

Heavy FLavor AVeraging group (HFLAV) - August 2017
 Compilation of B^+ Semi-leptonic and Radiative Branching Fractions ($\times 10^{-6}$) - UL at 90% CL
 In PDG2014 **New since PDG2014 (preliminary)** **New since PDG2014 (published)**

RPP#	Mode	PDG2014 Avg.	BABAR	Belle	CLEO	LHCb	Our Avg.
363	$K^{*+}\gamma$	42.1 ± 1.8	$42.2 \pm 1.4 \pm 1.6$ [1]	$37.6 \pm 1.0 \pm 1.2$ [2]	$37.6^{+8.9}_{-8.3} \pm 2.8$ [3]		$39.2^{+1.3}_{-1.2}$
364	$K_1^+(1270)\gamma$	43 ± 13	$44.1^{+6.3}_{-4.4} \pm 5.8$ † [4]	$43 \pm 9 \pm 9$ [5]			$43.8^{+7.1}_{-6.3}$
365	$K^+\eta\gamma$	7.9 ± 0.9	$7.7 \pm 1.0 \pm 0.4$ [6]	$8.4^{+1.5}_{-1.2} \pm 0.9$ [7]			7.9 ± 0.9
366	$K^+\eta'\gamma$	$2.9^{+1.0}_{-0.9}$	$1.9^{+1.5}_{-1.2} \pm 0.1$ [8]	$3.6 \pm 1.2 \pm 0.4$ [9]			$2.9^{+1.0}_{-0.9}$
367	$K^+\phi\gamma$	2.7 ± 0.4	$3.5 \pm 0.6 \pm 0.4$ [10]	$2.48 \pm 0.30 \pm 0.24$ [11]			2.71 ± 0.34
368	$K^+\pi^-\pi^+\gamma$	27.6 ± 2.2	$24.5 \pm 0.9 \pm 1.2$ † [4]	$25.0 \pm 1.8 \pm 2.2$ ‡ [5]			24.6 ± 1.3
369	$K^{*0}\pi^+\gamma$ §	20^{+7}_{-6}	$23.4 \pm 0.9^{+0.8}_{-0.7}$ † [4]	$20^{+7}_{-6} \pm 2$ [12]			$23.3^{+1.2}_{-1.1}$
370	$K^+\rho^0\gamma$ §	< 20	$8.2 \pm 0.4 \pm 0.8$ † [4]	< 20 [12]			8.2 ± 0.9
	$(K\pi)_0^0\pi^+\gamma$		$10.3^{+0.7+1.5}_{-0.8-2.0}$ † [4]				$10.3^{+1.7}_{-2.2}$
371	$K^+\pi^-\pi^+\gamma$ (N.R.) §	< 9.2	$9.9 \pm 0.7^{+1.5}_{-1.9}$ † [4]	< 9.2 [12]			$9.9^{+1.7}_{-2.0}$
	$K_0^*(1430)\pi^+\gamma$		$1.32^{+0.09+0.24}_{-0.10-0.30}$ † [4]				$1.32^{+0.26}_{-0.32}$
372	$K^0\pi^+\pi^0\gamma$	46 ± 5	$45.6 \pm 4.2 \pm 3.1$ † [13]				45.6 ± 5.2
373	$K_1^+(1400)\gamma$	< 15	$9.7^{+4.6+2.9}_{-2.9-2.4}$ † [4]	< 15 [5]			$9.7^{+5.4}_{-3.8}$
	$K^{*+}(1410)\gamma$		$27.1^{+5.4+5.9}_{-4.8-3.7}$ † [4]				$27.1^{+8.0}_{-6.1}$
374	$K_2^*(1430)^+\gamma$	14 ± 4	$8.7^{+7.0+8.7}_{-5.3-10.4}$ † [4]				$8.7^{+11.2}_{-11.7}$
375	$K^{*+}(1680)\gamma$	< 1900	$66.7^{+9.3+14.4}_{-7.8-11.4}$ † [4]				$66.7^{+17.1}_{-13.8}$
376	$K_3^*(1780)^+\gamma$	< 39		< 39 [7]			< 39
378	$\rho^+\gamma$	0.98 ± 0.25	$1.20^{+0.42}_{-0.37} \pm 0.20$ [14]	$0.87^{+0.29+0.09}_{-0.27-0.11}$ [15]			$0.98^{+0.25}_{-0.24}$
428	$\bar{p}\bar{\Lambda}\gamma$	$2.4^{+0.5}_{-0.4}$		$2.45^{+0.44}_{-0.38} \pm 0.22$ [16]			$2.45^{+0.49}_{-0.44}$
432	$p\bar{\Sigma}^0\gamma$	< 4.6		< 4.6 [17]			< 4.6
467	$\pi^+\ell^+\ell^-$	< 0.049	< 0.066 [18]	< 0.049 [19]			< 0.049
468	$\pi^+e^+e^-$	< 0.080	< 0.125 [18]	< 0.080 [19]			< 0.080
469	$\pi^+\mu^+\mu^-$	< 0.055	< 0.055 [18]	< 0.069 [19]		$0.0183 \pm 0.0024 \pm 0.0005$ ¹ [20]	0.0180 ± 0.0020
470	$\pi^+\nu\bar{\nu}$	< 98	< 100 [21]	< 14 [22]			< 14
471	$K^+\ell^+\ell^-$	0.451 ± 0.023	$0.48 \pm 0.09 \pm 0.02$ [23]	$0.53^{+0.06}_{-0.05} \pm 0.03$ [24]			0.51 ± 0.05
472	$K^+e^+e^-$	0.55 ± 0.07	$0.51^{+0.12}_{-0.12} \pm 0.02$ [23]	$0.57^{+0.09}_{-0.08} \pm 0.03$ [24]			0.55 ± 0.07
473	$K^+\mu^+\mu^-$	0.449 ± 0.023	$0.41^{+0.16}_{-0.15} \pm 0.02$ [23]	$0.53 \pm 0.08^{+0.07}_{-0.03}$ [24]		$0.429 \pm 0.007 \pm 0.021$ [25]	0.435 ± 0.021
	$K^+\tau^+\tau^-$		< 2250 [26]				< 2250
476	$K^+\nu\bar{\nu}$	< 16	< 16 [27]	< 19 [22]			< 16
477	$\rho^+\nu\bar{\nu}$	< 213		< 30 [22]			< 30
478	$K^{*+}\ell^+\ell^-$	1.29 ± 0.21	$1.40^{+0.40}_{-0.37} \pm 0.09$ [23]	$1.24^{+0.23}_{-0.21} \pm 0.13$ [24]			$1.29^{+0.22}_{-0.21}$
479	$K^{*+}e^+e^-$	$1.55^{+0.40}_{-0.31}$	$1.38^{+0.47}_{-0.42} \pm 0.08$ [23]	$1.73^{+0.50}_{-0.42} \pm 0.20$ [24]			$1.55^{+0.35}_{-0.32}$
480	$K^{*+}\mu^+\mu^-$	1.12 ± 0.15	$1.46^{+0.79}_{-0.75} \pm 0.12$ [23]	$1.11^{+0.32}_{-0.27} \pm 0.10$ [24]		$0.924 \pm 0.093 \pm 0.067$ [28]	$0.958^{+0.107}_{-0.104}$
481	$K^{*+}\nu\bar{\nu}$	< 40	< 64 [27]	< 40 [29]			< 40
	$K^+\pi^+\pi^-\mu^+\mu^-$					$0.436^{+0.029}_{-0.027} \pm 0.028$ ² [30]	$0.436^{+0.040}_{-0.039}$
	$K^+\phi\mu^+\mu^-$					$0.082^{+0.019+0.029}_{-0.017-0.027}$ [30]	$0.082^{+0.035}_{-0.032}$

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

CLEO upper limits that have been greatly superseded are not shown.

† $M_{K\pi\pi} < 1.8$ GeV/ c^2 .

‡ $1.0 < M_{K\pi\pi} < 2.0$ GeV/ c^2 .

§ $M_{K\pi\pi} < 2.4$ GeV/ c^2 .

¹ PDG2014 cites only the measurement: $\mathcal{B}(\pi^+\mu^+\mu^-)/\mathcal{B}(K^+\mu^+\mu^-) = 0.053 \pm 0.014 \pm 0.01$.

² Differential BF in bins of $m(\mu^+\mu^-)$ is also available.

Heavy Flavor AVeraging group (HFLAV) - August 2017
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 In PDG2014 New since PDG2014 (preliminary) New since PDG2014 (published)

RPP#	Mode	PDG2014 Avg.	BABAR	Belle	CLEO	LHCb	Our Avg.
336	$K^0 \eta \gamma$	7.6 ± 1.8	$7.1^{+2.1}_{-2.0} \pm 0.4$ [6]	$8.7^{+3.1+1.9}_{-2.7-1.6}$ [7]			$7.6^{+1.8}_{-1.7}$
337	$K^0 \eta' \gamma$	< 6.4	< 6.6 [8]	< 6.4 [9]			< 6.4
338	$K^0 \phi \gamma$	2.7 ± 0.7	< 2.7 [10]	$2.74 \pm 0.60 \pm 0.32$ [11]			2.74 ± 0.68
339	$K^+ \pi^- \gamma \S$	4.6 ± 1.4		$4.6^{+1.3+0.5}_{-1.2-0.7}$ [12]			4.6 ± 1.4
340	$K^{*0} \gamma$	43.3 ± 1.5	$44.7 \pm 1.0 \pm 1.6$ [1]	$39.6 \pm 0.7 \pm 1.4$ [2]	$45.5^{+7.2}_{-6.8} \pm 3.4$ [3]		41.8 ± 1.2
341	$K^*(1410)^0 \gamma$	< 130		< 130 [12]			< 130
342	$K^+ \pi^- \gamma$ (N.R.) §	< 2.6		< 2.6 [12]			< 2.6
344	$K^0 \pi^+ \pi^- \gamma$	19.5 ± 2.2	$18.5 \pm 2.1 \pm 1.2$ † [13]	$24 \pm 4 \pm 3$ ‡ [5]			19.5 ± 2.2
345	$K^+ \pi^- \pi^0 \gamma$	41 ± 4	$40.7 \pm 2.2 \pm 3.1$ † [13]				40.7 ± 3.8
346	$K_1^0(1270) \gamma$	< 58		< 58 [5]			< 58
347	$K_1^0(1400) \gamma$	< 12		< 12 [5]			< 12
348	$K_2^*(1430)^0 \gamma$	12.4 ± 2.4	$12.2 \pm 2.5 \pm 1.0$ [31]	$13 \pm 5 \pm 1$ [12]			12.4 ± 2.4
350	$K_3^*(1780)^0 \gamma$	< 83		< 83 [7]			< 83
352	$\rho^0 \gamma$	0.86 ± 0.15	$0.97^{+0.24}_{-0.22} \pm 0.06$ [14]	$0.78^{+0.17+0.09}_{-0.16-0.10}$ [15]			$0.86^{+0.15}_{-0.14}$
354	$\omega \gamma$	$0.44^{+0.18}_{-0.16}$	$0.50^{+0.27}_{-0.23} \pm 0.09$ [14]	$0.40^{+0.19}_{-0.17} \pm 0.13$ [15]			$0.44^{+0.18}_{-0.16}$
355	$\phi \gamma$	< 0.85	< 0.85 [32]	< 0.1 [33]			< 0.1
	$p \Lambda \pi^- \gamma$			< 0.65 [34]			< 0.65
465	$\pi^0 \ell^+ \ell^-$	< 0.053	< 0.053 [18]	< 0.154 [19]			< 0.053
466	$\pi^0 e^+ e^-$	< 0.084	< 0.084 [18]	< 0.227 [19]			< 0.084
467	$\pi^0 \mu^+ \mu^-$	< 0.069	< 0.069 [18]	< 0.184 [19]			< 0.069
468	$\eta \ell^+ \ell^-$	< 0.064	< 0.064 [18]				< 0.064
469	$\eta e^+ e^-$	< 0.108	< 0.108 [18]				< 0.108
470	$\eta \mu^+ \mu^-$	< 0.112	< 0.112 [18]				< 0.112
471	$\pi^0 \nu \bar{\nu}$	< 69		< 9 [22]			< 9
472	$K^0 \ell^+ \ell^-$	$0.31^{+0.08}_{-0.07}$	$0.21^{+0.15}_{-0.13} \pm 0.02$ [23]	$0.34^{+0.09}_{-0.08} \pm 0.02$ [24]			$0.31^{+0.08}_{-0.07}$
473	$K^0 e^+ e^-$	$0.16^{+0.10}_{-0.08}$	$0.08^{+0.15}_{-0.12} \pm 0.01$ [23]	$0.20^{+0.14}_{-0.10} \pm 0.01$ [24]			$0.16^{+0.10}_{-0.08}$
474	$K^0 \mu^+ \mu^-$	0.34 ± 0.05	$0.49^{+0.29}_{-0.25} \pm 0.03$ [23]	$0.44^{+0.13}_{-0.10} \pm 0.03$ [24]		$0.327 \pm 0.034 \pm 0.017$ [28]	$0.343^{+0.036}_{-0.035}$
475	$K^0 \nu \bar{\nu}$	< 49	< 49 [27]	< 26 [22]			< 26
476	$\rho^0 \nu \bar{\nu}$	< 208		< 40 [22]			< 40
477	$K^{*0} \ell^+ \ell^-$	$0.99^{+0.12}_{-0.11}$	$1.03^{+0.22}_{-0.21} \pm 0.07$ [23]	$0.97^{+0.13}_{-0.11} \pm 0.07$ [24]			$0.99^{+0.13}_{-0.11}$
478	$K^{*0} e^+ e^-$	$1.03^{+0.19}_{-0.17}$	$0.86^{+0.26}_{-0.24} \pm 0.05$ [23]	$1.18^{+0.27}_{-0.22} \pm 0.09$ [24]			$1.03^{+0.19}_{-0.17}$
479	$K^{*0} \mu^+ \mu^-$	1.05 ± 0.10	$1.35^{+0.40}_{-0.37} \pm 0.10$ [23]	$1.06^{+0.19}_{-0.14} \pm 0.07$ [24]		$1.036^{+0.018}_{-0.017} \pm 0.071$ ¶ [35]	$1.049^{+0.067}_{-0.065}$
480	$K^{*0} \nu \bar{\nu}$	< 55	< 120 [27]	< 18 [22]			< 18
481	$\phi \nu \bar{\nu}$	< 127		< 127 [29]			< 127
	$\pi^+ \pi^- \mu^+ \mu^-$					$0.0211 \pm 0.0051 \pm 0.0022$ ¹ [36]	0.0210 ± 0.0060
483	$\pi^0 e^\pm \mu^\mp$	< 0.14	< 0.14 [37]				< 0.14
484	$K^0 e^\pm \mu^\mp$	< 0.27	< 0.27 [38]				< 0.27
485	$K^{*0} e^\pm \mu^\mp$	< 0.53	< 0.53 [38]				< 0.53

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

CLEO upper limits that have been greatly superseded are not shown.

† $M_{K\pi\pi} < 1.8 \text{ GeV}/c^2$.

‡ $1.0 < M_{K\pi\pi} < 2.0 \text{ GeV}/c^2$.

§ $1.25 \text{ GeV}/c^2 < M_{K\pi} < 1.6 \text{ GeV}/c^2$.

¶ This result takes into account the S-wave fraction in the $K\pi$ system.

¹ Muon pairs do not originate from resonances and $0.5 < m(\pi^+ \pi^-) < 1.3 \text{ GeV}/c^2$.

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RPP#	Mode	PDG2014 Avg.	BABAR	Belle	CLEO	CDF	Our Avg.
66	$K\eta\gamma$	$8.5^{+1.8}_{-1.6}$		$8.5^{+1.3}_{-1.2} \pm 0.9$ [7]			$8.5^{+1.6}_{-1.5}$
68	$K_2^*(1430)\gamma$	17^{+6}_{-5}			$17 \pm 6 \pm 1$ [3]		17 ± 6
70	$K_3^*(1780)\gamma$	< 37		< 2.8 § [7]			< 2.8 §
77	$s\gamma$ †	340 ± 21	341 ± 28 ¹ [39-41]	328 ± 20 ¹ [42-44]		$329 \pm 44 \pm 29$ [45]	332 ± 15
77	$s\gamma$ ²		308 ± 22 ¹ [39-41]	305 ± 16 ¹ [43, 44]			306 ± 12
78	$d\gamma$	9.2 ± 3.0	$9.2 \pm 2.0 \pm 2.3$ [46]				9.2 ± 3.0
84	$\rho\gamma$	1.39 ± 0.25	$1.73^{+0.34}_{-0.32} \pm 0.17$ [14]	$1.21^{+0.24}_{-0.22} \pm 0.12$ [15]			$1.39^{+0.22}_{-0.21}$
85	$\rho/\omega\gamma$	1.30 ± 0.23	$1.63^{+0.30}_{-0.28} \pm 0.16$ [14]	$1.14 \pm 0.20^{+0.10}_{-0.12}$ [15]			$1.30^{+0.18}_{-0.19}$
119	se^+e^- ‡	4.7 ± 1.3	$7.69^{+0.82+0.71}_{-0.77-0.60}$ [47]				$7.69^{+1.08}_{-0.98}$
120	$s\mu^+\mu^-$ ‡	4.3 ± 1.2	$4.41^{+1.31+0.63}_{-1.17-0.50}$ [47]				$4.41^{+1.45}_{-1.27}$
121	$s\ell^+\ell^-$ ‡	4.5 ± 1.0	$6.73^{+0.70+0.60}_{-0.64-0.56}$ [47]				$6.73^{+0.92}_{-0.85}$
122	$\pi\ell^+\ell^-$	< 0.059	< 0.059 [18]	< 0.062 [19]			< 0.059
123	πe^+e^-	< 0.110	< 0.110 [18]				< 0.110
124	$\pi\mu^+\mu^-$	< 0.050	< 0.050 [18]				< 0.050
125	Ke^+e^-	0.44 ± 0.06	$0.39^{+0.09}_{-0.08} \pm 0.02$ [23]	$0.48^{+0.08}_{-0.07} \pm 0.03$ [24]			0.44 ± 0.06
126	$Ke^+\mu^-$	1.19 ± 0.20	$0.99^{+0.23}_{-0.21} \pm 0.06$ [23]	$1.39^{+0.23}_{-0.20} \pm 0.12$ [24]			$1.19^{+0.17}_{-0.16}$
127	$K\mu^+\mu^-$	0.44 ± 0.04	$0.41^{+0.13}_{-0.12} \pm 0.02$ [23]	$0.50 \pm 0.06 \pm 0.03$ [24]		$0.42 \pm 0.04 \pm 0.02$ [48]	0.44 ± 0.04
128	$K^*\mu^+\mu^-$	1.06 ± 0.09	$1.35^{+0.35}_{-0.33} \pm 0.10$ [23]	$1.10^{+0.16}_{-0.14} \pm 0.08$ [24]		$1.01 \pm 0.10 \pm 0.05$ [48]	1.06 ± 0.09
129	$K\ell^+\ell^-$	0.48 ± 0.04	$0.47 \pm 0.06 \pm 0.02$ [49]	$0.48^{+0.05}_{-0.04} \pm 0.03$ [24]			0.48 ± 0.04
130	$K^*\ell^+\ell^-$	1.05 ± 0.10	$1.02^{+0.14}_{-0.13} \pm 0.05$ [49]	$1.07^{+0.11}_{-0.10} \pm 0.09$ [24]			1.05 ± 0.10
131	$K\nu\bar{\nu}$	< 17	< 17 [27]	< 16 [22]			< 16
132	$K^*\nu\bar{\nu}$	< 76	< 76 [27]	< 27 [22]			< 27
132	$\pi\nu\bar{\nu}$			< 8 [22]			< 8
132	$\rho\nu\bar{\nu}$			< 28 [22]			< 28
134	$\pi e^\pm\mu^\mp$	< 0.092	< 0.092 [37]				< 0.092
135	$\rho e^\pm\mu^\mp$	< 3.2			< 3.2 [50]		< 3.2
136	$Ke^\pm\mu^\mp$	< 0.038	< 0.038 [38]				< 0.038
137	$K^*e^\pm\mu^\mp$	< 0.51	< 0.51 [38]				< 0.51

Results for CDF are relative BFs converted to absolute BFs.

CLEO upper limits that have been greatly superseded are not shown.

† Results extrapolated to $E_\gamma > 1.6$ GeV, using the method of Ref. [51].

‡ Belle: $m(\ell^+\ell^-) > 0.2$ GeV/ c^2 , BABAR: $m^2(\ell^+\ell^-) > 0.1$ GeV²/ c^4 .

§ The value quoted is $\mathcal{B}(B \rightarrow K_3^*\gamma) \times \mathcal{B}(K_3^* \rightarrow K\eta)$. PDG gives the BF assuming $\mathcal{B}(K_3^* \rightarrow K\eta) = 11^{+5}_{-4}\%$.

¹ Average of several results, obtained with different methods.

² Only results originally measured in the interval $E_\gamma > 1.9$ GeV (also taken into account in the previous line).

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RPP#	Mode	PDG2014 Avg.	BABAR	Belle	CDF	LHCb	CMS	ATLAS	Our Avg.
29	$e^+\nu$	< 0.98	< 1.9 [52]	< 0.98 [†] [53]					< 0.98 [†]
30	$\mu^+\nu$	< 1.0	< 1.0 [52]	< 1.7 [†] [53]					< 1.0
31	$\tau^+\nu$	114 ± 27	179 ± 48 [‡] [54]	$91 \pm 19 \pm 11$ [‡] [55]					106 ± 19
32	$\ell^+\nu\ell\gamma$	< 15.6	< 15.6 [56]	< 3.5 [57]					< 3.5
33	$e^+\nu e\gamma$	< 17	< 17 [56]	< 6.1 [57]					< 6.1
34	$\mu^+\nu\mu\gamma$	< 24	< 24 [56]	< 3.4 [57]					< 3.4
457	$\gamma\gamma$	< 0.32	< 0.32 [58]	< 0.62 [59]					< 0.32
458	e^+e^-	< 0.083	< 0.113 [60]	< 0.19 [61]	< 0.083 [62]				< 0.083
459	$e^+e^-\gamma$	< 0.12	< 0.12 [63]						< 0.12
460	$\mu^+\mu^-$	< 0.00063	< 0.052 [60]	< 0.16 [61]	< 0.0038 [64]	< 0.00034 [¶] [65]	< 0.00110 [¶] [66]	< 0.00042 [¶] [67]	$0.00039^{+0.00016}_{-0.00014}$ [§]
461	$\mu^+\mu^-\gamma$	< 0.16	< 0.16 [63]						< 0.16
462	$\mu^+\mu^-\mu^+\mu^-$	< 0.0053				< 0.00069 [¶] [68]			< 0.00069 [¶]
464	$\tau^+\tau^-$	< 4100	< 4100 [69]			< 1600 [70]			< 1600
482	$e^\pm\mu^\mp$	< 0.0028	< 0.092 [60]	< 0.17 [61]	< 0.064 [62]	< 0.0028 [71]			< 0.0028
488	$e^\pm\tau^\mp$	< 28	< 28 [72]						< 28
489	$\mu^\pm\tau^\mp$	< 22	< 22 [72]						< 22
490	$\nu\bar{\nu}$	< 24	< 24 [73]	< 130 [74]					< 24
491	$\nu\bar{\nu}\gamma$	< 17	< 17 [73]						< 17

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

[†] More recent results exist, with hadronic tagging [75], that do not improve the limits (< 3.5 and < 2.7) for $e^+\nu$ and $\mu^+\nu$, respectively).

[‡] The authors make the average with their previous results, derived from statistically independent samples [76, 77].

[§] This is the combined result obtained by the LHCb and CMS collaborations [78].

[¶] UL at 95% CL.

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RPP#	Mode	PDG2014 AVG.	Belle	BABAR	LHCb	Our Avg.
	$10^4 \times \mathcal{B}(K^+\pi^+\pi^-\mu^+\mu^-)/\mathcal{B}(\psi(2S)K^+)$				$6.95^{+0.46}_{-0.43} \pm 0.34$ [30]	$6.95^{+0.57}_{-0.55}$
	$10^4 \times \mathcal{B}(K^+\phi\mu^+\mu^-)/\mathcal{B}(\psi(2S)K^+)$				$1.58^{+0.36+0.19}_{-0.32-0.07}$ [30]	$1.58^{+0.41}_{-0.33}$
469	$\mathcal{B}(\pi^+\mu^+\mu^-)/\mathcal{B}(K^+\mu^+\mu^-)$ †	$0.053 \pm 0.014 \pm 0.01$			$0.038 \pm 0.009 \pm 0.001$ [20]	0.038 ± 0.009
473	$\mathcal{B}(K^+\mu^+\mu^-)/\mathcal{B}(K^+e^+e^-)$ ‡				$0.745^{+0.090}_{-0.074} \pm 0.036$ [79]	$0.745^{+0.097}_{-0.082}$
473	$\mathcal{B}(K^+\mu^+\mu^-)/\mathcal{B}(K^+e^+e^-)$ §		$1.03 \pm 0.19 \pm 0.06$ [24]			1.03 ± 0.20
473	$\mathcal{B}(K^+\mu^+\mu^-)/\mathcal{B}(K^+e^+e^-)$ ¶			$1.00^{+0.31}_{-0.25} \pm 0.07$ [49]		$1.00^{+0.32}_{-0.26}$
	$\mathcal{B}(K^*\mu^+\mu^-)/\mathcal{B}(K^*e^+e^-)$ §		$0.83 \pm 0.17 \pm 0.08$ [24]			0.83 ± 0.19
	$\mathcal{B}(K^*\mu^+\mu^-)/\mathcal{B}(K^*e^+e^-)$ ¶			$1.013^{+0.34}_{-0.26} \pm 0.010$ [49]		$1.013^{+0.340}_{-0.260}$
	$\mathcal{B}(K^{*0}\mu^+\mu^-)/\mathcal{B}(K^{*0}e^+e^-)$ ◊				$0.66^{+0.11}_{-0.07} \pm 0.03$ [80]	$0.66^{+0.11}_{-0.08}$
	$\mathcal{B}(K^{*0}\mu^+\mu^-)/\mathcal{B}(K^{*0}e^+e^-)$ ¹				$0.69^{+0.11}_{-0.07} \pm 0.05$ [80]	$0.69^{+0.12}_{-0.09}$
473	$\mathcal{B}(B^0 \rightarrow K^{*0}\gamma)/\mathcal{B}(B_s^0 \rightarrow \phi\gamma)$		$1.10 \pm 0.16 \pm 0.09 \pm 0.18$ [2]			1.10 ± 0.26

† For $0.1 < m^2(\ell^+\ell^-) < 6.0 \text{ GeV}^2/c^4$.

‡ For $1.0 < m^2(\ell^+\ell^-) < 6.0 \text{ GeV}^2/c^4$.

§ For the full $m^2(\ell^+\ell^-)$ range.

¶ For $0.10 < m^2(\ell^+\ell^-) < 8.12 \text{ GeV}^2/c^4$ and $m^2(\ell^+\ell^-) > 10.11 \text{ GeV}^2/c^4$.

◊ For $0.045 < m^2(\ell^+\ell^-) < 1.1 \text{ GeV}^2/c^4$.

¹ For $1.1 < m^2(\ell^+\ell^-) < 6.0 \text{ GeV}^2/c^4$.

Heavy FLavor AVeraging group (HFLAV) - August 2017
 Compilation of Branching Fractions of B^+/B^0 to \bar{q} gluon decays ($\times 10^{-6}$) - UL at 90% CL
 In PDG2014 New since PDG2014 (preliminary) New since PDG2014 (published)

RPP#	Mode	PDG2014 Avg.	BABAR	Belle	CLEO	Our Avg.
80	ηX	260^{+50}_{-80}		$261 \pm 30^{+44}_{-74}$ §[81]	< 440 [82]	261^{+53}_{-79}
81	$\eta' X$	420 ± 90	$390 \pm 80 \pm 90$ †[83]		$460 \pm 110 \pm 60$ †[84]	423 ± 86
82	$K^+ X$	< 187	< 187 ‡ [85]			< 187 ‡
83	$K^0 X$	195^{+71}_{-67}	$195^{+51}_{-45} \pm 50$ ‡ [85]			195^{+71}_{-67}
94	$\pi^+ X$	370 ± 80	$372^{+50}_{-47} \pm 59$ ¶ [85]			372^{+77}_{-75}

† $2.0 < p^*(\eta') < 2.7$ GeV/c.

‡ $m_X < 1.69$ GeV/c².

§ $0.4 < m_X < 2.6$ GeV/c².

¶ $m_X < 1.71$ GeV/c².

Heavy FLavor AVeraging group (HFLAV) - August 2017

Isospin Asymmetry

In PDG2014 New since PDG2014 (preliminary) New since PDG2014 (published)

Parameter	PDG2014 Avg.	BABAR	Belle	LHCb	Our Avg.
$\Delta_{0-}(X_s\gamma)$	-0.01 ± 0.06	-0.01 ± 0.06 ‡ [39, 86]			-0.01 ± 0.06
$\Delta_{0+}(K^*\gamma)$	0.052 ± 0.026	$0.066 \pm 0.021 \pm 0.022$ [1]	$0.062 \pm 0.015 \pm 0.006 \pm 1.2$ [2]		0.066 ± 0.030
$\Delta_{\rho\gamma}$	-0.46 ± 0.17	$-0.43_{-0.22}^{+0.25} \pm 0.10$ [14]	$-0.48_{-0.19-0.09}^{+0.21+0.08}$ [15]		$-0.46_{-0.16}^{+0.17}$
$\Delta_{0-}(K\ell\ell)$ †	-0.37 ± 0.13	$-0.41 \pm 0.25 \pm 0.01$ [49]	$-0.41_{-0.20}^{+0.25} \pm 0.07$ [24]	$-0.10_{-0.09}^{+0.08} \pm 0.02$ § [28]	-0.16 ± 0.08
$\Delta_{0-}(K^*\ell\ell)$ †	-0.22 ± 0.10	$-0.20_{-0.23}^{+0.30} \pm 0.03$ [49]	$0.33_{-0.43}^{+0.37} \pm 0.08$ [24]	$0.00_{-0.10}^{+0.12} \pm 0.02$ § [28]	$-0.01_{-0.09}^{+0.11}$

In some of the B -factory results it is assumed that $\mathcal{B}(\Upsilon(4S) \rightarrow B^+B^-) = \mathcal{B}(\Upsilon(4S) \rightarrow B^0\bar{B}^0)$, and in others a measured value of the ratio of branching fractions is used. See original papers for details. The averages quoted above are computed naively and should be treated with caution.

† Results given for the bin $1 < m^2(\ell^+\ell^-) < 6 \text{ GeV}^2/c^4$, see references for the other bins.

‡ Average of two independent measurements from BABAR.

§ Only muons are used.

Heavy FLavor AVeraging group (HFLAV) - August 2017

Compilation of B^+ Semi-leptonic LFV & LNV Branching Fractions ($\times 10^{-6}$) - UL at 90% CL

In PDG2014 New since PDG2014 (preliminary) New since PDG2014 (published)

RPP#	Mode	PDG2014 Avg.	BABAR	LHCb	Our Avg.
484	$\pi^+e^\pm\mu^\mp$	< 0.17	< 0.17 [37]		< 0.17
485	$\pi^+e^+\tau^-$	< 74	< 74 [87]		< 74
486	$\pi^+e^-\tau^+$	< 20	< 20 [87]		< 20
487	$\pi^+e^\pm\tau^\mp$	< 75	< 75 [87]		< 75
488	$\pi^+\mu^+\tau^-$	< 62	< 62 [87]		< 62
489	$\pi^+\mu^-\tau^+$	< 45	< 45 [87]		< 45
490	$\pi^+\mu^\pm\tau^\mp$	< 72	< 72 [87]		< 72
491	$K^+e^+\mu^-$	< 0.091	< 0.091 [38]		< 0.091
492	$K^+e^-\mu^+$	< 0.13	< 0.13 [38]		< 0.13
493	$K^+e^\pm\mu^\mp$	< 0.091	< 0.091 [38]		< 0.091
494	$K^+e^+\tau^-$	< 43	< 43 [87]		< 43
495	$K^+e^-\tau^+$	< 15	< 15 [87]		< 15
496	$K^+e^\pm\tau^\mp$	< 30	< 30 [87]		< 30
497	$K^+\mu^+\tau^-$	< 45	< 45 [87]		< 45
498	$K^+\mu^-\tau^+$	< 28	< 28 [87]		< 28
499	$K^+\mu^\pm\tau^\mp$	< 48	< 48 [87]		< 48
500	$K^{*+}e^+\mu^-$	< 1.3	< 1.3 [38]		< 1.3
501	$K^{*+}e^-\mu^+$	< 0.99	< 0.99 [38]		< 0.99
502	$K^{*+}e^\pm\mu^\mp$	< 1.4	< 1.4 [38]		< 1.4
503	$\pi^-e^+e^+$	< 0.023	< 0.023 [88]		< 0.023
504	$\pi^-\mu^+\mu^+$	< 0.013	< 0.107 [88]	< 0.004 † [89]	< 0.004 †
505	$\pi^-e^+\mu^+$	< 0.15	< 0.15 [90]		< 0.15
506	$\rho^-e^+e^+$	< 0.17	< 0.17 [90]		< 0.17
507	$\rho^-\mu^+\mu^+$	< 0.42	< 0.42 [90]		< 0.42
508	$\rho^-e^+\mu^+$	< 0.47	< 0.47 [90]		< 0.47
509	$K^-e^+e^+$	< 0.03	< 0.03 [88]		< 0.03
510	$K^-\mu^+\mu^+$	< 0.041	< 0.067 [88]	< 0.041 [91]	< 0.041
511	$K^-e^+\mu^+$	< 0.16	< 0.16 [90]		< 0.16
512	$K^{*-}e^+e^+$	< 0.40	< 0.40 [90]		< 0.40
513	$K^{*-}\mu^+\mu^+$	< 0.59	< 0.59 [90]		< 0.59
514	$K^{*-}e^+\mu^+$	< 0.30	< 0.30 [90]		< 0.30

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

CLEO upper limits that have been greatly superseded are not shown.

† UL at 95% CL.

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