

$\rho(770)$

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

A REVIEW GOES HERE – Check our WWW List of Reviews

$\rho(770)$ MASS

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

NEUTRAL ONLY, e^+e^-

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
775.26 ± 0.25 OUR AVERAGE				
775.02 ± 0.35		1 LEES	12G BABR	$e^+e^- \rightarrow \pi^+\pi^-\gamma$
775.97 ± 0.46 ± 0.70	900k	2 AKHMETSHIN 07		$e^+e^- \rightarrow \pi^+\pi^-$
774.6 ± 0.4 ± 0.5	800k	3,4 ACHASOV 06	SND	$e^+e^- \rightarrow \pi^+\pi^-$
775.65 ± 0.64 ± 0.50	114k	5,6 AKHMETSHIN 04	CMD2	$e^+e^- \rightarrow \pi^+\pi^-$
775.9 ± 0.5 ± 0.5	1.98M	7 ALOISIO 03	KLOE	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
775.8 ± 0.9 ± 2.0	500k	7 ACHASOV 02	SND	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
775.9 ± 1.1		8 BARKOV 85	OLYA	$e^+e^- \rightarrow \pi^+\pi^-$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
775.8 ± 0.5 ± 0.3	1.98M	9 ALOISIO 03	KLOE	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
775.9 ± 0.6 ± 0.5	1.98M	10 ALOISIO 03	KLOE	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
775.0 ± 0.6 ± 1.1	500k	11 ACHASOV 02	SND	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
775.1 ± 0.7 ± 5.3		12 BENAYOUN 98	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$, $\mu^+\mu^-$
770.5 ± 1.9 ± 5.1		13 GARDNER 98	RVUE	$0.28-0.92 e^+e^- \rightarrow \pi^+\pi^-$
764.1 ± 0.7		14 O'CONNELL 97	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$
757.5 ± 1.5		15 BERNICHA 94	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$
768 ± 1		16 GESHKEN... 89	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$

CHARGED ONLY, τ DECAYS and e^+e^-

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
775.11 ± 0.34 OUR AVERAGE					
774.6 ± 0.2 ± 0.5	5.4M	17,18 FUJIKAWA 08	BELL	±	$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
775.5 ± 0.7		18,19 SCHAEEL 05C	ALEP		$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
775.5 ± 0.5 ± 0.4	1.98M	7 ALOISIO 03	KLOE		$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
775.1 ± 1.1 ± 0.5	87k	20,21 ANDERSON 00A	CLE2		$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
774.8 ± 0.6 ± 0.4	1.98M	10 ALOISIO 03	KLOE	-	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
776.3 ± 0.6 ± 0.7	1.98M	10 ALOISIO 03	KLOE	+	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
773.9 ± 2.0 ^{+0.3} / _{-1.0}		22 SANZ-CILLERO03	RVUE		$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$
774.5 ± 0.7 ± 1.5	500k	7 ACHASOV 02	SND	±	$1.02 e^+e^- \rightarrow \pi^+\pi^-\pi^0$
775.1 ± 0.5		23 PICH 01	RVUE		$\tau^- \rightarrow \pi^-\pi^0\nu_\tau$

MIXED CHARGES, OTHER REACTIONS

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>	
763.0±0.3±1.2	600k	²⁴ ABELE	99E	CBAR	0±	0.0 $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$

CHARGED ONLY, HADROPRODUCED

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>	
766.5±1.1 OUR AVERAGE						
763.7±3.2		ABELE	97	CBAR	$\bar{p}n \rightarrow \pi^-\pi^0\pi^0$	
768 ±9		AGUILAR-...	91	EHS	400 pp	
767 ±3	2935	²⁵ CAPRARO	87	SPEC	-	200 $\pi^-\text{Cu} \rightarrow \pi^-\pi^0\text{Cu}$
761 ±5	967	²⁵ CAPRARO	87	SPEC	-	200 $\pi^-\text{Pb} \rightarrow \pi^-\pi^0\text{Pb}$
771 ±4		HUSTON	86	SPEC	+	202 $\pi^+\text{A} \rightarrow \pi^+\pi^0\text{A}$
766 ±7	6500	²⁶ BYERLY	73	OSPK	-	5 π^-p
766.8±1.5	9650	²⁷ PISUT	68	RVUE	-	1.7-3.2 $\pi^-p, t < 10$
767 ±6	900	²⁵ EISNER	67	HBC	-	4.2 $\pi^-p, t < 10$

NEUTRAL ONLY, PHOTOPRODUCED

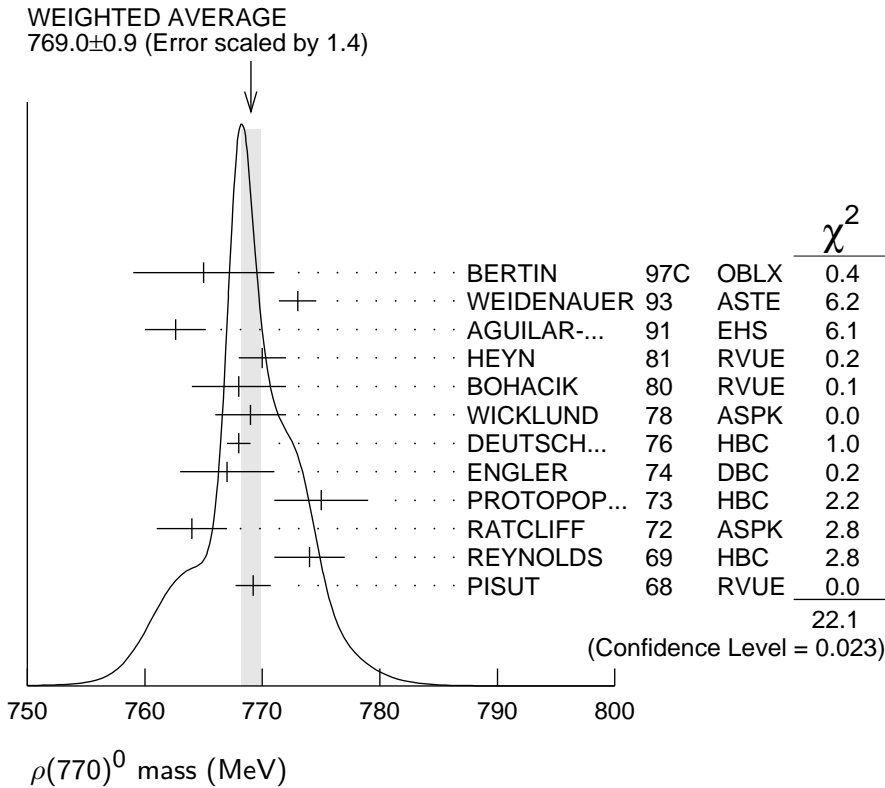
<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
769.0± 1.0 OUR AVERAGE				
771 ± 2 $\begin{smallmatrix} +2 \\ -1 \end{smallmatrix}$	63.5k	²⁸ ABRAMOWICZ12	ZEUS	$e p \rightarrow e \pi^+ \pi^- p$
770 ± 2 ±1	79k	²⁹ BREITWEG	98B	ZEUS 50-100 γp
767.6± 2.7		BARTALUCCI	78	CNTR $\gamma p \rightarrow e^+ e^- p$
775 ± 5		GLADDING	73	CNTR 2.9-4.7 γp
767 ± 4	1930	BALLAM	72	HBC 2.8 γp
770 ± 4	2430	BALLAM	72	HBC 4.7 γp
765 ±10		ALVENSLEB...	70	CNTR $\gamma A, t < 0.01$
767.7± 1.9	140k	BIGGS	70	CNTR $< 4.1 \gamma C \rightarrow \pi^+ \pi^- C$
765 ± 5	4000	ASBURY	67B	CNTR $\gamma + \text{Pb}$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
771 ± 2	79k	³⁰ BREITWEG	98B	ZEUS 50-100 γp

NEUTRAL ONLY, OTHER REACTIONS

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
769.0±0.9 OUR AVERAGE Error includes scale factor of 1.4. See the ideogram below.					
765 ±6		BERTIN	97C	OBLX	0.0 $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$
773 ±1.6		WEIDENAUER	93	ASTE	$\bar{p}p \rightarrow \pi^+\pi^-\omega$
762.6±2.6		AGUILAR-...	91	EHS	400 pp
770 ±2		³¹ HEYN	81	RVUE	Pion form factor
768 ±4		^{32,33} BOHACIK	80	RVUE	0
769 ±3		²⁶ WICKLUND	78	ASPK	0 3,4,6 $\pi^\pm N$
768 ±1	76000	DEUTSCH...	76	HBC	0 16 π^+p
767 ±4	4100	ENGLER	74	DBC	0 6 $\pi^+n \rightarrow \pi^+\pi^-p$
775 ±4	32000	³² 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 π^-p
769.2±1.5	13300	³⁴ 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		35 COLANGELO	01	RVUE		$\pi\pi \rightarrow \pi\pi$
762.3±0.5±1.2	600k	36 ABELE	99E	CBAR	0	0.0 $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$
777 ±2	4943	37 ADAMS	97	E665		470 $\mu p \rightarrow \mu XB$
770 ±2		38 BOGOLYUB...	97	MIRA		32 $\bar{p}p \rightarrow \pi^+\pi^-X$
768 ±8		38 BOGOLYUB...	97	MIRA		32 $p p \rightarrow \pi^+\pi^-X$
761.1±2.9		DUBNICKA	89	RVUE		π form factor
777.4±2.0		39 CHABAUD	83	ASPK	0	17 $\pi^- p$ polarized
769.5±0.7		32,33 LANG	79	RVUE	0	
770 ±9		33 ESTABROOKS	74	RVUE	0	17 $\pi^- p \rightarrow \pi^+\pi^-n$
773.5±1.7	11200	25 JACOBS	72	HBC	0	2.8 $\pi^- p$
775 ±3	2250	HYAMS	68	OSPK	0	11.2 $\pi^- p$



- ¹ Using the GOUNARIS 68 parametrization with the complex phase of the ρ - ω interference and leaving the masses and widths of the $\rho(1450)$, $\rho(1700)$, and $\rho(2150)$ resonances as free parameters of the fit.
- ² A combined fit of AKHMETSHIN 07, AULCHENKO 06, and AULCHENKO 05.
- ³ Supersedes ACHASOV 05A.
- ⁴ 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.
- ⁵ Using the GOUNARIS 68 parametrization with the complex phase of the ρ - ω interference.
- ⁶ Update of AKHMETSHIN 02.
- ⁷ Assuming $m_{\rho^+} = m_{\rho^-}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-}$.
- ⁸ From the GOUNARIS 68 parametrization of the pion form factor.
- ⁹ Assuming $m_{\rho^+} = m_{\rho^-} = m_{\rho^0}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-} = \Gamma_{\rho^0}$.
- ¹⁰ Without limitations on masses and widths.

- 11 Assuming $m_{\rho^0} = m_{\rho^\pm}$, $g_{\rho^0\pi\pi} = g_{\rho^\pm\pi\pi}$.
- 12 Using the data of BARKOV 85 in the hidden local symmetry model.
- 13 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.
- 14 A fit of BARKOV 85 data assuming the direct $\omega\pi\pi$ coupling.
- 15 Applying the S-matrix formalism to the BARKOV 85 data.
- 16 Includes BARKOV 85 data. Model-dependent width definition.
- 17 $|F_\pi(0)|^2$ fixed to 1.
- 18 From the GOUNARIS 68 parametrization of the pion form factor.
- 19 The error combines statistical and systematic uncertainties. Supersedes BARATE 97M.
- 20 $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV respectively.
- 21 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.
- 22 Using the data of BARATE 97M and the effective chiral Lagrangian.
- 23 From a fit of the model-independent parameterization of the pion form factor to the data of BARATE 97M.
- 24 Assuming the equality of ρ^+ and ρ^- masses and widths.
- 25 Mass errors enlarged by us to Γ/\sqrt{N} ; see the note with the $K^*(892)$ mass.
- 26 Phase shift analysis. Systematic errors added corresponding to spread of different fits.
- 27 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.
- 28 Using the KUHN 90 parametrization of the pion form factor, neglecting ρ - ω interference.
- 29 From the parametrization according to SOEDING 66.
- 30 From the parametrization according to ROSS 66.
- 31 HEYN 81 includes all spacelike and timelike F_π values until 1978.
- 32 From pole extrapolation.
- 33 From phase shift analysis of GRAYER 74 data.
- 34 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.
- 35 Breit-Wigner mass from a phase-shift analysis of HYAMS 73 and PROTOPODESCU 73 data.
- 36 Using relativistic Breit-Wigner and taking into account ρ - ω interference.
- 37 Systematic errors not evaluated.
- 38 Systematic effects not studied.
- 39 From fit of 3-parameter relativistic Breit-Wigner to helicity-zero part of P -wave intensity. CHABAUD 83 includes data of GRAYER 74.

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

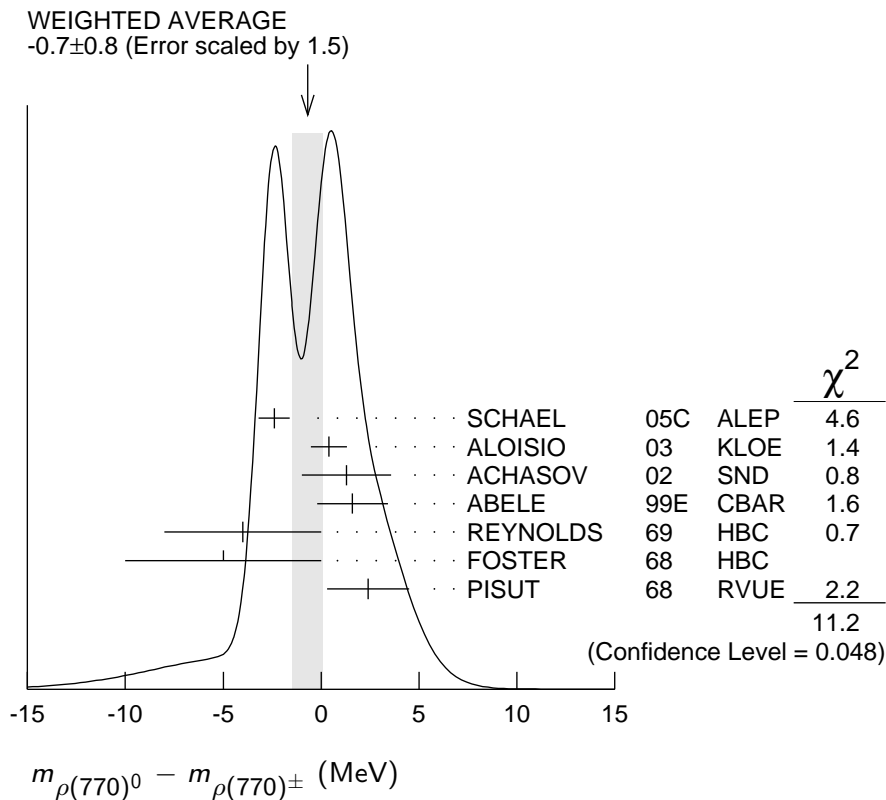
<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
-0.7±0.8 OUR AVERAGE					Error includes scale factor of 1.5. See the ideogram below.
-2.4±0.8		40 SCHAEL	05C ALEP		$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
0.4±0.7±0.6	1.98M	41 ALOISIO	03 KLOE		$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
1.3±1.1±2.0	500k	41 ACHASOV	02 SND		$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
1.6±0.6±1.7	600k	ABELE	99E CBAR	0±	$0.0 \bar{p} p \rightarrow \pi^+ \pi^- \pi^0$
-4 ±4	3000	42 REYNOLDS	69 HBC	-0	$2.26 \pi^- p$
-5 ±5	3600	42 FOSTER	68 HBC	±0	$0.0 \bar{p} p$
2.4±2.1	22950	43 PISUT	68 RVUE		$\pi N \rightarrow \rho N$

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

41 Assuming $m_{\rho^+} = m_{\rho^-}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-}$.

42 From quoted masses of charged and neutral modes.

43 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, GOLDBABER 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. ● ● ●

$1.5 \pm 0.8 \pm 0.7$ 1.98M 44 ALOISIO 03 KLOE 1.02 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$

44 Without limitations on masses and widths.

$\rho(770)$ 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, $q = q_r$.

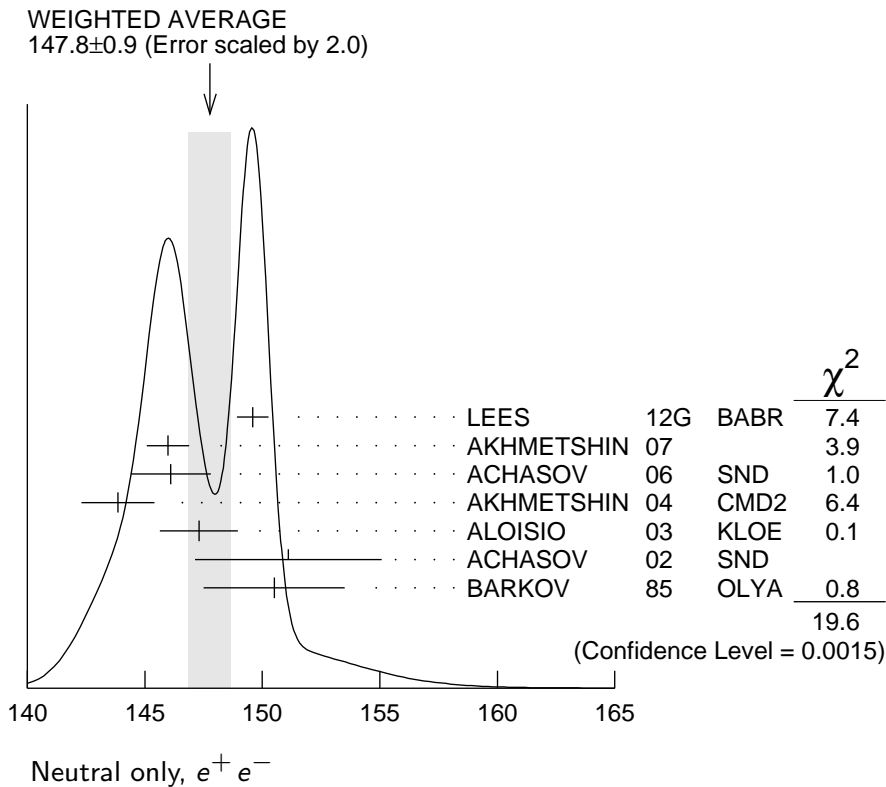
<u>VALUE (GeV⁻¹)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>	
5.3^{+0.9}_{-0.7}	CHABAUD	83	ASPK	0	17 $\pi^- p$ polarized

$\rho(770)$ WIDTH

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

NEUTRAL ONLY, $e^+ e^-$

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
147.8 ± 0.9	OUR AVERAGE	Error includes scale factor of 2.0. See the ideogram below.			
149.59 ± 0.67		45 LEES	12G	BABR	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$
145.98 ± 0.75 ± 0.50	900k	46 AKHMETSHIN	07		$e^+ e^- \rightarrow \pi^+ \pi^-$
146.1 ± 0.8 ± 1.5	800k	47,48 ACHASOV	06	SND	$e^+ e^- \rightarrow \pi^+ \pi^-$
143.85 ± 1.33 ± 0.80	114k	49,50 AKHMETSHIN	04	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^-$
147.3 ± 1.5 ± 0.7	1.98M	51 ALOISIO	03	KLOE	$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
151.1 ± 2.6 ± 3.0	500k	51 ACHASOV	02	SND	0 $1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
150.5 ± 3.0		52 BARKOV	85	OLYA	0 $e^+ e^- \rightarrow \pi^+ \pi^-$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
143.9 ± 1.3 ± 1.1	1.98M	53 ALOISIO	03	KLOE	$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
147.4 ± 1.5 ± 0.7	1.98M	54 ALOISIO	03	KLOE	$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
149.8 ± 2.2 ± 2.0	500k	55 ACHASOV	02	SND	$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
147.9 ± 1.5 ± 7.5		56 BENAYOUN	98	RVUE	$e^+ e^- \rightarrow \pi^+ \pi^-, \mu^+ \mu^-$
153.5 ± 1.3 ± 4.6		57 GARDNER	98	RVUE	$0.28-0.92 e^+ e^- \rightarrow \pi^+ \pi^-$
145.0 ± 1.7		58 O'CONNELL	97	RVUE	$e^+ e^- \rightarrow \pi^+ \pi^-$
142.5 ± 3.5		59 BERNICHA	94	RVUE	$e^+ e^- \rightarrow \pi^+ \pi^-$
138 ± 1		60 GESHKEN...	89	RVUE	$e^+ e^- \rightarrow \pi^+ \pi^-$



CHARGED ONLY, τ DECAYS and e^+e^-

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
149.1±0.8 OUR FIT					
149.1±0.8 OUR AVERAGE					
148.1±0.4±1.7	5.4M	^{61,62} FUJIKAWA	08	BELL	± $\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
149.0±1.2		^{62,63} SCHAEEL	05C	ALEP	$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
149.9±2.3±2.0	500k	⁵¹ ACHASOV	02	SND	± $1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
150.4±1.4±1.4	87k	^{64,65} 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	⁵¹ ALOISIO	03	KLOE	± $1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
142.9±1.3±1.4	1.98M	⁵⁴ ALOISIO	03	KLOE	- $1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
144.7±1.4±1.2	1.98M	⁵⁴ ALOISIO	03	KLOE	+ $1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
150.2±2.0 ^{+0.7} _{-1.6}		⁶⁶ SANZ-CILLERO	03	RVUE	$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
150.9±2.2±2.0	500k	⁵⁵ ACHASOV	02	SND	$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$

MIXED CHARGES, OTHER REACTIONS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
149.5±1.3	600k	⁶⁷ ABELE	99E	CBAR	0± $0.0 \bar{p} p \rightarrow \pi^+ \pi^- \pi^0$

CHARGED ONLY, HADROPRODUCED

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
150.2± 2.4 OUR FIT					
150.2± 2.4 OUR AVERAGE					
152.8± 4.3		ABELE	97	CBAR	$\bar{p}n \rightarrow \pi^- \pi^0 \pi^0$
155 ± 11	2935	⁶⁸ CAPRARO	87	SPEC	- 200 $\pi^- \text{Cu} \rightarrow \pi^- \pi^0 \text{Cu}$
154 ± 20	967	⁶⁸ CAPRARO	87	SPEC	- 200 $\pi^- \text{Pb} \rightarrow \pi^- \pi^0 \text{Pb}$
150 ± 5		HUSTON	86	SPEC	+ 202 $\pi^+ \text{A} \rightarrow \pi^+ \pi^0 \text{A}$
146 ± 12	6500	⁶⁹ BYERLY	73	OSPK	- 5 $\pi^- p$
148.2± 4.1	9650	⁷⁰ 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

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
151.7± 2.6 OUR AVERAGE				
155 ± 5 ± 2	63.5k	⁷¹ ABRAMOWICZ12	ZEUS	$ep \rightarrow e\pi^+\pi^-p$
146 ± 3 ± 13	79k	⁷² BREITWEG	98B	ZEUS 50-100 γp
150.9± 3.0		BARTALUCCI	78	CNTR $\gamma p \rightarrow e^+e^-p$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
138 ± 3	79k	⁷³ BREITWEG	98B	ZEUS 50-100 γp
147 ± 11		GLADDING	73	CNTR 2.9-4.7 γp
155 ± 12	2430	BALLAM	72	HBC 4.7 γp
145 ± 13	1930	BALLAM	72	HBC 2.8 γp
140 ± 5		ALVENSLEB...	70	CNTR $\gamma \text{A}, t < 0.01$
146.1± 2.9	140k	BIGGS	70	CNTR $< 4.1 \gamma \text{C} \rightarrow \pi^+\pi^-\text{C}$
160 ± 10		LANZEROTTI	68	CNTR γp
130 ± 5	4000	ASBURY	67B	CNTR $\gamma + \text{Pb}$

NEUTRAL ONLY, OTHER REACTIONS

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
150.9± 1.7 OUR AVERAGE					Error includes scale factor of 1.1.
122 ± 20		BERTIN	97C	OBLX	0.0 $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$
145.7± 5.3		WEIDENAUER	93	ASTE	$\bar{p}p \rightarrow \pi^+\pi^-\omega$
144.9± 3.7		DUBNICKA	89	RVUE	π form factor
148 ± 6		^{74,75} BOHACIK	80	RVUE	0
152 ± 9		⁶⁹ 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	⁷⁶ ABELE	99E	CBAR	0 0.0 $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$
146 ± 3	4943	⁷⁷ ADAMS	97	E665	470 $\mu p \rightarrow \mu XB$
160.0 ⁺ 4.1 - 4.0		⁷⁸ CHABAUD	83	ASPK	0 17 $\pi^- p$ polarized
155 ± 1		⁷⁹ HEYN	81	RVUE	0 π form factor
148.0± 1.3		^{74,75} LANG	79	RVUE	0

146	± 14	4100	ENGLER	74	DBC	0	6 $\pi^+ n \rightarrow \pi^+ \pi^- p$
143	± 13		⁷⁵ ESTABROOKS	74	RVUE	0	17 $\pi^- p \rightarrow \pi^+ \pi^- n$
160	± 10	32000	⁷⁴ PROTOPOP...	73	HBC	0	7.1 $\pi^+ p, t < 0.4$
145	± 12	2250	⁶⁸ HYAMS	68	OSPK	0	11.2 $\pi^- p$
163	± 15	13300	⁸⁰ PISUT	68	RVUE	0	1.7–3.2 $\pi^- p, t < 10$

⁴⁵ Using the GOUNARIS 68 parametrization with the complex phase of the ρ - ω interference and leaving the masses and widths of the $\rho(1450)$, $\rho(1700)$, and $\rho(2150)$ resonances as free parameters of the fit.

⁴⁶ A combined fit of AKHMETSHIN 07, AULCHENKO 06, and AULCHENKO 05.

⁴⁷ Supersedes ACHASOV 05A.

⁴⁸ 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.

⁴⁹ Using the GOUNARIS 68 parametrization with the complex phase of the ρ - ω interference.

⁵⁰ From a fit in the energy range 0.61 to 0.96 GeV. Update of AKHMETSHIN 02.

⁵¹ Assuming $m_{\rho^+} = m_{\rho^-}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-}$.

⁵² From the GOUNARIS 68 parametrization of the pion form factor.

⁵³ Assuming $m_{\rho^+} = m_{\rho^-} = m_{\rho^0}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-} = \Gamma_{\rho^0}$.

⁵⁴ Without limitations on masses and widths.

⁵⁵ Assuming $m_{\rho^0} = m_{\rho^\pm}$, $g_{\rho^0 \pi\pi} = g_{\rho^\pm \pi\pi}$.

⁵⁶ Using the data of BARKOV 85 in the hidden local symmetry model.

⁵⁷ 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.

⁵⁸ A fit of BARKOV 85 data assuming the direct $\omega \pi\pi$ coupling.

⁵⁹ Applying the S-matrix formalism to the BARKOV 85 data.

⁶⁰ Includes BARKOV 85 data. Model-dependent width definition.

⁶¹ $|F_\pi(0)|^2$ fixed to 1.

⁶² From the GOUNARIS 68 parametrization of the pion form factor.

⁶³ The error combines statistical and systematic uncertainties. Supersedes BARATE 97M.

⁶⁴ $\rho(1700)$ mass and width fixed at 1700 MeV and 235 MeV respectively.

⁶⁵ 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.

⁶⁶ Using the data of BARATE 97M and the effective chiral Lagrangian.

⁶⁷ Assuming the equality of ρ^+ and ρ^- masses and widths.

⁶⁸ Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.

⁶⁹ Phase shift analysis. Systematic errors added corresponding to spread of different fits.

⁷⁰ 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.

⁷¹ Using the KUHN 90 parametrization of the pion form factor, neglecting ρ - ω interference.

⁷² From the parametrization according to SOEDING 66.

⁷³ From the parametrization according to ROSS 66.

⁷⁴ From pole extrapolation.

⁷⁵ From phase shift analysis of GRAYER 74 data.

⁷⁶ Using relativistic Breit-Wigner and taking into account ρ - ω interference.

⁷⁷ Systematic errors not evaluated.

⁷⁸ From fit of 3-parameter relativistic Breit-Wigner to helicity-zero part of P -wave intensity. CHABAUD 83 includes data of GRAYER 74.

⁷⁹ HEYN 81 includes all spacelike and timelike F_π values until 1978.

⁸⁰ 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		⁸¹ SCHAEEL	05C ALEP	$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$
3.6±1.8±1.7	1.98M	⁸² ALOISIO	03 KLOE	$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$

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

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
1.8±2.0±0.5	1.98M	⁸³ ALOISIO	03 KLOE	$1.02 e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$

⁸¹From 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. Supersedes BARATE 97M.

⁸²Assuming $m_{\rho^+} = m_{\rho^-}$, $\Gamma_{\rho^+} = \Gamma_{\rho^-}$.

⁸³Without limitations on masses and widths.

$\rho(770)$ 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)	$\times 10^{-4}$ S=2.2
Γ_4 $\pi^\pm \eta$	< 6	$\times 10^{-3}$ CL=84%
Γ_5 $\pi^\pm \pi^+ \pi^- \pi^0$	< 2.0	$\times 10^{-3}$ CL=84%
$\rho(770)^0$ decays		
Γ_6 $\pi^+ \pi^-$	~ 100	%
Γ_7 $\pi^+ \pi^- \gamma$	(9.9 ±1.6)	$\times 10^{-3}$
Γ_8 $\pi^0 \gamma$	(6.0 ±0.8)	$\times 10^{-4}$
Γ_9 $\eta \gamma$	(3.00±0.20)	$\times 10^{-4}$
Γ_{10} $\pi^0 \pi^0 \gamma$	(4.5 ±0.8)	$\times 10^{-5}$
Γ_{11} $\mu^+ \mu^-$	[a] (4.55±0.28)	$\times 10^{-5}$
Γ_{12} $e^+ e^-$	[a] (4.72±0.05)	$\times 10^{-5}$
Γ_{13} $\pi^+ \pi^- \pi^0$	(1.01 ^{+0.54} _{-0.36} ±0.34)	$\times 10^{-4}$
Γ_{14} $\pi^+ \pi^- \pi^+ \pi^-$	(1.8 ±0.9)	$\times 10^{-5}$
Γ_{15} $\pi^+ \pi^- \pi^0 \pi^0$	(1.6 ±0.8)	$\times 10^{-5}$
Γ_{16} $\pi^0 e^+ e^-$	< 1.2	$\times 10^{-5}$ CL=90%
Γ_{17} $\eta e^+ e^-$		

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

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.

$$\begin{array}{c}
 x_3 \\
 \Gamma
 \end{array}
 \begin{array}{|c}
 -100 \\
 \hline
 15 \quad -15 \\
 \hline
 x_2 \quad x_3
 \end{array}$$

	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 21 measurements and one constraint to determine 9 parameters. The overall fit has a $\chi^2 = 6.0$ for 13 degrees of freedom.

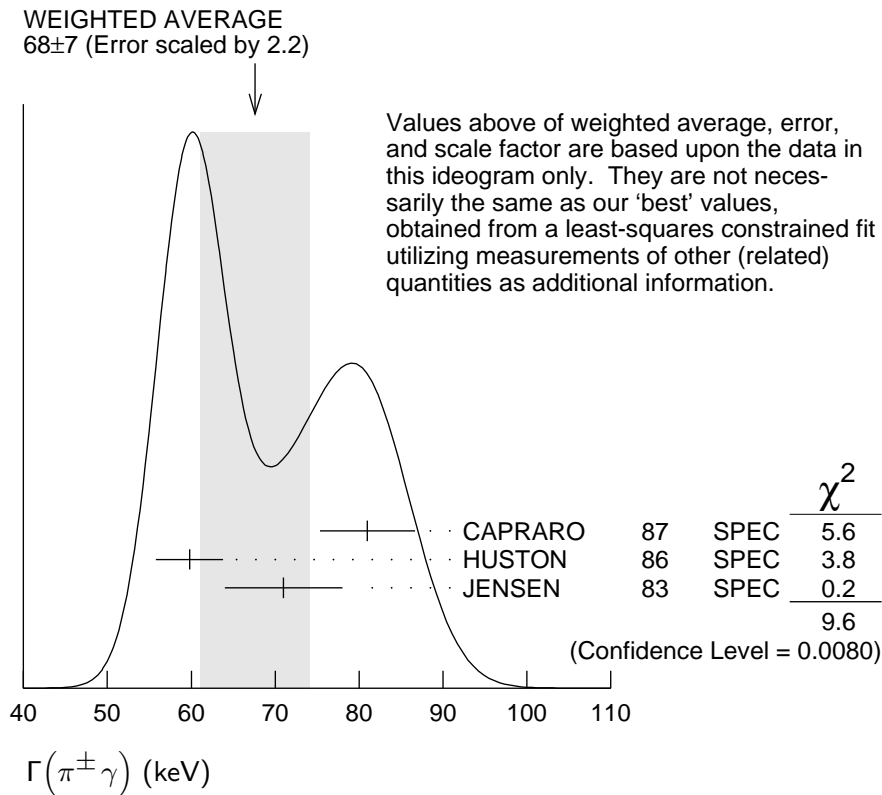
The following *off-diagonal* array elements are the correlation coefficients $\langle \delta p_i \delta p_j \rangle / (\delta p_i \cdot \delta p_j)$, in percent, from the fit to parameters p_i , including the branching fractions, $x_i \equiv \Gamma_i / \Gamma_{\text{total}}$. The fit constrains the x_i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

x_7	-100							
x_8	-5	0						
x_9	-1	0	1					
x_{10}	-1	0	0	0				
x_{11}	2	-3	0	0	0			
x_{12}	0	0	-8	-9	0	0		
x_{14}	-1	0	0	0	0	0	0	
Γ	0	0	4	5	0	0	-54	0
	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{14}

Mode	Rate (MeV)
Γ_6 $\pi^+ \pi^-$	147.5 \pm 0.9
Γ_7 $\pi^+ \pi^- \gamma$	1.48 \pm 0.24
Γ_8 $\pi^0 \gamma$	0.089 \pm 0.012
Γ_9 $\eta \gamma$	0.0447 \pm 0.0031
Γ_{10} $\pi^0 \pi^0 \gamma$	0.0066 \pm 0.0012
Γ_{11} $\mu^+ \mu^-$	[a] 0.0068 \pm 0.0004
Γ_{12} $e^+ e^-$	[a] 0.00704 \pm 0.00006
Γ_{14} $\pi^+ \pi^- \pi^+ \pi^-$	0.0027 \pm 0.0014

$\rho(770)$ PARTIAL WIDTHS

$\Gamma(\pi^\pm \gamma)$	VALUE (keV)	DOCUMENT ID	TECN	CHG	COMMENT	Γ_3
68 \pm 7 OUR FIT					Error includes scale factor of 2.3.	
68 \pm 7 OUR AVERAGE					Error includes scale factor of 2.2. See the ideogram below.	
81 \pm 4 \pm 4		CAPRARO	87	SPEC	-	200 $\pi^- A \rightarrow \pi^- \pi^0 A$
59.8 \pm 4.0		HUSTON	86	SPEC	+	202 $\pi^+ A \rightarrow \pi^+ \pi^0 A$
71 \pm 7		JENSEN	83	SPEC	-	156-260 $\pi^- A \rightarrow \pi^- \pi^0 A$



$\Gamma(e^+e^-)$

Γ_{12}

VALUE (keV)	EVTS	DOCUMENT ID	TECN	COMMENT
7.04 ±0.06				OUR FIT
7.04 ±0.06				OUR AVERAGE
7.048±0.057±0.050	900k	⁸⁴ AKHMETSHIN 07		$e^+e^- \rightarrow \pi^+\pi^-$
7.06 ±0.11 ±0.05	114k	^{85,86} AKHMETSHIN 04	CMD2	$e^+e^- \rightarrow \pi^+\pi^-$
6.77 ±0.10 ±0.30		BARKOV 85	OLYA	$e^+e^- \rightarrow \pi^+\pi^-$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
7.12 ±0.02 ±0.11	800k	⁸⁷ ACHASOV 06	SND	$e^+e^- \rightarrow \pi^+\pi^-$
6.3 ±0.1		⁸⁸ BENAYOUN 98	RVUE	$e^+e^- \rightarrow \pi^+\pi^-, \mu^+\mu^-$

$\Gamma(\pi^0\gamma)$

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	⁸⁹ ACHASOV 03	SND	0.60–0.97 $e^+e^- \rightarrow \pi^0\gamma$
121±31		DOLINSKY 89	ND	$e^+e^- \rightarrow \pi^0\gamma$

$\Gamma(\eta\gamma)$

Γ_9

VALUE (keV)	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
62±17	⁹⁰ DOLINSKY 89	ND	$e^+e^- \rightarrow \eta\gamma$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)$

Γ_{14}

VALUE (keV) EVTS DOCUMENT ID TECN COMMENT

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

2.8±1.4±0.5 153 AKHMETSHIN 00 CMD2 0.6–0.97 $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$

- 84 A combined fit of AKHMETSHIN 07, AULCHENKO 06, and AULCHENKO 05.
- 85 Using the GOUNARIS 68 parametrization with the complex phase of the ρ - ω interference.
- 86 From a fit in the energy range 0.61 to 0.96 GeV. Update of AKHMETSHIN 02.
- 87 Supersedes ACHASOV 05A.
- 88 Using the data of BARKOV 85 in the hidden local symmetry model.
- 89 Using $\Gamma_{\text{total}} = 147.9 \pm 1.3$ MeV and $B(\rho \rightarrow \pi^0\gamma)$ from ACHASOV 03.
- 90 Solution corresponding to constructive ω - ρ interference.

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

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

VALUE (units 10^{-5}) EVTS DOCUMENT ID TECN COMMENT

4.876±0.023±0.064 800k 91,92 ACHASOV 06 SND $e^+e^- \rightarrow \pi^+\pi^-$

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

4.72 ±0.02 93 BENAYOUN 10 RVUE 0.4–1.05 e^+e^-

- 91 Supersedes ACHASOV 05A.
- 92 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.
- 93 A simultaneous fit of $e^+e^- \rightarrow \pi^+\pi^-, \pi^+\pi^-\pi^0, \pi^0\gamma, \eta\gamma$ data.

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

VALUE (units 10^{-8}) EVTS DOCUMENT ID TECN COMMENT

1.42±0.10 OUR FIT

1.45±0.12 OUR AVERAGE

1.32±0.14±0.08 33k 94 ACHASOV 07B SND 0.6–1.38 $e^+e^- \rightarrow \eta\gamma$

1.50±0.65±0.09 17.4k 95 AKHMETSHIN 05 CMD2 0.60–1.38 $e^+e^- \rightarrow \eta\gamma$

1.61±0.20±0.11 23k 96,97 AKHMETSHIN 01B CMD2 $e^+e^- \rightarrow \eta\gamma$

1.85±0.49 98 DOLINSKY 89 ND $e^+e^- \rightarrow \eta\gamma$

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

1.05±0.02 99 BENAYOUN 10 RVUE 0.4–1.05 e^+e^-

- 94 From a combined fit of $\sigma(e^+e^- \rightarrow \eta\gamma)$ with $\eta \rightarrow 3\pi^0$ and $\eta \rightarrow \pi^+\pi^-\pi^0$, and fixing $B(\eta \rightarrow 3\pi^0) / B(\eta \rightarrow \pi^+\pi^-\pi^0) = 1.44 \pm 0.04$. Recalculated by us from the cross section at the peak. Supersedes ACHASOV 00D and ACHASOV 06A.
- 95 From the $\eta \rightarrow 2\gamma$ decay and using $B(\eta \rightarrow \gamma\gamma) = 39.43 \pm 0.26\%$.
- 96 From the $\eta \rightarrow 3\pi^0$ decay and using $B(\eta \rightarrow 3\pi^0) = (32.24 \pm 0.29) \times 10^{-2}$.
- 97 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).
- 98 Recalculated by us from the cross section in the peak.
- 99 A simultaneous fit of $e^+e^- \rightarrow \pi^+\pi^-, \pi^+\pi^-\pi^0, \pi^0\gamma, \eta\gamma$ data.

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

VALUE (units 10^{-8}) EVTS DOCUMENT ID TECN COMMENT

2.8 ±0.4 OUR FIT

2.8 ±0.4 OUR AVERAGE

2.90 $^{+0.60}_{-0.55}$ ±0.18 18680 AKHMETSHIN 05 CMD2 0.60–1.38 $e^+e^- \rightarrow \pi^0\gamma$

2.37 ±0.53 ±0.33 36500 ¹⁰⁰ACHASOV 03 SND 0.60–0.97 $e^+e^- \rightarrow \pi^0\gamma$

3.61 ±0.74 ±0.49 10625 ¹⁰¹DOLINSKY 89 ND $e^+e^- \rightarrow \pi^0\gamma$

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

1.875±0.026 ¹⁰²BENAYOUN 10 RVUE 0.4–1.05 e^+e^-

¹⁰⁰ Using $\sigma_{\phi \rightarrow \pi^0\gamma}$ from ACHASOV 00 and $m_\rho = 775.97$ MeV in the model with the energy-independent phase of ρ - ω interference equal to $(-10.2 \pm 7.0)^\circ$.

¹⁰¹ Recalculated by us from the cross section in the peak.

¹⁰² A simultaneous fit of $e^+e^- \rightarrow \pi^+\pi^-, \pi^+\pi^-\pi^0, \pi^0\gamma, \eta\gamma$ data.

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

VALUE (units 10^{-9}) EVTS DOCUMENT ID TECN COMMENT

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

0.903±0.076 ¹⁰³BENAYOUN 10 RVUE 0.4–1.05 e^+e^-

4.58 $^{+2.46}_{-1.64}$ ±1.56 1.2M ¹⁰⁴ACHASOV 03D RVUE 0.44–2.00 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$

¹⁰³ A simultaneous fit of $e^+e^- \rightarrow \pi^+\pi^-, \pi^+\pi^-\pi^0, \pi^0\gamma, \eta\gamma$ data.

¹⁰⁴ Statistical significance is less than 3σ .

$\rho(770)$ 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 $\pi^- \text{Cu} \rightarrow \mu^+\mu^-\pi^- \text{Cu}$

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

8.2 $^{+1.6}_{-3.6}$ ¹⁰⁵ROTHWELL 69 CNTR Photoproduction

5.6 ±1.5 ¹⁰⁶WEHMANN 69 OSPK 12 $\pi^- \text{C, Fe}$

9.7 $^{+3.1}_{-3.3}$ ¹⁰⁷HYAMS 67 OSPK 11 $\pi^- \text{Li, H}$

$\Gamma(e^+e^-)/\Gamma(\pi\pi)$

Γ_{12}/Γ_1

VALUE (units 10^{-4})	DOCUMENT ID	TECN	COMMENT
0.40 ± 0.05	¹⁰⁸ BENAKSAS	72	OSPK $e^+e^- \rightarrow \pi^+\pi^-$

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

Γ_9/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
3.00 ± 0.21 OUR FIT					
2.90 ± 0.32 OUR AVERAGE					
$2.79 \pm 0.34 \pm 0.03$	33k	¹⁰⁹ ACHASOV	07B	SND	0.6–1.38 $e^+e^- \rightarrow \eta\gamma$
3.6 ± 0.9		¹¹⁰ ANDREWS	77	CNTR 0	6.7–10 γ Cu
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$3.21 \pm 1.39 \pm 0.20$	17.4k	^{111,112} AKHMETSHIN	05	CMD2	0.60–1.38 $e^+e^- \rightarrow \eta\gamma$
$3.39 \pm 0.42 \pm 0.23$	110,113,114	AKHMETSHIN	01B	CMD2	$e^+e^- \rightarrow \eta\gamma$
$1.9^{+0.6}_{-0.8}$		¹¹⁵ BENAYOUN	96	RVUE	0.54–1.04 $e^+e^- \rightarrow \eta\gamma$
4.0 ± 1.1		^{110,112} DOLINSKY	89	ND	$e^+e^- \rightarrow \eta\gamma$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma_{total}$

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 $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<20		90	KURDADZE	88	OLYA $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma(\pi\pi)$

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. • • •					
$1.01^{+0.54}_{-0.36} \pm 0.34$		1.2M	¹¹⁶ ACHASOV	03D	RVUE 0.44–2.00 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$
<1.2	90		VASSERMAN	88B	ND $e^+e^- \rightarrow \pi^+\pi^-\pi^0$

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma(\pi\pi)$

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	$J/\psi \rightarrow \omega\pi^0$
<0.01	84	¹¹⁷ ABRAMS	71	HBC 0	3.7 $\pi^+ p$

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

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
$1.60 \pm 0.74 \pm 0.18$		118 ACHASOV 09A	SND	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0 \pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 4	90	AULCHENKO 87C	ND	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0 \pi^0$
< 20	90	KURDADZE 86	OLYA	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0 \pi^0$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
0.0099 ± 0.0016 OUR FIT				
0.0099 ± 0.0016		119 DOLINSKY 91	ND	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.0111 \pm 0.0014		120 VASSERMAN 88	ND	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$
< 0.005	90	121 VASSERMAN 88	ND	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$6.21^{+1.28}_{-1.18} \pm 0.39$	18680	122,123 AKHMETSHIN 05	CMD2	$0.60-1.38 e^+ e^- \rightarrow \pi^0 \gamma$
$5.22 \pm 1.17 \pm 0.75$	36500	123,124 ACHASOV 03	SND	$0.60-0.97 e^+ e^- \rightarrow \pi^0 \gamma$
6.8 ± 1.7		125 BENAYOUN 96	RVUE	$0.54-1.04 e^+ e^- \rightarrow \pi^0 \gamma$
7.9 ± 2.0		123 DOLINSKY 89	ND	$e^+ e^- \rightarrow \pi^0 \gamma$

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

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
< 1.2	90	ACHASOV 08	SND	$0.36-0.97 e^+ e^- \rightarrow \pi^0 e^+ e^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 1.6		AKHMETSHIN 05A	CMD2	$0.72-0.84 e^+ e^-$

$\Gamma(\eta e^+ e^-)/\Gamma_{\text{total}}$ 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	$0.72-0.84 e^+ e^-$

$\Gamma(\pi^0 \pi^0 \gamma)/\Gamma_{\text{total}}$ 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				
$5.2^{+1.5}_{-1.3} \pm 0.6$	190	126 AKHMETSHIN 04B	CMD2	$0.6-0.97 e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$
$4.1^{+1.0}_{-0.9} \pm 0.3$	295	127 ACHASOV 02F	SND	$0.36-0.97 e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$4.8^{+3.4}_{-1.8} \pm 0.5$	63	128 ACHASOV 00G	SND	$e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$

- 105 Possibly large ρ - ω interference leads us to increase the minus error.
- 106 Result contains $11 \pm 11\%$ 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 $\omega \rightarrow \mu^+ \mu^-$ from this experiment.
- 107 HYAMS 67's mass resolution is 20 MeV. The ω region was excluded.
- 108 The ρ' contribution is not taken into account.
- 109 ACHASOV 07B reports $[\Gamma(\rho(770) \rightarrow \eta\gamma)/\Gamma_{\text{total}}] \times [\text{B}(\rho(770) \rightarrow e^+e^-)] = (1.32 \pm 0.14 \pm 0.08) \times 10^{-8}$ which we divide by our best value $\text{B}(\rho(770) \rightarrow e^+e^-) = (4.72 \pm 0.05) \times 10^{-5}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Supersedes ACHASOV 00D and ACHASOV 06A.
- 110 Solution corresponding to constructive ω - ρ interference.
- 111 Using $\text{B}(\rho \rightarrow e^+e^-) = (4.67 \pm 0.09) \times 10^{-5}$ and $\text{B}(\eta \rightarrow \gamma\gamma) = 39.43 \pm 0.26\%$.
- 112 Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\eta\gamma)/\Gamma_{\text{total}}^2$.
- 113 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).
- 114 Using $\text{B}(\rho \rightarrow e^+e^-) = (4.75 \pm 0.10) \times 10^{-5}$ from AKHMETSHIN 02 and $\text{B}(\eta \rightarrow 3\pi^0) = (32.24 \pm 0.29) \times 10^{-2}$.
- 115 Reanalysis of DRUZHININ 84, DOLINSKY 89, and DOLINSKY 91 taking into account a triangle anomaly contribution. Constructive ρ - ω interference solution.
- 116 Statistical significance is less than 3σ .
- 117 Model dependent, assumes $l = 1, 2, \text{ or } 3$ for the 3π system.
- 118 Assuming no interference between the ρ and ω contributions.
- 119 Bremsstrahlung from a decay pion and for photon energy above 50 MeV.
- 120 Superseded by DOLINSKY 91.
- 121 Structure radiation due to quark rearrangement in the decay.
- 122 Using $\text{B}(\rho \rightarrow e^+e^-) = (4.67 \pm 0.09) \times 10^{-5}$.
- 123 Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\pi^0\gamma)/\Gamma_{\text{total}}^2$.
- 124 Using $\text{B}(\rho \rightarrow e^+e^-) = (4.54 \pm 0.10) \times 10^{-5}$.
- 125 Reanalysis of DRUZHININ 84, DOLINSKY 89, and DOLINSKY 91 taking into account a triangle anomaly contribution.
- 126 This branching ratio includes the conventional VMD mechanism $\rho \rightarrow \omega\pi^0$, $\omega \rightarrow \pi^0\gamma$, and the new decay mode $\rho \rightarrow f_0(500)\gamma$, $f_0(500) \rightarrow \pi^0\pi^0$ with a branching ratio $(2.0^{+1.1}_{-0.9} \pm 0.3) \times 10^{-5}$ differing from zero by 2.0 standard deviations.
- 127 This branching ratio includes the conventional VMD mechanism $\rho \rightarrow \omega\pi^0$, $\omega \rightarrow \pi^0\gamma$ and the new decay mode $\rho \rightarrow f_0(500)\gamma$, $f_0(500) \rightarrow \pi^0\pi^0$ 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.
- 128 Superseded by ACHASOV 02F.

$\rho(770)$ REFERENCES

ABRAMOWICZ 12	EPJ C72 1869	H. Abramowicz <i>et al.</i>	(ZEUS Collab.)
LEES 12G	PR D86 032013	J.P. Lees <i>et al.</i>	(BABAR Collab.)
BENAYOUN 10	EPJ C65 211	M. Benayoun <i>et al.</i>	
ACHASOV 09A	JETP 109 379	M.N. Achasov <i>et al.</i>	(SND Collab.)
	Translated from ZETF 136 442.		
ACHASOV 08	JETP 107 61	M.N. Achasov <i>et al.</i>	(SND Collab.)
	Translated from ZETF 134 80.		
FUJIKAWA 08	PR D78 072006	M. Fujikawa <i>et al.</i>	(BELLE Collab.)
ACHASOV 07B	PR D76 077101	M.N. Achasov <i>et al.</i>	(SND Collab.)
AKHMETSHIN 07	PL B648 28	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.)
	Translated from ZETF 130 437.		

ACHASOV	06A	PR D74 014016	M.N. Achasov <i>et al.</i>	(SND Collab.)
AULCHENKO	06	JETPL 84 413	V.M. Aulchenko <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
		Translated from ZETFP 84 491.		
ACHASOV	05A	JETP 101 1053	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETF 128 1201.		
AKHMETSHIN	05	PL B605 26	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	05A	PL B613 29	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ALOISIO	05	PL B606 12	A. Aloisio <i>et al.</i>	(KLOE Collab.)
AULCHENKO	05	JETPL 82 743	V.M. Aulchenko <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
		Translated from ZETFP 82 841.		
SCHAEEL	05C	PRPL 421 191	S. Schael <i>et al.</i>	(ALEPH Collab.)
AKHMETSHIN	04	PL B578 285	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	04B	PL B580 119	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ACHASOV	03	PL B559 171	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	03D	PR D68 052006	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ALOISIO	03	PL B561 55	A. Aloisio <i>et al.</i>	(KLOE Collab.)
SANZ-CILLERO	03	EPJ C27 587	J.J. Sanz-Cillero, A. Pich	
ACHASOV	02	PR D65 032002	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	02F	PL B537 201	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AKHMETSHIN	02	PL B527 161	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	01B	PL B509 217	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
COLANGELO	01	NP B603 125	G. Colangelo, J. Gasser, H. Leytwyler	
PICH	01	PR D63 093005	A. Pich, J. Portoles	
ACHASOV	00	EPJ C12 25	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	00D	JETPL 72 282	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETFP 72 411.		
ACHASOV	00G	JETPL 71 355	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETFP 71 519.		
AKHMETSHIN	00	PL B475 190	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ANDERSON	00A	PR D61 112002	S. Anderson <i>et al.</i>	(CLEO Collab.)
ABELE	99E	PL B469 270	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
BENAYOUN	98	EPJ C2 269	M. Benayoun <i>et al.</i>	(IPNP, NOVO, ADLD+)
BREITWEG	98B	EPJ C2 247	J. Breitweg <i>et al.</i>	(ZEUS Collab.)
GARDNER	98	PR D57 2716	S. Gardner, H.B. O'Connell	
Also		PR D62 019903 (errata)	S. Gardner, H.B. O'Connell	
ABELE	97	PL B391 191	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ADAMS	97	ZPHY C74 237	M.R. Adams <i>et al.</i>	(E665 Collab.)
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.)
BOGOLYUB...	97	PAN 60 46	M.Y. Bogolyubsky <i>et al.</i>	(MOSU, SERP)
		Translated from YAF 60 53.		
O'CONNELL	97	NP A623 559	H.B. O'Connell <i>et al.</i>	(ADLD)
BENAYOUN	96	ZPHY C72 221	M. Benayoun <i>et al.</i>	(IPNP, NOVO)
BERNICHIA	94	PR D50 4454	A. Bernichia, G. Lopez Castro, J. Pestieau	(LOUV+)
WEIDENAUER	93	ZPHY C59 387	P. Weidenauer <i>et al.</i>	(ASTERIX Collab.)
AGUILAR-...	91	ZPHY C50 405	M. Aguilar-Benitez <i>et al.</i>	(LEBC-EHS Collab.)
DOLINSKY	91	PRPL 202 99	S.I. Dolinsky <i>et al.</i>	(NOVO)
KUHN	90	ZPHY C48 445	J.H. Kuhn <i>et al.</i>	(MPIM)
ANTIPOV	89	ZPHY C42 185	Y.M. Antipov <i>et al.</i>	(SERP, JINR, BGNA+)
BISELLO	89	PL B220 321	D. Bisello <i>et al.</i>	(DM2 Collab.)
DOLINSKY	89	ZPHY C42 511	S.I. Dolinsky <i>et al.</i>	(NOVO)
DUBNICKA	89	JPG 15 1349	S. Dubnicka <i>et al.</i>	(JINR, SLOV)
GESHKEN...	89	ZPHY C45 351	B.V. Geshkenbein	(ITEP)
KURDADZE	88	JETPL 47 512	L.M. Kurdadze <i>et al.</i>	(NOVO)
		Translated from ZETFP 47 432.		
VASSERMAN	88	SJNP 47 1035	I.B. Vasserman <i>et al.</i>	(NOVO)
		Translated from YAF 47 1635.		
VASSERMAN	88B	SJNP 48 480	I.B. Vasserman <i>et al.</i>	(NOVO)
		Translated from YAF 48 753.		
AULCHENKO	87C	IYF 87-90 Preprint	V.M. Aulchenko <i>et al.</i>	(NOVO)
CAPRARO	87	NP B288 659	L. Capraro <i>et al.</i>	(CLER, FRAS, MILA+)
BRAMON	86	PL B173 97	A. Bramon, J. Casulleras	(BARC)
HUSTON	86	PR D33 3199	J. Huston <i>et al.</i>	(ROCH, FNAL, MINN)
KURDADZE	86	JETPL 43 643	L.M. Kurdadze <i>et al.</i>	(NOVO)
		Translated from ZETFP 43 497.		
BARKOV	85	NP B256 365	L.M. Barkov <i>et al.</i>	(NOVO)
DRUZHININ	84	PL 144B 136	V.P. Druzhinin <i>et al.</i>	(NOVO)
CHABAUD	83	NP B223 1	V. Chabaud <i>et al.</i>	(CERN, CRAC, MPIM)
JENSEN	83	PR D27 26	T. Jensen <i>et al.</i>	(ROCH, FNAL, MINN)
HEYN	81	ZPHY C7 169	M.F. Heyn, C.B. Lang	(GRAZ)
BOHACIK	80	PR D21 1342	J. Bohacik, H. Kuhnelt	(SLOV, WIEN)
LANG	79	PR D19 956	C.B. Lang, A. Mas-Parareda	(GRAZ)

BARTALUCCI	78	NC 44A 587	S. Bartalucci <i>et al.</i>	(DESY, FRAS)
WICKLUND	78	PR D17 1197	A.B. Wicklund <i>et al.</i>	(ANL)
ANDREWS	77	PRL 38 198	D.E. Andrews <i>et al.</i>	(ROCH)
DEUTSCH...	76	NP B103 426	M. Deuschmann <i>et al.</i>	(AACH3, BERL, BONN+)
ENGLER	74	PR D10 2070	A. Engler <i>et al.</i>	(CMU, CASE)
ESTABROOKS	74	NP B79 301	P.G. Estabrooks, A.D. Martin	(DURH)
GRAYER	74	NP B75 189	G. Grayer <i>et al.</i>	(CERN, MPIM)
BYERLY	73	PR D7 637	W.L. Byerly <i>et al.</i>	(MICH)
GLADDING	73	PR D8 3721	G.E. Gladding <i>et al.</i>	(HARV)
HYAMS	73	NP B64 134	B.D. Hyams <i>et al.</i>	(CERN, MPIM)
PROTOPOP...	73	PR D7 1279	S.D. Protopopescu <i>et al.</i>	(LBL)
BALLAM	72	PR D5 545	J. Ballam <i>et al.</i>	(SLAC, LBL, TUFTS)
BENAKSAS	72	PL 39B 289	D. Benaksas <i>et al.</i>	(ORSAY)
JACOBS	72	PR D6 1291	L.D. Jacobs	(SACL)
RATCLIFF	72	PL 38B 345	B.N. Ratcliff <i>et al.</i>	(SLAC)
ABRAMS	71	PR D4 653	G.S. Abrams <i>et al.</i>	(LBL)
ALVENSLEB...	70	PRL 24 786	H. Alvensleben <i>et al.</i>	(DESY)
BIGGS	70	PRL 24 1197	P.J. Biggs <i>et al.</i>	(DARE)
ERBE	69	PR 188 2060	R. Erbe <i>et al.</i>	(German Bubble Chamber Collab.)
MALAMUD	69	Argonne Conf. 93	E.I. Malamud, P.E. Schlein	(UCLA)
REYNOLDS	69	PR 184 1424	B.G. Reynolds <i>et al.</i>	(FSU)
ROTHWELL	69	PRL 23 1521	P.L. Rothwell <i>et al.</i>	(NEAS)
WEHMANN	69	PR 178 2095	A.A. Wehmann <i>et al.</i>	(HARV, CASE, SLAC+)
ARMENISE	68	NC 54A 999	N. Armenise <i>et al.</i>	(BARI, BGNA, FIRZ+)
BATON	68	PR 176 1574	J.P. Baton, G. Laurens	(SACL)
CHUNG	68	PR 165 1491	S.U. Chung <i>et al.</i>	(LRL)
FOSTER	68	NP B6 107	M. Foster <i>et al.</i>	(CERN, CDEF)
GOUNARIS	68	PRL 21 244	G.J. Gounaris, J.J. Sakurai	(ORSAY, MILA, UCLA)
HUSON	68	PL 28B 208	R. Huson <i>et al.</i>	(CERN, MPIM)
HYAMS	68	NP B7 1	B.D. Hyams <i>et al.</i>	(CERN, MPIM)
LANZEROTTI	68	PR 166 1365	L.J. Lanzerotti <i>et al.</i>	(HARV)
PISUT	68	NP B6 325	J. Pisut, M. Roos	(CERN)
ASBURY	67B	PRL 19 865	J.G. Asbury <i>et al.</i>	(DESY, COLU)
BACON	67	PR 157 1263	T.C. Bacon <i>et al.</i>	(BNL)
EISNER	67	PR 164 1699	R.L. Eisner <i>et al.</i>	(PURD)
HUWE	67	PL 24B 252	D.O. Huwe <i>et al.</i>	(COLU)
HYAMS	67	PL 24B 634	B.D. Hyams <i>et al.</i>	(CERN, MPIM)
MILLER	67B	PR 153 1423	D.H. Miller <i>et al.</i>	(PURD)
ALFF-...	66	PR 145 1072	C. Alff-Steinberger <i>et al.</i>	(COLU, RUTG)
FERBEL	66	PL 21 111	T. Ferbel	(ROCH)
HAGOPIAN	66	PR 145 1128	V. Hagopian <i>et al.</i>	(PENN, SACL)
HAGOPIAN	66B	PR 152 1183	V. Hagopian, Y.L. Pan	(PENN, LRL)
JACOBS	66B	UCRL 16877	L.D. Jacobs	(LRL)
JAMES	66	PR 142 896	F.E. James, H.L. Kraybill	(YALE, BNL)
ROSS	66	PR 149 1172	M. Ross, L. Stodolsky	
SOEDING	66	PL B19 702	P. Soeding	
WEST	66	PR 149 1089	E. West <i>et al.</i>	(WISC)
BLIEDEN	65	PL 19 444	H.R. Blieden <i>et al.</i>	(CERN MMS Collab.)
CARMONY	64	PRL 12 254	D.D. Carmony <i>et al.</i>	(UCB)
GOLDHABER	64	PRL 12 336	G. Goldhaber <i>et al.</i>	(LRL, UCB)
ABOLINS	63	PRL 11 381	M.A. Abolins <i>et al.</i>	(UCSD)