The CMS Iberian Computing Sites performance in the advent of the LHC era

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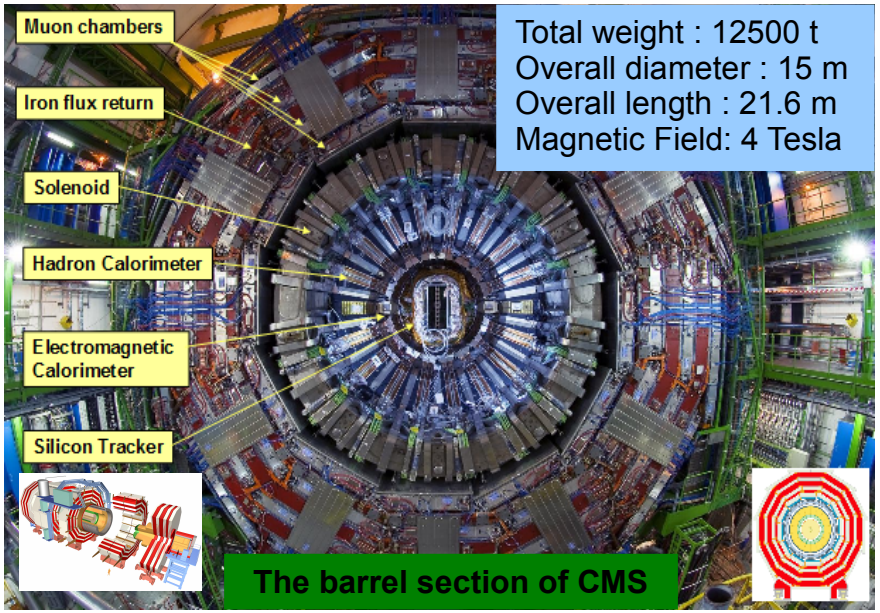
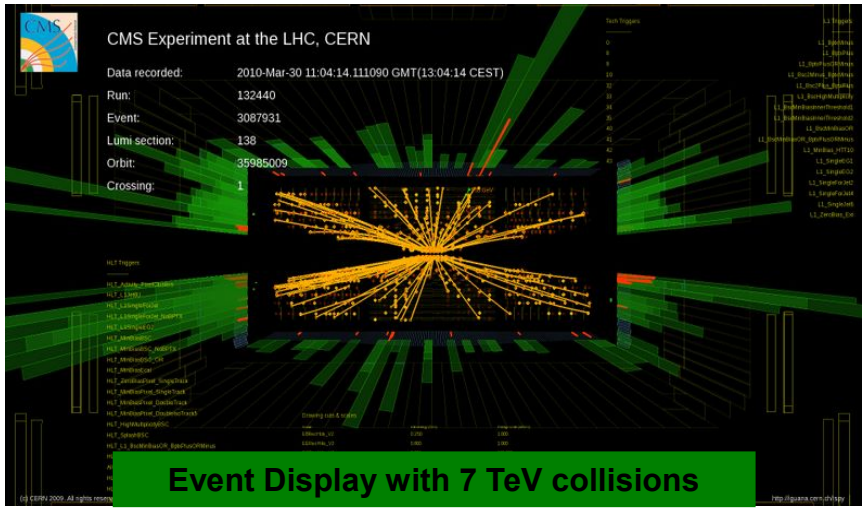
The CMS Experiment



The barrel section of CMS



Event Display with 7 TeV collisions

Compact Muon Solenoid(CMS)

- Generic purpose experiment of the **LHC** located near the French-Switzerland border in **CERN -** Geneva.

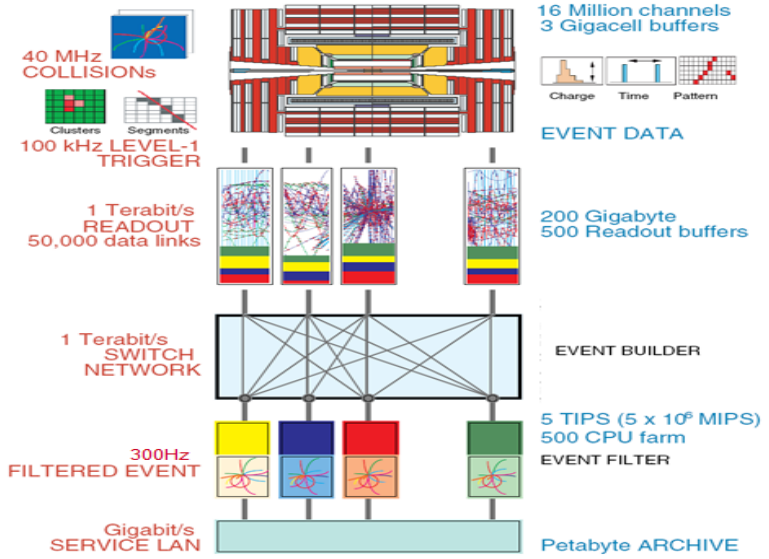
- Aims the **study of most fundamental properties of matter**, including the search for the Higgs boson, particles that could make up dark matter, extra dimensions,...

- The LHC set a world record for beam energy in particle colliders on **29 November 2009**, by accelerating **proton beams,** to energies of 1.18 TeV (**2.36 TeV collisions**) .

- Since **30 March 2010** CMS is collecting data with **7 TeV collisions**.

- First CMS paper with LHC data on February 2010.
"Transverse momentum and pseudorapidity distributions of charged hadrons in pp collisions at sqrt(s) = 0.9 and 2.36 TeV", 10.1007/JHEP02(2010)041

Computing at LHC era



The CMS Data acquisition

- 40 MHz proton bunch crossing.
- 10^9 collisions/s at design luminosity(10^{34} $cm^{-2}s^{-1}$).
- Events stored at : 100-450 Hz (after HLT)
- Event size : ~ 1.5 MB

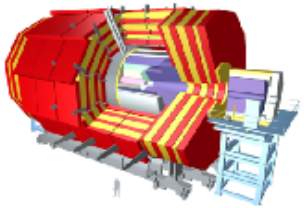
LHC will produce each year about **15 Petabytes** !
(raw data, processed data, simulated data, …)

Worldwide LHC Computing Grid (WLCG)

- Provides the computing infrastructure needed for LHC.
- Combines 170 computing centers in 34 countries.
- > 100 000 CPUs available for simulation and analysis.
- Supports a community of 8000 researchers.

The CMS Computing Model

1 Tier-0 at CERN:
Data Acquisition & Initial processing
Long-term mass data storage
Data distribution to Tier-1s



10 Gbps

CERN

7 Tier-1s :
Custodial mass storage
Data reconstruction and reprocessing
Skimming and data distribution to Tier-2s

10 Gbps LHC OPN

ASGC — Taiwan
RAL — UK
CNAF — Italy
PIC — Spain
IN2P3 — France
FNAL — US
FZK — Germany

1-10 Gbps NREN

CIEMAT — Madrid
IFCA — Santander
NCG — Lisbon
LIP — Lisbon

SWE Region

50 Tier-2s :
End user analysis
Monte Carlo Simulation

The CMS Iberian Site Resouces

SITES(*)	CPU[kHS06] (**)	Disk [TB]	Tape[TB]
PIC Tier-1	4.23	728	1266
CIEMAT Tier-2	6.00	240	-
LIP Tier-2	0.47	75	-
NCG Tier-2	2.73	125	-

Iberian CMS resources (Tier-1 and Tier-2) deployed as in March 2010

Spain provides

- 1 Tier-1 center located in **PIC-Barcelona** (~5% of the CMS Tier-1s).
- 1 federation of 2 Tier-2 centers: **CIEMAT-Madrid** and **IFCA-Santander** (~5% of the CMS Tier-2s).

Portugal provides :

- 1 federation of 2 centers: **LIP-Lisbon** and **NCG-Lisbon** (nominal Tier-2 : 200 TB, ~ 3.2 kHS06).

(*) Sites that present data to this conference

(**) HEP-SPEC06 : https://twiki.cern.ch/twiki/bin/view/FIOgroup/TsiBenchHEPSPEC
1kHS06 ~ 350 dual quad Intel Xeon E5472 CPUs

Site Readiness Evaluation

- **Site Readiness** used as a guide to mark sites as **good** or **bad** for running computing activities.

In CMS Site Readiness takes into account several sources of information :

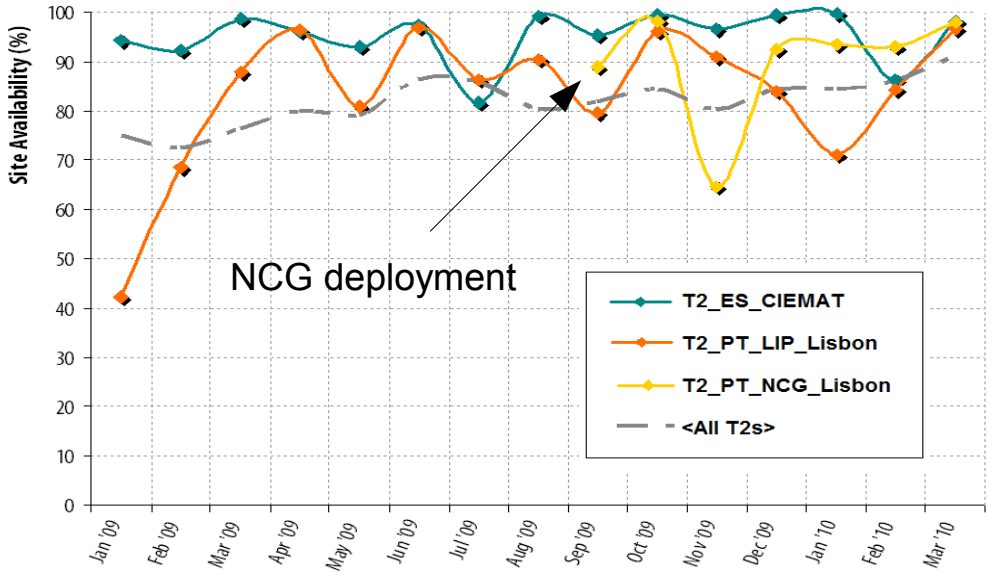
- **S**ite **A**vailability **M**onitoring (**SAM**) custom tests
- Job Robot Load Generator success rate
- Number of operational network links with other sites
- Data transfer quality (down/up links)
- Schedule downtime information

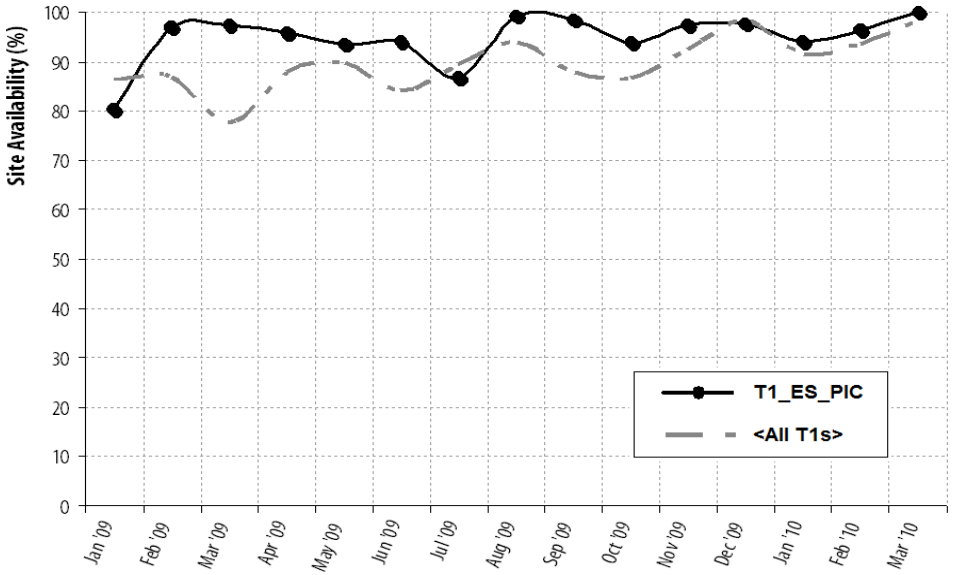
- **Sites will be chosen for operations above a certain threshold** on Site Readiness %15-days (placed at **90% for Tier-1** and **80% for Tier-2** sites).

SAM Tests

- **S**ite **A**vailability **M**onitoring (**SAM**) **tests run once per hour** on all **C**omputing **E**lement (**CE**) and **S**torage **R**esource **M**anager (**SRM**) instances accessible by CMS and allow to test :
  - If it is possible to send and run jobs;
  - The CMS software is correctly installed and configured;
  - It is possible to access local data;
  - It is possible to copy data into /out from the local storage.

Site availability : fraction of time where at least one instance of each relevant Grid service type (CE and SRM) is available (passed all tests).





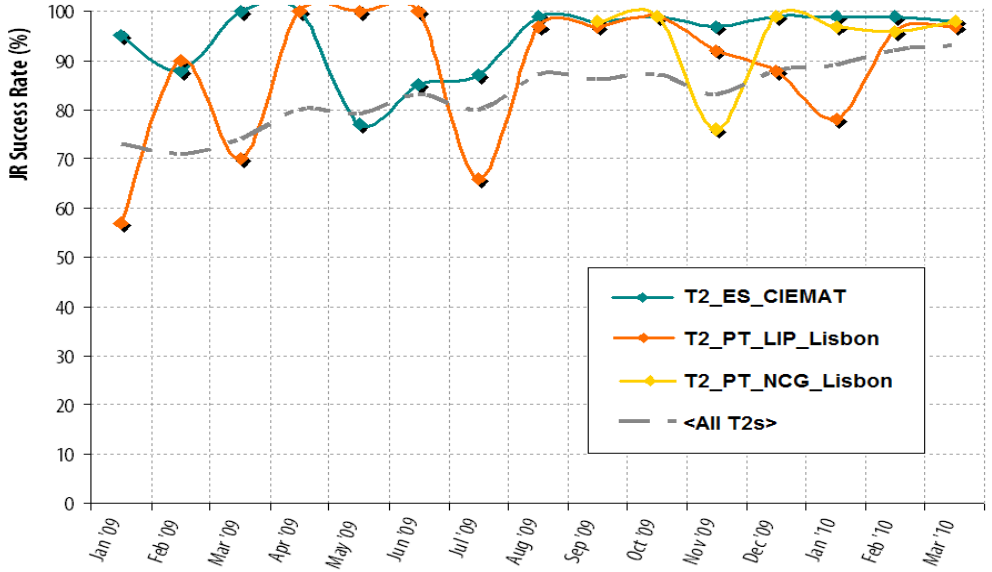
- In general Iberian sites show an **higher availability** than the CMS averages.

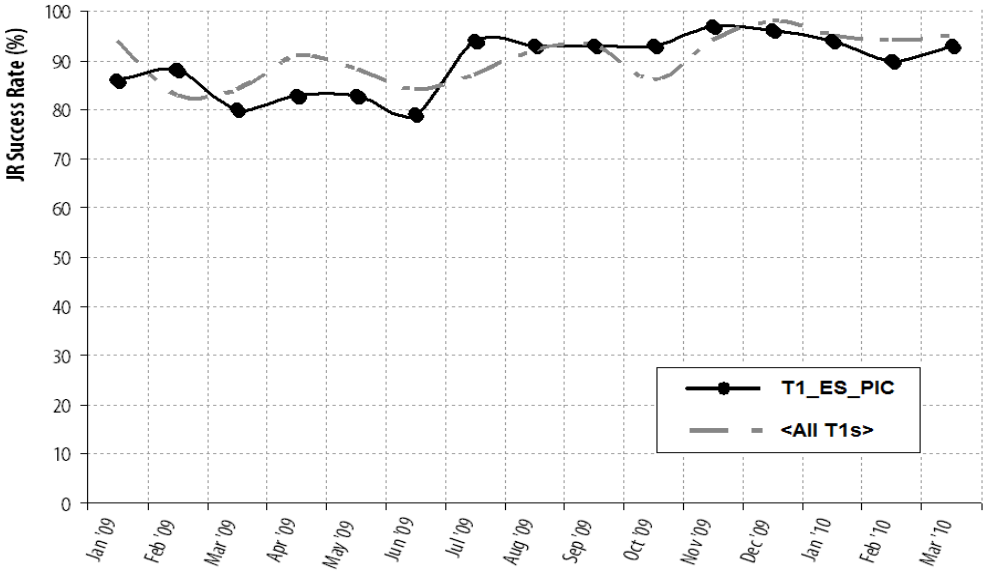
Job Robot Load Generator

- **Job Robot is an automated system** to automatically submit and manage fake analysis jobs using the CMS **R**emote **A**nalysis **B**uilder (CRAB).

- Commissioning tool to test if a site is capable to run the CMS workflow at the required scale.

- Around **600 daily jobs** are submitted per site and success job rate used as an indication of the fact that the site is working well or not.





- In general Iberian Tier-2 sites show an **higher job success rate** than the other CMS Tier-2 sites, while PIC shows a similar performance as the other CMS Tier-1s.

Network Link Commissioning

• In 2007 the **D**ebugging **D**ata **T**ransfers (**DDT**) task force was created to design and enforce a procedure to test and debug down/up links between sites.

A traffic generator is used to test the links and considers a link to be commissioned when :

- For links with source at Tier-0/Tier-1 sites : **20 MB/s** transfer rate **averaged over 24 hours**
- For links with source at Tier-2 sites : **5 MB/s** transfer rate **averaged over 24 hours**

• PIC has commissioned import/export links with Tier-0, all Tier-1s, is capable to import data from 40 Tier-2s and export to 48 Tier-2 sites.

• CIEMAT, LIP and NCG have commissioned links from all Tier-1s(implying they can get the data promptly) and to the majority of links to Tier-1s (used for MC production transfers).

Data Quality Transfers

- Active links in CMS (**~700 links**) probed with low rate transfers at 0.5 MB/s.
- Continuous tests allow to detect systematic problems, not only at the network level, but also in the data transfer services and the storage infrastructure.

Transfer quality since beginning 2009

Sites	Downlinks (%)	Uplinks %
PIC	75	70
<CMS Tier-1s>	60	70
CIEMAT	85	82
LIP	75	50
NCG	72	82
<CMS Tier-2s >	55	55

Monthly average cumulative (production+debug) transfers (in/out)

Sites	transfer[TB/month]
PIC	300
CIEMAT	45
LIP	25
NCG	20

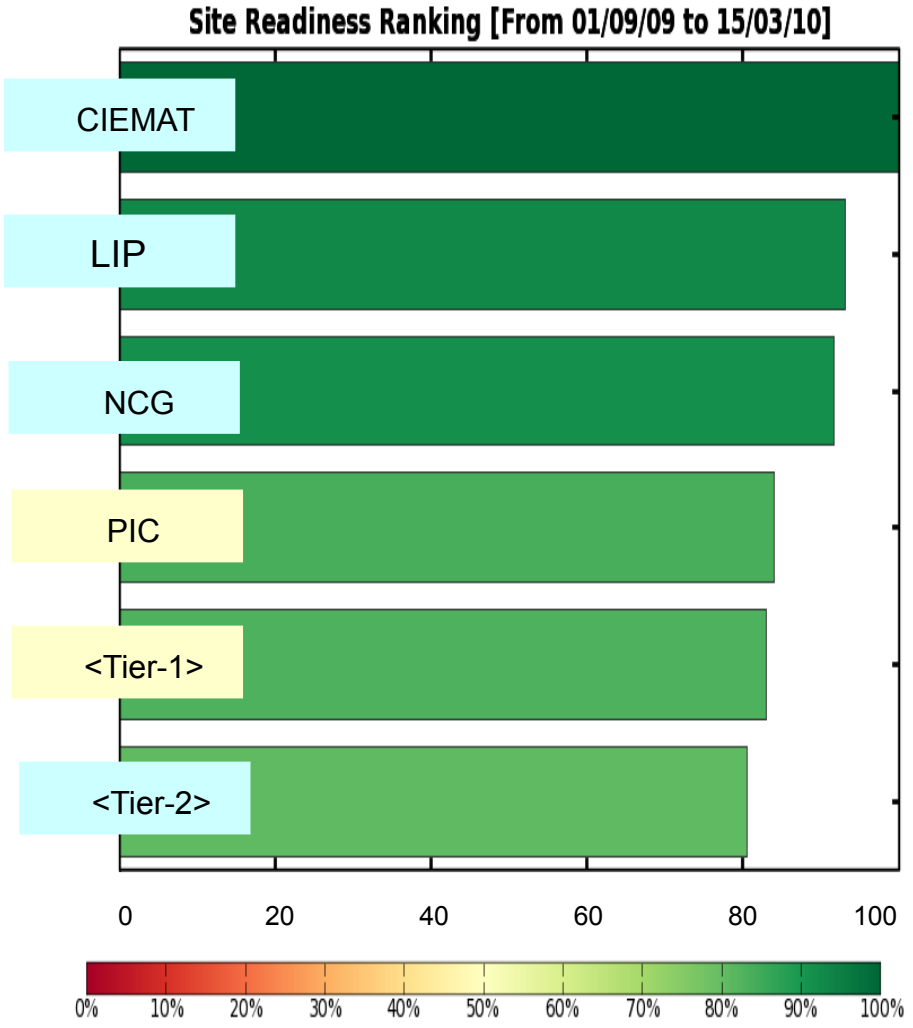
Site Readiness status

A site is Ok if :

Test	Tier-1 sites	Tier-2 sites
Daily SAM availability	≥ 90%	≥ 80%
Daily Job Robot success rate	≥ 90%	≥80%
Commissioned link from Tier-0	1	-
Commissioned links to Tier-2s	≥20	-
Commissioned links to Tier-1	≥4	≥2
Commissioned links from Tier-1	≥4	
Data transfer quality	> half of links with > 50 %	

Readiness transition rules :

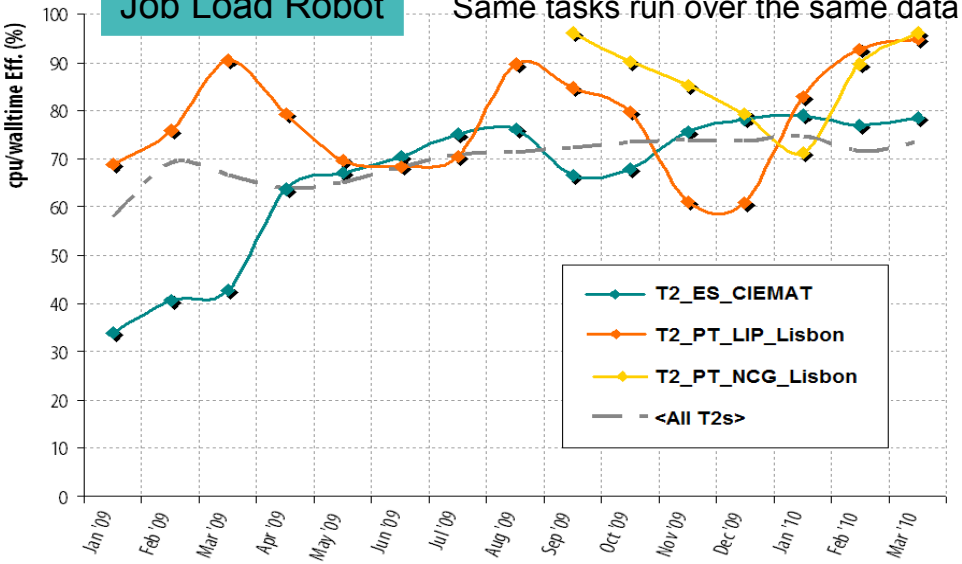
From/to	Not Ready(NR)	Ready(R)	Warning(W)
NR	-	Ok for last 2 days	-
R	Err for > 2 days	-	Err but not Err for >2 days
W	Err for >2days	Ok and not Err for > 2 days	-



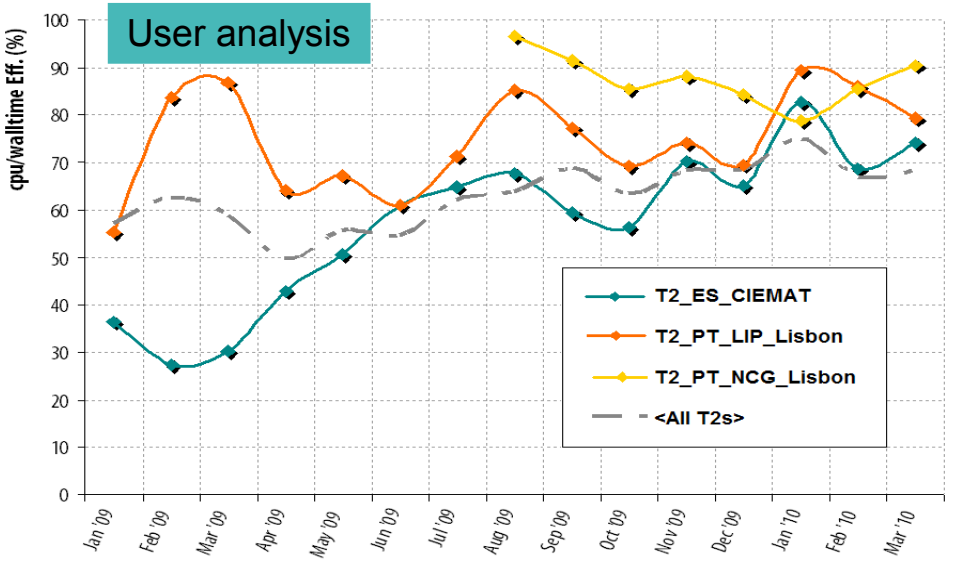
CPU efficiencies

Job Load Robot

Same tasks run over the same data and using same CMSSW releases



User analysis



- CPU efficiencies shown for **Job Load Robot jobs**(perform the same analysis tasks) and **user analysis jobs**.

CPU efficiencies affected by :

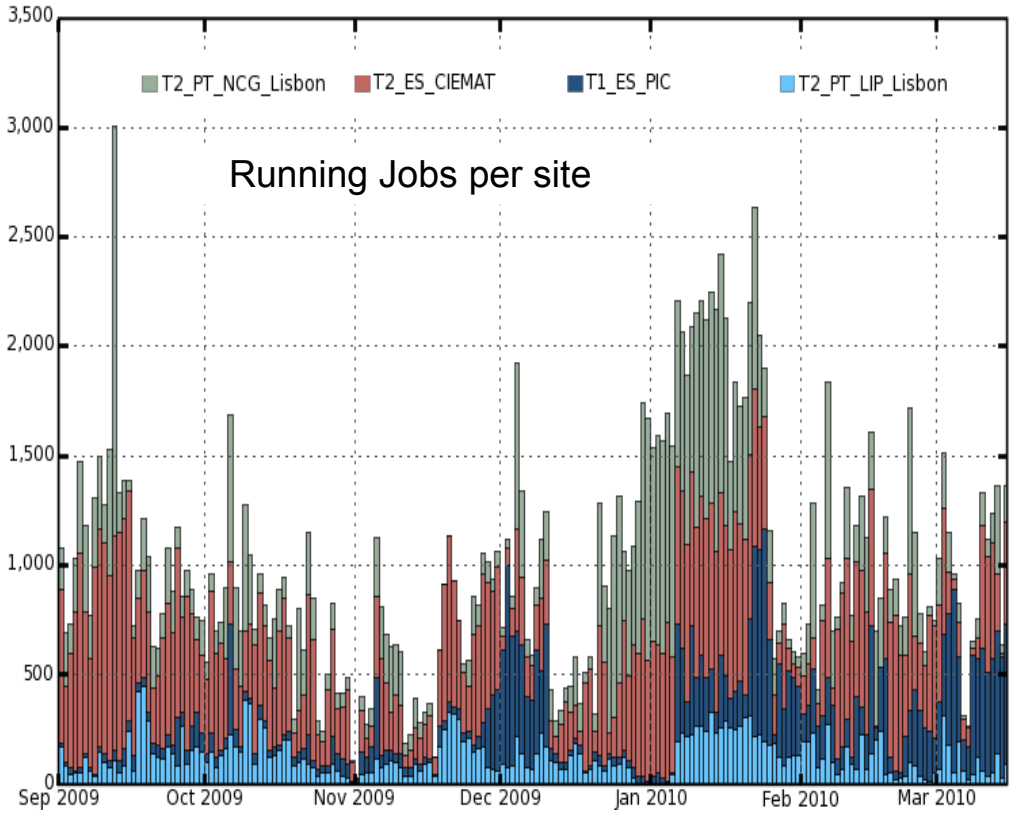
- Different CMS analysis soft. releases
- Load on site Storage Elements

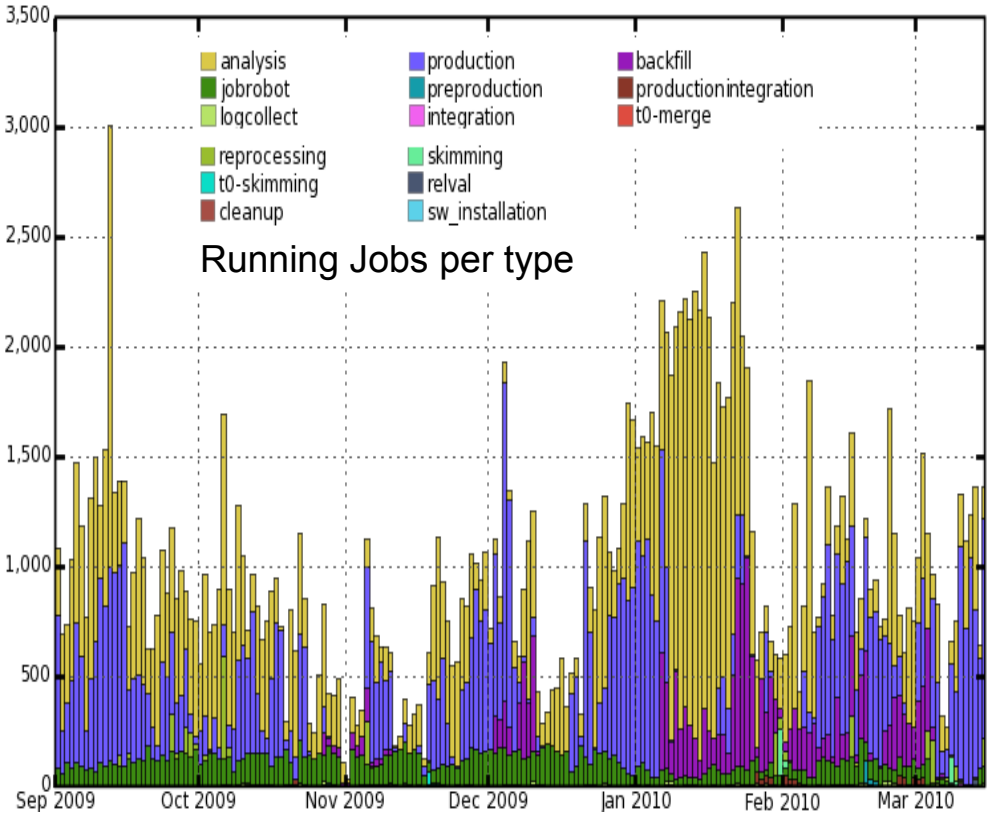
- Evolution of CPU efficiency has been positive

CPU efficiencies since beginning 2010 :

- CIEMAT ~ 78%
- NCG ~ 86%
- LIP ~ 89%
- <CMS Tier-2> ~ 74%

Site Usage





- **Analysis and production** activities dominate in CIEMAT, NCG and LIP Tier-2, while in PIC Tier-1 activity is dominated by **backfill jobs**.

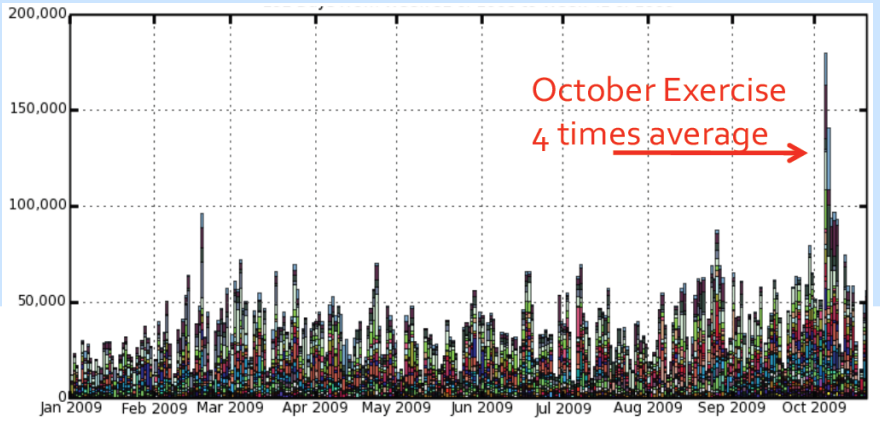
- The Tier-2 sites have been used actively : CIEMAT run cumulatively close to 106 kjobs/month, while LIP+NCG run close to 68 kjobs/month, these values can be compared with the average of 50 kjobs/month that run on the CMS Tier-2s.

CMS Computing Exercises

- CMS undertakes periodic computing challenges of increasing scale and complexity to test its computing model and the Grid infrastructure

- **STEP 09 exercise** (2 weeks in September)
- Multi VO exercise in the context of WLCG.
- Focused on testing VO overlaps in the system.
- PIC results were among the best of CMS Tier-1s :
  - Data recall from tape at 3 x target (150 MB/s).
  - Data replication with Tier-1s sustained at 400 MB/s.
  - Data transfers to up to 52 Tier-2 centers sustained at 200 MB/s.

- **OCT 09 exercise** (2 weeks in October)
- Analysis exercise at full scale
- Close to one million analysis jobs submitted to the different CMS Tier-2s
- Iberian region contributed with close to 10%



Conclusions

• CMS Iberian Computing sites have been continuously monitored, **showing a stability and readiness status among the best of CMS.**

• The Iberian sites have proven to operate with **high computing efficiencies**.

• Sites demonstrate a **good network connectivity** with **high data transfer throughput and quality** on both download and upload streams.

• The participation on the 2009 computing exercises was positive and major goals fulfilled.

• LHC data is being collected and **workflows responding positively,** focus now is to keep reliability/stability on ES+PT and continue improving performance on the whole CMS sites.