$\omega(1650)$

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

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	$e^+e^- \rightarrow \omega\eta \rightarrow \eta\pi^0\gamma$
$1651\pm 3^{+16}_{-6}$	183k	[2] ABLIKIM 19AQ	BES	$J/\psi \rightarrow K^+K^-\pi^0$
1673^{+6}_{-7}		ACHASOV 19	SND	$e^+e^- \rightarrow \pi^+\pi^-\pi^0\eta$
1671± 6±10	824	[3] AKHMETSHIN 17A	CMD3	1.4–2.0 $e^+e^- \rightarrow \omega\eta$
1660± 10	898	[4] ACHASOV 16B	SND	1.34–2.00 $e^+e^- \rightarrow \omega\eta$
1680± 10	13.1k	[5] AULCHENKO 15A	SND	1.05–1.80 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$
1667± 13± 6		AUBERT 07AU	BABR	10.6 $e^+e^- \rightarrow \omega\pi^+\pi^-\gamma$
1645± 8	13	AUBERT 06D	BABR	10.6 $e^+e^- \rightarrow \omega\eta\gamma$
1660± 10± 2		AUBERT,B 04N	BABR	10.6 $e^+e^- \rightarrow \pi^+\pi^-\pi^0\gamma$
1770± 50±60	1.2M	[6] ACHASOV 03D	RVUE	0.44–2.00 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$
1619± 5		[7] HENNER 02	RVUE	1.2–2.0 $e^+e^- \rightarrow \rho\pi$, $\omega\pi\pi$
1700± 20		EUGENIO 01	SPEC	18 $\pi^-p \rightarrow \omega\eta n$
1705± 26	612	[8] AKHMETSHIN 00D	CMD2	$e^+e^- \rightarrow \omega\pi^+\pi^-$
1820^{+190}_{-150}		[9] ACHASOV 98H	RVUE	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
1840^{+100}_{-70}		[10] ACHASOV 98H	RVUE	$e^+e^- \rightarrow \omega\pi^+\pi^-$
1780^{+170}_{-300}		[11] ACHASOV 98H	RVUE	$e^+e^- \rightarrow K^+K^-$
∼ 2100		[12] ACHASOV 98H	RVUE	$e^+e^- \rightarrow K^0_S K^\pm\pi^\mp$
1606± 9		[13] CLEGG 94	RVUE	
1662± 13	750	[14] ANTONELLI 92	DM2	1.34–2.4$e^+e^- \rightarrow \rho\pi$, $\omega\pi\pi$
1670± 20		ATKINSON 83B	OMEG	20–70 $\gamma p \rightarrow 3\pi X$
1657± 13		CORDIER 81	DM1	$e^+e^- \rightarrow \omega 2\pi$
1679± 34	21	ESPOSITO 80	FRAM	$e^+e^- \rightarrow 3\pi$
1652± 17		COSME 79	OSPK	$e^+e^- \rightarrow 3\pi$

[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 $J/\psi \rightarrow X\pi^0 \rightarrow K^+K^-\pi^0 = (5.3\pm0.3^{+0.6}_{-0.5})\times 10^{-5}$.

[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.

ω(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

ω(1650) Γ(i)Γ(e^+e^-)/Γ^2(total)

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

VALUE (units 10^{-6})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.56 $\pm$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$\pm$0.230		[4,5] CLEGG	94	RVUE	
0.479$\pm$0.050	750	[6,7] ANTONELLI	92	DM2	1.34–2.4$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.

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

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 ± 0.95		[3] AKHMETSHIN	00D	CMD2	1.2–1.38 $e^+e^- \to \omega\pi^+\pi^-$
3.18 ± 0.80		[4,5] CLEGG	94	RVUE	
6.07 ± 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 ± 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 ± 0.5	898	[3] ACHASOV	16B	SND	1.34–2.00 $e^+e^- \to \omega\eta$
5.7 ± 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. • • •					
~ 0.65	1.2M	[1] ACHASOV	03D	RVUE	0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$
0.380 ± 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.

ω(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)