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ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

DOCUMENT FOR THE 2020 UPDATE OF THE EUROPEAN STRATEGY FOR PARTICLE PHYSICS

Report by Working Group 1 on
Social and career aspects for the next generation

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Mandate

The working group aimed to identify the key challenges related to the items listed below, and proposes recommendations to address them.

- *How to keep the field of particle physics attractive and preserve expertise in view of the lengthening timescales of projects.*
- *How to ensure that there is a societal relevance for the accumulated expertise as a researcher in our field.*
- *How to improve the recognition of individuals in large collaborations (this essentially reflects the ECFA initiative on this topic).*
- *How to ensure appropriate reward of technical work on accelerator and detector development, software and computing, as well as code support and technical aspects for the highly involved theory calculations.*
- *How to include attention to diversity and gender balance aspects in the above issues.*

The working group consisted of A. Cattai, J. Królikowski, E. Laenen (chair), T. Montaruli (ApPEC chair), A. Rinkevicius and, ex-officio, U. Bassler (President of Council) and J. D'Hondt (ECFA chair). The working group met a number of times, in person and by Vidyo, and consulted with a variety of stakeholders. It also conducted a survey about various aspects of its remit in autumn 2019, targeting young scientists. A summary of the results of the survey, based on about 850 responses, can be found here. The results also underpin a number of our recommendations.

Attractiveness of the field and societal relevance

From our consultation of stakeholders and in particular from our survey, we found that, in the case of young scientists who were already working in the field, what had attracted them to particle physics were the fundamental questions that the field addresses, the associated innovation and advanced technologies and the way in which the field is organised into small (theory) and large (experiment) collaborations. Relatively few mentioned having seen images and stories in the media as a reason for entering the field.

The perspectives cited by respondents as the main reasons that kept them in the field were first and foremost the search for solutions to outstanding questions regarding the nature of dark matter and a consistent quantum description of gravity. Overcoming technological challenges in this search and the development of and prospects for new accelerators were described as very strong motivating factors. Possible spins-off to society were also frequently mentioned, albeit less than the aforementioned factors.

On the theoretical side, the quest for a more complete theory of nature, including gravity, was the most commonly mentioned factor. The challenges of optimally interfacing theoretical predictions with computer simulations and providing highly precise predictions were also mentioned by many respondents.

The long timelines of experiments were not the subject of major concern. Young scientists recommended that, to ensure a good start in the field, (possible) newcomers should acquire and develop good computing skills. Other advice was to try a summer programme, to focus on physics or engineering projects and to acquire a good basis in mathematics.

We noted that, for those already working in the field, the initial attraction was an interest in the fundamental questions of physics, but that motivation and interests evolved with time. In most cases, the main motivator became more practical aspects, such as computing, algorithms, hardware, detectors, etc. Some respondents indicated that they had become less motivated and even disappointed, often due to bad supervision, too much competition, the lack of new discoveries, etc.

We also probed how the field is viewed by young scientists from the outside. A group of about 40 physics students at Warsaw University who did not choose to specialise in particle physics said the fact that the science goals of the field did not seem sufficiently interesting was their main reason for not choosing to go into HEP. A second reason given was the concern that individual creativity would be limited in large experiments. Numerous other concerns regarding the attractiveness of the field, some of which we mention under Social Aspects, were voiced in the survey. Others can be found in the survey summary.

Recommendations:

- *The field should maintain its exploratory nature by seeking answers to open questions in fundamental particle physics and by pursuing the rewarding technological innovations, both hardware and software, needed for this quest.*
- *Opportunities to participate in this quest should be continuously demonstrated in order to attract a talent from a variety of fields, ranging from theory to experiment, engineering and physics.*

Recognition

A key driver for any researcher, and for forging a research career, is the recognition of their contributions, innovations and achievements. R&D on hardware, software and computing, in particular, is not always sufficiently recognised, even though these items form the backbone of what makes experimental particle physics possible.

Extending the mechanisms for reporting on these achievements and strengthening the means of recognition would be very valuable. Journals dedicated to the technology and methodology-related aspects of particle physics, preferably with fast peer review mechanisms, are essential. Expanding the scope of key particle physics journals to allow such aspects to be incorporated should be considered. In these journals each technical article could be accompanied by a layperson's summary in order to make it accessible to a broader readership. These thoughts are supported by the recent ECFA survey (https://w3.iihe.ac.be/~jdhondt/ECFA-WG-Recognition-collection-of-information.pdf).

Recommendations:

- *With a view to improving the recognition of individuals in large scientific collaborations, we support the recommendations of the ECFA study group that the exchange of best practices between collaborations should be facilitated and that the situation should continue to be monitored.*
- *We recommend support for journals dedicated to technologies and methodologies related to the theoretical and experimental aspects of particle physics, with fast peer reviews. To this end, the community should liaise with publishers and societies that manage existing journals in particle physics in order to explore the possibilities.*

The strength of our field relies upon our ability to innovate on the technology front. Introductory and advanced schools on these topics, which should include a hands-on approach, are essential in order to train newcomers to address current and future challenges. In such schools students can be exposed to a large spectrum of technology at the forefront of research and have the opportunity to form valuable networks that can be supportive in their further career.

With regard to schools, Europe has pioneered a model of summer and winter schools of excellence since the 1950s, which have served as pillars for educating and forging bonds between generations of advanced PhD students and Postdoctoral fellows over many decades, many of whom have become leaders in the field. To maintain this aspect of innovative leadership, such schools must have stable funding.

Preserving expertise in the field in view of the long timescales of projects is closely related to the issue of attracting new talent, for which purpose long-term prospects are necessary. In addition, the lack or poor quality of documentation for software and other methodology was often mentioned as a concern in the responses to our survey. Increased attention to the importance of good documentation would be beneficial to the transfer of expertise to the next generation.

The societal relevance of the field is strongly related to its innovative power. Innovation inherently presents a risk to the achievement of the stated goals and can take time to show its benefits, which need to be recognised both inside and outside the field and can be substantial in the long run (cf. the World Wide Web).

Recommendations:

- *The community should strongly support schools dedicated to the technology, methods and techniques needed for theoretical and experimental particle physics, including the European schools of excellence, which have a long tradition of fostering innovative leadership.*
- *The system of training in the field should stimulate the search for innovation in the broadest sense.*
- *In developing and maintaining methods and techniques for particle physics, especially with regard to software, the writing of good documentation should be valued and encouraged.*

<u>Diversity and gender balance issues.</u>

Particle physics brings together people of various ages and many ethnicities. In laboratories people work in close contact one with one another, while in large collaborations individual contributions are not always sufficiently recognised or are even barely possible. Minorities are

not always fully represented, leading to a lack of diversity. In many Research Performing Organisations (RPO) and Research Funding Organisations (RFO), the largest minority in physics are women, at all career levels, and the imbalance is more pronounced at the higher levels.

RPOs and RFOs should foster a culture founded on the belief that diversity creates a work environment that accelerates productivity and innovation, promotes a good work-life balance and has a positive impact in attracting and retaining talent. These aspects are added values, as demonstrated in various fields (such as industry and research). Such a culture promotes diverse skill sets, combats prejudice and discrimination and fosters a culture of inclusion based on respect for individual human beings. Valuing the characteristics, skills and talents of each person promotes equal treatment and opportunities for researchers, contributes to personal and professional development, enhances the efficiency and competitiveness of an organisation and improves social and economic standards. These principles are enshrined in the ApPEC-ECFA-NuPPEC Diversity Charter, which was endorsed by the corresponding physics communities.

As in other areas, there is clear evidence that women have a more difficult time making career steps in particle and astroparticle particle physics than men. A clear code of conduct, combined with an adequate administrative structure within RPOs and RFOs, including an office dedicated to diversity and equality, action plans, monitoring of data, sets of rules and policies, are needed. Organised training to recognise and avoid bias and allowing the exchange of best practices is also needed.

The H2020 project, GENERA, in which CERN was an observer and which ran from September 2015 to August 2019, collected available data on gender in physics from many RFOs and RPOs. It defined possible actions for RPOs and RFOs, which were put together in a toolkit that also described possible ways to realise them. Many organisations have already collected a lot of data on this issue, of which the field should avail itself in order to identify appropriate actions. Some have addressed the issue of gender balance through quotas, the presence of equality officers in selection committees and appropriate training. Quotas in particular are much debated but, if adopted in a transparent way, they could be quite effective.
Of course, the gender issue in physics goes further back than study at universities or employment. CERN and RFOs and RPOs involved in particle and astroparticle physics should maintain strong relations with schools not only by providing role models that foster the role of women in science, including at the level of images selected for news items, web portals, conferences, schools and masterclasses delivered to the public, but also by influencing governments to adopt earlier teaching of physics, comparable to biology, and by offering training to school teachers at all levels.

Recommendations:

- *It is recommended that CERN, like other RFOs and RPOs involved in particle physics, should provide expert bias-avoidance training, both in the classroom and online, and make this compulsory for staff members, as well as encouraging associates to follow such training as provided by their employing institutes.*
- *We recommend that CERN should actively engage in the exchange of best practices with RFOs and RPOs concerning measures to increase diversity among its staff.*

Social aspects

Providing a good work environment where social aspects are actively taken into account is beneficial for the efficiency and motivation of research teams. The main concerns of a social nature emerging from the survey are work-life balance and career uncertainty, as well as the social climate in the workplace, especially in large experiment collaborations.

From the survey we noticed that the largest concern by far is the uncertainty of securing a career in the field, caused by the short-term contracts associated with the mobility culture in our field and the scarcity of opportunities to be promoted to longer-term contracts. This concern was often mentioned in conjunction with the difficulty of having or starting a family at an early stage of a career, which is particularly difficult if the young scientist concerned is on a graduate study salary. A large proportion of the young scientists trained in the field go on to have successful careers elsewhere. Continuous guidance for this transition is needed.

Recommendations:

- *Information and advice about career opportunities should be exchanged between CERN and career offices in participating institutions in order to actively inform young scientists.*
- *The supervisors of young scientists should be encouraged and, if necessary, trained to advise on careers in particle physics and elsewhere.*

The next most commonly voiced concern was the not always optimal social climate in large experiments. Stress originates mostly from conveners and supervisors, and partially from deadlines. The everyday atmosphere seems to be positive in general. Nevertheless, a number of responses indicated that work-life balance, which is a known risk factor for stress, needs improvement.

Recommendation:

- *Professional training targeted towards people holding leadership positions in scientific collaborations should be made available.*