

## Editorial

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Editorial of the 14th International Conference on B-Physics at Hadron Machines - Beauty2013

*The 14th International Conference on B-Physics at Hadron Machines - Beauty2013,  
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This edition of the Proceedings of Science contains papers presented at the 14<sup>th</sup> International Conference on  $B$ -Physics at Hadron Machines (Beauty 2013), held on 8–12 April 2013 in Bologna, Italy. It was hosted by the Istituto Nazionale di Fisica Nucleare (INFN) and by the local Physics Department, in the prestigious “Giorgio Prodi” lecture hall, the heart of a magnificent complex in the downtown of the city. A place of extraordinary beauty and historical art, against the backdrop of a beautiful sixteenth-century fresco painting by Bartolomeo Cesi, the lecture hall was once the dining hall of the nunnery of the Lateran Canons. About one hundred physicists took part in the meeting, from all over the world. There were sixty invited talks in twelve topical sessions, and eleven posters.

The purpose of the Beauty conference series is to review results in the field of heavy flavour physics, and to address the physics potential of existing and upcoming  $B$ -physics experiments. The major goal of this line of research at the high-precision frontier is to perform stringent tests of the flavour structure of the Standard Model and new physics beyond, where strongly suppressed “rare decays” and the phenomenon of  $CP$  violation, i.e. the non-invariance of weak interactions under combined charge-conjugation ( $C$ ) and parity ( $P$ ) transformations, play the central roles. New particles may manifest themselves in the corresponding observables through new contributions to loop processes such as flavour-changing neutral currents which are forbidden at the tree level in the Standard Model. These studies are complementary to research at the high-energy frontier conducted by the ATLAS and CMS experiments, which aim at producing and detecting new particles directly.

During the previous decade the  $e^+e^-$   $B$  factories had been the main pioneers in the field of  $B$  physics, complemented by the Tevatron experiments which made giant leaps in the exploration of  $B_s^0$  decays. Exploiting the highly successful LHC operation, the experimental field of quark-flavour physics is now advanced by the purpose-built LHCb experiment and the LHC general-purpose detectors. In the coming years, a new  $e^+e^-$  machine will join the  $B$ -physics programme, following the upgrade of the KEKB collider and of the Belle detector. Hence this field of research will continue to be very active and lively for many years, with the exciting perspective of reaching ultimate precision in various key measurements.

A variety of impressive new results was reported at Beauty 2013.  $CP$  violation was established by LHCb with a significance exceeding five standard deviations in the  $B_s^0$ -meson system through the  $B_s^0 \rightarrow K^- \pi^+$  channel. The ATLAS collaboration reported their first flavour-tagged study of  $B_s^0 \rightarrow J/\psi \phi$  decays and the corresponding result for the the  $B_s^0-\bar{B}_s^0$  mixing phase  $\phi_s$ , which is in agreement with previous LHCb analyses. LHCb presented the first combination of several measurements of the angle  $\gamma$  of the unitarity triangle from pure tree-level decays. In the field of charm physics, a new LHCb analysis of the difference of the  $CP$  asymmetries in the  $D^0 \rightarrow \pi^+ \pi^-$  and  $D^0 \rightarrow K^+ K^-$  channels was presented, which does not support previous measurements pointing towards a surprisingly large asymmetry. Moreover, CDF reported the observation of  $D^0-\bar{D}^0$  mixing, confirming the previous LHCb measurement. Concerning the exploration of rare decays, LHCb presented the first angular analysis of  $B_s^0 \rightarrow \phi \mu^+ \mu^-$ .

In addition to this selection of highlights, one of the most prominent rare  $B$  decays – the  $B_s^0 \rightarrow \mu^+ \mu^-$  channel – was the focus of various discussions and presentations. In the Standard Model, this decay originates from quantum-loop effects and is strongly suppressed. Recently, LHCb has been able to observe for the first time evidence of  $B_s^0 \rightarrow \mu^+ \mu^-$  at the  $3.5\sigma$  level. The

reported (time-integrated) branching ratio  $(3.2_{-1.2}^{+1.5}) \times 10^{-9}$  agrees with the Standard Model prediction. Although the current experimental error is still very large, this measurement places important constraints on physics beyond the Standard Model; it will be very interesting to monitor the future experimental progress. With recently proposed new observables complementing the branching ratio, the measurement of this decay with increased precision will continue to be vital in the era of the LHC upgrade. In the exploration of  $B_s^0 \rightarrow \mu^+ \mu^-$ , ATLAS and CMS can also give significant contributions. Important information will also come from stronger experimental constraints on  $B^0 \rightarrow \mu^+ \mu^-$ , which has a Standard Model branching ratio about 30 times smaller than that for  $B_s^0 \rightarrow \mu^+ \mu^-$ ; the current experimental upper bound is about one magnitude above the Standard Model expectation. Assuming no suppression through New Physics,  $B^0 \rightarrow \mu^+ \mu^-$  should be observable at the LHC upgrade.

In addition to searching for new physics in the so-called “golden channels”, many other interesting measurements and progresses in theory were discussed at the conference. Results on heavy-flavour production and spectroscopy at the  $B$ -factories, the Tevatron and at the ALICE, ATLAS, CMS and LHCb experiments were presented. Despite the primary focus of the conference being  $B$ -physics, two sessions were entirely devoted to  $CP$  violation in top, charm and kaon physics. The status of lepton flavour violation and models of physics beyond the Standard Model were also presented. Moreover, the status and prospects for future  $B$ -physics experiments, SuperKEKB/Belle II and the LHCb upgrade, were discussed. Each session also featured a theoretical review talk. An exciting summary talk concluding the conference was given by Guy Wilkinson (Oxford).

The charming environment of the historical downtown, dating back to the Middle Ages, inspired informal physics discussions during tours through the most beautiful squares and churches of the city. A visit to the Bologna Museum of History was also included in the programme, followed by the conference dinner, with some jazz music to liven up the evening. The quality of the food was particularly appreciated by the participants, which lived up to the reputation of the traditional Bolognese cuisine.

The 14th Beauty conference has marked for the first time the dominance of the LHC experiments in the heavy-flavour sector. We are now entering a high-precision phase for  $B$ -physics, with LHC and SuperKEKB promising to enrich the field with many new measurements throughout this decade. The forthcoming increase of the LHC beam energy will double the production rate of  $b\bar{b}$  quark pairs, and this will play an important role in the exciting quest for physics beyond the Standard Model. We look forward to these new results and the next (15<sup>th</sup>) International Conference on  $B$ -Physics at Hadron Machines.

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