Grids for Science in Europe

planning for sustainability

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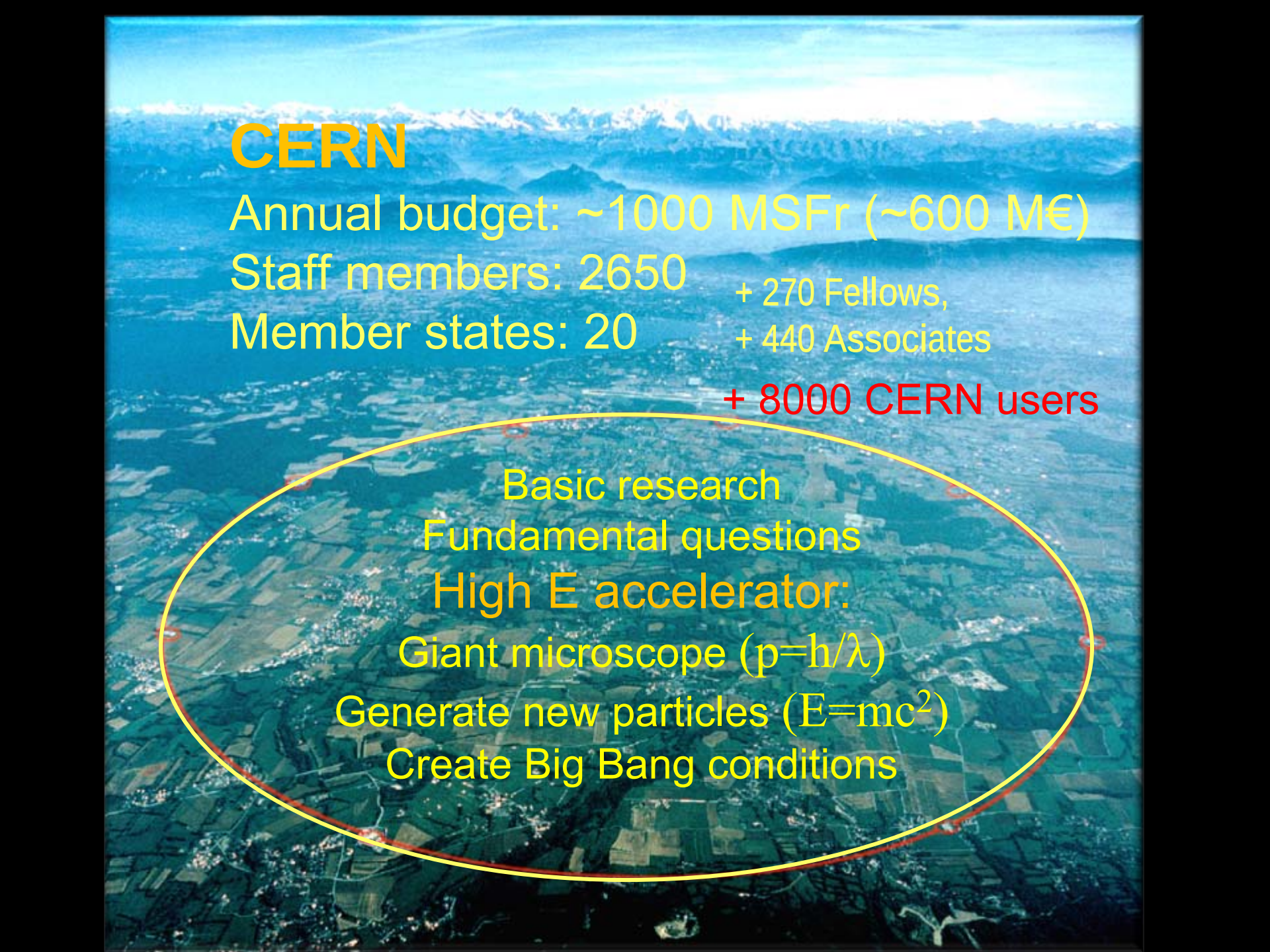
CERN IT-Department

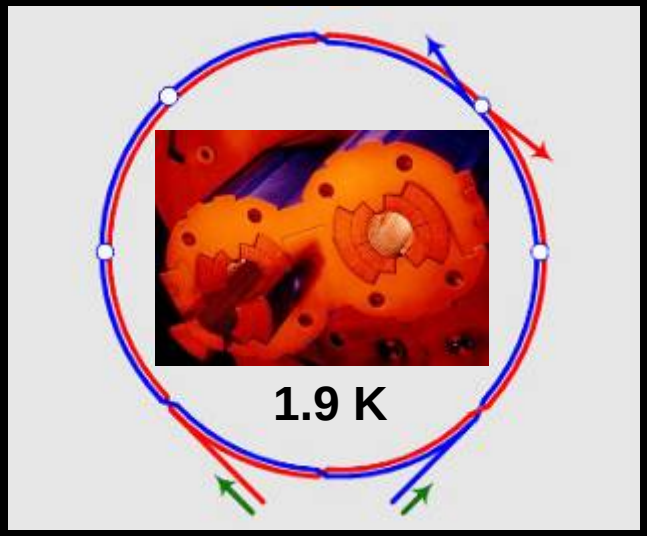
Presented at

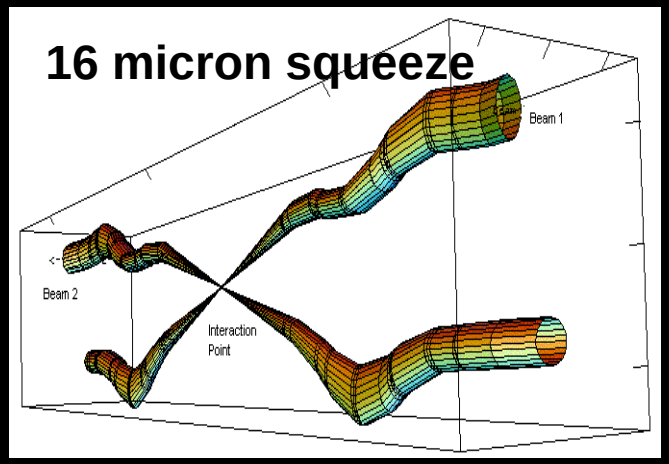
CERN openlab Board of Sponsors

25 April 2008


CERN
Annual budget: ~1000 MSFr (~600 M€)
Staff members: 2650
Member states: 20
+ 270 Fellows,
+ 440 Associates
+ 8000 CERN users
Basic research
Fundamental questions
High E accelerator:
Giant microscope (p=h/λ)
Generate new particles (E=mc²)
Create Big Bang conditions

Large Hadron Collider - LHC

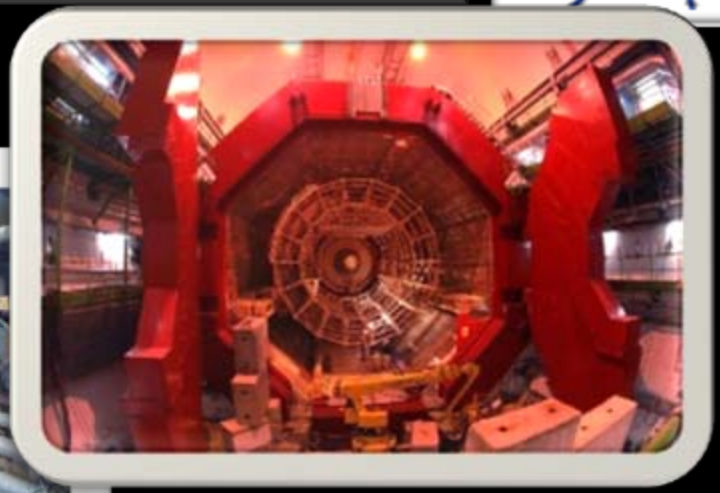


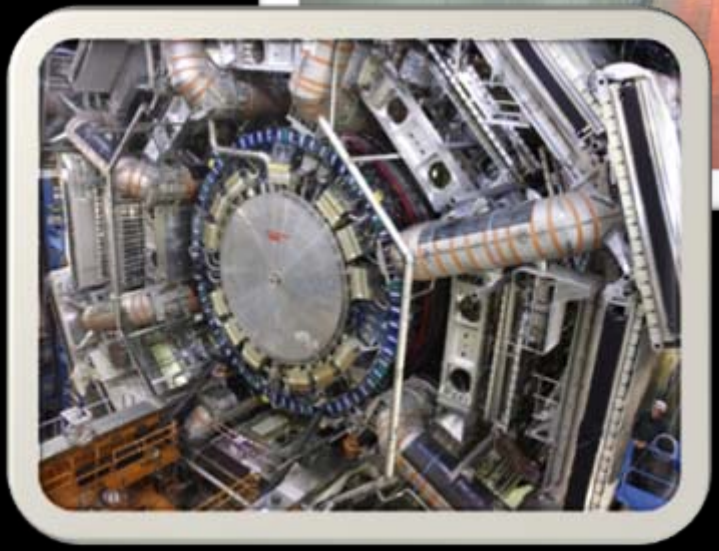


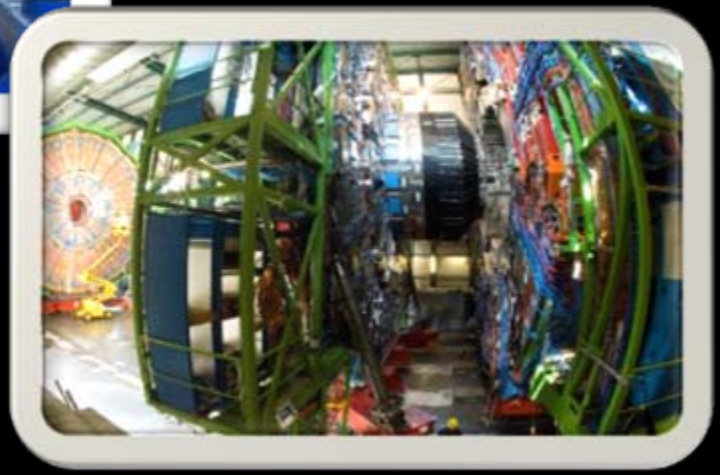
- 27 km circumference
- Cost ~ 3000 M€ (+ detectors)
- Proton-proton (or lead ion) collisions at 7+7 TeV
- Bunches 10^{11} protons cross every 25 nsec
- 600 million collisions/sec
- Physics questions
  - Origin of mass (Higgs?)
  - Dark matter?
  - Symmetry matter-antimatter
  - Forces – supersymmetry
  - Early universe – quark-gluon plasma
  - …

10^{-9} to 10^{-12}

LHC gets ready …

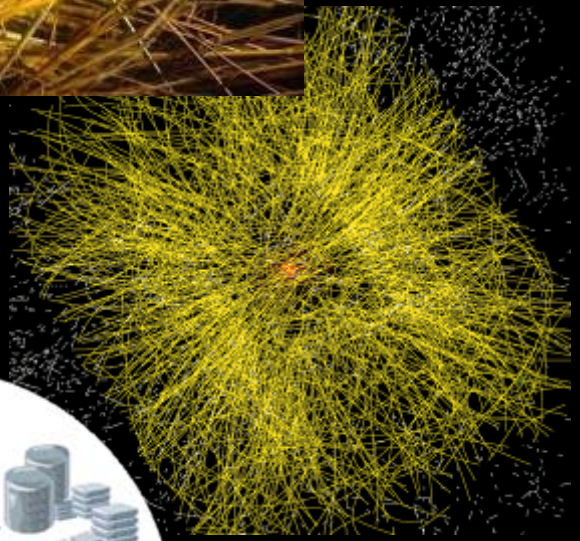


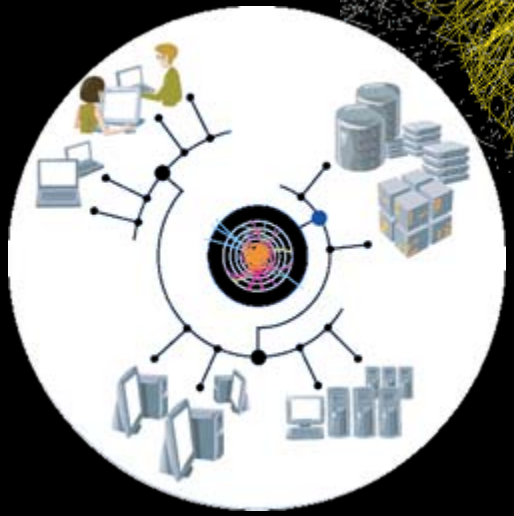




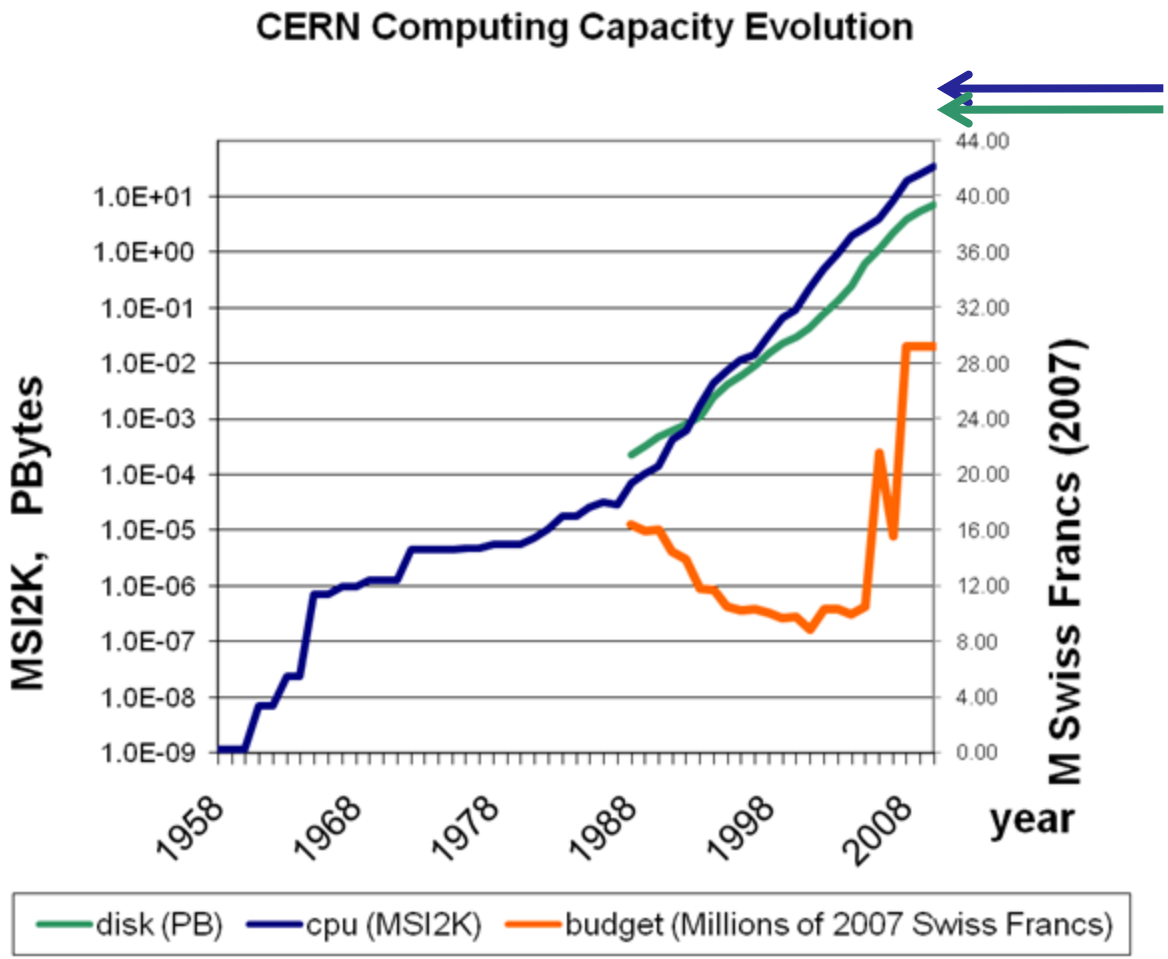
LHC Computing Challenge

- **Signal/Noise 10^{-9}**
- **Data volume**
  - High rate * large number of channels * 4 experiments
  - ➔ **15 PetaBytes of new data each year**
- **Compute power**
  - Event complexity * Nb. events * thousands users
  - ➔ **100 k CPUs (cores)**
- **Worldwide analysis & funding**
  - Computing funding locally in major regions & countries
  - Efficient analysis everywhere
  - ➔ **GRID technology**



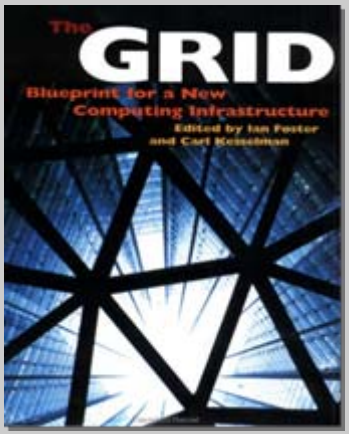


Requirements Match?



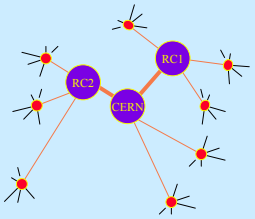
Tape & disk requirements: >10 times CERN possibility

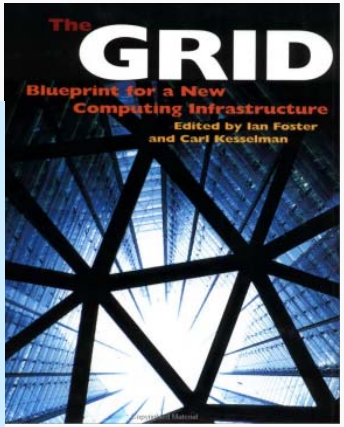
Substantial computing required outside CERN



Timeline - Grids

- Partially decentralized model
  - replicate the event data at about five regional centres
  - data transfer via network or movable media





GriPhyN, iVDGL, PPDG

GRID 3

OSG

Inter-operation

WLCG

EU DataGrid

EGEE 2

EGEE 3

LCG 1

LCG 2

1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

Service Challenges

Cosmics

First physics

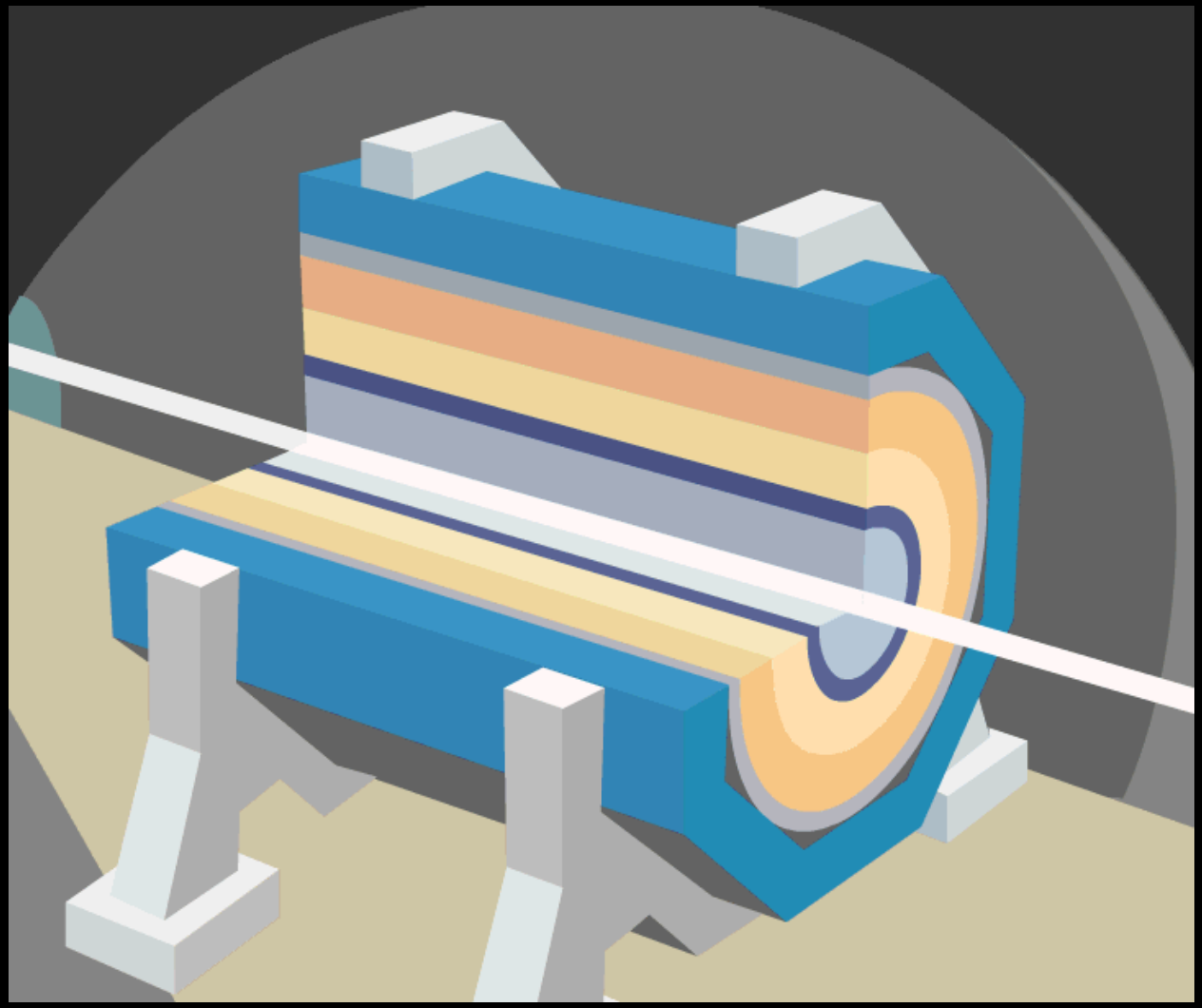
Data Challenges

CCRC08 Common Computing Readiness Challenge

WLCG Collaboration

- **The Collaboration**
  - 4 LHC experiments
  - ~250 computing centres
  - 12 large centres (Tier-0, Tier-1)
  - 38 *federations* of smaller "Tier-2" centres
  - Growing to ~40 countries
  - Grids: EGEE, OSG, Nordugrid
- **Technical Design Reports**
  - WLCG, 4 Experiments: June 2005
- **Memorandum of Understanding**
  - Agreed in October 2005
- **Resources**
  - 5-year forward look

Events at LHC

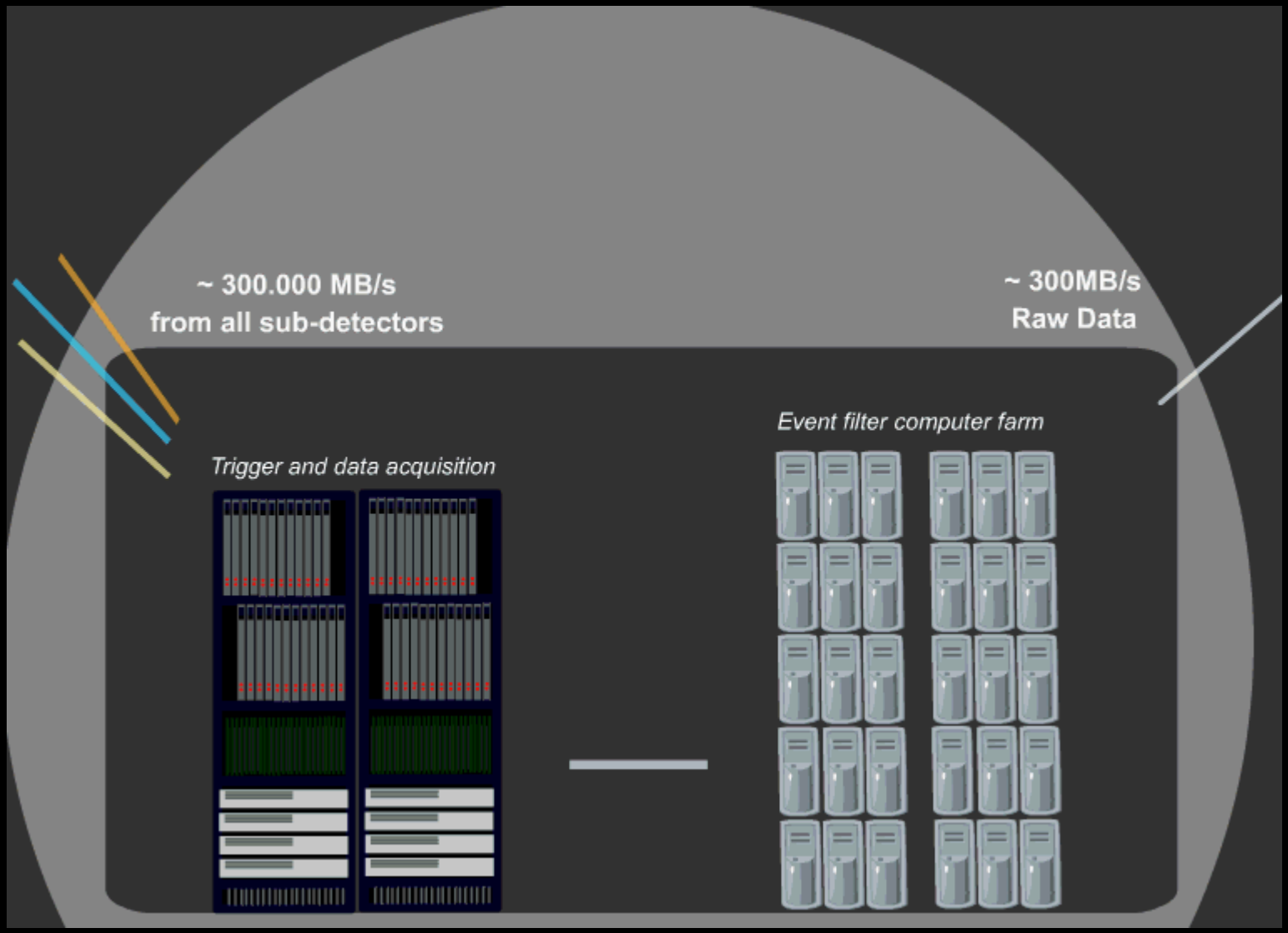


Luminosity :
$10^{34}cm^{-2}\ s^{-1}$

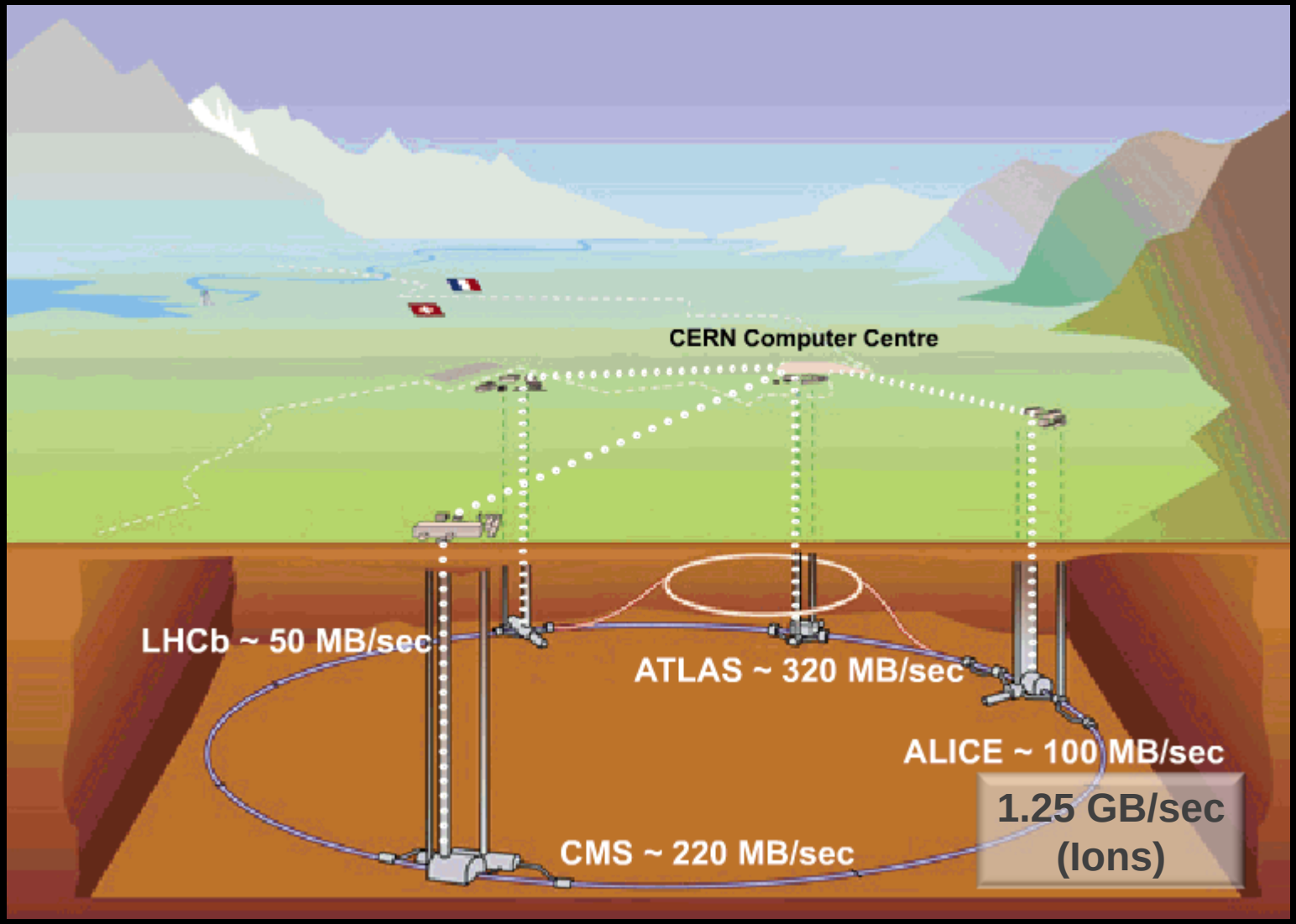
40 MHz – every 25 ns

20 events overlaying

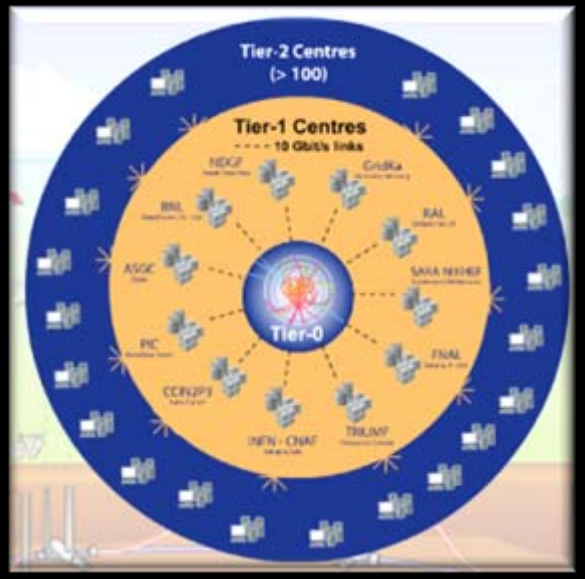
Trigger & Data Acquisition



Data Recording



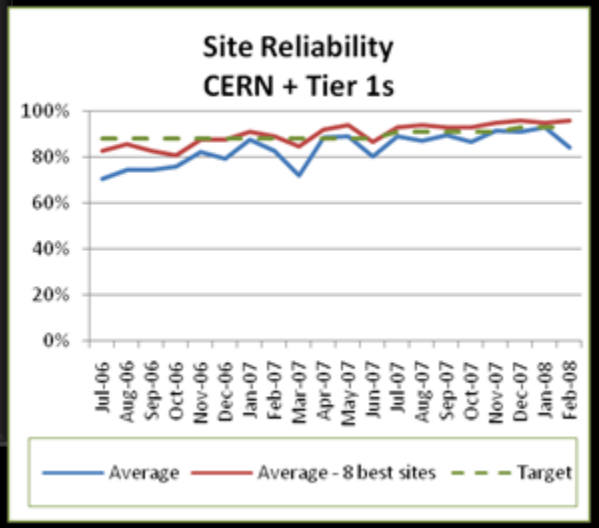
Tier-0, Tier-1, Tier-2



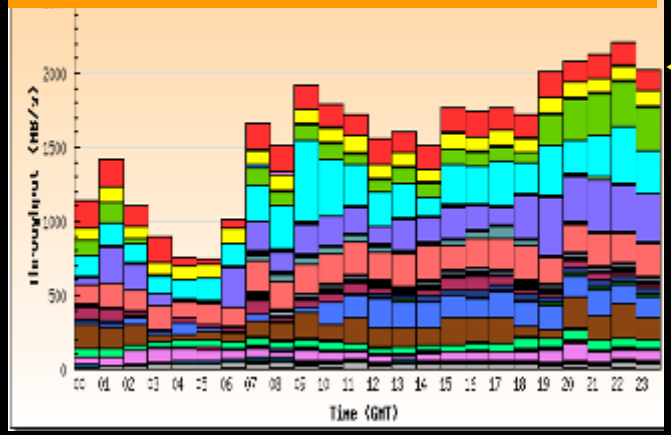
Tier-0 (CERN):
- Data recording
- First-pass reconstruction
- Data distribution

Tier-1 (11 centres):
- Permanent storage
- Re-processing
- Analysis

Tier-2 (>250 centres):
- Simulation
- End-user analysis



Data Transfer out of Tier-0



2 GB/sec

Target

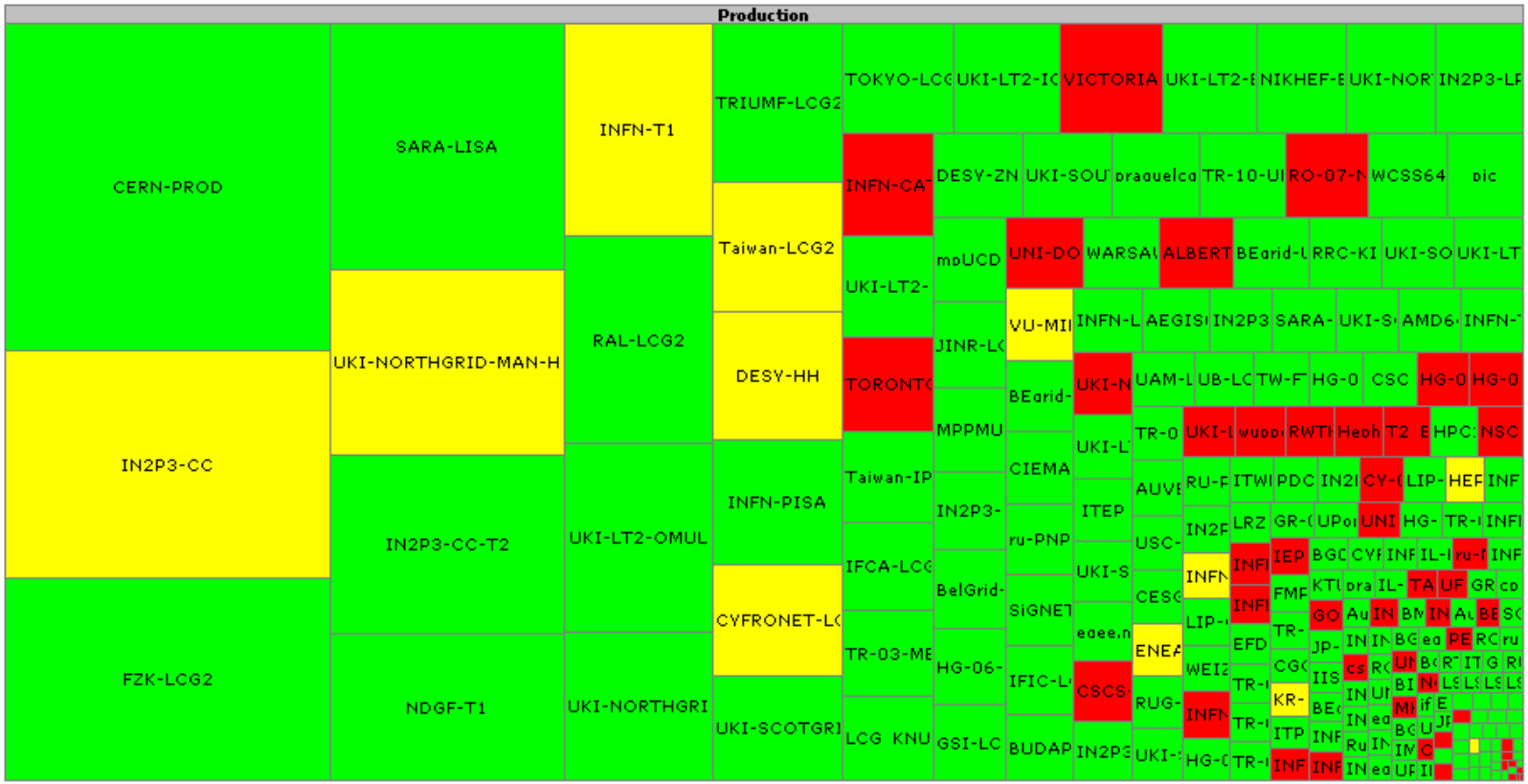
Note: For a site to be reliable, many things have to work simultaneously!

Middleware

- **Security**
  - Virtual Organization Management (VOMS)
  - MyProxy
- **Data management**
  - File catalogue (LFC)
  - File transfer service (FTS)
  - Storage Element (SE)
  - Storage Resource Management (SRM)
- **Job management**
  - Work Load Management System(WMS)
  - Logging and Bookeeping (LB)
  - Computing Element (CE)
  - Worker Nodes (WN)
- **Information System**
  - Monitoring: BDII (Berkeley Database Information Index), RGMA (Relational Grid Monitoring Architecture) → aggregate service information from multiple Grid sites, now moved to SAM (Site Availability Monitoring)
  - Monitoring & visualization (Gridview, Dashboard, Gridmap etc.)

Gridmap

GridMap Prototype – Visualizing the "State" of the Grid



Site Status, for 'OPS' VO, 11 Oct 2007 18:00-18:59 GMT.
Size of site rectangles is number of CPUs from BDII.
All sites known by GStat having data in BDII.

Down Degraded Ok

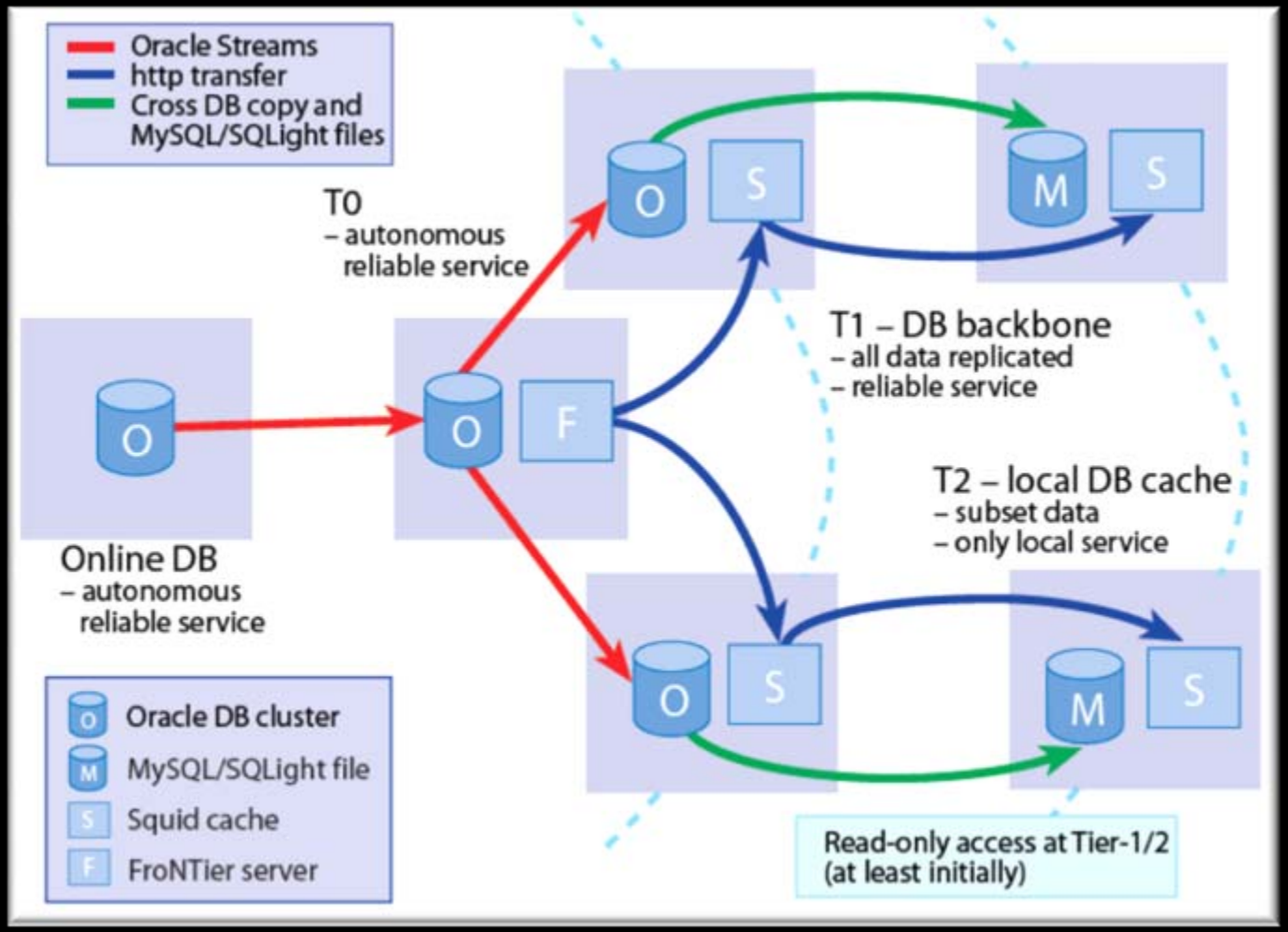
3D - Distributed Deployment of Databases for LCG

ORACLE Streaming with Downstream Capture

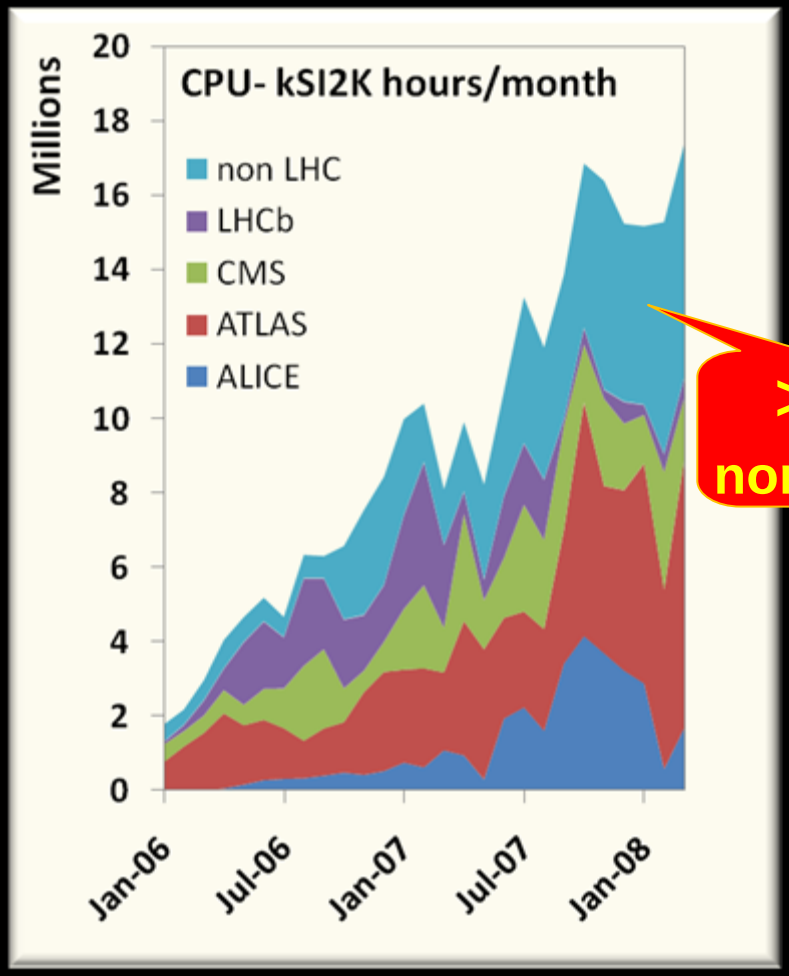
(ATLAS, LHCb)

SQUID/FRONTIER Web caching

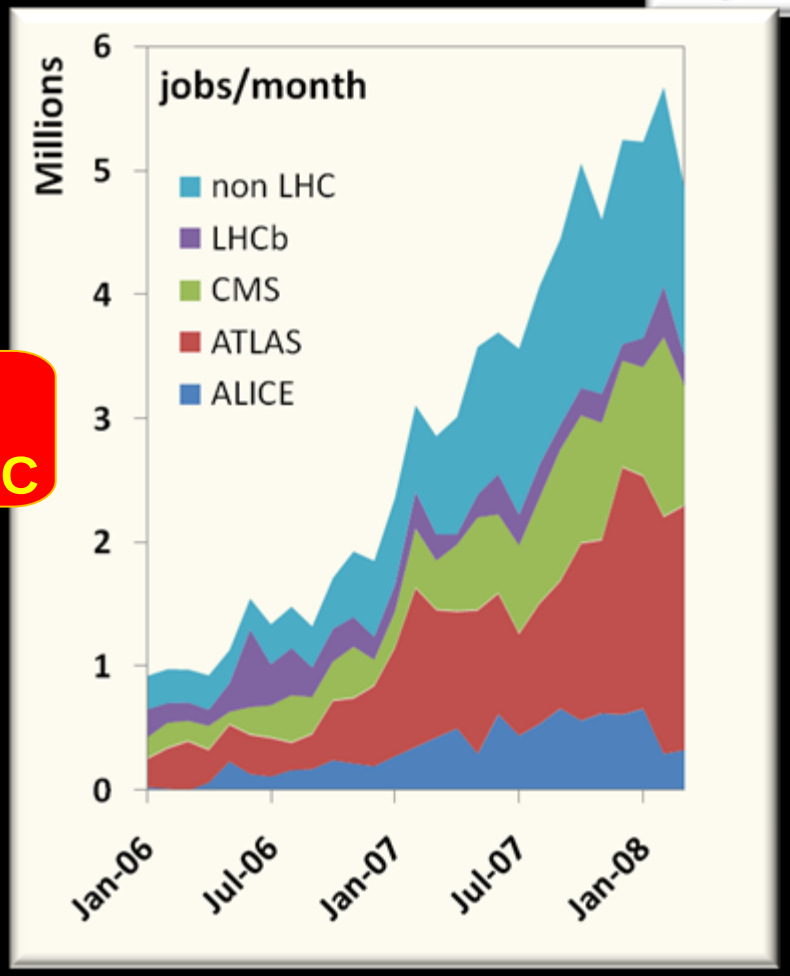
(CMS)



EGEE increasing workloads

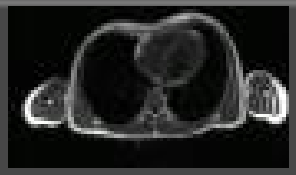


>⅓ non-LHC

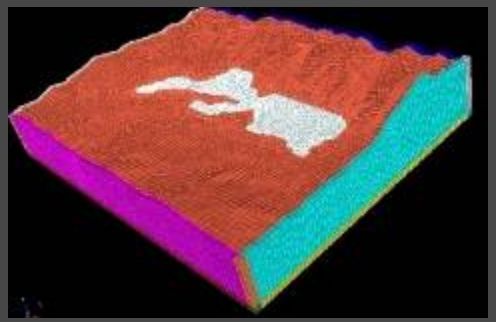


Factor 3 capacity ramp-up is in progress for LHC operation

Grid Applications

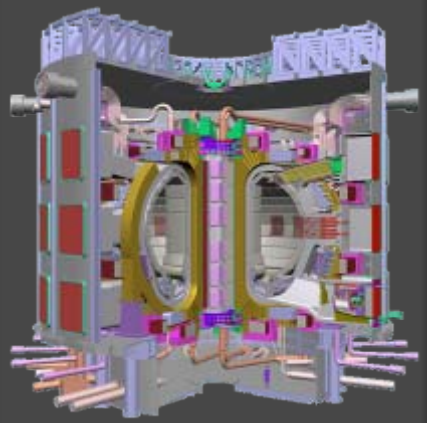

Medical



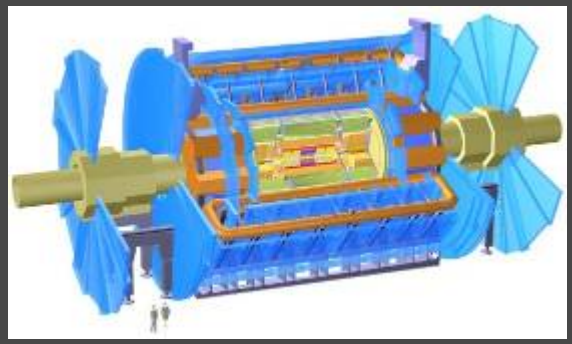
Seismology

Chemistry

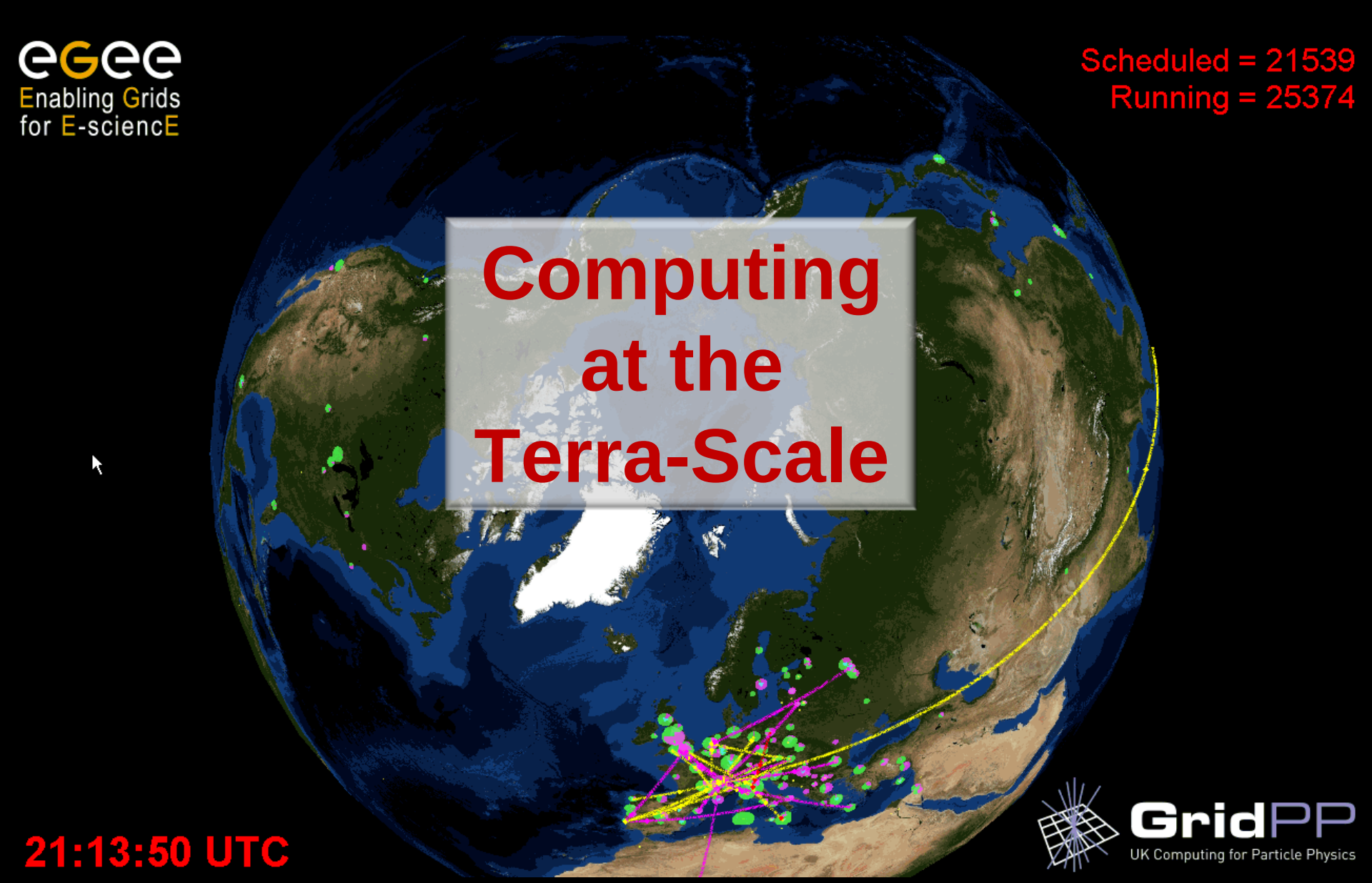
Astronomy



Fusion



Particle Physics

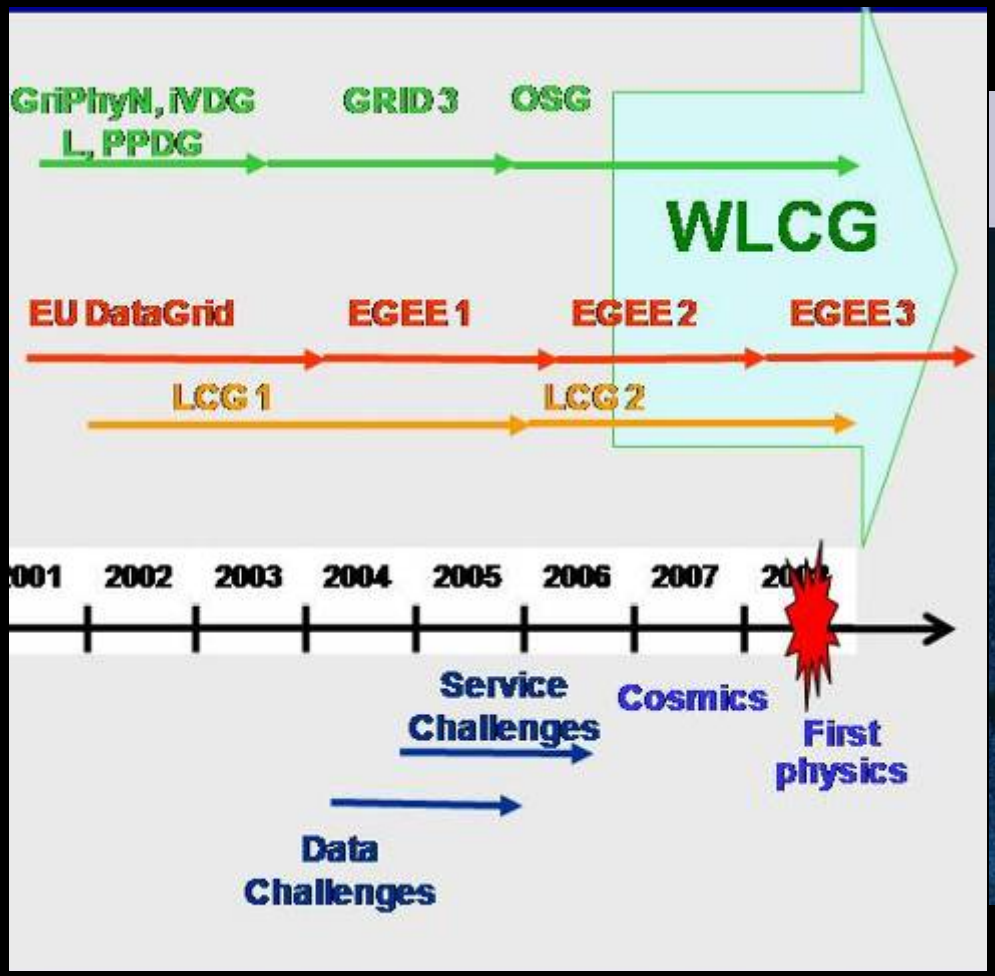


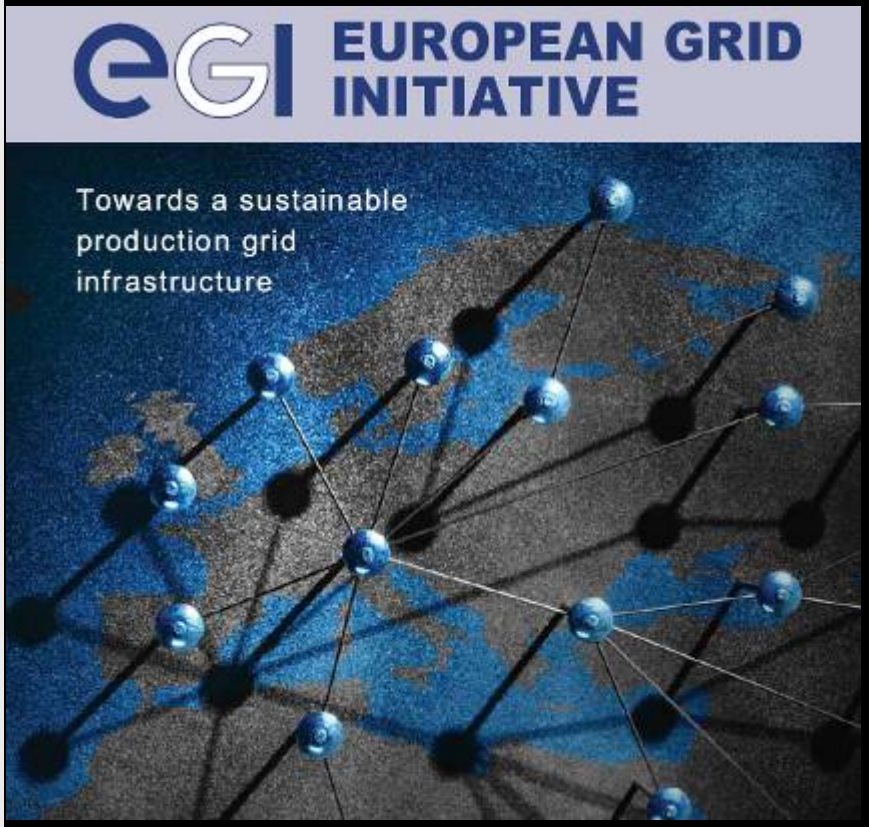
Tier-1 Centers: TRIUMF (Canada); GridKA(Germany); IN2P3 (France); CNAF (Italy); SARA/NIKHEF (NL); Nordic Data Grid Facility (NDGF); ASCC (Taipei); RAL (UK); BNL (US); FNAL (US); PIC (Spain)

Evolution


National
Global
European
e-Infrastructure
BEgrid
open middleware infrastructure institute
grid.it project
e-Toile
NGS National Grid Service
D-GRID
GridPP
UNICORE FORUM
HELLAS GRID Task Force
INFN GRID
NORDUGRID
ACI GRID
DutchGrid
euchinagrid
EUMED Grid
omii europe
SEE-GRID
eGee Enabling Grids for E-sciencE
Distributed European Infrastructure for Supercomputing Applications
BEinGRID
Data GRID
Diligent
ISSeG
BioinfoGRID
eTICS
Belief
Health-e-Child

Sustainability





European Grid Initiative

Goal:

- **Long-term sustainability of grid infrastructures in Europe**

Approach:

- **Establishment of a new federated model bringing together National Grid Initiatives (NGIs) to build the EGI Organisation**

EGI Organisation:

- **Coordination and operation of a common multi-national, multi-disciplinary Grid infrastructure**
  - To enable and support international Grid-based collaboration
  - To provide support and added value to NGIs
  - To liaise with corresponding infrastructures outside Europe

EGI – European Grid Initiative

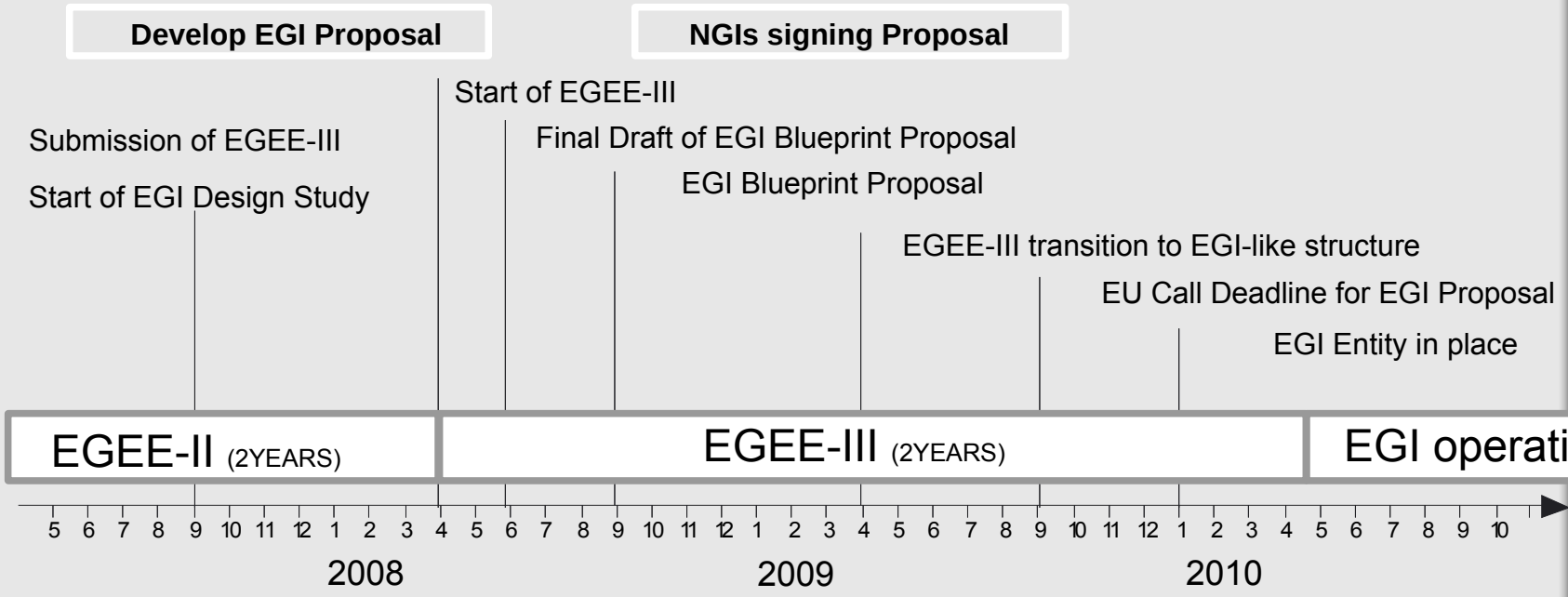
- EGI Design Study started Sept 07 to establish a sustainable pan-European grid infrastructure after the end of EGEE-3 in 2010
- The main foundations of EGI are 37 National Grid Initiatives (NGIs)
- Project is funded by the European Commission's 7th Framework Program

Work packages	Lead by
Project management	**Dieter Kranzlmüller** GUP, Austria
EGI Requirements Consolidation	Fotis Karayannis, GRNET, Greece
EGI Functions Definition	Laura Perini INFN, Italy
Design Study of EGI Legal and Organisational Options	Beatrice Merlin CNRS, France
Establishment of EGI	Jürgen Knobloch CERN
EGI Promotion and Links with Other Initiatives	Per Öster CSC, Finland

web.eu-egi.eu

EGI_DS Schedule

Duration 27 months:



EGI Functionality Overview

- Management, Outreach & Dissemination - Representation of EU Grid Efforts
- Operations & Resource Provisioning & Security
- Application Support & Training
- Middleware (Build&Test, Component Selection/Validation/Deployment)
- Standardisation & Policies
- Industry take-up

Characteristics of NGIs

Work in progress!
Things may change!

Each NGI

… should be a recognized national body with a single point-of-contact

… should mobilise national funding and resources

… should ensure an operational national grid infrastructure

… should support user communities (application independent, and open to new user communities and resource providers)

… should contribute and adhere to international standards and policies

Responsibilities between NGIs and EGI are split to be federated and complementary

EGI Operations

Work in progress!
Things may change!

- NGIs perform **operations** of their **national grid infrastructure**, including monitoring and accounting, following a general SLA
- Each NGI has full responsibility towards other NGIs but acts independently
- EGI provides **coordination level** to guarantee effective, integrated operations through the adoption of standard services

EGI Resource Strategy

Work in progress!
Things may change!

- EGI owns very few hardware resources
- **Resource provisioning** is responsibility of NGIs → Freedom to choose whatever resources to offer
- Development of a strategy for **simple entry** of new Virtual Organizations

EGI Middleware

Work in progress!
Things may change!

- **Convergence of middleware stacks towards full interoperability (through general standards interfaces)**
- **Distinction between core and high-level functions ➔ EGI coordinates core services**
  - Standards-compliance test for core services provided by EGI
  - Common build&test system needed in Europe

Issues being discussed

- Small vs. large central EGI
- Roles “core EGI” vs. NGI
- Transition from a (EU) project-funded grid to self-sustained operations
- Maintaining the available expertise
- Choice of legal structure and location
- Role of industry in EGI

Conclusion

- **Grids are essential for LHC computing!**
- **Arriving at reliable routine operation was a bumpy road**
- **But we are there now!**
- **Other communities have joined (and could only join because of the large effort spent in High Energy Physics)**

➔ **Next challenge:**
Moving towards a sustainable environment for the application communities utilizing grid infrastructures for their everyday work