



Early Career Researchers input to the European Strategy Update

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CLICdp General Meeting - 6th April 2020



Mandate



- **Debate** the topics of the current European Strategy Update (ESU) for Particle Physics.
- Deliver, beyond the event and on behalf of all participants, a **brief document** summarising the outcome of the debate.
 - No need to reach a consensus on all aspects, but to express in the document all aspects that were discussed during the meeting.
- The ECFA chair will bring this document to the attention of the European Strategy Group.



**Jorgen D'Hondt,
ECFA Chair**

- 15th November 2019 at CERN
- Participants: **~180 Early Career Researchers** (ECR) from across Europe
- Organisation committee: 25 volunteers
- **6 Working Groups** (WGs) established to gather opinions to feed into the debate:
 - Environment and Sustainability
 - Electroweak and Strong physics
 - Beyond Standard Model physics, Dark Matter and Dark Sector
 - Flavour, Neutrino physics and Cosmic Messengers
 - Accelerators and Detectors
 - Computing and Software
- Common themes: **Human and Social Factors** and **Environment and Sustainability**
- WGs discussed several topics in short meetings **before** the date of the debate
- Survey to get some quantitative data **after** the date of the debate (117 participants)

- What topics, if any, are missing in the **Physics Briefing Book**?
 - How do the different possible future collider scenarios influence the WG?
 - How appealing in terms of innovation, research, etc. is each scenario?
 - What is the importance of continuity of expertise vs keeping the field as diverse as possible?

- Impact on **sociological factors**
 - Social and career aspects, such as the identification of the career paths
 - Work-life-balance (including reconciliation of family life and a scientific career)
 - Recognition within the collaboration and in the field

- Other topics (based on the existing ECFA WGs):
 - Knowledge and technology transfer
 - Outreach, education and communication
 - Sustainability and environmental impact

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

- A very productive and well attended meeting
- Reports from the different WGs + time reserved for discussion (~50%)
- The debate was held in a very good spirit, fun and constructive!



- First draft as input to ESU meeting in Bad Hofen
- Final version published on 6th February 2020 on [arXiv](#) and [CDS](#)
- Signed by **145 authors** (24 editors)
- 23 full pages + Appendix for survey results

Structure:

- Executive Summary (2 pages)
- Introduction
- Survey Results
- Summary of Discussions During the ECFA ECR Debate and Working Group Meetings
- Final Remark
- **Disclaimer:** Lots of important points, not very easy to summarise

Report on the ECFA Early-Career Researchers Debate on the
2020 European Strategy Update for Particle Physics

The ECFA Early-Career Researchers

February 6, 2020

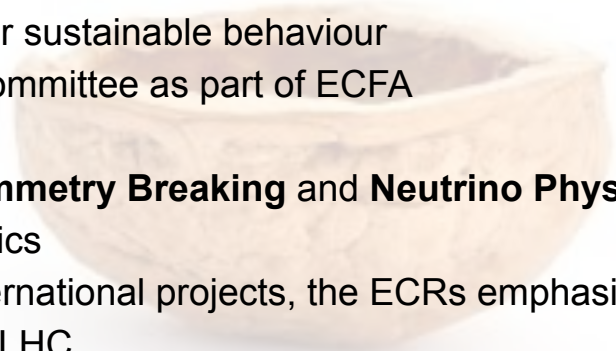
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- **Attractiveness** of our field is at risk
 - ESU must include **sociological and sustainability aspects** in addition to technical ones
 - More permanent positions
 - Play an exemplary role for sustainable behaviour
 - Establish a **permanent ECR** committee as part of ECFA
-
- **Dark Matter, Electroweak Symmetry Breaking** and **Neutrino Physics** are the three most important open questions in particle physics
 - While being open for future international projects, the ECRs emphasise the **importance of a European collider project** soon after HL-LHC
 - Postponing the choice of the next collider project at CERN to the 2030s has the potential to negatively impact the future of the field
 - Many ECRs stated their discomfort about the way the full CLIC and FCC programmes were compared, especially by how the different states of **maturity** of the projects were not taken into account sufficiently.





Sociological and Human Aspects



“

For the ESU to be effective and sustainable, it is imperative to holistically include social and human factors when planning the future of the field. Therefore, the ECRs strongly recommend that future project evaluations and strategy updates include the social impact of their implementation. Specifically, equal recognition and career paths for the various domains of our field have to be established to maintain expertise in the field. The possibility for a healthy work-life balance and the reconciliation of family and a scientific career is a must.

”

ECFA-ECR

- **Future Career Opportunities**

- Relax the importance of **mobility**

Researchers aiming to stay in the field are often required to move from one institution to another -> enrich scientific background but discriminate people with families

- Future strategy **risk** assessment

Concerns about timescales and possible delays of the next European collider

- Improve and extend support for **career outside HEP** (Ex. alumni networks)

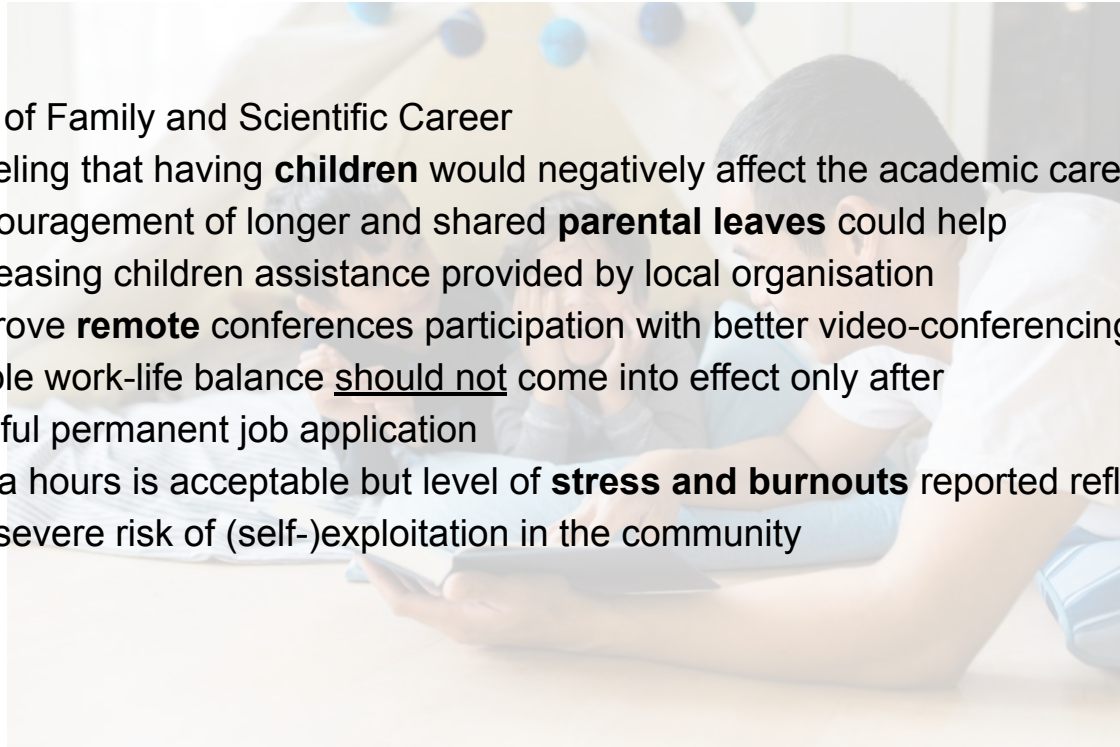
Many ECRs think that they have the skills to pursue a successful career in a non-academic job, but more support is needed

- **Towards Equal Recognition**

- Detector and software technology research are often less valued

- Establish professional career opportunities for all domains of expertise
- Introduce devoted awards inside the collaborations in the domains of detector/accelerator R&D, computing and analysis (and mixed) with the aim of balancing recognition and increasing the visibility of individuals
- Increase publications on R&D topics, especially on software and computing works

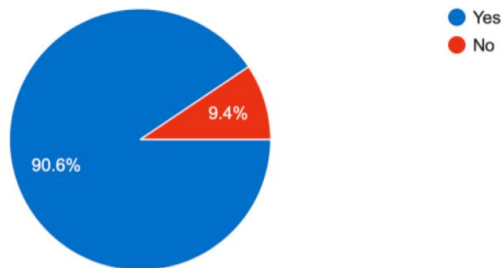
- Promote inclusion with establishment of **diversity officers** in each collaboration / facility / institute



- **Reconciliation** of Family and Scientific Career
 - Diffuse feeling that having **children** would negatively affect the academic career
 - Encouragement of longer and shared **parental leaves** could help
 - Increasing children assistance provided by local organisation
 - Improve **remote** conferences participation with better video-conferencing
 - Reasonable work-life balance should not come into effect only after a successful permanent job application
 - Extra hours is acceptable but level of **stress and burnouts** reported reflect the severe risk of (self-)exploitation in the community

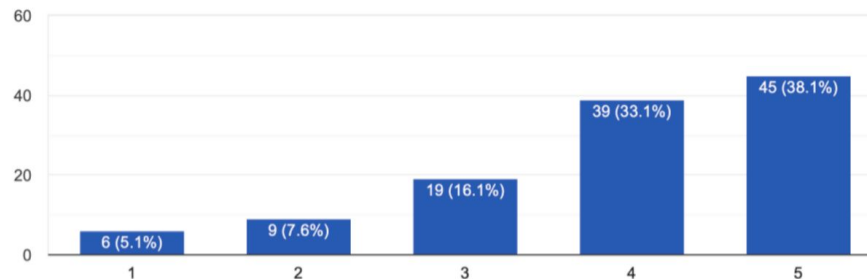
Are you interested in a long term career in research/academia?

117 responses



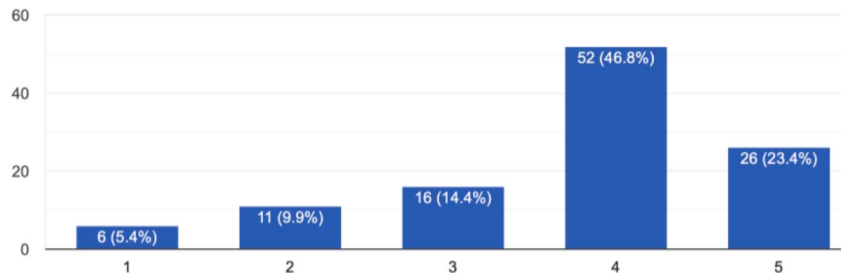
How anxious do you feel about your career prospects?

118 responses



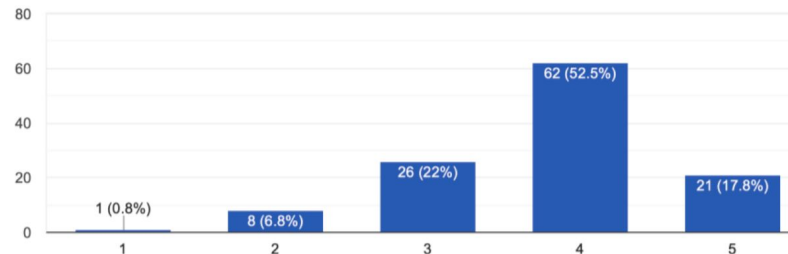
Having children would negatively affect my academic career

111 responses



How would you rate your level of work-related stress?

118 responses



Legend: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree and (5) strongly agree



Environment and Sustainability



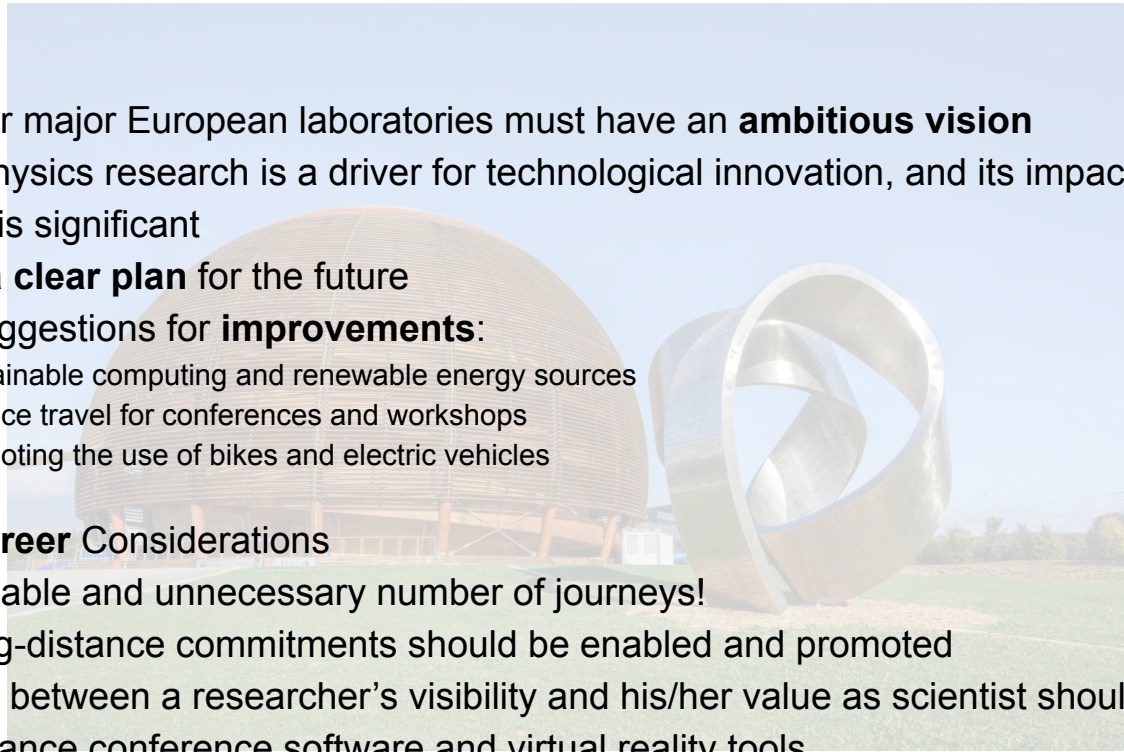
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Large European organisations and laboratories such as CERN have a unique position and responsibility in society. A strong statement from CERN putting the environment and sustainability at the forefront of decision-making, aiming at becoming a carbon-neutral laboratory in the short term future, would have a significant impact. The energy efficiency of equipment and the power consumption of the future collider scenarios are already considered but this should be extended to building insulation and the environmental impact of construction and disposal of large infrastructure. There should be further discussion of nuclear versus renewable energy usage and CERN could and should strive for a higher renewable energy fraction. More considerations should be put on the impact of computing and software resources. Travel and conference schedules should be seriously assessed to reduce the amount of travel and the associated carbon footprint.

”

ECFA-ECR

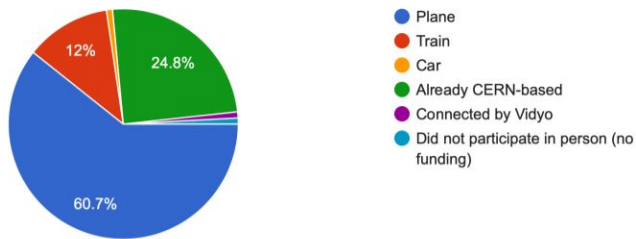
- CERN and other major European laboratories must have an **ambitious vision**
 - Particle physics research is a driver for technological innovation, and its impact on society and economy is significant
 - Develop a **clear plan** for the future
 - Lots of suggestions for **improvements**:
 - Sustainable computing and renewable energy sources
 - Reduce travel for conferences and workshops
 - Promoting the use of bikes and electric vehicles
 - ...
- **Human and Career Considerations**
 - Unsustainable and unnecessary number of journeys!
 - Long-distance commitments should be enabled and promoted
 - Link between a researcher's visibility and his/her value as scientist should be weaker
 - Enhance conference software and virtual reality tools



- CERN and other major European laboratories must have an **ambitious vision**
 - Particle physics research is a driver for technological innovation, and its impact on society and economy is significant
 - Develop a clear plan for the future
 - - Completely **lack of information** in the Briefing Book
 - It's in the nature of particle physics researchers to **explore uncharted territories** and be at the forefront of science and technology
 - The ECR community is ready to embrace the radical shift of paradigm that is needed
- **Hu**
 - **Many more information and concrete suggestion in the document !**
 - Unsustainable and unnecessary number of journeys!
 - Long-distance commitments should be enabled and promoted
 - Link between a researcher's visibility and his/her value as scientist should be weaker
 - Enhance conference software and virtual reality tools

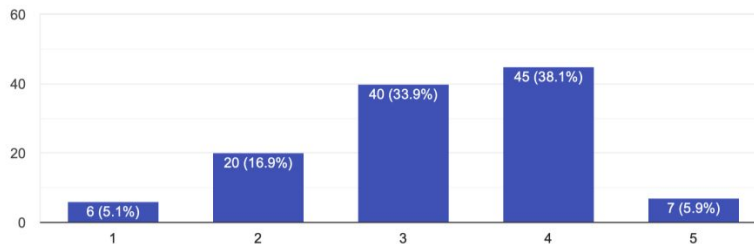
How did you travel to the ECFA-ECR meeting?

117 responses



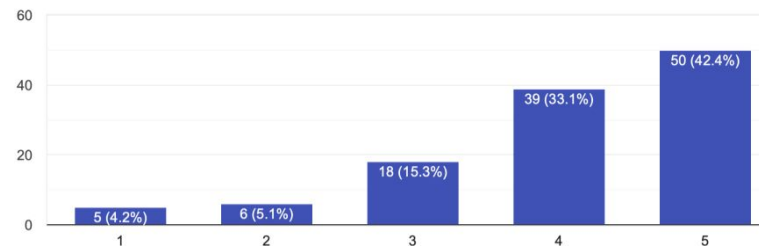
How often would you attend conferences remotely if better tools were available?

118 responses



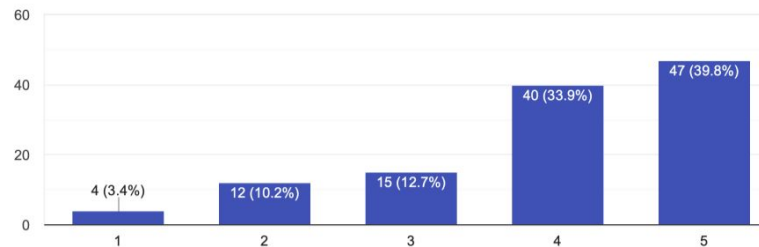
Giving up conferences over environmental concerns would damage my career

118 responses



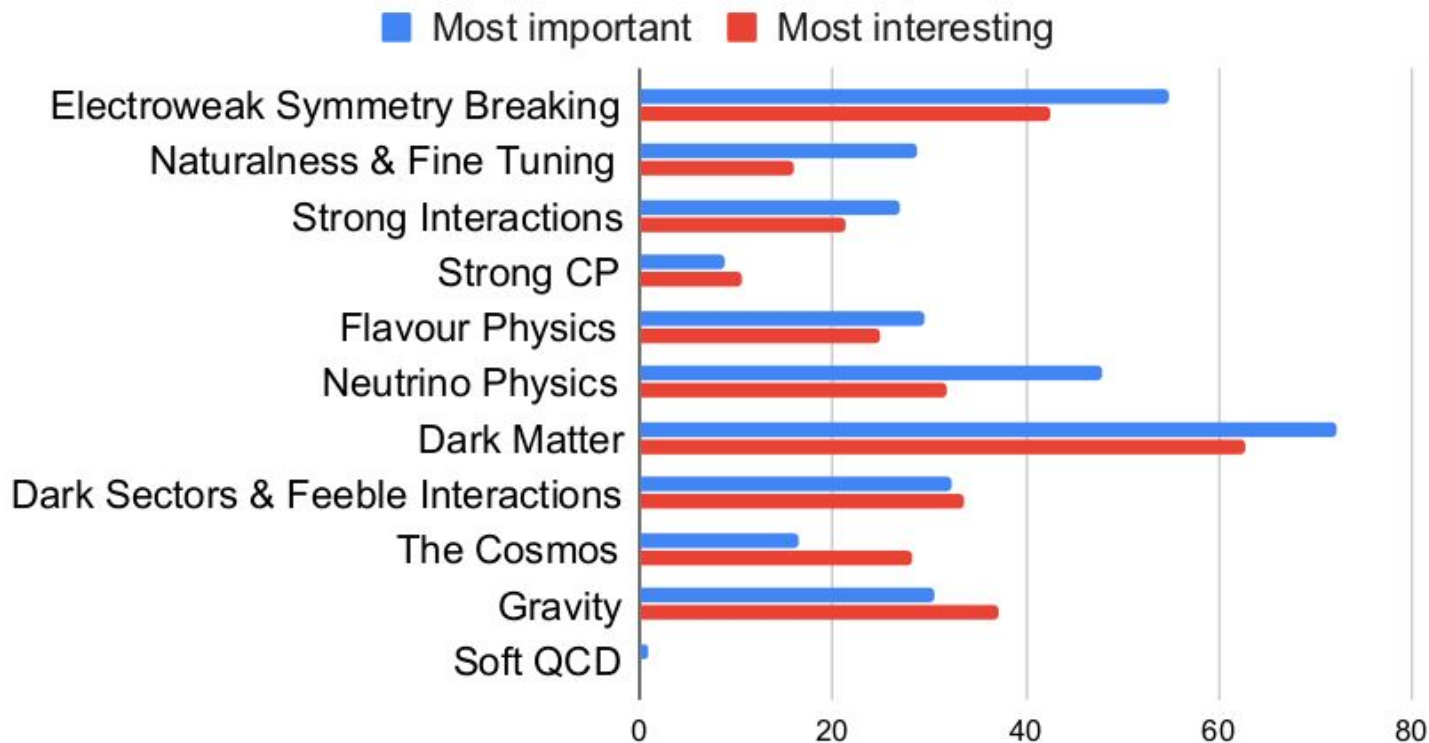
How important it is for you that the environmental impact is taken into account when taking decisions on future projects?

118 responses



Legend: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree and (5) strongly agree

Most important/interesting topics in HEP





Beyond Standard Model, Dark Matter and Dark Sector Physics



“

No clear consensus on future collider scenarios was found as different, equally valid, theoretical models can prefer one scenario over the other. However, the ECRs consider the diversification of experiments, building on projects such as Physics Beyond Colliders, as vital for the future of the field and should be pursued with high priority in parallel to the larger projects. Similarly to the discussion on electroweak and strong interaction physics, it is felt that better collaboration between theory and experiment is needed to extract the full potential of future programmes, more focus on this for ECRs (i.e. including more PhD students) is needed in particular.

”

ECFA-ECR

Beyond Standard Model, Dark Matter and Dark Sector Physics

- Dark Matter is cited as being the **most important** and **most interesting** open question in HEP
- **No obvious choice** for the next-generation experiments
 - Importance of experiments **diversity** for the future (Eg. Physics Beyond Colliders project)
 - More **collaboration** among experimentalists and theorists and among different experiments
- Biggest challenge is to **maintain excitement** for BSM searches
 - Both in the HEP community and in the public sector
 - Outreach, education and communication are active fields (Eg. Dark Matter Day)
- More **questions** than answers:
 - Is working with a few model benchmarks sufficient?
 - Would model scans be more effective in sampling the BSM landscape?
 - Should the particle physics community spend resources to find other more advanced and economical ways to provide a more robust input for BSM searches?



Electroweak and Strong Interaction Physics



“

Due to the different demands of electroweak and strong physics, there was no clear consensus in the electroweak and strong interaction physics discussion session as to which future collider should be pursued at this stage. For most Higgs couplings, decay width and electroweak precision measurements, e^+e^- colliders have a clear advantage. However, this is balanced by the greater precision that proton-proton colliders have for rare Higgs couplings, in particular the Higgs self-coupling. It was noted that e^+e^- colliders are very appealing due to the shorter timescales and their capability of running at the precise energies required to produce copious amounts of Higgs, W and Z bosons or top quark pairs. This is in contrast to the strong physics discussions, where a clear preference towards a pp or ep collider was voiced. Priority should be put on precision measurements and global fits rather than model-driven searches. Tighter collaboration between theory and experiment would enhance the precision of measurements

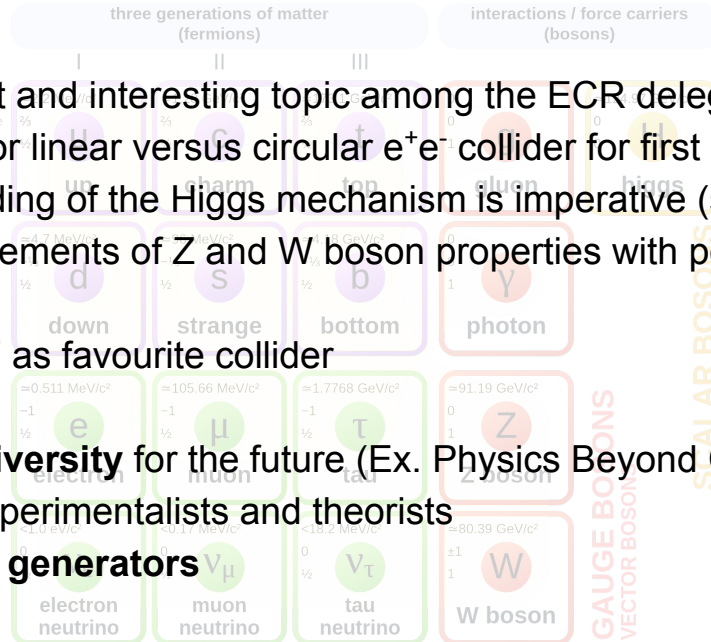
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ECFA-ECR

Electroweak and Strong Interaction Physics

Standard Model of Elementary Particles

- Electroweak Physics
 - **Second** most important and interesting topic among the ECR delegates
 - **No clear consensus** for linear versus circular e^+e^- collider for first stage
 - Better understanding of the Higgs mechanism is imperative (single and self-coupling)
 - Precision measurements of Z and W boson properties with polarisation or higher luminosity
- Strong Interaction Physics
 - FCC-hh and/or FCC-eh as favourite collider
- Importance of experiments **diversity** for the future (Ex. Physics Beyond Colliders project)
- More collaboration among experimentalists and theorists
- Need for improving the event **generators**
- Separate predictions for FCC-ee and FCC-hh are missing in Briefing Book as well as projections from the HE-LHC and LE-FCC projects





Flavour, Neutrino and Cosmic Messenger Physics



“

While the heavy flavour domain benefits from any future collider, numerous specialised smaller experiments in the light sector are needed outside these large-scale scenarios to complete the picture. Real-time observations between connected observatories, for example neutrino, gravitational wave and gamma ray telescopes, will be crucial in the future, and to fully realise the potential in this area synergies with HEP would be vital.

”

ECFA-ECR

Flavour, Neutrino and Cosmic Messenger Physics

- Briefing Book **well laid out** the physics goals
- Heavy flavour sector can benefit from **all of the five future scenarios**
 - Not clear if FCC-ee can get better results than colliders operating at the Y(4S)
 - Not clear if FCC-hh can perform well at such high levels of pile-up
 - Noted that both CLIC and ILC have studied in detail the capabilities of the flavour-tagging and quark-charge measurements, but not detail heavy-flavour physics programme
- Light, neutrino and cosmic messenger sectors require **dedicated experiments**
 - LFV experiments based outside CERN
 - Two long-baseline experiments are currently planned in the USA and one in Japan
- Importance of experiments diversity for the future (Eg. Physics Beyond Colliders project)
- More collaboration among experimentalists and theorists



Accelerator and Detector R&D



“

Among the ECRs, 88% are in favour of an e^+e^- machine as the next collider to be realised. A strong and diverse R&D programme on both accelerators and detectors must be a high priority for the future. On the accelerator side, concerns have been raised about whether the key numbers stated in the BB allow for a fair comparison of the various projects; while concerning the 4 detector side, there was no mention of which technology is suitable for which future project and the level of readiness of each technology.

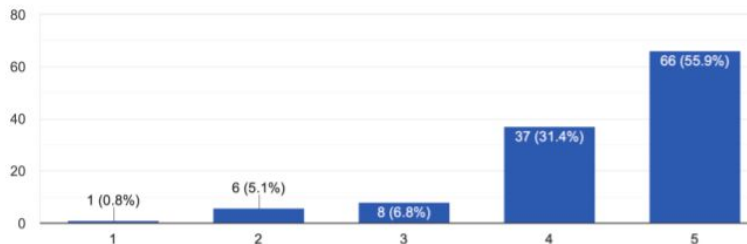
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ECFA-ECR

- Importance of Europe constructing a next-generation collider after the HL-LHC
- Next collider should be an e^+e^- machine
- **FCC-all** is favourite future scenario
- **Strong and diverse R&D programme** on both accelerators and detectors must be a high priority
- State of the art for accelerator and detector is **missing** in Briefing Book
 - Fair comparison? Uncertainties on financial aspects and timescales? Readiness of technologies?
 - Influence of other countries decision in ESU (“if ... then ... ” approach?)
 - Detailed studies on different scenarios
- Diversity
 - Importance of experiments diversity for the future (Eg. Physics Beyond Colliders project)
 - Some new accelerator technologies were not studied in detail
- **Environmental issues** and **career prospects** must be tackled much more seriously and thoroughly

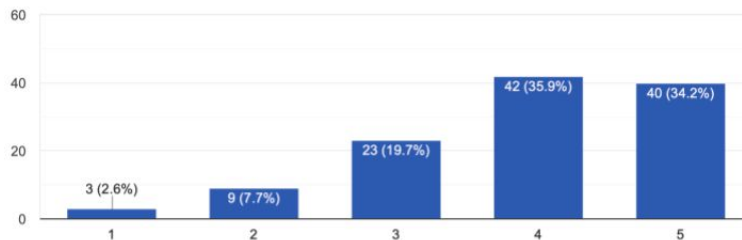
How important is it to you that Europe will continue with a collider after HL-LHC?

118 responses

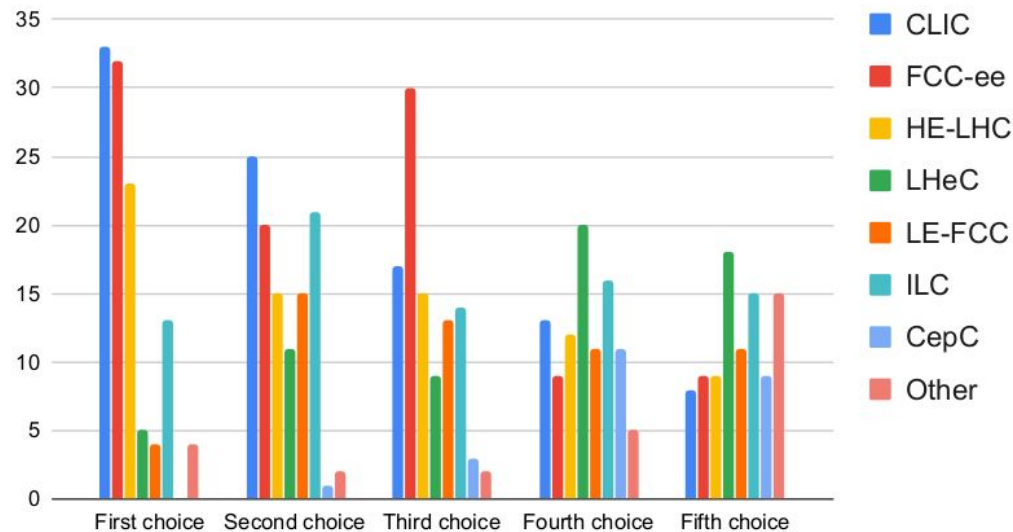


The next collider should be an e+e- machine?

117 responses

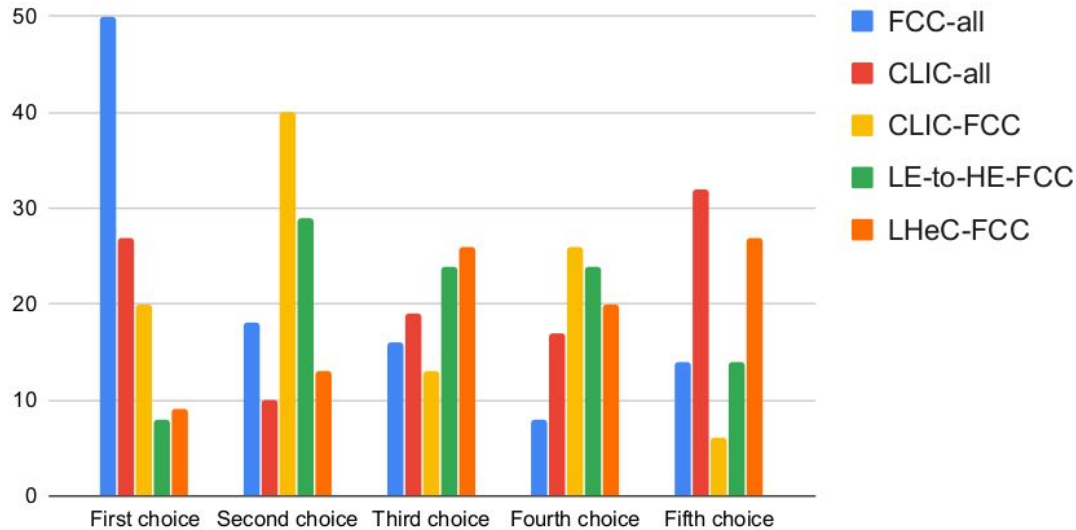


Preferred next generation collider



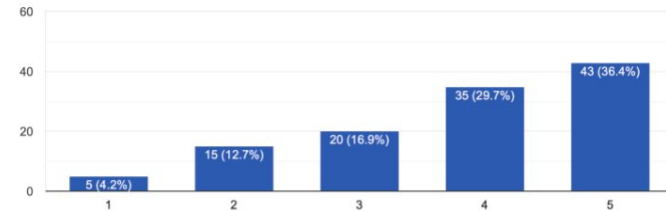
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Preferred future collider scenario



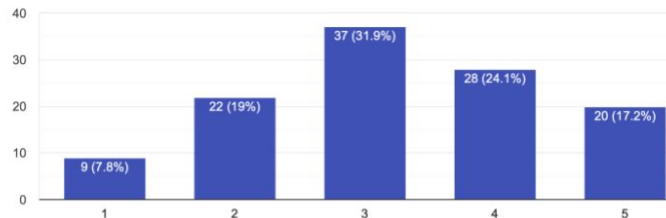
CERN should build the FCC in the future

118 responses



CERN should build CLIC in the future

116 responses



Legend: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree and (5) strongly agree



Computing and Software



Software and computing activities must be recognised not only as means to do physics analyses, but as research that requires a high level of skill. Innovation in physics analysis should strive to minimise the time to produce physics results allowing more person-power to be allocated to areas where innovation and development is truly needed. In an effort towards reducing the carbon footprint associated with travel for work purposes, our community can drive the development of new software for remote meetings, even for large groups of attendants. Furthermore, the researchers are generally in favor of open data and see the need for sharing knowledge and resources with other computing communities



ECFA-ECR

- “Computing in HEP” in Briefing Book as mainly the **central production processes**
- **Software for Physics Analysis** also important
 - Innovation is needed to reduce **duplication** of code
 - Centralising analysis workflows are essential but can be show-stopper for unconventional analyses, such as ML
 - **Analysis preservation** as challenge and opportunity
Eg. HEPData, toolkits like Rivet, CERN Analysis Preservation Portal
- In favor of **open data** mainly for education and scientific goals
- Increase **recognition** of the individuals contributing to software
 - Awards, career opportunities, publications...
- Impact on the **Environment**
 - New technologies to reduce the ecological footprint
 - Share resources with other local computing communities
 - Increase effort for software to reduce the amount of travel

Conclusions

- ECR-ECFA meeting was **highly appreciated** and proposed to be more regular
- IMHO, output document with high **valuable input** for ESU ([arXiv](#) and [CDS](#))
- Areas where significantly stronger emphasis is needed:
 - Keep the **field attractive** to the best minds
 - Put at higher priority issues of the **environment** and **sustainability**
 - Increase the focus on **sociological** and **human factors**.



Legend: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree and (5) strongly agree

Backup