

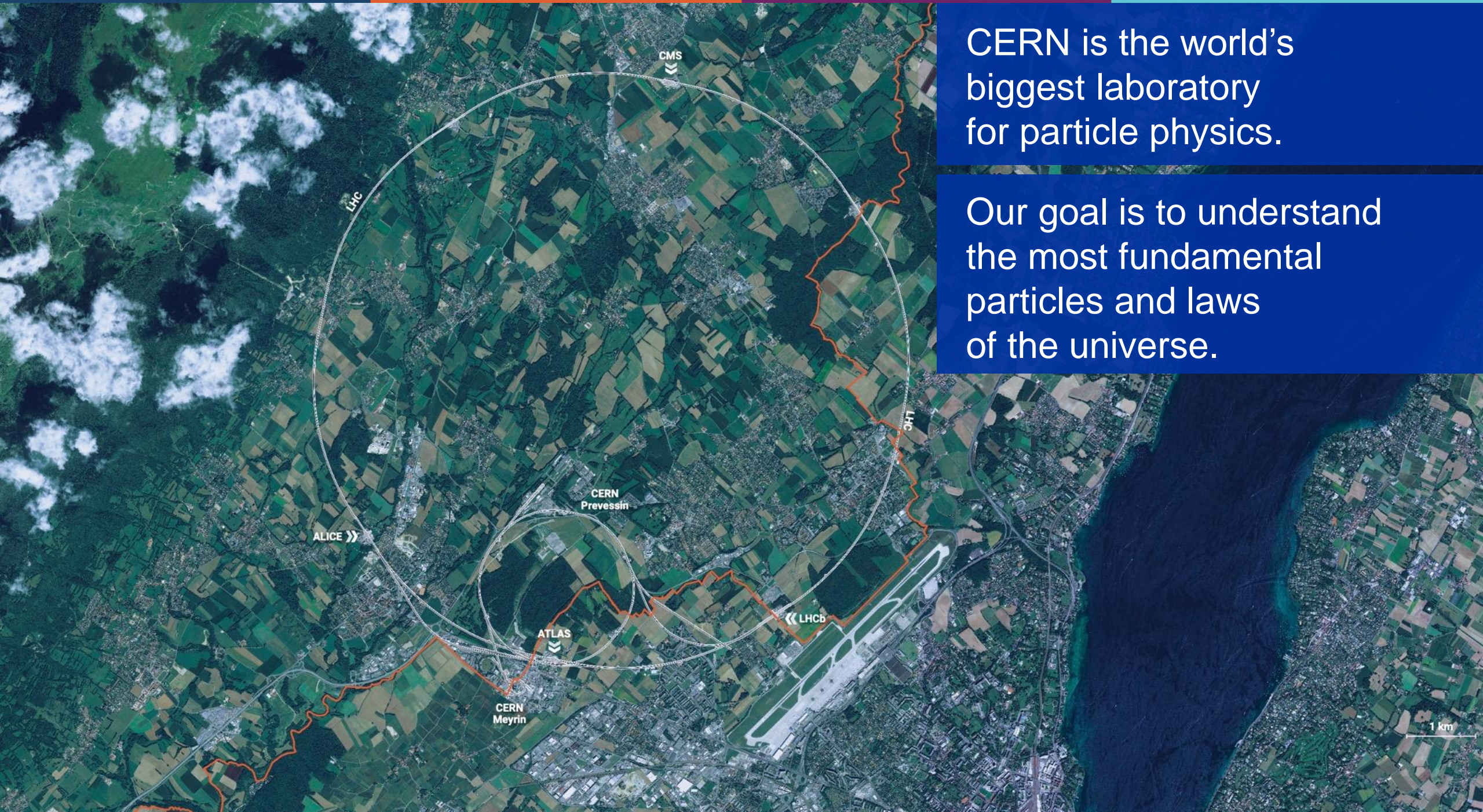




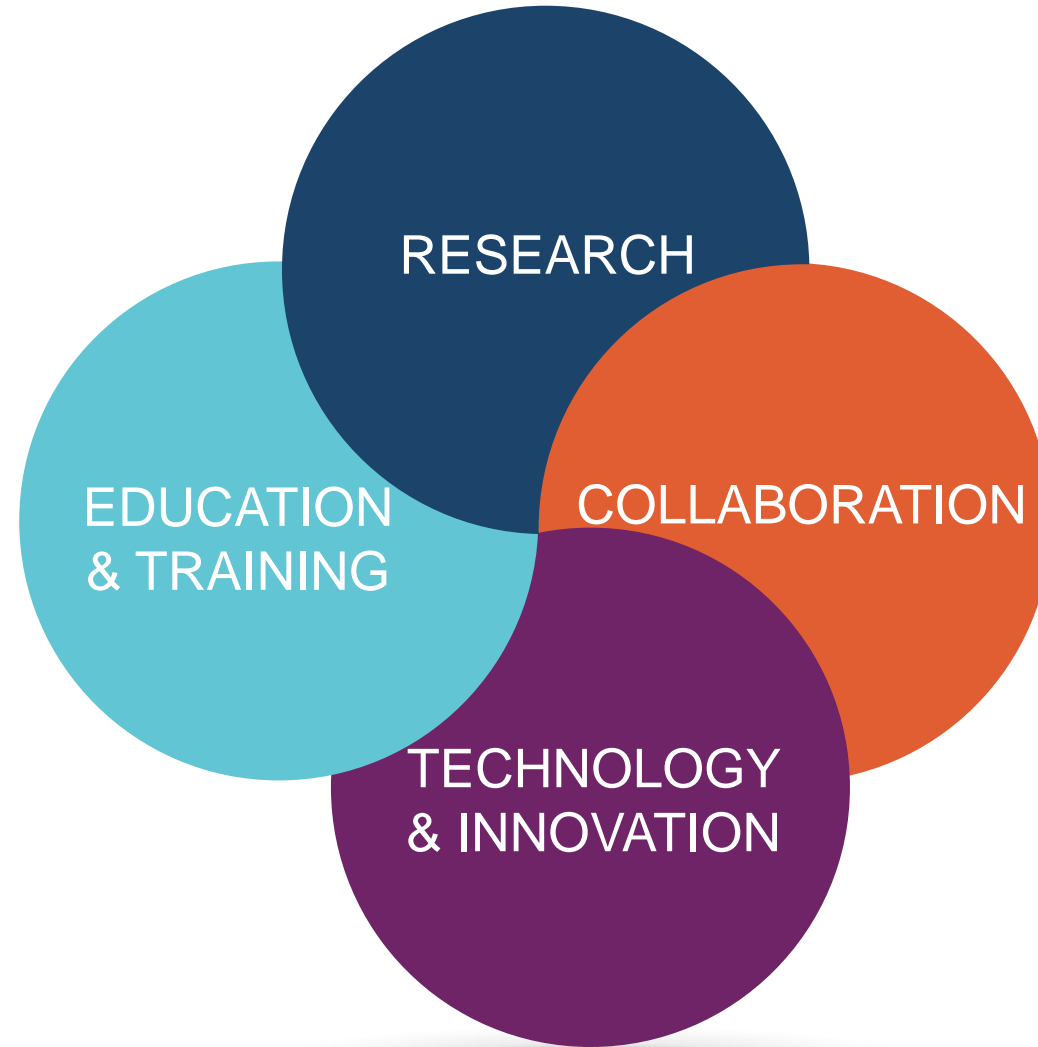
WELCOME TO CERN

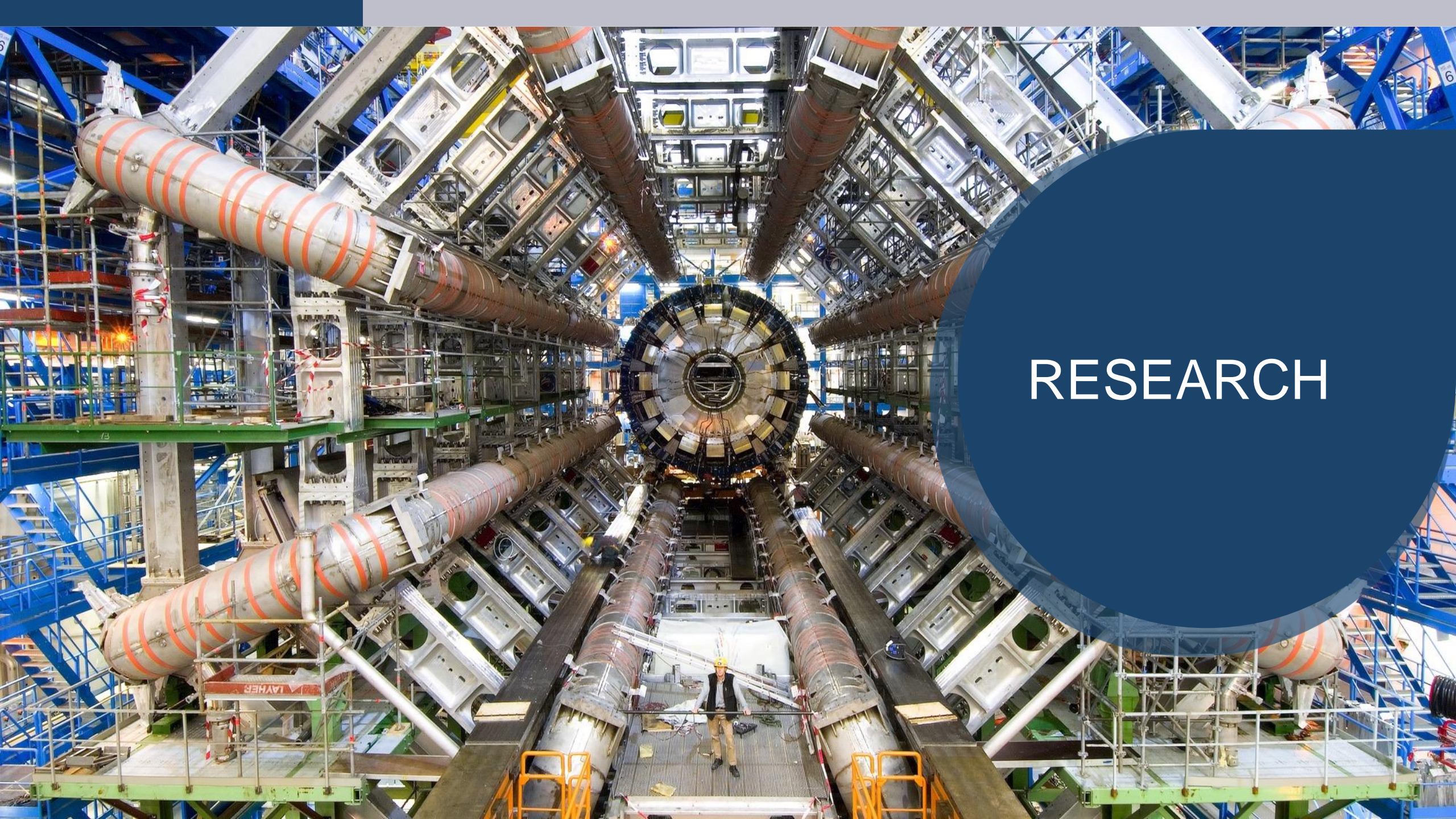
CERN is the world's biggest laboratory for particle physics.

Our goal is to understand the most fundamental particles and laws of the universe.



Four pillars underpin CERN's mission

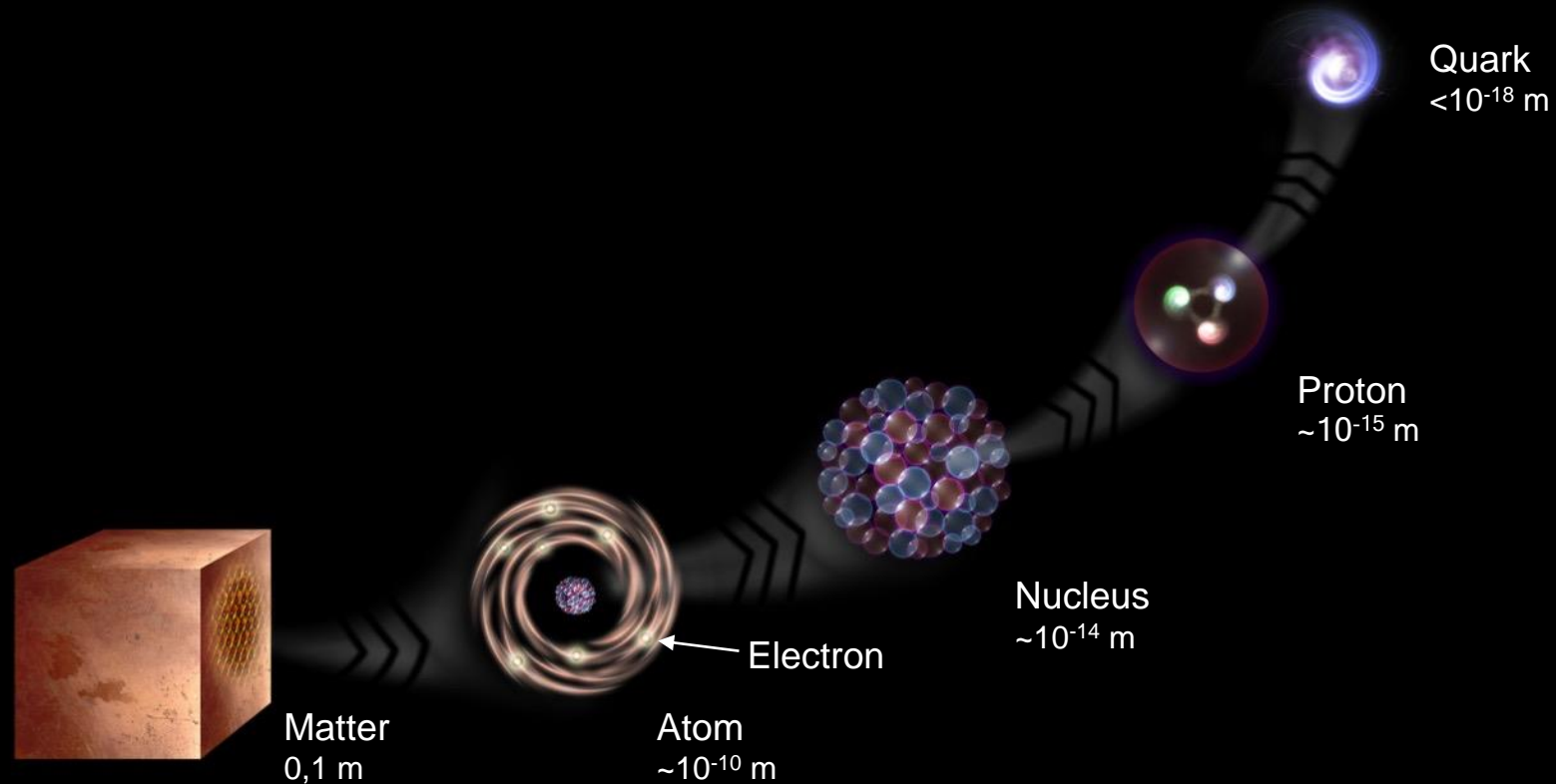


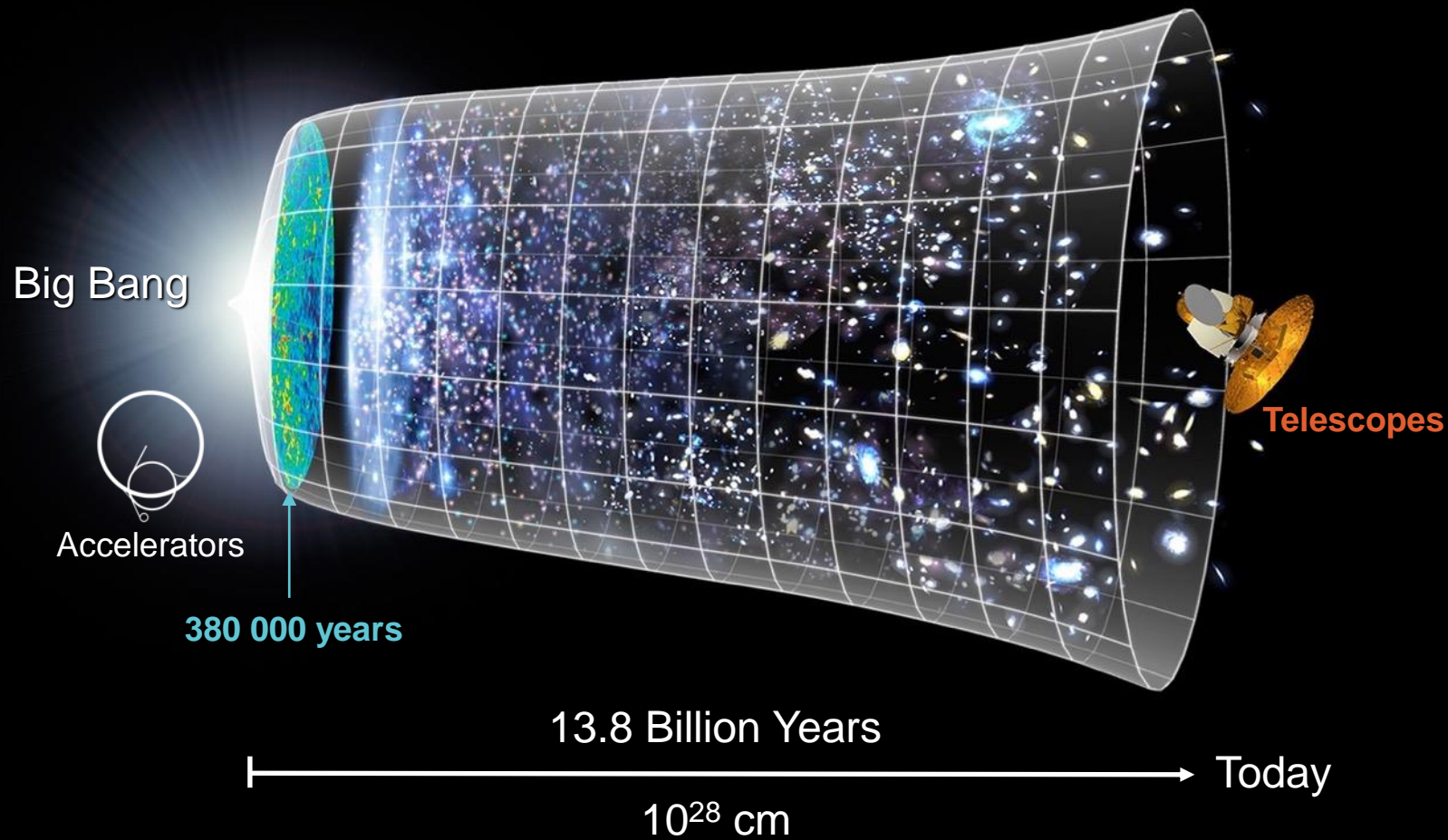


RESEARCH

What is the universe made of?

We study the elementary building blocks of matter and the forces that control their behaviour





How did the universe begin?

We reproduce the conditions a fraction of a second after the Big Bang, to gain insight into the structure and evolution of the universe.

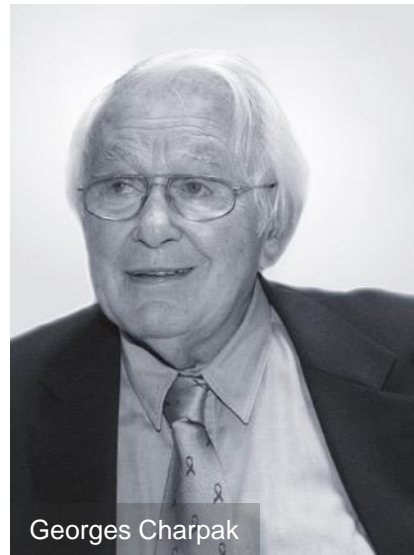
At CERN we help to answer these questions



Carlo Rubbia



Simon Van der Meer



Georges Charpak

Several CERN scientists have received Nobel Prizes for key discoveries in particle physics.

The Higgs boson was discovered in 2012; without it fundamental particles would be massless and atoms could not form.



François Englert and Peter Higgs. With Robert Brout, they proposed the mechanism in 1964.

How do we do it?

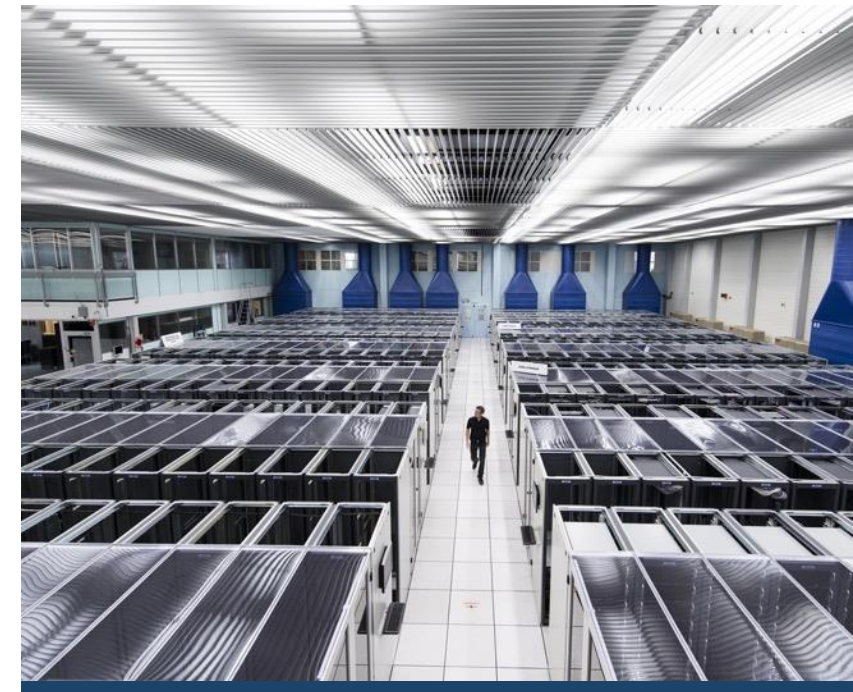
- We build the largest machines to study the smallest particles in the universe
- We develop technology to advance the limits of what is possible
- We perform world-class research in theoretical and experimental particle physics



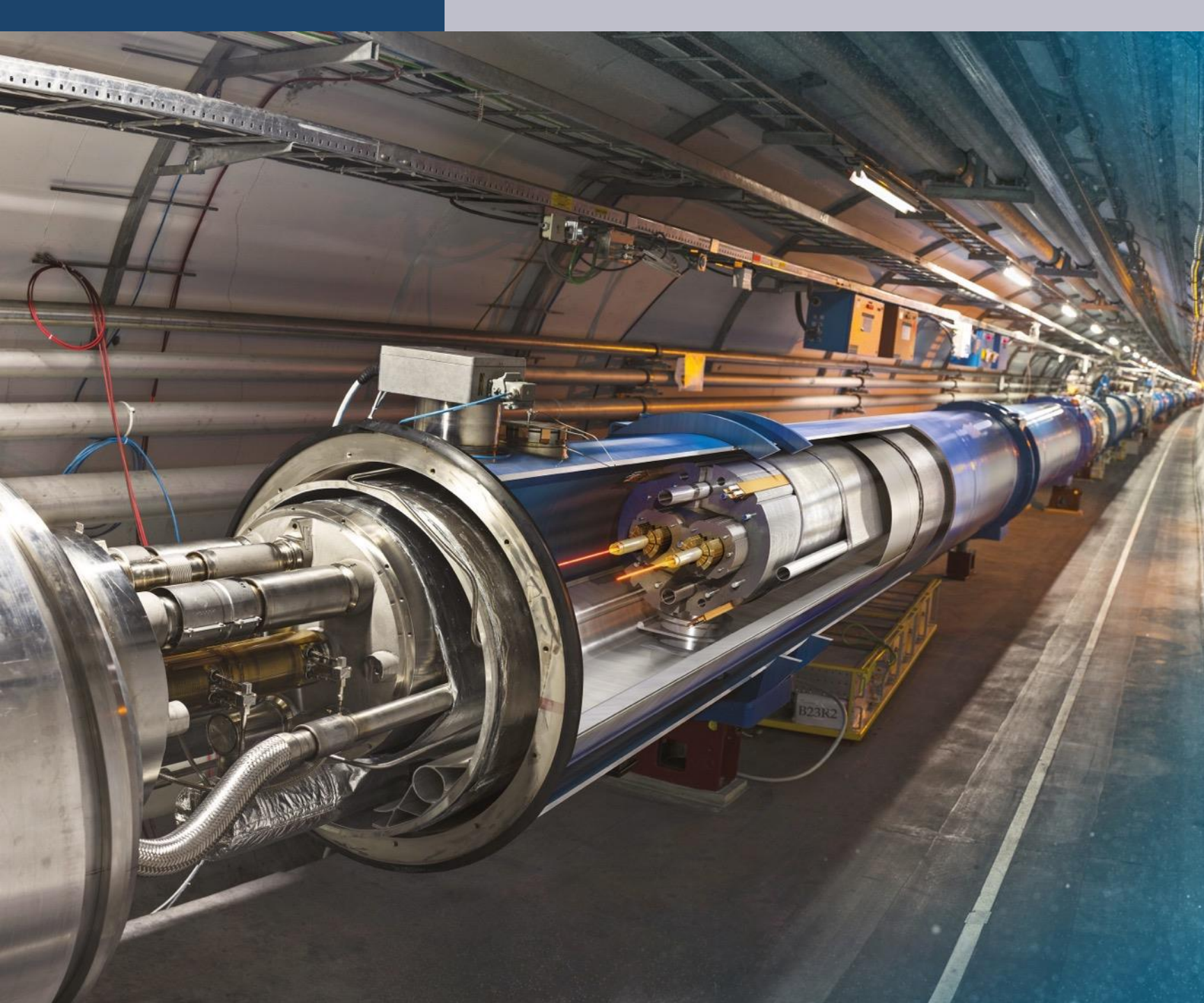
ACCELERATORS



DETECTORS



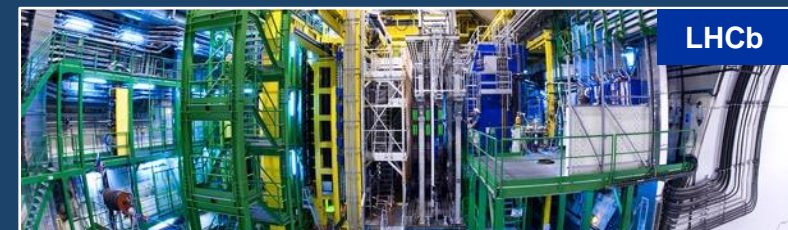
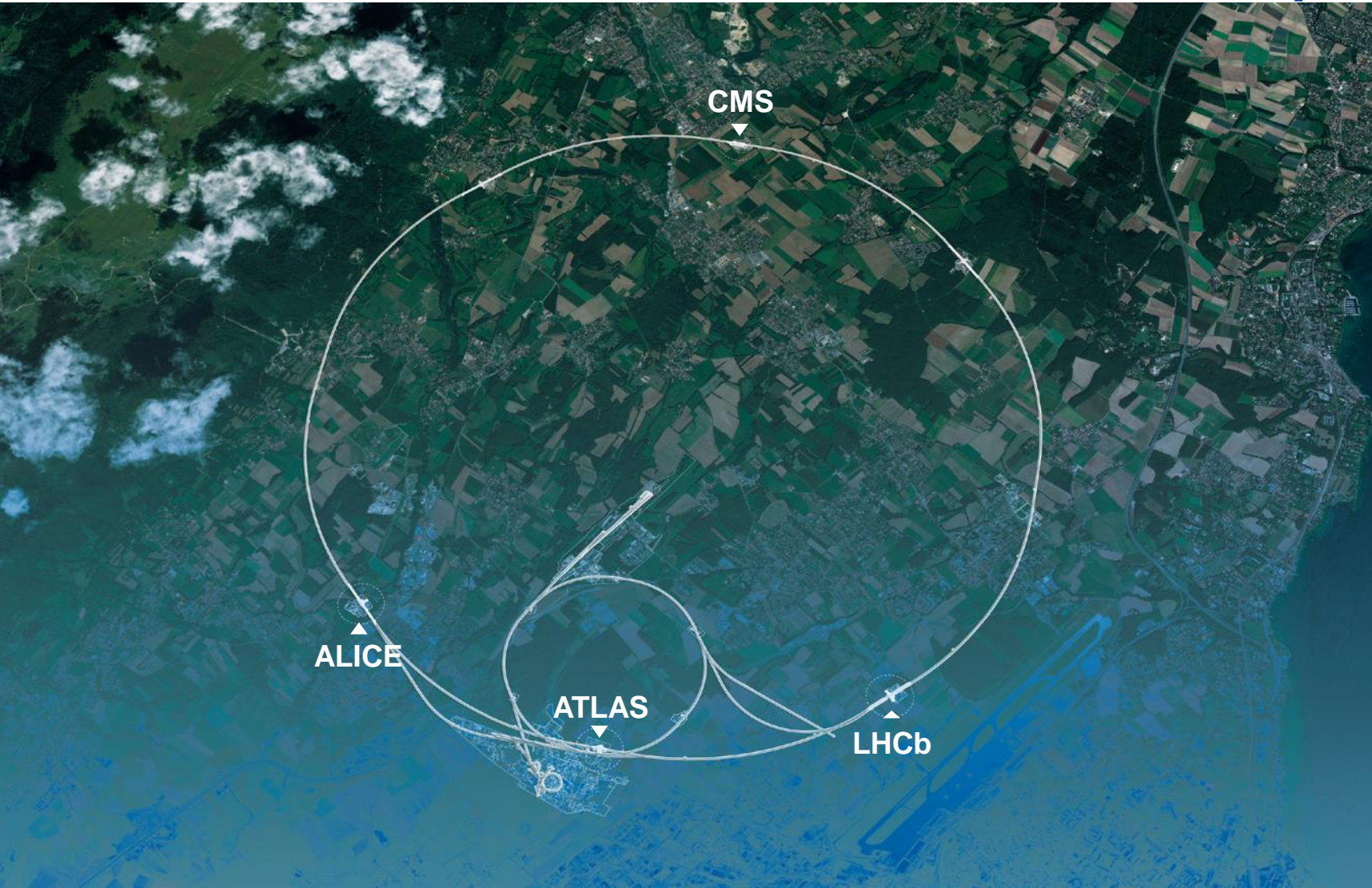
COMPUTING



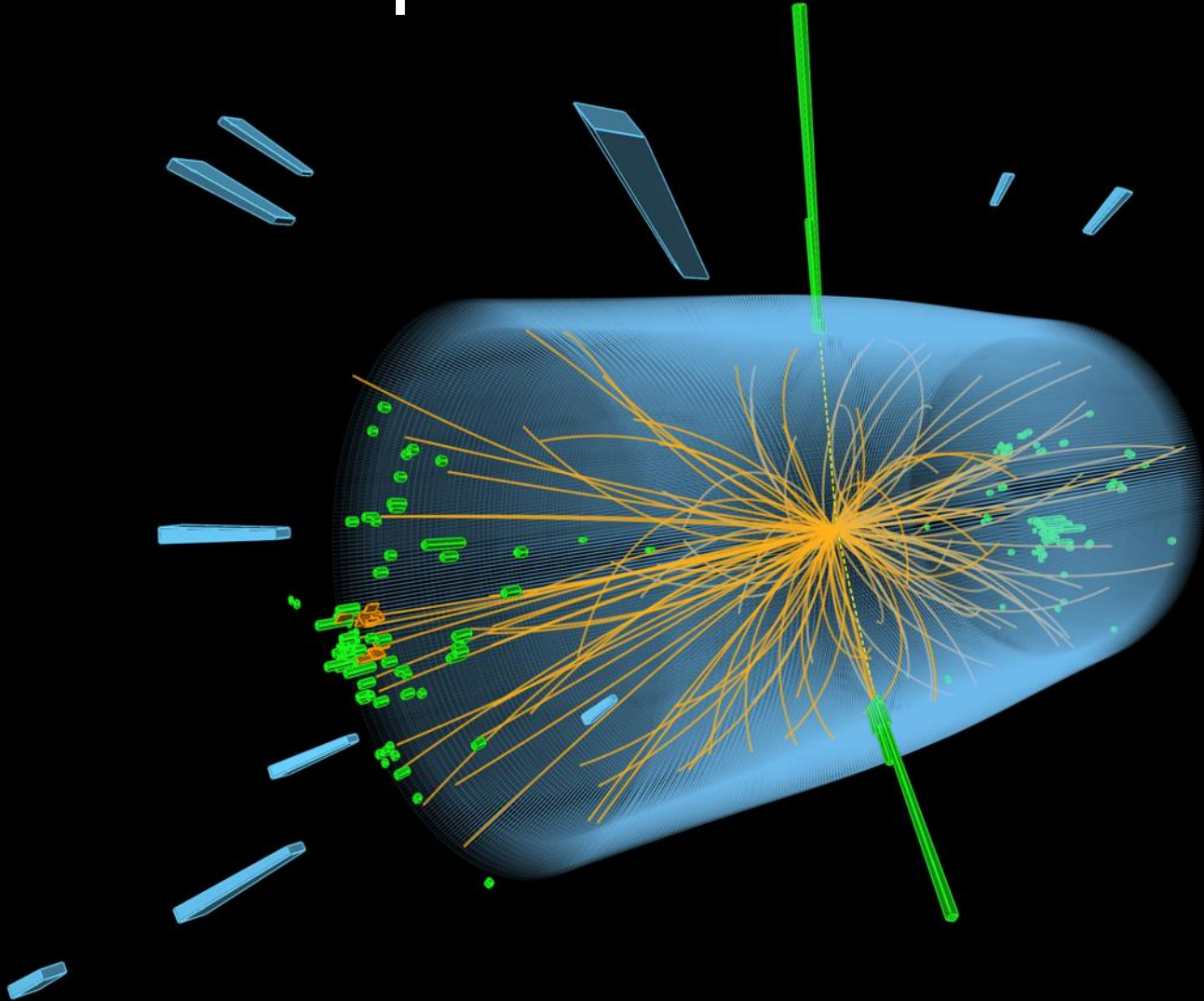
Large Hadron Collider (LHC)

- 27 km in circumference
- About 100 m underground
- Superconducting magnets steer the particles around the ring
- Particles are accelerated to close to the speed of light

Giant detectors record the particles formed at the four collision points

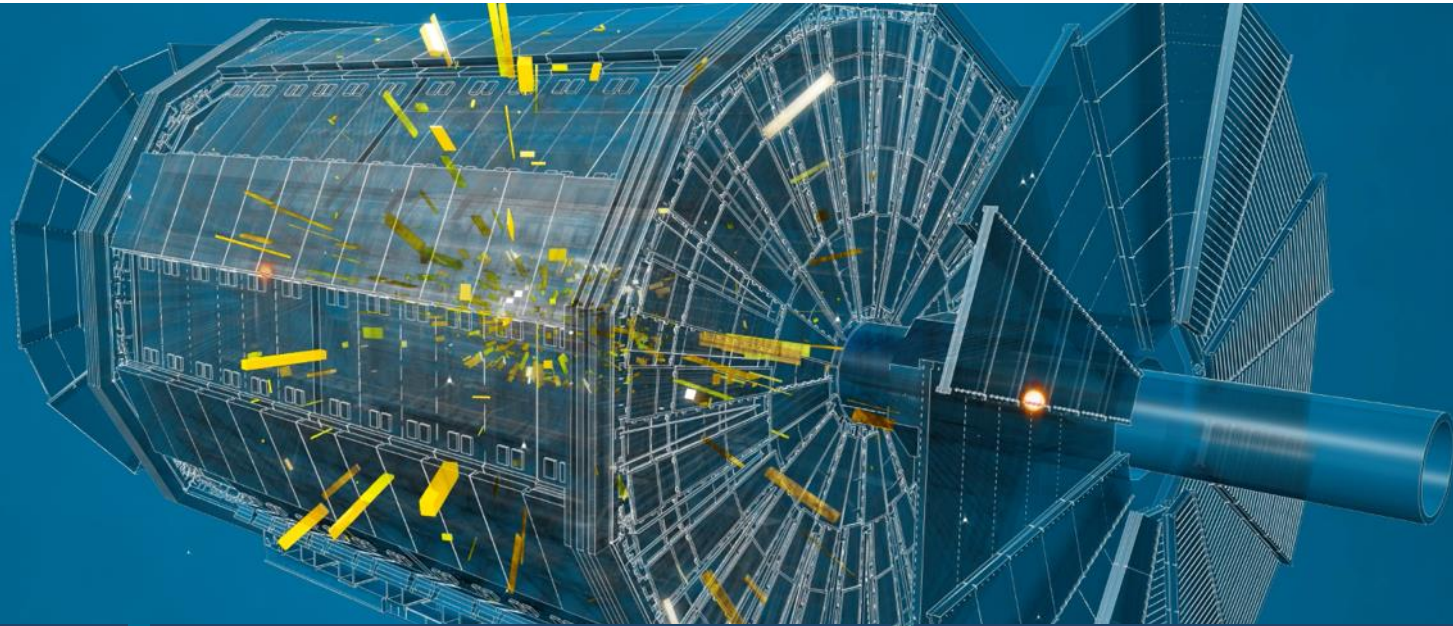


The LHC produces more than 1 billion particle collisions per second



The energy of the particles in collision is converted into new particles.

The LHC detectors are analogous to 3D cameras



The detectors measure the energy, direction and charge of new particles formed.



They take 40 million pictures a second. Only 1000 are recorded and stored.



The LHC detectors have been built by international collaborations covering all regions of the Globe.

The Worldwide LHC Computing Grid (WLCG)



Used to store, distribute, process and analyse data.



1 million processing cores in about 170 data centres and 42 countries.

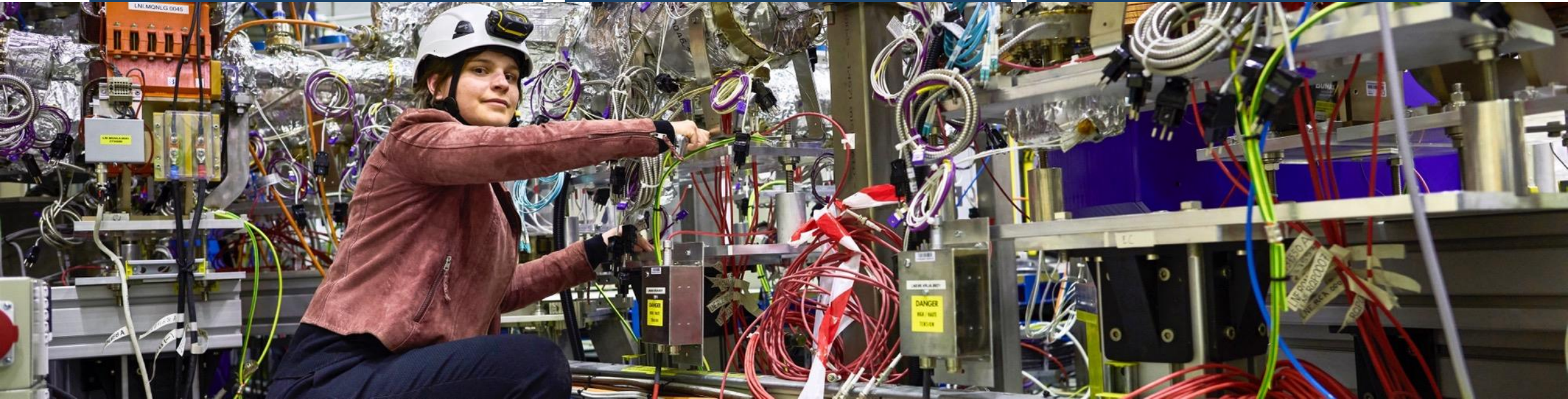
More than 1000 Petabytes of CERN data stored world-wide.

CERN has a diverse scientific programme

Nuclear Physics
(ISOLDE)

Antimatter Research
(Antiproton Decelerator)

Cosmic rays and cloud formation
(CLOUD)



Fixed-target experiments,
which include searches for rare phenomena

Contribution to the Long Baseline
Neutrino Facility in the USA (LBNF)

There are many unanswered questions in fundamental physics

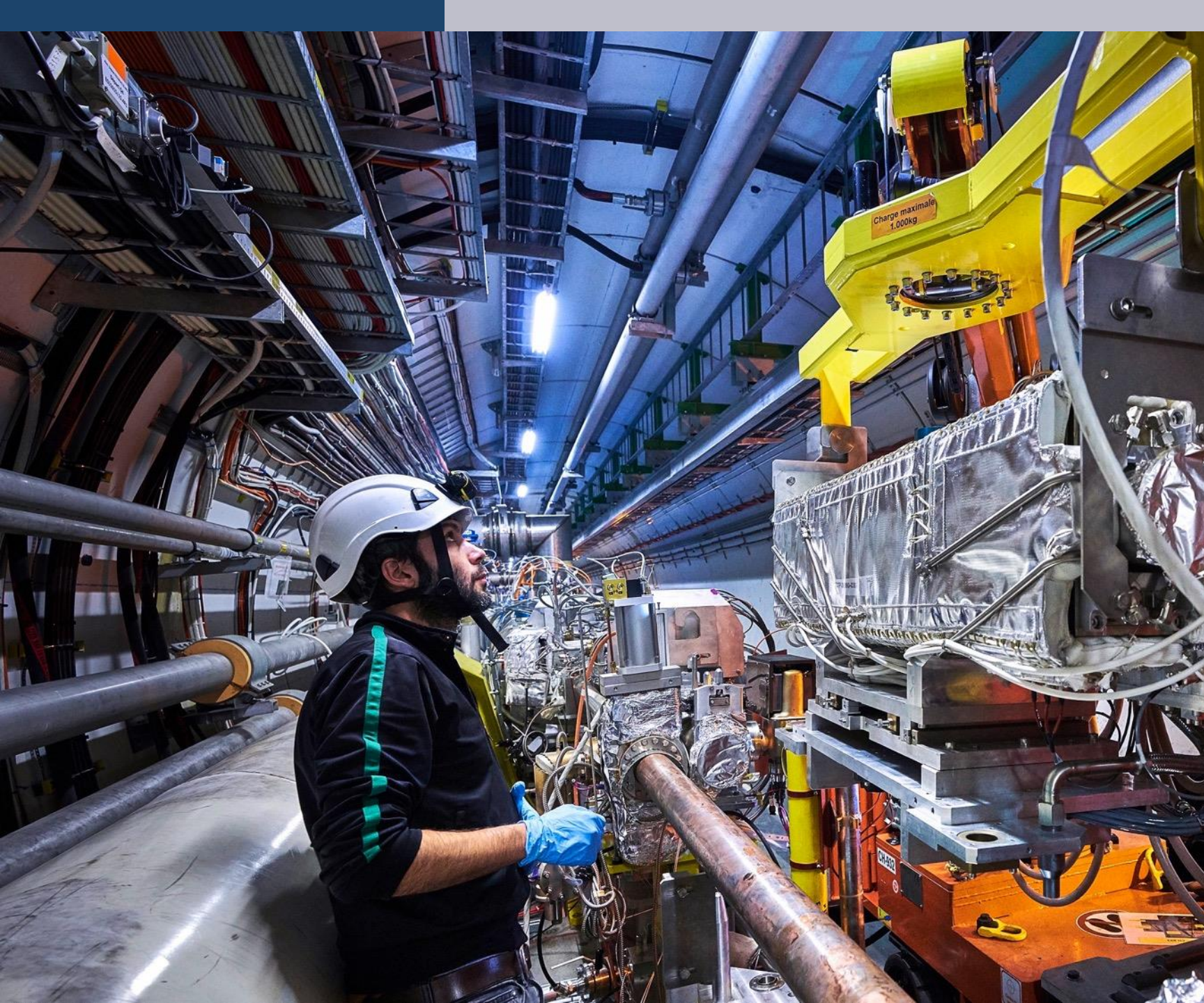
Including

95% of the mass and energy of the universe is unknown.

Is there only one Higgs boson, and does it behave exactly as expected?

Why is the universe made only of matter, with hardly any antimatter?

Why is gravity so weak compared to the other forces?



Upgrade to the High-Luminosity LHC is under way

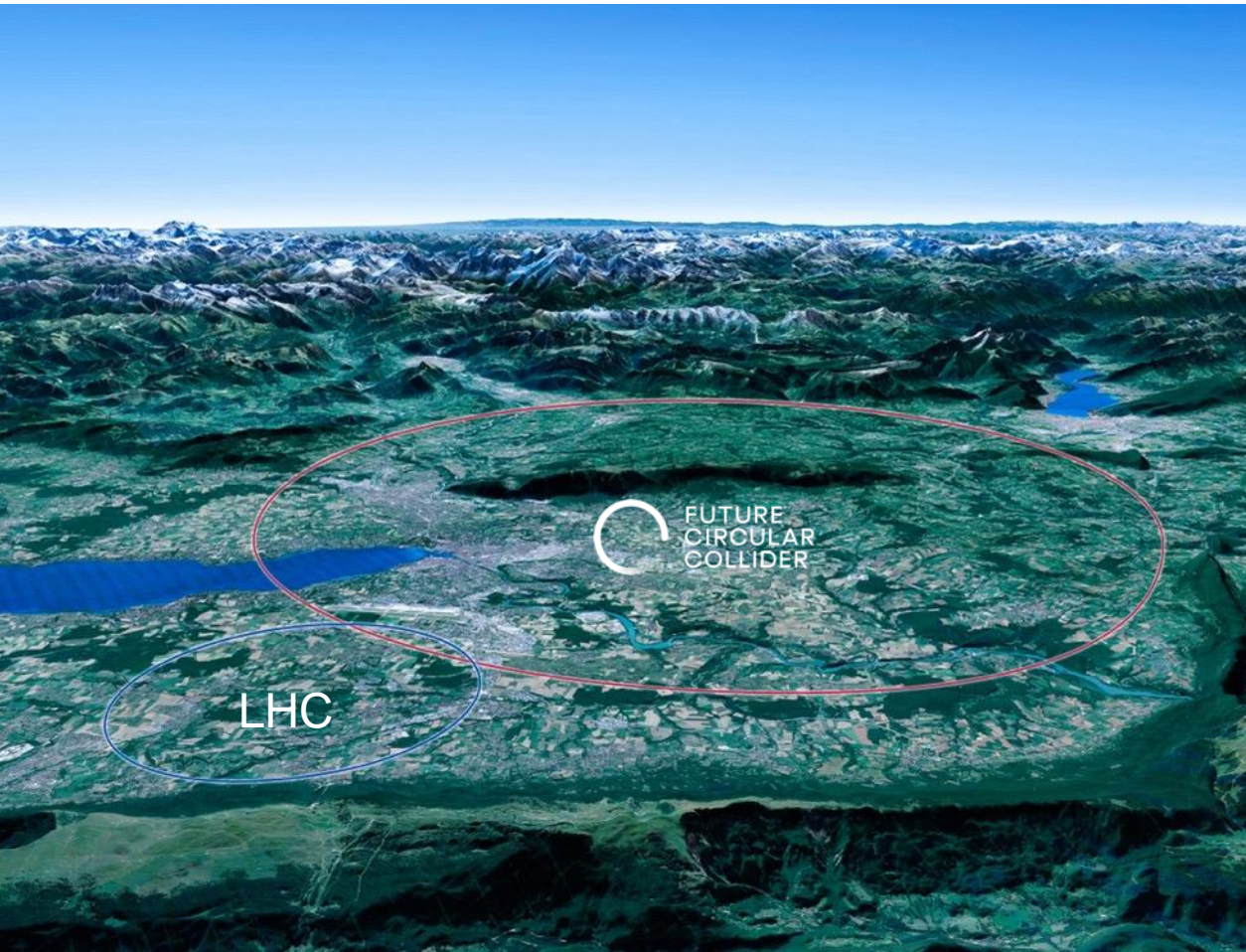
- The HL-LHC will use new technologies to provide 10 times more collisions than the LHC.
- It will give access to rare phenomena, greater precision and discovery potential.
- It will start operating in 2027, and run until 2040.



Scientific priorities for the future

Implementation of the recommendations
of the **2020 Update of the European Strategy
for Particle Physics:**

- Fully exploit the HL-LHC
- Build a Higgs factory to further understand this unique particle
- Investigate the technical and financial feasibility of a future energy-frontier 100 km collider at CERN
- Ramp up relevant R&D
- Continue supporting other projects around the world



A low-angle photograph of several flagpoles against a clear blue sky. The flagpoles are arranged in a diagonal line from the bottom left towards the top right. Various national flags are flying from the poles, including the Spanish flag, the Greek flag, the Italian flag, the German flag, the Danish flag, the Hungarian flag, the Finnish flag, and the flag of the United Nations. The sun is visible in the sky, creating a bright glow. On the left side, there is a large, semi-transparent orange circle containing the word "COLLABORATION" in white, uppercase letters.

COLLABORATION

Science for peace

CERN was founded in 1954 with 12 European Member States



23 Member States

Austria – Belgium – Bulgaria – Czech Republic
Denmark – Finland – France – Germany – Greece
Hungary – Israel – Italy – Netherlands – Norway
Poland – Portugal – Romania – Serbia – Slovakia
Spain – Sweden – Switzerland – United Kingdom

3 Associate Member States in the pre-stage to membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Latvia – Lithuania – Pakistan
Türkiye – Ukraine

6 Observers

Japan – Russia (suspended) – USA
European Union – JINR (suspended) – UNESCO

Around 50 Cooperation Agreements with non-Member States and Territories

Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bangladesh – Belarus – Bolivia
Bosnia and Herzegovina – Brazil – Canada – Chile – Colombia – Costa Rica – Ecuador – Egypt – Georgia – Honduras
Iceland – Iran – Jordan – Kazakhstan – Lebanon – Malta – Mexico – Mongolia – Montenegro – Morocco – Nepal
New Zealand – North Macedonia – Palestine – Paraguay – People's Republic of China – Peru – Philippines – Qatar
Republic of Korea – Saudi Arabia – Sri Lanka – South Africa – Thailand – Tunisia – United Arab Emirates – Vietnam

CERN's annual budget
is 1200 MCHF (equivalent
to a medium-sized European
university)

As of 31 December 2021
Employees:
2676 staff, **783** fellows

Associates:
11 175 users, **1556** others

A laboratory for people around the world

Distribution of all CERN Users by the country of their home institutes as of 31 December 2021



Geographical & cultural diversity
Users of **110 nationalities**
19.4% women

Member States **6642**

Austria 74 – Belgium 122 – Bulgaria 39 – Czech Republic 227
Denmark 42 – Finland 71 – France 811 – Germany 1129
Greece 133 – Hungary 69 – Israel 67 – Italy 1423
Netherlands 157 – Norway 69 – Poland 278 – Portugal 89
Romania 105 – Serbia 36 – Slovakia 66 – Spain 328
Sweden 88 – Switzerland 372 – United Kingdom 847

Associate Member States in the pre-stage to membership **55**

Cyprus 10 – Estonia 24 – Slovenia 21

Associate Member States **367**

Croatia 36 – India 130 – Latvia 11 – Lithuania 12 – Pakistan 30
Türkiye 122 – Ukraine 26

Observers **2917**

Japan 189 – Russia (suspended) 971 – United States of America 1757



Numbers for Spain



- Personnel by nationality as of 31 December 2021
 - **386 users**
 - **169 staff**
 - **88 fellows**

Non-Member States and Territories **1194**

Algeria 3 – Argentina 16 – Armenia 10 – Australia 20 – Azerbaijan 3 – Bahrain 2 – Belarus 24 – Brazil 106
Canada 189 – Chile 23 – Colombia 18 – Cuba 3 – Ecuador 6 – Egypt 16 – Georgia 36 – Hong Kong 17
Iceland 3 – Indonesia 6 – Iran 11 – Ireland 6 – Jordan 5 – Kuwait 5 – Lebanon 15 – Madagascar 1
Malaysia 4 – Malta 2 – Mexico 48 – Montenegro 5 – Morocco 18 – New Zealand 8 – Oman 1 – People's
Republic of China 314 – Peru 2 – Philippines 1 – Republic of Korea 113 – Singapore 3 – South Africa 52
Sri Lanka 10 – Taiwan 45 – Thailand 18 – United Arab Emirates 6

CERN is a model for open and inclusive collaboration



The LHC experiments are models of consensus building, competition and cooperation.

SESAME, a synchrotron light source in Jordan, is modelled on CERN's governance structure.



CERN provides the IT infrastructure for the satellite-analysis technology used for emergency response.



TECHNOLOGY & INNOVATION

CERN's technological innovations have applications in many fields

CERN is the birthplace of the World Wide Web

And there are many more examples

Medical imaging, cancer therapy, material science, cultural heritage, aerospace, automotive, environment, health & safety, industrial processes.

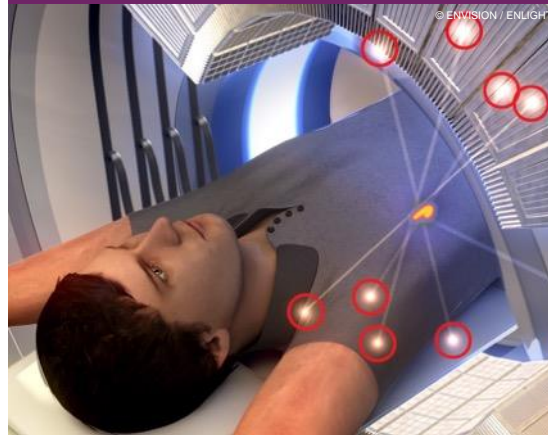
CERN's technological innovations have important applications in medicine and healthcare



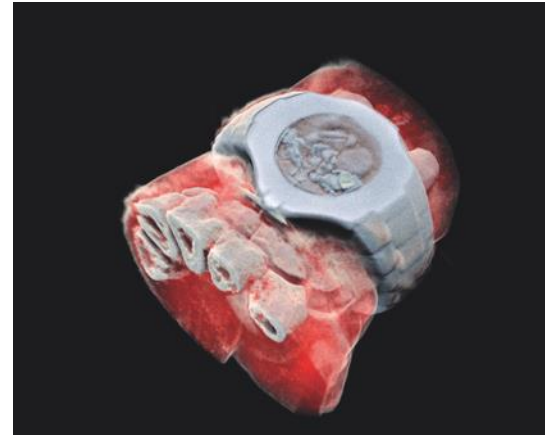
© CNAO

Accelerator technologies are applied in cancer radiotherapy with protons, ions and electrons.

Technologies applied at CERN are also used in PET, for medical imaging and diagnostics.



© ENVISION / ENLIGHT



Pixel detector technologies are used for high resolution 3D colour X-ray imaging.

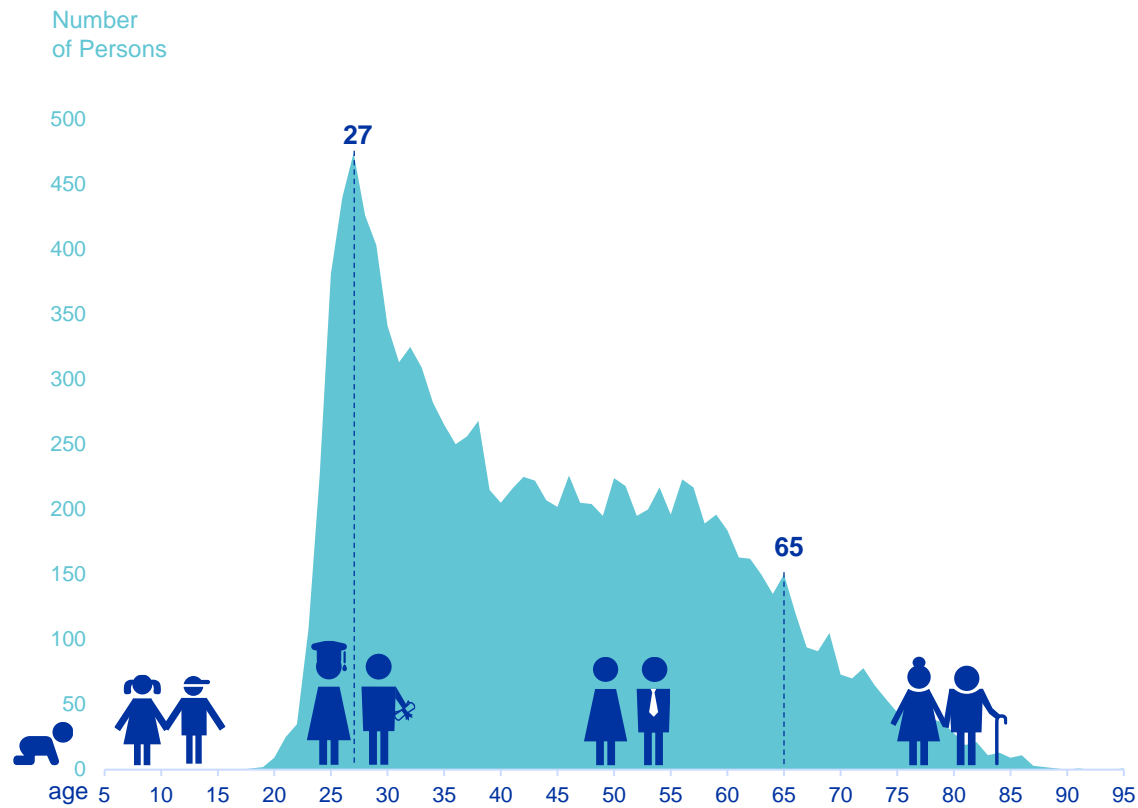
CERN produces innovative radioisotopes for nuclear medicine research.



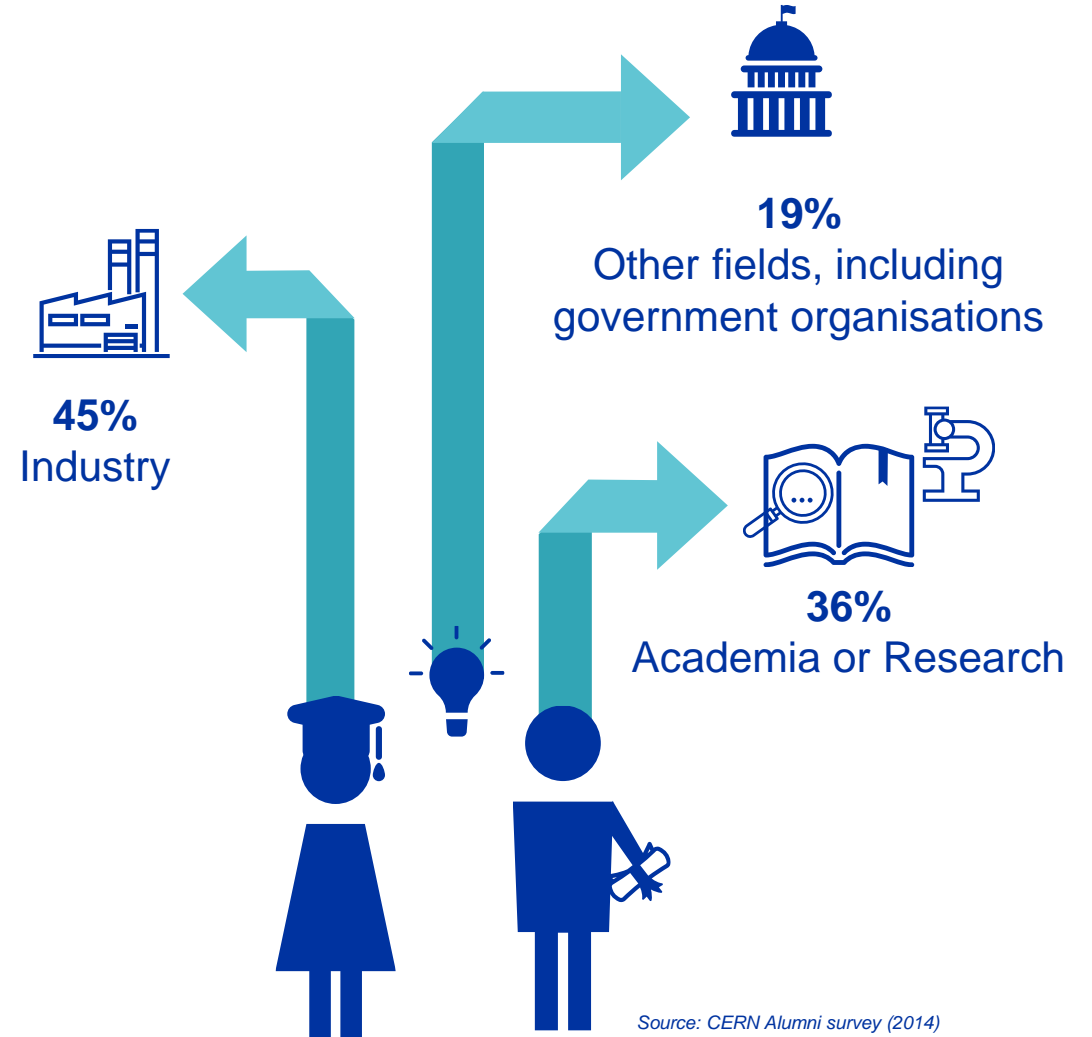
A group of students, both male and female, are wearing hard hats (yellow and blue) and are focused on working with a large, complex piece of equipment. The equipment is mounted on a metal frame and has a large black cylindrical component. The students are looking intently at the equipment, with some reaching out to touch it. The background shows a laboratory or workshop environment with various cables and equipment. A green exit sign is visible on the wall. A large teal circle is overlaid on the left side of the image, containing the text 'EDUCATION & TRAINING'.

EDUCATION & TRAINING

CERN opens a world of career opportunities



Age Distribution of Scientists working at CERN



PhD and Technical students leaving CERN

Source: CERN Alumni survey (2014)

CERN's training, education and outreach programmes

300 Undergraduate students in Summer programmes
>3000 registered PhD students.

>1000 Fellows, Technical and Doctoral Students in research and applied physics, engineering and computing.

13 304 teachers since 1998 and 2000 participants in the webinar since 2020.



Numbers for Spain



11 summer students during 2019
656 teachers in Teacher Programmes since 1998
114 teams in BL4S competition since 2014
1252 students participating in S'Cool LAB since 2015
4348 Spanish visitors in 2019

151 000 visitors on guided tours of CERN in 2019, from 95 countries.

CERN engages with citizens across the globe:
on-site and travelling exhibitions in 15 countries, > 1 million visitors

Science Gateway will open in 2023, expanding CERN's outreach reach and impact, locally and globally.

CERN Science Gateway



CERN's new education and outreach centre for all publics aged 5-plus.

Immersive exhibitions, education labs, events and shows.

<https://visit.cern>

Spain has a strong tradition in particle physics

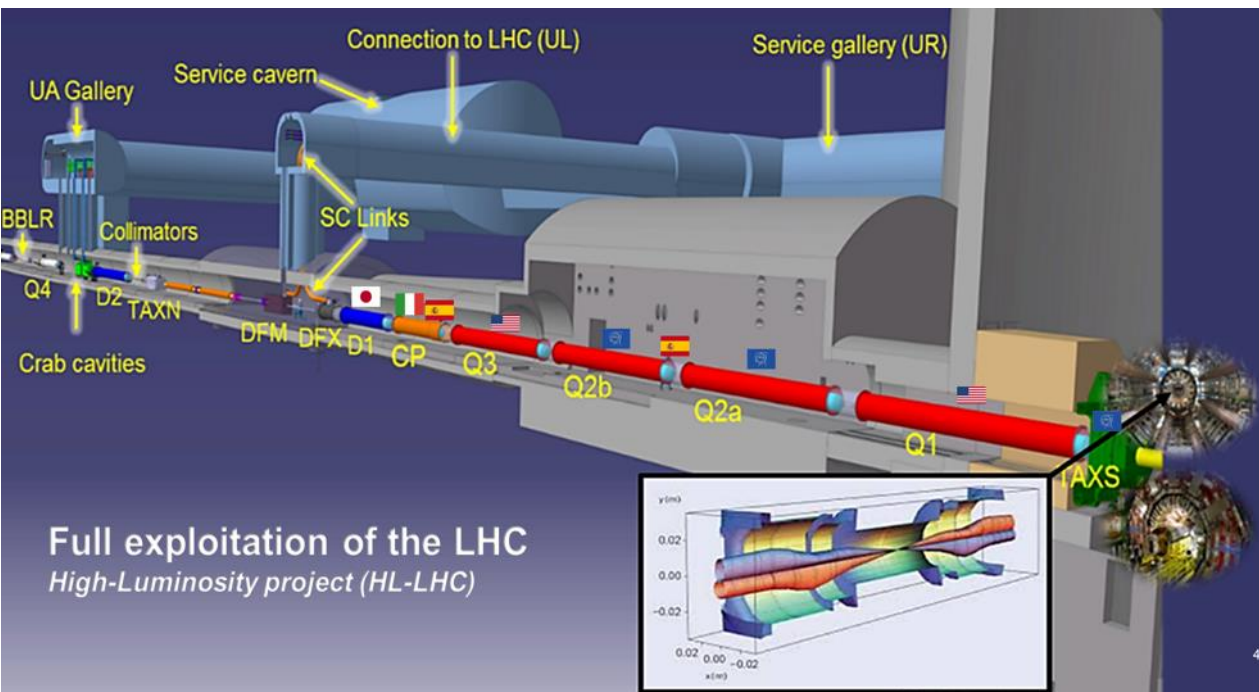
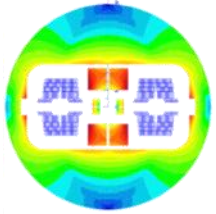


- Spain re-joined as a member state in 1983
- Spain has ~452 persons in the payroll, half of them Fellows, Students and Project Associates most Engineers and Physicists
- 80% of Spanish have an academic level
- Scientists in Spain (~384 users registered today) have made very important contributions to the advance of experimental Particle Physics and have maintained a strong involvement in CERN
- And a long-standing collaboration in theoretical physics

8 October, 2019; Minister for Science, Innovation and Universities P. Duque in the LHC tunnel at Point 5 with Technology Department Head J.M. Jiménez.



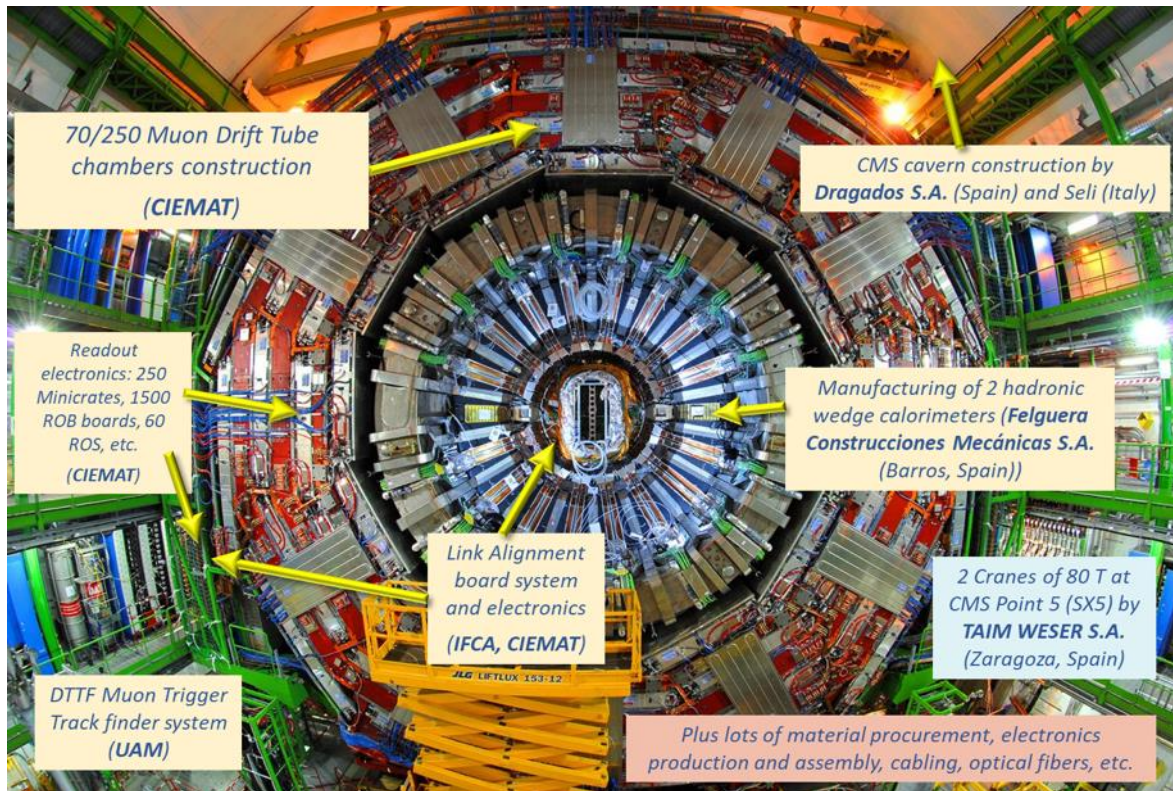
Spain is collaborating on forefront High Field Magnet technology involving Spanish Industry



- Spain also actively participates in European Grid activities
- Spain contributes in-kind to the HL-LHC project by supplying the Nested orbit correctors
- Spain is a strong partner of the High Field Magnet R&D program launched by CERN in a tripartite CERN-CIEMAT-CDTI (~30.4 MCHF)
- Spain is collaborating on Technologies for Ion Therapy centres

Spain flag pointing the in-kind contribution for HL-LHC Project (2.4% of the in-kind)

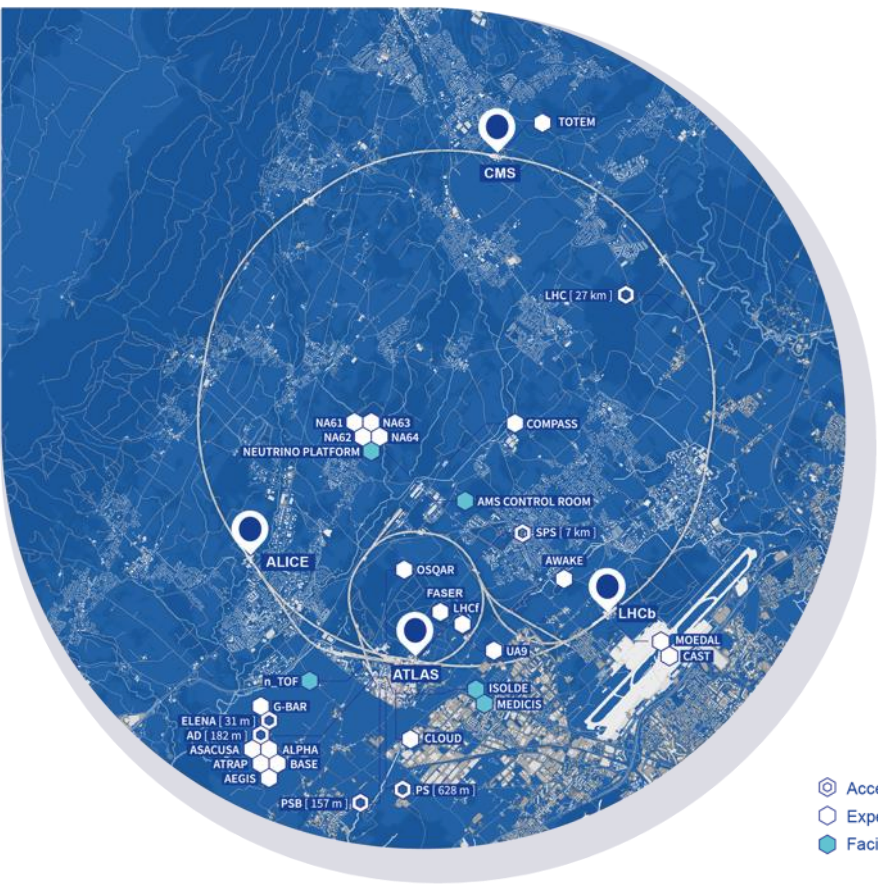
Spain is collaborating on forefront High Field Magnet technology involving Spanish Industry



- Spain has experience and capacity to lead large contributions to Experiments
- Spanish Institutes are expecting to contribute to LHC Detector's Upgrades, MoUs expected to be signed in 2022
- Spanish Institutes have been also very proactive on the Nuclear Physics domain, contributing to several initiatives in n-ToF and ISOLDE e.g. IDS, TAL, MINIBALL, T-REX, etc.

Spain historical contribution from Spanish companies and institutions, example of the CMS detector

Spain has a strong involvement across the CERN experimental programme



LHC EXPERIMENTS:

ATLAS 5 Institutes, 150 members

CMS 6 Institutes, 113 members

LHCb 5 Institutes, 81 members

FIXED TARGET EXPERIMENTS

- n_TOF
- **Neutrino Platform**
10 institutes, 56 members

ISOLDE

10 institutes, 55 members

OTHER LHC Experiments

MoEDAL 1 Institute, 1 member

Spain hosts the PIC, one of the leading European centres in Barcelona (Tier-1 for ATLAS, CMS and LHCb, and 3 distributed TIER-2 centres)



Spain & CERN



Industrial Returns

Spanish Industry has a strong record of producing equipment and providing services for CERN resulting in a return coefficient close to 1 on both of them (>35 MCHF)

R&D Collaborations

- Strong collaboration with CELLS, CIEMAT & IFAE for HL-LHC, HFM & FCC
- Collaboration between CERN and CIEMAT on Medical applications

Collaboration on Education Programmes

- >120 Associates/Trainees working yearly for Project & Collaboration programmes
- >120 Master+ early career participating since 2015 to the FTEC Trainee programme
- >600 participants to CERN Teacher Program



There are many unanswered questions
in fundamental physics

**CERN will continue to play a crucial role
in the journey of exploration**