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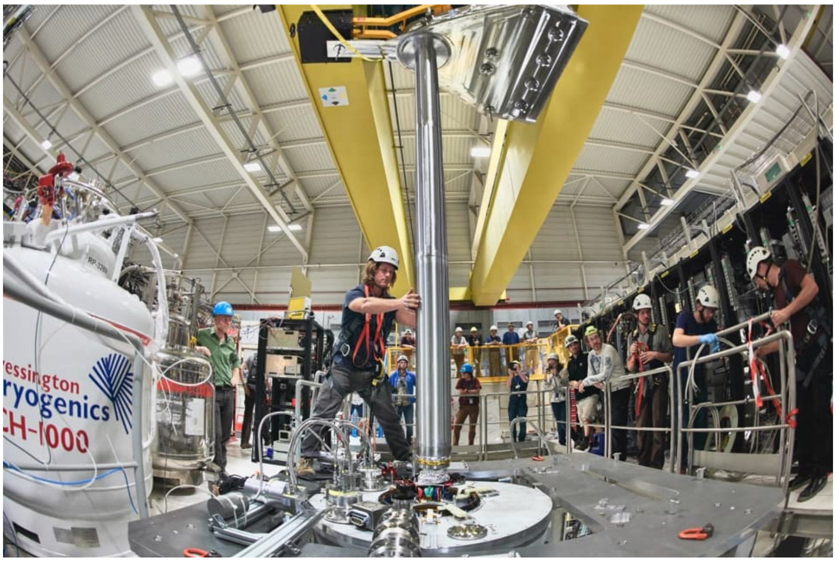
ALPHA experiment at CERN observes the influence of gravity on antimatter

The result is a milestone in the study of the properties and behaviour of antimatter



Insertion of the ALPHA-g apparatus (Image: CERN)

Isaac Newton's historic work on gravity was apparently inspired by watching an apple fall to the ground from a tree. But what about an "anti-apple" made of antimatter, would it fall in the same way if it existed? According to Albert Einstein's much-tested theory of general relativity, the modern theory of gravity, antimatter and matter should fall to Earth in the same way. But do they, or are there other long-range forces beyond gravity that affect their free fall?

In a paper published on 27 September in *Nature*, the ALPHA collaboration at CERN's Antimatter Factory shows that, within the precision of their experiment, atoms of antihydrogen – a positron orbiting an antiproton – fall to Earth in the same way as their matter equivalents.

"In physics, you don't really know something until you observe it," says ALPHA spokesperson Jeffrey Hangst. "This is the first direct experiment to actually observe a gravitational effect on the motion of antimatter. It's a milestone in the study of antimatter, which still mystifies us due to its apparent absence in the Universe."

Gravity is the attractive force between any two objects with mass. It is by far the weakest of the four fundamental forces of nature. Antihydrogen atoms are electrically neutral and stable particles of antimatter. These properties make them ideal systems in which to study the gravitational behaviour of antimatter.

Contents

The ALPHA collaboration creates antihydrogen atoms by taking negatively charged antiprotons, produced and slowed down in the Antimatter Factory's AD and ELENA machines, and binding them with positively charged positrons accumulated from a sodium-22 source. It then confines the neutral – but slightly magnetic – antimatter atoms in a magnetic trap, which prevents them from coming into contact with matter and annihilating.

Until now, the team has concentrated on spectroscopic studies in the ALPHA-2 device, shining laser light or microwaves onto the antihydrogen atoms to measure their internal structure. But the ALPHA team has also built a vertical apparatus called ALPHA-g, which received its first antiprotons in 2018 and was commissioned in 2021. The 'g' denotes the local acceleration of gravity, which, for matter, is about 9.81 metres per second squared. This apparatus makes it possible to measure the vertical positions at which the antihydrogen atoms annihilate with matter once the trap's magnetic field is switched off, allowing the atoms to escape.

This is exactly what the ALPHA researchers did in their new investigation, following a proof-of-principle experiment with the original ALPHA set-up in 2013. They trapped groups of about 100 antihydrogen atoms, one group at a time, and then slowly released the atoms over a period of 20 seconds by gradually ramping down the current in the top and bottom magnets of the trap. Computer simulations of the ALPHA-g set-up indicate that, for matter, this operation would result in about 20% of the atoms exiting through the top of the trap and 80% through the bottom, a difference caused by the downward force of gravity. By averaging the results of seven release trials, the ALPHA team found that the fractions of anti-atoms exiting through the top and bottom were in line with the results of the simulations.

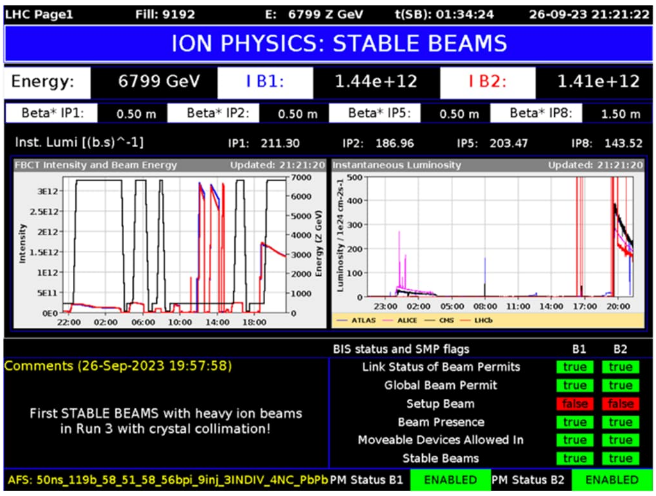
The full study involved repeating the experiment several times for different values of an additional "bias" magnetic field, which could either enhance or counteract the force of gravity. By analysing the data from this "bias scan", the team found that, within the precision of the current experiment (about 20% of *g*), the acceleration of an antihydrogen atom is consistent with the familiar, attractive gravitational force between matter and the Earth.

"It has taken us 30 years to learn how to make this anti-atom, to hold on to it, and to control it well enough that we could actually drop it in a way that it would be sensitive to the force of gravity," says Hangst. "The next step is to measure the acceleration as precisely as we can," continues Hangst. "We want to test whether matter and antimatter do indeed fall in the same way. Laser-cooling of antihydrogen atoms, which we first demonstrated in ALPHA-2 and will implement in ALPHA-g when we return to it in 2024, is expected to have a significant impact on the precision."

CERN's Antimatter Factory is a unique facility in the world for producing and studying antimatter. Two other experiments at this facility, AEgIS and GBAR, share with ALPHA the goal of measuring with high precision the gravitational acceleration of atomic antimatter. Also at the Antimatter Factory is the BASE experiment. Its main focus is to compare with high precision the properties of the proton with those of its antimatter twin, and it has recently compared the gravitational behaviour of these two particles.

Click here (https://videos.cern.ch/record/2298631) to download the video news release.

Accelerator Report: SPS and LHC lead-ion physics: navigating technical hurdles for success



The LHC fixed display showing the last verification and validation step before establishing collisions, initially with 119 bunches, which will gradually be increased to up to 1248 bunches in the coming days. (Image: CERN)

On Thursday, 28 September, at 8.00 a.m., as planned, the Operations team at the SPS stopped producing proton beams for the experiments in the SPS North Area (NA). Instead, they switched over to lead-ion beams, in preparation for a month-long physics run that begins on Monday, 2 October, and will continue until 6.00 a.m. on Monday, 30 October.

The end of the proton physics run is an excellent time to look back and reflect. The proton physics run for the North Area started on 1 May, 150 days ago. One important criterion for both the accelerators and the experiments is the “beam availability” – i.e. the amount of time the beam was ready for the experiments. This year, the beam was available for the NA experiments 85.8% of the time it was requested, which is more than our target (85%). This represents a significant improvement over the 2022 proton physics run, which reached only 72% of beam availability due to numerous major issues.

The 14.2% of non-availability was caused by a total of 1859 faults, amounting to 495 hours, as documented in the Accelerator Fault Tracking (AFT) system. This system is used across all CERN accelerators to log faults, along with their start and end times. Experts then review these faults to ensure consistency throughout the accelerator complex. The information is used by the equipment groups to address the issues and make decisions on system and equipment consolidation. Approximately half of the beam non-availability (6.7%) was due to issues in the SPS injector chain (Linac 4, PS Booster and PS). The other half (7.5%) resulted from faults within the SPS itself.

The longest fault we experienced this year was the malfunction of a dipole magnet in the SPS on 6 September. While the actual replacement took only a few hours, the time required to restore the vacuum to a level suitable for beam circulation resulted in a 24-hour downtime.

A more comprehensive analysis of the unavailability of each of the accelerators will be conducted at the end of 2023.

In the meantime, the LHC kicked off its lead-ion commissioning achieving the first lead-ion collisions on Tuesday, 26 September. This was earlier than originally planned for 2023 (although still later than anticipated, following the helium circuit and insulation vacuum leak that occurred during the summer). Indeed, despite a swift restart at the end of August, various unrelated technical problems arose in the injectors, the LHC machine and the experiments, leading to additional delays. These issues prevented the planned proton–proton reference run from occurring before the start of the lead-ion collisions.

One significant problem emerged on Thursday, 31 August, when a vacuum leak was detected at Point 8 in a TDIS (target dump injection system), which plays a crucial role in safeguarding the machine against beam losses during the injection process. On Tuesday, 8 September, another leak occurred in a different but identical component of the same system at Point 8. In both cases, the vacuum team took swift action, identified the leaks and successfully sealed them.

Due to these repairs, the affected parts of the system could no longer be repositioned into the machine, limiting the level of protection for beam injection at Point 8, but still guaranteeing a sufficient level of protection for injecting lead ions. If no further issues arise, both the LHC and the

experiments are looking forward to a productive and successful lead-ion physics run.
Meanwhile, protons continue to be the primary focus for the rest of the accelerator complex. They are supplied to various areas, including ISOLDE, the PS East Area and n_TOF and the AD and ELENA. AWAKE, situated behind the SPS, will also continue to rely on proton beams in the upcoming weeks.

Rende Steerenberg

The LHC lead-ion collision run starts

For the coming 5 weeks the LHC experiments will be taking data for their heavy-ion physics programmes

The LHC is back delivering collisions to the experiments after the successful leak repair in August. But instead of protons, it is now the turn of lead ion beams to collide, marking the first heavy-ion run in 5 years. Compared to previous runs, the lead nuclei will be colliding with an increased energy of 5.36 TeV per nucleon (compared to 5.02 TeV per nucleon previously) and the collision rate has increased by a factor of 10. The primary physics goal of this run is the study of the elusive state of matter known as quark-gluon plasma, that is believed to have filled the Universe up to a millionth of a second after the Big Bang and can be recreated in the laboratory in heavy-ion collisions.
Quark-gluon plasma is a state of matter made of free quarks (particles that make up hadrons such as the proton and the neutron) and gluons (carriers of the strong interaction, which hold the quarks together inside the hadrons). In all but the most extreme conditions, quarks cannot exist individually and are bound inside hadrons. In heavy-ion collisions however, hundreds of protons and neutrons collide, forming a system with such density and temperature that the colliding nuclei melt together, and a tiny fireball of quark-gluon plasma forms, the hottest substance known to exist. Inside this fireball quarks and gluons can move around freely for a split-second, until the plasma expands and cools down, turning back into hadrons.
The ongoing heavy-ion run is expected to bring significant advances in our understanding of quark-gluon plasma. In addition to the improved parameters of the lead-ion beams, significant upgrades have been performed in the experiments that detect and analyse the collisions. ALICE, the experiment which primarily focuses on studies of quark-gluon plasma, is now using an entirely new mode of data processing storing all collisions without selection, resulting in up to 100 times more collisions being recorded per second. In addition, its track reconstruction efficiency and precision have increased due to the installation of new subsystems and upgrades of existing ones. CMS and ATLAS have also upgraded their data acquisition, reconstruction and selection infrastructure to take advantage of the increased collision rates. ATLAS has installed improved Zero Degree Calorimeters, which are critical in event selection and provide new measurement capabilities. LHCb, in addition to performing studies of lead-lead collisions with an upgraded tracking system, is preparing a unique programme of fixed-target collisions of lead nuclei with other types of nuclei using its unique SMOG2 apparatus that allows various gases to be injected into the LHC collision area.
Studies of quark-gluon plasma in this heavy-ion will focus on rare processes such as the production of heavy quarks, quarkonium states, real and virtual photons and heavy nuclear states. The increased number of collisions is expected to allow measurement of the temperature of the plasma using thermal radiation in the form of photons and electron-positron pairs. Hydrodynamic properties of the near-perfect liquid state of matter will be measured in greater detail and “tomography” using particles such as the charm or beauty quarks that are produced in the initial phase of the collision, pass through the plasma and are detected afterwards. All these measurements will be far more precise than before.
In addition to studies of quark-gluon plasma, the experiments will be looking at so-called ultra-

peripheral collisions of heavy ions, in which the beams do not collide directly, but one beam emits a high-energy photon that strikes the other beam. These collisions will be used to probe gluonic matter inside nuclei and to study rare phenomena such as light-by-light scattering and τ lepton photoproduction.

Five years after the previous heavy-ion run, expectations are high.

Piotr Traczyk

CERN Science Gateway: interactive exhibitions for everyone

The new permanent exhibitions* – Discover CERN*, * Our Universe *and* Quantum World – *are unlike anything CERN has developed before...

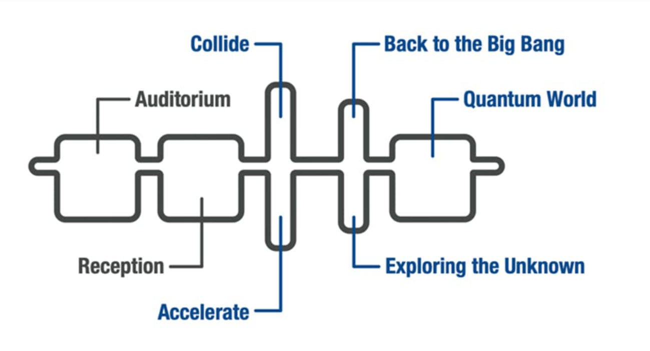
Children visiting Science Gateway's Collide exhibit. This model detector is tactile to allow visitors with visual impairments to discover the detector's components. (Image: CERN)

The opening of CERN Science Gateway is imminent and, inside the impressive building, teams are adding the final touches to the labs for schools, auditorium for events and three permanent, hands-on exhibitions.

CERN Science Gateway's exhibitions are unlike anything CERN has developed before. The Microcosm, which closed its doors last year, showcased CERN behind the scenes and was primarily aimed at visitors with some prior understanding of physics. In contrast, the Science Gateway exhibits, which are as hands-on and interactive as possible, target visitors aged 8 and up, from those with no scientific background to the most experienced of particle physicists – there's something for everyone.

Spanning the Route de Meyrin in two tubes reminiscent of CERN's accelerators are two of the three permanent exhibitions: *Discover CERN* and *Our Universe.* The walkway from the Science Gateway reception takes you first to *Discover CERN*, which is divided into *Accelerate*, to your right, and *Collide*, to your left. *Accelerate* houses a real, working particle accelerator, an LHC dipole magnet and a wealth of interactive exhibits to demonstrate the science and engineering concepts behind accelerator development. *Collide* features slices of a detector, guiding you through colliding and detecting particles, analysing the collisions and all the technological developments needed to make this happen.

Similarly, *Our Universe,* located in the second tube, is divided into *Exploring the Unknown* to your right and *Back to the Big Bang* to your left. *Back to the Big Bang* takes visitors on a trip back through time to find out where *their* particles come from. It situates CERN's research within the timeline of the Universe, featuring interactive exhibits on scientific concepts from dark matter to nucleosynthesis in stars and telling the CERN stories behind them. *Exploring the Unknown* is a more reflective space, inviting visitors to contemplate some of the big mysteries in physics, through themes such as the void and the invisible. Developing from a dialogue between artists and theorists, it features four artworks specially commissioned for Science Gateway: *Round About 4 Dimensions* by Julius von Bismarck, *data.gram* by Ryoji Ikeda, *Chroma VII* by Yunchul Kim and *TAFAA-SINGULARITY* by Chloé Delarue. Each artist has previously been an artist in residence at the Arts at CERN programme.



Bird's eye diagram of the new Science Gateway buildings. The two squares to the left house the reception, the auditorium and the labs. In the larger central tube are the Discover CERN exhibits, to the right of them are the Our Universe exhibits, and to the very right is the Quantum World exhibit. (Image: CERN)

Next to the two tubes is the exhibition *Quantum World.* Here, visitors can experience the strange laws of quantum physics as if they were themselves a particle. This immersive experience is audio-guided and interactive. In addition, playful hands-on exhibits include quantum tennis, quantum karaoke and a double slit experiment.

The interactive exhibits were all developed in collaboration with CERN scientists and expert exhibition developers. Each activity was tested with the target audiences in mind and many encourage open exploration and collaboration between visitors, with help from the Science Gateway guides.

"The exhibits give all visitors the chance to interact with CERN's science, technology and even the people," explains Emma Sanders, head of the Science Gateway exhibition team. "We really enjoyed the *CERNois* visits last week and often heard members of the CERN community keen to come back soon with members of their family.

"CERN thrives on collaboration," continues Emma, "and Science Gateway is no exception. I thank all the many members of the CERN community who have been involved in developing the exhibitions, as well as all the guide volunteers, for making this exciting interactive experience possible."

Want to explore the exhibitions further? It's not too late to become a CERN Science Gateway guide. Interactions with real people who work at CERN make the experience unforgettable for visitors, and may give you some surprising benefits, too (https://home.cern/news/news/knowledge-sharing/youll-never-guess-these-six-unlikely-benefits-being-cern-guide)*!*

Naomi Dinmore

ATLAS measures strength of the strong force with record precision

The result showcases the power of the LHC to push the precision frontier and improve our understanding of nature

The ATLAS experiment at CERN. (Image: CERN)

Binding together quarks into protons, neutrons and atomic nuclei is a force so strong, it's in the name. The strong force, which is carried by gluon particles, is the strongest of all fundamental forces of nature – the others being electromagnetism, the weak force and gravity. Yet, it's the least precisely measured of these four forces. In a paper just submitted to *Nature Physics*, the ATLAS collaboration describes how it has used the Z boson, the electrically neutral carrier of the weak force, to determine the strength of the strong force with an unprecedented uncertainty of below 1%.

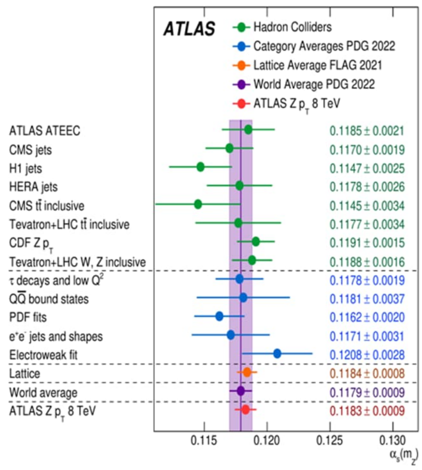
The strength of the strong force is described by a fundamental parameter in the Standard Model of particle physics called the strong coupling constant. While knowledge of the strong coupling constant has improved with measurements and theoretical developments made over the years, the uncertainty on its value remains orders of magnitude larger than that of the coupling constants for the other fundamental forces. A more precise measurement of the strong coupling constant is required to improve the precision of theoretical calculations of particle processes that involve the strong force. It is also needed to address important unanswered questions about nature. Could all of the fundamental forces be of equal strength at very high energy, indicating a potential common origin? Could new, unknown interactions be modifying the strong force in certain processes or at certain energies?

In its new study of the strong coupling constant, the ATLAS collaboration investigated Z bosons produced in proton–proton collisions at CERN's Large Hadron Collider (LHC) at a collision energy of 8 TeV. Z bosons are typically produced when two quarks in the colliding protons annihilate. In this weak-interaction process, the strong force comes into play through the radiation of gluons off the annihilating quarks. This radiation gives the Z boson a “kick” transverse to the collision axis (transverse momentum). The magnitude of this kick depends on the strong coupling constant. A precise measurement of the distribution of Z-boson transverse momenta and a comparison with equally precise theoretical calculations of this distribution allows the strong coupling constant to be determined.

In the new analysis, the ATLAS team focused on cleanly selected Z-boson decays to two leptons (electrons or muons) and measured the Z-boson transverse momentum via its decay products. A comparison of these measurements with theoretical predictions enabled the researchers to precisely determine the strong coupling constant at the Z-boson mass scale to be 0.1183 ± 0.0009. With a relative uncertainty of only 0.8%, the result is the most precise determination of the strength of the strong force made by a single experiment to date. It agrees with the current world average of experimental determinations and state-of-the-art calculations known as lattice quantum chromodynamics (see figure below).

This record precision was accomplished thanks to both experimental and theoretical advances. On the experimental side, the ATLAS physicists achieved a detailed understanding of the detection efficiency and momentum calibration of the two electrons or muons originating from the Z-boson decay, which resulted in momentum precisions ranging from 0.1% to 1%. On the theoretical side, the ATLAS researchers used, among other ingredients, cutting-edge calculations of the Z-boson production process that consider up to four “loops” in quantum chromodynamics. These loops represent the complexity of the calculation in terms of contributing processes. Adding more loops increases the precision.

“The strength of the strong nuclear force is a key parameter of the Standard Model, yet it is only known with percent-level precision. For comparison, the electromagnetic force, which is 15 times weaker than the strong force at the energy probed by the LHC, is known with a precision better than one part in a billion,” says CERN physicist Stefano Camarda, a member of the analysis team. “That we have now measured the strong force coupling strength at the 0.8% precision level is a spectacular achievement. It showcases the power of the LHC and the ATLAS



experiment to push the precision frontier and enhance our understanding of nature.”

The new ATLAS value of the strong coupling constant compared with other measurements. (Image: ATLAS/CERN)

ATLAS collaboration

A few words from CERN's first official guide

Félix Hoffmann was a CERN tour guide for more than 50 years

After reading your article in the *CERN Bulletin* (https://home.cern/news/news/knowledge-sharing/youll-never-guess-these-six-unlikely-benefits-being-cern-guide), I thought I'd write and tell you about my experience as a CERN guide:
I was CERN's first official guide.
I started work at the PS on 1 May 1956. About a year later, while visiting some old colleagues, I met Mr Menetrey of the Public Relations department for the first time.
After that he often asked me to come and give guided tours for visitors. In 1960, John Adams, the Director-General of the time, officially created the function of CERN guide, and we were allowed to give guided tours during or after working hours, and in particular on Saturdays.
After I retired in 1992, I continued to be a guide until I was 79 years of age, in 2009.

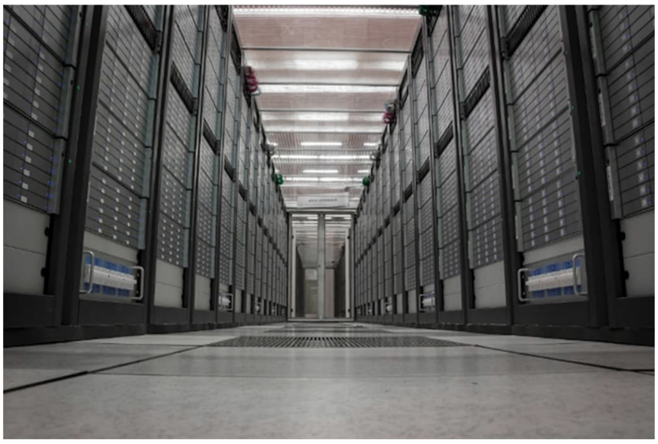
Félix Hoffmann in 2014. (Image: F. Hoffmann)

Being a CERN guide for over 50 years was a really interesting experience, which brought me into friendly contact with guides from other parts of CERN, go on excursions with them, meet visitors and sometimes even guide groups of famous people.
I remember the funniest question that anyone ever asked me was "Are any of the antiprotons that you produce for sale?"

Félix Hoffmann
CERN ID 51

An exabyte of disk storage at CERN

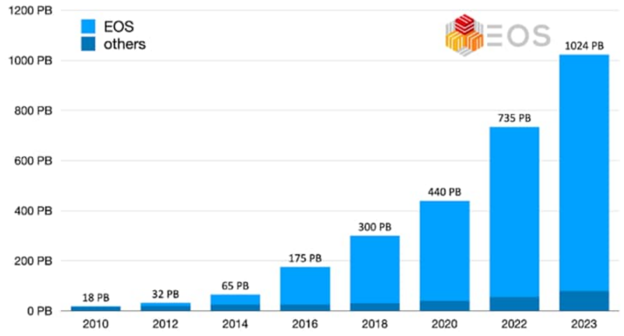
CERN disk storage capacity passes the threshold of one million terabytes of disk space



A fraction of the 111 000 devices that form CERN's data storage capacity. (Image: CERN)

CERN's data store has now crossed the remarkable capacity threshold of one exabyte, meaning that CERN has one million terabytes of disk space ready for data!
CERN's data store not only serves LHC physics data, but also the whole spectrum of experiments and services needing online data management.

This data capacity is provided using 111 000 devices, predominantly hard disks along with an increasing fraction of flash drives. Having such a large number of commodity devices means that component failures are common, so the store is built to be resilient, using different data replication methods. These disks, most of which are used to store physics data, are orchestrated by CERN's open-source software solution, EOS, which was created to meet the LHC's extreme computing requirements.
"We reached this new all-time record for CERN's storage infrastructure after capacity extensions for the upcoming LHC heavy-ion run," explains Andreas Peters, EOS project leader. "It is not just a celebration of data capacity, it is also a performance achievement, thanks to the reading rate of the combined data store crossing, for the first time, the one terabyte per second (1 TB/s) threshold."



This graph shows the capacity evolution of CERN's data store. (Image: CERN)

"This achievement marks the accomplishment of a significant target in data-handling capabilities. It sets new standards for high-performance storage systems in scientific research for future LHC runs," emphasises Joachim Mnich, CERN Director for Research and Computing.

How many bytes is that?
Megabyte = 1 000 000 bytes
Gigabyte = 1 000 000 000 bytes
Terabyte = 1 000 000 000 000 bytes
Petabyte = 1 000 000 000 000 000 bytes
Exabyte = 1 000 000 000 000 000 000 bytes

Tim Smith

HiLumi News: Recombination dipole prototype successfully tested for the LHC's high-luminosity upgrade

The D2 prototype magnet, developed and manufactured in Italy, has been integrated and tested in the longest HL-LHC cold mass with corrector magnets from China and CERN

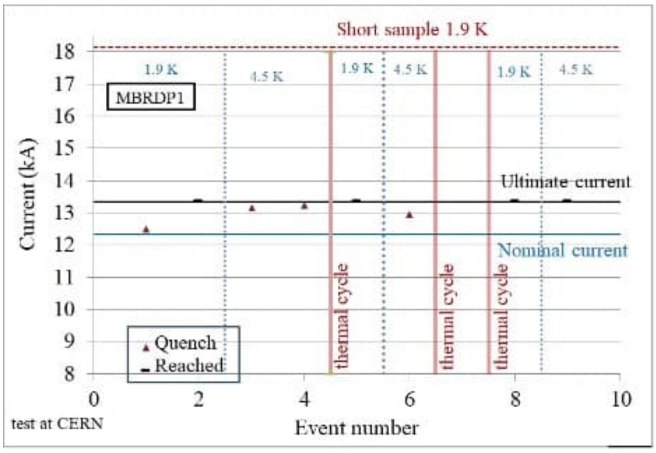
The longest HL-LHC cold mass, integrating magnets from Italy, China and CERN, on the test bench. (Image: CERN)

The LHC requires a variety of different types of magnets to direct the beams around its circular shape. Currently installed in the LHC's interaction regions are 9.45-m-long double-aperture magnets of 2.8 T, manufactured by BNL for the RHIC. For HL-LHC, the interaction region magnets will be replaced by the recombination dipole D2, the longest of all the HL-LHC interaction region magnets. While also based on the same Nb-Ti technology as the previous magnets, the D2 magnets have a stronger field (4.5 T) and a wider aperture. Thanks to this upgrade, the "kick" given to the beams to bring them on the same path around IP1 and IP5 will increase from 28 to 35 tesla-metres (T·m), allowing space to install the crab cavities.

The HL-LHC will need four units of these magnets, plus two spares. These six magnets are deliverables of a collaboration agreement between INFN-Genova and CERN. The Italian institute was in charge of the design and construction of a short model and a full-size prototype, and is now carrying out the series production. The construction of the magnets took place at ASG Superconductors, Genova.

After the prototype magnet was delivered in late 2021, the team at CERN integrated it in 2022 into a cold mass with two prototype orbit correctors providing 5 T·m dipolar kicks. These correctors are based on a canted cosine theta technology, proposed in the late 60s, which has had an increase in attention in the past decade for its potential wide range of applications. A prototype of these correctors was developed at CERN, a second one in China under the helm of IHEP, and the series magnets are an in-kind contribution of

China. These were then assembled alongside the D2 prototype in a 14-m-long cold mass at CERN.
The team at CERN ran power tests of the magnets from late 2022 to June 2023. The prototype D2 reached its performance requirements at 1.9 K, corresponding to operation at 7 TeV in the HL-LHC plus a 0.5 TeV margin (the so-called ultimate current).



Power test of the D2 prototype. (Image: CERN)

"We are extremely satisfied with the performances of the D2 prototype," says Stefania Farinon, from INFN-Genova, who is in charge of the D2 collaboration agreement. "We are now finishing the construction of the first series unit at ASG, which will be delivered to CERN at the end of September."
The powering of the correctors, already successfully tested in a standalone mode, showed an electrical issue in one of the circuits that will be analysed by the cold mass integration team. "Debugging these types of problems is one of the reasons to build prototype cold masses and not start directly with the series production," says Herve Prin, in charge of the cold mass assembly in the Large Magnet Facility at CERN.
As pointed out by Arnaud Foussat, the project engineer in charge of the magnet and of the correctors from CERN: "These results are remarkable, also considering that this complex prototype cold mass, assembling parts from Italy, CERN and China, was manufactured in a period in which collaborations and activities were jeopardised by the pandemic."

Ezio Todesco & Naomi Dinmore

Two new members elected to the Senior Staff Advisory Committee ("the Nine") in 2023


Sophie Baron (left) and Giovanna Vandoni (right), the new members of the Senior Staff Advisory Committee. (Image: CERN)

The electronic voting process for the Senior Staff Advisory Committee (known as "the Nine") closed at midnight on Friday, 25 August 2023.
The Senior Staff Advisory Committee was created in 1981 to serve as a channel of communication between the senior staff (grade 8 and above) and the Director-General. It is made up of nine members elected by the senior staff for a period of three years. The Nine share the ideas and feedback of the senior staff with the Director-General and offer advice on questions concerning scientific activities, organisational matters and use of resources. Elections for the Nine are held every year, ensuring an annual rotation of members.
In August 2023, out of the 576 senior staff members eligible to vote, 326 voted.
Candidates stood for election for Electoral Group 2 (members of IT, RCS, SCE, HSE and ATS, and members of EP and TH who are NOT in Electoral Group 1)*.
Sophie Baron and Giovanna Vandoni were elected to replace the outgoing Nine members, Stefan

Lüders and myself. Their mandate is from September 2023 to August 2026.
Christoph Rembser has been appointed as the new spokesperson for one year, starting in September 2023. The Nine now consists of the two newly elected members together with [end of mandate in brackets]:

- Marzia Bernardini [2025]
- Markus Brugger [2025]
- Cécile Curdy [2025]
- Niko Neufeld [2025]
- David Barney [2024]
- Christophe Delamare [2024]
- Christoph Rembser [2024]

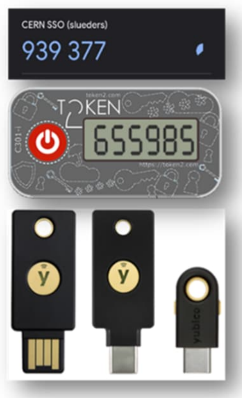
I wish to congratulate the newly elected members and warmly thank all the other candidates for having stood for election. Special thanks go to our polling officer, Alberto Pace.
Eric Montesinos, outgoing spokesperson of the Nine

The Nine seek input for topics to be investigated throughout the year, so please feel free to get in touch, either by sending an email to mailto:the-nine@cern.ch or by contacting one of its members. In 2023/2024 we meet once per week, on Thursdays from 12.15 p.m. to 1.45 p.m., and you are welcome to join the first 15–20 minutes of our meeting to raise your topic in person. We would appreciate your contacting one of us, either in person or by phone/email, in advance for more information, e.g. where we meet. Details of previous topics are available on the Nine pages (https://thenine.web.cern.ch/).

** Electoral Group 1: Research physicists/principal research physicists and applied physicists/principal applied physicists in EP or TH; Electoral Group 2: Members of IT, RCS, SCE, HSE and ATS, and members of EP and TH who are NOT in Electoral Group 1; Electoral Group 3: Members of DG, FAP, HR, IPT, IR and PF.*

Computer Security: T2U4U2FA* (* Thanks to you for using 2FA)

One year ago, the CERN Computer Security team and the IT Identity Management team started the CERN-wide roll-out of multifactor authentication to staff and users. The combination of a second "factor", i.e. something you have, and the primary factor "something you know"[1], i.e. your password, provides the ultimate silver bullet for the protection of your CERN computing account: "2-factor authentication" (2FA). This was seriously needed as, in our latest phishing campaign in August 2022, more than 2000(!) people provided their password to a fake login page. 2FA would have protected their accounts from any evil-doing. Hence, many thanks to you – T2U!
Technically, this new 2FA protection is not very different from that deployed for your Google mailbox or your bank account. And bear in mind that your CERN account is there not only to give you access to your emails and your money but also potentially provides you with much more power, with much more severe consequences if your account password is lost to an evil, malicious attacker. With your password gone, the attacker might be able to steer particle beams into uncharted territories and create previously unseen damage, delete our precious physics data or manipulate it such that none of our results make sense anymore, misuse data centre computing resources to create crypto-money or manipulate our invoices to extract money, or access confidential and sensitive information owned by or stored within the Organization…



After extensive experience of using 2FA to protect administrator access to CERN's data centre (using the "AIADM" gateways), expert access to our accelerator control systems (via the so-called "ROG") and CERN's VPN service, last summer we started adding 2FA protection to CERN web applications accessible via CERN's new Single Sign-On (SSO)[2]. Since then, the new CERN SSO requires your 2FA about every 12 hours when you stay on the same device. That's all. One quick extra step every half-day when using the same device. And at every login you can choose whether you want to use the one-time password (OTP) generator installed on your Android smartphone or iPhone (top row in the photo below, currently we recommend the privacy-preserving and secure "Aegis Authenticator"; and "Raivo OTP";), a pocket-style OTP generator (middle row) or a USB hardware dongle ("Yubikey", bottom row). Easy as pie – but also a potential pain in the arm when you are part of the population who regularly forgets their smartphone or keychain at home. In that case, it's like with your dosimeter: do a U-turn and head back home. So, acknowledged!, 2FA does add another (minor) inconvenience when accessing CERN's computing facilities. Sorry for that – S4T.

On the other hand, as mentioned before, 2FA provides the right industrial-standard state-of-the-art level of access protection that the Organization desperately needed. In fact, more than 5500 account owners from ATS & FHR desktop support, the BE/EN/FAP/IPT/IT/SY/TE departments, the CERN Pension Fund, the DG-IA/LS/TMC services & the Directorate secretariats, the EP-AGS/AID-DC/CMD/CMG/DI/DT/ESE/LBC/LBD/LBO/SFT/SME, HR-DHO/PXE, and RCS-SIS groups, the HSE unit, the IR sector, SCE-SMS/Site Security, SERCO support, and MPEs of the TH department as well as users of the AIADM/AITNADM/CS-CCR-DEV/ROG gateways, have already (been) enrolled for 2FA protection of their accounts. And the numbers of complaints, problems, issues, questions and the like raised with us were few and far between – and very appreciated to make 2FA even better. Hence, once more, a big THANKS to you – T2U!!!!

And we're not done yet. We still have some communities at CERN who have not yet been enrolled into 2FA protection. We'll address this by the end of the year. And we'll look into enlarging 2FA protection to other means, like CERN's Terminal Service. And, of course, we'll follow the evolution of 2FA software and might add new/other 2FA tokens to make your life even easier. If you're interested in joining and haven't done so yet, check out our Knowledge Base article here (https://cern.service-now.com/service-portal?id=kb_article&n=KB0006587). Thanks to you for using 2FA protection: T2U4U2FA. And S4T – sorry for those – who aren't yet enjoying its merits and benefits...

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[1] The third and last factor is "something you are" like using your fingerprint, an iris scan (like when entering the accelerator complex) or a blood/DNA sample. For obvious reasons, none of these are appropriate for digital access to your CERN account.

[2] Websites behind the old SSO are not affected as this old SSO has to die and shall RIP by the end of the year.

The Computer Security team

Official news

Changes to provision of duty travel services at CERN

A call for tender for the provision of duty travel services was launched in autumn 2022. As endorsed by the Enlarged Directorate in March 2022, the specifications did not include the obligation to offer on-site services.

The procurement process has resulted in a new supplier, Egencia, being selected to provide such services online with a team of agents supporting CERN off-site from 1 January 2024. As a result, CWT has decided to reallocate most of the CERN

on-site resources to their service centre in Nyon since 1
September and will be operating this hybrid service until the end of the year.
Trainings on the future online booking tool will be programmed towards the end of the year and in the start of 2024 for members of the personnel.

Questions can be addressed to the Duty Travel Coordination service (https://phonebook.cern.ch/search?q=duty+travel+coordination).

FAP department

Announcements

IT-SOS: a new place dedicated to basic IT support opens in Restaurant 2 on 2 October

The IT department is trialling a new drop-in desk called IT-SOS, which stands for "IT Support On-Site"

Links Sometimes it's quicker to show an IT problem in person and more efficient to test and troubleshoot interactively, so from 2 October, you will be able to drop by this new location and get hands-on assistance with a wide range of IT issues, such as:

- support with hardware, e.g. repairs, cables, chargers and adapters (to use, borrow or buy on budget code)
- assistance with basic IT services, such as email, network connections, storage, permissions and managing two-factor authentication
- assistance with supported Operating Systems such as Linux, MacOS and Windows
- help with telephony devices as IT-SOS replaces the popular Labo Telecom
- advice on other IT software and tools

All this at an easily accessible location in Restaurant 2 (Building 504/R-005, between the coffee area and the cash machine).
Opening hours: Mon–Fri, 8.00 a.m.–5.00 p.m. non-stop
Service Portal page: IT-SOS (https://cern.service-now.com/service-portal?id=it_sos)
Of course, our ticketing system on the CERN Service Portal provides efficient support to answer all your questions and, importantly, this new area is intended to complement rather than replace the Service Desk in Building 55, which covers IT and the whole of CERN.
And if the IT-SOS team are not able to quickly resolve your issue, then a ticket will be created for you with the relevant details and sent to the appropriate experts.
Our friendly support staff look forward to welcoming you there soon!

IT department

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5 octobre | Présentation du livre "Ottantesimo parallelo. Un'avventura tra scienza e ghiacci" de Paola Catapano

This announcement is in French, thank you for your understanding.

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Présentation du livre *"Ottantesimo parallelo. Un'avventura tra scienza e ghiacci"* (Salani, 2023) de Paola Catapano (IR-ECO), en collaboration avec la *Società Dante Alighieri*, Genève.
Le 5 octobre de 18h30 à 20h à la Bibliothèque du CERN (52/1-052)
Langues : francais, italien
Modération : Mara Marino, présidente de la *Società Dante Alighieri*, Genève
Lectures (en italien) : Ottavia Fusco Squitieri, actrice
Le livre est disponible : CERN Library & Bookshop.

Résumé :
En 2018, l'expédition Polarquest s'est lancée dans une aventure exceptionnelle, suivant les traces de la célèbre expédition au pôle Nord de 1928. Nanuq, un voilier écologique, avait des objectifs scientifiques : mesurer le rayonnement cosmique à haute latitude et échantillonner la présence de micro-plastiques dans l'Arctique. Cependant, le voyage a conduit à des découvertes inattendues et significatives, soulignant la détermination des explorateurs à repousser les limites de la connaissance et à imaginer un avenir différent pour l'humanité.
Une aventure mêlant la passion pour l'exploration avec la science et la durabilité.

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Plus d'informations sur la page Indico de l'événement : https://indico.cern.ch/event/1325490/.

CERN Library

Alumni event on 6 October: Moving out of academia into consulting

Building on the success of previous events in the "Moving Out of Academia" series, we would like to provide CERN Alumni – or soon to be alumni – with the opportunity to learn more about how fellow alumni successfully managed a **transition from academia to consulting**.
For those contemplating entry into this sector, this is your opportunity to come along with your questions and obtain first-hand information from our panellists.
The first part of the event is focused on the **nature of the work carried out by our panellists** and on other skills they acquired at CERN that have helped them (or not) in the transition. They also explain which additional skills they had to develop after CERN for a successful career move.
The second part of the event will provide you with very **practical advice** on how to prepare for such a transition, how to get started, what errors to avoid, where to look for help and how to promote your talents.
6 October – from 2 p.m. to 5 p.m.
Registration on the Alumni website (https://alumni.cern/events/120455).

Join three interactive sessions on effective tools to better deal with stress

In today's fast-paced world, stress has become an increasingly prevalent and often overwhelming aspect of our lives. While it is generally a positive emotion, giving us motivation and drive, it can be harmful to our health if it occurs over too long a period of time without sufficient time to recover. Whether it stems from work, relationships or other external factors, stress can significantly impact our well-being and quality of life. It is also the leading underlying cause of mental health issues and other diseases. However, by understanding what stress is, how it affects our bodies and brains, and implementing effective techniques to manage it, we can regain control and lead more balanced, fulfilling lives.

Stress is the most common issue cited by those seeking help from the CERN psychologists. In the light of World Mental Health Day on 10 October, whose overall objective is to raise awareness of mental health issues around the world and mobilise efforts in support of mental health, and of the "Efficiency and caring at work" awareness campaign announced by HR on 11 September, CERN's Medical service and psychologists invite you to **three interactive sessions to learn effective and useful tools to better deal with stress**.

The sessions will be held in both English and French. Places are limited, so register early to secure your place. Sessions will also be webcast and recorded. Follow the links below for more information.

You can find out more about mental health support at CERN on the dedicated Medical Service webpage (https://hse.cern/MentalHealth).

The CERN Medical Service and psychologists

Wednesday, 11 October – Flash disconnection
Discover a new tool to disconnect rapidly, reduce stress and recover your mental agility.
Room 774/R-013 (Prévessin): https://indico.cern.ch/event/1308955/
English session: 11.30 a.m. – 12.30 p.m.
French session: 1.30 p.m. – 2.30 p.m.

Wednesday, 18 October – Cardiac coherence
Learn how to manage your stress and increase your efficiency in just a few minutes a day with cardiac coherence.
Room 774/R-013 (Prévessin): https://indico.cern.ch/event/1308970/
English session: 11.30 a.m. – 12.30 p.m.
French session: 1.30 p.m. – 2.30 p.m.

Wednesday, 25 October – Self-evaluation tool
Presentation of a tool to help you gauge the state of your mental health so you can take action and prevent mental exhaustion.
Room 31/3-004 (IT Amphitheatre): https://indico.cern.ch/event/1308976
English session: 11.30 a.m. –- 12.30 p.m.
French session: 1.30 p.m. –- 2.30 p.m.

Photo Challenge! Take a picture of the new CERN Library and participate in the challenge until October 8

The new CERN library is being inaugurated on 28 and 29 September. We invite you to visit the new library, alone or with your colleagues or friends, but in all cases with your camera or smartphone!

Take photos of the new library, of its equipment, of you and your friends or colleagues in the new library…and submit your preferred photo(s) to the Photo Challenge (https://indico.cern.ch/event/1289266/registrati ons/96009/). At the end of October, the jury, composed of the members of the Archive & Library Team, will select the three winning photos. The photographers, as well as the people in the photo (maximum five people per photo), will win a prize! The Library Team is here to answer your questions in-person at the library desk, Monday to Friday, 9 a.m. to 6 p.m. or by email at library.desk@cern.ch.

CERN Library

Obituaries

Maria Fidecaro (1930 – 2023)

We are deeply saddened to learn that Maria Fidecaro, an experimental physicist who joined CERN in 1957, passed away on 17 September. Maria was a familiar face to the CERN community until long into her retirement, often seen arm-in-arm with her husband Giuseppe as they made their way through the CERN corridors. She was also well-known to CERN visitors, featuring prominently in the Synchrocyclotron exhibition's film.

Maria Fidecaro at her CERN retirement party in 1995. (Image: CERN)

Born in Rome in 1930, Maria completed her university studies at La Sapienza in 1951, studying cosmic rays using a detector located on the Matterhorn. In 1954, she and her future husband went to the University of Liverpool. Maria had obtained a fellowship from the International Federation of University Women while Giuseppe had obtained a CERN fellowship to carry out research at the Synchrocyclotron, CERN's first accelerator. After their marriage in July 1955, they carried out pion experiments: Maria with a diffusion chamber and Giuseppe with a lead-glass Cherenkov counter.

In summer 1956, the couple moved to Geneva, joining only a few hundred people at CERN, the Laboratory having been established just two years earlier. Maria obtained a CERN fellowship in 1957 and began working in a team of three that was developing a novel method to provide polarised proton beams at the Synchrocyclotron and would later carry out polarisation experiments at the PS and SPS. She remained at CERN for the rest of her career, where her early research interests included charge-exchange nucleon–nucleon scattering and proton–proton elastic scattering.

During the 1990s, Maria worked on detectors and analysis for the CPLEAR experiment, which was designed to enable precision measurements of CP, T and CPT violation in the neutral kaon system. She designed and led the construction of a high-granularity electromagnetic calorimeter, helping CPLEAR to achieve new levels of precision in the study of fundamental symmetries. From 1991 to 1995, she was group leader of the CPL group in the Particle Physics Experiments division. She also took part in the NA48/2 experiment, searching for CP violation in the decay of charged kaons, and contributed to the early phases of NA62.

Maria celebrated her retirement in 1995, but this did not mean the end of her research. She and Giuseppe continued their work at CERN as honorary members of the personnel. As Maria explained in an interview in 2012, "every day or every week there is something new connected with our old work".

A full obituary article will appear in the *CERN Courier*.

Oscar Barbalat (1935 – 2023)

Extracted proton beam of the PS: Oscar Barbalat at work. (Image: CERN)

Oscar Barbalat, electronics engineer and knowledge transfer pioneer at CERN, died on 8 September, aged 87. Born in Liège, Belgium, in 1935, he joined CERN in 1961, working initially for the PS-RF group. At the time, the PS beam intensity was still below 10^9 protons/pulse and the beam control system was somewhat difficult to master, even though the operations consisted mainly of striking internal targets at 24 GeV/c. The control system became increasingly complex when the PS slow-resonant extraction system of Hugh Hereward was put into service. A machine study team of expert accelerator physicists (Dieter Möhl, Werner Hardt, Pierre Lefèvre, Aymar Sörensen and Oscar Barbalat) tackled this issue, with Oscar writing a substantial FORTRAN simulation program to understand how the extraction efficiency depended on its numerous correlated parameters.

In the 1970s, the PS Division set out to digitise the controls of all PS subsystems (Linac, PS Booster, RF, beam transport systems, vacuum system, beam observation, etc.). These subsystems used independent control systems, which were based on different computers or operated manually. Oscar was tasked with devising a structured naming scheme for all components of the PS complex. After producing several versions, in collaboration with all the experts, the fourth iteration of his proposed scheme was adopted in 1977.

To design the scheme, Oscar used the detailed knowledge he had acquired of the accelerator systems and their control needs. His respectful and friendly but tenacious way with his colleagues enabled him to explore their desires and problems, which he was then able to reconcile with the needs of the automated controls. Oscar was modest. In the acknowledgements of his naming scheme, he says: "This proposal is the result of numerous contributions and suggestions from the many members of the division who were interested in this problem and the author is only responsible for the inconsistencies that remain."

On Giorgio Brianti's initiative, following the interest of the CERN Council's Finance Committee, the *"Bureau de Liaison pour l'Industrie et la Technologie"* (BLIT) was founded with Oscar in charge. His activity began in 1974 and ended in 1997 with his retirement. His approach to this new task was typical of his and CERN's collaborative style: low key and constructive. He was eager to inform himself in detail and he had a talent for explaining unclear technical aspects to others. It helped that he was well educated with broad interests in people, science, technologies, languages and cultural and societal purposes. He built a network of people who helped him and whom he convinced of the relevance of sharing technological insights beyond CERN.

After more than 20 years developing this area, he summarised the activities, successes and obstacles in "Technology Transfer from Particle Physics, the CERN experience 1974-1997". When activities began in the 1970s, few considered the usefulness of CERN technologies outside of particle physics as a relevant objective. Now, CERN prominently showcases its impact on society. After his retirement, he continued to be interested in CERN technology transfer, and in 2012 he became a founding member of the international Thorium Energy Committee (iThEC), promoting R&D in thorium energy technologies.

No doubt, Oscar is the pioneer of what is now Knowledge Transfer at CERN.

We will miss him.

His colleagues and friends

Ombud's corner

How the Ombud can help Doctoral Students

A very interesting article (https://ioa.memberclicks.net/assets/docs/JIOA_Articles/JIOA-2022-D-2.pdf) published in 2022 in the Journal of the International Ombudsman Association (JIOA) caught my attention as it examines the specific role that ombuds may play in supporting doctoral students.

For each of the past two years, CERN has hosted more than 230 doctoral students*, as part of its Doctoral Student Programme.

In my role as Ombud, I have been visited by many doctoral students. They come to discuss a variety of issues, but the common denominator in all situations is their significant vulnerability.

In this article, I would like to address where this vulnerability comes from, what impact it may have on the students and their PhD trajectory, and how important it is to seek support without delay.

A CERN doctoral student is attached to a university and has a university supervisor and a CERN supervisor. The student may also have a day-to-day supervisor, in cases where the CERN supervisor delegates part of their supervisory role. In most cases, CERN almost exclusively provides the financial support for this programme, for a maximum period of 36 months.

The JIOA article outlines some of the most common problems encountered by PhD students, as seen from an Ombud's Office. Below are the ones I have observed in my role:

Problematic relationships between supervisors and PhD students

In principle, the presence of two supervisors (one from CERN and one from the university) should mean that there is always an available supervisor, even in situations where cooperation between the PhD student and one of the supervisors has become difficult, or even unworkable.

However, in some cases, the university supervisor – often a full professor – may only be sporadically involved. In this case, bad chemistry between the student and the CERN supervisor, or simply a lack of availability of the supervisor, may become a critical issue.

Insufficient planning and follow-up between supervisors and PhD students

A clear and well-defined research plan is essential at the beginning of a PhD, and one is in place in most cases at CERN. However, if such a plan is not available, delays occur.

At CERN, the Doctoral Student Programme is mainly implemented within large collaborations, where doctoral students start their research in a well-established research environment. Students in other domains may need to be more proactive in setting up their research environment, which can delay the completion of their PhD.

Furthermore, CERN expects PhD students to complete "service tasks", i.e. tasks not directly related to the student's research, in the same way that the university may expect some educational tasks from the student. This service time, which may differ greatly between PhD positions, is included in the 36 months of financial support from CERN and may reduce the time students can dedicate to their research.

PhD students often complain to the Ombud that meetings with their supervisors (university and/or CERN supervisors) do not take place often enough. Regular meetings, adapted to the students' needs, are important to guide them and ensure they stay on track.

The CERN guidelines for university supervisors underline the need for regular contact between the university and CERN supervisors. They also state that the CERN supervisor's group should invite the university supervisor to CERN at least twice during the 36 months. These visits and regular contact help to make university supervisors more aware of the CERN environment and the constraints on CERN supervisors. For the university supervisor, it is also important to ensure that the PhD student sticks to the plan and is making progress.

Insufficient follow-up on the research plan between supervisors and PhD students may create tense work relationships and inequalities between students.

Competencies of the PhD student
PhD students may have little to no experience in academic writing. As a matter of fact, CERN offers a range of courses that are particularly relevant for doctoral students. These include Convincing Scientific Presentations; Fast Forward, the productivity system for researchers; Resilience for Researchers; and Scientific writing.

Nevertheless, poor mastery of such competencies, especially for non-native English-speaking students, may also lead to delays in the PhD trajectory.

Impact of delays
Delays mean the clock is ticking, and mainly – though not only – to the disadvantage of PhD students:

- Psychological problems and stress-related problems such as depression and burn-out
- If delays are such that the student exceeds their 36 months' allocated support, financial problems might occur and, for some students, problems accessing laboratories and research materials and equipment.

How can the Ombud help?
In the event of a problem, it is vital that the PhD student seeks support as early as possible and before the situation becomes unmanageable. There are several support channels available:

The doctoral student coordinators in the Human Resources Department are available to help and find solutions.

The CERN psychologists are here to provide support in cases where the difficulties are such that they might impact the student's mental health.

In some cases, it is desirable for PhD students to be able to rely on the support of an independent, informal, neutral, and impartial ombud, who is bound by the strictest confidentiality. When in doubt about who to contact, the student may of course use the Ombud as an starting point.

Provided that the Ombud is contacted early on when the difficulties arise, they can play an important role in listening actively, providing information and opening discussions between the supervisor – at CERN or at the university – and the student, and help them explore solutions to improve their work relationship.

Finally, the Ombud may mediate in improving working conditions and in resolving disputes between the supervisor(s) and the PhD student and achieving solutions that are timely, fair, and humane.

If you are a PhD student, or the supervisor of a PhD student, and you are experiencing difficulties in the working relationship, especially if these difficulties are causing delays to the research plan, I recommend that you contact the CERN Ombud or the ombud in the student's home institute without delay to discuss the situation. As an independent, impartial, informal, and confidential resource, the Ombud is in a position to provide you with effective support.

Laure Esteveny

I would like to hear your reactions and suggestions – join the CERN Ombud Mattermost team at https://mattermost.web.cern.ch/cern-ombud/.
All information on the role of the CERN Ombud and how to contact her may be found at https://ombud.web.cern.ch/

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* Figures from HRT 11/9/2023