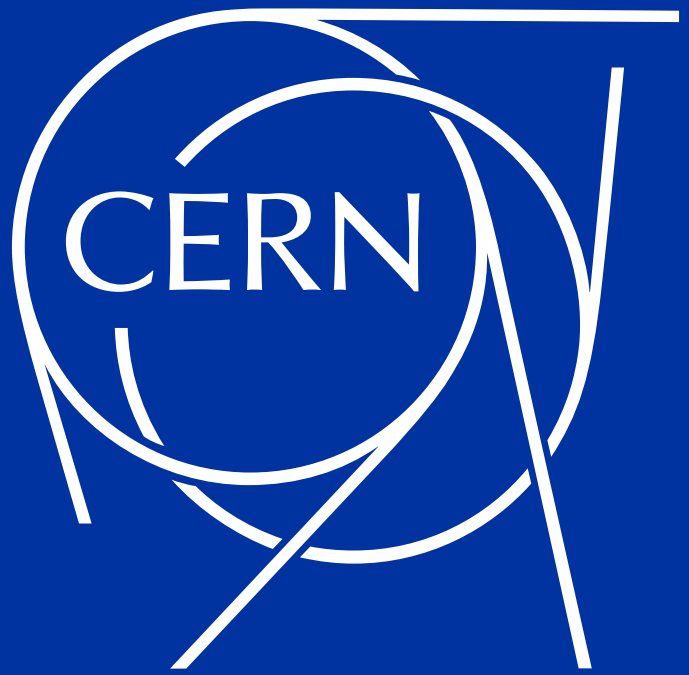
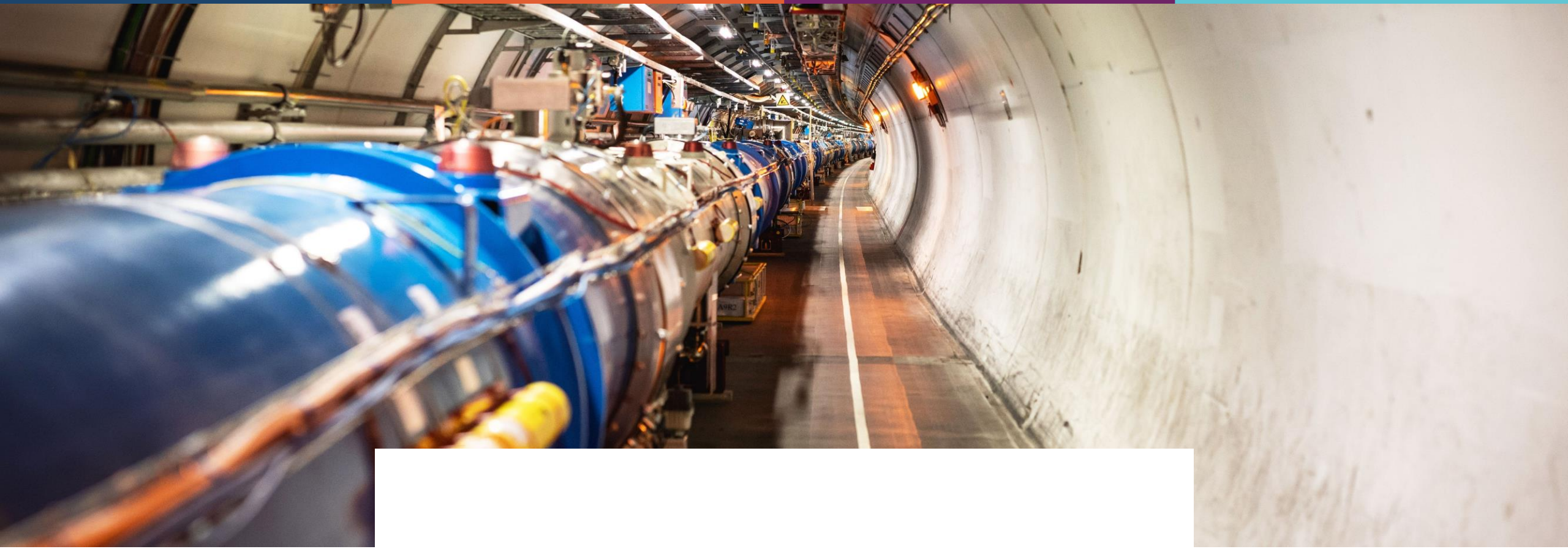
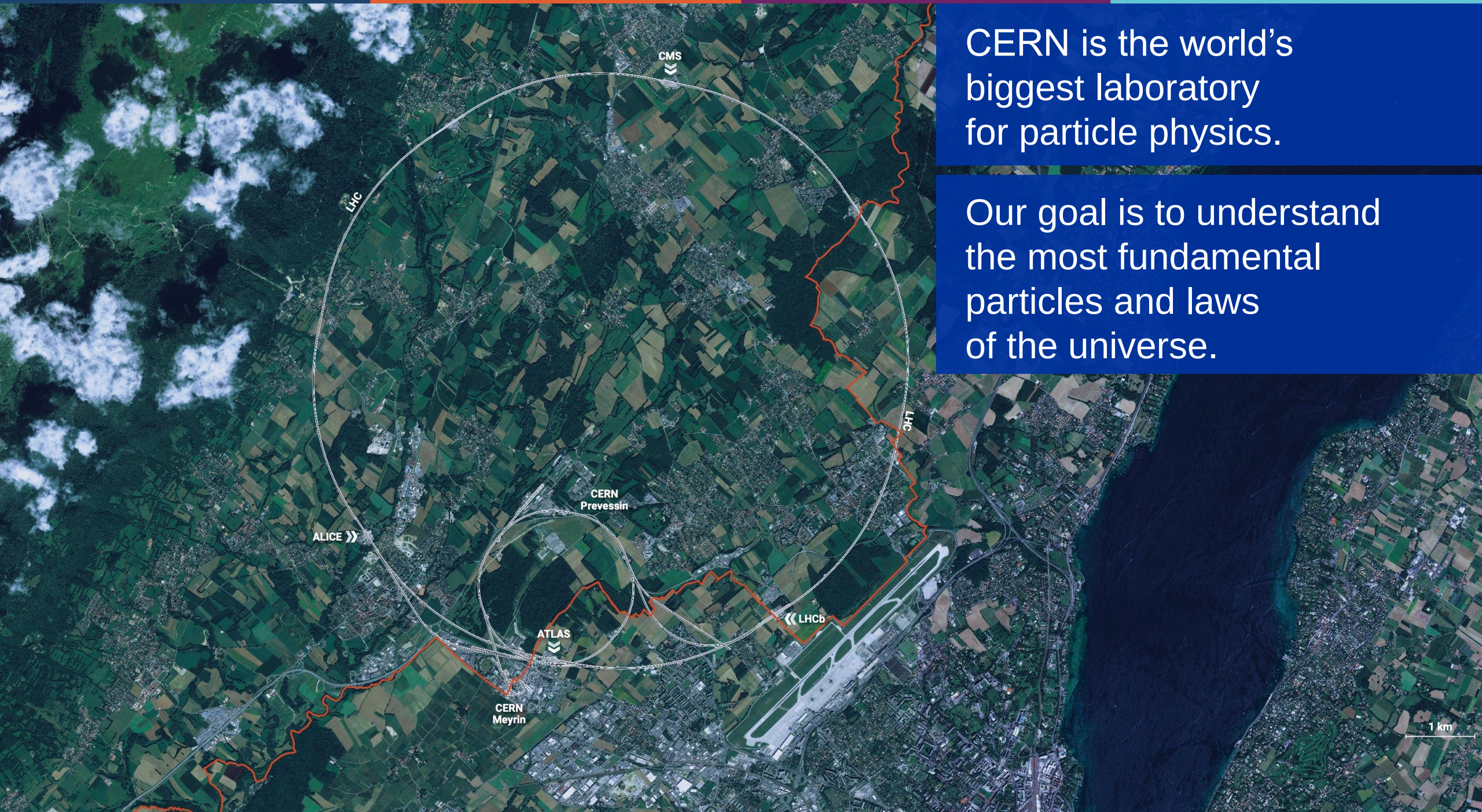

CERN



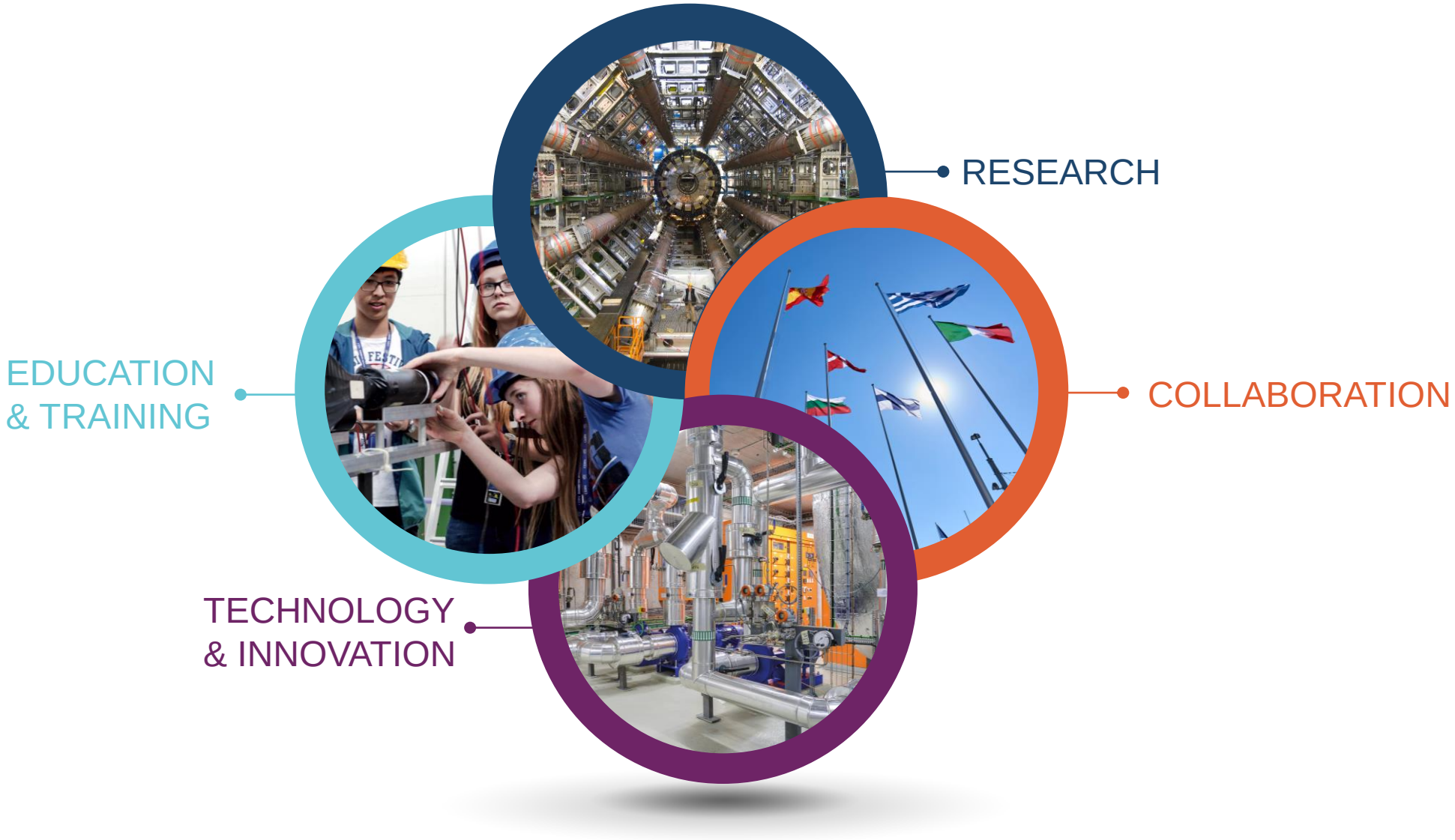
WELCOME TO CERN

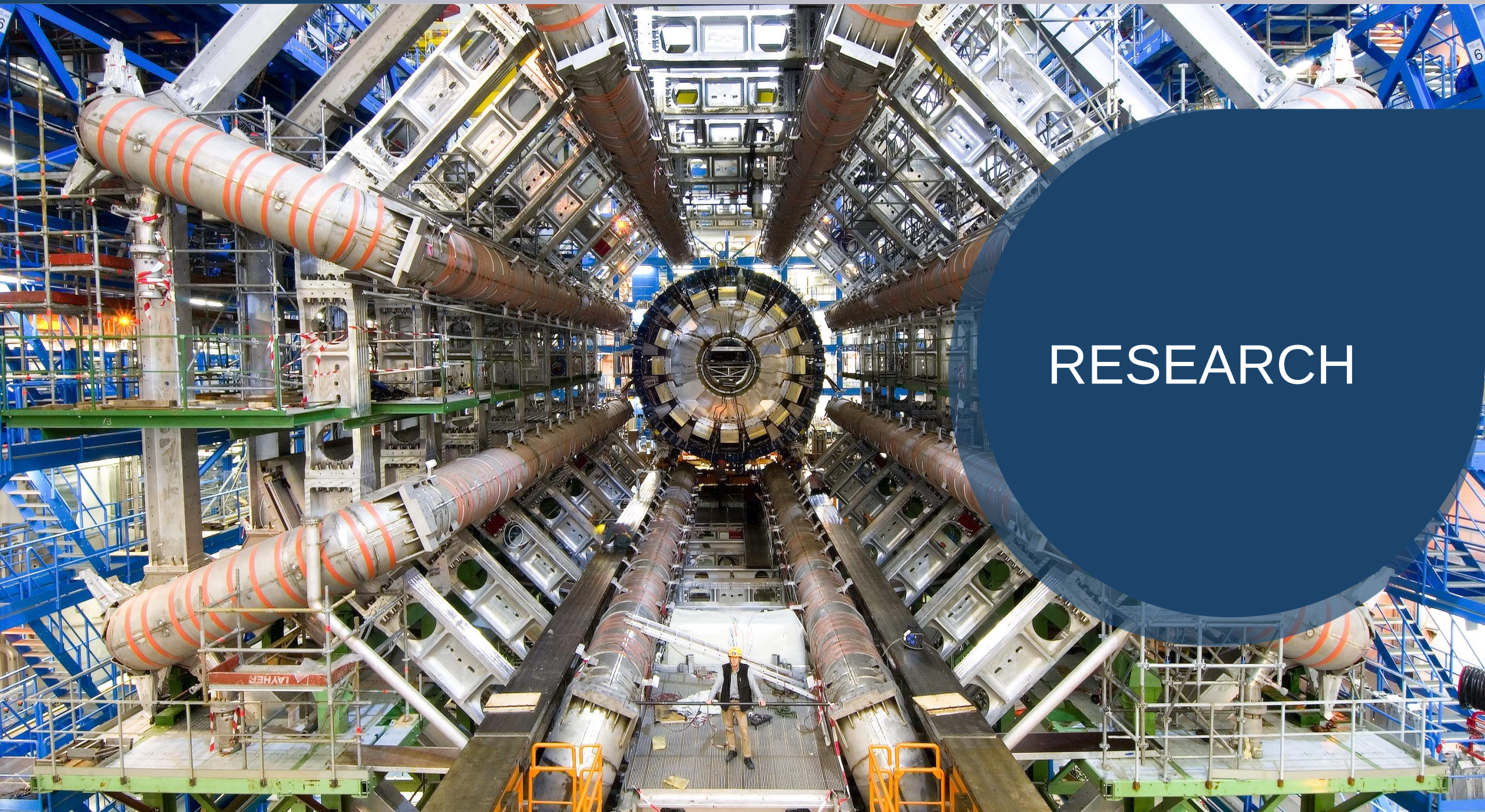


CERN is the world's biggest laboratory for particle physics.

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

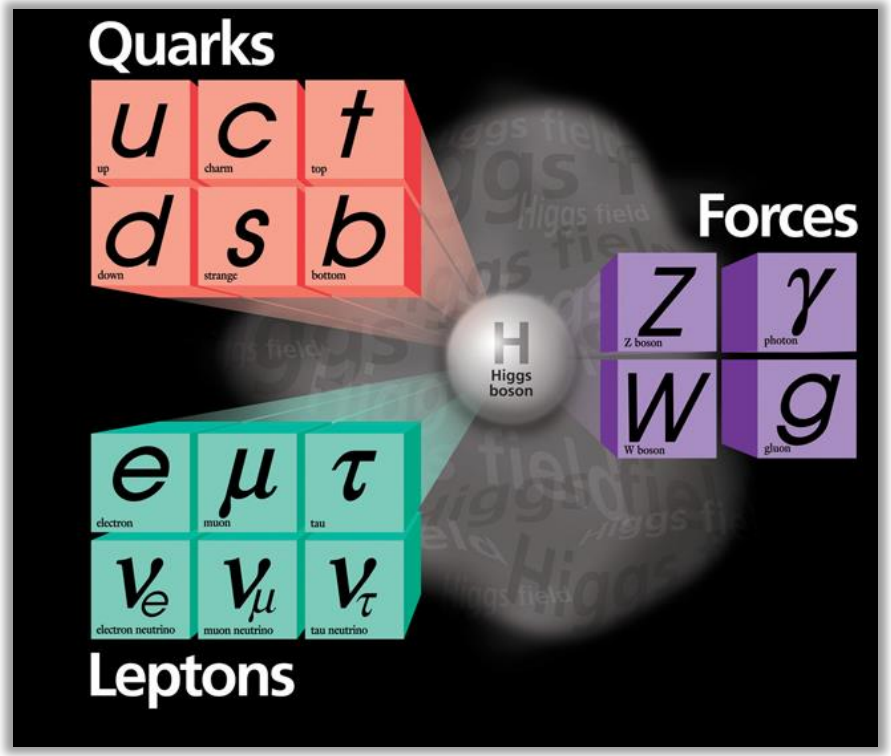
Four pillars underpin CERN's mission

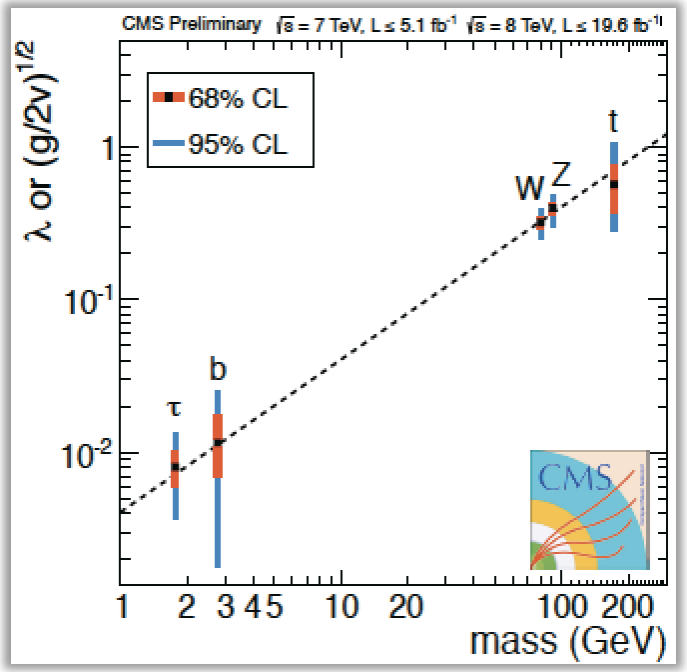


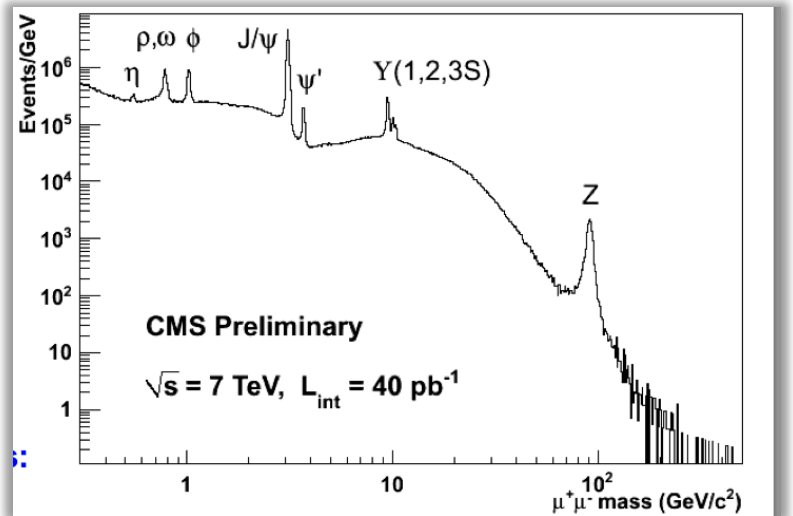


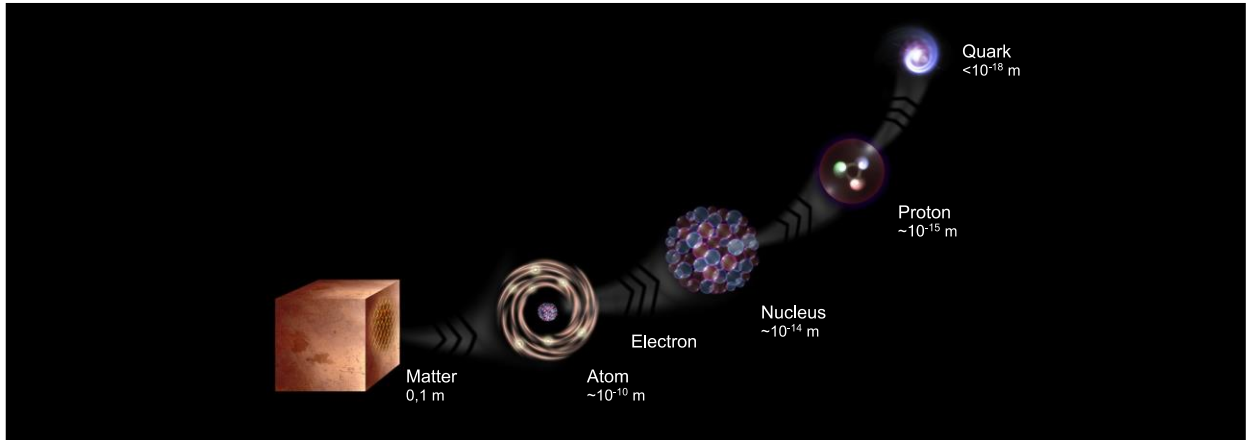
RESEARCH

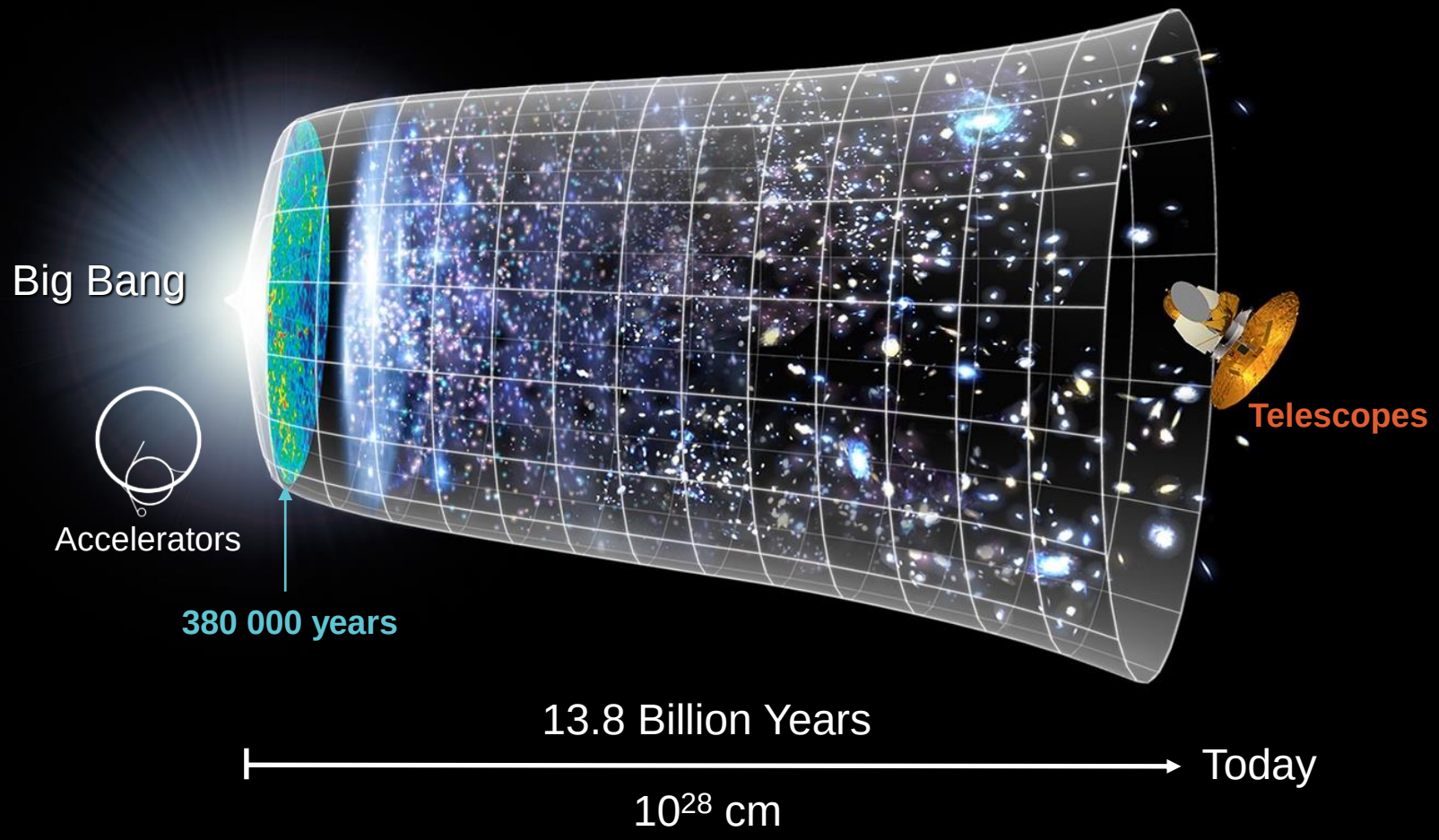
The Standard Model











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.

There are many unanswered questions in fundamental physics

Including

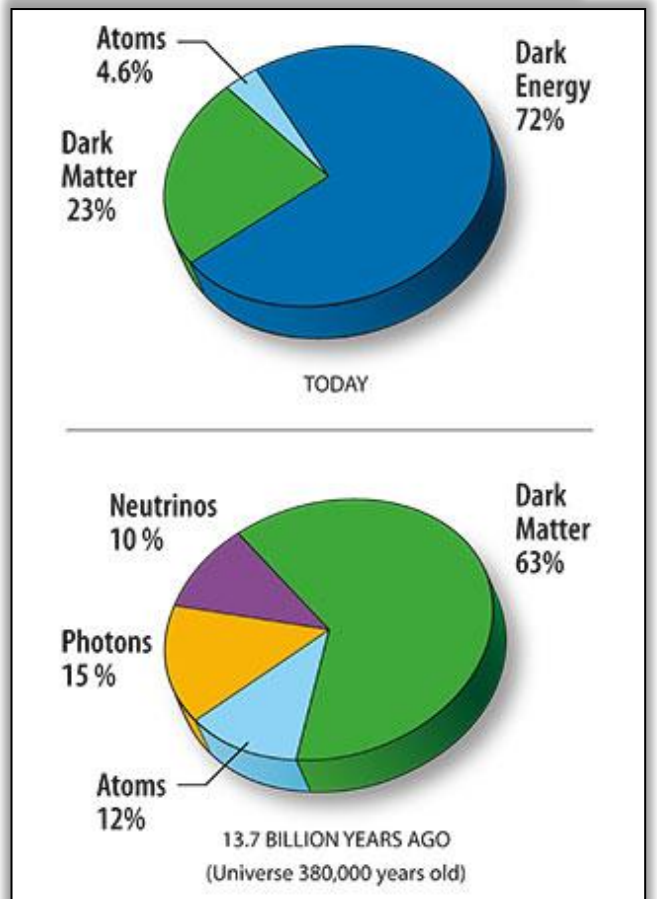
95% of the mass and energy of the universe is unknown.

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?

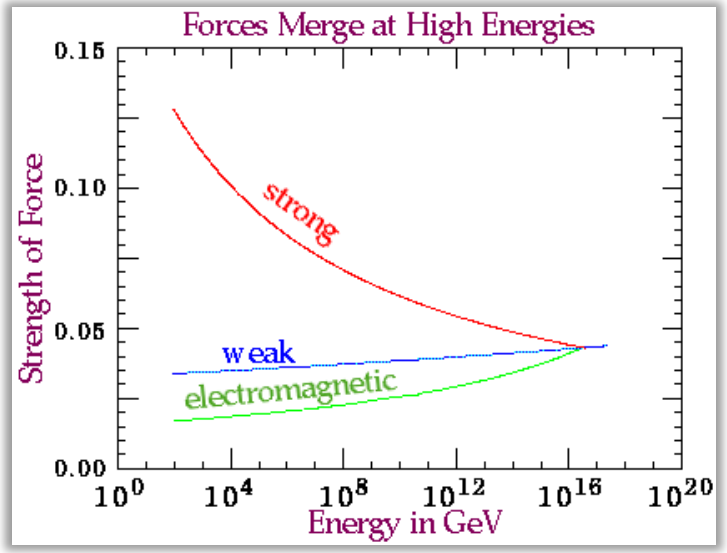
Why is gravity so weak compared to the other forces?

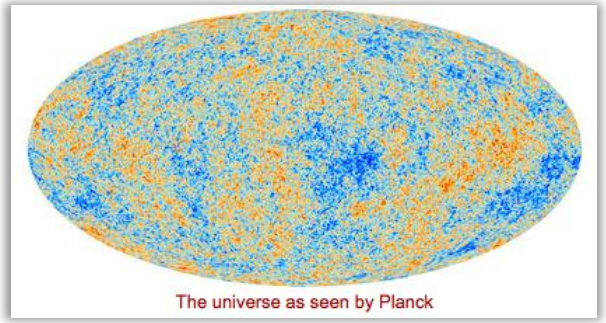
Beyond the Standard Model

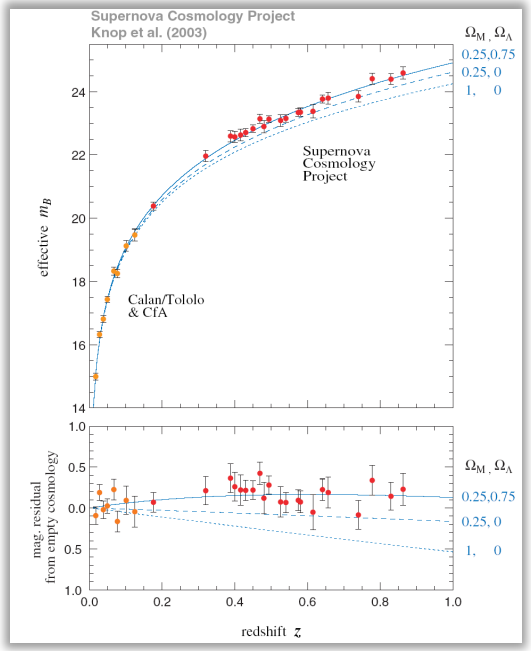


Unknowns:

- Flavour structure
- Matter-antimatter
- Why is the Higgs so light
- Forces merging ?
- Gravity
- …



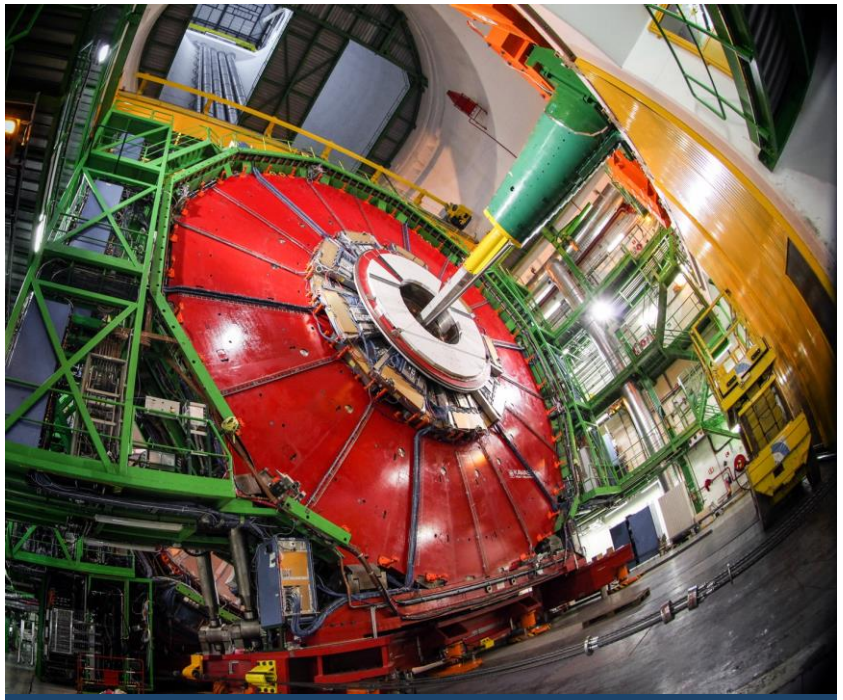




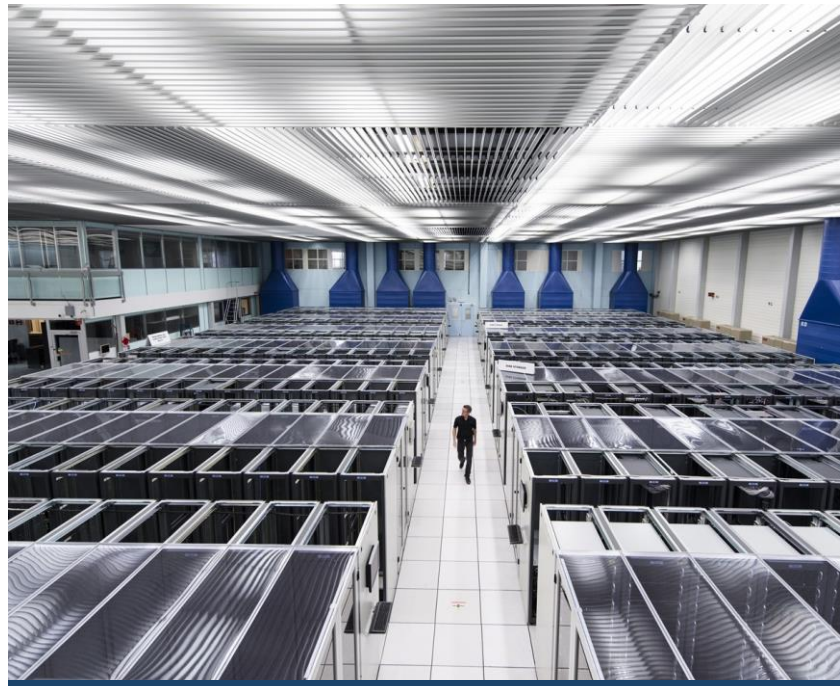
How do we do it?

- 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

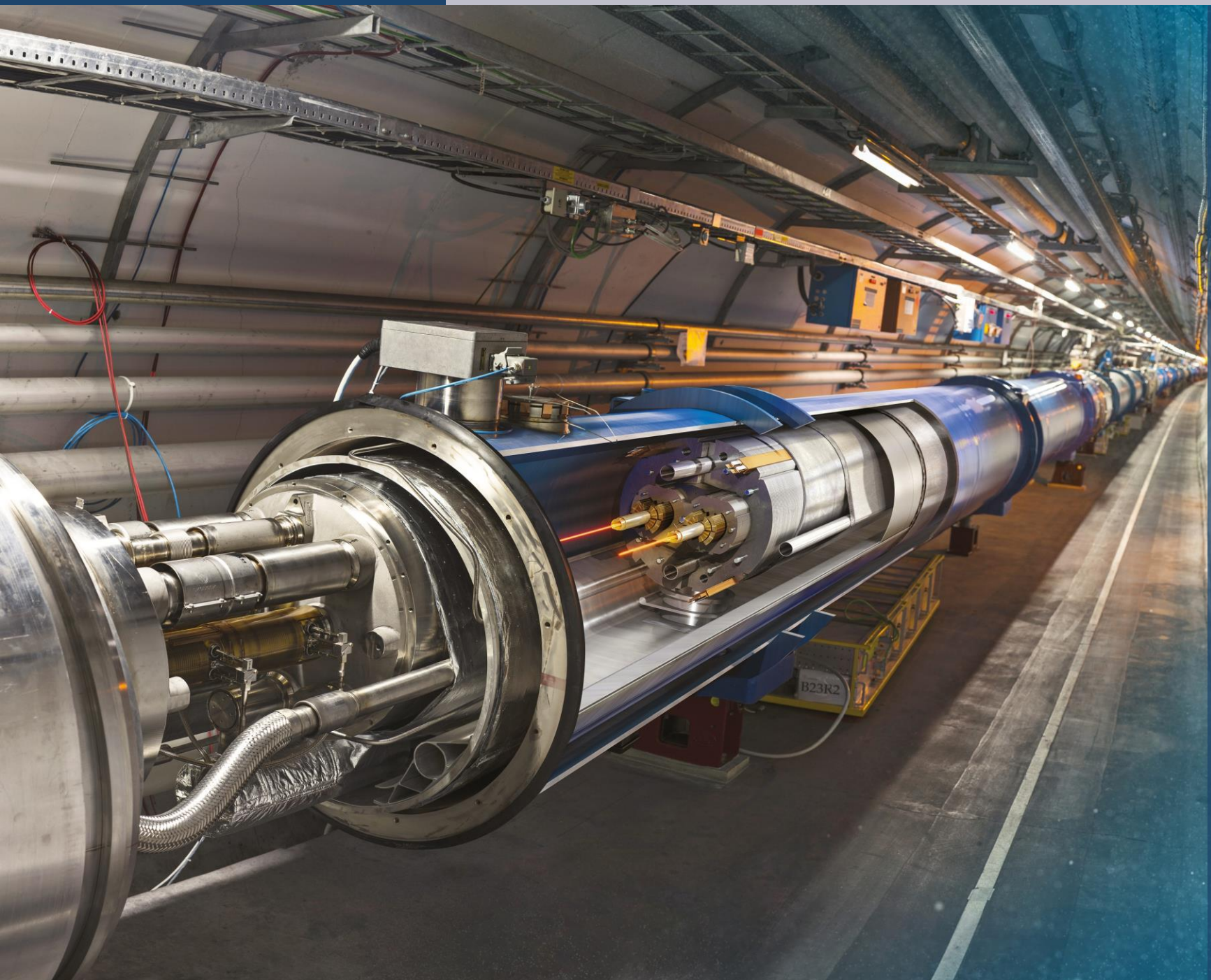
ACCELERATORS



DETECTORS



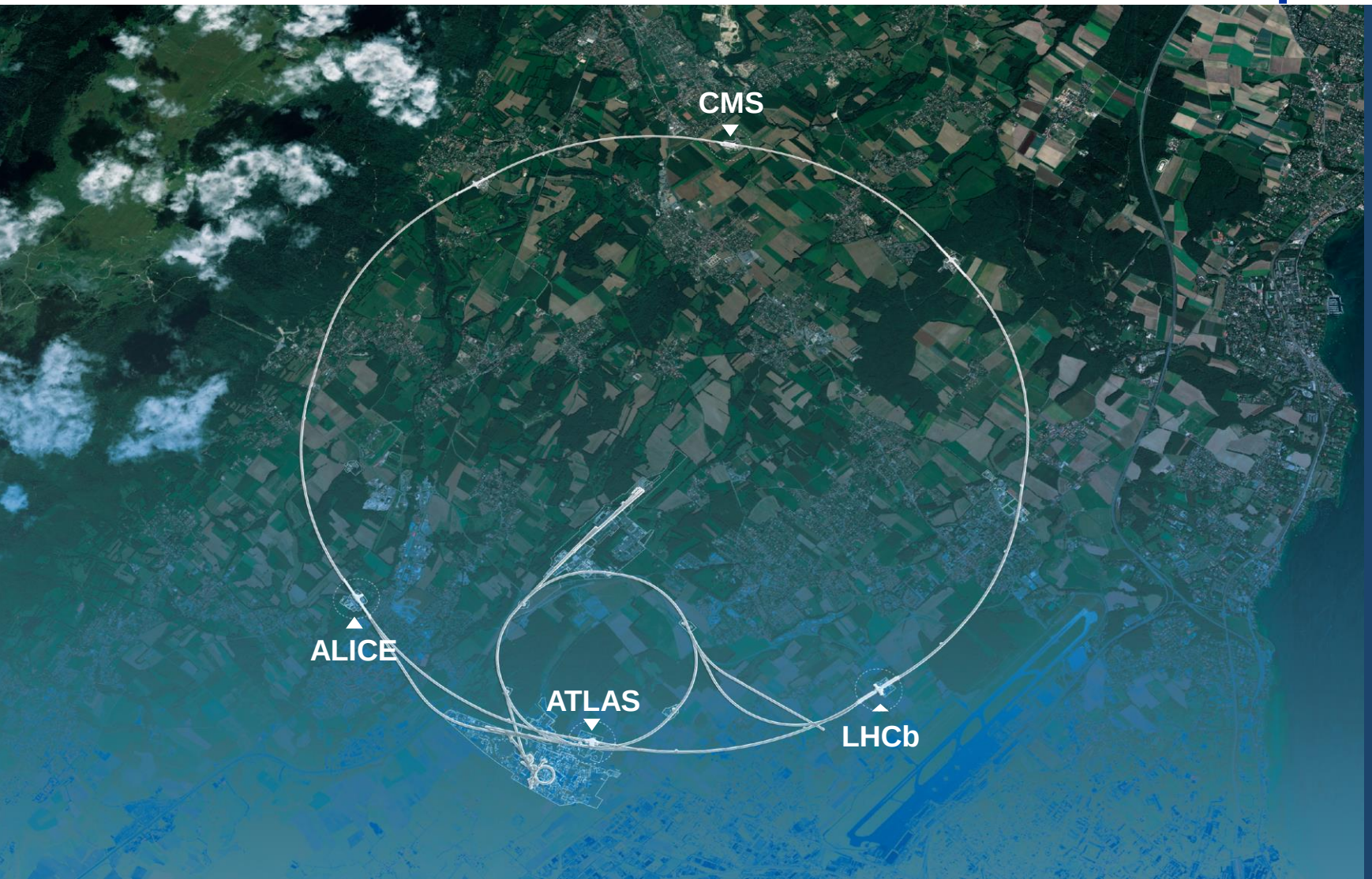
COMPUTING

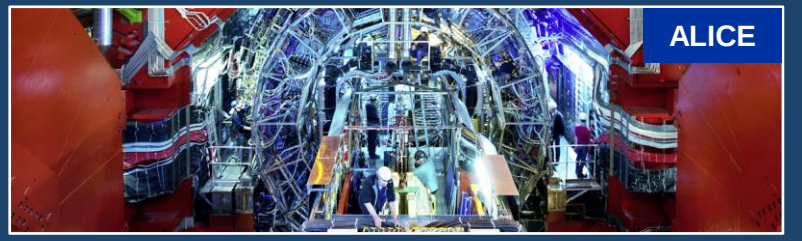


Large Hadron Collider (LHC)

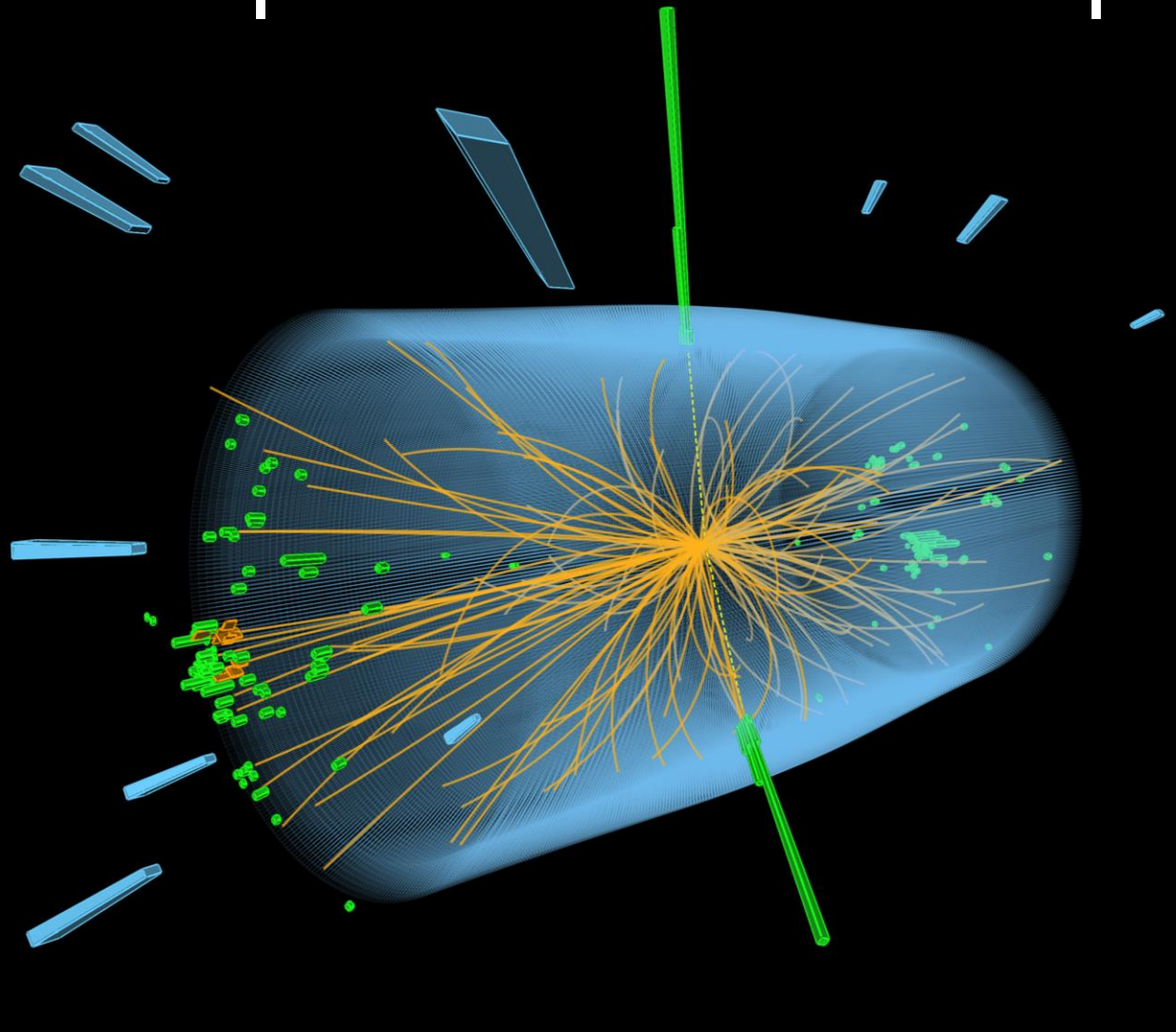
- 27 km in circumference
- About 100 m underground
- Superconducting magnets steer the particles around the ring
- Particles are accelerated to close to the speed of light

Giant detectors record the particles formed at the four collision points



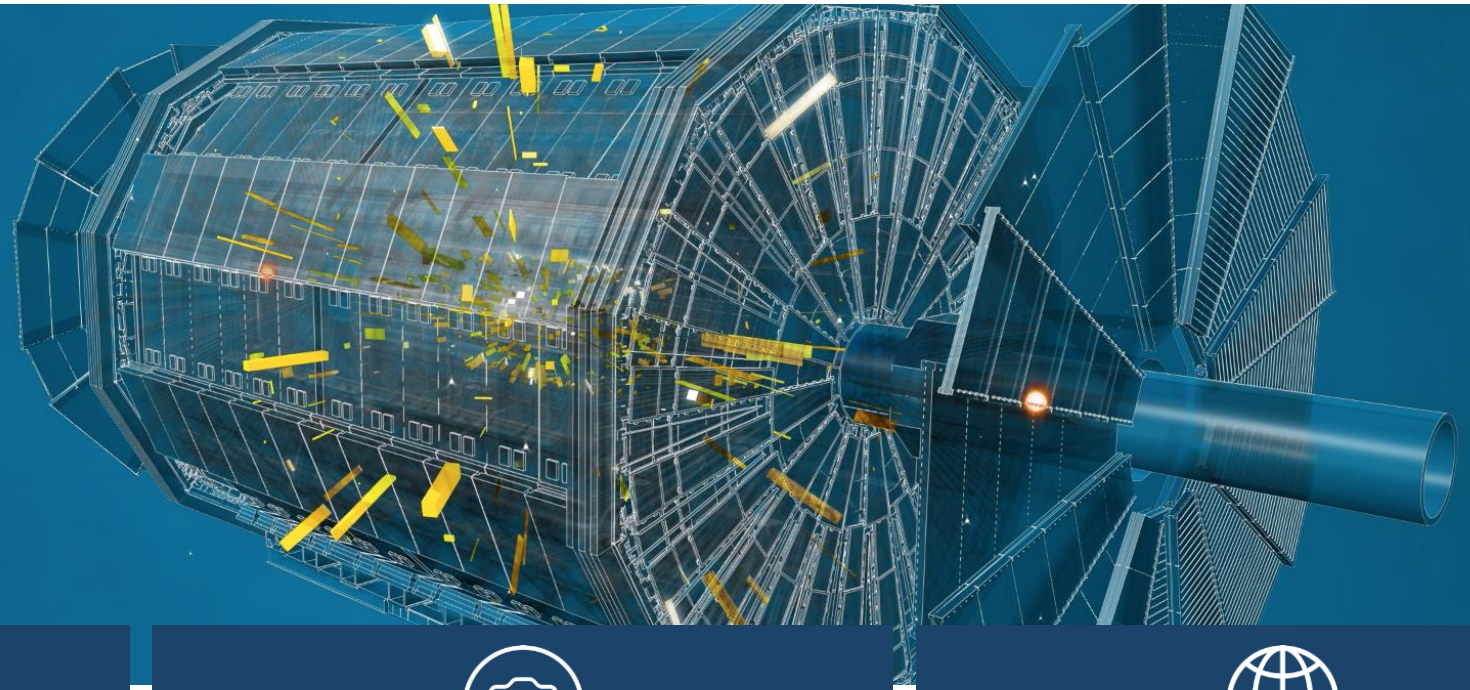


The LHC produces more than 1 billion particle collisions per second



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

The LHC detectors are analogous to 3D cameras

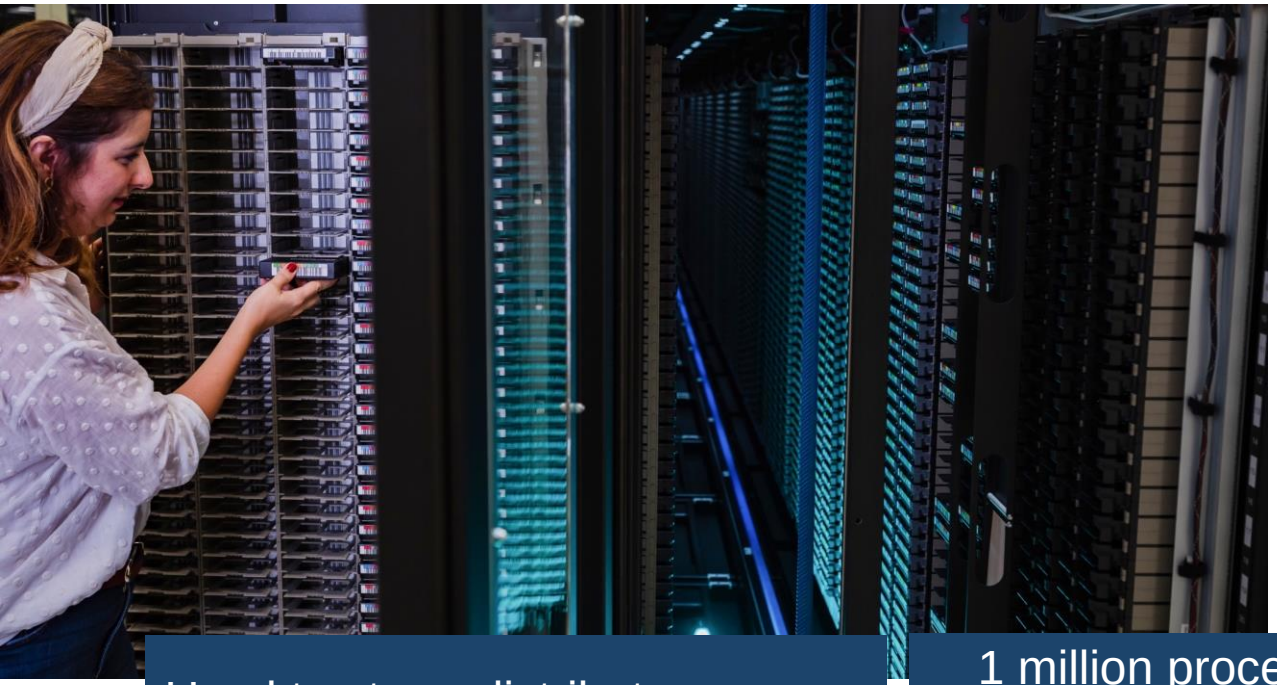


The detectors measure the energy, direction and charge of new particles formed.

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.

TECHNOLOGY & INNOVATION

CERN’s technological innovations have applications in many fields

CERN is the birthplace of the World Wide Web

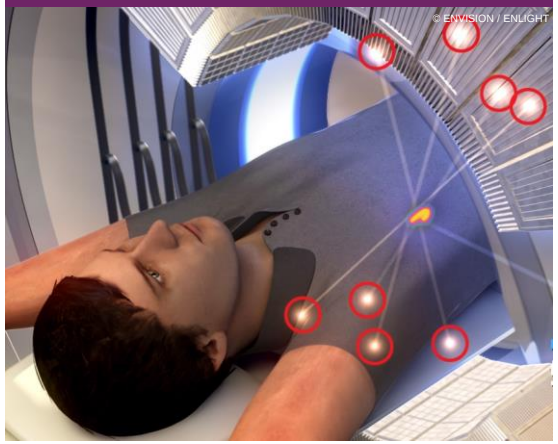
And there are many more examples

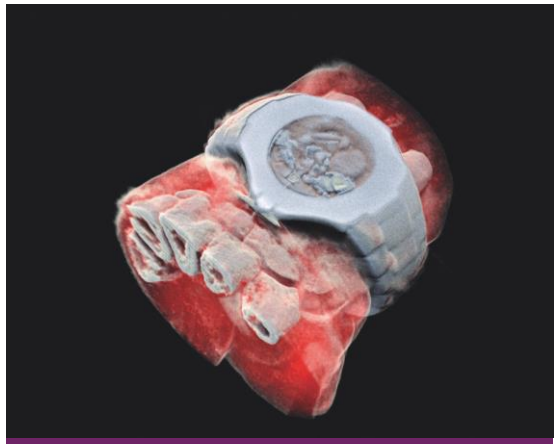
Medical imaging, cancer therapy, material science, cultural heritage, energy sector technologies, aerospace, automotive, environment, health & safety, industrial processes.

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.





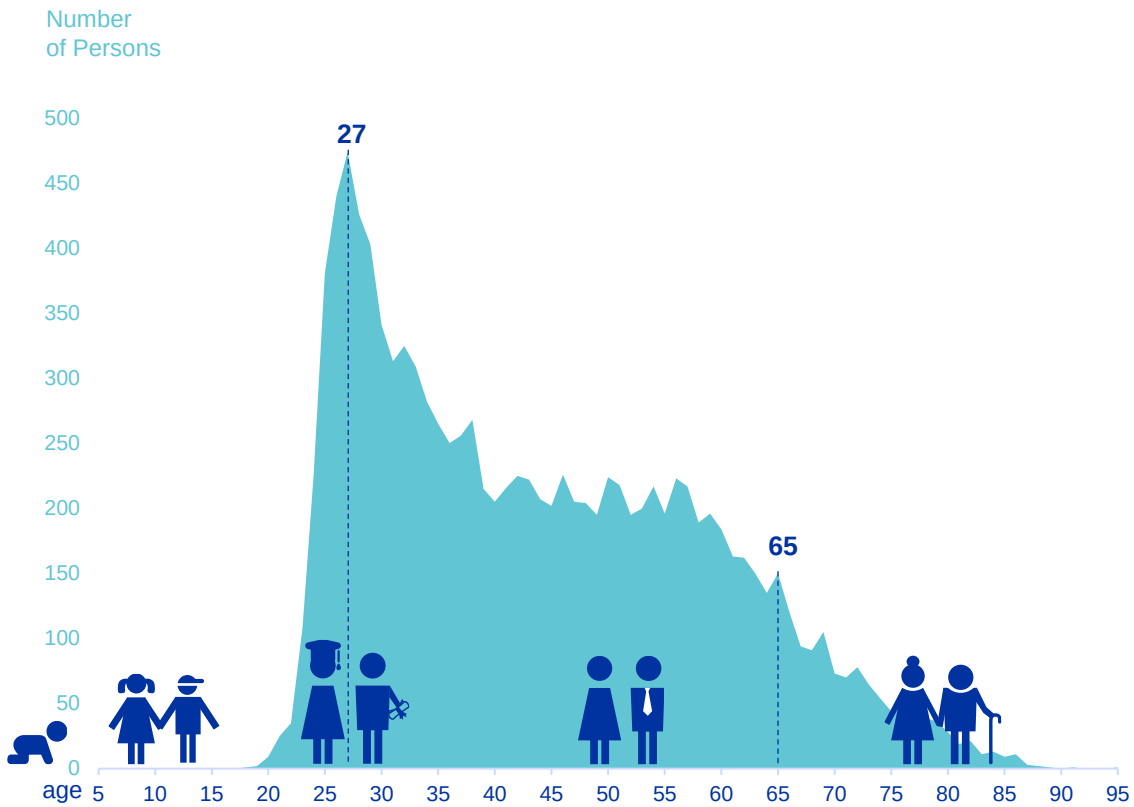
Pixel detector technologies are used for high resolution 3D colour X-ray imaging.

CERN produces innovative radioisotopes for nuclear medicine research.

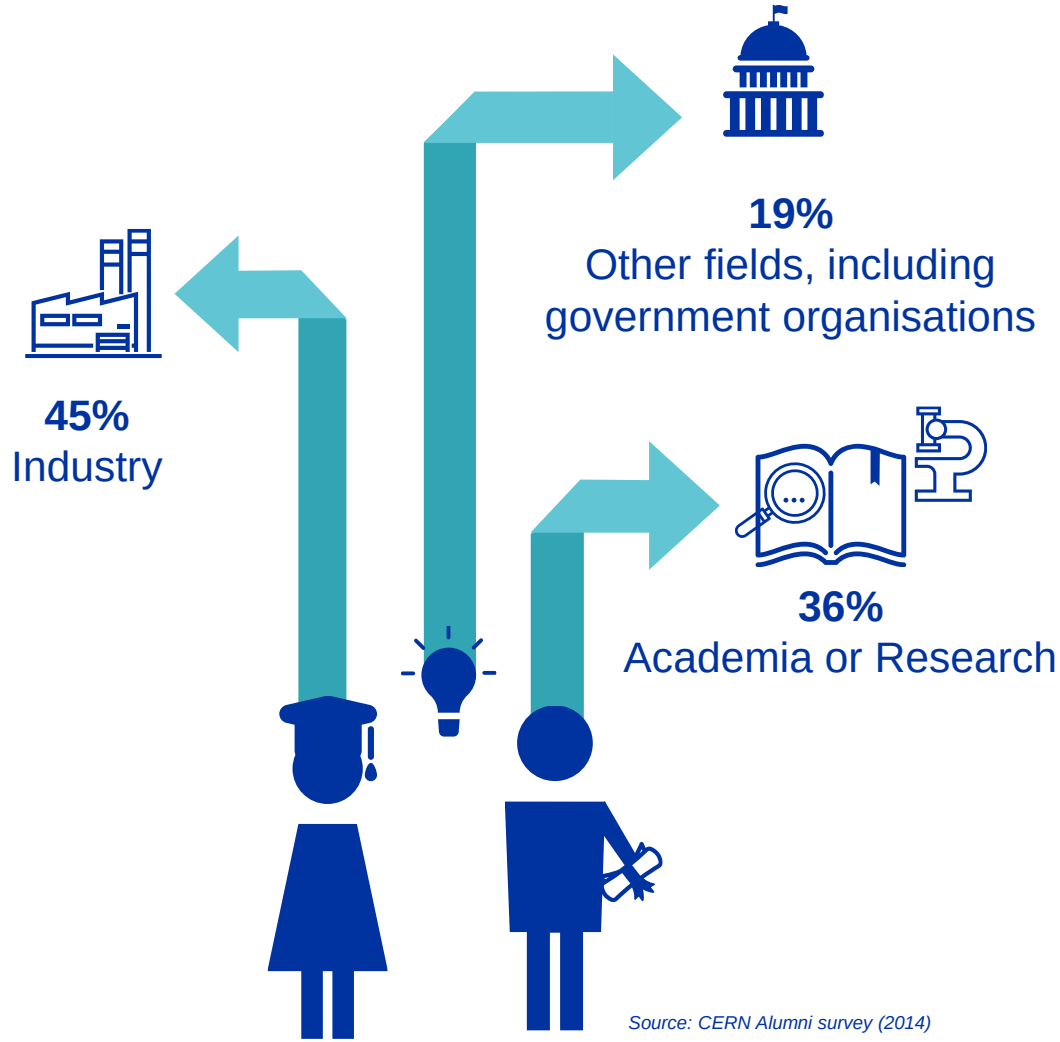
EDUCATION & TRAINING

COLLABORATION

CERN opens a world of career opportunities



Age Distribution of Scientists working at CERN



PhD and Technical students leaving CERN

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 Associates Member States in the pre-stage to membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Latvia – Lithuania – Pakistan
Turkey – Ukraine

6 Observers

Japan – Russia – USA
European Union – JINR – UNESCO

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

As of 31 December 2020
Employees:
2635 staff, **756** fellows

Associates:
11 399 users, **1687** others

More than 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 – 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

Norge og CERN medlemskapet

Medlem siden starten i 1954

Bidrag 2024

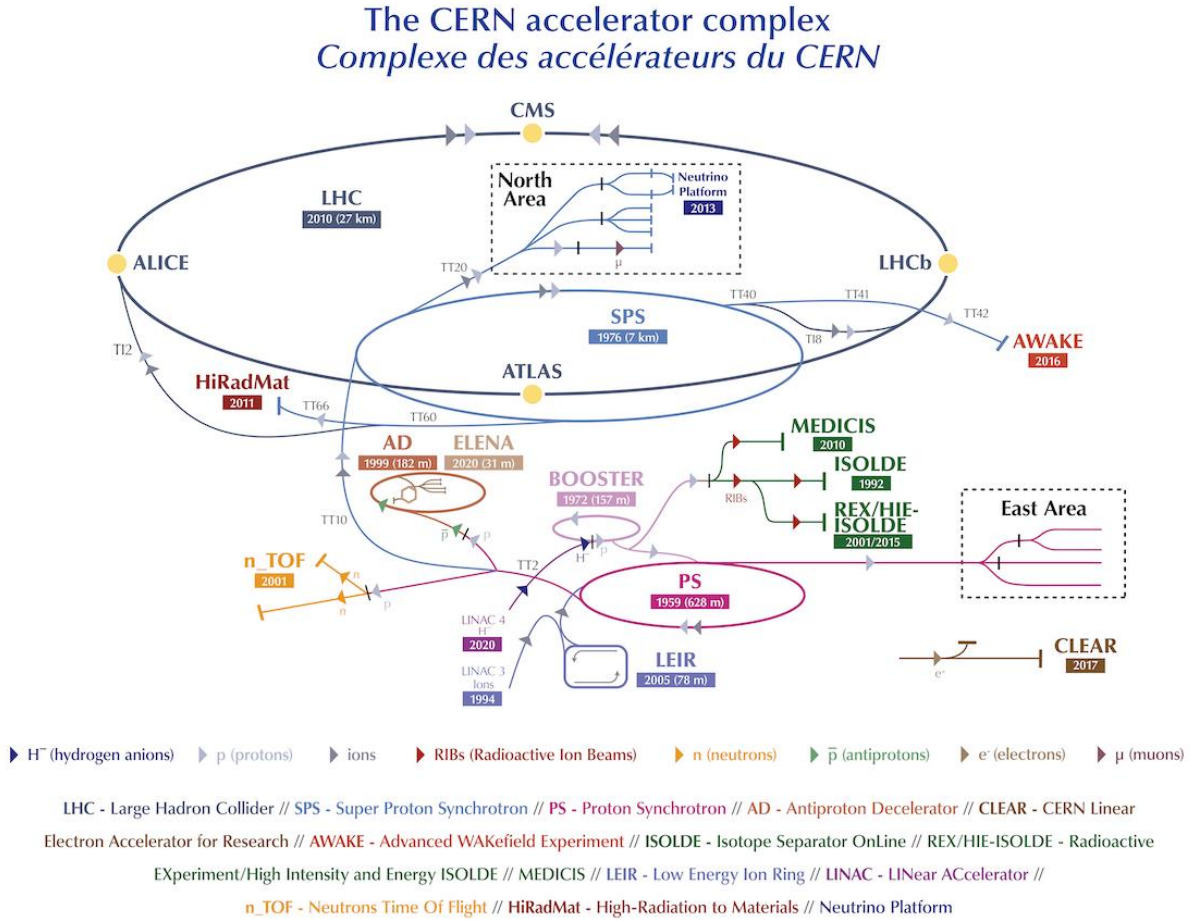
- Norge: 2,19 %

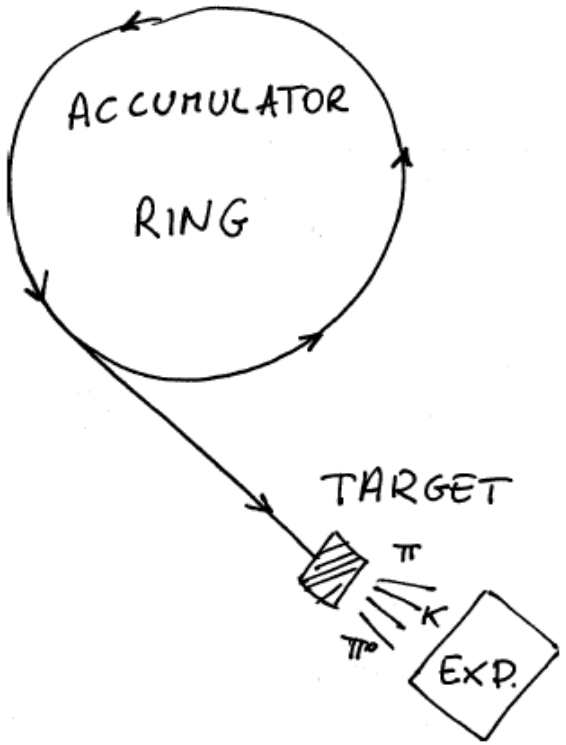
CERNs totale budsjett:

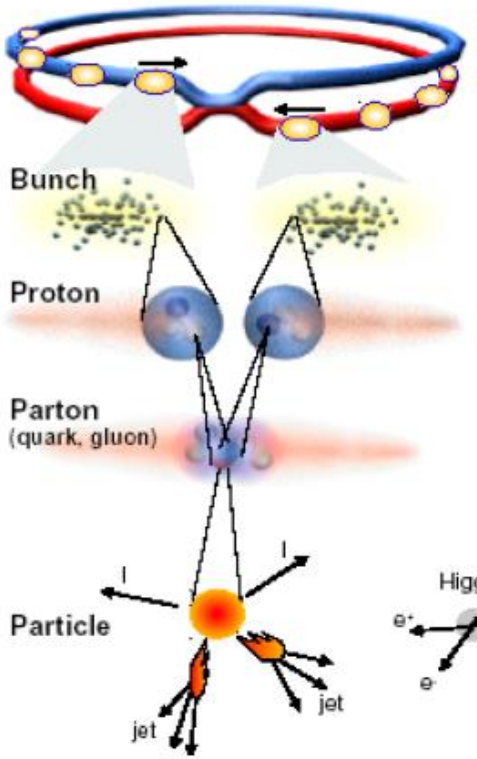
1,37 milliarder CHF

Viktig å involvere en stor gruppe unge mennesker

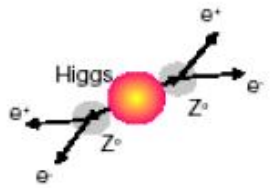
- Ikke bare fysikere,
- også ingeniører, administratorer osv.







Proton-Proton	(2835 x 2835 bunches
Protons/bunch	10^{11}
Beam energy	7 TeV (7×10^{12} eV
Luminosity	10^{34} cm^{-2} s^{-1}
Crossing rate	40 MHz
Collisions =	10^{7} - 10^{9} Hz

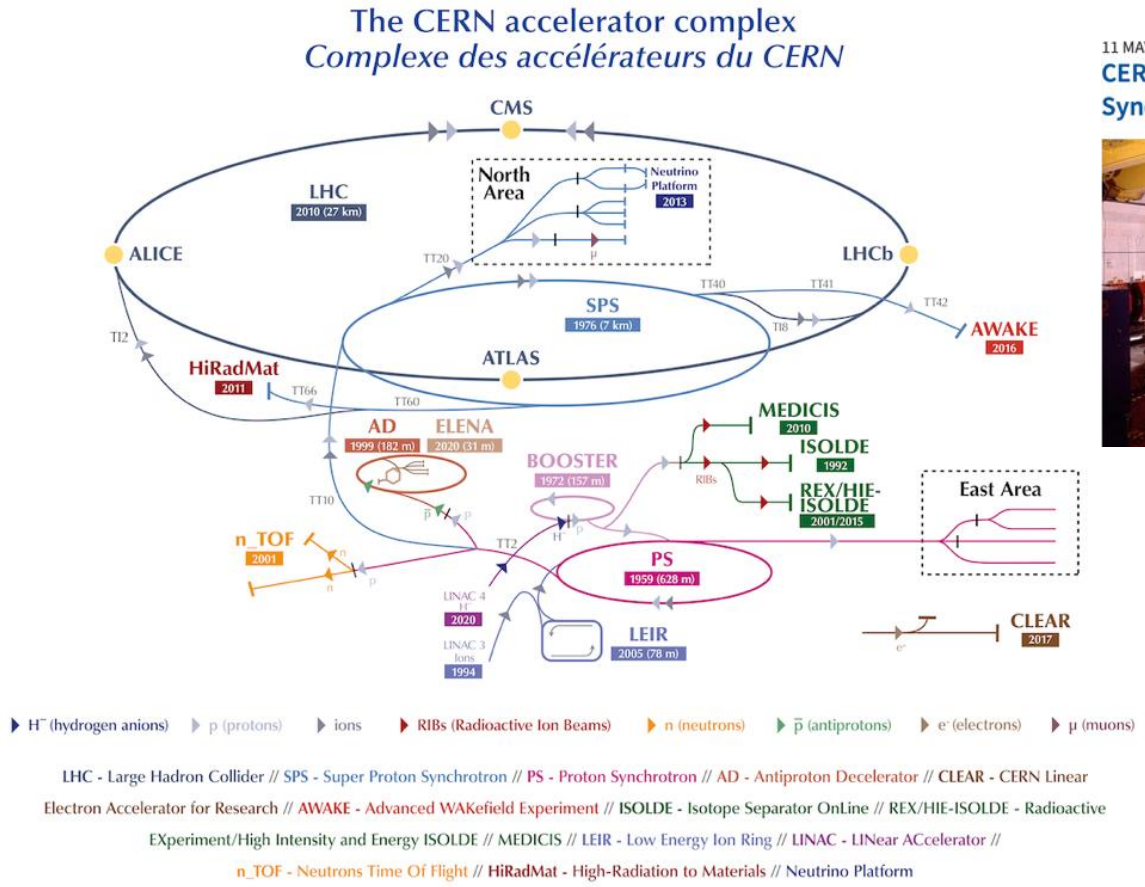


Higgs

SUSY.....

$$E_{CM} = \sqrt{2\left(E_{beam}mc^2 + m^2c^4\right)} \quad << \quad E_{CM} = 2\left(E_{beam} + mc^2\right)$$

From 1955 to ~1970



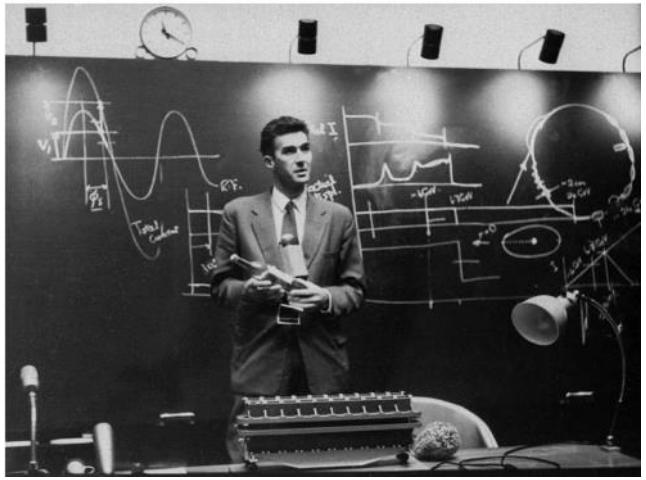
11 MAY 1957

CERN's first accelerator - the Synchrocyclotron - starts up

At the first Session in May 1952 of the provisional CERN Council, Odd Dahl, a Norvegian specialist in accelerators, was appointed Head of the Study Group in charge of studies and investigations regarding accelerators of particle for energies higher than 1 BeV. The other members of the preliminary group were H. Halfen, W. Gentner, F. K. Goward (Deputy Director), F. Regenstreif, and R. Wideroe.

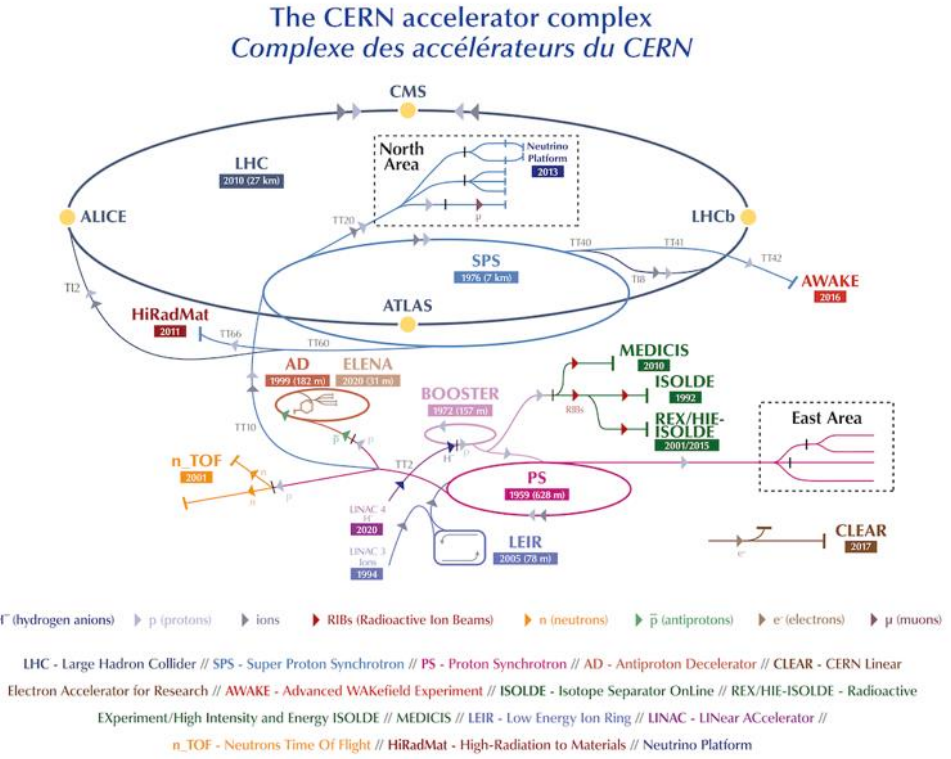
24 NOVEMBER 1959

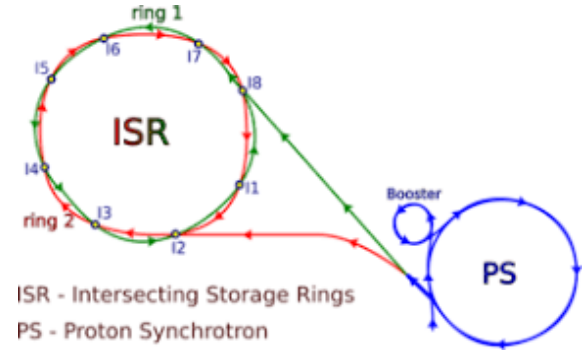
The Proton Synchrotron starts up



NO Bobble chamber experiments, ISOLDE (then using the SC), theory, users from UiO and UiB

From ~1970 to ~1985



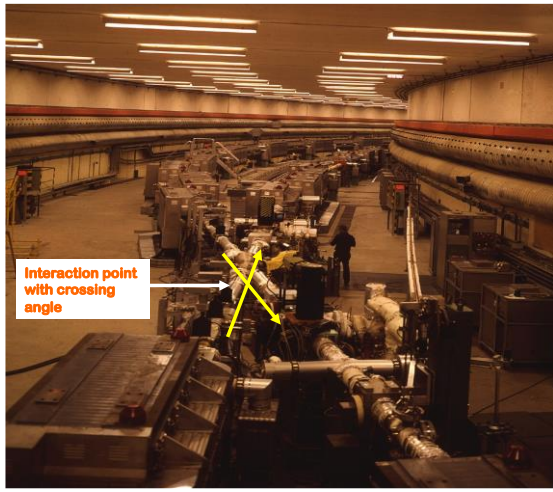


27 JANUARY 1971

First proton collisions: The Intersecting Storage Rings

31 JULY 1974

Super Proton Synchrotron tunnel completed

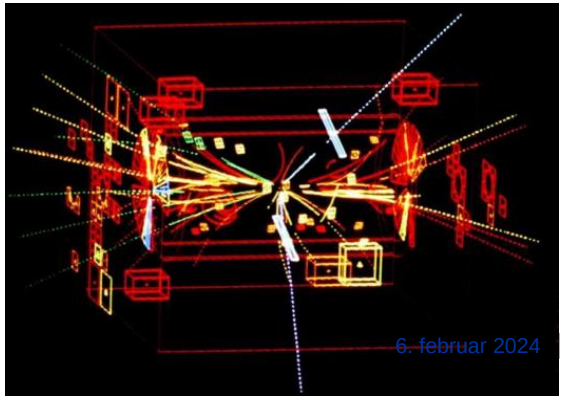


Electronic readout, much larger detectors, importance of larger user collaborations

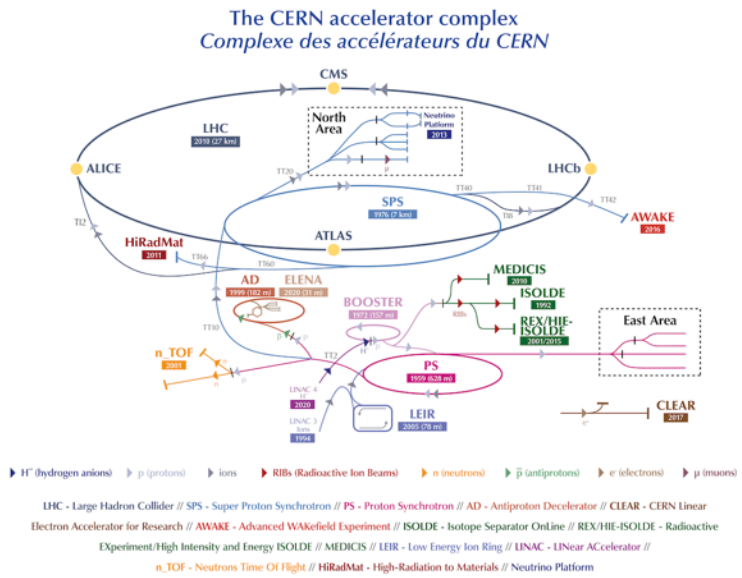
NO
Fixed target experiments (SPS, PS, ISR), ISOLDE, theory, heavy ions at the SPS from 1986

04 APRIL 1981

First proton-antiproton collisions



From ~1985



14 JULY 1989

Large Electron–Positron collider: First injection

NorCC@CERN

NO

- LEP DELPHI, LHC ATLAS and ALICE, fixed targets exp., AEGIS/AD, CLIC, AWAKE, CLEAR, ISOLDE, theory …
- Larger collaborations, silicon sensors, calorimeters, electronics, readout systems and more ..
- Computing became a major challenge/activity
- Technical student programme (master the last 20 years and recently Phd) co-supported from Norway – NTNU and other universities
- ILO and TTO
- Accelerator physics
- Many more universities, much larger community, much more technology

10 SEPTEMBER 2008

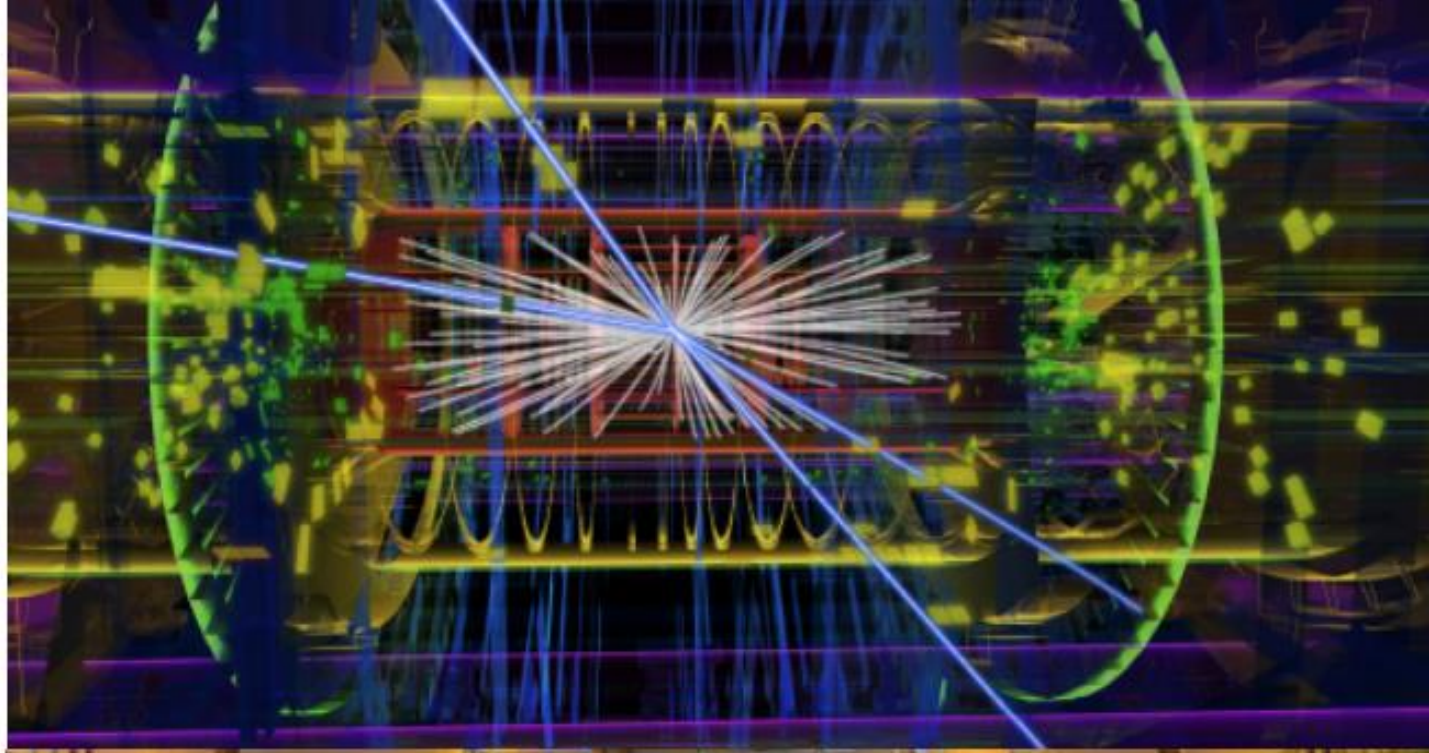
The LHC starts up

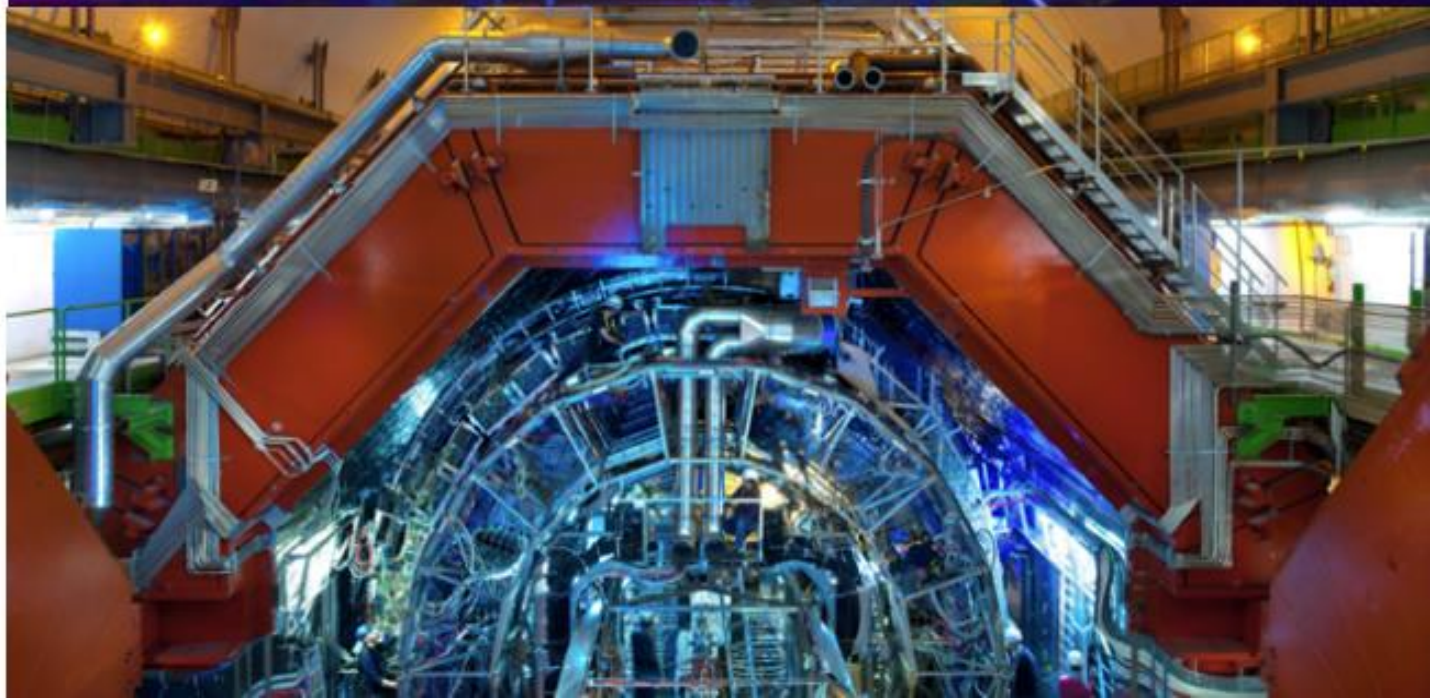
+ High Lumi including major experimental upgrades

+ studies of future collider options

About NorCC

- Opprettet 2020, samlet flere mindre prosjekter i et senter
- Finansiert 50% av NFR, 50% egenbidrag fra universitetene
- NFR finansiering dekker lang-tids forskningsdeltagelse i eksperimenter på CERN
- Vert er UiO og leder av senteret er fra UiO, UiB leder styret
- Med senteret ble det åpnet for deltagelse av andre universiteter i Norge





Organisation

- 5 forskningsaktiviteter
  - A1 - Partikkelfysikk
  - A2 - Kjernefysikk
  - A3 - Akseleratorfysikk
  - A4 - Lav energy fysikk
  - A5 - Teknologi
- 2 aktiviteter for ledelse og utnyttelse, formidling og utdanning
  - A6 - Utnyttelse, Formidling og Utdannelse
  - A7 - Ledelse
- 2 nettverk som jobber for synergi på tvers av forskningsaktivitetene
  - N1 - R&D Detektor og Elektronikk
  - N2 - R&D Computing, Maskinlæring og AI

Institutter i NorCC

- Antall universiteter har økt
- Før 2020: UiO, UiB, HVL, USN
- Etter 2020: **UiO, UiB, HVL, USN, NTNU, UiA**
- Teorigrupper ved UiS, UiA, NTNU, UiB, UiO

Forskere, teknisk ansatte, studenter: ~150

I tillegg betalt av CERN: ~50 nordmenn