$\rho(770)$

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

THE $\rho(770)$

Updated April 2006 by S. Eidelman (Novosibirsk).

The determination of the parameters of the $\rho(770)$ is beset with many difficulties because of its large width. In physical region fits, the line shape does not correspond to a relativistic Breit-Wigner function with a P-wave width, but requires some additional shape parameter. This dependence on parameterization was demonstrated long ago by PISUT 68. Bose-Einstein correlations are another source of shifts in the $\rho(770)$ line shape, particularly in multiparticle final state systems (LAFFERTY 93).

The same model dependence afflicts any other source of resonance parameters, such as the energy dependence of the phase shift δ_1^1, or the pole position. It is, therefore, not surprising that a study of $\rho(770)$ dominance in the decays of the η and η' reveals the need for specific dynamical effects, in addition to the $\rho(770)$ pole (ABELE 97B, BENAYOUN 03B).

The cleanest determination of the $\rho(770)$ mass and width comes from the e^+e^- annihilation and τ-lepton decays. BARATE 97M showed that the charged $\rho(770)$ parameters measured from τ-lepton decays are consistent with those of the neutral one determined from e^+e^- data of BARKOV 85. This conclusion is qualitatively supported by the high statistics study of ANDERSON 00A. However, model-independent comparison of the two-pion mass spectrum in τ decays and the $e^+e^- \to \pi^+\pi^-$ cross section gave indications of discrepancies between the overall normalization: τ data are about 3% higher than e^+e^- data (ANDERSON 00A, EIDELMAN 99). A detailed analysis using such two-pion mass spectra from τ decays measured by OPAL (ACKERSTAFF 99F), CLEO (ANDERSON 00A) and ALEPH

(DAVIER 03A, SCHAEL 05C) as well as recent pion form factor measurements in e^+e^- annihilation by CMD-2 (AKHMETSHIN 02, AKHMETSHIN 04) showed that the discrepancy can be as high as 10% above the ρ meson (DAVIER 03, DAVIER 03B). This discrepancy retains after recent measurements of the two-pion cross section in e^+e^- annihilation at KLOE (ALOISIO 05) and SND (ACHASOV 05A, ACHASOV 06). This effect is not accounted for by isospin breaking (ALEMANY 98, CZYZ 01, CIRIGLIANO 01, CIRIGLIANO 02), but the accuracy of its calculation may be overestimated (MALTMAN 06). GHOZZI 04 suggested that this effect can be explained if the charged ρ mass were higher than that of the neutral one by a few MeV. Existing theoretical models of the possible mass difference predict either a much smaller value (BIJNENS 96) or a heavier neutral ρ meson (ACHASOV 99F). Experimental accuracy is not yet sufficient for unambiguous conclusions.

ρ(770) MASS

We no longer list S-wave Breit-Wigner fits, or data with high combinatorial background.

NEUTRAL ONLY, e^+e^-

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
775.5 ±0.4 OUR AVERAGE						
774.9 ±0.4 ±0.5	4.5M	[2] ACHASOV	05A	SND		$e^+e^- \to \pi^+\pi^-$
775.65±0.64±0.50	114k	[3,4] AKHMETSHIN	04	CMD2		$e^+e^- \to \pi^+\pi^-$
775.9 ±0.5 ±0.5	1.98M	[5] ALOISIO	03	KLOE		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
775.8 ±0.9 ±2.0	500k	[5] ACHASOV	02	SND		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
775.9 ±1.1		[6] BARKOV	85	OLYA	0	$e^+e^- \to \pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
775.8 ±0.5 ±0.3	1.98M	[7] ALOISIO	03	KLOE		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
775.9 ±0.6 ±0.5	1.98M	[8] ALOISIO	03	KLOE		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
775.0 ±0.6 ±1.1	500k	[9] ACHASOV	02	SND		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
775.1 ±0.7 ±5.3		[10] BENAYOUN	98	RVUE		$e^+e^- \to \pi^+\pi^-$, $\mu^+\mu^-$

770.5 ±1.9 ±5.1	[11] GARDNER	98	RVUE	0.28–0.92 $e^+e^- \to \pi^+\pi^-$
764.1 ±0.7	[12] O'CONNELL	97	RVUE	$e^+e^- \to \pi^+\pi^-$
757.5 ±1.5	[13] BERNICHA	94	RVUE	$e^+e^- \to \pi^+\pi^-$
768 ±1	[14] GESHKEN...	89	RVUE	$e^+e^- \to \pi^+\pi^-$

CHARGED ONLY, τ DECAYS and e^+e^-

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
The data in this block is included in the average printed for a previous datablock.						
775.4±0.4 OUR AVERAGE						
775.5±0.7		[1] SCHAEL	05C	ALEP		$\tau^- \to \pi^-\pi^0\nu_\tau$
775.5±0.5±0.4	1.98M	[5] ALOISIO	03	KLOE		1.02 $e^+e^- \to \pi^+\pi^-\pi^0$
775.1±1.1±0.5	87k	[15,16] ANDERSON	00A	CLE2		$\tau^- \to \pi^-\pi^0\nu_\tau$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
774.8±0.6±0.4	1.98M	[8] ALOISIO	03	KLOE	−	1.02 $e^+e^- \to \pi^+\pi^-\pi^0$
776.3±0.6±0.7	1.98M	[8] ALOISIO	03	KLOE	+	1.02 $e^+e^- \to \pi^+\pi^-\pi^0$
$773.9\pm2.0^{+0.3}_{-1.0}$		[17] SANZ-CILLERO	03	RVUE		$\tau^- \to \pi^-\pi^0\nu_\tau$
774.5±0.7±1.5	500k	[5] ACHASOV	02	SND	±	1.02 $e^+e^- \to \pi^+\pi^-\pi^0$
775.1±0.5		[18] PICH	01	RVUE		$\tau^- \to \pi^-\pi^0\nu_\tau$

[1] From the GOUNARIS 68 parameterization of the pion form factor. The error combines statistical and systematic uncertainties. Supersedes BARATE 97M.

MIXED CHARGES, OTHER REACTIONS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
763.0±0.3±1.2	600k	[19] ABELE	99E	CBAR	0±	0.0 $\overline{p}p \to \pi^+\pi^-\pi^0$

CHARGED ONLY, HADROPRODUCED

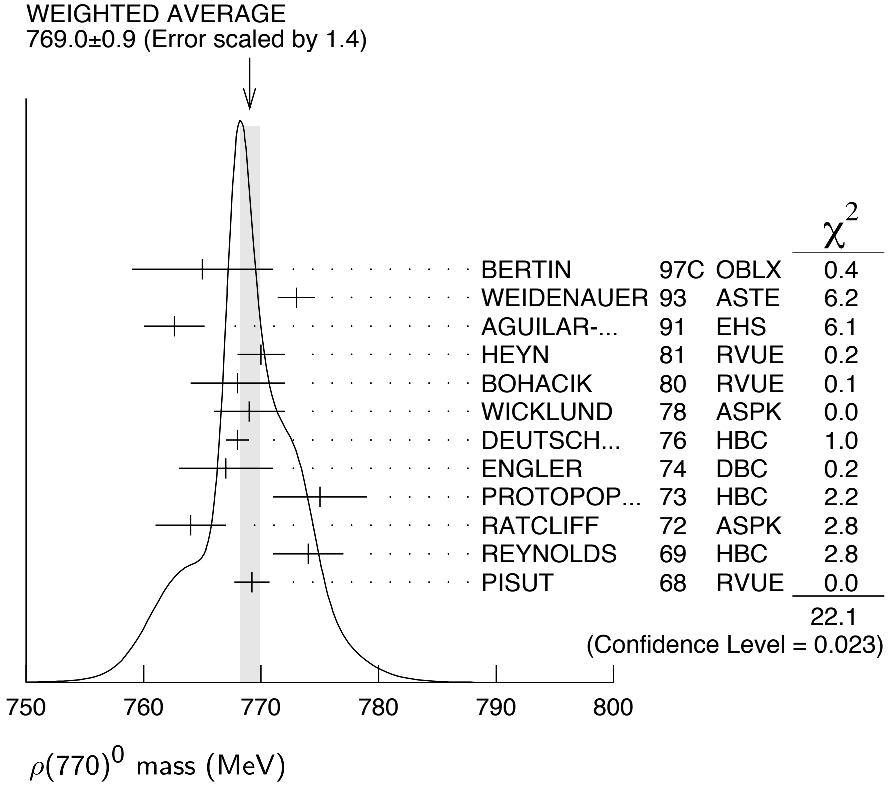
VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
766.5±1.1 OUR AVERAGE						
763.7±3.2		ABELE	97	CBAR		$\overline{p}n \to \pi^-\pi^0\pi^0$
768 ±9		AGUILAR-...	91	EHS		400 pp
767 ±3	2935	[20] CAPRARO	87	SPEC	−	200 π^- Cu $\to \pi^-\pi^0$ Cu
761 ±5	967	[20] CAPRARO	87	SPEC	−	200 π^- Pb $\to \pi^-\pi^0$ Pb
771 ±4		HUSTON	86	SPEC	+	202 π^+ A $\to \pi^+\pi^0$ A
766 ±7	6500	[21] BYERLY	73	OSPK	−	5 $\pi^- p$
766.8±1.5	9650	[22] PISUT	68	RVUE	−	1.7–3.2 $\pi^- p$, $t <10$
767 ±6	900	[20] EISNER	67	HBC	−	4.2 $\pi^- p$, $t <10$

NEUTRAL ONLY, PHOTOPRODUCED

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
768.5± 1.1 OUR AVERAGE						
770 ± 2 ±1	79k	[23] BREITWEG	98B	ZEUS	0	50–100 γp
767.6± 2.7		BARTALUCCI	78	CNTR	0	$\gamma p \rightarrow e^+ e^- p$
775 ± 5		GLADDING	73	CNTR	0	2.9–4.7 γp
767 ± 4	1930	BALLAM	72	HBC	0	2.8 γp
770 ± 4	2430	BALLAM	72	HBC	0	4.7 γp
765 ±10		ALVENSLEB...	70	CNTR	0	γA, t <0.01
767.7± 1.9	140k	BIGGS	70	CNTR	0	<4.1 γC $\rightarrow \pi^+ \pi^-$ C
765 ± 5	4000	ASBURY	67B	CNTR	0	$\gamma +$ Pb
• • • We do not use the following data for averages, fits, limits, etc. • • •						
771 ± 2	79k	[24] BREITWEG	98B	ZEUS	0	50–100 γp

NEUTRAL ONLY, OTHER REACTIONS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
769.0±0.9 OUR AVERAGE Error includes scale factor of 1.4. See the ideogram below.						
765 ±6		BERTIN	97C	OBLX		0.0 $\overline{p} p \rightarrow \pi^+ \pi^- \pi^0$
773 ±1.6		WEIDENAUER	93	ASTE		$\overline{p} p \rightarrow \pi^+ \pi^- \omega$
762.6±2.6		AGUILAR-...	91	EHS		400 $p p$
770 ±2		[25] HEYN	81	RVUE		Pion form factor
768 ±4		[26,27] BOHACIK	80	RVUE	0	
769 ±3		[21] WICKLUND	78	ASPK	0	3,4,6 $\pi^\pm N$
768 ±1	76000	DEUTSCH...	76	HBC	0	16 $\pi^+ p$
767 ±4	4100	ENGLER	74	DBC	0	6 $\pi^+ n \rightarrow \pi^+ \pi^- p$
775 ±4	32000	[26] PROTOPOP...	73	HBC	0	7.1 $\pi^+ p$, t <0.4
764 ±3	6800	RATCLIFF	72	ASPK	0	15 $\pi^- p$, t <0.3
774 ±3	1700	REYNOLDS	69	HBC	0	2.26 $\pi^- p$
769.2±1.5	13300	[28] PISUT	68	RVUE	0	1.7–3.2 $\pi^- p$, t <10
• • • We do not use the following data for averages, fits, limits, etc. • • •						
773.5±2.5		[29] COLANGELO	01	RVUE		$\pi\pi \rightarrow \pi\pi$
762.3±0.5±1.2	600k	[30] ABELE	99E	CBAR	0	0.0 $\overline{p} p \rightarrow \pi^+ \pi^- \pi^0$
777 ±2	4943	[31] ADAMS	97	E665		470 $\mu p \rightarrow \mu X B$
770 ±2		[32] BOGOLYUB...	97	MIRA		32 $\overline{p} p \rightarrow \pi^+ \pi^-$ X
768 ±8		[32] BOGOLYUB...	97	MIRA		32 $p p \rightarrow \pi^+ \pi^-$ X
761.1±2.9		DUBNICKA	89	RVUE		π form factor
777.4±2.0		[33] CHABAUD	83	ASPK	0	17 $\pi^- p$ polarized
769.5±0.7		[26,27] LANG	79	RVUE	0	
770 ±9		[27] ESTABROOKS	74	RVUE	0	17 $\pi^- p \rightarrow \pi^+ \pi^- n$
773.5±1.7	11200	[20] JACOBS	72	HBC	0	2.8 $\pi^- p$
775 ±3	2250	HYAMS	68	OSPK	0	11.2 $\pi^- p$



[2] A fit of the SND data from 400 to 1000 MeV using parameters of the $\rho(1450)$ and $\rho(1700)$ from a fit of the data of BARKOV 85, BISELLO 89 and ANDERSON 00A.

[3] Using the GOUNARIS 68 parametrization with the complex phase of the ρ-ω interference.

[4] Update of AKHMETSHIN 02.

[5] Assuming $m_{\rho^+} = m_{\rho^-}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-}$.

[6] From the GOUNARIS 68 parametrization of the pion form factor.

[7] Assuming $m_{\rho^+} = m_{\rho^-} = m_{\rho^0}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-} = \Gamma_{\rho^0}$.

[8] Without limitations on masses and widths.

[9] Assuming $m_{\rho^0} = m_{\rho^\pm}$, $g_{\rho^0 \pi\pi} = g_{\rho^\pm \pi\pi}$.

[10] Using the data of BARKOV 85 in the hidden local symmetry model.

[11] From the fit to $e^+ e^- \rightarrow \pi^+ \pi^-$ data from the compilations of HEYN 81 and BARKOV 85, including the GOUNARIS 68 parametrization of the pion form factor.

[12] A fit of BARKOV 85 data assuming the direct $\omega\pi\pi$ coupling.

[13] Applying the S-matrix formalism to the BARKOV 85 data.

[14] Includes BARKOV 85 data. Model-dependent width definition.

[15] $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV respectively.

[16] From the GOUNARIS 68 parametrization of the pion form factor. The second error is a model error taking into account different parametrizations of the pion form factor.

[17] Using the data of BARATE 97M and the effective chiral Lagrangian.

[18] From a fit of the model-independent parameterization of the pion form factor to the data of BARATE 97M.

[19] Assuming the equality of ρ^+ and ρ^- masses and widths.

[20] Mass errors enlarged by us to $\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.

[21] Phase shift analysis. Systematic errors added corresponding to spread of different fits.

[22] From fit of 3-parameter relativistic P-wave Breit-Wigner to total mass distribution. Includes BATON 68, MILLER 67B, ALFF-STEINBERGER 66, HAGOPIAN 66, HAGOPIAN 66B, JACOBS 66B, JAMES 66, WEST 66, BLIEDEN 65 and CARMONY 64.

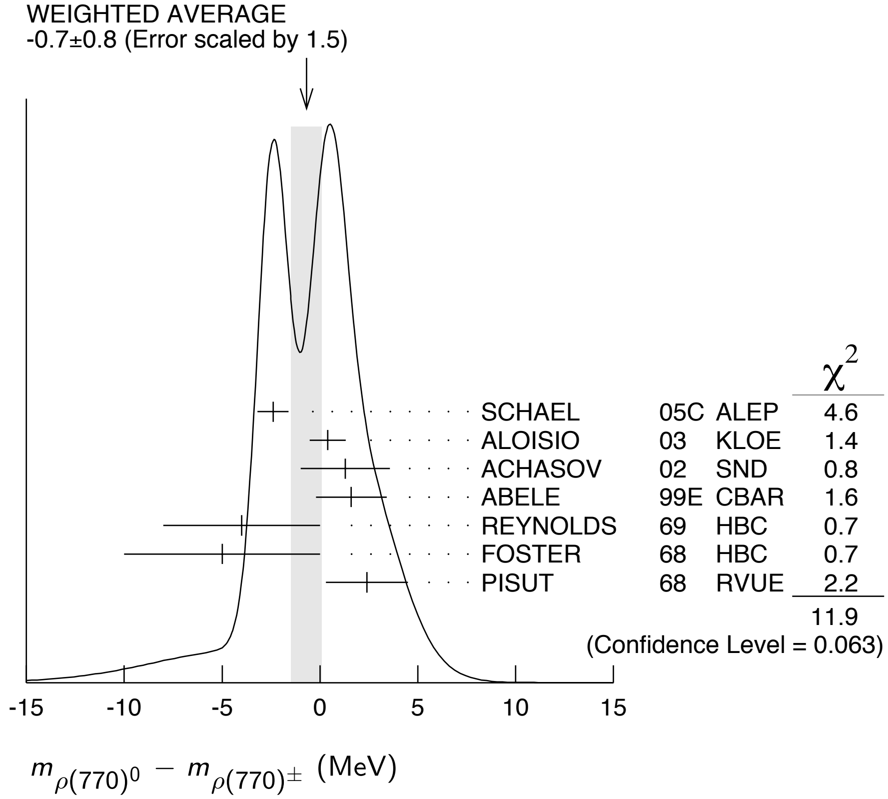
[23] From the parametrization according to SOEDING 66.

[24] From the parametrization according to ROSS 66.
[25] HEYN 81 includes all spacelike and timelike F_π values until 1978.
[26] From pole extrapolation.
[27] From phase shift analysis of GRAYER 74 data.
[28] Includes MALAMUD 69, ARMENISE 68, BACON 67, HUWE 67, MILLER 67B, ALFF-STEINBERGER 66, HAGOPIAN 66, HAGOPIAN 66B, JACOBS 66B, JAMES 66, WEST 66, GOLDHABER 64, ABOLINS 63.
[29] Breit-Wigner mass from a phase-shift analysis of HYAMS 73 and PROTOPOPESCU 73 data.
[30] Using relativistic Breit-Wigner and taking into account ρ-ω interference.
[31] Systematic errors not evaluated.
[32] Systematic effects not studied.
[33] From fit of 3-parameter relativistic Breit-Wigner to helicity-zero part of P-wave intensity. CHABAUD 83 includes data of GRAYER 74.

$m_{\rho(770)^0} - m_{\rho(770)^\pm}$

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
−0.7±0.8 OUR AVERAGE	Error includes scale factor of 1.5. See the ideogram below.					
−2.4±0.8		[34] SCHAEL	05C	ALEP		$\tau^- \to \pi^- \pi^0 \nu_\tau$
0.4±0.7±0.6	1.98M	[35] ALOISIO	03	KLOE		1.02 $e^+ e^- \to \pi^+ \pi^- \pi^0$
1.3±1.1±2.0	500k	[35] ACHASOV	02	SND		1.02 $e^+ e^- \to \pi^+ \pi^- \pi^0$
1.6±0.6±1.7	600k	ABELE	99E	CBAR	0±	0.0 $\overline{p} p \to \pi^+ \pi^- \pi^0$
−4 ±4	3000	[36] REYNOLDS	69	HBC	−0	2.26 $\pi^- p$
−5 ±5	3600	[36] FOSTER	68	HBC	±0	0.0 $\overline{p} p$
2.4±2.1	22950	[37] PISUT	68	RVUE		$\pi N \to \rho N$

[34] From the combined fit of the τ^- data from ANDERSON 00A and SCHAEL 05C and $e^+ e^-$ data from the compilation of BARKOV 85, AKHMETSHIN 04, and ALOISIO 05. Supersedes BARATE 97M.
[35] Assuming $m_{\rho^+} = m_{\rho^-}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-}$.
[36] From quoted masses of charged and neutral modes.
[37] Includes MALAMUD 69, ARMENISE 68, BATON 68, BACON 67, HUWE 67, MILLER 67B, ALFF-STEINBERGER 66, HAGOPIAN 66, HAGOPIAN 66B, JACOBS 66B, JAMES 66, WEST 66, BLIEDEN 65, CARMONY 64, GOLDHABER 64, ABOLINS 63.



$m_{\rho(770)^+} - m_{\rho(770)^-}$

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.5\pm0.8\pm0.7$	1.98M	[38] ALOISIO	03	KLOE	$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$

[38] Without limitations on masses and widths.

ρ(770) RANGE PARAMETER

The range parameter R enters an energy-dependent correction to the width, of the form $(1 + q_r^2\ R^2)\ /\ (1 + q^2\ R^2)$, where q is the momentum of one of the pions in the $\pi\pi$ rest system. At resonance, $q = q_r$.

VALUE (GeV^{-1})	DOCUMENT ID		TECN	CHG	COMMENT
$5.3^{+0.9}_{-0.7}$	CHABAUD	83	ASPK	0	17 $\pi^- p$ polarized

ρ(770) WIDTH

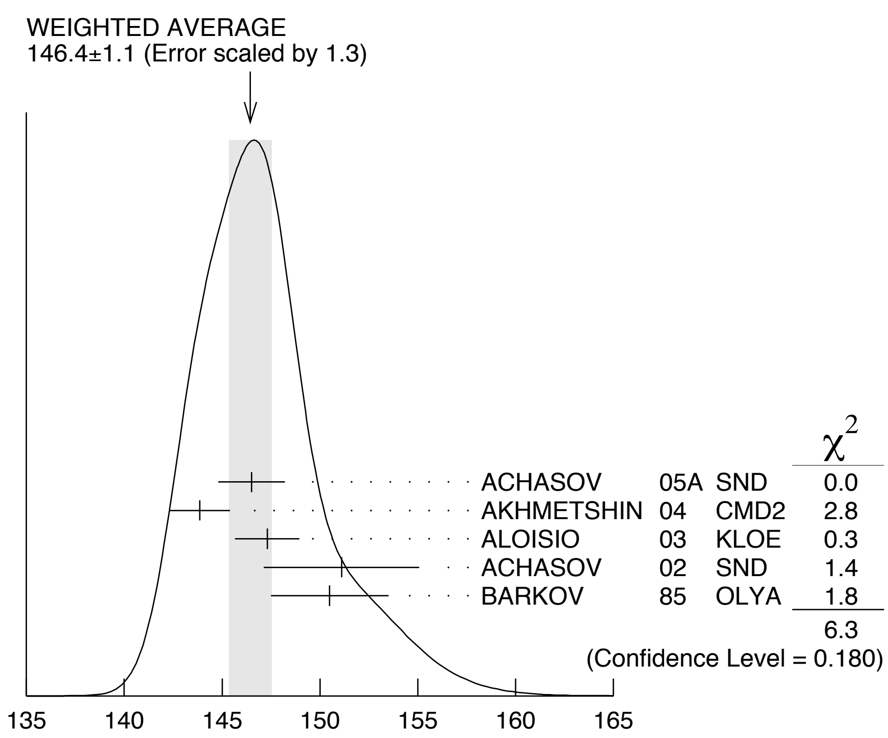
We no longer list S-wave Breit-Wigner fits, or data with high combinatorial background.

NEUTRAL ONLY, e^+e^-

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
146.4 ±1.1 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.				
146.5 ±0.8 ±1.5	4.5M	[42] ACHASOV 05A	SND		$e^+e^- \to \pi^+\pi^-$
143.85±1.33±0.80	114k	[43,44] AKHMETSHIN 04	CMD2		$e^+e^- \to \pi^+\pi^-$
147.3 ±1.5 ±0.7	1.98M	[39] ALOISIO 03	KLOE		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
151.1 ±2.6 ±3.0	500k	[39] ACHASOV 02	SND	0	$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
150.5 ±3.0		[45] BARKOV 85	OLYA	0	$e^+e^- \to \pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
143.9 ±1.3 ±1.1	1.98M	[46] ALOISIO 03	KLOE		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
147.4 ±1.5 ±0.7	1.98M	[47] ALOISIO 03	KLOE		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
149.8 ±2.2 ±2.0	500k	[40] ACHASOV 02	SND		$1.02\ e^+e^- \to \pi^+\pi^-\pi^0$
147.9 ±1.5 ±7.5		[48] BENAYOUN 98	RVUE		$e^+e^- \to \pi^+\pi^-, \mu^+\mu^-$
153.5 ±1.3 ±4.6		[49] GARDNER 98	RVUE		0.28–0.92 $e^+e^- \to \pi^+\pi^-$
145.0 ±1.7		[50] O'CONNELL 97	RVUE		$e^+e^- \to \pi^+\pi^-$
142.5 ±3.5		[51] BERNICHA 94	RVUE		$e^+e^- \to \pi^+\pi^-$
138 ±1		[52] GESHKEN... 89	RVUE		$e^+e^- \to \pi^+\pi^-$

[39] Assuming $m_{\rho^+} = m_{\rho^-}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-}$.

[40] Assuming $m_{\rho^0} = m_{\rho^\pm}$, $g_{\rho^0\pi\pi} = g_{\rho^\pm\pi\pi}$.



Neutral only, e^+e^-

CHARGED ONLY, τ DECAYS and e^+e^-

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT

The data in this block is included in the average printed for a previous datablock.

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
149.4±1.0 OUR FIT						
149.4±1.0 OUR AVERAGE						
149.0±1.2		[41] SCHAEL	05C	ALEP		$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
149.9±2.3±2.0	500k	[39] ACHASOV	02	SND	±	1.02 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$
150.4±1.4±1.4	87k	[53,54] ANDERSON	00A	CLE2		$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
143.7±1.3±1.2	1.98M	[39] ALOISIO	03	KLOE	±	1.02 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$
142.9±1.3±1.4	1.98M	[47] ALOISIO	03	KLOE	−	1.02 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$
144.7±1.4±1.2	1.98M	[47] ALOISIO	03	KLOE	+	1.02 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$
$150.2\pm2.0^{+0.7}_{-1.6}$		[55] SANZ-CILLERO	03	RVUE		$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
150.9±2.2±2.0	500k	[40] ACHASOV	02	SND		1.02 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$

[41] From the GOUNARIS 68 parameterization of the pion form factor. The error combines statistical and systematic uncertainties. Supersedes BARATE 97M.

MIXED CHARGES, OTHER REACTIONS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
149.5±1.3	600k	[56] ABELE	99E	CBAR	0±	0.0 $\overline{p}p \rightarrow \pi^+\pi^-\pi^0$

CHARGED ONLY, HADROPRODUCED

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
150.2± 2.4 OUR FIT						
150.2± 2.4 OUR AVERAGE						
152.8± 4.3		ABELE	97	CBAR		$\overline{p}n \rightarrow \pi^-\pi^0\pi^0$
155 ±11	2935	[57] CAPRARO	87	SPEC	−	200 π^- Cu $\rightarrow \pi^-\pi^0$ Cu
154 ±20	967	[57] CAPRARO	87	SPEC	−	200 π^- Pb $\rightarrow \pi^-\pi^0$ Pb
150 ± 5		HUSTON	86	SPEC	+	202 π^+ A $\rightarrow \pi^+\pi^0$ A
146 ±12	6500	[58] BYERLY	73	OSPK	−	5 $\pi^- p$
148.2± 4.1	9650	[59] PISUT	68	RVUE	−	1.7–3.2 $\pi^- p$, t <10
146 ±13	900	EISNER	67	HBC	−	4.2 $\pi^- p$, t <10

NEUTRAL ONLY, PHOTOPRODUCED

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
150.7± 2.9 OUR AVERAGE						
146 ± 3 ±13	79k	[60] BREITWEG	98B	ZEUS	0	50–100 γp
150.9± 3.0		BARTALUCCI	78	CNTR	0	$\gamma p \rightarrow e^+e^- p$

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

138 ±3	79k	[61] BREITWEG	98B	ZEUS	0	50–100 γp
147 ±11		GLADDING	73	CNTR	0	2.9–4.7 γp
155 ±12	2430	BALLAM	72	HBC	0	4.7 γp
145 ±13	1930	BALLAM	72	HBC	0	2.8 γp
140 ±5		ALVENSLEB...	70	CNTR	0	γA, t <0.01
146.1± 2.9	140k	BIGGS	70	CNTR	0	<4.1 $\gamma C \to \pi^+\pi^- C$
160 ±10		LANZEROTTI	68	CNTR	0	γp
130 ±5	4000	ASBURY	67B	CNTR	0	$\gamma +$ Pb

NEUTRAL ONLY, OTHER REACTIONS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
150.9± 1.7 OUR AVERAGE		Error includes scale factor of 1.1.				
122 ±20		BERTIN	97C	OBLX		0.0 $\overline{p}p \to \pi^+\pi^-\pi^0$
145.7± 5.3		WEIDENAUER	93	ASTE		$\overline{p}p \to \pi^+\pi^-\omega$
144.9± 3.7		DUBNICKA	89	RVUE		π form factor
148 ±6		[62,63] BOHACIK	80	RVUE	0	
152 ±9		[58] WICKLUND	78	ASPK	0	3,4,6 $\pi^\pm pN$
154 ±2	76000	DEUTSCH...	76	HBC	0	16 $\pi^+ p$
157 ±8	6800	RATCLIFF	72	ASPK	0	15 $\pi^- p$, t <0.3
143 ±8	1700	REYNOLDS	69	HBC	0	2.26 $\pi^- p$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
147.0± 2.5	600k	[64] ABELE	99E	CBAR	0	0.0 $\overline{p}p \to \pi^+\pi^-\pi^0$
146 ±3	4943	[65] ADAMS	97	E665		470 $\mu p \to \mu XB$
$160.0^{+4.1}_{-4.0}$		[66] CHABAUD	83	ASPK	0	17 $\pi^- p$ polarized
155 ±1		[67] HEYN	81	RVUE	0	π form factor
148.0± 1.3		[62,63] LANG	79	RVUE	0	
146 ±14	4100	ENGLER	74	DBC	0	6 $\pi^+ n \to \pi^+\pi^- p$
143 ±13		[63] ESTABROOKS	74	RVUE	0	17 $\pi^- p \to \pi^+\pi^- n$
160 ±10	32000	[62] PROTOPOP...	73	HBC	0	7.1 $\pi^+ p$, t <0.4
145 ±12	2250	[57] HYAMS	68	OSPK	0	11.2 $\pi^- p$
163 ±15	13300	[68] PISUT	68	RVUE	0	1.7–3.2 $\pi^- p$, t <10

[42] A fit of the SND data from 400 to 1000 MeV using parameters of the $\rho(1450)$ and $\rho(1700)$ from a fit of the data of BARKOV 85, BISELLO 89 and ANDERSON 00A.

[43] Using the GOUNARIS 68 parametrization with the complex phase of the ρ-ω interference.

[44] From a fit in the energy range 0.61 to 0.96 GeV. Update of AKHMETSHIN 02.

[45] From the GOUNARIS 68 parametrization of the pion form factor.

[46] Assuming $m_{\rho^+} = m_{\rho^-} = m_{\rho^0}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-} = \Gamma_{\rho^0}$.

[47] Without limitations on masses and widths.

[48] Using the data of BARKOV 85 in the hidden local symmetry model.

[49] From the fit to $e^+e^- \to \pi^+\pi^-$ data from the compilations of HEYN 81 and BARKOV 85, including the GOUNARIS 68 parametrization of the pion form factor.

[50] A fit of BARKOV 85 data assuming the direct $\omega\pi\pi$ coupling.

[51] Applying the S-matrix formalism to the BARKOV 85 data.

[52] Includes BARKOV 85 data. Model-dependent width definition.

[53] $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV respectively.

[54] From the GOUNARIS 68 parametrization of the pion form factor. The second error is a model error taking into account different parametrizations of the pion form factor.

[55] Using the data of BARATE 97M and the effective chiral Lagrangian.

[56] Assuming the equality of ρ^+ and ρ^- masses and widths.
[57] Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.
[58] Phase shift analysis. Systematic errors added corresponding to spread of different fits.
[59] From fit of 3-parameter relativistic P-wave Breit-Wigner to total mass distribution. Includes BATON 68, MILLER 67B, ALFF-STEINBERGER 66, HAGOPIAN 66, HAGOPIAN 66B, JACOBS 66B, JAMES 66, WEST 66, BLIEDEN 65 and CARMONY 64.
[60] From the parametrization according to SOEDING 66.
[61] From the parametrization according to ROSS 66.
[62] From pole extrapolation.
[63] From phase shift analysis of GRAYER 74 data.
[64] Using relativistic Breit-Wigner and taking into account ρ-ω interference.
[65] Systematic errors not evaluated.
[66] From fit of 3-parameter relativistic Breit-Wigner to helicity-zero part of P-wave intensity. CHABAUD 83 includes data of GRAYER 74.
[67] HEYN 81 includes all spacelike and timelike F_π values until 1978.
[68] Includes MALAMUD 69, ARMENISE 68, BACON 67, HUWE 67, MILLER 67B, ALFF-STEINBERGER 66, HAGOPIAN 66, HAGOPIAN 66B, JACOBS 66B, JAMES 66, WEST 66, GOLDHABER 64, ABOLINS 63.

$\Gamma_{\rho(770)^0} - \Gamma_{\rho(770)^\pm}$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.3±1.3 OUR AVERAGE		Error includes scale factor of 1.4.			
−0.2±1.0		[69] SCHAEL	05C	ALEP	$\tau^- \to \pi^- \pi^0 \nu_\tau$
3.6±1.8±1.7	1.98M	[39] ALOISIO	03	KLOE	1.02 $e^+ e^- \to \pi^+ \pi^- \pi^0$

[69] From the combined fit of the τ^- data from ANDERSON 00A and SCHAEL 05C and $e^+ e^-$ data from the compilation of BARKOV 85, AKHMETSHIN 04, and ALOISIO 05. Supersedes BARATE 97M.

$\Gamma_{\rho(770)^+} - \Gamma_{\rho(770)^-}$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.8±2.0±0.5	1.98M	[47] ALOISIO	03	KLOE	1.02 $e^+ e^- \to \pi^+ \pi^- \pi^0$

$\rho(770)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)		Scale factor/ Confidence level
Γ_1	$\pi\pi$	~ 100	%	
	$\rho(770)^\pm$ decays			
Γ_2	$\pi^\pm \pi^0$	~ 100	%	
Γ_3	$\pi^\pm \gamma$	(4.5 ±0.5	) × 10^{-4}	S=2.2
Γ_4	$\pi^\pm \eta$	< 6	× 10^{-3}	CL=84%
Γ_5	$\pi^\pm \pi^+ \pi^- \pi^0$	< 2.0	× 10^{-3}	CL=84%

$\rho(770)^0$ decays

Γ_6	$\pi^+\pi^-$		$\sim$ 100 %	
Γ_7	$\pi^+\pi^-\gamma$		$(9.9 \pm 1.6) \times 10^{-3}$	
Γ_8	$\pi^0\gamma$		$(6.0 \pm 0.8) \times 10^{-4}$	
Γ_9	$\eta\gamma$		$(2.95 \pm 0.30) \times 10^{-4}$	S=1.2
Γ_{10}	$\pi^0\pi^0\gamma$		$(4.5 \pm 0.8) \times 10^{-5}$	
Γ_{11}	$\mu^+\mu^-$	[a]	$(4.55 \pm 0.28) \times 10^{-5}$	
Γ_{12}	e^+e^-	[a]	$(4.70 \pm 0.08) \times 10^{-5}$	
Γ_{13}	$\pi^+\pi^-\pi^0$		$(1.01^{+0.54}_{-0.36} \pm 0.34) \times 10^{-4}$	
Γ_{14}	$\pi^+\pi^-\pi^+\pi^-$		$(1.8 \pm 0.9) \times 10^{-5}$	
Γ_{15}	$\pi^+\pi^-\pi^0\pi^0$		$< 4 \times 10^{-5}$	CL=90%
Γ_{16}	$\pi^0 e^+e^-$			
Γ_{17}	ηe^+e^-			

[a] The $\omega\rho$ interference is then due to $\omega\rho$ mixing only, and is expected to be small. If $e\mu$ universality holds, $\Gamma(\rho^0 \to \mu^+\mu^-) = \Gamma(\rho^0 \to e^+e^-) \times 0.99785$.

CONSTRAINED FIT INFORMATION

An overall fit to the total width and a partial width uses 10 measurements and one constraint to determine 3 parameters. The overall fit has a $\chi^2 = 10.7$ for 8 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\langle \delta p_i \delta p_j \rangle / (\delta p_i \cdot \delta p_j)$, in percent, from the fit to parameters p_i, including the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\text{total}}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_3	−100	
Γ	15	−15
	x_2	x_3

	Mode	Rate (MeV)	Scale factor
Γ_2	$\pi^\pm\pi^0$	150.2 ± 2.4	
Γ_3	$\pi^\pm\gamma$	0.068 ± 0.007	2.3

CONSTRAINED FIT INFORMATION

An overall fit to the total width, a partial width, and 7 branching ratios uses 18 measurements and one constraint to determine 9 parameters. The overall fit has a $\chi^2 = 6.7$ for 10 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle\delta p_i \delta p_j\right\rangle/(\delta p_i \cdot \delta p_j)$, in percent, from the fit to parameters p_i, including the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{total}$. The fit constrains the x_i whose labels appear in this array to sum to one.

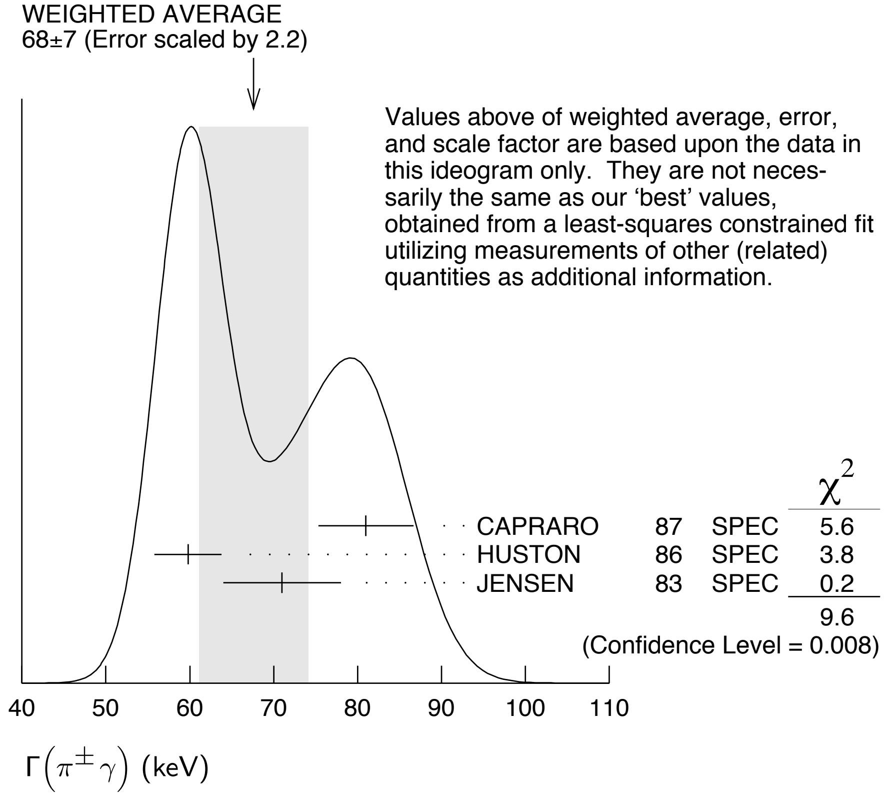
x_7	−100							
x_8	−5	0						
x_9	−2	0	2					
x_{10}	−1	0	0	0				
x_{11}	2	−3	0	0	0			
x_{12}	1	0	−13	−17	0	0		
x_{14}	−1	0	0	0	0	0	0	
Γ	0	0	5	6	0	0	−38	0
	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{14}

	Mode		Rate (MeV)	Scale factor
Γ_6	$\pi^+\pi^-$		147.8 ±1.0	
Γ_7	$\pi^+\pi^-\gamma$		1.48 ±0.24	
Γ_8	$\pi^0\gamma$		0.090 ±0.013	
Γ_9	$\eta\gamma$		0.044 ±0.005	1.2
Γ_{10}	$\pi^0\pi^0\gamma$		0.0067 ±0.0012	
Γ_{11}	$\mu^+\mu^-$	[a]	0.0068 ±0.0004	
Γ_{12}	e^+e^-	[a]	0.00702±0.00011	
Γ_{14}	$\pi^+\pi^-\pi^+\pi^-$		0.0027 ±0.0014	

ρ(770) PARTIAL WIDTHS

$\Gamma(\pi^\pm\gamma)$ Γ_3

VALUE (keV)	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
68 ±7 OUR FIT Error includes scale factor of 2.3.					
68 ±7 OUR AVERAGE Error includes scale factor of 2.2. See the ideogram below.					
81 ±4 ±4	CAPRARO	87	SPEC	−	200 $\pi^- A \to \pi^-\pi^0 A$
59.8±4.0	HUSTON	86	SPEC	+	202 $\pi^+ A \to \pi^+\pi^0 A$
71 ±7	JENSEN	83	SPEC	−	156–260 $\pi^- A \to \pi^-\pi^0 A$



$\Gamma(e^+e^-)$ Γ_{12}

VALUE (keV)	EVTS	DOCUMENT ID	TECN	COMMENT
7.02 ±0.11 OUR FIT				
7.02 ±0.11 OUR AVERAGE				
7.06 ±0.11 ±0.05	114k	[70,71] AKHMETSHIN 04	CMD2	$e^+e^- \to \pi^+\pi^-$
6.77 ±0.10 ±0.30		BARKOV 85	OLYA	$e^+e^- \to \pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
7.310±0.021±0.110	4.5M	ACHASOV 05A	SND	$e^+e^- \to \pi^+\pi^-$
6.3 ±0.1		[72] BENAYOUN 98	RVUE	$e^+e^- \to \pi^+\pi^-$, $\mu^+\mu^-$

$\Gamma(\pi^0\gamma)$ Γ_8

VALUE (keV)	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
77±17±11	36500	[73] ACHASOV 03	SND	0.60–0.97 $e^+e^- \to \pi^0\gamma$
121±31		DOLINSKY 89	ND	$e^+e^- \to \pi^0\gamma$

$\Gamma(\eta\gamma)$ Γ_9

VALUE (keV)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
62±17	[74] DOLINSKY 89	ND	$e^+e^- \to \eta\gamma$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)$ — Γ_{14}

VALUE (keV)	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$2.8\pm1.4\pm0.5$	153	AKHMETSHIN 00	CMD2	0.6–0.97 $e^+e^- \to \pi^+\pi^-\pi^+\pi^-$

[70] Using the GOUNARIS 68 parametrization with the complex phase of the ρ-ω interference.
[71] From a fit in the energy range 0.61 to 0.96 GeV. Update of AKHMETSHIN 02.
[72] Using the data of BARKOV 85 in the hidden local symmetry model.
[73] Using Γ_{total}= 147.9 ± 1.3 MeV and B($\rho \to \pi^0\gamma$) from ACHASOV 03.
[74] Solution corresponding to constructive ω-ρ interference.

$\rho(770)$ $\Gamma(e^+e^-)\Gamma(i)/\Gamma^2$(total)

$\Gamma(e^+e^-) \times \Gamma(\pi^+\pi^-)/\Gamma^2_{total}$ — $\Gamma_{12}\Gamma_6/\Gamma^2$

VALUE (units 10^{-5})	EVTS	DOCUMENT ID	TECN	COMMENT
4.991±0.028±0.066	4.5M	[75] ACHASOV 05A	SND	$e^+e^- \to \pi^+\pi^-$

[75] A fit of the SND data from 400 to 1000 MeV using parameters of the $\rho(1450)$ and $\rho(1700)$ from a fit of the data of BARKOV 85, BISELLO 89 and ANDERSON 00A.

$\Gamma(e^+e^-) \times \Gamma(\eta\gamma)/\Gamma^2_{total}$ — $\Gamma_{12}\Gamma_9/\Gamma^2$

VALUE (units 10^{-8})	EVTS	DOCUMENT ID	TECN	COMMENT
1.38±0.14 OUR FIT Error includes scale factor of 1.2.				
1.36±0.12 OUR AVERAGE				
$1.50\pm0.65\pm0.09$	17400	[78] AKHMETSHIN 05	CMD2	0.60-1.38 $e^+e^- \to \eta\gamma$
$1.61\pm0.20\pm0.11$	23k	[79,80] AKHMETSHIN 01B	CMD2	$e^+e^- \to \eta\gamma$
$1.21\pm0.14\pm0.04$	312	[81] ACHASOV 00D	SND	$e^+e^- \to \eta\gamma$
1.85 ± 0.49		[82] DOLINSKY 89	ND	$e^+e^- \to \eta\gamma$

$\Gamma(e^+e^-) \times \Gamma(\pi^0\gamma)/\Gamma^2_{total}$ — $\Gamma_{12}\Gamma_8/\Gamma^2$

VALUE (units 10^{-8})	EVTS	DOCUMENT ID	TECN	COMMENT
2.8 ±0.4 OUR FIT				
2.8 ±0.4 OUR AVERAGE				
$2.90^{+0.60}_{-0.55}\pm0.18$	18680	AKHMETSHIN 05	CMD2	0.60-1.38 $e^+e^- \to \pi^0\gamma$
$2.37\pm0.53\pm0.33$	36500	[76] ACHASOV 03	SND	0.60–0.97 $e^+e^- \to \pi^0\gamma$
$3.61\pm0.74\pm0.49$	10625	[82] DOLINSKY 89	ND	$e^+e^- \to \pi^0\gamma$

[76] Using $\sigma_{\phi \to \pi^0\gamma}$ from ACHASOV 00 and m_ρ= 775.97 MeV in the model with the energy-independent phase of ρ-ω interference equal to $(-10.2 \pm 7.0)^\circ$.

$\Gamma(e^+e^-) \times \Gamma(\pi^+\pi^-\pi^0)/\Gamma^2_{total}$ — $\Gamma_{12}\Gamma_{13}/\Gamma^2$

VALUE (units 10^{-9})	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$4.58^{+2.46}_{-1.64}\pm1.56$	1.2M	[77] ACHASOV 03D	RVUE	0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$

[77] Statistical significance in less than $3\,\sigma$.

[78] From the $\eta \to 2\gamma$ decay and using B($\eta \to \gamma\gamma$)= 39.43 ± 0.26%.
[79] From the $\eta \to 3\pi^0$ decay and using B($\eta \to 3\pi^0$)= (32.24 ± 0.29) × 10^{-2}.
[80] The combined fit from 600 to 1380 MeV taking into account ρ(770), ω(782), ϕ(1020), and ρ(1450) (mass and width fixed at 1450 MeV and 310 MeV respectively).
[81] From the $\eta \to 3\pi^0$ decay and using B($\eta \to 3\pi^0$)= (32.2 ± 0.4) × 10^{-2}.
[82] Recalculated by us from the cross section in the peak.

ρ(770) BRANCHING RATIOS

$\Gamma(\pi^\pm\eta)/\Gamma(\pi\pi)$ — Γ_4/Γ_1

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	CHG	COMMENT
<60	84	FERBEL	66	HBC	±	$\pi^\pm p$ above 2.5

$\Gamma(\pi^\pm\pi^+\pi^-\pi^0)/\Gamma(\pi\pi)$ — Γ_5/Γ_1

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	CHG	COMMENT
<20	84	FERBEL	66	HBC	±	$\pi^\pm p$ above 2.5
• • • We do not use the following data for averages, fits, limits, etc. • • •						
35±40		JAMES	66	HBC	+	2.1 $\pi^+ p$

$\Gamma(\mu^+\mu^-)/\Gamma(\pi^+\pi^-)$ — Γ_{11}/Γ_6

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
4.60±0.28 OUR FIT				
4.6 ±0.2 ±0.2	ANTIPOV	89	SIGM	π^- Cu $\to \mu^+\mu^-\pi^-$ Cu
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8.2 $^{+1.6}_{-3.6}$	[83] ROTHWELL	69	CNTR	Photoproduction
5.6 ±1.5	[84] WEHMANN	69	OSPK	12 π^- C, Fe
9.7 $^{+3.1}_{-3.3}$	[85] HYAMS	67	OSPK	11 π^- Li, H

$\Gamma(e^+e^-)/\Gamma(\pi\pi)$ — Γ_{12}/Γ_1

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.40±0.05	[86] BENAKSAS	72	OSPK	$e^+e^- \to \pi^+\pi^-$

$\Gamma(\eta\gamma)/\Gamma_{total}$ — Γ_9/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
2.95±0.30 OUR FIT Error includes scale factor of 1.2.						
3.6 ±0.9		[87] ANDREWS	77	CNTR	0	6.7–10 γCu
• • • We do not use the following data for averages, fits, limits, etc. • • •						
3.21±1.39±0.20	17400	[88,89] AKHMETSHIN	05	CMD2		0.60-1.38 $e^+e^- \to \eta\gamma$
3.39±0.42±0.23		[87,90,91] AKHMETSHIN	01B	CMD2		$e^+e^- \to \eta\gamma$
2.69±0.32±0.16	312	[92] ACHASOV	00D	SND		$e^+e^- \to \eta\gamma$
1.9 $^{+0.6}_{-0.8}$		[93] BENAYOUN	96	RVUE		0.54-1.04 $e^+e^- \to \eta\gamma$
4.0 ±1.1		[87,89] DOLINSKY	89	ND		$e^+e^- \to \eta\gamma$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma_{total}$ — Γ_{14}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.8±0.9 OUR FIT						
1.8±0.9±0.3		153	AKHMETSHIN	00	CMD2	0.6–0.97 $e^+e^- \to \pi^+\pi^-\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<20	90		KURDADZE	88	OLYA	$e^+e^- \to \pi^+\pi^-\pi^+\pi^-$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma(\pi\pi)$ — Γ_{14}/Γ_1

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	CHG	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<15	90	ERBE	69	HBC	0	2.5–5.8 γp
<20		CHUNG	68	HBC	0	3.2,4.2 $\pi^- p$
<20	90	HUSON	68	HLBC	0	16.0 $\pi^- p$
<80		JAMES	66	HBC	0	2.1 $\pi^+ p$

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ — Γ_{13}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$1.01^{+0.54}_{-0.36}\pm0.34$		1.2M	[94] ACHASOV	03D	RVUE	0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$
<1.2	90		VASSERMAN	88B	ND	$e^+e^- \to \pi^+\pi^-\pi^0$

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma(\pi\pi)$ — Γ_{13}/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	CHG	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
∼ 0.01		BRAMON	86	RVUE	0	$J/\psi \to \omega\pi^0$
<0.01	84	[95] ABRAMS	71	HBC	0	3.7 $\pi^+ p$

$\Gamma(\pi^+\pi^-\pi^0\pi^0)/\Gamma_{total}$ — Γ_{15}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	CHG	COMMENT
<0.4	90	AULCHENKO	87C	ND	0	$e^+e^- \to \pi^+\pi^-\pi^0\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<2	90	KURDADZE	86	OLYA	0	$e^+e^- \to \pi^+\pi^-\pi^0\pi^0$

$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{total}$ — Γ_7/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
0.0099±0.0016 OUR FIT					
0.0099±0.0016		[96] DOLINSKY	91	ND	$e^+e^- \to \pi^+\pi^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.0111±0.0014		[97] VASSERMAN	88	ND	$e^+e^- \to \pi^+\pi^-\gamma$
<0.005	90	[98] VASSERMAN	88	ND	$e^+e^- \to \pi^+\pi^-\gamma$

$\Gamma(\pi^0\gamma)/\Gamma_{total}$ Γ_8/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$6.21^{+1.28}_{-1.18}\pm0.39$	18680	[99,100] AKHMETSHIN 05	CMD2	0.60-1.38 $e^+e^- \to \pi^0\gamma$
$5.22\pm1.17\pm0.75$	36500	[100,101] ACHASOV 03	SND	0.60–0.97 $e^+e^- \to \pi^0\gamma$
$6.8\ \pm1.7$		[102] BENAYOUN 96	RVUE	0.54-1.04 $e^+e^- \to \pi^0\gamma$
$7.9\ \pm2.0$		[100] DOLINSKY 89	ND	$e^+e^- \to \pi^0\gamma$

$\Gamma(\pi^0 e^+e^-)/\Gamma_{total}$ Γ_{16}/Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
<1.6	AKHMETSHIN 05A	CMD2	0.72-0.84 e^+e^-

$\Gamma(\eta e^+e^-)/\Gamma_{total}$ Γ_{17}/Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
<0.7	AKHMETSHIN 05A	CMD2	0.72-0.84 e^+e^-

$\Gamma(\pi^0\pi^0\gamma)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID	TECN	COMMENT
4.5±0.8 OUR FIT				
$4.5^{+0.9}_{-0.8}$ OUR AVERAGE				
$5.2^{+1.5}_{-1.3}\pm0.6$	190	[103] AKHMETSHIN 04B	CMD2	0.6–0.97 $e^+e^- \to \pi^0\pi^0\gamma$
$4.1^{+1.0}_{-0.9}\pm0.3$	295	[104] ACHASOV 02F	SND	0.36–0.97 $e^+e^- \to \pi^0\pi^0\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$4.8^{+3.4}_{-1.8}\pm0.5$	63	[105] ACHASOV 00G	SND	$e^+e^- \to \pi^0\pi^0\gamma$

[83] Possibly large ρ-ω interference leads us to increase the minus error.

[84] Result contains 11 ± 11% correction using SU(3) for central value. The error on the correction takes account of possible ρ-ω interference and the upper limit agrees with the upper limit of $\omega \to \mu^+\mu^-$ from this experiment.

[85] HYAMS 67's mass resolution is 20 MeV. The ω region was excluded.

[86] The ρ' contribution is not taken into account.

[87] Solution corresponding to constructive ω-ρ interference.

[88] Using B($\rho \to e^+e^-$) = $(4.67 \pm 0.09)\times10^{-5}$ and B($\eta \to \gamma\gamma$) = 39.43 ± 0.26%.

[89] Not independent of the corresponding $\Gamma(e^+e^-)\times\Gamma(\eta\gamma)/\Gamma^2_{total}$.

[90] The combined fit from 600 to 1380 MeV taking into account $\rho(770)$, $\omega(782)$, $\phi(1020)$, and $\rho(1450)$ (mass and width fixed at 1450 MeV and 310 MeV respectively).

[91] Using B($\rho \to e^+e^-$) = $(4.75 \pm 0.10)\times10^{-5}$ from AKHMETSHIN 02 and B($\eta \to 3\pi^0$) = $(32.24 \pm 0.29)\times10^{-2}$.

[92] Using B($\rho \to e^+e^-$) = $(4.49\pm0.22)\times10^{-5}$ and B($\eta \to 3\pi^0$) = $(32.2\pm0.4)\times10^{-2}$.

[93] Reanalysis of DRUZHININ 84, DOLINSKY 89, and DOLINSKY 91 taking into account a triangle anomaly contribution. Constructive ρ-ω interference solution.

[94] Statistical significance is less than 3σ.
[95] Model dependent, assumes $I = 1$, 2, or 3 for the 3π system.
[96] Bremsstrahlung from a decay pion and for photon energy above 50 MeV.
[97] Superseded by DOLINSKY 91.
[98] Structure radiation due to quark rearrangement in the decay.
[99] Using $B(\rho \to e^+ e^-) = (4.67 \pm 0.09) \times 10^{-5}$.
[100] Not independent of the corresponding $\Gamma(e^+ e^-) \times \Gamma(\pi^0 \gamma)/\Gamma^2_{total}$.
[101] Using $B(\rho \to e^+ e^-) = (4.54 \pm 0.10) \times 10^{-5}$.
[102] Reanalysis of DRUZHININ 84, DOLINSKY 89, and DOLINSKY 91 taking into account a triangle anomaly contribution.
[103] This branching ratio includes the conventional VMD mechanism $\rho \to \omega\pi^0$, $\omega \to \pi^0\gamma$, and the new decay mode $\rho \to f_0(600)\gamma$, $f_0(600) \to \pi^0\pi^0$ with a branching ratio $(2.0^{+1.1}_{-0.9} \pm 0.3) \times 10^{-5}$ differing from zero by 2.0 standard deviations.
[104] This branching ratio includes the conventional VMD mechanism $\rho \to \omega\pi^0$, $\omega \to \pi^0\gamma$ and the new decay mode $\rho \to f_0(600)\gamma$, $f_0(600) \to \pi^0\pi^0$ with a branching ratio $(1.9^{+0.9}_{-0.8} \pm 0.4) \times 10^{-5}$ differing from zero by 2.4 standard deviations. Supersedes ACHASOV 00G.
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