

Heavy Flavor Averaging Group  
July 2005

Compilation of  $B^+$  Semi-leptonic and Radiative Branching Fractions  
All branching fractions are in units of  $10^{-6}$

In PDG2004    New since PDG2004 (preliminary)    New since PDG2004 (published)

RPP#	Mode	PDG2004 Avg.	BABAR	Belle	CLEO	New Avg.
160	$K^*(892)^+\gamma$	$38 \pm 5$	<span style="color: red;"><math>38.7 \pm 2.8 \pm 2.6</math></span>	<span style="color: red;"><math>42.5 \pm 3.1 \pm 2.4</math></span>	$37.6^{+8.9}_{-8.3} \pm 2.8$	$40.3 \pm 2.6$
161	$K_1(1270)^+\gamma$	$< 99$		<span style="color: red;"><math>43 \pm 9 \pm 9</math></span>		$43 \pm 12$
162	$K^+\phi\gamma$	$3.4 \pm 1.0$		$3.4 \pm 0.9 \pm 0.4$		$3.4 \pm 1.0$
163	$K^+\pi^-\pi^+\gamma$ §	$24^{+6}_{-5}$	<span style="color: blue;"><math>29.5 \pm 1.3 \pm 1.9</math></span>	<span style="color: red;"><math>25.0 \pm 1.8 \pm 2.2</math></span>		$27.7 \pm 1.8$
–	$K^0\pi^+\pi^0\gamma$ §	New	<span style="color: blue;"><math>45.6 \pm 4.2 \pm 3.1</math></span>			$45.6 \pm 5.2$
164	$K^{*0}\pi^+\gamma$ §	$20^{+7}_{-6}$		$20^{+7}_{-6} \pm 2$		$20^{+7}_{-6}$
165	$K^+\rho^0\gamma$ §	$< 20$		$< 20$		$< 20$
166	$K^+\pi^-\pi^+\gamma$ (N.R.) §	$< 9.2$		$< 9.2$		$< 9.2$
167	$K_1(1400)^+\gamma$	$< 50$		<span style="color: red;"><math>&lt; 15</math></span>		$< 15$
168	$K_2^*(1430)^+\gamma$	$< 1400$	<span style="color: red;"><math>14.5 \pm 4.0 \pm 1.5</math></span>			$14.5 \pm 4.3$
172	$\rho^+\gamma$	$< 2.1$	<span style="color: red;"><math>0.9^{+0.6}_{-0.5} \pm 0.1</math></span>	<span style="color: blue;"><math>0.55^{+0.43+0.12}_{-0.37-0.11}</math></span>	$< 13$	$0.68^{+0.36}_{-0.31}$
–	$K^+\eta\gamma$	New		<span style="color: blue;"><math>8.4^{+1.5}_{-1.1} \pm 0.9</math></span>		$8.4^{+1.7}_{-1.4}$
207	$p\bar{\Lambda}\gamma$	New		<span style="color: blue;"><math>2.16^{+0.58}_{-0.53} \pm 0.20</math></span>		$2.16^{+0.61}_{-0.57}$
208	$p\bar{\Sigma}^0\gamma$	New		$< 3.3$		$< 3.3$
–	$\pi^+\nu\bar{\nu}$	New	$< 100$			$< 100$
226	$K^+e^+e^-$	$0.63^{+0.19}_{-0.17}$	<span style="color: blue;"><math>0.43^{+0.12}_{-0.11} \pm 0.03</math></span>	$0.640^{+0.150+0.029}_{-0.134-0.031}$	$< 2.4$	$0.522^{+0.094}_{-0.090}$
227	$K^+\mu^+\mu^-$	$0.45^{+0.14}_{-0.12}$	<span style="color: blue;"><math>0.31^{+0.15}_{-0.12} \pm 0.04</math></span>	$0.628^{+0.110}_{-0.108} \pm 0.033$	$< 3.68$	$0.518 \pm 0.092$
228	$K^+l^+l^-$	$0.53^{+0.11}_{-0.10} \pm 0.3$		$0.632^{+0.092}_{-0.088} \pm 0.030$		$0.632^{+0.097}_{-0.093}$
229	$K^+\nu\bar{\nu}$	$< 240$	$< 52$	$< 36$	$< 240$	$< 36$
230	$K^*(892)^+e^+e^-$	$< 4.6$	<span style="color: blue;"><math>0.77^{+0.87}_{-0.70} \pm 0.60</math> ‡</span>	$1.60^{+1.04+0.14}_{-0.87-0.19}$ ‡		$1.22^{+0.73}_{-0.65}$
231	$K^*(892)^+\mu^+\mu^-$	$< 2.2$	<span style="color: blue;"><math>1.00^{+0.96}_{-0.71} \pm 0.16</math> ‡</span>	$1.63^{+0.64+0.10}_{-0.54-0.13}$ ‡		$1.44^{+0.54}_{-0.45}$
232	$K^*(892)^+l^+l^-$	$< 2.2$		$1.34^{+0.48+0.09}_{-0.40-0.10}$ ‡		$1.34^{+0.49}_{-0.41}$
238	$\pi^-e^+e^+$	$< 1.6$			$< 1.6$	$< 1.6$
239	$\pi^-\mu^+\mu^+$	$< 1.4$			$< 1.4$	$< 1.4$
240	$\pi^-e^+\mu^+$	$< 1.3$			$< 1.3$	$< 1.3$
241	$\rho^-e^+e^+$	$< 2.6$			$< 2.6$	$< 2.6$
242	$\rho^-\mu^+\mu^+$	$< 5.0$			$< 5.0$	$< 5.0$
243	$\rho^-e^+\mu^+$	$< 3.3$			$< 3.3$	$< 3.3$
244	$K^-e^+e^+$	$< 1.0$			$< 1.0$	$< 1.0$
245	$K^-\mu^+\mu^+$	$< 1.8$			$< 1.8$	$< 1.8$
246	$K^-e^+\mu^+$	$< 2.0$			$< 2.0$	$< 2.0$
247	$K^{*-}e^+e^+$	$< 2.8$			$< 2.8$	$< 2.8$
248	$K^{*-}\mu^+\mu^+$	$< 8.3$			$< 8.3$	$< 8.3$
249	$K^{*-}e^+\mu^+$	$< 4.4$			$< 4.4$	$< 4.4$

§  $M_{K\pi\pi} < 2.4 \text{ GeV}/c^2$  ‡ Central values are not significant.

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RPP#	Mode	PDG2004 Avg.	BABAR	Belle	CLEO	New Avg.
162	$K^*(892)^0\gamma$	$43 \pm 4$	<span style="color: red;"><math>39.2 \pm 2.0 \pm 2.4</math></span>	<span style="color: red;"><math>40.1 \pm 2.1 \pm 1.7</math></span>	$45.5^{+7.2}_{-6.8} \pm 3.4$	$40.1 \pm 2.0$
163	$K^0\phi\gamma$	$< 8.3$		$< 8.3$		$< 8.3$
164	$K^+\pi^-\gamma$ †	$4.6 \pm 1.4$		$4.6^{+1.3+0.5}_{-1.2-0.7}$		$4.6 \pm 1.4$
–	$K^0\pi^+\pi^-\gamma$	New	<span style="color: blue;"><math>18.5 \pm 2.1 \pm 1.2</math></span>	<span style="color: red;"><math>24 \pm 4 \pm 3</math></span>		$19.5 \pm 2.2$
–	$K^+\pi^-\pi^0\gamma$	New	<span style="color: blue;"><math>40.7 \pm 2.2 \pm 3.1</math></span>			$40.7 \pm 3.8$
165	$K^*(1410)^0\gamma$	$< 130$		$< 130$		$< 130$
166	$K^+\pi^-\gamma$ (N.R.) †	$< 2.6$		$< 2.6$		$< 2.6$
167	$K_1(1270)^0\gamma$	$< 7000$		$< 58$		$< 58$
168	$K_1(1400)^0\gamma$	$< 4300$		$< 12$		$< 12$
169	$K_2^*(1430)^0\gamma$	$13 \pm 5$	<span style="color: red;"><math>12.2 \pm 2.5 \pm 1.0</math></span>	$13 \pm 5 \pm 1$		$12.4 \pm 2.4$
–	$K^0\eta\gamma$	New		$8.7^{+3.1+1.9}_{-2.7-1.6}$		$8.7^{+3.6}_{-3.1}$
173	$\rho^0\gamma$	$< 1.2$	<span style="color: red;"><math>0.0 \pm 0.2 \pm 0.1</math></span>	$1.17^{+0.35+0.09}_{-0.31-0.08}$	$< 17$	$0.38 \pm 0.18$
174	$\omega\gamma$	$< 1.0$	<span style="color: red;"><math>0.5 \pm 0.3 \pm 0.1</math></span>	$0.58^{+0.35+0.07}_{-0.27-0.08}$	$< 9.2$	$0.54^{+0.23}_{-0.21}$
175	$\phi\gamma$	$< 3.3$	$< 0.94$		$< 3.3$	$< 0.94$
237	$K^0e^+e^-$	$< 0.54$	$0.14^{+0.16}_{-0.11} \pm 0.02$ ‡	$-0.070^{+0.129+0.014}_{-0.082-0.028}$ ‡	$< 8.45$	$0.045^{+0.090}_{-0.080}$
238	$K^0\mu^+\mu^-$	$0.56^{+0.29}_{-0.24}$	<span style="color: blue;"><math>0.60^{+0.34}_{-0.27} \pm 0.05</math></span>	$0.626^{+0.217+0.038}_{-0.181-0.041}$	$< 6.64$	$0.618^{+0.185}_{-0.155}$
239	$K^0l^+l^-$	$< 0.68$		$0.328^{+0.134+0.022}_{-0.113-0.026}$		$0.328^{+0.136}_{-0.116}$
240	$K^*(892)^0e^+e^-$	$< 2.4$	<span style="color: blue;"><math>1.03^{+0.33}_{-0.29} \pm 0.12</math></span>	$1.85^{+0.55}_{-0.49} \pm 0.19$		$1.28^{+0.30}_{-0.29}$
241	$K^*(892)^0\mu^+\mu^-$	$1.3 \pm 0.4$	<span style="color: blue;"><math>0.89^{+0.39}_{-0.33} \pm 0.14</math></span>	$1.85^{+0.35}_{-0.31} \pm 0.10$		$1.48 \pm 0.26$
243	$K^*(892)^0l^+l^-$	$1.17 \pm 0.30$		$1.69^{+0.26}_{-0.24} \pm 0.11$		$1.69^{+0.28}_{-0.26}$

†  $1.25 \text{ GeV}/c^2 < M_{K\pi} < 1.6 \text{ GeV}/c^2$  ‡ Central values are not significant.

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RPP#	Mode	PDG2004 Avg.	BABAR	Belle	CLEO	New Avg.
60	$K_3^*(1780)\gamma$	< 3000		< 2.8		< 2.8
67	$s\gamma$	$330 \pm 40$	$338 \pm 19_{-42}^{+64}$	$355 \pm 32_{-31-7}^{+30+11}$	$321 \pm 43_{-29}^{+32}$	$339_{-27}^{+30}$
–	$s\gamma$ with baryons	New			< 38 †	< 38 †
71	$\rho\gamma$	< 1.9	<span style="color: red;"><math>0.6 \pm 0.3 \pm 0.1</math></span>	$1.34_{-0.31-0.10}^{+0.34+0.14}$	< 14	$0.96 \pm 0.23$
–	$K\eta\gamma$	New		$8.5_{-1.2}^{+1.3} \pm 0.9$		$8.5_{-1.5}^{+1.6}$
101	$se^+e^-$ ‡	$5.0 \pm 2.6$	<span style="color: red;"><math>6.0 \pm 1.7 \pm 1.3</math></span>	$4.04 \pm 1.30_{-0.76}^{+0.80}$	< 57	$4.70_{-1.23}^{+1.24}$
102	$s\mu^+\mu^-$	$7.9_{-2.6}^{+3.0}$	<span style="color: red;"><math>5.0 \pm 2.8 \pm 1.2</math></span>	$4.13 \pm 1.05_{-0.69}^{+0.73}$	< 58	$4.26_{-1.16}^{+1.18}$
103	$sl^+\ell^-$ ‡	$6.1_{-1.8}^{+2.0}$	<span style="color: red;"><math>5.6 \pm 1.5 \pm 1.3</math></span>	$4.11 \pm 0.83_{-0.70}^{+0.74}$	< 42	$4.46_{-0.96}^{+0.98}$
104	$Ke^+e^-$	$0.48_{-0.13}^{+0.15}$	$0.33_{-0.08}^{+0.09} \pm 0.02$	$0.454_{-0.104-0.025}^{+0.116+0.023}$		$0.380_{-0.067}^{+0.073}$
105	$K^*(892)e^+e^-$	$1.5 \pm 0.5$	$0.97_{-0.27}^{+0.30} \pm 0.15$	$1.84_{-0.44}^{+0.48} \pm 0.17$		$1.26_{-0.27}^{+0.28}$
106	$K\mu^+\mu^-$	$0.48 \pm 0.12$	$0.35_{-0.11}^{+0.13} \pm 0.03$	$0.626_{-0.064-0.034}^{+0.103+0.033}$		$0.561_{-0.061}^{+0.066}$
107	$K^*(892)\mu^+\mu^-$	$1.17_{-0.33}^{+0.37}$	$0.90_{-0.30}^{+0.35} \pm 0.13$	$1.81_{-0.28}^{+0.30} \pm 0.11$		$1.45 \pm 0.23$
108	$K\ell^+\ell^-$	$0.54 \pm 0.08$	$0.34 \pm 0.07 \pm 0.03$	$0.550_{-0.070}^{+0.075} \pm 0.027$	< 1.7	$0.446 \pm 0.053$
109	$K^*(892)\ell^+\ell^-$	$1.05 \pm 0.20$	$0.78_{-0.17}^{+0.19} \pm 0.12$	$1.65_{-0.22}^{+0.23} \pm 0.11$	< 3.3	$1.18 \pm 0.17$
111	$\pi e^\pm\mu^\mp$	< 1.6			< 1.6	< 1.6
112	$\rho e^\pm\mu^\mp$	< 3.2			< 3.2	< 3.2
113	$Ke^\pm\mu^\mp$	< 1.6			< 1.6	< 1.6
114	$K^*e^\pm\mu^\mp$	< 6.2			< 6.2	< 6.2

† $E_\gamma > 2.0$  GeV; ‡ $M(\ell^+\ell^-) > 0.2$  GeV/ $c^2$

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RPP#	Mode	PDG2004 Avg.	BABAR	Belle	CLEO	CDF	D0	New Avg.
12	$e^+\nu$	< 15		< 5.4	< 15			< 5.4
13	$\mu^+\nu$	< 21	< 6.6	< 2.0	< 21			< 2.0
14	$\tau^+\nu$	< 570	$130^{+100}_{-90}$	$81^{+58}_{-45}$	< 840			$92^{+51}_{-41}$
15	$e^+\nu_e\gamma$	< 200		< 22	< 200			< 22
16	$\mu^+\nu_\mu\gamma$	< 52		< 23	< 52			< 23
234	$\gamma\gamma$	< 1.7	< 1.7	< 0.54				< 0.54
235	$e^+e^-$	< 0.19	< 0.061	< 0.19	< 0.83			< 0.061
236	$\mu^+\mu^-$	< 0.16	< 0.083	< 0.16	< 0.61	< 0.039		< 0.039
–	$\tau^+\tau^-$	New	< 2700					< 2700
244	$e^\pm\mu^\mp$	< 0.17	< 0.18	< 0.17	< 1.5			< 0.17
247	$e^\pm\tau^\mp$	< 530			< 110			< 110
248	$\mu^\pm\tau^\mp$	< 830			< 38			< 38
–	$\nu\bar{\nu}$	New	< 220					< 220
–	$\nu\bar{\nu}\gamma$	New	< 47					< 47

# Radiative and Leptonic Decays:

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