Physics and Understanding Among Peoples

Professor Rolf-Dieter Heuer, General Director of the European Organization for Nuclear Research (CERN)

CERN in Switzerland not only has the world's largest particle accelerator (Large Hadron Collider, LHC), but is an extreme "melting pot" of cultures as a major research institution comprising 21 member states and around 12,000 guest researchers from 100 nations. Its General Director, Professor Rolf-Dieter Heuer, studied physics in the 1970s at the University of Stuttgart. He talked with RESEARCH AND LIFE about why science needs globalization and what it gives back to society.

? Professor Heuer, you've headed CERN since 2009 and will pass on the baton at the end of this year to the Italian woman physicist Fabiola Gianotti. What were the milestones during your time, and where did the major challenges appear?

› In 2009 my management team and I set two primary goals for our period in office. The first, quite clearly, was to get the LHC working again after a long period of repairs and retrofitting and use it to implement our physics program. The second was to open up CERN for countries beyond the European region. I always said as a joke, that we had to change the "E" in CERN from "Europe" to "Everywhere". Now, as we near the end of my period in office, I'm happy to say that we have reached both targets. And milestones? Well, milestones for the LHC were clearly the beginning of data acquisition in the year 2009, the first high-energy beams in 2010, our announcement of the Higgs Particle in 2012, and the awarding of the Nobel Prize to François Englert and Peter Higgs the year thereafter. A last LHC highpoint - for the time being - was the successful new startup with higher energy this year, and I'm looking forward eagerly to the exciting physics results which will certainly follow. The challenges which stood in our way to reaching these targets us were very numerous and diverse in character. All the more so inasmuch as I took office just at the same time the economic and financial crisis reached its peak, and with very different financial problems among the 21 member nations. That situation made it difficult for us to keep to our budget. But we succeeded, and all members met their budget obligations - if only with a delay in some cases.

? What has your time at CERN meant for you personally?

› Being tapped on the shoulder to head this institution was a great honor for me, but also a challenge. CERN is a kind of Mecca for particle physicists, and it is truly wonderful to be in this position and to experience and help shape major physics developments in this discipline.
What's more, we were able to make these developments known outside CERN through good public relations work: more people today know what CERN and LHC mean, and that's very important, in my view. People need to see what fascinating work is going on at CERN and what is being achieved with their tax money. That is also a reason why we worked in 2012 for observer status at the UN General Assembly in New York: we want to bring the voice of research and science into the political discussion, and the UN is a venue where we can also have a voice in the task forces.
What especially excites me is the unbelievable diversity of nations and cultures here at CERN. And it works! Everyone pulls together in the same direction. The fact that this is possible is for me one of the greatest successes of CERN.

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"It is wonderful to head CERN and to experience and help shape the major physics developments in this discipline." Prof. Rolf-Dieter Heuer, General Director

? How does work take place in such culturally heterogenous teams?

› Just like everywhere else. When you speak the language of science, an individual's cultural background is no longer so important. People "tick" differently, that's true, even within one and same nationality: you have the "straight arrows", the "powerhouses," and the exceptional persons who think "out of the box". They're all needed. Successful and creative research requires a good balance between the people working on projects and the people looking for new discoveries. It's a structural issue, and also an issue of how much freedom is given to the team members. For me, motivation is an extremely important criterion of management.

? Last summer, experiments with the LHC demonstrated so-called Pentaquark Particles. What's the significance of that discovery?

› Like the discovery of the Higgs Particle, the discovery of the Pentaquark Particles crowned an intellectual adventure that had stretched over several decades. The quark model was worked out in the 1960s in order to describe the vast patchwork quilt of particles observed in laboratories and cosmic radiation. Just as the diversity of chemical elements can be explained in terms of how they are composed of different numbers of protons, neutrons and electrons, much of the diversity of particles is grounded in the fact that they consist of quarks. If we look at the elements, we find that hydrogen, for example, consists of only a single proton orbited by a single electron, whereas gold consists of 79 protons, 118 neutrons and 79 electrons. Similarly, protons and neutrons consist of three quarks, whereas another category of particles, the so-called mesons, consist of one quark and one antiquark. Now, the quark model also predicted that other configurations should also be possible, with five particles, four quarks, and one antiquark. Those are the "pentaquarks".

? What insights are hoped for from this?

› The new results I'm looking forward to most are precision measurements regarding the properties of the Higgs particle. We know that the behavior of the particle we discovered is based on the Brout-Englert-Higgs mechanism, which allows elementary particles to retain their masses. But we still don't know whether we're dealing here with a so-called "standard-model" Higgs particle or or something more exotic. The "standard model" is the theory that we use to describe the elementary particles which make up the visible universe and the manner in which they interact with each other. This is a very good, but also an incomplete theory. For example, it does not explain gravity; and even though the visible

Celebration with the team after the successful restart of the LHC particle accelerator this year.

universe encloses us and everything that we can see, it still makes up only around five percent of everything which composes the universe. The rest is “dark matter“ and “dark energy“, about both of which we still know only very little. Some theories which go beyond the “standard model“ are based on somewhat other properties of the Higgs Particle than those in the “standard model“, meaning that a precise analysis of the Higgs Particle could be very interesting. This also applies regarding a direct search for new particles, since some of those theories that go beyond the “standard model“ predict new particles. Should we see these, that would be a direct proof for dark matter. My hope is that one way or the other we will come upon a new physics - either through precise measurements of the Higgs Particle or through direct searches, and that these will carry us beyond the “standard model“ and into the dark universe.

? Where do you see CERN in 10 years?

› In the same position of excellence as today. We plan for the LHC to run for another 20 years, but we are also planning a major improvement. After collecting data for 10 years at a constant collision rate, we now need another ten years just to double the amount of data which has been gathered. In future we want to achieve this doubling in two years, which will require five times more collisions per second. We want to achieve that by the year 2025 by means of an upgrade which will open the way for another decade. It is also my hope that CERN can advance the topic of an even more advanced particle accelerator. Another important topic for the future is the expansion of CERN beyond the borders of Europe. Just last year, we accepted Israel as our 21st member nation. Romania is expected to follow this year, and Serbia, Turkey and Pakistan have already been accepted as extraordinary members. The last group, for example, has few team members at CERN and fewer contacts with industry, but pays only a fraction of the normal fee. We want to widen this opening, even if it may take longer than I would like. Research is a global affair, and for that reason such institutions should be global in character. And the next machine after the LHC will be a global machine. We'll need human resources for that.

? Does CERN, as one of the first major European research institutions, still set an example?

› That is certain. Over more than 60 years, CERN has shown what can be achieved when Europe pulls together - the political arena could take a page from this book. In the scientific world today, several major research institutions are set up according to the CERN model, such as the European Southern Observatory (ESO) in Garching near Munich, the European Space Agency (ESA), or the European Spallation Source (ESS) which is now going up in Lund in Sweden and will provide neutron radiation for materials research and production material technology. One very exciting research center modelled on CERN is also the SESAME Synchroton Laboratory which is going up in Jordan with UNESCO support. Those participating in addition to Jordan are Pakistan, Turkey, Cyprus, Bahrein, Israel, Egypt, and Palestine. That shows that in the world of science even quite adversarial countries can work together.


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Rolf-Dieter Heuer in the "tunnel" where the world's largest particle accelerator is located.

? Your career started with the study of physics at the University of Stuttgart. What advice would you like to give to your Alma Mater for the future?

› It's enormously important today that scientific institutions don't "live in an ivory tower". Cooperation and competition are not mutually exclusive, quite the contrary. To be successful, the university should concentrate on its strengths, that is, on areas where it has promising topics, good people, and a good research structure. And it should look for the right international partners in these areas. To be an international player, you have to start competing as early as possible and bring good students to Stuttgart from abroad. The German language, however, is very often a stumbling block in this regard. For that reason it's extremely important to offer more English-language instruction classes in the higher semesters. In this regard, it's a good idea to look to Switzerland, where both the students and the teaching faculty are very international.

? In April 2016 you will take over the office of the President of the Germany Physics Society (DPG). What do you envision there?

› At the moment I'm still very much involved with CERN, and for that reason I have no concrete concept for my future task area at the DPG. But two lines of action are emerging: for one thing, I would also like to help shape international networking and put the fund of experience I've gained at CERN to good use at the DPG. And secondly, it's dear to my heart to motivate young people to study the "difficult" subjects like mathematics, physics, and the natural and engineering sciences. This is an area where the DPG can help, for example, through the schools. And I will keep an eye on public relations work.

? And your personal plans for the future?

› I hope to have more influence on my own timetable, to be home more often, to spend more time with my wife, and to take more private trips. But my many side jobs will probably also keep me fully occupied in future. You can't come to a full stop from 100 miles an hour to zero in nothing flat. In one and a half years I'll take over the office of President of the Supervisory Board of SESAME. That is a very important project, particularly also for promoting better understanding among the nations.

Many thanks for talking to us!

Andrea Mayer-Grenu put the questions.