

# Heavy Flavor Averaging Group

## Sept. 2008

### Compilation of $B^+$ Semi-leptonic and Radiative Branching Fractions

All branching fractions are in units of  $10^{-6}$

In PDG2008    New since PDG2008 (preliminary)    New since PDG2008 (published)

RPP#	Mode	PDG2008 Avg.	BABAR	Belle	CLEO	CDF	New Avg.
276	$K^{*+}\gamma$	$40.3 \pm 2.6$	$47.3 \pm 1.5 \pm 1.7$	$42.5 \pm 3.1 \pm 2.4$	$37.6^{+8.9}_{-8.3} \pm 2.8$		$45.7 \pm 1.9$
277	$K_1^+(1270)\gamma$	$43 \pm 13$		$43 \pm 9 \pm 9$			$43 \pm 12$
278	$K^+\eta\gamma$	$9.4 \pm 1.1$	$7.7 \pm 1.0 \pm 0.4$	$8.4^{+1.5}_{-1.2} \pm 0.9$			$7.9 \pm 0.9$
279	$K^+\eta'\gamma$	$< 4.2$	$< 4.2$				$< 4.2$
280	$K^+\phi\gamma$	$3.5 \pm 0.6$	$3.5 \pm 0.6 \pm 0.4$	$3.4 \pm 0.9 \pm 0.4$			$3.5 \pm 0.6$
281	$K^+\pi^-\pi^+\gamma$	$27.6 \pm 2.2$	$29.5 \pm 1.3 \pm 2.0$ †	$25.0 \pm 1.8 \pm 2.2$ ‡			$27.6 \pm 1.8$
282	$K^{*0}\pi^+\gamma$ §	$20^{+7}_{-6}$		$20^{+7}_{-6} \pm 2$			$20^{+7}_{-6}$
283	$K^+\rho^0\gamma$ §	$< 20$		$< 20$			$< 20$
284	$K^+\pi^-\pi^+\gamma$ (N.R.) §	$< 9.2$		$< 9.2$			$< 9.2$
285	$K^0\pi^+\pi^0\gamma$	$46 \pm 5$	$45.6 \pm 4.2 \pm 3.1$ †				$45.6 \pm 5.2$
286	$K_1^+(1400)\gamma$	$< 15$		$< 15$			$< 15$
287	$K_2^*(1430)^+\gamma$	$14 \pm 4$	$14.5 \pm 4.0 \pm 1.5$				$14.5 \pm 4.3$
289	$K_3^*(1780)^+\gamma$	$< 39$		$< 39$			$< 39$
291	$\rho^+\gamma$	$0.98^{+0.25}_{-0.24}$	$1.20^{+0.42}_{-0.37} \pm 0.20$	$0.87^{+0.29+0.09}_{-0.27-0.11}$	$< 13$		$0.98^{+0.25}_{-0.24}$
338	$p\bar{\Lambda}\gamma$	$2.5^{+0.5}_{-0.4}$		$2.45^{+0.44}_{-0.38} \pm 0.22$			$2.45^{+0.49}_{-0.44}$
342	$p\bar{\Sigma}^0\gamma$	$< 4.6$		$< 4.6$			$< 4.6$
367	$\pi^+\ell^+\ell^-$	$< 0.12$	$< 0.12$	$< 0.049$			$< 0.049$
368	$\pi^+e^+e^-$	$< 0.18$	$< 0.18$	$< 0.080$			$< 0.080$
369	$\pi^+\mu^+\mu^-$	$< 0.28$	$< 0.28$	$< 0.069$			$< 0.069$
370	$\pi^+\nu\bar{\nu}$	$< 100$	$< 100$	$< 170$			$< 100$
371	$K^+\ell^+\ell^-$	$0.44^{+0.08}_{-0.07}$	$0.38^{+0.09}_{-0.08} \pm 0.02$	$0.53^{+0.06}_{-0.05} \pm 0.03$			$0.49 \pm 0.05$
372	$K^+e^+e^-$	$0.49 \pm 0.1$	$0.42^{+0.12}_{-0.11} \pm 0.02$	$0.57^{+0.09}_{-0.08} \pm 0.03$	$< 2.4$		$0.52 \pm 0.07$
373	$K^+\mu^+\mu^-$	$0.39^{+0.10}_{-0.09}$	$0.31^{+0.15}_{-0.12} \pm 0.03$	$0.53 \pm 0.08^{+0.07}_{-0.03}$	$< 3.68$	$0.59 \pm 0.15 \pm 0.04$	$0.50^{+0.07}_{-0.06}$
374	$K^+\nu\bar{\nu}$	$< 14$	$< 52$	$< 14$	$< 240$		$< 14$
375	$\rho^+\nu\bar{\nu}$	$< 150$		$< 150$			$< 150$
376	$K^{*+}\ell^+\ell^-$	$0.7 \pm 0.5$	$0.73^{+0.50}_{-0.42} \pm 0.21$	$1.24^{+0.23}_{-0.20} \pm 0.12$			$1.15^{+0.23}_{-0.21}$
377	$K^{*+}\nu\bar{\nu}$	$< 140$	$< 80$	$< 140$			$< 80$
378	$K^{*+}e^+e^-$	$0.8 \pm 0.8$	$0.75^{+0.76}_{-0.65} \pm 0.38$	$1.64^{+0.50}_{-0.42} \pm 0.18$			$1.42^{+0.43}_{-0.39}$
379	$K^{*+}\mu^+\mu^-$	$0.8^{+0.6}_{-0.4}$	$0.97^{+0.94}_{-0.69} \pm 0.14$	$1.14^{+0.32}_{-0.27} \pm 0.10$			$1.12^{+0.32}_{-0.27}$
382	$\pi^+e^\pm\mu^\mp$	$< 0.17$	$< 0.17$				$< 0.17$
383	$K^+e^+\mu^-$	$< 0.091$	$< 0.09$				$< 0.09$
384	$K^+e^-\mu^+$	$< 0.13$	$< 0.13$				$< 0.13$
386	$K^+\tau^\pm\mu^\mp$	$< 77$	$< 77$				$< 77$
389	$K^{*+}e^\pm\mu^\mp$	$< 1.4$	$< 1.4$				$< 1.4$
390	$\pi^-e^+e^+$	$< 1.6$			$< 1.6$		$< 1.6$
391	$\pi^-\mu^+\mu^+$	$< 1.4$			$< 1.4$		$< 1.4$
392	$\pi^-e^+\mu^+$	$< 1.3$			$< 1.3$		$< 1.3$
393	$\rho^-e^+e^+$	$< 2.6$			$< 2.6$		$< 2.6$
394	$\rho^-\mu^+\mu^+$	$< 5.0$			$< 5.0$		$< 5.0$
395	$\rho^-e^+\mu^+$	$< 3.3$			$< 3.3$		$< 3.3$
396	$K^-e^+e^+$	$< 1.0$			$< 1.0$		$< 1.0$
397	$K^-\mu^+\mu^+$	$< 1.8$			$< 1.8$		$< 1.8$
398	$K^-e^+\mu^+$	$< 2.0$			$< 2.0$		$< 2.0$
399	$K^{*-}e^+e^+$	$< 2.8$			$< 2.8$		$< 2.8$
400	$K^{*-}\mu^+\mu^+$	$< 8.3$			$< 8.3$		$< 8.3$
401	$K^{*-}e^+\mu^+$	$< 4.4$			$< 4.4$		$< 4.4$

†  $M_{K\pi\pi} < 1.8 \text{ GeV}/c^2$ ; ‡  $1.0 < M_{K\pi\pi} < 2.0 \text{ GeV}/c^2$ ; §  $M_{K\pi\pi} < 2.4 \text{ GeV}/c^2$

Heavy Flavor Averaging Group  
Sept. 2008

Compilation of  $B^0$  Semi-leptonic and Radiative Branching Fractions  
All branching fractions are in units of  $10^{-6}$

In PDG2008    New since PDG2008 (preliminary)    New since PDG2008 (published)

RPP#	Mode	PDG2008 Avg.	BABAR	Belle	CLEO	CDF	New Avg.
266	$K^{*0}\gamma$	$40.1 \pm 2.0$	<span style="color: blue;"><math>45.8 \pm 1.0 \pm 1.6</math></span>	$40.1 \pm 2.1 \pm 1.7$	$45.5^{+7.2}_{-6.8} \pm 3.4$		$44.0 \pm 1.5$
267	$K^0\eta\gamma$	$10.7^{+2.2}_{-1.5}$	<span style="color: blue;"><math>7.1^{+2.1}_{-2.0} \pm 0.4</math></span>	$8.7^{+3.1+1.9}_{-2.7-1.6}$			$7.6^{+1.8}_{-1.7}$
268	$K^0\eta'\gamma$	$< 6.6$	$< 6.6$				$< 6.6$
269	$K^0\phi\gamma$	$< 2.7$	$< 2.7$	$< 8.3$			$< 2.7$
270	$K^+\pi^-\gamma$ §	$4.6 \pm 1.4$		$4.6^{+1.3+0.5}_{-1.2-0.7}$			$4.6 \pm 1.4$
271	$K^*(1410)^0\gamma$	$< 130$		$< 130$			$< 130$
272	$K^+\pi^-\gamma$ (N.R.) §	$< 2.6$		$< 2.6$			$< 2.6$
273	$K^0\pi^+\pi^-\gamma$	$19.5 \pm 2.2$	$18.5 \pm 2.1 \pm 1.2$ †	$24 \pm 4 \pm 3$ ‡			$19.5 \pm 2.2$
274	$K^+\pi^-\pi^0\gamma$	$41 \pm 4$	$40.7 \pm 2.2 \pm 3.1$ †				$40.7 \pm 3.8$
275	$K_1^0(1270)\gamma$	$< 58$		$< 58$			$< 58$
276	$K_1^0(1400)\gamma$	$< 15$		$< 15$			$< 15$
277	$K_2^*(1430)^0\gamma$	$12.4 \pm 2.4$	$12.2 \pm 2.5 \pm 1.0$	$13 \pm 5 \pm 1$			$12.4 \pm 2.4$
279	$K_3^*(1780)^0\gamma$	$< 83$		$< 83$			$< 83$
281	$\rho^0\gamma$	$0.93 \pm 0.21$	<span style="color: blue;"><math>0.97^{+0.24}_{-0.22} \pm 0.06</math></span>	<span style="color: blue;"><math>0.78^{+0.17+0.09}_{-0.16-0.10}</math></span>	$< 17$		$0.86^{+0.15}_{-0.14}$
282	$\omega\gamma$	$0.46^{+0.20}_{-0.17}$	<span style="color: blue;"><math>0.50^{+0.27}_{-0.23} \pm 0.09</math></span>	<span style="color: blue;"><math>0.40^{+0.19}_{-0.17} \pm 0.13</math></span>	$< 9.2$		$0.44^{+0.18}_{-0.16}$
283	$\phi\gamma$	$< 0.85$	$< 0.85$		$< 3.3$		$< 0.85$
372	$\pi^0\ell^+\ell^-$	$< 0.12$	$< 0.12$	<span style="color: red;"><math>&lt; 0.154</math></span>			$< 0.12$
373	$\pi^0\nu\bar{\nu}$	$< 220$		$< 220$			$< 220$
374	$\pi^0e^+e^-$	$< 0.14$	$< 0.14$	<span style="color: red;"><math>&lt; 0.227</math></span>			$< 0.14$
375	$\pi^0\mu^+\mu^-$	$< 0.51$	$< 0.51$	<span style="color: red;"><math>&lt; 0.184</math></span>			$< 0.184$
379	$K^0e^+e^-$	$0.13^{+0.16}_{-0.11}$	$0.13^{+0.16}_{-0.11} \pm 0.02$	<span style="color: blue;"><math>0.20^{+0.14}_{-0.10} \pm 0.01</math></span>	$< 8.45$		$0.17^{+0.11}_{-0.08}$
380	$K^0\mu^+\mu^-$	$0.57^{+0.22}_{-0.18}$	$0.59^{+0.33}_{-0.26} \pm 0.07$	<span style="color: blue;"><math>0.43^{+0.13}_{-0.10} \pm 0.02</math></span>	$< 6.64$		$0.45^{+0.13}_{-0.10}$
376	$K^0\ell^+\ell^-$	$0.29^{+0.16}_{-0.13}$	$0.29^{+0.16}_{-0.13} \pm 0.03$	<span style="color: blue;"><math>0.33^{+0.09}_{-0.07} \pm 0.02</math></span>			$0.32^{+0.08}_{-0.06}$
377	$K^0\nu\bar{\nu}$	$< 160$		$< 160$			$< 160$
378	$\rho^0\nu\bar{\nu}$	$< 440$		$< 440$			$< 440$
382	$K^{*0}e^+e^-$	$1.04^{+0.35}_{-0.31}$	$1.04^{+0.33}_{-0.29} \pm 0.11$	<span style="color: blue;"><math>1.18^{+0.26}_{-0.21} \pm 0.09</math></span>			$1.13^{+0.21}_{-0.18}$
382	$K^{*0}\mu^+\mu^-$	$1.10^{+0.29}_{-0.26}$	$0.87^{+0.38}_{-0.33} \pm 0.12$	<span style="color: blue;"><math>1.08^{+0.19}_{-0.15} \pm 0.07</math></span>		<span style="color: blue;"><math>0.81 \pm 0.30 \pm 0.10</math></span>	$1.00^{+0.15}_{-0.13}$
384	$K^{*0}\nu\bar{\nu}$	$< 340$	$< 120$	$< 340$			$< 120$
381	$K^{*0}\ell^+\ell^-$	$0.95 \pm 0.18$	$0.81^{+0.21}_{-0.19} \pm 0.09$	<span style="color: blue;"><math>0.98^{+0.13}_{-0.11} \pm 0.07</math></span>			$0.93^{+0.12}_{-0.11}$
385	$\phi\nu\bar{\nu}$	$< 58$		$< 58$			$< 58$
387	$\pi^0e^\pm\mu^\mp$	$< 0.14$	$< 0.14$				$< 0.14$
388	$K^0e^\pm\mu^\pm$	$< 0.27$	$< 0.27$				$< 0.27$
391	$K^{*0}e^\pm\mu^\pm$	$< 3.4$	$< 0.58$				$< 0.58$

†  $M_{K\pi\pi} < 1.8 \text{ GeV}/c^2$ ; ‡  $1.0 < M_{K\pi\pi} < 2.0 \text{ GeV}/c^2$ ; §  $1.25 \text{ GeV}/c^2 < M_{K\pi} < 1.6 \text{ GeV}/c^2$

Heavy Flavor Averaging Group  
Sept. 2008

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

In PDG208    New since PDG2008 (preliminary)    New since PDG2008 (published)

RPP#	Mode	PDG2008 Avg.	BABAR	Belle	CLEO	New Avg.
63	$K\eta\gamma$	$8.5^{+1.6}_{-1.5}$		$8.5^{+1.3}_{-1.2} \pm 0.9$		$8.5^{+1.6}_{-1.5}$
65	$K_2^*(1430)\gamma$	$1.7^{+0.6}_{-0.5}$			$1.7 \pm 0.6 \pm 0.1$	$1.7 \pm 0.6$
73	$K_3^*(1780)\gamma$	$< 37$		$< 2.8$		$< 2.8$
74	$s\gamma$	$356 \pm 25$	$327 \pm 18^{+55}_{-41}$	$325 \pm 16 \pm 24$	$321 \pm 43^{+32}_{-29}$	$352 \pm 23 \pm 9$
–	$s\gamma$ with baryons	New			$< 38 \dagger$	$< 38 \dagger$
78	$\rho\gamma$	$1.36 \pm 0.30$	$1.73^{+0.34}_{-0.32} \pm 0.17$	$1.21^{+0.24}_{-0.22} \pm 0.12$	$< 14$	$1.39^{+0.22}_{-0.21}$
79	$\rho/\omega\gamma$	$1.28 \pm 0.21$	$1.63^{+0.30}_{-0.28} \pm 0.16$	$1.14 \pm 0.20^{+0.10}_{-0.12}$	$< 14$	$1.30^{+0.18}_{-0.19}$
109	$se^+e^- \ddagger$	$4.7 \pm 1.3$	$6.0 \pm 1.7 \pm 1.3$	$4.0 \pm 1.3^{+0.9}_{-0.8}$	$< 57$	$4.7 \pm 1.3$
110	$s\mu^+\mu^-$	$4.3 \pm 1.2$	$5.0 \pm 2.8 \pm 1.2$	$4.1 \pm 1.1^{+0.9}_{-0.8}$	$< 58$	$4.3^{+1.3}_{-1.2}$
111	$s\ell^+\ell^- \ddagger$	$4.5 \pm 1.0$	$5.6 \pm 1.5 \pm 1.3$	$4.11 \pm 0.83^{+0.85}_{-0.81}$	$< 42$	$4.50^{+1.03}_{-1.01}$
112	$\pi\ell^+\ell^-$	$< 0.091$	$< 0.091$	$< 0.062$		$< 0.062$
113	$Ke^+e^-$	$0.38^{+0.08}_{-0.07}$	$0.33^{+0.09}_{-0.08} \pm 0.02$	$0.48^{+0.08}_{-0.07} \pm 0.02$		$0.42 \pm 0.06$
114	$K^*e^+e^-$	$1.13 \pm 0.27$	$0.97^{+0.30}_{-0.27} \pm 0.14$	$1.37^{+0.23}_{-0.18} \pm 0.12$		$1.24^{+0.19}_{-0.17}$
115	$K\mu^+\mu^-$	$0.42^{+0.09}_{-0.08}$	$0.35^{+0.13}_{-0.11} \pm 0.03$	$0.50 \pm 0.06 \pm 0.03$		$0.47 \pm 0.06$
116	$K^*\mu^+\mu^-$	$1.03^{+0.26}_{-0.23}$	$0.88^{+0.35}_{-0.30} \pm 0.12$	$1.12^{+0.16}_{-0.14} \pm 0.08$		$1.08^{+0.16}_{-0.14}$
117	$K\ell^+\ell^-$	$0.39 \pm 0.07$	$0.34 \pm 0.07 \pm 0.02$	$0.48^{+0.05}_{-0.04} \pm 0.03$	$< 1.7$	$0.43 \pm 0.04$
118	$K^*\ell^+\ell^-$	$0.94 \pm 0.18$	$0.78^{+0.19}_{-0.17} \pm 0.11$	$1.08 \pm 0.10 \pm 0.09$	$< 3.3$	$1.00 \pm 0.11$
–	$K^*\nu\bar{\nu}$	New	$< 80$			$< 80$
120	$\pi e^\pm\mu^\mp$	$< 0.092$	$< 0.092$		$< 1.6$	$< 0.092$
121	$\rho e^\pm\mu^\mp$	$< 3.2$			$< 3.2$	$< 3.2$
122	$Ke^\pm\mu^\mp$	$< 0.038$	$< 0.038$		$< 1.6$	$< 0.038$
123	$K^*e^\pm\mu^\mp$	$< 0.51$	$< 0.51$		$< 6.2$	$< 0.51$

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

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Compilation of  $B$  Inclusive Branching Fractions  
All branching fractions are in units of  $10^{-6}$

In PDG2008

New since PDG2008 (preliminary)

New since PDG2008 (published)

RPP#	Mode	PDG2008 Avg.	BABAR	Belle	CLEO	New Avg.
–	$K^+ X$	New	$196^{+37+31}_{-34-30} \dagger$			$196^{+48}_{-45}$
–	$K^0 X$	New	$154^{+55+55}_{-48-41} \dagger$			$154^{+77}_{-63}$

$\dagger p^* > 2.34$  GeV

Heavy Flavor Averaging Group  
Sept. 2008

Compilation of  $B$  Leptonic Branching Fractions  
All branching fractions are in units of  $10^{-6}$

In PDG2008

New since PDG2008 (preliminary)

New since PDG2008 (published)

RPP#	Mode	PDG2008 Avg.	BABAR	Belle	CLEO	CDF	DØ	New Avg.
24	$e^+ \nu$	$< 9.8$	$< 5.2$	$< 1.0$	$< 15$			$< 1.0$
25	$\mu^+ \nu$	$< 1.7$	$< 1.3$	$< 1.7$	$< 21$			$< 1.3$
26	$\tau^+ \nu$	$140 \pm 40$	$120 \pm 40 \pm 36$	$170 \pm 42$	$< 840$			$151 \pm 33$
27	$e^+ \nu_e \gamma$	$< 200$			$< 200$			$< 200$
28	$\mu^+ \nu_\mu \gamma$	$< 52$			$< 52$			$< 52$
366	$\gamma \gamma$	$< 0.62$	$< 1.7$	$< 0.62$				$< 0.62$
367	$e^+ e^-$	$< 0.113$	$< 0.113$	$< 0.19$	$< 0.83$	$< 0.083$		$< 0.083$
368	$e^+ e^- \gamma$	$< 0.12$	$< 0.12$					$< 0.12$
369	$\mu^+ \mu^-$	$< 0.015$	$< 0.052$	$< 0.16$	$< 0.61$	$< 0.015$		$< 0.015$
370	$\mu^+ \mu^- \gamma$	$< 0.16$	$< 0.16$					$< 0.16$
371	$\tau^+ \tau^-$	$< 4100$	$< 4100$					$< 4100$
386	$e^\pm \mu^\mp$	$< 0.092$	$< 0.092$	$< 0.17$	$< 1.5$	$< 0.064$		$< 0.064$
392	$e^\pm \tau^\mp$	$< 110$	$< 28$		$< 110$			$< 28$
393	$\mu^\pm \tau^\mp$	$< 38$	$< 22$		$< 38$			$< 22$
394	$\nu \bar{\nu}$	$< 220$	$< 220$					$< 220$
395	$\nu \bar{\nu} \gamma$	$< 47$	$< 47$					$< 47$

# Radiative and Leptonic Decays:

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