

Diversity and equitable opportunities

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This report motivates why diversity and creating equal opportunities is relevant to all in particle physics. Everyone's career paths and experiences are different and people may face contrasting barriers and opportunities to reach the same position. Particle physics collaborations, universities and funding research councils are monitoring diversity and taking actions to create equitable opportunities, described here. The conclusion is that everyone contributes to a workplace culture and should aim to make their workplace positive for all.

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*Speaker

1. Diversity and equitable opportunities

This talk was composed of three sections. Firstly, motivation for why diversity and inclusion is relevant to particle physicists and why everyone should be aware of related issues. Secondly, what particle physics experimental collaborations and laboratories are doing about diversity and creating equitable opportunities. Finally, the talk summarised with an outline of how every particle physicist can contribute to create an inclusive and positive working environment.

1.1 Why do we need diversity talks at particle physics conferences?

Why spend 19 minutes of a plenary session at an international particle physics conference talking about "Diversity and equitable opportunities"? People's views of equity, diversity and inclusion (EDI) vary depending on their experiences. For some the field of particle physics holds no barriers, they consider that everything is fine and EDI is no concern of theirs. In stark contrast, others perceive that there are so many barriers that things have to improve for the field to survive, and they may be motivated to make differences themselves. In between these two views are those who perceive that everything is fine for them, but they recognise that others experience barriers.

Which of these camps a person falls into can depend on their "inclusion and belonging", i.e., if a person is within an "in-group" or out of the group. The definition of an group can have many dimensions - nationality, disability, financially secure family, language, gender, neuro-divergent, LGBTQ+, vegan, religious minority, first generation with higher education.... A person can be in the "in-group" or most dominant/popular group for one dimension, but be in the out-group for another.

Take the example of each person's journey to this international conference as an example, to demonstrate diversity. Everyone's path has been different. Attendees may have been invited to give a talk or a poster, a process which requires a selection process. They have had to register, which will have required some sort of approval by group lead, or themselves or supervisor. They have travelled here, which may have necessitated a passport and or a visa. To book transport requires funds. Attendees may have had to sort out home arrangements before leaving, for some this will have included arranging caring responsibilities for others.

Everyone's path to the conference was different, but did everyone have equitable opportunities? Each person will have experienced different opportunities/barriers at each stage! For some each step will have been easy; in contrast, others will have had to request, negotiate, compromise at each step. The selection process to be invited to give a talk or poster may depend on a person's career stage, nationality or gender. To register, approval by a group lead may involve biases related to gender, ethnicity, age, or caring responsibilities. Ease of travel could depend on visa requirements, passport type, nationality, mobility, health, age, religion and sexual orientation. The ability to fund transport could depend on funding approval, which could be influenced by biases, such as gender or ethnicity. Ease of leaving home for a week may depend on caring responsibilities which can be related to gender, age and ethnicity.

Even before the conference, every attendee's journey has been different. Each person has been given opportunities, but the path has been different for everyone, demonstrating diversity. For example, how did you achieve your present position? How many job applications did you write? Who did you approach for reference letters? Were you invited to interviews? Before that, how did you achieve your PhD placement? Were you given advice on where to apply, on CV writing

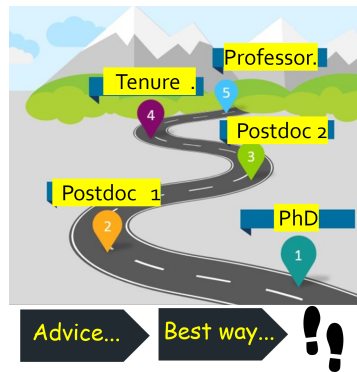


Figure 1: Cartoon to indicate steps in a career path.

or on interview techniques? How did you choose your undergraduate University? Did you guess, were you offered, or did you seek advice, did you have the opportunity to visit Universities before choosing? Did your family help support your career choices? If so, was this support mental, financial or helping with your physics. How/when/where did you even hear of particle physics? Was this at home, at your school, at undergraduate level, in the media, or via an outreach talk?

Progress and success in a physicist's career is different for each. For some their path is self-determined and can be a lonely, winding path. In contrast, others may be shown the way, guided and supported at all stages and pointed in the right direction, indicated in Figure 1.

The same career or workplace can seem like a "walk in the park" or be easy for some whereas for others this can seem like walking through a muddy field, due to the little obstacles, or setbacks at every stage, which can start to build up and slow progress. One example, for gender, is described by the leaky pipeline shown in Figure 2 [1]. This image is applicable for many minorities, not just gender and is similar across many different countries [3].

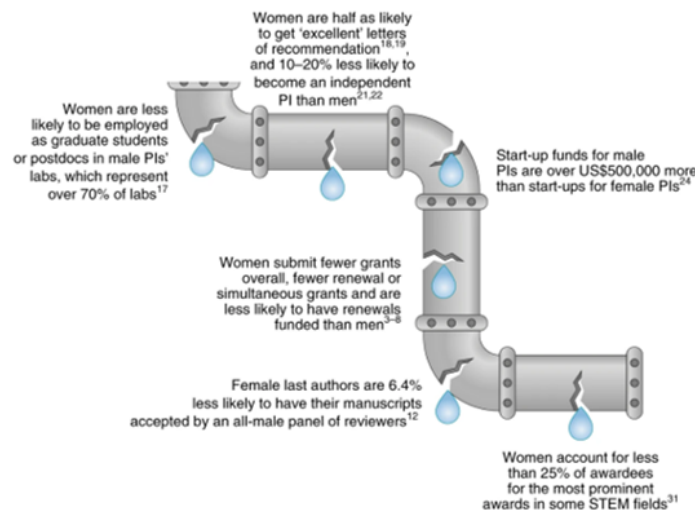


Figure 2: Leaky pipeline cartoon, indicating how every stage in a career can be harder for women than men, due to academic structures. [1].

Within Physics, original diversity studies and initiatives focused on gender. The lack of gender diversity is evident in the 5th Solvay conference on "Electrons and Photons" in 1927, attended by 29 participants including Neils Bohr, de Broglie, Albert Einstein, Heisenberg, Pauli and only one female, Marie Curie: 4 % female. Seventeen of the 29 attendees became Nobel prize winners, including Marie Curie, who was the only one to win two Nobel prizes in two separate scientific disciplines [4]. Diversity in gender has improved. In 2024 the ATLAS collaboration has 24 % per cent female authors (where gender is taken to be binary and from the CERN HR database) [10].

Diversity is more than gender, it is the quality of being different. There are many dimensions of diversity, indicated in Figure 3 [2]. In more recent years, diversity reviews have broadened to cover race, ethnicity, sexual orientation, gender identity, disability, neuro-diversity and age.



Figure 3: Image demonstrating the many dimensions of diversity[2].

What are particle physics collaborations, research councils and universities doing about diversity and creating equitable opportunities?

2. Diversity

2.1 Diversity and Inclusion Structures and Aims

Particle physics collaborations, research councils and Universities are now monitoring diversity and attempting to create equitable opportunities.

International research laboratories have tiered layers to support diversity and inclusion. Typically there is an overall diversity office which supports particular groups or networks such LGBTQ+ at CERN, neuro-diversity groups, Women In Technology, disability network. The next layer is collaboration management, below which they mandate diversity leads or diversity offices and/or early career support groups. This occurs at CERN, where ATLAS has four diversity and inclusion contacts [6], CMS has a Diversity and Inclusion office [8] and LHCb has an early career group [9]. Then there is every individual member of the collaboration.

The parallel EDI sessions at ICHEP2024 contained a mixture of collaboration talks: ATLAS, CMS, LHCb, ALICE, and g-2, and topic-based talks on Ukraine, European Research Council funding, LZ's community agreement, inclusivity in UK Physics departments, girls into physics workshops, and invisible dimensions [5]. Some highlights of these talks are presented below.

The collaboration and funder's aims were clearly summarised in the quotation in the g-2 contribution. "The mission of the collaboration is to measure with unprecedented precision (goal 140 ppb) the anomalous magnetic moment of the muon. Having a diverse collaboration with a variety of backgrounds is an asset to solve the complex problems we encounter, and an inclusive and equitable environment help us to maximise the productivity of the collaboration." Analogously, the goal of the ATLAS collaboration early career scientists group is "that all have equal opportunities independent of their backgrounds". The European Research Council's aim is to provide opportunities for frontier science ensuring equal treatment of applicants. So what are these groups doing to achieve their aims: firstly with respect diversity, and secondly creating equitable opportunities?

2.2 Diversity Monitoring and Activities

Collaborations are acknowledging diversity and monitoring diversity statistics and showing this data internal and externally and, where appropriate, celebrating positive changes. For example, CERN diversity office analyses CERN staff and has created an aim of achieving 25 % female staff by 2025. The fraction of female members and authors has been increasing from 2016, and in 2023 had reached 22 % female members and 20 % authors. ATLAS has 24.1 % women authors in 2024 up from 23 % in 2022. The fraction of women is higher for authors under 35 years old (20.7 % in 2024, up from 19.7 % in 2022). Compared to CERN staff and fellows of 22.5 % in 2022 [10].

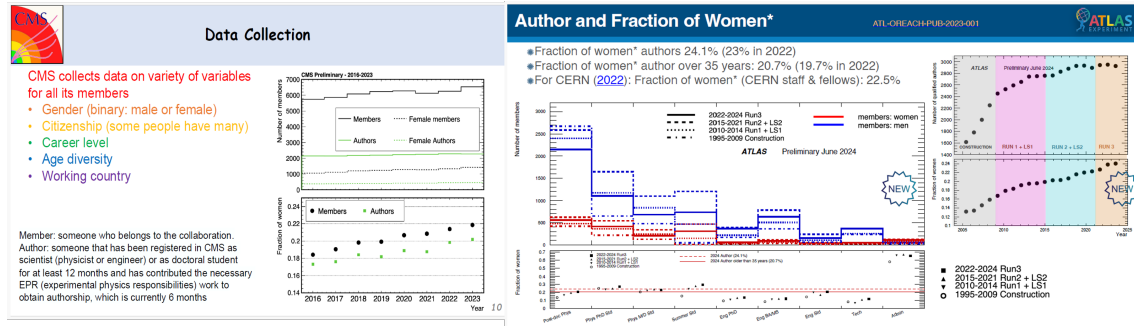


Figure 4: CMS and ATLAS collaboration female and male ratios for members and authors [5] [10].

They are also work on broadening the minds of their collaboration members, since each person has (only) their own lived experience. By hosting inclusive and cultural events, members can experience different traditions, and cultures. ALICE has run several workshops, "Collaborating in culturally diverse teams", the first in ALICE week in March 2024. The goal of the workshops is to recognise the tie between unconscious bias and cultural awareness, and to understand the impact of cultural differences on the collaboration. CERN celebrated LGBTQ+STEM day on 17th November 2023 by raising a flag just outside CERN [7].

Collaborations also run training sessions on topics such as unconscious bias, but they are endeavouring to make them more interactive and engaging, such as "The Coffee Machine - who

rinses the cups", advertised in Figure 5, and theatre is being used to educate in diversity and inclusion. CMS also introduced an interactive booklet on diversity and inclusion.

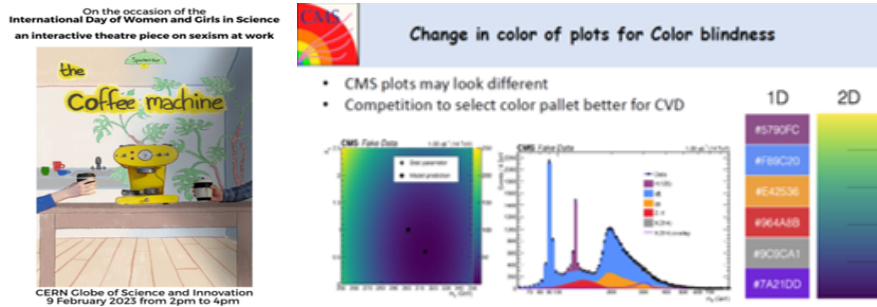


Figure 5: Left: CERN's interactive theatre on sexism at work. Right: CMS's colour palette to make plots more accessible [5].

CMS have raised awareness of colour blindness and have changed their standard colour palette used by the CMS collaboration in their standard style files, shown in Figure 6.

3. Equitable Opportunities

Collaborations and funding bodies are working to create equitable opportunities for all in a variety of ways. Equity implies that it may be necessary to give people different support in order to give everyone equal opportunities.

Most particle physics collaborations are actively promoting and raising awareness of particle physics through outreach events and programs. ATLAS summarised stating, "Diversity is key in outreach! Outreach is key in diversity.", aiming to make particle physics relatable and accessible to as many people as possible. To be inclusive their outreach is performed in a variety of languages, has multi-cultural representation, close-captioning is used on video material, exhibition material for visually impaired is on display and they host remote activities. They aim to show the diversity in the human and science endeavours and achievements at CERN.



Figure 6: Examples of diverse and inclusive outreach activities run by particle physics collaborations [5].

An example of the range of inclusive outreach activities CMS have undertaken is a colour run which engaged the local community around CERN and resulted in giving the public tours of

the CMS detector. ATLAS also organise cavern tours of their detector, in 2023 alone, 500 cavern tours and 65000 visitors were hosted in their visitor centre. In addition, virtual tours in 12 different languages from over 32 countries are offered, enabling a diverse range of people to access the tour, opening up the opportunity to those who can not travel to CERN or do not have the funds or time or opportunity to do so in-person. Similarly, at Fermilab, g-2 also offer in-person and virtual tours.

Some of this outreach is aimed towards groups with low income or those groups not presently exposed to science or focused on groups underrepresented in science. For example, collaborations run events focused around international day of women and girls in science in February, international women's day in March and international LGBTQ+STEM day in November.

International and national laboratories and Universities also run events and workshops for school students. Some invite students in for an event or day of activities and others organise longer multi-day workshops. An example of the latter is a program run in Germany, called "Physics Project Days". The goals of the workshops are to "encourage female high school students to study physics, to address the start of the pipeline. Figure 7 outlines the aims of the project, shows images of attendees over the years and a typical timetable for a workshop. Surveys of participants before and after the workshop indicates that the students were more likely to consider studying physics an option after (75 %) than before (40 %), shown in Figure 8.



Figure 7: Physics Project Days project is a four day workshop run for girls in schools. Left shows the aims, centre an image of the participants over the years, and right is a typical timetable [5].

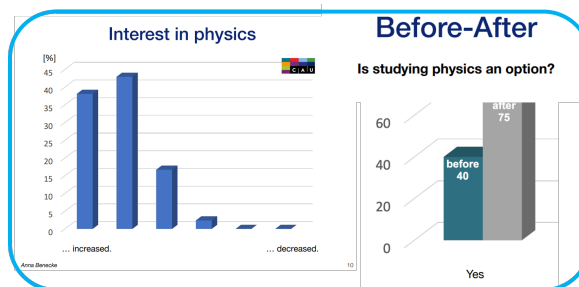


Figure 8: Image showing survey results from the Physics Project Days. Left: shows attendees' interest in physics and right interest in studying physics before and after attending [5].

Collaborations also host Early Career Research (ECR) Groups and run mentoring programs. Joining a collaboration, particularly the size of ATLAS and CMS, with 5000 members, can be very

intimidating, when others are already part of networks and you want to join in. ECR groups can work to pair up new starters to help integrate them into the collaboration. The ATLAS collaboration and the ECR group runs events and activities to support early career researchers throughout their career, shown in Figure 9. The g-2 collaboration also has an ECR group, called the g2early group.

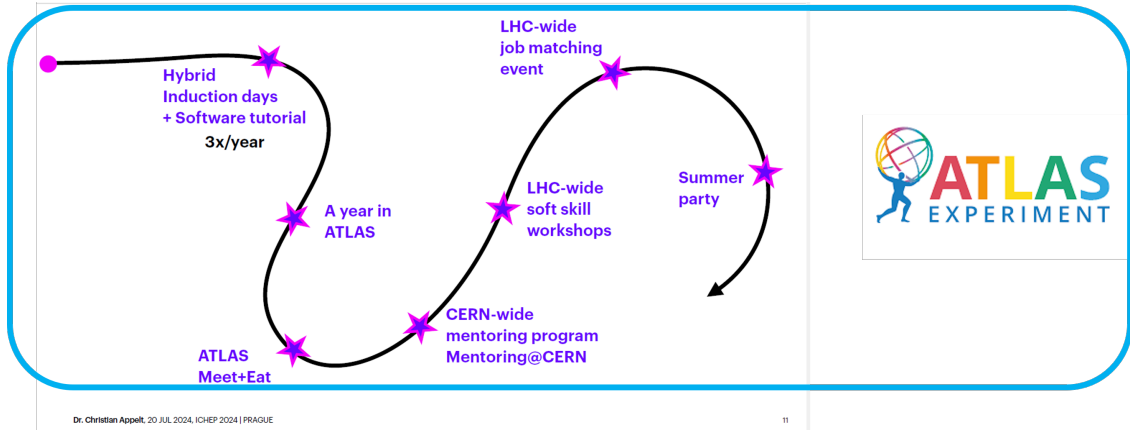


Figure 9: The ATLAS collaboration's support for early career researchers throughout their career [5].

One of the focuses of the LHCb Early Career Scientists group is on mental health and well-being. Between 2021 and 2023, they ran Healthy Minds for Masterminds. They have also run a LHC-wide survey on mental health and stress triggers, summarised in Figure 10.

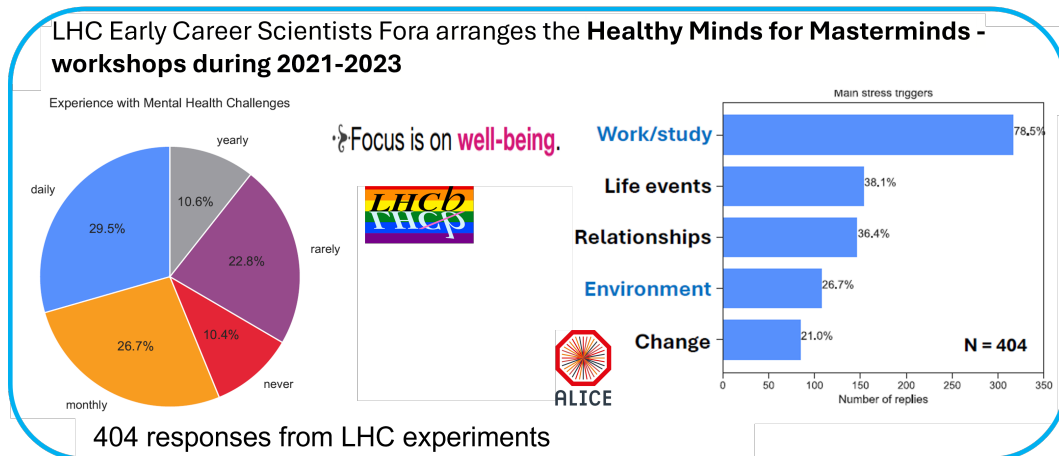


Figure 10: Results from LHCb early career scientists survey on stress and mental health [5].

One thing that contributes to inequities in promotion at universities and laboratories, is that one of the core criteria of promotion is grant income, success and quantity of income. So if the process of succeeding in attaining grants is unfair or biased, this has a knock-on effect on inequality in promotions between males and females and underrepresented groups.

The European Research Council (ERC) has monitored and analysed success rates by gender and country for various grants. Some of these results are shown in Figure 11. They do indeed show

that there used to be a higher success rate for men than women between 2007-2013 by 2 or 3 %. Following which the ERC developed more inclusive application and reviewing processes, which has resulted in a more equal success rate by gender in the Horizon 2020 grants (2014-2020).

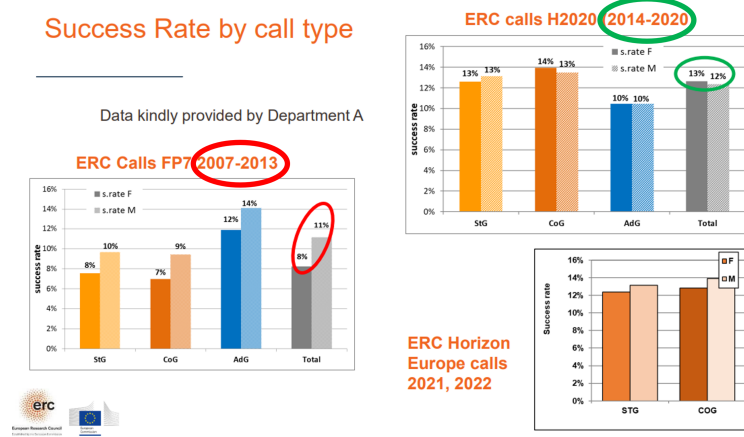


Figure 11: Summary of European Union Research Council grants success rates by gender [5].

The LZ collaboration have created a Community Agreement, a code of conduct for members and integrated into this an ombudsperson to review, resolve and deal with reported issues. Other laboratories, like CERN, have a lab-wide code of conduct.

The importance of Ukraine's contribution to particle physics was highlighted, with Breit, Budker, Goldhaber, Charpack and Gamow born there. ICHEP was hosted in Kyiv in 1959 and 70.

People are complex, and the intersectionality of multiple diversion dimensions should be considered. For example, a black woman may be differently treated, or have different experiences in the same workplace, as a white woman or a black man. People can have more than one nationality. Being the first to go to University in one's family can mean that their support structure and advice sources are different from those who can ask their parent or sibling. If people are financially supporting others, for example parents, they may have less available money for themselves, or have less to spend on work social events. Others may be caring for others, so their spare time and energies are spent on supporting relatives rather, than relaxing or having time to do extra work. Some people have daily long commutes to work or weekend commutes and live apart from their partners, in order to sustain their academic careers, which means less time together in the weeks, less support at home, having to sustain two homes and weekends or Mondays and Fridays can be mainly by travel. Travelling every five days can be draining and can reduce opportunities to socialise at work.

4. What Everyone Can Do To Help

Everyone's behaviour and actions contributes to their workplace environment. Advice given is to support everyone in your career, be considerate, mentor others if you have the opportunity, formally or informally. Be an ally to those treated unfairly and call out bad behaviour. Do not assume that your lived experience is the same as anyone else's, learn about others. Attend training courses to become more equipped.

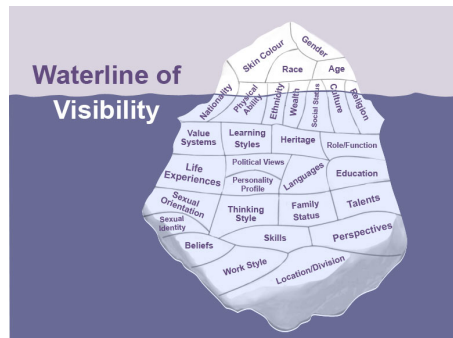


Figure 12: Image indicating invisible diversity dimensions below the waterline on an iceberg [13].

If you are a manager or are in charge of others: create a positive, inclusive, fair, open and transparent culture, where people can be heard and contributions valued. Note that giving people the same opportunities may be not treating people equally. Allocate resources fairly: money, time, PhD students, talks, workloads, shifts, etc.

Finally, do not be scared of equity, diversity and inclusion. Do your best – everyone contributes to a workplace culture: make your contribution positive rather than negative.

References

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