Introduction
– status of the network and scope of the meeting

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Jornadas CPAN, 19/11/2024

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The Spanish network for future colliders

A new call has been launched (deadline 10/07) to **renew the Spanish networks**
- particle/astro/nuclear institute CPAN, thematic networks LHC, FC, nuclear...
- little success for HEP in last round (LHC and future colliders not funded!)
- new network focused on instrumentation (HEP, nucl., astro) will apply, too

Expect additional funding at best (max. 50.000 euros for redes tematicas).
Regardless of outcome, the network for future colliders will continue to play its role.

We applied for a network for future colliders, that covers all aspects, from the physics case and experiments to the machine and the industrial return:

“desarrollo tecnológico en aceleradores y detectores, diseño de experimentos, y estudios del potencial científico para la proxima instalación en física de altas energías”

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

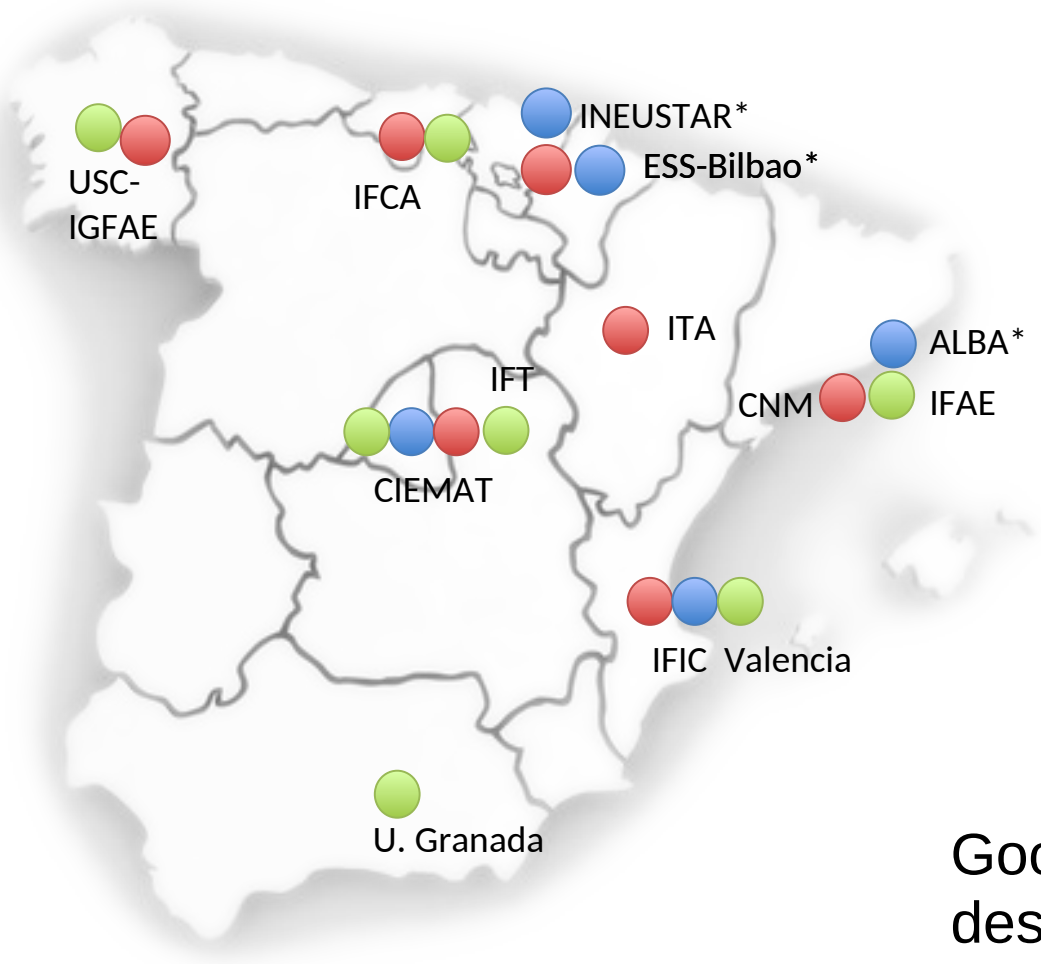
Nodos asociados:

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

Erik Fernandez, INEUSTAR (miembro asociado)

Thanks to Mary Cruz and the IPs of all nodes for help preparing the proposal in time

The Spanish network for future colliders



Activity	# Groups
Accelerator	5
Detectors	7
Phenomenology	7

Good coverage of theory, design of the experiments and detector and accelerator technology

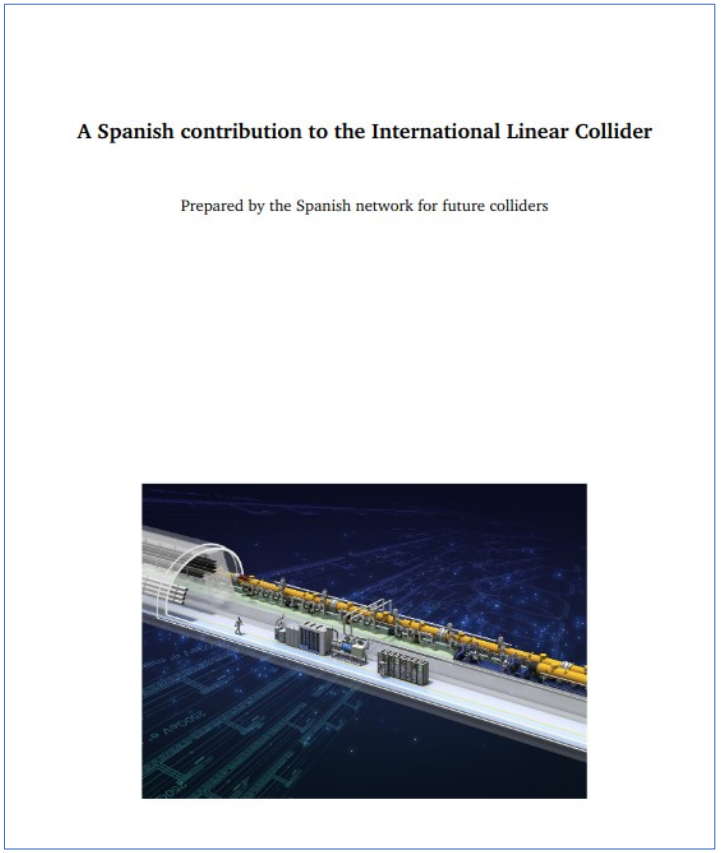
Role of the network

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



ECFA - the european committee for future accelerators

– the European equivalent of this network

Celso Martinez Rivero continues for another 3 years in Restricted ECFA
M.V. extended for 3 years in Plenary ECFA

Concepción Gonzalez Garcia → Jose Santiago (U. Granada)
Luis Garcia Tabares (CIEMAT) → Concepción Oliver (CIEMAT)

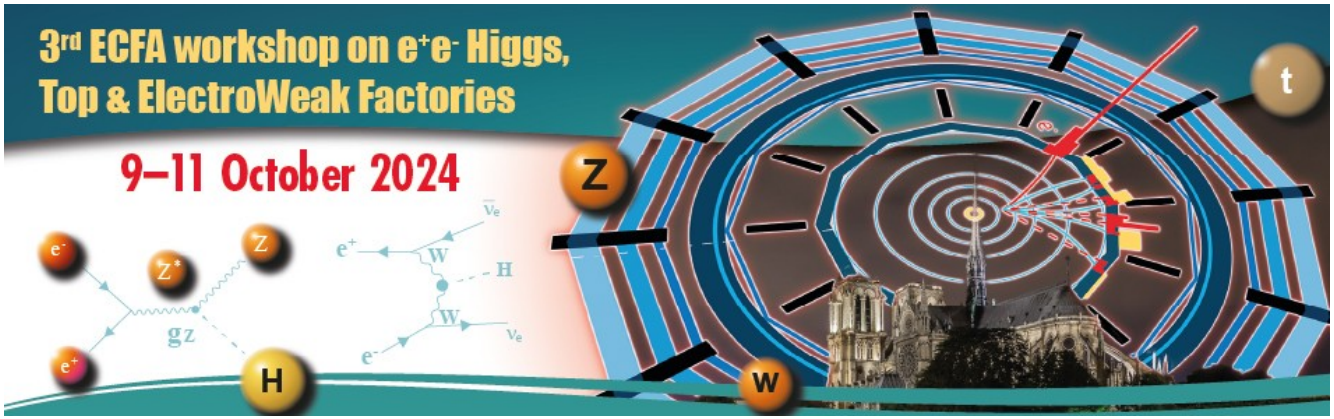
ECR: Sergio Blanco, Carla Marin, Paula Martinez + Cristina Martín
----- We'll hear from Cristina after my talk

Plenary ECFA meeting at CERN last week (many great talks):
https://indico.cern.ch/event/1361604/

ECFA Higgs/top/EW factory studies

Neutral terrain to further develop the electron positron “Higgs factory” physics case

Indeed, many joint studies on new topics (H→ss) were presented in Paris
---- see talk by Sven Heinemeyer

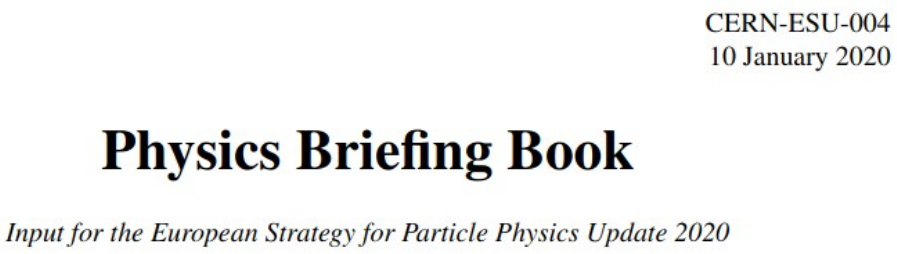


Good Spanish participation, from theory and experiment
(H→ ττ , e+e- → bb/cc, global analysis, top physics, detector studies)

Report + backup documents in progress; will be absorbed in physics briefing book

European strategy update

Preparations have started:
Karl Jakobs was recently elected as “strategy secretary”
Pilar Hernandez, Maria Jose Costa and Jorge de Blas from Spain


CERN-ESU-004
10 January 2020

Physics Briefing Book

Input for the European Strategy for Particle Physics Update 2020

(see arXiv:1910.11775)

Countries and projects provide inputs by March ‘25
-- see Spanish input to the last strategy here
-- current input from future collider network circulated in summer

Baseline and alternatives

Baseline and possible alternative scenarios

Current baseline – justified by 2020 Strategy – :
FCC integrated programme (FCC-ee followed by a hadron collider of at least 100 TeV)

Possible alternative scenarios (for next collider, following the HL-LHC)

- Realisation of a lower-energy hadron collider (50 – 80 TeV) on an earlier timescale (2050 – 2055)
- Linear Collider at CERN (CLIC, …)
- Muon Collider at CERN
- Further exploitation of the LHC physics programme, eventually with the addition of e-h collisions
- …

Non-exhaustive list, other scenarios may come up and be proposed by the community

Financial feasibilty?

Identification of funding beyon CERN budget is an intrinsic part of the mandate for the feasibility study

No explicit cost sharing model in mid-term report, but…

FCC cost (of approx. 17 billion $) to be shared by
- host states (FR and CH have greater return)
- member states, following the usual weight-by-PIB
- agreements with non-member states (i.e. US)
- European Union funding (Draghi report)
- private donors (sizable?)

NEWS | 06 June 2024

CERN's $17-billion supercollider in question as top funder criticizes cost

Germany has raised doubts about the affordability of the Large Hadron Collider's planned successor.

By Davide Castelvecchi

CERN will discuss cost sharing model with the council, but this information will not be made public in the feasibility study report, at the open symposium, or even for ECFA

Based on a recent Nature article:
https://www.nature.com/articles/d41586-024-01671-8

Germany, which already contributes €267 million (US$290 million) annually to CERN — some 20% of the lab's budget — cannot afford to spend more, said Eckart Lilienthal of the country's Federal Ministry of Education and Research (BMBF) on 23 May, at a workshop for particle physicists in Bonn, Germany. (see slides)

Can China really beat us?

NEWS | 17 June 2024 | Correction 18 June 2024

China could start building world's biggest particle collider in 2027

The US$5 billion facility would be cheaper, bigger and faster to build than a similar one proposed by European scientists.

By Gemma Conroy

Numbers and statements from a recent Nature article:
https://www.nature.com/articles/d41586-024-02005-4

Check out their TDR:
https://arxiv.org/abs/2312.14363

Total cost of the facility:
5.2 billion $ (vs. 17 billion $ in Europe)
Possible start of construction:
2027 (vs. 2030s in Europe)

Yifang Wang (IHEP, head of the project):
"We are now confident this is a real machine that we can build"
Frank Zimmerman (CERN, chair of TDR review):
"IHEP might now have more expertise in this area than does CERN"
Andy Cohen (Hong Kong, Int'l advisory panel:
"The TDR demonstrates that China is capable of building the CEPC's accelerator with little assistance from international researchers"

Note: Experiments (not in the TDR) would be international, according to Yifang Wang

Sustainable exploration?

We have only one planet!

The weight of environmental impact (i.e. cost in CO2, as well as in $) in the decision-making process is increasing, as requested by our ECR scientists

Full life-cycle assessments by professionals are being performed by most projects
- understand impact of construction vs. operation
- find ways to mitigate unnecessary impact

LDG Sustainability WG to hand in report on benchmarks (talk here)

Sustainable exploration of the energy frontier requires that we invest in novel acceleration technology! Brute-force scaling cannot be the (only) answer!

European strategy update

March 2024: CERN Council started the process

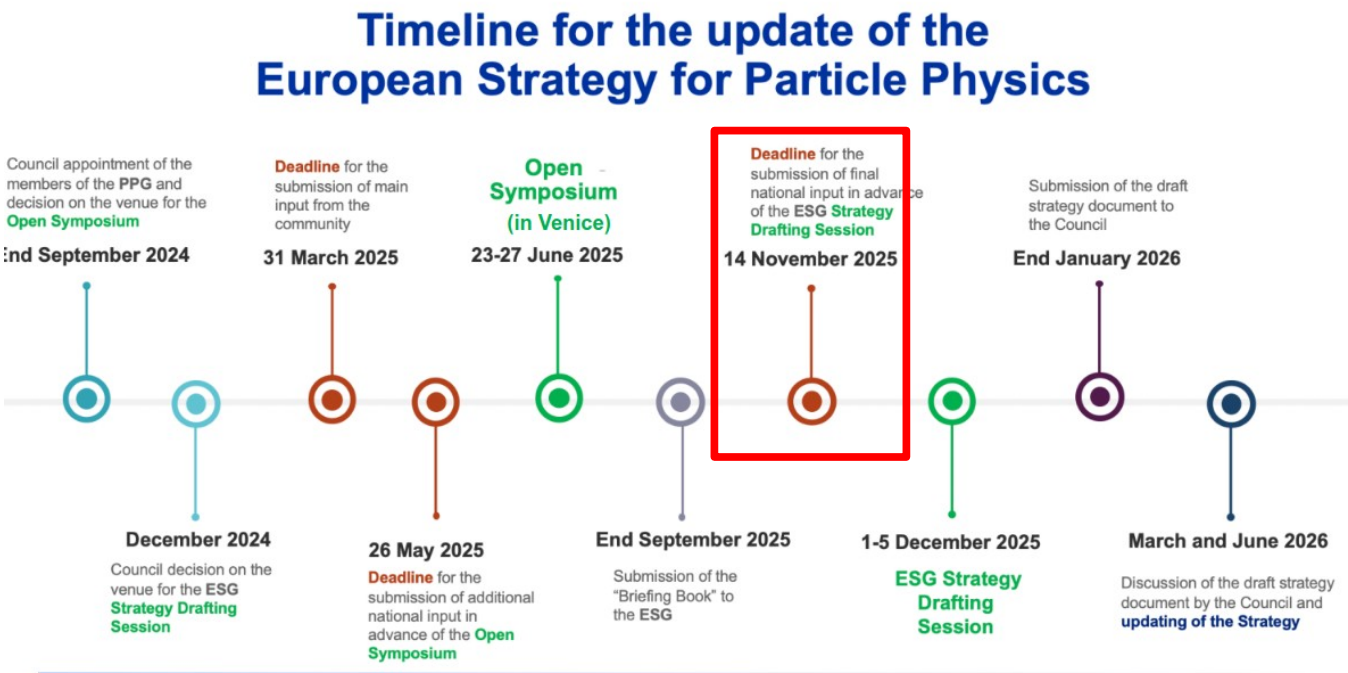
June 2024: Karl Jakobs (Freiburg) appointed Strategy Secretary

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/

Spanish input: future collider network

The first priority of the Spanish HEP community for a large facility beyond the LHC and HL-LHC is the realization of an electron-positron collider with sufficient center-of-mass energy and luminosity to produce a large sample of Higgs bosons and top quarks in a clean and calculable environment

The Spanish community has not reached a clear consensus in favour of either option, but will support a new “Higgs factory” facility, whether it is a circular or linear collider. Should a “Higgs factory” project for an electron-positron collider be approved, the Spanish HEP community will lend its full support to the project, actively contributing to accelerator and detector R&D, the experiment design and Standard Model calculations, and to studies of the scientific program.

In summary, Spanish institutes in fundamental physics, Spanish technological centres and the Spanish science industry are committed to making an important contribution to the next European facility in high energy physics. The facility of choice of the Spanish HEP community is a Higgs and top factory with a competitive precision physics programme, irrespective of whether it is implemented as a circular or linear collider. Spanish groups have a long track record in the definition of such a facility and considerable expertise exists regarding all aspects of this project, from accelerator technology to experiment design and from advanced analyses techniques to high-precision Standard Model predictions.

Spanish inputs: LHC + HL-LHC

The HL-LHC is not a “future” collider like the Higgs factory; it’s approved and under construction

Not surprisingly, the Spanish input will have a statement expressing its commitment to the LHC program and HL-LHC upgrade

Short/medium term priorities

- Spanish institutes are deeply involved in the LHC experiments: ATLAS, CMS, LHCb and MoEDAL, as well as in the high-luminosity upgrade of the collider and associated detectors.
- The LHC+HL-LHC program is the flagship of HEP for the next 15-20 years. Adequate completion of the HL-LHC program - exceeding an integrated luminosity of 3 ab^{-1} - is a priority

Spanish input

Several Spanish theory groups have indicated that they agree that the priority of the field at large must be a Higgs factory, but insist on the value of a healthy and diverse program, including e.g. heavy ion physics (EIC, LHCeC, FCChh)

Short/medium term priorities

- Diversity in physics interests should reflect in different experimental programs (e.g., lattice and hadron networks interested in heavy ions and hadronic structure - EIC, FAIR,...; lattice on flavor - Belle-II, FCCee,...; NA64;...). Diverse experimental programs, e.g., LHeC, could fill time gaps between major projects.

Spanish input: CERN facility beyond HL-LHC

CPAN networks have expressed an opinion:
- future colliders, LHC, hadron physics, lattice, instrumenation, accelerator experts

There are plenty of points where we do agree:

Which is the preferred option for CERN's next flagship facility?

The Spanish HEP community:

- supports a Higgs/top/EW factory electron-positron collider that can characterize Higgs, top and EW interactions at exquisite precision;
- insists that a positive decision should be reached as soon as possible to guarantee a timely start of the construction of this facility;
- is involved in the FCCee project and proposals for a linear collider, as well as the ECFA Higgs/top/EW factory studies;
- will contribute to the electron-positron collider that is selected by the European strategy process, whether it is circular or linear

Spanish input: CERN facility beyond HL-LHC

Discussion of scenarios is proving difficult:

- alternatives are not fully worked out
  (i.e. cost/feasibility of early hadron collider remains unknown)
- phrasing is delicate
  (enthusiastic/dismissive statements about a linear/circular option are vetoed)

After-LHC scenarios

- If the FCCee is feasible and is approved, the Spanish community will contribute to the FCC-ee project
- If the FCCee proves not to be feasible or is not approved, Spanish groups have expressed a preference for a linear electron-positron collider as the next flagship project at CERN
- A hadron collider with sqrt(s) > 50 TeV should also be considered: the feasibility, timeline and cost of such a machine should be assessed
- If the CEPC is approved early, there is limited interest in participating
- If a linear collider is approved in Japan, Spanish institutes, which have a long-standing participation in linear collider activities, will be interested to participate

This wording didn't make it. You'll hear what did from Maria Jose Costa on Thursday

Spanish input: longer term view

Longer-term view is conditioned by next facility decision:

- existing infrastructure
  (tunnels represent a significant fraction of cost and CO_2 budget)
- limited R&D resources
  (money spent on, say, magnets cannot be spent on wakefield acceleration)

Here, agreement turns out to be possible
(but these are just “words” if they don’t translate in a real investment)

Long-term: accelerator R&D

- Vigorous R&D of key accelerator technologies is crucial for the long-term future of High Energy Physics: high-field magnets for hadron colliders (14 T with Nb3Sn, 20 T with HTS), high-gradient RF cavities, recirculating LINACs, and novel collider schemes based on muon beams or plasma/wakefield acceleration are important parts of the current roadmap
- The sustainability of collider projects (CO2 footprint of construction and power consumption) and synergies with other fields and industry are key considerations
- Spanish institutes are involved in high-field magnets (CIEMAT, ALBA), high-gradient cavities (ALBA, IFIC) and Energy Recovery LINACs (ESS-Bilbao), as well as beam dynamics and instrumentation. Experience covers both future linear or circular colliders.
- Strong involvement of Spanish industry in accelerator development in close collaboration with research centers.

This week...

SHOULD!!

This is an important meeting, as the next European strategy can shape the future of the field for many years

This morning: ECR meeting (see report by Cristina)
Tomorrow: joint session with LHC and instrumentation networks
Thursday: presentation by Maria José Costa of progress on Spanish input

February 2025: network meeting in Madrid