The Spanish network for future colliders

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Introduction

The network for future colliders:
- is open to all Spanish institutes and researchers
- offers a forum to discuss accelerator and detector R&D
- is instrumental for contributions to future collider projects
- is not limited to one project; we will implement the global strategy

Regular (annual) meetings with all network nodes

Ad hoc (as needed) meetings to discuss specific issues

Progress of the European strategy update

Strategy update proceeding; the briefing book is public

Physics conclusions are as might be expected from discussion at Granada

Broad consensus that a “Higgs factory” is needed

- all initial e+e- collider projects offer similar performance for Higgs couplings
- complementary physics potential away from 250 GeV; TeraZ vs. HH and ttH production
- extra-scientific arguments: CERN vs. Japan vs. China

The goal beyond the Higgs factory is “exploration”

- energy reach is key to success
- pp colliders with current or next-generation **magnets**
- new accelerating technologies?

Scenarios

Distinguish three periods:

2020-2040: LHC and HL-LHC in Europa...

2040-2060: Higgs factory (ILC/CLIC/FCCee/CEPC)
pp collider at CERN (LE-FCC-hh, 40-50 TeV)
ep collider at CERN (LHeC)

2060-2080: CLIC3000 or FCChh
possibly a muon or plasma collider?

	2020-2040	2040-2060 1st gen technology	2060-2080 2nd gen technology
CLIC	HL-LHC	CLIC380-1500	CLIC3000
CLIC-FCC-mixed	HL-LHC	CLIC380	FCC-h/e/A (Adv HF magnets)
FCC	HL-LHC	FCC-ee (90-365)	FCC-h/e/A (Adv HF magnets)
LE-to-HE-FCC-h/e/A	HL-LHC	LE-FCC-h/e/A (LF magnets)	FCC-h/e/A (Adv HF magnets)
LHeC+FCC-h/e/A	HL-LHC + LHeC	LHeC	FCC-h/e/A (Adv HF magnets)

Call for “redes tematicas” 2018

16 nodes:

IFIC Valencia (M.V.),
IFCA Santander (A. Ruiz-Jimeno),
IMB-CNM Barcelona (S. Hidalgo),
U. Barcelona (A. Diéguez),
CIEMAT- (M.C. Fouz),
U. Santiago (A. Gallas),
ITAINNOVA Zaragoza (F. Arteche),
U. Granada (F. Cornet),
CIEMAT-TEC (L. García-Tabares),
ALBA-CELLS (F. Perez)
ESS-Bilbao (I. Bustinduy)
IFAE Barcelona (S. Grinstein)
IFT Madrid (J.M. No)
CNA Sevilla (J. Gomez)
U. Sevilla (R. Palomo)

Associated: INEUSTAR (E. Fernandez)

Cover every aspect, from accelerator R&D (ALBA, CNA, CIEMAT, ESS, IFIC) to detector R&D (CNM, CIEMAT, IFAE IFCA, IFIC, ITA, UB, US, USC), industry (INEUSTAR) and theory (IFAE, IFCA, IFIC, IFT, U. Granada)

Evaluation

Very positive description of the institutes and researchers involved in the network, clear understanding of the importance of a coordinated approach,
but our proposal was not selected for funding this call

Granted about half of network proposals. Approved in particle physics:
LHC, astro-particles, SKA, GAIA, nuclear physics

We're in good company: also the networks around Planck & NEXT and on hadronic physics, gravitational waves, relativity and gravitation have not received funding

We will continue to organize network meetings without funding
– up for discussion: date and venue for next meeting

We will definitely apply again in the next call
– encouraged by programme manager, suggestions are welcome

Challenges for the network (I)

During the R&D phase, the network's main tasks are:

- a meeting point for theory and experiment (e.g. talk by Sven Heinemeyer)
- forum for discussion of progress in accelerator and detector R&D
  (e.g. talks by Francis Perez, mary Cruz Fouz, Salvador Hidalgo)
- a help finding funding from diverse sources
  (ex. AIDA, AIDA2020, CSIC platform, see talk by Ivan Vila)
- representation of the the Spanish community in collider projects
  (e.g. Alberto Ruiz for CLIC, Juan Fuster for ILC)
- preparation of inputs from the Spanish community in strategy discussions

Challenges for the network

As soon as a future collider project is approved, the network will be instrumental to move quickly to consolidate our position in the organization of the project, to define a Spanish in-kind contribution to the machine, and to take a leading role in the formation of the experimental collaborations.

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It seems like a long wait for a decision now, but don't worry:
we'll wish we'd had more time to prepare things very soon

Today's menu:

Brief review of recent progress (accelerators, detectors, theory)

Discussion of CSIC platform

Some words from ILC and CLIC

Discussion on scenarios

The scenarios only deal with European (CERN) projects

- As European scientists we would like to see a strong European program
- CERN cannot afford to have a less-than-world-class project
- It's tepting to try and isolate a part of the proble

We can only decide CERN's future in the international context

New opportunities:

- the possibility to realize projects in the US and Asia with a strong European role
  (CERN in DUNE, European involvement in the International LC)
- the possibility to find a broader basis for particle physics
  (in econo with a stronger growth than ours)

Correctly identify "threats":

- the (very real) possibility that the Chinese governent realizes "our" project faster and cheaper than we can

Response of the Spanish network for future colliders to the physics briefing book and concrete collider scenarios – input to the 2020 European strategy update process

The goal of the Spanish network for future colliders is to ensure a healthy Spanish contribution to a vibrant and diverse high-energy physics programme. We take the point of view that the field of particle physics is a truly global effort. We expect that the global HEP programme will be led by Europe, but that contributions and facilities will not be limited to Europe. In that view, an optimal HEP programme depends on the international situation, in particular on the fate of collider projects in Asia, and the discussion of future installations in Europe must take into account the international environment.

Completing the Standard model

One clear consensus: the next installation in high-energy physics should be an e^+e^- collider capable of a precise characterization of the Higgs bosonn (and top quark)
(cf. LEP precision EW after discovery of W and Z bosons at SppS)

Two schools of thought about the realization of a higgs factory:
- circular (FCCee: 100 km/240 GeV, CEPC: idem)
- linear (ILC: 20 km/250 GeV, CLIC: 11 km/380 GeV)

- Very different stages of design - CDR vs. TDR – but all projects are technically feasible
- The cost of FCCee y CLIC380 correspond to 10-13% of the CERN budget between 2025 and 2045, if we assume that the civil engineering will be financed from outside the budget.

Electron-positron Higgs factory and precision measurements at the energy frontier

After the discovery of the Higgs boson at the LHC, the main priority of the field is to build an electron-positron collider with sufficient energy to produce the Higgs boson and (possibly at a later stage) top quark pairs, di-Higgs-boson events and ttH events. This programme allows for a determination of Higgs boson couplings to sub-% level and a robust observation of its self-coupling.

We believe that in the relevant energy range a linear collider offers a more cost-effective solution than a circular collider once all costs (including civil engineering and operating costs) are accounted for on an equal footing. While recognizing the value of the Z-pole capabilities of circular colliders, we believe that linear colliders, with their extendable energy reach, offer greater potential for a scientific breakthrough. Members of the Spanish network for future colliders remains deeply committed the projects for a linear electron-positron collider, to be hosted either in Japan (ILC) or in Europe (CLIC).

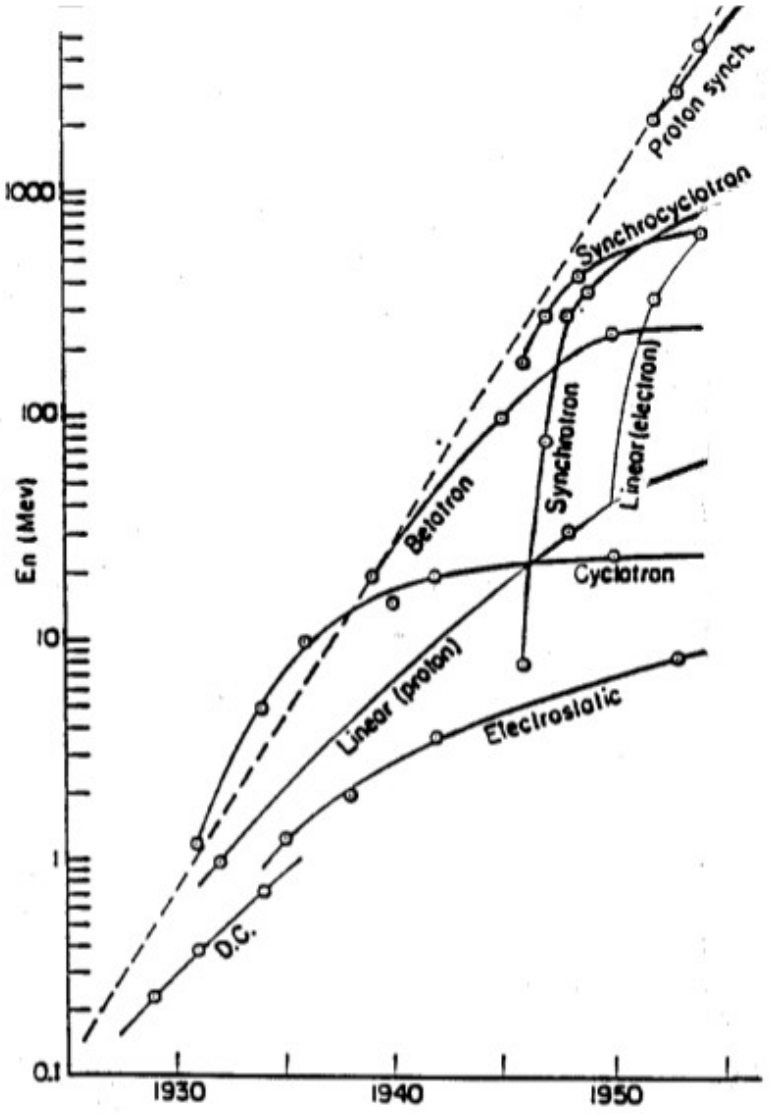
We distinguish the following scenarios for the realization of a high-energy electron-positron collider:

- If the Japanese government decides to host the ILC, the Spanish network recommends that CERN and Europe should take a pro-active role in the project. Toghether with Japan and other international partners we should ensure that the facility provides a world-class "Higgs factory" programme and should pursue a timely energy upgrade.

- If the negotations between Europe and Japan to build the International Linear Collider in Japan should not bear fruit, Europe should take responsibility for building the electron-positron Higgs factory. The CLIC380 initial stage should, at that point, become the first priority of the CERN programme.

The decision process to build a circular collider in China (CEPC) should be followed with attention, but is not expected to come in time to influence the current update of the European strategy for particle physics.

Second goal: exploration



Livingston: factor 10 each 6 years

"Past gains are no guarantee for future returns"

Successfull exploration of new energy regimes over 7 decades, with steep progress (on a log scale)

R. Palmer summarizes 1930-1997 as follows:

energy:	x 10^{12}
spending:	x 10^{6}
intellect:	x 10^{6}

Exploration of the energy frontier in the mid-term (2040-2060)

Complementary to the precision measurements of the Higgs sector, the case for exploration of the energy frontier remains strong. With the LHC, Europe will continue to lead the global effort until well into the 2030s.

A hadron collider based on super-conducting magnet technology forms a baseline solution. The LE-FCC based on established magnet technology, and with a 40-50 TeV collision energy, offers an interesting trade-off of ambition and cost. Realization on the relevant time line depends on a rapid design and decision-making process, but is not excluded. In case Europe should decide not to host an electron-positron collider, this is the preferred scenario.

Longer-term future (2060-2080)

A concrete vision for the very-long-term future of the field is much harder to formulate. The progress of the scientific endeavour is impossible to predict. We therefore cannot confidently commit to a concrete project for the end of the 21st century. The strategy for the next installation should be sufficiently flexible that the next generation of particle physicists can decide freely which direction to take. A vigorous R&D programme is required to make sure the technology is available for continued exploration.

It is currently unclear whether novel accelerating technologies will offer a more cost-effective solution for a high-energy collider, and on which time scale it will be ready to take over from the more established hadron collider technology. The next update of the strategy should answer this question. A focussed R&D effort is required to assess the feasibility of an energy frontier muon collider or advanced linear collider based on plasma wakefield acceleration.