



# Measurements of $CP$ violation in the three-body phase space of charmless $B^\pm$ decays (ADDITIONAL INFORMATION)

The LHCb collaboration

## Abstract

This document presents figures of the projections into the two-body invariant masses of the spectra of  $B^\pm \rightarrow K^\pm \pi^+ \pi^-$ ,  $B^\pm \rightarrow K^\pm K^+ K^-$ ,  $B^\pm \rightarrow \pi^\pm K^+ K^-$  and  $B^\pm \rightarrow \pi^\pm \pi^+ \pi^-$  decays. The figures show additional information related to the CP asymmetry in phase space, for section VII of the article Physical Review D 90, 112004 (2014).



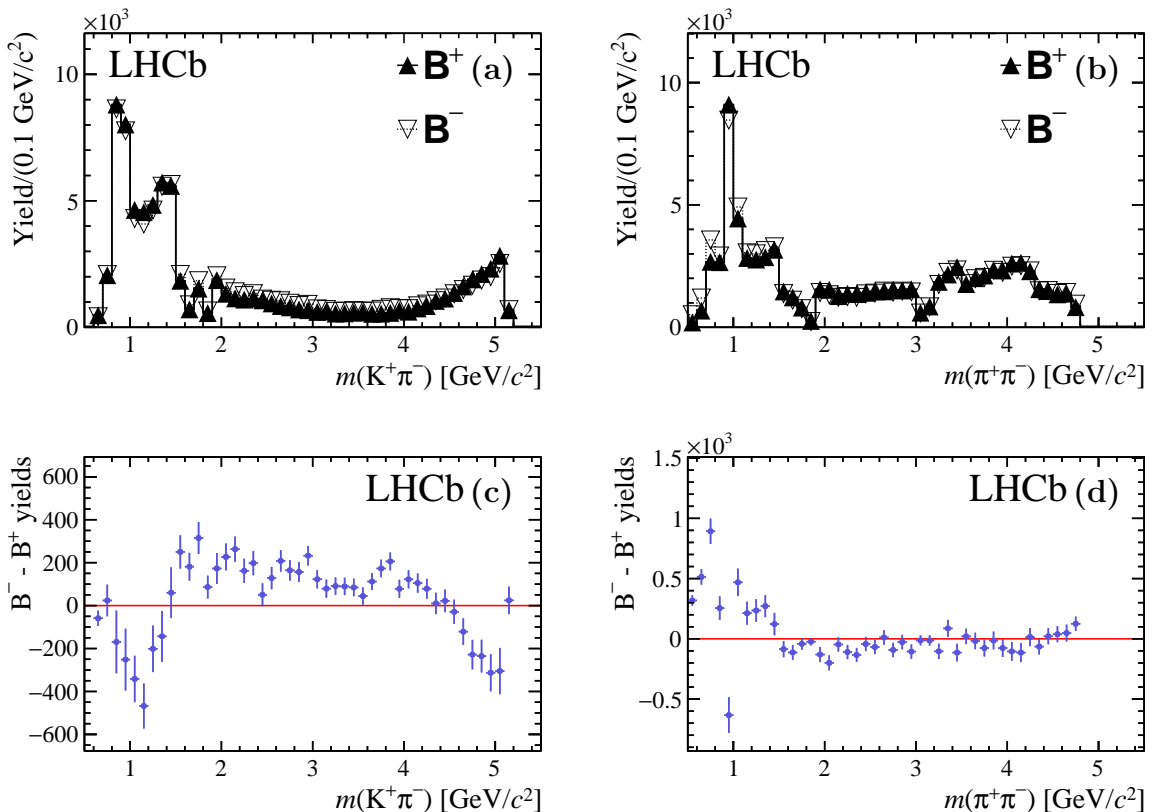


Figure 1: Projections in bins of the  $m(K^\pm\pi^\mp)$  and  $m(\pi^+\pi^-)$  variables of (a), (b) the number of  $B^-$  and  $B^+$  signal events and (c), (d) their difference for the  $B^\pm \rightarrow K^\pm\pi^+\pi^-$  decays. The yields are acceptance-corrected and background-subtracted. A guide line for zero (horizontal red line) was included in plots (c) and (d).

## 1 Two-body invariant mass projections

In Ref. [1] the  $A_{\text{raw}}^N$  distributions in the Dalitz plots reveal rich structures, which are more evident in the two-body invariant-mass projection plots. Figures 1, 2, 3 and 4 show the whole spectrum of the two-body invariant-mass projections for the  $B^\pm \rightarrow K^\pm\pi^+\pi^-$ ,  $B^\pm \rightarrow K^\pm K^+ K^-$ ,  $B^\pm \rightarrow \pi^\pm\pi^+\pi^-$  and  $B^\pm \rightarrow \pi^\pm K^+ K^-$  decays, respectively.

As was done in Ref. [1], the projections are split according to the sign of  $\cos\theta$ , where  $\theta$  is the angle between the momenta of the unpaired hadron and the resonance decay product with the same-sign charge. Figure 5 shows a zoom in the  $K^{*0}$  region of  $B^\pm \rightarrow K^\pm\pi^+\pi^-$  decays. The  $K^{*0}$  band seems to be shifted at  $\cos\theta < 0$  compared to  $\cos\theta > 0$ . This is a known effect due to the angular distribution dependence of a P-wave ( $K^{*0}$  in this case) interference that changes sign with the  $\cos\theta$ , which is zero around  $m(\pi^+\pi^-) \sim 3.05$  GeV/c<sup>2</sup> in the  $K^{*0}$  region. The signature of the  $CP$  asymmetry is located mainly in the low-mass region of  $m(\pi^+\pi^-) < 1.5$  GeV/c<sup>2</sup>, where a clear interference structure appears in the

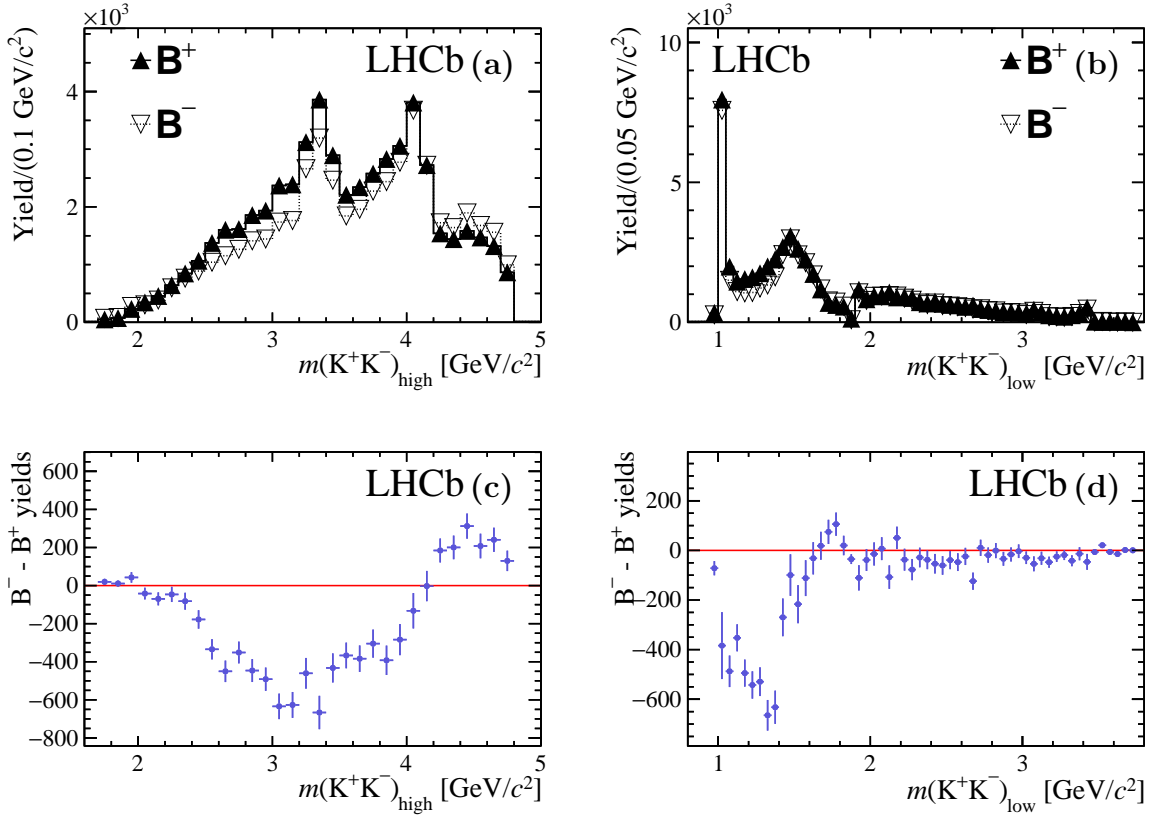


Figure 2: Projections in bins of the  $m(K^+K^-)_{\text{high}}$  and  $m(K^+K^-)_{\text{low}}$  variables of (a), (b) the number of  $B^-$  and  $B^+$  signal events and (c), (d) their difference for the  $B^\pm \rightarrow K^\pm K^+ K^-$  decays. The yields are acceptance-corrected and background-subtracted. A guide line for zero (horizontal red line) was included in plots (c) and (d).

distribution of the difference between  $B^-$  and  $B^+$  yields.

## References

- [1] LHCb collaboration, R. Aaij *et al.*, *Measurements of CP violation in the three-body phase space of charmless  $B^\pm$  decays*, Phys. Rev. **D90** (2014) 112004, arXiv:1408.5373.

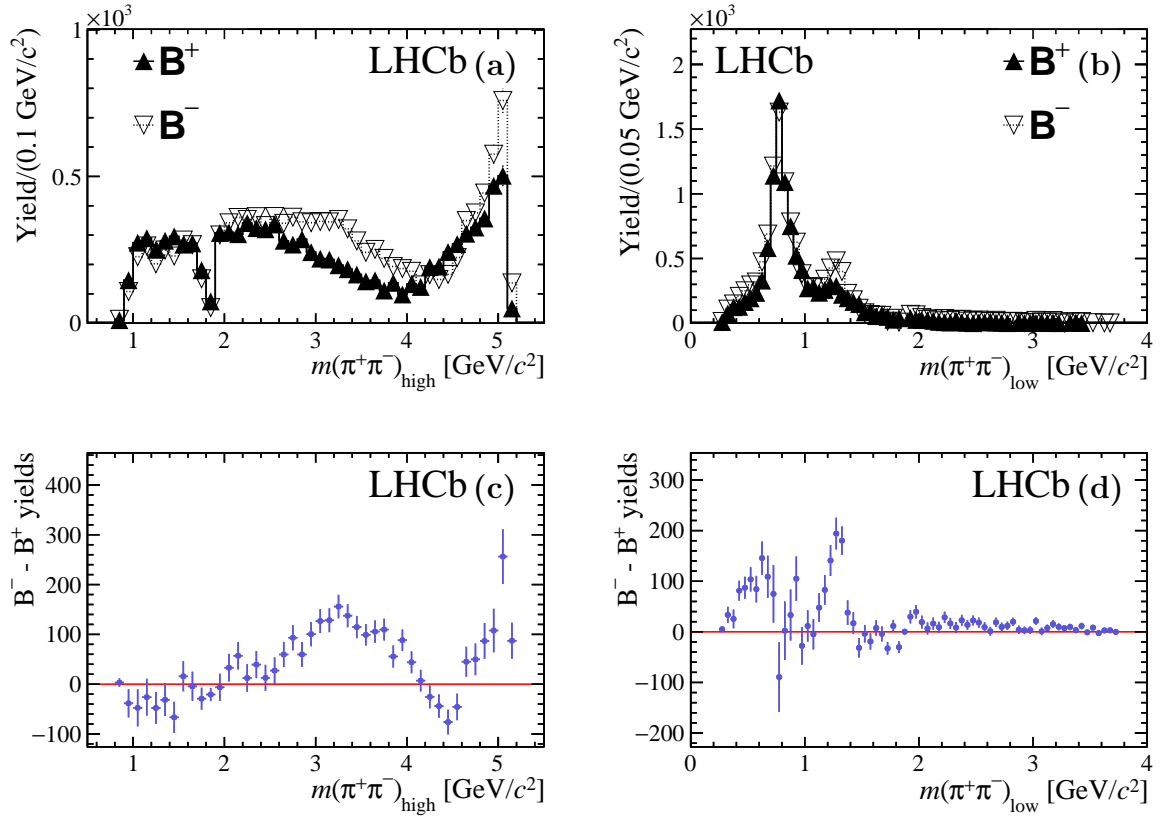


Figure 3: Projections in bins of the  $m(\pi^+\pi^-)_{\text{high}}$  and  $m(\pi^+\pi^-)_{\text{low}}$  variables of (a), (b) the number of  $B^-$  and  $B^+$  signal events and (c), (d) their difference for the  $B^\pm \rightarrow \pi^\pm\pi^+\pi^-$  decays. The yields are acceptance-corrected and background-subtracted. A guide line for zero (horizontal red line) was included in plots (c) and (d).

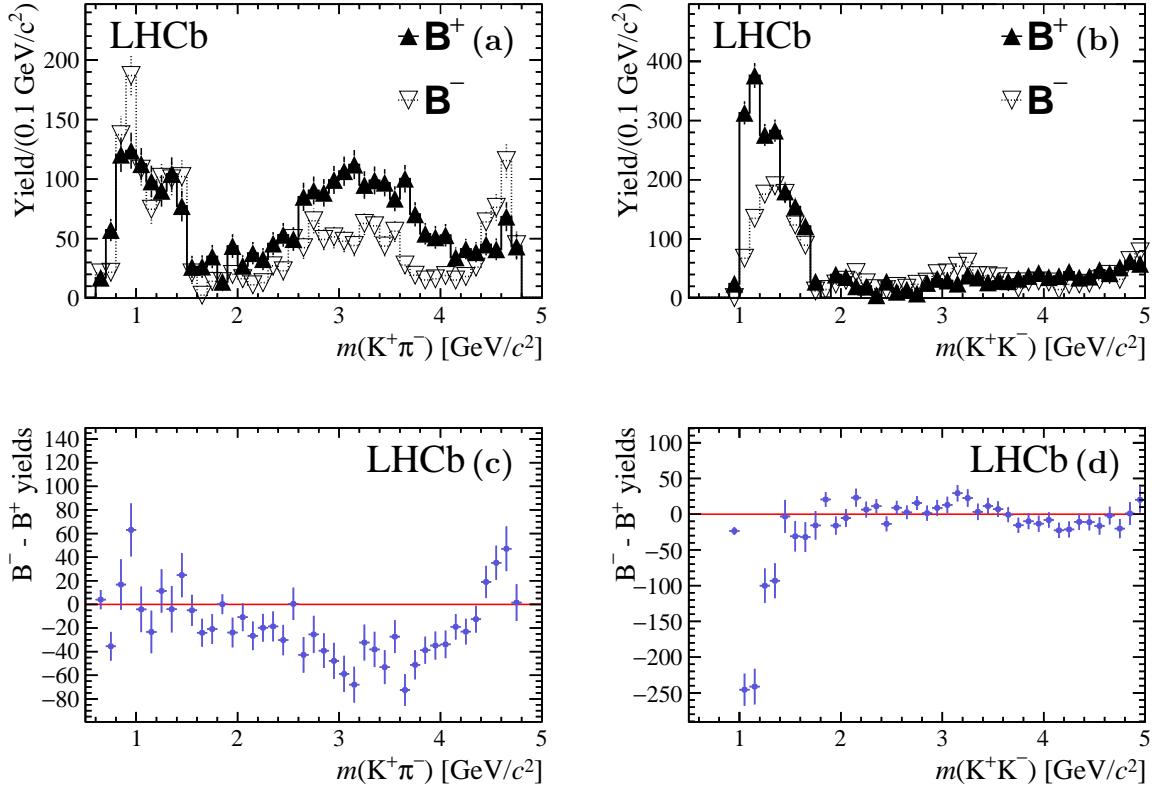


Figure 4: Projections in bins of the  $m(K^\pm\pi^\mp)$  and  $m(K^+K^-)$  variables of (a), (b) the number of  $B^-$  and  $B^+$  signal events and (c), (d) their difference for the  $B^\pm \rightarrow \pi^\pm K^+ K^-$  decays. The yields are acceptance-corrected and background-subtracted. A guide line for zero (horizontal red line) was included in plots (c) and (d).

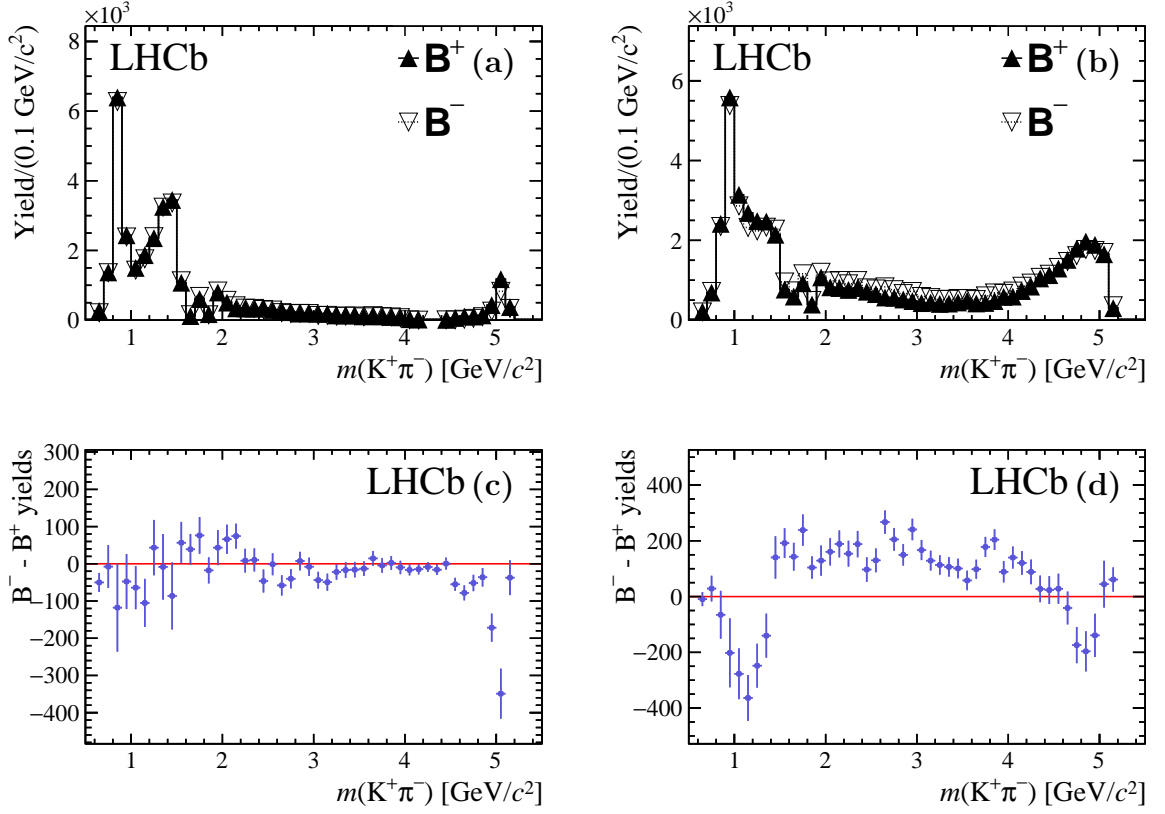


Figure 5: Projections in bins of the  $m(K^\pm\pi^\mp)$  variable of (a), (b) the number of  $B^-$  and  $B^+$  signal events and (c), (d) their difference for the  $B^\pm \rightarrow K^\pm\pi^+\pi^-$  decays. The plots are restricted to events in the  $K^{*0}$  region with (a), (c)  $\cos\theta < 0$  and (b), (d)  $\cos\theta > 0$ . The yields are acceptance-corrected and background-subtracted. A guide line for zero (horizontal red line) was included in plots (c) and (d).