Heavy Flavor Averaging Group
August 2014

Compilation of B_s Rare Branching Fractions
All branching fractions are in units of 10^{-6}

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

RPP#	Mode	PDG2014 Avg.	Belle	CDF	D0	LHCb	CMS	ATLAS	New Avg.
45	$\pi^+\pi^-$	0.76 ± 0.19	< 12	$0.60 \pm 0.17 \pm 0.04$ ‡		$0.98^{+0.23}_{-0.19} \pm 0.07$ ‡			0.76 ± 0.13
51	$\phi\phi$	19.1 ± 3.1		$19.1 \pm 2.6 \pm 1.6$ ‡					19.1 ± 3.1
52	π^+K^-	5.5 ± 0.6	< 26	$5.3 \pm 0.9 \pm 0.3$ ‡		$5.6 \pm 0.6 \pm 0.3$ ‡			5.5 ± 0.5
53	K^+K^-	24.9 ± 1.7	$38^{+10}_{-9} \pm 7$	$25.9 \pm 2.2 \pm 1.7$ ‡		$23.7 \pm 1.6 \pm 1.5$ ‡			24.8 ± 1.7
54	$K^0\overline{K}^0$	< 66	< 66						< 66
55	$K^0\pi^+\pi^-$	19 ± 5				$19 \pm 5 \pm 2$ ‡			19 ± 5
56	$K^0K^-\pi^+$	97 ± 17				$97 \pm 12 \pm 12$ ‡			97 ± 16
57	$K^0K^+K^-$	< 4				< 4 ‡			< 4 ‡
–	$K^{*-}K^+$	New				$12.7 \pm 1.9 \pm 1.9$ †			12.7 ± 2.7
–	$K^{*-}\pi^+$	New				$3.3 \pm 1.1 \pm 0.5$ †			3.3 ± 1.2
59	$K^{*0}\overline{K}^{*0}$	$28.1 \pm 4.6 \pm 5.6$				$28.1 \pm 4.6 \pm 5.6$ †			28.1 ± 7.2
60	$\phi\overline{K}^{*0}$	1.13 ± 0.3				$1.13 \pm 0.29 \pm 0.06$ ‡			1.13 ± 0.30
61	$p\overline{p}$	$0.028^{+0.022}_{-0.017}$				$0.0284^{+0.0203+0.0085}_{-0.0168-0.0018}$ †			$0.0280^{+0.0220}_{-0.0170}$
63	$\gamma\gamma$	< 8.7	< 8.7						< 8.7
64	$\phi\gamma$	36 ± 4	57^{+18+12}_{-15-11}			$35.1 \pm 3.5 \pm 1.2$ ‡			35.9 ± 3.6
65	$\mu^+\mu^-$	0.0031 ± 0.0007		$0.013^{+0.009}_{-0.007}$ †	< 0.012 †	$0.0029^{+0.0011+0.0003}_{-0.0010-0.0001}$ †	$0.0030^{+0.0010}_{-0.0009}$ †	< 0.019 †	0.0031 ± 0.0007
65	$\mu^+\mu^-$	CMS-LHCb comb.				$0.0028^{+0.0007}_{-0.0006}$	$0.0028^{+0.0007}_{-0.0006}$		
66	e^+e^-	< 0.28		< 0.28					< 0.28
67	$e^\pm\mu^\mp$	< 0.011		< 0.20		< 0.011 †			< 0.011 †
68	$\mu^+\mu^-\mu^+\mu^-$	< 0.012				< 0.012			< 0.012
70	$\phi\mu^+\mu^-$	0.76 ± 0.15		$1.17 \pm 0.18 \pm 0.37$ †	< 3.2 †	$0.707^{+0.064}_{-0.059} \pm 0.073$ †			$0.731^{+0.095}_{-0.092}$

‡ Original experimental relative BF multiplied by the best values (PDG2014) of reference BF. The first error is experimental, the second is from reference BF.

† Relative BF converted to absolute BF.

Heavy Flavor Averaging Group
August 2014

Compilation of B_s Rare Relative Branching Fractions (UL 90% CL)

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

RPP#	Mode	PDG2014 Avg.	CDF	LHCb	New Avg.
45	$f_s\mathcal{B}(B_s^0 \to \pi^+\pi^-)/f_d\mathcal{B}(B^0 \to K^+\pi^-)$		$0.008 \pm 0.002 \pm 0.001$		0.008 ± 0.002
45	$f_s\mathcal{B}(B_s^0 \to \pi^+\pi^-)/f_d\mathcal{B}(B^0 \to \pi^+\pi^-)$			$0.050^{+0.011}_{-0.009} \pm 0.004$	$0.050^{+0.012}_{-0.010}$
51	$\mathcal{B}(B_s^0 \to \phi\phi)/\mathcal{B}(B_s^0 \to J/\psi\phi)$		$0.0178 \pm 0.0014 \pm 0.0020$		0.0180 ± 0.0020
52	$f_s\mathcal{B}(B_s^0 \to K^+\pi^-)/f_d\mathcal{B}(B_d^0 \to K^+\pi^-)$		$0.071 \pm 0.010 \pm 0.007$	$0.074 \pm 0.006 \pm 0.006$	0.073 ± 0.007
53	$f_s\mathcal{B}(B_s^0 \to K^+K^-)/f_d\mathcal{B}(B_d^0 \to K^+\pi^-)$		$0.347 \pm 0.020 \pm 0.021$	$0.316 \pm 0.009 \pm 0.019$	0.327 ± 0.017
55	$f_s\mathcal{B}(B_s^0 \to K^0\pi^+\pi^-)/f_d\mathcal{B}(B^0 \to K^0\pi^+\pi^-)$			$0.29 \pm 0.06 \pm 0.04$	0.29 ± 0.07
56	$f_s\mathcal{B}(B_s^0 \to K^0K^-\pi^+)/f_d\mathcal{B}(B^0 \to K^0K^-\pi^+)$			$1.48 \pm 0.12 \pm 0.14$	1.48 ± 0.18
57	$f_s\mathcal{B}(B_s^0 \to K^0K^+K^-)/f_d\mathcal{B}(B^0 \to K^0K^+K^-)$			< 0.068	< 0.068
–	$\mathcal{B}(B_s^0 \to K^{*-}K^+)/\mathcal{B}(B^0 \to K^{*+}\pi^-)$	New		$1.49 \pm 0.22 \pm 0.18$	1.49 ± 0.28
–	$\mathcal{B}(B_s^0 \to K^{*-}\pi^+)/\mathcal{B}(B^0 \to K^{*+}\pi^-)$	New		$0.39 \pm 0.13 \pm 0.05$	0.39 ± 0.14
60	$\mathcal{B}(B_s^0 \to \phi\overline{K}^{*0})/\mathcal{B}(B^0 \to \phi\overline{K}^{*0})$			$0.113 \pm 0.024 \pm 0.016$	0.113 ± 0.029
64	$\mathcal{B}(B_s^0 \to \phi\gamma)/\mathcal{B}(B^0 \to K^{*0}\gamma)$			$0.81 \pm 0.04 \pm 0.07$	0.81 ± 0.08
70	$\mathcal{B}(B_s^0 \to \phi\mu^+\mu^-)/\mathcal{B}(B_s^0 \to J/\psi\phi) \times 10^3$	0.71 ± 0.13	$0.90 \pm 0.14 \pm 0.07$	$0.674^{+0.061}_{-0.056} \pm 0.016$	$0.704^{+0.060}_{-0.056}$

Heavy Flavor Averaging Group
August 2014
Partial Branching Fraction ($d\mathcal{B}$) in $B_s \to \phi\mu^+\mu^-$

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

All branching fractions are in units of 10^{-7}

Mode	q^2 $[(\mathrm{GeV}/c^2)^2]$	PDG2014 Avg.	CDF	LHCb	New Avg.
$\phi\mu^+\mu^-$	< 2.0 †	0.93 ± 0.21	$3.16 \pm 0.92 \pm 1.00$	$0.90^{+0.21}_{-0.19} \pm 0.10$	$0.96^{+0.23}_{-0.22}$
	$[2.0, 4.3]$	$0.55^{+0.18}_{-0.16}$	$0.27 \pm 0.41 \pm 0.09$	$0.53^{+0.18}_{-0.16} \pm 0.06$	$0.49^{+0.17}_{-0.16}$
	$[4.3, 8.68]$	1.40 ± 0.26	$0.64 \pm 0.68 \pm 0.20$	$1.38^{+0.25}_{-0.23} \pm 0.15$	$1.28^{+0.26}_{-0.25}$
	$[10.09, 12.86]$	1.22 ± 0.25	$2.25 \pm 0.69 \pm 0.71$	$1.20^{+0.23}_{-0.21} \pm 0.14$	$1.27^{+0.26}_{-0.25}$
	$[14.18, 16.00]$	0.80 ± 0.20	$1.11 \pm 0.42 \pm 0.35$	$0.76^{+0.19}_{-0.17} \pm 0.09$	$0.80^{+0.20}_{-0.18}$
	> 16.00 †	1.08 ± 0.24	$2.31 \pm 0.59 \pm 0.73$	$1.06^{+0.23}_{-0.21} \pm 0.12$	$1.14^{+0.25}_{-0.24}$
	$[1.00, 6.00]$	1.15 ± 0.25	$1.03 \pm 0.70 \pm 0.33$	$1.14^{+0.25}_{-0.23} \pm 0.13$	$1.13^{+0.26}_{-0.25}$

† See the references for the exact q^2 interval, which very slightly differs between experiments.

Heavy Flavor Averaging Group
August 2014
$B_s \to \phi\mu^+\mu^-$ F_L

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

Mode	q^2 $[(\mathrm{GeV}/c^2)^2]$	PDG2014 Avg.	LHCb	New Avg.
$\phi\mu^+\mu^-$	$0.1 - 2.0$	$0.37^{+0.19}_{-0.17} \pm 0.07$	$0.37^{+0.19}_{-0.17} \pm 0.07$	$0.37^{+0.20}_{-0.18}$
	$[2.0, 4.3]$	$0.53^{+0.25}_{-0.23} \pm 0.10$	$0.53^{+0.25}_{-0.23} \pm 0.10$	$0.53^{+0.27}_{-0.25}$
	$[4.3, 8.68]$	$0.81^{+0.11}_{-0.13} \pm 0.05$	$0.81^{+0.11}_{-0.13} \pm 0.05$	$0.81^{+0.12}_{-0.14}$
	$[10.09, 12.86]$	$0.33^{+0.14}_{-0.12} \pm 0.06$	$0.33^{+0.14}_{-0.12} \pm 0.06$	$0.33^{+0.15}_{-0.13}$
	$[14.18, 16.00]$	$0.34^{+0.18}_{-0.17} \pm 0.07$	$0.34^{+0.18}_{-0.17} \pm 0.07$	$0.34^{+0.19}_{-0.18}$
	$16.00 - 19.00$	$0.16^{+0.17}_{-0.10} \pm 0.07$	$0.16^{+0.17}_{-0.10} \pm 0.07$	$0.16^{+0.18}_{-0.12}$
	$[1.00, 6.00]$	$0.56^{+0.17}_{-0.16} \pm 0.09$	$0.56^{+0.17}_{-0.16} \pm 0.09$	$0.56^{+0.19}_{-0.18}$

Heavy Flavor Averaging Group
August 2014
$B_s \to \phi\mu^+\mu^-$ S_3

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

Mode	q^2 $[(\mathrm{GeV}/c^2)^2]$ †	PDG2014 Avg.	LHCb	New Avg.
$\phi\mu^+\mu^-$	$0.1 - 2.0$		$-0.11^{+0.28}_{-0.25} \pm 0.05$	$-0.11^{+0.28}_{-0.26}$
	$[2.0, 4.3]$		$-0.97^{+0.53}_{-0.03} \pm 0.17$	$-0.97^{+0.56}_{-0.17}$
	$[4.3, 8.68]$		$0.25^{+0.21}_{-0.24} \pm 0.05$	$0.25^{+0.22}_{-0.24}$
	$[10.09, 12.86]$		$0.24^{+0.27}_{-0.25} \pm 0.06$	$0.24^{+0.28}_{-0.26}$
	$[14.18, 16.00]$		$-0.03^{+0.29}_{-0.31} \pm 0.06$	$-0.03^{+0.30}_{-0.32}$
	$16.00 - 19.00$		$0.19^{+0.30}_{-0.31} \pm 0.05$	$0.19^{+0.30}_{-0.31}$
	$[1.00, 6.00]$		$-0.21^{+0.24}_{-0.22} \pm 0.08$	$-0.21^{+0.25}_{-0.23}$

Heavy Flavor Averaging Group

August 2014

$B_s \to \phi\mu^+\mu^-$ A_6

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

Mode	q^2 $[(\mathrm{GeV}/c^2)^2]$	PDG2014 Avg.	LHCb	New Avg.
$\phi\mu^+\mu^-$	$0.1 - 2.0$		$0.04^{+0.27}_{-0.32} \pm 0.12$	$0.04^{+0.29}_{-0.34}$
	$[2.0, 4.3]$		$0.47^{+0.39}_{-0.42} \pm 0.14$	$0.47^{+0.41}_{-0.44}$
	$[4.3, 8.68]$		$-0.02^{+0.20}_{-0.21} \pm 0.10$	$-0.02^{+0.22}_{-0.23}$
	$[10.09, 12.86]$		$-0.06^{+0.20}_{-0.20} \pm 0.08$	-0.06 ± 0.21
	$[14.18, 16.00]$		$-0.06^{+0.30}_{-0.30} \pm 0.08$	-0.06 ± 0.31
	$16.00 - 19.00$		$0.26^{+0.22}_{-0.24} \pm 0.08$	$0.26^{+0.23}_{-0.25}$
	$[1.00, 6.00]$		$0.20^{+0.29}_{-0.27} \pm 0.07$	$0.20^{+0.30}_{-0.28}$

Heavy Flavor Averaging Group
August 2014
$B_s \to \phi\mu^+\mu^-$ A_9

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

Mode	q^2 $[(\mathrm{GeV}/c^2)^2]$	PDG2014 Avg.	LHCb	New Avg.
$\phi\mu^+\mu^-$	$0.1 - 2.0$		$-0.16^{+0.30}_{-0.27} \pm 0.09$	$-0.16^{+0.31}_{-0.28}$
	$[2.0, 4.3]$		$-0.40^{+0.52}_{-0.35} \pm 0.11$	$-0.40^{+0.53}_{-0.37}$
	$[4.3, 8.68]$		$-0.13^{+0.27}_{-0.26} \pm 0.10$	$-0.13^{+0.29}_{-0.28}$
	$[10.09, 12.86]$		$0.29^{+0.25}_{-0.26} \pm 0.10$	$0.29^{+0.27}_{-0.28}$
	$[14.18, 16.00]$		$0.24^{+0.36}_{-0.35} \pm 0.12$	$0.24^{+0.38}_{-0.37}$
	$16.00 - 19.00$		$0.27^{+0.31}_{-0.28} \pm 0.11$	$0.27^{+0.33}_{-0.30}$
	$[1.00, 6.00]$		$-0.30^{+0.30}_{-0.29} \pm 0.11$	$-0.30^{+0.32}_{-0.31}$

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