

The FCC Feasibility Study and Global Collaboration

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<http://cern.ch/fcc>

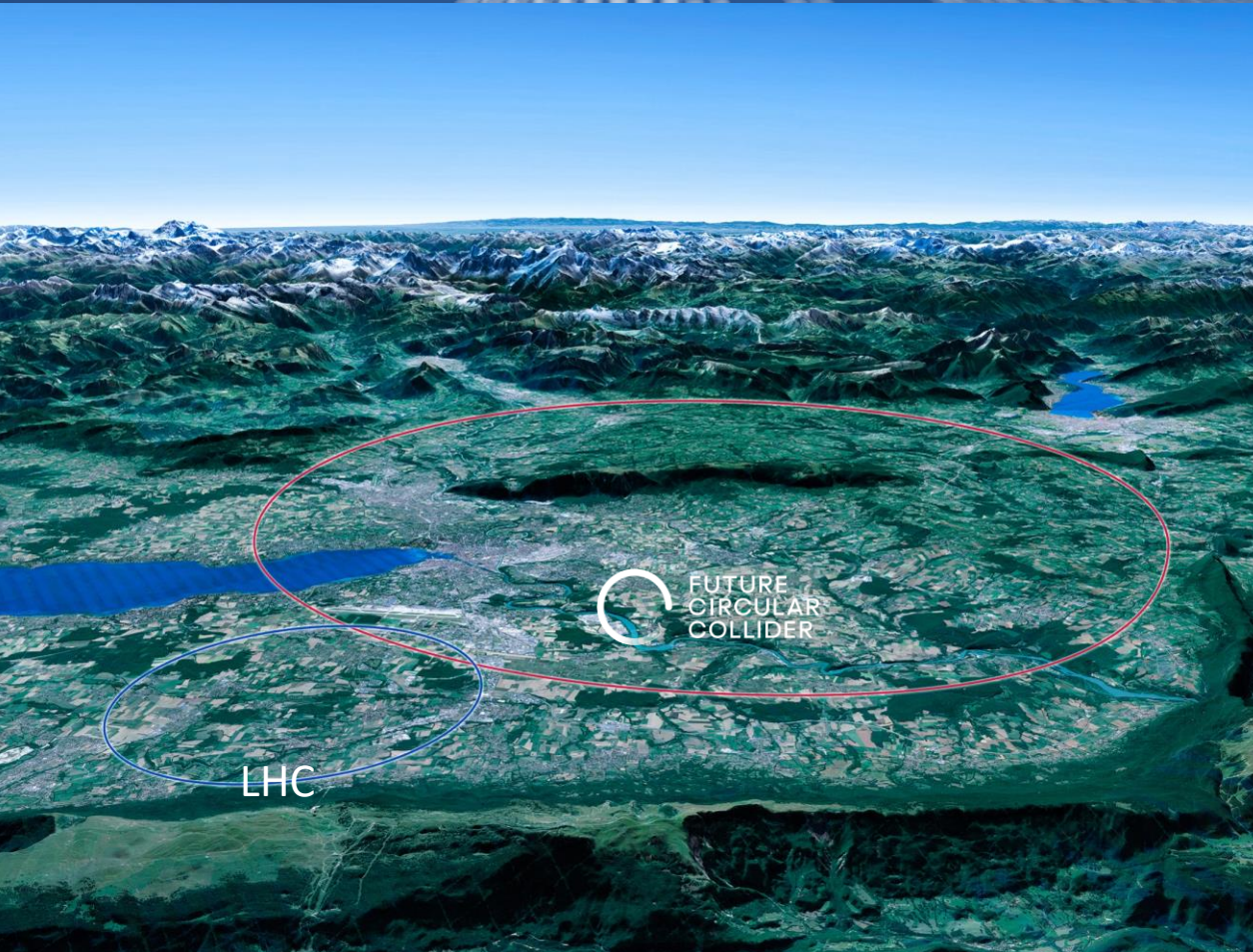
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Photo: J. Wenninger

The Future Circular Collider

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**.

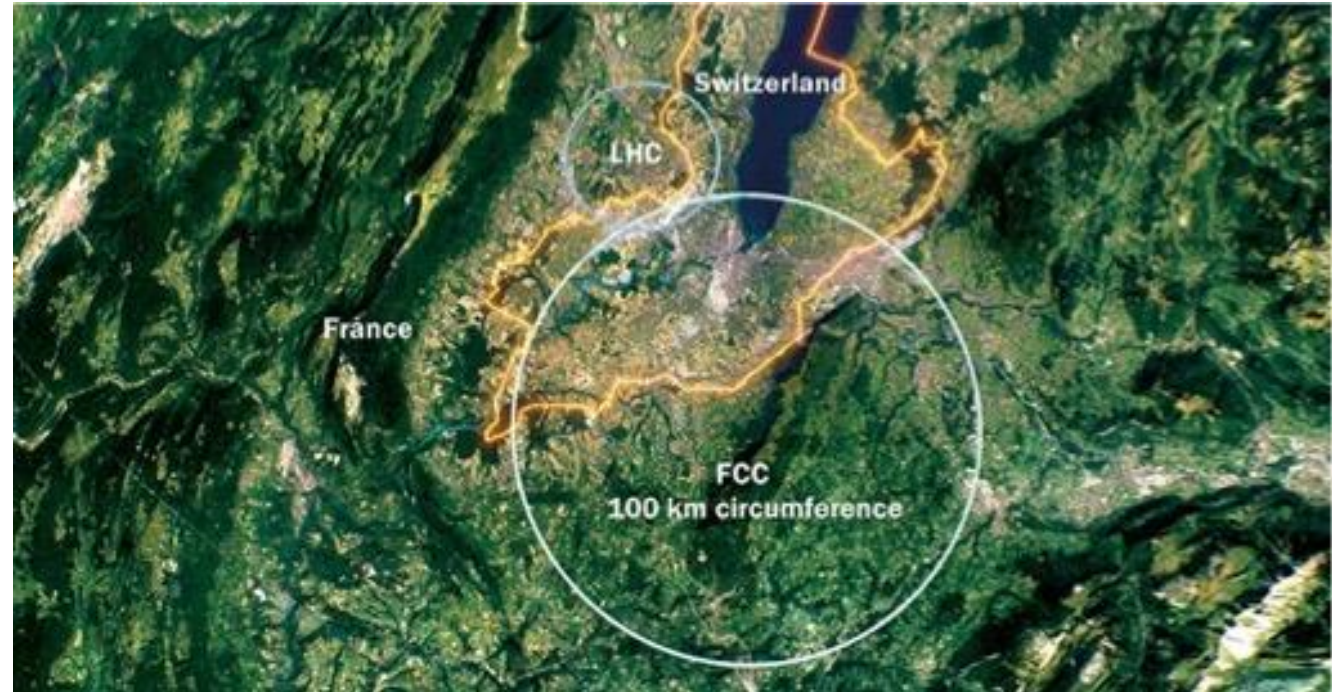


Future Circular Collider Study

Phase-1 started in 2014 Leading to CDR

International FCC collaboration
(CERN as host lab) to study:

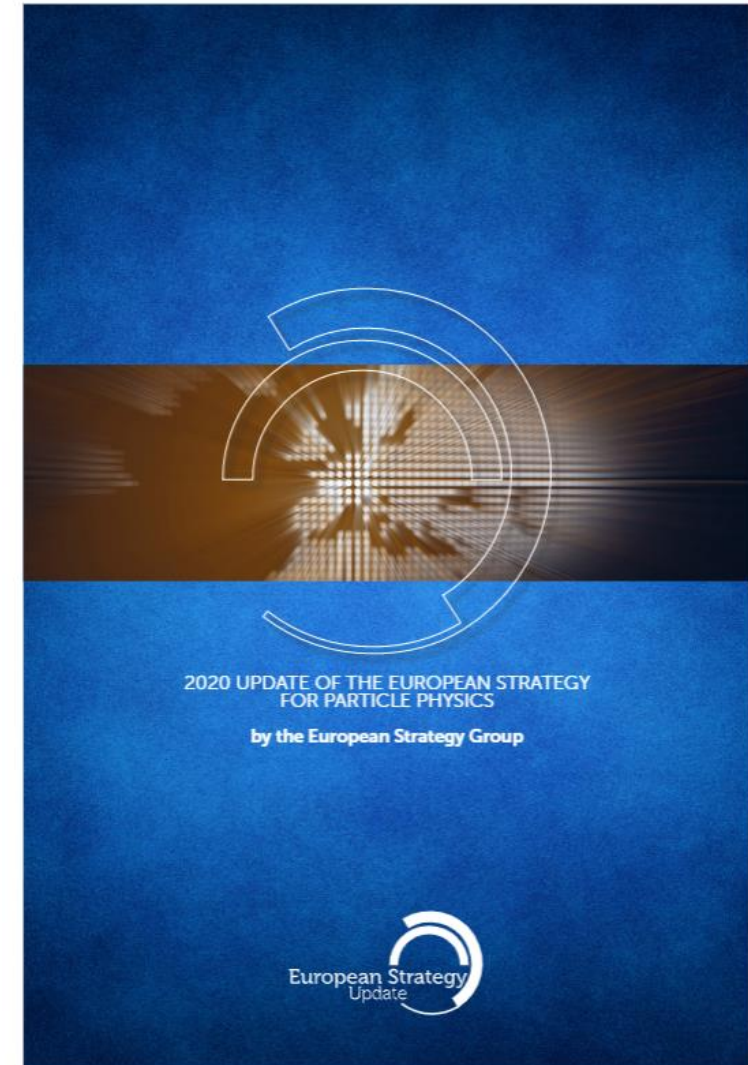
- **proton-proton collider (FCC-hh)**
 - defines infrastructure requirements
 - **80-100 km infrastructure** in Geneva area
 - ~16 T \Rightarrow 100 TeV pp in 100 km
- **electron-positron collider (FCC-ee)** as first step
- **proton-electron (FCC-he)** option



Phase-2 - FCC Feasibility Study

- **FCC Feasibility Study (FS)** will address a recommendation of the 2020 update of the European Strategy for Particle Physics (ESPP):
- “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.”

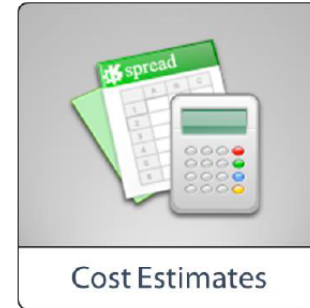
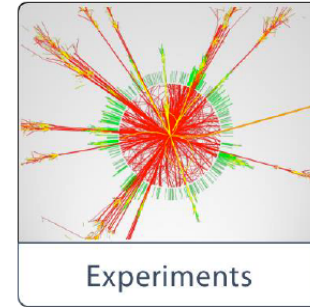
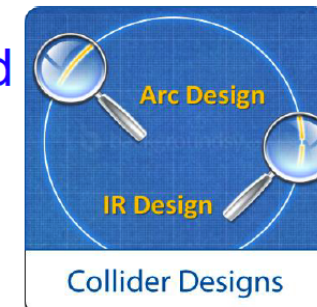
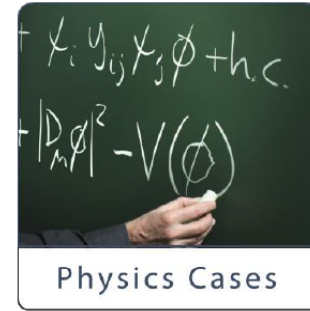
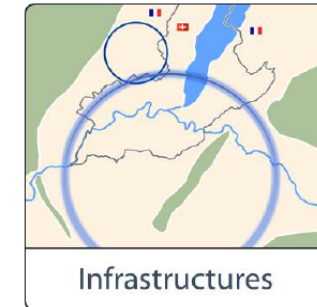
→ **Complete Feasibility Study by end 2025**



High-level Goals of Feasibility Study

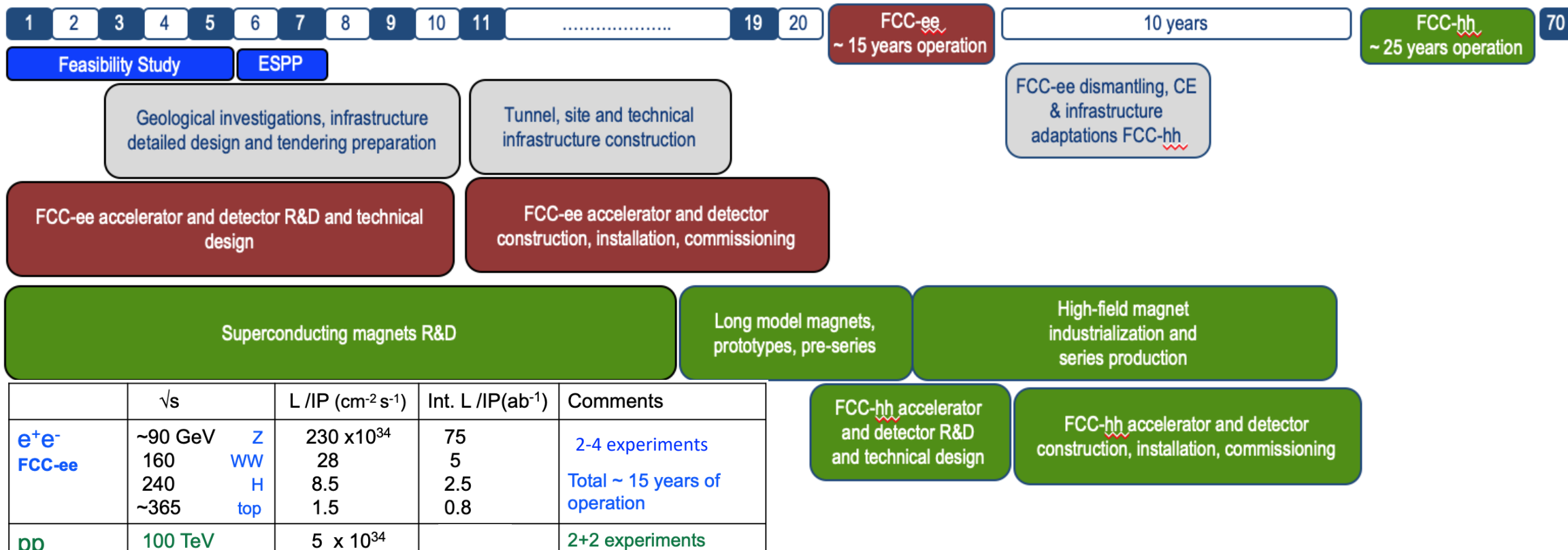
High-level goals of Feasibility Study

- optimisation of placement and layout of the ring and related infrastructure, and demonstration of the geological, technical, environmental and administrative feasibility of the tunnel and surface areas;
- pursuit, together with the Host States, of the preparatory administrative processes required for a potential project approval, with a focus on identifying and surmounting possible showstoppers;
- optimisation of the design of the colliders and their injector chains, supported by targeted R&D to develop the needed key technologies;
- development and documentation of the main components of the technical infrastructure;
- elaboration of a sustainable operational model for the colliders and experiments in terms of human and financial resource needs, environmental aspects and energy efficiency;
- identification of substantial resources from outside CERN's budget for the implementation of the first stage of a possible future project;
- consolidation of the physics case and detector concepts for both colliders.



Timeline of the FCC Integrated Programme

Technical
schedule



	\sqrt{s}	L /IP (cm ⁻² s ⁻¹)	Int. L /IP(ab ⁻¹)	Comments
e⁺e⁻ FCC-ee	~90 GeV 160 240 ~365	230 x 10 ³⁴ 28 8.5 1.5	75 5 2.5 0.8	2-4 experiments Total ~ 15 years of operation
pp FCC-hh	100 TeV	5 x 10 ³⁴ 30	20-30	2+2 experiments Total ~ 25 years of operation
PbPb FCC-hh	$\sqrt{s_{NN}} = 39\text{TeV}$	3 x 10 ²⁹	100 nb ⁻¹ /run	1 run = 1 month operation
ep Fcc-eh	3.5 TeV	1.5 10 ³⁴	2 ab ⁻¹	60 GeV e- from ERL Concurrent operation with pp for ~ 20 years
e-Pb Fcc-eh	$\sqrt{s_{eN}} = 2.2\text{TeV}$	0.5 10 ³⁴	1 fb ⁻¹	60 GeV e- from ERL Concurrent operation with PbPb

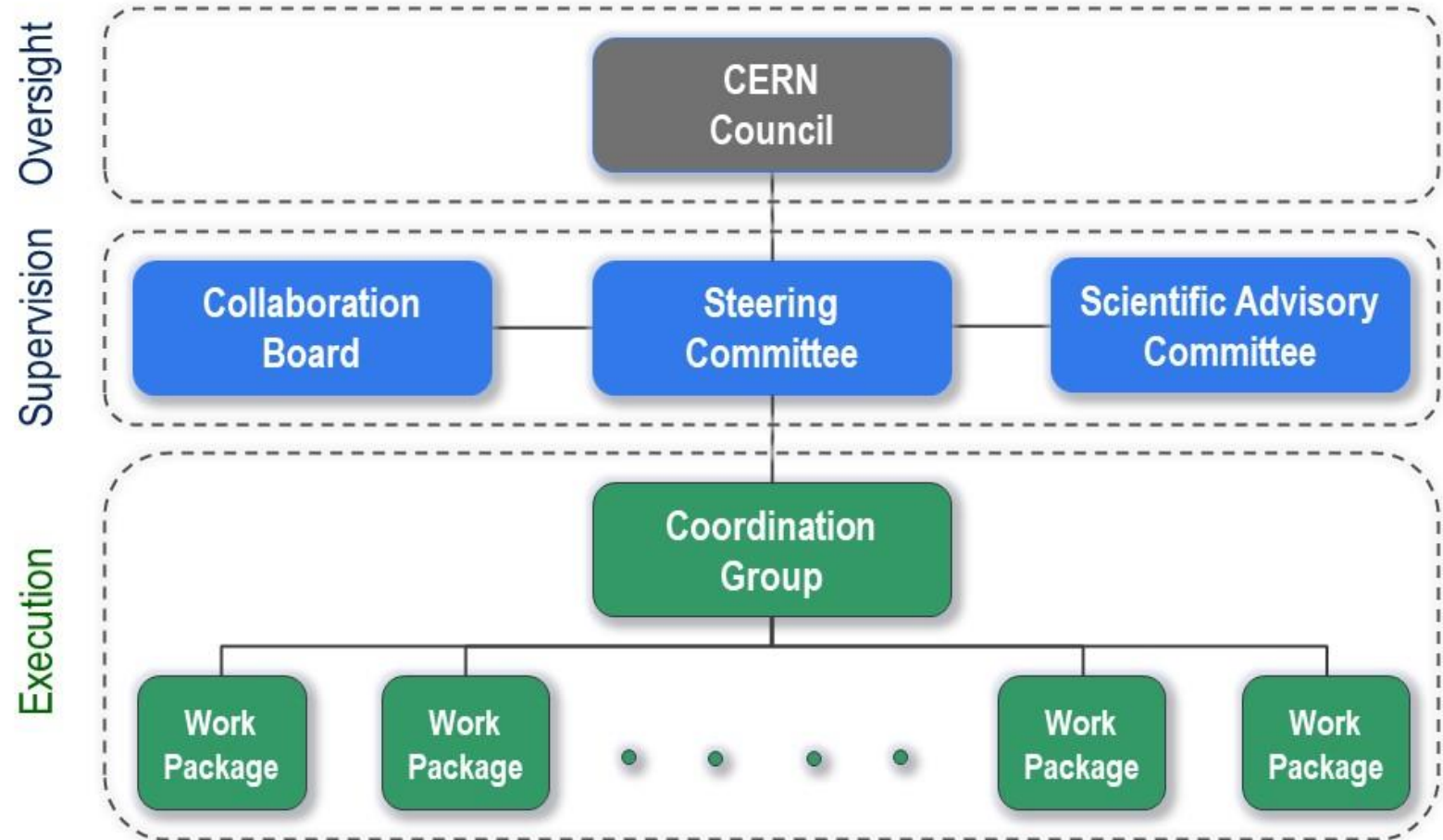


- Feasibility Study: 2021-2025
- If project approved before end of decade → construction can start beginning 2030s
- FCC-ee operation ~2045-2060
- FCC-hh operation 2070-2090++

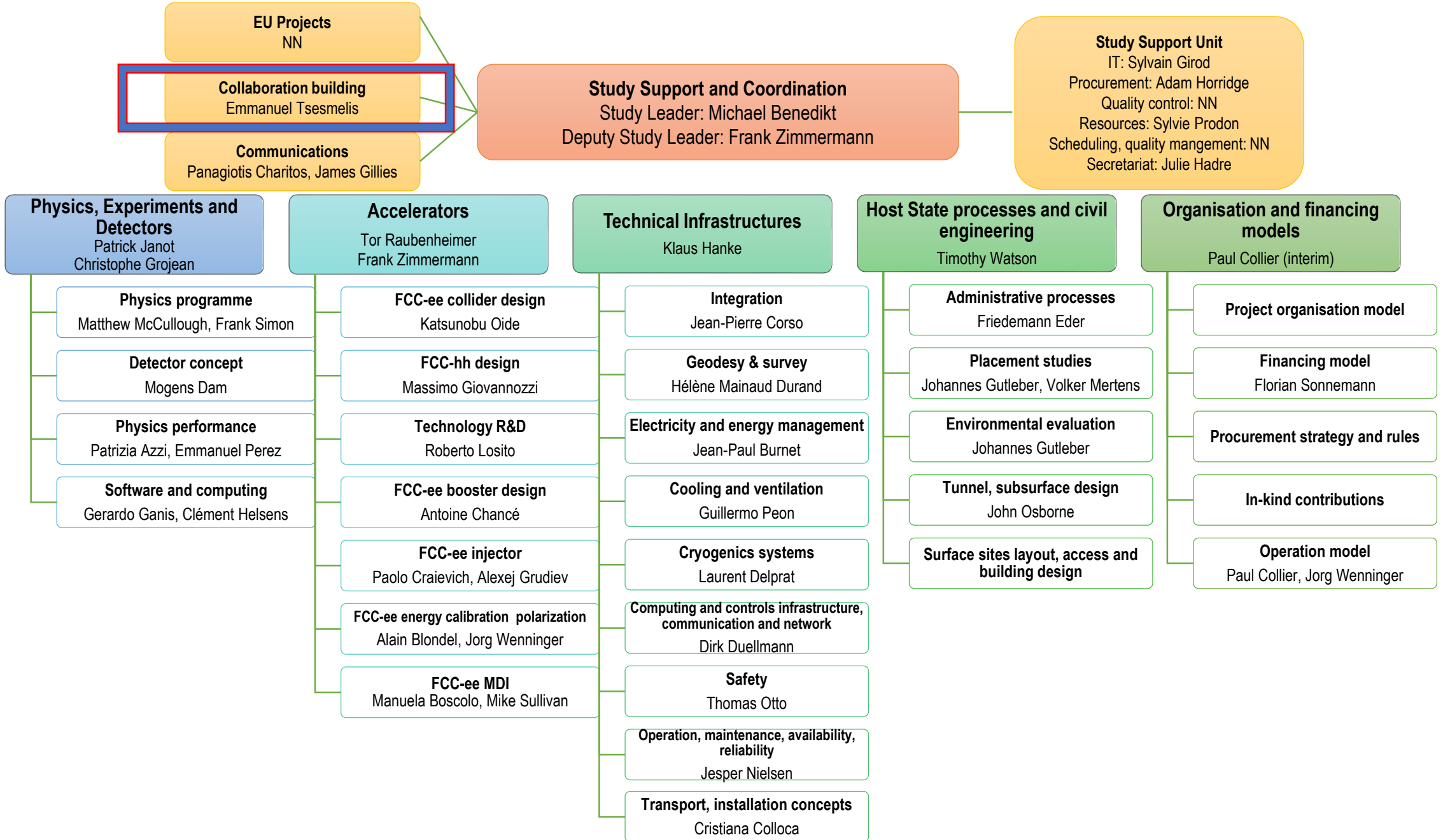
FCC Collaboration & Governance Structure

FCC Organisational Structure

- **Ownership** of the Feasibility Study by the Council.
- Effective and timely **supervision**.
- Integration of scientific and technical **advice**.
- **Participation of stakeholders** that can potentially make significant financial and technical contributions to a possible future project.
- **Execution** of Feasibility Study.



FCC Feasibility Study – Coordination Team and Contactpersons



EU Projects
NN

Collaboration building
Emmanuel Tsesmelis

Communications
Panagiotis Charitos, James Gillies

Study Support and Coordination
Study Leader: Michael Benedikt
Deputy Study Leader: Frank Zimmermann

Study Support Unit
IT: Sylvain Girod
Procurement: Adam Horridge
Quality control: NN
Resources: Sylvie Prodon
Scheduling, quality magement: NN
Secretariat: Julie Hadre

Physics, Experiments and Detectors
Patrick Janot
Christophe Grojean

Accelerators
Tor Raubenheimer
Frank Zimmermann

Technical Infrastructures
Klaus Hanke

Host State processes and civil engineering
Timothy Watson

Organisation and financing models
Paul Collier (interim)

Physics programme
Matthew McCullough, Frank Simon

Detector concept
Mogens Dam

Physics performance
Patrizia Azzi, Emmanuel Perez

Software and computing
Gerardo Ganis, Clément Helsens

FCC-ee collider design
Katsunobu Oide

FCC-hh design
Massimo Giovannozzi

Technology R&D
Roberto Losito

FCC-ee booster design
Antoine Chancé

FCC-ee injector
Paolo Craievich, Alexej Grudiev

FCC-ee energy calibration polarization
Alain Blondel, Jorg Wenninger

FCC-ee MDI
Manuela Boscolo, Mike Sullivan

Integration
Jean-Pierre Corso

Geodesy & survey
Hélène Mainaud Durand

Electricity and energy management
Jean-Paul Burnet

Cooling and ventilation
Guillermo Peon

Cryogenics systems
Laurent Delprat

Computing and controls infrastructure, communication and network
Dirk Duellmann

Safety
Thomas Otto

Operation, maintenance, availability, reliability
Jesper Nielsen

Transport, installation concepts
Cristiana Colloca

Administrative processes
Friedemann Eder

Placement studies
Johannes Gutleber, Volker Mertens

Environmental evaluation
Johannes Gutleber

Tunnel, subsurface design
John Osborne

Surface sites layout, access and building design

Project organisation model

Financing model
Florian Sonnemann

Procurement strategy and rules

In-kind contributions

Operation model
Paul Collier, Jorg Wenninger

FCC Feasibility Study Collaboration Membership



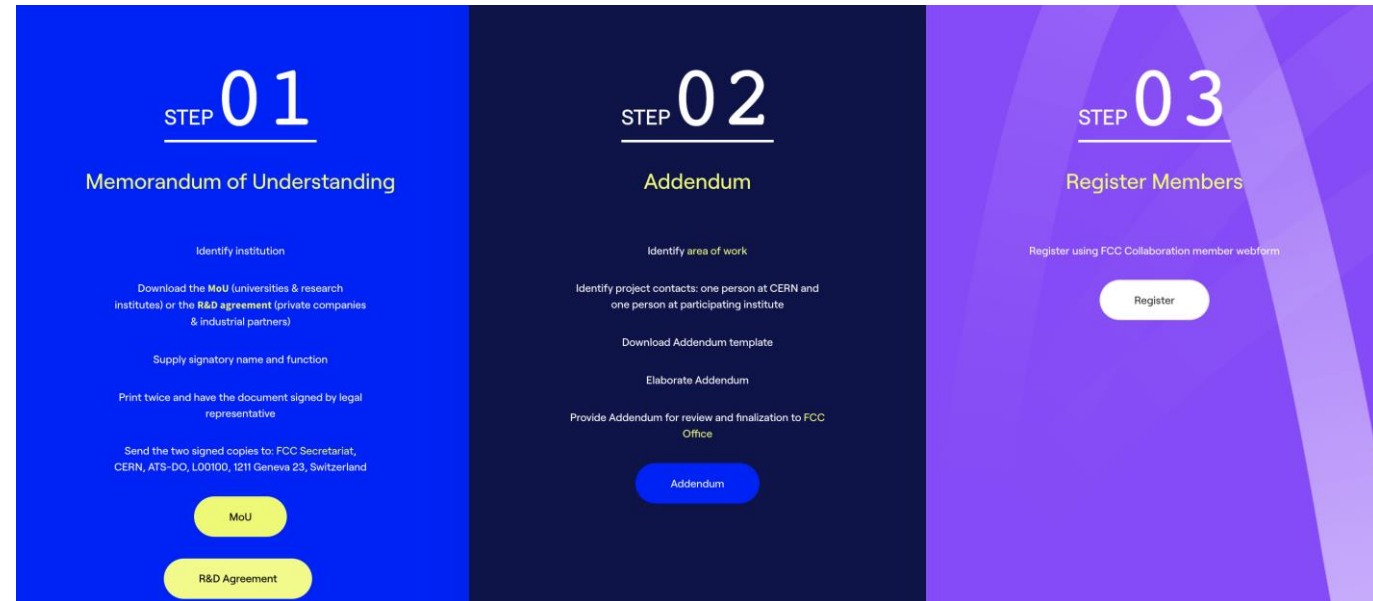
Participation in FCC through **MoU and Addenda**.



The FCC MoU for the first phase of the study has been **updated to cover the Feasibility Study**.



The current participating institutes who wish to take part in the Feasibility Study can continue to participate on the basis of the previously signed MoU until the updated MoU is signed.



The screenshot displays a three-step process for joining the FCC Collaboration Membership:

- STEP 01: Memorandum of Understanding**
 - Identify institution
 - Download the **MoU** (universities & research institutes) or the **R&D agreement** (private companies & industrial partners)
 - Supply signatory name and function
 - Print twice and have the document signed by legal representative
 - Send the two signed copies to: FCC Secretariat, CERN, ATS-DO, L00100, 1211 Geneva 23, Switzerland
 - Buttons: MoU, R&D Agreement
- STEP 02: Addendum**
 - Identify area of work
 - Identify project contacts: one person at CERN and one person at participating institute
 - Download Addendum template
 - Elaborate Addendum
 - Provide Addendum for review and finalization to FCC Office
 - Button: Addendum
- STEP 03: Register Members**
 - Register using FCC Collaboration member webform
 - Button: Register

<https://fccis.web.cern.ch/join-now>

Status of Global FCC Collaboration

Increasing international collaboration as a prerequisite for success:

links with science, research & development and **high-tech industry** will be essential to further advance and prepare the implementation of FCC

147
Institutes

30
Companies

34
Countries



From ESPP 2020: “Such a feasibility study of the colliders and related infrastructure should be established **as a global endeavour....**”

→ FCC Global Collaboration Working Group active since spring 2021

- Engage with institutes/countries/regions with **mature communities**, and the **potential to contribute substantially** to the Organization’s long-term scientific objectives, to facilitate participation in FCC FS.
- Work with national laboratories, institutes, universities and industry in MS, AMS and NMS to:
 - Encourage an **expanded membership** and explore **opportunities** for future prospective participants.
 - Explore **opportunities** for future prospective participants in defining **areas of collaboration**.
 - Prepare the foundations for research and contributions by **industry**.
 - Liaise with **national contact persons** and **forums**.

lets**COLLABORATE!**



Continue the **two-sided approach** from the **FGC Working Group** and from the **FCC-Physics, Experiment & Detectors Informal Forum of National Contacts** to strengthen global FCC collaboration.

FCC WEEK

2023

5 – 9 June

STAY
TUNED



Status and Outlook

- **First phase** of FCC design study **completed**
 - **Baseline machine designs** with performance matching physics requirements
 - Documented in **4 CDRs**
- **Integrated FCC programme** submitted to the European Strategy Update (2019/2020)
 - Request for **feasibility study** as basis for project **decision by 2026/2027**.
- Next step – prove **feasibility by 2025/2026**:
 - Concrete local/regional **implementation scenarios** in collaboration with Host State authorities.
 - Accompanied by **machine optimisation**, **physics studies** and **technology R&D**
 - Performed via **global collaboration** and supported by **EC H2020 Design Study FCC-IS**
- Long-term goal: **world-leading research infrastructure for the 21st century** to push the particle-physics precision and energy frontiers well beyond present limits.

Success of FCC relies on strong global participation in all domains.

The FCC looks forward to strengthen the collaboration with global partners.

