Vienna hosts a high-energy particle waltz

The first major summer conference in particle physics, EPS-HEP 2015 in Vienna offered participants the opportunity to hear all of the latest news in the field first hand.

The first results at a new high-energy frontier in particle physics were a major highlight for the 2015 edition of the European Physical Society Conference on High Energy Physics (EPS-HEP). The biennial conference took place at the University of Vienna on 22–29 July, only weeks after data taking at the LHC at CERN had started at the record centre-of-mass energy of 13 TeV. In addition to the hot news from the LHC, the 722 participants from all over the world were also able to share a variety of exciting news in different areas of particle and astroparticle physics, presented in 425 parallel talks, 194 posters and 41 plenary talks. The following report focuses on a few selected highlights, including the education and outreach session – a “first” for EPS-HEP conferences (see box p34).

After more than two years of intense work during the first long shutdown, the LHC and the experiments have begun running again, ready to venture into unexplored territories and perhaps observe physics beyond the Standard Model, following the discovery of the Higgs boson in 2012. Both the accelerator teams and the LHC experimental collaborations made a huge effort to provide collisions and to gather physics data in time for EPS-HEP 2015. By mid-July, the experiments had already recorded 100 times more data than they had at around the same time after the LHC had started up at 7 TeV in 2010, and the collaborations had worked hard to be able to bring the first results using 2015 data.

Talks at the conference provided detailed information about the operation of the accelerator and expectations for the near and distant future. The ATLAS, CMS and LHCb collaborations all presented results at 13 TeV for the first time (CERN Courier September 2015 pp8–11). Measurements of the charged-particle production rate as a function of rapidity provide a first possibility to test hadronic physics models in the new energy region. Several known resonances, such as the J/ψ, the Z and W bosons, have been rediscovered at these higher energies, and the cross-section for top–antitop production has been measured and found to be consistent with the predictions of the Standard Model. The first searches for new phenomena have also been performed, but unfortunately with no sign of unexpected behaviour. In all, the early results presented at the conference were very encouraging and everyone is looking forward to more data being delivered and analysed.

At the same time, the LHC collaborations have continued to extract interesting new physics from the collider’s first long run. According to the confinement paradigm of quantum chromodynamics, the gauge theory of strong interactions, only bound states of quarks and gluons that transform trivially under the local symmetries of this description are allowed to exist in nature. It forbids free quarks and gluons, but allows bound states composed of two, three, four, five, etc, quarks and antiquarks, and provides no reason why such states cannot exist. While quark–antiquark and three-quark bound states have been known since the first formulation of the basic theory some 40 years ago, it is only a year or so since unambiguous evidence for tetraquark states was first presented. Now, at EPS-HEP 2015, the LHCb collaboration reported on the observation of exotic resonances in the decay products of the A₀, which could be interpreted as charmonium–pentaquarks. The best fit of the findings requires two pentaquark states with spin-parity Jₚ = 3/2 and Jₚ = 5/2, although other assignments and even a fit in terms of merely one pentaquark are also possible (CERN Courier September 2015 p5).

The study of semileptonic decays of B mesons with τ leptons in the final state offers the possibility of revealing hints of “new
All about communication

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Each morning the participants were welcomed with a small newsletter containing information for the day. During the first part of the conference with only parallel sessions, the newsletter summarized the topics of all of the sessions, highlighting expected new results. The idea was to give the participants a glimpse of the topics being discussed at the parallel sessions they could not attend. For the second part of the conference with plenary presentations only, the daily newsletter also contained interviews that looked behind the scenes. The conference was accompanied online in social media, with tweets, Facebook entries and blogs highlighting selected scientific topics and social events. The tweets, in particular, attracted a large audience of people who were not able to attend the conference.

During the first week, a dedicated parallel session on education and outreach took place – the first ever at an EPS-HEP conference. The number of abstracts submitted for the session was remarkable, clearly indicating the need for exchange and discussions on this topic. The convenors chose a slightly different format from the standard parallel sessions, so that besides oral presentations on specific topics, a lively panel discussion with various contributions from the audience who took place. The session concluded with a “Science Slam” – a format in which scientists give short talks explaining the focus of their research in lively terms for the public. Extending the scope of the EPS-HEP conference towards topics concerned with education and outreach was clearly an important strength of this year’s edition.

In addition, a rich outreach programme formed an important part of the conference in Vienna, from the start, everyone involved in planning had a strong desire to take the scientific questions of the conference outside of the particle-physics community. One highlight of the programme was the public screening of the movie “Particle Fever” followed by a discussion with Fabiola Gianotti, who will be the next director-general of CERN, and the producer of the movie, David Kaplan. Visual arts have become another important way to bring the general public in touch with particle physics, and several exhibitions, reflecting different aspects of particle physics from an artistic point of view, took place during the conference.

Physics’ sensitive to non-Standard Model particles that preferentially couple to third-generation fermions. The BaBar experiment at SLAC, the Belle experiment at KEK and the LHCb experiment at CERN have all observed an excess of events for the B-meson decays $B \to D^+ + \tau^+\nu$, and $B \to D^+ + \tau^+\nu$. Averaging over the results of the three experiments, the discrepancy compared with Standard Model expectations amounts to some 3.9σ.

Nonzero neutrino masses and associated phenomena such as neutrino oscillations belong to what is currently the least well-understood sector of the Standard Model. The Tokai to Kamioka (T2K) experiment, using a $\nu_\tau$ beam generated at the Japan Proton Accelerator Complex situated approximately 300 km east of the Super-Kamiokande detector, was the first to observe $\nu_\tau$ oscillations. It has also made a precise measurement of the angle $\theta_{13}$, in the Pontecorvo–Maki–Nakagawa–Sakata neutrino-mixing matrix, the leptonic counterpart of the Cabibbo–Kobayashi–Maskawa (CKM) quark-mixing matrix. However, as this value is practically independent of the relative magnitudes of the neutrino masses, it does not enable the different scenarios for the neutrino-mass hierarchy to be distinguished. A comparison of neutrino oscillations with those of antineutrons might provide clues to the still unsolved puzzle of charge-parity violation. In this context, T2K presented an update of their earlier results on $\nu_\tau$ disappearance results and three candidates for the appearance of $\bar{\nu}_\tau$.

At the flavour frontier, the LHCb collaboration reported a new exclusive measurement of the magnitude of the CKM matrix element $V_{ub}$, while Belle revisited the CKM magnitude $V_{cb}$. In the case of $V_{ub}$, based on $A_{b\to D}$ decays, there remains a tension between the values distilled from exclusive and inclusive decay channels that is still not understood. For $V_{cb}$, Belle presented an updated exclusive measurement that is, for the first time, completely consistent with the inclusive measurement of the same parameter.

Weak gravitational lensing provides a means to estimate the distribution of dark matter in the universe. By looking at more than a million source galaxies at a mean co-moving distance of 2.9 Gpc (about nine thousand million light-years), the Dark Energy Survey collaboration has produced an impressive map of both luminous and dark matter, exhibiting potential candidates for superclusters and (super)voids. The mass distribution deduced from this map correlates nicely with the “known”, that is, optically detected, galaxy clusters in the foreground.

More than a year ago, the BICEP2 collaboration caused some disturbance in the scientific community by claiming to have observed the imprint of primordial gravitational waves, generated during inflation, in the B-mode polarization spectrum of the cosmic-microwave background. Since then, the Planck collaboration has collected strong evidence that, upon subtraction of the impact of foreground dust, the BICEP2 data can be explained by a “boring ordinary” cosmic-microwave background (CERN Courier November 2014 p15).

Following the parallel sessions that formed the first part of the conference, Saturday afternoon was devoted to the traditional special joint session with the European Committee for Future Accelerators (ECFA). The programme of the joint session for this year was “Connecting Scales: Bridging the Infinites”, with an emphasis on particle-physics topics that influence the evolution of the universe. This joint EPS-HEP/ECFA session, which was well attended, gave the audience a unique occasion to profit from broad overviews in various fields.

Prizes and more

As is traditional, the award of the latest prizes of the EPS High Energy and Particle Physics Division started the second half of the conference, which is devoted to the plenary sessions. The 2015 High Energy and Particle Physics Prize was awarded to Janne Bjorken “for his prediction of scaling behaviour in the structure of the proton that led to a new understanding of the strong interaction”, and to Guido Altarelli, Yuri Dokshitzer, Lev Lipatov, and Giorgio Parisi “for developing a probabilistic field theory framework for the dynamics of quarks and gluons, enabling a quantitative understanding of high-energy collisions involving hadrons”. The 2015 Giuseppe and Vanna Cocconi Prize was awarded to Francis Halzen “for his visionary and leading role in the detection of very-high-energy extraterrestrial neutrinos, opening new observational windows on the universe”.

The Gribkov Medal, Young Experimental Physicist Prize, and Outreach Prize for 2015 were also presented to their recipients, respectively, Pedro Vieira, Jan Fiete Grosse-Oetringhaus and Giovanni Petrucciani, and Kate Shaw (CERN Courier June 2015 p77).

An integral part of every conference is the social programme, which offers the local organizers the opportunity to present impressions of the city and the country where the conference is being held. Vienna is well known for classical music, and on this occasion the orchestra of the Vienna University of Technology performed Beethoven’s 7th symphony at the location where it was first performed – the Festival Hall of the Austrian Academy of Sciences. The participants were also invited by the mayor of the city of Vienna to “Heurigen” – an Austrian wine tavern where recent year’s wines are served, combined with local food. A play called Curie_Meister_Lamarnd_indivisible presented three outstanding women pioneers of science and technology, all of whom had a connection to Vienna. A dinner in the orangery of the Schönbrunn Palace, the former imperial summer residence, provided a fitting conclusion to the social programme of this important conference for particle physics.

EPS-HEP 2015 was jointly organized by the High Energy and Particle Physics Division of the European Physical Society, the Institute of High Energy Physics of the Austrian Academy of Sciences, the University of Vienna, the Vienna University of Technology, and the Stefan-Meyer Institute of the Austrian Academy of Sciences. For more details and the full programme, visit http://eps-hep2015.eu/.
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This parallel session in the university’s large festival hall.

A poster session in the arcades.

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Résumé

Valeur de particules à Vienne


Reiner Kruecken named TRIUMF deputy director

Reiner Kruecken, TRIUMF Science Division head since February 2011, has recently been named deputy director of the laboratory, effective from 1 August 2015. In his new role, Kruecken will support TRIUMF director Jonathan Bagger to develop and manage the laboratory’s long-term vision, as well as manage cross-divisional aspects of the ongoing scientific programme, as set out in the most recent five-year plan.

Kruecken has brought to TRIUMF worldwide expertise in nuclear physics, with a deep familiarity with rare-isotope beam facilities in the US, Europe and Asia. His research interests include nuclear structure, reactions and astrophysics; hadron properties in hot, dense nuclear matter, detector developments; biological and medical applications of nuclear methods; particle-induced light emission in dense gases and liquids; and the transmutation of nuclear waste. He earned his PhD in nuclear physics from the University of Cologne, and worked at the Lawrence Berkeley National Laboratory and at the Wright Nuclear Structure Laboratory at Yale, before moving to Technische Universität München in 2002, where he led a large group of researchers as part of the federal cluster of excellence on “Origins and structure of the universe”.

The search has begun to fill the (renamed) position of TRIUMF associate lab director of physical sciences.

Outreach
Accelerator showcase inspires the young

The international Symposium on Lasers and Accelerators for Science and Society, attracting a capacity audience at the Liverpool Arena Convention Centre, took place on 26 June. The event was a sell-out, with delegates comprising 100 researchers from across Europe and 180 local A-level students and teachers. The aim was to inspire young people about science, and the application of lasers and accelerators in particular. “Discovering the unknown”, “innovation”, “beating cancer”, “pioneering new technology” and “a possible career” – these were comments from some of the students.

The symposium included talks from experts in the field such as Victor Malka of the Laboratoire d’Optique Appliquée, Ralph Altmann of DESY and Brian Cox of the University of Manchester, best known for his television programmes about the origins of the universe. Graham Blair, executive director, programmes, at the UK’s Science and Technology Facilities Council, explained the range of science in which accelerators now have a key role. In addition, to research at the high-energy frontier of CERN’s LHC, accelerator science has applications across all sectors of industry and healthcare from, for example, measuring strain in jet engines to the accurate targeting of cancerous tumours.

The event also showcased a portfolio of projects by researchers at the forefront of this exciting field of science and engineering, through an interactive poster session with questions and answers. This gave young people the opportunity to see how scientists only a few years older are pushing back the boundaries of knowledge.

The event was organized by Carsten Welsch, head of the Liverpool Accelerator Physics Group at the Cockcroft Institute in Daresbury, who leads two pan-European training networks that aim to address the skills shortage in accelerator science – oPAC (Optimization of Particle Accelerators) and LA’NET (Lasers for Applications at Accelerators). Research fellows in these networks become experts in their discipline and also develop skills in physics, engineering, information technology, data analysis and project management. The involvement of partners from industry and academia and the opportunity to work at research institutions across Europe has provided training that would have been impossible by one company or one country alone.

Share the enthusiasm through the online presentations available at http://www.liv.ac.uk/quasar/events/outreach_events/symposium/