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THE PARTICLE PHYSICS SCIENTIFIC COMMUNITY APPROVES THE NEW EUROPEAN RESEARCH STRATEGY IN THIS FIELD

Interview with Roberto Tenchini, President of the INFN Particle Physics National Scientific Committee

On 19 June, the new ESPPU (European Strategy Particle Physics Update) document, which sets out the scientific objectives and new challenges that will shape the future of research in this field in the short and long term, was officially approved at an open session of the CERN Council. This event marked the conclusion of a process, started in 2017, coordinated by the European Strategy Group (ESG), a working group of experts that discussed with the entire international scientific community in order to identify priorities and outline recommendations to strengthen the scientific, technological, economic and human capital of major research infrastructures. On this issue, we spoke with Roberto Tenchini, President of the INFN National Scientific Committee 1, who directs and coordinates the research activities of the Institute in this field.

What objectives inspired the new strategy?

The update of the European Particle Physics Strategy was obviously inspired and guided by science. As a first step in the process, priority scientific objectives were identified and on the basis of these, projects to achieve them were defined and will now have to undergo studies to verify their feasibility. The recommendations in the strategy document indicate, as primary scientific objectives, precision measurement of the properties of the Higgs boson and exploration of high energy frontiers as routes to enter the unexplored territory of the new physics beyond the standard model.

And what milestones does it outline?

The first milestone in the short term is the completion of the high luminosity phase of the Large Hadron Collider (LHC), the High-Luminosity LHC (HL-LHC) project already underway at CERN.

In the medium and long term, on the other hand, the aspiration and the challenge is to be able to build first a "Higgs factory", such as a Higgs boson factory capable of producing these particles in great abundance, based on electron-positron (e+e-) collisions. In this first phase, the objective is to investigate the Z, W and, precisely, the Higgs bosons in detail, substantially increasing the knowledge of what is called "electroweak physics".

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This project should also serve to lay the foundations for a future proton collider that will allow previously unexplored energies to be achieved, reaching 100 TeV in the centre of mass. This can be achieved through the construction of an infrastructure that can firstly accommodate an electron and positron accelerator and subsequently a new generation proton machine. The scientific milestones clearly imply technological challenges: the accelerators of the future will, in fact, require the development of highly innovative technologies, such as the construction of large magnets based on high temperature superconductivity.

How does the new European strategy fit into the global context of research in this field?
Europe is currently the world leader in the high-energy frontier of particle physics. This strategy, if implemented, will allow this leadership to be maintained and consolidated, with repercussions on scientific and technological research that will go well beyond particle physics. Furthermore, Europe maintaining a "frontier" vision for particle physics is also an important opportunity for non-European countries to access new facilities in an open science environment and develop complementary and diversified programmes.

What should the relationship between particle physics and other related research areas, such as astroparticle physics and nuclear physics, be according to the new strategy?
The documents produced for the ESPP update recall that particle physics has close scientific and historical links with the study of the universe and with fundamental physics not based on particle accelerators. A clear example concerns the search for dark matter, an area in which studies at accelerators and those with experiments based on other techniques are complementary. Also, nuclear physics has strong links with high energy physics, suffice it to mention the LHC programme, a machine that accelerates not only protons but also ions, allowing nuclear physics studies: the detailed study of quark and gluon plasma is an important component of the global strategy. In this context of research collaboration and complementarity, the document underlines the importance of CERN continuing to act as a hub for certain experiments in complementary disciplines. The new strategy therefore underlines the importance of exploiting synergies between the various sectors of fundamental physics, whose activities are also based on the use of technologies that can be applied in more than one of these sectors.

What impact does the community expect outside the field of fundamental research?
The technological repercussions of a robust fundamental physics programme are evident, as history teaches us: there are many examples that demonstrate that basic research acts as a stimulus for technological innovation and is therefore able to generate significant benefits for our society and the economy of countries that invest in this research. For example, high priority is given in the strategy documents to the

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development of magnets based on high temperature superconductivity, a key technology for developing next generation accelerators and which at the same time is expected to have a significant impact on many civil applications, such as public transport. It goes without saying that maintaining world leadership in particle physics research in Europe also means achieving leadership in significant and very promising technological areas for the future. Basic research is the driver of progress because it enables us to make those leaps forward in both scientific and technological knowledge that trigger veritable paradigm shifts for societies. Fundamental research is the cornerstone on which we build and sustain our ability to effectively address the big challenges of the future.

What does approval of the strategy paper mean for the particle physics scientific community?
It is a milestone for particle physicists because it provides a common vision and an indication of a shared direction, both in the short and medium to long term. Completion of the LHC programme, preparation of Technical Design Reports (TDR) for future accelerators, research and development (R&D) on new detectors and new accelerator techniques will be the primary activities of our scientific community in Europe in the coming years. ■