

Global Cooperation on Science, Technology and Innovation for development: **the experience of CERN**

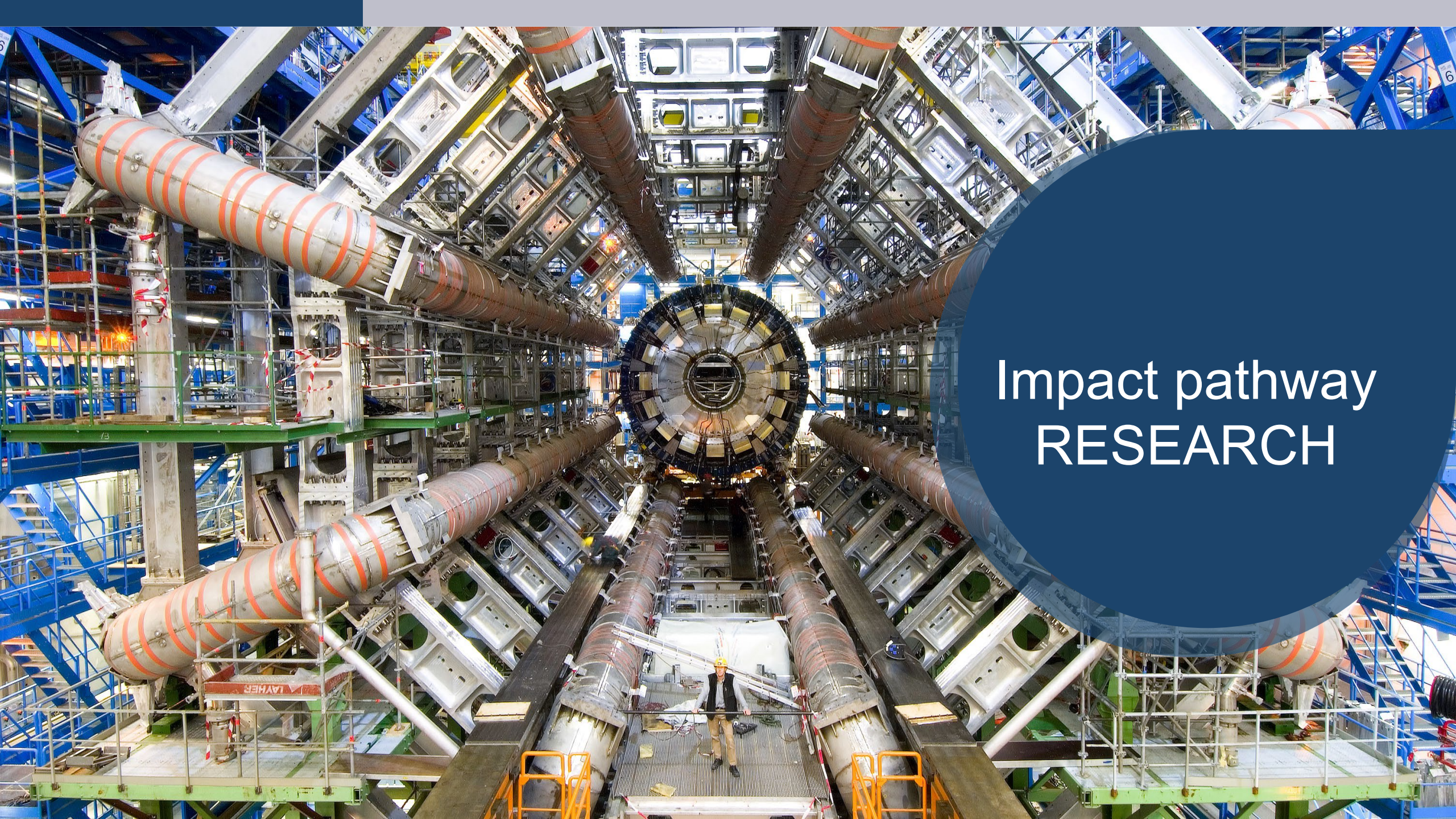
Charlotte Lindberg Warakaulle – CERN Director for International Relations
United Nations Commission on Science and Technology for Development
2023-2024 Inter-sessional Panel
Lisbon, 6 November 2023

Basic science: pathways for capacity-building

CERN is the world's biggest laboratory for **particle physics**, dedicated to understanding the most **fundamental particles** and **laws of the universe**.



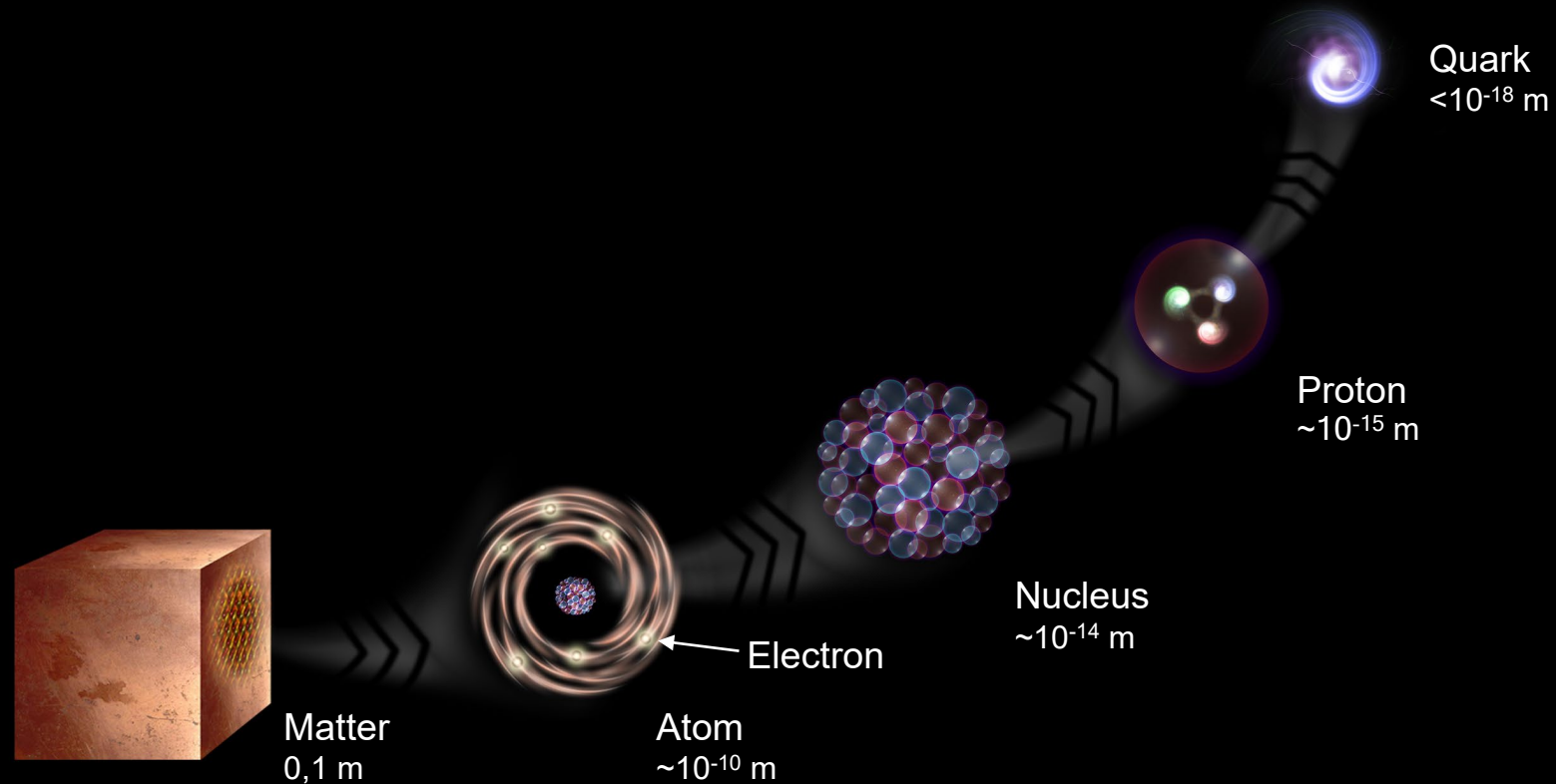
Drawing on the experience of CERN, this talk examines the role of **basic science** and **research infrastructures** in facilitating international collaboration and capacity-building.

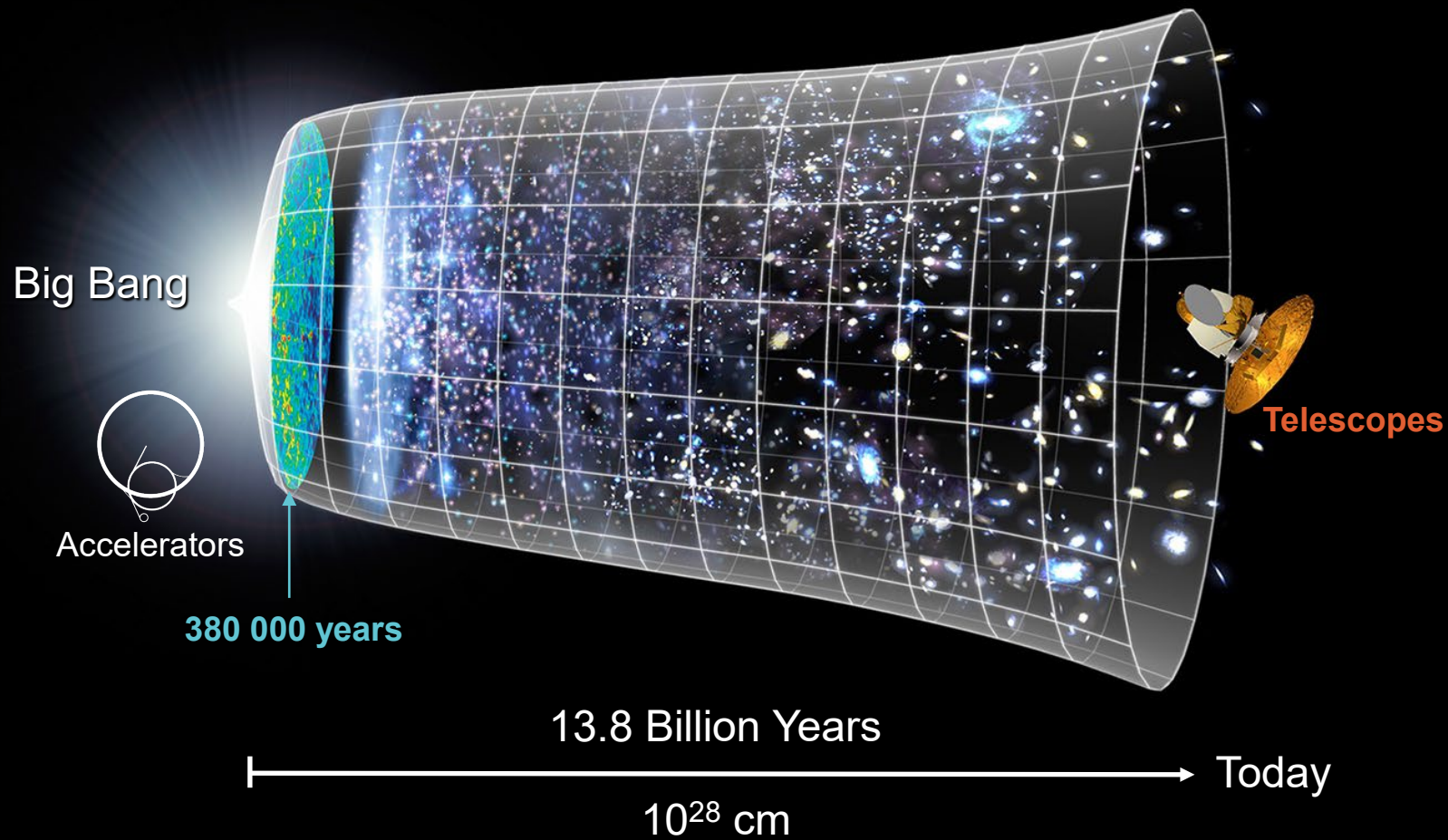


Impact pathway RESEARCH

What is the universe made of?

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





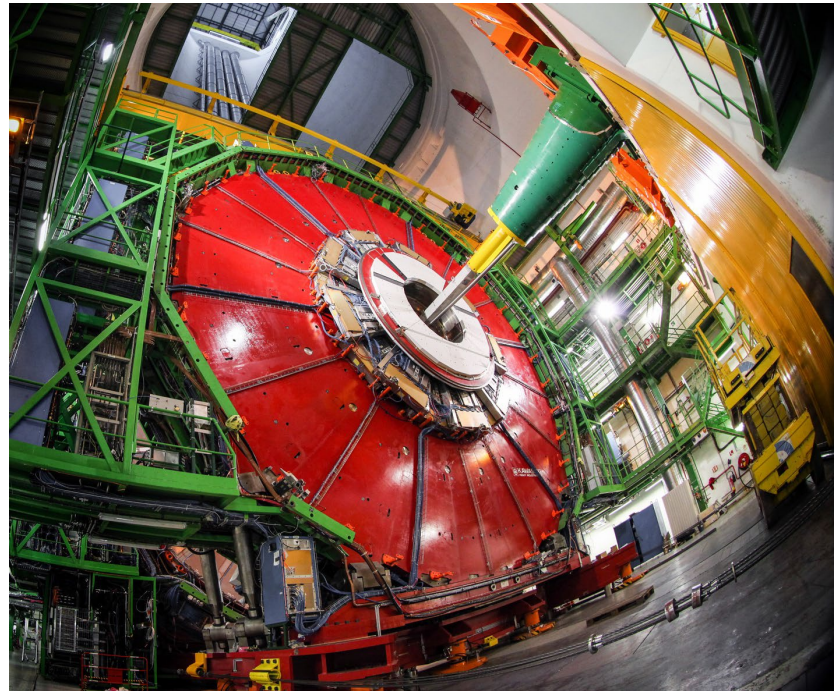
How did the universe begin?

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

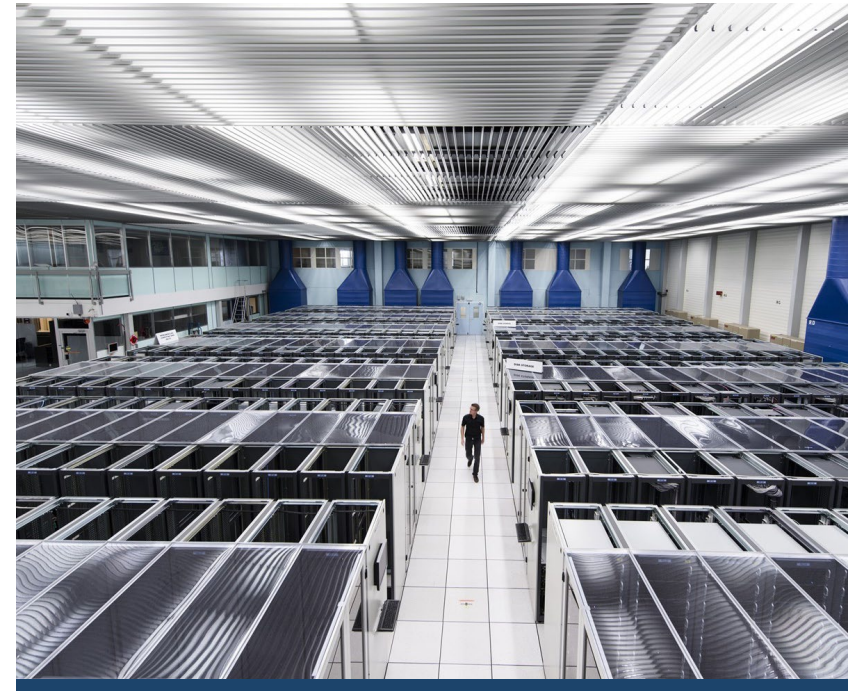
Technology development in three key areas: basis of societal impact and capacity-building



ACCELERATORS

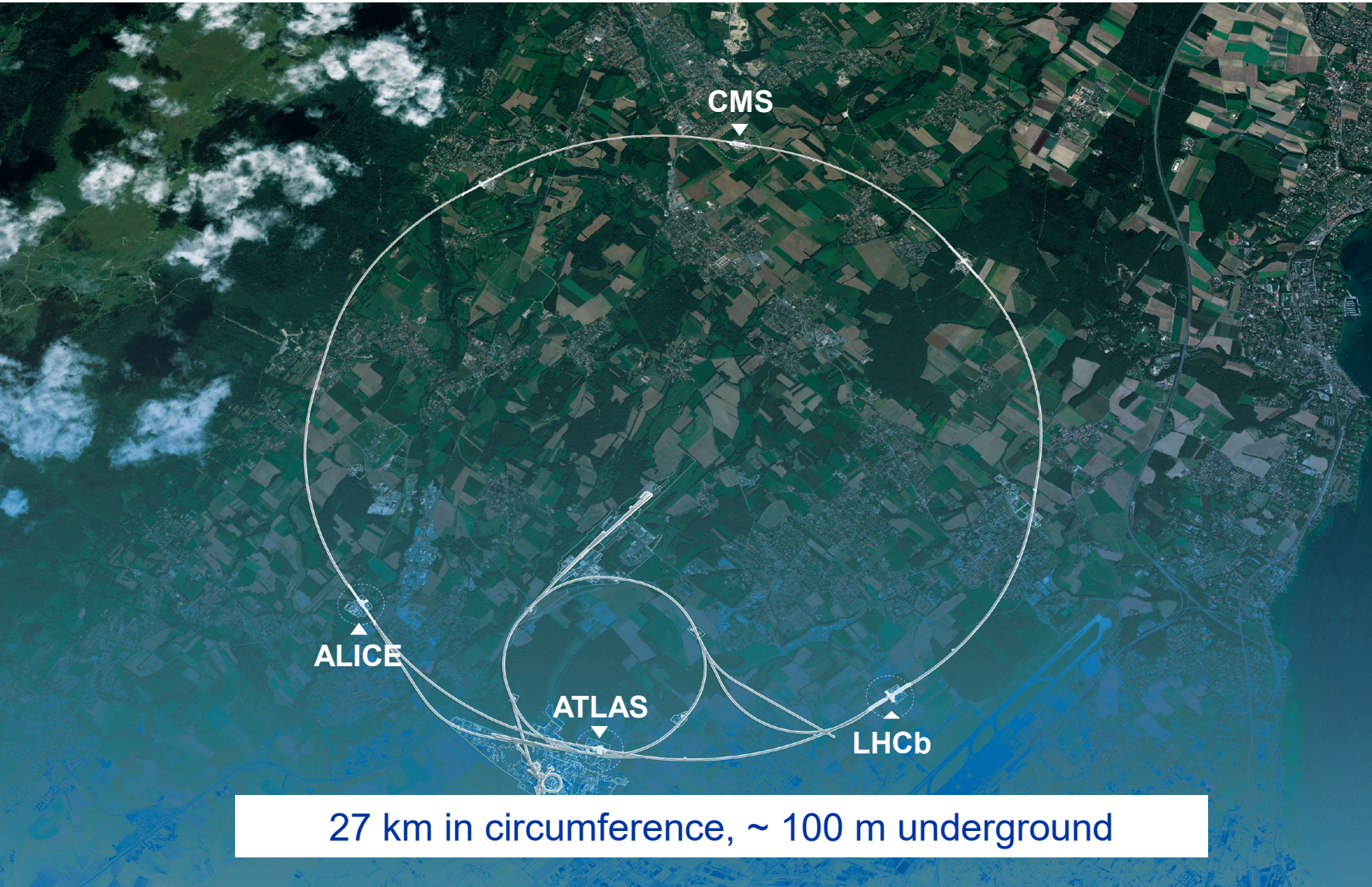


DETECTORS

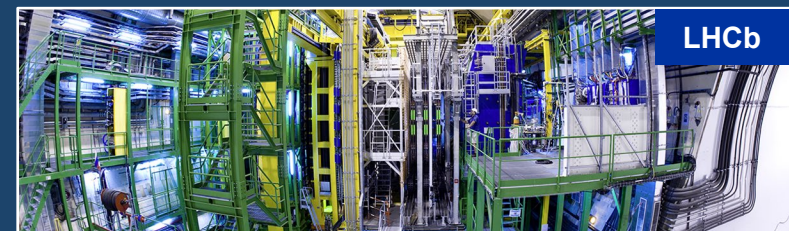
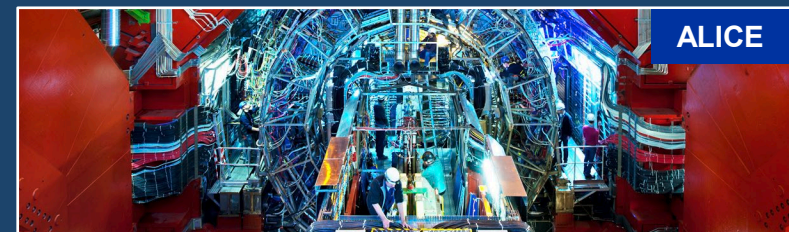
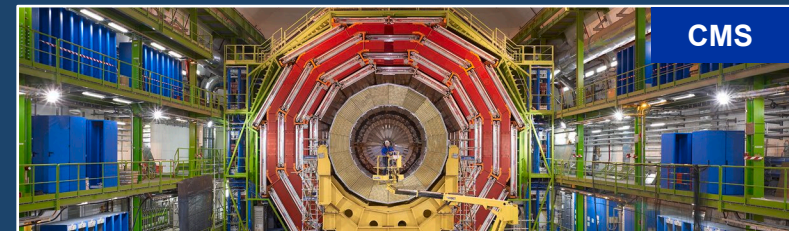


COMPUTING

Large Hadron Collider: research infrastructure across international borders



27 km in circumference, ~ 100 m underground

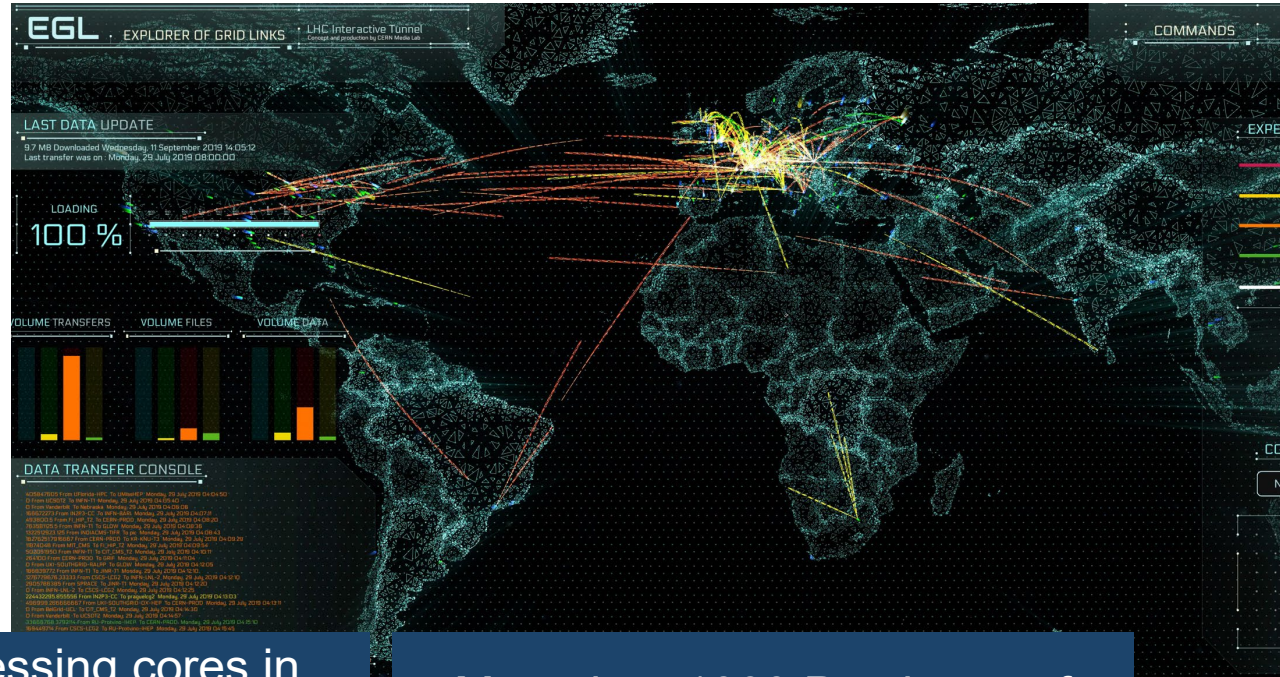


The Worldwide LHC Computing Grid (WLCG)



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.



Impact pathway
COLLABORATION

Science cooperation in global perspective



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 – Viet Nam

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

Practical models for open & 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.

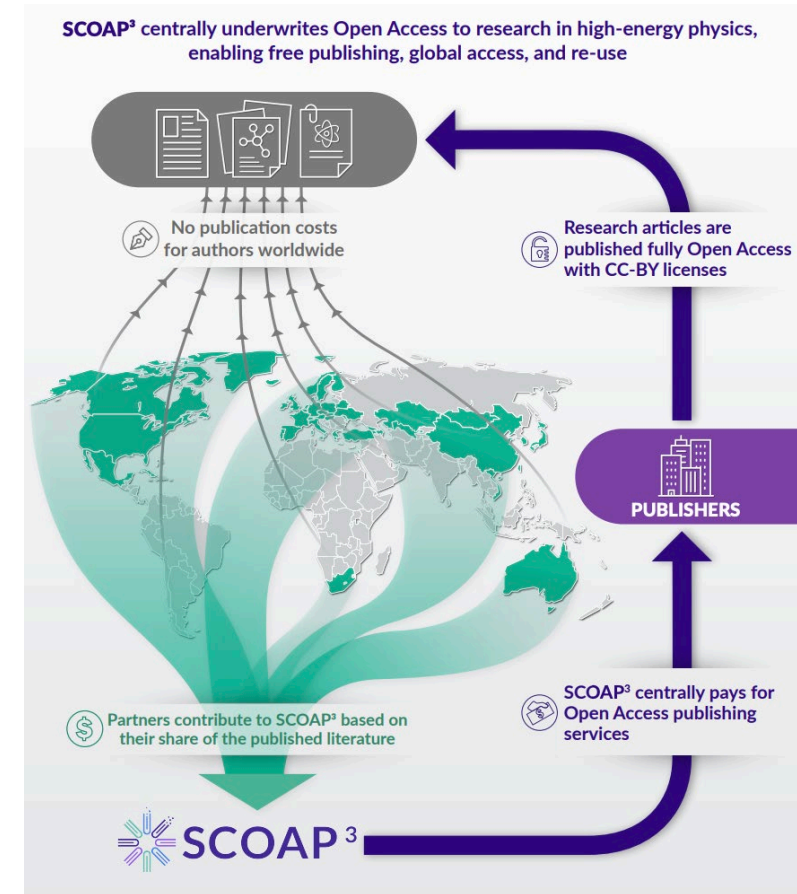


CERN provides the IT infrastructure for the satellite-analysis technology used for emergency response.

Core value: Open Science for deeper impact

CERN Convention Art. II.1.: *The Organization shall have no concern with work for military requirements, and the results of its experimental and theoretical work shall be published or otherwise made generally available*

- **Open Access Policy (2014)**
>90% of research produced at CERN published OA (CC-BY licenses)
Sponsoring Consortium for Open Access Publishing in Particle Physics - SCOAP³ (44 countries)
Inspired major global OA initiatives: PlanS, OA2020, etc.
- **LHC Open Data Policy (2020)**
LHC experiments committed to release experimental data for diverse scientific and educational uses
Data released together with associated analysis tools
- **CERN Open Science Policy (2022)**
Policy broadened to explicitly include open software, hardware, research integrity and assessment, education, training and outreach, citizen science



Promoting fact-based, science-driven decision-making

CERN engages with international organisations and platforms to share the values of science and help shape a global agenda conducive to fact-based decision-making with empowered citizens



CERN is an Observer with the UN General Assembly

SUSTAINABLE DEVELOPMENT GOALS



CERN actively promotes the SDGs with partners in the international system

Value of basic science for the SDGs: a CERN mapping

SDG 3 - HEALTH

CERN helps to develop technologies that contribute to better healthcare for all, such as medical imaging and hadron therapy.

SDG 4 - EDUCATION

Education is one of CERN's core missions. We offer high quality programmes that inspire thousands of students, teachers and young researchers each year.

SDG 5 - GENDER

Diversity is a core value for CERN. Our diversity policy aims at leveraging the added value that comes from bringing together people of different nationalities, genders, professions and ages.

SDG 7 - ENERGY

CERN develops strategies for minimise the increase of energy consumed by the installations, increase energy efficiency and implement energy recovery.

SDG 9 - INNOVATION

CERN inventions are brought to industry through knowledge transfer, to have a positive impact on society and innovation.

SDG 16 & 17 - INTERNATIONAL COOPERATION

CERN is a successful model for international collaboration. CERN gathers researchers from all over the world, contributing to human knowledge and peace, for the benefit of all.



THERAPY

Accelerators provide particle beams for more targeted cancer treatment.



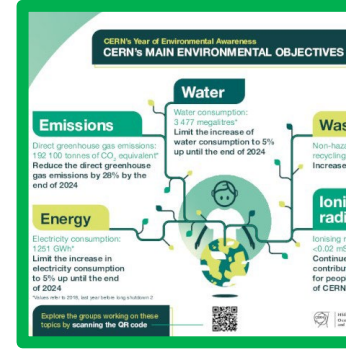
BEAMLINE FOR SCHOOLS COMPETITION

Students from the two winning teams spend a week at CERN to carry out their experiment using a CERN accelerator.



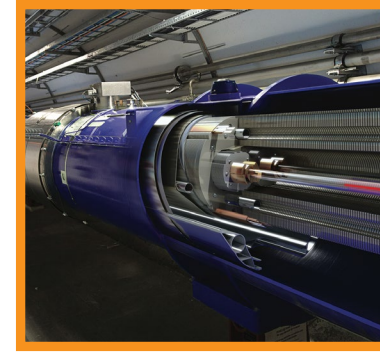
25 BY 25 DIVERSITY & INCLUSION INITIATIVE

First ever targets-based strategy to boost the nationality and gender diversity within the Staff and Fellows population.



HEATING LOCAL HOUSING

Heat recovered from CERN's accelerator cooling systems to heat a new residential area in the town of Ferney-Voltaire, benefiting up to 8000 people.



A MAGNET IN THE LHC TUNNEL

Exploring the universe requires new technologies and ingenious engineering to build the machines that explore physics at a new frontier.



SESAME

This new synchrotron light source in Jordan started operation in 2017. It is a unique collaboration between eight Middle East members, modelled on CERN's governance structure.



Impact pathway
**TECHNOLOGY
& INNOVATION**

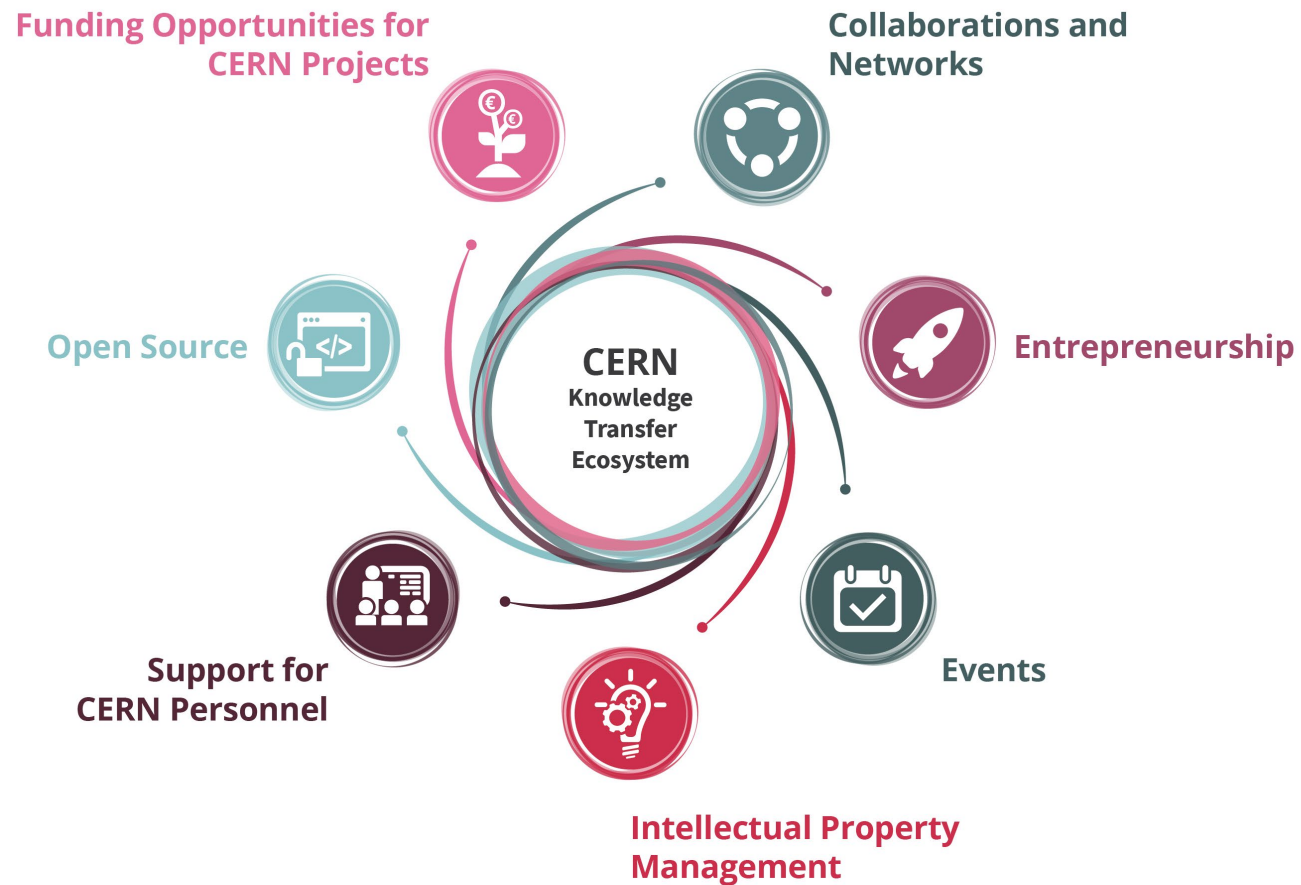
Technological innovations with wide societal application

CERN is the birthplace of the World Wide Web

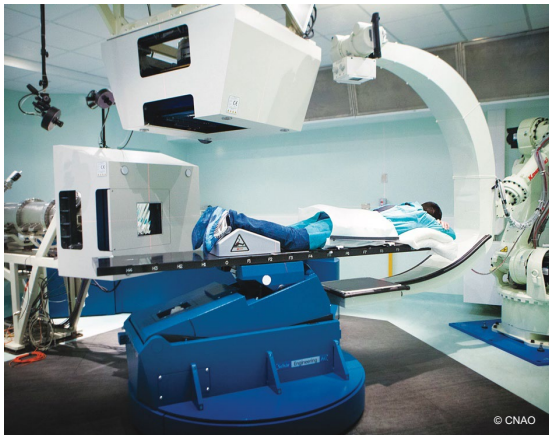
And there are many more examples

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

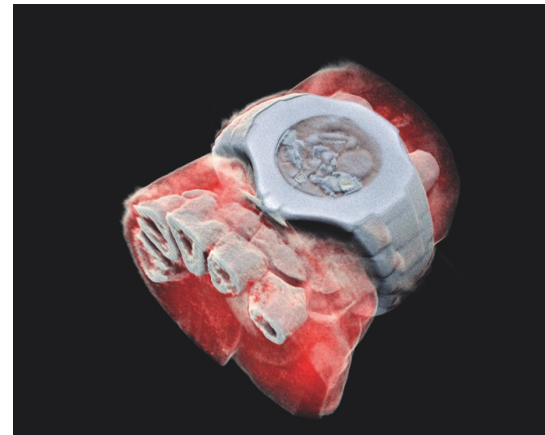
Knowledge transfer tools



Applications in medicine and healthcare

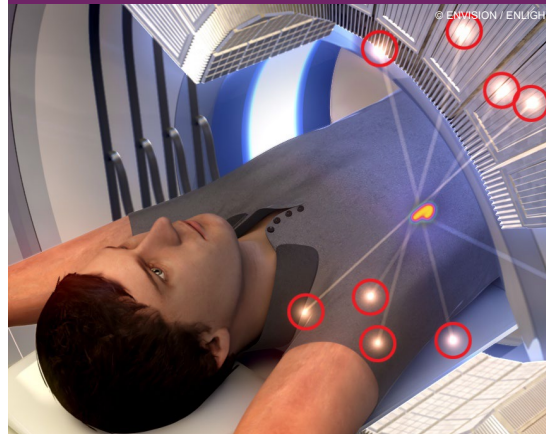


Technologies applied at CERN are also used in PET, for medical imaging and diagnostics.

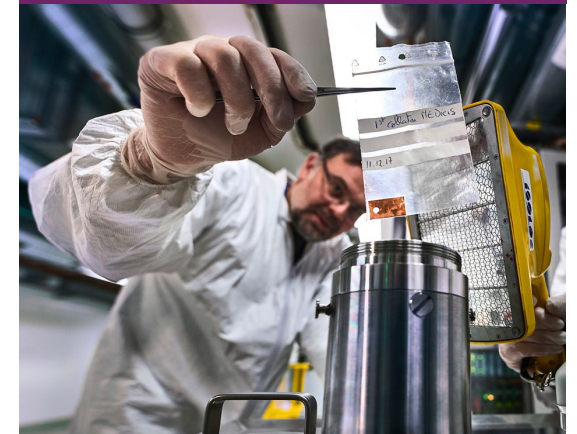


CERN produces innovative radioisotopes for nuclear medicine research.

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 Technology Impact Fund

Example: BioDynamo



A multidisciplinary
simulation framework

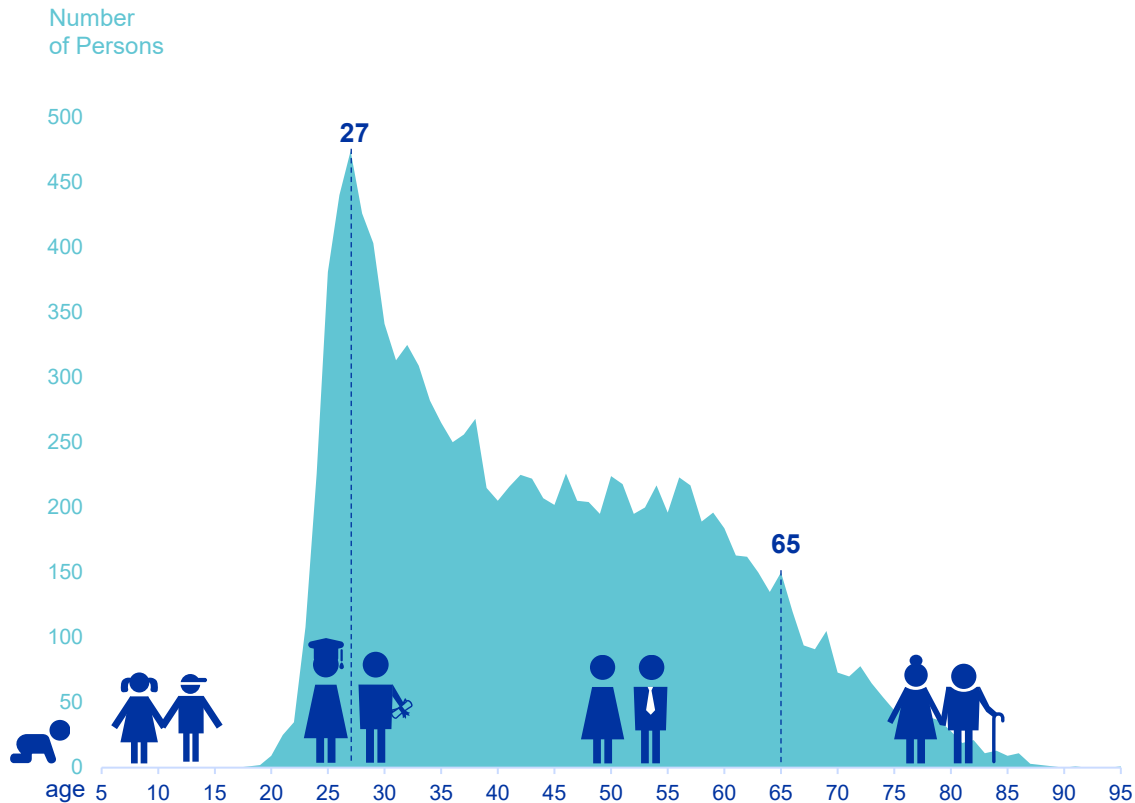
Example of application:
simulating dynamics of
mosquito populations and
dengue

Supported by donors
through the CERN&Society
Foundation

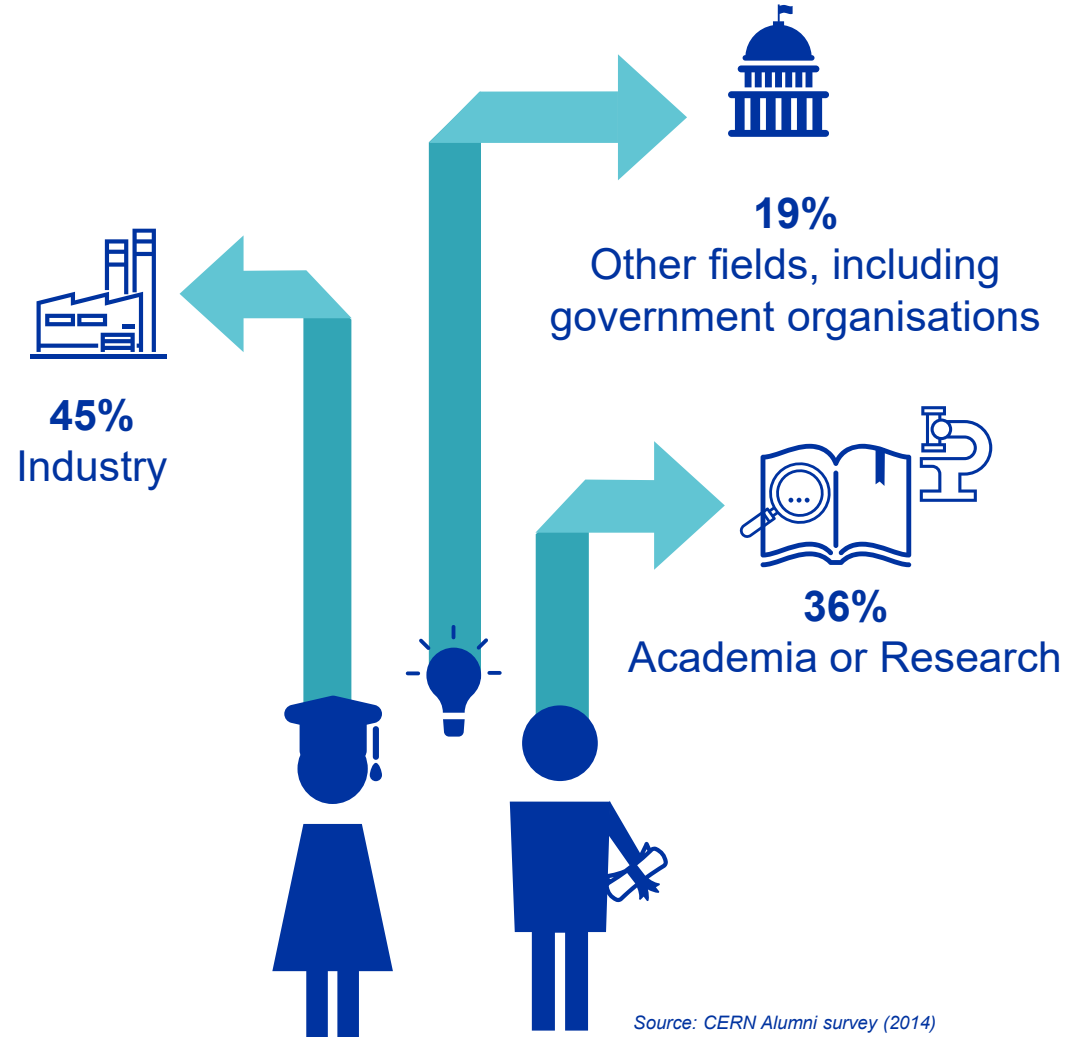
A group of students, both male and female, are wearing hard hats (yellow and blue) and are focused on a large, complex piece of equipment in a laboratory or industrial setting. The equipment is mounted on a metal frame. One student in the foreground is adjusting a component of the equipment. Other students are looking on with interest. The background shows a white wall with a green exit sign and some cables.

Impact pathway
EDUCATION
& TRAINING

Skills development through basic science



Age Distribution of Scientists working at CERN



PhD and Technical students leaving CERN

Source: CERN Alumni survey (2014)

Capacity-building through education programmes: teachers and students

900 graduates
(including Research Fellows)

3 000 PhD students

300 Undergraduate students in
Summer programmes



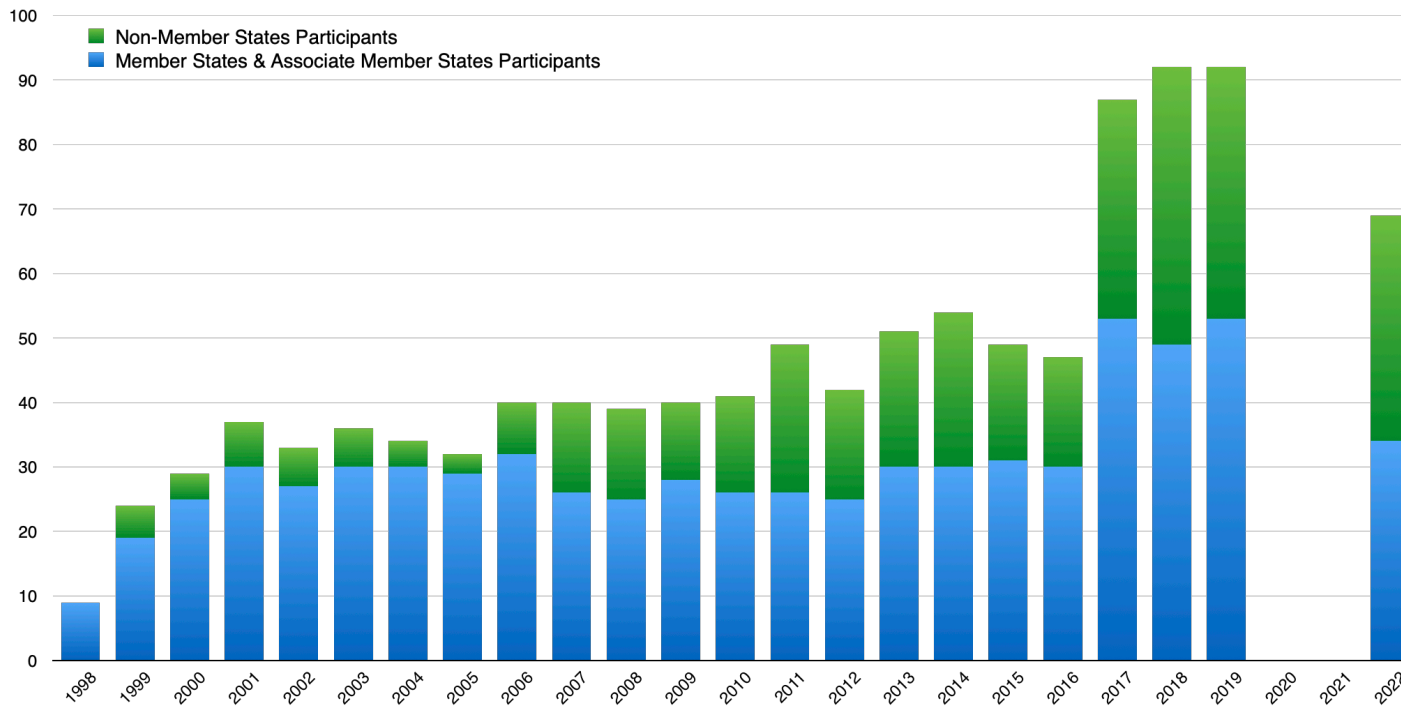
>14 000 teachers participating in
dedicated programmes, since 1998

Around 150 000 visitors on guided
tours of CERN, from >50 countries

4.7M followers on social media,
from around the globe

Multiplying through high-school teachers

International Teacher Programmes 1998-2022



Distribution of Member and Associate Member States and non-Member States participating in the International Teacher Programmes

- CERN hosts **~1,000 high-school teachers** from **>65 countries** in **35 national teacher programmes & 2 international teacher programmes** every year, which then, in turn, reach many thousands of students in classrooms across the world.
- Gender-inclusive teaching module developed to build competencies so as to spark interest of all students in STEM subjects => included in the International Teacher Programmes and in National Programmes on request.

Strengthening infrastructure

- Through a programme started in 2012, CERN donates **computing equipment** that no longer meets its highly specific requirements on efficiency but is still more than adequate for less exacting environments.
- Donations can play an important role in **providing opportunities for researchers and students in their home countries** through enhanced infrastructure.
- 2524 servers and 150 network switches have been donated in total, to institutions in Algeria, Bulgaria, Ecuador, Egypt, Ghana, Jordan (SESAME), Lebanon, Mexico, Morocco, Nepal, Pakistan, Palestine, Philippines, Senegal and Serbia.
- **Providing training opportunities** in addition to the infrastructure enhancement.



Computing equipment sent to Lebanon in January 2022.



Improving access through digital libraries

- Initiated in 2009, the CERN-UNESCO Schools for Digital Libraries are organised with support of the CERN & Society Foundation => **Rwanda** (2009), **Morocco** (2010), **Senegal** (2011), **Ghana** (2016) and **Kenya** (2019), with participation from **25 countries** in Africa.
- Training focused (~30 participants per School) on open access & open knowledge, with the goal of facilitating access by libraries to a more comprehensive literature, and to get the African repositories well-filled with the local academic production.
- Important progress made since the Schools started, with an increasing amount of African research output being discovered via digital libraries (or so-called repositories).



CERN & Society
Foundation

*Participants in the 5th edition of
the School, at University of
Nairobi (2019)*

Reflections: the value of basic science in STI capacity-building

- Fundamental research has deep societal impact through **several pathways**
 - Generating **knowledge** as a common good
 - Facilitating and promoting **international collaboration**
 - Driving **innovation**
 - Providing **education**, training and **skills development**
- The core **values of science** – collaboration, openness, excellence – support capacity-building
 - Providing **practical examples** for how to draw collective benefit from common efforts
 - Inspiration for **modus operandi** that allow **sharing** and helps to level the playing field

Reflections: how can we capitalise on this potential?

- **More can be done**, at national and international level, to **leverage research infrastructures** and capitalise on this potential.
- Notably, through support for **policies** and **programmes** that:
 - Facilitate **mobility** and **exchange** of **students** and **researchers**;
 - Support **open science** in line with agreed principles (UNESCO Recommendation on Open Science);
 - Strengthen **educational initiatives** at all levels (primary, secondary, tertiary) to make use of research infrastructures for practical programmes and platforms for inspiration of the next generation of scientists and many other professions;
 - Promote the development of **research capacity** and **infrastructure**.



Thank you!

Additional information

As the presentation includes only a small selection of initiatives and activities, below are links to reports and other resources that provide further background and examples:

1. CERN Annual Reports: <https://home.cern/tags/report>
2. CERN Environment Reports: <https://hse.cern/environment-report>
3. CERN Knowledge Transfer 2022 Highlights: <https://kt.cern/annual-report/knowledge-transfer-highlights-2022>
4. CERN IdeaSquare: <https://ideasquare.cern/>
5. CERN Teacher Programmes: <https://teacher-programmes.web.cern.ch/>
6. CERN Summer Student Opportunities: <https://careers.cern/summer>
7. CERN & Society Foundation: <https://cernandsocietyfoundation.cern/>
8. UNITAR/UNOSAT: <https://unosat.org/>