Introduction – status of the network and scope of the meeting

Marcel Vos (IFIC, UV/CSIC Valencia), Mary Cruz Fouz (CIEMAT)

Jornadas CPAN, 23/09/2025

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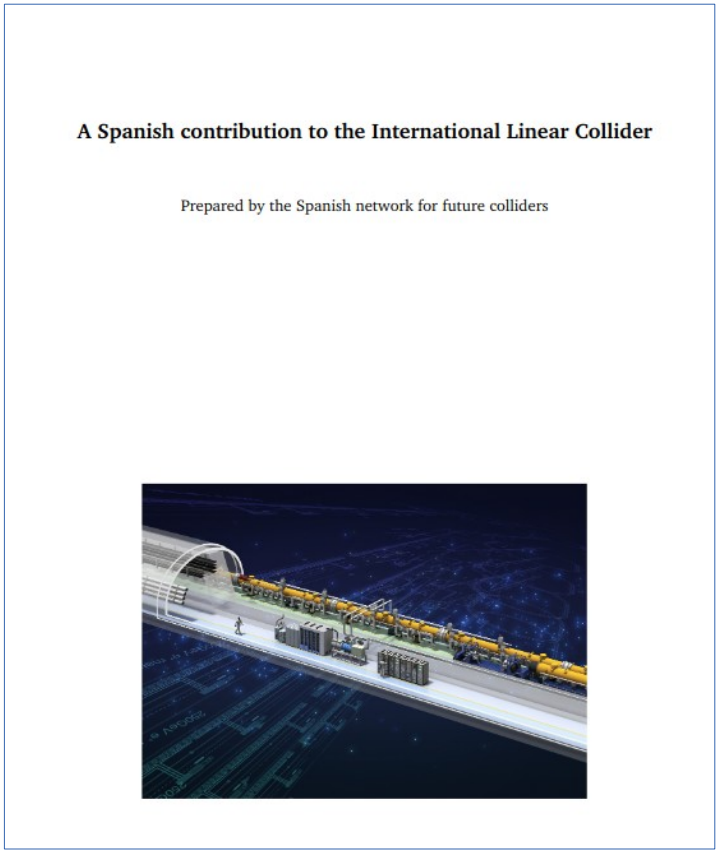
Role of the network for future colliders

Provide a forum to discuss all aspects of the next large facility in HEP
(~yearly meetings: theory, experiment, accelerator+detector experts & industry)
Represent the Spanish community involved in future colliders towards CPAN
(i.e. input on colliders for the European strategy update)
Enhance impact and visibility of Spanish effort in detector concepts and
(i.e. joined CLIC detector effort through network)

Make the most of the Spanish effort, maximizing:
- influence on decision
- contribution to winning project
- scientific and economic return

And, given the Spanish effort is sub-critical:
- encourage deeper Spanish involvement
- form an entry point for young scientists to join

Example: study of possible Spanish contributions to the ILC



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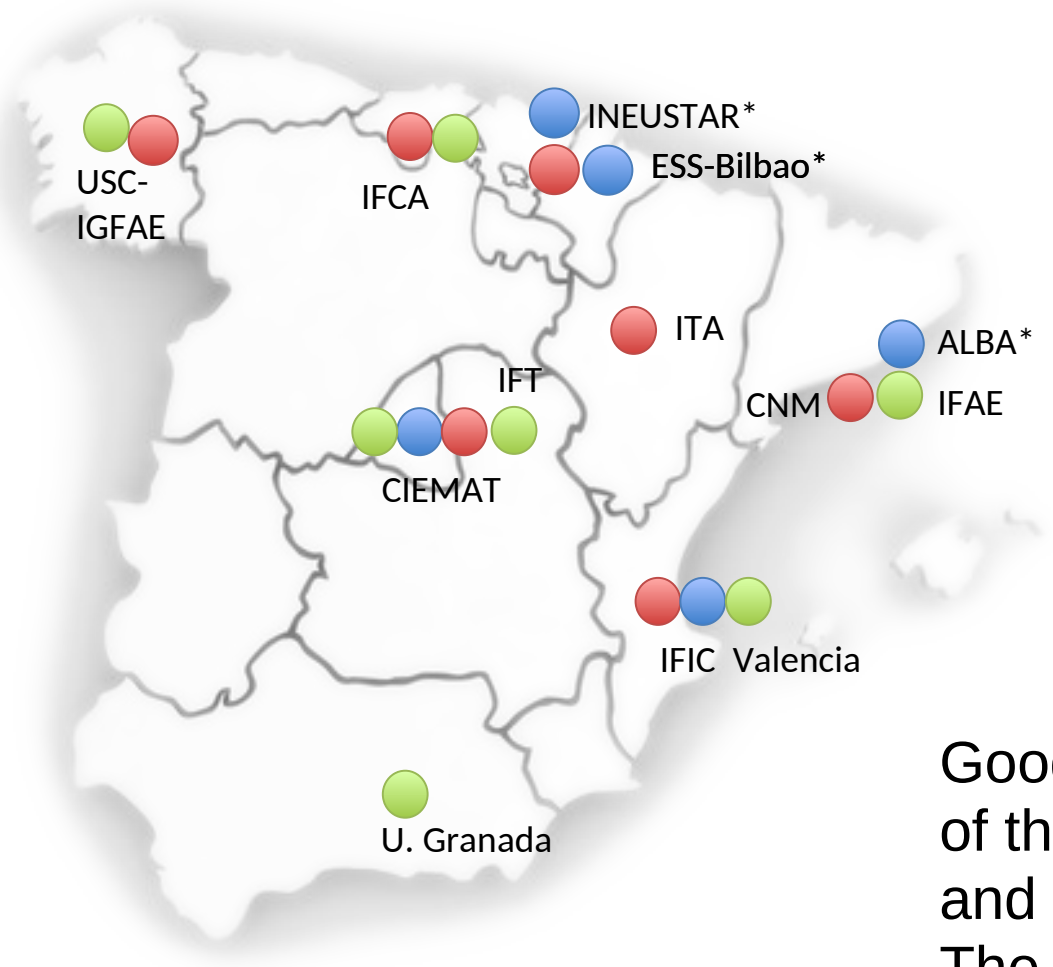
The Spanish network for future colliders



Activity	# Groups
Accelerator	5
Detectors	7
Phenomenology	7

Note: need to add Cordoba, Salamanca, Alicante…

Good coverage of theory, design of the experiments and detector and accelerator technology
The network is open to any group with an interest in future colliders (of any type or flavour)

The Spanish network for future colliders

The Spanish network for future colliders - 2024-2026

Two IPs: Marcel Vos & Mary Cruz Fouz
Ten nodes: IFIC Valencia & CIEMAT + CIEMAT-tech, IFAE, IFCA, IFT, CNM-IMB, ITAINNOVA, U. Granada and U. Santiago/IGFAE
Three associates: ALBA, ESS-Bilbao, INEUSTAR
(cannot sign for formal reasons; important for the coverage of the network)

Mary-Cruz Fouz Iglesias, CIEMAT en Madrid (división de investigación basica), PID2021-122134NB-C22
Juan Fuster Verdú, CSIC, IFIC (UV/CSIC) Valencia, PID2021-122134NB-C21
Gervasio Gomez, CSIC e IFCA (CSIC/Universidad de Cantabria), PID2020-113705RB-C31
Salvador Hidalgo, CSIC, IMB-CNM, PID2020-113705RB-C32
Juan José Saborido, U. Santiagol e IGFAE, PID2022-140591NB-I00
Mateo Iglesias Amella, ITAINNOVA en Zaragoza, PID2022-137268NB-C54
Jorge de Blas Mateo, Universidad de Granada, PID2022-139466NB-C21
Fernando Toral Fernandez, CIEMAT (unidad tecnológica de imanes), PID2020-120582GB-I00
Sebastian Grinstein, ICREA/IFAE, Barcelona, PID2021-124660OB-C21
José Miguel No, U. Autonoma de Madrid e Instituto de Física Teórica, I+D+I: PID2021-124704NB-I00

Associated nodes:

Ibon Bustinduy Uriarte, ESS Bilbao (miembro asociado)
Francis Perez, ALBA-CELLS (miembro asociado)
Erik Fernandez, INEUSTAR (miembro asociado)

Proposal has not found been rewarded with funding
(we're in good company, the LHC network is not funded either)

European strategy update

March 2024: CERN Council started the process

June 2024: Karl Jakobs (Freiburg) appointed Strategy Secretary

March 2025: Deadline for community input

June 2025: Open symposium

Nov 2025: Further inputs from countries

1st half 2026: Council discussions and decision

More details on ESPP web page: https://europeanstrategyupdate.web.cern.ch/

Update of the European strategy for particle physics

A lot of things going on this year…

ECFA Higgs factory study (several Spanish groups involved)
CERN yellow report, https://arxiv.org/pdf/2506.15390

Open Symposium Venice in June
Physics briefing book in preparation

Spanish input

Read the whole text:
https://indico.cern.ch/event/1439855/contributions/6461538/

"The FCC (FCC-ee+FCC-hh) project has broad support across the Spanish HEP community as the preferred next flagship facility at CERN, provided its feasibility study establishes that its realisation is technologically and financially achievable within the proposed timescale."

"If the FCC is found not to be feasible, a linear electron-positron collider facility at CERN would be the preferred alternative option, with an initial Higgs factory stage and the possibility of an energy upgrade to the TeV scale."

Spanish national input to the European Strategy for Particle Physics

The Spanish particle, astroparticle and nuclear physics community

Editorial team: J. Alcaraz Maestre (CIEMAT), N. Armesto (IGFAE), J. de Blas (UGR), L.M. Fraile (UCM), A. Juste (IFAE), M. Martínez (UZ), G. Merino (CIEMAT), C. Pena (IFT, UAM-CSIC), M. Sorel (IFIC, CSIC-UV), F. Toral (CIEMAT), I. Vila (IFCA, CSIC-UC), M. Vos (IFIC, CSIC-UV)

Contacts: N. Colino (CIEMAT), M.J. Costa (IFIC, CSIC-UV), P. Hernández (IFIC, CSIC-UV), C. Martínez (IFCA, CSIC-UC), C. Salgado (IGFAE)

Executive summary

The LHC will continue to be the world's leading project in particle physics for the next two decades. Therefore, completing its high-luminosity upgrade and fully exploiting its physics programme must remain the top medium-term priority. The FCC project, including the initial electron-positron and subsequent hadron-hadron phases, has broad support across the Spanish community as the preferred next flagship facility at CERN. The community is committed to participating at all levels. This ambitious project, with its large overall physics potential, would strengthen Europe's leadership in the field, with CERN as the global reference laboratory. Should the FCC be unfeasible, the preferred alternative would be a linear electron-positron collider at CERN, starting with a Higgs factory stage and further upgrading it to reach the TeV scale.

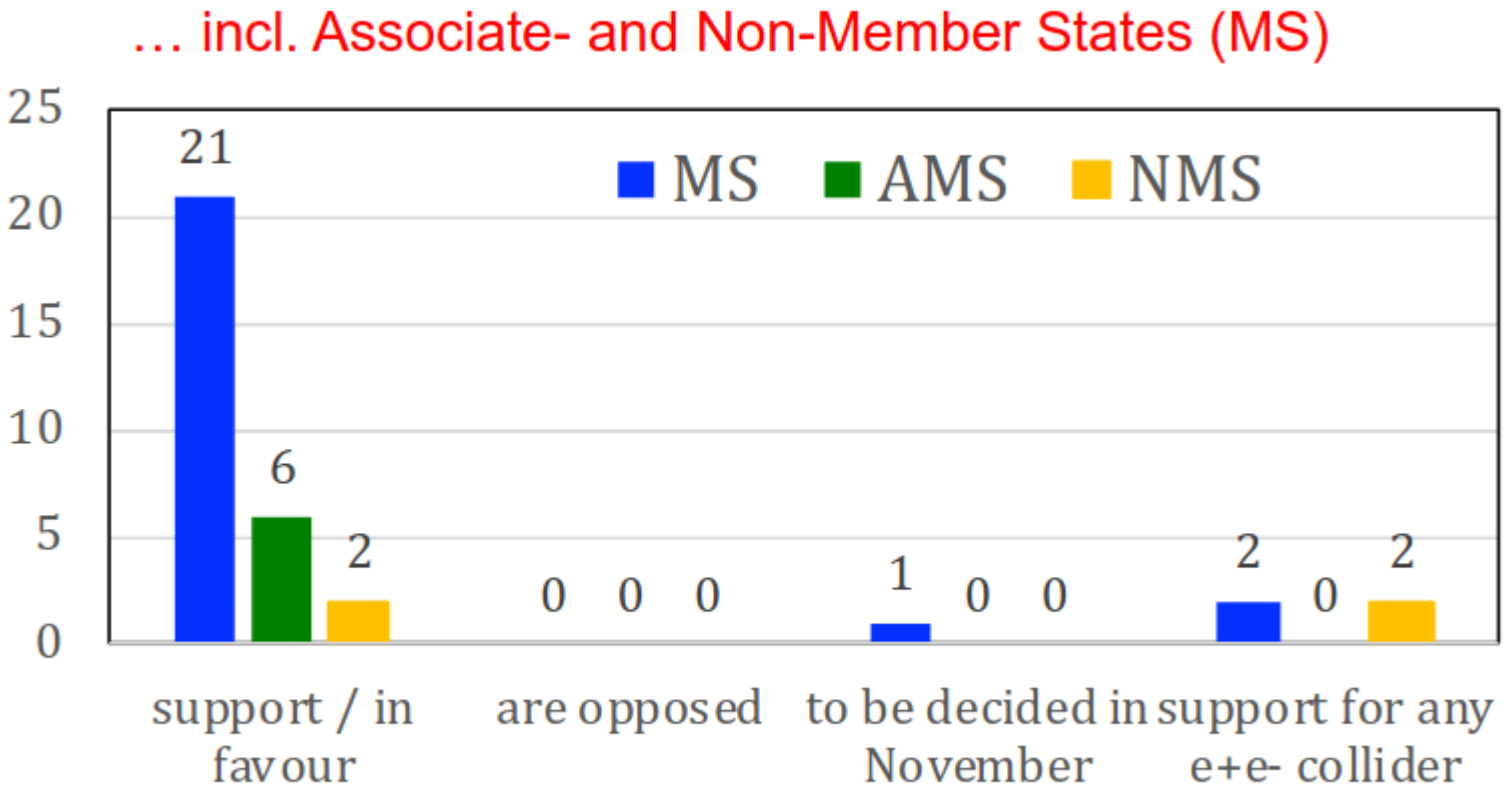
Ensuring a diverse and comprehensive physics programme is crucial for addressing fundamental physics questions, including fixed-target, neutrino, flavour, astroparticle and nuclear physics experiments. CERN should continue supporting leading-edge projects through the Recognized Experiment status and international collaboration agreements.

A strong investment in accelerator R&D, along with the necessary advancements in detectors and computing, is essential for the success of future endeavours. Full implementation of the corresponding ECFA R&D roadmaps, prioritizing the required FCC developments and including environmental sustainability considerations, must be achieved. Additionally, continued theoretical advancements, particularly in high-order perturbative computations, non-perturbative studies and model-building, are crucial for future discoveries, with CERN remaining a key hub for collaboration and support.

An early decision on CERN's next flagship project is critical for our young researchers, and their involvement in the early stages would be highly beneficial. Effective communication and outreach will be essential for such an unprecedented endeavour as the FCC.

Summary of the national inputs

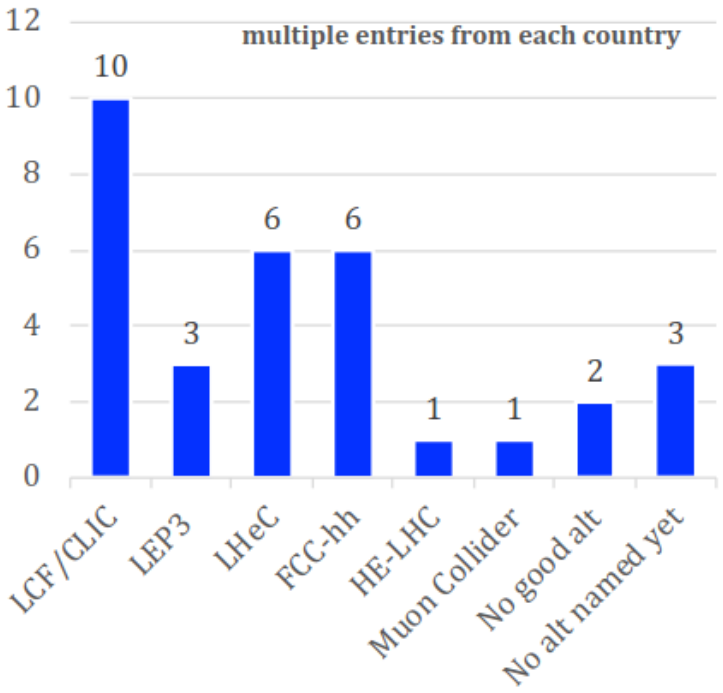
Karl Jakobs: “overwhelming support from CERN Member State HEP communities for the complete FCC project (FCCee+FCChh)”



Fabiola Gianotti: “Discussions on the financial feasibility are ongoing (CERN management and Council)”

Alterantive to the flagship program

What is the alternative if the preferred option is not feasible?



CERN Member States (MS) (multiple entries allowed)

- 10 MS HEP communities list a Linear Collider (LCF, CLIC) as second best choice
  (LCF is preferred to be realised with 550 GeV)
- 3 MS HEP mention LEP3 as a genuinely less costly alternative to FCC-ee
- 6 MS HEP communities support LHeC
- 6 MS HEP communities support a lower-energy hadron collider
- 2 MS HEP see no reason for another option, as they would be equally costly.

Spain voted for LCF as alternative should FCC fail
Spain refrained from opinions on an early hadron collider (HE-LHC, can it really be early?), LEP3/LHeC (detailed costing not available at the time)
Spain has not reached a consensus on what to do if China builds CEPC soon

Project comparison - cost

FCCee:	15.3 BCHF
FCChh:	19.1 BCHF
FCC integrated project	34.4 BCHF
LCF250:	8.5 BCHF
LCF550:	5.5 BCHF
LCF super-conducting	14.0 BCHF
Muon collider at CERN	~12 BCHF
LEP3:	~4 BCHF
LheC:	~2 BCHF

Numbers as per Karl Jakob's summary

Note: CERN costing rules, and CERN-site-specific cost estimates

Much more detail in Phil Burrow's EPS talk:
https://indico.in2p3.fr/event/33627/contributions/156477/

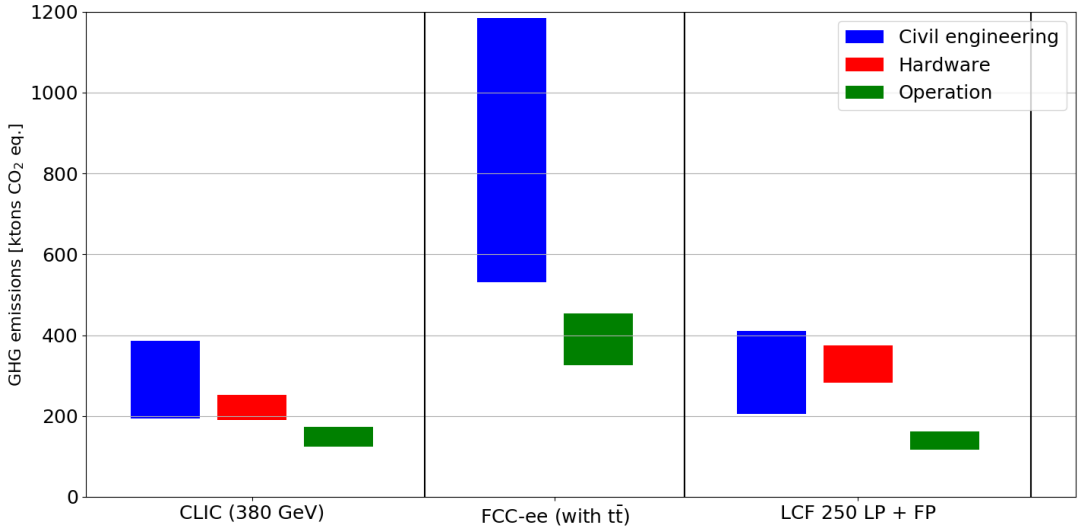
Project comparison – environmental impact

Environmental impact is important, but not so easy to assess.
Full life-cycle assessments ongoing for the major projects.

Range of values: estimates based on presently known technologies and potential for realistic reduction (e.g. taking into account the roadmap established by the European Cement Association for CE)

Accelerator and civil engineering more important for CO2 footprint, and more uncertain, than energy consumption of operation

Mitigation studies ongoing!!



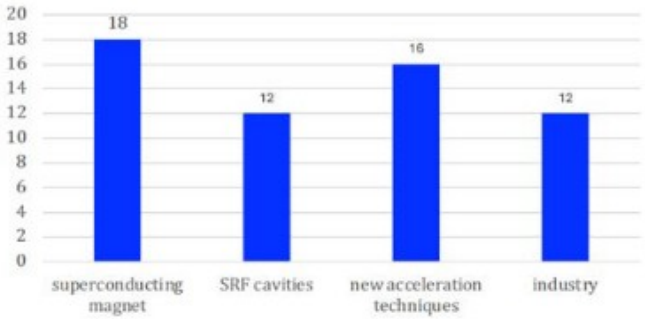
More detail in Gian Luigi Arduini's talk in Venice:
https://agenda.infn.it/event/44943/contributions/265707/

Accelerator technology

Accelerator R&D remains a high-priority research field!

Priorities as seen by the national HEP communities:

- **Superconducting magnet technology:**
  (especially high-temperature superconductors, HTS)
- **High-performance SRF cavities**
  (optimisation, higher gradients, quality factors, ..)
- **New acceleration techniques**
  (plasma wakefields, muon colliders, energy recovery linacs, ...)

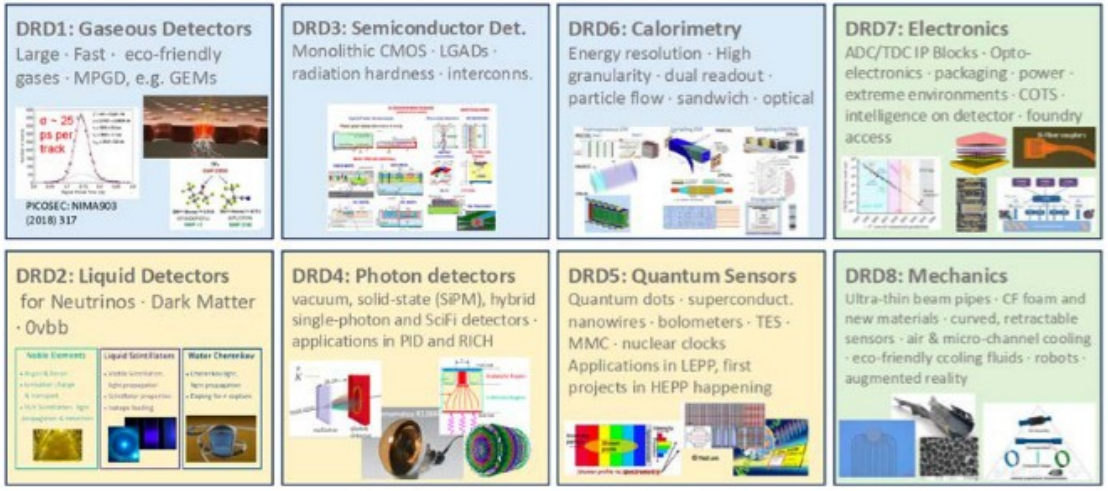


Priorities as seen by the national HEP communities

https://agenda.infn.it/event/44943/contributions/267517/attachments/137766/207161/ESPP_Venice_Summary_2025.06.27.pdf

Detector R&D

- Eight **Detector R&D Collaborations** (DRDs) have been set up, following the ECFA Detector R&D Roadmap, **focussing on strategic R&D**
- Still in infancy, but expected to grow, once HL-LHC is built
- **General Strategic recommendations** have not yet all been implemented



DRD are essential to redirect the HL-LHC crowd to the new project.
The implementation of the coordination structure requested by the previous strategy has taken the entire period of valididity of the strategy.

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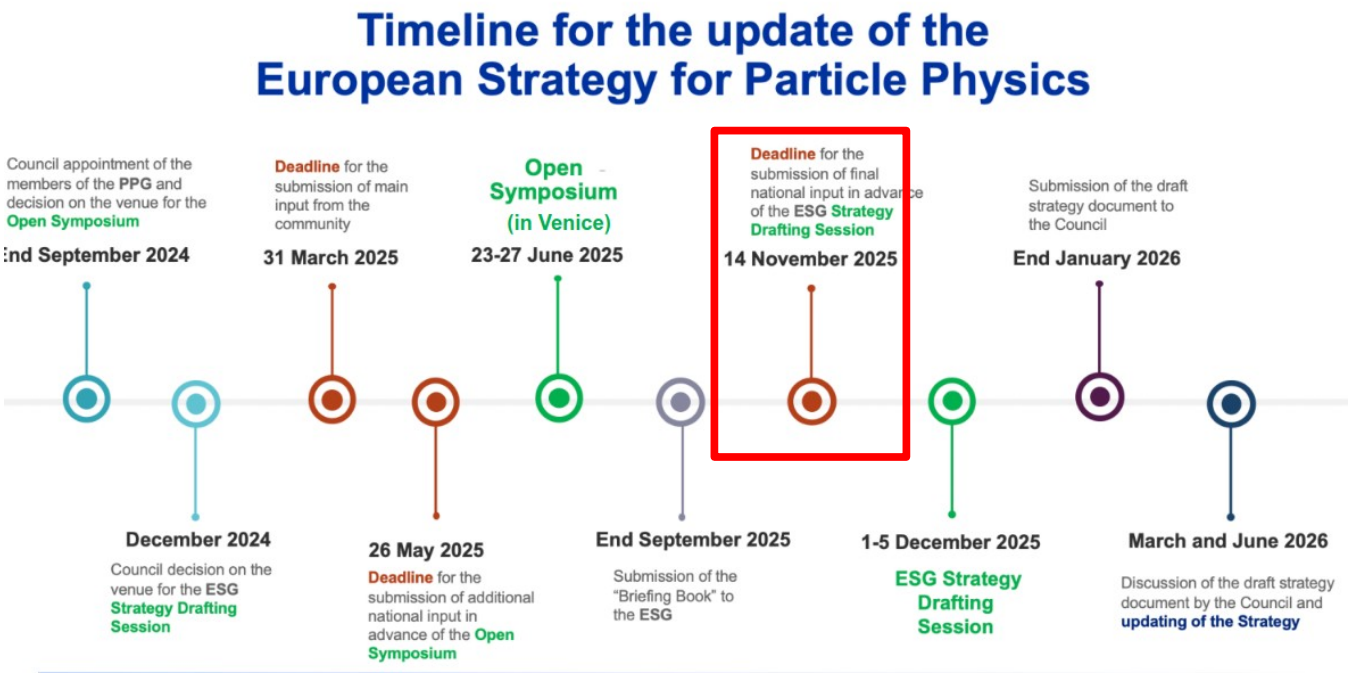

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CEPC meeting in Barcelona, June ‘25

Upcoming meetings

Autumn will be busy too

Winter meeting (Santiago 6-10 October)
Tuesday devoted to future colliders
Last opportunity for update of Spanish input to the strategy
https://indico.global/event/14697/

Linear Collider Workshop (Valencia 20-24 October)
Abstract submission is closed, but registration is still possible
https://agenda.linearcollider.org/event/10594/

Jornadas CPAN (Valencia 20-22 November)
Parallel sessions of all networks
Clashes with ECFA meeting
https://indico.ific.uv.es/event/8035/

First meetings for spring ‘26

RECFA vistis Spain (March 2026)
CSIC headquarters

Outlook

The network for future colliders has a few interesting years ahead; adapt to European strategy and make sure Spain is well-represented in the next flagship project(s) in HEP

Thanks to our local organizers, and especially to Mary Cruz, for hosting the meeting at CIEMAT

Looking forward to gaining an overview of activities in all areas – theory and experimental prospect studies, new ideas for better detectors, and Spanish contributions to the accelerator