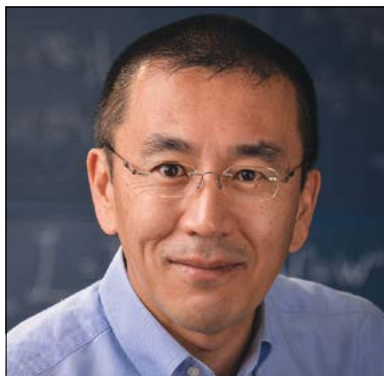


Faces & Places

APPOINTMENTS

Hiroshi 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 Hiroshi 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



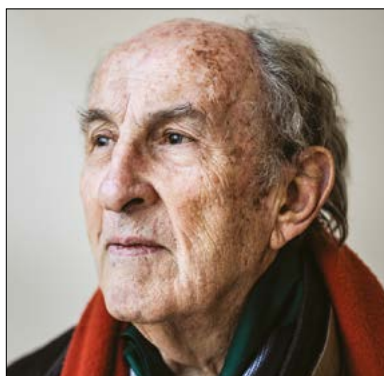
Hiroshi Ooguri will take over at Kavli IPMU.

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 Hiroshi 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



Synchrotron-radiation expert Yves Petroff.

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 (see feature on p17). 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.

AWARDS

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.

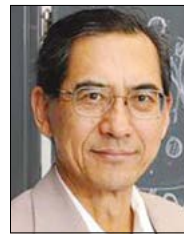
The Robert R Wilson Prize for Achievement in the Physics of Particle Accelerators went to Toshiki Tajima at the University of California, Irvine, "for the invention and leading the first realisation of laser wakefield acceleration, which opened the way to compact acceleration applications such as ultrafast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

Faces & Places

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



Clockwise from top left: Stone, Tran, Tajima, Randall, Freese, Jacak, Holstein and Sundrum.

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



The winners of the 2018 ATLAS Outstanding Achievement Awards, together with ATLAS spokesperson Karl Jakobs (far left), awards committee chair Jim Pilcher and collaboration board chair Max Klein (right).

to reward the people who have made dramatic improvements to the operation

and understanding of our detector, thus improving the quality of our measurements.”

EVENTS

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



Joanne Intrator, granddaughter of Jakob Intrator, and Charlotte Warakaulle, CERN's director for international relations, standing in front of the commemorative plaque.

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."

CERN PHOTO: 201810-263-28



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).



Inauguration event in La Palma for the first prototype large-sized telescope LST-1.

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.

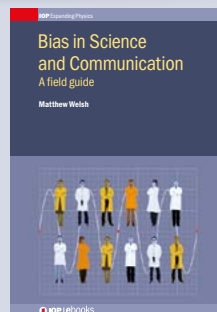
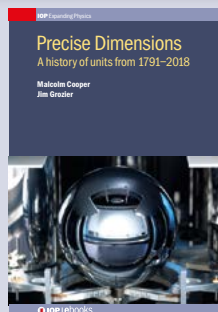
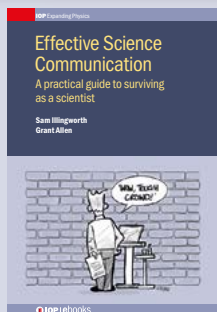
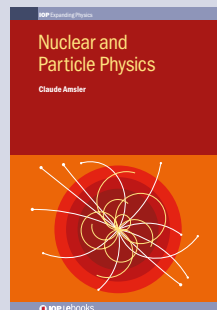
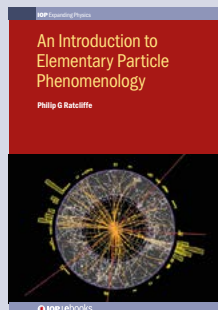
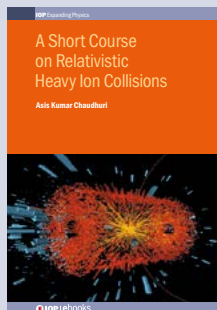
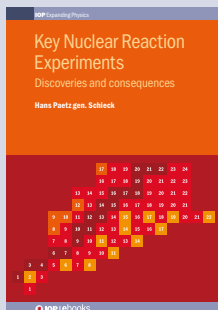
Like the LHC, the CTA represents a major data challenge: it is expected to generate 100 petabytes of data by 2030. With more than 100 telescopes planned for the northern and southern hemispheres, the CTA will be the largest and most sensitive high-energy gamma-ray observatory.

CTA Observatory

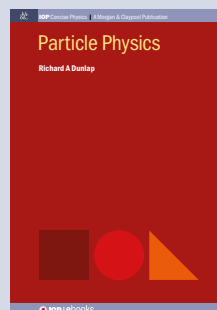
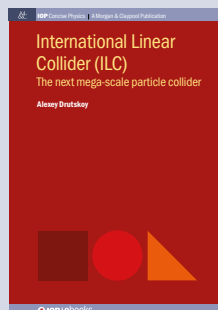
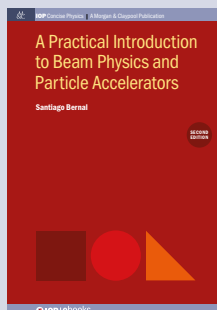
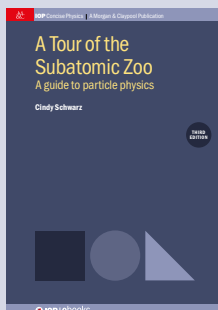
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MEETINGS

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 (see p5).

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



Some of the participants at the first workshop on high-energy theory and gender.

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 Vyrionidou (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 Gnechchi, CERN, and Marika Taylor, University of Southampton, on behalf of the conference organisers.

Faces & Places

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, $g-2$.

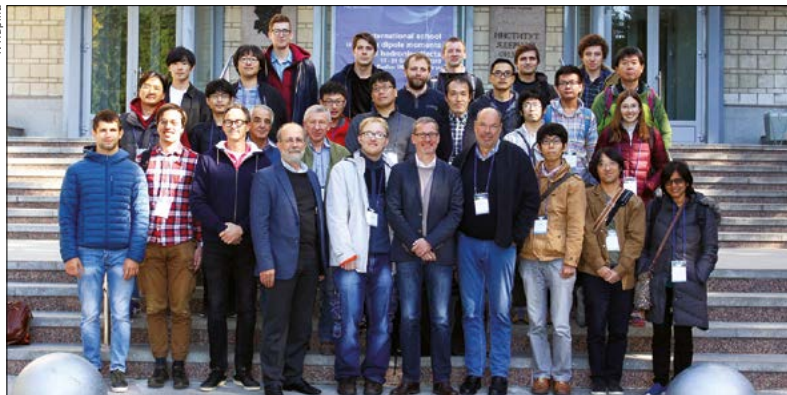
For more than 10 years, the large excess (more than 3.5 standard deviations) of the muon's anomalous magnetic moment over the Standard Model prediction measured by the muon $g-2$ experiment at the Brookhaven National Laboratory (BNL) in the US has caused great interest in the high-energy-physics community. 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.

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



Participants at the first international school on muon $g-2$ in Novosibirsk.

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.

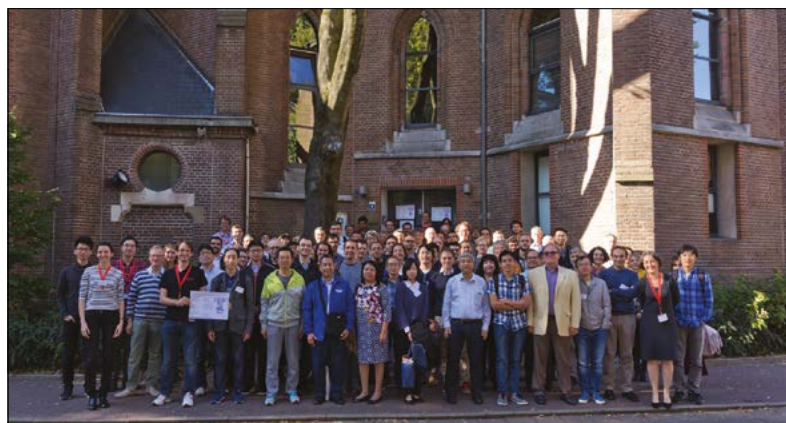
stimulate discussions between theorists and experimentalists and to review recent progress in the field. This year's edition attracted about 120 participants from all over the world, and the programme comprised 90 invited and contributed talks, half of which were given by theorists. The workshop featured 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_{ub} 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 $\tau \rightarrow 3\pi\nu$ 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 $Z \rightarrow \tau\tau$ 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



The TAU2018 participants in front of the conference venue Vondelkerk, a former church.

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 ▸

Faces & Places

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



Eckhard Elsen, CERN's director for research and computing, speaking at the quantum computing in high-energy physics event.

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-LHC 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



Participants at the High-Luminosity LHC collaboration's annual meeting.

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.

OBITUARIES

Leon Lederman 1922–2018

Leon Lederman, a pioneering US experimental particle physicist who shared the Nobel Prize in Physics for the discovery of the muon neutrino, passed away on 3 October at the age of 96. Lederman's career spanned more than 60 years and had a major impact in putting the Standard Model of particle physics on empirical ground.

Lederman was born in New York City on 15 July 1922 to Russian–Jewish immigrant parents. He graduated from City College of New York with a degree in chemistry in 1943, but had already fallen under the influence of future physicists including Isaac Halpern and Martin Klein. After graduating he spent three years in the US Army, where he rose to the rank of 2nd lieutenant in the signal corps. In 1946 he entered the graduate school of physics at Columbia University, chaired by I I Rabi, and in 1951 he received his PhD in particle physics.

During the 1950s Lederman contributed to two major physics results: the discovery of the long-lived neutral K meson at Brookhaven National Laboratory's 3 GeV Cosmotron in 1956; and, in 1957, the observation of parity violation in the pion–muon–electron decay chain at the Nevis 385 MeV synchrocyclotron at Columbia University. In 1958, shortly after he was promoted to professor, Lederman took his first sabbatical at CERN where he contributed to the organisation of the g-2 experiment. This programme lasted for almost two decades and involved many prominent CERN physicists, including Georges Charpak, Emilio Picasso, Francis Farley, Johannes Sens and Antonino Zichichi.

Lederman's crowning achievement came in 1962 with the co-discovery of the muon neutrino at Brookhaven's Alternating Gradient Synchrotron (AGS). For this work, he shared the 1988 Nobel Prize in Physics with Jack Steinberger and the late Melvin Schwartz "for the neutrino beam method and the demonstration of the doublet structure of the leptons through the discovery of the muon neutrino." The experiment used a spark chamber to show that the neutrinos from beta decay and the neutrinos from muon decay were different, leading to the first direct observation of muon neutrinos and marking a key step in the understanding



Pioneering particle physicist Leon Lederman.

of weak interactions. Steinberger, who joined CERN six years after the muon-neutrino discovery and is now 97, has fond memories of his collaboration with Lederman. "What I remember about Leon is that we worked together at the same labs, at Nevis and at Brookhaven, and we got the Nobel Prize together, with Mel Schwartz. It was for a non-trivial experiment. He was a good friend. I'm very sad that he's gone."

At the end of the 1960s, in another experiment at the AGS, Lederman discovered the production of muon pairs with a continuous mass distribution in proton–nucleon collisions – an unexpected phenomenon that was soon interpreted as the result of quark–antiquark annihilation. As a follow-up to this experiment, in collaboration with physicists from CERN, Columbia and Rockefeller universities, Lederman proposed to study the production of electron–positron pairs at CERN's Intersecting Storage Rings (ISR), which started operation in 1971. The experiment, known as R-103, discovered the production of neutral pions at high transverse momentum with a yield several orders of magnitude larger than expected. The result was again interpreted in terms of hard collisions between point-like proton constituents, demonstrating that these constituents also feel the strong interaction. "I had the privilege of working with Leon at Columbia in 1969–1970, when the R-103

experiment was proposed, and during the first years of ISR operation when he came to CERN," says Luigi Di Lella of CERN. "I remember Leon as a physicist with enormous imagination, a boundless source of stimulating and often unconventional new ideas, which he always presented in a friendly and joyful atmosphere."

As leader of the E70 and E288 experiments at Fermilab in the 1970s, Lederman also drove the effort that led to the discovery of the up quark, the bound state of a bottom quark and antiquark, in 1977 (*CERN Courier* June 2017 p35). But his influence on the field of particle physics permeates far beyond his specific areas of research. In particular, he was a passionate advocate of education and worked with government and schools to create opportunities for students and better integrate physics into public education. He also had the rare quality to not take himself too seriously. Concerning the Higgs boson, he famously coined the term "God Particle" by using it in the title of his 1993 popular-science book *The God Particle: If the Universe Is the Answer, What Is the Question?* – though legend has it that he had originally wanted to call it the "God-damned particle" because the Higgs boson was so difficult to find.

Lederman was director of the Nevis Laboratories at Columbia from 1961 to 1978. In 1979 he became director of Fermilab, where his vision and strategic planning led to the construction of the Tevatron (which operated from 1987 to 2011 and was the world's highest-energy accelerator before the Large Hadron Collider came along). He stepped down as Fermilab director in 1989 and joined the faculty of the University of Chicago and, later, the Illinois Institute of Technology.

"Leon Lederman provided the scientific vision that allowed Fermilab to remain on the cutting edge of technology for more than 40 years," says Nigel Lockyer, Fermilab's current director. "Leon's leadership helped to shape the field of particle physics, designing, building and operating the Tevatron and positioning the laboratory to become a world leader in accelerator and neutrino science. Leon had an immeasurable impact on the evolution of our laboratory and our commitment to future generations of scientists, and his legacy will live on in our daily work and our outreach efforts."

● His friends and colleagues at CERN, with additional input from Fermilab.

Faces & Places

Paul Kunz 1942–2018

Paul Kunz, who revolutionised particle-physics computing and established the first Web server in the US, passed away on 12 September.

After completing a PhD in physics at Princeton University, Kunz began his illustrious 35 year-long career at the Stanford Linear Accelerator Center (SLAC) in 1974 as a research associate in David Leith's experimental physics Group B. As well as being an accomplished particle physicist, he quickly took an interest in one of the computing challenges facing experiments at the time – how to increase offline data-processing capability at a reasonable cost.

Using his deep understanding of computer architecture, software and hardware, he proposed a novel solution well beyond the norms of the time: the construction of a “farm” of interconnected processors each capable of executing IBM 370/168 instructions generated from standard FORTRAN code by an intermediate translator. In effect, the collection of interconnected computers in the farm would emulate, at a much lower cost, a single mainframe, distributing tasks to the individual processors, which became known as emulators. Each emulator would process entire events from particle interactions. Thus a simple parallel processing algorithm that did not require special programming or intricate modification to an experiment's existing software was born.

After forming a small team at SLAC and building a prototype emulator known as the 168/E, Paul met CERN computer specialists David Lord and Adolfo Fucci. They immediately expressed a desire to join forces. In fact, they were looking for an online filter processor that would execute standard offline FORTRAN code to make a selection of events for fast analysis by CERN's UA1 experiment,



Paul Kunz established the first Web server in the US.

the so-called express line. Exhibiting his usual selfless interest in sharing ideas, Paul agreed to join forces, thereby establishing one of the first “real time” intercontinental collaborations by using the European Academic Research Network (EARN) and BITNET, courtesy of IBM.

The CERN/SLAC collaboration successfully constructed offline processing farms, notably for UA1. In parallel, one of the members of Paul's original team, Hanoch Brafman, went on to build a complementary 370/E emulator at the Weizmann Institute of Science in Israel. Subsequently, the CERN/SLAC teams developed the next-generation emulator, the 3081/E, which was used by UA1 and the Large Electron–Positron Collider (LEP) experiments in online and offline environments. The farms were inherently extendable by simply adding processors, and are arguably the inspiration for today's distributed offline computing facilities.

The success of the emulator-based UA1 third-level trigger facility pioneered the use of a processor farm for the so-called high-level trigger system, which has since been employed by most collider experiments (at LEP, the Tevatron and the LHC), albeit with commercial processors.

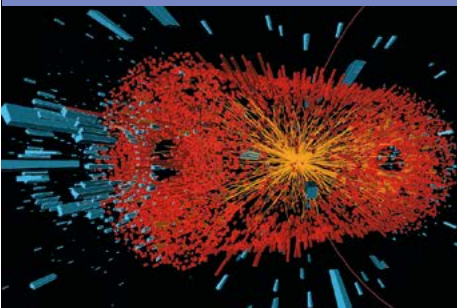
In the 1990s, Paul turned his attention to the challenges of software development and became a guru and advocator of object-oriented programming. He was a passionate user of Steve Job's NeXT computer and on an historic visit to CERN where he had regularly been giving courses on C++ programming, Paul immediately recognised the potential of the Web as demonstrated by Tim Berners-Lee and Robert Cailliau. Returning to SLAC, Paul not only installed the software on his NeXT, thereby establishing the first Web server in the US, he also connected it to the SPIRES database, giving the Web development team a “killer app”, which demonstrated the huge potential of their project.

In his personal life, Paul was a champion BMW autocross driver and president of the Bay Area BMW club, at which he was also, along with his wife, a driving instructor for teenagers. When travelling to CERN, he would often land in Frankfurt, hire a BMW, and take it for a spin round the Nuremberg ring. He loved Chinese food and liked nothing better than to enjoy dinner in one of the many Chinese restaurants in the SLAC area with visiting friends and colleagues, often speaking French with his unique accent, a legacy of time spent at CEA Saclay in the 1970s.

Paul Kunz was a computing visionary and pioneer, and a great communicator who loved to share his ideas with irrepressible energy.

Thank you for all the bytes and bites, Paul.

● *Mick Storr, Adolfo Fucci and Paris Sphicas, assisted by other friends and colleagues of Paul.*



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Karlheinz Meier 1955–2018

Karlheinz Meier, a visionary experimental particle physicist and co-founder of the Human Brain Project, unexpectedly passed away on 24 October, much too early, at the age of 63.

Karlheinz's career began at the University of Hamburg in Germany, where he studied physics. He completed his PhD there in 1984, with Gus Weber and Wulfrin Bartel as his supervisors, working for the JADE experiment at the PETRA electron-positron collider at DESY. During the following six years, he worked at CERN for the UA2 project, for two years as a CERN fellow and then as staff scientist. Returning to DESY in 1990, he joined the H1 collaboration. In 1992 he accepted a full professorship at Heidelberg University, where in 1994 he founded the Heidelberg ASIC Laboratory for Microelectronics and later, in 1999, the Kirchhoff Institute for Physics; during this period he also joined the ATLAS collaboration at CERN's Large Hadron Collider (LHC). He was vice-rector at Heidelberg University from 2001 to 2004, chair of the European Committee for Future Accelerators (ECFA) from 2007 to 2009, and a member of the governing board of the German Physical Society (DPG) from 2009 to 2013. Within the Human Brain Project – a major 10 year-long effort harnessing cutting-edge research infrastructure for the benefit of neuroscience, computing and brain-related medicine – he initiated the European Institute for Neuromorphic Computing (EINC) at Heidelberg. Sadly, the completion of the facility cannot be witnessed by him anymore.

Karlheinz was an extremely enthusiastic, visionary and energetic scientist. He made fundamental contributions to the instrumentation and data analysis of large particle-physics experiments, especially concerning calorimeter systems. Early on, during his PhD, he developed advanced algorithms for identifying photons with



Karlheinz Meier was co-founder of the Human Brain Project.

the lead-glass calorimeter of JADE, an essential ingredient for his analysis of the inclusive production of photons, pions and η -mesons in multi-hadronic final states, but also for many studies of hadronisation and jet production, which JADE became famous for. Later, at CERN's UA2 experiment, he participated in the first analyses of the newly discovered W and Z bosons.

Back at DESY, he was one of the advocates and initiators of the H1 scintillating fibre "spaghetti" calorimeter, which was decisive for precise measurements of the proton structure. In addition, his research group built another specialised backward calorimeter for H1, the VLQ; by analysing the VLQ data, he was able to refute the then theoretical predictions on special multi-gluon states, such as the odderon (*CERN Courier* April 2018 p9). Karlheinz recognised early on the need for developing highly integrated electronic circuits for experimental physics, and his group – together with colleagues from the Heidelberg ASIC Laboratory – developed the

pre-processor system of the ATLAS level-1 calorimeter trigger, which played a pivotal role in the discovery of the Higgs boson.

Since 2001, Karlheinz became increasingly interested in fundamental questions related to the physics of complex systems and information processing, with a focus on the development of neuromorphic hardware for decoding the functioning of the brain. In contrast to normal, programme-oriented Turing machines, neuromorphic systems are extremely energy efficient, error tolerant and self-adaptive – just like the human brain. His research results received special international recognition through the Human Brain Project, which he initiated together with Henry Markram and Richard Frackowiak, and which was selected by the European Union in 2012 as one of two so-called Flagship Projects of European research funding.

Karlheinz was also exceptional in supervising and motivating young researchers. He was a highly gifted teacher, whose lectures and seminars were loved by his students. Through his renowned "Team-Anderthalb" 90-second movies on a wide variety of basic physics topics, he became known to the wider public; they are available, like many other of his lectures and talks, on YouTube.

Curiosity for the fundamental questions of physics and technological innovation were the two driving forces that accompanied Karlheinz throughout his research life. He not only contributed significantly to the expansion of our knowledge about nature, but also gave new impetus to technological development, especially in the field of microelectronics and computing. His commitment to both research and teaching was outstanding and special. His passion, humanity, humour, overall guidance and inspiration will be sorely missed and not forgotten.

● *Siggi Bethke, Eckhard Elsen and Hans-Christian Schultz-Coulon, for his colleagues and friends worldwide.*

Ferenc Niedermayer 1945–2018

Ferenc Niedermayer, who played a prominent role in the development of lattice quantum chromodynamics (QCD), died on 12 August, aged 73.

Ferenc was born on 6 March 1945 in Budapest, Hungary. After obtaining a master's degree from Leningrad State

University in 1968, where he met his future wife Tamara, he received his PhD in 1971 from Eötvös University in Budapest. Following a three-month stay at CERN's theory division in 1979, he worked at the Joint Institute for Nuclear Research in Dubna in 1980–1985 and at the University

of California in San Diego in 1985–1986. Since 1989, he was a member of the Institute for Theoretical Physics at the University of Bern. In addition, he was a regular long-term visitor at the Max Planck Institute in Munich and at Eötvös University.

Ferenc was famous for possessing



Faces & Places

an extraordinarily broad knowledge of physics. During the early stages of his career, he worked on a variety of phenomenological topics, ranging from polarised lepton–hadron scattering to J/ψ production in hadron–nucleus collisions and to neutrino oscillations. When he came to Bern, Ferenc began to work in a more

theoretical direction, particularly on the novel discipline of lattice field theory – the study of lattice discretisations of quantum field theories such as QCD. Over the years, he obtained numerous results of lasting value in this and related fields, some of them in collaboration with his old friends János Balog, Péter Hasenfratz and Peter Weisz.

One famous result, which he obtained in collaboration with Hasenfratz and Michele Maggione and made use of the intricate Wiener–Hopf technique, was the derivation of the mass gap of the two-dimensional $O(3)$ model from its conjectured exact S-matrix. This model is often used as a prototypical solvable theory displaying many QCD-like features. Another celebrated result, which he achieved in collaboration with Hasenfratz and Victor Laliena and made use of the famous Ginsparg–Wilson relation, was the rigorous establishment of the Atiyah–Singer index theorem in a fully non-perturbative framework. This theorem plays a key role in the understanding of the vacuum structure and chiral symmetry properties of QCD.

R. Bastien



Ferenc Niedermayer played a key role in the development of lattice QCD.

After his retirement in 2010, Ferenc continued to work vigorously, both with new generations of students at Bern but in particular in a fruitful collaboration with Peter Weisz. This work continued and even accelerated after he received a diagnosis of liver cancer a few years ago. Ferenc talked openly about his illness. He always had a wonderful attitude towards work and life in general, and it was very inspiring to see how efficiently he spent his time.

Towards the end of his life, Ferenc visited Hungary to bid farewell to many old friends and colleagues. He died peacefully a few days after returning to Bern. Many of his friends and colleagues, both from Switzerland and Hungary, honoured a great scientist and a wonderful man at his funeral.

● *His friends and colleagues.*

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Polish business getting stronger in Big Science

Poland is one of the EU's fastest growing economies and is betting its future on the development of its R&D sector and innovation-based industry. Many Polish companies are now tapping into the potential of Big Science and venture into this market with more confidence, winning orders from the largest Big Science centres such as CERN, ESS and ESA.

Potential driven by talent and technology

Poland is unleashing its potential in Big Science. "We ensure our companies realise that this huge market works based on the synergy of smaller initiatives that may bring tremendous growth opportunities", says Maciej Potocki, president of Wrocław Technology Park (WTP). The Polish Big Science market is closely linked to Wrocław, especially regarding co-operation with CERN. One of the co-founders of WTP, professor Maciej Chorowski, the director of the National Centre for Research and Development, used to be a member of the CERN Finance Committee. "Co-operation with Big Science has been the focus of WTP since its inception. This is where we have launched the BIG SCIENCE HUB national portal – no other institution in Poland is better placed to assist companies in beginning co-operation with Big Science centres. Furthermore, we are fully equipped to help execute their orders thanks to our advanced R&D facilities", says Potocki. "We integrate Polish business around Big Science, which is why we run projects such as BIG SCIENCE HUB. We also intend to organise more international events that will bring together business and Big Science", adds the president of WTP.

Such actions produce tangible results. And not only in Wrocław; all of Poland is home to companies that provide orders for organisations like CERN. Creotech Instruments, KrioSystem, Techtra, DFUP or ZAPAS S.A. are among them. "We are CERN's regular, qualified supplier of GEM foil. We implemented its production technology based on a license that we acquired and this has been the foundation of our market success", says Piotr Bielówka, resident of TECHTRA, a company operating in WTP. KrioSystem, a designer and manufacturer of low-temperature installations, has enjoyed similar success. It is partnered, among others, with ESS and DESY (XFEL projects), and produced low-temperature installations for CERN. "Our participation in Big Science projects is an example of a business partnership on a truly international scale", says Piotr Grzegory, president of KrioSystem. Indeed, seeing the real



prospects of success serves as a catalyst, unlocking the Polish potential in Big Science.

BIG SCIENCE HUB

It is safe to say that Poland is witnessing a rapid growth in its Big Science environment. "Polish companies have discovered the potential offered by this market and want to benefit from it. Their technology and infrastructure enable them to compete with high-tech companies from all over the world", says Sylwia Wójtowicz, Polish ILO for CERN and F4E. Polish companies don't have to go it alone in the Big Science sector. Industrial liaison officers, business environment institutions such as WTP or government agencies, like the Polish Space Agency are there to provide assistance and advice on the process. So does the BIG SCIENCE HUB project, which was launched recently with the aim of encouraging smooth co-operation with Big Science centres among Polish entrepreneurs, and serves as a source of relevant information or provides the contacts that are required to kick-start this co-operation. "The heart of the project is big-science.pl – an online platform that guides companies on how to establish international business relations in the sector, and which shows that Polish companies are reliable and trusted partners", adds Wójtowicz.

Big Science, big possibilities

The institutions supporting domestic industry bring together Polish entrepreneurs and

researchers who are willing to team with one another to increase the Polish share in the Big Science market. "The awareness among Polish business people keeps growing. We win more and more tenders, and execute more and more technologically advanced orders for huge research centres. As part of the co-operation with CERN, we actively participate in Open Hardware Repository projects co-created by engineers from around the world", says Anna Kamińska from Creotech Instruments, a successful player in the Big Science market that delivers projects related to scientific instrumentation, the space sector and the collection of satellite data. Only this year, Creotech Instruments secured an order for the supply of advanced control and measurement electronics for CERN. It is one of four European centres supporting CERN in designing electronic solutions for future accelerators as well as for the purposes of high-energy physics experiments carried out by the institution. Action, another Polish company, helps CERN store its data, and has been its supplier of servers and mass storage media since 2009.

Such examples abound, and are a testimony to the trustworthiness of Polish entrepreneurs as business partners. Polish suppliers are reliable and have a high degree of technical expertise. Poland is held in great esteem in the Big Science sector, and its position will continuously gain in strength. More information on the success of Polish companies and researchers is available at: www.big-science.pl



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