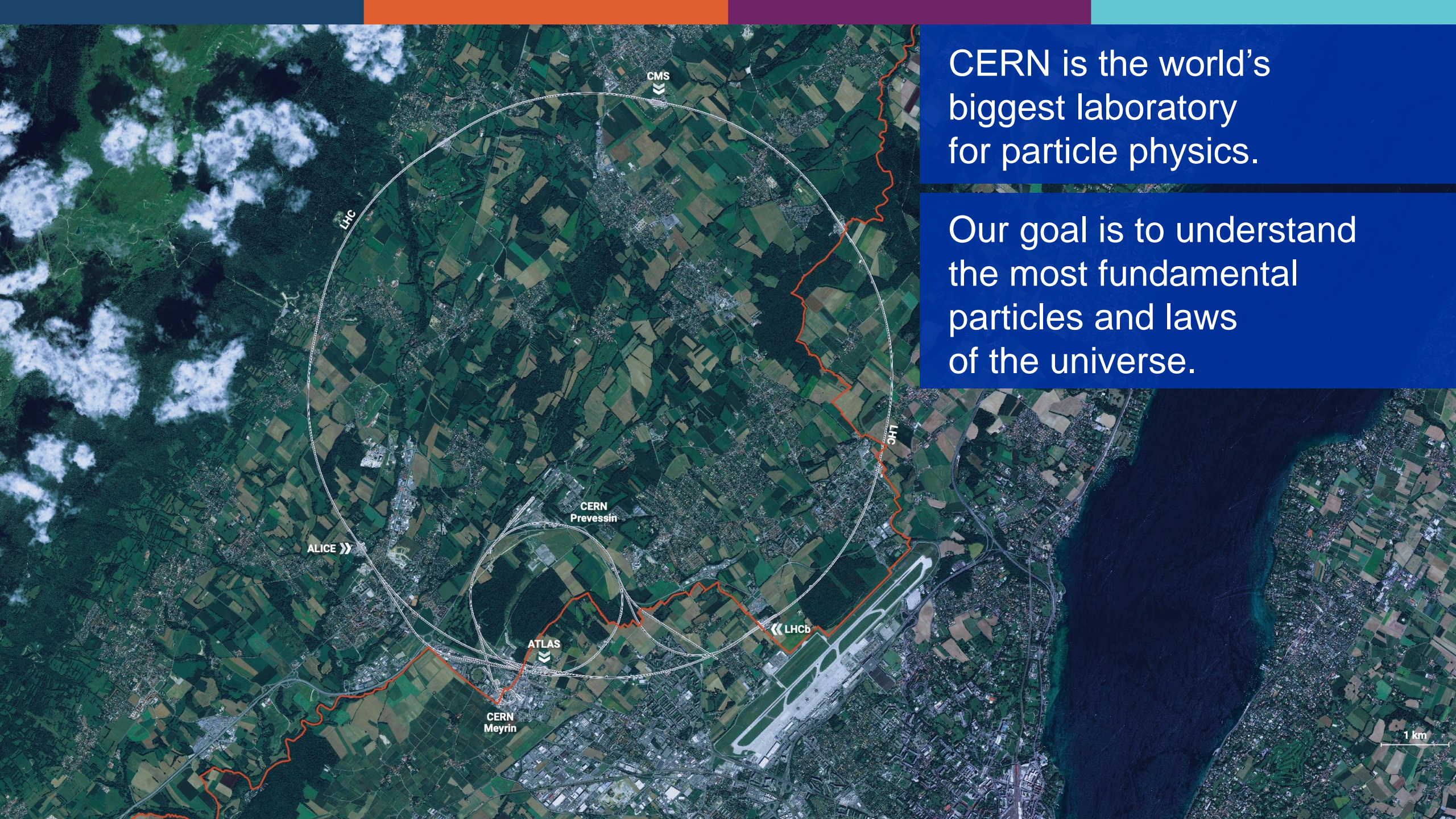




WELCOME TO CERN

Visit of AGC, October 13, 2022



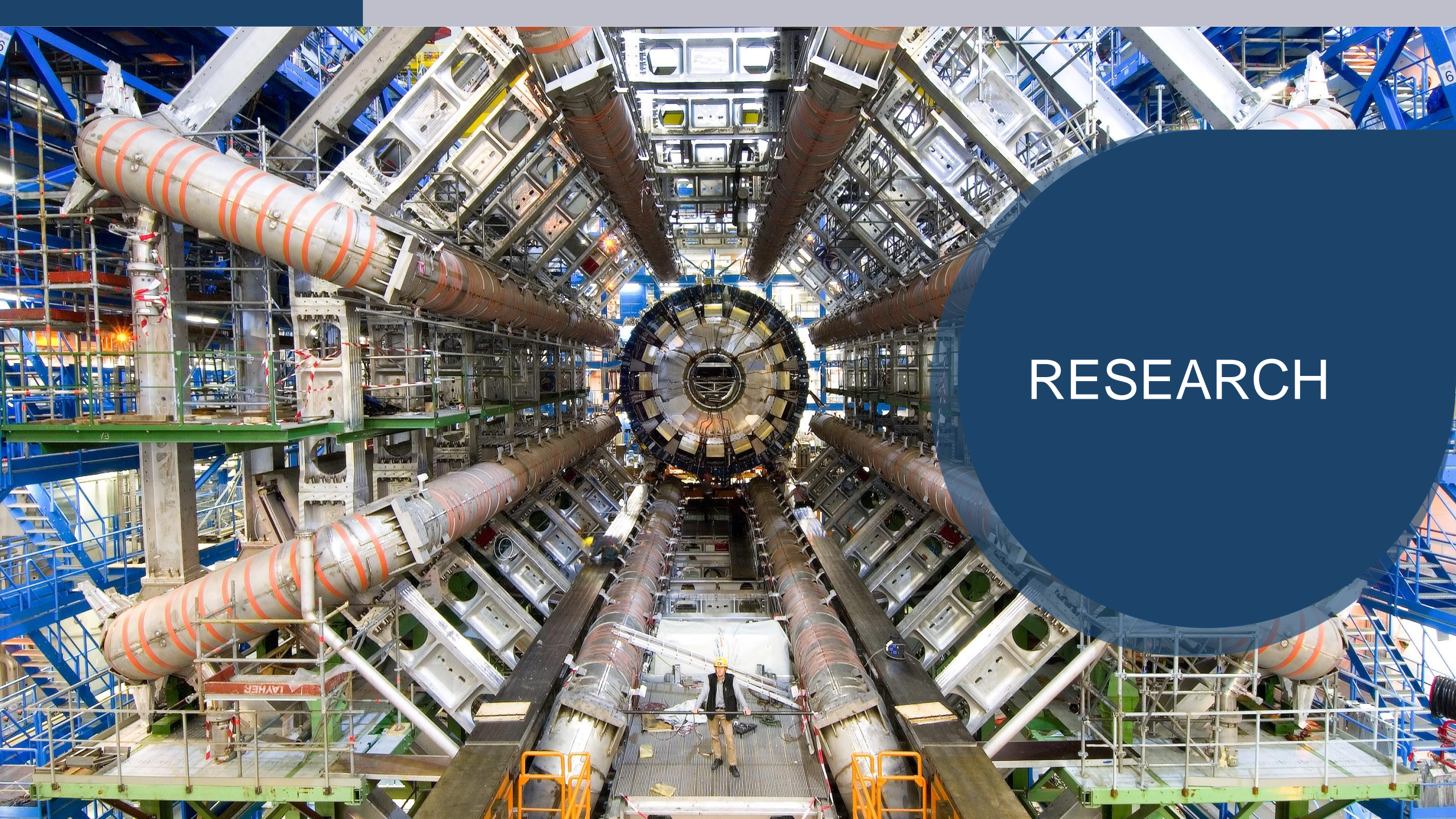
CERN is the world's biggest laboratory for particle physics.

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

1 km

Four pillars underpin CERN's mission

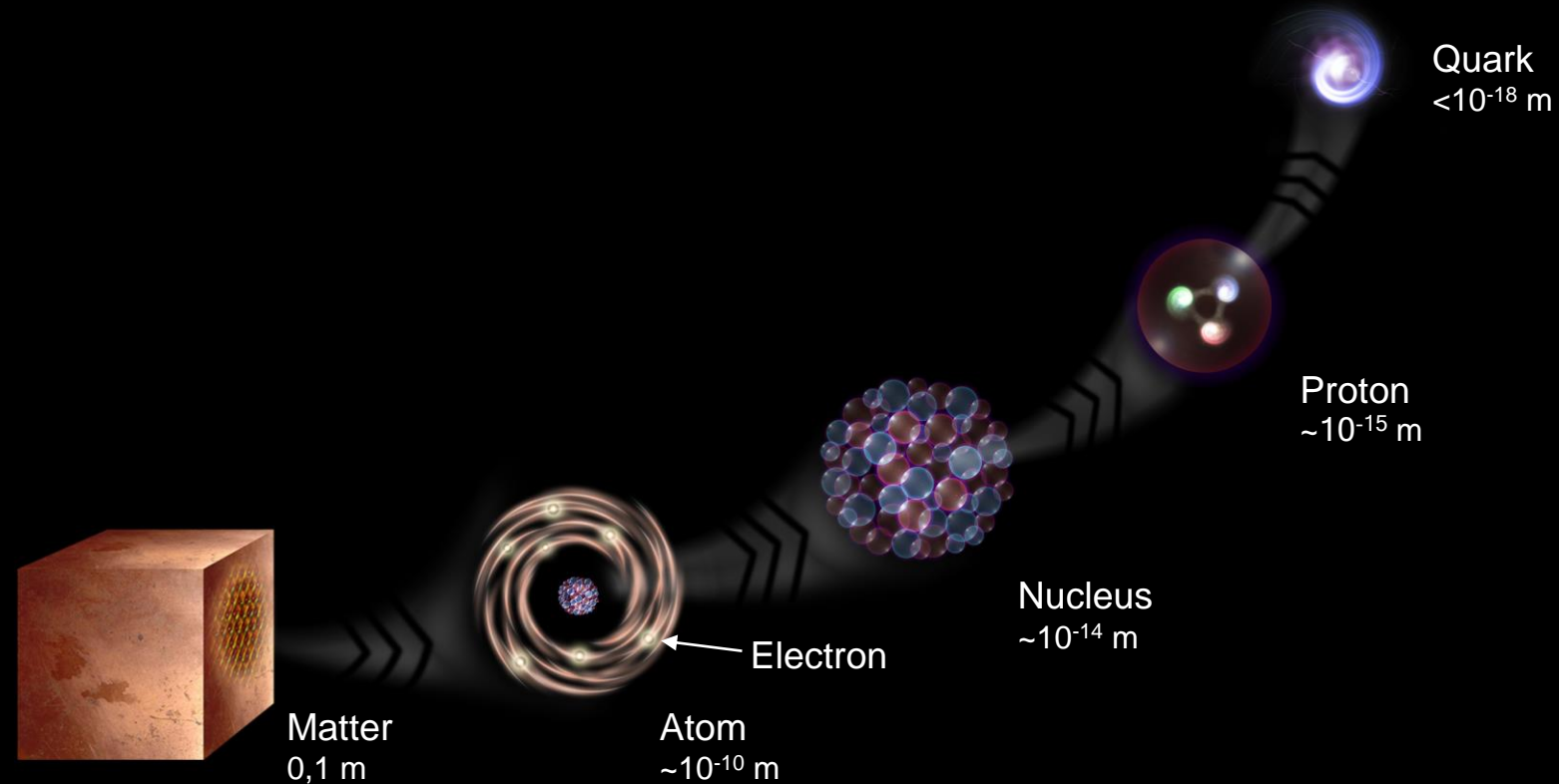


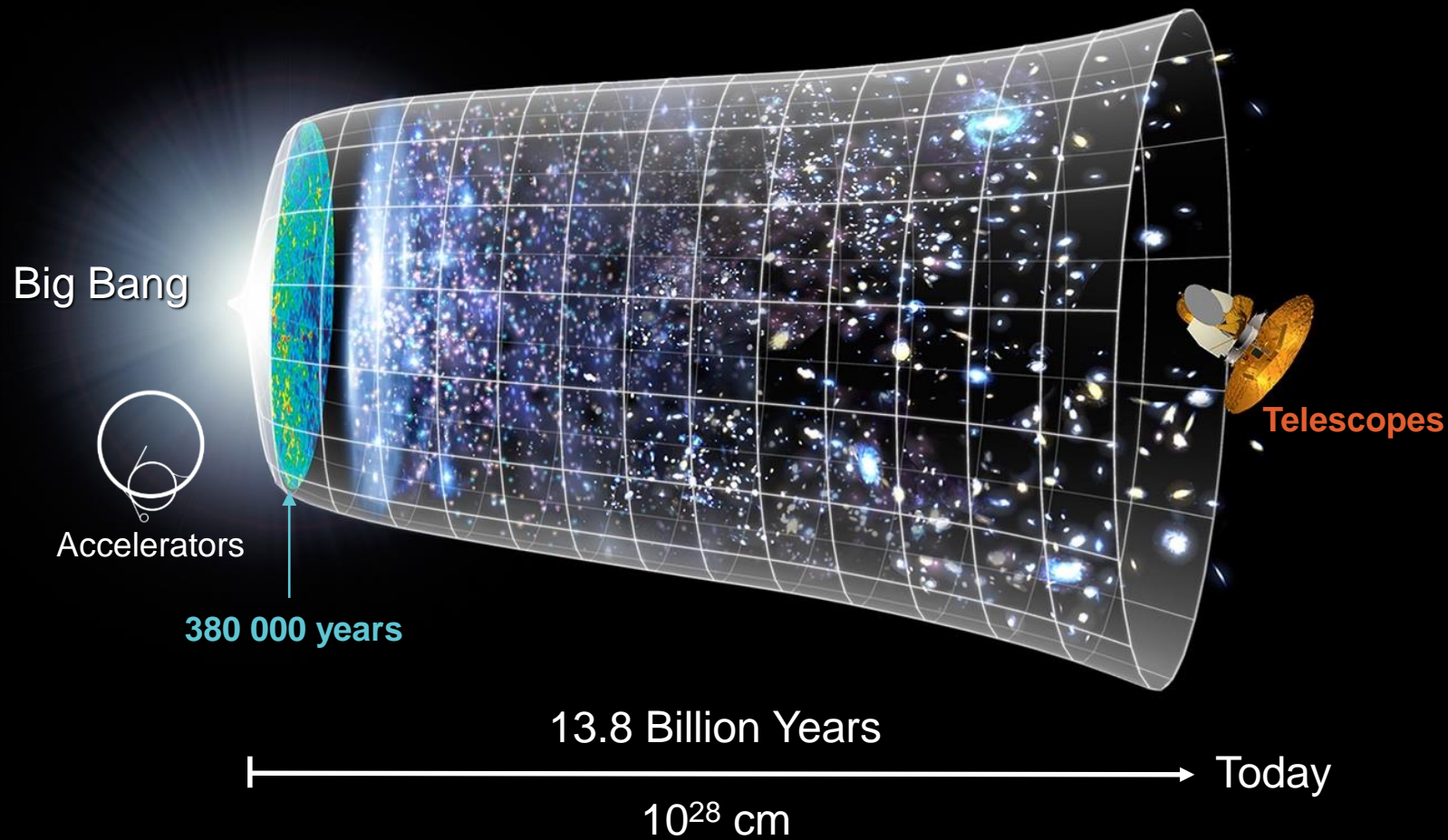


RESEARCH

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.

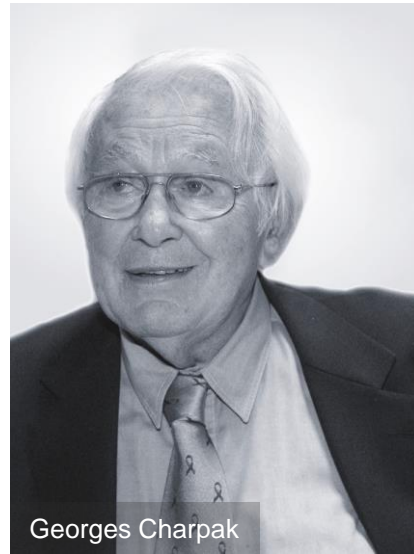
At CERN we help to answer these questions



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.

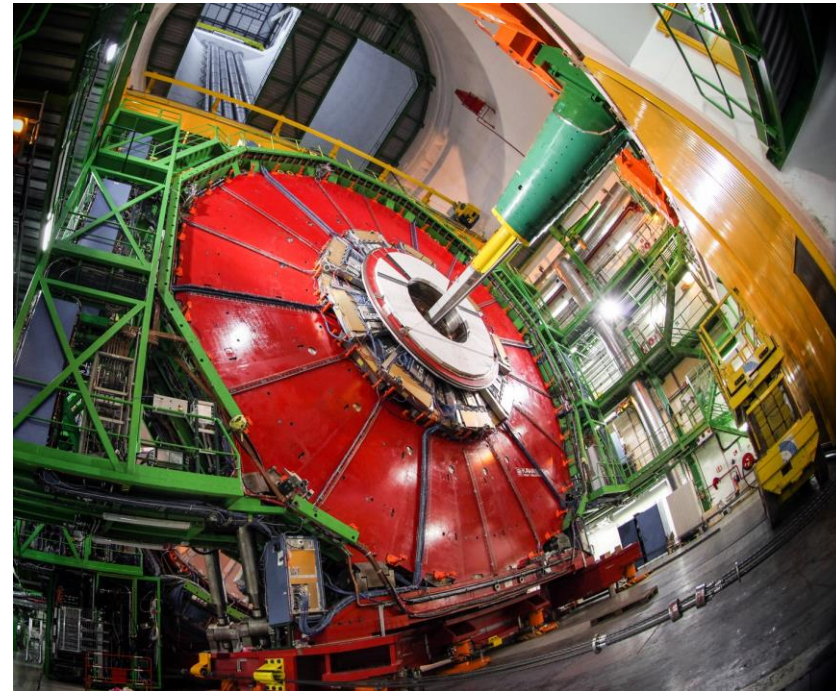


François Englert and Peter Higgs. With Robert Brout, they proposed the mechanism in 1964.

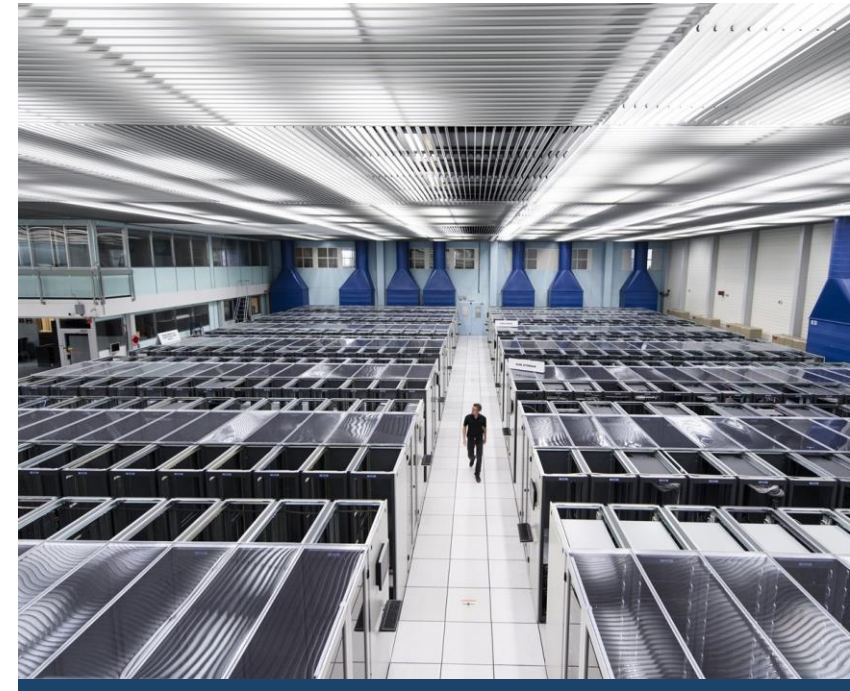
We develop technologies in three key areas



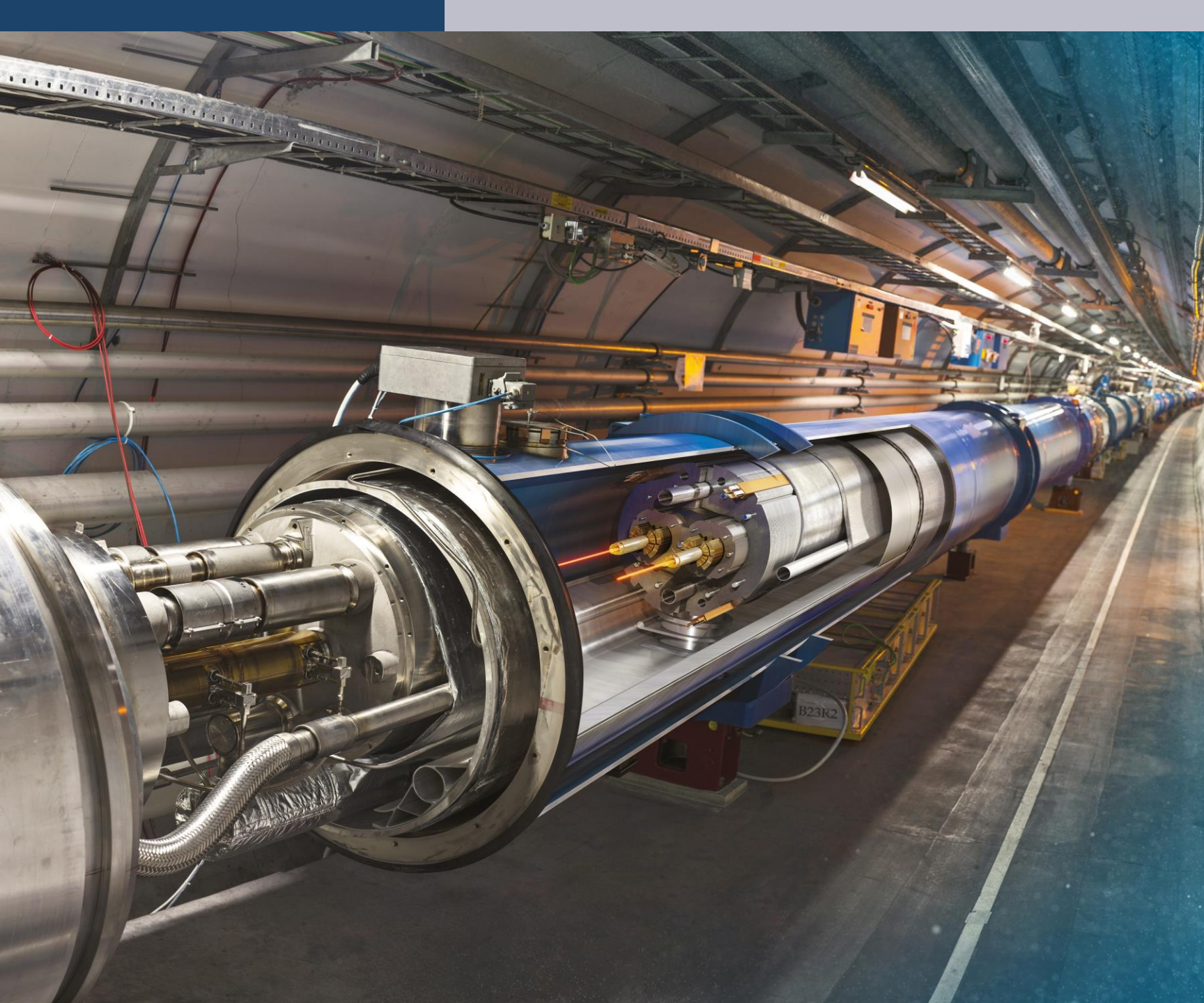
ACCELERATORS



DETECTORS



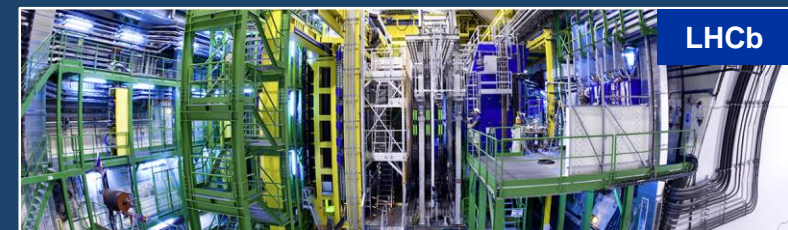
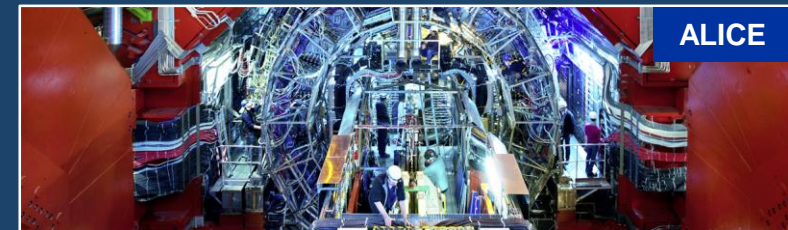
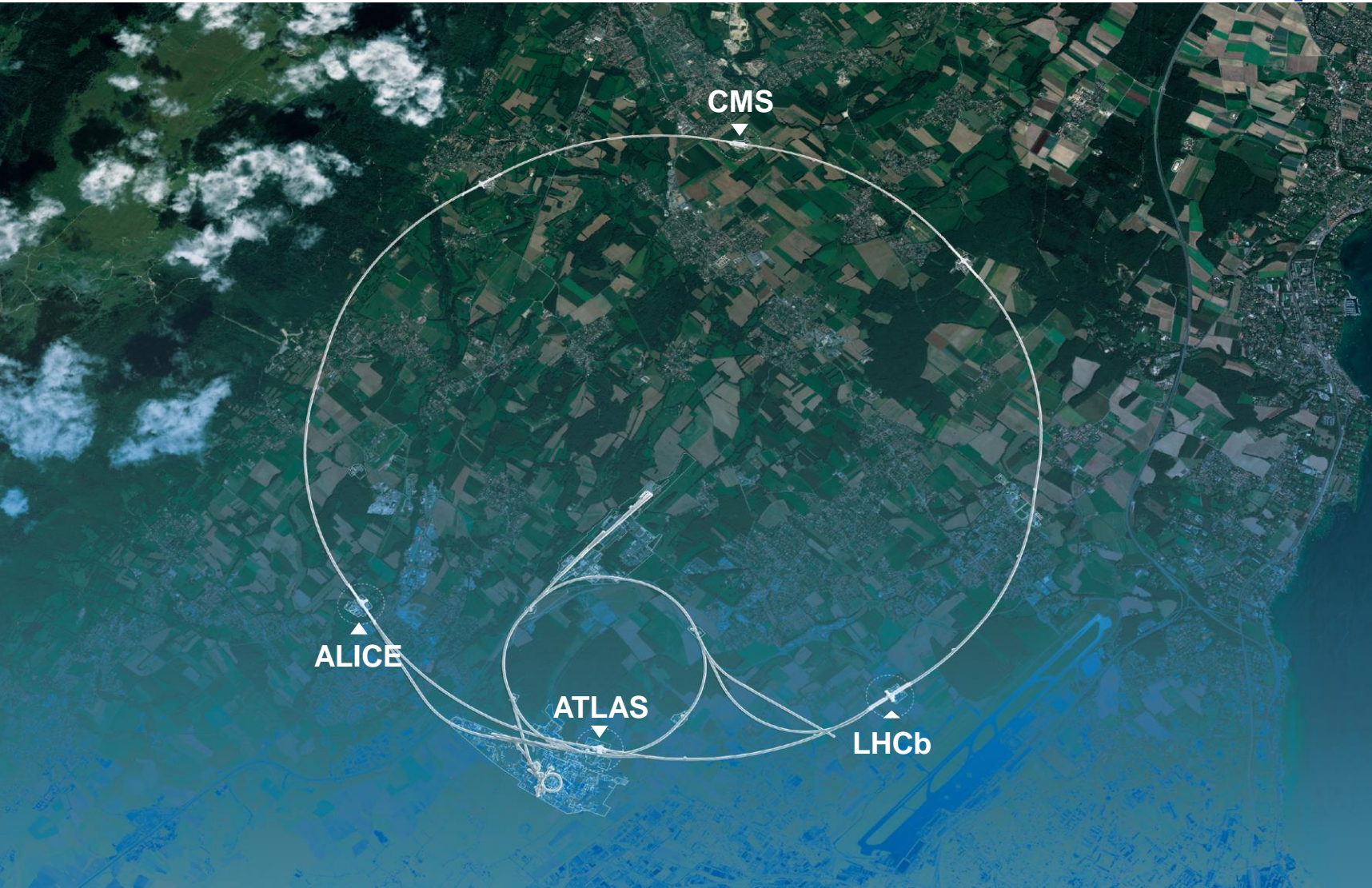
COMPUTING



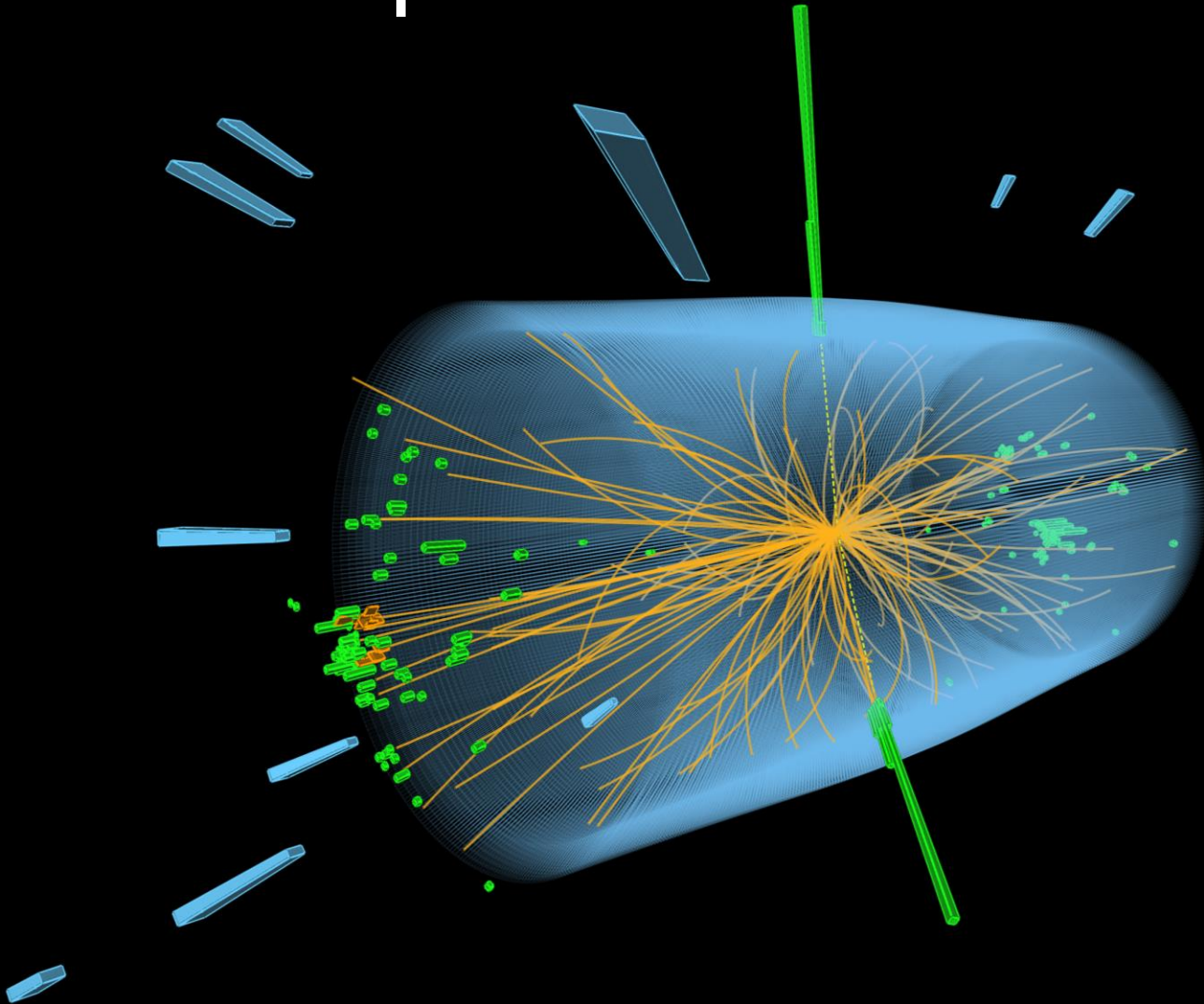
Large Hadron Collider (LHC)

- 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

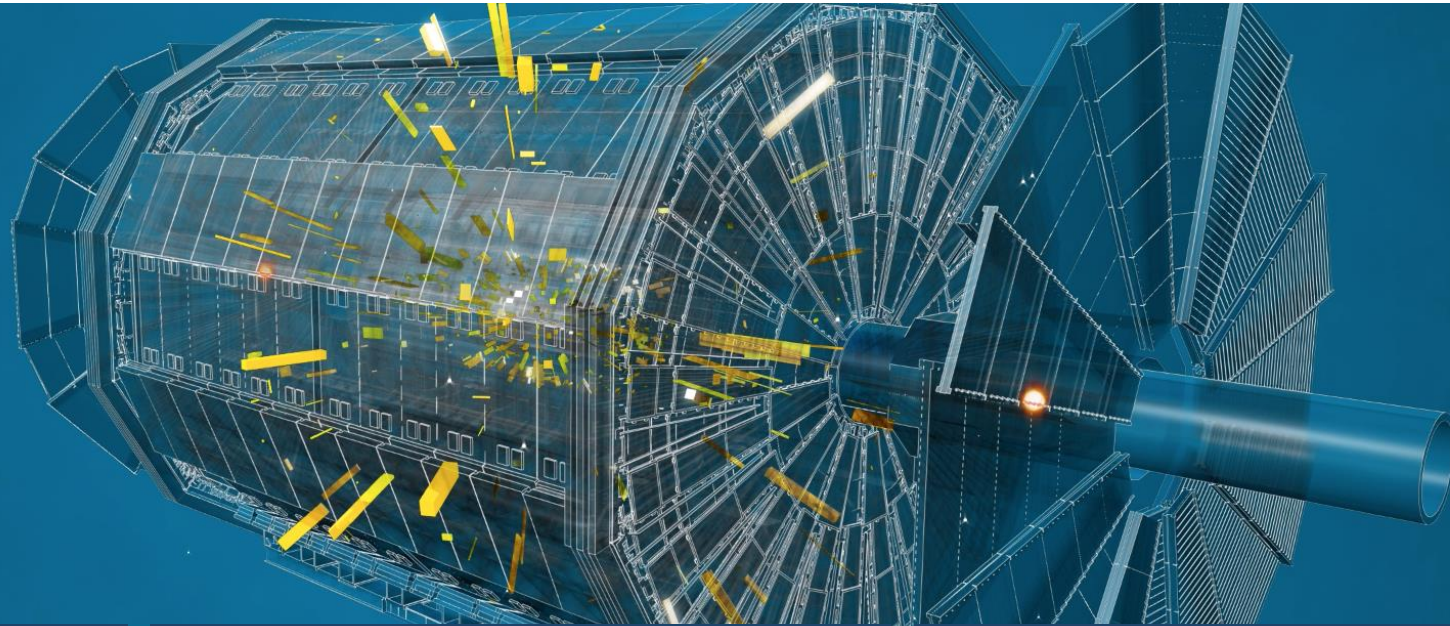


The LHC produces more than 1 billion particle collisions per second



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.

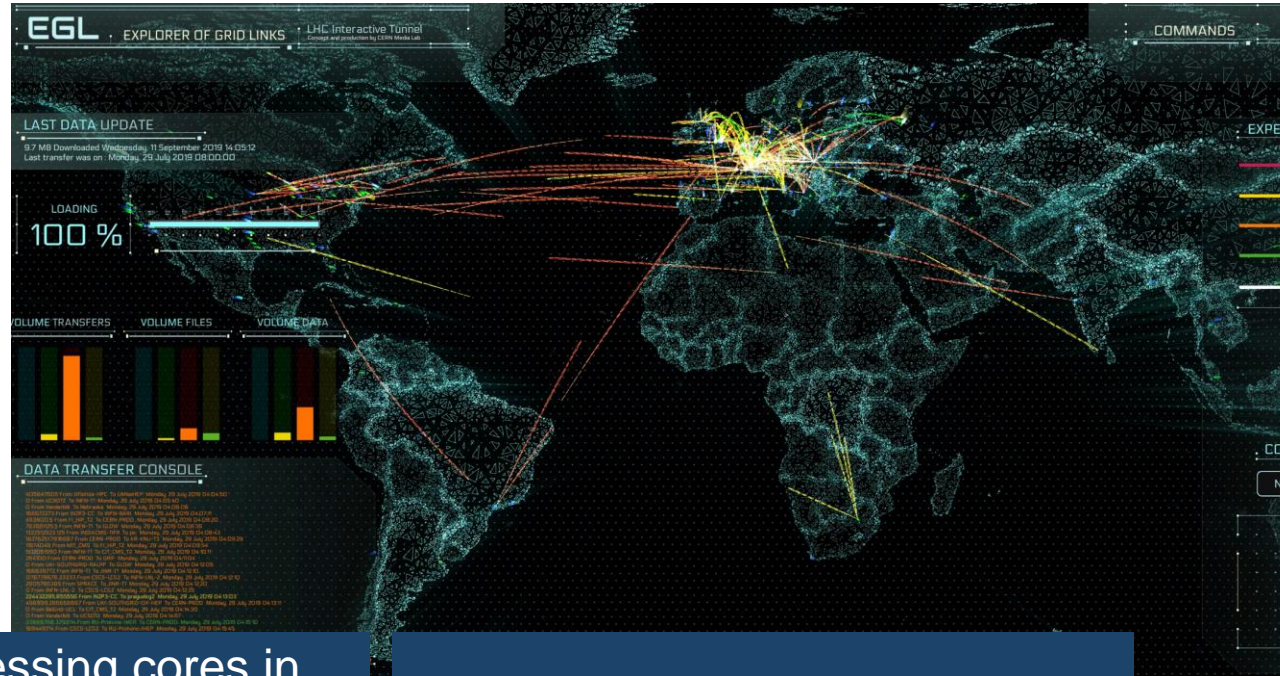


The LHC detectors have been built by international collaborations covering all regions of the Globe.

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.

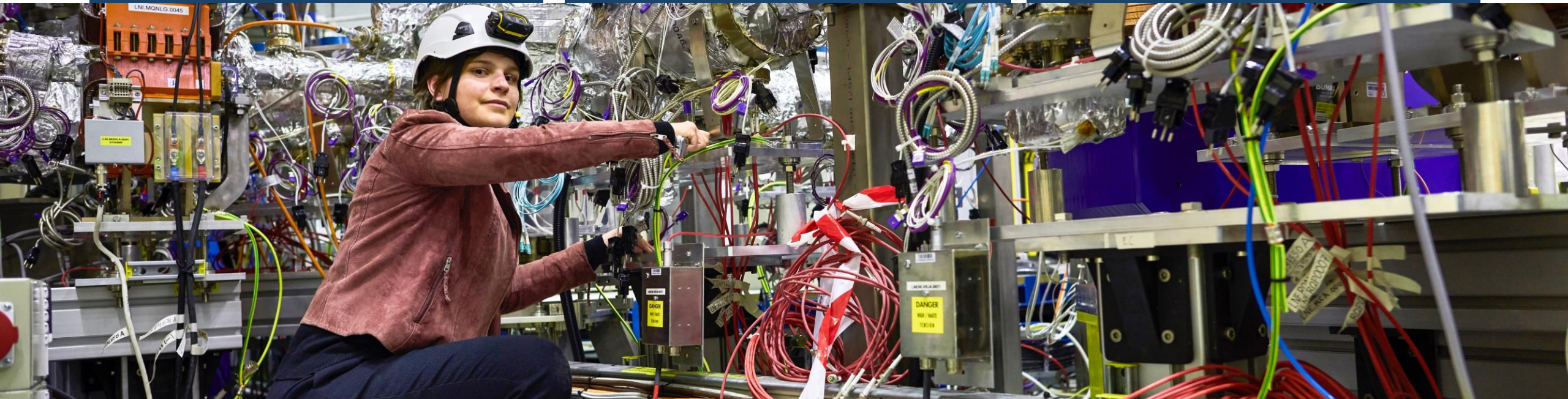
More than 1000 Petabytes of CERN data stored world-wide.

CERN has a diverse scientific programme

Nuclear Physics
(ISOLDE)

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?



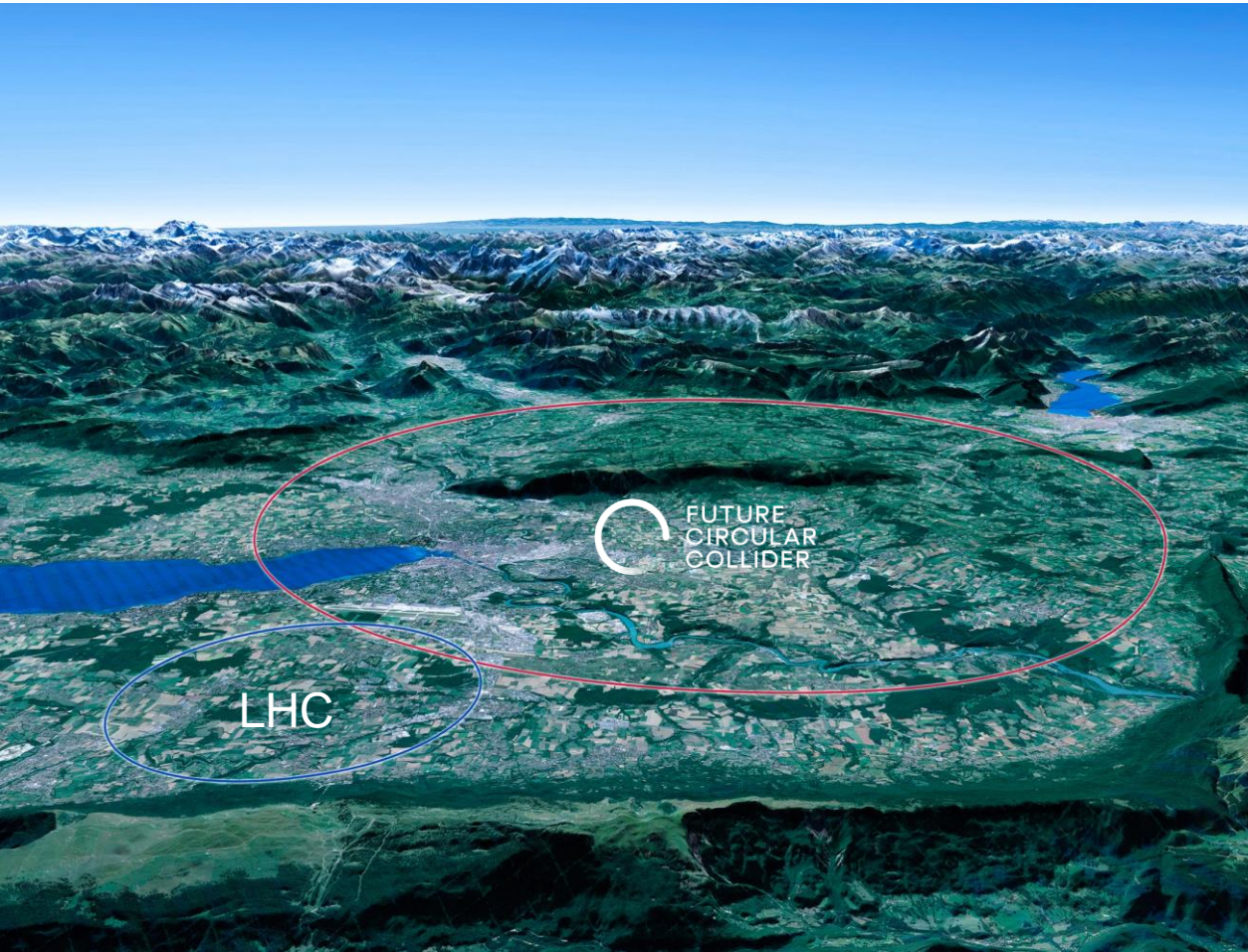
Upgrade to the High-Luminosity LHC is under way

- 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

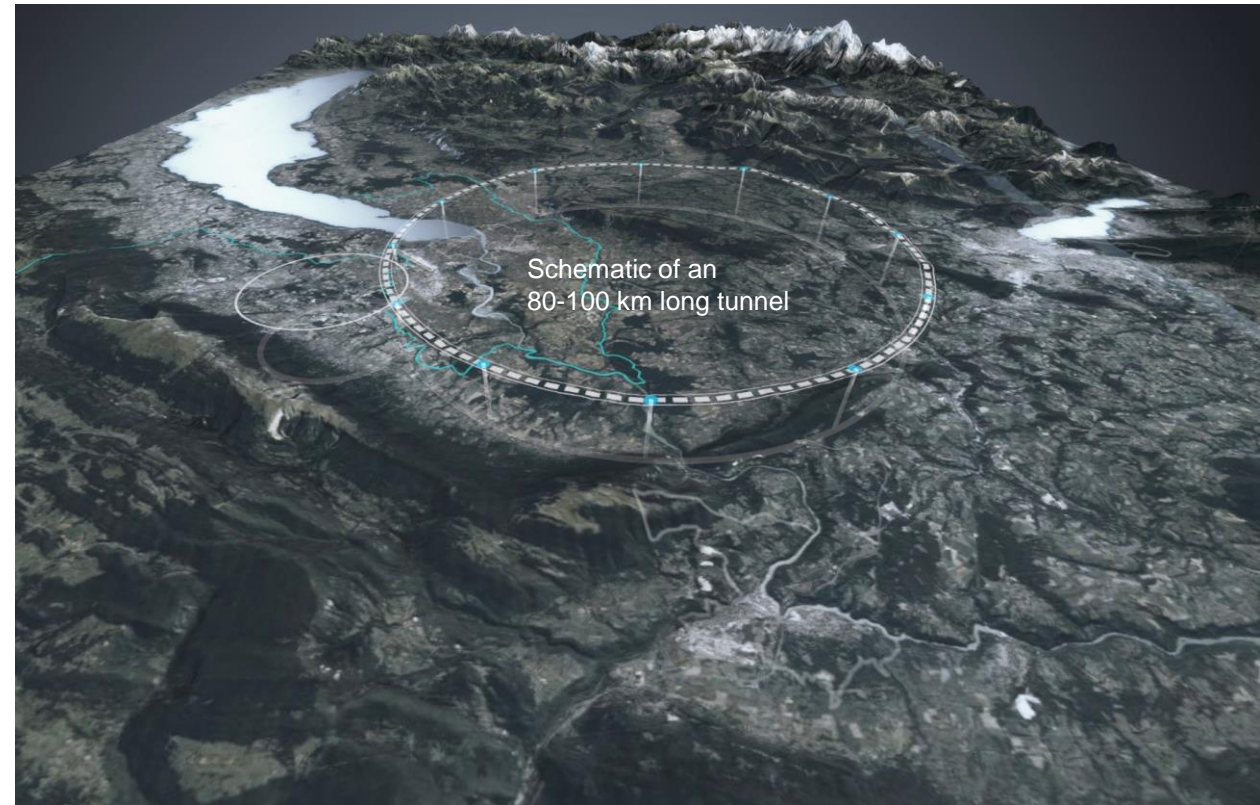


Which collider after the LHC ?

For the longer-term : the European particle physics community has recommended to assess the technical and financial feasibility of the FCC (Future Circular Collider)

FCC: Future Circular Collider: 100 km ring

- Technologically very ambitious → will push innovation
- Cost: ~ 10 BCHF for first stage (LHC: ~ 5 BCHF as tunnel pre-existed)
- Tentative timescale: project approval ~ **2028**, construction start ~ **2030**, first-stage operation **2045-2060**, second-stage operation **2070-2090++**
- Strong support from the US (strong, historical partnership of reciprocal contributions)
- Competition with China, which wants to realise the same project



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 Italy



- Personnel by nationality as of 31 December 2021
 - **1798** users
 - **323** staff
 - **106** 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



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

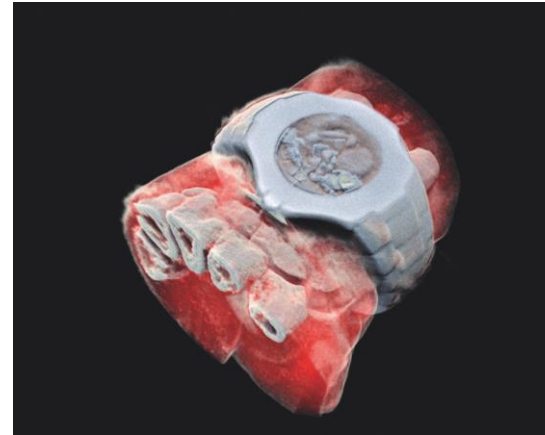
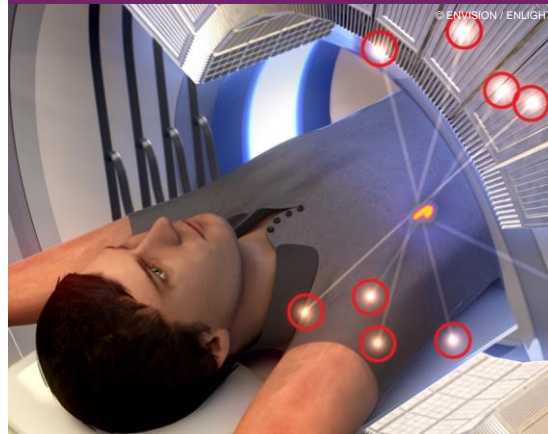
Medical imaging, cancer therapy, material science, cultural heritage, aerospace, automotive, environment, health & safety, industrial processes.

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



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

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



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

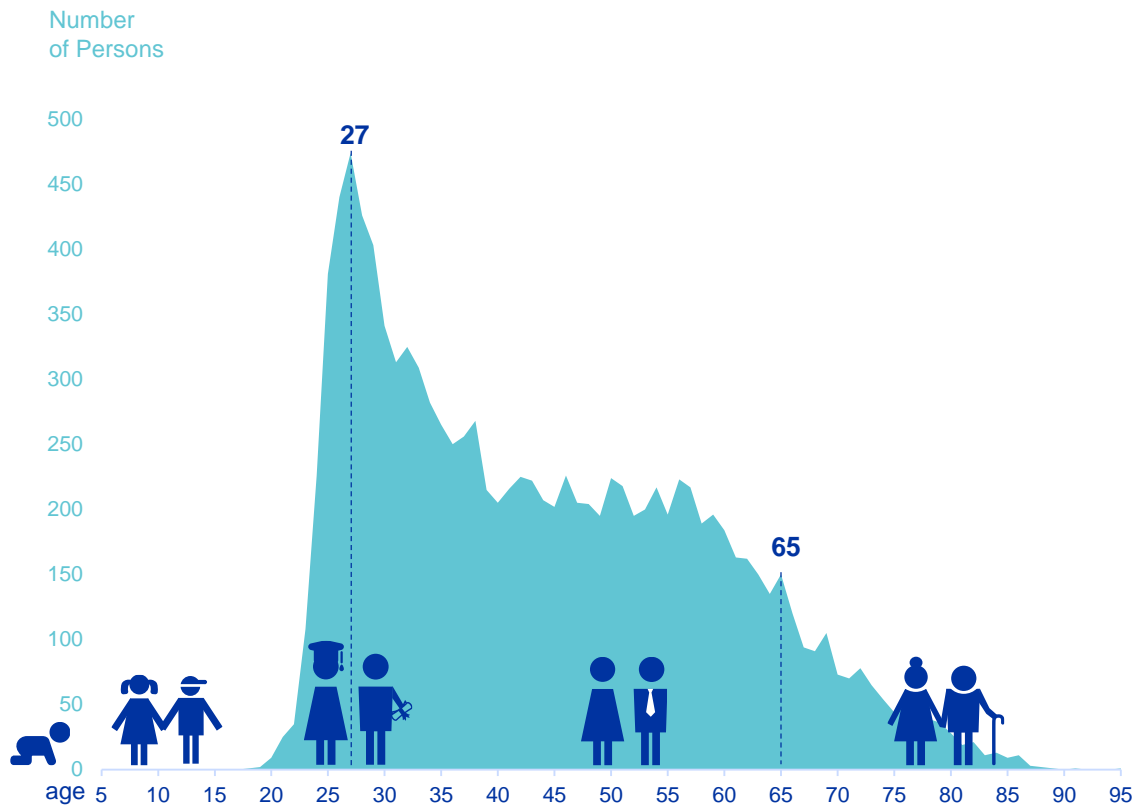
CERN produces innovative radioisotopes for nuclear medicine research.



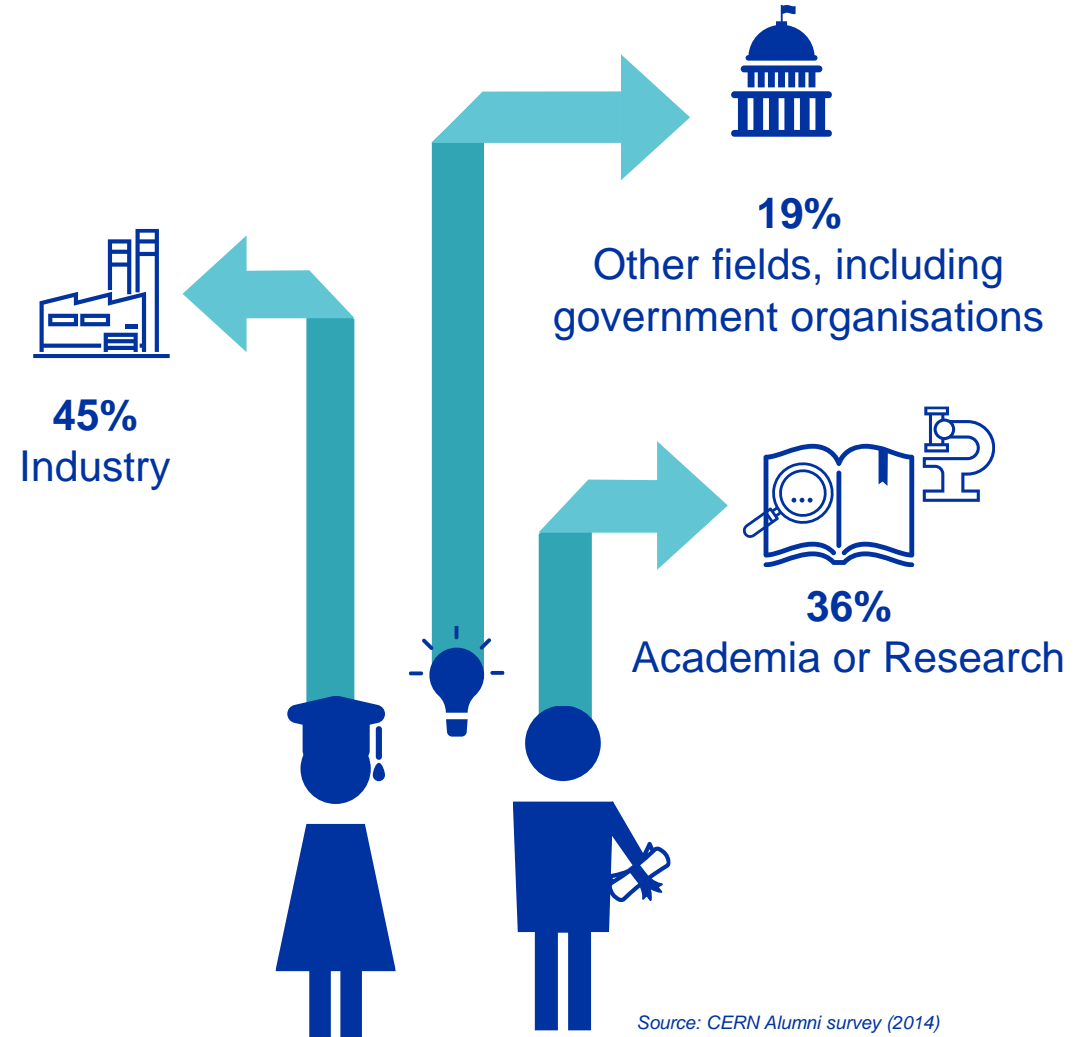
A group of students, both male and female, are wearing hard hats (yellow and blue) and are focused on a large, dark, cylindrical piece of equipment mounted on a metal frame. They appear to be in a laboratory or workshop setting. One student in the foreground is adjusting the equipment. In the background, there are other students and a green exit sign with a white arrow pointing down. A teal circular graphic 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 Italy



- 14 summer students during 2019
- 1066 teachers in Teacher Programmes since 1998
- 146 teams in BL4S competition since 2014
- 1765 students participating in S'Cool LAB since 2015
- 18 531 Italian 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



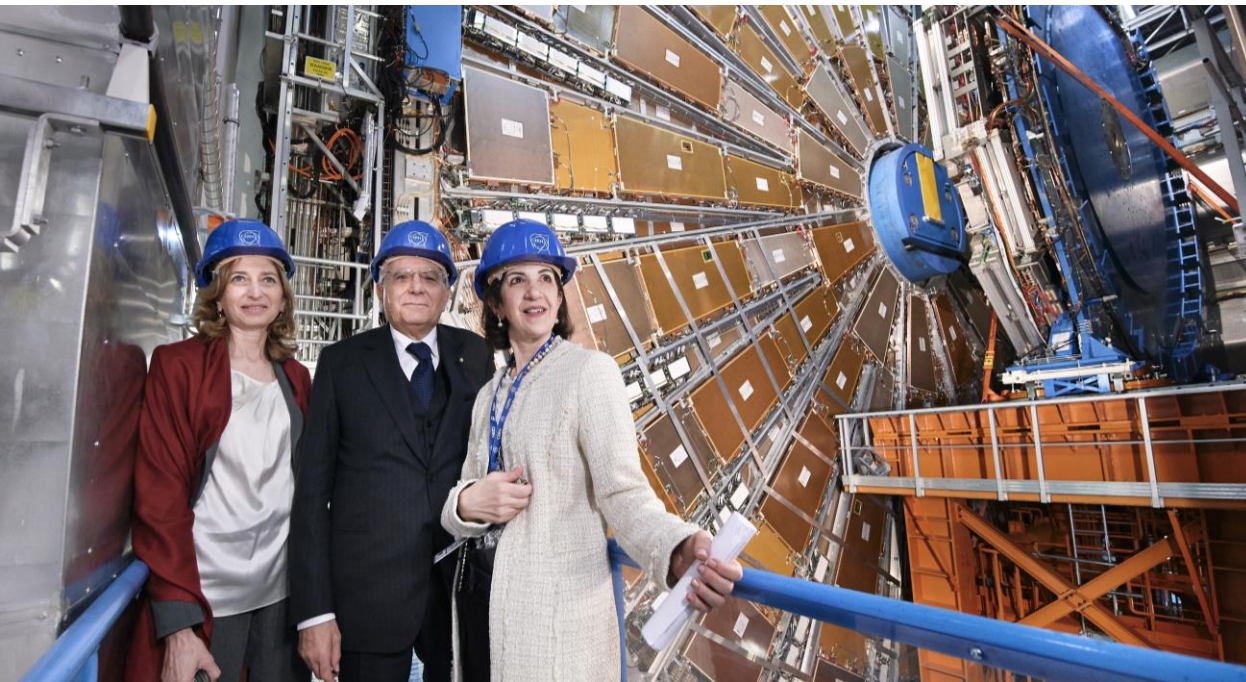
CERN's new education and outreach centre for all publics aged 5-plus.

Opening summer 2023.

Immersive exhibitions, education labs, events and shows.



Italy has a strong tradition in particle physics and is a founding member of CERN



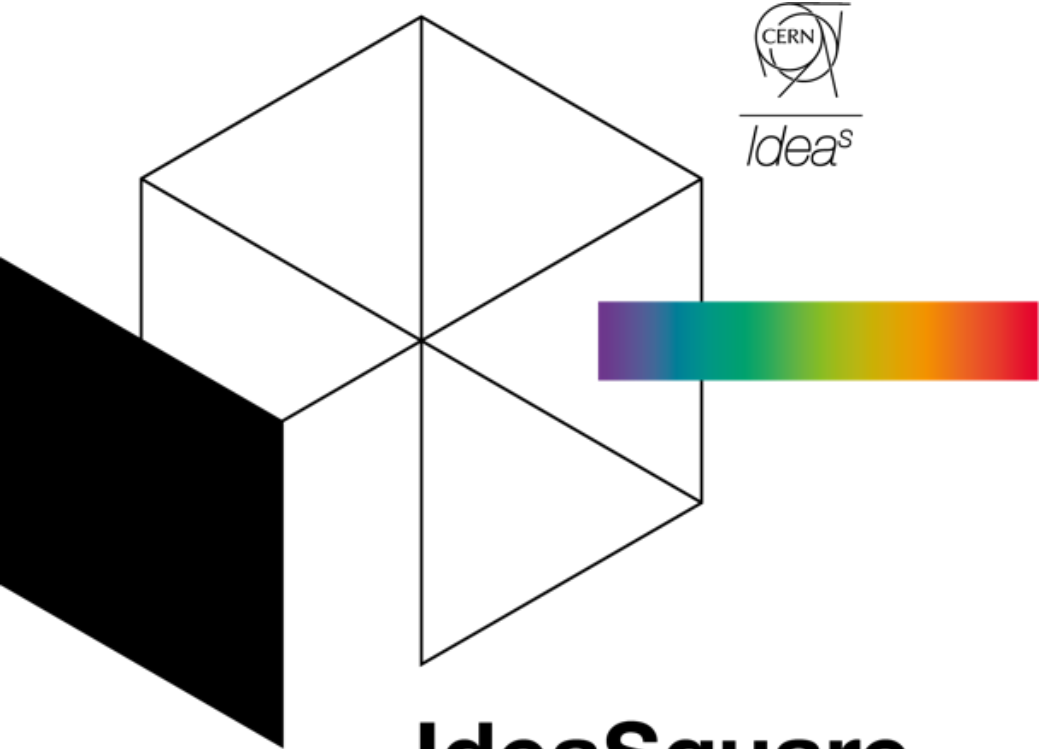
Visit by His Excellency Mr Sergio Mattarella President Italian Republic, 10 June 2019

- Edoardo Amaldi (Secretary General 1952-1954)
- Directors General: Carlo Rubbia, Luciano Maiani, Fabiola Gianotti
- Many Italian scientists in other important leading roles
- Nobel prize: Carlo Rubbia
- ~ 2400 Italian scientists involved today in projects at CERN (out of ~18000)



There are many unanswered questions
in fundamental physics

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



IdeaSquare
The innovation space at CERN

Introduction
#CERNIdeaSquare

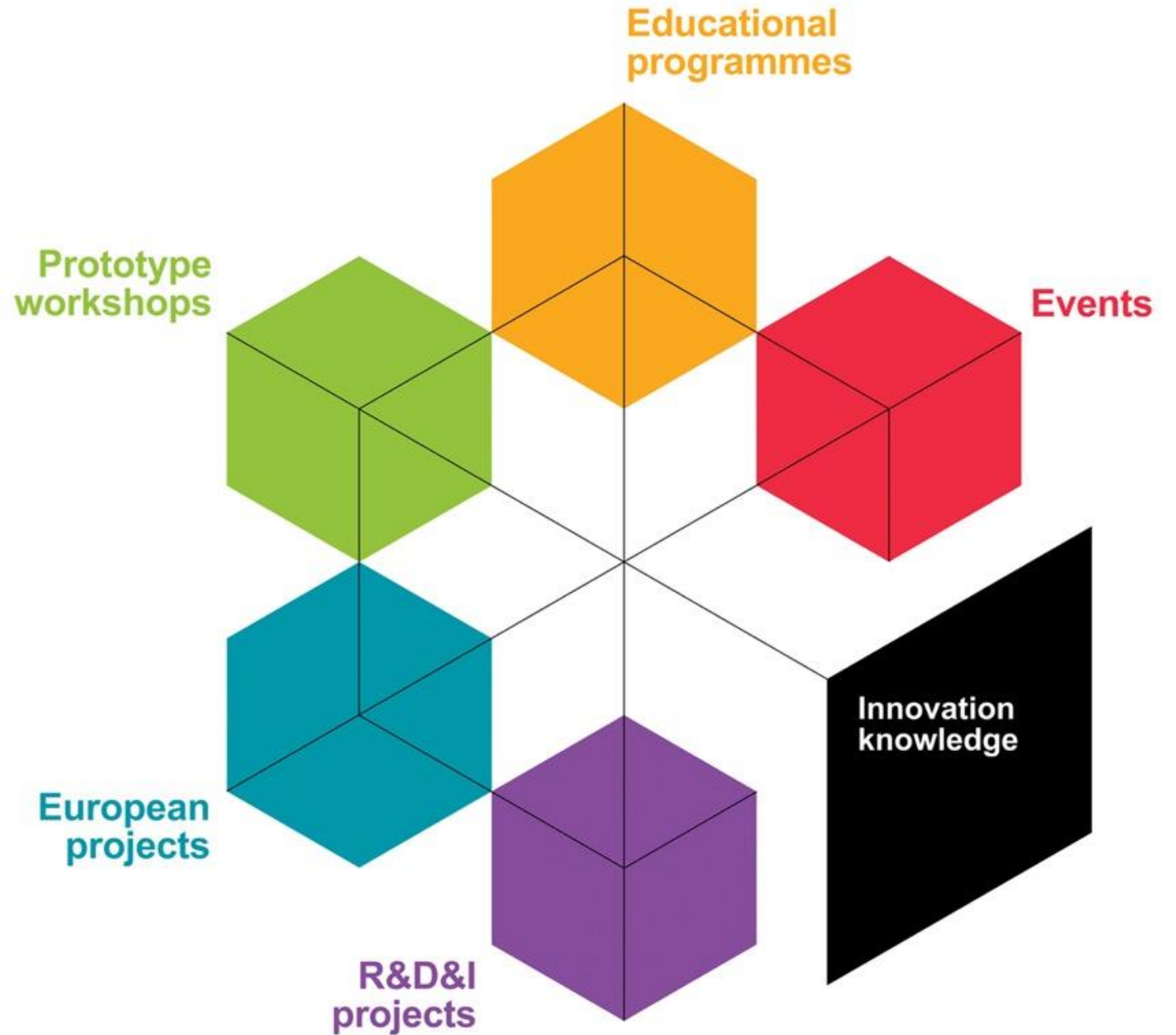
11 October 2022

By Markus.Nordberg@cern.ch

IdeaSquare

The Innovation Space at CERN

IdeaSquare is the innovation space at CERN, that uses collaborative methodologies, access to CERN expertise and cross-connectivity to ideate solutions for the future of humankind. A place where people have the licence to dream.

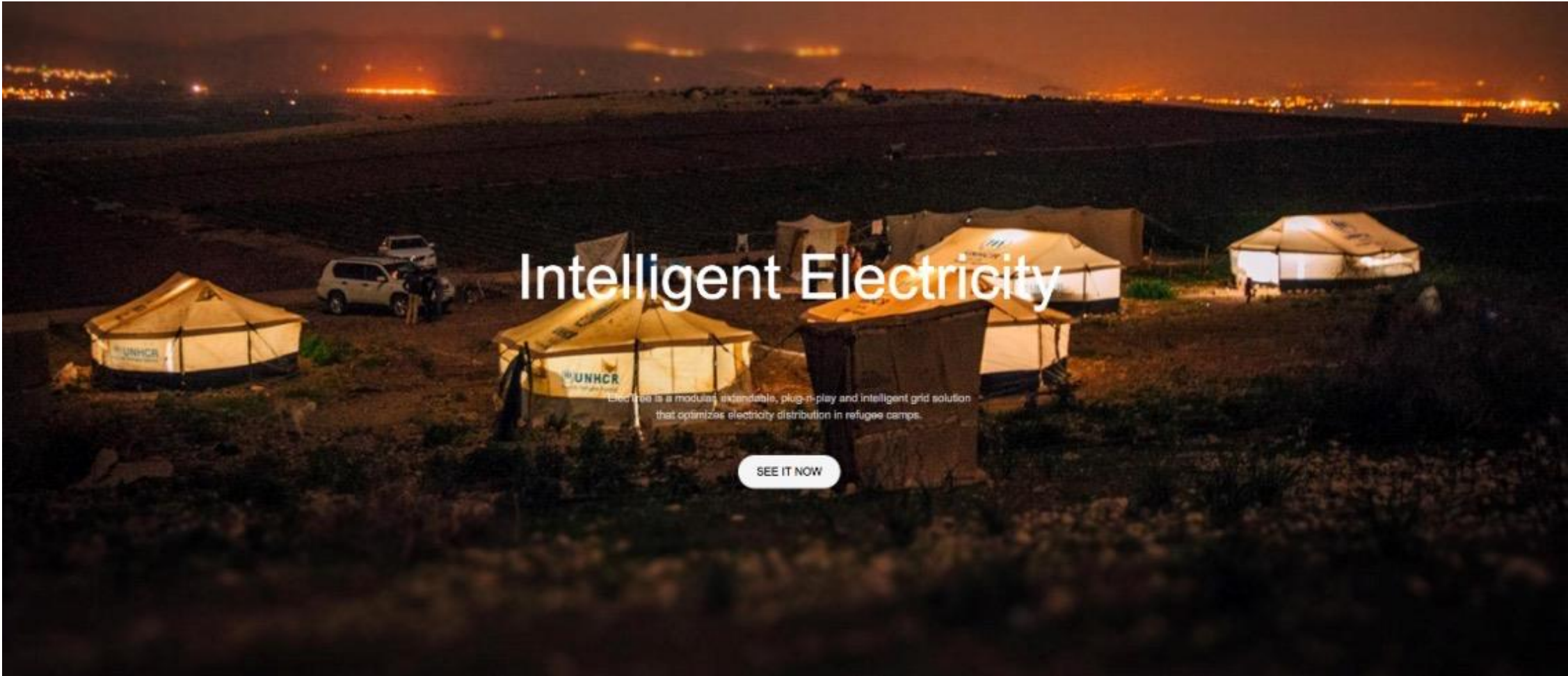


Challenge Based Innovation (CBI) and Innovation for Change



- 4 - 6 months MSc-level specialization courses for product and service development, run by participating universities from all around the world
- Over 1200 students have participated with more than 200 conceptual prototypes produced at IdeaSquare, contributing to UN Sustainable Development Goals
- In the course, multidisciplinary student teams learn how to apply Design Thinking – process for new product/service development; engaging with CERN researchers who act as technological coaches in the process
- “Work extremely hard, learn and have fun!” AND “Fail fast and often to succeed sooner”

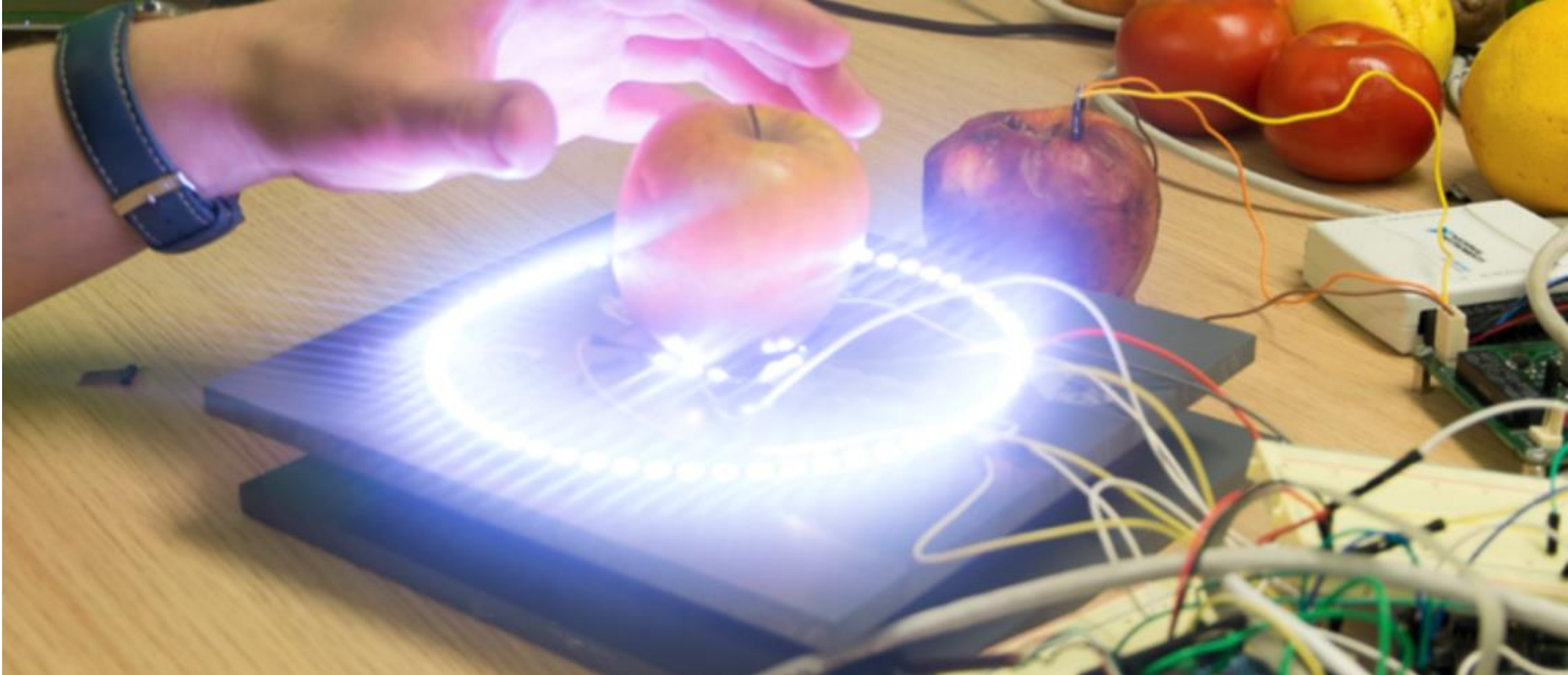
Students prototype to
TEDxCERN installation



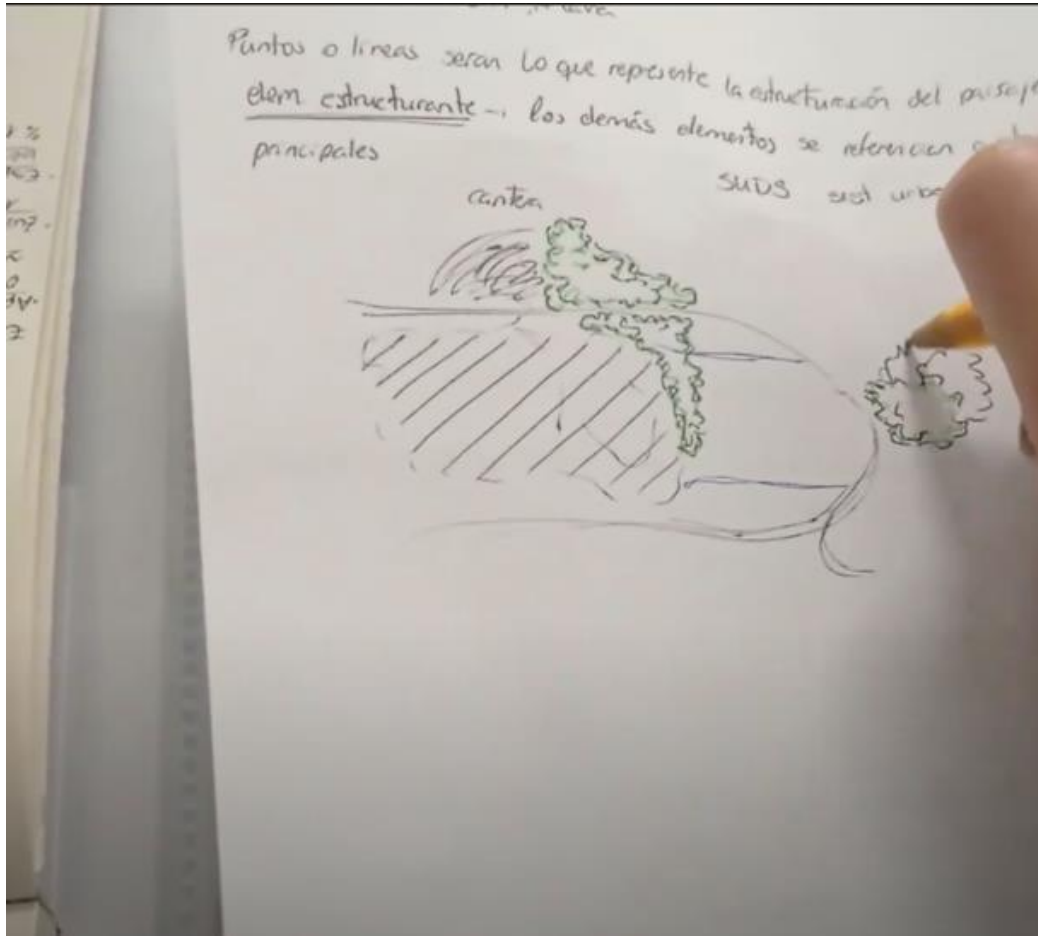
Intelligent Electricity

Electra is a modular, extendable, plug-n-play and intelligent grid solution that optimizes electricity distribution in refugee camps.

SEE IT NOW



Design the Future



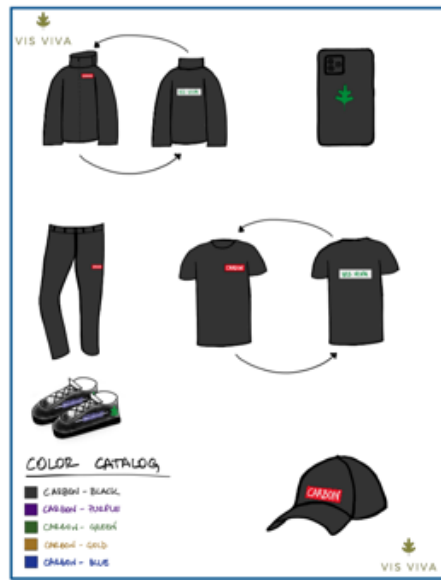
Design the Future is a programme which addresses so-called wicked problems and stimulates participants to use a combination of exponential thinking, system thinking as well as disruptive thinking. The aim of Design the Future is to provide students with a toolbox of methodologies combining the above thinking schools while stimulating their imagination. It is an invitation for designing our future society

Wristband ED project –
UPV/EHU

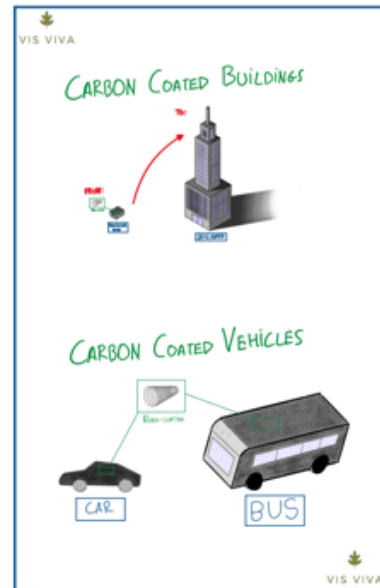
Design the future

VIS VIVA
Collection

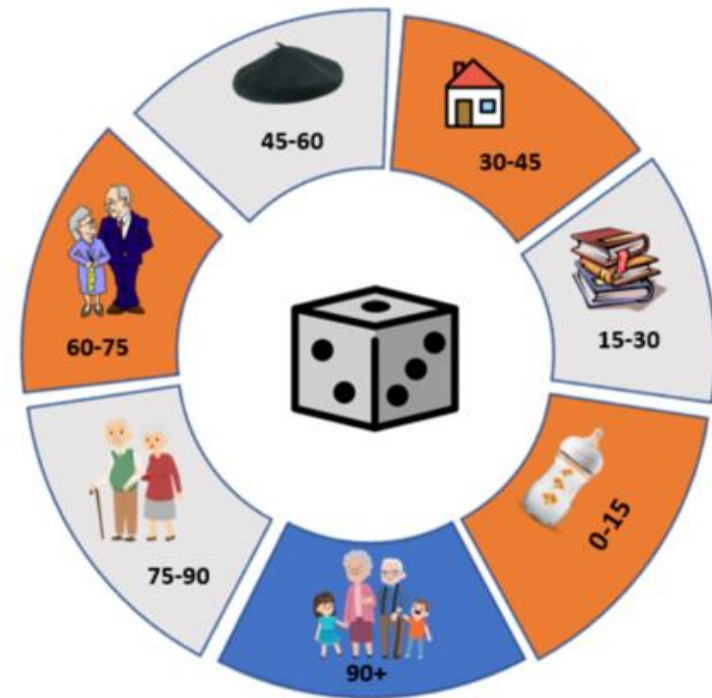
Clothes



Building and Vehicle Coatings



PREJUDICE-FREE LEARNING GAME



#ATTRACT EU Project



- ATTRACT funds breakthrough projects in Detection & Imaging
- Provides funding for developing early-stage ideas and prototypes
- Focuses on high innovation with potential outside research
- Engages with MSc-level, cross-disciplinary student activities, seeking for unforeseen entrepreneurial opportunities for the young
- Strong collaboration with partners in most European countries
- Purpose is to create a new innovation ecosystem in Europe
- ATTRACT is coordinated by CERN (IdeaSquare)



WPET - Wearable PET scanner jacket prototype

Events, workshops and hackatons



When the building is not in full use, Ideasquare can offer access to its open work areas, rapid prototyping facilities and its meeting rooms for short, deadline driven Challenge Events, such as :

- Innovation Events,
- Workshops
- Hackathons (an event compressed into a short number of days where participants work towards a concept prototype).

IdeaSquare Open Doors
event 2018

Neutrino Platform



- Neutrino Platform (CENF) fosters fundamental research in the field of Neutrino Accelerator Physics
- CENF supports generic detector, neutrino beams R&D and large detector prototypes or demonstrators. It gives technical, financial and logistics support to approved projects
- Currently includes seven projects, including significant involvement in (Proto) DUNE
- CERN & IdeaSquare provides a facility for R&D on future technologies (HW and SW) and partner in several neutrino research programs



Technology

Initially undefined/open

**Detector R&D
Projects**



**MSc-Level Student
Programs (e.g. CBI)**



Product

Process

Focus

