

## Research Project

### CP violation measurement at LHCb and development of a calorimeter detector for future LHCb upgrades

The LHCb experiment exploits the high cross-section of  $b\bar{b}$  quarks in proton-proton collisions at the LHC. The excellent performance in selecting and reconstructing the decays of hadrons containing b quarks allows LHCb to measure the properties of such decays with unprecedented precision. Observation of our Universe suggests abundant matter over antimatter, which can only be explained if the combined CP symmetry is violated. CP violation is discovered in strange, beauty and charm meson systems. However, no conclusive sign of CP violation in baryon decays has yet to be observed. The analysis of  $\Lambda_b^0$  meson decays into the  $p\pi^-$  and  $pK^-$  final states offers a unique opportunity to measure CP violation in baryon decays for the first time.

Furthermore, measuring this quantity allows us to verify the Standard Model (SM) accuracy, governed by the Cabibbo-Kobayashi-Maskawa (CKM) matrix. The selected candidate will analyze the RUN-2 and the coming RUN-3 data to realize one of the most precise measurements of direct CP violation in baryons with the possibility of unambiguously establishing CP violation in baryons with the quark beauty. The selected candidate will finalize RUN-2 data analysis, including evaluating all the systematic uncertainties, such as the one on the fitting model, the efficiencies necessary to assess the misidentified background, parametrization of the final state radiation, etc. In addition, the first RUN-3 data expected in 2024 and 2025, will be analysed.

### Training project

The grant holder will be integrated into the research activities of the LHCb-Bologna group to acquire the skills necessary to implement the research program described above. The training of the grant holder will develop on two levels. On the one hand, it can independently carry out measurements in high energy physics at colliders, producing one or more journal publications. On the other hand, they will acquire the skills necessary to design, develop and construct a particle detector. Thanks to the close collaboration with the LHCb-Bologna research group and the international groups at the CERN laboratories in Geneva, the grant holder will acquire a high professional qualification in high-energy physics.