FCC Collaboration Status

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http://cern.ch/fcc

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European Commission | Horizon 2020 European Union funding for Research & Innovation

photo: J. Wenninger

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

8 Associate Member States

Brazil – Croatia – India – Latvia – Lithuania – Pakistan
Türkiye – 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 2023
Employees:
2666 staff, **1002** graduates
Associates:
12 370 users, **1513** others

Around 50 Cooperation Agreements with non-Member States and Territories

Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bangladesh – Belarus – Bolivia
Bosnia and Herzegovina – 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 2023

Geographical & cultural diversity
Users of **110 nationalities**
22.5 % women

Member States 7438

Austria 86 – **Belgium** 129 – **Bulgaria** 46 – **Czech Republic** 252
Denmark 47 – **Finland** 88 – **France** 842 – **Germany** 1296
Greece 112 – **Hungary** 80 – **Israel** 74 – **Italy** 1609 – **Netherlands** 167
Norway 77 – **Poland** 322 – **Portugal** 105 – **Romania** 113
Serbia 38 – **Slovakia** 67 – **Spain** 413 – **Sweden** 106
Switzerland 419 – **United Kingdom** 950

Associate Member States in the pre-stage to membership **69**

Cyprus 14 – **Estonia** 29 – **Slovenia** 26

Associate Member States **541**

Brazil 135 – **Croatia** 37 – **India** 145 – **Latvia** 21 – **Lithuania** 17 – **Pakistan** 30
Türkiye 129 – **Ukraine** 27

Observers **3005**

Japan 219 – **Russia** (suspended) 779 – **United States of America** 2007

Non-Member States and Territories 1317

Algeria 2 – **Argentina** 16 – **Armenia** 16 – **Australia** 26 – **Azerbaijan** 3 – **Bahrain** 3 – **Belarus** 14 – **Canada** 206
Chile 45 – **China** 414 – **Colombia** 24 – **Costa Rica** 3 – **Cuba** 3 – **Ecuador** 4 – **Egypt** 24 – **Georgia** 34 – **Hong Kong** 15
Iceland 3 – **Indonesia** 7 – **Iran** 14 – **Ireland** 4 – **Jordan** 3 – **Kazakhstan** 3 – **Kuwait** 2 – **Lebanon** 7 – **Madagascar** 1
Malaysia 4 – **Malta** 1 – **Mexico** 56 – **Montenegro** 3 – **Morocco** 18 – **New Zealand** 2 – **Nigeria** 2 – **Oman** 1
Palestine 1 – **Peru** 3 – **Philippines** 1 – **Republic of Korea** 168 – **Saudi Arabia** 6 – **South Africa** 61 – **Sri Lanka** 10
Taiwan 52 – **Thailand** 17 – **Tunisia** 4 – United Arab Emirates 10 – **Vietnam** 1

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 (e.g. 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.

FCC Feasibility Study

EU Projects
NN

Collaboration building
Gregorio Bernardi, Tadeusz Lesiak, Emmanuel Tsesmelis,

Communications
Panagiotis Charitos, Arnaud Marsollier

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

Study Support Unit
IT: Sylvain Girod
Procurement: Adam Horridge
Quality management: Beatriz Arias
Resources: Sylvie Prodon
Secretariat: Julie Hadre, Jeanette Kotzian

Physics, Experiments and Detectors
Patrick Janot, Christophe Grojean

- **Physics programme**
  Matthew McCullough, Frank Simon
- **Detector concept**
  Mogens Dam, Marc-André Pleier, Felix Sefkow
- **Physics performance**
  Patrizia Azzi, Emmanuel Perez, Michele Selvaggi
- **Software and computing**
  Gerardo Ganis, Brieuc François

Accelerators
Tor Raubenheimer
Frank Zimmermann

- **FCC-ee accelerator design**
  Christian Carli, Frank Zimmermann
- **FCC-ee technical implementation**
  Jean-Paul Burnet, Tor Raubenheimer
- **FCC-ee injector**
  Paolo Craievich, Alexej Grudiev
- **FCC transfer lines**
  Wolfgang Bartmann
- **FCC-hh design**
  Massimo Giovannozzi
- **EPOL**
  Jacqueline Keintzel, Guy Wilkinson
- **MDI**
  Manuela Boscolo, Fabrizio Palla

Technical Infrastructures
Jean-Paul Burnet
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
- **Environmental evaluation**
  Johannes Gutleber
- **Tunnel, subsurface design**
  John Osborne
- **Surface sites layout, access and building design**
  A. Mayoux

Organisation and financing models
Florian Sonnemann

- **Project organisation model**
  NN
- **Financing model**
  Florian Sonnemann
- **Procurement strategy and rules**
  Anders Unnervik
- **In-kind contributions**
  Anders Unnervik
- **Operation model**
  Verena Kain

FCC Global Collaboration Working Group (FGC)

- 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**.

Convened by Emmanuel Tsesmelis (CERN International Relations)

FCC Engagement Meetings

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.

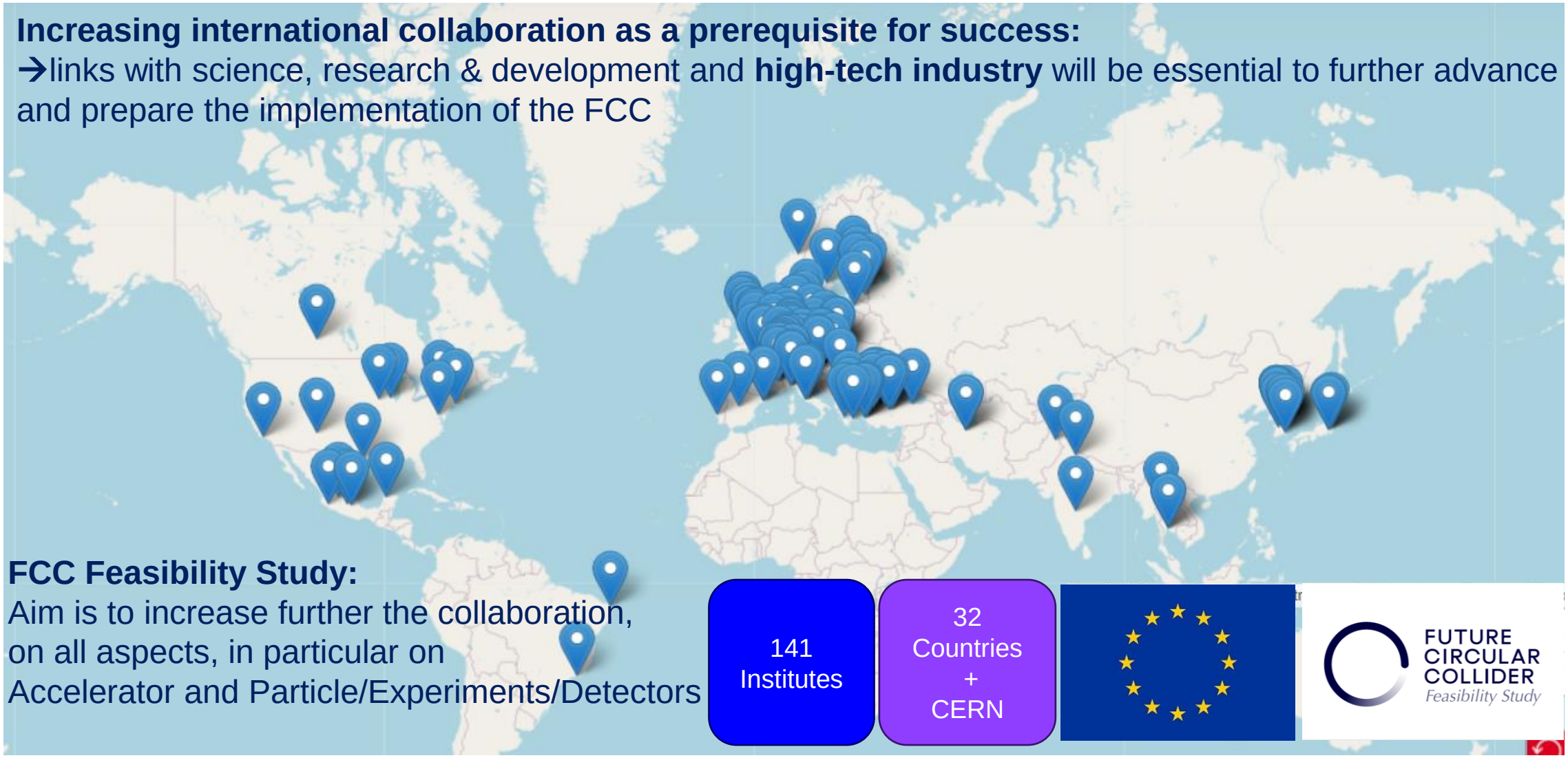
Meetings

- Mexico (mini meeting on accelerator)
  - June 2021
- Republic of Korea
  - September 2021
- Pakistan
  - September 2021
- Portugal
  - November 2021
- Estonia
  - March 2022
- Greece
  - January 2023, June 2023
- India
  - September 2024
- Lithuania
  - 2024 (date to be confirmed)

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

Status of the FCC Global 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 the FCC



FCC Feasibility Study:
Aim is to increase further the collaboration, on all aspects, in particular on Accelerator and Particle/Experiments/Detectors

141 Institutes

32 Countries + CERN

FUTURE CIRCULAR COLLIDER
Feasibility Study

US Institutes FCC

Institutes that have already signed an FCC MoU for the Feasibility Study Phase.

Northern Illinois University
University of Iowa
University of Houston
Cornell University
University of New Mexico
University of California Santa Barbara
Brookhaven National Laboratory

Addendum III to Accelerator Protocol III of International Cooperation Agreement between CERN and the DOE

Around 42 US institutes expressed interest to join the FCC at the US FCC Workshop in April 2023
Formalise participation through conclusion of separate MoUs

Institutes that have signed an FCC MoU for the Conceptual Design Phase

Center for Accelerator Science and Education
The Department of Energy of the United States of America
Brookhaven National Laboratory (part of DOE)
Duke University
Jefferson Lab
Massachusetts Institute of Technology (MIT)
Northern Illinois University
Stanford University
University of California, Irvine
University of California Santa Barbara
University of Houston
The University of Iowa
University of Michigan

Statement of Intent – CERN & USA

CERN and the US government have released a **joint statement** concerning future planning for large research infrastructures, advanced scientific computing and open science.

CERN and the US intend to **enhance collaboration** in planning activities for **large-scale, resource-intensive facilities** with the goal of providing a sustainable and responsible pathway for the peaceful use of future accelerator technologies.

“Should the CERN Member States determine the FCC-ee is likely to be CERN’s next world-leading research facility following the high-luminosity Large Hadron Collider, **the United States intends to collaborate on its construction and physics exploitation**, subject to appropriate domestic approvals.”

CERN Director-General, Fabiola Gianotti (right), and Principal Deputy US Chief Technology Officer, Deirdre Mulligan, of the White House Office of Science and Technology (left) at the signing ceremony. (Image:US Department of State, Bureau of Oceans & International Environmental & Scientific Affairs)

Washington, D.C., 26 April 2024

21 MoUs signed since last Collaboration Board (June 2023)

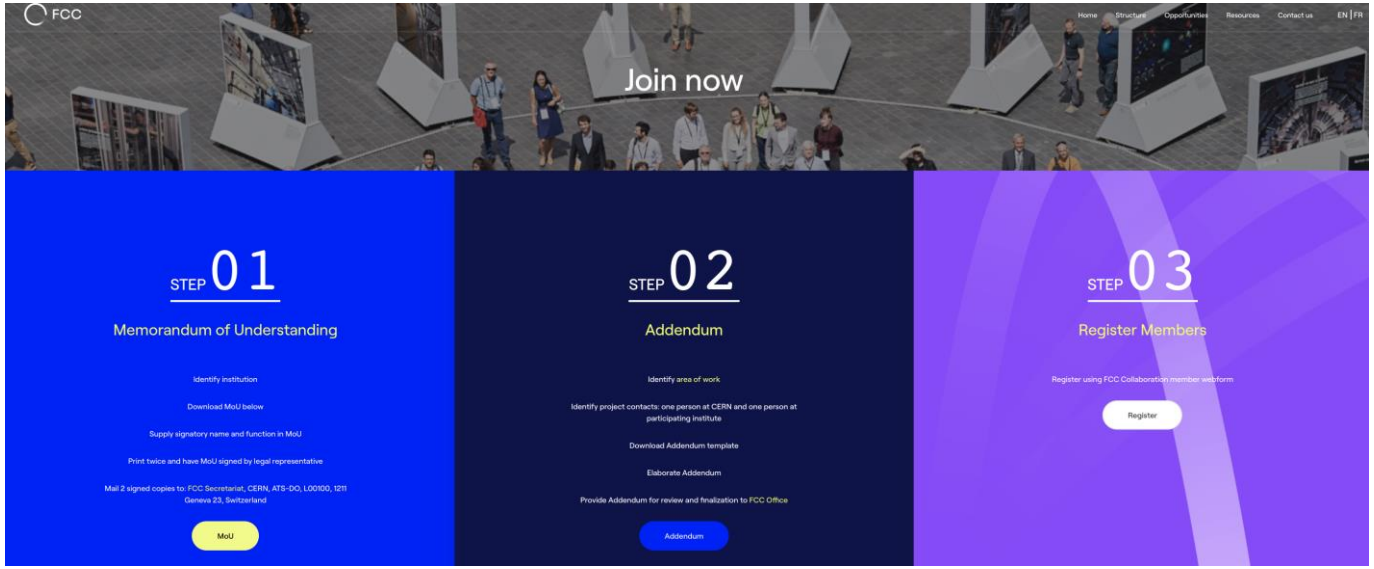
INSTITUTION	COUNTRY
Grand Accélérateur National d'Ions Lourds (GANIL)	France
Indian Institute of Technology Hyderabad	India
University of Petroleum and Energy Studies	India
Università degli studi Roma Tre	Italy
Vinča Institute of Nuclear Sciences	Serbia
Gangneung-Wonju National University	South Korea
Hanyang University	South Korea
Kyung Hee University	South Korea
Kyungpook National University	South Korea
Pusan National University	South Korea
Sungkyunkwan University	South Korea
University of Seoul	South Korea
Yonsei University	South Korea
Uppsala University	Sweden
Chulalongkorn University	Thailand
Srinakharinwirot University	Thailand
İzmir Bakırçay Üniversitesi	Türkiye
Uludag University	Türkiye
Brookhaven National Laboratory	United States
Cornell University	United States
The University of New Mexico	United States

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

Enlarging the Collaboration Further → 2nd Approach: IFNC

FCC has two approaches: one globally-oriented **(FGC),** as just described, the other more PED oriented **(IFNC),** both to 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 ➔ facilitate opportunities for national participation in the Feasibility Study and enlarge the HEP community of FCC

International Forum of National Contacts (IFNC)

- **Contact directly Physics groups in a country,** typically from LHC or Future Colliders groups to ask them **to join as new institution**
  - Discuss the physics case and the opportunities
    → To study **R&D/ Detector concepts** for FCC
    → To expand the FCC Physics scope via the study of **physics case studies**
    → To improve the **theoretical calculations** to exploit the FCC physics potential
  - Help **forming a national FCC group in each country**, with strong PED component, which can hold its national FCC meetings, including the Accelerator community when possible
  - Identify one or two **National Contacts** to exchange information between country situation and the FCC management, and to strengthen the national community
  - Exchange experience across countries (**IFNC meetings**)
  - Orient the new efforts towards the FCC working groups
  - Establish list of participating institutes and institute contacts **(IFIC)** inside each country

Convened by Gregorio Bernardi and Tadeusz Lesziak (also National Contacts of France and Poland)

Enlarging the Collaboration – IFNC Actions

IFNC: FCC PED Kick-off Meetings (cf. FGC: FCC Engagement Meetings)

- **Overview**
  - Forums with interested countries to discuss collaboration with FCC on PED topics:
    - Introduction to FCC Feasibility Study.
    - Detailed presentations of FCC physics, experiment, detector.
    - More general on accelerator and global collaboration.
- **Recent Kick-off Meetings**
  - Nordic Countries (Denmark, Norway, Sweden, Finland), March 2021
  - India (Bangalore), November 2022
  - Brazil (Rio de Janeiro), March 2023
  - Mexico (Mexico City), November 2024
  - + informal meetings
- **On-going discussions**
  - With not-yet-deeply-involved European countries
  - Chile, Canada, Argentina (Japan and China have special status…)

- **Several other initiatives, such as encouraging national meetings; since FCC week in Paris:**
  - Joint FCC France-Italy Workshop in Lyon in November 2022 **Joint FCC-France & Italy Workshop in Lyon** (140 participants)
    in Venice in November 2024 **Joint FCC-France & Italy Workshop in Venice**
  - 1st annual US-FCC Workshop at BNL in April 2023 **US FCC Workshop (24-26 April 2023)** ➔ ~45 US institutes signed up for FCC (cf France, UK, Italy, ~13-20 institutes each)
  - 2nd annual US-FCC Workshop at MIT, March 2024 US MIT-FCC Workshop (25-27 March 2024)
  - In May 2024 German meeting on future Colliders@CERN (150 participants, >10 institutes participating in FCC)

FUTURE CIRCULAR COLLIDER

HEP Collaboration Building

- **EOI for subdetectors and proto-detector concepts to be submitted by March 2025**
- **Set-up process for proto-collaboration formation in 2028-2029**

The CRP recommends to work with the scientific community, institutes, laboratories and funding agencies to ensure support and resources for **four experiments**, facilitating the exploitation of the full scientific potential offered by the large investment in the FCC-ee facility

- Completing list of tasks of the Institutes in the IFNC
- Iterate with National Contacts to gather latest information of possible funding of the HEP teams
- Explore how the countries/institutes position themselves on the current and future potential detector concepts

A possible strategy for community building for the next five years

- Start with EOI for subdetectors and detector concepts in 2025

- Assuming positive recommendation to push forward by end 2027 / beg. 2028 by the CERN Council:
  - Start setting up FCC Committee (FCCC) and proto-collaborations, probably around proposed proto-detector concepts, following call for CDR.
  - We are benefitting from observing the current setting up of the DRD collaborations.
  - Find a scheme to reduce the number of proto-collaborations (merging) if more than 4 proposals
  - Process could converge by 2030-2031

Concluding Remarks
Strengthening the FCC Collaboration

Starting from the unequivocal support of the **CERN Host States**, build the support of the **Member States, Associate Member States and non-Member States**.

- The successful realisation of the **LHC** is testament to the **strong and consistent support** CERN received from its **Member States and Associate Member States**.
- CERN Council required significant support from **Non-Member States, including the Observer States**, before giving final approval to the LHC.
- **High-level events** similar to that with the US should be organized with strong statements of intent.

Set up **governance structure** that will encourage participation / contribution / commitment to the FCC.

- FCC requires **long-term engagement and support of participants** from CERN's Member, Associate Member & Non-Member States. As the project evolves further, it is crucial to refine and adapt the collaboration model to ensure the efficient allocation of resources and sustained momentum.

Continue building interest in the FCC by engaging with communities world-wide through the **FCC Global Collaboration (FGC) Working Group** and the **International Forum of National Contacts** (IFNC).

Implement measures as proposed in the FCC-IS deliverable "**FCC Communication Plan**". https://zenodo.org/records/10567956

Thank you