CERN Bulletin

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THE YEAR OF THE CRAB

Tests carried out in 2018 on two crab cavities in the SPS validated their technical principle and many operating parameters

The cryomodule containing the first two crab cavities in the SPS tunnel. The mobile table can move the cryomodule in order to position it on the beam line with a high precision as well as to remove it. (Image: CERN)

The first two crab cavities were installed in the SPS tunnel last February, for a series of unprecedented tests. When the time came to take stock, the teams from the BE, EN and TE departments, which contributed to the development of the crab cavities, were all smiles.

Crab cavities are important components developed for the High-Luminosity LHC, which will be commissioned after 2025 and will run at a higher luminosity than the LHC. Installed on either side of the ATLAS and CMS experiments, the crab cavities will tilt the proton bunches of each beam in order to maximise their overlap when they meet at the heart of the two experiments and thus increase the likelihood of collisions.

The first two crab cavities were tested with the SPS beam during 70 hours of machine development. Following the complex installation of the system in April, the first success came during the initial test period, on 23 May: generating a transverse field, the superconducting cavities tilted the proton bunches, a world first.

Thereafter, a number of tests were carried out to show that the cavities could manipulate the beam with precision, i.e. tilt the bunches to the desired degree.

(Continued on page 2)

A WORD FROM THE DIRECTOR GENERAL

A YEAR OF GREAT PROMISE

I would like to wish you and your families a very happy New Year. 2019 promises to be an exciting year for CERN, offering a wealth of new challenges not only for physics, the accelerators, the infrastructure and the administration, but also for outreach, as CERN will be opening its doors to the public on 14 and 15 September. Before reviewing some of the highlights of 2018, I would like to take the opportunity to thank you for your hard work and for your commitment to the Organization. Without them, none of the year's many outstanding achievements would have been possible. I would also like to extend my appreciation to the Member and Associate Member States for their continuous support.

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A WORD FROM THE DIRECTOR GENERAL

A YEAR OF GREAT PROMISE

Run 2 has just ended on a glorious note, with more integrated luminosity produced for the LHC experiments than foreseen, thanks to the outstanding performance of the accelerator complex over the past four years. The detectors and the computing coped very well with the deluge of data. Beautiful physics results have been produced already , and more will be released in the coming months.

CERN is much more than the LHC. In 2018 we saw significant progress across the full scientific programme. To mention only a few examples, the upgrades of the HIE/ISOLDE and AD/ELENA facilities were completed, the Advanced Wakefield Experiment, AWAKE, demonstrated electron acceleration from plasma wakefields induced by a proton beam for the first time, and the world's largest liquid-argon neutrino detector, the single-phase proto-DUNE at the CERN Neutrino Platform, reconstructed beautiful tracks from incident test-beam particles.

It is fair to say that the long shutdown, LS2, which began in December, will not be an idle period. The upgrade of the LHC injectors (LIU project) will be completed in 2019 and 2020, and much work will be done by the accelerator teams and the experiments in preparation for Run 3 and the High-Luminosity LHC upgrade.

With the submission of input from the scientific community in December, the update of the European Strategy for Particle Physics (ESPP) has begun in earnest. The ESPP is a bottom-up process that involves the whole community. We should all commit to it and contribute to the crucial task of preparing the future of our field.

Beyond the scientific programme, the highlights of 2018 include the accession of Lithuania as an Associate Member State, as well as the admissions of Serbia as a Member State and Croatia as an Associate Member State, subject to completion of those countries' respective internal ratification processes. The Council also approved the implementation plan for the Science Gateway project, a new facility for scientific education and outreach in the area next to the Globe of Science and Innovation.

The presentation to the personnel this morning is available at: https://indico.cern.ch/event/779524/

Together with the other members of the Directorate, I would like to wish you, once again, all the very best for 2019.

Fabiola Gianotti, Frédérick Bordry, Eckhard Elsen, Martin Steinacher and Charlotte Warakaulle

Fabiola Gianotti
Director-General

THE YEAR OF THE CRAB

“We have validated the principle and its reproducibility and proven that crab cavities are an excellent tool for manipulating proton beams”, explains Rama Calaga of the BE-RF group, who is in charge of the project. “We have also shown that the operation is transparent – in other words, that we can manipulate the beams throughout the beam cycle without changing their dynamics.”

The cavities were used with beams at energies of 26 GeV and then 270 GeV, and with a transverse voltage of up to 2 megavolts, i.e. 60% of the nominal voltage that will be used in the HL-LHC. The high-power radiofrequency system proved that it works correctly.

One major concern was the disruption caused by the operation of the cavities. “These effects are less significant than we expected. In particular, the emittance increases only slightly, which was a very important factor”, explains Rama Calaga. The smaller the emittance, the smaller the transverse dimension of the beam; this is therefore a crucial parameter for an accelerator.

As well as the beam dynamics, other parameters had to be verified. The teams tested the cryogenics system that cools down the cavities so that they can operate in a superconducting state. A brand new cryogenics system, with a mobile cold box, was commissioned for the test bench. “We were able to validate the appropriate sizing of the cryogenics system, as well as the vacuum system”, says Rama Calaga.

The alignment of the cavities was also crucial: a particularly novel alignment system using interferometry made it possible to monitor the position of the cavities during cooling and align them to within 0.2 millimetres transversely. “We verified both our assembly technique and the alignment procedure”, says Rama Calaga.

During this first year of operation, the mobile table developed specially for the test bench proved invaluable: it moved the cryomodule, which is full of liquid helium cooled to 2 kelvins, around ten times, in order to position it on and then remove it from the beam line. No fewer than 8 tonnes were

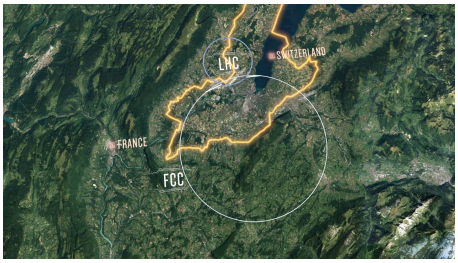
moved to a precision of within 100 microns or less. Quite a feat of engineering!

With the accelerators shut down, the development of the crab cavities continues. The pre-series of the two cavity types are currently being manufactured at CERN and by its industrial partners, in collaboration with American, British and Canadian institutes. The SPS test bench will be upgraded during the second long shutdown in order to carry out tests during Run 3, with the aim of improving the performance of the cavities.

Corinne Pralavorio

INTERNATIONAL COLLABORATION PUBLISHES CONCEPT DESIGN FOR A POST-LHC FUTURE CIRCULAR COLLIDER AT CERN

The Future Circular Collider (FCC) collaboration submits its Conceptual Design Report (CDR) for publication



The proposed layout of the future circular collider (Image: CERN)

Geneva. Today, the Future Circular Collider (FCC) collaboration submitted its Conceptual Design Report (CDR) for publication, a four-volume document that presents the different options for a large circular collider of the future. It showcases the great physics opportunities offered by machines of unprecedented energy and intensity and describes the technical challenges, cost and schedule for realisation.

Over the next two years, the particle physics community will be updating the European Strategy for Particle Physics, outlining the future of the discipline beyond the horizon of the Large Hadron Collider (LHC). The roadmap for the future should, in particular, lead to crucial choices for research and development in the coming years, ultimately with a view to building the particle accelerator that will succeed the LHC and will be able to significantly expand our knowledge of matter and the universe. The new CDR contributes to the European Strategy. The possibility of a future circular collider will be examined during the strategy process, together with the other post-LHC collider option at CERN, the CLIC linear collider.

The FCC study started in 2014 and stems directly from the previous update of the European Strategy, approved in May 2013, which recommended that design and feasibility studies be conducted in order for Europe "to be in a position to propose an ambitious post-LHC accelerator project at CERN by the time of the next Strategy update". The FCC would provide electron-positron, proton-proton and ion-ion collisions at unprecedented energies and intensities, with the possibility of electron-proton and electron-ion collisions.

"The FCC conceptual design report is a remarkable accomplishment. It shows the tremendous potential of the FCC to improve our knowledge of fundamental physics and to advance many technologies with a broad impact on society", said CERN Director-General Fabiola Gianotti. "While presenting new, daunting challenges, the FCC would greatly benefit from CERN's expertise, accelerator complex and infrastructures, which have been developed over more than half a century."

The discovery of the Higgs boson at the LHC opened a new path for research, as the Higgs boson could be a door into new physics. Detailed studies of its properties are therefore a priority for any future high-energy physics accelerator. The different options explored by the FCC study offer unique opportunities to study the nature of the Higgs boson. In addition, experimental evidence requires physics beyond the Standard Model to account for observations such as dark matter and the domination of matter over antimatter. The search for new physics, for which a future circular collider would have a vast discovery potential, is therefore of paramount importance to making significant progress in our understanding of the universe.

The FCC design study was a huge effort, possible only thanks to a large international collaboration. Over five years and with the strong support of the European Commission through the Horizon 2020 programme, the FCC collaboration involved more than 1300 contributors from 150 universities, research institutes and industrial partners who actively participated in the design effort and the R&D of new technologies to prepare for the sustainable deployment and efficient operation of a possible future circular collider.

"The FCC's ultimate goal is to provide a 100-kilometre superconducting proton accelerator ring, with an energy of up to 100 TeV, meaning an order of magnitude more powerful than the LHC", said CERN Director for Accelerators and Technology, Frédérick Bordry. "The FCC timeline foresees starting with an electron-positron machine, just as LEP preceded the LHC. This would enable a rich programme to benefit the particle physics community throughout the twenty-first century."

Using new-generation high-field superconducting magnets, the FCC proton collider would offer a wide range of new physics opportunities. Reaching energies of 100 TeV and beyond would allow precise studies of how a Higgs particle interacts with another Higgs particle, and thorough exploration of the role of the electroweak-symmetry breaking in the history of our universe. It would also allow us to access unprecedented energy scales, looking for new massive particles, with multiple opportunities for great discoveries. In addition, it would also collide heavy ions, sustaining a rich heavy-ion physics programme to study the state of matter in the early universe.

“Proton colliders have been the tool-of-choice for generations to venture new physics at the smallest scale. A large proton collider would present a leap forward in this exploration and decisively extend the physics programme beyond results provided by the LHC and a possible electron-positron collider.” said CERN Director for Research and Computing, Eckhard Elsen.

A 90-to-365-GeV electron-positron machine with high luminosity could be a first step. Such a collider would be a very powerful “Higgs factory”, making it possible to detect new, rare processes and measure the known particles with precisions never achieved before. These precise measurements would provide great sensitivity to possible tiny deviations from the Standard Model expectations, which would be a sign of new physics.

The cost of a large circular electron-positron collider would be in the 9-billion-euro range, including 5 billion euros for the civil engineering work for a 100-kilometre tunnel. This collider would serve the worldwide physics community for 15 to 20 years. The physics programme could start by 2040 at the end of the High-Luminosity LHC. The cost estimate for a superconducting proton machine that would afterwards use the same tunnel is around 15 billion euros. This machine could start operation in the late 2050s.

The complex instruments required for particle physics inspire new concepts, innovation and groundbreaking technologies, which benefit other research disciplines and eventually find their way into many applications that have a significant impact on the knowledge economy and society. A future circular collider would offer extraordinary opportunities for industry, helping to push the limits of technology further. It would also provide exceptional training for a new generation of researchers and engineers.

- CDR to be publicly available here: https://cern.ch/fcc-cdr
- Photos: https://cds.cern.ch/record/2653532
- Background information: https://cern.ch/fcc-cdr/webkit
- More information: https://cern.ch/fcc

SAVE THE DATE TO CELEBRATE THE WEB@30 ON 12 MARCH 2019

The Web@30 event is happening at CERN and you can join it from anywhere in the world

In 1989, CERN was a hive of ideas and information stored on multiple incompatible computers. Tim Berners-Lee envisioned a unifying structure for linking information across different computers, and wrote a proposal in March 1989 called “Information Management: A Proposal”. By 1991, this vision of universal connectivity had become the World Wide Web!

To celebrate 30 years since Tim Berners-Lee's proposal and to kick-start a series of celebrations worldwide, CERN will host a 30th anniversary event on the morning of 12 March 2019 in partnership with the World Wide Web Consortium (W3C) and the World Wide Web Foundation.

This anniversary event will be webcast and you can already start planning your Web@30 viewing party: a unique opportunity to reach out to and further extend your scientific and social community by inviting guests to watch the event (live or recorded, based on your time zone and constraints) and follow up with a discussion. The event itself in CERN's main auditorium will be by invitation only.

Find out more via the Web@30 website. Save the date to join us to watch live, and stay tuned to discover more in the coming weeks.

Mélissa Gaillard

THE FUTURE OF PARTICLE PHYSICS IN EUROPE IS TAKING SHAPE

CERN and the European particle physics community have submitted a wealth of contributions to shape the future of the discipline

Tuesday, 18 December was an important milestone in the process of updating the European Strategy for Particle Physics , marking the deadline for the submission of proposals from the particle physics community for the long-term priorities of the discipline in Europe.

The European Strategy Group, which was established at the end of 2017 to coordinate the update process, has received 157 contributions from universities, laboratories, national institutes, collaborations and individuals, predominantly from Europe but including projects that extend beyond the continent.

Along with its partner institutes, CERN, which operates the world's most powerful particle collider and a unique accelerator complex, has submitted several major contributions, ranging from experiments using existing machines to ambitious new collider projects. These projects are designed to provide answers to the host of unresolved questions relating to matter and the Universe, such as the nature of dark matter, which makes up most of the Universe, and the mysterious imbalance between matter and antimatter.

To determine the relevance of new projects, existing machines and approved projects must be assessed. The results of a year-long study involving hundreds of physicists has been submitted to the European Strategy Group: it details the physics potential of the High-Luminosity LHC (HL-LHC) and provides valuable data for assessing the two collider projects to which CERN is contributing, CLIC and the FCC, which could continue the work begun by the LHC and the HL-LHC.

The CLIC (Compact Linear Collider) project, in which 75 institutes from some thirty countries are participating, aims to develop a very high-energy electron–positron collider, to be built and operated in three stages of energy, starting with 380 GeV and increasing to 1.5 TeV and 3 TeV. The FCC (Future Circular Collider) study, which involves 135 institutes in 34 countries, is studying several scenarios for a collider in a tunnel measuring 100 km in circumference. In an initial phase, the FCC could collide electrons and positrons at energies of up to 365 GeV and very high luminosity (FCC-ee). Lepton machines like CLIC and FCC-ee could be used to carry out detailed studies of particles that are crucial to our understanding of the physics of the infinitesimally small, such as the Higgs boson and the top quark, in order to reveal new processes.

The FCC study is also exploring the possibility of a hadron collider (FCC-hh) with an energy of 100 TeV, seven times higher than that of the LHC, which would be used to explore new energy ranges that are inaccessible with the present machines, search for signs of new physics and continue to study known particles and processes. The FCC study also covers the possibility of colliding hadrons with leptons and developing a version of the LHC in the existing tunnel at twice the present energy.

CERN has also collaborated on several other proposals, submitted in the framework of the Physics Beyond Colliders study. Launched in 2016, this study aims to take advantage of the extraordinary potential of CERN's accelerator complex and research infrastructures in order to develop projects that complement the high-energy colliders. These projects would use a different approach to explore physics beyond the Standard Model. Twenty proposals have been submitted, ranging from the search for dark matter to the study of charge-parity symmetry breaking – which could explain the imbalance between matter and antimatter – and research into quantum chromodynamics. They aim to improve on existing experiments, set up new installations using CERN's beamlines or develop entirely new concepts.

All of the proposals will be presented at a public scientific symposium that will be held in Granada, Spain in May 2019. The contributions and discussions will help shape the long-term priorities of particle physics in Europe. These priorities will be formalised at the beginning of 2020 in the update of the European Strategy for Particle Physics.

For further information on the European Strategy update, see the press release (http:///news/press-release/cern/european-particle-physics-community-gears-new-shared-vision-future) issued in October 2018.

MAKING CERN'S EXHIBITIONS MORE ACCESSIBLE

Microcosm is collaborating with the Swiss Association for the Blind and Visually Impaired to create better content for everybody

Testing ideas at the workshop (Image: Julien Ordan/Rachel Lavy/CERN)

Every year, thousands of visitors of every age, cultural background and geographical origin discover and appreciate CERN's Microcosm exhibition. Very soon, its offer will be enlarged to welcome blind and visually impaired visitors.

“We have teamed up with the local Association for the Blind and Visually Impaired to understand their needs and together develop material,” explains Emma Sanders, Head of Microcosm. “It is an important step because we would like our exhibition to be open and accessible to everyone wanting to find out about CERN and perhaps to inspire them to pursue a career in science.”

Scientists, design experts, content developers and members of the association spent two days at IdeaSquare evaluating the accessibility of Microcosm, adapting the existing content, discussing issues related to developing new models and finding new solutions. “We set up four mixed teams that had to work on four different challenges,” describes Mélissa Samson, who is running the accessibility project in Microcosm. “With the help of the Ideasquare team, they followed the principles of ‘Design Thinking’ methodology, which consists of getting to know your user community and moving quickly from ideas to developing actual prototypes.”

At the end of the two days, the four teams had each developed ideas, ex-

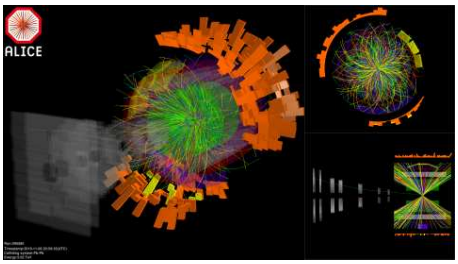
changed views, tested prototypes and received feedback from visually impaired users. “The workshop has changed how we think about exhibition content,” says Sanders. “From very practical aspects like fonts, contrast and lighting to using a combination of sound and other sensory techniques to introduce content in new ways. We have also clearly understood that by creating content for blind and visually impaired visitors, we enrich the exhibition for all categories of the public. The workshop was a source of inspiration in this regard.”

The accessibility project will continue to develop over the coming months and some new content should be made available quite rapidly, as areas have already been identified within the exhibition space. “The workshop has had a very positive impact and we'll soon be able to see its effects materialised in new exhibits and perhaps also extended into future exhibition projects,” confirms Samson.

For tips on how to make your content accessible, please read “Communiquer pour tous, Guide pour une information accessible (*http://inpes.santepubliquefrance.fr/CFESBases/catalogue/pdf/1844.pdf*)”.

LHC EXPERIMENTS SHARE HIGHLIGHTS FOR 2018

ALICE, ATLAS, CMS and LHCb presented their key physics results at an end-of-year series of talks



Particle showers in the ALICE detector during the first lead nuclei collisions of 2018 (Image: ALICE/CERN)

It has been a record-breaking year for the LHC, with the accelerator delivering over twice as much proton–proton collision data as it did in all three years of its first run. But while the experimental collaborations were eagerly collecting fresh data from the LHC, they were also busy analysing data they have gathered over the years, presenting many new physics results during the course of 2018. Today, young scientists from the four main LHC experiments presented the year's highlights at an open session of the CERN Council. Below are a few of dozens of new results, which showcase the richness and diversity of the LHC's physics programme.

The hot early universe

The results from ALICE, the heavy-ion specialist at the LHC, focused mainly on studies of the quark-gluon plasma (QGP), a dense state of free quarks and gluons thought to have existed in the early universe. The LHC can recreate these conditions by colliding together lead nuclei. ALICE showed that the particle jets emerging from lead–lead collisions are narrower (more collimated) than those formed in proton–proton collisions, due to the way these particles interact with the QGP “soup”.

Comparing results with the Relativistic Heavy Ion Collider (RHIC) in the US, ALICE noted that the production of J/ψmesons at the LHC was not as suppressed at low transverse momenta, concluding that the suppression caused by the QGP was countered by the recombination of charm and anticharm quarks into J/ψ mesons. They also observed that the ratio of $\Lambda_c$baryons to D mesons produced in lead–lead collisions was higher than in proton–proton and proton–lead collisions. This behaviour is expected if the charm quarks bind with other quarks in the QGP around them and form baryons and mesons. The dynamics of these processes will be studied precisely with future datasets that ALICE will collect in the next runs of the LHC. Furthermore, ALICE noted that this Λ_c-to-D ratio was higher than expected from theoretical calculations even in proton–proton and proton–lead collisions.

New Higgs signatures

The LHC's two general-purpose experiments – ATLAS and CMS – continued their examination of the Higgs boson that they jointly discovered in 2012. This scalar boson transforms into lighter particles almost immediately after it is produced, and by studying the various transformations, or “decay modes”, available to it, physicists can test the Standard Model of particle physics. This year, both ATLAS and CMS announced that they had observed the Higgs transforming into a pairs of bottom–antibottom quarks for the first time. Although the Standard Model predicts that this decay mode is the most abundant, such bottom-antibottom pairs are produced in the LHC from a variety of processes, making it challenging to isolate those that come from the Higgs.

Since the top quark is heavier than the Higgs boson, nature forbids a Higgs transformation to pairs of top–antitop quarks. However, scientists can study their interactions by looking for instances where the a Higgs boson is produced along with a top–antitop pair, and ATLAS and CMS observed this “associated production” in data recorded in previous years. Both collaborations also highlighted their observations of the Higgs transforming into a tau–antitau pair, which was first reported by combining data from ATLAS and CMS.

Testing the Standard Model

Discovered over twenty years ago, the top quark remains a source of novel physics measurements and observations. Its mass is of particular interest, and ATLAS recently measured it to a precision of 0.3% – 172.69 $\pm$ 0.25 (statistical error) $\pm$ 0.41 (systematic error) GeV – by combining data in different channels. Meanwhile, CMS explored rare production modes of the top quark that are sensitive to signs of physics beyond the Standard Model. The collaboration observed the production of a top quark in association with a Z boson and a second quark (tZq), and presented evidence for the production of a top along with a photon and another quark (tγq).

Unlike the massless photon, the W and Z bosons can bounce or “scatter” off each other, and the probability of this occurring is affected by the presence of the Higgs boson. ATLAS presented their observation of such scattering of pairs of W bosons ($W^{\pm}W^{\pm} \rightarrow W^{\pm}W^{\pm}$) as well as of a W and a Z boson ($W^{\pm}Z \rightarrow W^{\pm}Z$), both with statis-

tical significances of over five standard deviations. Future data will help measure this scattering with greater precision, as physicists look for deviations from predicted values. W and Z bosons can also help in searches for new particles, and ATLAS searched for instances in which extremely massive particles transform into pairs of these. Analysis of the data recorded by the detector ruled out the presence of specific types of massive particles up to a 4.15 TeV.

Some extensions of the Standard Model propose the existence of an exotic Z boson, known as the Z' ("Z-prime") boson. CMS searched for such Z' particles, but found no deviation in the data from the Standard Model's predictions. CMS also searched for hypothetical particles known as leptoquarks, which are thought to be hybrids of leptons and quarks; the data did not show their presence. Other highlights from CMS included measurements of known Standard Model processes with improved precisions as well as novel studies in physics of B mesons.

Both ATLAS and CMS searched for many different signatures for the presence of dark matter and supersymmetry but found no evidence for their existence in the various parameters that were explored. These null results are crucial as they allow scientists to place stringent constraints on theoretical models that seek to explain gaps in the Standard Model.

The mystery of matter-antimatter asymmetry

Particle physicists are looking for possible solutions to explain why the universe is dominated by matter with almost no antimatter around. This asymmetry could be explained by differences in the way matter and antimatter interact with the weak force. The LHCb experiment was built to study these differences, known as charge-parity (CP) violation, and presented a variety of precision measurements at the session. LHCb measured several parameters associated with the so-called CKM matrix, which quantifies possible CP violation among quarks. In particular, the collaboration measured the angle $\gamma$with different methods, and obtained an average value of around 74°, making it the most precise measurement of this angle from a single experiment. They also presented the first evidence of the rare $B_s$meson transforming into an excited kaon and two muons as well as the best limits on the transformation of a B^+meson into three muons and a neutrino. Further, LHCb also highlighted new properties of the Ξ_{cc}baryon, which they observed for the first time last year.

LHCb also operated in fixed-target mode besides its regular collider mode by injecting noble gases such as helium into the beam pipe in between particle bunches that race around the LHC. The atoms of these noble gases served as stationary targets for the circulating protons, and LHCb was able to observe the production of J/$\psi$and D^0particles in these collisions as well as make the first measurement of the production rate of antiprotons in proton-helium collisions.

Looking forward...

The LHC's Run 2 came to an end earlier this month and the second long shutdown (LS2) has begun ; but this does not mean that the collaborations go into hibernation! Indeed, the wealth of data already gathered will take many more months to be fully explored. And the detectors will undergo transformations of their own while collisions are suspended over the course of LS2. The LHCb detector has fulfilled its original mandate and will soon be overhauled completely, with every major subsystem getting upgraded or replaced. ALICE will be upgrading most of its subdetectors, aiming for greater precision in measuring particle tracks. CMS and ATLAS will similarly receive major modifications as they prepare for the restart of the LHC in 2021 and eventually higher luminosities from the High-Luminosity LHC in 2025. These upgrades will ensure that the LHC experiments can keep recording excellent data in the forthcoming runs and continue their searches for new discoveries.

Achintya Rao

CERN OPEN DAYS - EXPLORE THE FUTURE WITH US!

On 14 and 15 September 2019, CERN will open its doors to the general public

Visit underground to the CMS experiment during the 2013 Open Days (Image: CERN)

On 14 and 15 September 2019, CERN will open its doors to the public for two special days at the heart of one of the world's largest particle-physics laboratories*.

The CERN Open Days have become a regular feature of the period that we call the "long shutdown" during which our accelerators stop for around two years, to benefit from upgrades and renovation work. And Long Shutdown 2 has just started.

Similar to the 2013 edition, the 2019 Open Days will give people the chance to discover our facilities both underground and on the surface**. Debates, film screenings, theatre performances, experimental workshops and, of course, dozens of visit points spread all over the site will take you to the heart of our Laboratory, in direct contact with the science of today and tomorrow.

The programme of the event and all practical information will be communicated in 2019. For now, save the dates of this exceptional event and come and visit CERN.

** Admission is free of charge for all audiences.*
** Some sites may have age and access restrictions.*

COMPUTER SECURITY: FUN FACTS: DID YOU KNOW?

Like any other organisation, institute or enterprise, CERN is under permanent attack by evildoers

Like any other organisation, institute or enterprise, CERN is under permanent attack by evildoers. Attackers try to break into our data centres, misuse the computing power of the Worldwide LHC Computing Grid and attempt to steal your CERN password or compromise your laptop or PC. 2018 was no different from the years before. As 2019 begins, we would like to share a few fun facts on CERN computer security and our activities in 2018.

Cybersecurity is a marathon and, as in previous years, CERN computing resources were challenged by many different parties. Thanks to your awareness and care, the proactiveness of our colleagues in keeping the data centres and their computing services up to date, the quick responses when incidents have happened and the willingness of the CERN Management to embark on new protective measures, CERN has been spared from major cyber-disasters. Still, we have not been idle! All our computer security interventions are documented in our Monthly Report and some of them have been discussed in previous Bulletin articles. Here are a few fun facts:

- 116 computer security interventions were performed by the CERN Computer Security team in 2018;
- 2TB of data per day was analysed in CERN's Security Operations Centre ;
- This data is compared online with about 17 000 suspicious IP addresses, domain names or known malicious files (so-called indicators of compromise, IoC;
- The most serious computer security incident so far (back in 2016) required 30 person-weeks of in-depth studies before it was finally concluded;
- 3 Macbooks were found to have been infected in 2018;
- 2670 CERN e-mail addresses (and local passwords!) associated with an external web service were exposed in a single data breach of that service;
- In the last “clicking campaign”, 15.2% of the email recipients clicked and would potentially have rendered their device compromised;
- 516.878 EUR in compensation has been demanded following an alleged licence violation ;
- 126 CERN staff and users have so far been trained to become White Hats ;
- 26% of non-computer devices, e.g. control systems, webcams, printers, coffee machines, smart meters, oscilloscopes, Raspberry Pis and Arduinos – devices of the so-called Internet of Things – connected to CERN's office network have been found to be vulnerable ;
- 2766 Service Now tickets were handled in 2018.

Will 2019 be calmer? That would be unexpected and against worldwide trends. Instead, 2019 will doubtless be as interesting as the past! So we continue to count on your help : with a sufficient amount of awareness, sensitivity and caution – STOP – THINK – DON'T CLICK – you can protect your own computers, tablets and smart phones, documents, photos and data, bank accounts and online accounts – and contribute significantly to protecting CERN!!! We wish you, your friends and your families a safe and secure 2019!

———

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

INVENTORY OF CERN PREMISES – CHECK THE PICTURE OF YOUR WORKPLACE

The campaign to make an inventory of CERN premises for maintenance purposes is now finished. As announced, the panoramic pictures taken will be available to the personnel in charge of maintenance, safety/security and space management activities at CERN, from 15 February 2019.

You were invited to remove all personal belongings from your office. Our intention is to render the photos non-personal data. If the picture of your office still accidentally contains personal items, we ask for your cooperation and invite you to blur them from the image using the following URL: https://panoramas-blurrer.web.cern.ch/.

The Organization will, in its legitimate interest of using the photographs for a variety of purposes, blur any remaining ones.

SMB Department

CERN RELEASES A NEW POLICY ON SOFTWARE DISSEMINATION

In August 2017, the Enlarged Directorate endorsed a new policy which defines the framework of software dissemination activities at CERN, contributing to a more coherent approach in the licensing and dissemination of the Organization's software assets. As a member of the CERN community, your work may lead to potential applications across a wide range of industries beyond CERN. In order to maximise the dissemination, there is a number of important implications to consider when developing software.

CERN is a collaborative environment, where developers from different organisations, institutes, and countries often contribute to various degrees of a given software project. Despite its uniqueness as a fundamental research laboratory, CERN does not differ from industry or academia with respect to software creation. The majority of the laboratory's output is Components Based Software (CBS), and software that does not contain external components is the exception rather than the norm.

Development teams often focus on the desired outcome, employing the component that seems most suitable to satisfy the project's requirements. As a result, code may not always be properly identified and documented. This approach is perfectly valid if the CBS is not to be distributed outside CERN, but from a dissemination perspective, it may contribute to complicate the path as the licensing scheme of the different components are not taken into account.

The new software dissemination policy therefore recommends ways of anticipating software dissemination in order to facilitate it. The possible dissemination paths are greatly influenced by the freedom to choose a licensing model, and falls into four different cases depending on the involvement of external contributors in the development, and the usage of external code components.

In order to assess the dissemination potential, every software technology is evaluated on a case-by-case basis, considering the needs and aspirations of the developer's team. The Knowledge Transfer (KT) group is responsible for facilitating the transfer of CERN technology, undertaking a number of concrete actions to promote CERN software technologies, also providing support and expertise to assist in all steps of the dissemination process. Numerous technologies are brought to the attention of CERN's KT group every year, leading to various collaboration agreements and knowledge transfer activities with industry.

In 2017, a licence agreement was signed between CERN and the leading global display manufacturer LG Display, giving them access to controls middleware software from CERN to be used in factory automation across their plants. The software was originally developed by the BE-CO group for the LHC to provide a common software communication infrastructure for the accelerator controls, but will now be adapted to its new application by LG-Display with the support of the development team.

Another knowledge transfer activity conducted was a four-day training course on machine learning, in which a team of experts from CERN's EP-SFT group shared their expertise with Sanofi Pasteur, the vaccines business unit of the global life science company Sanofi. The aim was to improve vaccine production by using ROOT, the data analysis framework used to analyse HEP data, and the Toolkit for Multivariate Data Analysis (TMVA), a library of associated machine learning algorithms.

The possible disseminations paths for software technologies are many, and if you want to learn more about how KT can support the process, please visit kt.cern or access all CERN KT policy documents here (*https://kt.cern/cern-community*).

The new CERN-wide policy applies to all CERN Software, addressing both proprietary licensing and open source licensing, and complements the more general framework 'Policy on the Management of Intellectual Property in Technology Transfer Activities at CERN' (the "CERN IP Policy") while taking into account the recommendations of the 'Final Report OSL-2012 – Main Volume' by the 'Open Source Licence Task Force'.

Giovanni Anelli is the Head of CERN Knowledge Transfer group.

Giovanni Anelli

TO ALL MEMBERS OF PERSONNEL IN RECEIPT OF REMUNERATION FROM CERN

In 2019, net monthly remuneration will be paid into individual bank accounts on the following dates

In 2019, net monthly remuneration will be paid into individual bank accounts on the following dates:

- Friday 25 January
- Monday 25 February
- Monday 25 March
- Thursday 25 April
- Friday 24 May
- Tuesday 25 June
- Thursday 25 July
- Monday 26 August
- Thursday 26 September
- Friday 25 October
- Monday 25 November
- Friday 20 December

Finance and Administrative Processes Department

OPERATIONAL CIRCULAR NO. 11 – THE PROCESSING OF PERSONAL DATA AT CERN

Operational Circular No. 11 entitled “The processing of personal data at CERN”, has been approved by the Director-General following a recommendation for approval decided by the Standing Concertation Committee at its meeting on 18 October 2018.

It is available via the following link: http://cds.cern.ch/record/2651311

The purpose of this new circular is to set out the Organization's approach to data privacy. It brings together the privacy principles, as well as the rights and obligations of the Organization, with regard to the processing of personal data.

This circular enters into force on 1 January 2019, however, full implementation of the circular will be subject to an implementation calendar approved by the Director-General and published by the Office of Data Privacy.

It should be noted that any other provisions relating to the protection of personal data contained in other existing texts should henceforth be interpreted in the light of this circular, which will prevail over all conflicting provisions.

Additional information on processing of personal data may be found on the Office of Data Privacy website. Questions may also be addressed to the Office of Data Privacy or to any of the following Departmental Data Privacy Protection Coordinators:

- BE: K. Sigerud
- DG: N. Barzaghini
- EN: L. Serio
- EP, TH and RCS: B. Brugger
- FAP: D. Mathieson
- HR: N. Polivka
- HSE: C. Delamare
- IPT: A. Hahnel-Borgeaud
- IR: R. Bray
- IT: A. Dumitru
- PF: K. Mitchell
- SMB: O. Van Der Vossen
- TE and ATS-DO: G. Hobgen

HR Department

CERN HEALTH INSURANCE SCHEME (CHIS) - CONTRIBUTIONS AS OF 1 JANUARY 2019

As the CHIS contribution rates are unchanged for 2019, the CHIS contributions will only evolve if there is a change in the relevant Reference Salary (see Chapter XII of the CHIS Rules). For instance, as of 1 January 2019, the lump-sum monthly contributions based on Reference Salary II will be as follows:

1. Lump-sum contributions for voluntary members

The monthly contribution for voluntary members (e.g. users and associates) with the normal health insurance will be 1220 CHF per month, whilst for those with the reduced health insurance it will be 610 CHF.

2. Lump-sum contributions for post-compulsory members other than CERN pensioners

For post-compulsory members other than CERN pensioners, the monthly contribution will be 1303 CHF in the case of former staff members and former spouses continuing their affiliation, whilst in the case of formerly dependent children continuing theirs it will be 521 CHF.

HR Department

Announcements

GLOBE AND CLUBS CAR PARKS CLOSED ON THE MORNING OF THURSDAY, 17 JANUARY

The car parks next to the Globe (except the P+R) and in the clubs area will be **reserved for the Director-General's New Year ceremony with the local authorities from 9 a.m. to 1 p.m. on Thursday, 17 January**. You are requested to vacate the parking spaces **by Wednesday evening**. Both car parks will be inaccessible on Thursday morning (except to P+R pass holders). The car parks will re-open on Thursday afternoon.

As a reminder, please note that the Globe car park, as most parking lots at CERN, cannot be used for more than five consecutive days. For long-term parking, please consult the following page: https://admin-eguide.web.cern.ch/en/procedure/road-traffic-and-parking-regulations-cern-site

Thank you for your understanding.

The CERN Protocol Service

BOOK PRESENTATION: “FROM MY VAST REPERTOIRE: GUIDO ALTARELLI'S LEGACY”

This book is a collection of original contributions, at the cutting edge of scientific research, by some of the leading theoretical and experimental high-energy physicists currently in the field

Guido Altarelli was a leading figure in 20th century particle physics. His scientific contributions and leadership played a key role in the development of the Standard Model of fundamental interactions, as well as the current search for new physics beyond it, both at and beyond CERN.

This book is a collection of original contributions, at the cutting edge of scientific research, by some of the leading theoretical and experimental high-energy physicists currently in the field. These were inspired by Guido's ideas, whether directly or indirectly.

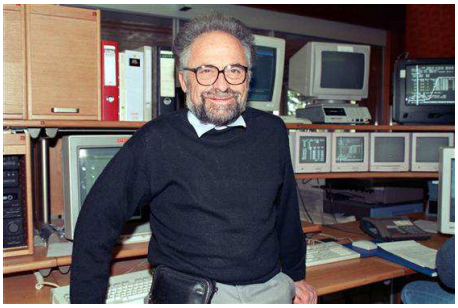
“From my Vast Repertoire”, ed. by S. Forte, A. Levy, G. Ridolfi, World Scientific, 2018, ISBN 9789813238046

The book presentation will take place on Monday 28 January 2019 from 15:30 to 17:00 in room Georges Charpak (room F / 60-6-015)

For more information, see: https://indico.cern.ch/event/782019/

Obituaries

ALBERT HOFMANN (1933–2018)



(Image: Hélèna Moya/CERN)

Albert Hofmann died on the night of 28 December 2018. We all had the good fortune to share time with this wonderful person and were deeply saddened to hear of his untimely death.

Albert finished his studies at ETH Zurich in the mid-sixties and then went on to work at the Cambridge Electron Accelerator (CEA) at Harvard University. The team at CEA was a highly reputed one, including names like Gus Voss and Herman Winick. We used to joke with Albert saying that, according to him, everything associated with accelerators was invented at CEA. He left CEA and came to the CERN ISR in 1973, joining the ISR Accelerator Theory group, where he made seminal contributions to the performance of this collider. When the ISR was closed, Albert returned to California to work on the SLC damping rings and on SPEAR. He was invited to return to CERN in 1989 to take joint responsibility for the commissioning of LEP. Albert made remarkable contributions to the performance of LEP throughout its operating lifetime of eleven years. He subsequently returned to California to work with Ron Ruth on a compact light source developed by Lyncean Technologies.

Albert was an inspiration, a mentor and a role model for everyone who worked with him. He was world-renowned as a brilliant accelerator physicist and, just as importantly, he was a kind, sweet person.

We witnessed on many occasions how younger staff were magnetically attracted to Albert for his simplified explanations of complicated physics issues. He gave many inspiring lectures at the CERN Accelerator School, simplifying, as only he could, some of the most difficult concepts in accelerator physics.

He also wrote his monumental book on synchrotron radiation. He was such a perfectionist that he often expressed his fear that this book would never be finished, as he wanted to include all the new ideas that were continuously being invented.

He was always over-generous in giving scientific credit to colleagues who had in some cases only made a minor contribution. Albert also had an impish, tongue-in-cheek sense of humour and told fascinating stories about his childhood and about the early days of colliders.

We feel an acute sense of loss as we say goodbye to this generous, modest, inspiring and unpretentious role model.

His colleagues and friends

A more complete obituary will be published in the March-April 2019 issue of the *CERN Courier*.

Ombud’s corner

ALL THE BEST FOR THE NEW YEAR!

As 2019 gets under way, I'd like to take the opportunity to wish you a year full of good things:

... a lot of listening: both listening to others and being listened to yourselves;

... understanding: may you and your colleagues have the courage to express yourselves openly and respectfully, making sure you've understood each other's needs;

... kindness: may you and your colleagues assume that each other's intentions are good, even if they may sometimes be interpreted wrongly;

... emotional openness: be able to express your feelings without fear at work, and take into account those of your colleagues; emotions are there whether you want them or not and ignoring them does no good;

... professional success: it's so satisfying to achieve your goals – find the right compromise between perfection and what's really necessary;

... the affection of friends and family: be attentive to the people around you outside the workplace; they need you and you need them too. Maintain a good balance between work and your personal life – it will benefit everyone!

Happy new year to you all and I wish you success in all your endeavours, both professional and personal!

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 .