

# Faces & Places

## APPOINTMENTS

# Committee to find next ERC president

On 30 May, the European commissioner for research, science and innovation, Carlos Moedas, appointed seven experts, including CERN Director-General Fabiola Gianotti, to conduct a search for the next president of the European Research Council (ERC). Established in 2007, the ERC is the European Union's funding body for frontier research and offers a number of grants as part of the European Union framework programme for research and innovation.

The committee, chaired by former European commissioner and also former prime minister of Italy, Mario Monti (pictured), will make recommendations to the European Commission in time for



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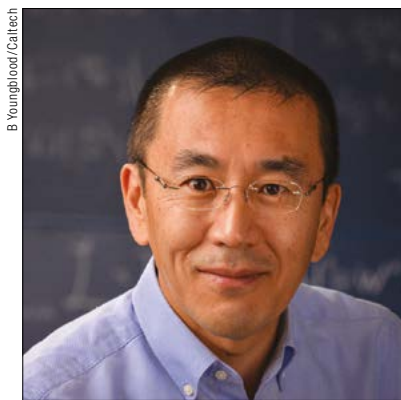
*Mario Monti will chair the committee appointed to search for the next European Research Council president.*

the next ERC president to take up duties on 1 January 2020, as successor to the current president Jean-Pierre Bourguignon. About the appointed committee, Moedas said: "The ERC has become a powerhouse of science, and will be a key pillar in an even more ambitious research and innovation framework programme that will follow Horizon 2020. I am confident that Mr Monti and his distinguished group of people from European science and research can help us find the right person to lead the ERC to even greater success."

## AWARDS

# Hamburg Prize for Theoretical Physics goes to Ooguri

Hiroshi Ooguri from the California Institute of Technology and the Aspen Center for Physics in the US, and the University of Tokyo in Japan, has been awarded the 2018 Hamburg Prize for Theoretical Physics. The prize is one of the most valuable science prizes in Germany, and is awarded by the Joachim Herz Foundation in partnership with the Wolfgang Pauli Centre of the University of Hamburg, DESY, and the Hamburg Centre for



B. Youngblood/CaRtech

*Ooguri will receive his award on 7 November at the Hamburg Planetarium.*

Ultrafast Imaging at the University of Hamburg. This year the prize covers all areas of theoretical physics (in previous years it was given to theorists in quantum information, quantum optics and quantum many-body systems), and, additionally, the prize money has been increased from €40,000 to €100,000.

Ooguri is recognised for his successful mathematical work on topological string theory, as well as for making his research more publicly available. The researcher is also the author of six books in Japanese, which have sold more than 300,000 copies and have been translated into Chinese and Korean. Ooguri's work and related science will be the subject of a three-day symposium that will take place in November at the University of Hamburg.

# James Pinfold wins a Killam Prize

James Pinfold from the University of Alberta, Canada, has received one of this year's Killam Prizes, in the natural-sciences category. The five awards, each worth C\$100,000, are given by the Canada Council for the Arts and recognise the career achievements of eminent Canadian scholars and scientists actively engaged in research.

Pinfold, who completed his PhD at University College London in 1977, has held senior roles in particle-physics experiments, and was a founding member of the ATLAS



University of Alberta

*Pinfold won his award in the natural-sciences category.*

experiment at CERN. He was also a leader in four major advances in particle physics, including the discovery of neutral currents, the first observation of charm particle production and the discovery of the Higgs boson. He now leads the MoEDAL experiment at the LHC, which is designed to search for highly ionising harbingers of new physics such as magnetic monopoles.

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# Hannah Petersen awarded Zimányi Medal

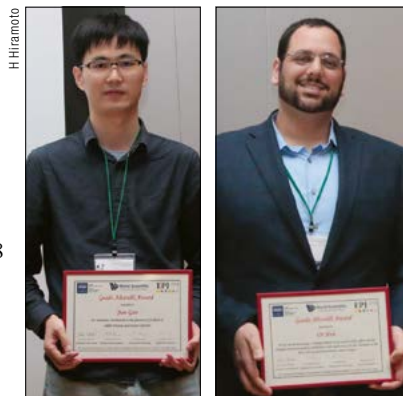
Hannah Petersen from Goethe University in Frankfurt, Germany, was awarded the Zimányi Medal at the 2018 Quark Matter conference in Venice, Italy. Created in memory of the nuclear physicist József Zimányi, the prize is awarded by the Wigner Research Center for Physics of the Hungarian Academy of Sciences in Budapest, and is given to theoretical physicists under the age of 40 who have achieved international recognition in the area of theoretical high-energy physics. Petersen is recognised for her pioneering development of an event-by-event hybrid description of high-energy heavy-ion collisions, which couples fluid dynamics in the quark–gluon plasma with hadron transport.



*Hannah Petersen with Tamás Sándor Bíró from the Zimányi Foundation during the award ceremony in Venice.*

## Guido Altarelli Award goes to Gao and Hen

The third Guido Altarelli Award was presented to two researchers during the 2018 international workshop on deep-inelastic scattering and related subjects (DIS18), which took place in Kobe, Japan, on 16–20 April. The award, which honours the memory of CERN theorist Guido Altarelli, recognises exceptional achievements from



*Jun Gao (left) and Or Hen (right) received their prizes at the DIS18 workshop.*

young scientists in the field of deep-inelastic scattering and related subjects. Jun Gao from Shanghai Jiao Tong University, China, is one of the main developers of the so-called CTEQ family of parton densities, and was recognised for his innovative contributions to precise QCD calculations. The other recipient, Or Hen from the Massachusetts Institute of Technology, US, received the award for his role in uncovering a striking relation between the nuclear “EMC effect” and nucleon–nucleon correlations, with implications for valence up- and down-quark distributions.

## High-energy physicists elected to Royal Society

Jim Al-Khalili, Fabiola Gianotti and Guy Wilkinson were among several physicists elected as 2018 Fellows and Foreign Members of the Royal Society. Gianotti, CERN Director-General, has worked on several CERN experiments, and was the spokesperson of the ATLAS experiment at the time of the discovery of the Higgs boson in 2012. She was included among *The Guardian* newspaper’s “Top 100 most inspirational women” in 2011 and ranked fifth in *Time* magazine’s Personality of the Year in 2012.

Guy Wilkinson, from the University of Oxford, studies CP violation and related



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CERN-201512-261-8



CERN-201611-285-3

*From left to right, Jim Al-Khalili, Fabiola Gianotti and Guy Wilkinson.*

open questions of the Standard Model through measurements of rare processes involving the decays of hadrons containing beauty or charm quarks. He was a founding member of the LHCb experiment and a spokesperson for the experiment between 2014 and 2017.

Jim Al-Khalili holds a joint chair in physics and in the public engagement in science at the University of Surrey, UK.

His current interest is in the application of quantum mechanics in biology and, together with colleagues, has set up the world’s first doctoral training centre in quantum biology at Surrey. He has also written 14 books, between them translated into 26 languages, is a regular presenter of TV science documentaries, and for the past seven years has hosted the weekly BBC Radio 4 programme, *The Life Scientific*.

## EVENT

# Laureates mark Standard Model anniversary

On June 1–4, several Nobel Prize winners in physics attended a symposium at Case Western Reserve University to mark 50 years of the Standard Model. The event included a free public lecture by 2004 laureate and co-inventor of QCD David Gross (pictured), and a concluding talk by 1979 laureate Steven Weinberg, whose 1967 paper “A Model of Leptons” established electroweak theory. Other contributors to the Standard Model attended the

R. Wetzel/CWRU



*Nobel Prize laureate David Gross speaking at the symposium marking 50 years of the Standard Model.*

symposium, including 1984 laureate and former CERN Director-General Carlo Rubbia. Glenn Starkman of Case Western Reserve remarked: “It’s a pretty amazing group of men and women who have contributed immeasurably to our understanding of the world.”

## MEETINGS

# Neutrino physics shines bright in Heidelberg

The 28th International Conference on Neutrino Physics and Astrophysics took place in Heidelberg, Germany, on 4–9 June. It was organised by the Max Planck Institute for Nuclear Physics and the Karlsruhe Institute of Technology. With 814 registrations, 400 posters and the presence of Nobel laureates, Art McDonald and Takaaki Kajita, it was the most attended of the series to date – showcasing many new results.

Several experiments presented their results for the first time at Neutrino 2018. T2K in Japan and NOvA in the US updated their results, strengthening their indication of leptonic CP violation and normal-neutrino mass ordering, and improving their precision in measuring the atmospheric oscillation parameters. Taken together with the Super-Kamiokande results of atmospheric neutrino oscillations, these experiments provide a  $2\sigma$  indication of leptonic CP violation and a  $3\sigma$  indication of normal mass ordering. In particular, NOvA presented the first  $4\sigma$  evidence of  $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$  transitions compatible with three-neutrino oscillations.

The next-generation long-baseline experiments DUNE and Hyper-Kamiokande in the US and Japan, respectively, were discussed in depth. These experiments have the capability to measure CP violation and mass ordering in the neutrino sector with a sensitivity of more than  $5\sigma$ , with great potential in other searches like proton decay, supernovae, solar and atmospheric neutrinos, and indirect dark-matter searches.

All the reactor experiments – Daya Bay, Double Chooz and Reno – have improved their results, providing precision measurements of the oscillation parameter  $\theta_{13}$  and of the reactor antineutrino spectrum. The Daya Bay experiment, integrating



R. Harvey/Wikimedia Commons

*Heidelberg was the setting for Neutrino 2018, the best attended edition in the series so far.*

1958 days of data taking, with more than four million antineutrino events on tape, is capable of measuring the reactor mixing angle and the effective mass splitting with a precision of 3.4% and 2.8%, respectively. The next-generation reactor experiment JUNO, aiming at taking data in 2021, was also presented.

The third day of the conference focused on neutrinoless double-beta decay (NDBD) experiments and neutrino telescopes. EXO, KamLAND-Zen, GERDA, Majorana Demonstrator, CUORE and SNO+ presented their latest NDBD search results, which probe whether neutrinos are Majorana particles, and their plans for the short-term future. The new GERDA results pushed their NDBD lifetime limit based on germanium detectors to  $0.9 \times 10^{26}$  years (90% CL), which represents the best real measurement towards a zero-background next-generation NDBD experiment. CUORE also updated its results based on tellurium to  $0.15 \times 10^{26}$  years.

Neutrino telescopes are of great interest

for multi-messenger studies of astrophysical objects at high energies. Both IceCube in Antarctica and ANTARES in the Mediterranean were discussed, together with their follow-up IceCube Gen2 and KM3NeT facilities. IceCube has already collected 7.5 years of data, selecting 103 events (60 of which have an energy of more than 60 TeV) and a best-fit power law of  $E^{-2.87}$ . IceCube does not provide any evidence for neutrino point sources and the measured  $\nu_e:\nu_\mu:\nu_\tau$  neutrino-flavour composition is 0.35:0.45:0.2. A recent development in neutrino physics has been the first observation of coherent elastic neutrino–nucleus scattering as discussed by the COHERENT experiment (CERN Courier October 2017 p8), which opens the possibility of searches for new physics.

A very welcome development at Neutrino 2018 was the presentation of preliminary results from the KATRIN collaboration about the tritium beta-decay end-point spectrum measurement, which allows a



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direct measurement of neutrino masses. The experiment has just been inaugurated at KIT in Germany and aims to start data taking in early 2019 with a sensitivity of about 0.24 eV after five years. The strategic importance of a laboratory measurement of neutrino masses cannot be overestimated.

A particularly lively session at this year's event was the one devoted to sterile-neutrino searches. Five short-baseline nuclear reactor experiments (DANSS, NEOS, STEREO, PROSPECT and SoLid) presented their latest results and plans regarding the so-called reactor antineutrino anomaly. These are experiments aimed at detecting the oscillation effects of sterile neutrinos at reactors free from any assumption about antineutrino fluxes. There was no reported evidence for sterile oscillations, with the exception of the DANSS experiment

reporting a  $2.8\sigma$  effect, which is not in good agreement with previous measurements of this anomaly. These experiments are only at the beginning of data taking and more refined results are expected in the near future, even though it is unlikely that any of them will be able to provide a final sterile-neutrino measurement with a sensitivity much greater than  $3\sigma$ .

Further discussion was raised by the results reported by MiniBooNE at Fermilab, which reports a  $4.8\sigma$  excess of electron-like events by combining their neutrino and antineutrino runs. The result is compatible with the  $3.8\sigma$  excess reported by the LSND experiment about 20 years ago in an experiment taking data in a neutrino beam created by pion decays at rest at Los Alamos. Concerns are raised by the fact that even sterile-neutrino oscillations do not

fit the data very well, while backgrounds potentially do (and the MicroBooNE experiment is taking data at Fermilab with the specific purpose of precisely measuring the MiniBooNE backgrounds). Furthermore, as discussed by Michele Maltoni in his talk about the global picture of sterile neutrinos, no sterile neutrino model can, at the same time, accommodate the presumed evidence of  $\nu_\mu \rightarrow \nu_e$  oscillations by MiniBooNE and the null results reported by several different experiments (among which is MiniBooNE itself) regarding  $\nu_\mu$  disappearance at the same  $\Delta m^2$ .

The lively sessions at Neutrino 2018, summarised in the final two beautiful talks by Francesco Vissani (theory) and Takaaki Kajita (experiment), reinforce the vitality of the null results at this time (see p5).

● Mauro Mezzetto, INFN University of Padova.

## LHCP reports from Bologna

Some 450 researchers from around the world headed to historic Bologna, Italy, on 4–9 June to attend the sixth Large Hadron Collider Physics (LHCP) conference. The many talks demonstrated the breadth of the LHC physics programme, as the collider's experiments dig deep into the high-energy 13 TeV dataset and look ahead to opportunities following the high-luminosity LHC upgrade.

Both ATLAS and CMS have now detected the Higgs boson's direct Yukawa coupling to the top quark, following earlier analyses, and the results are in agreement with the prediction from the Standard Model (SM). Further results on Higgs interactions included the determination by ATLAS of the boson's coupling to the tau lepton with high significance, which agrees well with the previous observation by CMS. Measuring the coupling between the Higgs and the other SM particles is a key element of the LHC physics programme, with bottom quarks now in the collaborations' sights.

The Bologna event also saw news on the spectroscopy front. CMS reported that it has resolved, for the first time, the  $J = 1$  and  $J = 2$  states of the  $X_{i_b}(3P)$  particle, using 13 TeV data corresponding to an integrated luminosity of  $80 \text{ fb}^{-1}$ . The measured mass difference between the two states,  $10.60 \pm 0.64 \text{ (stat)} \pm 0.17 \text{ (syst) MeV}$ , is consistent with most theoretical calculations (see p10). Meanwhile, the LHCb collaboration reported the measurement of the lifetime of the doubly charmed baryon  $\Xi_{cc}^{++}$  discovered by the collaboration last year, obtaining a value of  $0.256^{+0.024}_{-0.022} \text{ (stat)} \pm 0.014 \text{ (syst) ps}$ , which is within the



The LHCP participants in the San Domenico Centre.

predicted SM range (see p11).

The Cabibbo–Kobayashi–Maskawa (CKM) matrix, which quantifies the couplings between quarks of different flavours and possible charge-parity (CP) violation in the quark system, was another focus of the conference. LHCb presented a new measurement of the gamma angle, which is the least well measured of the three angles defining the CKM unitary triangle and is associated with the up–bottom quark matrix element. The collaboration obtained a value of  $74^\circ$  with an uncertainty of about  $5^\circ$ , making it the most precise measurement of gamma from a single experiment.

Nuclei–nuclei collisions also shone, with the ALICE collaboration showcasing measurements of the charged-particle multiplicity density, nuclear modification factor and anisotropic flow in Xe–Xe collisions at an energy of 5.44 TeV per

nucleon (see p12). These and other nuclei–nuclei measurements are providing a deeper insight into extreme states of matter such as the quark–gluon plasma.

Searches for physics beyond the SM by the LHC experiments so far continue to come up empty-handed, slicing into the allowed parameter space of many theoretical models such as those involving dark matter. However, as was also emphasised at this year's LHCP, there are many possible models and the range of parameters they span is large, requiring researchers to deploy “full ingenuity” in searching for new physics.

These are just a few of the many highlights of this year's LHCP, which also included updates on the experiments' planned upgrades for the high-luminosity LHC and perspectives on physics opportunities at future colliders.

● Ana Lopes, CERN.

# Heavy-flavour highlights from Beauty 2018

The international conference devoted to B physics at frontier machines, Beauty 2018, was held in La Biodola, Isola d'Elba, Italy, from 6–11 May, organised by INFN Pisa. The aims of the conference series are to review the latest results in heavy-flavour physics and discuss future directions. This year's edition, the 17th in the series, attracted around 80 scientists from all over the world. The programme comprised 58 invited talks, of which 13 were theory-based.

Heavy-flavour decays, in particular those of hadrons that contain b quarks, offer powerful probes of physics beyond the Standard Model (SM). In recent years, several puzzling anomalies have emerged from LHCb and b-factory data (*CERN Courier* April 2018 p23), and discussion of these set the scene for a very inspiring atmosphere at the conference. In particular, the ratio of branching fractions  $R_{D^{(*)}} = BR(B \rightarrow D^{(*)}\tau\nu)/BR(B \rightarrow D^{(*)}\ell\nu)$ , where  $\ell = \mu, e$ , provide a test of lepton universality and, intriguingly, now give combined experimental values which are about  $4\sigma$  away from the SM expectations. Furthermore, the ratios  $R_K = BR(B^+ \rightarrow K^*\mu^+\mu^-)/BR(B^+ \rightarrow K^*e^+e^-)$  and the corresponding measurement,  $R_{K^*}$ , yield results that are each around  $2.5\sigma$  away from unity. Other potential deviations from the SM are seen in the observable,  $P'_5$ , of the angular distribution of decay products in the rare decay  $B^0 \rightarrow K^*\mu^+\mu^-$ , and also measurements in related decay channels. Hence, the release of new LHCb results from LHC Run 2 is eagerly awaited later this year.

The rare decay  $B_s \rightarrow \mu^+\mu^-$ , already observed at the  $6\sigma$  level two years ago by a combined analysis of CMS and LHCb data, has now been observed by LHCb alone at a level greater than  $5\sigma$ , and is consistent with the SM. The effective lifetime of the decay offers additional tests of new physics, and a first measurement has now been made:  $2.04 \pm 0.44$  (stat)  $\pm 0.05$  (syst) ps – also consistent with the SM but with large uncertainties.

Theoretical overview talks put recent results such as those above in context.



The participants at Beauty 2018 in La Biodola.

Regarding the flavour anomalies, models involving leptoquarks and new  $Z'$  bosons are currently receiving much attention. Impressive progress has also been made in lattice-QCD calculations and in our understanding of hadronic form factors, which are crucial as inputs for theoretical predictions. Continued interplay between theory and experiment will be essential to understand the emerging data from the LHC and also from the Belle-II experiment in Japan, which has recently started taking data (*CERN Courier* June 2018 p7).

Concerning CP violation in the b sector, LHCb reported a new world-best determination of the angle  $\gamma$  of the unitarity triangle from a combination of measurements:  $74.0^{+5.0}_{-5.8}$  degrees, which differs from the prediction from other unitarity-triangle constraints by around  $2\sigma$ . Regarding CP violation in  $B_s^0 \rightarrow J/\psi \phi$  decays, which is predicted to be very small in the SM, the experimental knowledge from a combination of LHC experiments has now reached  $\phi_s = 21 \pm 31$  mrad, which is compatible with the SM.

Presentations were also devoted to hadron spectroscopy and exotic states, where there has been huge interest since the recent discovery of pentaquark-like states by LHCb (*CERN Courier* April 2017 p31). The udsb tetraquark candidate reported by the D0 experiment at Fermilab just over two years

ago has not been confirmed in LHC data and, significantly, neither by its sister experiment CDF. A plethora of other new results were reported at Beauty 2018, including from LHCb: a doubly-charmed baryon,  $\Xi_{cc}^{++}$ , and a  $\Xi_b^{*++}$  state, as well as a spectroscopy “gold mine” of X, Y and Z states from BES-III in China. Kaon physics was also discussed. With the completion of 2016 data analysis, the NA62 experiment at CERN has reached SM-sensitivity for the ultra-rare  $K^+ \rightarrow \pi^+\nu\bar{\nu}$  decay channel. A single candidate event was found with 0.15 background events expected, and a lower limit on the branching ratio of  $14 \times 10^{-10}$  at 95% confidence has been set.

The future experimental programme of flavour physics is full of promise. One of the highlights of the conference was a report on first data from Belle-II; further exciting options will emerge beyond 2021 when LHC Run 3 commences, with LHCb running at an increased luminosity of  $2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$  with an improved trigger, and high-luminosity upgrades to ATLAS and CMS to follow. The scientific programme of Beauty 2018 was complemented by a variety of social events, which, coupled with the stimulating presentations, made the conference a huge success at this exciting time for B physics.

● Robert Fleischer, Nikhef and Vrije Universiteit Amsterdam; Neville Hamewell and Guy Wilkinson, University of Oxford; and Giovanni Punzi, University and INFN Pisa.

## LETTER

### Chalk River operations

Your article “Tales from TRIUMF” (*CERN Courier* May 2018 p31), mentions, in paragraph 19, “...the shutdown of the

Chalk River reactor facility.”

The National Research Universal (NRU) reactor was indeed shutdown for the last time on 31 March this year. However, the NRU facility is but one of many facilities (nuclear and non-nuclear) at the Canadian Nuclear Laboratories Chalk River campus, which will continue

to operate without NRU. I'm afraid the wording in the article implies that Chalk River, which is a known reactor laboratory/site, is closing or ceasing research operations entirely. This is definitely not the case.

● Andrew Erlandson, Canadian Nuclear Laboratories.

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### MEETINGS

# Loops and legs in quantum field theory

The international conference Loops and Legs in Quantum Field Theory 2018 took place from 29 April to 4 May near Rheinfels Castle in St Goar, Rhine, Germany. The conference brought together more than 100 researchers from 18 countries to discuss the latest results in precision calculations for particle physics at colliders and associated mathematical, computer-algebraic and numerical calculation technologies. It was the 14th conference in the series, with 87 talks delivered.

Organised biennially by the theory group of DESY at Zeuthen, the locations for Loops and Legs are usually remote parts of the German countryside to provide a quiet atmosphere and room for intense scientific discussions. The first conference took place in 1992, just as the HERA collider started up, and the next event, close to the start of LEP2 in 1994, concentrated on precision physics at  $e^+e^-$  colliders. Since 1996, general precision calculations for physics at high-energy colliders form its focus.

This year, the topics covered new results on: the physics of jets; hadronic Higgs-boson and top-quark production; multi-gluon



The meeting poster.

amplitudes; multi-leg two-loop QCD corrections; electroweak corrections at hadron colliders; the Z resonance in  $e^+e^-$  scattering; soft resummation,  $e^+e^- \rightarrow t\bar{t}$ ; precision determinations of parton distribution functions; the heavy quark masses and the fundamental coupling constants;  $g-2$ ; and NNLO and  $N^3$ LO QCD corrections for various hard processes.

On the technologies side, analytic multi-summation methods, Mellin–Barnes techniques, the solution of large systems of ordinary differential equations and large-scale computer algebra methods were discussed, as well as unitarity methods, cut-methods in integrating Feynman integrals, and new developments in the field of elliptic integral solutions. These techniques finally allow analytic and numeric calculations of the scattering cross-sections for the key processes measured at the LHC.

All of these results are indispensable to make the LHC, in its high-luminosity phase,

a real success and to help hunt down signs of physics beyond the Standard Model (CERN Courier April 2017 p18). The calculations need to match the experimental precision in measuring the couplings and masses, in particular for the top-quark and the Higgs sector, and an even more precise understanding of the strong interactions.

Since the first event, when the most advanced results were single-scale two-loop corrections in QCD, the field has taken a breath-taking leap to inclusive five-loop results – like the  $\beta$  functions of the Standard Model, which control the running of the coupling constant to high precision – to mention only one example. In general, the various subfields of this discipline witness a significant advance every two years or so. Many promising young physicists and mathematicians participate and present results. The field became interdisciplinary very rapidly because of the technologies needed, and now attracts many scientists from computing and mathematics.

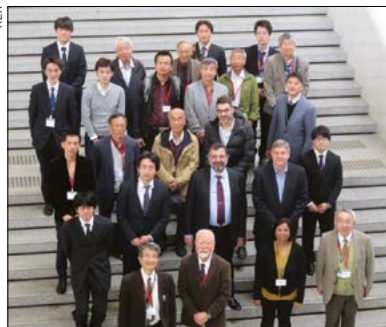
The theoretical problems, on the other hand, also trigger new research, for example in algebraic geometry, number theory and combinatorics. This will be the case even more with future projects, like an ILC, and planned machines such as the FCC, which needs even higher precision. The next conference will be held at the beginning of May 2020.

● Johannes Bluemlein, Peter Marquard and Tord Riemann, DESY.

## KEK hosts hadron-therapy symposium

The first International Symposium on the Next Generation of Hadron Therapy and its Drivers was held in Tsukuba, Japan, on 13–15 March. Around 40 participants from research institutes, universities and the private sector in Japan, Europe, India, Taiwan and Indonesia, attended. Leading companies in this field, such as Hitachi, Toshiba and Sumitomo Heavy Industries, presented details of their synchrotron- or cyclotron-based cancer-therapy systems, and introduced their own original irradiation methods, including spot-scanning techniques. The symposium was organised by the KEK Accelerator Laboratory and University of Tsukuba Proton Beam Therapy Center, and was sponsored by Tsukuba Innovation Arena.

To mention a few of the systems presented, the National Centre of Oncological Hadron Therapy in Pavia, Italy and the Gunma University Heavy-Ion Medical



Participants at the event in Japan.

Center in Maebashi, Japan, both reported progress achieved with their carbon-based therapy systems. Comparing these two therapy systems offers interesting insights. Meanwhile, the National Institute of Radiological Sciences in Chiba, Japan, described the long-anticipated compact superconducting gantry for its carbon-therapy system and its  $^{11}\text{C}$  ion source, which allows direct beam irradiation for PET imaging as well as cancer treatment.

The conference saw three systems presented to meet the demands of next-generation hadron-therapy systems, such as freedom in beam handling, different beam species and low cost. LIGHT, which was developed by the CERN spin-off ADAM, was also discussed. The first model of LIGHT, a linac-based hadron-therapy system that operates at 100 Hz with an energy sweep, is going to be installed at Harley Street, London. The present status of the Ion Rapid Cycling Medical Synchrotron (iRCMS), which was developed by a collaboration between BNL and Best Medical (Springfield, VA), was presented. The Energy Sweep Compact Rapid Cycling Therapy (ESCORT) proposed by a collaboration between KEK, SAMEER in India, and Nuclear Malaysia was also discussed.

These are just a few highlights of the event, which also saw presentations of therapy involving multi-beam irradiation and full-body PET cameras, which would be essential for monitoring tumour shape and position and dose image in real time.

● Ken Takayama, KEK.

## OBITUARIES

# Alberto Benvenuti 1940–2018

It was with great sadness that we learnt that Alberto Benvenuti, who was one of the main contributors to the construction of the CMS muon system, passed away in April.

Alberto graduated from the University of Florence, Italy, in 1964 and then moved to the US, where he did his PhD at the University of Minnesota. It was there that he met and married his lifelong companion, Rita. In 1969, he moved to the University of Wisconsin and joined the E1A experiment at Fermilab to measure high-energy neutrino–antineutrino interactions. Key results from the experiment were the first evidence for weak neutral currents and the observation of final states with multiple muons.

In 1978, Alberto moved to CERN and joined the NA4 experiment at the Super Proton Synchrotron (SPS) as a research staff member. At CERN, his principle contributions were: the measurement of the F2 structure function of the proton and its evolution – a key result still used in many global fits today; finding evidence for interference between photons and Z bosons in  $\mu^+$  and  $\mu^-$  deep-inelastic interactions; and the study of nuclear effects in different target materials.

After three years as a CERN staff member, he became a researcher at INFN Bologna, but also continued his work at CERN. In 1985 he joined the SLD collaboration at SLAC National Accelerator Laboratory in the US and worked on the



*Alberto Benvenuti was a key figure in the construction of the CMS muon system.*

construction, commissioning and operation of the SLD muon detector.

Returning to CERN in 1991, Alberto joined the DELPHI collaboration at the LEP collider, contributing to the design and construction of DELPHI's second-generation luminosity monitor and to Bhabha-scattering studies. He joined the CMS collaboration at the LHC in 1992, and became one of the key figures in the development of the drift-tube chambers

for the CMS detector. He guided the production of the 250 chambers in Russia and Bologna, coordinated their testing at CERN before installation, and led their installation and commissioning. The chambers were one of the main components of the CMS detector, playing a key role in the discovery of the Higgs boson. After his retirement in 2015 to Minneapolis, Alberto continued to participate actively in the life of CMS, advising students at the University of Minnesota and serving as co-chair of the annual detector review of CMS's replacement calorimeter for the high-luminosity LHC upgrade.

All through his career, in both analysis and hardware, Alberto made experiments work often with innovative solutions. He was admired by his colleagues for his sense of purpose, his honesty and his humour. He was a great example to those who worked with him, passing on skills learnt over a long career to the next generation of young physicists. He was always striving for excellence and had little tolerance for mistakes. He would say "do it with passion or don't do it at all..." Upon news of his passing, there was an outpouring of memories and thoughts of gratitude from many of his colleagues, from CMS and from around the world. He leaves behind his wife Rita and a little bit of himself in each one of us.

● *His friends and colleagues.*

# Ishfaq Ahmad 1930–2018

The architect of Pakistan–CERN collaboration and former chairman of the Pakistan Atomic Energy Commission (PAEC), Ishfaq Ahmad, passed away on 15 January in Islamabad aged 87. He remained associated with PAEC for more than 40 years. After joining the organisation in 1960 on completion of his PhD at the University of Montreal in Canada, and post-doc positions at University of Ottawa and Sorbonne (Université de Paris), he played a crucial role in the development of civil and military nuclear technology in Pakistan.

Ishfaq's doctoral work was based on the use of fine-grained nuclear emulsions, pioneered by his thesis supervisor, Pierre



*Ishfaq Ahmad brought Pakistan and CERN together.*

Demers. He also worked at the Niels Bohr Institute in Copenhagen between 1961 and 1962, where he had opportunities to interact with Bohr himself. It was during his stay there that his experimental work on nuclear reactions brought him to CERN, where nuclear emulsions were exposed for subsequent analyses at different laboratories. Years later, he recalled that his fascination with CERN and the work being done there never faded, resulting in the establishment of close ties between CERN and PAEC.

The first formal scientific and technical agreement between CERN

## Faces & Places

and Pakistan, which formed the basis of future Pakistan–CERN cooperation, was signed on 11 January 1994 by Ishfaq on behalf of Pakistan and the then CERN Director-General Chris Llewellyn-Smith, on behalf of CERN. Thereafter, a series of protocols, addendums and extensions of protocols, MoUs and Letters-of-Intent were signed by CERN DGs and PAEC chairmen,

many concerning specific projects related to the construction of the Large Hadron Collider and components of the CMS and ATLAS detectors. The most conspicuous of these projects was the supply of eight steel supports for the CMS yoke, which were fabricated in PAEC laboratories in Islamabad. Concurrently, the participation of the National Centre for Physics (NCP) in

the CMS collaboration resulted in scientific exchanges and data simulations. A node for grid computing was also established at NCP. Another institution in Pakistan that joined the CERN collaboration was the COMSATS Institute of Information Technology, which was granted membership of the ALICE collaboration. Eventually, Pakistan gained Associate Membership of CERN on 31 July 2015.

While overseeing the increasingly deeper ties between Pakistan and CERN, Ishfaq remained actively engaged with other international fora, such as the International Atomic Energy Agency (IAEA), the International Centre for Theoretical Physics (ICTP) and the International Institute for Applied Systems Analysis (IIASA). As member of the board of governors of IAEA, he was able to convince the then director-general of IAEA, Hans Blix, to establish an advisory group that strengthened the agency's role as a facilitator of civilian nuclear technology through improved technical cooperation programmes, especially for developing countries.

His avid support for ICTP was also based on his strong belief in science as a vehicle of peace and development. It is not surprising that he was the one who wrote to the then UN secretary-general Ban Ki Moon to launch World Science Day for Peace and Development, which was duly approved by the Security Council and has been organised internationally by UNESCO since 2001. He regularly participated in PUGWASH meetings following the 1974 Indian nuclear tests and strongly advocated for a nuclear-free South Asia. He was a strong supporter of nuclear power as a significant component of the energy mix in Pakistan, but kept open mind about alternative energy sources. He lobbied and successfully achieved Pakistan's membership of IIASA, and remained on its board from 2007 to 2012. His broader vision of national economic interests led to the creation of institutions such as the Global Climate Change Impact Study Centre and the Centre for Earthquake Studies in Pakistan.

In 1998 the government of Pakistan bestowed upon Ishfaq the highest civil award, "Nishan-i-Imtiaz", besides several other honours and awards in preceding years, and entrusted him with prestigious positions such as advisor to the prime minister of Pakistan and other senior roles. He held government posts until 2012, when he decided to restrict his activities to the work of NCP as the chairman of its board of governors. He was buried with state honours in Islamabad on 16 January.

● Imtihan Qureshi, Islamabad.

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