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Higgs10: Ten things we've learned about the Higgs boson in the past ten years

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During the early hours of 4 July 2012, the foyer outside the main CERN lecture hall looked more like the lead-up to a rock concert than the main building of the world's leading particle physics lab... (Image: CERN)

Since its discovery in 2012, the Higgs boson has become one of the most powerful tools to probe our understanding of nature and, with that, examine some of the biggest open questions in physics today. But what have we physicists learned about the particle in the past ten years? A scalar particle exists in nature During the early hours of 4 July 2012, the foyer outside the main CERN lecture hall looked more like the lead-up to a rock concert than the main building of the world's leading particle physics lab. Dozens of groggy-eyed students slowly rolled up their sleeping bags, stretching out after a long night on the hard floor. A line hundreds long snaked through the foyer, around the restaurant and out the door. The excitement in the line was pulsating – even though the odds of making it into the auditorium were small, just to be there was a thrill. We had found it. A scalar particle existed in nature and 4 July 2012 was its debut. It's heavy and short-lived The first measurements ...

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Monica Dunford, André David

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A scalar particle exists in nature

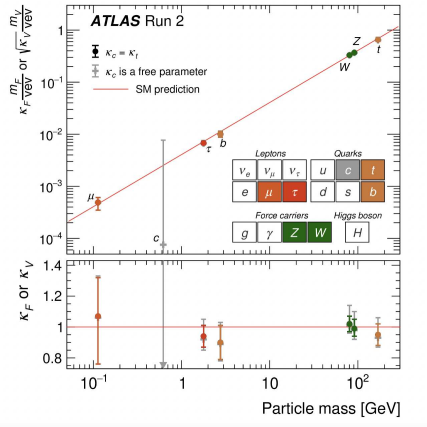
During the early hours of 4 July 2012, the foyer outside the main CERN lecture hall looked more like the lead-up to a rock concert than the main building of the world's leading particle physics lab. Dozens of groggy-eyed students slowly rolled up their sleeping bags, stretching out after a long night on the hard floor. A line hundreds long snaked through the foyer, around the restaurant and out the door. The excitement in the line was pulsating – even though the odds of making it into the auditorium were small, just to be there was a thrill. We had found it. A scalar particle existed in nature and 4 July 2012 was its debut.

It's heavy and short-lived

The first measurements of the new scalar particle, H(125), relied on two experimental channels: 4-lepton decays and 2-photon decays. Although these are not the most abundant decay channels, they are the best in determining the scalar particle's mass. The measured mass of about 125 GeV is maximally interesting: it is much heavier than was expected for popular models of supersymmetry, it puts the universe in a precarious position between being stable and metastable, and it has a rich phenomenology. In contrast to its heavy mass, the particle's lifetime is short; it is gone in 10^{-22} of a second.

It has no electric charge and no spin

The discovery of the H(125) via its decay to two photons immediately established that the new particle had no electric charge and strongly disfavoured it to have spin of 1. The exact spin of the new particle can be probed by examining the angular distributions of the final-state products in decays to two protons, two W bosons and two Z bosons. The spin 0 hypothesis has held up against a myriad of other possible assignments.



Measurements of the interaction strength between the H(125) and some of the Standard Model particles. The red line represents the Standard Model expectation. Recent progress has increased the reach to second generations fermions, like the muon, and first results concerning charm quarks. (Image: ATLAS)

It interacts with other bosons

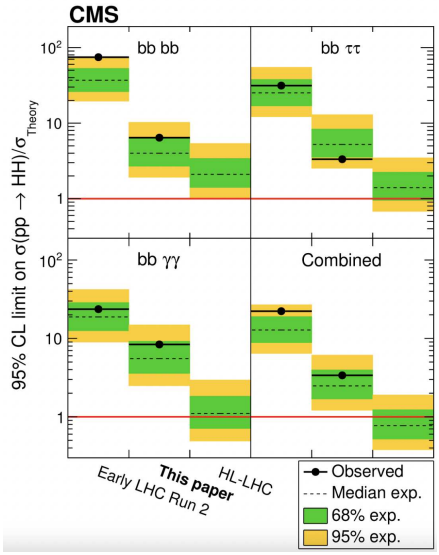
How the new boson interacts with other particles can be probed in both how it decays and how it is produced. With its discovery via decays to two photons and two Z bosons, it was readily concluded that the H(125) particle couples to bosons (in the case of photons, indirectly). This was further reaffirmed with measurements of decays to two W bosons. Furthermore, the production of the H(125) through couplings to bosons is measured when two vector bosons (force carriers such as W and Z bosons) fuse to produce the scalar or when the scalar radiates from a heavy boson (so-called V+H production).

It interacts with fermions

The Standard Model (SM) predicts that the strength of the coupling between the H(125) and other particles is proportional to their masses. Studying fermions tests these couplings over three fermion generations spanning three orders of magnitude of masses. For the heaviest fermions, all couplings have been measured – to top quarks (via measurements of ttH production), to beauty quarks and to tau leptons. Now, the experimental challenge lies in reaching the second generation, whose coupling with the Higgs boson is weaker. First evidence of decays to muons are emerging and both the ATLAS and CMS experiments are homing in on decays to charm quarks.

It could be a portal for dark matter

If dark matter consists of elementary particle(s), the SM simply does not predict any of them. If the H(125) and dark matter particles interact in nature, one possible signature is that of "invisible" Higgs boson decays. Such searches limit these decays to be lower than 15% and, consequently, set limits on interactions between this Higgs boson and possible dark matter particles and on the models that predict them. The SM predicts only a diminutive branching fraction of 0.1% – to four neutrinos.



Limits on Higgs boson pair production, a process that is sensitive to the Higgs boson self-interaction and the shape of the Higgs potential. Results are presented as a function of time along with projections for the full HL-LHC dataset that should provide enough sensitivity to challenge the SM prediction (red horizontal line). (Image: CMS)

It may touch the structure of the universe

The inclusion of the Brout-Englert-Higgs mechanism in the SM leads to precise predictions of how the universe evolved during one of its earliest stages, the electroweak epoch. A scalar field can influence several aspects of cosmology and even play a role in the observed matter–antimatter asymmetry in the universe. Depending on the shape of the vacuum potential, the universe could be metastable and decay, and one way to probe this shape is to measure the different ways in which the H(125) interacts with itself. One of the signatures that can be used to access this self-interaction is the production of Higgs boson pairs. While existing analyses of LHC data have already started to exclude some non-SM alternatives, more data and future accelerators – like Higgs factories – will allow us to explore this critical area.

It seems to be a lone child

The SM is minimalistic as far as scalars are concerned: it predicts one single elementary scalar particle, with distinct types of interactions. In straightforward extensions to the minimal SM, more than one Higgs boson is predicted, resulting in different sets of interactions. Therefore, a vigorous programme

of searches for other Higgs bosons – lighter and heavier, neutral and charged (and doubly charged) – has been undertaken. With other possibilities being strongly reduced, H(125) is presently the only scalar we know of in nature.

It's a new player in the team pushing past the SM

This Higgs boson is the newest player joining the team of particles that we use to understand the nature of the universe. Matter–antimatter asymmetry, dark matter, unification of all forces; these are some of the questions where a coherent and precise exploration of the properties of particles like the Z and W bosons, the beauty and top quarks and now the H(125), probe energy regimes far beyond those directly accessible at colliders. One possibility is to extend the SM with generic interactions that represent the effect of particles and interactions beyond the direct reach of present colliders. Making use of all the information from H(125) and its team members in a consistent fashion may point us in the direction of the next standard model.

It's just the beginning

While we have established several properties and interactions of the H(125), much remains to be learned about this Higgs boson. Far from just being the last prediction from the SM, the discovery of the H(125) and its singular scalar quality provides an important instrument to further our understanding of nature at its deepest. Is there really only one Higgs boson in nature? Do its properties differ from the SM predictions? Can it show us what is beyond the electroweak scale? Might it interact with dark matter particles? Will we be able to use it to measure the shape of the vacuum potential of the universe?

Ten years ago, before the discovery of this formidable tool, these questions were beyond our reach. The H(125) has opened new doors, inviting us to walk through.

Monica Dunford, André David

Exceptional ATLAS collaborators honoured at the 2022 Outstanding Achievement Awards

The ATLAS collaboration held its sixth Outstanding Achievement Awards ceremony at CERN on 23 June 2022

(Image: CERN)

The ATLAS collaboration held its sixth Outstanding Achievement Awards ceremony at CERN on 23 June 2022. Once every two years, these awards recognise the invaluable technical work made across the collaboration in all areas.

After an extensive review of 84 nominated candidates, the ATLAS Collaboration Board Chair Advisory Group, acting as the Awards Committee, decided to assign awards to four individuals and five groups across diverse categories. The winners specialised in the fields of detector operation, upgrade, software, outreach, computing and combined performance during the period from August 2020 to January 2022.

"It was very difficult to select among the many excellent nominations," highlight Hans-Christian Schultz-Coulon and Oleg Solovyanov, Awards Committee co-Chairs. "In particular, concerning the Muon New Small Wheel (NSW) award, hundreds of dedicated people did a tremendous job getting the project ready in time. These awards are intended to acknowledge a small fraction of the many efforts made throughout the collaboration."

The excitement surrounding this year's awards was particularly strong, as it was the first time in over two years that the winners could be applauded in person. Watching the teams walk up to the podium to receive their plaque and certificate, the future of the ATLAS collaboration seems bright!

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For outstanding contributions to the integration of large-radius tracking into the standard ATLAS reconstruction: Bingxuan Liu (Simon Fraser University), Matthias Danninger (Simon Fraser University), John Stupak (University of Oklahoma), Robin Newhouse (University of British Columbia), Giuliano Gustavino (University of Oklahoma, CERN) and Jackson Carl Burzynski (University of Massachusetts Amherst, Simon Fraser University):

(Image: CERN)

For outstanding contributions to the completion of the NSW integration and surface commissioning within the LS2 schedule: Artur Coimbra (CERN), Aimilianos Koulouris (National Technological University of Athens, University of Aegean, CERN), Luigi Longo (CERN, Università del Salento), Alexander Naip Tuna (CERN), Rimsky Alejandro Rojas Caballero (Federico Santa María Technical University, University of Victoria), Olga Zormpa (National Centre for Scientific Research "Demokritos"), Chiara Arcangeletti (University of Victoria), Rongkun Wang (Harvard University, University of Chicago and University of Science and Technology of China), Liang Guan (University of Michigan), Siyuan Sun (University of Michigan) (not pictured), Emanuele Romano (INFN Sezione di Pavia), Estel Perez Codina (TRIUMF), Alam Toro (TRIUMF), Gerardo Vasquez (University of Victoria), Camila Pazos (Brandeis University), Giada Mancini (National Laboratory of Frascati) and Polyneikis Tzanis (National Technical University of Athens):

(Image: CERN)

For outstanding contributions to the ATLAS outreach activities: Muhammad Alhroob (University of Oklahoma), Katarina Anthony (University of Udine), Steven Goldfarb (University of Melbourne), Clara Nellist (Radboud University) (not pictured), Elise Maria Le Boulicaut (Duke University) and Sascha Mehlhase (Ludwig-Maximilians-Universität München) (not pictured):

(Image: CERN)

***This list is not exhaustive**. See all the awards on the ATLAS website (https://atlas.cern/updates/news/outstanding-achievement-awards-2022).*

ATLAS collaboration

A summer of scientific encounters with CERN

This summer, CERN has organised several events for the population of the Greater Geneva area

The 2022 CineGlobe film festival at CERN (Image: CERN)

July is not yet over, but summer 2022 has already seen a whole variety of local scientific events involving CERN – so it's time for a round-up.

The events began at the end of June with the 11th edition of the CineGlobe international science-inspired film festival, around the theme "parallel worlds".

CineGlobe 2022 braved unpredictable weather conditions to entertain festivalgoers with 52 short films from 17 countries, across four categories (fiction, documentary, youth and immersive). As well as the films, the five days were packed with a series of workshops, virtual reality experiences and masterclasses for the enjoyment of some 1400 visitors of all ages. You can see photos from the festival on the CineGlobe website (https://cineglobe.ch/gallery-2022/).

The festival concluded on the evening of the 10th anniversary celebrations of the discovery of the Higgs boson, with an event attended by the CERN Director-General, Fabiola Gianotti. Three similar cinema and discussion evenings had already been held in the local area.

All the winning films can be viewed, free of charge, on the online platform online.cineglobe.ch (https://online.cineglobe.ch/), until 12 August 2022. Don't miss out!

The CERN stand at the 2022 edition of Nuit de la science (Image: CERN)

The following weekend, *Nuit de la science* gave CERN another opportunity to meet the public. The 13th edition of the event, which was organised by the Geneva History of Science Museum, offered curious visitors of all ages the chance to learn about science in a friendly, fun atmosphere.

CERN had a stand called "*Rencontre avec l'invisible*" *(Encounter the invisible)*, where a team of twenty volunteers ran a non-stop series of activities, two of which were on the tenth anniversary of the discovery of the Higgs boson.

Many thanks to all the CERN volunteers who helped run both these events and were exemplary ambassadors of the Organization!

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***Do you live in the Greater Geneva area? Would you like to take part in activities organised by CERN?** Visit voisins.cern* (https://voisins.cern/fr) *to find out about our upcoming events and what we offer to the local community.*

***Are you affiliated with CERN? Would you like to be a volunteer?** Contact the CERN events team* (mailto:public.events@cern.ch) *to find out about our upcoming calls for volunteers!*

LHCb 2022 PhD Thesis and Early-Career Scientist Awards

On 14 June, LHCb, which comprises over 1000 authors and 400 PhD students, announced the winners of the 2022 PhD Thesis and Early-Career Scientist Awards

The Thesis and Early-Career award winners during the ceremony held in the Globe of Science and Innovation. They are accompanied by LHCb spokesperson Chris Parkes and awards committee members Silvia Gambetta and Tomasz Skwarnicki. (Image: LHCb)

On 14 June, LHCb, which comprises over 1000 authors and 400 PhD students, announced the winners of the 2022 PhD Thesis and Early-Career Scientist Awards. The LHCb Thesis Awards recognise excellent PhD theses and additional work that have made an exceptional contribution to LHCb. In parallel, the Early-Career Scientist prizes are awarded to recognise outstanding achievements of early-career scientists for the benefit of LHCb.

This year's winners of the Thesis prize are Giulia Tulci (University of Pisa), Guillaume Pietrzyk (http://cds.cern.ch/record/2803301?ln=en) (EPFL) and Mengzhen Wang (http://cds.cern.ch/record/2806799/) (Tsinghua).

Maarten van Veghel (Groningen), Saverio Mariani (Florence), Sevda Esen (Zurich), Valeriia Zhovkovska (Orsay), Maarten Van Dijk (Lausanne), Fabio Ferrari (Bologna) and Vladyslav Orlov (CERN) were awarded the Early-Career prize.

"The Thesis prize is awarded to students who have performed exceptional research in their PhD and contributed fully to the collaboration," explains Ulrik Egede, chair of the Thesis committee. "This year's winners worked in charm CP violation and mixing and complex amplitude analyses for spectroscopy but also contributed to the trigger, novel FPGA-based tracking, outreach and the construction of the Upgrade I tracker."

The prizes for outstanding contributions by early-career scientists were awarded for a wide range of activities. "The prizes this year recognised improvements to electron identification and reconstruction, real-time reconstruction of beam–gas collisions, the persistence of the data produced by the trigger and the development of LHCb's new luminometer system," says Irina Nasteva, chair of the Early-Career Prize committee.

Irina and Ulrik agreed that the standard of the work carried out by the many individuals nominated for the prizes was very high and demonstrated the strength and breadth of the work performed by the younger colleagues at the experiment.

LHCb collaboration

CMS 2021 Award and Thesis Award winners and 2022 Young Researchers Prize

The CMS collaboration is proud to have been successfully advancing knowledge, scientific research and technology for years, and all this would certainly not have been possible without the contribution of each of its members

CMS PhD Thesis Award winners 2021

(Image: CMS)

Each year, the CMS collaboration recognises exceptional PhD student work with the Thesis Award. To select the best theses of 2021, a Thesis Award committee of 29 CMS scientists was appointed by the Collaboration Board (CB) Chair.

From the 25 nominations received this year, three winners were selected by the committee and then endorsed by the CB: Michael Andrews (Carnegie Mellon University), Matteo Bonanomi (LLR – *Institut Polytechnique de Paris*) and Viktoria Hinger (Institute of High Energy Physics of the Austrian Academy of Sciences and Vienna University of Technology).

The evaluation was based on the originality of the thesis author's personal contributions, clarity, quality of content, and impact within CMS and in the broader context of high-energy physics.

Read more on the CMS collaboration's website (https://cms.cern/news/cms-phd-thesis-award-winners-2021).

CMS Young Researchers Prize 2022

(Image: CMS)

The CMS collaboration also recognises the efforts and outstanding achievements of its younger members, honouring them with the CMS Young Researchers Prize. This endorsement of their skills and dedication not only paves the way for their future careers but also motivates other young researchers to excel in the field.

Each year since 2012, at least three members have been awarded the prize, which comprises cash and a memento, for their sustained contributions and dedication in any area of the collaboration's activities.

Congratulations to this year's prize recipients: Davide Ceresa (CERN), Rajdeep Mohan Chatterjee (University of Minnesota), Jan Kieseler (CERN) and Yuta Takahashi (University of Zurich).

Read more on the CMS collaboration's website (https://cms.cern/news/cms-young-researchers-prize-2022).

CMS Award 2021

(Image: CMS)

The CMS collaboration is proud to have been successfully advancing knowledge, scientific research and technology for years, and all this would certainly not have been possible without the contribution of each of its members.

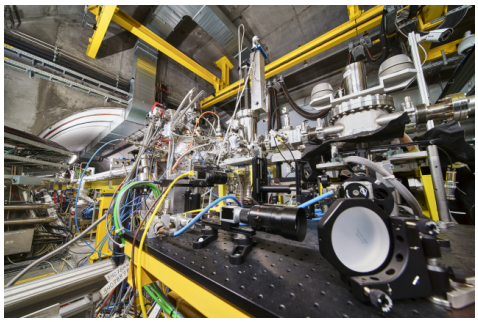
The CMS Award, which honours dedicated members of the CMS collaboration for their significant contributions and outstanding work, has been awarded every year since 2000. Nominations can be made by any CMS member, for work in a variety of fields, ranging from detector systems and coordination to outreach. The awardees are selected by a dedicated committee of five members, and the selection is then endorsed by the CMS Collaboration Board (CB) Chair.

To find out more about each of the forty-seven awardees who made incredible contributions in 2021, visit the CMS collaboration's website (https://cms.cern/news/cms-award-2021)!

CMS collaboration

AWAKE sows the seeds of controlled particle acceleration using plasma wakefields

The AWAKE collaboration has successfully seeded the self-modulation of a proton bunch, to control and stabilise plasma waves that can accelerate electrons with record gradients



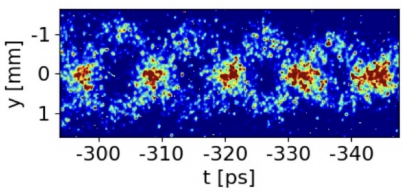
The AWAKE facility at CERN (Image: CERN)

From the tunnel that hosted the now-retired CERN Neutrinos to Gran Sasso (CNGS) facility, AWAKE (Advanced Wakefield Experiment) is looking to revolutionise the field of particle acceleration. The 23-institute-strong collaboration aims to introduce a viable and more efficient alternative to traditional radiofrequency acceleration – with charged particles (in this case, electrons) "surfing" on the waves of a plasma field (or "wakefield") generated by a short, intense proton bunch fired through the plasma.

While plasma wakefields have been shown to produce acceleration gradients up to 1000 times superior to those achieved with radiofrequency cavities, their use in high-energy and particle physics experiments has been limited by the impractical nature of current techniques, which require the juxtaposition of several plasma sources to achieve high energies. AWAKE, on the other hand, is the first experiment to investigate the use of protons, rather than lasers or electron beams, to drive the plasma. To create the appropriate wakefields in the plasma for efficient electron acceleration, the long proton beam extracted towards AWAKE from the CERN Super Proton Synchrotron (SPS) needs to be broken up into smaller bunches in a process known as modulation. In a Physics Review Letters paper (https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.129.024802) published on 6 July, the collaboration showed how such a modulation of the proton beam can be controlled by seeding the process with relativistic electrons – a crucial step towards a workable wakefield-based accelerator.

To grasp the concept of seeding, it is necessary to delve into the technology behind AWAKE. The proton beam from the SPS is injected into a vapour source containing rubidium, which is transformed into a plasma (a state of ionised gas) by a laser pulse that precedes the proton bunch. A short electron bunch can then be injected into the proton wake to be accelerated to high energy. For the electrons to ride the waves of the plasma efficiently, the length of the proton bunch needs to equal the plasma wavelength. Luckily, the long proton beam from the SPS automatically breaks up into such small bunches when propagating through the plasma (it "self-modulates"), which is what allowed AWAKE to demonstrate the first acceleration of electrons using this technique in 2018 (https://home.cern/news/news/experiments/awake-successfully-accelerates-electrons).

"To preserve the reproducibility of the entire modulated proton beam, and thereby its ability to accelerate electrons, we devised a technique to control exactly when the modulation begins: we seed it with an initial electron bunch, different from the one that is targeted for acceleration. By injecting this bunch several hundreds of picoseconds before the protons enter the plasma, the front of the proton beam modulates in sync, creating a regular wakefield whose phase can be precisely measured", explains Livio Verra, a physicist in the Lepton Accelerators and Facilities (ABP-LAF) section in the Beams department and the first author of the paper. Injection of the electron bunch whose acceleration the experiment is targeting can then be timed perfectly. The acceleration therefore becomes sustainable and controlled, producing an unparalleled overall gradient.



The figure shows the sum of ten consecutive time-resolved images of the self-modulated proton bunch. The bunch travels from left to right. The timing of the modulation is determined by the preceding electron bunch and it is reproducible from event to event. (Image: CERN)

Edda Gschwendtner, the AWAKE project leader at CERN, looks to the future with optimism: "The ultimate success of the wakefield technology developed by AWAKE rests on the feasibility of seeding the proton bunch self-modulation. With this milestone now achieved, the collaboration is ready to tackle our next challenges, starting with the commissioning of a new plasma source". This source, which is being developed by the Max Planck Institute (https://www.mpp.mpg.de/en/) in Munich, Germany, will generate a plasma with two regions of different density (and, therefore, of different temperature), which will further increase the overall acceleration gradient with respect to that achieved so far. The introduction of a new plasma source is only one aspect of the rich programme of studies to be performed during AWAKE's second physics run.

CERN's Long Shutdown 3 will see the dismantling of the last remaining components of the CNGS facility. AWAKE plans to make the most of this opportunity, using the freed space for the next phases of the experiment. These phases will focus on accelerating electrons to high energy while preserving the beam quality, a prerequisite for future applications in particle physics. In parallel, the collaboration will continue to develop scalable plasma source technologies, such as discharge and helicon plasma cells (https://home.cern/news/news/experiments/awake-more-plasma-more-acceleration), which are key to increasing the final energy reach. Once these technologies have been validated, and controlled electron acceleration has been demonstrated, it will open the door to future high-energy applications, such as fixed-target experiments searching for dark matter.

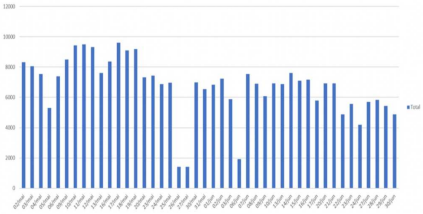
Thomas Hortala

Bike to Work 2022 wraps up with CERN first in French-speaking Switzerland

With participation at pre-COVID levels, the CERN community pedalled its way to the top of the competition

The "Critical Mass" ride on 16 June 2022 (Image: CERN)

It's been 10 years since CERN joined Bike to Work, a national initiative to promote health across companies based in Switzerland, organised by the PRO VELO association. The Laboratory has never missed an edition since 2012. In 2022, 941 CERN cyclists pedalled 62% of their working days during the campaign, propelling CERN to first place not only in Romandy, but also in the category of companies with 1000 to 4999 employees. The 252 CERN teams cycled, in total, a distance roughly equivalent to five times the length of the equator. To top it all off, about a hundred *cernois* participated in a "Critical Mass" ride around the Meyrin site on 16 June to celebrate the virtues of cycling.



Total kilometres cycled per day by the CERN community as part of the Bike to CERN campaign (Image: CERN)

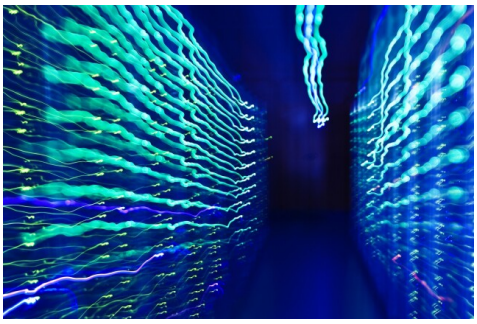
In the context of the COVID-19 pandemic and the associated public transportation restrictions, cycling has been surging across the Organization: it accounted for about 13% of all commutes in 2021. Challenges such as Bike to Work and Bike to CERN have helped to normalise cycling as a daily means of transport, as have individual initiatives: Benoît D'Hulster, who has taken part in all Bike to Work editions for the last eight years, has recorded a cycling distance of 40 000 km, equivalent to the circumference of the Earth, after cycling to CERN from Annemasse every working day for the past 800 days. His message to the CERN community is clear: "Do not hesitate – opt for the bike! The benefits, both physical and mental, are countless".

Along with CERN's annual participation in Bike to Work, the Organization is striving to boost road safety for cyclists by improving its soft-mobility infrastructure and negotiating with local authorities. The new bike lanes and bike sheds on the CERN sites have already made life easier for hundreds of cyclists across the Organization.

Reema Altamimi

CERN welcomes INFN and IIT as new members of its IBM Quantum Network hub

Two European research institutes have recently signed an agreement to become the latest members of CERN's hub in the IBM Quantum Network.



(Image: CERN)

Two European research institutes – INFN (*Istituto Nazionale di Fisica Nucleare*) and IIT (*Italian Institute of Technology*) – have recently signed an agreement to become the latest members of CERN's hub in the IBM Quantum Network (https://www.ibm.com/quantum/network). The move will see both institutes working closely with CERN to help investigate the full potential of the nascent quantum computing technology, sharing access to IBM's fleet of more than 20 quantum computers accessible on the cloud.

The next generation of computing technology holds great promise for supporting scientific research. Quantum computers may offer the necessary tools to perform more complicated computing tasks than ever and search for more deeply hidden patterns, thus helping to produce technical breakthroughs and advance scientific understanding of the universe. Having members like INFN and IIT joining the hub will help CERN – through its Quantum Technology Initiative (QTI) – to drive investigations into how quantum technologies can support the LHC research community, as well as other scientific fields.

"The mission of the CERN hub is to explore promising applications of quantum computing for high-energy physics and beyond, together with academia and research institutes in the CERN Member States," says Alberto Di Meglio, coordinator of the CERN Quantum Technology Initiative. "We are pleased to have INFN and IIT joining us now in the effort to foster quantum developments, exchange knowledge and innovation, and deploy R&D projects for the benefit of all."

"The signing of this agreement with CERN is another important step for INFN in the framework of its activities on quantum information science (QIS) and quantum technologies (QT)," says Valter Bonvicini, coordinator of the INFN quantum initiatives and member of the Advisory Board of the CERN QTI. "The agreement will provide the INFN community, both theoretical and experimental, with fast access to high-quality machines within the IBM Quantum Network. INFN considers teaming up with other key players sharing scientific interests or technology options in the field of QIS/QT as a very important aspect".

Uniting endeavours and establishing joint activities will help members of the hub to explore the complex nature of quantum computing technology, with a view to unlocking the full potential it could offer to speed up computationally expensive tasks.

"Quantum computing represents one of the concrete applications of quantum mechanical laws. It is fascinating to witness how quantum information evolves, along with the many quantum computational experiments that may have a real advantage for specific applications," says Andrea Cavalli, Associate Director for Computational Sciences and Vice-Scientific Director, *Istituto Italiano di Tecnologia*. "Building quantum computers large enough to supersede the current high-performance-computing (HPC) infrastructures is a goal of quantum computing technologists. Very likely, we will go through a hybrid era where classical computing and quantum

computing will work together, where certain algorithms will be more suited for quantum machines and classical HW architectures will solve others more efficiently. Certainly, an institute like IIT, which has always been at the edge of new technologies, will try to play a key role in the quantum revolution we are witnessing."

Following the agreement, the members of the hub are now planning a joint technical kick-off event later this year, hosted at CERN with the support of the CERN Quantum Technology Initiative.

About CERN QTI

The CERN Quantum Technology Initiative (CERN QTI) is a comprehensive R&D and knowledge-sharing initiative to investigate applications of quantum technologies for high-energy physics and beyond. Given CERN's increasing information and communications technology and computing demands, as well as the significant national and international interest in quantum-technology activities, CERN QTI aims to provide dedicated mechanisms for the exchange of both knowledge and innovation.

Find out more at quantum.cern (https://quantum.cern/) and on Twitter (https://twitter.com/CERNquantum) and LinkedIn (https://www.linkedin.com/showcase/cern-quantum-technology-initiative-cern-qti/?viewAsMember=true).

Link to the roadmap: https://doi.org/10.5281/zenodo.5553774 (https://doi.org/10.5281/zenodo.5553774)

HL-LHC magnet endurance test further confirms niobium–tin's resilience

A full-size, US-produced HL-LHC quadrupole magnet based on niobium–tin technology has passed a critical endurance test, another step towards confirming the technology's viability inside accelerators

The MQXFA05 magnet enters the vertical cryostat at the Brookhaven National Laboratory for its endurance test (Image: BNL)

As the CERN relay race tested the stamina of a community of determined accelerator enthusiasts on the outskirts of Geneva, a different sort of physical trial had just concluded across the ocean: the endurance test of a full-size superconducting magnet based on niobium–tin (Nb_3Sn) technology at Brookhaven National Laboratory, which yielded positive results, heralding clearer skies for the High-Luminosity LHC (HL-LHC) project.

The magnet in question is one of the triplet quadrupoles that have been produced and tested in the United States as part of a collaboration with CERN that foresees the contribution of a total of 20 magnets for the HL-LHC. These 4.2-metre-long superconducting magnets, along with their longer counterparts currently being prototyped at CERN, will focus proton beams more tightly around the ATLAS and CMS collision points to allow the ten-fold increase in integrated luminosity (the number of collisions) targeted by the HL-LHC.

Cold, warm, cold, warm, cold, warm … over the course of two years, the quadrupole endured five thermal cycles, three of which took place in the spring of this year. Each of these cycles subjects the magnets to a 300 °C excursion in temperature: down to 1.9 K – the temperature needed to unleash their superconducting abilities – when in operation and back up to room temperature, to which magnets are regularly brought for technical operations. This process is known to be demanding for magnets, whose materials expand and contract differently with the temperature change. The niobium–tin quadrupole went through five of these thermal cycles without any sign of performance degradation.

Thermal cycles are just one part of the picture: resilience to quenches makes up the other part of the endurance requirements, as tested at Brookhaven. A quench is an irreversible transition from superconducting to normal state, during which the energy stored in the magnet has to be safely dissipated throughout the whole winding, bringing it to room temperature. In April and May 2022, concurrently with the last two thermal cycles, the magnet underwent two provoked quenches every working day, for a total of fifty quenches in two months. Magnets are designed to be able to withstand such events, but testing their resilience is key to ensuring smooth operation of the accelerator. And after the quench heater was fired fifty times on the innocent quadrupole at Brookhaven, it turned out good as new.

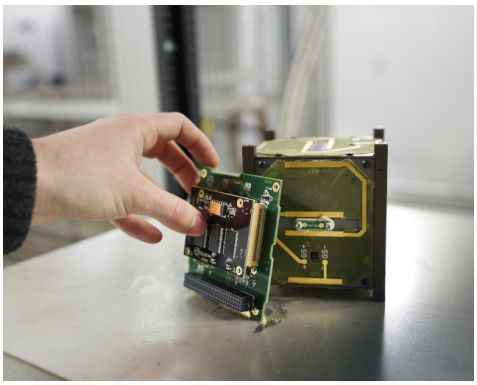
"This is the first endurance test successfully carried out on an Nb_3Sn 4.2-m-long magnet, and I am happy to announce that the results are further validating this technology's resilience and sustainability", explains Giorgio Apollinari, head of the Accelerator Upgrade Project (AUP) at Fermilab. Besides establishing the magnet's endurance, the tests revealed that it was able to maintain its operational peak field of 11.4 T up to 4.5 K, which gives the magnet a margin of operation far exceeding the requirements imposed by the collision debris heat coming from the ATLAS and CMS experiments.

"We asked that these tests be performed earlier than anticipated in the original schedule because of the special scrutiny under which the niobium–tin technology is standing. Indeed, the superconducting abilities of this alloy are higher than those of the niobium–titanium currently used in the LHC, but its fragility has been a lingering concern", explains Ezio Todesco, in charge of the HL-LHC interaction region magnets. "We know that our American friends have worked tirelessly to finish the job before the deadline of Memorial Day. For this, for their responsiveness and adaptability, we are extremely grateful", adds Ezio. The openness and trust between the European and American scientific communities was key to delivering this achievement, and the decision to build the same magnets on both sides of the ocean proved once more to be the right way to go, as both sides could learn from the other's achievements and challenges. "And we're still on speaking terms!" laughs Giorgio.

Thomas Hortala

CERN tech in space: the first CERN-driven satellite has been successfully launched

With the launch of the CELESTA satellite for radiation monitoring in space, CERN shows its expertise in the field of radiation effects on electronics



This picture shows the CELESTA Radiation Model. It was taken whilst inside the CHARM radiation testing facility at CERN. (Image: CERN)

CELESTA, the first CERN-driven satellite, successfully entered orbit during the maiden flight of Europe's Vega-C launch vehicle. Launched by the European Space Agency from the French Guiana Space Centre (CSG) at 13.13 UTC on 13 July 2022, the satellite deployed smoothly and transmitted its first signals in the afternoon.

Weighing one kilogram and measuring 10 centimetres on each of its sides, CELESTA (https://kt.cern/aerospace/celesta) (CERN latchup and radmon experiment student satellite) is a 1U CubeSat designed to study the effects of cosmic radiation on electronics. The satellite carries a Space RadMon (https://kt.cern/aerospace/spaceradmon), a miniature version of a well-proven radiation monitoring device deployed in CERN's Large Hadron Collider (LHC). CELESTA has been sent into an Earth orbit of almost 6000 kilometres. "Right in the middle of the inner Van Allen belt, CELESTA will survey an unusual orbit where radiation levels are at their highest," explains Markus Brugger, Head of the CERN Experimental Areas group and initiator of both the CHARM and CELESTA projects in the context of the R2E (Radiation to Electronics) initiative.

The Space RadMon is a flagship example of how CERN technologies can have applications beyond particle physics experiments. "Based entirely on standardised, ultra-sensitive components selected and calibrated by CERN, and mostly in CERN facilities, the Space RadMon is a lightweight and low-power instrument, ideal for future risk-tolerant space missions," says Ruben Garcia Alia, R2E project leader. "If CELESTA is successful, the Space RadMon could even be adapted to satellite constellations as a predictive maintenance tool – to anticipate the necessary renewal of satellites."

A radiation model of the CELESTA satellite was also tested in CHARM (https://kt.cern/technologies/charm-mixed-fields), a CERN mixed-field facility capable of reproducing, to a large extent, the radiation environment of low Earth orbit. The mission will be an important validation of this capability at the facility. "Capable of testing satellites all at once, rather than component by component, CHARM is a unique installation worldwide, remarkably different from other irradiation test facilities. It offers a simple, low-cost alternative and the possibility to assess system-level effects," says Salvatore Danzeca, CHARM facility coordinator.

The success of this satellite is the result of a fruitful partnership between CERN and the University of Montpellier (https://www.umontpellier.fr/en/), which involved many students from both institutions and radiation effect specialists from CERN. CELESTA is based on the CSUM (https://csum.umontpellier.fr/en/news/) radiation tolerant platform. It will be operated from the CSUM control centre. The European Space Agency (https://www.esa.int/) provided the launch slot in the framework of its small satellite programme.

"On a mission to make space more accessible, CELESTA is an exciting example of how CERN expertise can have a positive impact on the aerospace industry. With this mission, CERN displays its low-cost solutions for measuring radiation and testing satellites against it – thus providing universities, companies and startups with the means to realise their space ambitions," concludes Enrico Chesta, CERN's Aerospace and Environmental Applications Coordinator in the Knowledge Transfer group.

Further information:

Video of the launch (https://www.esa.int/ESA_Multimedia/Videos/2022/07/Vega-C_liftoff)

More about the aerospace applications (https://kt.cern/aerospace)

Promising start for future environmental applications of CERN technologies

On 27 June, the CIPEA Innovation Day welcomed 15 innovative project proposals reflecting the CERN community's commitment to tackling environmental challenges

The CIPEA Innovation Day brought together experts from all CERN technical departments. (Image: CERN)

The CIPEA Innovation Day (https://indico.cern.ch/event/1166768/) was held at CERN on 27 June. CIPEA, which stands for CERN Innovation Programme on Environmental Applications (https://kt.cern/environment/CIPEA), was launched in March 2022 with a virtual kick-off event (https://indico.cern.ch/event/1132085/) that was a direct, open call for contributions from the whole CERN community. After an intense three-month ideation phase, about 20 experts from different departments pitched innovative projects setting out how the Organization's technologies, facilities and expertise could be used to achieve a positive impact on the global environment.

Renewable and low-carbon energy, clean transportation and future mobility, climate change and pollution control, sustainability and green science – these topics were all enthusiastically addressed during the day. CERN's experts brilliantly demonstrated how the diversity of the Laboratory's technologies translates into a wide range of potential initiatives: accelerator systems for improving clean-tech and reducing pollution, vacuum technologies for renewable energy large-scale distribution, machine-learning algorithms for climate modelling, and innovative systems for reducing greenhouse gas emissions at CERN and beyond.

"Our experts' work and vision show that CERN can play a significant role in tackling environmental challenges on a global scale: this is not something to be taken for granted.

We are proud to be part of such a creative community," concluded Enrico Chesta, CIPEA Coordinator in the Knowledge Transfer (KT) group.

By the end of the day, 15 highly interesting and potentially impactful projects had been discussed and celebrated. In many cases, the projects involve one or several external partners (academic or industrial) who have shown interest in contributing to the implementation of the project.

This implementation will be undertaken in the coming phase of CIPEA, which will start with the definition of suitable support strategies on a case-by-case basis. Participants will explore the option of bundling new ideas and ongoing projects in focused application areas in order to optimise resources.

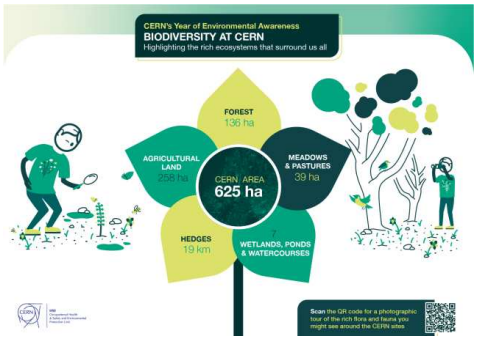
Some of the proposed CIPEA ideas have clear market potential and are therefore eligible for the KT Fund (https://kt.cern/news/news/cern/kt-fund-and-ma-budget-bridging-gap-between-cern-research-and-society) programme, which this year will focus on environmental applications (the KT Fund selection committee is still accepting applications until 8 August).

The CERN Knowledge Transfer group would like to thank the CERN community for its active participation in the CIPEA call and praises the commitment and inventiveness of those who took part in the ideation phase with such enthusiasm and creativity.

Antoine Le Gall

Environmental awareness: Biodiversity at CERN

This last infographic in the series highlights the diverse ecosystems that are found around CERN, host to a variety of species of flora and fauna



(Image: CERN)

This last infographic in the series highlights the diverse ecosystems that are found around CERN, host to a variety of species of flora and fauna. Let us all contribute to preserving this biodiversity that adds to the richness of our Organization.

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This infographic is part of the series "CERN's Year of Environmental Awareness"

The third run of the Large Hadron Collider has successfully started

A round of applause broke out in the CERN Control Centre on 5 July at 4.47 p.m. CEST when the Large Hadron Collider (LHC) detectors started recording high-energy collisions at the unprecedented energy of 13.6 TeV

Celebrations at the CERN control centre (CCC) to mark the start of LHC Run 3 (Image: CERN)

A round of applause broke out in the CERN Control Centre on 5 July at 4.47 p.m. CEST when the Large Hadron Collider (LHC) detectors switched on all subsystems and started recording high-energy collisions at the unprecedented energy of 13.6 TeV, ushering in a new physics season. This feat was made possible thanks to the operators who had worked around the clock since the restart of the LHC in April (https://home.web.cern.ch/news/news/accelerators/large-hadron-collider-restarts) to ensure the smooth beginning of these collisions with higher-intensity beams and increased energy.

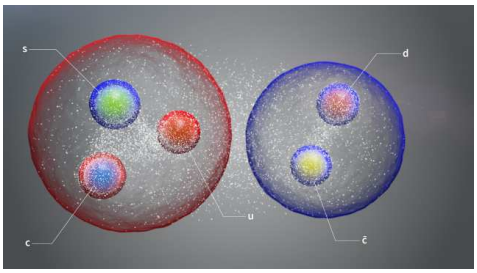
After over three years of upgrade and maintenance work, the LHC is now set to run for close to four years at the record energy of 13.6 trillion electronvolts (TeV), providing greater precision and discovery potential. Increased collision rates, higher collision energy, upgraded data readout and selection systems, new detector systems and computing infrastructure: all these factors point to a promising physics season that will further expand the already very diverse LHC physics programme!

Pictures of the day are available here (https://cernbox.cern.ch/index.php/s/EacPckkCMFcJ8ya).

Videos of the event are accessible here (https://newsdirect.ebu.ch/nodes/uuid:b212196f-4d36-4527-83be-73f0c2b97a9f/details).

LHCb discovers three new exotic particles

The collaboration has observed a new kind of “pentaquark” and the first-ever pair of “tetraquarks”



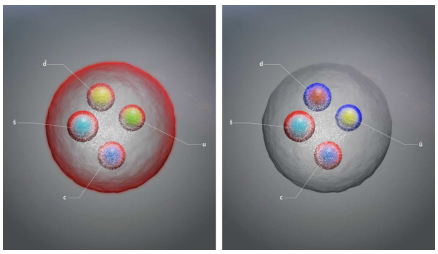
The new pentaquark, illustrated here as a pair of standard hadrons loosely bound in a molecule-like structure, is made up of a charm quark and a charm antiquark and an up, a down and a strange quark (Image: CERN)

The international LHCb (https://home.cern/science/experiments/lhcb) collaboration at the Large Hadron Collider (https://home.cern/science/accelerators/large-hadron-collider) (LHC) has observed three never-before-seen particles: a new kind of “pentaquark” and the first-ever pair of “tetraquarks”, which includes a new type of tetraquark. The findings, presented today at a CERN seminar (https://indico.cern.ch/event/1176505/), add three new exotic members to the growing list (https://www.nikhef.nl/~pkoppenb/particles.html) of new hadrons found at the LHC. They will help physicists better understand how quarks bind together into these composite particles.

Quarks are elementary particles and come in six flavours: up, down, charm, strange, top and bottom. They usually combine together in groups of twos and threes to form hadrons such as the protons and neutrons that make up atomic nuclei. More rarely, however, they can also combine into four-quark and five-quark particles, or “tetraquarks” and “pentaquarks”. These exotic hadrons were predicted by theorists at the same time as conventional hadrons, about six decades ago, but only relatively recently, in the past 20 years, have they been observed by LHCb and other experiments.

Most of the exotic hadrons discovered in the past two decades are tetraquarks or pentaquarks containing a charm quark and a charm antiquark, with the remaining two or three quarks being an up, down or strange quark or their antiquarks. But in the past two years, LHCb has discovered different kinds of exotic hadrons. Two years ago, the collaboration discovered a tetraquark made up of two charm quarks and two charm antiquarks, and two “open-charm” tetraquarks consisting of a charm antiquark, an up quark, a down quark and a strange antiquark. And last year it found the first-ever instance of a “double open-charm” tetraquark with two charm quarks and an up and a down antiquark. Open charm means that the particle contains a charm quark without an equivalent antiquark.

The discoveries announced today by the LHCb collaboration include new kinds of exotic hadrons. The first kind, observed in an analysis of “decays” of negatively charged B mesons, is a pentaquark made up of a charm quark and a charm antiquark and an up, a down and a strange quark. It is the first pentaquark found to contain a strange quark. The finding has a whopping statistical significance of 15 standard deviations, far beyond the 5 standard deviations that are required to claim the observation of a particle in particle physics.



The two new tetraquarks, illustrated here as single units of tightly bound quarks. One of the particles is composed of a charm quark, a strange antiquark and an up quark and a down antiquark (left), and the other is made up of a charm quark, a strange antiquark and an up antiquark and down quark (right) (Image: CERN)

The second kind is a doubly electrically charged tetraquark. It is an open-charm tetraquark composed of a charm quark, a strange antiquark, and an up quark and a down antiquark, and it was spotted together with its neutral counterpart in a joint analysis of decays of positively charged and neutral B mesons. The new tetraquarks, observed with a statistical significance of 6.5 (doubly charged particle) and 8 (neutral particle) standard deviations, represent the first time a pair of tetraquarks has been observed.

“The more analyses we perform, the more kinds of exotic hadrons we find,” says LHCb physics coordinator Niels Tuning. “We’re witnessing a period of discovery similar to the 1950s, when a ‘particle zoo’ of hadrons started being discovered and ultimately led to the quark model of conventional hadrons in the 1960s. We’re creating ‘particle zoo 2.0’.”

“Finding new kinds of tetraquarks and pentaquarks and measuring their properties will help theorists develop a unified model of exotic hadrons, the exact nature of which is largely unknown,” says LHCb spokesperson Chris Parkes. “It will also help to better understand conventional hadrons.”

While some theoretical models describe exotic hadrons as single units of tightly bound quarks, other models envisage them as pairs of standard hadrons loosely bound in a molecule-like structure. Only time and more studies of exotic hadrons will tell if these particles are one, the other or both.

Further information:

Read more on the LHCb (https://lhcb-outreach.web.cern.ch/2022/07/05/observation-of-a-strange-pentaquark-a-doubly-charged-tetraquark-and-its-neutral-partner/) website.

Illustrations: https://cds.cern.ch/record/2814136

The new LHCb VELO

The VELO (Vertex Locator), the most recent addition to LHCb, was successfully installed a few weeks before the start of Run 3

The VELO was installed at the LHCb experiment in May 2022, just in time for the start of the third LHC run, on 5 July, marking the end of 15 years of development and construction.

The pixel detector (https://cerncourier.com/a/velos-voyage-into-the-unknown/), with its millions of microscopic pixels, each measuring 55 x 55 micrometres, can recreate particles’ trajectories at an unprecedented speed of 40 million times per second and is located only 3 millimetres from the LHCb collision point. This frenetic rate will make it possible to obtain a complete picture of the collisions in the LHC.

Weighing 800 kilograms, the VELO was installed by the LHCb team with the utmost care to avoid damaging its fragile sensors. It was lowered 100 metres down through the experiment’s shaft before being inserted right up close to the collision point.

To find out more about the VELO’s installation, watch the interview with LHCb physicist Paula Collins.

(Video: CERN (https://videos.cern.ch/record/2296176/embed))

Reema Altamimi

Computer security

Computer Security: Thank you, folks!

“Thank you, folks!” to all of you for helping us keep the Organization secure

“Computer security” might be perceived as a technological endeavour – technology intended to solve technological problems. Firewall hardware. Anti-malware appliances. Multi-factor tokens. Encryption. Anti-virus software. EDR. BC/DR. SBOM. SOC. You name it. But, actually, computer security is far removed from technology. It is a people’s problem of sociological nature. The solutions are in front of the screen, not in the bits and bytes in the hardware. So: “Thank you, folks!” for reading on and helping us keep the Organization secure.

As we have shown in many past issues of the *Bulletin*, we live in symbiosis with information technologies (http://cds.cern.ch/journal/CERNBulletin/2014/43/News%20Articles/1955880?ln=en). Computer security is as important as protecting your apartment (https://home.cern/news/news/computing/computer-security-what-do-apartments-and-computers-have-common), industrial pipelines (https://home.cern/news/news/computing/computer-security-what-do-accelerators-and-pipelines-have-common) or your cooking skills (https://home.cern/news/news/computing/computer-security-fancy-dinner-or-burned-pie). Computer security is a game of permanent chess (https://home.cern/news/news/computing/computer-security-permanent-chess). You are the main player on the board of “prevention”, “protection”, “detection” and “response”.

Prevention-wise, computer security requires you to be vigilant and careful when browsing the web and its dark corners, when faced with weird links, when opening (or not!) attachments on unsolicited emails or when logging into a computing service through dodgy sign-on pages. Making sure that you stay alert is one of the main reasons why we run our annual “clicking campaigns (http://home.cern/news/news/computing/computer-security-truth-lies-url)”. Getting you to identify malicious emails, attachments and links is the very first line of computer security at CERN. Having you report them to us is the last line of defence – detection – because such emails, attachments and links were able to slip through our detection mechanisms and be delivered to your mailboxes. Hence, while we are inundated by the reports, questions and tickets we receive in this regard, we deeply appreciate them! Since your message – you having identified and reported our (and other) emails as malicious – is our last line of defence. Every report is a human sign of detection. Social detection at its best. “Thank you, folks!” for obeying the mantra “STOP – THINK – DON’T CLICK”! and for reporting to us.

Prevention implies avoiding the introduction of vulnerabilities and bugs. Prevention by secure coding. Following best coding practices, making sure that secrets, passwords and other credentials are not exposed in any source code hosted on public software repositories or exposed directly by distributing the software. Preventing web applications from being exploited by properly filtering and sanitising any third-party input (https://home.cern/news/news/computing/computer-security-time-spring-clean). And preventing the import of potentially malicious software by better controlling the supply chain (https://home.cern/news/news/computing/computer-security-supply-chain-time-bombs). “Thank you, folks!” for programming safely and securely!

Finally, prevention also means keeping our software stack secure, up-to-date, patched and based on the skills and professionalism of the people running the many IT services at CERN – throughout the IT department, in FAP-BC, in EP-SFT and in the Controls group of the Beams department. Use their centrally managed provisioning, and you won’t need to worry about computer security yourself. They’ll do it for you. “Thank you, folks!”

Computer security depends heavily on protection. It depends on the IT Network Engineering section, who have deployed a next-generation, highly sophisticated firewall (https://home.cern/news/news/computing/computer-security-cerns-new-first-line-defence). It depends on the IT Windows and Mac experts, who are readying a new – and free-for-you – anti-virus software solution (stay tuned here!). And it depends on the IT Identity and Access Management section, who are rolling out multi-factor authentication, requiring a hardware token like your smartphone or a USB dongle in addition to your password in order to better protect your account (https://home.cern/news/news/computing/computer-security-log-click-be-secure). “Thank you, folks!” for your tireless work for computer security. And a special “Thank you, folks!” to all the many volunteers who have already signed up for our two-factor pilot!

Response is what we want to avoid. Luckily, CERN is prepared with a qualified team of knowledgeable experts, the “Guys and Girls on Duty” (“Gods”) and the “Security Escalators”, who, day in and day out, run the computer security operations centre, react to its alerts, dig into details to understand the cause of a potential break and try to answer all your questions related to computer security and beyond. “Thank you, folks!”

And, last but not least, these awareness articles in the *CERN Bulletin* would not be possible without the help of many more people: IT communications, the Translation service, the Bulletin editors. “Thank you, too, folks!”

As you can see, computer security is so much more than just cold IT – hardware and software. It’s in the commitment, vigilance, skills and professionalism of all of us. It’s sociological. Hence, once more, a hearty and sincere “Thank you, folks!” to all of you for helping us keep the Organization secure. This. Is. Really. Appreciated!

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Do you want to learn more about computer security incidents and issues at CERN? Follow our Monthly Report (https://cern.ch/security/reports/en/monthly_reports.shtml). For further information, questions or help, check our website (https://cern.ch/Computer.Security) or contact us at Computer.Security@cern.ch.

Computer Security team

Official communications

CERN Graduate Programme review - update

The HR department is pleased that the CERN Council recently approved the Graduate Programme review. The rollout of the new programmes is now under way and we are happy to announce that we will welcome our first new hires under this initiative as of January 2023.

We would like to thank the many services CERN-wide that have contributed to this review, the aim of which is to simplify, clarify and streamline the opportunities that CERN is able to provide to graduates in order to harness talent as one of the pillars of our Organization.

We had a compelling case for change: CERN has to be able to attract and retain personnel of the highest competence coming from all Member States, and this clearly comes through creating offers that better meet the needs of the Organization and the candidates alike.

Currently, we simply have too many programmes, some with overlapping and similar identities. This in itself leads to confusion and a certain loss of attractiveness. Other drivers for change include the Member States themselves, their returns and the richness that comes from harnessing the diverse talent pool of all our countries. We are also aiming to achieve more equity in the conditions across all the programmes.

We are looking forward to the implementation of the new programmes, which will bring improvements in recruitment processes, branding and sourcing to better attract candidates and build talent pipelines. The scope of this review specifically concerns graduates: the student programmes (i.e. the technical, administrative, doctoral and summer student programmes) remain unchanged for the time being.

Our goal is to offer three programmes for graduates, but each with a clear identity:

1) **Early-Career Professionals (ORIGIN)**: a real work opportunity in a technical or administrative field, where graduates learn on the job and from the best. From technician up to master's level.

2) **Project Graduates (QUEST)**: time-limited, results-focused, project-based work opportunities for graduates looking to further hone their skills and build their professional network. From master's to PhD level.

3) **Research Fellows**: will now focus purely on post-doctoral candidates aiming for a research or academic career in physics or engineering.

A more streamlined recruitment process across the new programmes will help to ensure timely hiring to meet the Organization's needs. In addition, graduates under these schemes will all be employed members of personnel, which means that they will benefit from CERN health insurance coverage as well as membership of the Pension Fund.

This will be a major evolution in how we recruit and engage graduates across different countries and domains.

If you wish to learn more about the new programmes and find out the latest information, we invite you to an HR public webinar on Tuesday, 19 July 2022 (a recording will be made available afterwards).

If you would like more information on the programmes and how the changes might affect you, please contact your Human Resources Advisor or send an e-mail to afc.recruitment@cern.ch (mailto:afc.recruitment@cern.ch).

HR department

2021 Annual Report: Chapter VI of the Staff Rules and Regulations (settlement of disputes and discipline)

The Organization is committed to a fair and respectful work environment. Behavioural concerns or administrative disputes brought to the attention of the Organization are addressed in a timely manner using, whenever possible, informal resolution mechanisms such as mediation. In cases where informal resolution is not achievable or appropriate, the Organization or the member of personnel concerned may decide to initiate formal proceedings under the Organization's settlement of disputes procedure or conduct-related frameworks, as applicable*. This report provides an overview of the cases handled under Chapter VI of the Staff Rules and Regulations.

Introduction

The Annual Report under Chapter VI ("Settlement of Disputes and Discipline") of the Staff Rules and Regulations serves to report on:

- requests for review;
- internal appeals;
- cases in which disciplinary action was taken; and
- complaints before the Administrative Tribunal of the International Labour Organization (ILOAT).

Requests for review and internal appeals

Under Article S VI 1.01 of the Staff Rules, members of the personnel may challenge an administrative decision by the Director-General where it adversely affects the conditions of employment or association that derive from their contract or from the Staff Rules and Regulations.

If permitted by the Staff Rules and Regulations, a decision may be challenged internally within the Organization:

- through a review procedure; or
- through an internal appeal procedure. In this case, the Joint Advisory Appeals Board (JAAB) shall be consulted by the Director-General prior to taking any final decision on the merits.

Disciplinary Action

Under Article S VI 2.01 of the Staff Rules, the Director-General may take disciplinary action against members of the personnel who, whether intentionally or through carelessness, are guilty of a breach of the Rules and Regulations or of misconduct that is to the detriment of the Organization.

Article S VI 2.02 of the Staff Rules stipulates that, having regard to the gravity of the breach or misconduct in question, the disciplinary action shall be:

- a warning;
- a reprimand;
- suspension without remuneration or pay for a period not exceeding six months;
- downward adjustment of the staff member's salary;
- demotion;
- dismissal.

The Director-General shall consult the Joint Advisory Disciplinary Board (JADB) prior to taking any disciplinary action other than a warning or a reprimand (Article S VI 2.04 of the Staff Rules). In cases of particular serious misconduct, the Director-General may decide to dismiss without notice and without consulting the JADB (Article S VI 2.05 of the Staff Rules).

Complaints before the Administrative Tribunal of the International Labour Organization (ILOAT)

A decision may be challenged externally by filing a complaint before the ILOAT:

- when internal procedures have been exhausted and the decision is final;
- when an internal challenge is not permitted by the Staff Rules and Regulations; or
- when the complainant is authorised by the Director-General to proceed directly to the Tribunal.

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Requests for review:

From 1 January to 31 December 2021, one request for review of an administrative decision was introduced:

- In January 2021, a staff member requested a review of the decision refusing the payment of accommodation expenses for a dependent child attending an educational establishment at secondary level outside the local area. The decision was maintained.

Concerning previous review requests:

- In April 2021, a decision was taken with regard to a previous file introduced in January 2020, whereby a staff member, in the context of a decision recognizing their illness as being of an occupational nature, had contested the illness consolidation date and the indemnity rate for deterioration of physical or mental health. Further to completion of a procedure for the settlement of disputes of a medical nature, the final decision was to maintain the indemnity rate and to modify the consolidation date.

Internal appeals (Joint Advisory Appeals Board (JAAB)):

During the period from 1 January to 31 December 2021, seven internal appeals were introduced:

- In January 2021, a staff member introduced an internal appeal against the decision to follow the recommendation of the Harassment Investigation Panel that the facts established during the investigation did not constitute harassment. In October 2021, the Director-General decided to follow the recommendation of the JAAB to reject the appeal.
- In April 2021, three associated members of the personnel introduced internal appeals against the decision to replace the internal tax annual certificate by an individual annual statement in respect of cost-of-living allowances processed by CERN on behalf of third parties. In March 2022, the Director-General decided to follow the recommendations of the JAAB to reject the appeals.
- In July 2021, two staff members introduced internal appeals against the decision to qualify their performances as "fair" for the reference year 2020.
  - In the case of the first appellant, the procedure has been suspended pending the outcome of a Harassment Investigation procedure, expected in 2022.
  - In the case of the second appellant, the qualification was reviewed through informal resolution and the staff member decided to withdraw the appeal.
- In October 2021, a former staff member introduced an internal appeal against the calculation of the indemnity for permanent deterioration of physical or mental health he received under Annex 3 of Administrative Circular No. 14 (Rev. 4) "Protection of members of the personnel against the financial consequences of illness, accident and incapacity for work". The procedure is ongoing and a conclusion is expected in the second half of 2022.

Concerning previous appeals:

- In April 2021, the Director-General decided to follow the JAAB's recommendation to reject an appeal lodged in July 2020 by a staff member against the decision to qualify their performance as "fair" for the reference year 2019.
- In April 2021, it was considered that the subject of a pending appeal had been addressed and the complaint had become devoid of merit. In November 2018, a staff member had introduced the appeal against the refusal to grant reimbursement of medical expenses at the occupational rate, on the basis that the accident had been consolidated for a period of more than 10 years. In January 2020, the Administrative Circular No. 14 (Rev. 4) "Protection of members of the personnel against the financial consequences of illness, accident and incapacity for work" was revised with regard to the definition of, and time limit for, relapse, suppressing the 10-year time limit, hence allowing the staff member eligibility for full reimbursement and consideration for an indemnity.
- In June 2021, a staff member decided to withdraw two appeals that had been introduced in April and July 2019 but subsequently postponed due to health reasons. The appeals concerned (1) a career review decision and (2) the decision not to remove personal information from their CERN medical file.

Warnings and reprimands:

In 2021, the Organization issued one warning:

- A warning was issued to a staff member in the context of a road traffic offense, further to excessive speeding in a vehicle on the CERN site.

In 2021, the Organization issued one reprimand:

- A reprimand was issued to a User further to communications made containing erroneous and defamatory statements discrediting the work of CERN contributors and harming the reputation of the Organization.

The Joint Advisory Disciplinary Board (JADB):

In 2021, the JADB was convened to examine two cases following the outcome of a fraud investigation:

- One procedure concerned a User's implication in, *inter alia*, organising and facilitating fraudulent registration of associated members of personnel and misappropriation of funds. The Director-General decided to follow the recommendation of the JADB to terminate the contract of association.
- One procedure concerned a fraudulent violation of financial and administrative rules by a staff member, and conflict of interest. The Director for Finance and Human Resources decided to follow the recommendation of the Board to demote the staff member and applied, in addition, the sanction of downward adjustment of salary.

Dismissal notified during the probation period:

In 2021, one employment contract of a fellow was terminated due to insufficient performance during the probation period (as per Article S II 5.01 g of the Staff Rules).

Particularly serious misconduct

In 2021, a file was initiated based on a member of personnel's involvement in issuing communications presenting as established fact that CERN had illegally appropriated the member of personnel's work and undermining the scientific integrity of the Organization. The Director-General decided to terminate the contract of association pursuant to Article S VI 2.05 of the Staff Rules.

Additional information

With regard to the fraud investigation into alleged misrepresentation with a view to obtaining contracts of association and misappropriation of funds, based upon the facts identified by the investigation, the Director for Finance and Human Resources decided to take administrative measures to terminate the contracts of association of five associated members of the personnel and to suspend the eligibility of four persons for the award of contracts of association or employment for a certain period.

Complaints before the Administrative Tribunal of the International Labour Organization (ILOAT)**:

During the period from 1 January to 31 December 2021:

- In December 2018, a staff member filed a complaint with the ILOAT against the Director-General's decision which refused the recognition of a disability resulting in an incapacity for work. All court filings were completed in 2019, however the complaint was withdrawn by the Complainant in June 2021.
- In April 2020, a former staff member filed a complaint with the ILOAT against the Director-General's decision not to grant them an indefinite contract (IC). The Tribunal's ruling is expected in 2023.
- From July to October 2020, three associated members of the personnel filed individual complaints with the ILOAT against a change in the conditions governing the processing by CERN of subsistence allowance payments on behalf of third parties (introduction of a 'cap'). The Tribunal's rulings are expected in 2023.
- In January 2021, 59 associated members of the personnel filed a complaint with the ILOAT against the decision to replace their 2019 internal tax annual certificate by an individual annual statement in respect of subsistence/cost-of-living allowances processed on behalf of third parties. One of these complaints was rejected by the Tribunal and summarily dismissed, while 54 were ultimately withdrawn. The Tribunal's rulings in respect to the remaining 4 complaints are expected in 2023.
- In January 2021, a staff member filed a complaint with the ILOAT against the Director-General's decision to reject their internal appeal concerning an allegation of harassment. The Tribunal's ruling is expected in 2023.
- In February 2021, two staff members submitted requests for the revision of Judgments 4273 and 4274 with the ILOAT. The Tribunal's rulings are expected in 2023.
- In February 2021, a staff member filed a complaint with the ILOAT against the Director-General's decision to maintain their initial performance qualification. The Tribunal's ruling is expected in 2023.
- In March 2021, a staff member filed a complaint with the ILOAT against the Director-General's decision to deny their request for reclassification. The Tribunal's ruling is expected in 2023.
- In July 2021, a staff member filed a complaint with the ILOAT against the Director-General's decision to maintain their initial performance qualification. The Tribunal's ruling is expected in 2023.
- In July 2021, a staff member filed a complaint with the ILOAT against the Director-General's decision to refuse the recognition of a total disability resulting in an incapacity to work. The Tribunal's ruling is expected in 2023.
- In November 2021, a staff member filed a complaint against the amount received from the insurer following an occupational accident. The Tribunal's ruling is expected in 2023.

The ILOAT ruled in one case involving the Organization, which had been filed in 2020:

- In a case filed by an associated member of the personnel against the decision of the Organization to replace their internal tax certificates with an individual annual statement, the Tribunal dismissed the complaint as irreceivable.

**See Chapter VI of the Staff Rules and Regulations on "Settlement of Disputes and Discipline", also Operational Circular ("OC") 9 on "Principles and procedures governing complaints of harassment"; OC10 on "Principles and procedure governing investigation of fraud".*

***Due to a backlog of cases at the ILOAT, the judgments which were initially expected in 2021 have been delayed.*

HR department

Announcements

Help bridge the gap between science and society by donating to "Light their Spark"

Donations to "Light their Spark", the regular giving programme of the CERN & Society Foundation, will fuel opportunities for students, teachers and scientists across the world

(Image: CERN)

Since 2014, the CERN & Society Foundation has been supporting a portfolio of projects aimed at bridging the gap between science and society, thereby upholding CERN's mission of inspiring and benefitting society.

And now the CERN & Society Foundation is inviting you to join #LIGHTtheirSpark, the Foundation's regular giving programme, which offers you the chance to nurture the talent, ingenuity and ability of hundreds of students, teachers and scientists every year. By lighting the spark of their creativity, you will allow them to learn, discover, and inspire the world with their scientific curiosity.

A regular donation, however small, can have a big impact: it allows us to plan our work sustainably and effectively, keep administrative costs down, and react faster and more efficiently in times of emergency.

Read all about the benefits of joining the #LIGHTtheirSpark programme here (https://cernandsocietyfoundation.cern/make-a-monthly-donation). In the meantime, hear what other CERNois like you think about our projects.

(Video: CERN)

Are you thinking that this all sounds great, but it's just not up your donation alley? Fear not! You can still help us by sharing this message with your close network and advocating our cause.

Call for participation: radiation protection congress in Annecy-le-Vieux, 20–22 September 2022

With the support of CERN, the *Association pour les Techniques et les Sciences de Radioprotection* (French Association for Radiation Protection Techniques and Science) will be holding its 27th radiation protection congress (https://www.alphavisa.com/atsr/2022/index.php) at Espace Rencontre in Annecy-le-Vieux, from 20 to 22 September 2022.

The two-day congress will cover various subjects relating to radiation protection – notably in the particle accelerator environment – including its industrial and medical applications and the applicable legal framework. CERN visits are planned for the afternoons, the health situation permitting.

The congress is open to all radiation protection professionals interested in discussing techniques, skills and materials, and also to anyone who would simply like to learn more about the topic.

You can sign up on the event's website (https://www.alphavisa.com/atsr/2022/inscription.php). Please note that all the presentations and lectures will be in French.

Wasps at CERN's dedicated picnic and barbecue areas: stay alert!

On these warm summer days, many of us are enjoying picnics and barbecues at the various dedicated areas around the CERN sites, but wasps naturally seek their share of the delicious food and drink. On the Prévessin barbecue site, several incidents of wasp stings

(including among our emergency services) have been reported. These incidents cannot be attributed to nearby nests, but rather to the presence of leftover food that has either been disposed of in the dedicated dustbins (the correct disposal method, although the bins do not close tightly and are not emptied after each barbecue) or been thrown into the thickets (an inappropriate disposal method that attracts wasps).

Given that the use of insecticide would run counter to the biodiversity preservation efforts put in place by CERN, and in order to avoid a resurgence of incidents involving wasps, for safety reasons, the use of the Prévessin barbecue area in particular is strongly discouraged and caution is recommended for any picnic or barbecue held at the other dedicated areas.

Thank you for your understanding.

HSE unit

Ombud's corner

A duty of care to junior colleagues

"*Can you imagine? Taking part in the largest scientific experiment in the world. CERN needs more than physicists and engineers – if you're a student, a graduate, just starting your career or an experienced professional, whatever your field of expertise, CERN could be your next opportunity. Find out more about CERN and take virtual tours of this unique place to work and learn.*"

This is how the CERN careers page (https://careers.cern/)greets potential applicants - by emphasising that CERN is an unparalleled place to work and learn, which rightly sets a very high standard.

From my time as head of Alumni Relations, I remember the pride with which former younger colleagues at CERN, whether students or graduates at the beginning of their career, shared fond memories of their time at the Lab. They were very willing to discuss how their experience at CERN and, in particular, how its incredibly innovative, diverse and collaborative environment contributed to launching their career.

I believe that the high expectations of young people at CERN are met most of the time and that promises are fulfilled. However, in 2021, 20% of the visitors to the Ombud's office were under 30. I would like to share with you the main issues and concerns that affected them.

The first reason why junior colleagues asked to meet the Ombud was difficulties with their supervisor. They shared with me cases of lax or absent supervision and feelings of isolation when they were left alone with their problems and questions. Of course, the COVID-19 pandemic only made these feelings of isolation more acute.

Still related to issues with their supervisor, some junior visitors had to cope with overly demanding managers, who set objectives that they could not possibly reach while still in their learning curve, despite their efforts to do their best. In these circumstances, the feedback they received was not always respectful and constructive.

Female junior colleagues also suffered various forms of sexism, from regular comments on the way they dressed to perceived sexual harassment.

Some of them were doctoral students who were investing three to four years of their lives in completing their PhD thesis and were encountering issues with their CERN supervisor. When the success or failure of this thesis depended on one person, they felt helpless to address supervision issues and very vulnerable.

Many of these young visitors had tried to speak up about the difficulties that they were facing, but with no success. As CERN Ombud, I explored with them what options they had to move forward and provided guidance on specific steps, for example by preparing them for a conversation with their supervisor.

Talking with these young people about the challenging situations they encountered, I remembered how vulnerable and poorly equipped I had felt at the beginning of my own career when facing similar difficulties.

I take all opportunities to invite today's supervisors and managers to take a step back and remember how it can feel at the beginning of one's career to face an absence of communication, lack of supervision and/or abrasive leadership.

With increasingly overloaded diaries, deadlines to meet and results to deliver, do our leaders always remember that they are also expected to be role models and to model CERN values?

A common point between all of my young visitors: they were struck by the difference between the image they had of the Laboratory before they came to work here and what they were experiencing.

It is easy to understand that, if these young people leave with a bad experience, they might still be proud to have worked at CERN, but will have trouble talking enthusiastically about it. A large part of CERN's reputation is in the hands of all former colleagues who worked here and then left.

We all need to keep up the promises that CERN makes to junior colleagues and make sure that they find people to speak to when they have problems. Because supervisors are critical success factors in their work experience, they, with the help of the wider team, need to provide close supervision, an active listening ear, understanding and support.

As a manager or supervisor, you might sometimes feel that your supervisee expects/needs more than what you are in a position to give at that time. The Ombud offers a safe space for you to discuss your concerns. I am also here for you.

Laure Esteveny

I want to hear from you – feel free to email ombud@cern.ch with any feedback or suggestions for topics you'd like me to address.

NB: If you would like to be notified about posts, news and other communications from the CERN Ombud, please register to receive the CERN Ombud news (https://e-groups.cern.ch/e-groups/EgroupsSubscription.do?egroupName=cern-ombud-news).