université PARIS-SACLAY

ÉCOLE DOCTORALE
Particules, hadrons, énergie et noyau : instrumentation, imagerie, cosmos et simulation (PHENIICS)

Title: Measurement of the CKM angle γ using the double Dalitz method and commissioning of the calorimeters at the LHCb experiment

Keywords: *CP* violation, CKM matrix, Flavour physics, Calorimeter, LHCb

Abstract: The angle γ of the CKM unitarity triangle is one of the most essential parameters of the Standard Model (SM) of elementary particle physics. It bears a very small theoretical uncertainty because it can be measured by using only a tree-level decay of the B meson. Currently, the combination of the measurements of γ is still dominated by the statistical uncertainty. Therefore, measuring the angle γ with higher precision would be crucial to test the SM and potentially to discover a hint for the physics beyond the SM.

The core of this work is based on the double Dalitz method of measuring the angle γ. The double Dalitz method exploits the $B^0 \to DK^+\pi^-$ decay followed by the $D \to K^0_S\pi^+\pi^-$ decay, where D denotes both D^0 and $\overline{D}^0$. As this is a chain of two three-body decays, two Dalitz plots can be used hence the name double Dalitz. The double Dalitz method can bring an extra sensitivity compared to, for instance, the BPGGSZ method using the $B^0 \to DK^{*0}$ decay, which is a fraction of the $B^0 \to DK^+\pi^-$ decay phase space. In addition to the $D \to K^0_S\pi^+\pi^-$ decays, the following D final states are incorporated in this analysis: $K^0_SK^+K^-$, $\pi^+\pi^-$, K^+K^-, $K^\pm\pi^\mp$, $\pi^\pm K^\mp$, $\pi^+\pi^-\pi^+\pi^-$, $K^\pm\pi^\mp\pi^+\pi^-$, $\pi^\pm K^\mp\pi^+\pi^-$. These additional modes not only enhance the sensitivity to γ, but they also help to measure other hadronic parameters more precisely.

The analysis is performed using a dataset corresponding to an integrated luminosity of $9\,\text{fb}^{-1}$, collected in proton-proton collisions at centre-of-mass energies of 7, 8, and 13 TeV with the LHCb detector. The final results of the measurement including the systematic uncertainties are yet to come. However, the pseudo-experiment study based on the dataset suggests the statistical uncertainty of γ would be about 4 degrees. This would be one of the most precise measurements from a single analysis. Consequently, the results of this work are expected to make a significant contribution to the future combination of γ.

Part of the thesis work has been also devoted to the commissioning of the LHCb calorimeters for Run 3. The calorimeters have undergone a major upgrade, particularly for the electronics during Long Shutdown 2 of the LHC. Thus, a wider range of work has been done for the commissioning such as tuning the parameters of the front-end boards, time alignment of the channels, and the maintenance of the LED/HV system.