

Editorial: Beauty 2023 at Clermont-Ferrand, France

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The 20th International Conference on B-Physics at Frontier Machines, Beauty 2023, was held in Clermont-Ferrand, France, from the 3rd to the 7th July 2023, and hosted by the Laboratoire de Physique de Clermont (IN2P3/CNRS, Université Clermont Auvergne). Presentations at the conference detailed recent experimental achievements in *b*-physics and related fields, theoretical interpretation, and prospects for the coming years.

*20th International Conference on B-Physics at Frontier Machines (Beauty2023)
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Clermont-Ferrand was a highly appropriate venue for the 20th edition of Beauty, the International Conference on B -Physics at Frontier Machines. The University hosts a leading group in French and worldwide flavour physics, with a heritage that dates back to the days of the ALEPH experiment at LEP. At the LHC, Clermont-Ferrand is active not only in LHCb, but also in ATLAS and ALICE, and is prominent in advocating for flavour studies at future colliders such as the FCC. This experimental work is matched by phenomenological interpretation of flavour-physics measurements within the CKMfitter collaboration, and significant contributions to flavour theory in general.

Beauty 23 was the first in-person conference since the covid-19 pandemic, and attracted 75 participants from all over the world. The programme had 53 invited talks of which 13 were theoretical overviews, which put the experimental results in context and suggested future directions for exploration. An important element was also the Young Scientist Forum with 7 short presentations on recent results.

The key focus of the conference series is to review the latest results in heavy-flavour physics and discuss future directions. Heavy-flavour decays, in particular those of hadrons that contain b quarks, offer powerful probes of physics beyond the Standard Model (SM). Beauty 2023 took place 30 years after the opening meeting in the conference series. A dedicated session was devoted to reflecting on the developments in flavour physics over this period, and also celebrating the life of Sheldon Stone, who passed away in October 2021. Sheldon was both an inspirational figure in flavour physics as a whole, a driving force behind the CLEO, BTeV and LHCb experiments, and a long-term supporter of the Beauty conference series.

Many important results have emerged from the LHC since the last Beauty conference. The CP -violating parameter $\sin 2\beta$ holds great importance in flavour physics, as it was a measurement of this by the BaBar and Belle experiments at the start of the millennium that marked the dawn of the modern era of flavour physics. LHCb has now measured $\sin 2\beta$ with a precision better than any other experiment, to match its achievement for ϕ_s , the analogous parameter in B_s^0 decays, where ATLAS and CMS have also made a major contribution. Continued improvements in the knowledge of these fundamental parameters will be vital in probing for other sources of CP violation beyond the SM.

Over the past decade, the community has been intrigued by strong hints of the breakdown of lepton universality, one of the guiding tenets of the SM, in B decays. Following a recent update from LHCb, it seems that lepton universality may remain a good symmetry, at least in the class of electroweak-penguin decays such as $B \rightarrow K^{(*)} \ell^+ \ell^-$, where much of the excitement was focused. Nonetheless, there remain puzzles to be understood in this sector of flavour physics, and anomalies are emerging elsewhere. For example, non-leptonic decays of the kind $B_s \rightarrow D_s^+ K^-$ show intriguing patterns through CP violation and decay rate information.

The conference was noteworthy as being a showcase for the first major results to emerge from the Belle II experiment. Belle II has now collected 362 fb^{-1} of integrated luminosity on the $\Upsilon(4S)$ resonance, which constitutes a data set similar in size to that accumulated by BaBar and the original Belle experiment, and results were shown from early tranches of this sample. In some cases, these results already match or exceed in sensitivity and precision what was achieved at the first generation of B -factory experiments, or indeed elsewhere. These advances can be attributed to improved instrumentation and analysis techniques. For example, measurements of the lifetimes of several charm hadrons were presented, including the D^0 , the D^+ , the D_s^+ and the Λ_c^+ , which are all



Figure 1: A group photograph of the Beauty 2023 participants in the Jardin Lecoq.

world leading. Belle II and its accelerator, SuperKEKB, will emerge from a year-long shutdown in December, with the goal to increase the data set by a factor of 10-20 in the coming half decade.

The future experimental programme of flavour physics is full of promise. In addition to the upcoming riches expected from Belle II, an upgraded LHCb detector is being commissioned in order to collect significantly larger event samples over the coming decade. Upgrades to ATLAS and CMS will enhance these experiments' capabilities in flavour physics during the High Luminosity LHC era, for which a second upgrade to LHCb is also foreseen. The conference also learned of the exciting possibilities for flavour physics at FCC-ee, where samples of several 10^{12} Z^0 decays will open the door to ultra-precise measurements in an analysis environment much cleaner than at the LHC. These projects will be complemented by continued exploration of the kaon sector, and studies at charm threshold for which a high luminosity Super Tau Charm Factory is proposed in China.

The scientific programme of Beauty 2023 was complemented by outreach events in the city, including a 'Pints of Science' evening, and a public lecture, as well as a variety of social events. These and the stimulating presentations made the conference a huge success, demonstrating that flavour remains a vibrant field and continues to be a key player in the search for new physics beyond the Standard Model.