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Faces and places

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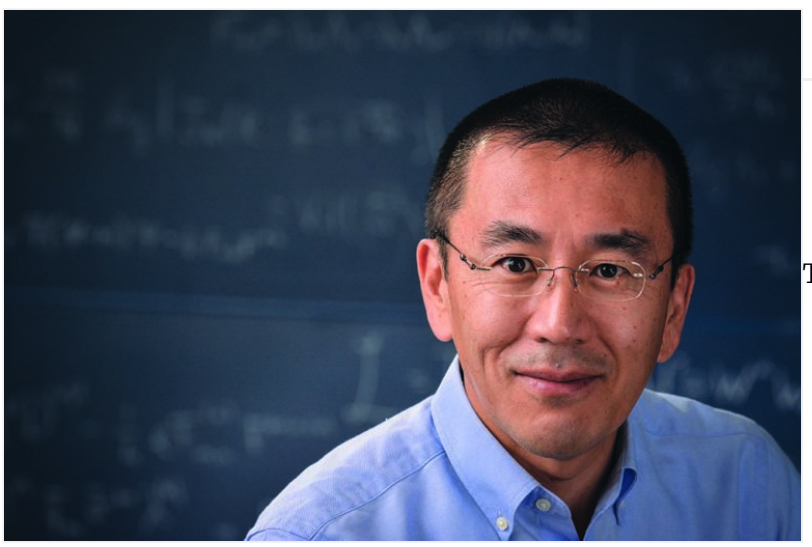
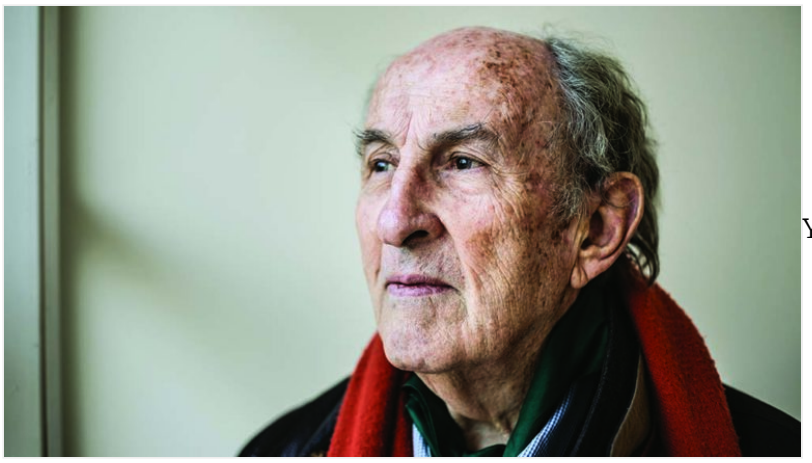
Hirosi Ooguri is the new director of Kavli IPMU



The Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU) at the University of Tokyo in Japan announced on 15 October the appointment of Hirosi Ooguri as its new director. The Kavli IPMU is one of Japan's most renowned research institutions, bringing together physicists, mathematicians and astronomers to address fundamental questions in the field. Ooguri, who bridges physics and mathematics, has extensive leadership experience as the founding director of the Walter Burke Institute for Theoretical Physics at Caltech and as president of the Aspen Center for Physics. He also received the 2018 Hamburg Prize for Theoretical Physics for his successful mathematical work on topological string theory and for making his research more publicly available (***CERN Courier*** July/August 2018 p35).

Ooguri will take over from Hitoshi Murayama, who has served as the institute's founding director for 11 years. Michael Turner, the director of the Kavli Institute for Cosmological Physics at the University of Chicago, said of the succession: "Hitoshi Murayama succeeded in creating the IPMU as a world centre, and six years ago brought IPMU into the Kavli family of world-leading institutes. With the appointment of Hirosi Ooguri, he has handed off IPMU to another visionary."

Petroff nominated director of Brazilian light source



Yves Petroff, a leading expert on synchrotron radiation, has been nominated as director of the Brazilian Synchrotron Light Laboratory LNLS, where a major new synchrotron called Sirius is about to enter operations. Starting with six beamlines in the first year of operation (2019), six more in the second and six others in the third, Sirius will open new perspectives for research in materials science, nanotechnology, biotechnology and environmental science.

Petroff directed the Grenoble-based European Synchrotron Radiation Facility (ESRF) during the facility's inaugural years, managing an increase in the number of ESRF beamlines from 15 in 1994 to 40 in 1998. On leaving the ESRF in 2001, Petroff took up an advisory role at LNLS and remained close to the facility in the ensuing years. The Sirius building is almost finished and the booster and storage ring are under installation, aiming for user operation in July 2020. "Sirius is a miracle for Brazil and it will have taken just over four years between ground-breaking and the first beam," Petroff said.

APS announces 2019 prize and award winners

The American Physical Society (APS) has awarded its prizes and awards for 2019, several of which are devoted to the fields of high-energy and nuclear physics.

The W K H Panofsky Prize in Experimental Particle Physics went to Sheldon Leslie Stone of Syracuse University "for transformative contributions to flavour physics and hadron spectroscopy, in particular through intellectual leadership on detector construction and analysis on the CLEO and Large Hadron Collider beauty (LHCb) experiments, and for the long-standing, deeply influential advocacy for flavour physics at hadron colliders." Stone served as coordinator for the upgrade of LHCb from 2008 until 2011, and currently the Syracuse group is leading the construction of the silicon-strip tracking component of the upgrade.

Also in the experimental field, the Henry Primakoff Award for Early-Career Particle Physics was granted to Nhan Tran from Fermilab, citing his wide-ranging contributions to the CMS experiment, including the development of a novel pileup-subtraction method at the LHC, and the use of jet substructure for the analysis of high-energy collisions. His work contributed, among other things, to the discovery and characterisation of the Higgs boson.

The Robert R Wilson Prize for Achievement in the Physics of Particle Accelerators went to Toshiki Tajima at the University of California, Irvine, "for the invention and leading the first realisation of laser wakefield acceleration, which opened the way to compact acceleration applications such as ultrafast radiolysis, brilliant x-rays, intra-operative radiation therapy, wakefield beam dump, and high-energy cosmic acceleration." (***CERN Courier*** October 2018 p7).

The J J Sakurai Prize for Theoretical Particle Physics is shared between Lisa Randall of Harvard University and Raman Sundrum of the University of Maryland, College Park. The citation noted their creative contributions to physics beyond the Standard Model, in particular the theoretical discovery that warped extra dimensions of space can solve the hierarchy puzzle, which has had a tremendous impact on searches at the LHC.

In the nuclear-physics area, Barry R Holstein of the University of Massachusetts, Amherst, won the Herman Feshbach Prize in Theoretical Nuclear Physics "for seminal theoretical studies of fundamental symmetries in nuclei, including radioactive nuclear decays, parity-violating nucleon–nucleon

interactions, and chiral dynamics of mesons and baryons." The Tom W Bonner Prize in Nuclear Physics, meanwhile, was awarded to Barbara V Jacak from the University of California, Berkeley and Lawrence Berkeley Laboratory "for leadership in the discovery and characterisation of the quark–gluon plasma, especially her contributions to the PHENIX experiment and its explorations of jets as probes."

On the gravitational physics and cosmology fronts, the Einstein Prize was awarded to Abhay Ashtekar of Pennsylvania State University, State College, "for numerous and seminal contributions to general relativity, including the theory of black holes, canonical quantum gravity and quantum cosmology," and the Julius Edgar Lilienfeld Prize awarded to Katherine Freese of the University of Michigan and Stockholm University "for ground-breaking research at the interface of cosmology and particle physics, and her tireless efforts to communicate the excitement of physics to the general public."

Other prizes and awards included the Abraham Pais Prize for History of Physics awarded to Helge Kragh of the Niels Bohr Institute, University of Copenhagen, "for influential contributions to the history of physics, especially analyses of cosmological theories and debates, the history of the quantum physics of elementary particles and the solid state, and biographical studies of Paul Dirac and Niels Bohr, and his early quantum atom," and the Distinguished Lectureship Award on the Applications of Physics awarded to Cynthia Keppel of the Thomas Jefferson National Accelerator Facility "for pioneering work in proton therapy and for the promotion of the applications of physics to both experts and non-experts."

ATLAS recognises outstanding members

On 11 October the ATLAS collaboration celebrated the outstanding achievements of 15 of its collaboration members with an awards ceremony. Established in 2014, the Outstanding Achievement Awards give recognition to excellent contributions made to the collaboration in all areas, excluding physics analysis. This year's awards celebrated contributions to the measurement of jet energy and missing transverse momentum; the inner-tracker upgrade project; the development, deployment and commissioning of the trigger burst-stopper for the ATLAS level-1 endcap muon system; the online luminosity software; the commissioning of the level-1 Topo trigger; and software development and deployment.

"Within the ATLAS collaboration, huge efforts go into making the detector function seamlessly," says Jim Pilcher, awards committee chair. "We sought to reward the people who have made dramatic improvements to the operation and understanding of our detector, thus improving the quality of our measurements."

CERN commemorates history of Berlin building

On 26 October, at a ceremony in Berlin, CERN in association with the Aktives Museum unveiled a plaque describing the history of a building owned by the CERN Pension Fund.

Number 16 Wallstrasse is an attractive building constructed in 1908 and acquired by cousins Jakob Berglas and Jakob Intrator in 1920. Following CERN's purchase of the building in 2015, Intrator's granddaughter, Joanne, a New York-based psychiatrist, contacted CERN to explain what happened after her grandfather and uncle acquired the building, and to ask that a commemorative plaque be placed to highlight its history.

Berglas and Intrator were Jewish, and although they escaped the Nazis, their building was one of many taken from Jewish people in 1930s Berlin. Some years later, it was home to a printing company that produced Jewish Stars there in the summer of 1941: the infamous symbols sewn onto the clothes of Jewish people in the Third Reich.

Joanne Intrator and several members of the wider Intrator family took part in the ceremony, together with representatives of the German and Israeli governments, and senior representatives from CERN. "The history of CERN is closely connected with that of the Second World War," said CERN director for international relations, Charlotte Warakaulle. "Our laboratory was created as a reaction and as a contrast to what happened in Europe in the 1930s and 1940s. We owe our existence to the foresight and determination of scientists and politicians from many nations who shared a vision of reconciling a war-torn continent through culture, including science. We continue to live by this vision and to be inspired by it."

Picture story

On 9 October, 42 companies from France came to CERN to take part in the annual France@CERN industry event. The firms spanned a large range of areas, from bolts and tubes to various instruments and devices for measurement, control and automation. Industries in member countries are of vital importance to CERN's projects, such as the LHC. In 2017, for example, more than 500 firms were involved as contractors and suppliers to CERN and its experiments, representing a total expenditure of more than 500 million Swiss francs.

Correction

The image on page 29 of the November issue depicts the KLOE-2 experiment, which recently concluded its data-taking campaign at the DAΦNE collider (***CERN Courier*** June p8), not the AdA collider as stated in the caption of the print issue. AdA was of course the first electron–positron collider and, as one reader kindly pointed out, is now an exhibit at Italy's INFN Frascati National Laboratories (***CERN Courier*** January/February 2014 p30).

First telescope on Cherenkov array site

More than 200 guests gathered on the island of La Palma, Spain, on 10 October to celebrate the inauguration of the first telescope for the Cherenkov Telescope Array (CTA), the next-generation ground-based gamma-ray observatory.
The prototype large-sized telescope (LST-1) is the first of four LSTs to be located on the north site of the CTA in La Palma, later to be joined by 15 medium-sized telescopes.

Like the LHC, the CTA represents a major data challenge: it is expected to generate 100 petabytes of data by 2030. With more than 100 telescopes planned for the northern and southern hemispheres, the CTA will be the largest and most sensitive high-energy gamma-ray observatory.

Theory event fuses physics and gender

CERN hosted a workshop on high-energy theory and gender on 26–28 September. It was the first activity of the "Gen-HET" working group, whose goals are to improve the presence and visibility of women in the field of high-energy theory and increase awareness of gender issues.

Most of the talks in the workshop were on physics. Invited talks spanned the whole of high-energy theory, providing an opportunity for participants to learn about new results in neighbouring research areas at this interesting time for the field. Topics ranged from the anti-de-Sitter/conformal field theory (AdS/CFT) correspondence and inflationary cosmology to heavy-ion, neutrino and beyond-Standard Model physics.

Agnese Bissi (Uppsala University, Sweden) began the physics programme by reviewing the now-two-decades-old AdS/CFT correspondence, and discussing the use of conformal bootstrap methods in holography. Korinna Zapp (LIP, Lisbon, Portugal and CERN) then put three recent discoveries in heavy-ion physics into perspective: the hydrodynamic behaviour of soft particles; jet quenching; and surprising similarities between soft particle production in high-multiplicity proton–proton and heavy-ion collisions.

JiJi Fan (Brown University, USA) delved into the myriad world of beyond-the Standard Model phenomenology, discussing the possibility that the Higgs is "meso-tuned" but that there are no other light scalars. Elvira Gamiz (University of Granada, Spain) reviewed key features of lattice simulations for flavour physics and mentioned significant tensions with some experimental results that are as high as 3σ in certain B-decay channels. The theory colloquium, by Ana Achucarro (University of Leiden, Holland, and UPV-EHU Bilbao, Spain), was devoted to the topic of inflation, which still presents a major challenge to theorists.

The importance of parton distribution functions in an era of high-precision physics was the focus of a talk by Maria Ubiali (University of Cambridge, UK), who explained the state-of-the-art methods used. Reviewing key topics in cosmology and particle physics, Laura Covi (Georg-August-University Göttingen, Germany) then described how models with heavy R-parity violating supersymmetry lead to scenarios for baryogenesis and gravitino dark matter.

In neutrino physics, Silvia Pascoli (Durham University, UK) gave an authoritative overview of the experimental and theoretical status, while Tracy Slatyer (MIT, USA) did the same for dark matter, emphasising the necessity of search strategies that test many possible dark-matter models.

Closing the event, Alejandra Castro (University of Amsterdam, the Netherlands) talked about black-hole entropy and its fascinating connections with holography and number theory. The final physics talk, by Eleni Vyronidou (CERN), covered Standard Model effective field theory (SMEFT), which provides a pathway to new physics above the direct energy-reach of colliders.

The rest of the workshop centred on talks and discussion sessions about gender issues. The full spectrum of issues was addressed, a few examples of which are given here.

Julie Moote from University College London, UK, delivered a talk on behalf of the Aspires project in the UK, which is exploring how social identities and inequalities affect students continuing in science, while Marieke van den Brink from Radboud University Nijmegen, the Netherlands, described systematic biases that were uncovered by her group's studies of around 1000 professorial appointments in the Netherlands. Meytal Eran-Jona from the Weizmann Institute of Science, Israel, reviewed studies about unconscious bias and its implications for women in academia, and described avenues to promote gender equality in the field.

The last day of the meeting focused on actions that physicists can take to improve diversity in their own departments. For example, Jess Wade from Imperial College London, UK, discussed UK initiatives such as the Institute of Physics Juno and Athena SWAN awards, and Yossi Nir from the Weizmann Institute gave an inspiring account of his work on increasing female participation in physics in Israel. One presentation drawing on bibliometric data in high-energy theory attracted much attention beyond the workshop, as has been widely reported elsewhere.

This first workshop on high-energy theory and gender combined great physics, mentoring and networking. The additional focus on gender gave participants the opportunity to learn about the sociological causes of gender imbalance and how universities and research institutes are addressing them.

We are very grateful to many colleagues for their support in putting together this meeting, which received help from the CERN diversity office and financial support from the CERN theory department, the Mainz "cluster of excellence" PRISMA, Italy's National Institute for Nuclear Physics (INFN), the University of Milano-Bicocca, the ERC and the COST network.

Similar activities are planned in the future, including discussions on other scientific communities and minority groups.

Alessandra Gnecchi, CERN, and Marika Taylor, University of Southampton, on behalf of the conference organisers.

Muon g-2 fans gather in Novosibirsk

The Budker Institute of Nuclear Physics and the Novosibirsk State University co-hosted the first international school on the muon's dipole moments and hadronic effects in Novosibirsk, Russia, on 17–21 September. About 40 researchers from 20 institutions in Austria, China, Germany, Italy, Japan, Russia and South Korea discussed the various problems related to investigations of the muon's anomalous magnetic moment, g-2.

For more than 10 years, the large excess (more than 3.5 standard deviations) of the muon's anomalous magnetic moment over the Standard Model prediction measured by the muon g-2 experiment at the Brookhaven National Laboratory (BNL) in the US has caused great interest in the high-energy-physics community. With more than 1700 citations, the final publication of the muon g-2 collaboration has stirred numerous discussions on whether the excess could be due to new physics. A solution to the problem will require combined efforts from both theorists, to estimate more accurately hadronic effects on the muon's moment, and experimentalists, to perform new high-precision measurements.

The idea of the Novosibirsk school was to bring together two communities of researchers, one involved in making new direct measurements of the muon's moment at Fermilab in the US (***CERN Courier*** September 2018 p9) and at J-PARC in Japan, and another measuring electron–positron annihilation into hadrons (BESIII, CMD-3 and SND collaborations) to be used in theoretical calculations of the hadronic effects.

The scientific programme of the school comprised five lecture courses. Yannis Semertzidis from the Institute for Basic Science in Daejeon, Korea, summarised the experimental situation with a review of the existing storage rings, a discussion of the statistical and systematic uncertainties of such measurements, and ideas for new experiments.

Achim Denig from the University of Mainz, Germany, described experiments on electron–positron annihilation into hadrons, based on the so-called scan method, mostly developed in Novosibirsk, used in the CMD-3 and SND experiments as well as on the initial-state radiation method extensively used in the BaBar, Belle, BESIII and KLOE experiments. A comprehensive review of modern detectors was given by Stephan Paul from the Technical University of Munich, Germany.

Massimo Passera from the University of Padova, Italy, focused on aspects of the Standard Model that are directly related to the magnetic moments of leptons generally. He spoke about the QED, electroweak and hadronic contributions to lepton magnetic moments, explaining their hierarchy and accuracy, and covered both the traditional dispersive approach and novel methods based on lattice calculations. Josef Pradler from the Institute of High Energy Physics in Vienna, Austria, spoke about attempts to explain the problem by invoking dark matter.

The programme also comprised review talks on searches for axions, the g-2/EDM experiment at J-PARC, which aims to measure the muon's anomalous moment and electric dipole moment (EDM) with ultra-high precision, and future facilities at the Budker Institute. The latter include the Super-charm-tau factory to study properties of charmed hadrons and tau leptons with unprecedented accuracy, and the Mumutron, a low-energy electron–positron collider to study dimuonium.

Finally, of the 18 additional brief presentations, most were devoted to the J-PARC g-2/EDM experiment, and three featured the MuSEUM experiment, which will provide a new high-precision measurement of the hyperfine structure of muonium. There were also talks about the already running muon g-2 experiment at Fermilab, and about analyses of hadronic data from the CMD-3 detector.

The success of the school led to the decision to make it a regular event, to be held every other year in one of the relevant research centres. The University of Mainz has offered to host the 2020 school.

Simon Eidelman and Anna Vinokurova, Budker Institute and Novosibirsk State University.

Tau physics focus in Amsterdam

The 15th International Workshop on Tau Lepton Physics (TAU2018) was held at Vondelkerk, a former church in the centre of Amsterdam, the Netherlands, on 24–29 September. The focus of the series is on the physics of the tau lepton, its neutrino and related processes, and the goal is to stimulate discussions between theorists and experimentalists and to review recent progress in the field. This year's edition attracted about 120 participants from all over the world, and the programme comprised 90 invited and contributed talks, half of which were given by theorists. The workshop featured new results from both high-energy experiments (such as ATLAS, CMS and LHCb) and low-energy experiments (BESIII and others), from B factories such as Belle II, and recent results from muon g-2 and neutrino-oscillation experiments.

New measurements of tau decays with kaons or pions in the final state were presented by both the Belle and the BaBar collaborations, followed by a discussion on the extraction of the coupling V_{us} between the up quark and the strange quark. The Belle II collaboration presented its first data plots, showing good progress with the commissioning of the Belle II detector and beautiful signals of J/ψ, K_S, π^0 and $\tau \to 3\pi\nu$ decays. Meanwhile, the BESIII collaboration is on track to obtain the single most precise measurement of the tau mass. The LHC-experiment collaborations presented searches for physics beyond the Standard Model (BSM) and measurements of Standard Model parameters. On the BSM front, a wide range of final states with tau leptons were explored in the pursuit of lepton-flavour-violating processes and other BSM phenomena, but no significant deviations from the Standard Model have been observed. On the Standard Model measurements front, highlights included the polarisation in $Z \to \tau\tau$ decays and the Higgs–tau coupling. Possible benefits of machine-learning tools in particle-physics measurements were also addressed.

The programme also included subjects such as hadron cross-section measurements at electron–positron colliders, lepton-flavour-universality puzzles in meson decays, searches for lepton-flavour violation in tau, muon and Z decays, and review talks on future experiments. The recent LHCb measurements indicating lepton non-universality in certain B-meson decays remain a hot topic, and discussions at the meeting suggested looking for possible connections between the LHCb results and high-momenta measurements and direct BSM searches at the LHC.

A session dedicated to neutrinos showed the power of neutrino physics to study BSM physics. The recent data from the LSND and MiniBooNE experiments, which could indicate the existence of sterile neutrinos, keep challenging results from other neutrino experiments, and the explanation for this has yet to be found. A session on muon g-2 covered the preparation of new experiments and improved predictions of g-2 based on lattice calculations. The BESIII collaboration presented new results on the light-by-light scattering contribution to g-2 and the VEPP-2000 collaboration showed improved measurements of hadronic effects on g-2. A session on quantum chromodynamics revisited the extraction of the strength of the parameter α_S from ALEPH data, with lively discussions focused on duality violation.

Finally, muon lepton-flavour-violation experiments are on the verge of delivering highly anticipated data on lepton-flavour-violating decays (in some cases, they are expected to improve existing measurements by a factor of 1000). The programme ended with presentations on future experiments at planned accelerators in China, Europe and Japan, as well as future neutrino and muon experiments. Simon Eidelman presented the conference's highlights in his stimulating summary talk. With many new results expected, the next edition of the workshop, TAU2020, promises to be a very interesting meeting.

Olya Igonkina, Nikhef and Radboud Universiteit Nijmegen, and Robert Fleischer, Nikhef and Vrije Universiteit Amsterdam.

Exploring quantum computing for high-energy physics

The ambitious upgrade programme for the Large Hadron Collider (LHC) will result in significant information and communications technology (ICT) challenges over the next decade and beyond. It is therefore vital that members of the HEP research community keep looking for innovative computing technologies so as to continue to maximise the discovery potential of the world-leading research infrastructures at their disposal (*CERN Courier* November 2018 p5).

On 5–6 November, CERN hosted a first-of-its kind workshop on quantum computing in high-energy physics (HEP). The event was organised by CERN openlab, a public–private partnership between CERN and leading ICT companies established to accelerate the development of computing technologies needed by the LHC research community.

More than 400 people followed the workshop, which provided an overview of the current state of quantum-computing technologies. The event also served as a forum to discuss which activities within the HEP community may be amenable to the application of quantum-computing technologies.

"In CERN openlab, we're always looking with keen interest at new computing architectures and trying to understand their potential for disrupting and improving the way we do things," says Alberto Di Meglio, head of CERN openlab. "We want to understand which computing workflows from HEP could potentially most benefit from nascent quantum-computing technologies; this workshop was the start of the discussion."

Significant developments are being made in the field of quantum computing, even if today's quantum-computing hardware has not yet reached the level at which it could be put into production. Nevertheless, quantum-computing technologies are among those that hold future promise of substantially speeding up tasks that are computationally expensive.

"Quantum computing is no panacea, and will certainly not solve all the future computing needs of the HEP community," says Eckhard Elsen, CERN's director for research and computing. "Nevertheless, quantum computers are starting to be available; a breakthrough in the number of qubits could emerge at any time. Fundamentally rethinking our algorithms may appear as an interesting intellectual challenge today, yet may turn out as a major benefit in addressing computing challenges in the future."

The workshop featured representatives of the LHC experiments, who spoke about how computing challenges are likely to evolve as we approach the era of the High-Luminosity LHC. There was also discussion of work already undertaken to assess the feasibility of applying today's quantum-computing technologies to problems in HEP. Jean-Roch Vlimant provided an overview of their recent work at the California Institute of Technology, with collaborators from the University of Southern California, to solve an optimisation problem related to the search for Higgs bosons. Using an approach known as quantum annealing for machine learning, the team demonstrated some advantage over traditional machine-

learning methods for small training datasets. Given the relative simplicity of the algorithm and its robustness to error, they report, this technique may find application in other areas of experimental particle physics, such as real-time decision making in event-selection problems and classification in neutrino physics.

Several large-scale research initiatives related to quantum-computing technologies were presented at the event, including the European Union's €1 billion Quantum Technologies Flagship project, which involves universities and commercial partners across Europe. Presentations were also given of ambitious programmes in the US, such as the Northeast Quantum Systems Center at Brookhaven National Laboratory and the Quantum Science Program at Fermilab, which includes research areas in superconducting quantum systems, quantum algorithms for HEP, and computational problems and theory.

Perhaps most importantly, the workshop brought members of the HEP community together with leading companies working on quantum-computing technologies. Intel, IBM, Strangeworks, D-Wave, Microsoft, Rigetti and Google all presented their latest work in this area at the event. Of these companies, Intel and IBM are already working closely with CERN through CERN openlab. Plus, Google also announced at the event that they have signed an agreement to join CERN openlab.

"Now is the right time for the HEP community to get involved and engage with different quantum-computing initiatives already underway, fostering common activities and knowledge sharing," says Federico Carminati, CERN openlab CIO and chair of the event. "With its well-established links across many of the world's leading ICT companies, CERN openlab is ideally positioned to help drive this activity forward. We believe this first event was a great success and look forward to organising future activities in this exciting area."

Recordings of the talks given at the workshop are available via the CERN openlab website at: openlab.cern.

Andrew Purcell, CERN.

Halfway to high luminosity

The High-Luminosity LHC (HL-LHC) has reached its halfway point. The upgrade project was launched eight years ago and is scheduled to start up in 2026, following major interventions to the CERN accelerator complex. From 15 to 18 October, representatives of the institutes contributing to the HL-HLC gathered at CERN for the 8th annual meeting of the HL-LHC to assess progress as the project moves from prototyping to the series production phase for much of the equipment.

The HL-LHC annual meeting is a chance to conduct a global review of the project. The civil-engineering work has progressed since it began in the spring: excavations have reached a depth of 30 m at Point 1 (ATLAS) and 25 m at Point 5 (CMS). The two 80 m shafts should be fully excavated by the beginning of 2019. As for the accelerator, one of the key tasks is the production of around 100 magnets of 11 different types. Some of these, notably the main superconducting quadrupole magnets that will replace the LHC's triplets and focus the beams very strongly before they collide, are made from the conductor niobium tin, which is particularly difficult to work with. The short prototype phase is already nearing completion for the quadrupole magnets: the long (7.15 m) quadrupoles are being produced at CERN, while shorter (4.2 m) quadrupoles are being developed in the framework of the US LHC-AUP (LHC Accelerator Upgrade Project) collaboration. Several short prototypes have already reached the required intensities on both sides of the Atlantic.

New dipole magnets at the interaction points, which divert the beams before and after the collision point, are being developed in Japan and Italy. One short model has been successfully tested at the KEK laboratory in Japan and a second is in the process of being tested. INFN in Italy is also assembling a short model. Finally, progress is being made on the development of the corrector magnets at CERN and in Spain (CIEMAT), Italy (INFN) and China (IHEP), with several prototypes already tested. In 2022, a test line will be installed at CERN's SM18 hall to test the first magnet chains.

One of the major successes of 2018 is the installation in the Super Proton Synchrotron (SPS) of a test bench with an autonomous cryogenic unit. The test bench houses two DQW (double-quarter wave) crab cavities, one of two designs under study (***CERN Courier*** May 2018 p18). The two cavities rotated the proton bunches as soon as the tests began in May, marking a world first. The construction of the DQW cavities will continue while the second architecture, the radiofrequency dipole, is being developed in the US.

Many other developments were presented during the symposium: new collimators have been tested in the LHC; a beam absorber for the injection points from the SPS was tested over the summer and will be installed during the LHC's second long shutdown; a demonstrator for a magnesium-diboride superconducting link is currently being validated; and studies have been undertaken to test and adjust the remote alignment of all the equipment in the interaction regions.

Over the four days that the meeting took place, some 180 presentations covered a wide range of technologies developed for the HL-LHC and beyond.

Corinne Pralavorio, CERN.