CERN Bulletin

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NEW SMALL-SCALE ACCELERATOR TO HELP STUDY HERITAGE ARTWORKS

A collaboration with INFN will see CERN technology optimised for use in cultural-heritage projects

The radio-frequency quadrupole of the MACHINA project under development (Image: Julien Marius Ordan/CERN)

Particle accelerators find several uses outside fundamental physics research. Following the first "miniature" accelerator developed for a compact injector for proton therapy, CERN has been building a new transportable high-frequency accelerator for use in the examination of art masterpieces.

The accelerator relies on the proton-induced X-ray emission (PIXE) technique, and CERN has been working on building a radio-frequency quadrupole (RFQ) for this purpose since mid-2017. Innovative beam dynamics have been developed to make the PIXE-RFQ more compact and consume less power. The result is a short proton accelerator measuring one metre in length that can provide a beam of 2 MeV with a power consumption of less than 6 kVA.

The study of cultural heritage requires in-situ, non-destructive analysis. A transportable accelerator using PIXE offers a unique way to overcome the limitations of the mobile X-ray fluorescence method generally used. PIXE also has better sensitivity, provides layer information by using different proton energies and can exploit other reactions (gamma emission, backscattering particles) for more efficient analysis.

(Continued on page 2)

A WORD FROM THE DIRECTOR GENERAL

2019 OPEN DISCUSSION WITH THE DIRECTORATE

I'm very much looking forward to the second open discussion session between CERN personnel and the Directorate on 19 March. As we promised after the first such session in November 2017, we've taken on board the feedback you gave us, and made some refinements to the form the meeting will take.

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In this issue

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A WORD FROM THE DIRECTOR GENERAL

2019 OPEN DISCUSSION WITH THE DIRECTORATE

Next time, you told us, we should be seated – that's an innovation we're more than happy to accept! More seriously, however, while you liked the number and diversity of questions addressed in that first meeting, you would have appreciated a little more depth on a few, selected topics. That means that we need to find a format that reconciles openness with the ability to consider subjects in detail. We've therefore decided to begin as we did last year by asking you to send questions you'd like to be considered to directorate-questions@cern.ch before 4 February. We'll then group your questions into themes and ask you to vote on those you'd most like to see discussed.

Online voting will open in mid-February and close in early March. Any important subjects that we do not have time to discuss at the meeting on 19 March will inform CERN's internal communication for the months to follow.

I'm sure you'll have plenty of things you'd like to discuss, but to get the ball rolling, the top themes that emerged from your submitted questions in 2017 were: priorities for future scientific projects (in the framework of the European Strategy for Particle Physics), energy saving, mobility in and around the CERN sites, diversity, work-life balance, geographical enlargement, and the societal impact of our research.

The whole Directorate looks forward to receiving your questions, and to a fruitful discussion of the things that concern you and CERN on 19 March. If you can't make it to the Main Auditorium, a webcast will be available as well as the possibility to send questions live by e-mail.

On behalf of the Directorate

Link to the Indico event page: https://indico.cern.ch/event/793416/
Link to last year's session: https://indico.cern.ch/event/675992/

Fabiola Gianotti
Director-General

NEW SMALL-SCALE ACCELERATOR TO HELP STUDY HERITAGE ARTWORKS

CERN and INFN are collaborating on a common project called MACHINA, which stands for Movable Accelerator for Cultural Heritage In-situ Non-destructive Analysis. INFN, and in particular the Laboratory for Nuclear Techniques for Cultural Heritage and the Environment (LABEC) in Florence, has more than 35 years of experience in accelerator analysis of cultural-heritage artworks. Through a collaboration with the *Opificio delle Pietre Dure* (OPD) in Florence, masterpieces by Leonardo da Vinci, Antonello da Messina, Vasari, Mantegna and others have been studied. Collaborating with INFN-LABEC thus allows compact proton accelerator technology developed at CERN to be optimised and used in cultural-heritage projects.

Last December, the PIXE-RFQ reached an important milestone: after about one and a half years of high-precision machining and metrology at the CERN workshop, the four vanes of the first of two modules were assembled by vacuum brazing. The modulation at the tip of the vanes allows the particles to be accelerated and must be machined with a precision of 10 µm. The vanes, which are 50 cm long and 7 cm high, must then be assembled with a precision of 30 µm. Vacuum brazing is the best technique for this assembly and, thanks to a procedure initially developed for the Linac4 RFQ, the process is now highly efficient. During a controlled heating cycle under vacuum, wires of a silver–copper alloy melt and the liquid flows between the pieces. Springs are used for alignment during the heating. After cooling and solidification, this forms a perfect joint between the copper pieces.

The construction of the new accelerator isn't finished yet, but the MACHINA/PIXE-RFQ project is well on its way. First beam tests are expected in late 2019 and first analysis of a real art object at the OPD is scheduled to be conducted in 2020.

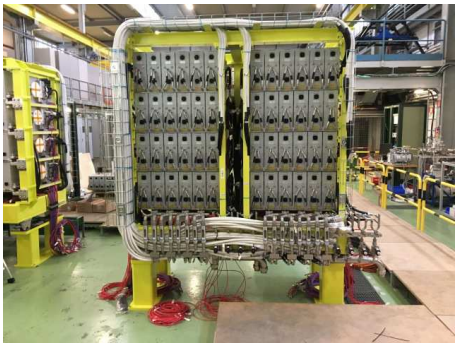
The construction of the PIXE-RFQ is fully supported by the CERN KT Fund, with contributions from the EN/MME and BE/RF groups.

More pictures of MACHINA are available on CDS (*https://cds.cern.ch/record/2653345*)

Serge Mathot

LS2 REPORT: METAMORPHOSIS OF THE BOOSTER

In the first of our series of articles on work done during LS2, we focus on the second link in the accelerator chain, the PS Booster



A new acceleration system has been developed for the PS Booster. It consists in new RF cavities based on a composite material (FineMet) assembled in three structures like the one above (Image: CERN)

The LS2 marathon has begun. In all the accelerators, teams have set about the tasks of maintaining or renovating numerous hardware components or replacing them with new and often innovative systems. Most of this major upgrade work is being done as part of the LHC Injectors Upgrade (LIU) project, which has been under preparation for several years and aims to increase the performance of the accelerators. The Engineering Department's ACE group has been coordinating the schedule for all the installation work, with one coordinator per accelerator assigned to organising the master schedule and to liaising with the coordinators of each work package.

The PS Booster is to be completely transformed. When the new linear accelerator, Linac4, starts operating at the end of LS2, the PS Booster will receive protons at an energy of 160 MeV, compared with 50 MeV from the old Linac2. The injection system into the Booster therefore needs to be completely modified, especially as Linac4 will be accelerating H^- ions (formed from a hydrogen atom and an additional electron). These ions will be stripped from their electrons by an ingenious injection system before being accelerated in the Booster up to 2 GeV, compared with 1.4 GeV in the past. In addition to the injection system upgrade, the radiofrequency acceleration and power supply systems will also be replaced, the magnets upgraded and the transfer line to the PS renovated.

David Hay is coordinating installation work at the PS Booster during LS2. “In actual fact, renovation work started as far back as 2016,” he explains, “with the civil engineering work, cable removal and laying campaigns and the installation of new instrumentation.” In parallel, all the new equipment for high-intensity beam operation was developed and manufactured, as part of the LIU project. A new building (245) has been constructed to house the Booster's new power supply system, designed to cope with the higher energy of the accelerator. The power converters will supply power to the magnets with electrical intensities of 5500 amps, compared with 4000 amps previously. The new “POPS-B” power supply system was tested at the end of 2018 and successfully supplied the required level of power. This was an important milestone in the Booster's performance upgrade.

The cable removal campaign has also begun. Another particularly tricky operation began this week with the dismantling of the equipment in the Booster's injection zone. “Out of the 215 metres of beamlines of the PS Booster complex, 70 metres will need to be removed to make way for new injection and extraction equipment,” explains Wim Weterings of the TE-ABT group, who is supervising the work on the transfer lines. The equipment to be removed includes septum and kicker magnets, dipoles, quadrupoles and corrector magnets. Installation of the new systems should begin towards the end of the spring.

Some magnets will need to be replaced in the transfer lines as well as in the Booster ring. “We have to take out over 60 magnets. Most will be replaced with new magnets but some will be reconditioned,” explains Antony Newborough of the TE-MSC group, who is responsible for the Booster magnets. The heaviest weigh around 18 tonnes.

The radiofrequency acceleration system will be completely replaced. Since 2012, a new system based on cavities built using a composite magnetic material called FineMet has been developed in collaboration with Japanese institute KEK. Two cavities have been conclusively tested *in situ* over the course of several runs. The three structures, each containing 8 cavities, are ready to be installed once the old cavities have been removed. A new electrical power system has also been developed. “From the end of February, we will be installing 24 racks containing 144 power converters as well as 18 racks containing the control modules in the surface building. This will take two months,” explains Matthias Haase of the BE-RF group, who is coordinating the work.

In addition to the work being performed at the heart of the accelerator, much is also being done on the infrastructures, including the replacement of the cooling system and the installation of new cooling towers.

The room housing the power converters and the control system for the PS Booster is completely empty during LS2. All cables running under the false floor are removed before installing the new power and control system (Image: Matthias Haase/CERN)

Corinne Pralavorio

FIRST CIVIL-ENGINEERING MILESTONE PASSED FOR THE HIGH-LUMINOSITY LHC

Excavation of the two new shafts for the HL-LHC at points 1 and 5 of the accelerator has been completed

A montage of three photos showing an excavator in one of the two shafts that were dug for the High-Luminosity LHC (Images: Antonino Panté)*

Nine months after work began, the excavation of the two new shafts for the High-Luminosity LHC has been completed. On the site of the CMS experiment (LHC Point 5) at Cessy, a 60-metre shaft with a diameter of 11 metres was fully excavated before the end of 2018. On the site of the ATLAS experiment (LHC Point 1), the 62-metre shaft has just been completed and the contractors are installing a concrete ring at its base. With this first phase of the underground work now complete, the contractors are starting to excavate the 50-metre-long underground halls, which will be 17 metres wide and 17 metres high. This work should last about four months. A number of service tunnels will then be constructed on each site, one of them 300 metres long to house equipment and four of them 50 metres long to connect the new structures to the LHC tunnel.

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LEADING ICT COMPANIES GATHER AT CERN FOR ANNUAL CERN OPENLAB TECHNICAL WORKSHOP

CERN openlab's annual technical workshop gathered leading ICT companies for a series of discussions on computing technologies

Frédéric Hemmer presents an award to representatives of Oracle, marking 15 years of fruitful collaboration with the company through CERN openlab. From left to right: Maria Girone, CERN openlab CTO; Alberto Di Meglio, head of CERN openlab; Frédéric Hemmer, head of the CERN IT Department; Cris Pedregal, technology director, Oracle Development; David Ebert, a director for industry solutions (public sector, education and research, healthcare) at Oracle. (Image: Rachel Tessa Lavy/CERN)

On 23 and 24 January, CERN openlab held its annual technical workshop. CERN openlab is a unique public-private partnership, through which CERN collaborates with leading ICT companies to accelerate the development of cutting-edge computing technologies for the LHC research community. This week's workshop saw representatives of these companies gather at CERN – along with representatives of several research organisations collaborating in CERN openlab – for a series of technical discussions.

Presentations were given on over 20 ongoing R&D projects being carried out through CERN openlab. A poster competition was also held, with fellows sponsored by CERN openlab presenting their latest work. Danilo Cicalese, of the CERN EP Department, was declared the joint winner with Matteo Migliorni and Viktor Khristenko, both of the CERN IT Department. In addition, the workshop featured a session dedicated to discussion of emerging technologies related to quantum computing. This follows on from CERN openlab's highly successful event on this topic in November.

“The technical workshop provided a fantastic opportunity to meet with representatives from our collaborators and the LHC experiments,” says Maria Girone, CERN openlab CTO. “Together, we discussed the progress made in our many ongoing projects, as well as emerging technologies that will play a critical role in enabling us to address new computing challenges.”

At the workshop, an award was given to Oracle in recognition of 15 years of fruitful collaboration through CERN openlab. While CERN's relationship with Oracle actually stretches back to 1982, Oracle has now been a partner in CERN openlab since 2003. During these 15 years, we have collaborated on a range of exciting and challenging projects related to databases, the cloud, storage, industrial controls and more. Frédéric Hemmer, head of the CERN IT Department, presented the award to David Ebert, a director for industry solutions (public sector, education and research, healthcare) at Oracle.

“The joint R&D projects carried out between CERN and Oracle through CERN openlab have played an important role in helping us address many computing challenges faced by our research community,” says Hemmer. “Collaboration with leading ICT companies like Oracle is central in enabling CERN to fulfil its mission.”

“We are honoured to be receiving this prestigious award in recognition of our long-standing collaboration with CERN openlab,” says Ebert. “We truly value and appreciate the close collaboration and are de-

lighted that Oracle technologies help advance CERN's pioneering research."

"As well as looking back on 15 years of successful partnership with Oracle, the technical workshop was also an excellent occasion to look ahead to the exciting work planned over the coming years – both with Oracle and with all of our collaborators from industry and research," says Alberto Di Meglio. "We're looking forward to continuing our work to tackle many of the ICT challenges outlined in our white paper, as well as fascinating new challenges that arise in relation to CERN's ambitious upgrade programme for the LHC."

All presentations and posters from the workshop can be found on the event website.

Andrew Purcell

COMPUTER SECURITY: WHEN "FREE" GETS EVEN MORE RESTRICTIVE

Why "free" does not necessarily mean "free of charge" or, in the CERN context, why "free" software should not be used for professional or educational purposes

In a previous *Bulletin* article, we discussed the problem of free software and why "free" does not necessarily mean "free of charge" or, in the CERN context, why "free" software should not be used for professional or educational purposes. Here is a new theory as to why the situation might get worse!

First of all, a "free" licence might insist upon "personal usage only". But this does not mean it is a single-user licence allowing you to install the software as an individual for professional purposes. It instead refers to the software's deployment at home and for completely private projects, not related to your profession, your job or the paid work you do. At most, it might permit professional testing for a (short) evaluation period or for you to "try it out". Care must be applied here, too, as "trying out" is definitely an activity not supposed to last forever.

Other "free" licences might authorise the software to be used by, for example, "small teams", even for professional purposes. While this sounds good, it also has a snag: CERN is a big organisation comprising many entities. While you might have deployed software for your "small CERN team", other teams at CERN might have considered this too (and already done so!). So, the software vendor might register a bigger picture, and conclude that CERN as a whole is contravening its licence conditions. And indeed, some have already pointed such a situation out to us and have pushed for CERN to subscribe to one of their professional licence packages. Are you prepared to contribute to these costs?

Finally, there is the "educational licence" for universities, generally intended for classroom usage. CERN is an academic institution and part of our campus can be fairly considered to be university-like. Our mission statement stipulates that we "enable research at the forefront of human knowledge[,] perform world-class research in fundamental physics[, and] unite people from all over the world to push the frontiers of science and technology, for the benefit of all" – a purely academic activity. We give lectures to students, and even issue certificates or diplomas through the CERN Accelerator School, CERN School of Computing (even leading to ECTS points), the CERN Teachers Programme and Beamline for Schools, among others. However, our academic environment, our fundamental research, lectures and seminars, as well as those certificates and diplomas, might not be sufficient for CERN to be entitled to an educational licence. Worse, and here is the new theory, licence conditions change. What was allowed for version 1.2.3 might not be the case any more for version 1.2.4. Eligibility changes. Terms change. The scope changes. Figuring all this out can be extremely cumbersome, as software vendors do not necessarily point you directly to the changes to their licence conditions! A formerly valid "free" licence might become a liability for CERN...

So, don't put the Organization at risk! Please check out the licence conditions carefully and read the fine print – not only when considering software for the first time, but also when updating it. If in doubt, please contact the CERN Software Licence Officer or the CERN-IPT Purchasing Service. If you want to stay on the safe side, check out the full portfolio of CERN-provided software via CMF for Windows PCs, LXSOFT for Linux systems and the CERN/ Apple Mac Self-Service. Dedicated licences are also available for engineering software and for control software. A register of all centrally purchased licences can be found here: https://slma.cern.ch/slma.

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 HEALTH INSURANCE SCHEME (CHIS) – DIRECTIVE ON THE RECOVERY OF UNDUE PAYMENTS

CHIS Directive No. 2 entitled "Recovery of Undue Payments" lays down the provisions governing the application of the CHIS Rules in respect of the recovery of undue payments

CHIS Directive No. 2 entitled "Recovery of Undue Payments", approved by the Director-General after discussion at the Standing Concertation Committee on 27 June 2018, lays down the provisions governing the application of the CHIS Rules in respect of the recovery of undue payments (sums unduly received by a Member, see Article V 4.01).

This Directive is available via the following link: https://cds.cern.ch/record/2654418?ln=en

It enters into force on 1 February 2019.

ANNUAL ADJUSTMENTS TO FINANCIAL BENEFITS WITH EFFECT FROM 1 JANUARY 2019

In accordance with recommendations made by the Finance Committee and decisions taken by Council in December 2018, certain financial benefits impacting salaries and stipends have been adjusted with effect from 1 January 2019.

Annual adjustments are the following:

- A **1.05%** increase to the scale of basic salaries paid to Staff Members and the scale of stipends paid to Fellows (Annexes R A 5 and R A 6 of the Staff Regulations).
- A **0.68%** increase to subsistence allowances (2019 subsistence rates (*https://cds.cern.ch/record/2652625/files/subsistence_2019.pdf*)), family, child and infant allowances (Annex R A 3 of the Staff Regulations) and to payment ceilings of education fees* (Annex R A 4 of the Staff Regulations) following the movement of the Geneva consumer price index.
- Related adjustments will be implemented wherever applicable to associated members of the personnel (Annex R A 7 of the Staff Regulations).

The amended text of the Staff Regulations will be available shortly on the Web at: CERN Staff Rules and Regulations (*https://cds.cern.ch/collection/StaffRulesandRegulations?ln=en*)

**The new payment ceilings are applicable to academic year 2018/2019*

Human Resources Department

EXTENSION OF THE PRE-RETIREMENT PROGRAMMES

Following a recommendation by the Standing Concertation Committee at its meeting on 27 November 2018 and approval by the Director-General, please note that:

- the Progressive Retirement Programme has been extended by one year, from 1 April 2019 until 31 March 2020;
- the Part-Time Work as a Pre-retirement Measure Scheme has also been extended by one year, from 1 January 2019 until 31 December 2019.

Further information is available on the following links:

- Progressive retirement programme (*https://admin-eguide.web.cern.ch/en/procedure/progressive-retirement-programme-prp*)
- Part-time work as a pre-retirement measure (*https://admin-eguide.web.cern.ch/en/procedure/part-time-work-pre-retirement-measure-ptp*)

Human Resources Department

Announcements

PUT A SENSOR IN YOUR LIFE WITH THE NEW LORAWAN NETWORK

The new LoRaWAN network allows you to easily connect low cost sensors and meters to the CERN campus

The Internet of Things (IoT) has been a trending topic for the past few years in talks, conferences and newspapers and you have probably heard or read about it already. Analysts predict that 'everything' will be connected and industry is pushing to deliver this vision and to open new markets.

Although IoT is not new at CERN - you may remember “Computer Security: IoTs: The Treasure trove of CERN” – new user requirements and hence technologies keep appearing on the market.

A key way to distinguish the different requirements is by their bandwidth requirements and the range over which communication is needed. As shown in the diagram, these needs are met by different technologies.

If you have power available you can afford to have higher bandwidth and hence data throughput. You can then connect to the Ethernet network, to the renewed Wi-Fi service or to the mobile network if you are out of Wi-Fi range. Personal Area Networks (PAN) offer you a solution if your device is only a few centimeters/meters away. Bluetooth printers or contactless cards using RFID (Radio-Frequency Identification) or NFC (Near Field Communication) are just some PAN examples.

“When you are not connected to the electrical grid, there is a trade-off between the range over which you can communicate with your device, its maximum data rate and its power consumption.” says Hubert Odziemczyk, the IT engineer developing the new LoRaWAN network. “Take your Bluetooth headsets as an example; you can have HD audio on them but you need to recharge them daily and cannot go further than 10 meters from the source”.

An LPWAN (Low Power Wireless Area Network) provides long range (up to several kilometers) communication capability to low power consumption devices (up to several years without changing the battery) in a cost effective way (low device cost). The price to pay is the low bit rate (few kbps).

An LPWAN is the perfect match for any kind of sensor or meter sending small amounts of data several times per day. These networks are conceived to support a massive number of devices since they spend most of their time silent.

CERN is introducing a Proof of Concept for a new LPWAN network based on LoRaWAN. You can now connect any LoRa device above ground anywhere on the CERN campus.

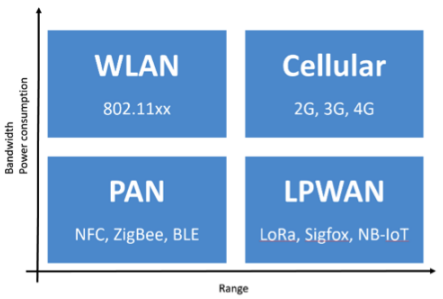
The list of applications is countless:

- Smart buildings: presence, temperature/humidity, opinion beacons, glass break...
- Smart cities: water leakage, flood sensors, waste management, parking...
- Environnent monitoring: air pollution, radiation, noise...
- Industrial: vehicles tracking, door opening sensors, industrial standard bridges...

Do you have a use case you would like to discuss? Please, contact lora-support@cern.ch to start using the new network.

Rodrigo Sierra

Please, read this IoT related Computer Security article if you have not already done so.



Wireless networks.

ACCESS TO SM18 REOPENED (EXCEPT FOR 1 FEBRUARY)

Kindly note that vehicle access to the SM18 hall from Route de l'Europe has reopened, but that it will be temporarily closed again on Friday, 1 February, for surfacing work (weather permitting).

Thank you for your understanding.

The SMB department

Ombud's corner

BONDING WITH COLLEAGUES CAN HELP BREAK SITUATIONS OF DEADLOCK

Paul* came to see me because he's not getting along with his colleague: *"Ben* is the ambitious coordinator of the project I'm working on, but he's doing it all his own way, without consulting any other members of the working group. There's no transparency and he takes credit for everything. He puts his career ahead of the interests of the project team. As someone who is keen on transparency and teamwork, I find this hard to take. I feel trapped, unable to change the situation. I'm even thinking about leaving the project."*

So we put our heads together and tried to define what means Paul has at his disposal to deal with the situation. Ben's management style is diametrically opposed to his own, and Paul realises that, in order to solve the conflict, he must put himself in Ben's shoes, so as to understand why he acts the way he does. This comes at a cost to Paul, but he recognises that, for the good of the project, he must get over his initial reluctance. I manage to convince him that taking this approach doesn't mean that he approves of Ben's methods.

A few weeks later, I see Paul again. *"I asked Ben whether he would mind reviewing the division of labour, assuring him that I had no intention of stealing his limelight. We spent a lot of time together and I got to know how he operates. Today, I still don't condone his methods but I remain on the project because I can make an essential contribution to its success. I'm not judging him, but I know that I won't be able to work with Ben again on other projects."*

At times, it's important to distance ourselves from what we feel in order to engage with others, in the interest of all. Getting to know what makes others tick doesn't necessarily mean condoning their behaviour. Paul made the effort to get over his initial distrust, and this has enabled him to understand how Ben operates. Today, without either approving of his colleague or judging him, he is still a member of their joint project. And he reached this decision in the interest of that project.

**Names have been changed*

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.