
Future Circular Collider
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CERN
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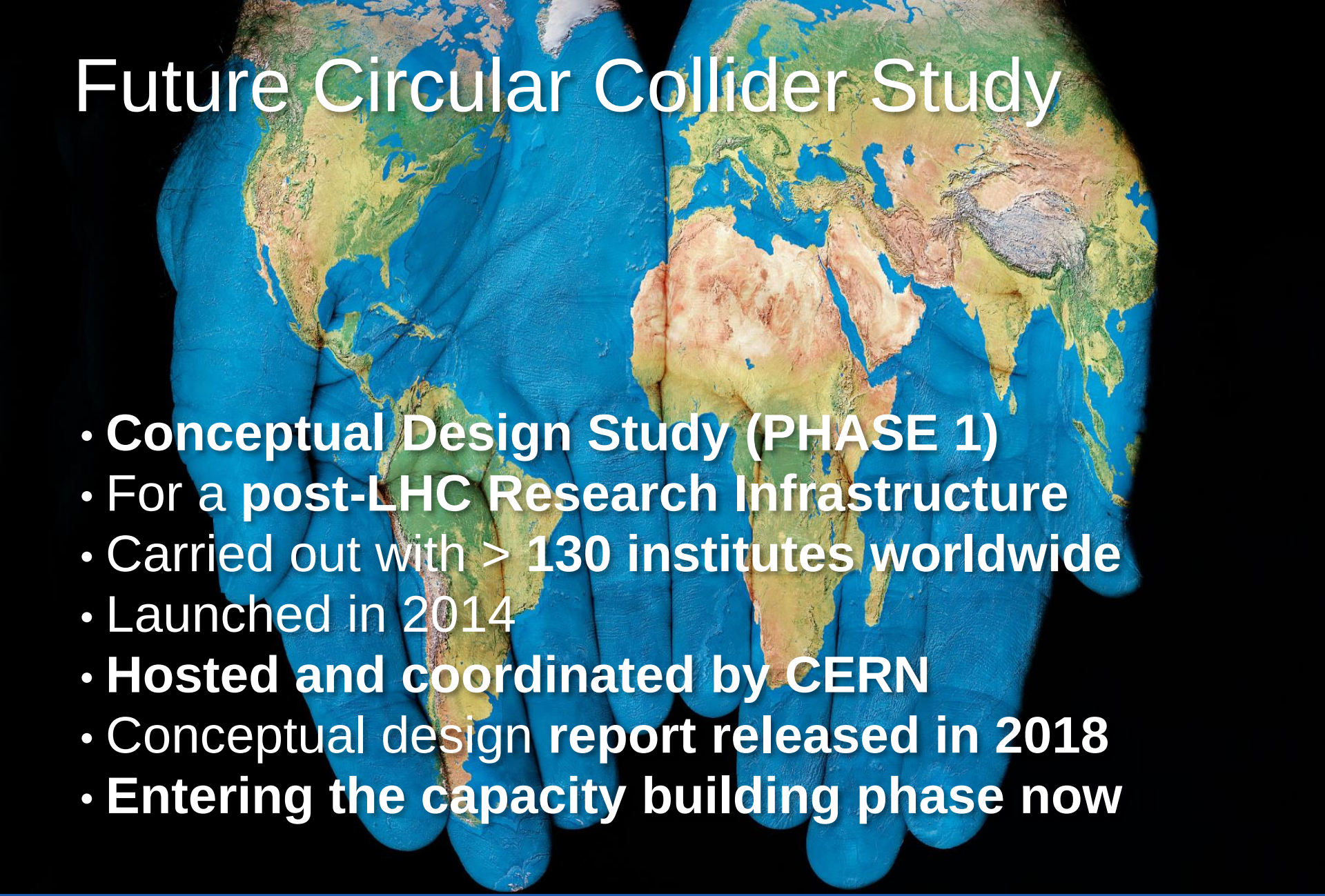
CERN
Google Earth

Future Circular Collider Study



- **Conceptual Design Study (PHASE 1)**
- For a **post-LHC Research Infrastructure**
- Carried out with > **130 institutes worldwide**
- Launched in 2014
- **Hosted and coordinated by CERN**
- Conceptual design **report released in 2018**
- **Entering the capacity building phase now**

FCC CDR and Study Documentation

- **FCC-Conceptual Design Reports:**
  - **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)**

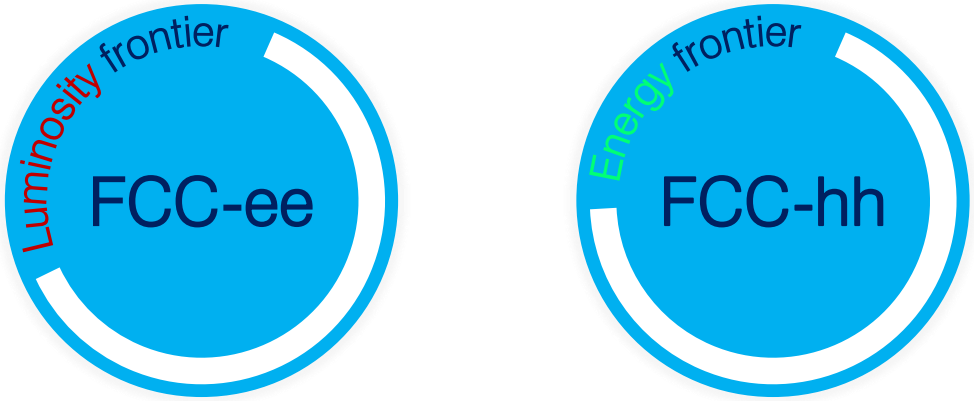
    EPJ C 79, 6 (2019) 474 , EPJ ST 228, 2 (2019) 261-623 ,

    EPJ ST 228, 4 (2019) 755-1107 , EPJ ST 228, 5 (2019) 1109-1382

- **Summary documents provided to EPPSU SG**
  - **FCC-integral, FCC-ee, FCC-hh, HE-LHC**
  - Accessible on http://fcc-cdr.web.cern.ch/

The Vision

FCC defines a **science mission** that lasts up to the end of the 21st century to address questions that cannot be answered by the Standard Model of Particle Physics today.



Two **complementary particle colliders** with **multiple interaction points** in a 100 km long, circular tunnel with **re-usable infrastructure**.

ESPPU 2020

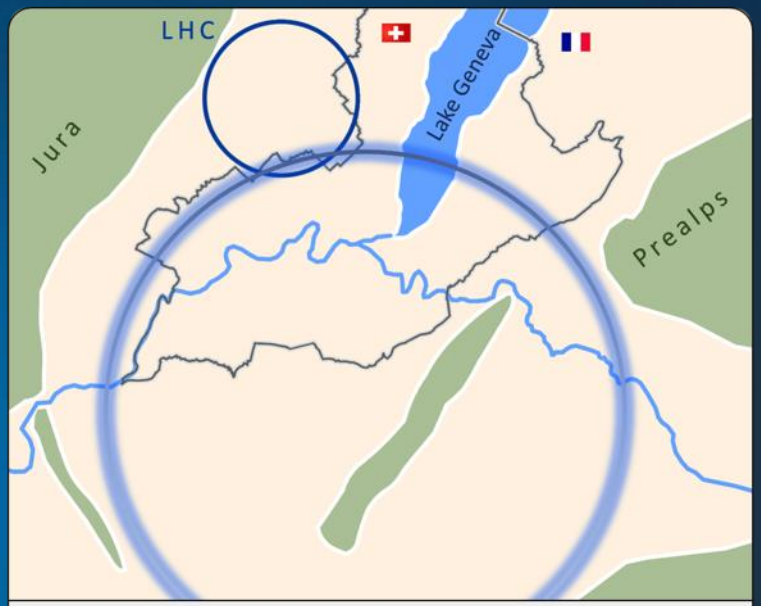
Core sentence and main request "order of the further FCC study":

"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. Such a feasibility study of the colliders and related infrastructure should be established as a global endeavour and be completed on the timescale of the next Strategy update."

Scope of the Study

- **e^+e^-** collider (FCC-ee)
  - First step at 90 – 350 GeV
  - **Extreme luminosities (5 x 10^{36})**
- **pp** collider (FCC-hh)

  The most demanding machine, which defines the infrastructure requirements
  - **100 TeV** collision energy
  - **100 km** circumference



Schematic of an 80 – 100 km long tunnel

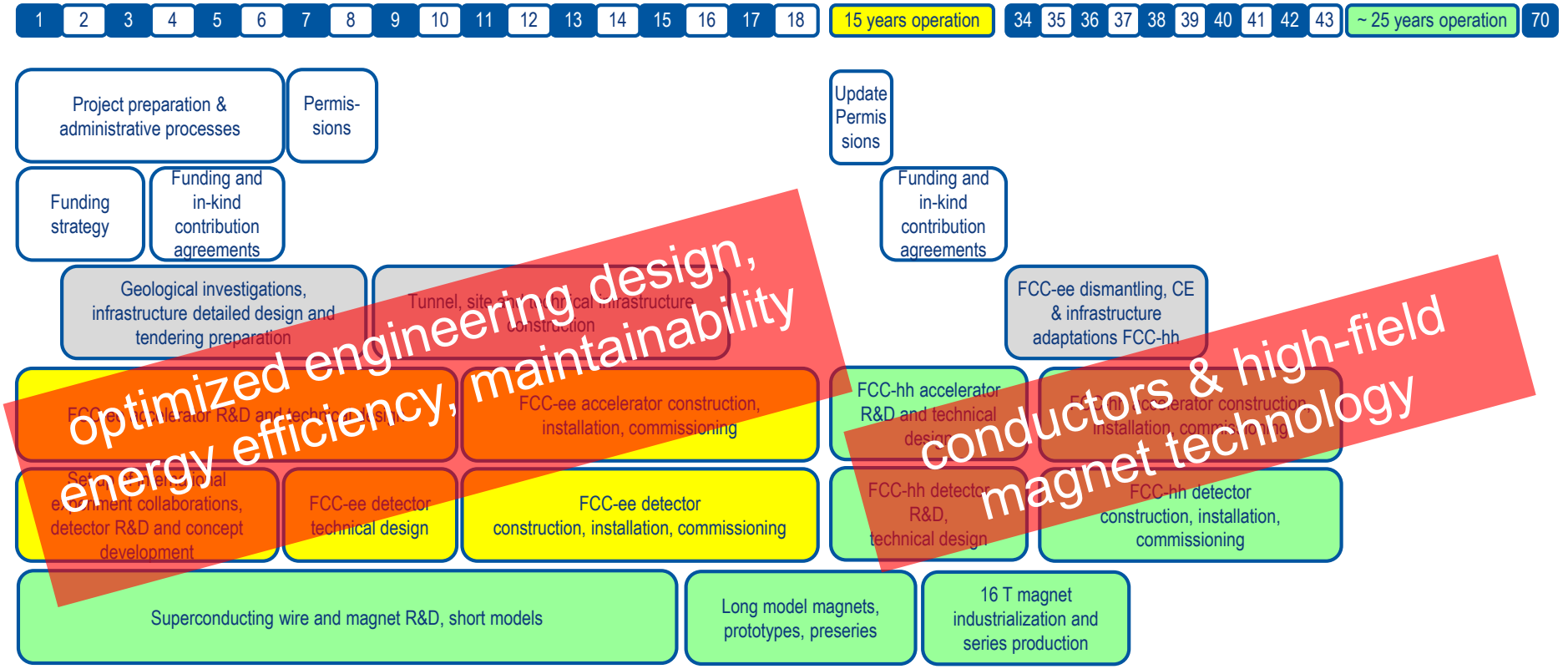
Leverage existing infrastructures at CERN, know-how, successful framework to manage a large-scale science project at global scale.

Capital of trust among international partners coming from different cultures and being governed by different administrative systems.

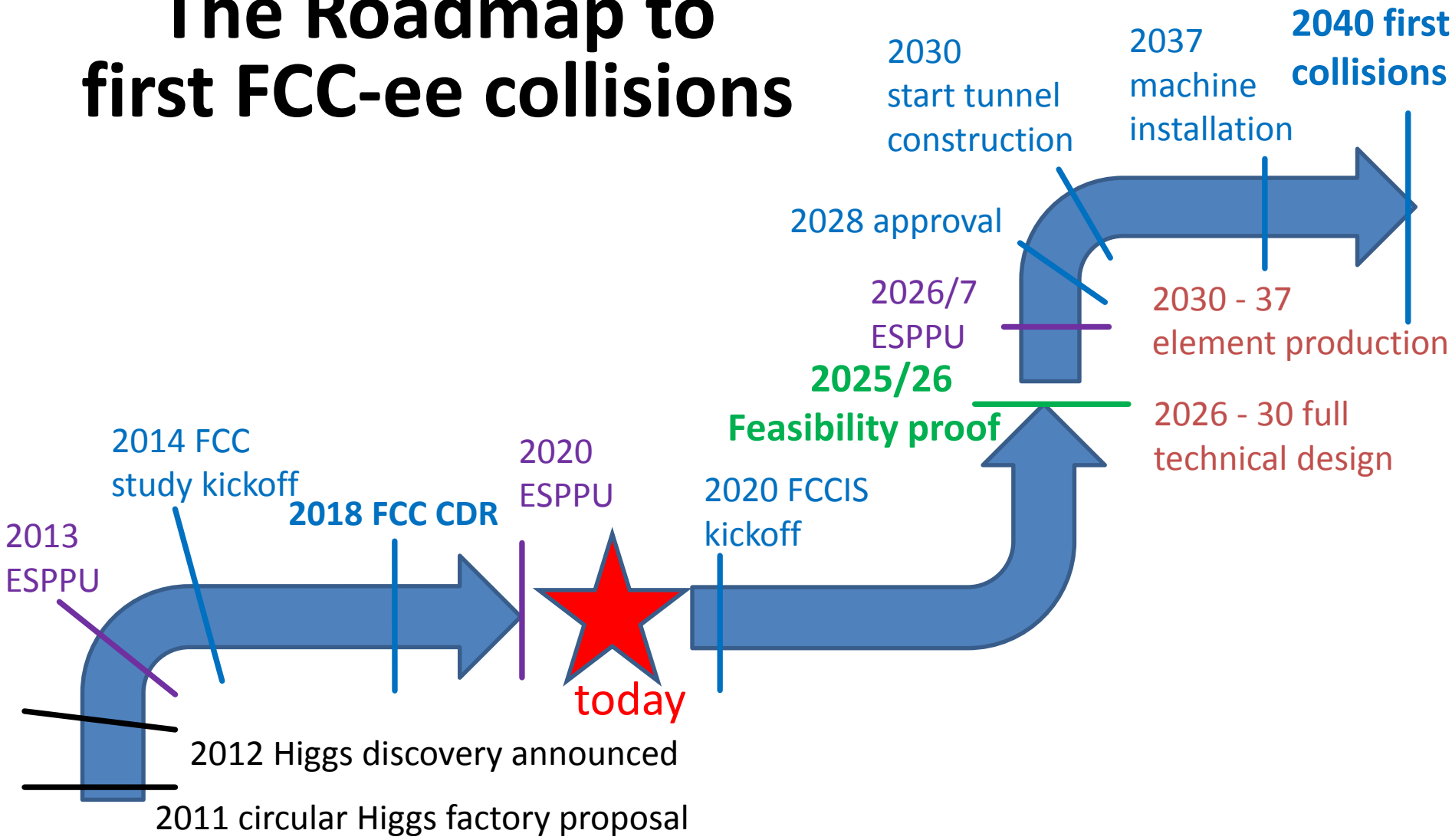
Engage **CERN as the cohesion-building entity and to promote the project** on behalf of an international collaboration.

The Plan

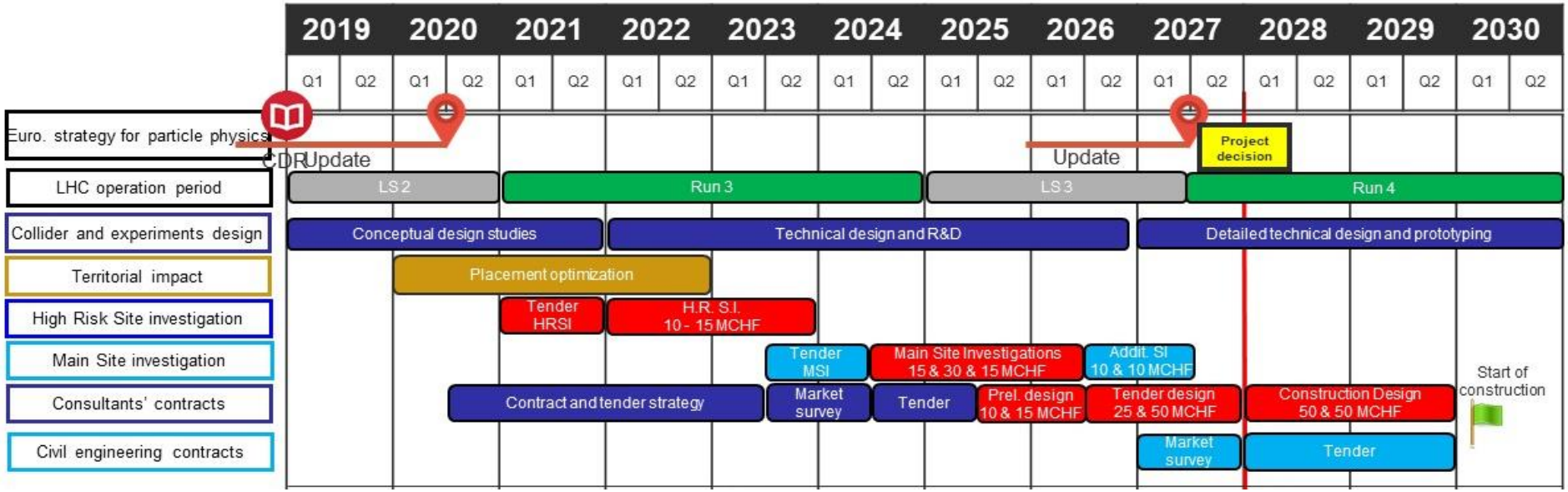
A mission of that scale and duration requires an early preparation to ensure a sustainable plan for construction and operation. **2021-2028** is the vital phase to **build up a user community** and a committed collaboration of **topically complementary partners from academia and industry for design and R&D**.



The Roadmap to first FCC-ee collisions



CE preparatory activities 2020 - 2030



- **Schedule of major processes leading to start of construction begin 2030.**
- **For proof of principle feasibility: High risk site investigations n 2022/23.**
- **Followed by main site investigations and CE planning contracts.**
- **Accompanying activities related to project preparation with host states such as environmental evaluation, preparation of "debat public", etc.**

Smart Specialisation Strategy

Innovation Value Chain

- **FCC implements the EU policy of smart specialization aiming at enhancing regional knowledge generation and diffusion to economy and society**
- Build up a committed network of geographically balanced and topically complementary public-private R&D&I poles, promoting regional innovation value chains for R&D of FCC key enabling technologies
- CERN focuses on accelerator design, user community capacity building, setting up the project organisation and catalyzing the cooperation of technology partners.
- Preparation of large-scale industrial involvement via collaboration with local – regional scientific partners as research institutes and universities.

Key Technologies (i)

- Superconducting RF cavities
  - Thin film coating
  - Rapid, high quality, low cost forming
- Efficient RF power sources
  - High efficiency klystrons
  - Scalable solid state amplifiers
- Reliable and efficient electricity distribution
  - MVDC grids
  - Energy recovery and short term buffering
  - Cost-effective substations with minimum real-estate needs
- Waste heat recovery, storage and re-use

Key Technologies (ii)

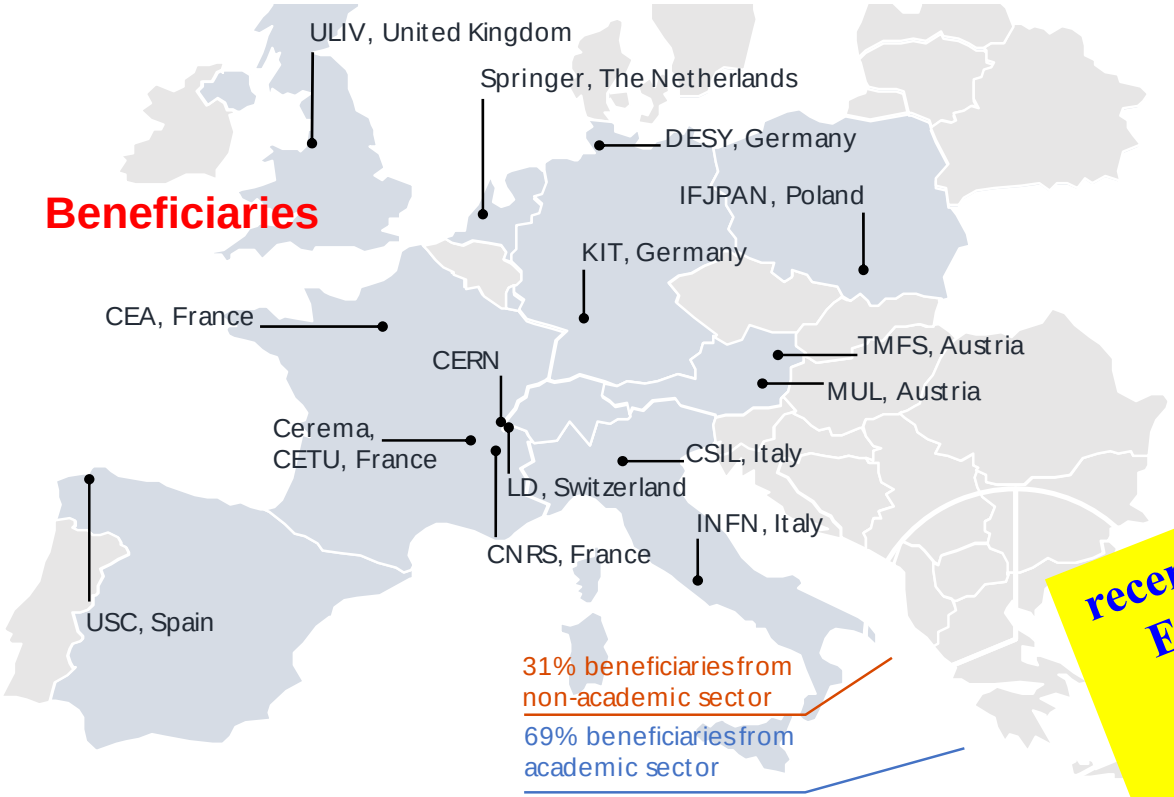
- Resource efficient cooling
  - Closed loop cooling systems
  - Water use and maintenance reduction
  - Heat storage
- Excavation materials re-use
  - Molasse materials applications within project and outside project
  - Cost-efficient pollutant separation (hydrocarbures, heavy metals)
  - Excavation materials status accounting, tracking and tracing
- Cost-effective, energy efficient and modular architecture
  - Industrial buildings that are integrated with the landscape, energy efficient, cost efficient and modular
- Cost effective tunnelling
  - Alternative inner lining construction (e.g. fibre based)
  - Alternative shaft construction technologies
  - TBM “plants” (look-ahead, adjust, bore, analyse, separate, pre-process, transfer)

Our DNA

Advance technologies together **with partners** involved in industrial R&D so that **FCC** can be **built and operated in a sustainable way** and **economic benefits** are created in the regions participating in the project.

H2020 DS FCC Innovation Study 2020-24

Beneficiaries



Partners

- D.R.R.T. (F)
- Etat de Geneve (CH)
- DOE (US)
- BINP (Ru)
- U Oxford (UK)

recently accepted for funding by the European Commission with the highest achievable score Kick-off meeting 9-13 November

Design optimisation, construction planning, environmental impact assessment, management of excavation materials, user community building and public engagement, socio-economic impact,…

Worldwide Collaboration

Summary and Outlook

- **1st phase** of FCC design study **completed** → **baseline machine designs,** performance matching physics requirements, in **4 CDRs**
- **Integrated FCC programme** submitted to the European Strategy Update 2019/20 → **request for feasibility study**
- **Next steps: concrete local/regional implementation scenario** in collaboration with host state authorities, accompanied by machine optimization, physics studies and technology R&D, supported by **EC H2020 Design Study FCCIS**
- Long term goal: a **world-leading HEP infrastructure for the 21st century** to push the particle physics **precision and energy frontiers** far