The FCC Feasibility Study and Global Collaboration

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1st Joint CERN-Estonia Liaison Committee Meeting
10 March 2022

Work supported by the European Commission under the HORIZON 2020 projects EuroCirCol, grant agreement 654305; EASITrain, grant agreement no. 764879; ARIES, grant agreement 730871; FCCIS, grant agreement 951754, and E-JADE, contract no. 645479

http://cern.ch/fcc

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

- **proton-proton collider** (**FCC-hh**)
  - defines infrastructure requirements
  - **80-100 km infrastructure** in Geneva area
    - \( \sim 16 \text{ T} \Rightarrow 100 \text{ TeV } pp \text{ in } 100 \text{ km} \)

- **electron-positron collider** (**FCC-ee**) as first step

- **proton-electron** (**FCC-he**) option
• 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

**F. Gianotti**

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Type</th>
<th>Energy</th>
<th>L (cm² s⁻¹)</th>
<th>Int. L (ab⁻¹)</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>e⁺e⁻ FCC-ee</td>
<td>160</td>
<td>230 x 10³⁴</td>
<td>75</td>
<td>2-4 experiments Total ~ 15 years of operation</td>
<td></td>
</tr>
<tr>
<td>~365</td>
<td>28</td>
<td>5</td>
<td>20-30</td>
<td>2+2 experiments Total ~ 25 years of operation</td>
<td></td>
</tr>
<tr>
<td>pp FCC-hh</td>
<td>100 TeV</td>
<td>5 x 10³⁴</td>
<td>70</td>
<td>1 run = 1 month operation</td>
<td></td>
</tr>
<tr>
<td>PbPb FCC-hh</td>
<td>39 TeV</td>
<td>3 x 10²⁹</td>
<td>100 nb⁻¹/run</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ep FCC-eh</td>
<td>3.5 TeV</td>
<td>1.5 x 10³⁴</td>
<td>2 ab⁻¹</td>
<td>60 GeV e⁻ from ERL Concurrent operation with pp for ~ 20 years</td>
<td></td>
</tr>
<tr>
<td>e⁻Pb FCC-eh</td>
<td>2.2 TeV</td>
<td>0.5 x 10³⁴</td>
<td>1 fb⁻¹</td>
<td>60 GeV e⁻ from ERL Concurrent operation with PbPb</td>
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</tr>
</tbody>
</table>

### Technical Schedule

- **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 Collaboration Membership

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

The FCC MoU for the first phase of the study is being **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.

[https://fccis.web.cern.ch/join-now](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.
FCC Global Collaboration Working Group

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.

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 Engagement Meeting with Estonia – 2 March 2022

- Interested entities from Estonia
  - National Institute for Chemical Physics and Biophysics
  - Tallinn University of Technology
  - University of Tartu
  - GScan (industry)
  - NPM Silmet (industry)
  - Testonica (industry)
FCC Week 2022

- Paris, 30 May - 3 June 2022

We are looking forward to seeing all collaborators there!
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.**