REPORT ON ECFA EARLY-CAREER RESEARCHERS DEBATE

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WHAT IS THE TALK ABOUT?

- On 15th of November 2019 (here), 180 ECRs across Europe participated in a one-day debate held at CERN on the European strategy update for particle physics.
- A document emerged from this discussion which was submitted as an input to the drafting session of European Strategy Update held at Bad Honnef, Germany.

Disclaimer:

- A lot of important details in the document, I only present a summary of it in this talk.
- Some material for the presentation has also been borrowed from Prof Jorgen d'Hondt (ECFA chair).

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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ACRONYMS…

European Committee for Future Accelerators

European Strategy for Particle Physics

ECFA, which is involved in the update of **ESPP**,
provided an opportunity to **ECRs** to conduct one-full day debate
on the topics presented in the Physics **BB**.

Early Career Researchers
(includes in this case PhDs and early career Postdocs)

Briefing Book
(Our invention in the report!)

As far as we know, this is the first time such an initiative has been taken by the ECFA with ECRs in mind!

ABOUT MYSELF

There were 24 organizers of the debate and the same members were also the editors of the document: I was one of them (of-course a participant of the debate too).

- I completed my PhD at University of Warwick at the end of 2018, focusing on search for "rare" b-baryon decays and searching for CP-violation in their decays at the LHCb experiment.
- Since 2019, I have been a postdoctoral researcher at University of Zurich, focusing on search for new physics in semileptonic b-baryon decays at the LHCb experiment.

Disclaimer: My expertise lies in flavor and b–physics.

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THEN, NOW, AFTER...

Before moving forward, we need to understand what the past, current and future situation is with ESPP.

ESPP 2013 laid out certain priorities that have been successfully achieved (upgrade activities for HL-LHC, CERN neutrino platform, etc)

ESPP 2020 is expected to (among others):

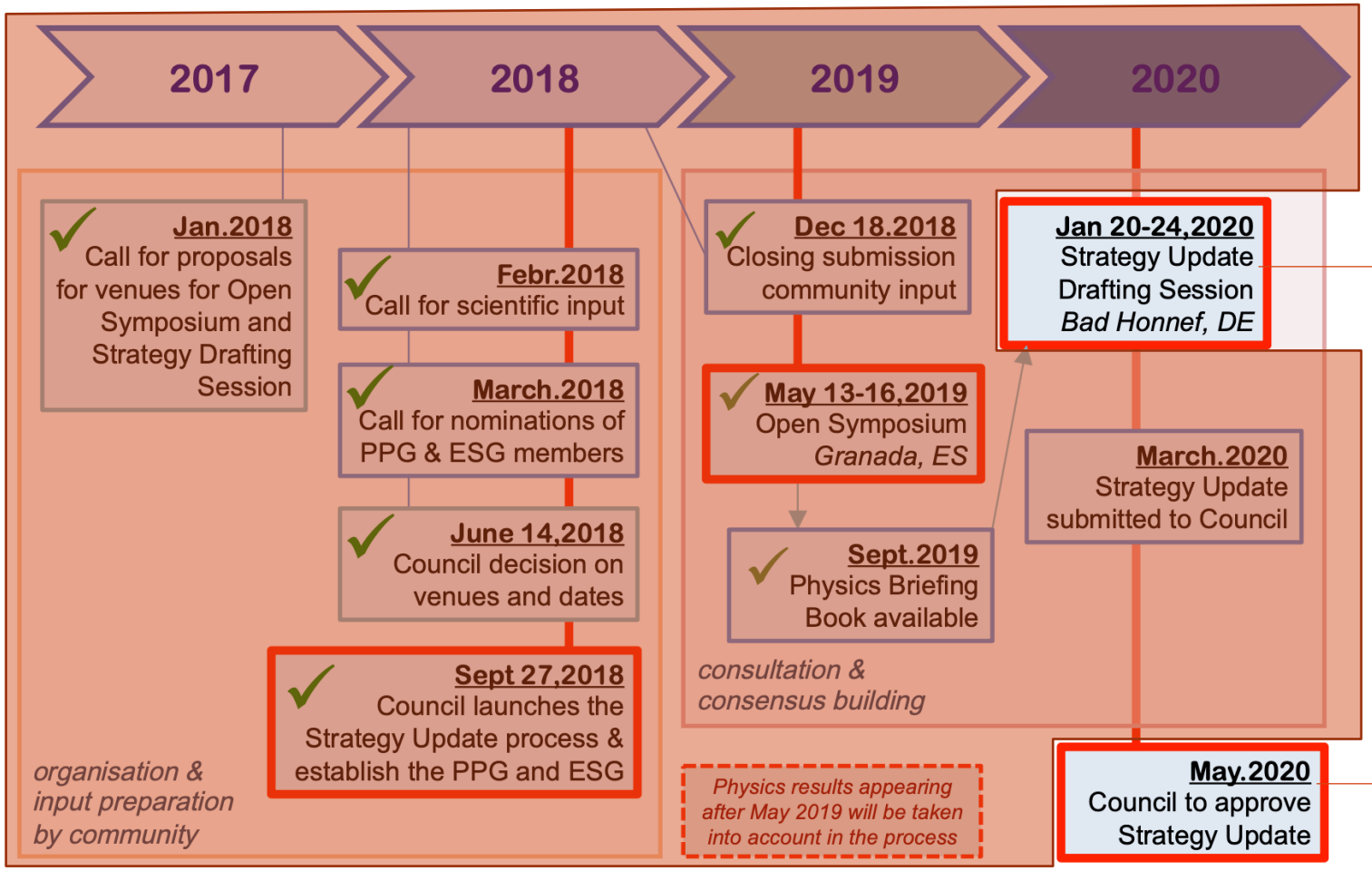
- **Commission Technical Design Report (TDR) for a future collider scenario.**
- **Commission Conceptual Design Report (CDR) for demonstration facilities for a muon collider and plasma-based collider.**

ESPP 2027 is expected to (among others):

- **Based on the TDR and in the global context, make a decision on whether or not to engage with the proposed collider scenario.**
- **Based on the CDR, decide on the construction of muon and/or plasma-based collider demonstration facility.**

New collider expected to be operational around 2040s!

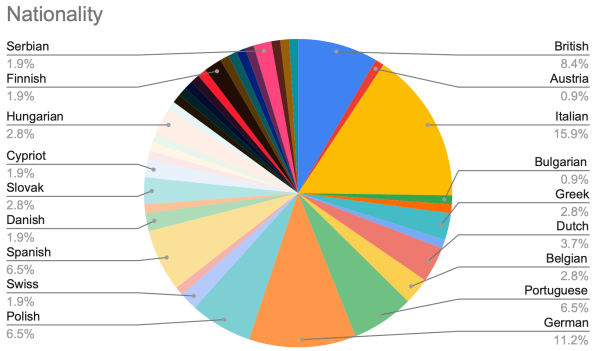
WHERE DOES THE CURRENT UPDATE STRATEGY STAND?

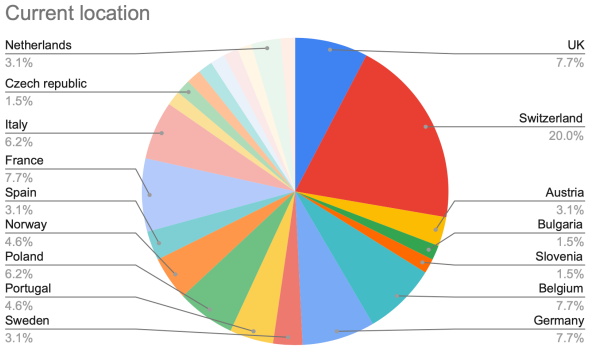


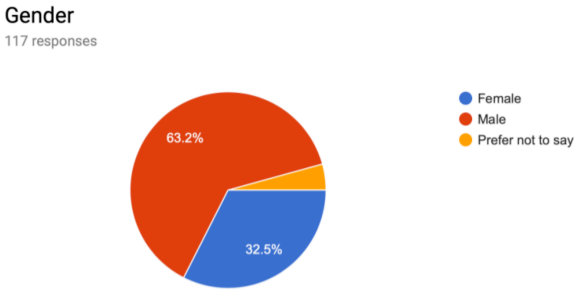
The ECFA ECR debate took place after the Physics Briefing Book was released and before this drafting session.

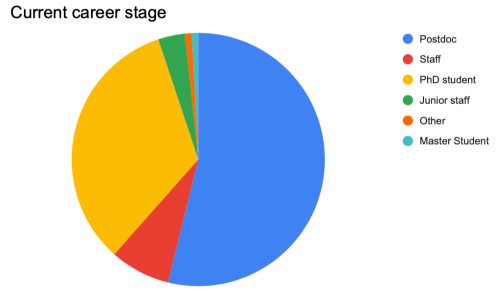
Currently the ESPP 2020 is at this final stage of choosing a collider scenario. Due to COVID-19 the session has been postponed. (Will hear about ECFA recommendation on 19 June).

WHO ARE THE ECR(S)?







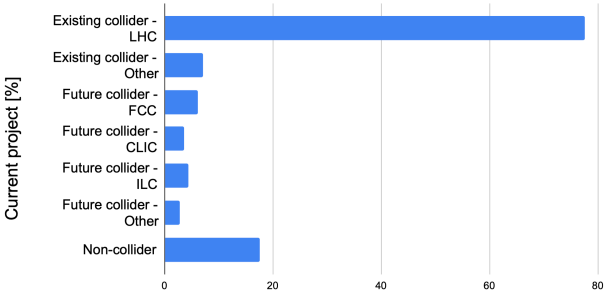


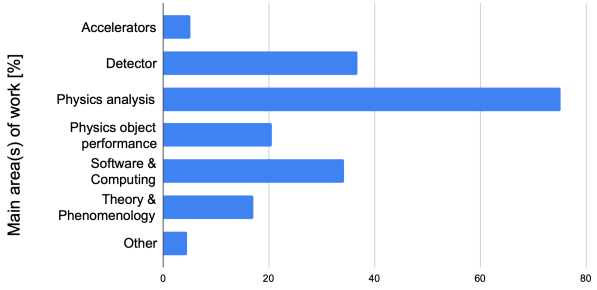
Many Italians, Germans, British.

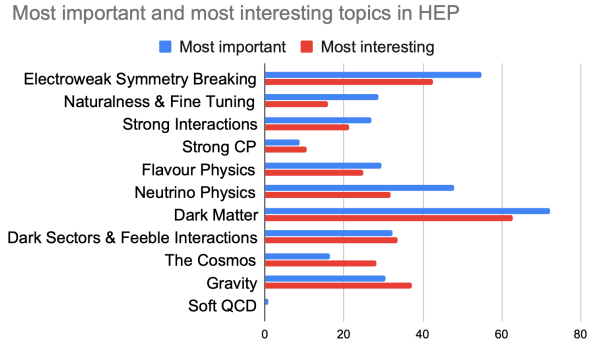
Many based at Switzerland, Belgium, France, Germany, UK.

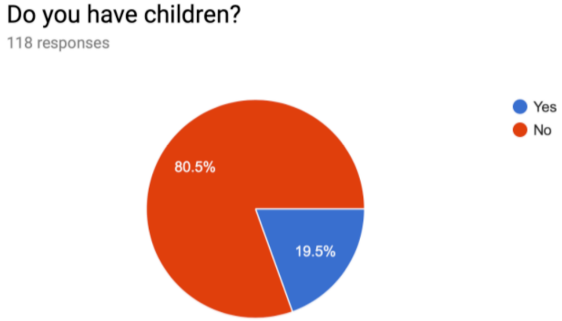
Not a gender-neutral sample!

Views dominated by postdocs and PhDs









Most of us work on existing collider, but in terms of a future collider the sample could slightly be biased towards FCC.

Most of us work on a physics analysis, detector and software. Also good fraction of people working on theory and phenomenology.

Most important: DM, EWSB, Neutrinos, Dark sector, Gravity, Flavour physics.
Most interesting: DM, EWSB, Gravity, Dark sector, Neutrinos.

20% of the ECRs have children

THE THREE FUTURES AND THE FIVE SCENARIOS

- the *immediate future* (2020-2040)
  e.g. the HL-LHC era
- the *mid-term future* (2040-2060)
  e.g. the Z/W/H/top-factory era
- the *long-term future* (2060-2080)
  e.g. the energy frontier era

Out of the three futures, the current ESPP 2020 has direct consequence on the "the mid-term future" i.e. collider scenario that is operational during 2040-2060.

For the mid-term future, five collider scenarios are foreseen. Will elaborate in next few slide.

A landscape for colliders in Europe

	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

COLLIDER SCENARIOS

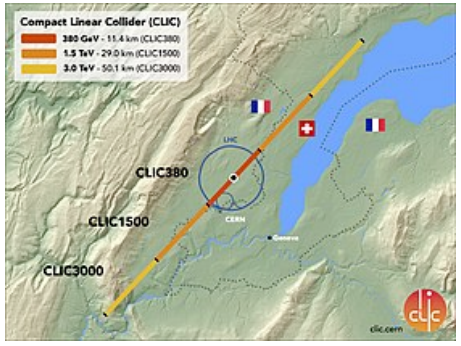
1st Scenario labelled "CLIC-all": In the **mid-term future**, start operation of an electron-positron Compact Linear Collider (**CLIC380**) at $\sqrt{s} = 380$ GeV moving to **CLIC1500** with a lengthier tunnel. For **long-term future**, upgrade to **CLIC3000** or other available technology.

2nd Scenario labelled "CLIC-FCC": In the **mid-term future**, start operation of **CLIC380** and for long term future, move to **FCC-h/e/A** (i.e. hh or he or hA or eA or AA) with **higher field magnets** (16 T) or other available technology. [NB: 'A' refers to heavy ions]

3rd Scenario labelled "FCC-all": Exactly like 2nd scenarios where **CLIC380 is replaced with FCC-ee** operating between $\sqrt{s} =$ 90 to 365 GeV.

4th Scenario labelled "LE-to-HE-FCC-h/e/A": In the **mid-term future**, using **low field magnets**, start with **FCC-h/e/A** and long term is same as 2nd scenario.

5tth Scenario labelled "LHeC-FCC-h/e/A": Start operation of **Large Hadron electron Collider (LHeC)** at $\sqrt{s} = 1200$ GeV during HL-LHC (early 2030s) and and long term is same as 2nd scenario. [NB: LHeC could be operational with other scenarios too.]



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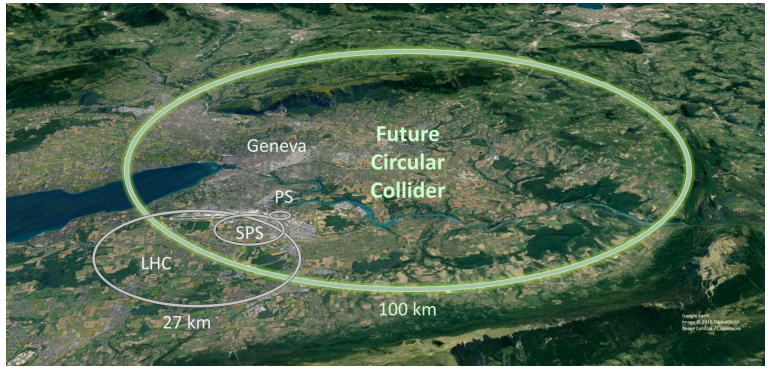

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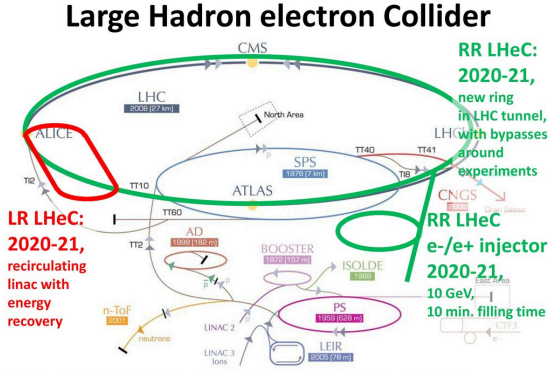


http://lhec.web.cern.ch/

ORGANIZATION OF THE DEBATE

- With the previous back-drop, 24 ECR members who volunteered to be in the organising committee, established a structure to the proposed debate.
- **Six Working Groups** (WGs) were formed:
  - 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
- **Human and Social Factors** were discussed across WGs.
- **Short online meetings** were also undertaken with the ECRs **before** the debate.
- Summaries of these short meetings were presented **at the debate**, triggering more discussion (50% of time was reserved for discussion).
- Finally a survey was conducted to get some quantitative data **after** the debate.

A full CERN main auditorium!

Let's dive straight in…

SOCIAL AND HUMAN FACTORS: THE CONCERNS

- More than 70% of ECRs feel anxious about there career
  - Short term contracts.
  - General lack of jobs for the expertise available.
  - Forced to move for employment which affected their personal life.
- More than 70% of ECRs experience work related stress
  - More than 70% of ECRs feel the need to work extra hours to secure an academic career.
  - More than 50% of the ECRs spend 10 to 30% of time applying for grants (impact on mental health due to negative result).
  - More than 50% of ECRs would like more flexibility for remote working.
- Nearly 80% of the ECRs feel having children would negatively impact their career.
- Around 20% of them have experienced discrimination at work due to their gender/race/sexuality? (NB: Our sample has 64% of males).
- More than 45% of the ECRs feel that they won't have enough support to find a career outside HEP.
- ECRs feel there isn't equal recognition in their field of work (specifically more than 40% of ECRs feel detector and software technology work is less valued).

SOCIAL AND HUMAN FACTORS: THE ACTIONS

- Relax the importance of mobility in grant applications (discriminates against people with families).
- Need to improve and extend support to match ECRs skills with careers outside of HEP (links with alumni is happening, but need to develop links to companies, etc).
- Devoted awards inside the collaborations in topics such as detector/accelerator R&D, computing and analysis.
- Increase publications on R&D topics, especially on software and computing works.
- Promote inclusion with establishment of diversity officers in each collaboration / facility / institute.
- Diffuse feeling that having children would negatively affect the academic career:
  - Encourage long and shared parental leaves.
  - Increase assistance with regard to childcare.
  - An option of remote conference participation.
- Supervisors must encourage a healthy work-life balance and prevent from (self-)inflicting stress.
- ECRs recommend that future project evaluations and strategy updates include the social impact of their implementation.

ENVIRONMENT AND SUSTAINABILITY: THE CONCERNS

- As scientists it is our responsibility to play an exemplary role in tackling climate change.
  - 97% of ECRs felt that environmental impacts should be taken into account when taking decisions on future projects.
  - The energy efficiency of equipment and the power consumption of the future collider scenarios are considered but need to extended to environmental impact of construction and disposal of large infrastructure.
- Concerns on air travels, which represents about 2% of global CO2 emissions.
  - 87% of ECRs felt that attending conferences is necessary to secure an academic career (most prioritise career over environmental considerations).
  - However, 78% of ECRs would attend conferences remotely if better tools were available.
- CERN and other major European laboratories have a unique position and responsibility in society.
  - Must have an ambitious vision and develop clear action plans to become carbon neutral in the future.

ENVIRONMENT AND SUSTAINABILITY: THE ACTIONS

- Due to their unique position, the major European laboratories can negotiate with energy providers in order to ease the switch to renewable energy sources.
- Initiatives like the Green IT cube @ GSI, recycling of waste heat @ LHC point 8 and @ PSI need to be promoted and extended.
- Need to consider also environmental impact due to computing and work-related travel (long-distance commitments should be enabled and promoted).
- Set of small actions for immediate future (only few listed below):
  - Vegetation to offices, reducing unnecessary heating, adding solar panels, better insulation, use of electric vehicles, etc.
- Set of actions for the update of ESPP (only few listed below):
  - Create a permanent committee in charge of establishing and enforcing sustainability.
  - New projects/upgrades include analysis of environmental impact in their proposal.
  - Seek funding for the transition to carbon neutrality (targeting European Commission funds dedicated to climate change.)
  - Carbon offsetting solutions should be considered and made part of the travel budget.
- Such initiatives/commitment would set an example in the society favouring important political decisions and an increased funding for research.

BEYOND STANDARD MODEL, DARK MATTER AND DARK SECTOR PHYSICS

- For ECRs the poll suggested Dark Matter as one of the most important and most interesting topics.
- Discussions lead to no obvious choice for the next-generation experiments
  - In favour of future collider that provides the opportunities for diverse experimental programmes (Eg. Physics Beyond Colliders project).
  - Desire for workshops with fewer talks and dedicated brainstorming sessions (enhances collaboration between experimentalists and theorists).
- Biggest challenge is to maintain excitement for BSM searches (both HEP and public):
  - Outreach dedicated to specific subjects were very successful (Eg. Dark Matter Day, Antimatter matters).
  - Favoured open-data for educational purposes to engage with teachers and students (eg. CRAYFIS and CREDO).

ELECTROWEAK AND STRONG INTERACTION PHYSICS

- EW physics is the second most important and interesting topic among the ECRs.
- Electroweak Physics
  - Favourite here is the lepton colliders:
    - Althgouh less sensitive to the Higgs self-coupling than hh machines, capable of running at precise energies with opputunities to explore Higgs (total width), W and Z boson sector.
    - Can be operational in shorter timescales than hh machines.
    - Linear Vs Circular: No clear consensus on this. Longitudinally polarised beams at linear collider help exploit increased number of EW observables, however the circular colliders provide higher luminosity.
- Strong Interaction Physics
  - Favourite here is FCC-hh and/or FCC-eh.
- Few other points were noted (only few noted here)
  - Separate predictions for FCC-ee and FCC-hh are missing in BB.
  - Lattice QCD as an important tool for precision tests of the Standard Model,
  - Need for improving the event generators.

FLAVOUR, NEUTRINO AND COSMIC MESSENGER PHYSICS

- Heavy flavour sector
  - Operating at Z pole, FCC-ee provides a clean environment with production of different b/c-hadron species. (No strong heavy-flavour physics programme at CLIC).
  - FCC-hh would lead to higher production rates of heavy flavoured hadrons. However, unclear whether such studies can actually be performed in such environments (high pile-up and highly collimated).
- Light, neutrino and cosmic messenger
  - Light sector: Kaon physics, electric dipole moments and lepton flavour violating (LFV) observables have dedicated experiments but might benefit from R&D from large-scale experiments.
  - Neutrino sector: Two long-baseline experiments currently planned in USA (Dune) and Japan (Hyper-Kamiokande). With strong involvement of Europe in the former.
  - Cosmic messenger: Benefit from studies of hadron-ion collisions (improve modelling of cosmic air showers) and real-time observations between connected observatories for transient events (neutrino, gravitational and gamma ray telescopes).
- ECRs, as a result, leaned towards circular FCC-ee collider, along with LHeC, and then moving towards FCC-hh ("FCC-all" scenario preferred).

COMPUTING AND SOFTWARE

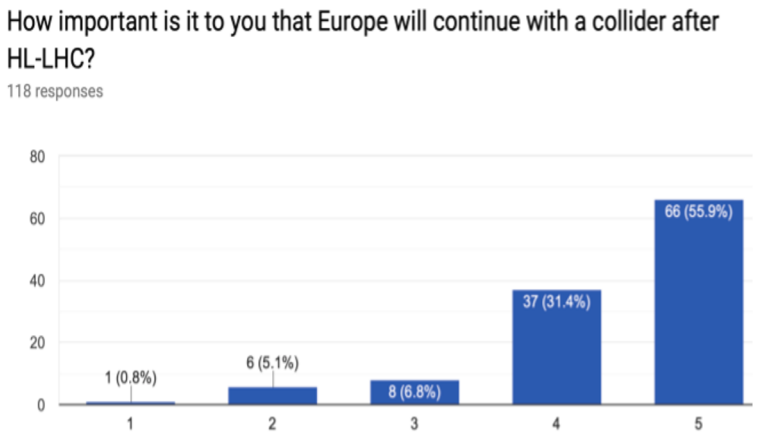
- Some actions and suggestions from the WG:
  - Impact of computing should be considered with detector design.
  - Computing must be recognised as research activity rather than a means for an analysis (encourage projects like DIANA-HEP, IRIS-HEP, etc).
  - Centralisation of selected analysis to reduce code duplication (come with their own risks).
  - Make use of standard software packages (skills acquired are transferable outside of HEP).
  - Emphasis of training individuals by experts (even outside of particle physics).
- For analysis preservation, collaborations could make software documentation mandatory (encourage tools like HEPData, Rivet, etc).
- In favour of open data mainly for education and scientific goals
- Impact of software technologies in reduction of ecological footprint was also noted.

ACCELERATOR AND DETECTOR R&D

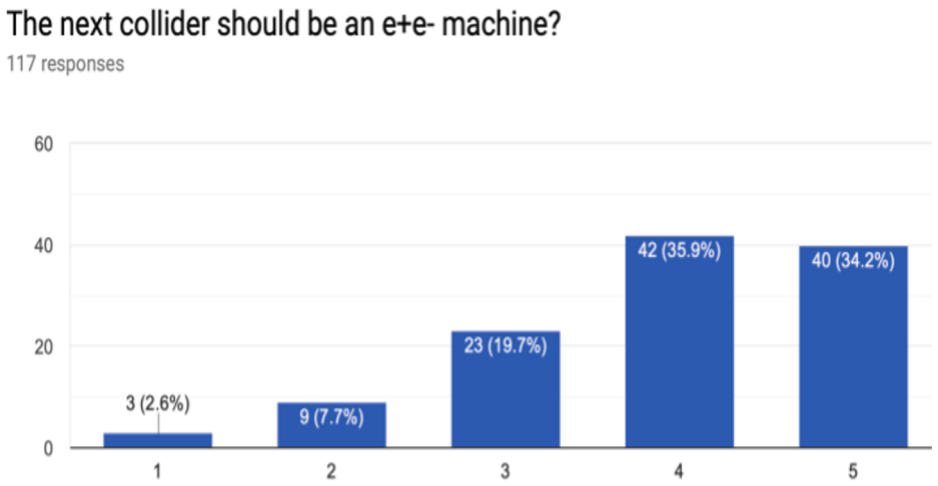
- Strong and diverse R&D programme on both accelerators and detectors is critical.
- The following points were noted by the WG about the briefing book:
  - There were no estimates of uncertainties on the financial aspects and timescales of the proposed future projects.
  - A lack of risk assessment related to a possible delay of the projects.
  - A statement on CERN's participation, possible support and synergies with other future international projects was missing.
- The issue of unequal recognition of people working on accelerator and detector R&D was stressed. In this regard, importance of training individuals to bridge the gap between technical tasks and physics analysis was also stressed.

ACCELERATOR AND DETECTOR R&D: WHAT DID THE POLLS SAY?

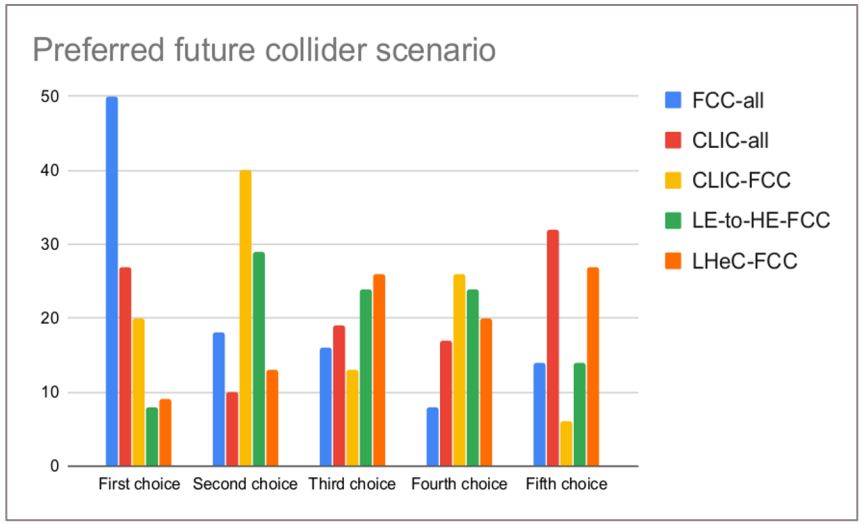
Around 84 % of ECRs agree that it is paramount for Europe to build a collider after HL-LHC.



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



More than 65% of ECRs think that the next collider must be an ee machine.



FCC-all is favorite 1st choice and CLIC-FCC is the favorite 2nd choice.

SUMMARY

- While being open for future international projects, the ECRs emphasise the importance of an European collider project soon after HL-LHC.
- Significant emphasis must be put on:
  - Keeping the field attractive to the bright and young minds (While nurturing the current ones).
  - Higher priority to environment and sustainability issues.
  - Increased focus on sociological and human factors.
- The document was well received and we thank the ECFA and in particular the ECFA chair (Prof Jorgen D'Hondt) for providing us such a great platform for learning and debate!

How do we see the relationship progress…

CURRENT RELATIONSHIP STATUS

European Strategy for Particle Physics (ESPP)

European Committee for Future Accelerators (ECFA) et al

Early Career Researchers (ECRs)

(HOPEFULLY) FUTURE STATUS

European Strategy for Particle Physics (ESPP)

European Committee for Future Accelerators (ECFA) et al

Early Career Researchers (ECRs)

With the setup for a permanent ECR ECFA panel (under discussion), we hope that the relationship really grows out to be pride!

BACKUP

PHYSICS AND TECHNOLOGY

Examples of physics explored

	2020-2040 *HL-LHC era*	2040-2060 *Z/W/H/top-factory era*	2060-2080 *energy frontier era*
precision frontier	H couplings to few % ν mass/mixing/nature QGP phase-transition b/c-physics	H couplings to % EW & QCD & top QGP vs Lattice QCD b/c/τ-physics	H couplings to ‰ H self-coupling to % proton structure di-boson processes
breaking the SM	next-gen K-beams proton precision e & n EDM lepton flavor (μ→e)	p EDM storage rings	rare top decays small-x physics
direct searches	Beam Dump Facility eSPS (light DM) Long-Lived Signals / ALPs DM vs neutrino floor	heavy neutral lepton	new high-mass part. next-gen hidden exp. low-mass DM

EW: Electroweak
QCD: Quantum Chromodynamics
QGP: Quark Gluon Plasma
DM: Dark Matter
ALPs: Axion-like particles

Examples of technology needed

	2020-2040 *HL-LHC era*	2040-2060 *Z/W/H/top-factory era*	2060-2080 *energy frontier era*
our technology	SCRF ~ 30 MV/m B ~ 11 T	SCRF ~ 50 MV/m B ~ 14 T plasma demo muon demo	SCRF ~ 70 MV/m B > 16 T (HTS?) plasma collider muon collider
other technology	AI for new physics quasi-online analysis digital imaging new transistors	quantum computing self-learning simulation	…
societal threats	eco friendly gases careers at mega-research facilities	energy consumption long-term engagement global vs sustained collaboration	human vs machine

SCRF: Superconducting Radio Frequency
HTS: High Temperature Superconductors

TIMELINES OF DIFFERENT COLLIDERS