CERN Bulletin

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LS2 REPORT: INCREASED CRYOGENIC POWER AT LHC POINT 4

At LHC Point 4, a refrigerator that cools helium from room temperature to 4.5 K (-268.65 °C) has undergone major improvements in preparation for the HL-LHC

The cold box located on the surface is approximately 6 metres long and 3 metres in diameter. All the elements are vacuum insulated to limit thermal radiation. (Image: CERN)

The LHC is one of the coldest places on Earth. The 1.9 K (-271.3 °C) operating temperature of its main magnets is even lower than the 2.7 K (-270.5 °C) of outer space. To get the LHC to this temperature, 120 tonnes of liquid helium flow around a closed circuit in the veins of the accelerator.

The LHC cooling system is made up of cryogenic islands with eight helium refrigerators in total. Each even-numbered point on the accelerator (Points 2*, 4, 6 and 8) has two refrigerators, one dating from the LEP (Large Electron-Positron Collider) era, and another newer refrigerator dating from the start-up of the LHC. The LEP refrigerator is composed of two cold boxes – one on the surface and the other downstream in the tunnel, which cool the helium from room temperature to 20 K (-253.15 °C) and from 20 K to 4.5 K respectively – and a unit located in a cavern generating superfluid helium at 1.9 K.

"These refrigerators date back to 1994, but they have undergone a number of upgrades since then, in particular in preparation for the LHC in 2006", says Emmanuel Monneret, an engineer from the TE-CRG group working on the refrigeration project.

(Continued on page 2)

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LS2 REPORT: INCREASED CRYOGENIC POWER AT LHC POINT 4

"On that occasion, their cooling power was increased from 12 to 16 kW at 4.5 K."

During LS2, further upgrades have been carried out on the LEP refrigerator at Point 4, increasing its cooling power to 18 kW at 4.5 K, in preparation for the HL-LHC (High-Luminosity LHC): "The Point 4 refrigerators are crucial for the HL-LHC, because as well as cooling sectors 3-4 and 4-5, they must also cool the sections where the radiofrequency cavities are installed, which require a considerable amount of cooling," continues Emmanuel Monneret.

To achieve this important extra 2 kW, the four turbines and heat exchangers in each of the cold boxes at Point 4 have been replaced with higher-performing equivalents. This task was relatively straightforward to carry out for the cold box at the surface, which is easily accessible to workers (see photo 1), but more arduous for the cold box in the tunnel. "We had not anticipated that it would be impossible to get inside the tunnel cold box, which is much more compact than the one on the surface," Emmanuel Monneret explains. "Working in close collaboration with the manufacturer, we eventually found a solution to allow us to replace the turbines and exchangers from the outside."

Thanks to a new interface (see photo 2) developed by the manufacturer in just a few months, the team in charge of the project was able to install the turbines and exchangers without having to connect them from inside the cold box. This new equipment, which has just been commissioned, will be operational by the end of the month.

**To be precise, there is one helium refrigerator at Point 2 and another at Point 1.8.*

The LHC has started cool-down

The post-LS2 cool-down of the LHC began on 5 October in sector 4-5. Cool-down is carried out in three stages: from room temperature to 80 K, from 80 K to 4.5 K, and finally from 4.5 K to 1.9 K. It takes around seven weeks for a sector to be cooled to 1.9 K, including checks and adjustments of the instrumentation and the process control systems. The sectors are cooled gradually, one after another. The LHC should therefore reach its nominal temperature in spring 2021.

The new turbines and their heat exchangers, recently installed in the lower cold box at Point 4. The turbines are mounted on an interface that was specially developed to allow them to be installed from outside the cold box. (Image: CERN)

Anaïs Schaeffer

CERN BEGINS TO MANUFACTURE ITS OWN SURGICAL MASKS

In the search for a more reliable and economical solution, CERN has procured a machine to manufacture surgical masks

CERN's new machine to manufacture surgical masks. (Image: CERN)

CERN has recently procured a machine to manufacture surgical masks. This will allow the Organization to provide masks for everyone working on the CERN sites and to ensure the safety of each and every one of us during the COVID-19 pandemic.

The machine was installed in Building 947 in September and several members of the EN-SMM group (Survey, Mechatronics and Measurements) have been trained to operate it. The aim is to be able to produce 400,000 masks a month.

"CERN, like everyone, was faced with a shortage of surgical masks at the start of the COVID-19 pandemic," Roberto Losito, head of the EN Department, recalls. "Fortunately, in April we were able to order hundreds of thousands of masks, but the prices were exorbitant. We therefore decided to procure our own manufacturing machine: it will be much more economical in the long term and will ensure we have enough regulation-compliant masks for everyone at CERN."

The masks produced at CERN are being tested at a French laboratory, in accordance with the EN 14683 regulations, and will receive the CE marking, which guarantees that the masks meet European Union requirements.

We would like to remind you that it is obligatory at CERN to wear a mask both inside and outside if two-metre physical distancing cannot be observed.

For more information on CERN's COVID-19 health and safety measures, please visit this page (https://hse.cern/content/hygiene-measures). All information related to COVID-19 is available here (https://hse.cern/covid-19-information).

Anaïs Schaeffer

FROM CRYOGENICS TO COMBATTING COVID

Meet Andre Henriques, Technical Coordinator for the CERN Safety Rules in the Occupational Health & Safety and Environmental Protection unit (HSE), in this issue of our Knowledge Transfer spotlight series

Andre Henriques, leader of the Kryolize project (Image: CERN)

As an intergovernmental organisation, CERN establishes its own safety rules to function properly, in line with best practices and regulations in the Host States. After building his expertise for nine years within HSE, Andre Henriques currently contributes to shaping the technical aspects of CERN's Safety Rules.

In addition to drafting safety measures at CERN, Andre also leads the Kryolize Project. This initiative aims to harmonise the approach to the sizing of safety valves for cryogenics applications at CERN via software developed with support from the Knowledge Transfer (KT) fund. The software goes hand in hand with experiments and measurements to improve the state of the art within cryogenics safety through an R&D collaboration with the Karlsruhe Institute of Technology. "The interaction with KT was great. They helped us secure funding for the project, enabling us to get to the next stage," explains Andre.

Although Kryolize was initially developed for CERN, word spread across the community and the software garnered interest from other institutes. Andre worked closely with KT to publicise the technology and establish collaborations. Legal advisors helped set up 11 licence agreements with seven academic and four commercial entities. To further improve the design parameters of safety devices, phase two of the Kryolize Project will start in 2021.

As an HSE expert, Andre's knowledge transfer activities extend beyond cryogenics software. He has also been involved in CERN's efforts against COVID-19 through the "Help to society" activities. As the HSE representative within the CERN against COVID task force, Andre contributed to initiatives such as the "High-Energy Ventilator" (HEV), a ventilator developed with CERN equipment and knowledge intended for hospitals around the world. Face shields and masks were also donated to local communities and further knowledge transfer is currently planned for some of the designs through CERN's Open Hardware Licence.

Find out more about how to get involved in CERN's Knowledge Transfer activities here (*https://kt.cern/cern-community*) **.**

Linn Tvede

TAKING STOCK OF DATA PRIVACY AT CERN

Operation Circular 11 describes the data-privacy rights and obligations at CERN, but much remains to be accomplished to protect personal data

In June 2017, our Director-General, Fabiola Gianotti, stated that taking all measures possible to protect personal data "is vital for maintaining the trust of the individuals sharing their information with us, and demonstrating that this laboratory applies the same high-level standards that we apply to our research to everything else we do". Operation Circular 11 (OC 11), which describes the data-privacy rights and obligations at CERN, came into force on 1 January 2019 and was a great start to improving data privacy. However, much remains to be accomplished to protect personal data.

The Data Privacy Coordination Committee (DPCC), a dedicated entity to coordinate data privacy at CERN, was created in 2018 to define common approaches to the implementation of the data-privacy rights and obligations. Each department has nominated a representative, the Departmental Data Privacy Protection Coordinator (see list of members (*https://indico.cern.ch/category/11222/attachments/2000380/3561780/Membership.pdf*)), who form the DPCC together with members of the Legal Service, the Staff Association and the Office of Data Privacy (ODP).

Since its inception in 2018, the DPCC has achieved an impressive amount of objectives. For instance, in 2019, an inventory of all CERN services dealing with personal data was carried out. It revealed that 560 such services are currently in existence. From that catalogue, the members of the DPCC coordinated the establish-

ment of privacy notices that explain what we do with and how we protect personal information given to us in confidence.

With regard to the day-to-day management, the DPCC has developed a set of specific procedures to guide people when confronted with aspects of data privacy in their work. One example is a procedure for organising events, something that many of us at CERN may be involved with at some point. The ODP website (*https://cern.ch/privacy*) offers detailed and newly reviewed information on data-privacy protection, while the FAQ page (*https://privacy.web.cern.ch/FAQ*) provides answers to specific questions. The Admin e-guide (*https://admin-eguide.web.cern.ch/en/administration-interne*), with its new sub-chapter dedicated to data privacy procedures, focuses on the practical implementation of OC11. Data-privacy notices can be found on Service Now.

The DPCC is working on many additional measures that are essential for the successful implementation of OC11. High-priority measures include developing the "Privacy by design" policy and procedure, reviewing the current e-learning course to align it with the OC11 and establishing data-retention guidelines.

Having a framework such as OC11 and all the supporting measures in place is very good, but alone they are not enough. We need the assistance and cooperation of each and every one at CERN, and we would like to invite you to join the DPCC team in this CERN-wide endeavour to protect the privacy of personal data.

Anne Kerhoas, Rachel Bray

(Image: CERN)

COUNCIL WEEK, ACCELERATOR RESTART AND COVID-19 MEASURES: YOUR QUESTIONS ANSWERED

The video and presentations from the 8 October information meeting are available online

On Thursday, 8 October, the Director-General Fabiola Gianotti addressed the CERN community alongside members of the directorate. They presented the conclusions of the September Council session and outlined the current situation of the Organization and its expected evolution, in light of the Update of the European Strategy for Particle Physics. The meeting was broadcast via Webcast and consisted of presentations by Fabiola Gianotti, Frédérick Bordry, Director for Accelerators and Technology, Eckhard Elsen, Director for Research and Computing and James Purvis, Human Resources Department Head. The presentations were followed by a questions and answers session.

Fabiola Gianotti introduced the new directorate - freshly appointed by the CERN Council - discussed the financial situation of the Organization, the scientific strategy of the Laboratory for the 2021-2025 period and announced the imminent start of the construction of CERN Science Gateway. The meeting was also an opportunity to present the schedule for the restart of the accelerators as well as the latest findings by the experiments, among which LHCb's time-dependent matter-antimatter asymmetry discovery and ATLAS and CMS's detection of a Higgs boson's decay into a pair of muons.

Much of the meeting was dedicated to the COVID-19 safety and HR-related measures dictated by the current health situation in the Member States and beyond. James Purvis and Doris Forkel-Wirth, Head of the HSE Unit, reasserted CERN's foremost commitment to ensuring the safety of its community, highlighting that no evidence for on-site infections had been established since the start of the pandemic. Teleworking, leave management, the restaurant situation, quarantine and travel restriction rules were then addressed in detail during the questions and answers section.

You can consult the presentations and watch the full recording of the meeting here (*https://indico.cern.ch/event/962228/*).

ALICE HONOURS ITS THESIS AWARD WINNERS

Fabrizio Grosa and Arild Velure are the young laureates of the 2020 award

ALICE Spokesperson, Luciano Musa (centre) presents the ALICE Thesis Award to Fabrizio Grosa (bottom right on the left screen) and Arild Velure (right) in the presence of Collaboration Board Chair Silvia Masciocchi, and the Chairs of the Thesis Award Committee, Giuseppe Bruno and Philippe Crochet (Image: CERN)

On 23 September, the ALICE collaboration celebrated its best PhD theses, which are selected based on the excellence of the results obtained, the quality of the thesis manuscript, and the importance of the contribution to the collaboration.

Out of the 11 outstanding PhD theses received by the selection committee, two theses stood out: **Fabrizio Grosa** 's, entitled "*Strange and non-strange D-meson production in pp, p-Pb, and Pb-Pb collisions with ALICE at the LHC*", and **Arild Velure's** - "*Design, Verification and Testing of a Digital Signal Processor for Particle Detectors*".

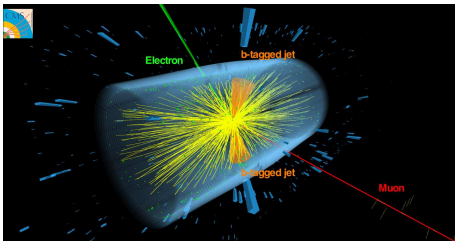
The winners were congratulated by ALICE Spokesperson, Luciano Musa, the Collaboration Board Chair, Silvia Masciocchi, and the Chairs of the Thesis Committee, Giuseppe Bruno and Philippe Crochet. Luciano awarded the certificates and prizes to Fabrizio and Arild, who then presented their work.

Fabrizio Grosa (Turin Polytechnic) analysed vast data on the production of several particle species in different colliding systems as part of his doctoral research. His results contributed to five published ALICE papers, with two more on the way. Fabrizio has also made significant contributions to the upgrade project of the ALICE Inner Tracking System for the forthcoming LHC runs, working on alignment procedures and physics performance studies.

Hailing from Bergen University, Arild Velure worked on the design of the so-called SAMPA ASIC, a complex mixed-signal chip that has become the state-of-the-art readout for gaseous detectors like the ALICE Time Projection Chamber and the muon tracking chambers. He made significant contributions to the ASIC specifications as well as to the design and implementation of the detector front-end cards. Arild's research is of paramount importance to the success of the forthcoming ALICE high-rate data-taking campaign.

CMS SEES EVIDENCE OF TOP QUARKS IN COLLISIONS BETWEEN HEAVY NUCLEI

The result opens the path to study in a new and unique way the extreme state of matter that is thought to have existed shortly after the Big Bang



CMS candidate event for a top quark and antitop quark producing an electron, a muon and jets originating from bottom (b) quarks. (Image: CERN)

The CMS collaboration has seen evidence of top quarks in collisions between heavy nuclei at the Large Hadron Collider (LHC).

This isn't the first time this special particle – the heaviest known elementary particle – has "made an appearance" at particle colliders. The top quark was first observed in proton–antiproton collisions at the Tevatron collider 25 years ago, and has since been spotted and studied in proton–proton and proton–nucleus collisions at the LHC. But the new finding, described in a paper just accepted for publication in *Physical Review Letters*, is sure to excite experimentalists and theorists alike, for analysis of top quarks in heavy-nuclei collisions offers a new and unique way to study the quark–gluon plasma that forms in these collisions and is thought to have existed in the early moments of the universe. In addition, such analysis could cast new light on the arrangement of quarks and gluons inside heavy nuclei.

There isn't exactly a shortage of particles, or "probes", with which to investigate the quark–gluon plasma. The LHC experiments have long been using several types of particle to study the properties of this extreme state of matter, in which quarks and gluons are not confined within composite particles but instead roam like particles in a liquid with small frictional resistance. But all of the existing probes provide time-averaged information about the plasma. By contrast, the top quark, owing to the particular way in which it transforms, or "decays" into other particles, can provide snapshots of the plasma at different times of its lifetime.

"Faster-moving top quarks provide later-time snapshots. By assembling snapshots taken with top quarks at a range of different speeds, we hope that it will eventually be possible to create a movie of the quark–gluon plasma's evolution," explains CERN-based researcher Guilherme Milhano, who co-authored a theoretical study on probing the quark–gluon plasma with top quarks. "The new CMS result represents the very first step down that road."

The CMS collaboration saw evidence of top quarks in a large data sample from lead–lead collisions at an energy of 5.02 TeV. The team searched for collisions producing a top quark and a top antiquark. These quarks decay very quickly into a W boson and a bottom quark, which in turn also decay very rapidly into other particles. The CMS physicists looked for the particular case in which the final decay products are charged leptons (electrons or their heavier cousins muons) and "jets" of multiple particles originating from bottom quarks.

After isolating and counting these top–antitop collision events, CMS estimated the probability for lead–lead collisions to produce top–antitop pairs via charged leptons and bottom quarks. The result has a statistical significance of about four standard deviations, so it doesn't yet cross the threshold of five standard deviations that is required to claim observation of top-quark production. But it represents significant evidence of the process – there's only a 0.003% chance that the result is a statistical fluke. What's more, the result is consistent with theoretical predictions, as well as with extrapolations from previous measurements of the probability in proton–proton collisions at the same collision energy.

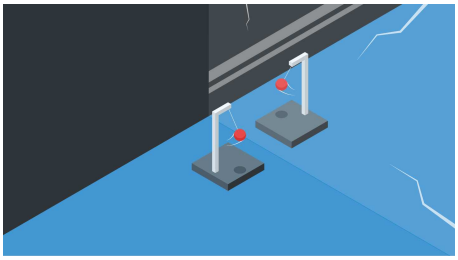
"Our result demonstrates the capability of the CMS experiment to perform top-quark studies in the complex environment of heavy-nuclei collisions," says CMS physicist Georgios Krintiras, a postdoctoral researcher at the University of Kansas, "and it's the first stepping stone in using the top quark as a new and powerful probe of the quark–gluon plasma."

Read more on the CMS website (https://cms.cern/news/heavy-metal-hits-top).

Ana Lopes

LHCB SEES NEW FORM OF MATTER–ANTIMATTER ASYMMETRY IN STRANGE BEAUTY PARTICLES

The LHCb collaboration has observed time-dependent matter–antimatter asymmetry in the decays of strange beauty particles into charged kaons



A CP-symmetry transformation swaps a particle with the mirror image of its antiparticle. The LHCb collaboration has observed a time-dependent breakdown of this symmetry in the decays of the strange beauty meson (red sphere on the left), which oscillates into its antimatter counterpart (oscillation illustrated by the pendulum motion). (Image: CERN)

The observed excess of matter over antimatter in the Universe is an enduring puzzle in physics. The imbalance implies a difference in the behaviour of matter and antimatter particles. This difference, or "asymmetry", is known as CP violation and is a fundamental part of the Standard Model of particle physics. But the amount of CP violation predicted by the model and observed so far in experiments is too small to explain the cosmic imbalance, suggesting the existence of as-yet-unknown sources and manifestations of CP violation beyond the Standard Model.

At the nineteenth beauty conference last month and at a seminar today at CERN, the LHCb collaboration reported the first observation of so-called time-dependent matter–antimatter asymmetry in particles known as B_s^0 mesons, which contain a beauty antiquark and a strange quark.

CP violation was first observed more than five decades ago in particles called K^0 mesons, and has since been observed in other types of particle – including in B^0 mesons in 2001 by experiments at the SLAC laboratory in the US and the KEK laboratory in Japan, and recently by the LHCb collaboration in D^0 mesons. The effect can manifest itself in two forms: time-integrated and time-dependent. In the time-integrated form, the number of transformations, or "decays", of a matter particle into certain particles differs from that of the corresponding antimatter particle. In the time-dependent form, the violation varies with the particle's lifetime due to the spontaneous oscillation of the particle into its antiparticle and back.

The new LHCb study provides the first observation of time-dependent CP violation in B_s^0 mesons, in their decays into charged K mesons. The result, obtained by combining data collected during the first and second runs of the Large Hadron Collider, has a statistical significance of 6.7 standard deviations, which is beyond the threshold of 5 standard deviations used by particle physicists to claim an observation.

"The B_s^0 mesons oscillate between particle and antiparticle three thousand billion times per second, but the excellent resolution of our detector made it possible to observe the effect of these oscillations. Our observation of time-dependent CP violation in B_s^0 mesons represents a further milestone in the study of the differences between matter and antimatter," says LHCb spokesperson Chris Parkes, "adding to our previous observation of time-integrated CP violation in these mesons."

The next steps will be to compare the measurement with other measurements of CP violation and with predictions from the Standard Model and beyond. It's only after researchers make these comparisons that they will be able to tell whether or not the new measurement hides any surprises that might help to explain the matter–antimatter imbalance in the universe.

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Read more on the LHCb website (http://lhcb-public.web.cern.ch/Welcome.html#CPBs).

Ana Lopes

SCIENCE GATEWAY CONSTRUCTION GETS THE GREEN LIGHT

Construction of CERN's Science Gateway is to start later this year, following receipt of official permission from the Geneva authorities. This unique facility is due to open to the public at the end of 2022

3D representation of the "piazza" which will be located at the centre of Science Gateway. (Image: ©RPBW)

Last year, CERN unveiled an ambitious project called the Science Gateway. This year, the project is taking major steps towards becoming a reality: the application for a building permit, which CERN submitted to the Geneva authorities in October 2019, was accepted on 29

September, thanks to invaluable cooperation between CERN and the Canton of Geneva. Construction work can therefore begin this autumn. This new facility, dedicated to science education and communication, is in line with one of CERN's objectives, i.e. education and outreach for the general public on the subject of science, as well as the transfer of knowledge and technology to society.

CERN's tunnels, workshops, experiment caverns and other emblematic areas and equipment associated with the fundamental research conducted at the Laboratory will all be reflected in the architecture of the Science Gateway. The facility was conceived and designed by the Renzo Piano Building Workshop and will comprise five different areas housing exhibitions, educational activities, laboratories for practical experiments, a large auditorium, a shop and a restaurant. All of these will be connected by a footbridge crossing over the Route de Meyrin. The new building will considerably increase the Organization's capacity for communication and for welcoming visitors and is designed to be in synergy with the Globe of Science and Innovation and the surrounding natural environment.

"*Our ambitious goal is for the facility to be a hub for scientific education and culture with the aim of inspiring the young generation with the beauty of science,*" explains Patrick Geeraert, who is in charge of the project. *"It evokes one of CERN's intrinsic characteristics: curiosity and the desire for openness and innovation. This new building is intended to be, both physically and symbolically, a gateway to CERN and to scientific knowledge."*

One of the ways in which the project is integrated into its environment is the "forest". Around 400 trees, of species indigenous to the area and of varying heights, will surround the buildings of the Science Gateway and create a link with CERN's existing buildings and the car park to the north of the Globe. The "forest" will be visible from all the main areas of the facility, reinforcing the idea of a gateway to science and conveying the implicit message that all scientific exploration is connected to nature.

The "piazza" at the centre of the facility will be accessible from all corners of the site. This ground-level public space aims to emphasise the urban vocation of the Science Gateway and will be arranged like a natural theatre, with staircases at its western end and access to the restaurant and the auditorium foyer on the same level. Green spaces with rich and diverse vegetation will surround the site and complement the "forest". The infrastructure will also be carbon-neutral thanks to the use of geothermal energy and photovoltaic panels.

To facilitate mobility and access to the site, a walkway to the existing public transport stops will be provided. In addition, a car park with 240 spaces will be built to the north of the Globe. It will be connected via pedestrian walkways to the Science Gateway and to the buildings of the Esplanade, the Globe and IdeaSquare.

The project is financed exclusively by donations to the CERN & Society Foundation. So far, thanks to the generosity of donors, CERN has succeeded in securing around 80% of the total budget, but additional donations are still being sought in order to cover all costs.

3D representation of one of the experimental laboratories. (Image : ©RPBW, Renzo Piano Building Workshop)

COMPUTER SECURITY: FROM THE DIGITAL TRENCHES

During a recent audit of CERN's computer security, the question was raised of how many attacks CERN is subjected to each day...

During a recent audit of CERN's computer security, the question was raised of how many attacks CERN is subjected to each day. It was a difficult question as there is no good metric for what constitutes an attack and how you quantify it. Does one connection to CERN constitute one attack? Or many connections to CERN from the same source? Or all connections linked to the same attack pattern or theme? Or from the same group of adversaries? Does one brute-force attempt to log into one CERN account count as an attack? Or many different attempts to break into one account at CERN via a so-called dictionary attack? Or is it one attack when one adversary brute forces their way into many CERN accounts via such a dictionary attack?

As you can see, answering that initial question is difficult, and other entities outside CERN answered it with "300-500 million a day". Apparently, they count every connection, every attempt. The basic fact, as measured with our intrusion detection mechanisms, is that CERN is under constant attack. Always. Even right now. There are few moments when we do not see brute force attacks against CERN accounts. Few moments when public CERN webpages and Internet-facing computing services are not being probed for vulnerabilities. Few moments when CERN mailboxes are not receiving SPAM or so-called phishing e-mails. And few moments when CERN computers are not subjected to viruses, worms and other malware... And that number is not even the most interesting one...

Delving deeper into the numbers from our digital trenches:

- Every day, CERN's Security Operations Centre (SOC) digests about 3-5 TB of log data, sifting through for suspicious or malicious activities ;
- CERN's firewall monitors a stream of 40 Gbps of incoming and outgoing traffic and tries to reject any unwanted or unauthorised packages. In the near future, the CERN Network Team will replace this firewall with a more powerful solution al-

lowing the filtering of up to 200 Gbps of traffic in each direction and the blocking of advanced, sophisticated or targeted attacks;
- The CERN SPAM filters usually reject about 70% of the 2 million e-mails CERN receives each day. For those that pass through, the subsequent advanced malware detection filters quarantine about 50 phishing campaigns and 20 campaigns using malicious attachments to target CERN per day;
- The SOC sends dozens of notifications per month to colleagues whose CERN e-mail address or external e-mail address – together with external passwords and other personal data – have been disclosed in data breaches from Internet-based cloud services. Much more widely, our automatic tools also regularly inform hundreds of peer organisations, institutes and universities about thousands of their e-mail addresses and passwords potentially being exposed;
- Members of the Computer Security Team run dozens of dedicated campaigns per year, informing users and those managing CERN's computing services about newly reported vulnerabilities (e.g. TeamViewer, RDP, SMBv1, WordPress, iOS, Flash) and ensuring, when needed, that these vulnerabilities are closed as fast as possible before the corresponding systems, devices or accounts are compromised by adversaries;
- Similarly, we receive dozens of external reports a year from friendly people and students of our CERN WhiteHat Challenge programme pointing us to sub-optimal configurations or weak set-ups, which are all well deserving of follow-up for improvement;
- On the proactive side, the IT department is running a series of projects (PC hardening, a new identity management system including multifactor authentication, deploying a new anti-virus solution, and providing better tools for programmers...) to improve CERN's cyber-security posture.

Despite those numbers, what matters more is the – hopefully low – number of successful attacks. In these more severe cases, the Computer Security Team engages five to ten times a year in direct incident response, figuring out how adversaries (like the RockeGroup but also nation-state sponsored actors) might have managed to infiltrate CERN, along with their motives and attack vectors. Due to severe violations of the CERN Computing Rules, three people were dismissed from CERN last year. Furthermore, we also assist several other HEP and HPC sites as well as the WLCG and EGI/EOSChub in incident response. Indeed, our academic community has suffered in recent months from Ransomware attacks. And, finally, we actively help Swiss health institutions protect their assets against attacks using "Covid-19"-related themes as a pretext.

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

The Computer Security Team

Official communications

CERN HAS A NEW CENTRALISED CHEMICAL DATABASE: CERES

In April 2020, the HSE Unit released a new web-based tool: the CERN Chemical Register for Environment, Health and Safety, CERES

In April 2020, the HSE Unit released a new web-based tool: the CERN Chemical Register for Environment, Health and Safety, CERES. It is based on the works of the PoLiChem (Prevention of Pollution by Liquid Chemical Agents) working group and Chemical inventories according to Chemical CERN Safety Rules. It was developed by the HSE Unit in close collaboration with concerned departments, including their Safety Officers.

The purpose of developing CERES was to create a user-friendly online tool that permits centralising, sharing and keeping a total traceability of CERN chemicals. The database includes information relating to solid, liquid and gaseous chemicals. Besides giving a global overview, the web tool also displays the evolution of the risk score of a case over several years. The database includes all safety information, the precise location, as well as data on chemical and environmental risk assessments and the mitigation measures in place.

CERES now has a catalogue of chemicals to make it easier to update and keep track of the products used at CERN. When entering a new case into the database, the register requires certain general information. It can then be completed by additional information regarding the environmental and chemical safety as well as information from the CERN Fire & Rescue Service. Each access request to CERES is handled by the designated department representative.

CERES is linked to the GIS portal to display the precise location of the chemical. This is very useful for the Fire & Rescue Service during emergency interventions. This view is also useful for Territorial Safety Officers

(TSOs) in order to assess the risks within a building or an area.

In terms of chemical safety, the database is essential as the first step in effective chemical risk management, in order to:

- identify the presence of particularly toxic or dangerous chemicals for risk assessment;
- identify and eliminate unknown substances or out-of-date chemicals;
- ensure the separation of incompatible chemicals in storage for accident prevention.

For the environmental protection group, CERES is used to identifying environmentally sensitive activities and areas on CERN sites, as well as increasing the interaction with CERN departments to improve pollution prevention measures.

For all CERN departments, CERES can steer the operational safety, to both personnel and the environment, by giving better access of information to all Safety Officers and trigger preventative and protective measures.

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For questions regarding chemical safety, contact safety-chemistry@cern.ch
For questions regarding environmental protection, contact Env-Prevention@cern.ch
For general questions regarding the CERES software, contact ceres-software-support@cern.ch

More information on the HSE website.

CERN PENSION FUND – 2020 ANNUAL INFORMATION MEETING: FRIDAY 20 NOVEMBER

All members and beneficiaries of the Pension Fund are invited to attend the Annual Information Meeting on Friday 20 November 2020 from 3 p.m. to 3:45 p.m. by webcast (*https://indico.cern.ch/event/960443/*).

The PFGB Chair and Chief Executive Officer of the Fund would also like to answer any questions you may have. Since they will unfortunately be unable to take questions live, they invite the Members and Beneficiaries to send questions in advance of the meeting by post to:

Mr Matthew Eyton-Jones
"Annual Information Meeting"
Chief Executive Officer
CERN Pension Fund
Office 5-5-012, Postbox C23800
CH- 1211 Geneva 23 - Switzerland

Or via email to: pension-fund@cern.ch

Printable PDF copied of the 2019 Pension Fund Annual Report and Financial Statements are already available on the Pension Fund website.

Announcements

WRIGHT COLLOQUIUM FOR SCIENCE AT THE UNIVERSITY OF GENEVA FROM 2 TO 6 NOVEMBER

The University of Geneva will host the 19th Wright Colloquium for Science entitled "The Art of Maths" from 2 to 6 November on the Dufour Campus.

Every evening of the week starting at 6:30 pm, mathematicians will present aspects of their research to highlight the beauty of mathematics. On the menu:

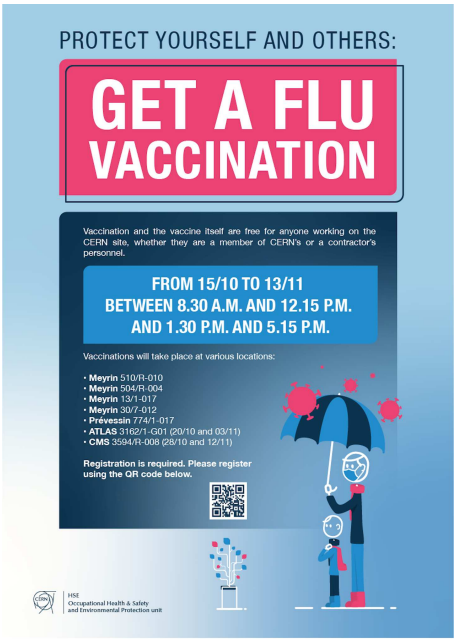
- "Chaos: unpredictable but understandable" by Etienne Ghys (CNRS, ENS Lyon), 2 November;
- "Disorder, chance and large numbers" by Laure Saint-Raymond (ENS Lyon), 3 November;
- "A mathematical journey from the infinitely small to the infinitely large" by Martin Hairer (Imperial College London, Fields medalist), 4 November;
- "The music of shapes", by Alain Connes (Paris-Saclay, Ohio State University, Fields medalist) on 5 November;
- "Mathematics: art or science?" by Stanislav Smirnov (University of Geneva, Fields medalist), 6 November.

Access to individual talks on campus and online is free of charge after online registration on the University of Geneva website. French and English translation will be available for the talks.

From Monday 2 to Friday 6 November - 18h30
Uni Dufour - Rue du Général Dufour 24 - 1204 Geneva
Auditoire Piaget

GET A FREE FLU VACCINATION AT CERN FROM 15 OCTOBER TO 13 NOVEMBER

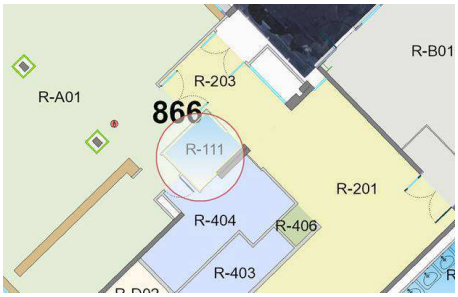
Please register on: https://cern.ch/plamed



(Image: CERN)

CERN Medical Service

CHANGE OF PREMISES FOR THE PRÉVESSIN LAUNDRY



Map of the new laundry service location (Image: CERN)

The Prévessin laundry service has changed premises. From Thursday 22 October 2020, it will operate from Building 866/R-111 (next to the entrance of Restaurant 3), without any change to its opening days and times.

For more information on this service, visit Service Now.

Cleaning Service

BOOKS BY ROGER PENROSE IN THE LIBRARY AND BOOKSHOP

A selection of books by Roger Penrose, 2020 Nobel Prize in Physics, is available in the Library and on sale at the Bookshop (bldg. 52/1-052):

- The emperor's new mind: concerning computers, minds, and the laws of physics, *Oxford University Press, 2016*
- Fashion, faith, and fantasy in the new physics of the Universe, *Princeton University Press, 2016*
- The nature of space and time, together with S. Hawking. Princeton *University Press, 2015*
- Cycles of time: an extraordinary new view of the universe, *Vintage, 2011*
- The road to reality, *Vintage, 2005*

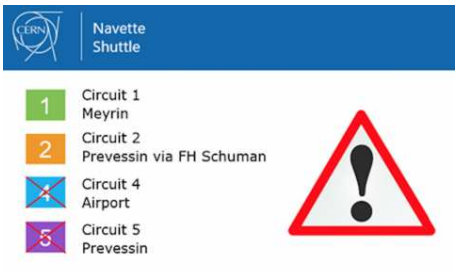
The Bookshop offers a wide variety of books on CERN-relevant subjects. You are welcome to visit us, either online or in person.

Our opening hours are: Monday-Friday, 8:30 a.m. - 6 p.m.

Happy reading, and welcome back to the Library!

CERN Library

REACTIVATION OF CIRCUIT 1 OF THE CERN SHUTTLE SERVICE



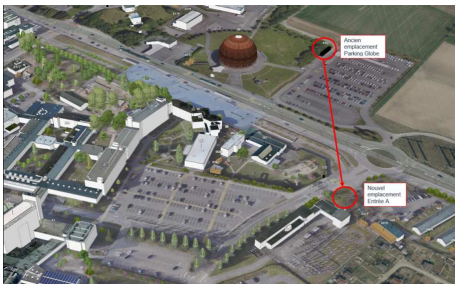
The shuttle service offer will be adapted as of Monday 5 October 2020 with the reactivation of circuit 1. Circuit 2 will not be impacted and continues being operated.

Thank you for your understanding.

CERN Mobility Services

REOPENING OF THE MOBILITY CENTRE AT A NEW LOCATION

The Mobility Centre moved to a new location near entrance A



(Image: CERN)

The Mobility Centre reopened its doors on 1 October after a hiatus of a few months. It is now located near entrance A (see image).

Our team will welcome you into the new building to meet all your mobility needs.

New building of the Mobility Centre. (Image: CERN)

CERN Mobility Services

Obituaries

YURI ORLOV (1924 – 2020)

Yuri Orlov, a world-renowned accelerator physicist and leading figure in the worldwide campaign for human rights in Soviet Russia, passed away at the end of September at the age of 96 years.

Yuri was born in Moscow in 1924. He studied and worked there until 1956, when a critical pro-democracy speech he gave at the Institute for Theoretical and Experimental Physics resulted in him being dismissed and banned from scientific work in Moscow. He moved to the Yerevan Physics Institute in Armenia, where he earned his first doctorate in 1958. While in Yerevan, he designed the 5 GeV electron synchrotron, became head of the electro-magnetic interaction laboratory and was elected to the Armenian Academy of Sciences. In 1963/64 he worked at the prestigious Budker Institute of Nuclear Physics in Novosibirsk, Siberia, where he was awarded a second PhD.

In 1973, Yuri returned to Moscow and joined the influential dissident movement alongside Andrei Sakharov, Aleksandr Solzhenitsyn and others. After the signature of the final documents of the Helsinki Conference on “Security and Co-operation in Europe” in 1975, Yuri founded the Moscow Helsinki Group to press the au-

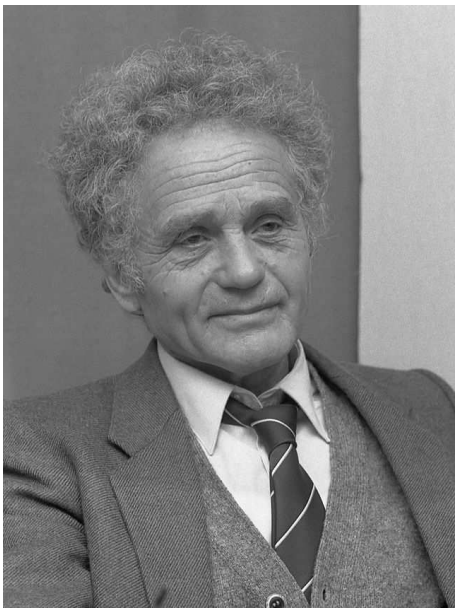
thorities in the Soviet Union to respect the human rights specified in the Helsinki agreements. This activism led to his arrest in 1976. He was tried in a political mock trial in 1978 and convicted to seven years of forced labour in Perm.

As soon as news of Yuri Orlov's ordeal reached Europe and North America, physicists protested against the treatment of their colleague. At CERN, where several physicists had had personal contacts with Yuri, the Yuri Orlov Committee was founded, with Georges Charpak as one of its founding members. The long-standing fruitful scientific collaboration with the Soviet Union was challenged and the support of eminent political leaders of the CERN Member States was solicited.

Yuri survived the seven years of labour camp under extreme conditions but was then deported to Siberia for an indefinite period. He was exiled to the USA in 1987 thanks to continuing international pressure. Yuri spent a sabbatical at CERN in 1988–89 as a Cornell University visiting scientist, working in the accelerator division to develop the idea of ion "shaking". At Cornell, he joined the muon g-2 experiment, worked on proposals to measure the electric dipole moments of protons, electrons and deuterons, and lectured on accelerator physics and human rights issues. Among the many honours Yuri received are the Wilson Prize for outstanding achievements in the physics of particle accelerators, and the American Physical Society's 2006 Andrei Sakharov prize "for his distinction as a creative physicist and as a life-long, ardent leader in the defence and development of international human rights, justice and the freedom of expression for scientists".

Yuri's example, as a scientist committed to the freedom of science and to the defence of the right to express one's convictions, is an inspiration to all of us. Thank you, Yuri.

Members of the former Yuri Orlov Committee



(Image: CERN)

Opinions

A ROADMAP FOR THE FUTURE

CERN Director-General Fabiola Gianotti and Gian Giudice, Head of CERN's Theory Department, comment on the scientific vision and priorities for the field laid out in the recently updated European Strategy for Particle Physics

What are the scientific priorities and future objectives of particle physics? Which instruments offer the best potential to achieve these objectives? And which technologies need to be developed to build such instruments? These are the main questions addressed by the European Strategy for Particle Physics (ESPP) following a bottom-up approach, driven by the scientific community.

The process is based on the physics knowledge at the time of the update, the results from existing facilities such as the Large Hadron Collider (LHC) at CERN, the status of the relevant technologies and the prospects for future advances, proposals and design studies for future experiments and facilities, and ideas for promising new avenues of investigation.

This input is scrutinised by the European Strategy Group, which includes representatives of all CERN's Member States and the directors of the major particle physics laboratories in Europe. The ESPP provides the scientific vision and priorities of the field for the short, medium and long terms, while also covering subjects of wider interest, such as education and public outreach, career prospects for young scientists, technology transfer, and the societal and environmental impact of particle physics. The Strategy update is a thorough and rigorous process, engaging the physics community for almost two years from beginning to end.

In June 2020, CERN's governing body, the Council, unanimously adopted the resolution to update the European Strategy, which provides a realistic and prudent approach to ambitious, visionary scientific objectives.

The Higgs boson as a starting point

Recent experimental results, in particular from the LHC, have radically transformed the status of particle physics and form the basis for future research directions. The discovery of the Higgs boson has been a turning point, unveiling a particle with unprecedented characteristics and shedding new light on a phenomenon that has surprising similarities with the way certain materials behave as superconductors below a critical temperature.

It was fascinating to realize that the same phenomenon operates at cosmic scales, and made the early Universe undergo a phase transition that transformed the nature of empty space. Nevertheless, be-

lieving that the Higgs boson discovery has completed our understanding of this complex phenomenon is too simplistic. On the contrary, much remains to be understood about this very special particle, including whether it is an elementary or composite object, how it leads to the peculiar pattern of quark and lepton masses observed, what determines the stability of the vacuum and what triggered the phase transition in the early Universe.

These questions are still largely unexplored experimentally and raise deep conceptual concerns theoretically. That is why the ESPP update has identified the detailed study of the Higgs boson as the most pressing priority for the field. Since the Higgs boson discovery in 2012 the general-purpose LHC experiments, ATLAS and CMS, have made extraordinary progress in pinning down the features of this particle and, by the end of LHC operation in 2038 — thanks to the high-luminosity upgrades of the collider and the detectors — they should be able to measure the Higgs boson properties with greatly improved precision.

To gain even deeper insights into the Higgs boson and its role in fundamental physics, the ESPP recommends an electron–positron collider as the next facility, followed by a high-energy proton–proton collider in the longer term.

A strategy for the future

Humanity's thirst for knowledge, curiosity and spirit of exploration have always been the engines that drive particle physics. Unsurprisingly, the more we dive into uncharted territory the more difficult it becomes to predict what future experimental endeavours could find. This is the very essence of research: if we knew for certain what future experiments will discover, we would not need to build them.

The value of exploring the unknown does not lie in the number of hypothetical discoveries that are promised, but in the knowledge acquired through investigation and the guidance obtained on future research directions. From more than a century of research we have learned that nature hides its fundamental laws at the smallest scales — and that is what drives us to explore the innermost structure of matter.

Hence, for the longer term, the 2020 update of the ESPP identifies a proton–proton collider reaching the highest energies allowed by technology (at least 100 TeV) as the most powerful tool for the exploration of uncharted territories. Even if it is difficult to anticipate what these studies will reveal, we can be certain that this path of exploration will greatly expand our knowledge on many fronts.

A good example of a guaranteed result is dark matter. A proton collider operating at energies around 100 TeV will conclusively probe the existence of weakly interacting dark-matter particles of thermal origin. This will lead either to a sensational discovery or to an experimental exclusion that will profoundly influence both particle physics and astrophysics. Another example is the precision measurement of the Higgs boson self-interaction which, by confirming or refuting the underlying theory — the Standard Model — will significantly advance our understanding of the phase transition that occurred in the early Universe.

Executing the strategy

Given the size, complexity and cost of such a project, the ESPP recommends first to perform an assessment of its technical and financial feasibility. If this is successful, approval may be granted by the end of this decade. Construction would most likely take place in stages, and the cost of around $30 billion, including the construction of a 100 km tunnel, the proton–proton collider and an electron–positron Higgs and electroweak factory as the possible first stage, would be spread over 50 years or more.

Such an ambitious project can only be implemented through the collaboration of scientists from all over the world. It will require the development of cutting-edge technologies in several domains, from new-generation superconducting magnets to cryogenics, vacuum, electronics and the handling of big data with significant technological spin-offs for society.

Over the past 70 years, accelerators have contributed immensely to shaping our understanding of fundamental physics and the structure and evolution of the Universe. This came about not only through fascinating discoveries, but also through precise measurements of known particles, forces and phenomena. Precision measurements are not only a way of testing and consolidating known theories, but also an extremely powerful tool for detecting hints of new phenomena in a way that is complementary to and — in some cases — more far-reaching than direct exploration.

A remarkable example is provided by the Large Electron–Positron collider at CERN and the Stanford Linear Collider at SLAC, which transformed our understanding of the Standard Model without discovering any new particles. The 2020 update of the ESPP reaffirms the crucial importance of precision measurements as discovery tools. This motivates a vast experimental programme not only at high-energy colliders, but also through a variety of lower-energy projects capable of probing known and new phenomena, for example, rare-decay or transition processes.

The ESPP also recommends support for accelerator-based neutrino projects in the US and Japan, theoretical research, and searches for very light, feebly interacting particles.

Another priority in the 2020 update of the ESPP is a reinforced accelerator research and development programme, with great potential for future applications in particle physics and other fields, focusing on new-generation superconducting high-field magnets and a variety of other technologies such as high-gradient accelerating structures, plasma wakefield acceleration, bright muon beams or energy-recovery linear accelerators. The ESPP also calls for intensified research and development on instrumentation, detectors, computing and software.

Continued, reinforced collaboration between European laboratories with partners in other regions of the world and with neighbouring fields such as nuclear and astroparticle physics is emphasised in the Strategy update as an indispensable tool for tackling extremely complex scientific questions. Last but not least, environmental protection is identified as a top priority with the recommendation that the impact of all future projects on the environment be carefully assessed and minimised, and that efforts be redoubled to save and re-use energy.

Outlook

Today, humanity is facing pressing challenges including climate change, combatting epidemics and poverty, confronting food and water shortages in many parts of the world, ensuring sustainable and clean energy production, and protecting the environment. Science is key to addressing these and other challenges and should be supported in all its facets. Investments in science are comparatively small on the macro-economic level, but their impact on the future of humanity is vast. In particular, history shows that fundamental research

is a driver of innovation, and accelerator-based particle physics has spawned numerous technological advances that have benefitted society, from the World Wide Web to technologies for medical imaging and cancer treatment. Research at future colliders will boost technological developments in many fields in ways that are unimaginable without the driving force of fundamental science.

Our understanding of particle physics and cosmology has today reached an unprecedented level of maturity, and this has dramatically changed the targets of research. Although we have equations that describe most observed phenomena, we lack a true understanding of the principles underlying those equations and the physical origin of their many free parameters. Moreover, many of the open questions in the microworld and the cosmos appear to be closely intertwined. For instance, some of the puzzles encountered in describing the current accelerating expansion of the Universe, and that which presumably took place in its early stages, show intriguing similarities with unexplained aspects related to the Higgs boson.

The focus of particle physics has thus evolved towards addressing structural questions about spacetime, fundamental interactions and the origin of the Universe. Some of these are as old as civilization itself and it is fascinating that we have today reached the maturity and developed the technologies to address them. The urge to seek answers to such questions is part of what defines us as humans. The ambitious task that lies ahead entails global collaboration on a courageous experimental venture, involving high-energy colliders, low-energy precision tests, observational cosmology, cosmic rays, dark-matter searches, gravitational waves, terrestrial and cosmic neutrinos, and much more.

Many different fields will enrich one another by sharing insights and experimental techniques, as the boundaries that used to separate them become increasingly blurred. In this global context, high-energy colliders will continue to be an indispensable and irreplaceable microscope to scrutinise nature at the smallest scales, providing knowledge that cannot be obtained through any other means.

Ombud's corner

LEADERSHIP, A QUESTION OF SKILLS OR OF PERSONAL QUALITIES?

"My boss has many personal qualities, but unfortunately he lacks expertise in his field. This means he has little credibility."

"Mine is a renowned expert in his field, but his social skills are so poor that no one wants to work with him."

Recent studies have shown that the list of characteristics required for good leadership is dominated by two traits: personal qualities and professional skills. However, the leaders with both are few and far between.

Although these two traits are equally important, the order in which they are employed is crucial: good leaders first use their personal qualities to gain the trust of their team, before putting their professional skills into play to ensure their authority.

Why?

We all have a tendency to show off our technical skills: knowing our job inside out, being innovative, following training, finding the best solutions to problems. This is what we are taught to do, both at school and then in higher education. However, if these technical skills are not backed up by at least some degree of personal skills, a team will do what is asked of it, but with little conviction.

A study that analysed the leadership qualities of 50,000 people working in a managerial role showed that only 27 lacked social skills. In other words, there is only a one in 2000 chance that someone with limited social skills will get a management position!

However, if team managers gain the support of their colleagues through their openness, willingness to listen, integrity and genuine interest and trust in their team members, they lay the foundations for good and strong leadership.

Why is this the case? Simple: they win over the heart before the mind, realising the importance of emotional needs before technical ones. When we like a manager as a person as well as a professional, we are more motivated in our work.

Being a good leader doesn't just happen. Keep in mind that, as well as technical, scientific and administrative knowledge, having the personal skills needed to get the team on board is essential. And for those who already manage a team, rest assured that it is possible, even though it is more difficult, to acquire people skills, if only by having more awareness of them.

Pierre Gildemyn

If you'd like to comment on any of my articles or suggest a topic that I could write about, please don't hesitate to e-mail me at Ombuds@cern.ch.