$\omega(1650)$

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

See also the $\omega(1420)$ particle listing.

$\omega(1650)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
1670± 30 OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1698± 10	267	[1] ACHASOV 20B	SND	$e^+e^- \to \omega\eta \to \eta\pi^0\gamma$
$1651\pm 3^{+16}_{-6}$	183k	[2] ABLIKIM 19AQ	BES	$J/\psi \to K^+K^-\pi^0$
1673^{+6}_{-7}		ACHASOV 19	SND	$e^+e^- \to \pi^+\pi^-\pi^0\eta$
1671± 6±10	824	[3] AKHMETSHIN 17A	CMD3	1.4–2.0 $e^+e^- \to \omega\eta$
1660± 10	898	[4] ACHASOV 16B	SND	1.34–2.00 $e^+e^- \to \omega\eta$
1680± 10	13.1k	[5] AULCHENKO 15A	SND	1.05–1.80 $e^+e^- \to \pi^+\pi^-\pi^0$
1667± 13± 6		AUBERT 07AU	BABR	10.6 $e^+e^- \to \omega\pi^+\pi^-\gamma$
1645± 8	13	AUBERT 06D	BABR	10.6 $e^+e^- \to \omega\eta\gamma$
1660± 10± 2		AUBERT,B 04N	BABR	10.6 $e^+e^- \to \pi^+\pi^-\pi^0\gamma$
1770± 50±60	1.2M	[6] ACHASOV 03D	RVUE	0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$
1619± 5		[7] HENNER 02	RVUE	1.2–2.0 $e^+e^- \to \rho\pi$, $\omega\pi\pi$
1700± 20		EUGENIO 01	SPEC	18 $\pi^-p \to \omega\eta n$
1705± 26	612	[8] AKHMETSHIN 00D	CMD2	$e^+e^- \to \omega\pi^+\pi^-$
1820^{+190}_{-150}		[9] ACHASOV 98H	RVUE	$e^+e^- \to \pi^+\pi^-\pi^0$
1840^{+100}_{-70}		[10] ACHASOV 98H	RVUE	$e^+e^- \to \omega\pi^+\pi^-$
1780^{+170}_{-300}		[11] ACHASOV 98H	RVUE	$e^+e^- \to K^+K^-$
∼ 2100		[12] ACHASOV 98H	RVUE	$e^+e^- \to K^0_S K^\pm\pi^\mp$
1606± 9		[13] CLEGG 94	RVUE	
1662± 13	750	[14] ANTONELLI 92	DM2	1.34–2.4$e^+e^- \to \rho\pi$, $\omega\pi\pi$
1670± 20		ATKINSON 83B	OMEG	20–70 $\gamma p \to 3\pi X$
1657± 13		CORDIER 81	DM1	$e^+e^- \to \omega 2\pi$
1679± 34	21	ESPOSITO 80	FRAM	$e^+e^- \to 3\pi$
1652± 17		COSME 79	OSPK	$e^+e^- \to 3\pi$

[1] From a fit with contributions from $\omega(1420)$, $\omega(1650)$, and $\phi(1680)$. The mass of $\omega(1420)$ is fixed to the PDG 18 value of 1420 MeV. Fixing also the width of $\omega(1420)$ to the PDG 18 value of 220 MeV results in 1694 ± 9 MeV measurement.

[2] Could also be $\rho(1700)$. Branching ratio $J/\psi \to X\pi^0 \to K^+K^-\pi^0 = (5.3\pm0.3^{+0.6}_{-0.5})\times 10^{-5}$.

[3] From a fit of the interfering $\omega(1420)$ and $\omega(1650)$ with a relative phase of π and other parameters floating.

[4] From a fit with contributions from $\omega(1420)$, $\omega(1650)$, and $\phi(1680)$.

[5] From a fit with contributions from $\omega(782)$, $\phi(1020)$, $\omega(1420)$, and $\omega(1650)$. See ACHASOV 20A for a further analysis of the $\pi^+\pi^-\pi^0$ data.

[6] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+\pi^-\pi^0$ and ANTONELLI 92 on the $\omega\pi^+\pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.
[7] Using results of CORDIER 81 and preliminary data of DOLINSKY 91 and ANTONELLI 92.
[8] Using the data of AKHMETSHIN 00D and ANTONELLI 92. The $\rho\pi$ dominance for the energy dependence of the $\omega(1420)$ and $\omega(1650)$ width assumed.
[9] Using data from BARKOV 87, DOLINSKY 91, and ANTONELLI 92.
[10] Using the data from ANTONELLI 92.
[11] Using the data from IVANOV 81 and BISELLO 88B.
[12] Using the data from BISELLO 91C.
[13] From a fit to two Breit-Wigner functions and using the data of DOLINSKY 91 and ANTONELLI 92.
[14] From the combined fit of the $\rho\pi$ and $\omega\pi\pi$ final states.

$\omega(1650)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
315± 35 OUR ESTIMATE					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
110± 16	267	[1] ACHASOV	20B	SND	$e^+e^- \to \omega\eta \to \eta\pi^0\gamma$
$194\pm 8^{+15}_{-7}$	183k	[2] ABLIKIM	19AQ	BES	$J/\psi \to K^+K^-\pi^0$
95± 11		ACHASOV	19	SND	$e^+e^- \to \pi^+\pi^-\pi^0\eta$
113± 9± 10	824	[3] AKHMETSHIN	17A	CMD3	1.4–2.0 $e^+e^- \to \omega\eta$
110± 20	898	[4] ACHASOV	16B	SND	1.34–2.00 $e^+e^- \to \omega\eta$
310± 30	13.1k	[5] AULCHENKO	15A	SND	1.05–1.80 $e^+e^- \to \pi^+\pi^-\pi^0$
222± 25± 20		AUBERT	07AU	BABR	10.6 $e^+e^- \to \omega\pi^+\pi^-\gamma$
114± 14	13	AUBERT	06D	BABR	10.6 $e^+e^- \to \omega\eta\gamma$
230± 30± 20		AUBERT,B	04N	BABR	10.6 $e^+e^- \to \pi^+\pi^-\pi^0\gamma$
$490^{+200}_{-150}\pm 130$	1.2M	[6] ACHASOV	03D	RVUE	0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$
250± 14		[7] HENNER	02	RVUE	1.2–2.0 $e^+e^- \to \rho\pi, \omega\pi\pi$
250± 50		EUGENIO	01	SPEC	18 $\pi^- p \to \omega\eta n$
370± 25	612	[8] AKHMETSHIN	00D	CMD2	$e^+e^- \to \omega\pi^+\pi^-$
113± 20		[9] CLEGG	94	RVUE	
280± 24	750	[10] ANTONELLI	92	DM2	1.34–2.4$e^+e^- \to \rho\pi, \omega\pi\pi$
160± 20		ATKINSON	83B	OMEG	20–70 $\gamma p \to 3\pi X$
136± 46		CORDIER	81	DM1	$e^+e^- \to \omega 2\pi$
99± 49	21	ESPOSITO	80	FRAM	$e^+e^- \to 3\pi$
42± 17		COSME	79	OSPK	$e^+e^- \to 3\pi$

[1] From a fit with contributions from $\omega(1420)$, $\omega(1650)$, and $\phi(1680)$. The mass of $\omega(1420)$ is fixed to the PDG 18 value of 1420 MeV. Fixing also the width of $\omega(1420)$ to the PDG 18 value of 220 MeV results in 94 ± 13 MeV measurement.
[2] Could also be $\rho(1700)$. Branching ratio $J/\psi \to X\pi^0 \to K^+K^-\pi^0 = (5.3\pm0.3^{+0.6}_{-0.5})\times 10^{-5}$.
[3] From a fit of the interfering $\omega(1420)$ and $\omega(1650)$ with a relative phase of π and other parameters floating.
[4] From a fit with contributions from $\omega(1420)$, $\omega(1650)$, and $\phi(1680)$.
[5] From a fit with contributions from $\omega(782)$, $\phi(1020)$, $\omega(1420)$, and $\omega(1650)$. See ACHASOV 20A for a further analysis of the $\pi^+\pi^-\pi^0$ data.

[6] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+\pi^-\pi^0$ and ANTONELLI 92 on the $\omega\pi^+\pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.
[7] Using results of CORDIER 81 and preliminary data of DOLINSKY 91 and ANTONELLI 92.
[8] Using the data of AKHMETSHIN 00D and ANTONELLI 92. The $\rho\pi$ dominance for the energy dependence of the $\omega(1420)$ and $\omega(1650)$ width assumed.
[9] From a fit to two Breit-Wigner functions and using the data of DOLINSKY 91 and ANTONELLI 92.
[10] From the combined fit of the $\rho\pi$ and $\omega\pi\pi$ final states.

$\omega(1650)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\rho\pi$	seen
Γ_2	$\rho(1450)\pi$	seen
Γ_3	$\omega\pi\pi$	seen
Γ_4	$\omega\eta$	seen
Γ_5	e^+e^-	seen
Γ_6	$\pi^0\gamma$	not seen

$\omega(1650)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma^2(\text{total})$

$\Gamma(\rho\pi)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_1/\Gamma \times \Gamma_5/\Gamma$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.56 ± 0.23	13.1k	[1] AULCHENKO	15A	SND	1.05–1.80 $e^+e^- \to \pi^+\pi^-\pi^0$
$1.3 \pm 0.1 \pm 0.1$		AUBERT,B	04N	BABR	10.6 $e^+e^- \to \pi^+\pi^-\pi^0\gamma$
$1.2\ ^{+0.4}_{-0.1} \pm 0.8$	1.2M	[2,3] ACHASOV	03D	RVUE	0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$
0.921 ± 0.230		[4,5] CLEGG	94	RVUE	
0.479 ± 0.050	750	[6,7] ANTONELLI	92	DM2	1.34–2.4 $e^+e^- \to \rho\pi$, $\omega\pi\pi$

[1] From a fit with contributions from $\omega(782)$, $\phi(1020)$, $\omega(1420)$, and $\omega(1650)$. See ACHASOV 20A for a further analysis of the $\pi^+\pi^-\pi^0$ data.
[2] Calculated by us from the cross section at the peak.
[3] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+\pi^-\pi^0$ and ANTONELLI 92 on the $\omega\pi^+\pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.
[4] From a fit to two Breit-Wigner functions and using the data of DOLINSKY 91 and ANTONELLI 92.
[5] From the partial and leptonic width given by the authors.
[6] From the combined fit of the $\rho\pi$ and $\omega\pi\pi$ final states.
[7] From the product of the leptonic width and partial branching ratio given by the authors.

$\Gamma(\omega\pi\pi)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_3/\Gamma \times \Gamma_5/\Gamma$

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
7.0 ± 0.5		AUBERT	07AU	BABR	10.6 $e^+e^- \to \omega\pi^+\pi^-\gamma$

4.1 $\pm$0.9 $\pm$1.3	1.2M	[1,2] ACHASOV	03D	RVUE	0.44–2.00 $e^+ e^- \to \pi^+ \pi^- \pi^0$
5.40$\pm$0.95		[3] AKHMETSHIN	00D	CMD2	1.2–1.38 $e^+ e^- \to \omega \pi^+ \pi^-$
3.18$\pm$0.80		[4,5] CLEGG	94	RVUE	
6.07$\pm$0.61	750	[6,7] ANTONELLI	92	DM2	1.34–2.4 $e^+ e^- \to \rho\pi$, $\omega\pi\pi$

[1] Calculated by us from the cross section at the peak.

[2] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+ \pi^- \pi^0$ and ANTONELLI 92 on the $\omega \pi^+ \pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.

[3] Using the data of AKHMETSHIN 00D and ANTONELLI 92. The $\rho\pi$ dominance for the energy dependence of the $\omega(1420)$ and $\omega(1650)$ width assumed.

[4] From a fit to two Breit-Wigner functions and using the data of DOLINSKY 91 and ANTONELLI 92.

[5] From the partial and leptonic width given by the authors.

[6] From the combined fit of the $\rho\pi$ and $\omega\pi\pi$ final states.

[7] From the product of the leptonic width and partial branching ratio given by the authors.

$\Gamma(\omega\eta)/\Gamma_{total} \times \Gamma(e^+ e^-)/\Gamma_{total}$ — $\Gamma_4/\Gamma \times \Gamma_5/\Gamma$

VALUE (units 10^{-7})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
6.4 $\pm$0.9	267	[1] ACHASOV	20B	SND	$e^+ e^- \to \omega\eta \to \eta\pi^0\gamma$
$5.62^{+0.45}_{-0.42}$		ACHASOV	19	SND	$e^+ e^- \to \pi^+ \pi^- \pi^0 \eta$
4.5 $\pm$0.3 $\pm$0.3	824	[2] AKHMETSHIN	17A	CMD3	1.4–2.0 $e^+ e^- \to \omega\eta$
4.4 $\pm$0.5	898	[3] ACHASOV	16B	SND	1.34–2.00 $e^+ e^- \to \omega\eta$
5.7 $\pm$0.6	13	AUBERT	06D	BABR	10.6 $e^+ e^- \to \omega\eta\gamma$
$<$ 60 at 90% CL		[4] AKHMETSHIN	03B	CMD2	$e^+ e \to \eta\pi^0\gamma$

[1] From a fit with contributions from $\omega(1420)$, $\omega(1650)$, and $\phi(1680)$. The mass of $\omega(1420)$ is fixed to the PDG 18 value of 1420 MeV. Fixing also the width of $\omega(1420)$ to the PDG 18 value of 220 MeV results in $(5.4 \pm 0.6) \times 10^{-7}$ measurement.

[2] From a fit of the interfering $\omega(1420)$ and $\omega(1650)$ with a relative phase of π and other parameters floating. From an alternative fit $\Gamma(\omega(1650) \to \omega\eta)/\Gamma_{total} \times \Gamma(\omega(1650) \to e^+ e^-) = 51 \pm 3$ eV.

[3] From a fit with contributions from $\omega(1420)$, $\omega(1650)$, and $\phi(1680)$.

[4] $\omega(1650)$ mass and width fixed at 1700 MeV and 250 MeV, respectively.

$\omega(1650)$ BRANCHING RATIOS

$\Gamma(\rho\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$\sim$ 0.65	1.2M	[1] ACHASOV	03D	RVUE	0.44–2.00 $e^+ e^- \to \pi^+ \pi^- \pi^0$
0.380$\pm$0.014		[2] HENNER	02	RVUE	1.2–2.0 $e^+ e^- \to \rho\pi$, $\omega\pi\pi$

[1] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+ \pi^- \pi^0$ and ANTONELLI 92 on the $\omega \pi^+ \pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.

[2] Assuming that the $\omega(1650)$ decays into $\rho\pi$ and $\omega\pi\pi$ only.

$\Gamma(\rho(1450)\pi)/\Gamma_{total}$ — Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
seen	ACHASOV	20A	SND	1.15–2.00 $e^+ e^- \to \pi^+ \pi^- \pi^0$

$\Gamma(\omega\pi\pi)/\Gamma_{total}$ — Γ_3/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
~ 0.35	1.2M	[1] ACHASOV	03D	RVUE	0.44–2.00 $e^+ e^- \to \pi^+ \pi^- \pi^0$
0.620 ± 0.014		[2] HENNER	02	RVUE	1.2–2.0 $e^+ e^- \to \rho\pi, \omega\pi\pi$

[1] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+ \pi^- \pi^0$ and ANTONELLI 92 on the $\omega\pi^+ \pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.

[2] Assuming that the $\omega(1650)$ decays into $\rho\pi$ and $\omega\pi\pi$ only.

$\Gamma(e^+ e^-)/\Gamma_{total}$ — Γ_5/Γ

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
~ 18	1.2M	[1,2] ACHASOV	03D	RVUE	0.44–2.00 $e^+ e^- \to \pi^+ \pi^- \pi^0$
32 ± 1		[2] HENNER	02	RVUE	1.2–2.0 $e^+ e^- \to \rho\pi, \omega\pi\pi$

[1] Calculated by us from the cross section at the peak.

[2] Assuming that the $\omega(1650)$ decays into $\rho\pi$ and $\omega\pi\pi$ only.

$\Gamma(\pi^0 \gamma)/\Gamma_{total}$ — Γ_6/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	[1] ACHASOV	10D	SND	1.075–2.0 $e^+ e^- \to \pi^0 \gamma$

[1] From a fit of a VMD model with two effective resonances with masses of 1450 MeV and 1700 MeV to describe the excited vector states $\omega(1420)$, $\rho(1450)$, $\omega(1650)$, and $\rho(1700)$. The width of the highest mass effective resonance is fixed at 315 MeV.

$\omega(1650)$ REFERENCES

ACHASOV 20A EPJ C80 993 M.N. Achasov et al. (SND Collab.)
ACHASOV 20B EPJ C80 1008 M.N. Achasov et al. (SND Collab.)
ABLIKIM 19AQ PR D100 032004 M. Ablikim et al. (BESIII Collab.)
ACHASOV 19 PR D99 112004 M.N. Achasov et al. (SND Collab.)
PDG 18 PR D98 030001 M. Tanabashi et al. (PDG Collab.)
AKHMETSHIN 17A PL B773 150 R.R. Akhmetshin et al. (CMD-3 Collab.)
ACHASOV 16B PR D94 092002 M.N. Achasov et al. (SND Collab.)
AULCHENKO 15A JETP 121 27 V.M. Aulchenko et al. (SND Collab.)
Translated from ZETF 148 34.
ACHASOV 10D PR D98 112001 M.N. Achasov et al. (SND Collab.)
AUBERT 07AU PR D76 092005 B. Aubert et al. (BABAR Collab.)
AUBERT 06D PR D73 052003 B. Aubert et al. (BABAR Collab.)
AUBERT,B 04N PR D70 072004 B. Aubert et al. (BABAR Collab.)
ACHASOV 03D PR D68 052006 M.N. Achasov et al. (Novosibirsk SND Collab.)
AKHMETSHIN 03B PL B562 173 R.R. Akhmetshin et al. (Novosibirsk CMD-2 Collab.)
ACHASOV 02E PR D66 032001 M.N. Achasov et al. (Novosibirsk SND Collab.)
HENNER 02 EPJ C26 3 V.K. Henner et al.
ACHASOV 01E PR D63 072002 M.N. Achasov et al. (Novosibirsk SND Collab.)
EUGENIO 01 PL B497 190 P. Eugenio et al.
AKHMETSHIN 00D PL B489 125 R.R. Akhmetshin et al. (Novosibirsk CMD-2 Collab.)

ACHASOV	99E	PL B462 365	M.N. Achasov *et al.*	(Novosibirsk SND 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 *et al.*	(DM2 Collab.)
BISELLO	91C	ZPHY C52 227	D. Bisello *et al.*	(DM2 Collab.)
DOLINSKY	91	PRPL 202 99	S.I. Dolinsky *et al.*	(NOVO)
BISELLO	88B	ZPHY C39 13	D. Bisello *et al.*	(PADO, CLER, FRAS+)
BARKOV	87	JETPL 46 164	L.M. Barkov *et al.*	(NOVO)
		Translated from ZETFP 46 132.		
ATKINSON	83B	PL 127B 132	M. Atkinson *et al.*	(BONN, CERN, GLAS+)
CORDIER	81	PL 106B 155	A. Cordier *et al.*	(ORSAY)
IVANOV	81	PL 107B 297	P.M. Ivanov *et al.*	(NOVO)
ESPOSITO	80	LNC 28 195	B. Esposito *et al.*	(FRAS, NAPL, PADO+)
COSME	79	NP B152 215	G. Cosme *et al.*	(IPN)