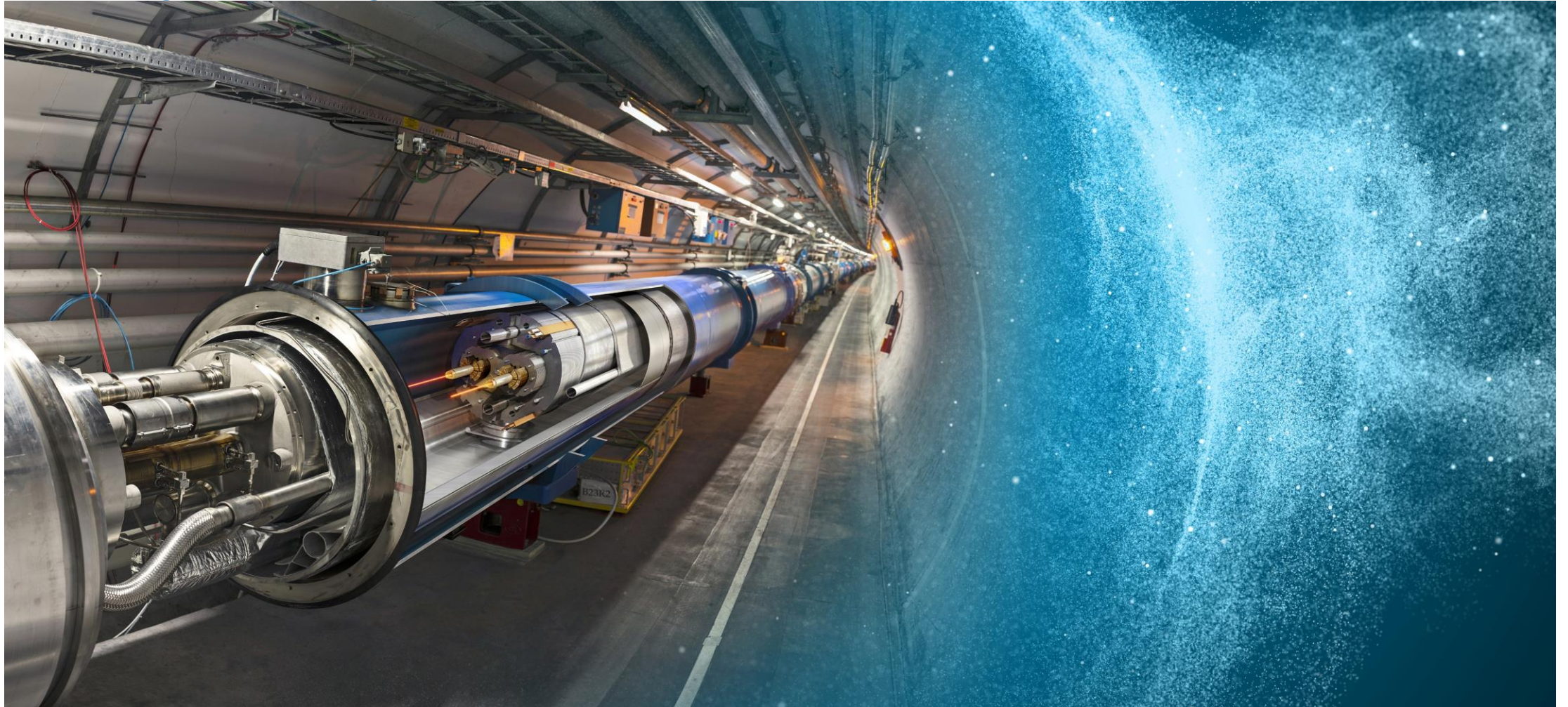# Phase VI Challenges and Opportunities

Alberto Di Meglio – CERN openlab Head

05/10/2017

CERN: A UNIQUE ENVIRONMENT

Pushing technologies to their limits

CERN

1954: 12 Member States

- International organisation close to Geneva, straddling Swiss-French border, founded 1954

- Facilities for fundamental research in particle physics

- 22 member states, 1.1 B CHF budget

- 3'197 staff, fellows, apprentices, …

- 13'128 associates

Members: Austria, Belgium, Bulgaria, Czech republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom
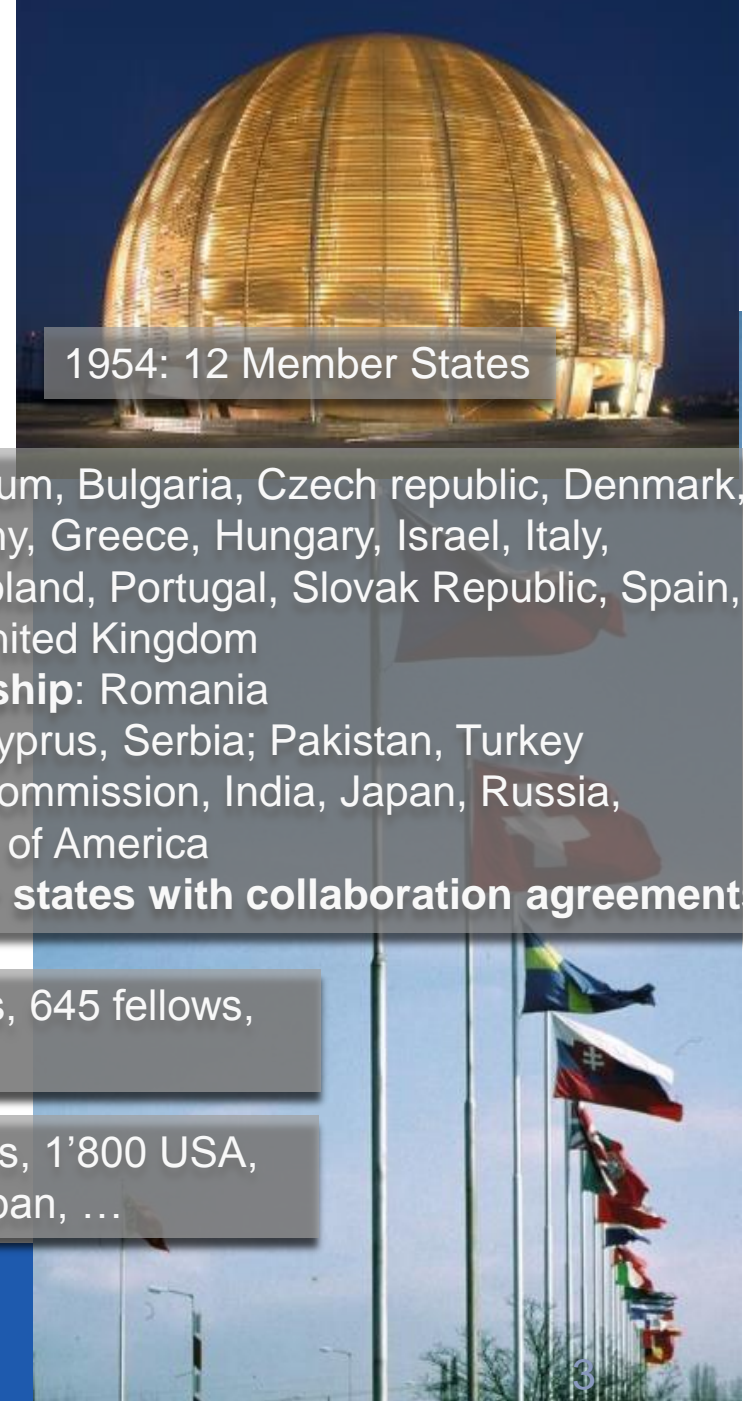**Candidate for membership**: Romania
Associate members: Cyprus, Serbia; Pakistan, Turkey
Observers: European Commission, India, Japan, Russia, UNESCO, United States of America
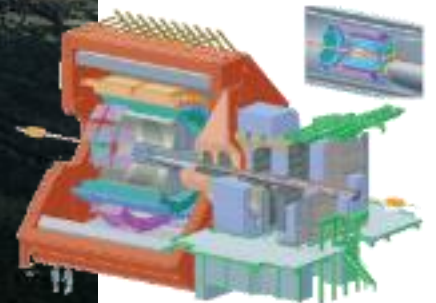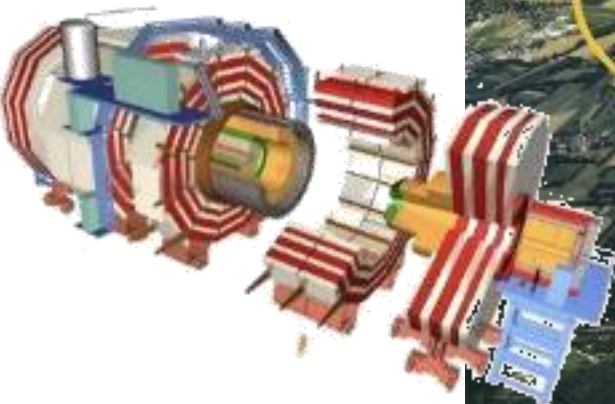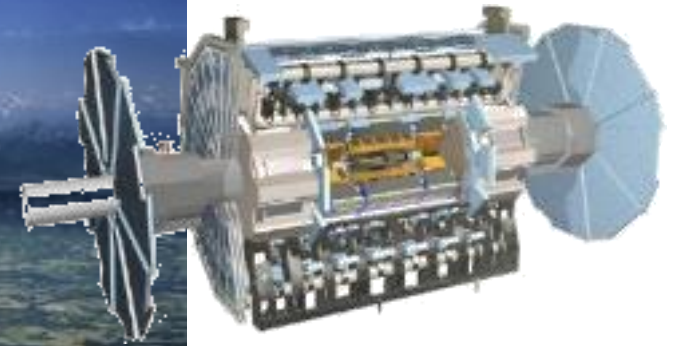Numerous **non-member states with collaboration agreement**

2'531 staff members, 645 fellows, 21 apprentices

7'000 member states, 1'800 USA, 900 Russia, 270 Japan, …

The Large Hadron Collider (LHC)
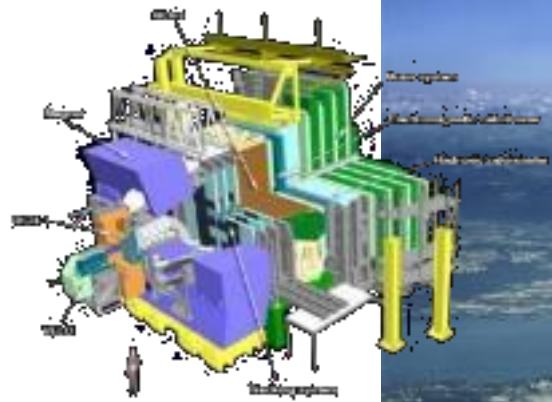
Worldwide LHC Computing Grid
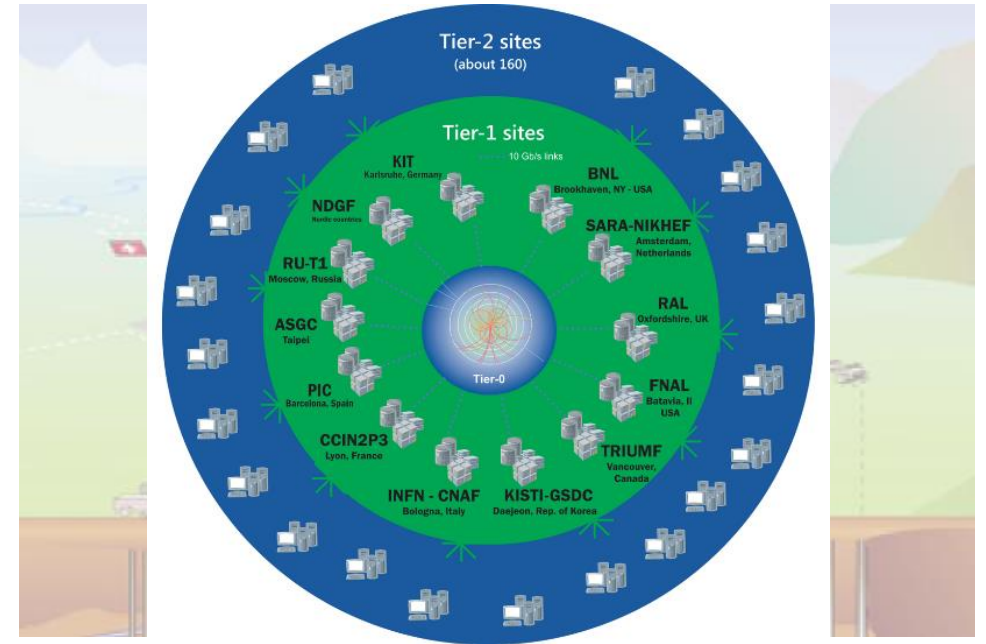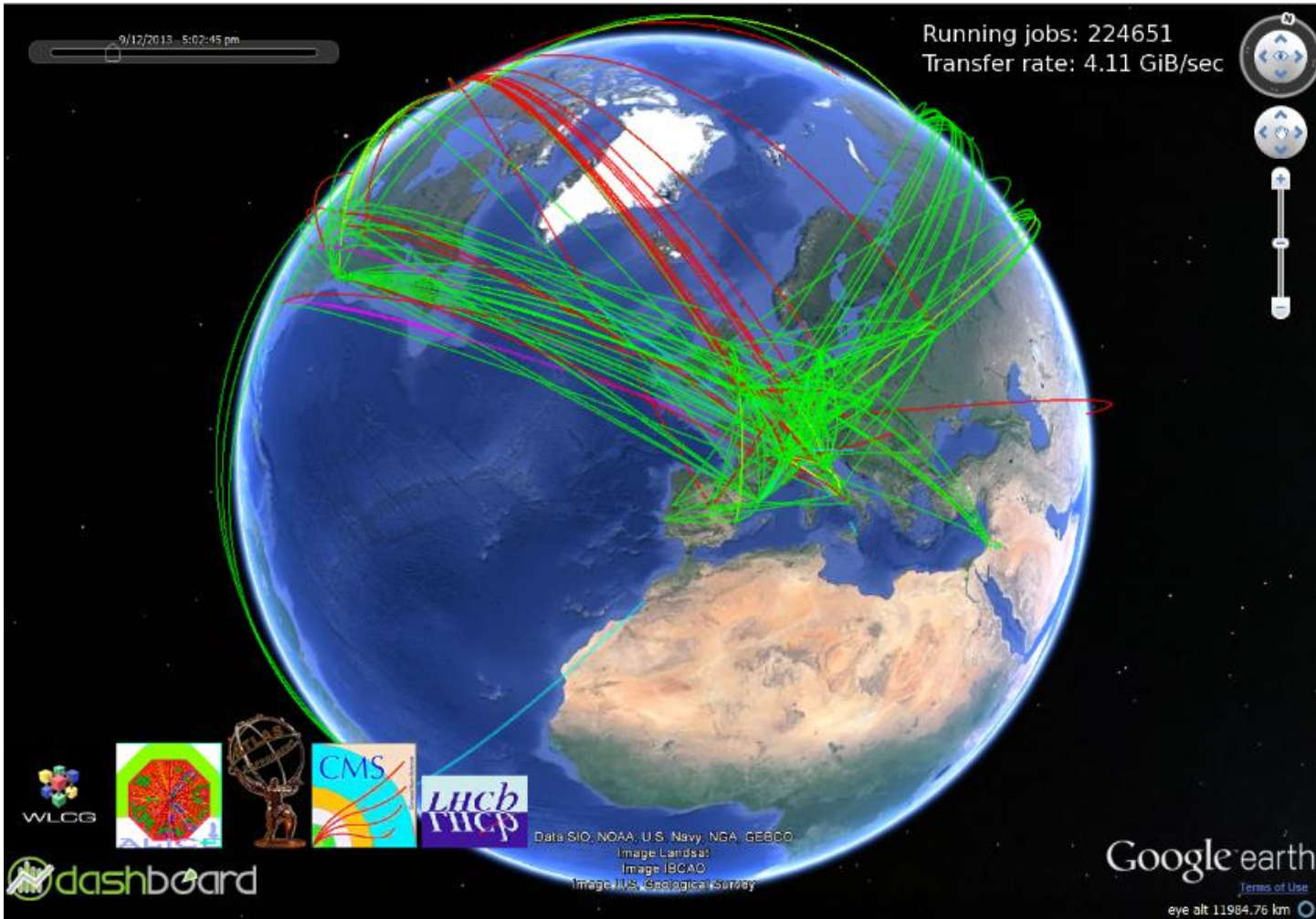
Tier-0 (CERN):
- Data recording
- Initial data reconstruction
- Data distribution

Tier-1 (14 centres):
- Permanent storage
- Re-processing
- Analysis

Tier-2 (72 Federations, ~149 centres):
- Simulation
- End-user analysis

- 760,000 cores
- 700 PB

CERN openlab Overview
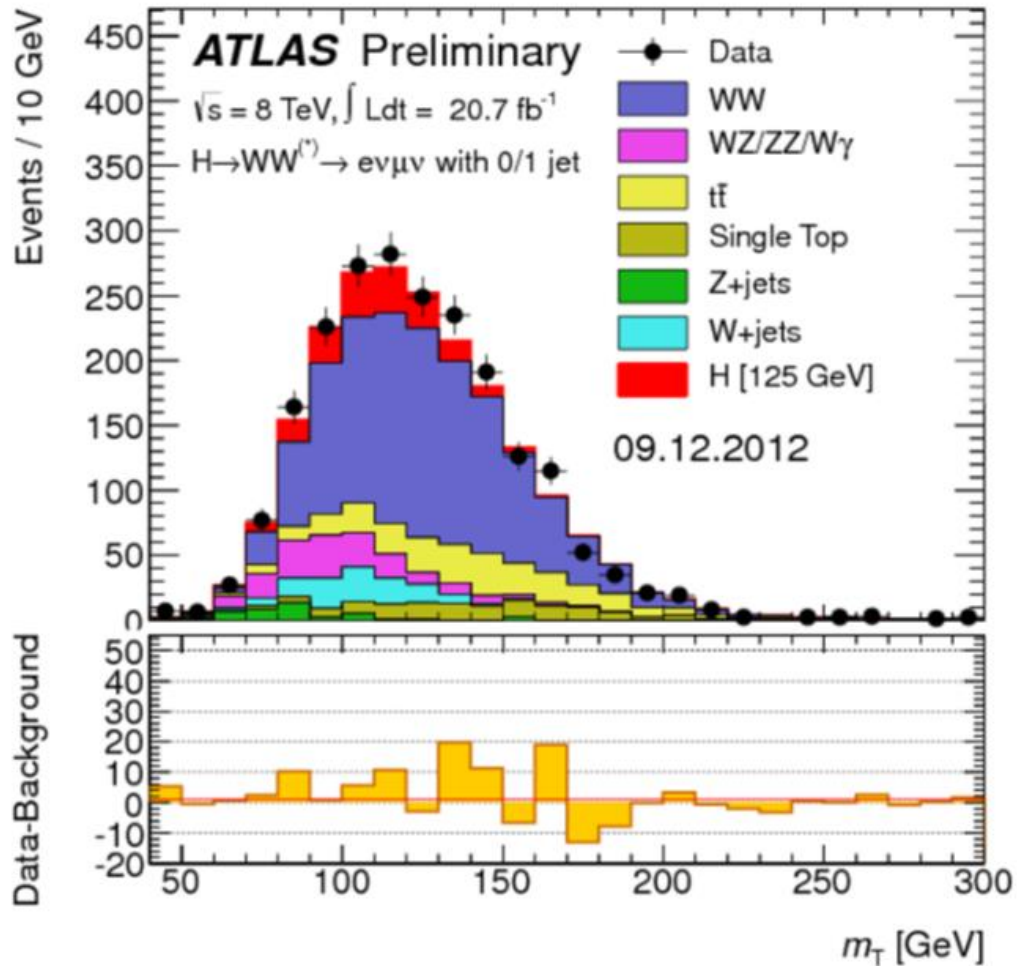
The Higgs Boson

The Higgs Boson completes the Standard Model,
but the Model explains only about 5% of our Universe

What is the other 95% of the Universe made of?
How does gravity really works?
Why there is no antimatter in nature?

CERN openlab Overview

LHC Schedule

Peak luminosity · Integrated luminosity

Run 1 — Trigger-Rate: ~500 Hz

Run 2 — Trigger-Rate: ~1 kHz

Run 3 — Trigger-Rate: ~1 kHz

Run 4 — Trigger-Rate: ~7.5 kHz

Run 5

Run 6 — Trigger-Rate: ~7.5 kHz

HL-LHC

LS1, LS2, LS3, LS4, LS5

Luminosity [cm^{-2}s^{-1}] — Integrated luminosity [fb^{-1}] — Year
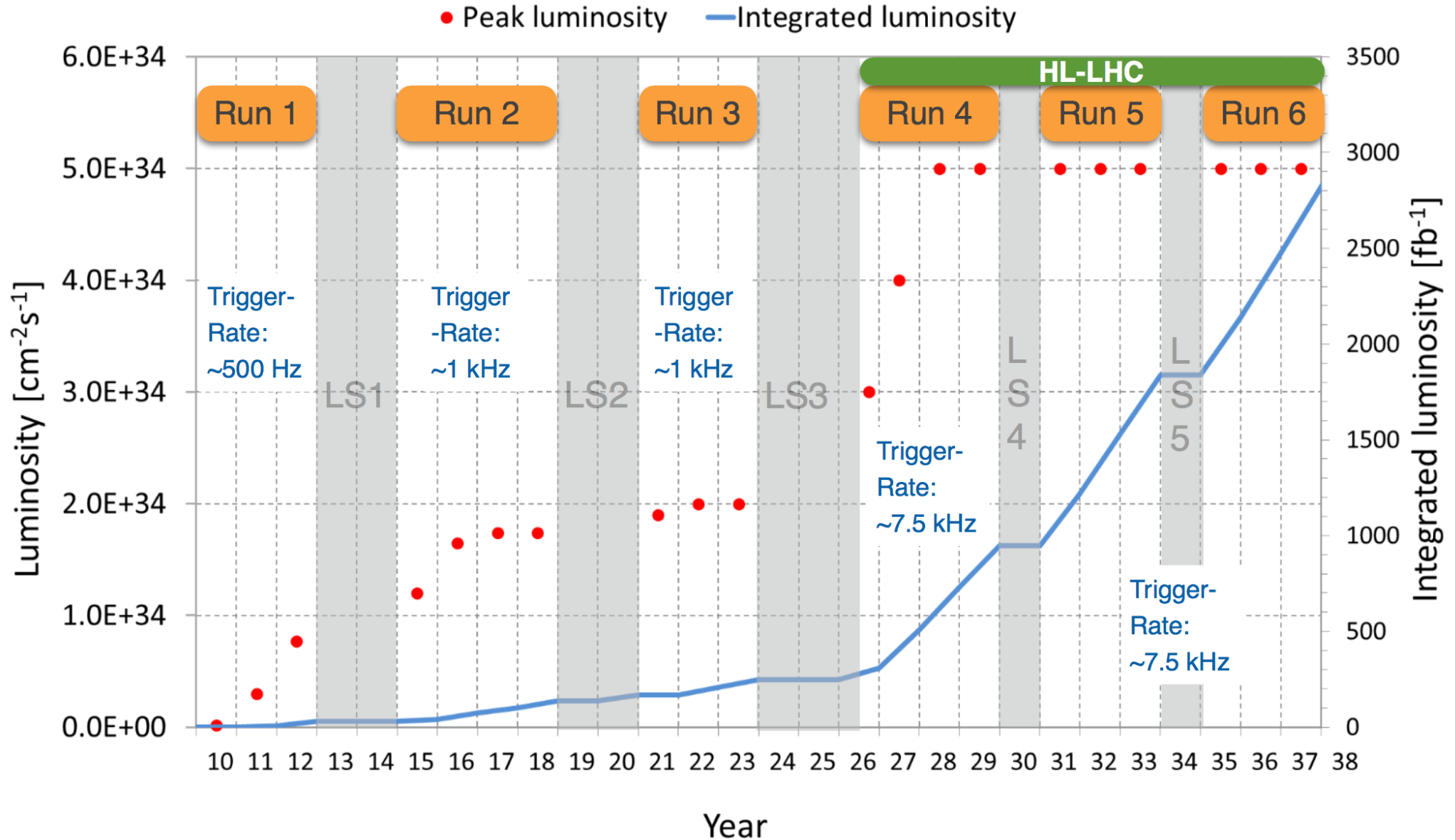
LHC Run3 and Run4

Scale and Challenges

| First run | LS1 | Second run | LS2 | Third run | LS3 | HL-LHC | FCC? |
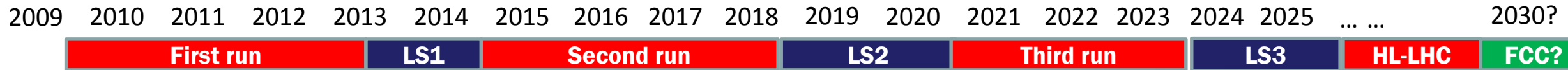
Raw data volume for LHC increases exponentially and with it processing and analysis load

Technology at ~20%/year will bring x6-10 in 10-11 years

Estimates of resource needs at HL-LHC x10 above what is realistic to expect from technology with reasonably constant cost

Data estimates for 1st year of HL-LHC (PB)

CPU Needs for 1st Year of HL-LHC (kHS06)
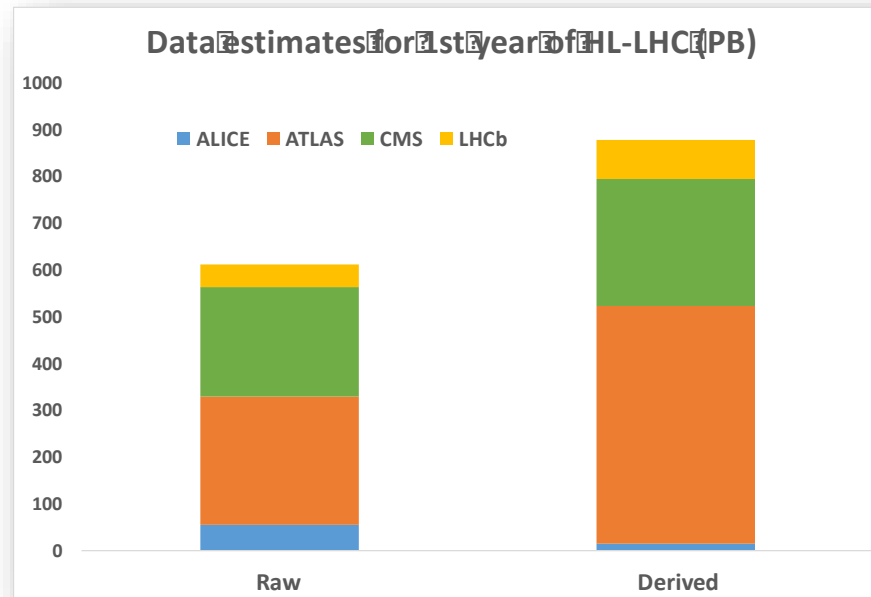
Data:
- Raw 2016: 50 PB → 2027: 600 PB
- Derived (1 copy): 2016: 80 PB → 2027: 900 PB
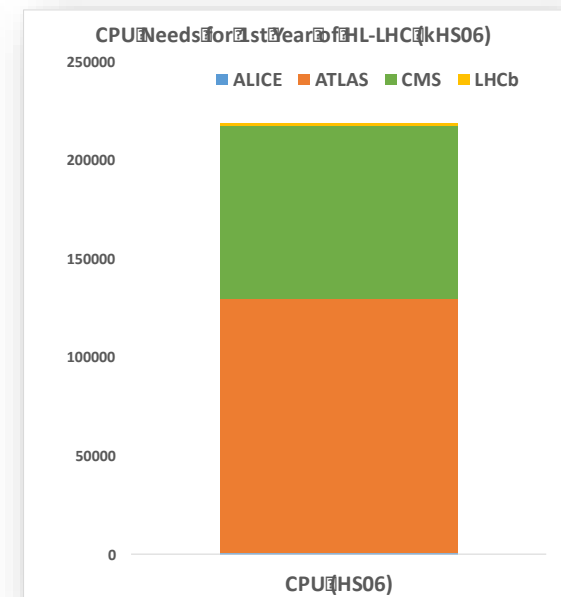
CPU:
- x60 from 2016

Technology revolutions are needed

DRIVING INNOVATION SINCE 2001

Entering our sixth three-year phase

	I 2003		III 2009		V 2015	2018

SET UP 2001

II 2006

IV 2012

2018

Sixth Phase

VI
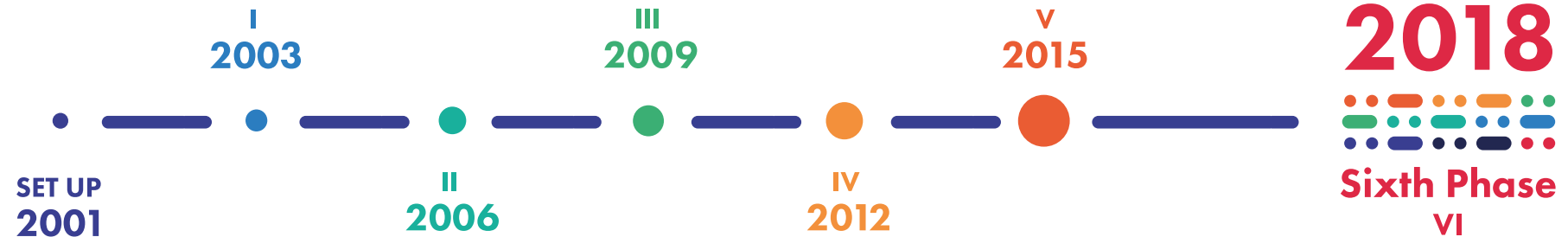
CERN openlab Collaboration Board 2017

CERN openlab Governance

The Collaboration Board is composed of the representatives of the member Companies and Research Institutes

Collaboration Board (Chaired by CERN DG)

CERN Legal Office, KT Office, HR

CERN Director of Research and Computing

CERN openlab Head

Chief Technology Officer

Chief Research Officer

Chief Innovation Officer

Communications

Administration and Finance

Projects with HEP and LHC Experiments

Knowledge sharing with other scientific communities

Disruptive technologies

CERN openlab

CERN OPENLAB'S MISSION

Our recipe for success

Evaluate and test state-of-the-art technologies in a challenging environment and improve them in collaboration with industry.

MANAGEMENT

JOINT R&D

INNOVATION & KNOWLEDGE TRANSFER

Collaborate and exchange ideas with other communities to create knowledge and innovation.

Communicate results, demostrate impact, and reach new audiences.

COMMUNICATION

EDUCATION

Train the next generation of engineers/researchers, **promote** education and cultural exchanges.

CERN openlab

JOINT R&D PROJECTS

High-bandwidth fabrics, accelerated platforms

Data quality monitoring, anomaly detection, physics data reduction, benchmarking/scalability, systems biology and large-scale multi-disciplinary platforms

Simulation, HPC on the Cloud, benchmarking

Predictive/proactive maintenance and operations

Cloud federations, containers, scalability

Software Defined Networks, Security

Storage architectures, scalability, monitoring

Data Acquisition (LHCb, IT-CF)

Data Analytics, Machine Learning (many)

Code modernization (EP-SFT, IT-CF)

Control Systems (BE-ICS)

Cloud infra (IT-CM)

Networks (IT-CS)

Data Storage (IT-ST, IT-DB)

IP Management, Open*

- The basic principle of any CERN openlab collaboration is openness

- We assume shared IP of results among project members
  - More specific IP agreements can be discussed with the CERN KT Office

- Within the respect of limited confidentiality agreements and short embargo periods, we expect the results of the projects to be released to the scientific communities following open policies
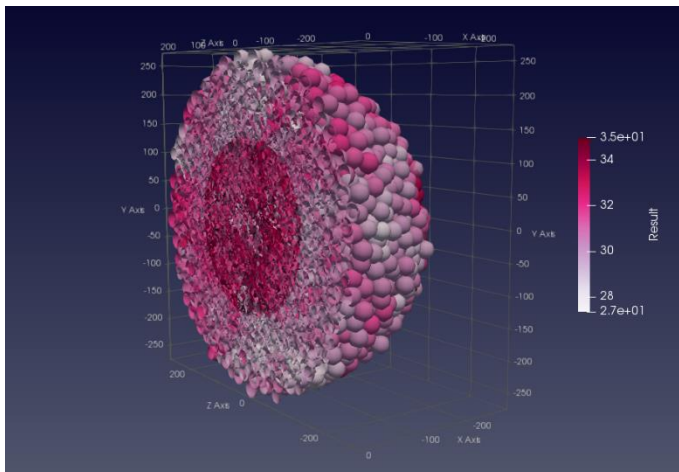
KNOWLEDGE SHARING

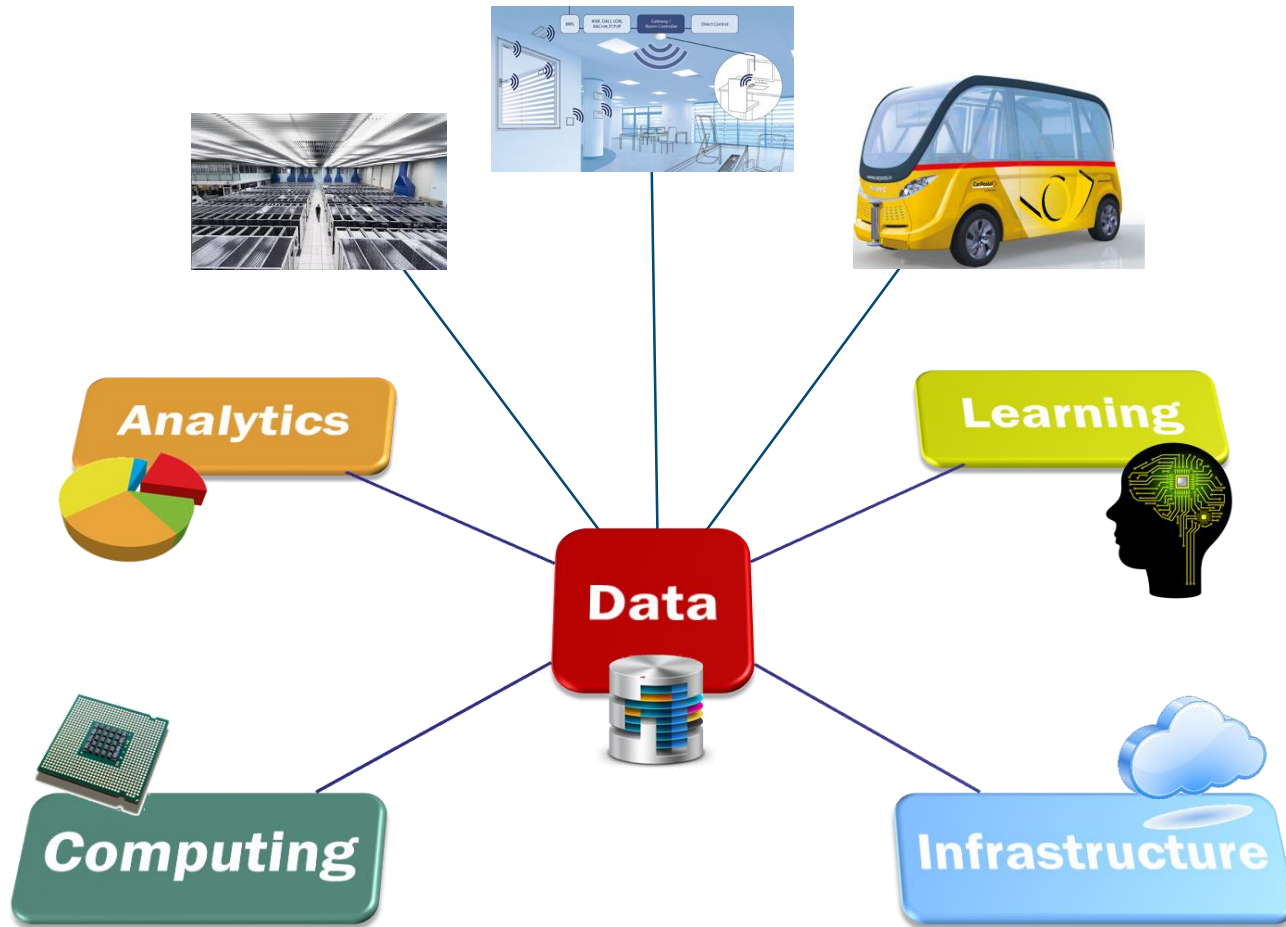*Working with communities beyond high-energy physics*

Working closely with CERN KT on initiatives aimed at transferring tools, skills, and knowledge from the high-energy physics community to other research fields.

Aligned with the recently approved knowledge transfer strategy for the benefit of medical applications

"SMART THINGS" AND IOT

Understand the potential and impact of technologies such as Internet of Things, fast wireless/mobile communication (5G), and large-scale DA/ML

Raise awareness among the community by collecting and aggregating interests and setting up PoC projects

Main interests so far: data center operations optimization, environmental control, mobility

CERN is well-placed geographically and technologically to play a central role

Current status: Requirements analysis

Seeking collaborations: developers, domain experts, testers, use cases

MEASURING IMPACT

Communication and Outreach

Our website: http://openlab.cern/
~150k unique visitors/year (+100%)

Articles in other **CERN and external channels**
~900 press cuts (+300%)

Facebook: http://cern.ch/go/p7pF
3.5k people reached / 100k single posts

Facebook group: http://cern.ch/go/n6xD

Twitter: http://cern.ch/go/7vvk

Workplace: http://cern.ch/go/6MTQ

LinkedIn: http://cern.ch/go/NK9k

Join the **alumni**: https://alumni.cern/

EDUCATION AND TRAINING

Training tomorrow's leaders in ICT

CERN openlab runs a **highly competitive** summer-student programme

~ 40 students selected from around 1500 applicants

Most dedicated CERN openlab personnel are **young, talented 'fellows'.**

Receive hands-on experience with cutting-edge technologies

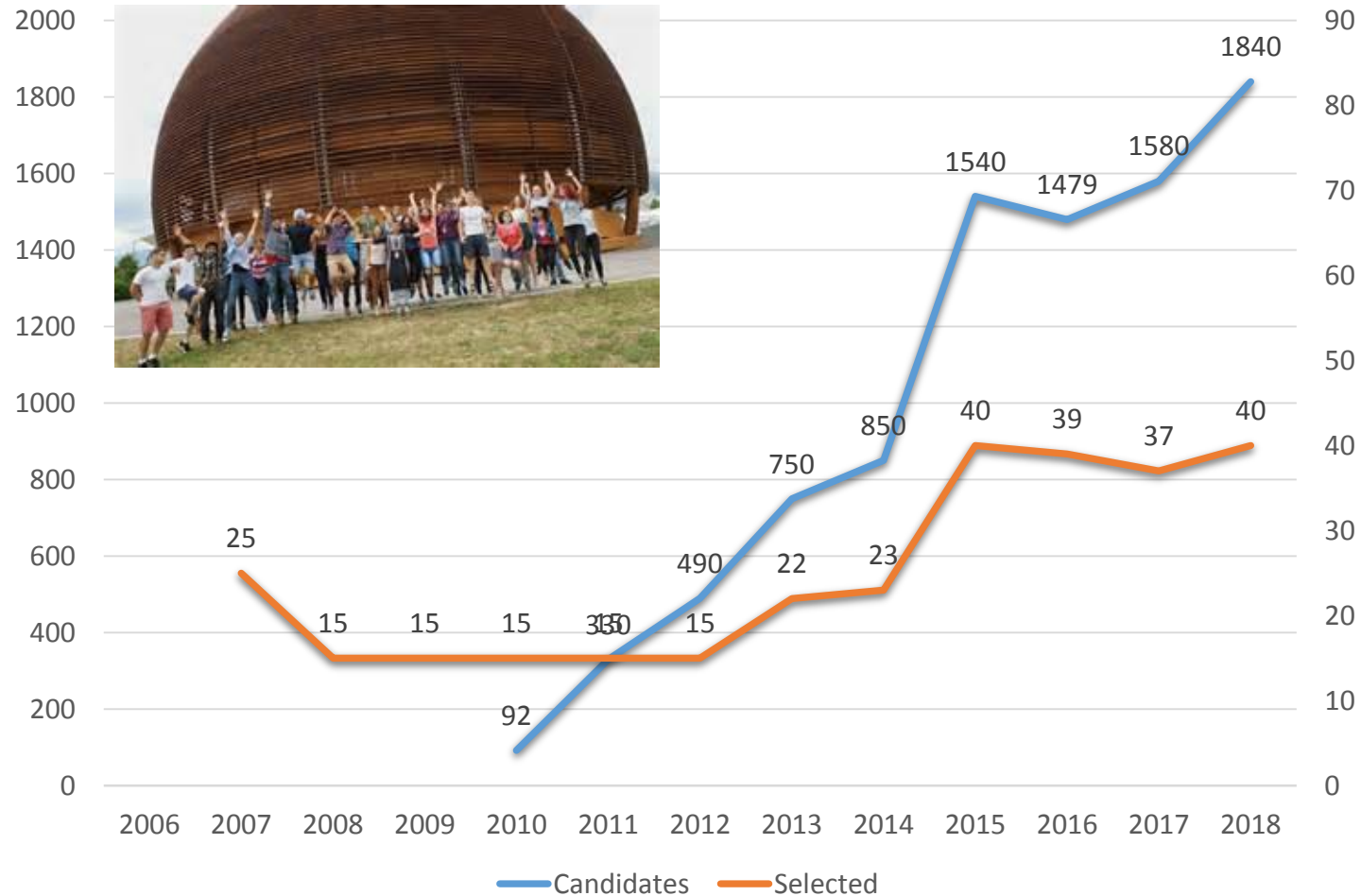**Workshops, training courses,** and other initiatives run with our collaborators.

Competitions, challenges, online training, hackathons.

Experts from industry and research give lectures.

Participate in events both inside and outside CERN.

SUMMER STUDENT PROGRAMME

In 2018

- 1840 applicants
- 40 selected students
- 14 lectures
- Visits to external labs and companies
- Lightning talks session
- 40 Technical reports

ICT WHITE PAPER 2017

WHITE PAPER

FUTURE ICT CHALLENGES
IN SCIENTIFIC RESEARCH

September 2017

Published on 21 September 2017

Summarises the results of extensive consultations with CERN experts, LHC Experiments representatives, ICT companies and international research labs and academic institutes

Based on 4 major research topics and 16 challenge areas

A solid starting point for a very challenging and constructive Phase VI

Main Areas of Investigation

Scale out capacity
(hybrid clouds, IaaS
& PaaS, business
models)

Change the way
data is processed
(Machine Learning)

Increase existing
data center
performance
(hardware
acceleration, GPUs,
better code)

CONTACTS

ALBERTO DI MEGLIO
CERN openlab Head
alberto.di.meglio@cern.ch

MARIA GIRONE
CERN openlab CTO
maria.girone@cern.ch

FONS RADEMAKERS
CERN openlab CRO
fons.rademakers@cern.ch

FEDERICO CARMINATI
CERN openlab CiO
federico.carminati@cern.ch

ANDREW PURCELL
CERN openlab Communications Officer
andrew.purcell@cern.ch

KRISTINA GUNNE
CERN openlab Administration/Finance Officer
kristina.gunne@cern.ch

www.cern.ch/openlab

Thanks!

alberto.di.meglio@cern.ch
@AlbertoDiMeglio