CERN/SPC/XXX
CERN/XXX
Original: English
XX XXX 2022

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Action to be taken		*Voting Procedure*
For information	**RESTRICTED COUNCIL** XXrd Session **XX XXX 2022**	-

FUTURE CIRCULAR COLLIDER FEASIBILITY STUDY:

PLAN FOR MID-TERM REVIEW 2023

The Future Circular Collider Feasibility Study was launched in 2021. This document describes the structure and contents of the mid-term review that is proposed for autumn 2023.

FUTURE CIRCULAR COLLIDER FEASIBILITY STUDY:

PLAN FOR MID-TERM REVIEW 2023

I. INTRODUCTION

Following the recommendations of the European Strategy for Particle Physics, updated by the CERN Council in June 2020, the Future Circular Collider (FCC) Feasibility Study focuses on investigating *"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."* (CERN/3493/C/Rev.). The organisational structure of the Feasibility Study is described in CERN/3566/RA/Rev. Its main deliverables and milestones are detailed in CERN/3588. The conclusions of this study are foreseen to be delivered in the form of a Feasibility Study Report by the end of 2025.

According to Council document CERN/3588, a committee, including external experts, will be established to review the cost of the first-stage project (the tunnel and the FCC-ee collider) by mid-2023. A second cost review will take place at the end of the Feasibility Study in 2025. The document CERN/3588 also proposes a mid-term review of the Feasibility Study in 2023.

Combining the 2023 mid-term review with the intermediate cost review was proposed by CERN management and confirmed by CERN Council. Objectives for the mid-term review include monitoring of the progress of the FCC Feasibility Study (FS), and an anticipation of the study evolution towards the next European Strategy Update. The proposed date for the mid-term review is autumn 2023.

II. MAIN GOALS OF THE FCC FEASIBILITY STUDY UPTO 2023

According to CERN/3588 the high-level objectives through to 2023 are as follows.

- **Feasibility of the tunnel and the surface infrastructures:**
    - down-selection of the number of placement options, identification of the preferred implementation variant(s) and full documentation of the conclusions by mid-2022;

- identification of the high-risk areas for the preferred placement and preparation of the site investigation contracts by end 2022.

- **Accelerators, technical infrastructure, and civil engineering:**
  - review of the design presented in the Conceptual Design Report, based on the preferred implementation variant(s), and update of the specifications and requirements by end-2022;
  - general coherence review (technical, operation concepts, cost update, etc.) across all three domains for mid-2023.
- **Financial feasibility:**
  - the development, by end-2021, of a preliminary spending profile as a function of time, and the corresponding funding needs, assuming a construction start in the early 2030s;
  - preliminary discussions with the main stakeholders by end-2023.

The figure in Annex I shows the main deliverables of the Feasibility Study and their timelines, as shown in document CERN/3588. Highlighted by the red box are the elements expected to be ready for review in autumn 2023.

It is proposed to organize the mid-term review in two parts: (1) review of the project proposal, and (2) review of feasibility, schedule and cost estimates for the tunnel construction and the first stage. This is further detailed below.

III. PREPARATION FOR MID-TERM REVIEW

The proposed implementation variant and the corresponding layout, both defined in 2021, are the basis for the ongoing work in the Feasibility Study towards the mid-term review. Confirmation of the viability of the preferred implementation variant is a primary goal.

The progress on territorial, administrative, communication and dialogue, and environmental aspects will depend strongly on coordination and interaction with the Host States.

The work on accelerators, technical infrastructures and civil engineering is based on the Conceptual Design with the goal to derive, mainly via scaling, a coherent scenario adapted to the new layout and implementation.

The cost update will then be performed for this new scenario.

The results of both the combined mid-term review and cost review should indicate the main directions and areas of attention for the second part of the Feasibility Study.

IV. MID-TERM REVIEW PART 1: REVIEW OF PROJECT PROPOSAL

The project proposal includes the optimized low-risk placement, refined layout of both collider options, parameters, main components, and overall homogeneity.

- **Placement**
  - Preferred placement and progress on implementation activities with host states
  - Updated civil engineering design
  - Status of preparations for site investigations
  - Dialogue with regional and local stakeholders

- **Parameters**
  - Performance targets, beam dynamics constraints
  - Adapted designs for both FCC-ee and FCC-hh for the preferred placement (parameters, optics, assignment of straight sections, specific designs, etc.)
  - Overall FCC-ee layout with injector and injection line(s), pre-injector complex
  - Comparison of the SPS as FCC-ee pre-booster with a 10-20 GeV linac (operation impact, cost, performance)
  - Overall FCC-hh layout with injection lines from LHC and SC-SPS
  - FCC-hh injection concept and injection-line integration in FCC tunnel

- **Technical Infrastructure**
  - Updated requirements on electrical network and cooling/ventilation systems
  - Scaled system designs, layouts, and concepts
  - Overall integration and resource requirements (grid connections, power lines and overall ratings, water flow requirements and water resources in/out)

- **Main accelerator components**
  - FCC-ee
    - Arc integration concept and plans for arc-cell mock-up
    - RF baseline, R&D status, system integration
    - Key technologies and status of technology R&D program
  - FCC-hh
    - Outline of HFM R&D status and plan (N.B. R&D programme factored out from FCC feasibility study)

- **Physics, experiments, and detectors for FCC-ee**
    - Operation sequence: staged increase in energy via Z, W, ZH, $t\bar{t}$ production compared with a start at ZH, and the impact on accelerator, cost, manpower, and schedule.

- **Environmental impact, socio-economic impact**
    - Status of studies and activities on environmental initial state analysis, construction feasibility, excavation material management, etc.
    - Status of socio-economic impact and sustainability studies.

V. MID-TERM REVIEW PART 2: FEASIBILITY, COST AND SCHEDULE FOR STAGE 1

- **Results regarding the spatial planning requirements for the tunnel construction:**
    - Feasibility
    - Time schedule.

- **Update cost estimate and schedule**
    - Updated cost estimate for stage 1: civil engineering, technical infrastructure, FCC-ee accelerator and injectors
    - Possible timeline for the construction project
    - Updated spending profile for construction project.

- **Outline of funding model**

VI. SUMMARY

The mid-term review is proposed for autumn 2023. It consists of two parts: (1) review of the project proposal, and (2) review of feasibility, time schedule, and cost estimates for the tunnel construction and the first stage.

The Council is invited to consider and approve the proposed plan for the mid-term review of the FCC Feasibility Study presented in this document.

ANNEX I

The figure below shows the main deliverables of the Feasibility Study and their timelines from CERN/3588. Highlighted by a red box are the study items which shall conclude in 2023.

main deliverables and timelines of the FCC Feasibility Study	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
technical design work and R&D in all relevant areas																				
progress review on key technology R&D programs																				
development and documentation of implementation scenario																				
design update for preferred implementation variant																				
communications plan development and implementation																				
development of funding models and concepts																	update			
development of project organisation and operation models																	update			
CDR cost update with external review																				
general coherence review (mid-term)																				
detailed design for Feasibility Study Report																				
environmental evaluation process and impact study with host states					preparation															
high-risk areas site investigations					preparation															
project cost update with external review																				
Feasibility Study Report																				