FCCee and the network for future colliders

Marcel Vos (IFIC, UV/CSIC Valencia)

FCCee open meeting, IFIC, 16 April 20266

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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

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 last year…

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

Open Symposium Venice in June, strategy drafting in Ascona
Physics briefing book (with important Spanish contributions)
Strategy documents (up for approval by CERN council in May)
Decision on flaghship expected by 2028

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.

European strategy outcome

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

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

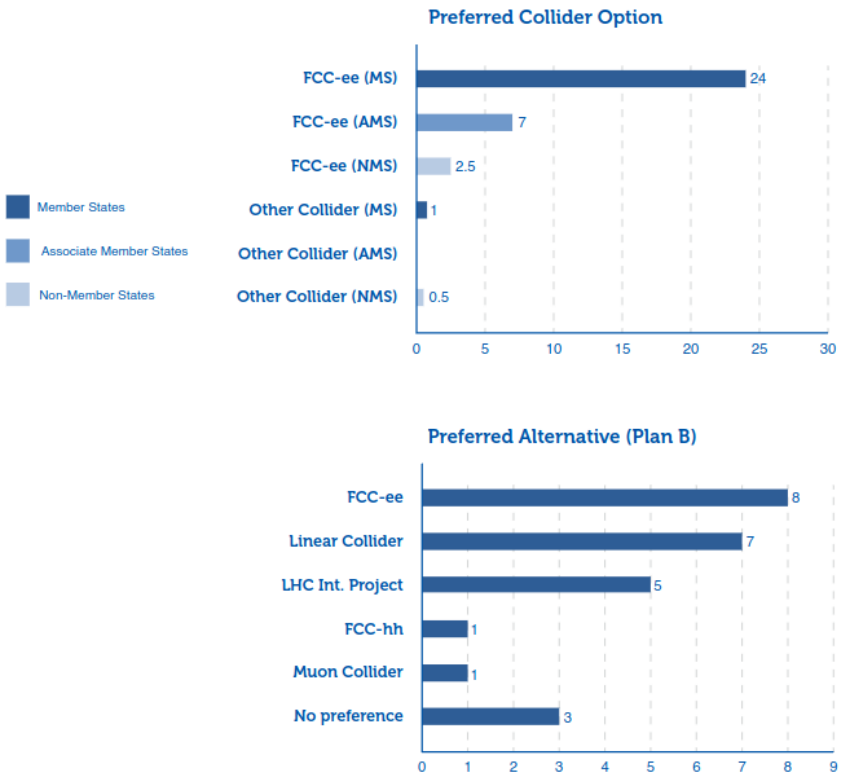
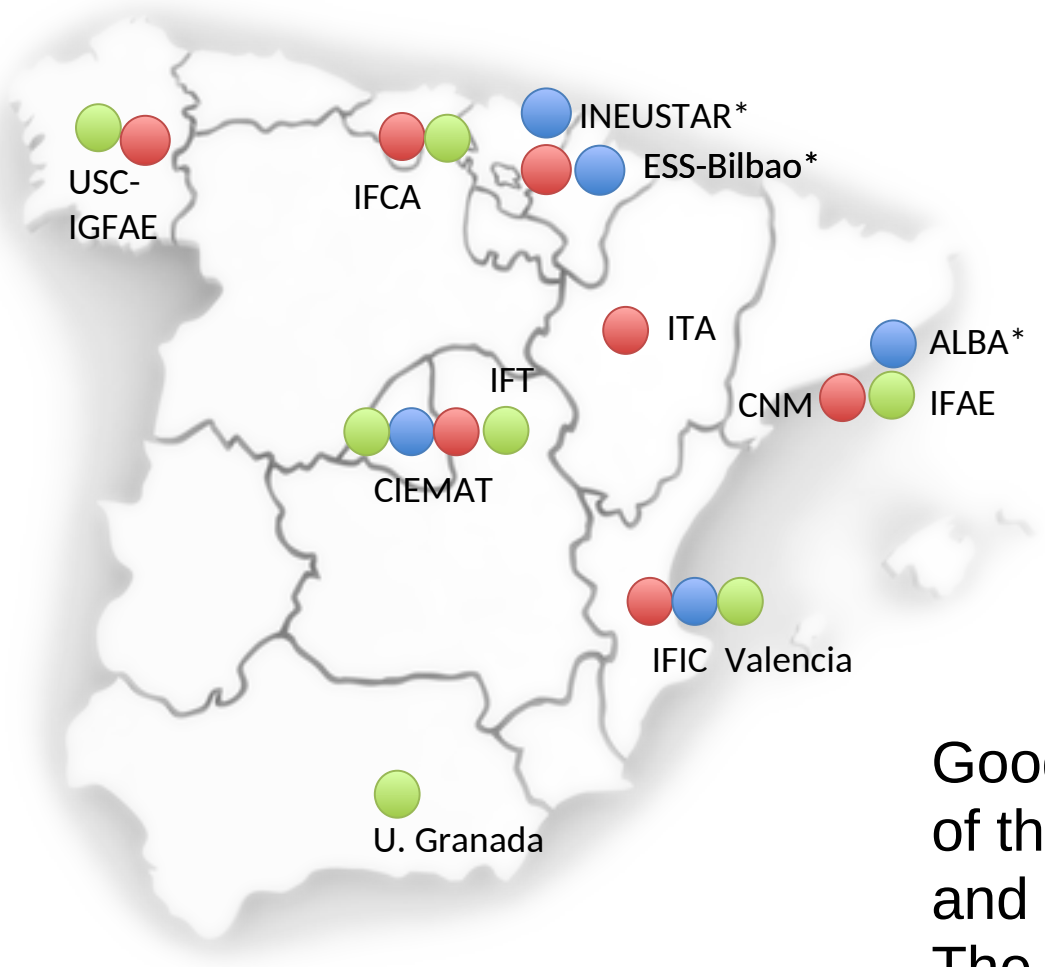


Figure 3.2: Input from national HEP communities on the preferred collider option (top) and on the preferred alternative if the preferred option would not be feasible (bottom). The three rows for the FCC-ee and the “Other Collider” in the top diagram correspond to input from CERN Member States (MS), Associate Member States (AMS) and non-Member States (NMS). In the bottom diagram, only input from MS is shown. The “LHC Int.” row refers to the two intermediate LHC-based projects, i.e. LEP3 and LHeC.

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

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, Francis Perez, ALBA-CELLS, Erik Fernandez, INEUSTAR

Future: -- change of focus and leadership (Mary Cruz Fouz + Daniel Esperante),
-- extension with Cordoba, Alicante, Salamanca….+ new groups in FCCee

Role of the network for future colliders

Provide a **forum to discuss all aspects** of the next large facility in HEP
(theory, experiment, accelerator; HEP, tech centers & 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)

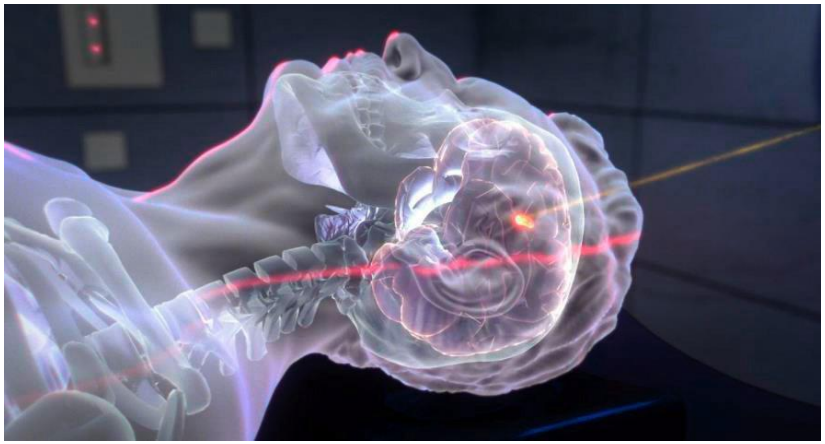
Make the most of the Spanish effort, maximizing:
- influence on decision
- contribution to winning project
- scientific and economic return

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

Spanish network: past successes

-- One structure that brings theory, accelerator and experiments together!
-- Important contributions to accelerator technology (CIEMAT, IFIC)
-- Influential phenomenological studies (NP, top and bottom, Higgs, taus)
-- Strong role in ILD detector concept and calorimetry (M.C. Fouz, A. Irles et al.)
-- Excellent connections with industry (INEUSTAR, CDTI, etc.)

Further reading:
CSIC installation for ion therapy:
press release, press release



ILC → CLIC → medical applications → FCCee

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Further reading:
ECFA Higgs factory study: document

ECFA Higgs/Electroweak/Top Factory Study Coordinators:

WG1 Physics Performance
Jorge de Blas (Granada)
Patrick Koppenburg (Nikhef)
Jenny List (DESY)
Fabio Maltoni (UC Louvain / Bologna)
Former coordinator:
Juan Alcaraz Maestre (CIEMAT Madrid)

Chief Editors
Christos Leonidopoulos (Edinburgh)
Aidan Robson (Glasgow)

WG2 Physics Analysis Methods
Patrizia Azzi (INFN Padova)
Fulvio Piccinini (INFN Pavia)
Dirk Zerwas (IJCLab/DMLab)

WG3 Detector R&D
Mary Cruz Fouz (CIEMAT Madrid)
Giovanni Marchiori (APC Paris)
Felix Sefkow (DESY)

Key role of Jorge de Blas in strategy update

Important contributions from IFIC
in BSM, two-fermion production,
top physics and global EFT interpretations

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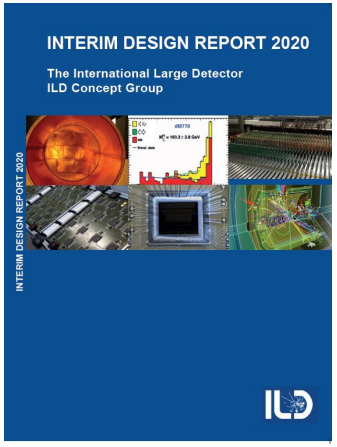
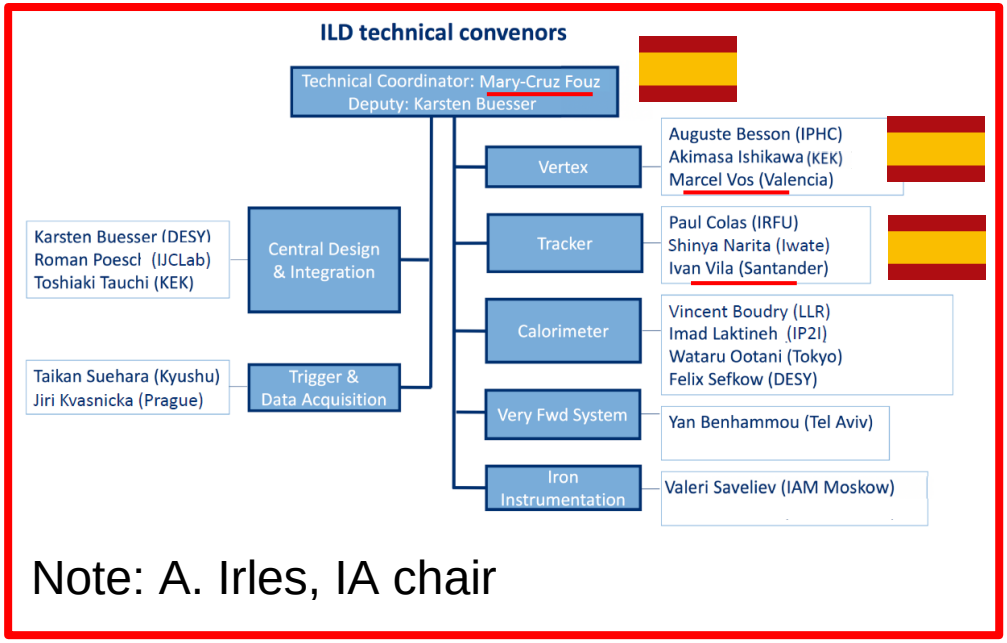
-- Strong role in ILD detector concept and calorimetry (M.C. Fouz, A. Irles et al.)
-- Influential phenomenological studies (new physics, top and bottom, Higgs, taus)
-- Small, but powerful theory involvement (S. Heinemeyer, J. De Blas)
-- Excellent connections with industry (INEUSTAR, CDTI, etc.)

CALICE → DRD6 → LUXE → FCCee Calorimeter!
DEPFET → Belle II → DRD3/8 → FCCee VXD?

Further reading:
ILD EOI for FCCee: document





Note: A. Irles, IA chair

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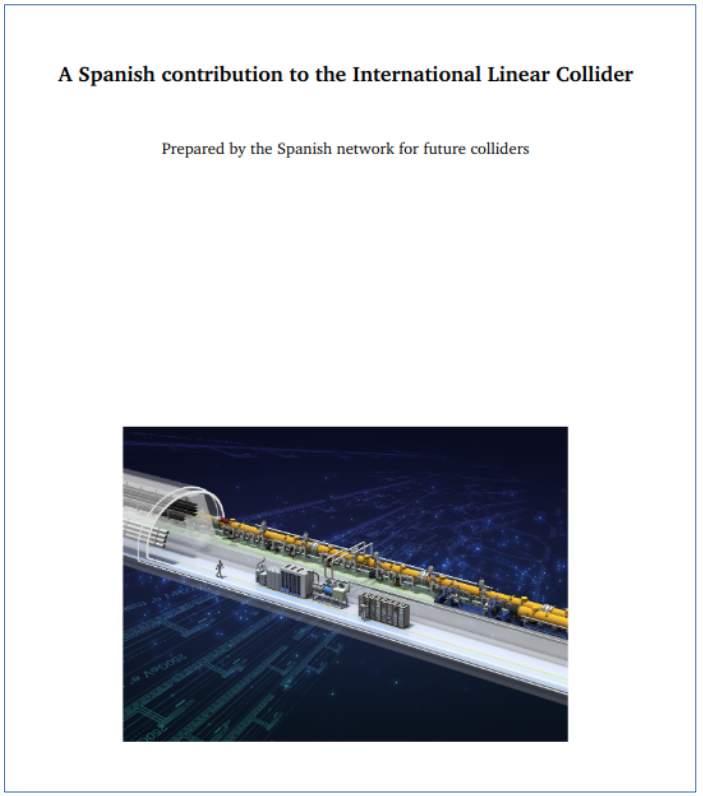
Further reading:
ECFA Higgs factory study: document
ILD EOI for FCCee: document
Study on possible Spanish contributions:
Newsline article



Upcoming FCCee session at the “winter meeting”

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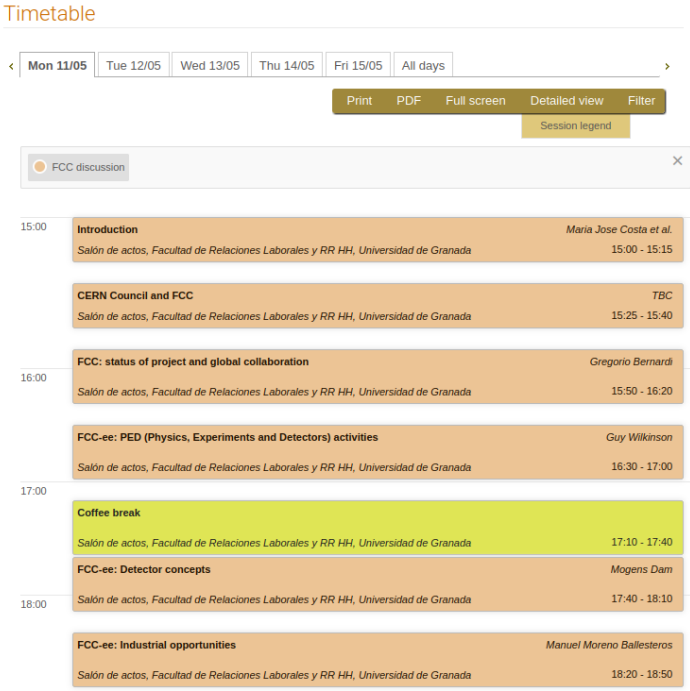
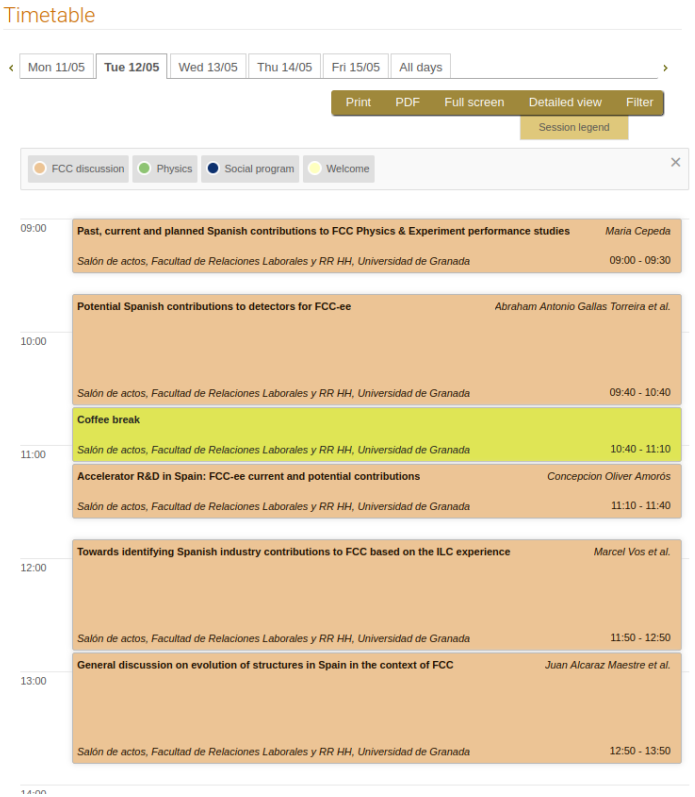


Monday: mostly FCCee speakers
Gregorio Bernardi, Guy Wilkinson, Mogens Dam
+ Manuel Moreno/Javier Echavarri



Tuesday: mostly Spanish discussion
-- experiment: Maria Cepeda/Mary Cruz Fouz
-- accelerator: C. Oliver, M.V., E. Fernandez
-- overall discussion: Juan Alcaraz

What can we do today?

Identify people and resources at IFIC contributing to FCCee
The main challenge is to find young people with time, in parallel to existing commitments to running projects

Join the discussion in Granada!

Join other institutes in the future collider network, preparing a complete and viable plan for a Spanish FCCee contribution:
--- starting from the accelerator (!)
--- not forgetting theory and computing,
--- playing our role in detector R&D (DRDs!) and experiment(s)