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maria.elena.angoletta@cern.ch

Highlights of the Diversity and Inclusion session at the LLRF22 workshop

M. E. Angoletta and M. Coletta,
CERN, Geneva, Switzerland

M. Spycher,
PSI, Villigen Switzerland

R. Schmitt,
FHNW Campus Brugg-Windisch, Switzerland

L. Doolittle,
LBNL, Berkeley, California, USA

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Abstract

The field of Low Level Radio Frequency (LLRF) for accelerators demands a broad range of skills but faces a lack of diversity among its specialists, reflecting a challenge common to many technical areas in accelerator facilities and research centers. To address this issue, a session on Diversity and Inclusion (D&I) in the workplace was held during the LLRF22 workshop in Brugg, Switzerland. The session aimed at raising awareness of D&I topics, exploring how diversity impacts the field, and sharing strategies to broaden workforce representation while counteracting bias. This note summarizes the outcomes of the D&I session, providing insights into its planning and execution. It is also intended to support the integration of similar sessions into future conferences and workshops across technical disciplines.

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1 D&I session overview

1.1 Introduction

Developing Low-Level Radio Frequency (LLRF) systems for particle accelerators requires multidisciplinary expertise, including knowledge of beam dynamics, analogue and digital electronics, firmware/ software engineering and feedback control theory.

Professionals working in LLRF typically come from Science, Technology, Engineering, and Mathematics (STEM) backgrounds—engineers, computer scientists, and physicists—making it a technically rich but demographically narrow field. Despite its complexity and appeal, LLRF continues to face a noticeable lack of diversity, likely reflecting broader trends within Radio Frequency (RF) groups across accelerator facilities and research centers.

To address this issue, a dedicated session on Diversity and Inclusion (D&I) in the workplace [1] was held during the LLRF22 workshop in Brugg, Switzerland [2]. The LLRF Workshop was part of an international series [3], jointly organized by CERN (European Organization for Nuclear Research) and PSI (Paul Scherrer Institute), and hosted by the University of Applied Sciences and Arts Northwestern Switzerland (FHNW). All three institutions have launched initiatives to advance diversity and inclusion (D&I), with a particular focus on improving representation and equity within STEM fields.

It should be underlined that D&I sessions have been a regular feature at international conferences on particle physics, accelerator technology and control. These sessions have been integrated either within the main conference program or organized as dedicated standalone events. Examples include the International Conference on High Energy Physics (ICHEP) [4–7], the International Particle Accelerator Conference (IPAC) [8–10], the International Linear accelerators Conference (LINAC) [11–12] and the International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS) [13] series.

1.2 Proposal

In June 2022, a proposal to include a Diversity and Inclusion (D&I) session was submitted to the LLRF Workshop Scientific Committee by the LLRF expert Maria Elena Angoletta, working in the Radio Frequency (RF) group of CERN's Accelerator Systems (SY) department. The initiative was also aligned with the CERN broader strategy to promote diversity and inclusion and received strong support from SY management.

The proposal was enthusiastically accepted by the LLRF community. The session's duration and placement within the workshop program were discussed and finalized over the summer.

1.3 Goals

The session aimed at:

- a) Raising awareness on D&I topics.
- b) Understanding how diversity—or the lack thereof—impacts technical fields, with a particular focus on the domain.
- c) Sharing strategies/approaches to increase the overall diversity in the workforce and minimize discrimination.
- d) Enhancing communication/networks across different institutions.
- e) Making explicit biases/behaviours that often might remain undetected.

The motto of the session was that “it is better to talk about D&I in a partial or incomplete manner rather than remaining silent”.

1.4 Organisation and unfolding

The session was embedded within the workshop technical programme and lasted seventy minutes, not a negligible amount of time for a workshop lasting four days. The initial part was focused mostly on gender, whilst the discussion part addressed all diversity dimensions.

The session began with an introductory presentation about D&I in the workplace and in the LLRF field. [14].

This was followed by a real-time poll [15] and an overview of the D&I programs at CERN [16], PSI [17] and FHNW [18].

Having presentations from the organising and the hosting institutions allowed getting input from an international organisation (CERN), a national one (PSI) and a university that feeds their hiring pools. It was quite interesting to see the commonalities in CERN and PSI approaches on gender. The FHNW talk about school development process and educational programs offered a different viewpoint onto the same diversity dimension.

A recorded video from US or Asian laboratories representatives was sought, as the diversity experienced in these countries and the corresponding D&I efforts are somehow different from Europe’s. Although it was finally not possible to obtain a video in time for the session, additional information on D&I in US laboratories was provided.

A lively discussion ensued, prompted by sets of slides [19–21] and focusing on actionable strategies to enhance diversity in STEM and specifically within the LLRF community.

The event welcomed participation from all workshop attendees, their accompanying guests, and FHNW students. A dedicated webpage [1] within the LLRF22 website was prepared to introduce the topic; the material for the session was also available beforehand [22].

An email address was created to allow participants to provide comments and questions before the session, especially for its Q&A session. Emails sent to this address would be automatically distributed to the panel members.

1.5 Panel members and presenters

The members of the panel and presenters were Maria Elena Angoletta (session organiser, LLRF expert and D&I Officer at CERN’s SY department), Melania Coletta (D&I at CERN), Melina Spycher (D&I at PSI), Ruth Schmitt (Head of education at FHNW university).

Larry Doolittle, an internationally renowned LLRF expert from Laurence Berkley National Laboratory, accepted to chair the session. He was in high demand to chair other, more technical, sessions but chose instead to chair the one about D&I. His choice sent a strong message to all workshop participants on this subject’s importance.

2 D&I in the workplace and in the LLRF field

2.1 Overview

Diversity in the workplace refers to a workforce composed by individuals with various visible and/or invisible differences. Examples include age, gender, sexual orientation, ethnicity, nationality, religion.

Diversity is a fact of life, depending on factors such as the company's geographical location, but it is also a choice. As an example, CERN must match as much the possible within its workforce the representation of each Member State to the budget contribution of that Member State.

Two additional strategies must be present for a company to fully reaping the advantages of diversity in its workforce: inclusion and equity.

Inclusion comprises organizational practices, strategies and policies that allow people's differences to coexist in a mutually beneficial manner.

Equity consists of practices a company enforces to satisfy the needs of less represented demographics, so that they get the support, training and resources to succeed and to access the same opportunities offered to others. Equity addresses historical, cultural, personal or sociopolitical factors that affect one person or group. Equity is complementary to equality. Equality means providing the same treatment to everybody in the workplace, for instance in terms of benefits and opportunities of training and of career progression.

Equity complements equality by addressing the special needs of some people or categories so that they can profit from equality. Examples of equity include offering flexible hours or childcare to employees caring for young children, thus levelling the playing field for those with family responsibilities. Another example is to provide structures allowing people with mobility impairments to access autonomously their working place, restrooms, restaurants and meeting rooms.

2.2 Driving forces and advantages

Having diversity and providing inclusion and equity in the workplace is an ethical choice and should be a core value in every organization. It is also a choice favourable to the success of a business, as studies [23] show that organizations with inclusive culture have higher performances (3x), are more innovative and agile (6x) and can achieve better business outcome (8x). Fostering diversity, inclusion and equity can boost a company's reputation and improve recruitment and retention.

The importance of diversity and inclusion was emphasized in the update of the European Strategy for Particle Physics [24], approved by the CERN Council in June 2020. In particular, it is underlined that "The particle physics community commits to placing the principles of equality, diversity and inclusion at the heart of all its activities".

The European Commission also focused on gender equality by introducing in 2021 stringent constraints for every public organisation seeking funding under the Horizon Europe funding program [25]. Funding-seeking institutions must have in place a Gender Equality Plan (GEP) or equivalent by the end of 2022 to be considered as eligible for financing

2.3 Some statistics for the LLRF workshop series and LLRF field

The first international LLRF event was organized in 2001 as a mini-workshop under the auspices of the International Committee for Future Accelerators (ICFA) Beam Dynamics Panel. Following a second workshop held at CERN in 2005, it was decided to establish a recurring workshop series on a biennial schedule [3]. Participation steadily increased with each edition, eventually attracting over a hundred attendees from around the world.

A preliminary assessment of diversity within the LLRF workshop series was conducted by examining the gender distribution among oral presenters—a dimension that is relatively accessible. Due to data privacy concerns and limited availability of information, it was not possible to analyse diversity across the broader participant base.

Figure 1 presents the number of talks delivered by male and female speakers at each LLRF workshop. The statistics include both invited and contributed talks. Also counted were laboratory updates, summaries of other workshops, tutorials, and special-topic presentations—provided they were

technical and relevant to the LLRF field. If a speaker gave multiple talks at the same workshop, each talk was counted individually. Opening or administrative remarks, industry presentations, and talks given during the D&I session described in this note were excluded from the analysis.

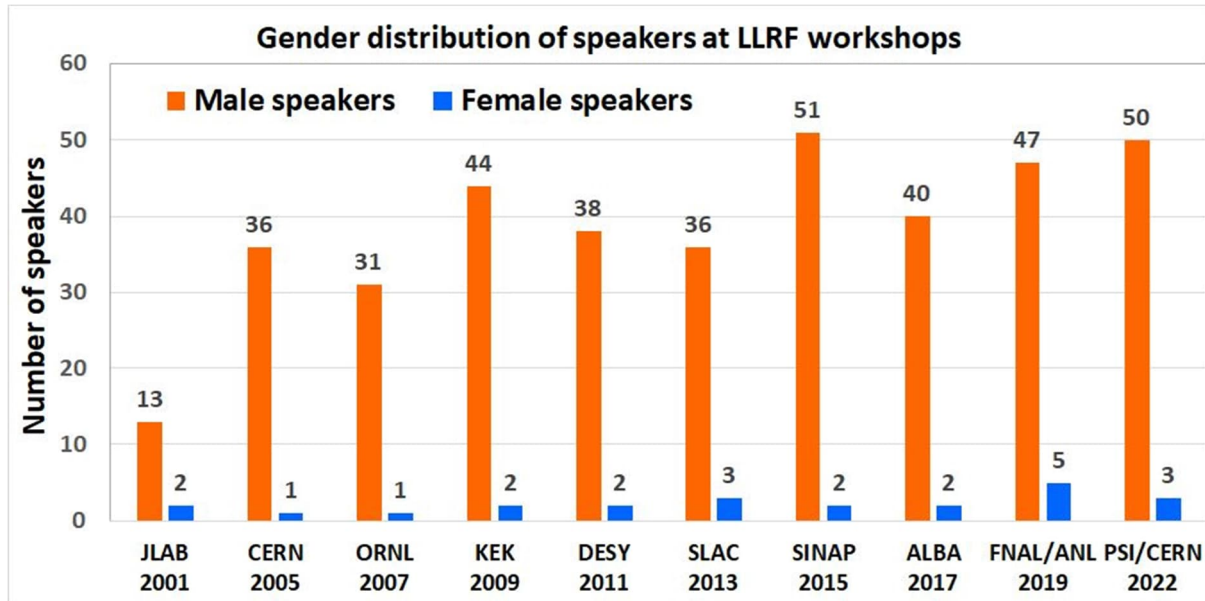


Fig. 1: Gender distribution of speakers for all LLRF workshops.

The under-representation of female speakers is clearly evident. On average, across all workshops, women accounted for less than 6% of the talks. This percentage was slightly higher for workshops held in the United States (8.4%) and lower for those in Europe and Asia (4.5% and 4.1%, respectively), although these differences may not be statistically significant. It is reasonable to assume that the gender distribution of speakers at LLRF workshops reflects the gender diversity within the LLRF teams at participating laboratories.

Figure 2 presents data from 2022 on the gender distribution within CERN’s RF group, offering a concrete example of workforce composition. Female staff members made up only 12% of the total group. It’s important to note that this figure reflects the entire RF group and not exclusively those involved in LLRF-related activities.

Nonetheless, this percentage is broadly consistent with the representation of female speakers in the LLRF workshop series, suggesting a correlation between speaker demographics and the gender composition of the wider RF community.

CERN RF Group staff gender distribution [2022]

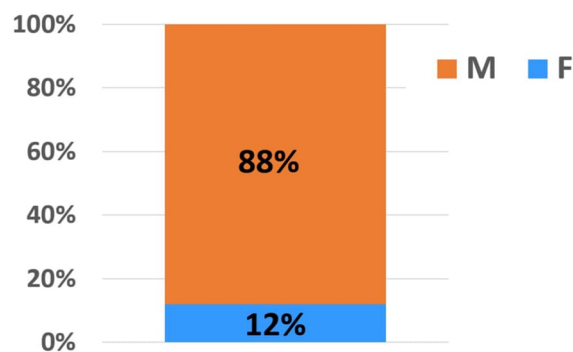


Fig. 2: Gender distribution for CERN RF staff. Data from May 2022.

4 D&I in various laboratories and institutes

4.1 D&I at CERN

4.1.1 *CERN long-standing commitment towards D&I*

Fostering gender diversity has been a long-standing commitment at CERN. The first documented effort dates back to 1983 with the publication of the “Report on Women in Scientific Careers at CERN” [27], followed by a second one in 1993 [28].

In 1996, CERN appointed its first Equal Opportunity Officer, marking a significant step toward institutionalizing equity efforts. Further progress was made in 2010 with the introduction of the CERN Code of Conduct, which formally recognized Diversity as one of the organization’s five core values.

In 2012, three major initiatives were launched, namely:

- a) the establishment of an Ombud function.
- b) The professionalization of the harassment resolution process.
- c) The creation of the Diversity Programme, renamed the Diversity & Inclusion Programme in 2019.

Most recently, in 2021, CERN launched its first Nationality & Gender Strategy, known as “25 by ’25”, outlined in the next paragraph.

4.1.2 *The “25 by ’25” strategy*

The “25 by ’25” strategy aims to enhance nationality and gender diversity among CERN Staff and Fellows, which are Members of the Personnel employed by CERN, by 2025. Its aspirational gender target is to increase female representation from 21% to 25%, while the nationality objective seeks to address cases where any single nationality exceeds 25% of a group’s population.

The “25 by ’25” strategy represents not only a clear commitment from CERN’s Executive Directorate, but also a valuable extension of the many gender-related and broader inclusion initiatives undertaken over the years.

A non-exhaustive list of these actions include:

- a) Contract extensions for fellows following maternity leave.
- b) Expanded co-parental leave options.
- c) STEM internships for students with disabilities.
- d) The “Career Break” fellowship for returning professionals.
- e) A central budget for office adaptations to support accessibility.
- f) The Disability & Inclusion Handbook.
- g) Infant feeding rooms to support parenting needs.
- h) Swiss work permits for spouses of international staff.
- i) D&I Awareness Workshops, Active Bystander training, and integration of D&I topics into mandatory learning programmes.

The “25 by ’25” strategy was initiated in 2020 with the submission of the Strategy Paper to the Director-General. In March 2021, the Enlarged Directorate formally endorsed the proposal, and implementation began in April 2021. As part of this rollout, all department heads appointed thirty-three D&I Focal Points and hosted kick-off meetings to launch the initiative. A departmental nationality and gender dashboard was developed and is regularly updated.

The Focal Points organised sessions within their Departments to gain a comprehensive understanding of each department's context, leading to the first Review Exercise at the end of 2021. In 2022, each department finalized a "fitness plan" outlining specific actions to foster inclusion within their respective areas.

Progress in gender representation is monitored through CERN's annually published Personnel Statistics. The data show a positive trend, with the proportion of female employed members of personnel increasing by 0.5% between 2020 and 2021, reaching 22%. These figures will continue to be closely tracked throughout the duration of the strategy and beyond.

Notably, thanks to CERN's long-standing commitment to gender inclusion and the ongoing "25 by '25" strategy, the Organization successfully met the European Commission's requirement for all public research institutions seeking Horizon Europe funding to establish and publish a Gender Equality Plan by 2022.

4.2 D&I at PSI

4.2.1 *PSI overview*

PSI is the largest research institute in Switzerland. With approximately 2,200 employees and around 2,500 visiting researchers each year, PSI engages with a diverse community that includes both international visitors and local collaborators.

As of December 2021, women made up 26% of the workforce at PSI. Among its broader Diversity and Inclusion objectives, PSI has identified increasing the number of female employees—particularly in leadership roles—as a core goal.

To support this, PSI launched its first D&I Action Plan for the 2017–2020 period. Many of the measures introduced during that time have since become embedded in the institute's culture, including junior leadership training, a diversity award for leaders, and the feM-LEAD programme. PSI is currently working toward the objectives outlined in its 2021–2024 Diversity, Equity, and Inclusion Action Plan.

4.2.2 *Diversity, Equity & Inclusion (DEI) plan for the 2021-2024 period*

PSI has set clear targets to improve gender representation in leadership and research roles. By 2024, the institute aims to increase the overall proportion of women in leadership positions to 15%, up from 12.2% in 2021. Additionally, PSI has set a goal for women to comprise 25% of all newly recruited leaders (averaged over the 2021–2024 period), and 30% of newly recruited postdoctoral researchers.

To achieve these goals, PSI has implemented several measures, including regular communication of objectives, unconscious bias training, proactive outreach to potential female candidates, and the feM-LEAD programme—a mentoring initiative designed to support women with leadership aspirations.

The PSI DEI Plan is structured around four key pillars of action:

- a) Increasing the representation of women in core scientific and technical areas
- b) Fostering an inclusive and supportive workplace culture
- c) Positioning PSI as an employer recognized for its strong commitment to diversity and inclusion
- d) Promoting the recruitment and integration of people with disabilities

The presentation delivered at the LLRF22 workshop focused specifically on pillar (a): increasing the representation of women in core areas.

4.2.3 *PSI feM-LEAD programme*

The feM-LEAD programme is a continuation of a mentoring initiative launched in 2017. It is open to all women at PSI, whether they work in science, technical fields, or administration. The programme is designed for those who do not currently hold leadership positions but are interested in pursuing one in the future—or are exploring whether leadership is the right path for them.

Throughout the programme, mentees are supported in advancing their careers and expanding their professional networks. Built on four pillars, feM-LEAD offers one-to-one mentoring sessions with experienced leaders from PSI and other institutions (of all genders), as well as training courses on leadership topics such as communication and negotiation techniques, and conflict management.

Participants also have the opportunity to complete the Bochumer Inventory for Job-Related Personality Description [29], which helps them assess their current leadership-related skills, identify strengths, and pinpoint areas for development. In addition, the programme provides access to valuable resources, literature, and networking opportunities.

4.2.4 *DEI video*

In 2022 PSI published a video about the mission statement on DEI with its five objectives on how PSI employees want to work together and act (responsible, open, fair, motivating, continuous).

The video was nominated by the regional film festival “Fantoche” and shows the PSI goals for D&I. Alongside the respect campaign, the video is shown during the introduction day for each new employee and contributes to raise awareness on the importance of D&I at PSI.

4.3 **D&I in US laboratories**

To enrich the session with international perspectives, a recorded video from laboratories in the United States and/or Asia was initially sought. These regions experience different diversity dynamics compared to Europe, and their corresponding D&I efforts reflect those unique challenges and opportunities. Unfortunately, it was not possible to obtain a video in time for the session. However, additional information on D&I practices in U.S. laboratories was successfully gathered and shared, contributing valuable insights to the discussion.

The U.S. Department of Energy (DOE) comprises 17 National Laboratories. As stated in their D&I website [30], each national laboratory has developed a specific programme for D&I. All programmes however share some common goals, namely:

- (a) advancing the recruitment, development, and retention of a diverse and talented workforce.
- (b) Preventing discrimination, bias, and harassment.
- (c) Expanding the STEM talent pipeline through Community Outreach and Education.

Figure 5 shows a demographic data snapshot, for instance, for all U.S. national laboratories and for all job types. Laboratory-recruited roles, postdoc employees, and students funded by each laboratory (not DOE funded students) are considered in the data. The category “under represented minorities” comprises African American/Black, Hispanic/Latino, and American Indian/Alaskan Native. The category “other people of colour” includes Asian/Asian American and Pacific Islanders.

The SLAC national laboratory provided D&I data specific to their situation [31]. In 2021 SLAC increased hiring of African American women by 200%, of Native Americans by 100% and of Asian American women by 11%. Furthermore, from 2020 to 2022 SLAC increased hiring of Latinx men by 66%. Although no specific numbers were provided, the percentages show a very positive trend towards diversity.

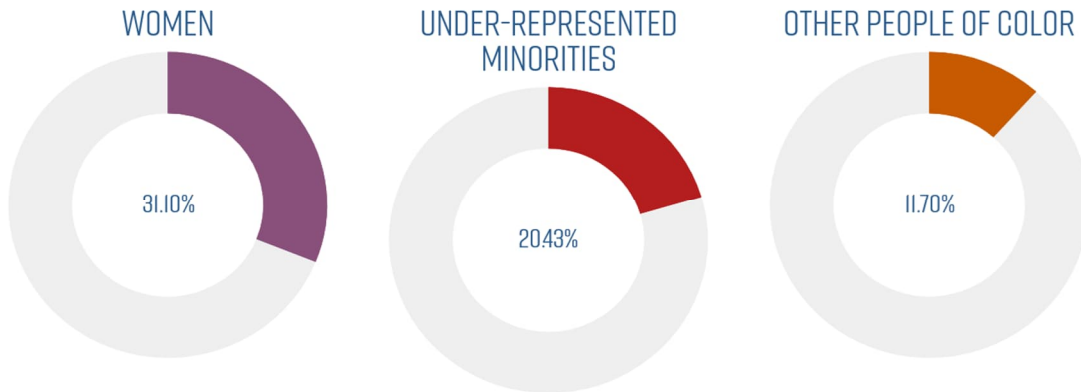


Fig. 5: Demographic data in the 17 US National Laboratories for all job types.

5 Discussion

D&I is often perceived as a deeply personal topic. As such, it was anticipated that some participants might feel hesitant to share their experiences or emotions openly in a group setting. To help ease into the conversation, some sets of slides were prepared in advance [19–21].

Once the discussion began, participants organically introduced additional topics, leading to a dynamic and highly engaging exchange. The conversation became so lively and insightful that it could have easily extended well beyond the scheduled time.

5.1 Leaky pipeline phenomenon

The “leaky pipeline” is a phenomenon where members of under-represented or historically marginalised groups are led to abandon a technical career in which they could have thrived. A clear symptom of this phenomenon is the significant disparity in representation between junior and senior levels for specific categories of employees.

To address this issue, it is essential for companies to implement robust support systems and foster a cultural evolution that promotes retention. Without such measures, efforts to increase hiring from underrepresented groups may not yield long-term impact, as the benefits are undermined by high attrition rates.

The leaky pipeline affects multiple dimensions of diversity, with gender being the most frequently cited. It is important to acknowledge, however, that a portion of women voluntarily choose to leave technical careers in pursuit of what they perceive as a more fulfilling life path—such as dedicating time to child-rearing. This nuance should be recognized in any analysis of the phenomenon.

Data from CERN’s SY Department were used to show the leaky pipeline effect. Counting over 500 members of personnel, SY is one of the biggest technical departments at CERN, is technically focused and includes the RF group.

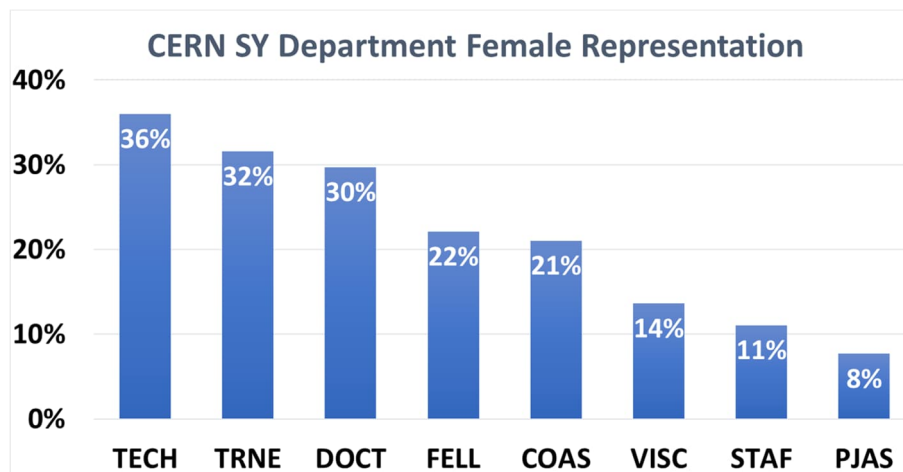


Fig. 6: Leaky pipeline in CERN's SY department. Data from May 2022. .

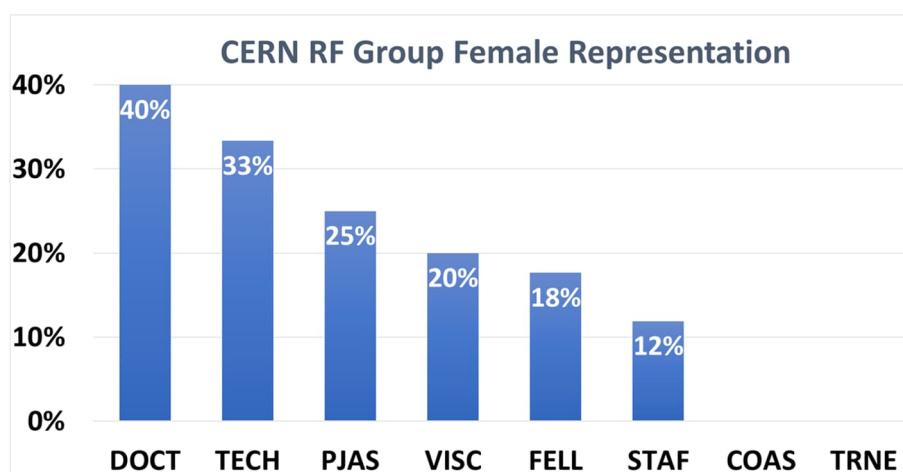


Fig. 7: Leaky pipeline in CERN's RF Group (data from May 2022).

Table 1: Overview of the CERN personnel categories mentioned in this paragraph for the year 2022

Acronym	Description
TECH	Technical student
TRNE	Trainee
DOCT	Doctoral Student
FELL	Fellow
COAS	Cooperation Associate
VISC	Visiting Scientist
STAF	Staff member
PJAS	Project Associate

Figure 6 and Figure 7 show the percentages of female members of personnel for different categories in the SY department and the RF group, respectively. Table 1 defines the considered personnel categories. The percentage of female members of personnel is considerably higher in the technical/doctoral students and fellows categories than it is for staff members. In the RF group, the percentage of female doctoral students is over three times that of female staff members.

5.2 Unconscious biases in recruitment

The construct of unconscious bias arises from psychological research and describes implicit associations we hold. A selection of different biases which play a role during the recruitment process were shown during the session, namely:

Primacy/Recency Effect describes the tendency of a person to recall the first and the last person/item in a series best. So the order of interviews or also looking at applications might already be influenced.

Mini-Me-Effect describes a bias where people tend to choose people who are similar to them. Similarities arouse sympathy and trust. This effect is particularly pronounced at higher hierarchical levels.

Halo Effect describes the tendency for positive impressions of a person in one area to positively influence one's opinion or feelings in other areas. During recruitment processes this might influence assumptions about certain skills of an applicant.

Confirmation Bias describes the tendency to search for, interpret, favour, and recall information in a way that confirms or supports one's prior beliefs or values.

There are additional cognitive biases that influence human decision-making. Raising awareness of these biases—and actively reflecting on one's own potential biases—is essential, particularly in contexts such as hiring processes or participation in strategic and career development committees.

5.3 Additional topics

The first topic addressed the role of women as role models during events or school visits to the laboratory—activities often undertaken alongside their already demanding professional responsibilities. One participant pointed out that this expectation can be unfair, as women may feel pressured to accept these additional tasks despite limited time and resources.

There was broad agreement, however, that showcasing women as role models is a powerful way to demonstrate to girls and younger generations that a career in STEM is both achievable and rewarding. To maintain this benefit without overburdening women, several strategies were discussed.

For example, CERN actively promotes STEM in local schools through both male and female presenters. Importantly, time spent on outreach is often recognized in annual performance evaluations as a percentage of working time. In line with the 25by'25 programme, a proposal from CERN's SY Department suggests compensating general outreach activities—such as giving presentations about CERN and technical work in schools in one's home country—with additional annual leave.

Ruth Schmitt from FHNW emphasized the importance of role models from underrepresented or disadvantaged backgrounds. She noted that such representation helps challenge the perception of universities as “exclusive” institutions.

Another topic of discussion was the impact of gender stereotypes in toys, which often reinforce the divide between boys and girls in STEM interests from an early age. Addressing these stereotypes is seen as a key step in closing the gender gap in STEM fields.

6 Main takeaways

The last ten years have seen a strong social and cultural evolution towards D&I: the concepts and ideas shown during this session would not have been so effective nor, likely, so well received even only one decade previously.

The LLRF community was undoubtedly up to the challenge and the very positive feedback received by the panel members after the session acknowledged that D&I topics are everybody's business, not just an "HR concern". This was shown by the many comments and very useful suggestions received by the session organiser after the session itself.

The session might have been felt as incomplete by some participants, as not all diversity dimensions were treated and input from European institutions was prevalently presented. But the general conclusion was that it was better to talk about D&I, although in a partial or incomplete manner, than to remain silent.

Finally, the existence of a gender unbalance in the LLRF field was also shown by a cursory count of the session attendees, composed mostly of workshop participants: out of over 80 people in the auditorium, only six were women.

7 Conclusions and outlook

The Diversity and Inclusion (D&I) session at the LLRF22 workshop proved to be a success, both in terms of attendance and the lively discussion it generated.

Looking ahead, it is recommended that future workshops consider collecting and evaluating data on gender and other diversity dimensions—in full compliance with privacy and data protection regulations—to better track the evolution of diversity within the LLRF community.

Additionally, exploring D&I practices in institutions outside Europe could be the focus of a second session, broadening the scope and relevance of the discussion.

Finally, the authors hope that the experience and outcomes of the LLRF22 D&I session, as detailed in this note, will inspire others to organize similar sessions in conferences and workshops across other technical fields.

8 Acknowledgements

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