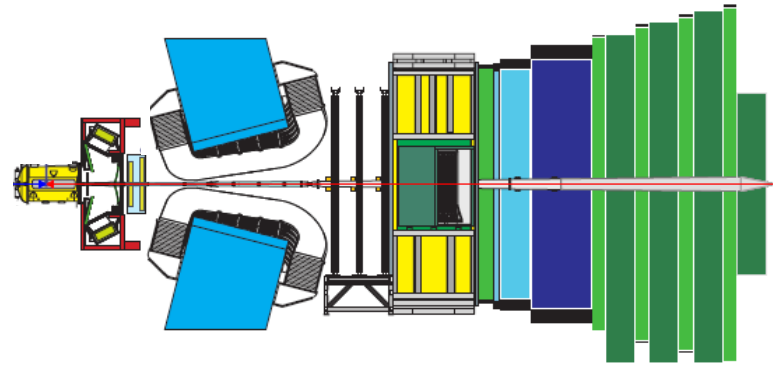


LHCb Operations in Run I:



Challenges and lessons learnt

*Clara Gaspar on behalf of the LHCb Collaboration,
"Physics at the LHC and Beyond",
Quy Nhon, Vietnam, August 2014*



■ Operations Strategy

- 2 people on shift (from day one)
 - | 1 Shift Leader (and main operator)
 - | 1 Data Quality Manager
 - | and small on-call team: ~10 people

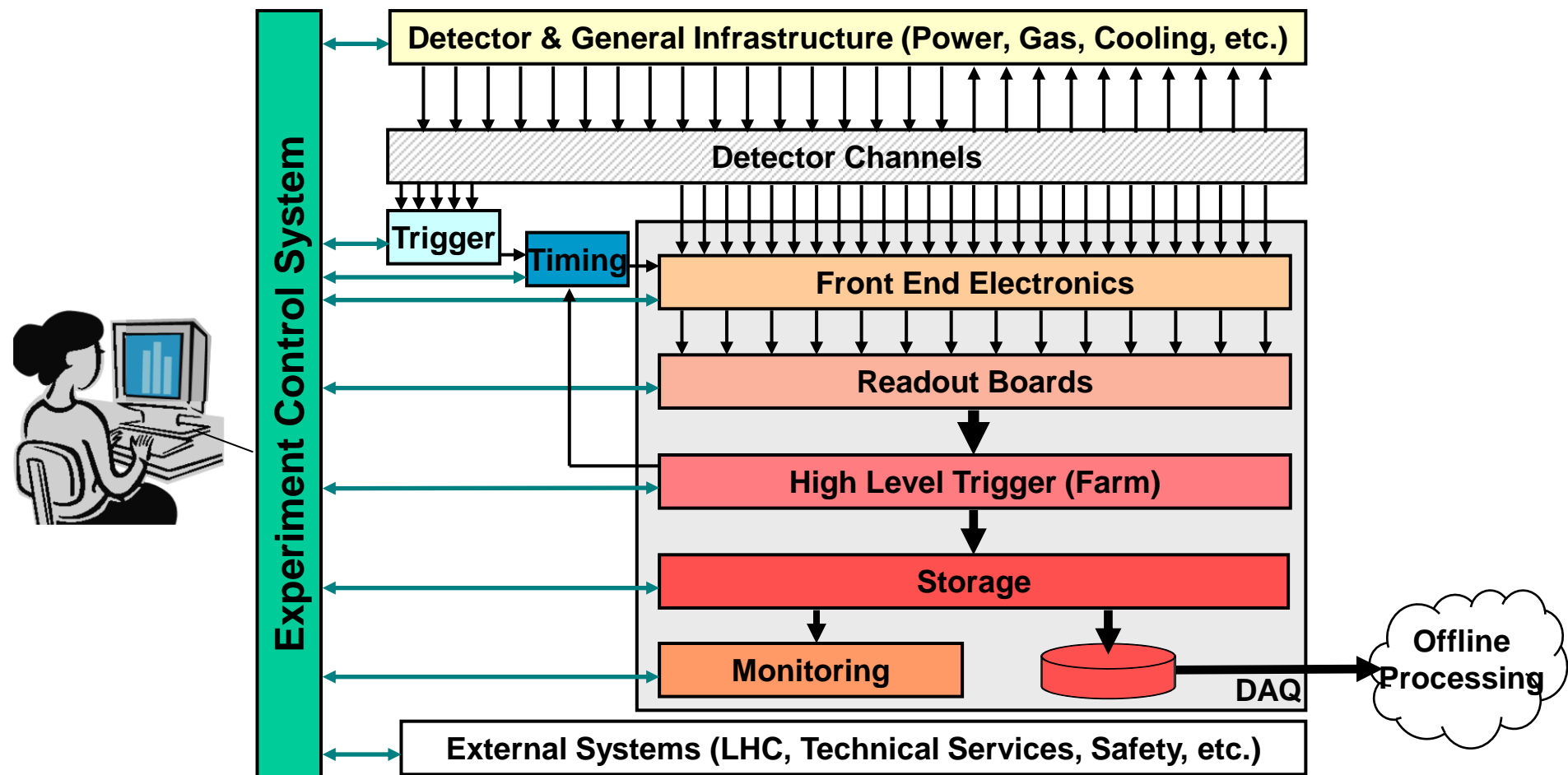
➡ Integrated Control System

- | Homogeneous User Interfaces to all areas:
 - | Data Acquisition (DAQ), Detector Control System (DCS), Trigger, High Level Trigger (HLT), etc.

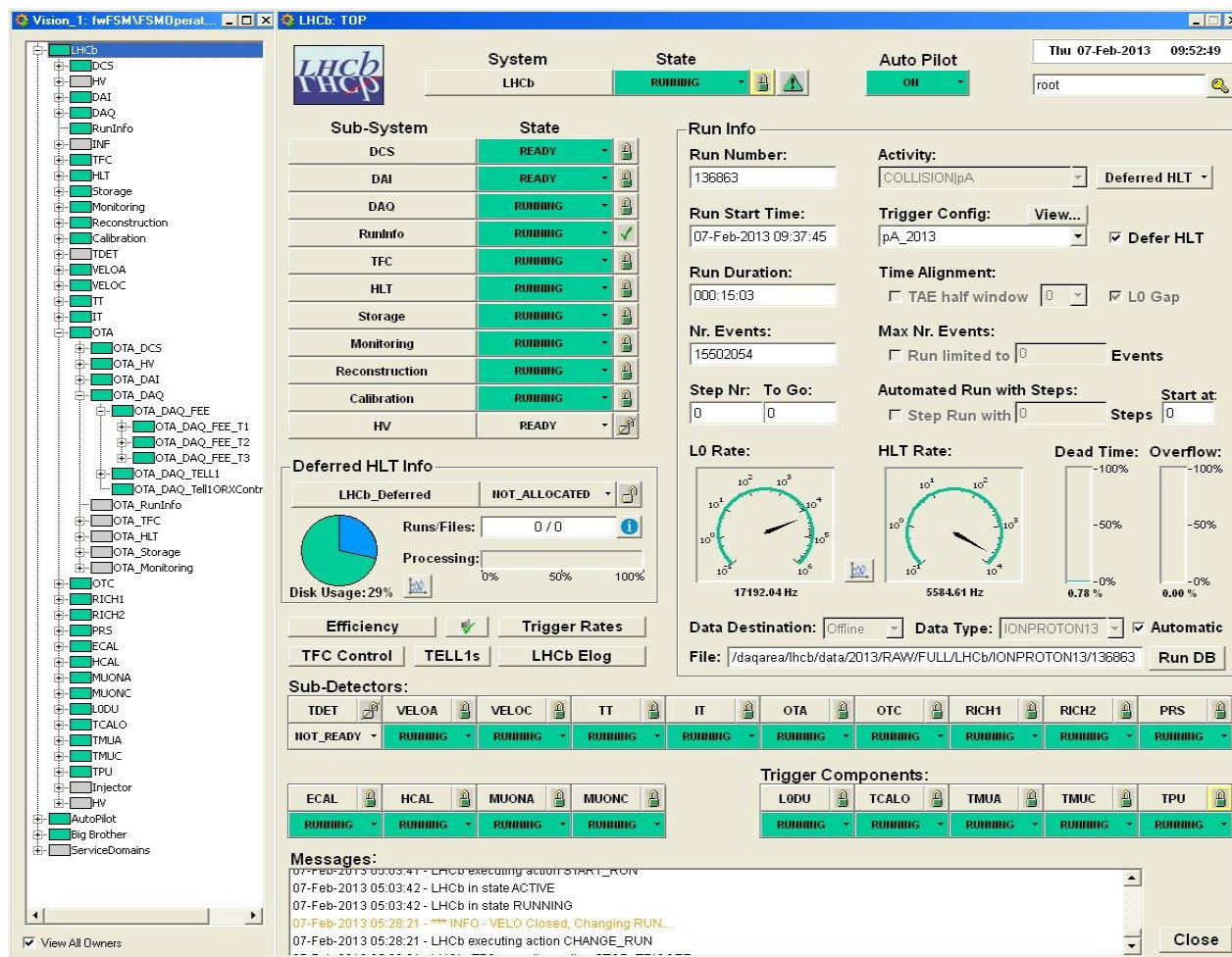
➡ Full Automation

- | For standard procedures and (known) error recovery

Operations Scope



Run Control Automation: The Autopilot

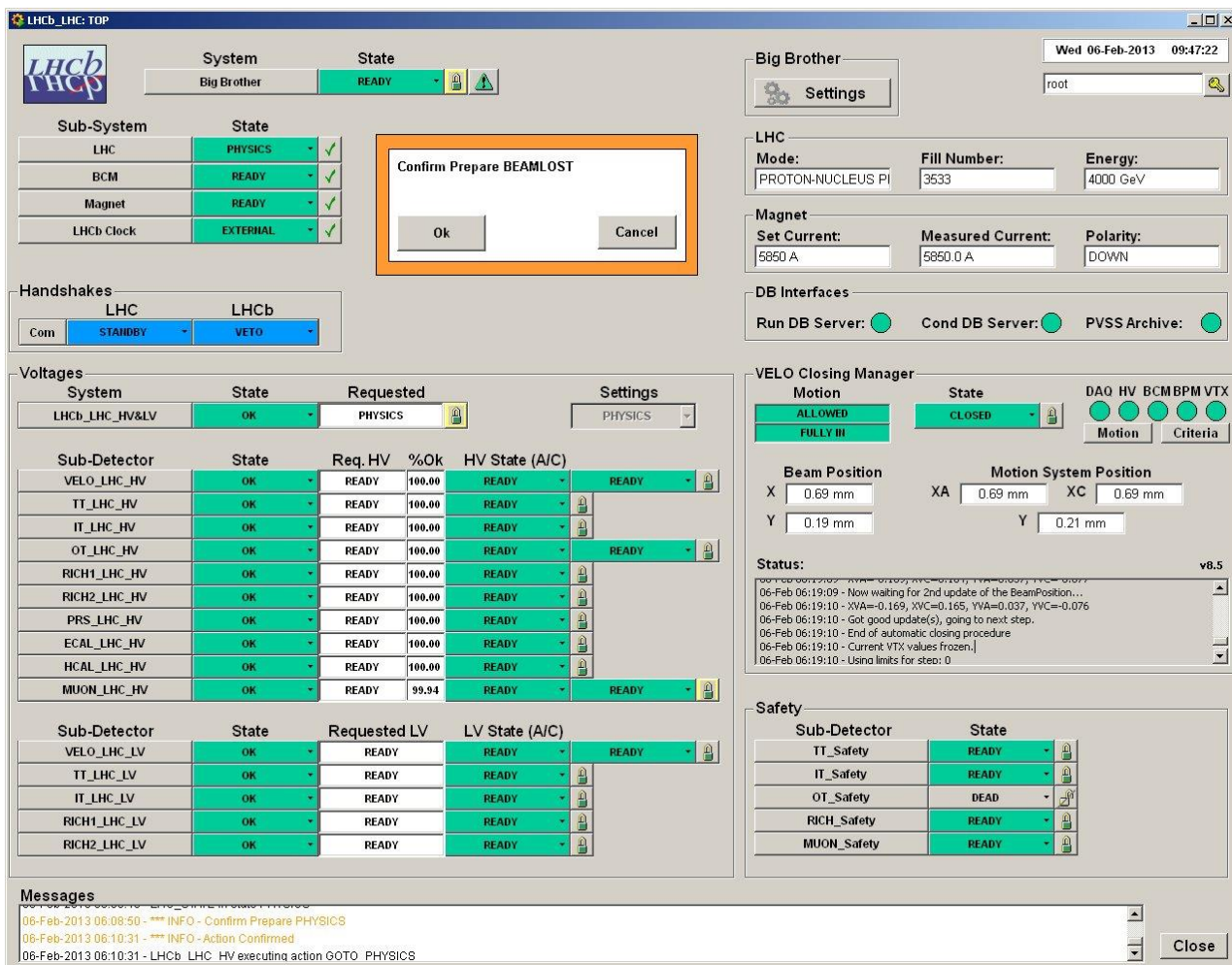


Configures,
Starts and
Keeps the RUN
going.

Recovers:

- Sub-detector de-synch.
- Misbehaving farm nodes
- Etc.

■ Big Brother



The screenshot shows the LHCb Big Brother Operations Tool interface. The main window is titled "LHCb_LHC_TOP". It features a "System" section with a "Big Brother" status indicator set to "READY". A "Sub-System" table lists various components and their states. A "Handshakes" section shows "LHC" and "LHCb" status. A "Voltages" section displays a table of detector voltages and their requested states. A "VELO Closing Manager" section shows the status of the VELO system. A "Safety" section displays a table of safety system status. A "Messages" section at the bottom shows a log of system events. A "Confirm Prepare BEAMLOST" dialog box is currently open in the center of the screen.

Sub-System	State
LHC	PHYSICS
BCM	READY
Magnet	READY
LHCb Clock	EXTERNAL

Com	LHC	LHCb
STANDBY	STANDBY	VETO

Sub-Detector	State	Req. HV	%Ok	HV State (A/C)
VELO_LHC_HV	OK	READY	100.00	READY
TT_LHC_HV	OK	READY	100.00	READY
IT_LHC_HV	OK	READY	100.00	READY
OT_LHC_HV	OK	READY	100.00	READY
RICH1_LHC_HV	OK	READY	100.00	READY
RICH2_LHC_HV	OK	READY	100.00	READY
PRS_LHC_HV	OK	READY	100.00	READY
ECAL_LHC_HV	OK	READY	100.00	READY
HCAL_LHC_HV	OK	READY	100.00	READY
MUON_LHC_HV	OK	READY	99.94	READY

Sub-Detector	State	Requested LV	LV State (A/C)
VELO_LHC_LV	OK	READY	READY
TT_LHC_LV	OK	READY	READY
IT_LHC_LV	OK	READY	READY
RICH1_LHC_LV	OK	READY	READY
RICH2_LHC_LV	OK	READY	READY

Sub-Detector	State
TT_Safety	READY
IT_Safety	READY
OT_Safety	DEAD
RICH_Safety	READY
MUON_Safety	READY

Messages:

```

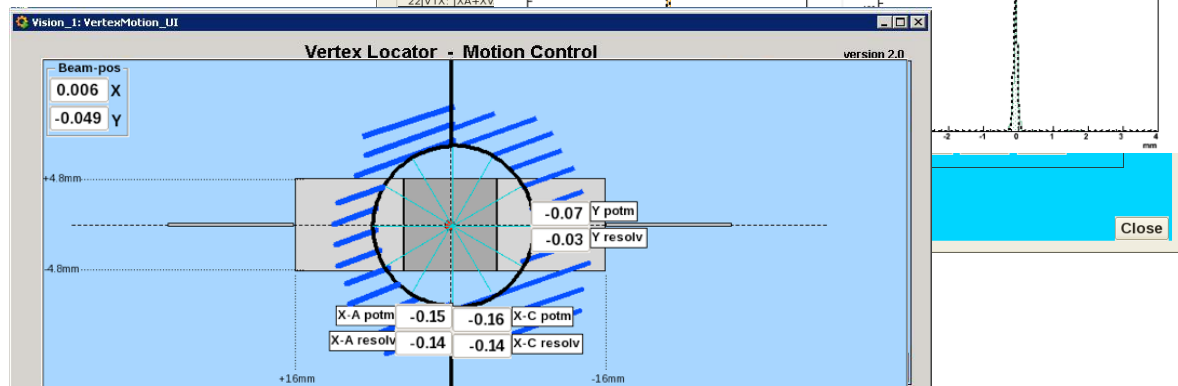
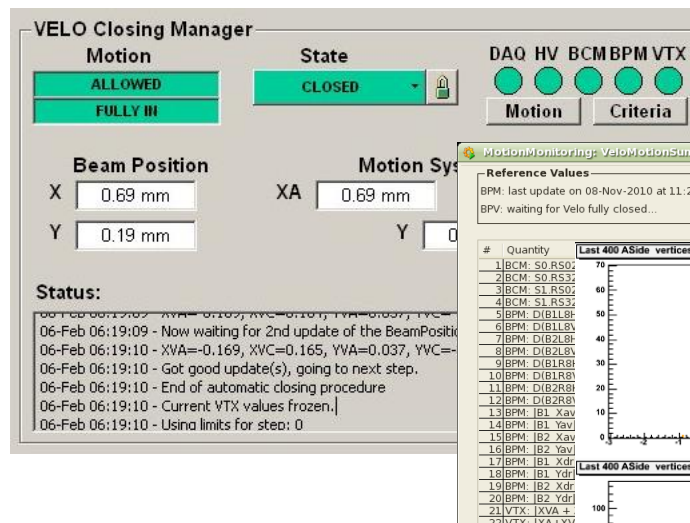
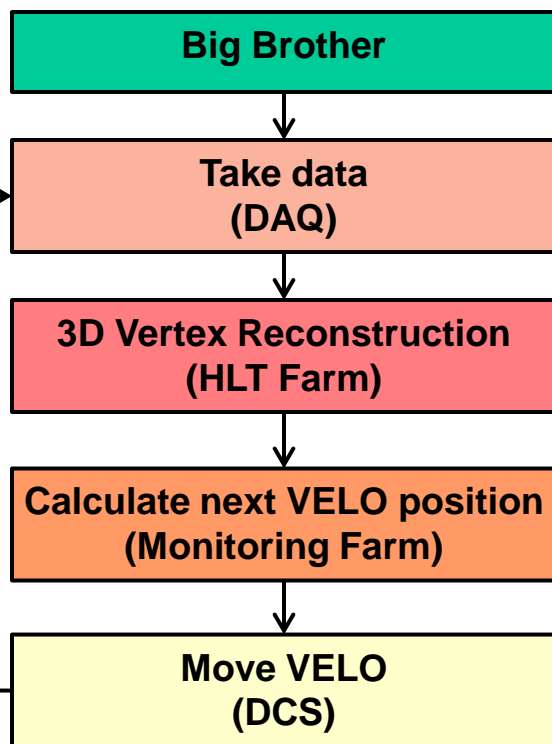
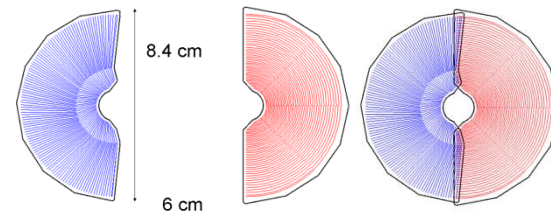
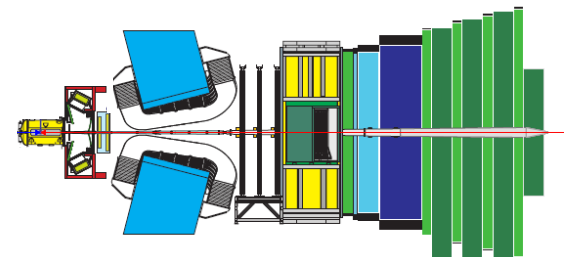
06-Feb-2013 06:08:50 - *** INFO - Confirm Prepare PHYSICS
06-Feb-2013 06:10:31 - *** INFO - Action Confirmed
06-Feb-2013 06:10:31 - LHCb_LHC HV executing action GOTO PHYSICS
  
```

- Based on LHC state, controls:
 - Voltages
 - VELO Closure
 - Run Control
- Can sequence activities, ex.:
 - End-of-fill Calibration
- Confirmation requests and Information
 - Voice Messages

Selected Challenges...

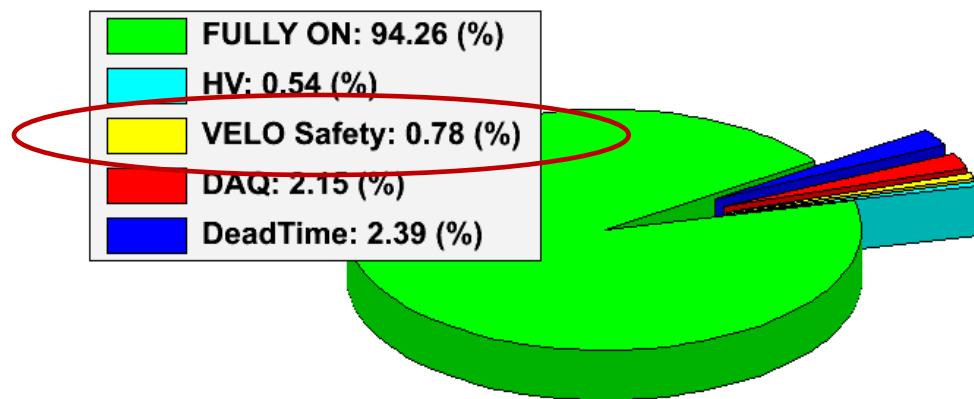


- Safety: Many criteria to respect
- Procedure: Iterative “Feedback” loop



VELO Closing

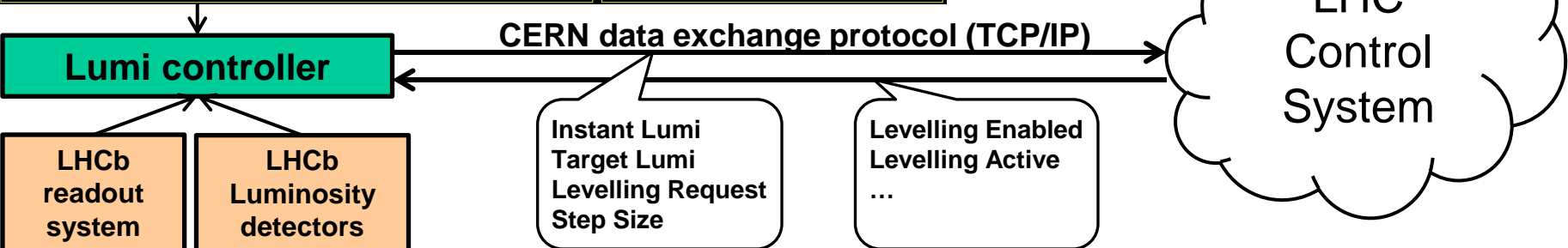
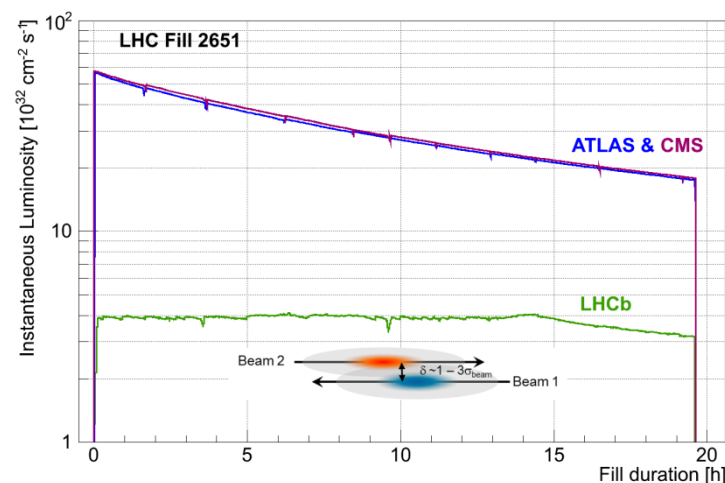
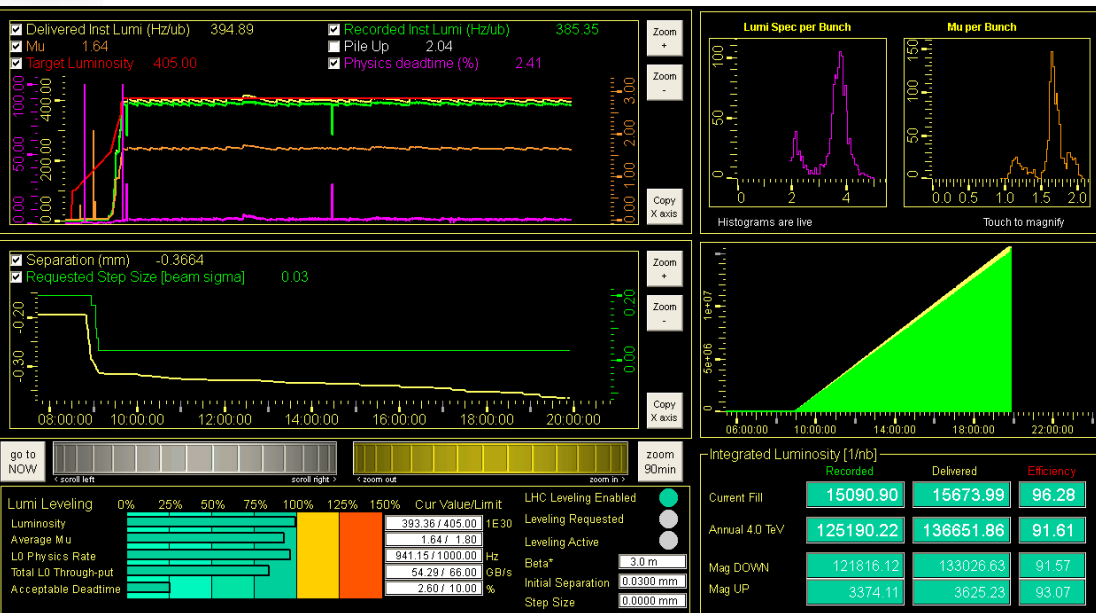
- Manually operated in the beginning
- Completely automated since 2011
 - Takes ~4 minutes at start of fill



LHCb Efficiency breakdown 2012

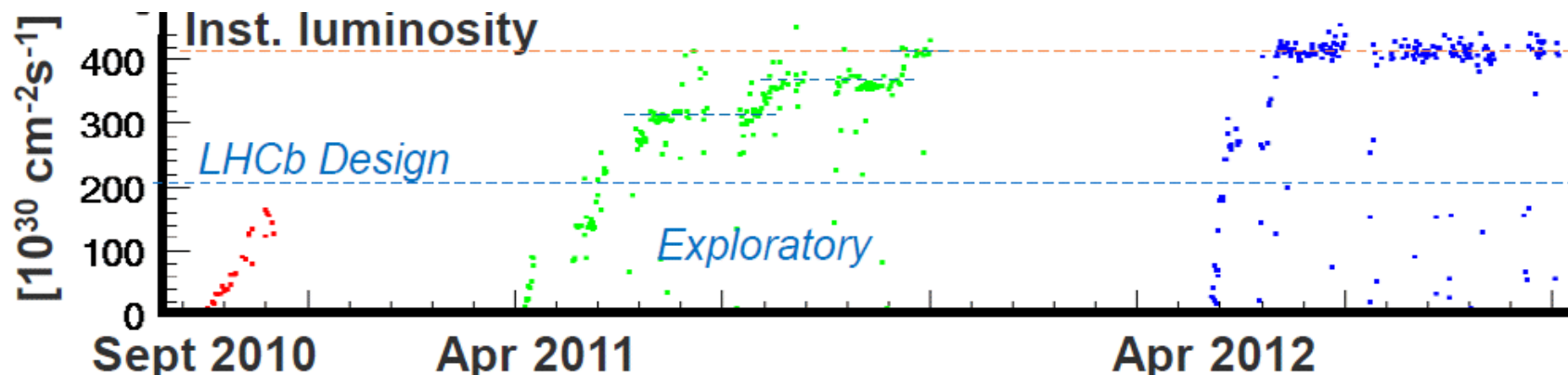
Luminosity Levelling

- Allows running LHCb under stable optimum conditions
- Constraints: Safety and Reliability



Luminosity Levelling

- In operation since 2011
- 95 % of integrated luminosity recorded within 3% of desired luminosity



- Thanks to the LHC experts and operators

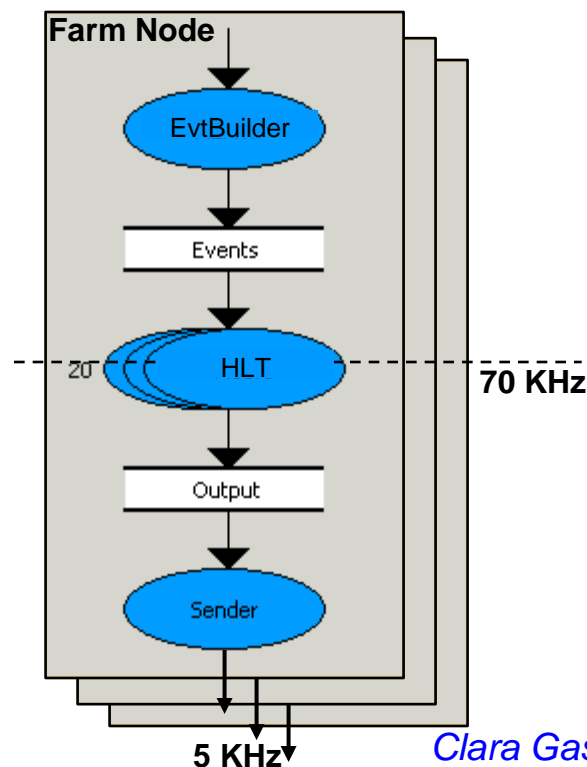
■ Resource Optimization -> Deferred HLT

- Idea: Buffer data to disk when HLT busy / Process in inter-fill gap
- Change of “paradigm”: A run can “last” days...

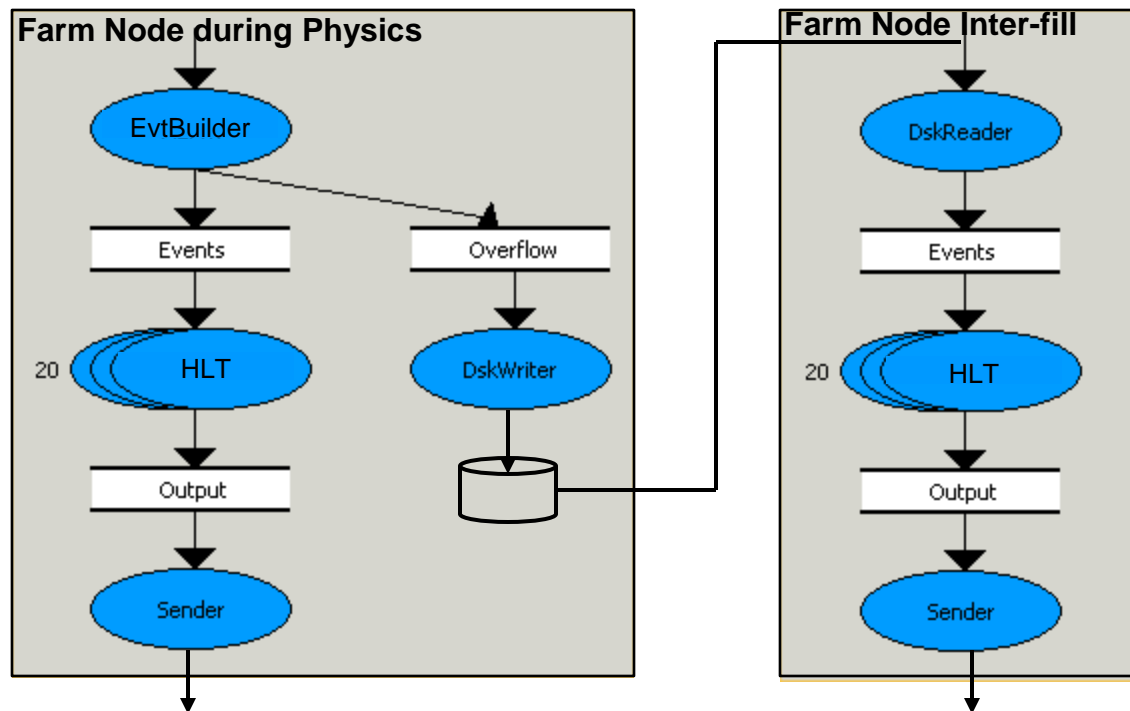


Standard HLT

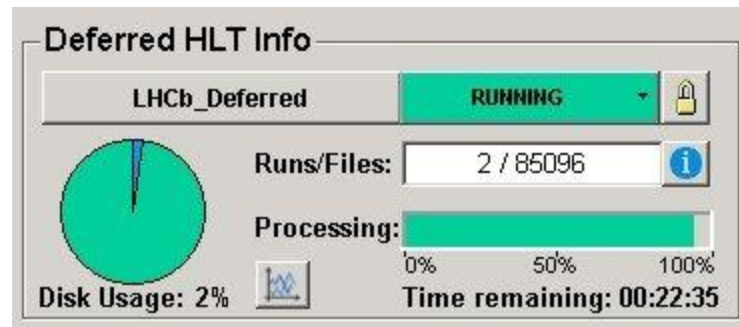
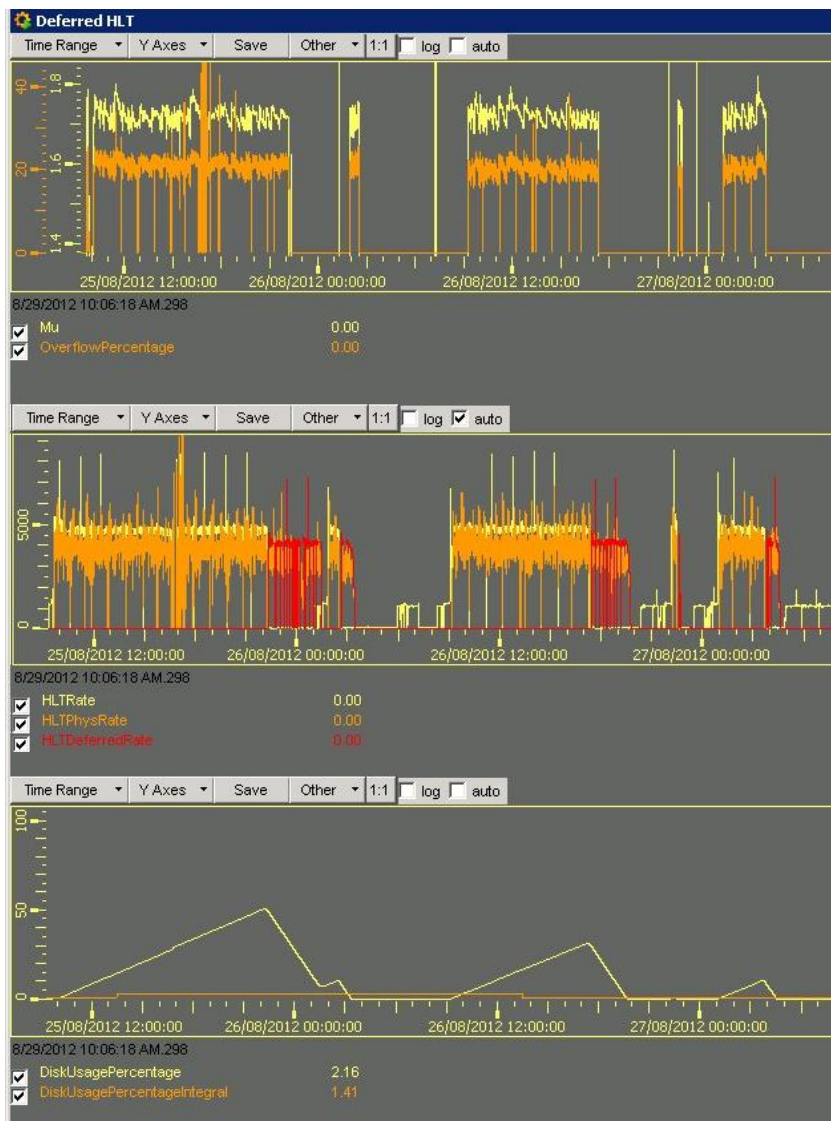
1 MHz



Deferred HLT



Deferred HLT



Major Success

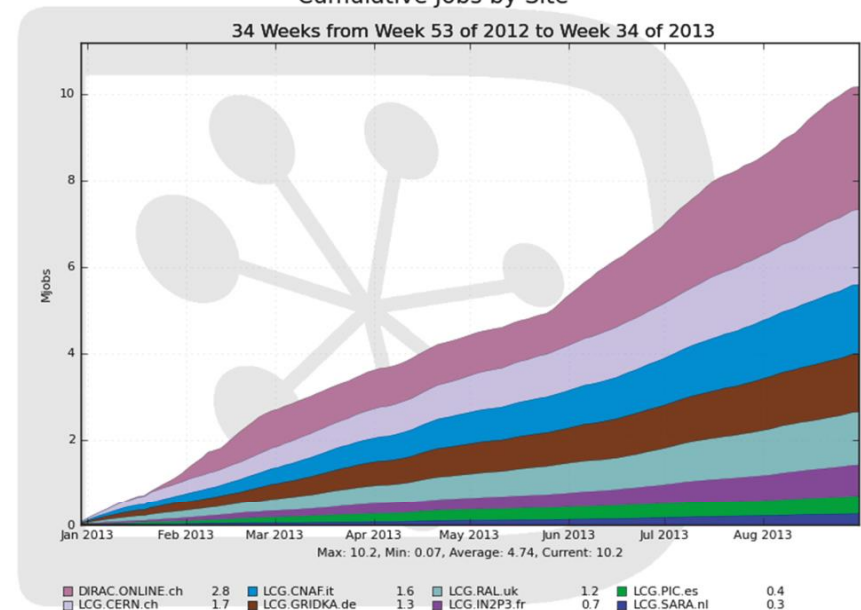
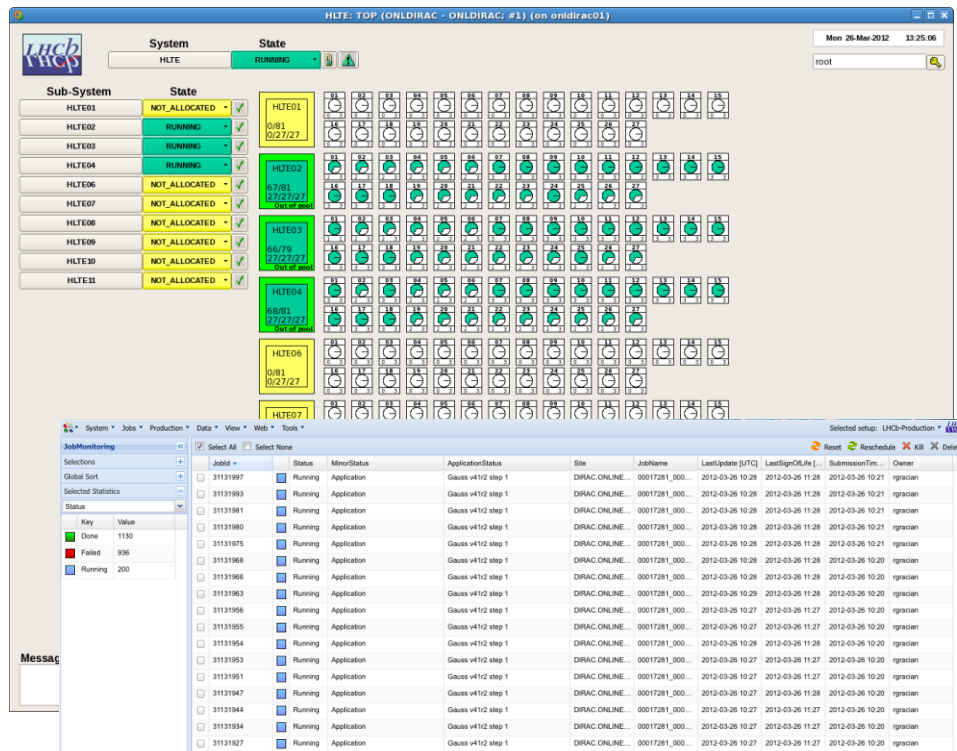
- In place since 2012
- ~20% resource gain for HLT
 - ➔ Better Trigger
- Cushion for central DAQ/Storage hiccups

Resource Optimization -> Offline Processing

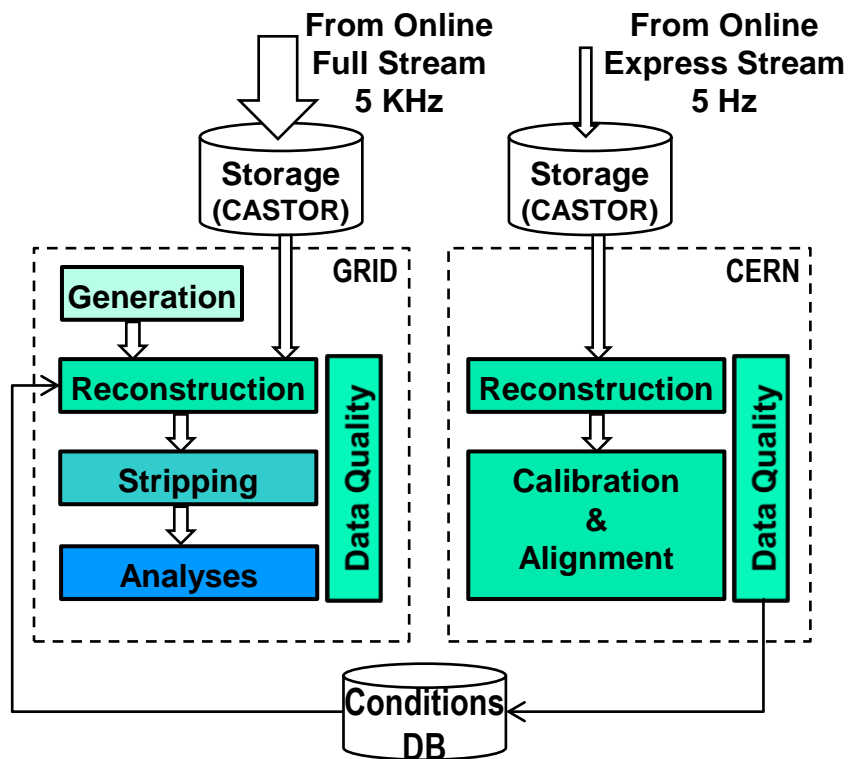
- Idea: Run standard Offline Simulation outside data taking periods
- Online Control System turns HLT Farm into Offline site
- In Operations since end 2012

Also a big Success:

- ~25K jobs simultaneously
- Largest LHCb producer



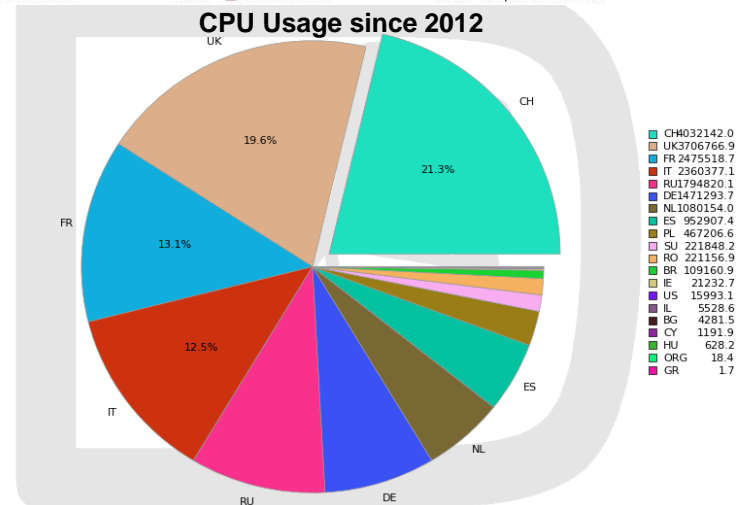
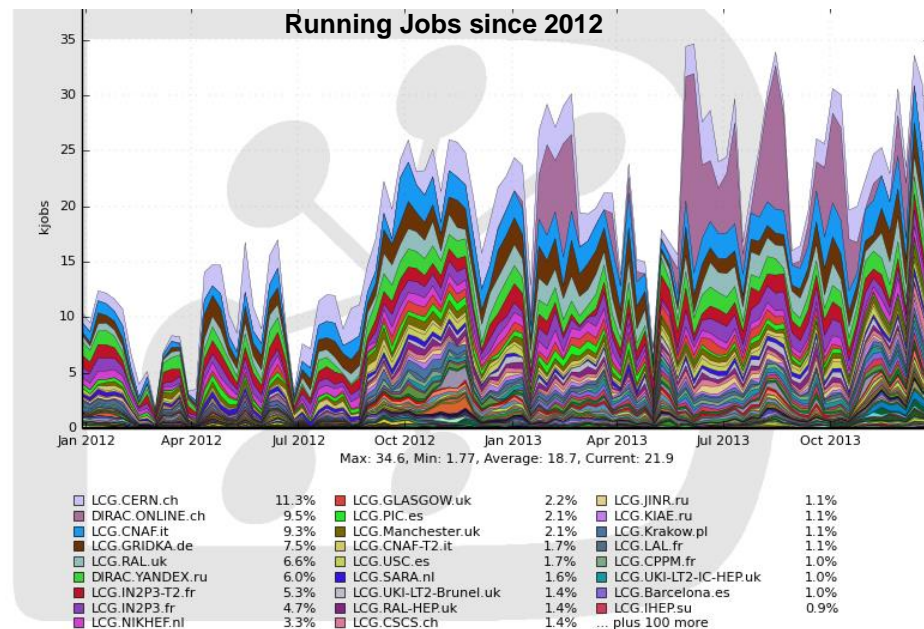
Distributed Computing



Running Fine



- 126 sites in 20 countries
- 2 Shifters (daytime only)



Lessons Learnt...

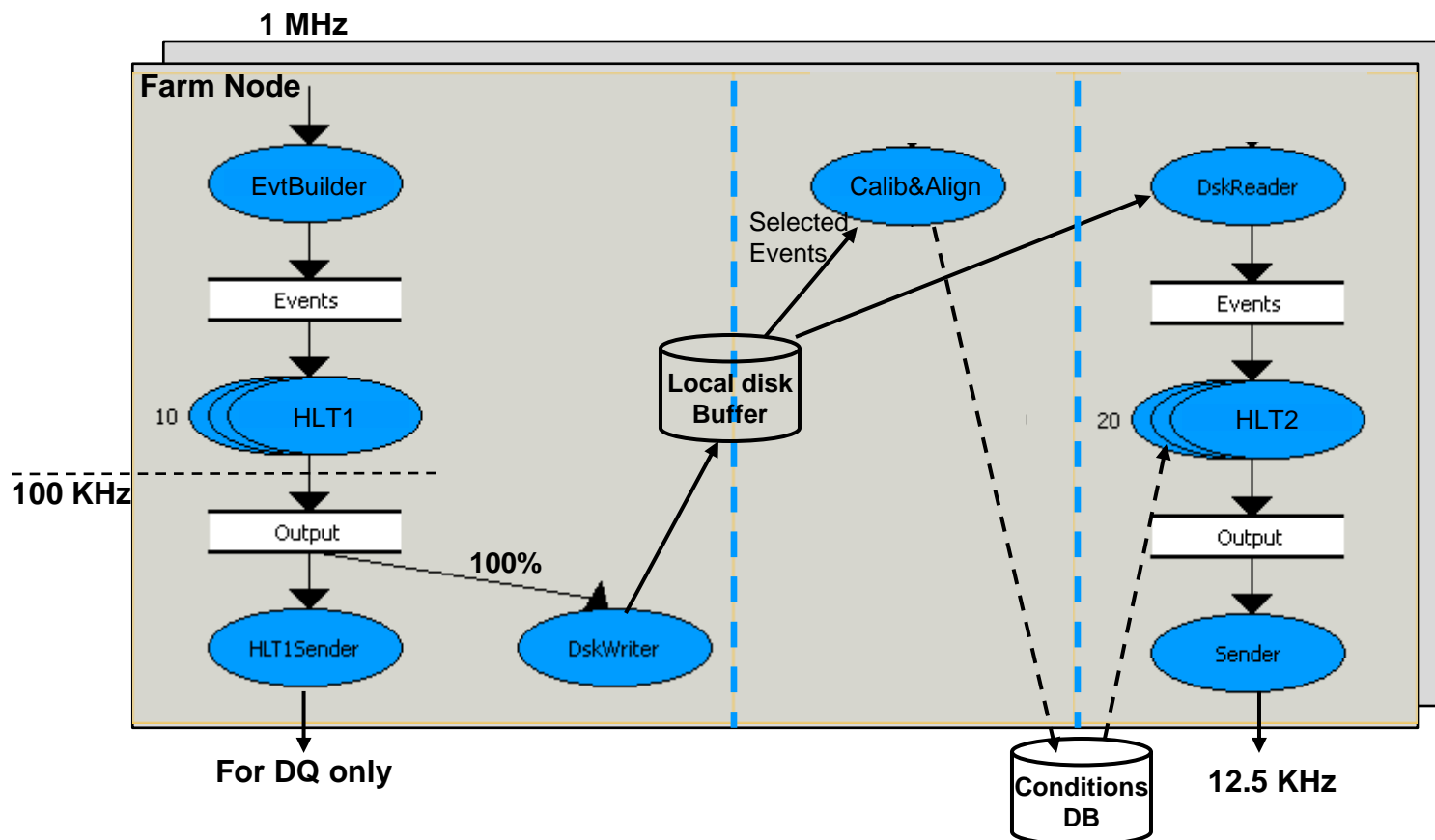


HLT Farm Usage in RUN II



■ Even better Resource Optimization -> Split HLT

- Idea: Buffer ALL data to disk after HLT1 / Perform Calibration & Alignment / Run HLT2 permanently in background



Clara Gaspar on behalf of the LHCb Collaboration, August 2014

■ LHCb Operations very successful

■ The strategy was good

- One operator is enough
- Integration & Homogeneity
 - Allows complex feedback mechanisms
 - Ex.: Re-synch or Reset a Sub-detector from Data Monitoring information
- Automated Operations
 - Saves time and avoids mistakes
 - But requires experience and learning...
- Further improve HLT Farm usage
 - Better Trigger and Online processing closer to Offline

■ Related talks:

- LHCb Run I Performance: Giacomo Graziani, Monday morning
- LHCb Run II Challenges: Karol Hennessy, Friday afternoon
- LHCb Upgrades: Olaf Steinkamp, Friday afternoon

