

Heavy Flavor Averaging Group  
May 2004

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

In PDG2002    New since PDG2002 (preliminary)    New since PDG2002 (published)

RPP#	Mode	PDG2002 Avg.	BaBar	Belle	CLEO	New Avg.
123	$K^*(892)^+\gamma$	$38 \pm 5$	$38.3 \pm 6.2 \pm 2.2$	$42.5 \pm 3.1 \pm 2.4$	$37.6_{-8.3}^{+8.9} \pm 2.8$	$40.9_{-3.1}^{+3.2}$
124	$K_1(1270)^+\gamma$	$< 7300$		$< 99$		$< 99$
125	$K_1(1400)^+\gamma$	$< 2200$		$< 50$		$< 50$
126	$K_2^*(1430)^+\gamma$	$< 1400$	$14.4 \pm 4.0 \pm 1.3$			$14.4 \pm 4.2$
130	$\rho^+\gamma$	$< 13$	$< 2.1$	$< 2.5$	$< 13$	$< 2.1$
—	$K^+\pi^-\pi^+\gamma$ §	New		$24 \pm 5_{-2}^{+4}$		$24_{-5}^{+6}$
—	$K^{*0}\pi^+\gamma$ §	New		$20_{-6}^{+7} \pm 2$		$20_{-6}^{+7}$
—	$K^+\rho^0\gamma$ §	New		$< 20$		$< 20$
—	$K^+\pi^-\pi^+\gamma$ (N.R.) §	New		$< 9.2$		$< 9.2$
—	$K^+\phi\gamma$	New		$3.4 \pm 0.9 \pm 0.4$		$3.4 \pm 1.0$
173	$K^+e^+e^-$	$< 1.4$	$1.05_{-0.22}^{+0.25} \pm 0.07$	$0.63_{-0.17}^{+0.19} \pm 0.03$	$< 2.4$	$0.80 \pm 0.15$
174	$K^+\mu^+\mu^-$	$1.0_{-0.4}^{+0.5}$	$0.07_{-0.11}^{+0.19} \pm 0.02$	$0.45_{-0.12}^{+0.14} \pm 0.03$	$< 3.68$	$0.34 \pm 0.10$
175	$K^+\nu\bar{\nu}$	$< 240$	$< 70$		$< 240$	$< 70$
176	$K^*(892)^+e^+e^-$	$< 8.9$	$0.20_{-0.87}^{+1.34} \pm 0.28$ ‡	$2.02_{-1.01-0.24}^{+1.27+0.23}$ ‡		$1.29_{-0.77}^{+0.90}$
177	$K^*(892)^+\mu^+\mu^-$	$< 3.9$	$3.07_{-1.78}^{+2.58} \pm 0.42$ ‡	$0.65_{-0.53-0.15}^{+0.69+0.14}$ ‡		$0.92_{-0.58}^{+0.70}$
182	$\pi^-e^+e^+$	$< 3900$			$< 1.6$	$< 1.6$
—	$\rho^-e^+e^+$	New			$< 2.6$	$< 2.6$
183	$\pi^-\mu^+\mu^+$	$< 9100$			$< 1.4$	$< 1.4$
—	$\rho^-\mu^+\mu^+$	New			$< 5.0$	$< 5.0$
184	$\pi^-e^+\mu^+$	$< 6400$			$< 1.3$	$< 1.3$
—	$\rho^-e^+\mu^+$	New			$< 3.3$	$< 3.3$
185	$K^-e^+e^+$	$< 3900$			$< 1.0$	$< 1.0$
186	$K^-\mu^+\mu^+$	$< 9100$			$< 1.8$	$< 1.8$
187	$K^-e^+\mu^+$	$< 6400$			$< 2.0$	$< 2.0$
—	$K^{*-}e^+\mu^+$	New			$< 4.4$	$< 4.4$
—	$K^{*-}e^+e^+$	New			$< 2.8$	$< 2.8$
—	$K^{*-}\mu^+\mu^+$	New			$< 8.3$	$< 8.3$

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

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RPP#	Mode	PDG2002 Avg.	BaBar	Belle	CLEO	New Avg.
123	$K^*(892)^0\gamma$	$43 \pm 4$	$42.3 \pm 4.0 \pm 2.2$	$40.1 \pm 2.1 \pm 1.7$	$45.5_{-6.8}^{+7.2} \pm 3.4$	$41.1 \pm 2.2$
–	$K^*(1410)^0\gamma$	New		$< 130$		$< 130$
126	$K_2^*(1430)^0\gamma$	$< 400$	$12.2 \pm 2.5 \pm 1.1$	$13 \pm 5 \pm 1$		$12.4 \pm 2.4$
130	$\rho^0\gamma$	$< 17$	$< 1.2$	$< 0.9$	$< 17$	$< 0.9$
131	$\omega\gamma$	$< 9.2$	$< 1.0$	$< 3.0$	$< 9.2$	$< 1.0$
–	$K^+\pi^-\gamma$ †	New		$4.6_{-1.2-0.7}^{+1.3+0.5}$		$4.6 \pm 1.4$
–	$K^+\pi^-\gamma$ (N.R.) †	New		$< 2.6$		$< 2.6$
–	$K^0\phi\gamma$	New		$< 8.3$		$< 8.3$
184	$K^0e^+e^-$	$< 2.7$	$-0.21_{-0.16}^{+0.23} \pm 0.08$ ‡	$0.00_{-0.12-0.05}^{+0.20+0.02}$ ‡	$< 8.45$	$-0.06_{-0.10}^{+0.14}$
185	$K^0\mu^+\mu^-$	$< 3.3$	$1.63_{-0.63}^{+0.82} \pm 0.14$	$0.56_{-0.23}^{+0.29} \pm 0.05$	$< 6.64$	$0.73_{-0.25}^{+0.28}$
186	$K^*(892)^0e^+e^-$	$< 6.4$	$1.11_{-0.47}^{+0.56} \pm 0.11$	$1.29_{-0.49-0.10}^{+0.57+0.13}$		$1.20_{-0.35}^{+0.41}$
187	$K^*(892)^0\mu^+\mu^-$	$< 4.2$	$0.86_{-0.58}^{+0.79} \pm 0.11$	$1.33_{-0.37}^{+0.42} \pm 0.11$		$1.22_{-0.33}^{+0.39}$

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

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RPP#	Mode	PDG2002 Avg.	BaBar	Belle	CLEO	New Avg.
63	$s\gamma$	$330 \pm 40$	$388 \pm 36_{-46}^{+57}$	$359 \pm 32_{-31-7}^{+30+11}$	$321 \pm 43_{-29}^{+32}$	$354_{-28}^{+30}$
–	$s\gamma$ with baryons	New			$< 38 \dagger$	$< 38 \dagger$
67	$\rho\gamma$	$< 14$	$< 1.9$	$1.8_{-0.5}^{+0.6} \pm 0.1$	$< 14$	$1.8_{-0.5}^{+0.6}$
97	$se^+e^- \ddagger$	$< 57$	$6.6 \pm 1.9_{-1.6}^{+1.9}$	$4.4 \pm 1.3 \pm 0.8$	$< 57$	$5.0 \pm 1.3$
98	$s\mu^+\mu^- \ddagger$	$< 58$	$5.7 \pm 2.8_{-1.4}^{+1.7}$	$4.3 \pm 1.1 \pm 0.7$	$< 58$	$4.5 \pm 1.2$
–	$sl^+l^- \ddagger$	New	$6.3 \pm 1.6_{-1.5}^{+1.8}$	$4.4 \pm 0.8_{-0.7}^{+0.8}$	$< 42$	$4.8 \pm 1.0$
99	$Ke^+e^-$	$< 1.3$	$0.74_{-0.16}^{+0.18} \pm 0.05$	$0.48_{-0.13}^{+0.15} \pm 0.03$		$0.59_{-0.11}^{+0.12}$
100	$K^*(892)e^+e^-$	$< 5.6$	$0.98_{-0.42}^{+0.50} \pm 0.11$	$1.49_{-0.46-0.13}^{+0.52+0.11}$		$1.24_{-0.33}^{+0.37}$
101	$K\mu^+\mu^-$	$0.99_{-0.32-0.14}^{+0.40+0.13}$	$0.45_{-0.19}^{+0.23} \pm 0.04$	$0.48_{-0.11}^{+0.13} \pm 0.04$		$0.47_{-0.10}^{+0.12}$
102	$K^*(892)\mu^+\mu^-$	$< 3.1$	$1.27_{-0.61}^{+0.76} \pm 0.16$	$1.17_{-0.31}^{+0.36} \pm 0.10$		$1.19_{-0.29}^{+0.34}$
103	$Kl^+l^-$	$0.75_{-0.21}^{+0.25} \pm 0.06$	$0.65_{-0.13}^{+0.14} \pm 0.04$	$0.48_{-0.09}^{+0.10} \pm 0.03$	$< 1.7$	$0.54 \pm 0.08$
104	$K^*(892)l^+l^-$	$< 3.3$	$0.88_{-0.29}^{+0.33} \pm 0.10$	$1.15_{-0.24}^{+0.26} \pm 0.08$	$< 3.3$	$1.05_{-0.20}^{+0.21}$
–	$Ke^\pm\mu^\mp$	New			$< 1.6$	$< 1.6$
–	$K^*e^\pm\mu^\mp$	New			$< 6.2$	$< 6.2$
–	$\pi e^\pm\mu^\mp$	New			$< 1.6$	$< 1.6$
–	$\rho e^\pm\mu^\mp$	New			$< 3.2$	$< 3.2$

$\dagger E_\gamma > 2.0 \text{ GeV}$ ;  $\ddagger M(l^+l^-) > 0.2 \text{ GeV}/c^2$

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RPP#	Mode	PDG2002 Avg.	BaBar	Belle	CLEO	CDF	D0	New Avg.
10	$e^+\nu$	< 15		< 5.4	< 15			< 5.4
11	$\mu^+\nu$	< 21	< 6.6	< 6.8	< 21			< 6.6
12	$\tau^+\nu$	< 570	< 410		< 840			< 410
182	$e^+e^-$	< 0.83	< 0.33	< 0.19	< 0.83			< 0.19
183	$\mu^+\mu^-$	< 0.61	< 0.20	< 0.16	< 0.61	< 0.25		< 0.16
189	$e^\pm\mu^\mp$	< 1.5	< 0.21	< 0.17	< 1.5			< 0.17

Compilation of  $B_s$  Leptonic Branching Fractions  
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RPP#	Mode	PDG2002 Avg.	CDF	D0	New Avg.
–	$\mu^+\mu^-$	New	< 0.95	< 1.6	< 0.95

# Radiative and Leptonic Decays:

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