

Heavy Flavor Averaging Group - October 2016

Measurements of the longitudinal polarization fraction (f_L) in B^+ decays

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

RPP#	Mode	PDG2014 Avg.	BABAR	Belle	Our Avg.
282	ωK^{*+}	$0.41 \pm 0.18 \pm 0.05$	$0.41 \pm 0.18 \pm 0.05$		0.41 ± 0.19
285	$\omega K_2^*(1430)^+$	$0.56 \pm 0.10 \pm 0.04$	$0.56 \pm 0.10 \pm 0.04$		0.56 ± 0.11
312	$K^{*+} \rho^0$	$0.78 \pm 0.12 \pm 0.03$	$0.78 \pm 0.12 \pm 0.03$		0.78 ± 0.12
316	$K^{*0} \rho^+$	0.48 ± 0.08	$0.52 \pm 0.10 \pm 0.04$	$0.43 \pm 0.11^{+0.05}_{-0.02}$	0.48 ± 0.08
338	$K^{*+} \bar{K}^{*0}$	$0.75^{+0.16}_{-0.26} \pm 0.03$	$0.75^{+0.16}_{-0.26} \pm 0.03$		$0.75^{+0.16}_{-0.26}$
349	ϕK^{*+}	0.50 ± 0.05	$0.49 \pm 0.05 \pm 0.03$	$0.52 \pm 0.08 \pm 0.03$	0.50 ± 0.05
351	$\phi K_1(1270)^+$	$0.46^{+0.12+0.06}_{-0.13-0.07}$	$0.46^{+0.12+0.06}_{-0.13-0.07}$		$0.46^{+0.13}_{-0.15}$
355	$\phi K_2^*(1430)^+$	$0.80^{+0.09}_{-0.10} \pm 0.03$	$0.80^{+0.09}_{-0.10} \pm 0.03$		0.80 ± 0.10
391	$\rho^+ \rho^0$	0.950 ± 0.016	$0.950 \pm 0.015 \pm 0.006$	$0.95 \pm 0.11 \pm 0.02$	0.950 ± 0.016
396	$\omega \rho^+$	$0.90 \pm 0.05 \pm 0.03$	$0.90 \pm 0.05 \pm 0.03$		0.90 ± 0.06

Heavy Flavor Averaging Group - October 2016

Measurements of the longitudinal polarization fraction (f_L) in B^0 decays
 In PDG2014 New since PDG2014 (preliminary) New since PDG2014 (published)

RPP#	Mode	PDG2014 Avg.	BABAR	Belle	LHCb	Our Avg.
246	ωK^{*0}	0.69 ± 0.13	$0.72 \pm 0.14 \pm 0.02$	$0.56 \pm 0.29^{+0.18}_{-0.08}$		0.70 ± 0.13
249	$\omega K_2^*(1430)^0$	$0.45 \pm 0.12 \pm 0.02$	$0.45 \pm 0.12 \pm 0.02$			0.45 ± 0.12
279	$\bar{K}^{*0} \rho^0$	$0.40 \pm 0.08 \pm 0.11$	$0.40 \pm 0.08 \pm 0.11$			0.40 ± 0.14
284	$K^{*+} \rho^-$	$0.38 \pm 0.13 \pm 0.03$	$0.38 \pm 0.13 \pm 0.03$			0.38 ± 0.13
312	ϕK^{*0}	0.497 ± 0.025	$0.494 \pm 0.034 \pm 0.013$	$0.499 \pm 0.030 \pm 0.018$	$0.497 \pm 0.019 \pm 0.015$	0.497 ± 0.017
315	$K^{*0} \bar{K}^{*0}$	$0.80^{+0.10}_{-0.12} \pm 0.06$	$0.80^{+0.10}_{-0.12} \pm 0.06$			$0.80^{+0.12}_{-0.13}$
333	$\phi K_2^*(1430)^0$	$0.901^{+0.046}_{-0.058} \pm 0.037$	$0.901^{+0.046}_{-0.058} \pm 0.037$			$0.901^{+0.059}_{-0.069}$
386	$\rho^0 \rho^0$	$0.75^{+0.11}_{-0.14} \pm 0.05$	$0.75^{+0.11}_{-0.14} \pm 0.05$	$0.21^{+0.18}_{-0.22} \pm 0.15$	$0.745^{+0.048}_{-0.058} \pm 0.034$	$0.714^{+0.055}_{-0.062}$
394	$\rho^+ \rho^-$	$0.977^{+0.028}_{-0.024}$	$0.992 \pm 0.024^{+0.026}_{-0.013}$	$0.941^{+0.034}_{-0.040} \pm 0.030$		$0.978^{+0.025}_{-0.022}$
405	$a_1^\pm a_1^\mp$	$0.31 \pm 0.22 \pm 0.10$	$0.31 \pm 0.22 \pm 0.10$			0.31 ± 0.24

Heavy Flavor Averaging Group - October 2016

Full angular analysis of $B^+ \rightarrow \phi K^{*+}$

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

Parameter	PDG2014 Avg.	BABAR	Belle	Our Avg.
$f_{\perp} = \Lambda_{\perp\perp}$	0.20 ± 0.05	$0.21 \pm 0.05 \pm 0.02$	$0.19 \pm 0.08 \pm 0.02$	0.20 ± 0.05
ϕ_{\parallel}	2.34 ± 0.18	$2.47 \pm 0.20 \pm 0.07$	$2.10 \pm 0.28 \pm 0.04$	2.34 ± 0.17
ϕ_{\perp}	2.58 ± 0.17	$2.69 \pm 0.20 \pm 0.03$	$2.31 \pm 0.30 \pm 0.07$	2.58 ± 0.17
δ_0	$3.07 \pm 0.18 \pm 0.06$	$3.07 \pm 0.18 \pm 0.06$		3.07 ± 0.19
A_{CP}^0	$0.17 \pm 0.11 \pm 0.02$	$0.17 \pm 0.11 \pm 0.02$		0.17 ± 0.11
A_{CP}^{\perp}	$0.22 \pm 0.24 \pm 0.08$	$0.22 \pm 0.24 \pm 0.08$		0.22 ± 0.25
$\Delta\phi_{\parallel}$	$0.07 \pm 0.20 \pm 0.05$	$0.07 \pm 0.20 \pm 0.05$		0.07 ± 0.21
$\Delta\phi_{\perp}$	$0.19 \pm 0.20 \pm 0.07$	$0.19 \pm 0.20 \pm 0.07$		0.19 ± 0.21
$\Delta\delta_0$	$0.20 \pm 0.18 \pm 0.03$	$0.20 \pm 0.18 \pm 0.03$		0.20 ± 0.18

Angles (ϕ , δ) are in radians. BF, f_L and A_{CP} are tabulated separately.

Heavy Flavor Averaging Group - October 2016

Full angular analysis of $B^0 \rightarrow \phi K^{*0}$

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

Parameter	PDG2014 Avg.	BABAR	Belle	LHCb	Our Avg.
$f_{\perp} = \Lambda_{\perp\perp}$	0.228 ± 0.021	$0.212 \pm 0.032 \pm 0.013$	$0.238 \pm 0.026 \pm 0.008$	$0.221 \pm 0.016 \pm 0.013$	0.225 ± 0.015
$f_S(K\pi)$	New			$0.143 \pm 0.013 \pm 0.012$	0.143 ± 0.018
$f_S(KK)$	New			$0.122 \pm 0.013 \pm 0.008$	0.122 ± 0.015
ϕ_{\parallel}	2.28 ± 0.08	$2.40 \pm 0.13 \pm 0.08$	$2.23 \pm 0.10 \pm 0.02$	$2.562 \pm 0.069 \pm 0.040$	2.430 ± 0.058
ϕ_{\perp}	2.36 ± 0.09	$2.35 \pm 0.13 \pm 0.09$	$2.37 \pm 0.10 \pm 0.04$	$2.633 \pm 0.062 \pm 0.037$	2.527 ± 0.056
δ_0	2.88 ± 0.10	$2.82 \pm 0.15 \pm 0.09$	$2.91 \pm 0.10 \pm 0.08$		2.88 ± 0.10
$\phi_S(K\pi)^\dagger$	New			$2.222 \pm 0.063 \pm 0.081$	2.222 ± 0.103
$\phi_S(KK)^\dagger$	New			$2.481 \pm 0.072 \pm 0.048$	2.481 ± 0.087
A_{CP}^0	-0.01 ± 0.05	$0.01 \pm 0.07 \pm 0.02$	$-0.03 \pm 0.06 \pm 0.01$	$-0.003 \pm 0.038 \pm 0.005$	-0.007 ± 0.030
A_{CP}^{\perp}	-0.11 ± 0.09	$-0.04 \pm 0.15 \pm 0.06$	$-0.14 \pm 0.11 \pm 0.01$	$0.047 \pm 0.072 \pm 0.009$	-0.014 ± 0.057
$\mathcal{A}_{CP}^S(K\pi)$	New			$0.073 \pm 0.091 \pm 0.035$	0.073 ± 0.097
$\mathcal{A}_{CP}^S(KK)$	New			$-0.209 \pm 0.105 \pm 0.012$	-0.209 ± 0.106
$\Delta\phi_{\parallel}$	0.06 ± 0.11	$0.22 \pm 0.12 \pm 0.08$	$-0.02 \pm 0.10 \pm 0.01$	$0.045 \pm 0.068 \pm 0.015$	0.051 ± 0.053
$\Delta\phi_{\perp}$	0.10 ± 0.08	$0.21 \pm 0.13 \pm 0.08$	$0.05 \pm 0.10 \pm 0.02$	$0.062 \pm 0.062 \pm 0.006$	0.075 ± 0.050
$\Delta\delta_0$	0.13 ± 0.09	$0.27 \pm 0.14 \pm 0.08$	$0.08 \pm 0.10 \pm 0.01$		0.13 ± 0.08
$\Delta\phi_S(K\pi)^\dagger$	New			$0.062 \pm 0.062 \pm 0.022$	0.062 ± 0.066
$\Delta\phi_S(KK)^\dagger$	New			$0.022 \pm 0.072 \pm 0.004$	0.022 ± 0.072

Angles (ϕ , δ) are in radians. BF, f_L and A_{CP} are tabulated separately. \dagger Original LHCb notation adapted to match similar existing quantities.

Heavy Flavor Averaging Group - October 2016

Full angular analysis of $B^0 \rightarrow \phi K_2^{*0}(1430)$

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

Parameter	PDG2014 Avg.	BABAR	Belle	Our Avg.
$f_{\perp} = \Lambda_{\perp\perp}$	$0.027^{+0.031}_{-0.025}$	$0.002^{+0.018}_{-0.002} \pm 0.031$	$0.056^{+0.050}_{-0.035} \pm 0.009$	$0.027^{+0.027}_{-0.024}$
ϕ_{\parallel}	4.0 ± 0.4	$3.96 \pm 0.38 \pm 0.06$	$3.76 \pm 2.88 \pm 1.32$	3.96 ± 0.38
ϕ_{\perp}	4.5 ± 0.4		$4.45^{+0.43}_{-0.38} \pm 0.13$	$4.45^{+0.45}_{-0.40}$
δ_0	3.46 ± 0.14	$3.41 \pm 0.13 \pm 0.13$	$3.53 \pm 0.11 \pm 0.19$	3.46 ± 0.14
A_{CP}^0	-0.03 ± 0.04	$-0.05 \pm 0.06 \pm 0.01$	$-0.016^{+0.066}_{-0.051} \pm 0.008$	$-0.032^{+0.043}_{-0.038}$
A_{CP}^{\perp}	$0.0^{+0.9}_{-0.7}$		$-0.01^{+0.85}_{-0.67} \pm 0.09$	$-0.01^{+0.85}_{-0.68}$
$\Delta\phi_{\parallel}$	-0.9 ± 0.4	$-1.00 \pm 0.38 \pm 0.09$	$-0.02 \pm 1.08 \pm 1.01$	-0.94 ± 0.38
$\Delta\phi_{\perp}$	-0.2 ± 0.4		$-0.19 \pm 0.42 \pm 0.11$	-0.19 ± 0.43
$\Delta\delta_0$	0.08 ± 0.09	$0.11 \pm 0.13 \pm 0.06$	$0.06 \pm 0.11 \pm 0.02$	0.08 ± 0.09

Angles (ϕ , δ) are in radians. BF, f_L and A_{CP} are tabulated separately.

Heavy Flavor Averaging Group - October 2016

Measurements of the longitudinal polarization fraction (f_L) in B_s^0 decays

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

RPP#	Mode	PDG2014 Avg.	CDF	LHCb	Our Avg.
51	$\phi\phi$	0.361 ± 0.022	$0.348 \pm 0.041 \pm 0.021$	$0.365 \pm 0.022 \pm 0.012$	0.361 ± 0.022
59	$K^{*0}\bar{K}^{*0}$	0.31 ± 0.13		$0.201 \pm 0.057 \pm 0.040$	0.201 ± 0.070
60	$\phi\bar{K}^{*0}$	0.51 ± 0.17		$0.51 \pm 0.15 \pm 0.07$	0.51 ± 0.17

Heavy Flavor Averaging Group - October 2016

Full angular analysis of $B_s^0 \rightarrow \phi\phi$

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

Parameter	PDG2014 Avg.	CDF	LHCb	Our Avg.
$f_{\perp} = \Lambda_{\perp\perp}$	0.306 ± 0.030	$0.365 \pm 0.044 \pm 0.027$	$0.291 \pm 0.024 \pm 0.010$	0.306 ± 0.023
ϕ_{\parallel}	2.59 ± 0.15	$2.71_{-0.36}^{+0.31} \pm 0.22$	$2.57 \pm 0.15 \pm 0.06$	2.59 ± 0.15

The parameter ϕ is in radians. BF, f_L and A_{CP} are tabulated separately.

Heavy Flavor Averaging Group - October 2016

Full angular analysis of $B_s^0 \rightarrow \phi\bar{K}^{*0}$

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

Parameter	PDG2014 Avg.	LHCb	Our Avg.
$f_{\perp} = \Lambda_{\perp\perp}$		$0.28 \pm 0.12 \pm 0.03$	0.28 ± 0.12
f_0		$0.51 \pm 0.15 \pm 0.07$	0.51 ± 0.17
f_{\parallel}	0.21 ± 0.11	$0.21 \pm 0.11 \pm 0.02$	0.21 ± 0.11
$\phi_{\parallel} \dagger$	$1.75 \pm 0.53 \pm 0.29$	$1.75_{-0.53-0.30}^{+0.59+0.38}$	$1.75_{-0.61}^{+0.70}$

The parameter ϕ is in radians. BF, f_L and A_{CP} are tabulated separately.

\dagger Converted from the measurement of $\cos(\phi_{\parallel})$. PDG takes the smallest resulting asymmetric error as parabolic.

Heavy Flavor Averaging Group - October 2016

Full angular analysis of $B_s^0 \rightarrow K^{*0}\bar{K}^{*0}$

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

Parameter	PDG2014 Avg.	LHCb	Our Avg.
f_L	$0.31 \pm 0.12 \pm 0.04$	$0.201 \pm 0.057 \pm 0.040$	0.201 ± 0.070
f_{\parallel}		$0.215 \pm 0.046 \pm 0.015$	0.215 ± 0.048
$ A_s^+ ^2$		$0.114 \pm 0.037 \pm 0.023$	0.114 ± 0.044
$ A_s^- ^2$		$0.485 \pm 0.051 \pm 0.019$	0.485 ± 0.054
$ A_{ss} ^2$		$0.066 \pm 0.022 \pm 0.007$	0.066 ± 0.023
δ_{\parallel}		$5.31 \pm 0.24 \pm 0.14$	5.31 ± 0.28
$\delta_{\perp} - \delta_s^+$		$1.95 \pm 0.21 \pm 0.04$	1.95 ± 0.21
δ_s^-		$1.79 \pm 0.19 \pm 0.19$	1.79 ± 0.27
δ_{ss}		$1.06 \pm 0.27 \pm 0.23$	1.06 ± 0.35

Charmless VV Polarization Measurements:

BABAR References

- [1] *BABAR* Collaboration (P. del Amo Sanchez *et al.*), Phys. Rev. D **83**, 051101 (2010).
- [2] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. D **78**, 092008 (2008).
- [3] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. D **76**, 052007 (2007).
- [4] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. D **78**, 071104 (2008).
- [5] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. D **79**, 052005 (2009).
- [6] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. Lett. **97**, 201801 (2006).
- [7] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. Lett. **102**, 141802 (2009).
- [8] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. Lett. **99**, 201802 (2007).
- [9] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. Lett. **100**, 081801 (2008).
- [10] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. Lett. **101**, 161801 (2008).
- [11] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. D **79**, 051102 (2009).
- [12] *BABAR* Collaboration (B. Aubert *et al.*), Phys. Rev. D **80**, 092007 (2009).
- [13] *BABAR* Collaboration, (J. P. Lees *et al.*), Phys. Rev. D **85**, 072005 (2012).
- [14]
- [15]
- [16]
- [17]
- [18]
- [19]
- [20]

Belle References

- [21] Belle Collaboration (J. Zhang, M. Nakao *et al.*), Phys. Rev. Lett. **91**, 221801 (2003).
- [22] Belle Collaboration, (K.-F. Chen *et al.*), Phys. Rev. Lett. **94**, 221804 (2005).
- [23] Belle Collaboration, (J. Zhang *et al.*), Phys. Rev. Lett. **95**, 141801 (2005).
- [24] Belle Collaboration, (A. Somov *et al.*), Phys. Rev. Lett. **96**, 171801 (2006).
- [25] Belle Collaboration, (P. Goldenzweig *et al.*), Phys. Rev. Lett. **101**, 231801 (2008).
- [26] Belle Collaboration (M. Prim *et al.*), Phys. Rev. D **88**, 072004 (2013).
- [27] Belle Collaboration, (P. Vanhoefer *et al.*), Phys. Rev. D **89**, 072008 (2014).
- [28]
- [29]

CDF References

- [30] CDF Collaboration, (A. Aaltonen *et al.*), Phys. Rev. Lett. **107**, 261802 (2011).

LHCb References

- [31] LHCb Collaboration, (R. Aaij *et al.*), J. High Energ. Phys. **07**, 166 (2015).
- [32] LHCb Collaboration (R. Aaij *et al.*), Phys. Lett. B **713**, 369 (2012).
- [33] LHCb Collaboration (R. Aaij *et al.*), J. High Energ. Phys. **1311**, 092 (2013).
- [34] LHCb Collaboration (R. Aaij *et al.*), J. High Energ. Phys. **1405**, 069 (2014).
- [35] LHCb Collaboration (R. Aaij *et al.*), Phys. Lett. B **747**, 468 (2015).