Supplementary material for LHCb-PAPER-2019-010

This appendix contains supplementary material that will posted on the public CDS record but will not appear in the paper.

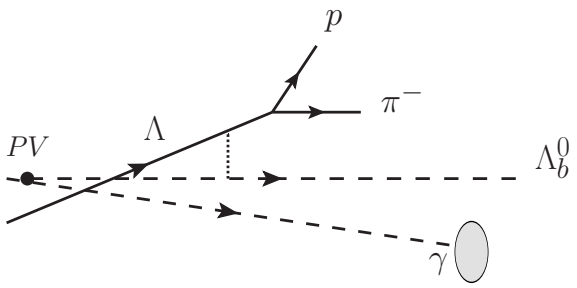

Figure 1: Sketch of the $\Lambda_b^0 \to \Lambda\gamma$ decay topology. The solid lines show the particle trajectories that are directly reconstructed from the detector information. The dashed lines represent trajectories that are derived from certain assumptions: the photon direction is computed from the position of the calorimeter cluster and the origin of the LHCb coordinate system, under the assumption that the photon originated there; the Λ_b^0 direction is reconstructed from the sum of the Λ and photon momenta and the trajectory built assuming it originates at the PV. The dotted line describes the distance of closest approach (DOCA) between the Λ_b^0 and Λ trajectories, exploited in this analysis to reject combinatorial background.

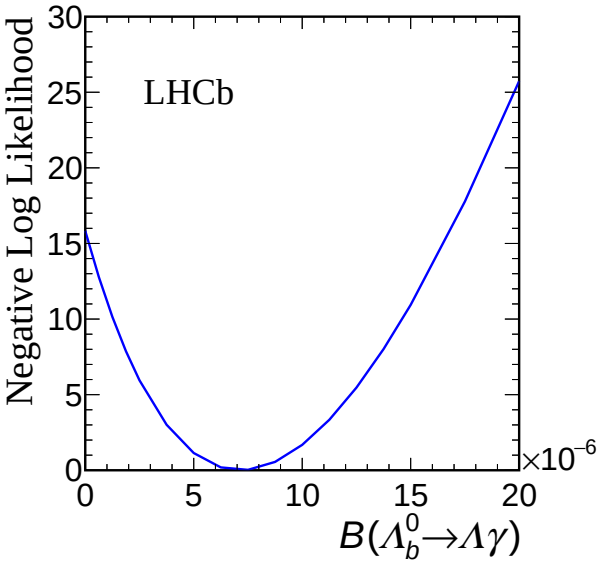

Figure 2: Profile of the Negative Log Likelihood along the $\mathcal{B}(\Lambda_b^0 \to \Lambda\gamma)$ value. The significance is obtained using Wilks' theorem [1] and the value of the profile at zero.

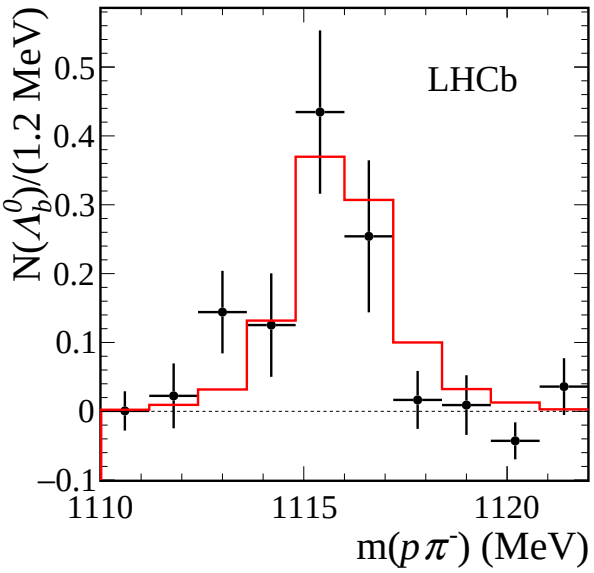

Figure 3: Background-subtracted distribution of the $p\pi$ invariant mass of the $\Lambda_b^0 \to \Lambda\gamma$ signal component in data (black dots) compared to that in simulation (red histogram).

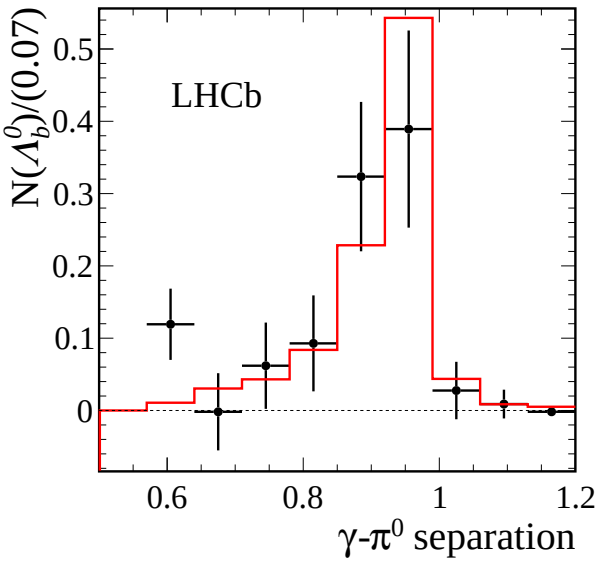

Figure 4: Background-subtracted distribution of the γ-π^0 separation variable of the $\Lambda_b^0 \to \Lambda\gamma$ signal component in data (black dots) compared to that for the $B^0 \to K^{*0}\gamma$ one (red histogram), after a tight selection in the kaon helicity angle of the second. The γ-π^0 separation variable is the output of a neural network classifier described in detail in Ref. [2]

Table 1: Comparison of the value of $\mathcal{B}(\Lambda_b^0 \to \Lambda\gamma)$ measured in this paper, including both statistical and systematic uncertainties, to theoretical predictions.

		$\mathcal{B}(\Lambda_b^0 \to \Lambda\gamma)$ $(\times 10^{-6})$
Light-cone Sum Rules - twist 6	[3]	7.3 ± 1.5
Heavy quark limit	[4]	$7.7^{+2.2}_{-1.9}$
QCD Sum Rules - Ioffe current	[5]	$0.61^{+0.14}_{-0.13}$
Relativistic quark model	[6]	10
This letter		7.1 ± 1.7

References

[1] S. S. Wilks, *The large-sample distribution of the likelihood ratio for testing composite hypotheses*, Ann. Math. Stat. **9** (1938) 60.

[2] M. Calvo Gomez *et al.*, *A tool for γ/π^0 separation at high energies*, LHCb-PUB-2015-016, 2015.

[3] Y.-M. Wang, Y. Li, and C.-D. Lü, *Rare decays of $\Lambda_b^0 \to \Lambda\gamma$ and $\Lambda_b^0 \to \Lambda\ell^+\ell^-$ in the light-cone sum rules*, Eur. Phys. J. **C59** (2009) 861, arXiv:0804.0648.

[4] T. Mannel and Y.-M. Wang, *Heavy-to-light baryonic form factors at large recoil*, JHEP **12** (2011) 067, arXiv:1111.1849.

[5] L.-F. Gan, Y.-L. Liu, W.-B. Chen, and M.-Q. Huang, *Improved light-cone QCD sum rule analysis of the rare decays $\Lambda_b^0 \to \Lambda\gamma$ and $\Lambda_b^0 \to \Lambda l^+ l^-$*, Commun. Theor. Phys. **58** (2012) 872, arXiv:1212.4671.

[6] R. N. Faustov and V. O. Galkin, *Rare $\Lambda_b^0 \to \Lambda l^+ l^-$ and $\Lambda_b^0 \to \Lambda\gamma$ decays in the relativistic quark model*, Phys. Rev. **D96** (2017) 053006, arXiv:1705.07741.