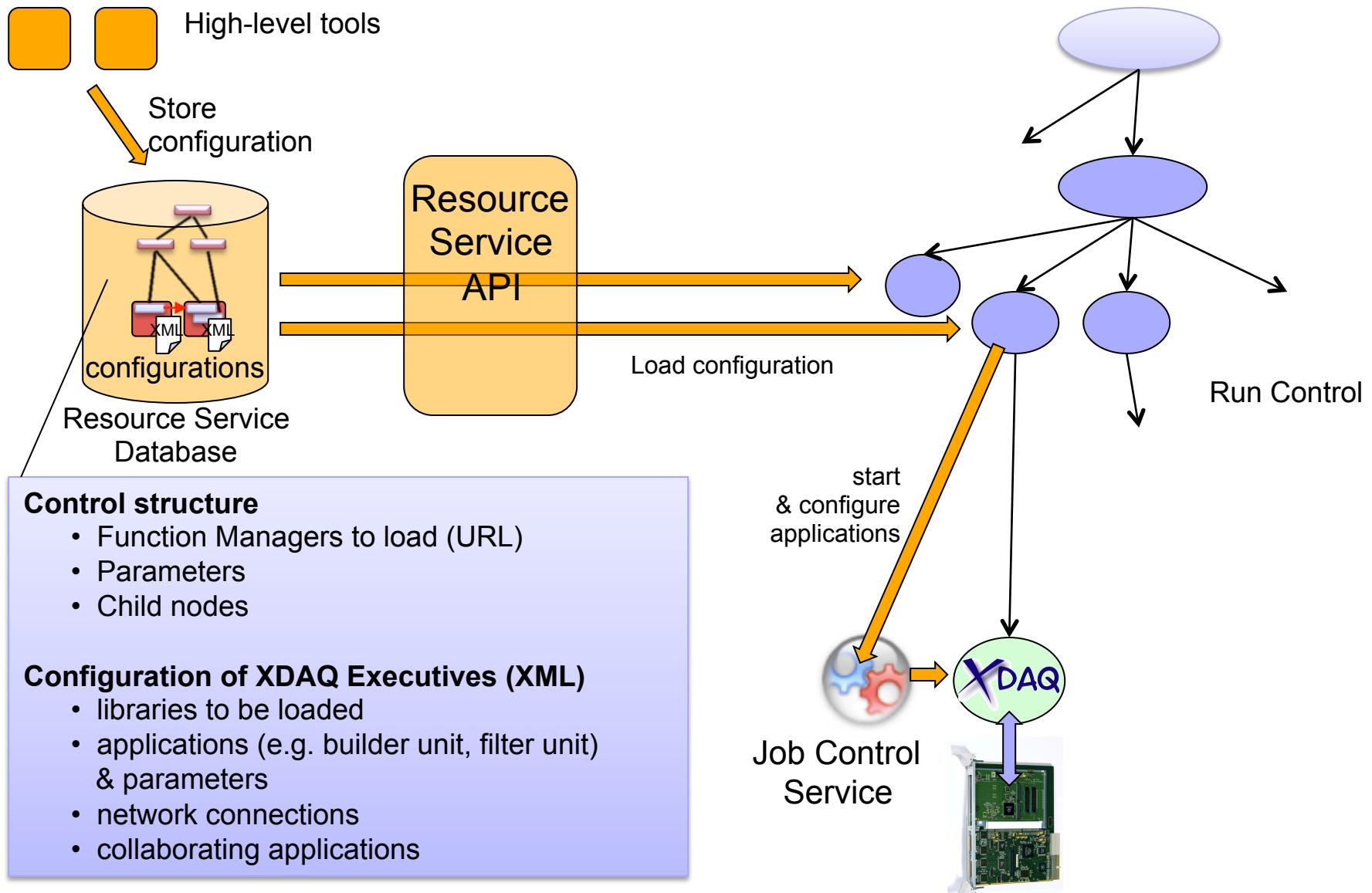


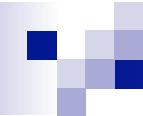
Appliances



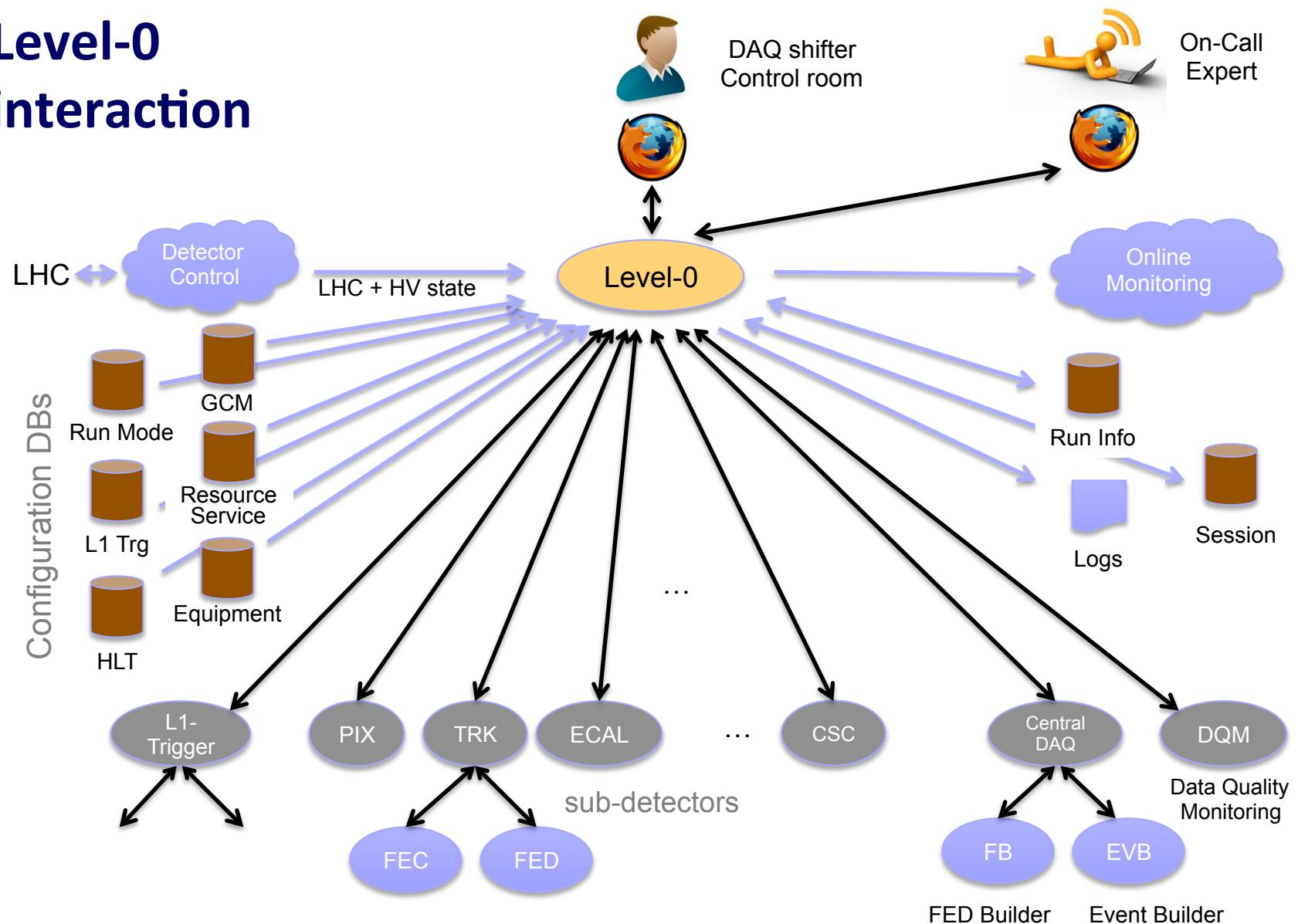
# How Run Control starts up a sub-system:

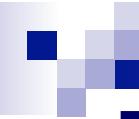
## Run Control + XDAQ system structure configurable





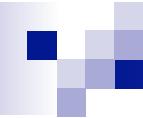
# Level-0 interaction





# RCMS: Registration and Keys

- Sub-system configurations need to be “**registered**” with the Global Configuration Map Database. This is done by the DAQ on-call expert or sub-system experts
- The Level-0 Function Manager queries the DB
  - to know what configuration to start for a subsystem
    - **Important: when a new configuration is registered you need to destroy (red recycle) the corresponding FM**
  - to know what **RUN KEYS** are available for a subsystem
    - You can parameterize a subsystem’s configuration by selecting a run key (unless the key is selected by a CMS Run Mode)



# Part 3: Controlling data taking through Run Control



# Create FM Level Zero

- RCMS workflow to create the FM Level Zero
  - Log into RCMS as topro (<http://cmsrc-top.cms:10000/rcms>)
  - Configuration Chooser: *Path: PublicGlobal/LevelZeroFMwithAutomator*
  - Press on “Create”
    - *At this point the Level 0 Function Manager is created in the tomcat.*

The figure consists of three vertically stacked screenshots of the RCMS web interface, illustrating the workflow to create a Level Zero Function Manager.

- Screenshot 1: Login Page**

This is the initial login screen for the RCMS system. It features a logo, the title "Run Control and Monitoring System", and version information ("Version : 3.1" and "Tag : RCMS\_3\_1\_4"). The URL "srv-C2D06-01.cms:10000" is visible at the top. On the left, there's a sidebar with links for "Login", "Configuration Chooser", "Running Configurations", "Diagnostic Page", and "Logging Collector". The main area contains a login form with fields for "User" (set to "topro") and "Password" (set to "\*\*\*\*\*"), along with a "LOGIN" button. A message "This is your first Login or the pr..." is partially visible.
- Screenshot 2: Configuration Chooser**

This screenshot shows the "Run Control and Monitoring System" dashboard. The top header includes the RCMS logo and the text "Run Control and Monitoring System". Below the header, it displays the IP address "kvm-s3562-1-ip151-01.cms:10000". The main content area is titled "Index of : /topro/PublicGlobal/" and lists three items: "Parent Directory", "levelZeroFM obsolete", and "levelZeroFMwithAutomator". On the left, a sidebar provides links for "Configuration Chooser", "Running Configurations", and "Diagnostic Page".
- Screenshot 3: Configuration Chooser - Create Page**

This screenshot shows the "Configuration Chooser" page for creating a new configuration. The top header and IP address are identical to the previous screen. The main content area has a form with "Full Path: /topro/PublicGlobal/levelZeroFMwithAutomator" and "Group Name: lv0A". At the bottom, there are "Create" and "Attach" buttons. The left sidebar remains the same as in the previous screenshot.



# 1. RCMS interface

- This is your main interface to DAQ management. This is the window where you will configure the CMS running mode, start / stop runs, remove / add subdetectors and FEDs, and look for errors.

Screenshot of the RCMS interface (Mozilla Firefox) showing the Level0-FM control panel.

**Top Bar:**

- File Edit View Bookmarks Tools Help
- Level0-FM (RCMS\_4\_1\_0\_L...
- cmsrc-top.cms:10000/rcms/gui/servlet/FMPilotServlet?PAGE=/gui/jsp/controlPanel.jsp
- Refresh Detach Destroy

**Control Buttons:**

- Status Table, RCMonitor, FED & TTS, Lock, save, Refresh
- Start, Connect, Configure, Stop, Halt, ColdReset, ForceStop, ForceHalt, Recover, Interrupt, FixSoftError, TTCResync, TTCHardReset, TTSTestMode, TestTTS
- Auto Soft Error Recovery:

**Configuration:**

- Configuration: /toproj/Public/Global/levelZeroFM
- Run Number: **229441**
- SD: 238516  
Seq Name: GLOBAL\_RUN  
Global Key: /GLOBAL\_CONFIGURATION\_MAP/CMS/CENTRAL/GLOBAL\_RUN  
HWCFG Key: /daq/eie\_141014/fb\_nsPiX\_TCDS1024\_HFuTCA/tpp\_b2ru1bu\_52x150  
Level-0 Action: Tasks completed  
Level-0 Error:

**LHC Information:**

LHC information not available. Clock source & stability cross-checks are disabled.

**Subsystem Status:**

Subsystem	TRACKER	HCAL	DT	CSC	RPC	TCDS	TRG	SCAL	DAQ
State	Running								
Time	00:15.6	00:10.0	00:06.2	00:04.3	00:00.0	00:08.9	00:04.1	00:06.2	00:04.2

**Enabled Slices:**

Current Run Key	DEFAULT	ZS	N/A	N/A	N/A	Automatic	N/A	TIER0_TRANSFER_ON
New Run Key	DEFAULT	ZS				Automatic		TIER0_TRANSFER_ON

**Commander:**

| select |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|        |        |        |        |        |        |        |        |        |

**Detectors:**

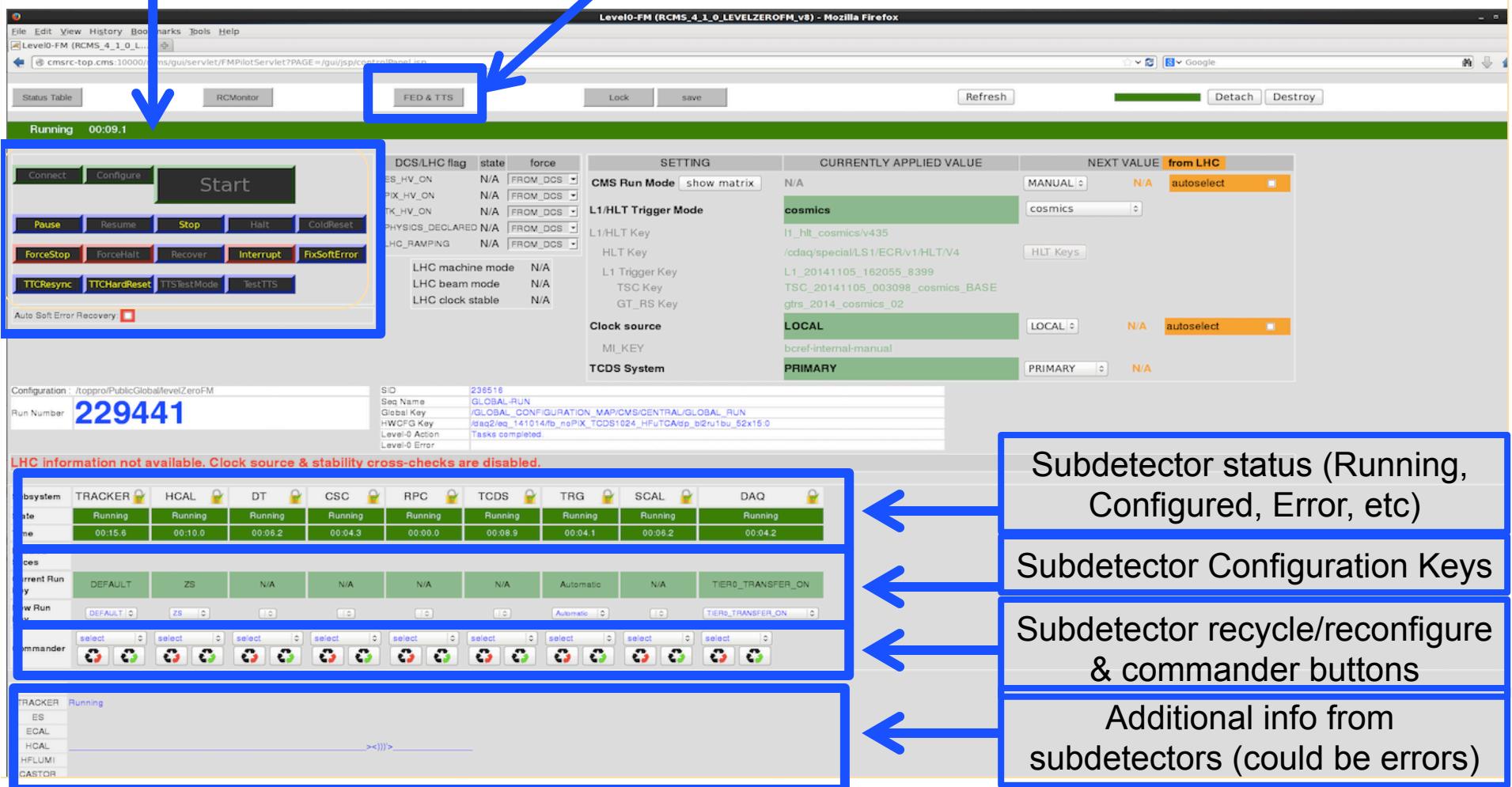
- PIXEL: Running
- TRACKER: Running
- ES
- ECAL
- HCAL
- HFLUMI
- CASTOR

><|>

# 1. RCMS interface

Main activity (start / stop / TTCResync etc)

FED/TTS configuration button – use this to take out FEDs



The screenshot shows the RCMS interface in a Mozilla Firefox browser. At the top, there's a navigation bar with links like 'File', 'Edit', 'View', 'History', 'Bookmarks', 'Tools', and 'Help'. Below the navigation bar, the title 'Level0-FM (RCMS\_4\_1\_0\_LEVELZEROFM\_v8) - Mozilla Firefox' is displayed. The main content area has several tabs: 'Status Table', 'RCMonitor', 'FED & TTS' (which is highlighted with a blue box and an arrow), 'Lock', 'save', 'Refresh', and 'Detach/Destroy'. A green banner at the top indicates 'Running 00:09:1'. On the left, there's a control panel with buttons for 'Start', 'Stop', 'Halt', 'ColdReset', 'ForceStop', 'Recover', 'Interrupt', 'FixSoftError', 'TTCResync', 'TTCHardReset', 'TTSTestMode', and 'TestTTS'. To the right of this is a 'CMS Run Mode' section with dropdown menus for 'SETTING', 'CURRENTLY APPLIED VALUE', and 'NEXT VALUE'. It includes options like 'cosmics', 'L1\_hlt\_cosmics/v435', and 'L1\_20141105\_162055\_8399'. Below this are sections for 'L1/HLT Trigger Mode', 'Clock source', and 'TCDS System'. At the bottom left, it says 'Configuration: /topprod/Public/Global/levelZeroFM' and 'Run Number: 229441'. The bottom part of the interface contains tables for 'Subsystems' (TRACKER, HCAL, DT, CSC, RPC, TCDS, TRG, SCAL, DAQ) and 'Detectors' (ZS, ZB, N/A, N/A, N/A, Automatic, N/A, TIER0\_TRANSFER\_ON). There are also 'Commander' buttons and a 'Subdetector' status table.

Subdetector status (Running, Configured, Error, etc)

Subdetector Configuration Keys

Subdetector recycle/reconfigure & commander buttons

Additional info from subdetectors (could be errors)



# 1. RCMS interface

Slow Control (DCS / LHC) information (when available)

Information (and settings) for Trigger keys, Clock source, TCDS

The screenshot shows the RCMS interface running in Mozilla Firefox. The main window has two main sections highlighted with blue boxes:

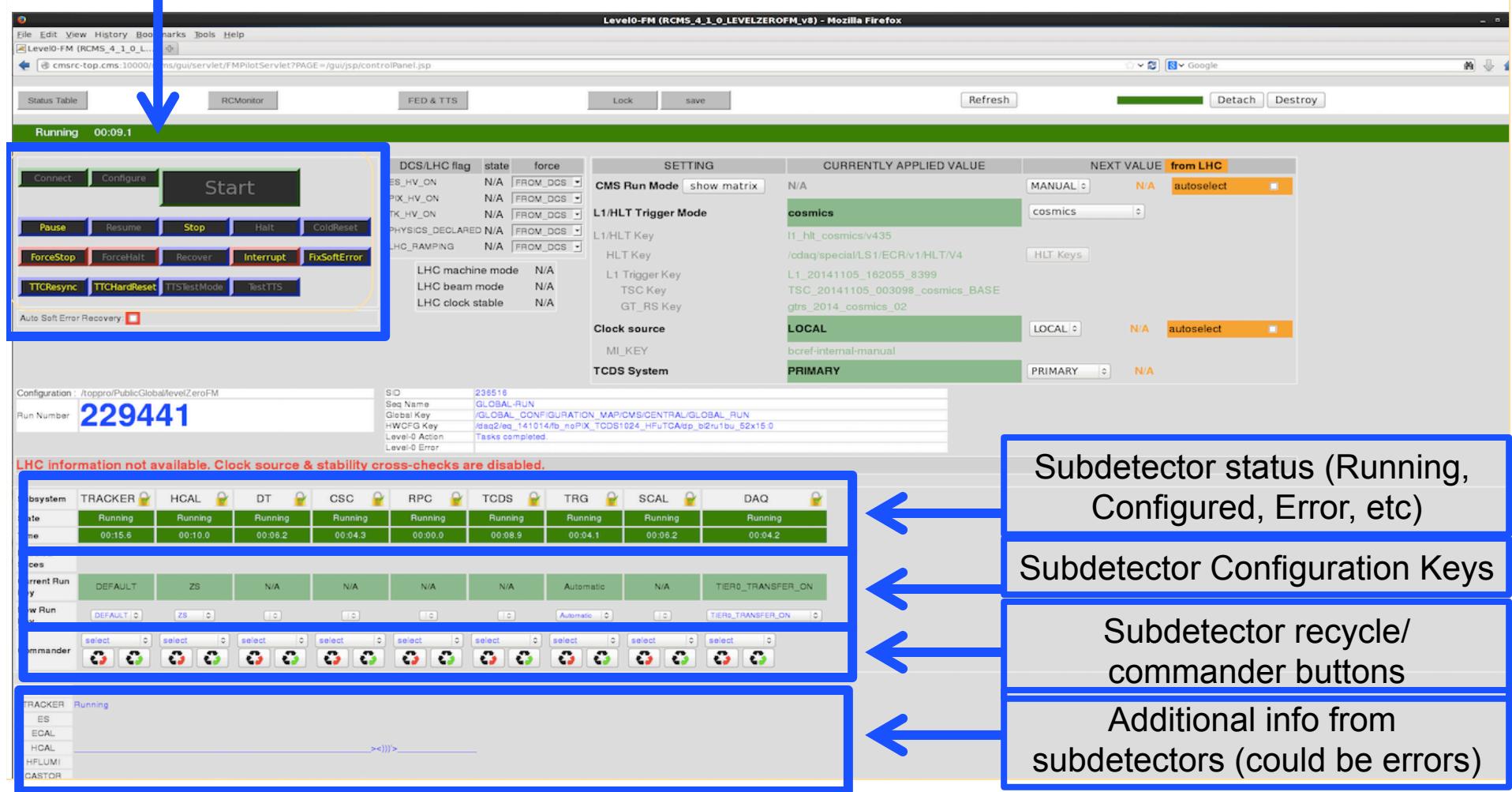
- Slow Control (DCS / LHC) information (when available):** This section is located on the left side of the interface. It contains a grid of buttons for DCS/LHC flags like ES\_HV\_ON, PIX\_HV\_ON, and TCK\_HV\_ON, along with their current state and force settings. Below this is a row of buttons for system control: Start, Stop, Halt, ColdReset, ForceStop, ForceHalt, Recover, Interrupt, FixSoftError, TTCTSync, TTCHardReset, TTCTestMode, and TestTTS. A status table at the bottom provides configuration details, including the Run Number (229441).
- Information (and settings) for Trigger keys, Clock source, TCDS:** This section is located on the right side. It displays a table of settings for CMS Run Mode (set to show matrix), L1/HLT Trigger Mode (set to cosmics), Clock source (set to LOCAL), and TCDS System (set to PRIMARY). The 'CURRENTLY APPLIED VALUE' column shows the current settings, and the 'NEXT VALUE' column shows the proposed changes.

Below these sections, there is a large table titled 'Subsystem' showing the state of various detectors: TRACKER, HCAL, DT, CSC, RPC, TCDS, TRG, SCAL, and DAQ. The table includes columns for State, Time, and Enabled Slices. At the bottom, there are sections for PIXEL, TRACKER, ES, ECAL, HCAL, HFLUMI, and CASTOR, each with a status indicator.

A message at the bottom of the interface states: "LHC information not available. Clock source & stability cross-checks are disabled."

# Managing the run: start / stop runs

Main activity (start / stop / TTCResync etc)



The screenshot shows the CMS Control Panel interface. A blue box highlights the top-left area containing buttons for 'Start', 'Stop', 'TTCResync', etc. A large blue arrow points from this box down to the main control panel area. To the right, a vertical stack of four boxes provides detailed information:

- Subdetector status (Running, Configured, Error, etc)**
- Subdetector Configuration Keys**
- Subdetector recycle/ commander buttons**
- Additional info from subdetectors (could be errors)**

**Control Buttons (Top Left):**

Connect	Configure	<b>Start</b>
Pause	Resume	<b>Stop</b>
ForceStop	ForceHalt	Recover
TTCResync	TTCHardReset	TTCTestMode
Auto Soft Error Recovery		

**Run Status:** Running 00:09:1

**Configuration:** /topprod/Public/Global/levelZeroFM  
**Run Number:** 229441

**LHC Information:** LHC information not available. Clock source & stability cross-checks are disabled.

**Subdetector Status Table:**

Subsystem	TRACKER	HCAL	DT	CSC	RPC	TCDS	TRG	SCAL	DAQ
State	Running								
Time	00:15.6	00:10.0	00:06.2	00:04.3	00:00.0	00:08.9	00:04.1	00:06.2	00:04.2

**Subdetector Configuration Keys:**

Current Run Key	DEFAULT	ZS	N/A	N/A	N/A	Automatic	N/A	TIER0_TRANSFER_ON
New Run Key	DEFAULT	ZB						TIER0_TRANSFER_ON
Commander	select	select	select	select	select	select	select	select

**Subdetector Recycle/Commander Buttons:**

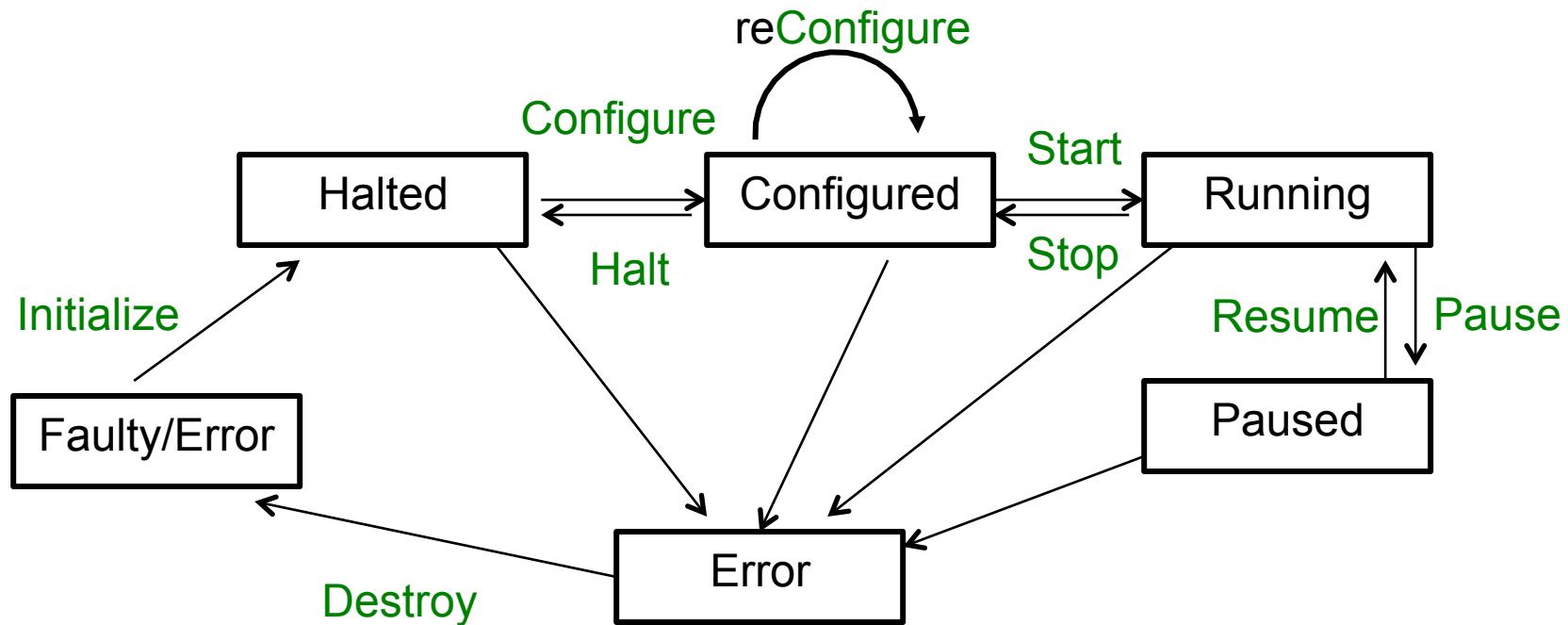
Buttons for each subdetector: TRACKER, ES, ECAL, HCAL, HFLUMI, CASTOR.

**Additional Info from Subdetectors:**

TRACKER: Running  
ES: Running  
ECAL: Running  
HCAL: Running  
HFLUMI: Running  
CASTOR: Running

# Simplified state diagram for run control

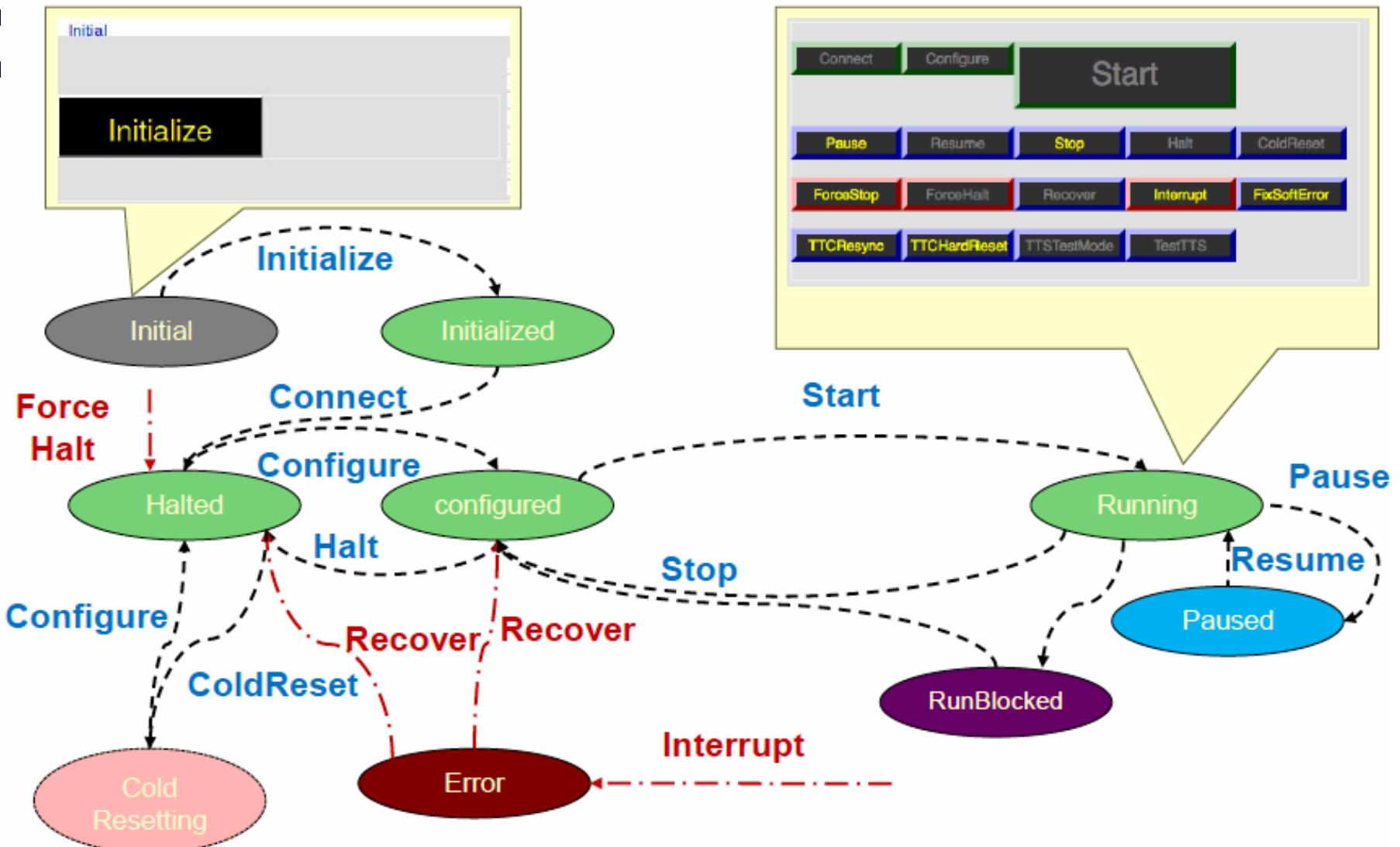
- In green are commands, in black are states reached after command is executed
- Note that “Error” state can happen during any step
- Only valid commands in each state are enabled in the Run Control screen

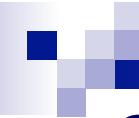


Re-configure = (Halt) + Configure

Re-cycle = Destroy + Initialize

# Full state diagram for run control





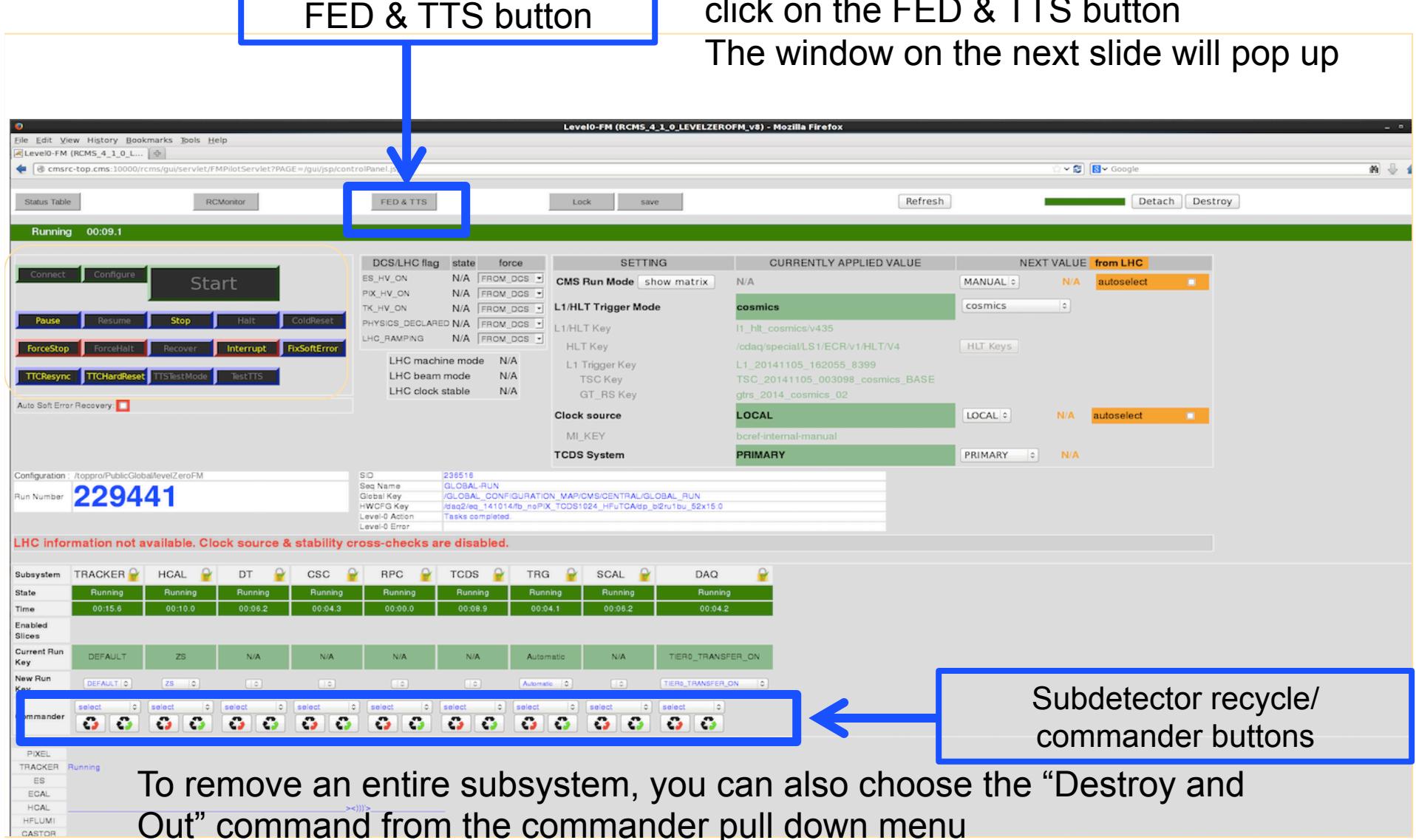
# Starting / Stopping runs

- In general, you will use the buttons in the main activity area
  - Here the initialize / configure / start / stop buttons will address all subdetectors in the run
    - There is an order in which the commands must be sent to subdetectors, and the order is built into the L0 function manager
- It is possible also to use the “commander” and / or “recycle” buttons below the subdetector
  - Sends commands only to one subdetector
  - If this command requires action on another subdetector, then there will be a flashing message next to the subdetector that requires action
    - E.g. if you add a subdetector into the run when the TCDS or DAQ (or both) is already configured, a flashing message next to the TCDS / DAQ will tell you to reconfigure it
  - Recycle/Reconfigure buttons
    - There are two: “red” recycle and “green” reconfigure
    - Red recycle destroys the subdetector function manager and restarts it, ending in the “halted” state. You can do this from any state, you **must** do this from the “error” state
    - Green reconfigure reconfigures the subdetector only. You can do this either from the “halted” or “configured” state

# Adding / removing subsystems and/or FEDs

To add / remove FEDs or subsystems,  
click on the FED & TTS button  
The window on the next slide will pop up

**FED & TTS button**

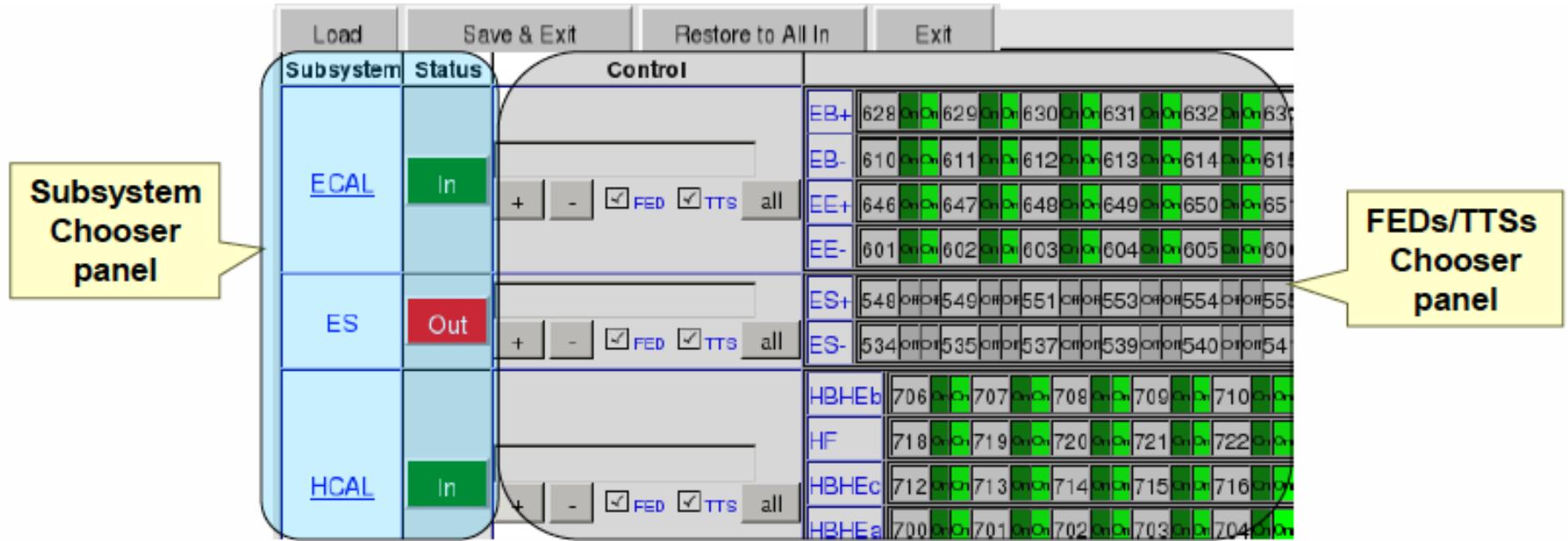


The screenshot shows the CMS Control Panel interface. At the top, there's a menu bar with File, Edit, View, History, Bookmarks, Tools, Help, and a search bar. Below the menu is a toolbar with Status Table, RCMonitor, Lock, save, Refresh, Detach, and Destroy buttons. A large green banner at the top indicates the system is Running (00:09:1). In the center, there's a control panel with various buttons like Connect, Configure, Start, Stop, Halt, ForceStop, Recover, Interrupt, FixSoftError, TTCSync, TTCHardReset, TTCTestMode, and TestTTS. To the right of these buttons are DCS/LHC flag settings for ES\_HV\_ON, PIX\_HV\_ON, TK\_HV\_ON, PHYSICS\_DECLARED, and LHC\_RAMPING. Further right are sections for CMS Run Mode (set to show matrix), L1/HLT Trigger Mode (set to cosmics), Clock source (set to LOCAL), and TCDS System (set to PRIMARY). At the bottom left, there's a configuration table for Run Number 229441. The bottom right contains a section for Subdetector recycle/ commander buttons, which are represented by a row of icons for different detectors.

**Subdetector recycle/ commander buttons**

To remove an entire subsystem, you can also choose the “Destroy and Out” command from the commander pull down menu

# Adding / removing subsystems and/or FEDs



## Subsystem chooser panel:

- you select the subsystems which participate in the run

**Important:** The panel may react slowly.  
Wait for the panel to reload after clicking an In/Out button before clicking the next one.

## FEDs/TTSs chooser panel:

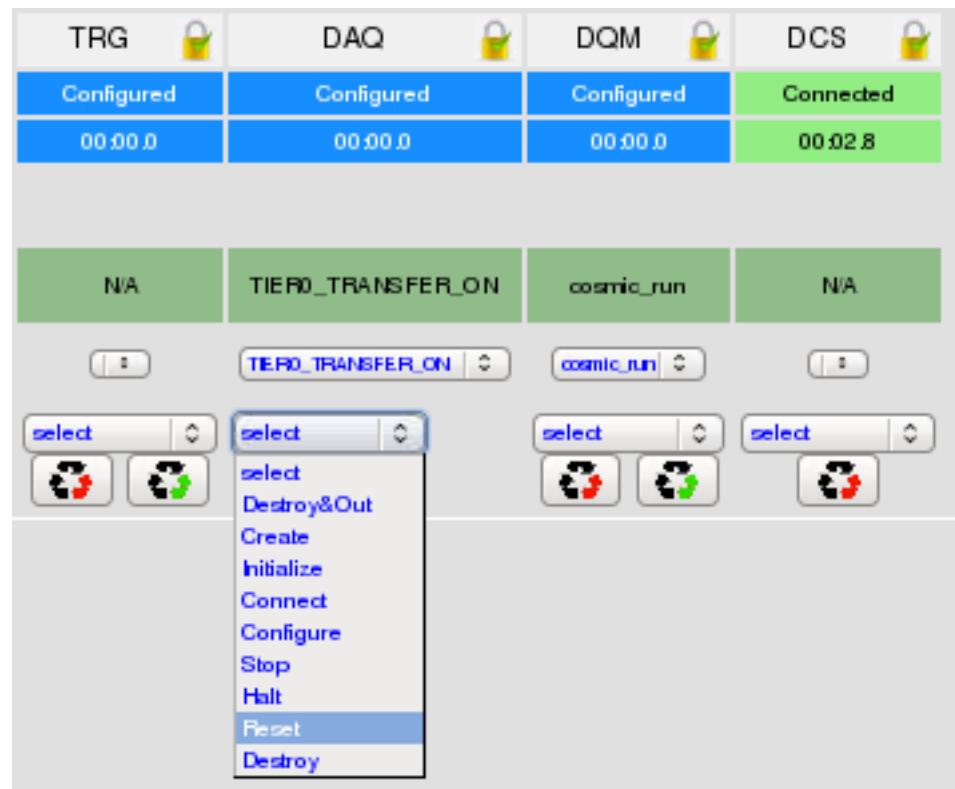
- you choose the TTC partitions and with finer granularity the FEDs which participate in the run
- the Entry for selecting feds supports partition names, FEDIDs and FEDID-intervals

*NB: press the “Save & Exit” button if you want to save the new setting.*



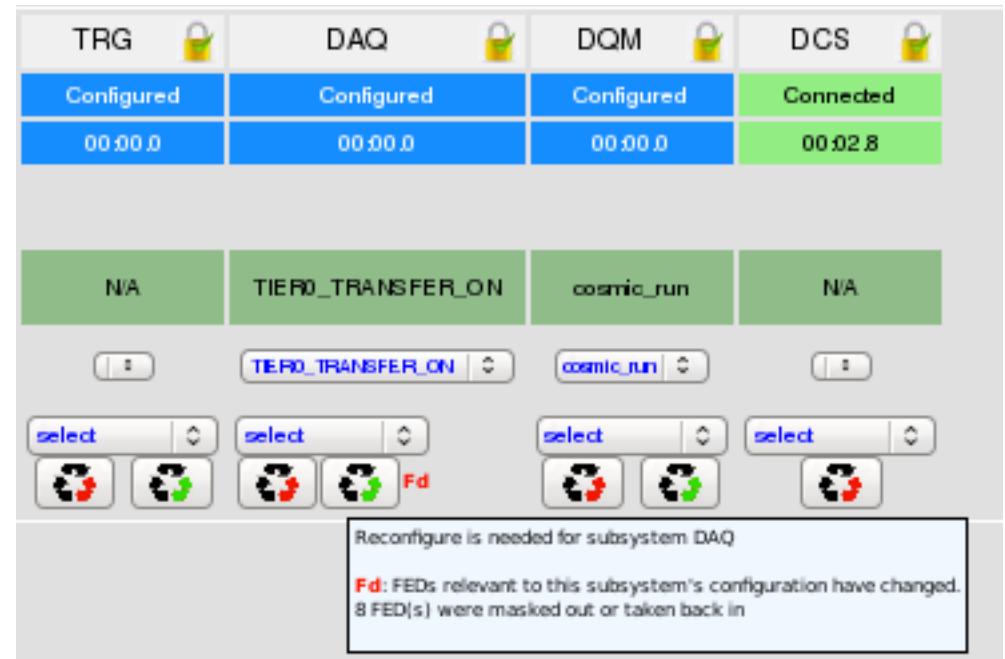
# Sub-Systems Control Panel

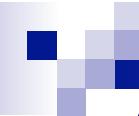
- The Sub-Systems panel contains:
  - All the subsystems included in the Global Run
  - State of each subsystem
  - Applied Run Key for each subsystem
  - Run Key selector
  - Commander for each subsystem:
    - The pull down menu allows to send command directly to the subsystem
    - Red re-cycle button allows to destroy the subsystem software and bring it to halted state.
    - Green re-cycle button allows to (re-)configure the subsystem software.



# FM L0 built-in cross-checks

- Indicate sub-systems to re-configure if :
  - A parameter is changed in the GUI
  - A sub-system / FED is added/ removed
  - External parameters change
- Enforce correct order of re-configuration
- Enforce procedure to follow if LHC clock stability changes





# Access Control



Subsystems are created by the Level-0 in a locked state and the subsystem RCMS GUIs may be attached for read access but may not command the subsystem or set parameters.



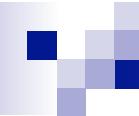
If a subsystem-expert needs to access the sub-system through their RCMS GUI, you may unlock the subsystem by clicking on the lock icon. You should lock the subsystem again after the intervention is finished.



If a subsystem was created by a GUI or by a different Level-0, the central Level-0 may not be able to command this subsystem. In order to control the subsystem from the central Level-0, the subsystem must be destroyed from where it was created.

**Destroy Backdoor** (this applies for any Function Manager, whether it belongs to a subsystem or it is the Level-0 itself): If things went wrong and you cannot destroy a Function Manager in any regular way.

HCAL	TRG	DAQ
Initial	Configured	Configured
00:00:0	00:00:0	00:00:0
FAST	N/A	TIER0_TRANSFER_ON
<input type="button" value="FAST"/>	<input type="button" value=""/>	<input type="button" value="TIER0_TRANSFER_ON"/>
<input type="button" value="select"/>	<input type="button" value="select"/>	<input type="button" value="select"/>



# Run and Trigger mode selection

Select CMS Run Mode other than MANUAL

SETTING	CURRENTLY APPLIED VALUE	NEXT VALUE	from LHC
CMS Run Mode	N/A	collisions	N/A
L1/HLT Trigger Mode	collisions2016	collisions2016	autoselect
L1/HLT Key	I1_hlt_collisions2016/v127	HLT Keys	
HLT Key	/cdaq/physics/Run2016/25ns10e33/v1.0.1 /HLT/V2	LHC	N/A
HLT SW ARCH	CMSSW_8_0_7 slc6_amd64_gcc493	PRIMARY	N/A
L1_TRG_CONF Key	collisions2016_TSC/v56		
L1_TRG_RS Key	collisions2016_RS/v36		
Clock source	N/A		autoselect
TCDS System	N/A		

Tick to auto-select CMS Run Mode Based on LHC mode (Only available if connection to DCS is working)

All keys defined by CMS Run Mode including (some) sub-system RUN KEYS

# You may sometimes need: Manual RUN MODE

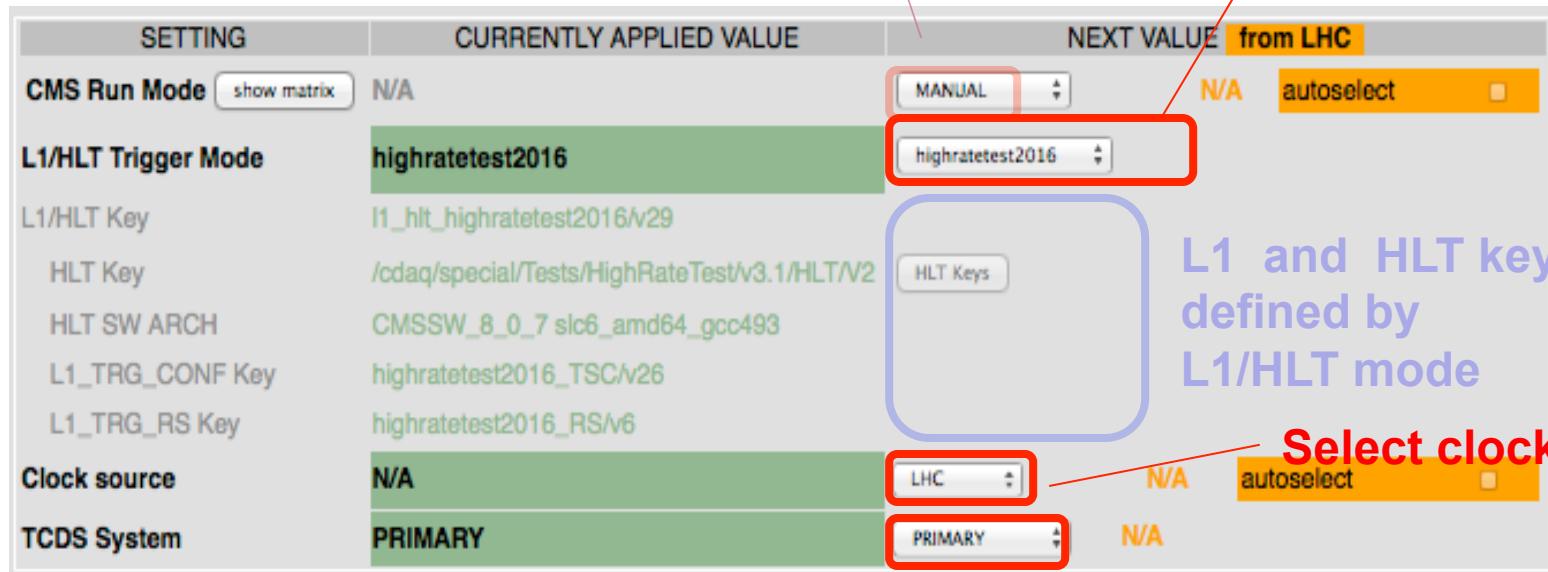
Select CMS Run Mode is MANUAL

Select L1/HLT Mode

L1 and HLT keys defined by L1/HLT mode

Select clock source

( Select primary/secondary TCDS system – not yet available)



SETTING	CURRENTLY APPLIED VALUE	NEXT VALUE from LHC	autoselect
CMS Run Mode	N/A	MANUAL	
L1/HLT Trigger Mode	highratetest2016	highratetest2016	
L1/HLT Key	I1_hlt_highratetest2016/v29		
HLT Key	/cdaq/special/Tests/HighRateTest/v3.1/HLT/V2		
HLT SW ARCH	CMSSW_8_0_7 slc6_amd64_gcc493		
L1_TRG_CONF Key	highratetest2016_TSC/v26		
L1_TRG_RS Key	highratetest2016_RS/v6		
Clock source	N/A	LHC	
TCDS System	PRIMARY	PRIMARY	

Attention: You also need to select sub-system run keys manually

# You may rarely need: Manual L1/HLT MODE

Select CMS Run Mode is MANUAL

L1/HLT Mode is MANUAL

SETTING	CURRENTLY APPLIED VALUE	NEXT VALUE from LHC
CMS Run Mode	N/A	<input type="button" value="MANUAL"/> N/A autoselect
L1/HLT Trigger Mode	MANUAL	<input type="button" value="MANUAL"/>
HLT Key	N/A	<input type="button" value="HLT Keys"/>
HLT SW ARCH	N/A	
L1_TRG_CONF Key	L1_TRIGGER_dummy_key_4	
L1_TRG_RS Key	L1_TRIGGER_RS_dummy_key_4	
Clock source	N/A	<input type="button" value="LHC"/> N/A autoselect
TCDS System	PRIMARY	<input type="button" value="PRIMARY"/> N/A

Choose HLT key and HLT SW Architecture

L1 Keys defined by trigger shifter

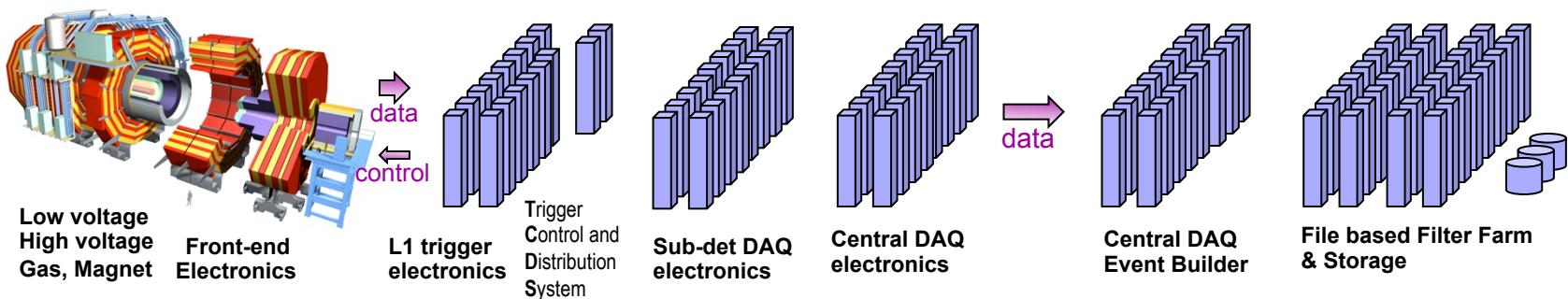
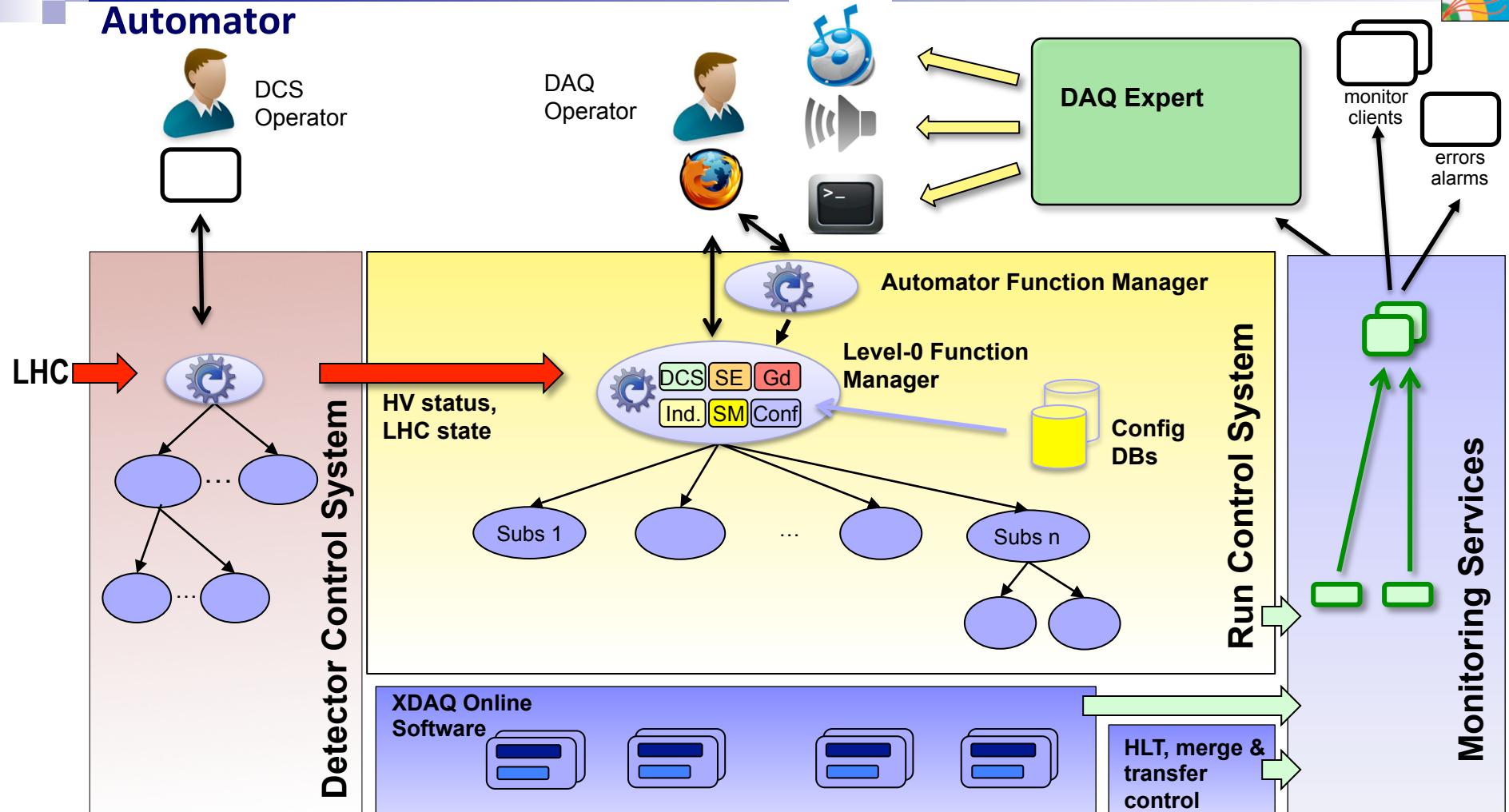
Select clock source

( Select primary/secondary TCDS system – not yet available)

Attention: You also need to select sub-system run keys manually



## Automator





# Level-0 Automator

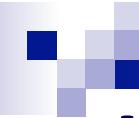
Start a run from any state  
Stop a run then re-start

- Taking into account all cross-checks (except sanity checks)
- Taking into account scheduled actions
- Attempting to recover from failures (2 retries, currently)

**Schedule**  
“at-fault” is for future automatic down-time splitting

The screenshot shows the CMS Level-0 Automator interface with several key components:

- Control Panel:** Includes buttons for Refresh, Detach, Destroy, Lock, Start Run, Recover Run, and Interrupt. A status message "Action: Idle" is displayed.
- Subsystem Status Table:** A grid showing the status of various subsystems across different modes (e.g., PIXEL, PIXEL\_UP, TRACKER, ES, ECAL, HCAL, HF, DT, CSC, RPC, TOTEM, TCDS, TRG, SCAL, DAQ, DQM). Rows include "OK + OK", "OK", and "at fault".
- Run Control Buttons:** Buttons for Connect, Configure, Start, Pause, Resume, Stop, Halt, ColdReset, ForceStop, ForceHalt, Recover, Interrupt, FixSoftError, TTCResync, TTCHardReset, TTSTestMode, and TestTTS.
- Auto Soft Error Recovery:** A checked checkbox.
- Configuration and Run Number:** Configuration path: /topro/PublicGlobal/levelZeroFMwithAutomator. Run number: 272858.
- Setting and Value Tables:** Tables for CMS Run Mode (set to N/A), L1/HLT Trigger Mode (set to cosmis2016), LHC machine mode (PROTON PHYSICS), LHC beam mode (NO BEAM), LHC clock stable (false), Clock source (LOCAL), and TCDS System (PRIMARY).
- SID and Sequence Details:** SID: 279182, Seq Name: GLOBAL-RUN, Global Key: /GLOBAL\_CONFIGURATION\_MAP/CMS/CENTRAL/GLOBAL\_RUN, HWCFG Key: /daq2/eq\_160404/fb\_all\_withTCA\_consolidated3\_no1240\_TOTEM/dp\_b1228\_72BU:0, Level-0 Action: Tasks completed, Level-0 Error: None.
- Subsystem Status Table:** A detailed table showing the state of various subsystems over time, with columns for Subsystem, State, Time, Applied Run Key, New Run Key, and Commander.



# Level-0 Automator

- When to use what button
  - If we are not “Running”
    - “Start Run” will start a new run ( “Recover Run” will do the same thing)
  - If we are “Running”
    - “Recover Run” will stop, then start a new run (“Start Run” has no effect)
- When to use the automator
  - To start a run
    - First set all settings (Subsystems & FEDs in/out, run mode etc. )
    - Then let the automator re-configure / re-cycle subsystems as necessary and start a new run
  - To recover from a problem (if you know the appropriate recovery action)
    - Select the recovery action in the Schedule
    - Let the automator stop the run, re-configure / re-cycle subsystems as necessary and start a new run
  - To apply changed settings such as a new run mode or trigger key
    - Just click “Recover Run” while a run is going
    - The automator stops the run, recycles/ reconfigures subsystems as requested by indicators and starts again



# Level-0 timeline

Shows history of subsystem states and all manual and automatic actions taken

Subsystem	PIXEL	PIXEL_UP	TRACKER	ES	ECAL	HCAL	HF	DT	CSC	RPC
at fault										

FED & TTS		Lock	save
<div style="background-color: #008000; height: 10px;"></div>			
	DCS/LHC flag	state	force
	ES_HV_ON	true	FROM DCS
	PIX_HV_ON	true	FROM DCS
	TK_HV_ON	true	FROM DCS
	PHYSICS_DECLARED	true	FROM DCS
	LHC_RAMPING	false	FROM DCS
	LHC machine mode	PROTON	
LHC beam mode	PHYSICS		
LHC clock stable	NO BEAM		
<b>SETTING</b> <b>CMS Run Mode</b> <input type="button" value="show matrix"/> <b>L1/HLT Trigger Mode</b> <b>L1/HLT Key</b> <b>HLT Key</b> <b>HLT SW ARCH</b> <b>L1_TRG_CONF Key</b> <b>L1_TRG_RS Key</b> <b>Clock source</b> <b>TCDS System</b>			

SID	279182
Seq Name	GLOBAL-RUN
Global Key	/GLOBAL_CONFIGURATION_MAP/CMS/CENTRAL/GLOB
HWCFG Key	/daq2/eq_160404/fb_all_withTCA_consolidated3_no1240
Level-0 Action	Tasks completed.
Level-0 Error	

ES	ECAL	CSC	RPC	TCDS
Running	Running	Running	Running	Running
00:05.5	00:07.9	00:09.5	00:06.0	00:0
s:LowGain-TCDs	Cosmics-SR	N/A	N/A	NoBxInfo
LowGain-TCDs	Cosmics-SR			NoBxInfo
<input type="button" value="select"/>				
<input type="button" value="Scan"/>				





# Level-0 timeline

Tool tips give information about the reasons for action

Subsystem	PIXEL	PIXEL_UP	TRACKER	ES	ECAL	HCAL	HF	DT	CSC	RPC
at fault										

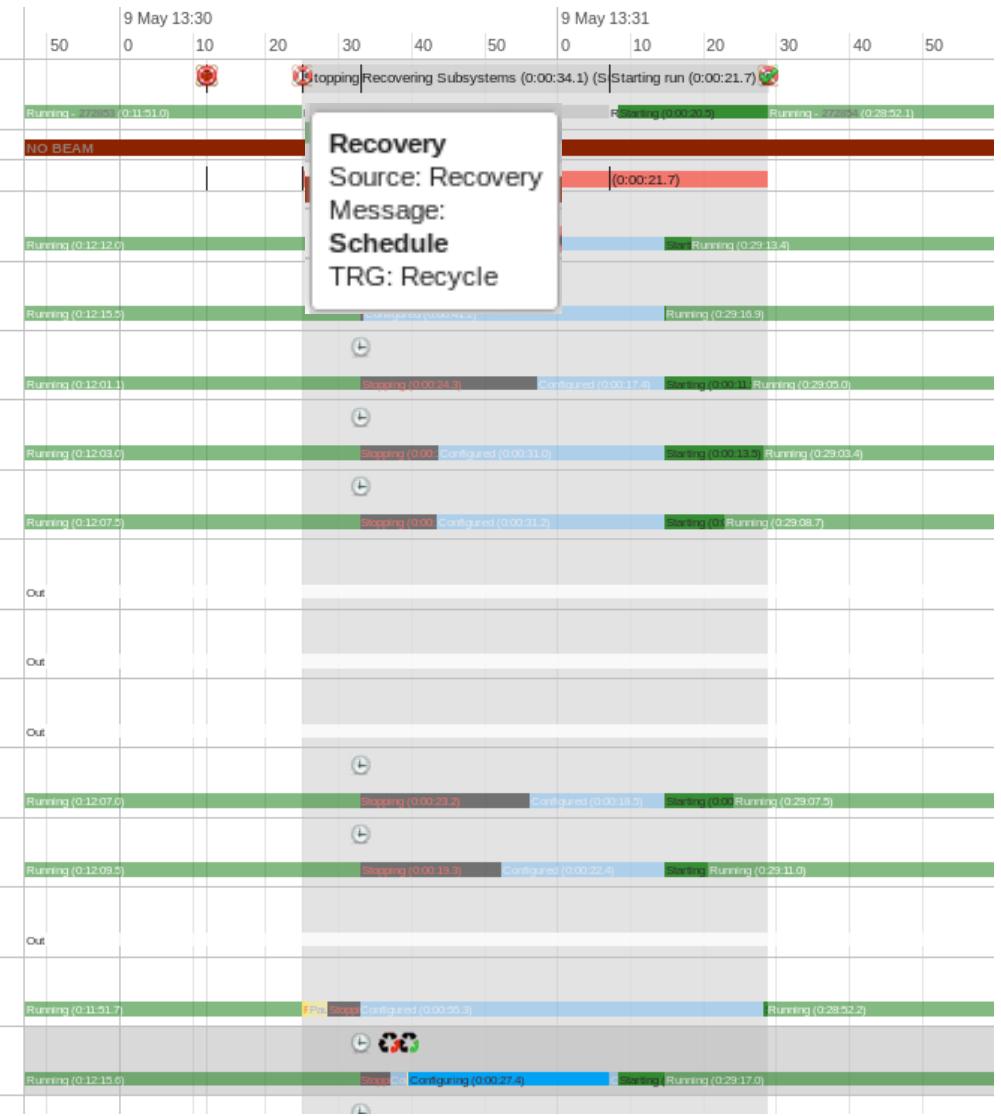
FED &amp; TTS

Lock

save

DCS/LHC flag	state	force
ES_HV_ON	true	FROM DCS
PIX_HV_ON	true	FROM DCS
TK_HV_ON	true	FROM DCS
PHYSICS_DECLARED	true	FROM DCS
LHC_RAMPING	false	FROM DCS
ColdReset		
FixSoftError		
LHC machine mode	PROTON	
LHC beam mode	PHYSICS	
LHC clock stable	NO BEAM	
Setting		
CMS Run Mode	show matrix	
L1/HLT Trigger Mode		
L1/HLT Key		
HLT Key		
HLT SW ARCH		
L1_TRG_CONF Key		
L1_TRG_RS Key		
Clock source		
TCDS System		
SID	279182	
Seq Name	GLOBAL-RUN	
Global Key	/IGLOBAL_CONFIGURATION_MAP/CMS/CENTRAL/GLOBAL	
HWCFG Key	/daq2/eq_160404/fb_all_withTCA_consolidated3_no1240	
Level-0 Action	Tasks completed.	
Level-0 Error		

ES	ECAL	CSC	RPC	TCDS
Running	Running	Running	Running	Running
00:05.5	00:07.9	00:09.5	00:06.0	00:0
s:LowGain-TCDs	Cosmics-SR	N/A	N/A	NoBxInfo
LowGain-TCDs	Cosmics-SR			NoBxInfo
	select	select	select	select





# Level-0 timeline

Tool tips give information about the reasons for action ... and their outcome

Subsystem	PIXEL	PIXEL_UP	TRACKER	ES	ECAL	HCAL	HF	DT	CSC	RPC
	<input type="checkbox"/>									
	<input type="checkbox"/>									
at fault	<input type="checkbox"/>									

FED & TTS
Lock
save

**DCS/LHC flag**  
 ES\_HV\_ON: true FROM DCS  
 PIX\_HV\_ON: true FROM DCS  
 TK\_HV\_ON: true FROM DCS  
 PHYSICS\_DECLARED: true FROM DCS  
 LHC\_RAMPING: false FROM DCS

**SETTING**  
**CMS Run Mode**: show matrix  
**L1/HLT Trigger Mode**  
 L1/HLT Key  
 HLT Key  
 HLT SW ARCH  
 L1\_TRG\_CONF Key  
 L1\_TRG\_RS Key  
**Clock source**  
**TCDS System**

SID: 279182	Seq Name: GLOBAL-RUN
Global Key: /IGLOBAL_CONFIGURATION_MAP/CMS/CENTRAL/GLOB	HWCFG Key: /daq2/eq_160404/fb_all_withTCA_consolidated3_no1240
Level-0 Action: Tasks completed.	Level-0 Error:

ES	ECAL	CSC	RPC	TCDS
Running	Running	Running	Running	Running
00:05.5	00:07.9	00:09.5	00:06.0	00:0
s:LowGain-TCDs	Cosmics-SR	N/A	N/A	NoBxInfo

LowGain-TCDs
Cosmics-SR
select
select
select
select

9 May 13:30
50 0 10 20 30 40 50
9 May 13:31
50 0 10 20 30 40 50

**Global**  
 Stopping | Recovering Subsystems (0:00:34.1) (S)

Starting run (0:00:21.7) (S)

**LHC Status**: NO BEAM

ForceStopping (0:00:00.0)

**PIXEL**  
 Running (0:12:12.0)

Stopping | Configured (0:00:00.0)

**PIXEL\_UP**  
 Running (0:12:15.5)

Configured (0:00:41.2)

Running (0:29:16.9)

**TRACKER**  
 Running (0:12:01.1)

Stopping | Configured (0:00:17.0)

Running (0:29:05.0)

**ES**  
 Running (0:12:03.0)

Stopping | Configured (0:00:31.0)

Running (0:29:03.4)

**ECAL**  
 Running (0:12:07.5)

Stopping | Configured (0:00:31.2)

Running (0:29:08.7)

**HCAL**  
 Out

**HF**  
 Out

**DT**  
 Out

**CSC**  
 Running (0:12:07.0)

Stopping | Configured (0:00:18.2)

Running (0:29:07.5)

**RPC**  
 Running (0:12:09.5)

Stopping | Configured (0:00:22.4)

Running (0:29:11.0)

**TOTEM**  
 Out

**TCDS**  
 Running (0:11:51.7)

Stopped | Configured (0:00:20.3)

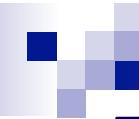
Running (0:28:52.2)

**TRG**  
 Running (0:12:15.6)

Stopped | Configuring (0:00:27.4)

Running (0:29:17.0)

**RecoverySuccess**  
Duration: 0:01:03.8  
Source: Recovery  
Message: Recovery completed successfully.



# Toolips for errors





# Going back to analyze problems

	Tue 10 May													
	:59	06:00	06:01	06:02	06:03	06:04	06:05	06:06	06:07	06:08	06:09	06:10	06:11	06:12
Global														
LHC Status	ADJUST													
Downtime														
PIXEL														
PIXEL_UP														
TRACKER														
ES														
ECAL														
HCAL														
HF														
DT														
CSC														
RPC														
TOTEM														
TCDS	Out													
TRG														
SCAL														
DAQ														
DQM														
	:59	06:00	06:01	06:02	06:03	06:04	06:05	06:06	06:07	06:08	06:09	06:10	06:11	06:12
	Tue 10 May													

☆ 🔍 📈 ✖️ ⏴ Auto-scroll showing the last 120 second(s)



# FM L0 Links Panel

**Run Control and Monitoring System**

Configuration Chooser  
Running Configurations  
Diagnostic Page  
Logging Collector  
Controller  
Monitoring Tools  
Administration  
Run Info  
Logout

sv-C2D06-02.cms:11000

FM Instance Summary

Name	URI	Owner	State
DAQFM	<a href="http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=DAQFMs_owner=cdaq">http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=DAQFMs_owner=cdaq</a>	DAQFM	Running
FEDBuilderFM	<a href="http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=FEDBuilderFM_owner=cdaq">http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=FEDBuilderFM_owner=cdaq</a>	FEDBuilderFM	Enabled
TTSFM	<a href="http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=TTSFM_owner=cdaq">http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=TTSFM_owner=cdaq</a>	TTSFM	Running
HLTSGFM	<a href="http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=HLTSGFM_owner=cdaq">http://cmsrc-daq:11000/um:rcms-fm fullPath=/cdag/Global/2009-06-10-MW24/allFEDs_8slice_5TC_BUFU_8eBU4FU_CMSSWpro_8SM/group=HLTSGFM_owner=cdaq</a>	HLTSGFM	Running

Messaging - Display

- [State Notification Display](#)
- [Input Display](#)
- [Error Display](#)
- [Notification Reply Command Display](#)

http://cmsrc-top:10000/rcms/gui/servlet/StateManager

Update	Refresh	full	▼	StorageManager	Exit	Updated: Thu Jun 11 11:58:33 CEST 2009
Running	levelZeroFM			Type	URI	
Running	levelZeroFM/DAQFM			FM	<a href="http://cmsrc-l0p:10000/um:rcms/gui/servlet/FMPilotServlet?groupID=3255">http://cmsrc-l0p:10000/um:rcms/gui/servlet/FMPilotServlet?groupID=3255</a>	
Enabled	levelZeroFM/DAQFM/FEDBuilderFM			FM	<a href="http://cmsrc-daq:11000/um:rcms/gui/servlet/FMPilotServlet?groupID=508444">http://cmsrc-daq:11000/um:rcms/gui/servlet/FMPilotServlet?groupID=508444</a>	
Running	levelZeroFM/DAQFM/HLTSGFM			FM	<a href="http://cmsrc-daq:11000/um:rcms/gui/servlet/FMPilotServlet?groupID=508445">http://cmsrc-daq:11000/um:rcms/gui/servlet/FMPilotServlet?groupID=508445</a>	
Running	levelZeroFM/DAQFM/SliceCEFM-0			FM	<a href="http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508455">http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508455</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-0/FEDBuilderFM-0			FM	<a href="http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508477">http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508477</a>	
Running	levelZeroFM/DAQFM/SliceCEFM-0/HLTSMF-0			FM	<a href="http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508479">http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508479</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-0/StorageManager			XDAQ	<a href="http://srv-c2c06-12.cms:1100/urn:xdaq-application:id=50">http://srv-c2c06-12.cms:1100/urn:xdaq-application:id=50</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-0/RUBuilderFM-0			FM	<a href="http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508478">http://cmsrc-daq:11100/um:rcms/gui/servlet/FMPilotServlet?groupID=508478</a>	
Running	levelZeroFM/DAQFM/SliceCEFM-1			FM	<a href="http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508454">http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508454</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-1/FEDBuilderFM-1			FM	<a href="http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508474">http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508474</a>	
Running	levelZeroFM/DAQFM/SliceCEFM-1/HLTSMF-1			FM	<a href="http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508476">http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508476</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-1/StorageManager			XDAQ	<a href="http://srv-c2c06-13.cms:1100/urn:xdaq-application:id=50">http://srv-c2c06-13.cms:1100/urn:xdaq-application:id=50</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-1/RUBuilderFM-1			FM	<a href="http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508475">http://cmsrc-daq:11200/um:rcms/gui/servlet/FMPilotServlet?groupID=508475</a>	
Running	levelZeroFM/DAQFM/SliceCEFM-2			FM	<a href="http://cmsrc-daq:11300/um:rcms/gui/servlet/FMPilotServlet?groupID=508449">http://cmsrc-daq:11300/um:rcms/gui/servlet/FMPilotServlet?groupID=508449</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-2/FEDBuilderFM-2			FM	<a href="http://cmsrc-daq:11300/um:rcms/gui/servlet/FMPilotServlet?groupID=508459">http://cmsrc-daq:11300/um:rcms/gui/servlet/FMPilotServlet?groupID=508459</a>	
Running	levelZeroFM/DAQFM/SliceCEFM-2/HLTSMF-2			FM	<a href="http://cmsrc-daq:11300/um:rcms/gui/servlet/FMPilotServlet?groupID=508461">http://cmsrc-daq:11300/um:rcms/gui/servlet/FMPilotServlet?groupID=508461</a>	
Enabled	levelZeroFM/DAQFM/SliceCEFM-2/StorageManager			XDAQ	<a href="http://srv-c2c06-14.cms:1100/urn:xdaq-application:id=50">http://srv-c2c06-14.cms:1100/urn:xdaq-application:id=50</a>	

Locked

## Save

- Save the configuration parameters of the Level Zero GUI.

## Refresh

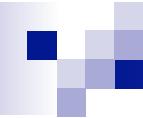
- Refresh the Level Zero page.

## Detach

- Disconnect the Level Zero GUI from the Level Zero FM.

## Destroy

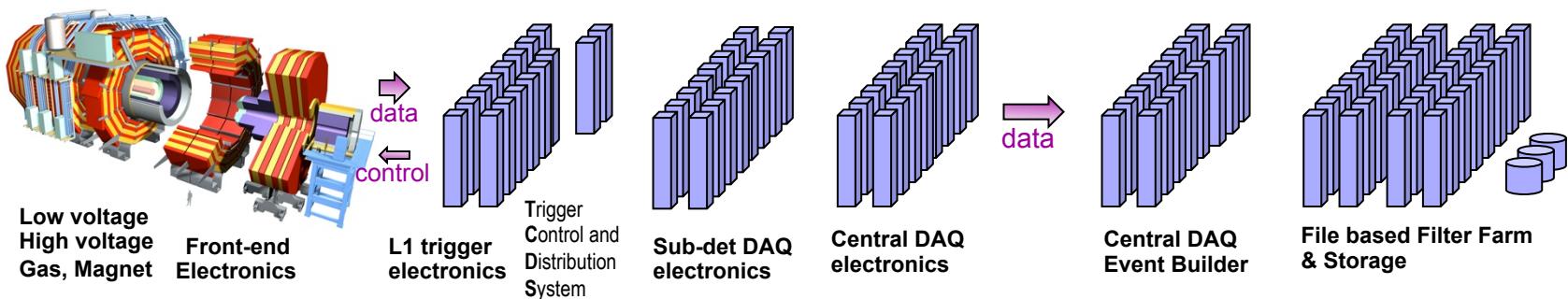
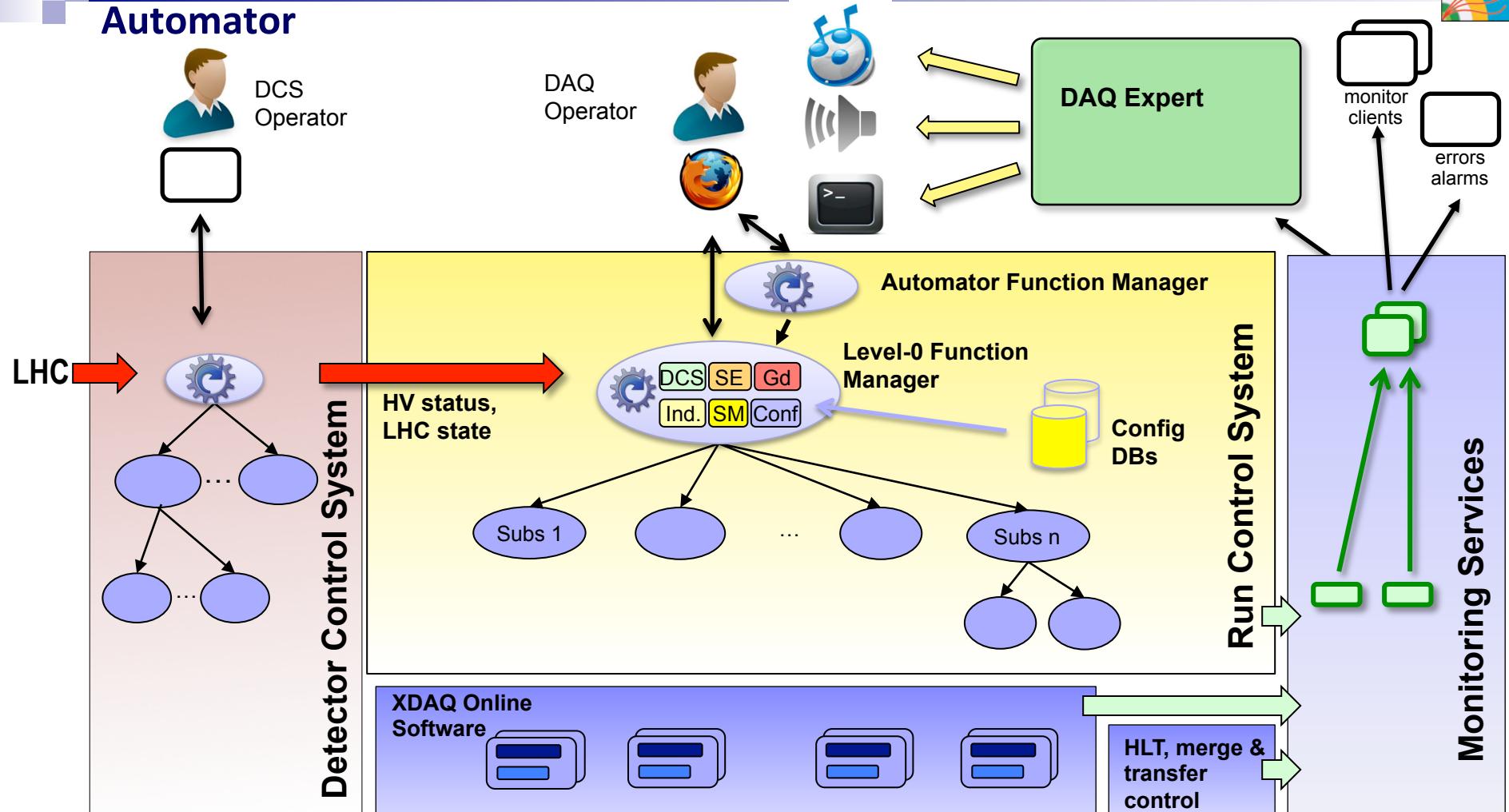
- Kill all Function Managers and XDAQs started by them



# **Automation: Automatic reaction to LHC beam/machine mode and DCS high voltage state**

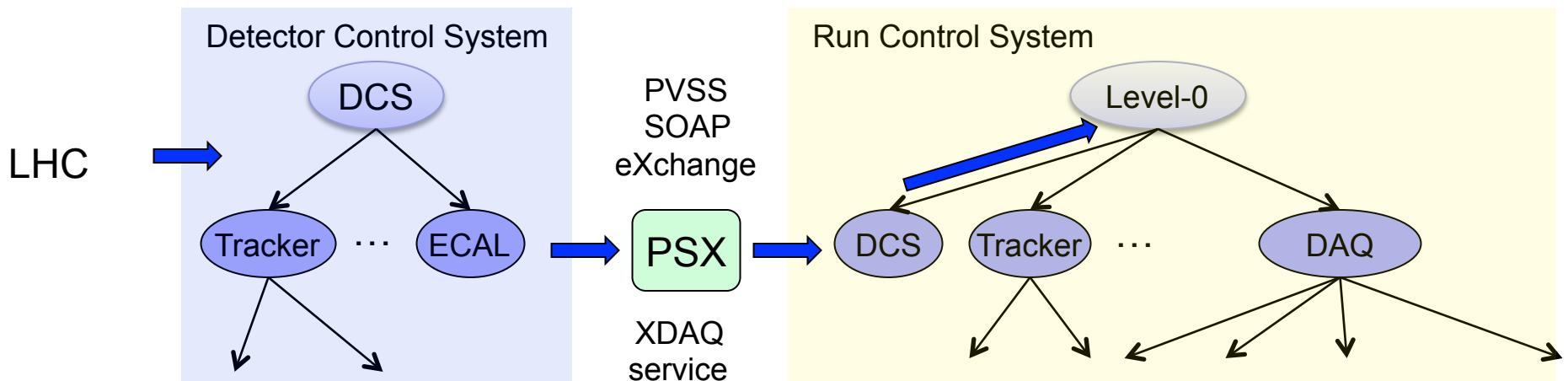


## Automator

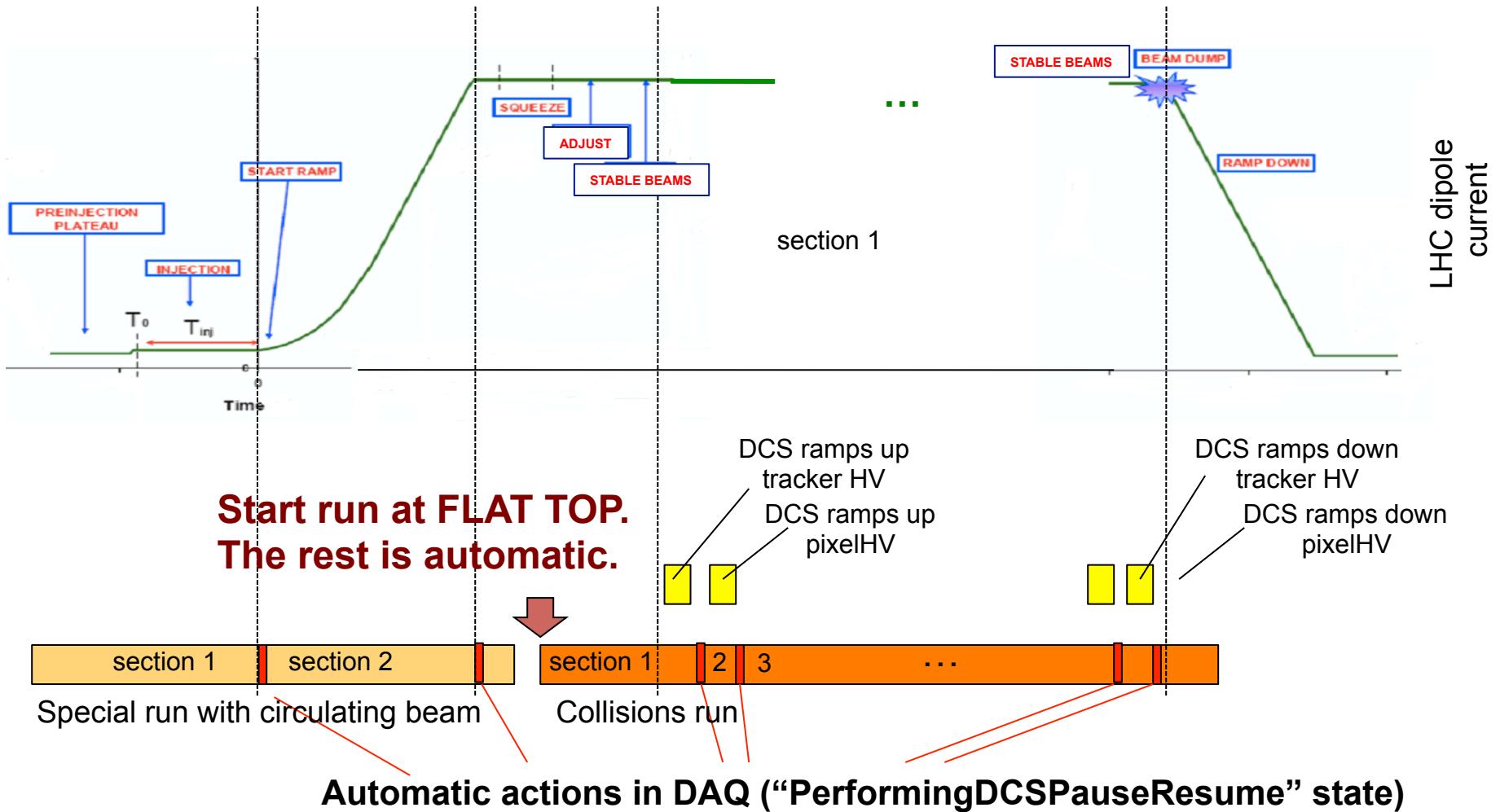


# DAQ actions on LHC and DCS state changes

- Extensive automation in the Detector Control System (DCS)
  - Automatic handshake with the LHC
  - Automatic ramping of high voltages (HV) driven by LHC machine and beam mode
- Some DAQ settings depend on the LHC and DCS states
  - Suppress tracker payload while HV is off (noise)
  - Reduce pixel gain while HV is off
  - Mask sensitive channels while LHC ramps ...
- Automatic new **run sections** driven by asynchronous state notifications from DCS/LHC



## Automatic actions driven by the LHC ...

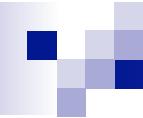


**ramp start**  
Mask  
sensitive  
trigger  
channels

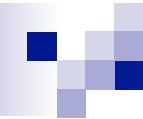
**ramp done**  
Unmask  
sensitive  
trigger  
channels

**Tracker HV on**  
Enable payload (Tk)  
raise gains (Pixel)

**Tracker HV off**  
Disable payload (Tk)  
reduce gains (Pixel)



# Automatic recovery from Soft Errors



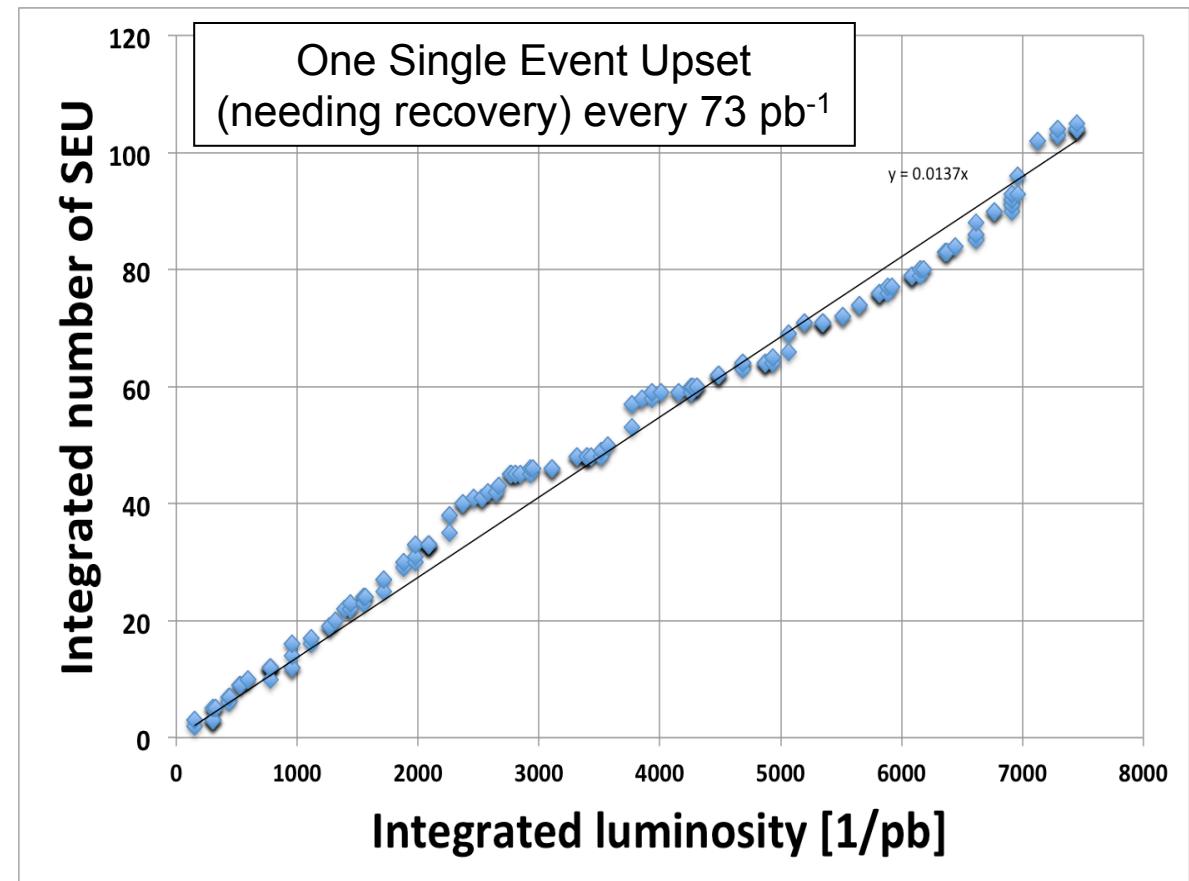
# Automatic soft error recovery

- With higher instantaneous luminosity in 2011 more and more frequent “soft errors” causing the run to get stuck

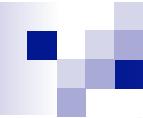
- Proportional to integrated luminosity
  - Believed to be due to single event upsets

- Recovery procedure
  - Stop run (**30 sec**)
  - Re-configure a sub-detector (**2-3 min**)
  - Start new run (**20 sec**)

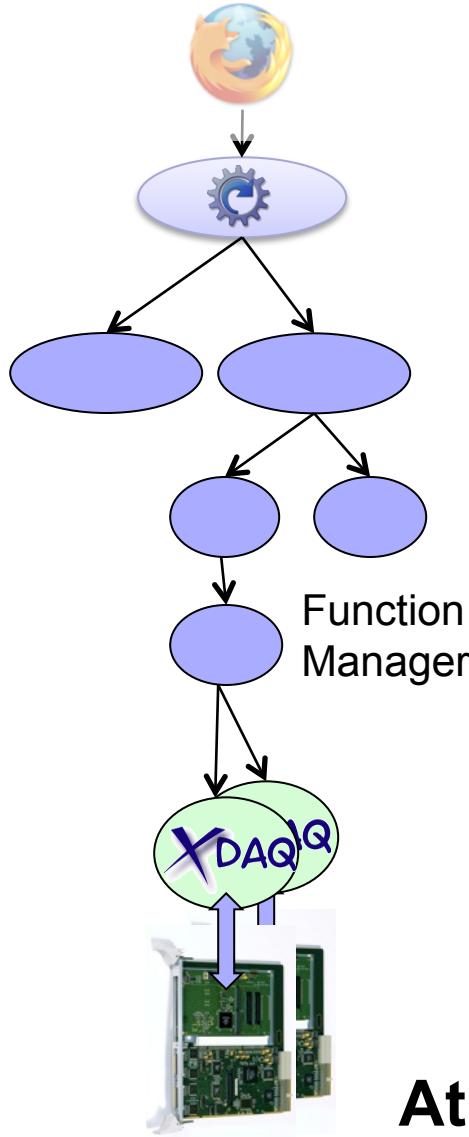
3-10 min down-time



Single-event upsets in the electronics of the Si-Pixel detector. Proportional to integrated luminosity.

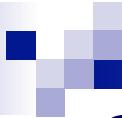


# Automatic soft error recovery



- From 2012, new automatic recovery procedure in top-level control node
    - 1. Sub-system detects soft error and signals by changing its state to **RunningSoftErrorDetected**
    - 2. Top-level control node invokes recovery procedure
      - a) Pause Triggers (TCDS)
      - b) Invoke newly defined selective recovery transition on requesting detector (**FixSoftError**)
      - c) In parallel perform preventive recovery of other detectors
      - d) Resynchronize
      - e) Resume
- 12 seconds down-time**

**At least 46 hours of down-time avoided in 2012**



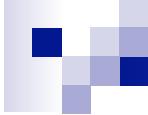
# Other special states

## ■ RunningDegraded

- Subsystems may change into **RunningDegraded** state if data taking is still continuing, but there is a problem requiring the attention of the shift crew
- The subsystem message panel should contain a message describing the problem
- Discuss with the shift leader how to proceed and check with the corresponding DOC if the message is not 100% clear.

## ■ RunBlocked

- The DAQ and Level-0 may change into the RunBlocked state if the DAQ received corrupted data from a subdetector
  - It is possible to (Force-)Stop the run from RunBlocked state.



## Part 4: Monitoring tools