$\rho(1700)$

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

THE $\rho(1450)$ AND THE $\rho(1700)$

In our 1988 edition, we replaced the $\rho(1600)$ entry with two new ones, the $\rho(1450)$ and the $\rho(1700)$, because there was emerging evidence that the 1600-MeV region actually contains two ρ-like resonances. ERKAL 86 had pointed out this possibility with a theoretical analysis on the consistency of 2π and 4π electromagnetic form factors and the $\pi\pi$ scattering length. DONNACHIE 87, with a full analysis of data in the annihilation reactions $e^+e^- \to \pi^+\pi^-$, $2\pi^+2\pi^-$, and $\pi^+\pi^-\pi^0\pi^0$, and in the photoproduction reactions $\gamma p \to \pi^+\pi^- p$, $2\pi^+2\pi^- p$, and $\pi^+\pi^-\pi^0\pi^0 p$, had also argued that to obtain a consistent picture two resonances, whose masses and widths could be fixed reasonably well, were necessary. This picture was supported by the analysis of DONNACHIE 87B of $J^P = 1^-$ $\eta\rho^0$ mass spectra obtained in photoproduction and in e^+e^- annihilations; the analysis showed the need for a contribution from a ρ meson with a mass of about 1470 MeV, but could say little about a higher-mass resonance (actually the data could be explained without it). Confirmation of the decay $\rho(1450) \to \omega\pi$, and a tight constraint on the mass due to strong interference with the $\rho(770)$ tail, was found by DONNACHIE 91 in an analysis of $e^+e^- \to \omega\pi$.

The analysis of DONNACHIE 87 was extended by CLEGG 88 to include new data on 4π systems produced in e^+e^- annihilation and in τ decay (4π τ decays and 4π annihilation reactions can be related by the Conserved Vector Current assumption). These systems were successfully analyzed using interfering contributions from two ρ-like states, and from the tail of the $\rho(770)$ decaying into two-body states. While specific conclusions on $\rho(1450) \to 4\pi$ were obtained, the quality of the data used by CLEGG 88 prevented any conclusion on $\rho(1700) \to 4\pi$ decay.

An analysis by CLEGG 90 of 6π mass spectra from e^+e^- annihilation and from diffractive photoproduction provides evidence for two ρ mesons, at about 2.1 and 1.8 GeV, that decay strongly into 6π states. While the former is a candidate for a new resonance, the latter could be a manifestation of the $\rho(1700)$ distorted by threshold effects.

Independent evidence for two 1^- states is provided by KILLIAN 80 in 4π electroproduction at $\langle Q^2\rangle = 1$ (GeV/c)^2, and by FUKUI 88 in a high-statistics sample of the $\eta\pi\pi$ system in $\pi^- p$ charge exchange.

This picture with two overlapping resonances is supported by other data. BISELLO 89 measured the pion form factor in the interval 1.35-2.4 GeV with significant statistics (280 $e^+e^- \rightarrow \pi^+\pi^-$ events with very low background). A deep minimum is observed around 1.6 GeV, and the best fit to the form factor is obtained with the hypothesis of ρ-like resonances at 1420 and 1770 MeV with widths of about 250 MeV. ANTONELLI 88 found that the $e^+e^- \rightarrow \eta\pi^+\pi^-$ cross section (using three different η decay modes) is better fitted with two fully interfering Breit-Wigners, with parameters in fair agreement with those of DONNACHIE 87 and BISELLO 89.

These results (although ANTONELLI 88 is statistically less significant than BISELLO 89) have also resolved the disagreement between DONNACHIE 87 and FUKUI 88 on the $\rho(1450)$ width in favor of the DONNACHIE 87 value. From this point of view, BISELLO 89 and ANTONELLI 88 can be considered as solid confirmation of the $\rho(1450)$. For the possibility that its $\phi\pi$ mode actually contains two independent vector states, see LANDSBERG 92.

Several observations on the $\omega\pi$ system in the 1200-MeV region (FRENKIEL 72, COSME 76, BARBER 80C, ASTON 80C, ATKINSON 84C, BRAU 88, AMSLER 93B) may be interpreted in terms of either $J^P = 1^-$ $\rho(770) \rightarrow \pi\omega$ production (LAYSSAC 71) or $J^P = 1^+$ $b_1(1235)$ production (BRAU 88, AMSLER 93B). We argue that no special entry for a $\rho(1250)$ is needed. The LASS amplitude analysis (ASTON 91B) showing evidence for a $\rho(1270)$ is preliminary and needs confirmation. For completeness, these various observations are listed under the $\rho(1450)$.

$\rho(1700)$ MASS

$\eta\rho^0$ AND $\pi^+\pi^-$ MODES

VALUE (MeV)	*DOCUMENT ID*
1700±20 OUR ESTIMATE	
1717±13 OUR AVERAGE	Includes data from the 2 datablocks that follow this one. Error includes scale factor of 1.2.

$\eta\rho^0$ MODE

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

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1740±20	ANTONELLI	88	DM2	$e^+e^- \rightarrow \eta\pi^+\pi^-$
1701±15	[1] FUKUI	88	SPEC	8.95 $\pi^- p \rightarrow \eta\pi^+\pi^- n$

[1] From a two Breit-Wigner fit.

$\pi^+\pi^-$ MODE

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
The data in this block is included in the average printed for a previous datablock.			
1730 ±30	CLEGG	94 RVUE	$e^+e^- \to \pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1768 ±21	BISELLO	89 DM2	$e^+e^- \to \pi^+\pi^-$
1745.7±91.9	DUBNICKA	89 RVUE	$e^+e^- \to \pi^+\pi^-$
1546 ±26	GESHKEN...	89 RVUE	
1650	[2] ERKAL	85 RVUE	20–70 $\gamma p \to \gamma\pi$
1550 ±70	ABE	84B HYBR	20 $\gamma p \to \pi^+\pi^- p$
1590 ±20	[3] ASTON	80 OMEG	20–70 $\gamma p \to p 2\pi$
1600 ±10	[4] ATIYA	79B SPEC	50 γC $\to$ C2π
1598 $^{+24}_{-22}$	BECKER	79 ASPK	17 $\pi^- p$ polarized
1659 ±25	[2] LANG	79 RVUE	
1575	[2] MARTIN	78C RVUE	17 $\pi^- p \to \pi^+\pi^- n$
1610 ±30	[2] FROGGATT	77 RVUE	17 $\pi^- p \to \pi^+\pi^- n$
1590 ±20	[5] HYAMS	73 ASPK	17 $\pi^- p \to \pi^+\pi^- n$

$K\overline{K}$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1582±36	1600	CLELAND	82B SPEC	±	50 $\pi p \to K^0_S K^\pm p$

$2(\pi^+\pi^-)$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1570± 20		[6] CORDIER	82 DM1	$e^+e^- \to 2(\pi^+\pi^-)$
1520± 30		[3] ASTON	81E OMEG	20–70 $\gamma p \to p 4\pi$
1654± 25		[7] DIBIANCA	81 DBC	$\pi^+ d \to pp2(\pi^+\pi^-)$
1666± 39		[6] BACCI	80 FRAG	$e^+e^- \to 2(\pi^+\pi^-)$
1780	34	KILLIAN	80 SPEC	11 $e^- p \to 2(\pi^+\pi^-)$
1500		[8] ATIYA	79B SPEC	50 γC $\to$ C$4\pi^\pm$
1570± 60	65	[9] ALEXANDER	75 HBC	7.5 $\gamma p \to p 4\pi$
1550± 60		[3] CONVERSI	74 OSPK	$e^+e^- \to 2(\pi^+\pi^-)$
1550± 50	160	SCHACHT	74 STRC	5.5–9 $\gamma p \to p 4\pi$
1450±100	340	SCHACHT	74 STRC	9–18 $\gamma p \to p 4\pi$
1430± 50	400	BINGHAM	72B HBC	9.3 $\gamma p \to p 4\pi$

$\pi^+\pi^-\pi^0\pi^0$ MODE

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1660±30	ATKINSON	85B OMEG	20–70 γp

$3(\pi^+\pi^-)$ AND $2(\pi^+\pi^-\pi^0)$ MODES

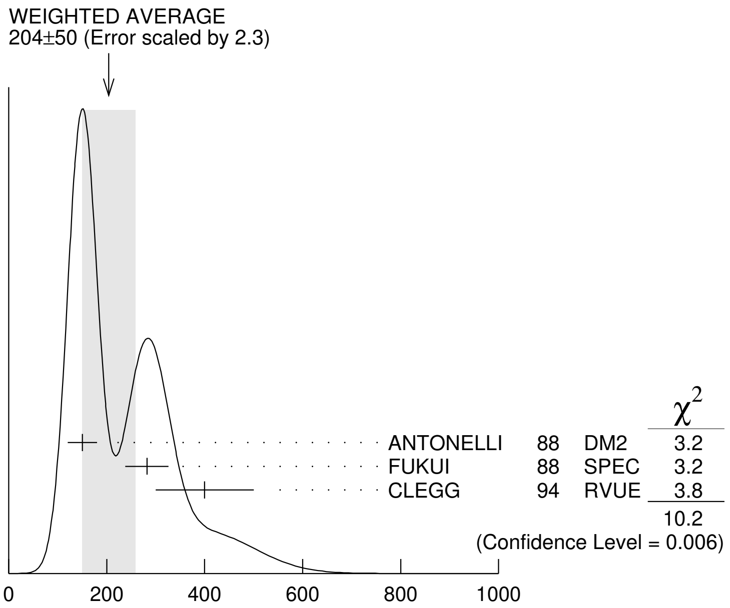
VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1783±15	CLEGG	90 RVUE	$e^+e^- \to 3(\pi^+\pi^-)2(\pi^+\pi^-\pi^0)$

[2] From phase shift analysis of HYAMS 73 data.
[3] Simple relativistic Breit-Wigner fit with constant width.
[4] An additional 40 MeV uncertainty in both the mass and width is present due to the choice of the background shape.
[5] Included in BECKER 79 analysis.
[6] Simple relativistic Breit-Wigner fit with model dependent width.
[7] One peak fit result.
[8] Parameters roughly estimated, not from a fit.
[9] Skew mass distribution compensated by Ross-Stodolsky factor.

$\rho(1700)$ WIDTH

$\eta\rho^0$ AND $\pi^+\pi^-$ MODES

VALUE (MeV)	DOCUMENT ID
235±50 OUR ESTIMATE	
204±50 OUR AVERAGE	Includes data from the 2 datablocks that follow this one. Error includes scale factor of 2.3. See the ideogram below.



$\rho(1700)$ width, $\eta\rho^0$ and $\pi^+\pi^-$ modes (MeV)

$\eta\rho^0$ MODE

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
The data in this block is included in the average printed for a previous datablock.				
150±30	ANTONELLI	88	DM2	$e^+e^- \rightarrow \eta\pi^+\pi^-$
282±44	[10] FUKUI	88	SPEC	8.95 $\pi^- p \rightarrow \eta\pi^+\pi^- n$

[10] From a two Breit-Wigner fit.

$\pi^+\pi^-$ MODE

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
The data in this block is included in the average printed for a previous datablock.				
400 ±100	CLEGG	94	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
224 ± 22	BISELLO	89	DM2	$e^+e^- \rightarrow \pi^+\pi^-$
242.5±163.0	DUBNICKA	89	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$
620 ± 60	GESHKEN...	89	RVUE	
<315	[11] ERKAL	85	RVUE	20–70 $\gamma p \rightarrow \gamma\pi$
280^{+30}_{-80}	ABE	84B	HYBR	20 $\gamma p \rightarrow \pi^+\pi^- p$
230 ± 80	[12] ASTON	80	OMEG	20–70 $\gamma p \rightarrow p 2\pi$
283 ± 14	[13] ATIYA	79B	SPEC	50 γC $\rightarrow$ C2π
175^{+98}_{-53}	BECKER	79	ASPK	17 $\pi^- p$ polarized
232 ± 34	[11] LANG	79	RVUE	
340	[11] MARTIN	78C	RVUE	17 $\pi^- p \rightarrow \pi^+\pi^- n$
300 ±100	[11] FROGGATT	77	RVUE	17 $\pi^- p \rightarrow \pi^+\pi^- n$
180 ± 50	[14] HYAMS	73	ASPK	17 $\pi^- p \rightarrow \pi^+\pi^- n$

$K\overline{K}$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
265±120	1600	CLELAND	82B	SPEC	±	50 $\pi p \rightarrow K^0_S K^\pm p$

$2(\pi^+\pi^-)$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
510± 40		[15] CORDIER	82	DM1	$e^+e^- \rightarrow 2(\pi^+\pi^-)$
400± 50		[12] ASTON	81E	OMEG	20–70 $\gamma p \rightarrow p4\pi$
400±146		[16] DIBIANCA	81	DBC	$\pi^+ d \rightarrow pp2(\pi^+\pi^-)$
700±160		[15] BACCI	80	FRAG	$e^+e^- \rightarrow 2(\pi^+\pi^-)$
100	34	KILLIAN	80	SPEC	11 $e^- p \rightarrow 2(\pi^+\pi^-)$
600		[17] ATIYA	79B	SPEC	50 γC $\rightarrow$ C$4\pi^\pm$
340±160	65	[18] ALEXANDER	75	HBC	7.5 $\gamma p \rightarrow p4\pi$
360±100		[12] CONVERSI	74	OSPK	$e^+e^- \rightarrow 2(\pi^+\pi^-)$
400±120	160	[19] SCHACHT	74	STRC	5.5–9 $\gamma p \rightarrow p4\pi$
850±200	340	[19] SCHACHT	74	STRC	9–18 $\gamma p \rightarrow p4\pi$
650±100	400	BINGHAM	72B	HBC	9.3 $\gamma p \rightarrow p4\pi$

$\pi^+\pi^-\pi^0\pi^0$ MODE

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
300±50	ATKINSON	85B	OMEG	20–70 γp

$3(\pi^+\pi^-)$ AND $2(\pi^+\pi^-\pi^0)$ MODES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
285±20	CLEGG	90	RVUE	$e^+e^- \rightarrow 3(\pi^+\pi^-)2(\pi^+\pi^-\pi^0)$

[11] From phase shift analysis of HYAMS 73 data.
[12] Simple relativistic Breit-Wigner fit with constant width.
[13] An additional 40 MeV uncertainty in both the mass and width is present due to the choice of the background shape.
[14] Included in BECKER 79 analysis.
[15] Simple relativistic Breit-Wigner fit with model-dependent width.
[16] One peak fit result.
[17] Parameters roughly estimated, not from a fit.
[18] Skew mass distribution compensated by Ross-Stodolsky factor.
[19] Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.

$\rho(1700)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\rho\pi\pi$	dominant
Γ_2	$\rho^0\pi^+\pi^-$	large
Γ_3	$\rho^0\pi^0\pi^0$	
Γ_4	$\rho^\pm\pi^\mp\pi^0$	large
Γ_5	$2(\pi^+\pi^-)$	large
Γ_6	$\pi^+\pi^-$	seen
Γ_7	$K\overline{K}^*(892)+$ c.c.	seen
Γ_8	$\eta\rho$	seen
Γ_9	$K\overline{K}$	seen
Γ_{10}	e^+e^-	seen
Γ_{11}	$\rho^0\rho^0$	
Γ_{12}	$\pi\omega$	

$\rho(1700)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(\text{total})$

This combination of a partial width with the partial width into e^+e^- and with the total width is obtained from the cross-section into channel$_I$ in e^+e^- annihilation.

$\Gamma(2(\pi^+\pi^-)) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_5\Gamma_{10}/\Gamma$

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
2.83±0.42	BACCI	80	FRAG	$e^+e^- \rightarrow 2(\pi^+\pi^-)$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.6 ±0.2	DELCOURT	81B	DM1	$e^+e^- \rightarrow 2(\pi^+\pi^-)$

$\Gamma(\pi^+\pi^-) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_6\Gamma_{10}/\Gamma$

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.13	[20] DIEKMAN	88	RVUE	$e^+e^- \rightarrow \pi^+\pi^-$

[20] Using total width = 220 MeV.

$\Gamma(K\overline{K}^*(892)+\text{c.c.}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_7\Gamma_{10}/\Gamma$

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.305±0.071	[21] BIZOT	80	DM1	e^+e^-

$\Gamma(\eta\rho) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_8\Gamma_{10}/\Gamma$

VALUE (eV)	*DOCUMENT ID*		*TECN*	*COMMENT*
7 ±3	ANTONELLI	88	DM2	$e^+e^- \rightarrow \eta\pi^+\pi^-$

$\Gamma(K\overline{K}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_9\Gamma_{10}/\Gamma$

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.035±0.029	[21] BIZOT	80	DM1	e^+e^-

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

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
3.510±0.090	[21] BIZOT	80	DM1	e^+e^-

[21] Model dependent.

$\rho(1700)$ BRANCHING RATIOS

$\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.287^{+0.043}_{-0.042}$	BECKER	79	ASPK	17 π^-p polarized
0.15 to 0.30	[22] MARTIN	78C	RVUE	17 $\pi^-p \rightarrow \pi^+\pi^-n$
<0.20	[23] COSTA...	77B	RVUE	$e^+e^- \rightarrow 2\pi,\ 4\pi$
0.30 ±0.05	[22] FROGGATT	77	RVUE	17 $\pi^-p \rightarrow \pi^+\pi^-n$
<0.15	[24] EISENBERG	73	HBC	5 $\pi^+p \rightarrow \Delta^{++}2\pi$
0.25 ±0.05	[25] HYAMS	73	ASPK	17 $\pi^-p \rightarrow \pi^+\pi^-n$
0.20 ±0.05	MONTANET	73	HBC	0.0 $\overline{p}p$

[22] From phase shift analysis of HYAMS 73 data.
[23] Estimate using unitarity, time reversal invariance, Breit-Wigner.
[24] Estimated using one-pion-exchange model.
[25] Included in BECKER 79 analysis.

$\Gamma(\pi^+\pi^-)/\Gamma(2(\pi^+\pi^-))$ Γ_6/Γ_5

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.13±0.05	ASTON	80	OMEG	20–70 $\gamma p \rightarrow p2\pi$
<0.14	[26] DAVIER	73	STRC	6–18 $\gamma p \rightarrow p4\pi$
<0.2	[27] BINGHAM	72B	HBC	9.3 $\gamma p \rightarrow p2\pi$

[26] Upper limit is estimate.
[27] 2σ upper limit.

$\Gamma(K\overline{K}^*(892)+\text{c.c.})/\Gamma(2(\pi^+\pi^-))$ Γ_7/Γ_5

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.15±0.03	[28] DELCOURT	81B	DM1	$e^+e^- \rightarrow \overline{K}K\pi$

[28] Assuming $\rho(1700)$ and ω radial excitations to be degenerate in mass.

$\Gamma(\eta\rho)/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.04		DONNACHIE	87B	RVUE	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.02	58	ATKINSON	86B	OMEG	20–70 γp

$\Gamma(\eta\rho)/\Gamma(2(\pi^+\pi^-))$ — Γ_8/Γ_5

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.123 ± 0.027	DELCOURT	82	DM1	$e^+e^- \rightarrow \pi^+\pi^-$ MM
~ 0.1	ASTON	80	OMEG	20–70 γp

$\Gamma(\pi^+\pi^-$ neutrals$)/\Gamma(2(\pi^+\pi^-))$ — $(\Gamma_3+\Gamma_4+0.709\Gamma_8)/\Gamma_5$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.6 ± 0.4	[29] BALLAM	74	HBC	9.3 γp

[29] Upper limit. Background not subtracted.

$\Gamma(K\overline{K})/\Gamma(2(\pi^+\pi^-))$ — Γ_9/Γ_5

VALUE	CL%	DOCUMENT ID		TECN	CHG	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.015 ± 0.010		[30] DELCOURT	81B	DM1		$e^+e^- \rightarrow \overline{K}K$
<0.04	95	BINGHAM	72B	HBC	0	9.3 γp

[30] Assuming $\rho(1700)$ and ω radial excitations to be degenerate in mass.

$\Gamma(K\overline{K})/\Gamma(K\overline{K}^*(892)+$ c.c.$)$ — Γ_9/Γ_7

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.052 ± 0.026	BUON	82	DM1	$e^+e^- \rightarrow$ hadrons

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma(2(\pi^+\pi^-))$ — Γ_2/Γ_5

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
~ 1.0		DELCOURT	81B	DM1	$e^+e^- \rightarrow 2(\pi^+\pi^-)$
$0.7\ \pm0.1$	500	SCHACHT	74	STRC	5.5–18 $\gamma p \rightarrow p4\pi$
0.80		[31] BINGHAM	72B	HBC	9.3 $\gamma p \rightarrow p4\pi$

[31] The $\pi\pi$ system is in S-wave.

$\Gamma(\rho^0\pi^0\pi^0)/\Gamma(\rho^\pm\pi^\mp\pi^0)$ — Γ_3/Γ_4

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.10	ATKINSON	85B	OMEG		20–70 γp
<0.15	ATKINSON	82	OMEG	0	20–70 $\gamma p \rightarrow p4\pi$

$\rho(1700)$ REFERENCES

CLEGG	94	ZPHY C62 455	+Donnachie	(LANC, MCHS)
CLEGG	90	ZPHY C45 677	+Donnachie	(LANC, MCHS)
BISELLO	89	PL B220 321	+Busetto+	(DM2 Collab.)
DUBNICKA	89	JPG 15 1349	+Martinovic+	(JINR, SLOV)
GESHKEN...	89	ZPHY 45 351	Geshkenbein	(ITEP)
ANTONELLI	88	PL B212 133	+Baldini+	(DM2 Collab.)
DIEKMAN	88	PRPL 159 101		(BONN)
FUKUI	88	PL B202 441	+Horikawa+	(SUGI, NAGO, KEK, KYOT, MIYA)
DONNACHIE	87B	ZPHY C34 257	+Clegg	(MCHS, LANC)
ATKINSON	86B	ZPHY C30 531	+	(BONN, CERN, GLAS, LANC, MCHS, CURIN+)
ATKINSON	85B	ZPHY C26 499	+	(BONN, CERN, GLAS, LANC, MCHS, CURIN+)
ERKAL	85	ZPHY C29 485	+Olsson	(WISC)
ABE	84B	PRL 53 751	+Bacon, Ballam+	(SLAC Hybrid Facility Photon Collab.)
ATKINSON	82	PL 108B 55	+	(BONN, CERN, GLAS, LANC, MCHS, CURIN+)
BUON	82	PL 118B 221	+Bisello, Bizot, Cordier, Delcourt+	(LALO, MONP)
CLELAND	82B	NP B208 228	+Delfosse, Dorsaz, Gloor	(DURH, GEVA, LAUS, PITT)
CORDIER	82	PL 109B 129	+Bisello, Bizot, Buon, Delcourt	(LALO)
DELCOURT	82	PL 113B 93	+Bisello, Bizot, Buon, Cordier, Mane	(LALO)
ASTON	81E	NP B189 15		(BONN, CERN, EPOL, GLAS, LANC, MCHS+)
DELCOURT	81B	Bonn Conf. 205		(ORSAY)
Also	82	PL 109B 129	Cordier, Bisello, Bizot, Buon, Delcourt	(LALO)
DIBIANCA	81	PR D23 595	+Fickinger, Malko, Dado, Engler+	(CASE, CMU)

ASTON 80 PL 92B 215 (BONN, CERN, EPOL, GLAS, LANC, MCHS+)
BACCI 80 PL 95B 139 +DeZorzi, Penso, Baldini-Celio+ (ROMA, FRAS)
BIZOT 80 Madison Conf. 546 +Bisello, Buon, Cordier, Delcourt+ (LALO, MONP)
KILLIAN 80 PR D21 3005 +Treadwell, Ahrens, Berkelman, Cassel+ (CORN)
ATIYA 79B PRL 43 1691 +Holmes, Knapp, Lee, Seto+ (COLU, ILL, FNAL)
BECKER 79 NP B151 46 +Blanar, Blum+ (MPIM, CERN, ZEEM, CRAC)
LANG 79 PR D19 956 +Mas-Parareda (GRAZ)
MARTIN 78C ANP 114 1 +Pennington (CERN)
COSTA... 77B PL 71B 345 Costa De Beauregard, Pire, Truong (EPOL)
FROGGATT 77 NP B129 89 +Petersen (GLAS, NORD)
ALEXANDER 75 PL 57B 487 +Benary, Gandsman, Lissauer+ (TELA)
BALLAM 74 NP B76 375 +Chadwick, Bingham, Fretter+ (SLAC, LBL, MPIM)
CONVERSI 74 PL 52B 493 +Paoluzi, Ceradini, Grilli+ (ROMA, FRAS)
SCHACHT 74 NP B81 205 +Derado, Fries, Park, Yount (MPIM)
DAVIER 73 NP B58 31 +Derado, Fries, Liu, Mozley, Odian, Park+ (SLAC)
EISENBERG 73 PL 43B 149 +Karshon, Mikenberg, Pitluck+ (REHO)
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