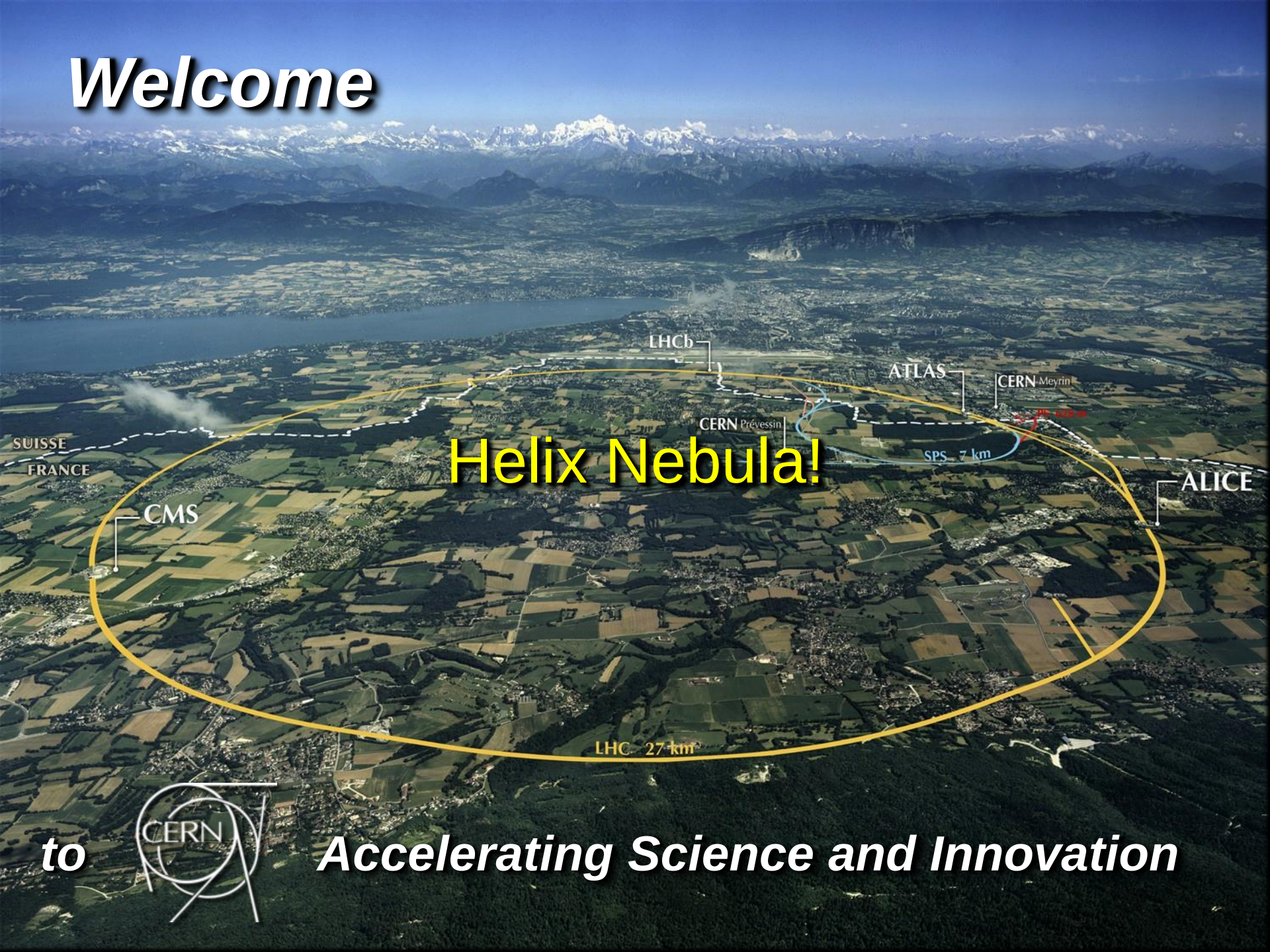
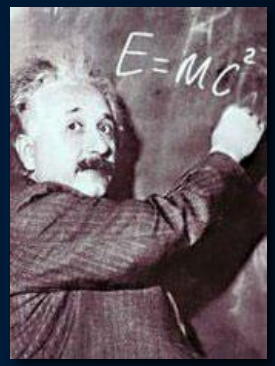

Welcome
LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SUISSE
FRANCE
Helix Nebula!
SPS 7 km
ALICE
CMS
LHC 27 km
to
CERN
Accelerating Science and Innovation

The Mission of CERN

- **Push back** the frontiers of knowledge

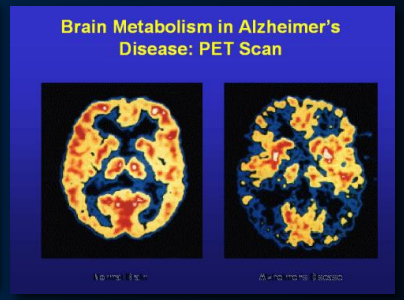
  E.g. the secrets of the Big Bang … what was the matter like within the first moments of the Universe's existence?

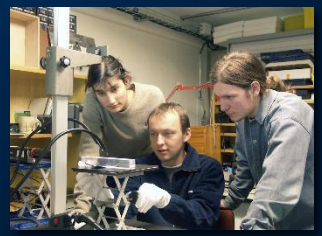


- **Develop** new technologies for accelerators and detectors

  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 was founded 1954: 12 European States

"Science for Peace"

Today: 21 Member States

~ 2300 staff
~ 1600 other paid personnel
~ 10500 users

Budget (2014) ~1000 MCHF

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

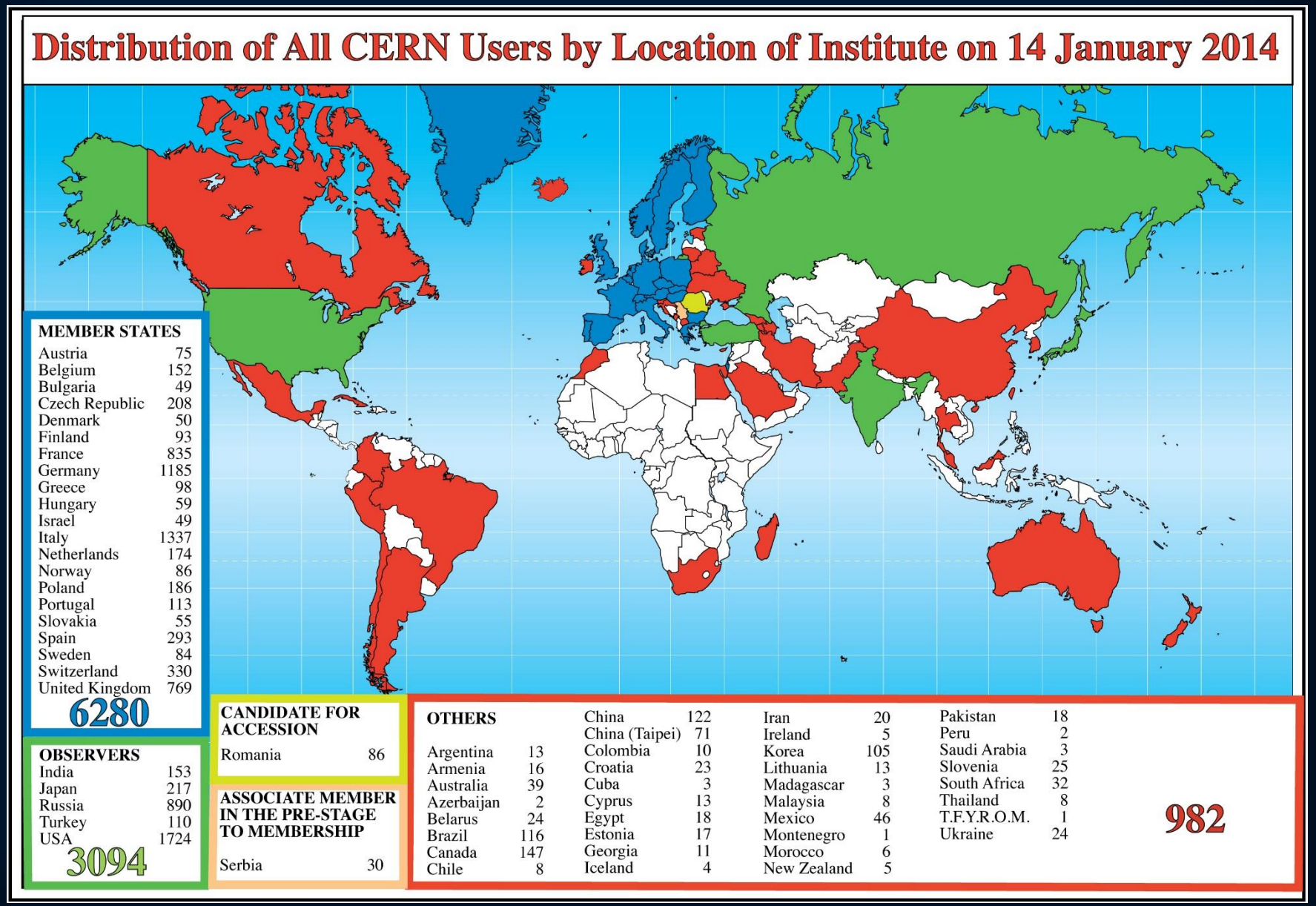
Candidate for Accession: Romania

Associate Member in Pre-Stage to Membership: Serbia

Applicant States for Membership or Associate Membership: Brazil, Cyprus, Pakistan, Russia, Slovenia, Turkey, Ukraine

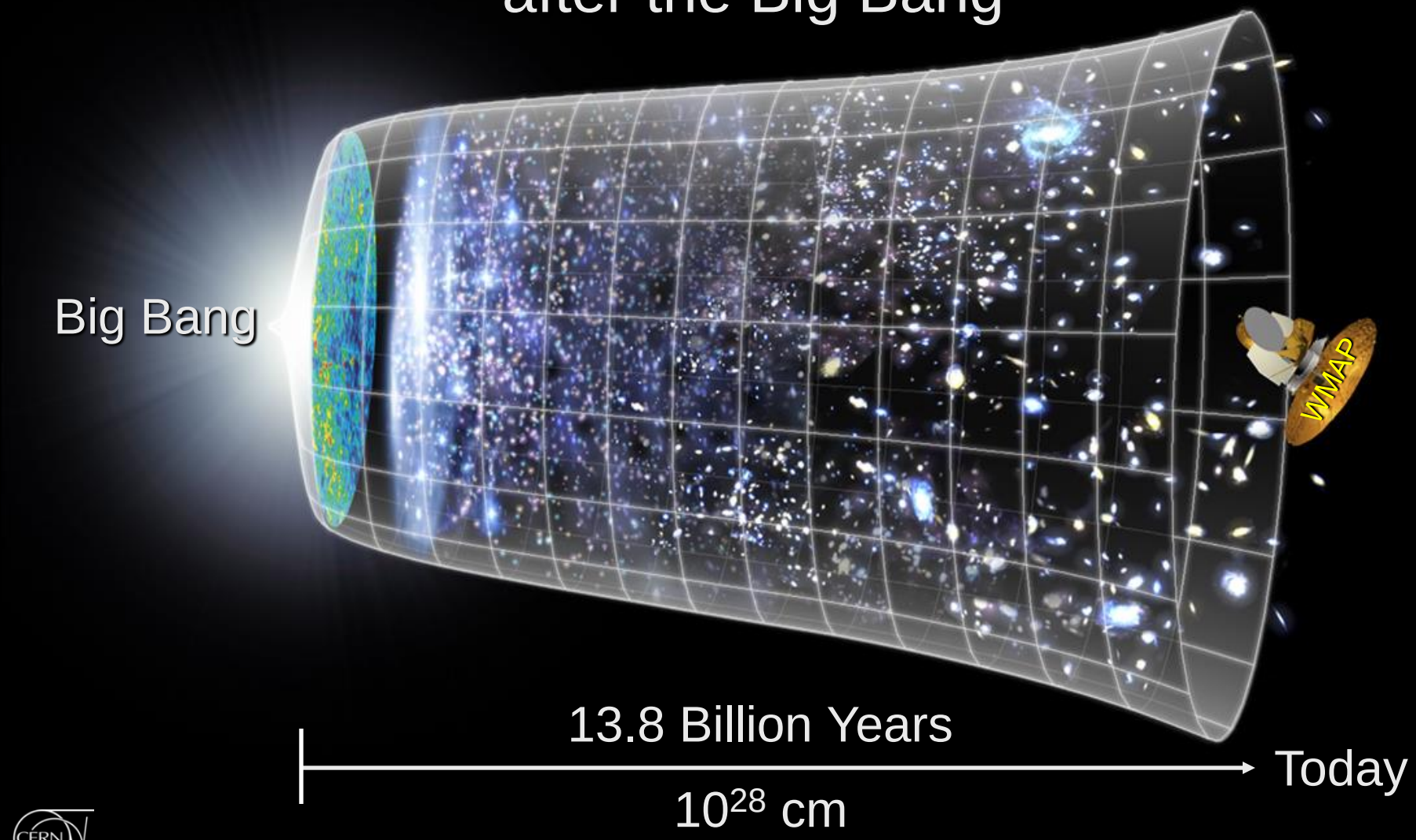
Observers to Council: India, Japan, Russia, Turkey, United States of America; European Commission and UNESCO

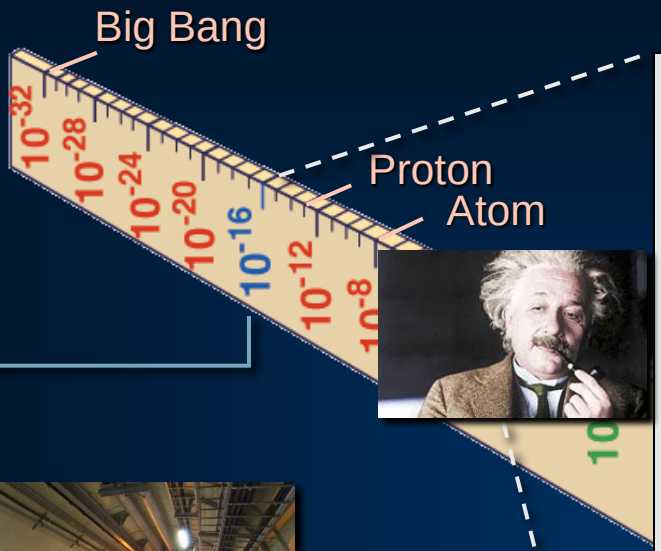
Science is getting more and more global

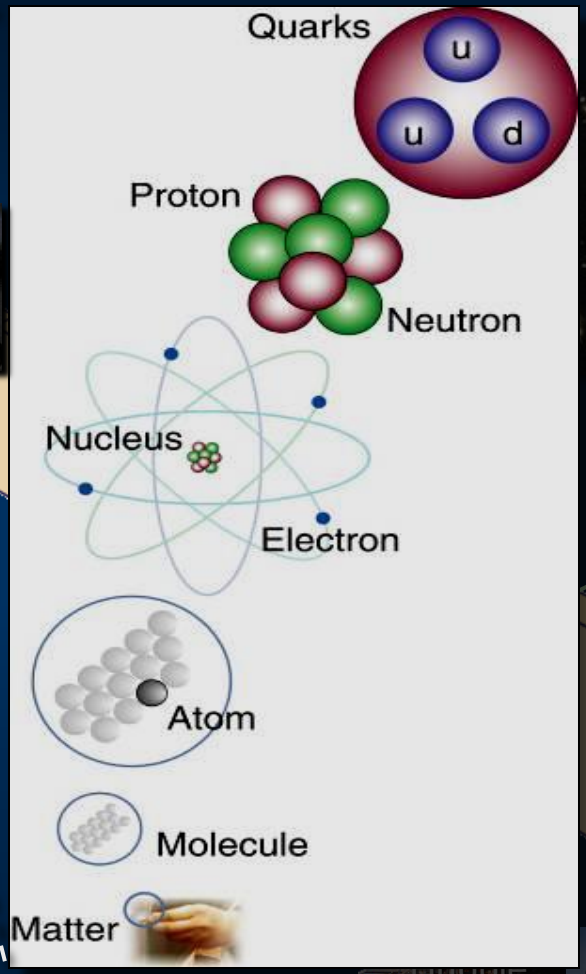


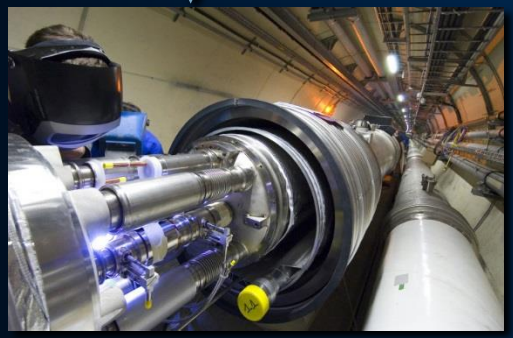
Next Scientific Challenge:

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









LHC

Super-Microscope

Radius of Galaxies

Universe

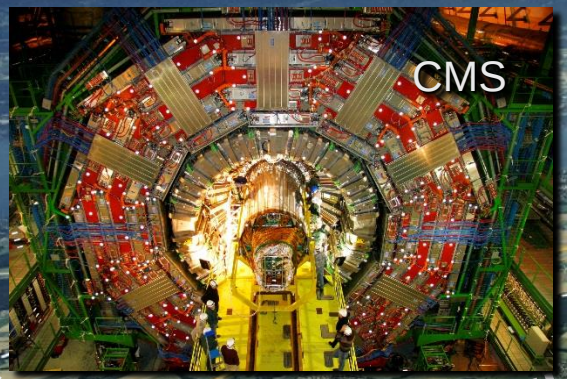
10^{24}

10^{28}

cm

Study physics laws of first moments after Big Bang
increasing Symbiosis between Particle Physics,
Astrophysics and Cosmology

2010: a New Era in Fundamental Science



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

CERN

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".*

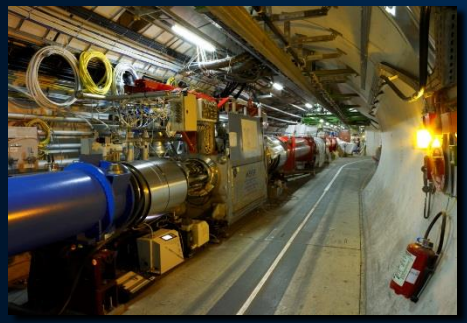
CERN

Innovation
Education
CERN
uniting people
Research

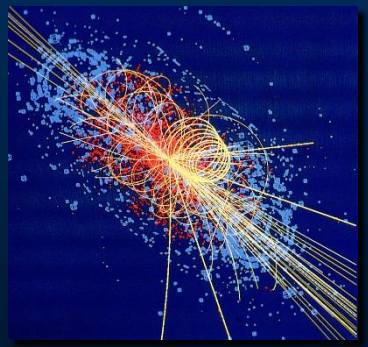
CERN: Particle Physics and Innovation

- Interfacing between fundamental science and key technological developments

- CERN Technologies and Innovation



Accelerating particle beams



Detecting particles

Large-scale computing (Grid)

CERN

Medical Application as an Example of Particle Physics Spin-off

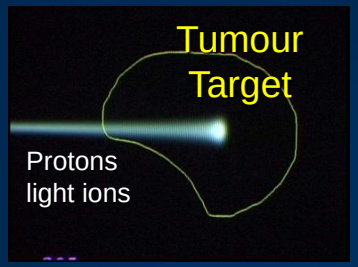
Combining Physics, ICT, Biology and Medicine to fight cancer

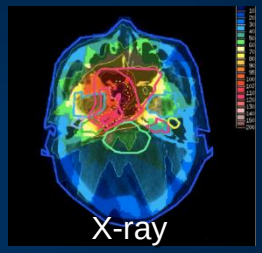
Accelerating particle beams

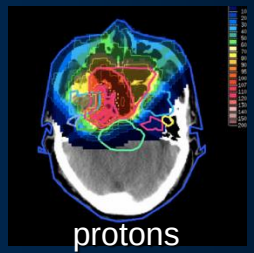
~30’000 accelerators worldwide

~17’000 used for medicine

Hadron Therapy



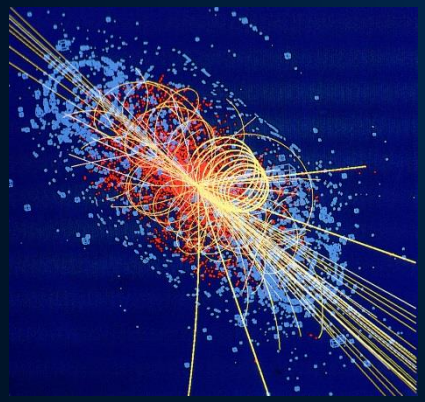




Leadership in Ion Beam Therapy now in Europe and Japan

>100’000 patients treated worldwide (45 facilities)

>50’000 patients treated in Europe (14 facilities)

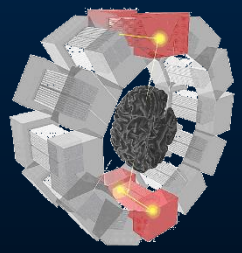


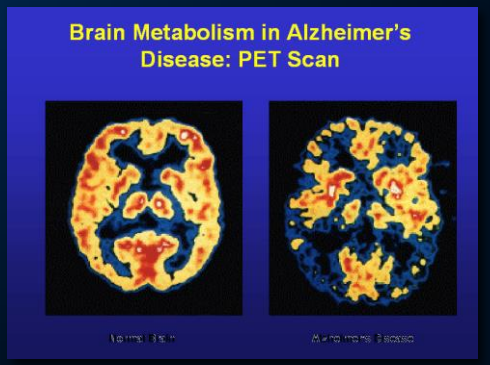
Detecting particles

Imaging

Clinical trial in Portugal, France and Italy for new breast imaging system (ClearPEM)

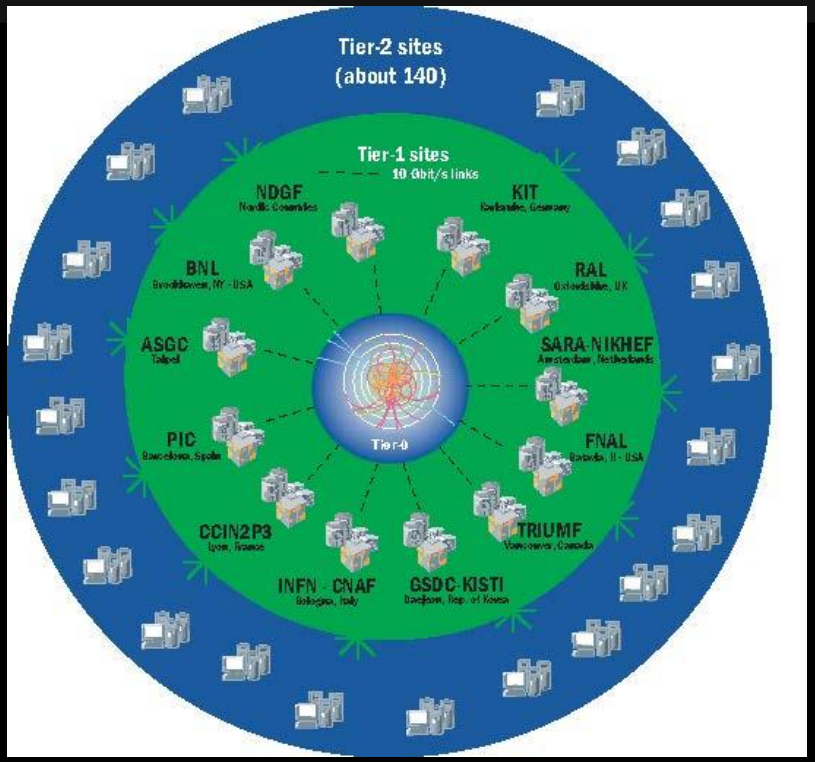
PET Scanner





The Worldwide LHC Computing Grid

- A distributed computing infrastructure to provide the production and analysis environments for the LHC experiments
- Managed and operated by a worldwide collaboration between the experiments and the participating computer centres
- The resources are distributed – for funding and sociological reasons
- Our task was to make use of the resources available to us – no matter where they are located



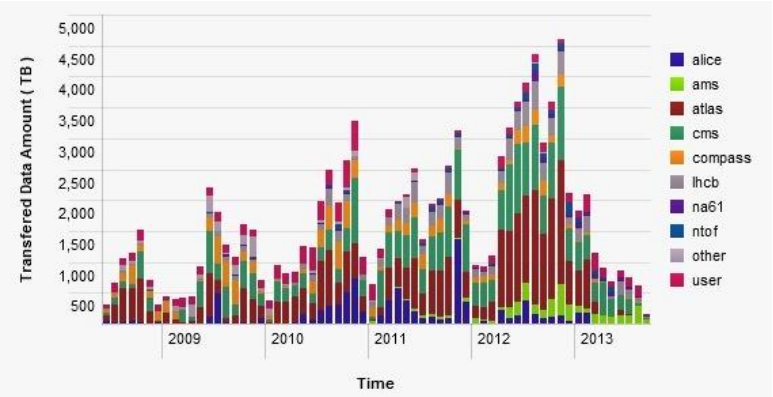
Tier-0 (CERN):
- Data recording
- Initial data reconstruction
- Data distribution

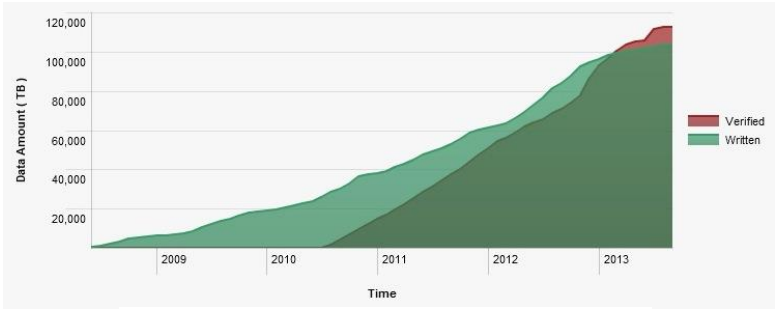
Tier-1 (12 centres + Russia):
- Permanent storage
- Re-processing
- Analysis

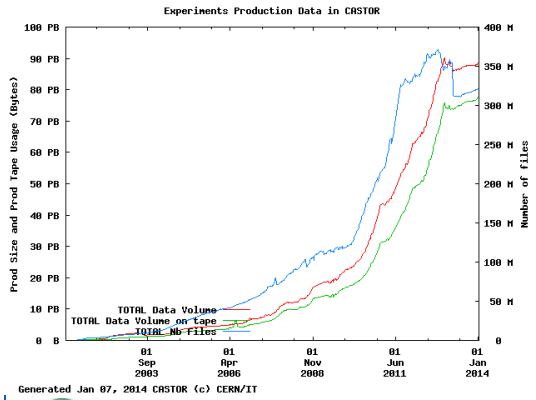
Tier-2 (~140 centres):
- Simulation
- End-user analysis

- **~ 160 sites, 35 countries**
- **300000 cores**
- **200 PB of storage**
- **2 Million jobs/day**
- **10+ Gbps links**

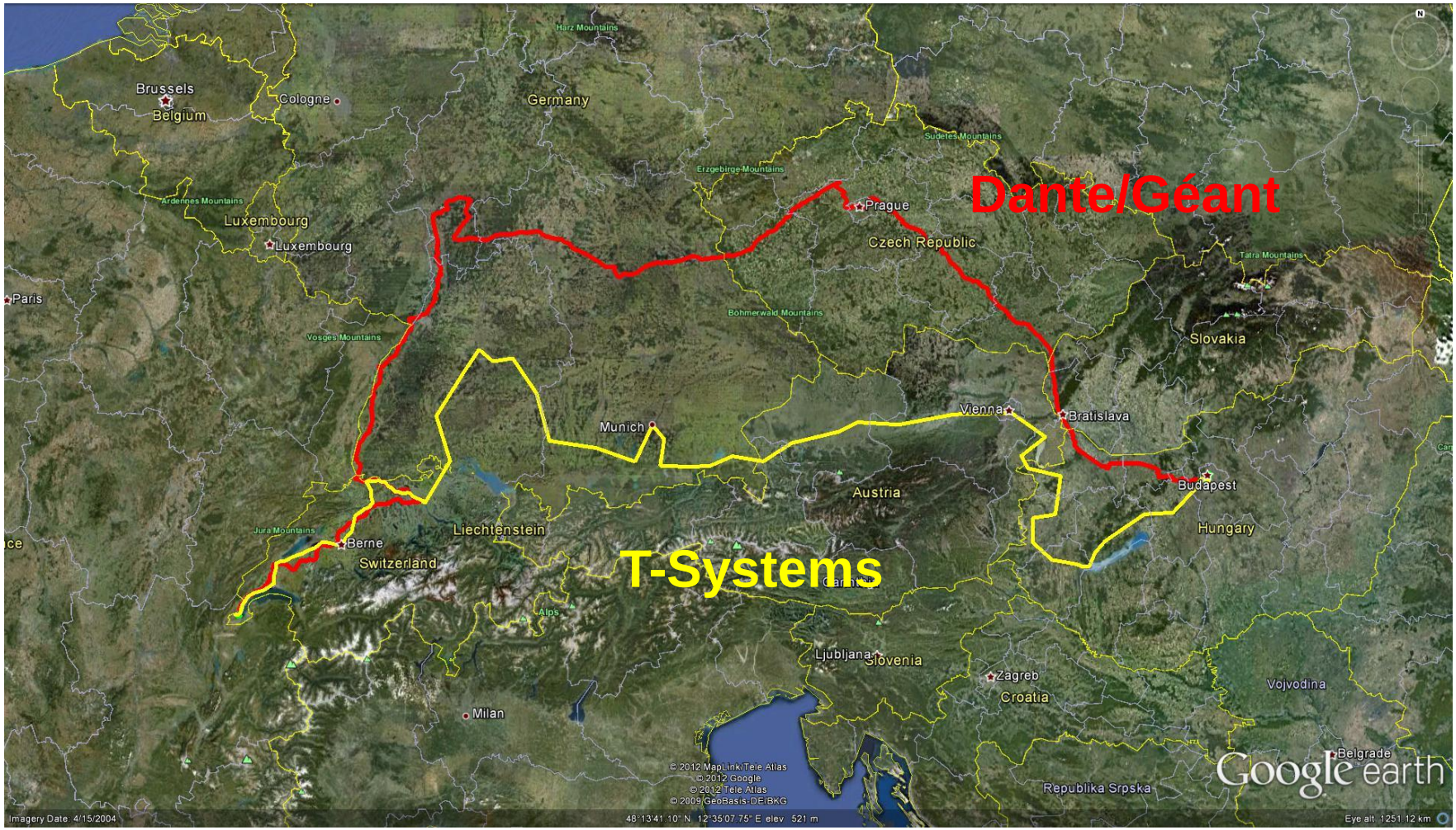
LHC Data Volumes @ CERN



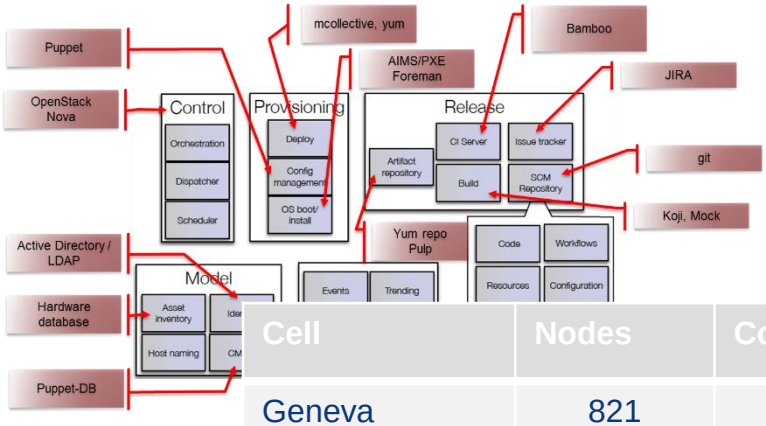




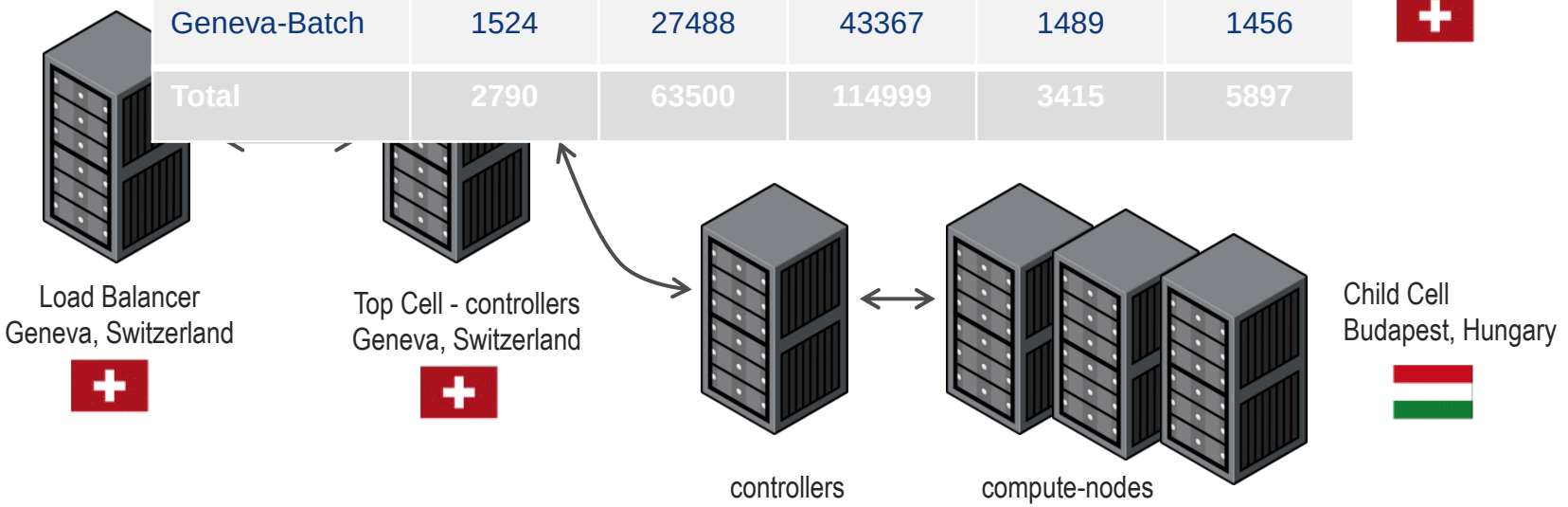
Connectivity (100 Gbps)



Scaling Architecture Overview



Cell	Nodes	Cores	RAM (GB)	Disk (TB)	VMs
Geneva	821	21772	43663	1167	3201
Wigner	***445***	***14240***	***27969***	***759***	***1240***
Geneva-Batch	1524	27488	43367	1489	1456
Total	**2790**	**63500**	**114999**	**3415**	**5897**



CERN Education Activities

Scientists at CERN
Academic Training Programme

Young Researchers
CERN School of High Energy Physics
CERN School of Computing
CERN Accelerator School

Physics Students
Summer Students
Programme

CERN Teacher Schools
International and National
Programmes

Summer Students 2013

Summer Students 2013

MEMBER STATES 136

Austria	3
Belgium	3
Bulgaria	2
Czech Republic	5
Denmark	6
Finland	3
France	13
Germany	20
Greece	8
Hungary	2
Israel	2
Italy	12
Netherlands	9
Norway	3
Poland	3
Portugal	3
Slovakia	3
Spain	9
Sweden	7
Switzerland	4
United Kingdom	16

OBSERVERS 43

India	7
Japan	5
Russia	9
Turkey	6
USA	16

CANDIDATE FOR ACCESSION

Romania	3

ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Serbia	2

OTHERS

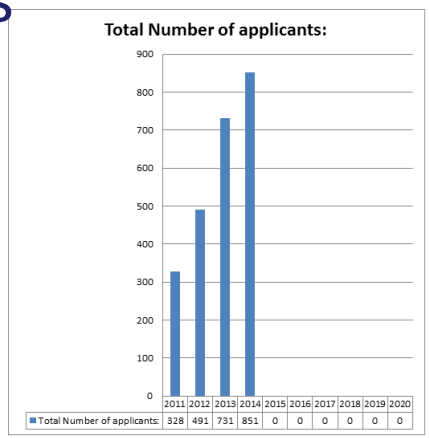
Algeria	2	China	5	Estonia	4	Korea, South	2	New Zealand	1	Tunisia	1
Argentina	1	Colombia	1	Georgia	1	Lebanon	1	Pakistan	4	Ukraine	2
Australia	1	Comoros	1	Ghana	1	Lithuania	2	Palestine	1	U.A.E.	2
Bangladesh	1	Costa Rica	1	Hong Kong	4	Madagascar	1	Philippines	1	Venezuela	1
Belarus	1	Croatia	3	Iceland	1	Malaysia	3	Saudi Arabia	1	Zambia	1
Benin	1	Cuba	1	Indonesia	3	Malta	3	Slovenia	1		
Brazil	1	Cyprus	2	Iran	2	Mexico	2	South Africa	2		
Canada	5	Ecuador	3	Ireland	1	Morocco	2	Thailand	2		
Chile	1	Egypt	4	Kazakhstan	1	Nepal	1	T.F.Y.R.O.M.	2		

92

Openlab Summer Student Program

- **Summer student program 2013**
  - 720+ applicants
  - 22 selected candidates
  - 13 lectures (including new lectures from external labs)
  - A new lightning talks session
  - 22 technical reports

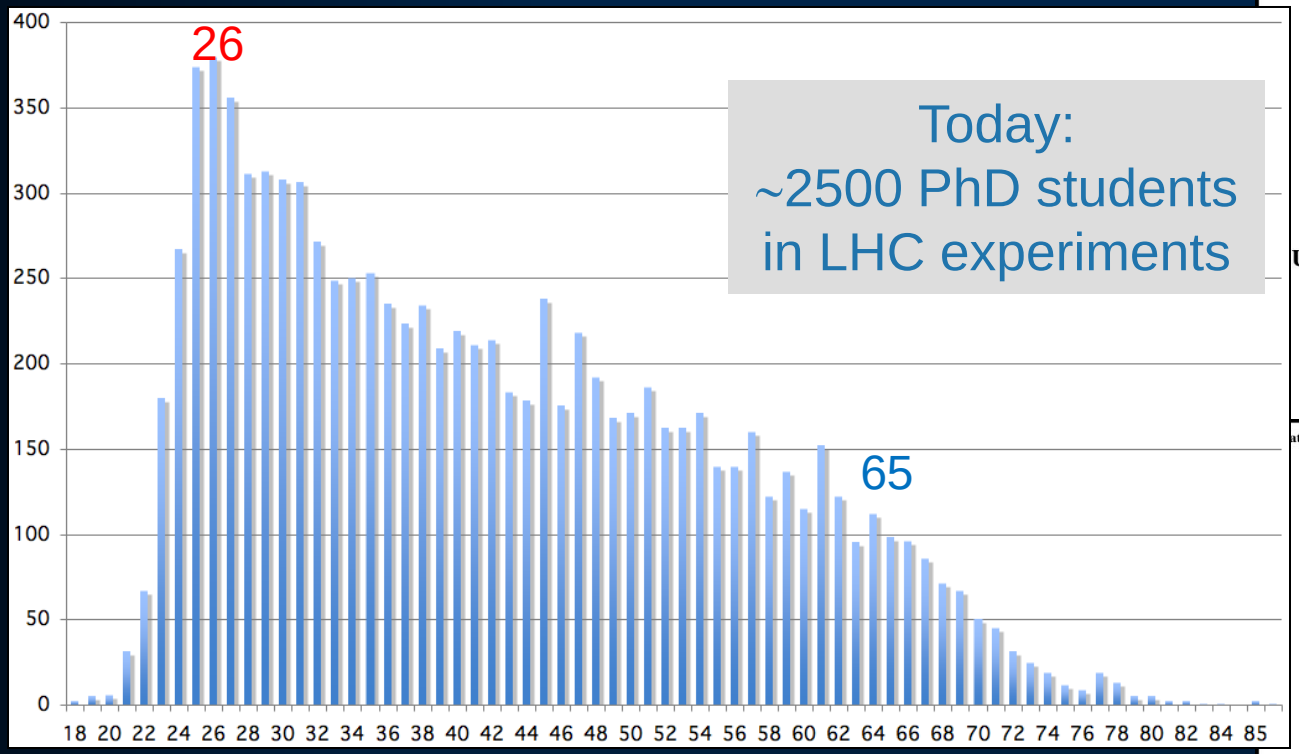
- **Summer student program 2014**
  - 850+ applicants
  - 23 selected candidates
  - Lectures and visits program being designed, will include contributions from external labs and companies



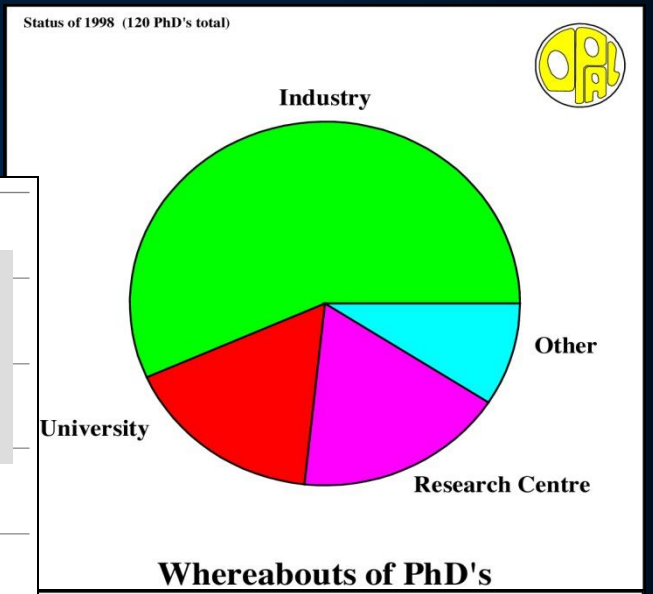
Age Distribution of Scientists

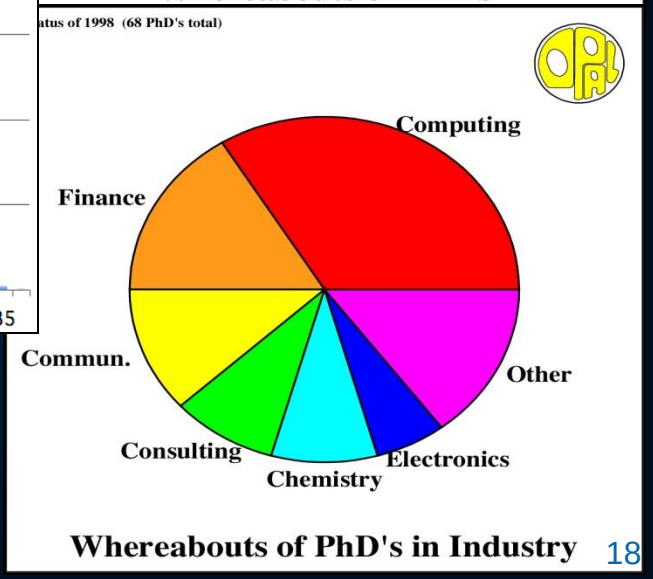
- and where they go afterwards

Survey in March 2009



Today:
~2500 PhD students
in LHC experiments





They do not all stay: where do they go?

Preparations for LHC Run 2

The main 2013-14 LHC consolidations

Opening:100%
1695 Openings and final reclosures of the interconnections

Closure: 80%

100 % done
Complete reconstruction of ~~1500~~ 3000 of these splices

100 % done
Consolidation of the 10170 13kA splices, installing 27 000 shunts

99 % done
Installation of 5000 consolidated electrical insulation systems

100 % done
300 000 electrical resistance measurements

97 % done
10170 orbital welding of stainless steel lines

90 % done
18 000 electrical Quality Assurance tests

70 % done
10170 leak tightness tests

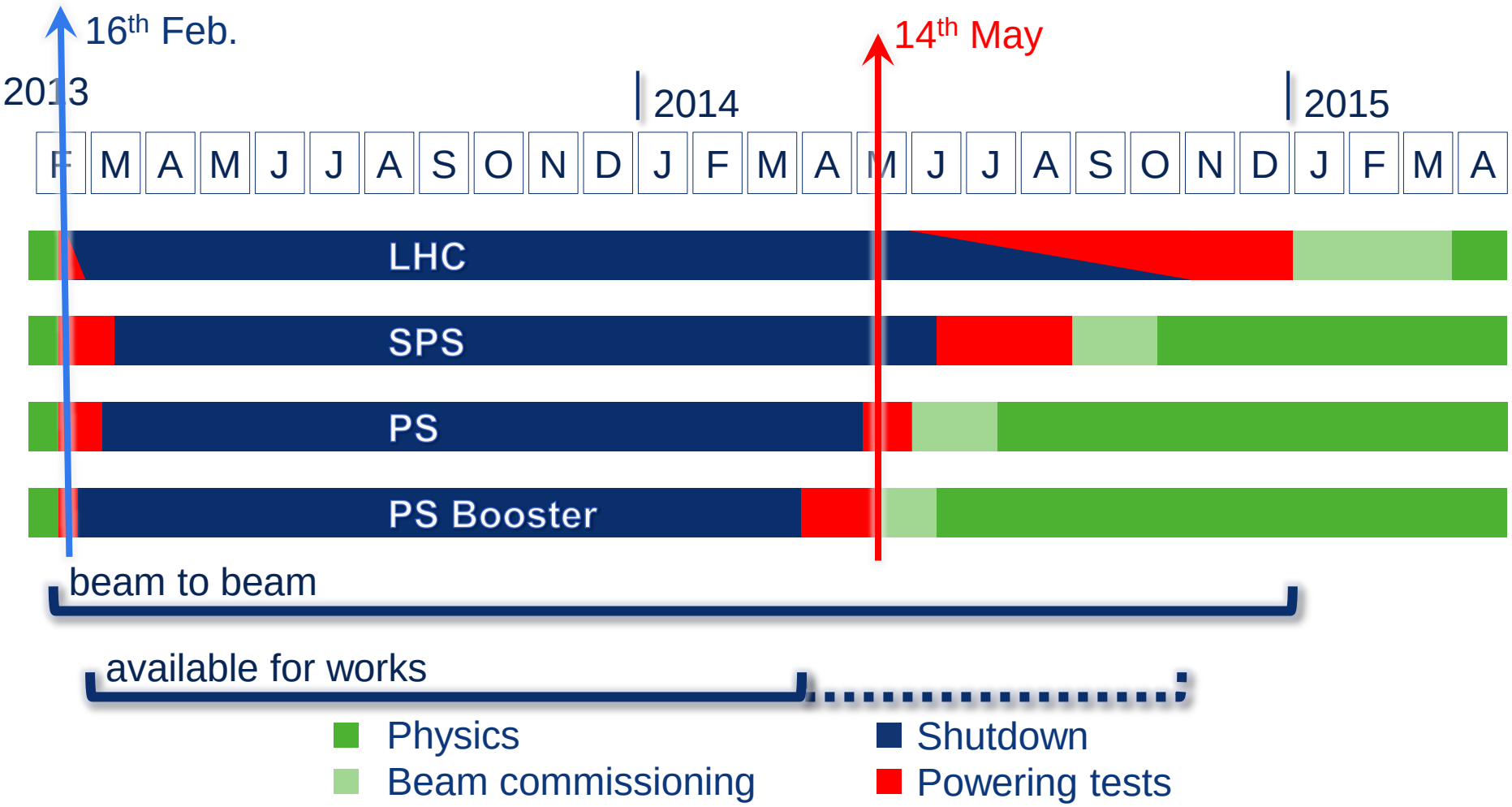
Done
3 quadrupole magnets to be replaced

Done
15 dipole magnets to be replaced

100 % done
Installation of 612 pressure relief devices to bring the total to 1344

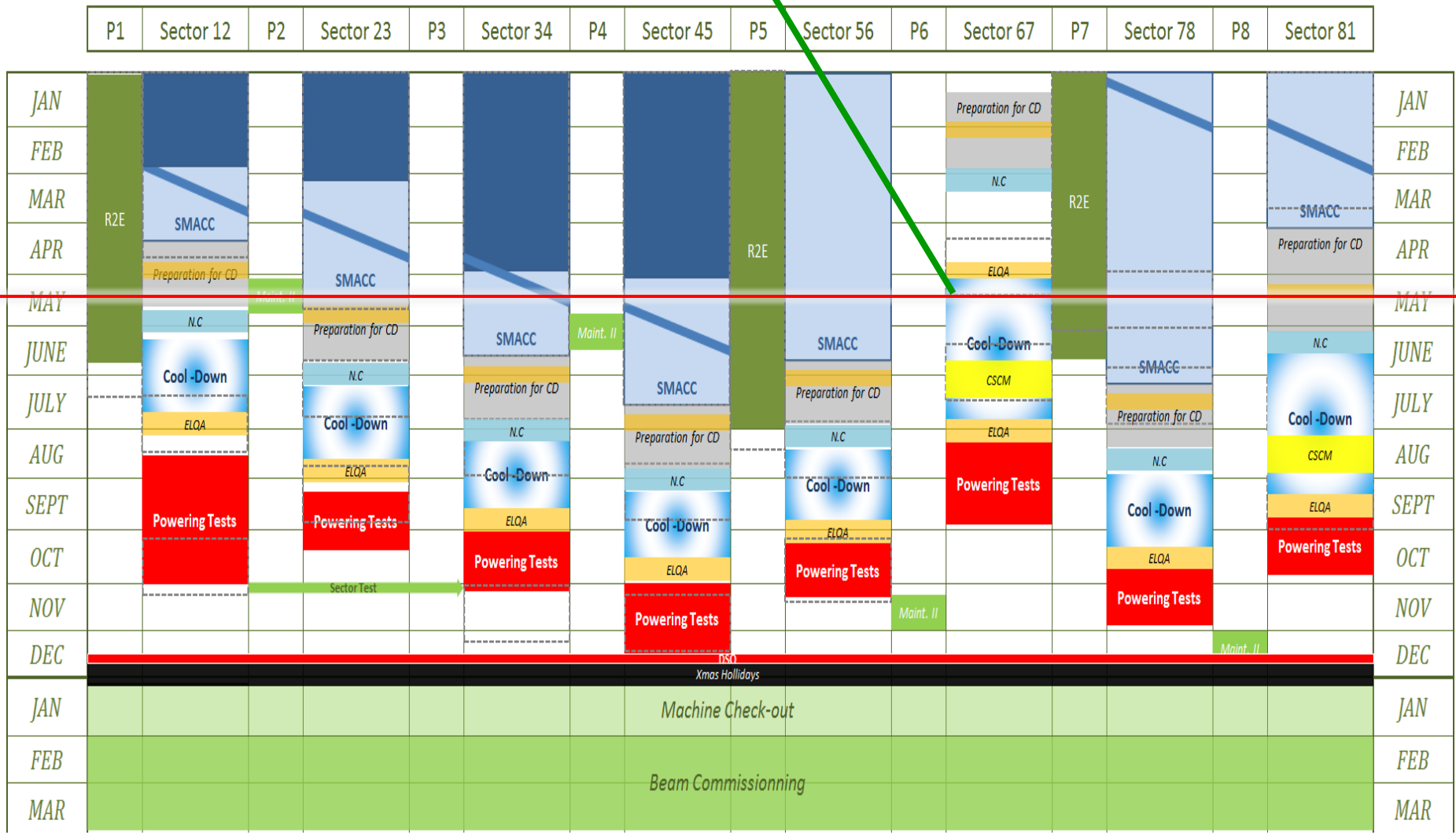
96 % done
Consolidation of the 13 kA circuits in the 16 main electrical feed-

LS 1 from 16th Feb. 2013 to Dec. 2014



LS 1: LHC status

1st Cool Down: starting on 7th May



Evolution of Computing requirements

Higher trigger (data) rates driven by physics needs

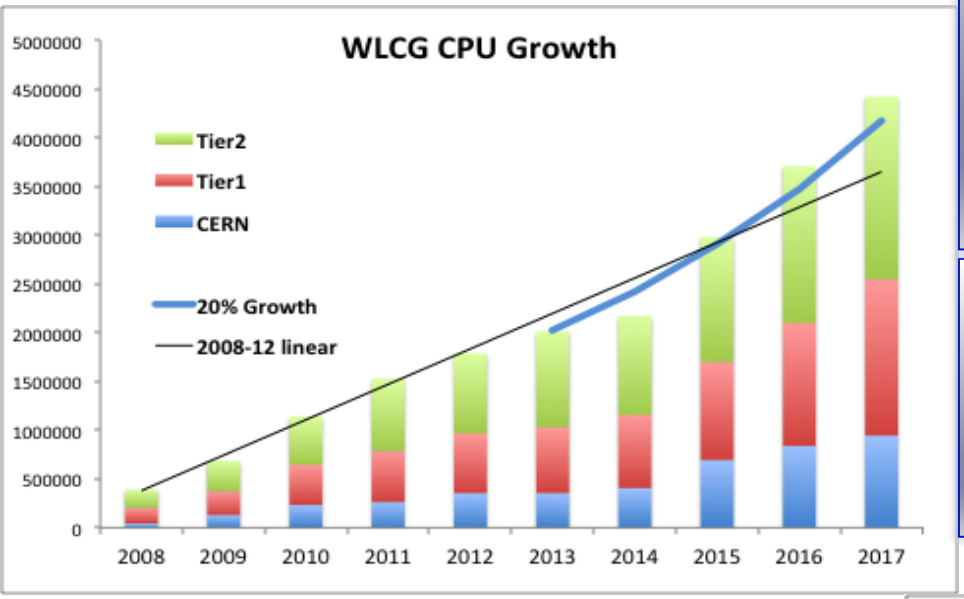
Based on understanding of likely LHC parameters;

Foreseen technology evolution (CPU, disk, tape)

Experiments work hard to fit within constant budget scenario

Estimated evolution of requirements 2015-2017

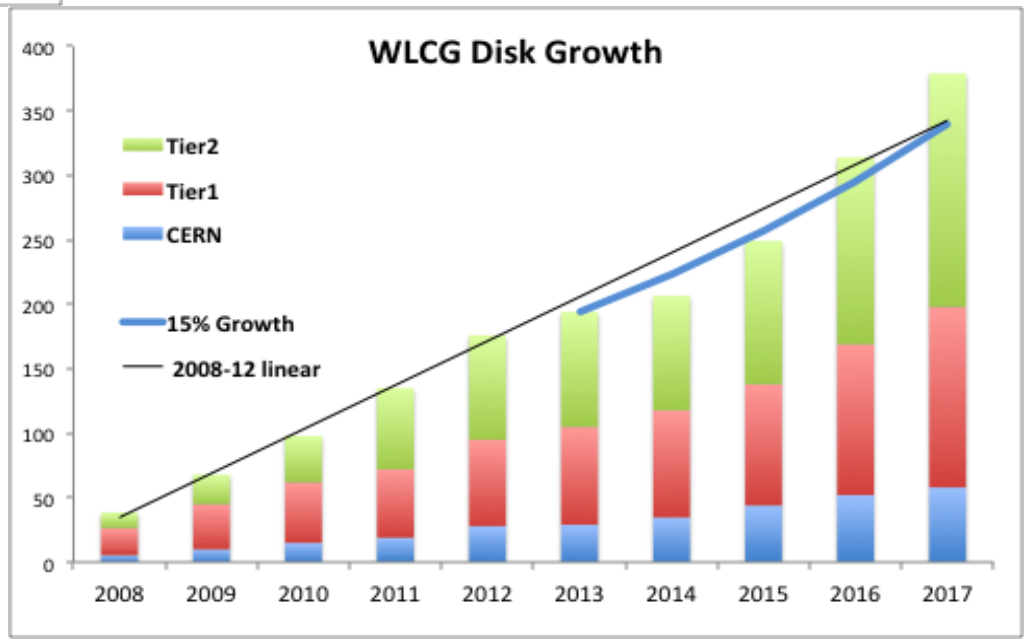
2008-2013: Actual deployed capacity



Line: extrapolation of 2008-2012 actual resources

Curves: expected potential growth of technology with a constant budget

- CPU: 20% yearly growth
- Disk: 15% yearly growth



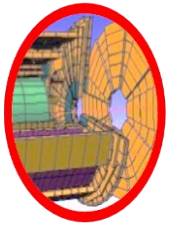
International Scientific Collaborations

- Many scientific projects are global collaborations of 100s of partners
- Efficient computing and data infrastructures have become critical as the quantity, variety and rates of data generation keep increasing
- Funding does not scale in the same way
  - Optimization and sharing of resources
- Collaboration with commercial IT companies increasingly important
  - Requirements are not unique anymore

CERN Biomedical Facility

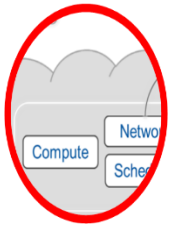
The Main IT Challenges

Data acquisition (online)



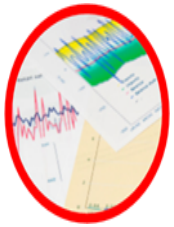
Computing platforms (offline)

Data storage architectures



Compute management & provisioning

Networks and connectivity



Data analytics

Further Reading…

Future IT Challenges in Scientific Research

Compute Management & Provisioning

- Data analysis facility
  - Preserve applications
  - Secure remote researcher access
- Secure data federation
  - Federated identity
  - Role based data access
- Remote management of analysis facility
  - Secure remote access for administration
  - Isolation of roles
- Research clouds at scale
  - Elastic access to large compute resources
  - Project based authentication, provisioning and resources

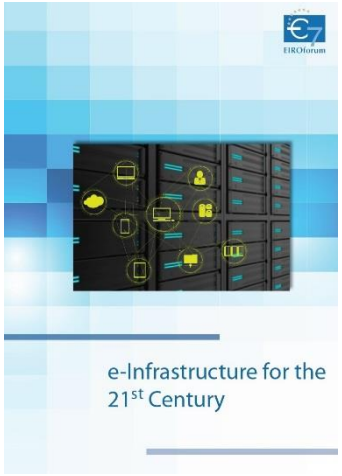
To be released soon

Update of the Computing Models of the WLCG and the LHC Experiments

http://cds.cern.ch/record/1695401

E-Infrastructure for the 21st century

http://zenodo.org/record/7592

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