

Grids for Science in Europe

planning for sustainability

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Presented at
CERN openlab Board of Sponsors

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CERN

Annual budget: ~1000 MSFr (~600 M€)

Staff members: 2650

+ 270 Fellows,

Member states: 20

+ 440 Associates

+ 8000 CERN users

Basic research

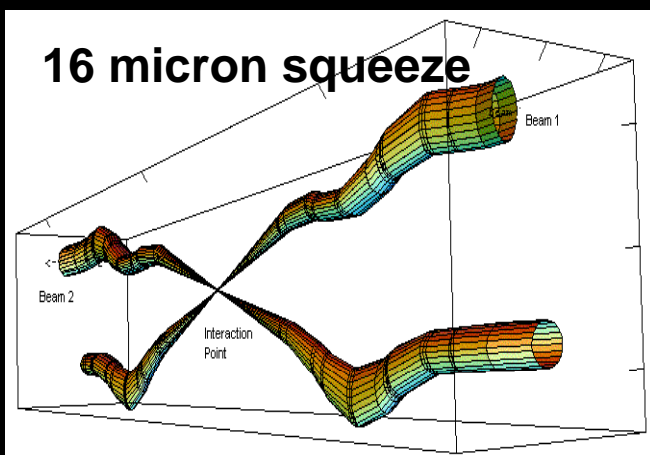
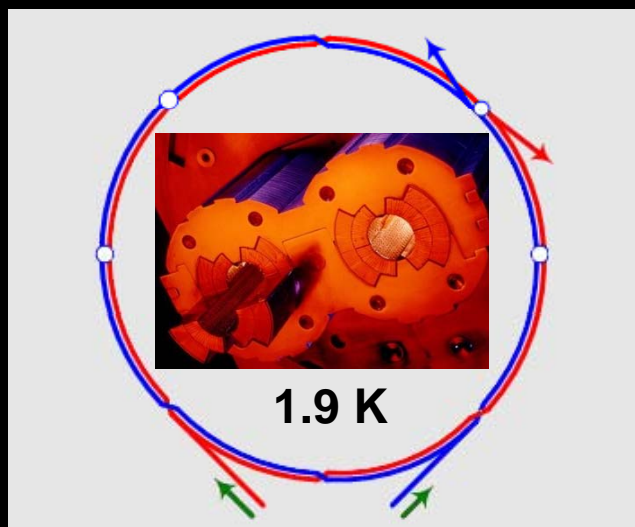
Fundamental questions

High E accelerator:

Giant microscope ($p=h/\lambda$)

Generate new particles ($E=mc^2$)

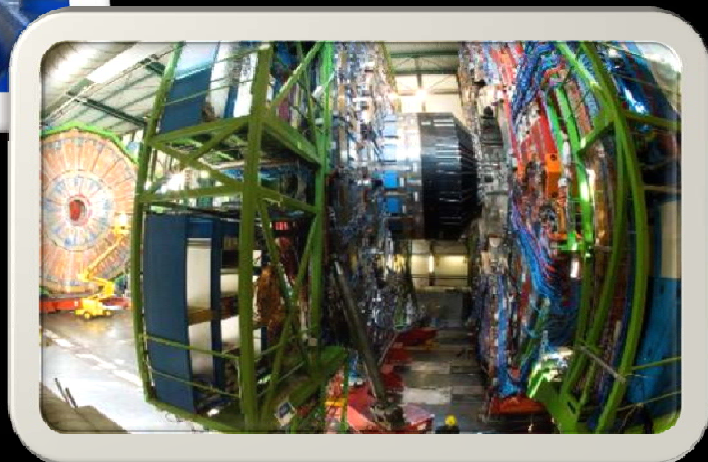
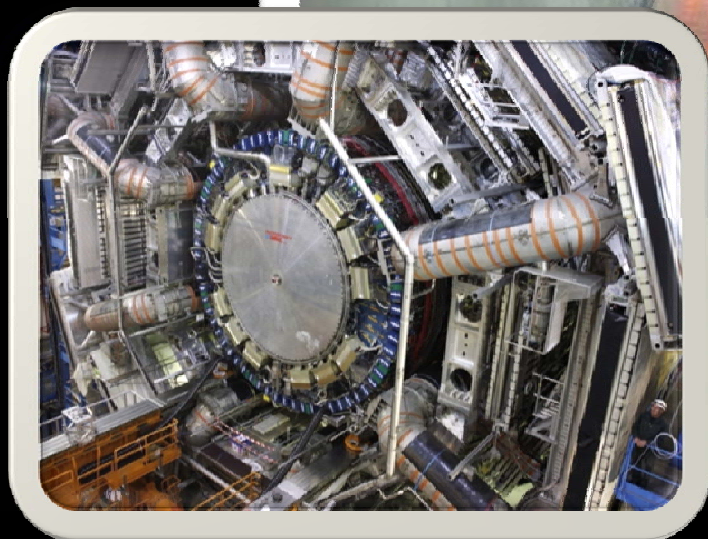
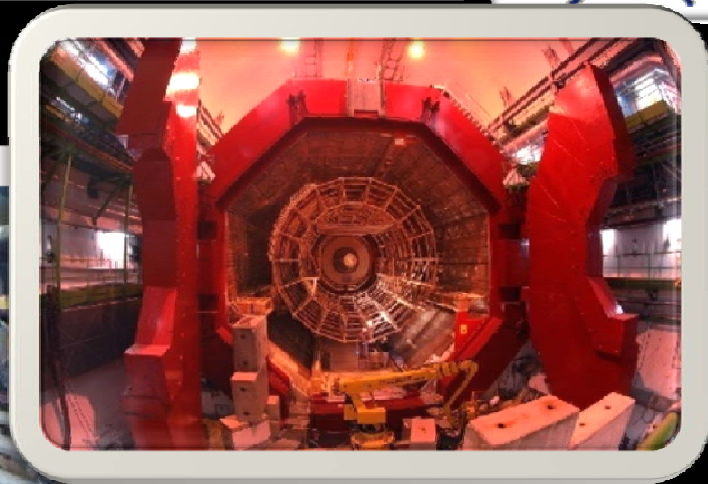
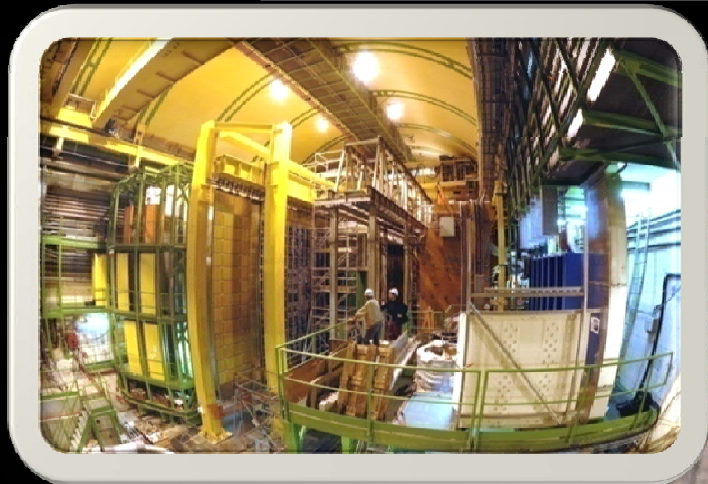
Create Big Bang conditions



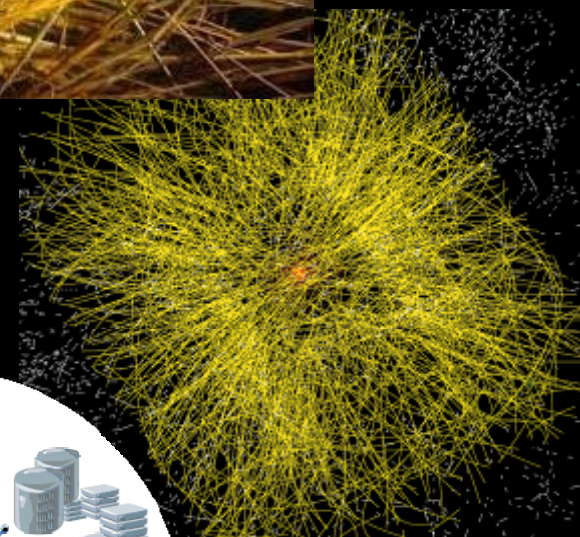
- 27 km circumference
- Cost ~ 3000 M€ (+ detectors)
- Proton-proton (or lead ion) collisions at 7+7 TeV
- Bunches 10^{11} protons cross every 25 nsec
- 600 million collisions/sec
- Physics questions
 - Origin of mass (Higgs?)
 - Dark matter?
 - Symmetry matter-antimatter
 - Forces – supersymmetry
 -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

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

LHC gets ready ...

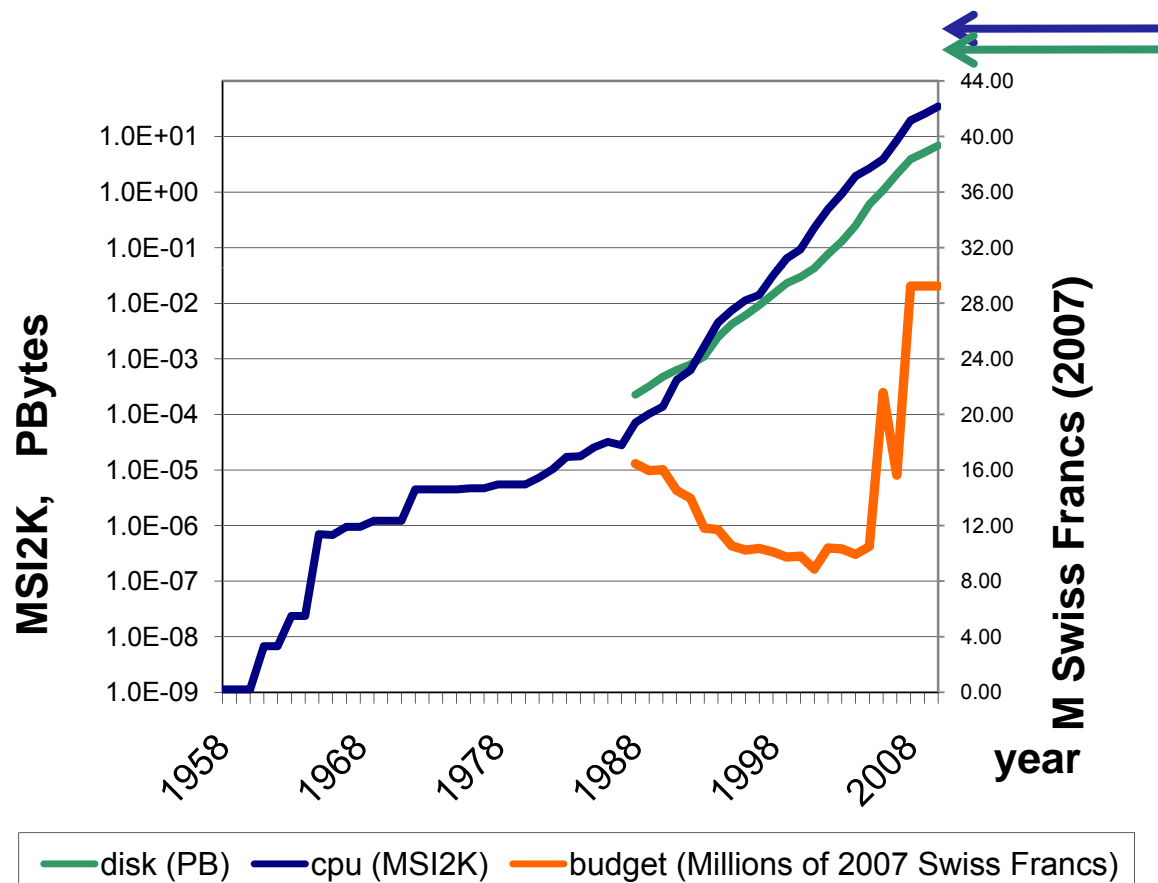


- **Signal/Noise 10^{-9}**
- **Data volume**
 - High rate * large number of channels * 4 experiments
 - **15 PetaBytes of new data each year**
- **Compute power**
 - Event complexity * Nb. events * thousands users
 - **100 k CPUs (cores)**
- **Worldwide analysis & funding**
 - Computing funding locally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



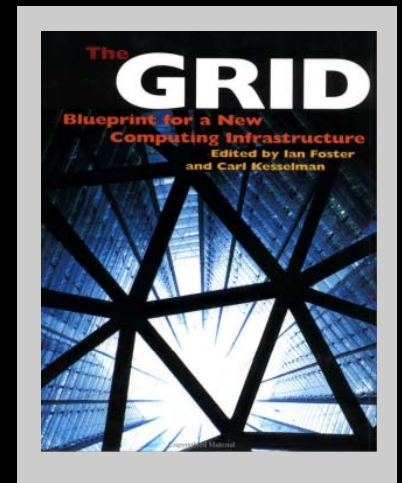
Requirements Match?

CERN Computing Capacity Evolution

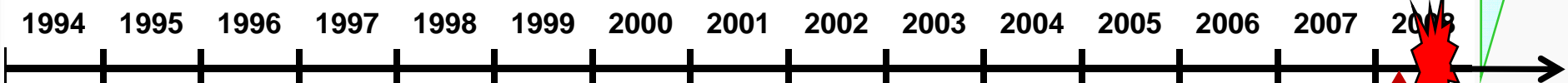
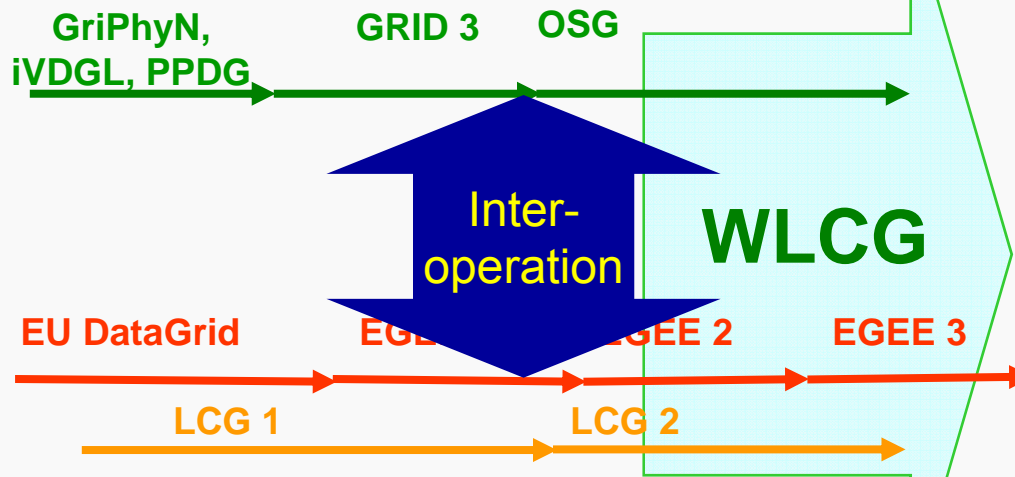
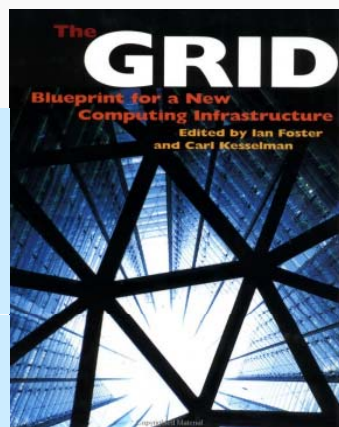
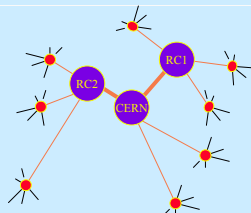


Tape & disk requirements: >10 times CERN possibility

Substantial computing required outside CERN

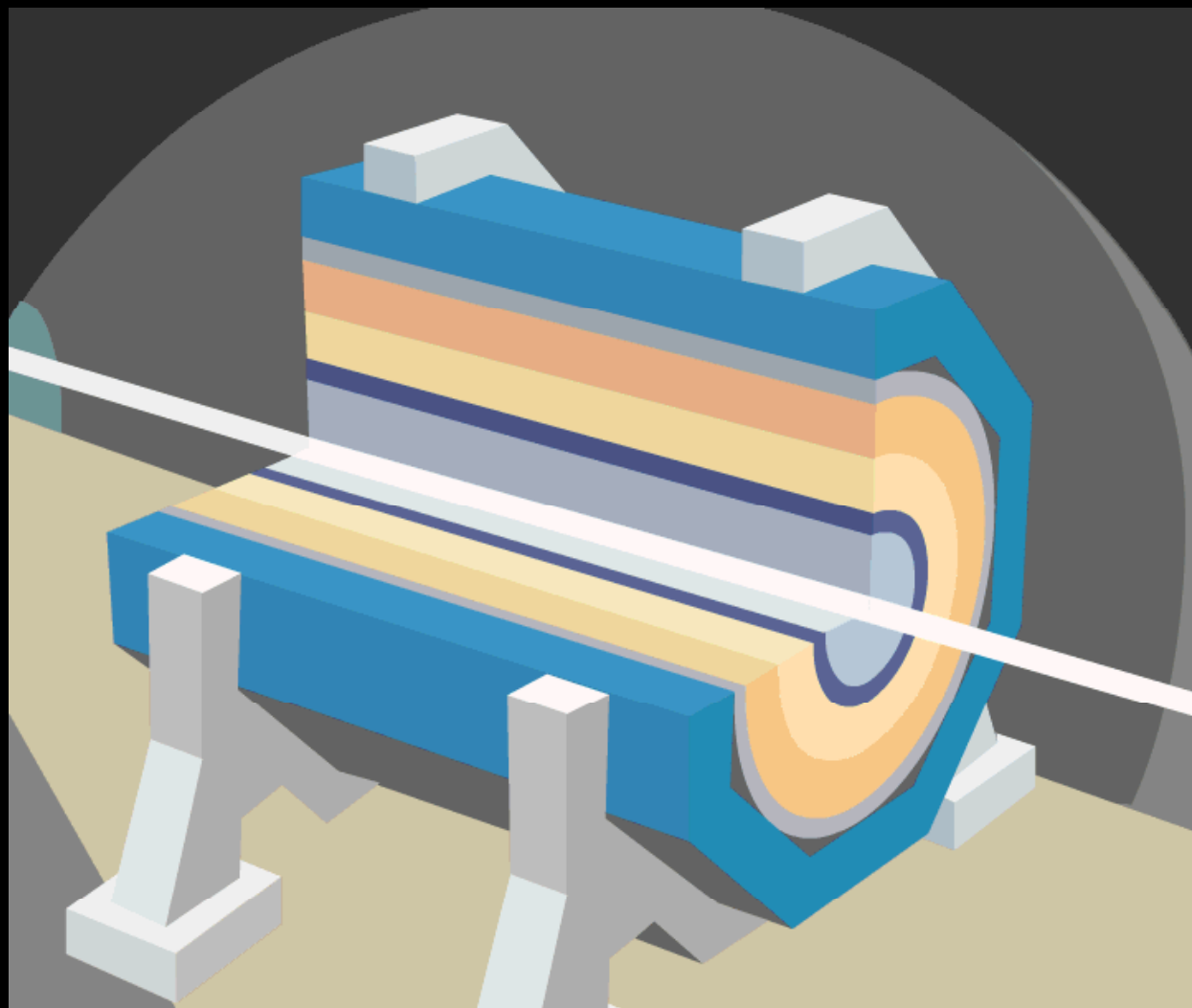


- Partially decentralized model
 - replicate the event data at about five regional centres
 - data transfer via network or movable media



- **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

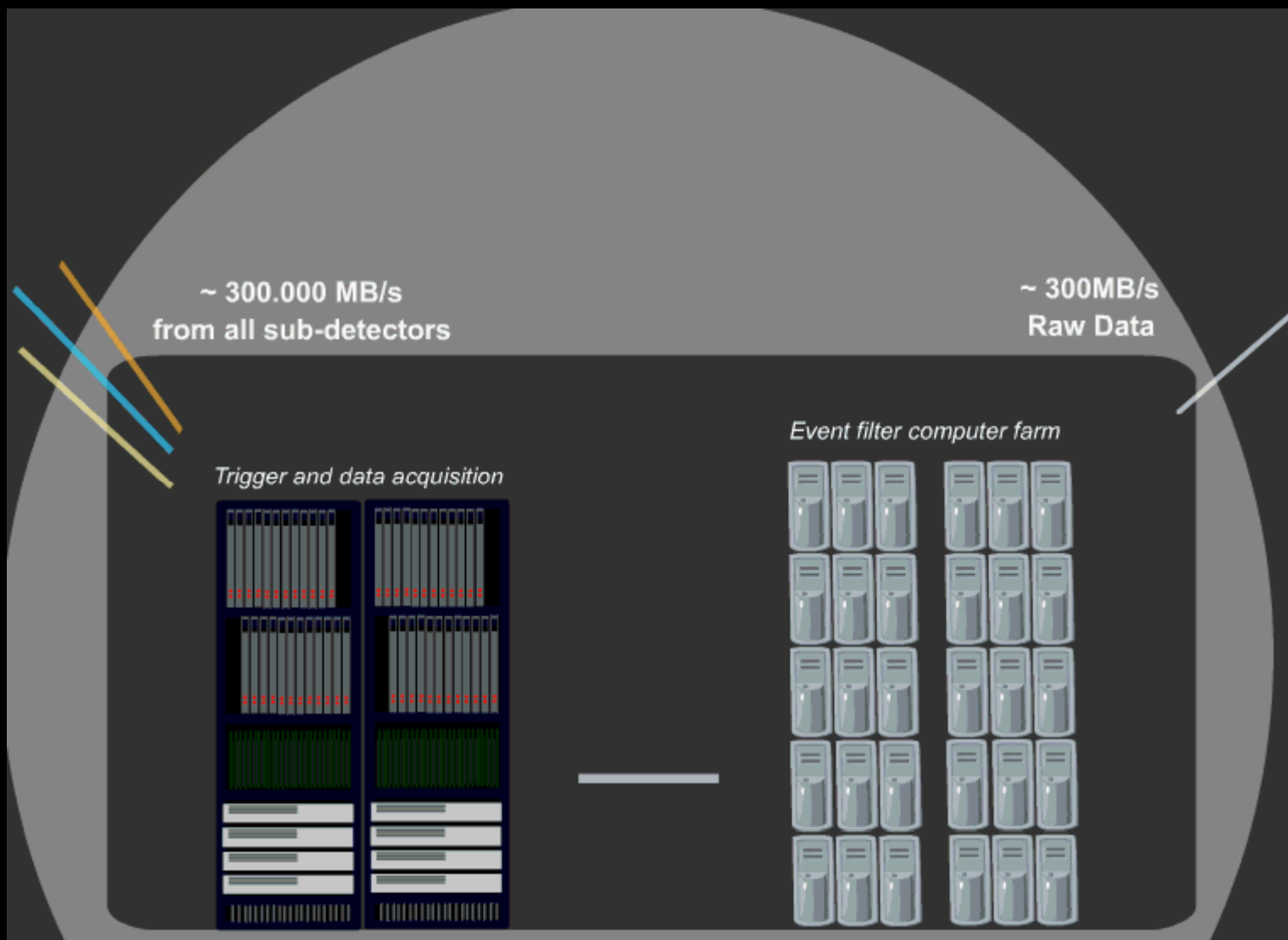


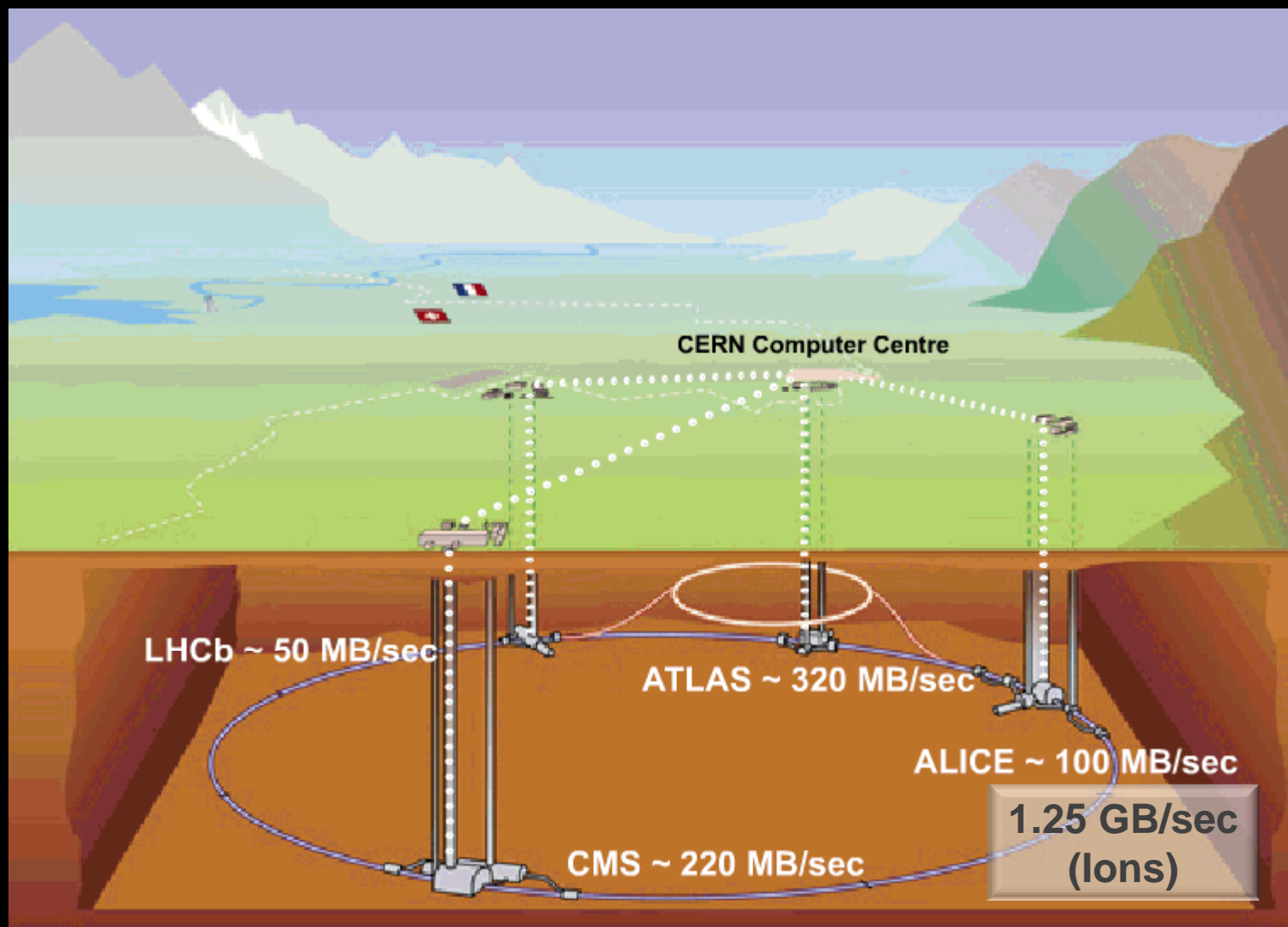


Luminosity :
 $10^{34} \text{cm}^{-2} \text{s}^{-1}$

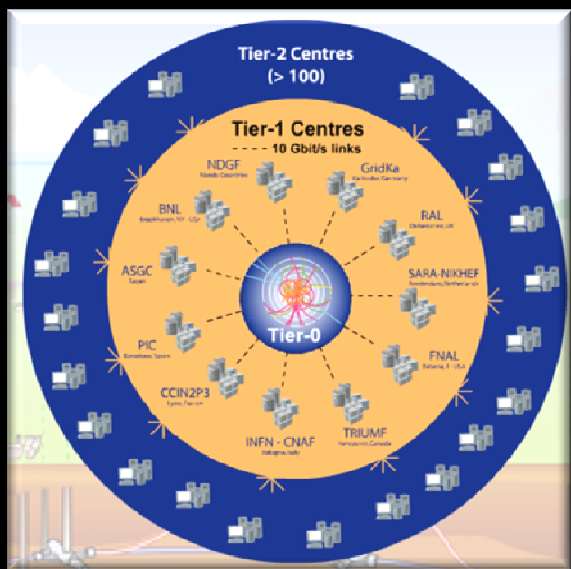
40 MHz – every 25 ns

20 events overlaying





Tier-0, Tier-1, Tier-2



Tier-0 (CERN):

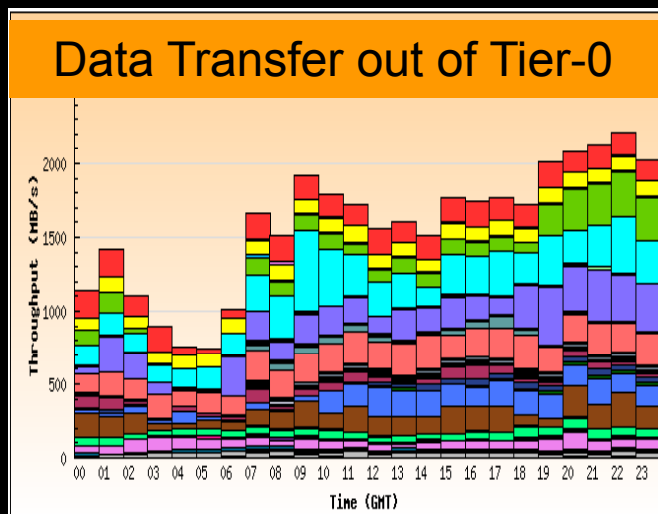
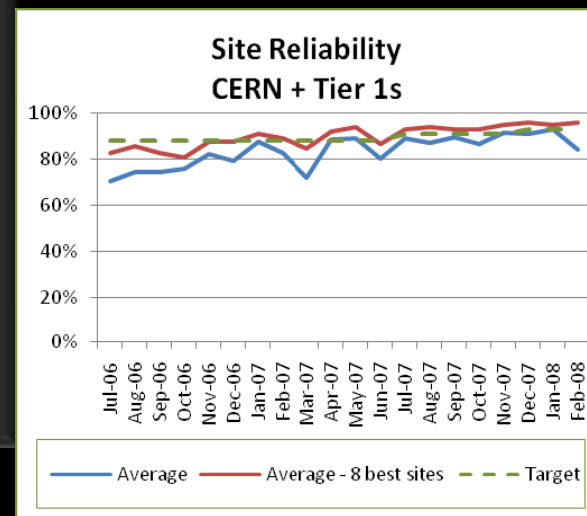
- Data recording
- First-pass reconstruction
- Data distribution

Tier-1 (11 centres):

- Permanent storage
- Re-processing
- Analysis

Tier-2 (>250 centres):

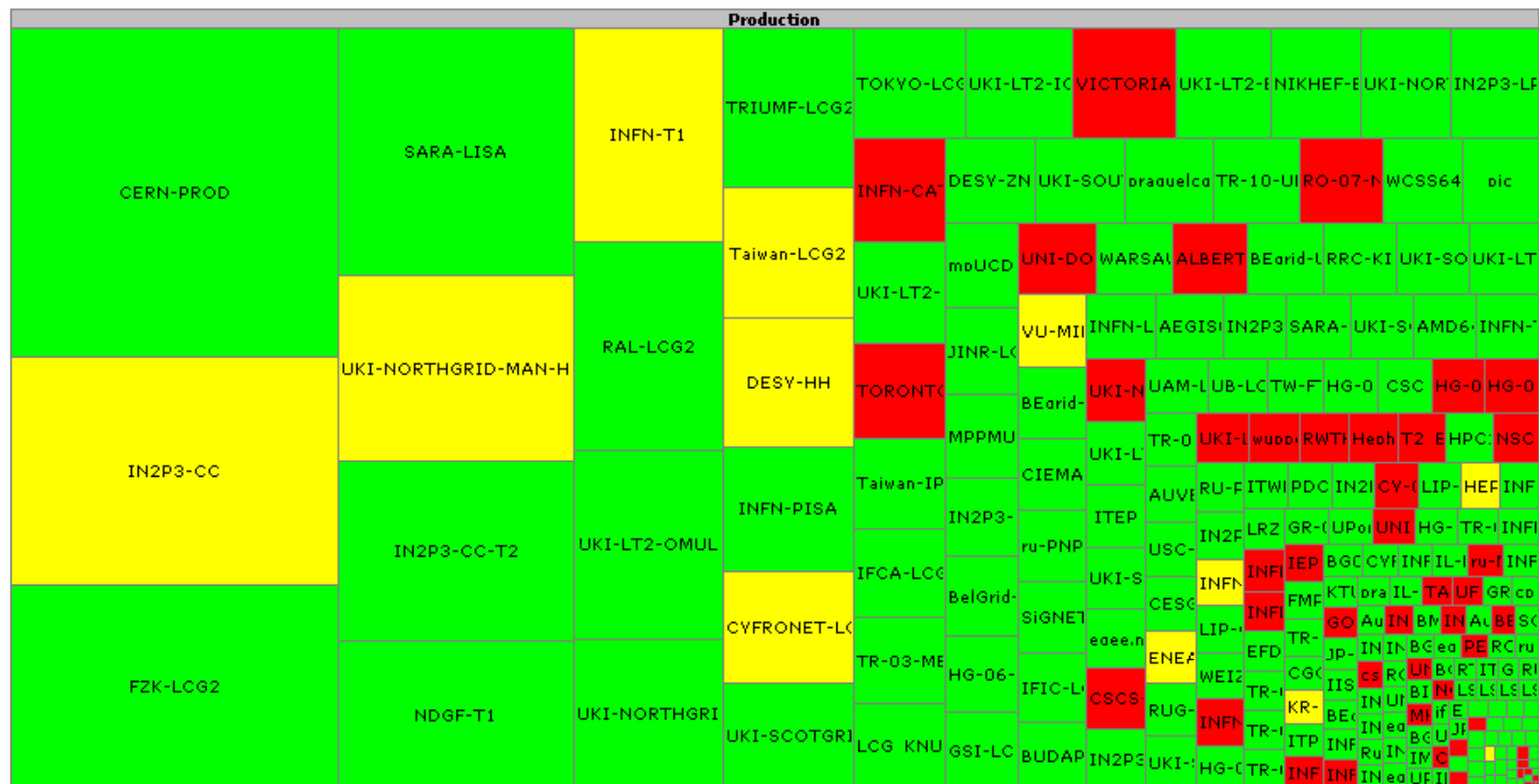
- Simulation
- End-user analysis



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

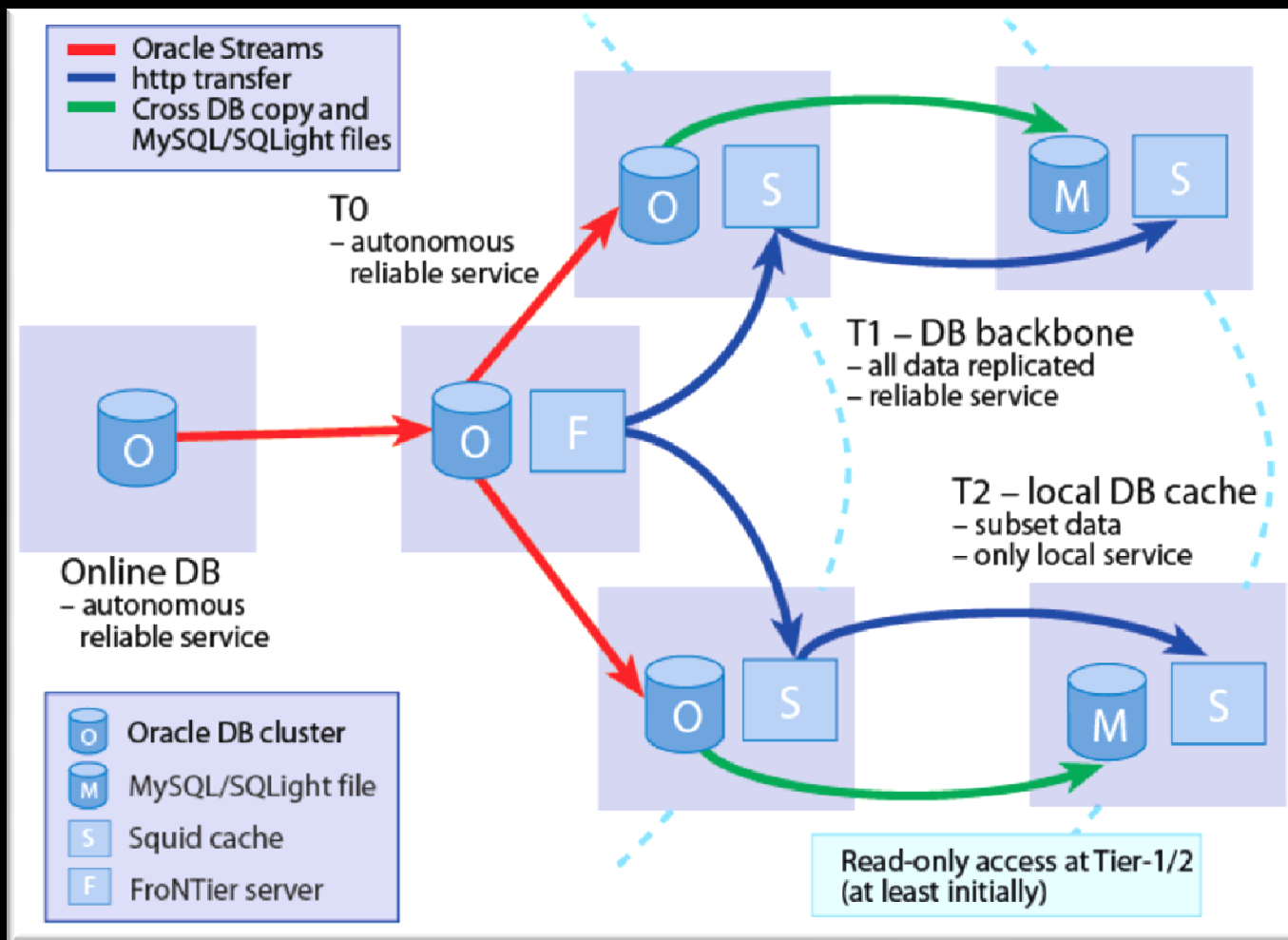
- **Security**
 - Virtual Organization Management (VOMS)
 - MyProxy
- **Data management**
 - File catalogue (LFC)
 - File transfer service (FTS)
 - Storage Element (SE)
 - Storage Resource Management (SRM)
- **Job management**
 - Work Load Management System(WMS)
 - Logging and Bookeeping (LB)
 - Computing 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.)

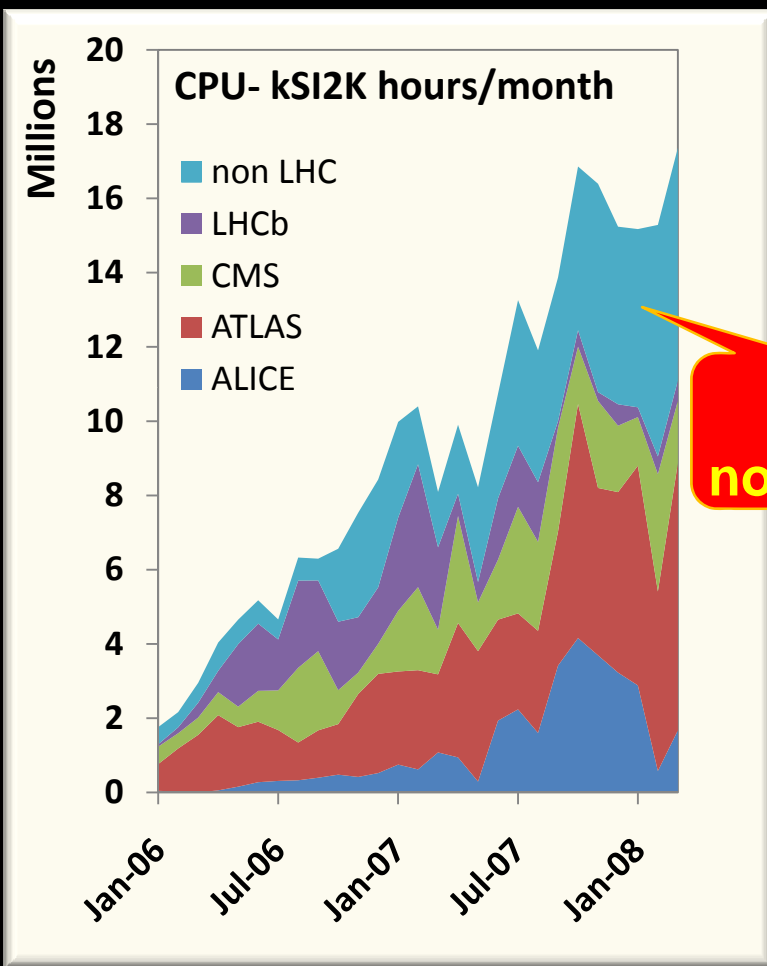
GridMap Prototype – Visualizing the "State" of the Grid



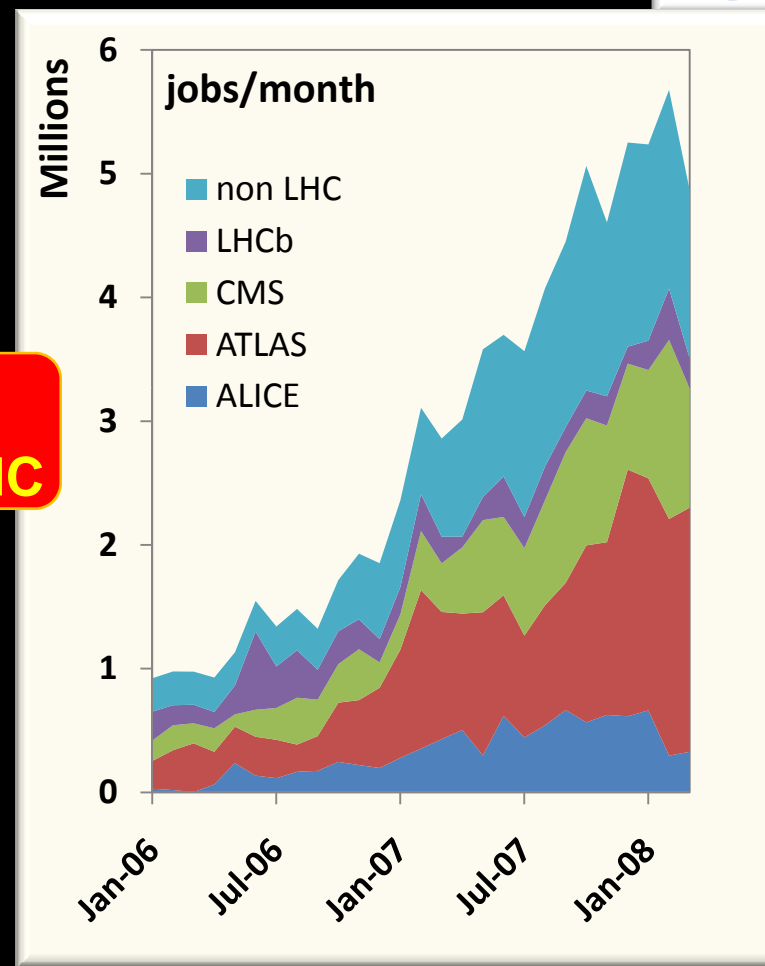
**ORACLE
Streaming with
Downstream
Capture
(ATLAS, LHCb)**

**SQUID/FRONTIER
Web caching
(CMS)**





**>1/3
non-LHC**



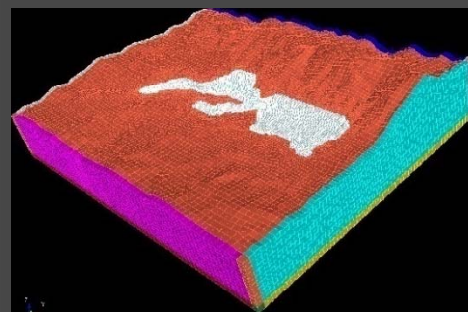
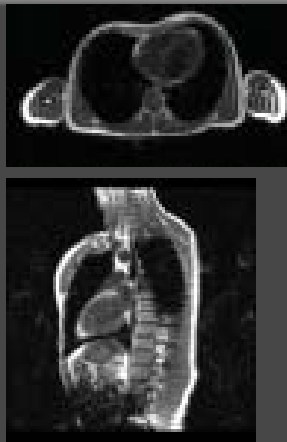
Factor 3 capacity ramp-up is in progress for LHC operation

At present there are about 20 applications from more than 10 domains on the EGEE Grid infrastructure

- Astronomy & Astrophysics - MAGIC, Planck
- Computational Chemistry
- Earth Sciences - Earth Observation, Solid Earth Physics, Hydrology, Climate
- Fusion
- High Energy Physics - 4 LHC experiments (ALICE, ATLAS, CMS, LHCb) BaBar, CDF, DØ, ZEUS
- Life Sciences - Bioinformatics (Drug Discovery, GPS@, Xmipp_MLrefine, etc.)
- Condensed Matter Physics
- Computational Fluid Dynamics
- Computer Science/Tools
- Civil Protection
- Finance (through the Industry Task Force)



Medical



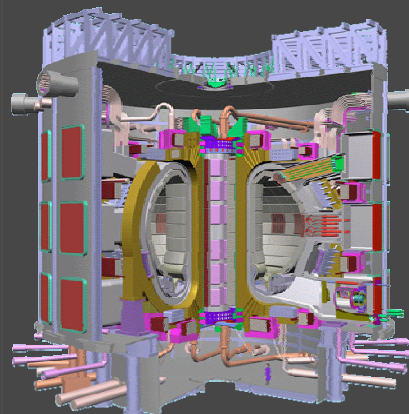
Seismology



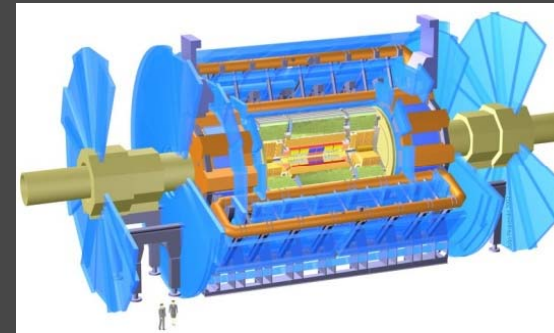
Chemistry



Astronomy



Fusion



Particle Physics



Computing at the Terra-Scale

21:13:50 UTC

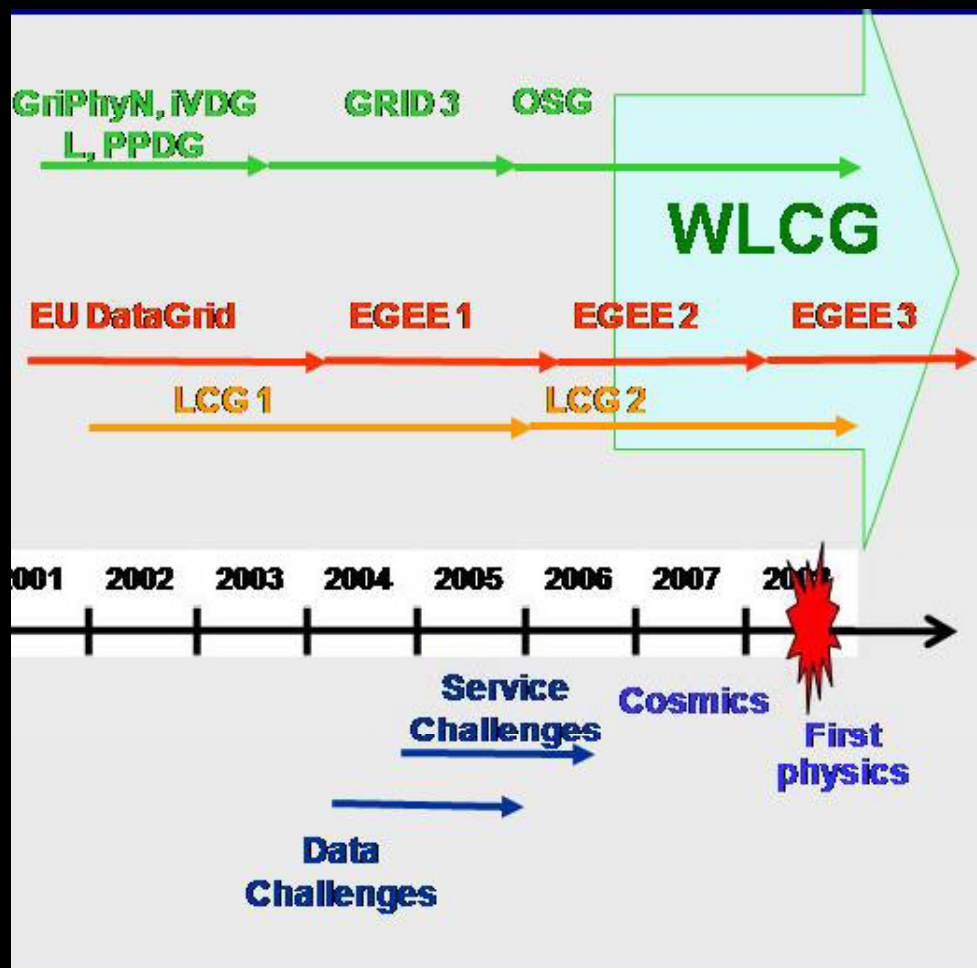
Tier-1 Centers: TRIUMF (Canada); GridKA(Germany); IN2P3 (France); CNAF (Italy); SARA/NIKHEF (NL); Nordic Data Grid Facility (NDGF); ASCC (Taipei); RAL (UK); BNL (US); FNAL (US); PIC (Spain)

National



European e-Infrastructure

Global



EGI EUROPEAN GRID INITIATIVE

Towards a sustainable production grid infrastructure



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

- **Johannes Kepler Universität Linz (GUP)**
- **Greek Research and Technology Network S.A. (GRNET)**
- **Istituto Nazionale di Fisica Nucleare (INFN)**
- **CSC - Scientific Computing Ltd. (CSC)**
- **CESNET, z.s.p.o. (CESNET)**
- **European Organization for Nuclear Research (CERN)**
- **Verein zur Förderung eines Deutschen Forschungsnetzes - DFN-Verein (DFN)**
- **Science & Technology Facilities Council (STFC)**
- **Centre National de la Recherche Scientifique (CNRS)**



- **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

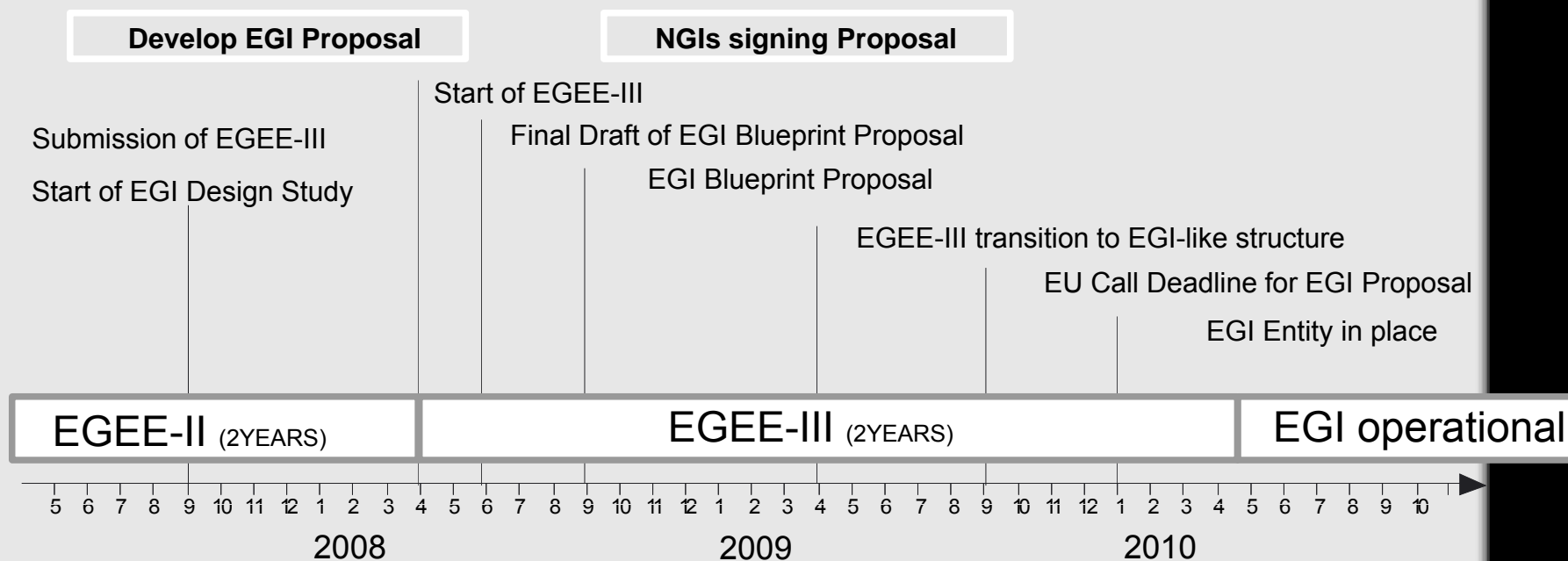
web.eu-egi.eu



EGI_DS Schedule



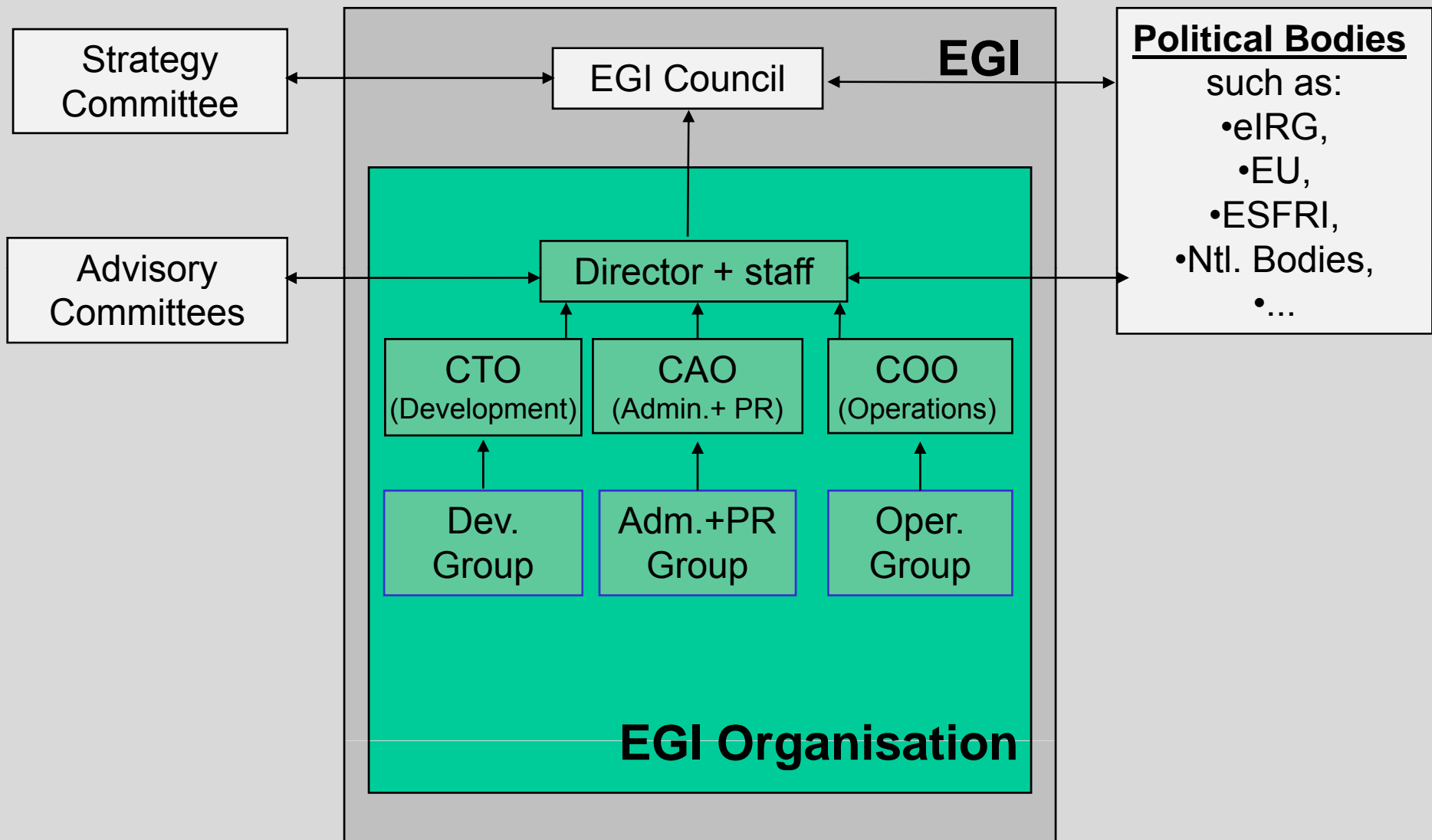
Duration 27 months:



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**



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

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

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

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

Work in progress!
Things may change!

- **Application support** implemented and provided by **NGIs**
- **EGI performs coordination role**
 - Validation of user support by NGIs
 - Facilitating experts between NGIs
 - Organization of user forums
- **EGI to coordinate training events**

**Work in progress!
Things may change!**

- **The EGI organisation has three major and separate cost centres:**
 - general central services
funded through contributions of the NGIs
 - service provisioning
funded through service charges
 - Developments
funded through project grants
- **There are in general no cross-subsidies possible between these cost centres.**

Issues being discussed



- **Small vs. large central EGI**
- **Roles “core EGI” vs. NCI**
- **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**

- **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