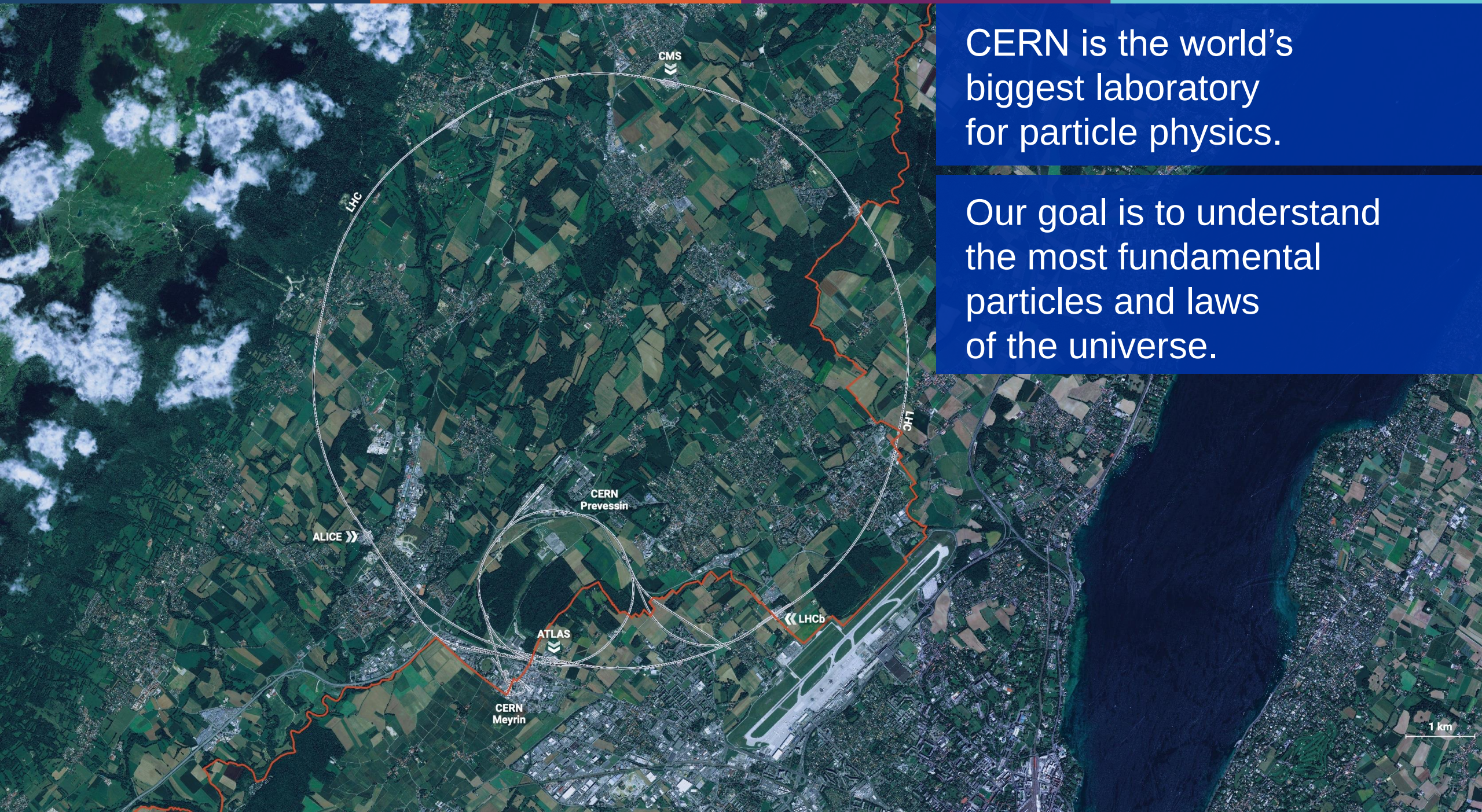
WELCOME TO CERN

Professor Emmanuel Tsesmelis
Principal Physicist
Head of Associate Member State and Non-Member State Relations
CERN

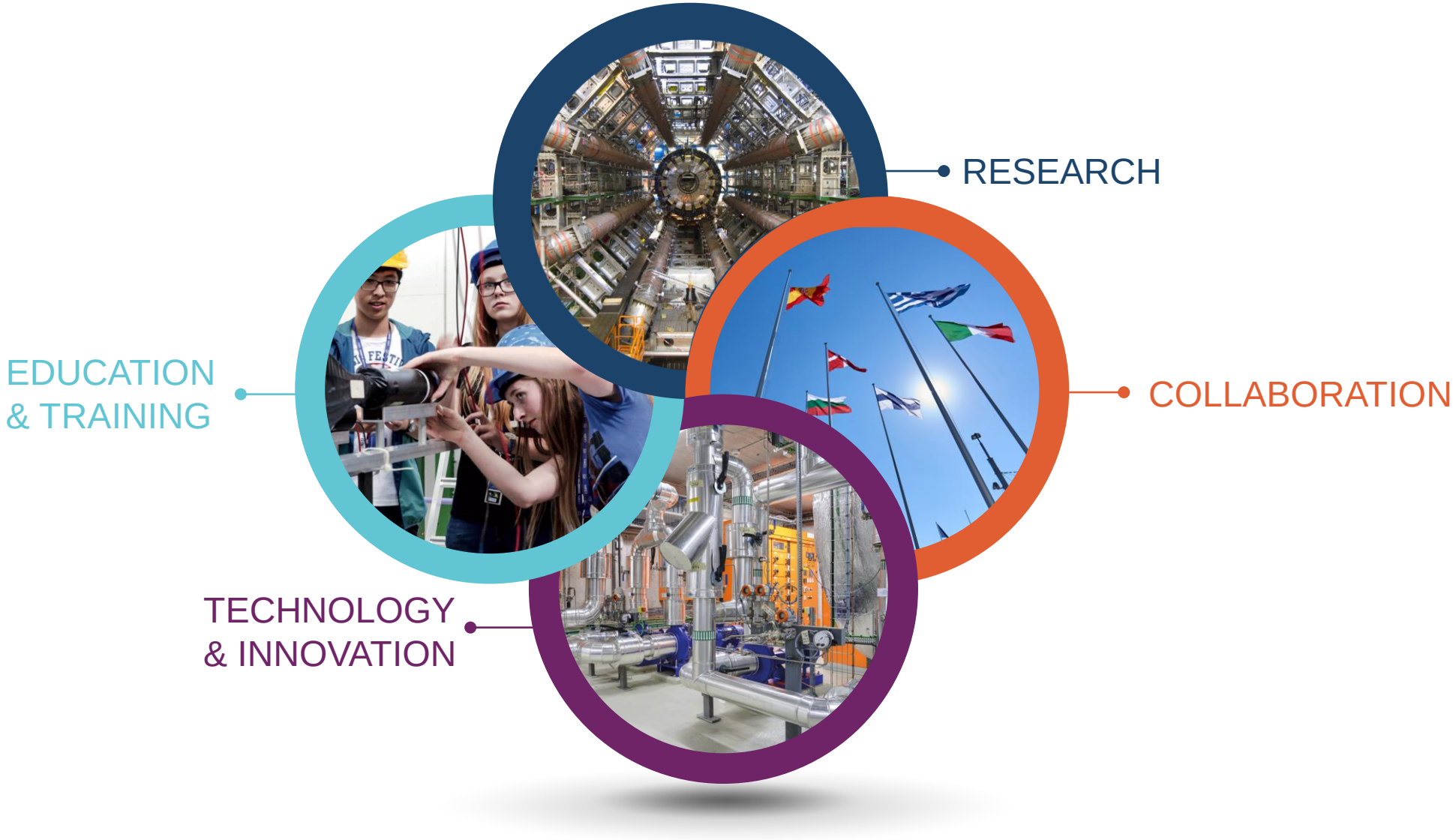
30 May 2023

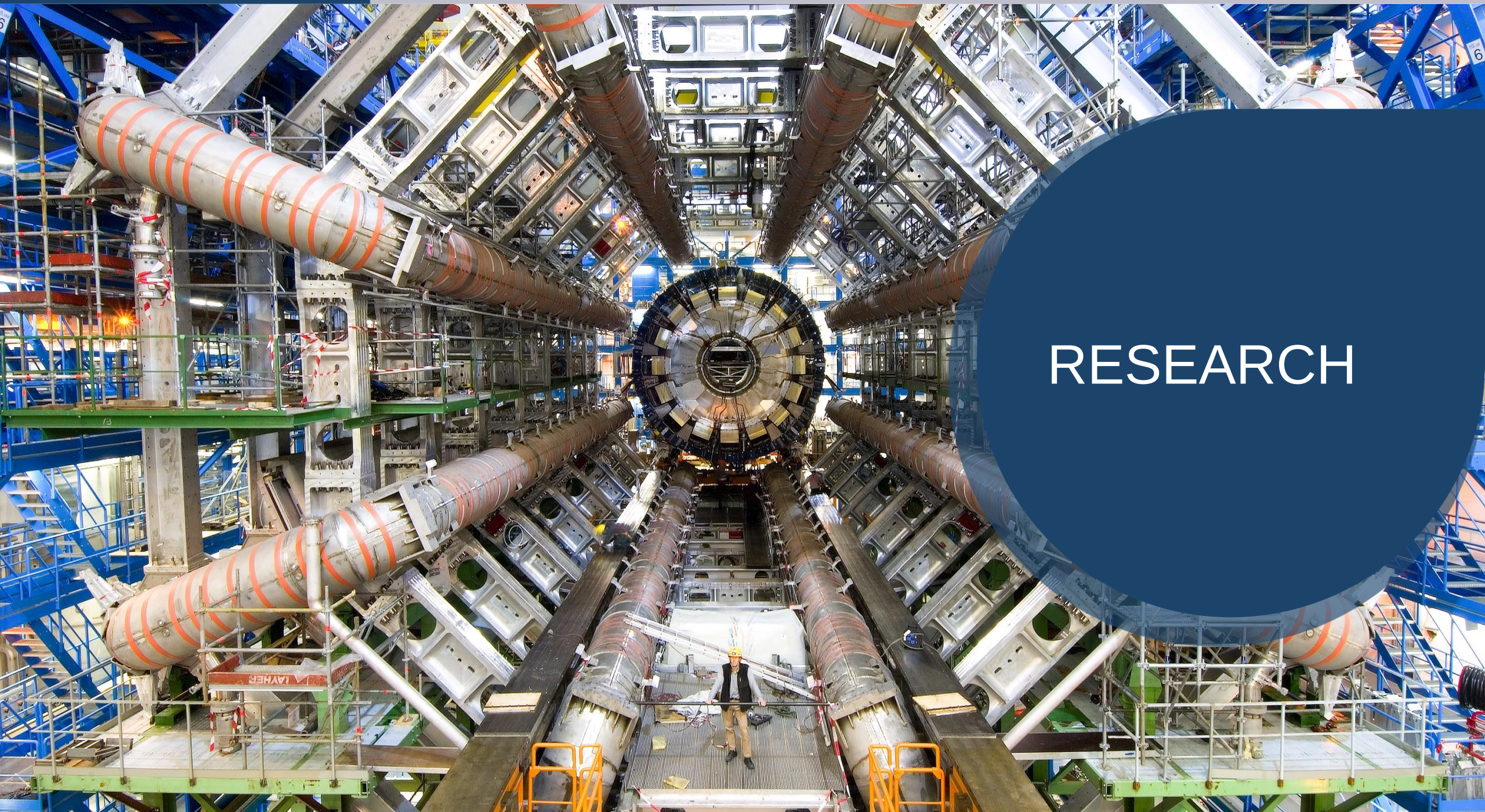


CERN is the world's biggest laboratory for particle physics.

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

Four pillars underpin CERN's mission

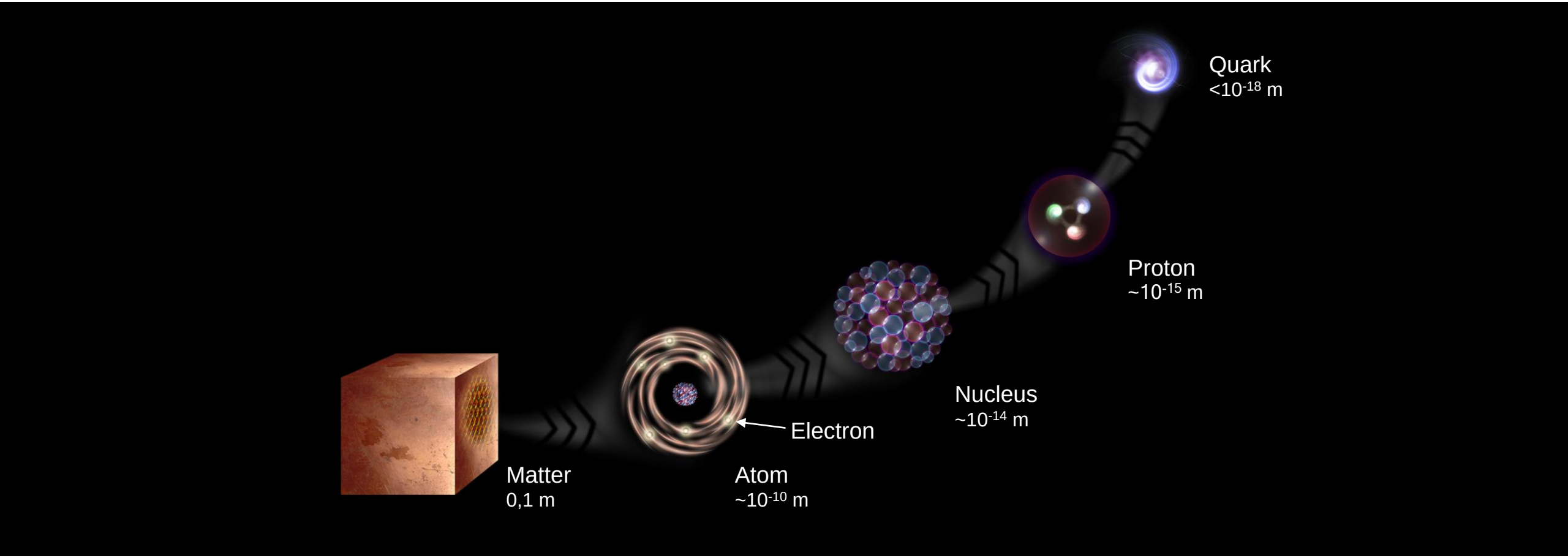


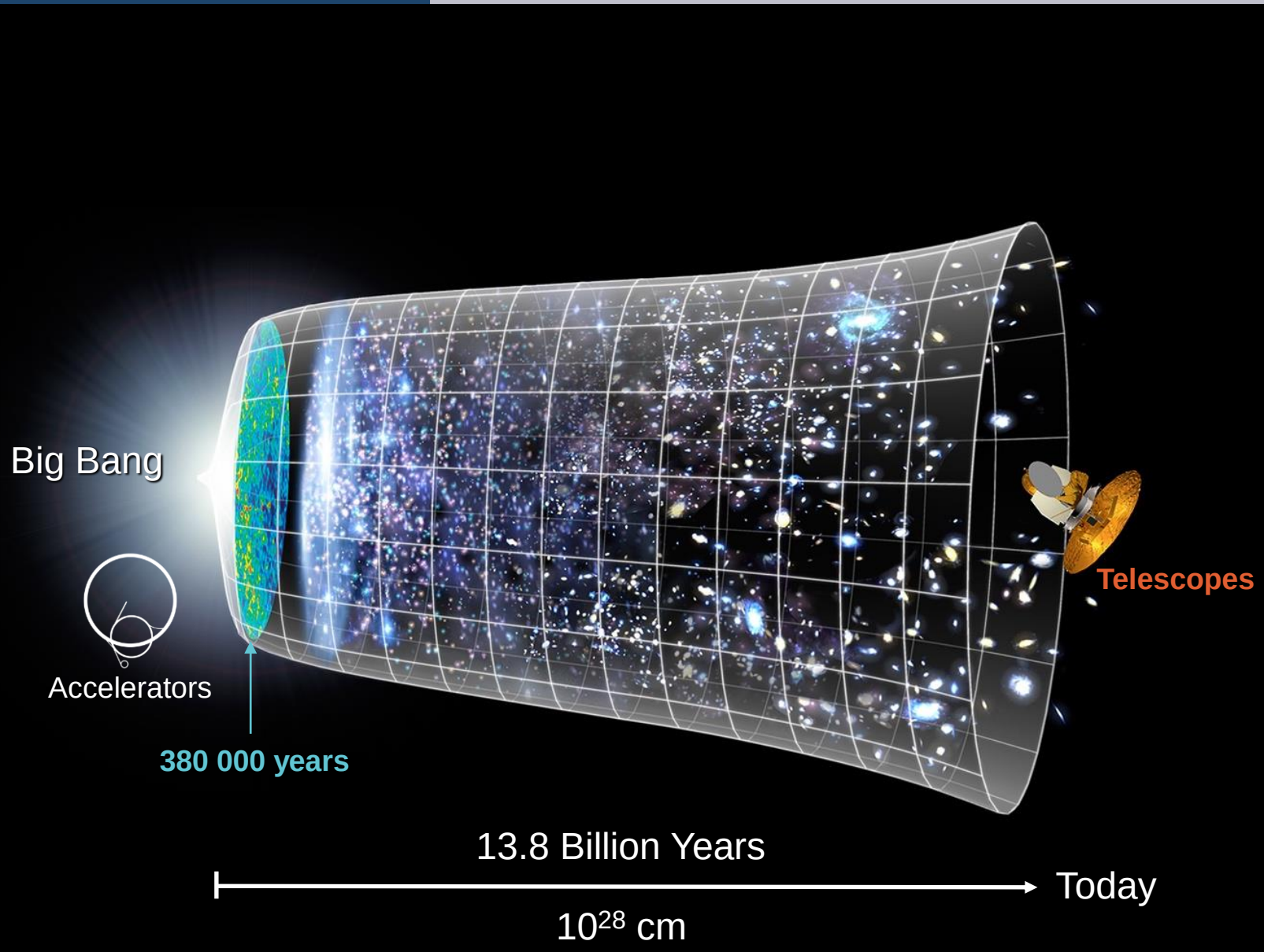


RESEARCH

What is the universe made of?

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





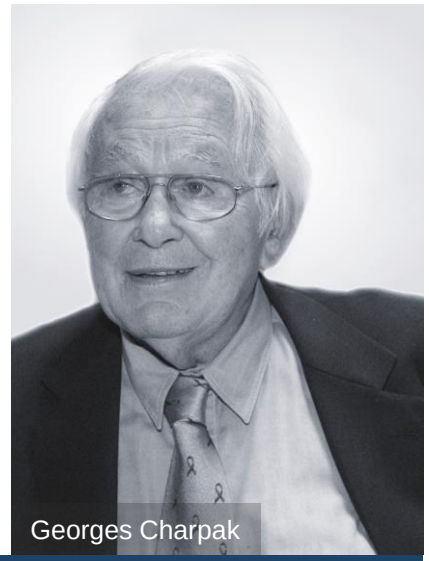
How did the universe begin?

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

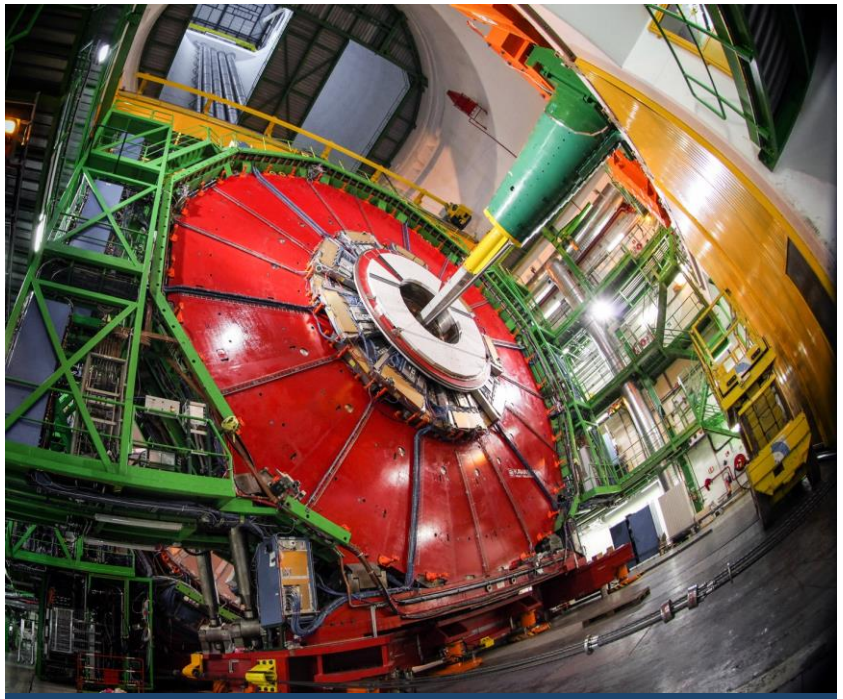
Several CERN scientists have received Nobel Prizes for key discoveries in particle physics.

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

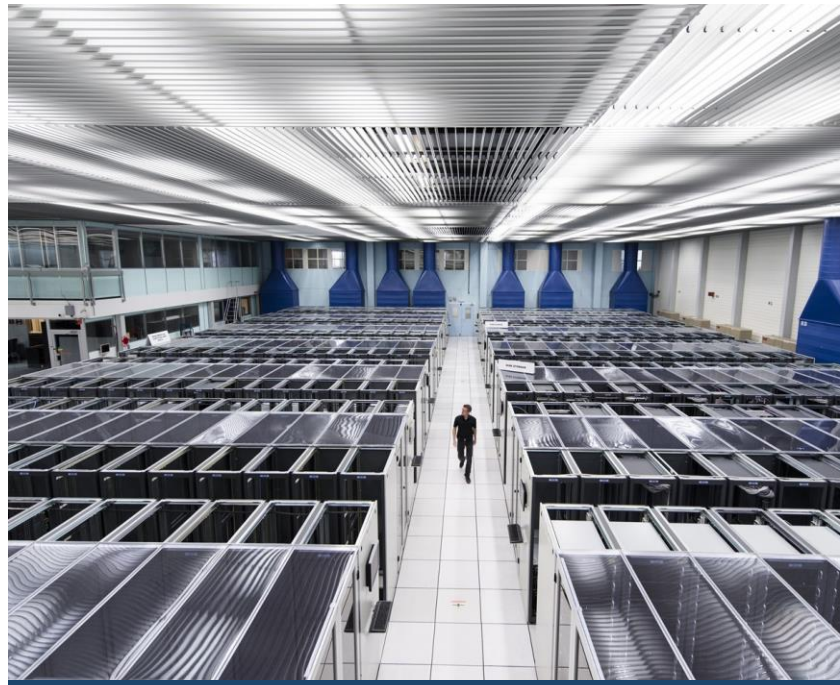

François Englert and Peter Higgs. With Robert Brout, they proposed the mechanism in 1964.

We develop technologies in three key areas

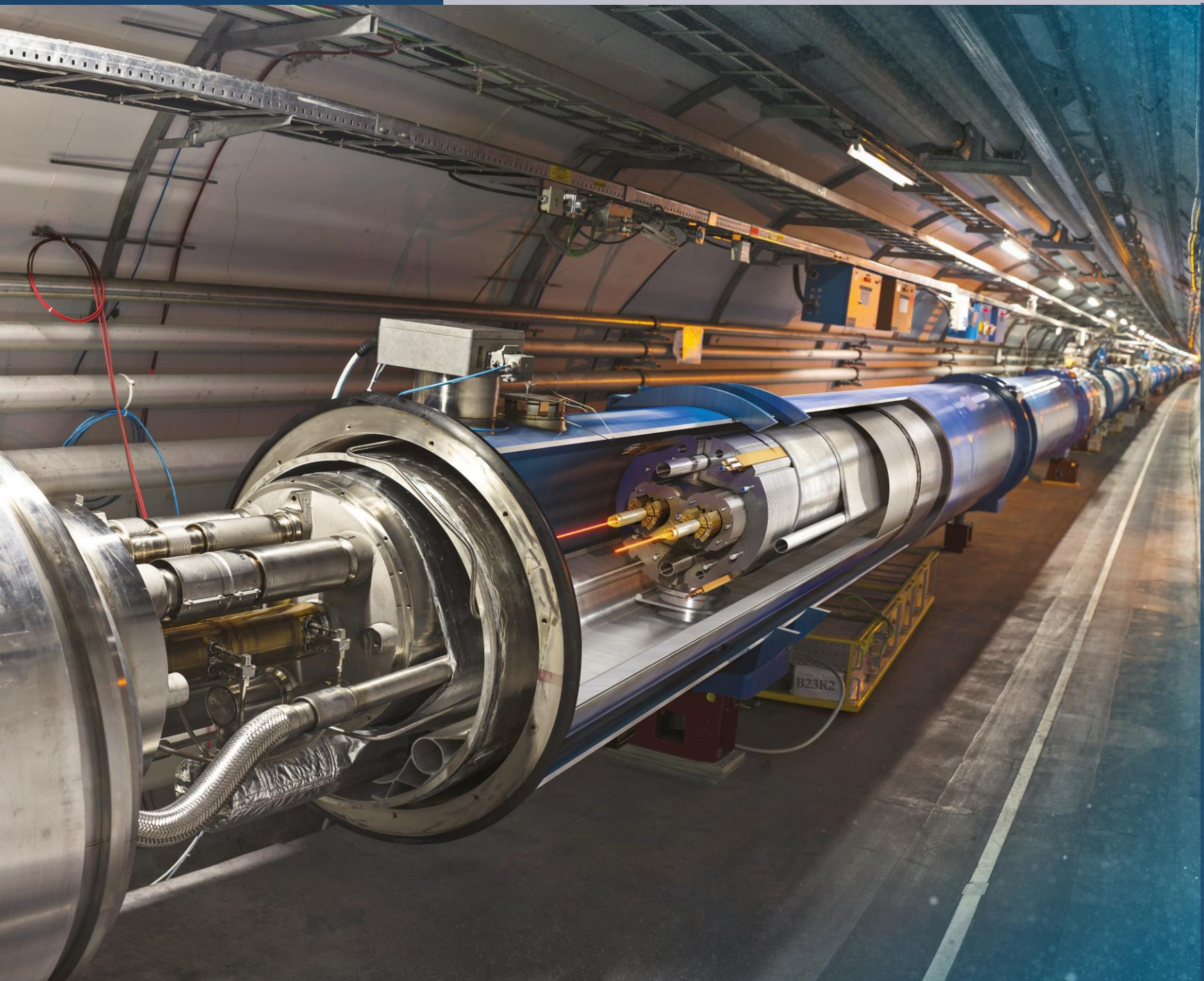
ACCELERATORS



DETECTORS



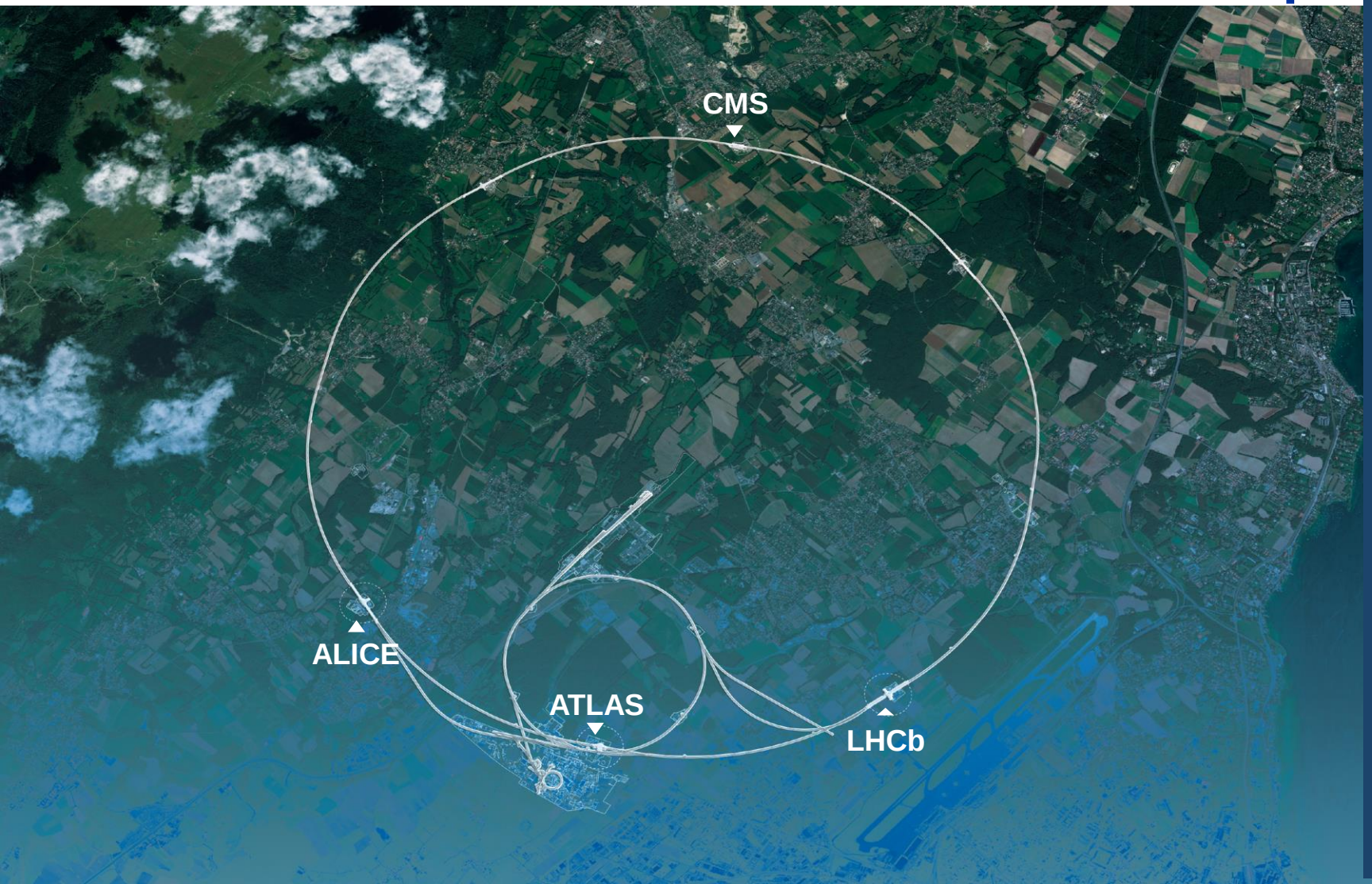
COMPUTING

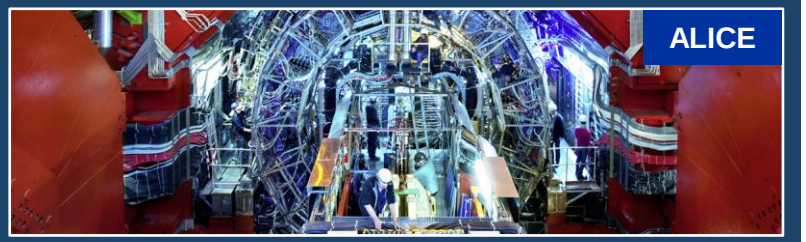


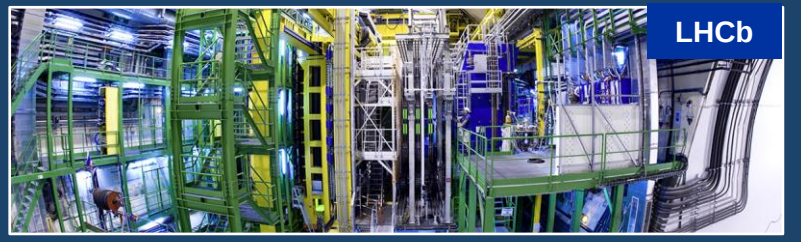
Large Hadron Collider (LHC)

- 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

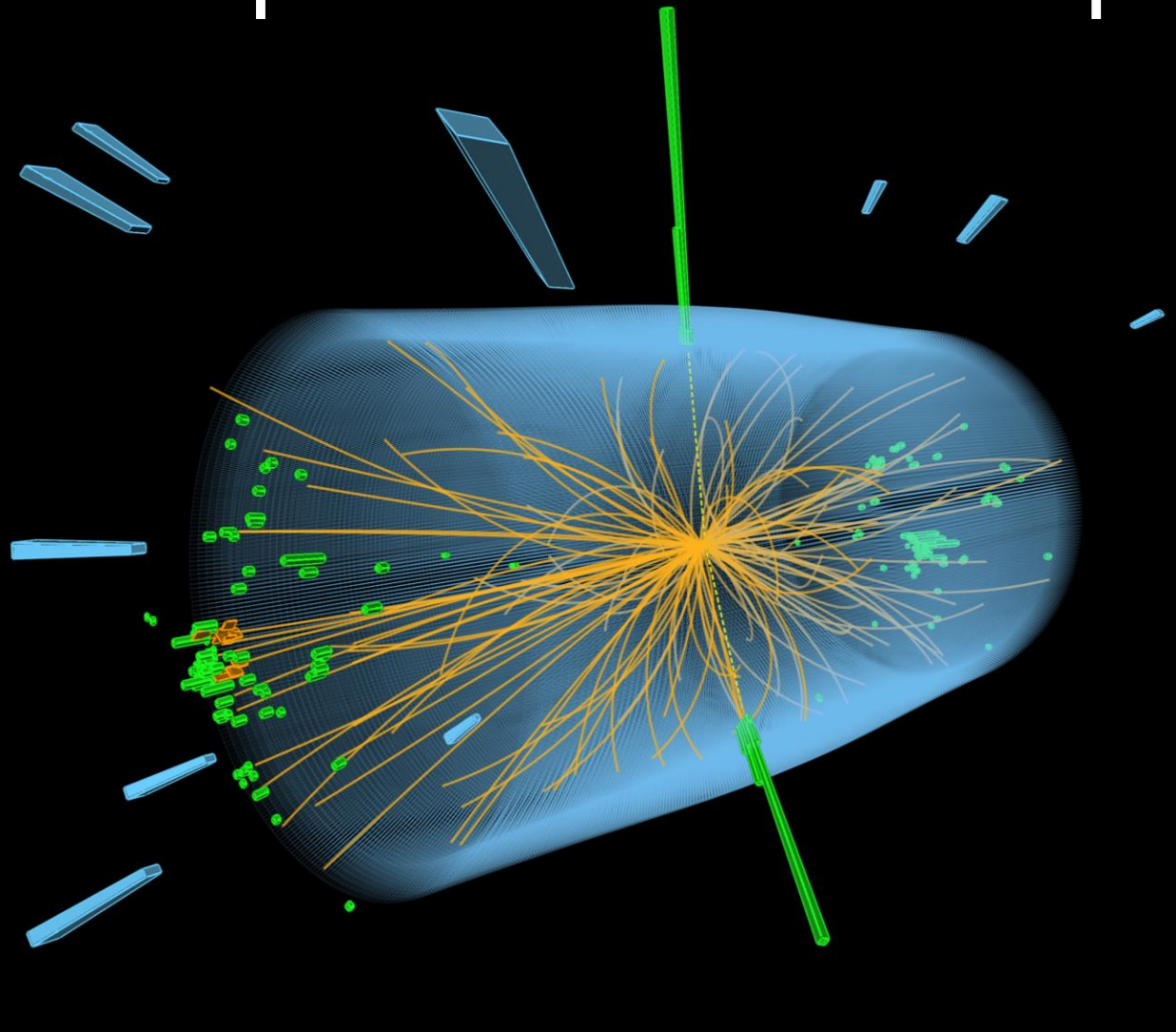
Giant detectors record the particles formed at the four collision points





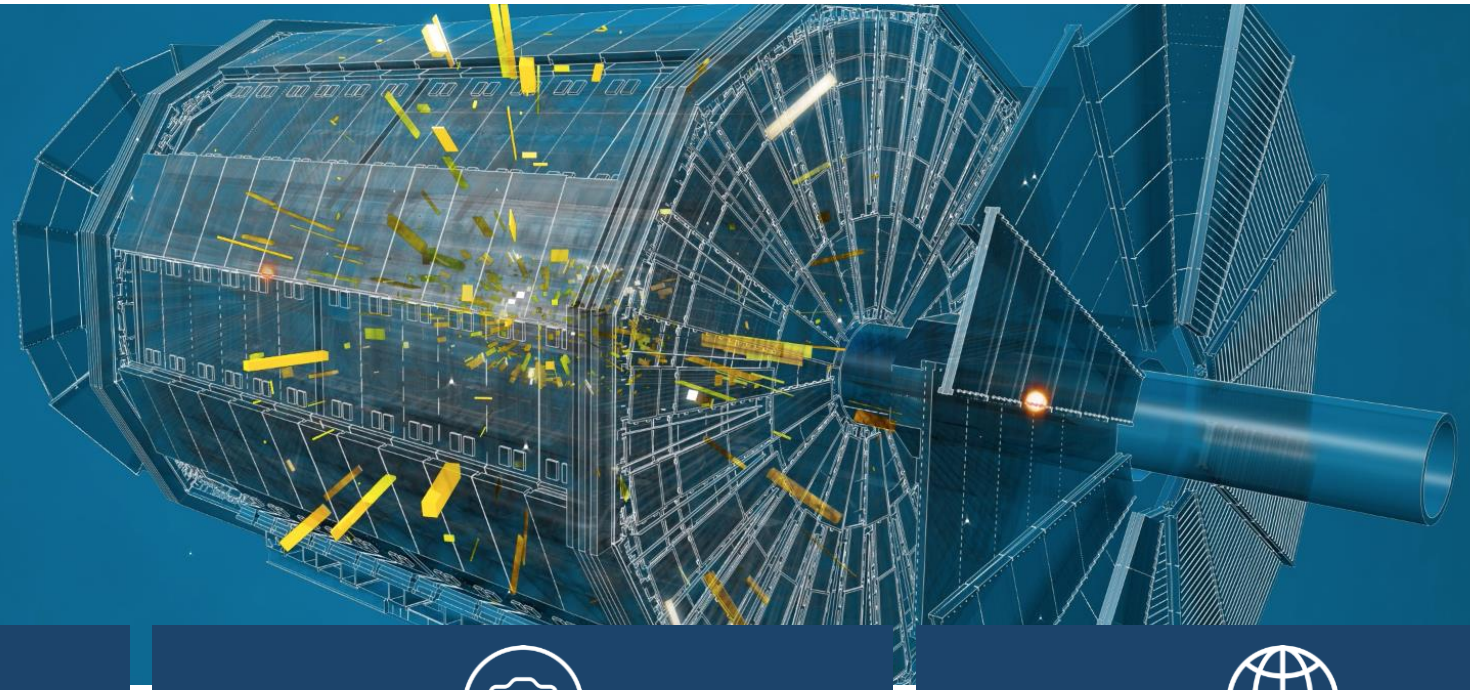


The LHC produces more than 1 billion particle collisions per second



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

The LHC detectors are analogous to 3D cameras

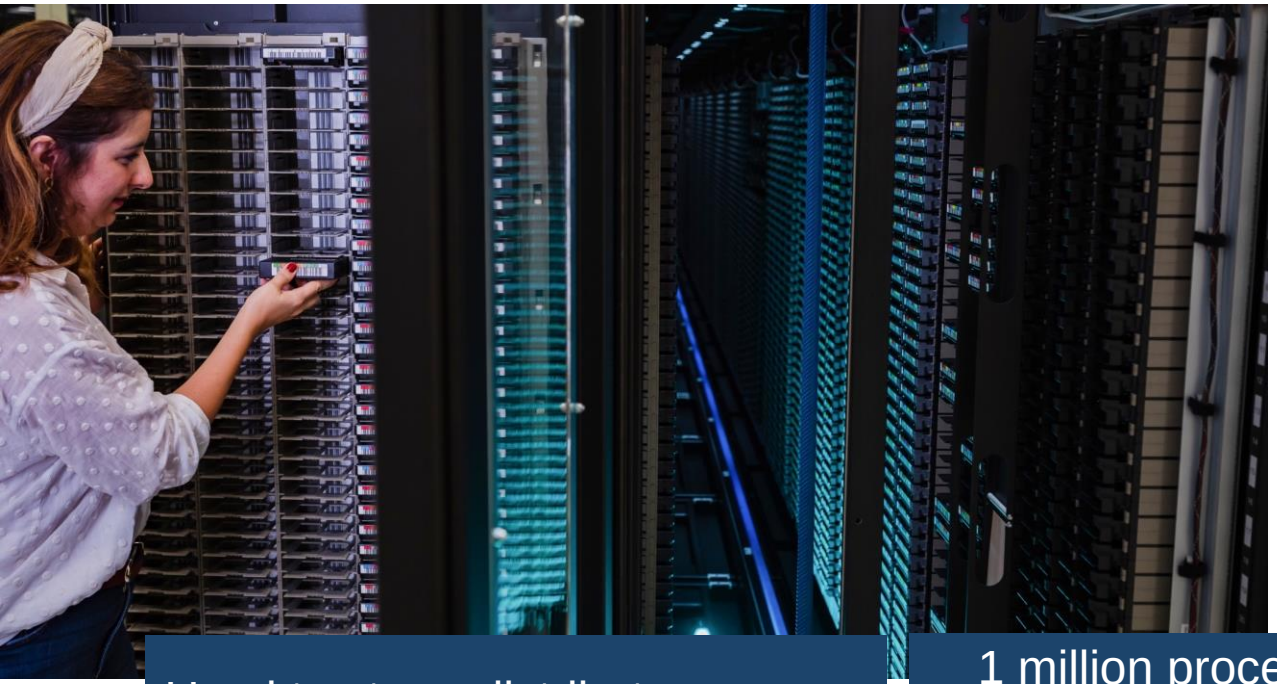


The detectors measure the energy, direction and charge of new particles formed.

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.

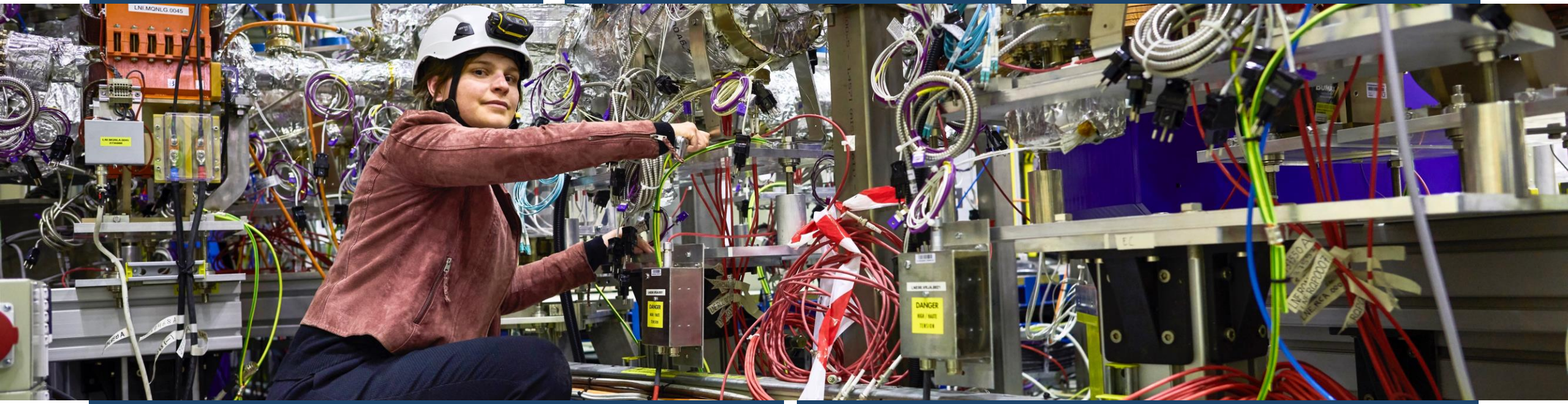
More than 1000 Petabytes of CERN data stored world-wide.

CERN has a diverse scientific programme

Nuclear Physics
(ISOLDE, n_TOF)

Antimatter Research
(Antiproton Decelerator)

Cosmic rays and cloud formation
(CLOUD)



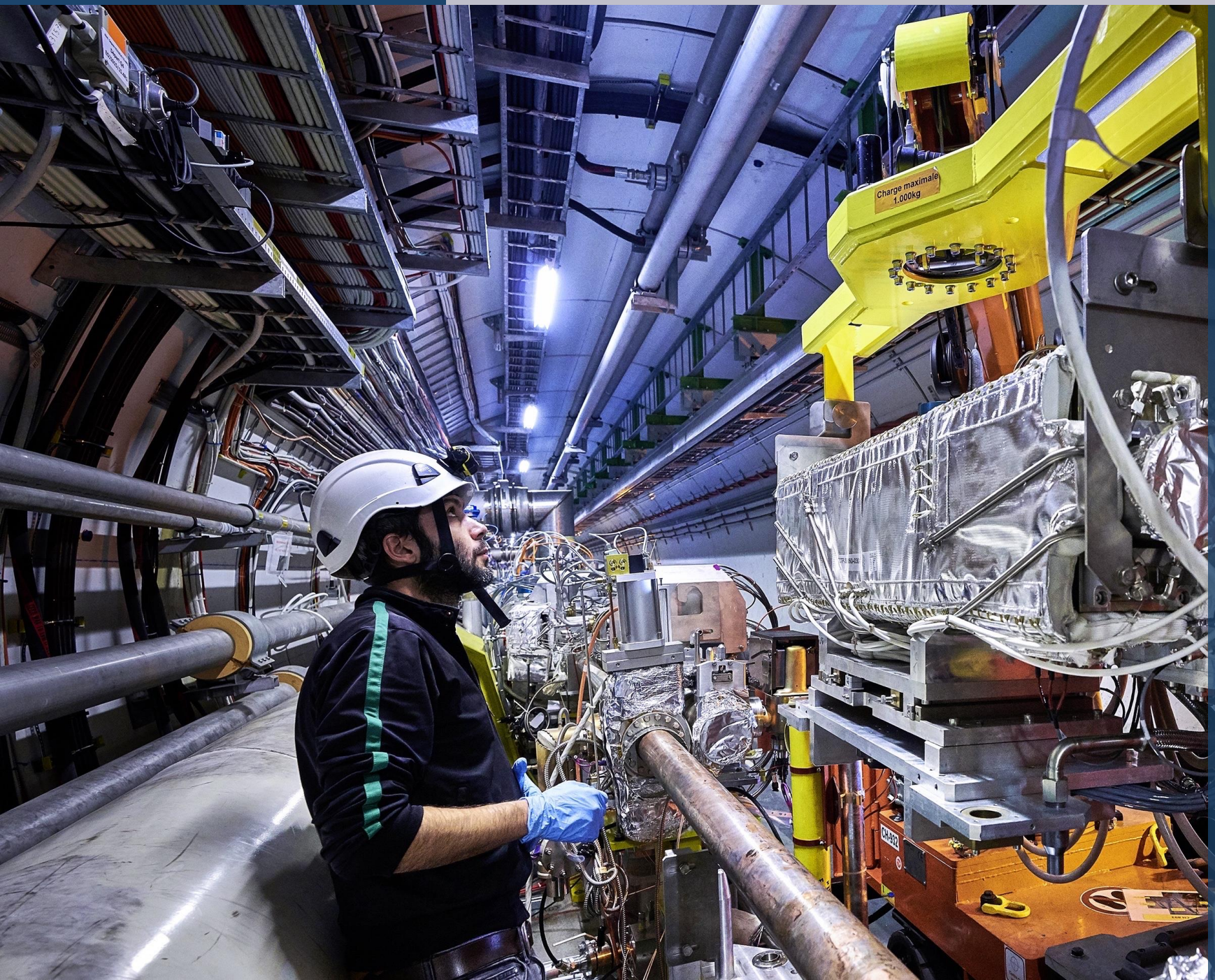
Fixed-target experiments,
which include searches for rare phenomena

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

There are many unanswered questions in fundamental physics

Including

What is the unknown 95% of the mass and energy of the universe?	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 2029, and run until approx. 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

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

(Brazil signed CERN Associate Membership Agreement in March 2022, to be ratified in parliament)

6 Observers

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

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

As of 31 December 2022
Employees:
2658 staff, **900** fellows

Associates:
11 860 users, **1516** others

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

A laboratory for people around the world

Distribution of all CERN Users by the country of their home institutes as of 31 December 2022

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

Member States 7147

Austria 85 – **Belgium** 129 – **Bulgaria** 43 – **Czech Republic** 244
Denmark 49 – **Finland** 90 – **France** 844 – **Germany** 1225
Greece 119 – **Hungary** 73 – **Israel** 64 – **Italy** 1527
Netherlands 169 – **Norway** 79 – **Poland** 305 – **Portugal** 100
Romania 109 – **Serbia** 33 – **Slovakia** 70 – **Spain** 383
Sweden 103 – **Switzerland** 406 – **United Kingdom** 898

Associate Member States in the pre-stage to membership **69**

Cyprus 15 – **Estonia** 30 – **Slovenia** 24

Associate Member States **382**

Croatia 38 – **India** 132 – **Latvia** 16 – **Lithuania** 14 – **Pakistan** 35
Türkiye 122 – **Ukraine** 25

Observers **2991**

Japan 216 – **Russia** (suspended) 873 – **United States of America** 1902

Non-Member States and Territories **1271**

Algeria 2 – **Argentina** 13 – **Armenia** 8 – **Australia** 21 – **Azerbaijan** 2 – **Bahrain** 4 – **Belarus** 18 – **Brazil** 122
Canada 199 – **Chile** 34 – **Colombia** 21 – **Costa Rica** 2 – **Cuba** 3 – **Ecuador** 4 – **Egypt** 20 – **Georgia** 32
Hong Kong 15 – **Iceland** 3 – **Indonesia** 5 – **Iran** 11 – **Ireland** 5 – **Jordan** 5 – **Kuwait** 4 – **Lebanon** 13 – **Madagascar** 1
Malaysia 4 – **Malta** 1 – **Mexico** 49 – **Montenegro** 4 – **Morocco** 19 – **New Zealand** 5 – **Nigeria** 1 – **Oman** 1
Palestine 1 – **People's Republic of China** 333 – **Peru** 2 – **Philippines** 1 – **Republic of Korea** 147 – **Singapore** 2
South Africa 52 – **Sri Lanka** 10 – **Taiwan** 45 – **Thailand** 17 – **Tunisia** 2 – **United Arab Emirates** 7 – **Viet Nam** 1

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

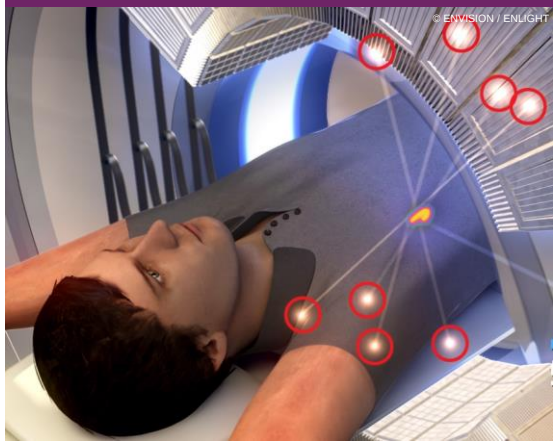
CERN is the birthplace of the World Wide Web

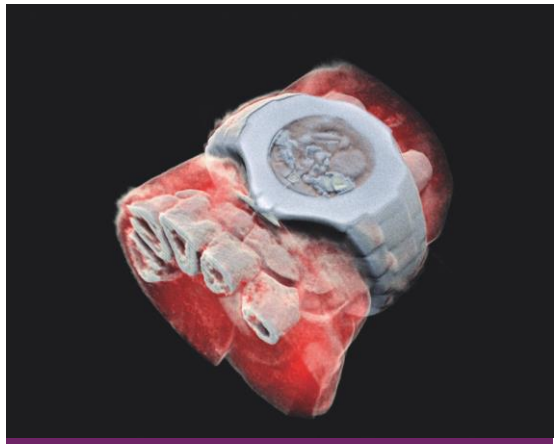
And there are many more examples
Medical imaging, cancer therapy, material science, cultural heritage, aerospace, automotive, environment, health & safety, industrial processes.

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

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.





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

CERN produces innovative radioisotopes for nuclear medicine research.

EDUCATION & TRAINING

CERN trains the next generation of physicists, engineers and technicians

>3000 PhD students are registered at CERN.

600 PhD theses are completed each year.

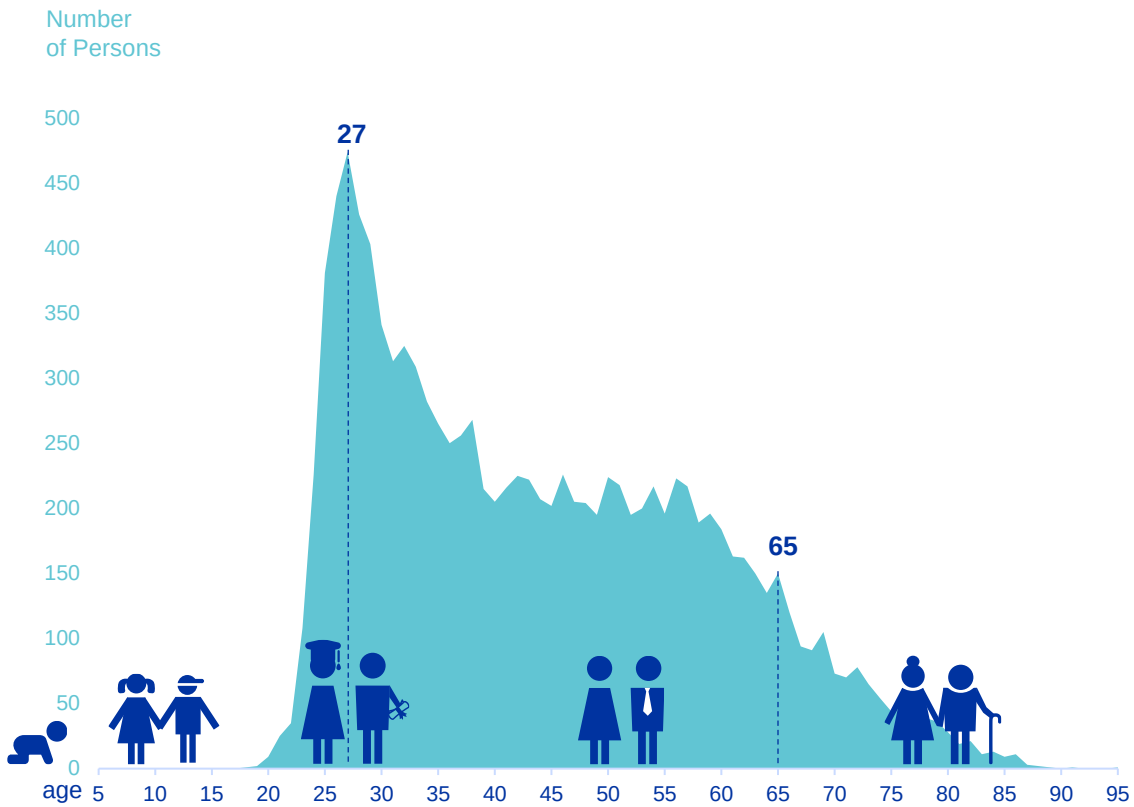
300 undergraduate students in Summer programmes.

~800 fellows in research and applied physics, engineering and computing.

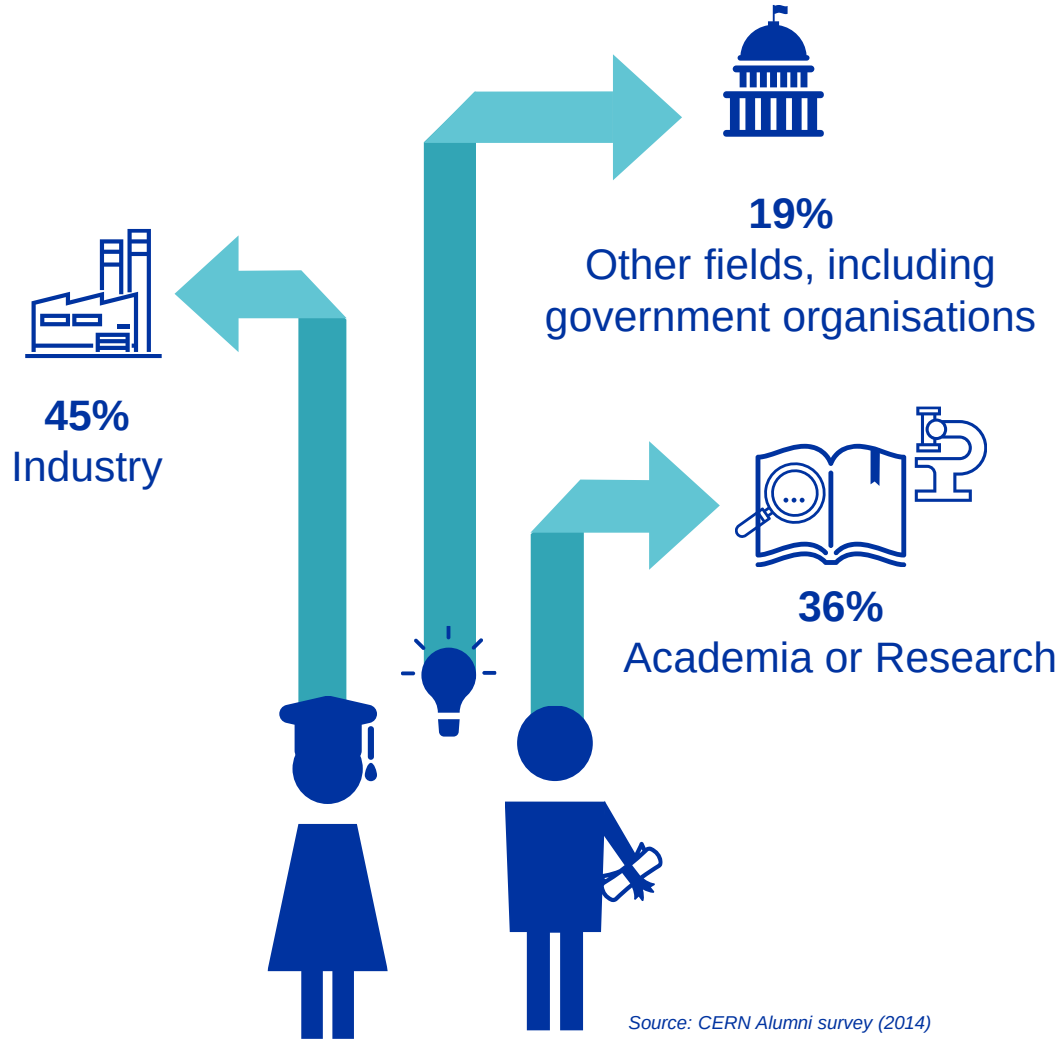
~200 Technical and Doctoral Students in applied physics, engineering and computing.

CERN organises schools for undergraduates and postgraduates, in all regions.

CERN opens a world of career opportunities



Age Distribution of Scientists working at CERN



PhD and Technical students leaving CERN

Our education programmes reach thousands of teachers and students from around the world each year

Teachers from > 40 countries participate in National and International Teacher Programmes

> 6000 students use S'Cool Lab, for hands-on physics experiments

> 1000 students propose an experiment to carry out at CERN in the Beamline4Schools competition

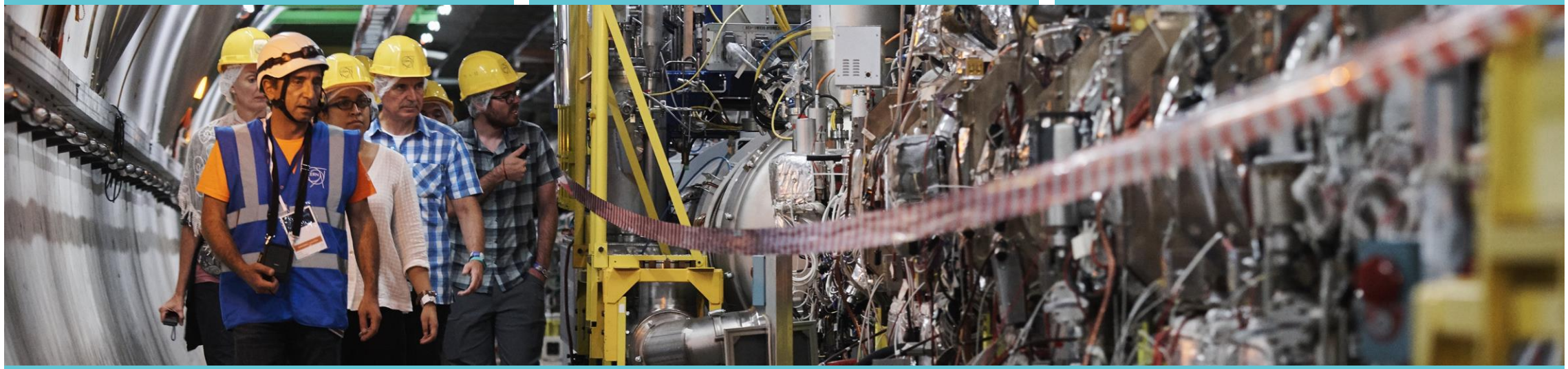
22 students from each Member State shadow researchers in the High-School Student Internship Programme

CERN engages with citizens across the globe

151 000 visitors on guided tours of CERN in 2019, from 95 countries
(> 60% come from more than 600 km away).

On-site and travelling exhibitions in 15 countries, with >1 million visitors.

Open Days during Long Shutdowns: two days in 2019, 75 000 visitors, 2800 volunteers.



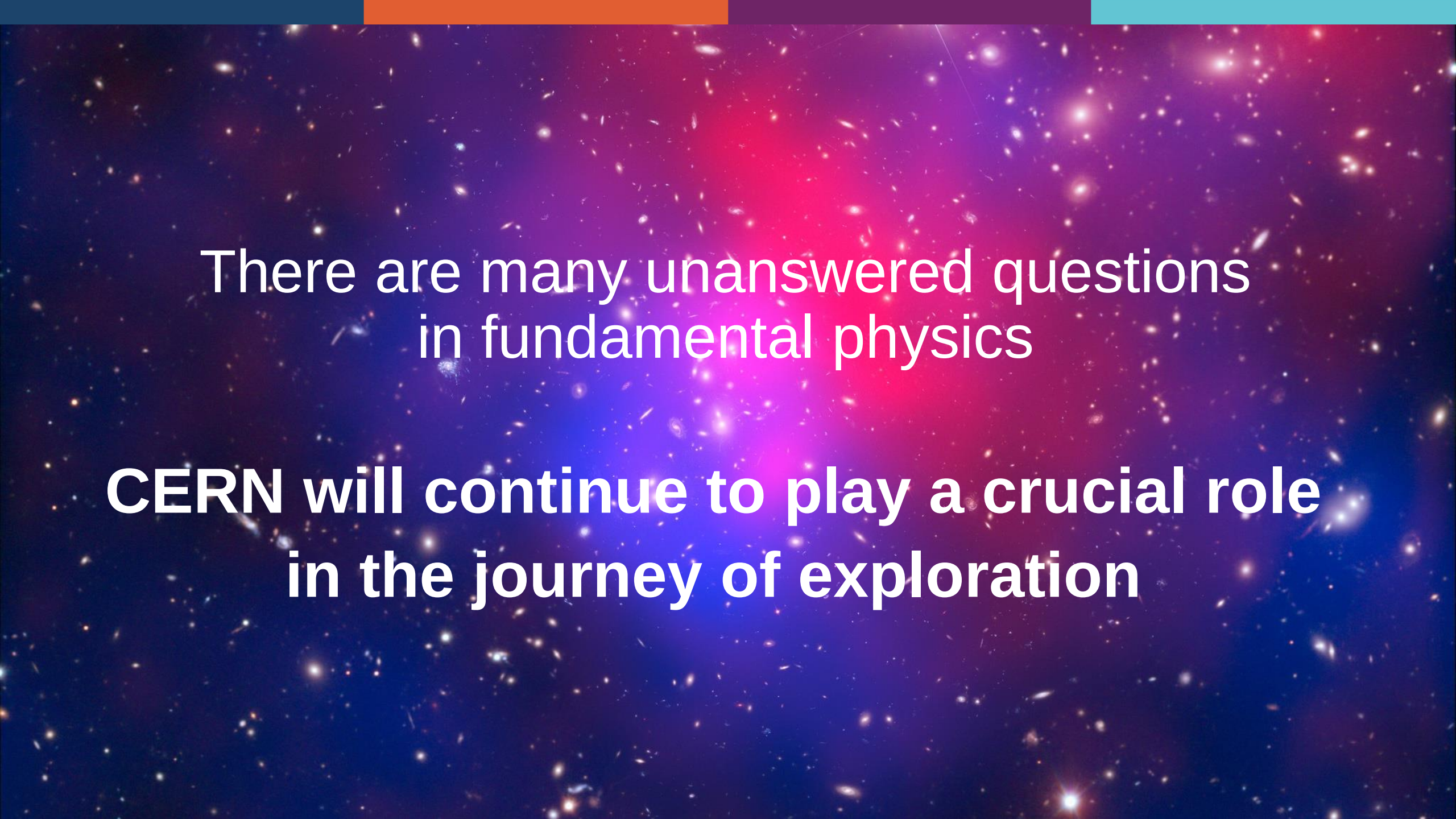
During the COVID-19 pandemic, several outreach and education activities moved online: virtual talks by CERN guides for schools and general public; educational resources; social media “lives” from LHC experiments and other facilities.

CERN Science Gateway

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

Opening Autumn 2023.

Immersive exhibitions, education labs, events and shows.


There are many unanswered questions
in fundamental physics
CERN will continue to play a crucial role
in the journey of exploration