

$\rho(1450)$

$$J^{PC} = 1^{+}(1^{-})^{-}$$

See the related review(s):

 [\$\rho\(1450\)\$ and \$\rho\(1700\)\$](#) **$\rho(1450)$ MASS** **$\rho(1450)$ MASS**

VALUE (MeV)

DOCUMENT ID

1465 ± 25 OUR ESTIMATE This is only an educated guess; the error given is larger than the error on the average of the published values. **$\eta\rho^0$ MODE**

VALUE (MeV)

EVTS

DOCUMENT ID

TECN

COMMENT

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

1500 ± 10	7.4k	¹ ACHASOV 18	SND	1.22–2.00	$e^+e^- \rightarrow \eta\pi^+\pi^-$
1497 ± 14		² AKHMETSHIN 01B	CMD2		$e^+e^- \rightarrow \eta\gamma$
1421 ± 15		³ AKHMETSHIN 00D	CMD2		$e^+e^- \rightarrow \eta\pi^+\pi^-$
1470 ± 20		ANTONELLI 88	DM2		$e^+e^- \rightarrow \eta\pi^+\pi^-$
1446 ± 10		FUKUI 88	SPEC	8.95	$\pi^-p \rightarrow \eta\pi^+\pi^-n$

¹From the combined fit of AULCHENKO 15 and ACHASOV 18 in the model with the interfering $\rho(1450)$, $\rho(1700)$ and $\rho(2150)$ with the parameters of the $\rho(1450)$ and $\rho(1700)$ floating and the mass and width of the $\rho(2150)$ fixed at 2155 MeV and 320 MeV, respectively. The phases of the resonances are π , 0 and π , respectively.

²Using the data of AKHMETSHIN 01B on $e^+e^- \rightarrow \eta\gamma$, AKHMETSHIN 00D and ANTONELLI 88 on $e^+e^- \rightarrow \eta\pi^+\pi^-$.

³Using the data of ANTONELLI 88, DOLINSKY 91, and AKHMETSHIN 00D. The energy-independent width of the $\rho(1450)$ and $\rho(1700)$ mesons assumed.

 $\omega\pi$ MODE

VALUE (MeV)

EVTS

DOCUMENT ID

TECN

COMMENT

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

1510 ± 7	10.2k	¹ ACHASOV 16D	SND	1.05–2.00	$e^+e^- \rightarrow \pi^0\pi^0\gamma$
1544 ± 22 ⁺¹¹ ₋₄₆	821	² MATVIENKO 15	BELL		$\bar{B}^0 \rightarrow D^{*+}\omega\pi^-$
1491 ± 19	7815	³ ACHASOV 13	SND	1.05–2.00	$e^+e^- \rightarrow \pi^0\pi^0\gamma$
1582 ± 17 ± 25	2382	⁴ AKHMETSHIN 03B	CMD2		$e^+e^- \rightarrow \pi^0\pi^0\gamma$
1349 ± 25 ⁺¹⁰ ₋₅	341	⁵ ALEXANDER 01B	CLE2		$B \rightarrow D^{(*)}\omega\pi^-$
1523 ± 10		⁶ EDWARDS 00A	CLE2		$\tau^- \rightarrow \omega\pi^-\nu_\tau$
1463 ± 25		⁷ CLEGG 94	RVUE		
1250		⁸ ASTON 80C	OMEG	20–70	$\gamma p \rightarrow \omega\pi^0 p$
1290 ± 40		⁸ BARBER 80C	SPEC	3–5	$\gamma p \rightarrow \omega\pi^0 p$

- ¹From a phenomenological model based on vector meson dominance with interfering $\rho(770)$, $\rho(1450)$, and $\rho(1700)$. The $\rho(1700)$ mass and width are fixed at 1720 MeV and 250 MeV, respectively. Systematic uncertainties not estimated. Supersedes ACHASOV 13.
- ²Using Breit-Wigner parameterization of the $\rho(1450)$ and assuming equal probabilities of the $\rho(1450) \rightarrow \pi\pi$ and $\rho(1450) \rightarrow \omega\pi$ decays.
- ³From a phenomenological model based on vector meson dominance with the interfering $\rho(1450)$ and $\rho(1700)$ and their widths fixed at 400 and 250 MeV, respectively. Systematic uncertainty not estimated.
- ⁴Using the data of AKHMETSHIN 03B and BISELLO 91B assuming the $\omega\pi^0$ and $\pi^+\pi^-$ mass dependence of the total width. $\rho(1700)$ mass and width fixed at 1700 MeV and 240 MeV, respectively.
- ⁵Using Breit-Wigner parameterization of the $\rho(1450)$ and assuming the $\omega\pi^-$ mass dependence for the total width.
- ⁶Mass-independent width parameterization. $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV respectively.
- ⁷Using data from BISELLO 91B, DOLINSKY 86 and ALBRECHT 87L.
- ⁸Not separated from $b_1(1235)$, not pure $J^P = 1^-$ effect.

4 π MODE

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1435 ± 40	ABELE	01B	CBAR 0.0 $\bar{p}n \rightarrow 2\pi^- 2\pi^0 \pi^+$
1350 ± 50	ACHASOV	97	RVUE $e^+e^- \rightarrow 2(\pi^+\pi^-)$
1449 ± 4	¹ ARMSTRONG	89E	OMEG 300 $pp \rightarrow p\rho 2(\pi^+\pi^-)$

¹Not clear whether this observation has $l=1$ or 0.

$\pi\pi$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1326.35 ± 3.46		¹ BARTOS	17	RVUE $e^+e^- \rightarrow \pi^+\pi^-$
1342.31 ± 46.62		² BARTOS	17A	RVUE $e^+e^- \rightarrow \pi^+\pi^-$
1373.83 ± 11.37		³ BARTOS	17A	RVUE $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
1429 ± 41	20K	⁴ LEES	17C	BABR $J/\psi \rightarrow \pi^+\pi^-\pi^0$
1350 ± 20	$^{+20}_{-30}$ 63.5k	⁵ ABRAMOWICZ12	ZEUS	$ep \rightarrow e\pi^+\pi^-p$
1493 ± 15		⁶ LEES	12G	BABR $e^+e^- \rightarrow \pi^+\pi^-\gamma$
1446 ± 7	± 28 5.4M	^{7,8} FUJIKAWA	08	BELL $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
1328 ± 15		⁹ SCHAEEL	05C	ALEP $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
1406 ± 15	87k	^{7,10} ANDERSON	00A	CLE2 $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
~ 1368		¹¹ ABELE	99C	CBAR 0.0 $\bar{p}d \rightarrow \pi^+\pi^-\pi^-p$
1348 ± 33		BERTIN	98	OBLX 0.05–0.405 $\bar{n}p \rightarrow$ $2\pi^+\pi^-$
1411 ± 14		¹² ABELE	97	CBAR $\bar{p}n \rightarrow \pi^-\pi^0\pi^0$
1370 $^{+90}_{-70}$		ACHASOV	97	RVUE $e^+e^- \rightarrow \pi^+\pi^-$
1359 ± 40		¹⁰ BERTIN	97C	OBLX 0.0 $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$
1282 ± 37		BERTIN	97D	OBLX 0.05 $\bar{p}p \rightarrow 2\pi^+ 2\pi^-$
1424 ± 25		BISELLO	89	DM2 $e^+e^- \rightarrow \pi^+\pi^-$
1265.5 ± 75.3		DUBNICKA	89	RVUE $e^+e^- \rightarrow \pi^+\pi^-$
1292 ± 17		¹³ KURDADZE	83	OLYA 0.64–1.4 $e^+e^- \rightarrow$ $\pi^+\pi^-$

- ¹ Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUB-NICKA 10 to analyze the data of LEES 12G and ABLIKIM 16C.
- ² Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUB-NICKA 10 to analyze the data of ACHASOV 06, AKHMETSHIN 07, AUBERT 09AS, and AMBROSINO 11A.
- ³ Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUB-NICKA 10 to analyze the data of FUJIKAWA 08.
- ⁴ From a Dalitz plot analysis in an isobar model with $\rho(1450)$ and $\rho(1700)$ masses and widths floating.
- ⁵ Using the KUHN 90 parametrization of the pion form factor, neglecting ρ - ω interference.
- ⁶ Using the GOUNARIS 68 parametrization of the pion form factor leaving the masses and widths of the $\rho(1450)$, $\rho(1700)$, and $\rho(2150)$ resonances as free parameters of the fit.
- ⁷ From the GOUNARIS 68 parametrization of the pion form factor.
- ⁸ $|F_\pi(0)|^2$ fixed to 1.
- ⁹ From the combined fit of the τ^- data from ANDERSON 00A and SCHAEEL 05C and e^+e^- data from the compilation of BARKOV 85, AKHMETSHIN 04, and ALOISIO 05. $\rho(1700)$ mass and width fixed at 1713 MeV and 235 MeV, respectively. Supersedes BARATE 97M.
- ¹⁰ $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV, respectively.
- ¹¹ $\rho(1700)$ mass and width fixed at 1780 MeV and 275 MeV respectively.
- ¹² T-matrix pole.
- ¹³ Using for $\rho(1700)$ mass and width 1600 ± 20 and 300 ± 10 MeV respectively.

$K\bar{K}$ MODE

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

1208 ± 8 ± 9	190k	¹ AAIJ	16N	LHCB	$D^0 \rightarrow K_S^0 K^\pm \pi^\mp$
1422.8 ± 6.5	27k	² ABELE	99D	CBAR \pm	$0.0 \bar{p}p \rightarrow K^+ K^- \pi^0$

¹ Using the GOUNARIS 68 parameterization with fixed width.

² K-matrix pole. Isospin not determined, could be $\omega(1420)$.

$K\bar{K}^*(892) + \text{c.c.}$ MODE

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

1505 ± 19 ± 7	AUBERT	08S	BABR 10.6 $e^+e^- \rightarrow K\bar{K}^*(892)\gamma$
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$m_{\rho(1450)^0} - m_{\rho(1450)^\pm}$

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

-31.53 ± 47.99	¹ BARTOS	17A	RVUE $e^+e^- \rightarrow \pi^+\pi^-$, $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
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¹ Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUB-NICKA 10 to analyze the data of ACHASOV 06, AKHMETSHIN 07, AUBERT 09AS, AMBROSINO 11A, and FUJIKAWA 08.

$\rho(1450)$ WIDTH

$\rho(1450)$ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
400 ± 60 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. • • •

480 ± 180	¹ ACHASOV	10D	SND	1.075–2.0 $e^+e^- \rightarrow \pi^0\gamma$
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¹From 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 $\rho(1700)$. Systematic errors not evaluated.

$\eta\rho^0$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
280 ± 20	7.4k	¹ ACHASOV	18	SND	1.22–2.00 $e^+e^- \rightarrow \eta\pi^+\pi^-$
226 ± 44		² AKHMETSHIN 01B	CMD2		$e^+e^- \rightarrow \eta\gamma$
211 ± 31		³ AKHMETSHIN 00D	CMD2		$e^+e^- \rightarrow \eta\pi^+\pi^-$
230 ± 30		ANTONELLI 88	DM2		$e^+e^- \rightarrow \eta\pi^+\pi^-$
60 ± 15		FUKUI	88	SPEC	8.95 $\pi^-p \rightarrow \eta\pi^+\pi^-n$

¹From the combined fit of AULCHENKO 15 and ACHASOV 18 in the model with the interfering $\rho(1450)$, $\rho(1700)$ and $\rho(2150)$ with the parameters of the $\rho(1450)$ and $\rho(1700)$ floating and the mass and width of the $\rho(2150)$ fixed at 2155 MeV and 320 MeV, respectively. The phases of the resonances are π , 0 and π , respectively.

²Using the data of AKHMETSHIN 01B on $e^+e^- \rightarrow \eta\gamma$, AKHMETSHIN 00D and ANTONELLI 88 on $e^+e^- \rightarrow \eta\pi^+\pi^-$.

³Using the data of ANTONELLI 88, DOLINSKY 91, and AKHMETSHIN 00D. The energy-independent width of the $\rho(1450)$ and $\rho(1700)$ mesons assumed.

$\omega\pi$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
440 ± 40	10.2k	¹ ACHASOV	16D	SND	1.05–2.00 $e^+e^- \rightarrow \pi^0\pi^0\gamma$
303 ⁺ _– 31 ⁺ _– 69 ⁺ _– 52 [–] _– 7	821	² MATVIENKO	15	BELL	$\bar{B}^0 \rightarrow D^{*+}\omega\pi^-$
429 ± 42 ± 10	2382	³ AKHMETSHIN 03B	CMD2		$e^+e^- \rightarrow \pi^0\pi^0\gamma$
547 ± 86 ⁺ _– 46 ⁺ _– 45	341	⁴ ALEXANDER	01B	CLE2	$B \rightarrow D^{(*)}\omega\pi^-$
400 ± 35		⁵ EDWARDS	00A	CLE2	$\tau^- \rightarrow \omega\pi^-\nu_\tau$
311 ± 62		⁶ CLEGG	94	RVUE	
300		⁷ ASTON	80C	OMEG	20–70 $\gamma p \rightarrow \omega\pi^0 p$
320 ± 100		⁷ BARBER	80C	SPEC	3–5 $\gamma p \rightarrow \omega\pi^0 p$

¹From a phenomenological model based on vector meson dominance with interfering $\rho(770)$, $\rho(1450)$, and $\rho(1700)$. The $\rho(1700)$ mass and width are fixed at 1720 MeV and 250 MeV, respectively. Systematic uncertainties not estimated. Supersedes ACHASOV 13.

²Using Breit-Wigner parameterization of the $\rho(1450)$ and assuming equal probabilities of the $\rho(1450) \rightarrow \pi\pi$ and $\rho(1450) \rightarrow \omega\pi$ decays.

³Using the data of AKHMETSHIN 03B and BISELLO 91B assuming the $\omega\pi^0$ and $\pi^+\pi^-$ mass dependence of the total width. $\rho(1700)$ mass and width fixed at 1700 MeV and 240 MeV, respectively.

- ⁴ Using Breit-Wigner parameterization of the $\rho(1450)$ and assuming the $\omega\pi^-$ mass dependence for the total width.
⁵ Mass-independent width parameterization. $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV respectively.
⁶ Using data from BISELLO 91B, DOLINSKY 86 and ALBRECHT 87L.
⁷ Not separated from $b_1(1235)$, not pure $J^P = 1^-$ effect.

4 π MODE

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
325 ± 100	ABELE	01B	CBAR 0.0 $\bar{p}n \rightarrow 2\pi^- 2\pi^0 \pi^+$

$\pi\pi$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
324.13 ± 12.01		¹ BARTOS 17	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$
492.17 ± 138.38		² BARTOS 17A	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$
340.87 ± 23.84		³ BARTOS 17A	RVUE	$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
576 ± 29	20K	⁴ LEES 17C	BABR	$J/\psi \rightarrow \pi^+\pi^-\pi^0$
460 ± 30	$\begin{matrix} +40 \\ -45 \end{matrix}$ 63.5k	⁵ ABRAMOWICZ12	ZEUS	$ep \rightarrow e\pi^+\pi^-p$
427 ± 31		⁶ LEES 12G	BABR	$e^+e^- \rightarrow \pi^+\pi^-\gamma$
434 ± 16	±60 5.4M	^{7,8} FUJIKAWA 08	BELL	$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
468 ± 41		⁹ SCHAEEL 05C	ALEP	$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
455 ± 41	87k	^{7,10} ANDERSON 00A	CLE2	$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
~ 374		¹¹ ABELE 99C	CBAR	0.0 $\bar{p}d \rightarrow \pi^+\pi^-\pi^-p$
275 ± 10		BERTIN 98	OBLX	0.05–0.405 $\bar{p}p \rightarrow \pi^+\pi^+\pi^-$
343 ± 20		¹² ABELE 97	CBAR	$\bar{p}n \rightarrow \pi^-\pi^0\pi^0$
310 ± 40		¹⁰ BERTIN 97C	OBLX	0.0 $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$
236 ± 36		BERTIN 97D	OBLX	0.05 $\bar{p}p \rightarrow 2\pi^+2\pi^-$
269 ± 31		BISELLO 89	DM2	$e^+e^- \rightarrow \pi^+\pi^-$
391 ± 70		DUBNICKA 89	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$
218 ± 46		¹³ KURDADZE 83	OLYA	0.64–1.4 $e^+e^- \rightarrow \pi^+\pi^-$

- ¹ Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUBNICKA 10 to analyze the data of LEES 12G and ABLIKIM 16C.
² Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUBNICKA 10 to analyze the data of ACHASOV 06, AKHMETSHIN 07, AUBERT 09AS, and AMBROSINO 11A.
³ Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUBNICKA 10 to analyze the data of FUJIKAWA 08.
⁴ From a Dalitz plot analysis in an isobar model with $\rho(1450)$ and $\rho(1700)$ masses and widths floating.
⁵ Using the KUHN 90 parametrization of the pion form factor, neglecting $\rho-\omega$ interference.
⁶ Using the GOUNARIS 68 parametrization of the pion form factor leaving the masses and widths of the $\rho(1450)$, $\rho(1700)$, and $\rho(2150)$ resonances as free parameters of the fit.
⁷ From the GOUNARIS 68 parametrization of the pion form factor.
⁸ $|F_\pi(0)|^2$ fixed to 1.
⁹ From the combined fit of the τ^- data from ANDERSON 00A and SCHAEEL 05C and e^+e^- data from the compilation of BARKOV 85, AKHMETSHIN 04, and ALOISIO 05.

$\rho(1700)$ mass and width fixed at 1713 MeV and 235 MeV, respectively. Supersedes BARATE 97M.

¹⁰ $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV, respectively.

¹¹ $\rho(1700)$ mass and width fixed at 1780 MeV and 275 MeV respectively.

¹² T-matrix pole.

¹³ Using for $\rho(1700)$ mass and width 1600 ± 20 and 300 ± 10 MeV respectively.

$K\bar{K}$ MODE

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

410 ± 19 ± 35	190k	¹ AAIJ	16N	LHCB	$D^0 \rightarrow K_S^0 K^\pm \pi^\mp$
146.5 ± 10.5	27k	² ABELE	99D	CBAR ±	$0.0 \bar{p}p \rightarrow K^+ K^- \pi^0$

¹ Using the GOUNARIS 68 parameterization with fixed mass.

² K-matrix pole. Isospin not determined, could be $\omega(1420)$.

$K\bar{K}^*(892) + c.c.$ MODE

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

418 ± 25 ± 4	AUBERT	08S	BABR 10.6 $e^+ e^- \rightarrow K\bar{K}^*(892)\gamma$
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$\Gamma_{\rho(1450)^0} - \Gamma_{\rho(1450)^\pm}$

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

151.30 ± 140.42	¹ BARTOS	17A	RVUE $e^+ e^- \rightarrow \pi^+ \pi^-$, $\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
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¹ Applies the Unitary & Analytic Model of the pion electromagnetic form factor of DUB-NICKA 10 to analyze the data of ACHASOV 06, AKHMETSHIN 07, AUBERT 09AS, AMBROSINO 11A, and FUJIKAWA 08.

$\rho(1450)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $\pi\pi$	seen
Γ_2 $\pi^+\pi^-$	seen
Γ_3 4π	seen
Γ_4 $\omega\pi$	
Γ_5 $a_1(1260)\pi$	
Γ_6 $h_1(1170)\pi$	
Γ_7 $\pi(1300)\pi$	
Γ_8 $\rho\rho$	
Γ_9 $\rho(\pi\pi)_S\text{-wave}$	
Γ_{10} e^+e^-	seen
Γ_{11} $\eta\rho$	seen

Γ_{12}	$a_2(1320)\pi$	not seen
Γ_{13}	$K\bar{K}$	seen
Γ_{14}	K^+K^-	seen
Γ_{15}	$K\bar{K}^*(892)+\text{c.c.}$	possibly seen
Γ_{16}	$\pi^0\gamma$	
Γ_{17}	$\eta\gamma$	seen
Γ_{18}	$f_0(500)\gamma$	not seen
Γ_{19}	$f_0(980)\gamma$	not seen
Γ_{20}	$f_0(1370)\gamma$	not seen
Γ_{21}	$f_2(1270)\gamma$	not seen

$\rho(1450)\Gamma(i)\Gamma(e^+e^-)/\Gamma(\text{total})$

$\Gamma(\pi\pi) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_1\Gamma_{10}/\Gamma$

<u>VALUE (keV)</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. • • •

0.12	¹ DIEKMAN	88	RVUE $e^+e^- \rightarrow \pi^+\pi^-$
$0.027^{+0.015}_{-0.010}$	² KURDADZE	83	OLYA $0.64\text{--}1.4 e^+e^- \rightarrow \pi^+\pi^-$

¹ Using total width = 235 MeV.

² Using for $\rho(1700)$ mass and width 1600 ± 20 and 300 ± 10 MeV respectively.

$\Gamma(\eta\rho) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_{11}\Gamma_{10}/\Gamma$

<u>VALUE (eV)</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. • • •

$210 \pm 24 \pm 10$	¹ LEES	18	BABR $e^+e^- \rightarrow \eta\pi^+\pi^-$
74 ± 20	² AKHMETSHIN 00D	CMD2	$e^+e^- \rightarrow \eta\pi^+\pi^-$
91 ± 19	ANTONELLI	88	DM2 $e^+e^- \rightarrow \eta\pi^+\pi^-$

¹ Includes non-resonant contribution. The selected fit model includes three ρ excited states. Model uncertainty is 20%.

² Using the data of ANTONELLI 88, DOLINSKY 91, and AKHMETSHIN 00D. The energy-independent width of the $\rho(1450)$ and $\rho(1700)$ mesons assumed.

$\Gamma(\eta\gamma) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_{17}\Gamma_{10}/\Gamma$

<u>VALUE (eV)</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. • • •

<16.4	¹ AKHMETSHIN 05	CMD2	$0.60\text{--}1.38 e^+e^- \rightarrow \eta\gamma$
$2.2 \pm 0.5 \pm 0.3$	² AKHMETSHIN 01B	CMD2	$e^+e^- \rightarrow \eta\gamma$

¹ From 2γ decay mode of η using 1465 MeV and 310 MeV for the $\rho(1450)$ mass and width. Recalculated by us.

² Using the data of AKHMETSHIN 01B on $e^+e^- \rightarrow \eta\gamma$, AKHMETSHIN 00D and ANTONELLI 88 on $e^+e^- \rightarrow \eta\pi^+\pi^-$. Recalculated by us using width of 226 MeV.

$\Gamma(K\bar{K}^*(892)+\text{c.c.}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_{15}\Gamma_{10}/\Gamma$

<u>VALUE (eV)</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. • • •

$127 \pm 15 \pm 6$	AUBERT	08S	BABR $10.6 e^+e^- \rightarrow K\bar{K}^*(892)\gamma$
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$\rho(1450) \Gamma(i)/\Gamma(\text{total}) \times \Gamma(e^+ e^-)/\Gamma(\text{total})$

$\Gamma(\omega\pi)/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ $\Gamma_4/\Gamma \times \Gamma_{10}/\Gamma$

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

2.1 ± 0.4	10.2k	¹ ACHASOV	16D SND	1.05–2.00 $e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$
5.3 ± 0.4	7815	² ACHASOV	13 SND	1.05–2.00 $e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$

¹From a phenomenological model based on vector meson dominance with interfering $\rho(770)$, $\rho(1450)$, and $\rho(1700)$. The $\rho(1700)$ mass and width are fixed at 1720 MeV and 250 MeV, respectively. Systematic uncertainties not estimated. Supersedes ACHASOV 13.

²From a phenomenological model based on vector meson dominance with the interfering $\rho(1450)$ and $\rho(1700)$ and their widths fixed at 400 and 250 MeV, respectively. Systematic uncertainty not estimated.

$\Gamma(\eta\rho)/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ $\Gamma_{11}/\Gamma \times \Gamma_{10}/\Gamma$

VALUE (units 10^{-7})	EVTS	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

7.3 ± 0.3	7.4k	¹ ACHASOV	18 SND	1.22–2.00 $e^+ e^- \rightarrow \eta \pi^+ \pi^-$
$4.3^{+1.1}_{-0.9} \pm 0.2$	4.9k	² AULCHENKO	15 SND	1.22–2.00 $e^+ e^- \rightarrow \eta \pi^+ \pi^-$

¹From the combined fit of AULCHENKO 15 and ACHASOV 18 in the model with the interfering $\rho(1450)$, $\rho(1700)$ and $\rho(2150)$ with the parameters of the $\rho(1450)$ and $\rho(1700)$ floating and the mass and width of the $\rho(2150)$ fixed at 2155 MeV and 320 MeV, respectively. The phases of the resonances are π , 0 and π , respectively.

²From a fit to the $e^+ e^- \rightarrow \eta \pi^+ \pi^-$ cross section with vector meson dominance model including $\rho(770)$, $\rho(1450)$, and $\rho(1700)$ decaying exclusively via $\eta\rho(770)$. Masses and widths of vector states are fixed to PDG 14. Coupling constants are assumed to be real.

$\Gamma(f_0(500)\gamma)/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ $\Gamma_{18}/\Gamma \times \Gamma_{10}/\Gamma$

VALUE (units 10^{-9})	CL%	DOCUMENT ID	TECN	COMMENT
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<4.0	90	ACHASOV	11 SND	$e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$
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$\Gamma(\pi^0\gamma)/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ $\Gamma_{16}/\Gamma \times \Gamma_{10}/\Gamma$

VALUE (units 10^{-9})	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

2.3 ± 1.4	¹ ACHASOV	10D SND	1.075–2.0 $e^+ e^- \rightarrow \pi^0 \gamma$
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¹From 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 $\rho(1700)$. Systematic errors not evaluated.

$\Gamma(f_0(980)\gamma)/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ $\Gamma_{19}/\Gamma \times \Gamma_{10}/\Gamma$

VALUE (units 10^{-9})	CL%	DOCUMENT ID	TECN	COMMENT
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<2.6	90	ACHASOV	11 SND	$e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$
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$\Gamma(f_0(1370)\gamma)/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ $\Gamma_{20}/\Gamma \times \Gamma_{10}/\Gamma$

VALUE (units 10^{-9})	CL%	DOCUMENT ID	TECN	COMMENT
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<3.5	90	ACHASOV	11 SND	$e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$
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$\Gamma(f_2(1270)\gamma)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}} \qquad \Gamma_{21}/\Gamma \times \Gamma_{10}/\Gamma$

VALUE (units 10^{-9})	CL%	DOCUMENT ID	TECN	COMMENT
<0.8	90	¹ ACHASOV	11	SND $e^+e^- \rightarrow \pi^0\pi^0\gamma$

¹ Using Breit-Wigner parametrization of the $\rho(1450)$ with mass and width of 1465 MeV and 400 MeV, respectively.

 $\rho(1450)$ BRANCHING RATIOS $\Gamma(\pi\pi)/\Gamma(4\pi) \qquad \Gamma_1/\Gamma_3$

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

0.37 ± 0.10 ^{1,2}ABELE 01B CBAR 0.0 $\bar{p}n \rightarrow 5\pi$

¹ $\omega\pi$ not included.

² Using ABELE 97.

 $\Gamma(K^+K^-)/\Gamma(\pi^+\pi^-) \qquad \Gamma_{14}/\Gamma_2$

VALUE (%)	EVTS	DOCUMENT ID	TECN	COMMENT
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30.7 ± 8.4 ± 8.2 20K ¹LEES 17C BABR $J/\psi \rightarrow h^+h^-\pi^0$

¹ From Dalitz plot analyses in isobar models.

 $\Gamma(\omega\pi)/\Gamma_{\text{total}} \qquad \Gamma_4/\Gamma$

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

seen 821 ¹MATVIENKO 15 BELL $\bar{B}^0 \rightarrow D^{*+}\omega\pi^-$

seen 1.6k ACHASOV 12 SND $e^+e^- \rightarrow \pi^0\pi^0\gamma$

~ 0.21 CLEGG 94 RVUE

¹ Using Breit-Wigner parameterization of the $\rho(1450)$ and assuming equal probabilities of the $\rho(1450) \rightarrow \pi\pi$ and $\rho(1450) \rightarrow \omega\pi$ decays.

 $\Gamma(\pi\pi)/\Gamma(\omega\pi) \qquad \Gamma_1/\Gamma_4$

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

~ 0.32 CLEGG 94 RVUE

 $\Gamma(\omega\pi)/\Gamma(4\pi) \qquad \Gamma_4/\Gamma_3$

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

<0.14 CLEGG 88 RVUE

 $\Gamma(a_1(1260)\pi)/\Gamma(4\pi) \qquad \Gamma_5/\Gamma_3$

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

0.27 ± 0.08 ¹ABELE 01B CBAR 0.0 $\bar{p}n \rightarrow 5\pi$

¹ $\omega\pi$ not included.

$\Gamma(h_1(1170)\pi)/\Gamma(4\pi)$

Γ_6/Γ_3

<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. • • •

0.08 ± 0.04	¹ ABELE	01B	CBAR 0.0 $\bar{p}n \rightarrow 5\pi$
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¹ $\omega\pi$ not included.

$\Gamma(\pi(1300)\pi)/\Gamma(4\pi)$

Γ_7/Γ_3

<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. • • •

0.37 ± 0.13	¹ ABELE	01B	CBAR 0.0 $\bar{p}n \rightarrow 5\pi$
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¹ $\omega\pi$ not included.

$\Gamma(\rho\rho)/\Gamma(4\pi)$

Γ_8/Γ_3

<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. • • •

0.11 ± 0.05	¹ ABELE	01B	CBAR 0.0 $\bar{p}n \rightarrow 5\pi$
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¹ $\omega\pi$ not included.

$\Gamma(\rho(\pi\pi)_{S\text{-wave}})/\Gamma(4\pi)$

Γ_9/Γ_3

<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. • • •

0.17 ± 0.09	¹ ABELE	01B	CBAR 0.0 $\bar{p}n \rightarrow 5\pi$
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¹ $\omega\pi$ not included.

$\Gamma(\eta\rho)/\Gamma_{\text{total}}$

Γ_{11}/Γ

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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seen	35	¹ ACHASOV	14	SND 1.15–2.00 $e^+e^- \rightarrow \eta\gamma$
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<0.04	DONNACHIE	87B	RVUE
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¹From a phenomenological model based on vector meson dominance with $\rho(1450)$ and $\phi(1680)$ masses and widths from the PDG 12.

$\Gamma(\eta\rho)/\Gamma(\omega\pi)$

Γ_{11}/Γ_4

<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. • • •

0.081 ± 0.020	^{1,2} AULCHENKO	15	SND 1.22–2.00 $e^+e^- \rightarrow \eta\pi^+\pi^-$
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~ 0.24	³ DONNACHIE	91	RVUE
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>2	FUKUI	91	SPEC 8.95 $\pi^-p \rightarrow \omega\pi^0n$
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¹From a fit to the $e^+e^- \rightarrow \eta\pi^+\pi^-$ cross section with vector meson dominance model including $\rho(770)$, $\rho(1450)$, and $\rho(1700)$ decaying exclusively via $\eta\rho(770)$. Masses and widths of vector states are fixed to PDG 14. Coupling constants are assumed to be real.

²Reports the inverse of the quoted value as 12.3 ± 3.1 .

³Using data from BISELLO 91B, DOLINSKY 86 and ALBRECHT 87L.

$\Gamma(\pi\pi)/\Gamma(\eta\rho)$ Γ_1/Γ_{11}

<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. ● ● ●

1.3 ± 0.4	¹ AULCHENKO 15	SND	$1.22\text{--}2.00 e^+ e^- \rightarrow \eta\pi^+\pi^-$
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¹ From a fit to the $e^+ e^- \rightarrow \eta\pi^+\pi^-$ cross section with vector meson dominance model including $\rho(770)$, $\rho(1450)$, and $\rho(1700)$ decaying exclusively via $\eta\rho(770)$. Masses and widths of vector states are fixed to PDG 14. Coupling constants are assumed to be real.

 $\Gamma(a_2(1320)\pi)/\Gamma_{\text{total}}$ Γ_{12}/Γ

<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. ● ● ●

not seen	AMELIN	00	VES $37 \pi^- p \rightarrow \eta\pi^+\pi^- n$
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 $\Gamma(K\bar{K})/\Gamma(\omega\pi)$ Γ_{13}/Γ_4

<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. ● ● ●

<0.08	¹ DONNACHIE 91	RVUE	
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¹ Using data from BISELLO 91B, DOLINSKY 86 and ALBRECHT 87L.

 $\Gamma(K\bar{K}^*(892)+\text{c.c.})/\Gamma_{\text{total}}$ Γ_{15}/Γ

<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. ● ● ●

possibly seen	COAN	04	CLEO $\tau^- \rightarrow K^- \pi^- K^+ \nu_\tau$
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 $\Gamma(\eta\gamma)/\Gamma_{\text{total}}$ Γ_{17}/Γ

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

 $\rho(1450)$ REFERENCES

ACHASOV	18	PR D97 012008	M.N. Achasov <i>et al.</i>	(SND Collab.)
LEES	18	PR D97 052007	J.P. Lees <i>et al.</i>	(BABAR Collab.)
BARTOS	17	PR D96 113004	E. Bartos <i>et al.</i>	
BARTOS	17A	IJMP A32 1750154	E. Bartos <i>et al.</i>	
LEES	17C	PR D95 072007	J.P. Lees <i>et al.</i>	(BABAR Collab)
AAIJ	16N	PR D93 052018	R. Aaij <i>et al.</i>	(LHCb Collab.)
ABLIKIM	16C	PL B753 629	M. Ablikim <i>et al.</i>	(BES III Collab.)
ACHASOV	16D	PR D94 112001	M.N. Achasov <i>et al.</i>	(SND Collab.)
AULCHENKO	15	PR D91 052013	V.M. Aulchenko <i>et al.</i>	(SND Collab.)
MATVIENKO	15	PR D92 012013	D. Matvienko <i>et al.</i>	(BELLE Collab.)
ACHASOV	14	PR D90 032002	M.N. Achasov <i>et al.</i>	(SND Collab.)
PDG	14	CP C38 070001	K. Olive <i>et al.</i>	(PDG Collab.)
ACHASOV	13	PR D88 054013	M.N. Achasov <i>et al.</i>	(SND Collab.)
ABRAMOWICZ	12	EPJ C72 1869	H. Abramowicz <i>et al.</i>	(ZEUS Collab.)
ACHASOV	12	JETPL 94 734	M.N. Achasov <i>et al.</i>	
		Translated from ZETFP 94 796.		
LEES	12G	PR D86 032013	J.P. Lees <i>et al.</i>	(BABAR Collab.)
PDG	12	PR D86 010001	J. Beringer <i>et al.</i>	(PDG Collab.)
ACHASOV	11	JETP 113 75	M.N. Achasov <i>et al.</i>	(SND Collab.)
		Translated from ZETF 140 87.		

AMBROSINO	11A	PL B700 102	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
ACHASOV	10D	PR D98 112001	M.N. Achasov <i>et al.</i>	(SND Collab.)
DUBNICKA	10	APS 60 1	S. Dubnicka, A.Z. Dubnickova	
AUBERT	09AS	PRL 103 231801	B. Aubert <i>et al.</i>	(BABAR Collab.)
AUBERT	08S	PR D77 092002	B. Aubert <i>et al.</i>	(BABAR Collab.)
FUJIKAWA	08	PR D78 072006	M. Fujikawa <i>et al.</i>	(BELLE Collab.)
AKHMETSHIN	07	PL B648 28	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ACHASOV	06	JETP 103 380	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AKHMETSHIN	05	Translated from ZETF 130 437.	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ALUISIO	05	PL B606 12	A. Aloisio <i>et al.</i>	(KLOE Collab.)
SCHAEEL	05C	PRPL 421 191	S. Schaeel <i>et al.</i>	(ALEPH Collab.)
AKHMETSHIN	04	PL B578 285	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
COAN	04	PRL 92 232001	T.E. Coan <i>et al.</i>	(CLEO Collab.)
AKHMETSHIN	03B	PL B562 173	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ABELE	01B	EPJ C21 261	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
AKHMETSHIN	01B	PL B509 217	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ALEXANDER	01B	PR D64 092001	J.P. Alexander <i>et al.</i>	(CLEO Collab.)
AKHMETSHIN	00D	PL B489 125	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AMELIN	00	NP A668 83	D. Amelin <i>et al.</i>	(VES Collab.)
ANDERSON	00A	PR D61 112002	S. Anderson <i>et al.</i>	(CLEO Collab.)
EDWARDS	00A	PR D61 072003	K.W. Edwards <i>et al.</i>	(CLEO Collab.)
ABELE	99C	PL B450 275	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ABELE	99D	PL B468 178	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
BERTIN	98	PR D57 55	A. Bertin <i>et al.</i>	(OBELIX Collab.)
ABELE	97	PL B391 191	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ACHASOV	97	PR D55 2663	M.N. Achasov <i>et al.</i>	(NOVM)
BARATE	97M	ZPHY C76 15	R. Barate <i>et al.</i>	(ALEPH Collab.)
BERTIN	97C	PL B408 476	A. Bertin <i>et al.</i>	(OBELIX Collab.)
BERTIN	97D	PL B414 220	A. Bertin <i>et al.</i>	(OBELIX Collab.)
CLEGG	94	ZPHY C62 455	A.B. Clegg, A. Donnachie	(LANC, MCHS)
BISELLO	91B	NPBPS B21 111	D. Bisello	(DM2 Collab.)
DOLINSKY	91	PRPL 202 99	S.I. Dolinsky <i>et al.</i>	(NOVO)
DONNACHIE	91	ZPHY C51 689	A. Donnachie, A.B. Clegg	(MCHS, LANC)
FUKUI	91	PL B257 241	S. Fukui <i>et al.</i>	(SUGI, NAGO, KEK, KYOT+)
KUHN	90	ZPHY C48 445	J.H. Kuhn <i>et al.</i>	(MPIM)
ARMSTRONG	89E	PL B228 536	T.A. Armstrong, M. Benayoun	(ATHU, BARI, BIRM+)
BISELLO	89	PL B220 321	D. Bisello <i>et al.</i>	(DM2 Collab.)
DUBNICKA	89	JP G15 1349	S. Dubnicka <i>et al.</i>	(JINR, SLOV)
ANTONELLI	88	PL B212 133	A. Antonelli <i>et al.</i>	(DM2 Collab.)
CLEGG	88	ZPHY C40 313	A.B. Clegg, A. Donnachie	(MCHS, LANC)
DIEKMAN	88	PRPL 159 99	B. Diekmann	(BONN)
FUKUI	88	PL B202 441	S. Fukui <i>et al.</i>	(SUGI, NAGO, KEK, KYOT+)
ALBRECHT	87L	PL B185 223	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
DONNACHIE	87B	ZPHY C34 257	A. Donnachie, A.B. Clegg	(MCHS, LANC)
DOLINSKY	86	PL B174 453	S.I. Dolinsky <i>et al.</i>	(NOVO)
BARKOV	85	NP B256 365	L.M. Barkov <i>et al.</i>	(NOVO)
KURDADZE	83	JETPL 37 733	L.M. Kurdadze <i>et al.</i>	(NOVO)
ASTON	80C	Translated from ZETFP 37 613.	D. Aston	(BONN, CERN, EPOL, GLAS, LANC+)
BARBER	80C	PL 92B 211	D.P. Barber <i>et al.</i>	(DARE, LANC, SHEF)
GOUNARIS	68	ZPHY C4 169	G.J. Gounaris, J.J. Sakurai	
		PRL 21 244		