Inputs for the European Strategy Update on Particle Physics: Perspectives from Early Career Researchers in the Spanish HEP community

Lourdes Urda
on behalf of the ECFA
ECR Spanish panel
Madrid 19.11.2024

2020 UPDATE OF THE EUROPEAN STRATEGY FOR PARTICLE PHYSICS

by the European Strategy Group

7 Environmental and societal impact

B. Particle physics, with its fundamental questions and technological innovations, attracts bright young minds. Their education and training are crucial for the needs of the field and of society at large. ***For early-career researchers to thrive, the particle physics community should place strong emphasis on their supervision and training. Additional measures should be taken in large collaborations to increase the recognition of individuals developing and maintaining experiments, computing and software. The particle physics community commits to placing the principles of equality, diversity and inclusion at the heart of all its activities.***

European Strategy Update

At the moment we are in our way towards the 2026 Update of the ESPP

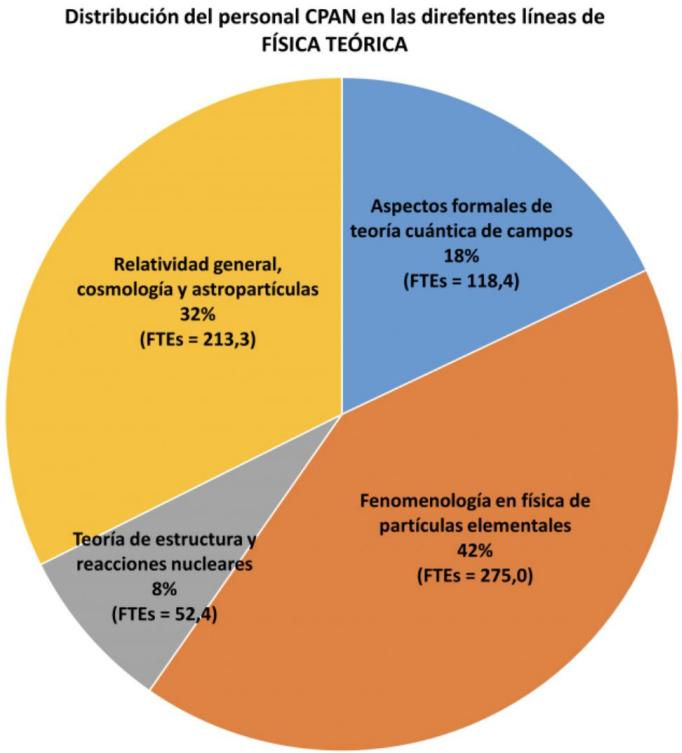
Timeline for the update of the European Strategy for Particle Physics

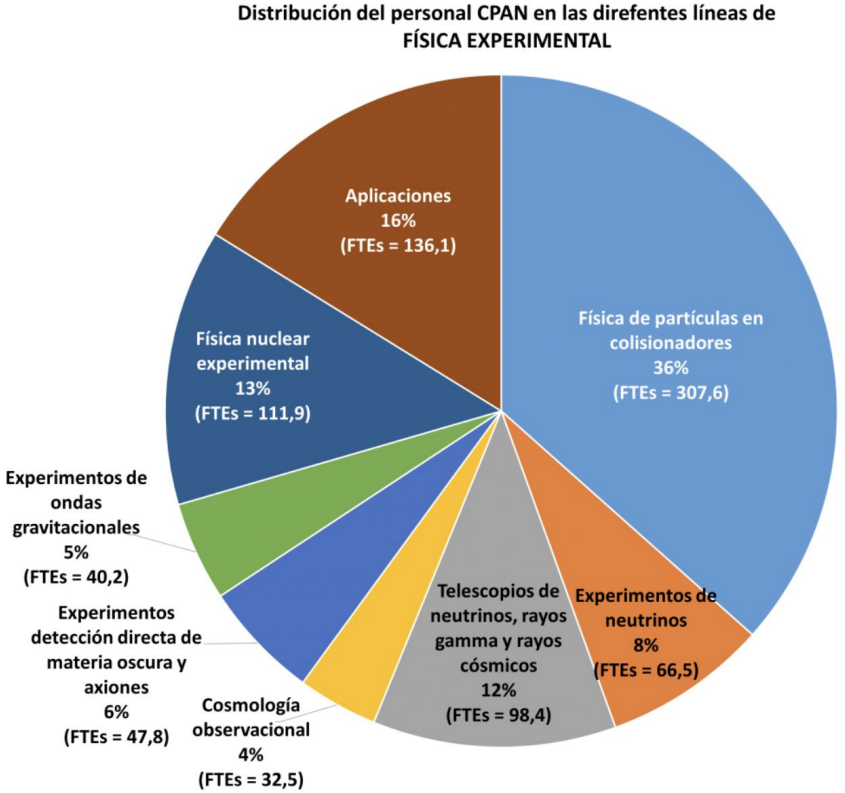
Key dates for the 2024-26 update of the European Strategy for Particle Physics.

Several inputs for the next ESPP from Spain

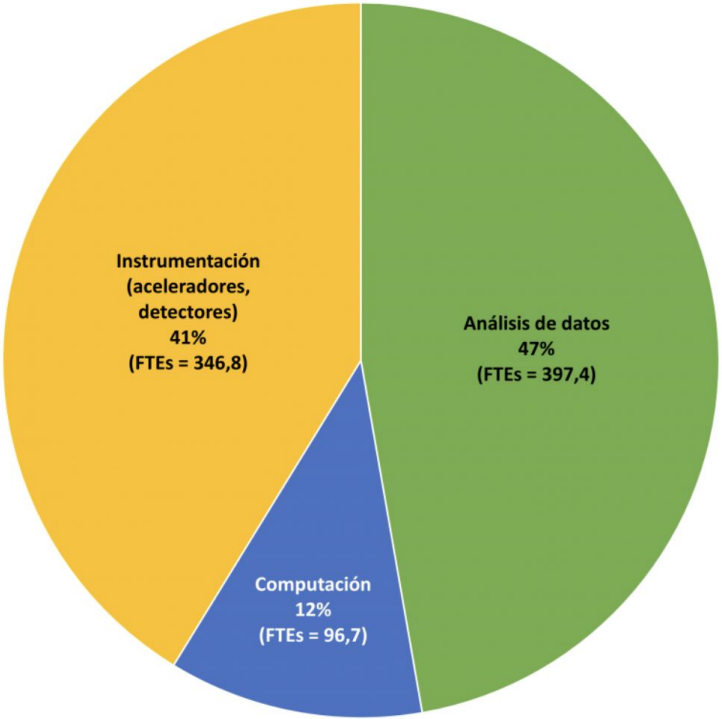
- Spanish Accelerator Community
- CNA (Centro Nacional de Aceleradores)
- COMCHA & Red LHC
- CNID (CPAN Network on Instrumentation and Detectors)
- NEXT Collaboration (Neutrino Experiment with a Xenon TPC)
- LATTICENET & Spanish QCD/Hadron Network
- NA64 & Belle II
- The Worldwide LHC Computing Grid (WLCG)
- **ECR (Early Career Researchers) – LINK TO THE DOCUMENT**

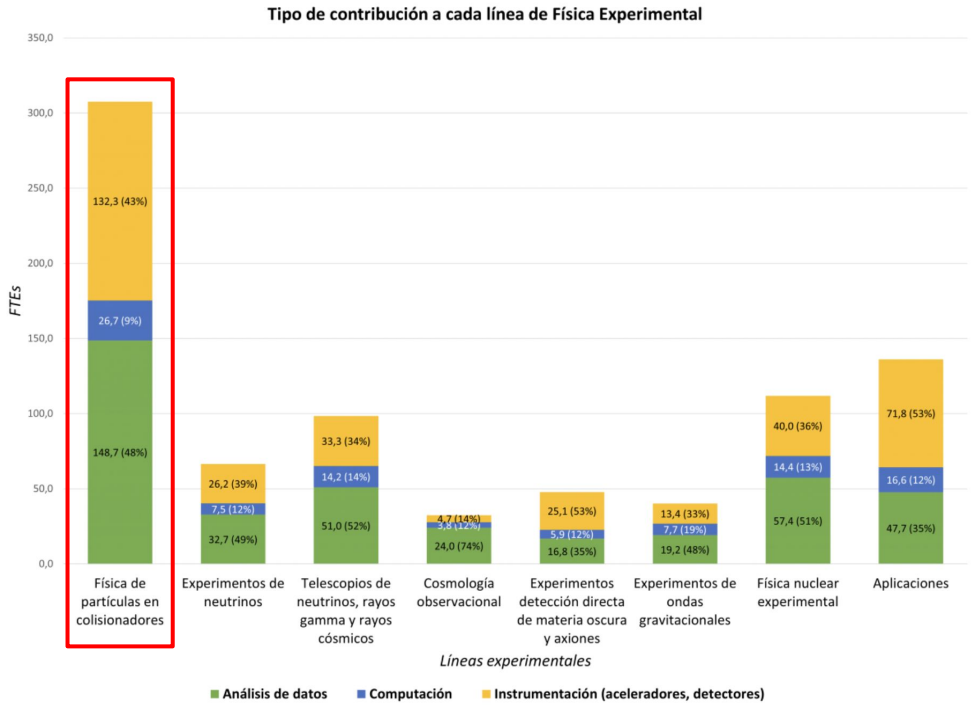
Statistical Data on CPAN Staff



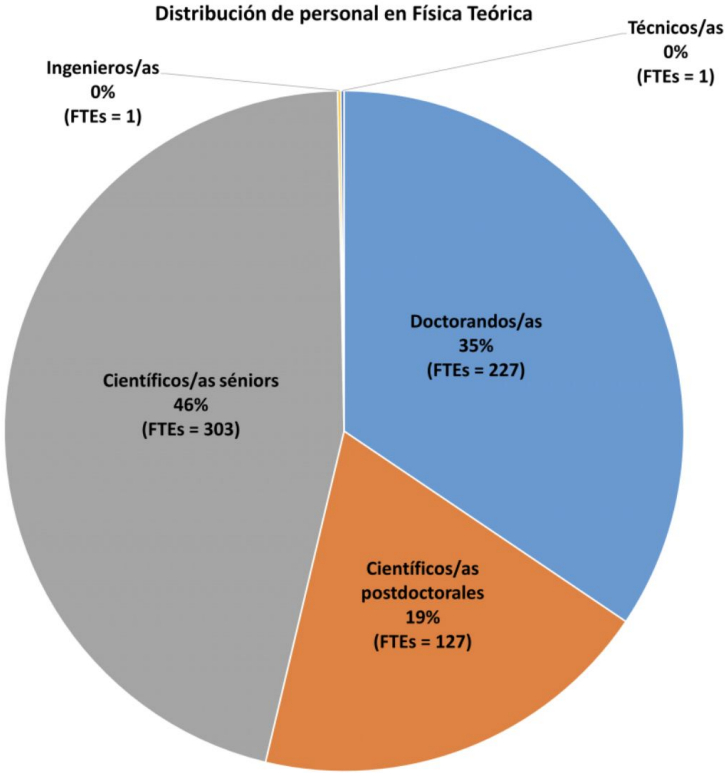


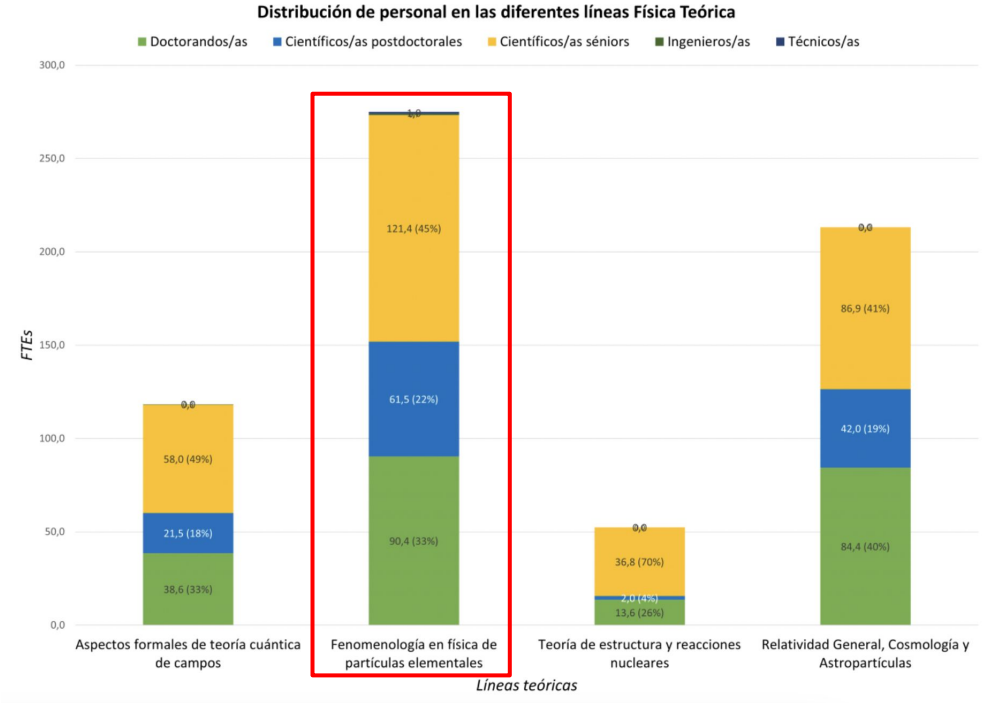
Global Data in Experimental Physics



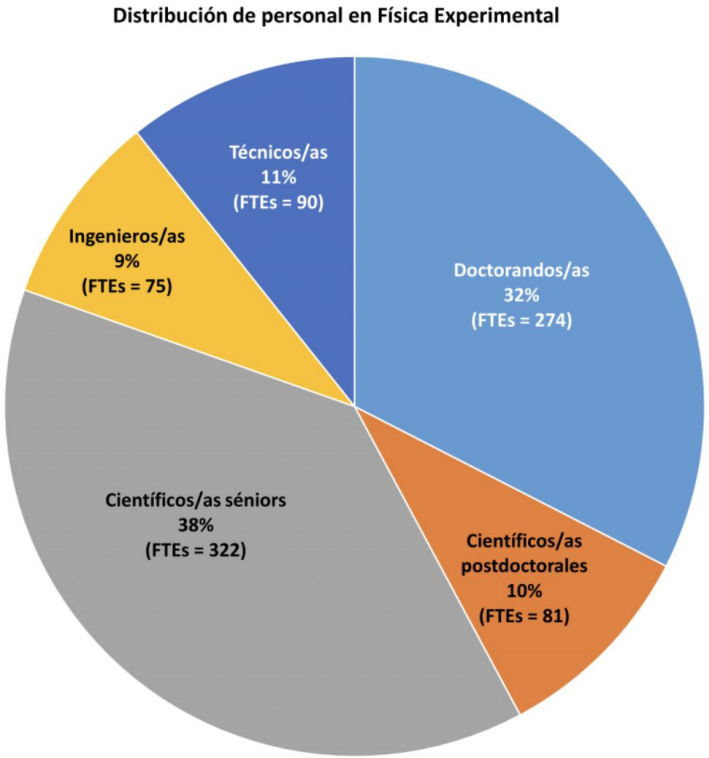


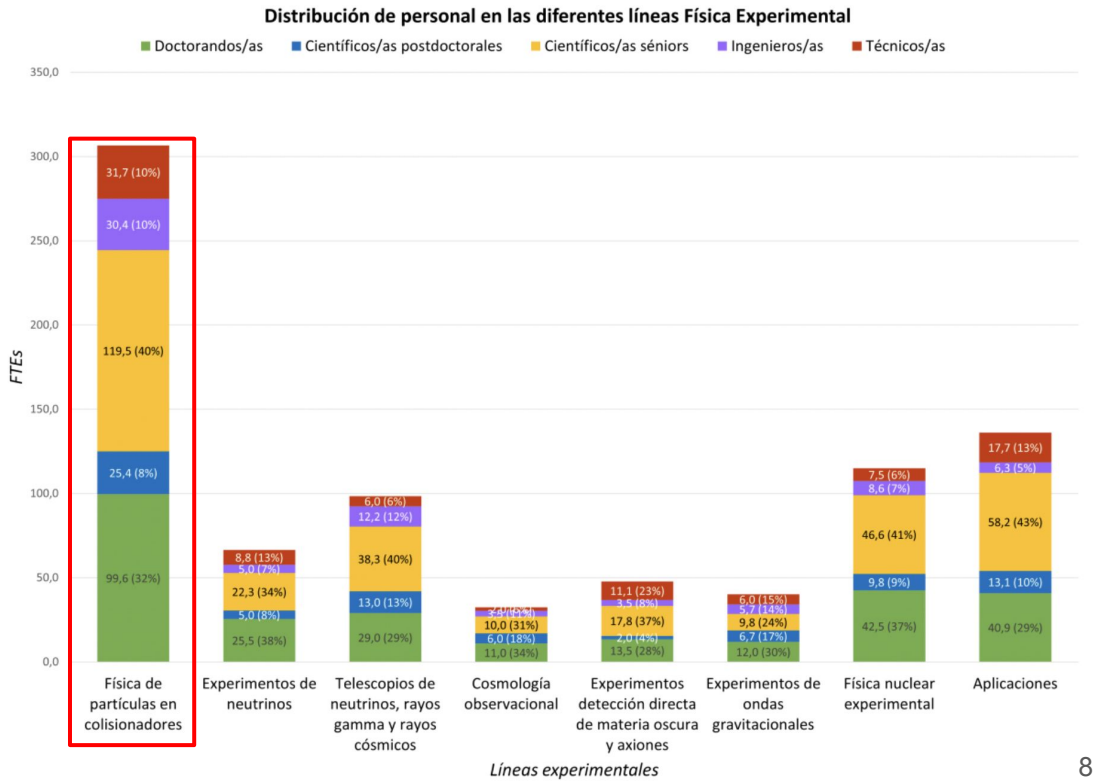
Staff in Theoretical Physics





Staff in Experimental Physics





Early Career Researchers (ECRs)

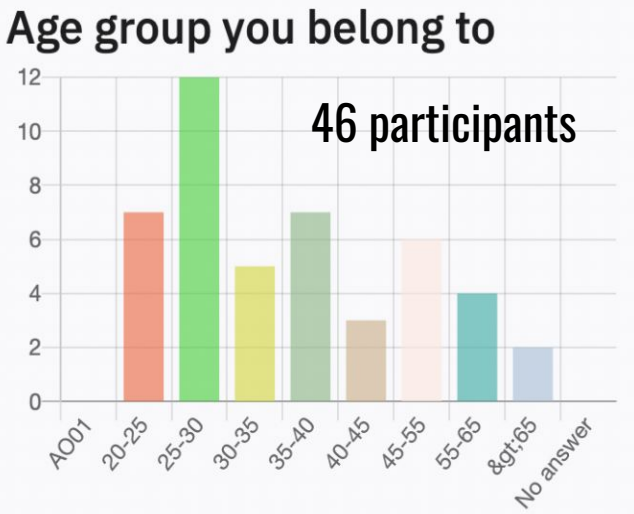
- An Early Career Researcher (ECR) is often defined as someone who is up to 8–10 years post-PhD and/or in a non-permanent position.
- The ESRC identifies three distinct ECR stages
  - Doctoral.
  - Immediately post-doctorate.
  - Transition to independent researcher.
- Only focusing on HEP physics in Spain we are:
  - 125 (Experimental) + 152 (Theory) = 277 ECRs !! – Our opinions are taking into account.

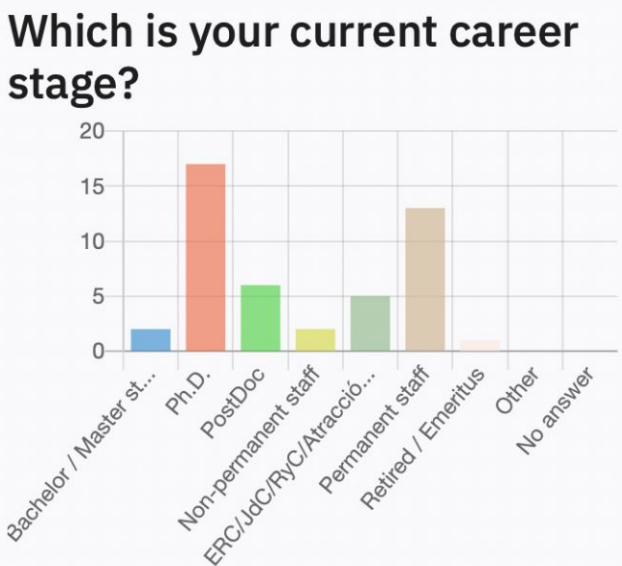
ECFA SPAIN 2024 survey

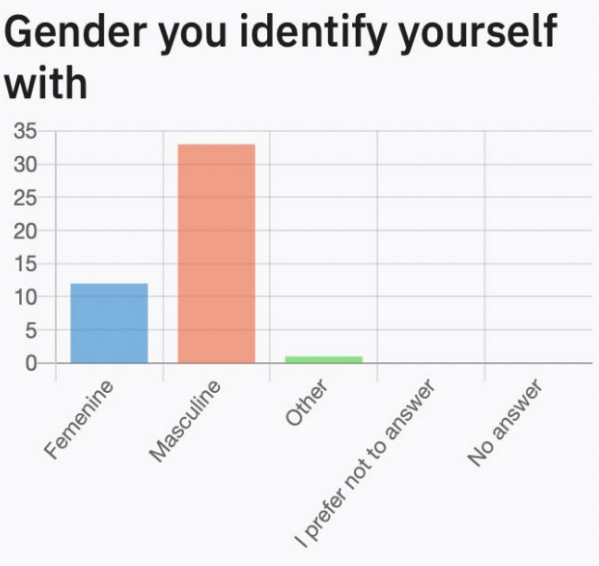
In principle targeting everybody within the Spanish HEP community.

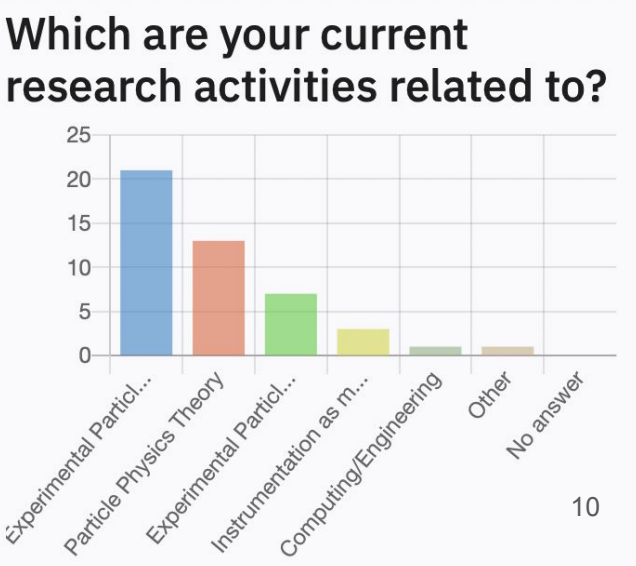
Only 24-31 ECR responded so far.

Join our e-group! : ecr-ecfa-spain@cern.ch

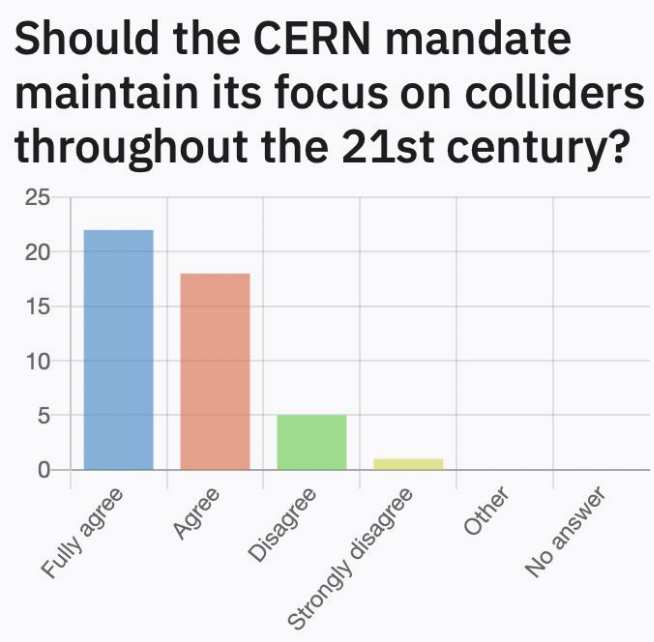


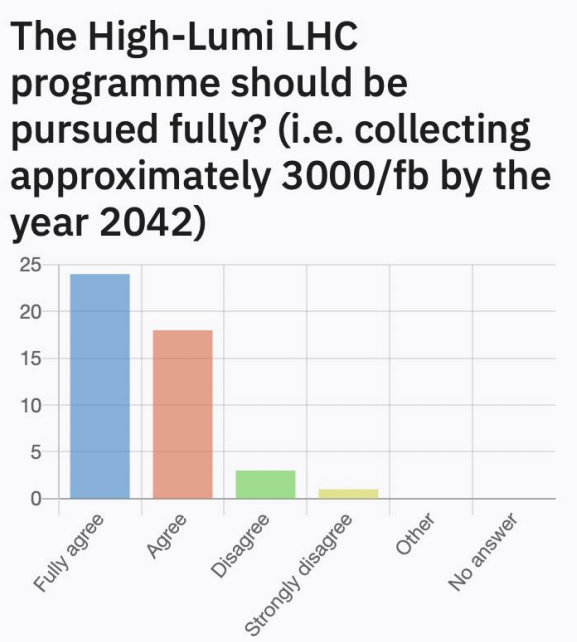






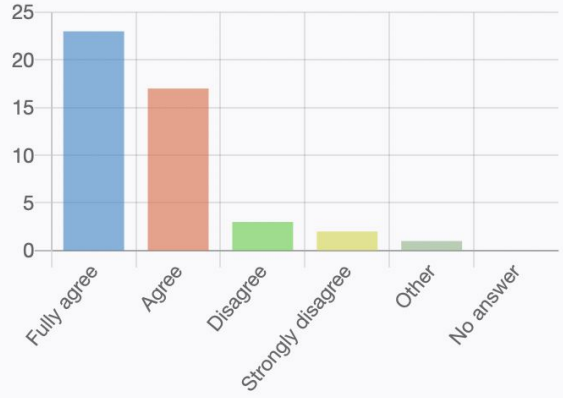
CERN PROGRAMME RELATED QUESTIONS



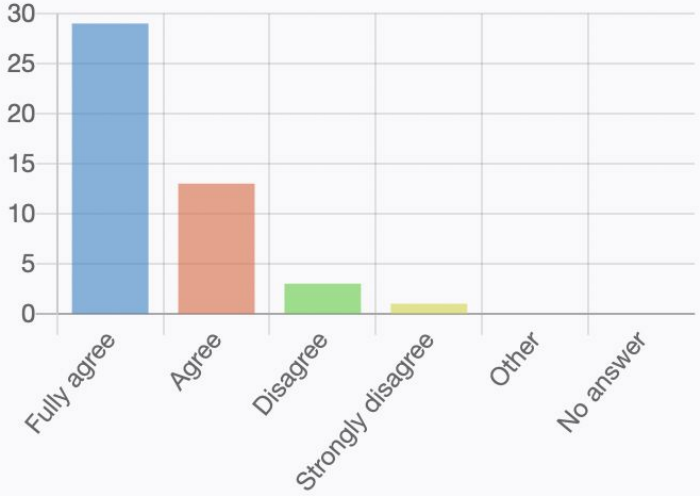


FUTURE COLLIDERS SCOPE

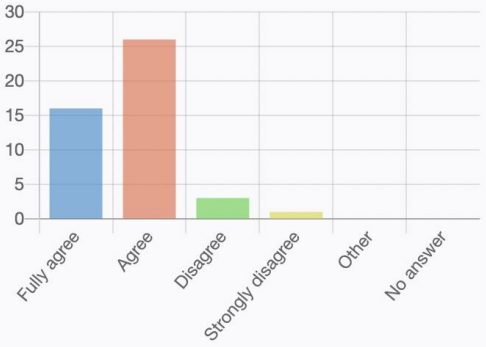
Does the world need a next generation of particle colliders beyond existing machines (LHC, RHIC, DAFNE...)?



Should Europe push for at least one big new facility?

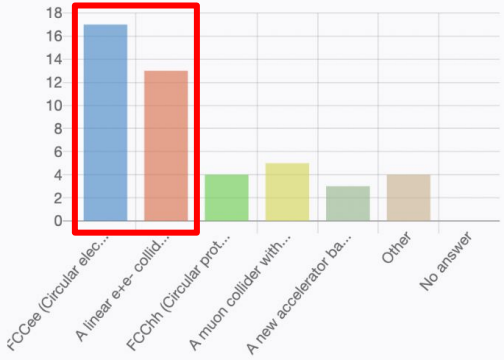


As explained in the introduction of the survey, how much do you agree that an electron-positron collider should be the next highest priority facility in High Energy Physics?



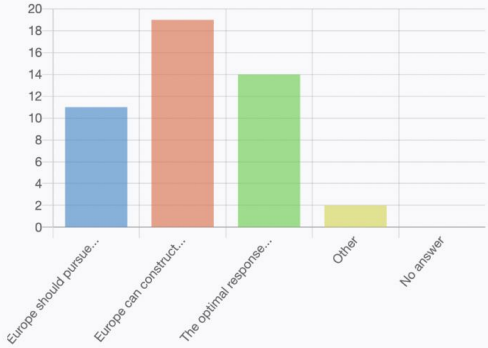
PREFERENCES FOR COLLIDER PROJECTS

Which collider should CERN build after the HL-LHC?



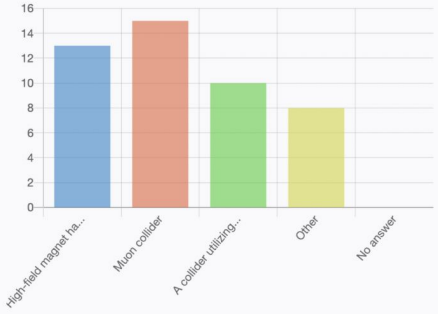
- FCCee (Circular electron-positron collider)
- A linear e+e- collider (based on CLIC or ILC technology)
- FCChh (Circular proton-proton collider)
- A muon collider with 3-10 TeV center-of-mass energy
- A new accelerator based on wakefield accelerator
- Other
- No answer

How will a new electron-positron collider project outside Europe (i.e. ILC in Japan, CEPC in China) affect the decision about the next facility at CERN?



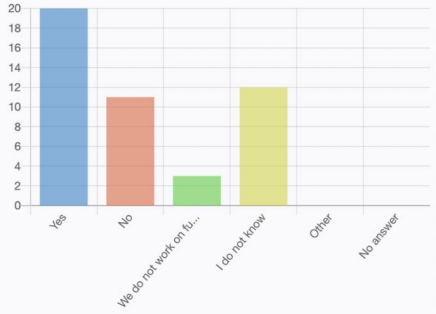
- Europe should pursue its own construction projects, regardless of what is happening outside the continent.
- Europe can construct a circular collider if Asia opts for a linear one, and vice versa, but we should avoid building identical colliders
- The optimal response to the establishment of a Higgs factory in Asia is to immediately pursue an energy frontier collider in Europe (such as FCChh or a muon collider), bypassing the e+e- stage
- Other
- No answer

Which do you think is the most promising technology for an energy-frontier collider beyond the Higgs factory?



- High-field magnet hadron collider
- Muon collider
- A collider utilizing plasma wakefield acceleration
- Other
- No answer

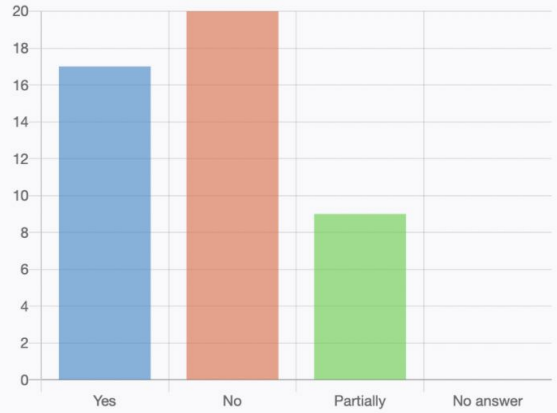
Do you know if your research group has a preference for the construction of a certain type of collider?



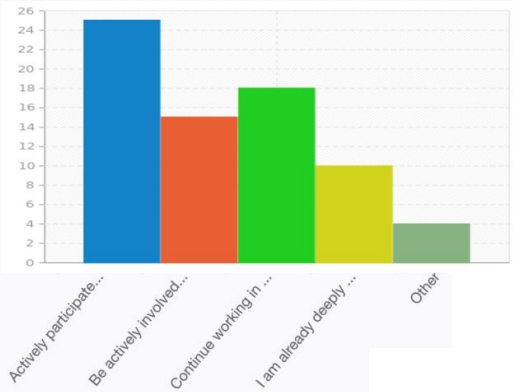
- Yes
- No
- We do not work on future colliders projects
- I do not know
- Other
- No answer

CURRENT ENGAGEMENT ON FUTURE COLLIDERS PROJECTS

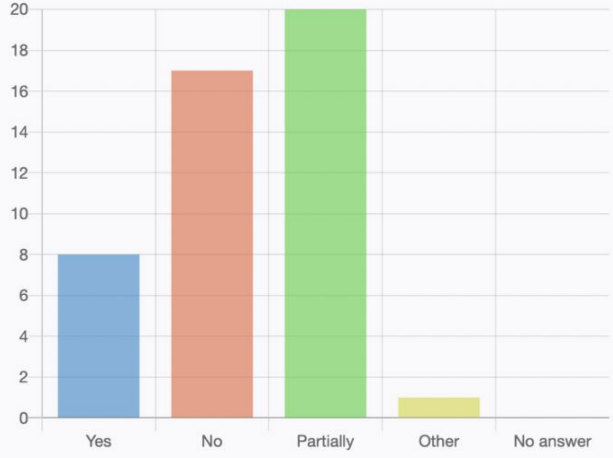
Are you currently working on projects connected to future colliders?



If a new facility is approved in Europe, I would:



Would you be willing to work nearly full time of a project connected to a future collider, while the decision on the next machine is still pending?



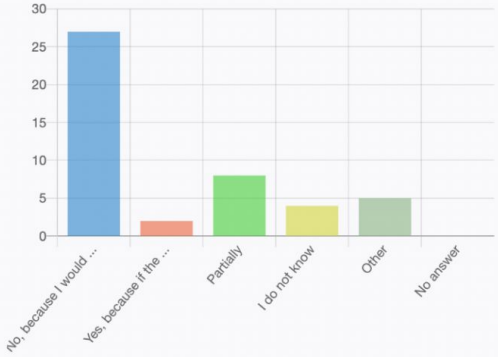
The reason I am not currently engaged in the future collider studies is:

- I'm occupied with current data, whether it's from the LHC or other sources.
- It's not a favorable career move; I'd rather pursue something else to secure a permanent position.
- I'm unsure of how to begin
- I am already deeply involved in the future of my field
- I am not interested at all
- Other

- Actively participate in studies of the physics program
- Be actively involved in detector research and development (R&D)
- Continue working in the analysis and calculation of LHC data
- I am already deeply involved in the future of my field
- Other

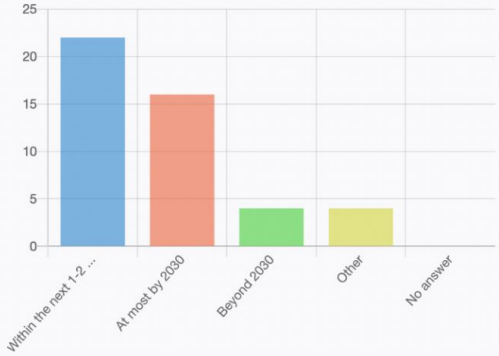
THINKING ABOUT THE FUTURE OF ECRs

Is the choice of a specific future collider or programme over another important for your career?



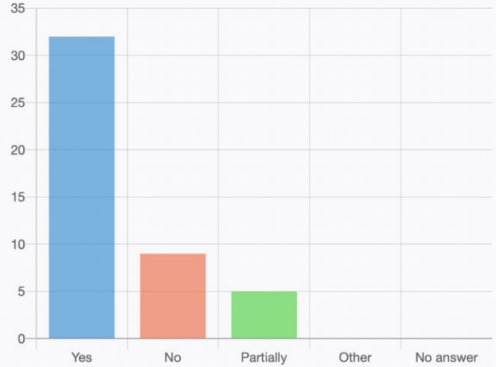
- No, because I would be working for one or the other
- Yes, because if the future collider project does not align with my current research efforts I would leave the field
- Partially
- I do not know
- Other
- No answer

In light of your career prospects, how long do you think it is acceptable to wait before the decision of which machine to build is made? Consider that there might be a gap between the end of the LHC operation and the start of any future facility. The gap between LEP and LHC was ~8 years but it was somehow compensated by Tevatron operating until 2011.



- Within the next 1-2 years
- At most by 2030
- Beyond 2030
- Other
- No answer

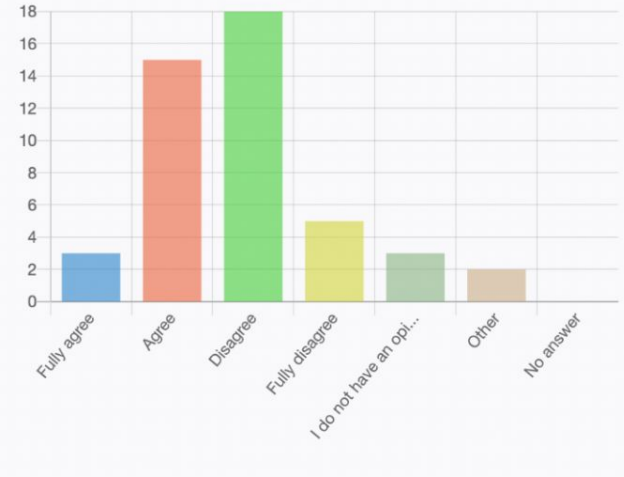
In 2020, the European Strategy for Particle Physics identified an electron-positron Higgs factory as the highest priority next collider. Studies on such and other colliders are ongoing worldwide. Were you aware of this?



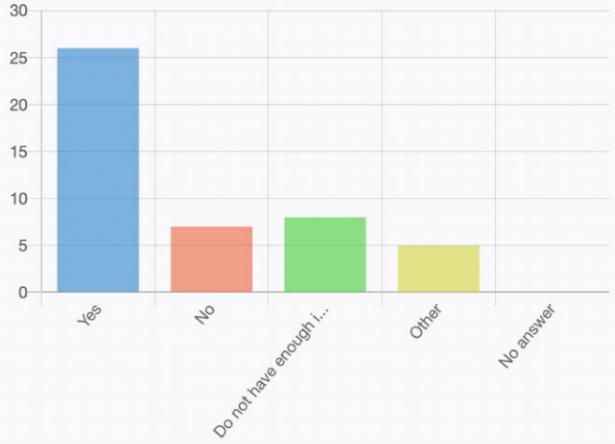
- Yes
- No
- Partially
- Other
- No answer

THINKING ABOUT THE FUTURE OF ECRs

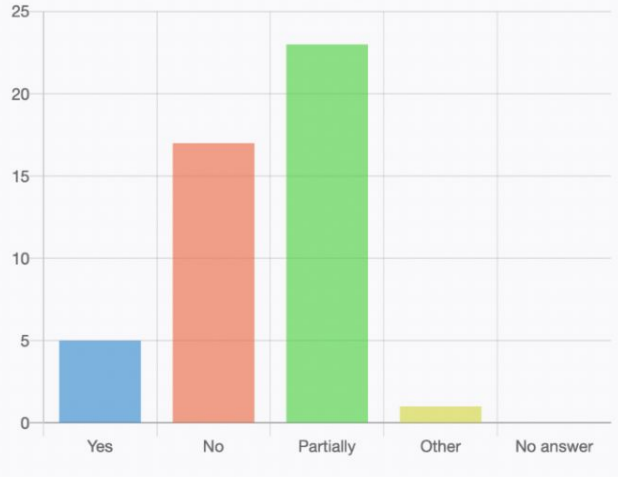
Do you think CERN should re-direct funding from collider physics to other areas of fundamental physics (cosmology, astro-particle physics, gravitational waves...)



Do you think projects such as the FCC or CLIC are realistic to accomplish within the next 50 years?

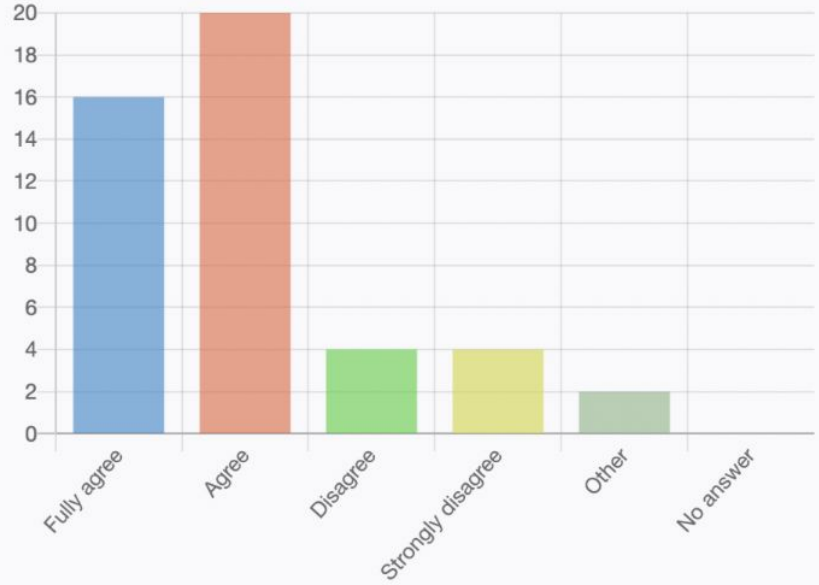


Do you think Early-Career people, who will become senior by the time of those possible future facilities, are well-informed about the current discussions in the future of high energy physics?

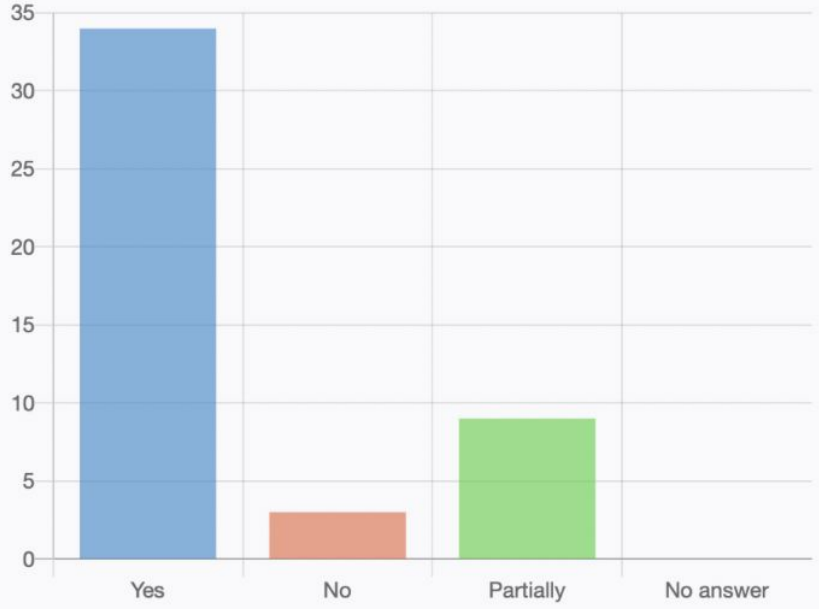


COLLATERAL IMPACTS

Is the scientific return of an electron-positron Higgs/Top/EW factory commensurate with the construction cost (~5,000-10,000 millions €) ?



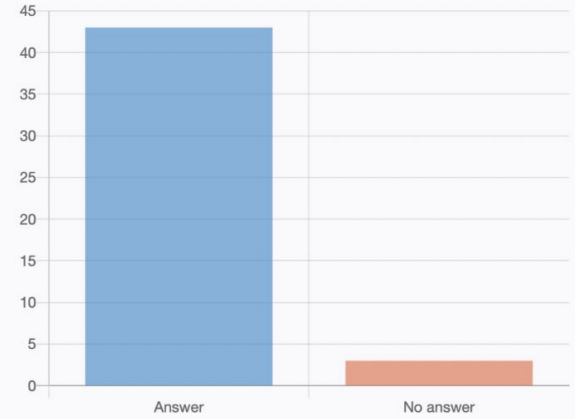
Do you ever consider the economic, environmental, and social impact of constructing a future facility centered at CERN?



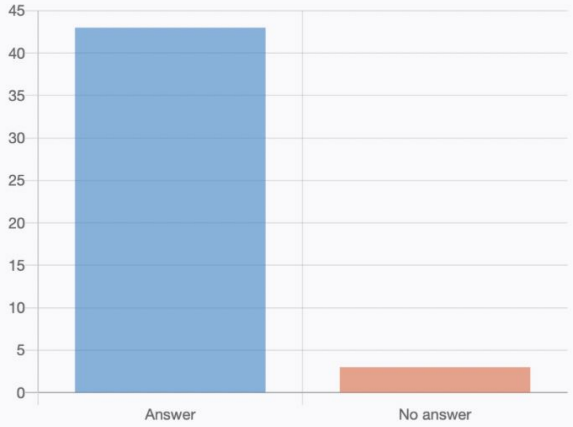
FREE STYLE QUESTIONS

Beyond the choice between Circular vs Linear colliders, there are numerous factors to consider when deciding which facility to construct, encompassing scientific, technological, economic, and social aspects. While it is complex to delve into all these motivations, it is particularly valuable for young scientists to understand the physics research goals behind each choice. Ideally, these goals should be the primary driver in selecting the future high-energy physics machines.

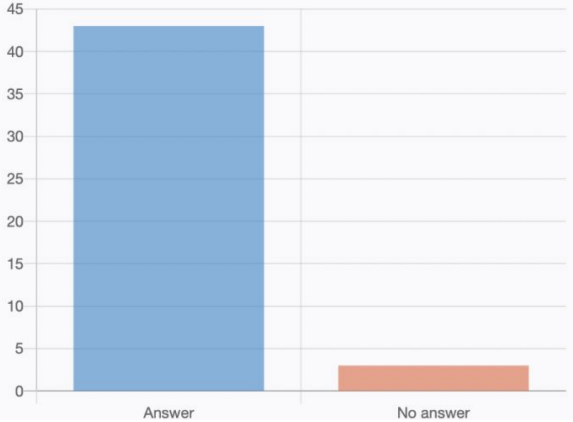
Which physics research goals do you believe we should pursue in the near future?



What do you think are the most critical challenges facing particle physics research in the next decade?



Do you have any additional comments or suggestions regarding the future of particle physics research in Europe? and in Spain?



Most of you answered these 3 important questions (see slides 22, 23 & 24), thank you!

ECFA
European Committee for Future Accelerators

...

ECFA SPAIN 2024

In 2020, the latest update of the European Strategy for Particle Physics was approved by the CERN Council. One of its twenty strategy statements emphasizes that an electron-positron Higgs factory is the highest-priority next collider. Studies on this and other colliders are in full swing worldwide. Moreover, the next update of the European Strategy is expected for 2026-2027, and the update has been moved up, with the Spanish input needing to be submitted by early 2025. Given the long timelines of these projects, we believe it is of paramount importance for Early Career Researchers (ECRs) to participate in an informed way in the many discussions currently taking place about the future of our field. The aim of this survey is to poll the Spanish High-Energy Physics community on this subject. An initial overview of the results will be presented at the Spanish network for future colliders meeting in Valencia (1-2 July, 2024), and ultimately, the final outcomes and conclusions will be shown at the XVI CPAN in Madrid (19-21 November, 2024), where we especially encourage ECRs to attend and participate in the discussions.

There are 29 questions in this survey.

We appreciate your personal input (5'-10')

THIS SURVEY IS ANONYMOUS.
The record of your survey responses does not contain any identifying information about you, unless a specific survey question explicitly asked for it.
If you used an identifying access code to access this survey, please rest assured that this code will not be stored together with your responses. It is managed in a separate database and will only be updated to indicate whether you did (or did not) complete this survey. There is no way of matching identification access codes with survey responses.

KEY REFLECTIONS FROM ECR

The future of particle physics research depends on a balance of scientific, technological, and social factors.

- Define 3–5-year milestones to maintain competitiveness, focusing on small-scale European experiments bridging HL-LHC and future projects.
- Ensure timely decisions on the next major project to support ECRs in securing consistent funding.
- Maximize the potential of Run 4 and Run 5 programs for continued advancements.
- Foster collaboration, invest in talent, and develop complementary projects for success in Europe and Spain.

This approach will enable sustained growth and significant discoveries in the coming decades.

Thanks for attending & participating in the survey

ECRs brainstorming insights on future collider facilities

About profiling HEP goals:

- **Collider Focus:** Strong support for a Large Lepton Collider targeting Higgs physics and high-energy collisions.
- **Key Research Areas:** Agreement on pursuing dark matter searches, Higgs physics, precision measurements, and new physics, with a focus on BSM phenomena.
- **Precision measurements**: Emphasis on precise measurements, especially of Higgs and Z boson couplings, for BSM studies.
- **Addressing the SM:** Exploration of the SM's incompleteness, including free parameters, mass hierarchies, neutrino oscillations, baryogenesis, CP violation, and dark matter.
- **Alternative approaches:** Interest in lower-energy observables, muon collisions, and e+e- colliders for precision measurements, alongside high-mass searches with pp colliders.
- **Sustainable technology**: Calls for advancing efficient technologies in accelerator physics to support sustainable collider construction.
- **Broader Scientific Goals**: Highlighting the importance of facilities for fusion energy and cancer therapies, demonstrating interdisciplinary applications of physics.
- **Optimizing Resources:** Concerns about resource allocation, advocating for the careful selection of research directions based on existing data and understanding in high-energy physics.

ECRs brainstorming insights on future collider facilities

About challenges in Particle Physics for the next decade:

- **Attractiveness and continuity**: Retaining ECR interest amid global instability and project uncertainties.
- **Defining future directions**: Deciding whether to build new accelerators or pursue alternative methods after the HL-LHC.
- **Lack of BSM signals**: Absence of BSM signals limits theory development and funding for young researchers.
- **Resource and workforce limits**: End of LHC risks workforce sustainability with many researchers leaving academia.
- **Societal challenges**: Balancing scientific progress with external issues like the climate crisis.
- **Precision frontier**: Focus on high-precision measurements, especially in Higgs and neutrino physics.
- **Technological advancements**: Need for innovative methodologies to uncover new physics.
- **Loss of momentum**: Gap between the HL-LHC and future experiments may reduce talent influx.
- **Career uncertainty**: Ambiguity around future collider projects creates uncertainty for ECRs.
- **Public perception and funding**: Justifying new facilities amid environmental concerns and limited discoveries.
- **Engagement of future generations**: Keeping younger generations engaged without new physics signals.
- **Collaboration and support**: Long-term projects depend on sustained public funding and international cooperation.

ECRs brainstorming insights on future collider facilities

About the future of HEP within Spain:

- **Mobility and diversity:** Encourage physicist mobility and interdisciplinary collaboration.
- **Career pathways:** Provide clear paths and job security for young talent.
- **Strengthening collaborations:** Enhance European cooperation to pool resources.
- **Education and outreach:** Invest in programs to inspire the next generation.
- **National support:** Increase Spain's support and participation in international collaborations.
- **Facility development:** Develop a dedicated particle physics facility in Spain.
- **Complementary projects:** Focus on complementary, not duplicative, European projects.
- **Global response:** Address global developments like the EIC to retain resources.
- **Support for small experiments:** Increase funding for smaller non-LHC projects.
- **Motivation & vision:** Improve conditions for young scientists and communicate a clear long-term vision.

International updates

The future of European competitiveness: Report by Mario Draghi

A 327-page report recommends that the EU invest 750-800 billion euros to close the economic and innovation gap with the U.S. and China.

The CERN success story (pag 236)

…"The Large Hadron Collider has propelled CERN to global leadership in particle physics – a mantle that has shifted from the US to Europe – and it stands as CERN's flagship facility. One of CERN's most promising current projects, with significant scientific potential, is the construction of the Future Circular Collider (FCC): a 90-km ring designed initially for an electron collider and later for a hadron collider. Chinese authorities are also considering constructing a similar accelerator in China, recognising its scientific potential and its role in advancing cutting-edge technologies. If China were to win this race and its circular collider were to start working before CERN's, Europe would risk losing its leadership in particle physics, potentially jeopardising CERN's future."

Invest in world-leading research and technological infrastructure (pag 252)

…"We have already discussed the remarkable returns from the creation of CERN and emphasised that the future of CERN is at risk due to China's progress in emulating one of CERN's most promising current projects, the Future Circular Collider (FCC). Refinancing CERN and ensuring its continued global leadership in frontier research should be regarded as a top EU priority, given the objective of maintaining European prominence in this critical area of fundamental research, which is expected to generate significant business spillovers in the coming years."...

Excerpts as significant as the White House/CERN statement from last April.

Publicly confirmed by Ursula von der Leyen in her speech at CERN's 70th anniversary.