

## Editorial

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The 15th International Conference on B-Physics at Frontier Machines (Beauty 2014) was held from 14<sup>th</sup> to 18<sup>th</sup> July 2014 at the University of Edinburgh, United Kingdom. Beauty 2014 was hosted in the magnificent Playfair Library in the historic centre of the city, which provided a spectacular setting for the scientific presentations. The conference attracted approximately ninety physicists, including many well known experts on flavour physics from all over the world. The programme consisted of 61 invited talks in 13 topical sessions. The majority of the presentations were on the discussion of experimental results. These were complemented by a series of theory review talks. In addition, seven early career researchers (PhD students and post docs) presented posters in a dedicated session.

*The 15th International Conference on B-Physics at Frontier Machines (Beauty2014),  
14 -18 July, 2014,  
University of Edinburgh, UK.*

The 15th International Conference on B-Physics at Frontier Machines (Beauty 2014) reviewed the field of heavy flavour physics and addresses the physics potential of existing and future B-physics experiments. Research in heavy quark flavours aims to explore the Standard Model (SM) at the high-precision frontier, with the goal to reveal footprints of “New Physics” originating from physics beyond the SM in observables that can be reliably predicted.

The key topics in the field of flavour physics are strongly suppressed rare decays and decay-rate asymmetries probing  $CP$  violation. The non-invariance of weak interactions under combined charge-conjugation ( $C$ ) and parity ( $P$ ) transformations, was discovered 50 years ago. The Cabibbo-Kobayashi-Maskawa (CKM) mechanism, postulated 40 years ago, allows for  $CP$  violation to arise in the SM, and large  $CP$  violating asymmetries are observed in decays of  $B$  mesons. In the case of the neutral  $B_d^0$  and  $B_s^0$  mesons, quantum-mechanical particle–antiparticle oscillations give rise to interference effects, which can induce manifestations of  $CP$  violation. Flavour-changing neutral currents, which mediate transitions of same charge quarks such as  $b \rightarrow s$  and  $b \rightarrow d$ , are forbidden at the tree level in the SM and are thus sensitive to new particles that may manifest themselves indirectly through their contributions to loop processes. These features are at the basis of the search for new physics at the high-precision frontier. The exploration of  $B$  physics is currently dominated by the dedicated LHCb experiment as well as the ATLAS and CMS experiment at the Large Hadron Collider. After the completion of the upgrade of the KEKB  $e^+e^-$  collider and of the Belle detector in Japan in the coming years, the Belle-II experiment will re-join the  $B$ -physics programme.

At Beauty 2014, many new analyses and results were presented. Highlights included a measurement of  $CP$  violation in the decay  $B_s^0 \rightarrow \phi\phi$  and new results on the determination of the angle  $\gamma$  of the unitarity triangle using  $B \rightarrow DK$  and  $B_s^0 \rightarrow D_s^\pm K^\mp$  as well as  $B_s^0 \rightarrow K^+K^-$ ,  $B_d^0 \rightarrow \pi^+\pi^-$  decays. The decays to charmed mesons ( $D$  and  $D_s$ ) are mediated only by SM-like “tree” topologies whereas the two body decays to  $\pi$  and  $K$  mesons also receive “penguin” contributions where new particles may enter in the loops, The results for  $\gamma$  are consistent amongst one another within the uncertainties and the information on the unitarity triangle coming from global fits of various observables. The error on direct  $\gamma$  measurements is now approximately 9 degrees, with significant contributions from the latest LHCb results. LHCb will continue to improve this precision. Impressive new measurements of the weak phase  $\phi_s$  and decay-width difference  $\Delta\Gamma_s$  were presented by CMS and LHCb in  $B_s^0 \rightarrow J\psi\phi$  and  $B_s^0 \rightarrow J\psi\pi\pi$  decays. The latter is the single most precise  $\phi_s$  result with an uncertainty of 68 mrad, and the results are in agreement with SM predictions.

In the field of rare  $B$  meson decays, impressive theoretical progress for  $B_s^0 \rightarrow \mu^+\mu^-$  decays was reported. This is one of the rarest decays that has ever been observed and therefore it is a very sensitive probe of New Physics. The experimental evidence for this decay was reported by the CMS and LHCb collaborations in the summer of 2013 and is one of the highlights of run-I of the LHC. Theoretical improvements relate to the calculation of higher-order electroweak and QCD corrections, which resulted in a higher precision on the predicted theoretical SM branching ratio for this channel.

Measurements of the angular distribution of the rare  $B_d^0 \rightarrow K^{*0}\mu^+\mu^-$  decay and the comparison with respect to calculations within the SM was another hot topic. A discrepancy is observed in a single bin in the distribution of the so-called  $P_5'$  observable. The key question is whether strong-interaction processes or New Physics effects are causing this discrepancy. The possibilities led to

interesting discussions during the session. More data on this decay and related channels are eagerly awaited from run-II at the LHC.

In the ratio of the rates of  $B^+ \rightarrow K^+ \mu^+ \mu^-$  and  $B^+ \rightarrow K^+ e^+ e^-$  decays, which test lepton flavour universality, a new  $2.6 \sigma$  deviation from the SM was reported by LHCb, which has to be explored in more detail in the future. Moreover, first results on measurements of the photon polarisation in  $b \rightarrow s \gamma$  by the  $B$  factories and LHCb were presented, which can be studied in a more powerful way at Belle-II and the LHCb upgrade.

Many other interesting measurements and developments were discussed at the conference. One was the first observation of a heavy flavored spin-3 particle, the  $D_s^*(2860)^-$  meson, observed by LHCb in the decay of a  $B_s^0$  meson, another the confirmation of an exotic resonance  $Z(4430)$  composed of four quarks was also presented by LHCb at the conference. Furthermore, many more results on heavy-flavour production and spectroscopy at the  $B$ -factories, the Tevatron and at the ALICE, ATLAS, CMS and LHCb experiments were presented. On the theory frontier, an excellent review of  $B$  hadron and Bottomonia spectroscopy was presented and impressive progress concerning the calculation of non-perturbative parameters with lattice QCD was reported, which has already an important impact on various analyses. Other topics were the status of lepton flavour violation and models of physics beyond the SM, searches for exotic New Physics such as Majorana neutrinos, charm physics and rare kaon decays.

The opening talk of the conference was given by John Ellis (King's College London and CERN), discussing his perspective and vision for the search of New Physics – in particular supersymmetry – at the LHC and beyond. A whole session was devoted to the prospects of the future  $B$ -physics programme, addressing the upgrades of LHCb, ATLAS, CMS and Belle-II. The conference was concluded by an exciting summary and outlook talk by Hassan Jawahery (University of Maryland).

Beauty 2014 also had an impressive social programme. No visit to Scotland would have been complete without whisky tasting, and participants were treated to the option of 25 different samples! A walking tour of the historic Edinburgh castle was complemented by a bus tour and a boat ride under the famous Forth Bridge. The conference dinner was held at the Dynamic Earth museum, where the quality of the food was particularly appreciated, including a filling of haggis. The conference also had its own twitter feed at <https://twitter.com/hashtag/beauty2014>.

In conclusion, the 15<sup>th</sup> Beauty conference was host to exciting new results and was a great success. The detailed programme, including the presenters' slides, is available at the conference web site <http://www.ph.ed.ac.uk/beauty2014>.

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Beauty 2014 Editors



**Figure 1:** Beauty 2014 participants next to the Playfair Library in Edinburgh [Image credit: Greig Cowan]





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**Figure 2:** Coffee break discussions in Playfair library [Image credit: Stephan Eisenhardt]