Finanzwesen an einer internationalen Forschungseinrichtung: Das Beispiel CERN

Dr. Florian Sonnemann, Department Head Finance and Administrative Processes

The European Research Organizations

CERN – European Organization for Nuclear Research

EMBL – European Molecular Biology Laboratory

ESA – European Space Agency

ESO – European Southern Observatory for Astronomical Research in the Southern Hemisphere

State like
- Outside national social security
- Contributions usually based on size of economy
- Changing Scale of contributions
- special tax status

International Organizations

ESRF – European Synchrotron Radiation Facility

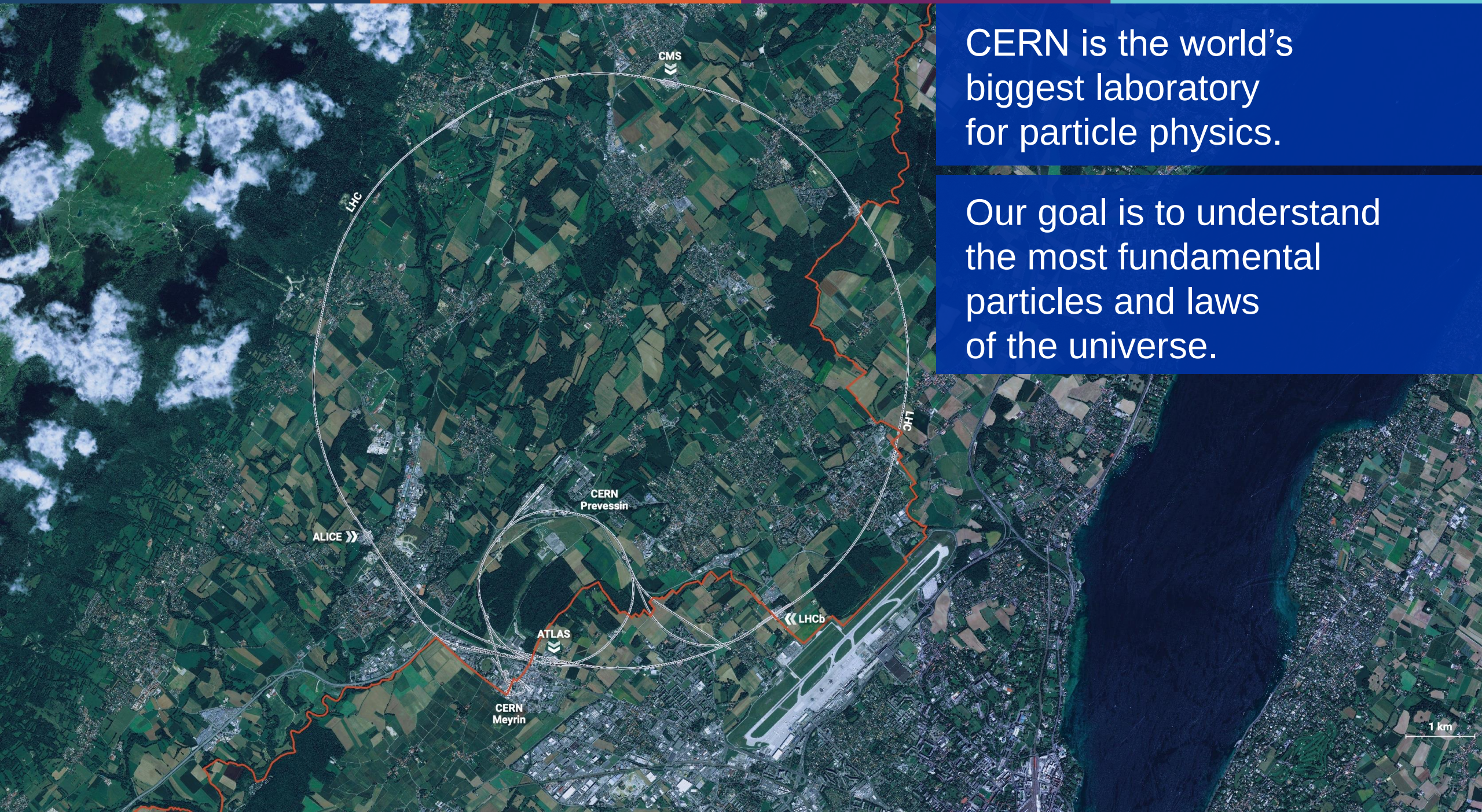
EUROfusion – European Consortium for the Development of Fusion Energy

European XFEL – European X-Ray Free-Electron Laser Facility

ILL – Institut Laue-Langevin

Company shares fixed by Member States
- Part of host state national social security
- Normal tax status
- Often higher contribution by host state

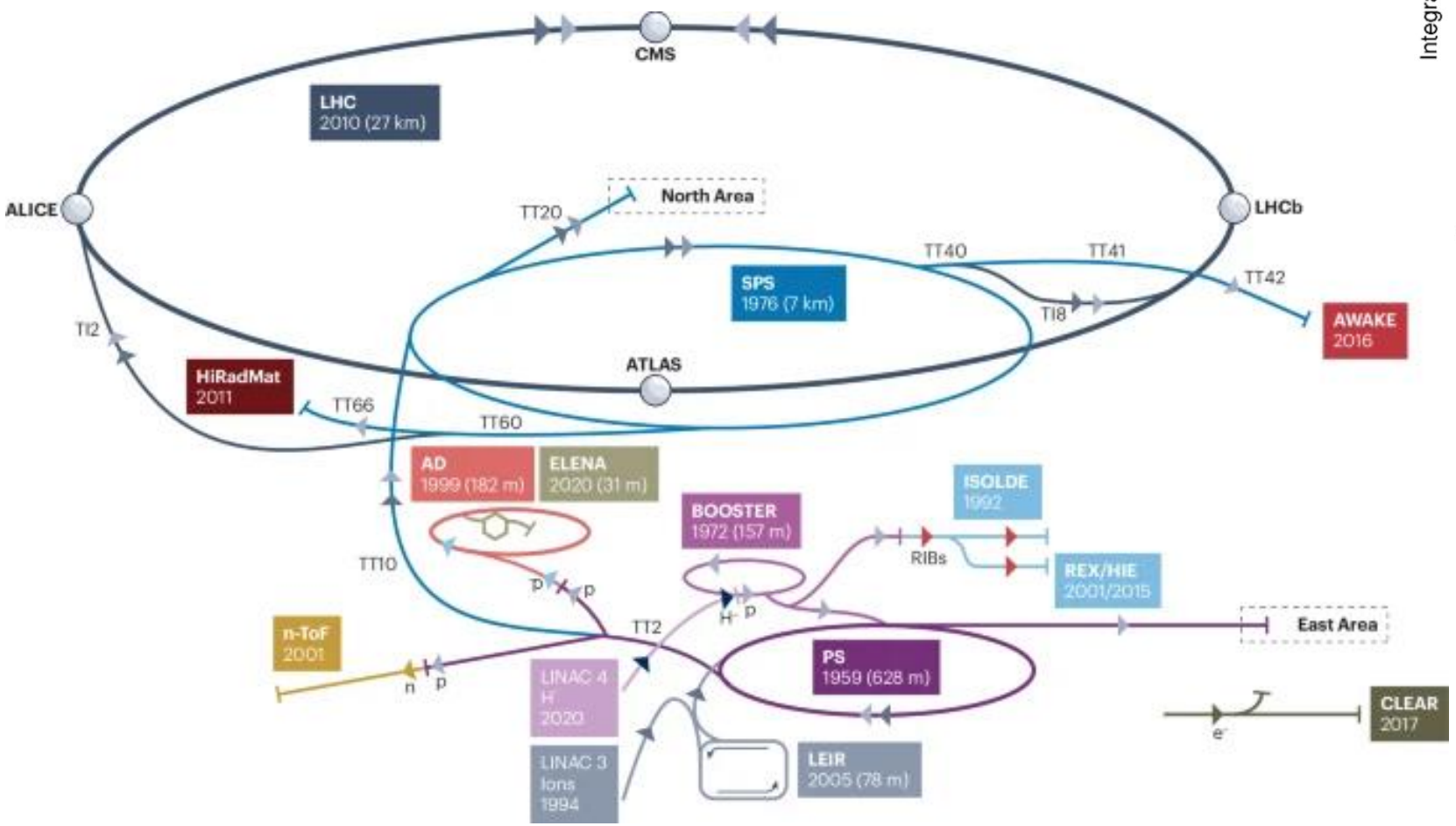
Companies with national legislation and international ownership

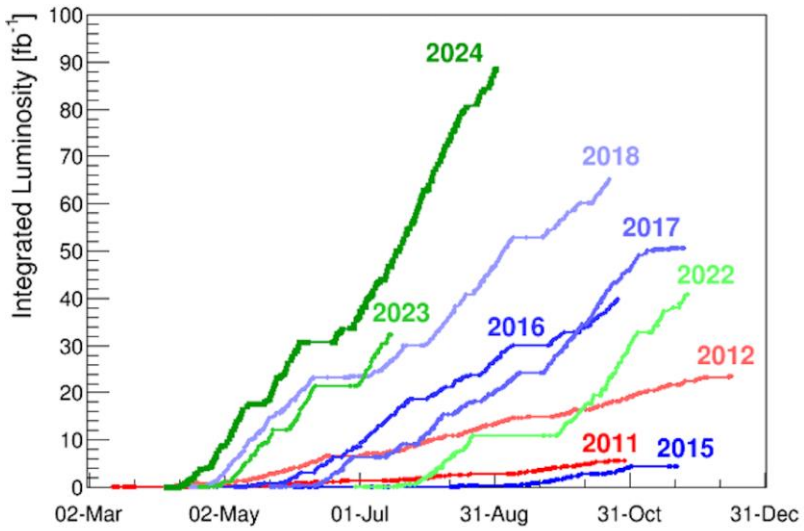


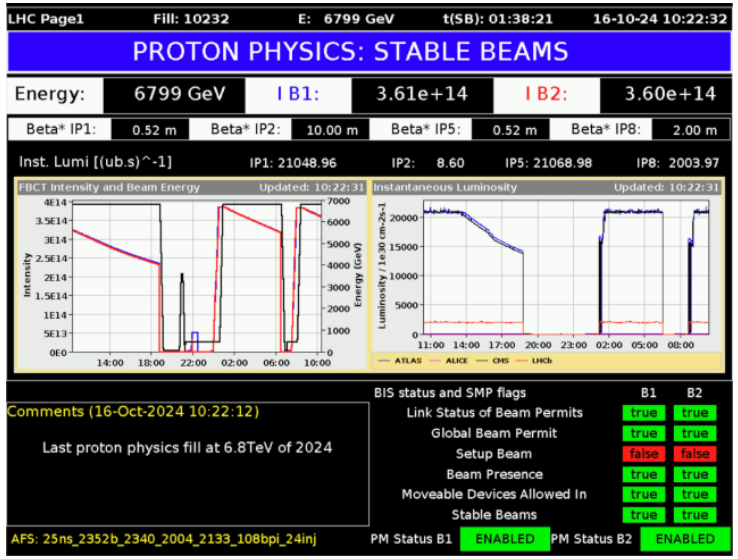
CERN is the world's biggest laboratory for particle physics.

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

The accelerators – record year 2024







Four pillars underpin CERN’s mission

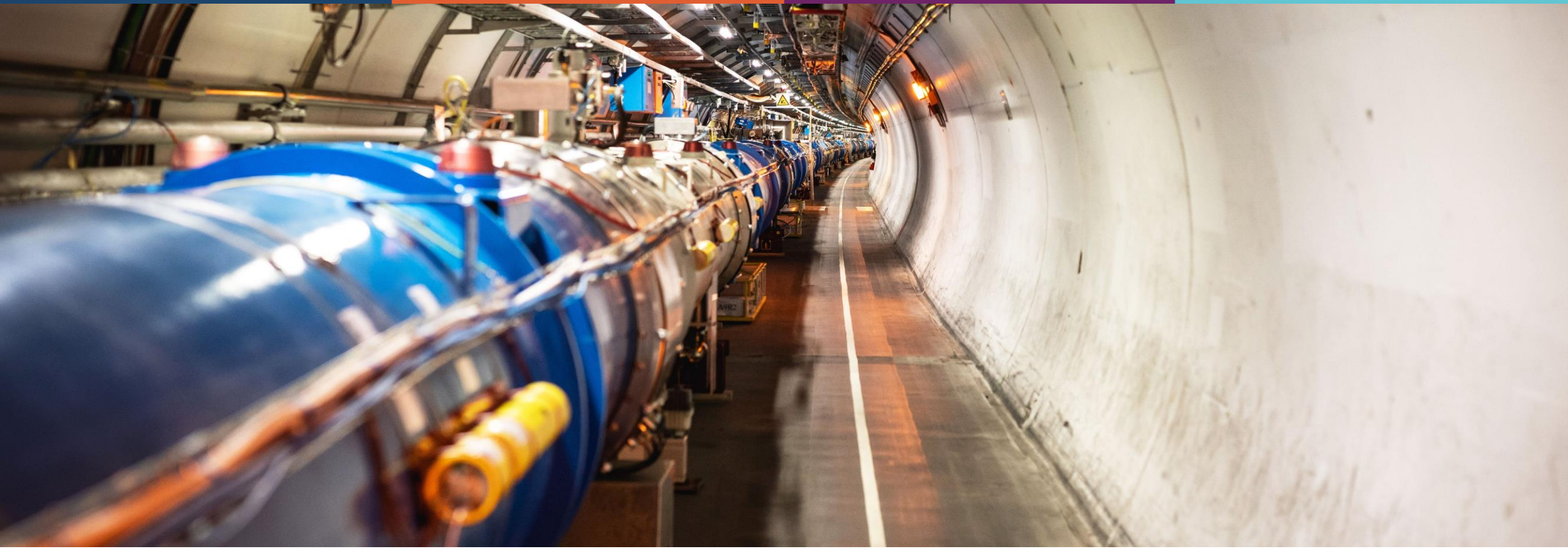
RESEARCH

COLLABORATION

EDUCATION
& TRAINING

TECHNOLOGY
& INNOVATION

Later more details



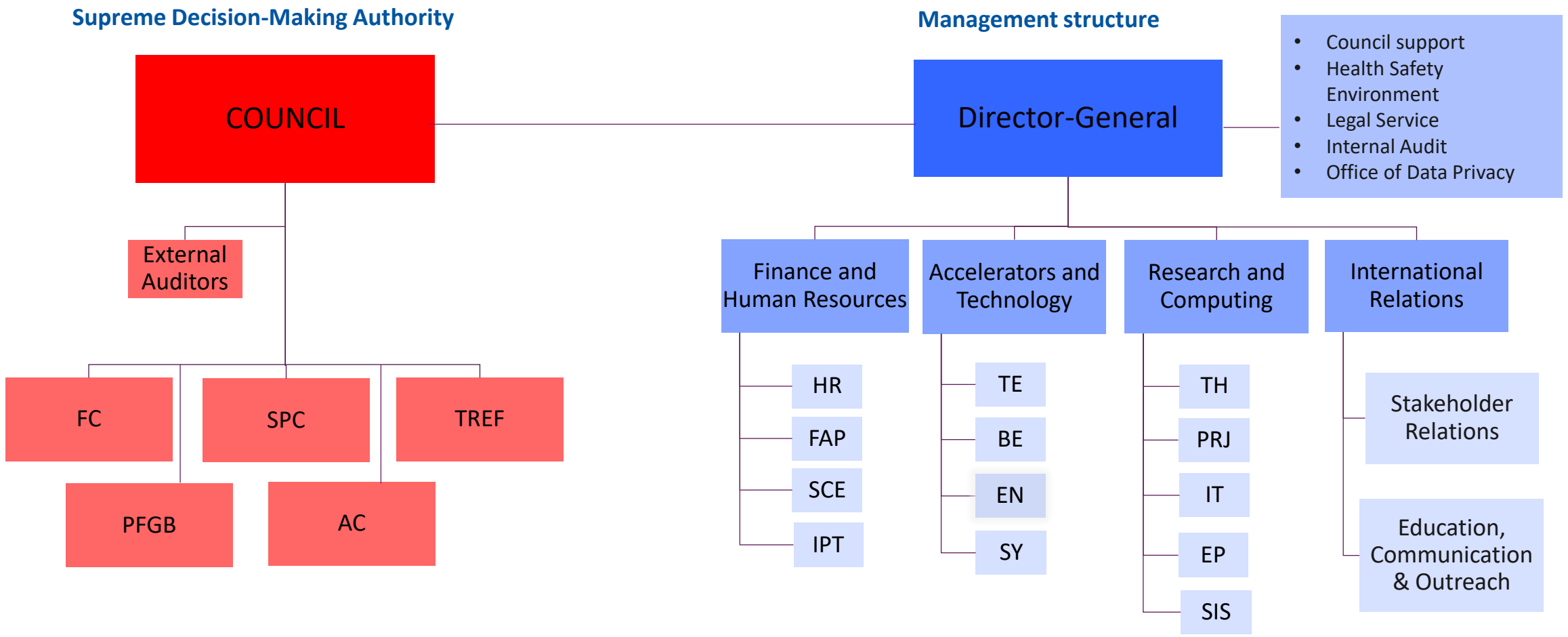
The Governance and Financial Framework

CERN is an international organization
Council Européen pour la Recherche Nucléaire

- Contributions based on size of Member States
- Convention was ratified in 1952-1953
- Start 1954
- Own social security
- Internal taxation – exemption from national taxation

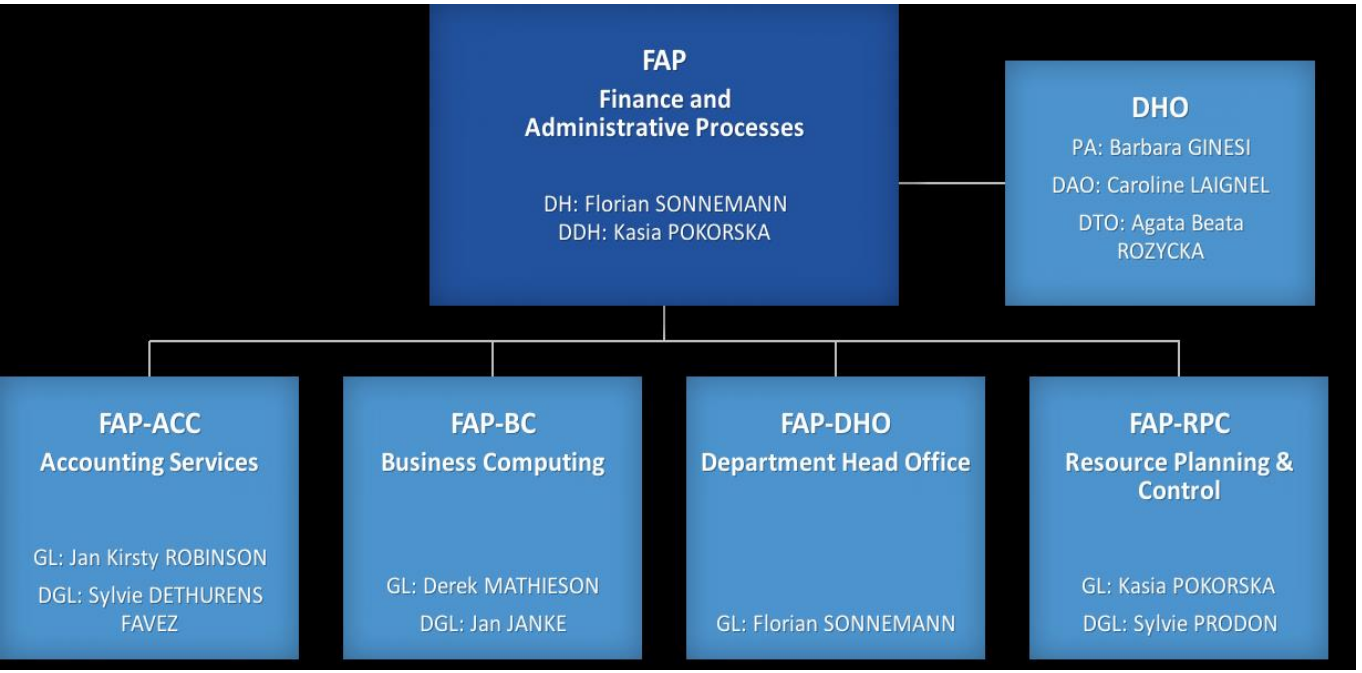
- Financial protocol governs finances
- Council (as supreme body) sets financial rules (no national legislation)
- Mechanism for compensating inflation
- Acting on financial markets to ensure cashflow
- Own social security (some 5 Bill CHF assets for the Pension Fund)

CERN’s governance and structure



Organigram and mission of the FAP department

https://fap-dep.web.cern.ch/

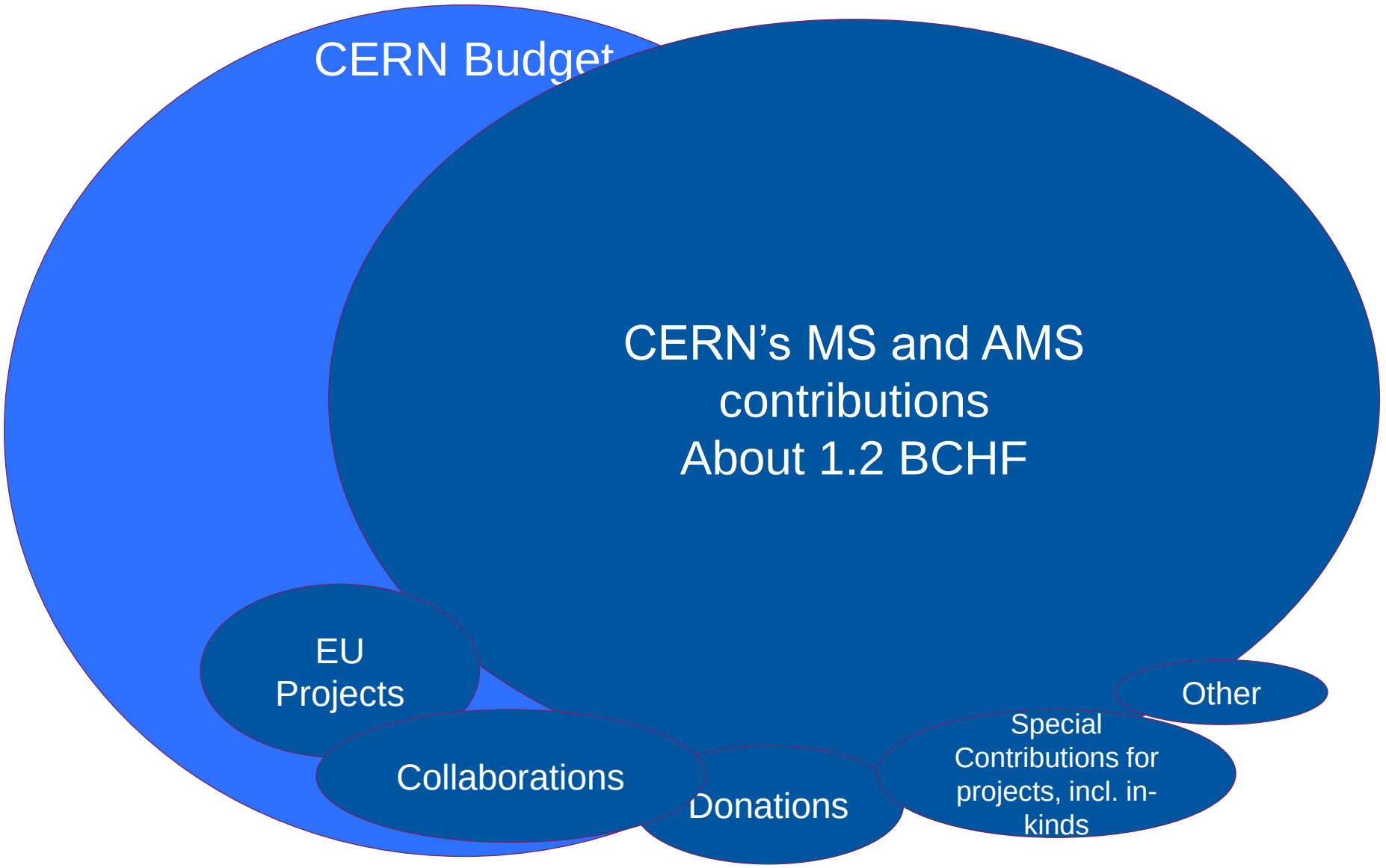


CERN's Finance and Administrative Processes (FAP) Department is responsible for the effective and efficient management of the Organization's financial resources and commitments while ensuring compliance with CERN's financial rules and procedures.

FAP is also responsible for the accuracy of the Organization's financial Data (including personnel and procurement) and as such, provides and support a set of integrated, secure and reliable enterprise information systems. It provides the tools for optimal support for CERN Business Processes, Project Planning and Management.

We produce the Council documents such as:
Financial Statements, Annual Progress Report
Medium Term Plan & Draft Budget
Final Budget
Cost-Variation index and scale of contributions

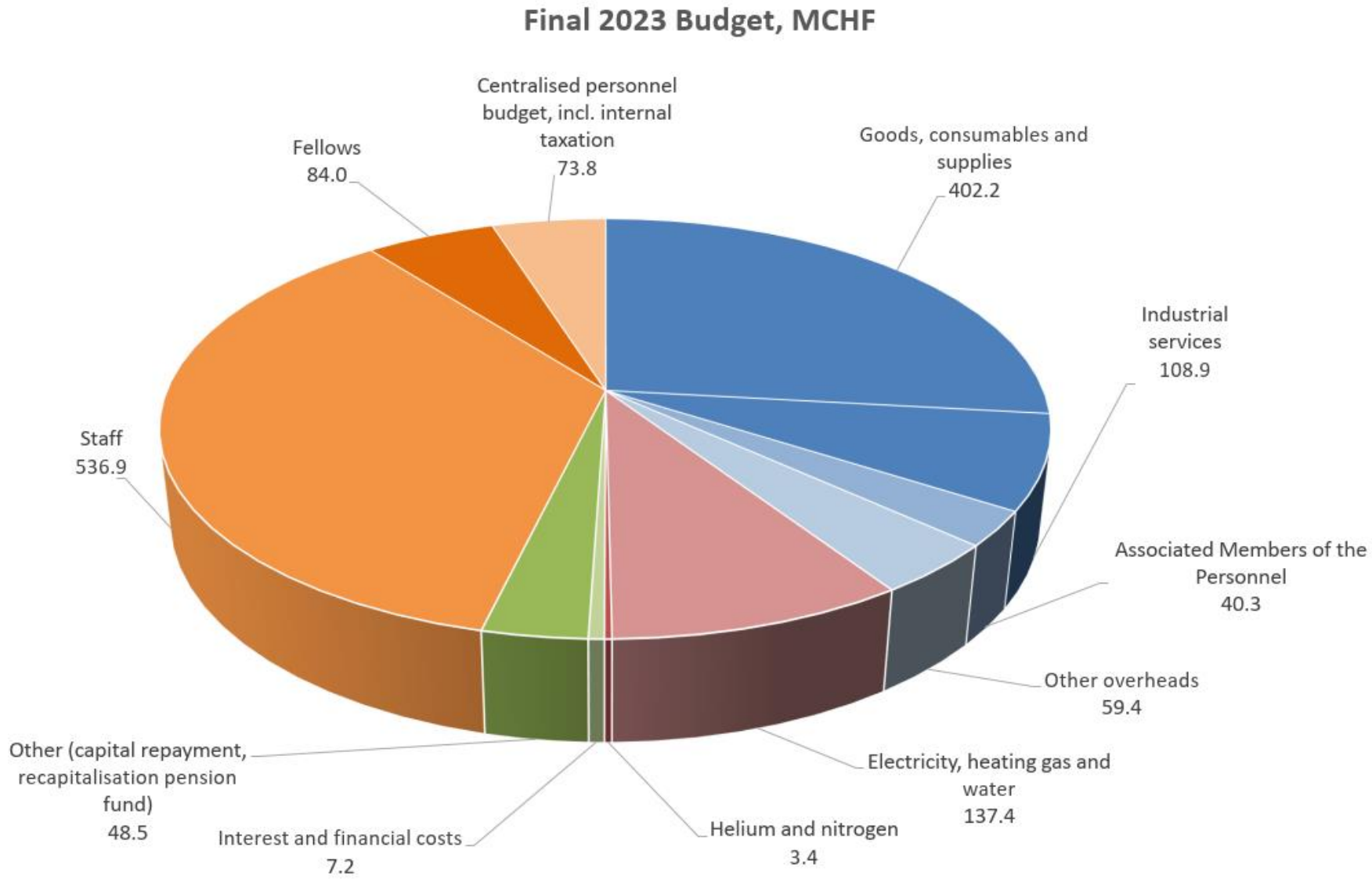
CERN : various funding sources and supervision



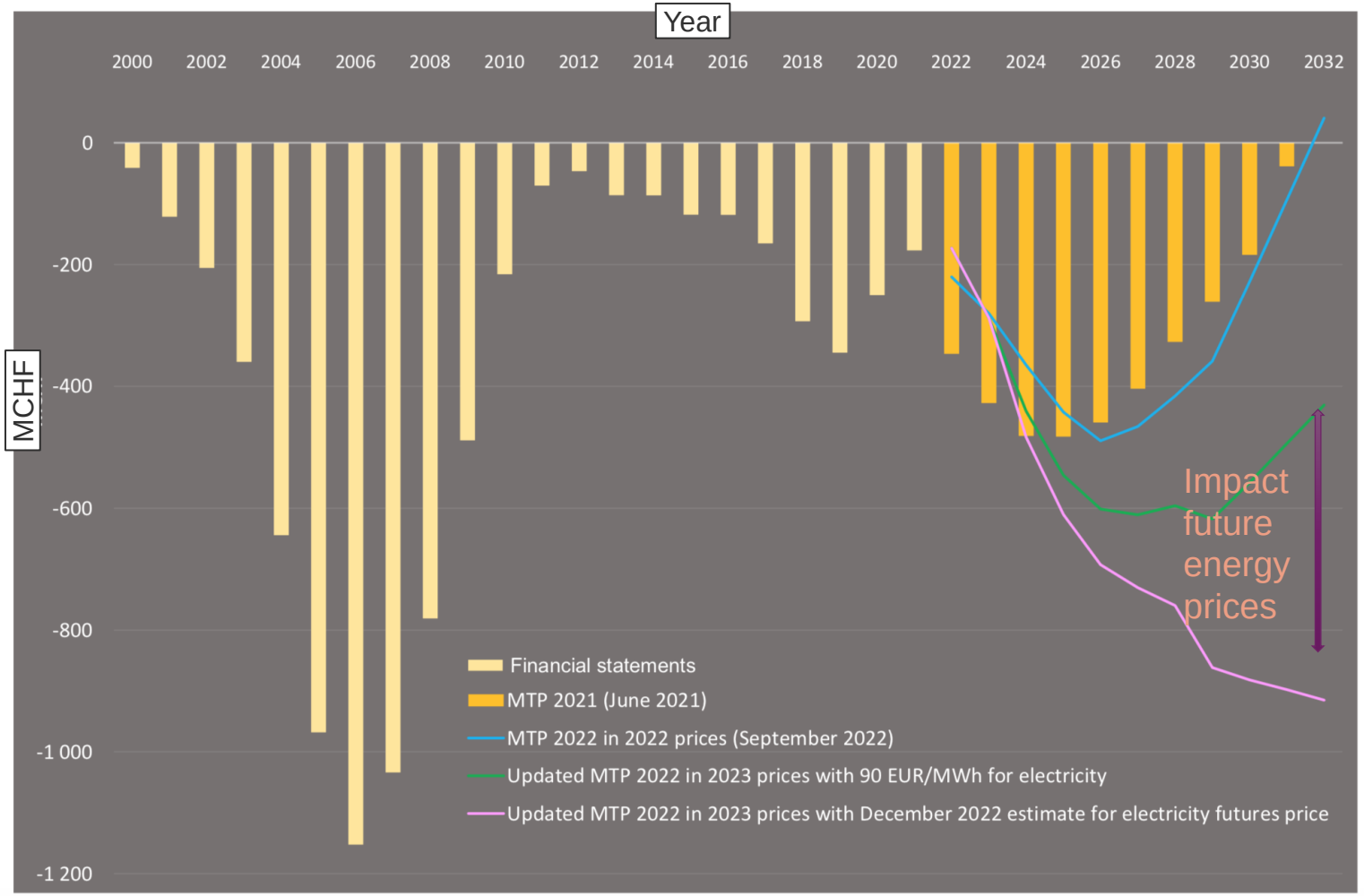
Supervision

- Council and its committees (notably FC)
- DG and Extended Directorate
- Management structures
- Projects cost & schedule review
- EU Commission
- External Auditors
- Agreements (Collaboration & others)

CERN Expenses



Impact on Cumulative Budget Deficit (CBD)



Remarks:

- ❑ CBD in 2023: lower than expected from 7% net CVI increase (94 MCHF) due mainly to expenses reprofiling from 2022 and 2023 (55 MCHF) to the future and mitigation measures: savings in energy consumption (13.8MCHF combining 2022 and 2023), "crisis levy" (8.7 MCHF, see later).

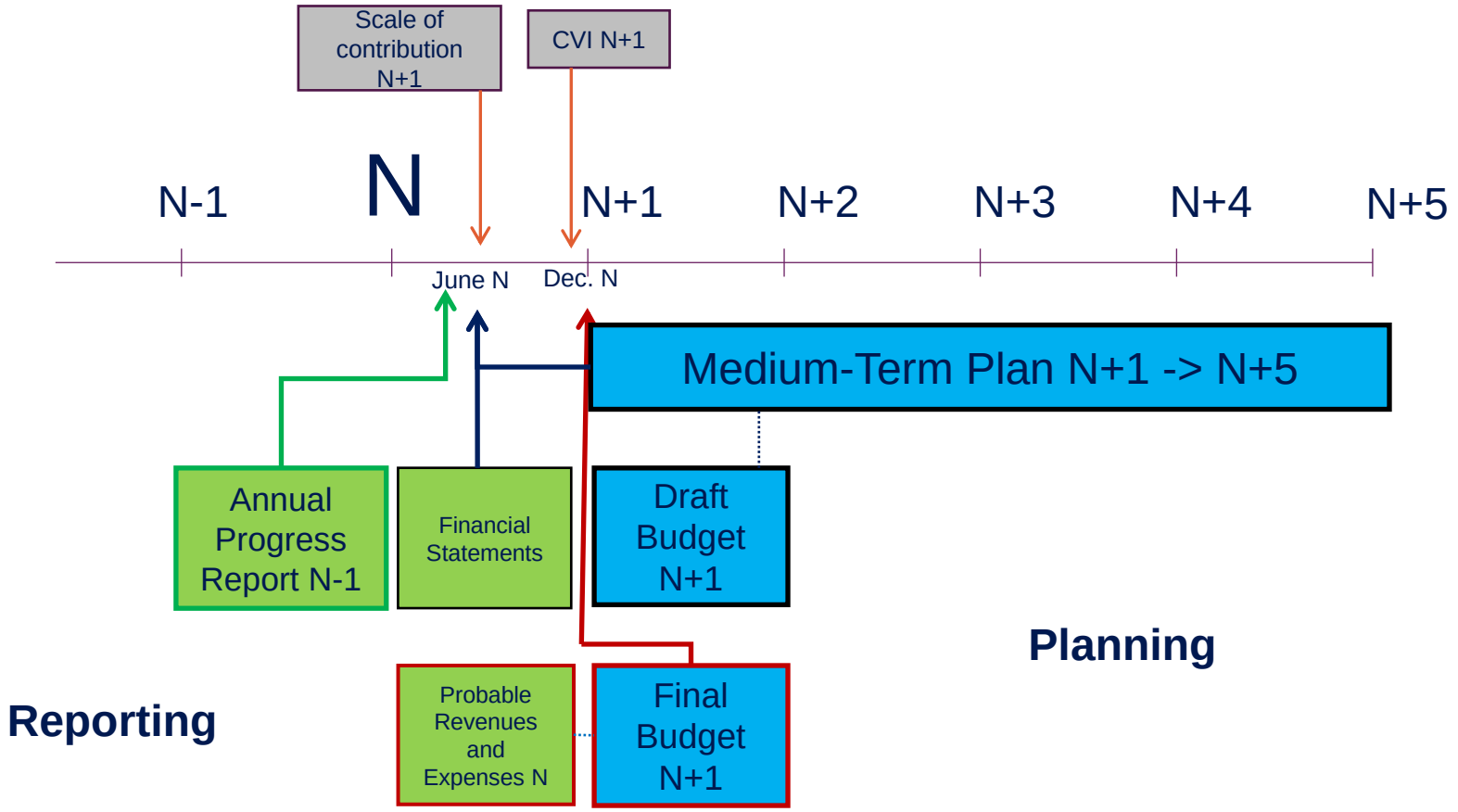
- ❑ CBD in 2032: a deficit between 440 and 930 MCHF (assuming CVI covered by indexation up to 2% in 2023 and fully after 2023, and depending on electricity price assumptions) would jeopardise the capability to invest in a new major facility at CERN at the start of the next decade.

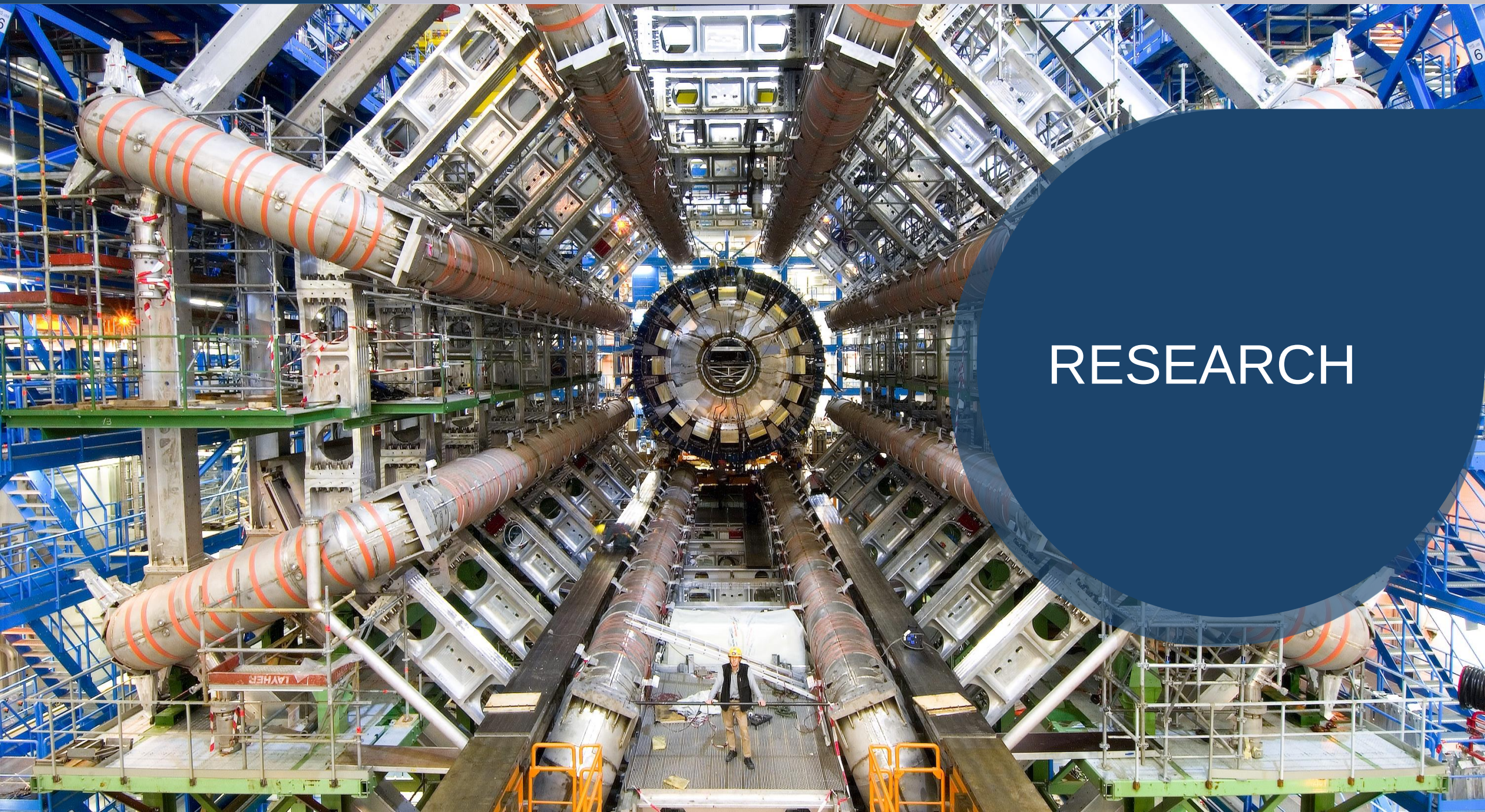
→ Package of measures presented here aims at offsetting up to ~ 900 MCHF deficit

Please note: Updated MTP 2022 includes the data for the Final Budget 2023 presented this Council week including the CVI and Crisis Levy.

Even if the CVI would be back below 2% as of 2024 AND the energy costs back to pre-crisis levels, a deficit of 440 MCHF by the end of 2032 would be the result of the 2022 to 2023 CVI!

Overview of the CERN planning and reporting cycle

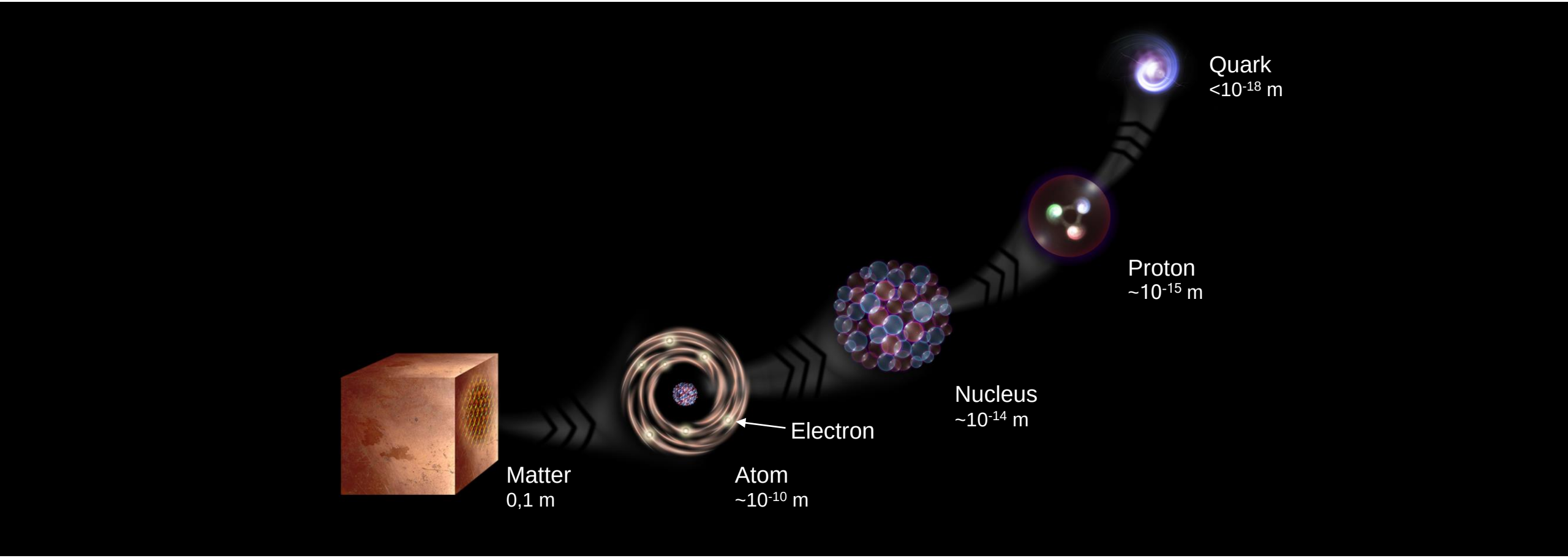


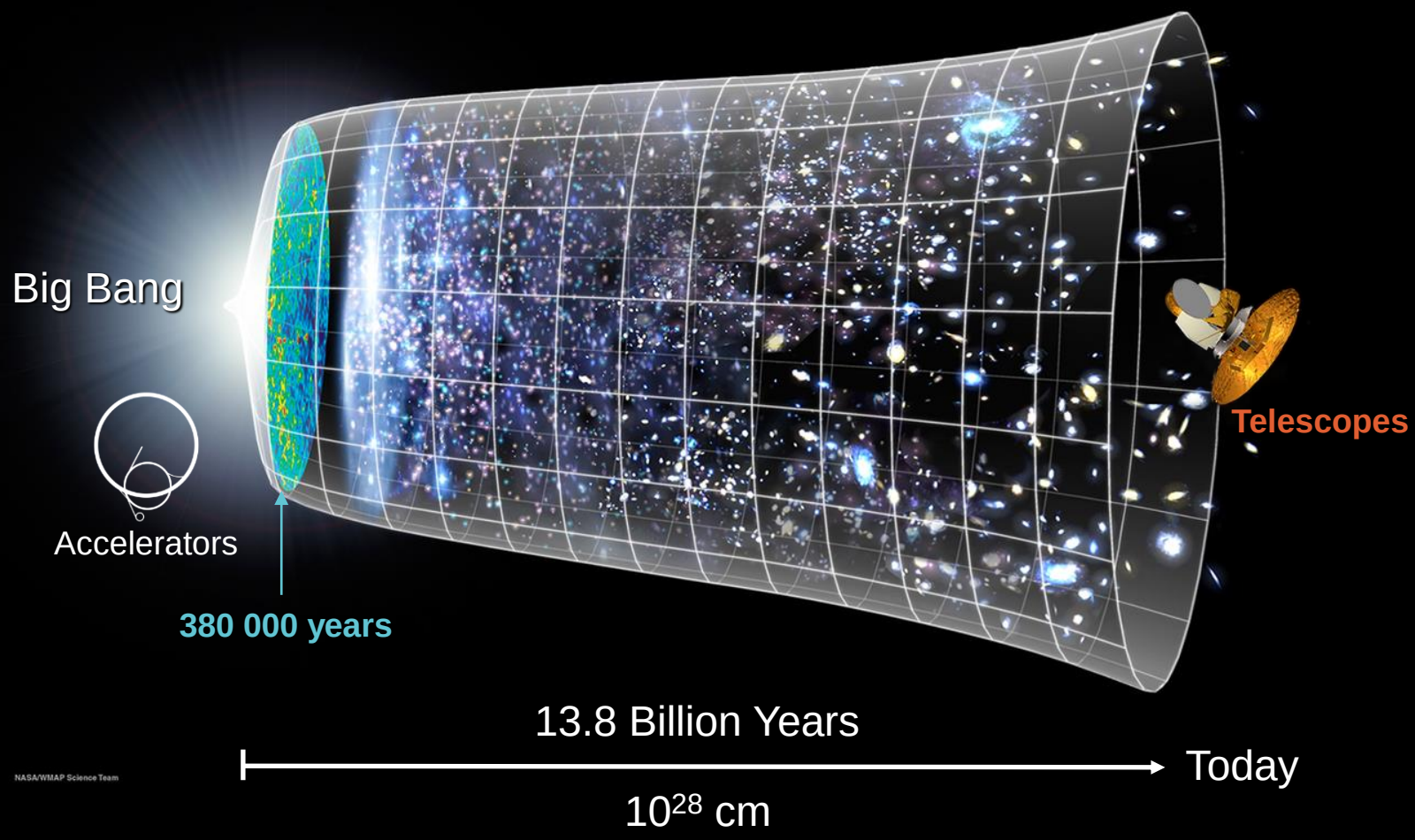


RESEARCH

What is the universe made of?

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





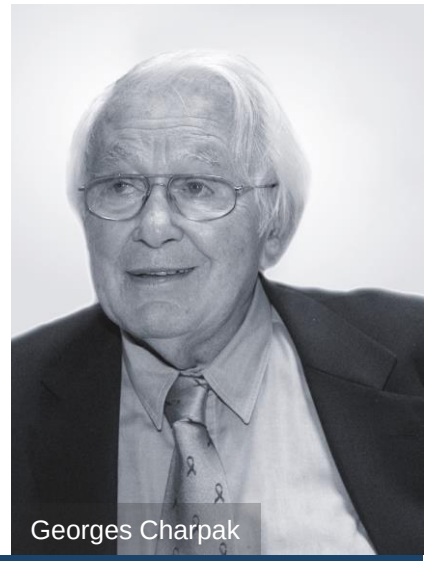
How did the universe begin?

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

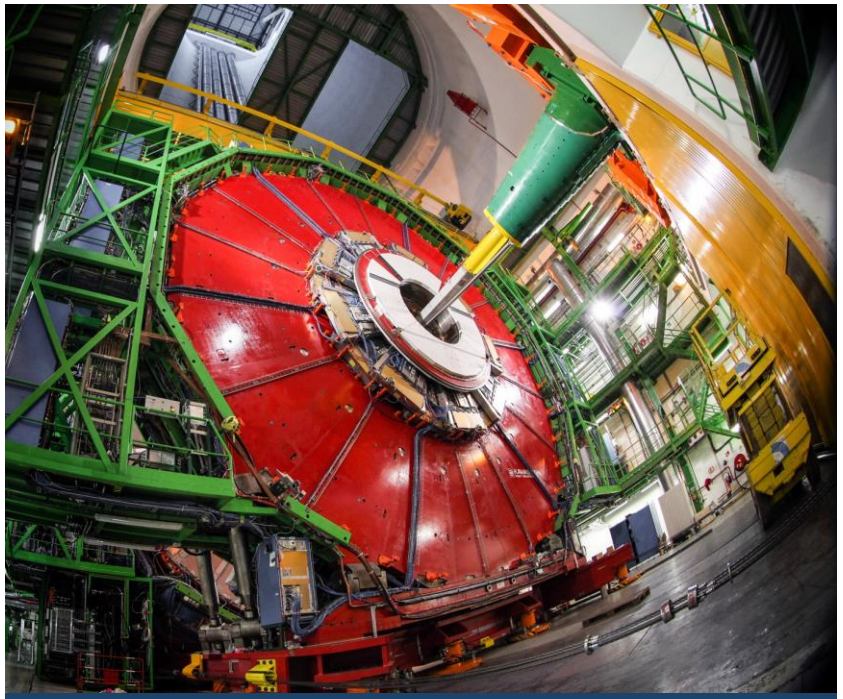
Several CERN scientists have received Nobel Prizes for key discoveries in particle physics.

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

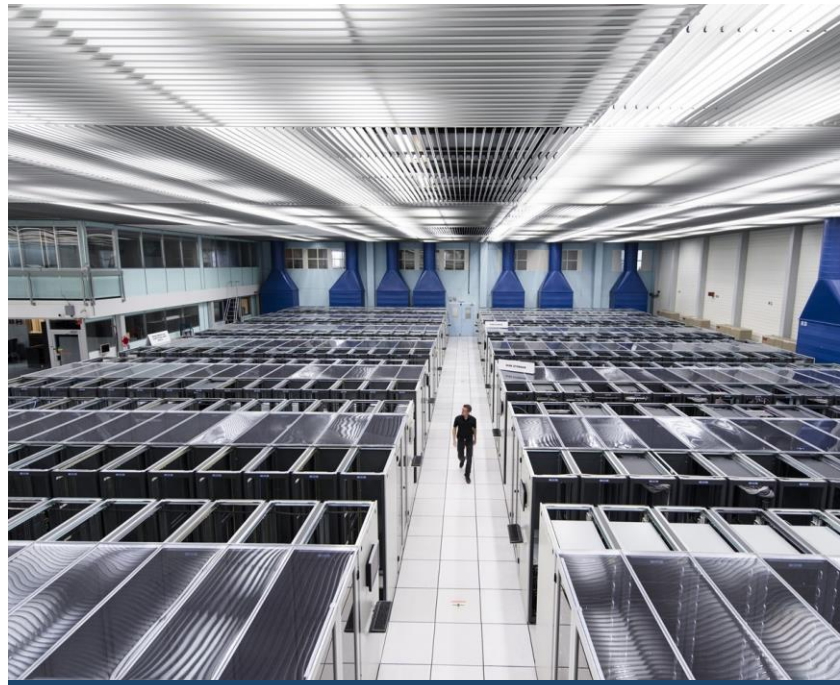

François Englert and Peter Higgs. With Robert Brout, they proposed the mechanism in 1964.

We develop technologies in three key areas

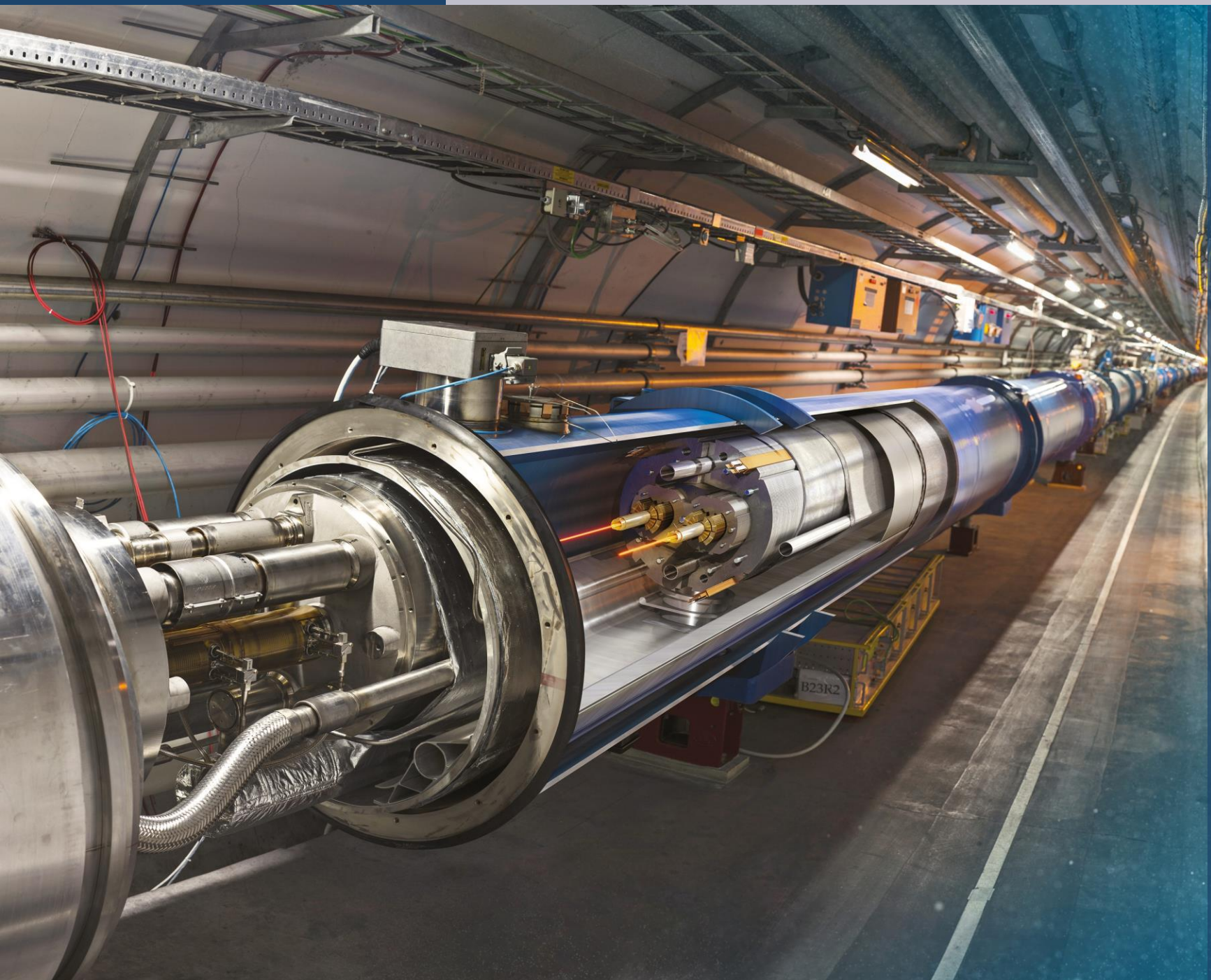
ACCELERATORS



DETECTORS



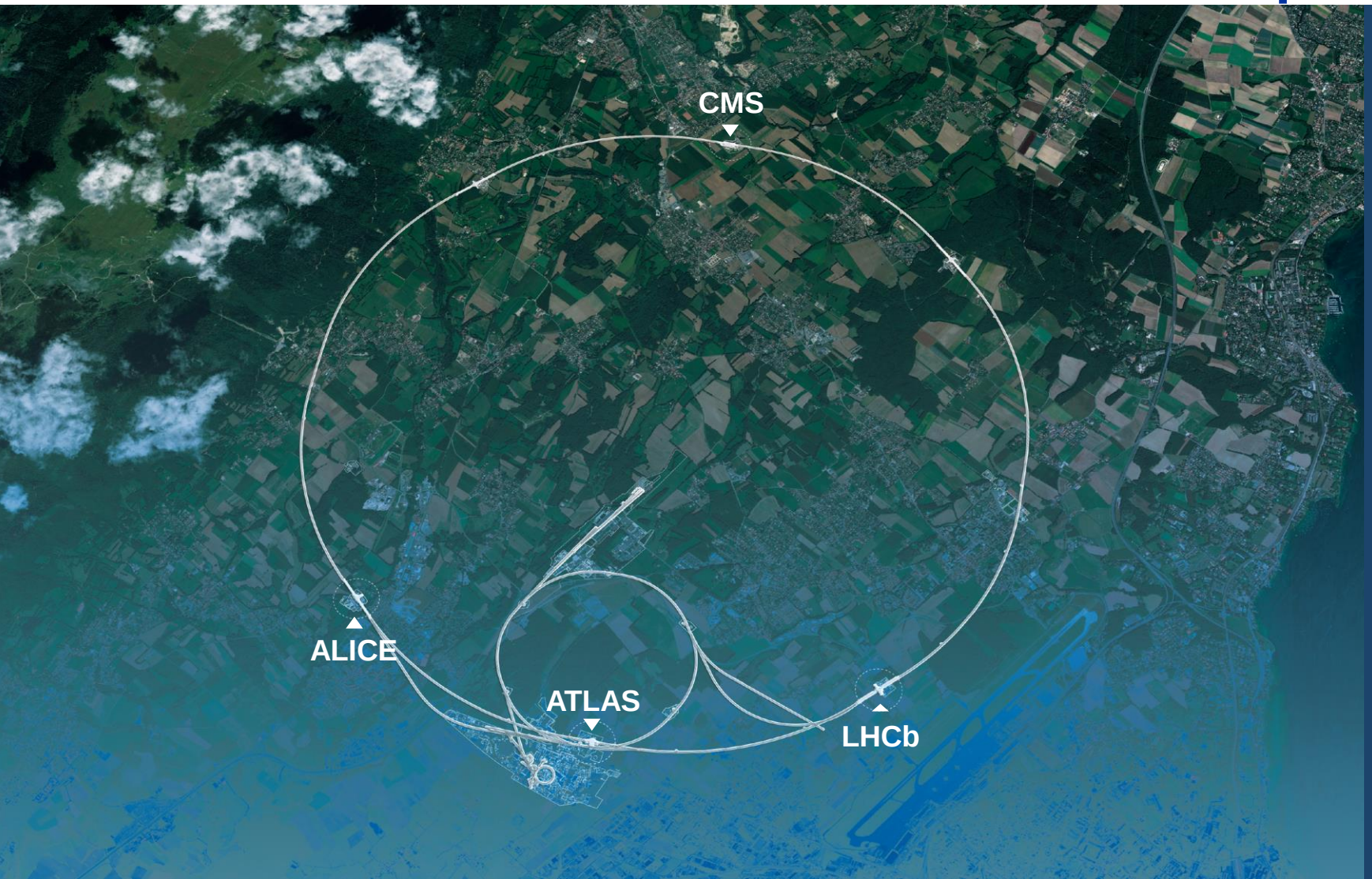
COMPUTING

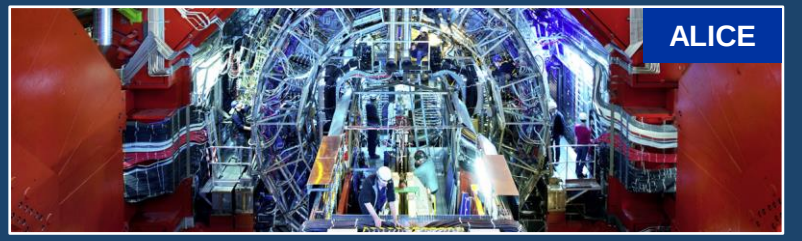


Large Hadron Collider (LHC)

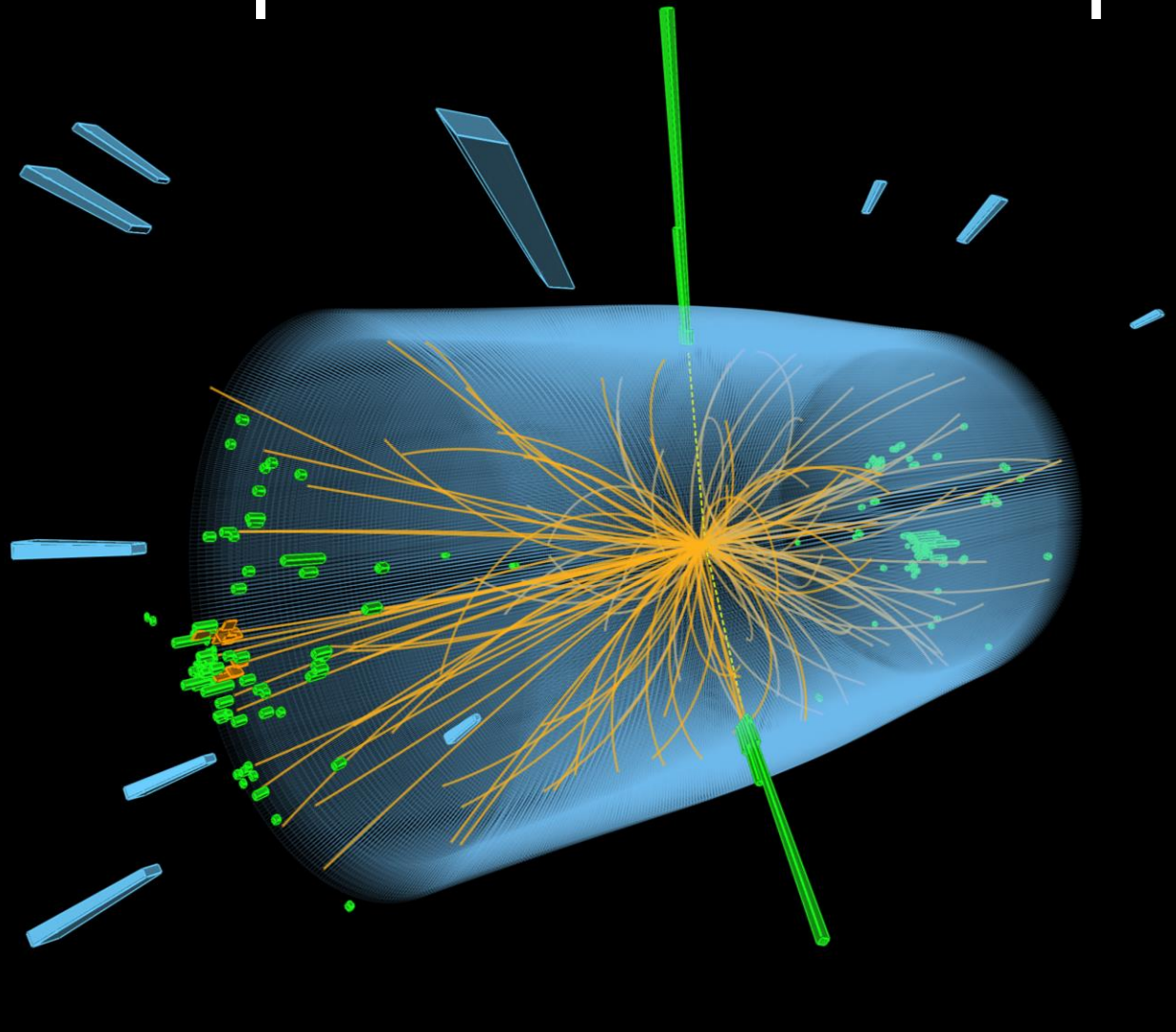
- 27 km in circumference
- About 100 m underground
- Superconducting magnets steer the particles around the ring
- Particles are accelerated to close to the speed of light

Giant detectors record the particles formed at the four collision points



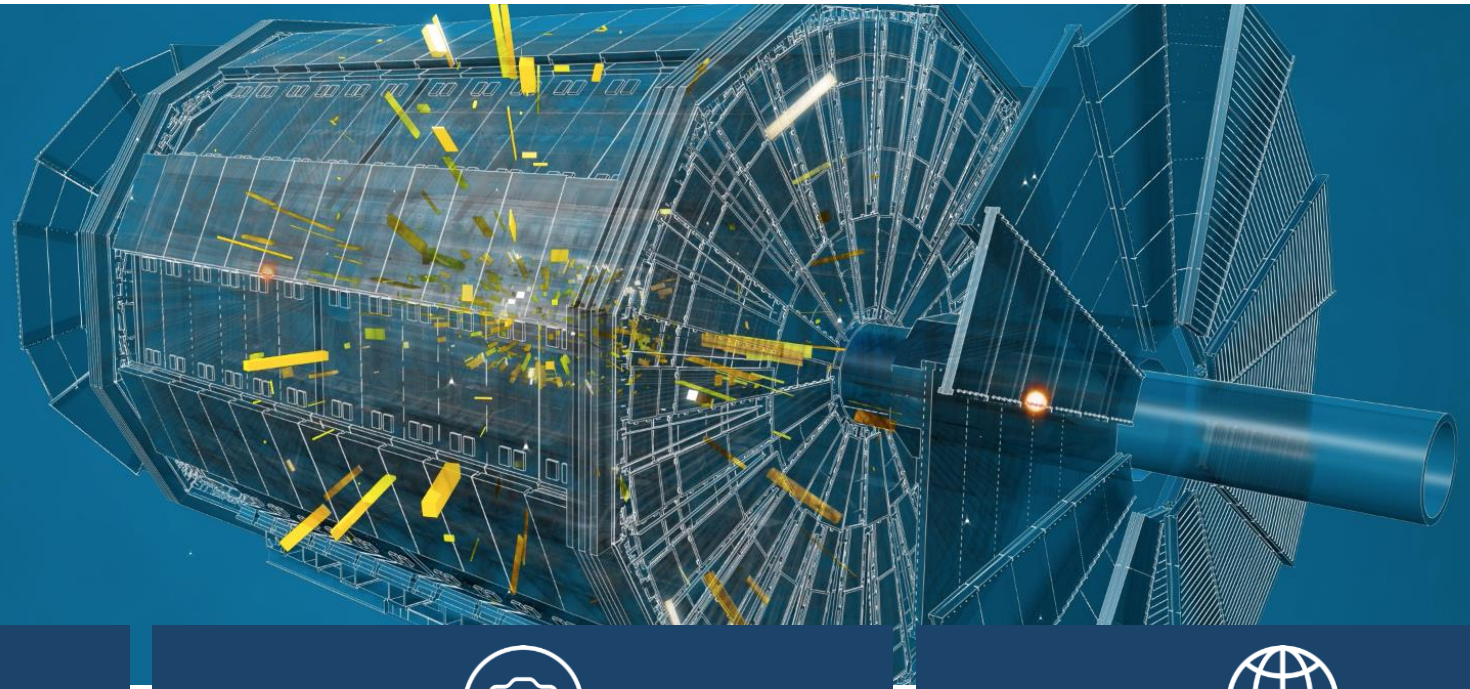


The LHC produces more than 1 billion particle collisions per second



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

The LHC detectors are analogous to 3D cameras

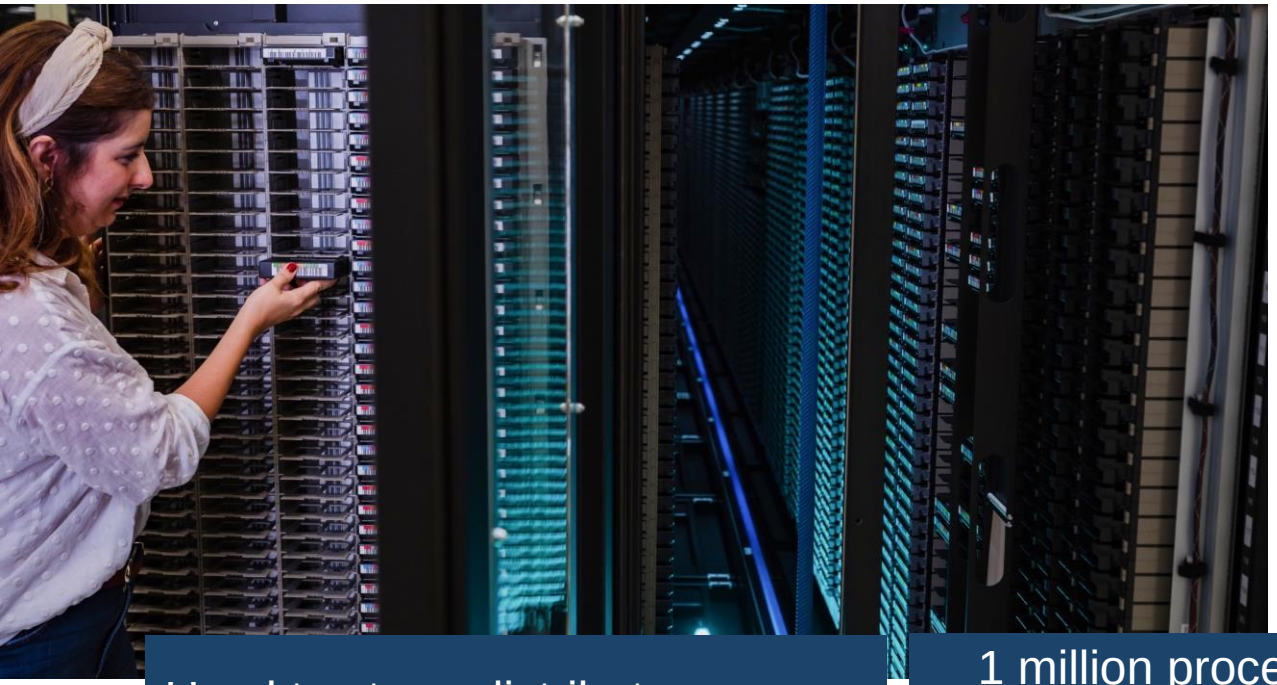


The detectors measure the energy, direction and charge of new particles formed.

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.

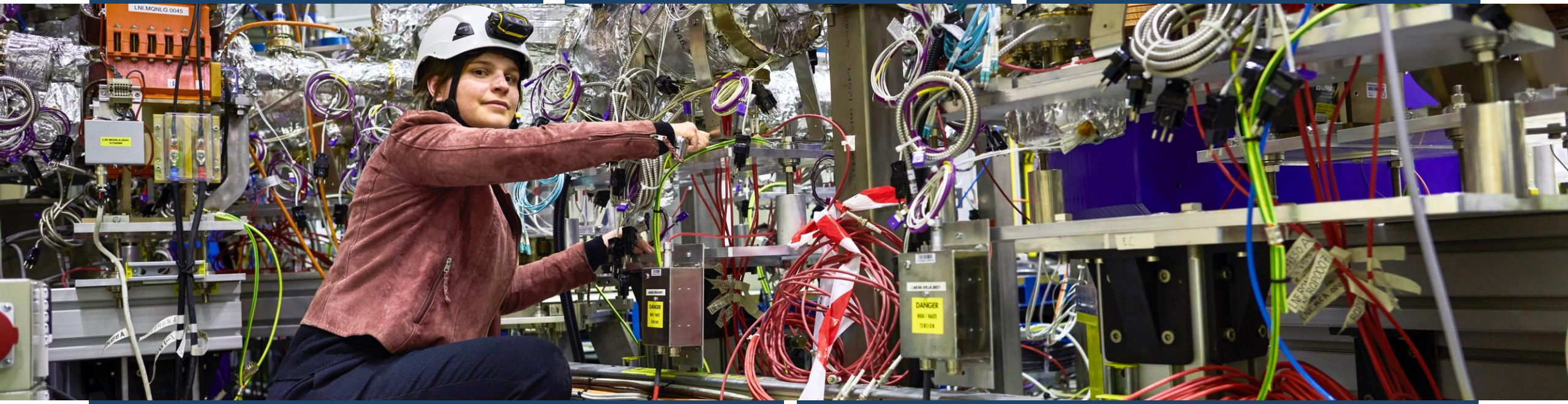
More than 1000 Petabytes of CERN data stored world-wide.

CERN has a diverse scientific programme

Nuclear Physics
(ISOLDE, n_TOF)

Antimatter Research
(Antiproton Decelerator)

Cosmic rays and cloud formation
(CLOUD)



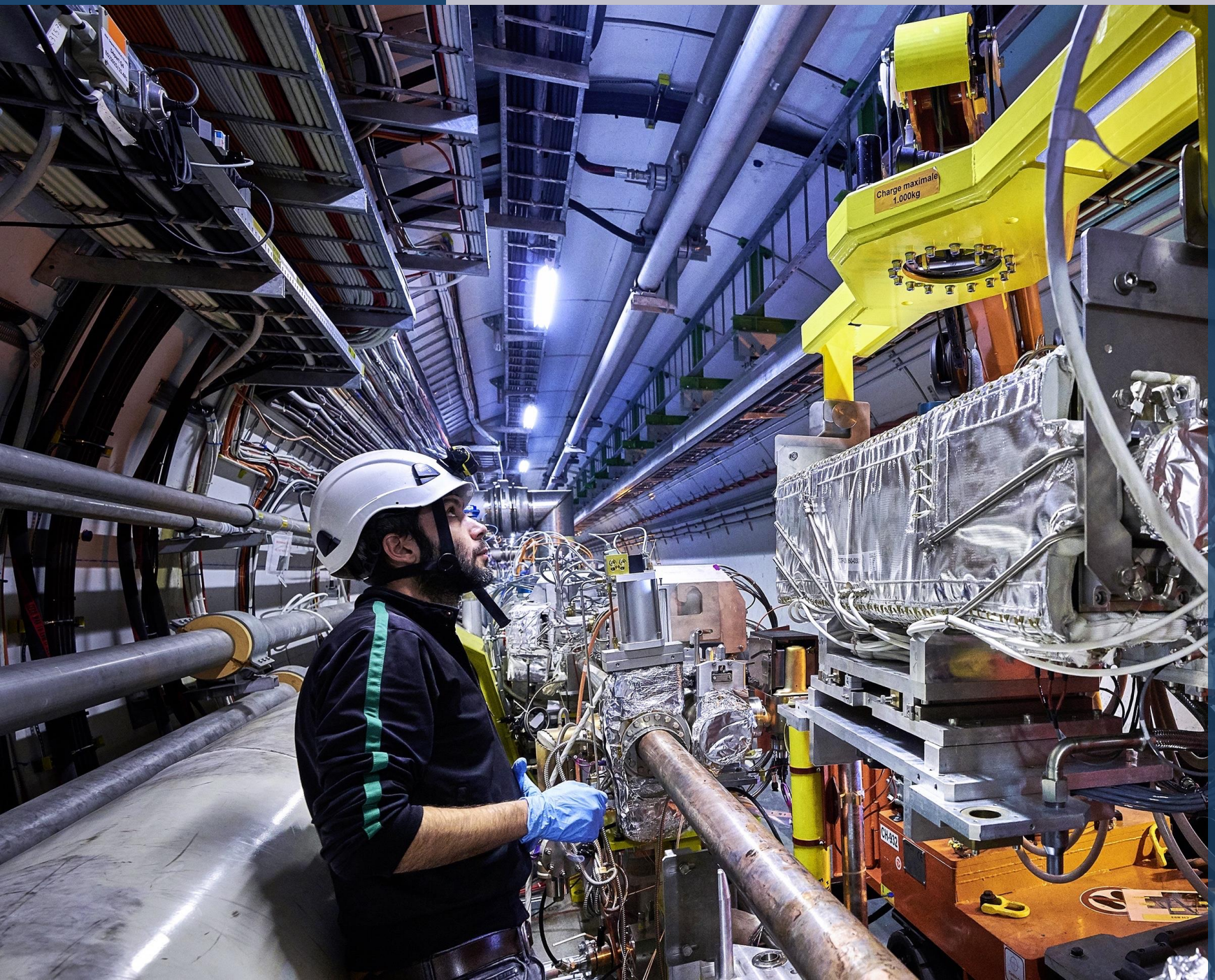
Fixed-target experiments,
which include searches for rare phenomena

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

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 2021
Employees:
2676 staff, **783** fellows

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

- Personnel by nationality as of 31 December 2021
  - **1048** users
  - **171** staff
  - **61** 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

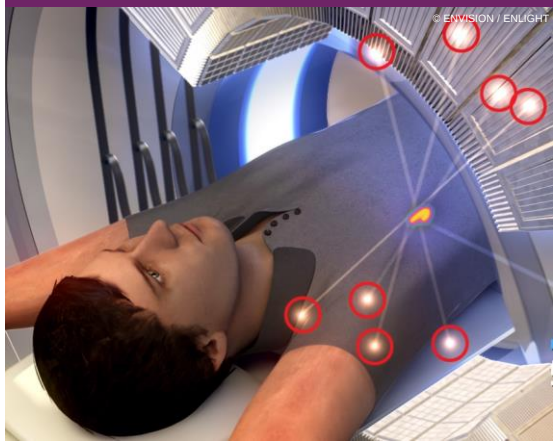
CERN is the birthplace of the World Wide Web

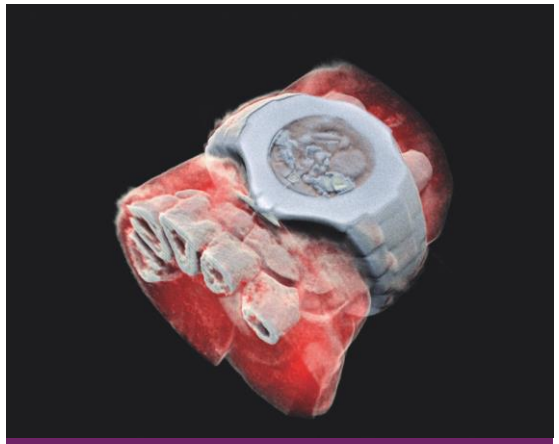
And there are many more examples
Medical imaging, cancer therapy, material science, cultural heritage, aerospace, automotive, environment, health & safety, industrial processes.

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

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.





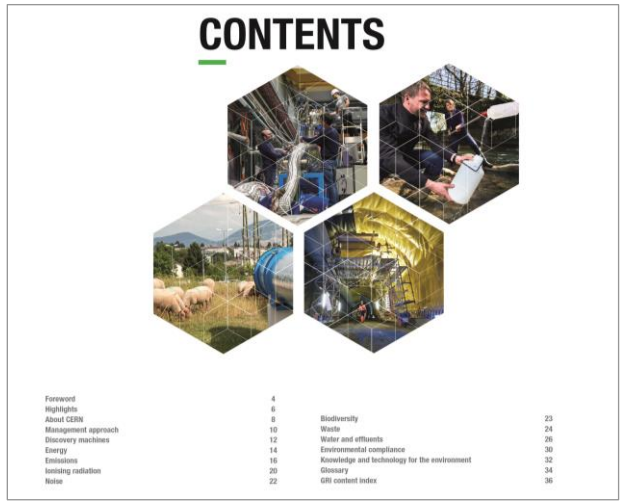
Pixel detector technologies are used for high resolution 3D colour X-ray imaging.

CERN produces innovative radioisotopes for nuclear medicine research.

ENVIRONMENT

Sustainability and the environment at CERN (examples)

CERN's first two public reports, issued in 2020 and 2021



Ambitious objectives for the future:
e.g. reduce greenhouse gas

Energy savings and recovery

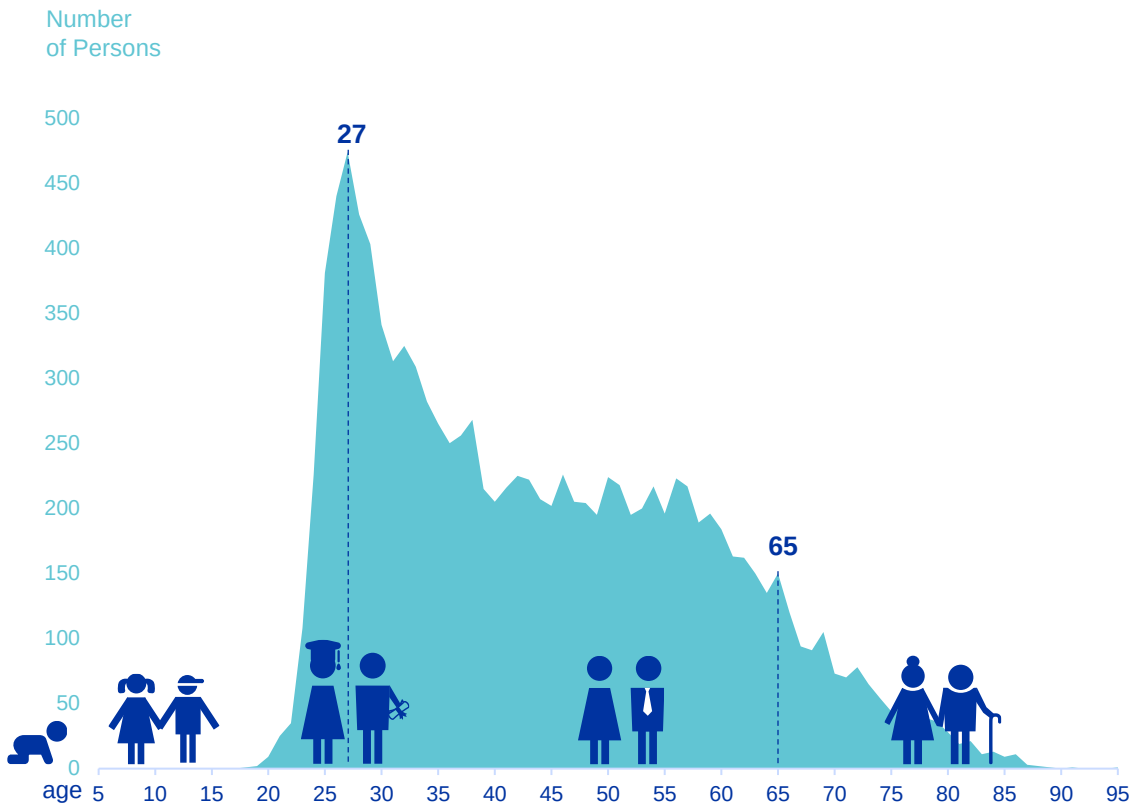
Heat from the LHC cooling towers is used to heat a nearby residential neighbourhood in Ferney-Voltaire (~ 8000 people)

CERN technologies for loss-free transport of electricity

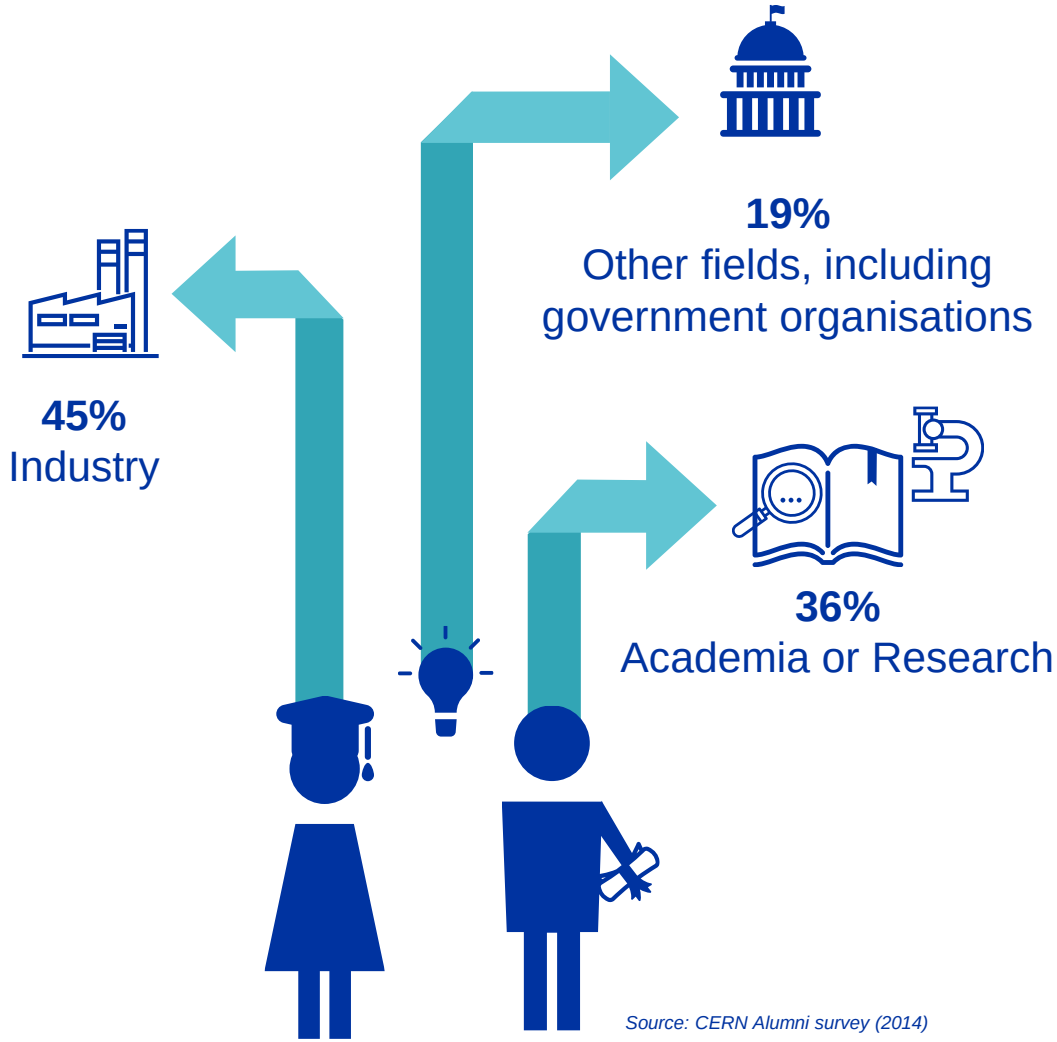
New energy efficient data centre in Prévessin. As of 2024 waste heat will be used for CERN buildings


EDUCATION
& TRAINING

CERN opens a world of career opportunities



Age Distribution of Scientists working at CERN



PhD and Technical students leaving CERN

CERN Science Gateway

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

Opened since October 2023.

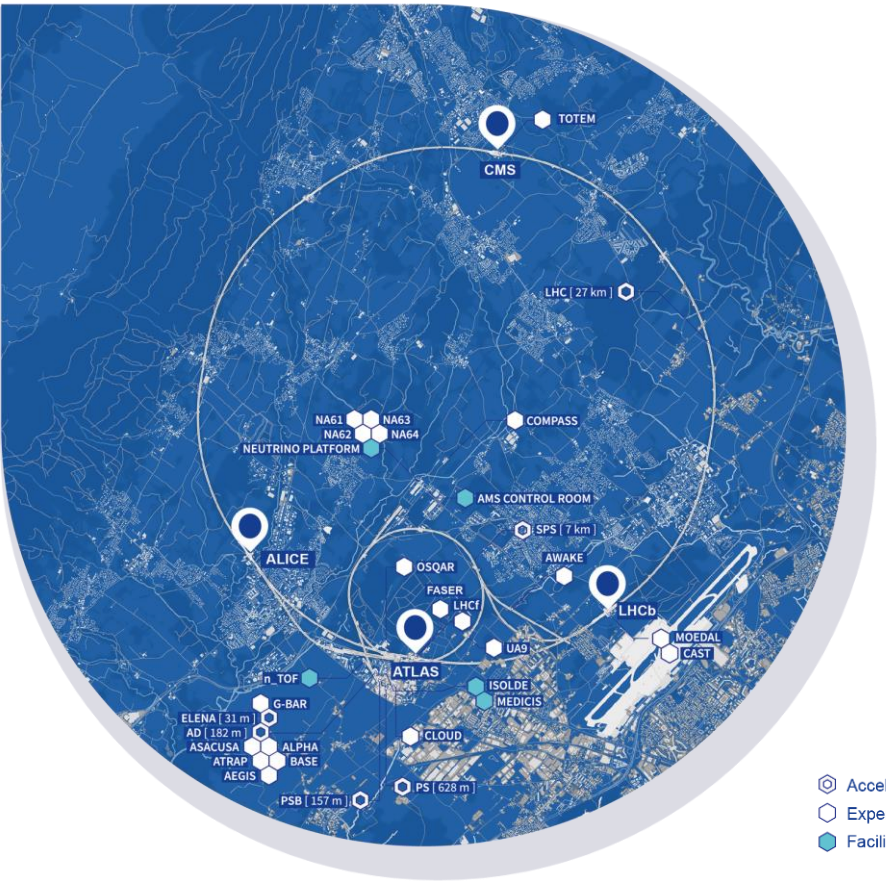
Immersive exhibitions, education labs, events and shows.

Germany plays a leading role in setting CERN's experimental agenda

2 April 2014 - H. E. Mr Joachim Gauck, President of the Federal Republic of Germany with Director-General R. Heuer.

- **Founding member of CERN (1954)**
- **Always well-represented in CERN top management**
- **Special PhD programme with a technical orientation. Funded by BMBF and organized through DESY**
- **Strong collaboration between CERN and German national labs**

Germany has a strong involvement across the whole of the CERN experimental programme



LHC EXPERIMENTS:

ALICE 11 Institutes, 248 Participants
ATLAS 17 Institutes, 678 Participants
CMS 7 Institutes, 393 Participants
LHCb 6 Institutes, 119 Participants

OTHER LHC EXPERIMENTS

FASER 2 Institutes, 7 Participants
SND 2 Institute, 4 Participants

FIXED TARGET EXPERIMENTS

- **AWAKE**
- **CLOUD**
- **COMPASS**
- **nToF**
- **NA61**
- **NA62**
- **NA64**
- **Neutrino Platform**

23 Institutes, 134 Participants

ANTIPROTON EXPERIMENTS

- **ASACUSA**
- **AEGIS**
- **BASE**

6 institutes,
21 Participants

ISOLDE

38 Institutes, 111 Participants

High performance computing centre GridKa (Tier-1) operated by KIT Karlsruhe as well as several Tier-2 centres (DESY, GSI, universities)

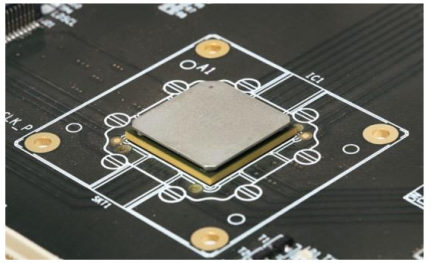
German Industry and CERN

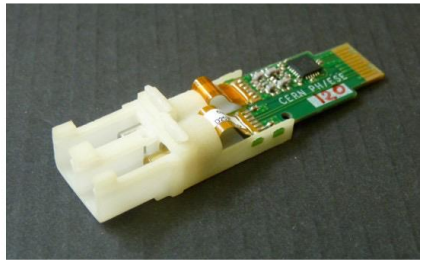
LHC superconducting dipole magnets (1/3 of total production) manufactured by Babcock Noell in Zeitz (Sachsen-Anhalt)

German industry has constructed important components for the LHC project, using advanced technologies.
Total industrial return: 600 Million € shared between 400 companies

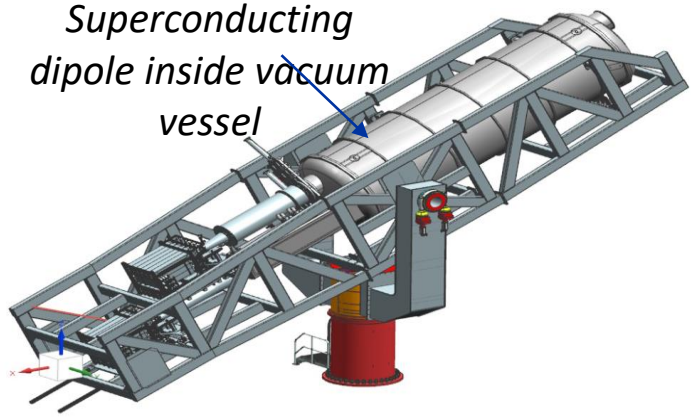
Iron yokes of CMS magnet manufactured by MAN Deggendorfer Werft

CERN support for and collaboration with German institutions





Superconducting dipole inside vacuum vessel



GSI/FAIR

- Test of FAIR magnets at CERN
- Simulation of transient effects in SIS100
- Development prototype lock for GSI-FAIR access system
- Equipment for mapping SIS100 dipole magnets
- CERN developed software for GSI accelerator control
- Beam loss monitors
- Timing system “White Rabbit”
- Support for GSI (ESR-Speicherring, FAIR) und KIT (ANKA) in commissioning stochastic cooling
- PANDA&CBM are CERN recognized experiments
- Donation of straw tube tracker from LHCb to PANDA
- CBM: CERN provided VTRx & ALPIDE chips, gas & cooling systems, 26 m^2 of GEM foils

DESY

- MEDIPIX: licensed to DESY spin-off X-Spectrum
- MEDIPIX4: spectroscopic X-ray imaging and particle ID&tracking
- Magnet design for BabyIAXO experiment, to be hosted at DESY
- CERN helped out with 2 tons of Helium

CERN support for and collaboration with German institutions

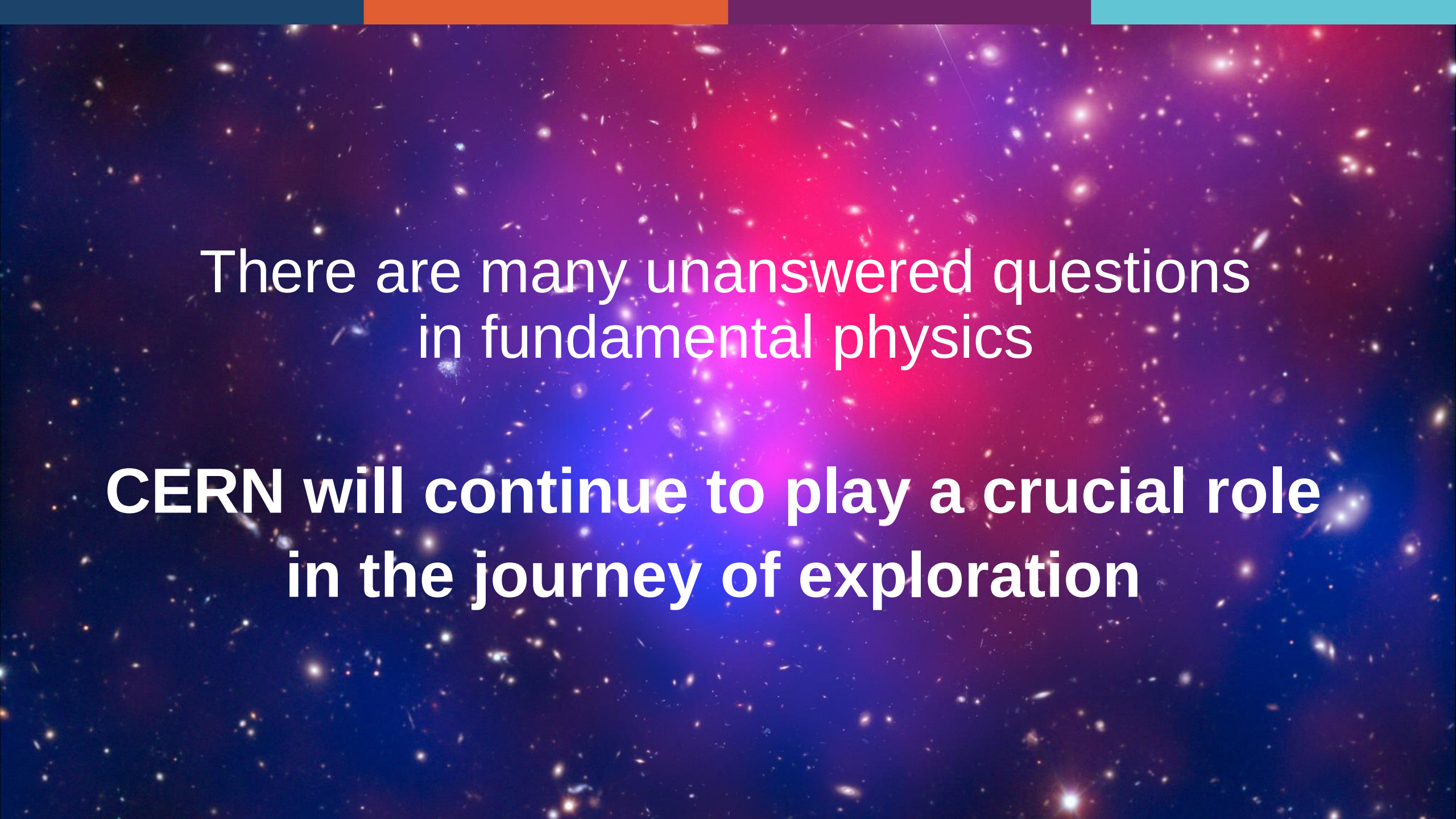
More examples:

Computing and Quantum Technologies

- CERN is associate partner in NFDI and ERuM-Data
- Collaborative R&D and Service/Consultancy licence to Bundesdruckerei GmbH, to advance identity management and cryptography solutions using CERN technologies

OpenLab collaborations with

- Siemens on industrial control systems
- T-Systems on cloud computing acceleration
- Leibniz centre Munich HPC on AI scalability and security
- GSI Helmholtz collaboration on computing acceleration and medical applications
- DESY on Quantum Computing for Experimental and Theoretical Physics
- TUM, Leibniz HPC, DIT (Deggendorf) on quantum computing for Earth Observation


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

Fragenliste Besuch CERN / DESY

List of questions for the visit to CERN / DESY

Inhaltsverzeichnis - Table of contents

FLORIAN

A Allgemeine Organisation - General Organization

1. Wie sieht die Aufbauorganisation des technischen Facility Management in diesem Zentrum aus?
   How is your center organized, in particular in the area of the technical infrastructure?
2. Wo gibt es Schnittstellen zwischen Facility Management <> Beschleuniger <> Forschung/Wissenschaft?
   Where are the interfaces between facility management <> accelerator <> research/science?
3. Wie sind die Prozesse, Abstimmungen und Kommunikation zwischen den, nach Nutzungsart gegliederten Organisationseinheiten?
   How are the processes, coordination and communication structured between the organizational units according to type of use (tertiary buildings, accelerator buildings…)?
4. Werden externe Mitarbeiter eingesetzt? Wenn ja, in welchem Umfang?
   Are external employees used? If so, to what extent?
5. Welcher Personalschlüssel wird angesetzt? Und ist dieser auskömmlich und umgesetzt?
   What staffing ratio is used? And is this adequate and implemented?
6. Welche Aufgaben werden extern vergeben? Make or Buy
   Which tasks are outsourced? Make or Buy

FLORIAN

A Allgemeine Organisation - General Organization

7. Wie ist das Verhältnis zwischen intern / extern Arbeitsstunden?
   What is the ratio between internal / external working hours?
8. Wie ist die Zugänglichkeit von Technikflächen gegen unbefugten Zutritt gesichert bzw. für z.B. externe Dienstleister geregelt?
   How is the accessibility of technical areas secured against unauthorized access or regulated for external service providers, for example?
9. Wie sind die Ablaufprozesse und das Prozessmanagement bei CERN/DESY?
   How are the operational processes and process management at CERN/DESY?
10. Wie sind die Betreiberpflichten, insbesondere auch im Hinblick auf die Nutzungsverträge, eindeutig geregelt?
    How are the operator's obligations clearly regulated, particularly with regard to usage contracts?
11. Gibt es standardisierte Nutzungsverträge mit den Forschungsinstituten/Forschern, die die Verantwortlichkeiten für Flächen und technische Anlagen spezifisch regeln und festschreiben? Welche Pflichten sind den Nutzern/Partnern verbindlich übertragen worden?
    Are there standardized usage contracts with the research institutes/researchers that specifically regulate and define the responsibilities for areas and technical facilities? What obligations have been bindingly assigned to the users/partners?

FLORIAN

A Allgemeine Organisation - General Organization

12. Wie lange ist Shutdown?
    How long is the shutdown?
13. Gibt es Rufbereitschaften und wenn ja, wie sind diese geregelt? Reaktionszeiten? Zentral oder gewerkeweise oder extern?
    Are there on-call duties and if so, how are these regulated? Response times? Centrally or by trade or externally?
14. Wie ist die Betreiberverantwortung/Anlagenverantwortung geregelt?
    How is operator responsibility/system responsibility regulated?
15. Wie werden die Verantwortlichkeiten abgebildet? (Betreiber, Sicherheitstechnisch Verantwortliche, Hallenkoordinatoren, Sicherheitsfachkräfte usw.)
    How are the responsibilities organized? (operators, safety officers, hall coordinators, safety specialists, etc.)
16. Welche Maintenance- Zeiten stehen im jeweiligen Institut zur Verfügung?
    What maintenance times are available at the institute?
17. Allgemeine tiefe der Digitalisierung?
    The general depth of digitization?

FLORIAN

B Dokumentation und Berichtswesen - Documentation and Reporting

1. Wie erfolgt die Ablagestruktur der technischen Dokumentation?
   How is the technical documentation filed?
2. Welche Tools kommen für die Arbeitsorganisation und -Dokumentation zum Einsatz?
   Which tools are used for work organization and documentation?
3. Gibt es eine Zuständigkeitsmatrix auf Gewerkebene? Gibt es erfahrungsgemäß „kritische Schnittstellen“ in den vermieteten Flächen und wie werden diese geregelt?
   Is there a matrix of responsibilities at trade level? Does experience show that there are "critical interfaces" in the rented areas and how are these regulated?
4. Ist die Dienstleistungssteuerung gewerkeübergreifend einheitlich organisiert? Gibt es standardisierte Vorgaben und Vorgehensweisen (z.B. Stichwort Qualitätsmanagement, Abnahme und Dokumentation von Leistungen)?
   Is service management organized uniformly across all trades? Are there standardized specifications and procedures (e.g. quality management, acceptance and documentation of services)?