The Future Circular Collider Study

Planning a research infrastructure for the 21st century

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on behalf of the FCC collaboration

http://cern.ch/fcc

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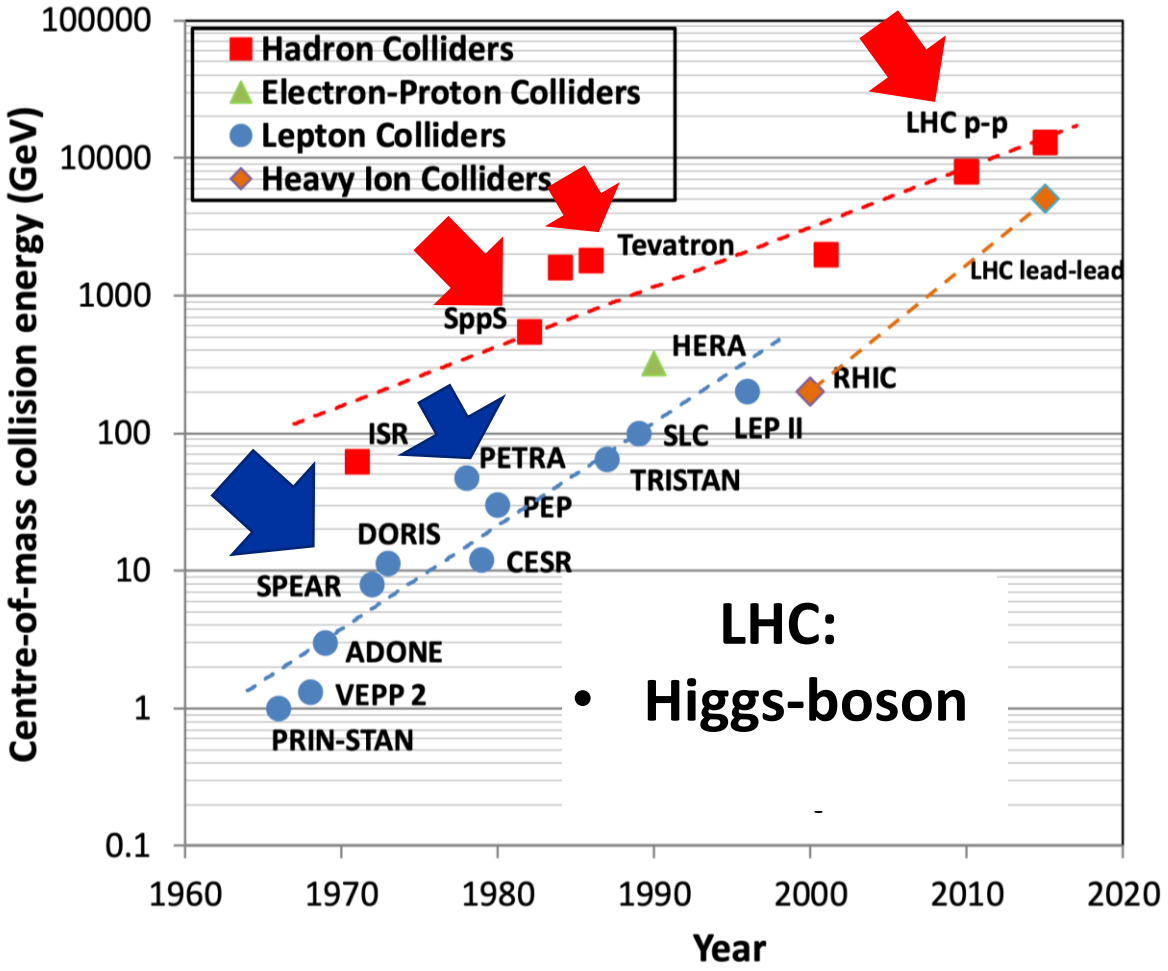
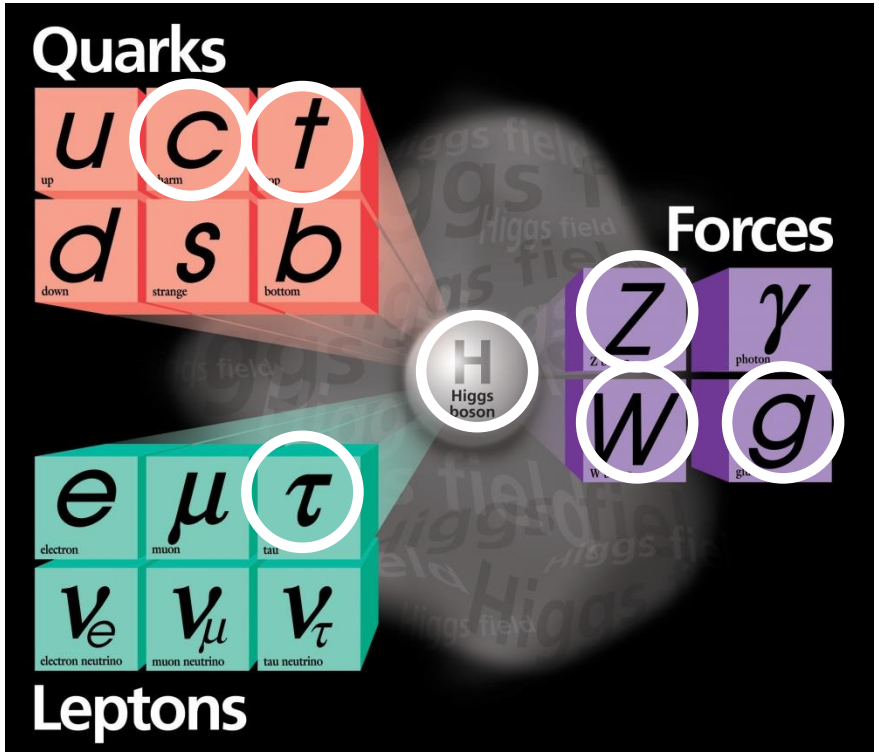
photo: J. Wenninger

Discoveries with colliders



Standard Model
Particles and forces



Colliders are powerful instruments in HEP for particle discoveries and precision measurements

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Innovation Study

Open Questions

Despite of impressive progress and discoveries in the past decades several fundamental questions remain open:

Today 80 % of the mass of the universe is unknown.
What is the universe made of?

Is there only a single type of Higgs boson and does it behave exactly as predicted?

Why is the universe composed only of matter? Where has the anti-matter gone that was produced simultaneously in the big bang?

Why do neutrinos have mass?
How do neutrinos get their masses?

European Strategy for Particle Physics

Recommendations of the 2020 update of the European Strategy for Particle Physics (ESPP):

- Full exploitation of the high-luminosity LHC upgrade
- An electron-positron Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy.
- **“Europe, together with its international partners, should investigate the 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**.

The FCC integrated program inspired by successful LEP – LHC programs at CERN

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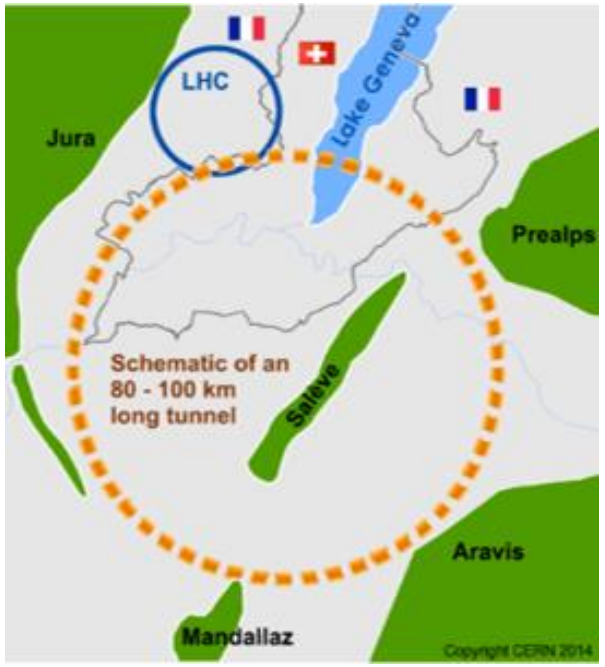
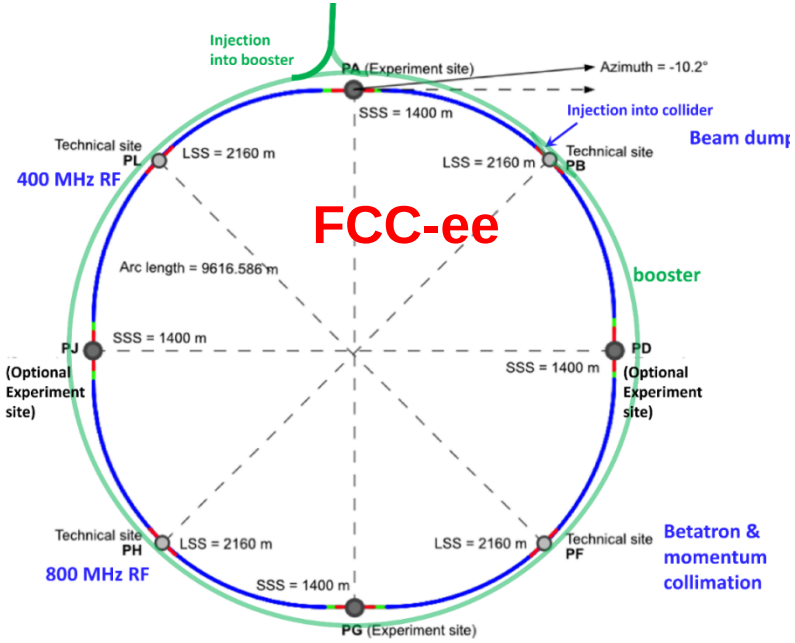
comprehensive long-term program maximizing physics opportunities

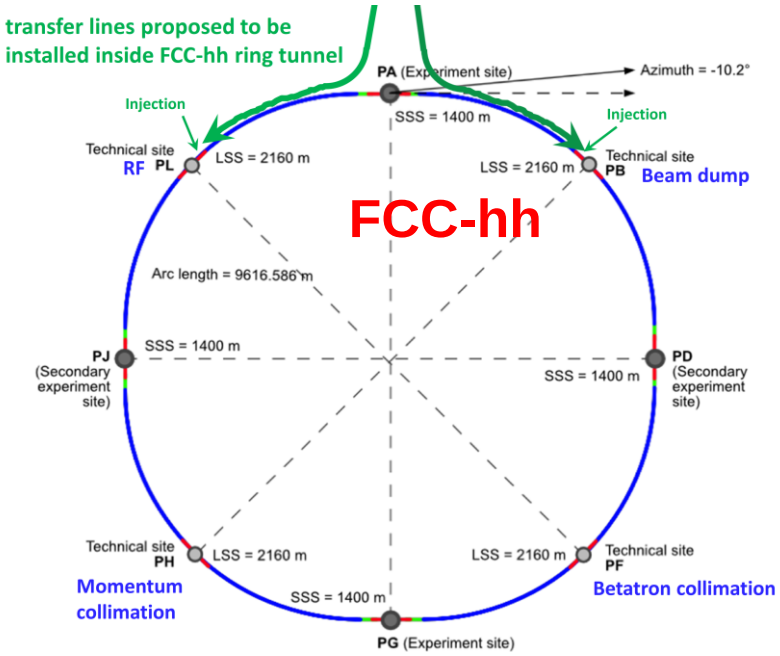
- common civil engineering and technical infrastructures, building on and reusing CERN's existing infrastructure

stage 1: FCC-ee: high-intensity electron-positron collider for detailed study of the Higgs boson (10^6), top-quark (10^6), W (10^8), Z (10^{12}) → indirect sensitivity to new physics up to ~ 70 TeV (> 10 times LHC)

stage 2: FCC-hh: proton-proton collider with collision energy of at least 100 TeV
→ direct discovery potential for new physics up to ~ 40 TeV (~ 10 times the LHC)

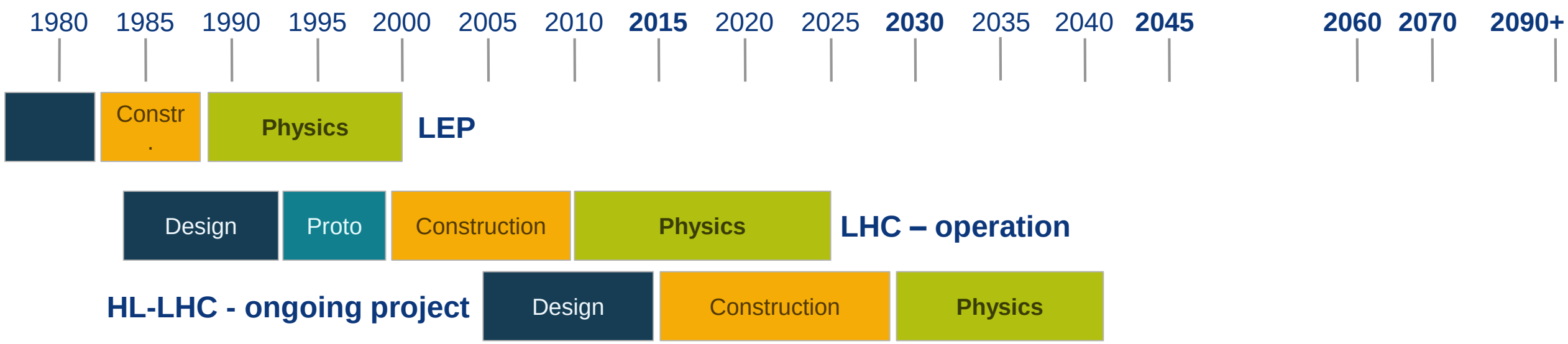


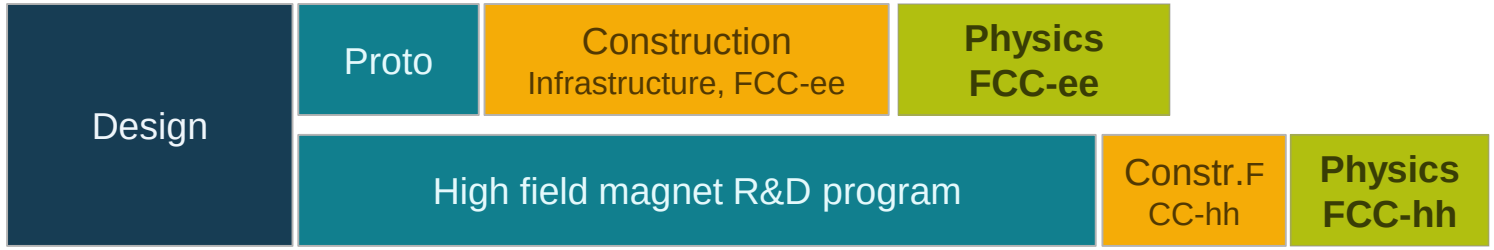




2020 - 2040 | 2045 - 2060 | 2070 - 2090++

CERN Circular Colliders & FCC





FCC – integrated programme

FCC integrated programme allows seamless continuation of collider-based HEP after completion of the HL-LHC program, until end of century

Goals of the feasibility study and roadmap towards first e^+e^- collisions

Highest priority goals:

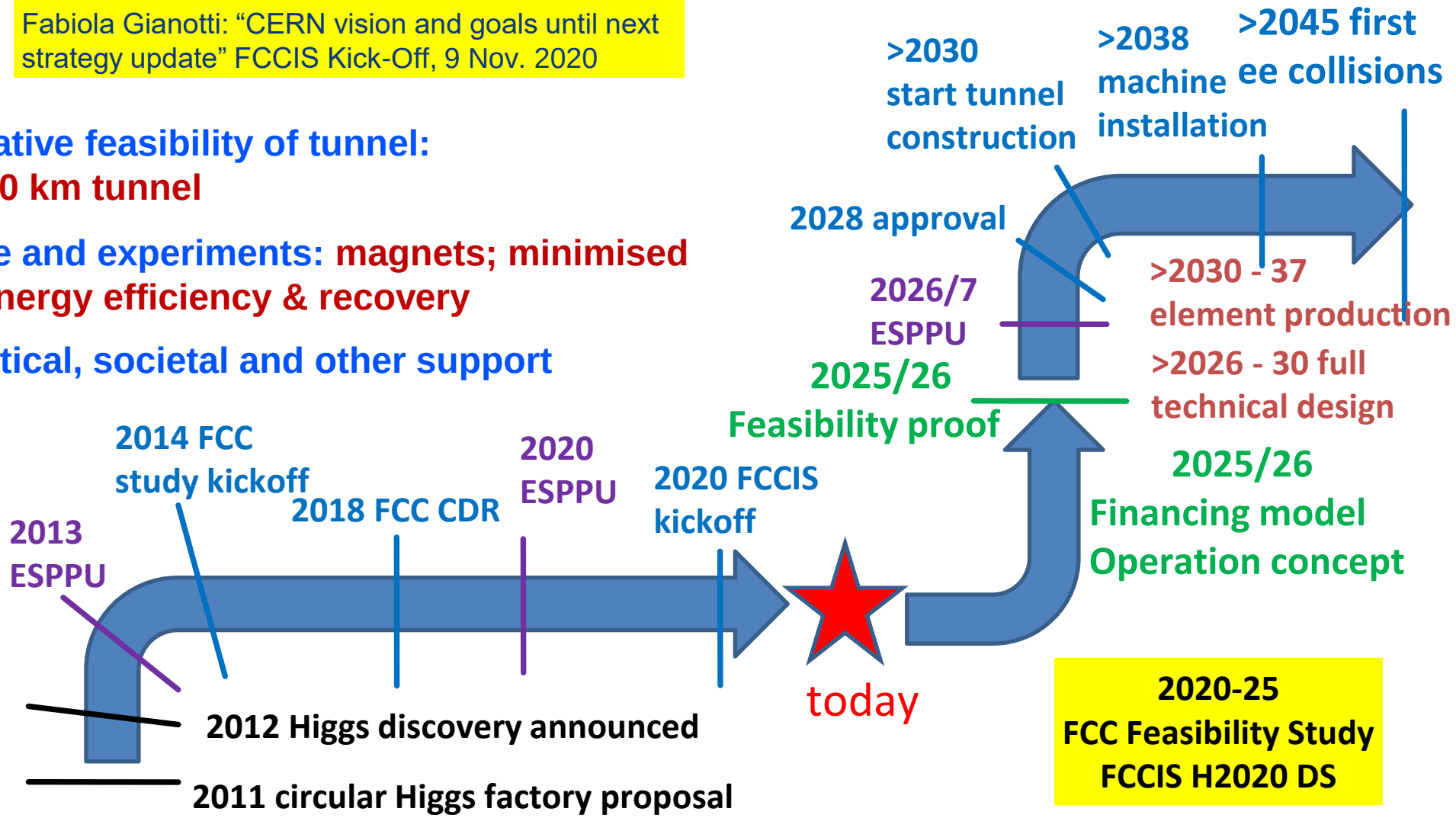
Fabiola Gianotti: "CERN vision and goals until next strategy update" FCCIS Kick-Off, 9 Nov. 2020

Financial feasibility

Technical and administrative feasibility of tunnel: no show-stopper for ~100 km tunnel

Technologies of machine and experiments: magnets; minimised environmental impact; energy efficiency & recovery

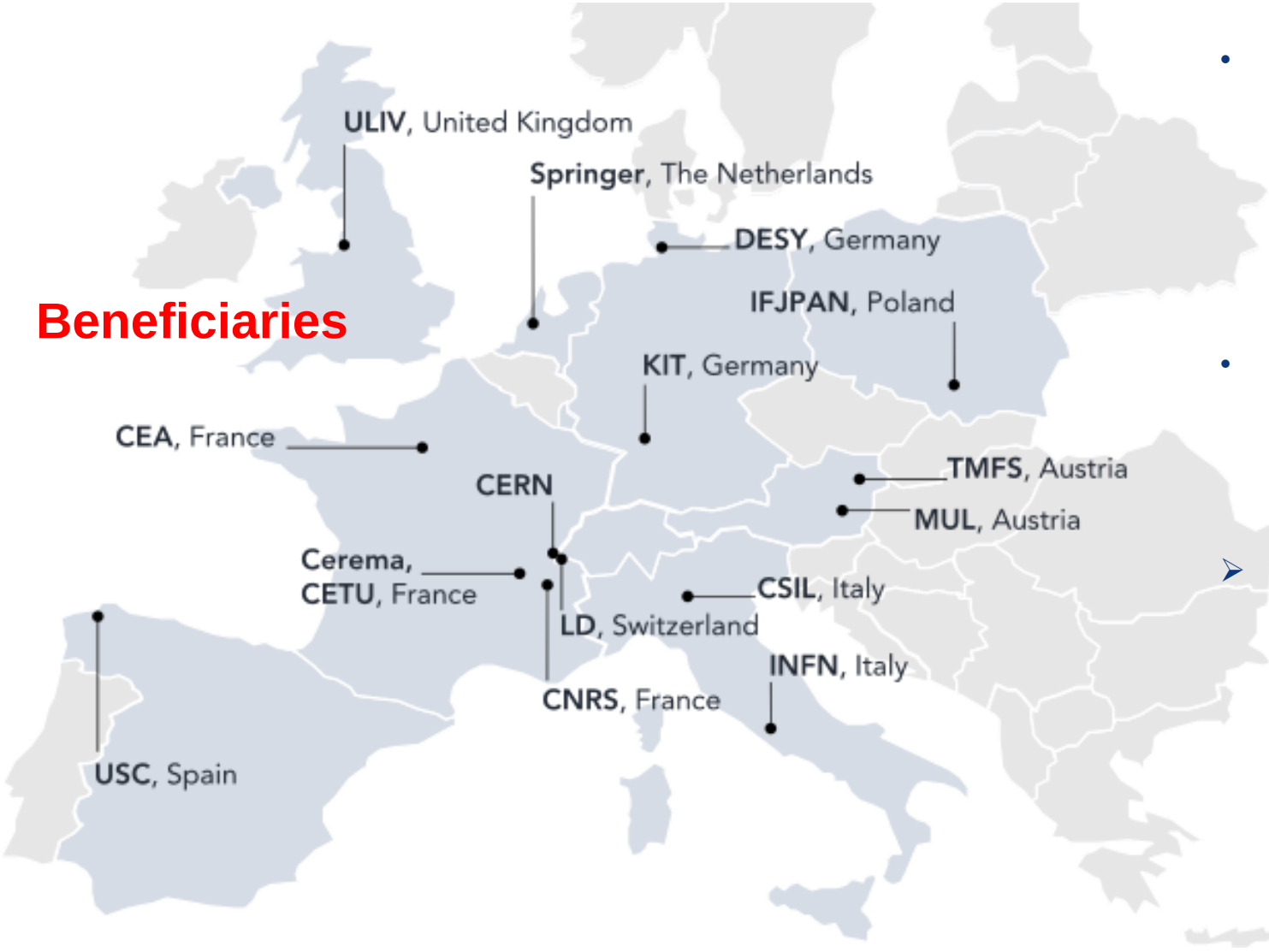
Gathering scientific, political, societal and other support



2020-25
FCC Feasibility Study
FCCIS H2020 DS

H2020 DS FCC Innovation Study 2020-24

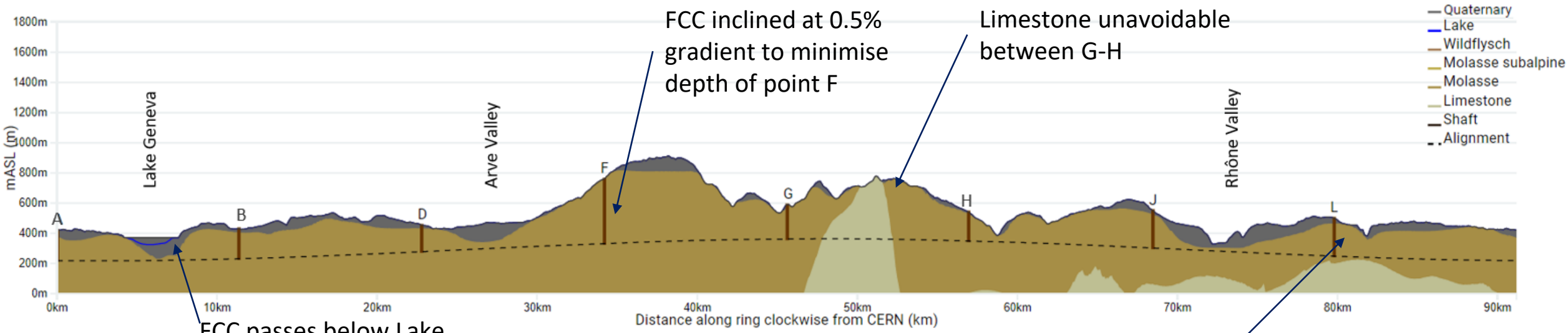
Beneficiaries



- **Optimise the design of the FCC-ee luminosity frontier particle collider** and **demonstrate the technical and organizational feasibility** of a ~100 km long, particle collider research infrastructure, seamlessly integrated in the European research landscape
- **Develop an innovation plan for a long-term sustainable research infrastructure**, focusing on responsible resource use and managing environmental impacts

➢ **Mining the Future competition**

FCC tunnel - geological conditions



Shaft depth:

A: 202 m B: 200 m D: 177 m F: 399 m G: 228 m H: 139 m J: 251 m L: 253 m

Tunnelling mainly in molasse layer (soft rock), well suited for fast, low-risk TBM construction.

Site investigations campaign planned for 2024 – 2025: ~40-50 drillings, 100 km of seismic lines

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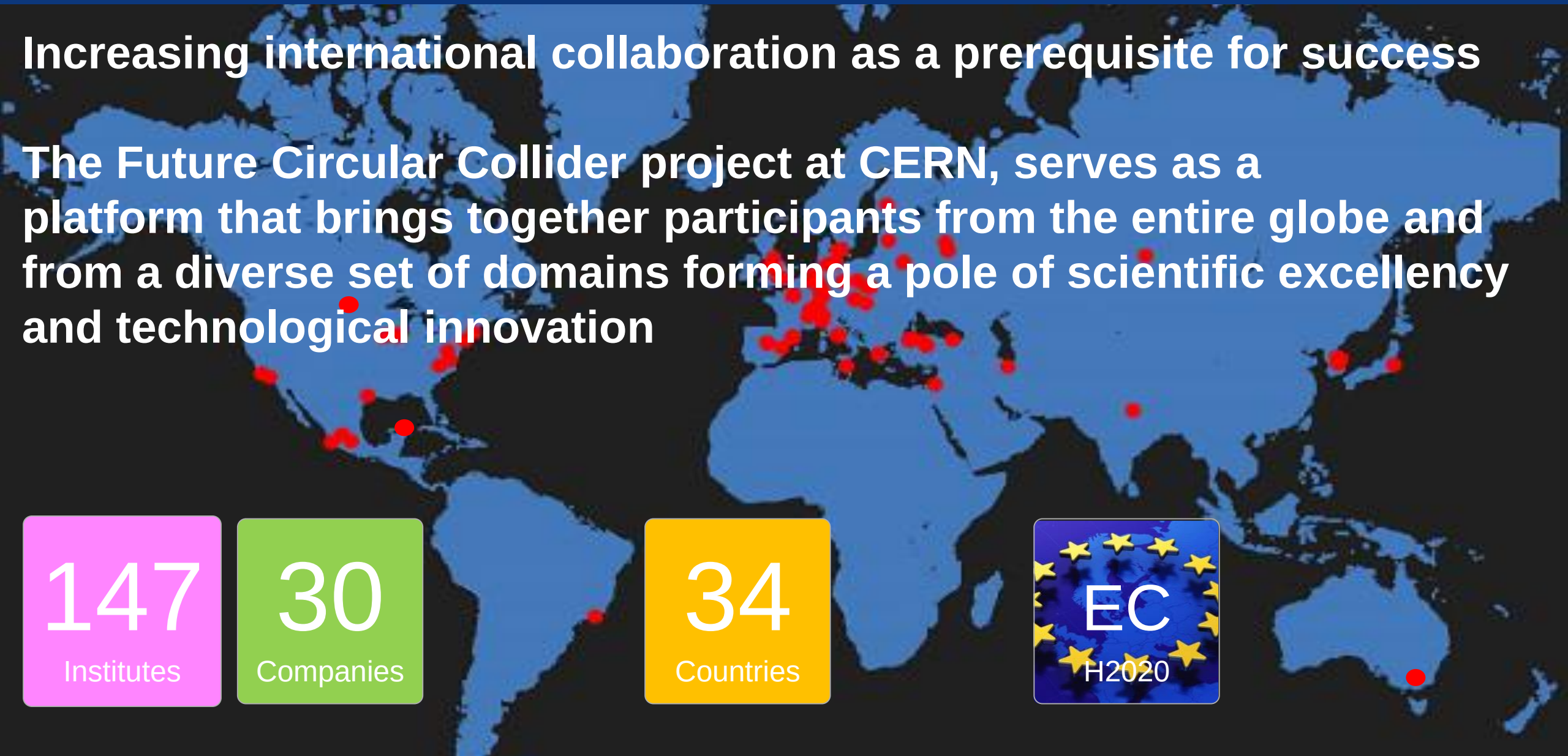
Status of Global FCC Collaboration

Increasing international collaboration as a prerequisite for success

The Future Circular Collider project at CERN, serves as a platform that brings together participants from the entire globe and from a diverse set of domains forming a pole of scientific excellency and technological innovation



147 Institutes

30 Companies

34 Countries

EC H2020

Conclusions

- The European Particle Physics Strategy Update 2020 issued the request for a feasibility study of the FCC integrated programme to be delivered for the next Strategy Update, with the goal to inform about technical, territorial and financial feasibility of the FCC project and bring all elements needed to decide on a potential project.

- Sustainability and environment are key topics for the feasibility study and the H2020 FCCIS design study with the Mining the Future competition is addressing a major topic, i.e. the potential reuse of excavation material. The results of the competition and future developments in this area will play a crucial role for FCC.

- Strengthening links with science, research & development, high-tech industry and society at large will be essential to further advance and prepare the implementation of FCC as a long-term sustainable world-leading HEP research infrastructure for the 21st century.

Thank you for your attention.