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# The Basic Elements of a Computing and Data Processing Model: The LHC Perspective

2nd ASPERA Workshop, Barcelona May 30 2011

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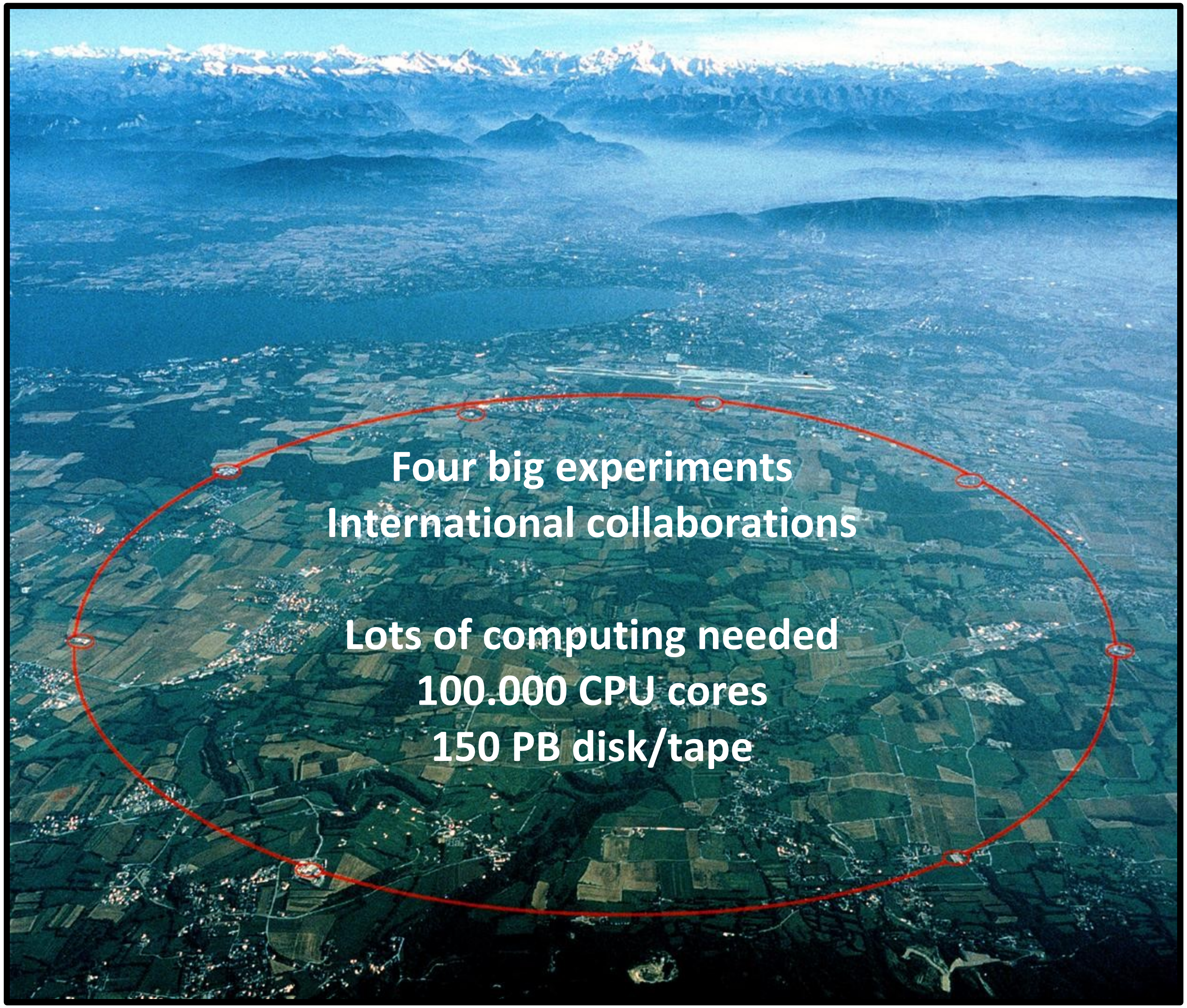
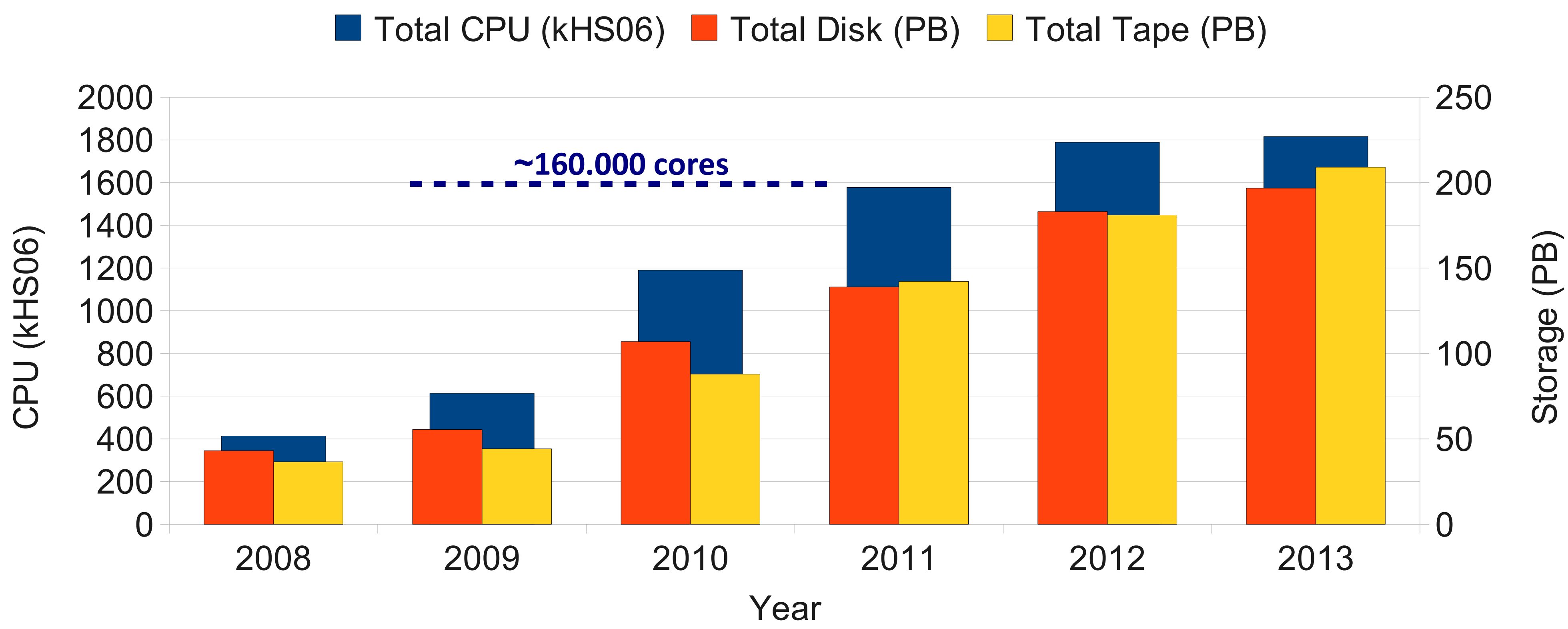
# Large Hadron Collider



# LHC computing requirements

The LHC computing needs are really large, with a constantly growing profile during the lifetime of the experiment (10-15 years).




*For a definition of HS06 CPU benchmark see http://w3.hepix.org/benchmarks*

# WLCG Memorandum of Understanding

Signed by Funding Agencies (52 F.A., 35 countries) representatives for LHC computing centres.

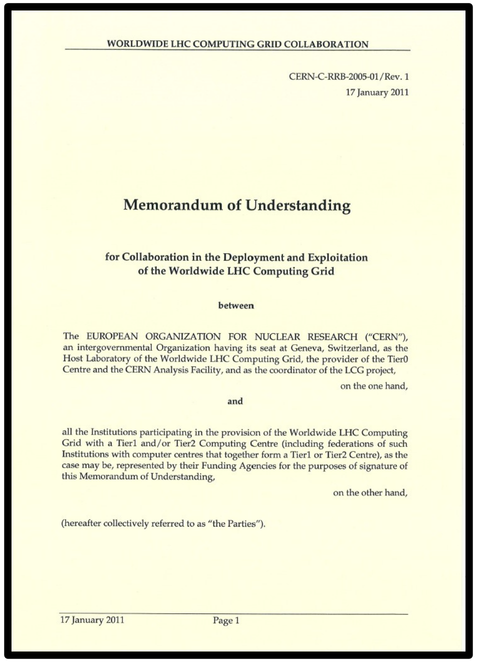
Defines

- Rights and duties of WLCG partners (Capacity Pledges & Quality of Service)
- A yearly process for capacity planning. Two annual meetings:
  - Spring:
    - Accounting report for the preceding year.
    - Experiment resource requests for the following 3 years.
  - Autumn:
    - Commitment made for the coming year.

Detailed resource pledges contained in the Annexes (updated at every meeting)

The resource requirements are obtained from the experiment Computing Models.

- This information is taken as input by each Funding Agency to compute their sites pledges.



WORLDWIDE LHC COMPUTING GRID COLLABORATION

CERN-C-RRB-2005-01/Rev. 1
17 January 2011

**Memorandum of Understanding**

**for Collaboration in the Deployment and Exploitation of the Worldwide LHC Computing Grid**

**between**

The EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ("CERN"), an intergovernmental Organization having its seat at Geneva, Switzerland, as the Host Laboratory of the Worldwide LHC Computing Grid, the provider of the Tier0 Centre and the CERN Analysis Facility, and as the coordinator of the LCG project,

on the one hand,

**and**

all the Institutions participating in the provision of the Worldwide LHC Computing Grid with a Tier1 and/or Tier2 Computing Centre (including federations of such Institutions with computer centres that together form a Tier1 or Tier2 Centre), as the case may be, represented by their Funding Agencies for the purposes of signature of this Memorandum of Understanding,

on the other hand,

(hereafter collectively referred to as "the Parties").

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*http://www.cern.ch/lcg/mou.htm*

# High level parameters

## Data Types

- RAW: real data coming from the detector
- RECO
- NTUP
- SIM

| | MB/evt |
|---|---|
| RAW size | 1.4 |
| RECO size | 1.8 |
| SIM size | 2 |

| | Efficiency |
|---|---|
| Disk | 70% |
| Tape | 100% |

## Work Flows

- Reconstruction: Calo clusters, tracks, particle ID ...
- Analysis: Selection algorithms, ...
- Simulation
- ...

| | HS06/evt |
|---|---|
| CPU RECO | 100 |
| CPU SIMUL | 4100 |

| | Efficiency |
|---|---|
| Data proc. | 80% |
| User Analysis | 60% |
| Simulation | 80% |

| | |
|---|---|
| Event Rate | 200 Hz |
| LHC Collisions Time | 3 Msec. |

# User analysis

One of the most difficult parts to model. Need to make some assumptions

Scheduled (group) analysis

- N physics groups (e.g. ATLAS set this to 20 in their original CM)
- N passes of full sample /year (e.g. ATLAS set this to 4 in their original CM)

Chaotic (individual) analysis: First, estimate the number of active users, then for each user:

- "... X analysis passes over Y% of the events collected"
- "... reconstruct X% of the physics events once a year "
- "... generate X events of private MC simulation"
- "... will use X TB of disk space to store private output"

# Big changes

As the experiment develops, big changes will occur, e.g:

- LHC schedule (Jan 2011: decision to move shutdown year from 2012 to 2013)
- Increase trigger rate due to physics interests
- LHC conditions: Nr. of p-p collisions per bunch crossing larger than planned

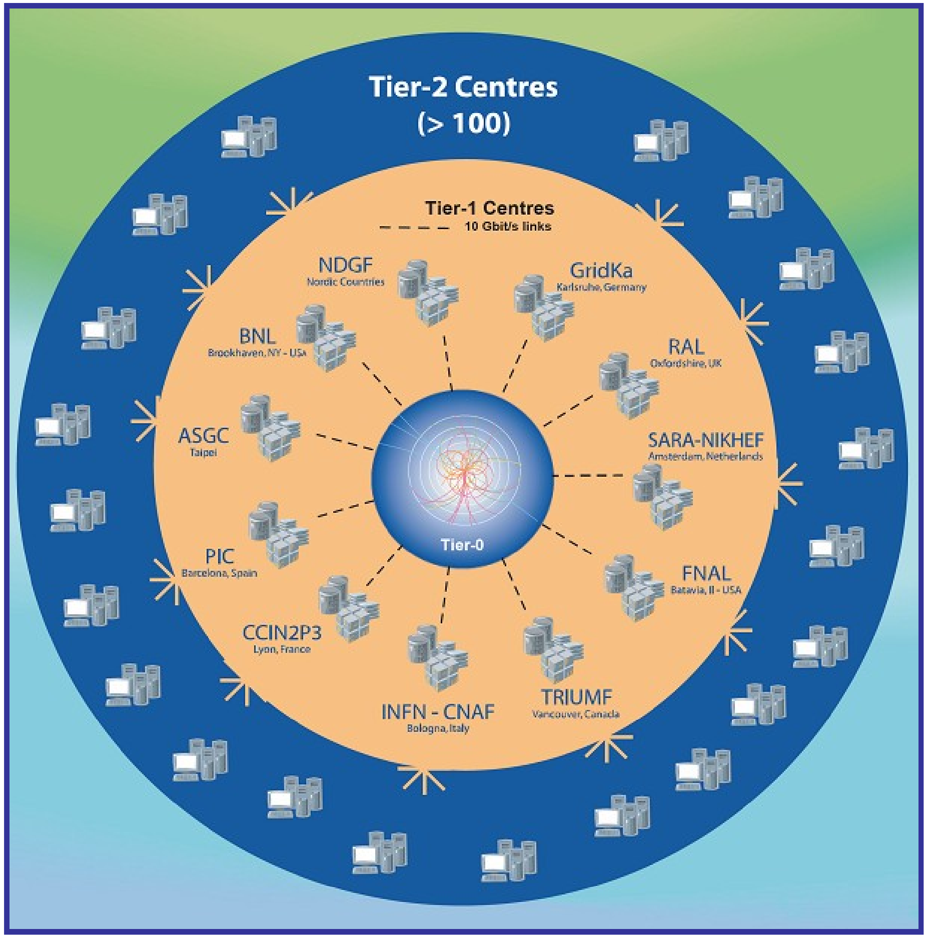
| MB/evt | 2010 | 2011 |
|---|---|---|
| RAW size | 1.4 | **2.8** |
| RECO size | 1.8 | **2.6** |
| SIM size | 2 | **2** |

| HS06·s/evt | 2010 | 2011 |
|---|---|---|
| CPU RECO | 100 | **200** |
| CPU SIMUL | 4100 | **5100** |

Feed them back into the Computing Model, quantify the impact and re-tune parameters to keep resources envelope under control.

# Distributed Infrastructure

Big experiments today make use of the Grid for data processing.




LHC example: Tier0/Tier1/Tier2 structure.

Part of the Computing Model:

**Workload**: Decide on the role of each type of centre, e.g:

- Tier0: online reconstruction
- Tier1: mass re-processing and pre-selection – distribution to Tier2
- Tier2: user analysis and MC

**Data**: Decide on where to store each data type and how many replicas.

# Time line

It is useful to plan the time line for the resource needs: number of reprocessing passes, users activity ...

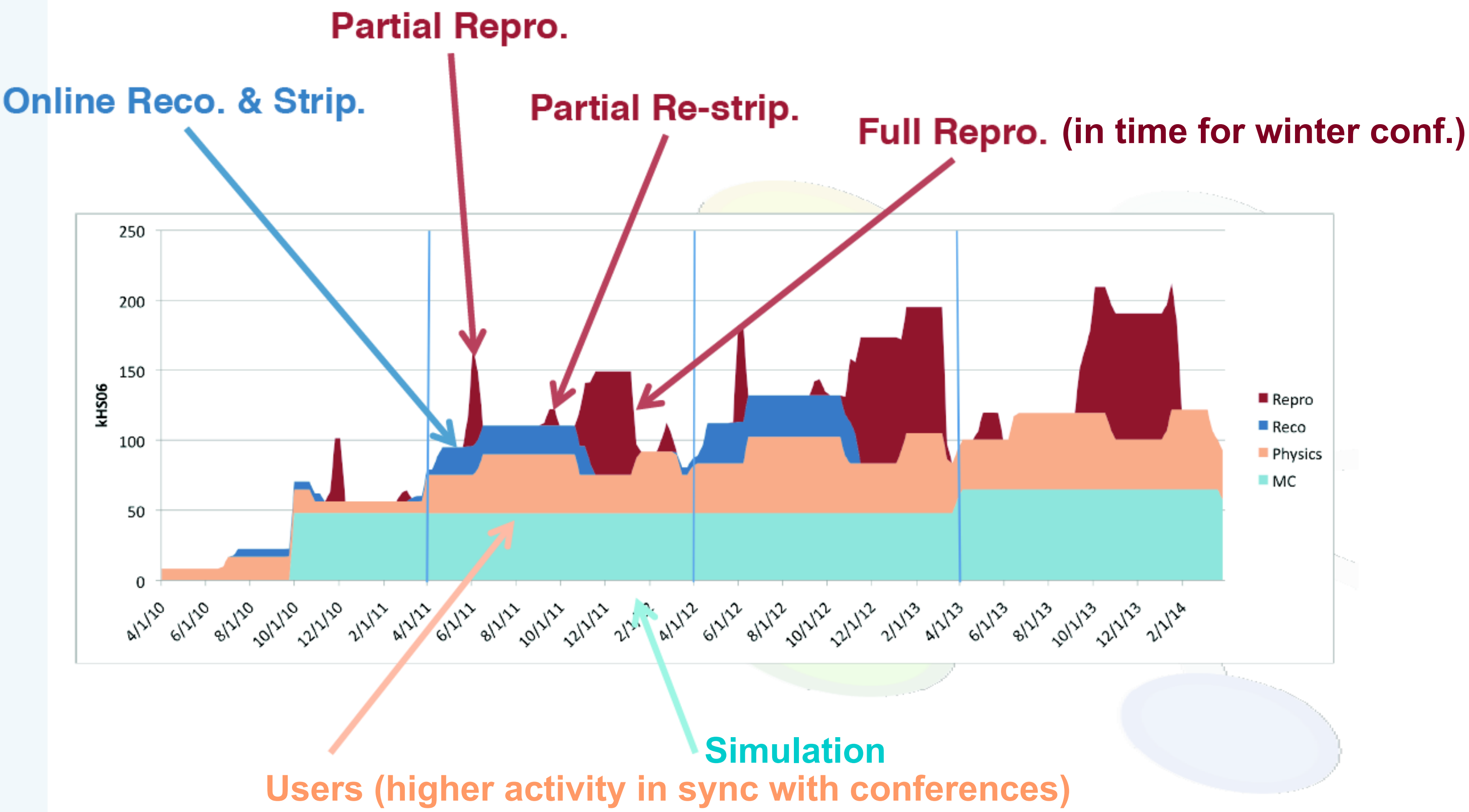



*Image from LHCb-PUB-2011-009 note, http://cdsweb.cern.ch/record/1332493*

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# Data deletion

In order to keep stored data growth under control, a policy for old data removal is needed.

- e.g. keep 2 most recent versions + only 1/2 replicas for next older

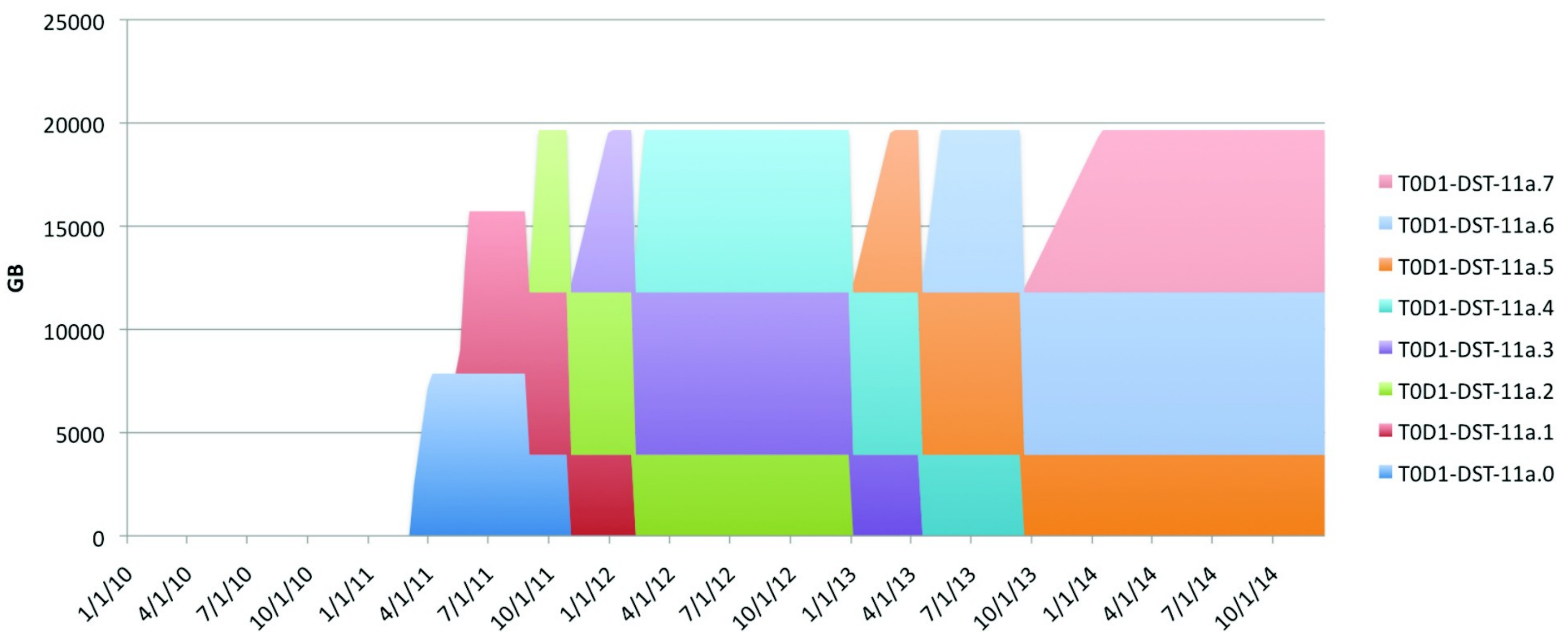


*Image from LHCb-PUB-2011-009 note, http://cdsweb.cern.ch/record/1332493*

# Storage time line

Steadily growing, due to accumulated data (some dips due to old versions removal).

Yearly requested capacity corresponds to the max. = end of the year.

- Sites encouraged to deploy not in more than 2 steps/year.
  - Bandwidth is important, and can suffer if capacity ramp up steps are too small.

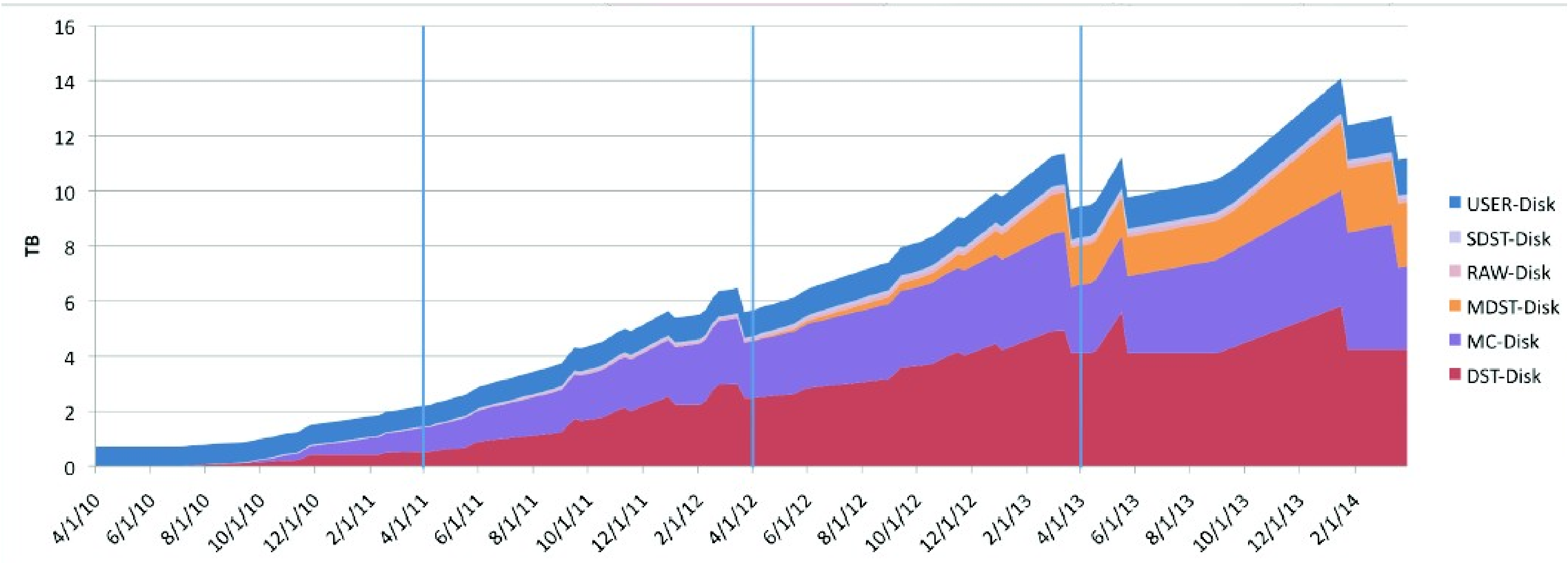


*Image from LHCb-PUB-2011-009 note, http://cdsweb.cern.ch/record/1332493*

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# Summary

The increasing complexity of experiments is generating a fast increase of the computing needs for their scientific exploitation.

When dealing with Petabytes, 10.000s of cores, etc. the development of a Computing Model is mandatory to make an efficient usage of the resources.

- Key tool in the planning/funding cycle.

The conditions will always evolve during the experiment lifetime.

Need a procedure to manage the requirements changes as much as the Computing Model itself.

- Solid accounting infrastructure that enables regular reporting.
- Formal procedure for periodically feedback requirement changes into the capacity planning/funding.

# Thank You

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# LHC requirement changes history