

$\phi(1680)$ 

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

### $\phi(1680)$ MASS

#### $e^+e^-$ PRODUCTION

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>1680±20 OUR ESTIMATE</b>				
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
1709±20±43		<sup>1</sup> AUBERT	08S BABR	10.6 $e^+e^- \rightarrow$ hadrons
1623±20	948	<sup>2</sup> AKHMETSHIN	03 CMD2	1.05–1.38 $e^+e^- \rightarrow K_L^0 K_S^0$
~ 1500		<sup>3</sup> ACHASOV	98H RVUE	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$ , $\omega\pi^+\pi^-$ , $K^+K^-$
~ 1900		<sup>4</sup> ACHASOV	98H RVUE	$e^+e^- \rightarrow K_S^0 K^\pm \pi^\mp$
1700±20		<sup>5</sup> CLEGG	94 RVUE	$e^+e^- \rightarrow K^+K^-$ , $K_S^0 K\pi$
1657±27	367	BISELLO	91C DM2	$e^+e^- \rightarrow K_S^0 K^\pm \pi^\mp$
1655±17		<sup>6</sup> BISELLO	88B DM2	$e^+e^- \rightarrow K^+K^-$
1680±10		<sup>7</sup> BUON	82 DM1	$e^+e^- \rightarrow$ hadrons
1677±12		<sup>8</sup> MANE	82 DM1	$e^+e^- \rightarrow K_S^0 K\pi$

#### PHOTOPRODUCTION

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1753± 3	<sup>9</sup> LINK	02K FOCS	20–160 $\gamma p \rightarrow K^+K^-p$
1726±22	<sup>9</sup> BUSENITZ	89 TPS	$\gamma p \rightarrow K^+K^-X$
1760±20	<sup>9</sup> ATKINSON	85C OMEG	20–70 $\gamma p \rightarrow K\bar{K}X$
1690±10	<sup>9</sup> ASTON	81F OMEG	25–70 $\gamma p \rightarrow K^+K^-X$

#### $p\bar{p}$ ANNIHILATION

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1700±8	<sup>10</sup> AMSLER	06 CBAR	0.9 $\bar{p}p \rightarrow K^+K^-\pi^0$
<sup>1</sup> 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.			
<sup>2</sup> From the combined fit of AKHMETSHIN 03 and MANE 81 also including $\rho$ , $\omega$ , and $\phi$ . Neither isospin nor flavor structure known.			
<sup>3</sup> Using data from IVANOV 81, BARKOV 87, BISELLO 88B, DOLINSKY 91, and ANTONELLI 92.			
<sup>4</sup> Using the data from BISELLO 91C.			
<sup>5</sup> Using BISELLO 88B and MANE 82 data.			
<sup>6</sup> From global fit including $\rho$ , $\omega$ , $\phi$ and $\rho(1700)$ assume mass 1570 MeV and width 510 MeV for $\rho$ radial excitation.			
<sup>7</sup> From global fit of $\rho$ , $\omega$ , $\phi$ 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 $\rho$ radial excitations, mass 1570 and width 500 MeV for $\omega$ radial excitation.			
<sup>8</sup> Fit to one channel only, neglecting interference with $\omega$ , $\rho(1700)$ .			
<sup>9</sup> We list here a state decaying into $K^+K^-$ possibly different from $\phi(1680)$ .			
<sup>10</sup> Could also be $\rho(1700)$ .			

## $\phi(1680)$ WIDTH

### $e^+e^-$ PRODUCTION

VALUE (MeV)	EVTs	DOCUMENT ID	TECN	COMMENT
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**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.

• • • We do not use the following data for averages, fits, limits, etc. • • •

322±77±160		<sup>11</sup> AUBERT	08S BABR	10.6 $e^+e^- \rightarrow$ hadrons
139±60	948	<sup>12</sup> AKHMETSHIN	03 CMD2	1.05–1.38 $e^+e^- \rightarrow K_L^0 K_S^0$
300±60		<sup>13</sup> 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		<sup>14</sup> BISELLO	88B DM2	$e^+e^- \rightarrow K^+ K^-$
185±22		<sup>15</sup> BUON	82 DM1	$e^+e^- \rightarrow$ hadrons
102±36		<sup>16</sup> MANE	82 DM1	$e^+e^- \rightarrow K_S^0 K \pi$

### PHOTOPRODUCTION

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

122±63	<sup>17</sup> LINK	02K FOCS	20–160 $\gamma p \rightarrow K^+ K^- p$
121±47	<sup>17</sup> BUSENITZ	89 TPS	$\gamma p \rightarrow K^+ K^- X$
80±40	<sup>17</sup> ATKINSON	85C OMEG	20–70 $\gamma p \rightarrow K \bar{K} X$
100±40	<sup>17</sup> ASTON	81F OMEG	25–70 $\gamma p \rightarrow K^+ K^- X$

### $p\bar{p}$ ANNIHILATION

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

143±24	<sup>18</sup> AMSLER	06 CBAR	0.9 $\bar{p}p \rightarrow K^+ K^- \pi^0$
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<sup>11</sup> 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.

<sup>12</sup> From the combined fit of AKHMETSHIN 03 and MANE 81 also including  $\rho$ ,  $\omega$ , and  $\phi$ . Neither isospin nor flavor structure known.

<sup>13</sup> Using BISELLO 88B and MANE 82 data.

<sup>14</sup> From global fit including  $\rho$ ,  $\omega$ ,  $\phi$  and  $\rho(1700)$

<sup>15</sup> From global fit of  $\rho$ ,  $\omega$ ,  $\phi$  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  $\rho$  radial excitations, mass 1570 and width 500 MeV for  $\omega$  radial excitation.

<sup>16</sup> Fit to one channel only, neglecting interference with  $\omega$ ,  $\rho(1700)$ .

<sup>17</sup> We list here a state decaying into  $K^+ K^-$  possibly different from  $\phi(1680)$ .

<sup>18</sup> Could also be  $\rho(1700)$ .

## $\phi(1680)$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $K \bar{K}^*(892) +$ c.c.	dominant
$\Gamma_2$ $K_S^0 K \pi$	seen
$\Gamma_3$ $K \bar{K}$	seen
$\Gamma_4$ $K_L^0 K_S^0$	

$\Gamma_5$	$e^+ e^-$	seen
$\Gamma_6$	$\omega \pi \pi$	not seen
$\Gamma_7$	$\phi \eta$	
$\Gamma_8$	$K^+ K^- \pi^0$	

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

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  $e^+ e^-$ .

$$\Gamma(K_L^0 K_S^0) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}^2 \qquad \Gamma_4 \Gamma_5 / \Gamma^2$$

<u>VALUE (units <math>10^{-6}</math>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$0.131 \pm 0.059$	948	<sup>19</sup> AKHMETSHIN 03	CMD2	$1.05\text{--}1.38 e^+ e^- \rightarrow K_L^0 K_S^0$
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<sup>19</sup> From the combined fit of AKHMETSHIN 03 and MANE 81 also including  $\rho$ ,  $\omega$ , and  $\phi$ . Neither isospin nor flavor structure known. Recalculated by us.

$$\Gamma(K \bar{K}^*(892) + \text{c.c.}) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}^2 \qquad \Gamma_1 \Gamma_5 / \Gamma^2$$

<u>VALUE (units <math>10^{-6}</math>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$1.15 \pm 0.16 \pm 0.01$		<sup>20</sup> AUBERT 08S	BABR	$10.6 e^+ e^- \rightarrow K \bar{K}^*(892) \gamma +$
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$3.29 \pm 1.57$	367	<sup>21</sup> BISELLO 91C	DM2	$1.35\text{--}2.40 e^+ e^- \rightarrow K_S^0 K^\pm \pi^\mp$
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<sup>20</sup> 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.

<sup>21</sup> Recalculated by us with the published value of  $B(K \bar{K}^*(892) + \text{c.c.}) \times \Gamma(e^+ e^-)$ .

$$\Gamma(\phi \eta) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}^2 \qquad \Gamma_7 \Gamma_5 / \Gamma^2$$

<u>VALUE (units <math>10^{-6}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$0.43 \pm 0.10 \pm 0.09$		<sup>22</sup> AUBERT 08S	BABR	$10.6 e^+ e^- \rightarrow \phi \eta \gamma$
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<sup>22</sup> 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

$$\Gamma(K \bar{K}^*(892) + \text{c.c.})/\Gamma(K_S^0 K \pi) \qquad \Gamma_1/\Gamma_2$$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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dominant	MANE 82	DM1	$e^+ e^- \rightarrow K_S^0 K^\pm \pi^\mp$
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$$\Gamma(K \bar{K})/\Gamma(K \bar{K}^*(892) + \text{c.c.}) \qquad \Gamma_3/\Gamma_1$$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$0.07 \pm 0.01$	BUON 82	DM1	$e^+ e^-$
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$\Gamma(\omega\pi\pi)/\Gamma(K\bar{K}^*(892)+c.c.)$				$\Gamma_6/\Gamma_1$
VALUE	DOCUMENT ID	TECN	COMMENT	
<0.10	BUON	82	DM1	$e^+e^-$

$\Gamma(\phi\eta)/\Gamma(K\bar{K}^*(892)+c.c.)$				$\Gamma_7/\Gamma_1$
VALUE	DOCUMENT ID	TECN	COMMENT	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$\approx 0.37$	<sup>23</sup> AUBERT	08S	BABR	$10.6 e^+e^- \rightarrow \text{hadrons}$
<sup>23</sup> From the fit including data from AUBERT 07AK.				

## $\phi(1680)$ REFERENCES

AUBERT	08S	PR D77 092002	B. Aubert <i>et al.</i>	(BABAR Collab.)
AUBERT	07AK	PR D76 012008	B. Aubert <i>et al.</i>	(BABAR Collab.)
AMSLER	06	PL B639 165	C. Amsler <i>et al.</i>	(CBAR 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.		
LINK	02K	PL B545 50	J.M. Link <i>et al.</i>	(FNAL FOCUS Collab.)
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)
BUSENITZ	89	PR D40 1	J.K. Busenitz <i>et al.</i>	(ILL, FNAL)
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.		
ATKINSON	85C	ZPHY C27 233	M. Atkinson <i>et al.</i>	(BONN, CERN, GLAS+)
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)
ASTON	81F	PL 104B 231	D. Aston	(BONN, CERN, EPOL, GLAS, LANC+)
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)

## OTHER RELATED PAPERS

ACHASOV	07A	PR D76 072012	M.N. Achasov <i>et al.</i>	(SND Collab.)
ACHASOV	06D	JETP 103 720	N.N. Achasov <i>et al.</i>	(SND Collab.)
		Translated from ZETF 130 831.		
AUBERT	06D	PR D73 052003	B. Aubert <i>et al.</i>	(BABAR Collab.)
CLOSE	02	PR D65 092003	F.E. Close, A. Donnachie, Yu.S. Kalashnikova	
LINK	02K	PL B545 50	J.M. Link <i>et al.</i>	(FNAL FOCUS Collab.)
ABELE	99D	PL B468 178	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ACHASOV	97F	PAN 60 2029	N.N. Achasov, A.A. Kozhevnikov	(NOVM)
		Translated from YAF 60 2212.		
ATKINSON	86C	ZPHY C30 541	M. Atkinson <i>et al.</i>	(BONN, CERN, GLAS+)
ATKINSON	84	NP B231 15	M. Atkinson <i>et al.</i>	(BONN, CERN, GLAS+)
ATKINSON	84B	NP B231 1	M. Atkinson <i>et al.</i>	(BONN, CERN, GLAS+)
ATKINSON	83C	NP B229 269	M. Atkinson <i>et al.</i>	(BONN, CERN, GLAS+)
CORDIER	81	PL 106B 155	A. Cordier <i>et al.</i>	(ORSAY)
MANE	81	PL 99B 261	F. Mane <i>et al.</i>	(ORSAY)
ASTON	80F	NP B174 269	D. Aston	(BONN, CERN, EPOL, GLAS, LANC+)