

$\phi(1680)$

$$I^G(J^{PC}) = 0^-(1^{--})$$

$\phi(1680)$ MASS

e^+e^- PRODUCTION

VALUE (MeV)	EVTs	DOCUMENT ID	TECN	COMMENT
1680±20 OUR ESTIMATE				
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
1680 ⁺¹² ₋₁₃ ±21	1.8k	¹ ABLIKIM	20F BES3	$\psi(2S) \rightarrow K^+K^-\eta$
1662±20		² ACHASOV	20C SND	1.3–2.0 $e^+e^- \rightarrow K^+K^-\pi^0$
1641 ⁺²⁴ ₋₁₈		ACHASOV	19 SND	$e^+e^- \rightarrow \pi^+\pi^-\pi^0\eta$
1667±5±11	3k	³ IVANOV	19A CMD3	1.59–2.007 $e^+e^- \rightarrow K^+K^-\eta$
1700±23	2k	⁴ ACHASOV	18A SND	1.3–2.0 $e^+e^- \rightarrow K_S^0K_L^0\pi^0$
1674±12±6	6.2k	⁵ LEES	14H BABR	$e^+e^- \rightarrow K_S^0K_L^0\gamma$
1733±10±10		⁶ LEES	12F BABR	10.6 $e^+e^- \rightarrow \phi\pi^+\pi^-\gamma$
1689±7±10	4.8k	⁷ SHEN	09 BELL	10.6 $e^+e^- \rightarrow K^+K^-\pi^+\pi^-\gamma$
1709±20±43		⁸ AUBERT	08S BABR	10.6 $e^+e^- \rightarrow$ hadrons
1623±20	948	⁹ AKHMETSHIN	03 CMD2	1.05–1.38 $e^+e^- \rightarrow K_L^0K_S^0$
~1500		¹⁰ ACHASOV	98H RVUE	$e^+e^- \rightarrow \pi^+\pi^-\pi^0, \omega\pi^+\pi^-, K^+K^-$
~1900		¹¹ ACHASOV	98H RVUE	$e^+e^- \rightarrow K_S^0K^\pm\pi^\mp$
1700±20		¹² CLEGG	94 RVUE	$e^+e^- \rightarrow K^+K^-, K_S^0K\pi$
1657±27	367	BISELLO	91C DM2	$e^+e^- \rightarrow K_S^0K^\pm\pi^\mp$
1655±17		¹³ BISELLO	88B DM2	$e^+e^- \rightarrow K^+K^-$
1680±10		¹⁴ BUON	82 DM1	$e^+e^- \rightarrow$ hadrons
1677±12		¹⁵ MANE	82 DM1	$e^+e^- \rightarrow K_S^0K\pi$

¹ Seen in $\psi(2S)$ decay with branching ratio $\psi(2S) \rightarrow X\eta \rightarrow K^+K^-\eta = (12.0 \pm 1.3^{+6.5}_{-6.9}) \times 10^{-6}$.

² From a fit using a vector meson dominance model with contribution from $\rho(770)$, $\omega(782)$, $\phi(1020)$, $\omega(1420)$, $\rho(1450)$.

³ From a fit with coherent interference of the $\phi(1680)$ with a non-resonant contribution.

⁴ Assuming the $K\bar{K}^*(892) + c.c.$ dynamics. Systematic uncertainties not estimated.

⁵ Using a vector meson dominance model with contribution from $\phi(1020)$, $\phi(1680)$, and higher mass excitations of $\rho(770)$ and $\omega(782)$.

⁶ Using events with $\pi\pi$ invariant mass less than 0.85 GeV.

⁷ From a fit with two incoherent Breit-Wigners.

⁸ From the simultaneous fit to the $K\bar{K}^*(892) + c.c.$ and $\phi\eta$ data from AUBERT 08S using the results of AUBERT 07AK.

⁹ From the combined fit of AKHMETSHIN 03 and MANE 81 also including ρ , ω , and ϕ . Neither isospin nor flavor structure known.

¹⁰ Using data from IVANOV 81, BARKOV 87, BISELLO 88B, DOLINSKY 91, and ANTONELLI 92.

¹¹ Using the data from BISELLO 91C.

¹² Using BISELLO 88B and MANE 82 data.

¹³ From global fit including ρ , ω , ϕ and $\rho(1700)$ assume mass 1570 MeV and width 510 MeV for ρ radial excitation.

¹⁴ From global fit of ρ , ω , ϕ and their radial excitations to channels $\omega\pi^+\pi^-$, K^+K^- , $K_S^0 K_L^0$, $K_S^0 K^\pm\pi^\mp$. Assume mass 1570 MeV and width 510 MeV for ρ radial excitations, mass 1570 and width 500 MeV for ω radial excitation.

¹⁵ Fit to one channel only, neglecting interference with ω , $\rho(1700)$.

$\rho\bar{\rho}$ ANNIHILATION

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1700 ± 8	¹ AMSLER	06	CBAR $0.9 \bar{p}p \rightarrow K^+ K^- \pi^0$

¹ Could also be $\rho(1700)$.

$\phi(1680)$ WIDTH

e^+e^- PRODUCTION

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
150 ± 50				OUR ESTIMATE This is only an educated guess; the error given is larger than the error on the average of the published values.
$185^{+30}_{-26} + \frac{25}{47}$	1.8k	¹ ABLIKIM	20F BES3	$\psi(2S) \rightarrow K^+ K^- \eta$
159 ± 32		² ACHASOV	20C SND	$1.3-2.0 e^+ e^- \rightarrow K^+ K^- \pi^0$
103^{+26}_{-24}		ACHASOV	19 SND	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0 \eta$
$176 \pm 23 \pm 38$	3k	³ IVANOV	19A CMD3	$1.59-2.007 e^+ e^- \rightarrow K^+ K^- \eta$
300 ± 50	2k	⁴ ACHASOV	18A SND	$1.3-2.0 e^+ e^- \rightarrow K_S^0 K_L^0 \pi^0$
$165 \pm 38 \pm 70$	6.2k	⁵ LEES	14H BABR	$e^+ e^- \rightarrow K_S^0 K_L^0 \gamma$
$300 \pm 15 \pm 37$		⁶ LEES	12F BABR	$10.6 e^+ e^- \rightarrow \phi \pi^+ \pi^- \gamma$
$211 \pm 14 \pm 19$	4.8k	⁷ SHEN	09 BELL	$10.6 e^+ e^- \rightarrow K^+ K^- \pi^+ \pi^- \gamma$
$322 \pm 77 \pm 160$		⁸ AUBERT	08S BABR	$10.6 e^+ e^- \rightarrow \text{hadrons}$
139 ± 60	948	⁹ AKHMETSHIN	03 CMD2	$1.05-1.38 e^+ e^- \rightarrow K_L^0 K_S^0$
300 ± 60		¹⁰ CLEGG	94 RVUE	$e^+ e^- \rightarrow K^+ K^-, K_S^0 K \pi$
146 ± 55	367	BISELLO	91C DM2	$e^+ e^- \rightarrow K_S^0 K^\pm \pi^\mp$
207 ± 45		¹¹ BISELLO	88B DM2	$e^+ e^- \rightarrow K^+ K^-$
185 ± 22		¹² BUON	82 DM1	$e^+ e^- \rightarrow \text{hadrons}$
102 ± 36		¹³ MANE	82 DM1	$e^+ e^- \rightarrow K_S^0 K \pi$

¹ Seen in $\psi(2S)$ decay with branching ratio $\psi(2S) \rightarrow X\eta \rightarrow K^+ K^- \eta = (12.0 \pm 1.3^{+6.5}_{-6.9}) \times 10^{-6}$.

² From a fit using a vector meson dominance model with contribution from $\rho(770)$, $\omega(782)$, $\phi(1020)$, $\omega(1420)$, $\rho(1450)$.

³ From a fit with coherent interference of the $\phi(1680)$ with a non-resonant contribution.

⁴ Assuming the $K\bar{K}^*(892) + \text{c.c.}$ dynamics. Systematic uncertainties not estimated.

⁵ Using a vector meson dominance model with contribution from $\phi(1020)$, $\phi(1680)$, and higher mass excitations of $\rho(770)$ and $\omega(782)$.

⁶ Using events with $\pi\pi$ invariant mass less than 0.85 GeV.

⁷ From a fit with two incoherent Breit-Wigners.

⁸ From the simultaneous fit to the $K\bar{K}^*(892) + \text{c.c.}$ and $\phi\eta$ data from AUBERT 08S using the results of AUBERT 07AK.

⁹ From the combined fit of AKHMETSHIN 03 and MANE 81 also including ρ , ω , and ϕ . Neither isospin nor flavor structure known.

¹⁰ Using BISELLO 88B and MANE 82 data.

¹¹ From global fit including ρ , ω , ϕ and $\rho(1700)$

¹² From global fit of ρ , ω , ϕ and their radial excitations to channels $\omega\pi^+\pi^-$, K^+K^- , $K_S^0 K_L^0$, $K_S^0 K^\pm\pi^\mp$. Assume mass 1570 MeV and width 510 MeV for ρ radial excitations, mass 1570 and width 500 MeV for ω radial excitation.

¹³ Fit to one channel only, neglecting interference with ω , $\rho(1700)$.

$\rho\bar{\rho}$ ANNIHILATION

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
143 ± 24	¹ AMSLER	06	CBAR $0.9 \bar{p}p \rightarrow K^+ K^- \pi^0$
¹ Could also be $\rho(1700)$.			

$\phi(1680)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $K\bar{K}^*(892) + \text{c.c.}$	seen
Γ_2 $K_S^0 K\pi$	seen
Γ_3 $K\bar{K}$	seen
Γ_4 $K_L^0 K_S^0$	
Γ_5 e^+e^-	seen
Γ_6 $\omega\pi\pi$	not seen
Γ_7 $\phi\pi\pi$	
Γ_8 $K^+K^-\pi^+\pi^-$	seen
Γ_9 $\eta\phi$	seen
Γ_{10} $K^+K^-\eta$	
Γ_{11} $\eta\gamma$	seen
Γ_{12} $K^+K^-\pi^0$	

$\phi(1680)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(\text{total})$

This combination of a partial width with the partial width into e^+e^- and with the total width is obtained from the integrated cross section into channel (I) in e^+e^- annihilation. We list only data that have not been used to determine the partial width $\Gamma(I)$ or the branching ratio $\Gamma(I)/\text{total}$.

$$\Gamma(K_L^0 K_S^0) \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \quad \Gamma_4\Gamma_5/\Gamma$$

VALUE (eV)	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$14.3 \pm 2.4 \pm 6.2$	6.2k	¹ LEES	14H	BABR $e^+e^- \rightarrow K_S^0 K_L^0 \gamma$

¹ Using a vector meson dominance model with contribution from $\phi(1020)$, $\phi(1680)$, and higher mass excitations of $\rho(770)$ and $\omega(782)$.

$$\Gamma(\phi\pi\pi) \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \quad \Gamma_7\Gamma_5/\Gamma$$

VALUE (10^{-2} keV)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$4.2 \pm 0.2 \pm 0.3$	LEES	12F	BABR $10.6 e^+e^- \rightarrow \phi\pi^+\pi^-\gamma$

$$\Gamma(\eta\phi) \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \qquad \Gamma_9\Gamma_5/\Gamma$$

VALUE (eV)	EVTS	DOCUMENT ID	TECN	COMMENT
$94 \pm 13 \pm 15$	3k	¹ IVANOV	19A	CMD3 1.59–2.007 $e^+e^- \rightarrow K^+K^-\eta$

¹ From a fit with coherent interference of the $\phi(1680)$ with a non-resonant contribution.

$$\phi(1680) \Gamma(i)\Gamma(e^+e^-)/\Gamma^2(\text{total})$$

This combination of a branching ratio into channel (i) and branching ratio into e^+e^- is directly measured and obtained from the cross section at the peak. We list only data that have not been used to determine the branching ratio into (i) or e^+e^- .

$$\Gamma(K_L^0 K_S^0)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \qquad \Gamma_4/\Gamma \times \Gamma_5/\Gamma$$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID	TECN	COMMENT
0.131 ± 0.059	948	¹ AKHMETSHIN 03	CMD2	1.05–1.38 $e^+e^- \rightarrow K_L^0 K_S^0$

¹ From the combined fit of AKHMETSHIN 03 and MANE 81 also including ρ , ω , and ϕ . Neither isospin nor flavor structure known. Recalculated by us.

$$\Gamma(K\bar{K}^*(892) + \text{c.c.})/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \qquad \Gamma_1/\Gamma \times \Gamma_5/\Gamma$$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID	TECN	COMMENT
$1.15 \pm 0.16 \pm 0.01$		¹ AUBERT	08S	BABR 10.6 $e^+e^- \rightarrow K\bar{K}^*(892)\gamma + \text{c.c.}$
3.29 ± 1.57	367	² BISELLO	91C	DM2 1.35–2.40 $e^+e^- \rightarrow K_S^0 K^\pm \pi^\mp$

¹ From the simultaneous fit to the $K\bar{K}^*(892) + \text{c.c.}$ and $\phi\eta$ data from AUBERT 08S using the results of AUBERT 07AK.

² Recalculated by us with the published value of $B(K\bar{K}^*(892) + \text{c.c.}) \times \Gamma(e^+e^-)$.

$$\Gamma(\phi\pi\pi)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \qquad \Gamma_7/\Gamma \times \Gamma_5/\Gamma$$

VALUE (units 10^{-7})	EVTS	DOCUMENT ID	TECN	COMMENT
$1.86 \pm 0.14 \pm 0.21$	4.8k	¹ SHEN	09	BELL 10.6 $e^+e^- \rightarrow K^+K^-\pi^+\pi^-\gamma$

¹ Multiplied by 3/2 to take into account the $\phi\pi^0\pi^0$ mode. Using $B(\phi \rightarrow K^+K^-) = (49.2 \pm 0.6)\%$.

$$\Gamma(\eta\phi)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \qquad \Gamma_9/\Gamma \times \Gamma_5/\Gamma$$

VALUE (units 10^{-7})	EVTS	DOCUMENT ID	TECN	COMMENT
$5.64^{+1.74}_{-1.80}$		ACHASOV	19	SND $e^+e^- \rightarrow \pi^+\pi^-\pi^0\eta$
$5.3 \pm 0.6 \pm 0.9$	3k	¹ IVANOV	19A	CMD3 1.59–2.007 $e^+e^- \rightarrow K^+K^-\eta$
$4.3 \pm 1.0 \pm 0.9$		² AUBERT	08S	BABR 10.6 $e^+e^- \rightarrow \phi\eta\gamma$

¹ From a fit with coherent interference of the $\phi(1680)$ with a non-resonant contribution.

² From the simultaneous fit to the $K\bar{K}^*(892) + \text{c.c.}$ and $\phi\eta$ data from AUBERT 08S using the results of AUBERT 07AK.

$\phi(1680)$ BRANCHING RATIOS

$\Gamma(K\bar{K}^*(892)+c.c.)/\Gamma(K_S^0 K\pi)$				Γ_1/Γ_2
VALUE	DOCUMENT ID	TECN	COMMENT	
dominant	MANE	82	DM1	$e^+e^- \rightarrow K_S^0 K^\pm \pi^\mp$

$\Gamma(K\bar{K})/\Gamma(K\bar{K}^*(892)+c.c.)$				Γ_3/Γ_1
VALUE	DOCUMENT ID	TECN	COMMENT	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.07 ± 0.01	BUON	82	DM1	e^+e^-

$\Gamma(\omega\pi\pi)/\Gamma(K\bar{K}^*(892)+c.c.)$				Γ_6/Γ_1
VALUE	DOCUMENT ID	TECN	COMMENT	
<0.10	BUON	82	DM1	e^+e^-

$\Gamma(\eta\phi)/\Gamma_{\text{total}}$				Γ_9/Γ	
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
seen	35	¹ ACHASOV	14	SND	$1.15\text{--}2.00 e^+e^- \rightarrow \eta\gamma$
¹ From a phenomenological model based on vector meson dominance with $\rho(1450)$ and $\phi(1680)$ masses and widths from the PDG 12.					

$\Gamma(\eta\phi)/\Gamma(K\bar{K}^*(892)+c.c.)$				Γ_9/Γ_1
VALUE	DOCUMENT ID	TECN	COMMENT	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
≈ 0.37	¹ AUBERT	08S	BABR	$10.6 e^+e^- \rightarrow \text{hadrons}$
¹ From the fit including data from AUBERT 07AK.				

$\Gamma(\eta\gamma)/\Gamma_{\text{total}}$				Γ_{11}/Γ	
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
seen	35	¹ ACHASOV	14	SND	$1.15\text{--}2.00 e^+e^- \rightarrow \eta\gamma$
¹ From a phenomenological model based on vector meson dominance with $\rho(1450)$ and $\phi(1680)$ masses and widths from the PDG 12.					

 $\phi(1680)$ REFERENCES

ABLIKIM	20F	PR D101 032008	M. Ablikim <i>et al.</i>	(BESIII Collab.)
ACHASOV	20C	EPJ C80 1139	M.N. Achasov <i>et al.</i>	(SND Collab.)
ACHASOV	19	PR D99 112004	M.N. Achasov <i>et al.</i>	(SND Collab.)
IVANOV	19A	PL B798 134946	V.L. Ivanov <i>et al.</i>	(CMD-3 Collab.)
ACHASOV	18A	PR D97 032011	M.N. Achasov <i>et al.</i>	(SND Collab.)
ACHASOV	14	PR D90 032002	M.N. Achasov <i>et al.</i>	(SND Collab.)
LEES	14H	PR D89 092002	J.P. Lees <i>et al.</i>	(BABAR Collab.)
LEES	12F	PR D86 012008	J.P. Lees <i>et al.</i>	(BABAR Collab.)
PDG	12	PR D86 010001	J. Beringer <i>et al.</i>	(PDG Collab.)
SHEN	09	PR D80 031101	C.P. Shen <i>et al.</i>	(BELLE Collab.)
AUBERT	08S	PR D77 092002	B. Aubert <i>et al.</i>	(BABAR Collab.)
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AMSLER	06	PL B639 165	C. AMSler <i>et al.</i>	(Crystal Barrel Collab.)
AKHMETSHIN	03	PL B551 27	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
Also		PAN 65 1222	E.V. Anashkin, V.M. Aulchenko, R.R. Akhmetshin	
		Translated from YAF 65 1255.		

ACHASOV	98H	PR D57 4334	N.N. Achasov, A.A. Kozhevnikov	
CLEGG	94	ZPHY C62 455	A.B. Clegg, A. Donnachie	(LANC, MCHS)
ANTONELLI	92	ZPHY C56 15	A. Antonelli <i>et al.</i>	(DM2 Collab.)
BISELLO	91C	ZPHY C52 227	D. Bisello <i>et al.</i>	(DM2 Collab.)
DOLINSKY	91	PRPL 202 99	S.I. Dolinsky <i>et al.</i>	(NOVO)
BISELLO	88B	ZPHY C39 13	D. Bisello <i>et al.</i>	(PADO, CLER, FRAS+)
BARKOV	87	JETPL 46 164	L.M. Barkov <i>et al.</i>	(NOVO)
		Translated from ZETFP 46 132.		
BUON	82	PL 118B 221	J. Buon <i>et al.</i>	(LALO, MONP)
MANE	82	PL 112B 178	F. Mane <i>et al.</i>	(LALO)
IVANOV	81	PL 107B 297	P.M. Ivanov <i>et al.</i>	(NOVO)
MANE	81	PL 99B 261	F. Mane <i>et al.</i>	(ORSAY)
