Simulation of Extensive Air Showers for Auger on GRID

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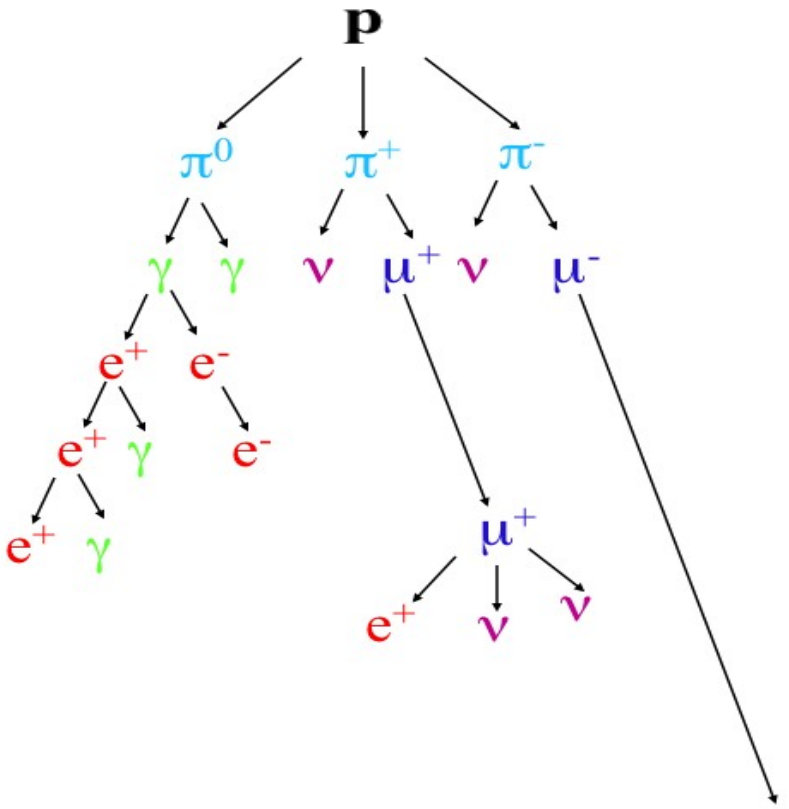
Simulation of Extensive Air Showers

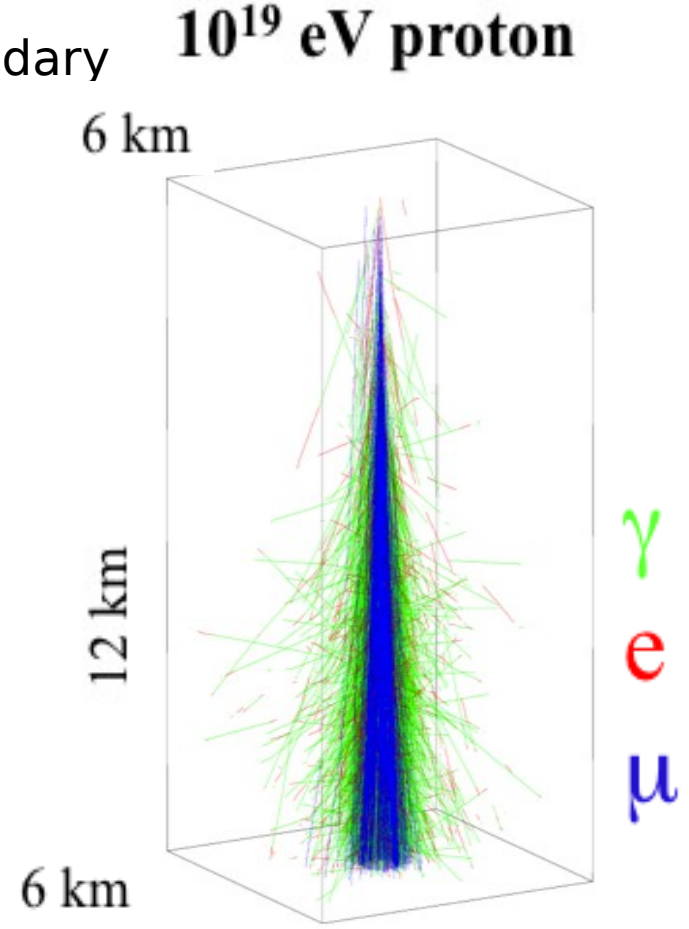
Shower

Cosmic ray primary interacts creating mostly secondary pions :

Neutral pions : electromagnetic shower

Charged pions : decay in muons





Simulation of a 10^{19} eV proton EAS using the MOCCA program. A sample of tracks at > 300 m from the shower axis are shown. Frame box: 6 × 6 × 12 km high. Color code: γ green, e red, μ blue. *Drawn by Clem Pryke — University of Chicago*

Simulation by Clem Prike

Simulation of EAS

Shower generation:

- **CORSIKA** and AIRES are the software packages that generate those kind of events. In official simulations we have only used CORSIKA

- A compilation tool lets the user decide on:
  - Low energy interaction models
  - High energy interaction models (epos, QGSjetI/II, ...)
  - and some other options

- CORSIKA requires only an **input card** (run number, particle type, energy, zenith angle, seeds, etc ...) which is specific for each job.

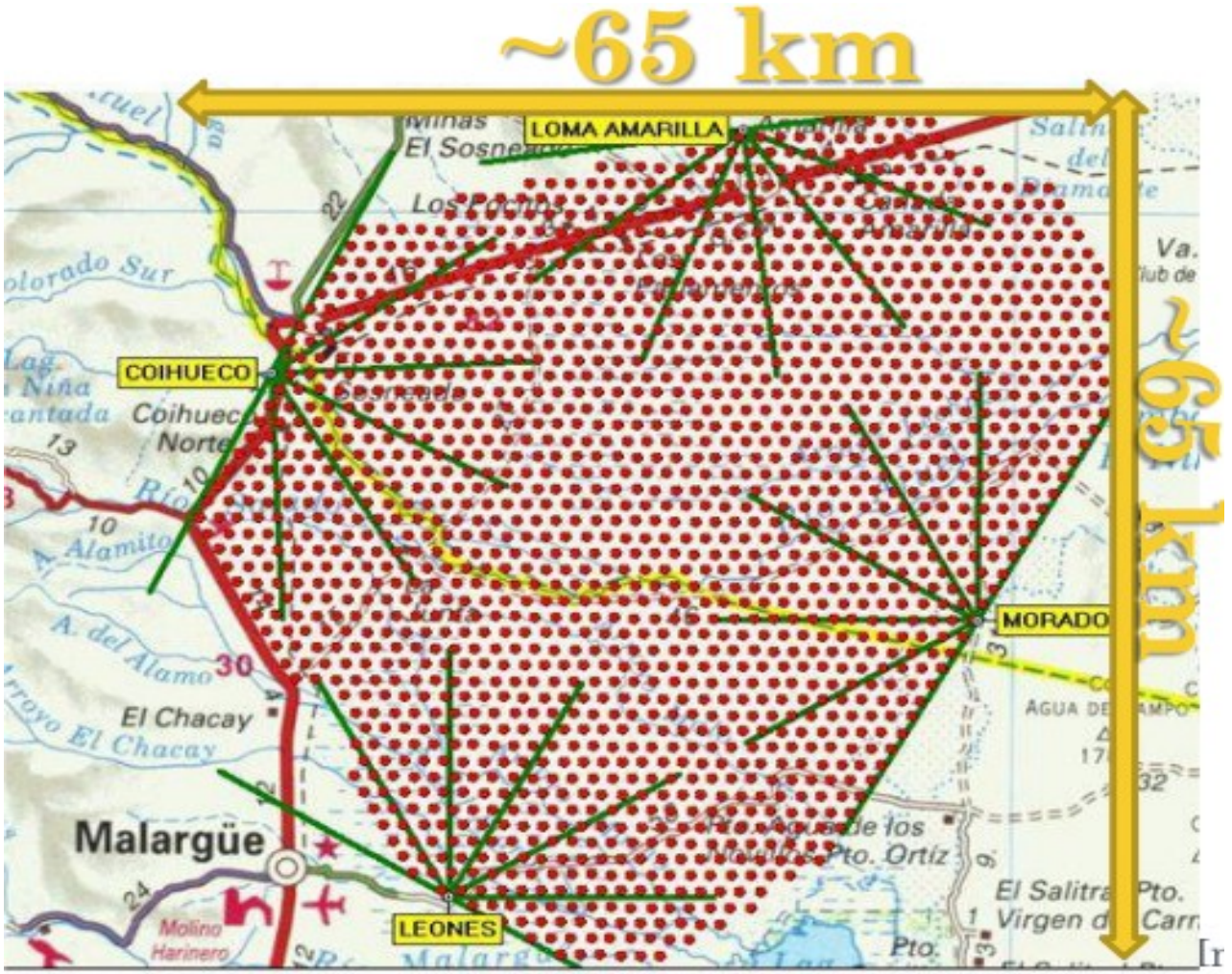
- Billions of particles being tracked:
  - A full shower simulation can consume hundreds of hours of CPU time and several TBs of disk space.
  - **Statistical thinning method** is needed, but still tens of hours of CPU and hundreds of MB of disk space are required for a single shower.

Pierre Auger Observatory

It is located near Malargüe, south of Mendoza in Argentina

- Red dots : water tanks (SD)
- Yellow labels : location of telescope eyes (FD)

Green lines: coverage in azimuth



Detector sim. and rec.

Detector simulation and reconstruction:

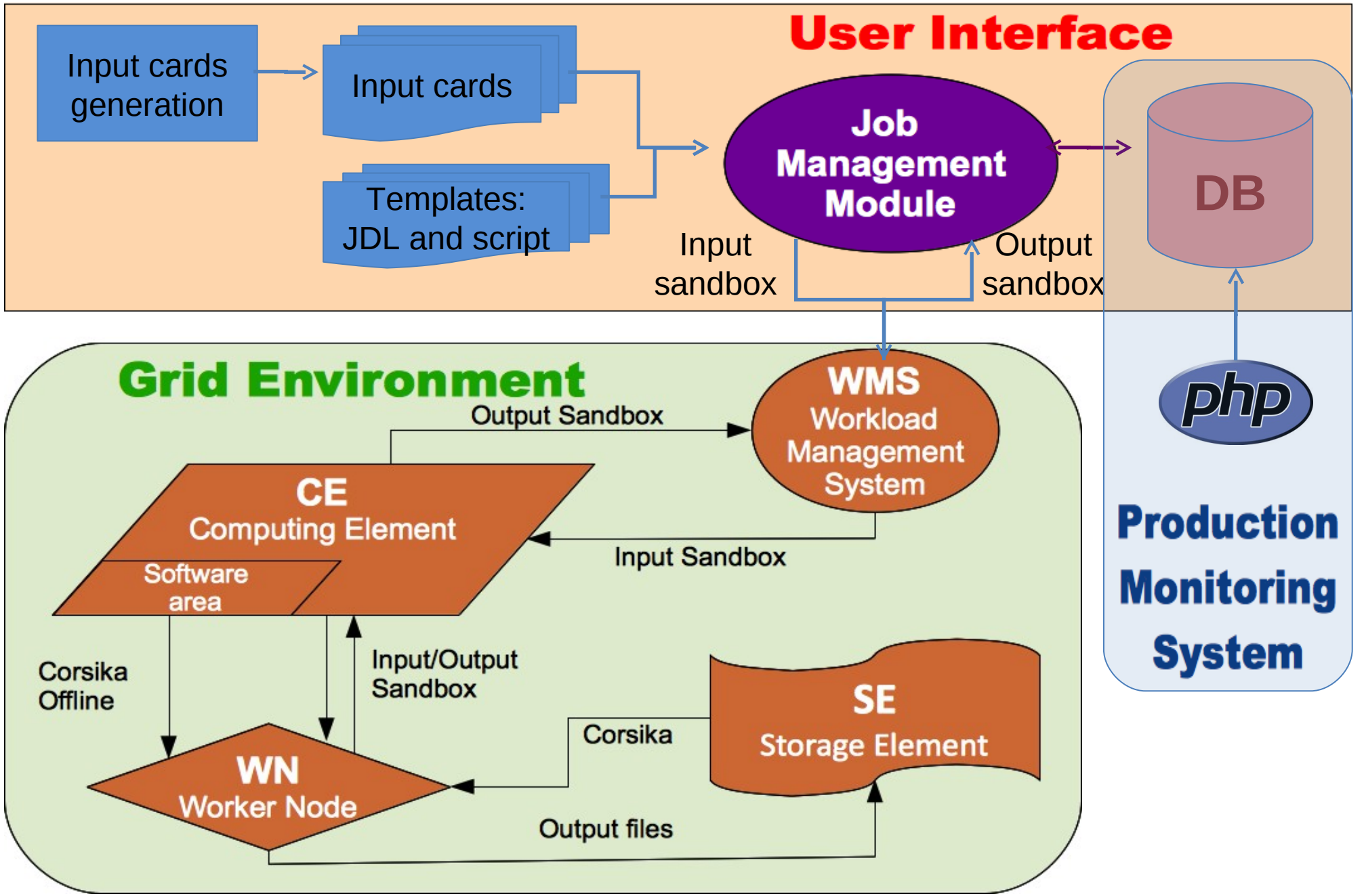
- Needs previously generated shower files → showers have to be kept on Grid

- Auger experimental devices detect :
  - Cherenkov light of particles remaining at ground level as secondaries from the shower (SD)
  - Fluorescence light emitted while those secondaries are traveling through the atmosphere (FD)
  - In both cases the output of the detectors are FADC traces (not much data)

- ***OffLine***: modular package to simulate the response of the SD and FD and to reconstruct physical parameters of the shower.

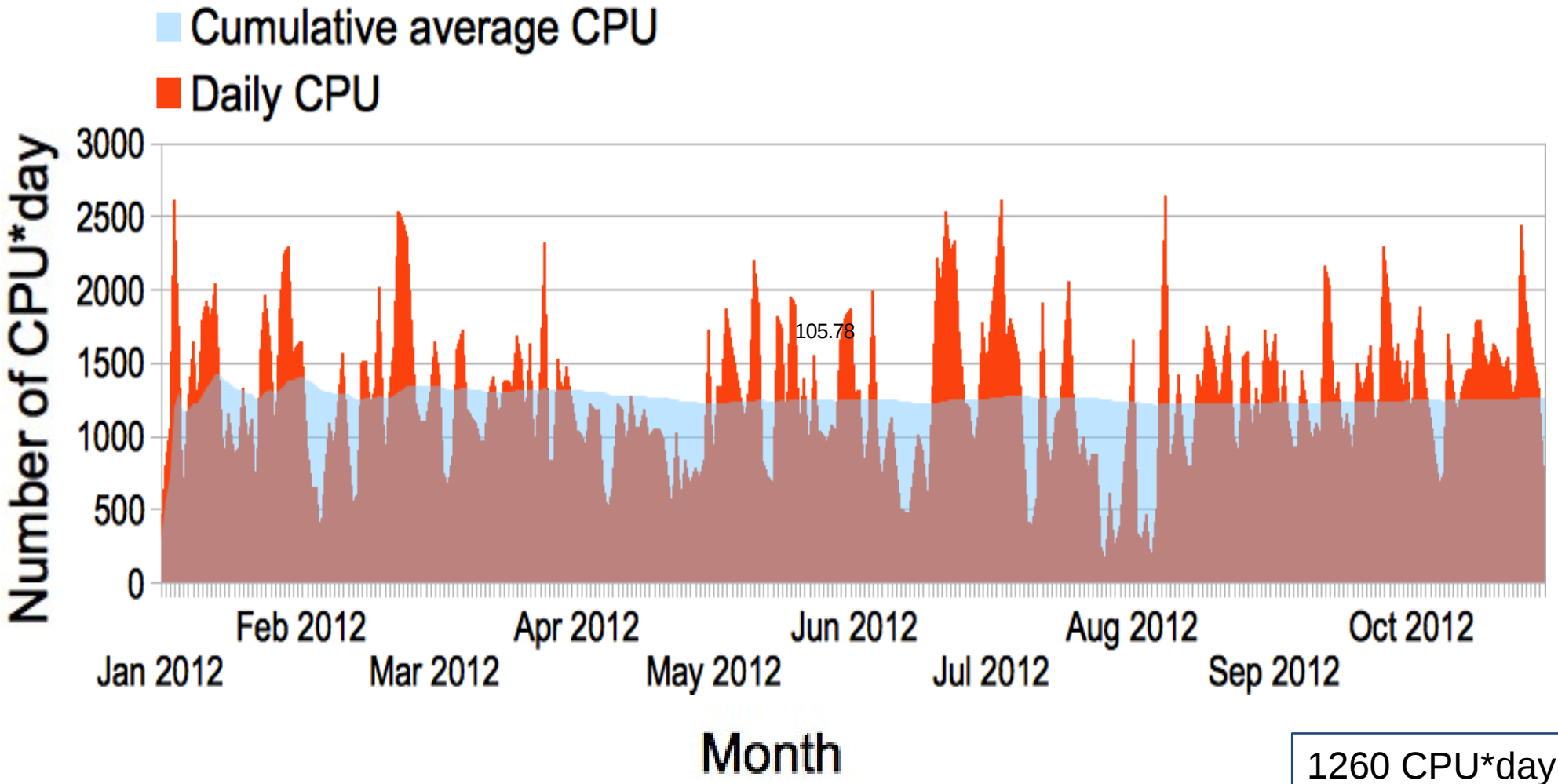
- File sizes are usually of the order of MBs

Grid Computing Model



Usage of resources 2012

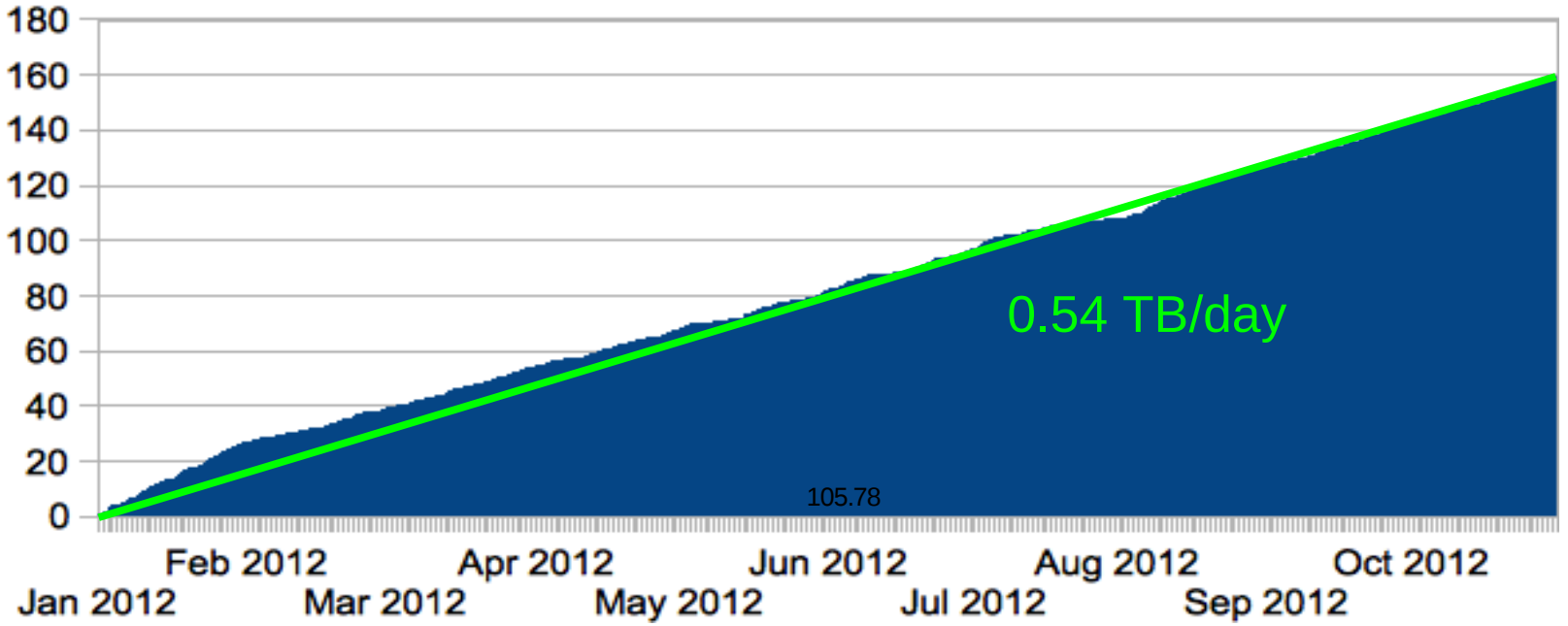
Consumption of CPU time since the start of 2012



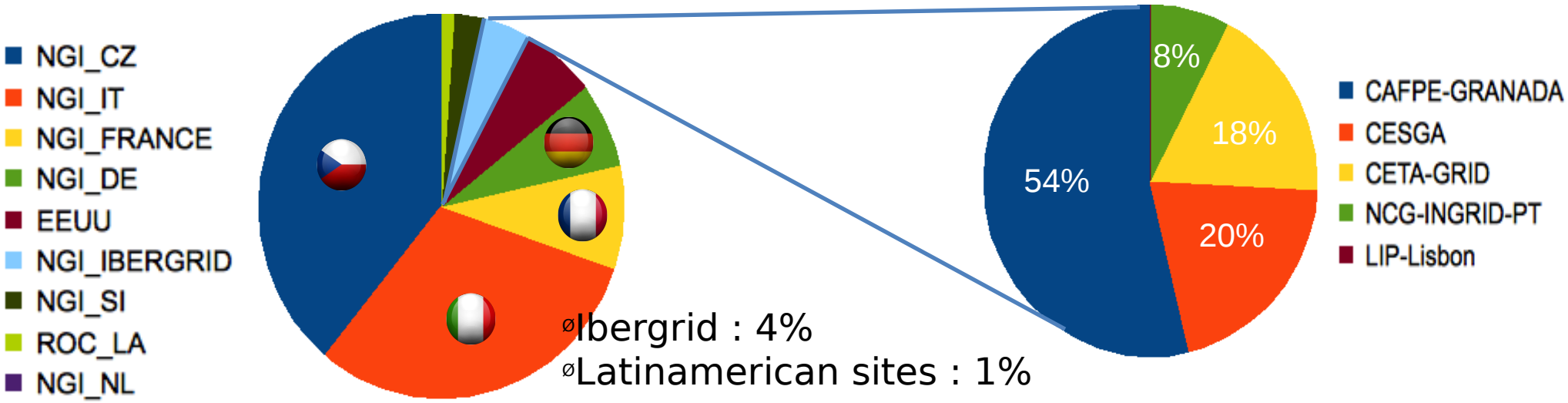
1260 CPU*day

Usage of resources 2012

Disk space accumulated on Storage Elements



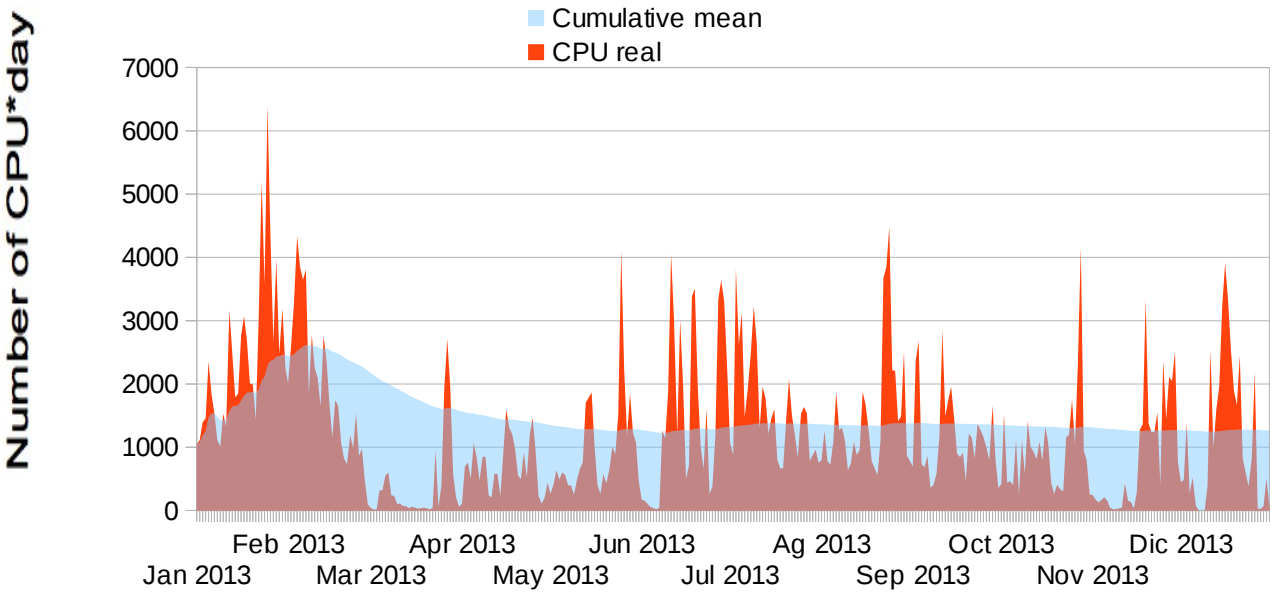
160 TB



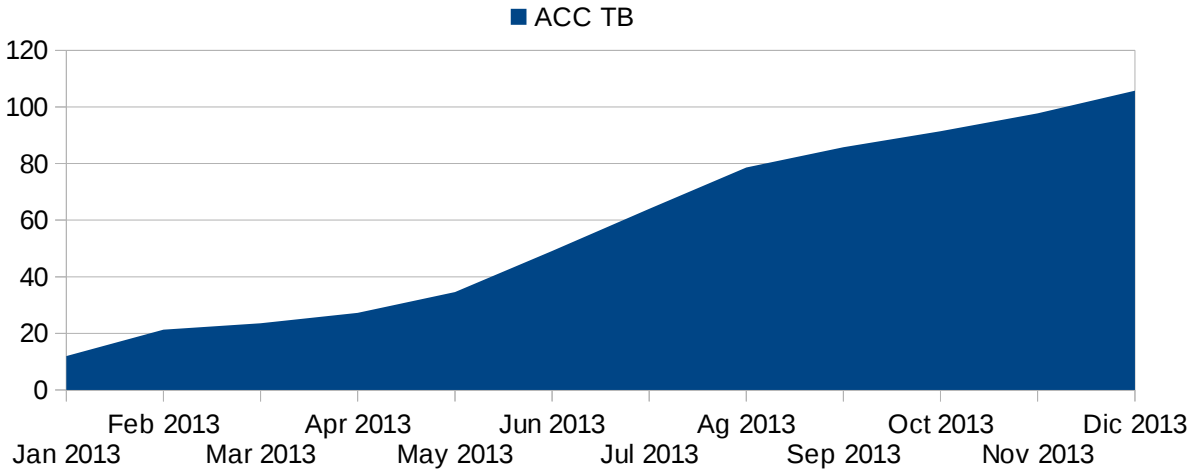
- Ibergrid : 4%
- Latinamerican sites : 1%

Usage of resources 2013

Consumption of CPU time since the start of 2013



1291 CPU*day



106 TB