

Worldwide LHC Computing Grid (WLCG)によるLHC 加速器 ATLAS 実験のデータ解析

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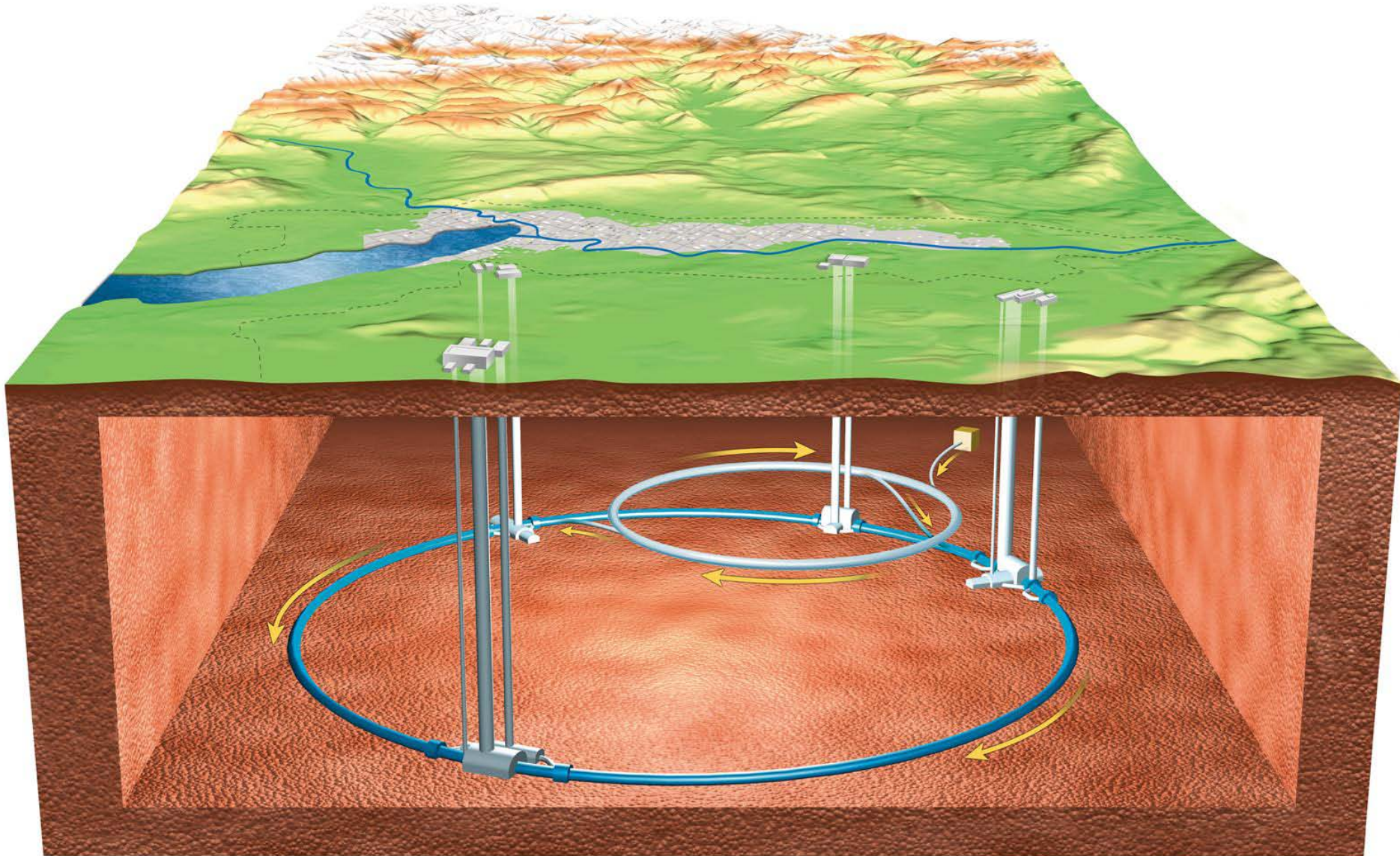
Contents

- LHC (Large Hadron Collider)
 - Accelerator
 - Experiments
- WLCG (Worldwide LHC Computing Grid)
 - Computing model
 - Performance



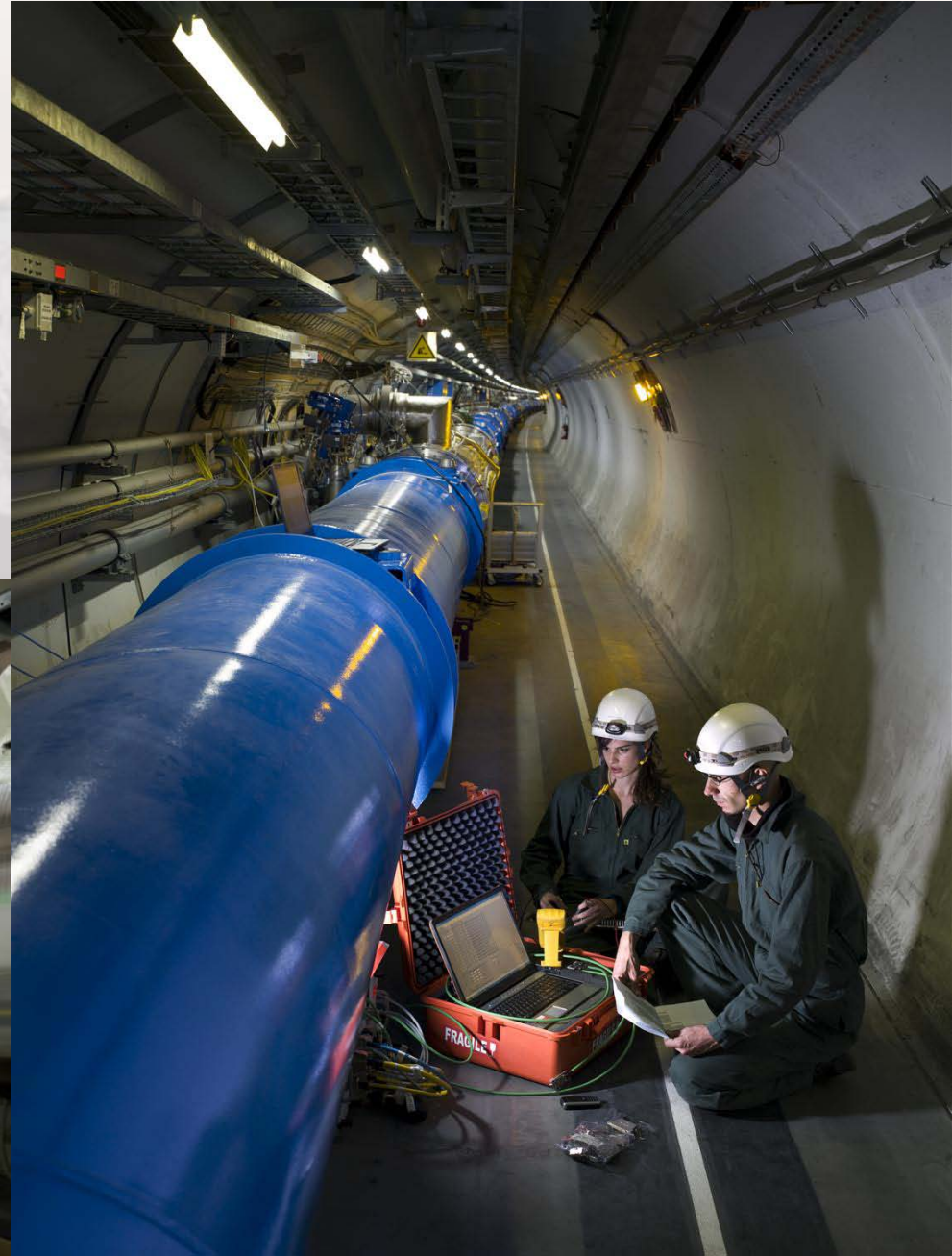


LHC Accelerator Tunnel



Accelerator Components

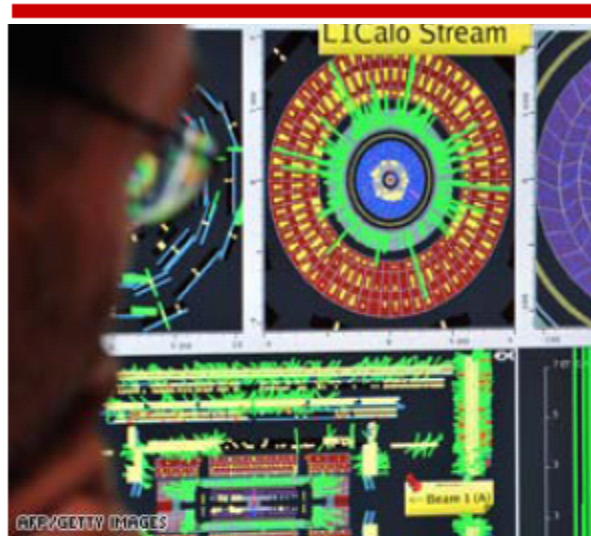
- 1232 Main Dipole Magnets
- 386 Main Quadrupole Magnets
- A few thousands of Correction Magnets.





LHC First Beam

- There were over 300 journalists on site,
- Google news found over 3500 press cuttings on the day,
 - not to mention featuring the LHC on the Google logo.
- Around 450 television stations picked up our broadcast signal.
- Eurovision has reported that it was broadcast over 2100 times.
- And our websites strained under the pressure of over 100 million hits.
- In our Member States and around the world, CERN was the lead news story on television news, even demoting the US elections to second place.
- Particle physics has never had such a high profile, and it gives us an opportunity over the coming years to get basic science back into the mainstream. (Robert Aymar: DG CERN)



updated 11 minutes ago

Scientists cheer atom smasher success

Scientists applauded as one of the most ambitious experiments ever conceived began today. The Large Hadron Collider – designed to simulate conditions of the Big Bang – was switched on this morning. Skeptics claim the experiment could create a black hole capable of swallowing the Earth. full story

'The biggest scientific experiment ever' 🇯🇵

Explainer: A look at the atom smasher

id (WLCG)によるLHC 加速器ATLAS 実験のデータ解析



CERN Control Center



Atlas Control Room



10-09-2008 15:03:39

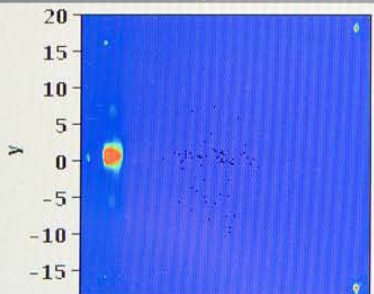
BEAM SETUP: INJECTION PROBE BEAM

TED T12 position: **BEAM** TED T18 position: **BEAM**

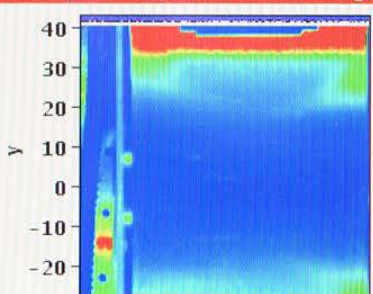
TDI P2 gaps/mm	upstream: 29.83	downstream: 30.16
TDI P8 gaps/mm	upstream: 29.98	downstream: 30.00

BCT T12:	0.00e+00	BCT T18:	0.00e+00
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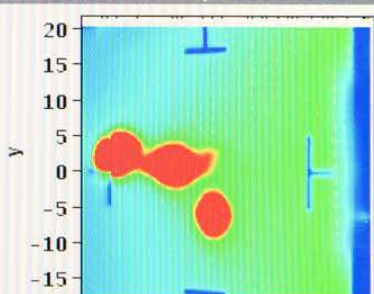
BTVSI.C5L2.B1 Updated: 15:03:22



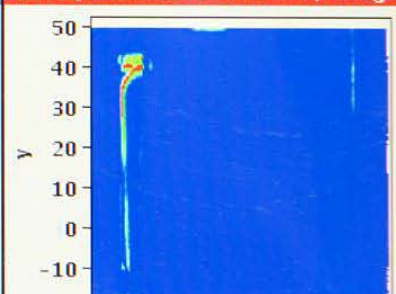
BTVSI.C5R8.B2 Updated: 15:03:22



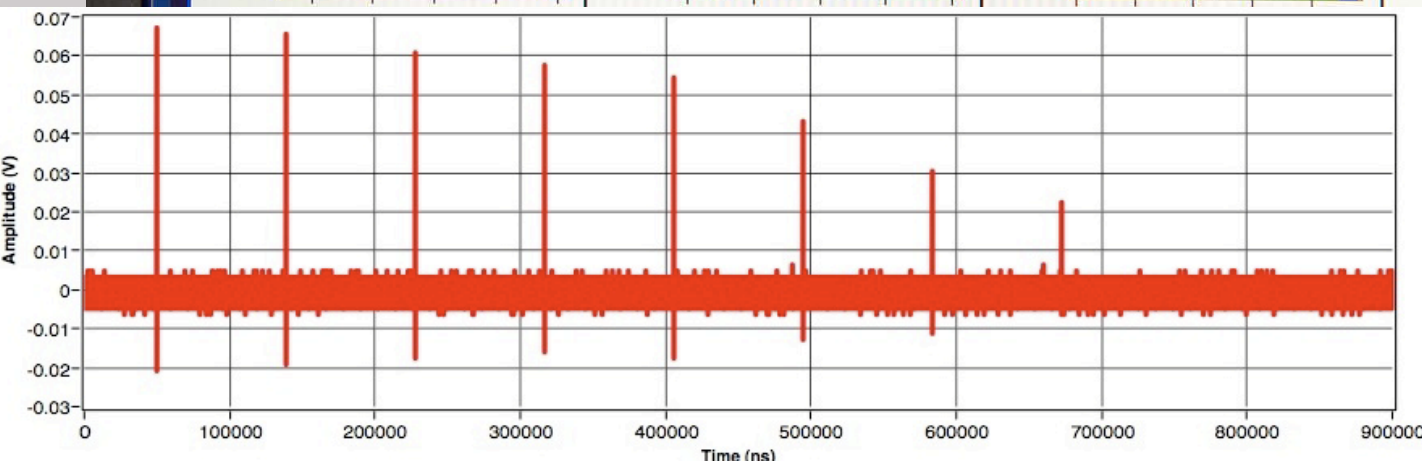
BTVSI.C5R8.B2 Updated: 15:03:22



BTVSI.C5R8.B2 Updated: 15:03:22



-30 -20 -10 0 10 20 30 40 50
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Japanese Contribution to LHC



2008年10月21日
LHC完成式典にて

Christopher Llewellyn Smith, at the ceremony marking the start of collaboration between CERN and Japan in 1995.

Worldwide LHC Data Analysis Workshop (データ解析)

坂本 宏(東京大学ICEPP) データ科学ワークショップ、国立天文台2009年1月16日



Black Hole?



<http://public.web.cern.ch/public/en/LHC/Safety-en.html>



European Organization for Nuclear Research

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Over the past billions of years, Nature has already generated on Earth as many collisions as about a million LHC experiments – and the planet still exists.

- Why
- How the LHC works

The safety of the LHC

- The ALIC
- ATLAS
- CMS
- LHCb
- TOTEM
- LHCf
- Com
- The
- Fact
- LHC milestones

The Universe as a whole conducts more than 10 million million LHC-like experiments per second. The possibility of any dangerous consequences contradicts what astronomers see - stars and galaxies still exist.

title
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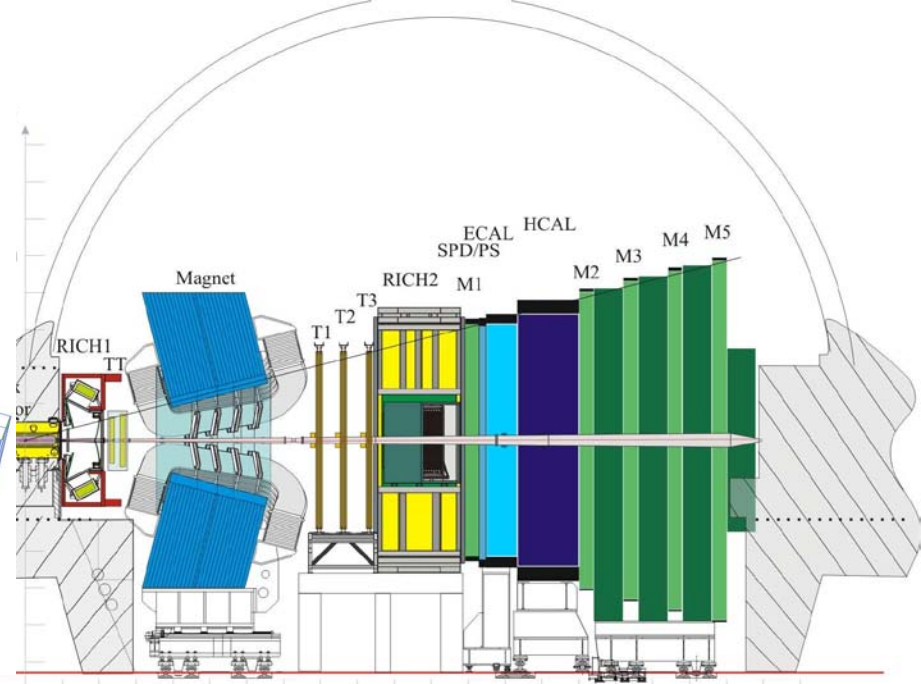
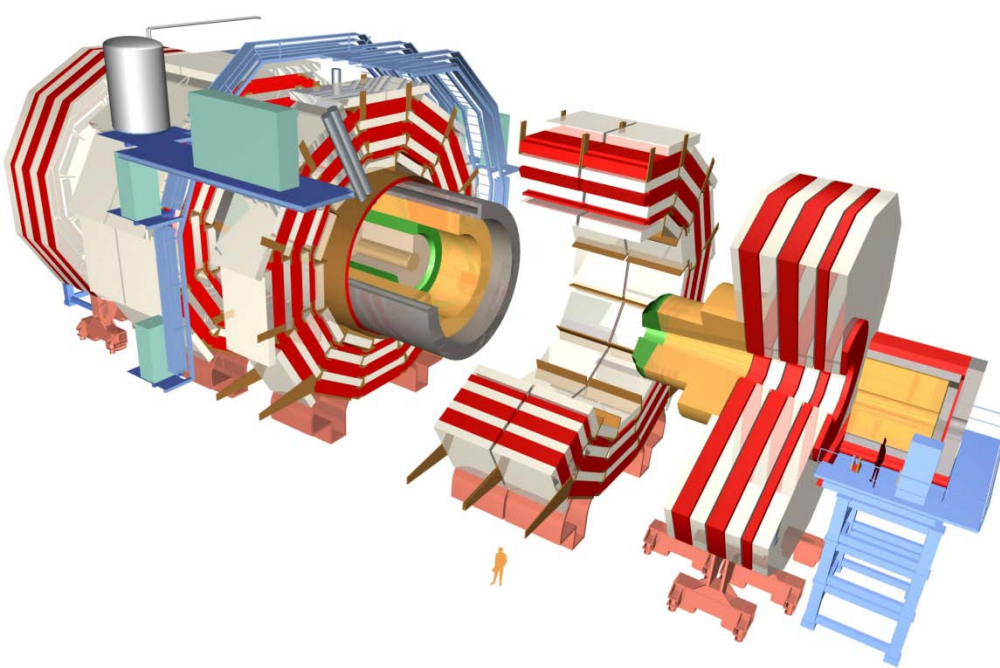
collisions
the LHC
ie Earth

...tists that

...advised by CERN's Safety Review Committee, a group of external scientists that advises CERN's governing body, its Council.

一夕解析





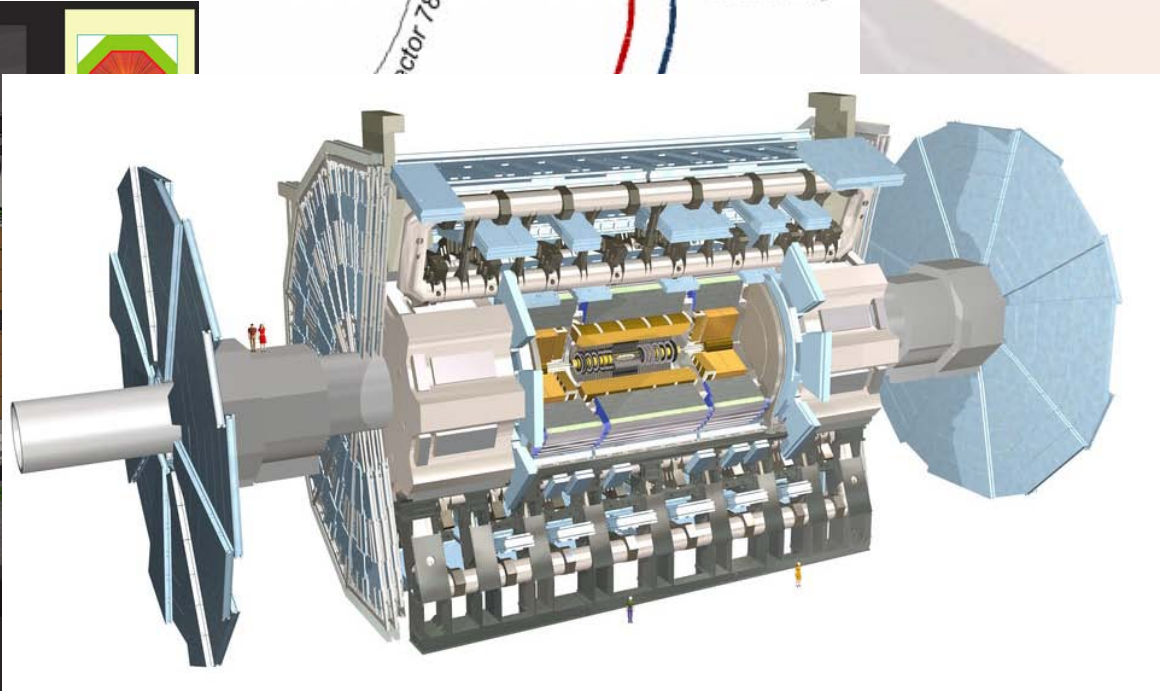
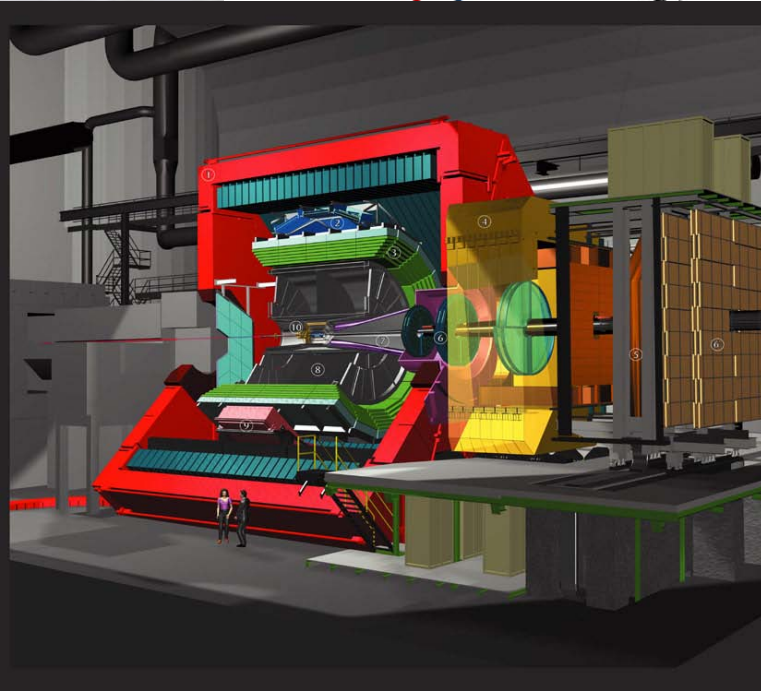
Momentum Cleaning

A diagram illustrating momentum cleaning. A blue dashed line represents the particle trajectory. A red arrow points downwards, indicating the direction of momentum cleaning. A vertical line is labeled 'S'.

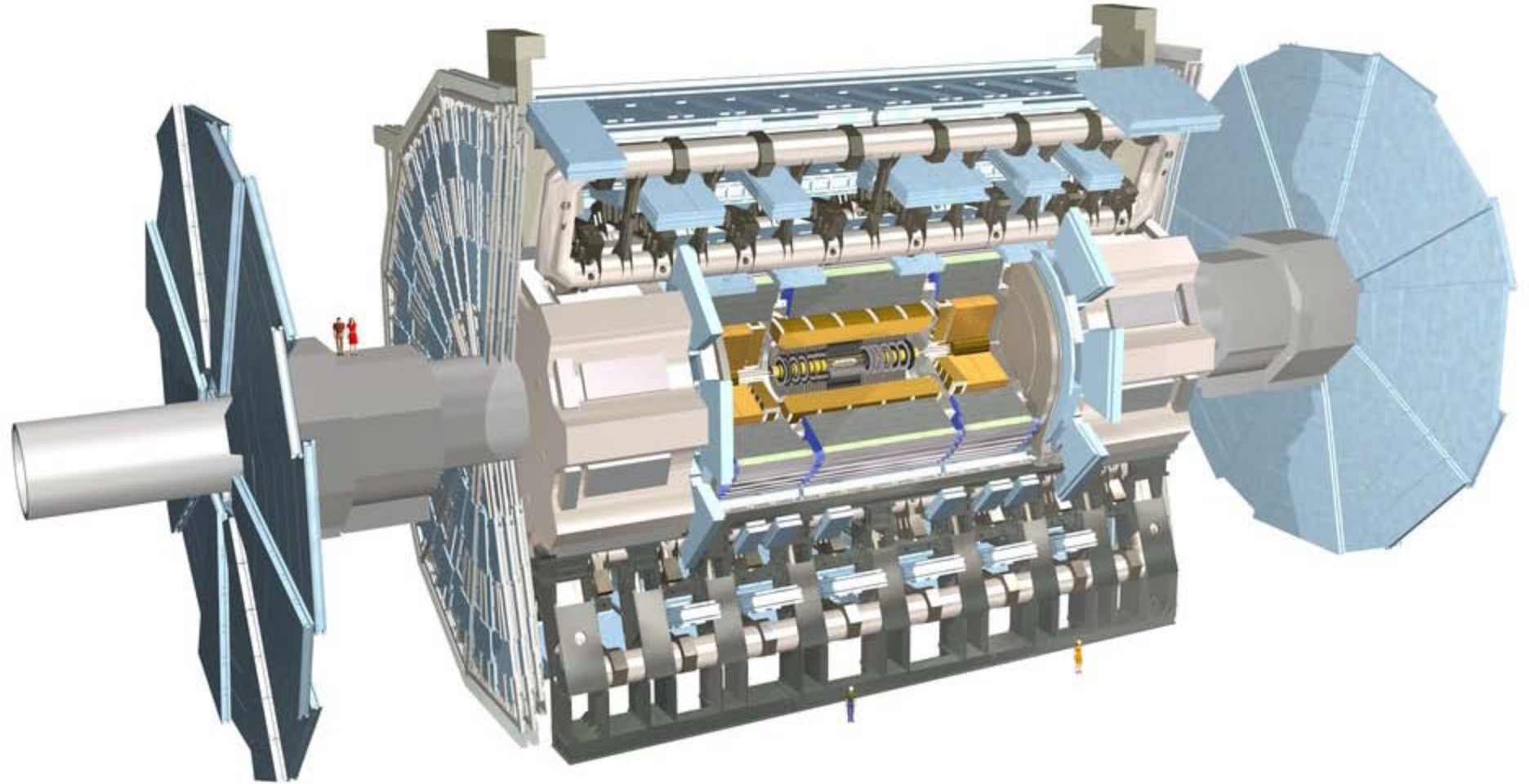
5m 10m 15m 20m z

Cleaning

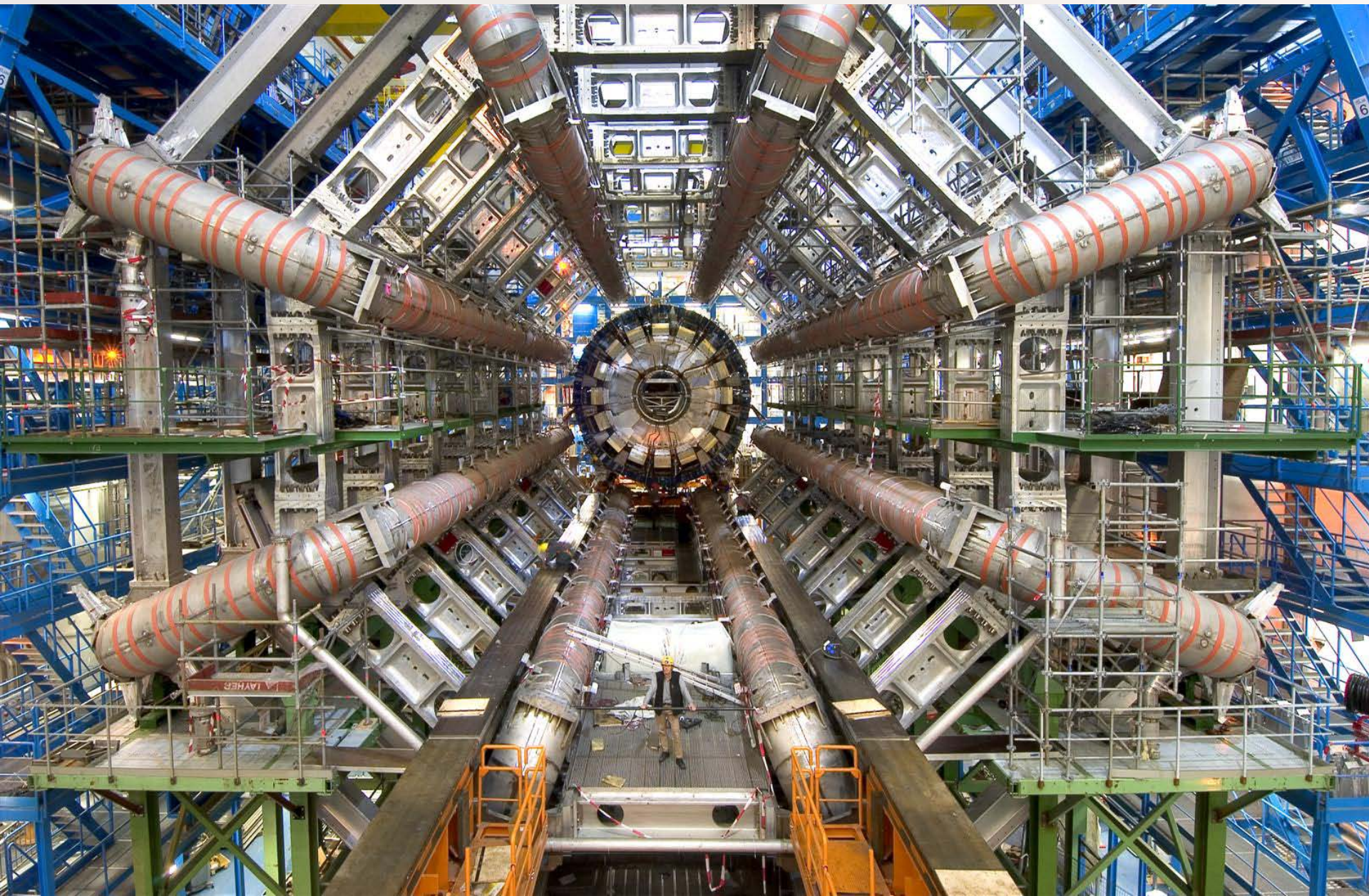
A diagram illustrating cleaning. A red and blue line represent the particle trajectory. A vertical line is labeled 'Cleaning'. A curved line is labeled 'ector 78'.

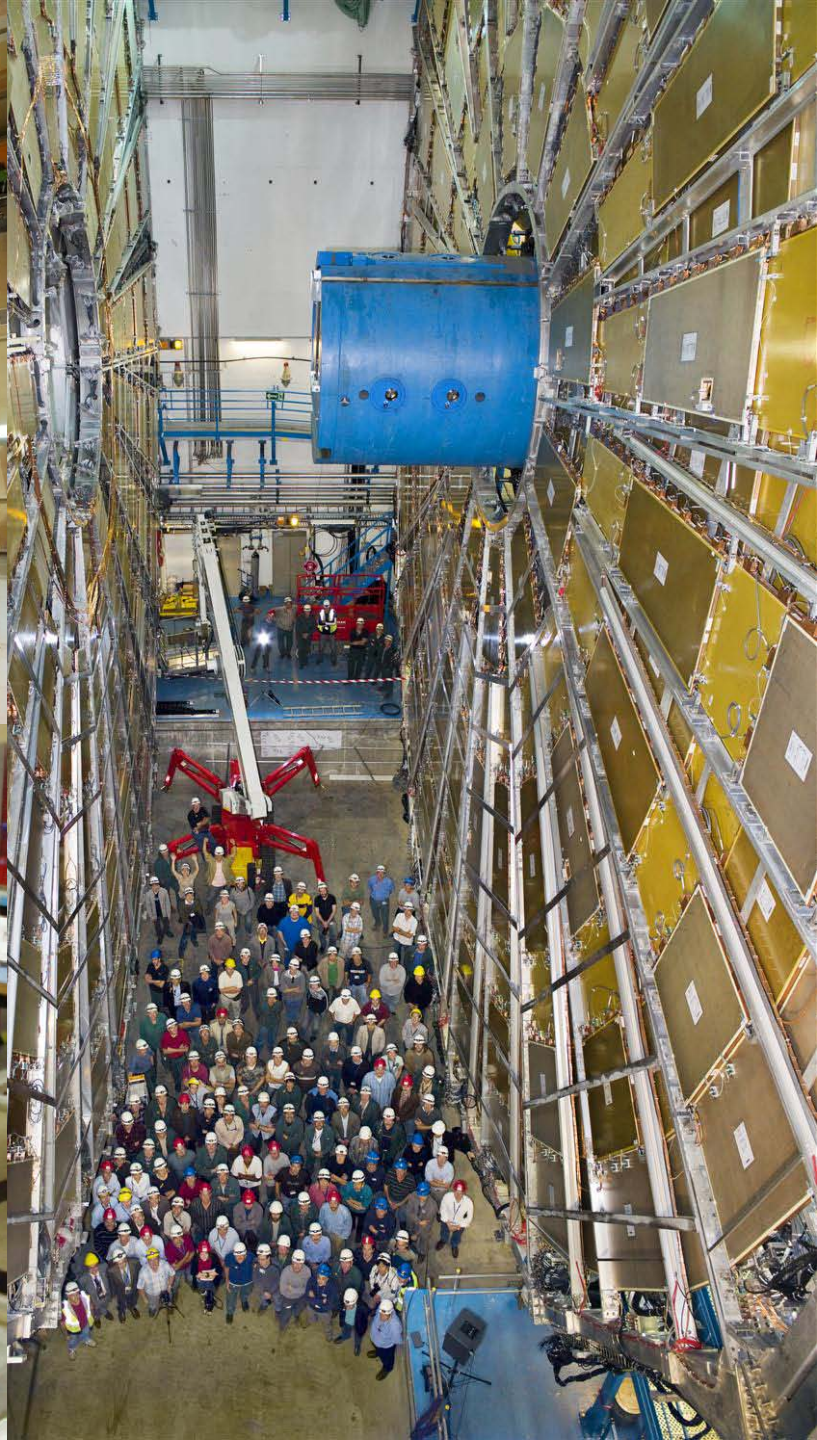
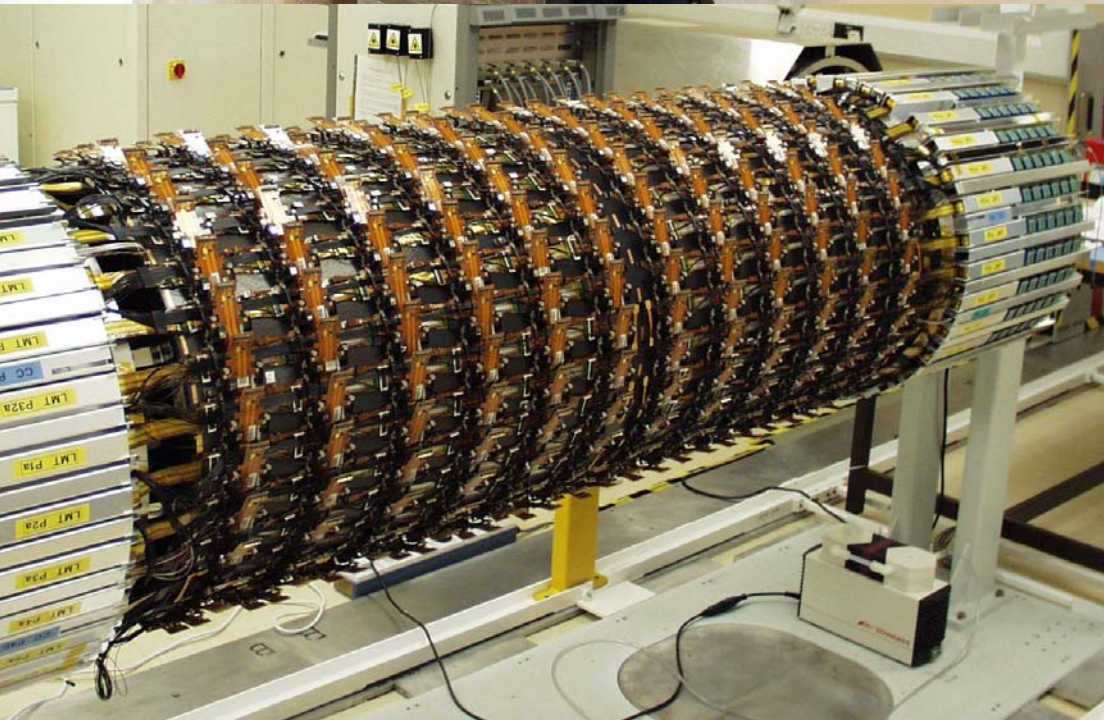


The ATLAS Detector



ATLAS under Construction







37 countries
170 institutes
2200 researchers

ATLAS Collaboration

- | | |
|----------------|-------------|
| Argentina | Morocco |
| Armenia | Netherlands |
| Australia | Norway |
| Austria | Poland |
| Azerbaijan | Portugal |
| Belarus | Romania |
| Brazil | Russia |
| Canada | Serbia |
| Chile | Slovakia |
| China | Slovenia |
| Colombia | Spain |
| Czech Republic | Sweden |
| Denmark | Switzerland |
| France | Taiwan |
| Georgia | Turkey |
| Germany | UK |
| Greece | USA |
| Israel | CERN |
| Italy | JINR |
| Japan | |

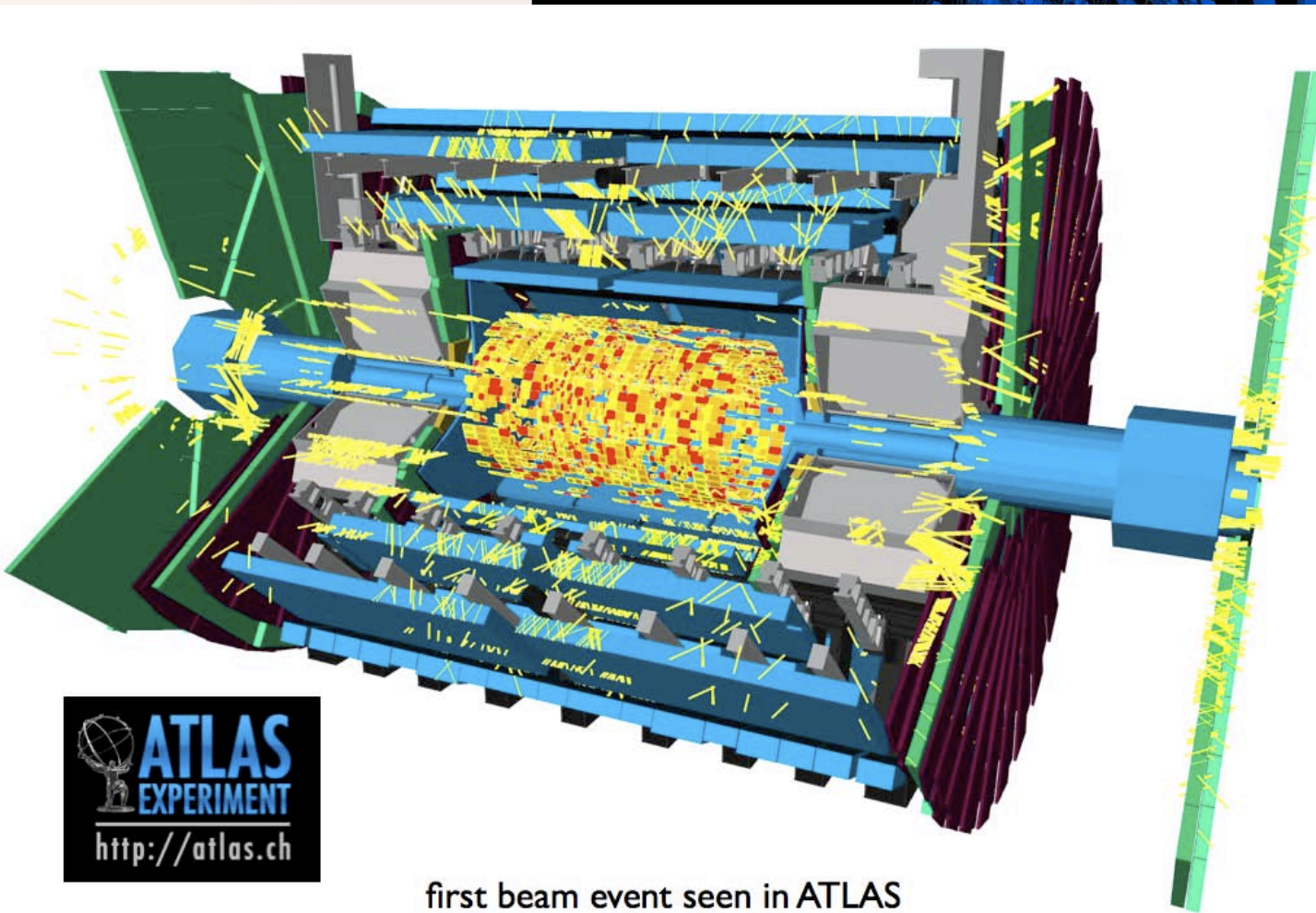


First Beam on Detectors



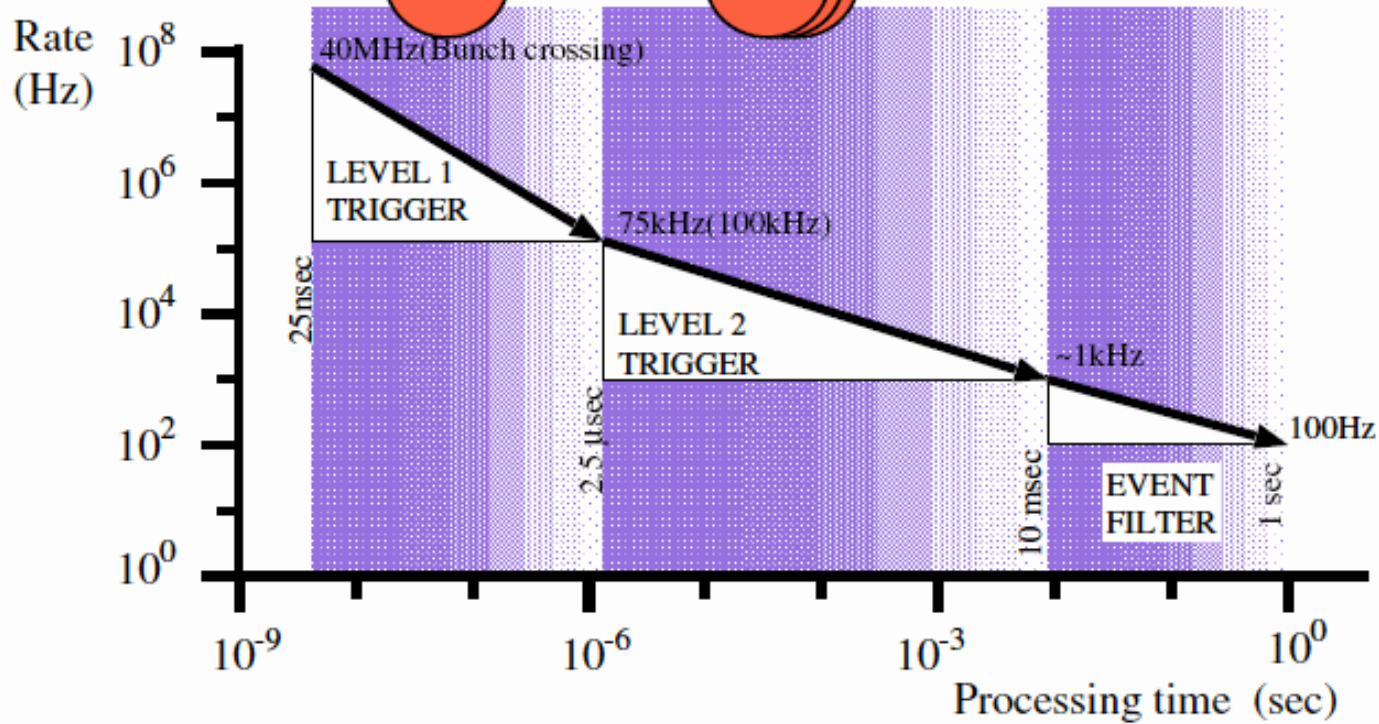
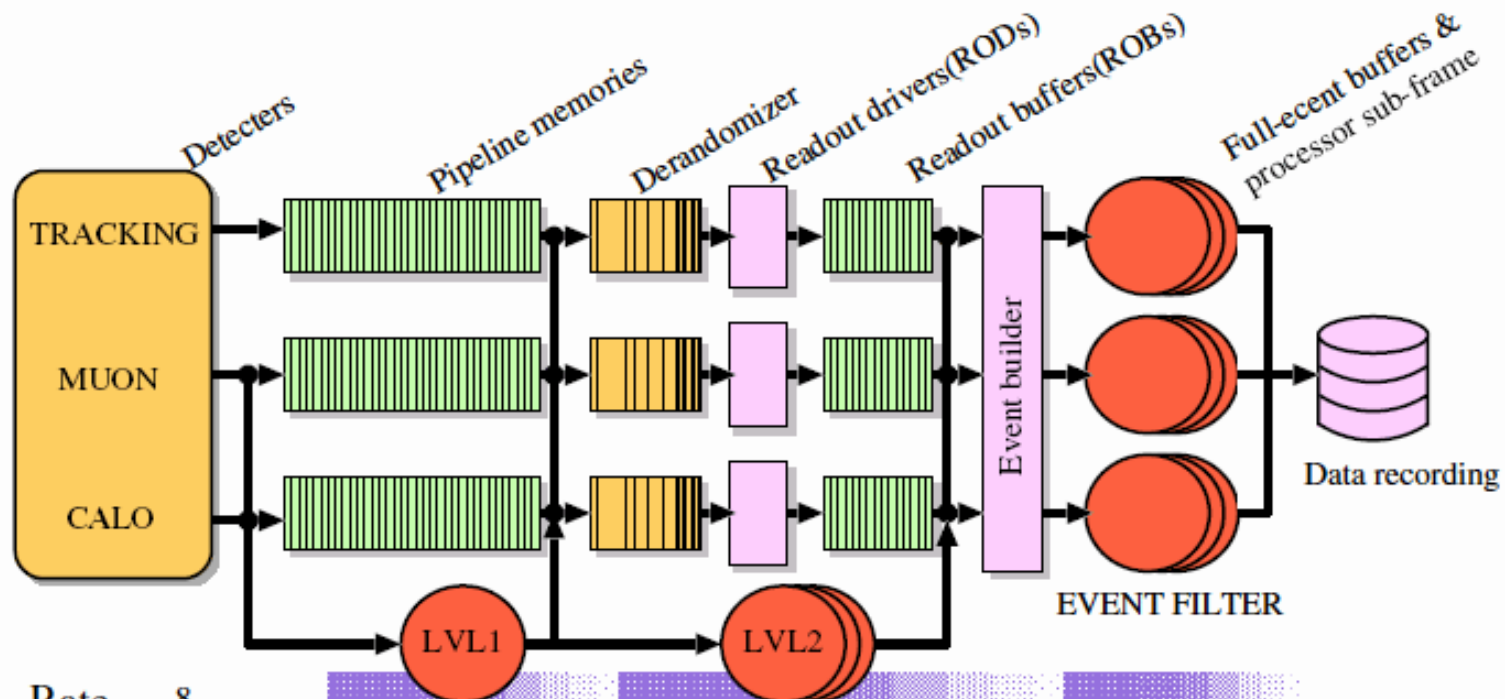
CMS

Run 62063, Event 2433, Orbit 15231634, BX 680



first beam event seen in ATLAS





Data from ATLAS

320MB/s Throughput ~ 6 seconds for 2GB file

3.2PB/2GB = 1.6M files

	Rate(Hz)	sec/year	Events/y	Size(MB)	Total(TB)
Raw Data	200	1.00E+07	2.00E+09	1.6	3200
ESD (Reconstruction out)	200	1.00E+07	2.00E+09	0.5	1000
General ESD	180	1.00E+07	1.80E+09	0.5	900
General AOD (Analysis)	180	1.00E+07	1.80E+09	0.1	180
General TAG (Event db)	180	1.00E+07	1.80E+09	0.001	2
Calibration					40
MC Raw			1.00E+08	2	200
ESD Cl			1.00E+08	0.5	50

Processing Power for ATLAS

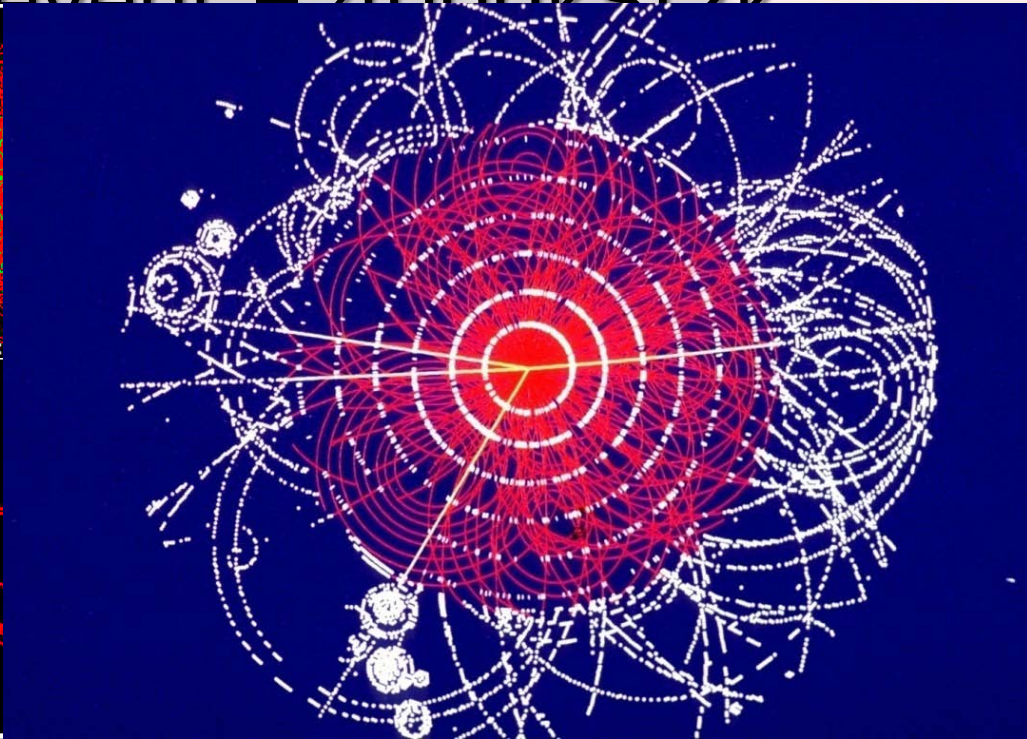
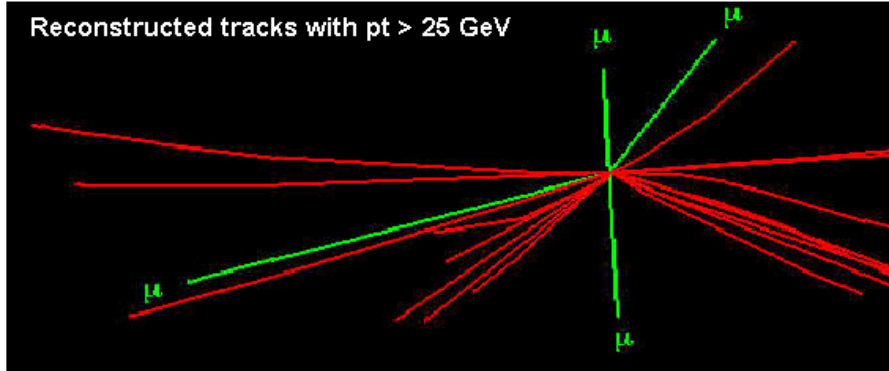
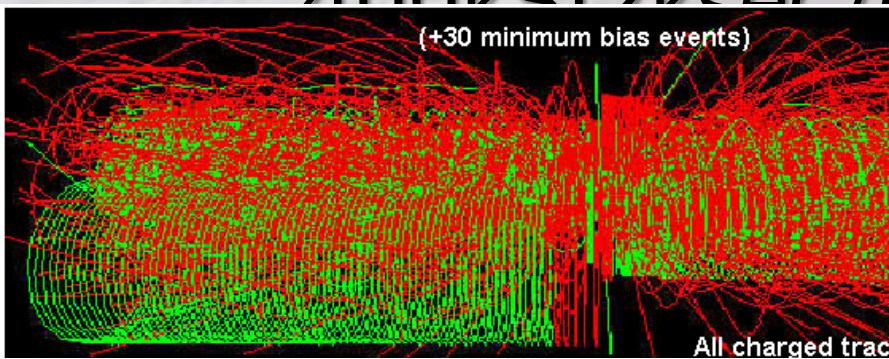
Reconstruction:

15kSI2ksec/event – 3000kSI2k

(200Hz)

Simulation:

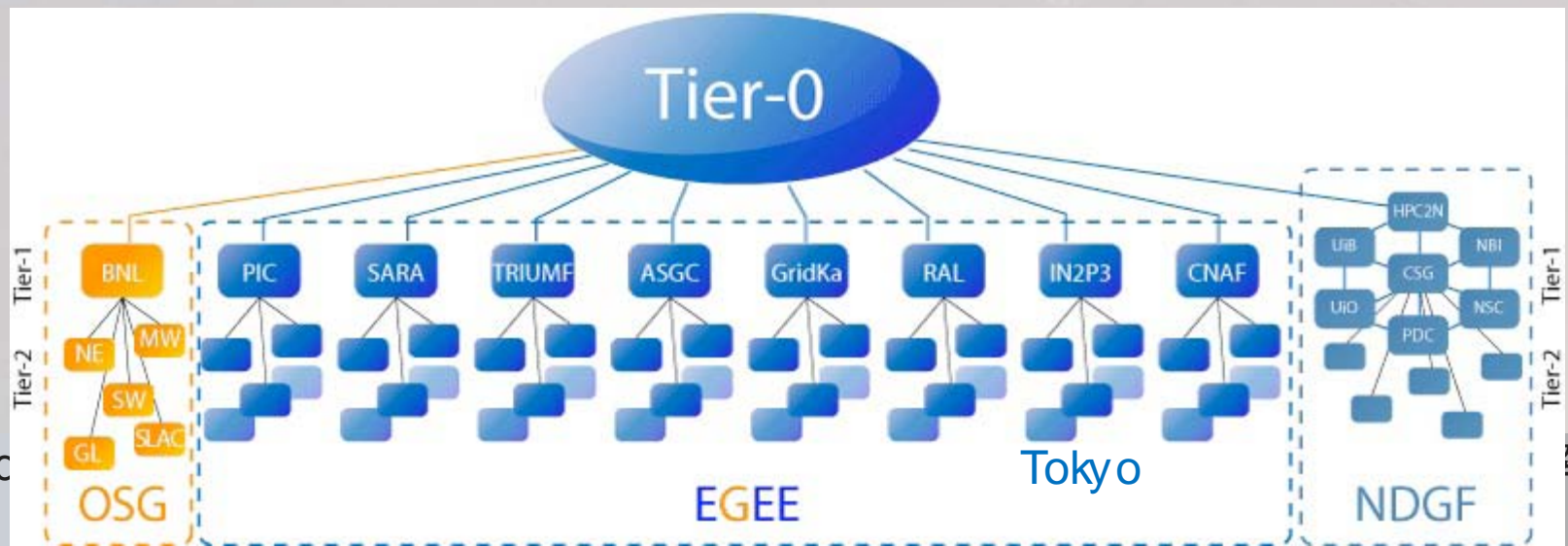
400kSI2ksec/event – 4000kSI2k



ATLAS Distributed Computing Model

● Tier Model ~ Hierarchy Under WLCG MoU

- Tier0: CERN
- Tier1: Quasi-Online Data Center
- Tier2: National/Regional Analysis Center
- Tier3: Department Facility
- Tier4: User Desktop



Worldwide LHC Computing Grid



Climate research

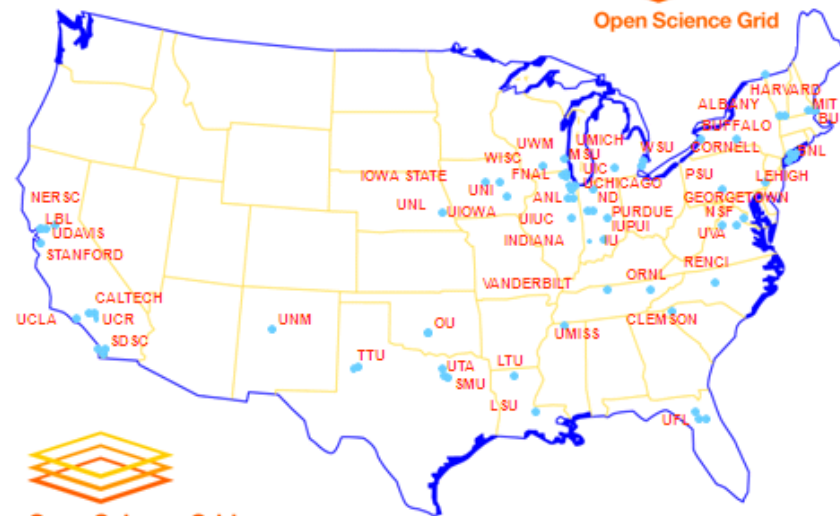


Scheduled = 10020
Running = 17920

Open Science Grid



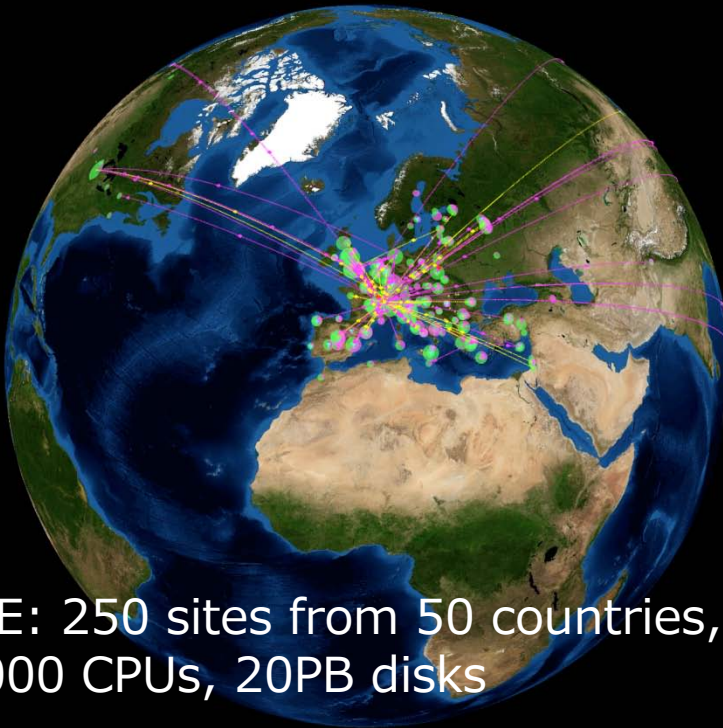
Open Science Grid



Open Science Grid



EGEE
Enabling Grids
for E-science



EGEE: 250 sites from 50 countries,
72,000 CPUs, 20PB disks

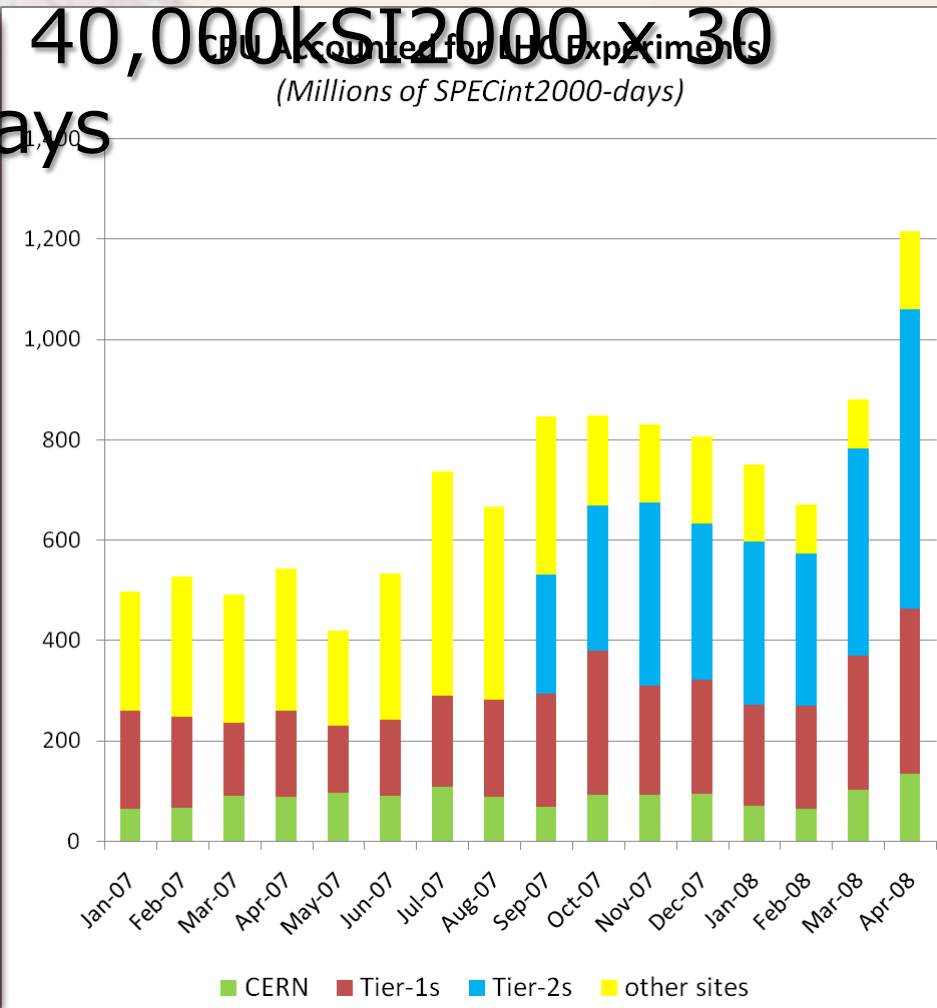
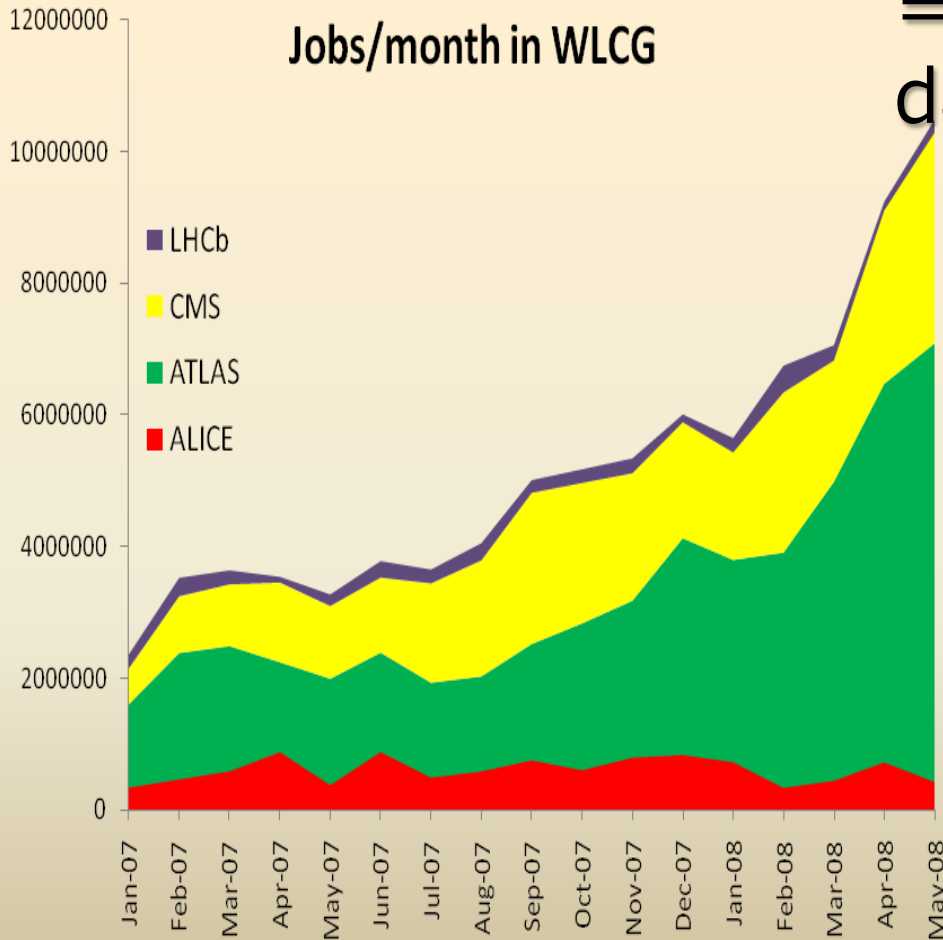
WLCG CPU and Jobs - Accounting

1,200,000kSI2000days

10,000,000 jobs/month used.

= 40,000kSI2000 x 30 days

Jobs/month in WLCG



Grid Deployment in Asia Pacific Region

eGEE
Enabling Grids
for E-science



Users ~ Virtual Organizations of WLCG

- >130 Virtual Organizations
- >7500 registered users

GStat: 06:36:55 09/28/08 GI

[home](#) [alert](#) [table](#) [service](#) [regional](#) [service](#)
[ireland](#) [aegis](#)

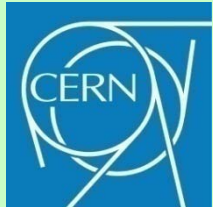
VOs: [ALICE](#) [ALL](#) [ARGO](#) [ATLAS](#) [CMS](#) [DTE](#)
[astrogrid](#) [astron](#) [astrop](#) [atlas](#) [atlasPD](#) [at](#)
[biomath](#) [biomed](#) [biowur](#) [blaubert](#) [c3](#) [c3g](#)
[cyclops](#) [d4science](#) [research-infrastructur](#)
[edteam](#) [earth](#) [eela](#) [egeode](#) [egrid](#) [elis](#) [er](#)
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[vo.u-psud.fr](#) [vo.ucad.sn](#) [voce](#) [vocet](#) [web](#)

Group	Group Access	Group Description	Group Role
/atlas	Open		AMIManager AMIWriter lcgadmin pilot production root software
/atlas/au	Restricted	Australian users	
/atlas/ca	Restricted	Canada users	poweruser0 production
/atlas/ch	Restricted	Swiss users	
/atlas/cn	Restricted	Chinese users	
/atlas/cz	Restricted	Czech users	
/atlas/de	Restricted	German users	
/atlas/det-indet	Restricted		AMIManager AMIWriter lcgadmin production root software
/atlas/det-larg	Restricted		AMIManager AMIWriter lcgadmin production root software
/atlas/det-muon	Restricted		AMIManager

• In ATLAS

- 39 groups for
 - Sub-detectors
 - Physics groups
 - National users
- 6 group roles

How to build a usable grid



Developers

WLCG Grid Deployment Board



Experiments

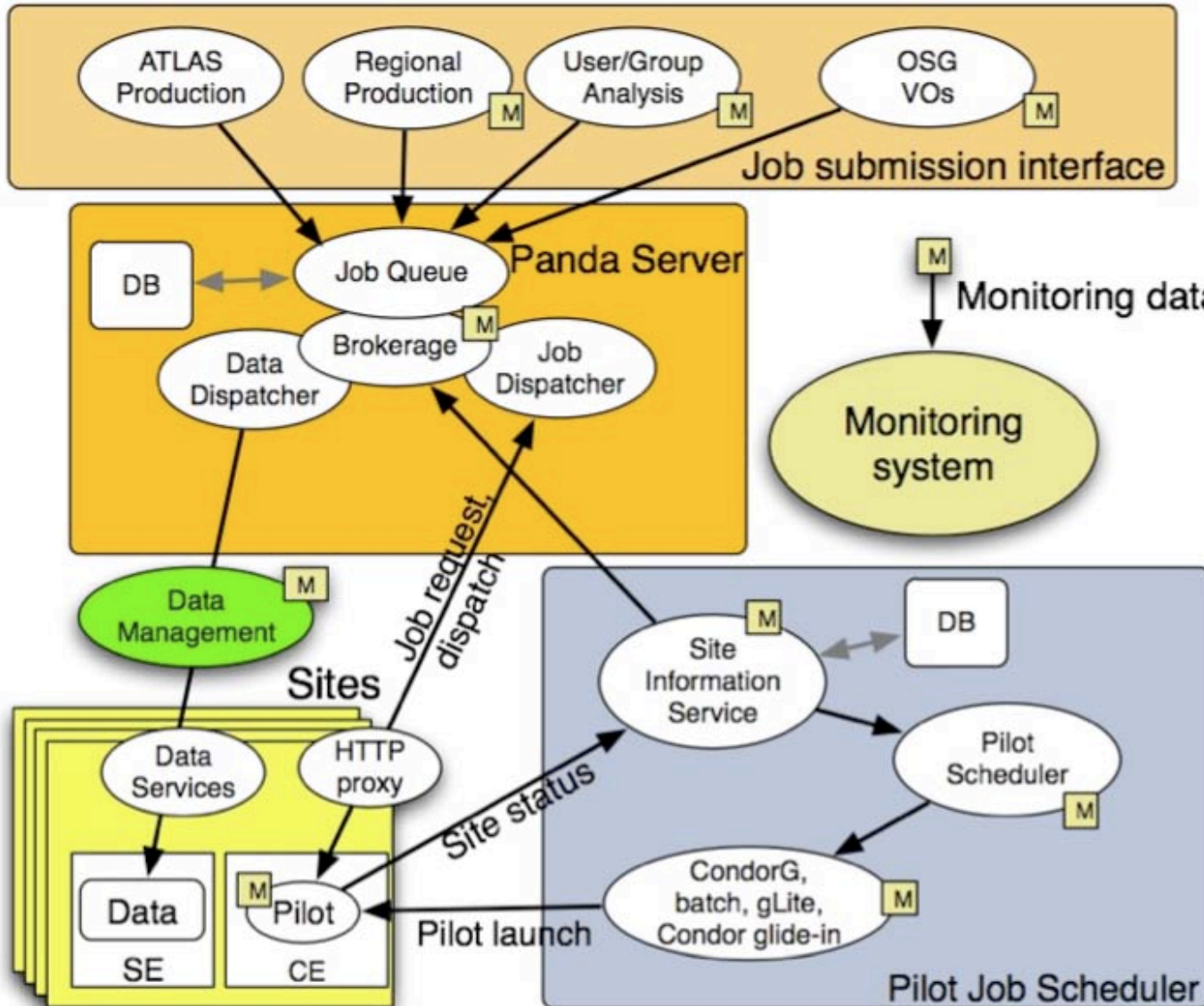


ATLAS Distributed Data Management Requirements

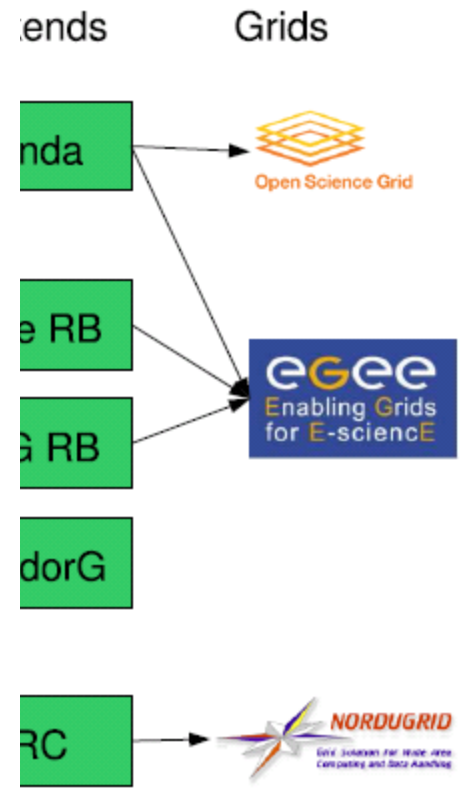
- in the order of **4000 new data sets from data taking per day** (data set defined per run and physics stream along with data sets for log files)
- additionally **20 to 30%** of the previous number for **monte carlo simulation**
- user data sets are less clear: a very rough estimate is having an equivalent number to the monte carlo datasets
- it is expected that **each data set has $O(1)$ versions.**
- it is expected that **each data set has $O(100)$ files.**
- it is expected that the majority of the data sets will be on a state where the latest data set version is closed or the data set is frozen.
- **each site** should have in order of **$O(100)$ data set transfers** at any moment (the majority being data sets from data taking).
- there are in the order of **50 to 100 computing sites** providing storage for ATLAS (these are possible data set locations).



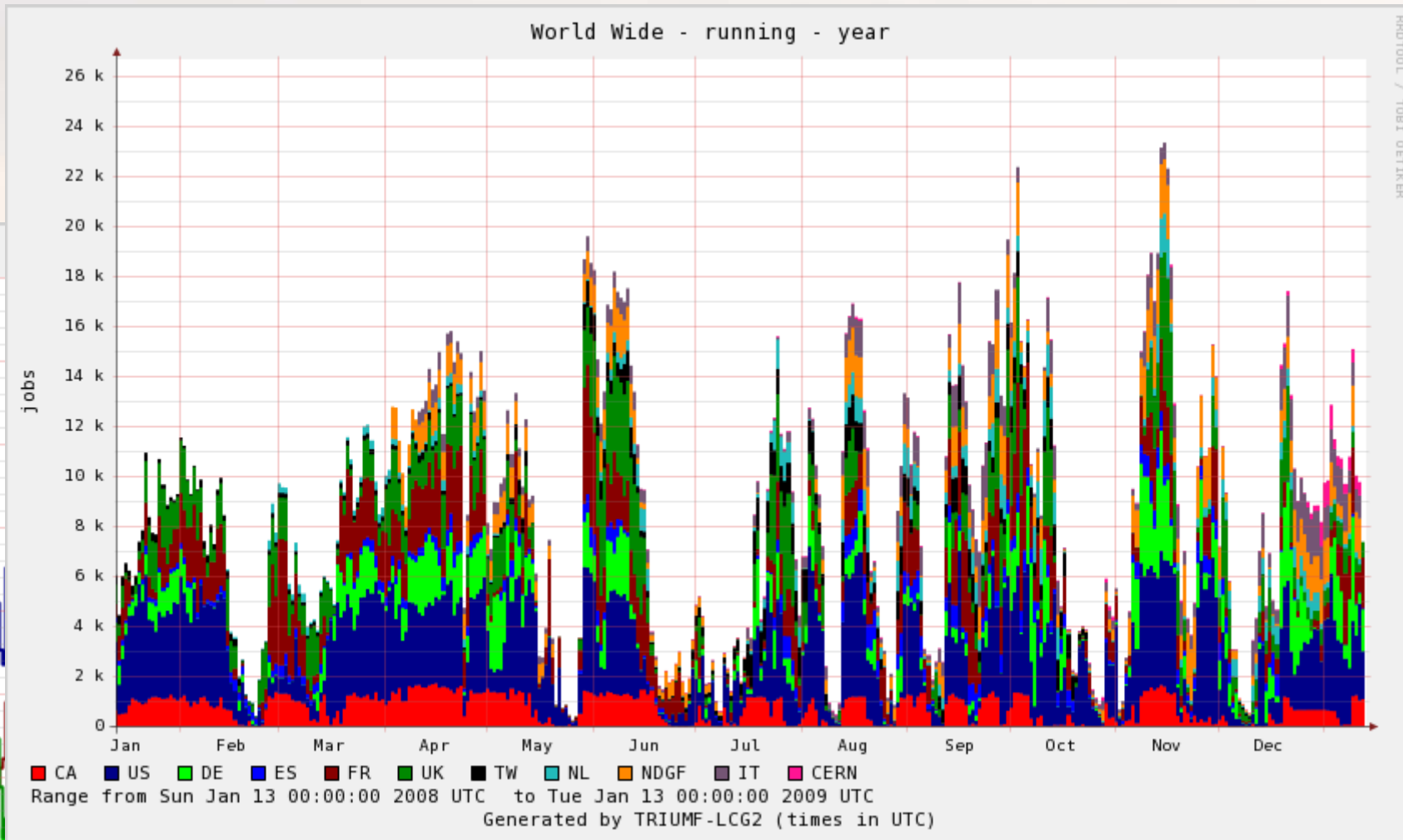
PanDA System Schematic



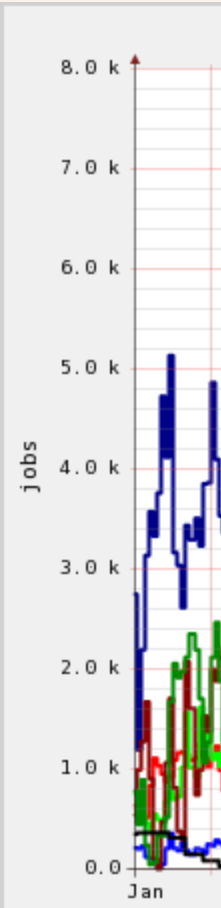
ATLAS Production System Architecture



Job Submission Statistics

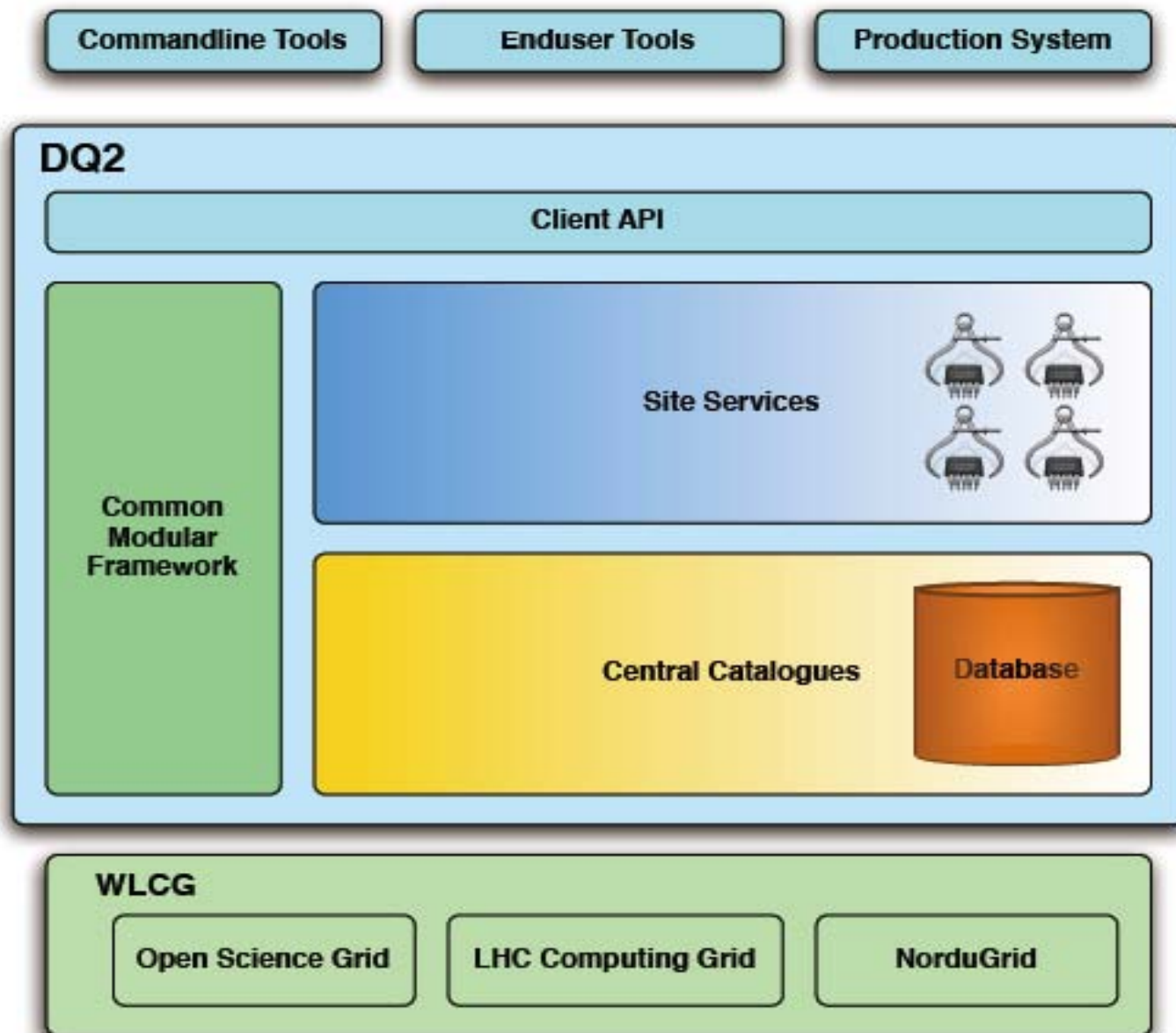


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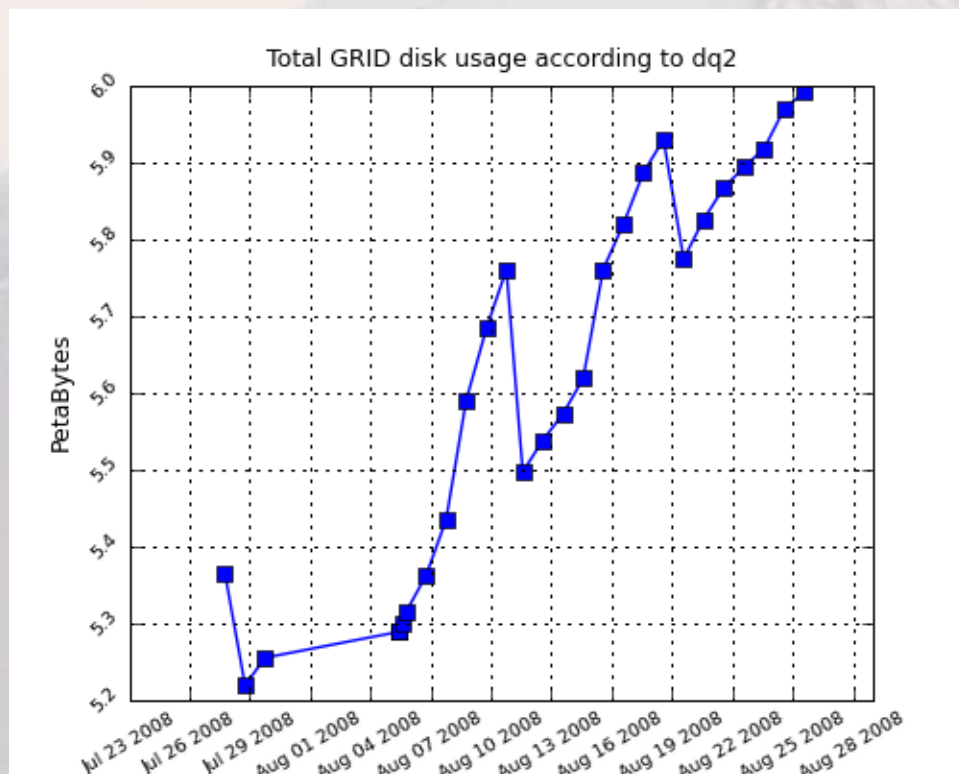


CA US DE ES FR UK TW NL NDGF IT CERN
Range from Sun Jan 13 00:00:00 2008 UTC to Tue Jan 13 00:00:00 2009 UTC
Generated by TRIUMF-LCG2 (times in UTC)

ATLAS Distributed Data Management Architecture



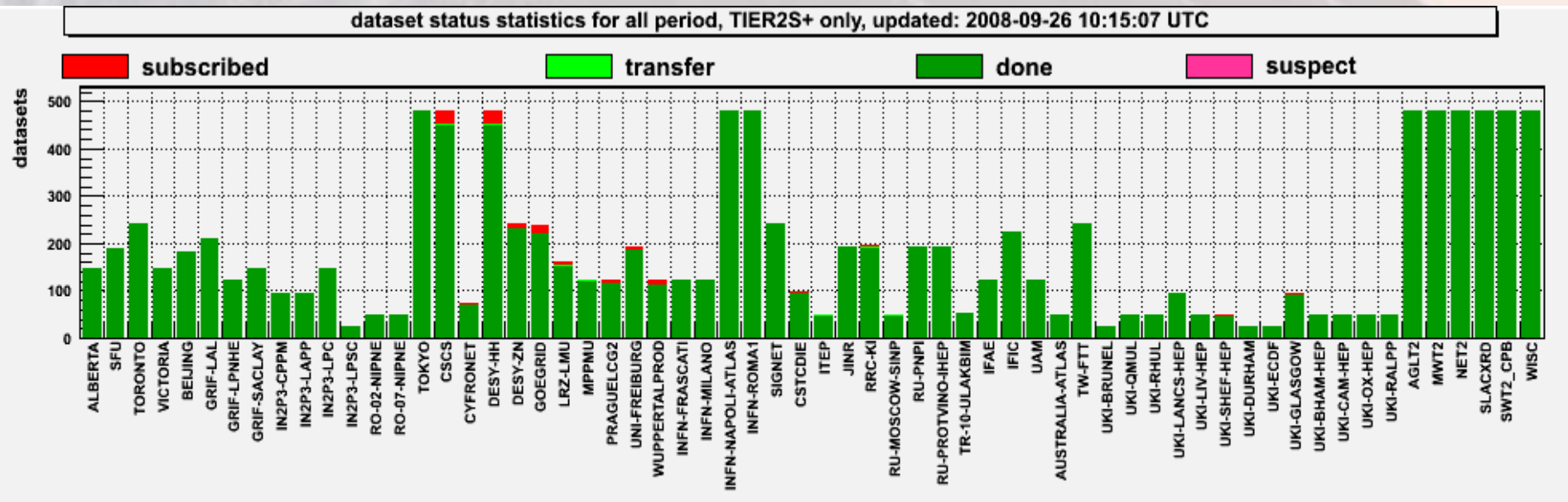
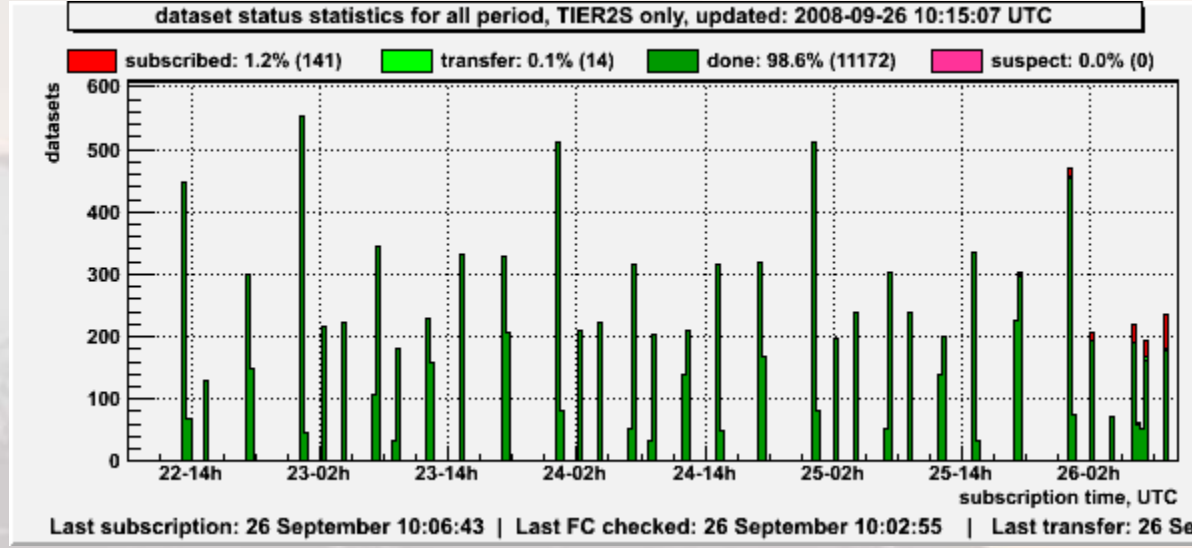
Performance: Catalogue



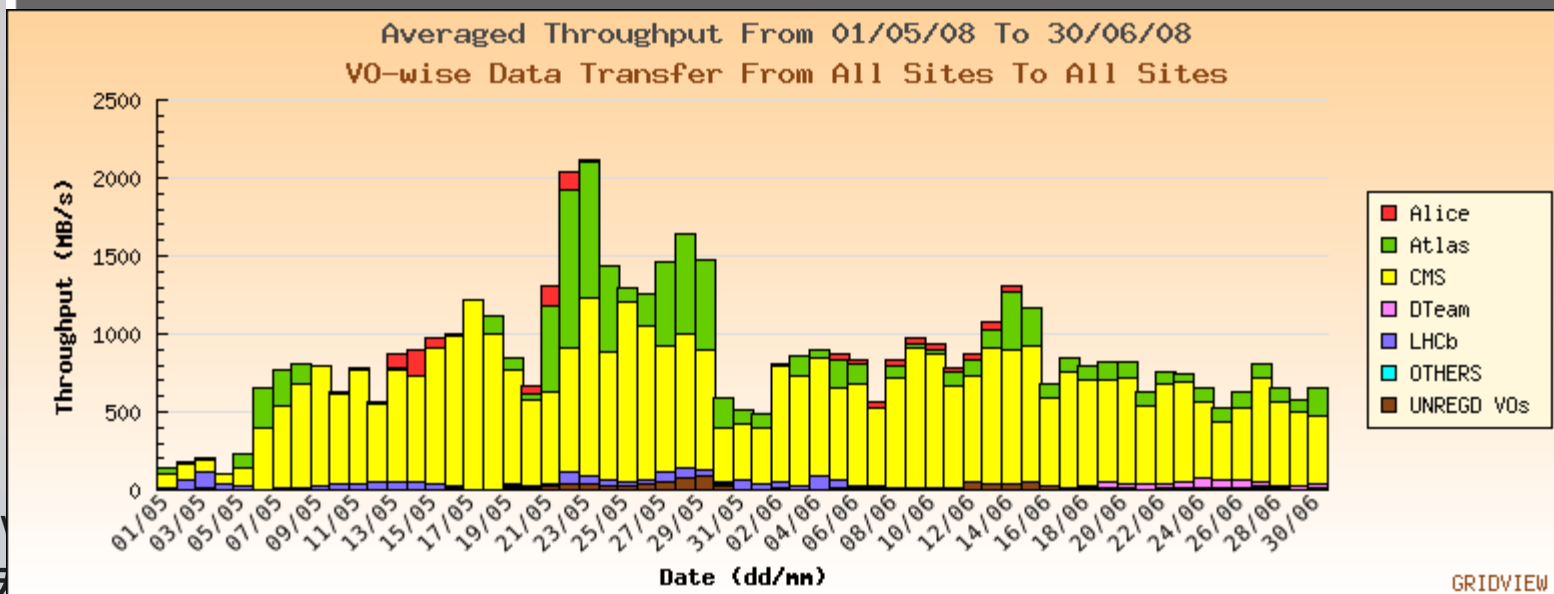
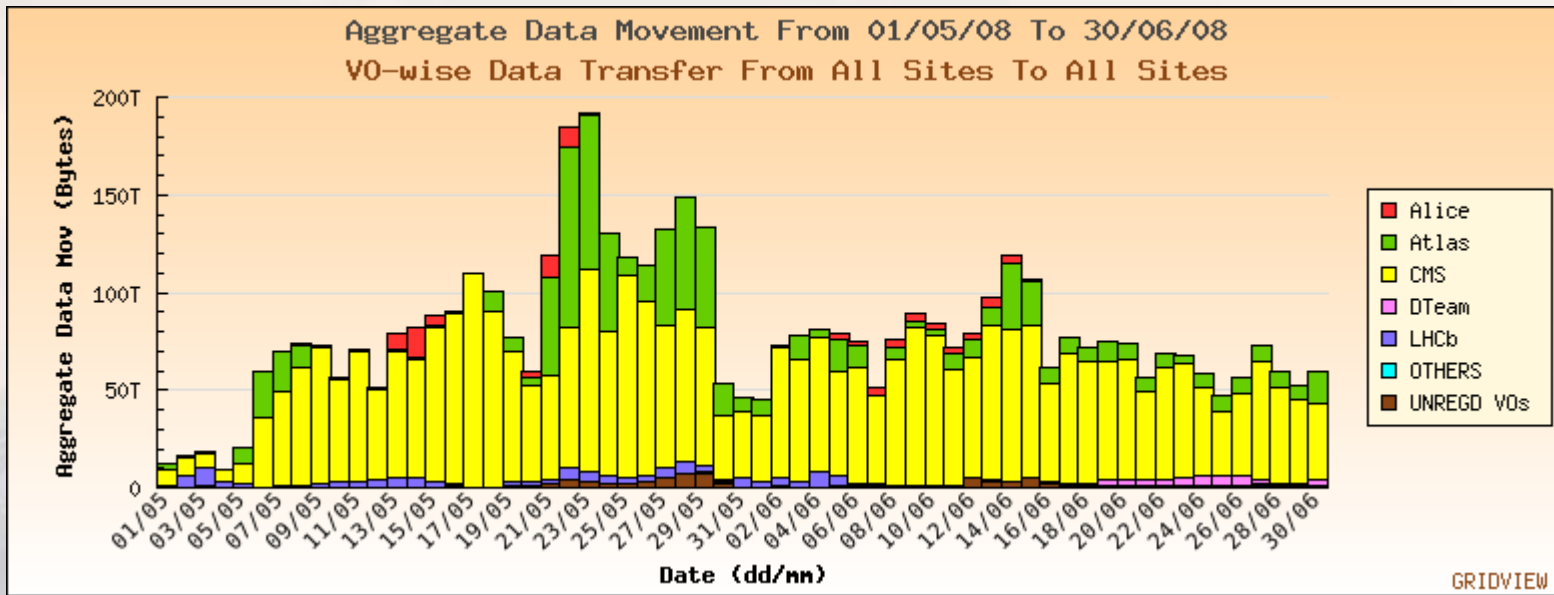
- Total: 565,000 datasets
- replicas ~ 60 millions file replicas
- ~ 6 petabytes



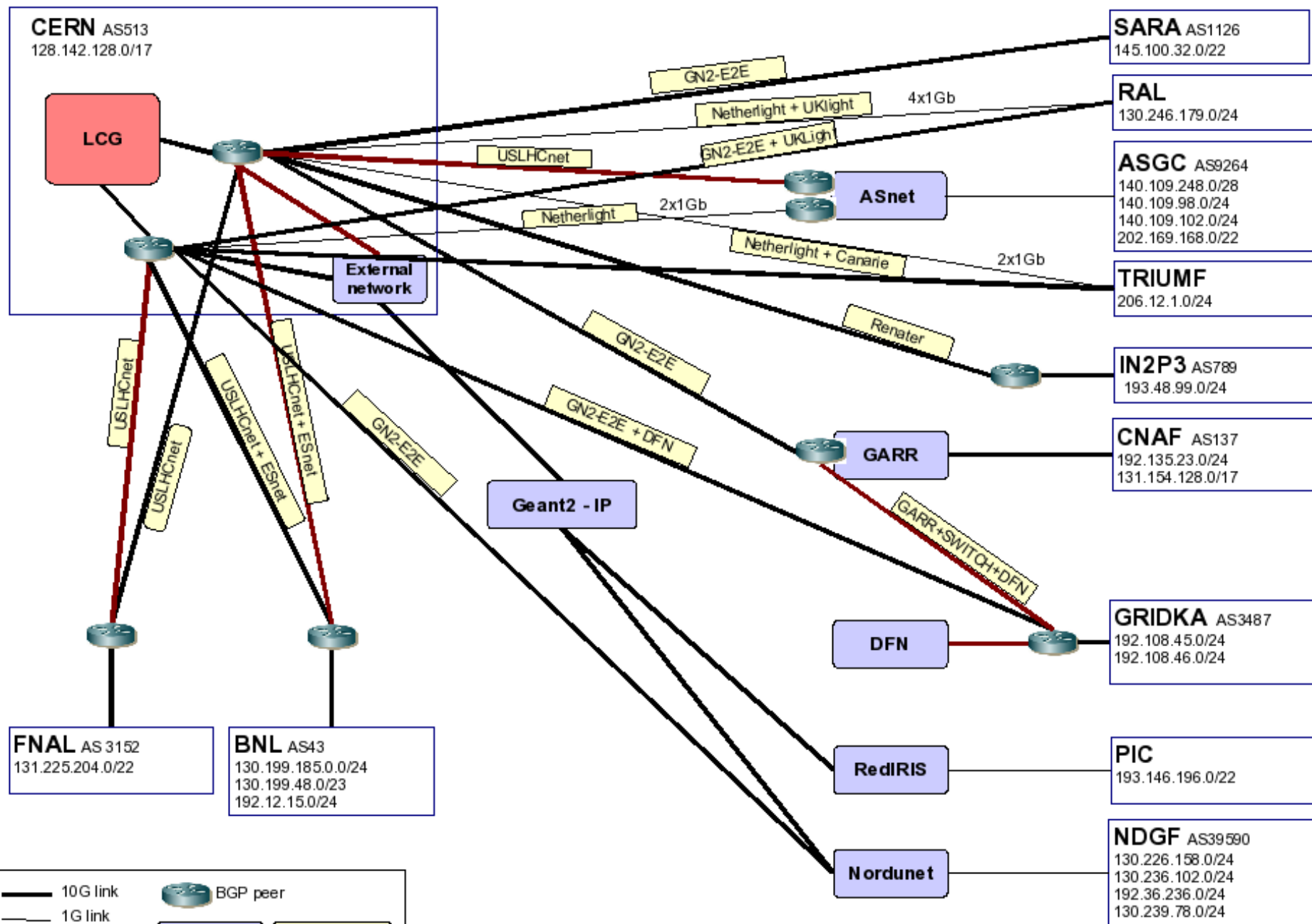
DDM Daily Functional Tests



Performance: File Transfer at CCRC08



LHCOPN – current status



Networks in Asia-Pacific Region

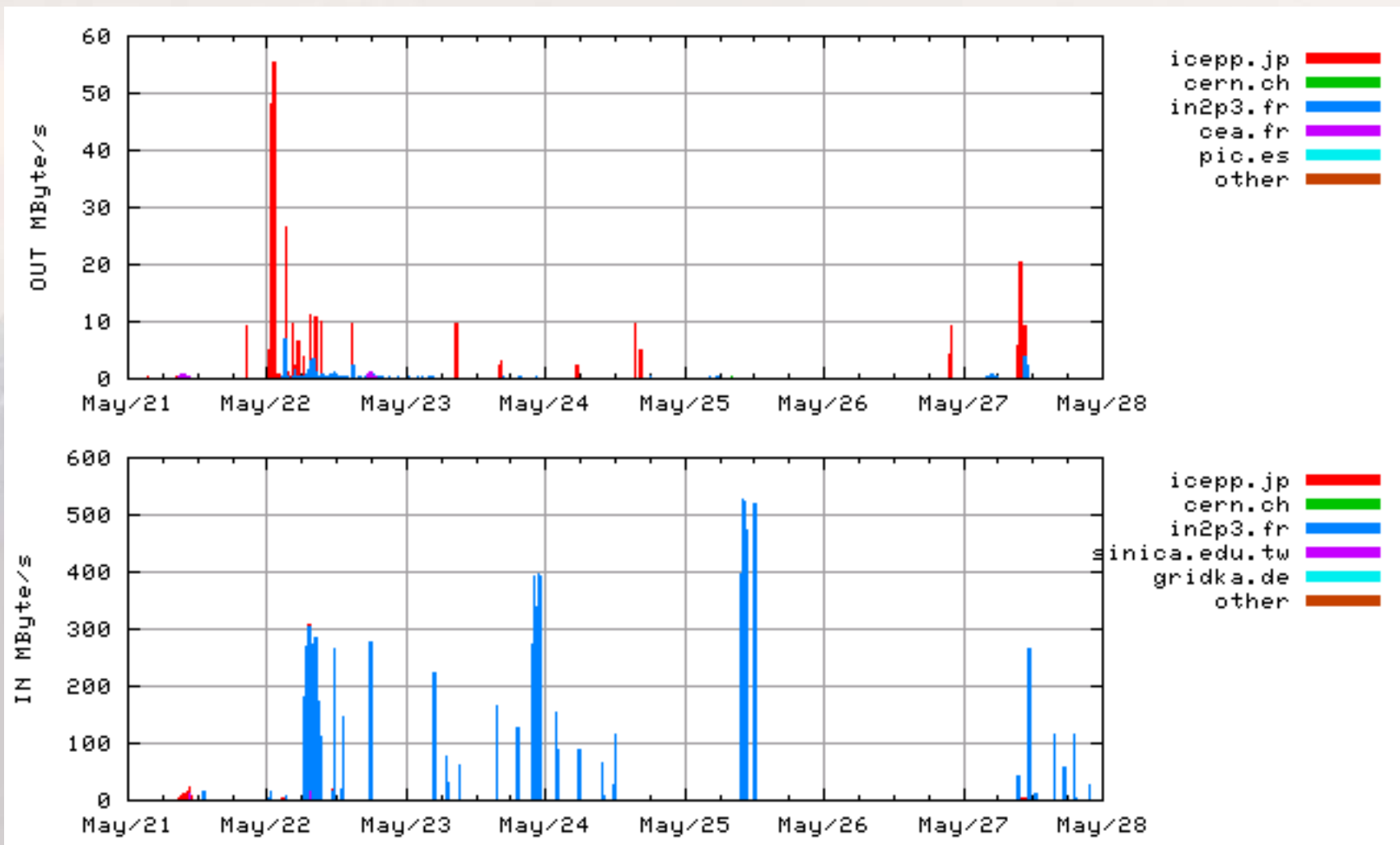
Asia-Pacific Backbone Topology



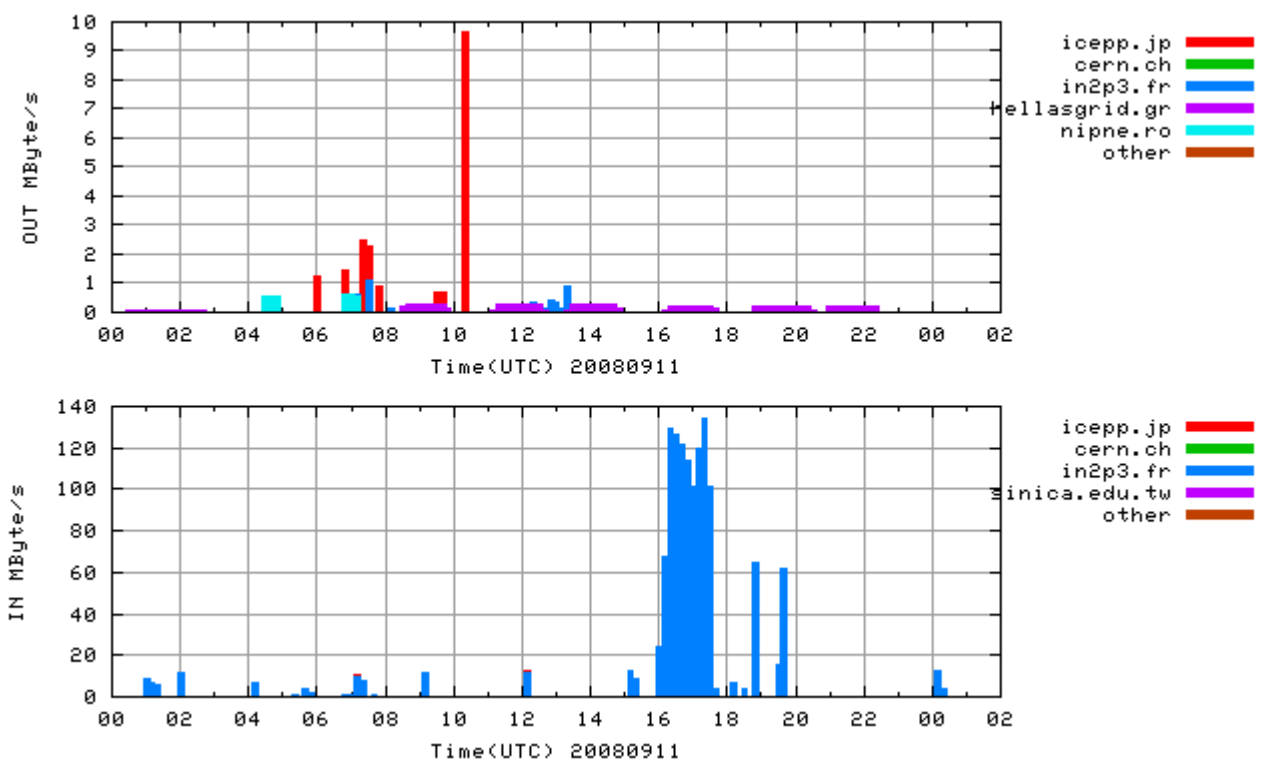
As of End of Jan. 2008



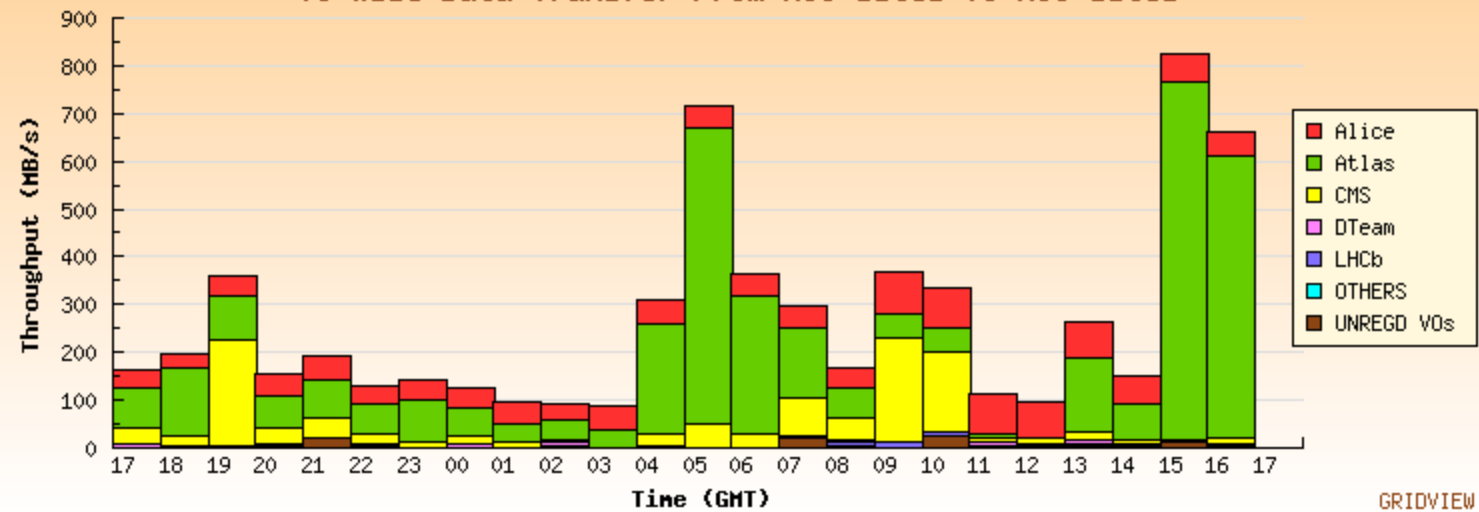
File Transfer from Lyon to Tokyo



First Beam on Grid



Averaged Throughput during the last 24 hrs (09/09 - 10/09)
VO-wise Data Transfer From All Sites To All Sites

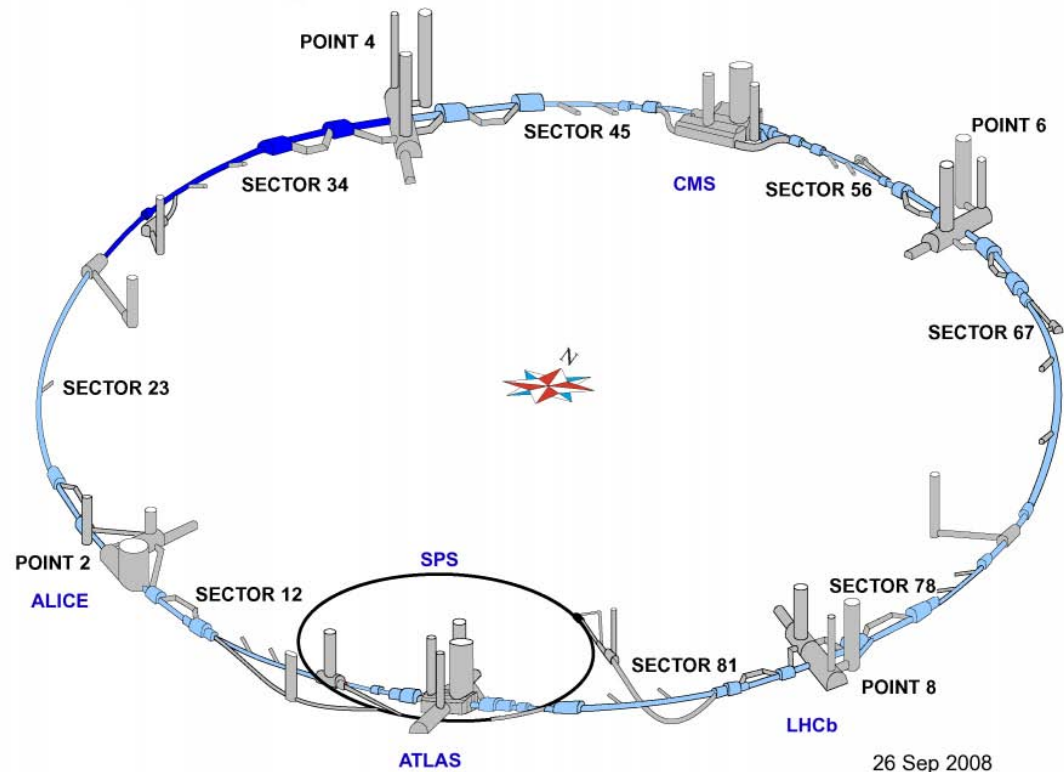




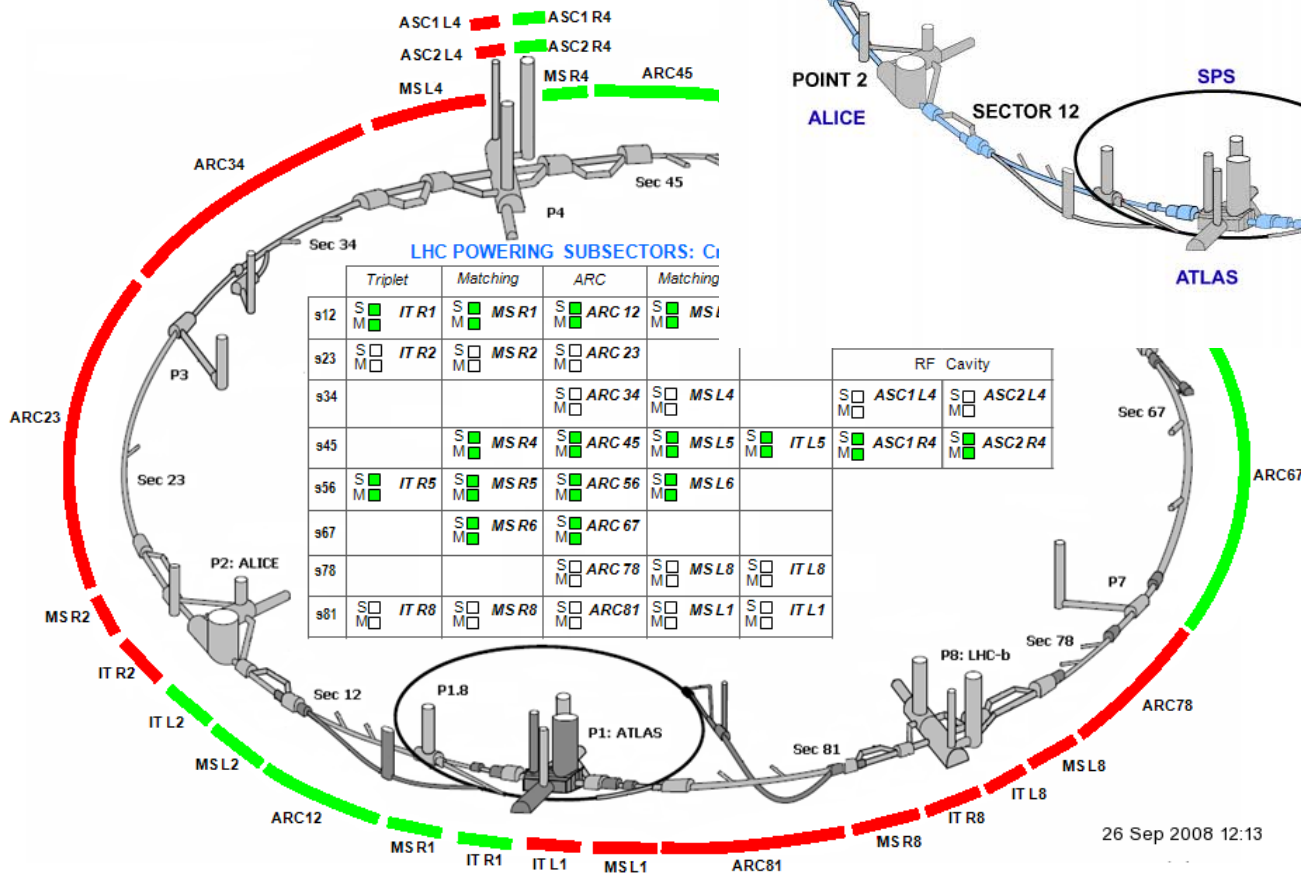
Geneva, 20 September 2006. During the final LHC sector (sector 3-4) an incident occurred at mid-day or a large helium leak into the tunnel.



LHC Beam will come again in next spring at the energy highest ever.



26 Sep 2008



26 Sep 2008 12:13

LHC Accelerator Now

ATLAS 実験のデータ解析
2009年1月16日



Summary

- LHC Experiments Started
 - Detectors are ready ~ Recorded events by beam
 - Waiting recovery of LHC accelerator
- Worldwide LHC Computing Grid is ready
 - Showed enough performances
 - **Sharing physics data worldwide**
 - New style of computing for high energy physics
- High energy physics **enters its new era** in 2009
 - Please stay tuned

