

# Heavy FLavor AVeraging group (HFLAV) - April 2019

Compilation of  $\Lambda_b^0$  Branching Fractions ( $\times 10^{-6}$ ) - UL at 90% CL

Preliminary Updated results not included in PDG Live as of Dec. 31, 2017

RPP#	Mode	PDG2017 Avg.	CDF	LHCb	Our Avg.
12	$\bar{K}^0 p \pi^-$	$13.0 \pm 4.0$		$12.6 \pm 1.9 \pm 0.9 \pm 3.4 \pm 0.5$ § [1]	$12.6 \pm 4.0$
13	$K^0 p K^-$	$< 3.5$		$< 3.5$ [1]	$< 3.5$
33	$p \pi^-$	$4.3 \pm 0.8$	$3.5 \pm 0.6 \pm 0.9$ [2]		$3.5 \pm 1.1$
34	$p K^-$	$5.1 \pm 0.9$	$5.6 \pm 0.8 \pm 1.5$ [2]		$5.6 \pm 1.7$
37	$\Lambda \mu^+ \mu^-$	$1.08 \pm 0.28$	$1.73 \pm 0.42 \pm 0.55$ [3]	$0.96 \pm 0.16 \pm 0.25$ [4]	$1.08 \pm 0.27$
38	$\Lambda \gamma$	$< 1300$	$< 1300$ [5]	$7.1 \pm 1.5 \pm 0.6 \pm 0.7$ † [6]	$7.1 \pm 1.8$
39	$\Lambda \eta$	$9_{-5}^{+7}$		$9.3_{-5.3}^{+7.3}$ ¶ [7]	$9.3_{-5.3}^{+7.3}$
40	$\Lambda \eta'$	$< 3.1$		$< 3.1$ [7]	$< 3.1$
41	$\Lambda \pi^+ \pi^-$	$4.7 \pm 1.9$		$4.6 \pm 1.2 \pm 1.4 \pm 0.6$ † 2 [8]	$4.6 \pm 1.9$
42	$\Lambda K^+ \pi^-$	$5.7 \pm 1.3$		$5.6 \pm 0.8 \pm 0.8 \pm 0.7$ † 2 [8]	$5.6 \pm 1.3$
43	$\Lambda K^+ K^-$	$16.1 \pm 2.3$		$15.9 \pm 1.2 \pm 1.2 \pm 2.0$ † 2 [8]	$15.9 \pm 2.6$
44	$\Lambda \phi$	$2.0 \pm 0.5$		$5.18 \pm 1.04 \pm 0.35_{-0.62}^{+0.67}$ † 3 [9]	$5.18_{-1.26}^{+1.29}$
	$p \pi^- \mu^+ \mu^-$			$0.069 \pm 0.019 \pm 0.011_{-0.010}^{+0.013}$ † [10]	$0.069_{-0.024}^{+0.026}$
	$p \pi^- \pi^+ \pi^-$			$19.0 \pm 0.6 \pm 1.0 \pm 1.6 \pm 0.7$ 1 [11]	$19.0 \pm 2.1$
	$p K^- \pi^+ \pi^-$			$45.5 \pm 0.8 \pm 2.0 \pm 3.9 \pm 1.7$ 1 [11]	$45.5 \pm 4.8$
	$p K^- K^+ \pi^-$			$3.7 \pm 0.3 \pm 0.4 \pm 0.3 \pm 0.1$ 1 [11]	$3.7 \pm 0.6$
	$p K^- K^+ K^-$			$11.4 \pm 0.3 \pm 0.7 \pm 1.0 \pm 0.5$ 1 [11]	$11.4 \pm 1.4$
	$\Psi(2S) p \pi^-$			$7.17 \pm 0.82 \pm 0.33_{-1.03}^{+1.30}$ 4 [12]	$7.17_{-1.36}^{+1.57}$

Channels with no RPP# were not included in PDG Live as of Dec. 31, 2017.

Results for CDF and LHCb are relative BF's converted to absolute BF's.

† Last quoted uncertainty is due to the precision with which the normalization channel branching fraction is known.

‡ Third uncertainty is related to external inputs.

§ Third uncertainty is from the ratio of fragmentation fractions  $f_{\Lambda_b^0}/f_d$ , and the fourth is due to the uncertainty on  $\mathcal{B}(B^0 \rightarrow K^0 \pi^+ \pi^-)$ .

¶ Result at 68% CL.

1 Third uncertainty is from  $\mathcal{B}(\Lambda_b \rightarrow \Lambda_c^+ \pi^-)$ , and the fourth is due to the uncertainty on  $\mathcal{B}(\Lambda_c^+ \rightarrow p K^- \pi^+)$ .

2 Normalization taken directly from LHCb paper.

3 Difference w.r.t. PDG value due to different values for the production rate ratio  $f_{\Lambda_b}/f_d$ .

4 Calculated using the value of  $\mathcal{B}(\Lambda_b^0 \rightarrow \Psi(2S) p K^-) = (6.29 \pm 0.23 \pm 0.14_{-0.90}^{+1.14}) \times 10^{-6}$ .

# Heavy FLavor AVeraging group (HFLAV) - April 2019

Partial Branching Fractions of  $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$  decays ( $\times 10^{-7}$ )

Preliminary Updated results not included in PDG Live as of Dec. 31, 2017

Mode	$q^2$ [GeV <sup>2</sup> /c <sup>4</sup> ] † ‡	PDG2017 Avg.	CDF	LHCb	Our Avg.
$\Lambda \mu^+ \mu^-$	$< 2.0$	$0.71 \pm 0.27$	$0.15 \pm 2.01 \pm 0.05$ [3]	$0.72_{-0.22}^{+0.24} \pm 0.14$ [13]	$0.71_{-0.26}^{+0.27}$
$\Lambda \mu^+ \mu^-$	[2.0, 4.3]	$0.28_{-0.21}^{+0.28}$	$1.8 \pm 1.7 \pm 0.6$	$0.253_{-0.207}^{+0.276} \pm 0.046$ [13]	$0.281_{-0.218}^{+0.286}$
$\Lambda \mu^+ \mu^-$	[4.3, 8.68]	$0.5 \pm 0.7$	$-0.2 \pm 1.6 \pm 0.1$	$0.66 \pm 0.72 \pm 0.16$ [4]	$0.51 \pm 0.67$
$\Lambda \mu^+ \mu^-$	[10.09, 12.86]	$2.2 \pm 0.6$	$3.0 \pm 1.5 \pm 1.0$	$2.08_{-0.39}^{+0.42} \pm 0.42$ [13]	$2.17_{-0.55}^{+0.57}$
$\Lambda \mu^+ \mu^-$	[14.18, 16.00]	$1.7 \pm 0.5$	$1.0 \pm 0.7 \pm 0.3$	$2.04_{-0.33}^{+0.35} \pm 0.42$ [13]	$1.70 \pm 0.44$
$\Lambda \mu^+ \mu^-$	$> 16.00$	$7.0 \pm 2.9$	$7.0 \pm 1.9 \pm 2.2$		$7.0 \pm 2.9$

Results for CDF and LHCb are relative BF's converted to absolute BF's.

† See the original paper for the exact  $m^2(\mu^+ \mu^-)$  selection.

‡ The two LHCb measurements include additional binning not reported here.

Heavy FLavor AVeraging group (HFLAV) - April 2019  
 Compilation of  $\Xi_b^0$  Branching Fractions ( $\times 10^{-6}$ )

Preliminary Updated results not included in PDG Live as of Dec. 31, 2017

RPP#	Mode	PDG2017 Avg.	LHCb	Our Avg.
4	$f_{\Xi_b^0}/f_d \mathcal{B}(\Xi_b^0 \rightarrow \bar{K}^0 p \pi^-)$	< 1.6	< 1.6	[1] < 1.6
5	$f_{\Xi_b^0}/f_d \mathcal{B}(\Xi_b^0 \rightarrow \bar{K}^0 p K^-)$	< 1.1	< 1.1	[1] < 1.1
10	$f_{\Xi_b^0}/f_{\Lambda_b^0} \mathcal{B}(\Xi_b^0 \rightarrow \Lambda \pi^+ \pi^-)$	< 1.7	< 1.7	[8] < 1.7
11	$f_{\Xi_b^0}/f_{\Lambda_b^0} \mathcal{B}(\Xi_b^0 \rightarrow \Lambda K^+ \pi^-)$	< 0.8	< 0.8	[8] < 0.8
12	$f_{\Xi_b^0}/f_{\Lambda_b^0} \mathcal{B}(\Xi_b^0 \rightarrow \Lambda K^+ K^-)$	< 0.3	< 0.3	[8] < 0.3
	$f_{\Xi_b^0}/f_{\Lambda_b^0} \mathcal{B}(\Xi_b^0 \rightarrow p K^- \pi^+ \pi^-)$		$1.72 \pm 0.21 \pm 0.25 \pm 0.15 \pm 0.07$ [11]	$1.72 \pm 0.37$
	$f_{\Xi_b^0}/f_{\Lambda_b^0} \mathcal{B}(\Xi_b^0 \rightarrow p K^- \pi^+ K^-)$		$1.56 \pm 0.16 \pm 0.19 \pm 0.13 \pm 0.06$ [11]	$1.56 \pm 0.29$
	$f_{\Xi_b^0}/f_{\Lambda_b^0} \mathcal{B}(\Xi_b^0 \rightarrow p K^- K^+ K^-)$		< 0.25 [11]	< 0.25

Channels with no RPP# were not included in PDG Live as of Dec. 31, 2017.  
 Results for LHCb are relative BF's converted to absolute BF's.

Heavy FLavor AVeraging group (HFLAV) - April 2019  
 Compilation of  $\Xi_b^-$  Branching Fractions ( $\times 10^{-5}$ )

Preliminary Updated results not included in PDG Live as of Dec. 31, 2017

RPP#	Mode	PDG2017 Avg.	LHCb	Our Avg.
6	$f_{\Xi_b^-} \mathcal{B}(\Xi_b^- \rightarrow p K^- K^-)/(f_u \mathcal{B}(B^- \rightarrow K^+ K^- K^-))$	†	$265 \pm 35 \pm 47$ [14]	$265 \pm 58$
	$f_{\Xi_b^-} \mathcal{B}(\Xi_b^- \rightarrow p K^- \pi^-)/(f_u \mathcal{B}(B^- \rightarrow K^+ K^- K^-))$		$259 \pm 64 \pm 49$ [14]	$259 \pm 80$
8	$\mathcal{B}(\Xi_b^- \rightarrow p \pi^- \pi^-)/(\mathcal{B}(\Xi_b^- \rightarrow p K^- K^-))$	< 0.56	< 0.56 [14]	< 0.56
	$f_{\Xi_b^-} \mathcal{B}(\Xi_b^- \rightarrow p \pi^- \pi^-)/(f_u \mathcal{B}(B^- \rightarrow K^+ K^- K^-))$		< 147 [14]	< 147
9	$\mathcal{B}(\Xi_b^- \rightarrow p K^- \pi^-)/(\mathcal{B}(\Xi_b^- \rightarrow p K^- K^-))$	$0.98 \pm 0.27 \pm 0.09$	$0.98 \pm 0.27 \pm 0.09$ [14]	$0.98 \pm 0.28$

Channels with no RPP# were not included in PDG Live as of Dec. 31, 2017.  
 † PDG reports results multiplied by  $\mathcal{B}(B^+ \rightarrow K^+ K^- K^+)$  and  $\mathcal{B}(\bar{b} \rightarrow B^+)$ .

Heavy FLavor AVeraging group (HFLAV) - April 2019  
 Compilation of  $\Omega_b^-$  Branching Fractions ( $\times 10^{-5}$ )

Preliminary Updated results not included in PDG Live as of Dec. 31, 2017

RPP#	Mode	PDG2017 Avg.	LHCb	Our Avg.
2	$f_{\Omega_b^-} \mathcal{B}(\Omega_b^- \rightarrow p K^- K^-)/(f_u \mathcal{B}(B^- \rightarrow K^+ K^- K^-))$	†	< 18 [14]	< 18
3	$f_{\Omega_b^-} \mathcal{B}(\Omega_b^- \rightarrow p K^- \pi^-)/(f_u \mathcal{B}(B^- \rightarrow K^+ K^- K^-))$	†	< 51 [14]	< 51
4	$f_{\Omega_b^-} \mathcal{B}(\Omega_b^- \rightarrow p \pi^- \pi^-)/(f_u \mathcal{B}(B^- \rightarrow K^+ K^- K^-))$	†	< 109 [14]	< 109

† PDG reports results multiplied by  $\mathcal{B}(B^+ \rightarrow K^+ K^- K^+)$  and  $\mathcal{B}(\bar{b} \rightarrow B^+)$ .

# References

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