The Status of the Global FCC Collaboration

Report from the FCC Global Collaboration Working Group

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on behalf of the FGC Working Group

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Convenor of FCC Global Collaboration Working Group

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CERN International Collaboration

Science for Peace

CERN was founded in 1954 with 12 European Member States

23 Member States

Austria – Belgium – Bulgaria – Czech Republic
Denmark – Finland – France – Germany – Greece Hungary –
Israel – Italy – Netherlands – Norway
Poland – Portugal – Romania – Serbia – Slovakia Spain –
Sweden – Switzerland – United Kingdom

3 Associate Member States
in the pre-stage to membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Latvia – Lithuania – Pakistan
Turkey – Ukraine

6 Observers

Japan – Russia (suspended) – USA
European Union – JINR (suspended) – UNESCO

CERN's annual budget is 1200 MCHF (equivalent to a medium-sized European university)

As of 31 December 2021
Employees:
2676 staff, **783** fellows

Associates:
11 175 users, **1556** others

Around 50 Cooperation Agreements
with non-Member States and Territories

Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bangladesh – Belarus – Bolivia
Bosnia and Herzegovina – Brazil – Canada – Chile – Colombia – Costa Rica – Ecuador – Egypt – Georgia – Honduras
Iceland – Iran – Jordan – Kazakhstan – Lebanon – Malta – Mexico – Mongolia – Montenegro – Morocco – Nepal
New Zealand – North Macedonia – Palestine – Paraguay – People's Republic of China – Peru – Philippines – Qatar
Republic of Korea – Saudi Arabia – Sri Lanka – South Africa – Thailand – Tunisia – United Arab Emirates – Vietnam

A laboratory for people around the world

Distribution of all CERN Users by the country of their home institutes as of 31 December 2021

Geographical & cultural diversity
Users of **110 nationalities**
19.4% women

Member States 6642

Austria 74 – **Belgium** 122 – **Bulgaria** 39 – **Czech Republic** 227 **Denmark** 42 – **Finland** 71 – **France** 811 – **Germany** 1129 **Greece** 133 – **Hungary** 69 – **Israel** 67 – **Italy** 1423
Netherlands 157 – **Norway** 69 – **Poland** 278 – **Portugal** 89 **Romania** 105 – **Serbia** 36 – **Slovakia** 66 – **Spain** 328
Sweden 88 – **Switzerland** 372 – **United Kingdom** 847

Associate Member States in the pre-stage to membership **55**

Cyprus 10 – **Estonia** 24 – **Slovenia** 21

Associate Member States **367**

Croatia 36 – **India** 130 – **Latvia** 11 – **Lithuania** 12 – **Pakistan** 30
Turkey 122 – **Ukraine** 26

Observers **2917**

Japan 189 – **Russia** (suspended) 971 – **United States of America** 1757

Non-Member States and Territories **1194**

Algeria 3 – **Argentina** 16 – **Armenia** 10 – **Australia** 20 – **Azerbaijan** 3 – **Bahrain** 2 – **Belarus** 24 – **Brazil** 106 **Canada** 189 – **Chile** 23 – **Colombia** 18 – **Cuba** 3 – **Ecuador** 6 – **Egypt** 16 – **Georgia** 36 – **Hong Kong** 17 **Iceland** 3 – **Indonesia** 6 – **Iran** 11 – **Ireland** 6 – **Jordan** 5 – **Kuwait** 5 – **Lebanon** 15 – **Madagascar** 1
Malaysia 4 – **Malta** 2 – **Mexico** 48 – **Montenegro** 5 – **Morocco** 18 – **New Zealand** 8 – **Oman** 1 – **People's Republic of China** 314 – **Peru** 2 – **Philippines** 1 – **Republic of Korea** 113 – **Singapore** 3 – **South Africa** 52
Sri Lanka 10 – **Taiwan** 45 – **Thailand** 18 – **United Arab Emirates** 6

FCC Global Collaboration Working Group

Strategic Framework (I)

- The **ESPP** update of June 2020 calls for **wider scientific & technological support** for CERN endeavours, from full exploitation of LHC to preparation of longer-term future of CERN.

- Alongside completion of HL-LHC, ESPP objectives for future projects require a **multi-tiered engagement** with government entities, as well as individual national laboratories, institutes and universities, in the **MS, AMS & NMS (including Observer States).**

Strategic Framework (II)

- The ESPP concluded the following:
  - *Particle physics community considering **several large future projects***
    - *Due to size, complexity, duration & cost, will need to be planned on **global scale**.*
  - *For new global facility hosted at CERN, **long-term commitments are needed,** taking account of construction & operating costs.*
  - *NMS might contribute to new facility at CERN in two ways:*
    - ***Becoming a CERN MS / AMS**, participating in the entirety of CERN basic programme or in a new programme of activities encompassing new facility and related infrastructure.*
    - ***Participation at project level**, implemented through long-term bilateral or multilateral agreement.*
    - ***CERN should engage now** with potential partners to explore preferred option.*

The FCC Approach to Global Collaboration

- FCC Collaboration being formed through a **global, two-way and integrative process**, while being **geographically balanced** and **topically complementary**.
- Open to **areas beyond conventional accelerator R&D** (environment & sustainability; education & training; knowledge transfer to society; & public engagement) and in areas that are **non-core activities** for CERN (geology, geodesy, logistics & materials science).
- Prepare foundations for **industrial R&D** and contributions via national laboratories, institutes and universities.
- CERN is engaging in **discussions with potential major partners** as part of the FCC Feasibility Study for such a global project being hosted at CERN.

The Example of the LHC and HL-LHC

- Successful realisation of the LHC is testament to the strong and consistent support CERN received from its **Member States & Associate Member States**.
  - CERN Council required significant support from **Non-Member States, including the Observer States,** before giving final approval to the LHC.
- Construction of any future front-line accelerator is likely to be an even more **global project** for **scientific, technical and financial reasons**.
- **Siting future accelerator at CERN** would build on the **scientific, technical, diplomatic and personal relations** established during the construction and operation of the LHC & HL-LHC and its experiments.
- CERN's **international relations** with States continue to grow, reflecting **increased globalisation** and the **uniqueness of CERN's experimental programme**, centred on the LHC & HL-LHC.

The FCC Global Collaboration Working Group

- Engage with countries with **mature communities**, a **long-standing participation** in CERN's programmes and the **potential to contribute substantially** to the Organization's long-term scientific objectives, to facilitate opportunities for national participation in the FCC Feasibility Study through:
  - **Membership or Associate Membership**, as provided by CERN's geographical enlargement policy.
  - **Long-term bilateral agreements** (MoUs and Addenda).

Mandate of Working Group (II)

- Engage with the participants - **national laboratories, institutes and universities** as well as **industry** in the MS, AMS and NMS - to carry out the following mandate:

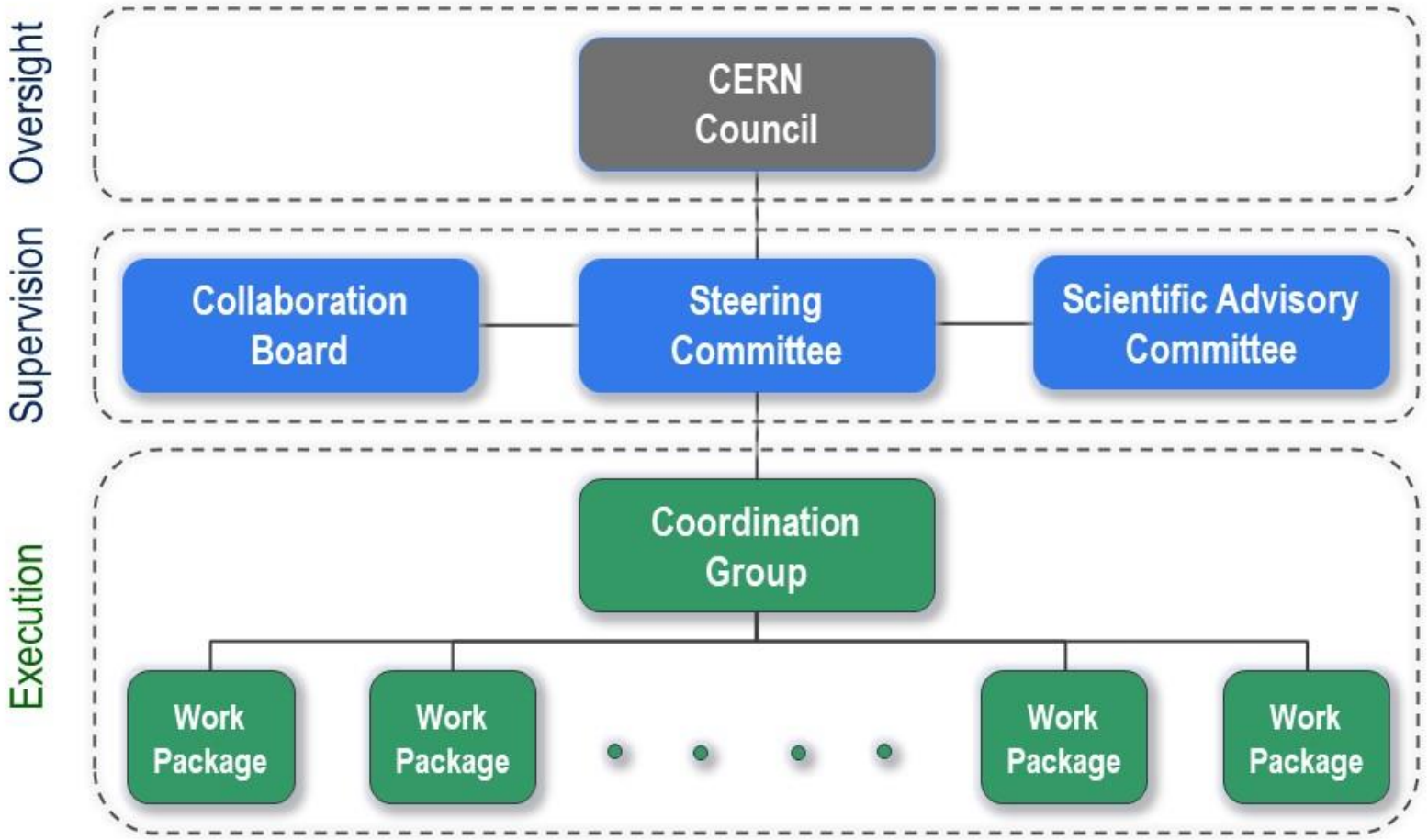
  - Encourage an **expanded membership**.
  - Explore **opportunities** for future prospective participants.
  - Support new participants in **application process**.
  - Assist the new participants in defining **areas of collaboration**.
  - Conclude relevant **agreements**.
  - Facilitate the **integration** process.
  - Facilitate interest in **CERN non-core areas** - geology, geodesy, logistics, materials science.
  - Prepare the foundations for R&D and contributions by **industry.**
  - Liaise with **national contact persons** and **forums**.

FGC Working Group Membership

- **Emmanuel Tsesmelis** (Convenor)
  CERN International Relations
- **Michael Benedikt** (CERN), **Frank Zimmermann** (CERN)
  FCC Feasibility Study Leader and Deputy
- **Alain Blondel** (IN2P3 & UNIGE), **Patrick Janot** (CERN)
  FCC PED Coordinators
- **John Ellis** (King's College London), **Panagiotis Charitos** (CERN)
  FCC Coordination Group
- **Gregorio Bernardi** (IN2P3), **Tadeusz Lesiak** (IFJ PAN), **Marcin Chrzaszcz** (IFJ PAN)
  Convenors of FCC-PED Informal Forum of National Contacts

FCC Feasibility Study 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

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 management: NN
Resources: Sylvie Prodon
Scheduling: NN
Secretariat: Julie Hadre

Physics, Experiments and Detectors
Patrick Janot, Christophe Grojean

- **Physics programme** — Matthew McCullough, Frank Simon
- **Detector concept** — Mogens Dam
- **Physics performance** — Patrizia Azzi, Emmanuel Perez
- **Software and computing** — Gerardo Ganis, Clément Helsens

Accelerators
Tor Raubenheimer
Frank Zimmermann

- **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

Technical Infrastructures
Klaus Hanke

- **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** — Pablo Saiz
- **Safety** — Thomas Otto
- **Operation, maintenance, availability, reliability** — Jesper Nielsen
- **Transport, installation concepts** — Roberto Rinaldesi

Host State processes and civil engineering
Timothy Watson

- **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** — LD opening

Organisation and financing models
Paul Collier (interim)

- **Project organisation model** — NN
- **Financing model** — Florian Sonnemann
- **Procurement strategy and rules** — NN
- **In-kind contributions** — NN
- **Operation model** — Paul Collier, Jorg Wenninger

FCC Collaboration

FUTURE CIRCULAR COLLIDER

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 Feasibility Study: 58 fully-signed existing members, 17 new members, rest in the process

147	30	34	EC
Institutes	Companies	Countries	H2020

New FCC Feasibility Study Collaboration Members
Universities & Research Institutes

Institute Country	Institute Name	Proposed Area of Activity
Austria	University of Graz (UNIGRAZ)	Physics studies
Belgium	Vrije Universiteit Brussel (VUB)	Physics studies and detector R&D
Canada	Canadian Light Source (CLS) & University of Saskatchewan (USASK)	FCC-ee injector design
Estonia	National Institute of Chemical Physics and Biophysics (NICPB)	Detector development, theoretical particle physics, Grid computing, physics analysis.
Estonia	University of Tartu (UT)	Vacuum & thin-film technology, robotics, detector technology, theoretical particle physics
Estonia	Tallinn University of Technology (TalTech)	AI & robotics, Nb R&D, computer system & circuit reliability
Finland	Helsinki Institute of Physics (HIP)	Accelerator RF and physics studies
Germany	Max-Planck-Institut Muenich (MPI)	Physics studeis, contribution to contribution to PED pillar coordination
Iran	University of Tehran (UT)	Physics, Experiments and Detectors (PED) studies
Italy	Istituto Italiano di Tecnologia (IIT)	Maintenance assisted by advanced robotics
Japan	Tokyo International University (TIU)	Accelerator studies
Mexico	Universidad Autonoma de Sinaloa (UAS)	FCC-hh injector design
Portugal	Laboratory of Instrumentation & Experimental Particle Physics (LIP)	Physics studies and detector R&D
United Kingdom	University of Sussex (SUSSEX)	Physics, Experiments and Detectors (PED) studies

FCC Engagement Meetings (Online)

- **Overview**
  - Recently-launched extended forums with interested countries to discuss collaboration with FCC.
  - Topics:
    - Introduction to FCC Feasibility Study.
    - Presentation of FCC physics, experiment, detector, accelerator and global collaboration.
    - Presentations from the country scientific community.

- **Meetings**
  - Mexico (mini meeting on accelerator)
    - 21 June 2021
  - Republic of Korea
    - 3 September 2021
  - Pakistan
    - 14 September 2021
  - Portugal
    - 26 November 2021
  - Estonia
    - March 2022
  - India (TBC)

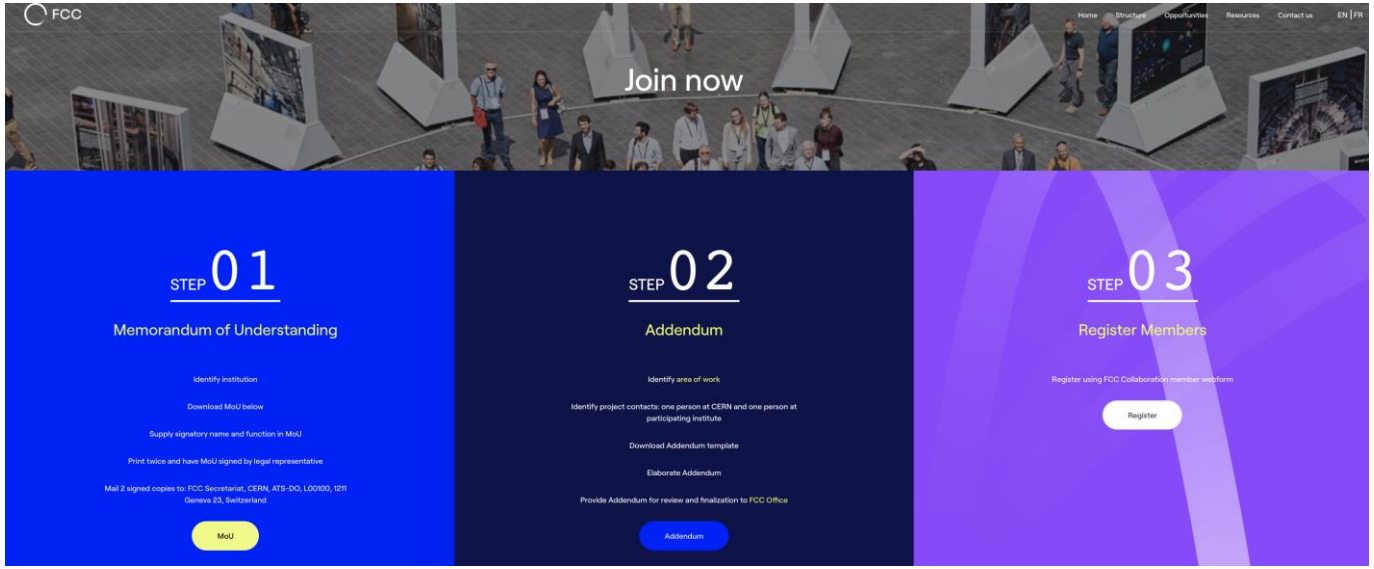
Much interest expressed by participating countries and the FCC looks forward to stronger / deeper involvement in the follow-up.

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

On-going Developments in FCC Collaboration

- **Discussions with CERN Member States to join FCC Collaboration**
  - Bulgaria, Norway, Romania and Slovakia.
  - Through FCC National Contacts & CERN Management Liaisons.
- **Discussions with CERN Associate Member States to strengthen collaboration with FCC**
  - India, Latvia, Lithuania, Turkey.
- **Forthcoming MoUs**
  - Pakistan Atomic Energy Commission (PAEC), Pakistan
  - Rutherford Appleton Laboratory (RAL), United Kingdom

FGC Working Group Work-plan

- **Priority Actions with Countries**
  - Strengthen existing collaborations with CERN MS, AMS, Observer States & NMS
    - Organise events / workshops in the **CERN MS & AMS**
  - Engage with CERN institutional partners
    - Member States: **Bulgaria, Norway, Romania, Slovakia.**
    - Associate Member States in pre-stage to Membership: **Cyprus, Estonia, Slovenia.**
    - Associate Member States: **Croatia, India, Latvia, Lithuania, Pakistan, Turkey, Ukraine.**
  - Establish collaborations with **CERN NMS** with ICAs (total 50)
- Organise **FCC Engagement Meetings**.
- Continue the **two-sided approach** from the **FGC Working Group** and from the **FCC-PED Informal Forum of National Contacts** to strengthen the global FCC collaboration.

Concluding Remarks

- Aim is to grow and strengthen FCC collaboration on a global scale:
  - Countries with **mature communities, long-standing participation in CERN's programmes & potential to contribute substantially** to Organization's long-term scientific objectives.
  - **National laboratories, institutes and universities** in support of the FCC Feasibility Study. Conclude relevant **bilateral agreements** for their participation.
- Continue the **two-sided approach** from the **FGC Working Group** and from the **FCC-PED Informal Forum of National Contacts** to strengthen the global FCC collaboration.

Success of FCC relies on strong global participation in all domains.
The FCC looks forward to strengthen the collaboration with global partners.

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Thank you