Visit of SKA

Ian Bird

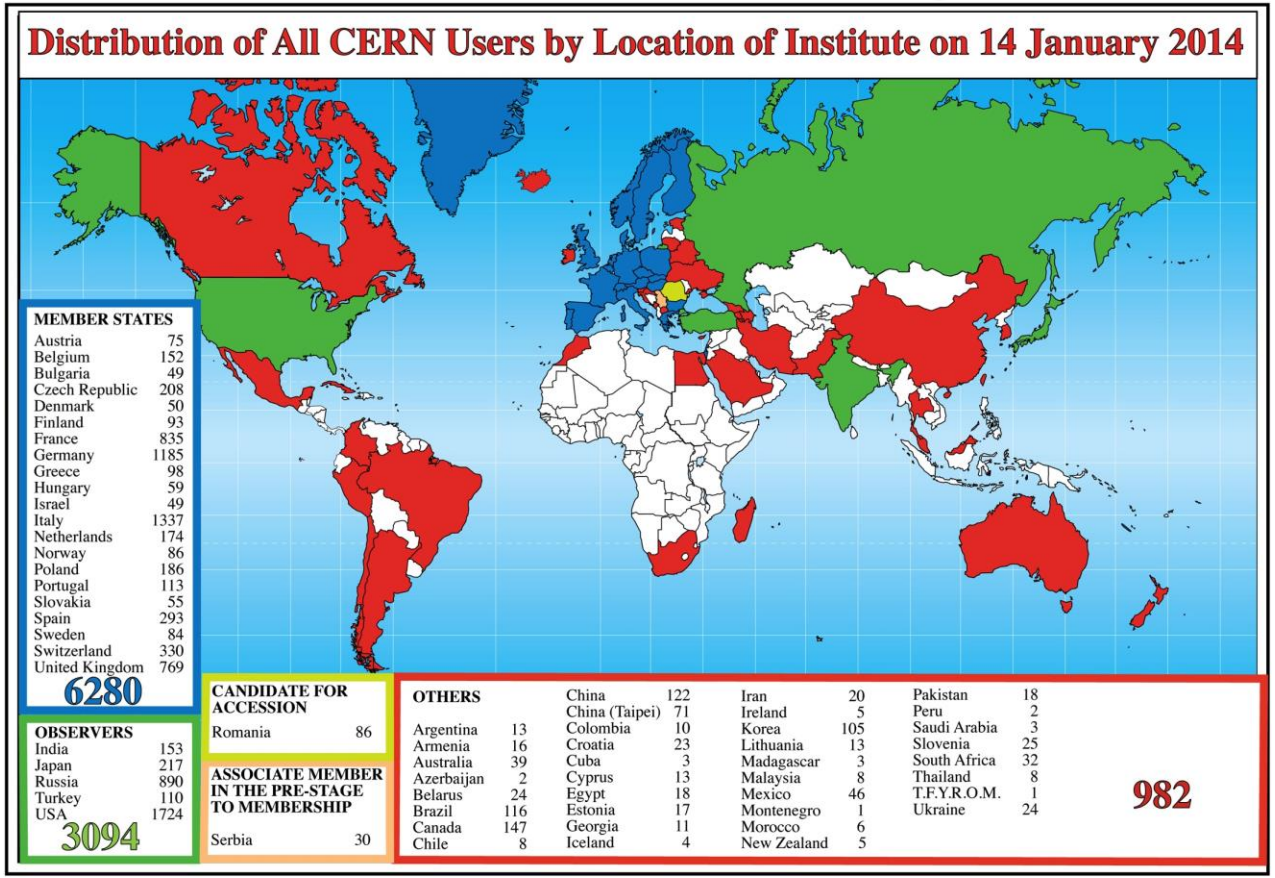
CERN, 16th May 2017

About CERN

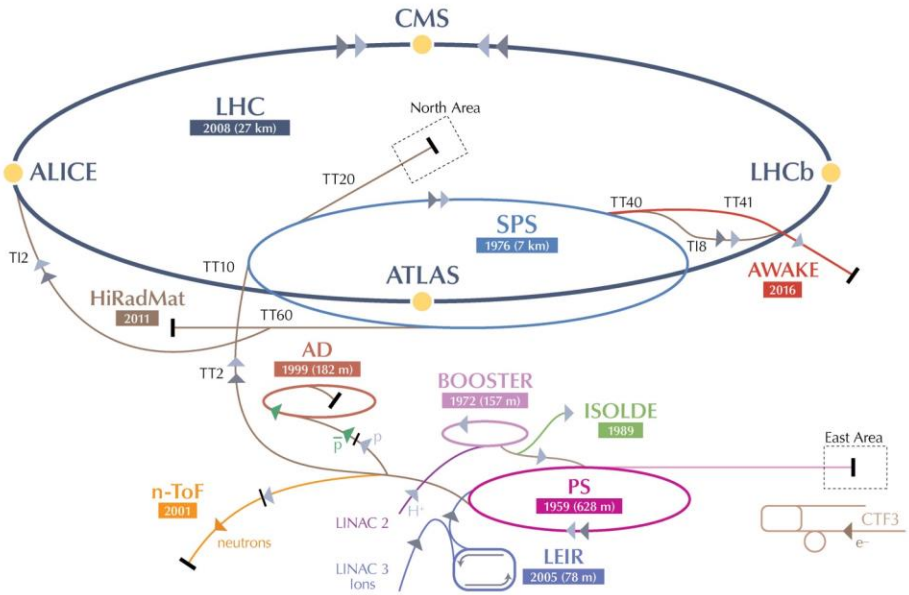
- CERN is the European Organization for Nuclear Research in Geneva
  - Particle accelerators and other infrastructure for high energy physics (HEP) research
  - Worldwide community
    - 21 member states (+ 2 incoming members)
    - Observers: Turkey, Russia, Japan, USA, India
    - About 2300 staff
    - >10’000 users (about 5’000 on-site)
    - Budget ~1000 MCHF

- Birthplace of the World Wide Web

Science is more and more global



CERN's Accelerator Complex



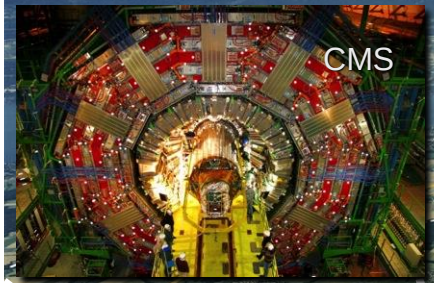
LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

AD Antiproton Decelerator CTF3 Clic Test Facility AWAKE Advanced WAKefield Experiment ISOLDE Isotope Separator OnLine DEvice

LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight HiRadMat High-Radiation to Materials

Tools: LHC and Detectors

pp, B-Physics, CP Violation
(matter-antimatter symmetry)

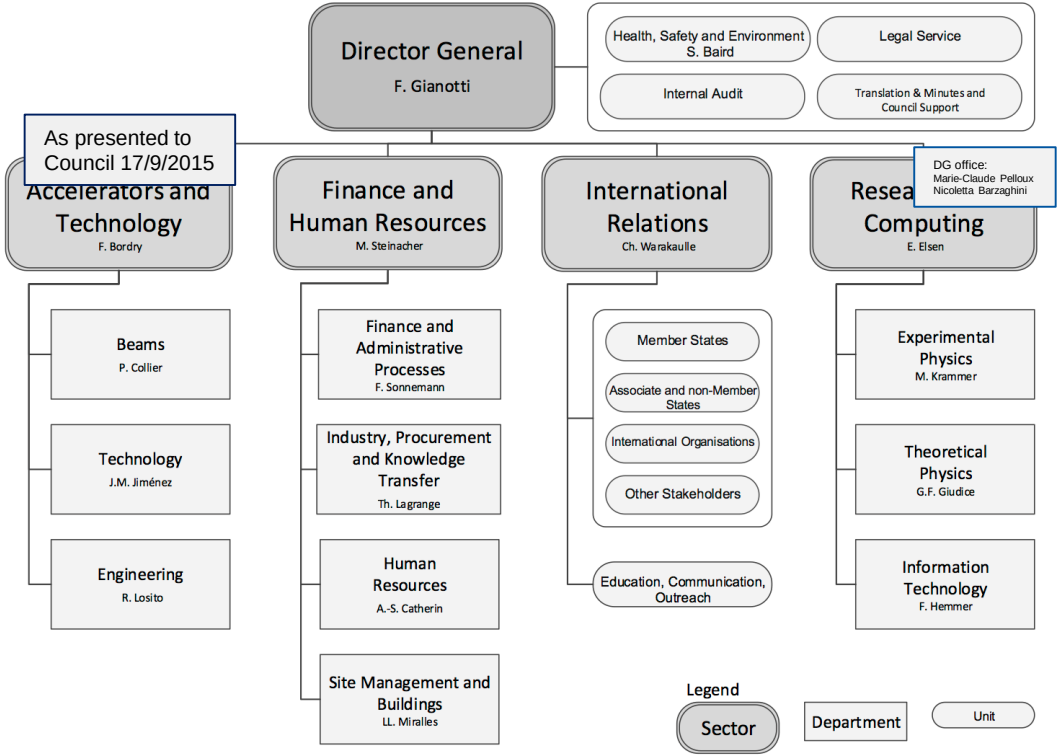


General Purpose,
proton-proton, heavy ions
Discovery of new physics:
Higgs, SuperSymmetry

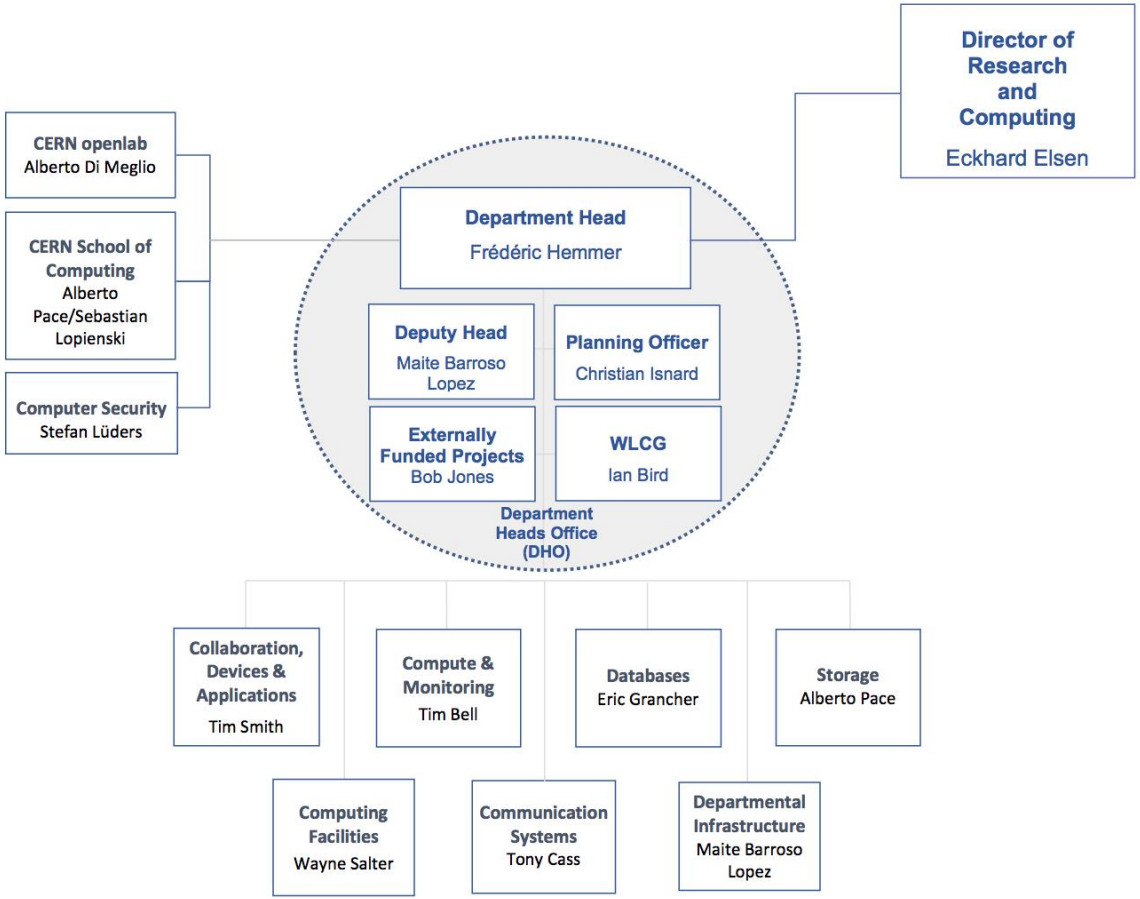
Exploration at a new energy frontier
in p-p and Pb-Pb collisions

Heavy ions, pp
(state of matter of early universe)

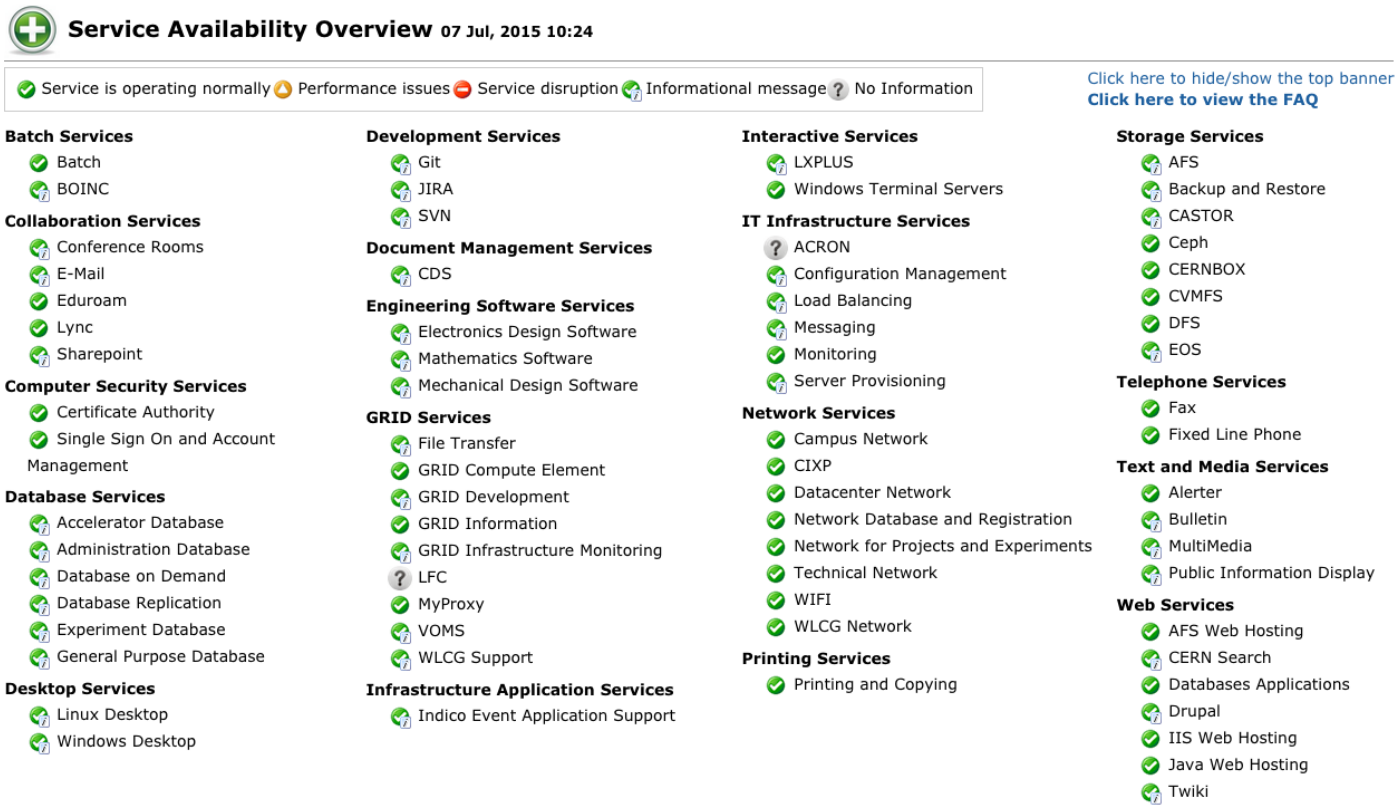
The CERN organisational and management structure



- Four sectors: each sector comprises several departments and/or units and is led by a Director
- The Director General and the four Directors form the Directorate
- The Enlarged Directorate brings together the Directorate, Department Heads and Head of HSE


Director of Research and Computing
Eckhard Elsen
CERN openlab
Alberto Di Meglio
CERN School of Computing
Alberto Pace/Sebastian Lopienski
Computer Security
Stefan Lüders
Department Head
Frédéric Hemmer
Deputy Head
Maite Barroso Lopez
Planning Officer
Christian Isnard
Externally Funded Projects
Bob Jones
WLCG
Ian Bird
Department Heads Office (DHO)
Collaboration, Devices & Applications
Tim Smith
Compute & Monitoring
Tim Bell
Databases
Eric Grancher
Storage
Alberto Pace
Computing Facilities
Wayne Salter
Communication Systems
Tony Cass
Departmental Infrastructure
Maite Barroso Lopez

All IT Services



Service Availability Overview 07 Jul, 2015 10:24

Service is operating normally | Performance issues | Service disruption | Informational message | No Information

Click here to hide/show the top banner
Click here to view the FAQ

Batch Services
- Batch
- BOINC

Collaboration Services
- Conference Rooms
- E-Mail
- Eduroam
- Lync
- Sharepoint

Computer Security Services
- Certificate Authority
- Single Sign On and Account Management

Database Services
- Accelerator Database
- Administration Database
- Database on Demand
- Database Replication
- Experiment Database
- General Purpose Database

Desktop Services
- Linux Desktop
- Windows Desktop

Development Services
- Git
- JIRA
- SVN

Document Management Services
- CDS

Engineering Software Services
- Electronics Design Software
- Mathematics Software
- Mechanical Design Software

GRID Services
- File Transfer
- GRID Compute Element
- GRID Development
- GRID Information
- GRID Infrastructure Monitoring
- LFC
- MyProxy
- VOMS
- WLCG Support

Infrastructure Application Services
- Indico Event Application Support

Interactive Services
- LXPLUS
- Windows Terminal Servers

IT Infrastructure Services
- ACRON
- Configuration Management
- Load Balancing
- Messaging
- Monitoring
- Server Provisioning

Network Services
- Campus Network
- CIXP
- Datacenter Network
- Network Database and Registration
- Network for Projects and Experiments
- Technical Network
- WIFI
- WLCG Network

Printing Services
- Printing and Copying

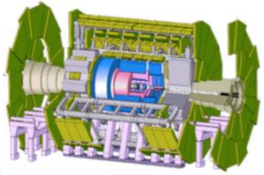
Storage Services
- AFS
- Backup and Restore
- CASTOR
- Ceph
- CERNBOX
- CVMFS
- DFS
- EOS

Telephone Services
- Fax
- Fixed Line Phone

Text and Media Services
- Alerter
- Bulletin
- MultiMedia
- Public Information Display

Web Services
- AFS Web Hosting
- CERN Search
- Databases Applications
- Drupal
- IIS Web Hosting
- Java Web Hosting
- Twiki

HEP Computing



~40 MHz ~ PB/s

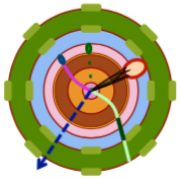
"Online" – Real time
Funded as part of the detector

L1 Trigger (HW) → ~100 kHz → HL Trigger (SW) → ~1 kHz

WLCG

"Raw Data" ~ 1-10 GB/s

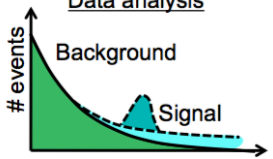
Reconstruction



Calibration

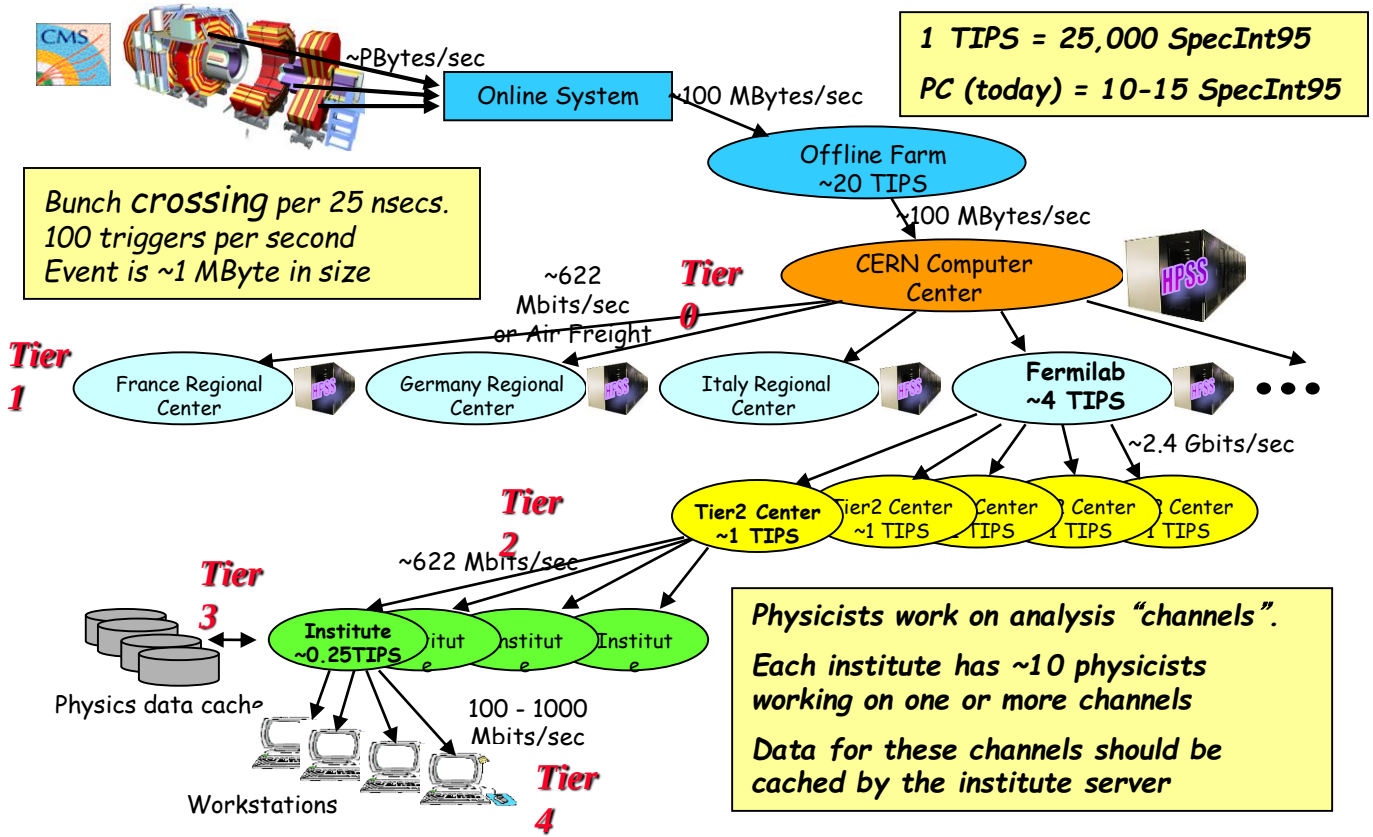
Monte Carlo Simulations

Data analysis



"Offline" - Asynchronous

Original LHC computing model ~1999

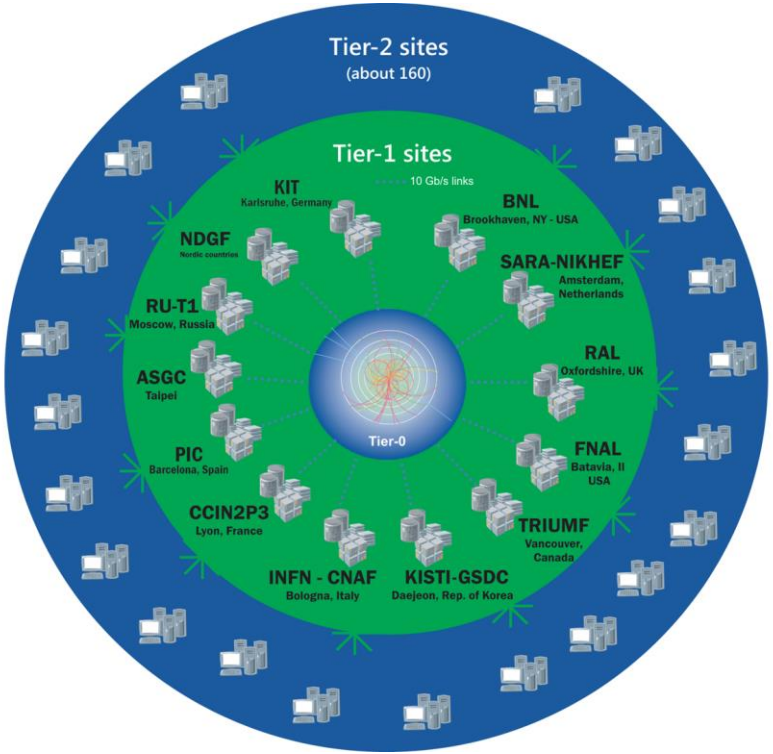


The Worldwide LHC Computing Grid

Tier-0 (CERN): data recording, reconstruction and distribution

Tier-1: permanent storage, re-processing, analysis

Tier-2: Simulation, end-user analysis



nearly 170 sites, 40 countries

~750k cores

~985 PB of storage

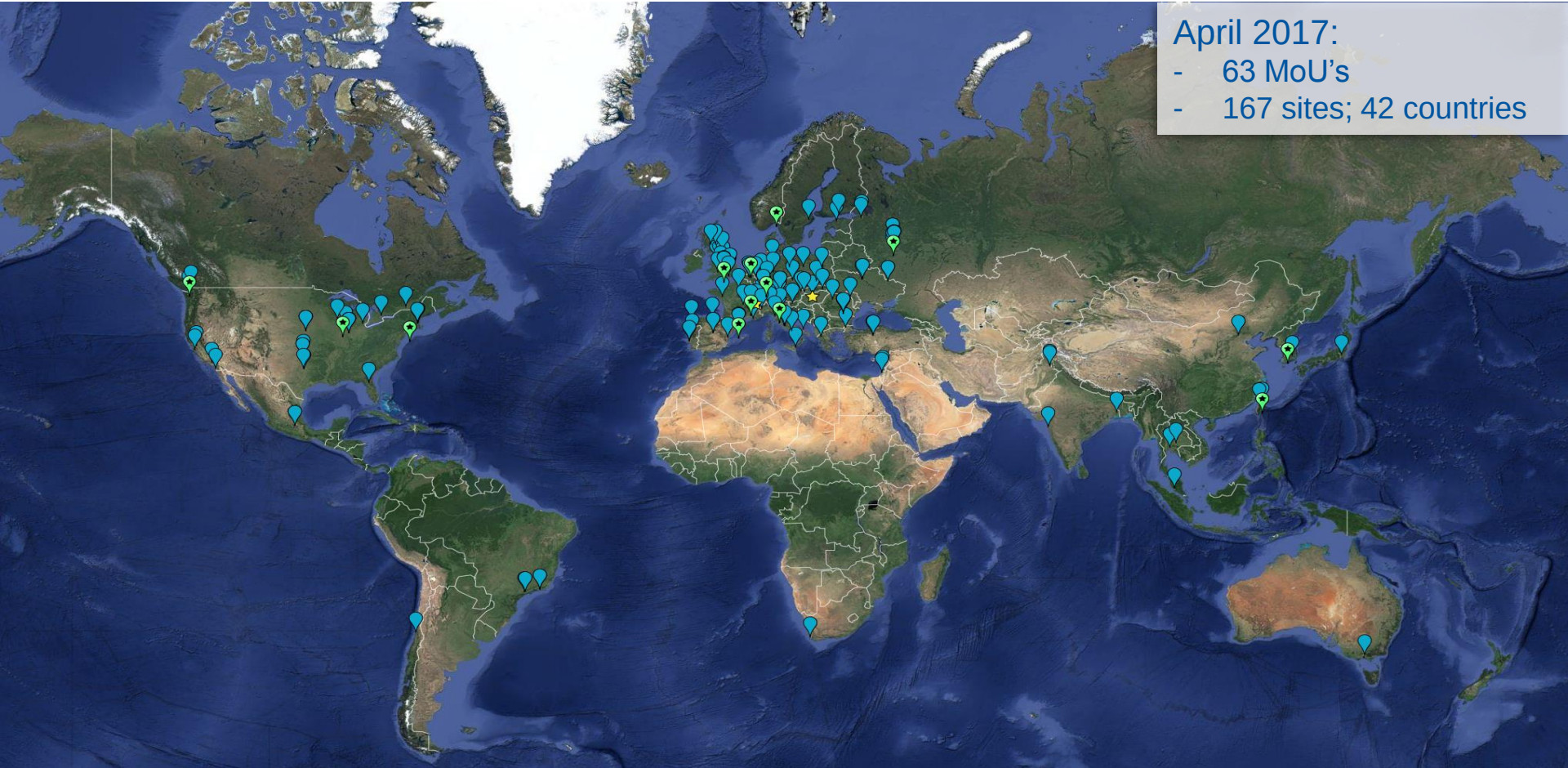
> 2 million jobs/day

10-100 Gb links

WLCG:
An International collaboration to distribute and analyse LHC data

Integrates computer centres worldwide that provide computing and storage resource into a single infrastructure accessible by all LHC physicists

WLCG Collaboration



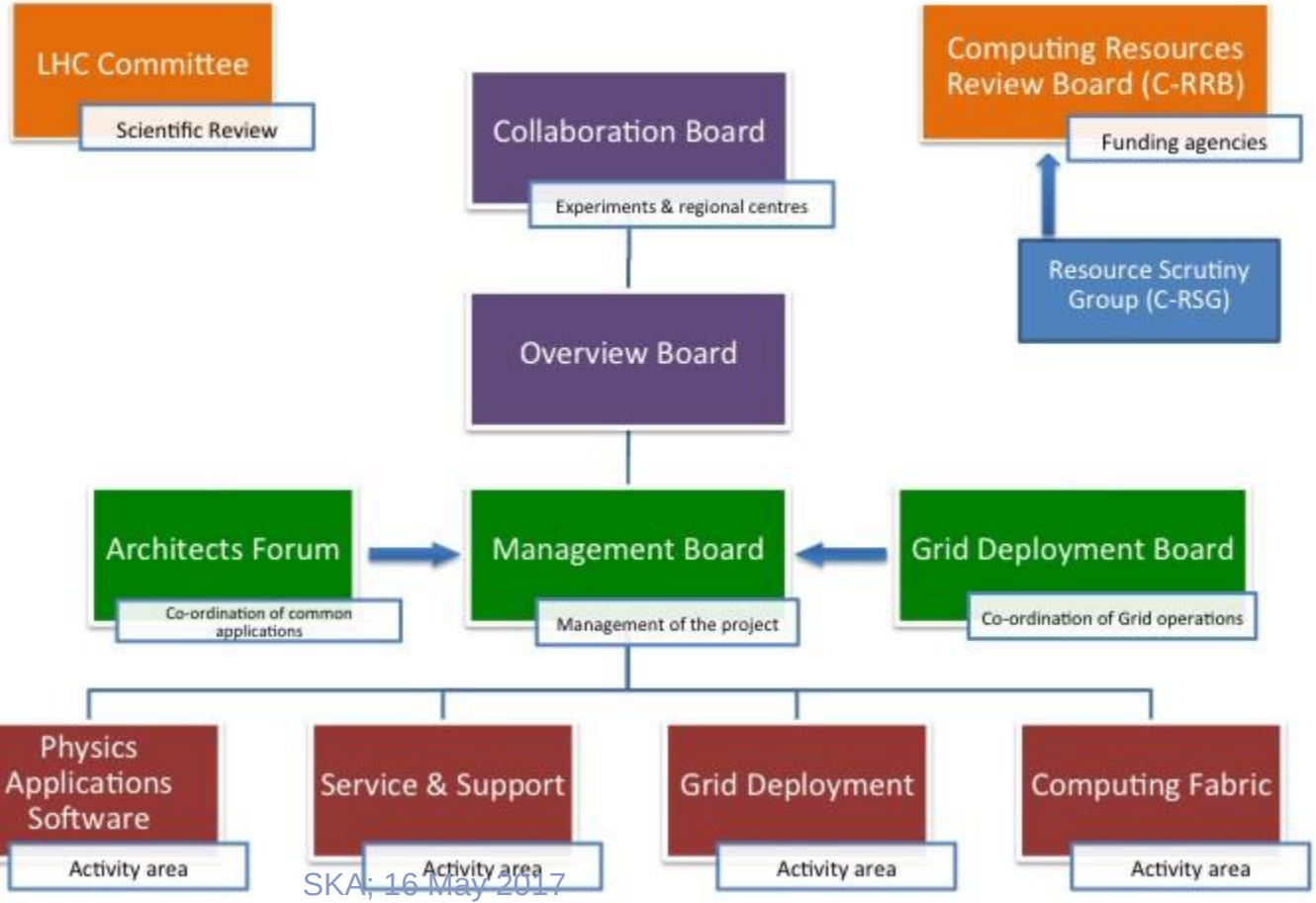
CERN & Scientific collaborations

- CERN (accelerators) is the facility
  - CERN budget funds the facility
  - But other contributions to LHC etc construction
- LHC (and other) experiments are global collaborations, as is WLCG for computing
  - CERN is one institute of many
  - Funding is outside of CERN base funds – national contributions to ATLAS, CMS, etc
- Relationship and structure of the collaboration is subject of MoU's between CERN and the funding agencies for each collaboration

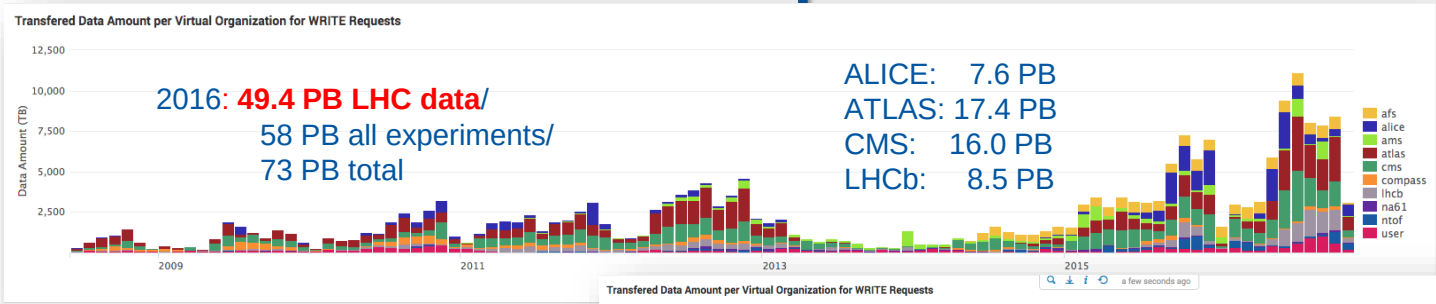
The WLCG

- Is a collaboration, bound by a Memorandum of Understanding (MoU) between CERN and Funding Agencies
  - ~50 FA's today … still adding more
- Specifies:
  - Services and service levels of Tier 0, 1, 2
  - Process for managing the collaboration
- Process to manage the resource requirement/pledges
  - Yearly cycle, 3 year outlook
  - Review by RRB (FA's), scrutiny group

Worldwide LHC Computing Grid - Organisation



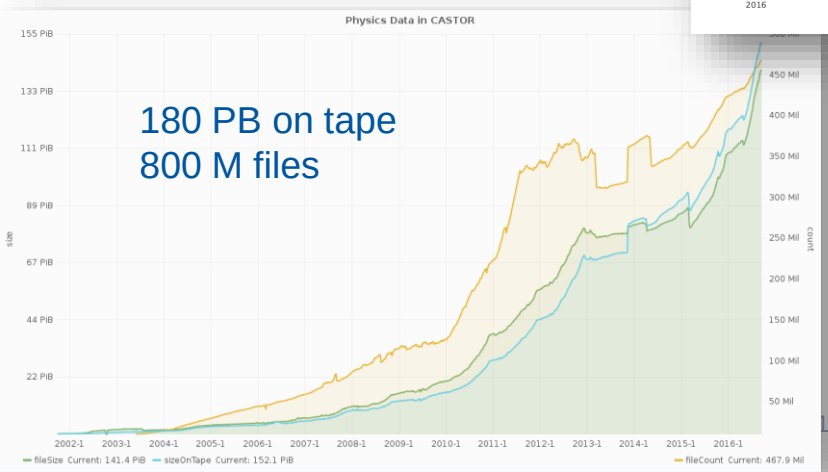
Data in 2016 - updated



2016: **49.4 PB LHC data**/
58 PB all experiments/
73 PB total

ALICE: 7.6 PB
ATLAS: 17.4 PB
CMS: 16.0 PB
LHCb: 8.5 PB

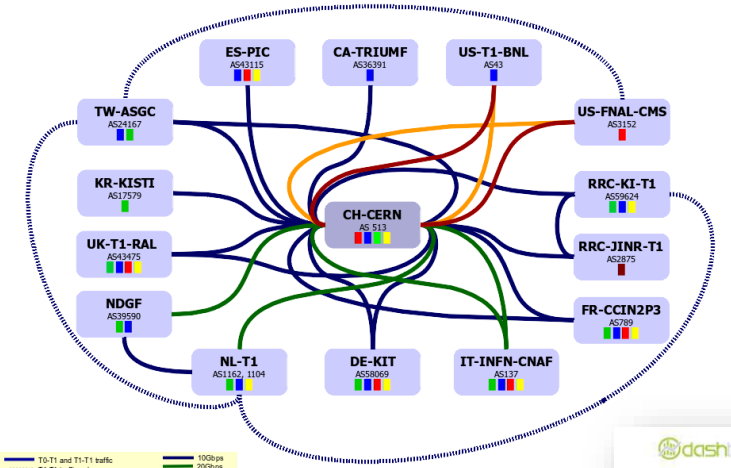
11 PB in July

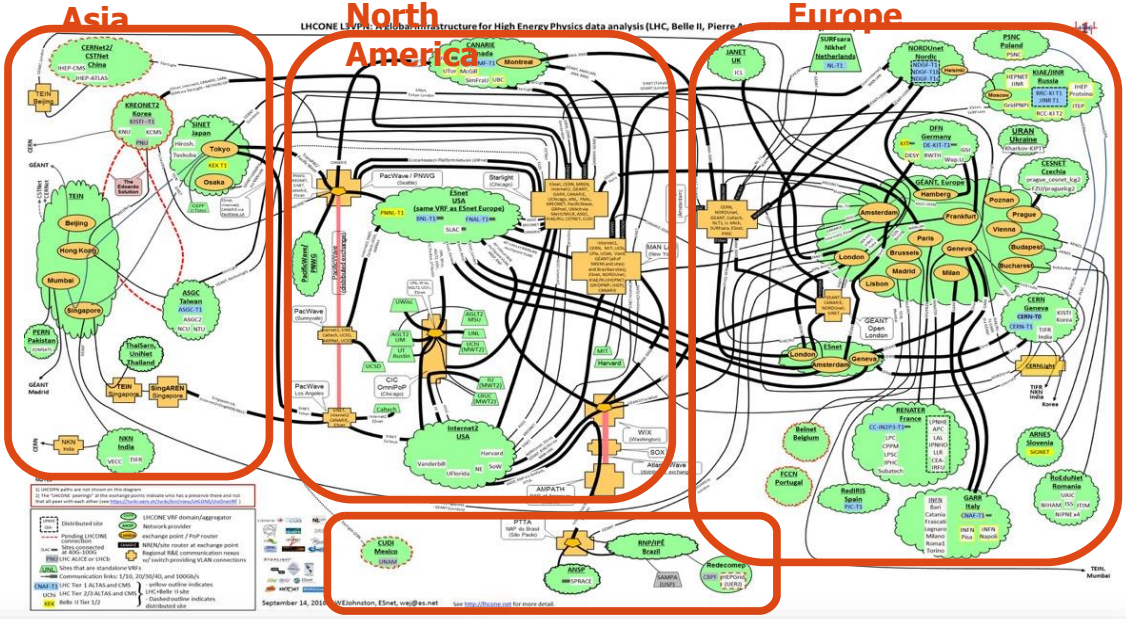


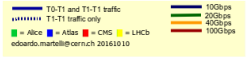
180 PB on tape
800 M files

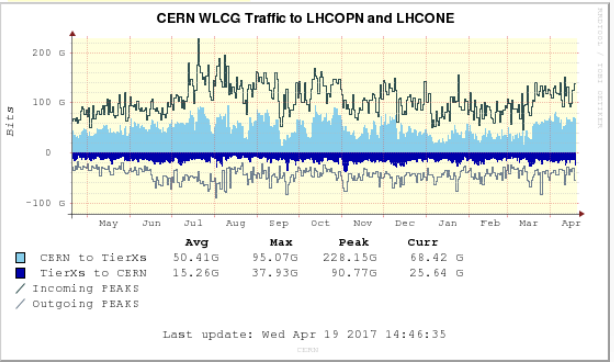
Data transfers

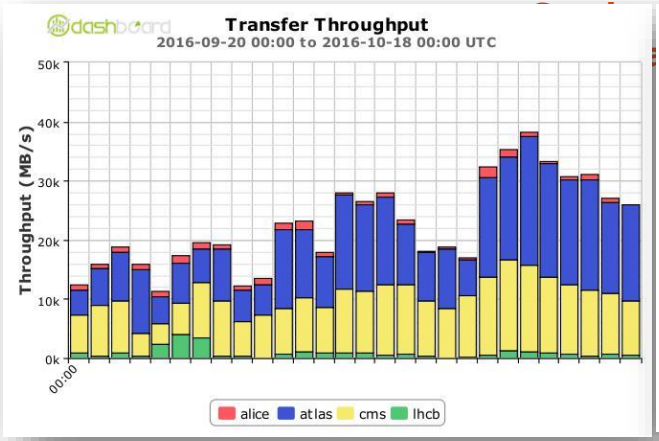
LHCOPN

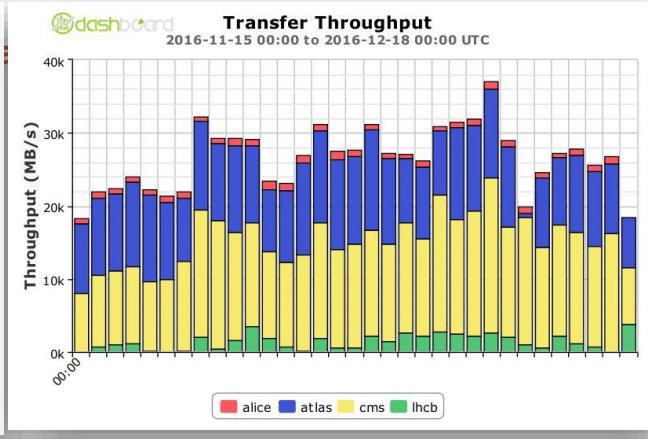




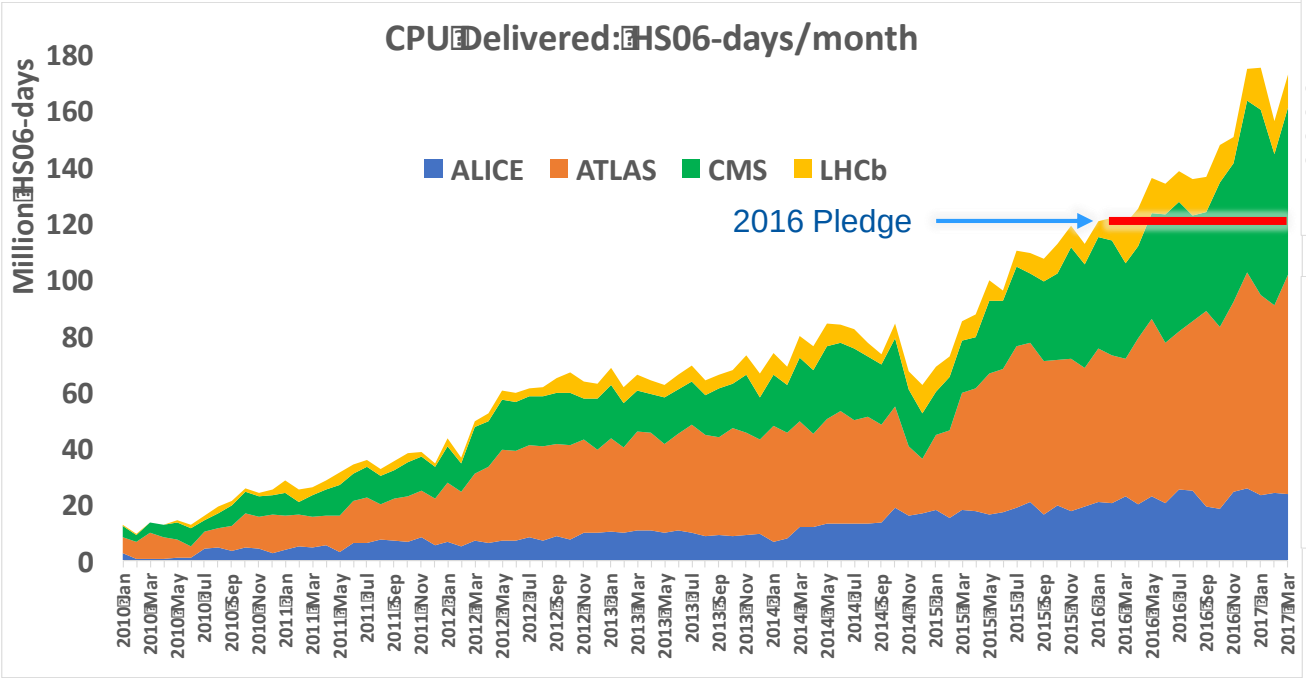


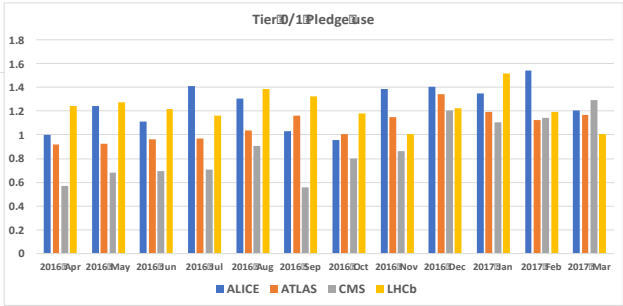


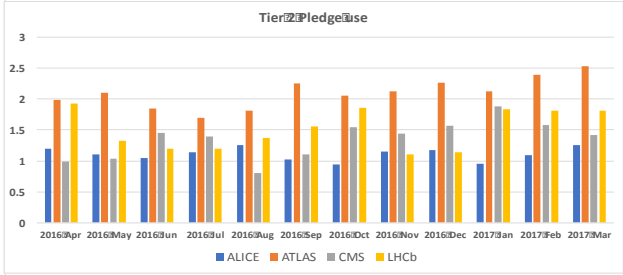




CPU Delivered



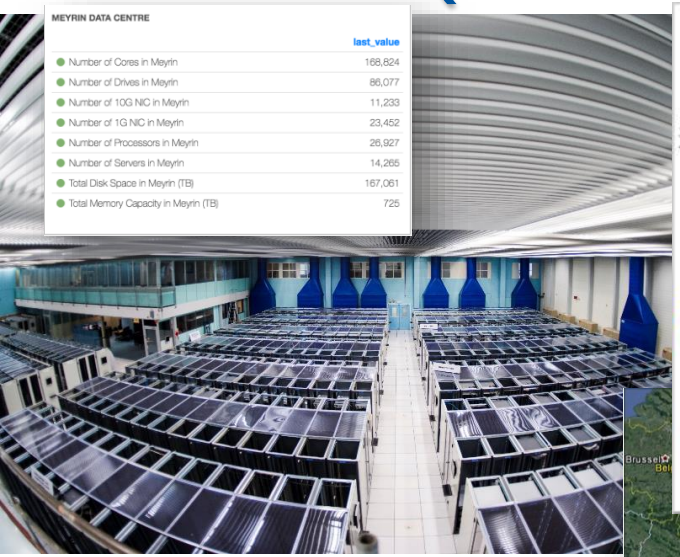




New peak: ~180 M HS06-days/month

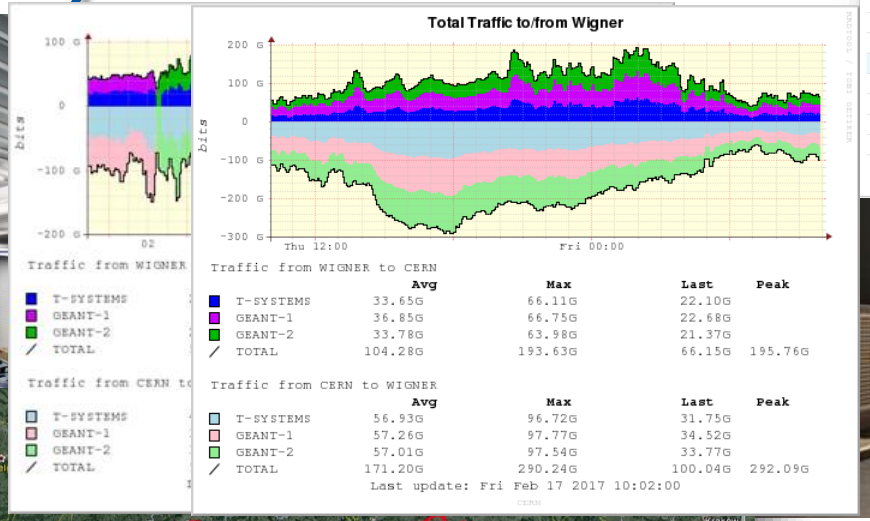
~ 600 k cores continuous

CERN (Tier 0) Facilities



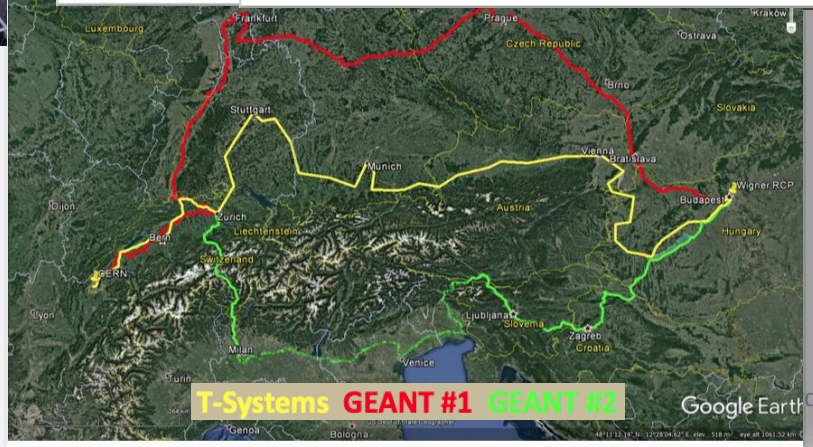
MEYRIN DATA CENTRE

	last_value
Number of Cores in Meyrin	168,824
Number of Drives in Meyrin	86,077
Number of 10G NIC in Meyrin	11,233
Number of 1G NIC in Meyrin	23,452
Number of Processors in Meyrin	26,927
Number of Servers in Meyrin	14,265
Total Disk Space in Meyrin (TB)	167,061
Total Memory Capacity in Meyrin (TB)	725



WIGNER DATA CENTRE

	last_value
Number of Cores in Wigner	56,000
Number of Drives in Wigner	29,694
Number of 10G NIC in Wigner	2,981
Numer of 1G NIC in Wigner	6,579
Number of Processors in Wigner	7,002
Number of Servers in Wigner	3,504
Total Disk Space in Wigner (TB)	97,315
Total Memory Capacity in Wigner (TB)	221



2017:

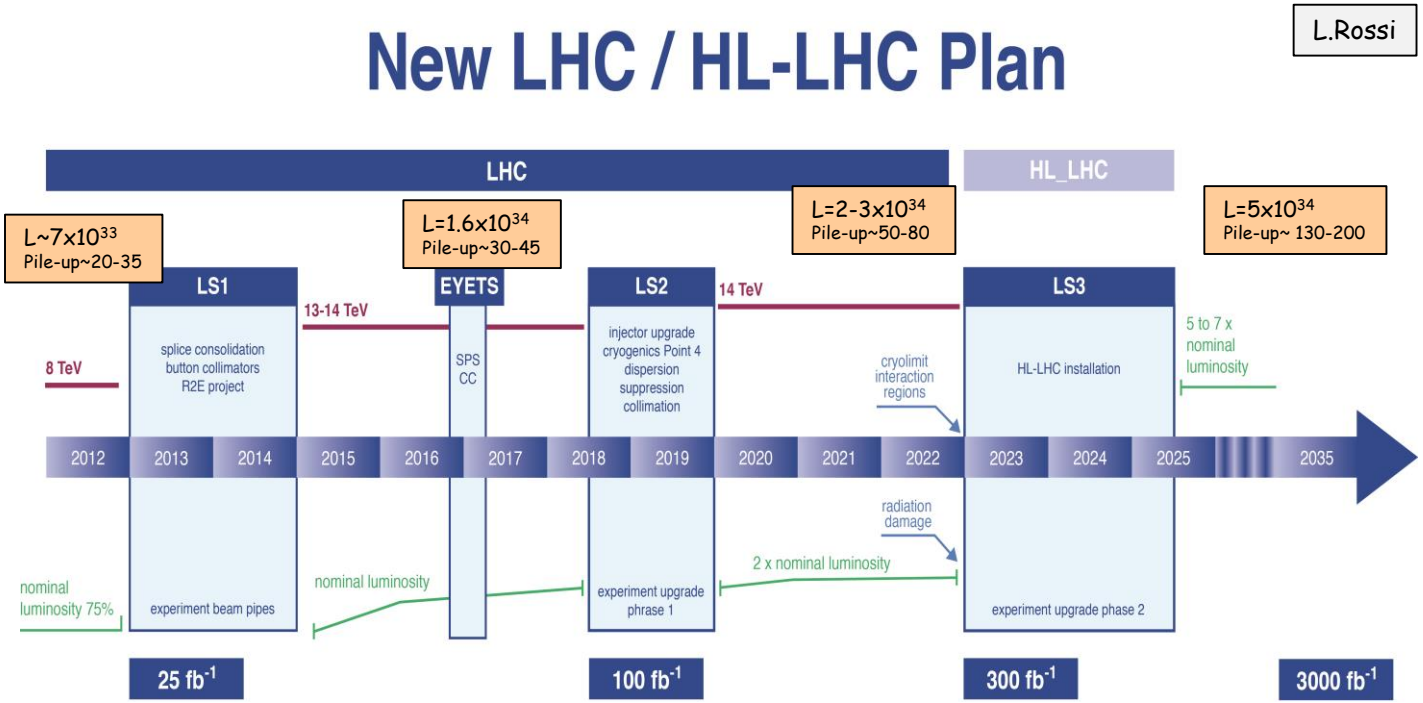
- 225k cores → 325k
- 150 PB raw → 250 PB

2017-18/19

- Upgrade internal networking capacity
- Refresh tape infrastructure

The LHC timeline

L.Rossi

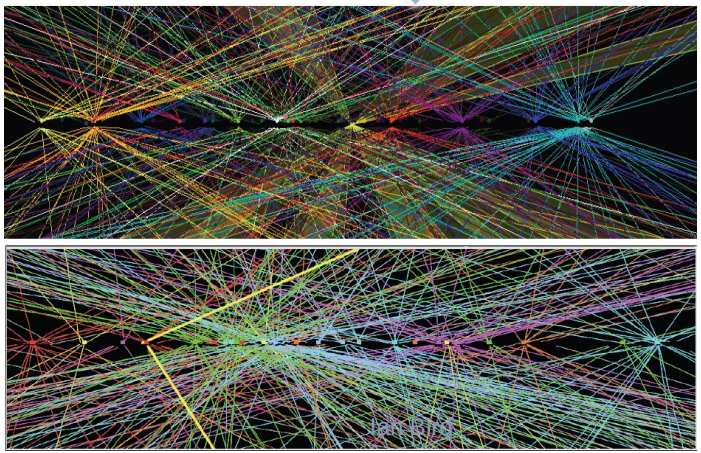


LHC Upgrades

- Run 3: ALICE + LHCb
  - LHCb:
    - 1 MHz → 40 MHz
  - ALICE:
    - 50 kHz event rate (75 GB/s) for 6 weeks/year
- Run 4: CMS + ATLAS upgrades
  - ~10 kHz event rate (today 1 kHz)
  - 10-40 GB/s data rates

	Integrated L (fb^{-1})	Pileup ATLAS+CMS
Run 1	25	25
Run 2	100	40
Run 3	300	60
Run 4	+300/yr	140

This x5!



Evolution and challenges

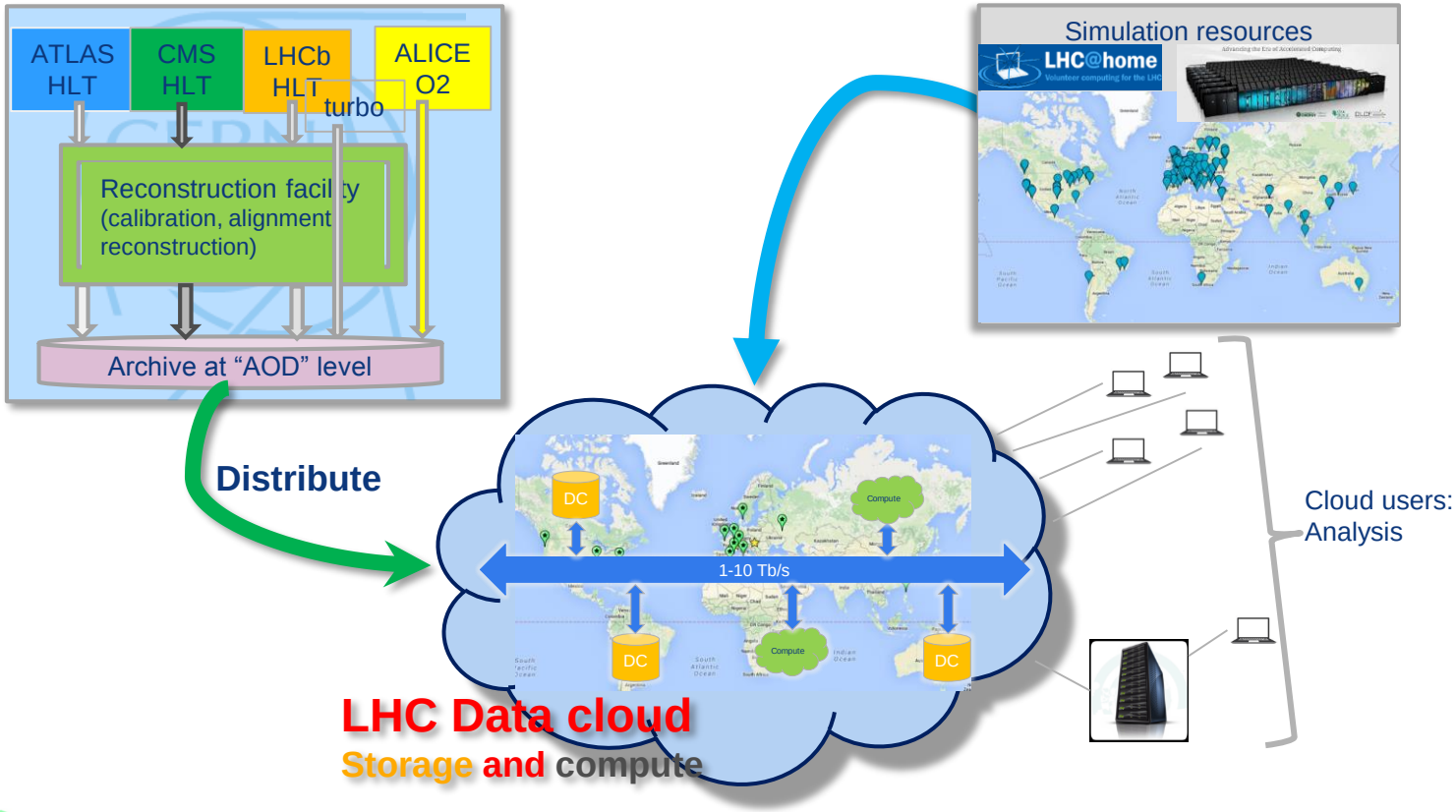
- WLCG Grid → federated grid/cloud/other resources
  - Reduce operational effort so that WLCG Tiers can be self supporting (no need for external funds for operations)
  - Enable the experiments to easily make use of opportunistic resources
    - (Grid) clusters, clouds, HPC, …

- Challenges:
  - Huge increases in data volumes and processing needs
    - 50 PB/year in 2016 → >>1 EB/year in 2026
    - > x60 more CPU needs
    - Technology evolution not obvious
  - Software complexity and performance
    - Modern CPU architectures require significant software re-engineering
  - Must live within ~flat budgets

Key Components of an evolved infrastructure

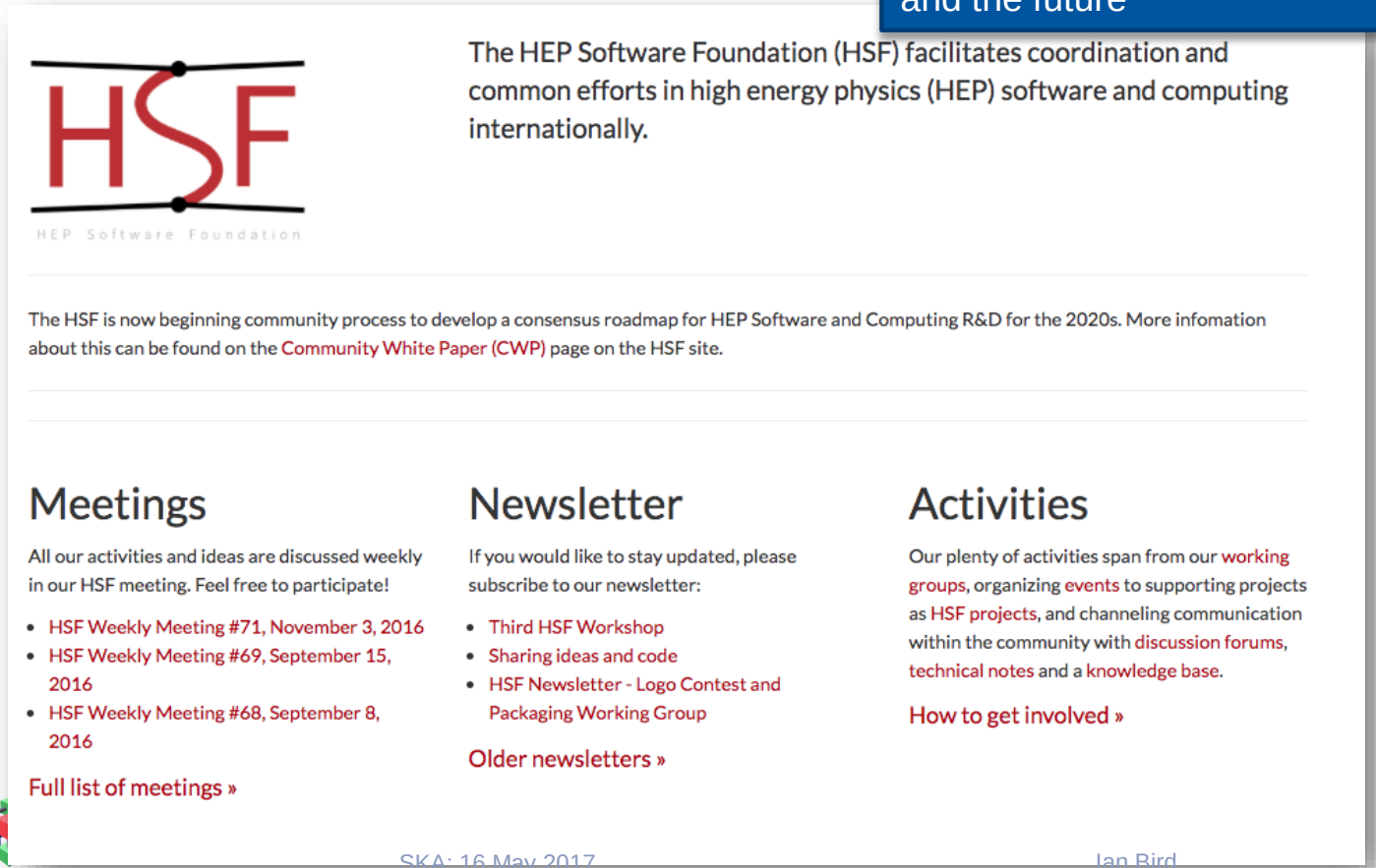
- A general infrastructure and services (data stores, compute facilities, networking, etc.);
  - Associated services like AAA, security, base monitoring, operational support
  - Needs to be capable of supporting different computing models and agile to technology changes
- "Software": full stack from workflow and data management tools to application level; Common tools, libraries, etc.;
  - BUT: a set of optional tools, contributed, developed, maintained, by the community;
  - Common R&D and support tools (technology tracking, software tooling);
  - This is essentially what the HSF is mandated to do.
- A Steering group structure to organize and evolve the above – mandated by e.g. ICFA
  - Constituted from major global HENP facilities, experiments, observers (A-P)
- Experiment/facility-specific (optional) processes
  - e.g. WLCG for the LHC resource management, etc.

Possible Model for future HL-LHC computing infrastructure



Software

HSF Set up in response to recognition that software will be key to success for HL-LHC and the future



Prototyping

- Building a prototype data cloud/science cloud now would also allow us to provide additional value-add services to HEP
  - (Web-)FTS, cernbox, data archiving, DBOD, data preservation (Zenodo) and open access platform
    - All of these “as-a-service”
  - Could demonstrate to other sciences – to eventually contribute to a science cloud
    - And then include other collaborative services (Indico, Vidyo, etc.)
  - Leverages CERN’s & HEP key competencies and experience
- This would be a clear unique contribution of HEP to an EOSC infrastructure …