



Analysis in CMS

Andrea Sartirana

LLR, École Polytechnique, Palaiseau.



Intro

CMS Computing Model

- Designed to fulfill the requirements for **storage, processing and analysis of data** produced by CMS experiment
 - ✗ rely on a *distributed infrastructure* of Grid resources, services and toolkits whose building blocks are provided by **Worldwide LHC Computing Grid** [WLCG]
 - ✦ WLCG : Computing resources available for LHC experiments. Different MiddleWare implementations: EGEE, NorduGrid, OSG, etc;
 - ✗ the **CMS VO** should provide the **application layer**
 - ✦ Data Bookkeeping and Location, Data Transfer and Placement, Distributed Analysis and Production Tools, etc.;
 - ✗ resources are organized in a **tier-ed hierarchical structure**
 - ✦ T0 at CERN, 7 national level T1's, 51 regional level T2's (~50 local T3's).
- **References :**
 - CMS computing model document (CERN-LHCC-2004-035)
 - ❖ http://www.gridpp.ac.uk/eb/ComputingModels/cms_computing_model.pdf;
 - CMS C-TDR released (CERN-LHCC-2005-023)
 - ❖ <http://doc.cern.ch/archive/electronic/cern/preprints/lhcc/public/lhcc-2005-023.pdf>.



Intro

Analysis at T2/T3's

- In CMS Computing Model **Tier-2's** are the **official resources** for **organized Analysis**
 - ✗ **40% of comp. power** to support analysis (50% to MC)
 - ✗ **100TB** centrally managed (**Analysis Operation**)
 - ✦ primary datasets/skims, **global interest** MonteCarlo samples;
 - ✗ **70TB for each** supported analysis **group**
 - ✦ importing from T1's and other T2's **data** relevant **for analysis**;
 - ✦ **skims and private productions**;
 - ✗ **~1.5TB** for **each supported user** (~40);
 - ✗ **10% of comp. power** and **75TB** for **local community**.

- Tier-3's are **private resources** for the **local communities** (54 official sites)
 - ✗ they are not **part of the Computing Model**
 - ✦ **no duties or requirements**;
 - ✗ may be **embedded in Tier-2's** ...
 - ✦ **dedicated resources**: clusters, storage, etc.;
 - ✗ ...or real, **standalone**, computing centers
 - ✦ they can be **fully embedded** in the Computing System.



Intro FR Tier-2's and Tier-3's

CC-Lyon

T2_FR_CCIN2P3

- 296TB disk ;
- 1176 kSI2k (567 slots).

T3_FR_IPNL

- 100TB disk ;
- 616 slots.

Strasbourg

T2_FR_IPHC

- 300TB disk ;
- 1675 kSI2k (800 slots).

GRIF

T2_FR_GRIF_LL2

- 171 TB disk ;
- 907 kSI2k (362 slots).

T2_FR_GRIF_IRFU

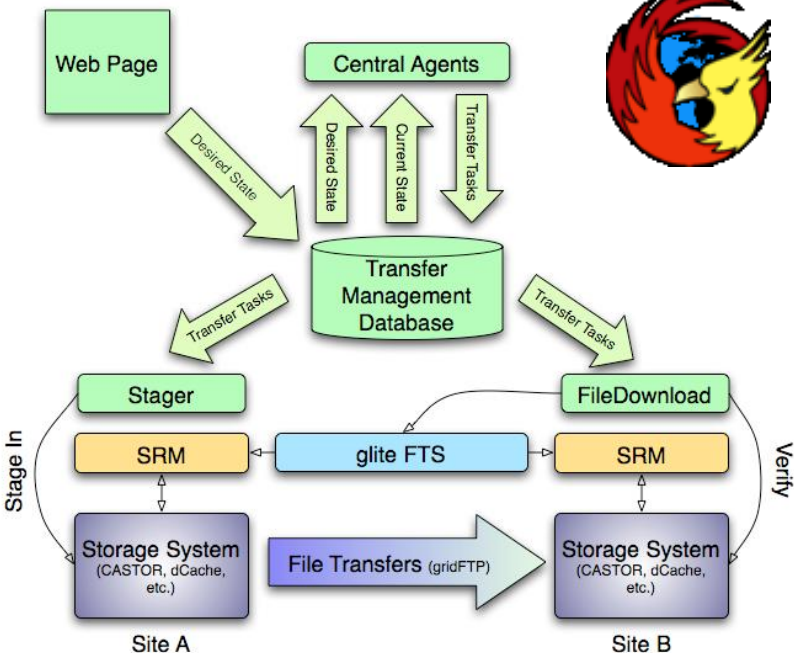
- 171 TB disk ;
- 907 kSI2k (362 slots).

- ❖ T2's data: CMS pledges from SiteDB;
- ❖ IPNL: data taken from BDII (total);
- ❖ LL2, IRFU and IPHC have a co-located Tier-3 part/share.



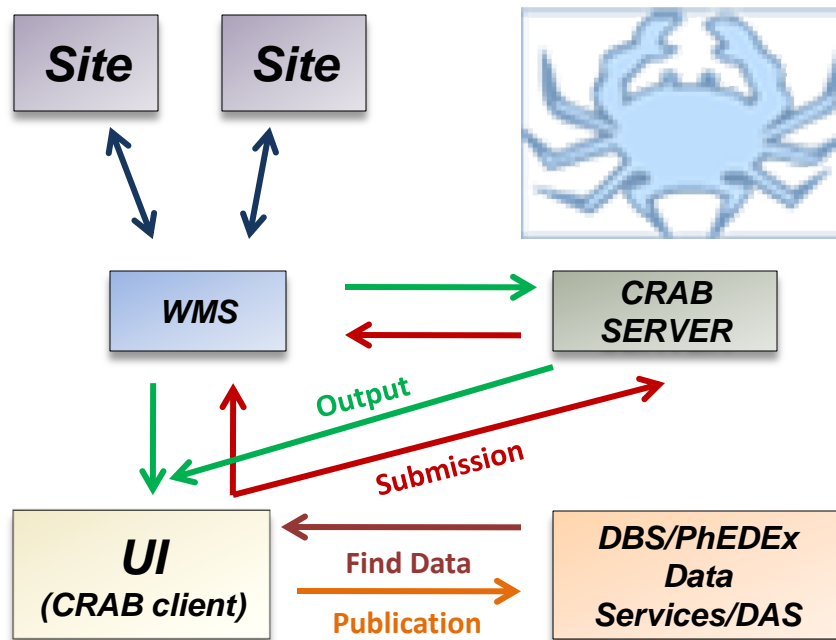
Intro

CMS Applications



- Data Transfer and Placement System: **PhEDEx**

- ✗ routes requested data to sites selecting multiple sources;
- ✗ Interfaced with other services: **DBS, FTS**, etc.



- Distributed Analysis Tool: **CRAB**

- ✗ fit Grid usage with **CMS "data driven" model**;
- ✗ interfaced with **DBS** and **PhEDEx**.



Intro

CMS Analysis Survey

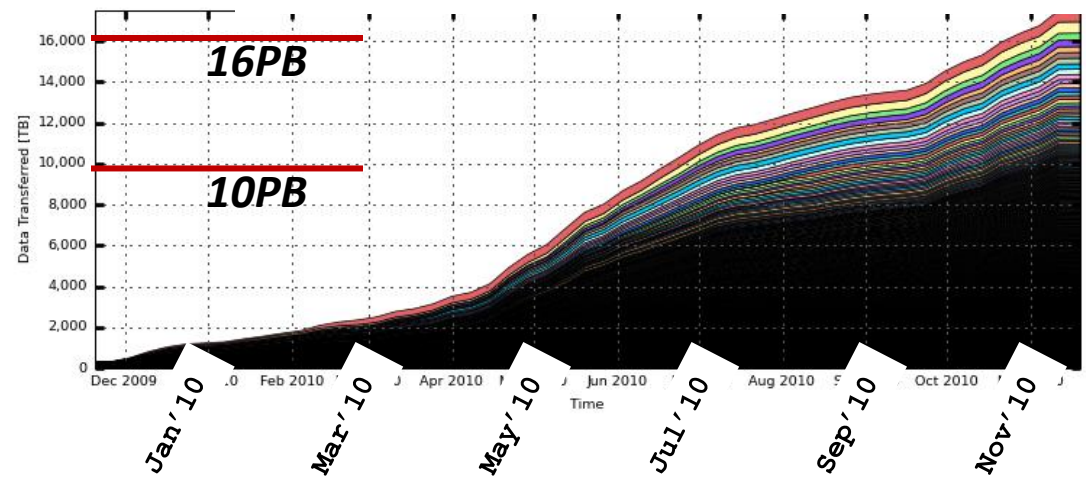
- Survey on **how the users exploit resources**, ~100 people answered to some relevant questions
 - ✗ how do you **spend time** in your analysis?
 - ✗ **on which resources** do you work?
 - ✗ how is the **stability**, the **support**, the **effectiveness**?
 - ✗ what kind of **data** do you use?
 - ✗ how many **sites** do you use?
 - ✗ etc.
- This gives **important feedback** and some reflections can be done starting from it
 - ✗ we will include some of these data in this talk (**marked with S**)
- The results were first presented by I.Fisk:
 - ❑ **Analysis Operations - Input from Computing , CMS Week (14-18 Sep. 2010 Bodrum)**
 - ❖ [http://indico.cern.ch/getFile.py/access?contribId=92&sessionId=23&resId=1&materialId=slides&confId=101503;](http://indico.cern.ch/getFile.py/access?contribId=92&sessionId=23&resId=1&materialId=slides&confId=101503)



Data Placement

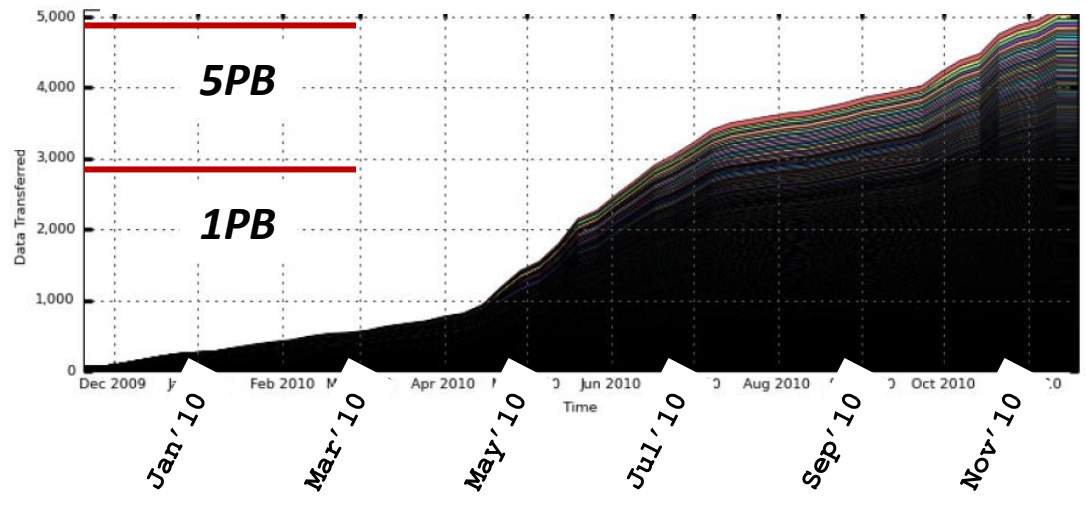
CMS view

T2/3's import volume last 52 weeks

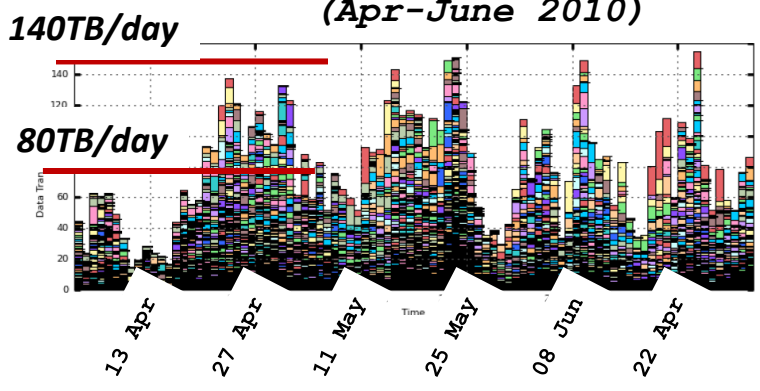


- ✗ 17PB moved in 2010
 - up to 800TB weekly and 150TB daily;
- ✗ full mesh model
 - ~30% of traffic from T2/3-T2/3 transfers.

T2/3-T2/3 trasf. volume last 52 weeks



Daily transf. volume to T2's (Apr-June 2010)



22/11/2010

LCG-France - CC-IN2P3, Lyon.



Data Placement *FR-CMS view...*

✘ FR/CMS ~ 5-6% (1.2PB);

✘ good links

✦ room for improvement of IRFU links with major T1s and T2s in EU and US.

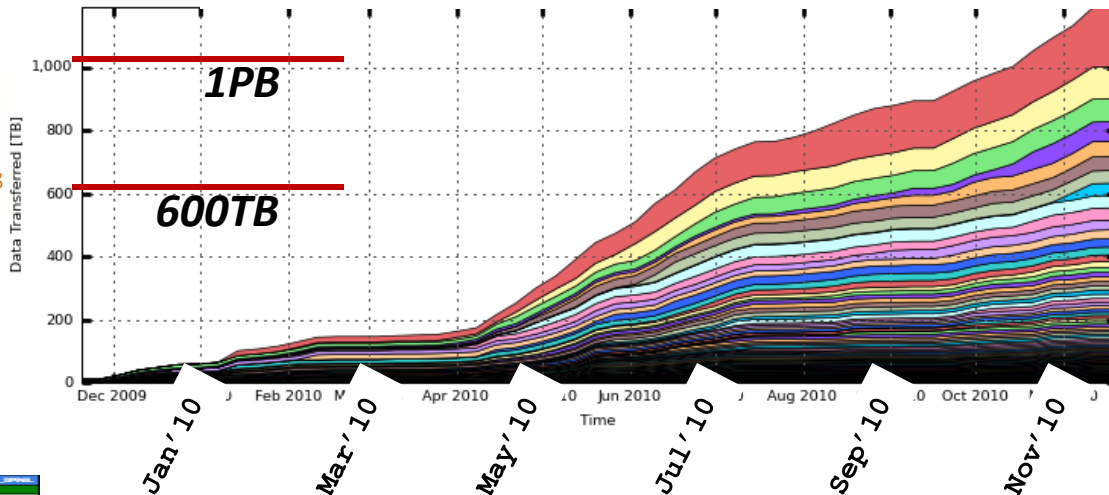
**-T2/3_FR_* links*

Commissioned: ok for prod.

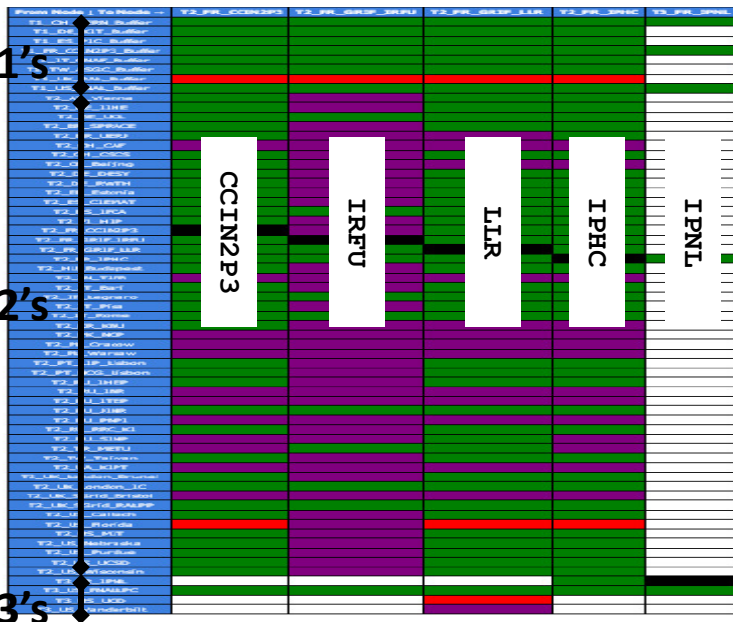
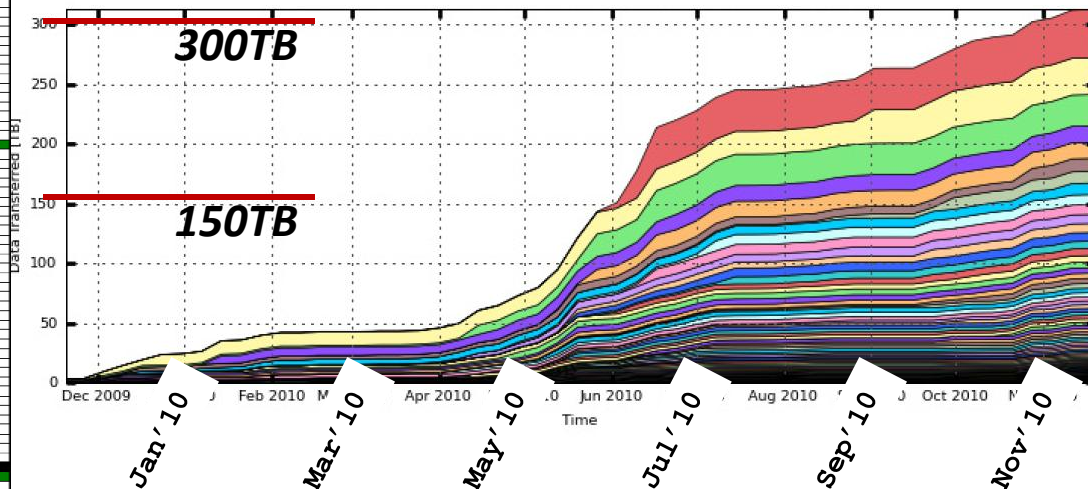
Not commissioned: not in prod.

White: not tested.

T2/3_FR import volume last 52 weeks



T2/3-T2/3_FR trasf. volume last 52 weeks



22/11/2010

LCG-France - CC-IN2P3, Lyon.



Data Placement ...FR-CMS view

T2_FR_CCIN2P3 Group Usage

| Group | Subscribed | Resident |
|---------------|------------|-----------|
| AnalysisOps | 46.05 TB | 46.05 TB |
| DataOps | 36.96 GB | 36.96 GB |
| FacOps | 639.69 GB | 639.69 GB |
| ewk | 4.57 TB | 4.57 TB |
| jets-met_hcal | 173.33 GB | 173.33 GB |
| qcd | 45.94 TB | 45.94 TB |
| tau-pflow | 40.15 TB | 32.50 TB |
| tracker-dpg | 53.19 TB | 53.19 TB |
| | 190.72 TB | 183.07 TB |

T3_FR_IPNL Group Usage

| Group | Subscribed | Resident |
|-------------|------------|-----------|
| higgs | 280.19 GB | 280.19 GB |
| top | 33.13 TB | 33.13 TB |
| tracker-dpg | 6.81 TB | 6.81 TB |
| undefined | 10.21 GB | 10.21 GB |
| | 40.23 TB | 40.23 TB |

*

T2_FR_GRIF_IRFU Group Usage

| Group | Subscribed | Resident |
|-------------|------------|-----------|
| AnalysisOps | 40.50 TB | 39.90 TB |
| DataOps | 36.96 GB | 36.96 GB |
| FacOps | 519.76 GB | 519.76 GB |
| exotica | 10.34 TB | 10.34 TB |
| local | 82.28 TB | 70.32 TB |
| | 133.66 TB | 121.10 TB |

PhEDEx data placed at FR T2's and T3's

✘ 806TB subscribed;

✘ 533TB requested by the 12 groups supported;

✘ 273TB requested by local communities.

[*] Undefined: data subscribed before the introduction of the group flag.

T2_FR_IPHC Group Usage

| Group | Subscribed | Resident |
|-------------|------------|-----------|
| AnalysisOps | 55.71 TB | 55.56 TB |
| DataOps | 36.96 GB | 36.96 GB |
| FacOps | 519.76 GB | 519.76 GB |
| b-tagging | 47.36 TB | 47.36 TB |
| local | 106.11 TB | 96.42 TB |
| top | 48.07 TB | 48.07 TB |
| trigger | 3.92 TB | 3.92 TB |
| undefined | 333.80 GB | 0.00 B |
| | 262.04 TB | 251.87 TB |

*

T2_FR_GRIF_LLRC Group Usage

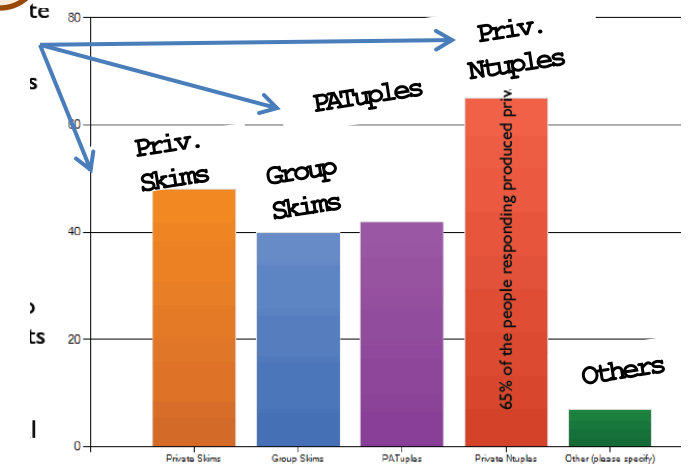
| Group | Subscribed | Resident |
|--------------|------------|-----------|
| DataOps | 36.96 GB | 36.96 GB |
| FacOps | 519.76 GB | 519.76 GB |
| e-gamma_ecal | 42.96 TB | 42.96 TB |
| heavy-ions | 7.53 TB | 7.16 TB |
| higgs | 42.96 TB | 42.25 TB |
| local | 85.70 TB | 83.78 TB |
| | 179.70 TB | 176.70 TB |



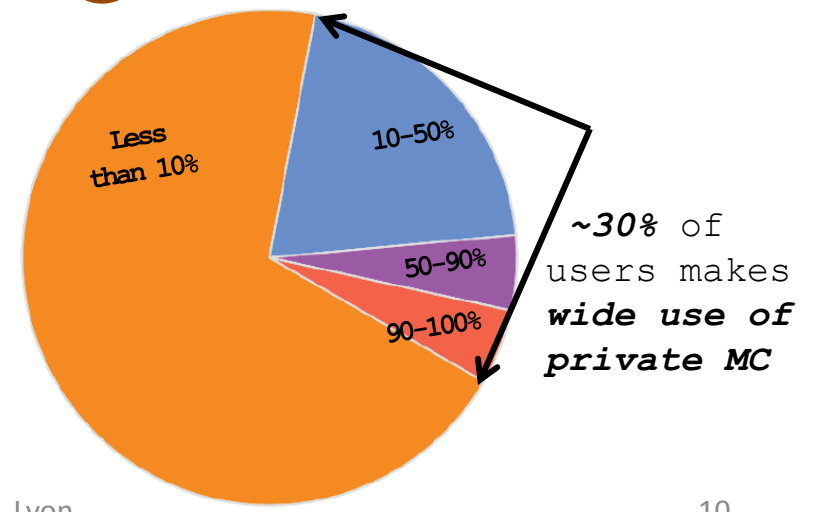
Data Placement Private Data

- Private data (/store/user/*)
 - private Skims, PATuples, Ntuples, etc;
 - private MC;
- not marginal data
 - considerable volume
 - e.g. @ T2_FR_GRIF_LLJ ~ 130TB;
 - relevant for analysis
 - can become very popular;
- not officially tracked and managed by the Computing System
 - not accounted in statistic of data placement;
 - no transfers allowed;
- work for computing
 - reduce the need for private data;
 - be able to track and manage them.

S What reduced data do you use?



S What % of MC used is private?

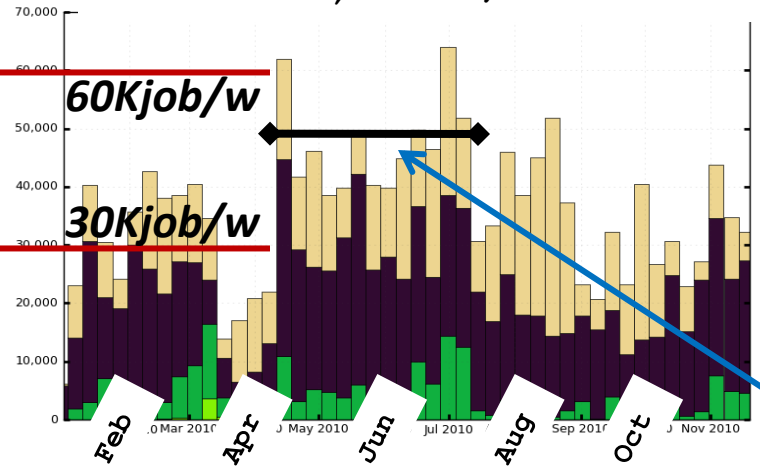




Analysis jobs

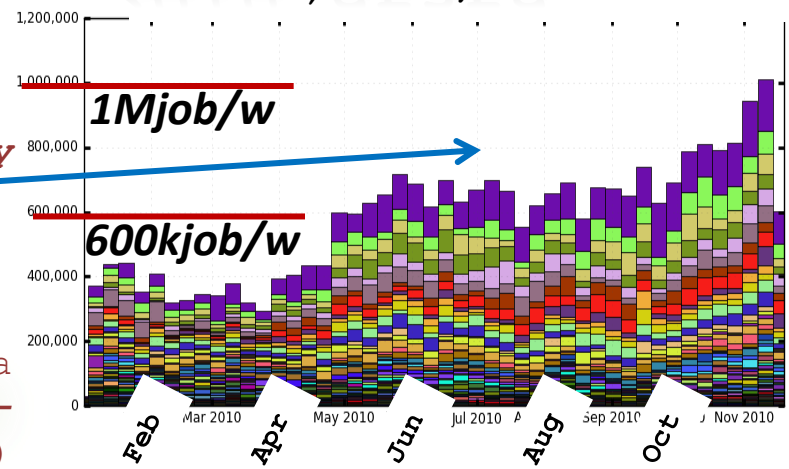
2010 stats...

CMS FR T2, Jobs/week in 2010

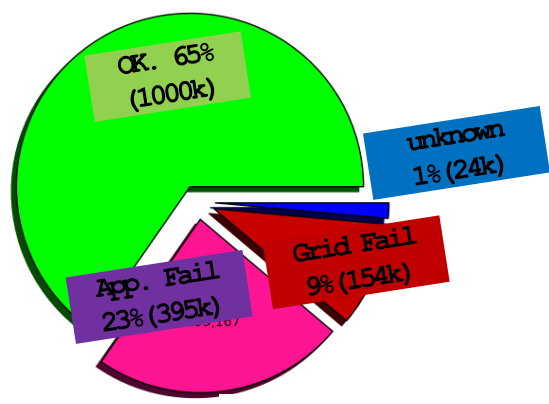


- ✗ CMS steadily increasing
- ✗ CMS FR had a peak in May-July (ICHEP)

CMS T2, Jobs/week in 2010

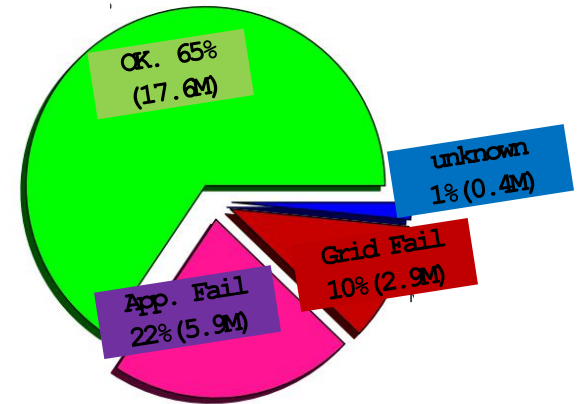


CMS FR T2, Jobs status in 2010



- ✗ FR/CMS ~ 5-6%
- ✗ 65% effic.
- ✗ Fail dominated by App. Fail. (this includes stageout and file access failures)

CMS T2, Jobs status in 2010

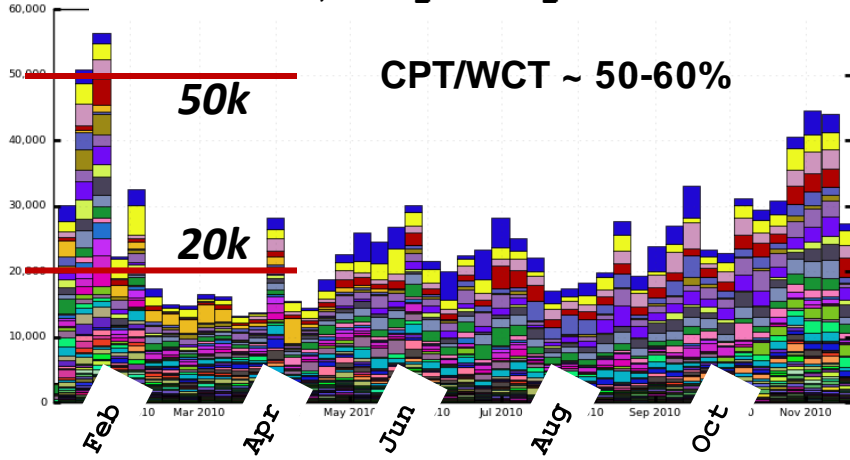




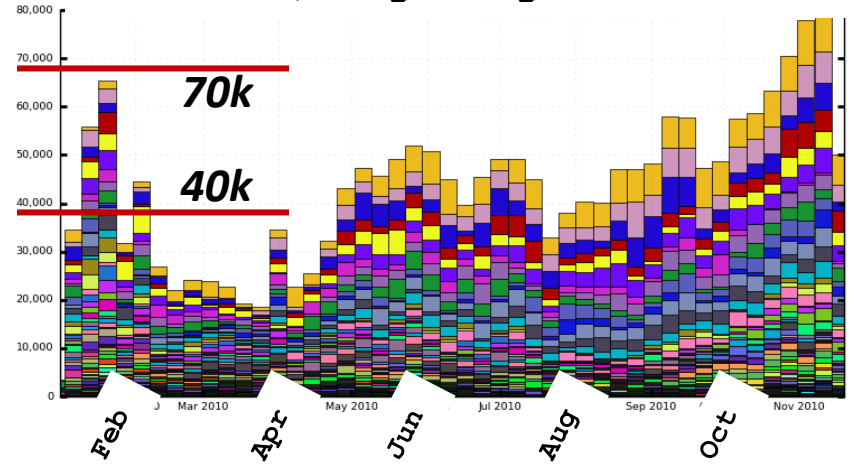
Analysis

...2010 stats

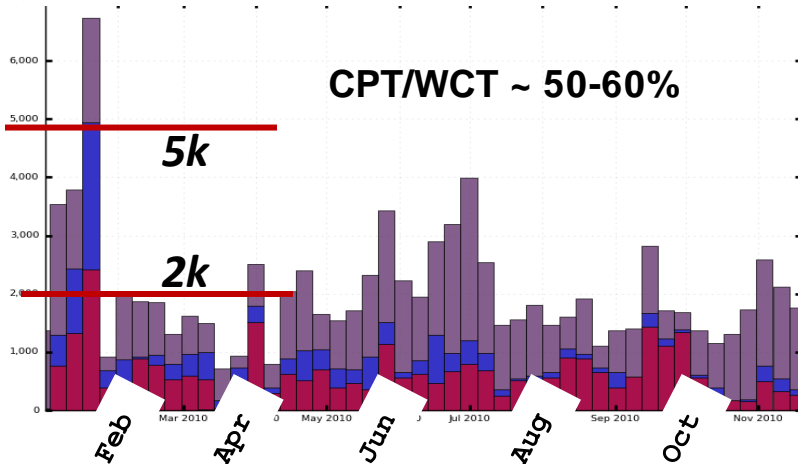
CMS T2's, days/day CPT in 2010



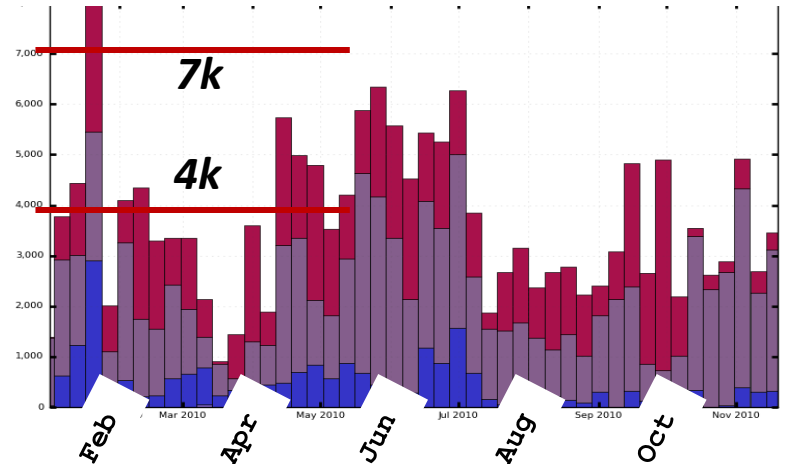
CMS T2's, days/day WCT in 2010



CMS FR T2's, days/day CPT in 2010



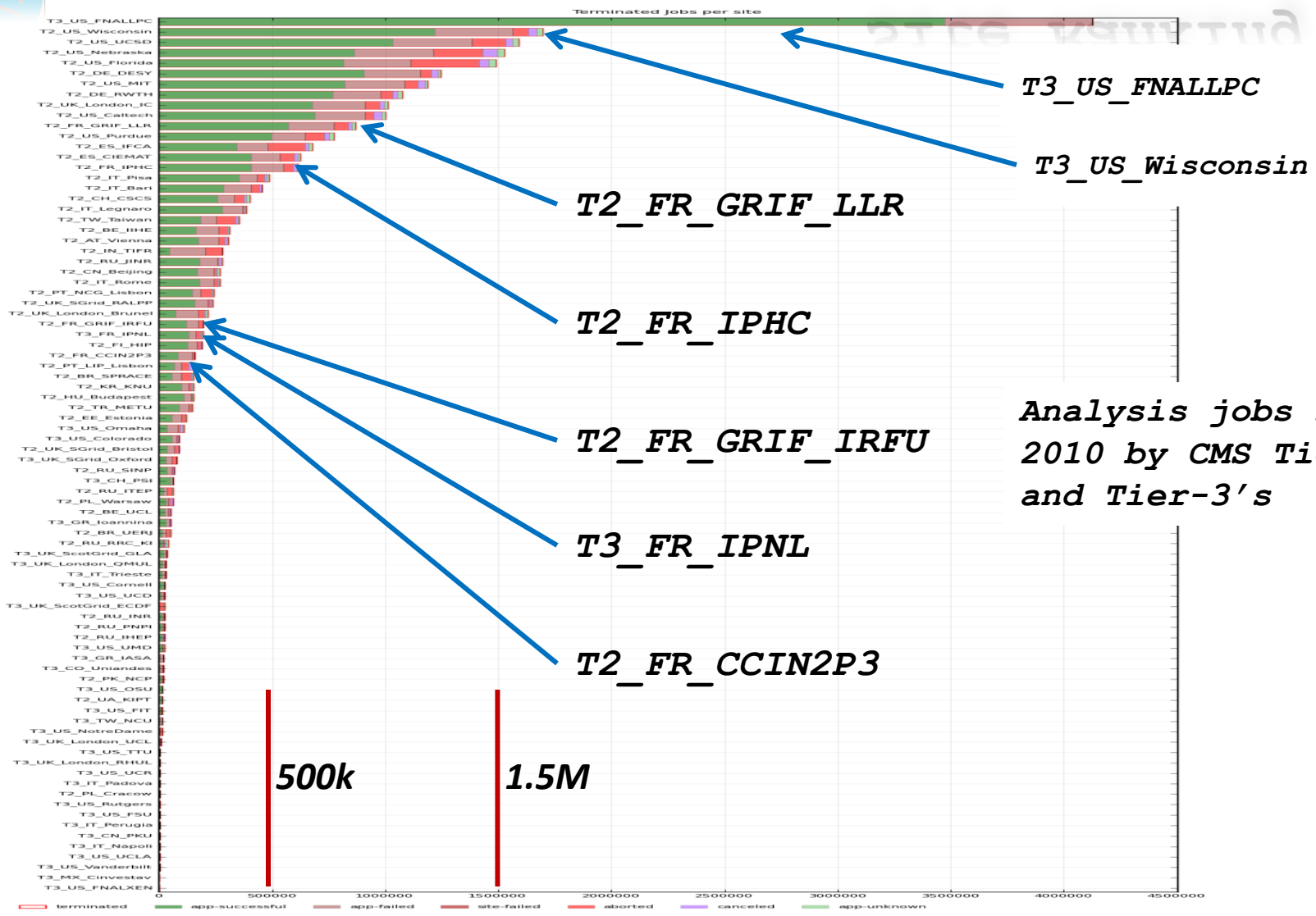
CMS FR T2's, days/day WCT in 2010





Analysis

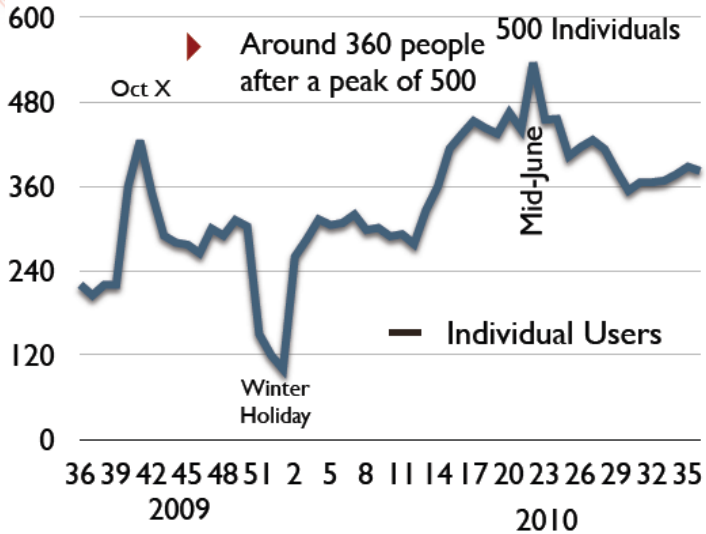
Site Ranking



Analysis jobs ran in 2010 by CMS Tier-2's and Tier-3's

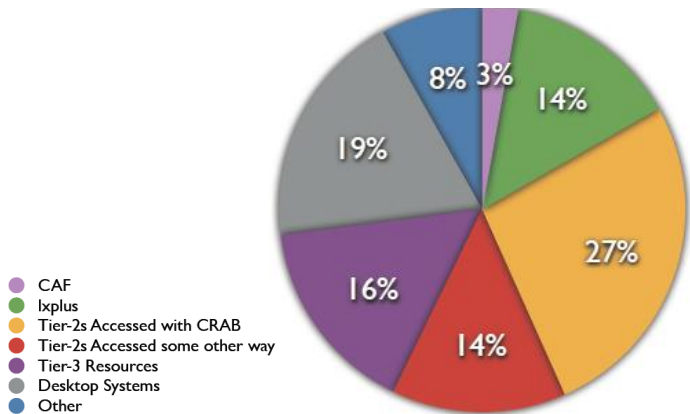


Analysis jobs Users & usage

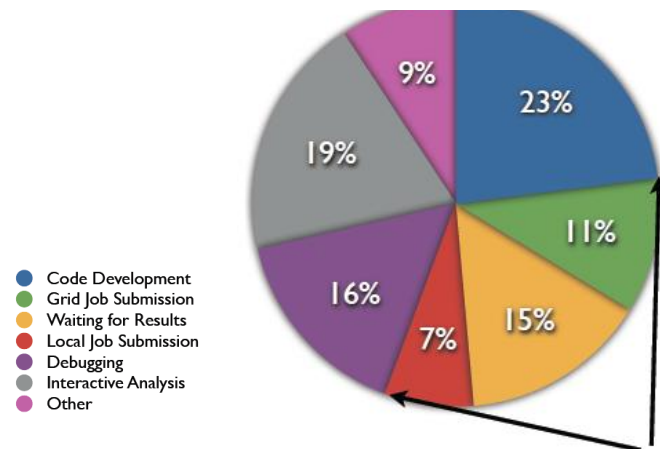


- Steadily **360 users**;
- how do they work?
 - ✗ **30% of time** spent in **technical work**: room for improvement
- which resources** do they use?
 - ✗ **T2 by CRAB**: larger contribution
 - ✗ **"local" resources usage quite high**
 - ✗ **CAF is a low fraction**

S Which part of your time you spend on which resource?



S Which part of your time you spend doing what?



Reduce These



Summary & Outlook

- In 2010 CMS *successfully performed analysis* at Tier-2's and Tier-3's
 - ✗ close to **100% pledged** resources usage (*hit the C-TDR job count*);
 - ✗ we will soon move to a **resource constrained regime**;
 - ✦ Need to **improve efficiency** in resource usage
- considerable contribution of **"local" activities**: local groups, private resources, private data
 - ✗ the official CMS computing needs to work to **reduce the need for this**;
 - ✗ and also **improve the support to these activities** by the official infrastructure;
- **CMS-FR contribution** to Tier-2's and Tier-3's analysis activity is **roughly the 5-6%**.