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CERN and the LHC-Grid as an example for international research projects

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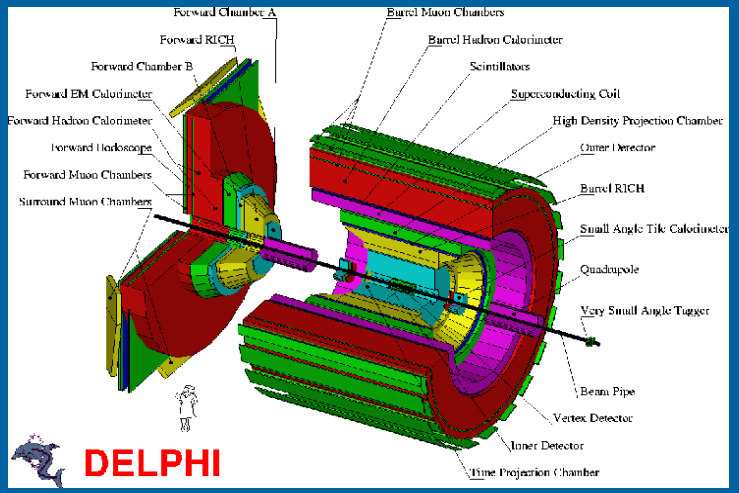
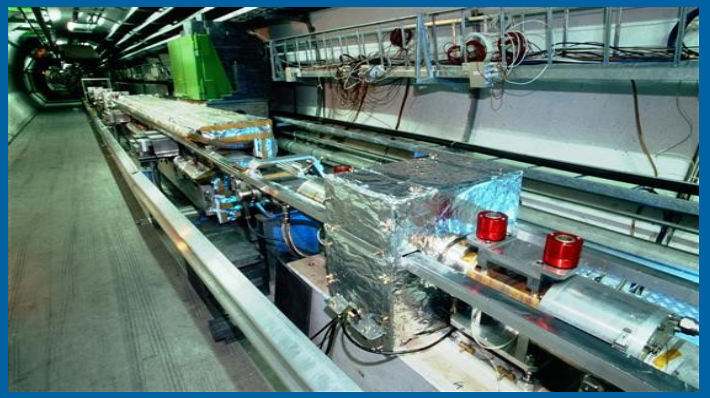
20 Years ago ...

- Austria connects to the Internet via CERN
- Particle physicist in Austria were happy users who could now login remotely
- Relatively small international collaborations (few 100 persons)
- Computing problem could be solved at CERN

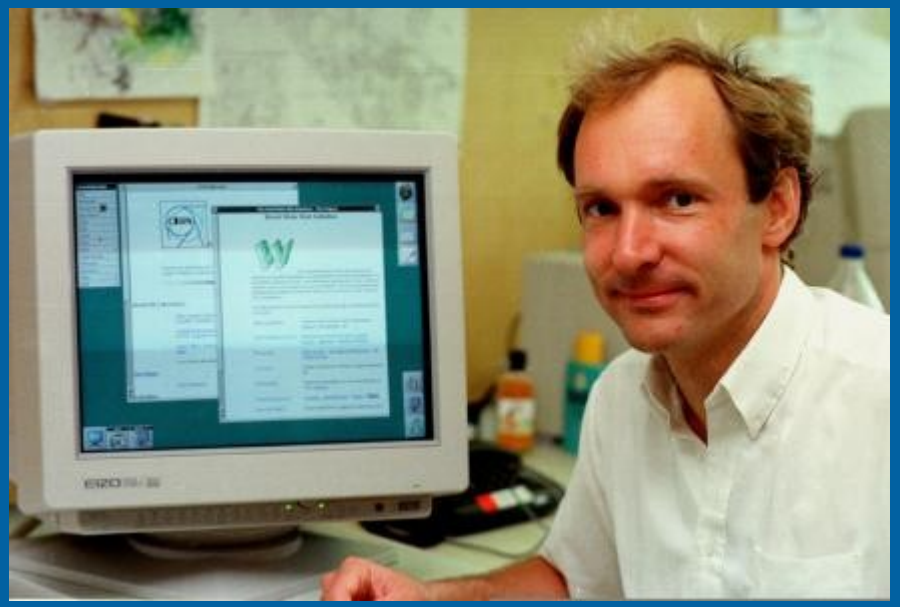




CERN was already then an exciting place ...

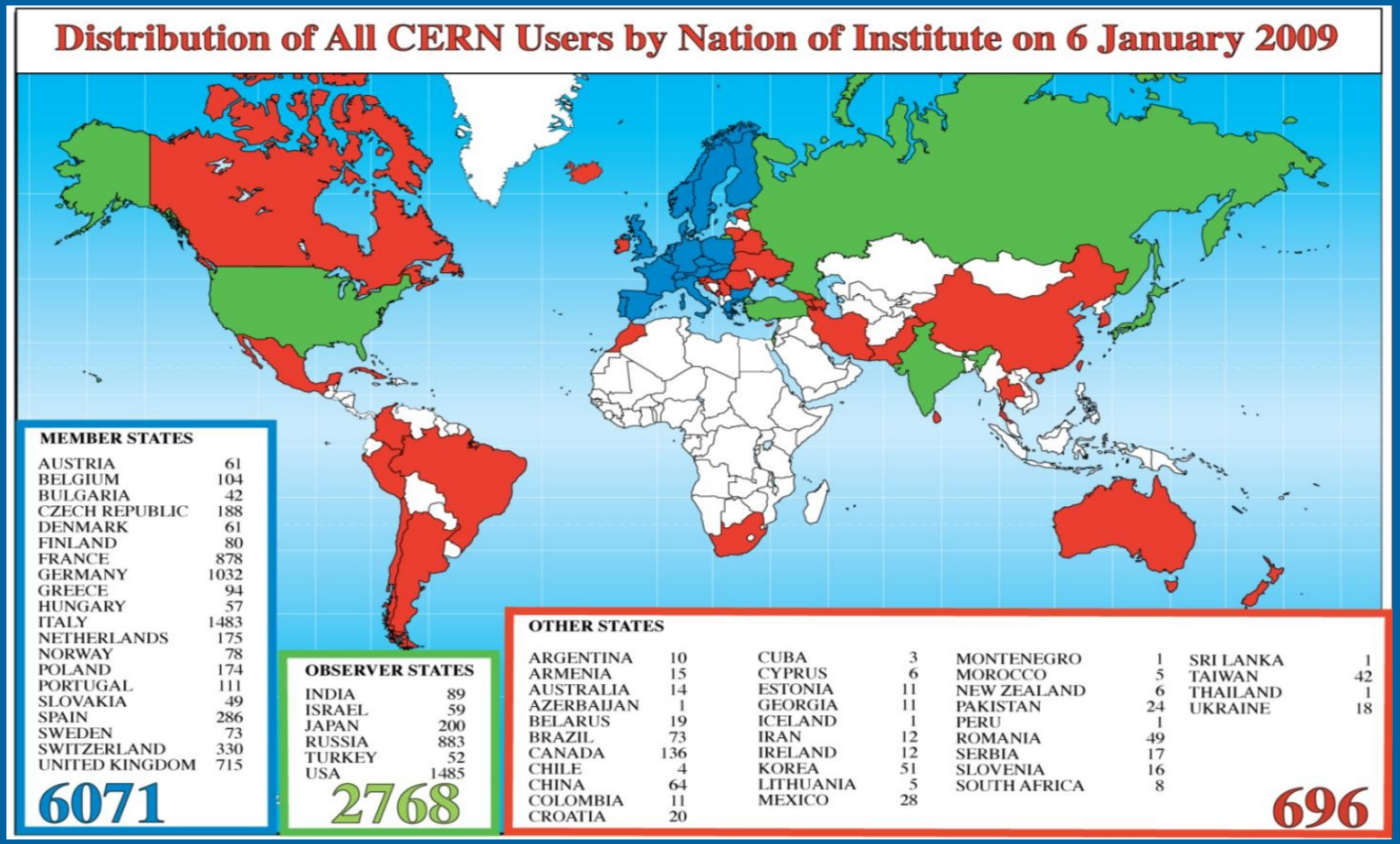
- Evidently for particle physicist …
  - LEP projects were ongoing
  - LHC was in preparation

- But also for other persons ....
  - Tim Berners Lee makes an invention as he foresees the communication problems in the large collaborations which will construct and operate the LHC



And he was right – without the internet and a new way of international collaboration LHC would not be reality today ....

International Scope



Fundamental Physics Questions

- Why do particles have mass ?
  - Quest for the Higgs Boson
- What is Dark Matter ?
  - Astronomy has strong evidence for Dark Matter
  - Today we assume that the visible matter makes only 4 % of the universe
- Where is antimatter ?
  - Can CP Violation explain its evaporation ?
- Are there additional dimensions ?
  - Many theories hint at hidden dimensions

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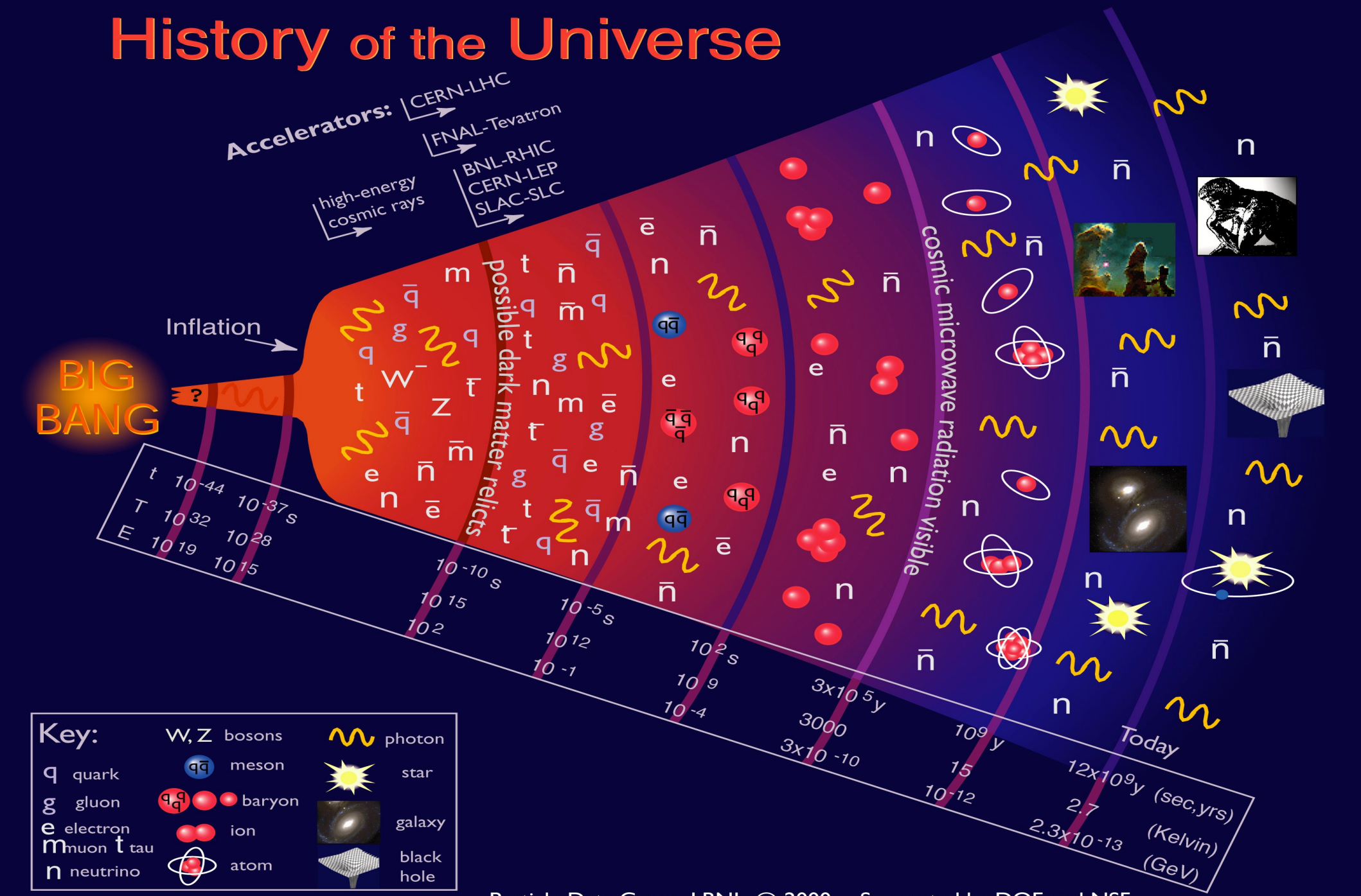
History of the Universe



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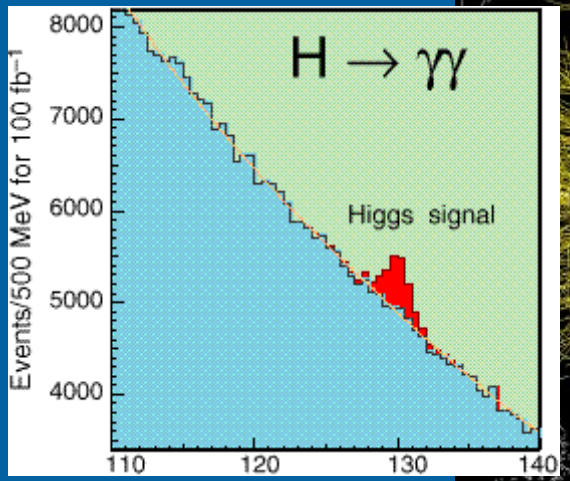
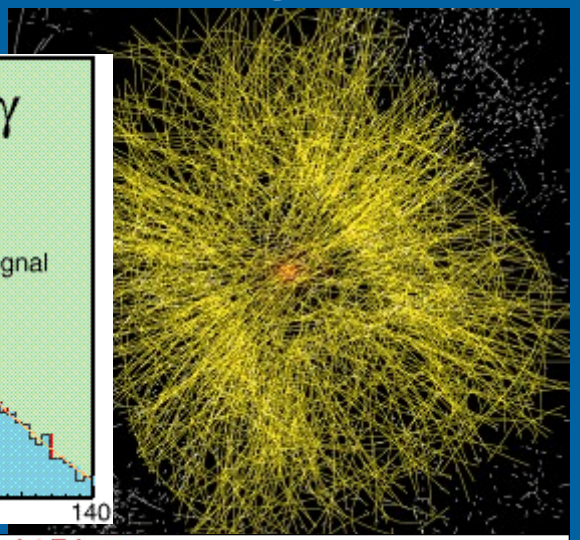
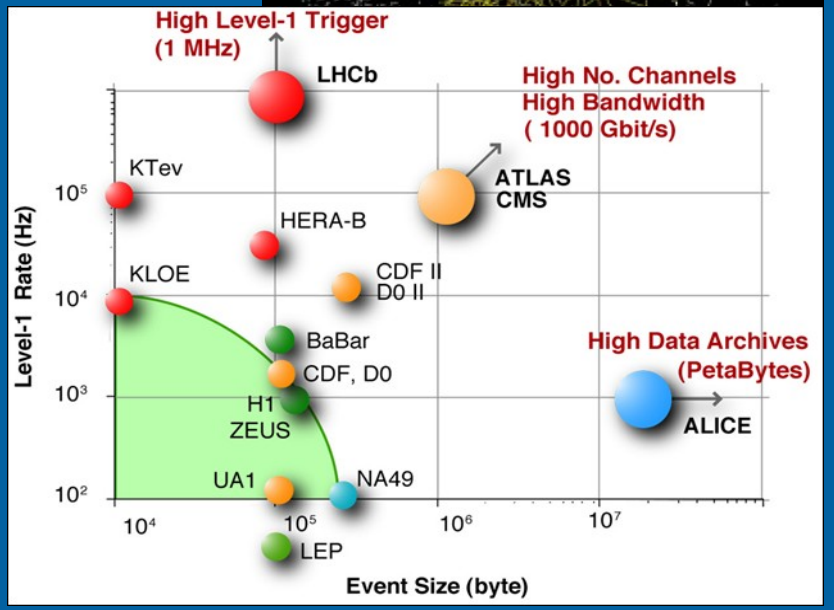
The LHC Computing Challenge

- Signal/Noise 10^{-13}
  - Offline 10^{-9}
- Large Data Volume
  - High rate * large channel number * 4 experiments
  - 15 PetaByte per year
- Compute Power
  - Event complexity * Nr of channels * Nr of users
- Worldwide analysis & funding
  - Only 20 % at CERN
  - Analysis everywhere

Grid Technology is for us the solution







WLCG Today

Tier 0; 11 Tier 1s; 61 Tier 2 federations (121 Tier 2 sites)

Today we have 49 MoU signatories, representing 34 countries:

Australia, Austria, Belgium, Brazil, Canada, China, Czech Rep, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, India, Israel, Japan, Rep. Korea, Netherlands, Norway, Pakistan, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Taipei, Turkey, UK, Ukraine, USA.

WLCG Infrastructure

A map of the worldwide LCG infrastructure operated by EGEE and OSG.

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In Austria: Tier-2 for LHC

- Clusters in Vienna and Innsbruck
  - More then 1000 cores
  - More then 500 TB
- Supported by the BMWF as part of the AustrianGrid project

BMWF
Bundesministerium für Wissenschaft und Forschung

AUSTRIAN GRID

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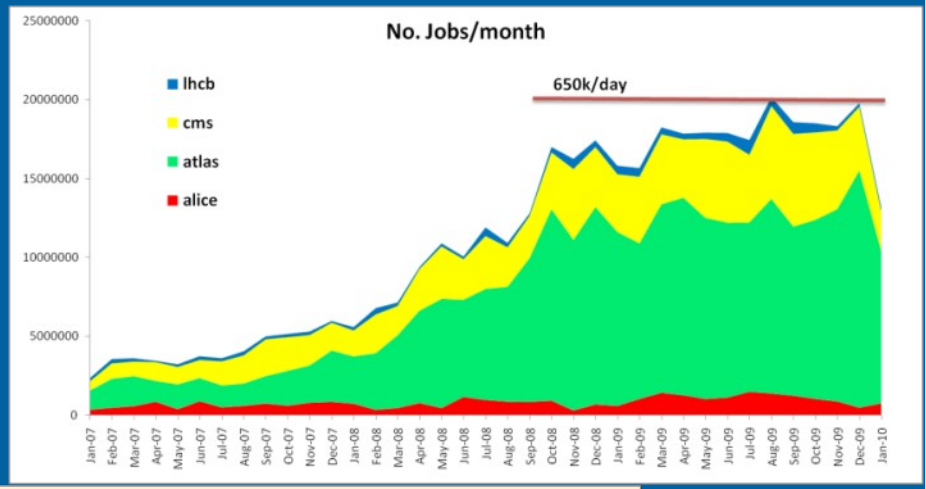
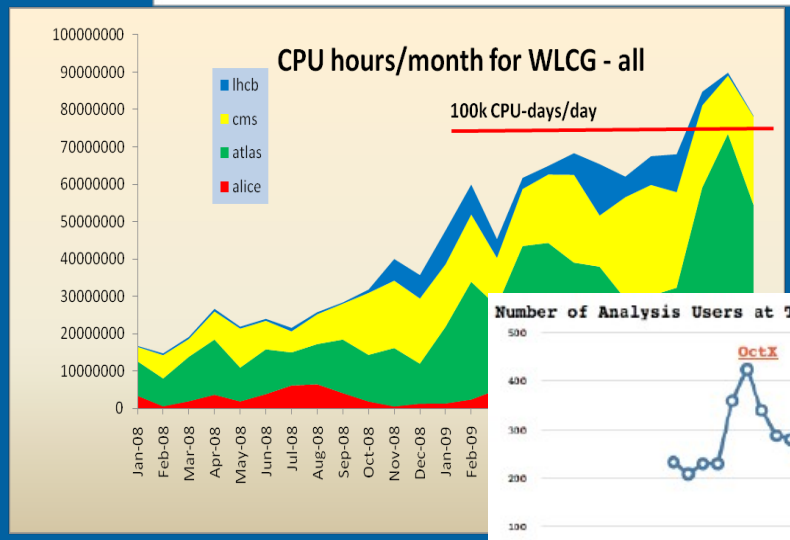
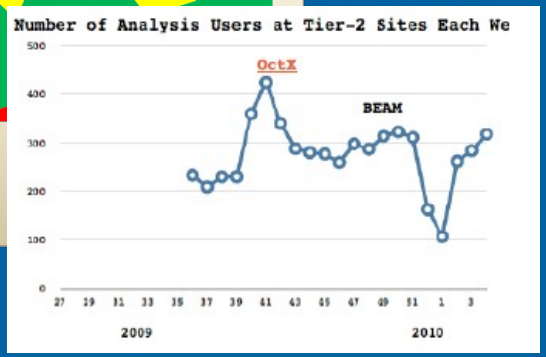
Jobload to analyze the data

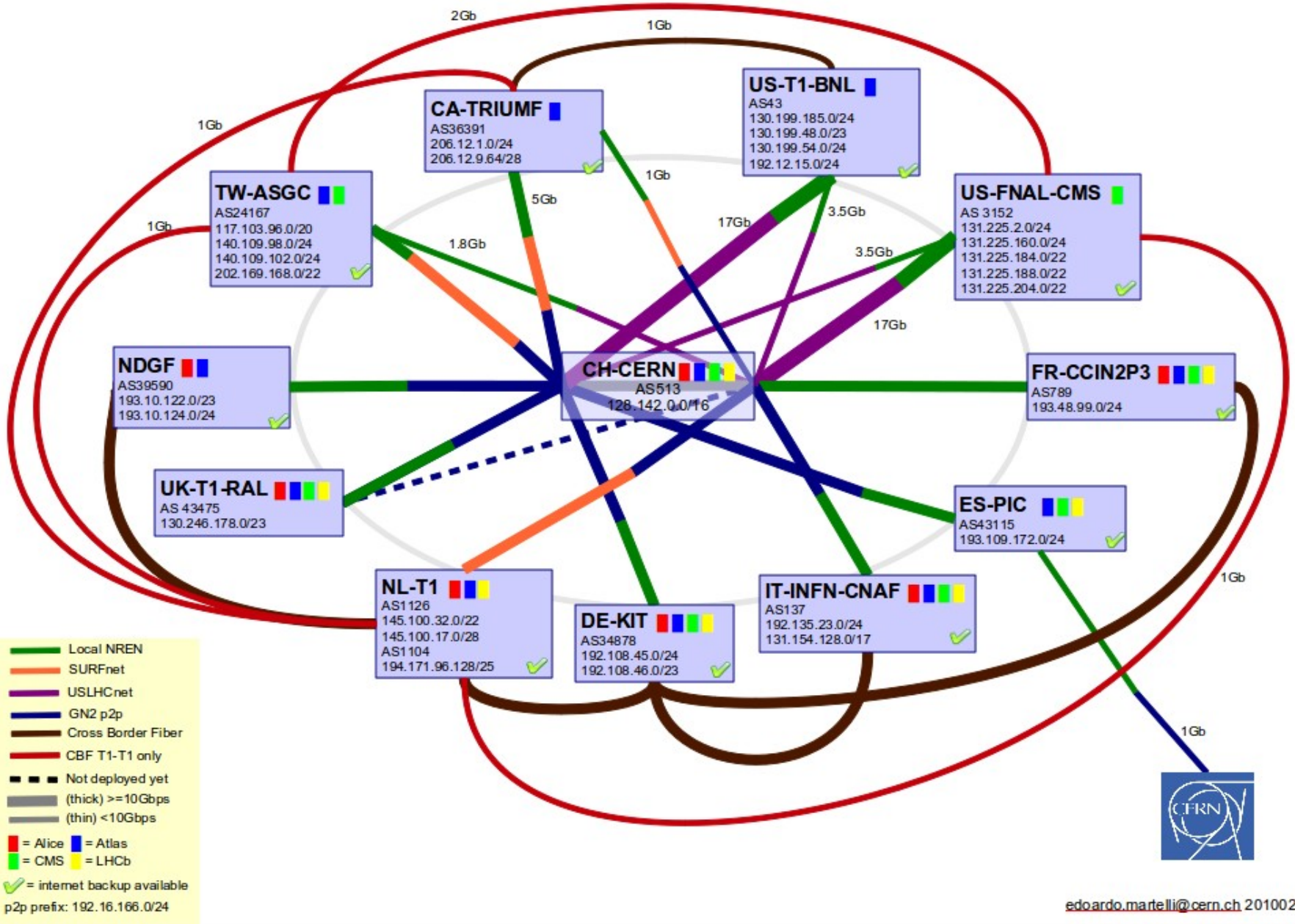
- More then 650k Batch jobs per day
  - Will be a million soon
- 100K CPU cores
- Production and hundreds of individual users every day







LHCOPN – current status



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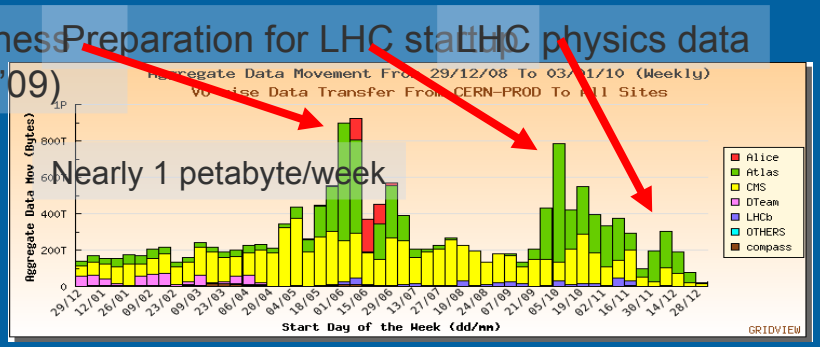
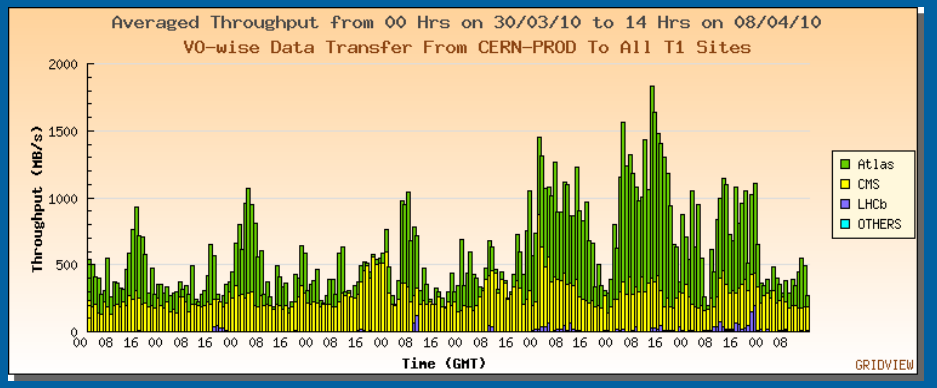
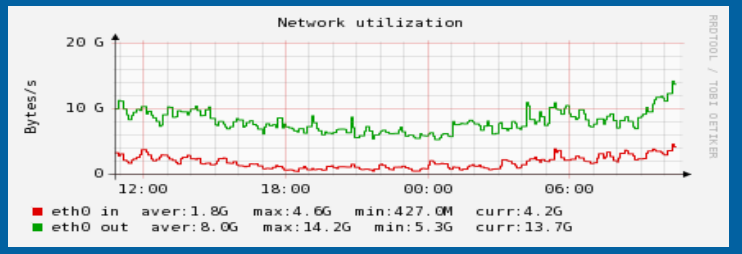
Data transfers

- Tested to 1 Petabyte per week
- We have also now real life data (1.5 GB/sec)
- At CERN a high load of the Storage







In Vienna

- No access to resources at CERN
- We can copy data from Tier-1 centers
- We can run our jobs on our and on the other Tier-2 centers

- A network with high capacity is essential for our work

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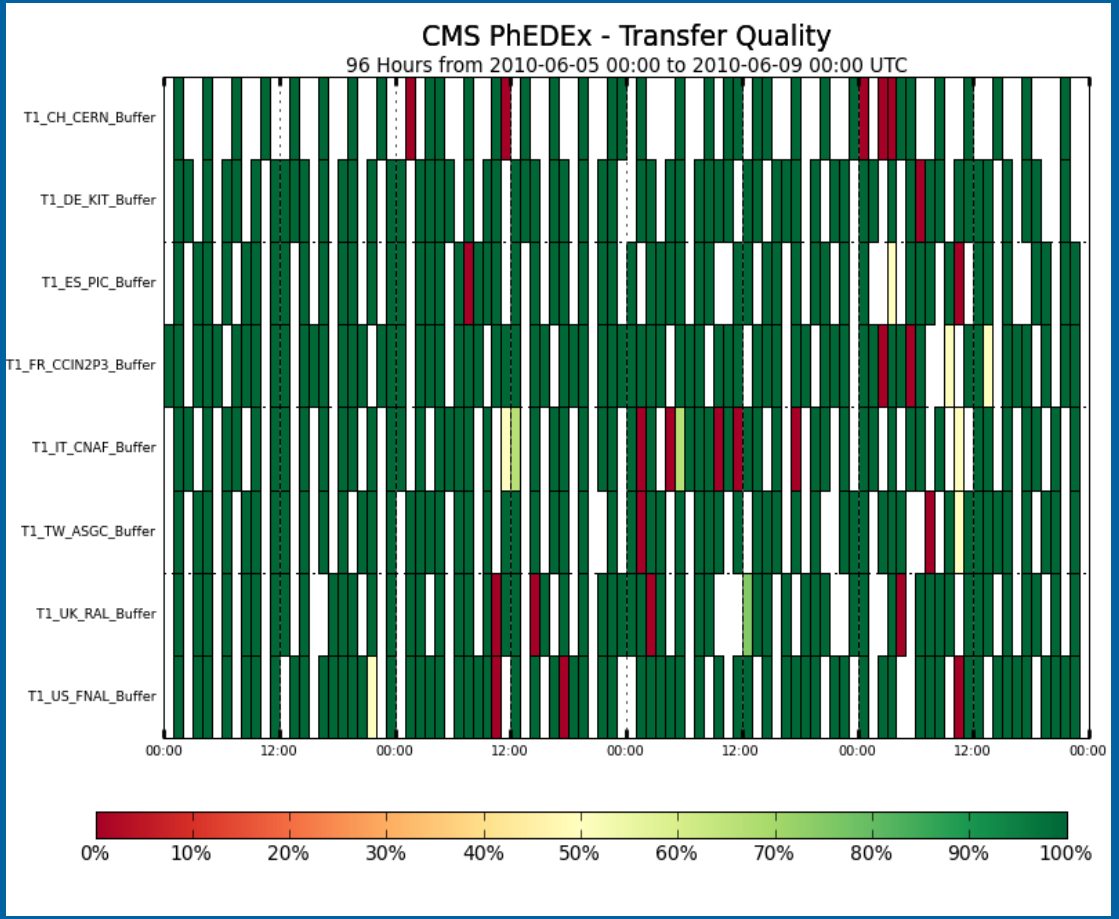
Monitoring of transfer quality

- Regular testing of connections
- Usually the link is not the problem ...



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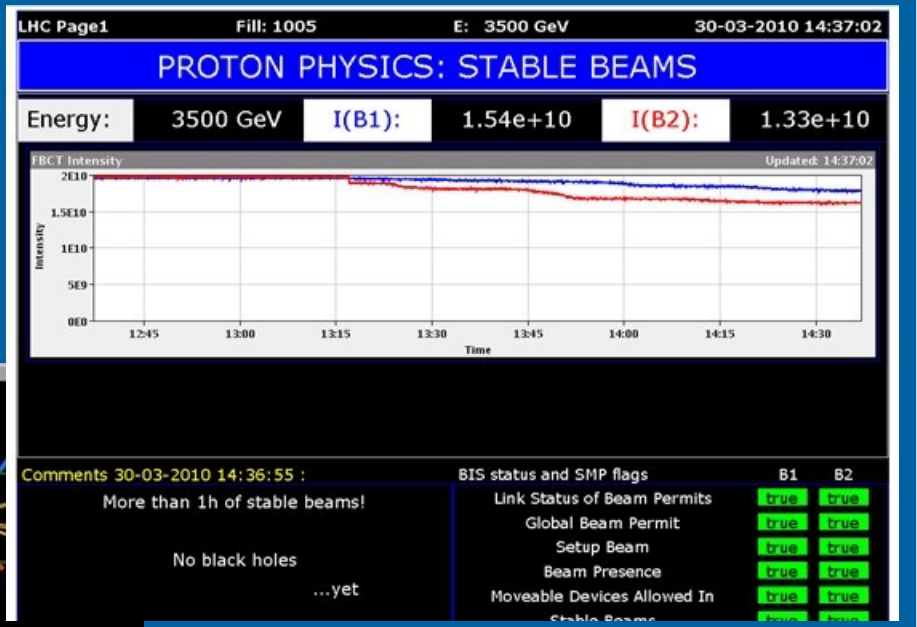
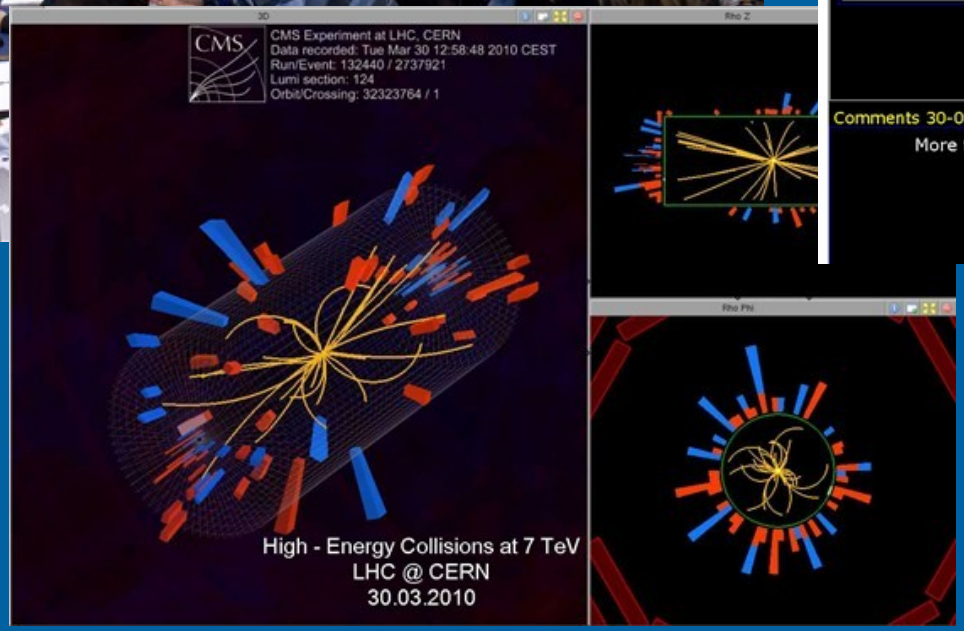
First physics at CERN

LHC in Operation at 7 TeV





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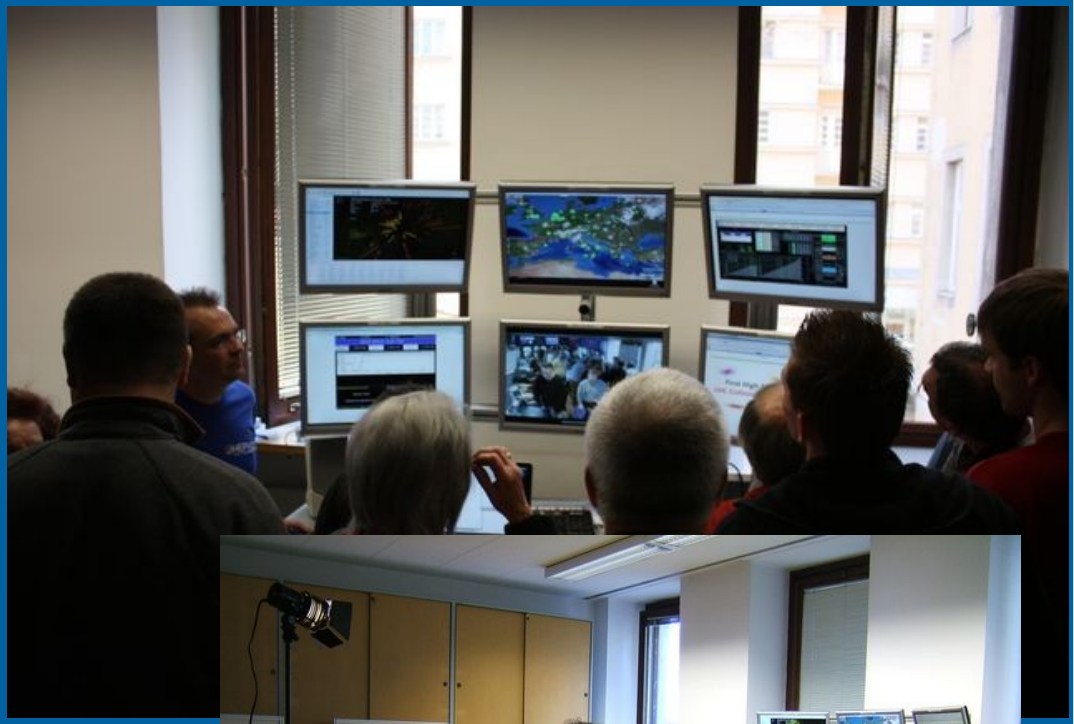
In Austria

- Video allows us top participate directly
- Also data available on the same day in Vienna



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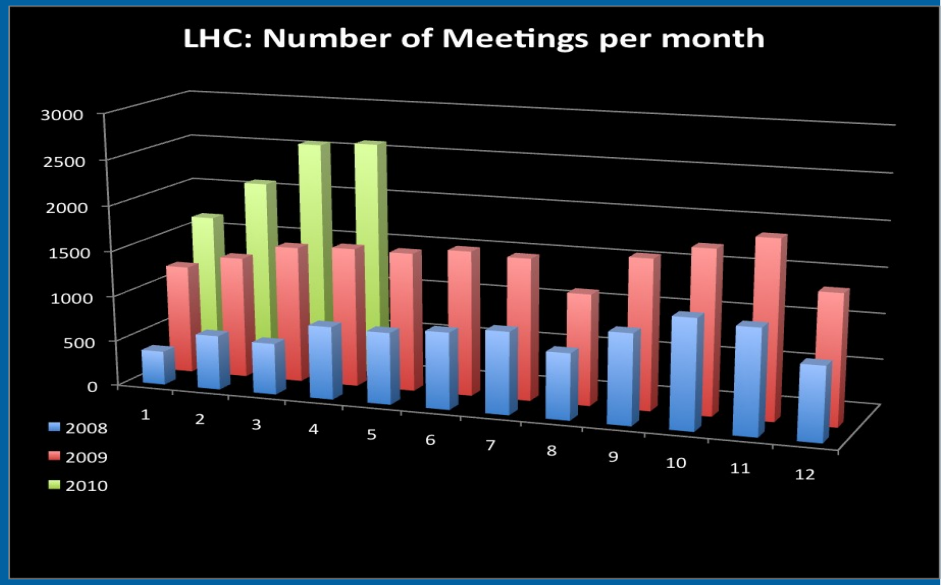
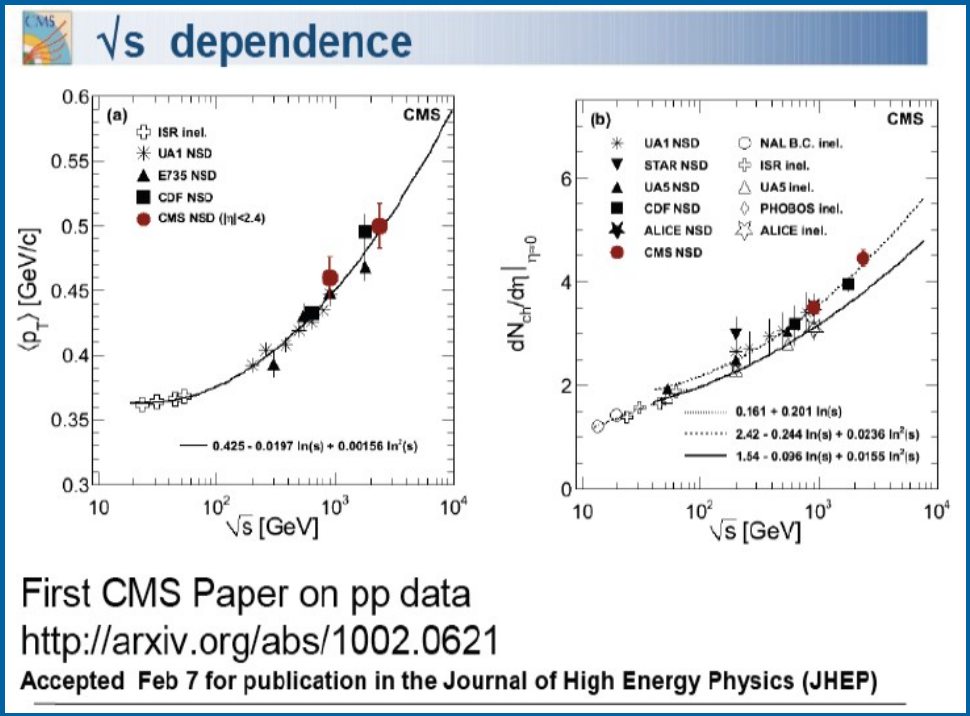
Videomeetings



- 3000 Video meetings per month
- LHC Controlroom in the Parlament

First publications



- First publication in February
- A whole new set of publications in preparation for the summer
- The Austrian physicist can participate in the quest due to the grid + Networking

Future of the LCG grid

- Sustainability
  - End of EGEE project
  - Creation of National Grid Initiatives

- Technological
  - Reduction of Data storage sites
    - Closer to HPC community
  - Workload Management
    - Cloudservices seem much simpler
  - We have a AA infrastructure based on x509
    - Not mainstream

LHC is not alone

- HEP has been a leader in needing and building global collaborations in order to achieve its goals
- It is no longer unique – many other sciences now have similar needs
  - Life sciences, astrophysics, ESFRI projects
  - Anticipate huge data volumes
- Need global collaborations

International Projects

- In the last years EGEE Project
  - Austrian Grid
- EGI
- PRACE (HPC)

- It is currently under discussion how to organize and finance Austrian participation in such activities
- Evidently the availability of the networking is the basis of such projects ...

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- The LHC has finally started its operation
  - The LHC grid is supporting the computing operation on a global scale
  - Physicist are happily working on their analysis
  - High capacity networking allows the Austrian physicist to part in that quest

- We run middleware services, we have our own certificates and we are currently establishing a NGI
  - I see clear possibilities for further cooperation

- Other sciences have also large computing requirements
  - Internationally and in Austria

- Access to the international computing projects is an important issue for Austrian Scientists
  - Evidently funding is an issue ....

- Networking is an integral part of the discussion