b-hadron decays to charmless final states

This section provides branching fractions (BF), polarization fractions, CP asymmetries (A_{CP}) and other observables of b-hadron decays to final states that do not contain charm hadrons or charmonium mesons[1], except for a few lepton-flavour- and lepton-number-violating decays reported in Sec. 0.6.

Four categories of B^0 and B^+ decays are reported: mesonic (*i.e.*, final states containing only mesons), baryonic (hadronic final states with baryon-antibaryon pairs), radiative (including a photon or a lepton-antilepton pair) and semileptonic/leptonic (including/only leptons). We also report measurements of B_s^0, B_c^+ and b-baryon decays, and measurements of final-state polarization in b-hadron decays. Measurements included in our averages are those supported with public notes, including journal papers, conference-contributed papers, preprints or conference proceedings, except when a result has not led to a journal publication after an extended period of time.

The largest improvements since our last report [1] have come from a variety of new measurements from LHCb and Belle-II. This includes LHCb's update of the ratio R_{K^*}, which is now consistent with the standard model prediction at the level of 0.6 standard deviations, as well as the first evidence of the decay $B \to K\nu\overline{\nu}$ from Belle II.

The averaging procedure follows the methodology described in Sec. 3 of the latest HFLAV publication. We perform fits of the full likelihood function and do not use the approximation described in Sec. 3.1. Thus, observables that are related to each other, e.g., by ratios of branching fractions, are fitted jointly. Details about all the observables involved in each average, as well as the induced correlation coefficients and p-values, are available via clickable links from each average in the tables on our web page [2][2]. In total 407 fits are performed, with on average (maximally) 1.2 (37) parameters and 4.1 (20) measurements per fit. In our tables, each group of rows contains the individual measurements and the average corresponding to a given parameter p_j. The cases where the fits incorporate measurements that are functions of p_j, which are used as direct inputs to the fits, are indicated with a footnote. In general, a value of p_j is not quoted in the tables. There are two exceptions to this: a ratio of branching fractions, p_j/p_k, where p_k is the branching fraction of a normalization mode, and a product, $p_j p_k$ of the branching fraction of interest with that of a daughter decay. In these two cases the numerical value of p_j, naively obtained using the known value of p_k, is quoted in the tables for reference, and the uncertainty on p_k is included in the systematic uncertainty on p_j.

Systematic uncertainties are taken as quoted in the original publications, without the scaling of multiplicative uncertainties discussed in Sec. 3.3 of the latest HFLAV publication. When several systematic uncertainties are given separately, we sum them in quadrature and quote a single systematic uncertainty. These cases are marked by a footnote.

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[1]The treatment of intermediate charm or charmonium states differs between observables and sometimes among results for the same observable. In the latter case, when these results are averaged, we indicate the differences by footnotes.

[2]Where available, other sources of correlations between measurements of the same observable and among different observables are also taken into account.

If one or more experiments report a BF measurement with a significance of more than three standard deviations (σ), all available central values for that BF are used in our average. For BFs that do not satisfy this criterion, the most stringent limit is used. Quoted upper limits are at 90% confidence level (C.L.), unless mentioned otherwise. For observables that are not BFs, such as A_{CP} or polarization fractions, we include in our averages all the available results, regardless of their significance.

Many of the branching fractions from *BABAR* and Belle assume equal production of charged and neutral B-meson pairs. The best measurements to date show that this is still a reasonable approximation (see Sec. 4 of the latest HFLAV publication), and thus, we do not correct for it and simply quote the results from the original publications.

At the end of some of the sections, we list results that were not included in the tables. Typical cases are measurements of distributions, such as differential branching fractions or longitudinal polarizations, which are measured in different binning schemes by the different collaborations, and thus cannot be directly used to obtain averages.

Observables obtained by Dalitz-plot analyses are marked by footnotes. In these analyses, different experimental collaborations often use different models, in particular for the nonresonant component. When applicable, we detail the model used for the nonresonant component in a footnote. In addition to this, Dalitz-plot analyses often yield multiple solutions. In this case, we take the results corresponding to the global minimum and follow the conclusions of the papers.

In most of the tables, the averages are compared to those from the PDG 2024 updates [3]. When this is done, the "Average" column quotes the PDG averages (In gray) only if they differ from ours. In general, such differences are due to different input parameters, differences in the averaging methods and different rounding conventions. Unlike the PDG, no error scaling is applied in our averages when the fit χ^2 is greater than 1. On the other hand, the fit p-value is quoted if it is below 1%. Input values that are not included in the PDG 2024 average are marked in red. These are new results published since the closing of PDG 2024 and before finalizing of this report in March 2025. Input values that were unpublished at this time (unpublished results are never included in the PDG averages) are marked in blue. Sections 0.1 and 0.2 provide compilations of branching fractions of B^0 and B^+ to mesonic and baryonic charmless final states, respectively. Sections 0.3 and 0.4 and 0.5 give branching fractions of b-baryon, B^0_s-meson, and B^+_c meson decays to charmless final states, respectively [3]. In Sec. 0.6 observables of interest are given for radiative decays and FCNC) decays with leptons of B^0 and B^+ mesons, including limits from searches for lepton-flavour/number-violating decays. Finally, sections 0.7 and 0.8 give CP asymmetries and results of polarization measurements, respectively, in various b-hadron charmless decays.

[3] Except for decays of B^+_c mesons to final states containing B^0_s mesons, which are quoted in Sec. 7.5 of the latest HFLAV publication.

0.1 Mesonic decays of B^+ and B^0 mesons

This section provides branching fractions of charmless mesonic decays. Tables 1 to 12 are for B^+ and Tables 13 to 27 are for B^0 mesons. For both, decay modes with and without strange mesons in the final state appear in different tables. Finally, Tables 28 and 29 detail several relative branching fractions of B^+ and B^0 decays, respectively. Figure 1 gives a graphic representation of a selection of high-precision branching fractions given in this section.

Table 1: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to K^0\pi^+)$[1]	Belle [4]	$23.97 \pm 0.53 \pm 0.71$	23.9 ± 0.6
	Belle II [5]	$24.4 \pm 0.7 \pm 0.9$	23.7 ± 0.8
	BaBar [6]	$23.9 \pm 1.1 \pm 1.0$	
	CLEO [7]	$18.8\,^{+3.7}_{-3.3}\,^{+2.1}_{-1.8}$	
	LHCb [8][2]		
$\mathcal{B}(B^+ \to K^+\pi^0)$	Belle [4]	$12.62 \pm 0.31 \pm 0.56$	13.2 ± 0.4
	Belle II [5]	$13.9 \pm 0.4 \pm 0.7$	12.9 ± 0.5
	BaBar [9]	$13.6 \pm 0.6 \pm 0.7$	
	CLEO [7]	$12.9\,^{+2.4}_{-2.2}\,^{+1.2}_{-1.1}$	
$\mathcal{B}(B^+ \to \eta' K^+)$	BaBar [10]	$71.5 \pm 1.3 \pm 3.2$	68.9 ± 2.3
	Belle [11]	$69.2 \pm 2.2 \pm 3.7$	70.4 ± 2.5
	Belle II [12]	$63.4\,^{+3.4}_{-3.3} \pm 3.4$	
	Belle [13]	$61\,^{+10}_{-8} \pm 1$	
	CLEO [14]	$80\,^{+10}_{-9} \pm 7$	
	LHCb [15][3]		
$\mathcal{B}(B^+ \to \eta' K^*(892)^+)$	BaBar [16]	$4.8\,^{+1.6}_{-1.4} \pm 0.8$	$4.8\,^{+1.8}_{-1.6}$
	Belle [17]	< 2.9	
$\mathcal{B}(B^+ \to \eta' (K\pi)^{*+}_0)$	BaBar [16]	$6.0\,^{+2.2}_{-2.0} \pm 0.9$	6.0 ± 2.3 / none
$\mathcal{B}(B^+ \to \eta' K^*_0(1430)^+)$	BaBar [16][4]	$5.2 \pm 1.9 \pm 1.0$	5.2 ± 2.1
$\mathcal{B}(B^+ \to \eta' K^*_2(1430)^+)$	BaBar [16]	$28.0\,^{+4.6}_{-4.3} \pm 2.6$	28.0 ± 5.2 / $28.0\,^{+5.3}_{-5.0}$

[1] The PDG average is a result of a fit including input from other measurements.
[2] Measurement of $\mathcal{B}(B^+ \to K^+\overline{K}^0)/\mathcal{B}(B^+ \to K^0\pi^+)$ used in our fit.
[3] Measurement of $\mathcal{B}(B^0_s \to \eta'\eta')/\mathcal{B}(B^+ \to \eta' K^+)$ used in our fit.
[4] Multiple systematic uncertainties are added in quadrature.

Table 2: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 2).

Parameter [10^{-6}]	Measurements		Average HFLAV	Average PDG
$\mathcal{B}(B^+ \to \eta K^+)$[1]	Belle [18]	$2.12 \pm 0.23 \pm 0.11$	2.36 ± 0.21	$2.36\,^{+0.38}_{-0.37}$
	BaBar [10]	$2.94\,^{+0.39}_{-0.34} \pm 0.21$		
	CLEO [14]	$2.2\,^{+2.8}_{-2.2}$		
$\mathcal{B}(B^+ \to \eta K^*(892)^+)$	BaBar [19]	$18.9 \pm 1.8 \pm 1.3$	19.2 ± 1.3	19.3 ± 1.6
	Belle [20]	$19.3\,^{+2.0}_{-1.9} \pm 1.5$		
	CLEO [14]	$26.4\,^{+9.6}_{-8.2} \pm 3.3$		
$\mathcal{B}(B^+ \to \eta (K\pi)^{*+}_0)$	BaBar [19]	$18.2 \pm 2.6 \pm 2.6$	18.2 ± 2.6	none
$\mathcal{B}(B^+ \to \eta K^*_0(1430)^+)$[2]	BaBar [19][3]	$12.9 \pm 1.8 \pm 1.8$	12.9 ± 1.8	18.2 ± 3.7
$\mathcal{B}(B^+ \to \eta K^*_2(1430)^+)$	BaBar [19]	$9.1 \pm 2.7 \pm 1.4$	9.1 ± 2.2	9.1 ± 3.0
$\mathcal{B}(B^+ \to \eta(1295) K^+) \times \mathcal{B}(\eta(1295) \to \eta\pi\pi)$	BaBar [21]	$2.9\,^{+0.8}_{-0.7} \pm 0.2$	$2.9\,^{+0.8}_{-0.7}$	
$\mathcal{B}(B^+ \to \eta(1405) K^+) \times \mathcal{B}(\eta(1405) \to \eta\pi\pi)$	BaBar [21]	< 1.3	< 1.3	
$\mathcal{B}(B^+ \to \eta(1405) K^+) \times \mathcal{B}(\eta(1405) \to K^* K)$	BaBar [21]	< 1.2	< 1.2	
$\mathcal{B}(B^+ \to \eta(1475) K^+) \times \mathcal{B}(\eta(1475) \to K^* K)$	BaBar [21]	$13.8\,^{+1.8}_{-1.7}\,^{+1.0}_{-0.6}$	$13.8\,^{+2.1}_{-1.8}$	
$\mathcal{B}(B^+ \to f_1(1285) K^+) \times \mathcal{B}(f_1(1285) \to \eta\pi\pi)$	BaBar [21]	< 0.8	< 0.80	none
$\mathcal{B}(B^+ \to f_1(1420) K^+) \times \mathcal{B}(f_1(1420) \to \eta\pi\pi)$	BaBar [21]	< 2.9	< 2.9	
$\mathcal{B}(B^+ \to f_1(1420) K^+) \times \mathcal{B}(f_1(1420) \to K^* K)$	BaBar [21]	< 4.1	< 4.1	
$\mathcal{B}(B^+ \to \phi(1680) K^+) \times \mathcal{B}(\phi(1680) \to K^* K)$	BaBar [21]	< 3.4	< 3.4	
$\mathcal{B}(B^+ \to f_0(1500) K^+)$	BaBar [22][4]	$17 \pm 4 \pm 12$	17 ± 12	4 ± 2
	BaBar [22][5]	$20 \pm 10 \pm 27$		

[1] The PDG uncertainty includes a scale factor.
[2] The PDG entry corresponds to $\mathcal{B}(B^+ \to \eta (K\pi)^{*+}_0)$.
[3] Multiple systematic uncertainties are added in quadrature.
[4] Result extracted from Dalitz-plot analysis of $B^+ \to K^+ K^+ K^-$ decays.
[5] Result extracted from Dalitz-plot analysis of $B^+ \to K^0_S K^0_S K^+$ decays.

Table 3: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 3).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to \omega(782) K^+)$[1]	Belle [23]	$6.8 \pm 0.4 \pm 0.4$	6.47 ± 0.40
	BaBar [24]	$6.3 \pm 0.5 \pm 0.3$	
	CLEO [25]	$3.2\,^{+2.4}_{-1.9} \pm 0.8$	
$\mathcal{B}(B^+ \to \omega(782) K^*(892)^+)$	BaBar [26]	< 7.4	< 7.4
$\mathcal{B}(B^+ \to \omega(782)(K\pi)^{*+}_0)$	BaBar [26]	$27.5 \pm 3.0 \pm 2.6$	27.5 ± 4.0
$\mathcal{B}(B^+ \to \omega(782) K^*_0(1430)^+)$	BaBar [26]	$24.0 \pm 2.6 \pm 4.4$	24.0 ± 5.1
$\mathcal{B}(B^+ \to \omega(782) K^*_2(1430)^+)$	BaBar [26]	$21.5 \pm 3.6 \pm 2.4$	21.5 ± 4.3
$\mathcal{B}(B^+ \to a_0(980)^+ K^0) \times \mathcal{B}(a_0(980)^+ \to \eta\pi^+)$	BaBar [27]	< 3.9	< 3.9
$\mathcal{B}(B^+ \to a_0(980)^0 K^+) \times \mathcal{B}(a_0(980)^0 \to \eta\pi^0)$	BaBar [27]	< 2.5	< 2.5
$\mathcal{B}(B^+ \to K^*(892)^0 \pi^+)$	BaBar [28][2]	$10.8 \pm 0.6\,^{+1.2}_{-1.4}$	10.0 ± 0.8
	Belle [29][2]	$9.67 \pm 0.64\,^{+0.81}_{-0.89}$	10.1 ± 0.8
	BaBar [30][3,4,5]	$10.1 \pm 1.7 \pm 1.0$	
$\mathcal{B}(B^+ \to K^*(892)^+ \pi^0)$	BaBar [30][3,4,5]	$6.4 \pm 0.9\,^{+0.4}_{-0.5}$	6.81 ± 0.88
	BaBar [31]	$8.2 \pm 1.5 \pm 1.1$	$6.80\,^{+0.87}_{-0.90}$
	CLEO [25]	$7.1\,^{+11.4}_{-7.1} \pm 1.0$	
$\mathcal{B}(B^+ \to K^+\pi^+\pi^-)$	LHCb [32][6]	$57.71 \pm 0.37 \pm 1.45$	57.6 ± 1.4
	BaBar [28][2]	$54.4 \pm 1.1 \pm 4.6$	51.0 ± 2.9
	Belle [29][2]	$48.8 \pm 1.1 \pm 3.6$	
	Belle II [33]	$67.0 \pm 3.3 \pm 2.3$	
$\mathcal{B}(B^+ \to K^+\pi^+\pi^-(\mathrm{NR}))$	BaBar [28][2,7]	$9.3 \pm 1.0\,^{+6.9}_{-1.7}$	$16.3\,^{+2.0}_{-1.8}$
	Belle [29][2]	$16.9 \pm 1.3\,^{+1.7}_{-1.6}$	$16.3\,^{+2.1}_{-1.5}$

[1] The measurement from the Dalitz-plot analysis of $B^+ \to K^+\pi^+\pi^-$ decays [28] was not included in this average. It is quoted as a separate entry.
[2] Result extracted from Dalitz-plot analysis of $B^+ \to K^+\pi^+\pi^-$ decays.
[3] Result extracted from Dalitz-plot analysis of $B^+ \to K^0_S\pi^+\pi^0$ decays.
[4] The final published version includes updates to some of the results presented in the arXiv version. Readers should refer to the version published in PRD as the valid reference.
[5] Multiple systematic uncertainties are added in quadrature.
[6] Using $\mathcal{B}(B^+ \to K^+K^+K^-)$.
[7] The total nonresonant contribution is obtained by combining a exponential nonresonant component with the effective-range part of the LASS lineshape.

Table 4: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 4).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to \omega(782)K^+ \; (K^+\pi^+\pi^-))$[1]	BaBar [28][2]	$5.9\,^{+8.8}_{-9.0}\,^{+0.5}_{-0.4}$	5.9 ± 8.9 $5.9\,^{+8.8}_{-9.0}$
$\mathcal{B}(B^+ \to f_0(980)K^+) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$	BaBar [28][2] Belle [29][2]	$10.3 \pm 0.5\,^{+2.0}_{-1.4}$ $8.78 \pm 0.82\,^{+0.85}_{-1.76}$	$9.40\,^{+0.84}_{-0.92}$ $9.40\,^{+1.02}_{-1.18}$
$\mathcal{B}(B^+ \to f_2(1270)K^+)$	Belle [29][2] BaBar [28][2]	$1.33 \pm 0.30\,^{+0.23}_{-0.34}$ $0.89\,^{+0.38}_{-0.33}\,^{+0.01}_{-0.03}$	1.07 ± 0.31 1.07 ± 0.27
$\mathcal{B}(B^+ \to f_0(1370)K^+) \times \mathcal{B}(f_0(1370) \to \pi^+\pi^-)$	BaBar [34][2]	< 10.7	< 11
$\mathcal{B}(B^+ \to \rho(1450)^0K^+) \times \mathcal{B}(\rho(1450)^0 \to \pi^+\pi^-)$	BaBar [34][2]	< 11.7	< 12
$\mathcal{B}(B^+ \to f_2'(1525)K^+) \times \mathcal{B}(f_2'(1525) \to \pi^+\pi^-)$	BaBar [34][2]	< 3.4	< 3.4
$\mathcal{B}(B^+ \to \rho^0(770)K^+)$	BaBar [28][2] Belle [29][2]	$3.56 \pm 0.45\,^{+0.57}_{-0.46}$ $3.89 \pm 0.47\,^{+0.43}_{-0.41}$	3.74 ± 0.47 $3.74\,^{+0.48}_{-0.45}$
$\mathcal{B}(B^+ \to K_0^*(1430)^0\pi^+)$[3]	BaBar [28][2] Belle [29][2] BaBar [30][4,5,6]	$32.0 \pm 1.2\,^{+10.8}_{-6.0}$ $51.6 \pm 1.7\,^{+7.0}_{-7.5}$ $34.6 \pm 3.3 \pm 4.6$	39.3 ± 4.4 $39.0\,^{+5.7}_{-5.0}$
$\mathcal{B}(B^+ \to K_2^*(1430)^0\pi^+)$	BaBar [28][2] Belle [35][2]	$5.6 \pm 1.2\,^{+1.8}_{-0.8}$ < 6.9	$5.6\,^{+2.2}_{-1.4}$ $5.6\,^{+2.2}_{-1.5}$
$\mathcal{B}(B^+ \to K^*(1410)^0\pi^+)$	Belle [35][2]	< 45.0	< 45
$\mathcal{B}(B^+ \to K^*(1680)^0\pi^+)$	Belle [35][2] BaBar [34][2]	< 12.0 < 15.0	< 12
$\mathcal{B}(B^+ \to K^+\pi^0\pi^0)$	BaBar [31]	$16.2 \pm 1.2 \pm 1.5$	16.2 ± 1.9
$\mathcal{B}(B^+ \to f_0(980)K^+) \times \mathcal{B}(f_0(980) \to \pi^0\pi^0)$	BaBar [31]	$2.8 \pm 0.6 \pm 0.5$	2.8 ± 0.8

[1] This result was not included in the main entry of $\mathcal{B}(B^+ \to \omega(782)K^+)$.
[2] Result extracted from Dalitz-plot analysis of $B^+ \to K^+\pi^+\pi^-$ decays.
[3] The PDG uncertainty includes a scale factor.
[4] Result extracted from Dalitz-plot analysis of $B^+ \to K_S^0\pi^+\pi^0$ decays.
[5] The final published version includes updates to some of the results presented in the arXiv version. Readers should refer to the version published in PRD as the valid reference.
[6] Multiple systematic uncertainties are added in quadrature.

Table 5: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 5).

Parameter $[10^{-6}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^+ \to K^-\pi^+\pi^+)$	LHCb [36]	< 0.046	< 0.046
	BaBar [37]	< 0.95	
	Belle [38]	< 4.5	
$\mathcal{B}(B^+ \to K^-\pi^+\pi^+(\mathrm{NR}))$	CLEO [39]	< 56	< 56
$\mathcal{B}(B^+ \to K_1(1270)^0\pi^+)$	BaBar [40]	< 40	< 40
$\mathcal{B}(B^+ \to K_1(1400)^0\pi^+)$	BaBar [40]	< 39	< 39
$\mathcal{B}(B^+ \to K^0\pi^+\pi^0)$	BaBar [30][1,2,3]	$31.8 \pm 1.8\,^{+6.4}_{-2.1}$	$31.8\,^{+6.6}_{-2.8}$ < 66.0
$\mathcal{B}(B^+ \to K_0^*(1430)^+\pi^0)$	BaBar [30][1,2,3]	$11.9 \pm 1.7\,^{+1.0}_{-1.6}$	$11.9\,^{+2.0}_{-2.4}$ $11.9\,^{+2.0}_{-2.3}$
$\mathcal{B}(B^+ \to \rho^+(770)K^0)$	BaBar [30][1,2,3]	$6.5 \pm 1.1\,^{+0.8}_{-1.9}$	$6.5\,^{+1.4}_{-2.2}$ $7.3\,^{+1.0}_{-1.2}$
$\mathcal{B}(B^+ \to K^*(892)^+\pi^+\pi^-)$	BaBar [41]	$75.3 \pm 6.0 \pm 8.1$	75 ± 10
$\mathcal{B}(B^+ \to K^*(892)^+\rho^0(770))$	BaBar [42]	$4.6 \pm 1.0 \pm 0.4$	4.6 ± 1.1
$\mathcal{B}(B^+ \to f_0(980)K^*(892)^+) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$	BaBar [42]	$4.2 \pm 0.6 \pm 0.3$	4.2 ± 0.7
$\mathcal{B}(B^+ \to a_1(1260)^+K^0)$	BaBar [43]	$34.9 \pm 5.0 \pm 4.4$	34.9 ± 6.7
$\mathcal{B}(B^+ \to b_1(1235)^+K^0) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^+)$	BaBar [47]	$9.6 \pm 1.7 \pm 0.9$	9.6 ± 1.9
$\mathcal{B}(B^+ \to K^*(892)^0\rho^+(770))$	BaBar [44]	$9.6 \pm 1.7 \pm 1.5$	9.2 ± 1.5
	Belle [45][4]	$8.9 \pm 1.7 \pm 1.2$	
$\mathcal{B}(B^+ \to K_1(1400)^+\rho^0(770))$	ARGUS [46]	< 780	< 780
$\mathcal{B}(B^+ \to K_2^*(1430)^+\rho^0(770))$	ARGUS [46]	< 1500	< 1500

[1] Result extracted from Dalitz-plot analysis of $B^+ \to K_S^0\pi^+\pi^0$ decays.

[2] The final published version includes updates to some of the results presented in the arXiv version. Readers should refer to the version published in PRD as the valid reference.

[3] Multiple systematic uncertainties are added in quadrature.

[4] See also Ref. [48].

Table 6: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 6).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to b_1(1235)^0 K^+) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [52]	$9.1 \pm 1.7 \pm 1.0$	9.1 ± 2.0
$\mathcal{B}(B^+ \to b_1(1235)^+ K^*(892)^0) \times \mathcal{B}(b_1(1235)^+ \to \omega(782)\pi^+)$	BaBar [53]	< 5.9	< 5.9
$\mathcal{B}(B^+ \to b_1(1235)^0 K^*(892)^+) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [53]	< 6.7	< 6.7
$\mathcal{B}(B^+ \to K^+ \overline{K}^0)$[1]	Belle [4]	$1.11 \pm 0.19 \pm 0.05$	1.32 ± 0.14
	LHCb [8][2]	$1.53 \pm 0.22 \pm 0.10$	1.31 ± 0.17
	BaBar [6]	$1.61 \pm 0.44 \pm 0.09$	
$\mathcal{B}(B^+ \to \overline{K}^0 K^+ \pi^0)$	CLEO [49]	< 24.0	< 24
$\mathcal{B}(B^+ \to K^+ K^0_S K^0_S)$[3]	Belle [50]	$10.42 \pm 0.43 \pm 0.22$	10.29 ± 0.37
	BaBar [22][4,5]	$10.1 \pm 0.5 \pm 0.3$	10.49 ± 0.37
$\mathcal{B}(B^+ \to f_0(980) K^+) \times \mathcal{B}(f_0(980) \to K^0_S K^0_S)$	BaBar [22][4]	$14.7 \pm 2.8 \pm 1.8$	14.7 ± 3.3
$\mathcal{B}(B^+ \to f_0(1710) K^+) \times \mathcal{B}(f_0(1710) \to K^0_S K^0_S)$	BaBar [22][4]	$0.48\,^{+0.40}_{-0.24} \pm 0.11$	$0.48\,^{+0.41}_{-0.26}$
$\mathcal{B}(B^+ \to K^+ K^0_S K^0_S(\text{NR}))$	BaBar [22][6,4]	$19.8 \pm 3.7 \pm 2.5$	19.8 ± 4.5
$\mathcal{B}(B^+ \to K^0_S K^0_S \pi^+)$	BaBar [51]	< 0.51	< 0.51
	Belle [50]	< 0.87	

[1] The PDG average is a result of a fit including input from other measurements.
[2] Using $\mathcal{B}(B^+ \to K^0 \pi^+)$.
[3] PDG uses the BABAR result including the χ_{c0} intermediate state.
[4] Result extracted from Dalitz-plot analysis of $B^+ \to K^0_S K^0_S K^+$ decays.
[5] All charmonium resonances are vetoed. The analysis also reports $\mathcal{B}(B^+ \to K^0_S K^0_S K^+) = (10.6 \pm 0.5 \pm 0.3) \times 10^{-6}$ including the χ_{c0} intermediate state.
[6] The nonresonant amplitude is modelled using a polynomial function of order 2.

Table 7: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 7).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to K^+K^-\pi^+)$	LHCb [32][1] Belle [54][2] BaBar [55]	$5.12 \pm 0.14 \pm 0.29$ $5.38 \pm 0.40 \pm 0.35$ $5.0 \pm 0.5 \pm 0.5$	5.16 ± 0.26 5.24 ± 0.42
$\mathcal{B}(B^+ \to K^+K^-\pi^+(\text{NR}))$	LHCb [56][3,4]	$1.625 \pm 0.075\,^{+0.221}_{-0.222}$	$1.63\,^{+0.24}_{-0.23}$ 1.68 ± 0.26
$\mathcal{B}(B^+ \to \overline{K}^*(892)^0K^+)$	BaBar [57] LHCb [56][5,6]	< 1.1	$0.57\,^{+0.07}_{-0.06}$ 0.59 ± 0.08
$\mathcal{B}(B^+ \to \overline{K}^*_0(1430)^0K^+)$	BaBar [57] LHCb [56][5,7]	< 2.2	$0.37\,^{+0.13}_{-0.12}$ 0.38 ± 0.13
$\mathcal{B}(B^+ \to K^+K^-\pi^+)$ $\pi\pi \leftrightarrow KK$ rescattering	LHCb [56][8,4]	$0.825 \pm 0.040 \pm 0.065$	$0.825\,^{+0.077}_{-0.075}$ 0.853 ± 0.094
$\mathcal{B}(B^+ \to K^+K^+\pi^-)$	LHCb [36] BaBar [37] Belle [38]	< 0.011 < 0.16 < 2.4	< 0.011
$\mathcal{B}(B^+ \to f_2'(1525)K^+)$[9]	BaBar [22][10] BaBar [22][11] Belle [35][10]	$1.56 \pm 0.36 \pm 0.30$ $2.8 \pm 0.9\,^{+0.5}_{-0.4}$ < 8.0	1.79 ± 0.42 1.79 ± 0.48
$\mathcal{B}(B^+ \to f_J(2220)K^+) \times \mathcal{B}(f_J(2220) \to p\overline{p})$	Belle [58]	< 0.41	< 0.41
$\mathcal{B}(B^+ \to K^*(892)^+\pi^+K^-)$	BaBar [41]	< 11.8	< 12
$\mathcal{B}(B^+ \to K^*(892)^+\overline{K}^*(892)^0)$	Belle [59] BaBar [60]	$0.77\,^{+0.35}_{-0.30} \pm 0.12$ $1.2 \pm 0.5 \pm 0.1$	0.91 ± 0.30 $0.91\,^{+0.30}_{-0.27}$
$\mathcal{B}(B^+ \to K^*(892)^+K^+\pi^-)$	BaBar [41]	< 6.1	< 6.1

[1] Using $\mathcal{B}(B^+ \to K^+K^+K^-)$.
[2] Also measured in bins of $m_{K^+K^-}$ and $m_{K^+\pi^-}$.
[3] LHCb uses a model of the nonresonant contribution obtained from a phenomenological description of the partonic interaction that produces the final state. This contribution is referred to as the single pole in the paper; see Ref. [56] for details.
[4] Using $\mathcal{B}(B^+ \to K^+K^-\pi^+)$.
[5] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^-\pi^+$ decays.
[6] Measurement of $(\mathcal{B}(B^+ \to \overline{K}^*(892)^0K^+)\mathcal{B}(K^*(892)^0 \to K\pi)2/3)/\mathcal{B}(B^+ \to K^+K^-\pi^+)$ used in our fit.
[7] Measurement of $(\mathcal{B}(B^+ \to \overline{K}^*_0(1430)^0K^+)\mathcal{B}(K^*(1430) \to K\pi)2/3)/\mathcal{B}(B^+ \to K^+K^-\pi^+)$ used in our fit.
[8] LHCb uses a dedicated lineshape to take into account $\pi\pi \leftrightarrow KK$ rescattering, which is particularly significant in the region $1 < m_{KK} < 1.5$ GeV$/c^2$. See Ref. [56] for details.
[9] The PDG uncertainty includes a scale factor.
[10] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^+K^-$ decays.
[11] Result extracted from Dalitz-plot analysis of $B^+ \to K^0_S K^0_S K^+$ decays.

Table 8: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 8).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to K^+K^+K^-)$ [1,2]	BaBar [22][3,4]	$34.6 \pm 0.6 \pm 0.9$	33.9 ± 0.7
	Belle [35][3]	$30.6 \pm 1.2 \pm 2.3$	34.0 ± 1.4
	Belle II [33]	$35.8 \pm 1.6 \pm 1.4$	
	LHCb [61][5,6,7], [32][8,9,10]		
$\mathcal{B}(B^+ \to \phi(1020)K^+)$ [1]	BaBar [22][3]	$9.2 \pm 0.4\,^{+0.7}_{-0.5}$	8.53 ± 0.47
	Belle [35][3]	$9.60 \pm 0.92\,^{+1.05}_{-0.85}$	$8.83\,^{+0.67}_{-0.57}$
	Belle II [62]	$6.7 \pm 1.1 \pm 0.5$	
	CDF [63]	$7.6 \pm 1.3 \pm 0.6$	
	CLEO [64]	$5.5\,^{+2.1}_{-1.8} \pm 0.6$	
$\mathcal{B}(B^+ \to f_0(980)K^+) \times \mathcal{B}(f_0(980) \to K^+K^-)$	BaBar [22][3]	$9.4 \pm 1.6 \pm 2.8$	9.4 ± 3.2
$\mathcal{B}(B^+ \to a_2(1320)^0K^+) \times \mathcal{B}(a_2(1320)^0 \to K^+K^-)$	Belle [35][3]	< 1.1	< 1.1
$\mathcal{B}(B^+ \to \phi(1680)K^+) \times \mathcal{B}(\phi(1680) \to K^+K^-)$	Belle [35][3]	< 0.8	< 0.8
$\mathcal{B}(B^+ \to f_0(1710)K^+) \times \mathcal{B}(f_0(1710) \to K^+K^-)$	BaBar [22][3]	$1.12 \pm 0.25 \pm 0.50$	1.12 ± 0.56
$\mathcal{B}(B^+ \to K^+K^+K^-(\mathrm{NR}))$	Belle [35][3]	$24.0 \pm 1.5\,^{+2.6}_{-6.0}$	$23.7\,^{+3.0}_{-4.9}$
	BaBar [22][11,3]	$22.8 \pm 2.7 \pm 7.6$	$23.8\,^{+2.8}_{-4.9}$

[1] The PDG uncertainty includes a scale factor.
[2] Treatment of charmonium intermediate components differs between the results.
[3] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^+K^-$ decays.
[4] All charmonium resonances are vetoed, except for χ_{c0}. The analysis also reports $\mathcal{B}(B^+ \to K^+K^+K^-) = (33.4 \pm 0.5 \pm 0.9) \times 10^{-6}$ excluding χ_{c0}.
[5] Measurement of $\frac{f_{\Omega_b^-}}{f_u} \times \mathcal{B}(\Omega_b^- \to pK^-K^-)/\mathcal{B}(B^+ \to K^+K^+K^-)$ used in our fit.
[6] Measurement of $\frac{f_{\Omega_b^-}}{f_u} \times \mathcal{B}(\Omega_b^- \to pK^-\pi^-)/\mathcal{B}(B^+ \to K^+K^+K^-)$ used in our fit.
[7] Measurement of $\frac{f_{\Omega_b^-}}{f_u} \times \mathcal{B}(\Omega_b^- \to p\pi^-\pi^-)/\mathcal{B}(B^+ \to K^+K^+K^-)$ used in our fit.
[8] Measurement of $\mathcal{B}(B^+ \to K^+K^-\pi^+)/\mathcal{B}(B^+ \to K^+K^+K^-)$ used in our fit.
[9] Measurement of $\mathcal{B}(B^+ \to K^+\pi^+\pi^-)/\mathcal{B}(B^+ \to K^+K^+K^-)$ used in our fit.
[10] Measurement of $\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-)/\mathcal{B}(B^+ \to K^+K^+K^-)$ used in our fit.
[11] The nonresonant amplitude is modelled using a polynomial function including S-wave and P-wave terms.

Table 9: Branching fractions of charmless mesonic B^+ decays with strange mesons (part 9).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to K^*(892)^+ K^+ K^-)$	BaBar [41]	$36.2 \pm 3.3 \pm 3.6$	36.2 ± 4.9
$\mathcal{B}(B^+ \to \phi(1020) K^*(892)^+)$ [1]	BaBar [65] [2]	$11.2 \pm 1.0 \pm 0.9$	10.6 ± 1.1
	Belle [66]	$6.7\,^{+2.1}_{-1.9}\,^{+0.7}_{-1.0}$	10.0 ± 2.0
	Belle II [62]	$21.7 \pm 4.6 \pm 1.9$	
	CLEO [64]	$10.6\,^{+6.4}_{-4.9}\,^{+1.8}_{-1.6}$	
$\mathcal{B}(B^+ \to \phi(1020)(K\pi)^{*+}_0)$	BaBar [67]	$8.3 \pm 1.4 \pm 0.8$	8.3 ± 1.6
$\mathcal{B}(B^+ \to K_1(1270)^+ \phi(1020))$	BaBar [67]	$6.1 \pm 1.6 \pm 1.1$	6.1 ± 1.9
$\mathcal{B}(B^+ \to K_1(1400)^+ \phi(1020))$	BaBar [67]	< 3.2	< 3.2
$\mathcal{B}(B^+ \to K^*(1410)^+ \phi(1020))$	BaBar [67]	< 4.3	< 4.3
$\mathcal{B}(B^+ \to K^*_0(1430)^+ \phi(1020))$	BaBar [67]	$7.0 \pm 1.3 \pm 0.9$	7.0 ± 1.6
$\mathcal{B}(B^+ \to K^*_2(1430)^+ \phi(1020))$	BaBar [67]	$8.4 \pm 1.8 \pm 1.0$	8.4 ± 2.1
$\mathcal{B}(B^+ \to K_2(1770)^+ \phi(1020))$	BaBar [67]	< 15.0	< 15
$\mathcal{B}(B^+ \to \phi(1020) K_2(1820)^+)$	BaBar [67]	< 16.3	< 16
$\mathcal{B}(B^+ \to a_1(1260)^+ K^*(892)^0)$	BaBar [68]	< 3.6	< 3.6
$\mathcal{B}(B^+ \to \phi(1020)\phi(1020) K^+)$ [1]	BaBar [69] [3]	$5.6 \pm 0.5 \pm 0.3$	4.98 ± 0.52
	Belle [70] [3]	$2.6\,^{+1.1}_{-0.9} \pm 0.3$	$4.22\,^{+0.82}_{-0.79}$
$\mathcal{B}(B^+ \to \eta' \eta' K^+)$	BaBar [71]	< 25.0	< 25
$\mathcal{B}(B^+ \to \phi(1020)\omega(782) K^+)$	Belle [72]	< 1.9	< 1.9
$\mathcal{B}(B^+ \to X(1812) K^+) \times \mathcal{B}(X(1812) \to \phi(1020)\omega(782))$	Belle [72]	< 0.32	< 0.32
$\mathcal{B}(B^+ \to h^+ X^0(\text{Familon}))$ [4]	CLEO [73]	< 49	< 49

[1] The PDG uncertainty includes a scale factor.

[2] Combination of two final states of the $K^*(892)^\pm$, $K^0_S\pi^\pm$ and $K^\pm\pi^0$. In addition to the combined results, the paper reports separately the results for each individual final state.

[3] Measured in the $\phi\phi$ invariant mass range below the η_c resonance ($m_{\phi\phi} < 2.85$ GeV/c^2).

[4] $h = \pi, K$.

Table 10: Branching fractions of charmless mesonic B^+ decays without strange mesons (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to \pi^+\pi^0)$ [1]	Belle [4]	$5.86 \pm 0.26 \pm 0.38$	5.33 ± 0.27 5.48 ± 0.41
	Belle II [5]	$5.1 \pm 0.3 \pm 0.3$	
	BaBar [9]	$5.02 \pm 0.46 \pm 0.29$	
	CLEO [7]	$4.6\,^{+1.8}_{-1.6}\,^{+0.6}_{-0.7}$	
$\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-)$	LHCb [32] [2]	$16.54 \pm 0.17 \pm 0.47$	16.46 ± 0.48 $15.20\,^{+1.43}_{-1.34}$
	BaBar [74] [3,4,5]	$15.2 \pm 0.6\,^{+1.3}_{-1.2}$	
$\mathcal{B}(B^+ \to \rho^0(770)\pi^+)$	LHCb [75] [3,6,5,7]	$8.82 \pm 0.10 \pm 0.50$	8.76 ± 0.47 $8.29\,^{+1.20}_{-1.28}$
	BaBar [74] [3,5]	$8.1 \pm 0.7\,^{+1.3}_{-1.6}$	
	Belle [76]	$8.0\,^{+2.3}_{-2.0} \pm 0.7$	
	CLEO [25]	$10.4\,^{+3.3}_{-3.4} \pm 2.1$	
$\mathcal{B}(B^+ \to f_0(980)\pi^+) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$	BaBar [74] [3]	< 1.5	< 1.5
$\mathcal{B}(B^+ \to f_2(1270)\pi^+) \times \mathcal{B}(f_2(1270) \to \pi^+\pi^-)$	LHCb [75] [3,6,5,7]	$1.43 \pm 0.05 \pm 0.27$	1.27 ± 0.17 none
	BaBar [74] [3,5]	$0.9 \pm 0.2\,^{+0.3}_{-0.1}$	
$\mathcal{B}(B^+ \to f_2(1270)\pi^+) \times \mathcal{B}(f_2(1270) \to K^+K^-)$	LHCb [56] [8,9]	$0.377 \pm 0.040 \pm 0.040$	$0.377\,^{+0.057}_{-0.056}$ none
$\mathcal{B}(B^+ \to \rho(1450)^0\pi^+) \times \mathcal{B}(\rho(1450)^0 \to \pi^+\pi^-)$	LHCb [75] [3,6,5,7]	$0.83 \pm 0.05 \pm 0.89$	$1.14\,^{+0.59}_{-0.67}$ $1.40\,^{+0.64}_{-0.89}$
	BaBar [74] [3,5]	$1.4 \pm 0.4\,^{+0.5}_{-0.8}$	
$\mathcal{B}(B^+ \to \rho(1450)^0\pi^+) \times \mathcal{B}(\rho(1450)^0 \to K^+K^-)$	LHCb [56] [8,9]	$1.545 \pm 0.060\,^{+0.089}_{-0.090}$	1.54 ± 0.11 1.60 ± 0.14
$\mathcal{B}(B^+ \to \rho_3(1690)^0\pi^+) \times \mathcal{B}(\rho_3(1690)^0 \to \pi^+\pi^-)$	LHCb [75] [3,6,5,7]	$0.08 \pm 0.02 \pm 0.16$	0.08 ± 0.16 none

[1] The PDG uncertainty includes a scale factor.
[2] Using $\mathcal{B}(B^+ \to K^+K^+K^-)$.
[3] Result extracted from Dalitz-plot analysis of $B^+ \to \pi^+\pi^+\pi^-$ decays.
[4] Charm and charmonium contributions are subtracted.
[5] Multiple systematic uncertainties are added in quadrature.
[6] This analysis uses three different approaches: isobar, K-matrix and quasi-model-independent, to describe the S-wave component. The results are taken from the isobar model with an additional error accounting for the different S-wave methods as reported in Appendix D of Ref. [77].
[7] Using $\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-)$.
[8] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^-\pi^+$ decays.
[9] Using $\mathcal{B}(B^+ \to K^+K^-\pi^+)$.

Table 11: Branching fractions of charmless mesonic B^+ decays without strange mesons (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-)$ $S-$wave	LHCb [75][1,2,3,4]	$4.04 \pm 0.08 \pm 0.64$	4.04 ± 0.64 none
$\mathcal{B}(B^+ \to f_0(1370)\pi^+) \times \mathcal{B}(f_0(1370) \to \pi^+\pi^-)$	BaBar [74][5]	< 4.0	< 4.0
$\mathcal{B}(B^+ \to \pi^+\pi^-\pi^+(\mathrm{NR}))$	BaBar [74][6,3]	$5.3 \pm 0.7\,^{+1.3}_{-0.8}$	$5.3\,^{+1.4}_{-1.0}$ $5.3\,^{+1.5}_{-1.1}$
$\mathcal{B}(B^+ \to \pi^+\pi^0\pi^0)$	Belle [78] ARGUS [79]	$19.0 \pm 1.5 \pm 1.4$ < 890	19.0 ± 2.1 < 890.0
$\mathcal{B}(B^+ \to X_{\pi^0\pi^0}\pi^+) \times \mathcal{B}(X(\pi^0\pi^0) \to \pi^0\pi^0)$	Belle [78][7]	$6.9 \pm 0.9 \pm 0.6$	6.9 ± 1.1 none
$\mathcal{B}(B^+ \to \pi^+\pi^0\pi^0(\mathrm{NR}))$	Belle [78]	< 0.6	< 0.60 none
$\mathcal{B}(B^+ \to \rho^+(770)\pi^0)$	Belle [78][3] BaBar [80]	$11.2 \pm 1.1\,^{+1.2}_{-1.8}$ $10.2 \pm 1.4 \pm 0.9$	10.6 ± 1.3 $10.9\,^{+1.4}_{-1.5}$
$\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-\pi^0)$	ARGUS [79]	< 4000	< 4000
$\mathcal{B}(B^+ \to \rho^+(770)\rho^0(770))$	BaBar [81] Belle II [82] Belle [83]	$23.7 \pm 1.4 \pm 1.4$ $23.2\,^{+2.2}_{-2.1} \pm 2.7$ $31.7 \pm 7.1\,^{+3.8}_{-6.7}$	23.8 ± 1.7 24.0 ± 1.9
$\mathcal{B}(B^+ \to f_0(980)\rho^+(770)) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$	BaBar [81]	< 2.0	< 2.0
$\mathcal{B}(B^+ \to a_1(1260)^+\pi^0)$	BaBar [84]	$26.4 \pm 5.4 \pm 4.1$	26.4 ± 6.8
$\mathcal{B}(B^+ \to a_1(1260)^0\pi^+)$	BaBar [84]	$20.4 \pm 4.7 \pm 3.4$	20.4 ± 5.8
$\mathcal{B}(B^+ \to \omega(782)\pi^+)$	BaBar [24] Belle [85] CLEO [25] LHCb [75][5,2,3,8]	$6.7 \pm 0.5 \pm 0.4$ $6.9 \pm 0.6 \pm 0.5$ $11.3\,^{+3.3}_{-2.9} \pm 1.4$	$6.60\,^{+0.46}_{-0.45}$ 6.88 ± 0.49
$\mathcal{B}(B^+ \to \omega(782)\rho^+(770))$	BaBar [26]	$15.9 \pm 1.6 \pm 1.4$	15.9 ± 2.1

[1] LHCb accounts for the S-wave component using a model that comprises the coherent sum of a σ pole and a rescattering amplitude. See Ref. [75] for details.
[2] This analysis uses three different approaches: isobar, K-matrix and quasi-model-independent, to describe the S-wave component. The results are taken from the isobar model with an additional error accounting for the different S-wave methods as reported in Appendix D of Ref. [77].
[3] Multiple systematic uncertainties are added in quadrature.
[4] Using $\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-)$.
[5] Result extracted from Dalitz-plot analysis of $B^+ \to \pi^+\pi^+\pi^-$ decays.
[6] The nonresonant amplitude is modelled using a sum of exponential functions.
[7] $X_{\pi^0\pi^0}$ corresponds to a structure observed in Ref. [78], likely arising due to multiple resonances.
[8] Measurement of $(\mathcal{B}(B^+ \to \omega(782)\pi^+)\mathcal{B}(\omega(782) \to \pi^+\pi^-))/\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-)$ used in our fit.

Table 12: Branching fractions of charmless mesonic B^+ decays without strange mesons (part 3).

Parameter $[10^{-6}]$	**Measurements**		**Average** (HFLAV / PDG)
$\mathcal{B}(B^+ \to \eta\pi^+)$	Belle [18]	$4.07 \pm 0.26 \pm 0.21$	4.02 ± 0.27
	BaBar [10]	$4.00 \pm 0.40 \pm 0.24$	$4.02\,^{+0.27}_{-0.26}$
	CLEO [14]	$1.2\,^{+2.8}_{-1.2}$	
$\mathcal{B}(B^+ \to \eta\rho^+(770))$[1]	BaBar [86]	$9.9 \pm 1.2 \pm 0.8$	6.9 ± 1.0
	Belle [20]	$4.1\,^{+1.4}_{-1.3} \pm 0.4$	$7.0\,^{+2.9}_{-2.8}$
	CLEO [14]	$4.8\,^{+5.2}_{-3.8}$	
$\mathcal{B}(B^+ \to \eta'\pi^+)$[1]	BaBar [10]	$3.5 \pm 0.6 \pm 0.2$	2.68 ± 0.46
	Belle [11]	$1.76\,^{+0.67}_{-0.62}\,^{+0.15}_{-0.14}$	$2.70\,^{+0.87}_{-0.84}$
	CLEO [14]	$1.0\,^{+5.8}_{-1.0}$	
$\mathcal{B}(B^+ \to \eta'\rho^+(770))$	BaBar [16]	$9.7\,^{+1.9}_{-1.8} \pm 1.1$	9.8 ± 2.1
	CLEO [14]	$11.2\,^{+11.9}_{-7.0}$	$9.7\,^{+2.2}_{-2.1}$
	Belle [17]	< 5.8	
$\mathcal{B}(B^+ \to \phi(1020)\pi^+)$	BaBar [87]	< 0.24	0.031 ± 0.014
	Belle [88]	< 0.33	0.032 ± 0.015
	LHCb [56][2,3]		
$\mathcal{B}(B^+ \to \phi(1020)\rho^+(770))$	BaBar [89]	< 3.0	< 3.0
$\mathcal{B}(B^+ \to a_0(980)^0\pi^+) \times \mathcal{B}(a_0(980)^0 \to \eta\pi^0)$	BaBar [27]	< 5.8	< 5.8
$\mathcal{B}(B^+ \to \pi^+\pi^+\pi^+\pi^-\pi^-)$	ARGUS [79]	< 860	< 860
$\mathcal{B}(B^+ \to a_1(1260)^+\rho^0(770))$	CLEO [90][4]	< 620.0	< 620
$\mathcal{B}(B^+ \to a_2(1320)^+\rho^0(770))$	CLEO [90][4]	< 720.0	< 720
$\mathcal{B}(B^+ \to b_1(1235)^0\pi^+) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [52]	$6.7 \pm 1.7 \pm 1.0$	6.7 ± 2.0
$\mathcal{B}(B^+ \to b_1^+\pi^0)$	BaBar [47]	< 3.3	< 3.3
$\mathcal{B}(B^+ \to \pi^+\pi^+\pi^+\pi^-\pi^-\pi^0)$	ARGUS [79]	< 6300	< 6300
$\mathcal{B}(B^+ \to b_1(1235)^+\rho^0(770)) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^+)$	BaBar [53]	< 5.2	< 5.2
$\mathcal{B}(B^+ \to a_1(1260)^+a_1(1260)^0)$	ARGUS [79]	< 13000	< 13000
$\mathcal{B}(B^+ \to b_1(1235)^0\rho^+(770)) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [53]	< 3.3	< 3.3

[1] The PDG uncertainty includes a scale factor.

[2] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^-\pi^+$ decays.

[3] Measurement of $(\mathcal{B}(B^+ \to \phi(1020)\pi^+)\mathcal{B}(\phi(1020) \to K^+K^-))/\mathcal{B}(B^+ \to K^+K^-\pi^+)$ used in our fit.

[4] CLEO assumes $\mathcal{B}(\Upsilon(4S) \to B^0\overline{B}^0) = 0.43$. The result has been modified to account for a branching fraction of 0.50.

Table 13: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to K^+\pi^-)$	Belle [4]	$20.00 \pm 0.34 \pm 0.60$	20.1 ± 0.4 19.6 ± 0.5
	Belle II [5]	$20.7 \pm 0.4 \pm 0.6$	
	BaBar [91]	$19.1 \pm 0.6 \pm 0.6$	
	CLEO [7]	$18.0\,^{+2.3}_{-2.1}\,^{+1.2}_{-0.9}$	
	CDF [92][1,2], [93][3,4], [94][5,6]		
	LHCb [95][3,4,1], [96][5,6]		
$\mathcal{B}(B^0 \to K^0\pi^0)$	Belle [4]	$9.68 \pm 0.46 \pm 0.50$	10.12 ± 0.43 9.93 ± 0.49
	BaBar [97]	$10.1 \pm 0.6 \pm 0.4$	
	Belle II [5][7]	$10.73 \pm 0.63 \pm 0.62$	
	CLEO [7]	$12.8\,^{+4.0}_{-3.3}\,^{+1.7}_{-1.4}$	
$\mathcal{B}(B^0 \to \eta' K^0)$[8]	BaBar [10]	$68.5 \pm 2.2 \pm 3.1$	65.0 ± 2.8 $66.1\,^{+4.5}_{-4.4}$
	Belle [11]	$58.9\,^{+3.6}_{-3.5} \pm 4.3$	
	Belle II [12]	$59.9\,^{+5.8}_{-5.5} \pm 2.7$	
	CLEO [14]	$89.0\,^{+18.0}_{-16.0} \pm 9.0$	
	LHCb [98][9,10]		
$\mathcal{B}(B^0 \to \eta' K^*(892)^0)$	Belle [99]	$2.6 \pm 0.7 \pm 0.2$	2.8 ± 0.6
	BaBar [16]	$3.1\,^{+0.9}_{-0.8} \pm 0.3$	
$\mathcal{B}(B^0 \to \eta' K_0^*(1430)^0)$	BaBar [16][11]	$6.3 \pm 1.3 \pm 0.9$	6.3 ± 1.6
$\mathcal{B}(B^0 \to \eta' (K\pi)_0^{*0})$	BaBar [16]	$7.4\,^{+1.5}_{-1.4} \pm 0.6$	7.4 ± 1.6 none
$\mathcal{B}(B^0 \to \eta' K_2^*(1430)^0)$	BaBar [16]	$13.7\,^{+3.0}_{-2.9} \pm 1.2$	13.7 ± 3.2 $13.7\,^{+3.2}_{-3.1}$

[1] Measurement of $(\mathcal{B}(B_s^0 \to K^-\pi^+)/\mathcal{B}(B^0 \to K^+\pi^-))\frac{f_s}{f_d}$ used in our fit.
[2] Measurement of $(\mathcal{B}(\Lambda_b^0 \to p\pi^-)/\mathcal{B}(B^0 \to K^+\pi^-))(f_{\Lambda_b^0}/f_d)$ used in our fit.
[3] Measurement of $\mathcal{B}(B^0 \to \pi^+\pi^-)/\mathcal{B}(B^0 \to K^+\pi^-)$ used in our fit.
[4] Measurement of $(\mathcal{B}(B_s^0 \to K^+K^-)/\mathcal{B}(B^0 \to K^+\pi^-))\frac{f_s}{f_d}$ used in our fit.
[5] Measurement of $\mathcal{B}(B^0 \to K^+K^-)/\mathcal{B}(B^0 \to K^+\pi^-)$ used in our fit.
[6] Measurement of $(\mathcal{B}(B_s^0 \to \pi^+\pi^-)/\mathcal{B}(B^0 \to K^+\pi^-))\frac{f_s}{f_d}$ used in our fit.
[7] Combination of time-integrated and time-dependent analyses using the best linear unbiased estimator Ref. [100].
[8] The PDG uncertainty includes a scale factor.
[9] Measurement of $\mathcal{B}(\Lambda_b^0 \to \Lambda^0\eta)/\mathcal{B}(B^0 \to \eta' K^0)$ used in our fit.
[10] Measurement of $\mathcal{B}(\Lambda_b^0 \to \Lambda^0\eta')/\mathcal{B}(B^0 \to \eta' K^0)$ used in our fit.
[11] Multiple systematic uncertainties are added in quadrature.

Table 14: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 2).

Parameter $[10^{-6}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^0 \to \eta K^0)$	Belle [18]	$1.27\,^{+0.33}_{-0.29} \pm 0.08$	1.23 ± 0.25
	BaBar [10]	$1.15\,^{+0.43}_{-0.38} \pm 0.09$	$1.23\,^{+0.27}_{-0.24}$
$\mathcal{B}(B^0 \to \eta K^*(892)^0)$	BaBar [19]	$16.5 \pm 1.1 \pm 0.8$	16.09 ± 0.81
	Belle [20]	$15.2 \pm 1.2 \pm 1.0$	$15.87\,^{+1.01}_{-1.00}$
	CLEO [14]	$13.8\,^{+5.5}_{-4.6} \pm 1.6$	
$\mathcal{B}(B^0 \to \eta (K\pi)^{*0}_0)$	BaBar [19]	$11.0 \pm 1.6 \pm 1.5$	11.0 ± 1.6 / none
$\mathcal{B}(B^0 \to \eta K^*_0(1430)^0)$	BaBar [19][1]	$7.8 \pm 1.1 \pm 1.1$	7.8 ± 1.1 / 11.0 ± 2.2
$\mathcal{B}(B^0 \to \eta K^*_2(1430)^0)$	BaBar [19]	$9.6 \pm 1.8 \pm 1.1$	9.6 ± 1.5 / 9.6 ± 2.1
$\mathcal{B}(B^0 \to \omega(782) K^0)$	Belle [23]	$4.5 \pm 0.4 \pm 0.3$	4.78 ± 0.43
	BaBar [24]	$5.4 \pm 0.8 \pm 0.3$	
	CLEO [25]	$10.0\,^{+5.4}_{-4.2} \pm 1.4$	
$\mathcal{B}(B^0 \to a_0(980)^0 K^0) \times \mathcal{B}(a_0(980)^0 \to \eta\pi^0)$	BaBar [27]	< 7.8	< 7.8
$\mathcal{B}(B^0 \to b_1(1235)^0 K^0) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [47]	< 7.8	< 7.8
$\mathcal{B}(B^0 \to a_0(980)^- K^+) \times \mathcal{B}(a_0(980)^- \to \eta\pi^-)$	BaBar [101]	< 1.9	< 1.9
$\mathcal{B}(B^0 \to b_1(1235)^- K^+) \times \mathcal{B}(b_1(1235)^- \to \omega(782)\pi^-)$	BaBar [52]	$7.4 \pm 1.0 \pm 1.0$	7.4 ± 1.4
$\mathcal{B}(B^0 \to b_1(1235)^0 K^*(892)^0) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [53]	< 8.0	< 8.0
$\mathcal{B}(B^0 \to b_1(1235)^- K^*(892)^+) \times \mathcal{B}(b_1(1235)^- \to \omega(782)\pi^-)$	BaBar [53]	< 5.0	< 5.0
$\mathcal{B}(B^0 \to a_0(1450)^- K^+) \times \mathcal{B}(a_0(1450)^- \to \eta\pi^-)$	BaBar [101]	< 3.1	< 3.1
$\mathcal{B}(B^0 \to K^0_S X^0(\text{Familon}))$	CLEO [73]	< 53	< 53

[1] Multiple systematic uncertainties are added in quadrature.

Table 15: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 3).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to \omega(782)K^*(892)^0)$	BaBar [26]	$2.2 \pm 0.6 \pm 0.2$	2.04 ± 0.49
	Belle [102]	$1.8 \pm 0.7 \pm 0.3$	
$\mathcal{B}(B^0 \to \omega(782)(K\pi)^{*0}_0)$	BaBar [26]	$18.4 \pm 1.8 \pm 1.7$	18.4 ± 2.5
$\mathcal{B}(B^0 \to \omega(782)K^*_0(1430)^0)$	BaBar [26]	$16.0 \pm 1.6 \pm 3.0$	16.0 ± 3.4
$\mathcal{B}(B^0 \to \omega(782)K^*_2(1430)^0)$	BaBar [26]	$10.1 \pm 2.0 \pm 1.1$	10.1 ± 2.3
$\mathcal{B}(B^0 \to \omega(782)K^+\pi^-(\mathrm{NR}))$	Belle [102][1]	$5.1 \pm 0.7 \pm 0.7$	5.1 ± 1.0
$\mathcal{B}(B^0 \to K^+\pi^-\pi^0)$	BaBar [103][2]	$38.5 \pm 1.0 \pm 3.9$	37.9 ± 2.7
	Belle II [33]	$38.1 \pm 3.5 \pm 3.9$	37.8 ± 3.2 (PDG)
	Belle [104]	$36.6\,^{+4.2}_{-4.1} \pm 3.0$	
$\mathcal{B}(B^0 \to \rho^-(770)K^+)$	BaBar [103][2]	$6.6 \pm 0.5 \pm 0.8$	7.01 ± 0.92
	Belle [104][3]	$15.1\,^{+3.4}_{-3.3}\,^{+2.4}_{-2.6}$	
$\mathcal{B}(B^0 \to \rho(1450)^-K^+)$	BaBar [103][2]	$2.4 \pm 1.0 \pm 0.6$	2.4 ± 1.2
$\mathcal{B}(B^0 \to \rho(1700)^-K^+)$	BaBar [103][2]	$0.6 \pm 0.6 \pm 0.4$	0.6 ± 0.7
$\mathcal{B}(B^0 \to K^+\pi^-\pi^0(\mathrm{NR}))$	BaBar [103][4]	$2.8 \pm 0.5 \pm 0.4$	2.8 ± 0.6
	Belle [104]	< 9.4	
$\mathcal{B}(B^0 \to (K\pi)^{*+}_0\pi^-) \times \mathcal{B}((K\pi)^{*+}_0 \to K^+\pi^0)$	BaBar [103][2]	$34.2 \pm 2.4 \pm 4.1$	34.2 ± 4.8
$\mathcal{B}(B^0 \to (K\pi)^{*0}_0\pi^0) \times \mathcal{B}((K\pi)^{*0}_0 \to K^+\pi^-)$	BaBar [103][2]	$8.6 \pm 1.1 \pm 1.3$	8.6 ± 1.7
$\mathcal{B}(B^0 \to K^*_2(1430)^0\pi^0)$	BaBar [105][2]	< 4.0	< 4.0
$\mathcal{B}(B^0 \to K^*(1680)^0\pi^0)$	BaBar [105][2]	< 7.5	< 7.5
$\mathcal{B}(B^0 \to K^{*0}_x\pi^0)$	Belle [104][5,6]	$6.1\,^{+1.6}_{-1.5}\,^{+0.5}_{-0.6}$	6.1 ± 1.6
			$6.1\,^{+1.7}_{-1.6}$ (PDG)

[1] $0.755 < m_{K\pi} < 1.250\ \mathrm{GeV}/c^2$.
[2] Result extracted from Dalitz-plot analysis of $B^0 \to K^+\pi^-\pi^0$ decays.
[3] Multiple systematic uncertainties are added in quadrature.
[4] The nonresonant amplitude is taken to be constant across the Dalitz plane.
[5] $1.1 < m_{K\pi} < 1.6\ \mathrm{GeV/c}^2$.
[6] K^*_x stands for the possible candidates of $K^*(1410)$, $K^*_0(1430)$ and $K^*_2(1430)$

Table 16: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 4).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ [1,2]	BaBar [106][3,4]	$50.15 \pm 1.47 \pm 1.76$	49.7 ± 1.8
	Belle [107][3]	$47.5 \pm 2.4 \pm 3.7$	
	CLEO [49]	$50.0\,^{+10.0}_{-9.0} \pm 7.0$	
	LHCb [108][4,5,6,7,8], [109][9], [110][10,11], [110][10,12], [110][10,13], [110][10,14], [110][10,15]		
$\mathcal{B}(B^0 \to K^0\pi^+\pi^-(\text{NR}))$ [16]	LHCb [111][3,17,4,18]	$12.60 \pm 0.67 \pm 3.05$	14.0 ± 1.7 (p=0.16%) / $13.9\,^{+2.6}_{-1.8}$
	BaBar [106][3,19,4]	$11.07\,^{+2.51}_{-0.99} \pm 0.90$	
	Belle [107][3,20]	$19.9 \pm 2.5\,^{+1.7}_{-2.0}$	
$\mathcal{B}(B^0 \to \rho^0(770)K^0)$ [16]	BaBar [106][3,4]	$4.36\,^{+0.71}_{-0.62} \pm 0.31$	3.45 ± 0.48 (p=0.16%) / $3.41\,^{+1.08}_{-1.14}$
	LHCb [111][3,4,18]	$1.97\,^{+0.57}_{-0.83} \pm 0.42$	
	Belle [107][3]	$6.1 \pm 1.0\,^{+1.1}_{-1.2}$	
$\mathcal{B}(B^0 \to K^*(892)^+\pi^-)$	BaBar [106][3,4]	$8.29\,^{+0.92}_{-0.81} \pm 0.82$	7.64 ± 0.44 (p=0.16%) / 7.50 ± 0.44
	BaBar [103][21]	$8.0 \pm 1.1 \pm 0.8$	
	Belle [107][3]	$8.4 \pm 1.1\,^{+1.0}_{-0.9}$	
	CLEO [49]	$16.0\,^{+6.0}_{-5.0} \pm 2.0$	
	LHCb [112][22,23], [111][3,4,24]		

[1] The PDG average is a result of a fit including input from other measurements.
[2] Treatment of charmonium intermediate components differs between the results.
[3] Result extracted from Dalitz-plot analysis of $B^0 \to K^0_S\pi^+\pi^-$ decays.
[4] Multiple systematic uncertainties are added in quadrature.
[5] Measurement of $\mathcal{B}(\Lambda_b^0 \to p\overline{K}^0\pi^-)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[6] Measurement of $\mathcal{B}(\Lambda_b^0 \to pK^0K^-)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[7] Measurement of $\frac{f_{\Xi_b^0}}{f_d}\mathcal{B}(\Xi_b^0 \to p\overline{K}^0\pi^-)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[8] Measurement of $\frac{f_{\Xi_b^0}}{f_d}\mathcal{B}(\Xi_b^0 \to p\overline{K}^0K^-)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[9] Measurement of $\mathcal{B}(B^0 \to K^*(892)^0\overline{K}^0+\text{c.c.})/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[10] Regions corresponding to D, Λ_c^+ and charmonium resonances are vetoed in this analysis.
[11] Measurement of $\mathcal{B}(B^0 \to K^0K^+\pi^-+\text{c.c.})/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[12] Measurement of $\mathcal{B}(B^0 \to K^0K^+K^-)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[13] Measurement of $\mathcal{B}(B_s^0 \to K^0\pi^+\pi^-)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[14] Measurement of $\mathcal{B}(B_s^0 \to K^0K^+\pi^-+\text{c.c.})/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[15] Measurement of $\mathcal{B}(B_s^0 \to K^0K^+K^-)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.
[16] The PDG uncertainty includes a scale factor.
[17] The nonresonant component is modelled as a flat contribution over the Dalitz plane.
[18] Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
[19] This value includes the flat NR component and the effective range of the LASS lineshape. The value corresponding to the flat component alone is also given in the article.
[20] The nonresonant component is modelled using a sum of two exponential functions.
[21] Result extracted from Dalitz-plot analysis of $B^0 \to K^+\pi^-\pi^0$ decays.
[22] Measurement of $\mathcal{B}(B_s^0 \to K^*(892)^-\pi^+)/\mathcal{B}(B^0 \to K^*(892)^+\pi^-)$ used in our fit.
[23] Measurement of $\mathcal{B}(B^0 \to K^*(892)^-K^++\text{c.c.})/\mathcal{B}(B^0 \to K^*(892)^+\pi^-)$ used in our fit.
[24] Measurement of $(\mathcal{B}(B^0 \to K^*(892)^+\pi^-)2/3)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.

Table 17: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 5).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV	**Average** PDG
$\mathcal{B}(B^0 \to K_0^*(1430)^+\pi^-)$[1]	BaBar [106][2,3] Belle [107][2]	$29.9\,^{+2.3}_{-1.7} \pm 3.6$ $49.7 \pm 3.8\,^{+6.8}_{-8.2}$	$33.6\,^{+3.8}_{-4.0}$	$33.5\,^{+7.4}_{-7.2}$
$\mathcal{B}(B^0 \to K_x^{*+}\pi^-)$	Belle [104][4,5]	$5.1 \pm 1.5\,^{+0.6}_{-0.7}$	5.1 ± 1.6	$5.1\,^{+1.6}_{-1.7}$
$\mathcal{B}(B^0 \to K^*(1410)^+\pi^-) \times \mathcal{B}(K^*(1410)^+ \to K^0\pi^+)$	Belle [107][2]	< 3.8	< 3.8	
$\mathcal{B}(B^0 \to (K\pi)_0^{*+}\pi^-) \times \mathcal{B}((K\pi)_0^{*+} \to K^0\pi^+)$	LHCb [111][2,3,6] BaBar [106][2,3]	$16.95 \pm 0.73 \pm 1.12$ $22.7\,^{+1.7}_{-1.3} \pm 1.3$	18.6 ± 1.1 p=0.16%	16.2 ± 1.3
$\mathcal{B}(B^0 \to f_0(980)K^0) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$[1]	LHCb [111][2,3,6] BaBar [106][2,3] Belle [107][2]	$9.64 \pm 0.41 \pm 0.79$ $6.92 \pm 0.77 \pm 0.56$ $7.6 \pm 1.7\,^{+0.9}_{-1.3}$	8.38 ± 0.61 p=0.16%	$8.15\,^{+0.78}_{-0.79}$
$\mathcal{B}(B^0 \to f_0(500)K^0)$	LHCb [111][2,3,6]	$0.166\,^{+0.207}_{-0.041} \pm 0.155$	$0.17\,^{+0.26}_{-0.16}$ p=0.16%	$0.16\,^{+0.25}_{-0.16}$
$\mathcal{B}(B^0 \to f_0(1500)K^0) \times \mathcal{B}(f_0(1500) \to \pi^+\pi^-)$	LHCb [111][2,3,6]	$1.348 \pm 0.280 \pm 0.734$	1.35 ± 0.79 p=0.16%	1.29 ± 0.75
$\mathcal{B}(B^0 \to f_2(1270)K^0)$	BaBar [106][2,3] Belle [107][2,7]	$2.71\,^{+0.99}_{-0.83} \pm 0.87$ < 2.5	2.7 ± 1.3	$2.7\,^{+1.3}_{-1.2}$
$\mathcal{B}(B^0 \to f_x(1300)^0K^0) \times \mathcal{B}(f_x(1300)^0 \to \pi^+\pi^-)$	BaBar [106][2,3]	$1.81\,^{+0.55}_{-0.45} \pm 0.48$	$1.81\,^{+0.73}_{-0.66}$	

[1] The PDG uncertainty includes a scale factor.
[2] Result extracted from Dalitz-plot analysis of $B^0 \to K_S^0\pi^+\pi^-$ decays.
[3] Multiple systematic uncertainties are added in quadrature.
[4] $1.1 < m_{K\pi} < 1.6$ GeV/c^2.
[5] K_x^* stands for the possible candidates of $K^*(1410)$, $K_0^*(1430)$ and $K_2^*(1430)$
[6] Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
[7] Using $\mathcal{B}(f_2(1270) \to \pi^+\pi^-)$.

Table 18: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 6).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to K^*(892)^0\pi^0)$	BaBar [103][1]	$3.3 \pm 0.5 \pm 0.4$	3.3 ± 0.6
	Belle [104]	< 3.5	
$\mathcal{B}(B^0 \to K_2^*(1430)^+\pi^-)$	Belle [107][2]	< 6.3	3.82 ± 0.36
	BaBar [105][1]	< 16.2	p=0.16%
	LHCb [111][2,3,4]		$3.65\,^{+0.34}_{-0.33}$
$\mathcal{B}(B^0 \to K^*(1680)^+\pi^-)$	Belle [107][2]	< 10.1	$14.7\,^{+1.5}_{-1.3}$
	BaBar [105][1]	< 25.0	p=0.16%
	LHCb [111][2,3,5]		14.1 ± 1.0
$\mathcal{B}(B^0 \to K^+\pi^-\pi^+\pi^-)$	DELPHI [113]	< 230	< 230
$\mathcal{B}(B^0 \to \rho^0(770)K^+\pi^-)$	Belle [114][6]	$2.8 \pm 0.5 \pm 0.5$	2.8 ± 0.7
$\mathcal{B}(B^0 \to f_0(980)K^+\pi^-) \times \mathcal{B}(f_0(980) \to \pi\pi)$			
	Belle [114][6]	$1.4 \pm 0.4\,^{+0.3}_{-0.4}$	$1.4\,^{+0.5}_{-0.6}$
$\mathcal{B}(B^0 \to K^+\pi^-\pi^+\pi^-(\text{NR}))$	Belle [114][6,7]	< 2.1	< 2.1
$\mathcal{B}(B^0 \to K^*(892)^0\pi^+\pi^-)$	BaBar [115]	$54.5 \pm 2.9 \pm 4.3$	54.5 ± 5.2
$\mathcal{B}(B^0 \to K^*(892)^0\rho^0(770))$[8]	BaBar [116]	$5.1 \pm 0.6\,^{+0.6}_{-0.8}$	3.88 ± 0.77
	Belle [114]	$2.1\,^{+0.8}_{-0.7}\,^{+0.9}_{-0.5}$	$3.88\,^{+1.33}_{-1.25}$
$\mathcal{B}(B^0 \to f_0(980)K_0^*(892)^0) \times \mathcal{B}(f_0(980) \to \pi\pi)$[8]			
	Belle [114]	$1.4\,^{+0.6}_{-0.5}\,^{+0.6}_{-0.4}$	3.90 ± 0.55
			p=0.01%
	BaBar [116]	$5.7 \pm 0.6 \pm 0.4$	$3.90\,^{+2.12}_{-1.85}$

[1] Result extracted from Dalitz-plot analysis of $B^0 \to K^+\pi^-\pi^0$ decays.

[2] Result extracted from Dalitz-plot analysis of $B^0 \to K_S^0\pi^+\pi^-$ decays.

[3] Multiple systematic uncertainties are added in quadrature.

[4] Measurement of $(\mathcal{B}(B^0 \to K_2^*(1430)^+\pi^-)\mathcal{B}(K_2^*(1430)^+ \to K\pi)2/3)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.

[5] Measurement of $(\mathcal{B}(B^0 \to K^*(1680)^+\pi^-)\mathcal{B}(K^*(1680)^+ \to K\pi)2/3)/\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$ used in our fit.

[6] $0.75 < m_{K\pi} < 1.20$ GeV/c^2.

[7] $0.55 < m_{\pi\pi} < 1.20$ GeV/c^2.

[8] The PDG uncertainty includes a scale factor.

Table 19: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 7).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to K_1(1270)^+\pi^-)$	BaBar [40]	< 30	< 30
$\mathcal{B}(B^0 \to K_1(1400)^+\pi^-)$	BaBar [40]	< 27	< 27
$\mathcal{B}(B^0 \to a_1(1260)^- K^+)$	BaBar [43]	$16.3 \pm 2.9 \pm 2.3$	16.3 ± 3.7
$\mathcal{B}(B^0 \to K^*(892)^+\rho^-(770))$	BaBar [116]	$10.3 \pm 2.3 \pm 1.3$	10.3 ± 2.6
$\mathcal{B}(B^0 \to (K\pi)^{*+}_0\rho^-(770)) \times \mathcal{B}((K\pi)^*_0 \to K\pi)$	BaBar [116]	< 48	< 48 none
$\mathcal{B}(B^0 \to K^*_0(1430)^+\rho^-(770))$	BaBar [116][1]	$28 \pm 10 \pm 6$	28 ± 12
$\mathcal{B}(B^0 \to K_1(1400)^0\rho^0(770))$	ARGUS [46]	< 3000	< 3000
$\mathcal{B}(B^0 \to (K\pi)^{*0}_0\rho^0(770)) \times \mathcal{B}((K\pi)^*_0 \to K\pi)$	BaBar [116]	$31 \pm 4 \pm 3$	31.0 ± 5.0 none
$\mathcal{B}(B^0 \to K^*_0(1430)^0\rho^0(770))$	BaBar [116][1]	$27 \pm 4 \pm 4$	27.0 ± 5.4 27.0 ± 5.7
$\mathcal{B}(B^0 \to (K\pi)^{*0}_0 f_0(980)) \times \mathcal{B}(f_0(980) \to \pi\pi) \times \mathcal{B}((K\pi)^*_0 \to K\pi)$	BaBar [116]	$3.1 \pm 0.8 \pm 0.7$	3.1 ± 1.1 none
$\mathcal{B}(B^0 \to K^*_0(1430)^0 f_0(980)) \times \mathcal{B}(f_0(980) \to \pi\pi)$	BaBar [116][1]	$2.7 \pm 0.7 \pm 0.6$	2.7 ± 0.9
$\mathcal{B}(B^0 \to K^*_2(1430)^0 f_0(980)) \times \mathcal{B}(f_0(980) \to \pi\pi)$	BaBar [116]	$8.6 \pm 1.7 \pm 1.0$	8.6 ± 2.0
$\mathcal{B}(B^0 \to K^+K^-)$	LHCb [96][2] Belle [4] CDF [94][2] BaBar [91]	$0.0799 \pm 0.0130 \pm 0.0086$ $0.10 \pm 0.08 \pm 0.04$ $0.24 \pm 0.10 \pm 0.10$ < 0.5	0.082 ± 0.015 0.078 ± 0.015
$\mathcal{B}(B^0 \to K^0\overline{K}^0)$	Belle [4] BaBar [6]	$1.26 \pm 0.19 \pm 0.05$ $1.08 \pm 0.28 \pm 0.11$	1.21 ± 0.16
$\mathcal{B}(B^0 \to K^0K^+\pi^-$+c.c.$)$	LHCb [110][3,4] Belle [117] BaBar [118]	$6.11 \pm 0.45 \pm 0.78$ $7.20 \pm 0.66 \pm 0.30$ $6.4 \pm 1.0 \pm 0.6$	6.7 ± 0.5
$\mathcal{B}(B^0 \to K^*(892)^-K^+$+c.c.$)$	LHCb [112][5]	< 0.38	< 0.4
$\mathcal{B}(B^0 \to K^*(892)^0\overline{K}^0$+c.c.$)$[6]	LHCb [109][4] BaBar [119]	< 1.0 < 1.9	< 0.99 < 0.96

[1] Multiple systematic uncertainties are added in quadrature.
[2] Using $\mathcal{B}(B^0 \to K^+\pi^-)$.
[3] Regions corresponding to D, Λ_c^+ and charmonium resonances are vetoed in this analysis.
[4] Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
[5] Using $\mathcal{B}(B^0 \to K^*(892)^+\pi^-)$.
[6] $0.75 < m_{K\pi} < 1.20$ GeV/c^2.

Table 20: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 8).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to K^+K^-\pi^0)$	Belle [120]	$2.17 \pm 0.60 \pm 0.24$	2.17 ± 0.65
$\mathcal{B}(B^0 \to K^0_S K^0_S \pi^0)$	BaBar [121]	< 0.9	< 0.9
$\mathcal{B}(B^0 \to K^0_S K^0_S \eta)$	BaBar [121]	< 1.0	< 1.0
$\mathcal{B}(B^0 \to K^0_S K^0_S \eta')$	BaBar [121]	< 2.0	< 2.0
$\mathcal{B}(B^0 \to K^0 K^+ K^-)$	LHCb [110][1,2]	$27.29 \pm 0.89 \pm 1.90$	26.8 ± 1.0
	BaBar [22][3,4]	$26.5 \pm 0.9 \pm 0.8$	26.8 ± 1.1
	Belle [38]	$28.3 \pm 3.3 \pm 4.0$	
$\mathcal{B}(B^0 \to \phi(1020) K^0)$	BaBar [22][3]	$7.1 \pm 0.6\,^{+0.4}_{-0.3}$	7.24 ± 0.60
	Belle II [62]	$5.9 \pm 1.8 \pm 0.7$	$7.32\,^{+0.69}_{-0.63}$
	Belle [66]	$9.0\,^{+2.2}_{-1.8} \pm 0.7$	
	LHCb [122][5], [123][6,7]		
$\mathcal{B}(B^0 \to f_0(980) K^0) \times \mathcal{B}(f_0(980) \to K^+K^-)$			
	BaBar [22][3]	$7.0\,^{+2.6}_{-1.8} \pm 2.4$	$7.0\,^{+3.5}_{-3.0}$
$\mathcal{B}(B^0 \to f_0(1500) K^0)$	BaBar [22][3]	$13.3\,^{+5.8}_{-4.4} \pm 3.2$	$13.3\,^{+6.6}_{-5.4}$
$\mathcal{B}(B^0 \to f_2'(1525) K^0)$	BaBar [22][3]	$0.29\,^{+0.27}_{-0.18} \pm 0.36$	$0.29\,^{+0.45}_{-0.40}$
$\mathcal{B}(B^0 \to f_0(1710) K^0) \times \mathcal{B}(f_0(1710) \to K^+K^-)$			
	BaBar [22][3]	$4.4 \pm 0.7 \pm 0.5$	4.4 ± 0.9
$\mathcal{B}(B^0 \to K^0 K^+ K^- (\mathrm{NR}))$	BaBar [22][8]	$33 \pm 5 \pm 9$	33 ± 10

[1] Regions corresponding to D, Λ_c^+ and charmonium resonances are vetoed in this analysis.
[2] Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
[3] Result extracted from Dalitz-plot analysis of $B^0 \to K^0_S K^+ K^-$ decays.
[4] All charmonium resonances are vetoed, except for χ_{c0}. The analysis also reports $\mathcal{B}(B^0 \to K^0 K^+ K^-) = (25.4 \pm 0.9 \pm 0.8) \times 10^{-6}$ excluding χ_{c0}.
[5] Measurement of $(\mathcal{B}(\Lambda_b^0 \to \Lambda^0 \phi(1020))/\mathcal{B}(B^0 \to \phi(1020)K^0))(f_{\Lambda_b^0}/f_d)2$ used in our fit.
[6] Multiple systematic uncertainties are added in quadrature.
[7] Measurement of $\mathcal{B}(B_s^0 \to K^0 \overline{K}^0)/\mathcal{B}(B^0 \to \phi(1020)K^0)$ used in our fit.
[8] The nonresonant amplitude is modelled using a polynomial function including S-wave and P-wave terms.

Table 21: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 9).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV PDG
$\mathcal{B}(B^0 \to K_S^0 K_S^0 K_S^0)$ [1]	BaBar [124] [2,3] Belle [38]	$6.19 \pm 0.48 \pm 0.19$ $4.2\,^{+1.6}_{-1.3} \pm 0.8$	6.04 ± 0.50 $6.04\,^{+0.53}_{-0.52}$
$\mathcal{B}(B^0 \to f_0(980) K_S^0) \times \mathcal{B}(f_0(980) \to K_S^0 K_S^0)$	BaBar [124] [2,3]	$2.7\,^{+1.3}_{-1.2} \pm 1.3$	2.7 ± 1.8
$\mathcal{B}(B^0 \to f_0(1710) K_S^0) \times \mathcal{B}(f_0(1710) \to K_S^0 K_S^0)$	BaBar [124] [2,3]	$0.50\,^{+0.46}_{-0.24} \pm 0.11$	$0.50\,^{+0.47}_{-0.26}$
$\mathcal{B}(B^0 \to f_2(2010) K_S^0) \times \mathcal{B}(f_2(2010) \to K_S^0 K_S^0)$	BaBar [124] [2,3]	$0.54\,^{+0.21}_{-0.20} \pm 0.52$	0.54 ± 0.56
$\mathcal{B}(B^0 \to K_S^0 K_S^0 K_S^0(\mathrm{NR}))$	BaBar [124] [4,3]	$13.3\,^{+2.2}_{-2.3} \pm 0.6$	13.3 ± 2.3 $13.3\,^{+3.1}_{-3.2}$
$\mathcal{B}(B^0 \to K_S^0 K_S^0 K_L^0)$	BaBar [125] [5]	< 16	< 16

[1] The PDG uncertainty includes a scale factor.
[2] Result extracted from Dalitz-plot analysis of $B^0 \to K_S^0 K_S^0 K_S^0$ decays.
[3] Multiple systematic uncertainties are added in quadrature.
[4] The nonresonant amplitude is modelled using an exponential function.
[5] $0.75 < m_{K\pi} < 1.20$ GeV/c^2.

Table 22: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 10).

Parameter $[10^{-6}]$	**Measurements**		**Average** $^{\rm HFLAV}_{\rm PDG}$
$\mathcal{B}(B^0 \to K^*(892)^0 K^+ K^-)$	BaBar [115]	$27.5 \pm 1.3 \pm 2.2$	27.5 ± 2.6
$\mathcal{B}(B^0 \to \phi(1020) K^*(892)^0)$	BaBar [126]	$9.7 \pm 0.5 \pm 0.5$	10.08 ± 0.48
	Belle [127]	$10.4 \pm 0.5 \pm 0.6$	10.04 ± 0.52
	Belle II [62]	$11.0 \pm 2.1 \pm 1.1$	
	CLEO [64]	$11.5\,^{+4.5}_{-3.7}\,^{+1.8}_{-1.7}$	
	LHCb [128][1,2], [129][1,3], [130][1,4], [131][5]		
$\mathcal{B}(B^0 \to K^+ \pi^- \pi^+ K^- (\mathrm{NR}))$	Belle [132][6]	< 71.7	< 72
$\mathcal{B}(B^0 \to K^*(892)^0 \pi^+ K^-)$	BaBar [115]	$4.6 \pm 1.1 \pm 0.8$	4.5 ± 1.3
	Belle [132][6]	$2.11\,^{+5.63}_{-5.26}\,^{+4.85}_{-4.75}$	
$\mathcal{B}(B^0 \to K^*(892)^0 \overline{K}^*(892)^0)$[7]	LHCb [133][1,8]	$0.835 \pm 0.063\,^{+0.158}_{-0.160}$	0.83 ± 0.16
	Belle [132]	$0.26\,^{+0.33}_{-0.29}\,^{+0.10}_{-0.08}$	$0.83\,^{+0.25}_{-0.23}$
	BaBar [134]	$1.28\,^{+0.35}_{-0.30} \pm 0.11$	
$\mathcal{B}(B^0 \to K^+ \pi^- K^+ \pi^- (\mathrm{NR}))$	Belle [132][6]	< 6.0	< 6.0
$\mathcal{B}(B^0 \to K^*(892)^0 K^+ \pi^-)$	BaBar [115]	< 2.2	< 2.2
	Belle [132][6]	< 7.6	
$\mathcal{B}(B^0 \to K^*(892)^0 K^*(892)^0)$	Belle [132]	< 0.20	< 0.2
	BaBar [134]	< 0.41	
$\mathcal{B}(B^0 \to K^*(892)^+ K^*(892)^-)$	BaBar [135]	< 2.0	< 2.0
$\mathcal{B}(B^0 \to K_1(1400)^0 \phi(1020))$	ARGUS [46]	< 5000	< 5000
$\mathcal{B}(B^0 \to (K\pi)^{*0}_0 \phi(1020))$	Belle [127]	$4.3 \pm 0.4 \pm 0.4$	4.30 ± 0.45
	BaBar [126]	$4.3 \pm 0.6 \pm 0.4$	
$\mathcal{B}(B^0 \to (K\pi)^{*0}_0 \phi), 1.60 < m_{K\pi} < 2.15~\mathrm{GeV/c^2}$.			
	BaBar [136]	< 1.7	< 1.7

[1] Multiple systematic uncertainties are added in quadrature.
[2] Measurement of $\mathcal{B}(B_s^0 \to \phi(1020)\overline{K}^*(892)^0)/\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)$ used in our fit.
[3] Measurement of $\mathcal{B}(B_s^0 \to K^*(892)^0\overline{K}^*(892)^0)/\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)$ used in our fit.
[4] Measurement of $\mathcal{B}(B_s^0 \to \phi(1020)\phi(1020))/\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)$ used in our fit.
[5] Measurement of $\mathcal{B}(B^0 \to \rho^0(770)\rho^0(770))/\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)$ used in our fit.
[6] $0.70 < m_{K\pi} < 1.70~\mathrm{GeV/c^2}$.
[7] The PDG uncertainty includes a scale factor.
[8] Using $\mathcal{B}(B_s^0 \to K^*(892)^0\overline{K}^*(892)^0)$.

Table 23: Branching fractions of charmless mesonic B^0 decays with strange mesons (part 11).

Parameter [10^{-6}]	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to K_0^*(1430)^0\pi^+K^-)$	Belle [132][1]	< 31.8	< 32
$\mathcal{B}(B^0 \to K_0^*(1430)^0\overline{K}^*(892)^0)$	Belle [132]	< 3.3	< 3.3
$\mathcal{B}(B^0 \to K_0^*(1430)^0\overline{K}_0^*(1430)^0)$	Belle [132]	< 8.4	< 8.4
$\mathcal{B}(B^0 \to \phi(1020)K_0^*(1430)^0)$	BaBar [126]	$3.9 \pm 0.5 \pm 0.6$	3.90 ± 0.78
$\mathcal{B}(B^0 \to K_0^*(1430)^0K^*(892)^0)$	Belle [132]	< 1.7	< 1.7
$\mathcal{B}(B^0 \to K_0^*(1430)^0K_0^*(1430)^0)$	Belle [132]	< 4.7	< 4.7
$\mathcal{B}(B^0 \to \phi(1020)K^*(1680)^0)$	BaBar [136]	< 3.5	< 3.5
$\mathcal{B}(B^0 \to \phi(1020)K_3^*(1780)^0)$	BaBar [136]	< 2.7	< 2.7
$\mathcal{B}(B^0 \to \phi(1020)K_4^*(2045)^0)$	BaBar [136]	< 15.3	< 15
$\mathcal{B}(B^0 \to \rho^0(770)K_2^*(1430)^0)$	ARGUS [46]	< 1100	< 1100
$\mathcal{B}(B^0 \to \phi(1020)K_2^*(1430)^0)$[2]	Belle [127] BaBar [126]	$5.5\,^{+0.9}_{-0.7} \pm 1.0$ $7.5 \pm 0.9 \pm 0.5$	6.8 ± 0.8 $6.8\,^{+1.0}_{-0.9}$
$\mathcal{B}(B^0 \to \phi(1020)\phi(1020)K^0)$	BaBar [69][3]	$4.5 \pm 0.8 \pm 0.3$	4.5 ± 0.9 3.7 ± 0.7
$\mathcal{B}(B^0 \to \eta'\eta'K^0)$	BaBar [71]	< 31.0	< 31

[1] $0.70 < m_{K\pi} < 1.70$ GeV/c^2.
[2] The PDG uncertainty includes a scale factor.
[3] Measured in the $\phi\phi$ invariant mass range below the η_c resonance ($m_{\phi\phi} < 2.85$ GeV/c^2).

Table 24: Branching fractions of charmless mesonic B^0 decays without strange mesons (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to \pi^+\pi^-)$	LHCb [95][1]	$5.26 \pm 0.18 \pm 0.36$	5.36 ± 0.16 5.12 ± 0.19
	Belle II [5]	$5.8 \pm 0.2 \pm 0.2$	
	Belle [4]	$5.04 \pm 0.21 \pm 0.18$	
	CDF [93][1]	$5.20 \pm 0.34 \pm 0.34$	
	BaBar [91]	$5.5 \pm 0.4 \pm 0.3$	
	CLEO [7]	$4.5\,^{+1.4}_{-1.2}\,^{+0.5}_{-0.4}$	
$\mathcal{B}(B^0 \to \pi^0\pi^0)$[2]	Belle [137]	$1.31 \pm 0.19 \pm 0.19$	1.46 ± 0.14 1.59 ± 0.26
	Belle II [138]	$1.25 \pm 0.20 \pm 0.11$	
	BaBar [97]	$1.83 \pm 0.21 \pm 0.13$	
$\mathcal{B}(B^0 \to \eta\pi^0)$	Belle [139]	$0.41\,^{+0.17}_{-0.15}\,^{+0.05}_{-0.07}$	0.41 ± 0.17 $0.41\,^{+0.18}_{-0.17}$
	BaBar [86]	< 1.5	
	CLEO [14]	< 2.9	
$\mathcal{B}(B^0 \to \eta\eta)$	BaBar [10]	< 1.0	< 1.0
$\mathcal{B}(B^0 \to \eta'\pi^0)$[2]	BaBar [86]	$0.9 \pm 0.4 \pm 0.1$	1.2 ± 0.4 1.2 ± 0.6
	Belle [11]	$2.79\,^{+1.02}_{-0.96}\,^{+0.25}_{-0.34}$	
$\mathcal{B}(B^0 \to \eta'\eta')$	BaBar [10]	< 1.7	< 1.7
	Belle [17]	< 6.5	
$\mathcal{B}(B^0 \to \eta'\eta)$	BaBar [86]	< 1.2	< 1.2
	Belle [17]	< 4.5	
$\mathcal{B}(B^0 \to \eta'\rho^0(770))$	Belle [17]	< 1.3	< 1.3
	BaBar [16]	< 2.8	
$\mathcal{B}(B^0 \to f_0(980)\eta') \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$			
	BaBar [16]	< 0.9	< 0.9
$\mathcal{B}(B^0 \to \eta\rho^0(770))$	BaBar [101]	< 1.5	< 1.5
	Belle [20]	< 1.9	
$\mathcal{B}(B^0 \to f_0(980)\eta) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$			
	BaBar [101]	< 0.4	< 0.4
$\mathcal{B}(B^0 \to \omega(782)\eta)$	BaBar [10]	$0.94\,^{+0.35}_{-0.30} \pm 0.09$	$0.94\,^{+0.36}_{-0.31}$

[1] Using $\mathcal{B}(B^0 \to K^+\pi^-)$.

[2] The PDG uncertainty includes a scale factor.

Table 25: Branching fractions of charmless mesonic B^0 decays without strange mesons (part 2).

Parameter [10^{-6}]	**Measurements**		**Average** HFLAV PDG
$\mathcal{B}(B^0 \to \omega(782)\eta')$	BaBar [10] Belle [17]	$1.01\,^{+0.46}_{-0.38} \pm 0.09$ < 2.2	$1.01\,^{+0.47}_{-0.39}$
$\mathcal{B}(B^0 \to \omega(782)\rho^0(770))$	BaBar [26]	< 1.6	< 1.6
$\mathcal{B}(B^0 \to f_0(980)\omega(782)) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$	BaBar [26]	< 1.5	< 1.5
$\mathcal{B}(B^0 \to \omega(782)\omega(782))$	BaBar [140]	$1.2 \pm 0.3\,^{+0.3}_{-0.2}$	1.2 ± 0.4
$\mathcal{B}(B^0 \to \phi(1020)\pi^0)$	Belle [88] BaBar [87]	< 0.15 < 0.28	< 0.15
$\mathcal{B}(B^0 \to \phi(1020)\eta)$	BaBar [10]	< 0.5	< 0.5
$\mathcal{B}(B^0 \to \phi(1020)\eta')$	Belle [17] BaBar [10]	< 0.5 < 1.1	< 0.5
$\mathcal{B}(B^0 \to \phi(1020)\pi^+\pi^-)$	LHCb [141][1,2]	$0.182 \pm 0.025 \pm 0.043$	0.182 ± 0.050
$\mathcal{B}(B^0 \to \phi(1020)\rho^0(770))$	BaBar [89]	< 0.33	< 0.33
$\mathcal{B}(B^0 \to f_0(980)\phi(1020)) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$	BaBar [89]	< 0.38	< 0.38
$\mathcal{B}(B^0 \to \omega(782)\phi(1020))$	BaBar [140]	< 0.7	< 0.7
$\mathcal{B}(B^0 \to \phi(1020)\phi(1020))$	LHCb [142] BaBar [89]	< 0.027 < 0.2	< 0.027
$\mathcal{B}(B^0 \to a_0(980)^+\pi^-$+c.c.$) \times \mathcal{B}(a_0(980)^+ \to \eta\pi^+)$	BaBar [101]	< 3.1	< 3.1
$\mathcal{B}(B^0 \to a_0(1450)^+\pi^-$+c.c.$) \times \mathcal{B}(a_0(1450)^+ \to \eta\pi^+)$	BaBar [101]	< 2.3	< 2.3

[1] $400 < m_{\pi^+\pi^-} < 1600$ MeV/c^2.
[2] Multiple systematic uncertainties are added in quadrature.

Table 26: Branching fractions of charmless mesonic B^0 decays without strange mesons (part 3).

Parameter [10^{-6}]	**Measurements**		**Average** HFLAV PDG
$\mathcal{B}(B^0 \to \pi^+\pi^-\pi^0)$	ARGUS [79]	< 720	< 720
$\mathcal{B}(B^0 \to \rho^0(770)\pi^0)$	Belle [143][1]	$3.0 \pm 0.5 \pm 0.7$	2.0 ± 0.5
	BaBar [144]	$1.4 \pm 0.6 \pm 0.3$	
	CLEO [25]	$1.6\,^{+2.0}_{-1.4} \pm 0.8$	
$\mathcal{B}(B^0 \to \rho^+(770)\pi^-+\text{c.c.})$	Belle [143][1]	$22.6 \pm 1.1 \pm 4.4$	23.0 ± 2.3
	BaBar [145]	$22.6 \pm 1.8 \pm 2.2$	
	CLEO [25]	$27.6\,^{+8.4}_{-7.4} \pm 4.2$	
$\mathcal{B}(B^0 \to \pi^+\pi^-\pi^+\pi^-)$	Belle [146][2]	< 11.2	< 11
	BaBar [147][3]	< 23.1	
$\mathcal{B}(B^0 \to \rho^0(770)\pi^+\pi^-)$	BaBar [147][3]	< 8.8	< 8.8
	Belle [146][2]	< 12.0	
$\mathcal{B}(B^0 \to \rho^0(770)\rho^0(770))$	LHCb [131][4]	$0.95 \pm 0.17 \pm 0.10$	0.96 ± 0.15
	Belle [146]	$1.02 \pm 0.30 \pm 0.15$	
	BaBar [147]	$0.92 \pm 0.32 \pm 0.14$	
$\mathcal{B}(B^0 \to f_0(980)\pi^+\pi^-) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$			
	Belle [146][2]	< 3.0	< 3.0
$\mathcal{B}(B^0 \to f_0(980)\rho^0(770)) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$			
	Belle [146]	$0.78 \pm 0.22 \pm 0.11$	0.78 ± 0.25
	BaBar [147]	< 0.40	
$\mathcal{B}(B^0 \to f_0(980)f_0(980)) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$			
	BaBar [147]	< 0.19	< 0.19
	Belle [146]	< 0.2	
$\mathcal{B}(B^0 \to f_0(980)f_0(980)) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-) \times \mathcal{B}(f_0(980) \to K^+K^-)$			
	BaBar [89]	< 0.23	< 0.23

[1] Result extracted from Dalitz-plot analysis of $B^0 \to \pi^+\pi^-\pi^0$ decays.
[2] $0.52 < m_{\pi^+\pi^-} < 1.15$ GeV/c^2.
[3] $0.55 < m_{\pi^+\pi^-} < 1.050$ GeV/c^2.
[4] Using $\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)$.

Table 27: Branching fractions of charmless mesonic B^0 decays without strange mesons (part 4).

Parameter $[10^{-6}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^0 \to a_1(1260)^+\pi^- + \text{c.c.})$[1]	Belle [148] BaBar [149]	$22.2 \pm 2.0 \pm 2.8$ $33.2 \pm 3.8 \pm 3.0$	25.9 ± 2.8 25.9 ± 5.2
$\mathcal{B}(B^0 \to a_2(1320)^+\pi^- + \text{c.c.})$	Belle [148]	< 6.3	< 6.3
$\mathcal{B}(B^0 \to \pi^+\pi^-\pi^0\pi^0)$	ARGUS [79]	< 3100	< 3100
$\mathcal{B}(B^0 \to \rho^+(770)\rho^-(770))$	Belle [150] BaBar [151] Belle II [152]	$28.3 \pm 1.5 \pm 1.5$ $25.5 \pm 2.1\,^{+3.6}_{-3.9}$ $28.8\,^{+2.3}_{-2.2}\,^{+2.9}_{-2.7}$	28.0 ± 1.7 27.7 ± 1.9
$\mathcal{B}(B^0 \to a_1(1260)^0\pi^0)$	ARGUS [79]	< 1100	< 1100
$\mathcal{B}(B^0 \to \omega(782)\pi^0)$	BaBar [86] Belle [85]	< 0.5 < 2.0	< 0.5
$\mathcal{B}(B^0 \to \pi^+\pi^+\pi^-\pi^-\pi^0)$	ARGUS [79]	< 9000	< 9000
$\mathcal{B}(B^0 \to a_1(1260)^+\rho^-(770) + \text{c.c.})$	BaBar [153]	< 61.0	< 61
$\mathcal{B}(B^0 \to a_1(1260)^0\rho^0(770))$	ARGUS [79]	< 2400	< 2400
$\mathcal{B}(B^0 \to b_1(1235)^+\pi^- + \text{c.c.}) \times \mathcal{B}(b_1(1235)^+ \to \omega(782)\pi^+)$	BaBar [52]	$10.9 \pm 1.2 \pm 0.9$	10.9 ± 1.5
$\mathcal{B}(B^0 \to b_1(1235)^0\pi^0) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [47]	< 1.9	< 1.9
$\mathcal{B}(B^0 \to b_1(1235)^-\rho^+(770)) \times \mathcal{B}(b_1(1235)^- \to \omega(782)\pi^-)$	BaBar [53]	< 1.4	< 1.4
$\mathcal{B}(B^0 \to b_1(1235)^0\rho^0(770)) \times \mathcal{B}(b_1(1235)^0 \to \omega(782)\pi^0)$	BaBar [53]	< 3.4	< 3.4
$\mathcal{B}(B^0 \to \pi^+\pi^+\pi^+\pi^-\pi^-\pi^-)$	ARGUS [79]	< 3000	< 3000
$\mathcal{B}(B^0 \to a_1(1260)^+a_1(1260)^-) \times \mathcal{B}(a_1(1260)^+ \to \pi^+\pi^+\pi^-) \times \mathcal{B}(a_1(1260)^- \to \pi^-\pi^-\pi^+)$	BaBar [154]	$11.8 \pm 2.6 \pm 1.6$	11.8 ± 3.1
$\mathcal{B}(B^0 \to \pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0)$	ARGUS [79]	< 11000	< 11000

[1] The PDG uncertainty includes a scale factor.

Table 28: Relative branching fractions of mesonic B^+ decays.

Parameter	Measurements		Average
$\frac{\mathcal{B}(B^+ \to K^+K^-\pi^+)}{\mathcal{B}(B^+ \to K^+K^+K^-)}$	LHCb [32]	$0.151 \pm 0.004 \pm 0.008$	0.151 ± 0.009
$\frac{\mathcal{B}(B^+ \to K^+\pi^+\pi^-)}{\mathcal{B}(B^+ \to K^+K^+K^-)}$	LHCb [32]	$1.703 \pm 0.011 \pm 0.022$	1.703 ± 0.025
$\frac{\mathcal{B}(B^+ \to \pi^+\pi^+\pi^-)}{\mathcal{B}(B^+ \to K^+K^+K^-)}$	LHCb [32]	$0.488 \pm 0.005 \pm 0.009$	0.488 ± 0.010

Table 29: Relative branching fractions of mesonic B^0 decays.

Parameter	Measurements		Average
$\frac{\mathcal{B}(B^0 \to K^+K^-)}{\mathcal{B}(B^0 \to K^+\pi^-)}$ $[10^{-3}]$	LHCb [96] CDF [94]	$3.98 \pm 0.65 \pm 0.42$ $12 \pm 5 \pm 5$	4.07 ± 0.77
$\frac{\mathcal{B}(B^0 \to K^*(892)^+K^- + \text{c.c.})}{\mathcal{B}(B^0 \to K^*(892)^+\pi^-)}$ $[10^{-2}]$	LHCb [112]	< 5	< 5.0
$\frac{\mathcal{B}(B^0 \to K^0_S K^*(892)^0 + \text{c.c.})}{\mathcal{B}(B^0 \to K^0_S \pi^+\pi^-)}$ $[10^{-2}]$	LHCb [109]	< 2	< 2.0
$\frac{\mathcal{B}(B^0 \to \pi^+\pi^-)}{\mathcal{B}(B^0 \to K^+\pi^-)}$	LHCb [95] CDF [93]	$0.262 \pm 0.009 \pm 0.017$ $0.259 \pm 0.017 \pm 0.016$	0.261 ± 0.015
$\frac{\mathcal{B}(B^0 \to K^0K^+\pi^- + \text{c.c.})}{\mathcal{B}(B^0 \to K^0\pi^+\pi^-)}$	LHCb [110][1]	$0.123 \pm 0.009 \pm 0.015$	0.123 ± 0.017
$\frac{\mathcal{B}(B^0 \to K^0K^+K^-)}{\mathcal{B}(B^0 \to K^0\pi^+\pi^-)}$	LHCb [110][1]	$0.549 \pm 0.018 \pm 0.033$	0.549 ± 0.038
$\frac{\mathcal{B}(B^0 \to K^*(892)^0\overline{K}^*(892)^0)}{\mathcal{B}(B^0_s \to K^*(892)^0\overline{K}^*(892)^0)}$ $[10^{-2}]$	LHCb [133][2]	$7.58 \pm 0.57 \pm 0.30$	7.58 ± 0.64
$\frac{f_s}{f_d}\frac{\mathcal{B}(B^0 \to K^+K^-)}{\mathcal{B}(B^0_s \to K^+K^-)}$ $[10^{-2}]$	LHCb [95]	$1.8\,^{+0.8}_{-0.7} \pm 0.9$	1.8 ± 1.2
$\frac{\mathcal{B}(B^0 \to \rho^0(770)\rho^0(770))}{\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)}$ $[10^{-2}]$	LHCb [131]	$9.4 \pm 1.7 \pm 0.9$	9.4 ± 1.9
$\frac{\mathcal{B}(B^0 \to K^0\overline{K}^0)}{\mathcal{B}(B^0_s \to K^0\overline{K}^0)}$ $[10^{-2}]$	LHCb [123][2]	$7.5 \pm 3.1 \pm 0.6$	7.5 ± 3.2
$\frac{\mathcal{B}(B^0 \to K^0\overline{K}^0)}{\mathcal{B}(B^0 \to \phi(1020)K^0)}$	LHCb [123]	$0.17 \pm 0.08 \pm 0.02$	0.17 ± 0.08

[1] Regions corresponding to D, Λ_c^+ and charmonium resonances are vetoed in this analysis.
[2] Multiple systematic uncertainties are added in quadrature.

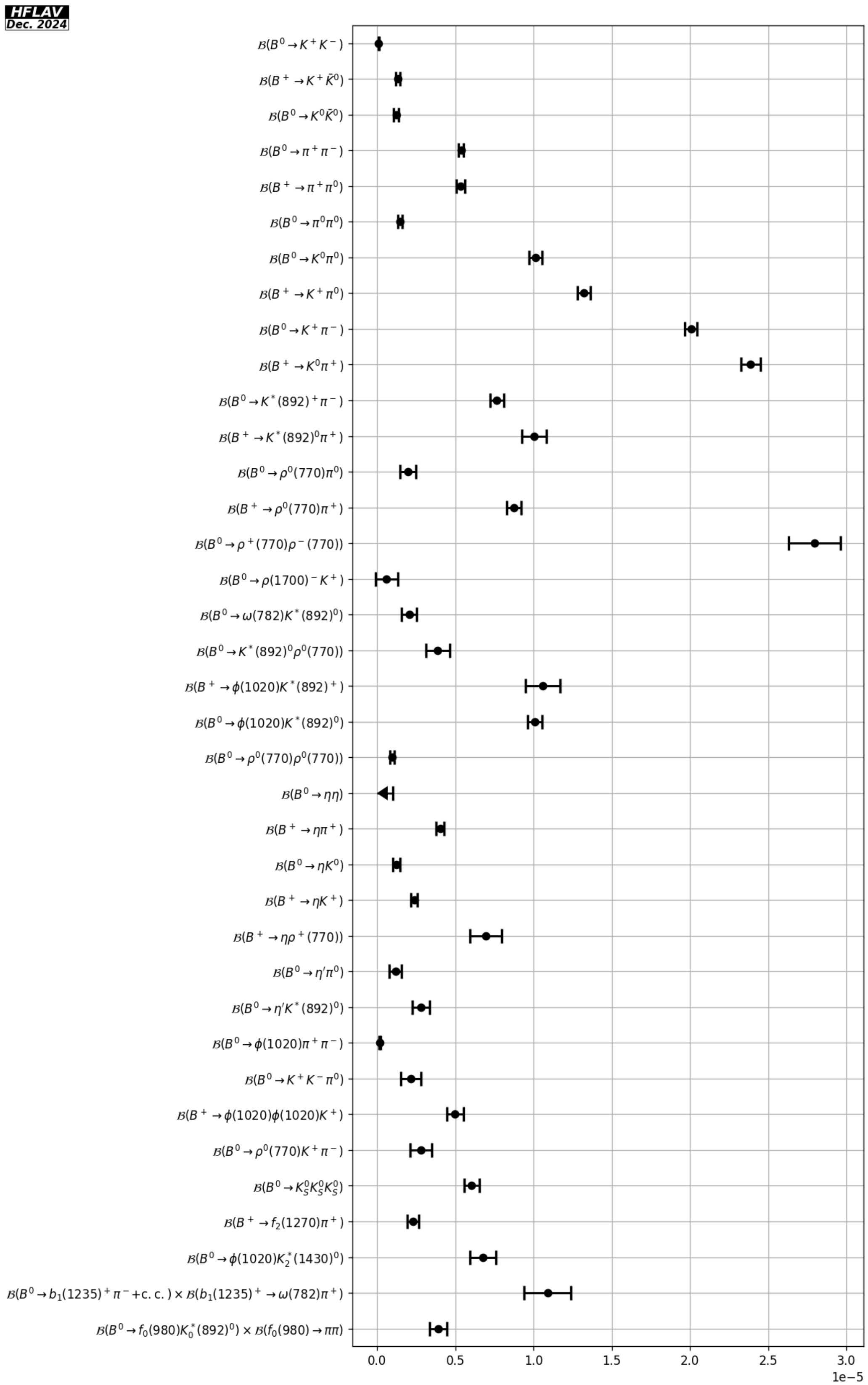

Figure 1: A selection of high-precision measurements of Branching Fractions of B-meson decays into charmless mesonic final states.

0.2 Baryonic decays of B^+ and B^0 mesons

This section provides branching fractions of charmless baryonic decays of B^+ and B^0 mesons in Tables 30-32 and 33-34, respectively. Relative branching fractions are given in Table 35. Figures 2 and 3 show graphic representations of a selection of results given in this section.

Table 30: Branching fractions of charmless baryonic B^+ decays (part 1).

Parameter $[10^{-6}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^+ \to p\overline{n}\pi^0)$	Belle [155]	< 6.1	< 6.1 none
$\mathcal{B}(B^+ \to p\overline{p}\pi^+)$	Belle [156][1] BaBar [157][2]	$1.60\,^{+0.22}_{-0.19} \pm 0.12$ $1.69 \pm 0.29 \pm 0.26$	1.62 ± 0.21 $1.62\,^{+0.21}_{-0.19}$
$\mathcal{B}(B^+ \to p\overline{p}\pi^+),\ m_{p\overline{p}} < 2.85\ \mathrm{GeV}/c^2$	LHCb [158][3]		1.00 ± 0.10 none
$\mathcal{B}(B^+ \to p\overline{p}\pi^+(\mathrm{NR}))$	CLEO [39]	< 53	< 53
$\mathcal{B}(B^+ \to p\overline{p}\pi^+\pi^0)$	Belle [159][4]	$4.58 \pm 1.17 \pm 0.67$	4.6 ± 1.3
$\mathcal{B}(B^+ \to p\overline{p}\pi^+\pi^+\pi^-)$	ARGUS [160]	< 520	< 520 none

[1] The charmonium mass regions are vetoed.
[2] Charmonium decays to $p\overline{p}$ have been statistically subtracted.
[3] Measurement of $\mathcal{B}(B^+ \to p\overline{p}\pi^+),\ m_{p\overline{p}} < 2.85\ \mathrm{GeV}/c^2/(\mathcal{B}(B^+ \to J/\psi\pi^+)\mathcal{B}(J/\psi \to p\overline{p}))$ used in our fit.
[4] $m_{\pi^+\pi^0} < 1.3\ \mathrm{GeV/c}^2$.

Table 31: Branching fractions of charmless baryonic B^+ decays (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to p\overline{p}K^+)$[1]	Belle [156][2]	$5.54\,^{+0.27}_{-0.25} \pm 0.36$	5.9 ± 0.4
	BaBar [161][3]	$6.7 \pm 0.5 \pm 0.4$	5.9 ± 0.5
$\mathcal{B}(B^+ \to p\overline{p}K^+),\ m_{p\overline{p}} < 2.85\ \mathrm{GeV}/c^2$	LHCb [162][4]		4.37 ± 0.29
			none
$\mathcal{B}(B^+ \to \Theta^{++}(1710)\overline{p}) \times \mathcal{B}(\Theta^{++}(1710) \to pK^+)$[5]			
	Belle [58]	< 0.091	< 0.091
$\mathcal{B}(B^+ \to f_J(2220)K^+) \times \mathcal{B}(f_J(2220) \to p\overline{p})$			
	Belle [58]	< 0.41	< 0.41
$\mathcal{B}(B^+ \to p\overline{\Lambda}(1520))$	BaBar [161]	< 1.5	$0.305\,^{+0.084}_{-0.081}$
	LHCb [158][6]		0.315 ± 0.055
$\mathcal{B}(B^+ \to p\overline{p}K^+(\mathrm{NR}))$	CLEO [39]	< 89	< 89
$\mathcal{B}(B^+ \to p\overline{p}K^*(892)^+)$	Belle [163][7]	$3.38\,^{+0.73}_{-0.60} \pm 0.39$	$3.6\,^{+0.8}_{-0.7}$
	BaBar [157][3]	$5.3 \pm 1.5 \pm 1.3$	
$\mathcal{B}(B^+ \to f_J(2220)K^*(892)^+) \times \mathcal{B}(f_J(2220) \to p\overline{p})$			
	BaBar [157]	< 0.77	< 0.77
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0)$	LHCb [164]	$0.24\,^{+0.10}_{-0.08} \pm 0.03$	$0.24\,^{+0.10}_{-0.09}$
	Belle [165]	< 0.32	
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0\pi^0)$	Belle [166]	$3.00\,^{+0.61}_{-0.53} \pm 0.33$	$3.00\,^{+0.69}_{-0.62}$
$\mathcal{B}(B^+ \to p\overline{\Sigma}(1385)^0)$	Belle [166]	< 0.47	< 0.47
$\mathcal{B}(B^+ \to \Delta(1232)^+\overline{\Lambda}^0)$	Belle [166]	< 0.82	< 0.82

[1] The PDG uncertainty includes a scale factor.
[2] The charmonium mass regions are vetoed.
[3] Charmonium decays to $p\overline{p}$ have been statistically subtracted.
[4] Measurement of $\mathcal{B}(B^+ \to p\overline{p}K^+),\ m_{p\overline{p}} < 2.85\ \mathrm{GeV}/c^2/(\mathcal{B}(B^+ \to J/\psi K^+)\mathcal{B}(J/\psi \to p\overline{p}))$ used in our fit.
[5] Pentaquark candidate.
[6] Measurement of $(\mathcal{B}(B^+ \to p\overline{\Lambda}(1520))\mathcal{B}(\overline{\Lambda(1520)} \to K^+p))/(\mathcal{B}(B^+ \to J/\psi K^+)\mathcal{B}(J/\psi \to p\overline{p}))$ used in our fit.
[7] The charmonium mass region has been vetoed.

Table 32: Branching fractions of charmless baryonic B^+ decays (part 3).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0\pi^+\pi^-)$	Belle [167]	$11.28\,^{+0.91}_{-0.72} \pm 1.03$	11.3 ± 1.3 $11.3\,^{+1.4}_{-1.3}$
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0\pi^+\pi^-(\mathrm{NR}))$	Belle [167]	$5.92\,^{+0.88}_{-0.84} \pm 0.69$	5.9 ± 1.1
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0\rho^0(770)) \times \mathcal{B}(\rho^0(770) \to \pi^+\pi^-)$	Belle [167]	$4.78\,^{+0.67}_{-0.64} \pm 0.60$	4.8 ± 0.9
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0 f_2(1270)) \times \mathcal{B}(f_2(1270) \to \pi^+\pi^-)$	Belle [167]	$2.03\,^{+0.77}_{-0.72} \pm 0.27$	2.0 ± 0.8
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0 K^+K^-)$	Belle [168]	$4.10\,^{+0.45}_{-0.43} \pm 0.50$	4.1 ± 0.7
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0\phi(1020))$	Belle [168]	$0.795 \pm 0.209 \pm 0.077$	0.80 ± 0.22
$\mathcal{B}(B^+ \to \overline{p}\Lambda^0 K^+K^-)$	Belle [168]	$3.70\,^{+0.39}_{-0.37} \pm 0.44$	3.7 ± 0.6
$\mathcal{B}(B^+ \to \Lambda^0\overline{\Lambda}^0\pi^+)$	Belle [169][1,2]	< 0.94	< 0.94
$\mathcal{B}(B^+ \to \Lambda^0\overline{\Lambda}^0 K^+)$	Belle [169][1]	$3.38\,^{+0.41}_{-0.36} \pm 0.41$	3.4 ± 0.6 $3.4\,^{+0.6}_{-0.5}$
$\mathcal{B}(B^+ \to \Lambda^0\overline{\Lambda}^0 K^*(892)^+)$	Belle [169][1,2]	$2.19\,^{+1.13}_{-0.88} \pm 0.33$	$2.2\,^{+1.2}_{-0.9}$
$\mathcal{B}(B^+ \to \Lambda(1520)\overline{\Lambda}^0 K^+)$	Belle [168]	$2.23 \pm 0.63 \pm 0.25$	2.2 ± 0.7
$\mathcal{B}(B^+ \to \overline{\Lambda}(1520)\Lambda^0 K^+)$	Belle [168]	< 2.08	< 2.1
$\mathcal{B}(B^+ \to \overline{\Delta}(1232)^0 p)$	Belle [156]	< 1.38	< 1.4
$\mathcal{B}(B^+ \to \Delta^{++}\overline{p})$	Belle [156]	< 0.14	< 0.14

[1] The charmonium mass regions are vetoed.

[2] $m_{\Lambda^0\overline{\Lambda}^0} < 2.85$ GeV/c^2.

Table 33: Branching fractions of charmless baryonic B^0 decays (part 1).

Parameter $[10^{-6}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^0 \to p\overline{p})$	LHCb [170][1,2]	$0.0127 \pm 0.0013 \pm 0.0006$	0.0127 ± 0.0014
	Belle [165]	< 0.11	0.0125 ± 0.0032
	BaBar [171]	< 0.27	
$\mathcal{B}(B^0 \to p\overline{p}\pi^+\pi^-)$	LHCb [172][3,2]	$2.7 \pm 0.1 \pm 0.2$	2.7 ± 0.2
			2.9 ± 0.2
$\mathcal{B}(B^0 \to p\overline{p}\pi^+\pi^-),\ m_{\pi^+\pi^-} < 1.22$ GeV/c^2	Belle [159][4]	$0.83 \pm 0.17 \pm 0.17$	0.8 ± 0.2
			none
$\mathcal{B}(B^0 \to p\overline{p}K^+\pi^-)$	LHCb [172][3,2]	$5.9 \pm 0.3 \pm 0.5$	5.90 ± 0.58
			6.27 ± 0.52
$\mathcal{B}(B^0 \to p\overline{p}K^0)$	Belle [163][5]	$2.51\,^{+0.35}_{-0.29} \pm 0.21$	2.7 ± 0.3
	BaBar [157][6]	$3.0 \pm 0.5 \pm 0.3$	
$\mathcal{B}(B^0 \to \Theta(1540)^+\overline{p}) \times \mathcal{B}(\Theta(1540)^+ \to pK^0_S)$[7]			
	BaBar [157]	< 0.05	< 0.05
	Belle [58]	< 0.23	
$\mathcal{B}(B^0 \to f_J(2220)K^0) \times \mathcal{B}(f_J(2220) \to p\overline{p})$			
	BaBar [157]	< 0.45	< 0.45
$\mathcal{B}(B^0 \to p\overline{p}K^*(892)^0)$	Belle [163][5]	$1.18\,^{+0.29}_{-0.25} \pm 0.11$	1.24 ± 0.27
	BaBar [157][6]	$1.47 \pm 0.45 \pm 0.40$	$1.24\,^{+0.28}_{-0.25}$
$\mathcal{B}(B^0 \to f_J(2220)K^*(892)^0) \times \mathcal{B}(f_J(2220) \to p\overline{p})$			
	BaBar [157]	< 0.15	< 0.15

[1] Run I and run II combination.
[2] Multiple systematic uncertainties are added in quadrature.
[3] $m_{p\overline{p}} < 2.85$ GeV/c^2.
[4] $0.46 < m_{\pi^+\pi^-} < 0.53$ GeV/c^2 invariant mass region has been excluded.
[5] The charmonium mass region has been vetoed.
[6] Charmonium decays to $p\overline{p}$ have been statistically subtracted.
[7] Pentaquark candidate.

Table 34: Branching fractions of charmless baryonic B^0 decays (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to p\overline{p}K^+K^-)$	LHCb [172][1,2]	$0.113 \pm 0.028 \pm 0.014$	0.113 ± 0.031 0.121 ± 0.032
$\mathcal{B}(B^0 \to p\overline{p}\pi^0)$	Belle [173]	$0.50 \pm 0.18 \pm 0.06$	0.50 ± 0.19
$\mathcal{B}(B^0 \to pp\overline{p}\overline{p})$	BaBar [174]	< 0.2	< 0.2
$\mathcal{B}(B^0 \to p\overline{\Lambda}^0\pi^-)$	Belle [175] BaBar [176]	$3.21\,^{+0.28}_{-0.25} \pm 0.16$ $3.07 \pm 0.31 \pm 0.23$	3.16 ± 0.24 $3.14\,^{+0.29}_{-0.28}$
$\mathcal{B}(B^0 \to p\overline{\Sigma}(1385)^-)$	Belle [166]	< 0.26	< 0.26
$\mathcal{B}(B^0 \to \Delta(1232)^+\overline{p}$+c.c.$)$	Belle [173]	< 1.6	< 1.6
$\mathcal{B}(B^0 \to \Delta(1232)^0\overline{\Lambda}^0)$	Belle [166]	< 0.93	< 0.93
$\mathcal{B}(B^0 \to p\overline{\Lambda}^0K^-)$	Belle [177]	< 0.82	< 0.82
$\mathcal{B}(B^0 \to p\overline{\Sigma}^0\pi^-)$	Belle [175]	$1.17\,^{+0.43}_{-0.40} \pm 0.07$	1.17 ± 0.42 < 3.80
$\mathcal{B}(B^0 \to \overline{\Lambda}^0\Lambda^0)$	Belle [165]	< 0.32	< 0.32
$\mathcal{B}(B^0 \to \overline{\Lambda}^0\Lambda^0K^0)$	Belle [169][3]	$4.76\,^{+0.84}_{-0.68} \pm 0.61$	$4.8\,^{+1.0}_{-0.9}$
$\mathcal{B}(B^0 \to \Lambda^0\overline{\Lambda}^0K^*(892)^0)$	Belle [169][3]	$2.46\,^{+0.87}_{-0.72} \pm 0.34$	$2.46\,^{+0.93}_{-0.80}$
$\mathcal{B}(B^0 \to \Delta(1232)^0\overline{\Delta}(1232)^0)$	CLEO [90][4]	< 1500	< 1500
$\mathcal{B}(B^0 \to \Delta^{++}\overline{\Delta}^{--})$	CLEO [90][4]	< 110	< 110
$\mathcal{B}(B^0 \to p\overline{p}p\overline{p})$	LHCb [178][5]		0.0222 ± 0.0038 none

[1] $m_{p\overline{p}} < 2.85$ GeV/c^2.
[2] Multiple systematic uncertainties are added in quadrature.
[3] The charmonium mass regions are vetoed.
[4] CLEO assumes $\mathcal{B}(\Upsilon(4S) \to B^0\overline{B}^0) = 0.43$. The result has been modified to account for a branching fraction of 0.50.
[5] Measurement of $\mathcal{B}(B^0 \to p\overline{p}p\overline{p})/(\mathcal{B}(B^0 \to J/\psi K^*(892)^0)\mathcal{B}(J/\psi \to p\overline{p})\mathcal{B}(K^*(892)^0 \to K\pi)2/3)$ used in our fit.

Table 35: Baryonic relative branching fractions.

Parameter	Measurements		Average
$\frac{\mathcal{B}(B^+\to p\overline{p}\pi^+, m_{p\overline{p}}<2.85\text{ GeV}/c^2)}{\mathcal{B}(B^+\to J/\psi\pi^+)\times\mathcal{B}(J/\psi\to p\overline{p})}$	LHCb [158]	$12.0 \pm 1.2 \pm 0.3$	12.0 ± 1.2
$\frac{\mathcal{B}(B^+\to p\overline{p}K^+)}{\mathcal{B}(B^+\to J/\psi K^+)\times\mathcal{B}(J/\psi\to p\overline{p})}$	LHCb [162][1]	$4.91 \pm 0.19 \pm 0.14$	4.91 ± 0.24
$\frac{\mathcal{B}(B^+\to p\overline{p}K^+, m_{p\overline{p}}<2.85\text{ GeV}/c^2)}{\mathcal{B}(B^+\to J/\psi\pi^+)\times\mathcal{B}(J/\psi\to p\overline{p})}$	LHCb [162]	$2.02 \pm 0.10 \pm 0.08$	2.02 ± 0.13
$\frac{\mathcal{B}(B^+\to\overline{\Lambda}(1520)p)\times\mathcal{B}(\overline{\Lambda}(1520)\to K^+\overline{p}))}{\mathcal{B}(B^+\to J/\psi\pi^+)\times\mathcal{B}(J/\psi\to p\overline{p})}$	LHCb [158]	$0.033 \pm 0.005 \pm 0.007$	0.033 ± 0.009
$\frac{\mathcal{B}(B^0\to p\overline{p}K^+K^-)}{\mathcal{B}(B^0\to p\overline{p}K^+\pi^-)}$	LHCb [172][2]	$0.019 \pm 0.005 \pm 0.002$	0.019 ± 0.005
$\frac{\mathcal{B}(B^0\to p\overline{p}\pi^+\pi^-)}{\mathcal{B}(B^0\to p\overline{p}K^+\pi^-)}$	LHCb [172][2]	$0.46 \pm 0.02 \pm 0.02$	0.46 ± 0.03
$\frac{\mathcal{B}(B^0\to p\overline{p}p\overline{p})}{\mathcal{B}(B^0\to J/\psi K^{*0})\mathcal{B}(J/\psi\to p\overline{p})\mathcal{B}(K^{*0}\to K^+\pi^-)}$	LHCb [178]	$0.0124 \pm 0.0021 \pm 0.0004$	0.0124 ± 0.0021
$\frac{\mathcal{B}(B^0\to p\overline{p}p\overline{p})}{\mathcal{B}(B^0\to J/\psi\phi)\mathcal{B}(J/\psi\to p\overline{p})\mathcal{B}(\phi\to K^+K^-)}$	LHCb [178]	$0.021 \pm 0.009 \pm 0.002$	0.0210 ± 0.0092

[1] Includes contribution where $p\overline{p}$ is produced in charmonium decays.
[2] $m_{p\overline{p}} < 2.85$ GeV/c^2.

Measurements that are not included in the tables:

- In Ref. [179], Belle searches for B^0 mesons decaying into a final state containing a Λ baryon and missing energy. Upper limits on the branching fractions are set in the range $2.1 - 3.8 \times 10^{-5}$.

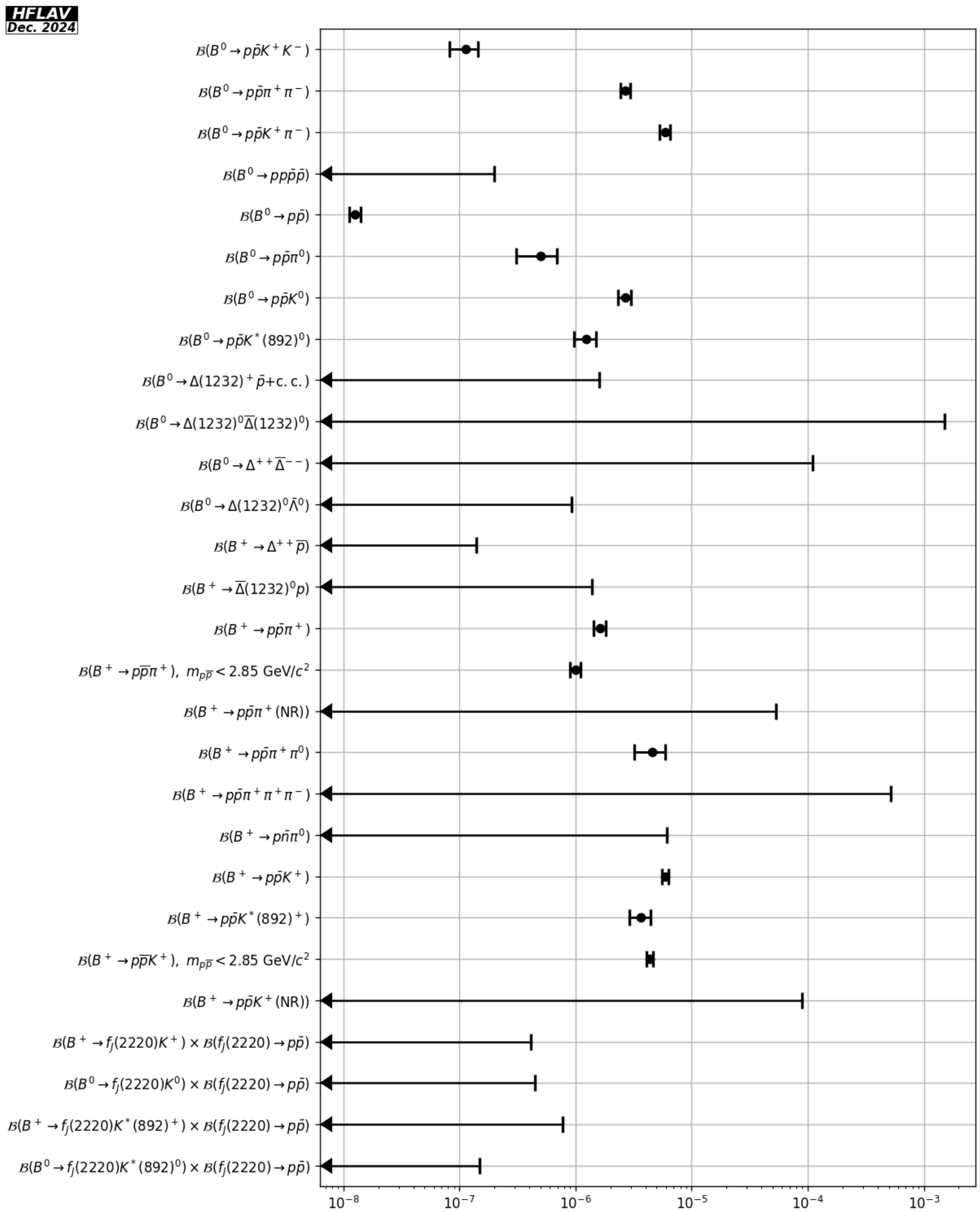

Figure 2: Branching fractions of charmless B^+ and B^0 decays into nonstrange baryons.

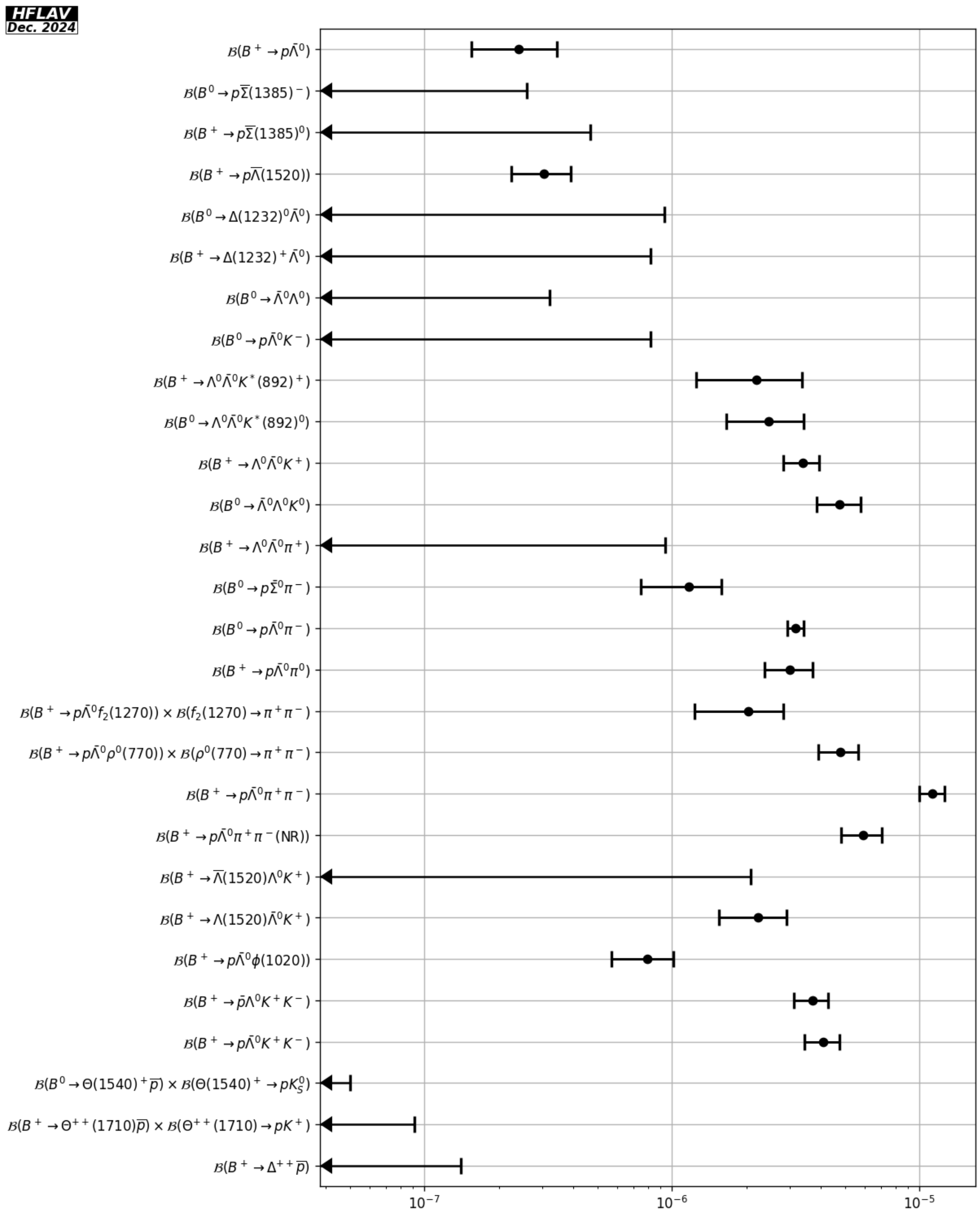

Figure 3: Branching fractions of charmless B^+ and B^0 decays into strange baryons.

0.3 Decays of b baryons

A compilation of branching fractions of Λ_b^0 baryon decays is given in Tables 36 to 38. Table 39 provides the partial branching fractions of $\Lambda_b^0 \to \Lambda\mu^+\mu^-$ decays in intervals of $q^2 = m^2(\mu^+\mu^-)$. Compilations of branching fractions of Ξ_b^0, Ξ_b^- and Ω_b^- baryon decays are given in Tables 40, 41, and 42, respectively. Finally, ratios of branching fractions of Λ_b^0, Ξ_b^0, Ξ_b^- and Ω_b^- baryon decays are detailed in Tables 43, to 47. Figures 4 and 5 show graphic representations of branching fractions of Λ_b^0 and Ξ_b decays, respectively.

Table 36: Branching fractions of charmless Λ_b^0 decays (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(\Lambda_b^0 \to p\overline{K}^0\pi^-)$	LHCb [108][1,2]	$12.4 \pm 2.0 \pm 3.6$	12.4 ± 4.2 12.6 ± 4.1
$\mathcal{B}(\Lambda_b^0 \to pK^0K^-)$	LHCb [108][2]	< 3.5	< 3.5
$\mathcal{B}(\Lambda_b^0 \to p\pi^-)$[3]	LHCb [95][4] CDF [92][5]	$4.76 \pm 0.44 \pm 0.96$	$4.6\,^{+0.9}_{-0.8}$ 4.5 ± 0.8
$\mathcal{B}(\Lambda_b^0 \to pK^-)$[3]	CDF [92] LHCb [95][6]	$6.3 \pm 1.2 \pm 0.8$	5.5 ± 1.1 5.4 ± 1.0
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0\mu^+\mu^-)$	LHCb [180][1,7] CDF [181][7]	$0.955 \pm 0.186 \pm 0.249$ $1.520 \pm 0.366 \pm 0.387$	$1.09\,^{+0.34}_{-0.29}$ 1.08 ± 0.28
$\mathcal{B}(\Lambda_b^0 \to p\pi^-\mu^+\mu^-)$	LHCb [182][8]		$0.068\,^{+0.027}_{-0.023}$ $0.069\,^{+0.025}_{-0.024}$
$\mathcal{B}(\Lambda_b^0 \to pK^-e^+e^-)$	LHCb [183][9,10]	$0.314\,^{+0.045}_{-0.042}\,^{+0.064}_{-0.055}$	$0.31\,^{+0.08}_{-0.07}$ $0.31\,^{+0.07}_{-0.06}$
$\mathcal{B}(\Lambda_b^0 \to pK^-\mu^+\mu^-)$	LHCb [183][9,10]	$0.269 \pm 0.013\,^{+0.052}_{-0.044}$	$0.269\,^{+0.054}_{-0.045}$ $0.265\,^{+0.051}_{-0.041}$

[1] Multiple systematic uncertainties are added in quadrature.
[2] Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
[3] The PDG average is a result of a fit including input from other measurements.
[4] Using $\mathcal{B}(\Lambda_b^0 \to pK^-)$.
[5] Measurement of $(\mathcal{B}(\Lambda_b^0 \to p\pi^-)/\mathcal{B}(B^0 \to K^+\pi^-))(f_{\Lambda_b^0}/f_d)$ used in our fit.
[6] Measurement of $\mathcal{B}(\Lambda_b^0 \to p\pi^-)/\mathcal{B}(\Lambda_b^0 \to pK^-)$ used in our fit.
[7] Using $\mathcal{B}(\Lambda_b^0 \to J/\psi\Lambda^0)$.
[8] Measurement of $\mathcal{B}(\Lambda_b^0 \to p\pi^-\mu^+\mu^-)/(\mathcal{B}(\Lambda_b^0 \to J/\psi p\pi^-)\mathcal{B}(J/\psi \to \mu^+\mu^-))$ used in our fit.
[9] Measured in the $m^2_{\ell^+\ell^-}$ bin $[0.1, 6.0]$ GeV^2/c^4 and for $m_{pK} < 2.6$ GeV/c^2.
[10] Using $\mathcal{B}(\Lambda_b^0 \to J/\psi pK^-)$.

Table 37: Branching fractions of charmless Λ_b^0 decays (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0\gamma)$	LHCb [184][1]		6.9 ± 1.5 7.1 ± 1.7
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0\eta)$	LHCb [98][2]	$9.23\,^{+7.15}_{-5.20} \pm 0.40$	$9.2\,^{+7.2}_{-5.2}$ $9.4\,^{+7.3}_{-5.3}$
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0\eta')$	LHCb [98][2]	< 3.05	< 3.1
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0\pi^+\pi^-)$	LHCb [185][3,4]	$5.3 \pm 0.4 \pm 0.7$	5.30 ± 0.81 4.61 ± 1.87
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0K^+\pi^-)$	LHCb [185][3,4]	$4.6 \pm 0.2 \pm 0.6$	4.60 ± 0.67 5.62 ± 1.21
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0K^+K^-)$	LHCb [185][3,4]	$10.7 \pm 0.3 \pm 1.2$	10.7 ± 1.2 16.0 ± 2.2
$\mathcal{B}(\Lambda_b^0 \to \Lambda^0\phi(1020))$	LHCb [122][5]		$10.0\,^{+2.9}_{-2.4}$ 9.8 ± 2.6

[1] Measurement of $(\mathcal{B}(\Lambda_b^0 \to \Lambda^0\gamma)/\mathcal{B}(B^0 \to K^*(892)^0\gamma))\frac{f_{\Lambda_b^0}}{f_d}$ used in our fit.

[2] Using $\mathcal{B}(B^0 \to \eta' K^0)$.

[3] LHCb measures a ratio of branching fractions, using $\Lambda_b^0 \to \Lambda_c^+(\to \Lambda\pi^+)\pi^-$ as a reference mode for normalization.

[4] Multiple systematic uncertainties are added in quadrature.

[5] Measurement of $(\mathcal{B}(\Lambda_b^0 \to \Lambda^0\phi(1020))/\mathcal{B}(B^0 \to \phi(1020)K^0))(f_{\Lambda_b^0}/f_d)2$ used in our fit.

Table 38: Branching fractions of charmless Λ_b^0 decays (part 3).

Parameter $[10^{-6}]$	**Measurements**	**Average** $^{\rm HFLAV}_{\rm PDG}$
$\mathcal{B}(\Lambda_b^0 \to p\pi^+\pi^-\pi^-)$	LHCb [186][1,2,3]	$21.1\,^{+2.4}_{-2.3}$ 20.9 ± 2.1
$\mathcal{B}(\Lambda_b^0 \to pK^-K^+\pi^-)$	LHCb [186][2,4]	$4.06\,^{+0.66}_{-0.61}$ 4.03 ± 0.60
$\mathcal{B}(\Lambda_b^0 \to pK^-\pi^+\pi^-)$	LHCb [186][2,5]	$50.5\,^{+5.6}_{-5.3}$ 50.0 ± 4.9
$\mathcal{B}(\Lambda_b^0 \to pK^-K^+K^-)$	LHCb [186][2,6]	$12.6\,^{+1.5}_{-1.4}$ 12.5 ± 1.3

[1] Vetoes on charm and charmonium resonances are applied.
[2] Multiple systematic uncertainties are added in quadrature.
[3] Measurement of $\mathcal{B}(\Lambda_b^0 \to p\pi^+\pi^-\pi^-)/(\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-)\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+))$ used in our fit.
[4] Measurement of $\mathcal{B}(\Lambda_b^0 \to pK^-K^+\pi^-)/(\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-)\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+))$ used in our fit.
[5] Measurement of $\mathcal{B}(\Lambda_b^0 \to pK^-\pi^+\pi^-)/(\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-)\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+))$ used in our fit.
[6] Measurement of $\mathcal{B}(\Lambda_b^0 \to pK^-K^+K^-)/(\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-)\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+))$ used in our fit.

Table 39: Partial branching fractions of $\Lambda_b^0 \to \Lambda\mu^+\mu^-$ decays in intervals of $m^2_{\mu^+\mu^-}$.

Parameter $[10^{-7}]$	Measurements		Average HFLAV / PDG
$m^2_{\mu^+\mu^-} < 2.0$ GeV^2/c^4			
	LHCb [187]	$0.72\,^{+0.24}_{-0.22} \pm 0.14$	0.7 ± 0.3
	CDF [181]	$0.15 \pm 2.01 \pm 0.05$	
$2.0 < m^2_{\mu^+\mu^-} < 4.3$ GeV^2/c^4			
	LHCb [187]	$0.253\,^{+0.276}_{-0.207} \pm 0.046$	$0.3\,^{+0.3}_{-0.2}$
	CDF [181]	$1.84 \pm 1.66 \pm 0.59$	
$4.3 < m^2_{\mu^+\mu^-} < 8.68$ GeV^2/c^4			
	LHCb [180]	$0.66 \pm 0.72 \pm 0.16$	0.5 ± 0.7
	CDF [181]	$-0.20 \pm 1.64 \pm 0.08$	
$10.09 < m^2_{\mu^+\mu^-} < 12.86$ GeV^2/c^4			
	LHCb [187]	$2.08\,^{+0.42}_{-0.39} \pm 0.42$	2.2 ± 0.6
	CDF [181]	$2.97 \pm 1.47 \pm 0.95$	$2.2\,^{+0.6}_{-0.5}$
$14.18 < m^2_{\mu^+\mu^-} < 16.00$ GeV^2/c^4			
	LHCb [187]	$2.04\,^{+0.35}_{-0.33} \pm 0.42$	1.7 ± 0.4
	CDF [181]	$0.96 \pm 0.73 \pm 0.31$	1.7 ± 0.5
$m^2_{\mu^+\mu^-} > 16.00$ GeV^2/c^4			
	CDF [181]	$6.97 \pm 1.88 \pm 2.23$	7.0 ± 2.9

Table 40: Branching fractions of charmless Ξ_b^0 decays.

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\frac{f_{\Xi_b^0}}{f_d}\mathcal{B}(\Xi_b^0 \to p\overline{K}^0\pi^-)$	LHCb [108][1]	< 1.5	< 1.5 < 1.6
$\frac{f_{\Xi_b^0}}{f_d}\mathcal{B}(\Xi_b^0 \to p\overline{K}^0K^-)$	LHCb [108][1]	< 1.0	< 0.99 < 1.10
$\mathcal{B}(\Xi_b^0 \to \Lambda^0\pi^+\pi^-)$	LHCb [185][2,3]	$11.0 \pm 2.6 \pm 4.0$	11.0 ± 4.8 none
$\mathcal{B}(\Xi_b^0 \to \Lambda^0K^-\pi^+)$	LHCb [185][2,3]	$10.4 \pm 1.4 \pm 3.4$	10.4 ± 3.7 none
$\mathcal{B}(\Xi_b^0 \to \Lambda^0K^+K^-)$	LHCb [185][2]	< 2.4	< 2.4 none
$\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}}\mathcal{B}(\Xi_b^0 \to pK^-\pi^+\pi^-)$	LHCb [186][3,4]		$1.91\,^{+0.41}_{-0.38}$ 1.89 ± 0.39
$\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}}\mathcal{B}(\Xi_b^0 \to pK^-K^-\pi^+)$	LHCb [186][3,5]		$1.72\,^{+0.33}_{-0.30}$ 1.71 ± 0.31
$\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}}\mathcal{B}(\Xi_b^0 \to pK^+K^-K^-)$	LHCb [186][3,6]		0.18 ± 0.10 0.17 ± 0.10

[1] Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.

[2] LHCb measures a ratio of branching fractions, using $\Lambda_b^0 \to \Lambda_c^+(\to \Lambda\pi^+)\pi^-$ as a reference mode for normalization.

[3] Multiple systematic uncertainties are added in quadrature.

[4] Measurement of $\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}}\mathcal{B}(\Xi_b^0 \to pK^-\pi^+\pi^-)/(\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-)\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+))$ used in our fit.

[5] Measurement of $\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}}\mathcal{B}(\Xi_b^0 \to pK^-K^-\pi^+)/(\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-)\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+))$ used in our fit.

[6] Measurement of $\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}}\mathcal{B}(\Xi_b^0 \to pK^+K^-K^-)/(\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-)\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+))$ used in our fit.

Table 41: Branching fractions of charmless Ξ_b^- decays.

Parameter [10^{-6}]	**Measurements**		**Average** HFLAV PDG
$\mathcal{B}(\Xi_b^- \to \Sigma(1385)^0 K^-)$	LHCb [188][1,2]	$0.26 \pm 0.11 \pm 0.20$	0.26 ± 0.23 none
$\mathcal{B}(\Xi_b^- \to \Lambda(1405) K^-)$	LHCb [188][1,2]	$0.19 \pm 0.06 \pm 0.10$	0.19 ± 0.12 none
$\mathcal{B}(\Xi_b^- \to \Lambda(1520) K^-)$	LHCb [188][1,2]	$0.76 \pm 0.09 \pm 0.31$	0.76 ± 0.32 none
$\mathcal{B}(\Xi_b^- \to \Lambda(1670) K^-)$	LHCb [188][1,2]	$0.45 \pm 0.07 \pm 0.22$	0.45 ± 0.23 none
$\mathcal{B}(\Xi_b^- \to \Sigma(1775) K^-)$	LHCb [188][1,2]	$0.22 \pm 0.08 \pm 0.13$	0.22 ± 0.15 none
$\mathcal{B}(\Xi_b^- \to \Sigma(1915) K^-)$	LHCb [188][1,2]	$0.26 \pm 0.09 \pm 0.23$	0.26 ± 0.25 none

[1] Result extracted from Dalitz plot analysis of $\Xi_b^- \to p K^- K^-$.
[2] Multiple systematic uncertainties are added in quadrature.

Table 42: Branching fractions of charmless Ω_b^- decays.

Parameter [10^{-8}]	**Measurements**		**Average**
$\frac{f_{\Omega_b^-}}{f_u} \times \mathcal{B}(\Omega_b^- \to p K^- K^-)$	LHCb [61][1]	< 0.61	< 0.61
$\frac{f_{\Omega_b^-}}{f_u} \times \mathcal{B}(\Omega_b^- \to p K^- \pi^-)$	LHCb [61][1]	< 1.73	< 1.7
$\frac{f_{\Omega_b^-}}{f_u} \times \mathcal{B}(\Omega_b^- \to p \pi^- \pi^-)$	LHCb [61][1]	< 3.69	< 3.7

[1] Using $\mathcal{B}(B^+ \to K^+ K^+ K^-)$.

Table 43: Relative branching fractions of Λ_b^0 decays (part 1).

Parameter	Measurements		Average
$\frac{\mathcal{B}(\Lambda_b^0 \to p\pi^-)}{\mathcal{B}(\Lambda_b^0 \to pK^-)}$	LHCb [95]	$0.86 \pm 0.08 \pm 0.05$	0.86 ± 0.09
$\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda^0\eta)}{\mathcal{B}(B^0 \to \eta' K^0)}$	LHCb [98]	$0.142\,^{+0.110}_{-0.080}$	$0.14\,^{+0.11}_{-0.08}$
$\frac{f_{\Lambda_b^0}}{f_d}\frac{\mathcal{B}(\Lambda_b^0 \to p\pi^-)}{\mathcal{B}(B^0 \to K^+\pi^-)}$	CDF [92]	$0.042 \pm 0.007 \pm 0.006$	0.042 ± 0.009
$\frac{f_{\Lambda_b^0}}{f_d}\frac{\mathcal{B}(\Lambda_b^0 \to pK^-)}{\mathcal{B}(B^0 \to K^+\pi^-)}$	CDF [92]	$0.066 \pm 0.009 \pm 0.008$	0.066 ± 0.012
$\frac{f_{\Lambda_b^0}}{f_d}\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda^0\phi)}{\mathcal{B}(B^0 \to K_S^0\phi)}$	LHCb [122]	$0.55 \pm 0.11 \pm 0.04$	0.55 ± 0.12
$\frac{\mathcal{B}(\Lambda_b^0 \to p\pi^-\mu^+\mu^-)}{\mathcal{B}(\Lambda_b^0 \to J/\psi p\pi^-) \times \mathcal{B}(J/\psi \to \mu^+\mu^-)}$	LHCb [182]	$0.044 \pm 0.012 \pm 0.007$	0.044 ± 0.014
$\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda^0\pi^+\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to \Lambda^0\pi^+)}$	LHCb [185]	$0.088 \pm 0.006 \pm 0.009$	0.088 ± 0.011
$\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda^0 K^+\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to \Lambda^0\pi^+)}$	LHCb [185]	$0.078 \pm 0.004 \pm 0.006$	0.0780 ± 0.0072
$\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda^0 K^+K^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to \Lambda^0\pi^+)}$	LHCb [185]	$0.178 \pm 0.005 \pm 0.007$	0.1780 ± 0.0086

Table 44: Relative branching fractions of Λ_b^0 decays (part 2).

Parameter	Measurements		Average
$\frac{\mathcal{B}(\Lambda_b^0 \to p\pi^+\pi^-\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	LHCb [186][1]	$0.0685 \pm 0.0019 \pm 0.0033$	0.0685 ± 0.0038
$\frac{\mathcal{B}(\Lambda_b^0 \to pK^-\pi^+\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	LHCb [186][1]	$0.164 \pm 0.003 \pm 0.007$	0.164 ± 0.008
$\frac{\mathcal{B}(\Lambda_b^0 \to pK^-K^+\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	LHCb [186][1]	$0.0132 \pm 0.0009 \pm 0.0013$	0.0132 ± 0.0016
$\frac{\mathcal{B}(\Lambda_b^0 \to pK^-K^+K^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	LHCb [186][1]	$0.0411 \pm 0.0012 \pm 0.0020$	0.0411 ± 0.0023
$\frac{\mathcal{B}(\Lambda_b^0 \to p\overline{K}^0\pi^-)}{\mathcal{B}(B^0 \to K^0\pi^+\pi^-)}$	LHCb [108][1]	$0.25 \pm 0.04 \pm 0.07$	0.25 ± 0.08
$\frac{\mathcal{B}(\Lambda_b^0 \to p\overline{K}^0K^-)}{\mathcal{B}(B^0 \to K^0\pi^+\pi^-)}$	LHCb [108]	< 0.07	< 0.07
$\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda^0\mu^+\mu^-)}{\mathcal{B}(\Lambda_b^0 \to J/\psi\Lambda^0)}$	LHCb [180][1]	$0.00154 \pm 0.00030 \pm 0.00020$	0.00154 ± 0.00036
$\frac{\mathcal{B}(\Lambda_b^0 \to pK^-e^+e^-)}{\mathcal{B}(\Lambda_b^0 \to J/\psi pK^-)}$	LHCb [183][2]	$0.00098\,^{+0.00014}_{-0.00013} \pm 0.00008$	0.00098 ± 0.00016
$\frac{\mathcal{B}(\Lambda_b^0 \to pK^-\mu^+\mu^-)}{\mathcal{B}(\Lambda_b^0 \to J/\psi pK^-)}$	LHCb [183][2]	$0.00084 \pm 0.00004 \pm 0.00004$	0.000840 ± 0.000057
$\frac{\mathcal{B}(\Lambda_b^0 \to pK^-e^+e^-)}{\mathcal{B}(\Lambda_b^0 \to pK^-\mu^+\mu^-)}$	LHCb [183][2]	$1.17\,^{+0.18}_{-0.16} \pm 0.07$	$1.17\,^{+0.19}_{-0.17}$

[1] Multiple systematic uncertainties are added in quadrature.

[2] Measured in the $m^2_{\ell^+\ell^-}$ bin $[0.1, 6.0]$ GeV^2/c^4 and for $m_{pK} < 2.6$ GeV/c^2.

Table 45: Relative branching fractions of Ξ_b^0 decays.

Parameter $[10^{-2}]$	**Measurements**		**Average**
$\frac{f_{\Xi_b^0}}{f_d} \times \frac{\mathcal{B}(\Xi_b^0 \to p\overline{K^0}\pi^-)}{\mathcal{B}(B^0 \to K^0\pi^+\pi^-)}$	LHCb [108]	< 3	< 3.0
$\frac{f_{\Xi_b^0}}{f_d} \times \frac{\mathcal{B}(\Xi_b^0 \to p\overline{K^0}K^-)}{\mathcal{B}(B^0 \to K^0\pi^+\pi^-)}$	LHCb [108]	< 2	< 2.0
$\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}} \times \frac{\mathcal{B}(\Xi_b^0 \to pK^-K^+K^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	LHCb [186][1]	$0.057 \pm 0.028 \pm 0.013$	0.057 ± 0.031
$\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}} \times \frac{\mathcal{B}(\Xi_b^0 \to pK^-\pi^+\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	LHCb [186][1]	$0.62 \pm 0.08 \pm 0.08$	0.62 ± 0.11
$\frac{f_{\Xi_b^0}}{f_{\Lambda_b^0}} \times \frac{\mathcal{B}(\Xi_b^0 \to pK^-\pi^+K^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	LHCb [186][1]	$0.56 \pm 0.06 \pm 0.06$	0.560 ± 0.088
$\frac{\mathcal{B}(\Xi_b^0 \to \Lambda^0\pi^+\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to \Lambda^0\pi^+)}$	LHCb [185][1]	$18.5 \pm 4.3 \pm 6.5$	18.5 ± 7.8
$\frac{\mathcal{B}(\Xi_b^0 \to \Lambda^0K^+\pi^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to \Lambda^0\pi^+)}$	LHCb [185][1]	$17.3 \pm 2.3 \pm 5.9$	17.3 ± 6.4
$\frac{\mathcal{B}(\Xi_b^0 \to \Lambda^0K^+K^-)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^+\pi^-) \times \mathcal{B}(\Lambda_c^+ \to \Lambda^0\pi^+)}$	LHCb [185][1]	$2.0 \pm 1.2 \pm 1.3$	2.0 ± 1.8

[1] Multiple systematic uncertainties are added in quadrature.

Table 46: Relative branching fractions of Ξ_b^- decays.

Parameter $[10^{-2}]$	**Measurements**		**Average**
$\frac{f_{\Xi_b^-}}{f_u} \frac{\mathcal{B}(\Xi_b^- \to pK^-K^-)}{\mathcal{B}(B^- \to K^+K^-K^-)}$	LHCb [61]	$0.2650 \pm 0.0350 \pm 0.0470$	0.265 ± 0.059
$\frac{f_{\Xi_b^-}}{f_u} \frac{\mathcal{B}(\Xi_b^- \to p\pi^-\pi^-)}{\mathcal{B}(B^- \to K^+K^-K^-)}$	LHCb [61]	< 0.1470	< 0.15
$\frac{f_{\Xi_b^-}}{f_u} \frac{\mathcal{B}(\Xi_b^- \to pK^-\pi^-)}{\mathcal{B}(B^- \to K^+K^-K^-)}$	LHCb [61]	$0.2590 \pm 0.0640 \pm 0.0490$	0.259 ± 0.081
$\frac{\mathcal{B}(\Xi_b^- \to p\pi^-\pi^-)}{\mathcal{B}(\Xi_b^- \to pK^-K^-)}$	LHCb [61]	< 56	< 56
$\frac{\mathcal{B}(\Xi_b^- \to pK^-\pi^-)}{\mathcal{B}(\Xi_b^- \to pK^-K^-)}$	LHCb [61]	$98 \pm 27 \pm 9$	98 ± 28
$\frac{\mathcal{B}(\Xi_b^- \to \Xi^-\gamma)}{\mathcal{B}(\Xi_b^- \to \Xi^-J/\psi)}$	LHCb [189]	< 8	< 8.0

Table 47: Relative branching fractions of Ω_b^- decays.

Parameter $[10^{-3}]$	**Measurements**		**Average**
$\frac{f_{\Omega_b^-}}{f_u} \frac{\mathcal{B}(\Omega_b^- \to pK^-K^-)}{\mathcal{B}(B^- \to K^+K^-K^-)}$	LHCb [61]	< 0.180	< 0.18
$\frac{f_{\Omega_b^-}}{f_u} \frac{\mathcal{B}(\Omega_b^- \to p\pi^-\pi^-)}{\mathcal{B}(B^- \to K^+K^-K^-)}$	LHCb [61]	< 1.090	< 1.1
$\frac{f_{\Omega_b^-}}{f_u} \frac{\mathcal{B}(\Omega_b^- \to pK^-\pi^-)}{\mathcal{B}(B^- \to K^+K^-K^-)}$	LHCb [61]	< 0.510	< 0.51

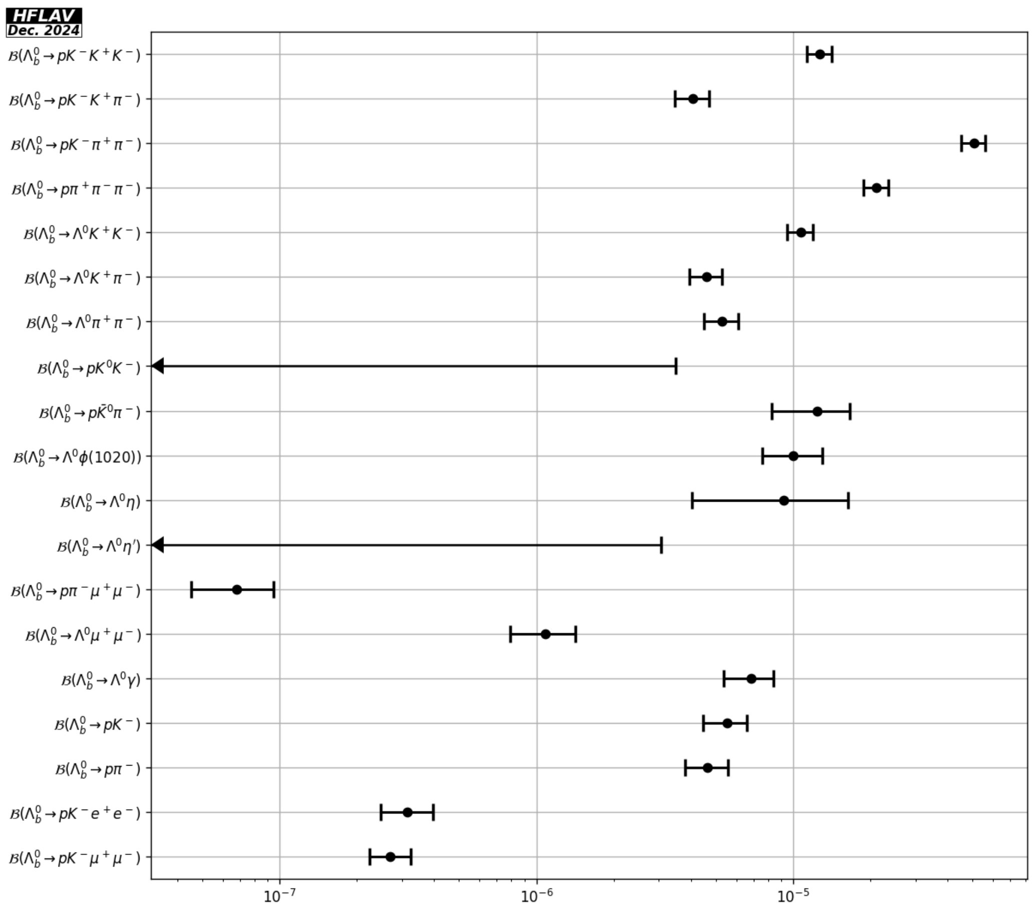

Figure 4: Branching fractions of charmless Λ_b^0 decays.

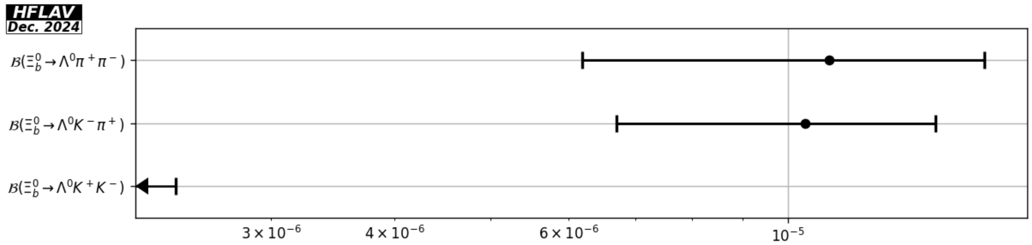

Figure 5: Branching fractions of charmless Ξ_b decays.

Measurements that are not included in the tables:

- In Ref. [190], LHCb performs the measurement of the partial branching fraction and angular observables of the $\Lambda_b^0 \to pk^- \mu^+ \mu^-$ decay, in bins of $m^2(\mu\mu)$ and $K\pi$ mass.
- In Ref. [191], LHCb measures angular observables of the decay $\Lambda_b^0 \to \Lambda \mu^+ \mu^-$, including the lepton-side, hadron-side and combined forward-backward asymmetries of the decay in the low recoil region $15 < m^2(\ell\ell) < 20\ \mathrm{GeV}^2/c^4$.
- In Ref. [192], LHCb performs a search for baryon-number-violating Ξ_b^0 oscillations and set an upper limit of $\omega < 0.08\ \mathrm{ps}^{-1}$ on the oscillation rate.
- In Ref. [193], LHCb measures the photon polarization in $\Lambda_b \to \Lambda\gamma$ decays to be $\alpha_\gamma = 0.82\,^{+0.17}_{-0.26}\,^{+0.04}_{-0.13}$.
- In Ref. [194], LHCb reports the amplitude analysis of the $\Lambda_b \to pK\gamma$ decay, in the region $m(pK) < 2.5\mathrm{GeV}^2/c^4$.

0.4 Decays of B_s^0 mesons

Tables 48 to 53 and 54 to 55 detail branching fractions and relative branching fractions of B_s^0 meson decays, respectively. Figures 6 and 7 show graphic representations of a selection of results given in this section.

Table 48: Branching fractions of charmless B_s^0 decays (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B_s^0 \to \pi^+\pi^-)$	Belle [195] CDF [94][1] LHCb [96][1]	< 12	$0.74\,^{+0.12}_{-0.10}$ 0.70 ± 0.10
$\mathcal{B}(B_s^0 \to \pi^0\pi^0)$	Belle [196]	< 7.7	< 7.7 < 210.0
$\mathcal{B}(B_s^0 \to \eta\pi^0)$	L3 [197]	< 1000	< 1000
$\mathcal{B}(B_s^0 \to \eta\eta)$	Belle [198][2]	< 144	< 144 < 143
$f_s \times \mathcal{B}(B_s^0 \to \eta\eta)$	Belle [198]	< 29	< 29 none
$\mathcal{B}(B_s^0 \to \rho^0(770)\rho^0(770))$	SLD [199]	< 320	< 320
$\mathcal{B}(B_s^0 \to \eta'\eta')$	LHCb [15][3]	$32.4 \pm 6.2 \pm 3.0$	32 ± 7 33 ± 7
$\mathcal{B}(B_s^0 \to \eta'\phi(1020))$	LHCb [200]	< 0.82	< 0.82
$\mathcal{B}(B_s^0 \to \phi(1020)f_0(980)) \times \mathcal{B}(f_0(980) \to \pi^+\pi^-)$	LHCb [141][4]	$1.12 \pm 0.16 \pm 0.14$	1.12 ± 0.21
$\mathcal{B}(B_s^0 \to f_2(1270)\phi(1020)) \times \mathcal{B}(f_2(1270) \to \pi^+\pi^-)$	LHCb [141][4]	$0.61 \pm 0.13\,^{+0.13}_{-0.08}$	$0.61\,^{+0.19}_{-0.15}$ $0.61\,^{+0.18}_{-0.15}$
$\mathcal{B}(B_s^0 \to \phi(1020)\rho^0(770))$	LHCb [141][4]	$0.27 \pm 0.07 \pm 0.03$	0.27 ± 0.08
$\mathcal{B}(B_s^0 \to \phi(1020)\pi^+\pi^-)$	LHCb [141][5,4]	$3.48 \pm 0.23 \pm 0.39$	3.48 ± 0.45
$\mathcal{B}(B_s^0 \to \phi(1020)\phi(1020))$	LHCb [130][4,6] CDF [201][7]	$18.5 \pm 0.5 \pm 1.6$ $18.5 \pm 1.5 \pm 2.2$	18.5 ± 1.4

[1] Measurement of $(\mathcal{B}(B_s^0 \to \pi^+\pi^-)/\mathcal{B}(B^0 \to K^+\pi^-))\frac{f_s}{f_d}$ used in our fit.
[2] Using f_s.
[3] Using $\mathcal{B}(B^+ \to \eta' K^+)$.
[4] Multiple systematic uncertainties are added in quadrature.
[5] $400 < m_{\pi^+\pi^-} < 1600$ MeV/c^2.
[6] Using $\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)$.
[7] Using $\mathcal{B}(B_s^0 \to J/\psi\phi(1020))$.

Table 49: Branching fractions of charmless B_s^0 decays (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B_s^0 \to K^-\pi^+)$	Belle [195] CDF [92][1] LHCb [95][1]	< 26	$6.1\,^{+0.9}_{-0.8}$ 5.8 ± 0.7
$\mathcal{B}(B_s^0 \to K^+K^-)$	Belle [195][2] CDF [93][3] LHCb [95][3]	$38\,^{+10}_{-9} \pm 7$	$27.4\,^{+3.2}_{-2.8}$ 26.6 ± 2.2
$\mathcal{B}(B_s^0 \to K^0\overline{K}^0)$	LHCb [123][2,4] Belle [202][2]	$16.7 \pm 2.9 \pm 2.1$ $19.6\,^{+5.8}_{-5.1} \pm 2.2$	17.4 ± 3.1 $17.6\,^{+3.2}_{-3.1}$
$\mathcal{B}(B_s^0 \to K^0\pi^+\pi^-)$	LHCb [110][5,6]	$9.49 \pm 1.34 \pm 1.67$	9.5 ± 2.1
$\mathcal{B}(B_s^0 \to K^0K^+\pi^-$+c.c.$)$	LHCb [110][5,6]	$84.5 \pm 3.5 \pm 8.0$	84.5 ± 8.7 84.5 ± 8.8
$\mathcal{B}(B_s^0 \to K^*(892)^-\pi^+)$	LHCb [112][7]	$2.98 \pm 0.99 \pm 0.42$	3.0 ± 1.1 p=0.16% 2.9 ± 1.1

[1] Measurement of $(\mathcal{B}(B_s^0 \to K^-\pi^+)/\mathcal{B}(B^0 \to K^+\pi^-))\frac{f_s}{f_d}$ used in our fit.
[2] Multiple systematic uncertainties are added in quadrature.
[3] Measurement of $(\mathcal{B}(B_s^0 \to K^+K^-)/\mathcal{B}(B^0 \to K^+\pi^-))\frac{f_s}{f_d}$ used in our fit.
[4] Using $\mathcal{B}(B^0 \to \phi(1020)K^0)$.
[5] Regions corresponding to D, Λ_c^+ and charmonium resonances are vetoed in this analysis.
[6] Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
[7] Using $\mathcal{B}(B^0 \to K^*(892)^+\pi^-)$.

Table 50: Branching fractions of charmless B_s^0 decays (part 3).

Parameter [10^{-6}]	Measurements		Average HFLAV / PDG
$\mathcal{B}(B_s^0 \to K^*(892)^+K^-$+c.c.)	LHCb [203][1,2]	$18.6 \pm 1.2 \pm 4.5$	18.6 ± 4.7
$\mathcal{B}(B_s^0 \to (K\pi)_0^{*+}K^-$+c.c.)	LHCb [203][1,2]	$24.9 \pm 1.8 \pm 20.2$	25 ± 20 none
$\mathcal{B}(B_s^0 \to K_0^*(1430)^+K^-$+c.c.)	LHCb [203][1,2]	$31.3 \pm 2.3 \pm 25.3$	31 ± 25
$\mathcal{B}(B_s^0 \to K_2^*(1430)^+K^-$+c.c.)	LHCb [203][1,2]	$10.3 \pm 2.5 \pm 16.4$	10 ± 17
$\mathcal{B}(B_s^0 \to K^*(892)^0\overline{K}^0$+c.c.)	LHCb [203][1,2]	$19.8 \pm 2.8 \pm 5.0$	19.8 ± 5.7
$\mathcal{B}(B_s^0 \to (K\pi)_0^{*0}\overline{K}^0$+c.c.)	LHCb [203][1,2]	$26.2 \pm 2.0 \pm 7.8$	26.2 ± 8.1 none
$\mathcal{B}(B_s^0 \to K_0^*(1430)^0\overline{K}^0$+c.c.)	LHCb [203][1,2]	$33.0 \pm 2.5 \pm 9.8$	33 ± 10
$\mathcal{B}(B_s^0 \to K_2^*(1430)^0\overline{K}^0$+c.c.)	LHCb [203][1,2]	$16.8 \pm 4.5 \pm 21.3$	17 ± 22
$\mathcal{B}(B_s^0 \to K_S^0K^*(892)^0$+c.c.)	LHCb [109][2,3]	$17.1 \pm 3.6 \pm 2.4$	17.1 ± 4.3 p=0.16% 16.4 ± 4.1
$\mathcal{B}(B_s^0 \to K^0K^+K^-)$	LHCb [110][4,5]	$1.29 \pm 0.55 \pm 0.36$	1.29 ± 0.66 1.29 ± 0.65
$\mathcal{B}(B_s^0 \to \overline{K}^*(892)^0\rho^0(770))$	SLD [199]	< 767	< 767
$\mathcal{B}(B_s^0 \to K^*(892)^0\overline{K}^*(892)^0)$	LHCb [129][2,6] LHCb [133][2,7]	$11.2 \pm 2.2 \pm 1.5$	$11.0^{+2.0}_{-2.1}$ 11.1 ± 2.7
$\mathcal{B}(B_s^0 \to \phi(1020)\overline{K}^*(892)^0)$	LHCb [128][2,6]	$1.14 \pm 0.24 \pm 0.17$	1.14 ± 0.29 1.14 ± 0.30

1 Result extracted from Dalitz-plot analysis of $B_s^0 \to K_S^0K^+\pi^-$ decays.
2 Multiple systematic uncertainties are added in quadrature.
3 Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
4 Regions corresponding to D, Λ_c^+ and charmonium resonances are vetoed in this analysis.
5 Using $\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$.
6 Using $\mathcal{B}(B^0 \to \phi(1020)K^*(892)^0)$.
7 Measurement of $\mathcal{B}(B^0 \to K^*(892)^0\overline{K}^*(892)^0)/\mathcal{B}(B_s^0 \to K^*(892)^0\overline{K}^*(892)^0)$ used in our fit.

Table 51: Branching fractions of charmless B_s^0 decays (part 4).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B_s^0 \to p\bar{p})$	LHCb [170]	< 0.0044	< 0.0044 < 0.0150
$\mathcal{B}(B_s^0 \to p\bar{p}K^+K^-)$	LHCb [172][1,2]	$4.2 \pm 0.3 \pm 0.4$	4.2 ± 0.5 4.5 ± 0.5
$\mathcal{B}(B_s^0 \to p\bar{p}K^+\pi^-)$	LHCb [172][1,2]	$1.3 \pm 0.2 \pm 0.2$	1.3 ± 0.3 1.4 ± 0.3
$\mathcal{B}(B_s^0 \to p\bar{p}\pi^+\pi^-)$	LHCb [172][1]	< 0.66	< 0.66 0.43 ± 0.20
$\mathcal{B}(B_s^0 \to p\overline{\Lambda}^0 K^- + \text{c.c.})$	LHCb [204][2]	$5.46 \pm 0.61 \pm 0.82$	5.5 ± 1.0
$\mathcal{B}(B_s^0 \to \gamma\gamma)$	Belle [205]	< 3.1	< 3.1
$\mathcal{B}(B_s^0 \to \phi(1020)\gamma)$	LHCb [206][3] Belle [205] LHCb [207][4,5], [207][4,6]	$33.7 \pm 1.7 \pm 3.0$ $36.0 \pm 5.0 \pm 7.0$	34.0 ± 3.2 34.2 ± 3.6
$\mathcal{B}(B_s^0 \to f_2'(1525)\gamma)$	LHCb [207][4,5]		$6.50\,^{+0.85}_{-0.72}$ none
$\mathcal{B}(B_s^0 \to f_2(1270)\gamma)$	LHCb [207][4,6]		$8.4\,^{+4.0}_{-4.4}$ none

[1] $m_{p\bar{p}} < 2.85$ GeV/c^2.
[2] Multiple systematic uncertainties are added in quadrature.
[3] Using $\mathcal{B}(B^0 \to K^*(892)^0\gamma)$.
[4] Result extracted from Dalitz-plot analysis of $B_s^0 \to K^+K^-\gamma$ decays.
[5] Measurement of $\mathcal{B}(B_s^0 \to f_2'(1525)\gamma)/\mathcal{B}(B_s^0 \to \phi(1020)\gamma)(\mathcal{B}(f_2'(1525) \to K\overline{K})/\mathcal{B}(\phi(1020) \to K^+K^-))0.5$ used in our fit.
[6] Measurement of $\mathcal{B}(B_s^0 \to f_2(1270)\gamma)/\mathcal{B}(B_s^0 \to \phi(1020)\gamma)(\mathcal{B}(f_2(1270) \to K\overline{K})/\mathcal{B}(\phi(1020) \to K^+K^-))0.5$ used in our fit.

Table 52: Branching fractions of charmless B_s^0 decays (part 5).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B_s^0 \to e^+e^-)$	LHCb [208]	< 0.0094	< 0.0094
	CDF [209]	< 0.28	
	Belle [210]	< 15.3	
$\mathcal{B}(B_s^0 \to \tau^+\tau^-)$ [1]	LHCb [211]	< 5200	< 5200 < 6800
$\mathcal{B}(B_s^0 \to \mu^+\mu^-\gamma)$	LHCb [212] [2]	< 0.025	< 0.025 none
$\mathcal{B}(B_s^0 \to \mu^+\mu^-\mu^+\mu^-)$	LHCb [213] [3]	< 0.00086	< 0.00086
$\mathcal{B}(B_s^0 \to aa) \times \mathcal{B}(a \to \mu^+\mu^-) \times \mathcal{B}(a \to \mu^+\mu^-)$	LHCb [213] [4,5,3]	< 0.00058	< 0.00058 none
$\mathcal{B}(B_s^0 \to \phi(1020)\mu^+\mu^-)$ [6,7]	LHCb [214] [8,9]	$0.832 \pm 0.022 \pm 0.035$	$0.838\,^{+0.042}_{-0.041}$ 0.841 ± 0.041
	CDF [181] [9]	$1.18 \pm 0.20 \pm 0.09$	
$\mathcal{B}(B_s^0 \to \overline{K}^*(892)^0\mu^+\mu^-)$	LHCb [215] [8]	$0.029 \pm 0.010 \pm 0.004$	0.029 ± 0.011
$\mathcal{B}(B_s^0 \to \pi^+\pi^-\mu^+\mu^-)$	LHCb [216] [10,11]		0.084 ± 0.016 0.084 ± 0.017
$\mathcal{B}(B_s^0 \to \phi(1020)\nu\overline{\nu})$	DELPHI [113]	< 5400	< 5400

[1] PDG shows the result obtained at 95% CL.
[2] Limit obtained via a simultaneous fit in three q^2 regions. Limits from the individual q^2 regions are reported in the paper.
[3] At CL=95 %.
[4] The mass windows corresponding to ϕ and charmonium resonances decaying to $\mu\mu$ are vetoed.
[5] a is a promptly decaying scalar particle with a mass of 1 GeV/c^2
[6] The PDG uncertainty includes a scale factor.
[7] Treatment of charmonium intermediate components differs between the results.
[8] Multiple systematic uncertainties are added in quadrature.
[9] Using $\mathcal{B}(B_s^0 \to J/\psi\phi(1020))$.
[10] $0.5 < m_{\pi^+\pi^-} < 1.3$ GeV/c^2.
[11] Measurement of $\mathcal{B}(B_s^0 \to \pi^+\pi^-\mu^+\mu^-)/(\mathcal{B}(B^0 \to J/\psi K^*(892)^0)\mathcal{B}(J/\psi \to \mu^+\mu^-)\mathcal{B}(K^*(892)^0 \to K\pi)2/3)$ used in our fit.

Table 53: Branching fractions of charmless B_s^0 decays (part 6).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B_s^0 \to e^+\mu^- + \text{c.c.})$	LHCb [217] CDF [209]	< 0.0054 < 0.2	< 0.0054
$\mathcal{B}(B_s^0 \to \tau^+ e^- + \text{c.c.})$	Belle [218]	< 1410	< 1410 none
$\mathcal{B}(B_s^0 \to \tau^+\mu^- + \text{c.c.})$[1]	LHCb [219] Belle [218]	< 34 < 730	< 34 < 42
$\mathcal{B}(B_s^0 \to \phi(1020) e^+\mu^- + \text{c.c.})$	LHCb [220]	< 0.0160	< 0.016 none
$\mathcal{B}(B_s^0 \to \phi(1020) \mu^+\tau^- + \text{c.c.})$	LHCb [221]	< 10	< 10 none
$\mathcal{B}(B_s^0 \to p\mu^-)$	LHCb [222]	< 0.0121	< 0.012 none
$\mathcal{B}(B_s^0 \to \eta'\eta)$	Belle [223]	< 65	< 65
$\mathcal{B}(B_s^0 \to f_2'(1525)\mu^+\mu^-)$	LHCb [214][2,3]	$0.161 \pm 0.020 \pm 0.011$	0.161 ± 0.022 none
$\mathcal{B}(B_s^0 \to \eta' X_{s\bar{s}})$	Belle [224][4]	< 1400	< 1400 none
$\mathcal{B}(B_s^0 \to \eta' K_S^0)$	Belle [225][5]	< 8.16	< 8.2 none
$\mathcal{B}(B_s^0 \to p\bar{p}p\bar{p})$	LHCb [178][6]		0.0227 ± 0.0100 none

[1] PDG shows the result obtained at 95% CL.
[2] Multiple systematic uncertainties are added in quadrature.
[3] Using $\mathcal{B}(B_s^0 \to J/\psi\phi(1020))$.
[4] $m_{X_{ss}} < 2.4$ GeV$/c^2$
[5] Using f_s.
[6] Measurement of $\mathcal{B}(B_s^0 \to p\bar{p}p\bar{p})/(\mathcal{B}(B_s^0 \to J/\psi\phi(1020))\mathcal{B}(J/\psi \to p\bar{p})\mathcal{B}(\phi(1020) \to K^+K^-))$ used in our fit.

Table 54: Relative branching fractions of B_s^0 decays (part 1).

Parameter $[10^{-2}]$	**Measurements**		**Average**
$\frac{f_s}{f_d}\frac{\mathcal{B}(B_s^0\to\pi^+\pi^-)}{\mathcal{B}(B^0\to K^+\pi^-)}$	LHCb [96] CDF [94]	$0.915 \pm 0.071 \pm 0.083$ $0.8 \pm 0.2 \pm 0.1$	0.893 ± 0.098
$\frac{f_s}{f_d}\frac{\mathcal{B}(B_s^0\to\pi^+\pi^-)}{\mathcal{B}(B^0\to\pi^+\pi^-)}$	LHCb [95]	$5.0\,^{+1.1}_{-0.9} \pm 0.4$	$5.0\,^{+1.2}_{-1.0}$
$\frac{\mathcal{B}(B_s^0\to\phi(1020)\phi(1020))}{\mathcal{B}(B_s^0\to J/\psi\phi(1020))}$ [1]	CDF [201]	$1.78 \pm 0.14 \pm 0.20$	1.78 ± 0.24
$\frac{\mathcal{B}(B_s^0\to\phi(1020)\phi(1020))}{\mathcal{B}(B^0\to\phi(1020)K^*(892)^0)}$	LHCb [130][2]	$184 \pm 5 \pm 13$	184 ± 14
$\frac{f_s}{f_d}\frac{\mathcal{B}(B_s^0\to K^+\pi^-)}{\mathcal{B}(B_d^0\to K^+\pi^-)}$	LHCb [95] CDF [92]	$7.4 \pm 0.6 \pm 0.6$ $7.1 \pm 1.0 \pm 0.7$	7.30 ± 0.70
$\frac{f_s}{f_d}\frac{\mathcal{B}(B_s^0\to K^+K^-)}{\mathcal{B}(B_d^0\to K^+\pi^-)}$	LHCb [95] CDF [93]	$31.6 \pm 0.9 \pm 1.9$ $34.7 \pm 2.0 \pm 2.1$	32.7 ± 1.7
$\frac{\mathcal{B}(B_s^0\to K^0\pi^+\pi^-)}{\mathcal{B}(B^0\to K^0\pi^+\pi^-)}$	LHCb [110][3,2]	$19.1 \pm 2.7 \pm 3.3$	19.1 ± 4.3
$\frac{\mathcal{B}(B_s^0\to K^0K^+\pi^-+\text{c.c.})}{\mathcal{B}(B^0\to K^0\pi^+\pi^-)}$	LHCb [110][3,2]	$170 \pm 7 \pm 15$	170 ± 16
$\frac{\mathcal{B}(B_s^0\to K^0K^+K^-)}{\mathcal{B}(B^0\to K^0\pi^+\pi^-)}$	LHCb [110][3]	< 5.1	< 5.1
$\frac{\mathcal{B}(B_s^0\to K^*(892)^-\pi^+)}{\mathcal{B}(B^0\to K^*(892)^+\pi^-)}$	LHCb [112]	$39 \pm 13 \pm 5$	39 ± 14
$\frac{\mathcal{B}(B_s^0\to K^*(892)^0\overline{K}^*(892)^0)}{\mathcal{B}(B^0\to\phi(1020)K^*(892)^0)}$	LHCb [129][2]	$111 \pm 22 \pm 13$	111 ± 26
$\frac{\mathcal{B}(B_s^0\to\phi(1020)\overline{K}^*(892)^0)}{\mathcal{B}(B^0\to\phi(1020)K^*(892)^0)}$	LHCb [128][2]	$11.3 \pm 2.4 \pm 1.6$	11.3 ± 2.9
$\frac{\mathcal{B}(B_s^0\to\phi(1020)\mu^+\mu^-)}{\mathcal{B}(B_s^0\to J/\psi\phi(1020))}$	LHCb [214][2] CDF [181]	$0.0800 \pm 0.0021 \pm 0.0016$ $0.113 \pm 0.019 \pm 0.007$	0.0806 ± 0.0026

[1] The PDG average is a result of a fit including input from other measurements.
[2] Multiple systematic uncertainties are added in quadrature.
[3] Regions corresponding to D, Λ_c^+ and charmonium resonances are vetoed in this analysis.

Table 55: Relative branching fractions of B_s^0 decays (part 2).

Parameter $[10^{-2}]$	**Measurements**		**Average**
$\frac{\mathcal{B}(B_s^0 \to p\overline{p}K^+\pi^-)}{\mathcal{B}(B^0 \to p\overline{p}K^+\pi^-)}$	LHCb [172][1,2]	$22 \pm 4 \pm 2$	22 ± 5
$\frac{\mathcal{B}(B_s^0 \to p\overline{p}K^+\pi^-)}{\mathcal{B}(B_s^0 \to p\overline{p}K^+K^-)}$	LHCb [172][1]	$31 \pm 5 \pm 2$	31 ± 5
$\frac{\mathcal{B}(B_s^0 \to \overline{K}^*(892)^0\mu^+\mu^-)}{\mathcal{B}(B_s^0 \to J/\psi\overline{K}^*(892)^0) \times \mathcal{B}(J/\psi \to \mu^+\mu^-)}$	LHCb [215][2]	$1.4 \pm 0.4 \pm 0.1$	1.4 ± 0.4
$\frac{\mathcal{B}(B_s^0 \to \overline{K}^*(892)^0\mu^+\mu^-)}{\mathcal{B}(\overline{B}^0 \to \overline{K}^*(892)^0\mu^+\mu^-)}$	LHCb [215][2]	$3.3 \pm 1.1 \pm 0.4$	3.3 ± 1.2
$\frac{\mathcal{B}(B_s^0 \to \phi(1020)\phi(1020)\phi(1020))}{\mathcal{B}(B_s^0 \to \phi(1020)\phi(1020))}$	LHCb [226]	$11.7 \pm 3.0 \pm 1.5$	11.7 ± 3.4
$\frac{\mathcal{B}(B_s^0 \to K^0\overline{K}^0)}{\mathcal{B}(B^0 \to \phi(1020)K^0)}$	LHCb [123][2]	$230 \pm 40 \pm 22$	230 ± 46
$\frac{\mathcal{B}(B_s^0 \to K_S^0K^*(892)^0\text{+c.c.})}{\mathcal{B}(B^0 \to K_S^0\pi^+\pi^-)}$	LHCb [109][2]	$33 \pm 7 \pm 4$	33 ± 8
$\frac{\mathcal{B}(B_s^0 \to f_2'(1525)\mu^+\mu^-)}{\mathcal{B}(B_s^0 \to J/\psi\phi(1020))}$	LHCb [214][2]	$0.0155 \pm 0.0019 \pm 0.0008$	0.0155 ± 0.002
$\frac{\mathcal{B}(B_s^0 \to \pi^+\pi^-\mu^+\mu^-)}{\mathcal{B}(B^0 \to J/\psi K^*(892)^0) \times \mathcal{B}(J/\psi \to \mu^+\mu^-) \times \mathcal{B}(K^*(892)^0 \to K^+\pi^-)}$	LHCb [216][3]	$0.167 \pm 0.029 \pm 0.013$	0.167 ± 0.032
$\frac{\mathcal{B}(B^0 \to p\overline{p}p\overline{p})}{\mathcal{B}(B^0 \to J/\psi\phi)\mathcal{B}(J/\psi \to p\overline{p})\mathcal{B}(\phi \to K^+K^-)}$	LHCb [178]	$2.1 \pm 0.9 \pm 0.2$	2.10 ± 0.92
$\frac{\mathcal{B}(B_s^0 \to f_2'(1525)\gamma)}{\mathcal{B}(B_s^0 \to \phi(1020)\gamma)}$	LHCb [207][4,5]		$19.1\,^{+1.8}_{-1.1}$
$\frac{\mathcal{B}(B_s^0 \to f_2(1270)\gamma)}{\mathcal{B}(B_s^0 \to \phi(1020)\gamma)}$	LHCb [207][4,6]		$25\,^{+11}_{-13}$
$\frac{\mathcal{B}(B_s^0 \to \phi(1680)\gamma) \times \mathcal{B}(\phi(1680) \to K^+K^-)}{\mathcal{B}(B_s^0 \to \phi(1020)\gamma)}$	LHCb [207][4]	$2.6\,^{+0.4}_{-0.3} \pm 0.5$	2.60 ± 0.61
$\frac{\mathcal{B}(B_s^0 \to \phi e^+e^-)}{\mathcal{B}(B_s^0 \to phi\mu^+\mu^-)}$, $0.1 < m^2_{\ell^+\ell^-} < 1.1\ \text{GeV}^2/\text{c}^4$	LHCb [227]	$157\,^{+28}_{-25} \pm 5$	$157\,^{+28}_{-25}$
$\frac{\mathcal{B}(B_s^0 \to \phi e^+e^-)}{\mathcal{B}(B_s^0 \to phi\mu^+\mu^-)}$, $1.1 < m^2_{\ell^+\ell^-} < 6.0\ \text{GeV}^2/\text{c}^4$	LHCb [227]	$91\,^{+20}_{-19} \pm 5$	91 ± 20
$\frac{\mathcal{B}(B_s^0 \to \phi e^+e^-)}{\mathcal{B}(B_s^0 \to phi\mu^+\mu^-)}$, $15.0 < m^2_{\ell^+\ell^-} < 19.0\ \text{GeV}^2/\text{c}^4$	LHCb [227]	$85\,^{+24}_{-23} \pm 10$	85 ± 26

[1] $m_{p\overline{p}} < 2.85\ \text{GeV/c}^2$.
[2] Multiple systematic uncertainties are added in quadrature.
[3] $0.5 < m_{\pi^+\pi^-} < 1.3\ \text{GeV/c}^2$.
[4] Result extracted from Dalitz-plot analysis of $B_s^0 \to K^+K^-\gamma$ decays.
[5] Measurement of $\frac{\mathcal{B}(B_s^0 \to f_2'(1525)\gamma)}{\mathcal{B}(B_s^0 \to \phi(1020)\gamma)}(\mathcal{B}(f_2'(1525) \to K\overline{K})/\mathcal{B}(\phi(1020) \to K^+K^-))0.5$ used in our fit.
[6] Measurement of $\frac{\mathcal{B}(B_s^0 \to f_2(1270)\gamma)}{\mathcal{B}(B_s^0 \to \phi(1020)\gamma)}(\mathcal{B}(f_2(1270) \to K\overline{K})/\mathcal{B}(\phi(1020) \to K^+K^-))0.5$ used in our fit.

Measurements that are not included in the tables (the definitions of observables can be found in the corresponding experimental papers):

- In Ref. [228], LHCb performs an angular analysis of $B_s^0 \to \phi e^+e^-$ in the $m^2(e^+e^-)$ mass region $[0.0009; 0.2615]\mathrm{GeV}^2/c^4$ and measures $A_T^{(2)}$, A_T^{ImCP},A_T^{ReCP} and F_L.
- In Ref. [214], LHCb reports the differential $B_s^0 \to \phi\mu^+\mu^-$ branching fraction in bins of $m^2(\mu^+\mu^-)$.
- In Ref. [229], LHCb performs an angular analysis of $B_s^0 \to \phi\mu^+\mu^-$ decays and reports F_L, S_3, S_4, S_7, A_5, A_{FB}^{CP}, A_8 and A_9 in bins of $m^2(\mu^+\mu^-)$.
- In Ref. [230], LHCb reports the photon polarization in $B_s^0 \to \phi\gamma$ decays.
- We do not perform the average of the branching fraction of $B \to \mu^+\mu^-$ decays, which is taken care of by the LHC Heavy Flavour Working Group [231], taking into account the correlations between the $B^0 \to \mu^+\mu^-$ and $B_s^0 \to \mu^+\mu^-$ branching fractions. The latest results from ATLAS, CMS and LHCb are in Refs. [232–234], respectively.
- In [227], LHCb reports the branching fraction of $B_s^0 \to \phi e^+e^-$ in three bins of $m^2(e^+e^-)$.
- In Ref. [207], which describes a Dalitz-Plot analysis of $B_s^0 \to K^+K^-\gamma$ decays, LHCb reports the overall tensor contribution to the decay amplitude. This includes the resonant contributions of the $f_2(1270)$, $f_2'(1525)$, and $f_2(2010)$ states.

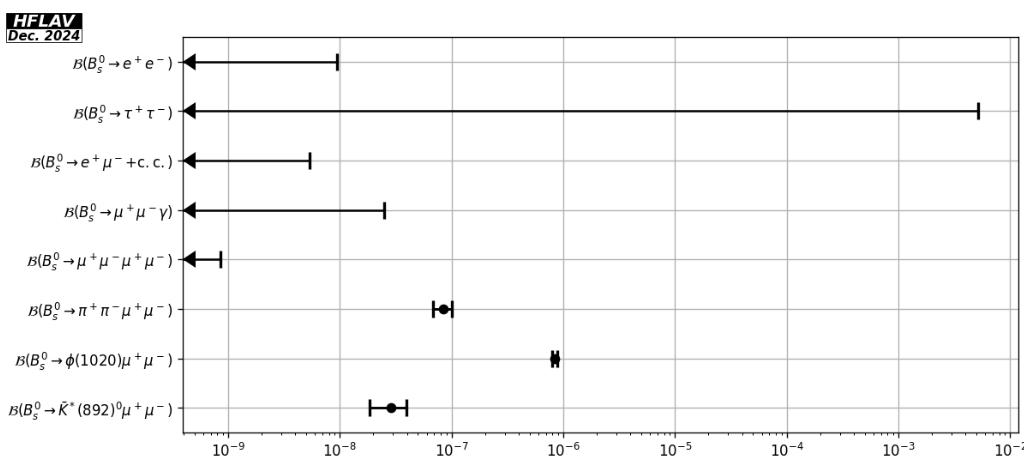

Figure 6: Branching fractions of charmless leptonic B_s^0 decays.

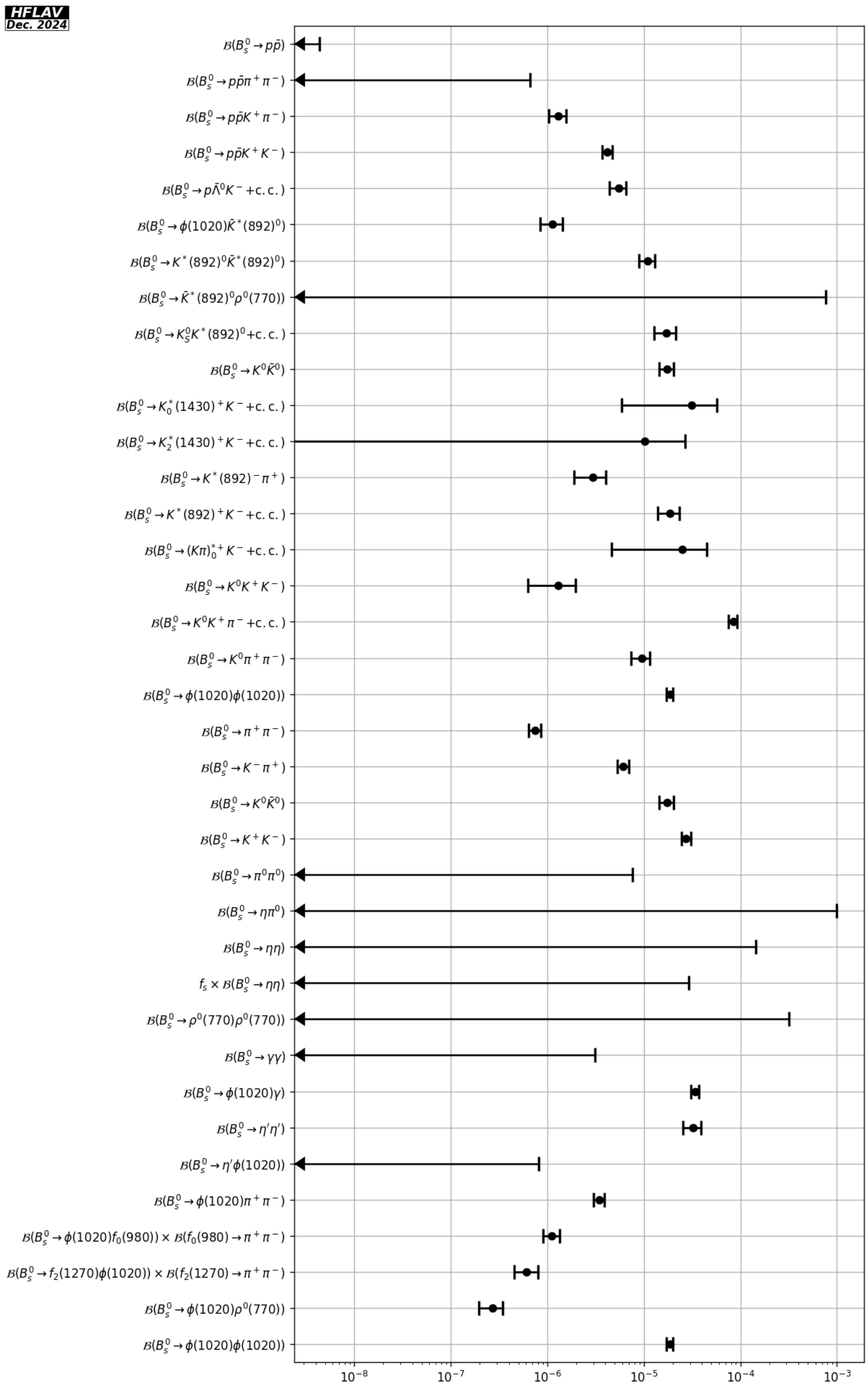

Figure 7: Branching fractions of charmless nonleptonic B_s^0 decays.

0.5 Decays of B_c^+ mesons

Table 56 details branching fractions and ratios of branching fractions of B_c^+ meson decays to charmless hadronic final states, except for decays to final states containing B_s^0 mesons that are quoted in Sec. 7.5 of the latest HFLAV publication.

Table 56: Branching fractions and relative branching fractions of B_c^+ decays.

Parameter	Measurements		Average
$\mathcal{B}(B_c^+ \to p\bar{p}\pi^+) \times \frac{f_c}{f_u}$ $[10^{-8}]$	LHCb [235][1]	< 2.8	< 2.8
$\frac{\mathcal{B}(B_c^+ \to K^+ K_S^0)}{\mathcal{B}(B^+ \to K_S^0 \pi^+)} \times \frac{f_c}{f_u}$ $[10^{-2}]$	LHCb [8]	< 5.8	< 5.8
$\mathcal{B}(B_c^+ \to K^+ \overline{K}^0)^2$ $[10^{-4}]$	LHCb [8]	< 4.6	< 4.6
$\mathcal{B}(B_c^+ \to K^+ K^- \pi^+) \times \frac{f_c}{f_u}$ $[10^{-7}]$	LHCb [236][3]	< 1.50	< 1.5
$\frac{\mathcal{B}(B_c^+ \to \pi^+ \mu^+ \mu^-)}{\mathcal{B}(B_c^+ \to J/\psi \pi^+)}$ $[10^{-4}]$	LHCb [237]	< 2.1	< 2.1
$\frac{\mathcal{B}(B_c^+ \to B_s^{*0}(\to \mu^+ \mu^-)\pi^+)}{\mathcal{B}(B_c^+ \to J/\psi \pi^+)}$ $[10^{-5}]$	LHCb [238]	< 5.0	< 5.0
$\frac{\mathcal{B}(B_c^+ \to B^{*0}(\to \mu^+ \mu^-)\pi^+)}{\mathcal{B}(B_c^+ \to J/\psi \pi^+)}$ $[10^{-5}]$	LHCb [238]	< 3.8	< 3.8

[1] Measured in the region $_{p\bar{p}} < 2.85$ GeV/c^2, $p_T(B) < 20$ GeV/c and $2.0 < y(B) < 4.5$.

[2] Derived from the ratio in the previous entry using $\mathcal{B}(B^+ \to K^0 \pi^+) = (23.97 \pm 0.53 \pm 0.71) \times 10^{-6}$, $f_u = 0.33$ and $f_c = 0.001$.

[3] Measured in the annihilation region $m_{K^+\pi^+} < 1.834$ GeV/c^2, and in the fiducial region $p_T(B) < 20$ GeV/c and $2.0 < y(B) < 4.5$

0.6 Rare decays of B^0 and B^+ mesons with photons and/or leptons

This section reports different observables for radiative decays, lepton-flavour/number-violating (LFV/LNV) decays and flavour-changing-neutral-current (FCNC) decays with leptons of B^0 and B^+ mesons. In all decays listed in this section, charmonium intermediate states are vetoed. Tables 57 to 61, 62 to 66 and 67 to 69 provide compilations of branching fractions of radiative and FCNC decays with leptons of B^+ mesons, B^0 mesons and their admixture, respectively. Tables 66 and 69 also include LFV/LNV decays. Tables 70 and 71 contain branching fractions of leptonic and radiative-leptonic B^+ and B^0 decays. These are followed by Tables 72 to 74, which give relative branching fractions of B^+ and B^0 decays, then Table 75, which gives a compilation of inclusive decays. In the modes listed in Table 75, the radiated particle is a gluon, which is an exception in this section. Table 76 contains isospin asymmetry measurements. Finally, Tables 77 to 79 and 80 provide compilations of branching fractions of B^+ and B^0 mesons to lepton-flavour/number-violating final states, respectively. The average of Figures 8 to 13 show graphic representations of a selection of results given in this section.

Table 57: Branching fractions of B^+ radiative and FCNC decays with leptons (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to K^*(892)^+\gamma)$ [1]	Belle [239]	$37.6 \pm 1.0 \pm 1.2$	
	Belle II [240]	$40.2 \pm 1.3 \pm 1.3$	39.5 ± 1.0
	BaBar [241]	$42.2 \pm 1.4 \pm 1.6$	39.2 ± 2.2
	CLEO [242]	$37.6\,^{+8.9}_{-8.3} \pm 2.8$	
$\mathcal{B}(B^+ \to K^+\pi^0\gamma)$	Belle [239] [2]	$39.1 \pm 1.6 \pm 1.6$	40.7 ± 1.9
	BaBar [241] [3]	$43.8 \pm 1.9 \pm 2.6$	none
$\mathcal{B}(B^+ \to K^0_S\pi^+\gamma)$	Belle [239] [2]	$36.9 \pm 1.2 \pm 1.2$	38.4 ± 1.4
	BaBar [241] [3]	$41.3 \pm 1.8 \pm 1.6$	none
$\mathcal{B}(B^+ \to K_1(1270)^+\gamma)$	BaBar [243] [4]	$44.1\,^{+6.3}_{-4.4} \pm 5.8$	$43.8\,^{+7.0}_{-6.3}$
	Belle [244] [5]	$43.0 \pm 9.0 \pm 9.0$	$43.8\,^{+7.1}_{-6.3}$
$\mathcal{B}(B^+ \to \eta K^+\gamma)$	BaBar [245] [6]	$7.7 \pm 1.0 \pm 0.4$	7.89 ± 0.92
	Belle [246] [7]	$8.4 \pm 1.5\,^{+1.2}_{-0.9}$	$7.88\,^{+0.94}_{-0.92}$
$\mathcal{B}(B^+ \to \eta' K^+\gamma)$	Belle [247] [8]	$3.6 \pm 1.2 \pm 0.4$	2.9 ± 1.0
	BaBar [248] [6]	$1.9\,^{+1.5}_{-1.2} \pm 0.1$	$2.9\,^{+1.0}_{-0.9}$
$\mathcal{B}(B^+ \to \phi(1020)K^+\gamma)$ [1]	Belle [249]	$2.48 \pm 0.30 \pm 0.24$	2.71 ± 0.34
	BaBar [250] [9]	$3.5 \pm 0.6 \pm 0.4$	2.71 ± 0.42

[1] The PDG uncertainty includes a scale factor.
[2] $m_{K\pi} < 2.0$ GeV/c^2.
[3] $0.79 < m_{K\pi} < 1.0$ GeV/c^2.
[4] Multiple systematic uncertainties are added in quadrature.
[5] $1 < m_{K\pi\pi} < 2$ GeV/c^2.
[6] $m_{K\eta^{(\prime)}} < 3.25$ GeV/c^2.
[7] $m_{K\eta} < 2.4$ GeV/c^2.
[8] $m_{K\eta'} < 3.4$ GeV/c^2
[9] $m_{\phi K} < 3.0$ GeV/c^2.

Table 58: Branching fractions of B^+ radiative and FCNC decays with leptons (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to K^+\pi^-\pi^+\gamma)$[1]	BaBar [243][2] Belle [244][3]	$24.5 \pm 0.9 \pm 1.2$ $25.0 \pm 1.8 \pm 2.2$	24.6 ± 1.3 25.8 ± 1.5
$\mathcal{B}(B^+ \to K^*(892)^0\pi^+\gamma)$	BaBar [243][2] Belle [251][4]	$23.4 \pm 0.9\,^{+0.8}_{-0.7}$ $20.0\,^{+7.0}_{-6.0} \pm 2.0$	23.3 ± 1.2 $23.3\,^{+1.2}_{-1.1}$
$\mathcal{B}(B^+ \to K^+\rho^0(770)\gamma)$	BaBar [243][2] Belle [251][4]	$8.2 \pm 0.4 \pm 0.8$ < 20.0	8.2 ± 0.9
$\mathcal{B}(B^+ \to (K\pi)^{*0}_0\pi^+\gamma) \times \mathcal{B}((K\pi)^{*0}_0 \to K^+\pi^-)$[5]	BaBar [243][2]	$10.3\,^{+0.7}_{-0.8}\,^{+1.5}_{-2.0}$	$10.3\,^{+1.7}_{-2.2}$ none
$\mathcal{B}(B^+ \to K^+\pi^-\pi^+\gamma(\mathrm{NR}))$	BaBar [243][2,6] Belle [251][7]	$9.9 \pm 0.7\,^{+1.5}_{-1.9}$ < 9.2	$9.9\,^{+1.7}_{-2.0}$
$\mathcal{B}(B^+ \to K^0\pi^+\pi^0\gamma)$	BaBar [252][2]	$45.6 \pm 4.2 \pm 3.1$	45.6 ± 5.2
$\mathcal{B}(B^+ \to K_1(1400)^+\gamma)$	BaBar [243][2,8] Belle [244]	$9.7\,^{+4.6}_{-2.9}\,^{+2.9}_{-2.4}$ < 15.0	$9.7\,^{+5.4}_{-3.8}$
$\mathcal{B}(B^+ \to K^*(1410)^+\gamma)$	BaBar [243][2,8]	$27.1\,^{+5.4}_{-4.8}\,^{+5.9}_{-3.7}$	$27.1\,^{+8.0}_{-6.1}$
$\mathcal{B}(B^+ \to K^*_0(1430)^0\pi^+\gamma)$	BaBar [243][2,8]	$1.32\,^{+0.09}_{-0.10}\,^{+0.24}_{-0.30}$	$1.32\,^{+0.26}_{-0.31}$ $1.32\,^{+0.26}_{-0.32}$
$\mathcal{B}(B^+ \to K^*_2(1430)^+\gamma)$	BaBar [253] BaBar [243][2,8]	$14.5 \pm 4.0 \pm 1.5$ $8.7\,^{+7.0}_{-5.3}\,^{+8.7}_{-10.4}$	13.8 ± 4.0
$\mathcal{B}(B^+ \to K^*(1680)^+\gamma)$	BaBar [243][2,8]	$66.7\,^{+9.3}_{-7.8}\,^{+14.4}_{-11.4}$	$67\,^{+17}_{-14}$
$\mathcal{B}(B^+ \to K^*_3(1780)^+\gamma)$	Belle [246]	< 14	< 14 < 39
$\mathcal{B}(B^+ \to K^*_4(2045)^+\gamma)$	ARGUS [254]	< 9900	< 9900

[1] The PDG uncertainty includes a scale factor.
[2] $m_{K\pi\pi} < 1.8$ GeV/c^2.
[3] $1 < m_{K\pi\pi} < 2$ GeV/c^2.
[4] $m_{K\pi\pi} < 2.4$ GeV/c^2.
[5] This corresponds to the $(K\pi)$ S-wave obtained with LASS parameterisation [255].
[6] $m_{K\pi} < 1.6$ GeV/c^2.
[7] $1.25 < m_{K\pi} < 1.6$ GeV/c^2 and $m_{K\pi\pi} < 2.4$ GeV/c^2.
[8] Multiple systematic uncertainties are added in quadrature.

Table 59: Branching fractions of B^+ radiative and FCNC decays with leptons (part 3).

Parameter $[10^{-6}]$	Measurements		Average HFLAV PDG
$\mathcal{B}(B^+ \to \rho^+(770)\gamma)$	Belle II [256][1] BaBar [257]	$1.31\,^{+0.20}_{-0.19}\,^{+0.13}_{-0.12}$ $1.2 \pm 0.4 \pm 0.2$	1.29 ± 0.20 $0.98\,^{+0.25}_{-0.24}$
$\mathcal{B}(B^+ \to p\overline{\Lambda}^0\gamma)$	Belle [166]	$2.45\,^{+0.44}_{-0.38} \pm 0.22$	$2.45\,^{+0.49}_{-0.44}$
$\mathcal{B}(B^+ \to p\overline{\Sigma}^0\gamma)$	Belle [258]	< 4.6	< 4.6

[1] Result obtained with a combination of Belle and Belle II datasets.

Table 60: Branching fractions of B^+ radiative and FCNC decays with leptons (part 4).

Parameter $[10^{-6}]$	Measurements		Average HFLAV PDG
$\mathcal{B}(B^+ \to \pi^+\ell^+\ell^-)$[1]	Belle [259] BaBar [260]	< 0.049 < 0.066	< 0.049
$\mathcal{B}(B^+ \to \pi^+e^+e^-)$[1]	Belle [261][2] BaBar [260]	< 0.054 < 0.125	< 0.05 < 0.08
$\mathcal{B}(B^+ \to \pi^+\mu^+\mu^-)$[1]	BaBar [260] Belle [259] LHCb [262][3,4]	< 0.055 < 0.069	0.0178 ± 0.0023
$\mathcal{B}(B^+ \to \rho^+(770)\ell^+\ell^-)$	Belle [261][2]	< 0.189	< 0.19 none
$\mathcal{B}(B^+ \to \rho^+(770)e^+e^-)$	Belle [261][2]	< 0.467	< 0.47 none
$\mathcal{B}(B^+ \to \rho^+(770)\mu^+\mu^-)$	Belle [261][2]	< 0.381	< 0.38 none
$\mathcal{B}(B^+ \to \pi^+\nu\overline{\nu})$	Belle [263] BaBar [264]	< 14.0 < 100.0	< 14

[1] Treatment of charmonium intermediate components differs between the results.
[2] Result obtained with Belle dataset.
[3] LHCb also reports the branching fraction in bins of $m^2_{\ell^+\ell^-}$.
[4] Measurement of $\mathcal{B}(B^+ \to \pi^+\mu^+\mu^-)/(\mathcal{B}(B^+ \to J/\psi K^+)\mathcal{B}(J/\psi \to \mu^+\mu^-))$ used in our fit.

Table 61: Branching fractions of B^+ radiative and FCNC decays with leptons (part 5).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to K^+\ell^+\ell^-)$[1]	Belle [265]	$0.599\,^{+0.045}_{-0.043} \pm 0.014$	0.576 ± 0.040
	BaBar [266]	$0.476\,^{+0.092}_{-0.086} \pm 0.022$	0.471 ± 0.046
$\mathcal{B}(B^+ \to K^+e^+e^-)$[1]	Belle [265]	$0.575\,^{+0.064}_{-0.061} \pm 0.015$	0.561 ± 0.056
	BaBar [266]	$0.51\,^{+0.12}_{-0.11} \pm 0.02$	$0.560\,^{+0.058}_{-0.055}$
$\mathcal{B}(B^+ \to K^+\mu^+\mu^-)$[2,1]	LHCb [267]	$0.429 \pm 0.007 \pm 0.021$	
	CMS [268][3]	$0.435 \pm 0.019 \pm 0.015$	0.443 ± 0.016
	Belle [265]	$0.624\,^{+0.065}_{-0.061} \pm 0.016$	0.453 ± 0.035
	BaBar [266]	$0.41\,^{+0.16}_{-0.15} \pm 0.02$	
$\mathcal{B}(B^+ \to K^+\tau^+\tau^-)$	BaBar [269]	< 2250.0	< 2250
$\mathcal{B}(B^+ \to K^+\nu\overline{\nu})$	Belle [263][4]	10.0 ± 6.0	
	Belle II [270]	$23 \pm 5\,^{+5}_{-4}$	
	BaBar [271][5]	$2.0\,^{+8.0}_{-7.0}$	13.8 ± 3.5 / < 16.0
	Belle [272][6]	29.0 ± 16.0	
	BaBar [273][7]	$15.0\,^{+17.0}_{-8.0}\,^{+4.0}_{-2.0}$	
$\mathcal{B}(B^+ \to \rho^+(770)\nu\overline{\nu})$	Belle [263]	< 30.0	< 30
$\mathcal{B}(B^+ \to K^*(892)^+\ell^+\ell^-)$[2,1]	LHCb [267][8]	$0.924 \pm 0.093 \pm 0.067$	1.010 ± 0.099
	Belle [274]	$1.24\,^{+0.23}_{-0.21} \pm 0.13$	$1.009\,^{+0.113}_{-0.112}$
	BaBar [266]	$1.40\,^{+0.40}_{-0.37} \pm 0.09$	
$\mathcal{B}(B^+ \to K^*(892)^+e^+e^-)$[1]	BaBar [266]	$1.38\,^{+0.47}_{-0.42} \pm 0.08$	1.55 ± 0.33
	Belle [274]	$1.73\,^{+0.50}_{-0.42} \pm 0.20$	$1.55\,^{+0.36}_{-0.31}$
$\mathcal{B}(B^+ \to K^*(892)^+\mu^+\mu^-)$[1]	LHCb [267]	$0.924 \pm 0.093 \pm 0.067$	
	Belle [274]	$1.11\,^{+0.32}_{-0.27} \pm 0.10$	0.96 ± 0.10
	BaBar [266]	$1.46\,^{+0.79}_{-0.75} \pm 0.12$	
$\mathcal{B}(B^+ \to K^*(892)^+\nu\overline{\nu})$	Belle [272]	< 40.0	
	Belle [263]	< 61.0	< 40
	BaBar [273]	< 64.0	
$\mathcal{B}(B^+ \to K^+\pi^+\pi^-\mu^+\mu^-)$	LHCb [275][9]	$0.4337\,^{+0.0287}_{-0.0268} \pm 0.0254$	0.434 ± 0.038 / $0.433\,^{+0.038}_{-0.037}$
$\mathcal{B}(B^+ \to \phi(1020)K^+\mu^+\mu^-)$	LHCb [275][10]	$0.0790\,^{+0.0180}_{-0.0160}\,^{+0.0114}_{-0.0072}$	$0.079\,^{+0.022}_{-0.017}$ / $0.079\,^{+0.021}_{-0.017}$
$\mathcal{B}(B^+ \to \overline{\Lambda}^0 p\nu\overline{\nu})$	BaBar [276]	< 30.0	< 30

[1] Treatment of charmonium intermediate components differs between the results.
[2] The PDG uncertainty includes a scale factor.
[3] Value extrapolated from the low q^2 region using Flavio package. The paper also provides the value using SuperIso, which is 0.439 with the same errors.
[4] Semileptonic tag. Paper only reports UL. The value reported here is calculated in Ref. [270].
[5] Semileptonic tag
[6] Hadronic tag. Paper only reports UL. The value reported here is calculated in Ref. [270].
[7] Hadronic tag
[8] Only muons are used.
[9] Using $\mathcal{B}(B^+ \to \psi(2S)K^+)$.
[10] Using $\mathcal{B}(B^+ \to J/\psi\phi(1020)K^+)$.

Table 62: Branching fractions of B^0 radiative and FCNC decays with leptons (part 1).

Parameter $[10^{-6}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^0 \to K^*(892)^0\gamma)$[1]	Belle [239]	$39.6 \pm 0.7 \pm 1.4$	41.63 ± 0.92
	Belle II [240]	$41.4 \pm 1.0 \pm 1.0$	41.77 ± 2.48
	BaBar [241]	$44.7 \pm 1.0 \pm 1.6$	
	CLEO [242]	$45.5\,^{+7.2}_{-6.8} \pm 3.4$	
	LHCb [206][2], [184][3]		
$\mathcal{B}(B^0 \to K^+\pi^-\gamma)$	Belle [239][4]	$39.5 \pm 0.7 \pm 1.4$	41.4 ± 1.2
	BaBar [241][5]	$44.5 \pm 1.0 \pm 1.7$	4.6 ± 1.4
$\mathcal{B}(B^0 \to K^0_S\pi^0\gamma)$	Belle [239][4]	$40.0 \pm 2.7 \pm 2.4$	42.2 ± 2.9
	BaBar [241][6]	$46.6 \pm 3.7 \pm 3.5$	none
$\mathcal{B}(B^0 \to K^*(1410)^0\gamma)$	Belle [251][7]	< 130.0	< 130
$\mathcal{B}(B^0 \to K^+\pi^-\gamma(\mathrm{NR}))$	Belle [251][7]	< 2.6	< 2.6
$\mathcal{B}(B^0 \to \eta K^0\gamma)$	BaBar [245][8]	$7.1\,^{+2.1}_{-2.0} \pm 0.4$	7.6 ± 1.8
	Belle [246][9]	$8.7\,^{+3.1}_{-2.7}\,^{+1.9}_{-1.6}$	$7.6\,^{+1.8}_{-1.7}$
$\mathcal{B}(B^0 \to \eta' K^0\gamma)$	Belle [247][10]	< 6.4	< 6.4
	BaBar [248][8]	< 6.6	
$\mathcal{B}(B^0 \to \phi(1020)K^0\gamma)$	Belle [249]	$2.74 \pm 0.60 \pm 0.32$	2.74 ± 0.68
	BaBar [250][11]	< 27	
$\mathcal{B}(K^{*0}X(214)) \times \mathcal{B}(X(214) \to \mu^+\mu^-)$	Belle [277][12]	< 0.0226	< 0.023

[1] The PDG uncertainty includes a scale factor.
[2] Measurement of $\mathcal{B}(B^0_s \to \phi(1020)\gamma)/\mathcal{B}(B^0 \to K^*(892)^0\gamma)$ used in our fit.
[3] Measurement of $(\mathcal{B}(\Lambda^0_b \to \Lambda^0\gamma)/\mathcal{B}(B^0 \to K^*(892)^0\gamma))\frac{f_{\Lambda^0_b}}{f_d}$ used in our fit.
[4] $m_{K\pi} < 2.0$ GeV$/c^2$.
[5] $0.78 < m_{K\pi} < 1.1$ GeV$/c^2$.
[6] $0.82 < m_{K\pi} < 1.0$ GeV$/c^2$.
[7] $1.25 < m_{K\pi} < 1.6$ GeV$/c^2$.
[8] $m_{K\eta^{(\prime)}} < 3.25$ GeV$/c^2$.
[9] $m_{K\eta} < 2.4$ GeV$/c^2$.
[10] $m_{K\eta'} < 3.4$ GeV$/c^2$
[11] $m_{\phi K} < 3.0$ GeV$/c^2$.
[12] $X(214)$ is searched for in the mass range $[212, 300]$ MeV$/c^2$.

Table 63: Branching fractions of B^0 radiative and FCNC decays with leptons (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to K^0\pi^+\pi^-\gamma)$	BaBar [243][1] BaBar [252][1] Belle [244][2]	$20.5 \pm 2.0\,^{+2.6}_{-2.2}$ $18.5 \pm 2.1 \pm 1.2$ $24.0 \pm 4.0 \pm 3.0$	19.9 ± 1.8
$\mathcal{B}(B^0 \to K^+\pi^-\pi^0\gamma)$	BaBar [252][1]	$40.7 \pm 2.2 \pm 3.1$	40.7 ± 3.8
$\mathcal{B}(B^0 \to K_1(1270)^0\gamma)$	Belle [244]	< 58.0	< 58
$\mathcal{B}(B^0 \to K^0_S K^0_S\gamma)$	Belle [278][3]	< 0.58	< 0.58 none
$\mathcal{B}(B^0 \to f_2(1270)\gamma) \times \mathcal{B}(f_2(1270) \to K^0_S K^0_S)$	Belle [278][4]	< 0.31	< 0.31 none
$\mathcal{B}(B^0 \to f_2'(1525)\gamma) \times \mathcal{B}(f_2'(1525) \to K^0_S K^0_S)$	Belle [278][5]	< 0.21	< 0.21 none
$\mathcal{B}(B^0 \to K_1(1400)^0\gamma)$	Belle [244]	< 12.0	< 12
$\mathcal{B}(B^0 \to K_2^*(1430)^0\gamma)$	BaBar [253] Belle [251]	$12.2 \pm 2.5 \pm 1.0$ $13.0 \pm 5.0 \pm 1.0$	12.4 ± 2.4
$\mathcal{B}(B^0 \to K_3^*(1780)^0\gamma)$	Belle [246]	< 30	< 30 < 83

[1] $m_{K\pi\pi} < 1.8$ GeV$/c^2$.

[2] $1 < m_{K\pi\pi} < 2$ GeV$/c^2$.

[3] Measured in bins of $m_{K^0_S K^0_S}$. We report the result for the full range, 1.0 GeV$/c^2 < m_{K^0_S K^0_S} <$ 3.0 GeV$/c^2$.

[4] Measured in bins of $m_{K^0_S K^0_S}$. We report the result for the full range, 1.00 GeV$/c^2 < m_{K^0_S K^0_S} <$ 1.44 GeV$/c^2$.

[5] Measured in bins of $m_{K^0_S K^0_S}$. We report the result for the full range, 1.44 GeV$/c^2 < m_{K^0_S K^0_S} <$ 1.63 GeV$/c^2$.

Table 64: Branching fractions of B^0 radiative and FCNC decays with leptons (part 3).

Parameter $[10^{-6}]$	**Measurements**		**Average** $^{\text{HFLAV}}_{\text{PDG}}$
$\mathcal{B}(B^0 \to \rho^0(770)\gamma)$	Belle II [256][1]	$0.75 \pm 0.13\,^{+0.10}_{-0.08}$	0.82 ± 0.13
	BaBar [257]	$0.97\,^{+0.24}_{-0.22} \pm 0.06$	0.86 ± 0.15
$\mathcal{B}(\rho^0 X(214)) \times \mathcal{B}(X(214) \to \mu^+\mu^-)$	Belle [277][2]	< 0.0173	< 0.017
$\mathcal{B}(B^0 \to \omega(782)\gamma)$	Belle [279]	$0.40\,^{+0.19}_{-0.17} \pm 0.13$	0.44 ± 0.17
	BaBar [257]	$0.50\,^{+0.27}_{-0.23} \pm 0.09$	$0.44\,^{+0.18}_{-0.16}$
$\mathcal{B}(B^0 \to \phi(1020)\gamma)$	Belle [280]	< 0.1	< 0.1
	BaBar [281]	< 0.85	
$\mathcal{B}(B^0 \to p\overline{\Lambda}^0\pi^-\gamma)$	Belle [282]	< 0.65	< 0.65
$\mathcal{B}(B^0 \to \pi^0\ell^+\ell^-)$[3]	Belle [261][4]	< 0.038	< 0.038
	BaBar [260]	< 0.053	< 0.053
$\mathcal{B}(B^0 \to \pi^0 e^+e^-)$[3]	Belle [261][4]	< 0.079	< 0.079
	BaBar [260]	< 0.084	< 0.084
$\mathcal{B}(B^0 \to \pi^0\mu^+\mu^-)$[3]	Belle [261][4]	< 0.059	< 0.059
	BaBar [260]	< 0.069	< 0.069

[1] Result obtained with a combination of Belle and Belle II datasets.
[2] $X(214)$ is searched for in the mass range $[212, 300]$ MeV$/c^2$.
[3] Treatment of charmonium intermediate components differs between the results.
[4] Result obtained with Belle dataset.

Table 65: Branching fractions of B^0 radiative and FCNC decays with leptons (part 4).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to \eta \ell^+ \ell^-)$	Belle [261][1] BaBar [260]	< 0.048 < 0.064	< 0.048 < 0.064
$\mathcal{B}(B^0 \to \eta e^+ e^-)$	Belle [261][1] BaBar [260]	< 0.105 < 0.108	< 0.10 < 0.11
$\mathcal{B}(B^0 \to \eta \mu^+ \mu^-)$	Belle [261][1] BaBar [260]	< 0.094 < 0.112	< 0.094 < 0.112
$\mathcal{B}(B^0 \to \omega(782) \ell^+ \ell^-)$	Belle [261][1]	< 0.220	< 0.22 none
$\mathcal{B}(B^0 \to \omega(782) e^+ e^-)$	Belle [261][1]	< 0.307	< 0.31 none
$\mathcal{B}(B^0 \to \omega(782) \mu^+ \mu^-)$	Belle [261][1]	< 0.249	< 0.25 none
$\mathcal{B}(B^0 \to \rho^0(770) e^+ e^-)$	Belle [261][1]	< 0.455	< 0.46 none
$\mathcal{B}(B^0 \to \pi^0 \nu \overline{\nu})$	Belle [263]	< 9.0	< 9.0
$\mathcal{B}(B^0 \to K^0 \ell^+ \ell^-)^2$	LHCb [267][3] Belle [265] BaBar [266]	$0.327 \pm 0.034 \pm 0.017$ $0.351\,^{+0.069}_{-0.060} \pm 0.010$ $0.21\,^{+0.15}_{-0.13} \pm 0.02$	0.328 ± 0.032 $0.329\,^{+0.063}_{-0.055}$
$\mathcal{B}(B^0 \to K^0 e^+ e^-)^{4,2}$	Belle [265] BaBar [266]	$0.306\,^{+0.098}_{-0.086} \pm 0.008$ $0.08\,^{+0.15}_{-0.12} \pm 0.01$	0.249 ± 0.072 $0.247\,^{+0.109}_{-0.094}$
$\mathcal{B}(B^0 \to K^0 \mu^+ \mu^-)^{4,2}$	LHCb [267] Belle [265] BaBar [266]	$0.327 \pm 0.034 \pm 0.017$ $0.394\,^{+0.096}_{-0.084} \pm 0.012$ $0.49\,^{+0.29}_{-0.25} \pm 0.03$	0.341 ± 0.034 0.339 ± 0.035
$\mathcal{B}(B^0 \to K^0 \nu \overline{\nu})$	Belle [263] BaBar [273]	< 26.0 < 49.0	< 26
$\mathcal{B}(B^0 \to \rho^0(770) \nu \overline{\nu})$	Belle [263]	< 40.0	< 40
$\mathcal{B}(B^0 \to K^*(892)^0 \ell^+ \ell^-)^2$	Belle [274] BaBar [266]	$0.97\,^{+0.13}_{-0.11} \pm 0.07$ $1.03\,^{+0.22}_{-0.21} \pm 0.07$	0.99 ± 0.12 $0.99\,^{+0.12}_{-0.11}$
$\mathcal{B}(B^0 \to K^*(892)^0 e^+ e^-)^2$	Belle [274] BaBar [266]	$1.18\,^{+0.27}_{-0.22} \pm 0.09$ $0.86\,^{+0.26}_{-0.24} \pm 0.05$	1.04 ± 0.17 $1.03\,^{+0.19}_{-0.17}$
$\mathcal{B}(B^0 \to K^*(892)^0 \mu^+ \mu^-)^{5,2}$	LHCb [283][6] Belle [274] BaBar [266]	$0.904\,^{+0.016}_{-0.015} \pm 0.062$ $1.06\,^{+0.19}_{-0.14} \pm 0.07$ $1.35\,^{+0.40}_{-0.37} \pm 0.10$	0.94 ± 0.06 0.94 ± 0.05
$\mathcal{B}(B^0 \to K^*(892)^0 \tau^+ \tau^-)$	Belle [284]	< 3100	< 3100 none

[1] Result obtained with Belle dataset.
[2] Treatment of charmonium intermediate components differs between the results.
[3] Only muons are used.
[4] The PDG uncertainty includes a scale factor.
[5] The PDG average is a result of a fit including input from other measurements.
[6] Multiple systematic uncertainties are added in quadrature.

Table 66: Branching fractions of B^0 radiative and FCNC decays with leptons (part 5).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^0 \to \pi^+\pi^-\mu^+\mu^-)$	LHCb [216][1,2,3]		0.021 ± 0.005
$\mathcal{B}(B^0 \to K^*(892)^0\nu\overline{\nu})$	Belle [263]	< 18.0	< 18
	Belle [272]	< 55.0	
	BaBar [273]	< 120.0	
$\mathcal{B}(B^0 \to \phi(1020)\nu\overline{\nu})$	Belle [272]	< 127.0	< 127
$\mathcal{B}(B^0 \to \pi^0 e^+\mu^- + \text{c.c.})$	BaBar [285]	< 0.14	< 0.14
$\mathcal{B}(B^0 \to K^0 e^+\mu^- + \text{c.c.})$	Belle [265]	< 0.038	< 0.038
	BaBar [286]	< 0.27	
$\mathcal{B}(B^0 \to K^*(892)^0 e^+\mu^-)$	LHCb [220]	< 0.0068	< 0.0068
	Belle [287]	< 0.16	< 0.1600
	BaBar [286]	< 0.53	
$\mathcal{B}(B^0 \to K^*(892)^0 e^-\mu^+)$	LHCb [220]	< 0.0057	< 0.0057
	Belle [287]	< 0.12	< 0.1200
	BaBar [286]	< 0.34	
$\mathcal{B}(B^0 \to K^*(892)^0 e^+\mu^- + \text{c.c.})$	LHCb [220]	< 0.0101	< 0.010
	Belle [287]	< 0.18	< 0.180
	BaBar [286]	< 0.58	
$\mathcal{B}(B^0 \to \Lambda_c^+\mu^-)$	BaBar [288]	< 1.4	< 1.4
$\mathcal{B}(B^0 \to \Lambda_c^+ e^-)$	BaBar [288]	< 4.0	< 4.0
$\mathcal{B}(B^0 \to \phi(1020)\mu^+\mu^-)$	LHCb [289][4]	< 0.0032	< 0.0032 / none

[1] The mass windows corresponding to ϕ and charmonium resonances decaying to $\mu\mu$ are vetoed.

[2] $0.5 < m_{\pi^+\pi^-} < 1.3$ GeV/c^2.

[3] Measurement of $\mathcal{B}(B^0 \to \pi^+\pi^-\mu^+\mu^-)/(\mathcal{B}(B^0 \to J/\psi K^*(892)^0)\mathcal{B}(J/\psi \to \mu^+\mu^-)\mathcal{B}(K^*(892)^0 \to K\pi)2/3)$ used in our fit.

[4] LHCb also reports an upper limit at 2.3×10^{-9} excluding the ϕ and charmonium regions.

Table 67: Branching fractions of radiative, FCNC decays with leptons and LFV/LNV decays of $B^{\pm}/B^0$ admixture (part 1).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B \to K\eta\gamma)$	Belle [246][1]	$8.5 \pm 1.3\,^{+1.2}_{-0.9}$	$8.5\,^{+1.8}_{-1.6}$
$\mathcal{B}(B \to K_1(1400)\gamma)$	CLEO [242]	< 127	< 127
$\mathcal{B}(B \to K_2^*(1430)\gamma)$	CLEO [242]	$16.6\,^{+5.9}_{-5.3} \pm 1.3$	$16.6\,^{+6.0}_{-5.5}$
$\mathcal{B}(B \to K_3^*(1780)\gamma)$	Belle [246]	< 14	< 14 < 37
$\mathcal{B}(B \to X_s\gamma)$	Belle [290][2,3]	$351 \pm 15 \pm 41$	349 ± 19
	BaBar [291][2,4]	$331 \pm 16 \pm 31$	
	Belle [292][2,5]	$375 \pm 18 \pm 35$	
	BaBar [293][2,5]	$352 \pm 20 \pm 51$	
	CLEO [294][2,6]	$328 \pm 44 \pm 28$	
	Belle II [295][2,4]	$366 \pm 81 \pm 86$	
	BaBar [296][2,5]	$390 \pm 91 \pm 64$	
$\mathcal{B}(B \to X_d\gamma)$	BaBar [297]	$9.2 \pm 2.0 \pm 2.3$	9.2 ± 3.0
$\mathcal{B}(B \to \rho\gamma)$[7]	Belle [279]	$1.21\,^{+0.24}_{-0.22} \pm 0.12$	1.40 ± 0.22
	BaBar [257]	$1.73\,^{+0.34}_{-0.32} \pm 0.17$	$1.39\,^{+0.25}_{-0.24}$
$\mathcal{B}(B \to \rho/\omega\gamma)$[7]	Belle [279]	$1.14 \pm 0.20\,^{+0.10}_{-0.12}$	1.30 ± 0.18
	BaBar [257]	$1.63\,^{+0.30}_{-0.28} \pm 0.16$	$1.30\,^{+0.23}_{-0.24}$
$\mathcal{B}(B \to X_s e^+e^-)$[7,8,9]	BaBar [298][10]	$7.69\,^{+0.82}_{-0.77}\,^{+0.71}_{-0.60}$	6.67 ± 0.83
	Belle [299]	$4.04 \pm 1.30\,^{+0.87}_{-0.83}$	$6.67\,^{+1.76}_{-1.63}$
$\mathcal{B}(B \to X_s\mu^+\mu^-)$[8,9]	Belle [299]	$4.13 \pm 1.05\,^{+0.85}_{-0.81}$	4.27 ± 0.95
	BaBar [298][10]	$4.41\,^{+1.31}_{-1.17}\,^{+0.63}_{-0.50}$	$4.27\,^{+0.99}_{-0.92}$
$\mathcal{B}(B \to X_s\ell^+\ell^-)$[8,7,9]	BaBar [298][10]	$6.73\,^{+0.70}_{-0.64}\,^{+0.60}_{-0.56}$	5.84 ± 0.69
	Belle [299]	$4.11 \pm 0.83\,^{+0.85}_{-0.81}$	$5.84\,^{+1.31}_{-1.23}$

[1] $m_{K\eta} < 2.4$ GeV/c^2.
[2] Measurement extrapolated to $E_\gamma > 1.6$ GeV using the method from Ref. [300].
[3] The systematic error includes a shape-function systematic of 0.01.
[4] The systematic error includes a shape-function systematic of 0.02.
[5] The systematic error includes a shape-function systematic of 0.04.
[6] The systematic error includes a shape-function systematic of 0.06.
[7] The PDG uncertainty includes a scale factor.
[8] Belle uses $m_{\ell^+\ell^-} > 0.2$ GeV/c^2, BABAR uses $m_{\ell^+\ell^-} > 0.1$ GeV/c^2.
[9] Treatment of charmonium intermediate components differs between the results.
[10] Multiple systematic uncertainties are added in quadrature.

Table 68: Branching fractions of radiative, FCNC decays with leptons and LFV/LNV decays of $B^{\pm}/B^0$ admixture (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B \to \pi \ell^+ \ell^-)$[1]	BaBar [260]	< 0.059	< 0.059
	Belle [259]	< 0.062	
$\mathcal{B}(B \to \pi e^+ e^-)$	BaBar [260]	< 0.11	< 0.11
$\mathcal{B}(B \to \pi \mu^+ \mu^-)$	BaBar [260]	< 0.05	< 0.05
$\mathcal{B}(B \to K e^+ e^-)$[1]	Belle [274]	$0.48\,^{+0.08}_{-0.07} \pm 0.03$	0.44 ± 0.06
	BaBar [266]	$0.388\,^{+0.090}_{-0.083} \pm 0.020$	
$\mathcal{B}(B \to K^* e^+ e^-)$[2,1]	Belle [274]	$1.39\,^{+0.23}_{-0.20} \pm 0.12$	1.22 ± 0.16
	BaBar [266]	$0.99\,^{+0.23}_{-0.21} \pm 0.06$	$1.19\,^{+0.21}_{-0.19}$
	Belle II [301][3,4]	$1.42 \pm 0.48 \pm 0.09$	
$\mathcal{B}(B \to K \mu^+ \mu^-)$[1]	CDF [181]	$0.42 \pm 0.04 \pm 0.02$	0.442 ± 0.036
	Belle [274]	$0.50 \pm 0.06 \pm 0.03$	
	BaBar [266]	$0.41\,^{+0.13}_{-0.12} \pm 0.02$	
$\mathcal{B}(B \to K^* \mu^+ \mu^-)$[1]	CDF [181]	$1.01 \pm 0.10 \pm 0.05$	1.07 ± 0.09
	Belle [274]	$1.10\,^{+0.16}_{-0.14} \pm 0.08$	1.06 ± 0.09
	Belle II [301][3]	$1.19 \pm 0.31\,^{+0.08}_{-0.07}$	
	BaBar [266]	$1.35\,^{+0.35}_{-0.33} \pm 0.10$	
$\mathcal{B}(B \to K \ell^+ \ell^-)$[1]	Belle [274]	$0.48\,^{+0.05}_{-0.04} \pm 0.03$	0.48 ± 0.04
	BaBar [302]	$0.47 \pm 0.06 \pm 0.02$	
$\mathcal{B}(B \to K^* \ell^+ \ell^-)$[1]	Belle [274]	$1.07\,^{+0.11}_{-0.10} \pm 0.09$	1.07 ± 0.10
	BaBar [302]	$1.02\,^{+0.14}_{-0.13} \pm 0.05$	1.05 ± 0.10
	Belle II [301][3,4]	$1.25 \pm 0.30\,^{+0.08}_{-0.07}$	

[1] Treatment of charmonium intermediate components differs between the results.
[2] The PDG uncertainty includes a scale factor.
[3] J/ψ and $\psi(2S)$ regions are vetoed.
[4] $m_{e^+e^-} > 0.14$ GeV/c^2.

Table 69: Branching fractions of radiative, FCNC decays with leptons and LFV/LNV decays of $B^{\pm}/B^{0}$ admixture (part 3).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV PDG
$\mathcal{B}(B \to K\nu\overline{\nu})$	Belle [263] BaBar [273]	< 16.0 < 17.0	< 16
$\mathcal{B}(B \to K^{*}\nu\overline{\nu})$	Belle [263] BaBar [273]	< 27.0 < 76.0	< 27
$\mathcal{B}(B \to \pi\nu\overline{\nu})$	Belle [263]	< 8.0	< 8.0
$\mathcal{B}(B \to \rho\nu\overline{\nu})$	Belle [263]	< 28.0	< 28
$\mathcal{B}(B \to \pi e^{\pm}\mu^{\mp})$	BaBar [285]	< 0.092	< 0.092
$\mathcal{B}(B \to \rho e^{\pm}\mu^{\mp})$	CLEO [303]	< 3.2	< 3.2
$\mathcal{B}(B \to K e^{\pm}\mu^{\mp})$	BaBar [286]	< 0.038	< 0.038
$\mathcal{B}(B \to K^{*} e^{\pm}\mu^{\mp})$	BaBar [286]	< 0.51	< 0.51

Table 70: Branching fractions of leptonic and radiative-leptonic B^+ and B^0 decays (part 1).

Parameter $[10^{-7}]$	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to e^+\nu_e)$	Belle [304]	< 9.8	< 9.8
	BaBar [305]	< 19	
$\mathcal{B}(B^+ \to \mu^+\nu_\mu)$	Belle [306]	< 8.6	< 8.6
	BaBar [305]	< 10	
	Belle [307]	< 10.7	
$\mathcal{B}(B^+ \to \tau^+\nu_\tau)$[1]	Belle [308]	$720\,^{+270}_{-250} \pm 110$	1094 ± 208
	Belle [309]	$1250 \pm 280 \pm 270$	$1094\,^{+247}_{-236}$ (PDG)
	BaBar [310]	$1830\,^{+530}_{-490} \pm 240$	
	BaBar [311]	$1700 \pm 800 \pm 200$	
$\mathcal{B}(B^+ \to \ell^+\nu_\ell\gamma)$	Belle [312][2]	< 30	< 30
	BaBar [313]	< 156	
$\mathcal{B}(B^+ \to e^+\nu_e\gamma)$	Belle [312][2]	< 43	< 43
	BaBar [313]	< 170	
$\mathcal{B}(B^+ \to \mu^+\nu_\mu\gamma)$	Belle [312][2]	< 34	< 34
	BaBar [313]	< 260	
$\mathcal{B}(B^0 \to \gamma\gamma)$	Belle [314][3]	< 0.64	< 0.64
	BaBar [315]	< 3.3	< 3.20 (PDG)
$\mathcal{B}(B^0 \to e^+e^-)$	LHCb [208]	< 0.025	< 0.025
	CDF [209]	< 0.83	
	BaBar [316]	< 1.13	
	Belle [317]	< 1.9	
$\mathcal{B}(B^0 \to e^+e^-\gamma)$	BaBar [318]	< 1.2	< 1.2

[1] The PDG uncertainty includes a scale factor.
[2] $E_\gamma > 1$ GeV.
[3] Result obtained with a combination of Belle and Belle II datasets.

Table 71: Branching fractions of leptonic and radiative-leptonic B^+ and B^0 decays (part 2).

Parameter $[10^{-7}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^0 \to \mu^+\mu^-\gamma)$	BaBar [318]	< 1.5	< 1.5 none
$\mathcal{B}(B^0 \to \mu^+\mu^-\mu^+\mu^-)$	LHCb [213][1,2]	< 0.0018	< 0.0018
$\mathcal{B}(B^0 \to SP) \times \mathcal{B}(S \to \mu^+\mu^-) \times \mathcal{B}(P \to \mu^+\mu^-)$	LHCb [323][1,2]	< 0.006	< 0.0060
$\mathcal{B}(B^0 \to aa) \times \mathcal{B}(a \to \mu^+\mu^-) \times \mathcal{B}(a \to \mu^+\mu^-)$	LHCb [213][1,3,2]	< 0.0023	< 0.0023 none
$\mathcal{B}(B^0 \to \tau^+\tau^-)$[4]	LHCb [211] BaBar [319]	< 16000 < 41000	< 16000 < 21000
$\mathcal{B}(B^0 \to \nu\overline{\nu})$	BaBar [320] Belle [321]	< 240 < 780	< 240
$\mathcal{B}(B^0 \to \nu\overline{\nu}\gamma)$	Belle [321][5] BaBar [320][6]	< 160 < 170	< 160
$\mathcal{B}(B^+ \to \mu^+\mu^-\mu^+\nu_\mu)$	LHCb [322][2]	< 0.16	< 0.16

[1] The mass windows corresponding to ϕ and charmonium resonances decaying to $\mu\mu$ are vetoed.
[2] At CL=95 %.
[3] a is a promptly decaying scalar particle with a mass of 1 GeV/c^2
[4] PDG shows the result obtained at 95% CL.
[5] $E_\gamma > 0.5$ GeV.
[6] $E_\gamma > 1.2$ GeV.

Table 72: Relative branching fractions of B radiative and FCNC decays with leptons (part 1).

Parameter	**Measurements**		**Average**
$\frac{\mathcal{B}(B^+\to\pi^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^+\mu^+\mu^-)}$, $1.0 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4	LHCb [262]	$0.038 \pm 0.009 \pm 0.001$	0.038 ± 0.009
$\frac{\mathcal{B}(B^+\to K^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^+e^+e^-)}$, Full $\mathrm{m}^2_{\ell^+\ell^-}$ range	Belle [265]	$1.08\,^{+0.16}_{-0.15} \pm 0.02$	1.08 ± 0.16
$\frac{\mathcal{B}(B^+\to K^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^+e^+e^-)}$, $0.1 < m^2_{\ell^+\ell^-} < 1.1$ GeV^2/c^4	LHCb [324]	$0.994\,^{+0.090}_{-0.082}\,^{+0.029}_{-0.027}$	0.994 ± 0.090
$\frac{\mathcal{B}(B^+\to K^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^+e^+e^-)}$, $1.1 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4	LHCb [324]	$0.949\,^{+0.042}_{-0.041} \pm 0.022$	0.947 ± 0.047
	CMS [268]	$0.78\,^{+0.46}_{-0.23}\,^{+0.09}_{-0.05}$	
$\frac{\mathcal{B}(B^+\to K^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^+e^+e^-)}$, $0.10 < m^2_{\ell^+\ell^-} < 8.12$ GeV^2/c^4 and $\mathrm{m}^2_{\ell^+\ell^-} > 10.11$ GeV^2/c^4	BaBar [302]	$1.00\,^{+0.31}_{-0.25} \pm 0.07$	$1.00\,^{+0.32}_{-0.26}$
$\frac{\mathcal{B}(B^+\to K^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^+e^+e^-)}$, $1.0 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4 [1]	Belle [265]	$1.39\,^{+0.36}_{-0.33} \pm 0.02$	1.39 ± 0.35
$\frac{\mathcal{B}(B^0\to K^0_S\mu^+\mu^-)}{\mathcal{B}(B^0\to K^0_S e^+e^-)}$, Full $\mathrm{m}^2_{\ell^+\ell^-}$ range	Belle [265]	$1.29\,^{+0.52}_{-0.45} \pm 0.01$	$1.29\,^{+0.52}_{-0.45}$
$\frac{\mathcal{B}(B^0\to K^0_S\mu^+\mu^-)}{\mathcal{B}(B^0\to K^0_S e^+e^-)}$, $1.0 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4 [1]	Belle [265]	$0.55\,^{+0.46}_{-0.34} \pm 0.01$	$0.55\,^{+0.46}_{-0.34}$
$\frac{\mathcal{B}(B^0\to K^0_S\mu^+\mu^-)}{\mathcal{B}(B^0\to K^0_S e^+e^-)}$, $1.1 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4	LHCb [325]	$0.66\,^{+0.20}_{-0.14}\,^{+0.02}_{-0.04}$	$0.66\,^{+0.20}_{-0.15}$
$\frac{\mathcal{B}(B\to K\mu^+\mu^-)}{\mathcal{B}(B\to Ke^+e^-)}$, Full $\mathrm{m}^2_{\ell^+\ell^-}$ range	Belle [265]	$1.10\,^{+0.16}_{-0.15} \pm 0.02$	1.10 ± 0.16
$\frac{\mathcal{B}(B\to K\mu^+\mu^-)}{\mathcal{B}(B\to Ke^+e^-)}$, $1.0 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4 [1]	Belle [265]	$1.03\,^{+0.28}_{-0.24} \pm 0.01$	$1.03\,^{+0.28}_{-0.24}$

[1] For the other bins see the article.

Table 73: Relative branching fractions of B radiative and FCNC decays with leptons (part 2).

Parameter	Measurements		Average
$\frac{\mathcal{B}(B\to K^*\mu^+\mu^-)}{\mathcal{B}(B\to K^*e^+e^-)}$, Full $\mathrm{m}^2_{\ell^+\ell^-}$ range	Belle [274]	$0.83 \pm 0.17 \pm 0.08$	0.83 ± 0.19
$\frac{\mathcal{B}(B\to K^*\mu^+\mu^-)}{\mathcal{B}(B\to K^*e^+e^-)}$, $0.10 < m^2_{\ell^+\ell^-} < 8.12$ GeV^2/c^4 and $\mathrm{m}^2_{\ell^+\ell^-} > 10.11$ GeV^2/c^4	BaBar [302]	$1.13\,^{+0.34}_{-0.26} \pm 0.10$	$1.13\,^{+0.35}_{-0.28}$
$\frac{\mathcal{B}(B\to K^*\mu^+\mu^-)}{\mathcal{B}(B\to K^*e^+e^-)}$, $0.045 < m^2_{\ell^+\ell^-} < 1.1$ GeV^2/c^4	Belle [327]	$0.52\,^{+0.36}_{-0.26} \pm 0.06$	$0.52\,^{+0.36}_{-0.27}$
$\frac{\mathcal{B}(B\to K^*\mu^+\mu^-)}{\mathcal{B}(B\to K^*e^+e^-)}$, $1.1 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4	Belle [327]	$0.96\,^{+0.45}_{-0.29} \pm 0.11$	$0.96\,^{+0.46}_{-0.31}$
$\frac{\mathcal{B}(B\to K^*\mu^+\mu^-)}{\mathcal{B}(B\to K^*e^+e^-)}$, $15 < m^2_{\ell^+\ell^-} < 19$ GeV^2/c^4	Belle [327]	$1.18\,^{+0.52}_{-0.32} \pm 0.11$	$1.18\,^{+0.53}_{-0.34}$
$\frac{\mathcal{B}(B^0\to K^*(892)^0\mu^+\mu^-)}{\mathcal{B}(B^0\to K^*(892)^0e^+e^-)}$, $0.045 < m^2_{\ell^+\ell^-} < 1.1$ GeV^2/c^4	Belle [327]	$0.46\,^{+0.55}_{-0.27} \pm 0.13$	$0.46\,^{+0.56}_{-0.30}$
$\frac{\mathcal{B}(B^0\to K^*(892)^0\mu^+\mu^-)}{\mathcal{B}(B^0\to K^*(892)^0e^+e^-)}$, $1.1 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4	LHCb [324] Belle [327]	$1.027\,^{+0.072}_{-0.068}\,^{+0.027}_{-0.026}$ $1.06\,^{+0.63}_{-0.38} \pm 0.14$	1.028 ± 0.074
$\frac{\mathcal{B}(B^0\to K^*(892)^0\mu^+\mu^-)}{\mathcal{B}(B^0\to K^*(892)^0e^+e^-)}$, $15 < m^2_{\ell^+\ell^-} < 19$ GeV^2/c^4	Belle [327]	$1.12\,^{+0.61}_{-0.36} \pm 0.10$	$1.12\,^{+0.62}_{-0.37}$
$\frac{\mathcal{B}(B^0\to K^*(892)^0\mu^+\mu^-)}{\mathcal{B}(B^0\to K^*(892)^0e^+e^-)}$, $0.1 < m^2_{\ell^+\ell^-} < 1.1$ GeV^2/c^4	LHCb [324]	$0.927\,^{+0.093}_{-0.087}\,^{+0.036}_{-0.035}$	0.927 ± 0.097
$\frac{\mathcal{B}(B^+\to K^*(892)^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^*(892)^+e^+e^-)}$, $0.045 < m^2_{\ell^+\ell^-} < 1.1$ GeV^2/c^4	Belle [327]	$0.62\,^{+0.60}_{-0.36} \pm 0.09$	$0.62\,^{+0.61}_{-0.37}$
$\frac{\mathcal{B}(B^+\to K^*(892)^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^*(892)^+e^+e^-)}$, $1.1 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4	Belle [327]	$0.72\,^{+0.99}_{-0.44} \pm 0.15$	$0.7\,^{+1.0}_{-0.5}$
$\frac{\mathcal{B}(B^+\to K^*(892)^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^*(892)^+e^+e^-)}$, $15 < m^2_{\ell^+\ell^-} < 19$ GeV^2/c^4	Belle [327]	$1.40\,^{+1.99}_{-0.68} \pm 0.12$	$1.4\,^{+2.0}_{-0.7}$
$\frac{\mathcal{B}(B^+\to K^*(892)^+\mu^+\mu^-)}{\mathcal{B}(B^+\to K^*(892)^+e^+e^-)}$, $0.045 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4	LHCb [325]	$0.70\,^{+0.18}_{-0.13}\,^{+0.03}_{-0.04}$	$0.70\,^{+0.18}_{-0.14}$
$\frac{\mathcal{B}(B^+\to K^+\pi^+\pi^-e^+e^-)}{\mathcal{B}(B^+\to K^+\pi^+\pi^-\mu^+\mu^-)}$, $1.1 < m^2_{\ell^+\ell^-} < 7.0$ GeV^2/c^4	LHCb [326]	$1.31\,^{+0.18}_{-0.17}\,^{+0.12}_{-0.09}$	$1.31\,^{+0.22}_{-0.19}$

Table 74: Relative branching fractions of B radiative and FCNC decays with leptons (part 3).

Parameter	Measurements		Average
$\frac{\mathcal{B}(B^0 \to K^*(892)^0\gamma)}{\mathcal{B}(B^0_s \to \phi(1020)\gamma)}$	LHCb [206][1] Belle [239][1]	$1.23 \pm 0.06 \pm 0.11$ $1.10 \pm 0.16 \pm 0.20$	1.21 ± 0.11
$\frac{\mathcal{B}(B^0 \to \mu^+\mu^-)}{\mathcal{B}(B^0_s \to \mu^+\mu^-)}$ $[10^{-2}]$	LHCb [234]	< 8.1	< 8.1
$\frac{\mathcal{B}(B^0 \to \phi(1020)\mu^+\mu^-)}{\mathcal{B}(B^0_s \to \phi(1020)\mu^+\mu^-)}$ $[10^{-3}]$	LHCb [289][2]	< 4.4	< 4.4
$\frac{\mathcal{B}(B^0 \to \pi^+\pi^-\mu^+\mu^-)}{\mathcal{B}(B^0 \to J/\psi K^*(892)^0) \times \mathcal{B}(J/\psi \to \mu^+\mu^-) \times \mathcal{B}(K^*(892)^0 \to K^+\pi^-)}$ $[10^{-4}]$	LHCb [216][3,4]	$4.1 \pm 1.0 \pm 0.3$	4.1 ± 1.0

[1] Multiple systematic uncertainties are added in quadrature.
[2] ϕ and charmonium regions excluded from the dimuon spectrum.
[3] The mass windows corresponding to ϕ and charmonium resonances decaying to $\mu\mu$ are vetoed.
[4] $0.5 < m_{\pi^+\pi^-} < 1.3$ GeV/c^2.

Table 75: Branching fractions of $B^+/B^0 \to q\overline{q}'$ gluon decays.

Parameter $[10^{-4}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B \to \eta X)$	Belle [328][1] CLEO [329][2]	$2.610 \pm 0.300\,^{+0.440}_{-0.740}$ < 4.400	$2.61\,^{+0.53}_{-0.80}$
$\mathcal{B}(B \to \eta' X)$	BaBar [330][3] CLEO [331][3]	$3.90 \pm 0.80 \pm 0.90$ $4.60 \pm 1.10 \pm 0.60$	4.24 ± 0.87
$\mathcal{B}(B \to K^+ X)$	BaBar [332][4]	< 1.87	< 1.9
$\mathcal{B}(B \to K^0 X)$	BaBar [332][4]	$1.95\,^{+0.51}_{-0.45} \pm 0.50$	1.95 ± 0.69 $1.95\,^{+0.71}_{-0.67}$
$\mathcal{B}(B \to \pi^+ X)$	BaBar [332][5]	$3.72\,^{+0.50}_{-0.47} \pm 0.59$	3.72 ± 0.76 $3.72\,^{+0.77}_{-0.75}$

[1] $0.4 < m_X < 2.6$ GeV/c^2.
[2] $2.1 < p_\eta < 2.7$ GeV/c.
[3] $2.0 < p^*(\eta') < 2.7$ GeV/c.
[4] $p^*(K) < 2.34$ GeV/c.
[5] $p^*(\pi^+) < 2.36$ GeV/c.

Table 76: Isospin asymmetry in B mesons radiative and FCNC decays with leptons. In some of the B-factory results it is assumed that $\mathcal{B}(\Upsilon(4S) \to B^+B^-) = \mathcal{B}(\Upsilon(4S) \to B^0\overline{B}^0)$, and in others a measured value of the ratio of branching fractions is used. See original papers for details. The averages quoted here are computed naively and should be treated with caution.

Parameter	Measurements		Average HFLAV / PDG
$\Delta_{0^-}(B \to X_s\gamma)$	Belle [333][1,2]	$-0.0048 \pm 0.0149 \pm 0.0150$	-0.005 ± 0.020
	BaBar [334][1,2]	$-0.006 \pm 0.058 \pm 0.026$	
$\Delta_{0^-}(B \to X_{s+d}\gamma)$	BaBar [296][3]	$-0.06 \pm 0.15 \pm 0.07$	-0.06 ± 0.17
$\Delta_{0^+}(B \to K^*\gamma)$	Belle [239][2]	$0.062 \pm 0.015 \pm 0.013$	0.059 ± 0.014
	Belle II [240][2]	$0.050 \pm 0.020 \pm 0.015$	0.063 ± 0.017
	BaBar [241]	$0.066 \pm 0.021 \pm 0.022$	
$\frac{\Gamma(B^+\to\rho^+\gamma)}{2\Gamma(B^0\to\rho^0\gamma)} - 1$	Belle [279]	$-0.48\,^{+0.21}_{-0.19}\,^{+0.08}_{-0.09}$	-0.46 ± 0.17
	BaBar [257]	$-0.43\,^{+0.25}_{-0.22} \pm 0.10$	$-0.46\,^{+0.17}_{-0.16}$
$\Delta_{0-}(B \to K\ell^+\ell^-)$[4]	LHCb [267][5]	$-0.10\,^{+0.08}_{-0.09} \pm 0.02$	$-0.191\,^{+0.073}_{-0.071}$
	Belle [265][6]	$-0.31\,^{+0.13}_{-0.11} \pm 0.01$	$-0.148\,^{+0.064}_{-0.065}$
	BaBar [302][6]	$-0.41 \pm 0.25 \pm 0.01$	
$\Delta_{0-}(B \to K^*\ell^+\ell^-)$[4]	BaBar [302][6]	$-0.20\,^{+0.30}_{-0.23} \pm 0.03$	$-0.01\,^{+0.11}_{-0.09}$
	Belle [274][6]	$0.33\,^{+0.37}_{-0.43} \pm 0.08$	$-0.03\,^{+0.08}_{-0.07}$
	LHCb [267][5]	$0.00\,^{+0.12}_{-0.10} \pm 0.02$	
$\Delta_{0^-}(B \to K^{(*)}\ell^+\ell^-)$[4]	Belle [274][7]	$-0.30\,^{+0.12}_{-0.11} \pm 0.08$	-0.45 ± 0.10
	BaBar [266][8]	$-0.64\,^{+0.15}_{-0.14} \pm 0.03$	$-0.45\,^{+0.17}_{-0.16}$
$\frac{2\Gamma(\overset{(-)}{B}{}^0\to\rho^0\gamma)-\Gamma(B^\pm\to\rho^\pm\gamma)}{2\Gamma(\overset{(-)}{B}{}^0\to\rho^0\gamma)+\Gamma(B^\pm\to\rho^\pm\gamma)}$[9]	Belle II [256][10,2]	$0.109\,^{+0.112}_{-0.117}\,^{+0.078}_{-0.073}$	0.11 ± 0.14 / none

[1] $m_{X_s} < 2.8$ GeV$/c^2$.
[2] Multiple systematic uncertainties are added in quadrature.
[3] $E_\gamma > 2.2$ GeV.
[4] The PDG uncertainty includes a scale factor.
[5] Only muons are used, $1.1 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4.
[6] $1.0 < m^2_{\ell^+\ell^-} < 6.0$ GeV^2/c^4.
[7] $m^2_{\ell^+\ell^-} < 8.68$ GeV^2/c^4.
[8] $0.1 < m^2_{\ell^+\ell^-} < 7.02$ GeV^2/c^4.
[9] Isospin asymmetry with CP-average branching fractions.
[10] Result obtained with a combination of Belle and Belle II datasets.

Table 77: Branching fractions of semileptonic B^+ decays to LFV and LNV final states (part 1).

Parameter [10^{-6}]	**Measurements**		**Average** HFLAV / PDG
$\mathcal{B}(B^+ \to \pi^+ e^+ \mu^- + \text{c.c.})$	BaBar [285]	< 0.17	< 0.17
$\mathcal{B}(B^+ \to \pi^+ e^+ \tau^-)$	BaBar [335]	< 74.0	< 74
$\mathcal{B}(B^+ \to \pi^+ e^- \tau^+)$	BaBar [335]	< 20.0	< 20
$\mathcal{B}(B^+ \to \pi^+ e^+ \tau^- + \text{c.c.})$	BaBar [335]	< 75.0	< 75
$\mathcal{B}(B^+ \to \pi^+ \mu^+ \tau^-)$	BaBar [335]	< 62.0	< 62
$\mathcal{B}(B^+ \to \pi^+ \mu^- \tau^+)$	BaBar [335]	< 45.0	< 45
$\mathcal{B}(B^+ \to \pi^+ \mu^+ \tau^- + \text{c.c.})$	BaBar [335]	< 72.0	< 72
$\mathcal{B}(B^+ \to K^+ e^+ \mu^-)$	LHCb [336] Belle [265] BaBar [286]	< 0.0070 < 0.03 < 0.091	< 0.007
$\mathcal{B}(B^+ \to K^+ e^- \mu^+)$	LHCb [336] Belle [265] BaBar [286]	< 0.0064 < 0.085 < 0.13	< 0.0064
$\mathcal{B}(B^+ \to K^+ e^+ \mu^- + \text{c.c.})$	BaBar [286]	< 0.091	< 0.091
$\mathcal{B}(B^+ \to K^+ e^+ \tau^-)$	BaBar [335]	< 43.0	< 43
$\mathcal{B}(B^+ \to K^+ e^- \tau^+)$	BaBar [335] Belle [210]	< 15.0 < 15.1	< 15
$\mathcal{B}(B^+ \to K^+ e^+ \tau^- + \text{c.c.})$	BaBar [335]	< 30.0	< 30
$\mathcal{B}(B^+ \to K^+ \mu^+ \tau^-)$	Belle [210] BaBar [335]	< 24.5 < 45.0	< 24 < 45
$\mathcal{B}(B^+ \to K^+ \mu^- \tau^+)$	Belle [210] BaBar [335] LHCb [337]	< 5.9 < 28.0 < 39.0	< 5.9 < 28.0
$\mathcal{B}(B^+ \to K^+ \mu^+ \tau^- + \text{c.c.})$	BaBar [335]	< 48.0	< 48

Table 78: Branching fractions of semileptonic B^+ decays to LFV and LNV final states (part 2).

Parameter $[10^{-6}]$	**Measurements**		**Average** $^{\text{HFLAV}}_{\text{PDG}}$
$\mathcal{B}(B^+ \to K^*(892)^+ e^+ \mu^-)$	BaBar [286]	< 1.30	< 1.3
$\mathcal{B}(B^+ \to K^*(892)^+ e^- \mu^+)$	BaBar [286]	< 0.99	< 0.99
$\mathcal{B}(B^+ \to K^*(892)^+ e^+ \mu^- + \text{c.c.})$	BaBar [286]	< 1.40	< 1.4
$\mathcal{B}(B^+ \to \pi^- e^+ e^+)$	BaBar [338]	< 0.023	< 0.023
$\mathcal{B}(B^+ \to \pi^- \mu^+ \mu^+)$	LHCb [339][1]	< 0.0040	< 0.004
	BaBar [338]	< 0.107	
$\mathcal{B}(B^+ \to \pi^- e^+ \mu^+)$	BaBar [340]	< 0.15	< 0.15
$\mathcal{B}(B^+ \to \rho^-(770) e^+ e^+)$	BaBar [340]	< 0.17	< 0.17
$\mathcal{B}(B^+ \to \rho^-(770) \mu^+ \mu^+)$	BaBar [340]	< 0.42	< 0.42
$\mathcal{B}(B^+ \to \rho^-(770) e^+ \mu^+)$	BaBar [340]	< 0.47	< 0.47

[1] At CL=95 %.

Table 79: Branching fractions of semileptonic B^+ decays to LFV and LNV final states (part 3).

Parameter $[10^{-6}]$	**Measurements**		**Average** HFLAV PDG
$\mathcal{B}(B^+ \to K^- e^+ e^+)$	BaBar [338]	< 0.030	< 0.030
$\mathcal{B}(B^+ \to K^- \mu^+ \mu^+)$	LHCb [341] BaBar [338]	< 0.041 < 0.067	< 0.041
$\mathcal{B}(B^+ \to K^- e^+ \mu^+)$	BaBar [340]	< 0.16	< 0.16
$\mathcal{B}(B^+ \to K^*(892)^- e^+ e^+)$	BaBar [340]	< 0.40	< 0.40
$\mathcal{B}(B^+ \to K^*(892)^- \mu^+ \mu^+)$	BaBar [340]	< 0.59	< 0.59
$\mathcal{B}(B^+ \to K^*(892)^- e^+ \mu^+)$	BaBar [340]	< 0.30	< 0.30
$\mathcal{B}(B^+ \to D^- e^+ e^+)$	BaBar [340] BELLE [342]	< 2.6 < 2.6	< 2.6
$\mathcal{B}(B^+ \to D^- e^+ \mu^+)$	BELLE [342] BaBar [340]	< 1.8 < 2.1	< 1.8
$\mathcal{B}(B^+ \to D^- \mu^+ \mu^+)$	LHCb [343][1] BELLE [342] BaBar [340]	< 0.69 < 1.0 < 1.7	< 0.69
$\mathcal{B}(B^+ \to D^*(2010)^- \mu^+ \mu^+)$	LHCb [343][1]	< 2.4	< 2.4
$\mathcal{B}(B^+ \to D_s^- \mu^+ \mu^+)$	LHCb [343][1]	< 0.58	< 0.58
$\mathcal{B}(B^+ \to \overline{D}^0 \pi^- \mu^+ \mu^+)$	LHCb [343][1]	< 1.5	< 1.5
$\mathcal{B}(B^+ \to \Lambda^0 \mu^+)$	BaBar [288]	< 0.061	< 0.061 < 0.060
$\mathcal{B}(B^+ \to \Lambda^0 e^+)$	BaBar [288]	< 0.032	< 0.032
$\mathcal{B}(B^+ \to \overline{\Lambda}^0 \mu^+)$	BaBar [288]	< 0.062	< 0.062 < 0.060
$\mathcal{B}(B^+ \to \overline{\Lambda}^0 e^+)$	BaBar [288]	< 0.081	< 0.081 < 0.080

[1] At CL=95 %.

Table 80: Branching fractions of semileptonic B^0 decays to LFV and LNV final states.

Parameter $[10^{-6}]$	Measurements		Average HFLAV / PDG
$\mathcal{B}(B^0 \to K^*(892)^0 e^- \mu^+)$	LHCb [220] Belle [287] BaBar [286]	< 0.0057 < 0.12 < 0.34	< 0.0057 < 0.1200
$\mathcal{B}(B^0 \to K^*(892)^0 e^+ \mu^-)$	LHCb [220] Belle [287] BaBar [286]	< 0.0068 < 0.16 < 0.53	< 0.0068 < 0.1600
$\mathcal{B}(B^0 \to K^*(892)^0 e^+ \mu^- + \text{c.c.})$	LHCb [220] Belle [287] BaBar [286]	< 0.0101 < 0.18 < 0.58	< 0.010 < 0.180
$\mathcal{B}(B^0 \to K^0 e^+ \mu^- + \text{c.c.})$	Belle [265] BaBar [286]	< 0.038 < 0.27	< 0.038
$\mathcal{B}(B^0 \to \pi^0 e^+ \mu^- + \text{c.c.})$	BaBar [285]	< 0.14	< 0.14
$\mathcal{B}(B^0 \to e^+ \mu^- + \text{c.c.})$	LHCb [217] CDF [209] BaBar [316] Belle [317]	< 0.0010 < 0.064 < 0.092 < 0.17	< 0.001
$\mathcal{B}(B^0 \to K^0_S \tau^+ \mu^-)$	Belle II [344][1]	< 11.0	< 11 none
$\mathcal{B}(B^0 \to K^0_S \tau^- \mu^+)$	Belle II [344][1]	< 36.0	< 36 none
$\mathcal{B}(B^0 \to K^0_S \tau^+ e^-)$	Belle II [344][1]	< 15.0	< 15 none
$\mathcal{B}(B^0 \to K^0_S \tau^- e^+)$	Belle II [344][1]	< 8.0	< 8.0 none
$\mathcal{B}(B^0 \to K^*(892)^0 \tau^+ \mu^-)$	LHCb [345]	< 10	< 10 none
$\mathcal{B}(B^0 \to K^*(892)^0 \tau^- \mu^+)$	LHCb [345]	< 8.2	< 8.2 none
$\mathcal{B}(B^0 \to \tau^\pm \mu^\mp)$[2]	LHCb [219] Belle [346] BaBar [347]	< 12 < 15 < 22.0	< 12 < 14
$\mathcal{B}(B^0 \to \tau^\pm e^\mp)$	Belle [346] BaBar [347]	< 16 < 28.0	< 16
$\mathcal{B}(B^0 \to p \mu^-)$	LHCb [222]	< 0.0026	< 0.0026 none

[1] Result obtained with a combination of Belle and Belle II datasets.
[2] PDG shows the result obtained at 95% CL.

Measurements that are not included in the tables (the definitions of observables can be found in the corresponding experimental papers):

- In Ref. [348], LHCb reports the up-down asymmetries in bins of the $K\pi\pi\gamma$ mass of the $B^+ \to K^+\pi^-\pi^+\gamma$ decay.
- For the $B \to K\ell^-\ell^+$ analysis, partial branching fractions and angular observables in bins of $m^2(\ell^+\ell^-)$ are also available:
  - LHCb measures the differential branching fraction of $B^+ \to K^+\mu^-\mu^+$, $B^0 \to K^0\mu^-\mu^+$ and isospin asymmetries [267]
  - CMS measurea the differential branching fraction of $B^+ \to K^+\mu^-\mu^+$ [268].
  - In Ref. [349], LHCb measures the phase difference between the short- and long-distance contributions to the $B^+ \to K^+\mu^+\mu^-$ decay. The measurement is based on the analysis of the dimuon mass distribution in the regions of the J/ψ and $\psi(2S)$ resonances and far from their poles, to probe long and short distance effects, respectively.
  - In Ref. [350], CMS performs the study of the angular distribution of the $B^+ \to K^+\mu^+\mu^-$ channel and measures, in 7 $m^2(\mu^+\mu^-)$ bins, $A_{\rm FB}$ and the contribution $F_{\rm H}$ from the pseudoscalar, scalar and tensor amplitudes to the decay.
  - LHCb measures F_H and $A_{\rm FB}$ in 17 (5) bins of $m^2(\ell^+\ell^-)$ for the K^+ (K^0_S) final state [351].
  - Belle measures F_L and $A_{\rm FB}$ in 6 $m^2(\ell^+\ell^-)$ [274].
- For the $B \to K^*\ell^-\ell^+$ analyses, partial branching fractions and angular observables in bins of $m^2(\ell^+\ell^-)$ are also available:
  - $B^0 \to K^{*0}e^-e^+$: LHCb reports F_L, $A_T^{(2)}$, $A_T^{\rm Im}$, $A_T^{\rm Re}$ in the $[0.0008, 0.257]$ GeV$^2/c^4$ bin of $m^2(\ell^+\ell^-)$ putting constraints on the $B \to K^{*0}\gamma$ photon polarization [352]. In Ref. [353], LHCb determines the branching fraction in the dilepton mass region $[0.0009, 1.0]$ GeV$^2/c^4$.
  - $B \to K^*e^-e^+$: Belle reports $A_T^{(2)}$, $A_T^{\rm Im}$,fixing F_L and $A_T^{\rm Re}$ in the $[0.0008, 0.257]$ GeV$^2/c^4$ bin of $m^2(e^+e^-)$ putting constraints on the Wilson coeficient $\mathcal{C}_7'$ [354].
  - $B \to K^*\ell^-\ell^+$: Belle measures F_L, $A_{\rm FB}$, isospin asymmetry in 6 $m^2(\ell^+\ell^-)$ bins [274] and P_4', P_5', P_6', P_8' in 4 $m^2(\ell^+\ell^-)$ bins [355]. In a more recent paper [356], they report measurements of P_4' and P_5', separately for $\ell = \mu$ or e, in 4 $m^2(\ell^+\ell^-)$ bins and in the region $[1, 6]$ GeV$^2/c^4$. The measurements use both B^0 and B^+ decays. They also measure the LFU observables $Q_i = P_i^\mu - P_i^e$, for $i = 4, 5$. *BABAR* reports F_L, $A_{\rm FB}$, P_2 in 5 $m^2(\ell^+\ell^-)$ bins [357].
  - $B^0 \to K^{*0}\mu^-\mu^+$: LHCb measures F_L, $A_{\rm FB}$, $S_3 - S_9$, $A_3 - A_9$, $P_1 - P_3$, $P_4' - P_8'$ in 8 $m^2(\ell^+\ell^-)$ bins [358]. An updated measurement of the *CP*-averaged observables is presented in Ref. [359]. In [360], LHCb performs an amplitude analysis in the $m^2(\mu^+\mu^-)$ range $[0.1, 18.0]$GeV$^2/c^4$ to measure directly the Wilson coefficients $\mathcal{C}^{(\prime)}_{\exists,\infty\prime}$ and $\mathcal{C}_{\exists\tau}$ and isolate the local and non-local contributions. CMS measures F_L and $A_{\rm FB}$ in 7 $m^2(\ell^+\ell^-)$ bins [361], as well as P_1, P_5' [362] using Run1 data. In [363], CMS

uses 140fb^{-1} of Run2 data to measure F_L and the CP-averaged angular observables $P_{1,2,3}$ and $P'_{4,5,6,8}$ in six bins of $M^2(\mu^+\mu^-)$. ATLAS measures F_L, $S_{3,4,5,7,8}$ and $P'_{1,4,5,6,8}$ in 6 $m^2(\ell^+\ell^-)$ bins [364].

  - $B^+ \to K^{*+}\mu^-\mu^+$: LHCb reports the full set of CP-averaged angular observables in 8 $m^2(\ell^+\ell^-)$ bins [365]. CMS measures F_L and $A_{\rm FB}$ in 3 $m^2(\ell^+\ell^-)$ bins [366].
  - In Ref. [367, 368], LHCb performs an unbinned amplitude analysis extracting the coefficients associated to short-distance physics effect ($\mathcal{C}^{(\prime)}_{9,10}$ Wilson coefficients) using events in the bins $[1,1,8.0]$ GeV$^2/c^4$ and $[11.0,12.5]$ GeV$^2/c^4$ of $m^2(\ell^+\ell^-)$.
  - In Ref. [360], LHCb determines the non-local contributions and the local ones (Wilson coefficients $\mathcal{C}^{(\prime)}_{9,10}$ and $\mathcal{C}_{9\tau}$) in the $m^2(\ell^+\ell^-)$ range $[.1,18.0]$ GeV$^2/c^4$ $m^2(\ell^+\ell^-)$.
  - In Ref. [354], Belle reports on an angular analysis of the $B \to K^*e^+e^-$ decay for $q^2 \in (0.0008, 1.1200)$ GeV$^2/c^4$, where the imaginary component of the transversality amplitude is measured to be $A_T^{\rm Im} = -1.27 \pm 0.52 \pm 0.12$, and the K^* transverse asymmetry to be $A_T^{(2)} = 0.52 \pm 0.53 \pm 0.11$.

- $B \to X_s\ell^-\ell^+$ (where X_s is a hadronic system with an s quark): Belle measures $A_{\rm FB}$ in bins of $m^2(\ell^+\ell^-)$ with a sum of 10 exclusive final states [369].

- $B^0 \to K^+\pi^-\mu^+\mu^-$, with $1330 < m(K^+\pi^-) < 1530$ GeV/c^2: LHCb measures the partial branching fraction in bins of $m^2(\mu^+\mu^-)$ in the range $[0.1, 8.0]$ GeV$^2/c^4$, and reports angular moments [370].

- In Ref. [371], LHCb performs a search for a hidden-sector boson χ decaying into two muons in $B^0 \to K^{*0}\mu^+\mu^-$ decays. Results are given as function of mass and lifetime in the range $214 < m(\chi) < 4350$ MeV/$c^2$and $0 < \tau(\chi) < 1000$ ps.

- In Ref. [372], LHCb performs a search for a hypothetical new scalar particle χ, assumed to have a narrow width, through the decay $B^+ \to K^+\chi(\mu^+\mu^-)$ in the ranges of mass $250 < m(\chi) < 4700$ MeV/c^2 and lifetime $0.1 < \tau(\chi) < 1000$ ps. Upper limits are given as a function of $m(\chi)$ and $\tau(\chi)$.

- In Ref. [373] LHCb reports the differential branching fraction of $\Lambda_b^0 \to \Lambda(1520)\mu^+\mu^-$ in 5 $m(\mu^+\mu^-)$ intervals in the range $[0.1, 17]$ GeV$^2/c^4$. It also reports the branching fraction in the interval $1.1 < m^2(\mu^+\mu^-) < 6$ GeV$^2/c^4$.

- In Ref. [374], Belle-II performs a search for long-lived spin-0 particles (S) in B-meson decays mediated by a $b \to s$ quark transition. They set model-independent upper limits, at the level of 10^{-7}, on the products of branching fractions $\mathcal{B}(B^0 \to K^*(892)^0S) \times \mathcal{B}(S \to x^+x^-)$ and $\mathcal{B}(B^+ \to K^+S) \times \mathcal{B}(S \to x^+x^-)$, where x^+x^- indicates e^+e^-, $\mu^+\mu^-$, $\pi^+\pi^-$, or K^+K^-, as functions of the S mass and lifetime.

- We do not perform the average of the branching fraction of $B \to \mu^+\mu^-$ decays, which is taken care of by the LHC Heavy Flavour Working Group [231], taking into account the correlations between the $B^0 \to \mu^+\mu^-$ and $B_s^0 \to \mu^+\mu^-$ branching fractions. The latest results from ATLAS, CMS and LHCb are in Refs. [232–234], respectively.

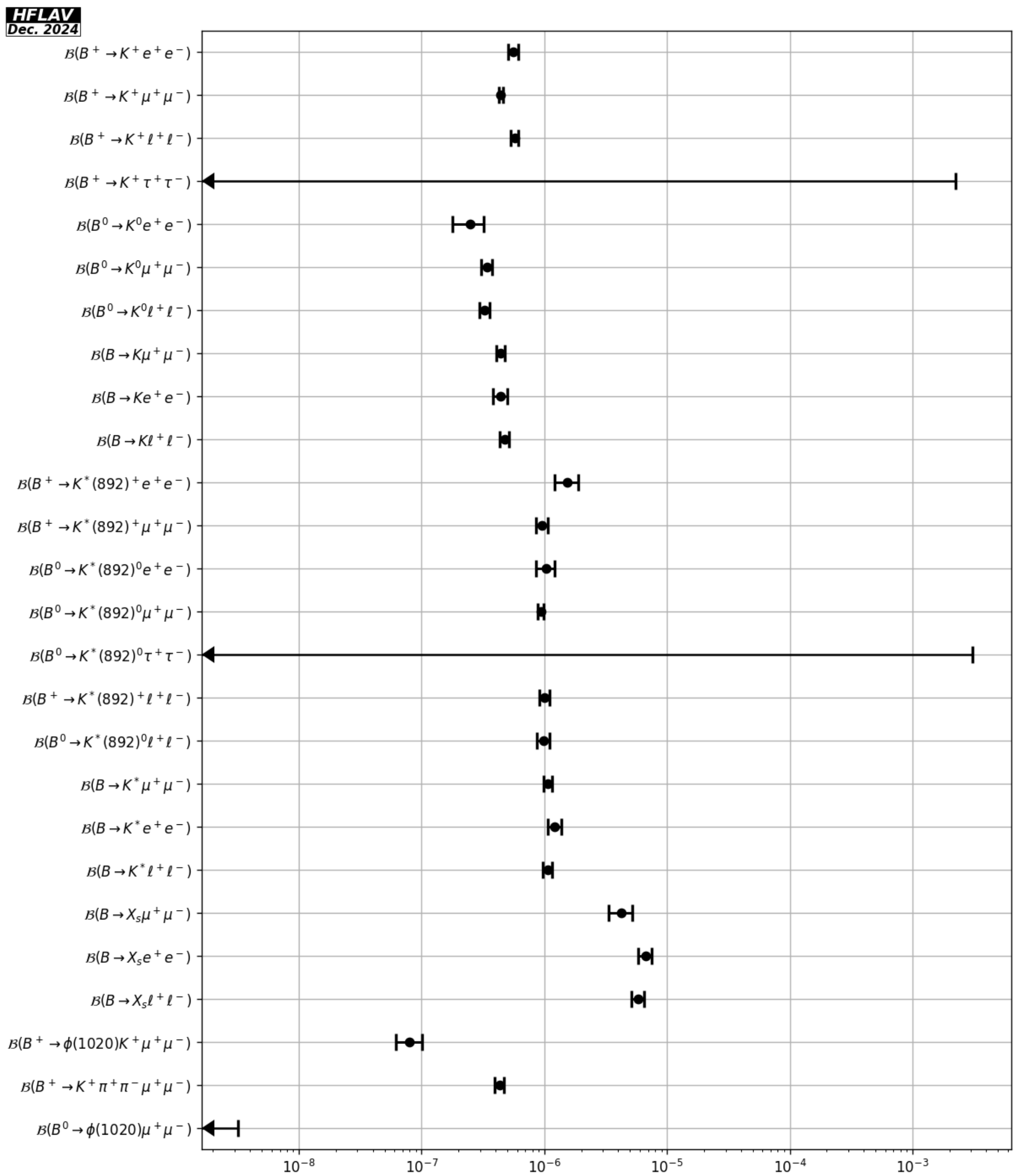

Figure 8: Branching fractions of B^+ and B^0 decays of the type $b \to s\ell^+\ell^-$.

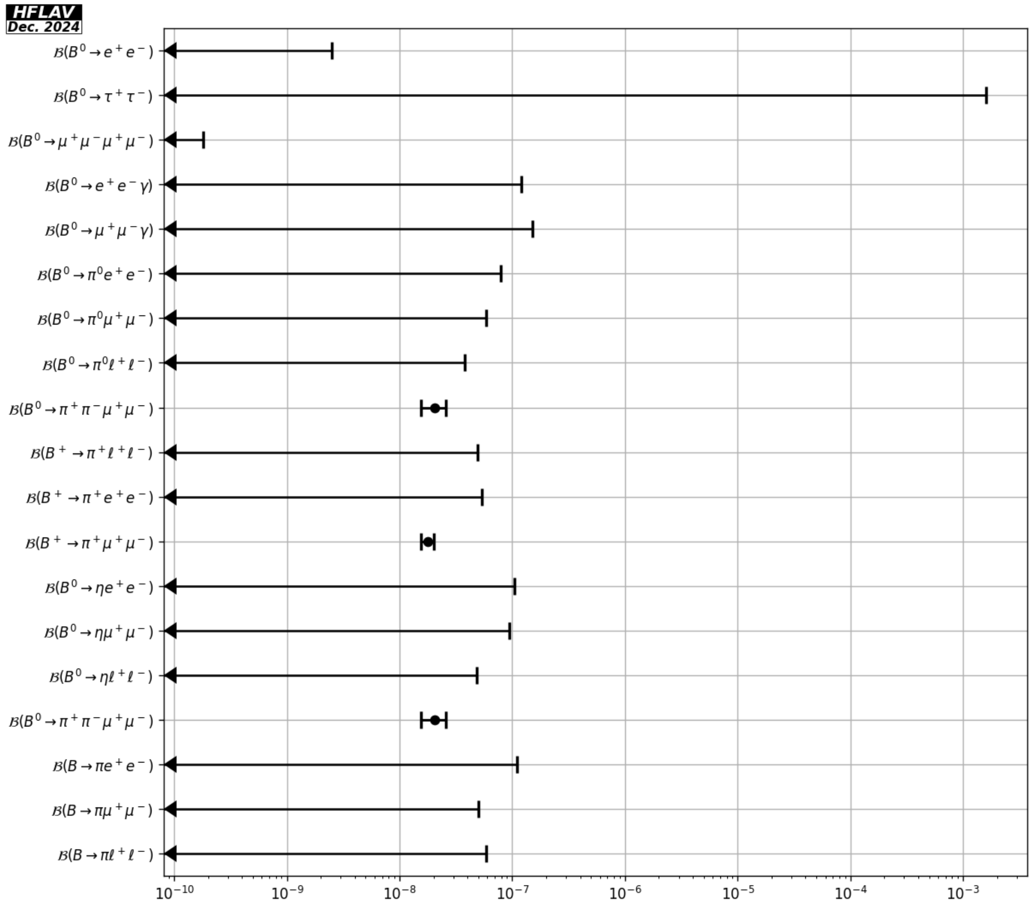

Figure 9: Branching fractions of B^+ and B^0 decays of the type $b \to u\ell^+\ell^-$, purely leptonic and leptonic radiative.

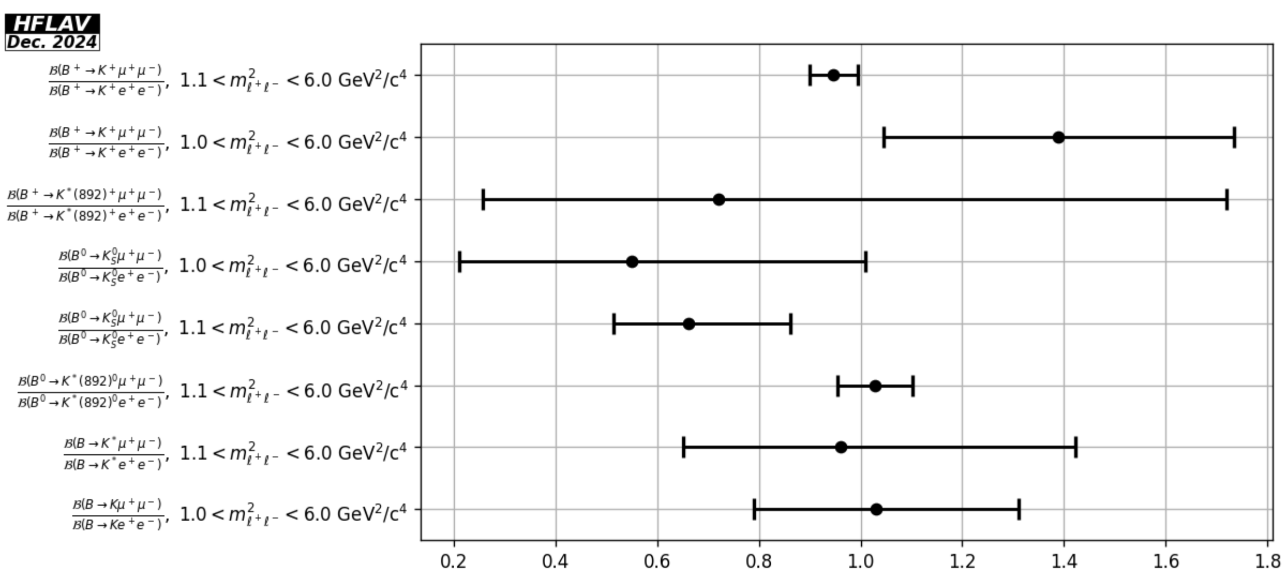

Figure 10: Compilation of $R_K^{(*)}$ ratios in the low dilepton invariant-mass region. These are ratios between branching fractions of B-meson decays to $K^{(*)}\mu^+\mu^-$ and $K^{(*)}e^+e^-$, which provide information on lepton universality.

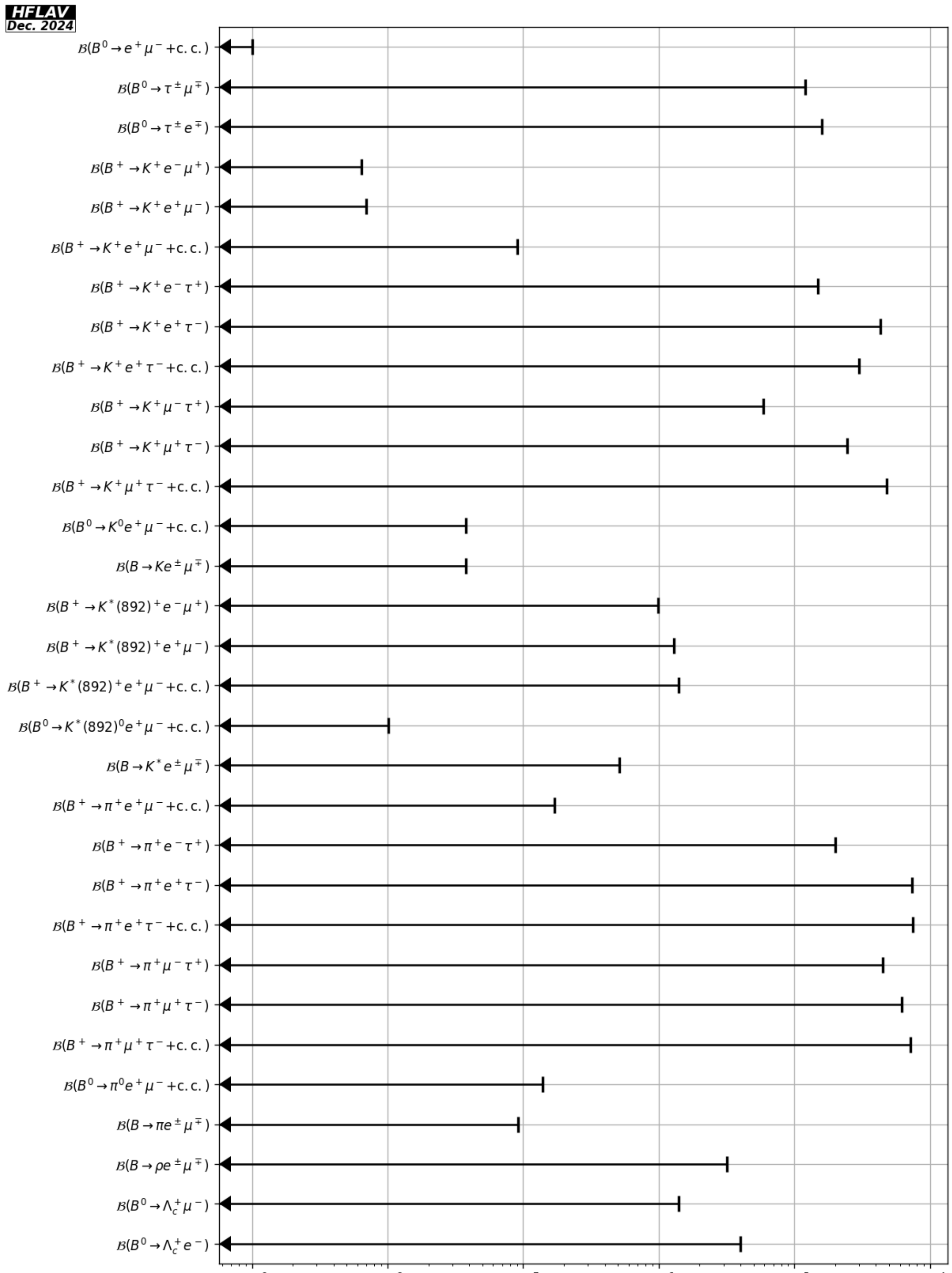

Figure 11: Limits on branching fractions of lepton-flavour-violating B^+ and B^0 decays.

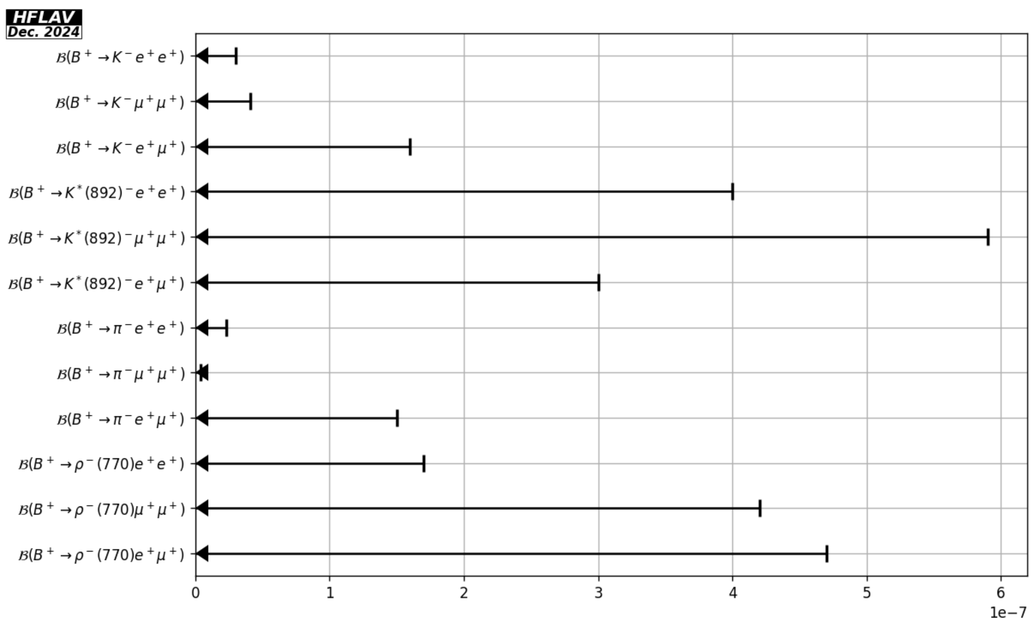

Figure 12: Limits on branching fractions of lepton-number-violating B^+ and B^0 decays.

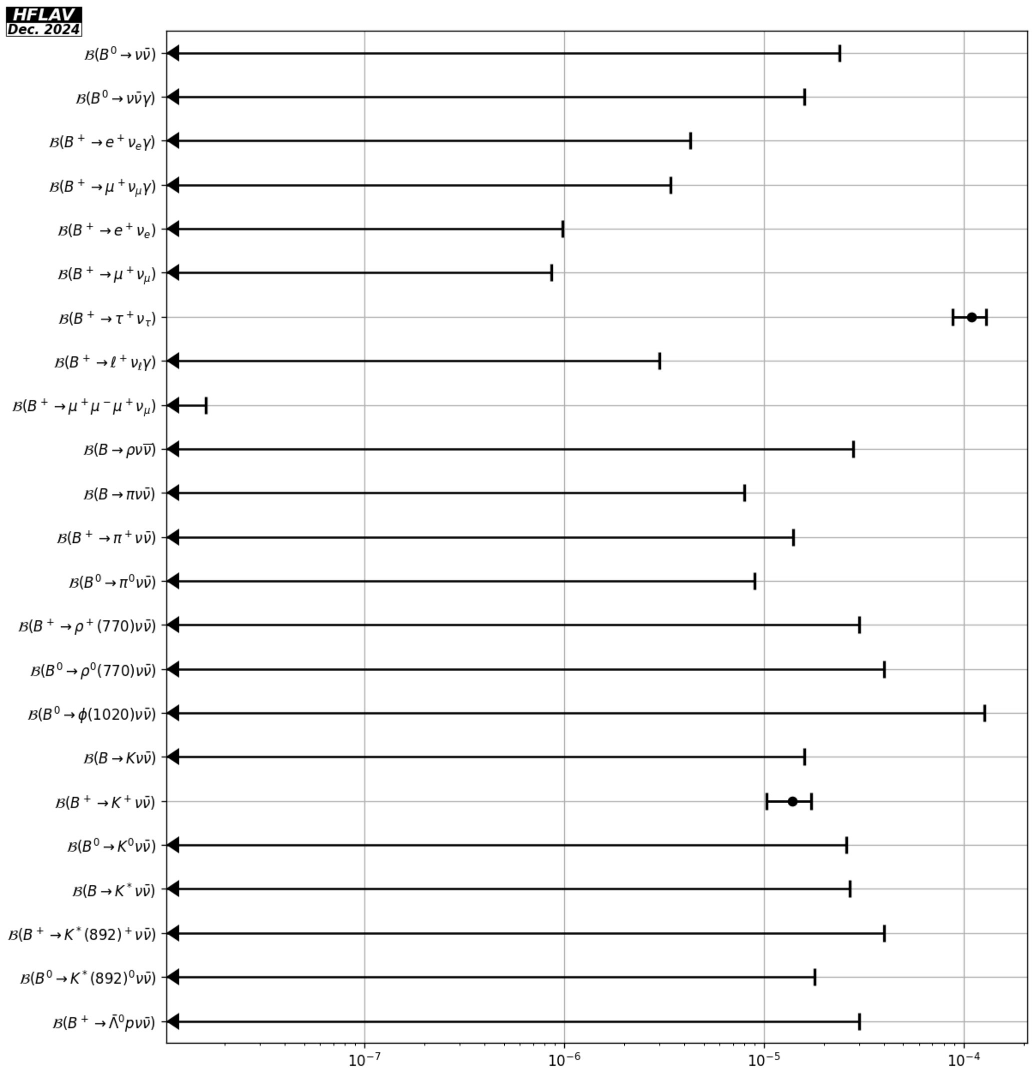

Figure 13: Branching fractions of charmless B decays with neutrinos.

0.7 *CP* asymmetries in *b*-hadron decays

This section contains, in Tables 81 to 99, compilations of CP asymmetries in decays of various b-hadrons: B^+, B^0 mesons, $B^\pm/B^0$ admixtures, B^0_s mesons and finally Λ^0_b baryons. The CP asymmetry is defined as

$$A_{CP} = \frac{N_b - N_{\overline{b}}}{N_b + N_{\overline{b}}}, \tag{1}$$

where N_b ($N_{\overline{b}}$) is the number of hadrons containing a b ($\overline{b}$) quark decaying into a specific final state (the CP-conjugate state). Figure 14 shows a graphic representation of a selection of results given in this section.

Table 81: CP asymmetries of charmless hadronic B^+ decays (part 1).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to K^0_S\pi^+)$	Belle [4]	$-0.011 \pm 0.021 \pm 0.006$	-0.023 ± 0.014
	LHCb [8]	$-0.022 \pm 0.025 \pm 0.010$	
	Belle II [5]	$-0.05 \pm 0.03 \pm 0.01$	
	BaBar [6]	$-0.029 \pm 0.039 \pm 0.010$	
	CLEO [375]	$0.18 \pm 0.24 \pm 0.02$	
$A_{\rm CP}(B^+ \to K^+\pi^0)$	LHCb [376][1]	$0.025 \pm 0.015 \pm 0.007$	0.027 ± 0.012
	Belle [4]	$0.043 \pm 0.024 \pm 0.002$	
	Belle II [5]	$0.01 \pm 0.03 \pm 0.01$	
	BaBar [9]	$0.030 \pm 0.039 \pm 0.010$	
	CLEO [375]	$-0.29 \pm 0.23 \pm 0.02$	
$A_{\rm CP}(B^+ \to \eta' K^+)$	LHCb [15][1]	$-0.002 \pm 0.012 \pm 0.006$	0.004 ± 0.011
	BaBar [10]	$0.008\,^{+0.017}_{-0.018} \pm 0.009$	
	Belle [11]	$0.028 \pm 0.028 \pm 0.021$	
	CLEO [375]	$0.03 \pm 0.12 \pm 0.02$	
$A_{\rm CP}(B^+ \to \eta' K^*(892)^+)$	BaBar [16]	$-0.26 \pm 0.27 \pm 0.02$	-0.26 ± 0.27
$A_{\rm CP}(B^+ \to \eta' (K\pi)^{*+}_0)$	BaBar [16]	$0.06 \pm 0.20 \pm 0.02$	0.06 ± 0.20
$A_{\rm CP}(B^+ \to \eta' K^*_2(1430)^+)$	BaBar [16]	$0.15 \pm 0.13 \pm 0.02$	0.15 ± 0.13
$A_{\rm CP}(B^+ \to \eta K^+)$	BaBar [10]	$-0.36 \pm 0.11 \pm 0.03$	-0.37 ± 0.08
	Belle [18]	$-0.38 \pm 0.11 \pm 0.01$	
$A_{\rm CP}(B^+ \to \eta K^*(892)^+)$	BaBar [19]	$0.01 \pm 0.08 \pm 0.02$	0.02 ± 0.05
	Belle [20]	$0.03 \pm 0.10 \pm 0.01$	
$A_{\rm CP}(B^+ \to \eta (K\pi)^{*+}_0)$	BaBar [19]	$0.05 \pm 0.13 \pm 0.02$	0.050 ± 0.093
$A_{\rm CP}(B^+ \to \eta K^*_2(1430)^+)$	BaBar [19]	$-0.45 \pm 0.30 \pm 0.02$	-0.45 ± 0.21

[1] Multiple systematic uncertainties are added in quadrature.

Table 82: CP asymmetries of charmless hadronic B^+ decays (part 2).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to \omega(782)K^+)$	Belle [23]	$-0.03 \pm 0.04 \pm 0.01$	-0.025 ± 0.036
	BaBar [24]	$-0.01 \pm 0.07 \pm 0.01$	
$A_{\rm CP}(B^+ \to \omega(782)K^*(892)^+)$	BaBar [26]	$0.29 \pm 0.35 \pm 0.02$	0.29 ± 0.35
$A_{\rm CP}(B^+ \to \omega(782)(K\pi)^{*+}_0)$	BaBar [26]	$-0.10 \pm 0.09 \pm 0.02$	-0.10 ± 0.09
$A_{\rm CP}(B^+ \to \omega(782)K^*_2(1430)^+)$	BaBar [26]	$0.14 \pm 0.15 \pm 0.02$	0.14 ± 0.15
$A_{\rm CP}(B^+ \to K^*(892)^0\pi^+)$	BaBar [28][1,2]	$0.032 \pm 0.052\,^{+0.016}_{-0.013}$	-0.04 ± 0.04
	Belle [29][1,2]	$-0.149 \pm 0.064 \pm 0.022$	
	BaBar [30][3,2]	$-0.12 \pm 0.21\,^{+0.08}_{-0.14}$	
$A_{\rm CP}(B^+ \to K^*(892)^+\pi^0)$	BaBar [30][3,2]	$-0.52 \pm 0.14\,^{+0.06}_{-0.04}$	-0.39 ± 0.13
	BaBar [31]	$-0.06 \pm 0.24 \pm 0.04$	
$A_{\rm CP}(B^+ \to K^+\pi^+\pi^-)$[4]	LHCb [377][5,6,2]	$0.011 \pm 0.002 \pm 0.004$	0.0146 ± 0.0041
	LHCb [378][7,2]	$0.025 \pm 0.004 \pm 0.008$	
	BaBar [28][1,2]	$0.028 \pm 0.020 \pm 0.023$	
	Belle [29][1]	$0.049 \pm 0.026 \pm 0.020$	
	Belle II [33]	$-0.010 \pm 0.050 \pm 0.021$	
$A_{\rm CP}(B^+ \to K^+K^+K^-({\rm NR}))$	BaBar [22][8]	$0.060 \pm 0.044 \pm 0.019$	0.06 ± 0.05

[1] Result extracted from Dalitz-plot analysis of $B^+ \to K^+\pi^+\pi^-$ decays.
[2] Multiple systematic uncertainties are added in quadrature.
[3] Result extracted from Dalitz-plot analysis of $B^+ \to K^0_S\pi^+\pi^0$ decays.
[4] Treatment of charmonium intermediate components differs between the results.
[5] Using run II dataset, corresponding to an integrated luminosity of 5.9 fb^{-1} collected at a center-of-mass energy of 13 TeV (2015 to 2018).
[6] Also measured in several invariant mass regions.
[7] Using run I dataset, corresponding to an integrated luminosity of 3.0 fb^{-1} collected at a center-of-mass energy of 7 TeV (2011) and 8 TeV (2012).
[8] The nonresonant amplitude is modelled using a polynomial function including S-wave and P-wave terms.

Table 83: CP asymmetries of charmless hadronic B^+ decays (part 3).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to f_0(980)K^+)$	BaBar [28][1,2]	$-0.106 \pm 0.050\,^{+0.036}_{-0.015}$	-0.08 ± 0.04
	Belle [29][1,2]	$-0.077 \pm 0.065\,^{+0.046}_{-0.026}$	
	BaBar [22][3]	$-0.08 \pm 0.08 \pm 0.04$	
	BaBar [31]	$0.18 \pm 0.18 \pm 0.04$	
$A_{\rm CP}(B^+ \to f_2(1270)K^+)$	BaBar [28][1,2]	$-0.85 \pm 0.22\,^{+0.26}_{-0.13}$	-0.67 ± 0.19
	Belle [29][1,2]	$-0.59 \pm 0.22 \pm 0.04$	
$A_{\rm CP}(B^+ \to f_2'(1525)K^+)$	BaBar [22][3]	$0.14 \pm 0.10 \pm 0.04$	0.14 ± 0.11
$A_{\rm CP}(B^+ \to \rho^0(770)K^+)$	BaBar [28][1,2]	$0.44 \pm 0.10\,^{+0.06}_{-0.14}$	0.37 ± 0.12
	Belle [29][1,2]	$0.30 \pm 0.11\,^{+0.11}_{-0.04}$	
$A_{\rm CP}(B^+ \to K^0\pi^+\pi^0)$	BaBar [30][4,2]	$0.07 \pm 0.05 \pm 0.04$	0.07 ± 0.06
$A_{\rm CP}(B^+ \to K_0^*(1430)^0\pi^+)$	Belle [29][1,2]	$0.076 \pm 0.038\,^{+0.028}_{-0.022}$	0.084 ± 0.043
	BaBar [30][4,2]	$0.14 \pm 0.10\,^{+0.14}_{-0.06}$	
$A_{\rm CP}(B^+ \to (K\pi)_0^{*0}\pi^+)$	BaBar [28][1,2]	$0.032 \pm 0.035\,^{+0.034}_{-0.028}$	0.032 ± 0.046
$A_{\rm CP}(B^+ \to K_0^*(1430)^+\pi^0)$	BaBar [30][4,2]	$0.26 \pm 0.12\,^{+0.14}_{-0.08}$	$0.26\,^{+0.19}_{-0.14}$
$A_{\rm CP}(B^+ \to K_2^*(1430)^0\pi^+)$	BaBar [28][1,2]	$0.05 \pm 0.23\,^{+0.18}_{-0.08}$	$0.05\,^{+0.29}_{-0.24}$
$A_{\rm CP}(B^+ \to K^+\pi^0\pi^0)$	BaBar [31]	$-0.06 \pm 0.06 \pm 0.04$	-0.06 ± 0.07
$A_{\rm CP}(B^+ \to \rho^+(770)K^0)$	BaBar [30][4,2]	$0.21 \pm 0.19\,^{+0.24}_{-0.20}$	$0.21\,^{+0.31}_{-0.28}$
$A_{\rm CP}(B^+ \to K^*(892)^+\pi^+\pi^-)$	BaBar [41]	$0.07 \pm 0.07 \pm 0.04$	0.07 ± 0.08
$A_{\rm CP}(B^+ \to K^*(892)^+\rho^0(770))$	BaBar [42]	$0.31 \pm 0.13 \pm 0.03$	0.31 ± 0.13
$A_{\rm CP}(B^+ \to f_0(980)K^*(892)^+)$	BaBar [42]	$-0.15 \pm 0.12 \pm 0.03$	-0.15 ± 0.12
$A_{CP}(B^+ \to X_{\pi^0\pi^0}\pi^+)$	Belle [78][5]	$0.182 \pm 0.116 \pm 0.007$	0.18 ± 0.12

[1] Result extracted from Dalitz-plot analysis of $B^+ \to K^+\pi^+\pi^-$ decays.
[2] Multiple systematic uncertainties are added in quadrature.
[3] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^+K^-$ decays.
[4] Result extracted from Dalitz-plot analysis of $B^+ \to K_S^0\pi^+\pi^0$ decays.
[5] $X_{\pi^0\pi^0}$ corresponds to a structure observed in Ref. [78], likely arising due to multiple resonances.

Table 84: CP asymmetries of charmless hadronic B^+ decays (part 4).

Parameter	Measurements		Average
$A_{\mathrm{CP}}(B^+ \to a_1(1260)^+ K^0)$	BaBar [43]	$0.12 \pm 0.11 \pm 0.02$	0.12 ± 0.11
$A_{\mathrm{CP}}(B^+ \to b_1(1235)^+ K^0)$	BaBar [47]	$-0.03 \pm 0.15 \pm 0.02$	-0.03 ± 0.15
$A_{\mathrm{CP}}(B^+ \to K^*(892)^0 \rho^+(770))$	BaBar [44]	$-0.01 \pm 0.16 \pm 0.02$	-0.01 ± 0.16
$A_{\mathrm{CP}}(B^+ \to b_1(1235)^0 K^+)$	BaBar [52]	$-0.46 \pm 0.20 \pm 0.02$	-0.46 ± 0.20
$A_{\mathrm{CP}}(B^+ \to K^+ K^0_S)$	LHCb [8]	$-0.21 \pm 0.14 \pm 0.01$	-0.086 ± 0.100
	Belle [4]	$0.014 \pm 0.168 \pm 0.002$	
	BaBar [6]	$0.10 \pm 0.26 \pm 0.03$	
$A_{\mathrm{CP}}(B^+ \to K^+ K^0_S K^0_S)$[1]	Belle [50][2]	$0.016 \pm 0.039 \pm 0.009$	0.025 ± 0.032
	BaBar [22][3]	$0.04\,^{+0.04}_{-0.05} \pm 0.02$	
$A_{\mathrm{CP}}(B^+ \to K^+ K^- \pi^+)$[1]	LHCb [377][4,5,6]	$-0.114 \pm 0.007 \pm 0.004$	-0.1151 ± 0.0076
	LHCb [378][7,6]	$-0.123 \pm 0.017 \pm 0.014$	
	Belle [54][8]	$-0.170 \pm 0.073 \pm 0.017$	
	BaBar [55]	$0.00 \pm 0.10 \pm 0.03$	
$A_{\mathrm{CP}}(B^+ \to K^+ K^- \pi^+(\mathrm{NR}))$	LHCb [56][9]	$-0.107 \pm 0.053 \pm 0.035$	-0.107 ± 0.064
$A_{\mathrm{CP}}(B^+ \to \overline{K}^*(892)^0 K^+)$	LHCb [56][10]	$0.123 \pm 0.087 \pm 0.045$	0.123 ± 0.098
$A_{\mathrm{CP}}(B^+ \to \overline{K}^*_0(1430)^0 K^+)$	LHCb [56][10]	$0.104 \pm 0.149 \pm 0.088$	0.10 ± 0.17
$A_{\mathrm{CP}}(B^+ \to \phi(1020)\pi^+)$	LHCb [56][10]	$0.098 \pm 0.436 \pm 0.266$	0.10 ± 0.51
$A_{CP}(B^+ \to K^+ K^- \pi^+)$ $\pi\pi \leftrightarrow KK$ rescattering			
	LHCb [56][10]	$-0.664 \pm 0.038 \pm 0.019$	-0.664 ± 0.042

[1] Treatment of charmonium intermediate components differs between the results.
[2] A_{CP} is also measured in bins of $m_{K^0_S K^0_S}$
[3] Result extracted from Dalitz-plot analysis of $B^0 \to K^0_S K^+ K^-$ decays.
[4] Using run II dataset, corresponding to an integrated luminosity of 5.9 fb^{-1} collected at a center-of-mass energy of 13 TeV (2015 to 2018).
[5] Also measured in several invariant mass regions.
[6] Multiple systematic uncertainties are added in quadrature.
[7] Using run I dataset, corresponding to an integrated luminosity of 3.0 fb^{-1} collected at a center-of-mass energy of 7 TeV (2011) and 8 TeV (2012).
[8] Also measured in bins of $m_{K^+K^-}$.
[9] LHCb uses a model of the nonresonant contribution obtained from a phenomenological description of the partonic interaction that produces the final state. This contribution is referred to as the single pole in the paper; see Ref. [56] for details.
[10] Result extracted from Dalitz-plot analysis of $B^+ \to K^+ K^- \pi^+$ decays.

Table 85: CP asymmetries of charmless hadronic B^+ decays (part 5).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to K^+K^+K^-)$	LHCb [377][1,2,3]	$-0.037 \pm 0.002 \pm 0.004$	-0.036 ± 0.004
	LHCb [378][4,3]	$-0.036 \pm 0.004 \pm 0.007$	
	BaBar [22][5]	$-0.017\,^{+0.019}_{-0.014} \pm 0.014$	
	Belle II [33]	$-0.103 \pm 0.042 \pm 0.020$	
$A_{\rm CP}(B^+ \to \phi(1020)K^+)$	LHCb [15][4,3]	$0.017 \pm 0.011 \pm 0.006$	0.024 ± 0.012
	BaBar [22][5]	$0.128 \pm 0.044 \pm 0.013$	
	Belle [66]	$0.01 \pm 0.12 \pm 0.05$	
	CDF [63]	$-0.07 \pm 0.17\,^{+0.03}_{-0.02}$	
$A_{\rm CP}(B^+ \to K^*(892)^+K^+K^-)$	BaBar [41]	$0.11 \pm 0.08 \pm 0.03$	0.11 ± 0.09
$A_{\rm CP}(B^+ \to \phi(1020)K^*(892)^+)$	Belle [379]	$-0.02 \pm 0.14 \pm 0.03$	-0.01 ± 0.08
	BaBar [65][6]	$0.00 \pm 0.09 \pm 0.04$	
$A_{\rm CP}(B^+ \to (K\pi)^{*+}_0\phi(1020))$	BaBar [67]	$0.04 \pm 0.15 \pm 0.04$	0.04 ± 0.16
$A_{\rm CP}(B^+ \to K_1(1270)^+\phi(1020))$	BaBar [67]	$0.15 \pm 0.19 \pm 0.05$	0.15 ± 0.20
$A_{\rm CP}(B^+ \to K^*_2(1430)^+\phi(1020))$	BaBar [67]	$-0.23 \pm 0.19 \pm 0.06$	-0.23 ± 0.20
$A_{\rm CP}(B^+ \to \phi(1020)\phi(1020)K^+)$	BaBar [69][7]	$-0.10 \pm 0.08 \pm 0.02$	-0.10 ± 0.08

[1] Using run II dataset, corresponding to an integrated luminosity of 5.9 fb^{-1} collected at a center-of-mass energy of 13 TeV (2015 to 2018).
[2] Also measured in several invariant mass regions.
[3] Multiple systematic uncertainties are added in quadrature.
[4] Using run I dataset, corresponding to an integrated luminosity of 3.0 fb^{-1} collected at a center-of-mass energy of 7 TeV (2011) and 8 TeV (2012).
[5] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^+K^-$ decays.
[6] Combination of two final states of the $K^*(892)^\pm$, $K^0_S\pi^\pm$ and $K^\pm\pi^0$. In addition to the combined results, the paper reports separately the results for each individual final state.
[7] Measured in the $\phi\phi$ invariant mass range below the η_c resonance ($m_{\phi\phi} < 2.85$ GeV$/c^2$).

Table 86: CP asymmetries of charmless hadronic B^+ decays (part 6).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to K^*(892)^+\gamma)$	Belle [239]	$0.011 \pm 0.023 \pm 0.003$	0.012 ± 0.015
	BaBar [241]	$0.018 \pm 0.028 \pm 0.007$	
	Belle II [240]	$0.007 \pm 0.029 \pm 0.006$	
$A_{\rm CP}(B^+ \to K^+\pi^0\gamma)$	Belle [239][1]	$0.010 \pm 0.036 \pm 0.003$	0.024 ± 0.027
	BaBar [241][2]	$0.040 \pm 0.039 \pm 0.007$	
$A_{\rm CP}(B^+ \to K^0_S\pi^+\gamma)$	Belle [239][1]	$0.013 \pm 0.029 \pm 0.004$	0.007 ± 0.024
	BaBar [241][2]	$-0.006 \pm 0.041 \pm 0.007$	
$A_{CP}(B^+ \to X_s\gamma)$	Belle [333][3]	$0.0275 \pm 0.0184 \pm 0.0032$	0.028 ± 0.019
$A_{\rm CP}(B^+ \to \eta K^+\gamma)$	Belle [246][4]	$-0.16 \pm 0.09 \pm 0.06$	-0.12 ± 0.07
	BaBar [245][5]	$-0.090\,^{+0.104}_{-0.098} \pm 0.014$	
$A_{\rm CP}(B^+ \to \phi(1020)K^+\gamma)$	Belle [249][6]	$-0.03 \pm 0.11 \pm 0.08$	-0.13 ± 0.10
	BaBar [250][7]	$-0.26 \pm 0.14 \pm 0.05$	
$A_{\rm CP}(B^+ \to \rho^+(770)\gamma)$	Belle II [256][8]	$-0.082 \pm 0.152\,^{+0.016}_{-0.012}$	-0.08 ± 0.15

[1] $m_{K\pi} < 2.0$ GeV$/c^2$.
[2] $0.79 < m_{K\pi} < 1.0$ GeV$/c^2$.
[3] $m_{X_s} < 2.8$ GeV$/c^2$.
[4] $m_{K\eta} < 2.4$ GeV$/c^2$.
[5] $m_{K\eta^{(\prime)}} < 3.25$ GeV$/c^2$.
[6] $1.4 \leq E^*_\gamma \leq 3.4$ GeV$/c^2$, where E^*_γ is the photon energy in the center-of-mass frame.
[7] $m_{\phi K} < 3.0$ GeV$/c^2$.
[8] Result obtained with a combination of Belle and Belle II datasets.

Table 87: CP asymmetries of charmless hadronic B^+ decays (part 7).

Parameter	**Measurements**		**Average**
$A_{\rm CP}(B^+ \to \pi^+\pi^0)$	Belle [4]	$0.025 \pm 0.043 \pm 0.007$	-0.01 ± 0.03
	Belle II [5]	$-0.08 \pm 0.05 \pm 0.01$	
	BaBar [9]	$0.03 \pm 0.08 \pm 0.01$	
$A_{\rm CP}(B^+ \to \pi^+\pi^+\pi^-)$[1]	LHCb [377][2,3,4]	$0.080 \pm 0.004 \pm 0.004$	0.0764 ± 0.0054
	LHCb [378][5,4]	$0.058 \pm 0.008 \pm 0.011$	
	BaBar [74][6,4]	$0.032 \pm 0.044\,^{+0.040}_{-0.037}$	
$A_{\rm CP}(B^+ \to \rho^0(770)\pi^+)$	LHCb [75][5,6,7,4]	$0.007 \pm 0.011 \pm 0.040$	$0.016\,^{+0.041}_{-0.039}$
	BaBar [74][6,4]	$0.18 \pm 0.07\,^{+0.05}_{-0.15}$	
$A_{\rm CP}(B^+ \to f_2(1270)\pi^+)$	LHCb [75][6,7,4]	$0.468 \pm 0.061 \pm 0.103$	0.365 ± 0.079
	LHCb [56][8]	$0.267 \pm 0.102 \pm 0.048$	
	BaBar [74][6,4]	$0.41 \pm 0.25\,^{+0.18}_{-0.15}$	
$A_{\rm CP}(B^+ \to \rho(1450)^0\pi^+)$	LHCb [75][6,7,4]	$-0.129 \pm 0.033 \pm 0.421$	-0.109 ± 0.049
	LHCb [56][8]	$-0.109 \pm 0.044 \pm 0.024$	
	BaBar [74][6,4]	$-0.06 \pm 0.28\,^{+0.23}_{-0.40}$	
$A_{\rm CP}(B^+ \to \rho_3(1690)^0\pi^+)$	LHCb [75][6,7,4]	$-0.801 \pm 0.114 \pm 0.511$	-0.80 ± 0.52
$A_{\rm CP}(B^+ \to f_0(1370)\pi^+)$	BaBar [74][6,4]	$0.72 \pm 0.15 \pm 0.16$	0.72 ± 0.22
$A_{CP}(B^+ \to \pi^+\pi^+\pi^-), S-$wave	LHCb [75][6,7,4]	$0.144 \pm 0.018 \pm 0.026$	0.144 ± 0.032
$A_{\rm CP}(B^+ \to \pi^+\pi^+\pi^-({\rm NR}))$	BaBar [74][9,4]	$-0.14 \pm 0.14\,^{+0.18}_{-0.08}$	$-0.14\,^{+0.23}_{-0.16}$
$A_{\rm CP}(B^+ \to \rho^+(770)\pi^0)$	BaBar [80]	$-0.01 \pm 0.13 \pm 0.02$	0.03 ± 0.10
	Belle [78]	$0.080 \pm 0.150\,^{+0.023}_{-0.075}$	

[1] Treatment of charmonium intermediate components differs between the results.
[2] Using run II dataset, corresponding to an integrated luminosity of 5.9 $\rm fb^{-1}$ collected at a center-of-mass energy of 13 TeV (2015 to 2018).
[3] Also measured in several invariant mass regions.
[4] Multiple systematic uncertainties are added in quadrature.
[5] Using run I dataset, corresponding to an integrated luminosity of 3.0 $\rm fb^{-1}$ collected at a center-of-mass energy of 7 TeV (2011) and 8 TeV (2012).
[6] Result extracted from Dalitz-plot analysis of $B^+ \to \pi^+\pi^+\pi^-$ decays.
[7] This analysis uses three different approaches: isobar, K-matrix and quasi-model-independent, to describe the S-wave component. The A_{CP} results are taken from the isobar model with an additional error accounting for the different S-wave methods as reported in Appendix D of Ref. [77].
[8] Result extracted from Dalitz-plot analysis of $B^+ \to K^+K^-\pi^+$ decays.
[9] The nonresonant amplitude is modelled using a sum of exponential functions.

Table 88: CP asymmetries of charmless hadronic B^+ decays (part 8).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to \rho^+(770)\rho^0(770))$	BaBar [81]	$-0.054 \pm 0.055 \pm 0.010$	-0.056 ± 0.047
	Belle II [82]	$-0.069 \pm 0.068 \pm 0.060$	
	Belle [83]	$0.00 \pm 0.22 \pm 0.03$	
$A_{\rm CP}(B^+ \to \omega(782)\pi^+)$	LHCb [75][1,2,3]	$-0.048 \pm 0.065 \pm 0.049$	-0.041 ± 0.048
	BaBar [24]	$-0.02 \pm 0.08 \pm 0.01$	
	Belle [85]	$-0.02 \pm 0.09 \pm 0.01$	
	CLEO [375]	$-0.34 \pm 0.25 \pm 0.02$	
$A_{\rm CP}(B^+ \to \omega(782)\rho^+(770))$	BaBar [26]	$-0.20 \pm 0.09 \pm 0.02$	-0.20 ± 0.09
$A_{\rm CP}(B^+ \to \pi^+\pi^0\pi^0)$	Belle [78]	$0.092 \pm 0.068 \pm 0.007$	0.092 ± 0.068
$A_{\rm CP}(B^+ \to \eta\pi^+)$	Belle [18]	$-0.19 \pm 0.06 \pm 0.01$	-0.14 ± 0.05
	BaBar [10]	$-0.03 \pm 0.09 \pm 0.03$	
$A_{\rm CP}(B^+ \to \eta\rho^+(770))$	BaBar [86]	$0.13 \pm 0.11 \pm 0.02$	0.11 ± 0.11
	Belle [20]	$-0.04\,^{+0.34}_{-0.32} \pm 0.01$	
$A_{\rm CP}(B^+ \to \eta'\pi^+)$	BaBar [10]	$0.03 \pm 0.17 \pm 0.02$	0.06 ± 0.15
	Belle [11]	$0.20\,^{+0.37}_{-0.36} \pm 0.04$	
$A_{\rm CP}(B^+ \to \eta'\rho^+(770))$	BaBar [16]	$0.26 \pm 0.17 \pm 0.02$	0.26 ± 0.17
$A_{\rm CP}(B^+ \to b_1(1235)^0\pi^+)$	BaBar [52]	$0.05 \pm 0.16 \pm 0.02$	0.05 ± 0.16

[1] Result extracted from Dalitz-plot analysis of $B^+ \to \pi^+\pi^+\pi^-$ decays.

[2] This analysis uses three different approaches: isobar, K-matrix and quasi-model-independent, to describe the S-wave component. The A_{CP} results are taken from the isobar model with an additional error accounting for the different S-wave methods as reported in Appendix D of Ref. [77].

[3] Multiple systematic uncertainties are added in quadrature.

Table 89: CP asymmetries of charmless hadronic B^+ decays (part 9).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to p\bar{p}\pi^+)$	BaBar [157]	$0.04 \pm 0.07 \pm 0.04$	0.04 ± 0.08
$A_{CP}(B^+ \to p\bar{p}\pi^+), m_{p\bar{p}} < 2.85$ GeV/c^2			
	LHCb [158]	$-0.041 \pm 0.039 \pm 0.005$	-0.058 ± 0.037
	Belle [156]	$-0.17 \pm 0.10 \pm 0.02$	
$A_{CP}(B^+ \to p\bar{p}K^+), m_{p\bar{p}} < 2.85$ GeV/c^2			
	LHCb [158]	$0.021 \pm 0.020 \pm 0.004$	
	Belle [156]	$-0.02 \pm 0.05 \pm 0.02$	0.007 ± 0.019
	BaBar [161]	$-0.16\,^{+0.07}_{-0.08} \pm 0.04$	
$A_{\rm CP}(B^+ \to p\bar{p}K^*(892)^+)$[1]	BaBar [157]	$0.32 \pm 0.13 \pm 0.05$	0.21 ± 0.11
	Belle [163]	$-0.01 \pm 0.19 \pm 0.02$	
$A_{\rm CP}(B^+ \to p\overline{\Lambda}^0\gamma)$	Belle [166]	$0.17 \pm 0.16 \pm 0.05$	0.17 ± 0.17
$A_{\rm CP}(B^+ \to p\overline{\Lambda}^0\pi^0)$	Belle [166]	$0.01 \pm 0.17 \pm 0.04$	0.01 ± 0.17

[1] Treatment of charmonium intermediate components differs between the results.

Table 90: CP asymmetries of charmless hadronic B^+ decays (part 10).

Parameter	Measurements		Average
$A_{\rm CP}(B^+ \to K^+\ell^+\ell^-)$	Belle [274]	$0.04 \pm 0.10 \pm 0.02$	0.02 ± 0.08
	BaBar [302]	$-0.03 \pm 0.14 \pm 0.01$	
$A_{\rm CP}(B^+ \to K^+e^+e^-)$	Belle [274]	$0.14 \pm 0.14 \pm 0.03$	0.14 ± 0.14
$A_{\rm CP}(B^+ \to K^+\mu^+\mu^-)$	LHCb [380][1,2]	$0.012 \pm 0.017 \pm 0.001$	0.011 ± 0.017
	Belle [274][3]	$-0.05 \pm 0.13 \pm 0.03$	
$A_{\rm CP}(B^+ \to \pi^+\mu^+\mu^-)$	LHCb [262]	$-0.11 \pm 0.12 \pm 0.01$	-0.11 ± 0.12
$A_{\rm CP}(B^+ \to K^*(892)^+\ell^+\ell^-)$	Belle [274]	$-0.13\,^{+0.17}_{-0.16} \pm 0.01$	-0.09 ± 0.14
	BaBar [266]	$0.01\,^{+0.26}_{-0.24} \pm 0.02$	
$A_{\rm CP}(B^+ \to K^*(892)^+e^+e^-)$	Belle [274]	$-0.14\,^{+0.23}_{-0.22} \pm 0.02$	-0.14 ± 0.23
$A_{\rm CP}(B^+ \to K^*(892)^+\mu^+\mu^-)$	Belle [274]	$-0.12 \pm 0.24 \pm 0.02$	-0.12 ± 0.24

[1] A_{CP} is also measured in bins of $m_{\mu^+\mu^-}$
[2] Mass regions corresponding to ϕ, J/ψ and $\psi(2S)$ are vetoed.
[3] Mass regions corresponding to J/ψ and $\psi(2S)$ are vetoed.

Table 91: CP asymmetries of charmless hadronic B^0 decays (part 1).

Parameter	**Measurements**		**Average**
$A_{\rm CP}(B^0 \to \pi^0\pi^0)$	BaBar [97]	$0.43 \pm 0.26 \pm 0.05$	0.23 ± 0.18
	Belle II [138]	$0.03 \pm 0.30 \pm 0.04$	
	Belle [137]	$0.14 \pm 0.36 \pm 0.10$	
$A_{\rm CP}(B^0 \to K^+\pi^-)$	LHCb [381][1]	-0.0831 ± 0.0034	-0.0831 ± 0.0031
	CDF [382]	$-0.083 \pm 0.013 \pm 0.004$	
	Belle [4]	$-0.069 \pm 0.014 \pm 0.007$	
	BaBar [97]	$-0.107 \pm 0.016\,^{+0.006}_{-0.004}$	
	Belle II [5]	$-0.07 \pm 0.02 \pm 0.01$	
$A_{\rm CP}(B^0 \to K^0\pi^0)$	Belle II [5][2]	$-0.01 \pm 0.12 \pm 0.04$	-0.01 ± 0.13
$A_{\rm CP}(B^0 \to \eta' K^*(892)^0)$	BaBar [16]	$0.02 \pm 0.23 \pm 0.02$	-0.07 ± 0.18
	Belle [99]	$-0.22 \pm 0.29 \pm 0.07$	
$A_{\rm CP}(B^0 \to \eta' (K\pi)^{*0}_0)$	BaBar [16]	$-0.19 \pm 0.17 \pm 0.02$	-0.19 ± 0.17
$A_{\rm CP}(B^0 \to \eta' K_2^*(1430)^0)$	BaBar [16]	$0.14 \pm 0.18 \pm 0.02$	0.14 ± 0.18
$A_{\rm CP}(B^0 \to \eta K^*(892)^0)$	BaBar [19]	$0.21 \pm 0.06 \pm 0.02$	0.20 ± 0.04
	Belle [20]	$0.17 \pm 0.08 \pm 0.01$	
$A_{\rm CP}(B^0 \to \eta (K\pi)^{*0}_0)$	BaBar [19]	$0.06 \pm 0.13 \pm 0.02$	0.060 ± 0.093
$A_{\rm CP}(B^0 \to \eta K_2^*(1430)^0)$	BaBar [19]	$-0.07 \pm 0.19 \pm 0.02$	-0.07 ± 0.14
$A_{\rm CP}(B^0 \to b_1(1235)^- K^+)$	BaBar [52]	$-0.07 \pm 0.12 \pm 0.02$	-0.07 ± 0.12
$A_{\rm CP}(B^0 \to \omega(782) K^*(892)^0)$	BaBar [26]	$0.45 \pm 0.25 \pm 0.02$	0.45 ± 0.25
$A_{\rm CP}(B^0 \to \omega(782) (K\pi)^{*0}_0)$	BaBar [26]	$-0.07 \pm 0.09 \pm 0.02$	-0.07 ± 0.09
$A_{\rm CP}(B^0 \to \omega(782) K_2^*(1430)^0)$	BaBar [26]	$-0.37 \pm 0.17 \pm 0.02$	-0.37 ± 0.17

[1] LHCb combines results of the 1.9 fb^{-1} run 2 data analysis with those based on Run 1 dataset [383]. The full statistical and systematic covariance matrices are used in the combination.

[2] Combination of time-integrated and time-dependent analyses using the best linear unbiased estimator Ref. [100].

Table 92: CP asymmetries of charmless hadronic B^0 decays (part 2).

Parameter	Measurements		Average
$A_{\rm CP}(B^0 \to K^+\pi^-\pi^0)$	BaBar [105][1]	$-0.030\,^{+0.045}_{-0.051} \pm 0.055$	0.06 ± 0.05
	Belle II [33]	$0.207 \pm 0.088 \pm 0.011$	
	Belle [104]	$0.07 \pm 0.11 \pm 0.01$	
$A_{\rm CP}(B^0 \to \rho^-(770)K^+)$	BaBar [103][1]	$0.20 \pm 0.09 \pm 0.08$	0.20 ± 0.11
	Belle [104]	$0.22\,^{+0.22}_{-0.23}\,^{+0.06}_{-0.02}$	
$A_{\rm CP}(B^0 \to \rho(1450)^-K^+)$	BaBar [103][1]	$-0.10 \pm 0.32 \pm 0.09$	-0.10 ± 0.33
$A_{\rm CP}(B^0 \to \rho(1700)^-K^+)$	BaBar [103][1]	$-0.36 \pm 0.57 \pm 0.23$	-0.36 ± 0.61
$A_{\rm CP}(B^0 \to K^+\pi^-\pi^0({\rm NR}))$	BaBar [103][2]	$0.10 \pm 0.16 \pm 0.08$	0.10 ± 0.18
$A_{\rm CP}(B^0 \to K^0\pi^+\pi^-)$	BaBar [106][3]	$-0.01 \pm 0.05 \pm 0.01$	-0.01 ± 0.05
$A_{\rm CP}(B^0 \to K^*(892)^+\pi^-)$	LHCb [111][3,4]	$-0.308 \pm 0.060 \pm 0.016$	-0.274 ± 0.045
	BaBar [106][3,4]	$-0.21 \pm 0.10 \pm 0.02$	
	BaBar [103][1]	$-0.29 \pm 0.11 \pm 0.02$	
	Belle [384][3]	$-0.21 \pm 0.11 \pm 0.07$	
$A_{\rm CP}(B^0 \to (K\pi)^{*+}_0\pi^-)$	LHCb [111][3,4]	$-0.032 \pm 0.047 \pm 0.031$	0.017 ± 0.043
	BaBar [106][3,4]	$0.09 \pm 0.07 \pm 0.03$	
	BaBar [103][1]	$0.07 \pm 0.14 \pm 0.01$	
$A_{\rm CP}(B^0 \to K^*_2(1430)^+\pi^-)$	LHCb [111][3,4]	$-0.29 \pm 0.22 \pm 0.09$	-0.29 ± 0.24
$A_{\rm CP}(B^0 \to K^*(1680)^+\pi^-)$	LHCb [111][3,4]	$-0.07 \pm 0.13 \pm 0.04$	-0.07 ± 0.13
$A_{\rm CP}(B^0 \to f_0(980)K^0_S)$[5]	LHCb [111][3,4]	$0.28 \pm 0.27 \pm 0.15$	0.28 ± 0.31
$A_{\rm CP}(B^0 \to (K\pi)^{*0}_0\pi^0)$	BaBar [103][1]	$-0.15 \pm 0.10 \pm 0.04$	-0.15 ± 0.11
$A_{\rm CP}(B^0 \to K^*(892)^0\pi^0)$	BaBar [103][1]	$-0.15 \pm 0.12 \pm 0.04$	-0.15 ± 0.13

[1] Result extracted from Dalitz-plot analysis of $B^0 \to K^+\pi^-\pi^0$ decays.
[2] The nonresonant amplitude is taken to be constant across the Dalitz plane.
[3] Result extracted from Dalitz-plot analysis of $B^0 \to K^0_S\pi^+\pi^-$ decays.
[4] Multiple systematic uncertainties are added in quadrature.
[5] The official HFLAV average includes results from time-dependent analyses and is given in the section Measurements related to Unitarity Triangle angles.

Table 93: CP asymmetries of charmless hadronic B^0 decays (part 3).

Parameter	Measurements		Average
$A_{\rm CP}(B^0 \to K^*(892)^0\pi^+\pi^-)$	BaBar [115]	$0.07 \pm 0.04 \pm 0.03$	0.07 ± 0.05
$A_{\rm CP}(B^0 \to K^*(892)^0\rho^0(770))$	BaBar [116]	$-0.06 \pm 0.09 \pm 0.02$	-0.06 ± 0.09
$A_{\rm CP}(B^0 \to f_0(980)K^*(892)^0)$	BaBar [116]	$0.07 \pm 0.10 \pm 0.02$	0.07 ± 0.10
$A_{\rm CP}(B^0 \to K^*(892)^+\rho^-(770))$	BaBar [116]	$0.21 \pm 0.15 \pm 0.02$	0.21 ± 0.15
$A_{\rm CP}(B^0 \to K^*(892)^0K^+K^-)$	BaBar [115]	$0.01 \pm 0.05 \pm 0.02$	0.01 ± 0.05
$A_{\rm CP}(B^0 \to a_1(1260)^-K^+)$	BaBar [43]	$-0.16 \pm 0.12 \pm 0.01$	-0.16 ± 0.12
$A_{\rm CP}(B^0 \to \phi(1020)K^*(892)^0)$	Belle [127] BaBar [126]	$-0.007 \pm 0.048 \pm 0.021$ $0.01 \pm 0.06 \pm 0.03$	-0.001 ± 0.041
$A_{\rm CP}(B^0 \to K^*(892)^0\pi^+K^-)$	BaBar [115]	$0.22 \pm 0.33 \pm 0.20$	0.22 ± 0.39
$A_{\rm CP}(B^0 \to (K\pi)^{*0}_0\phi(1020))$	Belle [127] BaBar [126]	$0.093 \pm 0.094 \pm 0.017$ $0.20 \pm 0.14 \pm 0.06$	0.123 ± 0.081
$A_{\rm CP}(B^0 \to K^*_2(1430)^0\phi(1020))$	BaBar [126] Belle [127]	$-0.08 \pm 0.12 \pm 0.05$ $-0.155\,^{+0.152}_{-0.133} \pm 0.033$	-0.112 ± 0.099

Table 94: CP asymmetries of charmless hadronic B^0 decays (part 4).

Parameter	Measurements		Average
$A_{\rm CP}(B^0 \to K^*(892)^0\gamma)$	LHCb [206] Belle [239] BaBar [241] Belle II [240]	$0.008 \pm 0.017 \pm 0.009$ $-0.013 \pm 0.017 \pm 0.004$ $-0.016 \pm 0.022 \pm 0.007$ $-0.033 \pm 0.023 \pm 0.004$	-0.012 ± 0.010
$A_{\rm CP}(B^0 \to K^+\pi^-\gamma)$	Belle [239][1] BaBar [241][2]	$-0.013 \pm 0.017 \pm 0.004$ $-0.016 \pm 0.022 \pm 0.007$	-0.014 ± 0.014
$A_{\rm CP}(B^0 \to K^*_2(1430)^0\gamma)$	BaBar [253]	$-0.08 \pm 0.15 \pm 0.01$	-0.08 ± 0.15
$A_{CP}(B^0 \to X_s\gamma)$	Belle [333][3]	$-0.0094 \pm 0.0174 \pm 0.0047$	-0.009 ± 0.018

[1] $m_{K\pi} < 2.0$ GeV$/c^2$.
[2] $0.78 < m_{K\pi} < 1.1$ GeV$/c^2$.
[3] $m_{X_s} < 2.8$ GeV$/c^2$.

Table 95: CP asymmetries of charmless hadronic B^0 decays (part 5).

Parameter	Measurements		Average
$A_{\rm CP}(B^0 \to b_1(1235)^+\pi^- + {\rm c.c.})$	BaBar [52]	$-0.05 \pm 0.10 \pm 0.02$	-0.05 ± 0.10
$A_{\rm CP}(B^0 \to p\overline{p}K^*(892)^0)$ [1]	BaBar [157] Belle [163]	$0.11 \pm 0.13 \pm 0.06$ $-0.08 \pm 0.20 \pm 0.02$	0.05 ± 0.12
$A_{\rm CP}(B^0 \to p\overline{\Lambda}^0\pi^-)$	BaBar [176] Belle [166]	$-0.10 \pm 0.10 \pm 0.02$ $-0.02 \pm 0.10 \pm 0.03$	-0.06 ± 0.07
$A_{\rm CP}(B^0 \to K^*(892)^0\ell^+\ell^-)$	Belle [274] BaBar [266]	$-0.08 \pm 0.12 \pm 0.02$ $0.02 \pm 0.20 \pm 0.02$	-0.05 ± 0.10
$A_{\rm CP}(B^0 \to K^*(892)^0e^+e^-)$	Belle [274]	$-0.21 \pm 0.19 \pm 0.02$	-0.21 ± 0.19
$A_{\rm CP}(B^0 \to K^*(892)^0\mu^+\mu^-)$	LHCb [380] [2,3] Belle [274] [4]	$-0.035 \pm 0.024 \pm 0.003$ $0.00 \pm 0.15 \pm 0.03$	-0.034 ± 0.024

[1] Treatment of charmonium intermediate components differs between the results.
[2] A_{CP} is also measured in bins of $m_{\mu^+\mu^-}$
[3] Mass regions corresponding to ϕ, J/ψ and $\psi(2S)$ are vetoed.
[4] Mass regions corresponding to J/ψ and $\psi(2S)$ are vetoed.

Table 96: CP asymmetries of charmless hadronic decays of $B^\pm/B^0$ admixture.

Parameter	Measurements		Average
$A_{\rm CP}(B \to K^*\gamma)$	Belle [239] BaBar [241]	$-0.004 \pm 0.014 \pm 0.003$ $-0.003 \pm 0.017 \pm 0.007$	-0.004 ± 0.011
$A_{CP}(B \to X_s\gamma)$	Belle [333] [1] BaBar [385] [2]	$0.0144 \pm 0.0128 \pm 0.0011$ $0.017 \pm 0.019 \pm 0.010$	0.015 ± 0.011
$A_{CP}(B \to X_{s+d}\gamma)$	Belle [386] [3] BaBar [291] [4]	$0.022 \pm 0.039 \pm 0.009$ $0.057 \pm 0.060 \pm 0.018$	0.032 ± 0.034
$A_{CP}(B \to X_s\ell^+\ell^-)$	BaBar [298]	$0.04 \pm 0.11 \pm 0.01$	0.04 ± 0.11
$A_{\rm CP}(B \to K^*e^+e^-)$	Belle [274]	$-0.18 \pm 0.15 \pm 0.01$	-0.18 ± 0.15
$A_{\rm CP}(B \to K^*\mu^+\mu^-)$	Belle [274]	$-0.03 \pm 0.13 \pm 0.02$	-0.03 ± 0.13
$A_{\rm CP}(B \to K^*\ell^+\ell^-)$	Belle [274] BaBar [302]	$-0.10 \pm 0.10 \pm 0.01$ $0.03 \pm 0.13 \pm 0.01$	-0.05 ± 0.08
$A_{CP}(B \to X_s\eta)$	Belle [328] [5]	$-0.13 \pm 0.04\,^{+0.02}_{-0.03}$	$-0.13\,^{+0.04}_{-0.05}$
$A_{\rm CP}(B \to K\ell^+\ell^-)$	BaBar [302]	$-0.03 \pm 0.14 \pm 0.01$	-0.03 ± 0.14

[1] $m_{X_s} < 2.8$ GeV/c^2.
[2] $0.6 < m_{X_s} < 2.0$ GeV/c^2.
[3] $E^*_\gamma \geq 2.1$ GeV where E^*_γ is the photon energy in the center-of-mass frame.
[4] $2.1 < E^*_\gamma < 2.8$ GeV where E^*_γ is the photon energy in the center-of-mass frame.
[5] $0.4 < m_X < 2.6$ GeV/c^2.

Table 97: CP asymmetries of charmless hadronic B_s^0 decays.

Parameter	Measurements		Average
$A_{CP}(B_s^0 \to \pi^+ K^-)$	LHCb [381][1]	0.225 ± 0.012	0.225 ± 0.012
	CDF [382]	$0.22 \pm 0.07 \pm 0.02$	

[1] LHCb combines results of the 1.9 fb^{-1} run 2 data analysis with those based on Run 1 dataset [383]. The full statistical and systematic covariance matrices are used in the combination.

Table 98: CP asymmetries of charmless hadronic Λ_b^0 decays.

Parameter	Measurements		Average
$A_{\rm CP}(\Lambda_b^0 \to p\pi^-)$	LHCb [387]	$0.002 \pm 0.008 \pm 0.004$	0.0028 ± 0.0089
	CDF [382]	$0.06 \pm 0.07 \pm 0.03$	
$A_{\rm CP}(\Lambda_b^0 \to pK^-)$	LHCb [387]	$-0.011 \pm 0.007 \pm 0.004$	-0.0117 ± 0.0080
	CDF [382]	$-0.10 \pm 0.08 \pm 0.04$	
$A_{\rm CP}(\Lambda_b^0 \to p\overline{K}^0\pi^-)$	LHCb [108]	$0.22 \pm 0.13 \pm 0.03$	0.22 ± 0.13
$A_{\rm CP}(\Lambda_b^0 \to \Lambda^0 K^+\pi^-)$	LHCb [185][1]	$-0.118 \pm 0.045 \pm 0.021$	-0.133 ± 0.049
	LHCb [388]	$-0.53 \pm 0.23 \pm 0.11$	
$A_{\rm CP}(\Lambda_b^0 \to \Lambda^0 K^+K^-)$	LHCb [185][1]	$0.083 \pm 0.023 \pm 0.016$	0.065 ± 0.027 p=0.38%
	LHCb [388]	$-0.28 \pm 0.10 \pm 0.07$	
$A_{\rm CP}(\Lambda_b^0 \to \Lambda^0\pi^+\pi^-)$	LHCb [185][1]	$-0.013 \pm 0.053 \pm 0.018$	-0.013 ± 0.056

[1] LHCb reports the ACP difference relative to control mode, $\Lambda_b^0 \to \Lambda_c^+(\to \Lambda\pi^+)\pi^-$, assumed to have no CP asymmetry.

Table 99: CP asymmetries of charmless hadronic Ξ_b decays.

Parameter	Measurements		Average
$A_{\rm CP}(\Xi_b^- \to \Sigma(1385)^0 K^-)$	LHCb [188]	$-0.01 \pm 0.24 \pm 0.32$	-0.01 ± 0.40
$A_{CP}(\Xi_b^- \to \Lambda(1405) K^-)$	LHCb [188]	$-0.27 \pm 0.34 \pm 0.73$	-0.27 ± 0.81
$A_{CP}(\Xi_b^- \to \Lambda(1520) K^-)$	LHCb [188]	$-0.05 \pm 0.09 \pm 0.08$	-0.05 ± 0.12
$A_{CP}(\Xi_b^- \to \Lambda(1670) K^-)$	LHCb [188]	$0.03 \pm 0.14 \pm 0.10$	0.03 ± 0.17
$A_{CP}(\Xi_b^- \to \Sigma(1775) K^-)$	LHCb [188]	$-0.47 \pm 0.26 \pm 0.14$	-0.47 ± 0.30
$A_{CP}(\Xi_b^- \to \Sigma(1915) K^-)$	LHCb [188]	$0.11 \pm 0.26 \pm 0.22$	0.11 ± 0.34
$A_{\rm CP}(\Xi_b^0 \to \Lambda^0 K^-\pi^+)$	LHCb [185][1]	$0.27 \pm 0.12 \pm 0.05$	0.27 ± 0.13

[1] LHCb reports the ACP difference relative to a control mode, $\Lambda_b^0 \to \Lambda_c^+(\to \Lambda\pi^+)\pi^-$, assumed to have no CP asymmetry.

Measurements that are not included in the tables (the definitions of observables can be found in the corresponding experimental papers):

- In Ref. [389], LHCb reports the triple-product asymmetries ($a_{CP}^{\hat{T}-odd}$, $a_{P}^{\hat{T}-odd}$) for the decays $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$ and $\Lambda_b^0 \to p\pi^-K^+K^-$.

- In Ref. [390], LHCb reports $a_{CP}^{\hat{T}-odd}$, $a_{P}^{\hat{T}-odd}$ and $\Delta(A_{CP}) = A_{CP}(\Lambda_b^0 \to pK^-\mu^+\mu^-) - A_{CP}(\Lambda_b^0 \to pK^-J/\psi)$.

- In Ref. [391], LHCb reports $a_{CP}^{\hat{T}-odd}$ and $a_{P}^{\hat{T}-odd}$ for the decays $\Lambda_b^0 \to pK^-\pi^+\pi^-$, $\Lambda_b^0 \to pK^-K^+K^-$ and $\Xi_b^0 \to pK^-K^-\pi^+$.

- In Ref. [392] LHCb measures differences of CP asymmetries between Λ_b^0 and Ξ_b^0 charmless decays into a proton and three charged mesons and the decays to the same final states with an intermediate charmed baryon.

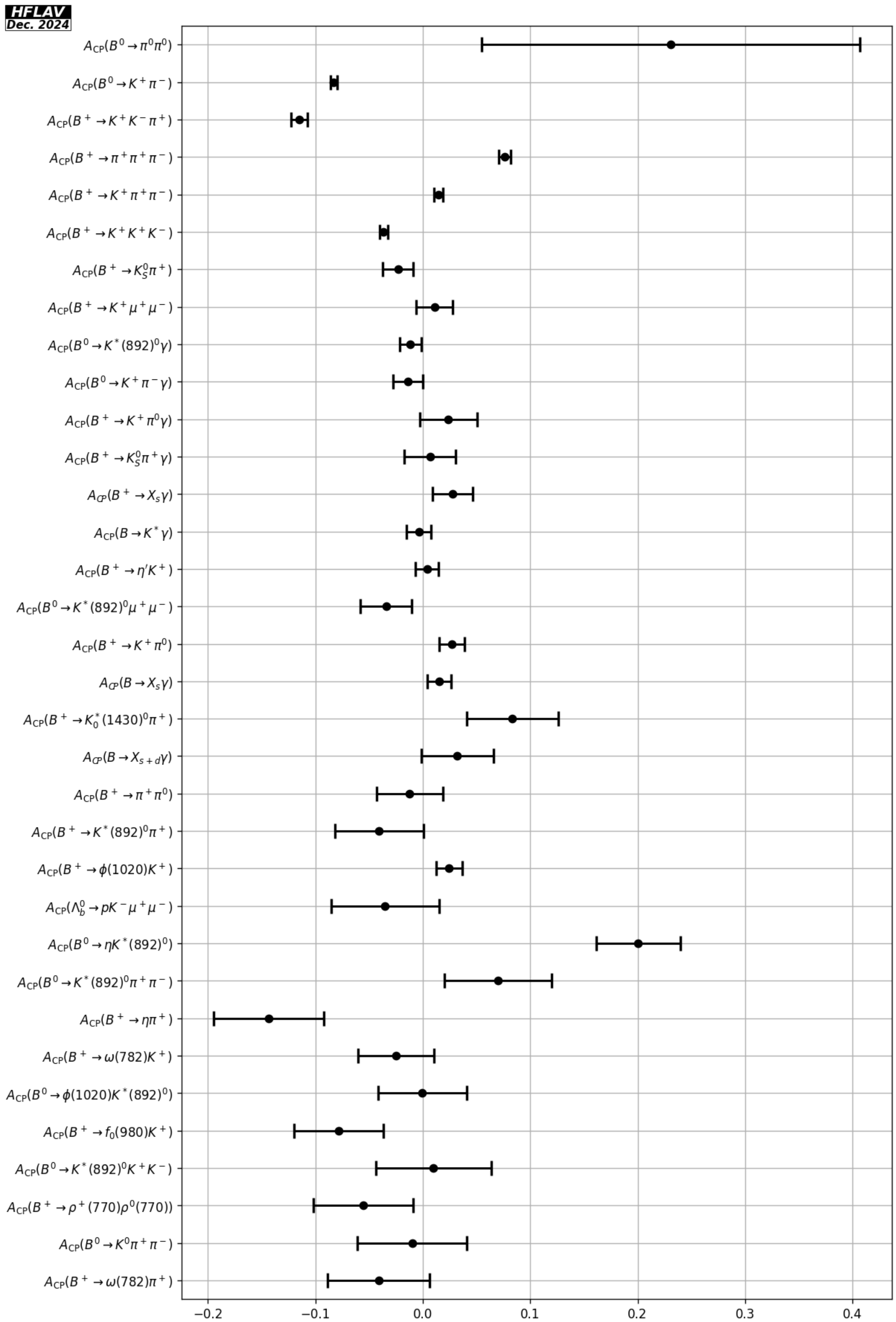

Figure 14: A selection among the most precise direct CP asymmetries (A_{CP}) measured in charmless B^+ and B^0 decay modes.

0.8 Polarization measurements in b-hadron decays

In this section, compilations of polarization measurements in b-hadron decays are given. Tables 100, 101, and 102 detail measurements of the longitudinal polarization fraction f_L in B^+ B^0, and B_s^0 decays, respectively. They are followed by Tables 103, 104 and 105, which list polarization fractions and CP parameters measured in full angular analyses of B^+, B^0 and B_s^0 decays. Figures 15 and 16 show graphic representations of a selection of results shown in this section.

Most of the final states considered in the tables are pairs of vector mesons and thus, we detail below the corresponding definitions. For specific definitions, for example regarding vector-tensor final states or vector recoiling against dispin-half states, please refer to the articles. In the decay of a pseudoscalar meson into two vector mesons, momentum conservation allows for three helicity configurations: $H_0, H_{\pm 1}$. They can be expressed in terms of longitudinal polarisation amplitudes, $A_0 = H_0$, and transverse polarization amplitudes, $A_\perp = (H_{+1} - H_{-1})/\sqrt{2}$ and $A_\parallel = (H_{+1} + H_{-1})/\sqrt{2}$. The corresponding amplitudes for the charge conjugate decays are denoted $\overline{A_0}$, $\overline{A_\parallel}$, and $\overline{A_\perp}$. Using the definition

$$F_{k=0,\parallel,\perp} = \frac{|A_k|^2}{|A_0|^2 + |A_\perp|^2 + |A_\parallel|^2}, \quad \overline{F}_{k=0,\parallel,\perp} = \frac{|\overline{A_k}|^2}{|\overline{A_0}|^2 + |\overline{A_\perp}|^2 + |\overline{A_\parallel}|^2}, \tag{2}$$

the following CP conserving and CP violating observables, which are used in our tables, are defined:

$$f_{k=0,\parallel,\perp} = \frac{1}{2}(F_k + \overline{F_k}), \quad A_{CP}^{k=0,\perp} = \frac{F_k - \overline{F_k}}{F_k + \overline{F_k}}. \tag{3}$$

Note that, in the literature, f_0 and f_L are used interchangeably to denote the longitudinal polarization fraction.

Table 100: Longitudinal polarization fraction, f_L, in B^+ decays.

Parameter	**Measurements**		**Average**
$f_L(B^+ \to \omega(782)K^*(892)^+)$	BaBar [26]	$0.41 \pm 0.18 \pm 0.05$	0.41 ± 0.19
$f_L(B^+ \to \omega(782)K_2^*(1430)^+)$	BaBar [26]	$0.56 \pm 0.10 \pm 0.04$	0.56 ± 0.11
$f_L(B^+ \to K^*(892)^+\overline{K}^*(892)^0)$	BaBar [60] Belle [59]	$0.75\,^{+0.16}_{-0.26} \pm 0.03$ $1.06 \pm 0.30 \pm 0.14$	$0.82\,^{+0.13}_{-0.17}$
$f_L(B^+ \to \phi(1020)K^*(892)^+)$	BaBar [65][1] Belle [379] Belle II [62]	$0.49 \pm 0.05 \pm 0.03$ $0.52 \pm 0.08 \pm 0.03$ $0.58 \pm 0.23 \pm 0.02$	0.50 ± 0.05
$f_L(B^+ \to \phi(1020)K_1(1270)^+)$	BaBar [67]	$0.46\,^{+0.12}_{-0.13}\,^{+0.06}_{-0.07}$	0.46 ± 0.14
$f_L(B^+ \to \phi(1020)K_2^*(1430)^+)$	BaBar [67]	$0.80\,^{+0.09}_{-0.10} \pm 0.03$	0.80 ± 0.10
$f_L(B^+ \to K^*(892)^+\rho^0(770))$	BaBar [42]	$0.78 \pm 0.12 \pm 0.03$	0.78 ± 0.12
$f_L(B^+ \to K^*(892)^0\rho^+(770))$	BaBar [44] Belle [45][2]	$0.52 \pm 0.10 \pm 0.04$ $0.43 \pm 0.11\,^{+0.05}_{-0.02}$	0.48 ± 0.08
$f_L(B^+ \to \rho^+(770)\rho^0(770))$	BaBar [81] Belle II [82] Belle [83]	$0.950 \pm 0.015 \pm 0.006$ $0.943\,^{+0.035}_{-0.033} \pm 0.027$ $0.948 \pm 0.106 \pm 0.021$	0.949 ± 0.015
$f_L(B^+ \to \omega(782)\rho^+(770))$	BaBar [26]	$0.90 \pm 0.05 \pm 0.03$	0.90 ± 0.06
$f_L(B^+ \to p\overline{p}K^*(892)^+)$	Belle [163]	$0.32 \pm 0.17 \pm 0.09$	0.32 ± 0.19

[1] Combination of two final states of the $K^*(892)^\pm$, $K_S^0\pi^\pm$ and $K^\pm\pi^0$. In addition to the combined results, the paper reports separately the results for each individual final state.
[2] See also Ref. [48].

Table 101: Longitudinal polarization fraction, f_L, in B^0 decays.

Parameter	**Measurements**		**Average**
$f_L(B^0 \to \omega(782)K^*(892)^0)$	BaBar [26]	$0.72 \pm 0.14 \pm 0.02$	0.69 ± 0.11
	LHCb [393]	$0.68 \pm 0.17 \pm 0.16$	
	Belle [102]	$0.56 \pm 0.29\,^{+0.18}_{-0.08}$	
$f_L(B^0 \to \omega(782)K_2^*(1430)^0)$	BaBar [26]	$0.45 \pm 0.12 \pm 0.02$	0.45 ± 0.12
$f_L(B^0 \to K^*(892)^0\overline{K}^*(892)^0)$	LHCb [133]	$0.724 \pm 0.051 \pm 0.016$	0.73 ± 0.05
	BaBar [134]	$0.80\,^{+0.10}_{-0.12} \pm 0.06$	
$f_L(B^0 \to \phi(1020)K^*(892)^0)$	LHCb [394]	$0.497 \pm 0.019 \pm 0.015$	0.497 ± 0.017
	Belle [127]	$0.499 \pm 0.030 \pm 0.018$	
	BaBar [126]	$0.494 \pm 0.034 \pm 0.013$	
	Belle II [62]	$0.57 \pm 0.20 \pm 0.04$	
$f_L(B^0 \to \phi(1020)K_2^*(1430)^0)$	Belle [127]	$0.918\,^{+0.029}_{-0.060} \pm 0.012$	$0.912\,^{+0.032}_{-0.046}$
	BaBar [126]	$0.901\,^{+0.046}_{-0.058} \pm 0.037$	
$f_L(B^0 \to K^*(892)^0\rho^0(770))$	LHCb [393]	$0.164 \pm 0.015 \pm 0.022$	0.173 ± 0.026
	BaBar [116]	$0.40 \pm 0.08 \pm 0.11$	
$f_L(B^0 \to K^*(892)^+\rho^-(770))$	BaBar [116]	$0.38 \pm 0.13 \pm 0.03$	0.38 ± 0.13
$f_L(B^0 \to \rho^+(770)\rho^-(770))$	Belle [150]	$0.988 \pm 0.012 \pm 0.023$	$0.970\,^{+0.015}_{-0.016}$
	BaBar [151]	$0.992 \pm 0.024\,^{+0.026}_{-0.013}$	
	Belle II [152]	$0.921\,^{+0.024}_{-0.025}\,^{+0.017}_{-0.015}$	
$f_L(B^0 \to \rho^0(770)\rho^0(770))$[1]	LHCb [131]	$0.745\,^{+0.048}_{-0.058} \pm 0.034$	0.71 ± 0.06
	BaBar [147]	$0.75\,^{+0.11}_{-0.14} \pm 0.04$	
	Belle [146]	$0.21\,^{+0.18}_{-0.22} \pm 0.15$	
$f_L(B^0 \to a_1(1260)^+a_1(1260)^-)$	BaBar [154]	$0.31 \pm 0.22 \pm 0.10$	0.31 ± 0.24
$f_L(B^0 \to p\overline{p}K^*(892)^0)$	Belle [163]	$1.01 \pm 0.13 \pm 0.03$	1.01 ± 0.13
$f_L(B^0 \to \Lambda^0\overline{\Lambda}^0K^*(892)^0)$	Belle [169][2,3]	$0.60 \pm 0.22 \pm 0.08$	0.60 ± 0.23
$f_L(B^0 \to K^{*0}\mu^+\mu^-), 0.04 < q^2 < 6.0\ \mathrm{GeV}^2/\mathrm{c}^4$			
	ATLAS [364]	$0.50 \pm 0.06 \pm 0.04$	0.50 ± 0.07
$f_L(B^0 \to K^{*0}e^+e^-), 0.002 < q^2 < 1.120\ \mathrm{GeV}^2/\mathrm{c}^4$			
	LHCb [395]	$0.16 \pm 0.06 \pm 0.03$	0.16 ± 0.07

[1] The PDG uncertainty includes a scale factor.
[2] The charmonium mass regions are vetoed.
[3] $m_{\Lambda^0\overline{\Lambda^0}} < 2.85\ \mathrm{GeV}/c^2$.

Table 102: Longitudinal polarization fraction, f_L, in B_s^0 decays.

Parameter	Measurements		Average
$f_L(B_s^0 \to \phi(1020)\phi(1020))$	LHCb [142] CDF [201]	$0.381 \pm 0.007 \pm 0.012$ $0.348 \pm 0.041 \pm 0.021$	0.378 ± 0.013
$f_L(B_s^0 \to K^*(892)^0\overline{K}^*(892)^0)$	LHCb [133]	$0.240 \pm 0.031 \pm 0.025$	0.24 ± 0.04
$f_L(B_s^0 \to \phi(1020)\overline{K}^*(892)^0)$	LHCb [128]	$0.51 \pm 0.15 \pm 0.07$	0.51 ± 0.17
$f_L(B_s^0 \to \overline{K}_2^*(1430)^0 K^*(892)^0)$	LHCb [396]	$0.911 \pm 0.020 \pm 0.165$	0.91 ± 0.17
$f_L(B_s^0 \to K_2^*(1430)^0\overline{K}^*(892)^0)$	LHCb [396]	$0.62 \pm 0.16 \pm 0.25$	0.62 ± 0.30
$f_L(B_s^0 \to K_2^*(1430)^0\overline{K}_2^*(1430)^0)$	LHCb [396]	$0.25 \pm 0.14 \pm 0.18$	0.25 ± 0.23

Table 103: Results of full angular analyses of B^+ decays.

Parameter	Measurements		Average
$f_\perp(B^+ \to \phi(1020)K^*(892)^+)$	BaBar [65][1] Belle [379]	$0.21 \pm 0.05 \pm 0.02$ $0.19 \pm 0.08 \pm 0.02$	0.20 ± 0.05

[1] Combination of two final states of the $K^*(892)^\pm$, $K_S^0\pi^\pm$ and $K^\pm\pi^0$. In addition to the combined results, the paper reports separately the results for each individual final state.

Table 104: Results of full angular analyses of B^0 decays.

Parameter	Measurements		Average
$f_\perp(B^0 \to \phi(1020)K^*(892)^0)$	LHCb [394] Belle [127] BaBar [126]	$0.221 \pm 0.016 \pm 0.013$ $0.238 \pm 0.026 \pm 0.008$ $0.212 \pm 0.032 \pm 0.013$	0.224 ± 0.015
$f_\perp(B^0 \to \phi(1020)K_2^*(1430)^0)$[1]	BaBar [126] Belle [127]	$0.002\,^{+0.018}_{-0.002} \pm 0.031$ $0.056\,^{+0.050}_{-0.035} \pm 0.009$	$0.029\,^{+0.024}_{-0.026}$

[1] The PDG uncertainty includes a scale factor.

Table 105: Results of full angular analyses of B_s^0 decays.

Parameter	Measurements		Average
$f_\perp(B_s^0 \to \phi(1020)\phi(1020))$	LHCb [142] CDF [201]	$0.290 \pm 0.008 \pm 0.007$ $0.365 \pm 0.044 \pm 0.027$	0.293 ± 0.010
$f_\parallel(B_s^0 \to \phi(1020)\overline{K}^*(892)^0)$	LHCb [128]	$0.21 \pm 0.11 \pm 0.02$	0.21 ± 0.11
$f_\perp(B_s^0 \to K^*(892)^0\overline{K}^*(892)^0)$	LHCb [133]	$0.526 \pm 0.032 \pm 0.019$	0.526 ± 0.037
$f_\parallel(B_s^0 \to K^*(892)^0\overline{K}^*(892)^0)$	LHCb [133]	$0.234 \pm 0.025 \pm 0.010$	0.23 ± 0.03

Measurements that are not included in the tables (the definitions of observables can be found in the corresponding experimental papers):

- In the angular analysis of $B^0 \to \phi K^*(892)^0$ decays [394], in addition to the results quoted in Table 104, LHCb reports observables related to the S-wave component contributing the final state $K^+K^-K^+\pi^-$: $f_S(K\pi)$, $f_S(KK)$, $\delta_s(K\pi)$, $\delta_s(KK)$, $\mathcal{A}_S(K\pi)^{CP}$, $\mathcal{A}_S(KK)^{CP}$, $\delta_S(K\pi)^{CP}$, $\delta_S(KK)^{CP}$.

- In the amplitude analysis of $B_s^0 \to \phi\phi$ decays, in addition to the results quoted in Table 105, LHCb, in Ref. [142], extracts the *CP*-violating phase $\phi_s^{s\bar{s}s}$ and the *CP*-violating parameter $|\lambda|$ from a decay-time-dependent and polarisation independent fit. The *CP*-violating phases $\phi_{s,\parallel}$ and $\phi_{s,\perp}$ are obtained in a polarisation-dependent fit. A time-integrated fit is performed to extract the triple-product asymmetries A_U and A_V. CDF, in Ref. [201] also reports the triple-product asymmetries A_U and A_V.

- In Ref. [396], LHCb presents a flavor-tagged, decay-time-dependent amplitude analysis of $B_s^0 \to (K^+\pi^-)(K^-\pi^+)$ decays in the $K^\pm\pi^\mp$ mass range from 750 to 1600 MeV$/c^2$. The paper includes measurements of 19 *CP*-averaged amplitude parameters corresponding to scalar, vector and tensor final states as well as the first measurement of the *CP*-violating phase $\phi_s^{d\bar{d}}$.

- Reference [393] presents an amplitude analysis of $B^0 \to \rho K^*(892)^0$ realised by LHCb. Scalar (S) and vector (V) contributions to the final state $(\pi^+\pi^+)(K^+\pi^-)$ are considered through partial waves sharing the same angular dependence (VV, SS, SV, VS) and the corresponding amplitudes are extracted for each case. Triple product asymmetries are also reported.

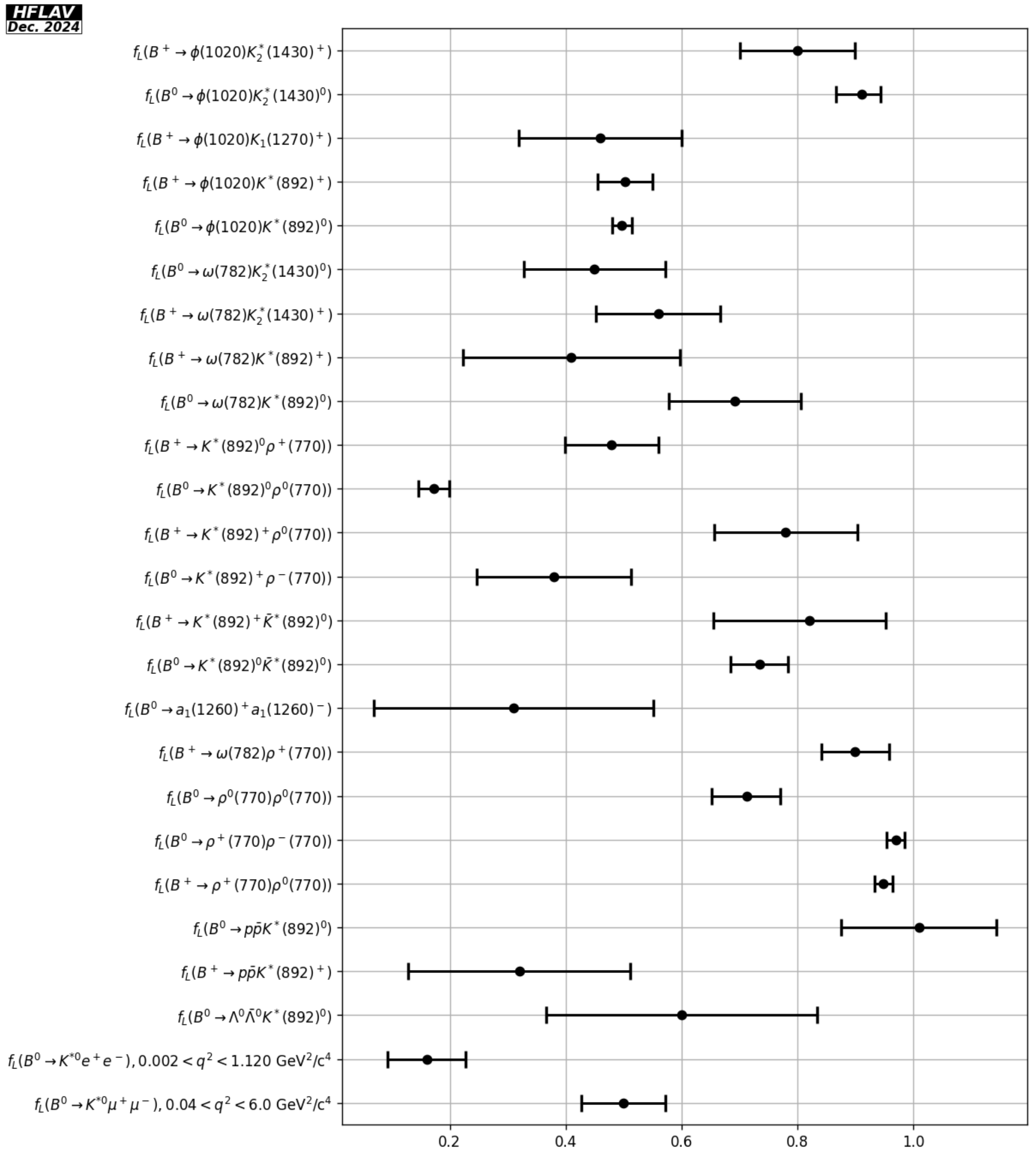

Figure 15: Longitudinal polarization fraction in charmless B decays.

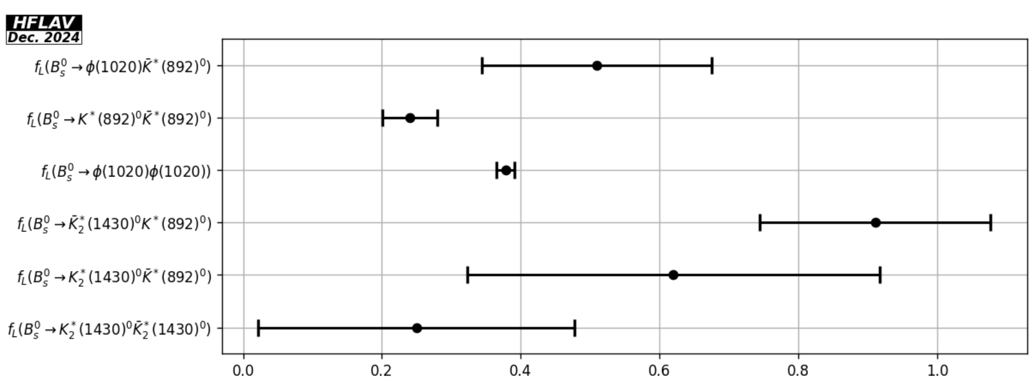

Figure 16: Longitudinal polarization fraction in charmless B_s^0 decays.

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