European Strategy
for Particle Physics

ECR Perspectives

Uli Einhaus (KIT)
for the European Early Career
Researcher Community

L CWS 2025

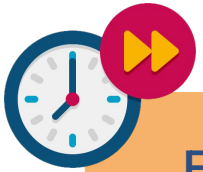
International Workshop
on Future Linear Colliders

Community building, leadership and recognition

Careers, wellbeing and DEI

EARLY CAREER RESEARCHERS

Communication and outreach



Future projects

Timeline

[ECR session @ 3rd ECFA Workshop in Paris](#)

10 October 2024

[ECR Workshop on EPPSU @ CERN](#)

14 November 2024

[Open ECR Symposium @ CERN](#)

20th February 2025

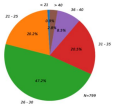
[Open Seminar about White Paper @ CERN](#)

27 May 2025

Document drafting

18 December 2024 - 27 January 2025

ECR survey



31 March 2025

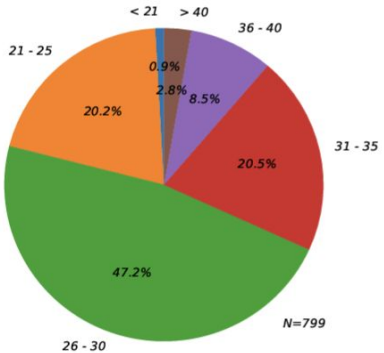
Submission to ESPPU

27 June 2025
Venice Symposium

Survey

- 18 Dec - 27 Jan
- 800 submissions from European ECRs*
- Reached all relevant groups, good representation

Additional reference: 2022 survey by ECFA ECR Panel on career prospects and diversity



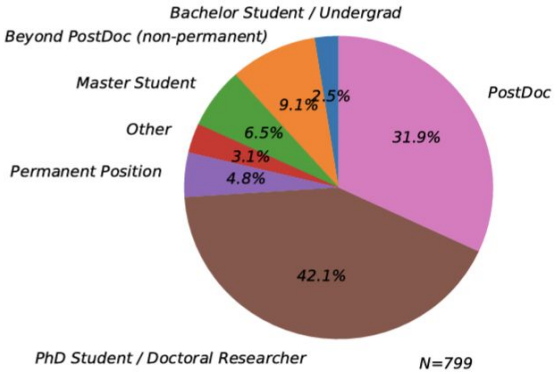
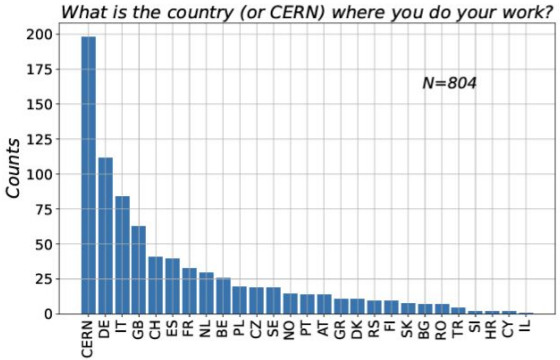
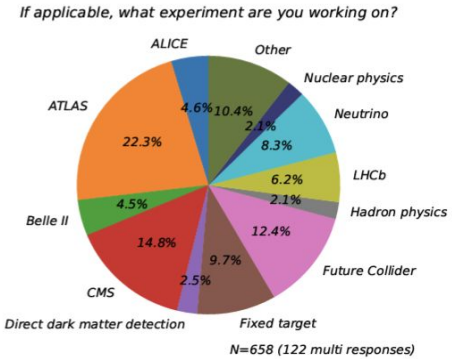


Figure 1: Distribution of age (left) and academic status (right) of survey respondents.





*Non permanent position or < 10 a after PhD, employed in Europe

The White Paper and ESPPU Input

Early Career Researcher Input to the
European Strategy for Particle Physics Update:
White Paper

Fifty-five recommendations for the future of our field

Editors

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Endorsed by the ECFA ECR Panel
27th of March, 2025

Abstract

This document, written by early career researchers (ECRs) in particle physics, aims to represent the perspectives of the European ECR community and serves as input for the 2025–2026 update of the European Strategy for Particle Physics. With input from a community-wide survey, it highlights key challenges faced by ECRs — career stability, funding access and long-term research opportunities — while proposing policy recommendations and targeted initiatives. It underscores the importance of practices fostering diverse, equitable, inclusive and healthy workplaces, as well as of stronger ECR communities, and highlights how effective communication and interdisciplinary collaborations reinforce the societal relevance of particle physics and promote continued support for large-scale and long-term projects. Finally, the future of both collider and beyond-collider experiments is addressed, emphasising the critical role of ECRs in shaping future projects.

The ECR contribution is formed of two parts: the ten-page executive summary submitted as input to the European Strategy for Particle Physics Update and, as backup document, this extended white paper providing additional context.

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arXiv:2503.19862v2 [hep-ex] 27 Mar 2025

arXiv:2503.19862

- 100 pages document
- 55 recommendations, plus statements and examples of best practices
- > 100 people contributed via working groups or workshops

Input to ESPPU [42]

- 10-page executive summary as main input

Endorsement

- Endorsed by the ECFA ECR Panel
- 150 supporters via indico page (in addition to authors)

Context

55 recommendations
Concrete suggestions for improvement
intended as constructive ideas for change.
Resulting from

- Survey Results
- WG discussions

We cover what is of particular importance for ECRs

We avoid focusing on
- Physics
- Individual projects
- Project locations

The order of topics is **deliberate,** non-physics topics are equally important for the future of our field

Community building, leadership and recognition

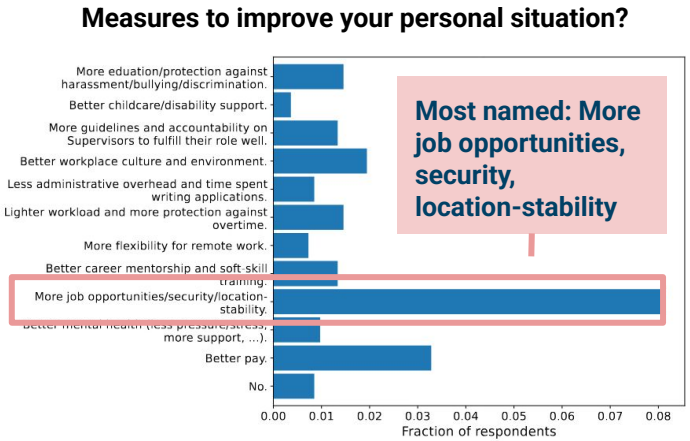
Careers, wellbeing and DEI

EARLY CAREER RESEARCHERS

Communication and outreach

Future projects

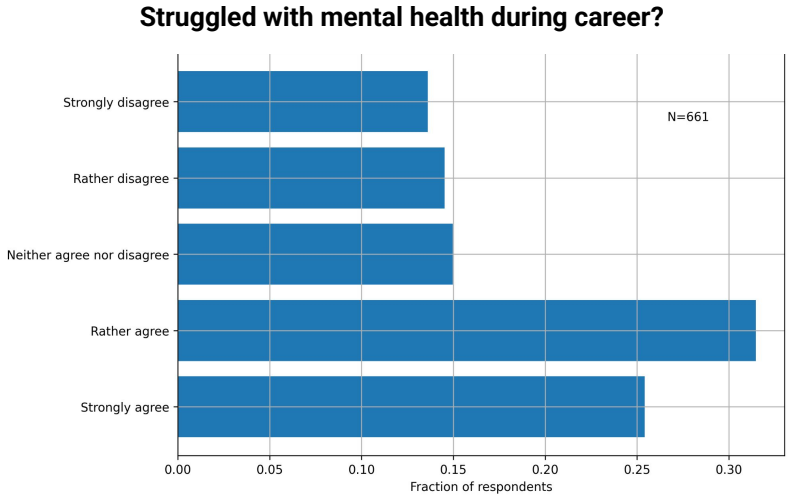
Career prospects



- Increase awareness about employment perspectives in the field
- Offer ≥ 3 y postdoc contracts
- Reconsider emphasis on long-term mobility (!)
- Recognise secondary research interests and non-research contributions in evaluations
- Provide career guidance and skills training relevant to academia and industry ➠ mentorship program

Great science only with great scientists and careers to keep them

Wellbeing and support



- **57% struggled** with their **mental health**
  - including **80%** of those who have suffered **discrimination** or **harassment**
  - new Swedish study (Sep ‘25): PhD students in nat. science have 80% more increase in psych. medication compared to peers

➠ Allocate part of institutional funding to mental health services for the research community

- 80% support mandatory supervision training
- **59%** report that **no such training** exists at their institution

➠ Mandatory supervision course for staff in supervisory roles

Diversity, Equity, Inclusion (DEI)

- Establish DEI offices in all institutions with DEI training and safe spaces
  - Guarantee anonymity and discretion in complaint procedures
- Ensure diversity in hiring panels and leadership roles
  - including age, gender and career stage
- Institutions and events should have a publicly accessible Code of Conduct
  - Zero tolerance for harassment or discrimination
- CERN should maintain its commitment to DEI policies that enrich its working environment

Related input: DEI [259]

Inclusion needs structure: DEI offices, mentorship

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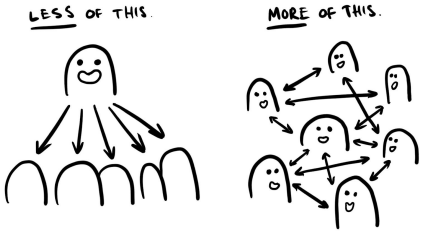
Leadership and recognition



- Only 20% of ECRs feel their voice is heard in the ESPPU process – even though 31% say the outcome will affect their future in academia
- 81% feel heard in local research groups, but only 54% in collaborations
    - Especially low in LHC collaborations

➠ Include ECRs in executive boards of collaborations

➠ Involve ECRs in topical working groups and event organisation

➠ Make dedicated ECR sessions a standard part of conferences and similar events

➠ Ensure equal recognition for detector work, software and service roles – not only physics analysis

ECRs need a stronger voice in strategy and leadership

Community building and ECFA ECRs

- Create national fora with regular meetings and ECR mailing lists where not available, mandate them to elect ECFA ECR Panel -> new mandate now under construction
- ECFA ECR Panel
    - Should have dedicated funding to organise events and other initiatives to strengthen the community -> now under discussion
    - Mandate to send an ECR delegate to ESG
- More inclusive ECFA in general
    - Dedicated panel on future beyond-collider particle physics experiments

Community building, leadership and recognition

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EARLY CAREER RESEARCHERS

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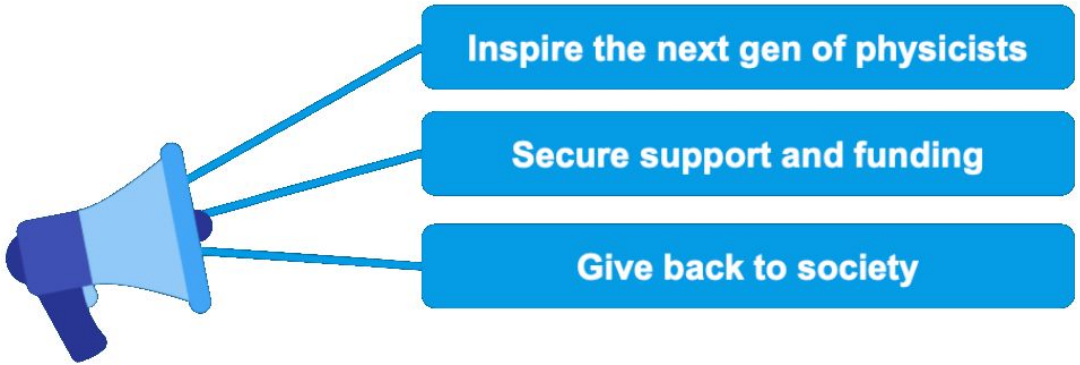
Effective science communication and outreach



➠ Promote a culture where outreach and communication are integral to research

Several of our recommendations align with input from IPPOG [60] and EPPCN [144]

Supporting ECRs in communication

- 85% of ECRs are motivated to engage with public on future projects
- 40% feel unprepared for outreach

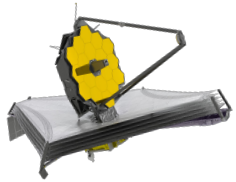
  ➠ Develop standardised training programs with experts

- 40% feel undervalued for their outreach

  ➠ Integrate communication into institutional benchmarks

- Create centralised platform to share material, tools
- Use CERN's high visibility to highlight science no matter the size or location of experiments

Storytelling



- Community should adopt a realistic and inspiring narrative

  ➠ Emphasise the role of future experiments as *observatories*, rather than just discovery machines

Communication is a shared responsibility - let's all engage in novel ways!

Community building, leadership and recognition

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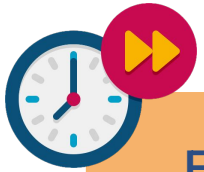
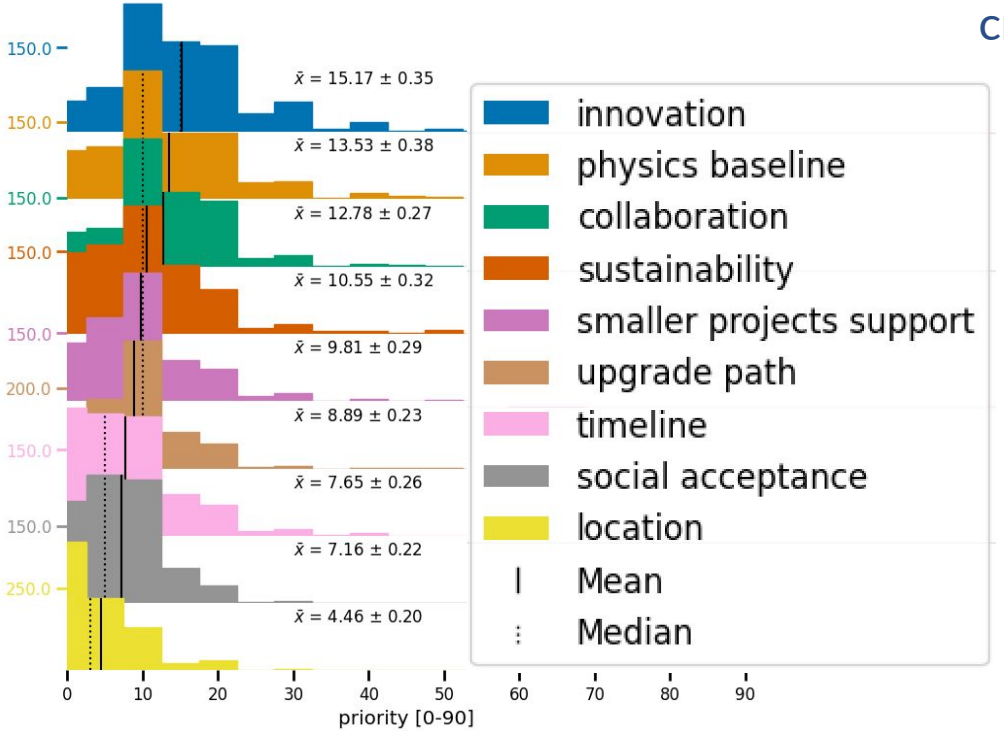


Future projects

Flagship collider - decision criteria priorities



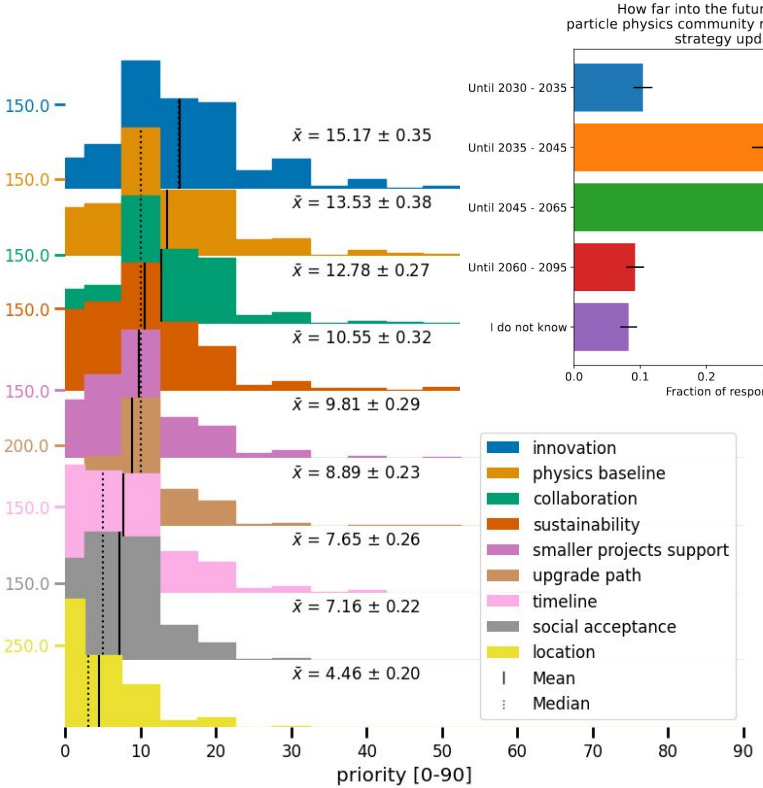
Task: distribute 90 points among 9 criteria for a flagship decision (∅=10)

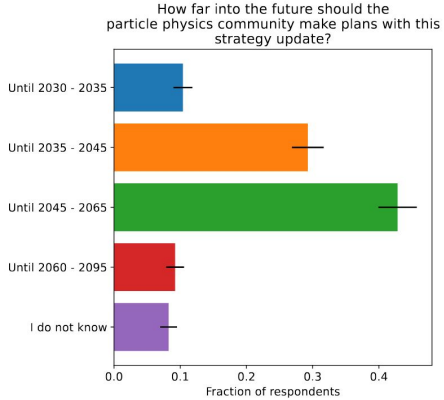
> 10

~ 10

< 10

Flagship collider - ambition for a challenge

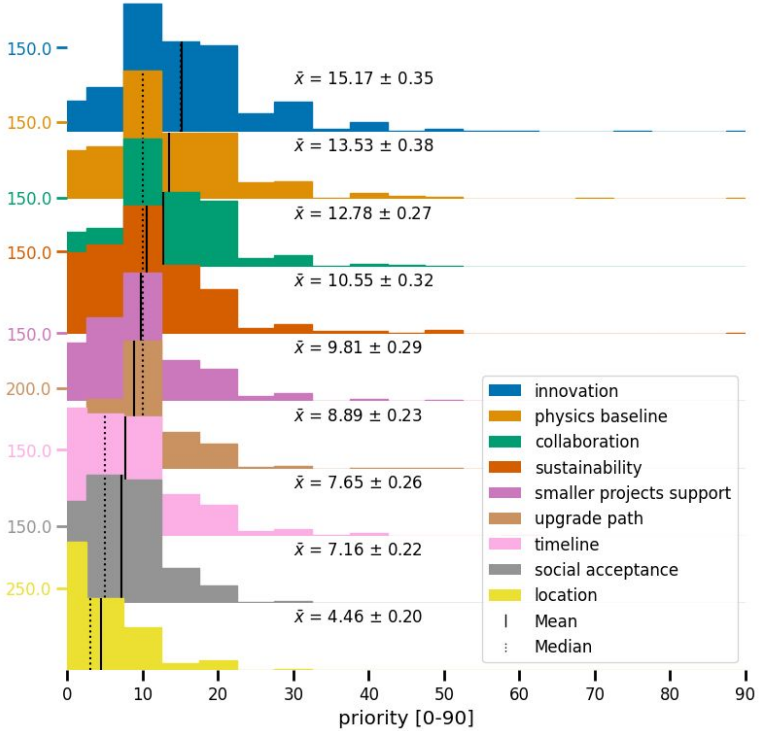




- 80% want a flagship as such
- Top criteria: innovation and physics baseline
- Project's upgrade path and timeline less important
- Target: next flagship, not 2065+

ECRs first and foremost want the challenge of an ambitious next project - technologically and scientifically

Flagship collider - physics and society



- Sustainability at average, social acceptance below → for decision *which* flagship
- However: 74% say flagship should built and run in the most sustainable way
- Social acceptance equally important to have a flagship at all

Sustainability and social acceptance should be smaller drivers for the flagship decision, but are necessary conditions for any flagship

Timely decision

Motivation: have motivating goal, plan for careers, have positions from funding agencies

Project doesn't have to be the fastest one, but it needs to be clear asap which one it is going to be

A clear recommendation on the next flagship collider for Europe should be given in this ESPPU process. -> Plan A rather clear, Plan B still under discussion

The ESPPU should urge the CERN Council to make a timely decision on the next flagship collider.

Corollary: commitment to move through flagship priority list if funding for plan A etc. is not achieved in a timely manner

Timely decision!

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Flagship collider - preference

- "What is your preferred option for the next flagship collider?"
- 28% *circular* e^+e^-, 15% *muon collider*, 14% *hadron collider*, 8% *linear* e^+e^-
- 23% *do not have a strong opinion or do not know,* 9% *any collider as soon as possible*
- ECRs working already on a future collider:
  - ~60% voted for "their" project, second most common is *any collider asap*

Statement: The main collider proposals (...) have received recognition from the ECR community. A relative majority prefers a circular e^+e^- collider, closely followed by the option "I do not know/I do not have a strong opinion".

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- 23% *do not have a strong opinion or do not know*, 9% *any collider as soon as possible*
- Need to involve and train ECRs more in future collider projects (cf. [15] & ECFA Training Panel [30])

Statement: The main collider proposals (...) have received recognition from the ECR community. A relative majority prefers a circular e^+e^- collider, closely followed by the option “I do not know/I do not have a strong opinion”.

Flagship collider - linear option?

Private opinion!

- “What is your preferred option for the next flagship collider?”
- 28% *circular* e^+e^-, 15% *muon collider*, 14% *hadron collider*, **8% *linear* e^+e^-**

- Possible interpretation: survey participants saw ‘linear collider’ as ILC250 - not competitive (wrt FCC-ee less lumi at 250, vastly less at Z pole) and not innovative (20-year old TESLA cavities)
- Stressing LCF as 550+ GeV with technological options (CLIC, C³, plasma) and a possibility to combine with a muon collider might change some people’s preference

Flagship collider – the what-ifs

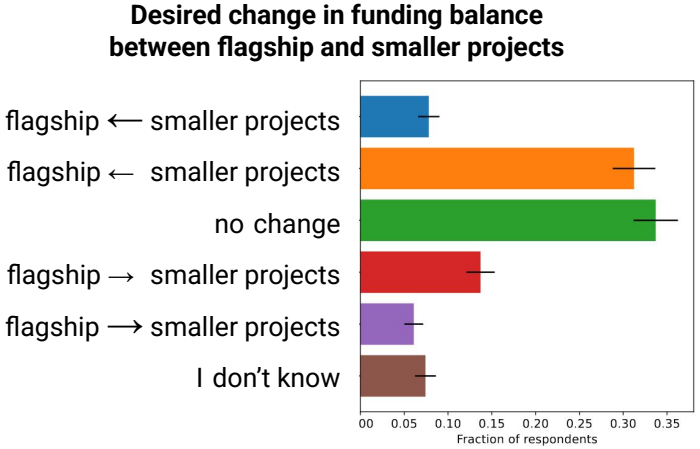
If a major collider project is approved outside Europe, the European community should start the construction of a complementary collider project.

84% of ECRs are willing to support the ESPPU outcome, even if their preferred collider option is not prioritised.

No ‘vast majority’ for any one project, considerable convincing work to do, but openness for it clear

Smaller-scale and beyond-collider projects

- Maintain smaller-scale and beyond-collider projects in their own right, as pathfinders for colliders and as bridge after HL-LHC
- Sustain diversity in scale, infrastructure, duration and location
  → cf. [106], [136], [280]
- Do not significantly change budget split between flagship and smaller projects



Note: 60% of experimentalists are from current or future flagship collider experiments

Strong support for smaller-scale and beyond-collider experiments

Beyond-colliders strategy

What actions would benefit you most?

A forum for beyond-collider researchers should be established to enhance coherence and collaboration

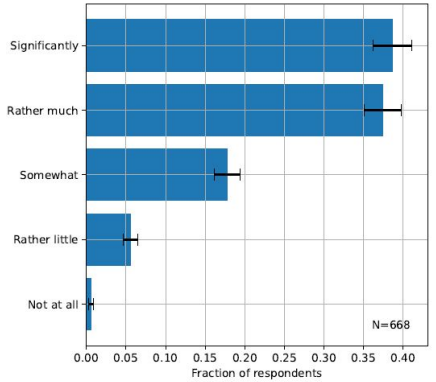
- Enable easier career transition between collider and beyond-collider
- Dedicated funding scheme for beyond-collider experiments

ESPPU should include concrete recommendations for beyond-collider PP research

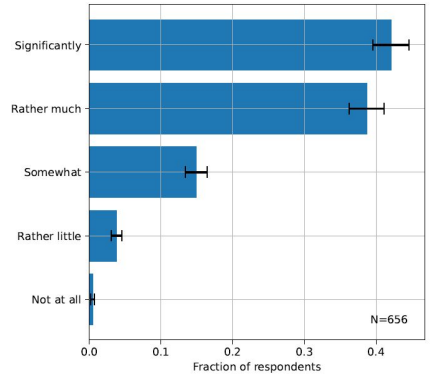
- → Important for career guidance and motivation to the funding agencies

Strengthen beyond-collider field with forum & concrete strategy recommendations

Easier transition C/BC experiments



Dedicated funding scheme



Conclusions

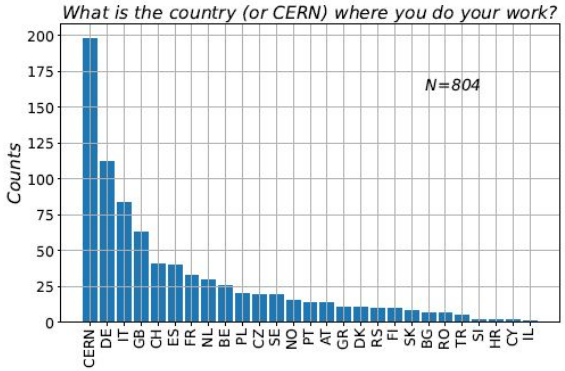
- Investing in ECRs is investing in the future of particle physics
- Great science only with great scientists and careers to keep them
- Inclusion needs structure: DEI offices, mentorship
- All contributions matter – analysis, software, R&D, outreach
- ECRs need a stronger voice in strategy and leadership
- Communication is a shared responsibility - let's all engage in novel ways!

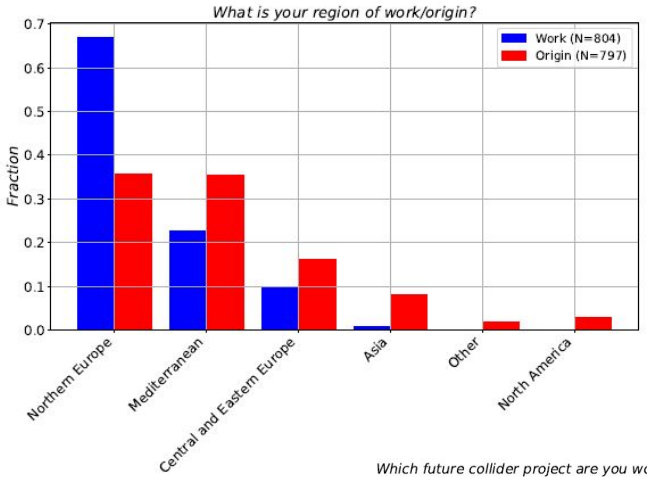
- Timely flagship decision!
- Ambitious flagship - technologically and scientifically
- No 'vast majority' for any one project, considerable convincing work to do, but openness for it clear
- Unity through openness and convincing
- Strong support for smaller-scale and beyond-collider experiments
- Strengthen beyond-colliders with forum and concrete strategy recommendations

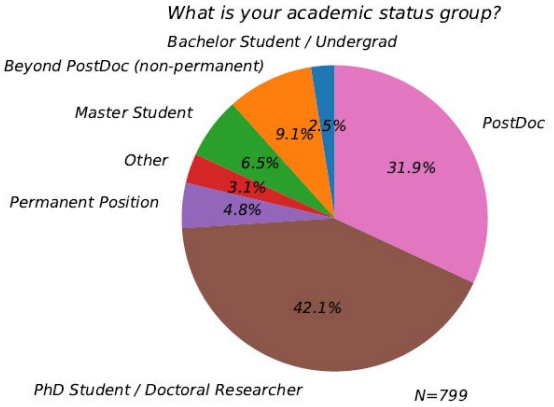
Thank you very much on behalf of the European ECR community!

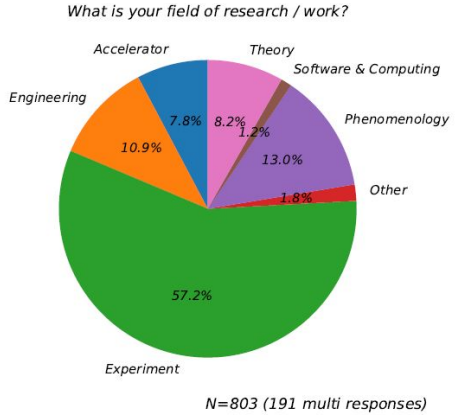
BACKUP

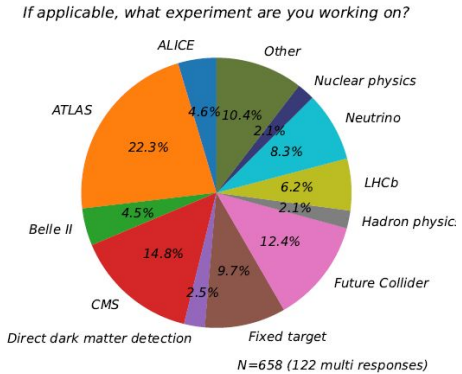
Survey demographics

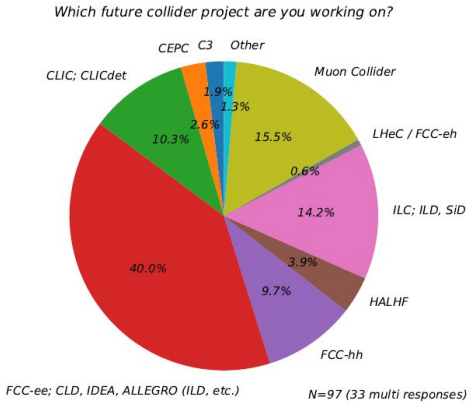


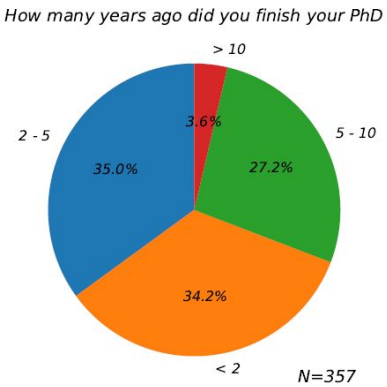




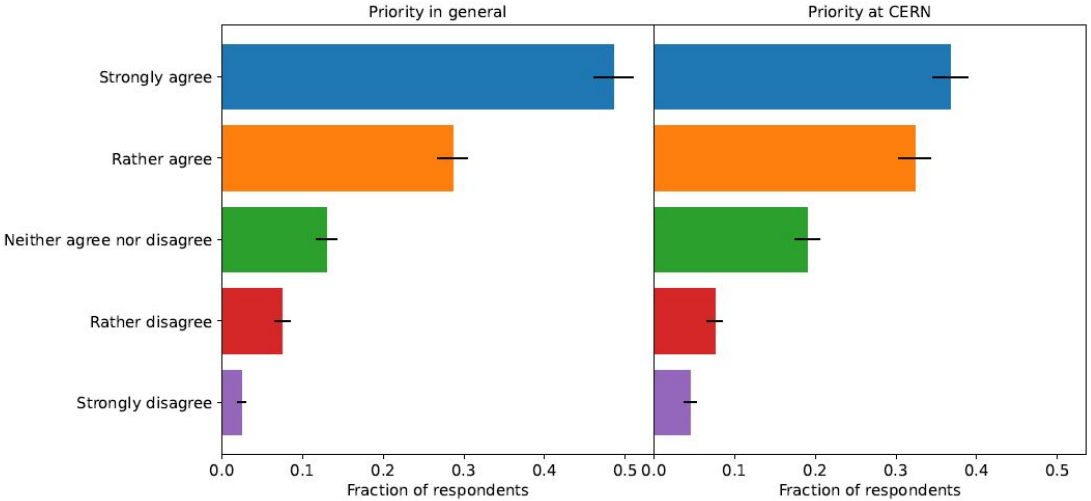








Flagship & strategy



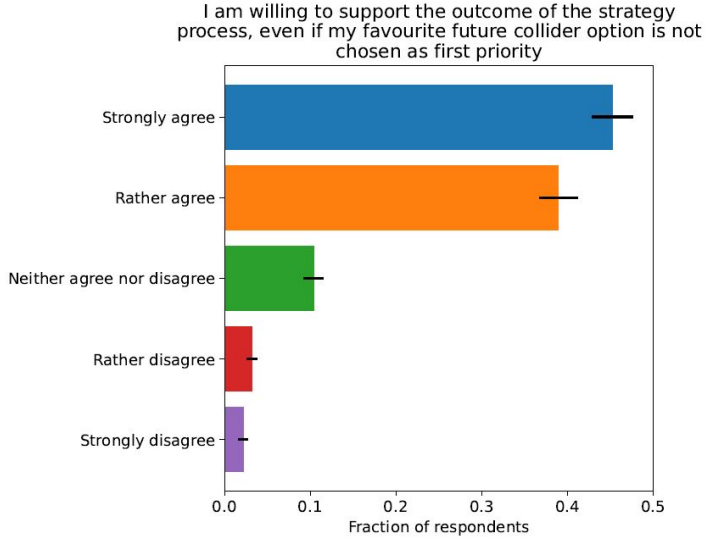
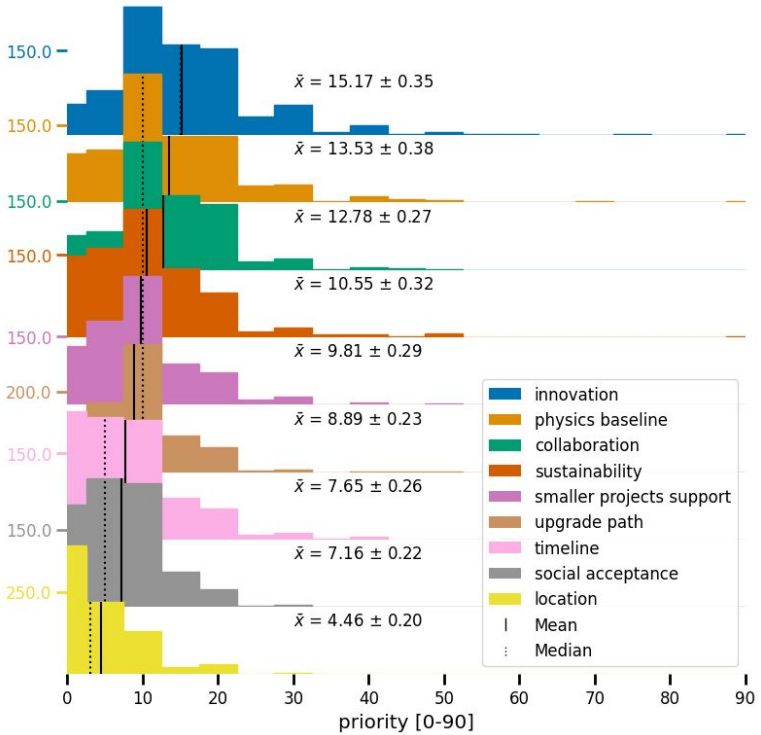


Figure Appendix.48: Distribution of responses to the question on the priority of a next flagship project in general (left) and whether it should be built at CERN (right).

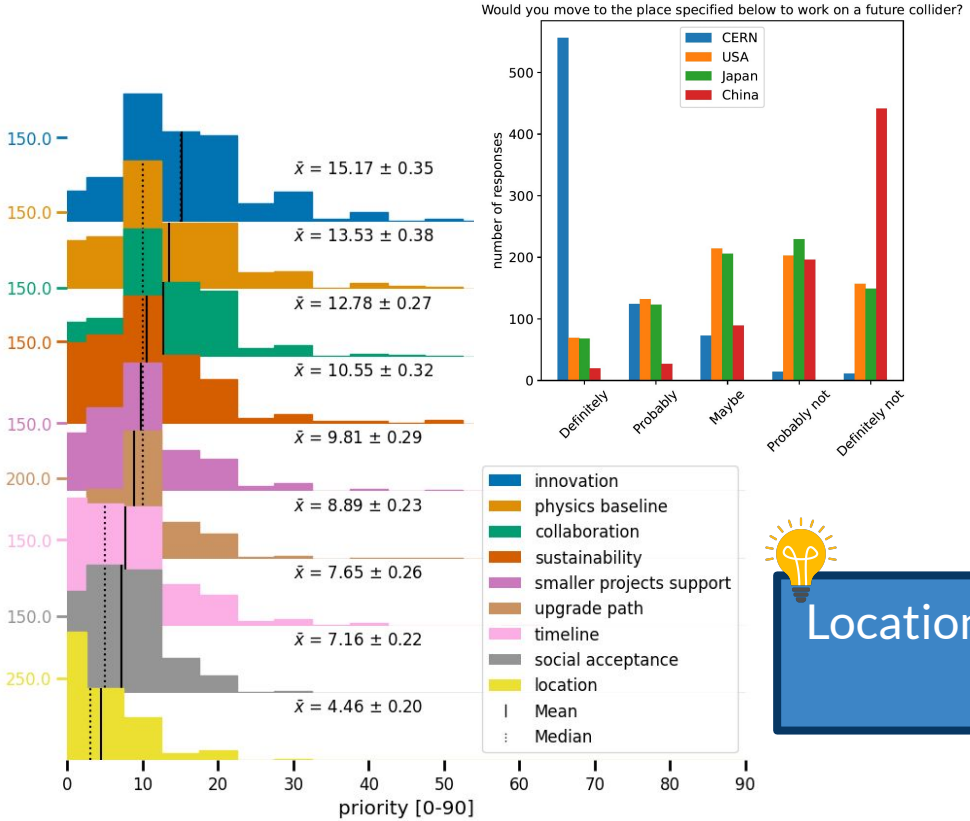
Priority criteria: exact wording



The next collider facility should...

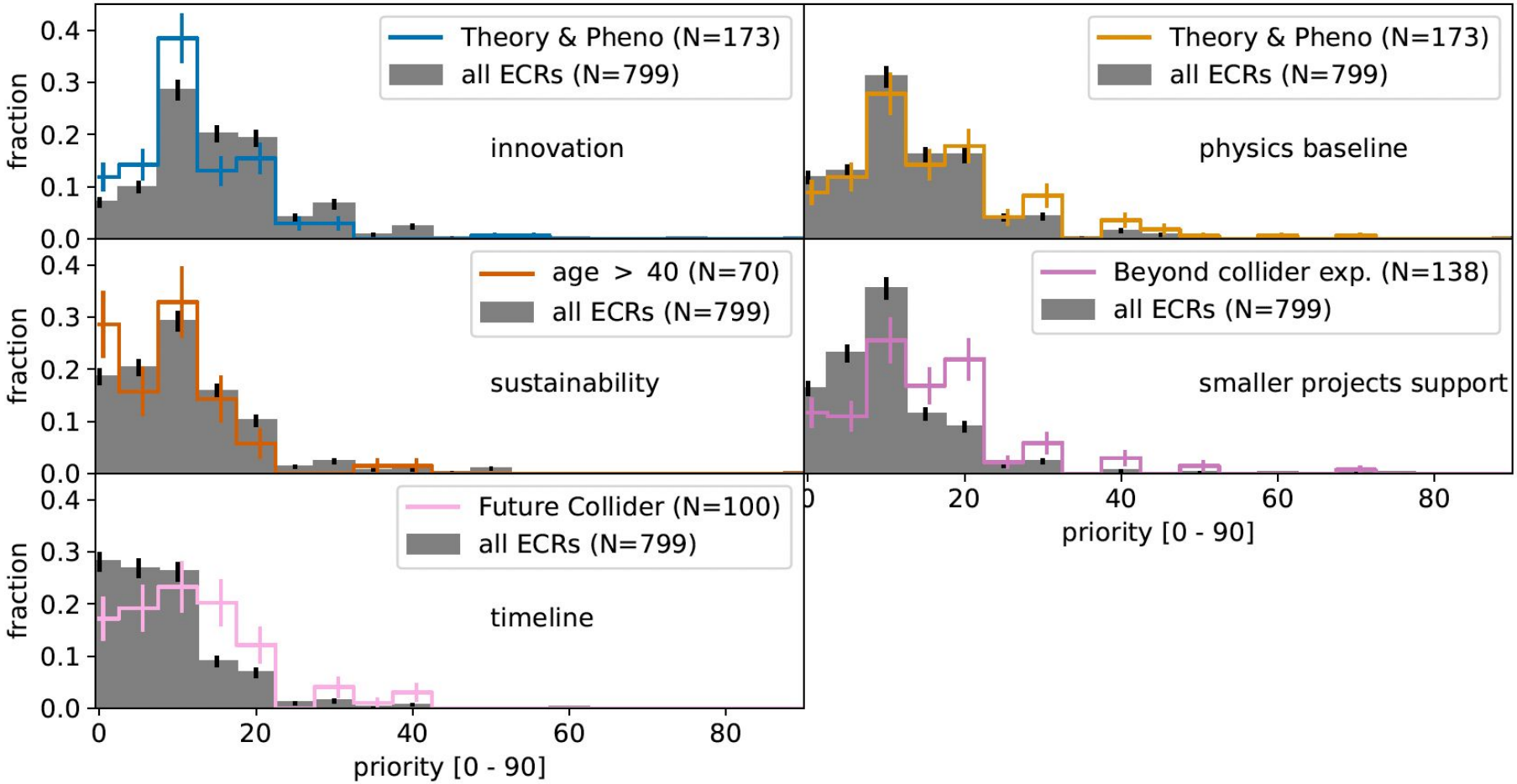
- *have an ambitious baseline physics programme (without upgrades).* [Physics Baseline]
- *have a well-defined long-term upgrade path.* [Upgrade Path]
- *minimise the time to first collision (timeline).* [Timeline]
- *be built at a specific location.* [Location]
- *drive technology R&D and innovation.* [Innovation]
- *allow stable support for smaller projects.* [Smaller Project Support]
- *minimise the environmental impact (sustainability).* [Sustainability]
- *be open to world-wide collaboration.* [Collaboration]
- *maximise social/public acceptance (e.g. regarding cost and land use).* [Social Acceptance]

Flagship collider - location

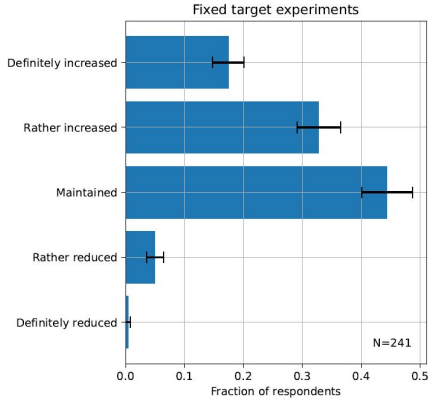


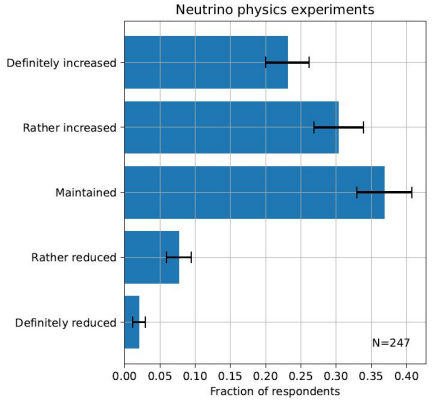
- 70% want a flagship at CERN
- ECRs are much more willing to move to a place in Europe than to USA or Japan, and than to China
- But: in comparison with other criteria specific location has lowest priority
- Collaboration high importance

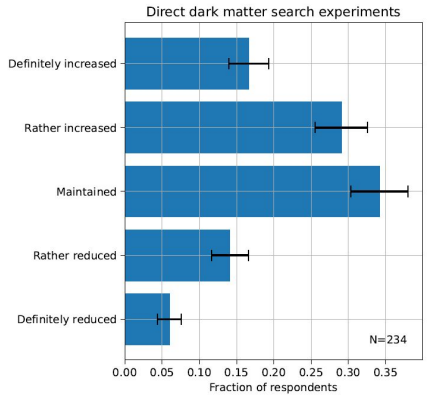
Location at CERN is appreciated but not a driving factor, collaboration is a must

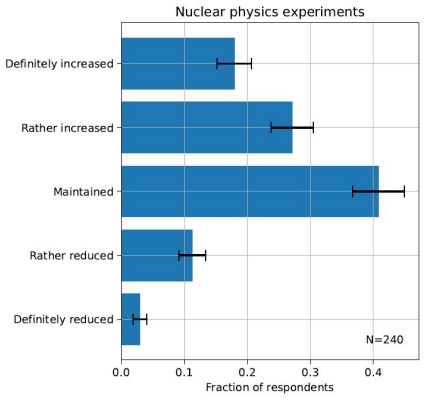

Theory & Pheno (N=173)
all ECRs (N=799)
innovation
Theory & Pheno (N=173)
all ECRs (N=799)
physics baseline
age > 40 (N=70)
all ECRs (N=799)
sustainability
Beyond collider exp. (N=138)
all ECRs (N=799)
smaller projects support
Future Collider (N=100)
all ECRs (N=799)
timeline
fraction
0.0
0.1
0.2
0.3
0.4
0
20
40
60
80
priority [0 - 90]

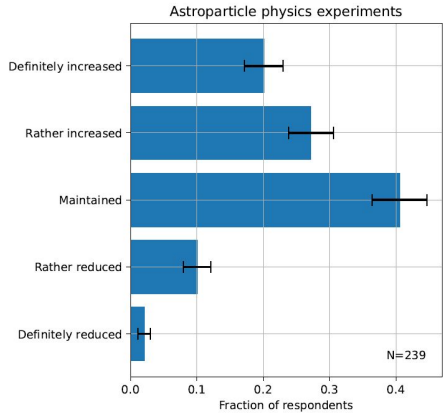
CERN's participation in beyond-collider projects: desired change in the future

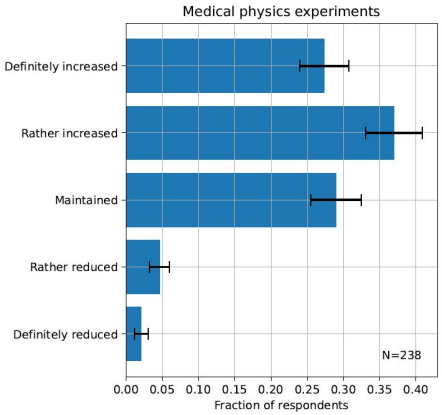


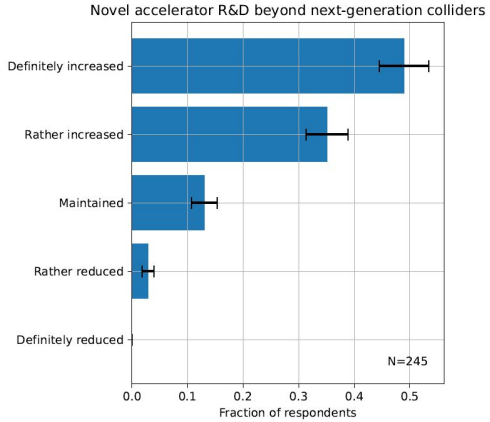












Career Prospects and Diversity in Physics Programme survey

Designed a survey to collect information about…

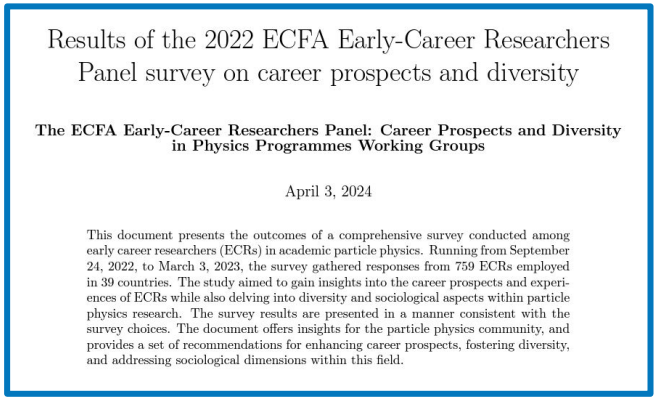
- The impact of the collaboration size on ECRs
- Assess the career prospects of ECRs: how can our panel help, what are the main problems?

Circulated to ECR community ☞ 760 responses!

- ~ 1/3 of the respondents are Mediterranean, ~1/3 from Northern Europe and 1/5 from Central and Eastern Europe
- ~50% on 36–47 months or 24–35 months contracts
- Almost 1/2 aged between 26 and 30

Responses have been analysed and written report put on arXiv (arXiv:2404.02074)

Extensively discussed at 114th PECFA meeting by P. Dougan and A. Garcia Alonso



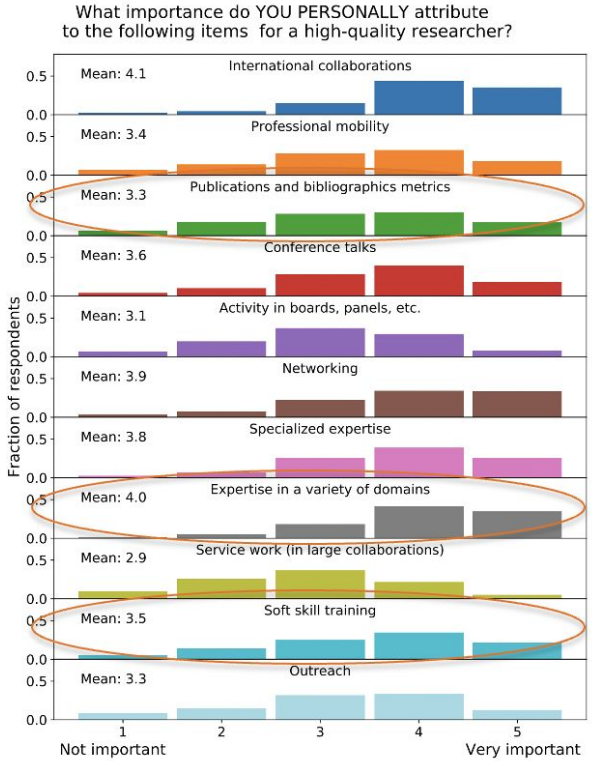
Results of the 2022 ECFA Early-Career Researchers Panel survey on career prospects and diversity

The ECFA Early-Career Researchers Panel: Career Prospects and Diversity in Physics Programmes Working Groups

April 3, 2024

This document presents the outcomes of a comprehensive survey conducted among early career researchers (ECRs) in academic particle physics. Running from September 24, 2022, to March 3, 2023, the survey gathered responses from 759 ECRs employed in 39 countries. The study aimed to gain insights into the career prospects and experiences of ECRs while also delving into diversity and sociological aspects within particle physics research. The survey results are presented in a manner consistent with the survey choices. The document offers insights for the particle physics community, and provides a set of recommendations for enhancing career prospects, fostering diversity, and addressing sociological dimensions within this field.

Career Prospects and Diversity in Physics Programme survey

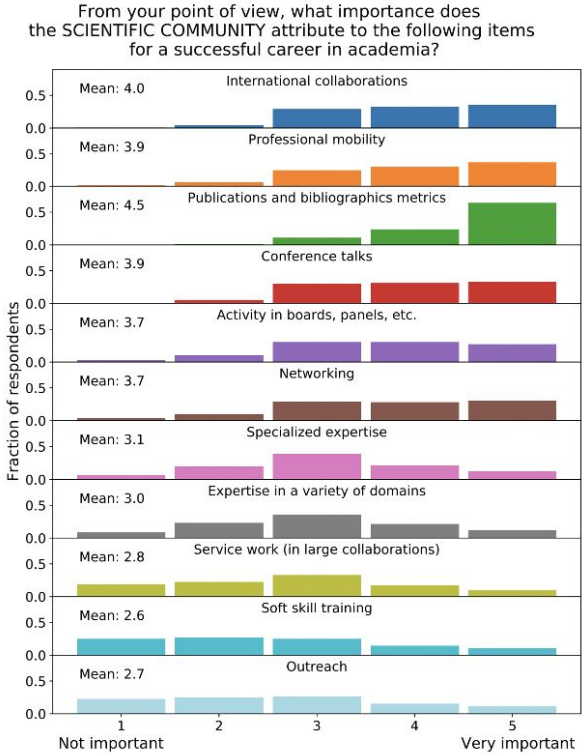


What do ECRs *think* is:

needed to be a **good researcher**

versus

needed for a **successful career**?



ECFA ECR Panel

[...] *to discuss* ***all aspects*** *that contribute in a broad sense to the* ***future of the research field of particle physics*** [...] ..

Aiming to represent the European early-career particle physics community

- From PhD students to young assistant professors
- Theoreticians, phenomenologists, experimentalists, …
- 3 members per country + 1 member per LDG lab
- Organization committee (Marko Pesut, Jan-Hendrik Arling, Louis Portales, Arnau Morancho Tarda)
- 5 delegates in Plenary ECFA, 1 delegate in Restricted ECFA
    - Andrea Garcia Alonso, Patrick Dougan, Bruno Alves (RECFA), Kevin Urquía, Magdalena Vande Voorde

The panel was created as a follow-up to the ECFA Early-Career Researchers report to the 2020 Update of the European Strategy for Particle Physics

→ The ECFA ECR panel is tightly linked with the Update of the European Strategy

→ Make sure that this time ECRs are in the loop from the beginning!

ESPPU: how to choose a flagship

Great appreciation for the fact that we have a community-driven strategy process
But: many discussions about the past and current ESPPU
- some communication entailed pressure rather than convincing to unite
- some communication already represented one project as default plan A

→ not consistent with an open and fair process

The process towards defining the European strategy for particle physics must be more transparent and democratic. After the decision has been made, a structured explanation of the criteria which led to a certain result is necessary.

A fair and inclusive decision process is essential to create acceptance for the decision among proponents of the future collider alternatives and is vital for trust in the procedure.

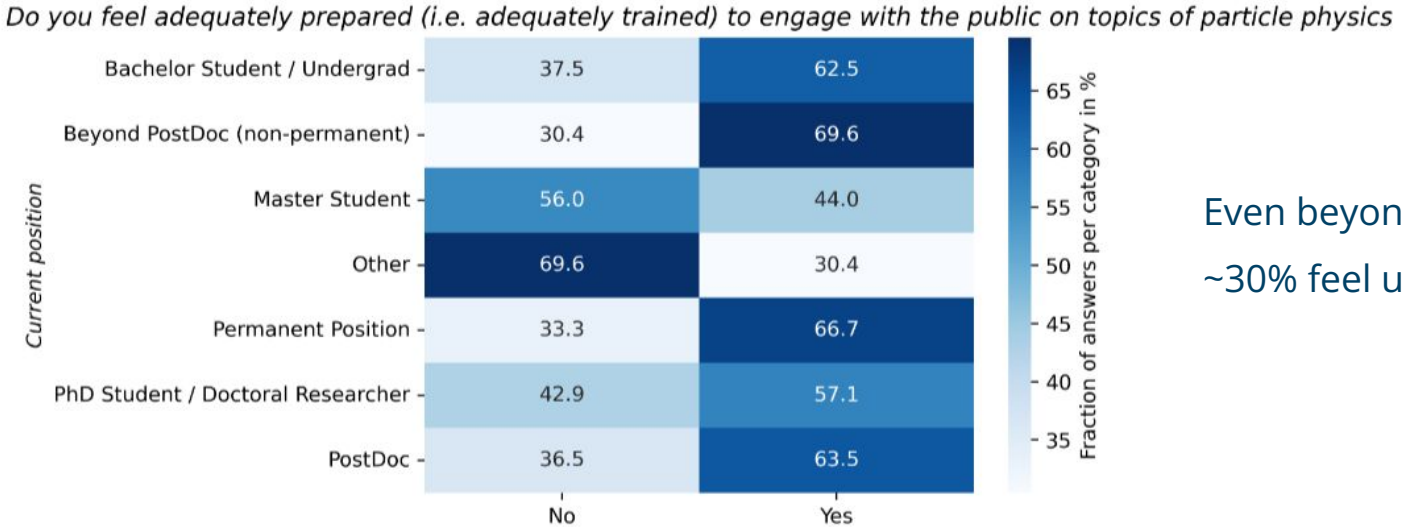
- Selection of collider is *not trivial*
- Need to clearly reason the outcome
- Target: unity through openness and convincing

Communication & outreach

Training for outreach

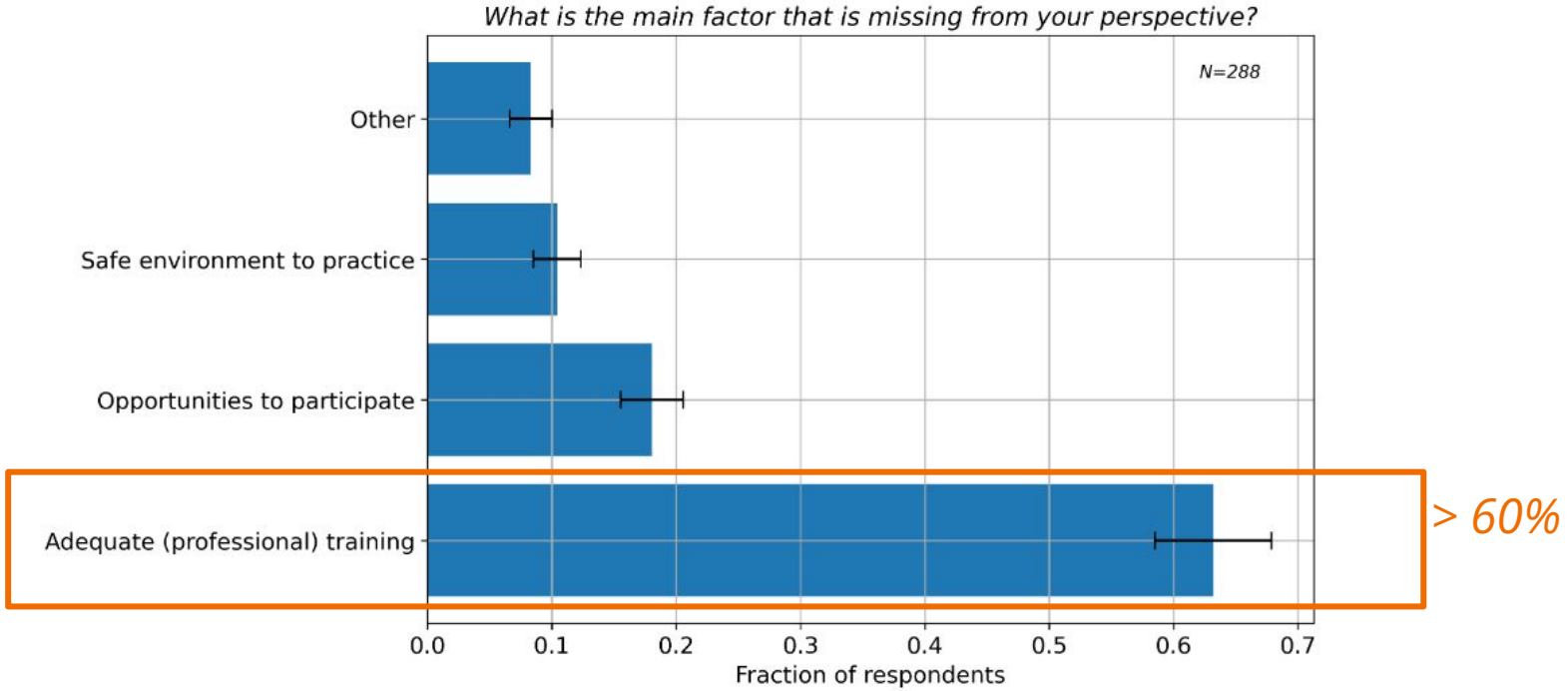
Do you feel adequately trained to engage with the public on topics of particle physics?

vs Career Status



Even beyond post-doc, ~30% feel unprepared

Training for outreach



Significant majority (>60%) would like courses taught by professional science communicators

Training for outreach

During your career so far, have you received any training on science communication or outreach topics?

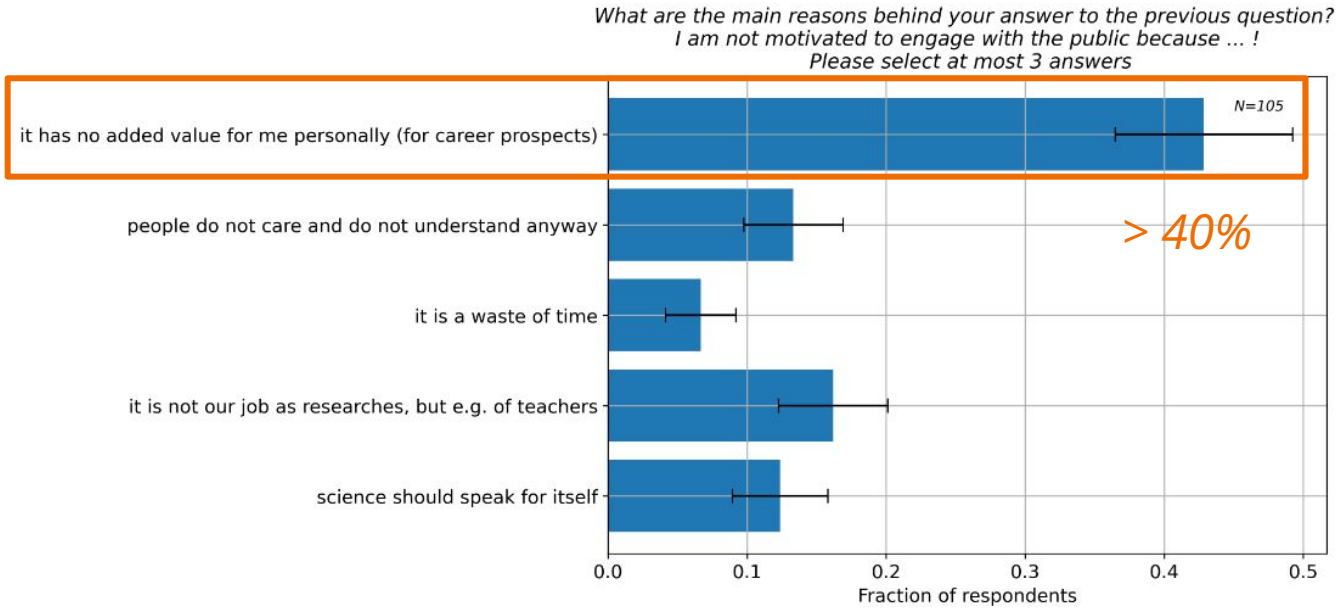
NO	YES
55%	45%

85%

Results from optional questions (~50% of respondents)

Recognising outreach efforts

ECRs who are NOT motivated to participate in outreach ..



- "Other" open answers: lack of confidence, lack of job stability, disagreement with the EPPSU

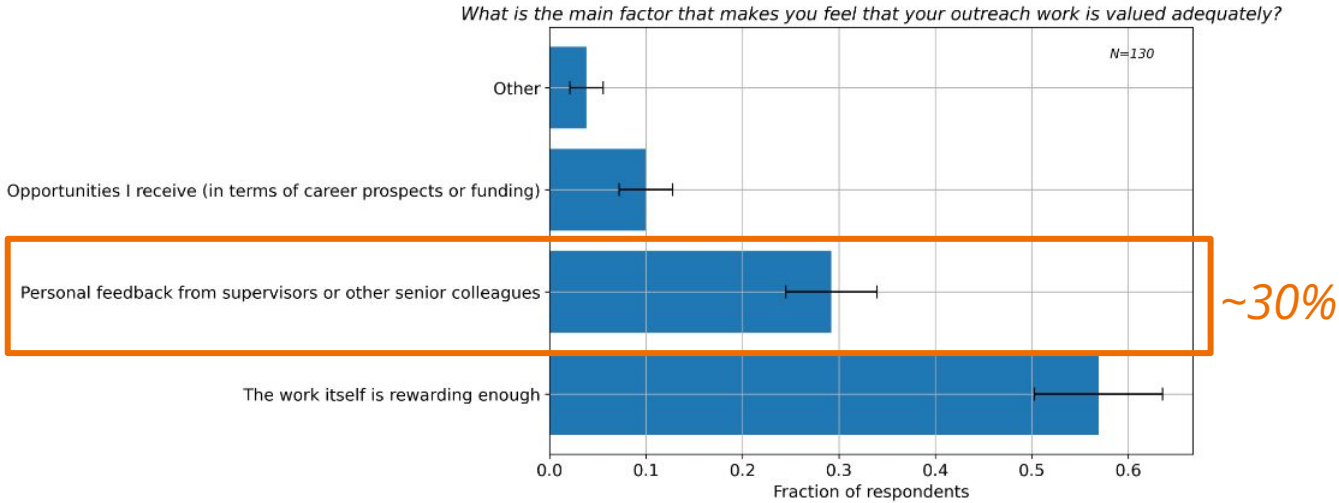
Recognising outreach efforts

ECRs who are motivated & active in outreach ..

Do you feel adequately valued for your outreach work?

NO	YES
40%	60%

Results from optional questions (~50% of respondents)



Social media outreach

cern Follow Message •••

2,323 posts 1.1M followers 133 following

CERN

cern

CERN is the European laboratory for particle physics, home to the Large Hadron Collider.
-
Images © CERN, unless... more
1 Esplanade des Particules, Meyrin, Switzerland 1217
linktr.ee/CERN_official

atlasexperiment Follow Message •••

841 posts 70.3K followers 78 following

ATLAS Experiment at CERN

atlasexperiment

cmsexperiment Follow Message •••

411 posts 32K followers 224 following

Compact Muon Solenoid at CERN

- CERN is the most attractive institution for particle physics research
- Other institutions and experiments struggle to reach such a wide audience

Outreach motivation

Results from optional questions (~50% of respondents)

Are you participating in outreach activities?

59% **involved** in outreach

65% of **motivated** ECRs are **involved** in outreach

66% of ECRs **planning to stay** in the field are **involved** in outreach

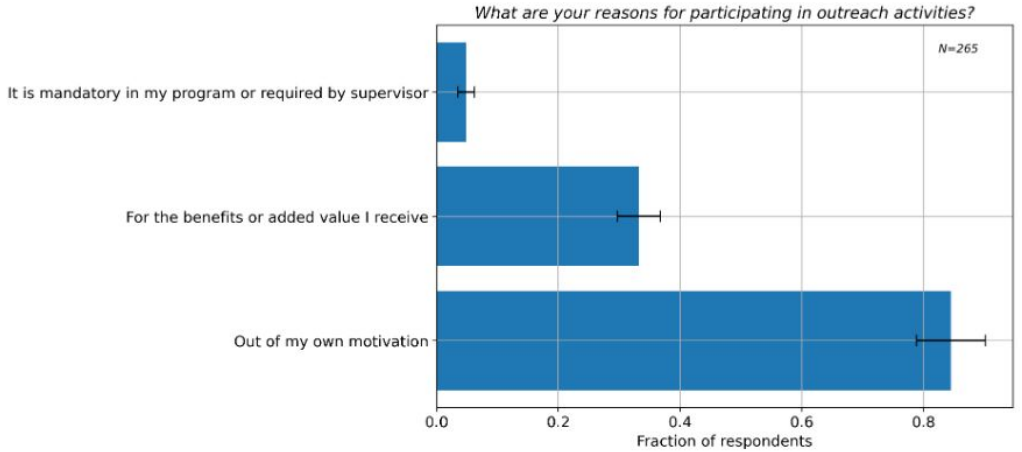
When do your outreach activities take place?

59% free time and working hours

27% working hours

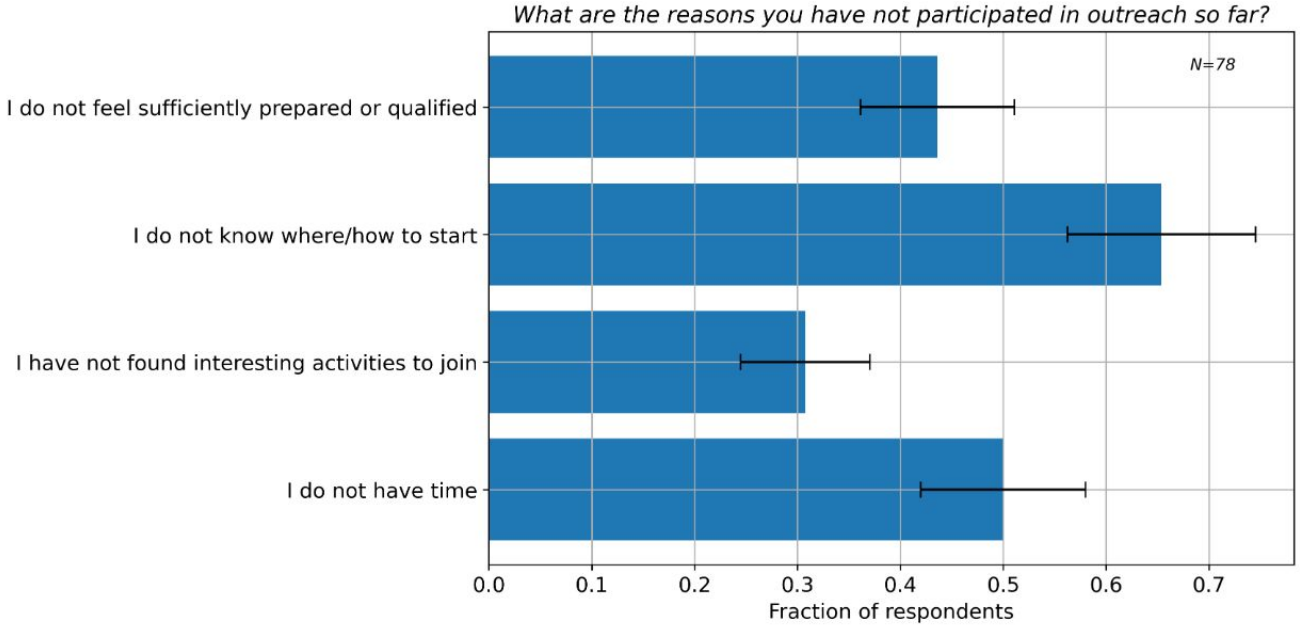
14% free time

- The significant majority of ECRs do outreach out of their own motivation
- “Other” open answers consider outreach fun and rewarding and of moral value



Outreach opportunities

ECRs who are NOT active in outreach but motivated ..



** Small sample - could be biased*

Results from optional questions (~50% of respondents)

- Lack of clear path
- Lack of interesting activities
- Lack of time and preparedness