CERN Bulletin

Issue No. 48-49/2018-Wednesday 28 November 2018
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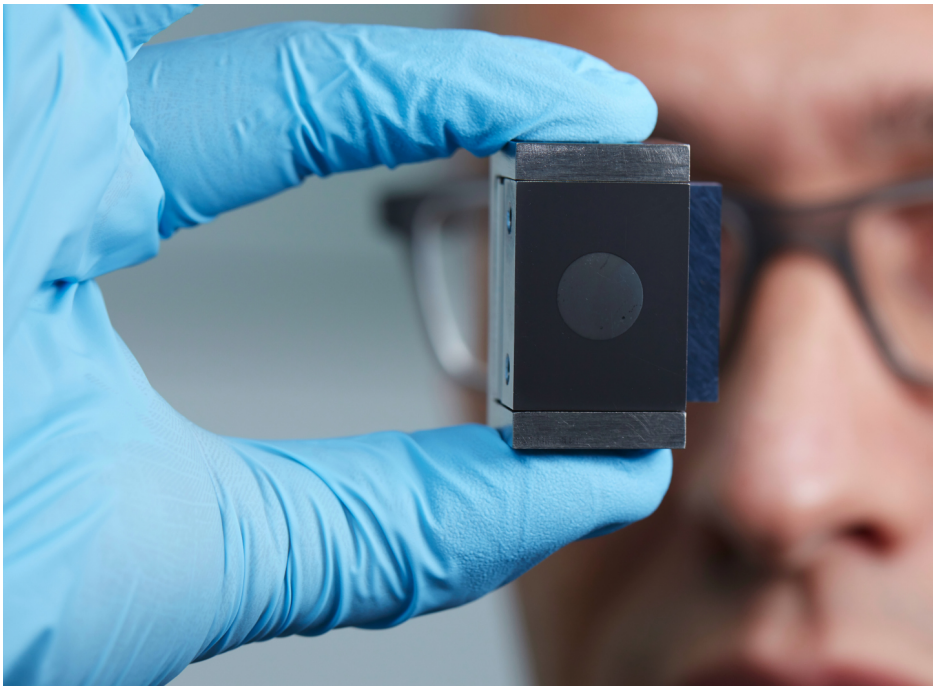
CRYSTAL CLEANING THE LHC BEAM

In October, for the first time, crystal collimators were used to improve the performance of the beam cleaning process at the LHC during a physics run



A crystal developed under the aegis of the UA9 collaboration to improve collimation in the LHC.

Beams travel inside the LHC at close to the speed of light and cleaning out particles that fly too far from the main path is not an easy feat. More than 100 collimators punctuate the ring at specific locations to make sure that the particles that stray – called beam halos – are cleaned or absorbed to protect delicate accelerator equipment. This October, an advanced technique using bent crystals was proven to increase the overall performance of the cleaning process.

Bent crystals, as the name suggests, are crystals bent mechanically to create a curve at a microscopic angle. The nature of crystalline structure means that halo particles, which would otherwise scatter at random angles, can be steered and channeled directly toward absorbers installed downstream, relaxing the need for the secondary and tertiary collimators used by the LHC's existing system. This application for beam collimation was triggered by the pioneering work started by the UA9 collaboration in 2009, and is supported by funds from the High-Luminosity LHC project. Used in several scenarios, bent crystals were a tool for collimation studies in the LHC, but had never been used in a physics run until now.

(Continued on page 2)

A WORD FROM DORIS FORKEL-WIRTH

HOW TO HAVE A SAFE AND HEALTHY WINTER

Last week's snow reminded us that winter is on its way, with all its attendant possibilities. However, it is not all fun: winter also brings potential health and safety risks, most of which can be easily avoided by taking a few simple precautions. Every year, seasonal influenza – the flu – takes its toll, but the seasonal flu vaccine can protect you and those around you. If you work on the CERN site, you can be vaccinated at CERN's Medical Service. Just bring along your sealed dose of vaccine – no need for a prescription. Moreover, the flu virus is not the only one waiting to get us in the winter, so the Medical Service publishes a guide to the simple things we can do to avoid infection as the temperature drops.

(Continued on page 2)

In this issue

Published by:
CERN-1211 Geneva 23, Switzerland writing-team@cern.ch
Printed by: CERN Printshop

CERN-ISSN: **Printed version:** 2011-950X
Electronic Version: 2077-9518

A WORD FROM DORIS FORKEL-WIRTH

HOW TO HAVE A SAFE AND HEALTHY WINTER

The winter months also see an increase in road accidents due to shorter days and icy roads and footpaths. Make sure your car is equipped for winter weather conditions, make sure you wear appropriate clothing and allow more time for journeys. On dark winter nights, it is especially important to make sure you can be seen. Research shows that when we are wearing dark clothes on a dark evening, even with street lighting, drivers see us only when they are just 25 metres away. That is not enough for them to stop safely from a speed of 50km/h. Wearing light-coloured clothing increases this distance to 40 metres. But only if we are wearing something reflective can the driver see us in time to stop safely.

To help inform you of these risks, we will be running a short campaign on the importance of being visible in the dark, and will shortly be distributing reflectors outside CERN's three main restaurants at lunchtime. Keep an eye on the *Bulletin* for the exact dates. Reflectors are proven lifesavers – make sure you get yours!

So, keep warm, keep healthy, keep safe…and enjoy the snow!

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Useful information:

- ***Advice on avoiding the flu (https://medical-service.web.cern.ch/seasonal-flu) from CERN's Medical Service***
- ***Road safety advice (https://www.ate.ch/themes/rues-pour-tout-le-monde/hiver-en-securite/) (in German, French and Italian)***
- ***Winter safety guide (https://www.rospa.com/resources/hubs/winter/) (in English)***
- ***Swiss Made Visible (https://madevisible.swiss/fr/journee-de-la-lumiere/) campaign (in German, French and Italian)***
- ***Guide to safety in the mountains (http://www.preventionhiver.sports.gouv.fr/Memento-haute-definition) in winter (available in many languages)***

Doris Forkel-Wirth
Head of the HSE Unit

CRYSTAL CLEANING THE LHC BEAM

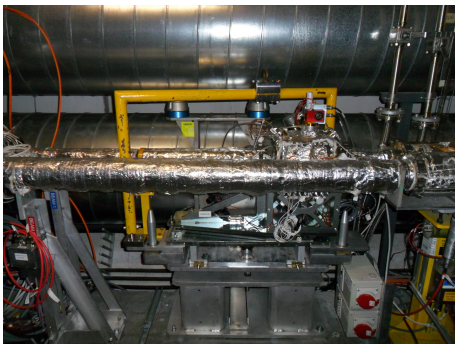
"We have two bent crystals installed on each LHC beam pipe at Point 7 for crystal collimation studies," says Stefano Redaelli, who is in charge of the LHC collimation system and its upgrade for the High-Luminosity LHC. "In these devices, halo particles are steered by the highly pure periodical lattice structure of the crystal. At 7 TeV, channeling in bent crystals can curve the particle trajectory by amounts that are beyond the reach of the LHC superconducting magnets. For instance, a 4mm long silicon crystal, with a bending angle of 50 micro radiant, produces about the same effect as that of 10 standard LHC dipoles together!"

Beam halos are a nuisance, as they can damage sensitive equipment like superconducting magnets and also affect the quality of physics data by creating more background noise. To reduce this effect, the LHC's beam collimation team use many different techniques. One such technique is scraping, which requires interrupting the beam to clean and diffuse the halo, causing a significant time loss per fill before data-taking can resume. With bent crystals, beam halos are steered toward dedicated absorbers, reducing this time loss and increasing the quality of data by providing cleaner backgrounds.

"We decided to use crystals to control background particles on the TOTEM and ATLAS-ALFA experiments' Roman pot detectors. Detailed simulations were carried out before the crystals were inserted and used as primary collimators for low-intensity beams," says Redaelli. The results measured showed less background noise and frequent scraping was not needed.

Tests of crystal collimation to clean beams will continue until the end of the year. Many teams have been involved in the development of crystal collimation systems installed in the LHC, including the Accelerator and Beam Physics (BE-ABP), Survey, Mechatronics and Measurements (EN-SMM), and Sources, Targets and Interactions (EN-STI) groups. These new results will provide important input to decide if crystal collimation can become part of the upgrade plans for the HL-LHC.

** The UA9 Collaboration consists of CERN, PNPI, INFN, LAL, JINR, IHEP, Imperial College London.*



Tunnel view of the crystal goniometer that is used to adjust the crystal angle with respect to the beam, with sub-micro radiant precision. The design is developed by the EN/SMM group and installed in the LHC by the EN/STI group. (Image: courtesy of D. Mirarchi, CERN)

Abha Eli Phoboo

LHC REPORT: ENTERING THE LAST WEEK OF THE HEAVY-ION RUN

The one-month 2018 heavy-ion run has just one week left to go

Although the LHC is approaching the end of Run 2, a major milestone in its history, there is little sense of this in the CERN Control Centre, where the one-month 2018 heavy-ion run has just one week left to go. Much still has to be achieved before the start of Long Shutdown 2 (LS2) on the morning of 3 December and there is no let-up in the pace of activity.

The heavy-ion source has made a remarkable recovery from its emergency surgery at the start of the run. The chain of accelerators downstream, starting with LEIR, have cooled, bunched, stripped and accelerated the stream of ions emerging from Linac3. The single-bunch intensity quickly exceeded the target for the HL-LHC. Until 19 November, bunches were delivered from the PS to the SPS in batches of four separated by 100 ns. A new scheme with batches of three bunches separated by 75 ns is now in use. Besides allowing more bunches to be packed into the LHC rings, this is already delivering even higher intensities in each bunch.

Nevertheless, one should not get the impression that all is plain sailing. Taking the injectors and LHC into new domains of operation continually throws up surprises and the teams concerned are in permanent problem-solving mode. The unprecedented intensities cause collimation losses that are always close to limits that can cause the beam to be dumped to avoid magnet quenches (new installations during LS2 will help with that). An unexplained motion of the beam orbit at a frequency of 10 Hz has provoked a few premature dumps. It is now clear that this was present in the preceding proton run but it causes more trouble for lead beams.

Problem-solving is further complicated by the need to weigh the time taken for conclusive investigations against the potential gains in the remaining run time. Decisions are based on hard data, physical understanding and judgement, but are subject to the strictures of machine protection. Continual interaction with the LHC Programme Coordinators ensures that the priorities of the LHC experiments are best served.

For example, the beam size at the ALICE interaction point was found to be twice the size it should be and measures had to be taken to reduce the impact on the integrated luminosity. A textbook explanation for this is a shift of the beam waist (the place where the beam is smallest) away from the interaction point (see a picture of the beam optics in the ALICE experiment in the last LHC Report). An initial measurement (moving the collision point using the RF system) hinted that this was the case – just before it was aborted by an interlock. A later measurement was completed but refuted this hypothesis. Finally, based largely on theoretical considerations, Stéphane Fartoukh identified the cause as a strong, but highly localised, coupling of the horizontal and vertical betatron motions and proposed an elegant solution. This worked almost magically, restoring the proper beam sizes and luminosity for ALICE.

This was accomplished during the scheduled refill of the ion source. Then followed a rigorous re-validation of a new collision configuration with the polarity of the ALICE spectrometer magnet and crossing angle reversed, as requested for the second half of the data-taking. At the same time, the injectors have been switching to the new 75 ns injection scheme and the LHC has been learning to handle very high lead bunch intensities up to four times the original design value.

On 25 November, a new peak luminosity record of $6\times10^{27}\text{cm}^{-2}\text{s}^{-1}$ (i.e. six times the original LHC design value!) was set in both ATLAS and CMS. LHCb is also receiving far greater heavy-ion luminosity than ever before and ALICE is being held at its saturation value for 8 hours in typical fills.

Peak luminosities in ATLAS and CMS are being steadily increased from fill to fill, with the goal of demonstrating the nominal value for the HL-LHC. And a few special measurements are still to come…

John Jowett

GOOGLE AND MICRON JOIN CERN OPENLAB

Google and Micron announce that they are joining CERN openlab at major US supercomputing conference

View of the CERN data centre. CERN openlab is a public-private partnership to develop cutting-edge computing solutions for the research community.

Last week, at the 2018 Supercomputing Conference in Dallas, Texas, two new companies announced that they are joining CERN openlab. CERN openlab is a unique public-private partnership through which CERN collaborates with leading ICT companies to accelerate the development of the computing technologies needed by the high-energy physics research community.

On Monday 12 November, Micron Technology announced that they had joined CERN openlab. As part of the work

with CERN, Micron will develop and introduce a specially designed Micron memory solution that will be tested by researchers at CERN to rapidly comb through the vast amounts of data generated by experiments. Specifically, the technology will be tested in the data-acquisition systems of the CMS experiment and the ProtoDUNE detectors.

“CERN collaborates openly with both the public and private sector, and working with technology partners like Micron helps ensure that members of the research community have access to the advanced computing technologies needed to carry out our groundbreaking work,” says Maria Girone, CTO at CERN openlab. “It is critical to the success of the Large Hadron Collider that we are able to examine the petabytes of data generated in a fast and intelligent manner that enables us to unlock new scientific discoveries.”

On Wednesday 14 November, Google published a blog post announcing that they had signed an initial agreement to collaborate with CERN through CERN openlab. Together, we are now exploring possibilities for joint research-and-development projects related to cloud computing, machine learning, and quantum computing. Google also participated in a quantum-computing workshop organised at CERN earlier this month.

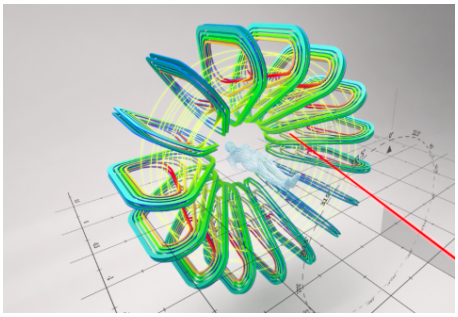
“CERN has an ambitious upgrade programme for the Large Hadron Collider, which will result in a wide range of new computing challenges,” says Alberto Di Meglio, head of CERN openlab. “Overcoming these will play a key role in ensuring physicists are able to make new ground-breaking discoveries about our universe. We believe that working with Google can help us to successfully tackle some of these challenges, as well as producing technical breakthroughs that can have impact beyond our research community.”

With 2018 marking the start of a new three-year phase for CERN openlab, there are now around 20 ongoing research-and-development projects. E4 computer engineering also joined CERN openlab last month, bringing the total membership to 12 companies and nine research organisations. During this phase, the collaboration is working to address many of the ICT challenges laid out in its latest white paper.

Andrew Purcell

USING CERN MAGNET TECHNOLOGY IN INNOVATIVE CANCER TREATMENT

A new “gantry” design using CERN magnet technology has the potential to revolutionise hadron therapy



The new compact non-rotating gantry design enables the treatment of tumours from different angles using superconducting toroidal magnets (Image: Daniel Dominguez/CERN)

Derived from developments in accelerators, detectors and computing, the state-of-the-art technologies behind particle physics have historically contributed to innovations in medical technologies. CERN's latest addition to this is GaToroid, a novel superconducting and lightweight gantry that can surround a patient and potentially revolutionise the delivery of hadrons for therapies, including cancer treatment.

Hadron therapy is an advanced radiotherapy technique using proton or ion beams to deliver precision treatment of tumours, sparing the surrounding healthy tissues from unwanted radiation. The intrinsic precision of this technique makes it particularly suitable for treating tumours in children or close to organs at risk. Furthermore, using rotating gantries to move the beam around the patient, medical doctors can irradiate the tumours from different angles, sparing even more of the surrounding tissue.

Gantries are complex pieces of engineering, representing a considerable part of the installation costs and size, or footprint, in hadron therapy. Particularly for carbon ions, there are only two gantries in the world. The first one is at the Heidelberg Ion-Beam Therapy Center in Germany, measuring 25 metres in length and weighing more than 600 tonnes. The second one, in Chiba, Japan, is a superconducting gantry with a reduced size and weight, but with the added challenge of a rotating cryogenic system. While the therapeutic interest for carbon or other ions heavier than protons is increasing, the enormous size of today's gantries, combined with the lack of viable standard technological solutions, poses relevant constraints on future hadron therapy facilities.

Well aware of these challenges, CERN scientist and magnet expert Luca Bottura came up with a new, innovative gantry design based on a toroidal magnet concept, GaToroid, which bends the treatment beam without the need to rotate the structure. The gantry comprises a set of fixed, discrete superconducting coils constituting the toroidal magnet, and a bending device at the entrance of the structure to direct the beam at the right angle. Due to the use of superconductors, GaToroid will substantially reduce weight and footprint compared to conventional gantries, especially for ion beams. This invention was not the output of a dedicated research study, but a result of serendipity coming from Luca's connection to other fields of applied science and his own professional experience.

Luca Bottura presented his idea at the last Knowledge Transfer Seminar, GaToroid: A Novel Superconducting Compact and Lightweight Gantry for Hadron Therapy *, which was held on 22 November. Watch the recording here (https://cds.cern.ch/record/2648720).*

For previous features on hadron therapy, see the CERN Courier articles “” Therapeutic Particles and “” The changing landscape of cancer therapy .

Linn Tvede, Giovanni Porcellana

LET'S WANDER IN THE FOREST

A series of visits were organised in November to help discover horse-logging at CERN

Some of the activities at CERN can be rustic. More than 65 CERN people discovered in November the horse-logging technique during a series of visits organized by the Education and Communication Group and the French National Forestry Office (ONF).

During maintenance work on the CERN wooded plots, horses are regularly used to remove the fallen trees, thus minimizing the impact on forest soils. The CERN site covers 625 hectares, of which 90 are woods and forests. These wooded areas are maintained and valued by the National Forestry Office.

Corinne Pralavorio

COMPUTER SECURITY: THE PROBLEM WITH CRYPTO-MINING

When using CERN resources, mining for professional purposes lacks any reasonable professional justification

Following on from Java, app programming, Raspberry Pi, cloud computing and machine learning, the latest trend for computer engineering students is blockchains. One particular application of blockchains is "crypto-currencies", i.e. virtual money. The past year has seen the birth of a plethora of crypto-currencies. Bitcoin is the best known, but there are also Ethereum, Litecoin, Dogecoin and many more (see Wikipedia for an even longer list). Even some famous football players are considering creating their own currencies. All these currencies have one thing in common; in order to obtain coins, there are just two legal methods: you buy them or you "mine" them. The latter is based on a complex mathematical calculation, which eventually results in more coins being added to the total pool and to your digital purse. So here is the problem: what about crypto-mining at CERN?

In order to answer that question, one has to distinguish between crypto mining for professional or private purposes, and whether you're using a CERN-owned computer or a private computer. CERN's Operational Circular No. 5 (OC5) on the "Use of CERN Computing Facilities" stipulates that the private or personal use of those facilities is tolerated or allowed as long as "it does not constitute [. . .] profit-making activity" (OC5 "Rules for personal usage" 3c). However, the fundamental nature of crypto-mining is exactly this: making money. Hence, OC5 and its "Rules for personal usage" do NOT allow any kind of crypto-currency mining. Any violation could have serious consequences (see our *Bulletin* article on "Computing power for professionals. . . only!").

When using CERN resources (computers, laptops, servers or virtual machines), mining for professional purposes lacks any reasonable professional justification. While the potential additional demand for electricity is debatable, crypto-mining blocks CERN resources from performing their professional tasks as it takes away CPU cycles, storage memory and network bandwidth. Given that, for Run 3 of the LHC, CERN's computing needs will grow exponentially, our computing resources should be invested wisely and not wasted. Hence, as the "CERN computing facilities are intended for the attainment of the Organization's aims" (OC5 II 6.), cryptocurrency mining on CERN owned hardware is completely forbidden. Exemptions are possible under the authorisation of CERN's Computer Security Officer, e.g. for stress testing computing hardware or computing power benchmarking. However, experts would need to justify why globally-recognised tools like those provided by the HEPix benchmarking working group are not suitable. And in any event, any money generated in this way belongs to CERN and should be transferred to the appropriate CERN budget code.

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

ACCESS TO THE ORGANIZATION'S SITE DURING THE END-OF-YEAR CLOSURE

The only persons who will be entitled to enter the CERN site during the end-of-year closure are those who are required to perform essential or emergency work

This year, CERN will be closed from Saturday, 22 December 2018 to Sunday, 6 January 2019 inclusive. The first working day of the new year will be Monday, 7 January 2019.

As is the case every year, the only persons who will be entitled to enter the CERN site during the end-of-year closure are those who have received authorisation to do so for strictly professional reasons such as stand-by service and indispensable maintenance work.

Each department and, in particular, each experiment's technical coordinator, is responsible for compiling a list of the people in receipt of such authorisation by Friday, 21 December 2018 at the latest.

Unlike in previous years, it is no longer necessary to include members of the personnel of outside companies in these lists. Any members of the personnel of outside companies who are required to work on the CERN site during the closure must have a valid AET (notice of work done outside normal working hours). Note that each AET will be limited to the time needed to perform the work in question.

During the period when the Laboratory is closed, i.e. after 21 December, anyone who needs to enter the CERN site for an urgent reason and without the prior authorisation of her/his department or her/his experiment's technical coordinator will be obliged to submit an access request (select the “CERNXMAS” permission) that can be signed by the Security Service or the CCC (TI) after assessing its merits. The “CERNXMAS” permission option will not be available in the ADAMS system prior to 22 December. This provision does not apply to members of the personnel of outside companies since they must have a valid AET.

You are also kindly asked to note that all CERN services (including the restaurants and the library) will be closed during the end-of-year closure.

We thank you for your cooperation and wish you a very happy end-of-year holiday!

The SMB department

EXCHANGING A FOREIGN DRIVING LICENCE IN FRANCE

CERN has asked the Ministry for Europe and Foreign Affairs to investigate the possibility of authorising the exchange of a foreign driving licence in France

French law does not authorise holders of a special residence permit issued by the Ministry for Europe and Foreign Affairs (MEAE) to exchange a driving licence issued by a country that does not belong to either the European Union (EU) or the European Economic Area (EEA) for a French driving licence (cf. http://international-relations.web.cern.ch/stakeholder-relations/hoststates/Vehicles/Foreign-driving-licenses-France).

Following problems encountered by several members of the personnel, CERN has asked the MEAE to investigate the possibility of authorising such an exchange in cases where the issuing country has signed a reciprocal agreement and refuses to replace a stolen, lost or expired driving licence. This would avoid those concerned being systematically required to pass a driving test in France.

In this context, you are reminded that people residing in Switzerland and holding a carte de légitimation issued by the Federal Department of Foreign Affairs (DFAE) may exchange their foreign driving licence for a Swiss licence without taking a test, provided that Switzerland and the country of origin have signed an agreement on this matter (cf. https://www.eda.admin.ch/missions/mission-onu-geneve/en/home/manual-regime-privileges-and-immunities/introduction/manual-vehicles/foreign-driving-license.html).

Host-States Relations Service
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Announcements

ACCESS TO SM18 IN DECEMBER AND JANUARY

Access to hall SM18 via the Route de l'Europe will not be possible on 17 and 18 December 2018 and from 14 to 18 January 2019

Please note that, due to work under way to install a new gate, access to hall SM18 via the Route de l'Europe will not be possible on 17 and 18 December and from 14 to 18 January 2019. People requiring access to the site during these periods are invited to use the BA7 entrance.

The work will begin on 26 November 2018 and will last until 24 January 2019.

Thank you for your understanding.

The SMB department

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4 AND 5 DECEMBER: WORLD SCIENTIFIC PUBLISHING BOOK FAIR

The World Scientific Publishing Book Fair will take place in the Main Building (500) on Tuesday, 4 and Wednesday, 5 December 2018

The World Scientific Publishing Book Fair will take place on the ground floor of the Main Building (500), near Restaurant 1, on Tuesday, 4 and Wednesday, 5 December 2018.

In the framework of the Book Fair, a presentation by Antonio Ereditato of the book *The State of the Art of Neutrino Physics* is scheduled for 3.30 p.m. on 5 December in the Library (52-1-052). After the book presentation, Antonio Ereditato will also present, as the editor-in-chief, the Open Access journal Instruments, published by MDPI: https://www.mdpi.com/journal/instruments.

The State of the Art of Neutrino Physics: A Tutorial for Graduate Students and Young Researchers, ed. Antonio Ereditato, World Scientific, 2018, ISBN 9789813226081 https://www.worldscientific.com/worldscibooks/10.1142/10600

AT RESTAURANT 1 FROM 26 TO 30 NOVEMBER: RACLETTE!

- 18.00 CHF per person -

Three portions of raclette

Charcuterie

Potatoes

Complimentary limoncello

Book on 022 767 28 14 or at the tills in restaurant 1

PLACES AVAILABLE – CRÈCHE AND SCHOOL AT CERN

The Jardin des Particules, the crèche and school run by the Staff Association, currently has a number of full- and part-time places available

The *Jardin des Particules*, the crèche and school run by the Staff Association, currently has a number of full- and part-time places available.

Places available immediately:

- Crèche: in the class for children aged 2-3 years
- School: in the class for children aged 4-6 years

Places available as of January 2019:

- Crèche: in the classes for children aged 2-4 years (mornings only) and 3-4 years

For further information, do not hesitate to contact us by e-mail: Staff.Kindergarten@cern.ch

The Jardin des Particules steering committee

Ombud's corner

BE KIND TO YOURSELF!

Tomas* has spent the whole day in meetings with his industrial partners, discussing highly sensitive matters that have required him to be very diplomatic. He's had to rein in his desire to say what he really thinks and put all his energy into arguing his case in the negotiations.

On returning to his office, he finds that the report he'd asked his colleague Raphael* to write hasn't been done properly. Furious, he calls him straight over and launches into a relentless tirade, not giving him the slightest chance to defend himself. Raphael leaves the office without a word, hanging his head. Of course, Tomas's behaviour is inappropriate and inadmissible.

So what happened?

Tomas has a very spontaneous nature and knows he's sometimes too direct. That day, he'd had to restrain himself for hours and, by the end of the afternoon, his supply of self-control was exhausted, so he lost his temper with Raphael. Keeping himself in check all day had been so tiring that he ended up losing control completely.

Tomas is an extreme example. However, our workplace is somewhere where we have to try to show restraint: we must be polite to our colleagues, listen attentively to our clients and be available to our team, all while dealing with various emergencies. This is mentally very tiring, and our ability to do it decreases over the course of the day.

What can we learn from this example?

When you need to have sensitive conversations, try to schedule them for the beginning of the day, when your stock of self-control is intact.

On a daily basis, alternate intense effort with activities that require less concentration. During your breaks, take the time to relax properly: talk to your colleagues about your hobbies, play cards, practise a sport, do some yoga, take a nap – whatever works for you.

We're hearing more and more often that we should be kinder to ourselves. Excellence is all well and good, but no one can be at the top of their game all day. By rationing your efforts and showing yourself a bit of understanding, you can maintain a calm atmosphere at work and get good results all the time.

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.

**Names have been changed*