



# Welcome to CERN

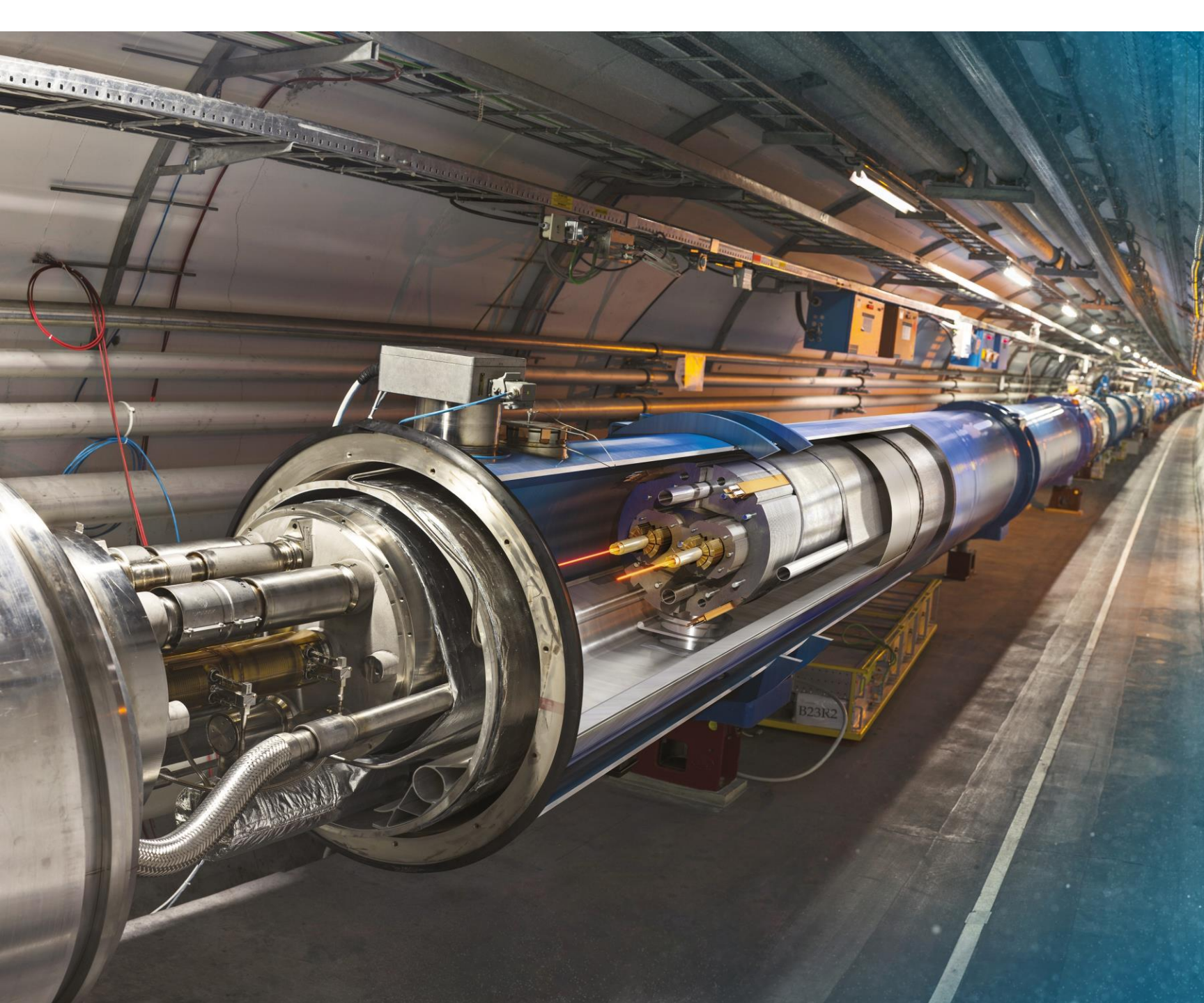
13<sup>th</sup> CERN Baltic Group General Meeting

Prof. Emmanuel Tsesmelis

Head of Associate Member State and Non-Member State Relations, CERN

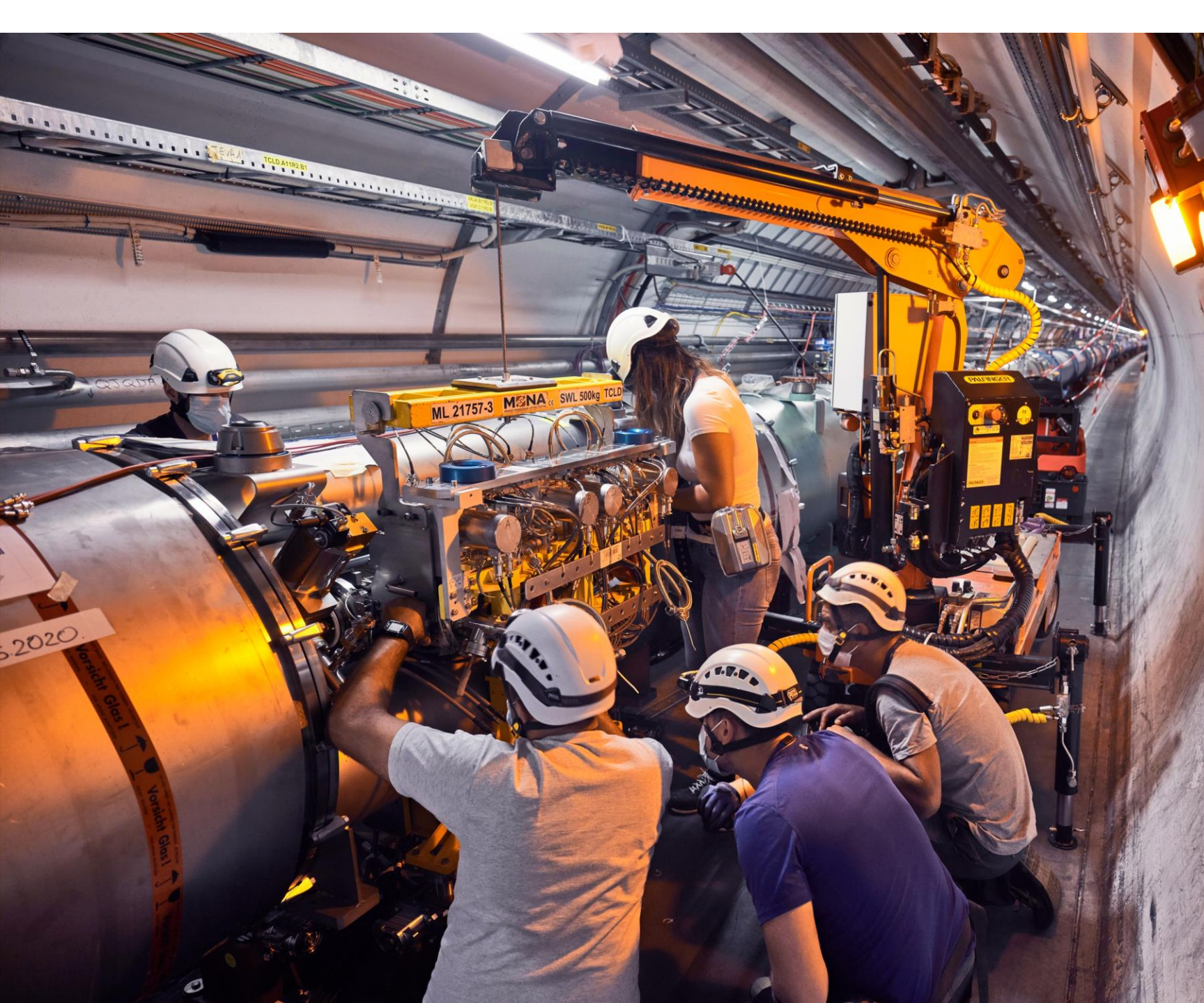
Convenor of FCC Global Collaboration Working Group

22 March 2024



# Large Hadron Collider (LHC)

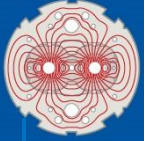
- 27 km in circumference
- About 100 m underground
- Superconductivity is the enabling technology for magnets and RF cavities.



# 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, improved precision and discovery potential.
- It will start operating in 2029 and run until 2040.

**The LHC / HL-LHC will make significant progress but new collider needed to advance research in totally new areas.**



# LHC / HL-LHC Plan



EU funded HiLumi Design Study

Approval of HL-LHC Project  
**LHC**

We are here

HL-LHC Operation  
**HL-LHC**

Run 1      Run 2      Run 3      Run 4 - 5...

LS1

13 TeV

EYETS

LS2

13.6 TeV

EYETS

LS3

13.6 - 14 TeV

energy

7 TeV

8 TeV

splice consolidation  
button collimators  
R2E project

cryolimit  
interaction  
regions

Diodes Consolidation  
LIU Installation  
Civil Eng. P1-P5

pilot beam

inner triplet  
radiation limit

HL-LHC  
installation

2011   2012   2013   2014   2015   2016   2017   2018   2019   2020   2021   2022   2023   2024   2025   2026   2027   2028   2029   2030   2031   2032   2033   2034   2035   2036   2037   2038   2039   2040

5 to 7.5 x nominal Lumi

75% nominal Lumi

nominal Lumi

2 x nominal Lumi

2 x nominal Lumi

HL-LHC TECHNICAL EQUIPMENT:

30 fb<sup>-1</sup>

190 fb<sup>-1</sup>

450 fb<sup>-1</sup>

integrated  
luminosity  
3000 fb<sup>-1</sup>  
4000 fb<sup>-1</sup>

**Run3 operation**

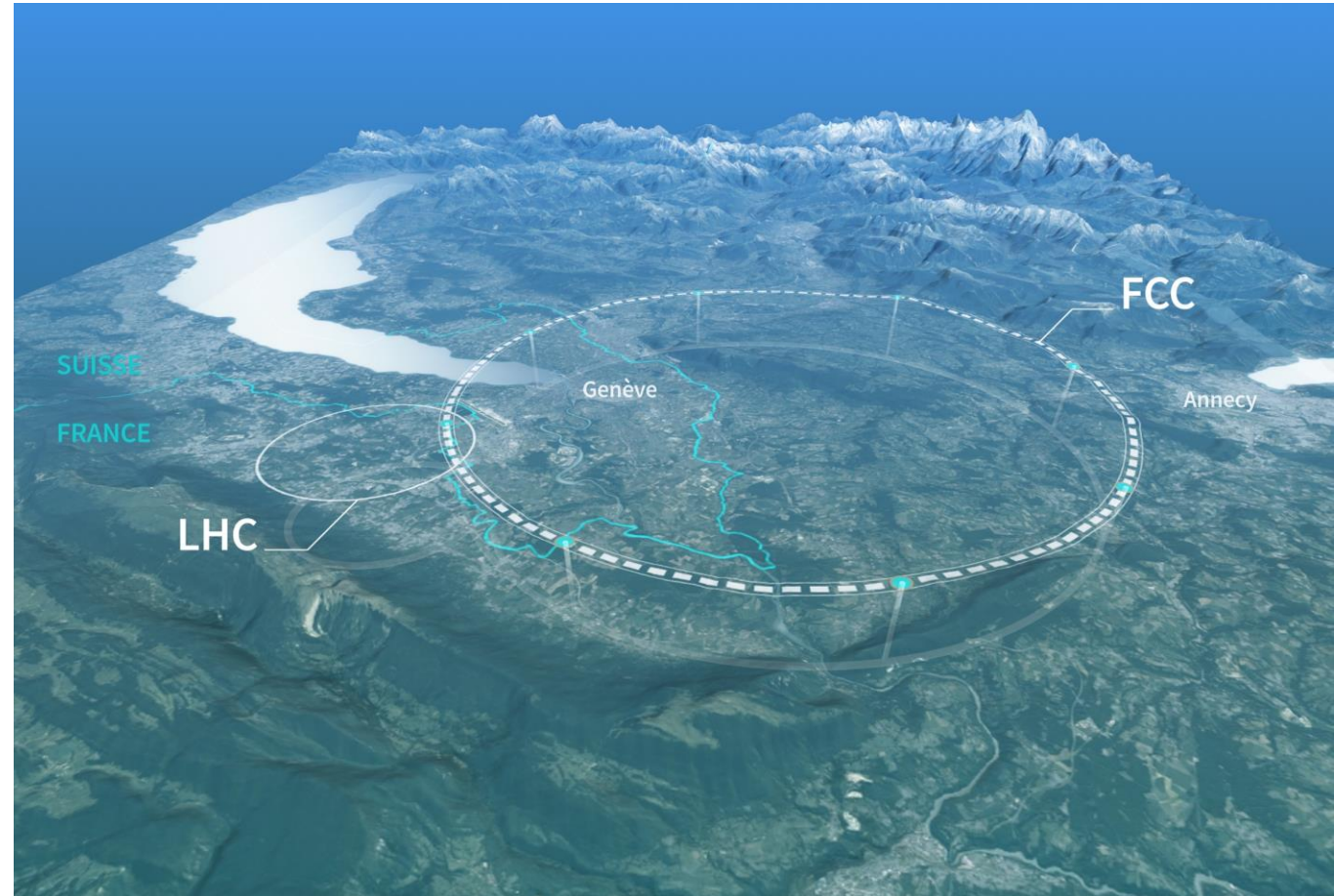
→ 2 years until start of Long Shutdown 3

→ The project is ready for installation start in 2026! → endorsed by 2023 C&SR

# Preparing CERN's Future

## Driven by the 2020 Update of the European Strategy for Particle Physics

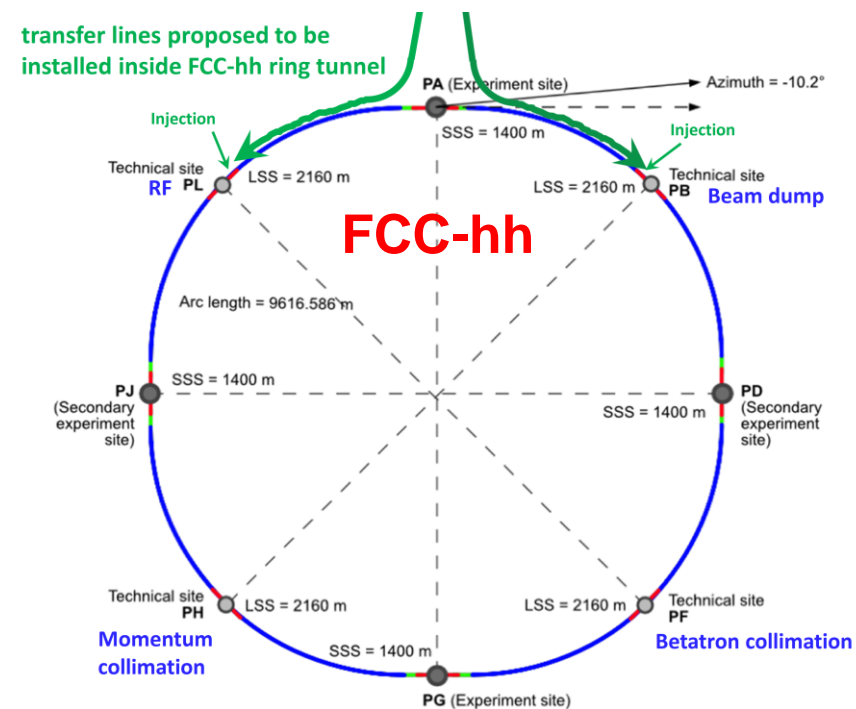
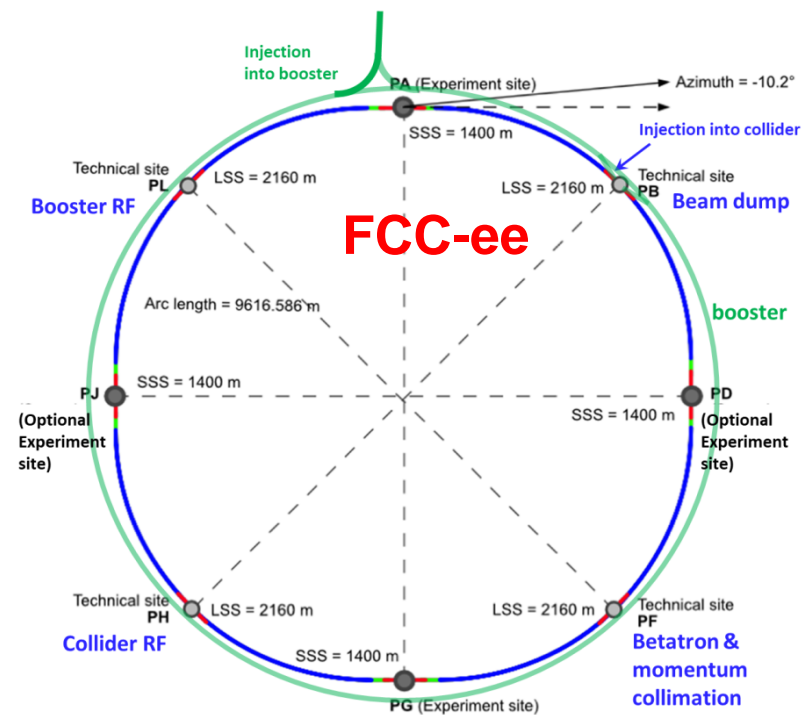
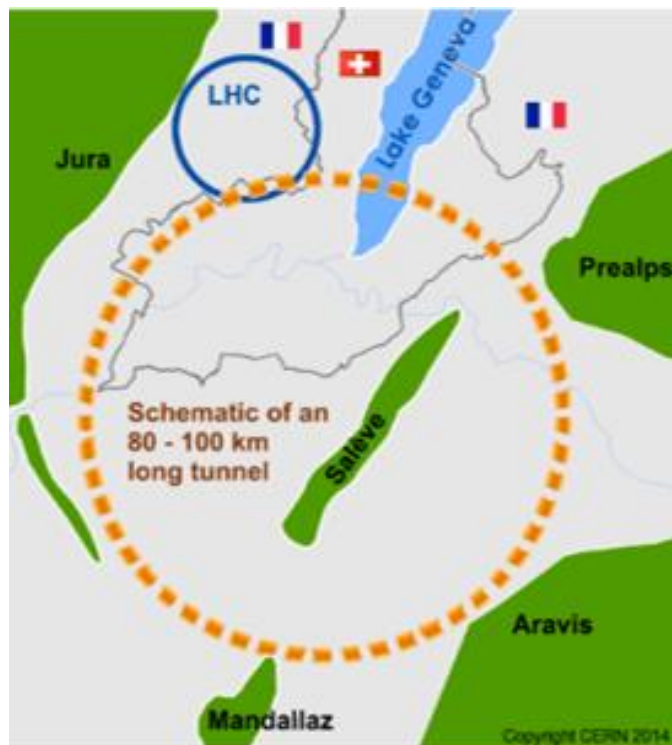
- Technical and financial feasibility study of a Future Circular Collider (**FCC**).
- Accelerator R&D to develop technologies for FCC and for alternative options.
- Detector and computing R&D.
- Maintain and expand a compelling scientific diversity programme.
- Continue to support other projects around the world.



# FCC Integrated Programme

Comprehensive long-term programme maximising physics opportunities

- Stage 1: FCC-ee (Z, W, H,  $t\bar{t}$ ) as Higgs factory, electroweak & top factory at highest luminosities
- Stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, pp & AA collisions; e-h option
- Highly synergetic and complementary programme boosting the physics reach of both colliders
- Common civil engineering and technical infrastructures, building on and reusing CERN's existing infrastructure
- FCC integrated project allows the start of a new, major facility at CERN within a few years of the end of HL-LHC



## 2013 Update of European Strategy for Particle Physics:

*“CERN should undertake design studies for accelerator projects in a global context, with emphasis on proton-proton and electron-positron high-energy frontier machines.”*

### → FCC Conceptual Design Reports (2018/19)



Vol 1 Physics, Vol 2 FCC-ee, Vol 3 FCC-hh, Vol 4 HE-LHC

CDRs published in **European Physical Journal C (Vol 1)** and **ST (Vol 2 – 4)**

EPJ C 79, 6 (2019) 474 , EPJ ST 228, 2 (2019) 261-623 ,  
EPJ ST 228, 4 (2019) 755-1107 , EPJ ST 228, 5 (2019) 1109-1382

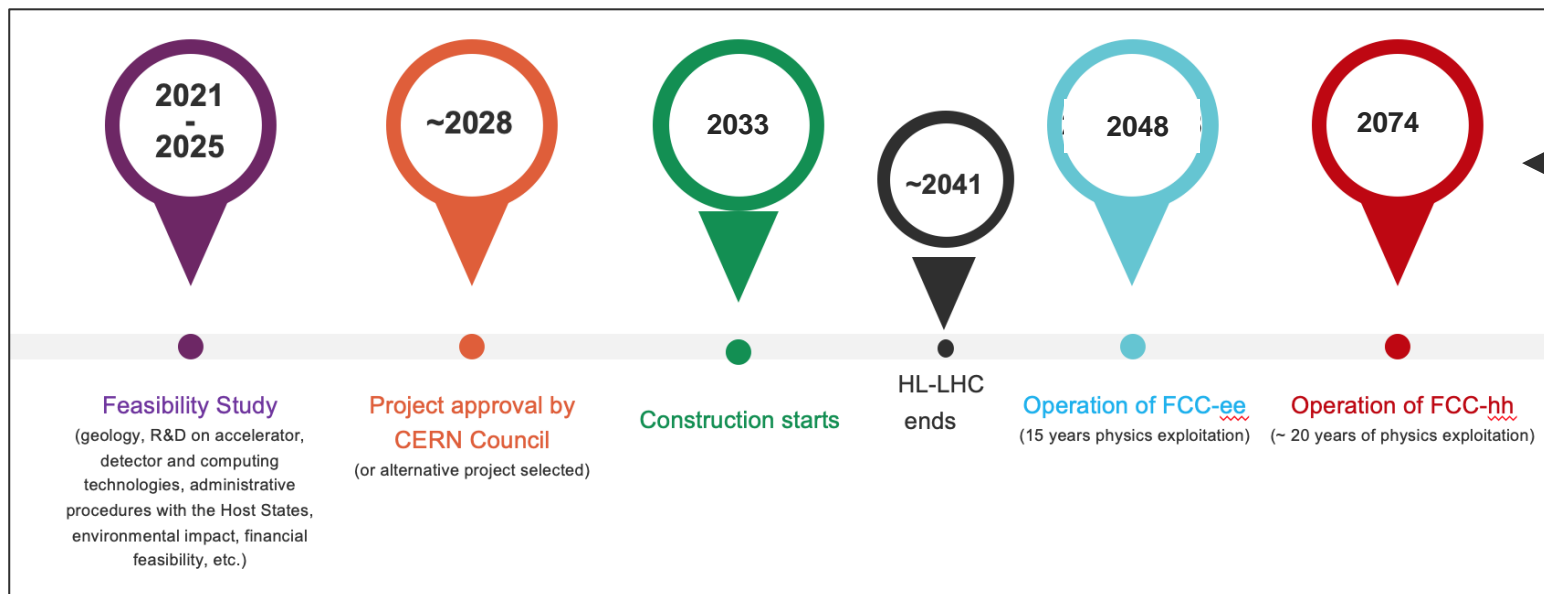
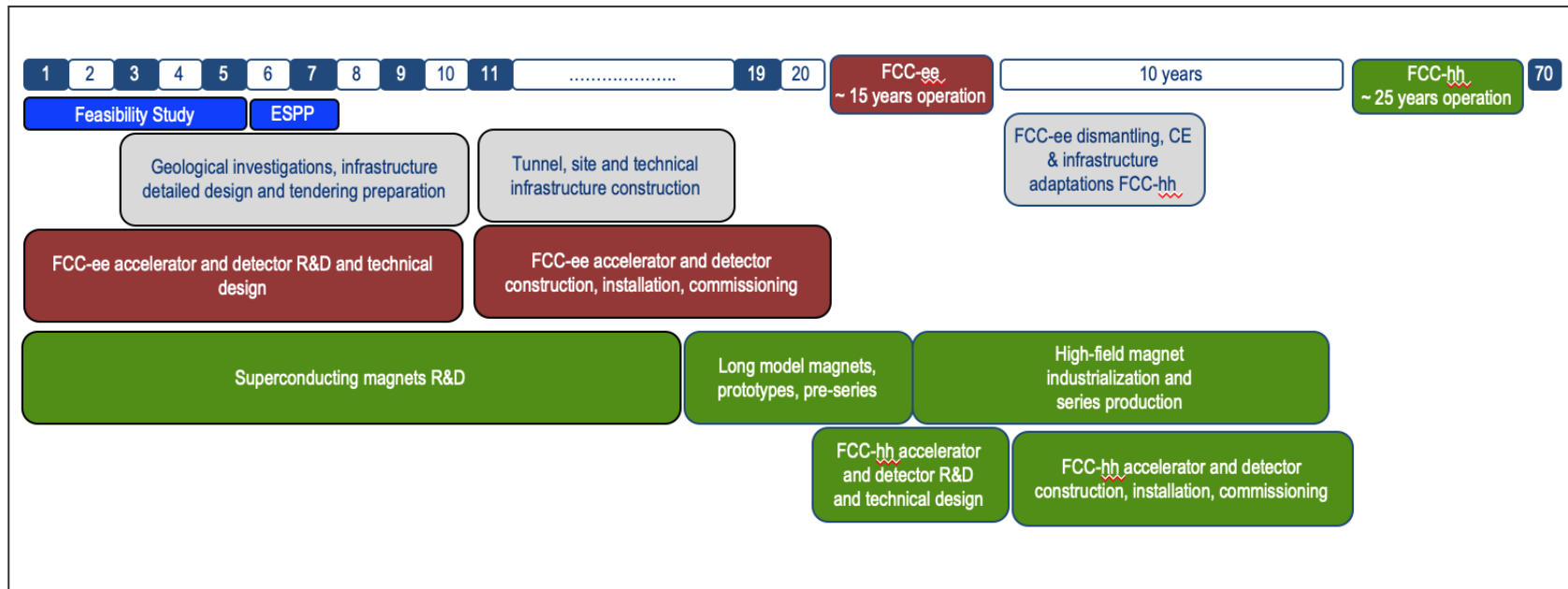
## 2020 Update of European Strategy for Particle Physics:

*“Europe, together with its international partners, should investigate technical and financial feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage.”*

# FCC Integrated Programme - Timeline

Note: FCC Conceptual Design Study started in 2014 leading to CDR in 2018

FCC construction can proceed in parallel with HL-LHC operation.



**“Realistic” schedule** taking into account:

- past experience in building colliders at CERN
- approval timeline: ESPP, Council decision
- that HL-LHC will run until 2041

Can be accelerated if more resources available

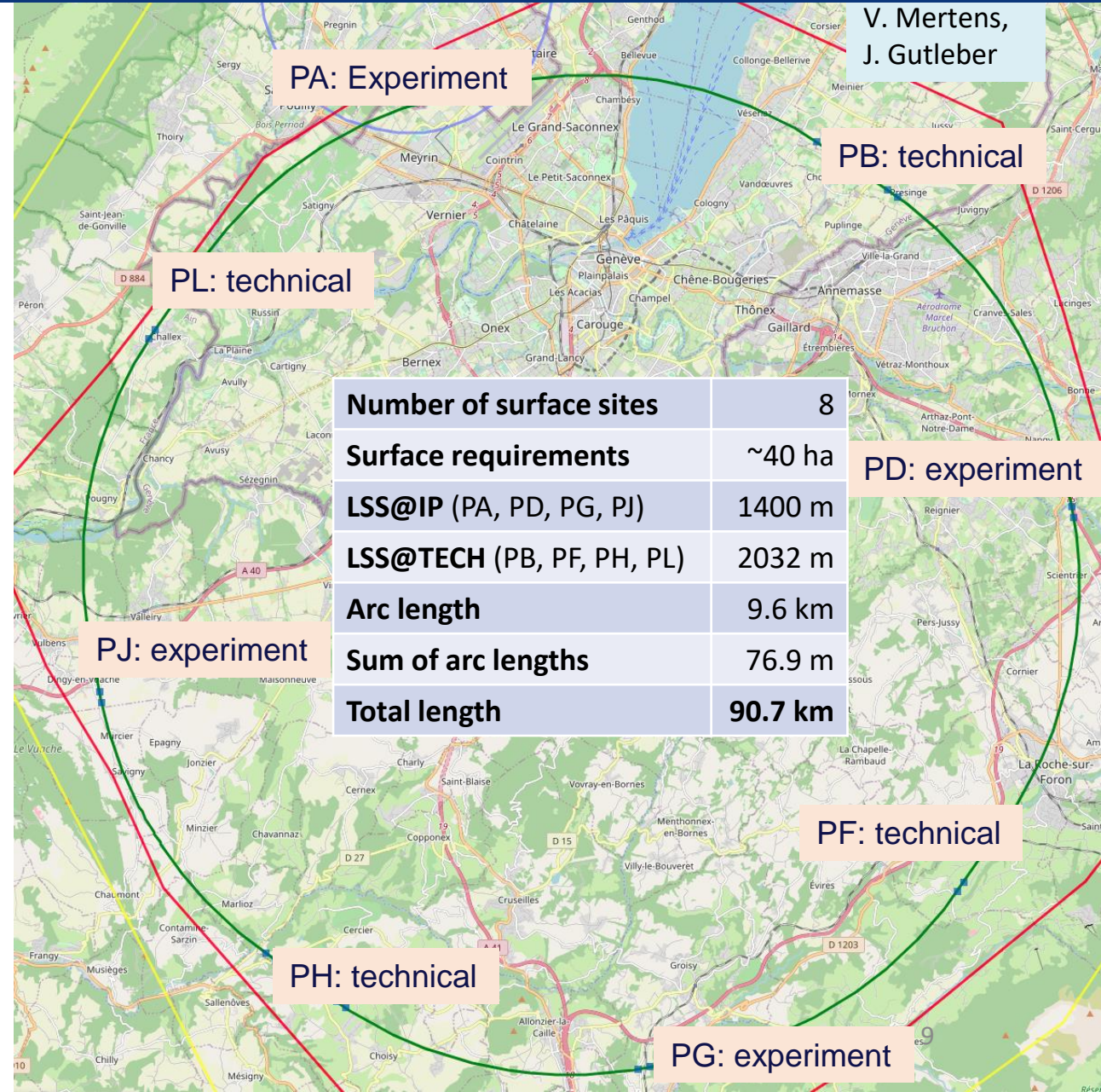
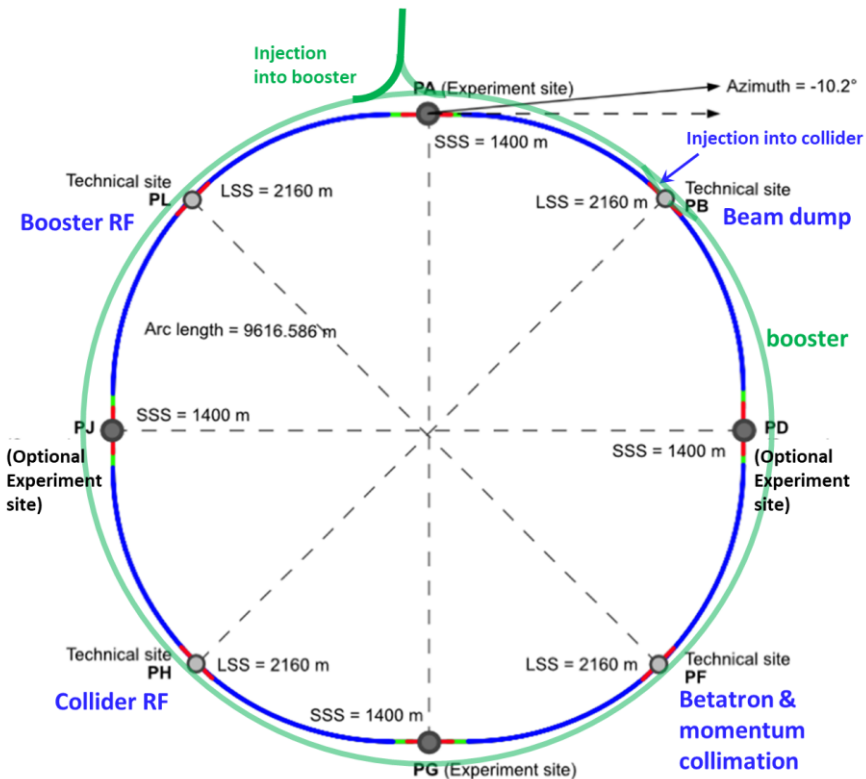


# Optimised Placement and Lay-out for Feasibility Study

Layout chosen out of ~ 100 initial variants, based on **geology** and **surface constraints** (land availability, access to roads, etc.), **environment**, (protected zones), **infrastructure** (water, electricity, transport), **machine performance** etc.

“**Avoid-reduce-compensate**” principle of EU and French regulations

**Overall lowest-risk baseline: 90.7 km ring, 8 surface points,**  
Whole project now adapted to this placement



V. Mertens,  
J. Gutleber

PA: Experiment

PB: technical

PL: technical

<b>Number of surface sites</b>	<b>8</b>
<b>Surface requirements</b>	<b>~40 ha</b>
<b>LSS@IP (PA, PD, PG, PJ)</b>	<b>1400 m</b>
<b>LSS@TECH (PB, PH, PL)</b>	<b>2032 m</b>
<b>Arc length</b>	<b>9.6 km</b>
<b>Sum of arc lengths</b>	<b>76.9 m</b>
<b>Total length</b>	<b>90.7 km</b>

PD: experiment

PJ: experiment

PH: technical

PH: technical

PG: experiment

# Status of FCC Global Collaboration

The CERN Council reviewed the work undertaken in a fruitful meeting on 2 February 2024. It congratulated and thanked all the teams involved in the study for the excellent and significant work done so far and for the impressive progress, and looks forward to receiving the final report in 2025.

**Estonia:** National Institute for Chemical Physics and Biophysics, Tallinn University of Technology, University of Tartu, GScan (industry), NPM Silmet (industry), Testonica (industry)

**Latvia:** Riga Technical University

**Lithuania:** FCC Engagement Meeting under preparation

150

Institutes

32

Companies

34

Countries



FCC Feasibility Study: Aim is to increase further the collaboration, on all aspects, in particular, on Accelerator and Particle/Experiments/Detectors (PED).

**FCC Week 2023**  
London, UK

**473 participants**

**362 in person and  
111 remote**

**FCC Week 2024**  
San Francisco, USA  
10-14 June 2024

Courtesy P. Charitos



# 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 2022  
Employees:  
**2658** staff, **900** graduates  
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

Estonia: Advanced stage of completing Membership procedure  
Brazil: Advanced stage of completing procedure for AM\*  
Ireland: Application submitted for AM\*

AM\* Associate Membership

# 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  
22.5 % 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 Science Gateway

Centrepiece of CERN70  
high-level event on 1 October 2024

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

Inaugurated  
7 October 2023.

Immersive exhibitions,  
education labs, events  
and shows.

