Worldwide LHC Computing Grid

Report on Project status, Resources and financial plan

Computing Resources Review Board
24th April 2012

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This status report covers the period from October 2011 – March 2012. Further details on progress, planning and resources, including accounting and reliability data, and detailed quarterly progress reports, can be found in the documents linked to the Reporting section on the WLCG web site.

CONTENT

1. THE WLCG COLLABORATION

1.1. WLCG MOU SIGNATURE STATUS

As mentioned in the previous report the ALICE Tier 2 at Lawrence Livermore National Lab in the USA was granted full member access based on a Letter of Intent. Discussions on how to sign the MoU are on-going, however this Tier 2 site is now reporting and working according to the MoU terms.

Discussions with several new countries (Thailand, Slovakia, Cyprus) that have expressed interest in becoming new Tier 2s are also still on-going.

The list of Tier 1 and Tier 2 sites, together with the various contact names are available on the WLCG web site at http://cern.ch/lcg/mou.htm (Annex 1 and Annex 2). It is important that the lists of contact people given in these tables are kept up to date. Any changes should be signalled to lcg.office@cern.ch.

1.2. PROPOSALS FOR NEW TIER 1 SITES

In recent months there have been discussions with several countries over the suggestions to provide new Tier 1 sites. In order to clarify and facilitate these discussions, a document has been written that describes the process a site proposing to become a Tier 1 should follow. The WLCG Overview Board in its March 2012 meeting approved this process. The document (WLCG-OB-2012-001) is available at the following link:
https://espace.cern.ch/WLCG-document-repository/Collaboration/New%20Tier1%20Process

Also in that meeting of the Overview Board, KISTI (S. Korea) made a proposal to become a new Tier 1 site for ALICE. In accordance with the new process, their application was approved, and KISTI have now the status of "Associate Tier 1", and are expected shortly to provide a detailed plan to achieve the milestones described in the process document.

1.3. OTHER COLLABORATION TOPICS

The Grid Deployment Board, at its meeting in March, has elected a new chairman who will take over the role from May 2012. This is Michel Jouvin of GRIF (Paris), France. The collaboration thanks John Gordon of STFC who has served in this role since 2007, and has seen the change in focus from deployment to real operations and has adapted the work of the GDB accordingly.
One of the tasks of the new chairman is to help continue to develop the GDB into a body that engenders an increased level of technical collaboration between the stakeholders in WLCG. A has been discussed in several recent GDB meetings; this is seen as an important role of the GDB in helping the collaboration to be more self-sufficient in technical areas.

2. WLCG STATUS AND OVERVIEW

2.1. THE WLCG SERVICE

During this reporting period, the main activities were the month of Heavy Ion data taking, and reprocessing of the full 2011 data samples by all 4 experiments. The WLCG service has provided full production service without any significant interruptions. Even during the holiday period resources were occupied and production and analysis work continued. Overall during 2011, the majority of Tier 1 and Tier 2 resources have seen full occupation.

All experiments have worked on improving their software to improve their overall efficiencies. ATLAS and CMS have both made steady and significant improvements specifically to be able to manage the very high pile up rates; while ALICE has implemented improvements to improve the low efficiencies of CPU use that had been observed last year.

ATLAS: during the Christmas technical stop ATLAS completed the HI processing at the Tier 0, and had completed a full reprocessing of the full 2011 pp sample. They have also completed a production of an improved 7 TeV MC sample in preparation for the winter conferences. They were also able to use some Tier 0 capacity for this during the technical stop once the HI processing was completed.

CMS: also did a full reprocessing of the 2011 data and MC samples with their latest improved software, and started MC production for the 8 TeV run. A high level of analysis activities continued in preparation for the conferences. With the increased pile up CMS expect to need to use more of the Tier 0 resources in 2012, and have less time between fills.

LHCb: completed the reprocessing of their 1 fb^{-1} 2011 data sample by the end of November, and over the holiday period completed the MC production for the 2011 configuration. As mentioned previously due to the larger event sizes than anticipated and the increased trigger rates their available disk capacity is very tight. To mitigate this they reduced the copies of data for older processing passes, and have taken steps to have an organised central analysis production to reduce the need for individual group processing. They also have started to commission the online farm for offline use.

ALICE: have also fully processed the 2011 pp data and have performed 2 reconstruction passes of the HI data ready for the conferences. Analysis continues at a high level. Resources are tight for ALICE, but there are prospects of new sites coming on-line for them. The HI run resulted in some 140 M events – the HLT data compression of a factor 3 enabled them to write more data to the Tier 0 in a given bandwidth. Data replication of the HI data to the Tier 1s was completed within a few days of the end of the run. This removes concerns (and risks) related to having only a single copy of data before it is replicated to the Tier 1s as the original expectation was that it would take several weeks.

2.1.1. Tier 0 Performance

The performance of the Tier 0 mass storage system has been very smooth, with unprecedented data rates being demonstrated during the Heavy Ion running in November. Overall some 23 PB of data were written to tape in the Tier 0 in 2011, rather more than the 15 PB anticipated for a nominal year of LHC data taking. This brings the total for 2010+2011 to 38 PB. This rate is expected to continue to increase over the coming year.

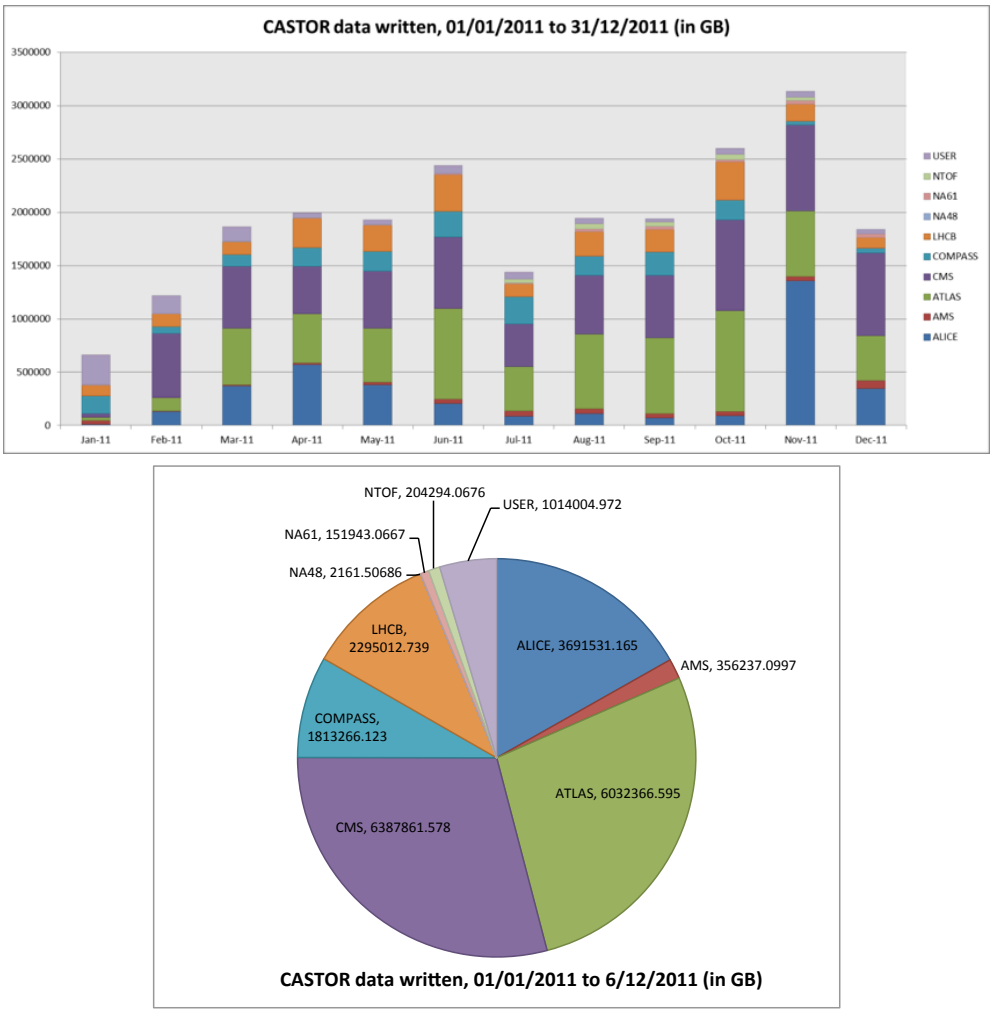

Figure 1: Data written to tape in 2011; 23 PB total: (top) by month and experiment; (bottom) total written by experiment

Figure 1 shows the monthly accumulation of data in 2011, averaging 2 PB/month for pp running and close to 4 PB/month in HI running. The accumulated data by experiment are also shown in the Figure.

Figure 2 shows the data rates into Castor during the HI run. The instantaneous rates from ALICE reached 4 GB/s, limited now only by the fibre connection from the experiment. Total instantaneous rates (from all 3 HI-capable experiments) to tape during HI running exceeded 6 GB/s. In testing, Castor itself was demonstrated to be able to accept data rates far higher than this (in excess of 12 GB/s).

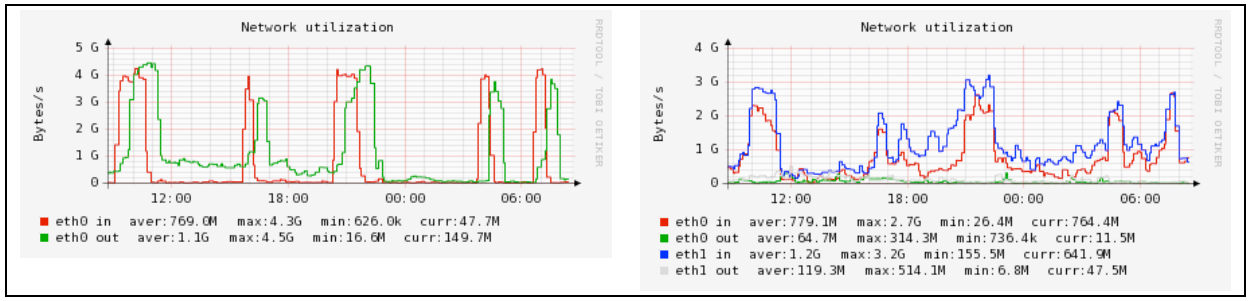

Figure 2: Data rates into Castor during Heavy Ion running: (left) ALICE data alone at > 4 GB/s (red line); (right) total HI rates > 6 GB/s (red+blue lines)

In addition there have been major improvements in tape writing efficiencies in Castor, allowing the tape drives to operate much closer to the native drive speeds, resulting in fewer drives being required to achieve these high data rates. This improved efficiency will result in real cost savings in tape drives in the coming years. The techniques used; which involve buffering the tape marks rather than writing them directly, should in principle be applicable to other tape systems at the Tier 1 sites.

Also at the Tier 0, CMS and ATLAS have migrated the majority of their analysis use to the EOS disk pool service, and LHCb and ALICE will also migrate. This allows a significantly better read performance for analysis than the Castor pools.

2.1.2. WLCG Workloads

Figure 3 and Figure 4 show the continued high use of the grid infrastructure in terms of the numbers of jobs and CPU usage. These figures remain at a high level even during the winter holiday period.

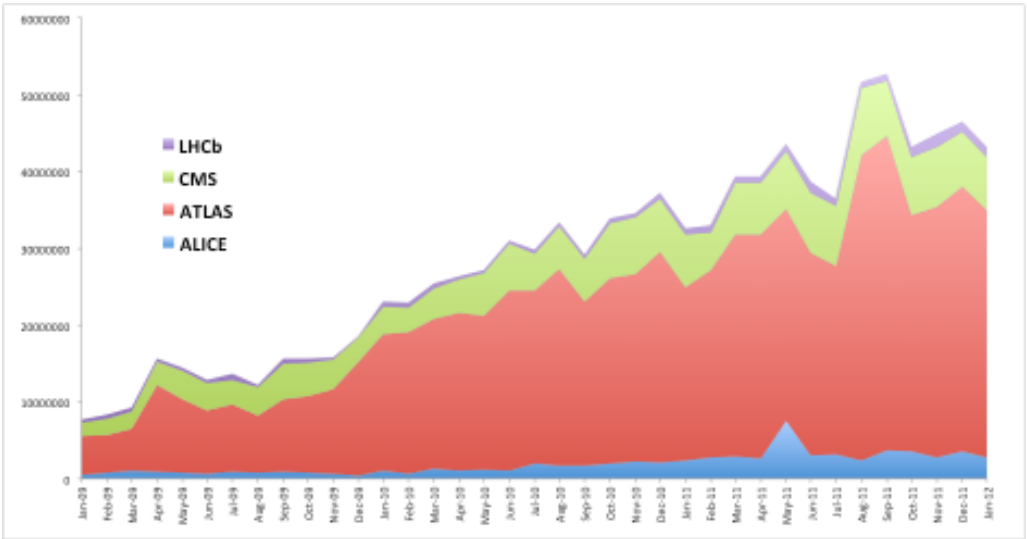

Figure 3: Continued evolution of jobs run per month; well in excess of 1.5 M /day

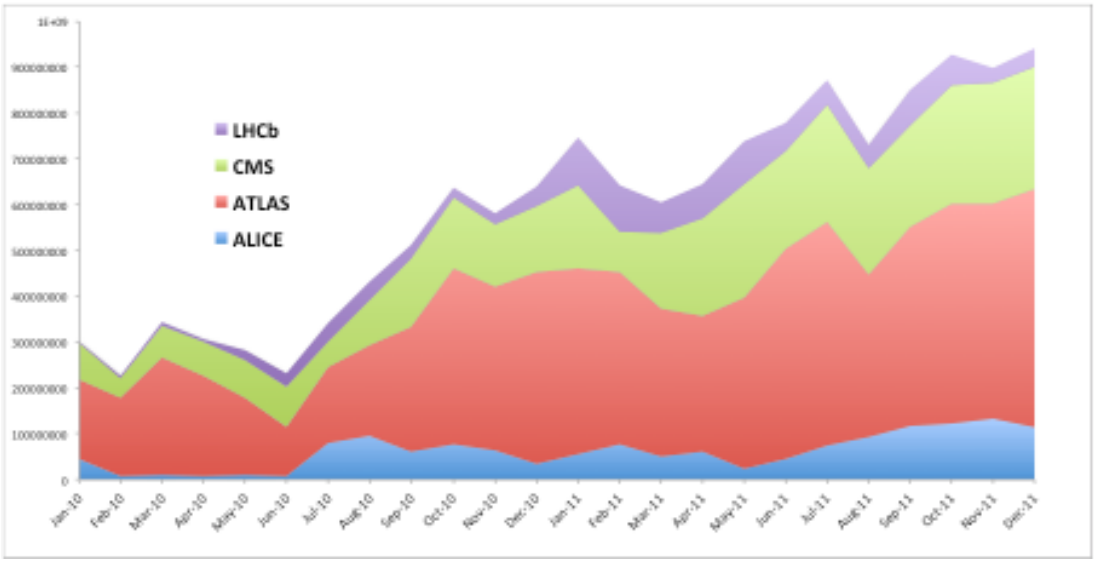

Figure 4: CPU use continues to grow; 10^9 HS06-hours/month (equiv. to ~150 k CPU continuous use)

More details on resource usage are given in Section 4.

2.1.3. WLCG Service Status

As previously described, significant service interruptions require a documented follow up (Service Incident Report). The full list for this period, summarised in the Table below, can be consulted on-line at https://twiki.cern.ch/twiki/bin/view/LCG/WLCGServiceIncidents. The number of incidents serious enough to require this documented follow up continues to decrease.

Figure 5 shows the types of incidents and how this has evolved over the last several years. Also shown in the Figure are the lengths of time needed to resolve the problems. What can be observed is that the majority of problems now are those that take longer to resolve (and are probably thus the most complex ones), and are usually related to the physical infrastructure at a site, or are database-related. However, one should remember that the overall level is now significantly less than earlier, and at a level that is considered to be sustainable in terms of the amount of effort required by sites for daily operations.

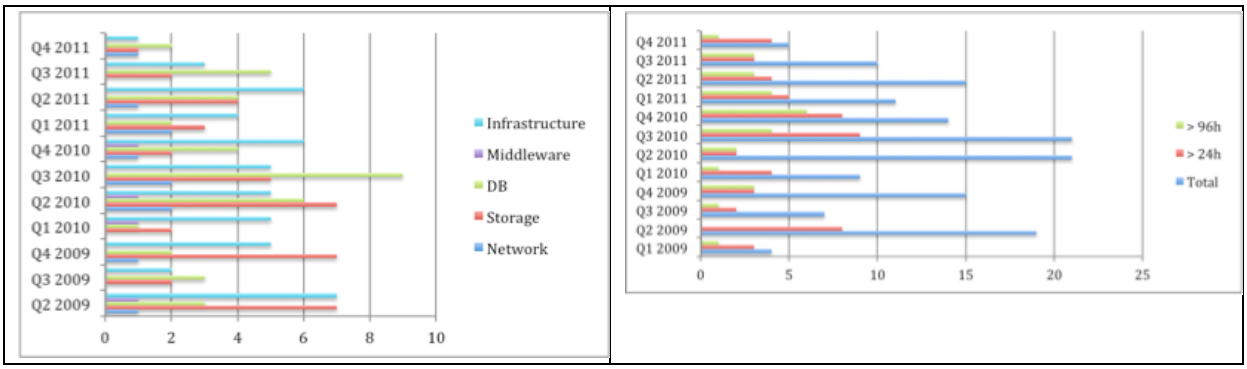

Figure 5: Service Incidents by quarter since 2009: (left) by type; (right) by time to resolve

Site	Service Area	Date	Duration	Service	Impact
CERN (and probably others)	Infrastructure	20 Mar 2012	<=20hrs	GGUS	Some sites couldn't access GGUS web pages
T0+T1s	DB	Q1	n/a	Database	Various
PIC	All Tier1 services	22 Jan 2012	5 hours	All Tier1 services	Outage due to site poweroff caused by cooling incident
CERN	Compute	17/18 Dec 2011	18 hours	CERN batch service	Batch service downtime (unavailable for users)
KIT	Storage	Dez 2011	3 Months	tape archival	2 lost files
KIT	Infrastructure	Nov 4-7	2.5 days	GGUS external interfaces	No ticket updates entered other ticketing systems including SNOW at the T0
RAL	Database (was Storage)	Oct 22-23	1.5 days	CASTOR DB	CASTOR down
CERN	DB	Oct 11		GGUS alarms	GGUS alarm to IT-DB workflow
CERN	DB	Oct 11-12		ATLAS Offline (ATLR)	ATLAS Offline database (ATLR) high load
KIT	Network	Oct 6	24h	GGUS	Ticketing systems at the T0 & some T1s couldn't get GGUS updates.

Table 1: Service Incidents requiring follow-up; Q4 2011 - Q1 2012

2.2. SITE RELIABILITY

The reliabilities for the last 6 months for CERN and the Tier 1 sites are shown in Table 2.

Table 2: WLCG Tier0/1 Site Reliability - last 6 months

Oct 2011 - Mar 2012

Average of the 8 best sites (not always the same 8)					
Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12
100	100	100	100	100	100

Average of ALL Tier0 and Tier 1 sites					
Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12
98	98	99	99	98	99

Detailed Monthly Site Reliability						
Site	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12
CA-TRIUMF	100	99	100	100	100	100
CERN	100	98	98	100	94	94
DE-KIT	96	99	100	100	100	100
ES-PIC	100	100	100	99	100	99
FR-IN2P3	100	100	100	99	96	100
IT-INFN-CNAF	100	100	100	99	100	100
NDGF	100	100	100	100	100	100
NL-T1	100	89	98	99	100	93
TW-ASGC	71	97	94	100	99	99
UK-T1-RAL	98	100	97	98	88	100
US-FNAL-CMS	99	100	100	100	99	100
US-T1-BNL	100	98	99	96	100	100
Target	*97*	*97*	*97*	*97*	*97*	*97*

Colours: Green > Target; Orange > 90% Target; Red < 90% Target

Figure 6 show the recent evolution of the reliabilities for the Tier 1 and Tier 2 sites. These reliabilities continue to be rather stable now for all Tier 1 sites, and the majority of the Tier 2s. Full reports on the availability and reliability of all sites, including the readiness measured by the experiments, can be consulted at http://cern.ch/lcg/reliability.htm.

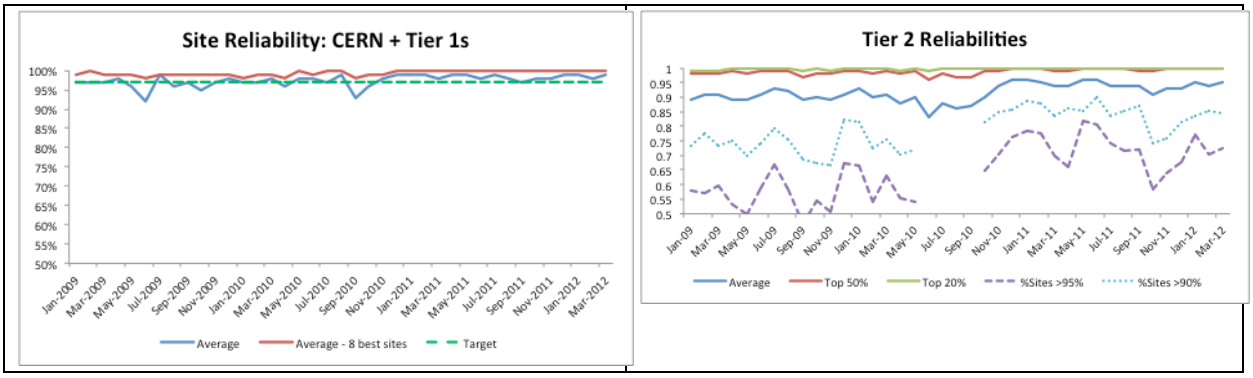

Figure 6: Site reliability evolution for Tier 0+1 (left) and Tier 2 sites (right)

Since February 2012, the experiment-specific availability and reliability reports are now based on the sets of tests run by the experiments (rather than different sub-sets of a standard set). This means that the results of the new test reports are more representative of exactly what the experiments see of the site. This change was coincident with the introduction of a new reliability computation program that enables this level of functionality (allowing to use test results injected into the system). For this reason, the monthly reports now have changed slightly and the history in the reports only goes back to February 2012. Of course all the previous results and reports are still available.

2.3. APPLICATIONS AREA

2.3.1. ROOT

ROOT version 5.32/00 was released on Nov 29, 2011 and includes many improvements in almost all packages. Among the changes it includes a new version of RooFit 3.50 that has undergone a substantial amount of core engineering to improve computational efficiency and improve algorithmic likelihood optimizations. The expected increases in execution speed range from roughly 20% (for problems that were already implemented in a close-to optimal form) to more than 2000% for certain type of problems. The release of ROOT version 5.34 is scheduled for May 29, 2012.

2.3.2. Persistency Framework

Validation of COOL performance on Oracle 11g servers has been completed, confirming that COOL queries exhibit good performance and scalability on 11.2.0.3 for all COOL use cases. The poor performance previously observed on 11.2.0.2 servers is finally confirmed to be due to an Oracle bug, absent in 11.2.0.1 and fixed in 11.2.0.3.

Releases of all PF projects have been prepared for ATLAS and LHCb in Q4 2011 for the five new LCG configurations. Changes to the PF code bases (such as important fixes in CORAL and COOL for the upgrade to Oracle 11g servers), were included in several of these configurations. LCG_62 is the first release that does not include POOL (as discussed below); it also includes the first production build with the gcc46 compiler on SLC5, a preliminary step to the release of the software using this compiler on SLC6.

POOL support has been clarified with LHCb and ATLAS. LHCb has already stopped using POOL, while ATLAS will continue to use it and need support for as long as the 2012 production version of the ATLAS software, based on the LCG61 series, is actively used. ATLAS will no longer need support for POOL for their releases based on LCG62 in 2013.

2.3.3. Simulation

The new Geant4 release 9.5 was announced as scheduled on December 2nd; the validation has been carried out on the grid, making use for the first time of both WLCG and Japanese (KEK) resources, as well as LXBATCH. A technical report on the validation of release 9.5 is available as LCG note (CERN-LCGAPP-2011-04).

The new release includes many new features and fixes. In addition to those mentioned in the previous quarterly report, it should be mentioned: a new model for Bremsstrahlung, based on the tabulated cross-sections published by S.M. Seltzer and M.J. Berger and providing better agreement with the low energy Livermore and Penelope models below 10 MeV and the standard relativistic model at 1 GeV, now used by default at energies below 1 GeV. The Fritiof (FTF) model has been extended to treat interaction of antinucleons with matter. The Binary cascade model has been revised to improve the excitation energy for re-scattering. The physics-lists interface has been revised, allowing a considerable reduction in the number of reference physics-lists, but enabling more options for electromagnetic and ion physics including a new interface to DPMJET-II.5. A new base-material approach is now implemented, allowing reuse of the physics table build for one material by a group of similar materials with different densities. A new geometrical shape, a tube with possible cuts in +-Z, has been defined, completing the set of geometrical primitives foreseen in the GDML schema.

Among the fixes there is a correction to field propagation and navigation for resolving a long-standing issue of charged tracks stuck on boundaries reported by ATLAS. This fix, along with others collected, has been also included in a patch release 9.4.p03 released last December as well, and provided to the LHC experiments for their 2012 simulation production.

The first prototype of the multi-threaded Geant4 (Geant4-MT) based on release 9.4.p01 has been announced early November, now downloadable from the Geant4 web site and available for Alpha-testers.

The Simplified-Calorimeter application for physics validation has been moved to the SVN repository; it now includes also the necessary scripts to allow production of data on distributed resources (including the grid); the code can be used as an example demonstrating how to extend a simulation application to run on the grid.

A new note (CERN-LCGAPP-2011-03) describing validation of meson-induced target diffraction has been prepared.

2.4. PLANNING AND EVOLUTION

2.4.1. Level 1 Milestones

The deployment of CREAM has now reached a point where the majority of the resources (other than those managed through OSG or NDGF) are now accessible through a CREAM CE. The support for the Grid Engine batch system, which was a blocking factor, is now in place. The availability computations now also use the CREAM CE preferentially.

The other significant milestone was the issue of the support for multi-user pilot jobs. During the 2011 data taking addressing this issue was not a priority. The topic has been picked up by the Technical Evolution working groups (see below) and will be addressed in that context.

2.4.2. Technical Evolution of WLCG

As reported to the last RRB, during 2011 a series of working groups were set up to address various aspects of the technical implementation of the WLCG infrastructure and how that is expected or

desired to evolve in the future. Those six working groups ("Technical Evolution Groups" – TEGs) were given until the end of March to produce their initial reports, which they have now done. These reports contain a number of recommendations and proposals for future work. In the coming weeks these reports will be reviewed and a set of concrete actions and proposals will be made. A full coherent report is yet to be made, but the individual reports can be consulted at https://espace.cern.ch/Boards/MB in the "Technical Evolution Strategy" folder.

While there are many details still to analyse from these reports there are already good signs that there is a lot of potential commonality between experiments that can hopefully be exploited, and collaborative efforts built to address developments for the future. This will be particularly important in the coming years as the current round of grid projects in Europe come to an end, and the WLCG collaboration must ensure that it is able to support the software and services required. In a similar vein, another positive outcome of these working groups has been the realisation that there is significant scope to strengthen some collaborative activities between sites and experiments on topics of common interest and that this may be one mechanism to build WLCG community support for parts of the infrastructure and be less reliant on externally funded projects.

Another positive development from the security TEG was a thorough updated risk analysis, and the acceptance by all experiments of a common need to ensure logging and traceability of workloads at a site. This now will enable a common technical implementation to address the "multi-user pilot job" issue that has been long outstanding.

2.4.3. Tier 0 Evolution

As reported at the last RRB meeting, the tendering process for the remote Tier 0 extension was closed at the end of November last year, and the adjudication process concluded in the March 2012 Finance Committee of the CERN Council. The result of the process was that the contract for the Tier 0 extension has been awarded to the Wigner Institute in Budapest, Hungary.

Now that the location is known, work is underway to design the architecture of the future Tier 0 facility to encompass both the CERN and Budapest sites. This has only just started, and will be reported on at a later date. However, the intent is to deploy some services as soon as possible in 2013, and to prepare to have the facility in full production in 2014 ready for the next LHC run after the long shutdown. The expectation is that significant testing activities will take place during 2013.

The consolidation work to provide additional critical power to the existing CERN Computer Centre is also on-going and is scheduled to finish in October 2012.

3. FUNDING AND EXPENDITURE FOR WLCG AT CERN

Following the final book-closing exercise of 2011 there is a 4.9 MCHF carry-forward from 2011 to 2012-2015. Table 3 shows current and future estimated expenditure for the years 2012-2017 inclusive based on the CERN Medium term Plan and the current WLCG Personnel and Material planning.

Table 3: LHC Computing budget estimates for 2012-2017

LHC Future Computing Funding and Expenditure Estimates
(all figures in MCHF)

	2012	2013	2014	2015	2016	2017	TOTAL
Funding							
From CERN Budget							
- Personnel	16.5	17.0	17.0	16.9	17.0	17.0	**101.4**
- Materials *	25.8	23.0	23.3	21.3	20.3	20.3	**134.0**
Contributions via Team Accounts**							
- Personnel	1.0	0.5					**1.5**
- Materials							
Total							
- Personnel	**17.5**	**17.5**	**17.0**	**16.9**	**17.0**	**17.0**	**102.9**
- Materials	**25.8**	**23.0**	**23.3**	**21.3**	**20.3**	**20.3**	**134.0**
Total Funding	**43.4**	**40.5**	**40.3**	**38.2**	**37.3**	**37.3**	**236.8**
Expenditure							
- Personnel ***	**17.0**	**17.7**	**17.2**	**17.1**	**17.0**	**16.7**	**102.7**
- Materials	**26.4**	**23.1**	**22.3**	**22.7**	**21.2**	**19.8**	**135.5**
Total Planned Expenditure	**43.4**	**40.8**	**39.6**	**39.8**	**38.3**	**36.5**	**238.3**
Balance Personnel	**0.5**	**-0.2**	**-0.2**	**-0.2**	**-0.1**	**0.3**	**0.1**
Balance Materials	**-0.5**	**-0.1**	**0.9**	**-1.4**	**-0.9**	**0.5**	**-1.5**
Balance	**0.0**	**-0.3**	**0.7**	**-1.6**	**-1.0**	**0.8**	**-1.4**

* Includes 4.9 MCHF carry-forward from 2011 to 2012-2015
** As planned to be pledged in the WLCG MoU (Annex 6.6)
*** Excluding EGI/EMI funded personnel and Computer Centre Operators

For personnel costs, nominative details continue to be entered in the CERN APT planning tool, including current personnel commitments, planned replacements and estimates for on-going recruitment from 2012 and beyond. There is little discrepancy relative to the budget and factors such as internal mobility, resignations, and later than expected start dates can impact these figures at any time.

The Materials planning is based on the current LCG resource planning, based on provisional requirements that evolve frequently, and on the latest LHC accelerator schedule. In addition the planning for the consolidation of the existing Computer Centre and the remote extension have continually evolved. Now that the tender for the remote centre has been adjudicated, the cost planning

will start to be firmed up. Overall there are no major problems foreseen in the materials budget, although we count on the continued project flexibility to carry-forward into future years where necessary.

4. RESOURCES

4.1. RESOURCE ACCOUNTING

Full accounting reports are published monthly for the Tier 0, Tier 1, and Tier 2 sites. These reports are archived in the WLCG Document Repository.

4.1.1. CERN and Tier 1 Accounting

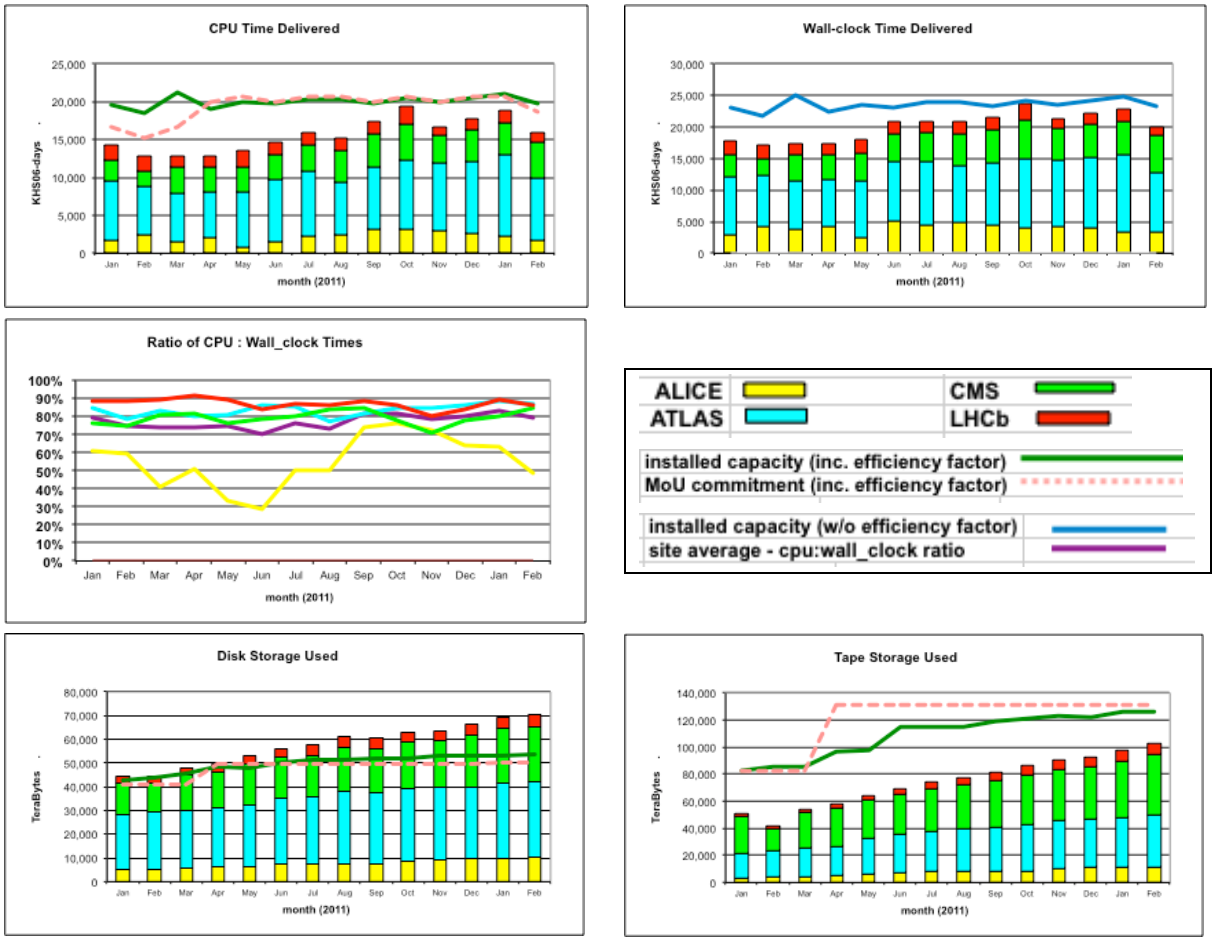

Figure 7: Accounting for Tier 0 + Tier 1s; Jan 2011 - Feb 2012

Figure 7 shows the summary of the usage of CPU, Disk, and Tape at the Tier 0 and Tier 1 sites for 2011 and Jan, Feb of 2012. The use is compared globally with the pledges and installed capacity in this Figure, while in Figure 8 the experiments' use of CPU is compared to the pledges directly. As can be seen, the Tier 1 use is close to 100% almost all of the time. It is also clear that at certain times (e.g. early in the year, when the following year pledges start to be installed) the experiments are able to use more than the nominal pledges. LHCb and ALICE in particular can be seen to make use of significantly more than their nominal pledges when resources are available.

The earlier problems with low CPU efficiency for ALICE were addressed through a series of actions, and these have improved the situation for the production activities. However, the efficiency is still lower for ad-hoc analysis activities, and at times when there is more such use (such as Jan, Feb of

2012) the overall efficiency still appears low. ALICE are working to adapt their analysis activities to improve this.

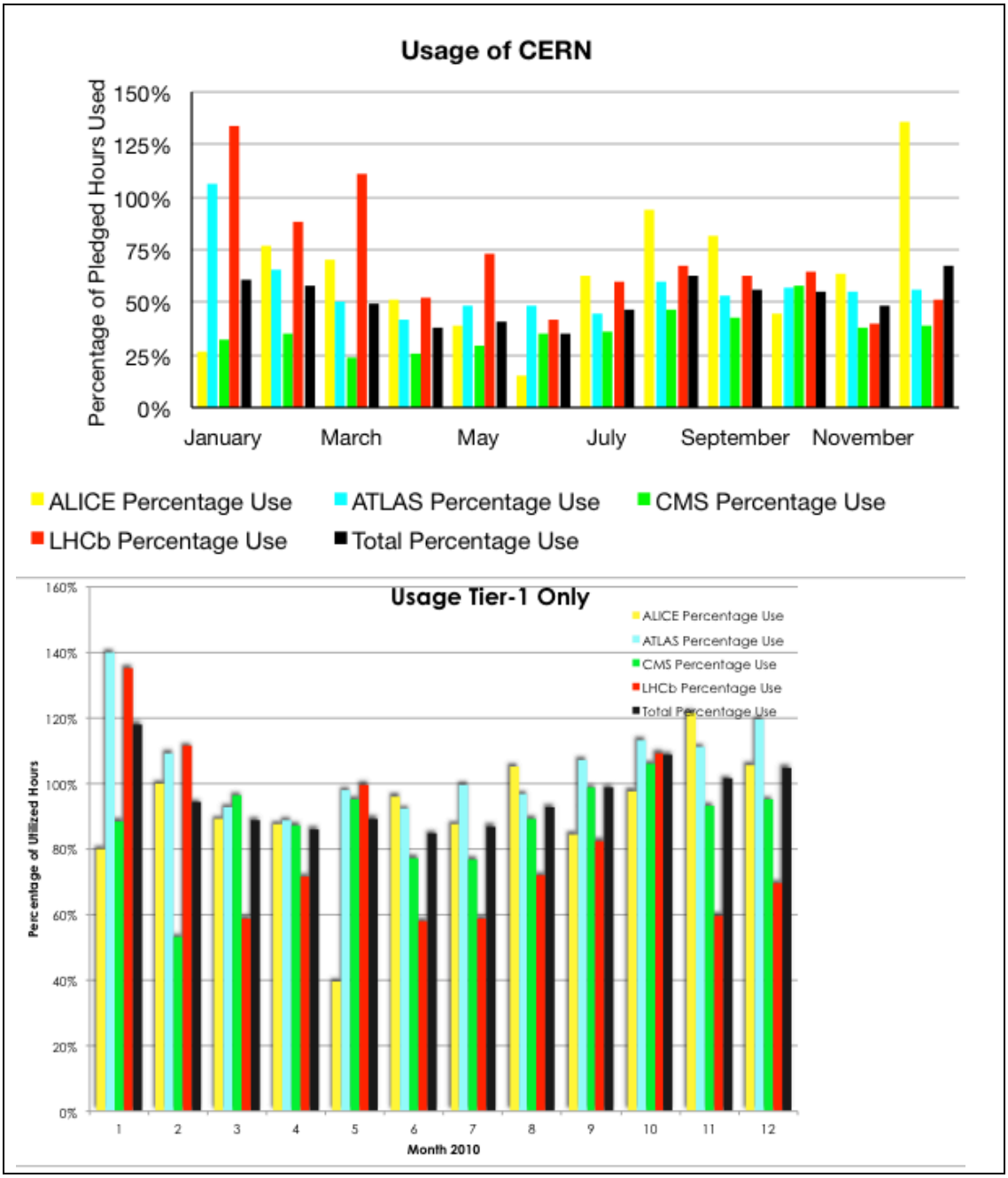

Figure 8: Comparison of CPU usage with pledges for 2011;(top) CERN; (bottom) Tier 1s

4.1.2. Tier 2 Accounting

Tier 2 accounting reports can also be found in the WLCG Document Repository.

Figure 9 shows the Federations with 2011 pledge values above 9000 HS06 and Figure 10 all those with pledge values below 9000 HS06, in both cases ordered by pledge and showing CPU used monthly from November 2011 to February 2012.

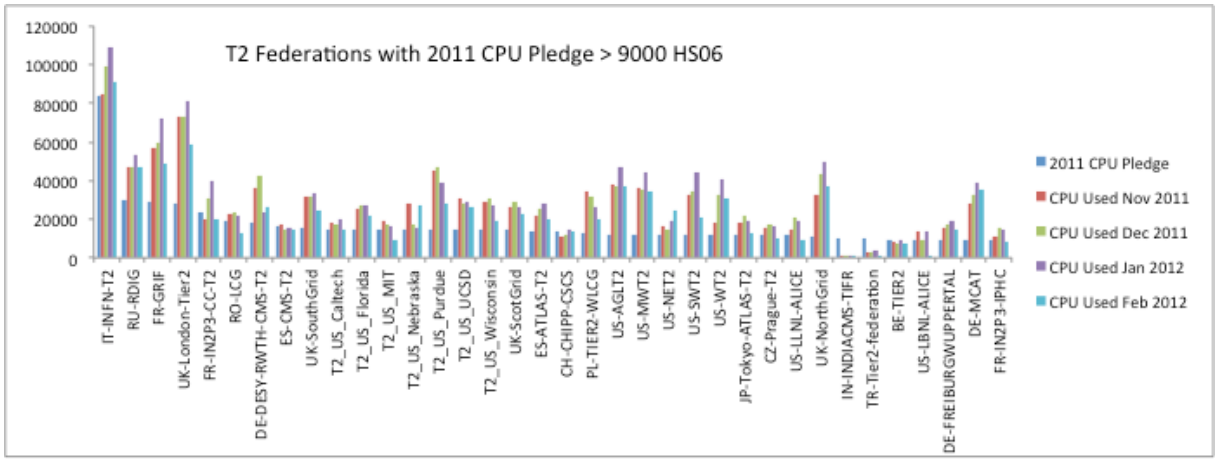

Figure 9: Accounting for Tier 2 Federations with 2011 CPU pledge > 9000 HS06 Nov 2011 - Feb 2012

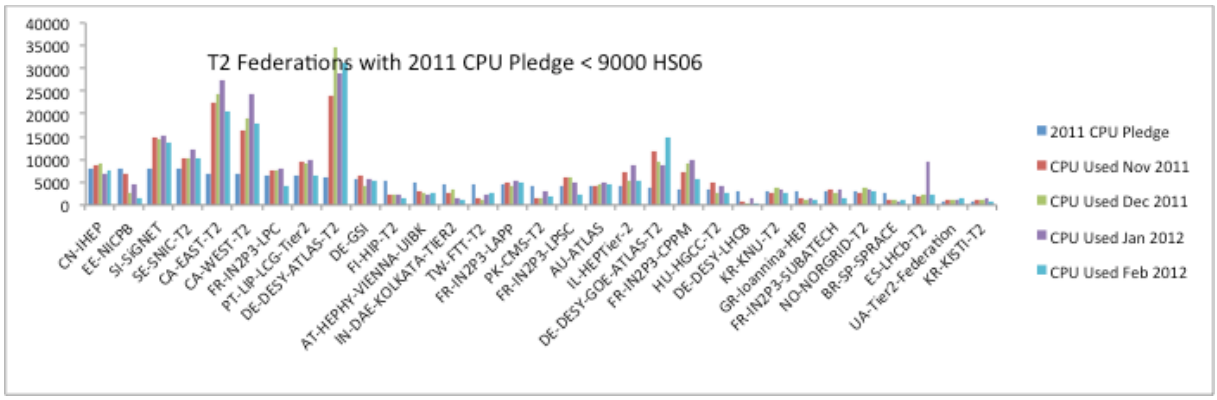

Figure 10: Accounting for Tier 2 Federations with 2011 CPU pledge < 9000 HS06 Nov 2011 - Feb 2012

Figure 11 shows the cumulative Tier 2 CPU delivered during 2011 and the first 2 months of 2012 by country. This partitioning is very close to that expected from the pledge values.

Figure 12 compares the Tier 2 CPU delivered in 2011 with the pledges, for each experiment and overall. Again, as was observed with the Tier 1s the overall use is at or even above 100% (indicating that often more resources are available than actually pledged), and that LHCb in particular have been able to make good use of available resources not specifically pledged to them.

Overall it is clear that resources in Tier 1 and Tier 2 sites are being very well used by all 4 experiments, and that there is very little free capacity. The exception is the Tier 0, where the capacity must be available for the periods when the accelerator is running, but is not necessarily used fully outside of those times. In the long shutdown, the experiments intend to make full use of the CERN resources as additional analysis capacity.

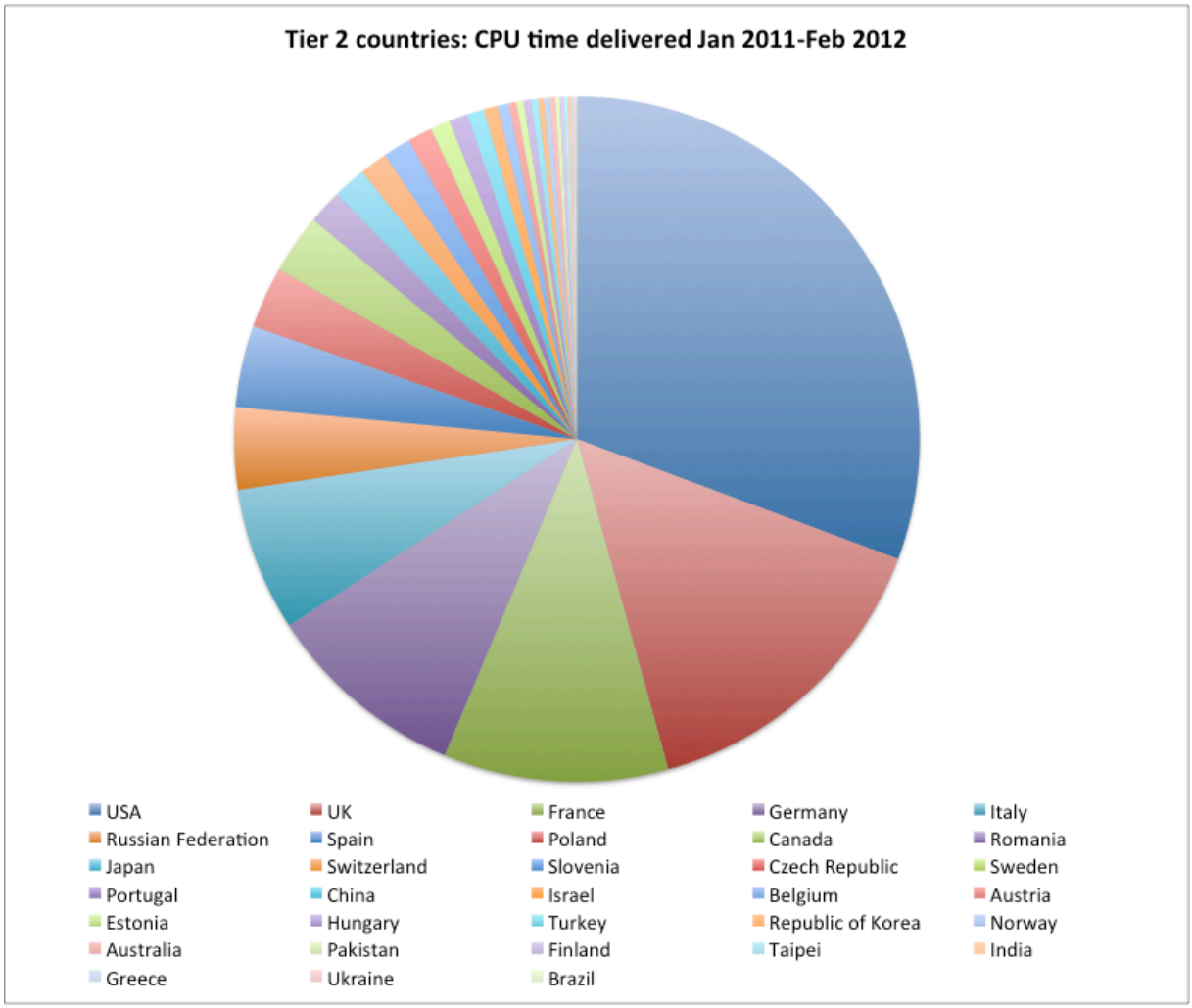

Figure 11: Tier 2 cumulative CPU time delivered by Country (Jan 2011 - Feb 2012)

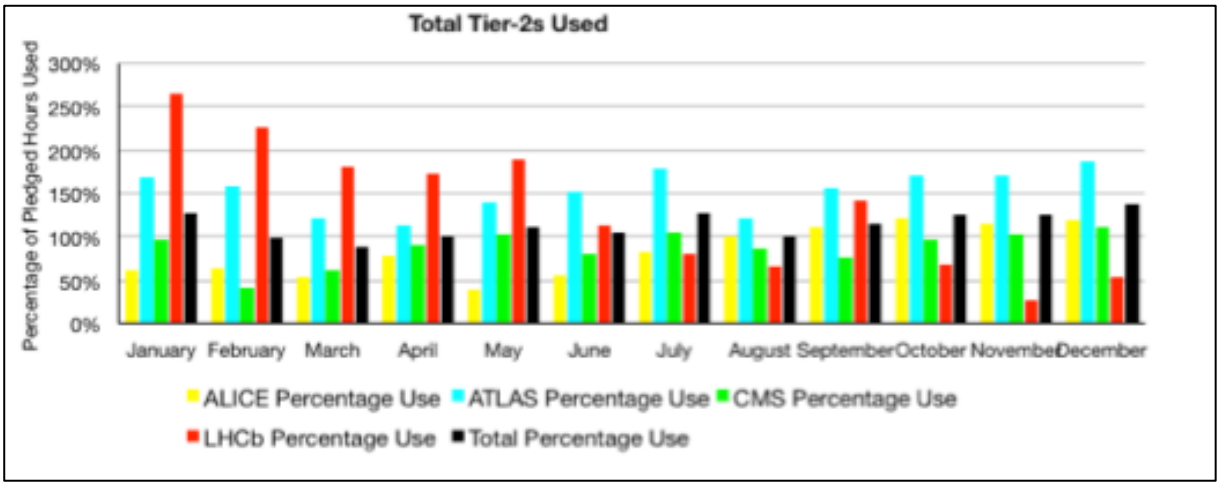

Figure 12: Comparison of CPU usage with pledges for 2011: Tier 2s

4.2. STATUS OF EXPERIMENT REQUIREMENTS AND RESOURCE PLEDGES

As described at the previous RRB meeting, the requirements and pledges are now managed through the online REBUS tool. Figure 13 gives a snapshot of the situation in for 2012 April 2012 (but this can be consulted using the REBUS tool at any time). The annexes of this report give the detailed breakdown by experiment and federation for 2012 and 2013.

Tier	Pledge Type	ALICE	Required	Balance	ATLAS	Required	Balance	CMS	Required	Balance	LHCb	Required	Balance	SUM	Required	Balance
Tier 0	CPU (HEP-SPEC06)	90000	116000	-22%	111000	111000	0%	121000	120000	1%	34000	34000	0%	356000	381000	-7%
Tier 0	Disk (Tbytes)	8100	14300	-43%	9000	9000	0%	7000	7000	0%	3500	3500	0%	27600	33800	-18%
Tier 0	Tape (Tbytes)	20000	20000	0%	18000	18000	0%	23000	23000	0%	6400	6400	0%	67400	67400	0%
Tier 1	CPU (HEP-SPEC06)	94507	160000	-41%	288472	259000	11%	137085	145000	-5%	90567	113000	-20%	610631	677000	-10%
Tier 1	Disk (Tbytes)	7030	10800	-35%	30548	27000	13%	20882	22000	-5%	7360	9500	-23%	65820	69300	-5%
Tier 1	Tape (Tbytes)	11523	21000	-45%	39108	29000	35%	46531	45000	3%	5572	6200	-10%	102734	101200	2%
Tier 2	CPU (HEP-SPEC06)	128688	145000	-11%	328237	266000	23%	320373	315000	2%	47335	43000	10%	824633	769000	7%
Tier 2	Disk (Tbytes)	9109	8300	10%	45059	47000	-4%	26520	26000	2%	296	0	0%	80984	81300	0%

Figure 13: Summary of pledge situation for 2012: Experiment requirements updated since October 2011 RRB, compared to pledge data of March 2012

The data in this snapshot has changed somewhat with respect to what was shown at the last RRB. The requirements of ATLAS and CMS have been updated slightly following discussions with the C-RSG following the report at the last meeting. However, what is not yet reflected in this snapshot is the updated requirements for ALICE, which have significantly decreased with respect to last October, particularly at CERN, to be more in line with what is pledged. This change was again following discussions with the LHCC and the scrutiny group, as well as following significant work invested by ALICE in software improvements and adapting computing strategies that will permit them to be more in line with resources available.

Figure 14 and Figure 15 show the installation status of the 2012 pledges. In general the sites are on track to have the majority of the pledges in place according to the agreed schedules. The fear at the time of the last RRB that the floods in Thailand that disrupted disk production would seriously affect the availability and cost of the pledge purchases has not really been a major factor. There has been some cost impact, but availabilities have generally not been affected. The largest impact was at CERN were some 15% of the pledges are not available in April.

Finally, 3 of the experiments (ATLAS, CMS, and LHCb) have all expressed the desire to take additional triggers during the 2012 run, which they may not be able to process until 2013 during the long shutdown. The intent is to extend the physics reach of the experiments. These ideas were discussed in the March LHCC meetings. The LHCC supports these experiment strategies to take advantage of the unique situation provided by the long shutdown. These additional data do require some additional computing resources in 2013 relative to what has been discussed so far, and the experiments are expected to update their 2013 requests accordingly.

Tier-1	CPU	Disk	Tape	Tier-2
CERN	85% in April and 100% at the end of May	85% in April and 100% at the end of May	ok	-
Canada, TRIUMF	In production	In production by 1 Apr	In production by 1 Apr	**Tier-2 east federation:** ok. **Tier-2 west federation:** CPU: ok, disk: expected on time (in procurement).
France, CC-IN2P3	97% in production (no further increase for 2012)	88% in production (no further increase for 2012)	98% of pledge will be provided	**Lyon Tier-2:** CPU: 99 %, Disk: 97% (no further increase for 2012). **GRIF Tier-2:** 10 % reduction of ATLAS pledges. **IPHC Tier-2:** ok for Apr. **SUBATECH Tier-2:** disk may be delayed due to late delivery. **CPPM Tier-2:** by 1 Apr. **LPSC Tier-2:** CPU: by Apr, disk: 90% by end Apr. **LAPP Tier-2:** disk may be affected by supply problems. **LPC Tier-2:** disk by Sep.
Germany, GridKA	by end Jun (with additional kHEPSPECs - compensation for late delivery)	by early Apr	ok	**Aachen CMS-Tier2:** ok. **Atlas-T2s MPPMU, Wuppertal**: ok, **LRZ and Freiburg** ready before April 1st. **GoeGrid (Goettingen):** Disk delayed. **Alice-T2 @ GSI:** CPUs in place, Disks may be delayed by a few weeks. **DESY(Atlas, CMS, LHCb)** ok.
Italy, CNAF	~80% now and rest in production by Apr	~30% now and rest in production by end Apr	by end Apr	**Alice T2s:** CPU: by Apr, disk: mostly ok (complete by end Jun). **Atlas T2s:** CPU: by Apr, disk: by end Apr. **CMS T2s:** CPU: by Apr, disk: 50% by Apr (rest by Sep). **LHCb T2:** CPU: by Apr, no disk.
Netherlands, NIKHEF/SARA	Expected for Oct (in negotiation)	Expected for Oct (in negotiation)	ok	no tier-2s
Nordic Data Grid Facility (NDGF)	Installed	100% by ~Jun (80% installed or in shipping and rest expected in Apr)	ok	**SE-SNIC-T2:** ok. **HIP-FI-T2:** disk is being intalled. **SIGMA-UNINETT-T2:** by ~Jun (delivery in Apr).
Spain, PIC	By mid-March (35% above pledge)	By mid-March (35% above pledge)	ok	**ATLAS T2 Federation Spain:** CPU: ok (15% above pledge), disk: by 1 Apr (85% now). **CMS T2 Federation Spain:** CPU: ok (25% above pledge), disk: ok (10% above pledge). **LHCb T2 Federation Spain:** ok. **ATLAS LIP T2 Federation, Portugal:** ok.
Tapei, ASGC	Installed	90% in March and 100% by July	ok	**T2 TW-FTT:** CPU:ok. Disk: 72.5% in March and 100% by July. **CMS T2 LCG_KNU:** ok
UK, RAL	deployment by Apr	deployment by Apr	ok	**UK Tier 2s:** All ok
USA, BNL	Installed	Installed	ok	**US-ATLAS:** CPU: ok. Disk: 88% and rest in Apr
USA, FNAL	Installed	Installed	ok	**7 US Tier 2 sites:** CPU: ok. Disk: ok (aggregate of 7 PB, with some site-to-site variation above and below 1 PB). **SPRACE T2:** by end of May (pledge: 10 kHS06 and 720 TB of disk).

Figure 14: Installation status of pledges for 2012; Tier 0, countries with Tier 1s and associated Tier 2s

-	-	-	-	**Greece IOANNINA T2** CPU: 62% installed, remainder by September, Disk: 94% installed, no further increase expected as only 30% used.
-	-	-	-	**Israel Tier2** CPU: 100% available, new CPUs to be installed by mid-May, Disk: 66% installed, full pledge expected by mid-May.
-	-	-	-	**India Kolkata Tier-2** CPU: 100% available, Disk: 96% installed, full pledge expected by (tbc).
-	-	-	-	**KISTI ALICE Tier-2** CPU: 100% available, Disk: 100% available.
-	-	-	-	**CH-CHIPP-CSCS Tier-2** CPU: 83% available by April and at least 100% end July following re-location of the T2 site, Disk: 100% available.
-	-	-	-	**T2-IN-TIFR** CPU: 82% available, 100% end July, Disk: 77% available, 100% end July.
-	-	-	-	**Turkey, Turkish Tier-2 Federation** CPU: 45% available, Disk: 56% available, due to reorganisation definitive date for full pledge not yet known.
-	-	-	-	**T2_HU_Budapest** CPU: ok, Disk: ok.
-	-	-	-	**Czech Republic FZU Prague** CPU: ok, Disk:80% Available, 100% from July.
-	-	-	-	**JP-TOKYO-ATLAS-T2** CPU: ok, 133%, Disk: ok.
-	-	-	-	**Austrian Tier-2 Federation** CPU: ok, Disk: ok.
-	-	-	-	**Estonia NICPB** CPU: ok, Disk: ok. Preliminary estimate from current tender process is to double the computing capacity and increase the storage capacity to 1PB while improving the overall performance. Availability estimated at late summer/early Autumn
-	-	-	-	**WLCG-PK-CMS-T2** CPU: ok, Disk: 56% installed, 100% June-July.
-	-	-	-	**RO-LCG Tier-2** CPU: ok revised, increased pledge, Disk: 90% installed, 100% August following procurement delays revised, increased pledge.
-	-	-	-	**Ukranian Tier-2 Federation** CPU: 50% available, 100% expected by September, Disk: 50% available, 100% expected by September.
-	-	-	-	**Australia Tier-2** CPU: 77% available, 100% expected by May, Disk: 70% available, 100% expected by May.
-	-	-	-	**Slovenia SiGNET Tier-2** CPU: 133% available, Disk: 66% available, delay due to funding delays and cooling upgrade in the computing room which is also delayed 100% expected by Autumn.
-	-	-	-	**WLCG-CN-IHEP** CPU: 92% available, 100% expected by mid-June, Disk: 100%.

Figure 15: Installation status of pledges for 2012; other Tier 2 countries

5. ANNEX: TIER 0/1 RESOURCES

WLCG Tier 0-1 Resources
Situation on 16 April 2012

CERN-RRB-2012-041
Annex 1

CERN Tier0 / CAF	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	264100	356000	356000	Offered	90000	111000	121000	34000	356000
				Required	116000	73000	120000	34000	343000
				% of Req.	78%	152%	101%	100%	104%
Disk (Tbytes)	19100	27600	29100	Offered	8100	9000	7000	3500	27600
				Required	14300	9000	5500	3500	32300
				% of Req.	57%	100%	127%	100%	85%
Tape (Tbytes)	43100	67400	70700	Offered	20000	18000	23000	6400	67400
				Required	20000	18000	23000	6000	67000
				% of Req.	100%	100%	100%	107%	101%

Canada Tier1	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	11300	25900	27300	Offered		25900			25900
				% of Total		10%			10%
Disk (Tbytes)	1240	2700	3000	Offered		2700			2700
				% of Total		10%			10%
Tape (Tbytes)	1505	3600	4000	Offered		3600			3600
				% of Total		10%			10%

KIT	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	83550	106580	108200	Offered	40000	32380	15000	19200	106580
				% of Total	25%	13%	10%	17%	16%
Disk (Tbytes)	7805	9885	11030	Offered	2700	3375	2200	1610	9885
				% of Total	25%	13%	10%	17%	14%
Tape (Tbytes)	13290	15900	19260	Offered	5250	4500	5100	1050	15900
				% of Total	25%	13%	10%	18%	14%

IN2P3 Lyon (note 4)	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	72331	68100	70150	Offered	7700	31350	10350	18700	68100
				% of Total	5%	12%	7%	17%	10%
Disk (Tbytes)	6761	6480	7240	Offered	710	3440	1240	1090	6480
				% of Total	7%	13%	6%	11%	9%
Tape (Tbytes)	10426	8800	9000	Offered	800	3400	3600	1000	8800
				% of Total	4%	9%	7%	17%	8%

INFN CNAF	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	59500	85000	85000	Offered	25000	25000	18500	16500	85000
				% of Total	16%	10%	13%	15%	13%
Disk (Tbytes)	6250	8500	8950	Offered	1600	2700	2800	1400	8500
				% of Total	15%	10%	13%	15%	12%
Tape (Tbytes)	9900	14100	16600	Offered	3000	3600	6600	900	14100
				% of Total	14%	10%	13%	15%	12%

Netherlands LHC/Tier1 (Note 1)	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	61296	55083	59790	Offered	6220	35015		13848	55083
				% of Total	4%	14%		12%	10%
Disk (Tbytes)	4736	4743	5243	Offered	511	3422		810	4743
				% of Total	5%	13%		9%	10%
Tape (Tbytes)	5593	5393	6793	Offered	231	4210		952	5393
				% of Total	1%	12%		16%	9%

NDGF Tier1	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	18319	25764	28049	Offered	12535	13229			25764
				% of Total	8%	5%			6%
Disk (Tbytes)	1964	2690	2987	Offered	1325	1365			2690
				% of Total	12%	5%			7%
Tape (Tbytes)	2566	3672	4560	Offered	1761	1911			3672
				% of Total	8%	5%			6%

Spain PIC	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	23272	26367	26928	Offered		13209	7395	5763	26367
				% of Total		5%	5%	5%	5%
Disk (Tbytes)	2438	2984	3473	Offered		1377	1122	485	2984
				% of Total		5%	5%	5%	5%
Tape (Tbytes)	4234	4743	5457	Offered		1836	2601	306	4743
				% of Total		5%	5%	5%	5%

WLCG Tier 0-1 Resources
Situation on 16 April 2012

CERN-RRB-2012-041
Annex 1

Taipei ASGC	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	32000	33075	33874	Offered		16835	16240		33075
				% of Total		7%	11%		8%
Disk (Tbytes)	3600	3920	4275	Offered		2160	1760		3920
				% of Total		8%	8%		8%
Tape (Tbytes)	4000	4710	5940	Offered		2160	2550		4710
				% of Total		6%	5%		5%

UK Tier1 (Notes 2 + 3)	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	54736	62055	62629	Offered	3200	32375	11600	14880	62055
				% of Total	2%	13%	8%	13%	9%
Disk (Tbytes)	5469	7118	8149	Offered	216	3375	1760	1767	7118
				% of Total	2%	13%	8%	19%	10%
Tape (Tbytes)	8860	10116	11768	Offered	420	4500	4080	1116	10116
				% of Total	2%	13%	8%	19%	9%

US-ATLAS Tier1	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	51980	60000	63000	Offered		60000			60000
				% of Total		23%			23%
Disk (Tbytes)	5704	6300	7000	Offered		6300			6300
				% of Total		23%			23%
Tape (Tbytes)	6923	8300	9200	Offered		8300			8300
				% of Total		23%			23%

US-CMS Tier1	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	56000	58000	58000	Offered			58000		58000
				% of Total			40%		40%
Disk (Tbytes)	6500	10000	11000	Offered			10000		10000
				% of Total			45%		45%
Tape (Tbytes)	21000	22000	24000	Offered			22000		22000
				% of Total			43%		43%

Summary Ext. Tier1s	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	524284	605924	622920	Offered	94655	285293	137085	88891	605924
				Required	160000	259000	145000	113000	677000
				Balance	-41%	10%	-5%	-21%	-10%
Disk (Tbytes)	52467	65320	72347	Offered	7062	30214	20882	7162	65320
				Required	10800	27000	22000	9500	69300
				Balance	-35%	12%	-5%	-25%	-6%
Tape (Tbytes)	88297	101334	116578	Offered	11462	38017	46531	5324	101334
				Required	21000	36000	51000	6000	114000
				Balance	-45%	6%	-9%	-11%	-11%

Ext. Tier1 Requ. 2012	ALICE	ATLAS	CMS	LHCb	SUM
CPU (HEP-SPEC06)	160000	259000	145000	113000	677000
Disk (Tbytes)	10800	27000	22000	9500	69300
Tape (Tbytes)	21000	36000	51000	6000	114000

TIER 1 Notes

Note 1: Netherlands: The OB recommends the pledge table is changed for NL-T1, to delay pledges by 1 year to guarantee they can be commissioned by the start of the LHC year; the realized 2011 pledges become those of 2012.

Note 2: UK : The LHCb CPU pledge is based on the average LHCb Tier-1 CPU requirement, rather than the peak requirement, on the assumption that the UK Tier-1 should be able to meet peak requirements for LHCb by adjusting the fair-shares during the peak periods.

Note 3: UK: UK Tape is provisioned on demand. The full pledge will not be deployed until required.

Note 4: France: April 2012 - Revised pledges due to reduced funding

See also the online WLCG Resources Pledges database at: **http://gstat-wlcg.cern.ch/apps/pledges/**

6. ANNEX: TIER 2 RESOURCES

WLCG Tier 2 Resources
Situation on 16 April 2012

CERN-RRB-2012-041
Annex 2

Australia, University of Melbourne	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	4000	6500	6500	Offered		6500			6500
				% of Total		2%			1%
Disk (Tbytes)	400	700	700	Offered		700			700
				% of Total		1%			1%

Austria, Austrian Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	5057	5057	5057	Offered		1857	3200		5057
				% of Total		1%	1%		2%
Disk (Tbytes)	420	420	420	Offered		120	300		420
				% of Total		0%	1%		1%

Belgium, Belgian Tier-2 Fed. FNRS/FWO	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	9600	9600	9600	Offered			9600		9600
				% of Total			3%		3%
Disk (Tbytes)	1190	1560	1560	Offered			1560		1560
				% of Total			6%		6%

Brazil, SPRACE, Sao Paulo	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	2630	10000	10000	Offered			10000		10000
				% of Total			3%		3%
Disk (Tbytes)	120	720	720	Offered			720		720
				% of Total			3%		3%

Canada, Canada-East Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	6672	6650	7225	Offered		6650			6650
				% of Total		3%			3%
Disk (Tbytes)	902	1175	1325	Offered		1175			1175
				% of Total		3%			3%

Canada, Canada-West Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	6672	6650	7225	Offered		6650			6650
				% of Total		3%			3%
Disk (Tbytes)	902	1175	1325	Offered		1175			1175
				% of Total		3%			3%

China, IHEP, Beijing	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	8000	9600	9600	Offered		4800	4800		9600
				% of Total		2%	2%		2%
Disk (Tbytes)	600	640	640	Offered		320	320		640
				% of Total		1%	1%		1%

Czech Rep., FZU, Prague	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	11500	15000	13000	Offered	5000	10000			15000
				% of Total	3%	4%			4%
Disk (Tbytes)	1060	1450	1350	Offered	420	1030			1450
				% of Total	5%	2%			3%

Estonia, NICPB, Tallinn	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	8000	10000	16000	Offered			10000		10000
				% of Total			3%		3%
Disk (Tbytes)	280	750	750	Offered			750		750
				% of Total			3%		3%

Finland, NDGF/HIP Tier-2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	5250	6300	6300	Offered			6300		6300
				% of Total			2%		2%
Disk (Tbytes)	346	520	520	Offered			520		520
				% of Total			2%		2%

France, CC-IN2P3 AF, Lyon	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	23781	23850	23850	Offered	2300	9750	6600	5200	23850
				% of Total	2%	4%	2%	12%	3%
Disk (Tbytes)	2033	2030	2090	Offered	210	1310	510	0	2030
				% of Total	3%	3%	2%	0%	2%

France, CPPM, Marseille	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	3350	4264	4264	Offered		2264		2000	4264
				% of Total		1%		5%	1%
Disk (Tbytes)	254	404	419	Offered		400		4	404
				% of Total		1%		20%	1%

France, GRIF, Paris	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	28960	29053	32679	Offered	6670	9044	9293	4046	29053
				% of Total	5%	3%	3%	9%	4%
Disk (Tbytes)	2221	2748	3294	Offered	381	1598	767	2	2748
				% of Total	5%	3%	3%	10%	3%

WLCG Tier 2 Resources

Situation on 16 April 2012

CERN-RRB-2012-041
Annex 2

France, IPHC, Strasbourg	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	9100	11000	11000	Offered	3500		7500		11000
				% of Total	2%		2%		2%
Disk (Tbytes)	550	800	800	Offered	200		600		800
				% of Total	2%		2%		2%

France, LAPP, Annecy	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	4400	4800	5600	Offered		3200		1600	4800
				% of Total		1%		4%	2%
Disk (Tbytes)	412	462	652	Offered		460		2	462
				% of Total		1%		10%	1%

France, LPC, Clermont	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	6527	6527	8000	Offered	2078	3146		1303	6527
				% of Total	1%	1%		3%	1%
Disk (Tbytes)	609	677	796	Offered	119	556		2	677
				% of Total	1%	1%		10%	1%

France, LPSC Grenoble	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	4246	4222	4613	Offered	1900	2322			4222
				% of Total	1%	1%			1%
Disk (Tbytes)	419	519	589	Offered	109	410			519
				% of Total	0%	0%			0%

France, Subatech, Nantes	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	3000	3000	3000	Offered	3000				3000
				% of Total	2%				2%
Disk (Tbytes)	270	310	310	Offered	310				310
				% of Total	4%				4%

Germany, ATLAS Federation, DESY	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	6200	12000	12000	Offered		12000			12000
				% of Total		5%			5%
Disk (Tbytes)	1050	1500	1500	Offered		1500			1500
				% of Total		3%			3%

Germany, ATLAS Federation, U. Goettingen	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	3800	3853	3853	Offered		3853			3853
				% of Total		1%			1%
Disk (Tbytes)	400	1000	1000	Offered		1000			1000
				% of Total		2%			2%

Germany, CMS Federation DESY RWTH Aachen	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	18400	23625	23625	Offered			23625		23625
				% of Total			8%		8%
Disk (Tbytes)	970	1950	1950	Offered			1950		1950
				% of Total			8%		8%

Germany, DESY-LHCb	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	3200	3200	3200	Offered				3200	3200
				% of Total				7%	7%
Disk (Tbytes)	2	2	2	Offered				2	2
				% of Total				10%	10%

Germany, GSI, Darmstadt	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	5700	7000	7000	Offered	7000				7000
				% of Total	5%				5%
Disk (Tbytes)	440	550	550	Offered	550				550
				% of Total	7%				7%

Germany, ATLAS Federation Munich	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	9220	11560	11560	Offered		11560			11560
				% of Total		4%			4%
Disk (Tbytes)	1040	1340	1340	Offered		1340			1340
				% of Total		3%			3%

Germany, ATLAS Fed. Freiburg Wuppertal	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	9243	8860	8860	Offered		8860			8860
				% of Total		3%			3%
Disk (Tbytes)	1151	1566	1566	Offered		1566			1566
				% of Total		3%			3%

Greece, HEP Laboratory, University of Ioannina	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	3040	3040	3040	Offered			3040		3040
				% of Total			1%		1%
Disk (Tbytes)	200	200	200	Offered			200		200
				% of Total			1%		1%

Hungary, HGCC Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	3340	3760	4300	Offered	960		2800		3760
				% of Total	1%		1%		1%
Disk (Tbytes)	146	204	282	Offered	54		150		204
				% of Total	1%		1%		1%

Situation on 16 April 2012 — WLCG **Annex 2**

India, VECC/SINP, Kolkata	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	4700	6000	6000	Offered	6000				6000
				% of Total	4%				4%
Disk (Tbytes)	150	240	240	Offered	240				240
				% of Total	3%				3%

India, TIFR, Mumbai (Note 1)	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	10400	3000	7000	Offered			3000		3000
				% of Total			1%		1%
Disk (Tbytes)	750	700	850	Offered			700		700
				% of Total			3%		3%

Israel, IL-HEP Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	4000	4800	5400	Offered		4800			4800
				% of Total		2%			2%
Disk (Tbytes)	560	735	840	Offered		735			735
				% of Total		2%			2%

Italy, INFN T2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	84000	102100	102100	Offered	25000	26600	44000	6500	102100
				% of Total	17%	10%	14%	15%	13%
Disk (Tbytes)	5900	8200	8200	Offered	1400	3400	3400		8200
				% of Total	17%	7%	13%		10%

Japan, ICEPP, Tokyo	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	12000	12000	15000	Offered		12000			12000
				% of Total		5%			5%
Disk (Tbytes)	1000	1200	1500	Offered		1200			1200
				% of Total		3%			3%

Republic of Korea, KISTI, Daejeon	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	600	600	600	Offered	600				600
				% of Total	0%				0%
Disk (Tbytes)	50	50	50	Offered	50				50
				% of Total	1%				1%

Republic of Korea, CHEP of KNU, Daegu	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	3200	3600	4000	Offered			3600		3600
				% of Total			1%		1%
Disk (Tbytes)	230	250	250	Offered			250		250
				% of Total			1%		1%

Norway, UNINETT SIGMA Tier2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	2905	3275	3838	Offered		3275			3275
				% of Total		1%			1%
Disk (Tbytes)	273	488	620	Offered		488			488
				% of Total		1%			1%

Pakistan, Pakistan Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	4352	5440	6365	Offered			5440		5440
				% of Total			2%		2%
Disk (Tbytes)	300	300	300	Offered			300		300
				% of Total			1%		1%

Poland, Polish Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	13050	15800	18200	Offered	4240	4840	4060	2660	15800
				% of Total	3%	2%	1%	6%	2%
Disk (Tbytes)	810	1010	1180	Offered	300	480	230		1010
				% of Total	4%	1%	1%		1%

Portugal, LIP Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	6400	6400	6400	Offered		3200	3200		6400
				% of Total		1%	1%		1%
Disk (Tbytes)	420	420	420	Offered		220	200		420
				% of Total		0%	1%		1%

Romania, Romanian Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	19000	32800	27400	Offered	16000	13000		3800	32800
				% of Total	11%	5%		9%	7%
Disk (Tbytes)	1705	2050	1990	Offered	1200	810		40	2050
				% of Total	14%	2%		200%	4%

Russian Federation, RDIG (note 2)	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	30000	51498	63036	Offered	14530	17105	17105	2758	51498
				% of Total	10%	6%	5%	6%	7%
Disk (Tbytes)	2800	4429	5534	Offered	1250	1471	1471	237	4429
				% of Total	15%	3%	6%	1185%	5%

Slovenia, SiGNET, Jozef Stefan Inst.	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	8000	12000	20000	Offered		12000			12000
				% of Total		5%			5%
Disk (Tbytes)	600	900	1500	Offered		900			900
				% of Total		2%			2%

WLCG Tier 2 Resources

Situation on 16 April 2012

CERN-RRB-2012-041
Annex 2

Spain, ATLAS Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	13900	13300	14450	Offered		13300			13300
				% of Total		5%			5%
Disk (Tbytes)	1880	2350	2650	Offered		2350			2350
				% of Total		5%			5%

Spain, CMS Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	16000	15750	15750	Offered			15750		15750
				% of Total			5%		5%
Disk (Tbytes)	1000	1300	1300	Offered			1300		1300
				% of Total			5%		5%

Spain, LHCb Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	2340	2800	2800	Offered				2800	2800
				% of Total				7%	7%
Disk (Tbytes)	1	1	1	Offered				1	1
				% of Total				5%	5%

Sweden, SNIC Tier2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	7870	7870	7870	Offered	2820	5050			7870
				% of Total	2%	2%			2%
Disk (Tbytes)	920	920	920	Offered	400	520			920
				% of Total	5%	1%			2%

Switzerland, CHIPP, Manno	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	13550	17670	20800	Offered		7100	7100	3470	17670
				% of Total		3%	2%	8%	3%
Disk (Tbytes)	975	1226	1474	Offered		612	612	2	1226
				% of Total		1%	2%	10%	2%

Taipei, Taiwan Analysis Facility Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	4480	5320	6000	Offered		2660	2660		5320
				% of Total		1%	1%		1%
Disk (Tbytes)	480	600	650	Offered		340	260		600
				% of Total		1%	1%		1%

Turkey, Turkish Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	9800	9800	9800	Offered		5100	4700		9800
				% of Total		2%	1%		2%
Disk (Tbytes)	900	900	900	Offered		550	350		900
				% of Total		1%	1%		1%

UK, London	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	28186	26225	27094	Offered		10050	14809	1366	26225
				% of Total		4%	5%	3%	4%
Disk (Tbytes)	2440	3079	3295	Offered		1688	1390	1	3079
				% of Total		4%	5%	5%	4%

UK, NorthGrid	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	11185	15953	17121	Offered		13508		2445	15953
				% of Total		5%		6%	5%
Disk (Tbytes)	1540	2170	2447	Offered		2169		1	2170
				% of Total		5%		5%	5%

UK, ScotGrid	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	14630	9635	10233	Offered		6918		2717	9635
				% of Total		3%		6%	3%
Disk (Tbytes)	1238	1291	1456	Offered		1290		1	1291
				% of Total		3%		5%	3%

UK, SouthGrid	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15425	17536	17716	Offered	2900	2775	10391	1470	17536
				% of Total	2%	1%	3%	3%	2%
Disk (Tbytes)	1210	1585	1678	Offered	166	728	690	1	1585
				% of Total	2%	2%	3%	5%	2%

Ukraine, Ukrainian Tier-2 Federation	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	637	4690	1100	Offered	690		4000		4690
				% of Total	0%		1%		1%
Disk (Tbytes)	100	380	100	Offered	80		300		380
				% of Total	1%		1%		1%

USA, LBNL ALICE Berkeley CA	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	9500	12000	14500	Offered	12000				12000
				% of Total	8%				8%
Disk (Tbytes)	740	1020	1200	Offered	1020				1020
				% of Total	12%				12%

USA, LLNL ALICE, Livermore CA	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	11500	11500	11500	Offered	11500				11500
				% of Total	8%				8%
Disk (Tbytes)	650	650	650	Offered	650				650
				% of Total	8%				8%

WLCG Tier 2 Resources
Situation on 16 April 2012

CERN-RRB-2012-041
Annex 2

USA, Northeast ATLAS T2 (Note 3)	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	12232	12500	13400	Offered		12500			12500
				% of Total		5%			5%
Disk (Tbytes)	1654	1648	2500	Offered		1648			1648
				% of Total		4%			4%

USA, Southwest ATLAS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	12232	12500	13400	Offered		12500			12500
				% of Total		5%			5%
Disk (Tbytes)	1654	2200	2500	Offered		2200			2200
				% of Total		5%			5%

USA, Midwest ATLAS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	12232	12500	13400	Offered		12500			12500
				% of Total		5%			5%
Disk (Tbytes)	1654	2200	2500	Offered		2200			2200
				% of Total		5%			5%

USA, Great Lakes ATLAS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	12232	12500	13400	Offered		12500			12500
				% of Total		5%			5%
Disk (Tbytes)	1654	2200	2500	Offered		2200			2200
				% of Total		5%			5%

USA, SLAC ATLAS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	12232	12500	13400	Offered		12500			12500
				% of Total		5%			5%
Disk (Tbytes)	1654	2200	2500	Offered		2200			2200
				% of Total		5%			5%

USA, Caltech CMS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15000	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	900	1000	1000	Offered			1000		1000
				% of Total			4%		4%

USA, Florida CMS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15000	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	900	1000	1000	Offered			1000		1000
				% of Total			4%		4%

USA, MIT CMS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15000	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	900	1000	1000	Offered			1000		1000
				% of Total			4%		4%

USA, Nebraska CMS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15000	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	900	1000	1000	Offered			1000		1000
				% of Total			4%		4%

USA, Purdue CMS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15000	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	900	1000	1000	Offered			1000		1000
				% of Total			4%		4%

USA, UC San Diego CMS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15000	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	900	1000	1000	Offered			1000		1000
				% of Total			4%		4%

USA, U. Wisconsin CMS T2	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	SUM 2012
CPU (HEP-SPEC06)	15000	12500	12500	Offered			12500		12500
				% of Total			4%		4%
Disk (Tbytes)	900	1000	1000	Offered			1000		1000
				% of Total			4%		4%

WLCG Tier 2 Resources

Situation on 16 April 2012

CERN-RRB-2012-041
Annex 2

Summary Tier2s with Split in 2012	2011	2012	2013	Split 2012	ALICE	ATLAS	CMS	LHCb	Sum 2012
CPU (HEP-SPEC06)	740658	828333	877524	Offered	128688	328237	324073	47335	828333
				Required	145000	266000	315000	43000	769000
				Balance	-11%	23%	3%	10%	8%
Disk (Tbytes)	62579	81264	88345	Offered	9109	45059	26800	296	81264
				Required	8300	47000	26000	20	81320
				Balance	10%	-4%	3%	1380%	0%

Requirements 2012	ALICE	ATLAS	CMS	LHCb	SUM
CPU (HEP-SPEC06)	145000	266000	315000	43000	769000
Disk (Tbytes)	8300	47000	26000	20	81320
Number of T2s					67

TIER 2 Notes

Note 1: India (Mumbai): CPU and storage hardware may not be fully online by April 2012

Note 2: Russia: CPU breakdown between VOs is not normally calculated as all CPU resources in all sites are available for all experiments. For the sake of REBUS, the 2011 disk VO allocation percentage has been used to calculate the theoretical breakdown between VOs.

Note 3: USA (NorthEast ATLAS): As of April 2012 USA, Northeast T2 will provide 1,648 TB of disk storage capacity that will grow to 2,324 TB by the end of calendar year 2012.

See also the online WLCG Resources Pledges database at: http://gstat-wlcg.cern.ch/apps/pledges/