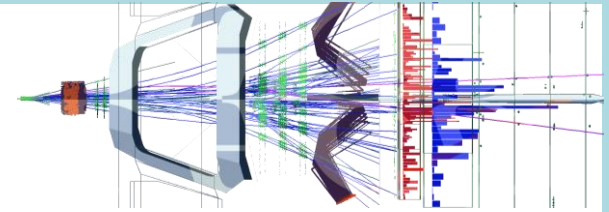


Simultaneous usage of the LHCb HLT farm for Online and Offline processing workflows

J. Closier, C.Haen, L. Granado Cardoso (CERN)

CHEP July 2018

On behalf of the LHCb collaboration

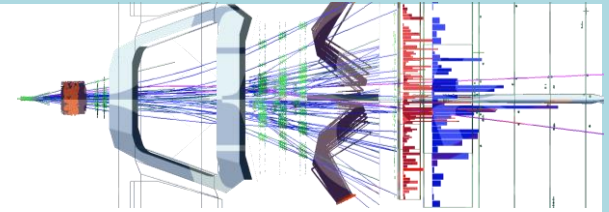


Introduction

LHCb is one of the 4 LHC experiments and continues to revolutionize data acquisition and analysis techniques.

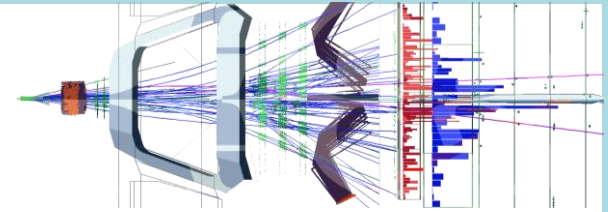
Concepts of “online” and “offline” analysis unified:

- calibration and alignment take place automatically in real time and are used in the triggering process such that Online data are immediately available offline for physics analysis (Turbo analysis),
 - (see talk from C. Bur : [LHCb full-detector real-time alignment and calibration: latest developments and perspectives](#))
- HLT farm used simultaneously for different workflows
 - synchronous first level trigger
 - asynchronous second level trigger
 - Monte-Carlo simulation

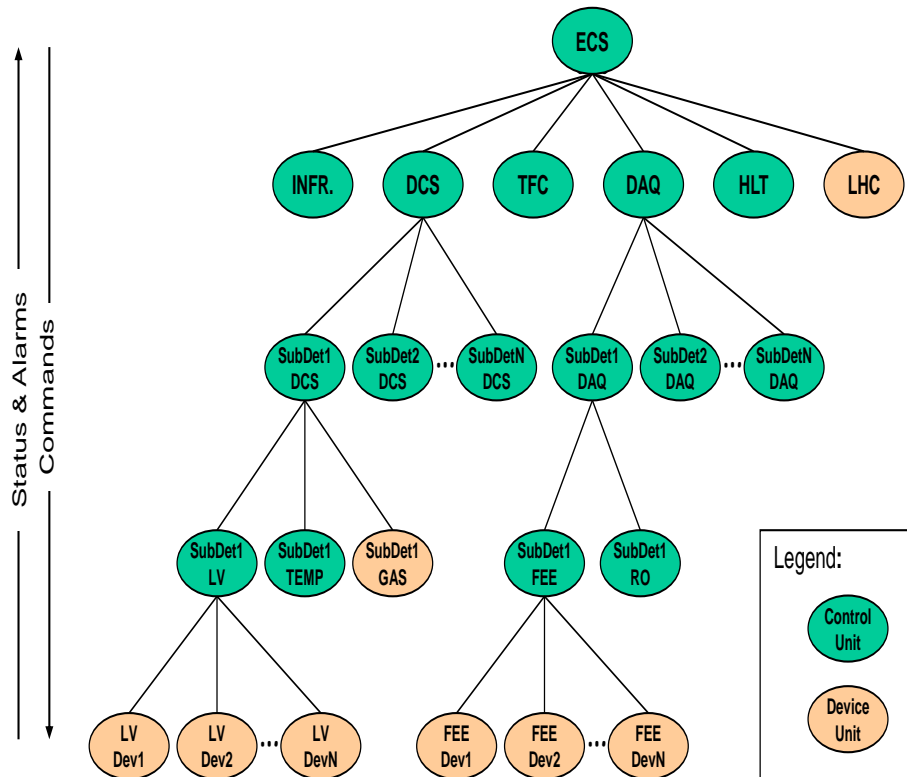


HLTFarm environment

- HLTFarm is composed by ~1500 PCs, distributed over ~60 subfarms.
- These subfarms are logically divided in the Control System and each subfarm row is composed with 24 or 28 or 32 PCs each
- Each of the subfarms is controlled by a controller PC with WinCC OA installed – which manages the HLT tasks on the HLT nodes.
- These controller nodes are also connected to a top level HLT control node, which manages the availability and allocation of the subfarms for the global Experiment Control System (ECS).
- Each HLT node have minimum 24 CPU (Hyper-)Cores and local disk partitioned for various activities

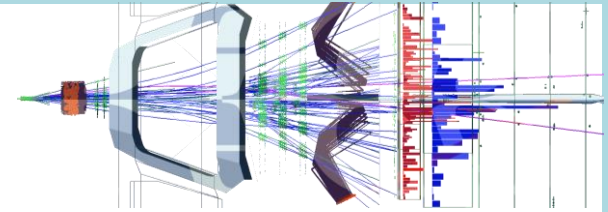


Control System ECS



Control System (ECS) in LHCb is based on the SCADA WinCC OA with custom LHCb developed components.

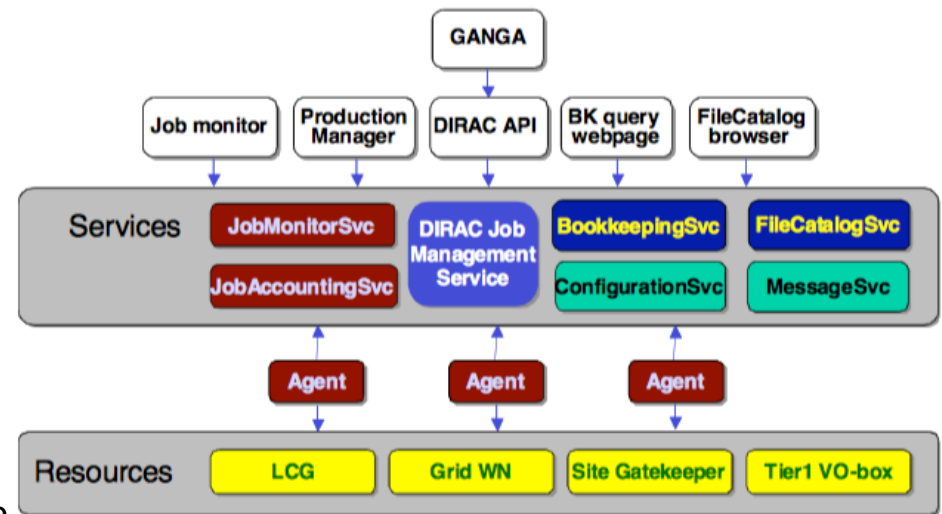
- ECS controls the whole experiment:
 - Front End electronics
 - HLT
 - DAQ
- ECS is able to configure the whole experiment based on the different states of the LHC accelerator
- We wanted to integrate also in ECS the configuration of the production tools for Offline activities (DIRAC)



DIRAC

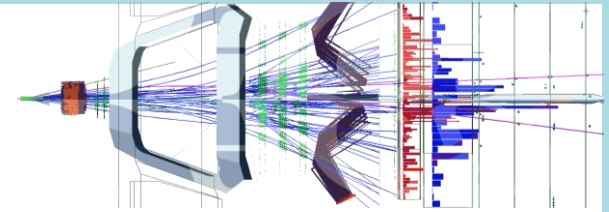
DIRAC Script : task started on each worker node

- sets proper computing environment
- launches the Agent
 - query the DIRAC Workload Management System to check if there is some task to be executed.
- If the Agent gets a job
 - execution in the local disk where the input data, if any, will be downloaded and the output will be written.
 - At the end of the task, the output(s) will be uploaded to the Storage located in the Computer Center.
- During the execution of the task, information sent to DIRAC monitoring to follow the progress of the job.



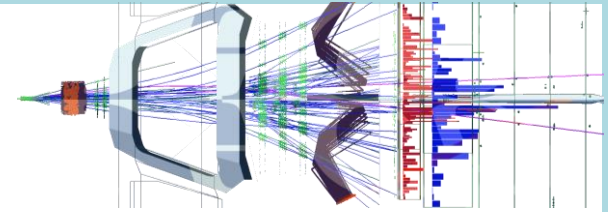
❖ Standard DIRAC job submission cycle





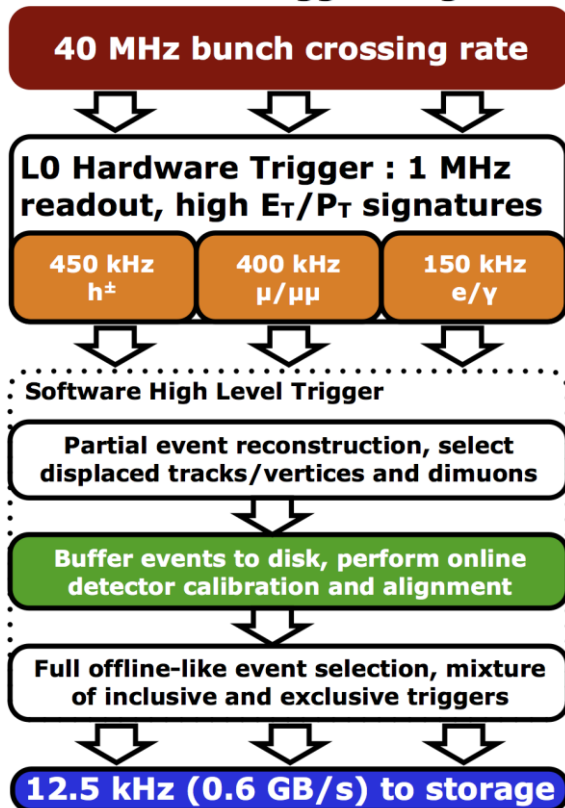
LHCb software environment

- LHCb is using CVMFS to distribute all the LHCb applications
- CVMFS is mounted on all the computer center that are providing computing resources for LHCb
 - Grid centers : T1, T2
 - HLTfarm
- The environment in which the LHCb applications is running is also based on CVMFS

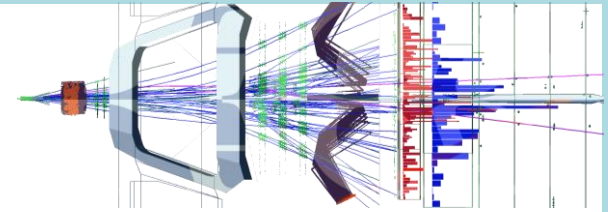


LHCb Workflows used in the HLT Farm

LHCb 2015 Trigger Diagram



- HLT1 runs **synchronously** and reduces rate from 1MHz to about 100kHz
- HLT2 runs **asynchronously** on HLT1 output buffered to disk and reduces rate to about 12kHz
 - HLT is completely software based and runs on a dedicated computer farm with ~1500 PCs totalling over 50.000 (Hyper) cores.
 - HLT software installed on CVMFS
- Monte-Carlo simulation
 - DIRAC jobs during idle cycle if tasks are available
 - Simulation software install on CVMFS



WinCC OA

HLTE: TOP (ONLDIRAC - ONLDIRAC; #1) (on onldirac01)

System State: HLTE RUNNING

Mon 26-Mar-2012 13:25:06

Agents running on sub-farm nodes

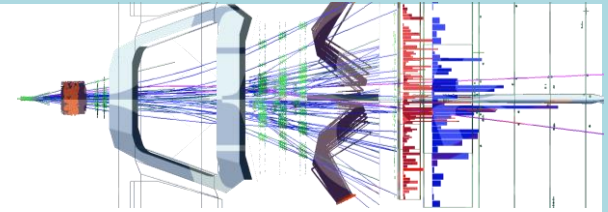
Sub-System	State
HLTE01	NOT_ALLOCATED
HLTE02	RUNNING
HLTE03	RUNNING
HLTE04	RUNNING
HLTE06	NOT_ALLOCATED
HLTE07	NOT_ALLOCATED
HLTE08	NOT_ALLOCATED
HLTE09	NOT_ALLOCATED
HLTE10	NOT_ALLOCATED
HLTE11	NOT_ALLOCATED

FSM Control

Agents monitoring on DIRAC

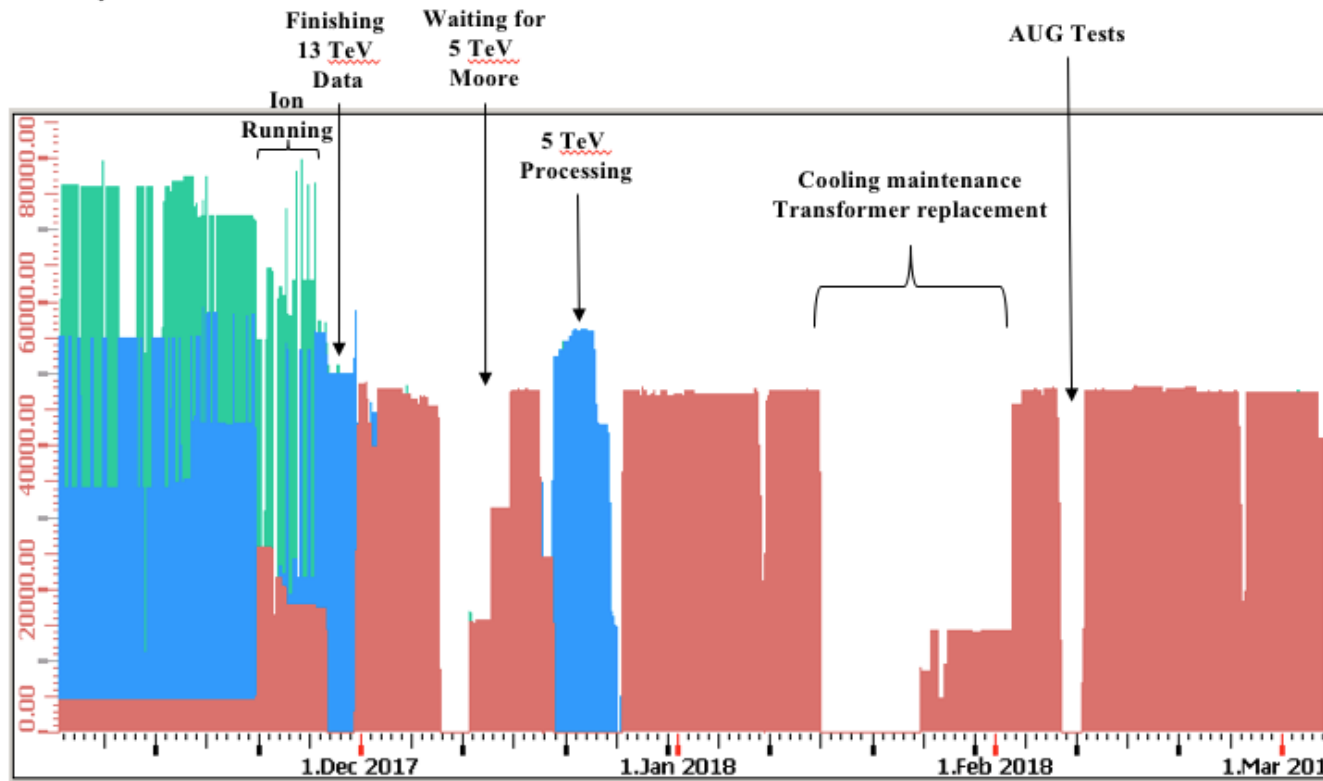
JobId	Status	MinorStatus	ApplicationStatus	Site	JobName	LastUpdate [UTC]	LastSignOffLife	SubmissionTim...	Owner
31131987	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:21	igracion
31131993	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:21	igracion
31131981	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:21	igracion
31131980	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:21	igracion
31131975	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:21	igracion
31131968	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:20	igracion
31131966	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:20	igracion
31131963	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:29	2012-03-26 11:28	2012-03-26 10:20	igracion
31131956	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion
31131955	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:28	2012-03-26 11:28	2012-03-26 10:20	igracion
31131954	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion
31131953	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion
31131951	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion
31131947	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion
31131944	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion
31131934	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion
31131927	Running	Application	Gauss v412 step 1	DIRAC.ONLINE...	00017281_000...	2012-03-26 10:27	2012-03-26 11:27	2012-03-26 10:20	igracion

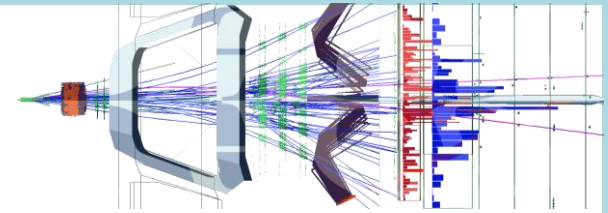
- Each node is independent
 - Settings are individual per machine
- All tasks controlled by WinCC OA on each nodes
 - Possibility to set the exact number of jobs on each machine
 - Possibility to set automatically the number of jobs depending on the machine CPU
 - In case of automatic configuration, the number of cores to be left unused (for DIRAC) can be set
- No need to change the settings of the node to switch between task
- Can easily utilize just a part of the farm (in case some is needed for data taking/tests)



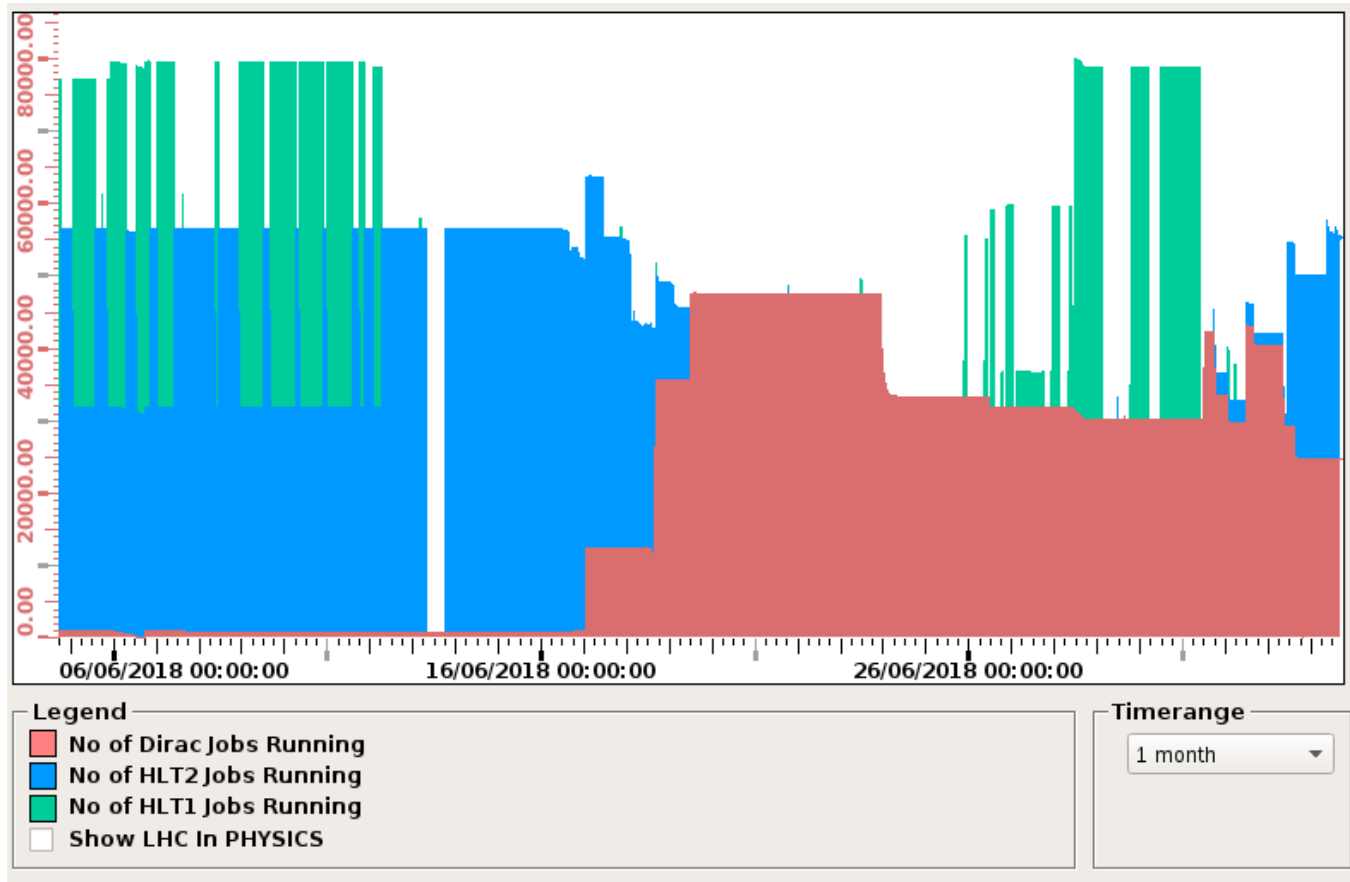
Activities during Christmas shutdown

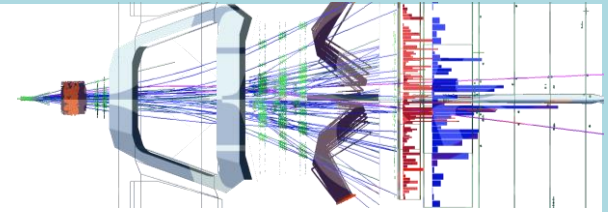
- Mostly trying to run as much Monte-Carlo production as possible as possible





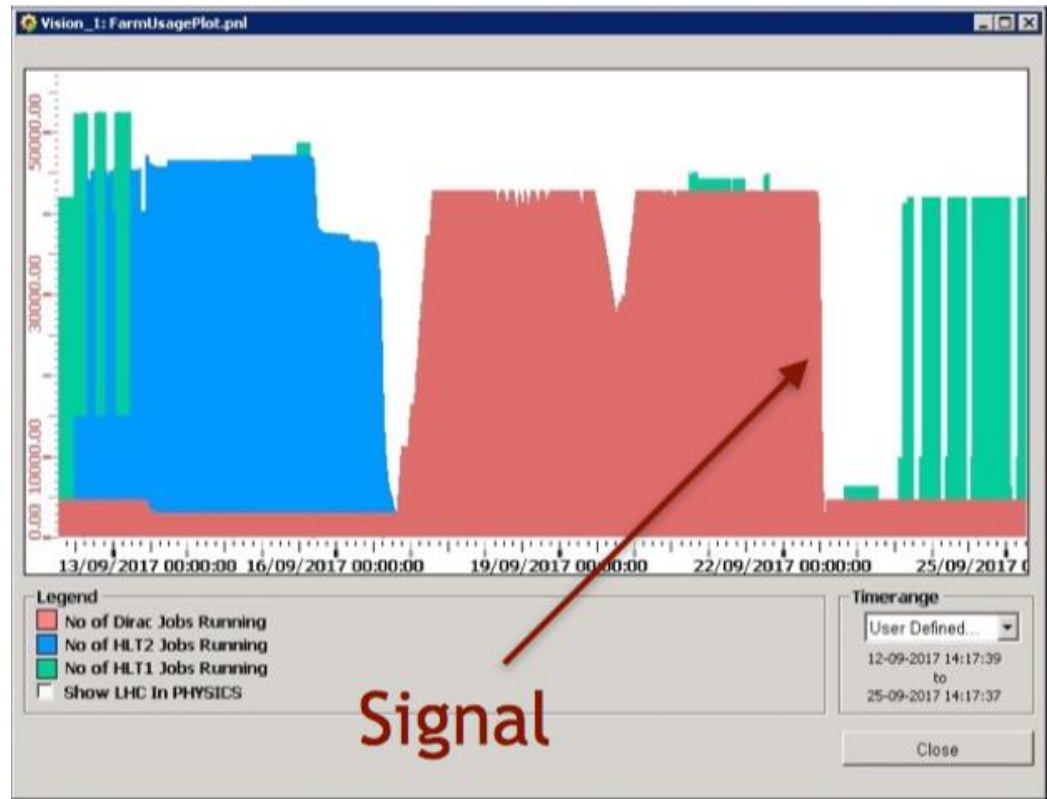
Activities during data taking startup



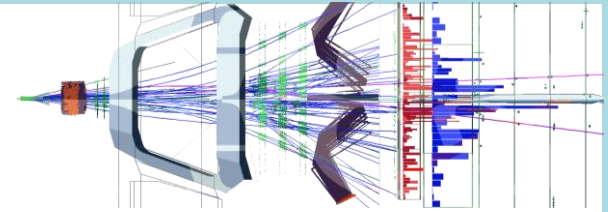


Switching HLT Farm configuration

In 2017 the HLT team added the ability to use the LHCb application signal handling to interrupt running Monte Carlo jobs cleanly from the WINCC OA when HLT jobs slots are needed again



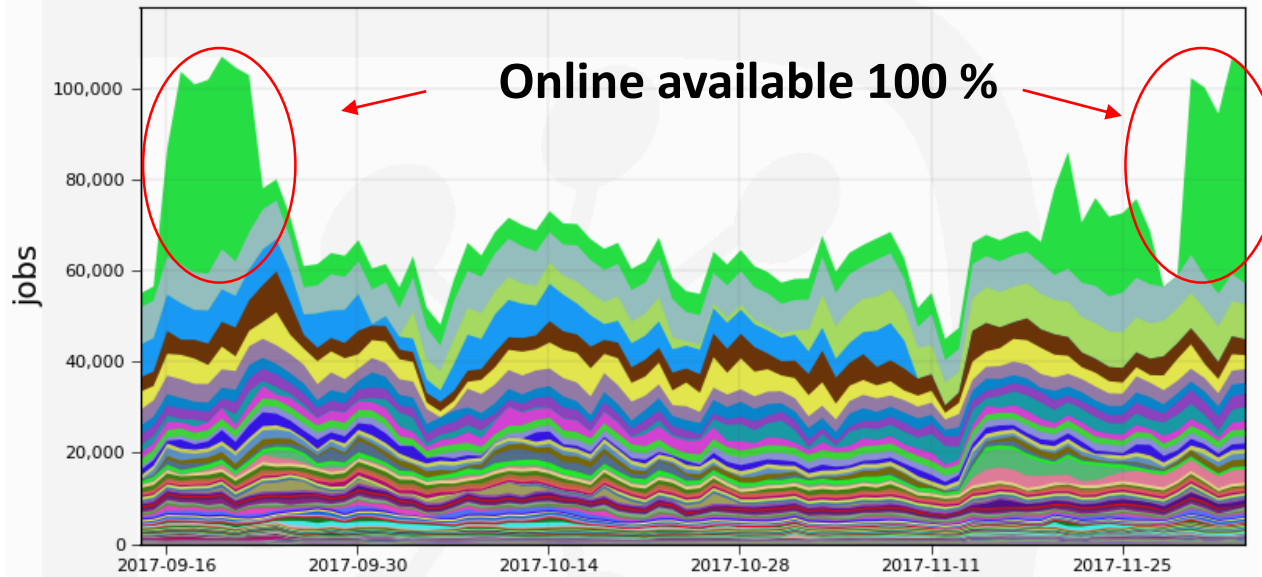
See Talk from A. McNab
Interruptible LHCb Monte Carlo jobs
Track 3 Tuesday



HLTFarm usage during 11 weeks

Jobs by Site

11 Weeks from Week 37 of 2017 to Week 49 of 2017

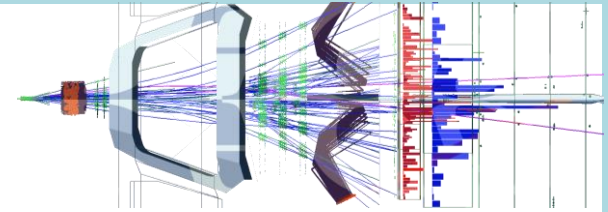


Online available 100 %

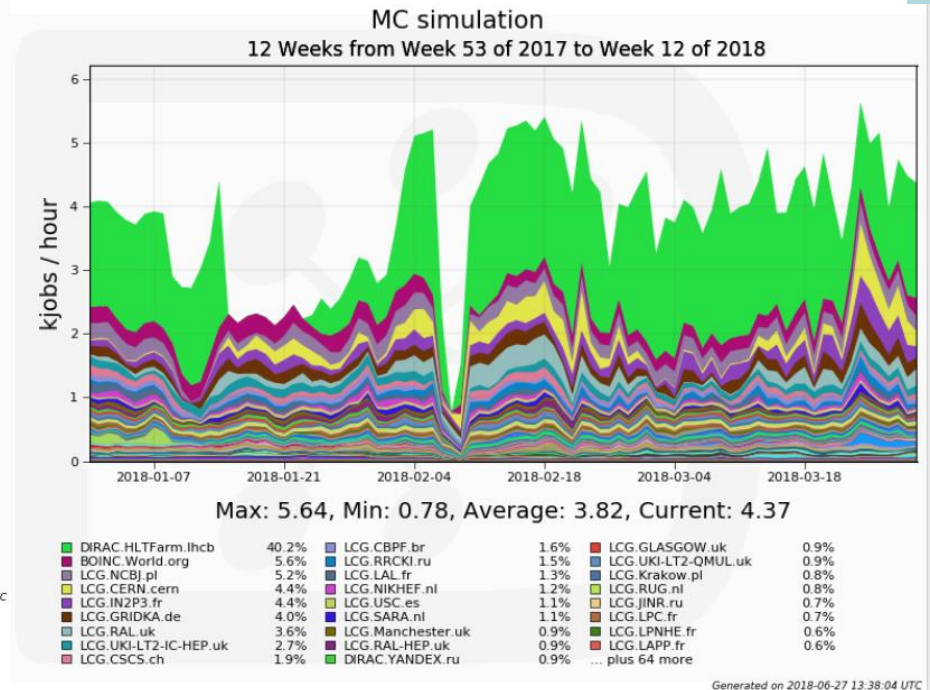
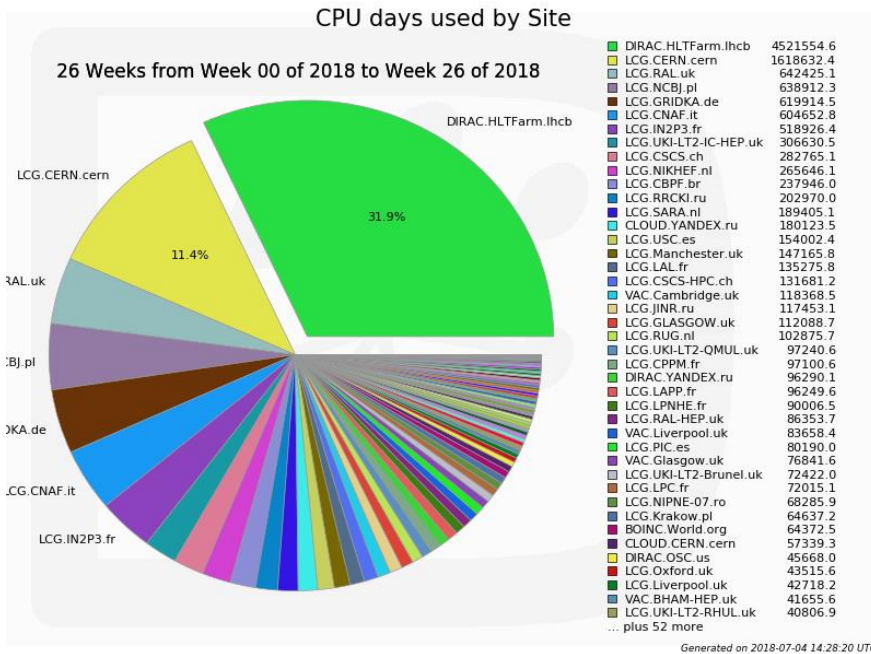
Max: 107,101, Min: 45,045, Average: 69,691, Current: 104,691

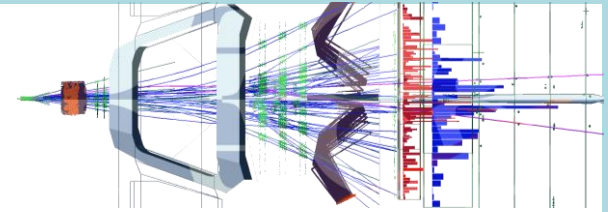
DIRAC.HLTFarm.lhcb	15.8%	LCG.UKI-LT2-IC-HEP.uk	2.6%	LCG.PIC.es	1.1%
LCG.RAL.uk	10.5%	LCG.NIKHEF.nl	2.5%	LCG.DESYHH.de	1.1%
LCG.Oracle.cern	6.1%	DIRAC.YANDEX.ru	2.2%	LCG.CSCS.ch	1.1%
LCG.CNAF.it	5.9%	LCG.CBPF.br	1.8%	LCG.JINR.ru	1.0%
LCG.GRIDKA.de	5.8%	LCG.SARA.nl	1.7%	LCG.LPNHE.fr	1.0%
LCG.CERN.cern	5.8%	LCG.USC.es	1.3%	LCG.LPC.fr	0.8%
LCG.NCBJ.pl	4.6%	LCG.UKI-LT2-QMUL.uk	1.2%	LCG.LAPP.fr	0.7%
LCG.RRCKI.ru	3.2%	LCG.Manchester.uk	1.2%	BOINC.World.org	0.7%
LCG.IN2P3.fr	2.9%	LCG.LAL.fr	1.2%	... plus 68 more	

Generated on 2017-12-04 09:03:38 UTC

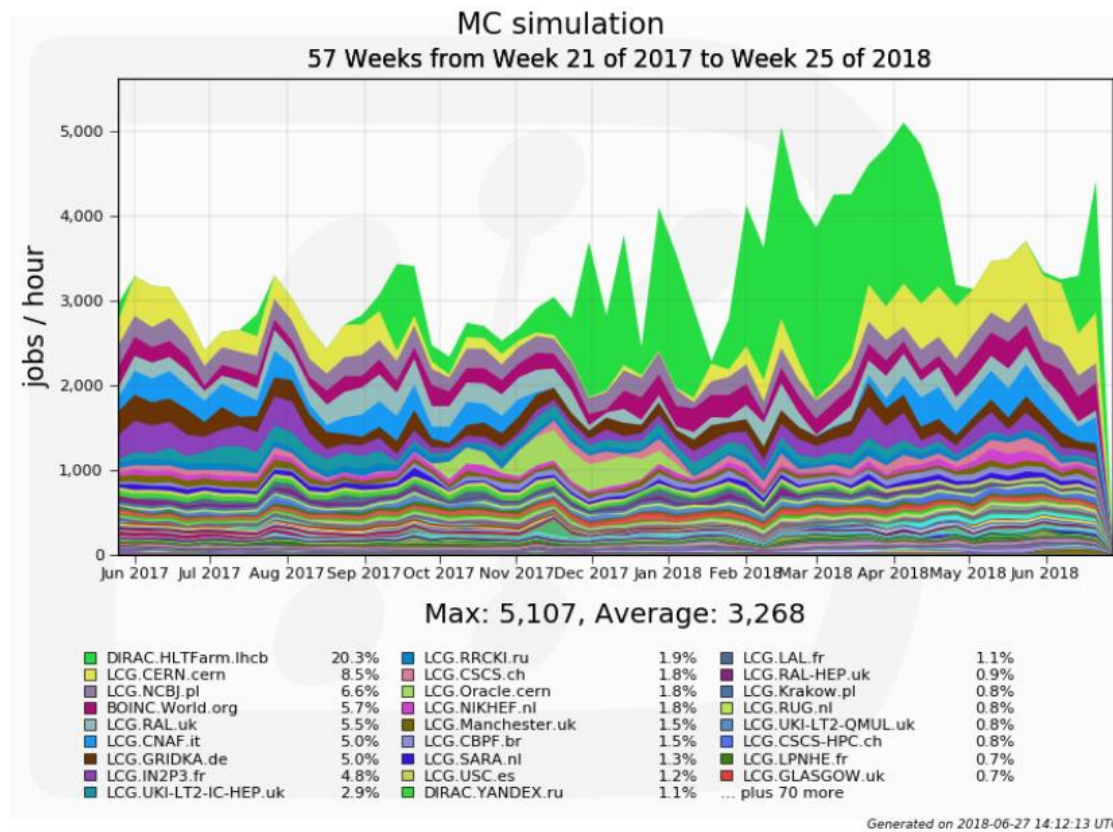


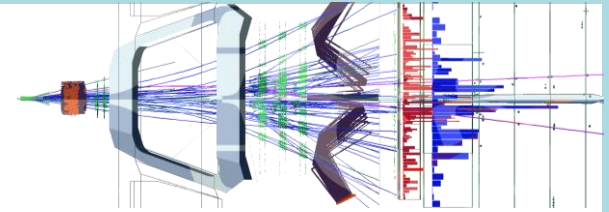
HLTFarm provides more CPU to LHCb than biggest T1





Monte Carlo production during one year





Conclusion

- Simultaneous usage is possible due to the fact :
 - Same environment for data taking and Monte Carlo
 - Same handling of the LHCb software with CVMFS
 - Fine grain configuration with WinCC OA to handle the nodes
- It has been running successfully for a while now
- It maximizes the HLT Farm usage
- HLT Farm is now only idle when there's some maintenance operations needed
- 20% of 10 Billion events of Monte Carlo have been simulated on the HLT Farm over the last year