CERN Bulletin

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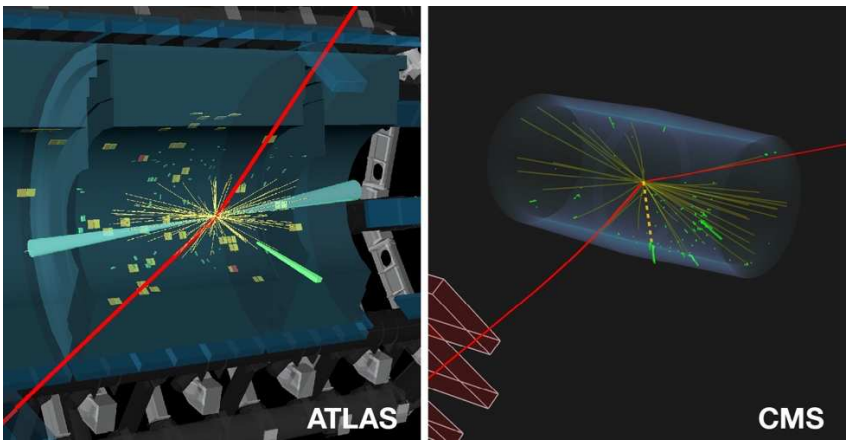
LHC experiments see first evidence of a rare Higgs boson decay

The ATLAS and CMS collaborations have joined forces to establish the first evidence of the rare decay of the Higgs boson into a Z boson and a photon



Candidate events from ATLAS (left) and CMS (right) for a Higgs boson decaying into a Z boson and a photon, with the Z boson decaying into a pair of muons. (Image: CERN)

The discovery of the Higgs boson at CERN's Large Hadron Collider (LHC) in 2012 marked a significant milestone in particle physics. Since then, the ATLAS and CMS collaborations have been diligently investigating the properties of this unique particle and searching to establish the different ways in which it is produced and decays into other particles.

At the Large Hadron Collider Physics (LHCP) conference this week, ATLAS and CMS report how they teamed up to find the first evidence of the rare process in which the Higgs boson decays into a Z boson, the electrically neutral carrier of the weak force, and a photon, the carrier of the electromagnetic force. This Higgs boson decay could provide indirect evidence of the existence of particles beyond those predicted by the Standard Model of particle physics.

The decay of the Higgs boson into a Z boson and a photon is similar to that of a decay into two photons. In these processes, the Higgs boson does not decay directly into these pairs of particles. Instead, the decays proceed via an intermediate "loop" of "virtual" particles that pop in and out of existence and cannot be directly detected. These virtual particles could include new, as yet undiscovered particles that interact with the Higgs boson.

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The Standard Model predicts that, if the Higgs boson has a mass of around 125 billion electronvolts, approximately 0.15% of Higgs bosons will decay into a Z boson and a photon. But some theories that extend the Standard Model predict a different decay rate. Measuring the decay rate therefore provides valuable insights into both physics beyond the Standard Model and the nature of the Higgs boson.

Previously, using data from proton–proton collisions at the LHC, ATLAS and CMS independently conducted extensive searches for the decay of the Higgs boson into a Z boson and a photon. Both searches used similar strategies, identifying the Z boson through its decays into pairs of electrons or muons – heavier versions of electrons. These Z boson decays occur in about 6.6% of the cases.

In these searches, collision events associated with this Higgs boson decay (the signal) would be identified as a narrow peak, over a smooth background of events, in the distribution of the combined mass of the decay products. To enhance the sensitivity to the decay, ATLAS and CMS exploited the most frequent modes in which the Higgs boson is produced and categorised events based on the characteristics of these production processes. They also used advanced machine-learning techniques to further distinguish between signal and background events.

In a new study, ATLAS and CMS have now joined forces to maximise the outcome of their search. By combining the data sets collected by both experiments during the second run of the LHC, which took place between 2015 and 2018, the collaborations have significantly increased the statistical precision and reach of their searches.

This collaborative effort resulted in the first evidence of the Higgs boson decay into a Z boson and a photon. The result has a statistical significance of 3.4 standard deviations, which is below the conventional requirement of 5 standard deviations to claim an observation. The measured signal rate is 1.9 standard deviations above the Standard Model prediction.

“Each particle has a special relationship with the Higgs boson, making the search for rare Higgs decays a high priority,” says ATLAS physics coordinator Pamela Ferrari. "Through a meticulous combination of the individual results of ATLAS and CMS, we have made a step forward towards unravelling yet another riddle of the Higgs boson."

“The existence of new particles could have very significant effects on rare Higgs decay modes,” says CMS physics coordinator Florencia Canelli. “This study is a powerful test of the Standard Model. With the ongoing third run of the LHC and the future High-Luminosity LHC, we will be able to improve the precision of this test and probe ever rarer Higgs decays.

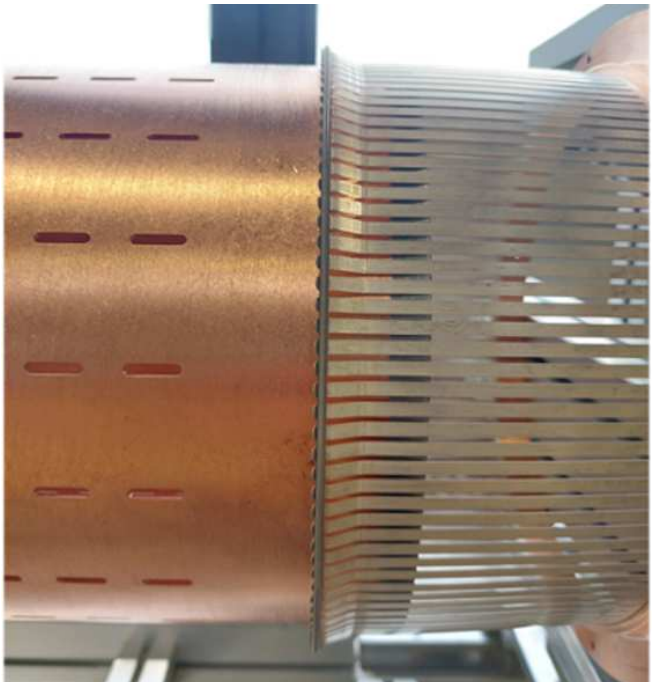
Accelerator Report: Overcoming setbacks, antiprotons return as LHC recovers luminescent brilliance

The Accelerator Report published on 10 May highlighted that the 2023 antiproton physics run was delayed by 50 days (reducing the run to 122 days instead of the 172 initially scheduled) due to a broken magnet in the injection region of the Antiproton Decelerator (AD). Consequently, the beam commissioning of the AD was due to start on 12 June and the delivery of antiprotons to the AD-ELENA experiments on 30 June.

Following the hard work of many experts, the AD operations team received on Friday, 1 June at 11:58 – 12 days earlier than rescheduled – the green light from the AD injection kicker expert: beam could be injected again in the AD ring, signalling the start of the beam commissioning. The AD operations team and the equipment experts rescheduled their activities to focus on the AD beam commissioning in order to bring forward the rescheduled start of physics, reducing the

number of lost physics days from 50 to about 40. This is, of course, much welcomed by the AD-ELENA experimental users, who are eagerly awaiting low-energy antiprotons to perform their experiments.

The rest of the LHC injector chain is running well for the LHC and the fixed-target experiments. However, the LHC suffered a temporary dip in luminosity production due to the replacement last week of a radiofrequency (RF) finger module in the machine section located near the ATLAS experiment (Point 1).



The RF finger module (right-hand side) ensures a low-impedance (low-resistivity) electrical connectivity between the LHC vacuum chambers. When this electrical connection is not good enough, it affects the circulating beam by making it unstable, deteriorating its quality or creating losses that can lead to a beam dump. (Image: CERN)

In the early evening of Thursday, 25 May, the LHC beam was dumped during acceleration on two consecutive fills. Both beam dumps were triggered by slow local losses* left of Point 1. X-ray imaging investigations and beam-loss studies led to the conclusion that one of the RF finger modules in a warm section was heating up or arcing, degrading the vacuum in that area and causing the slow local beam losses. The luminosity production was interrupted and, during the long Whitsun weekend, various teams intervened in the LHC tunnel to replace the RF finger module (with subsequent vacuum pumping). Already in the morning of Tuesday, 30 May, beams were injected and circulated to check the vacuum conditions. In the evening, a first fill with only 700 bunches per beam, followed by a second fill with 1200 bunches, were used for physics while also conditioning the area of the newly installed RF finger module. In the following days, the intensity ramped up to 2400 bunches and, in a second stage, the intensity per bunch was increased from 1.3×10^{11} to 1.6×10^{11} protons per bunch.

Until further notice and pending greater understanding of the cause of the RF finger module fault, the bunch intensity will be limited to 1.6×10^{11} protons per bunch. By now, the LHC is again filled with the default 2400 bunch filling scheme with 1.55×10^{11} protons per bunch, producing close to 1 fb^{-1} per day. As I write, the integrated luminosities for ATLAS and CMS are each 16 fb^{-1}, which is about 5 fb^{-1} below the target value, but we're catching up.

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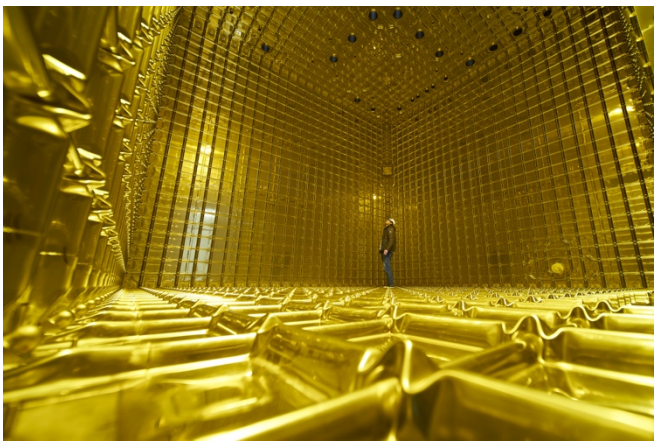
** "Slow local losses" happen when some beam particles get lost in specific parts of the ring when interacting with the gas molecules in the degraded vacuum. This process takes some time before the threshold to dump the beam is reached.*

Rende Steerenberg

Live: Particle pursuit, a journey of the Deep Underground Neutrino Experiment

Join CERN, Fermilab and Sanford Underground Research Facility on 15 June at 6 p.m. CEST for its first gameshow-style livestream to learn about all things neutrinos



A view of the ProtoDUNE cryostat at CERN. (Image: CERN)

On 15 June, join CERN, Fermilab and Sanford Underground Research Facility (SURF) for an interactive livestream that will take you on a journey of the Deep Underground Neutrino Experiment (DUNE). The CERN Neutrino Platform has provided a large-scale demonstration of the future DUNE detectors with the construction and operation of two prototypes known as ProtoDUNE.

The DUNE experiment is hosted by the U.S. Department of Energy's Fermi National Accelerator Laboratory, and more than 1000 scientists and engineers from 35 countries spanning five continents – Africa, Asia, Europe, North America and South America – are working on the development, design and construction of the DUNE detectors. The experiment seeks to understand the nature of neutrinos – almost massless particles that could help answer fundamental questions such as why the Universe has much more matter than antimatter.

DUNE will be built at two locations: Fermilab, near Chicago, and SURF, in South Dakota. The Fermilab particle accelerator complex will provide the world's most intense beam of high-energy neutrinos and send it 1300 kilometres through Earth to huge neutrino detectors 1.5 kilometres underground at SURF. ProtoDUNE, the largest liquid-argon neutrino detector in the world, recorded its first particle tracks from both cosmic rays and a beam created at CERN's accelerator complex in 2018. ProtoDUNE is all set to begin its second run this year.

To mark the occasion, CERN will go live from the Neutrino Platform with the two other international laboratories -– Fermilab will broadcast from the control room for its neutrino experiments and SURF from its Ross Hoistroom.

Follow the live from CERN on Facebook, LinkedIn and YouTube on 15 June at 6 p.m. CEST (GMT +2). The live will also be broadcasted simultaneously on Fermilab (11 a.m. CDT) and SURF (10 a.m. MDT) social media channels.

What makes studying neutrinos unique? Why do we need a giant liquid-argon detector to study neutrinos? You can submit your questions as a short video clip to CERN, Fermilab and SURF directly via Instagram by 10 June at the latest. If selected, your questions will be answered directly by the experts from the three laboratories working on the DUNE experiment.

The livestream will be in quiz-show style, so be ready to test your knowledge of all things neutrinos while going on this journey of DUNE with CERN, Fermilab and SURF.

Watch the teaser on CERN's Youtube channel: https://youtu.be/u0QajtaCENA.

Discover how IdeaSquare will form part of the upcoming CERN Science Gateway offerings

The resources developed by IdeaSquare for the Crowd4SDG project will continue to drive innovation through future Science Gateway workshops and masterclasses

Finalists of the Crowd4SDG conference. (Image: Crowd4SDG)

In March 2023, five student teams stepped onto the stage at the Globe of Science and Innovation to showcase their technological solutions to global problems: from tackling waste disposal in Italy, to hand pump borehole monitoring in Sub Saharan Africa, to mapping flood levels in real time in San José in California, USA.

IdeaSquare has helped these young innovators through organising online challenge-based innovation (CBI) workshops, allowing teams to build prototypes and develop their projects into a reality. These students were the finalists of Crowd4SDG, an EU-funded project in which CERN has been a key partner, with a focus on how citizen science and crowdsourcing tools can be used to address the United Nations Sustainable Development Goals (SDGs).

This is just one example of the CBI workshops offered by IdeaSquare, which currently co-designs and runs over 22 project-based student courses with international universities. IdeaSquare, in collaboration with Crowd4SDG, developed a handbook as a guide to CBI workshops for citizen science, designed to help others' organise such events.

IdeaSquare will form part of the upcoming CERN Science Gateway offerings, scheduled to open its doors in October 2023. The space will now adapt the lessons learned through Crowd4SDG and other experiences and apply them to future workshops for the public. As part of CERN Science Gateway, IdeaSquare will hold monthly workshops and masterclasses to visiting students, centred around topics such as science, sustainability and future thinking. In addition to workshops, IdeaSquare will also offer monthly visits to the space, showcasing the experiments and prototyping taking place. The student programme final gala will also be held at the Science Gateway later this year.

Find out more information about the current activities of IdeaSquare here (https://ideasquare.cern/) and more about CERN Science Gateway here (https://sciencegateway.cern/).

Alexia Yiannouli

CERN marks World Environment Day with a new video

Monday 5 June marked the 50th anniversary of World Environment Day, one of the United Nations' vehicles for encouraging worldwide awareness and action for the environment. As a leading scientific organisation, CERN is committed to environmentally responsible research, with the support of its Member and Associate Member States and collaborating institutes, notably through the European Particle Physics Communications (EPPCN network). On this special day, CERN published a new video (https://videos.cern.ch/record/2297993) showcasing the diverse ways in which it acts to minimise its impact on the environment.

CERN will publish its third environment report later this year. In the meantime, you can find out more in its first and second reports on: https://hse.cern/environment-report.

Computer Security: Zebra has been hacked. Again.

After the serious compromise of 2022, the Zebra Scientific Alliance has been compromised again – hit hard by an attacker. Zebra's IT experts and computer emergency response teams are on the prowl, trying to get to the bottom of the malicious deeds. The scenario is opaque. Details are unclear. Log files are missing. Time is running out. Pressure rises. The police are pushing. Journalists are inquiring. And nothing is as it seems.

Fortunately, Zebra is not real. Fortunately, nobody has been attacked here. Fortunately, this is just a table-top exercise for system administrators, computing personnel and security experts to better understand the complexity of today's IT sphere, the interconnectivity of data centres and the problems that can arise when resolving large-scale cyber-security incidents. A mysterious, but serious, crime, for which teams have to join forces. In order to save the Zebra Scientific Alliance from disaster. To protect its reputation. To enable research to resume quickly. And to find the culprit who has put Zebra's mission at risk.

The exercise has been designed to depict the complexity of real computer security incidents as handled in the past by the CERN, EGI and WLCG computer incident response teams (CSIRTs). Usually, such incidents are vast, involving lots of different partners, several physically distant sites and administrators responsible for different layers of the local software stack, like the operating system, web applications and databases. Some administrators might not understand or know what is running within their data centre, others are busy with daily operations and reluctant to help, and others might not even speak or understand your language. Local computer emergency response teams might lack the necessary skills or tools or simply do not exist. Access and system logs are usually incomplete and almost certainly distributed such that they would need to be gathered together to have a more holistic picture of what goes on. Attackers are using their skills to further obfuscate this picture, trying to hide their traces, manipulate or purge logs and sabotage any incident investigation in order to avoid getting caught. And Management is pressing to get that incident resolved so that personnel resources can get back to focusing on their core work and computing services can resume operations.

In summary, large-scale computer security incident response is stressfully fun. This exercise will bring that fun to you. Teaching you the inherent problems of incident response. Making you aware of the struggles involved. And pointing you towards ways that we all can do better.

So, stay tuned. A Zebra scenario played out just last month at CERN, and another edition will be organised soon, looking to recruit people with a bit of an IT or security background to participate in this table-top exercise designed to promote better understanding of large-scale incident response. Sign up to get the call at cert-info@cern.ch (https://e-groups.cern.ch/e-groups/EgroupsSubscription.do?egroupName=cert-security-info).

The Computer Security team

Announcements

Inauguration of Science Gateway on 7 October

Find out more about Science Gateway volunteering opportunities

CERN Science Gateway in April 2023. (Image: CERN)

CERN Science Gateway will be officially inaugurated on 7 October and open to the public as of 8 October. From the next issue of the Bulletin, we will be running a series of articles about CERN's new flagship education and outreach centre; the first article will be a "Word from" the Director-General.

In the meantime, you can find out more about opportunities to volunteer at Science Gateway and interact with the public : https://guides.web.cern.ch/join.

Get to know CERN's orchids and why the grass is left to grow

New biodiversity signage pops up around the sites

CERN's sites span 625 hectares, comprising 409 hectares of cultivated fields, recreation land and meadows, 104 hectares of woodland and three wetlands. All this land teems with wildlife, including some rare species.

While CERN has a predominantly industrial and functional appearance, it harbours a vast variety of flora and fauna that the Organization manages and preserves with great care. Several measures aim to promote biodiversity in CERN's green spaces, with an approach based on low-intensity maintenance, keeping watering to a minimum and eliminating fertilisers and chemicals wherever possible. As you drive around the site, you might see "late mowing" signs on the verge as shown below: the reason for this is that delaying grass mowing allows the flora's full life cycle to complete. In some places, the grass is cut the first metre or so in from the verge for road safety reasons.

In 2022, CERN carried out biodiversity surveys: these are crucial for monitoring populations and enable the Organization to identify zones of biological interest and put in place concrete protection measures. These zones are marked out on the GIS portal.* As well as cataloguing a wide range of insects, birds and amphibians, the inventory led to the identification of 13 threatened species of flora as well as two new orchid species on the CERN sites, bringing the total to 18.

dTo help us all identify and get to know these orchids, dedicated panels will soon be appearing around the site (also shown below), some giving you an overview of all 18 species, others focusing on a specific species that thrives in a given area. These include the bee orchid, the autumn lady's tresses, the pyramidal orchid and the lizard orchid. Take a moment to admire them, at a distance: please do not pick the orchids and watch your step when you walk through the meadows so that we can all continue to enjoy them for years to come.

** To find the zones of biological interest on the GIS portal, click on Data > Thematic map > Biodiversity > Surfaces d'intérêt écologique (SIE)public.*

Alumni event on 16 June: "Virtual company showroom" with Bergoz Instrumentation

Join representatives from Bergoz Instrumentation to find out more about the company, potential job opportunities and the skills and talents they are now seeking.

The event will start at 11 a.m. on 16 June with a general presentation and will be followed by a Q&A session, come armed with your questions.

Please register here (https://alumni.cern/networks/events/116046) for the event to receive the zoom link.

About Bergoz Instrumentation

Bergoz Instrumentation is a French company founded in 1981, focusing on non-destructive beam instrumentation for particle accelerators. Their non-intercepting measurement systems allow a characterisation of low current particle beams without disturbing beam quality.

CERN Alumni programme

New books and e-books in May

The Library team adds new resources for the CERN community every day in its catalogue. Check the May 2023 additions here (https://catalogue.library.cern/search?q=_create

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Enjoy reading! For any question or suggestion, contact the Library: library.desk@cern.ch.

CERN Library

RD51 MicroPattern Gaseous Detector School | 27 November – 1 December

The RD51 MicroPattern Gaseous Detector School will take place from 27 November to 1 December 2023 at CERN. The school focuses on state-of-the-art MPGD technologies. Its programme comprises morning lectures by global experts in the field, which will give an overview of gas detector physics, MPGD technologies, simulation and modelling, readout approaches, manufacturing techniques and applications, as well as hands-on afternoon exercises on various technologies, with an emphasis on methodologies.
The school is targeted to PhD students and young scientists working on gaseous detectors or entering the field. Students are invited to present a poster with a short oral introduction during a dedicated session of the school. Thanks to the support from the RD51 Collaboration, registration is free for students. However, please note that accommodation, travel and other expenses have to be covered by the participants.
Applications for the school are open from now until 17 July 2023. Admission to the school is limited. The lecture sessions are open to the community and can be followed in-person or remotely via videoconference.
Visit the school's website for more information and registration: https://indico.cern.ch/e/rd51mpgdschool
Contact: rd51.mpgdschool@cern.ch

Obituaries

Louis Guerrero (1943 – 2023)

It Louis, known as "Loulou", arrived at CERN in 1970. He began his engineering career at the PS Booster under the leadership of Helmut Reich and Gianni Gelato, then later moved to the SPS to join Raymond Rausch's team, where he worked on the communication system for the SPS computers (TITN). During the construction of LEP, he joined the Network Management (NM) section under Patrick Lienard, which was responsible for reconfiguring the token-ring control network. Continuing to work in the NM section during the construction of the LHC, he was put in charge of the selection and installation of the routers for the FDDI (fibre distributed data interface) communication network.
Following the restructuring under Robin Lauckner (LHC Controls Coordination), the NM section was moved to the IT division. Thanks to his in-depth knowledge of communication technologies, Louis was promoted to take over responsibility for the digital telephone network in the division.

Louis was an excellent colleague, proactive, reliable and devoted to the Organization. He was always ready and willing to invest energy and time in supporting interns and visitors. He was a good listener and everyone always turned to him for wise advice.

He loved to organise social gatherings, whether at CERN or at home, and unforgettable moments abounded. We followed his sporting endeavours with curiosity and interest: he was a committed and enthusiastic golf, tennis and volleyball player (he coached women's volleyball teams in Geneva) and a keen amateur cyclist.

He faced his illness with his usual discretion, to avoid worrying his family and friends, and we always hoped that he would beat it.

Loulou, we'll miss you.

His colleagues and friends.

Ombud's corner

Managers and burnout – put your own oxygen mask on first!

One of the new trends observed in the Ombud's Office in 2022 was supervisors feeling a lack of support. As the CERN Ombud Annual Report for 2022 highlights:

"The few managers who come to discuss challenging managerial situations with the Ombud complain of lack of support. They feel that they are left alone to deal with conflicts, complaints, or mental health issues such as depression."

One recent Harvard Business Review (HBR) article provides food for thought on this emerging trend and quotes, from Microsoft's most recent Work Trend Index report, that "more than 53% of managers report feeling burnout at work". In connection with the trend that I have observed at CERN, I propose to share with you interesting insights from this article.

Christina Maslach, a pioneer in burnout research, says burnout in the workplace is a result of continually experiencing stress, resulting in exhaustion, cynicism and a perceived lack of personal accomplishment – the three dimensions of burnout.

The reasons outlined for these burnout symptoms are an unsustainable workload, a perceived lack of control, insufficient reward for efforts, a lack of fairness, mismatched values and skills, and lack of a supportive community.

While all employees may potentially be stretched between high workload and limited resources, managers have the added responsibility of ensuring that their team members get what they need to be able to give their best, on top of doing their own work. You need to be in good shape to manage a team, and managers' unhappiness can have an impact on the team.

Interestingly, but not surprisingly, it appears that front-line managers are more likely to experience exhaustion and a lack of professional efficacy than leaders higher up in the hierarchy.

While managers have a key role to play in mitigating burnout risks in their teams, their own levels of resistance to burnout are just as important. The HBR article provides a few effective tools to help managers protect themselves from burnout:

- Managers, like any worker, must connect their work with what matters and makes sense to them. An open discussion with their managers on what gives them energy and meaning at work is important.
- Managers need opportunities for learning and development, which are key to providing bursts of energy. The offer from HR-L&D for managers is large and varied. Managers' leaders should seek and integrate multiple feedback sources to get a complete picture of how they are doing and help target where they need to grow, such as through coaching.
- Flexible work is as important for managers as for their team members. Being able to work in the way that is best for them, as part of a collective design of the team's work schedule, can help reduce feelings of exhaustion.
- Psychological safety, which is widely recognized as a prerequisite for well-performing teams, also applies to managers. Managers need to feel comfortable speaking up about their ideas, questions, concerns and mistakes. As a manager, it is important to set an example of owning up to your own mistakes, showing your vulnerability, inviting input from your team and responding constructively to the feedback that you receive.
- Finally, managers need to "put their own oxygen masks on first" and be a role model for caring for themselves. Recharging batteries, as well as setting boundaries and respecting others' boundaries, help protect managers from burnout.

Setting direction and leveraging the work of team members, while caring for the team and managing escalating demands with potentially fewer resources, is no easy task. The risk of burnout exists for managers, too, and they need support from their hierarchy, from the Organization's processes and from their team members. Managers are welcome in the Ombud's Office!

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/.