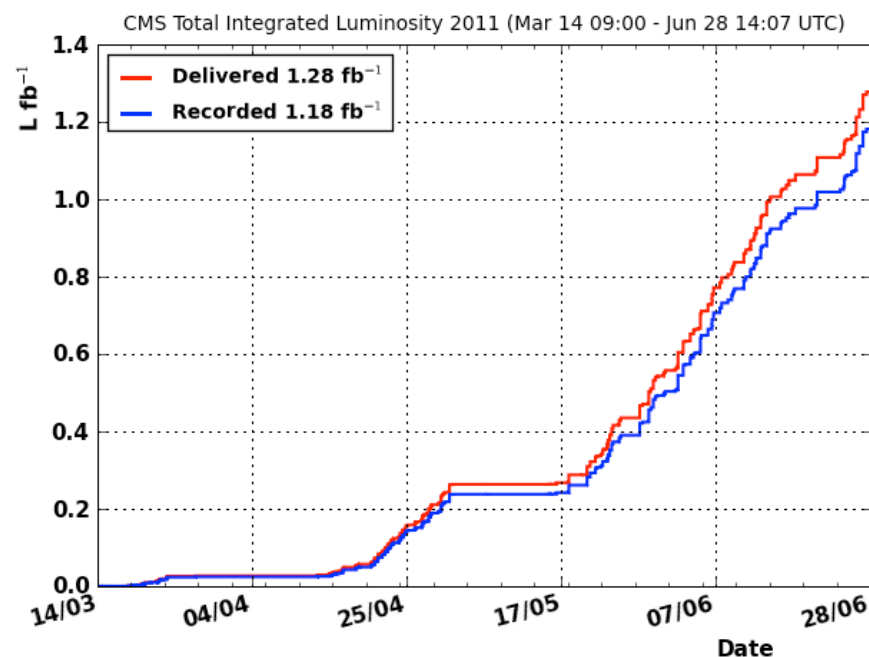# Operational Experience from the Experiments

July 11, 2011
Ian Fisk

2011

➡ Second year of running is a lot more luminosity

- Each fill is now similar to the data taken in 2010
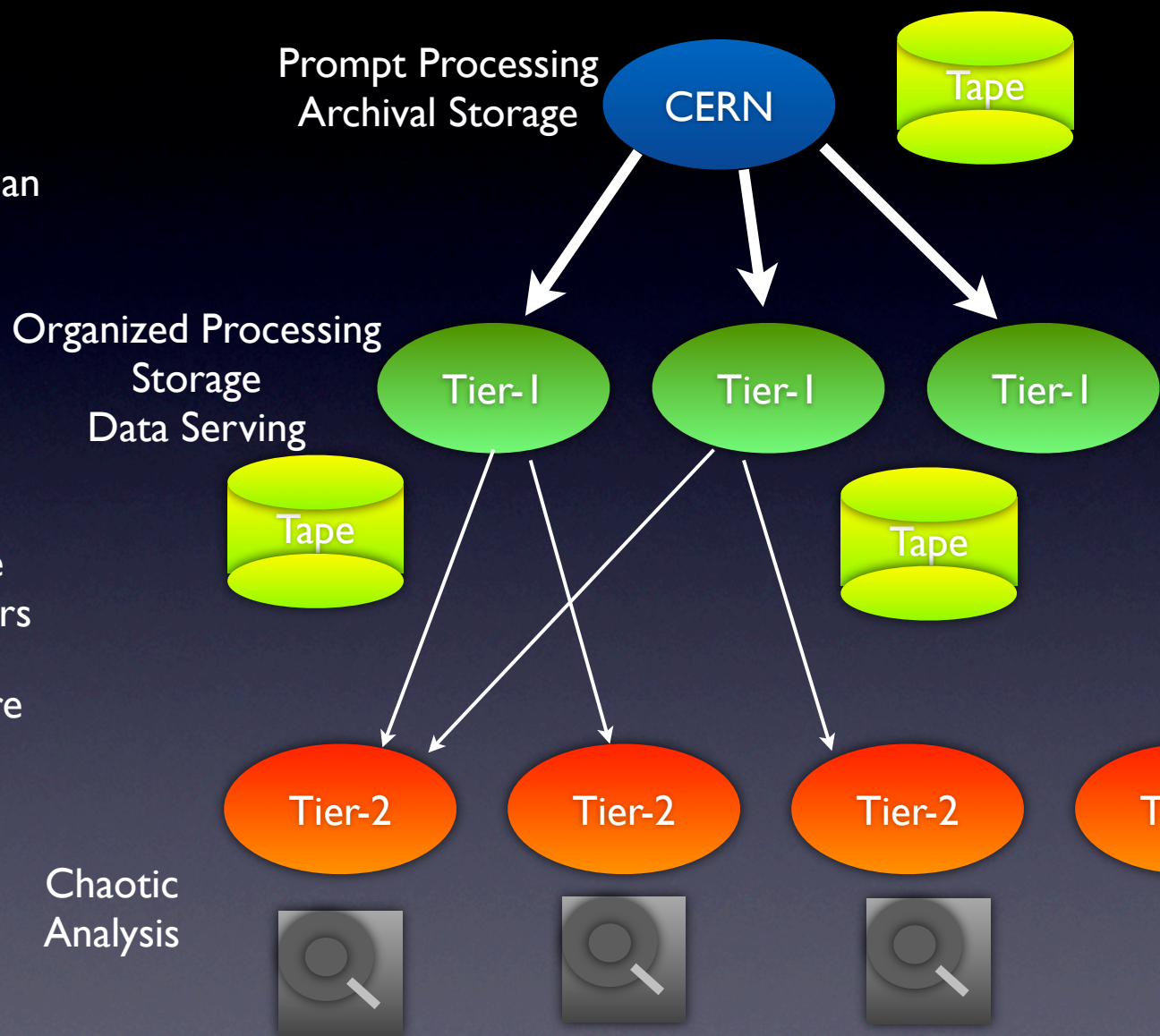
- New computing challenges and activity levels

CMS Total Integrated Luminosity 2011 (Mar 14 09:00 - Jun 28 14:07 UTC)

Delivered 1.28 fb^{-1}
Recorded 1.18 fb^{-1}

Refinements

Refinements rather than revolutions

- Indicates the experiment computing models are holding up

- ATLAS using more inter-cloud transfers

- LHCb Making more use of Tier-2s

- CMS moving data Tier-2 to Tier-2

- Etc.

Prompt Processing
Archival Storage

CERN

Tape

Organized Processing
Storage
Data Serving

Tier-1 Tier-1 Tier-1

Tape Tape

Tier-2 Tier-2 Tier-2 Ti

Chaotic
Analysis

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Generally

➡ Generally the WLCG has been a stable and reliable service

- Components, services and sites are performing well

- Distributed analysis and processing is a big success

- We have survived our first year in operations and systems are scaling, including another resource increase in 2011

- Component migrations in progress

 ✦ LCG-CE to CREAM CE, changes in BDII architecture, roll-out of glExec

Tier-0
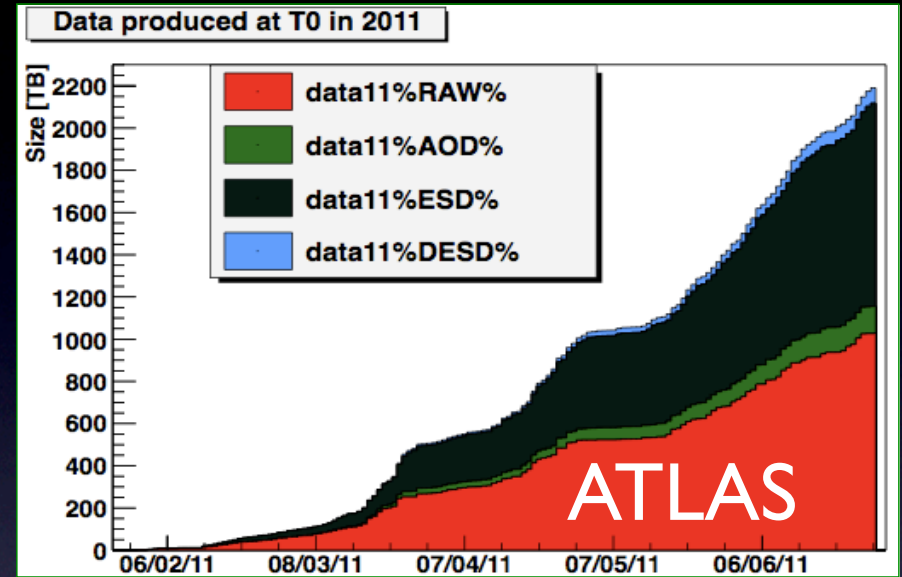
➡ CERN usage is higher that 2010 with more complex events that take longer to process and a harder triggering process

- Still lower than expected

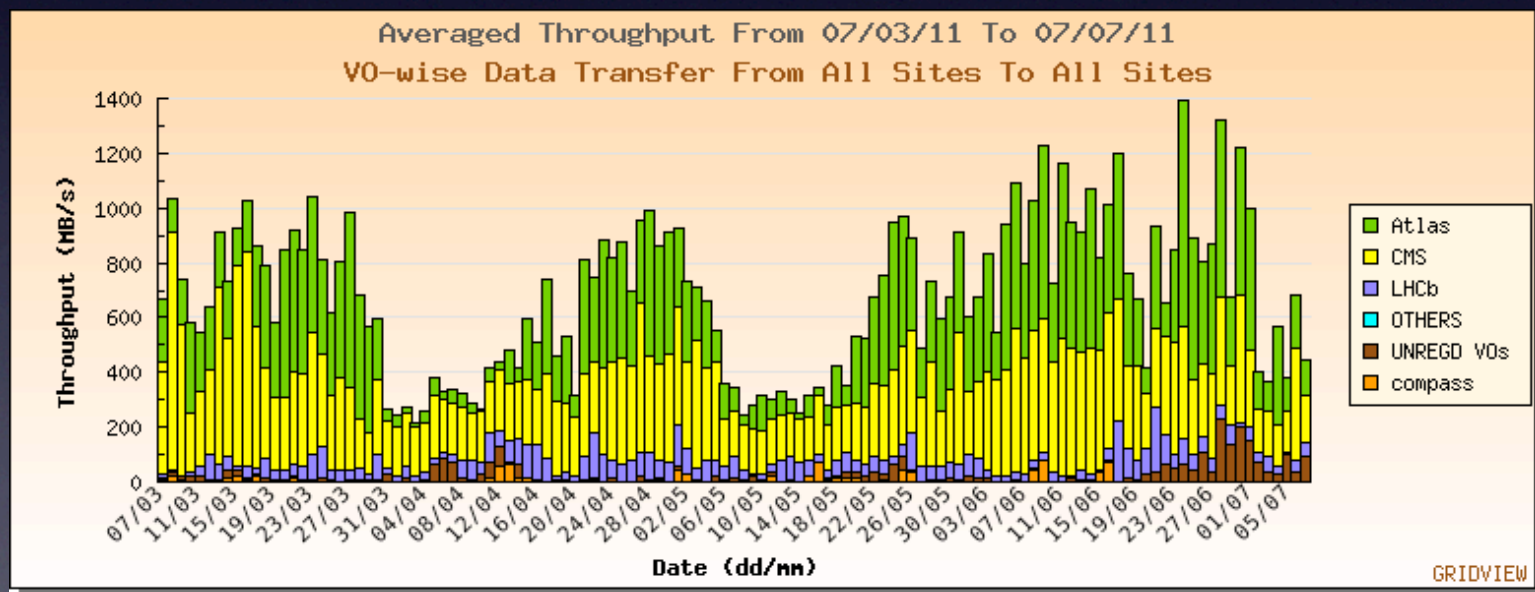- Built for peak, well utilized for bursts

Usage of CERN

Job statistics - last week

5
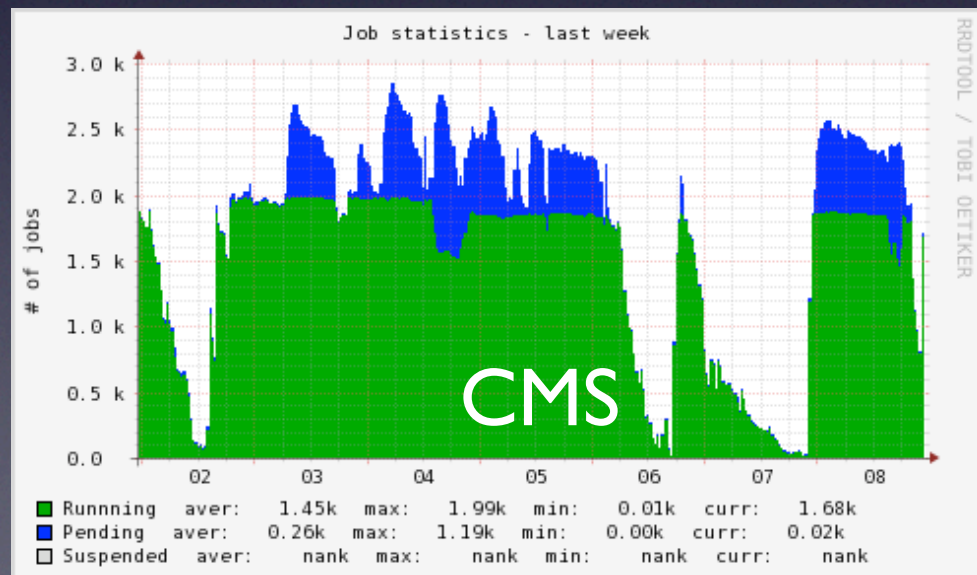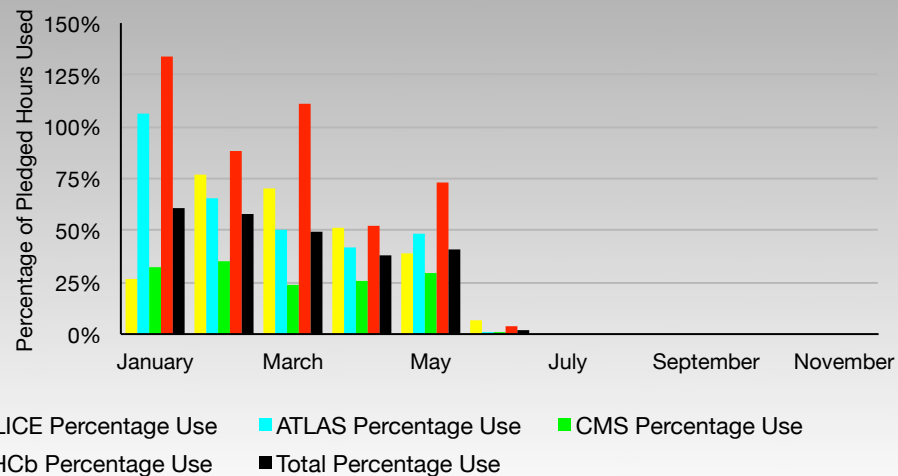
Tier-0 Data

➡ LHC Experiments now have PB datasets

➡ Bigger simulation samples
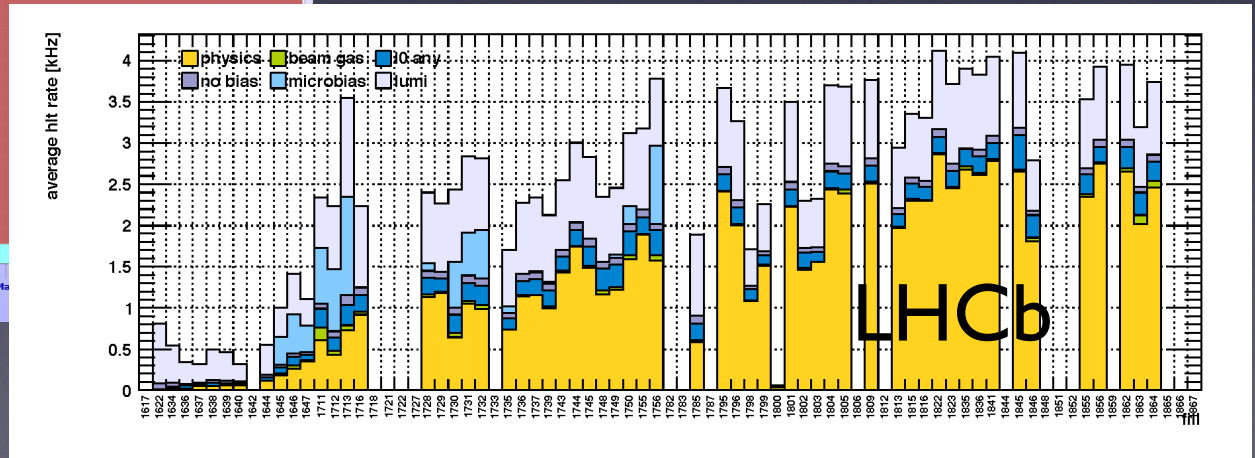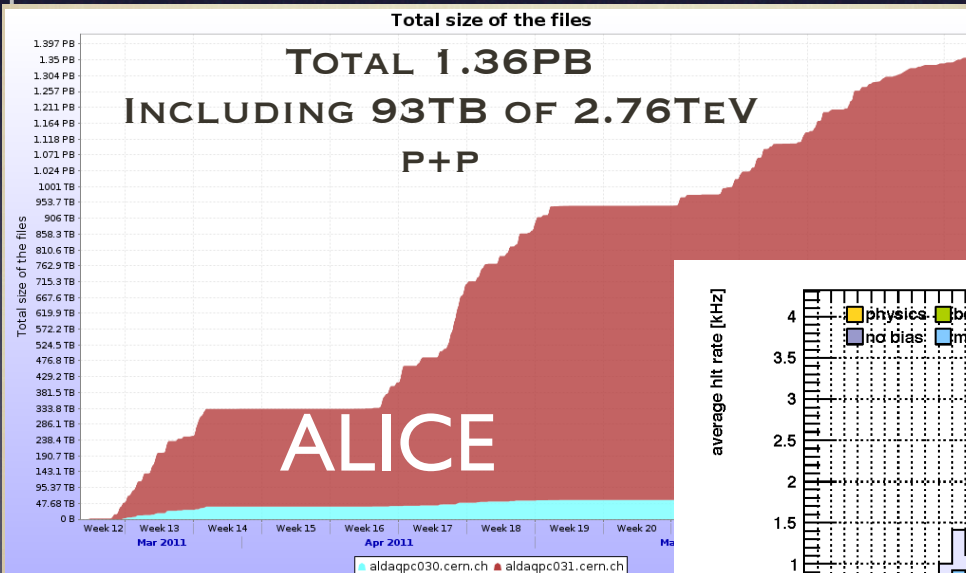
Tier-0 to Tier-1

➡ Replication of data from CERN has been lower in 2011

➡ Event sizes and data volumes are larger

- Fewer redundant copies

Averaged Throughput From 07/03/11 To 07/07/11
VO-wise Data Transfer From All Sites To All Sites
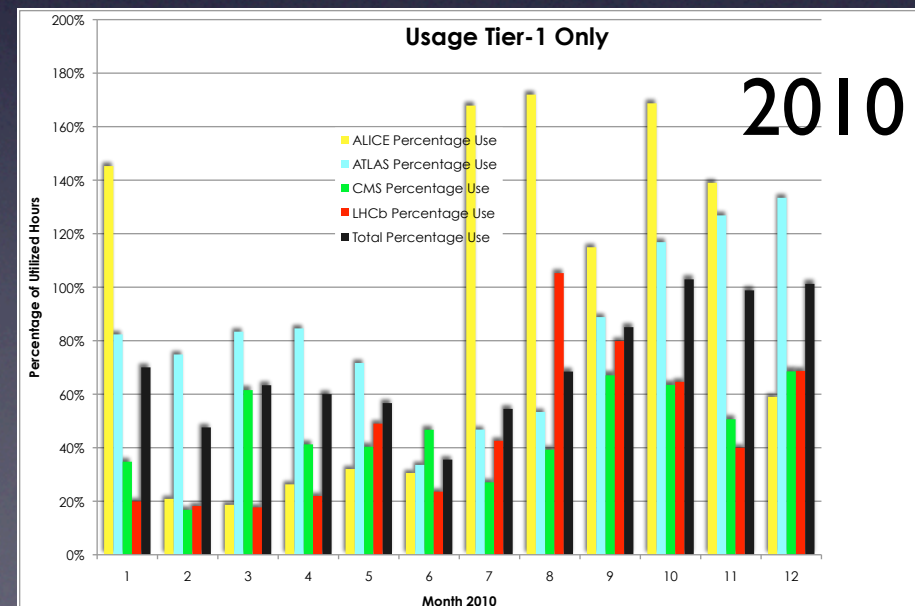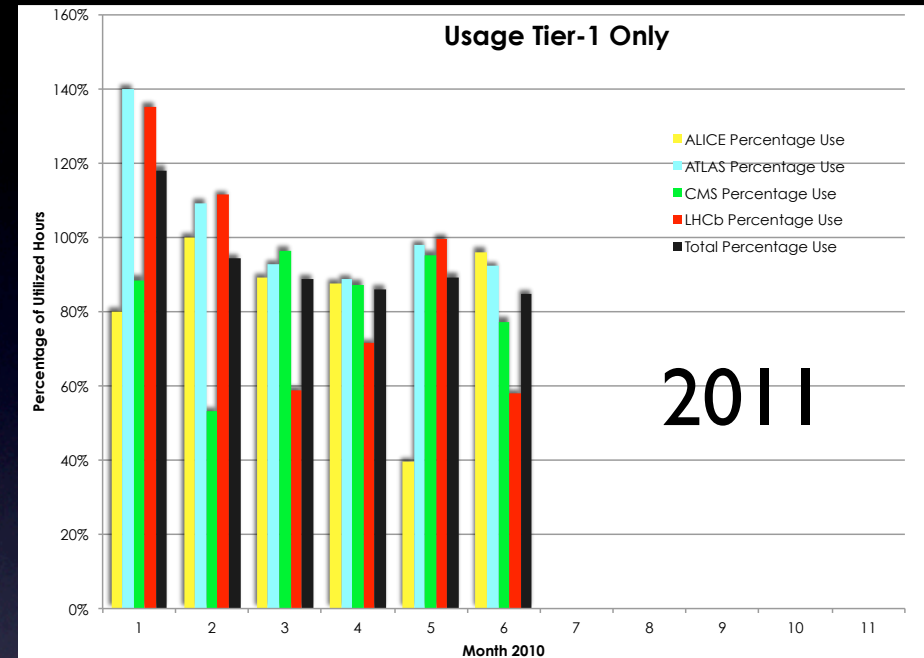
Legend: Atlas, CMS, LHCb, OTHERS, UNREGD VOs, compass

- More stable utilization

Tier-1 Utilization

➡ Average Tier-1 utilization is higher than 2010

- Good usage by all VOs

- At the end of the year we will be resource constrained

- Big increase in resources in April and already well used

Tier-1 Reprocessing

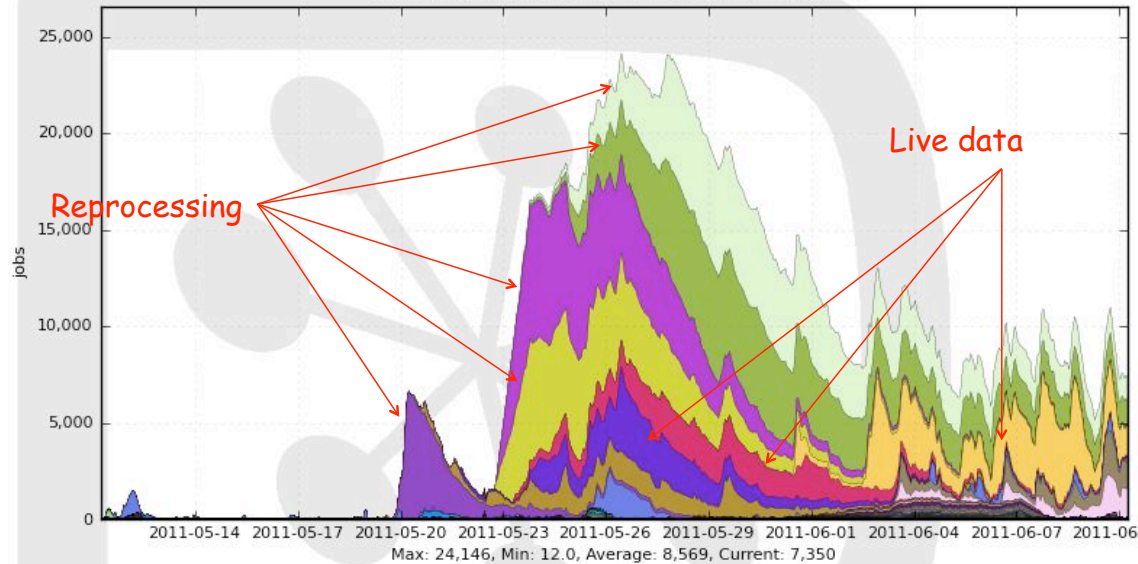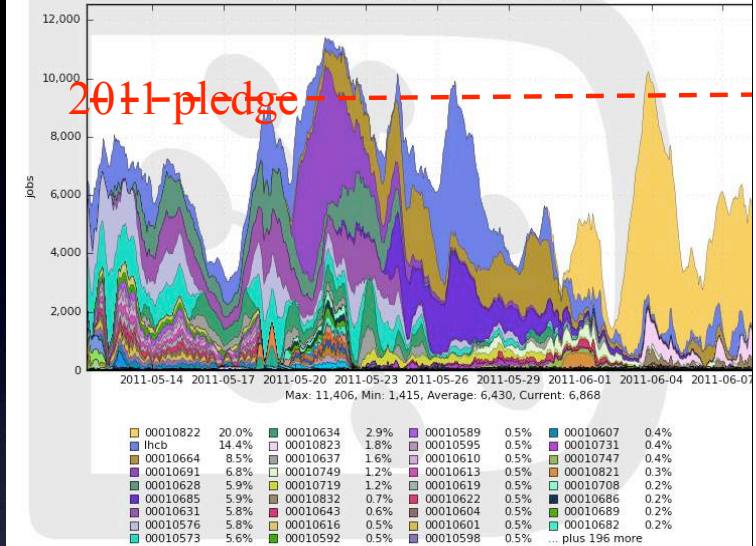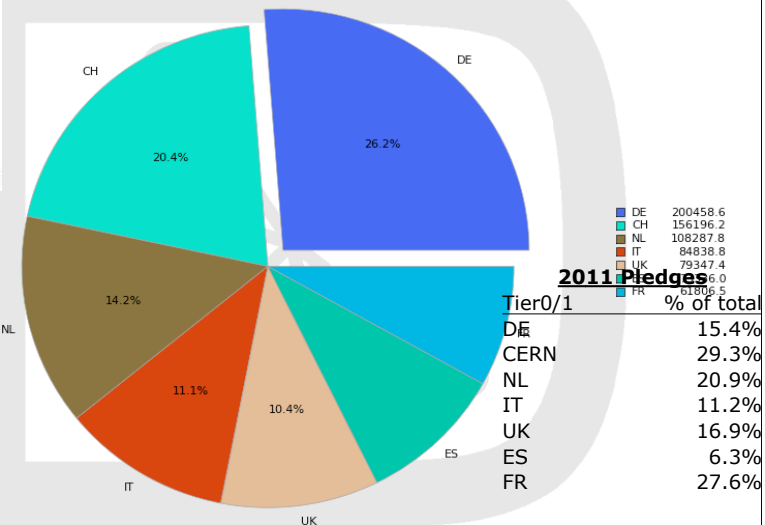Waiting jobs at Tier 1
30 Days from 2011-05-11 to 2011-06-10

Live data

Reprocessing

2011 pledge

Running jobs at Tier 1
30 Days from 2011-05-11 to 2011-06-10

LHCb CPU @ T1

➡ LHCb

– Heavy use of distributed Tier-1s

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ATLAS Data Processing

Completed Jobs (last 6 months, daily)
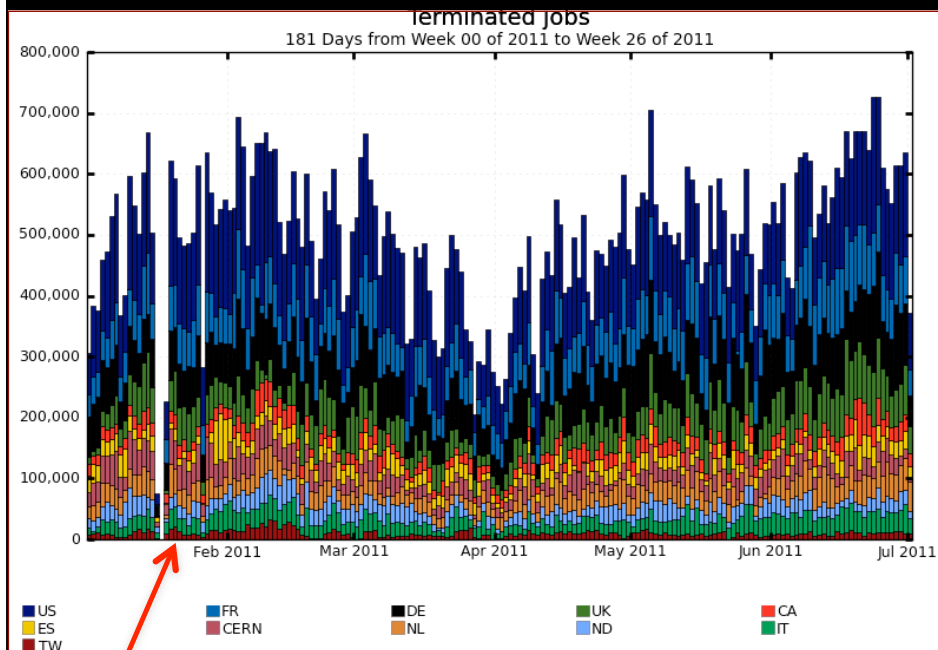
CPU time (last 6 months, daily)

Terminated Jobs
181 Days from Week 00 of 2011 to Week 26 of 2011

Legend: US, FR, DE, UK, CA, ES, CERN, NL, ND, IT, TW
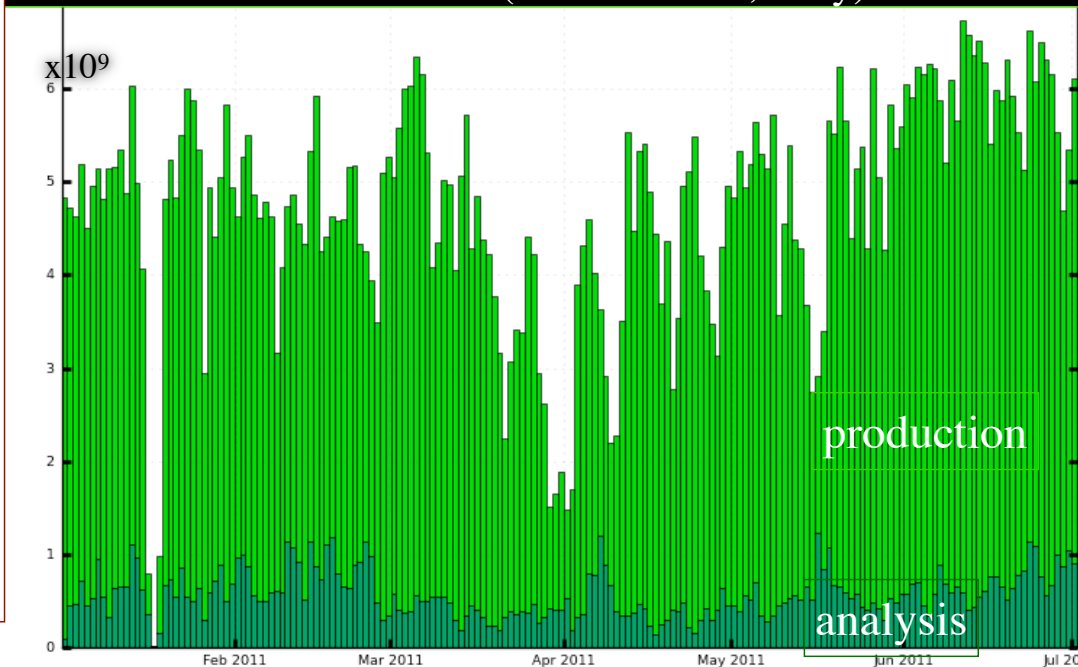
Grid global downtime to scale up DB capacity for >=2011

WLCG W...

- CPU ~ 4 10⁹ sec daily

- > 600K jobs /day

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5 July 2011

- Reprocessing of 0.5 PB of select data: HI, Muon, Fast, Tags

- ~ one cycle/month of group reprocessing (NTUPs)

  ## MC production 2011

- new G4 production: 8400 tasks: 800M events produced

- digi + reco

  - MC10a campaign (2011 data analysis), start beginning of April (~2 weeks)
  - MC10b campaign (2011 data analysis), start end of April (~5 weeks for the bulk, new requests still coming in)

- MC11 new event generation and G4 started: progressing as expected

ALICE

➡ Average of 17k jobs running (2/3rds are Production Jobs)
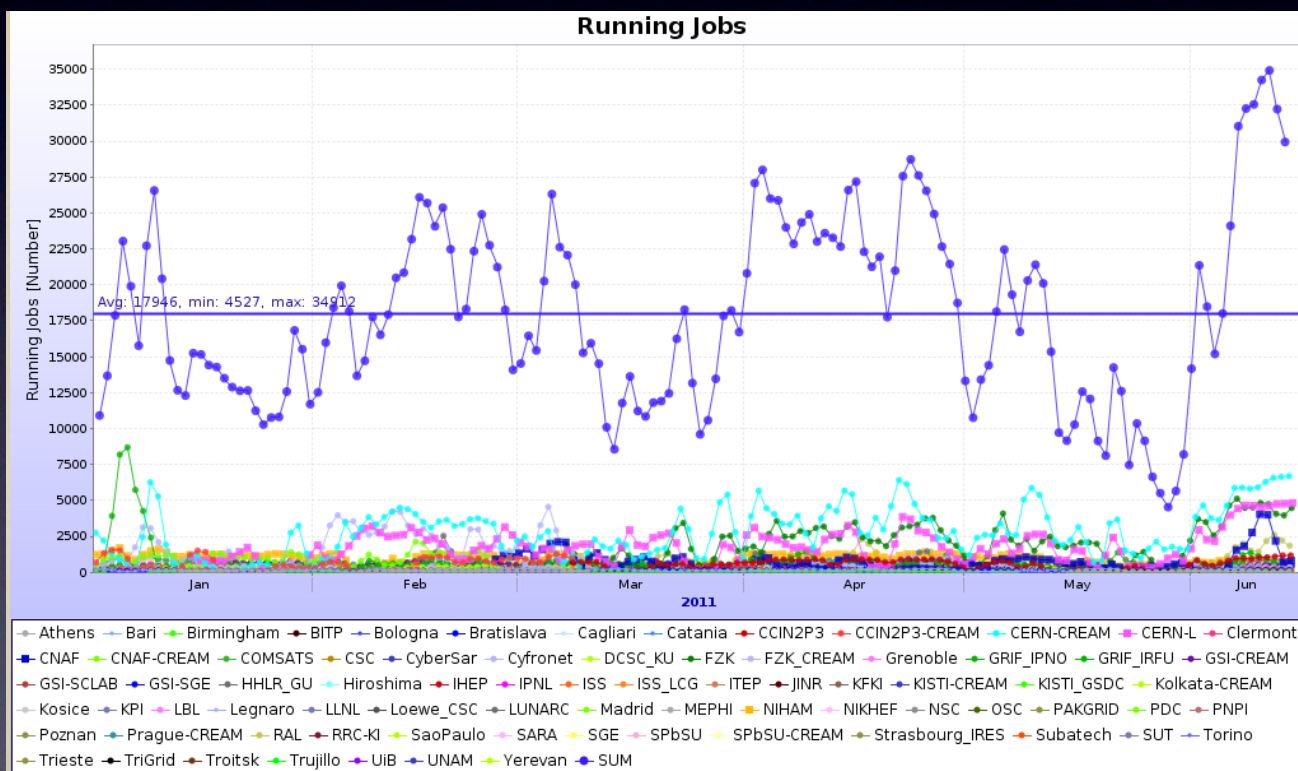
CMS MC Production

➡ Planning was for 1.2B Simulated Events to be Completed by the end of May

- Simulation Production was 1.6B, but first 0.4M were 8TeV from before the planning change and were deleted

- Total Re-reconstructed is 1.5B. Roughly half with full out of time pile-up

  ✦ RECO Event size is larger than estimates

    • 0.97MB for GEN-SIM RECO (Compared to 0.63)

  ✦ AOD is very close at 0.25

MC in 2010/2011: Simulated Events per Month

Events, total ~4.84 Billion RAW events

MC in 2010/2011: Size in TiB per Month

AOD Size [TiB], total ~0.36 PiB
RECO Size [TiB], total ~1.61 PiB
RAW Size [TiB], total ~3.16 PiB
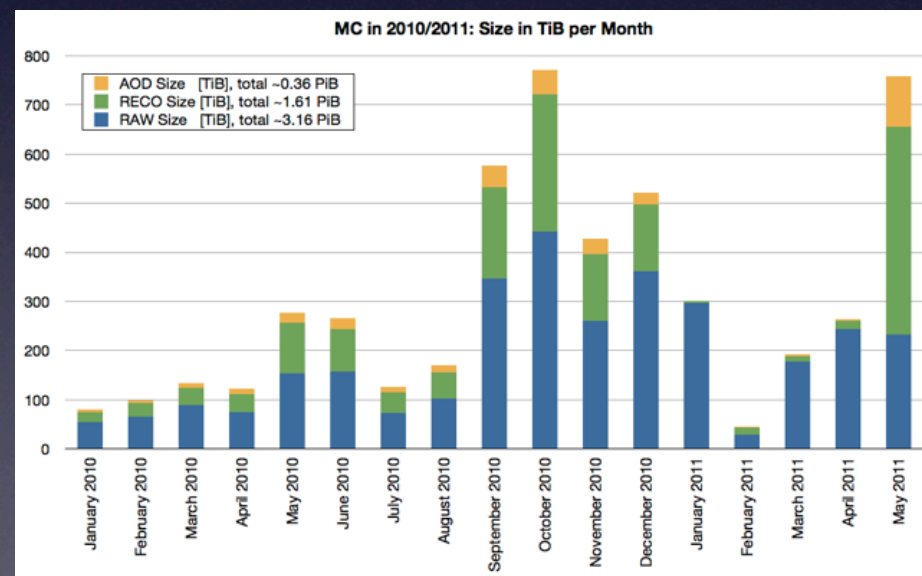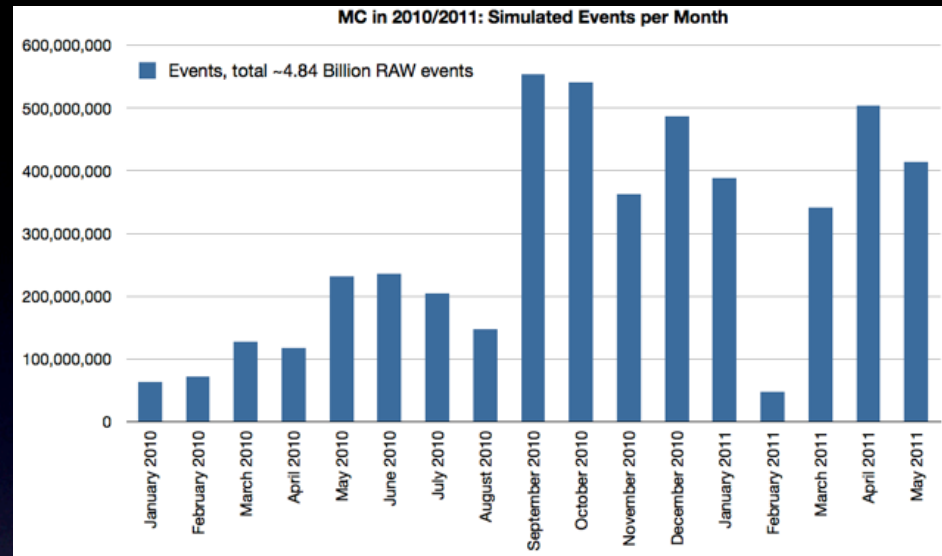
CERN Analysis

➡ Both ATLAS and CMS has moved to EOS for data access at CERN

- EOS: high performance highly scalable redundant disk storage, based on xrootd framework

  ✦ ATLAS tested and stress tested this new solution at the end of 2010 - start of 2011

  ✦ to improve the CERN reliability for analysis, ATLAS is now migrating the CASTOR disk-only pools to the new EOS disk only storage.   CMS has moved the CAF

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CMS/FNAL

CAF

CAF Disk

LXBatch

Default Disk

Castor

CAF Disk EOS

CAF

Redirector

LXBatch

Default Disk

Castor
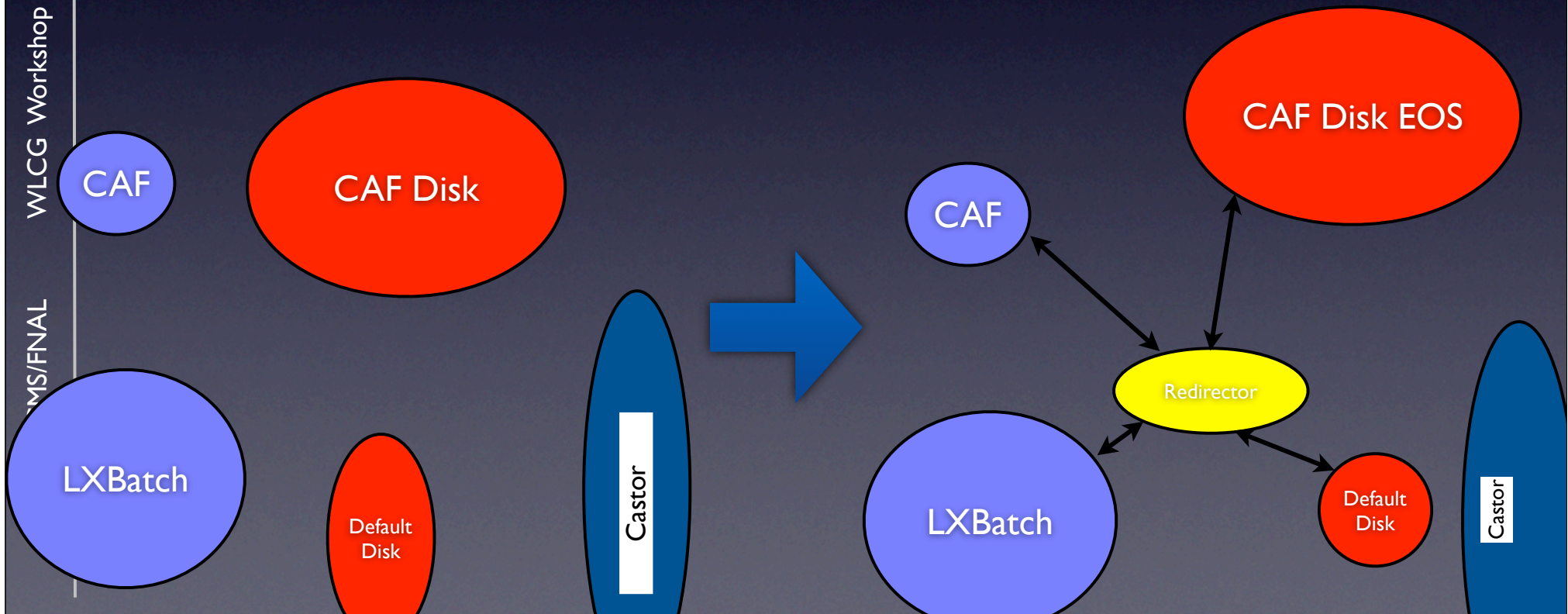
Distributed Analysis

➡ Distributed Analysis on the Tier-2s remains an extremely successful application

Total Tier-2s Used

Legend:
- ALICE Percentage Use (yellow)
- ATLAS Percentage Use (cyan)
- CMS Percentage Use (green)
- LHCb Percentage Use (red)
- Total Percentage Use (black)

Y-axis: Percentage of Pledged Hours Used (0% – 300%)
X-axis: January, February, March, April, May, June, July, August, September, October, November, December
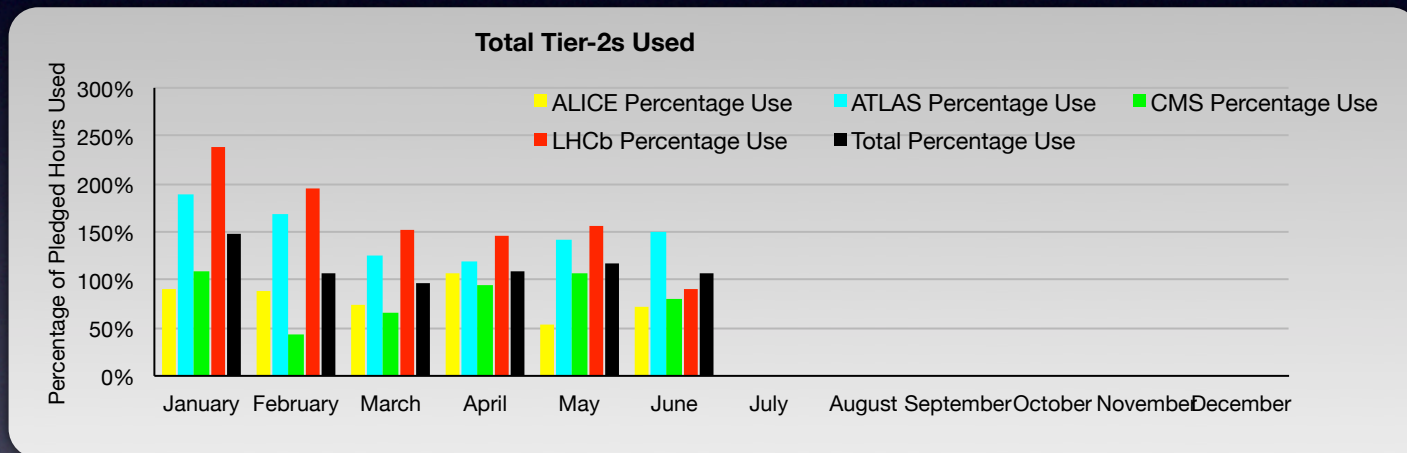
➡ Generally 100% utilization of the pledge on average despite a big increase in T2 resources in April

ALICE and ATLAS

Running jobs per user

AVERAGE 6500 USER JOBS IN PARALLEL

350 USERS

QM2011 START

Avg: 6432, min: 2043, max: 19176

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Number of Successful Jobs - 79%

35,313,640

5,211,671

Number of GRID-Failed Jobs - 11%

Successful jobs 79%
GRID failed 11%
Application failed 8%

Number of Successful Jobs - 79% (35,313,640)   Number of GRID-Failed Jobs - 11% (5,211,671)
Number of Application-Failed Jobs - 8% (3,782,667)   Number of Unknown-Status Jobs - 0% (1,327)

World Wide - analy_running - year

Range from Sat Jul 3 00:00:00 2010 UTC to Sun Jul 3 00:00:00 2011 UTC
Generated by TRIUMF-LCG2 (times in UTC)

CA CERN DE ES FR IT ND NL TW UK US

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CMS

More than 800 users per month

ICHEP10

Oct X

Holiday 2010

Holiday 2009

—— Individual Users per week

Running jobs
30 Days from 2011-05-27 to 2011-06-26

- analysis
- production
- jobrobot
- hcjobrobot
- hammercloud
- reprocessing
- simulation
- cleanup
- storeresults
- logcollect
- hcprivate
- sw_installation
- hctest
- integration

Maximum: 44,610 , Minimum: 27,188 , Average: 35,653 , Current: 29,807

Terminated jobs
30 Days from 2011-05-27 to 2011-06-26

- analysis
- production
- jobrobot
- hcjobrobot
- hammercloud
- storeresults
- cleanup
- reprocessing
- logcollect
- hcprivate
- simulation
- hctest
- sw_installation
- integration

Maximum: 357,863 , Minimum: 88,729 , Average: 261,292 , Current: 88,729

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Popularity

- **Common Project in IT-ES supporting ATLAS and CMS**

Data Tier	Number of access	CPU Time	Number of Users
ALCARECO	37	0	1
AOD	890268	2171413937	830
AODSIM	756939	1038795500	677
DQM	154	0	5
FEVT	20680	0	9
GEN-SIM	20	0	2
GEN-SIM-DIGI-RAW-HLTDEBUG	2023	0	8
GEN-SIM-DIGI-RECO	220280	5475706	17
GEN-SIM-RAW	5050	800378	5
GEN-SIM-RAW-RECO	163	6087	5
GEN-SIM-RECO	291753	84403131	162
GEN-SIM-RECODEBUG	16273	16535210	15
RAW	12857	2894465	25
RAW-RECO	22937	64814428	51
RECO	418386	246586849	272
unknown	1	12	1
USER	197866	88028660	236
Data Tier	Number of access	CPU Time	Number of Users

- ➡ **Can now see what data is being accessed most and how they are accessed, what tiers and what users are looking at things**

- **Allows us to see the transition to AOD**
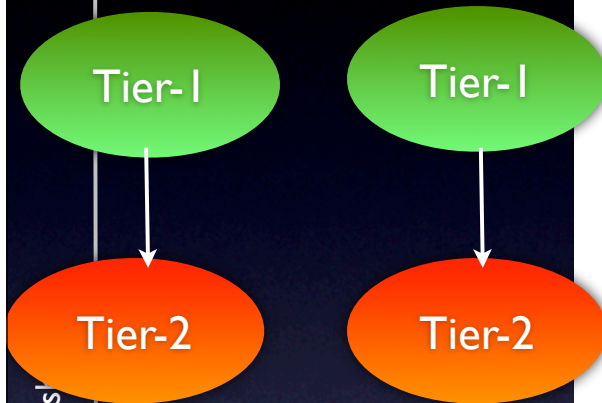

DataTier Time Evolution

17
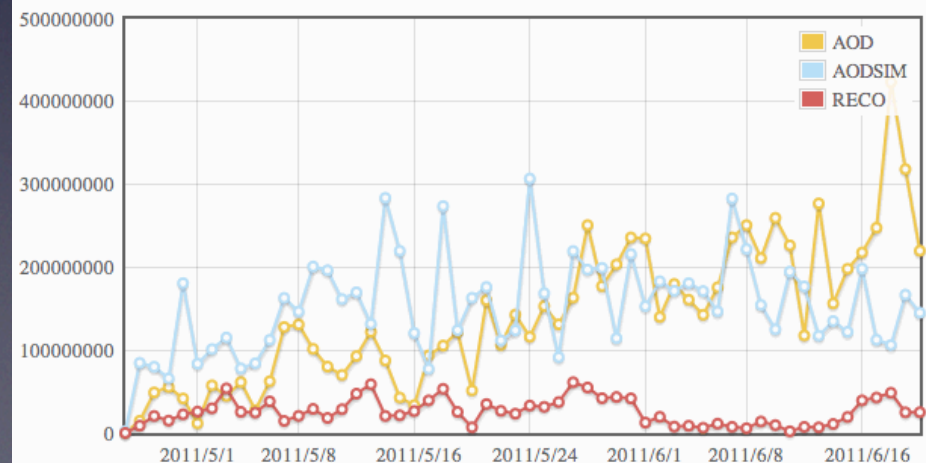
In Progress

➡ A number of interesting optimizations some of which will be more thoroughly covered

- Xrootd for remote data access beyond ALICE

- Network improvements and more site connections with LHCOne

- Better disk management and cleaning separation of disk and tape.

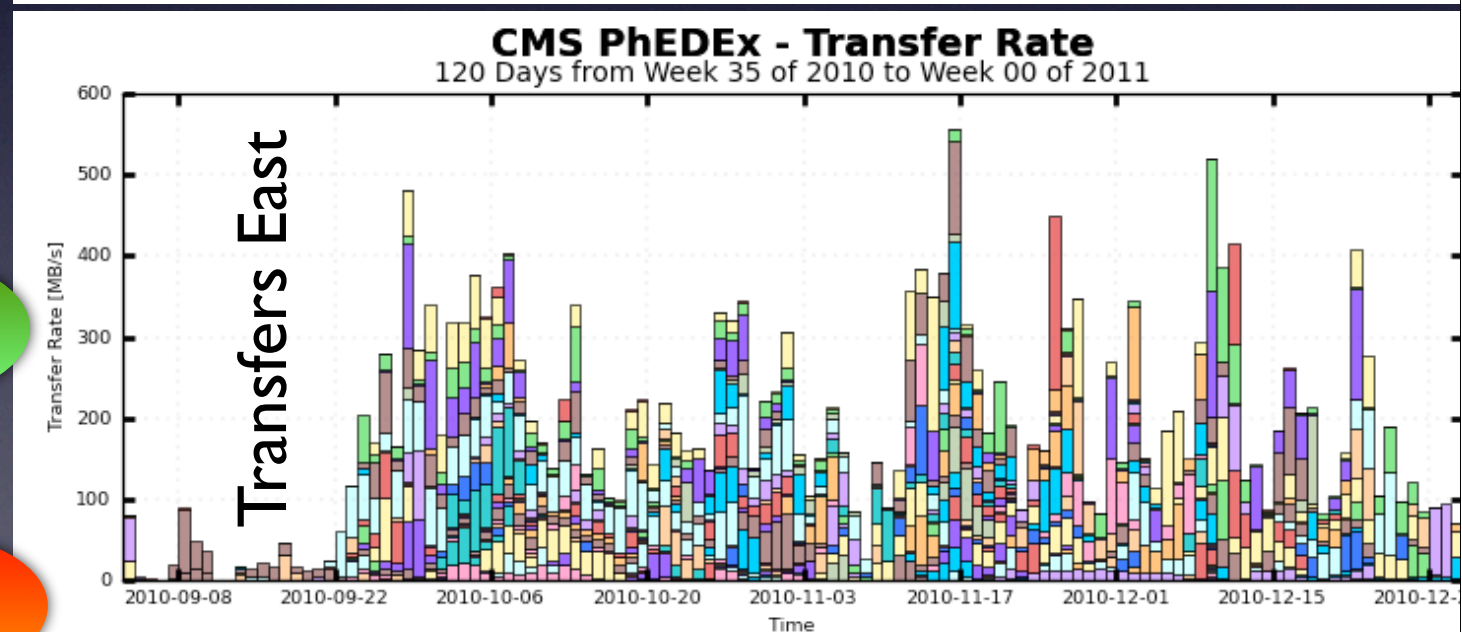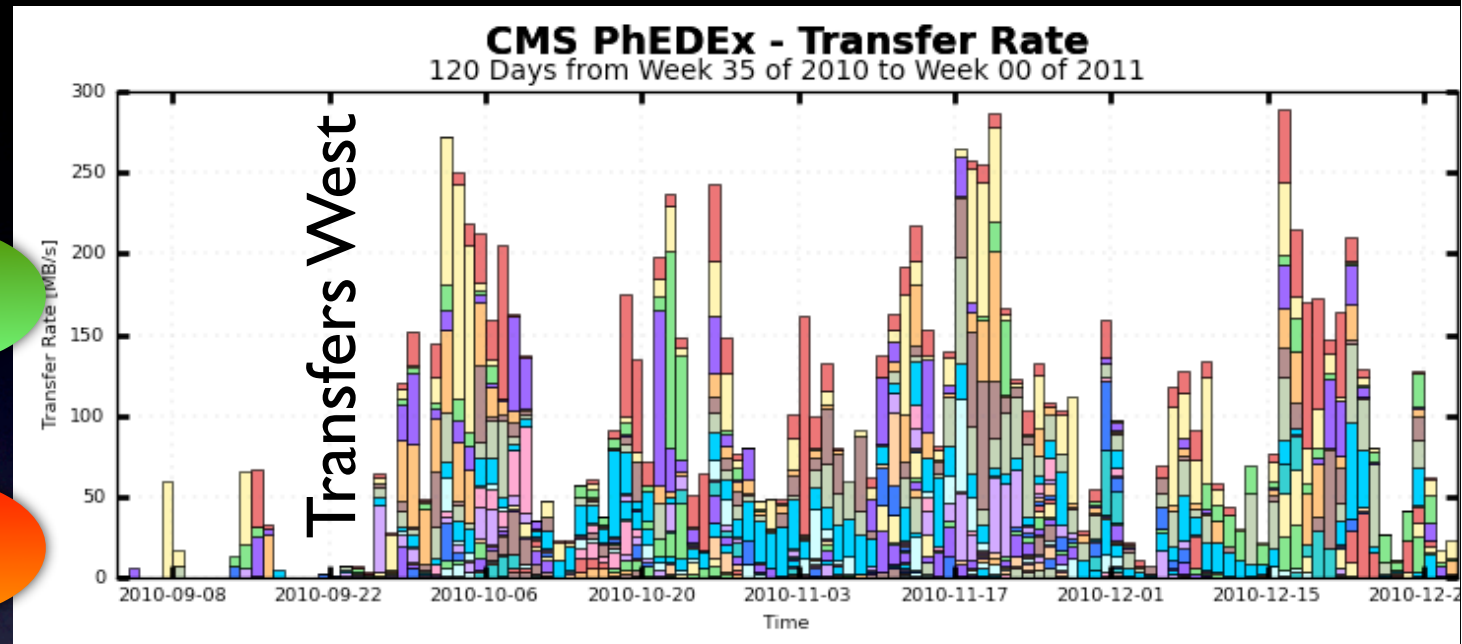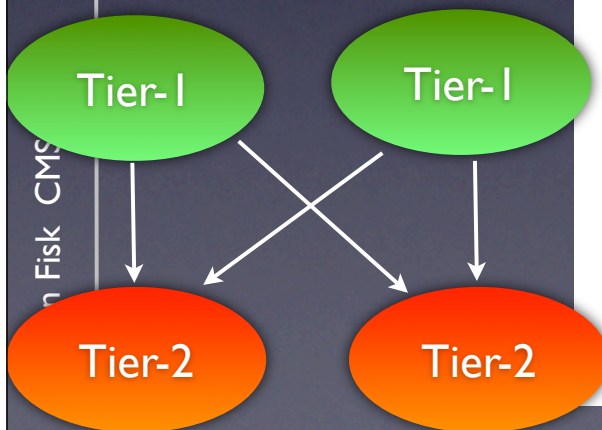- Looking at cloud components and broader use of virtualization

Distribution

- Change from

Tier-1 → Tier-2

Tier-1 → Tier-2

- To

Tier-1, Tier-1 → Tier-2, Tier-2

CMS PhEDEx - Transfer Rate
120 Days from Week 35 of 2010 to Week 00 of 2011

Transfers West

CMS PhEDEx - Transfer Rate
120 Days from Week 35 of 2010 to Week 00 of 2011

Transfers East

Outlook

➡ First year of running on LHC went well

- There are some interesting adjustments to improve the efficiency, but the biggest change in 2011 will be resources constraints

    ✦ Already we see high utilization of Tier-2s and growing Tier-1s

    ✦ Resources will be a premium and optimization and choices will be needed.