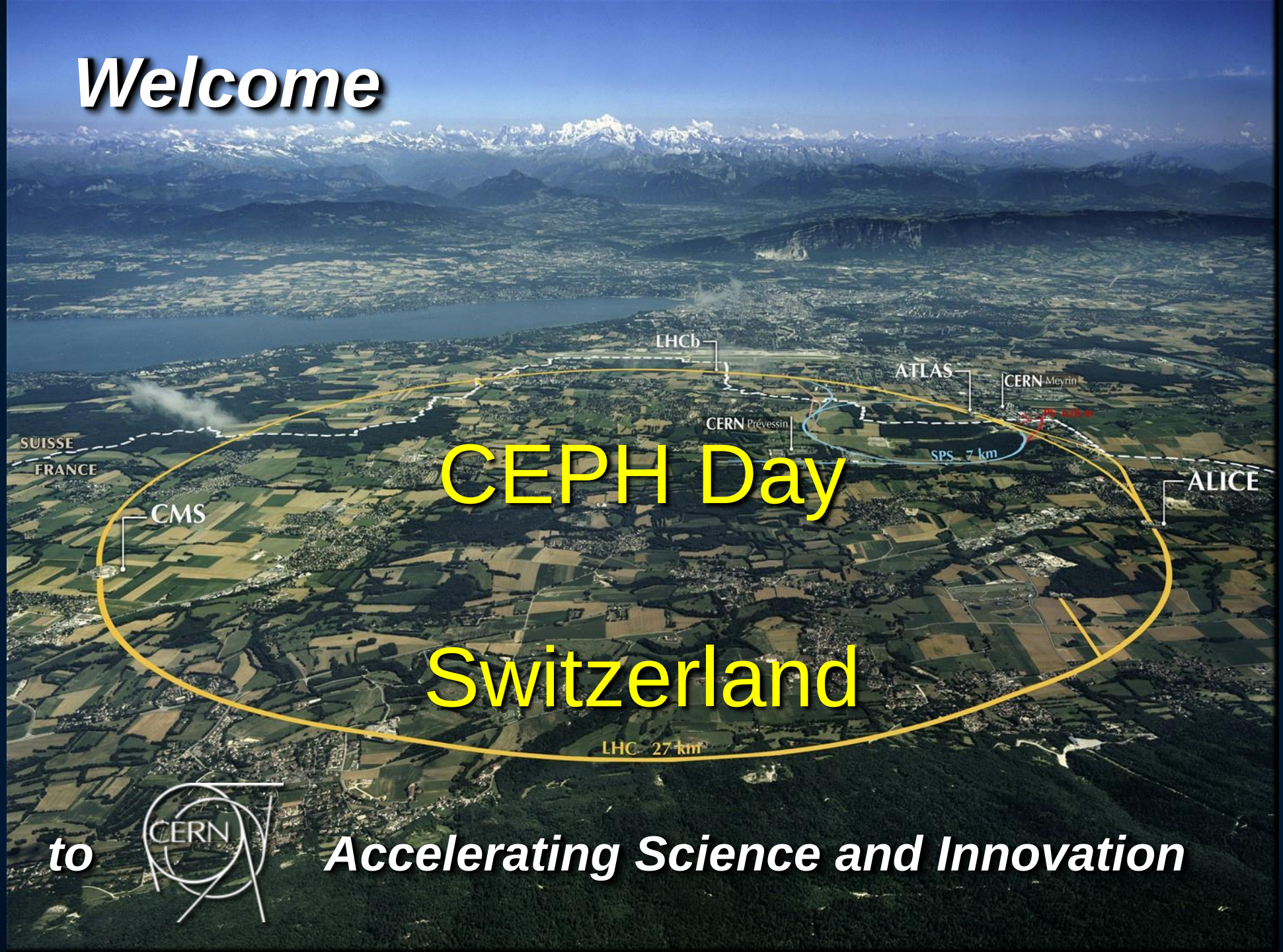
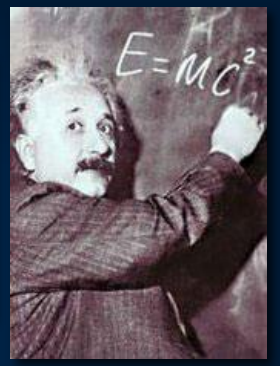
CERN

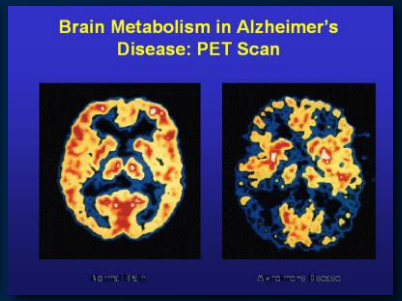

Welcome
LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SUISSE
FRANCE
SPS 7 km
ALICE
CMS
CEPH Day
Switzerland
LHC 27 km
to
CERN
Accelerating Science and Innovation

The Mission of CERN



- **Push back** the frontiers of knowledge

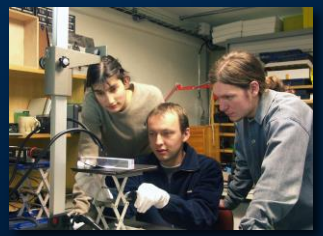
  E.g. the secrets of the Big Bang …what was the matter like within the first moments of the Universe's existence?



- **Develop** new technologies for accelerators and detectors

  Information technology - the Web and the GRID

  Medicine - diagnosis and therapy



- **Train** scientists and engineers of tomorrow

- **Unite** people from different countries and cultures

CERN: founded in 1954: 12 European States
"Science for Peace"
Today: 21 Member States

~ 2300 staff
~ 1400 other paid personnel
~ 12500 scientific users

Budget (2016) ~1000 MCHF

Member States: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland and United Kingdom

Associate Member States: Pakistan, Turkey

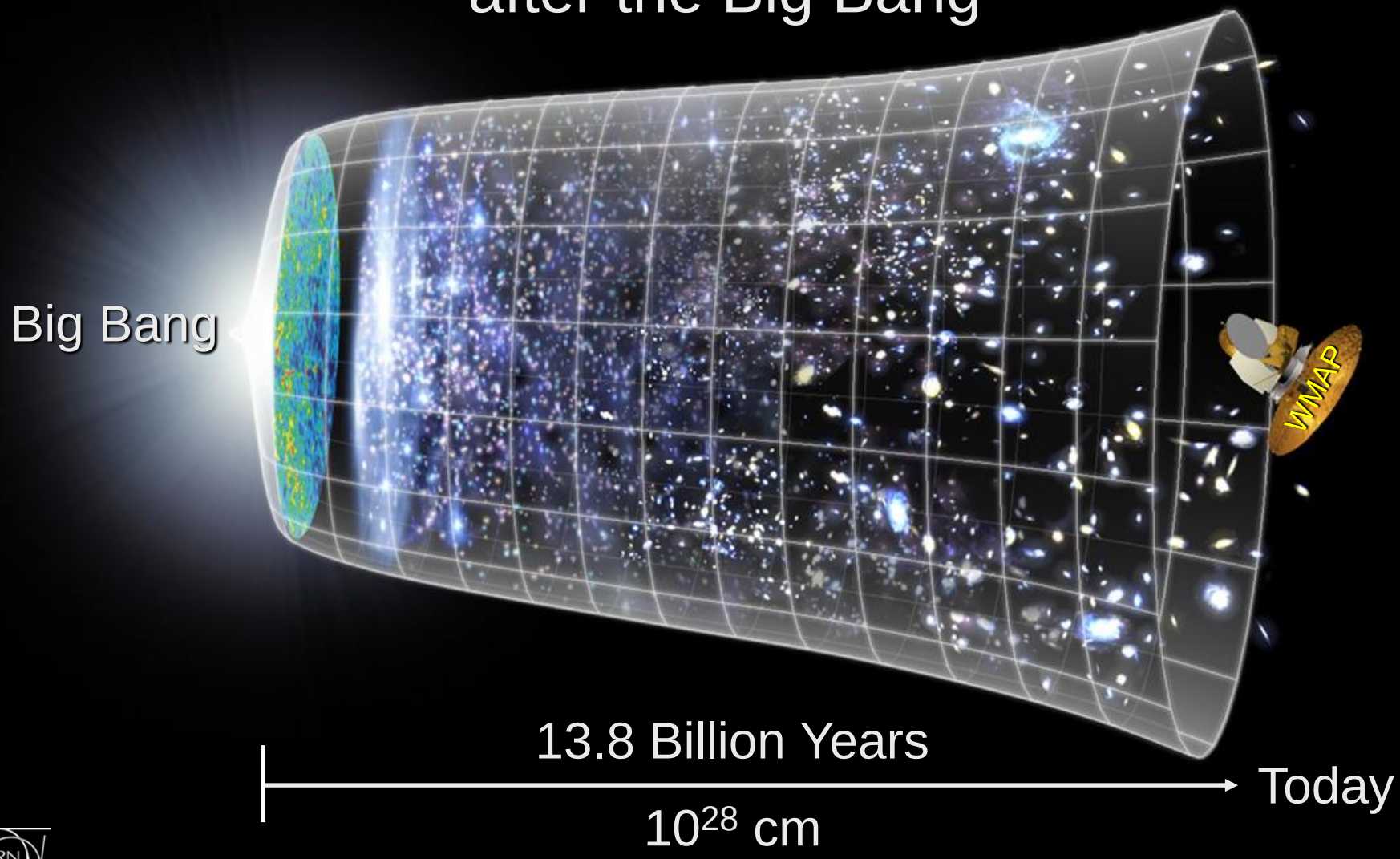
States in accession to Membership: Cyprus, Romania, Serbia

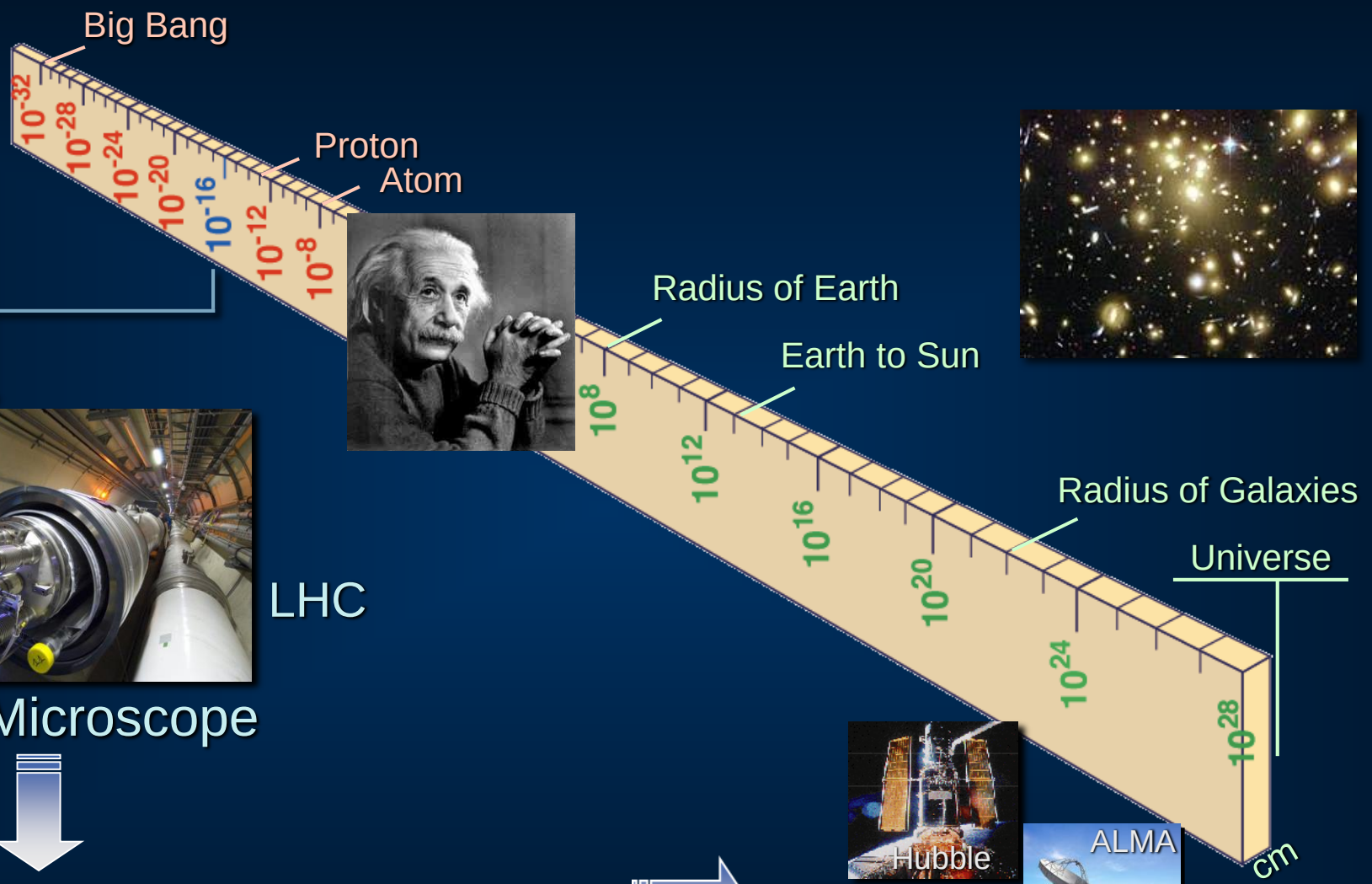
Applications for Membership or Associate Membership: Brazil, Croatia, India, Lithuania, Russia, Slovenia, Ukraine

Observers to Council: India, Japan, Russia, United States of America; European Union, JINR and UNESCO

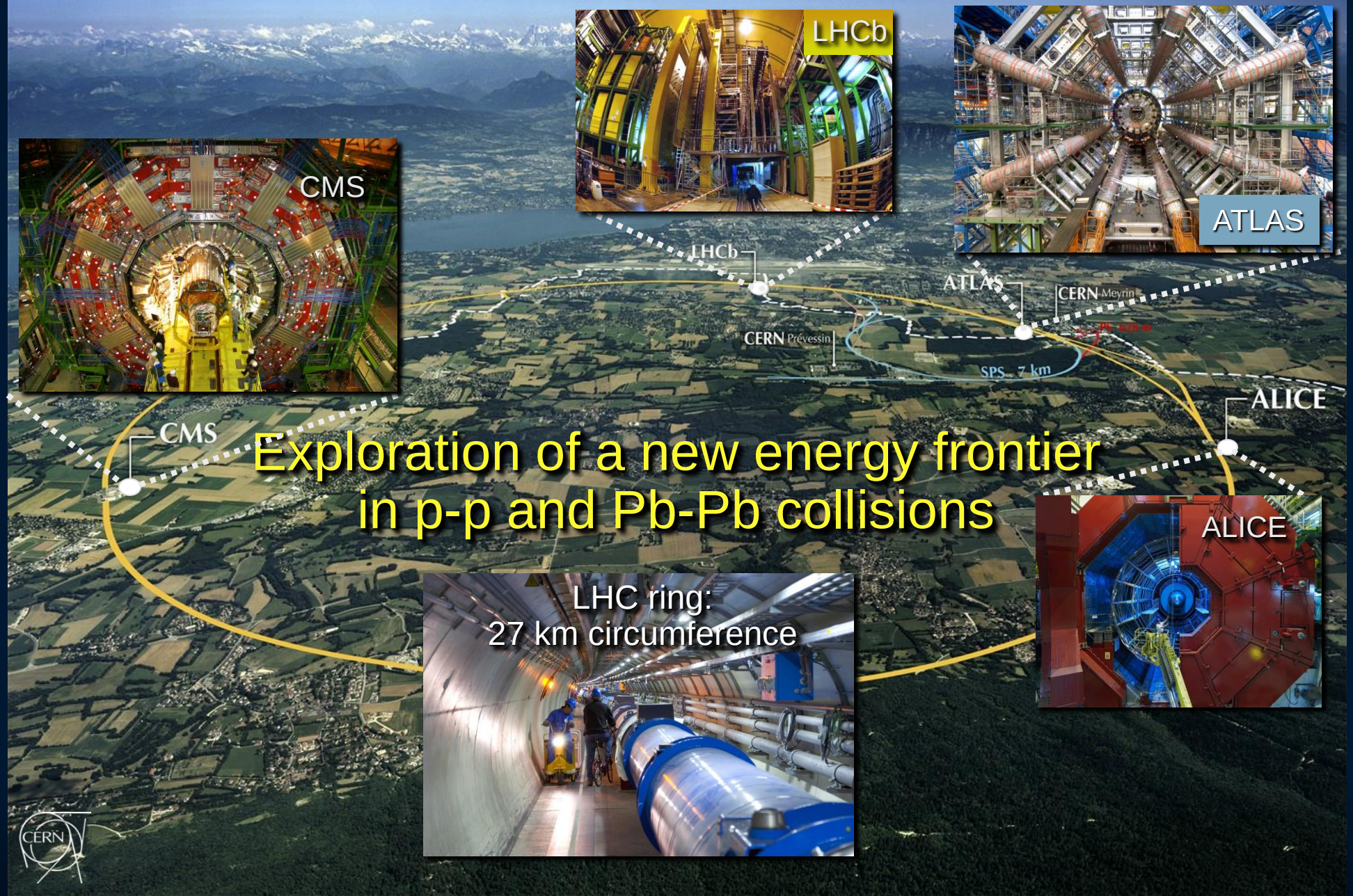
Next Scientific Challenge:

to understand the very first moments of our Universe after the Big Bang




Big Bang
Proton
Atom
Radius of Earth
Earth to Sun
Radius of Galaxies
Universe
cm
LHC
Super-Microscope
Reproducing conditions
Looking back
Hubble
ALMA
AMS
VLT

2010: a New Era in Fundamental Science



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

Discovery 2012, Nobel Prize in Physics 2013

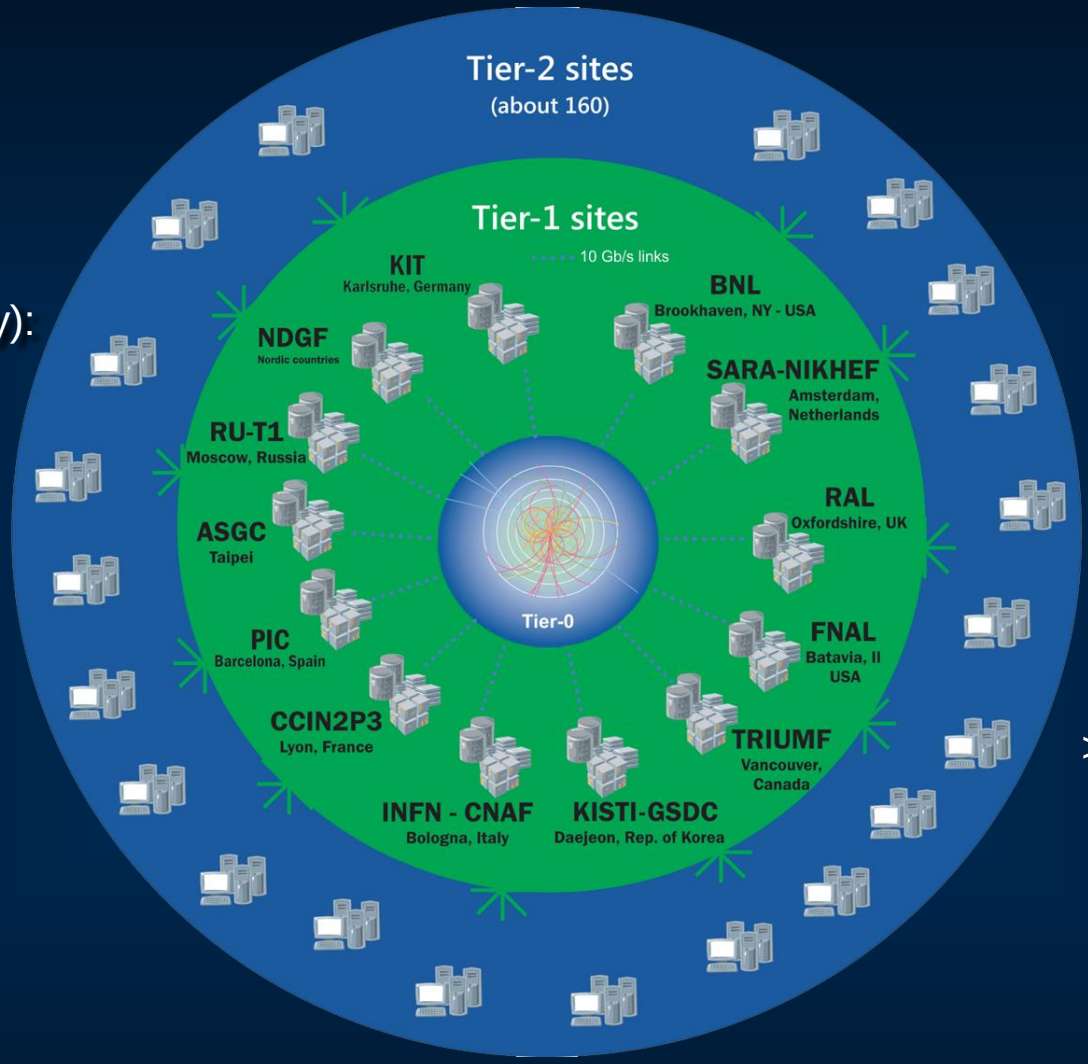
The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs *"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider".*

The Worldwide LHC Computing Grid

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

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

Tier-2: Simulation,
end-user analysis



~170 sites,
40 countries

~500k CPU cores

500 PB of storage

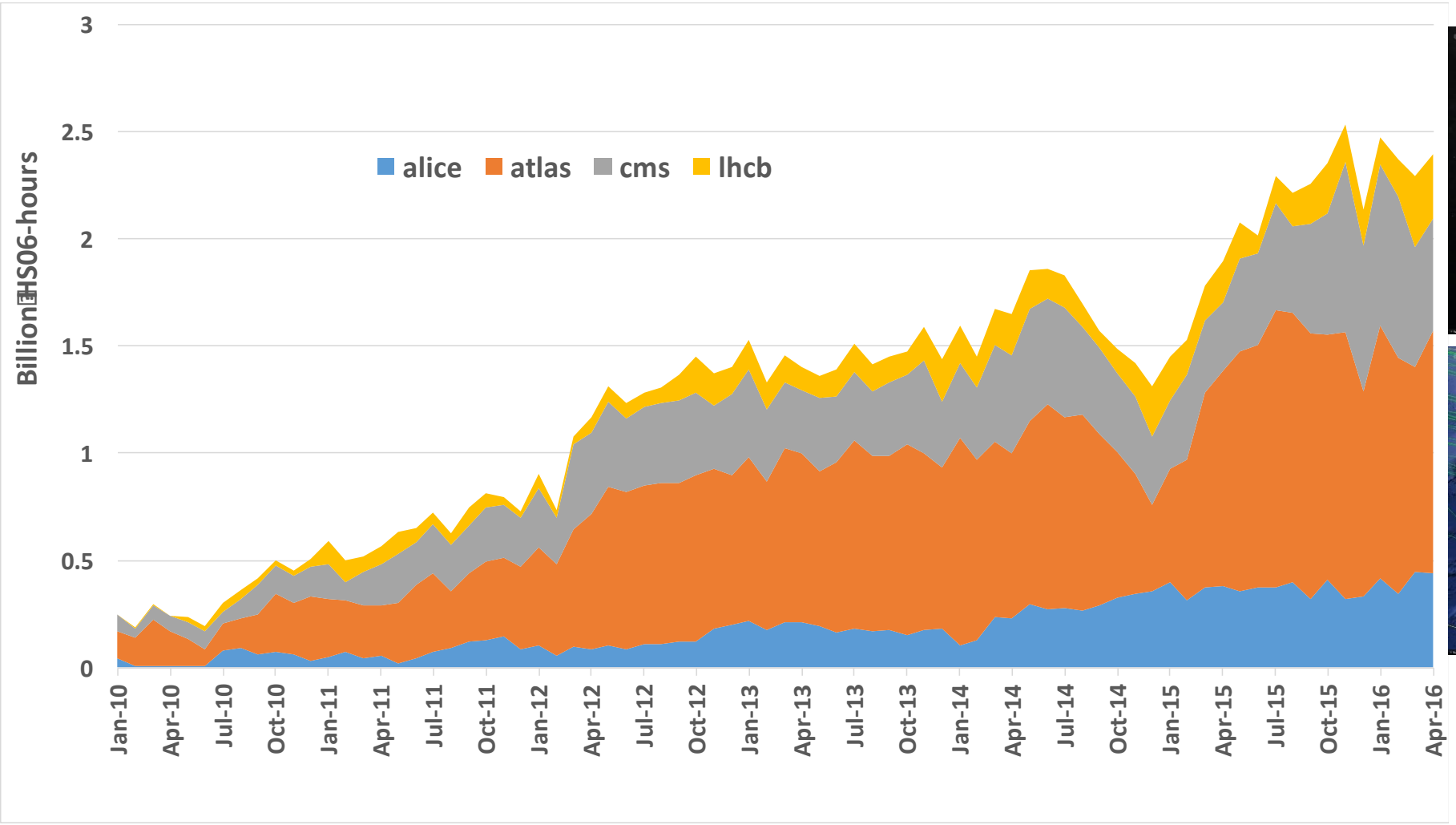
> 2 million jobs/day

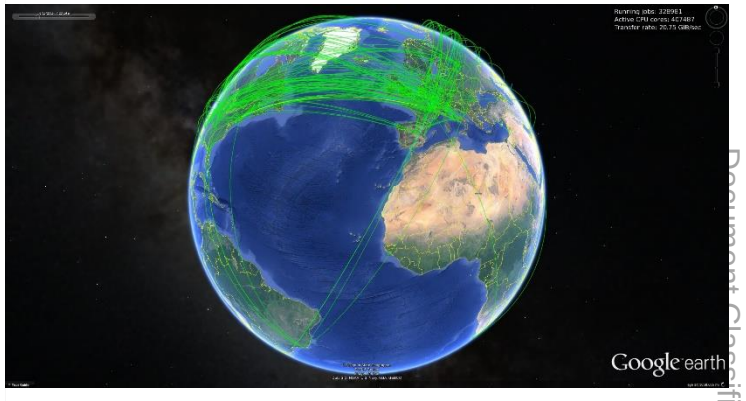
10-100 Gb links

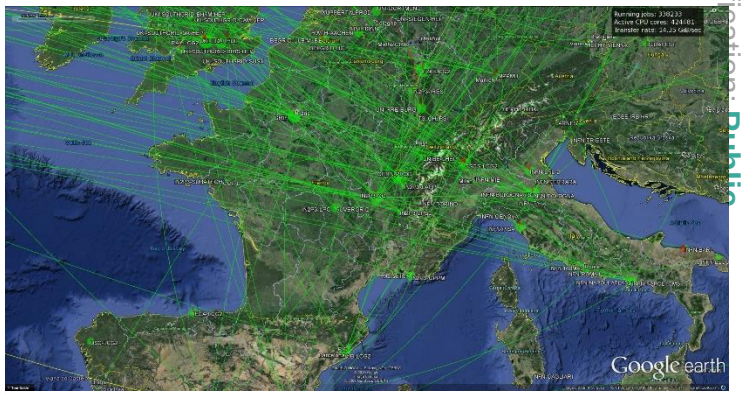
WLCG:
An International collaboration to distribute and analyse LHC data

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

Ramp-up of WLCG CPU







Document Classification: Public

The CERN Data Centres

Overview: Data Centre — a day ago to a few seconds ago

MEYRIN DATA CENTRE

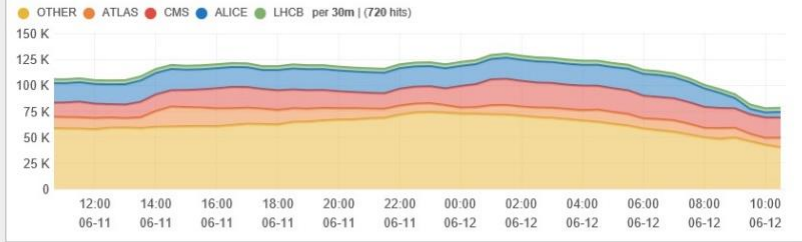
	last_value
Number of Cores in Meyrin	145,647
Number of Drives in Meyrin	79,505
Number of 10G NIC in Meyrin	8,630
Number of 1G NIC in Meyrin	22,137
Number of Processors in Meyrin	24,530
Number of Servers in Meyrin	13,035
Total Disk Space in Meyrin (TB)	156,116
Total Memory Capacity in Meyrin (TB)	590

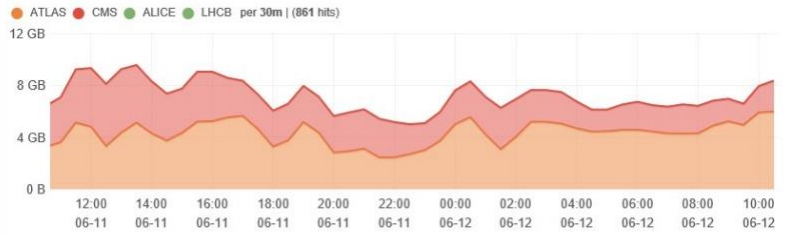
WIGNER DATA CENTRE

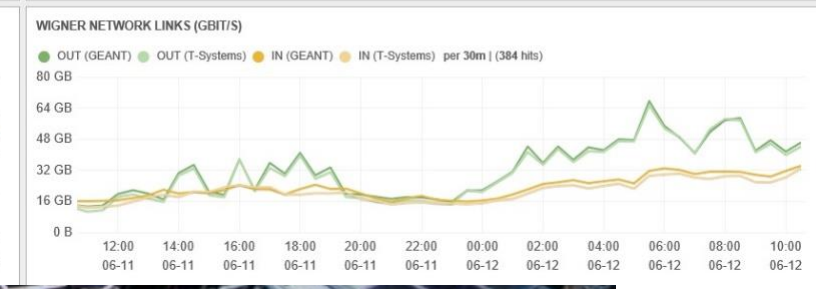
	last_value
Number of Cores in Wigner	56,000
Number of Drives in Wigner	28,220
Number of 10G NIC in Wigner	2,981
Numer of 1G NIC in Wigner	6,571
Number of Processors in Wigner	7,002
Number of Servers in Wigner	3,504
Total Disk Space in Wigner (TB)	91,973
Total Memory Capacity in Wigner (TB)	221

NETWORK AND STORAGE

	last_value
Tape Drives	104
Tape Cartridges	20,517
Data Volume on Tape (TB)	145,231
Free Space on Tape (TB)	39,576
Routers (GPN)	139
Routers (TN)	30
Routers (Others)	107
Switches	3,711

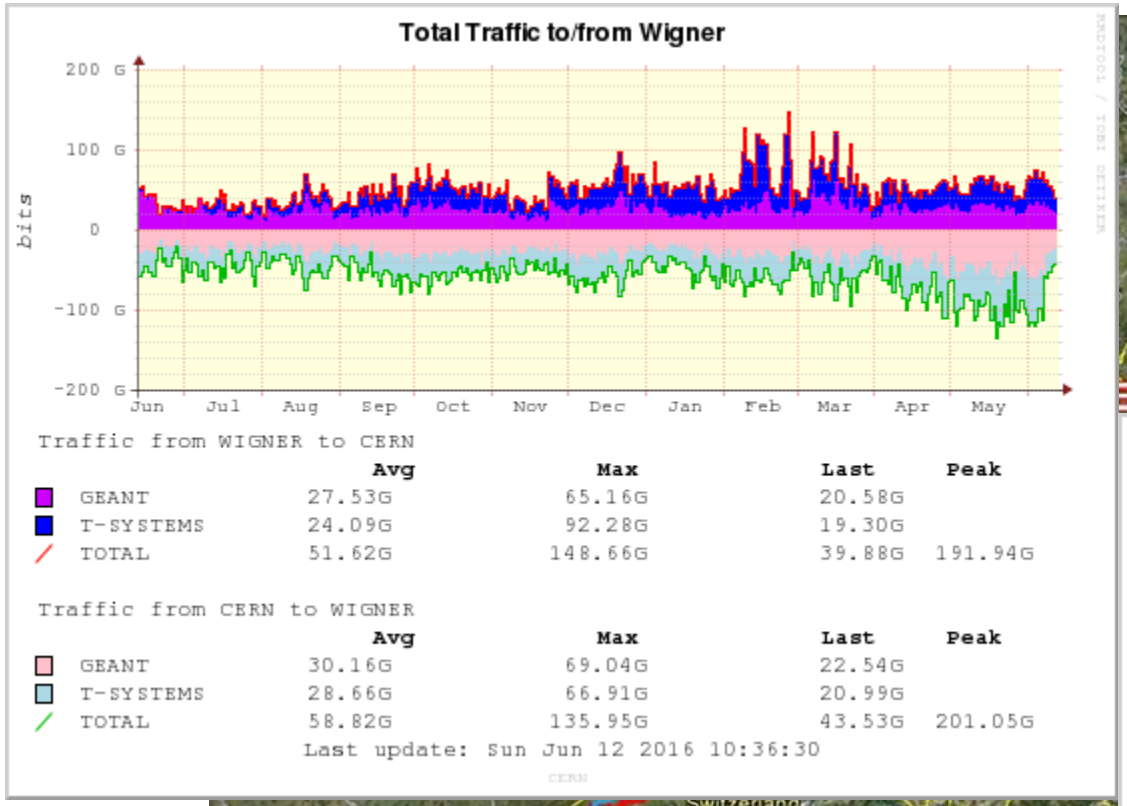


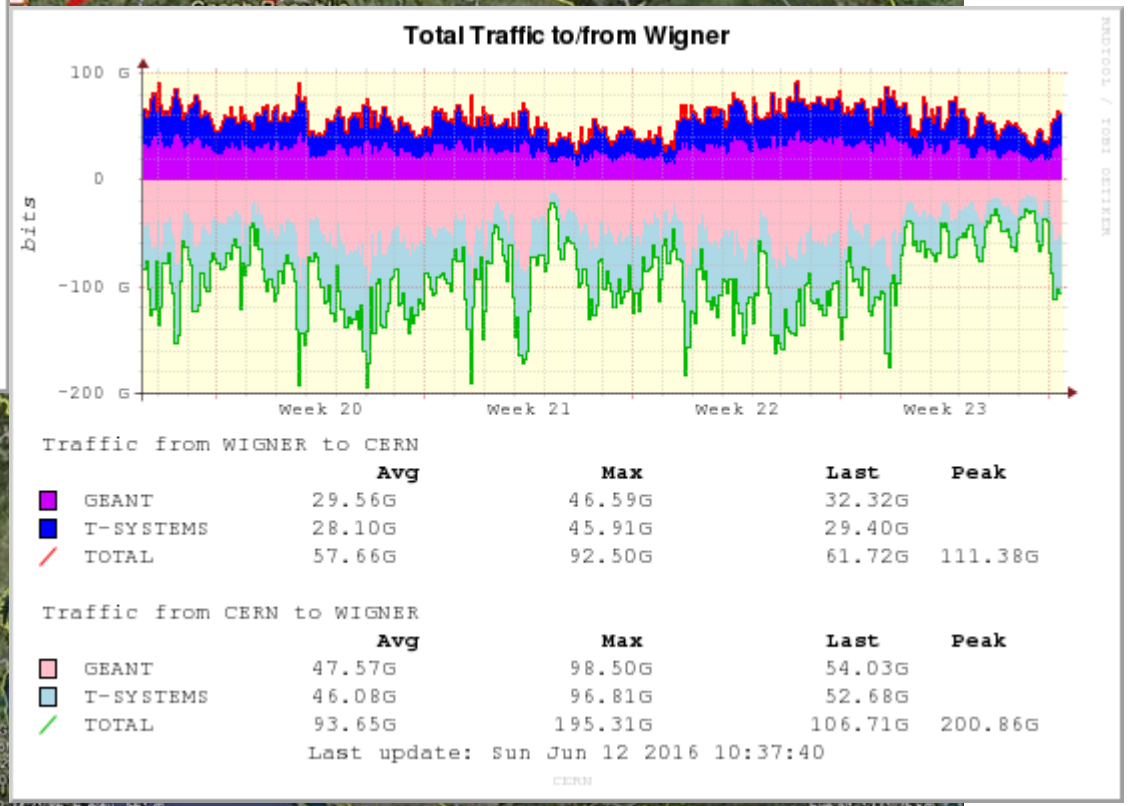




Document Classification: Public

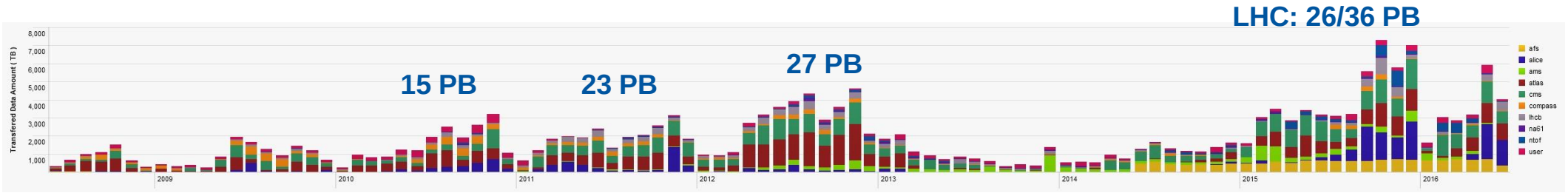
Linking the CERN Data Centres

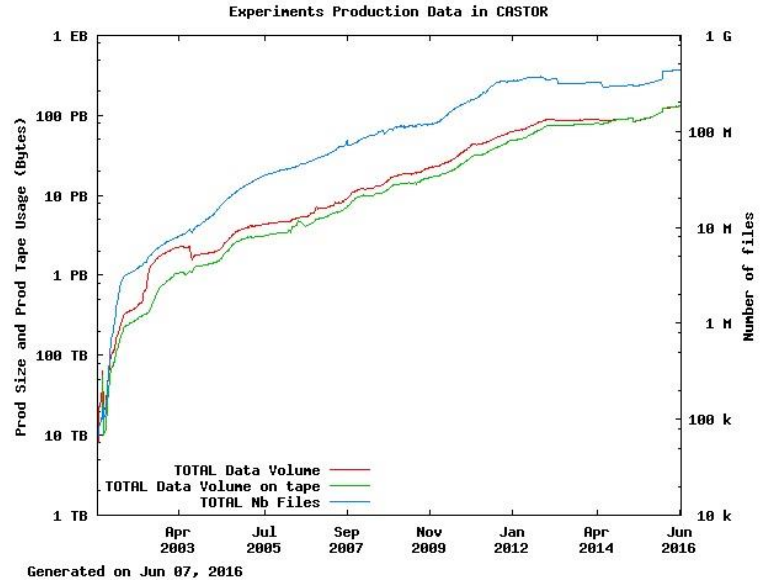




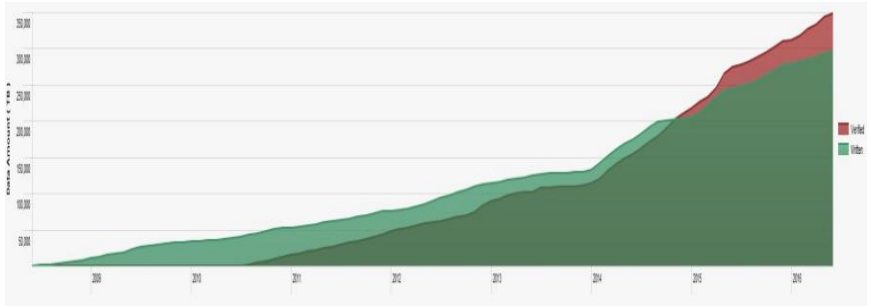
Document Classification: Public

Data in the Tier-0





Tape Verification



Document Classification: Public

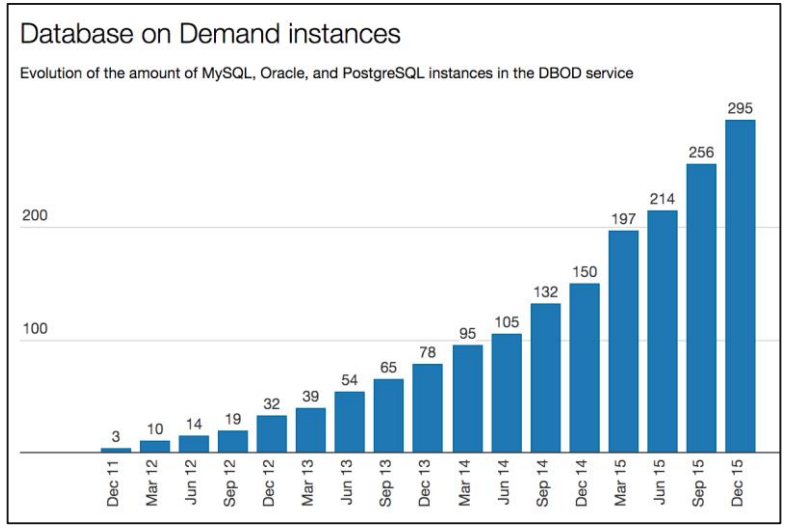
Databases for Run2

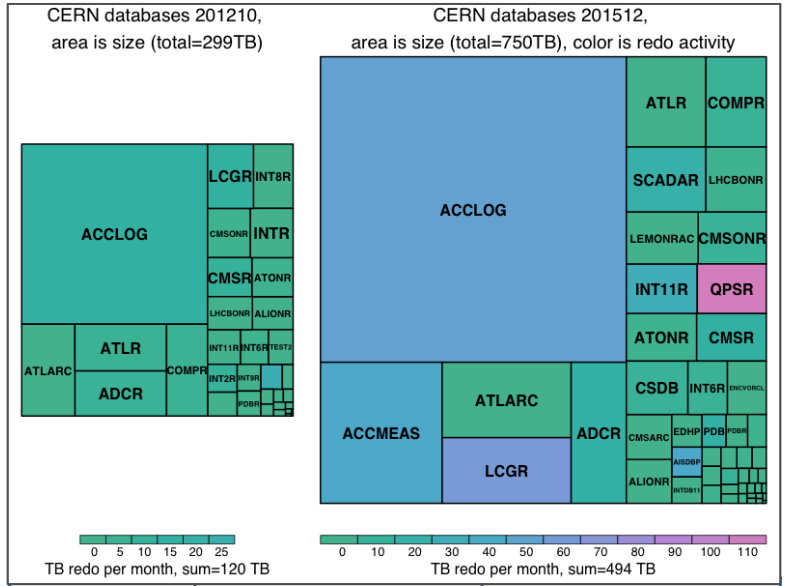
Based on three main solutions:

- MySQL / PostgreSQL (DBoD managed)
  - High growth, count of databases ~doubles every year.
  - With critical databases: OpenStack, Zenodo, Drupal, Puppet (stored configuration and Foreman Data, and Puppet Cert Manager), VOMS, Dirac (LHCb Dirac and Dirac File Catalog), Jupyter, Indico, Gitlab (VCS), Alfresco (eFiles), etc.

- OracleDB, HW/OS/SW stable combination
  - Stable number, growing in size and activity:
  - Significant size increase (500GB/day for ACCLOG since beginning of Run2).
  - Very active, total changes size (redo) per month around 500TB.

- Hadoop-based components/databases
  - For larger scale data analysis and OracleDB offloading.
  - Production for WDT dashboards, ATLAS DDM, IT monitoring, OpenStack Ceilometer, etc.
  - Working on improving integration with OracleDB.
  - Investigating next generation accelerator control and logging (ACCLOG being loaded: 250TB in OracleDB is compressed to 50TB on Hadoop/Parquet format).



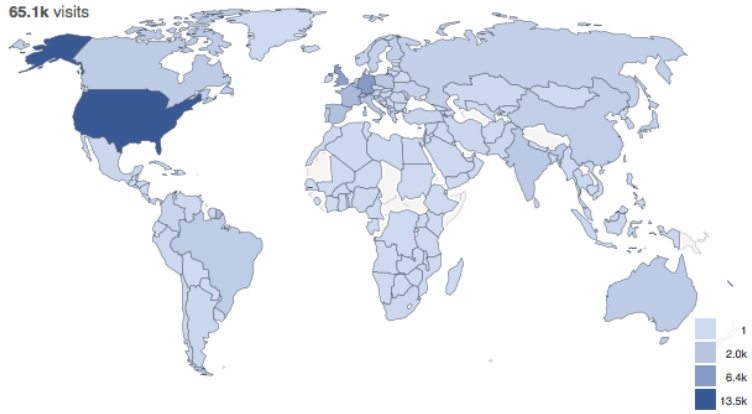


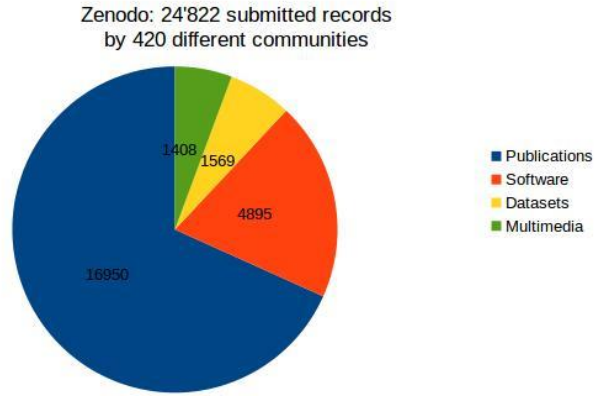
	October 2012	December 2015
Max size	ACCLOG 136TB	ACCLOG 352TB
Max redo	ACCMEAS 27TB / month	QPSR 115TB / month

Document Classification: Public

Open Access to Data

- Zenodo launched in May 2013
- CERN has continued to operate its underlying infrastructure
  - Which benefits from the same storage services than the LHC Data
- Interfacing with Github
  - Making your code citable
  - ~25000 records from 420 communities
  - incl. 32 software packages not accessible on github ANYMORE

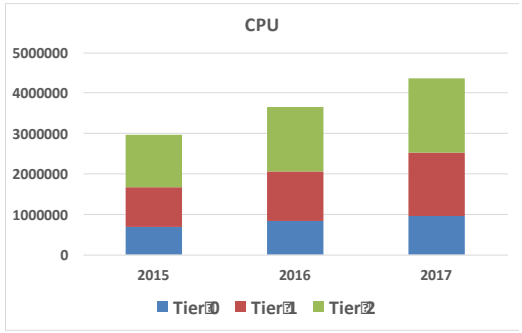


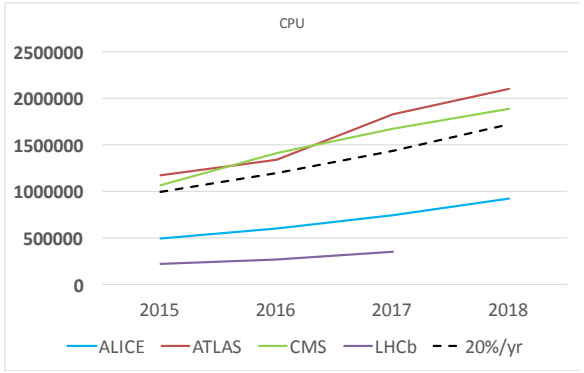


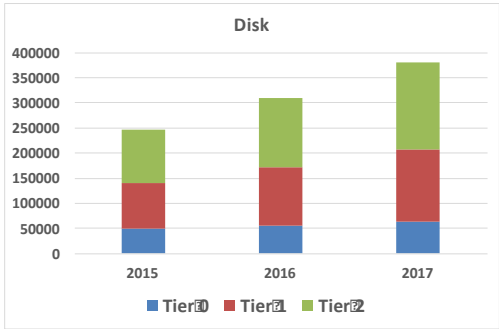
Document Classification: Public

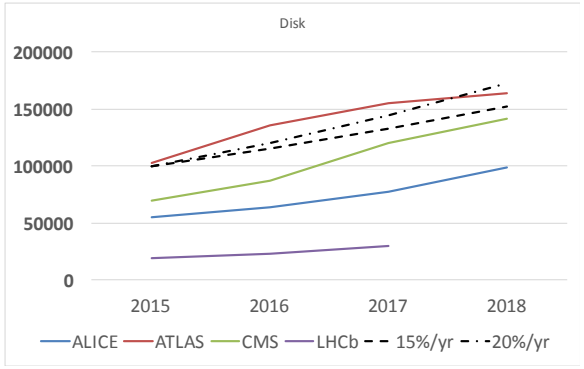
Evolution

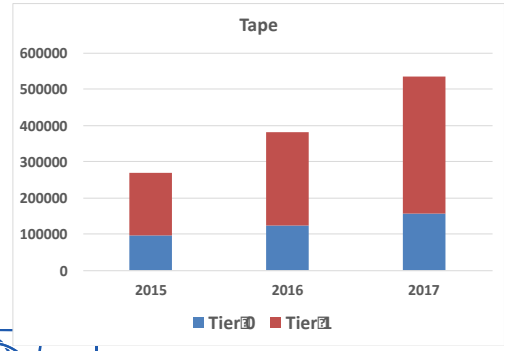
LHC RUN 2

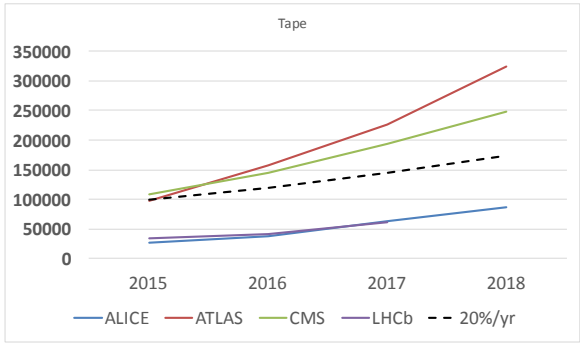




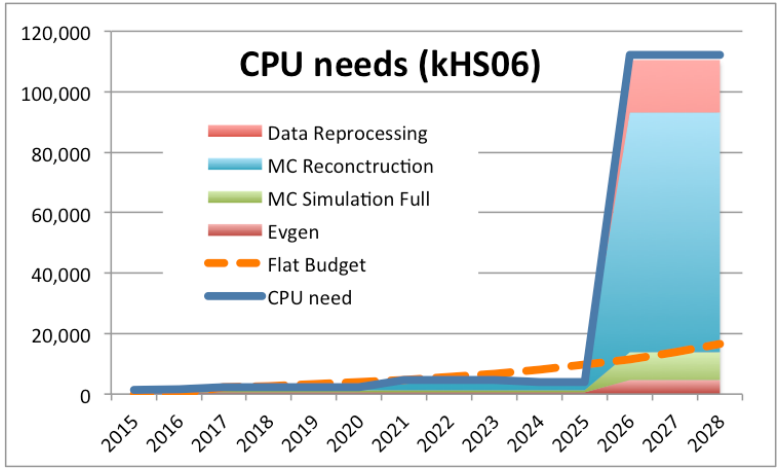


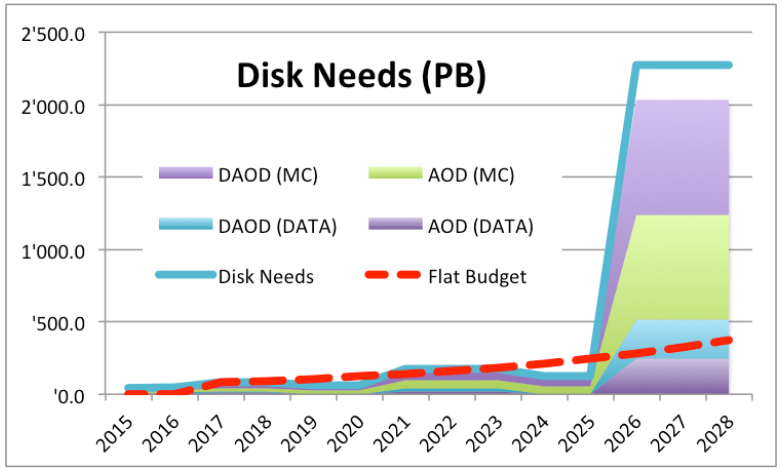






Initial studies on Computing for HL-LHC





Document Classification: Public

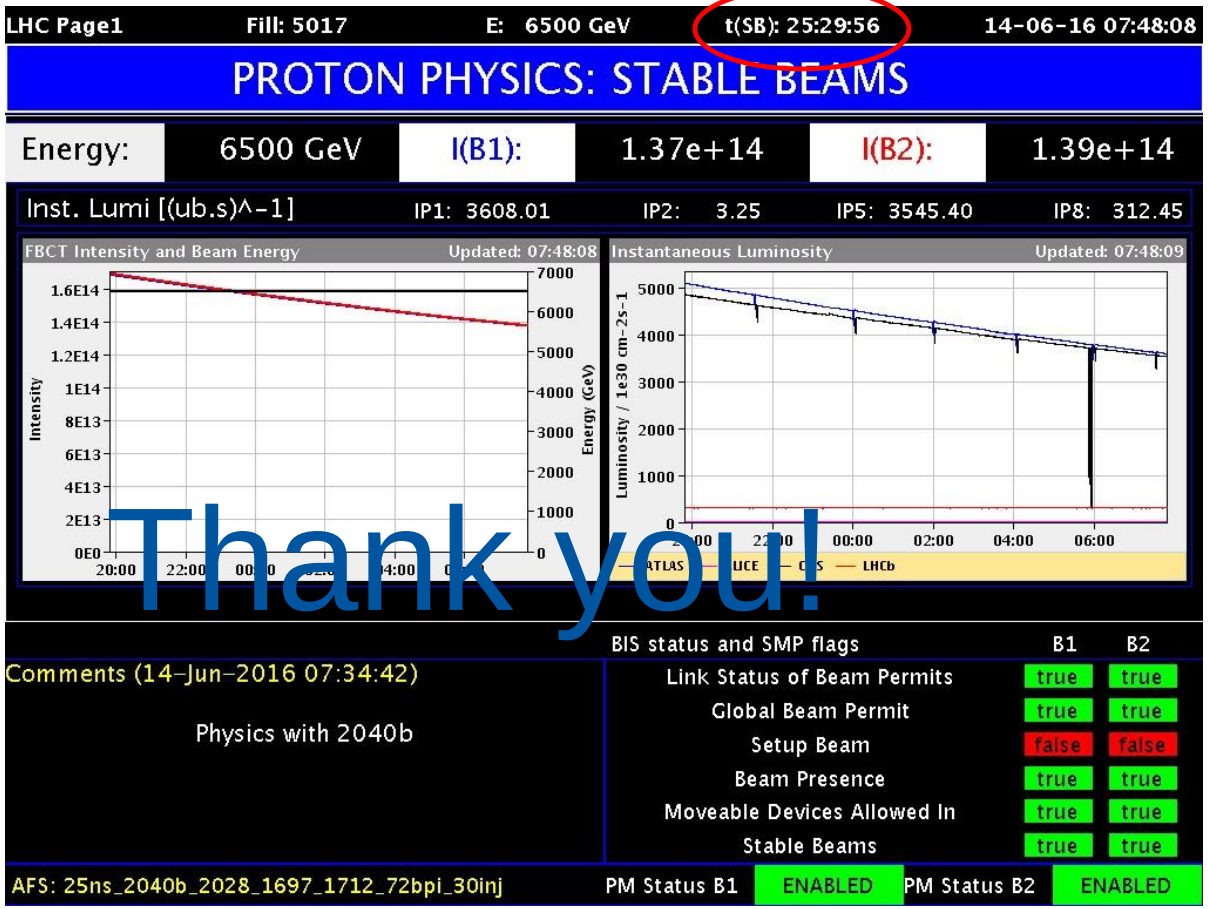
Data Preservation for Re-Use

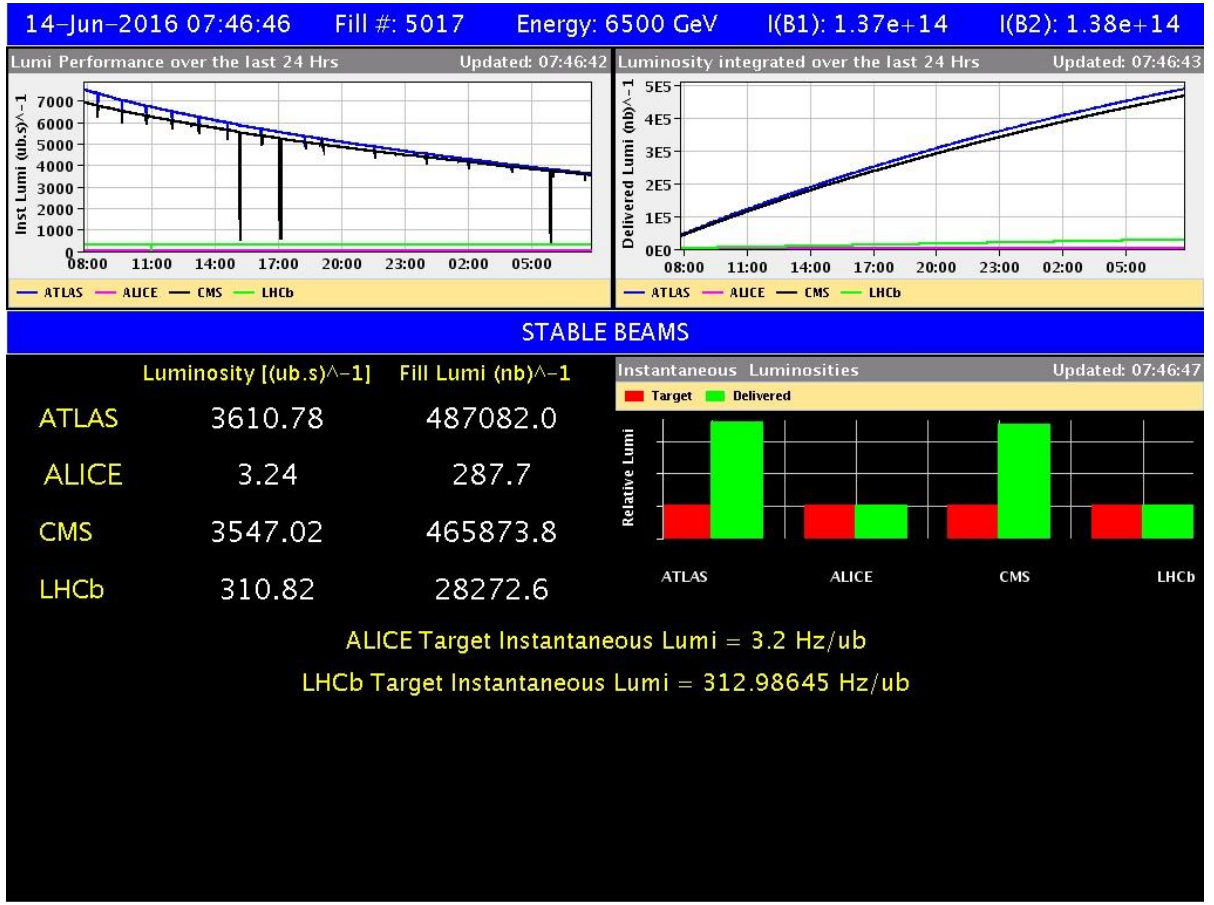
- Re-use: by Collaboration, Theorists, Scientists, Public, Others for Science, Education, & more
  - New analyses, reproducibility of results, linking papers to data, data sharing, etc (= Data Management Plan)
  - LEP data: ~100TB/expt until ~2030 (and more)
  - LHC data: many EB and more – until FCC??
- Preserve data, documentation, code, meta-data, etc
  - "Data" is the "easy" bit (no pun intended)
- Collaboration: IT groups, other CERN depts, expts, other HEP labs, other DP projects worldwide…
- OPERA: a new challenge for 2016
  - ~70TB in ***Oracle***, ~10TB in ROOT files
  - Can we use our "template" on other HEP experiments?

Document Classification: **Public**

CERN openlab in a nutshell

- A science – industry partnership to drive R&D and innovation with over a decade of success
- Evaluate state-of-the-art technologies in a challenging environment and improve them
- Test in a research environment today what will be used in many business sectors tomorrow
- Train next generation of engineers/employees
- Disseminate results and outreach to new audiences





Document Classification: Public

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