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CERN and **Belgium**

70 years of cooperation and investment for the benefit of science

Palace of the Academies - November 27, 2024 - Brussels

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PROGRAM | November 27, 2024 - 11 AM

- « 70 years of Scientific Discoveries » [video]
- Welcome Speech by Véronique Halloin, Secretary General FNRS - Belgian Delegate to the CERN Council and Finance Committee
- Interview with Fabiola Gianotti, Director-General of CERN
- Testimony of François Englert, Nobel Prize in Physics 2013, Emeritus Professor ULB [video]
- Panel on ISOLDE and CMS experiments
  · Gerda Neyens, Professor, KU Leuven
  · Barbara Clerbaux, Professor, ULB
  · Christophe Delaere, Research Director FNRS, UCLouvain
  · Steven Lowette, Professor, VUB
  · Didar Dobur, Professor, UGent
- « Accelerating Innovation Through Partnerships - CERN Knowledge Transfer 2023 Highlights » [video]
- Debate on Knowledge Transfer
  · Serge Goldman, Professor ULB, Hôpital Erasme - Delegate to CERN KT Forum on Medical Applications
  · Serge Mathot, Applied Physicist, CERN
  · Pierre Van Mechelen, Professor, UAntwerpen
  · Thomas Cocolios, Professor, KU Leuven - Delegate to CERN KT Forum and to KT Forum on Medical Applications
- Adrien Dolimont, Minister-President of Wallonia, responsible for Budget, Finance, Research and Animal Welfare and Minister of the Scientific Research of Wallonia-Brussels Federation [video]
- Matthias Diependaele, Minister-President of the Government of Flanders, Flemish Minister for Economy, Innovation and Industry, Foreign Affairs, Digitalisation and Facility Management [video]
- Young researchers at CERN [video]
  · Anna Benecke, Postdoctoral Researcher FNRS, UCLouvain
  · Laurent Thomas, Research Associate FNRS, ULB
  · Gul Gökbulut, Postdoctoral Fellow, UGent
  · Ruben de Groote, Associate Professor, KU Leuven
- Conclusion Speech by Dirk Ryckbosch, Professor UGent - Belgian Delegate to the CERN Council and Finance Committee

Moderator : Cathy Smith.

The **universal** lab

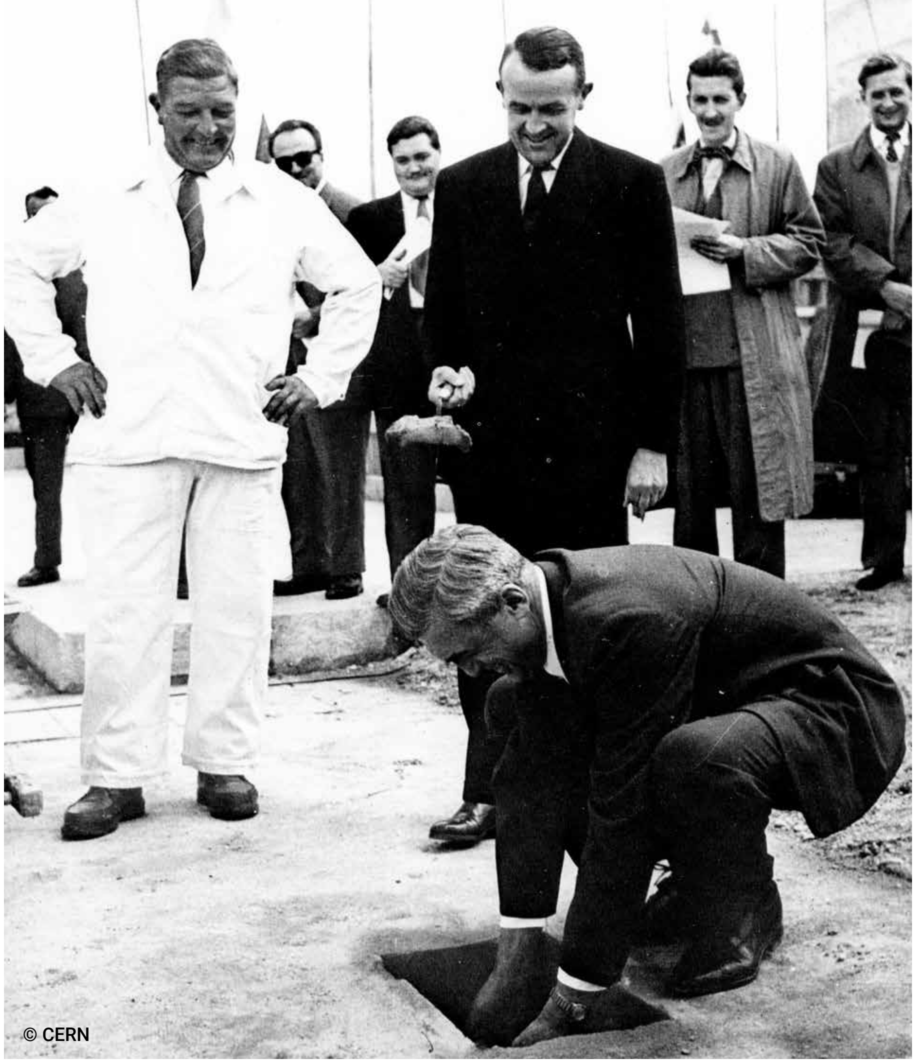
In the seventy years of its existence, CERN has transformed physics. And the world too. The convention establishing CERN, the European Organization for Nuclear Research, was ratified on 29 September 1954, by the 12 founding states: West Germany (FRG), Belgium, Denmark, France, Greece, Italy, Norway, the Netherlands, the United Kingdom, Sweden, Switzerland and Yugoslavia (who left the organisation in 1961). This "official" date marks its 70th anniversary.

But the adventure began before that, at the end of the Second World War. Europe suffered a brain drain of physicists to the United States and, basking in the glow of its success in atomic research, the New World well and truly took the lead in fundamental physics. In a Europe devastated by war, abandoned by its best talents, a handful of visionary scientists started to think about how they could get European science back on its feet. Following the example of the now mushrooming international organizations, the idea of creating a European atomic physics laboratory gradually emerged.

The American laboratories were building accelerators more powerful than ever before, in the interests of furthering knowledge of the atom. Physicists in Europe were well aware that the financial investment involved in such projects was beyond the means of any single European country. The time of experiments done on makeshift equipment was over and the war had taught them the benefits of international cooperation.

The first official proposal for the creation of a European laboratory was put forward at the European Cultural Conference in Lausanne in December 1949, which was organised by another European visionary, the Swiss thinker Denis de Rougemont. It came from Louis de Broglie, French Nobel laureate for physics, who had a message read out calling for scientific co-operation between European countries in order to open up projects that were beyond the means of individual national laboratories.

An additional impetus came from the United States. Many leading figures of US physics were European. Out of idealism but also in order to re-establish healthy competition, they were keen to encourage European cooperation. Among them was Robert Oppenheimer, who also suggested the creation of a joint laboratory. At the fifth UNESCO General Conference held in Florence in June 1950, another American physicist, the Nobel laureate Isidor Rabi, made a decisive contribution to the process. He tabled a resolution authorizing UNESCO to "assist and encourage the formation of regional research centres and laboratories in order to increase and make more fruitful the international collaboration of scientists…". The text was still rather vague but Pierre Auger, Director of Exact and Natural Sciences at UNESCO, assisted by the Italian physicist Edoardo Amaldi, launched a campaign that involved meeting numerous European scientists in order to bring them round to the idea of a new joint research centre.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On 10 June 1955, CERN Director-General, Felix Bloch, laid the foundation stone on the Laboratory site, watched by Max Petitpierre, the President of the Swiss Confederation.

Determination vs scepticism

Their determination was countered by scepticism from many scientific leaders, who were afraid that their national laboratories would be left on the sidelines if a European centre were created. For example, the Scandinavians — led by Niels Bohr — and the British were more in favour of cooperation between existing laboratories. However, the proponents of the Franco-Italian idea were undeterred.

At an intergovernmental meeting of UNESCO in Paris in December 1951, chaired by the French diplomat François de Rose, the first resolution concerning the establishment of a European Council for Nuclear Research was adopted. Two months later, 11 countries signed an agreement establishing the provisional Council. The acronym CERN was born. The signatories sent Isidor Rabi a letter informing him of the happy event: "We have just signed the Agreement which constitutes the official birth of the project you fathered at Florence. Mother and child are doing well, and the Doctors send you their greetings."

At the provisional Council's third session in October 1952, Geneva was chosen as the site of the future Laboratory, while Copenhagen, one of the unlucky losers and the home of Niels Bohr, was to host the centre for theoretical physics. The CERN Convention, established in July 1953, was gradually ratified by the 12 founding Member States: Belgium, Denmark, France, the Federal Republic of Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and Yugoslavia. On 29 September 1954, following ratification by France and Germany, the European Organization for Nuclear Research officially came into being. The provisional CERN was dissolved but the acronym remained.

The story of CERN is remarkable for the speed of its establishment: it took only a decade (from the aftermath of the Second World War) for it to become operational and produce its first results. After initial nationalist misgivings, the project quickly aroused enthusiasm. Not least because of its subject matter: high-energy physics is a field of fundamental research that studies the constituents of matter and the energies involved. This made it easier to avoid tensions, particularly between ideological blocs during the Cold War. After all, as Erwin Schrödinger pointed out, "you can't kill anyone with one of these fast particles, or we'd all be dead already!" The aim of particle physics is to advance knowledge, not to gain any competitive, military or economic advantage. Even so, the founders of particle physics were careful to ensure that the results of their research, and the technologies used to achieve them, would be accessible to researchers the world over and would become part of the public domain (Article 11 of the Convention).

Success

From its very first experiments, CERN went from one success to the next. In 1958, with its first accelerator, a synchrocyclotron, it obtained proof that a pion sometimes disintegrates into an electron and a neutrino, thus confirming what had been predicted by the theory of weak interaction. In 1968, Georges Charpak considerably improved (by a factor of 1000!) the detection of events occurring during particle collisions by creating the 'multi wire proportional chamber' for which he was awarded the Nobel Prize. This technology found applications in biology and radiology, for example. Three years later, the first proton-proton collisions were recorded. July 1973, and a major discovery was announced: weak neutral currents, which confirmed the electroweak theory that predicts that the weak force and the electromagnetic force are two manifestations of a single interaction which existed at the very beginning of the Universe. In 1976, a new accelerator, the Super Proton Synchrotron (SPS), was inaugurated. After converting the SPS into a proton-antiproton collider, researchers announced in 1983 that they had observed W+ and W- bosons, followed shortly afterwards by the neutral Z boson, thus confirming the theory and further consolidating the Standard Model of Particles. These discoveries earned Carlo Rubbia and Simon van der Meer the Nobel Prize. In the 1980s, the Electron Positron Collider (LEP) was excavated in a tunnel 27 km in circumference (a feat of engineering precision that would also benefit the Channel Tunnel). In autumn 1995, a team at the small LEAR accelerator succeeded in producing the first antiatom (antihydrogen), opening up a new field of study and launching the development of a new machine to study antimatter. LEP was shut down on 2 November 2000 to make way for the current Large Hadron Collider (LHC), installed in the same tunnel. LHC's greatest success was the experimental confirmation in 2012 of the Brout-Englert-Higgs (BEH) mechanism, leading to the award of the Nobel Prize to our compatriot François Englert and Peter Higgs the year after.

Spin-offs

CERN is often perceived as a high-flying experimental centre, providing experimental proof of the theories about how matter behaves at the most fundamental scale. Which, of course, it is. But not just that. It involves technological development that benefits society as a whole. Medicine in particular has benefited from technical developments performed for particle accelerators and detectors. CERN's experts in particle detectors have for instance contributed to develop the first positron emission tomography (PET) scanner for the Geneva University Cantonal Hospital. CERN researchers have also contributed to develop hadron therapy for cancer, i.e. using carbon ions and protons better suited to treat some deep-seated tumors. Other fields benefit from particle physics, such as the aerospace sector (protection against radiation, for example), the environment (sensors to detect pollution), or the coming quantum revolution thanks to its unrivalled knowledge of the world of atoms. Of course, the information technology sector has undoubtedly benefited from the knowledge developed at CERN. In 1976, the SPS was the first accelerator to be computer-controlled. The engineers came up with a system of touch screens and trackballs. Then there was the World Wide Web, which CERN placed in the public domain on 30 April 1993. A 'simple gesture' that revolutionized the economy, culture and our relationships with each other. According to the World Intellectual Property Organization (WIPO), "If CERN had tried to limit access to the Web in any way, it is more than likely that there would be a whole mess of different systems in the world today for accessing information online, instead of just one."

Belgium & CERN: 70 years of cooperation

The solid relationship established from the outset between our country and CERN has been mutually beneficial. As a country with limited resources, Belgium alone was not in a position to offer its researchers such favourable conditions. For its part, CERN has, from its inception, benefited from the investment of an enthusiastic and enterprising founding country. As early as 1947, Belgium set up an Interuniversity Institute for Nuclear Physics, headed by Jean Willems, the Director of the FNRS-NFWO, which was a national body at the time. The IIPN soon became the IISN (Institut Interuniversitaire des Sciences Nucléaires, Interuniversity Institute for Nuclear Sciences), which still exists today and is a key element in Belgium's relationship with CERN.

It was therefore quite fitting that Jean Willems negotiated CERN's founding agreement and signed it on behalf of Belgium. Jean Willems also played a key role in the early days of CERN since, as well as continuing to head the FNRS-NFWO, he was the Belgian representative on the CERN Council from 1954, chairing the Finance Committee until 1957, and serving as Vice-President and then President. This impressive career path was also followed by his successor at FNRS, Paul Levaux, another leading Belgian figure at CERN. Belgium's high profile at CERN is partly due to its strong representation on the CERN Council, the highest decision-making body. Paul Levaux, Secretary General of the FNRS-NFWO, was our 'political' delegate, while a Flemish scientist was our 'scientific' delegate. This joint NL/FR structure is still in place today.

Many of our scientists have played and continue to play a major role in CERN's decision-making bodies. For example, the theoretician Léon van Hove, a mathematician from ULB, became co-director of CERN from 1976 to 1981, the only Belgian to have held this position to date. Jean Sacton in the 1980s and Jorgen D'Hondt (2018-2020) have chaired the European Committee for Future Accelerators (ECFA), which provides scientific expertise and a long-term vision.

Design and construction

While Belgian scientists have played an important role in CERN's discoveries, the contribution of our researchers, engineers and manufacturers to the design and construction of the 'machines' that have shaped the history of CERN should not be underestimated. Hundreds of Belgian firms work or have worked for CERN: including the dipole magnets of the first proton synchrotron (PS), commissioned in 1959, which were manufactured by ACEC in Charleroi. Today, this machine is still in use and is an important link in the CERN network.

The IIHE (Institut Interuniversitaire des Hautes Énergies, Interuniversity Institute for High Energies - ULB/VUB) and the University of Mons-Hainaut pooled their resources to develop and build the muon detector for the DELPHI experiment in the 1980s. Walter Van Doninck held key positions in DELPHI which operated from LEP, the predecessor of the current LHC. He also played a similar role in the design of the CMS experiment. Today, several Belgian universities have been commissioned to design and build the next generation trajectograph (an instrument that reconstructs the trajectory of charged particles) for the new CMS detector. Belgian scientists are building 1,500 modules in a white room on the Brussels campus, which will then be assembled at UCLouvain before being transported to CERN and installed in the CMS.

This quick overview would not be complete without a mention of the contribution made by our compatriot Robert Cailliau to the creation of the World Wide Web in the late 1980s.

Nobel Prize

Belgium has opted to mainly concentrate its efforts on a small number of projects in two flagship experiments: CMS and ISOLDE (see the articles

Francois Englert and Peter Higgs at the official award ceremony for the 2013 Nobel Prize in Physics ©BELGA

François Englert was a regular visitor to CERN's Theory Department, which led to several articles, notably on supergravity, being published in the CERN Preprints collection. He worked there while continuing to lecture at ULB. The future Nobel Prize winner loved the atmosphere at CERN and made many friends there. In fact, he said in an interview: "CERN should be awarded the Nobel Peace Prize. Over and above the extraordinary technological development achieved, it is the image of this gathering of humanity that is amazing."

CERN and Belgium today

Belgium has two delegates on the CERN Council and the Finance Committee: Véronique Halloin, Secretary General of the FNRS, and Dirk Ryckbosch, Professor of Experimental Particle Physics at Ghent University.
This year, our country is contributing € 36 million to CERN's budget (the amount varies according to the country's net national income), i.e., 2.8% of the member states' contribution.

devoted to the research carried out by our compatriots). The CMS and ATLAS collaborations of course became famous in Belgium, and around the world, with the 2012 discovery of the BEH (Brout-Englert-Higgs) boson, which earned the 2013 Nobel Prize for our compatriot François Englert and Peter Higgs, Robert Brout having sadly passed away. Research groups from the universities of Antwerp (UA), Brussels (ULB, VUB), Ghent (UGent), Louvain-la-Neuve (UCLouvain) and Mons (UMH) pooled resources to participate collectively in the CMS experiment. The Belgian contribution to the discovery of the BEH boson is thus significant and played a key role in an international collaboration involving some 4,000 scientists and engineers.

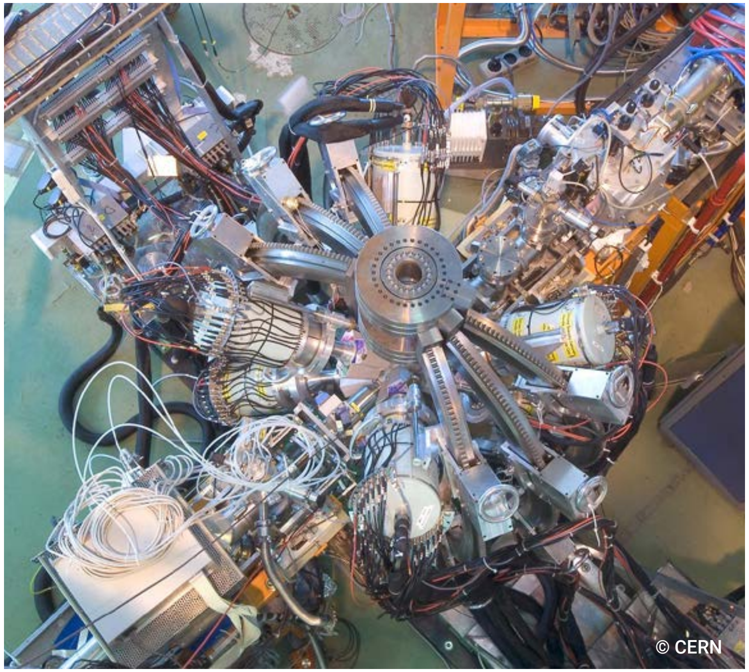
It is true to say that while CERN is best known for the results of its experiments, it is also home to a theoretical physics department that François Englert knew well. Léon van Hove, before becoming Director-General of CERN, was one of its first directors. From 1982 onwards,

In addition, the FNRS has allocated more than €5.6 million to upgrading the CMS experiment since 2018, and an additional amount of almost €1.25 million last year. Above all, the FNRS funds projects via the IISN to the tune of €5 to €7 million a year, and by paying the salaries of the 14 permanent researchers, 80 PhD students and 50 post-docs working in the field.

The Flemish research foundation FWO has allocated €5.2 million for the upgrade of the CMS experiment, with supplementary funding of €800,000 in 2024. In addition, since 2018, Flemish researchers working at CERN have been structurally financed through the International Research Infrastructures programme. This support amounts to a total of €11.2 million for the period 2018-2026. Through its regular financing for research projects and fellowships (PhD and postdocs), the FWO also stimulates research in this domain, which has resulted in more than 10,000 publications in the past ten years.

From star origins to cancer therapies: **ISOLDE's impact on science and society**

For over 50 years, the CERN ISOLDE experiment has pioneered nuclear science and driven innovations from particle physics to cancer treatments. Professors Gerda Neyens and Riccardo Raabe, both from KU Leuven, reveal how ISOLDE continues to push the boundaries of nuclear research, and why its next steps promise even greater impact.



What is the core mission of ISOLDE?

Gerda Neyens: Our mission is to use unstable isotopes for fundamental research in very diverse disciplines. There exist around 300 stable isotopes on Earth, but ISOLDE has enabled the production of nearly 1,300 rare, short-lived ones, helping us understand the nuclear forces shaping the universe. By measuring properties including mass, decay, and shape, we can explore two fundamental forces: the strong force, which binds the nucleus, and the weak force, responsible for radioactive decay. These studies not only deepen our comprehension of matter, but also of star formation and the universe's beginning.

Riccardo Raabe: ISOLDE also creates isotopes that can be applied for research in other fields: from materials research to the development of new cancer therapies. This dual focus on fundamental and applied research is typical of CERN's influence on science and society.

How does ISOLDE differ from other experiments at CERN?

Riccardo Raabe: Unlike single-purpose experiments at the Large Hadron Collider, ISOLDE is a multi-station lab that supports about 15 different experiments. Each collaboration works on distinct goals, in a multidisciplinary environment. Moreover, we are also unique in using a 1.4 GeV proton beam, making us the only facility in the world to operate at this energy level for isotope production. Managing so many experiments presents certain challenges, due to the high demand for beam time and limited space in the ISOLDE experimental hall.

Could you share some recent discoveries at ISOLDE that have made a significant impact?

Gerda Neyens: One major breakthrough was the first production and study of radioactive molecules, in 2018. These molecules have applications not only in nuclear physics but also in particle physics, chemistry, and medical research. By developing these new types of radioactive beams, we can create exciting possibilities for precision testing of fundamental theories, such as the Standard Model, as well as for applied research in medicine, including isotope production for cancer treatment.
Another very recent exciting achieve-

ment was the detection of photon decay in a unique state of the thorium-229 isotope. This low-energy nuclear state, studied at ISOLDE, holds the potential to revolutionise time measurement. A nuclear clock would be vastly more stable over extended periods than current atomic clocks, offering unparalleled precision in fields from scientific research to navigation systems. For instance, it could make current GPS systems far more accurate.

Which role does Belgium play in the ISOLDE experiment?

Gerda Neyens: Belgian scientists, especially from KU Leuven, are leading many fundamental research projects with dedicated experimental setups at ISOLDE, putting Belgium at the forefront of global nuclear physics. We are also one of the initiators of the MEDICIS project, which supplies isotopes for innovative cancer therapies that are being investigated in collaboration with hospitals in Leuven, Ghent, and Brussels.

Riccardo Raabe: Unlike the larger collaborations at CERN, PhD students at ISOLDE work in smaller teams, giving them the opportunity to directly handle equipment, develop technical skills, and gain leadership experience. This prepares them for careers in diverse fields, including energy, data science and medicine. Their ability to manage a science project from proposal to publication puts them in high demand.

What does the future hold for ISOLDE, and which support is needed to achieve these goals?

Gerda Neyens: We need to expand the ISOLDE hall to meet the growing interest from scientists worldwide. This would allow us to host their new dedicated equipment as well as enhance security by implementing modern radiation protection standards.

Riccardo Raabe: That's why sustained funding from CERN and member states like Belgium is so critical. ISOLDE is a unique facility for high-precision nuclear research, continuously exploring new areas in rare isotope investigations.

Bios

Gerda Neyens, Professor at KU Leuven, specialises in nuclear physics and rare isotope research. As a leading figure at ISOLDE, her work spans fundamental science and its applications across different disciplines, with a focus on precision experiments using atomic techniques.

Riccardo Raabe, Professor of Physics at KU Leuven, focuses on nuclear reactions with rare isotopes. At ISOLDE, he leads research that bridges fundamental physics with practical applications, by developing novel radiation detection systems.

CMS, the boson detector

Around a hundred Belgian scientists are working on the CMS experiment. They are involved in taking data from the detector, analysing the collisions recorded and contributing to the construction of the new, more powerful CMS trajectograph, planned for the second phase of the experiment.

Belgian universities have always participated in CERN's major particle physics projects in a concerted and coordinated manner. "For the LHC, the Large Hadron Collider, our work focused on CMS, one of the four experiments involving the machine," explains Professor Barbara Clerbaux, Director of the ULB particle physics department. We were closely involved in the construction of the trajectograph, part of the detector. It was a joint effort between the Flemish-speaking universities of Ghent, Antwerp and the VUB, and the French-speaking ULB, the UCLouvain and the UMons."

The CMS (Compact Muon Solenoid) is, along with its counterpart ATLAS, a multi-purpose detector installed on the ring of the LHC, the Large Hadron Collider. Designed to investigate questions relating to a wide range of physics, it is built around an enormous solenoid magnet, a cylindrical superconducting coil generating a magnetic field of almost 4 teslas, or around 100,000 times the Earth's magnetic field. "In the large circular tunnel, 27 km in circumference," explains Barbara Clerbaux, "two proton beams circulate in opposite directions. A beam is a collection of packets of particles, each packet containing around 10^{11} protons, and up to 2,800 packets can circulate simultaneously in each direction in the ring. These packets collide at 4 specific points, the interaction points, around which are placed the detectors that record the particles produced in the collisions. Two packets of protons collide every 25 nanoseconds (10^{-9} sec), i.e., 40 million collisions per second." It is not possible to record all the collisions, there are so many. The scientists have therefore developed what is known as the trigger system, to select the most interesting events which are stored for subsequent analysis. The optimal development of these trigger menus is crucial, because events that are not selected are eliminated for good. Many Belgians have acquired real expertise in this field.

Once the events have been recorded, scientists still have to analyse them.

"A whole series of interactions can occur during proton-proton collisions. One particularly interesting analysis is the search for the famous Brout-Englert-Higgs (BEH) boson. Observing this boson is difficult because its production rate at the LHC is very low. What's more, the BEH boson is not stable and decays into a series of particles. To observe this boson, it was necessary to select this particular type of event from among a multitude of other events. The discovery of the BEH boson by the CMS and ATLAS experiments at CERN in 2012 was an important moment for our community. Many Belgian scientists collaborated on this discovery and continue to study the BEH boson."

While the study of the BEH boson is a very active area in CMS, Belgian scientists are also involved in other analyses, such as the study of strong interactions between proton constituents, or the study of the most massive elementary particle in the model, called the top quark. The search for new particles is also particularly developed in CMS, for example the search for a candidate for the famous dark matter of the universe. Professor Clerbaux and her team have specialised in this area, in particular in the search for new hypothetical neutral and massive particles, or in the search for additional BEH bosons.

New BEH boson and new trajectograph

But what if there wasn't just one BEH boson? At least that's what some theories postulate. This is what Christophe Delaere, Research Director at the FNRS (UCLouvain), is trying to discover. "To explain what the Standard Model of particles (SM) does not explain - dark matter and the apparent asymmetry between matter and antimatter, for example - we would need a more complex BEH boson than the one discovered in 2012." A boson also called BEH because it is still scalar and linked to the Brout-Englert-Higgs mechanism that confers mass on certain particles, but with a slightly different mass to the one discovered at CERN and not necessarily neutral.

However, Christophe Delaere spends a great deal of his time building the new CMS trajectograph. This is an essential piece of equipment, since it is the instrument that enables the trajectory of charged particles to be reconstructed. The LHC will continue to operate in its current configuration for around a year before being shut down to be upgraded, giving researchers access to beams of higher intensity. "The energies involved will not be

Barbara Clerbaux, **Director of the ULB particle physics department ©ULB**

Christophe Delaere, **Research Director at the FNRS, Research Institute in Mathematics and Physics (IRMP) UCLouvain ©FNRS**

Gauthier Durieux, **Research Associate FNRS, IResearch Institute in Mathematics and Physics (IRMP) ©UCLouvain**

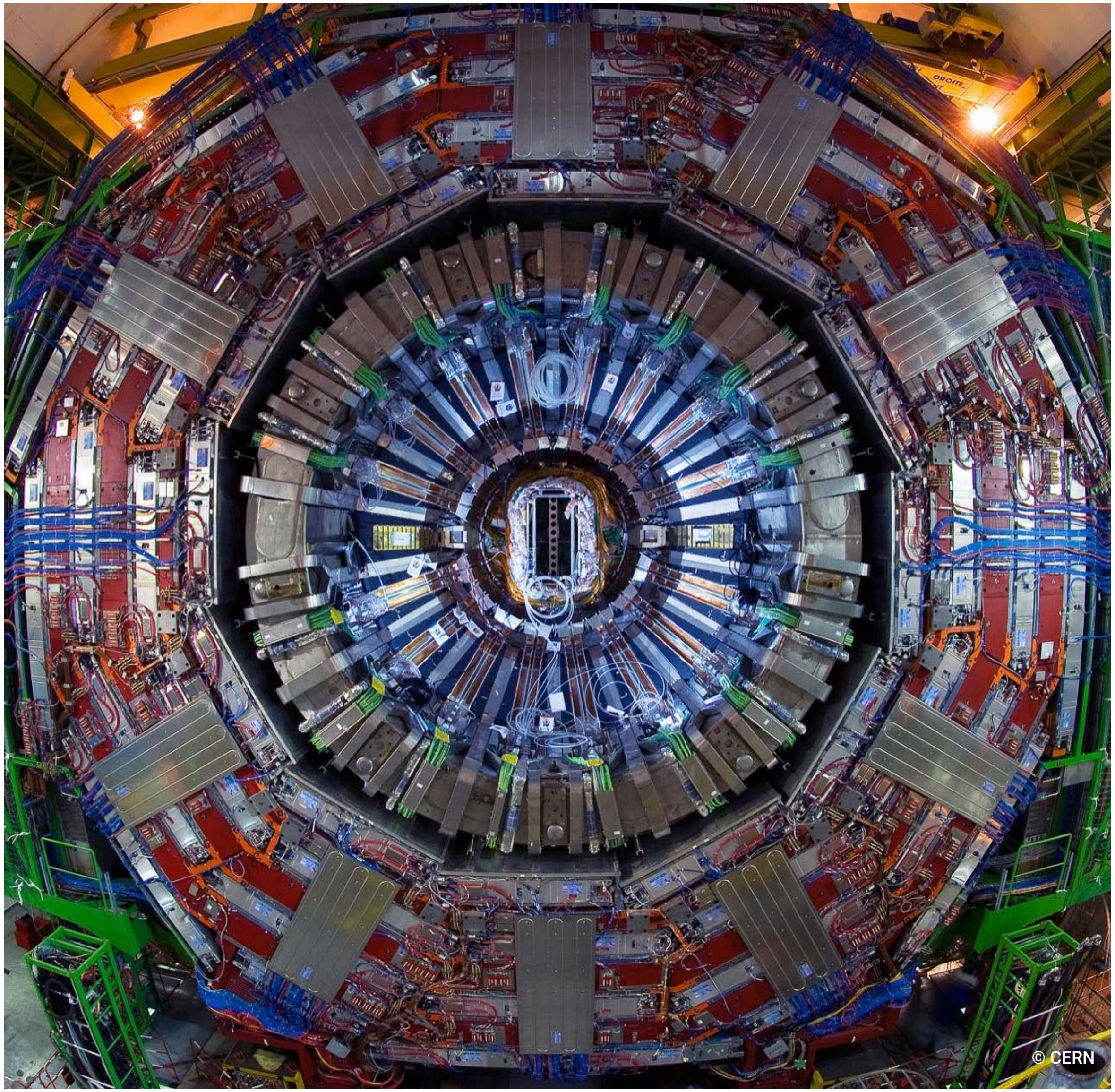
any greater, but 10 times as many collisions may be produced, which will enable even more data to be collected," explains the Louvain researcher. Five Belgian universities (UGent, UAntwerpen, VUB, ULB and UCLouvain) are taking part in this large-scale project, because the new trajectograph will be much more efficient than its predecessor: it will be more precise, more resistant to radiation, and more intelligent, capable of automatically selecting the most interesting tracks and thus determining in real time whether a collision is interesting or not. "The construction of 1,500 modules has just begun in the white room on the Brussels campus of the IIHE (Interuniversity Institute for High Energy, which brings together researchers active in this field from the VUB and ULB) before being integrated into the UCLouvain." Installation in the CMS is slated for 2027.

Beyond the Standard Model

Although more modest in size than experimental collaborations, which often have several thousand members, CERN's Department of Theoretical Physics is nonetheless one of the largest in the world, with around a hundred staff. Gauthier Durieux worked there for three years before becoming a FNRS researcher at UCLouvain. "Fewer than ten researchers are employed here on a permanent basis, the others have three- or five-year contracts. This means there's constant renewal, backed up by an impressive flow of visitors passing through for a week, a month or a year. This makes for a particularly dynamic and stimulating research environment!" Gauthier Durieux is studying models that go beyond the current Standard Model (SM). "How can we develop it so that it can explain what it cannot do today?" To achieve this, Gauthier Durieux uses the tool of effective theories: starting with known particles and symmetries, then systematically constructing the possible interactions between these particles, from the simplest to the most complicated. "In this way, we add successive layers to the SM, rather like an onion. By interpreting the experimental measurements within this framework, we hope to identify a mark through these layers, in the direction in which the SM should be extended."

Gauthier Durieux is also involved in research for future accelerators at CERN. "The preferred option is to dig a new tunnel 90 km in circumference, three times longer than the current LHC." Two accelerators would be built in succession from the 2040s onwards. "First, collisions between electrons and positrons would enable measurements of unprecedented precision. Collisions between protons would then reach unprecedented energies." The combination of the two phases would enable high-precision measurements of the BEH Boson in particular, and direct exploration of energies seven times greater than at present. Another type of accelerator has also recently been the subject of renewed interest. By causing muons - elementary particles like the electron and positron, but heavier - to collide, it would make it possible to combine high precision and energy. However, the technologies needed to build this new type of accelerator have yet to be developed. Next year, the feasibility of the Future Circular Collider (FCC) will be assessed. CERN's member states could then designate it as the successor to the LHC, confirming Europe's lead in this field and opening up a new era of exploration in fundamental physics!

The CMS experiment: preparing knowledge



The Compact Muon Solenoid (CMS) experiment at CERN is a cornerstone project of the Large Hadron Collider (LHC), and plays a critical role in advancing our understanding of particle physics, from exploring the Higgs boson to uncovering new phenomena beyond the Standard Model. The participation of scientists from Belgian universities, including Steven Lowette (VUB) and Didar Dobur (UGent), is helping push the boundaries of our scientific knowledge.

What is the impact and importance of the CMS experiment within CERN's activities?

Didar Dobur: The Compact Muon Solenoid, or CMS, is one of the largest detectors running on the Large Hadron Collider (LHC), which is itself the most powerful particle collider ever built. The CMS allows us to explore particles resulting from high-energy collisions, including the BEH Boson, and to search for new physics beyond the Standard Model.

Steven Lowette: Over the past 70 years, particle physics has evolved into a field driven by large-scale international collaborations like the CMS experiment. The LHC has brought particle physics into a new era, where such global cooperation is necessary to tackle the complexity of the experi-

for the next generation

ments. The CMS plays a pivotal role in addressing a broad range of physics questions and advancing CERN's mission.

Technology and knowledge transfer are key in CERN's mission. How does this work in practice?

Steven Lowette: CERN's technology transfer happens on multiple levels. Real-world applications using technologies developed for particle physics include proton therapy for cancer treatment and medical imaging. There are also many innovations in detectors and accelerators that push the boundaries of existing industrial capabilities, driving new collaborative developments with industry.

Didar Dobur: Knowledge transfer also occurs through training. Engineers and technicians working at CERN gain cutting-edge expertise. Taking this knowledge back to their respective industries, universities and institutions, they contribute to scientific and technological growth across Europe.

Our country is one of the founding members of CERN. Can you elaborate on Belgium's specific contributions to the CMS project?

Didar Dobur: Belgian universities in Flanders and Wallonia have been integral in constructing key parts of the CMS detector. A major contribution has been the upgrade of the tracking system, which is essential for reconstructing particle trajectories. Another highlight of our involvement is the development and construction of the muon detector. Additionally, Belgium is heavily involved in building one of the tracker's endcaps, positioning us at the forefront of these advancements.

Steven Lowette: Beyond the hardware, Belgian physicists have made significant contributions to the CMS project's physics programme. Belgian physicists play a key role in Higgs and top quark physics, as well as the search for exotic particles including dark matter. Sustained investment is crucial to maintain Belgian leadership in the global effort to understand the universe.

The experiment is still evolving. What are the next major milestones for the CMS project and CERN?

Didar Dobur: We are preparing for the next phase of the LHC, set to begin in 2030, which will see significant upgrades to both the collider and the detectors. This will enhance our ability to make precise measurements, and could lead to discoveries that reshape our understanding of the universe.

Steven Lowette: Preparing for the future goes beyond building the next big machine. It is also about training the next generation of scientists and engineers who will lead these projects. The work we do in Belgium is vital in building the knowledge base and infrastructure for future discoveries.

Bios

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Steven Lowette is an Associate Professor at Vrije Universiteit Brussel (VUB), specialising in dark matter and exotic particle research within the CMS collaboration at CERN. He investigates whether dark matter can be created in laboratory conditions, looking for signatures such as particles that may escape detection but can be inferred through energy conservation.

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Didar Dobur is a Professor of Physics at UGhent, where she leads a research team focused on top quark physics and the search for new physics as part of the CMS experiment at CERN. One of her principal areas of study is heavy neutrinos that could explain the puzzle of observed neutrino oscillations and the theoretical predictions of their mass.

When CERN shares its knowledge

CERN scientists invented the Web. In doing so, they have profoundly transformed our society. But we owe (and will continue to owe) many other advances to them, in fields as diverse as medicine, information technology and art.

CERN's primary mission is obviously research in fundamental physics, especially particle physics. To fulfil this mission, CERN has developed expertise in three main technical areas: accelerators, detectors and information technology. Behind these three key elements lie a large number of fields: from cryogenics to ultra-high vacuum, from particle tracking and radiation monitoring to superconductivity, and many others. These technologies, and the human expertise associated with them, are having a positive impact on society in a range of different areas: the environment (nuclear waste and batteries), IT (big data processing and artificial intelligence), aerospace (monitoring radiation and extreme temperatures), health (medical imaging and radiotherapy) and the quantum world (photonics). For quite some time, transfers of knowledge and technology were not an explicit objective for CERN. Today, however, the policy has changed and there is a large group that deals solely with technology transfer, notably organising the KT (Knowledge Transfer) Forums that bring together CERN researchers and companies or other groups interested in their expertise.

Imaging and radiotherapy
Serge Goldman is a medical neurologist, a former head of the Nuclear Medicine Department at the Erasme Hospital and Honorary Professor of Nuclear Medicine (ULB). He is the current Belgian delegate to the KT Forum on Medical Applications. "CERN has come under a lot of pressure in recent years," he explains, "to use the public money it receives in a more practical way, more directly targeted at the general public, particularly in Europe. It soon became clear that CERN's ability to track particles in motion, with extreme sensitivity, could benefit medical imaging."
CERN has contributed to advances in X-ray and positron emission tomography, for example. And CERN's expertise has led to real advances in the use of accelerators as therapeutic tools in the treatment of cancer. "In this field, CERN has moved towards industrial involvement, producing innovative radioisotopes that not only help with cancer diagnosis, but also its treatment, by emitting precise radiation into the body that destroys diseased cells without damaging healthy tissue. This is the MEDICIS programme, which produced its first isotopes at the end of 2017."

Serge Goldman points to future developments in hadrontherapy, a form of radiotherapy, carried out using heavy ions, even carbon ions! Heavier particles target cancer cells more precisely, sparing healthy tissue. "The NIMMS (Next Ion Medical Machine Study) programme plans to develop synchrotrons for accelerating carbon or helium ions, which offer a good compromise between proton (better targeting) and carbon (lower cost)."

Another innovation in which CERN is involved is 'flash therapy', a very short-duration, high-intensity radiotherapy. And then there is a new generation of gantries (the part that directs the flow of heavy ions) with a superconducting magnet that rotates 360° around the patient. In short, CERN is undoubtedly playing an important role in the future of medicine.

Climate and nuclear reactor control
Knowledge Transfer can also take place within physics. Andrea Giammanco, FNRS Research Director (UCLouvain) and Belgium's representative on the Advisory Committee of CERN Users (a committee that brings together all CERN users), likes to cite the CLOUD experiment. "CERN developed the cloud chamber technique a while ago to visualise the path of particles. Today, climatologists are very interested in this technique to understand the influence of cosmic rays in cloud formation. In a way, we create a cloud in the laboratory. We can then vary various parameters, including the presence of aerosols or contaminants. This is the first time that an accelerator has been used to study the climate."

CERN was also a pioneer in the use of accelerators to control nuclear reactors. And to reduce nuclear waste. "Accelerator-driven systems (ADS)," explains Andrea Giammanco, "are very promising applications for particle accelerators in the transmutation of nuclear waste and the production of electricity. By efficiently burning minor actinides, ADS could potentially transform the landscape of the problem of waste disposal and storage."

Andrea Giammanco, FNRS Research Director (UCLouvain) and Belgium's representative on the Advisory Committee of CERN Users.

Serge Goldman, Medical neurologist, former Head of the Nuclear Medicine Department at the Erasme Hospital, Honorary Professor of Nuclear Medicine (ULB), Belgian delegate to the KT Forum on Medical Applications. ©Fonds Erasme-HUB

Serge Mathot, Physicist at CERN, and a former researcher of UNamur. ©CERN

CERN is collaborating with CEN (Centre d'Etudes Nucléaires – Belgian Nuclear Research Centre), in Mol, Belgium, on the (very Belgian) MYRRHA project, one of the most advanced in this field.
However, Andrea Giammanco has not waited for directives to launch his own applied research. "At CERN," he explains, "we have very good knowledge of detectors and particles. That's what I'm putting to good use in applications."
Muons are among the particles that make up the cosmic rays striking us all the time, and are highly penetrative. When they collide with radioactive substances such as plutonium, their trajectory is bent, a phenomenon well known to physicists at CERN.
"We are currently trying to develop scanners for nuclear security applications. This will enable us to combat fraud involving radioactive products." This is a breakthrough of great interest to the International Atomic Energy Agency. Especially as such devices could also be used to monitor nuclear non-proliferation treaties. "Even at a distance, our system can detect the presence of fissile materials in warheads," Andrea Giammanco enthuses. The use of cosmic particles is also of interest to other sectors, such as the mining industry: "An American company has asked us to study the manufacture of small detectors that are easily transportable and easy to use to determine the quantity of exploitable ore in excavated land!"

"Pocket" accelerators

We would be remiss if we did not finish this rapid and incomplete overview without mentioning the work of Serge Mathot, a physicist at CERN (appointed in 1995) and a former student of UNamur. He quickly became a specialist in the assembly of RFQ (Radio Frequency Quadrupole) accelerator cavities. These are used to produce the first stage of acceleration from a continuous beam of particles, by forming packets of particles that are themselves sent to the LHC for acceleration. "In 2011, with the LHC's RFQ completed, we set about building a much more compact RFQ for medical applications, in particular cancer treatment. It was a success, so in 2016 I proposed building one for materials analysis." This is the MACHINA project, developed with the Italian National Institute of Nuclear Physics. It led to the construction of a portable proton accelerator on wheels, transported on a simple van. It is currently being used by a Florentine art restoration laboratory. "When you bombard a sample with a proton beam, it emits X-rays that are characteristic of the material. And it's 100 times more precise than an electron microscope. So, we can identify objects, analyse the pigments in a painting, and so on."

In 2019, Serge Mathot proposed that CERN build another example, ELISA, for demonstration purposes in the 'CERN Science Gateway', open to the general public. It has been up and running since November, and allows visitors to see the accelerator beam with the naked eye, carry out experiments, understand how to deflect the beam using magnets or identify the materials placed in the beam's path. It's a fantastic opportunity for anyone who wants a better understanding of the usefulness of these 'machines

CERN's Belgian Connection:
Pioneering technology and knowledge transfer for a brighter future

For 70 years, CERN has made groundbreaking advancements in particle physics, with an influence that extends far beyond scientific discovery. Through the transfer of technology and knowledge, the organisation has revolutionised industries and cultivated the next generation of innovators. Belgium plays a crucial role in this endeavour, advancing not only the frontier of research but also ensuring that CERN's innovations benefit society at large. Thomas Cocolios (KU Leuven) and Pierre Van Mechelen (UAntwerpen) comment on Belgium's contributions, the importance of sustained investment, and the role of technology and knowledge transfer in translating research into real-world applications.

What are the key types of technology transfer at CERN, and how do they apply to Belgian research?

Thomas Cocolios: CERN's technology transfer operates through three key mechanisms: technology push, technology pull, and serendipity. Technology push occurs when CERN develops a novel technology and actively seeks applications for it beyond the lab. For example, touchscreens were invented there in the 1970s to simplify particle accelerator operations; today they are integral to everyday life. In Belgium specifically, we have seen a major impact in nuclear medicine: CERN's MEDICIS facility and KU Leuven's work with the PRISMAP project are pioneering new radionuclides for cancer treatment. Through Belgian institutions like SCK CEN and via the university hospitals, these advancements are now being directly applied in hospitals, improving diagnosis and treatment options for patients.

Pierre Van Mechelen: Technology pull occurs when external partners approach the organisation with specific challenges. CERN's grid computing infrastructure is a prime example: developed to manage the massive amounts of data from particle physics experiments, it now benefits industries handling big data, including finance and healthcare. The Worldwide LHC Computing Grid (WLCG) distributes complex computing tasks globally, and this same technology is now used in sectors such as environmental science and financial services, where computational demands are high.

Thomas Cocolios: Then there's serendipity innovations that find their way into unexpected fields. This was the case with the White Rabbit system: originally designed for precise timestamping in particle physics, it is now used by the Frankfurt Stock Exchange to ensure transaction accuracy. It's an excellent illustration of how discoveries from fundamental science can spill over into practical, everyday applications.

How does knowledge transfer from CERN benefit Belgian industry and education in particular?

Thomas Cocolios: Firstly, through the training of highly skilled personnel. At KU Leuven, our doctoral students and post-doctoral researchers who collaborate with CERN acquire expertise in areas such as machine learning, data acquisition and advanced computing. Many then transition into industry roles, where they apply the skills gained at CERN to sectors including energy and sustainability. For instance, several of my former students and colleagues now work at Energyville living lab, where they use what they learned at CERN to tackle pressing challenges in renewable energy.

In the medical field, Belgian graduates are contributing to innovations in radionuclide therapy for cancer. CERN's collaboration with institutions such as SCK CEN has led to the production of isotopes for new cancer treatments, which are now used in hospitals across Europe.

Pierre Van Mechelen: The same dynamic occurs in particle physics. Students and post-doctoral researchers who gain experience at CERN bring those skills into diverse sectors. Some of my former students are now working in finance, applying the data analysis techniques they developed at CERN to solve complex financial challenges. This highlights the broad applicability of the skills gained at CERN and demonstrates how knowledge transfer extends beyond academia to create economic value in sectors ranging from finance to high-tech industries.

Which are notable examples of technology transfer from CERN that have impacted the broader world?

Thomas Cocolios: CERN's contribution to cancer treatment, particularly through charged particle therapy, is one of the most transformative examples. Another breakthrough is in medical radionuclide therapy, where a CERN spinoff has developed a radiopharmaceutical based on the Lutetium-177 isotope. This has become a standard treatment for neuroendocrine tumours in Belgium.

Pierre Van Mechelen: One of the most well-known examples of technology transfer from CERN is the PET scan, which uses positrons (antimatter particles) to create detailed images of the human body. This technology, rooted in CERN's particle detection expertise, is now a vital tool in medical diagnostics worldwide.

How can our country and Belgian researchers maintain their impactful role at CERN?

Pierre Van Mechelen: Building and maintaining detectors like the Compact Muon Solenoid (CMS) requires decades of commitment, and funding disruptions risk slowing down or even halting progress. Institutions such as the Research Foundation Flanders (FWO) are vital in ensuring our universities remain key players in CERN's experiments. The same applies in Wallonia and Brussels, where sustained investment by FNRS in projects like radionuclide therapy is essential for maintaining Belgium's leadership in innovative research.

Thomas Cocolios: Consistent support is key to the success of technology transfer projects. Developing new therapies in nuclear medicine, for instance, can take more than a decade. Without support, these projects could lose momentum, delaying critical advancements in cancer treatment. Additionally, with CERN's upcoming High-Luminosity LHC set to generate 10 times more data than previous runs, it is crucial for Belgium to remain at the forefront of developments.

Bios


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Thomas Cocolios is a Professor of Physics at KU Leuven, specialising in nuclear physics and the knowledge transfer process at CERN. His research bridges fundamental nuclear physics with practical applications, particularly in the medical field. As a member of CERN's Knowledge Transfer Forum, he facilitates the transfer of CERN's innovative technologies to Belgian industry.

Pierre Van Mechelen is a Professor of Physics at the University of Antwerp, where he leads research in experimental particle physics within CERN's CMS collaboration. His work focuses on uncovering phenomena beyond the Standard Model and advancing technology transfer, particularly in training future physicists to contribute across both academic and industrial sectors.

Anna Benecke: From Puzzles to Particles

As CERN celebrates its 70th anniversary, we spoke with Anna Benecke, a dedicated particle physicist doing her postdoctoral research with FNRS at UC Louvain in Belgium. She shared insights into her work at the Large Hadron Collider, her journey into physics, and her hopes for the future.

How do you explain your work to others?
"One part of my research is called pileup mitigation. At the LHC, we collide bunches of protons, which leads to multiple collisions at the same time. We're usually interested in just one of these collisions: the additional collisions, known as pileup, create extra particles and energy that can distort our data. I develop techniques to remove these additional collisions."

Why is your work important?
The techniques I develop are crucial for accurate measurements, allowing other researchers to focus on analysing data to search for new particles. We currently understand only about 5% of the universe. Improving our measurements helps us explore the unknown and piece together the cosmic puzzle."

Some might ask, why invest in this kind of research?
"Advancing knowledge always benefits us, even if immediate applications aren't apparent. Fundamental research at CERN has led to significant developments like the World Wide Web. Technologies we rely on daily, such as GPS, originated from basic science. Who knows what today's discoveries might lead to tomorrow?"

When did you realize that particle physics was your calling?
"As a kid, I loved solving puzzles and understanding how things work. I was fascinated by mathematics and physics. Initially, I wanted to be a teacher, but during my master's studies in Germany, I discovered particle physics and was captivated. The collaborative atmosphere and exciting research convinced me to pursue it as a career."

Did you have any role models who inspired you?
"Beate Heinemann, now project director for particle physics at DESY. Hearing about her career path and challenges was motivating. Seeing women in senior scientific positions is inspiring."

As a woman in your field, have you faced any particular challenges?
"Being a woman can be challenging. There were times I didn't feel heard or seen. It's sometimes hard to tell if that's due to gender or age. I believe in supporting each other, regardless of gender or age. Diversity enriches science."

What qualities do you think are essential for a particle physicist?
"Teamwork and resilience. We work in large international collaborations, so communication is key. Resilience is important because research can be demanding, and sometimes progress requires taking a step back to move forward."

Do you feel working at CERN is a dream come true?
"Absolutely. CERN is a diverse and international place, and I'm privileged to work in such an environment. It's inspiring to collaborate with people from different cultures and backgrounds. Every day is a learning experience, especially during data collection. CERN is a major laboratory and project for Europe and the world, and I believe it's essential that we continue its legacy."

If you had a magic wand, what would you change?
"I'd create more opportunities for scientists from underfunded countries, making it easier for them to participate in meetings and work at CERN. Science should be accessible to everyone."

You mentioned meeting Nobel laureates recently. Can you tell us about that?
"Thanks to FNRS, I attended the Lindau Nobel Laureate Meetings. It was inspiring to hear their views on science and culture and discuss how to attract more young people to research. Their insights were truly motivating."

How do you encourage young people, especially women, to pursue physics?
"I'm one of the main organisers of the Physics Project Days, a workshop for female high school students to explore physics. They work on projects like searching for the Higgs boson using CMS open data. We aim to show them that physics is for everyone."

As CERN celebrates seven decades of groundbreaking science, it's clear that passionate scientists like Anna Benecke are driving the field forward. With their dedication to unravelling the mysteries of the universe and making science accessible to all, the future of particle physics looks bright.

Laurent Thomas: Exploring the Mysteries of Particle Physics

In this landmark year, which marks CERN's 70th anniversary, we sat down with Laurent Thomas, Research Associate FNRS at the Université Libre de Bruxelles, to talk about his journey in particle physics, his work at CERN, and the broader significance of the research conducted there.

Can you briefly introduce yourself and tell us about your academic background?
"I completed both my undergraduate studies and Ph.D. at ULB and spent several years abroad, including three years at CERN in Geneva, working for the University of Florida."

How would you explain your research to someone without a scientific background?
"My work focuses on particle physics. I try to understand the smallest building blocks of matter and how they interact. Most people know that matter is made of atoms, but we go much further. We study even smaller particles, such as quarks, which make up protons and neutrons. The goal is to discover how these particles interact and to solve some of the unsolved mysteries of the universe."

And how do you explain your research to fellow physicists?
"We focus on experimental particle physics, specifically the collisions of protons at extremely high energies at the Large Hadron Collider (LHC) at CERN. This allows us to explore uncharted regions of energy and look for rare phenomena that may explain open questions in the field."

Some might ask about the practical usefulness of your research. What is your response?
"While our work doesn't have direct everyday applications, it's vital for advancing our understanding of the universe. Beyond that, the technological advances that come from building complex machines like the LHC or the detectors used at CERN often find their way into practical applications. For example, advances in medical imaging and data processing can trace their origins back to particle physics research."

Why do you believe it's important to continue this research?
"If we stop searching for answers, we risk believing that we know everything, which would be a dangerous mindset. There are still fundamental questions about the universe that remain unanswered, and continuing this research helps us expand our understanding and challenge our current assumptions."

When did you realize that particle physics was the right path for you?
"It became clear during my master's thesis. I was working on particle searches with the early data from the LHC. Even though there wasn't much data at the time, I found the work incredibly stimulating."

What is it like working at CERN?
"It's a dream come true. CERN is the place to be for particle physicists. You're surrounded by experts from all over the world, working on cutting-edge research. It's truly inspiring. I first visited CERN as a student, and I was immediately struck by the scale of the experiments. Working here now is an incredible privilege."

Do you have any specific ambitions for the future?
"A major dream is to see the mystery of dark matter solved within my lifetime. It could be a new particle we haven't yet discovered, or something entirely unexpected, like primordial black holes. I'd be thrilled to witness such a breakthrough."

If you had a magic wand, what would you wish for in particle physics?
"I'd love to collide particles at Planck energy. That's where we believe gravity becomes as strong as the other forces, which could reveal groundbreaking insights into how fundamental forces interact. Unfortunately, that's beyond our current technological capabilities, but a physicist can dream!"

What qualities do you think are essential for a great particle physicist?
"You need to be sceptical of your results and open to admitting when you're wrong. It's crucial for progress. Also, thinking outside the box is important—innovation often comes from new ideas, even if they don't always work out at first."

As CERN celebrates 70 years of scientific achievement, it's clear that researchers like Laurent Thomas are pushing the boundaries of our understanding, driven by curiosity, perseverance, and a passion for discovery.

Gül Gökbulut's curiosity and dedication

In this year which marks the 70th anniversary of CERN, we took the opportunity of speaking to Gül Gökbulut, a postdoctoral researcher at Ghent University, and asking about her career in in particle physics, the challenges and rewards of her work, and her thoughts on inspiring more women to enter the field.

Could you introduce yourself and tell us about your background?
"I'm Gül Gökbulut, and I'm working as a postdoctoral researcher at Ghent University (UGent). I was born in Turkey and, as a child, was always very curious about the world around me. I studied physics during my bachelor's degree, and in my third year, I had the opportunity to intern at the Center for Nuclear Physics and Astrophysics at the University of Washington, where I had my first experience with data science. I was totally fascinated! I decided to pursue a career in physics, continued with a master's degree, and then completed my PhD at Çukurova University in Turkey, where I started working with CERN for the first time."

Can you tell us more about your current research?
"I'm working on the Gas Electron Multiplier (GEM) subsystem within the CMS experiment at CERN. Gas electron multipliers are essential for improving the performance of the CMS Muon system. I'm involved in the production, testing, and quality control of GEMs to prepare for the challenges of the High-Luminosity LHC. At Ghent University, we have a clean room and a laboratory dedicated to producing some of these modules, where we also conduct related testing and quality control."

Some people might ask, what's the purpose of this research? Is it useful?
"Of course! Gas Electron Multipliers will help improve the precision and efficiency of the CMS Muon system, impacting almost every measurements in CMS experiment. These improvements will expand our understanding of the subatomic world."

But at the end of the day, how does this benefit society?
"Everything comes out of curiosity, actually. Research is not always driven by a specific goal – it is also driven by a desire to learn more about the universe and the fundamental building blocks of everything. While our primary goal isn't immediate application, the knowledge we gain can lead to technological advancements and benefits for society."

Did you have role models who inspired you?
"First of all, my sister. She's also a scientist, working in molecular biology and genetics, and she's always been very dedicated to her work. Another inspiration is Lise Meitner. When I was younger, I watched a documentary about her and was amazed. She was an extraordinary physicist who achieved so much in the male-dominated physics of the 20th century. Her dedication, ethics, and strength continue to inspire me."

Being a woman in physics, do you find it to be a special challenge?
"I think it's a strength. With dedication and hard work, women can achieve anything."

What do you think could be done to attract more women to physics?
"Getting hands-on research experience is great for young people. It sparks their interest and shows them what lab work is really like. More accessible opportunities and mentorship can build confidence, especially for young women, and this will bring more diverse talent into the field."

What is the most challenging part of your job?
"I would say the uncertainty. You can work on something for years and never know if it will lead to a breakthrough or just more questions. Staying motivated can be challenging. Also, CERN is a very competitive environment, so finding your own way can sometimes be difficult."

What qualities do you think are essential to be a good physicist?
"Curiosity comes first. Then persistence, because particle physics experiments are very long, and progress can be slow. Teamwork is also crucial because you need to collaborate with physicists from all over the world."

As CERN marks its 70th anniversary, physicists like Gül Gökbulut remind us of the passion and dedication driving the quest to understand our universe. Her journey underscores the importance of curiosity, persistence, and collaboration in pushing the boundaries of knowledge and inspiring the next generation of scientists

Unveiling Nuclear Physics with **Ruben de Groote**

As CERN celebrates its 70th anniversary, we take a closer look at the diverse research beyond particle physics being carried out there. Ruben de Groote, an experimental nuclear physicist at KU Leuven, shares insights into his work and the significance of nuclear physics at CERN.

Tell us about your career and recent work.
"I started my journey in experimental physics at KU Leuven with my master's and PhD theses, which involved working at CERN and the ISOLDE laboratory—a nuclear physics lab there. After completing my PhD, I moved to Jyväskylä in Finland, on a Marie Curie fellowship for a few years, working at their accelerator facility. Returning to Belgium, I'm now an assistant professor at KU Leuven. My current research involves studying radioactive isotopes at CERN and Jyväskylä using innovative techniques and technologies."

How do you explain your research to non-physicists and to colleagues?
"To non-physicists, I explain that I study how atomic nuclei hold together and behave, using experiments to understand the universe's building blocks. To physicists, I focus on bridging quantum chromodynamics (QCD) and nuclear physics, using experiments to test how the strong nuclear force emerges at nuclear energy scales. At CERN, we use the particle accelerators to produce short-lived isotopes. My main focus of work is the implementation of new techniques to measure properties of short-lived radioactive isotopes."

Do people question the usefulness of your research?
"Yes. We're talking about big projects and big budgets, so there needs to be justification for the spending. While our fundamental research may not have immediate applications, it lays the groundwork for future innovations in fields like medicine and technology. Additionally, we train skilled scientists who contribute to various sectors, strengthening our societies."

What are your thoughts on serendipity and technology transfer?
"Serendipity is essential. Many significant discoveries, like the World Wide Web developed at CERN, happen unintentionally. Funding fundamental research allows for unexpected breakthroughs that can have a profound impact."

Do you have role models?
"I'm fortunate to work with inspiring colleagues at KU Leuven and the Institute of Nuclear and Radiation Physics who have made significant discoveries and who remain curious and supportive."

What challenges do you face in your work?
"As an assistant professor, balancing research, teaching, and administrative duties is challenging. Time management is crucial and it can sometimes be difficult to prioritize accordingly."

Is working at CERN a dream come true?
"Absolutely. I think if you had told me when I was 18, that I would be at CERN, I would have been very excited at the prospect. Being at CERN, surrounded by people at the forefront of science and technology, is something I deeply appreciate and which I hope inspires others."

What qualities are essential for a nuclear physicist?
"Determination, perseverance, and teamwork are vital. Physics is a collaborative and often challenging field that requires resilience and the ability to work well with others."

If you had a magic wand, what would you do?
"From a human perspective, I'd wish for an end to conflicts. In science, I'd ensure adequate funding for researchers, as many excellent projects lack resources."

What message would you like to convey at CERN's 70th anniversary event?
"The work at CERN is crucial. It's an international organization where the world collaborates to advance knowledge. We should continue supporting CERN to keep it productive, diverse, and a key player in science, not just in particle physics but across all research areas enabled by its facilities and expertise."

As CERN marks seven decades, Ruben de Groote's insights highlight the broader impact of its research. His passion underscores the importance of fundamental science and collaboration in unveiling the mysteries of the universe.

Education at CERN

Although sometimes seen as a closed place, the reserve of physicists and mathematicians, the international organisation based in Geneva is in fact remarkably outward-looking. Every year, hundreds of thousands of people take part in activities aimed at a wide range of people.

“It was stipulated in CERN’s founding convention that the organisation must communicate its research and results,” explains François Briard, who organises visits and events at CERN. “From the outset, successive management teams have interpreted this very broadly. We could have confined ourselves to scientific communication and said: ‘we have communicated’. Fortunately, those in charge quickly realised that we needed to win the public’s understanding and approval, since we operate with public money. CERN has always wanted to be open to as many people as possible.” With this aim in mind, the organisation has developed a range of schemes, which have proved to be outstandingly successful.

Paid internships

François Briard is a computer scientist, a UNamur graduate, who has worked at CERN for 30 years. He is himself the product of the educational programme set up by CERN.

“While I was a student, I was lucky enough to do a six-month internship there. It was 1992 and I worked alongside the team developing the Web with Tim Berners-Lee. Training is one of CERN’s fundamental missions,” he explains. “And so the organisation offers university students paid internships in various fields, including obviously, physics, engineering, electronics and IT, but also in less obvious areas such as administration (purchasing department, for example) or human resources.” Between 500 and 1,000 young people are chosen each year by selection committees, on the basis of a letter of motivation. Our compatriots are probably not as well-represented as they could be because the Belgian educational system does not encourage long-term internships, whereas CERN prefers internships of at least 6 months to a year or longer.

Teachers and students

François Briard is also keen to bring secondary school students and their teachers to CERN. He is also the Belgian contact (NL and FR) for ‘student and teacher programmes’.

There are national and international programmes for secondary school teachers who want to learn about the latest developments in particle physics. On the national level, (mostly) physics teachers attend special week-long courses, and more importantly are able to have discussions with each other, meet CERN researchers or take part in experiments. “Unfortunately,” explains François Briard, “there hasn’t been a Belgian programme since 2013. One of my current concerns is to relaunch this programme in conjunction with the country’s educational networks.”

The international scheme brings together teachers from different countries for a similar two-week programme during the summer holidays.

There are also two programmes at CERN aimed at secondary school students. The first is the CERN-Solvay Student Camp, a week-long course for 30 students from all over the world, and national courses funded by individual countries or institutions.

Then there’s the Beamline for Schools competition, in which three groups can come and carry out their own scientific experiment in CERN’s facilities or those of the DESY particle accelerator in Hamburg. “It’s a competition between groups of students from all over the world,” adds François Briard. “Each group designs an experiment using accelerated particle beams. The CERN jury selects three. This year, groups from Estonia, Japan and the United States won. Another year, a team from South Africa won the competition by proposing an experiment bombarding a wave crystal with a beam of protons!”

Of course, CERN is aware that not everyone can travel to Geneva. That’s why most of the public lectures and even some of the tours are avail-

able online. There is even a 'Belgian' programme dedicated to distance learning: the CERN-Solvay educational programme. "It's the sponsorship that's 'Belgian', because it's obviously accessible to everyone," explains François Briard. It offers short videos on social networks linking do-it-yourself experiments with CERN physics, and online courses for secondary school students.

The general public

CERN's buildings are, to a certain extent, open to the general public. As early as 1955, a few thousand visitors flocked to the campus each year, mainly on open days. Today, the Science Portal, inaugurated a year ago, attracts nearly 400,000 visitors a year, making CERN the most visited site in Geneva and the surrounding area. Designed by the architect Renzo Piano, this 'portal', a large building in the shape of a component of the accelerator, has become CERN's education and communication centre for the general public. Visitors can discover three permanent interactive exhibitions (CERN, the Universe, the Quantum World), which are suitable for age 8 and up, as well as practical workshops in the laboratory or they can attend scientific events and shows that combine science and culture. The lucky ones (only around 10% of individual visitors) will also be able to visit the research facilities accompanied by a guide who is a member of CERN staff. As François Briard explains, "Unfortunately, we can't accommodate everyone in the laboratories. For reasons of safety and space, of course: but those who aren't so lucky don't leave disappointed, because they find what they came for in the portal. The success of the portal is answering a need: there is a real public interest in scientific issues." (We're talking about visitors from 170 countries!) Standing at the entrance to the site, the famous 'Globe' has long been a landmark for the general public. It is still in use: the large auditorium screens films and stages events, and also holds temporary exhibitions. "The space should host one or two exhibitions a year, either in-house or organised by outside institutions." A case in point? In collaboration with CERN, Geneva's Museum of Natural History is hosting an 'curious connections' exhibition in which visitors can discover some surprising parallels between particle physics and life and earth science, or how nature inspires technology.

Four missions

All of these activities reflect the four fundamental messages that CERN wants to get across, that correspond to the four missions it has set itself. Fundamental research, in addition to contributing to knowledge, sooner or later benefits society. François Briard points out that: "it wasn't by perfecting the candle as much as possible that we ended up with the electric light bulb. And when Thomson discovered the electron in 1899, nobody could have imagined the development of electronics". Secondly, many of the technologies developed for this fundamental research will be applied to everyday life: the web, scanners and energy transmission are just a few examples. The third message is that CERN has an important role to play in education. Finally, CERN remains, as its founders intended, a model of international collaboration.

To find out more and explore all the opportunities from a Belgian angle https://belgium.cern and to visit CERN: https: //visit.cern

70 YEARS / ANS CERN

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