

# *European Physics Strategy*

African Strategy for Fundamental and Applied Physics  
Town Hall meeting  
12<sup>th</sup> July 2021

*Karl Jakobs, ECFA Chair  
University of Freiburg / Germany*

**ECFA**

European Committee for Future Accelerators

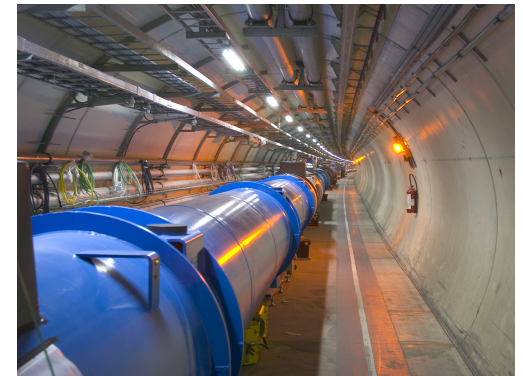


# CERN, the European Laboratory for Particle Physics

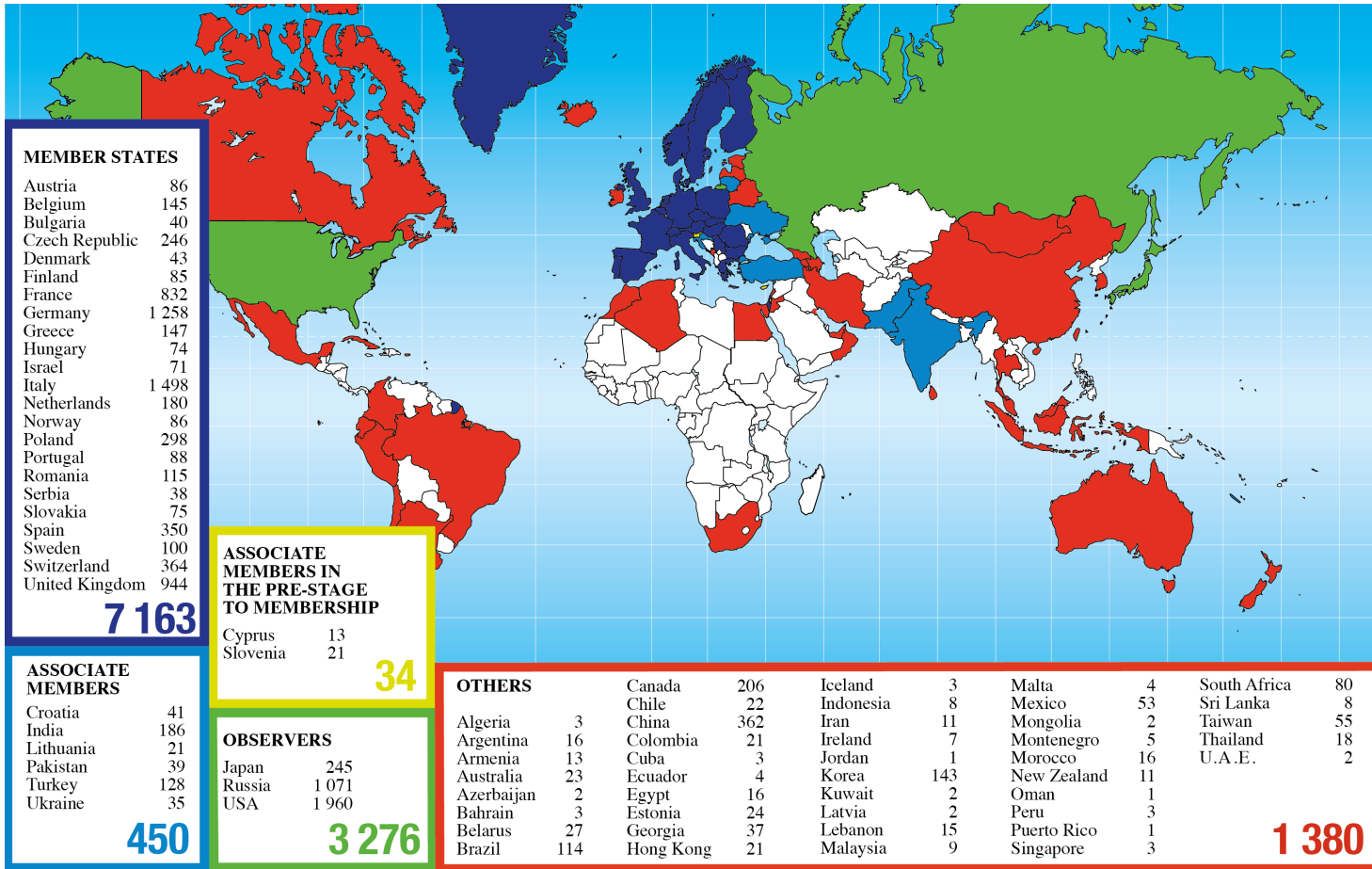
- CERN is the leading laboratory for Particle Physics in Europe / worldwide
- Founded in 1954, to provide the basic infrastructure for fundamental research in particle physics for European Universities and Research Labs and to foster collaboration between countries after the war.

*Research – Education & Training - Technology and Innovation - Collaboration*

- Today: 23 member states  
9 Associate member states  
6 Observers
- Open to a large, **worldwide user community**;  
CERN's "population" today: ~ 17'000 (users + staff)
- Operating the largest accelerator, the LHC, at the energy frontier  
*(Diverse and rich physics programme, complemented by experiments beyond colliders, ...)*

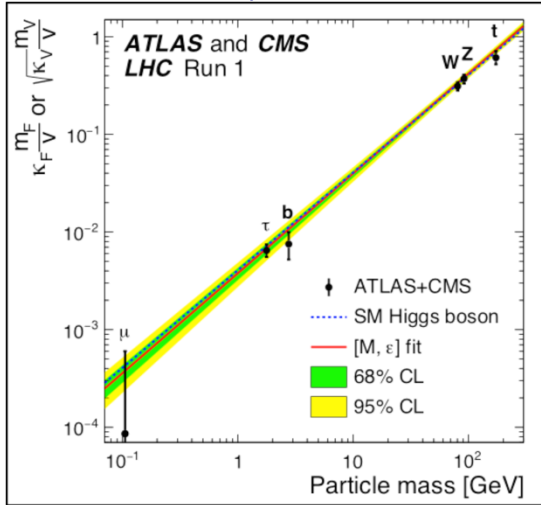


# CERN Users (by Location of Institute on 27 January 2020)

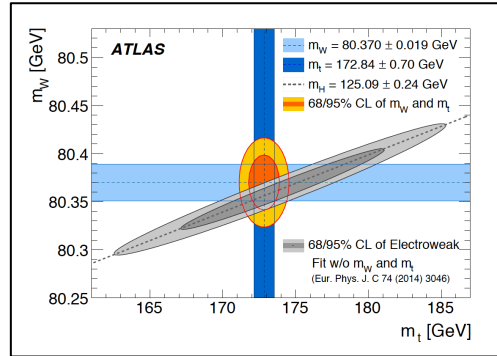


# 10 Years at the Energy Frontier

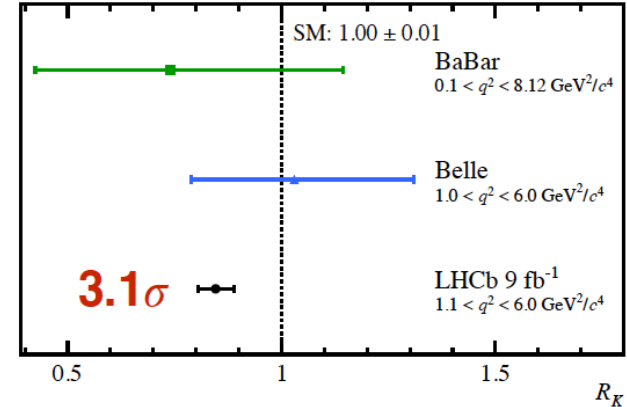
Discovery of the **Higgs boson** and precise measurement of its parameters



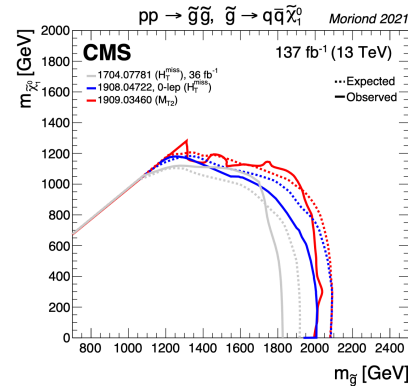
Precision tests of the Standard Model (SM)



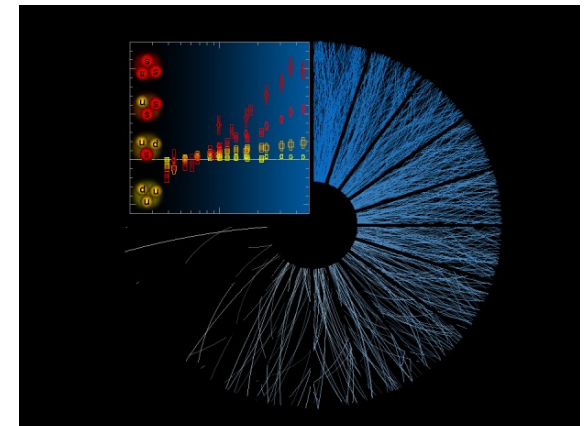
Challenging the SM in Flavour Physics



Constraints on Physics Beyond SM



Exploring QCD at extreme conditions





# High-Luminosity LHC



# 2020 Update of the European Strategy for Particle Physics

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*A two-year process involving the whole community and aiming at developing a common vision for the future of particle physics in Europe.*

- Particle-physics community across universities, laboratories and national institutes was invited to submit written input by 18 December 2018.
- [Scientific Open Symposium](#) in Granada, Spain (13 - 16 May 2019), where the community was invited to debate the future orientation of European particle physics.
- Writing of a **“Briefing Book”** followed by a Strategy Drafting Session in Bad Honnef, Germany, in January 2020
- *Update of the Strategy by CERN Council in June 2020*

# Update of the European Strategy for Particle Physics



## 1. Major developments from the 2013 Strategy

...

*The successful completion of the high-luminosity upgrade of the machine and detectors should remain the focal point of European particle physics, together with continued innovation in experimental techniques. **The full physics potential of the LHC and the HL-LHC, including the study of flavour physics and the quark-gluon plasma, should be exploited.***

...

*Europe, and CERN through the Neutrino Platform, should continue to support long baseline experiments in Japan and the United States. In particular, they should continue to collaborate with the United States and other international partners towards the successful implementation of the Long-Baseline Neutrino Facility (LBNF) and the Deep Underground Neutrino Experiment (DUNE).*

# Update of the European Strategy for Particle Physics



## 2. General considerations for the 2020 update

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*Europe, through CERN, has world leadership in accelerator-based particle physics and related technologies. **The future of the field in Europe and beyond depends on the continuing ability of CERN and its community to realise compelling scientific projects.** This Strategy update should be implemented to ensure Europe's continued scientific and technological leadership.*

...

*The particle physics community must further strengthen the unique ecosystem of research centres in Europe. In particular, cooperative programmes between CERN and these research centres should be expanded and sustained with adequate resources in order to address the objectives set out in the Strategy update.*

***The implementation of the Strategy should proceed in strong collaboration with global partners and neighbouring fields.***



## 3. High-priority future initiatives

An **electron-positron Higgs factory is the highest-priority next collider**. For the longer term, the **European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy**. Accomplishing these compelling goals will require innovation and cutting-edge technology:

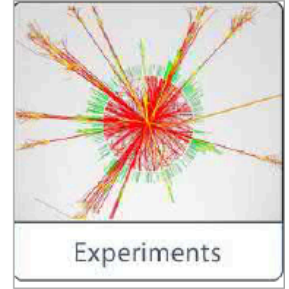
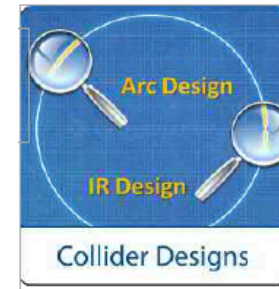
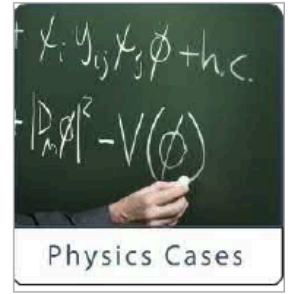
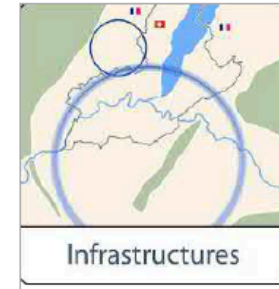
- *the particle physics community should ramp up its R&D effort focused on advanced accelerator technologies, in particular that for high-field superconducting magnets, including high-temperature superconductors;*
- *Europe, together with its international partners, should investigate the technical and 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.*

*The timely realisation of the electron-positron International Linear Collider (ILC) in Japan would be compatible with this strategy and, in that case, the European particle physics community would wish to collaborate.*

# FCC Feasibility Study and its Major Goals

- Optimisation of placement and layout of the ring 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;
- Optimisation of the design of the colliders and their injector chains;
- Elaboration of a sustainable operational model for the colliders and experiments (human and financial resources, 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.

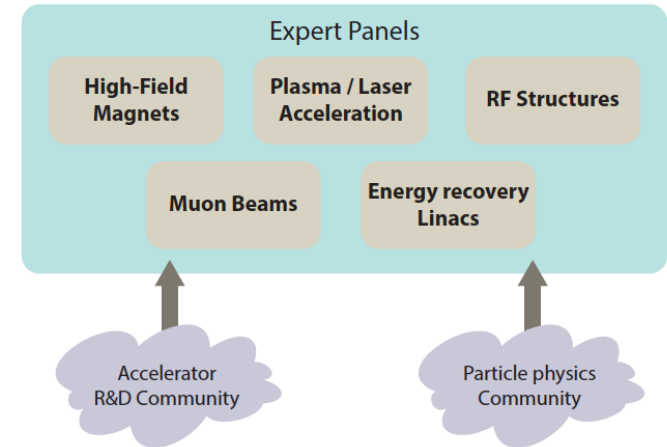
Studies have started, approved by CERN Council





# Accelerator R&D Roadmap

- Provide an agreed structure for a coordinated and intensified programme of particle accelerator R&D, including into new technologies, **to be coordinated across national laboratories**
- Be based on the goals of the European Strategy, but defined in its implementation through consultation with the community and, where appropriate, through the **work of Expert Panels**
- Take into account, and coordinate with, international activities and work being carried out in other related scientific fields, including development of new large-scale facilities
- **Specify a series of concrete deliverables, including demonstrators, over the next decade;**
- **Designed to inform, through its outcomes, subsequent updates to the European Strategy**



Accelerator R&D Roadmap planned to be released by end of 2021

# ECFA Workshops towards an Higgs/EW/Top Factory

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- *ECFA recognizes the need for the experimental and theoretical communities involved in physics studies, experiment designs and detector technologies at future Higgs factories to gather. **ECFA supports a series of workshops** with the aim to **share challenges and expertise, to explore synergies in their efforts** and to respond coherently to this priority in the European Strategy for Particle Physics (ESPP).*

*Goal: bring the entire  $e^+e^-$  Higgs factory effort together, foster cooperation across various projects, collaborative research programmes are to emerge*

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- **Studies started with a Kick-off meeting on 18<sup>th</sup> June 2021**
- Working Groups on: (i) Physics Potential  
(ii) Physics Analysis Methods  
(iii) Detector R&D

to prepare ECFA Workshops in 2022 and 2023

- Open for collaboration with other ongoing activities, e.g. Snowmass, ...
- Process is open for all interested physicists
- More information / updates on: <https://indico.cern.ch/event/1044297/>



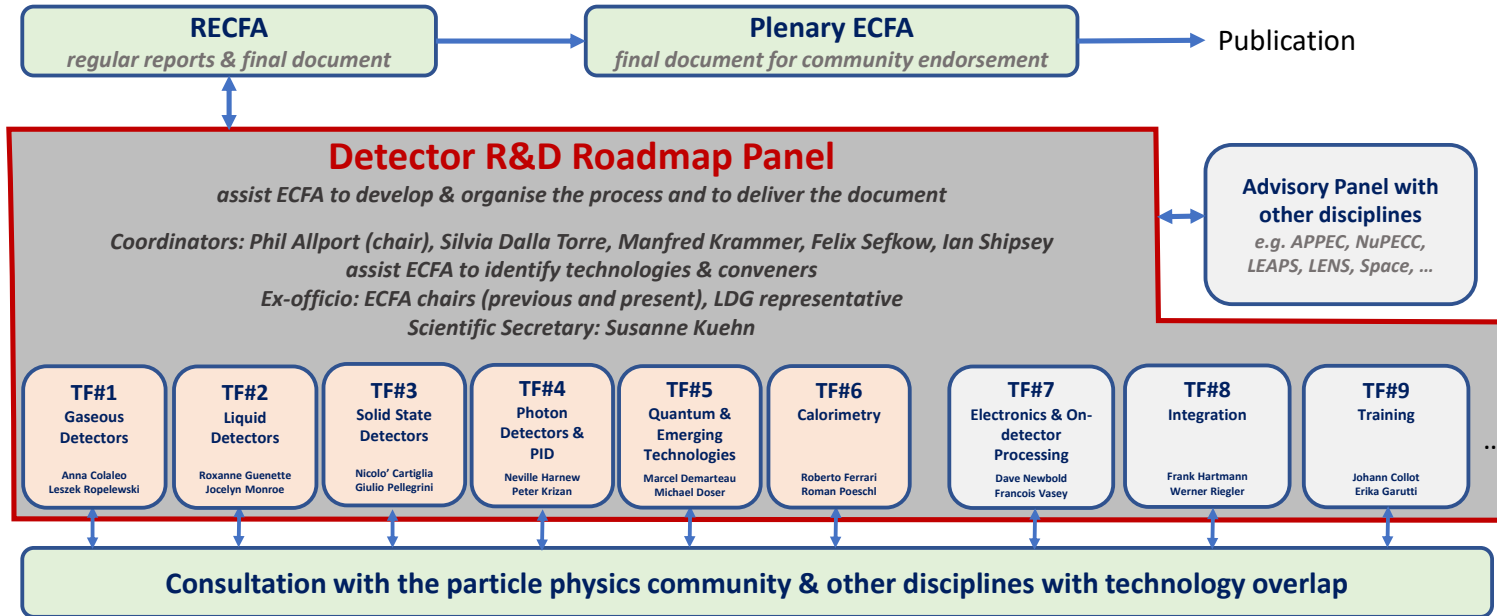
## 4. Other essential scientific activities for particle physics

...

- c) *The **success of particle physics experiments relies on innovative instrumentation and state-of-the-art infrastructures.** To prepare and realise future experimental research programmes, the community must **maintain a strong focus on instrumentation. Detector R&D programmes and associated infrastructures should be supported at CERN, national institutes, laboratories and universities.** Synergies between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase opportunities for more technology transfer benefiting society at large. Collaborative platforms and consortia must be adequately supported to provide coherence in these R&D activities. The community should define a **global detector R&D roadmap** that **should be used to support proposals at the European and national levels.***

*Organised by ECFA, a roadmap should be developed by the community to balance the detector R&D efforts in Europe, taking into account progress with emerging technologies in adjacent fields. The roadmap should identify and describe a diversified detector R&D portfolio that has the largest potential to enhance the performance of the particle physics programme in the near and long term. ...*

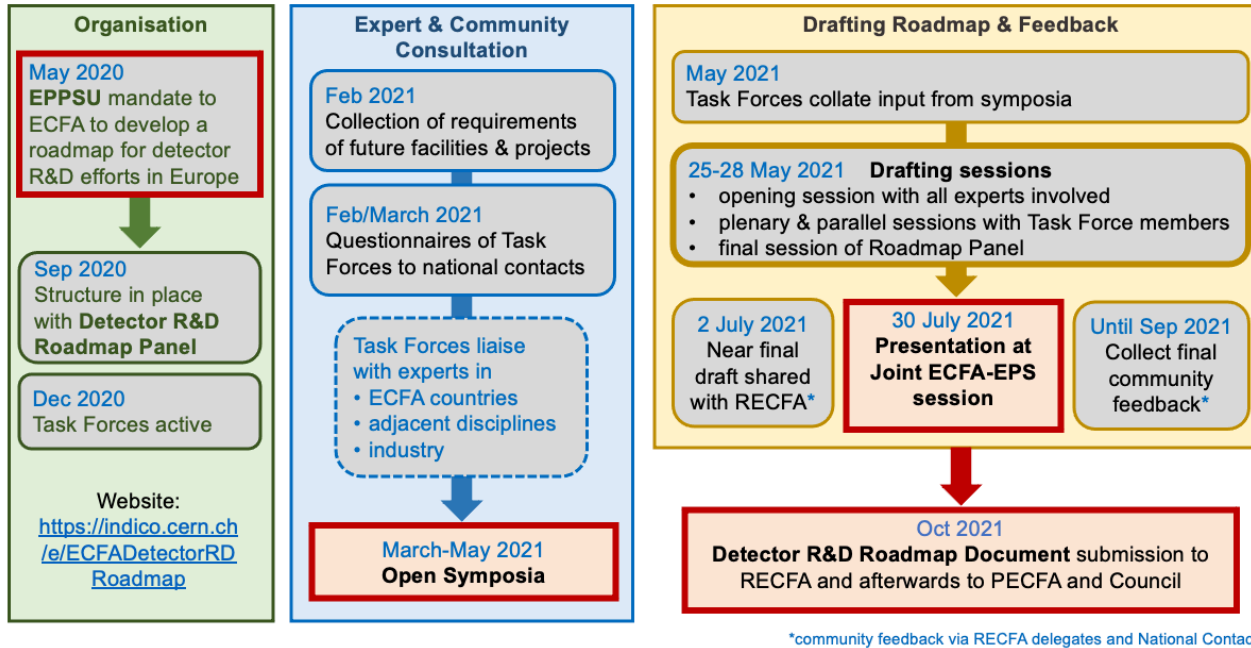
# The Detector R&D Roadmap Process



- **Task forces** are composed of experts from the community covering key sub-topics in the relevant technology areas, including **two conveners** (who are part of the Roadmap Panel)
- Progress with emerging technologies in adjacent fields is provided through an **Advisory Panel with Other Disciplines** ( → expert contacts by Task Forces area)

Information on the full process: [ECFA Detector R&D Roadmap](#)

# The Detector R&D Roadmap Process



- Expert and Community consultation phase completed; major input at Open Symposia <https://indico.cern.ch/event/957057/program>
- First Open Presentation at the [EPS Conference](#) in the [ECFA-EPS Session](#) on 30<sup>th</sup> July 2021

Detector R&D Roadmap planned to be released by end of 2021

# Update of the European Strategy for Particle Physics



## 5. Synergies with neighbouring fields

*Europe should maintain its capability to perform innovative experiments at the boundary between particle and nuclear physics, and CERN should continue to coordinate with NuPECC on topics of mutual interest.*

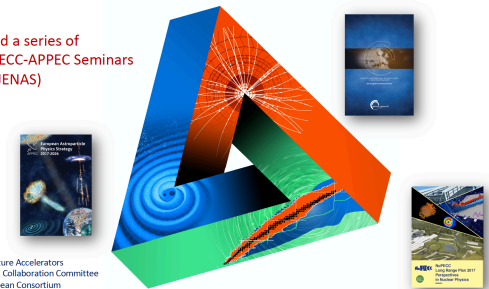
*Synergies between particle and astroparticle physics should be strengthened through scientific exchanges and technological cooperation in areas of common interest and mutual benefit.*

Followed up by e.g. Joint ECFA-NuPECC-APPEC activities and seminars

2<sup>nd</sup> Joint Seminar in Madrid 3 – 6 May 2022  
(under preparation)

Exploring and strengthening synergies

Initiated a series of  
Joint ECFA-NuPECC-APPEC Seminars  
(JENAS)



ECFA: European Committee for Future Accelerators  
NuPECC: Nuclear Physics European Collaboration Committee  
APPEC: Astroparticle Physics European Consortium





## 6. Organisational Issues

*An ambitious next-generation collider project will require **global collaboration** and a **long-term commitment** to construction and operations by all parties.*

*CERN should initiate discussions with potential major partners as part of the feasibility study for such a project being hosted at CERN.*

*In the case of a global facility outside Europe in which CERN participates, CERN should act as the European regional hub, providing strategic coordination and technical support. Individual Member States could provide resources to the new global facility either through additional contributions made via CERN or directly through bilateral and multilateral arrangements with the host organisation.*